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EEOS Workshop on

EUROPEAN DATA NETWORKS AND EARTH OBSERVATION USER INFORMATION SERVICES:

SURVEY AND CONSULTATION

MARINO (ROME)

13 - 15 December, 1994

Workshop Proceedings

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Introductory Note

Workshop Proceedings contain full papers on which presentations were based, including those that were submitted but not presented. A few papers are missing. We have therefore published only their presentation slides.

Workshop Organisation Committee

Joint-Chairmen:

Mr. Peter Churchill, CEO-Centre for Earth Observation Project Manager, Joint Research Centre, Institute for Remote Sensing Applications, I-21020 Ispra (VA), Italy; e-mail: peter.churchill@jrc.it

Mr. Livio Marelli, Head of Projects & Engineering Dept., ESA-ESRIN, Via Galileo Galilei, I-00044 Frascati (RM), Italy; e-mail: livio.marelli@mail.esrin.esa.it

Programme Committee:

Mr. Sergio Balestreri, Joint Research Centre, Institute for Systems Engineering and Informatics (ISEI), I-21020 Ispra (VA), Italy; e-mail: sergio.balestreri@jrc.it

Mr. Rui Meneses, Joint Research Centre, Institute for Systems Engineering and Informatics (ISEI), I-21020 Ispra (VA), Italy; e-mail: rui.meneses@jrc.it

Mr. Luigi Fusco, ESA-ESRIN, Via Galileo Galilei, I-00044 Frascati (RM), Italy; e-mail: luigi.fusco@mail.esrin.esa.it

Mr. Hermann Ludwig Möller, ESA-ESRIN, Via Galileo Galilei, I-00044 Frascati (RM), Italy; e-mail Ludwig Möller@mail.esrin.esa.it

Workshop Logistics and Local Support:

Ms. Clare Brooker, ESA-ESRIN, Via Galileo Galilei, I - 00044 Frascati (RM), Italy

Ms. Ippolita Montaudo, ESA-ESRIN, Via Galileo Galilei, I - 00044 Frascati (RM), Italy

Ms. Christine Violetti, ESA-ESRIN, Via Galileo Galilei, I - 00044 Frascati (RM), Italy

Demonstration set-up:

G. Landgraf, H. Orrhammar, J. Reid and B. Virondeau, ESA-ESRIN, Via Galileo Galilei, I - 00044 Frascati (RM), Italy

Travel organisation:

Ms. A. Llewellyn, Mizar, ESA-ESRIN, Via Galileo Galilei, I - 00044 Frascati (RM), Italy

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Programme

EEOS Workshop 13-15 December 1994

Monday 12th December

18.00-20.00: Registration

at the registration desk in the Sala Ambasciatori, Grand Hotel Helio Cabala

Tuesday 13th December

08.30 - 09.15: Registration

at the registration desk in Sala Ambasciatori, Grand Hotel Helio Cabala

09.15 - 09.30: Welcome and Introduction

Welcome by Mr F Roscian, Head of ESA-ESRIN Establishment

Logistics and Workshop set-up (L Fusco)

09.30 - 13.00: Key note Presentations, session A (Chair: F Roscian, ESRIN)

- European Earth Observation System (P Churchill, EC and L Marelli, ESA)
- User Service Concept in EOSDIS (M Elkington, EOS Ltd)
- EEOS Views from the Value Added Industry (C Borg, SSC)

11.00 - 11.30: Coffee break (and demonstrations)

- The telecommunications regulatory framework in the European Union (T Howell,
- DGXIII)
- High Performance Networking: Initiatives from the European Commission (P De Sousa, DGXIII)
- EuroCAIRN and the Trans-European Research Backbone Project (H Davies, DANTE)

13.00 - 14.00: Buffet lunch

14.00 - 18.00: Panel 1, session B: "Networking Trends in Europe" (Chair: T Howell, DGXIII)

Due to time restrictions, some contributions have only been considered for posters or publication.

- 1. Building pan European Networks and bridging European Countries (G Pellegrini, Telecom Italia)

- 11. Overview of the Spanish Data Networks (PSDN) (J Monedero, Direccion General de Telecommunicaciones DGT, Spain)

  Questions and answers

13.00-14.00: Buffet lunch (and demonstrations)

14.00 - 14.45: Panel 1, session D: "European Information System Initiatives" (Chair: S Tafvelin, TERENA)

- 1. The Information Services and User Support (ISUS) Working Group of TERENA (D Hartland, TERENA)
- 2. Advanced Telematics Applications for the support of European Research (ATELIER) and the EU 4th Framework Programme (D Hartland, TERENA)
- 3. Hyper G (F Kappe, Graz University of Technology)

  Questions and answers

14.45 - 18.00: Panel 2, session E: "Networks related to Earth Observation in Europe" and "Earth Observation Providers View" (Chair: P Churchill, EC-JRC)

Due to time restrictions some contributions have only been considered for publication

- 1. Experience of using pan-European Research Networks within an ESPRIT project (T Stanford, ECMWF)
- 2. Data Networks and User Information Services (R Wolf, Eumetsat)
- 3. The role of Networks on the Earth Observation Community (R Monaco, Eurimage)
- 4. Easy access to SPOT data: the prime characteristic of a business oriented distribution (P Delclaux, Spotimage)
- 5. Finnish Data Networks related to EO (J Hyyppa, TEKES, Finland)

  Questions and answers

16.10 - 16.40 Coffee break (and demonstrations)

- 6. French Information Providers (G Lapaian and JP Antikidis, CNES, France)
- 7. The Intelligent Satellite Data Information System ISIS of DLR (H Lotz-Iven, DFD/DLR, Germany)
- 8. UK Information Providers (R Robinson, BNSC, GB)
- 9. ASI views on European Ground Segment Evolution (G Sylos Labini, ASI, Italy)
- 10. Network connectivity in Sweden and Swedish Information Providers (O Vretblad and S Zenker, SSC, Sweden)

  Questions and answers

  Paper contribution only:

- *Dissemination of Earth Observation Images using electronic mail (A van Dorp, NLR)*

18.00: Transfer to ESRIN by courtesy bus

18.30 - 19.30: Presentation and facilities tour at ESRIN

19.30 - 21.30: Dinner buffet hosted by ESA at ESRIN

16.15 - 17.30 Conclusions by rapporteurs of Panel 1 and Panel 2, discussion and winding-up of the Workshop

Friday 16th December 1994

09.00-13.00: Demonstrations and informal discussions at ESRIN

13.00-14.00: Lunch in ESRIN canteen

14.00-16.00: Continuation of demonstrations and informal discussions at ESRIN

Panel 1
EUROPEAN DATA NETWORKS

Rapporteur : Rupesh Paul

Objectives & Expectations

In the framework of the preparatory activities of the EEOS, it is considered important to survey and consult with Member States on the current status and future plans related to European Data Networks. In this context the overall objectives of Panel 1 was firstly, to identify existing and planned national and trans-national data networks and EO services in Europe, and secondly to introduce the basic concepts of emerging high performance communication technologies . With these objectives in mind the Workshop (WS) was organised into specialist sessions e.g. Keynote (session A) and Networking trends (session B) . Whereas, topics R&D Networks in Europe and European Information Initiatives were covered by sessions C and sessions D, respectively.

Main expectations from this workshop were to obtain a series of preliminary and general indications of the state of telecommunications networks and technologies; networks for R&D and other infrastructures; European Union's regulatory directives to liberalise technologies and markets and its special initiatives under the Fourth Framework Programme. With these expectations in mind various experts were invited to present their viewpoints and to comment in the sessions mentioned above.

Some of the theme messages which have emerged from the presentations are given below in order to highlight their relevance with respect to the general expectations from the Workshop. Whereas particular conclusions are reported in the aptly named last chapter :

DG XIII regulatory directives can be of help in exerting some leverage with respect to pricing of certain technologies .

Certain integrated broadband networking initiatives of the EU under the Fourth Framework Programme can provide some special networking infrastructure in some of the Member States where they are being experimented with.

In the European context there exist several technologies which are available and usable now . Beyond the existing technologies there are other emergent, high performance technologies where there are still open issues to be resolved .

National networks for Research & Development have extensive and well developed infrastructures which are available today. Pan - European networks for R&D lag somewhat behind their national counterparts but they are progressing well.

Inspite of the EU efforts to de-monopolise infrastructures, it appears that the PTTs will continue to keep their monopoly on leased lines higher than 2 Mbit/s, well beyond the deadline of 1998. Since Open Network Provision (it stands for the EU policy framework for equal conditions for open and efficient access to and use of public telecommunication networks and services) is not envisaged to cover these high speed lines, their pricing might be strictly controlled by the PTTs. Consequently, the rate of development of some of the emerging technologies, which use very high speed leased lines for interconnection, might be retarded.

PTTs and PTOs have jointly embarked on Trans-European Backbone , Transmission and Fibre Optic Leased Line projects which will further consolidate their monopolistic dominance by offering one-stop shopping for all or nothing, in several EU countries.

Regulatory Aspects of the European Union

Some of the main pillars of these aspects which could certainly influence the EEOS plans are summarised and commented upon :

- liberalisation of the telecom market and services
- the framework for harmonisation , and Open Network Provision (ONP) .

In line with the liberalisation policies mentioned above several equipment and services have already been de-monopolised. For the interest of the EEOS the following can be cited :

- both the Public Data Services and Resale of non-voice lines became legally open businesses in 1993.
- Satellite Service Providers will be open to competition as of March 1995.
- The basis for ONP is to create conditions for open and fair competition to guarantee non-discriminatory and equality of access to telecom services throughout the Member States. In particular, there are directives for specific services e.g.: leased lines (see also leased lines), Packet Switched Data Services (PSDS) and Integrated Services Digital Network (ISDN) . These three directives were adopted in June 1992 and each one aims at the availability of a minimum set of services throughout the Union.

From the EEOS point of view the above three services, under the ONP, can provide some leverage in terms of availability and pricing in many countries where they can be adopted selectively as access or some form of backbone network.

There are other potential candidates for ONP Framework Directives for which studies have been carried out and report published in July 1994, e.g. new types of access network, including intelligent network functions and network management, Broadband networks and Mobile services. A decision will be taken sometime for applying ONP to these areas.

The ONP Framework Directive also set out the establishment of a mutual recognition regime of declaration and/or licensing procedures for telecom services in order to remove internal barriers to trade in services within the Union. This directive is currently being discussed with the European Parliament and Council .

Fourth Framework Programme : High Performance Networking Initiatives

There are a number of EU initiatives under way in RACE (Research in Advance Communications in Europe) programme covering the field of Integrated Broadband Communications (IBC).

Beyond RACE there is Advance Communications Technologies and Services (ACTS), which represents a major effort to support pre-competitive R&D in the context of trials in the field of telecoms during the period of the Fourth Framework Programme of scientific research and development (1994 - 1998).

BINET is a project for linking four R&D centres in Portugal & Spain using ATM technology. In the EEOS networking context such a project can be used as a high speed hub for interconnecting to these R&D centres for data interchange.

SUNRISE is another project which uses VSAT technology to link up some of the less favoured regions of Greece, Italy, Portugal & Ireland. This project can be used to implement the EEOS access links from these countries.

There is yet another project called STEN (Scientific Trans-European Net) to interconnect different locations in Portugal, Spain and Switzerland using satellite links, which could give EEOS an extra set of access points and user interconnections from these countries via a separate non-terrestrial means.

In the Trans-European Networks covering the field of integrated broadband communications there is the TEN-IBC project which involves all the parties e.g. users manufacturers, service providers cooperating to implement a trans-European network. In line with its recent emphasis in existing network trends rather than begin new ones , the European ATM pilot project set up independently by telecom operators is seen as the basis for linking EU Member States into an initial broadband infrastructure. There are other objectives set up in TEN project which, can provide EEOS with a readily available system of infrastructure for interconnecting various national networks into this broadband backbone . For example , after initial field trial, expansion of broadband services at transmission speeds up to 2 Mbit/s, 34 Mbit/s and 155 Mbit/s for interconnecting Local Area Networks and, later on expanding them to small-to-medium sized towns and cities. Such infrastructures could be equally useful for EEOS use.

There is also an important study project, started in November 1994, called EuroCAIRN which has been assigned to the organisation DANTE (Delivery of Advanced Network Technology in Europe). This project is for carrying out a study which includes a survey of requirements, an examination of available technologies, and development of an implementation plan for a high speed backbone service for research over whole of Europe.

Available Networking Technologies :

The available technologies of today are mainly narrowband including Packet Switching, Leased Lines (upto 2 Mbps), Euro-ISDN, VSAT. As the evolving technologies move towards broadband which covers Frame Relay, Broadband ISDN, and Switched Multimegabit Data Services (SMDS), and to be based on Asynchronous Transfer Mode (ATM) platform. Such evolution in network technologies is in parallel with evolution from Plesiochronous Digital Hierarchy (PDH) to Synchronous Digital Hierarchy (SDH) multiplexing technology. In this report we will examine them in this evolving order.

Packet Switching (PS)

This is the most diffused data switching technology available throughout the world. It is available both nationally via Packet Switching Data Networks (PSDN) and internationally as well . Tariffs vary from one country to another; the service can, however, be made available at a short notice by telecom operators.

Its main limitations are that it is a low-speed technology for transferring packets of data using low speed lines and virtual path (VP) connections. Its slowness derives also from the fact that data corrections take place at every node and corrected retransmission takes place before the packets are moved to the next node. Equally X-25 (as CCITT generic standard number for PS it's known the world over) cannot satisfy sudden and bursty computer to computer traffic due to its bandwidth limitations and inherent latency . It is not suitable for multimedia traffic .
It is not suitable as access line other than for low speed usage only. However, packet switching can be employed as a stand-by for certain data links in certain countries where it may be the only technology available.

Leased Lines

A very high percentage of network interconnects,cross-connects and access for data, voice and video is transported using leased lines. Therefore leased lines(which are not technologies) are essential elements for any network whether it is private, public or for research and development.

A minimum set of five leased lines have been stipulated under the Open Network Provision (ONP) of the EU which should be offered under harmonised usage conditions and tariff principles to all the Member States. These are :

- two (ordinary & special quality) analogue leased lines for voice band
- 64 Kbit/s digital
- 2 Mbit/s digital (unstructured)
- 2 Mbit/s (with error-check) digital.

There are other leased lines e.g. 144 Kbit/s, n* 64 Kbits/s, higher order 34 Mbits/s and 140 Mbit/s for which standards are being produced by ETSI , although it is not the Commission's intention to add them to the minimum set listed above.

Lowering of some leased line prices would play a catalytic role towards the emergence of Broadband Backbone. Put simply, it means that if the pricing of higher order (above 2 Mbit/s and upwards to 140 Mbit/s) leased lines are carefully tailoured then we might be able to see the broadband being developed sooner than it would be otherwise.

ISDN (Integrated Services Digital Network)

Integrated Services Digital Network is intended to cover a range of voice and data services and provide end-to-end data and voice traffic simultaneously on the same links via the same exchanges. Although it has been available for sometime, it has not become prominent due to lack of marketing and it is only now starting to emerge. It is now available in a very large number of European countries and is being deployed rapidly all over.

Main benefits from using a connection mode service like ISDN is that it offers a service that is priced on usage basis . Using a number of ISDN lines (basic rate is 144 Kbit/s) in an aggregated manner, it can provide equally higher bandwidth up to the primary rate.

ISDN- based technologies are advantageous for using as access lines only in those countries where they are competitively tariffed against leased lines of similar speed.

The main advantages are that:

- users can utilise multiple lines by bundling the basic rate ones i. e. increase in bandwidth
- usage is paid for only during the duration of transmission ,and
- rapid connectivity using PDN (Public Data Network) is possible.

VSAT (Very Small Aperture Satellite)

Today this satellite-based technology can offer one of the most cost-effective ways to transmit one-way or two-way to remote locations.

Although it is a very well established technology in the U.S.A., it has been very slow to develop in Europe, not simply due to the merits of the technology in doubt, but rather due to numerous regulatory and other obstacles placed by governments and telecom operators. European Union liberalisation is scheduled for March,1995 which will help overcome some of these obstacles.

Main advantages of this satellite-based technology are that it can support different groups of users, it is boundary (international) transparent, cost-predictable and single technology which can be used all across Europe :

- one-way VSAT: from one point-to-multipoint (for EO data directly from remote sensing stations to multiple sites where databases reside)
- two-way VSAT: interactive data transmission with additional broadcast,data/video/audio
- one-way video, two-way audio .

For EEOS, VSAT could provide a cost-effective solution. It costs less than leased lines; it is readily available in all the European countries ; it can be set up pretty quickly. However it does have some transmission delay drawback which should not be overlooked. It can be used, nevertheless, to connect different inaccessible parts of Europe where terrestrial lines are not feasible .

Frame Relay

A frame-based technology is much more efficient in providing bandwidth-on-demand and can transport data much faster than the ubiquitous X-25. It is now available, to different extents, in 17 European countries. Although it is not so abundant in some southern European countries, nonetheless it has managed to become a viable technology within a few years .

The reason for the rapid growth of Frame Relay lies in its capacity to interconnect Local Area Networks (LANs) . It can handle also sudden demand for large amounts of bandwidth for short periods of time. This feature known as *bandwidth admission* helps optimise utilisation and control congestion due to peaks and troughs of traffic.

There are still some very important issues to sort out before EEOS starts to use Frame Relay even in some of the countries where this has been available for a couple of years : a) clear pricing and tariffs ,and b) Quality of Service (Q o S) options. With regard to the pricing policy, it is as yet unclear how a customer is to be charged : based on, either access line speed or bandwidth utilisation or partly on both of them. Provided these issues are satisfactorily dealt with, then Frame Relay can be the contender in the 2 Mbit/s league of line access and international conections in some of the EU countries. It can serve equally for interconnecting EEOS LANs.

Like many other technology forums Frame Relay has its own non-profit, worldwide organisation. It supports marketing and education activities and produces implementation agreements.

Emerging High Performance Networking Technologies :

ATM (Asynchronous Transfer Mode)

Basically it can be regarded as a multiplexing technology i.e. very simply a technique for sharing the capacity of a communication channel amongst its users. ATM's strength lies in its ability to provide very high bandwidth instantaneously for 'bursty' traffic while allowing other traffic to use the bandwidth between bursts. This characteristics makes very efficient use of network capacity for a wide range of communication services, especially data communications between computers, which can be very bursty. It has other features which make it even more attractive :

- scalable : the same cells can be sent at megabit or gigabit speeds
- predictable : since all cells are of the same length, a switch can schedule ahead and guarantee delay (important for voice & video transfers)
- selectable : data, voice & video services i.e. Multimedia.

There are some ATM trials currently being carried out and it is also on offer in a few countries. But wider public offerings of ATM have still to go some way before being made. There are still some technological as well as tariffing issues to be resolved before ATM can be offered widely.

Service providers will be unwilling to put ATM tariffs at the same level as conventional circuits (known as Tariff Balancing) . EuropaNET gave an 'example' of the cost of a 34 Mbit/s link - quoted by an unnamed PTO - which could likely be as high as 17 times that of a 2 Mbit/s one !

Since ATM can carry voice services just as easily as data and video, the PTO service provider will be undercutting its regular voice traffic if it were to tariff its prices too low. Do not, therefore, expect ATM to be 'reasonably priced' throughout Europe within the next few years, a) before it has been made into a firm standard and, b) clearly priced both for national and international usage .

ATM, 'when' it becomes available, can be ideal as backbone for carrying large volumes of data across Europe and this can be achieved through the current initiatives of the Network Operators already under way (see ATM Backbone).Here the trials are being aimed at checking interoperability between different operators' and vendors' applications.

SMDS (Switched Multimegabit Data Service)

This is also a high-performance technology which can also be used for connecting to ATM network. The UK network for R&D uses SMDS technology to interconnect its network sites. Once again SMDS is a cell based technology like ATM. Unlike the ATM, SMDS is a connectionless technology. It can work from the E1 level i.e. 2.048 Mbit/s to higher bandwidth e.g. 34 Mbit/s.

Our comment: SMDS will take some time to be developed to its full potential and offered at a 'reasonable cost ' both nationally and internationally . There is still no indication as to when international SMDS will be available or what it is likely to cost.

The Internet

Internet is the most important network of networks. It started its life as a interconnection of R&D networks but also provides services to commercial users. Internet's global coverage provides links and interconnections to the Pan-European R&D networks like EuropaNET , EBONE and NorduNET. Internet should, therefore, be regarded as one of the networks vital to the EEOS.
At present Internet appears - with its million of users and many tens of thousands of interconnected networks and millions of computers - as the global network available today.
Its internetwork services are provided through a series of Internet Service Providers (ISP) who charge their customers on the basis of bandwidth but not on the amount of traffic they generate. Internet has established several sites throughout Europe (and the world) called Distributed Global Internet Exchanges to offer to any other ISP to connect their customers for interchanging packets of data at no additional cost.

There is also a means of exchanging packets of data with any other network without settlement, via its system of a " route of last resort ". Internet provides many forms of value added services, from networked information services to 'simple' e-mail, through PIPEX(UK), who install and maintain their customers' services. It does not have a governing body or owner. There is, however, an advisory board and committees centred around the Internet Architecture Board (IAB).
From EEO networking point of view, such offerings as those from Internet should be considered as a global networking option available today.

Networks for Research & Development

In the special session dedicated to Networks for R&D there were presentations both from the national networks e.g. BELNET (Belgium); RENATER (French); GARR (Italian); SWITCH (Switzerland); SUPERJANET (United Kingdom - SMDS switching technology has been used there to interconnect 53 sites and it is operational as of March '93); WIN (German) and,the Austrian data communications system forming the bulk of the European national networks in this field. There were also presentations from Pan-European R&D networks e.g. : EuropaNET , EBONE and NorduNET. There was also a presentation from Trans-European Research Backbone study project called EuroCAIRN assigned to the organisation known as DANTE (Delivery of Advanced Network Technology in Europe).

Presentations from the above mentioned R&D organisations concentrated mainly on describing each network in its geographical context and its nodes and interconnections with other networks as well as operating link speeds and the services that each one provides. Most of them also outlined their future plans for upgrading link speeds and extending the coverage of their networks. All national networks are vital to EEOS & its user communities since they already have network infrastructure with which to provide many access and linking facilities to different nodes, and, to other networks via some of their fellow pan-European R&D networks . On the international level the pan-European networks are strategically important for providing cross-border and intercontinental connection links for EEOS. Both EuropaNET, EBONE and, to a certain extent NorduNET, can therefore play a very prominent networking partnership role in European Networking strategies of the EEOS.

Networks for R&D provide their well-established infrastuctures at non-profit prices to research communities with gateways to other internet providers, both scientific and commercial. Therefore, EEOS needs can be catered for - to a large extent - by these established infrastructures.

EuropaNET

It is run by the 16 -nation shareholding organisation DANTE. It provides, via its European Multi-Protocol Backbone (EMPB), guaranteed pan-European services in availability and performance . It has also high-speed international links to the US, NorduNET, EBONE, ESA & CERN. Apart from providing services to national research networks it provides access or interconnection agreements with commercial networks. Its charging policy is based on access capacity i.e. line speed and not on amount of traffic being transferred. All traffic is bundled and therefore no differentiation is made between European and international traffic. Until recently its maximum access speed was 2 Mbit/s and this is being increased to 4 & 8 Mbit/s in certain countries . It plans to increase these to 34 / 155 Mbit/s in the future.Its curent intercontinental capacity to the US and to the global Internet is 5 Mbit/s . EuropaNET nodes are installed in each country and, each node location is connected to at least two other node locations . Currently in Western Europe , The Netherlands has a total access capacity of 5 Mbit/s , the UK has 4 Mbit/s ; Belgium, Switzerland, Germany, Italy, Spain and the Nordic countries each has 2 Mbit/s access capacity. There are also lower rate access capacities in other European countries .

It can be seen therefore that EuropaNET services from DANTE are extremely useful for the EEOS. A network of such wide spread and interconnection nodes and by far the largest Internet backbone can provide EEOS with a ready infrastructure for interconnecting with different R&D and commercial networks.

EBONE

It is the European Backbone network dedicated to educational, research and technological usage. It is another important network for R&D which can be taken into consideration for EEO networking strategy. EBONE provides internet backbone linking all major R&D networks in Europe , including EuropaNET, NorduNET, RENATER (French R&D network), connecting all the EU, EFTA and five east European countries ; its high-speed link to the US is backed up via NorduNET. It plans to carry out ATM pilots nationally and to interconnect it to the European pilot study.

This Pan-European R&D network can be of equal importance to EEOS , because it can provide interconnection to all R&D nodes in Europe and to the US through its backbone and other high-speed links. Its major links are from Paris to: Geneva at 2 Mbit/s, to Stockholm at 1 Mbit/s , to Vienna at 1 Mbit/s . Its access from Paris to the US is 3.5 Mbit/s and also to the US via Stockholm is a 2 Mbit/s with a redundant link at 2 Mbit/s for re-routing in case of failure of the Paris to the US access .

Network Operators' & PTT Initiatives

Several joint initiatives in pan-European context have already been started, namely :

High-Speed Transmission

METRAN (Managed European TRAnsmission Network) which has been jointly agreed, in the form of a Memorandum of Understanding (M o U) by 27 Network Operators, for building a high-performance transport network using Synchronous Digital Hierarchy (SDH) transmission technology. Primary transport medium is fibre. This initiative is an agreement to interconnect national infrastructures in a logical manner by using cross-connections at gateways. This is a very important project which when in place could provide a basis for building a wideband trans-European Network.
Inter-operation between the PTOs is supposed to start during mid- 1995- 1996.

High-Speed ATM backbone pilot

13 PTOs have signed a M o U to create an ATM backbone with which to start pilot testing. Initial transmission is to be at 34 Mbit/s progressing to 144 Mbit/s PDH and therefrom to 155 Mbit/s SDH. Trials which have begun at the end of last year will try out interoperability amongst vendors and operators and test applications using pilot users. This project could become the basis of a Trans-European Broadband infrastructure.

Fibre Optic Network for Leased Line Services

Five PTOs from the UK,F,D,I & E have already set up Global European Network **(GEN)**, a fibre-based service with which to provide leased lines up to 2 Mbit/s. Its nodes are based in Frankfurt, London, Paris, Madrid & Rome. One-stop-shopping and short waiting times are some of the advantages of this combined commercial leased line service offering .

These three combined high-performance services, once all operational, could give the PTTs and PTOs a virtual monopoly in access, switching and tranport facilities in a one-stop shopping , in quite a few European countries. EEO communities will need to take these initiatives into consideration in the light of costs and future networking strategies specifically for backbone traffic in Pan-European context.

ACTS /National Host Programme

European Commissions actions or rather initiatives are governed by the principle of subsidiarity. This means that the Commission will intervene where a pan-European action is either necessary or appropriate. Areas where national actions would provide the most suitable means is left to the nations. This principle of action has given rise to the "National Host " concept as embodied under the ACTS programme. Each member country runs its own NH programme.

Here follows an example of the Italian experiment. The national programme in Italy , called ITALHOST, which hosts experiments defined under ACTS as well as EU specific programmes both national and international. Amongst others this three-centred system experiments with ATM pilot and interfaces with most other European hosts . Its access points are located in Piedmont, Tuscany and Naples area.

Main relevance for a national host service as ITALHOST is that it can provide the EEOS with an opportunity to connect to the ATM pilot and use it experimentally to transmit data for limited periods. This connection for trials can be further extended to the Italian R&D networks and, through them, to other national hosts across Europe.

Conclusions

Although Panel 1 part of the workshop has produced a general picture of the ' status ' of the world of European networks in terms of technologies and the service providers and a broad view of what to expect in the near future, the EEOS will still need to prepare a future policy in which will figure the following outputs from the WS :

- the possibilities for using 64 Kbit/s leased lines and basic rate ISDN (144 Kbit/s) as access links and LAN interconnections , and to use VSAT technology in remote locations, in different EU and EFTA member countries
- Frame Relay provides the technological choice now and for the near future to interconnect EEOS LANS
- Pan-European and national networks for R&D are a vital element : namely EuropaNET & EBONE as EEOS networking partners, and their national counterparts respectively
- The Internet, as the network of networks, is to be considered as EEOS partner for networks
- PTT and PTO initiatives such as METRAN, GEN & ATM pilot need to be watched for valuable use as EEOS carriers of trans-European high-speed traffic.
- due to PTT monopoly, above 2 Mbit/s leased line prices are too high and are likely to stay that way longer beyond the 1998 deadline .

On the basis of the future policy statement mentioned above, the EEOS Networking Strategy for the period of implementation should be developed in general terms with enough safeguards built in to accommodate refinements brought about by technological enhancements hitherto not anticipated.

Users of EEOS are the ones for whom the EU and ESA have embarked on the project to make EO data easily accessible and readily available. Therefore, further results from studies, now under way or to be started soon, need to be integrated into the overall Strategy statement reflecting the requirements of those who need to use the network. Furthermore, EU intiatives already started under the Fourth Framework Programme need certainly to be taken into consideration as prerequisite inputs to the overall development plan of the 'European Information Interchange Exchange' that the project plans to create.

DG XIII intends to propose in 1995 a new ONP Interconnection Directive which should establish clear, European-wide rules for the setting of access charges, including ceilings on access charges, framework for negotiation and a mechanism for dispute resolution (between the interconnecting parties). Such an initiative is welcome, for it might help in realising 'the Exchange' more economically than it would have been otherwise.

Abbreviations Used

PTO	: Private Telecom Operator
PTT	: Post Telephone & Telegraph
CEO	: Centre for Earth Observation
ITU-TS	: International Telecommunication Union - Telecom Standards
ETSI	: European Telecommunications Standards Institute
EFTA	: European Free Trade Area
CERN	: European Laboratory for Particle Physics

Panel 2:
Earth Observation User Information Services
Rapporteur: Mark Elkington

Objectives and Approach

The overall objectives of Panel 2 were to review existing and planned developments of Earth Observations (EO) user information services within Europe in the context of their impact on the underlying network infrastructure for the proposed EEOS initiative. Specific objectives of the panel were to:

- review information services at a generic level and specific EO information system initiatives which could be of interest for the EO community
- review existing and planned national and European scale initiatives to improve access to EO data and information from national, European or international sources
- identify major user needs for accessing EO data and related information
- refine the process for systematic and continuing consultation with representatives from the Member States to ensure the fulfillment of end-user requirements in the conception of the EEOS.

The expectation for the workshop was that it would provide an essential first step in starting to establish a European wide consensus for the way in which EEOS might best facilitate the extended utilisation of EO data at the regional, national and European level.

Contributions were requested from a wide cross-section of communities who will be stake holders in the EEOS initiative and were provided by research users, operational users, service providers, national and other organisation representatives. Three sessions were organised to cover the views of information providers (Session E), users (Session F), and national authorities (Session G). In all three sessions the importance of recognising that information providers are very often also intermediate users of services from other data/information provider became very clear. This is true for commercial, academic and governmental service providers.

Network Problems

EEOS is considered to be an EO data network. The use of the term network in this context has several connotations:

- a physical communications network view,
- a logical view of the types of entity using the network,
- a physical configuration view in which specific entities forming a current or planned EEOS are identified,

- the human or organisational network view which is concerned with the interaction and collaboration of the people and organisations involved with the network.

All of these views of the EEOS as a network are interrelated. So in identifying network problems it is inevitable that they will cut across these views of the system.

Several of the papers identify network problems which are preventing the wider utilisation of earth observation data. Some of these problems will be significantly impacted by the improved interconnectivity and interoperability (at a human and network level) that a successful EEOS would be bring. Common problems identified by the participants included:

- lack of proven applications for the data,
- difficulties in finding out what the data can be used for,
- high price of data,
- incompatibility of data and user analysis/visualisation tools,
- incompatibility of data from different sensors and from other sources making combination and comparison difficult,
- difficulties in locating specific data,
- data delivery via networks,
- data characteristics do not match specific application (e.g. resolution),
- copyright restrictions.

Not of all the above problems are related to European network services. The key problems in network terms are:

- *lack of on-line information and searching service*

  Few EO data sets are adequately represented by services describing their application or detailed content. More services supporting both the major data set repositories and the smaller value-added data sets need to be provided.

- *resolution of incompatibility*

  There are a wide range of service interfaces and data types available in Europe. The current network infrastructure does not support the resolution of potential incompatibilities between the tools and service interfaces available to users and the services and data made available by service providers. This could be mitigated by better on-line information, more conversion services, and uniform cross-service interfaces ('one-stop shopping interfaces').

- *lack of connectivity*

  Access to data and services on a European basis is severely compromised by the lack of connectivity at a suitable bandwidth. While several demonstrations of improved access to data archives have been made within limited projects, this cannot be effectively widened to the European and international community due to the problems of connectivity reported in Panel 1.

End-User Perspectives

An important discussion at the workshop focused on who are the potential users of the EEOS. The conclusion was that EEOS users were both end-users of EO and the providers of services on the network; both groups need to be addressed in establishing the architectural, design and operational concept for the network. The contributions from service providers made it clear that they would be important users of some of the current services available from the large data repositories.

There were several end-user perspectives given during the meeting. Their concerns can be summarised as follows:

- *make it easier to find out about and locate relevant data*

  The EEOS must make it easier to find out about data (and/or associated services) which may be relevant to a particular application and also find the specific part of a data set that is required. Searching for data will principally be using space, time and quality attributes but other attributes will become increasingly important for higher value services, e.g. coincidence searching between data sets or between environmental phenomena and a data set.

- *make it easier to get relevant data and to merge it with other EO and non-EO data types*

  Once the data has been located then users want the capability to be able to precisely extract the relevant data from the archive; i.e. not necessarily on a standard product-by-product basis, receive it via electronic or mail delivery (depending on data volume and application) and then merge it with data from other sources

- *known quality*

  The data and services provided within EEOS must have a known and documented quality. Users are prepared to accept that there will be a very wide range of quality of service on EEOS, but they need to understand when the quality characteristics change as they move from service to service. Quality information must be part of service and data advertisements.

- *subscriptions*

  Users want to register an interest in a specific geographic area and/or phenomena and then allow the EEOS network to inform them when either data and/or a service of relevance is available. This is essentially a generalisation of the standing order concept common in many EO ground segment systems.

Service Provider Perspectives

The majority of 'user' contributions were in fact from potential or current service providers. There was a consistent view that the general improvement of network capabilities within the context of EEOS would help them in developing user based services. The difficulty of predicting the evolution of communications network capabilities and cost over the next 5-10 years on a European wide basis makes it extremely difficult to plan what level of service they should be targeting.

It is clear however that many of the current service concepts will not be relevant in an environment where improved network services are ubiquitous. New user-driven services will be possible and EEOS must not preclude these evolutionary changes in response to accelerating developments in communication networks and other technologies to support searching and access of EO data. The specification of protocols and interfaces for EEOS must be sufficiently far-sighted and extensible to support the unpredictable changes ahead. Even though the changes cannot be predicted it can be assumed that there will be many types of service and this will require the networks and EEOS infrastructure to be flexible to support many different types of service concepts, and evolvable to take advantage of changing technology. Particularly challenging will be the ability to provide this flexibility and evolvability when many of the component parts provided from current and planned developments in EO services do not have these characteristics.

National Perspectives

The final perspective given was that of the national and other governmental representatives. The contributions to Session G clearly demonstrate the wide range of national and regional activities that are either underway or planned for the next 5 years. These represent the emerging signs of a healthy user and service provider community which must form a key part of the EEOS and be able to take advantage of the cross-European collaboration that this program will engender. Although there are many common aspects of these developments they all have a local context to meet specific local needs and to respond to the local technical environment in terms of network connectivity and user expertise. Many of the national organisations reported problems with service connectivity; either for making their services available on European or international basis or for accessing services/data in other countries. An important consideration for EEOS will be how to support wider interconnectivity and interoperability between these various activities, and with other international service providers, while not constraining the essential local context of many of the services.

The specific national contributions were:

Austria

This contribution focused on the diverse and decentralized nature of environmental agencies in Austria. To support these users EEOS must be able to scale to the needs of divers and decentralized user communities. It was proposed that higher level products/data be held locally; a district would be responsible for the data relevant to their district The desirability of a subscription service was stressed to reduce time consuming information hunting and to allow passive monitoring of change.

Belgium

The Belgian contribution reported the result of a survey of its user community. The problems identified were reiterated in many other national and user group presentations. Many of these problems were related to nature of the data/products content and structure rather than the network access method e.g. quality control and limited availability of geocoded products. In common with other contributions the Belgian report recommended the establishment of data 'pools' of reduced cost or free data for research purposes.

Denmark

The contribution attempted to define the Danish requirements in the future EEOS. Accent was put on the possible use of European sensor data for monitoring of the environment in Denmark and Greenland based on data acquired via EEOS. It is expected that monitoring in the Greenland area will be carried out by institutions placed in Denmark with communication of interpreted data to the area by suitable data information systems.

Finland

The importance of EEOS supporting the needs of operational application developers was stressed. In summary these were improved applicability (higher level information products), availability, quality, response time, user customisation and onwards dissemination of value added products through appropriate mechanisms. The presenter gave current examples of work in sea-ice mapping, but also mentioned national development in hydrological forecasting, crop yield estimation and forest management.

France

The French Remote Sensing user community is rapidly evolving and progressing with respect to Space Data utilization. From pure science to applied large scale applications like geodesy, cartography or agriculture, operations are now based on a coherent set of coordinated subsystems providing a complete end-to-end service. The interaction of the French User organisations and the French Earth Observation programmes was described.

Germany

This contribution described the development of the Intelligent Satellite Information System and how its design responded to the decentralization of environmental responsibility in Germany. The system is a central user interface which provides local access to national archives and also interconnection with data held by NASA and ESA. Current development is focused on making the system WWW compatible and making it possible to include data from the GOME sensor and Russian PRIRODA mission.

Greece

Earth Observation data is a valuable tool for monitoring the Mediterranean region. In common with several other contributors this report emphasised that products/services must be tailored to regional or application specific characteristics. Examples were given of the connection between the use of EO data, Community directives and local action plans for the protection of the environment

Iceland

Iceland has a small EO user community with six institutes using such data and two institutes actively analysing the data. Key applications are oceanic research, glacial movement, geothermal energy, volcano research and soil/vegetation erosion. Although the community is small, the region of interest and economic importance means that the potential for increased utilization of EO data is high. Coordination of community and projects is a future objective within Iceland and the EEOS may be an important catalyst for this.

Italy

ASI provided the Italian contribution. The various facilities for EO data reception, processing and analysis were described and it is the intention to base new ground infrastructure on the foundations already set by these facilities.

Norway

The Norwegian contribution also emphasised the importance of operational services and particularly the requirements for applications which need near real-time data, e.g. oil spill detection, ice monitoring, sea state monitoring, and ship detection. All of these applications also have important needs for non-space data and the parallel near real-time delivery of these data should be a critical requirement for EEOS.

Netherlands

The Netherlands Earth Observation Network (NEONet) project was described. This is a national study looking at needs for data and information structure within Europe. With the completion of Phase 1 the next step will be to develop a prototype based on existing network capability. One focus of the prototype will be atmospheric chemistry and specifically the processing and analysis of GOME data from ERS-2. Another will be the water quality community. The need for coordination between national developments such as NEONet and CEO/EEOS as well as wider coordination with EOSDIS and EOIS, was highlighted.

Portugal

The Portuguese contribution summarized the work being done to connect the network of Remote Sending Thematic Nodes of the SNIG (National Geographic Information Systems). The main objective of this initiative is to promote the use of EO data among the Portuguese research groups and institutes. Their plan is to build the network on top of the RCCN; a national academic network. The focus of this is higher level geographical information applications.

Spain

The National Point of Contact is the main contribution that Spain would make to the

EEOS. Its current role and relationship to the ESA network was described. The main problem reported by users was the high price of data, which is preventing the wider application of the data.

Switzerland

The Swiss contribution highlighted the need for better storage and retrieval facilities for EO data. They favoured the distribution of archiving facilities under the responsibility of national authorities. It was postulated that new technologies will permit extensive and sophisticated facilities to be developed inexpensively, but sufficient funding must be directed to the transfer of important historical data to these new archives.

Sweden

The large archives of EO data held at Kiruna were described as background to the future Swedish plans to establish processing and archiving centres for the SPOT VEGETATION and MERIS instruments. In addition an Environmental Data Centre is being set up in Kiruna with the objective of making global and regional data sets available to research and operational users. This centre will make full use of the expanding network possibilities in Sweden.

UK

The UK contribution considered the issues related to why an EEOS was necessary and what sort of organisations will be involved. The impact of these issues on service providers and how they would want to interact with the proposed EEOS was also described.

Common Issues to be addressed by EEOS

A clear consensus was achieved on the basic assumption that the EEOS concept should be one of a service market place, in which providers bring services to the market place to meet user needs. There were however many perspectives presented on how providers would respond to user needs, and it is also clear that EEOS must have enough flexibility to support a wide variety of operational service concepts, provided by academic, commercial and governmental organisations.

The implications of this largely new and flexible approach to EO service provision, will be many, but some key issues which need to considered in further development of the EEOS concept to meet the user/provider needs and the national aspirations, described above, are:

- *support a dynamic market place*

  EEOS must be able to support a market of service providers which will respond to the user demand for services. This support structure must be flexible to different service needs and evolvable to take advantage of technological change. The market place must be sufficiently populated in the initial releases of EEOS to make it attractive for user and service providers to begin planning in EEOS terms.

- *multi-mission and non EO scope*

  The EEOS must have a multi-mission scope and support non-EO data sources, particularly meteorological data sources. The addition of data and services from future missions must not require significant architectural or protocol changes to the EEOS.

- *interconnectivity of users and service-providers*

  EEOS must support interconnectivity between users and service-providers on a European and international basis. It must also support the notion that a service provider organisation will often be a user of other services on the network.

- *interoperability of service (and data)*

  EEOS should support interoperability at both the service and data level. At the service level the user should be able to access specific services with service optimised interfaces and vocabularies as well as be able to access a service(s) which provides a unified view of all the services and data on the network. This may require the support for different, overlapping domains within the system which have a subset of services and a specific vocabulary to provide an optimised environment for a certain subset of users.

  At the data level, EEOS must promote collaboration between service providers for compatible data formats, and also the inclusion of sufficient meta and ancillary data with data so that tool developers have the opportunity to combine data sets in intelligent ways.

- *variability of service*

  EEOS must be able to support a wide variability of service on its network. This variability will extend to information models, quality of service, service management principles, and service capacity. Not only must EEOS support this variability, it must help the user deal with this variability in service, through maintaining service information and characteristics in a form that can be used by human and machine interaction with the network.

- *flexible and open for user extension*

  As well as providing a dynamic environment for the inclusion and removal of services on the network, EEOS must also support services in which users and providers can extend services to more precisely meet their needs. For example, some services might permit a user to be able insert application specific search algorithms on an archive to extract all data of relevance.

- *intelligent subscriptions*

  The EEOS must support intelligent subscriptions to data and services and other mechanisms to reduce mundane information searching and particularly routine information searching.

- *user controlled combination of services*

  EEOS should support users in finding a set of interconnected services that meet their needs and combining them to perform a routine or unique process. Such sets of services might be specific to a user or a group of users. In the latter case they might form the equivalent of a 'distributed' value-added centre.

Further Analysis

The workshop also identified several areas where there clearly is need for further consideration and reflection on a European basis. Perhaps the two most important relate to the impact of improved networks on the way users will work and subsequently the types of services that might be offered and the nature of standards for service applications:

- Most EO users and service providers do not have access to high speed networks with good connectivity, thus many of the contributions focused on incremental improvements to current service concepts. The implications of improved networks on the way users might work and how services might change as a result needs further consideration. Although this will be hampered by the difficulty in predicting what the future network capability and cost will be on a European-wide basis, it is an important activity to provide input to the EEOS initiative.

- Many of the contributions recognised the important role of standards in making connectivity and interoperability achievable. Unfortunately at the application service level many of the standards are immature or are evolving in response to user need and technological developments. There are several emerging standards that might be relevant to EEOS and these need to be identified so that an understanding of the implications and even the chance to influence their development is not lost. Some examples of relevant emerging standards are CORBA, SQL3, OQL, Open-GIS, SAIF, W3, etc.

Conclusions

Although this workshop represents an early step in the development of a consensus view on the role of EEOS in developing the EO infrastructure with Europe, there were several conclusions reached by the panel.

Perhaps the most important conclusion from the workshop is the need to establish a 'vision' statement for the EEOS which documents the consensus view and is updated periodically to add increasing detail and knowledge as the concept for EEOS is developed. This vision statement will be a vital tool to 'test' the EEOS concept with users and service providers as part of the ongoing requirements capture, and will assist in providing a framework for all future workshops and consultative meetings reviews related to EEOS. It will also be useful to assess the impacts of different concepts, different technologies and different management concepts.

The vision statement should reflect the following issues which are a generic summary of the issues described above. The EEOS concept should:

- be a service market place in which providers can offer services and users can access them using defined infrastructure interfaces
- support user/providers in dealing with incompatibility of data and services
- allow different qualities of service to be offered, but the quality should be made known to users.
- reconsider impact of improved networks on the way users will want to access services and the different types of services that might be needed to make optimum use of the networks
- be able to accommodate change so that services can respond to changing user needs and take advantage of new technologies as they emerge.

Keynote Presentations

THE EUROPEAN EARTH OBSERVATION SYSTEM (EEOS)

P.N. CHURCHILL
European Commission
Joint Research Centre
Institute for Remote Sensing Applications
ISPRA , ITALY

Abstract

This paper is intended to outline the objectives of the European Earth Observation System (EEOS) a joint initiative of the European Commission (EC) and the European Space Agency (ESRIN) and specially the context, strategic orientation, objectives, foundation and in particular the network and network services and user information dissemination with respect to this workshop.

Context

Data derived from Earth observation sensors are an essential source of short and long term information invaluable to a wide range of research topics and thematic applications. Large volumes of data have been collected on a European and global scale since the early 1970s.

By the end of the century the volumes of data available will increase by several orders of magnitude. Planned polar orbiting satellites which include European, North American and Japanese initiatives, should significantly increase the number and type of Earth observation sensors in space. New technologies will lead to new applications, while new needs will lead to the definition of new missions.

The present situation in Europe is that ESA has and will invest billions of ECU in Earth observation systems. It has, or will have a ground segment for each of its missions (ERS, ENVISAT), to which the Member States of the Agency contribute. ESA has an agreement with the USA and Japan to provide European users with data from many of their satellites.

However, by contrast with the investment in the space segment, the use of the data remains poorly developed.

In Europe data from space missions are currently handled on a mission specific basis. There is no common approach to processing, managing or distributing these data. As a result there are often incompatibilities between data sets from different satellites, and further incompatibilities between the media and the means of accessing the data. This applies equally to relevant non-space data. Potential European users of these data may not be aware that these data exist and existing users are often hampered by this lack of compatibility.

Strategic Orientation

Europe has invested in the space sector, it is now essential to make full use of this investment.

The ultimate aim must be to support and enhance a healthy, flexible and self-sustaining community of users capable of handling large quantities of Earth observation and relevant non-Earth observation data. To achieve this goal the requirements for information, and thus those of the user or client of the system, must be fully addressed. The services provided must meet the requirements of the users, and more importantly, the products must satisfy information needs.

The data currently supplied within Europe are generally only processed to a low level (for example Level 1b or Level 2), with a few organisations generating ad hoc value-added products. The current dedicated ground segments do not allow the user to access multi-mission services independently of the operator of the space system.

Users also need access to data on a worldwide basis. The USA with EOSDIS, and the Japanese with EOIS are developing the basis of a global network of information systems that will address this requirement. Europe needs an equivalent system, connected to international networks.

So far in the European context no organisation has had the responsibility to promote and develop the use of Earth Observation data, except in limited application fields as is the case of EUMETSAT, and thus to process such data further, to add value or to ensure that once processed they are properly stored, catalogued and put at the disposal of all potential users. This observation applies equally to space-based Earth observation data, to ground data and to the associated ancillary data required for further data processing or product validation.

The EC and ESA have decided to join their efforts to fill this gap; this initiative is the European Earth Observation System (EEOS).

The need for ESA and the EC to work together on such issues was confirmed by ESA at its Ministerial Council Meeting in Granada in November 1992, and by the EC at its Research Council Meeting in April 1993. Joint effort at the European level helps to avoid duplication and incompatibilities. A European level approach will also help to take into account the regional and global dimension of some important application .

A European approach will benefit from the complementary and essential roles of ESA and the EC, ESA as a provider of space data from its own and selected third party satellite missions, and the EC as a major civilian user. Through this operation the two organisations will give Europe the political weight to act as an equal partner in negotiations with the USA and Japan.

EEOS should aim to:

- provide a framework within which all relevant elements within Europe may come together to form a coherent whole that will make it easier to access and use the wealth of data and information available;

- encourage users to develop applications that incorporate information derived from Earth Observation data;

- ensure that services are in place that will make data and information available to the widest possible user community;

- consist of a distributed decentralised network that will, on the one hand, consist of a physical network of facilities across Europe, and on the other hand will consist of a human network of suppliers and users .

EEOS will be based on a partnership between the ESA and the EC, complemented by national activities and the infrastructure and services offered by EO data suppliers, including industry, intergovernmental Agencies and European parts of international organisations.

Foundation of EEOS

The EEOS will serve the user by providing services,data and derived information of relevance to a given application area.
In so doing the EEOS will be :

* driven by the requirements of the scientific , operational and commercial users;
* built upon existing infrastructure, services , projects and expertise;
* flexible;
* decentralised system;
* able to make data,information both available and accessible;
* capable to stimulate the creation of information and high level products.

EEOS - A User of Networks and Network Services

In order to attain these objectives and to adhere to the fundamantal requirements, it is considered important to survey the current status and future plans related to European Data Networks and Earth Observation User Information Services. Hence this Workshop is the beginning of a continous consultation and technical coordination meetings with technical experts of the Member States in these fields.

The main aims of this preparatory activity are :

* the identification of the network and services context in which the EEOS will operate
* the identification of possible actions needed to interconnect and integrate existing and planned national & trans-national data networks in Europe.

The Workshop

As the very first consultation session the Workshop is aimed at conducting a survey of

* R & D and corporate networking related to Earth Observation in Europe

* networking trends in Europe

* EO user's and information provider's views.

It will indicate:

* and identify the context in which EEOS will develop and operate

* the means by which the networks and user information services will emerge to meet the EEOS scenarios.

Objectives of the Workshop are:

* to review:

    * generic information services

* European systems relevant for the EO community
* existing and planned national and pan-European scale initiatives to improve access to EO data ;

* to identify:

    * major user needs , both on a national and European scales , for accessing EO data and related information ;

* to refine:

    * the process for systematic and periodical consultations with Member States' representatives concerning the design and development of future Europe-wide distributed EO infrastructure.

A number of key issues will have to be considered e.g. :

* common network application protocols for interoperability of information systems

* Distributed systems with specific reference to user access and reduced information search times

* volume of EO data from instruments with reference to their organisation and structures to support efficient data transmission and delivery

* cost-effectiveness of the whole range of services comprising user and operational elements.

EO User Information Services

A range of services are to be envisaged for the user communities to help, guide and maximise the usage of EO data. A sample of essential ones are listed here :

* Interactive Services for:

- guides and directories
- inventories and browsing

- ordering and data retrieval

* Non-Interactive (batch mode) services:
- batch mode is necessary for automisation of service requests installed at user site

* Data Dissemination Services:
- delivery of products to users via electronic mail or via the post

* Help Desk & Order Desk Services

* User Network Resource Services:
- user administration
- user to user communication
- network computing resources (access to distributed computing resources for special usage).

* Future Perspectives:
In order to develop these services for full exploitations by the EO user communities, it is intended to :

- continue systematic consultations between network providers and EO users so that the network service requirements of EO value added industry are properly fulfilled.

The European Earth Observation System
Views from the Value Added Industry

Claes-Göran Borg
General Manager
Strategy Division
Swedish Space Corporation

Mr Chairman, Ladies and Gentlemen!

This is the third time this year that I have been invited to give some kind of key-note address to a Symposium or Meeting. At first I was flattered. However, I have now understood that people that know me do not expect me to say something very technically knowledgable or important. Still I am very often talking and asking qustions - thus it is better to let him give a key-note address nobody expects anything interesting from them anyhow.

Anyhow, from the vantage point of 20 years of experience in commercializing Earth Observation and close relations with many of the key Value Added companies, I will try to say something worth remembering as one view from the Value Added sector.

It has not always been easy commercializing Earth Observation. But it has given me the possibility to see the problems from the point of view of the supplier, the Value Added companies as well as from the users.

Well, let's come to the problem. I believe we are all up for a big challenge during the rest of the century.

Up till now it has been an easy ride! From the early elated 70th when everything was new and fantastic. Over the rather dull 80th when not very much seemed to happen contradicting our hopes. To the present situation where the promised land is still just behind the horizon.

True - much has happened - the technology and the methodology has matured. Computers and GIS are here to help us. The Space Agencies' plans for the coming years are truly impressing.

The Space Agencies have done their job. We have fantastic plans for marvelous satellites giving us incomparable data. Now we have decided on the Ground Segment for ENVISAT.

However, some sacrifices had to be done on the way:
* all satellites had to be "painted green" (even those already up in the sky),
* the satellites had to be expensive enough to satisfy the space industry, leaving very little left on the ground,
* all nations - and some small like Sweden - must have their piece of the pie of the ground segment. Maybe not an operational optimum - but a political,
* finally, big promises were given about applications and application needs that will be satisfied. But there was regretfully no time to really ask the users.

But why dwell on these pettinesses.

Back to the challenge. The Space Agencies have spend all their money. They have left us with tremendous amounts of data. We must show that there is meaningful information in these data. If not - there will be no more satellites. The back-lash will be painful and we will all be out of jobs. And we do not have too much time.

We must develop routine applications of significant importance. And the truth is there are terrifying few such applications today. The next generation of remote sensing satellites will have to be payed by the users - like the meteorological satellites are today. The users may be the scientific community (eg Global Change), the operational public benefit users (eg environmental monitoring, sea ice mapping) or perhaps even a commercial user (and I hope there will be more of those).

But how do we arrive at these applications?

Some years ago it was like building a house in the 19th century. You had to know everything. Not very many houses were built. Today we can buy prefabricated doors and windows at stores for building material. A similar devleopment is about in Remote Sensing with myriads of datasets. And we are walking around in the store with the only vision that we want to build a house.

But how should we start?

Definitely not by buying the building material, not with an engineer that makes the drawings and calculations, not even with an architect's vision and paintings. Presumable you start by asking the people that are to live in the house (the end user as we call him), which are their needs?
* What functions (bedrooms, bathrooms, kitchen, patio)?
* How much are you willing to spend on your house?
* Big or small, practical or impressive, cheap or luxious?

And we are not only to build one house. We shall build a whole village on the ancient ruins of Landsat and ERS-1 ground segments. So let us remember that the network that we are talking about here is just like the infrastructure of the house. The electrical cables, video cables, the pipes and arming iron that keeps it all together and gives the possibilities for good functionality.

So my first essential point is: You do not start with deciding the infrastructure or network. However, its basic structure must be decided early in the process when user needs and functionality is defined.

Back to the problem.

We do not know who are going to live in our house and what is worse - they do not even know that they need this new and better house. Therefore it is difficult just to go out and interview people. Who are we going to ask? We just have some vague visions to offer. We have no firm calculations. We do not know when it is ready, if ever we start building it.

Would you sign up for a new house or even a small apartment under these circumstances? I would not. Only the ones with no homes at all might sign. These are the people under the bridges, les Clochards, and they do not have too much money.

Shall we build our house on pure speculation? Hoping that we are the best to know how people would like to live in the next decade.

In Sweden a lot of companies in housing did this ten years ago. This resulted in thousands of empty houses and the collapse of the estate market and bankruptcy for the investors.

We can not do this within Earth Observation in Europe. There must be a better way forward. I believe that the EEOS and CEO concepts are superb answers to this. I congratulate the people and the minds behind. With this we have a framework idea shared by many people all over Europe. This is a good vision.

As I read it we build small experimental houses with some common roles (or infrastructure)
- one in Italy in marble with arcades,
- one in Scandinavia - a wooden cottage,
- an old stone house in UK,
- maybe an igloo for the Eskimoes,
- and a fishing boat for our Norwegian friends.

Here I am convinced that the Value Added industry has a very important role in the design, construction and experimental phazes. The Value Added industry can be substitute users. They know the user needs much better than the scientists and the technicians and they mostly have a fair technical competence. The Value Added industry can thus set up initial User Requirement. The Value Added industry can be instrumental in setting up and initially running various user communities from experiments through demo/pilot projects to the preoperational phaze.

We have seen this happen in agriculture with its depending on fast delivery. Coastal zones monitoring would need even faster use of the data making electronic networking a must. Forestry is an area coming with high data volumes and time series but less stringent needs for quick delivery.

Environmental monitoring is a field we all believe will expand quickly,
- many kinds of datasets,
- many kinds of processing levels,
- many kinds of time constants,
- many kinds of end users from scientiest to operational agencies and government ministries.

This makes environmental monitoring the ideal playground for experiments in Earth Observation Data Networking. In Sweden we have realized this and we are just now starting a big experiment in this field - the Centre for Environmental Data from Satellites in Kiruna.

To summarize this part, I am convinced that the Value Added sector can be the backbone when we start building the EEOS and define the networking that should go with it. Bridging the gap betweeen the providers, the scientists, the technicians and the users.

Needs of the Value Added sector

Let us now look from the other side. Which needs and priorities on the EEOS has the Value Added sector. Of course this sector is not homogenious. On the contrary. But I believe that many from the Value Added sector would share these priorities:

1 First make it simple and start with basics. To me that means stable standard products from the providers. Well documented.

2 We also want guaranteed access to all commercially interesting data sources. And with well defined Data Policy.

3 As the third step we want good tools for search and retrieval of data. That of course includes guide and directory, inventory browse, ordering and dissemination systems.

4 The need for electronic data distribution should not be overestimated. However, its future use depends to a very hight degree on transmission costs.

But all this can be found in a study called GENIUS, read it!

Future role

I would like to end with saying something about the future role of the Value Added industry. I believe we are in a transition phaze. Today it looks like in this figure. Tomorrow I believe it will evolve like this.

Some Value Added industries will go into the data brooker category. Some we will find integrated with the users. Some - and I do not believe they will be many more than today - will remain Earth Observation Value Added companies, mainly occupied with methodology development.

This leads to my final conclusion and recommendation. There are no Earth Observation data users - only people in need of information. Any network and information service must be built with a good vision of the structure of the coming marketplace.

To summarize the few points I have tried to bring forward:

- It is of outmost importance that we focus on developing volume end use - otherwise there will be no more satellites.

- So go out and ask the end user what he wants.

- Develop user communities with various data and network needs. The Value Added industry should be instrumenteal in this, bridging the gap between providers, scientists, technicians and end users.

- The network is the infrastructure, important but just a tool.

- For the Value Added companies, priorities should be on stable standard products, access to all interesting data, easy access to information and electronic transfer of data.

- There are no Remote Sensing/Earth Observation end users, only people in need of information. Any network must be built with a good vision of how the future marketplace will develop.

So finally;

Lets not build a new Tower of Babel not even an Eifel Tower. But more of a living village with organic growth, customized buildings for rich and poor, with big and small houses and with a well adjusted infrastructure (or netowrk capability).

Because if we not build according to the users needs they do not rent our houses and we will all be out of jobs. And I love my work. I believe you do as well.

With that, thank you for listening.

User Service Concepts in the Earth Observing System Data Information System

M. D. Elkington

Earth Observation Sciences Ltd.
Broadmede, Farnham Business Park, Farnham, Surrey, UK

Abstract

NASA's Earth Observing System (EOS) is a long-term, multi-disciplinary research mission to study the processes leading to global change and to develop the capability to predict the future evolution of the Earth system on time scales of decades to centuries. The EOS Data Information System (EOSDIS) provides computing and data network facilities to support the EOS research activities, including data interpretation and modeling; processing, distribution, and archiving of EOS data; and command and control of the spacecraft and instruments. Its initial development will be complete in 2002 and it will be operated and allowed to evolve for perhaps a further 20 years or more. Ultimately its archive will exceed 15 Petabytes, which will be divided into hundreds of distinct data sets distributed across nine primary archiving and processing sites and many tens of secondary community research sites. Each of these sites is autonomously managed within system wide mandates Enabling effective user access to these distributed data sets is clearly a major challenge.

Although EOSDIS' functional scope in supporting global change research could be argued to be more limited than the scope for EEOS, there are perhaps some important lessons in its architecture and design. There are some specific features of the design which are particularly appropriate for the EEOS programme to consider for the support the development of operational applications from earth observation data; as well as some important omissions. Moreover it is generally accepted that the EEOS and EOSDIS networks need to be interoperable at some to be defined level of service. An understanding of the EOSDIS architecture and resulting network issues are essential in establishing an appropriate level of interoperability.

This paper outlines the factors leading to the current EOSDIS architecture and their impacts on the functions that the infrastructure network needs to support.

1. Introduction

NASA's Earth Observing System (EOS) is a long-term, multi-disciplinary research mission to study the processes leading to global change and to develop the capability to predict the future evolution of the Earth system on time scales of decades to centuries (Asrar and Dokken, 1993). The EOS Data Information System (EOSDIS) provides computing and network facilities to support the EOS research activities, including data interpretation and modeling, processing, distribution, and archiving of EOS data; and command and control of the spacecraft and instruments.

Although EOSDIS will eventually contain an enormous volume of valuable Earth observation (EO) data, there are other sources of information that are essential to the study of climate change. Of critical importance are holdings of other Global Change agencies, such as NOAA, USGS, etc. and other international organizations. The Inter-Agency Working Group for Data Management for Global Change Data (IWGDMGC) are currently in the process of defining the Global Change Data and Information System (GCDIS) intended to provide linkages between data services through a common set of interoperability services. NASA is actively participating in these efforts.

In addition, there is also a growing interest by earth scientists in the possibility of developing information systems for earth science data which not only encompass the existing major data repositories but also enables users to take an active part in the information system, by providing data/services to the system. This concept, known as USERDIS, seeks to encourage the maximum scientific return from the investment in data and information systems by ensuring that the scientists are an integral part of the system.

Although NASA does not have the responsibility for developing either GCDIS or USERDIS it wants to make sure that the development of EOSDIS can support both of these evolutionary paths. This implies taking an architectural direction which ensures that EOSDIS can play a role within wider data systems and also identifying architectural components which EOSDIS might contribute to these systems.

This paper summarises the results of NASA's architectural analysis for EOSDIS. It presents

- high level user issues related to a generalised data and information system
- an outline of a generalised architectural concept which has been used to guide the specific EOSDIS solution; it is stressed that the description here reflects an architecture which could encompass GCDIS, USERDIS as well as EOSDIS, and is therefore perhaps more applicable to EEOS.
- a discussion of the key user service issues associated with the architecture which may be relevant to EEOS.

The focus of the paper will not be on the archiving, processing and DBMS technologies which will be employed to realise the EOSDIS concept (e.g. hierarchical storage management systems, parallel processing environments, etc.), but rather the intersite and inter-component architectures which are necessary to allow the distributed system to be presented as a unified framework of services to potential users.

2. User Needs

The nature of the use of EO data leads to some key architectural drivers for a data and information network. These are summarised below and described in more detail in NASA (1994b).

- The organizations who will participate in the network are essentially autonomous entities, and the architecture should intrude upon autonomy to a minimal extent. For example, the architecture cannot dictate how organizations will manage their data, their networks, and their users internally.
- Developing experiments, instrumentation, algorithms, and hence new kinds of data is an integral part of developing applications for EO data. Different organisations and groups of users may have valid preferences for different or new data formats and tools. The architecture cannot make adherence to strict data interchange format standards or the use of specific tool sets a precondition of network operation.
- In developing applications, users often collaborate on projects and exchange information in many different ways. The architecture should facilitate this kind of collaboration and exchange and extend to new ways of collaboration which future technologies may enable.
- Operational users and developers of operational applications may need the ability to reconfigure the flow of data from acquisition site to user to meet quality of service requirements. For example a non-standard feature identification algorithm could be inserted as part of the routine QA process at a ground station with an event trigger to inform service subscribers when the feature is identified.
- Application expertise is distributed on a world-wide scale. The EEOS architecture should make it possible to distribute the appropriate functions and data to where the expertise resides in Europe

and to allow European experts to cooperate and collaborate with international experts whose primary network is not EEOS.

- Users would like to access EO information in many different ways. The architecture should extend to new ways of data access which future technologies may enable. Data volume makes it impossible today to perform large scale searches on data based on their contents, but the rapid evolution of processing and storage technology may change that in the not too distant future.
- The collaboration between geographically distributed users is limited by current communications facilities to file and mail exchanges. In the future, it may be possible to exchange data in real time, and view and browse them in a coordinated fashion while communicating annotations and comments. Such developments will have a profound impact on how EO information is accessed and used for research.

The focus for the EOSDIS development is supporting global change research, but EEOS has a wider remit and particularly wants to support the operational application of EO data. Despite these differences of emphasis many of the user needs listed above are highly relevant to EEOS

The generalised architecture must support both users and service providers. The users of the system want to be able to find and access relevant services within the system as efficiently as possible. Service providers want to be able to support the mission objectives in terms of capturing and maintaining the important data sets, and ultimately providing the best services[1] possible to their user community. To achieve the latter goal each provider needs the flexibility to organise their data and services in the most appropriate way for their user community and be free to re-configure existing services and add new ones to accommodate new user requirements and/or new technological capabilities.

This view of the two types of organisation involved in the network, naturally leads to a market place concept; EEOS should provide a market infrastructure to which service providers can bring their services, and at which users can discover what is available and select the service(s) which best match their needs. This concept is discussed in more detail in the CEONet feasibility study (CCRS, 1994).

The principles that were used in defining the generalised architecture are listed below:

- There will be considerable variety in the user objectives, missions and priorities. Users will also be data providers.
- The architecture must not assume a common information model or management system. The adoption of evolving standards should be encouraged within the user/provider community, though this should be achieved through participation in the standards process by the organizations involved rather than the development of specific standards for these systems.
- There should not be any restrictions on the number of providers, their location and the data/services they provide. The system must be able to cope successfully with dynamic data and network topology.
- All responsibilities for system management or development policies and authorities will be voluntary, though within a part of the system, such as a national network, they can be mandated by some management authority. The architecture must therefore accommodate autonomously managed provider sites and not assume a single management approach to development, operation, user authentication or data protection. In particular the system should not depend on the availability of network wide management information.

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1 The concept of a service is synonymous with the concept of data, since data and information can only be accessed through a service.

- The data management solutions should be scalable, and cost effective to scale. The design of components should avoid limits on capacity which preclude low-end providers or restrict what high-end providers can offer.
- In this scenario of autonomous service providers, there will inevitably be the potential for incompatibilities between the services available from the system and a user's query, or the tool they are using to access the service(s). The system must recognise that incompatibilities will exist and assist the user in overcoming them as effectively as possible.
- The architecture must help a user work effectively within an environment characterised by variability of quality in terms of responsiveness, reliability, accuracy, availability, and throughput.

From the above list it should already be clear that the architecture will need to support considerable heterogeneity in all of its aspects (e.g. data model, interconnection, etc.). A primary objective of the architectural concept summarised below is providing the ability for the user and service provider to deal with this heterogeneity effectively.

3. Architectural Concept

This section will describe an architecture which follows the principles outlined above. The architecture will define:

- capabilities which let a user locate, obtain or use resources which are available in the network (e.g. tools and data)
- features which would help a user cope with the ensuing problems e.g. of differences in data formats, terminology, tool i/o requirement,
- support functions which would make it easier for users to collaborate on application development

The non-specific form of the architecture was termed X^nDIS in NASA's analysis (NASA, 1994a). This was the basic architectural framework from which the specific EOSDIS design was produced (NASA, 1994b). The architectural description does not imply an implementation, these decisions are ongoing work within the EOSDIS programme. Much of the architecture could be implemented using likely developments in the World Wide Web (WWW) and associated technologies, but there are several key aspects of the design for which the WWW is not a good model.

The architectural description will also not specify *which* user services should be provided (e.g browse, process on-demand etc.). The decisions on which user services to provide will vary for different user communities and will also change over time as technologies change; user services which are technically expensive to support with current technology will become feasible at some time in the future. The architecture described below concentrates on a framework in which user services can be provided to a changing user community and can evolve as technology develops.

A standard architectural division for EOSDIS is shown in Figure 1. It can be divided into three layers: the client layer, the service provider layer and the inter-site architecture. Individual sites, which may host one or more of these layers, are heterogeneous and autonomously managed.

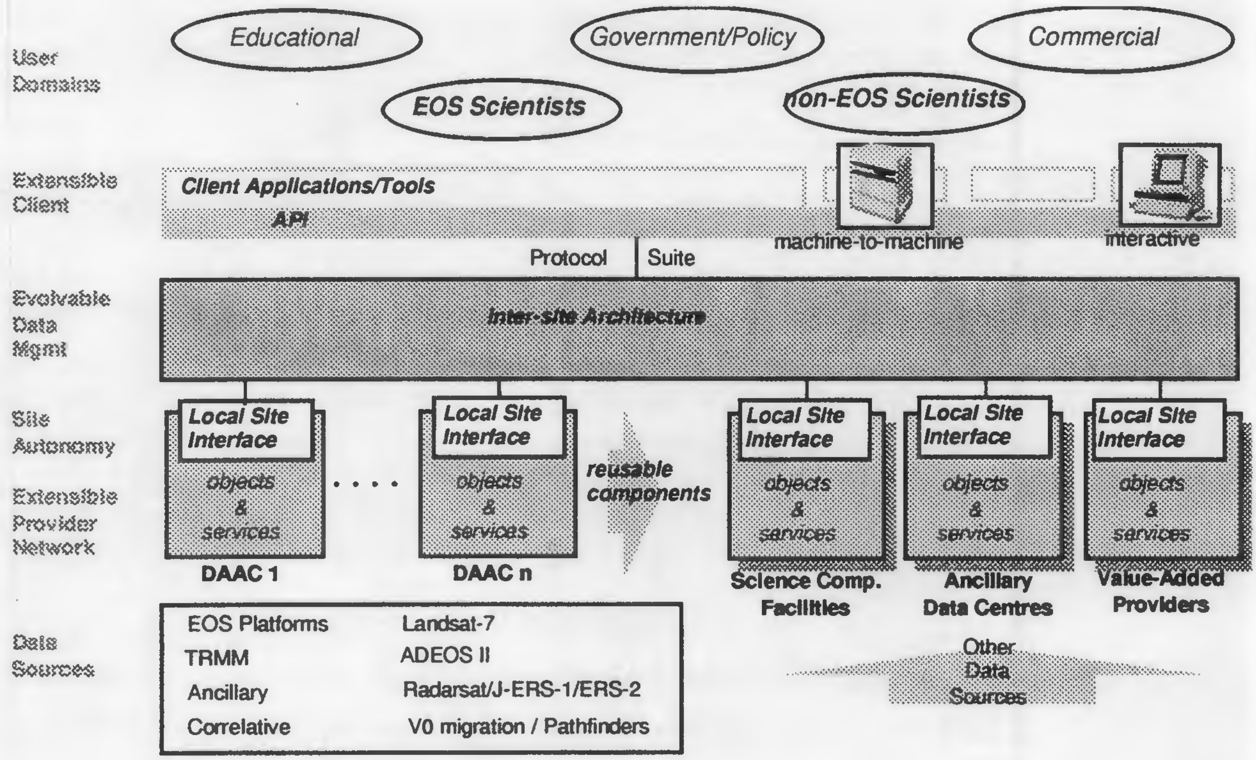

Figure 1 High Level Architectural Concept for EOSDIS

It exhibits the following characteristics:

- **Object- and service-oriented architecture**

  Provider sites are characterised as a collection of objects with associated services. Users access to objects through the inter-site architecture.

- **Extensible client environment**

  EOSDIS will provide some core client capability. The architecture provides an API so that the community can develop more advanced or more specific client interfaces.

- **Evolutionary approach to Data Management**

  The architecture establishes a vision for the required approach to accessing objects and services through the inter-site architecture. Some aspects of this vision are still the result of research; but the architecture is being organised to accommodate evolutionary changes.

- **Logical Distribution of components**

  The architecture does not mandate the location of client, inter-site or provider site components. Indeed it supports both transparent physical distribution and service migration. This enables EOSDIS to respond to changing technical, organisational and political pressures.

- **Site autonomy and heterogeneity**

  Each provider site can be different from the others and can operate autonomously as long as it provides an EOSDIS compatible local site interface. This feature also allows the incorporation of heritage systems

- **Extensible Provider Network**

The architecture does not mandate that only DAACs can be providers. Any organisation can theoretically join the network as long as it provides the local site interface. The architecture supports domain specific representations of objects and services, and the development of new types and services to meet specific user community needs. The inclusion of value-added providers is especially important to be able to offload the very large education and library communities so that they do not adversely impact the limited DAAC resources to support global change research. New providers will be able to make use of EOSDIS developed components from which to develop their own local services.

Since the architecture supports both site and client heterogeneity, the remaining description focuses on the characteristics of the inter-site architecture and its interfaces to the client and providers.

Sections 3.2 through 3.5 describe the architectural elements and concepts of a network interoperability infrastructure which allows research organizations to find and use data, algorithms, and computing resources in a data network. The infrastructure maintains the autonomy of the individual organizations and does not force the adoption of a particular set of standard tools and data formats. It is assumed that organizations which want to offer data or services to the research community will cooperate in maintaining the infrastructure, and that some of them will volunteer hardware resources to operate its elements.

Sections 3.6 and 3.7 describe architectural provisions which support multiple data access and search protocols. Such capabilities are needed because sites will differ in terms of the search capabilities which they can offer, and because those capabilities will evolve over time. An architecture which can only deal with a single, universal data search and access protocol would stifle such evolution.

Names and identifiers are the key means by which things are references and located. Unfortunately, different organizations, software packages, and operating environments use different types of names. Examples are file names, image identifications, document titles, and mailing addresses. A network community needs a method of referencing network resources with identifiers which can be exchanged easily, are applicable to all objects in the network in a universal fashion, and can be used everywhere on the network. Section 3.8 introduces the concept of a universal reference and explains its role.

The analysis of EO data often involves transferring source data from one site for processing to some algorithm located at another site. Finding relevant coincidences of events often requires the concatenation of several such processing steps. Section 3.9 generalises a capabilities needed for distributed searching into an intersite service for executing scripts which span multiple sites.

In a large network, there are often alternative ways in which a set of intersite searches and data transfers could be executed. The sequence of these steps and the locations where they are executed may have a significant impact both on overall execution cost and total response time. Section 3.10 describes how the architecture supports network components which can optimise execution sequence.

Correlating information across databases requires some measure of data compatibility. For example, the same geophysical parameters may have different names in different databases or the same names may be used for entirely different parameters. Sometimes, the differences may be significant, and at other times they may be so subtle that they are irrelevant in a particular context. Section 3.11 shows how concepts like data dictionaries and vocabularies can be employed to help users deal with these issues.

Lack of interoperability among databases also poses issues with respect to the execution of searches. A data provider may not always be able to execute a search exactly as posed by the user, for example, because the database does not support the necessary indexes. Users may not even be interested in only receiving responses which match the query exactly, e.g., when they do text searches. Section 3.12 describes provisions needed in the architecture to help users deal with search accuracy.

Once researchers have located a valuable source of experimental or theoretical data or information, they often want to receive new releases of this data as soon as they become available. Not only would this be more efficient than repeating the original search over and over again, the scientist also would receive updates on a more timely basis. Similarly, if researchers use some service offered on the network, they would like to receive announcements of changes well ahead of their implementation. Section 3.13 introduces the concept of a subscription service which makes this possible.

Section 3.14 describes architecture concepts which deal with issues of tool and data interoperability. The X^nDIS architecture does not prescribe a particular suite of tools or data formats. However, exchange of data between programs will require format compatibility, and may involve format translation. Scientists will need to be aware of data incompatibilities, and may require information which helps them with format conversion.

3.2. Intersite Services

X^nDIS is assumed to be developed from a number of individual system developments which will not be developed under contract to some central design and development authority. Rather, they represent networks which are intended to evolve through the voluntary efforts of the organizations which participate in and benefit from a unifying X^nDIS framework. Organizations which want to participate in that system would use the framework as guidance to determine what they need to do in order to make their information and system resources available to others and connect their users into the network.

Achieving interoperability should not mean that these organizations must completely revamp their own systems to comply with some common hardware and software specification. Rather, the architecture of the systems at each location or site should be internal to that site and remain under control of that organization. As a consequence, the X^nDIS architecture is mainly an intersite architecture. It defines rules and capabilities for interoperation among sites, but does not intrude upon the site architectures except through the specification of interfaces.

Conceptually, X^nDIS sites can be user sites, provider sites, or both A provider site offers data and services to the network community. A user site includes one or several scientists (or other kinds of users) who want to access data and services which are available somewhere on the network. No assumptions are made about the size of these sites. A user site might include just one user or several thousand. A provider site might offer just a small database of local in-situ measurements, or may manage several large archives of satellite image data.

Provider sites need to tell the network community what kinds of data and services they are offering. For example, they may choose to make only a subset of their databases accessible to outside users. Users need to be able to find out what resources are available on the network, where they are located, and how they can be accessed. Finally, when users issue requests (e.g., to retrieve data from another site), the requests must be routed to the appropriate provider and the results of the requests must be returned to the user.

These kinds of network wide capabilities are provided by the X^nDIS *Intersite Services* which operate according to the specifications of the X^nDIS architecture framework. It is essential that all users and providers have access to these services, but it should be irrelevant where the services are located. Typically, they would be at larger sites which are volunteering their computing resources to operate the services for the benefit of the rest of the research community. However, *any* site can host one or several intersite services if it so chooses.

A user or data provider site will interface with the X^nDIS network through a *Local Site Interface* (in EOSDIS this is known as the LIM - Local Information Manager). The interface decouples the internal access/archiving/processing architectures and conventions from those of the network. For example, it would map the protocols which are used by the intersite services into the protocols which are used at the site. The implementation of the site interface is left to the organization at that site. Often, the organization will be able to adapt a site interface developed elsewhere; for example by a central authority.

The remaining sections of this chapter introduce a number of intersite services and describe their functions, their data requirements, and their place in the X^nDIS architecture in more detail.

3.3. Advertising and Request Brokering Services

This section describes two key intersite services which are closely related. The first is called the *Advertising Service*. It is used by providers to inform the rest of the network of the data and services they offer. The other is called the *Request Brokering Service*. It refers requests for services issued by users to the appropriate provider, for example, by routing them across the network.

There are several alternative methods which users could employ to find relevant data or services. The solution which best matches the architectural principles described above involves routing requests in an intelligent fashion. Information which describes a request (i.e., the *Request Description*) is matched against information which describes the data and services on the network, and matching providers are selected to receive the request.

A possible approach for doing this is depicted in Figure 2. Providers advertise the data and services which they want to make available to others. The advertisements are managed by the advertising service. Requests are sent to a network component called a request broker. It uses the request description to query the advertising service and redirects the requests based on the response. Alternatively, the request broker returns information about candidate providers to the user. The user could save this information and use it later to issue requests directly to a provider.

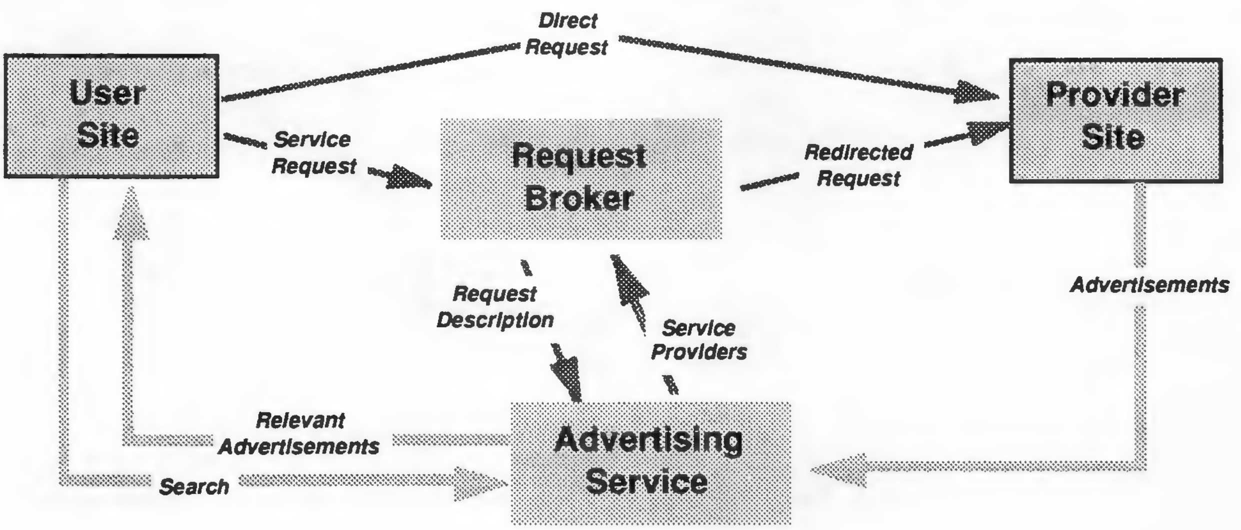

Figure 2. Interaction Between Request Broker and Advertising Service

The collection of advertisements which is managed by the advertising service is called the *Advertising Directory*. Again, there are several alternative solutions to the management and distribution of this directory. For EOSDIS, the advertising directories will be distributed to a number of volunteer sites, and that other sites would connect to one of those sites when they need advertising information. Sites with requirements for high availability might provide connections to several alternate directory sites or might install their own directory. The X^nDIS architecture does not dictate a particular distribution approach, but it specifies that the architecture must allow for any number of advertising service agents, and that any site on the network must be able to become an advertising directory site.

It is natural to perceive the advertising directory as a database which can be accessed in several ways. Some users might want to view advertisements as textual descriptions of services and search them using a text search interface. Other users might want to browse through advertisements in a hyperlink fashion, for example, in the style of the World Wide Web (WWW), using some entry in the directory as their 'home page'. Finally, an advanced advertising directory might have a knowledge representation of the advertisements, and may be able to match descriptions of desired services or data against this knowledge. Therefore, an advertising directory should offer access via: text searching, database querying, hyperlink style browsing, and possibly in the future information (e.g., knowledge) matching.

The full advertising information must be accessible via any advertising service agent. A site which decides to store only part of the advertising information in the local directory must have provisions to answer queries about advertising information it does not possess. For example, the site might automatically contact other sites transparently to the requester. In other words, users should not have to be aware of any aspects of partial replication of advertising data (see Figure 3).

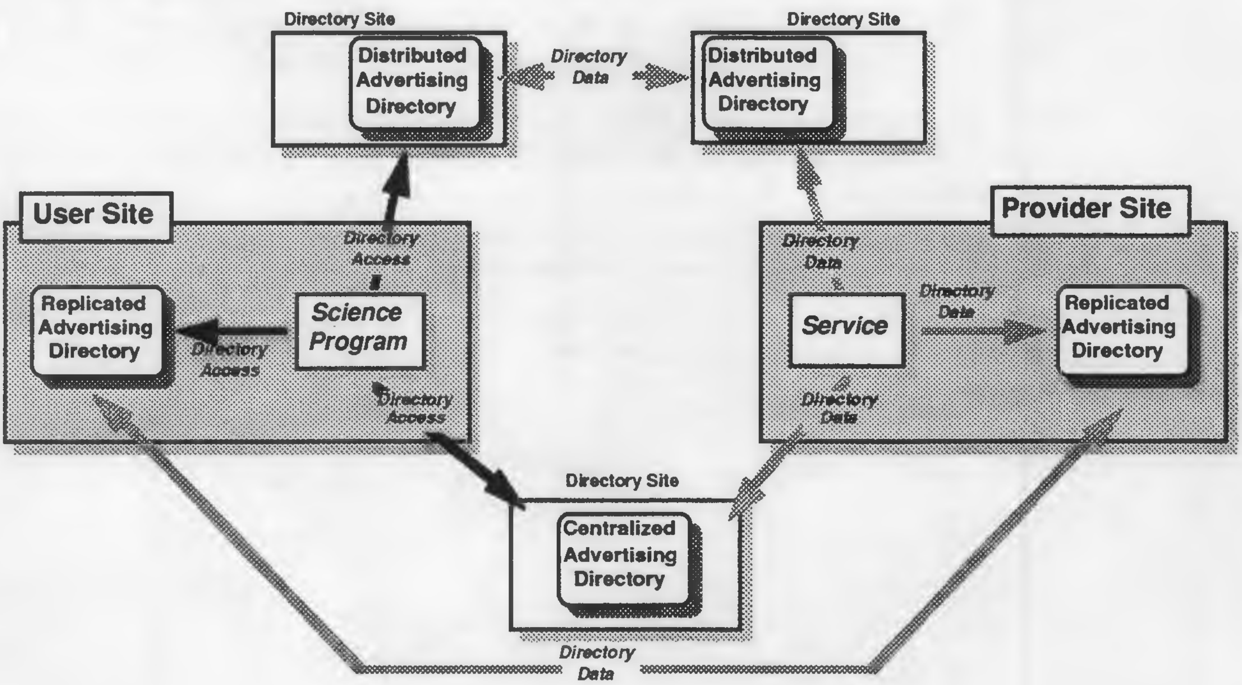

Figure 3. There Are Several Distribution Possibilities for the Advertising Service

Because of delays in propagating changes across the network, the information in an advertising directory may not reflect the current network status in an accurate fashion. The architecture does not mandate that advertising directories synchronise with each other in the style of database transactions. This is because there are many other reasons why advertising data may be erroneous, for example:

- providers may submit inaccurate advertisements;
- providers may change their services but neglect to update their advertisements;
- providers may disconnect from the network without bothering to remove their advertising information; or

- unauthorised changes in the advertising directory occurred.

Users of the advertising service must therefore be able to deal with potential errors. For example, a service request may be sent to a provider only to be rejected because the provider removed that service. It is possible to design some corrective mechanisms into the advertising service. For example, advertisements could be timed and removed unless renewed before time-out. Request brokers could provide feed-back to the advertising directory about unavailable providers and other errors. Such measures would improve the reliability of the advertising information but it is evident that they would not completely remove the possibility of error.

In distributed, heterogeneous client-server systems it is often advantageous to differentiate between the generic aspects of a service, and the specific system process which implements it. This is because the same service may be available at several different locations and may have been implemented by several different programs. In the rest of this paper, the instances of a specific service will be called the 'service agents'. Moreover, users do not directly access services. They employ programs which act on their behalf. We will call these programs 'clients'.

A client, therefore, communicates with some request broker, which is an agent of the generic 'request brokering service'. The request broker interfaces with some agent of the advertising service. Conceptually, it is important to understand that the X^nDIS architecture specifies generic services, not their implementation. A given service may have several different implementations, i.e., agents. For example, There may be several implementations of an advertising service on the network, e.g., to accommodate different machine architectures or directory organizations.

The definition of the generic advertising and request brokering services requires that the X^nDIS community achieve agreement on their protocols and data, including for the following:

- request descriptions and advertisements;
- submittal of advertisements by providers;
- removing or updating advertisements;
- transmitting changes to advertisements between different advertising directories;
- ways of presenting requests to a request broker; and
- interface between request broker and advertising service to match request descriptions against advertisements.

3.4. Service Descriptions

Advertisements need not contain a complete description of all aspects of a service. In fact, doing so might inflate the size of the advertising service without a compensating payback. In general, advertisements only need to provide the information needed by request brokers to determine the candidate providers for a request. There may be other information which is not needed to route requests, but which clients might need to interoperate with a service.

As a consequence, the X^nDIS architecture defines the concept of a service description. Service descriptions may be available upon request, but they are not necessarily advertised.

3.5. Intersite Search Service

The previous section presented intersite services for finding data and service providers in the network, and sending requests for services or data to them. These capabilities are sufficient if the user is merely attempting to find potential data sources based on advertisements. Once a data provider is located, the user can send requests for data searches directly to that site.

More often, however, users want to search for information which meets complex criteria. The user may not yet know which site has matching data, or the search may require access to data at several sites. As examples, a user might be looking for documents which discuss the use of particular instruments and their calibration; or they may want to locate coincident *in situ* and remotely sensed data for a comparison study.

Advertising and request brokering service will provide insufficient support in cases where users want to perform extensive data searches. Rather, users need a service which can locate relevant providers and determine how each provider needs to be queried to satisfy the original search request. The service should be able to do this for all types of data available in the network. This section describes such an intersite service, called the *Intersite Search Service*.

The intersite search service handles a particular kind of service request called an *Intersite Search Request*. The request defines the search criteria which are supposed to be evaluated, and the retrieval operations which are to be performed against the matching information. Search requests are specified in a formal *Search Language*, and the messages which are exchanged between the search service and its clients follow a *Search Protocol*.

The model for the intersite search architecture is shown in Figure 4. The following components participate in the execution of an intersite search request:

- The search requests are issued by a *Search Client*. The search client will have received the request from some other program, for example, user interface software translating user input or a science algorithm which wants to find satellite images in a remote archive.
- The search requests are passed on to an *Intersite Search Agent*. The search agent takes responsibility for executing the search. The search client can stay connected to the agent or disconnect from it. It can check back regularly for results, or request that it receive regular progress reports or notification of search completion. The intersite search agent will determine which sites need to be contacted, and what portion of the search each site should receive.
- Site specific searches are transmitted to *Data Access Services*. A data provider may offer one or several such access services. Providers advertise their data access services like any other service. The advertisements provide part of the information which the intersite search agent needs to execute intersite searches.
- The remaining components have been introduced earlier. The *Local Site Interface* connects each data access service with the intersite network. The *Advertising Service* manages information about the data access services on the network and their providers. The *Request Broker* routes the various requests among the service. For example, the request broker could be used by the search client to find an appropriate intersite search agent if that agent is not yet known.

Two other concepts are important; the *Data Scope* and the *Search Scope*. A data scope describes the data holdings offered by a particular data access service, and forms part of the advertisement. A search scope describes the data requirements of a search request. The search scope is matched against advertised data scope to determine which data access service(s) are needed to satisfy a given request. The data scope and search scope must contain sufficient information to make this matching process possible.

The following are examples of the kinds of information which a search scope might contain:

- providers (e.g., to direct search to particular sites with which the user has a service agreement);
- databases (e.g., to restrict a search to a particular collection of documents); and
- datasets and parameters (e.g., to indicate which particular instruments and observational parameters the user is interested in).

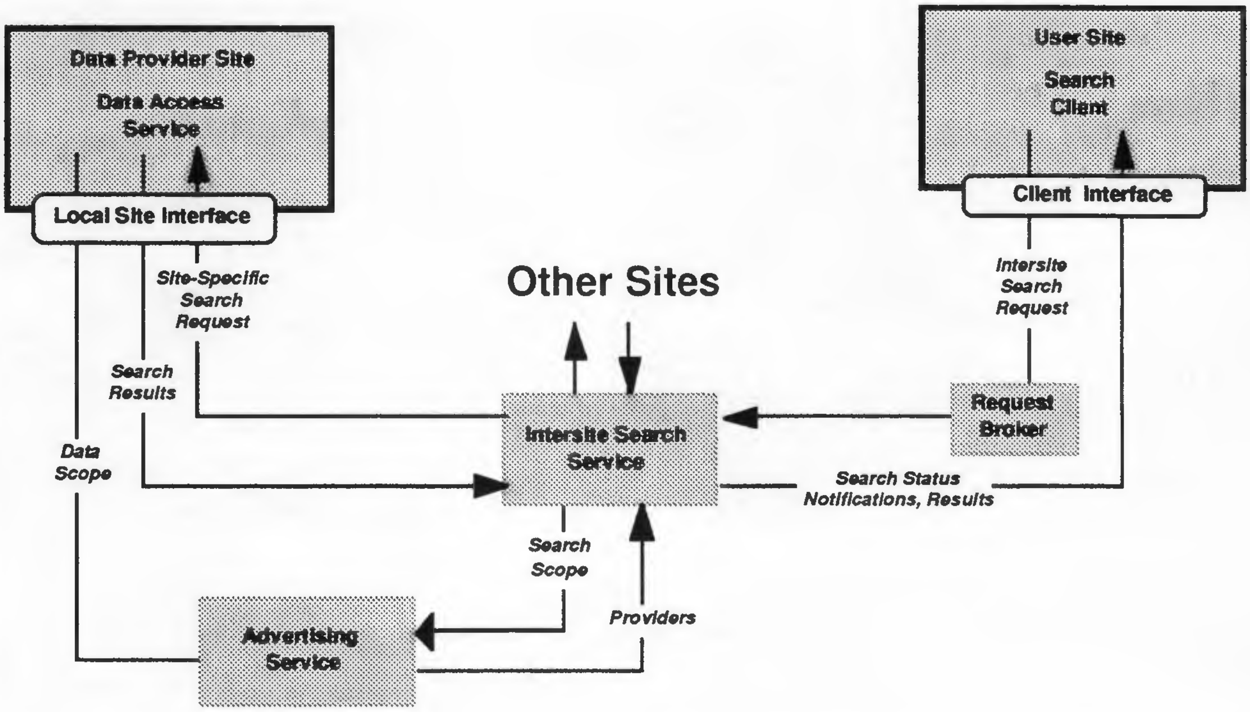

Figure 4 The Intersite Search Service Supports Data Searches Across The Network.

Examples of data scope include:

- databases (or named data collection) which are accessible at a site;
- the datasets contained in a database and the parameters which they offer;
- the schema of each database; and
- textual descriptions for each database.

There may be several providers which can cover the scope of a search. In such a case, the advertising service will return a list of data providers. It is also possible, that a search scope spans multiple sites, that is, no single data access service has all the data needed to execute the intersite search request. In that case, the advertising service will be unable to return a provider because the provider is not well defined.

Instead, the original request must be decomposed into smaller units called 'sub-queries' which can be allocated to individual providers (i.e., which do have a well defined search scope). The agent which breaks up a search must be able to parse it. Thus, while request brokers need not interpret the requests which they are routing, search agents may be required to do so. The process of decomposing a search and allocating it to specific sites is called 'search planning'. It is typical for systems which include distributed databases.

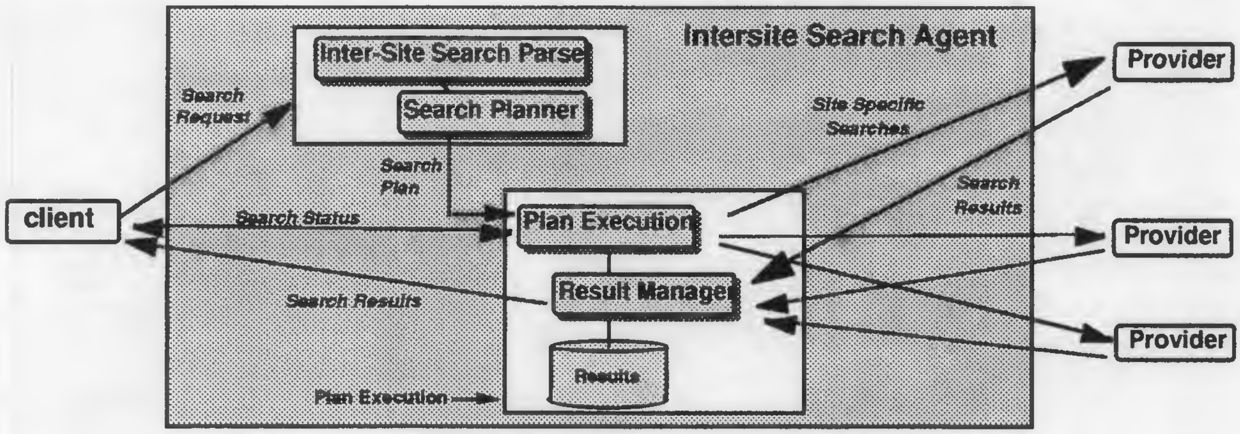

Figure 5 The Intersite Service Plans And Executes Intersite Searches.

Figure 5 summarises the functions which an intersite search service may perform:

- It might parse an intersite search request into individual components. The nature of these components will depend upon the type of search language is not of relevance here.
- Using the advertising service, it determines the providers for each query component. For example, the search may reference observations from several instruments, and the search agent may ask the advertising service to name the data provider(s) for each.
- Based on this information, the search agent develops a plan for executing the search. For example, the search agent might recombine query components which reference the same data provider so they can be sent in a single site specific search request.
- The plan is turned over to some execution monitor which dispatches the individual queries and watches over their progress. For example, some later sub-query may require the result of an earlier sub-query as input.
- The result of the sub-queries are collected by a results manager. For example, a text search may have been sent to several sites; the result manager would add the results sent by each site to the combined search result,

Search clients can interact with the intersite search agent to determine the status of a previous search, or to obtain the final or interim results. As Figure 5 shows, they actually interface with the components of the search agent which monitor the execution of the plan and manage the results.

There are many issues relating to the intersite search agent which are discussed in the following sections.

3.6. Data Access Services And Multi-Protocol Searching

Providers who offer data on the network must also offer a service for accessing this data. This is called a *Data Access Service*. Data access services will vary in terms of their capabilities. Different access services may interface to different types of search languages and protocols. Therefore, a provider needs to advertise the services which are needed to access the data.

For example, one provider may simply offer a collection of files and brief textual descriptions for each. Since the provider has a simple text search engine, the decision is made to interface with an intersite text search protocol (P1, e.g. Z39.50). The result of the text searches will be pointers to the files which can be used to retrieve them over the network using an intersite data access protocol (P2, e.g. HTTP). The provider will advertise the following:

- a brief textual description of the file collection;
- the availability of file descriptions for searching via protocol P1; and
- the availability of file pointers and descriptions for retrieval via P1, and of the files themselves via P2.

On the other hand, a provider which offers an archive of satellite images, a relational database which describes and indexes these images, and a collection of documents describing the calibration of these images would attempt to advertise a more elaborate capability. The provider might decide to interface the document collection to a text search protocol (P1), the directory and inventory data to a data search protocol (P3, e.g. SQL3/RDA), and access to the images themselves via a data access protocol (P2). To support the full scope of these capabilities, the provider would advertise:

- a textual description of the document collection;
- access to the collection of documents via P1.
- a textual description of the image database;
- a list of the observations and science parameters available;
- a complete description of all the data which is accessible via P3; and
- an indication that the image identifications returned by searches in P3 can be used for retrieval of the images via P2.

The two examples illustrate the following. First, a provider does not merely advertise the data being offered to the network, but also the capabilities of the access services which can be used to search and/or retrieve this data. Second, the X^nDIS architecture will offer several different protocols for data search and retrieval. Providers can choose to which of the protocols they will interface, and indicate their choice in their advertisement. Finally, providers can identify in their advertisements what data items or elements a user can search or retrieve, and can indicate restrictions that may exist with respect to search capabilities.

Figure 6 illustrates the second example. In essence, the provider advertised three data access services. A intersite search request which searches the directory and inventory data to identify relevant images and then wants to retrieve the images themselves would have to be decomposed by the intersite search agent into two requests. The first would search the directory / inventory database using P3. The second would use the result of the search to retrieve the images via P2. This assumes that such a search agent is available. Otherwise, the user would have had to formulate two separate requests.

It is conceivable that there is an alternate protocol (say P4) which allows for text and data searches, and can retrieve and transport large images efficiently. In studying the available protocols and the issue of interfacing with them, the provider may discover that an interface which connects relational and image databases to protocol P4 has already been built, and that an interface between P4 and his text search engine is available elsewhere. The provider, therefore, decides to build a single interface component, between the three databases and P4. As a consequence, the three databases now would be advertised as a single one (Figure 7).

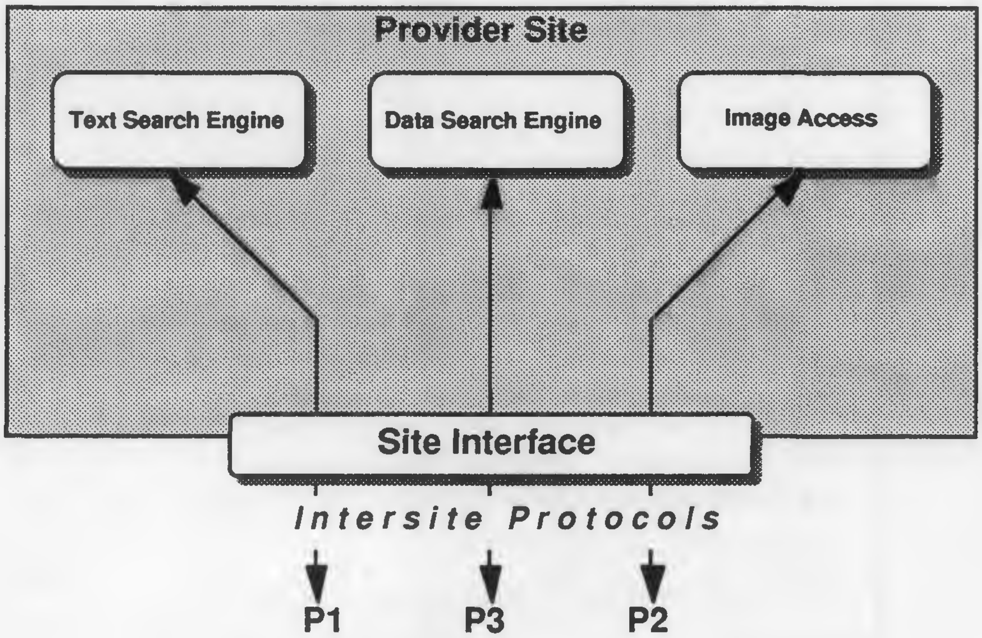

Figure 6. A Provider Can Advertise Data Holdings Via Several Access Services.

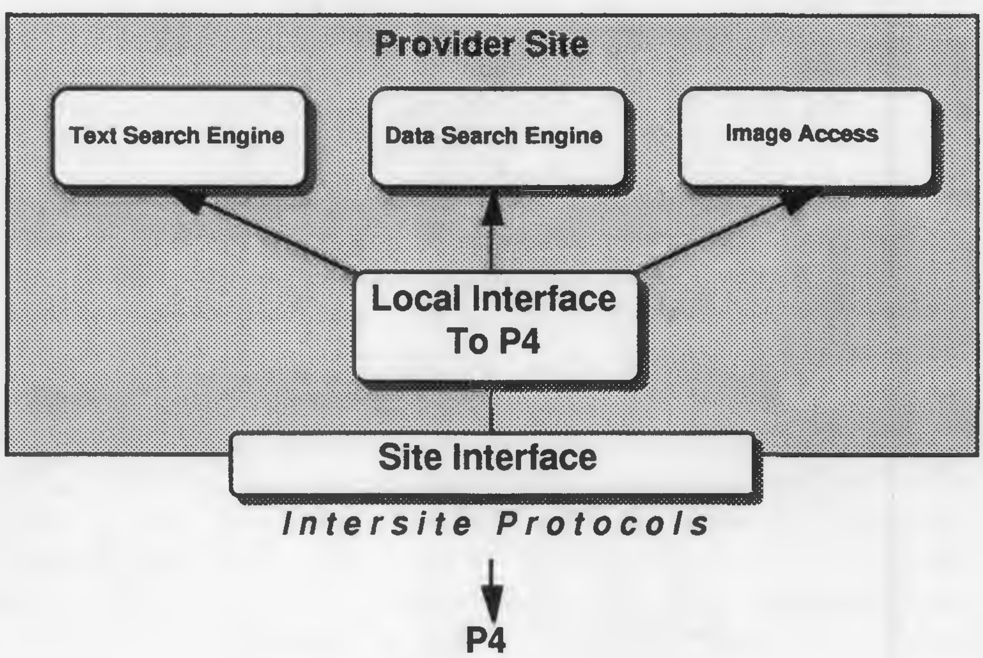

Figure 7. A Provider Can Front-end Data Holdings With A Local Search Interface And Advertise Them Via A Single Access Service.

The software needed to interface local search and retrieval software to a specific intersite search and retrieval protocol is called a *Local Search Interface*.

It is apparent that a local search interface performs many of the same functions needed in an intersite search agent. One would expect that components of an intersite search agent for a particular intersite search and data access protocol could be reused to build a local site interface for the same protocol.

There is obviously potential for the simplification of the architecture if a single protocol could be used for all client - agent - service traffic. Unfortunately there is no emerging protocol which is suited to all of the types of services required to access EO data effectively. Even so the selection of a limited suite of protocols for EEOS will have many benefits. Obviously HTTP, or whatever that evolves too, is likely to provide the main protocol, but there will need to be at least one more to support a more effective querying paradigm.

3.7. Search Envelopes

One of the examples in the previous section showed that a provider might partition data holdings in order to interface them to different intersite protocols. It would be desirable to let users search and access this data via a single request. This would offer certain conveniences to the users. It would also address the following problem. As technology matures, the capabilities of the search engines used by the providers will change. As a result, providers will change the way in which they offer the data on the network. In particular, the manner in which the data is partitioned would change.

In a large network like EOSDIS and EEOS, users might be faced with such changes quite frequently. It would be desirable to hide these changes, for example, by having intersite search requests span data partitions which interface to different protocols. However, this presents the following issue: how would an intersite search agent handle such requests?

Search Envelopes are designed to address this issue. A search envelope is a protocol which is used by a family of search languages; and a specification which allows searches formulated in different languages to be packaged into a single request. Moreover, the envelope would also support a small number of operators which can be combined into, perhaps expressed in the form of an *Envelope Script*, which indicates how the results of the different searches should be processed (Figure 8).

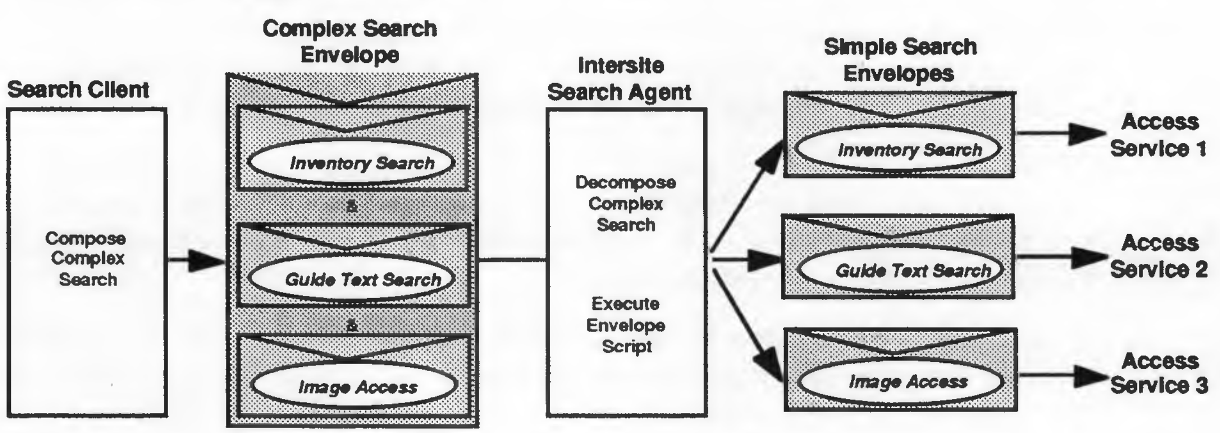

Figure 8. Search Specifications Are Encapsulated Into Search Envelopes.

An intersite search agent which receives such a search would only need to know how to parse the specifications on each envelope (e.g., the search scope), and how to execute the instructions of the envelope script. It would turn the envelope script into a plan for execution, but it would never need to 'open' the envelopes and look inside them.

Rather, it would pass each envelope to some other component which can interpret its contents, for example, another intersite search agent which specialises in the protocol contained in the envelope, or (more likely) a data access service which accepts the requests contained in the envelope.

An example of this would be a coincident search involving a combined index search using SQL on a DBMS and a content-based search on the data set itself using a provider specific tool which uses the results of the index search in the criteria for the content based search (e.g. find all SST images which contain values less than 10 degrees C). In this case there would be two envelopes; the one 'labeled' as SQL would be opened by the DBMS access service and processed, the other would be opened by the provider specific tool and interpreted in conjunction with the results from the SQL search.

3.8. Universal References

When users search for data, they don't always want to retrieve this data right away. This is because users often do not know how much data a search will return, or how large the individual data objects are which were found by the search. Instead, users often want to retrieve information which describes the data in more detail, and associated references to this data which later can be used to access the data objects.

For example, a user may issue several searches to find satellite observations which coincide with a set of measurements taken in a recent field verification. The user directs the searches to obtain summary data about these observations. In the case of the satellite data this might include time of day, cloud coverage, resolution, quality indicators, and perhaps a histogram summarizing the distribution of measurements.

The user may examine this summary information in more detail, and perhaps browse some of the images to select the observations which should be included in the subsequent analysis. In the course of this examination, the user copies references to data which are of interest to him into some common result set.

These data may have come from several different sources. The access protocols and requirements may differ from provider to provider. Finally, when the user actually issues the search, some of the references may turn out to be invalid, for example, because the data have changed location without the user being aware of it. It would be very convenient if there was some uniform method of referencing all of these data objects. The referencing mechanism should provide some protection against integrity problems. It should also hide the differing access requirements, perhaps based on information which is stored with the reference.

A *Universal Reference* provides such a mechanism. The syntax and meaning of a universal reference follow standard conventions which every component in the network recognises and supports. It encapsulates the identifiers which are used internally at a site or by a specific service. This encapsulation is similar in concept to the query envelopes discussed in the previous section.

At a minimum, a universal reference must identify the service where the reference can be presented and further interpreted. It must be possible to locate and reach that service, i.e., the service must have been advertised. The envelope may carry additional information, for example, it might specify:

- a name (which is not relevant for identification but might help the user to recognise the referenced object);
- authentication requirements;
- an expiration period after which the reference would be invalid, but which could be refreshed; and
- an indication of the type of object being referenced.

The use of universal references is not restricted to data. In fact, a universal reference actually points to a service, namely the data access service which can interpret the remainder of the reference. As a generalization, a universal reference can, therefore, point to anything - an object, a service, an action to be performed, etc. The reference merely must enable intersite services to determine where the reference should be presented. Upon presentation, the service which issued the reference is assumed to know how its contents are to be interpreted.

The Universal Reference also supports collaboration and work flow organisation. A set of different data items can be identified by one user e.g an operational analysis set, or research data set, and given a Universal Reference. This reference can then be provided to a program responsible for the operational analysis of the data, or in the case of the research data set to all collaborators in the research program.

This concept is used in distributed hypermedia approaches, for example the and World Wide Web. It is clear that hypermedia software needs to understand the concept of references to external objects, and that it may need information which lets it interpret the information in the appropriate fashion (e.g., by dispatching a viewing program for graphical data).

The Universal Reference is similar, but not the same as a Universal Resource Locator (URL) which are used in the WWW. One key missing feature is the lack of persistence in the URL; the reference only works if the object doesn't move. The work in the WWW community on URNs and URCs is moving in the direction of the Universal Reference, and it is highly probable that these developments will form the basis for the EOSDIS universal reference.

3.9. Intersite Script Service

Section 3.5 introduced the concept of a search plan and explained the need for a component which monitors the execution of that plan. Section 3.7 introduced the concept of search scripts in the context of search envelopes. The two concepts are clearly related: an envelope script would have to be converted into some form of plan for its execution; a search plan created by an intersite search agent can be viewed as a kind of script for executing sub-queries.

In the most general case, a search plan will include:

- queries which are to be sent to data access services on the network; and
- operations which define further processing on the query results, such as joining two results or calculating summary information not provided by the access service.

The example in Figure 9 shows such a plan. The original query (Q) was broken into three queries (q_1, q_2, q_3), each intended for a different site. The plan also contains an operation to combine the results of the first two queries (o_1). The results of this operation and the results of the third query are then combined by the last operation (o_2) to produce the final result.

Operations o_1 and o_2 cannot be sent to any of the data access services. Their execution support must be somewhere else. In Figure 5-19, it is provided by the intersite search agent. This may not always be the best place. For example, q_1 might fetch dates at which the ground temperature at some given location (based on local meteorological observations) was below freezing all day; q2 might fetch SAR images for the same location. If the purpose of o2 was to join on date (i.e., establish coincidence), it would be better to execute o2 at the site of the image archive, in essence combining o_1 with q_2.

From a general perspective, it makes no difference whether the q_i and o_i are operations inside an envelope or not, because the execution monitor does not interpret them. It merely schedules each operation for execution as soon as its inputs are available and dispatches the execution support for that operation.

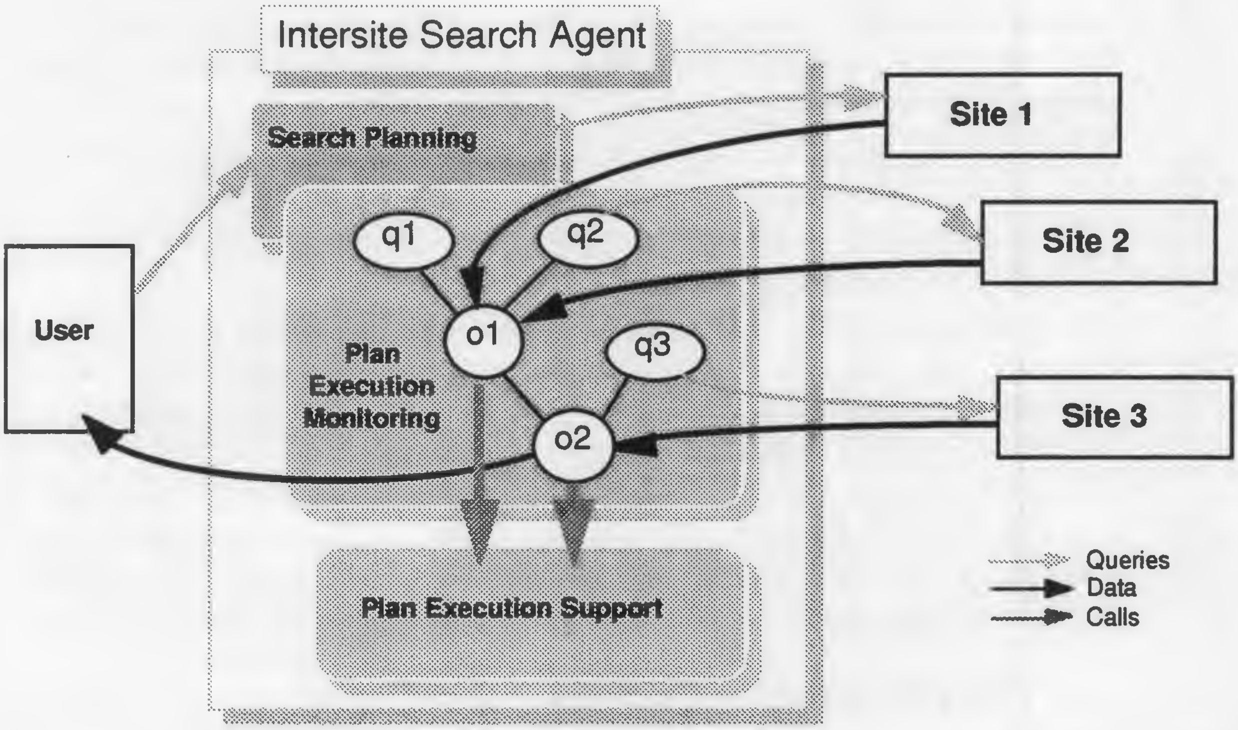

Figure 9. A Search Plan Is A Script Defining A Flow Of Distributed Operations.

That is, the script must contain the information needed by the execution monitor to perform these functions. However, it is irrelevant whether this information is part of the original envelopes sent to a search agent, or whether it was created by a search agent during the query planning stage. For consistency, there should be a single format for describing a script or execution plan and each operation they contain.

To accomplish this, the X^nDIS architecture employs the method of envelopes introduced in Section 3.7. Each 'envelope' describes the requirements of the operation(s) it contains. The execution monitor uses advertising information to determine what kind of execution support is needed to process the operation(s) in the envelope and at which sites it is offered. Of course, the necessary execution support might be available within the execution monitor itself.

These capabilities are not really tied to search plans. They are useful from a general system architecture perspective. Users might want to create a script to execute several intersite operations rather than specifying and executing each operation individually. For example, a operational user might wish to set up an intersite process which retrieves possible oil-slicks from satellite image processing at a ground station when they occur, obtains corresponding meteorological observations from another site, routes both sets of data through some preprocessing, and finally into an environmental prediction model.

Therefore, the X^nDIS architecture includes an intersite service called the Intersite Script Service this is known as the Distributed Information Manager in the EOSDIS design. The scripts are executed by an agent of that service called a Script Agent.. The origin of a script is not relevant for the agent. The intersite script service must provide the following capabilities:

- determine which services at which sites can execute a given script operation;
- select a site and assign a script operation to it;

- label inputs and outputs and identify them to each operation; and
- verify that the format and nature of inputs match the expectations of the services reading them.

3.10. Supporting Search Optimization

The previous discussions raise the following issues. A search agent may discover that the data requested by a user is offered by several sites. A script agent which needs to dispatch an operation may be presented with several alternative providers. How do these agents decide which of the alternatives they should pick? Moreover, a search agent may have alternative ways of decomposing a search. Which of these alternatives should it choose?

Wherever there is a need to decide among alternative execution strategies, there is also an opportunity for optimizing the execution, for example, in terms of cost or response time. The X^{n}DIS architecture does not prescribe how service agents should perform optimization, nor whether they should do so at all. However, the architecture must include provisions which allow the incorporation of components which perform optimization.

Decisions on execution strategy are performed at various layers (see Figure 10). Different layers might want to rely on different information to support their decisions. While creating an execution plan, a search agent may want to rely on size and cost attributes which have been advertised by the data providers. A script agent may find this information insufficient and instead ask providers to supply quotes for the specific operations at hand. Finally, local search interface may use private data available locally to decide on the best strategy for executing a query[2].

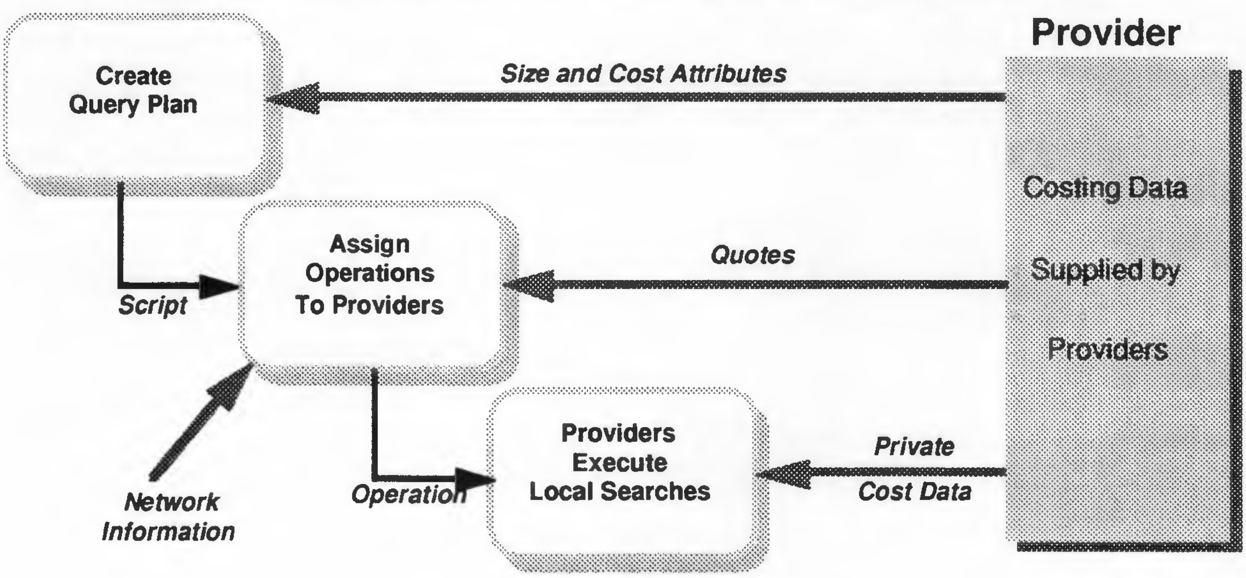

Figure 10. Optimization Decisions Occur At Different Points In The Execution Of A Request.

2 Optimization also may require access to network information in general (e.g., connectivity to other sites or network loading).

The key issue, therefore, is to provide within the architecture, mechanisms for obtaining the information which is needed at each point in the execution. The X^nDIS architecture must provide at least the following three mechanisms for obtaining costing support data[3]:

- through advertisements;
- in response to specific requests for cost data; and
- in response to requests for quotes.

Much of the work on query optimisation in heterogenous distributed databases is still the subject of research, the the architecture must be able to support solutions as they become available.

3.11. Vocabularies and Dictionaries

When submitting searches across a network of data providers, there is always the possibility that the terminology of the user and the target sites differ. The problem is pervasive in text searching and has been studied extensively. However, the problem is not limited to text searching. Different databases may use different names for the same science parameter, the same name for different parameters, or store similar parameters in different constructs. For example, an oceanographic database may store the wind speed over the ocean as "wind speed", whereas some meteorological database may contain a parameter "wind speed" in an array as a function of altitude.

The successful implementation of a general solution to the problems of terminology differences has eluded research, but there are many approaches which can improve the situation. For example, some text search approaches give the user access to a thesaurus so the user can identify the specific meaning of each word in a search. A provider of a database of scientific articles might employ a thesaurus which reflects the terminology of that particular field of science. Text search software would use the thesaurus to establish the meaning of individual words based on the context of surrounding words (e.g., using 'semantic distance'), and then compare that meaning with the meaning intended by the words supplied by the user.

Database queries usually contain constraints which relate some database attribute with some value (e.g., wind speed greater than 35 mph). Different databases may not only store wind speed under different names, they may also employ different units (e.g., mph vs. kmph vs. knots), or they may provide wind speed as part of some other construct (e.g., a three dimensional wind vector from which horizontal air speed could be derived). As a result, solving terminology problems in database querying can be even more complicated than in text searching and may require elaborate mechanisms for semantic mapping.

To address these problems, we recommend that the X^nDIS architecture employ the following concepts.

- It should be possible to formulate text queries in the context of a Vocabulary, and database queries in the context of a Data Dictionary[4]. Search requests should be able to indicate their vocabulary or data dictionary context. However, it should also be possible to perform queries outside a specific vocabulary and dictionary context.
- The architecture should support the coexistence of several vocabularies and dictionaries. It should be possible to make them accessible to the network users, perhaps as a Dictionary / Vocabulary Service.

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3 Throughout this paper, the term 'cost' is used as a general measure of resource consumption, such as processing time, disk space, network traffic, and amount of physical media, not just monetary value.

4 A Dictionary can be viewed as a kind of vocabulary.

- Data providers should be able to advertise their databases in the context of some vocabulary or data dictionary of their choosing. Their advertisements should be able to reflect that context, and a mechanism should be available which allows users to retrieve that vocabulary or data dictionary.

These concepts are illustrated in Figure 11. The search interface software on the user's workstation has been set up to use a specific data dictionary available on the network. It might use it to provide 'help' assistance to the user, set up selection lists, or label menu items and input fields. When the search interface software transmits the search, it inserts an identification of the data dictionary on the search envelope (e.g., a universal reference to the dictionary).

The components through which the query passes can make use of this identification. For example, the request broker may be clever enough to route the search to a service which advertises that it supports this dictionary / vocabulary. An intersite search agent might compare the vocabulary used by the search with that of the site to which the query needs to be sent and provide feedback about potential mismatch to the search interface and user. A provider receiving that query might use the vocabulary information for the same purpose, or might translate the search terms from the indicated vocabulary into that used internally at the site.

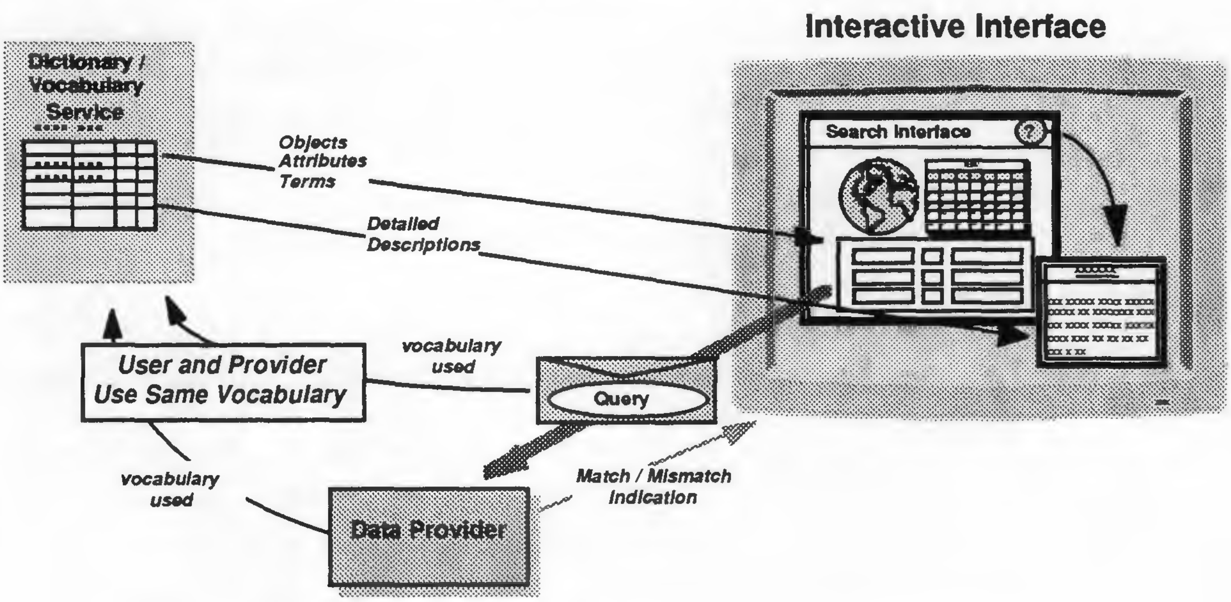

Figure 11. X^nDIS Supports The Concept of Vocabularies And Dictionaries

Data dictionaries may be available directly from data providers for their databases. For example, it may be returned in response to a request for service description (see Section 3.4). Alternatively, a community of users may have decided to establish a common data dictionary and vocabulary as a common reference base and provide access to it as a network service[5]. The fact that the search interface software uses a particular vocabulary could be transparent to users. For example, the community of researchers at a site may decide to set up their user interface such that it uses that particular vocabulary by default.

The X^nDIS architecture allows the use of vocabularies, but it does not mandate it. If a search is sent directly to a specific provider without identifying a particular search vocabulary, that provider may interpret the terms in the

5 It is hoped that at least within GCDIS, Government agencies would mount a concerted effort to converge on a common vocabulary. It would then provide an excellent reference base for the whole network.

search verbatim. The provider may reject the search if any of the terms is invalid, or perform a translation - the assumption is that the user has familiarised himself with the conventions employed by that provider. Network components might assume that the user is aware of the potential vocabulary problems and not issue any warnings.

The availability of vocabularies makes it possible to implement elaborate vocabulary mappings within the network components. For example, a vocabulary may define relationships between terms, such as synonyms, antonyms, and hypernyms (i.e., categorization). A science community may decide that providers should use these capabilities to classify science parameters, e.g., into 'temperature', 'wind speed', etc. A local search interface might substitute the appropriate type of wind speed in a query which simply references the class name; or it may interpret the search as referencing any of the available wind speeds and return them all.

The use of dictionaries and vocabularies should obey the following rules:

- There should be a common protocol for dictionary and vocabulary access. At a minimum, a component should be able to retrieve the complete dictionary or vocabulary, and access the definition of a specific term.
- Dictionary and vocabulary references should be in the form of universal references (see Section 3.7). This allows any network component to gain access to the dictionary or vocabulary.
- The references may point to a specific term. This allows any network component to access the definition of that term.

There is no requirement that all network components must be able to read and interpret dictionaries, vocabularies, or terms. The rules are meant to support those components which have this ability.

3.12. Search Accuracy

In a network environment like EOSDIS (and EEOS), users often submit queries before they know how well the individual data providers can respond to them. The recipient of a query is often asked to process the query as best as possible, rather than rejecting it because it cannot be evaluated accurately. These kinds of searches are known as partial match queries. Examples include the following:

- When users search the network for relevant data, they are often unable to provide an exact search specification. This is because they do not know what exactly characterises the relevant data at each provider. For example, in a text search, the user would include alternative phrases or words describing the same concepts; in a database search, the user might want to try several different names which he thinks might be used for the science parameter he needs. Users will expect to get some irrelevant material, and they are willing to sift through the responses.
- When searches are submitted against multiple data providers, their capability to evaluate the searches may vary. For example, a search may specify an irregular spatial region (e.g., by defining its bounding polygon). Some databases may return data for some larger rectangular region which contains the specified one; other databases may be able to evaluate the search precisely.
- The user may have specified a set of parameters for retrieval. None of the databases offer all of these parameters, but there are several databases which contain various combinations. The user wants each database to return whatever information it has that matches the query, rather than having to specify a separate search for each database.

To assist users in the interpretation of a partial match query result, many search engines rate the accuracy of the results and return the rating to the user. This is typical for text search systems, but it is unusual for database systems. This is because traditional databases do not support the notion of partial match searches and a reference model for rating accuracy is not available.

Data providers may decide to ignore partial match requests (i.e., reject them) or process them in a literal fashion. For example, data providers typically will use a *local search interface* (Figure 4) to translate incoming searches. The design of the translator will decide how partial match queries are handled.

Leaving the decision as to how to interpret partial match queries to the data provider is reasonable. Users already need to accept the fact that different providers will perform partial matches with different levels of accuracy and skill, depending on their internal capabilities. During the translation however, providers can and should derive an estimate of search accuracy. The X^nDIS architecture should permit data providers to transmit these estimates with the search results.

Intersite services must maintain the integrity of the feedback options. Client programs (e.g., user interfaces) can then use the feedback data to rank results on the screen, display comments, and highlight or otherwise mark rows or objects in a result. An intersite agent which manipulates search results may use query feedback to compensate for inadequacies in the local systems. For example, the agent may clip the result into the requested spatial region.

3.13. Subscription Service

Once a user has found a source of data useful for their application, they generally will want to stay current in terms of new data which the provider may bring on-line, or changes to data which the user has retrieved.

Most current systems, with the exception of standing orders, would require that a user repeats queries to get recently added information. This is clearly not practical for operational applications. It would be extremely useful to be able to inform all interested users when a processing algorithm detects a specific phenomenon in a newly acquired image. Another example, would be a user requesting to be informed each time a new product is produced for a specific area of interest.

The X^nDIS architecture supports this by allowing providers to offer a *Subscription Service*. When a provider offers a subscription service, users can indicate their areas of interest, and then receive notifications of new information items in those areas. When users retrieve information items, they can indicate that they want to subscribe to changes (i.e., future releases) of that item. This concept is extremely powerful and in EOSDIS will be used for much of the normal management interfaces as well as a user service (e.g. one site will place a subscription on another to be informed each time the processing plan changes).

Figure 12 illustrates the operation of a subscription service. A subscriber formulates a subscription request for a specific data provider and submits it to the intersite services. The request is routed to the provider. The provider files the subscription and as the changes to the data occur, sends notifications (or the data itself or more likely a Universal Reference to the data) to the user.

The subscription request can identify a recipient different from the user (via a universal reference). For example, the new data could be shipped directly to a program which might analyze the data and inform the user only if new patterns are found.

From a user perspective, the advertising service is a data provider: it contains information about the services and data on the network. Therefore, the advertising service should accept subscription requests, as well. Users might subscribe to the advertising service if they want to be informed of new services and data appearing on the network or if they want to receive announcements of planned changes, regardless of provider.

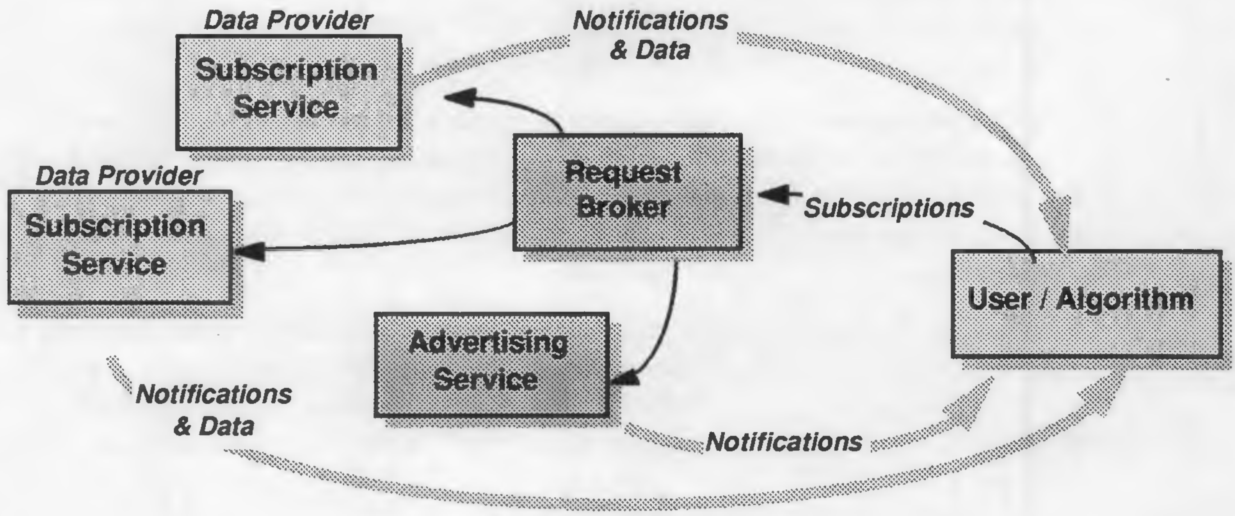

Figure 12. X^nDIS Providers Can Offer A Subscription Service

3.14. Tool And Data Interoperation

The previous section presented an example in which a subscription service routed data newly acquired by the provider directly into an algorithm at the user's site. The user site would have to provide a mechanism to dispatch the algorithm. Presumably, the universal reference which the user supplied for the algorithm actually points to this program launcher and would contain the identification of the program as internal data. The launch mechanism would also have to be able accept the input data, or perhaps open a pipe to this data using a universal reference provided by the subscription service. These capabilities have been postulated in earlier sections, for example, in Section 3.9 they supported the intersite script service.

There is, however, yet another important aspect to this exchange. The data provided by the subscription service must be compatible with the tool requirements in type and format, or the tool will not be able to process the input. For example, a browse tool may expect a single image with eight-bit pixel values, and instead be presented with 36 registered images, each with ten-bit pixel values. Moreover, the subscription service might have been able to deliver the data in the right format, had it only known what the tool's format requirements are.

In response to these problems, the X^nDIS architecture should support the concept of *Data Format Profiles*. The purpose of a profile is to characterise those aspects of a data object (or collection of data objects) which are relevant to data interchange. For example, a profile might include the following:

- data classification;
- format classification;
- format subtypes;
- format version;
- physical encoding (e.g., ASCII, IEEE floating point); and
- instructions and comments.

The syntax of a data format profile must be common across the network. It must be described in a language which is extensible. The meaning of the keywords and keyword values must be agreed upon within the user community.

The main purpose of format profiles is to enable:

- providers to advertise, if they so choose, the formats in which they can provide data;
- programs and users to indicate the format(s) in which they want data, e.g., as a list of preferences;
- a data transfer to indicate the format of the data being transferred.

Although the format profile specification must follow a common convention, not all network components need to understand all specifications. Typically, the profile provided in a request would be matched against the profiles of the formats in which the data can be made available to determine whether format compatible interchange is possible. Profiles also might be used to determine whether there is a conversion which can take an available format as input and produce the requested format as output. For example, if a request profile specifies a keyword 'xyz' which the provider cannot interpret, the provider would assume that it cannot provide the data in the requested format, and might respond with the format profiles it does support.

3.15 Site Capabilities

The preceding sections presented features and components of a data network architecture which was the guiding model for the EOSDIS design. The architecture responds to many user needs, but not to all of them. A number of them are related to capabilities which are internal to a site, or to the internal design of intersite components and are, therefore, not part of the intersite architecture:

- *Supporting contents based searching of earth science data*: This is an important, but very challenging requirement which will be increasingly expressed by users, i.e the archive is seen as a single DBMS which can be queried like a GIS. While it is difficult to support on major archives with today's technologies, the question is not if this capability will be supported by data providers, but when. The X^nDIS architecture is insensitive to the issue at the level defined in this study. However, it will require a search language in which content searches can be expressed. The architecture provides the facilities needed to implement such a language, e.g., schema advertisements and data dictionary services. It is up to providers to determine whether they can offer the capability at their site.
- *Support for site management*: How a site manages its resources and protects them against being overrun by external users is a site-internal decision.
- *Data protection*: The mechanisms which a site employs to protect its data resources are determined by each site individually. The X^nDIS architecture must provide 'hooks' within its protocols to support exchanges between users and providers which may be needed (e.g., for user authentication or conveying copyright information), and should provide support for encrypting or crypto-sealing messages between users and providers.
- *Collaboration support*: It is likely that future networks will provide support for multi-media communications. Examples are desktop video-conferencing and the concurrent manipulation of display objects from multiple sites. The corresponding capabilities and interoperability protocols will be driven by the commercial vendors and the standards they adopt. The architecture presented in this study does not conflict with these developments, but will allow their insertion at the appropriate point of maturity.
- *Service guarantees*: The negotiation of service characteristics is a common feature of most client-service protocols and should be adopted by the X^nDIS architecture to support operational applications. However, the extension to more general performance characteristics such as

throughput and response time is not currently supported by most products and is an open issue[6]. In a large data network, many components participate in the delivery of a service. Architectural provisions needed to support the allocation of throughput and response time requirements across components in an intelligent fashion will require additional research.

- *Openness To Application Methods* The architecture must be open to extension in many areas, but particularly in its ability to support new application specific functionality e.g new retrieval algorithms, data type services etc. The architecture is designed to support the dynamic addition and removal of services but also has some other features which are important (see Section 4.3)

4. EEOS RELEVANT FEATURES

NASA has taken the general architectural concept described above, and interpreted it in terms of the EOSDIS project. The EOSDIS design (NASA, 1994b) identifies specific components to provide the capabilities outlined above in the intersite architecture and to provide the basic reception, archiving, processing, access and distribution functions at each of the service provider sites. This section deals with some of the issues that faced the designers in this activity.

It is stressed that the design solution adopted for EOSDIS is only one of several possibilities. Its solution is rather complex due to some of the sophisticated services that the user community require to facilitate the intensive global change research. Other solutions could be significantly simpler; indeed it would be possible to map much of the above functionality into likely future WWW capability. It is likely that EEOS will be some combination of WWW like capability and more complex services; the exact mix being dependent on the types of services to be offered to the community and the quality of services provision made for each.

4.1 Interconnection Architecture

The architecture described in Section 3 and other EOSDIS requirements implies that the following features be enabled through the mechanisms used to connect providers to users (service provision), users to users (collaboration), and providers to providers (processing dependencies). These features are discussed further in a working paper on the selection of the communications and systems management architecture (NASA, 1994d).

Technology Driver	Importance
Synchronous Interprocessing	basic distributed processing requirement
Asynchronous Messaging	provides efficient utilization of client resources
Static Invocation	another basic distributed processing requirement
Explicit Static Binding	enables direct client access to remote services
Implicit Static Binding	enables client access to services without *a-priori* knowledge of service location
Directory Service Scalability	provides graceful growth of directory elements through ecs lifecycle
Naming Service	enables extension of directory service for identification of remote objects
Security Service	inhibits unwanted intruders - protects resources
Object Technology	essential enabler for advanced distributed and collaborative processing
Time Synchronization	essential for correlation of events across sites

6 The Open System Foundation (OSF) currently has such capabilities on the evolution path of its Distributed Computing Environment (DCE).

Multivendor Interoperability	provides flexibility and evolvability over ecs lifecycle
O/S Transparency	enables technology migration to advanced o/ss
Event Processing	provides efficient distributed processing of all events and error conditions
Concurrency	increases utilization of system resources
Internationalized Security	enables international security extensions
Multiple Language Support	provides application developer flexibility and support for legacy code
Legacy Server Integration	enables reuse of existing applications with minimaltransition difficulty
Dynamic Invocation	enables client access to services without *a-priori* knowledge of the service existence and service access operations
Dynamic Load Balancing	provides efficient assignment of system resources and improves performance
Request Brokering	essential enabler to carry out distributed processing operations with minimal client burden
Server Export/Scaling	provides for advertising of services
Real-Time Collaboration	enables user to user direct interaction
Trading	primary client interface for service negotiation (import) and naming access
Federation Transparency	true open distributed processing hallmark - enables large-scale interworking

A number of options were considered. The best fit was CORBA 2 as recently specified by OMG (Object Management Group) which extends the original CORBA Object Request Broker model to interoperability between different ORBs . This encapsulates some key features that are valuable in the EOSDIS architecture (see Table 1).

Table 1 Comparison of Features in Different Interconnection Approaches

Technology Drivers	EOSDIS V0	DCE	Object Ext. DCE	CORBA
Synchronous Interprocessing	√	√	√	√
Asynchronous Messaging	√	√	√	√
Static Invocation	√	√	√	√
Explicit Static Binding	√	√	√	√
Implicit Static Binding	?	√	√	√
Directory Service Scalability	P	√	√	√
Naming Service	P	F	F	F
Security Service	P	√	√	F
Object Technology	?	P	P	F
Time Synchronization	?	√	√	F
Multivendor Interoperability		√	√	F
O/S Transparency		√	√	F
Event Processing		P	P	F
Concurrency		√	√	√
Internationalized Security		F	F	F
Multiple Language Support		F	P	F
Legacy Server Integration			√	F
Dynamic Invocation			√	√
Dynamic Load Balancing			√	

Request Brokering			√	√
Server Export/Scaling			P	F
Real-Time Collaboration			P	F
Trading				?
Federation Transparency				?

[Key: √ - compliance P - partial compliance F - future compliance ? - incomplete information]

Unfortunately the CORBA specification and subsequent development is not sufficiently advanced to support at least the first two releases of EOSDIS and perhaps the third. Thus the EOSDIS program has to consider a technology migration problem within the core of the entire system. The chosen approach is to identify the minimum number of types of interconnection interface and to provide a stable interface for these for application developers based on the CORBA IDL. These will be implemented initially in an OO form of DCE and then migrated as mature commercial products for CORBA 2 appear. This decision is being readdressed in the light of OMG selecting a non-DCE based solution for CORBA 2, but is likely to remain the chosen approach even though the rework between releases will be higher than if OMG had chosen a DCE compatible approach.

4.2 Schema Management

To allow intersite services to work as described in Section 3, it is essential to define a mechanism by which the schema describing the data types and the permitted operations can be managed throughout the system. If EOSDIS could work in isolation from other data systems, the provider environment could be assumed to be homogenous, and an essentially common schema be defined for the entire system, then a commercial distributed DBMS could be used to provide distributed schema management and much of the inter-site search agent capability. Unfortunately (for the system designers) non of these pre-requisites are true.

The current approach to schema management is shown in Figure 13. The diagram has been modified from the specific EOSDIS components to the generic components described in Section 3.

The key features of this approach are the integration of schema from different data bases at the Local Site Interface and the federation of schema at the Intersite Search Agent (ISA). At a provider site it is assumed that there is a management staff who are knowledgeable about the schema used for each of their databases, and therefore are able to perform the integration (essentially manually). The Local Site Interface is capable of exporting part or all of this integrated schema to a ISA where it is federated to provide an overall schema to support distributed queries between the provider services covered by the ISA. In the early releases of EOSDIS the ISA-like component will provide a limited set of unified common services across all data sets in the system. Later it is expected that the community will provide a wider range of services at other ISA's, but these will be limited to a subset of providers (data sets).

EEOS will face the same problem as EOSDIS in distributed schema management. Indeed, one could argue that it could be more difficult since it has a wider application remit and the providers will not be funded through a single management authority. Although the above approach will cope with a completely heterogeneous environment there is no doubt that there are considerable simplifications and cost savings are possible if a common schema, with an agreed system-wide mechanism for extension, can be defined; even if this only applies within a single domain of the EEOS.

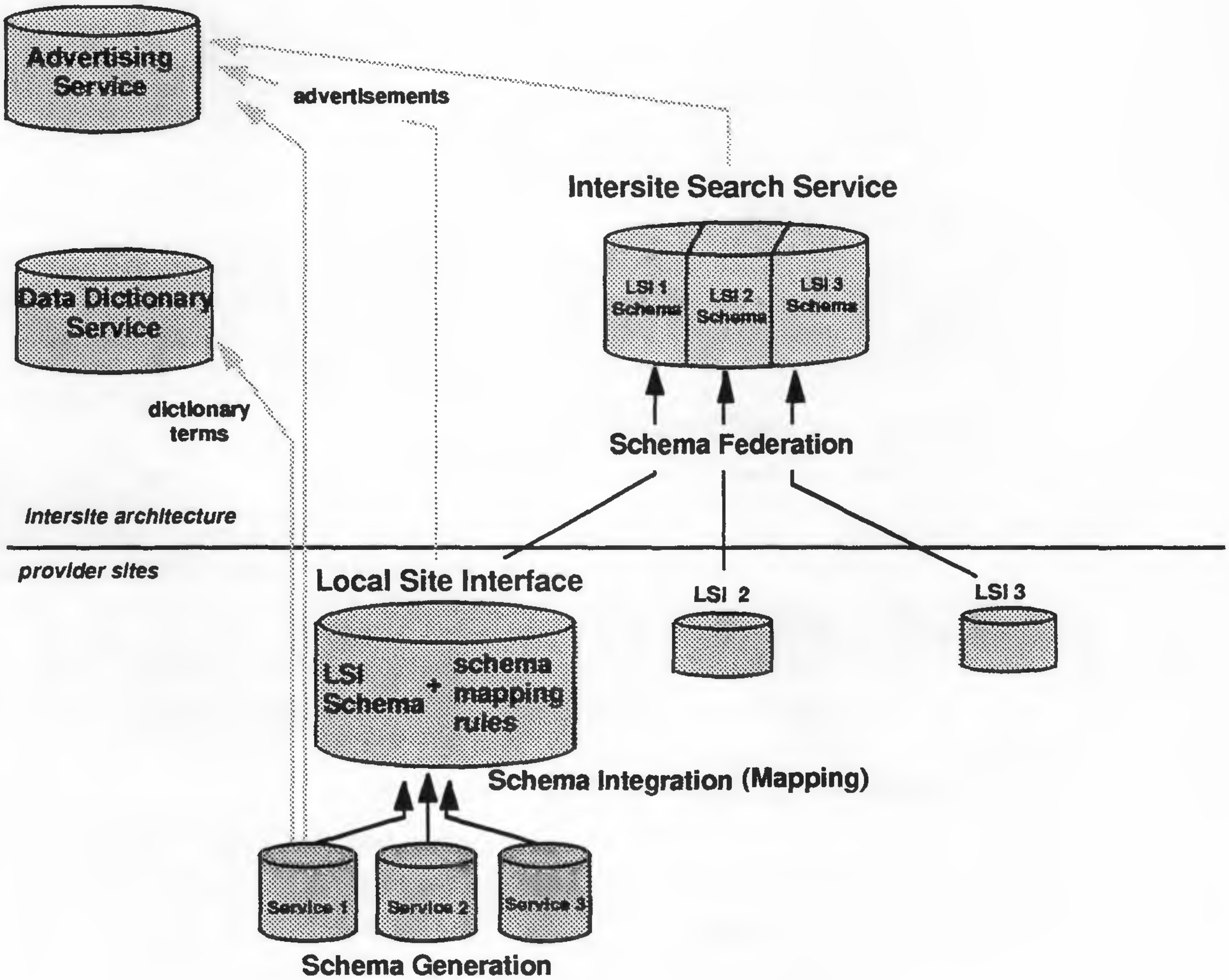

Figure 13: Schema Management Concept within the EOSDIS Architecture

4.3 Designing for Evolvability

This is an issue which was much misunderstood at the start of the EOSDIS project. Evolution is not the same as flexibility. System flexibility is the ability to reconfigure the system to do the same things in different ways. Evolvability is the ability to do new things in new ways. Recognising that EOSDIS is a 25 year programme (10 years development plus 15 years operations), the user community has focused on this issue as a key characteristic that the design and architecture must exhibit. The two principles used for trying to maximise evolvability are open interfaces between components using non-EOSDIS specific standards so that new components can be introduced on a trial basis, and the encouragement of community developments of components.

Evolvability is the key to effectively supporting both the research and operational communities for a network like EEOS:

- The *research* community need to be able to extend the system to enable new theories to be assessed. This might require a new access method (i.e. be able to extract time slices from an archive), or the ability to add a specialised processing algorithm into the standard product chain (e.g. to test new algorithms for performing geophysical extractions).

In addition to the support for adding new operators within the system, an architecture supporting research must also support the ability to bring the results of research back into the system for access by the wider community; e.g.:

- conversion of user methods into standard products
- acceptance of experimental results in terms of calibrations, papers etc., as part of the information archive

If the architecture could support this interaction it would be a part of the research process and the system would inevitably benefit from expanding knowledge base that is generated. Alternatively, it will simply be a tool used by research scientists which will tend to always fall behind what the science community needs to do to make efficient progress, and revert to the receive, standardised processing, archive and deliver paradigm which has .only been marginally effective in supporting the progress in earth science research.

- The argument for community extension of the system is even stronger for the *operational* community. Currently if a potential operational application does not fit the limited flexibility of the standard processing and user service capability built into the system it is extremely difficult to get the required support from the data network; even when the controlling authority is also keen to see the network support the application. Thus the second biggest constraint on the development of operational applications[7] has been the inability of the ground facilities to respond to the reconfiguration and quality of service needs of application developers. This might require:
  - the addition of new processing algorithms at various points in the ground station to user data flow
  - the addition of new archive access/analysis mechanisms
  - reconfiguration of parts of the network to support guaranteed quality of service (bandwidth, processing latency etc.)

It should be clear that although there are significant differences between the objectives of the research and operational community needs there are also many similarities in their need to be able to extend and reconfigure the system to meet changing needs.

The 'openness' of the data network to extension is clearly more than utilising an 'open' computing architecture, the architecture must also support application (i.e. EO) related extensions; which may be developed by the management authority(s) for the network, a single service provider, or a user. The definition of openness should be the ability of the network architecture to accept new data types and new services developed outside of the EEOS project with the minimum of software development and system reconfiguration.

The EOSDIS architecture has a number of features specifically designed to open the system to community extension; it is unlikely that these features will meet every need, but they should allow a significant change in the way the data system is used and can evolve over time; i.e. the user community drive the evolution directly.

Some examples of the EOSDIS features that support 'flexibility' and 'evolvability' are:

- **Subscriptions**

  Many of the EOSDIS services has by default a subscription capability. This means that a user (or another system component) can subscribe to it such that on a particular event that is monitored by that service a particular action can be initiated (see Section 3.13). This will have a major effect in both the research and operational communities. Both communities will be freed from the inefficient searching, processing and retrieving all candidate data to only that which matches some criteria of interest. At its simplest this functionality replaces the standing order concept i.e. get me

7 The biggest constraint being the lack of operational satellite systems .

all data which covers region X with a cloud cover less than Y, but its generality provides the community with much more power as described below in the section on user methods.

- **Community Method Integration**

  Each archive is being represented as a collection of related data; the data includes what is traditionally considered to be the data (i.e. standard products), but also the metadata, calibrations, browse products, algorithm details, etc. There were several reasons for doing this which are beyond the scope of this paper (see, NASA 1994c, Ordille, J., and B. Miller, 1993, Stonebraker, M. and L. Rowe, 1986). However as a result each collection is a set of different types of objects. Each data 'type' has a different set of services associated with it. These are the services that are ultimately advertised to users (see Section 3.3). NASA will develop type services which meet much of the traditional service capability (e.g. browse, subsetting, search etc.), but will also provide an programmers interface to these types so that third-party type services can be developed, delivered to the provider site and integrated with the rest of the provider services.

  For example, a research user would be able to deliver a user method which implemented the latest and greatest geopyhsical retrieval algorithm to process at the archive, and an operational application developer would be able to insert a specialised subsetting routine to ensure that only relevant data is extracted from the archive.

  Community methods are particularly powerful when combined with subscriptions. For example, a method could be developed to look for a particular environmental phenomena (e.g. internal waves, algal blooms, oceanic gyres, etc.) and integrated into the system. The user would also place a subscription against this method; which is part of the functionality provided by being a network services. As the data is received at the ground station, or in the archive after standard processing the method would be routinely applied. If the phenomena is detected by the user supplied method, a subscription event is activated and a universal reference to the data of interest is sent to the user (by email or some other mechanism). The user can then use the universal reference to retrieve the data.

- **Adaptive Data/Process Interaction**

  One of the potential advantages of the intersite service agent concept is that the decision about where to apply an operation to some data can be applied adaptively. To take a simple example; if a single image needs to be subsetted then it could be performed through some toolkit at the user's site, but if the request was to perform the subset on a complete year's worth of images then this should be done either at an archive or some other processing site that has the capacity and power to do this. EOSDIS has been designed such that as intersite components develop in sophistication they will be able to construct service plans (see Section 3.5) which adaptively pass data to the operator or the operator to the data depending on the type and scope of the request.

  This capability might also be extended to support the notion of network wide collaborative processing (i.e. a particular important operation is distributed over many provider sites at non-peak hours) and the possibility of incorporating European super-computing centres into the network.

4.4 Domain Specialisation

The EEOS objectives have a wider remit than EOSDIS. In many ways it is more equivalent to the GCDIS concept, with a higher degree of autonomy from service providers. Within this environment there will inevitably be domains where local heterogeneity is sacrificed to a lesser or greater extent to allow more sophisticated services to be permitted. Domains within a network such as EEOS might cover discipline (vertical) needs (e.g. an oceanographic research domain) or quality of service (horizontal) needs (e.g. reliable and fast access to Europe's major EO data archives). The definition of an initial set of domains and providing the mechanisms by which new domains can emerge would seem to be one of the main early challenges facing EEOS.

Some EOSDIS features which support the notion of multiple domains within the network are described below:

- **Service Provider Interface**

  The primary service providers within EOSDIS as the initial releases are completed will be the Distributed Active Archive Centres (DAACs). However as the system develops it is expected that many of the Science Computer Facilities (SCFs) will start offering specialised services based on local developments.

  To support this the EOSDIS design includes a *service provider interface specification.* This defines a number of levels of interface to which a service provider might commit too. This ranges from simple advertising of a service (e.g. ftp access to some interesting research results) to a full EOSDIS interface with multiple services that can be accessed with the complete set of EOSDIS protocols. Following the Internet analogy it is the intention that 'community interest' groups of users and service providers (e.g. oceanographers) can define a domain sub-network which can encompass some of the DAACs (that contain relevant oceanographic data) as well as organisations within the community, and who will define a level of service that will be uniformly exist across the sub-network. These sub-networks will also take account of the other domain related features described below.

- **Domain Specific Intersite Services**

  NASA will produce an intersite search agent (see Section 3.5) which will provide a core service to search across all providers within EOSDIS. This will provide a basic access service for all EOSDIS users. To support the establishment of domains within the network which provide more advanced services the architecture has been defined to permit the development of other intersite search agents which can provide additional inter-site services across subsets of the data and/or service providers.

- **Advertising**

  The Advertising Service will support a flexible classification of services. This could be used to create a domain of all oceanographic services, or all services suitable for the educational community etc.

- **Multiple Vocabularies**

  As described in Section 3.11, the architecture has also been defined to support a vocabulary service which can a) access different dictionaries and b) have within it different contexts based on the service being used. This functionality can be used to create and use a domain specific vocabulary. Thus a generally applicable vocabulary used at the EOSDIS level could be extended with a more detailed oceanographic vocabulary which are only accessible for the oceanographic related services.

4.5 EEOS/EOSDIS Interoperability

As described in Section 2, the development of EO applications whether for research or operations, will not be an international activity. It will be important that European users whose primary data network access is through EEOS, can use this network to access data/functions within other networks that have important and unique data sets. Although EOSDIS is only one of several networks being planned (e.g. EOIS, CEONet, AEONet, etc.) its size and scope will mean that it is probably the most important to be interoperable with.

Interoperability should be two way, not only to support the bi-lateral collaboration with NASA, but also to make important European datasets more accessible, whether it is on a commercial or research basis.

In the worst case the EEOS and EOSDIS would follow entirely different architectural and data models. This would require the development of gateways for all services which is expensive because it will mainly be custom code development and this will inevitably reduce functionality that is available between the two networks, i.e. the gateways would only support a core subset of service functionality. While this approach is achievable[8] and does add significantly to the capability of both networks it is far from ideal.

Obviously it would be much easier if both networks followed the same architectural framework - since the framework summarised in Section 3 is designed to deal with incompatibility between services and service providers. For example, if both networks used the concept of an advertising service that was broadly compatible a simple gateway could provide a transformation of advertisements such that EOSDIS services could be advertised within EEOS and vice versa. This would fairly easily and relatively transparently enable users to access services from the union of both networks. It would not of course deal with incompatibilities in such things as user interfaces, data types, etc. The more agreement the development authorities have about the network design the easier interoperability will be to implement, and consequently the level of service to users (assuming finite development resources) will be higher. The most critical areas where agreement will have the most beneficial effects are:

- protocol suite
- data model
- the number of data formats required
- common inter-site components (e.g. advertising service)
- common API at the data type service level

5. Conclusion

EOSDIS and EEOS are facing similar but not identical architectural and design issues. In developing a generic architectural framework before producing a specific architecture for EOSDIS, NASA have provided an opportunity for other organisations involved in development of earth science networks to consider the applicability of the generic approaches to other network developments.

There is a significant body of architectural and design details being generated for EOSDIS which will be valuable material to assist in the development of the EEOS concept and later in its design. Given the importance of EEOS to the success of European capability in EO it would be inappropriate to ignore both the positive and negative aspects of the EOSDIS design.

Finally, EOSDIS will be a critically important data network for users of EO data for the next 30 or more years. A high level of two-way interoperability between EEOS and EOSDIS must be designed into both networks at the outset to ensure that the inevitable differences in two independently developed system does not continue to propagate the constraining boundaries between data networks.

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13 Dec	Keynote	• **The telecommunications regulatory framework in the European Union (T Howell, DGXIII)**

The telecommunications regulatory framework in the European Union

Name: T.Howell
Affiliation: DGXIII
Abstract:

The following is the table of contents of the full paper:

1. Introduction
2. The 1987 Green paper
3. Liberalisation of the telecommunications market
    1. Terminal equipment
    2. Services
4. Open Network Provision: the framework for harmonisation
    1. The ONP framework Directive
    2. Specific ONP Legislation
    3. Further areas for ONP application
    4. Mutual recognition of licences
5. Satellite communications
    1. Liberalisation of the earth segment
    2. Access to the space segment
    3. Satellite personal communications
6. Mobile and personal communications
7. Main developments in specific areas
    1. Frequencies and numbering
    2. Data protection and privacy
8. The 1992 review of the sector
9. The future regulator agenda
    1. Universal service
    2. Tariff rebalancing
    3. Network interconnection
    4. Personal communications and multimedia
    5. Infrastructure liberalisation
10. Conclusion

13 Dec	Keynote	• **EEOS Views from the Value Added Industry (C Borg, SSC)**

EEOS Views from the Value Added Industry

Name: Mr.Claes–Goran Borg
Affiliation: SSC – Swedish Space Corporation
Abstract:

From the vantage point of 20 years of experience in commercializing Earth Observation and close relations with many of the key Value Added companies, the presentation will concentrate on two major issues:

1. How can Value Added companies contribute to the development of the European Earth observation data services?

2. What role should the commercial sector play in the operational European Earth Observation System (EEOS)?

Today we have very few real end users. Thus we lack users beeing really able to define valid user requirements. The Value Added industry has however vast experience and could act as substitute users help put priorities on developing the data services and for defining European standards for accessing and untilizing Remote Sensing data. The presentation will give some examples.

Furthermore, in developing EEOS, User Communities in various applications have to be created. The Value Added sector can be instrumental in setting up and initially running these either as projects fully founded by the Commission or as shared cost actions.

Finally, the way to operationalize EEOS is critical. What should be done centralized or on a regional scale? Which are the national priorities in this field? An open and constructive dialogue is essential between all parties concerned (ESA, the Commission, national agencies, scientific, operational and commercial users, as well as the commercial Value Added industry). The presentation will give some views on the definition and implementation process and on the role of the private sector in the operational EEOS.

2. The 1987 Green Paper

By issuing the Green Paper on the development of the common market for telecommunications services and equipment in tune 1987, the Commission originated a Europe-wide debate on the telecommunications regulatory environment, with the basic aim to adapt it to the requirements of a single European Community (EC) market.

In the Green Paper, the Commission proposed the introduction of more competition in the telecommunications market combined with a higher degree of harmonisation in order to enjoy to a maximum extent of the opportunities offered by a single EC market, in particular in terms of economies of scale.

The Green Paper proposals received a broad general support from the market actors – operators, users, manufacturers and service providers. On the basis of this favourable reaction, the Commission prepared a programme of action which was supported by Council(4) and the other institutions of the EC, i.e. the European Parliament and the Economic and Social Committee. This programme included the following actions:

- Rapid full opening of the terminal equipment market to competition;
- Full mutual recognition of type-approval for terminal equipment;
- Progressive opening of the telecommunications services market to competition;
- Clear separation of regulatory and operational activities in the Member States to conform with the EC Treaty competition rules;
- Establishment of open access conditions to networks and services through the Open Network Provision (ONP) programme;
- Establishment of the European Telecommunications Standards Institute (ETSI), in order to stimulate European standardisation;
- Full application of Community's competition rules to the sector.

These actions have subsequently been implemented to a large extent through the adoption of a series of legislative measures.

3. Liberalisation of the Telecommunications Market

3.1 Terminal Equipment

In accordance with the Green Paper outcome, the terminal equipment market was the first to be open to competition This was done through a Directive adopted by the Commission in May 1988 (5) removing the special and exclusive rights to import, market, connect, bring into service and maintain terminal equipment existing at that time in the Member States.

As a further measure to support an open Community–wide market for telecommunications terminals, the Council adopted a Directive in April 1991(6) establishing procedures for Europe–wide type approval based on a mutual recognition arrangement. This allows terminal equipment which has been approved against European Common Technical Regulations (CTRs) based on harmonised European standards to be sold and used freely throughout the Union.

The first two CTRs under this Directive were adopted in September 1993(7) and relate to type approval of terminals for the pan–European digital cellular system – GSM.

Support must be given, pending adoption of full CTRs, to market–driven initiatives, such as development of interim CTRs, as a means of rapidly deploying new technologies and services in the market.

3.2 Services

The opening of the telecommunications services market to competition was initiated by the so–called Services Directive(8) adopted by the Commission in June 1990. This Directive provided for the removal of special or exclusive rights granted by Member States to Telecommunications Organisations (TOs) for the provision of a number of services, including:

- **data services;**
- the commonly designated **value–added services;**
- **voice services for corporate communications** (so–called 'closed user groups').

This Directive has allowed Member States to maintain the monopoly of TOs over the supply of the **public voice telephony service**, on the basis that immediate liberalisation of this service, which represented around 85% of the total revenues of TOs, could damage the financial stability of the incumbent TOs and thus preventing them from ensuring the provision of an universal network. However, it was explicitly recognised in the Directive that further change might be necessary, and that the situation in the telecommunications sector should be assessed further during 1992 (see chapter 8).

A number of services were excluded from the scope of this Directive:

- **telex**, a service which use is gradually declining throughout the Union owing to the emergence of competing means of telecommunication such as telefax;

- **satellite communications**, also excluded from the scope of the 1987 Green Paper proposals and subject to a specific Green Paper which was published later (end of 1990):
- **mobile communications**, still at an early stage of development at that time, and also subject to a specific Green Paper published earlier this year.

In view of the introduction of competition, the Directive also required the **separation of regulatory and operational functions**, which were at the time accumulated by the Tog in order to eliminate their double role of referees and players. This separation, already proposed in the 1987 Green Paper, has been one of the most far-reaching provisions of this Directive (and of EU telecommunications policy in general), as it established an arms' length relationship of the Tog with the State, creating the necessary conditions for deep organisational reform of the sector.

This separation of regulatory and operational functions has now been implemented in almost all Member States, particularly through the creation of government departments and/or independent agencies to handle regulatory matters, with day to day operation of the business firmly in the hands of the Tog. This separation is often supported by the conclusion of management contracts between the State and the incumbent TO.

The liberalisation of the telecommunications market was complemented, in accordance with the outcome of the 1987 Green Paper, by the establishment of a framework for harmonisation aimed to ensure open access to the network resources and services still provided under restrictive arrangements or subject to monopoly provision, whilst at the same time harmonising the methods and conditions of access to remove barriers to pan– European supply of services and equipment. This framework is **Open Network Provision (ONP)**.

4. Open Network Provision: The Framework for Harmonisation

4.1 The ONP Framework Directive

Open Network Provision (ONP) is the Union policy framework aimed at harmonising conditions for open and efficient access to and use of public telecommunications networks and services, in order to promote European–wide telecommunications services and to create conditions for open and fair competition in telecommunications services.

The principles which these harmonised conditions must comply with were laid down in the so–called ONP Framework Directive(9), adopted by Council in June 1990 – simultaneously with the adoption by the Commission of the Services Directive (90/388/EEC)(10) –, with a view to ensure an appropriate balance between liberalisation and harmonisation in the Community.

These principles establish that ONP conditions must:

- be based on objective criteria;
- be transparent and published in an appropriate manner;
- guarantee equality of access and be non–discriminatory, in accordance with Community law.

The ONP Framework Directive also specified that ONP conditions should apply to the three following main areas:

- technical interfaces, in particular the encouragement of the use of European standards or, in their absence, international standards;
- usage conditions (e.g. delivery period, quality of service, maintenance, etc.) and supply conditions (e.g. conditions for resale of capacity, shared use or interconnection, etc.)
- tariff principles, in particular cost–orientation and unbundling.

This Directive also introduces the concept of'essential requirements', which are defined as non–economic reasons in the general interest which may cause a Member State to restrict access to the public telecommunications network or services. These reasons are the following:

- security of network operations;
- maintenance of network integrity;
- inter operability of services, in justified cases;

- protection of data, as appropriate.

The ONP Framework Directive also included a provision on the review in 1992 of the progress in the achievement of the objectives of the Directive (see chapter 8).

4.2 Specific ONP Legislation

The ONP Framework Directive further set a timetable for action, identifying the need for specific ONP Community legislation applying the general ONP principles to specific areas, which has now been, or is in the process of being, adopted:

1. A **Directive on the application of ONP to leased lines(11)**, adopted by Council in June 1992. One of the main aims of this Directive is to ensure the availability throughout the Union of a minimum set of analogue and digital leased lines up to 2 Mbit/s with harmonised technical characteristics, with the intention to consider higher–rate leased lines as the market develops. It also aims at eliminating technical restrictions for the interconnection between leased lines and public telecommunications networks.

   Additional relevant provisions concern:
   - availability of information on technical characteristics, tariffs, supply and usage conditions, licensing and declaration requirements, and conditions for the attachment of terminal equipment;
   - establishment of common ordering and billing procedures throughout the Union;
   - implementation of cost accounting systems by TOs in order to assess compliance with the basic principle of cost orientation of tariffs;
   - setting up of a conciliation procedure involving the Commission for the resolution of disputes related with the implementation of the Directive to be used when requested by users.

2. A **Recommendation on the application of ONP to public packet–switched data services (PSDS)(12)**, adopted by Council in June 1992. This Recommendation calls upon Member States to ensure that on their territory a minimum set of packet–switched data services with harmonised technical characteristics is provided, taking into account market demand. This Recommendation also deals with transparency of information, harmonised tariff principles and quality of service issues;

3. A **Recommendation on the application of ONP to ISDN(13)**, adopted by Council in June 1992 This Recommendation calls upon Member States to ensure that on their territory an ISDN with harmonised access arrangements and a minimum set of ISDN offerings according to ETSI standards is provided, together with adequate and efficient inter operability between ISDNs in order to allow for Community–wide operation. As for PSDS, this Recommendation also deals with transparency of information, harmonised tariff principles, quality of service issues and, in addition, numbering;

4. A **proposal for a Directive on the application of ONP to voice telephony services**

(14), for which Council reached a common position in June 1993. This Directive aims to establish the rights of users, to improve access to the public telephone network infrastructure for all users (including service providers), and to enhance Community–wide provision of voice telephony services.

The scope of this proposal goes further than the ONP Directive on leased lines, including further provisions, mostly arising from the bigger social nature of the voice telephony service. These consist in:

- definition at national level of targets for supply time and quality of service;
- provision of advanced facilities;
- discounts, low–usage schemes and other specific tariff provisions;
- availability of itemised billing;
- access to and use of directory services;
- provision of public pay–telephones;
- harmonisation of telephone pre–payment cards;
- specific conditions for disabled users and people with special needs;
- numbering issues.

4.3 Further Areas for ONP Application

The ONP Framework Directive identified also a number of other areas as potential candidates for the application of ONP conditions, for which studies have recently been carried out for the Commission:

- Mobile services;
- New types of access to networks, including intelligent network functions and network management;
- Broadband networks.

The results of these studies have been compiled in an Analysis Report published by the Commission in July 1994, which will be subject to a three months public comments period. The Commission expects to receive comments from a broad range of market actors, including TOs and service providers, manufacturers, users and consumers and regulators. On the basis of this public consultation, the Commission then will take decisions on the future application of Open Network Provision to these areas.

It is foreseen that this future application will be on the basis of voluntary standards aimed at promoting the availability of offerings on a pan–European level in these areas.

4.4 Mutual Recognition of Licences

The ONP Framework Directive also set out the establishment of a mutual recognition regime of declaration and/or licensing procedures for telecommunications services, in order to remove internal barriers to trade in services within the Union On this basis, the Commission prepared a proposal for a Directive on the mutual recognition of licences of telecommunications services(15).

which is currently being discussed with the European Parliament and Council.

The aim of this Directive is to establish full mutual recognition based on Europe–wide harmonisation of licence conditions by service category, allowing service providers meeting these conditions to operate throughout the Union. For the period during which harmonised licensing conditions are being prepared, the proposal establishes a so–called one–stop shopping procedure to facilitate applications for licences in different Member States.

Licences for the provision of public voice telephony, satellites and mobile communications fall outside the scope of this proposal: public voice telephony services are not still liberalised in the Union and satellite and mobile services have independent treatments in Union's telecommunications law (as explained in the two following chapters).

5. Satellite Communications

Satellite communications was one of the areas identified by the 1987 Green Paper as needing specific attention with a view to define a common policy in the Union. As a result, the Commission published in November **1990** the Green Paper on satellite communications(16) setting out such policy orientations.

This Green Paper basically proposed the extension of the principles of European Union's telecommunications policy to the satellite area, namely concerning the liberalisation of the earth segment, access to the space segment and commercial freedom for space segment providers. The goals set out were endorsed by Council at the end of 1991(17).

In line with this, the following results have been achieved up to now:

5.1 Liberalisation of the Earth Segment

Satellite services and equipments had been left out of the scope of the two previous Directives opening the markets for telecommunications services and terminal equipment (90/388/EEC and 88/301/EEC)(18). A draft Commission Directive(19) including satellites in the scope of these two Directives is currently under consideration. The aim is to introduce competition in the areas of satellite services and equipment by withdrawing special and exclusive rights given to specific undertakings.

Furthermore, a Directive introducing mutual recognition of type approval of satellite earth station equipment was adopted by Council in October 1993(20). Again, the scope of the previous Directive on mutual recognition of type approval of telecommunications terminal equipment (91/263/EEC) was extended to satellite equipment.

In addition, a proposal for a Directive on the mutual recognition of licences for satellite services(21) is currently being discussed with the European Parliament and Council, which is closely related with the proposed Directive on the mutual recognition of licences for general telecommunications services also under discussion (COM/94/41).

5.2 Access to the Space Segment

A Communication further elaborating policy for access to the space segment capacity has been published by the Commission in June 1994(22).

This communication analyses the present state of the sector and lists the key issues that need to be addressed by a European Union policy with a view to secure Europe's potential to participate in the development of the new satellite communications technologies and to maximise the potential of the sector for developing the Union's communications infrastructure as a whole.

On the basis of the analysis set out in this Communication, the Commission considers necessary:

- ensuring direct access to the space segment, including in particular space segment provided by the International Satellite Organisations (EUTELSAT, INTELSAT and INMARSAT);
- joint action by the EU Member States in the reform of International Satellite Organisations and in particular of EUTELSAT;
- joint management in the future of the space segment as a common resource of the Union, in particular concerning future applications to the ITU(23) for orbital positions and related co-ordination procedures and availability of radio-frequencies;
- the establishment of measures in order to ensure comparable and effective access to third countries, in parallel to the Union's market liberalisation;
- inclusion of satellite-based services in programmes for Trans-European Networks as a major priority in particular with regard to the new technology developments.

5.3 Satellite Personal Communications

In the light of recent attention to the subject of satellite personal communications, in particular through systems comprising low-earth orbiting satellites (LEOs), the Commission has produced a Communication on this subject(24).

On the basis of this Communication, Council adopted a Resolution(25) in December 1993 emphasising the importance of developing a Community policy in this area and smiting the Commission, among other things, to investigate the significance of satellite personal communications in the formulation of Union policies for telecommunications, space, trade, industry and regional developments and, where necessary, to propose appropriate measures and/or actions.

Two elements that will receive particular attention in the Commission's approach, in accordance with the Resolution, are the competitive position of the European industry and the regulatory framework both within the Union and on a global level for global telecommunications ventures.

6. Mobile and Personal Communications

In response to the imperatives of the EC internal market, specific measures were taken as early as 1987 in order to promote the Union–wide introduction of GSM (the European digital cellular communications system), DECT (the European digital cordless communications systems and ERMES (the European digital radio–messaging system). Council Directives(26) were adopted to set out common frequency bands to be allocated throughout the Union to ensure pan–European operation of these systems, together with Council Recommendations and Resolutions(27) promoting the co–ordinated introduction of services based on these systems.

The major development for mobile communications has been the publication by the Commission in April 1994 of a Green Paper setting out guidelines for an Union policy on mobile and personal communications(28). This Paper builds on the current European successes in the field of digital mobile communications and proposes the extension of the basic principles of Union telecommunications policy to this sector.

The global aims of this Green Paper are:

- to permit the **development of a Union–wide market for mobile services, equipment and terminals**, and the identification, where required, of common principles for achieving this objective in relation to the provision of mobile infrastructure, the development of mobile networks and services, and the supply and operation of mobile terminals;
- to promote the **evolution of the mobile communications market into mass personal communication services**, with particular emphasis on pan–European services;
- to facilitate and promote the **emergence of trans–European networks and services in the sector**, and to ensure that such development is achieved in a manner consistent with public interest.

The Green Paper proposes five major changes to the current environment for mobile communications in the Union in order to remove the existing barriers to further development of the sector:

1. **abolishing remaining exclusive and special rights in the sector**, subject where required to appropriate licensing conditions;
2. **removal of all restrictions on the provision of mobile services** either by independent service providers or through direct service provision by mobile network operators This means that service providers should be allowed to combine different services provided under different licences (such as GSM telephony and paging) and to provide services in different member States;

3. **full freedom for mobile network operators to operate and develop their own networks**, including the right to self–provide or use third party infrastructure to operate their mobile networks, and the removal of restrictions on sharing infrastructure;
4. **unrestricted combined offering of services via the fixed and mobile networks**, within the overall time schedule set by Council Resolution on the 1992 review of the situation in the telecommunications sector for the full liberalisation of public voice services via the fixed network (see section 8);
5. **facilitating pan–European operation and service provision.** This should include further development of mutual recognition of type approval of mobile terminal equipment, as well as co–ordination of licensing and award procedures, where appropriate, to facilitate development of trans–European networks.

This Green Paper is intended to launch a broad public consultation of all actors in the sector which will take place during this Summer, leading to a report by the Commission in Autumn on the results of this consultation process, including future concrete proposals for regulatory measures.

7. Main Developments in Specific Areas

7.1 Frequencies and Numbering

The Council has expressed the view that the overall management of frequency and numbering resources in a competitive pan-European environment is best co-ordinated in a Europe-wide context, through Resolutions adopted respectively in June 1990(29) and November 1992(30).

The goals set out by Council call for the development of a co-operation framework based on CEPT(31) co-ordination mechanisms and the establishment of procedures for consultation of all interested parties. Further to this initiative, some important developments have already taken place:

1. In the **Frequency** field:

    - The European Radiocommunications Office (ERO) has been set up under the CEPT European Radio Communications Committee (ERC), being located in Copenhagen;
    - A mechanism was adopted in October 1992 under which the CEPT members commit themselves to implement ERC Decisions concerning radio-frequencies. This mechanism was supported by the EU Council as the primary means of Europe-wide frequency co-ordination in November 1992(32), requesting that the Commission give its full consideration to this mechanism;
    - By way of response, the Commission has adopted in September 1993 a Communication(33) setting out the principles governing Union action and Commission proposals on radio-frequencies. These are linked to meeting communications needs in the single market, achieving Union-wide markets for radio equipment and ensuring common Union positions at global frequency co-ordination conferences.

2. In the **Numbering** field:

    - The European Telecommunications Office (ETO) has recently been set up under the CEPT European Committee for Telecommunications Regulatory Affairs (ECTRA), also being located in Copenhagen;
    - The regulatory basis for this framework stems from the requirement in a competitive environment for control of national numbering schemes to be the responsibility of national regulatory authorities, in accordance with the Council common position on the ONP Voice Telephony proposed Directive.

The relationship of the Commission with these CEPT institutions is being formalised. A memorandum of understanding (MoU) with the ERC and a framework contract under which the Commission can issue requests and funding for the carrying out of technical work to the ERO was signed at the beginning of April 1994. As a result of this agreement a number of work requirements have now be given to ERC/ERO, concentrating in particular on the designation of harmonised frequency bands for DCS 1800 services, the TETRA system and in the field of Terrestrial Digital Audio Broadcasting. Similar developments will shortly take place with respect to ECTRA and ETO.

Other important developments in the numbering area have been the introduction of specific Europe–wide numbers, such as a common emergency call number ('112') and a common international telephony access code ('00') (through two Council Decisions(34)). The introduction of these common numbers was justified by the requirements of the EU internal market, specially concerning the free circulation of people and the increasing needs for communication from foreign Member States.

7.2 Data Protection and Privacy

Commission proposals for a general Directive and a specific telecommunications Directive on privacy and data protection were originally tabled in 1990. The specific Directive applying the general data protection principles to telecommunications was proposed in response to growing concern over the potential impact of new digital networks. It aims at a basic level of protection of personal data and privacy for the user, whilst maintaining the right of the user to 'information self–determination'.

Negotiations on the general Directive are continuing within the European Parliament and Council, while a simplified version of the specific telecommunications Directive was proposed by the Commission in June 1994(35), in accordance with the bigger role accorded to the principle of subsidiarity in the framework of EU law.

In the specific telecommunications Directive the Commission proposes in particular to:

- limit the period of storage of sensitive billing data which would allow a subscriber to be identified;
- require per line or per call elimination at the caller's request of Calling Line Identification;
- Limit call forwarding to a third party number only with the consent of the third party and provide a right not to receive unsolicited calls.

8. The 1992 Review of the Sector

At the time of the simultaneous adoption of the Services Directive (90/388/EEC) and the ONP Framework Directive (90/387/EEC) in 1990 it was recognised that further change would be necessary and that the situation in the sector should be reviewed in 1992.

That '1992 Review'(36) and the subsequent broad public consultation took place **during 1992 and early 1993**, and resulted in a Commission Communication(37) drawing conclusions from the consultation and proposing a concrete timetable for the full development of the telecommunications sector in Europe. These proposals were endorsed by Council in a Resolution adopted in July 1993(38).

The Council Resolution confirmed that:

- **the provision of all public voice telephony services should be liberalised throughout the Union by 1 January 1998**. Additional transition periods of up to five years were granted to Spain, Ireland, Greece and Portugal, in order to allow these countries to achieve the necessary structural adjustments, in particular of tariffs, and a possible additional period of up to two years may be granted if justified, to countries with very small networks (e g Luxembourg);

- **the Open Network Provision (ONP) principles should form the basis for the future regulatory framework in the Union, and should be adapted as necessary in the light of further liberalisation in respect of the entities covered and issues such as universal service, interconnection and access charges;**

- **a policy on mobile and personal communications should be set out in the respective Commission's Green Paper**, adopted later (April 1994);

- **a policy on provision of telecommunications infrastructure and cable TV networks should be worked out**, based on the result of a broad consultation process following the **publication by the Commission of a Green Paper by the end of 1994.**

The Council further requested the Commission to prepare **by 1 January 1996** a package of measures designed to adjust the Union regulatory framework in the light of the 1998 liberalisation of public voice telephony services.

9. The Future Regulatory Agenda

The future agenda for European Union's telecommunications policy will be dominated by the follow–up of the conclusions of the 1993 Council Resolution on the review of the telecommunications sector (93/C213/01), and in particular the preparation for the 1998 services' liberalisation. This has been confirmed by the Bangemann Group Report on 'Europe and the global information society'(39) and by the subsequent Action Plan of the Commission(40).

This agenda will cover the five main following areas:

1. Universal service guarantee;
2. Rebalancing of current tariff structures;
3. Network interconnection agreements;
4. Personal communications and multimedia;
5. Liberalisation of network infrastructure.

9.1 Universal Service

Early action on the way to liberalisation was already taken on the issue of universal service through the publication by the Commission of a Communication last November(41).

This initiative, which was endorsed by Council in February 1994(42), recognises the absolute political priority of maintaining and developing universal service in a liberalised market, which was also recognised in the recommendations of the Bangemann Group.

The Communication identifies the basic elements of universal service at a European level and sets out principles governing the future financing of universal service in a competitive environment This builds on the ONP framework, as Council has stated in its Resolution on the " 1992 Review" (93/C213/01).

At the request of Council, the Commission is continuing to work with Member States on this issue with a view to developing common principles for access charges and assisting national adjustment programmes.

9.2 Tariff Rebalancing

Major tariff reforms to be undertaken by European telecommunications operators are called in view of three main factors:

- opening of telecommunications service markets to competition;
- regulatory requirements on pricing (within the ONP framework);
- availability of new technologies, which modify existing cost structures.

In its Communication on tariffs issued in July 1992(43), the Commission sets out guidelines for cost orientation and adjustment of pricing structures. This builds on the principles set in the ONP Directives that tariffs should be cost–oriented and that National Regulatory Authorities should ensure that cost accounting systems are put in place by Telecommunications Organisations to provide information on the cost basis for pricing.

Following last year's agreement on full future services' liberalisation, almost every Member State has already started or has announced plans to rebalance current national tariff structures in order to meet the 1998 deadline. This tariff rebalancing involves lower prices for international and long–distance calls, and consequently higher charges for local calls and the basic connection, and as such is closely linked to the issue of universal service.

Substantial adjustment is still required in order to reduce the estimated 16 billion ECUs transferred annually within the Union from the profitable long distance and international lines to finance universal service in the local area. This adjustment will require a firm commitment of operators and regulators concerning not only adjustment of price structures, but also efficiency increases, the future level of transfers and the access charges for competitors

9.3 Network Interconnection

The main future orientation of EU policy should be an open interconnected environment. This has been emphasised by the Bangemann Group Report and by the subsequent Action Plan of the Commission.

Three key orientations should be followed:

- commercial negotiation should be the basis for interconnection agreements;
- the National Regulatory Authorities must have a role in laying down principles for the negotiation;
- there must be common principles for interconnection charges.

As regards interconnection charges, the charge for interconnection should be analysed with regard to three main elements:

- reimbursement for one–off costs associated with providing the interconnection requested;
- a conveyance costs related to the volume of traffic carried and the number of interconnection circuits employed;
- a contribution to any cost burden associated with the provision of universal service ('access charges'), in accordance with Council Resolution 94/C48/01 on universal service.

The principle of cost orientation for the first two items is already established in the ONP

Framework Directive (90/387/EEC). Some costing principles related to the last item were agreed in general terms by the European Parliament and the Council during the recent negotiations over the application of ONP principles to Voice Telephony.

In order to set out a transparent and stable regulatory framework for network interconnection in the Union, the Commission intends to propose in 1995 a new ONP Interconnection Directive. Areas to be addressed by such Directive would be:

1. **General principles for interconnection.** These principles derive from the ONP Framework Directive, that is they should be based on objective criteria, be transparent and published in an appropriate manner, and be objective and non–discriminatory, in accordance with EU law.
2. **Framework for negotiation.** A negotiating framework should be set ensuring that commercial negotiations result in a fair and timely agreement. Regulatory authorities should have a responsibility for ensuring a balance between the bargaining power of the parties concerned, the provision of adequate information, cost–oriented structuring of the offering, and for issues such as unbundling and collocation.
3. **A common approach and ceilings on that part of the interconnection charge which relates to sharing any burden of universal service.** This approach should be based on the current consultations being carried out in the context of the Council Resolution on Universal Service principles in the telecommunications sector(94/C48/01). It should establish clear, European–wide rules for the setting of access charges, including ceilings on access charges.
4. **A mechanism for dispute resolution.** A mechanism for dispute resolution betweenthe interconnecting parties must be established, with defined roles for the national regulatory authorities and the Commission.

9.4 Personal Communications and Multimedia

Two of the major global challenges which the European telecommunications sector will face during this decade concern the areas of Personal Communications and Multimedia.

The recent publication of the Green Paper on Mobile and Personal Communications constitutes a major element in transforming the telecommunications market in preparation for a liberalised environment, as it proposes market structures which will transform the role of wireless–based services from today's premium services to mass market deployment alongside the fixed network by the end of the decade.

In doing this the Green Paper builds on Europe's technological strength in digital mobile technologies, represented by the World–wide deployment of GSM, the launch in the UK and Germany (and shortly in France) of DCS 1800 services, and the arrival of new digital systems such as DECT(44) and ERMES(45).

The follow–up of the Paper will involve the proposal by the Commission in 1995 of concrete regulatory measures building on the results of the broad public consultation currently taking place, with the aim to take the best possible advantage of the current leading position of Europe in the world market in this field.

With respect to the new major growth of the multimedia market, this marks a turning point for any telecommunications policy, as it means the entry of the giants of the media industry and of personal computing into the telecommunications world.

In both areas the United States and Japan have major strengths, presenting Europe with a difficult challenge. This is witnessed by the flurry of recent on–off announcements of new alliances in this field by the RBOCs, Time Warners, Segas, IBMs and Apples of this World.

Although Europe has strong actors in this field, major efforts will have to be done by Europe to build up its position in this market A necessary condition to develop such market in Europe could be the rapid deregulation of cable–distribution and local networks to allow distribution of multimedia products via telecommunications networks.

An early development of a market in Europe for multimedia applications should help European actors to build up their strength in the international environment.

9.5 Infrastructure Liberalisation

As a result of the '1992 Review', infrastructure liberalisation is now firmly on the Union's political agenda, responding to user and service provider concerns about the availability and pricing of leased line capacity, particularly for high–end applications Cost differences of 1 to 10 have been identified vis–a–vis North American markets Such market deficiencies have been also highlighted by the Bangemann Group Report.

Possible infrastructure liberalisation to overcome these bottlenecks to innovation will be addressed by the Commission's Infrastructure Green Paper, building on the political recognition of need for a strong European infrastructure to promote new applications and service innovation. This Green Paper, to be published by the end of the year in accordance with the request of Council, will be afterwards open to a broad consultation process. Infrastructure liberalisation will have to be the result of a political agreement with the Member States and the newly elected European Parliament.

At the same time, the Commission has completing studies on the effects of limited action in the shorter term to open up the provision of the underlying infrastructure needed for the delivery of services already liberalised (46), which are currently still provided on the basis of leased lines provided by the dominant operators. Action here could focus on the so–called 'alternative infrastructure' (utility–owned) and cable–TV networks.

The Commission has taken a first step by requesting in the Green Paper on mobile and personal communications the right to use own or third party infrastructure for mobile services.

A Communication will be issued by the Commission in September 1994 on the proposed framework for action in the area of infrastructure liberalisation.

10. Conclusion

Since its launch in the mid–eighties, the main principles of European Union's telecommunications policy have been market liberalisation, harmonisation of conditions for a common regulatory framework and the promotion of European players in the World telecommunications market.

The development of this policy has involved a broad participation, including users, telecommunications operators, service providers, industry, trade unions and consumer organisations.

The Commission's White Paper on 'Growth, Competitiveness and Employment', with the full political support of Council, has placed the Union's telecommunications policy at the heart of the Union's general policy.

In its condition of the White Paper's follow–up, the Bangemann Group Report has confirmed the Union's telecommunications regulatory agenda. The Report pleads for a break with the past, ending monopolies and making rapid progress towards a fully liberalised environment.

The European Commission will pursue its role of proposing and ensuring the implementation of the necessary policy measures, in strict respect of the powers conferred by the Treaties, in order to achieve a stronger European telecommunications sector, for the benefit of all the market players and the European citizens in general.

Footnotes for Chapter 1

'Introduction'

(1) Original Treaty on the European Economic Community, signed in 1957

(2) Set up by the Single European Act, the first important reform of the Treaty of Rome, which entered into force on 1 July 1987

(3) Towards a dynamic European economy: Green Paper on the development of the common market for telecommunications services and equipment (COM(87) 290 final, 30.07.87)

Footnotes for Chapter 2

'The 1987 Green Paper'

(4) Council Resolution of 30 June 1988 on the development of the common market for Telecommunications services and equipment up to 1992 (88/C257/01; OJ C257/1, 04.10.88)

Footnotes for Chapter 3

'Liberalisation of the Telecommunications Market'

(5) Commission Directive of 16 May 1988 on competition in the markets in telecommunications equipment (88/301/EEC; OJ L131/73, 27.05.88)

(6) Council Directive of 29 April 1991 on the approximation of the laws of the Member States concerning telecommunications terminal equipment, including the mutual recognition of their conformity (91/263/EEC; OJ L128/1, 23.05.91)

(7) Council Decision of 21 December 1993 on a common technical regulation for the general attachment requirements for public pan–European cellular digital land based mobile communications (94/11/EC; OJ L8/20, 12.1.94)
Council Decision of 21 December 1993 on a common technical regulation for the telephony application requirements for public pan–European cellular digital land based mobile communications (94/12/EC; OJ L8/23, 12.1.94)

(8) Commission Directive of 28 June 1990 on competition in the markets for telecommunications services (90/388/EEC; OJ L192/10, 24.07.90)

Footnotes for Chapter 4

'Open Network Provision: The Framework for Harmonisation'

(9) Council Directive of 28 June 1990 on the establishment of the internal market for telecommunications services through the implementation of open network provision (90/387/EEC; OJ L192/1, 24.07.90)

(10) Which has constituted the so called '1989 Compromise' between the EC institutions

(11) Council Directive of 5 June 1992 on the application of open network provision to leased lines (92/44/EEC; OJ L165/27, 19.06.92)

(12) Council Recommendation of 5 June 1992 on the harmonised provision of a minimum set of packet-switched data services (PSDS) in accordance with open network provision (ONP) principles (92/382/EEC; OJ L200/1, 18.07.92)

(13) Council Recommendation of 5 June 1992 on the provision of harmonised integrated services digital network (ISDN) access arrangements and a minimum set of ISDN offerings in accordance with open network provision (ONP) principles (92/383/EEC; OJ L200/10, 18.07.92)

(14) Proposal for a Council Directive on the application of open network provision (ONP) to voice telephony (COM(92)247 final - SYN 437, 28.08.92) - Council common position on 30 June 1993

(15) Amended proposal for a European Parliament and Council Directive on the mutual recognition of licences and other national authorisations for telecommunications services (COM(94)41 final - COD 438, 22.03.94)

Footnotes for Chapter 5

'Satellite Communications'

(16) Towards Europe–wide systems and services: Green Paper on a common approach in the field of satellite communications in the European Community (COM(90)490, 20.11.1990)

(17) Council Resolution of 19 December 1991 on the development of the common market for satellite communications services and equipment (92/C8/01; OJ C8/1, 14.1.92)

(18) Only receive–only satellite stations not reconnected to the public network had been included in the scope of Directive 88/301/EEC

(19) Draft Commission Directive amending Directives 88/30/EEC and 90/388/EEC in particular with regard to satellite communications (01.12.93)

(20) Council Directive of 29 October 1993 supplementing Directive 91/263/EEC in respect of satellite earth station equipment (93/97/EEC; OJ L290/01, 24.11.93)

(21) Proposal ror an European Parliament and Council Directive on a policy for the mutual recognition of licences and Other national authorisations for the provision of satellite network services and/or satellite communications services (COM(93) 653 final – COD 482, 4.1.94)

(22) Communication from the Commission to the Council and the European Parliament on satelLite communications: the provision of – and access to – space segment capacity (COM (94)

Footnotes for Chapter 6

'Mobile Personal Communications'

(26) Council Directive of 25 June 1987 on the frequency bands to be reserved for the coordinated introduction of public pan–European cellular digital land based mobile communications in the European Community (87/372/EEC; OJ L196/85, 17.07.87) – GSM
Council Directive of 9 October 1990 on the frequency bands designated for the co–ordinated introduction of pan–European land based public radio paging in the Community (90/544/EEC; OJ L310/28, 09.11.90) – ERMES
Council Directive of 3 June 1991 on the frequency bands designated for the co–ordinated introduction of digital European cordless telecommunications (DECT) into the Community (91/287/EEC: OJ L144/45, 08.06.91)

(27) Council Recommendation of 25 June 1987 on the co–ordinated introduction of public pan–European cellular digital land–based mobile communications in the Community (87/371/EEC; OJ L196/81, 17.07.87), and Council Resolution of 14 December 1990 on the final stage of the co–ordinated introduction of pan–Europcan land based public digital mobile cellular communications in the Community (GSM) (90/C329/09; OJ C329/25, 31.12.90)
Council Recommendation of 9 October 1990 on the co–ordinated introduction of pan–European land–based public radio paging in the Community (90/543/EEC; OJ L310/23, 09.11.90) – ERMES
Council Recommendation of 3 June 1991 on the co–ordinated introduction of digital European cordless telecommunications (DECT) into the Community (91/288/EEC; OJ L144/47, 08.06.91)

(28) Towards the personal communications environment: Green Paper on a common approach to mobile and personal communications in the European Union (COM(94) 145 final)

Footnotes for Chapter 7

'Main Developments in Specific Areas'

(29) Council Resolution of 28 June 1990 on the strengthening of the European-wide co-operation on radio frequencies, in particular with regard to services with a pan-European dimension (90/C166/02; OJ C166/4, 07.07.90)

(30) Council Resolution of 19 November 1992 on the promotion of European-wide co operation on numbering of telecommunications services (92/C318/02; OJ C318/2, 04.12.92)

(31) CEPT stands for the European Conference of Postal and Telecommunications Administrations and currently covers almost the totality of the European countries, including all the countries of the European Economic Area

(32) Council Resolution of 19 November 1992 on the implementation in the Community of European Radiocommunications Committee decisions (92/C318/01; OJ C318/1, 04.12.92)

(33) A new approach to the co-ordination of radio-frequencies in the Community: Communication from the Commission (COM(93)382 final, 10.9.93)

(34) Council Decision of 29 July 1991 on the introduction of a single European emergency call number (91/396/EEC; OJ L217/31, 06.08.91)
Council Decision of 11 May 1992 on the introduction of a standard international telephone access code in the Community (92/264/EEC; OJ L137/21, 20.05.92)

(35) Amended proposal for a European Parliament and Council Directive concerning the protection of personal data and privacy in the context of digital telecommunications networks, in particular the Integrated Services Digital Network (ISDN) and digital mobile networks (COM(94) 128 final - COD 288, 13.06.94)

Footnotes for Chapter 8

'The 1992 Review of the Sector'

(36) 1992 review of the situation in the telecommunications services sector: Communication by the Commission (SEC(92)1018 final, 21.10.92)

(37) Communication to the Council and European Parliament on the consultation on the review of the situation in the telecommunications services sector (COM(93) 159 final, 28.4.93)

(38) Council Resolution of 22 July 1993 on the review of the situation in the telecommunications sector and the need for further development in that market (93/C213/01; OJ C213/1, 06.08.93)

Footnotes for Chapter 9

'The Future Regulatory Area'

(39) 'Europe and the global information society – Recommendations to the European Council', 26.05.94. This report is the result of a request of the European Council in its Brussels meeting of December 1993, and is a follow–up of the Commission's White Paper on 'Growth, Competitiveness, Employment – The challenges and ways forward into the 21st century' (COM(93) 700, 5.12.93). The European Council requested that a report was prepared for its meeting on 24–25 June 1994 in Corfu by a group of prominent persons on the specific measures to be taken into consideration by the Community and the Member States for the infrastructures in the sphere of information

(40) Europe's way to the information society, an Action Plan: Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions (COM(94) 347, 19.07.94)

(41) Developing universal service for telecommunications in a Competitive environment: Communication to the Council and European Parliament (COM (93) 543, 15.11.1993)

(42) Council Resolution of 7 February 1994 on universal service principles in the telecommunications sector (94/C48/01; OJ C 48/1, 16.2.94)

(43) Towards cost orientation and the adjustment of pricing structures – Telecommunications tariffs in the Community: Communication from the Commission (SEC (92) 1050 final, 15.7.92)

(44) Digital European Cordless Telecommunications

(45) European Radio Messaging System

(46) This concerns both voice and data services for private corporate networks and for closed user groups, as well as all non–voice services for the public

High-Performance Networking: Initiatives from the European Commission

Paulo T. de Sousa

European Commission

Brussels, Belgium

High-speed networking will be the core of the information infrastructure of the twenty-first century. Research on high-speed communication networks is increasing drastically in countries trying to secure prominent positions in the telecommunications and information industries of the future. Several R&D testbeds have already been established in the USA to develop gigabit technology, and significant interest is also being shown by researchers in Japan. An active participation by European organisations is necessary to guarantee our competitivity and a leadership role in the process. The European Commission intends to act as co-ordinator and catalyst of this process through its programmes, specially RACE/ACTS and the TEN-IBC initiative.

The paper will cover projects concerned with high-speed networking that are part of the above programmes, as well as related projects in Telework actions.

Paulo de Sousa is a scientific officer with the Directorate for Advanced Communications Technologies and Services of the European Commission. He has a PhD in Electrical Engineering and an extensive background on telecommunications network planning with several multinational companies.

1. INTRODUCTION

Advanced communications is recognised as being of increasing importance to the well-being of national economies and to that of the Community as a whole. An increasing proportion of national wealth is being taken up by investments in telecommunications, and telecommunications services have an ever-larger impact on other economic sectors and on the quality of life.
Telecommunications networks for voice telephony and data networks continue to develop relatively independently. New applications are being developed for both types with emphasis on the capability of the former to access large numbers of users and the latter for their functional and performance superiority. Further integration of cable TV (CATV) networks would allow the addition of distributive services. ATM (Asynchronous Transfer Mode) provides the opportunity of a bridging technology. The challenge is its deployment to provide a high performance networking platform for multimedia communications while allowing access to the existing worlds of voice, data and broadcasting.
There is a need for collaboration between hardware and software manufacturers, Public Network Operators, and early users to prepare for the Europe-wide mass deployment of high performance networks. Operational experience must be gained in order to master organisational and technical constraints and to establish and verify requirements. User application experiments with Multimedia services on the integrated high performance networks should be implemented to validate service requirements, quality of service, network performance and user acceptability.
This paper is a survey of some of the efforts undertaken by the European Commission in this field. The programmes covered are RACE and its successor ACTS, Accompanying measures related to Telework and research co-operation in Europe, and TEN-IBC.
Specific projects that deal with the development of high-speed networks are described: PAGEIN in RACE, BINET, SUNRISE, and WISE among the regional co-operation activities, STEN and E=MC2 in TEN-IBC.

2. THE RACE PROGRAMME

2.1 RACE Objectives

RACE (R&D in Advanced Communications in Europe) is a programme of a pre-competitive nature and is a major collaborative effort towards the development and implementation of integrated broadband communications (IBC). The first stage of RACE (RACE I) provided an opportunity to explore a variety of options in the field of high speed telecommunications, and the choice fell on ATM technology, which is currently in the process of being standardised at a global level. The current phase of RACE (RACE II) has as goal the validation of the choices made, by means of field trials and testbeds consisting of broadband islands and network interconnections.

The RACE programme was launched as part of the Second Framework Programme in 1987, after a two-year definition phase. The programme was conceived to cover a period of 10 years in two phases. Its aim is "to prepare for the introduction in Europe of networks and wide-band communication services in 1995 taking into account the national strategies" and to bring together network operators, service suppliers, manufacturers of electronic and user equipment within pre competitive and pre-normative R&D projects. To the horizontal collaboration between various organizations based in Member States, vertical collaboration between engineers, operators and users is added. The programme is accompanied by a cooperation mechanism helping to strengthen co-operation between projects, and to form a European consensus preparing for the presentation of common proposals to the international standards institutions.

An underlying objective of RACE is to "promote the competitiveness of the Community's telecommunications industry, operators and service providers in order to make available to final users the services which will sustain the competitiveness of the European economy and contribute to maintaining and creating employment in Europe".

The results of the RACE programme provide the European telecommunications and service actors with a strategic competitive advantage. The programme is creating large-scale awareness within the industry of the market opportunities that will accompany the implementation of the next generation of telecommunications services and systems in Europe. At the same time, it is contributing to the creation of awareness among users of the competitive advantage that application of advanced communications will deliver. It exploits the advantages of collaboration on a European scale in the pre-competitive and pre-normative R&D necessary to bring innovative system designs to the global marketplace.

2.2 RACE Structure

The RACE programme consists today of 116 projects, bringing together 350 European organizations. The total budget covering phases I and II amounts to approximately ECU 2500 Million of which approximately 1100 Million ECU correspond to the financial contribution of the European Union.

To achieve maximum synergy and efficiency, RACE II is structured into "Project Lines" containing groups of related projects in particular subject areas. Each group has identifiable and precise objectives of establishing technological, application and exploitation feasibility and addressing specific groups of actors. All project lines have components relating to systems engineering, technology development and verification.
The Project Lines are:

- o PL1 - IBC Developments
- o PL2 - Intelligence in Networks/Flexible Communications Resource Management
- o PL3 - Mobile and Personal Communications
- o PL4 - Image and Data Communications
- o PL5 - Service Engineering
- o PL6 - Information Security
- o PL7 - Advanced Communications Experiments
- o PL8 - Test Infrastructure and Interworking.

2.3 The PAGEIN Project

PAGEIN aims to demonstrate, exploit and characterise some key features of High Performance Computing (HPC) on IBC usage by the aerospace industries. Computational Fluid Dynamics will be taken as a typical activity of the pre-design phase applicable by a multi-site, multi-company, European scale conception team. Super computers of different architectures situated in different countries will be utilised to tackle complex tasks which would be otherwise intractable.
Users have closely followed development teams who have transformed existing applications into heterogeneous distributed applications. Test beds have been set up using existing PDH technology, part of which is being developed by one partner. ATM technology has been introduced on one testbed. These test beds will carry a significant number of parallel

experiments, an approach comparable with that of the Gigabit Testbed programme in the United States.
Current work should be followed by a phase of implementation on user sites, supporting existing industrial applications with the PAGEIN environment, and inter-connecting different user sites.
A demonstration of multimedia assisted collaborative visualisation environment that activated ATM technology and 140 Mbit Wide Area Networking over 650 km was provided at the CeBit'93 Fair in Hannover.
PAGEIN should result in a significant contribution to Europe's ability for usage of IBC, by solving key problems of co-operation with controlled sharing of technology, as major users have been co-operating with application and network designers. A major impact will be to demonstrate to PTOs and the IBC community that increased computation power, expected to spread widely in the coming five years, can generate increased communication needs.
Development of a fully operational environment for distributed design applications represents a large investment for early users. To justify such investment requires further convincing preliminary steps: progress towards operational usage in the community of potential aeronautical users demands both an enlarged consensus and an enlarged communication basis. Such actions are being undertaken in the extension to the initial PAGEIN project.

3. BEYOND RACE

Already, at the conceptual stage in 1984, three phases were distinguished on the way towards implementing IBC: Phase I, concentrating on the system engineering, specifications and key technologies; Phase II, concentrating on integration and the prototyping of new services and applications, and a Phase III, beyond the RACE Programme, consisting of user-driven experimentation and trials demonstrating that IBC can meet the user demands and expectations both in usefulness and performance as well as acceptable costs.
Phases I and II were implemented by means of a set of closely related but autonomous projects. The burden of exploring advanced communications was shared roughly equally between the sector actors and the European Union under the 2nd and 3rd Framework Programmes.
RACE is coming to its conclusion in 1995 and the 4th Framework Programme has set out the orientation for future collaborative R&D in Advanced Communications Technologies and Services (ACTS). ACTS represents the Phase III of the path to implementing IBC, i.e. the support of R&D carried out in the context of demand-driven trials which are preparing the ground for Europe-wide internationally competitive information infrastructure (so-called *infostructure*).
The specific mission of the ACTS Programme will be, in the context of user-driven trials, to support R&D in advanced communications and services with a special emphasis on the mobilisation of Europe's technological assets and the exploitation of the advantages of scale, scope and integration to be gained by sharing experience and results.

The new programme should be centred on the following dual objectives:

- o to promote operational trials of advanced services, to improve their usability and ensure that the end-result is attractive enough for widespread use in the daily life of Europeans;
- o to further research future technologies needed to support advanced communications, to achieve a cost reduction of key components and so enable the provision of more economically feasible advanced services."

ACTS will benefit from the well-established practice of collaboration on a European level and address the challenges shaping the next decade. Perhaps the most important distinction between ACTS and RACE is that, in the former, operational trials will form the focus and the rationale for performing all the R&D.

3.1 ACTS

The ACTS Programme (Advanced Communications Technologies and Services) represents a major effort to support pre competitive R&D in the context of trials in the field of telecommunications during the period of the Fourth Framework Programme of scientific research and development (1994-1998).

Advanced communications technologies already available provide for an unprecedented improvement in quality, cost/performance and user friendliness in telecommunications systems. They are far from having reached their full capabilities however. It is anticipated that within the coming decades distance and capacity constraints to communications will be largely overcome, and progressively the user will have at his command world-wide networks providing access to services made up of image, sound and text in whichever form is required for his application.

A recently emerged consideration is that, in addition to the communications operators, service providers and equipment industry, users and their applications are becoming a significant new element in the play of forces governing the development of the telecommunications communications infrastructure and services. The communications system evolving from a mere passive conduit of data to an intelligent and active process of adding value to information implies a significant qualitative change. A transparent and open global communication system will offer access to an unprecedented wealth of information and services for users.

There are cultural and social implications to be taken into consideration. The increase in access to information and communications in general will entail the need to address, more so than in the past, questions of relevance and selectivity. Without such developments the advantages of advanced communications and access to information will be eroded by the phenomena of "information overkill". Communications technology has to mature from concentrating on quantitative improvements (more bits for less money) to qualitative improvements (quality of communication) and improved relevance (communicating with the right partner or obtaining the relevant and correct service/information). A simple example of the operation of relevance and selectivity- when, in the next few years, the average European television viewer is presented with 500 channels rather than four, neither his viewing habits, nor his television industry, will ever be the same again.

3.2. Rationale for the EC intervention and commitment to advanced communications

Advanced communications technologies and services are crucial for consolidation of the internal market, for Europe's industrial competitiveness and for balanced economic development. The services are a vital link between industry, services sector and market as well as between peripheral areas and economic centres. They are also a pre-requisite for social cohesion and cultural development. All of these considerations have been for many years important concerns of European policy.

The intervention of the Commission in telecommunications also arises from the truly international nature of the industry. Increasingly, telecommunications in Europe is across national borders - this is particularly so for the larger companies who are most frequently the pioneering users of innovative services. This implies that individual national actions, be they by governments in the regulatory field or by national telecom operators in the field of

services, though absolutely necessary will not however be sufficient. A level of international actions and co-ordination is required. This is supplied by the European Commission.
The Commission's actions in telecommunications are and will be governed by the principle of *subsidiarity* which, simply put, is that Commission intervention is made only at a level where a pan-european action is appropriate and necessary, and not otherwise. Areas where a national action would supply the most appropriate means is left to that national action. This important principle leads to the "National Host" concept which is one of the basic elements of the ACTS Programme.
Close collaboration with other organisation adds additional strength to the EU level actions. Specifically this applies to Standardisation Bodies (ETSI, CEN/CENELEC), Specification Bodies (EURESCOM), EUREKA and others.

As was remarked in the recent White Paper on Growth, Competitiveness and Employment, in the Commission's opinion Europe's research and industrial base suffers from a series of weaknesses:

- *Level of resources* - In 1991 RTD spending represented only 2% of GDP in the EU, compared with 2.8% in the USA and 3% Japan.
- *Co-ordination of research* - Historically there has been a lack of co-ordination between the national research policies.
- *Application of research results* - The greatest weakness of Europe's research base is its comparatively limited capacity to convert scientific breakthroughs and technical achievements into industrial and commercial successes.

Intensive consultations carried out with sector actors and other interested parties identified the need in the ACTS Programme to concentrate on interworking, integration and verification through projects on high-speed, photonic and mobile communication systems, and the distribution of network and service intelligence.

In the White Paper, the Commission has proposed that the Member States of the European Union, and the European institutions, should together focus on five priorities, among them the promotion of investment in basic trans-European services, for ISDN and high-speed networking;
Specifically in the area of trans-European telecommunications networks, eight priorities for investment stimulation are identified, including the establishment of high-speed communications networks.

3.3. High-speed Networking in ACTS

There are six R&D areas defined in ACTS:

Interactive digital multimedia systems and services
Photonic technologies
High-speed Networking
Mobility and personal communications networks
Intelligence in networks and service engineering
Quality, security and safety of communication services and systems

Area 3, High-Speed Networking, intends to provide integrated high-speed multi-gigabit networks by 2000 to leading-edge users in European industry, research organisations and universities, and to prepare for the Europe-wide mass deployment of these networks.

The area addresses the definition of the target networks, accounting for the emerging technologies, the identification of the missing elements, the development of the means to control these networks, and the integration of all the pieces while verifying their operation through extensive usage. The user of high performance networks depends on the overall performance of the communication system, including high speed of management, transmission and access. The objective of this area is to improve the integral performance delivered to the end-user.

The scope of work in the area is summarised in the following figure.

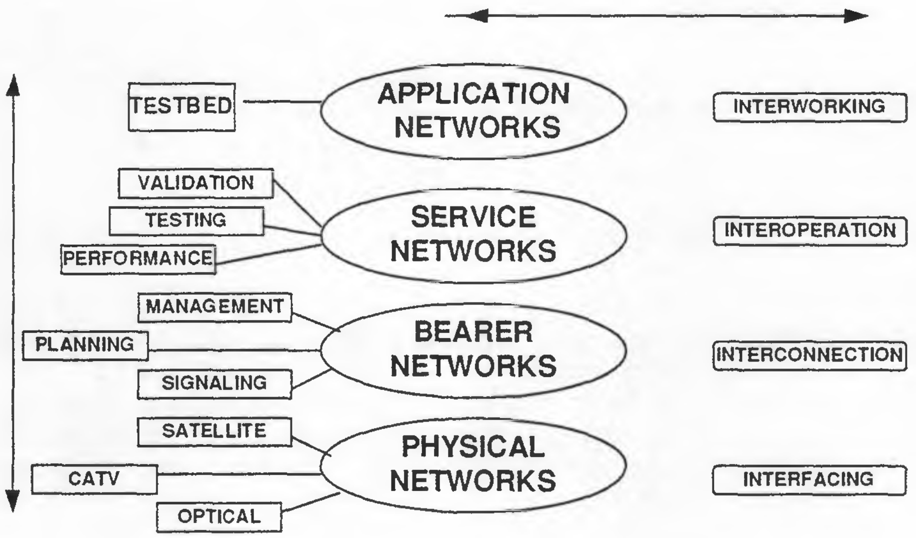


Figure 1: Scope of High Performance Networking Area

The creation and usage of a high performance network testbed is central to the whole area, and addressed by a specific task. All the other tasks of high performance networking make contributions on specific aspects to this central objective.

4. ACCOMPANYING MEASURES, TOOLS AND RELATED ACTIONS

In 1993, there were a number of Calls for Proposals for accompanying measures and preparatory actions and other work related to the RACE Programme. Though these accompanying measures and related actions do not form part of RACE per se, they nevertheless have particularly strong and complementary relationships with many RACE projects. The following actions have resulted from the calls:

Trans European Networks - IBC. - Preparatory actions to define demand driven IBC trials, to develop specifications for their implementation and to analyse the corresponding investment and interworking implications.

Trusted Third Party Services and Electronic Signatures - Initial field studies and subsequent specification and implementation of user oriented field trials.

Accompanying Measures and Preparatory Actions in the Area of Advanced Communications Technology Developments (APAS) - Essentially comprising calls in five separate domains:

experimentation and implementation of trans-national telework systems; the assessment of social, environmental and economic impacts of new uses of advanced communications; to stimulate consensus on European standards and implementation strategies in digital image communications; to stimulate the establishment of research and supporting facilities in less favoured regions; and finally to establish teleworking facilities and networks in central and eastern Europe.
TEN-IBC is covered in Section 5. Among the APAS actions, three projects in the area of regional research co-operation deal with trans-European high-speed networks.

4.1 Regional research co-operation

The objectives of the regional co-operation area are:

- to stimulate the establishment of research and supporting facilities in less favoured regions in order to enable a greater participation of organisations, particularly small businesses, in future EU research and technology development in the areas of advanced communications and telematics, and
- to establish teleworking facilities and networks in central and eastern Europe in order to strengthen research links with the European Union.

The projects cover contributions to:

- the establishment of research facilities in less favoured regions of general interest to organisations throughout the European Union, and supporting facilities in less favoured regions that can be of general value to European R&D;
- the development of advanced communications services **both** to facilitate access to information and co-operative working with partners in the development and execution of R&D projects, **and** as a research tool for experimentation with new uses of advanced communications and telematic systems;
- the development of a network of organisations which can work together in the stimulation of interest in European R&D, in stimulation of working contacts between scientists, researchers and industry (particularly SMEs) throughout Europe, and in research exploitation by SMEs.

The projects addressing these objectives and relevant to high-performance networking are listed below.

The **BINET** project (G1001) will plan, develop, install, configure and operate an Advanced Broadband Interconnection Network, based on ATM technology, linking four telecommunications research and development centres in Spain and Portugal and a high-tech Industrial Park in Portugal. The BINET infrastructure will be connected also to the European ATM trials, allowing the interconnection to other research networks and R&D laboratories in other European countries. The project is co-ordinated by Telecom Portugal, and involves two other Portuguese organisations as well as Telefonica in Spain and the Polytechnic University of Madrid.

The **SUNRISE** project will plan, develop, install, configure and operate a VSAT-based system for research collaboration between small and medium-sized businesses and universities in the less favoured regions of Greece, Italy, Portugal and Ireland. It is based on the systems developed for distance learning in the JANUS project (DELTA) and involves the identification of businesses and universities with complementary research interests in the less favoured regions using the geographical information system on the socio-economic characteristics of less favoured regions developed in the MEDORA project (ORA). The

5.2. TEN-IBC Trials Structure

Trials for Integrated Broadband Communications (IBC Trial) are the follow-up the RACE Programme and have the objective of validation of technical feasibility and economic viability of advanced communications.

The trials will use the evolving service infrastructures and public bearer networks as available, e.g.:

- ATM Trial network
- IBC islands
- Satellite networks
- Cable Networks
- Mobile Networks

A call for tenders took place in 1993, leading to the launching of 14 projects within the framework of the TEN-IBC initiative. These projects are original in that they follow a timetable accelerated in three steps:

1. a period of approximately 6 months to develop specifications,
2. an evaluation of the specifications and of the viability of demonstration by external experts,
3. an implementation of demonstrations for a limited period, for the groups having carried the evaluation successfully.

The results of demonstrations and tests will contribute to the adoption of a master plan for the introduction of pan-European wide-band services.

The following types of networks are included in the trials:

- Citizen Network (Health Care, Social Services, Transport, Education/Training, Training, Telecommuting,...)
- Network of Competence and Science (including High Performance Computing)
- Industry Network (providing for the needs of manufacturing and their relations with suppliers and customers)
- Business Network (addressing the needs of service industries with particular reference of the needs of equal access to services throughout Europe)
- Administrative Network (providing for the provision of cost-effective administrative services to the citizens and business throughout Europe).
- Media Network (providing for the development of general purpose dial-up video services and interactive multimedia services based on digital video).

5.3 Networks of Competence and Science (including High Performance Computing) in TEN-IBC

The principal conclusion of the 'Report of the High Performance Computing and Networking Advisory Committee' (Rubbia, October 1992) was that "networking is crucial to the development of a competitive European HPCN infrastructure", in order to provide:

- easy access to major HPCN facilities and expertise often concentrated in a few sites, free from geographical constraints on users and equipment.

project is co-ordinated by a Greek organisation (IIS) and involves the multi-media systems institute in Greece and the Association of Distance Learning Organisations as well as the two organisations responsible for research information exchange in the south of Italy. The project has the support of the UNISOURCE satellite service organisation.

The **WISE** project builds on the very extensive INTERNET systems of inter-operating research information networks, to which over 200,000 connections to European organisations, institutes and enterprises are already installed, to facilitate access to information in a simple and consistent way for organisations throughout Europe, including SMEs in less favoured regions. The project complements the actions of the SUNRISE and other projects, as well as the new actions in central and eastern Europe. Special actions will be taken in Germany and Portugal to ensure that there are appropriate access facilities to world-wide information systems. The project is co-ordinated by the Fraunhofer Gesellschaft acting for and on behalf of Fraunhofer IGD in Germany, and involves the University of Coimbra in Portugal, the Computer Graphic Centre in Germany and technical expertise from CERN, Switzerland.

5. TEN-IBC (Trans European Networks - Integrated Broadband Communications)

5.1. Introduction

TEN-IBC is a follow-up of the Maastricht Treaty, that calls for the establishment of Trans-European Networks in the field of communications, among others. This implies the preparation of guidelines for the introduction of Broadband Networks in the Community. The Treaty recommends actions favouring the interconnection and interoperation of the national networks and the access to these networks, taking into account the necessity to link the peripheral regions with the central regions of the Community.
The TEN-IBC actors include the end-users, the network operators, the equipment manufacturers and the service providers, co-operating to implement a trans-European broadband networking infrastructure and match the broadband technology with the end-user needs.
Technological breakthroughs are changing the price/performance of telecommunications in a fundamental way and pose both a major opportunity and challenge to the Community. This is particularly true in the area of broadband communications. Evidence suggests that applications of advanced communications will become increasingly multi-media, with varying pattern and configuration during a "call" or "session", calling for increased bandwidth and higher degree of service integration. This applies to the office and the factory of the future as well as the home including both conversational and distributive services.
Present day Europe's mostly national communication networks differ considerably in their status. This fragmentation is a major drawback for the functioning of the internal market and the performance of the EU economy in international competition.
It is important to ensure that, as far as possible, networks develop along the same general direction across Europe and broadly align with developments in other regions of the world in order that advanced services can be offered on a global scale. A way must be found in which these aims can be realised while still preserving commercial freedom for the sector actors to act decisively and rapidly to the changing environment. Areas where collaboration is desirable and areas where competition should be the presumption must be identified. The TEN-IBC Draft Guidelines focus on areas proper for collaboration.

- inter working of large HPCN resources on a wide-area scale to tackle exceptionally challenging problems.
- testbeds of multi-usage services.
- dissemination of information and knowledge for operational use and education.
- high technology access to and from CEC regional development areas.

HPC users are prevented from making the most effective use of super computers and powerful "workstation clusters" today because the requirements for transfer of data (in application synchronisation, client-server applications, distributed "metacomputing", front end visualisation of complex simulations and high volume/high speed file transfer) typical of HPC users' needs far exceed the capacity of all but the most expensive networks. Similarly, network constraints prevent HPC Centres realising the full potential of their resources - in marketing their services to external prospects, in achieving the most effective use by teams of researchers attacking single or complementary problems, and in optimising their resources by load balancing and load sharing between centres.

For the first time, the potential availability of ATM across Europe provides a real chance for these aspirations to be met, by providing a reasonable traffic throughput *between end connections* in the tens of megabits per second without the inter network bottlenecks which are the main reasons for restriction today. The possibilities of hundreds of megabits per second now also seems realisable in the foreseeable future.

A Trans European Broadband Network is important since present scientific grand challenges will be solved only by using common European resources. Scientific and technical skills have to be shared in order to be successful in solving this type of problems. The network is one of the key elements for a necessary improved human communication and is fundamental as a link between hardware computation resources.

5.3.1 E=mc2 Project

The objective of the $E=MC^2$ project is to evaluate the impact of Europe-wide broadband network availability on the use of supercomputers by research agencies and commercial users.

The high performance computing (HPC) community is severely limited by network bandwidth in the degree to which the resources available at HPC Centres throughout Europe can be harnessed. The Rubbia report in October 1992 identified the need for high bandwidth connectivity as a key factor constraining the economic benefits of wider and more co-operative uses of HPC

For the first time, the HPC community is now offered the possibility of a unified trans-national network in the form of ATM which could resolve network bottlenecks. $E=MC^2$ will exploit this opportunity for applications which demand high network performance for their research or commercial success, or even for them to be feasible at all.

The project involves 3 HPC Centres, a telecommunications value added services company, and a commercial HPC manufacturer with special expertise in marketing and visualisation of complex HPC modelling tasks. The partners engage common interest groups covering the domain of HPC - research and commercial users, HPC Centres and manufacturers, national research networks and value added service providers.

$E=MC^2$ will run 3 trials, each concentrating on a different aspect of network requirements and reflecting applications of strong interest in the HPC community. These trials will concentrate on

a) coupled computing in modelling and simulation, using atmospheric and oceanographic simulation as its application,

b) distributed supercomputing and workstation clustering between all 3 centres,

c) remote submission and execution of complex applications, investigating the potential for commercial brokerage of HPC services.

Initial trials will use the currently available network as a benchmark, and to eliminate any application problems for phase 2-involving the end users. (i.e. essentially technical trials). The second phase will migrate the same applications to the European ATM Pilot, to which all 3 HPC centres will be connected, and run trials focusing on user feedback, commercial options and the impact of actual measured network performance.

A second important area for the project is network management of HPC services. Through the network monitoring and set-up tasks, the commercial partners expect to achieve detailed knowledge of good practice in networking, in the details of traffic management and monitoring, and the impact of traffic management on the end-users perceptions of application quality and utility.

5.3.2 Scientific Trans European Network (STEN) Project

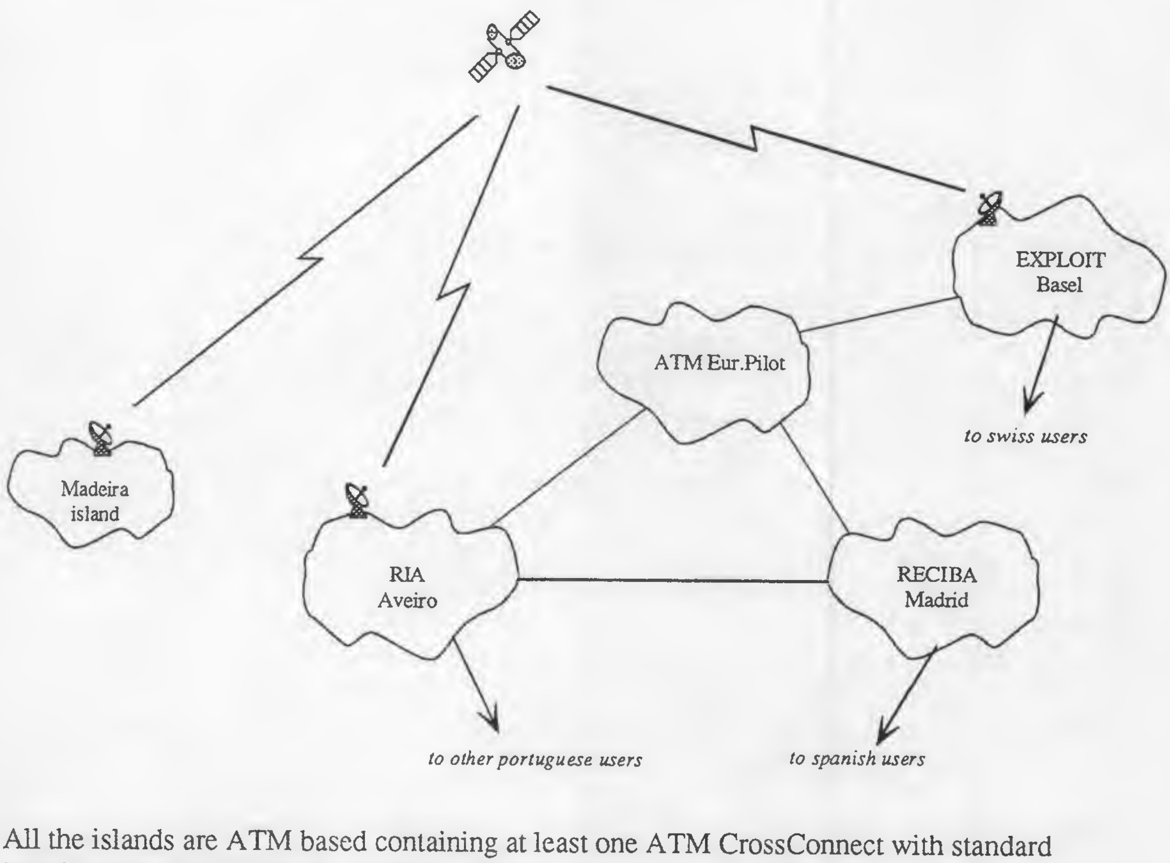
In terms of infrastructure the project STEN relies on three existing IBC islands:

RIA-Aveiro,Portugal

RECIBA-Madrid,Spain

EXPLOIT-Basel,Switzerland

Note that all these islands are deeply involved in projects running under EC support.



All the islands are ATM based containing at least one ATM CrossConnect with standard interfaces that allow the interconnection with the transport network.

Each user, in each country, has its internal network interconnected to the IBC island through ATM over 34 Mb/s terrestrial link. Exception is made for users in the Atlantic Islands that are connected through satellite links at 2 Mb/s.

In total there are 7 locations in Portugal, 4 in Spain and 6 in Switzerland.

The main objectives of the project are :

- to verify the completeness of the requirements of the scientific users and the applications commonly used.
- to implement a network trial to demonstrate the approach and to validate results.
- to evaluate the behavior of the common protocols used taking into account the high bandwidth and the quality of today's networks, mainly in interactive multimedia applications.
- to initiate the study of the addressing problem in a broadband environment
- to integrate "users" in broadband networking environments in order to harmonize services and applications needs with the technology developments and network evolution scenarios.

The network services offered by the STEN trial network are the following:

VP bearer service

SMDS/CBDS (LAN interconnection)

Circuit emulation (for isochronous services up at least to 2 Mb/s)

The trial will evaluate not only the technical network solutions (interworking units, mixture of terrestrial and satellite networks, bit rates, traffic behavior) but will also be used as a demonstration platform where other users can evaluate the benefits of broadband.

The target users - the scientific community - is already running distributive applications and are interested in increasing the interconnection facilities in order to share, in a more efficient way, not only their human resources but also their equipment resources. This is particularly important to small isolated communities (e.g., less favoured regions as Atlantic and Mediterranean islands), where a greater need for communications is felt and resources are scarce.

5.3.3 Benefits

There are several benefits to be derived from the trials. The Community (including all the interested sector actors) will gain:

- A clearer view of the requirements of High Performance Computing on the IBC network infrastructure (the primary programme objective), and of the future strategy for HPC provision, including a better insight into the commercial and operational relationship between industry and academia as mediated through HPC centres, and considering how commercial use of HPC services can develop given high bandwidth connectivity.
- A definition of further areas of research and development in High Performance Computing and Networking in which the Community, through the fourth Framework Programme, may wish to become involved, including the development of new applications making better use of distributed HPC resources, and the development of intelligent distribution management.

- An increased impetus to the development of interest in HPC among the potential users in that the trials will not just measure and record, but visibly demonstrate and promote the use of HPC remotely accessed over a broadband network.
- Input into the debate about the future commercial directions of super computing, and in particular the new possibilities opened up by high speed remote access for commercial marketing of HPC services.

The existence of the very first trans-national broadband network is the first chance for a serious attempt to explore the future prospects for co-operative scientific HPC usage and for commercial futures for HPC centres.

6. Conclusion

We described several specific programmes and selected projects within these programmes that are making a major contribution to the development of the European "information highways" of the future. The survey is by no means exhaustive, but rather a selection of the most relevant initiatives.

The research and the development, undertaken within a European framework, are essential for the successful introduction of high-speed networks in Europe. During the last seven years, the RACE programme contributed successfully to the achievement of this objective by developing the technological capacities which will now have to be integrated and put into test under ACTS. In parallel, accompanying measures like TEN-IBC and helping to accelerate the process.

Beyond the R&D efforts, many other factors which will be just as determining to the success of high-speed implementation must however not be forgotten. Among those we include the installed infrastructure, the regulatory environment, the standardization procedures, the potential customers expectations, techno-economic issues, international competition pressures.

References

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EuroCAIRN and the Trans-European Research Backbone Project

H E Davies[1]

DANTE

Abstract: *Networking services for the research community in Europe are about to advance dramatically. The state of development of new communications technologies has reached the point where new services can be introduced; the national research networks in about half of the Western European countries have set up services based on 34 Mbps technology or are about to do so. Applications which make use of constant bit rate services for the support of multi-media (high quality video and audio) are already being tested.*

On the pan-European scale, there are still problems to be tackled at different levels: technical (interworking between national services, exploitation of the potential of the new technology); organisational (how can services be provided in advance of routine availability from PNOs); and financial/political (what will be the costs and how will they be met).

1. Introduction

This paper presents a general description of the likely impact on network services for the European research community of recent developments in telecommunications technology.

A major activity at present is the Eureka EuroCAIRN Project which aims to provide the framework for organising the pooling of national funding resources, to promote co-operation between national (high speed) networking activities, and to involve the information technology and telecommunications service industries. It has formal participation from 17 countries plus the European Commission. However, the results of its work will not be limited to the participating countries; the potential beneficiaries are all European countries including those in Central and Eastern Europe.

In July 1994, EuroCAIRN awarded a contract to DANTE to carry out a study which includes a survey of requirements, an examination of available technologies, and the development of an implementation plan for a high speed service which could eventually cover the whole of Europe At the beginning of November 1994, DANTE submitted an Interim Report to EuroCAIRN which includes a first draft of such a plan. A Final Report, which will refine the material in the Interim Report, is due to be submitted to EuroCAIRN in January 1995.

Much of the material in the paper is based on work that DANTE has recently carried out for EuroCAIRN. The views expressed are however those of the author and not necessarily those of EuroCAIRN.

2. The New Technology

For many years, the use of optical fibres has promised to transform telecommunications technology. More recently, the terms "multi-media" and "Information Superhighway" have become fashionable and frequently used. Yet, for the average end user who has for years been able to log on to remote computers, transfer files between computers, inspect networked data

[1] Postal address: DANTE, Lockton House, Clarendon Road, UK - Cambridge CB2 2BH. Tel +44 223 302 992; e-mail H.E.Davies@dante.org.uk

bases, and send electronic mail to colleagues, little seems to have changed except that the quality of user interfaces has improved and things sometimes work faster. What exactly is different about the new technology, and how soon will it bring real benefits in the form of new applications?

Current network technology, including that of the global Internet which is now the predominant service used by the research community, is based on designs which were invented between 15 and 20 years ago. These designs aimed to make the best possible use of available bandwidth as well as allowing a common infrastructure to be shared between many users. However, they do not include features which allow a defined level of service to be provided for any particular user or even any which allow prioritisation of traffic from different users. As a result, the service to individual users suffers from performance degradation when the aggregate network load is high and there is no way of guaranteeing that the delivery of data will be synchronised with its transmission.

The more recent availability of high bandwidth at low cost by itself encourages new applications; a high quality digital image can be transmitted in the same time and at the same cost as was previously necessary for a page of ASCII text. It also diminishes the importance of effective sharing of capacity between users. Accepting this less efficient use of bandwidth and taking advantage of other developments in the use of digital technology, it becomes feasible to introduce new services based on constant bit rate (CBR) delivery in which a stream of data is delivered over the network to end user equipment at a rate which is constant within very narrow limits. If this stream of data represents successive frames of a video picture and its soundtrack, television quality video sequences can be supplied on user demand. Combined with new switching techniques which enable logical transmission circuits to be set up and closed down rapidly under user control, a whole new range of video-based (multi-media) applications becomes possible.

Although the principles of these techniques have already been convincingly demonstrated and a number of pilot schemes which make use of them are already in progress, large scale operational services are not yet available. The technology is not yet pervasive; usage is therefore limited to a very small sub-set of potential users. Standardisation is incomplete, so that although full communication can be established between pieces of equipment from the same supplier, interworking between equipment from different suppliers is not straightforward. In any case, procedures for the management of the more advanced services, including the dynamic creation of logical circuits, and the signalling systems between equipment in different management domains which are needed to implement these procedures are still undefined.

3. Requirements of the Research Community

A recent DANTE survey of national research networks (carried out as part of the EuroCAIRN study) confirmed the general pattern, common throughout the Internet, of exponential increases in activity (as measured in a number of different ways) with an approximate doubling of numbers every year. The Internet Society's data on the number of connected systems is shown in Fig. 1; the total monthly traffic on the EuropaNET backbone is shown in Fig. 2. This organic growth in current activity is expected to continue for some time. However, the introduction of new multimedia services is also expected to result in a step increase in bandwidth demand of an order of magnitude (factor of 10). National network plans then foresee a slower rate of growth - typically a doubling every two years - but all that can be said with confidence is that much higher bandwidths will be exploited if suitable services are made available at an acceptable cost.

National implementations of high speed services are already demonstrating their utility, especially for example in the fields of medicine (rapid transmission of X-ray images, remote diagnosis by specialists), distance learning, and several uses of video conferencing techniques. There is now a clear requirement for international connections to link the national islands that are growing rapidly. High speed links between Europe and North America are also seen as a vital element of any pan-European service.

A limited survey by DANTE of discipline-oriented user groups was also revealing. The results confirmed the general picture of bandwidth requirements identified in the national networks survey but also put emphasis on quality of service. It is clear that more use would be made even of existing services if they were more reliable, more predictable in their response, and easier to use. This also points to the continuing danger with new technologies that services will be introduced at a quality level that satisfies the technicians who work to develop them but falls short of the minimum requirements of end users whose interest is in the application and not in the underlying technology.

Another danger is of too much dependence on technology alone; psychological factors will have to be taken into account too if new services are to be successful. Some potential applications, eg internal body inspections by surgeons, already use video techniques and it is easy to extend them to work over long distances Others are more problematic, especially when human-human interaction is involved and "total system" problems will need to be addressed. User groups have an important role to play in combining the voices of large numbers of people in order to make sure that their real requirements are met.

4. Implementation Issues

The national research networks in Finland, France, Italy, the Netherlands, Norway, Sweden and the UK have already demonstrated through pilot services that it is possible to establish simple high bandwidth (34 Mbps or greater) services on a national scale. Germany and Switzerland have plans (and funding commitments) that will enable them to do so during 1995.

Most of these networks are making experimental use of ATM switches as a way of multiplexing bandwidth use and supporting new multi-media applications. Two countries are relying on a simple IP service at the higher speeds. IP can offer a perfectly adequate service if there is plenty of spare bandwidth and it has the advantage of being proven and well understood. However, even with the improvements planned for IP New Generation (IPng), it will never meet a requirement to support constant bit rate services.

On the other hand, the potential of ATM still remains to be demonstrated and there are voices within the community which claim that its promise will never be fulfilled in practice. The principal justifications for such claims are that: the overhead associated with the small cell size chosen for ATM makes its use of bandwidth inefficient; the fixed cell size limits the scope for devising more effective ways of using network resources; cell loss even at low rates can lead to dramatic degradation of performance if error correction mechanisms at higher levels are not well tuned; and the complexity of the signalling systems that will be needed to implement the variable bandwidth features which are possible in principle is such that the associated problems may never be solved satisfactorily.

These claims may prove to be unduly pessimistic and early experience, for example in the UK, shows that equipment on the market now can adequately support the simpler ATM services. Nevertheless, much work remains to be done on the standardisation and development of end-to-end signalling, ie between two sets of end user equipment which are interconnected via a concatenation of private (site, national research) and public networks.

In addition, resolving the outstanding problems at the basic telecommunications level is not by itself enough to establish user services. Complex management issues also need to be addressed, eg in relation to booking of conferences, user control of switching, automated conference establishment according to a pre-set timetable, accounting and charging mechanisms. Multicasting - a powerful technique which allows a video or audio feed to be distributed to individual users or groups who choose to join is potentially very powerful (and is already heavily used on the Internet within the constraints of current bandwidths) - has its own management problems. Distribution mechanisms have to be further developed to minimise the risk of multiple copies of the same traffic passing over the same circuits to different ultimate destinations. The essentially manual methods that are used at present to control the Mbone service on the Internet are simply not scalable for use by the hundreds of simultaneous multicasts that the new capacities will make possible.

A major constraint on the establishment of any high speed service at present is the lack of availability of international lines (or services) at 34 Mbps and higher speeds within Europe. Lines at this speed are available nationally in many countries, but there are only a few such international lines and even these are used in special projects in which one or more Public Network Operators (PNOs) are themselves participating. DANTE's conclusions from a survey of European PNOs are that: there is a lot of installed basic capacity (the PNO in one of the smaller European countries said that the aggregate capacity to its neighbours would be 9 Gbps by September 1995); several PNOs claim to be prepared to deliver high speed circuits but few of them have published tariffs; and none was able (or prepared) to point to a reference sale.

When international lines (and services) do start to become available, this will not happen all over Europe simultaneously. There will therefore be a progressive introduction of services, probably starting between countries with the more liberalised telecommunications regimes or where the national PNOs have already formed alliances (eg France and Germany). An important part of the planning which will be required is to include an interconnection between the IP component of the new high speed service and the existing service in order to maintain full connectivity between all countries.

Although the long term aim should be to make use of advanced services offered by the PNOs, the first services are likely to be at the level of simple leased lines even if the PNOs use ATM or other advanced techniques as the underlying means of supporting them. Because of the development that remains to be done, it is likely to be some time before any PNO offers ATM services which interact directly with customer equipment. The PNOs' ATM pilot which is about to start operation exemplifies this. The PNOs' objective in mounting the pilot to test interworking between their own sets of ATM equipment under realistic usage conditions. It was never the intention to make the ATM facilities visible to customers who see a straightforward (relatively) high speed leased line.

The lack of availability of high speed circuits and the problems of discrimination between countries and their researchers which will arise when such lines do start to become available are both issues which need to be addressed at a political level.

5. Organisational Structures

One view of the way that high speed services should be established is that, if the demand exists, the market will provide - and should be left to do so. DANTE and others dispute this view. Experience shows that new infrastructure does not develop without some form of centralised promotion or funding, if only in a catalytic role. It is not at all obvious that the PNOs will be prepared to deliver what the research community wants without being exposed to some form of (political) pressure.

The national services that have been established all involve a collaboration between the national research network and the equivalent PNO. This is a highly desirable state of affairs - both parties can benefit from such collaboration - but it is not so easy to reproduce on a pan-European scale. One of the motives of the national research networks in setting up DANTE to provide them with international services was that there was no organisation already in place which could do this job. The national networks as potential service customers have solved their part of the organisational problem, but the lack of pan-European structures still exists in the areas of supply and of funding.

The European Union has a number of activities which can be used to support the development and early use of new technologies but the European Commission says that it has no mandate to fund network infrastructure. The Fourth Framework Programme will start to provide funds to support R&D during 1995 via the ACTS, Esprit and Telematics Programmes amongst others but, so far and despite positive comments in the Bangemann Report [1], no funds have yet been made available to create any kind of 34 Mbps service.

Some of the national governments are addressing this issue more directly via EuroCAIRN which, besides promoting the creation of 34 Mbps services and coordinating the provision of the necessary funding, can also make recommendations about other policy issues. The most important of these is likely to be finding ways of limiting inequalities of service in different parts of Europe. On one hand, there is a desire to allow all researchers to have the same opportunities to take advantage of the new technology; on the other had, it is clear that national infrastructures are not at the same stage of development in all countries and that developments in the more advanced countries should not be delayed simply to let the others catch up. Solutions to such problems are likely to involve government organisations in their implementation.

6. Costs and Funding

As mentioned above, the PNOs have not yet set tariffs for 34 Mbps and higher speed international services. Some PNOs as suppliers have taken the starting position of suggesting a factor of 17 as the cost of a 34 Mbps circuit relative to that of one at 2 Mbps. A counter position from a customer point of view is that the cost of providing any circuit is now relatively independent of the bandwidth and that the cost of a circuit with the highest available capacity should remain constant, ie the 34 Mbps price tomorrow should be the same as the 2 Mbps price today. A realistic target which takes account of the interests of both suppliers and customers is for a price ratio between 34 and 2 Mbps capacities which is between two and four.

Experience with earlier centrally funded initiatives has shown that it can be unwise to promote new services by offering them initially at zero cost and it is generally accepted that the national networks as users of a new international service will be required to make some financial contribution from day one. National network managers also accept that it is inevitable that 34 Mbps services will cost more than those at 2 Mbps. Several of them are have already budgeted for an increase in expenditure on international services to between 2.5 and 3.5 times the current level. A guide price which is being used for planning purposes is that a 34 Mbps service providing global network access should cost about 2 - 3 MECU per year.

7. A Possible Scenario

Given the complexity of the new technology, the different situations in different countries and the constraints on national funding bodies, it is unlikely that a single, uniform service will be established to cover all European countries simultaneously. It is in any case doubtful whether it would be realistic to plan the creation of a single monolithic service which might prevent the testing of alternative methods of working. DANTE's own proposal, which would be implemented in collaboration with a few national networks (and if possible, one or more PNOs) would provide a 34 Mbps IP service as soon as possible. In parallel, an ATM test network would be set up and used for the verification of new services and for the testing of new applications, including those which will be developed within the EC's Fourth Framework Programme. Later, there would be a migration to an ATM based service providing IP-over-ATM plus a constant bit rate service based on managed Permanent Virtual Circuits (PVCs). The configuration of PVCs, which provide logical circuits with a fixed (and guaranteed) bandwidth between two end points, would be changed manually from time to time to allow multi-media applications such as video conferences to be run according to a pre-arranged timetable. The ATM service would be progressively improved by the addition of new operational services as soon as they had been validated on the test network; development of particular interest are those which enable the bandwidth allocation procedures to be automated so that individual applications can be run at short notice in response to user demand. Expansion of service to countries besides those in the initial set would take place as soon as the relevant national service could fulfil the conditions necessary for exploitation: a viable national service in place, available international infrastructure, and committed funding

8. Conclusion

Research users of networking services are on the threshold of exciting developments. The technology for basic high speed services is already available but further development work is needed before the more sophisticated applications become operational. The PNOs also have to be persuaded to make their transmission capacity available - at reasonable rates. It is essential that user requirements are taken into account from the earliest stages of the planning phase. User communities should make sure their requirements - especially for quality of service - are well known and well expressed.

Reference

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Panel 1, session B: "Networking Trends in Europe"

European Earth Observation System Workshop (EEOS-WS)

(Marino - Rome, 13-15 December 1994)

Building pan-European Networks and bridging european Countries: TELECOM Italia's experience

Giorgio Pellegrini - Domenico Serafini
TELECOM Italia

Summary

This paper deals with some European PNOs common projects and implementations: in particular those regarding Telecom Italia formal involvement.
During the last five years several initiatives were launched by European PNOs, all of them aiming at building pan-European high speed infrastructures. In the following, some of those, mainly devoted to play a key role in the future european scenario, are briefly presented.

1. ISDN

The development of the ISDN represents an evolutionary path of the PSTN following the wide-spread deployment of digital techniques pursued in the last 15 years, both in the transport and in the switching network of Telecom Italia.
By the end of 1994 the digitalization of the local switches will reach about 64 %, while the digitalization of the transit switching nodes will be almost completed.
As regards the transmission, the digitalization of the junction network is around 91%, whereas for long distance network the 100% will be reached by the end of 1994.
In the meantime sophisticated signalling and control facilities have been deployed through wide-spread use of SSN°7 to fully exploit the benefits and the flexibility of the digital infrastructures.
Along the evolutionary path of the basic digital switched network, ISDN involves essentially the deployment of digital access form in the subscriber premises and ISDN facilities in the local exchanges.

Since the end of 1991, italian ISDN Pilot Service has been operated in the main cities based on the use of dedicated exchanges. Since the end of 1993 the commercial ISDN service has been offered, suited for wide-spread diffusion and provided by ISDN facilities made available in the existing local exchanges of the basic network.

Nowadays, ISDN deployment is proceeding sucessfully; the national coverage is planned by the end of 1995; international interconnections are available with the major European and extra-European countries. Extensive investements are planned on '94 - '96 period with the objective of installing more the 700,000 equivalent lines.
ISDN applications are gaining popularity as effective solutions to telecommunications needs expecially for small business customers. Main services with increasing usage are telephony, G.3 and G.4 facsimile, circuit switched data transmission, packet switched data transmission, audioconference and videotelephony.

The ISDN growth in Italy is positively affected by the advancement of the Euro-ISDN project involving 26 Network Operators from 20 European Countries on the basis of common technical standards, user-network interfaces, and international connections. This facilitates common European-wide market leading, among other things, to common approval procedures.

A number of applications are expected to boost the overall growth of the EuroISDN in the forthcoming years; examples are the replacement of voiceband modems and digital leased lines, interconnection of ISPBXs and multimedia applications.

2. GEN

Subsequently, since early 1993, the Global European Network (GEN) is being constructed and operated as a European-wide digital transmission network to provide the customers with high quality and reliable international leased lines with bit rates ranging from 64kbit/s to 2 Mbit/s. GEN originates from an agreement among five Network Operators (Telekom /Germany, Telefonica/Spain, France Telecom/France, British Telecom/UK, and

STET/Italy); however other European Carriers have already expressed their interest to partecipate in the project.

GEN has a mesh structure, with five national nodes implemented by DXCs systems, installed in Paris, London, Milan, Madrid and Frankfurt, with 2 Mbit/s interconnecting links on optical fibre systems.

3. ATM Pilot

The ATM Pilot network has been started in 1994 in Italy with the deployement of three ATM cross-connect nodes and collecting some Pilot Users. This ATM backbone network is also interconnected with other European countries under a Memorandum of Understanding (MOU) signed by 16 major European Network Operators to implement an Euro-ATM Pilot Network in order to perform technical and market assessments troughout Europe.

As announced in late 1992, the European Operators launched the pan European ATM Pilot Network on July 1st, 1994. It is based on the ITU-T recommendations, ETSI standards and the Eurescom specifications and more specifically the Eurescom Project P-105 dedicated to ATM sudies. The ATM Pilot will last 18 months. It has 18 signatories which, following the two significant mergers in Portugal and Italy, represent today 16 operators spanning over 15 countries: Austria, Belgium, Denmark, Finland, France, Germany, Great-Britain, Ireland, Italy, Norway, Portugal, Spain, Sweden, Switzerland and The Netherlands.

Moreover, this is currently the world's largest and most sophisticated ATM network.
The ATM Pilot represents a major achievement of the list of commitments made by the European Operators. In the long term, these Operators have already rolled out a significant number of large-scale networks, such as the GSM network, the Euro-ISDN and the Global European Network; and in the near future, will very likely deploy the METRAN network across Europe. The ATM Pilot is on the same line: it fosters the global European Information Superhighways.

The first interconnection tests took place on March 1994 and each of the 15 ATM cross-connects was connected on July 1st, 1994. The first actual video-conference on ATM took place, after some preliminary tests, on July 22nd, 1994 between the CSELT in Turin and CNET in Lannion.

The main features of this ATM Pilot: indeed, this is an ATM Pilot in a multi-operator and multi-vendor environment: 16 Operators and around 10 equipment Manufacturers are taking part directly, or indirectly in this pan-European experience. The 15 ATM cross-connects are today interconnected with 34 Mbit/s links. Where practicable and depending upon the requested traffic from Pilot Users, upgrades may be installed following different time-scales: 155 Mbit/s or 140 Mbit/s links and also releases of network management software.

The Pilot Users are basically of three types:
- Operators research laboratories which were connected even before the launch of the Pilot on July 1st 1994. They were eager to test "their" ATM Pilot and indeed the Operators research labs successfully performed many rigorous tests;
- numerous Pilot Applications have been supported by the European Commission and are part of Europeaan programs such as Esprit , TEN-IBC or RACE. To give you a concrete European example, the ATM Pilot was used by the National Hosts demonstration, held in Madrid, on October 19-20 th, 1994, with great success;
- multinational Companies who want the leading edge in this new and promising multimedia technology. Indeed, these pioneer companies will have a competitive advantage because they will master all the features of ATM techniques well before their competitors.

From the beginning of the Pilot, different benchmark services were available on the Pilot: the VP bearer service, which is less requested, the CBDS (or SMDS) service and the Constant Bit Rate service.
However, today there is very little feed-back from the Pilot Users because it is too early for them to give any relevant information on their results. Most of the Pilot Applications will supply valuable information at the beginning of next year. However, it can be foresee that: the Pilot Users, and generally speaking, the customers, are not immediately concerned by ATM technology as such. What they want and what they need is a faster service at a lower price than yesterday. If any other service can offer

them this benefit right away, then, the customer will use the other service.

Many other Pilot Applications are however scheduled to be connected during next months, according to their time scale and their readiness to come onboard the Pilot.
There are no common tariffs for the ATM Pilot. Each Operators remains free to request a financial contribution from its Pilot Users according to its own local habits. The ATM Pilot Coordination Group has no authority to deal with commercial matters. These matters are indeed a question for each Operator individually.

What will be the future of the ATM Pilot?
This is a crucial topic. Today, the following statement could be done:
- considering the requests of the Pilot Users and the strong demand for the Information Society, the ATM Pilot representatives decided to extend the ATM Pilot for another 6-month period (new MoU deadline: 31 December 1995);
- in any case, it is expected that ATM Pilot members may make bilateral arrangements to keep the ATM VP network. It would allow our Pilot Users to maintain their ATM connections.
The ATM Pilot has allowed initial technical work on this topic to be undertaken. We hope that continued ATM connectivity would provide the opportunity to the Pilot Users to complete their new applications and will foster the European entry into the Information Age.
On the switched VC side, further in depth studies are also ongoing, coordinated between the ATM Pilot Working Groups and relevant Eurescom Projects.

Indeed, the ATM Pilot is a major step towards the European Information Superhighways and should pave the way for a European broadband offer within few years.

The European ATM Pilot has already given the opportunity to better understand the potential ATM has as a networking technology of the future. A considerable amount of time and effort has gone into the development of the ATM Pilot, and nobody pretends that everything has been straightforward: indeed that would be far from true.

The European ATM Pilot is by far the most complex and extensive ATM testbed anywhere in the world, linking 15 cities through Europe. The pilot has been developed to evaluate and prove ATM, which will be a key technology for the building of the Information superhighways of the future.

To introduce some of the more technical aspects, the European ATM Pilot is a trial to assess the concept of a network in a multi-operator and multi-vendor environment. To reach this objective, operators agreed to set up a network relying on products compliant with current ATM standards and recommendations. Today's network representas a snapshot of the ongoing development of ATM.
For the transfer of cells, the so called User plane in the standards world, ETSI and ITU have set up sufficiently stable standards to allow manufacturers to design the relevant equipment.

The specifications for the Pilot where drawn up by the ATM Pilot Coordination Group, their work built on the earlier deliverable form EURESCOM Project 105. It is important to underline the close co-operation between Eurescom and the ATM Pilot. Eurescom has provided some useful groundwork. The operational procedures are also based on P105.

Management of ATM networks is certainly one of the current "Hot topics". For the management of this equipment, each operator has procured a local management system which does not interwork with peer equipment from other manufacturers. This is the reason why the EURESCOM project P105, defined a common set of specifications for the management of cooperative networks. This was delivered in October 93 and is now being proposed for standardization in ETSI/NA5 and planned to be the basis for a European standard in 1995. In the meantime, the European ATM Pilot has applied these specifications on a slower network (POTS) to connect these Network Manager Centres. Using faxes as a temporary provisional procedure, the time to set up, modify or release the bandwidth of one VP is a few hours. This is of course recognized as being inadequate and therefore represnts a key area for development. We intend to trial a much improved system before the end of the Pilot.

When the Pilot was first conceived we realised that there would be many issues to be resolved before we could reach the position of actually connecting users over the network. We have established a number of working groups to address specific issues. Some of these have concentrated on the testing of the interoperability between the different crosss-connects, the evaluation and testing of the benchmark services, while others have been concerned with performance and network aspects. The ATM pilot has brought together many specialists, technical experts, manufacturers and operational teams. The last 20 months have seen a period of rapid developments, requiring a great deal of flexibility form all sides. The experience gained has fostered the development and understanding of all involved.

The pilot has now entered a new phase with the introductions of pilot Users to the network, this will bring additional requirements and will doubtless uncover many new and ecciting issues. As before flexibility will be required on all sides by working together experience and understanding during this pioneering phase.

The key message that we would like you to take away from these worhshop is that ATM is the key technology for future broadband networks and that as a result of the knowledge gained from ATM Pilot the participants will be well prepared to provide Europe and beyond with the broadband services of the future. With this trial the European PNO prove their capability to cooperate on advanced issues and stimulate the introduction of new technique able to support innovative services. As such, the ATM MoU is a major initiative of European PNOs for the introduction of ATM in the networks.

4. METRAN

Since 1988 DGXIII stimulated the European PNOs to provide the 'electronic highways' of Europe, which were required to enable the cost-effective, pan-European communication capability to support the Integration of Europe as a common trading block to rival the United States.

At a similar time, standardization activities within CCITT were developing as new 'highly manageable' transmission multiplex structure which would enable significantly more flexibility than currently available for 2Mbit/s, 140 Mbit/s and potentially higher capacity transmission 'circuits'. This was the Synchronous Digital Hierarchy (SDH).

Meanwhile, the CEPT realized the need for coordination between the independent deployments of SDH technology and management within each PNO.

The resulting target network, named the Managed European Transmssion Network (METRAN) was seen to offer the best opportunity to meet the electronic highway requirements. Whatever data, voice or video transport mechanism was deployed to provide advanced services to customers, the rapid availability of high-quality underpinning all future pan-European communication capability.

Twenty-six European PNOs signed a Memorandum of understanding (MOU) about METRAN. MOU was developed which would govern the interaction of the PNOs during a joint, co-operative study to develop proposals for the future capacity supply mechanism for Europe. The scope of this study was broad, covering all aspects of the PNOs interaction to plan provide and operate the correspondent trasmission network, including common equipment functionality, network design architectures, operational procedures, performance targets and monitoring methods, future organizational structures and the optimum type or form of legal structure to deliver all of this.

The project was overseen and managed by the Management Board (MB), which had representation from all of the Signatories of the MOU. Over twenty separate areas of study (Tasks) were identified and international task teams were created. Tasks which required significant discussion and consensus development had a large number of participants (10-15). EURESCOM was used to co-ordinate and manage the more technical tasks in a supplier role to the METRAN MB.

Overall day-to-day project co-ordination was provided by a Project Leader, who ran a forum for all Task leader's named the Support Group. Midway through the project, the MB recognised the need create the MB Advisory Group comprising some eight named individuals chosen for their knowledge of METRAN activies which acted as a 'think tank' for the MB, developing proposed solution to those issues which coul not be solved intially at the larger MB meetings.

The target of the METRAN study is the production of a comprehensive agreement that captures the common technical, process and organizational proposals developed in the projects, and defines the commitments that the PNOs will make to each other to follow these proposals in a defined manner. After considerable discussion on the best form for such an agreement, addressing options ranging from a further MoU to the creation of a jointly owned company to 'operate a single pan-European network, a multi-lateral contract has been developed termed the METRAN Operating Agreement. This is currently in advanced draft stage and to be opened for signature in early 1995.
The METRAN project will allow to meet the needs of current and emerging services across Europe, still mantening a full control over national networks by each national operator.

5. Conclusion

ISDN is already a reality through Europe and will play a key role in the near future.
ATM Pilot is already started and is certainly considered an opportunity to investigate new issues, such as: state of technology versus existing standards, maturity of the market for broadband services, regulatry aspects, initiative from the Commission towards user applications.
METRAN initiative is approaching the implementation phase by signing the Operating Agreement in the forthcoming 1995. The question is: what will be the future ?
The question is raised: the answer will be based, of course, on the results, but PNOs are convinced that building pan-European Networks allows the Countries to be closer.

Open Network Provision and Leased Lines

John Horrocks

ETSI BTC2 Chairman

1 Introduction and Background

Open Network Provision (ONP) is a programme of regulation being undertaken by the European Commission designed to ensure non-discriminatory access to and use of public telecommunications networks.

The concept of ONP arose from concern to facilitate the development of an expanding and competitive market for value-added services, and from consideration of regulatory measures in the USA called Open Network Architecture and Comparably Efficient Interconnection.

The main concern about value added services is that public network operators are both monopoly providers of basic services and also providers of value added services. Competing value added service providers are dependent on basic services provided by the public network operators and therefore regulation is necessary to ensure that the public network operators do not use their monopoly to put these competing value added service providers at a disadvantage by failing to provide them with the basic services that they need.

The first proposal came from the Analysis and Forecasting Group (GAP) which is a sub-group of the Senior Officials Group - Telecommunications in 1988 as part of discussions in connection with the Green Paper on telecommunications. A Framework Directive for ONP was submitted to the Council in January 1989 on the basis of Article 100A of the Treaty of Rome. A Services Directive under Article 90 was also proposed at approximately the same time to ensure the development of competition in all services other than the provision of infrastructure and voice telephony. Agreement on both these Directives was reached in December 1989 and they were adopted and notified formally to Member States in July 1990.

The Framework Directive will lead to other Directives on specific areas to be covered by ONP. These Directives are addressed to Member States not to telecommunications operators or users, and Member States are required to put into effect national regulations and procedures to implement the requirements of the Directive.

2 The ONP Framework Directive

2.1 Description

This Directive defines the areas to be covered by ONP as:

- leased lines
- packet and circuit switched data services
- ISDN
- voice telephony
- telex
- mobile services
- new forms of access such as data over voice and access to intelligent network functions
- broadband networks.

The Directive addresses the preparation of ONP conditions for open and efficient access to the public networks and directs the Council to prepare specific directives to establish these conditions. The three conditions that may be harmonised are:

- technical interfaces
- supply and usage conditions
- tariff principles

Supply and usage conditions cover provision time, quality of service including transmission, and maintenance. The tariff principles require tariffs to be cost based if the service is the subject of an exclusive or special right, and where possible to be unbundled leaving the user to choose which elements he requires.

These ONP conditions have to be based on objective criteria, be transparent and published, and guarantee equality of access without discrimination. Access to the public network must not be restricted except for reasons based on the essential requirements of:

- security of network operations
- maintenance of network integrity
- interoperability of services in justified cases
- protection of data, as appropriate

It should be noted that these requirements are not exactly the same as the essential requirements in the Second Phase Directive.

Thus the focus is on establishing a harmonised set of conditions for the use of ONP services.

The procedure for each of the areas covered is that the Commission:

- initiates detailed analysis and prepares a report
- invites public comment over a period of at least three months
- requests ETSI to draw up appropriate standards for technical interfaces and service features
- draws up proposals for ONP conditions

The Commission is assisted by an advisory committee of representatives of Member States, known as the ONP Committee, and is bound to take the utmost account of the opinion of this committee.

The Directive contains guidelines for implementation in the period up to the end of 1992. These guidelines propose:

- specific Directives for leased lines and voice telephony
- implementation by January 1991 of harmonised technical interfaces and features for ISDN and packet switched data services
- adoption by the Council by 1 July 1991 of a recommendation on the application of ONP to packet data services
- adoption by 1 January 1992 of a similar recommendation on ISDN

- examination of specific Directives on packet switched data and ISDN to follow the Recommendations

2.2 Progress To Date

The highest priority item for ONP initially was leased lines, but great attention was also given to voice telephony until the draft Directive was rejected by the European Parliament (see later)..

Progress to date is that:

- A Directive has been adopted for leased lines
- Two Recommendations, possibly to be followed later by Directives, have been adopted for ISDN and public data networks

The reason for issuing Directives for leased lines and voice telephony is that these services are normally the subject of exclusive or special rights, whereas other services may be the subject of greater competition. As a result of the recent plans to liberalise all services and infrastructure by 1 January 1998, the future role of ONP is being reconsidered (see later).

3 ONP Leased Lines Directive

3.1 Introduction

Directive 92/44/EEC was adopted on 5 June 1992.

The scope of the Directive is limited to leased lines that provide transmission capacity between network termination points but do not include on-demand switching under the control of the user. Thus the scope includes "part time" leased lines which are available for only part of the day but excludes the newer virtual private network services with switching under user control.

The Directive contains two main requirements:

- it requires all leased lines to be offered under harmonised usage conditions and tariff principles

- it requires certain types of leased lines to be offered in all Member States as soon as possible and not later than the date on which the Directive is brought into effect in the Member State concerned, which must be not later than 5 June 1993 (but it does not restrict other types of leased line from being offered).

3.2 Minimum Set

Five leased line types have been defined so far, and they are listed in Table 1, but standards for additional types (eg 2B+D, n*64kbit/s, higher order 34Mbit/s and 140Mbit/s) are being produced in connection with the ONP programme although it is not the Commission's intention to add them to the minimum set.

Leased Line Type
Ordinary quality voice bandwidth 2 or 4 wire analogue (M.1040)
Special quality voice bandwidth 2 or 4 wire analogue(M.1020 & M.1025)
64kbit/s digital to G.703, but X.21 or X.21bis may be used for an interim period
2Mbit/s digital to G.703 (unstructured)
2Mbit/s digital to G.703 and G.704 (excluding section 5) and with CRC check to G.706

Table 1: Minimum Set of Leased Lines

ETSI is developing a set of standards and corresponding terminal interface standards to define these leased line types more precisely. The status of these standards is as follows:

Leased Line	No	Contents	Status
2048 kbit/s Unstructured	ETS 300 246	Network interface (NB: Will be withdrawn following introduction of ETS 300 418)	Adopted Oct 93
	ETS 300 247	Connection characteristics	Adopted Oct 93
64 kbit/s	ETS 300 288	Network interface	Adopted Jan 94
	ETS 300 289	Connection characteristics	Adopted Jan 94
2048 kbit/s Structured	pr ETS 300 418	Network interface (NB: Will be used for both structured and unstructured)	Adoption expected Spring 95
	pr ETS 300 419	Connection characteristics	Adoption expected Spring 95
2 wire, ordinary	pr ETS 300 448	Network interface and connection characteristics	Adoption expected July 95
2 wire, special	pr ETS 300 449	Network interface and connection characteristics	Adoption expected July 95
4 wire, ordinary	pr ETS 300 451	Network interface and connection characteristics	Adoption expected July 95
4 wire, special	pr ETS 300 452	Network interface and connection characteristics	Adoption expected July 95

Table 2: ETSI Standards for Minimum Set of Leased Lines

The corresponding terminal interface standards and TBRs are:

Leased Line	Interface Standard	TBR
2048 kbit/s Unstructured	ETS 300 248	TBR 12
64 kbit/s	ETS 300 290	TBR 14
2048 kbit/s Structured	pr ETS 300 420	TBR 13
2 wire, ordinary and special	pr ETS 300 450	TBR 15
4 wire, ordinary and special	pr ETS 300 453	TBR 17

Table 3: ETSI Standards for Terminal Equipment Interfaces for Connection to Leased Lines.

Their status is the same as that of the corresponding leased line standards.

In June 1994, the Commission, through Commission Decision (94/439/EEC), changed annex II to Directive 92/44/EEC to introduce the European standards for the 2048 kbit/s unstructured and 64 kbit/s leased lines. Until 31 December 1996 leased lines may be provided in accordance with either the European standards or the ITU-T Recommendations, but after that date they must be provided in accordance with the European standards. In the case of the 64 kbit/s leased line, interfaces based on X.21 or X.21 bis may be used instead of the European standards even beyond 31 December 1996. The reason for the relatively long transitional period is that several countries use 75Ω unbalanced interfaces rather than the 120Ω balanced interface specified in the European standards.

The standards for the digital leased lines all specified the use of the ISO/IEC 10173 connector used for ISDN primary rate access. Early in 1994 it was discovered that this connector is not available because it is impracticable to manufacture it because the specification does not allow sufficient material adjacent to one of the keyways to give adequate strength. In consequence the standards that have already been produced will have to be amended. The current versions permit a hardwiring option as an alternative to a plug/socket and it is expected that hardwiring will be the most common form of connection.

The development of standards for the analogue leased lines has proved to be rather controversial. ETSI has found it difficult to reach agreement on a number of techincal parameters because of historical differences in the various national networks. Furthermore ETSI, in accordance with advice given initially by the Commission, has specified low levels of performance in line with the ITU-T recommendations. However the ONP Committee has expressed concern that better levels of performance should be specified. Because the consensus within ETSI is fragile, the Commission has proposed that this should be achieved through additional informative annexes that could be added to the standards rather than through changes to the requirements. The issue is still under discussion.

3.3 Other Requirements

Member States have to ensure that information on the technical characteristics, tariffs, general supply conditions and conditions for attachment are published in a way that provides easy access for users. Information on new leased lines must be provided at least two months before the new lines are introduced.

The supply conditions have to include:

- the typical delivery period within which 80% of leased line services are delivered
- the minimum contractual period that the user must accept
- the typical repair time for 80% of lines of the same type
- any refund policy

Member States have to ensure that usage conditions derived from the essential requirements are imposed by regulation and not through technical restrictions. No restrictions are allowed on the interconnection of leased lines to other leased lines, or to the public telecommunications networks.

The only essential requirements under which access to leased lines can be refused are:

- interruption of service or denial of access in an emergency
- interruption and disconnection if non-approved apparatus is used, or
- restrictions on access to ensure compliance with data protection requirements

Member States have to notify the Commission before 1 January 1993 of the identity of the national regulatory body that will supervise the provision of ONP services and lay down procedures for deciding on the legitimacy of actions by the public network operators such as interruptions of service, and for defining general rules that can be followed in such circumstances. The national regulatory body also has to adjudicate on cases where public network operators provide transmission capacity equivalent to leased lines for their own provision of competitive services such as value added or data services, but do not make such capacity available to others.

In August 1994, the Commission published (94/C 214/04) a list of the National Regulatry Authorities that are supervisiong the ONP Leased Lines Directive and gave further information on the use of the conciliation procedure in the event of disputes.

Member States have to promote the setting up, by 31 December 1992, of a common ordering procedure, a one-stop ordering procedure and a one-stop billing procedure.

Member States have to ensure that the tariffs for leased lines are cost orientated, transparent, based on objective criteria and independent of use. They also have to ensure that the telecommunications operators implement an appropriate accounting system capable of assigning costs to the provision of leased lines.

Users who claim that the provisions of the Directive have been infringed, may complain to the national regulatory body or to the Commission.

The obligations to provide the minimum set of leased lines may be deferred if the requirement places an excessive burden on a particular Member State.

3.4 Additional Leased Line Standards

The Commission has requested ETSI to prepare as soon as possible a set of standards and corresponding TBRs for higher order leased lines at 34 Mbit/s and 140 Mbit/s. ETSI has completed a preliminary study of the work to be done (see ETR:087) and produced the following drafts:

Standard	Title
pr ETS 300	34 & 140 Mbit/s Network Interface
pr ETS 300	34 Mbit/s Connection Characteristics (structured and unstructured)
pr ETS 300	140 Mbit/s Connection Characteristics (structured and unstructured)

Table 4: ETSI Standards for Högher Order Leased Lines

The structured versions of these standards are based on a new form of structure defined in ETS 300 337 (ITU-T G.832), and not on the G.704 structures.

Although the Commission has said that it does not intend to add these higher order leased lines to the minimum set under the Directive, it does attach considerable importance to the availability of these standards to support international leased lines for use by trans-European networks such as "resale" networks providing valu added, data and corporate communications services.

ETSI is also studying the production of leased line standards for:

- "2B+D" leased lines for off-premises extensions for ISDN basic access
- "SDH" leased line.

and is expected to produce ETRs on these subjects towards the end of 1995.

ESTI is currently working on standards for n*64kbit/s leased lines presented in a 2 Mbit/s interface; these standards will be derived from ETS 300 289 and prETS 300 418.

Additional information on standards may be found in the:

"European Guide to Telecommunications Standards"

Published by:

Horrocks Technology
Bethany
Chapel Lane
Pirbright
Surrey GU24 0JZ
England

Tel: +44 1483 797807
Fax: +44 1483 797617

Annex: The Evolving European Network

The purpose of this section is to explain the current thinking as to how the various technological developments will be brought together in practice in the development of wide area switched bearer networks in Europe.

For the purpose of this explanation, switched networks and their services should be considered as consisting of four layers:

- The service
- The switch
- The transmission system
- The transmission medium

Before the introduction of these new developments, switched networks were as shown the Figure 1. (This explanation assumes a wholly digital network based on the Plesiochronous Digital Hierarchy, PDH, in practice the phasing out of analogue transmission and switching has overlapped the introduction of optical fibre and SDH.)

There was a network of copper cables (there were also some fixed radio links and satellite links but to simplify the description we will ignore them), and the capacity on these cables was subdivided into separate 64 kbit/s and 2Mbit/s channels using transmission systems based on the PDH. The channels were used to interconnect switches. The routing of channels between switches could be controlled at the 64 kbit/s and 2Mbit/s level to some extent through cross connects and patch panels but the degree of flexibility for altering routings was somewhat limited because individual channels could not be extracted easily from higher order multiplexes. There were two types of switches, circuit switches and packet switches, each providing its own particular service. Leased lines were provided from the PDH transmission system and its cross connects.

There are three general strategies for the introduction of new technologies:

- Substitution, involving the removal of the old technology.

- Overlay, involving the addition of new technology without the removal of the old, but with some interconnection between the two.

- Overlay, involving the addition of new technology without the removal of the old, but without interconnection (introduction as islands).

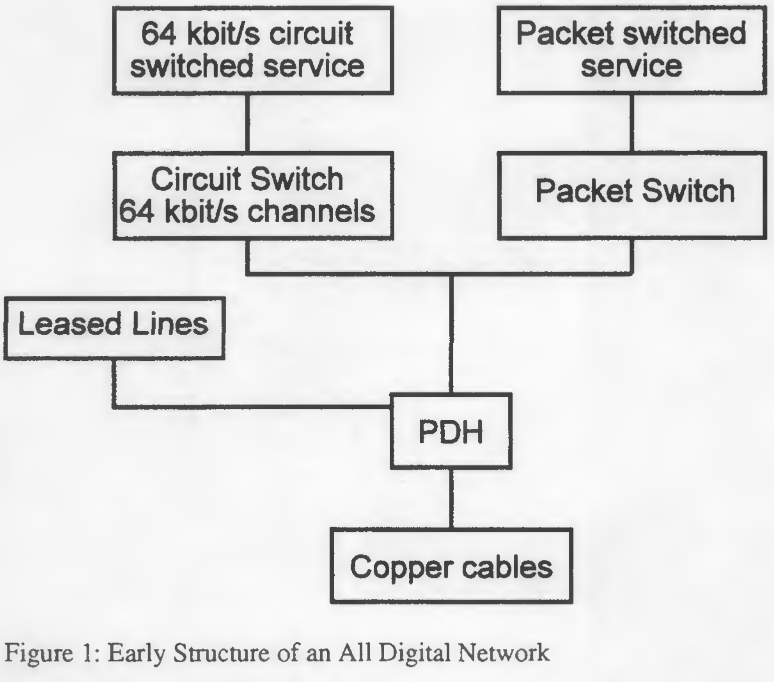

Figure 1: Early Structure of an All Digital Network

Chronologically the first change was the introduction of optical fibre which normally replaced copper but in some cases was introduced alongside copper. The early transmission systems used with optical fibre were PDH.

The next two changes are tending to coincide chronologically. They are the introduction of SDH and the introduction of new broadband services such as frame relay and SMDS.

The introduction of SDH is either through substitution or overlay. Interconnection between SDH and PDH is common, SDH can carry circuits that are also carried by PDH, because many circuits will have to pass sequentially through routes served by SDH and routes served by PDH. SDH can also use either optical fibres or copper cables as the transmission medium, but the tendency is for SDH systems to be introduced where the transmission medium is optical fibre. The circuits carried between switches by the SDH transmission network were initially structured according to the frame formats defined for PDH but new structures for rates of 34 Mbit/s and 140 Mbit/s provided on SDH have standardised by ITU-T (G.832) and ETSI (ETS 300 337) and will be introduced soon. These structures contain better error monitoring and management facilities than the G.704/G.706 structures, and are designed to be well suited to the transport of ATM cells.

The introduction of SDH creates much greater flexibility for reconfiguration of the transmission network because SDH provides an efficient drop and insert and cross connect capability, where channels can easily be removed or inserted at any level of the hierarchy. The introduction of SDH will therefore coincide with new and greatly improved cross connect and circuit management capabilities. In the diagrams, the cross connect switching is implicit in the PDH and SDH boxes and should not be confused with the circuit switch and packet switch boxes which apply to the provision of switched services, ie switching in response to customer signalling.

The existing switch technologies are incapable of providing new switched services such as SMDS and frame relay. These new services may therefore be introduced initially using separate special purpose switches. The interconnection of these switches may be either on the PDH or SDH. The interfaces to terminal equipment are normally based on the PDH.

The structure of the network after these further changes is shown in figure 2. This figure shows only the more common connections and not all the possibilities.

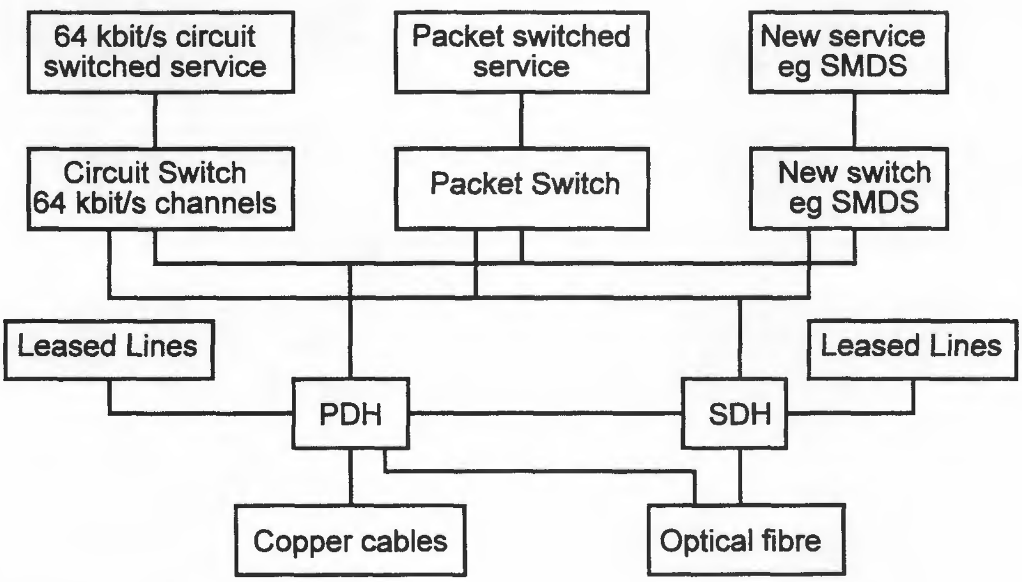

Figure 2: Current Network Structure

An ATM "service", as an alternative to a network of leased lines - rather similar in purpose to a Virtual Private Network, is one of the new services that may be introduced at this stage, and this use of ATM should be distinguished from the later use of ATM as the universal transfer mechanism.

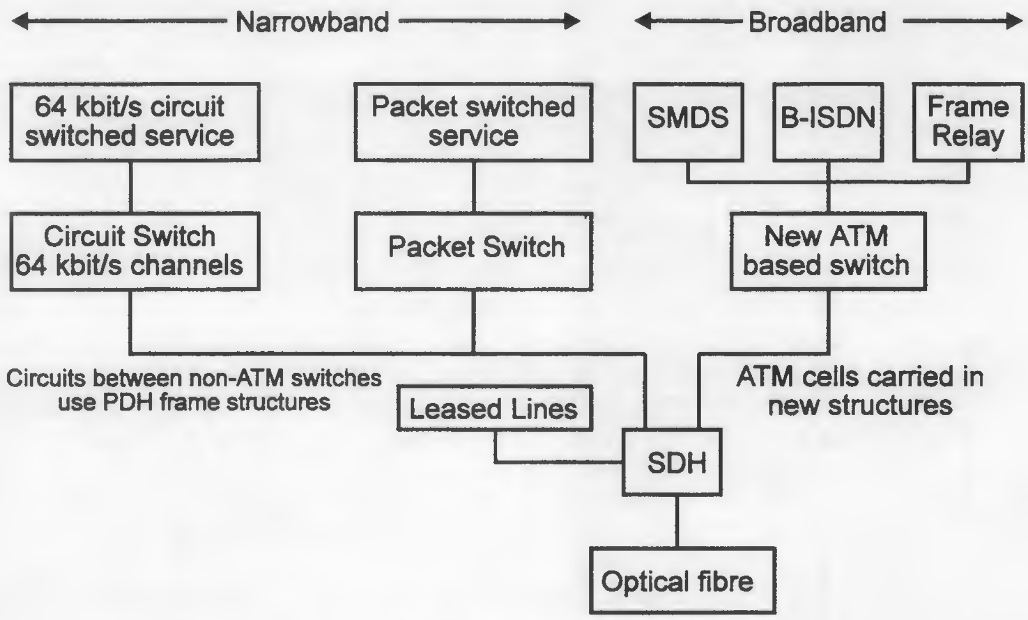

Figure 3: Network Structure in the 1996-2005 timeframe

The next stage of development, typically in the 1996-2005 timeframe, will be the introduction of an overlay network of ATM switches to provide a range of new services. These ATM switches will be used predominantly for broadband services with the current generation of switches remaining to carry narrowband services. PDH and copper cables will tend to be phased out during this period, except in the local loop. The circuits between the old switches will use the frame structures designed for PDH, although they will be carried in the SDH transmission system. Circuits carrying ATM cells between the new ATM switches will use the new frame structures (G.832) referred to earlier. Where new services such as Broadband ISDN include narrowband services there will need to be gateways between the switches to provide the interconnectivity required by users. The structure of the network is illustrated in figure 3.

Interfaces to terminal equipment will begin to be based on ATM cells contained in SDH frames during this period and some optical interfaces to terminal equipment will be introduced. If optical switching is introduced at all, it will be towards the end of this period and will probably be limited to cross connect applications perhaps using wave division multiplexing.

The final stage of development foreseen at present is the phasing out of the current generation of switches so that ATM switches will be used for both broadband and narrowband services, giving the structure shown in figure 4.

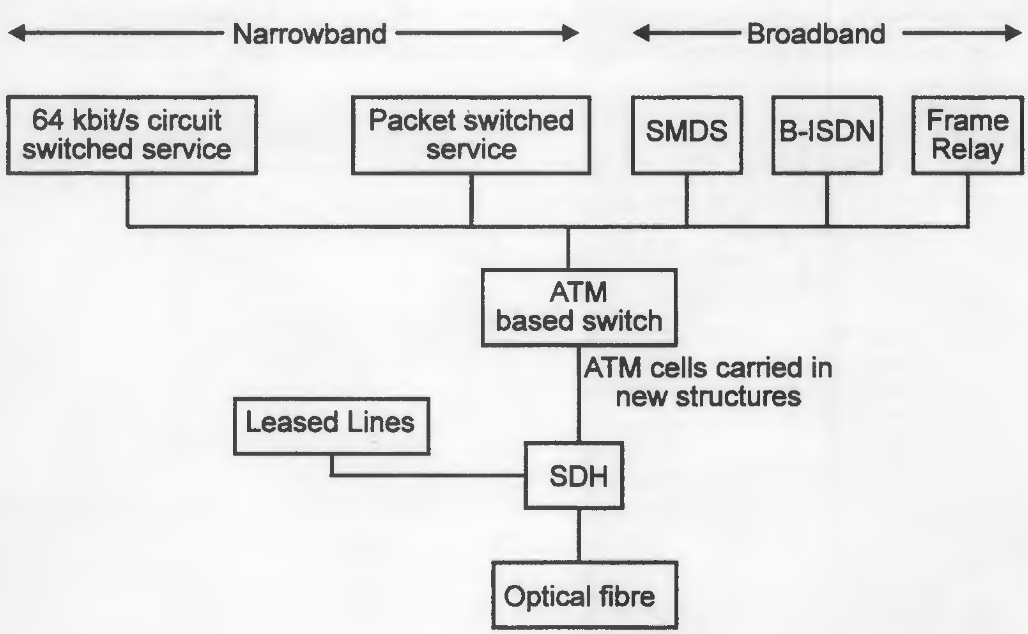

Figure 4: ATM Based Network (2005+)

The development outlined here represents the general consensus within Europe. Some assumptions have been made and some possibilities have been excluded. The following points should also be borne in mind:

- The generation of electronics used in the current digital exchanges has a long potential life and requires little maintenance. They may therefore remain in use much longer than expected unless the majority of residential users require services that they cannot provide. Thus their phasing out will be driven more by the requirement for new services than by cost savings through the use of newer technology.

- ATM cells do not have to be carried in SDH (or PDH) frames, and there is a placeholder in the ITU-T standards work programme for the development of a purely cell based transmission system and interface, where the transmission management information as well as the user information would be carried in ATM cells. Such a development would enable the same switches to be used for both cross connect switching and switching in support of services. However in view of the development of SDH there is little support for pursuing this approach, although it has been studied within RACE.

- Some services such as speech require a fixed transmission delay. Where speech is carried in ATM it should be given priority over data to reduce delay variation although paradoxically it does not matter too much if a few speech samples are lost.

- ATM cells have a rather high overhead for bulk data transfers and while they can carry such traffic fixed rate circuit connections at rates of 2Mbit/s and upwards may be preferable, but it remains to be seen whether there is sufficient demand for a new type of circuit switch capable of meeting such a requirement. High bit rate leased line services will be provided directly from the SDH transmission network.

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by John Horrocks and Robin Scarr
Published by:
Horrocks Technology Tel: +44 1483 797807
Bethany Fax: +44 1483 797617
Chapel Lane
Pirbright
Surrey GU24 0JZ
England

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Frame Relay in Europe

Harman H Hopkins
H3 Communications Consultancy
Vice Chair, European Frame Relay Forum

Frame Relay Forum

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Why Frame Relay?

By now, you will have heard of Frame Relay. However, hearing and believing are not the same thing. If you are to make use of Frame Relay you need to know some facts about Frame Relay:

- Why Frame Relay?
- What is Frame Relay?
- What can it do (and not do)?
- Can it benefit me?
- Is it available?
- Will it last?
- Are there any barriers to using Frame Relay?
- What is the Frame Relay Forum and how can it help?

This short paper gives brief answers to these questions. It also explains the role of the Frame Relay Forum both Worldwide and in Europe.

The convergence of computing and telecommunications has been an aim that is now becoming a reality. The power of desktop computing allied with Local Area Networks has brought new opportunities and challenges. New applications make extensive use of graphics and demand high speed communications. New requirements at the desktop place demands on Local and Wide Area Networks alike. Cost effective, efficient, and high speed networks are, therefore, in demand.

These networks must be:

- Flexible.
- Efficient.
- Cost-effective.
- Manageable.
- Standardized.
- Capable of high speed, low delay operation.
- Able to link LANs over a wide area.
- Interoperable.

Frame Relay delivers these benefits. That is why it is needed and is in demand.

What is Frame Relay?

The term "Frame Relay" can mean many things, including:

- A communications service.
- A Technology for Public, Private and mixed public/private networking.
- A Protocol.

It helps to know which aspect is being discussed, and this paper discusses Frame Relay as a Service. So, what characterises a Frame Relay Service? Important facts are that Frame Relay provides:

1. Lower cost solutions.
2. High speed, low delay any-to-any connectivity.
3. Guaranteed bandwidth.
4. Efficient support for traffic that is bursty in nature.
5. Support for existing communications devices and protocols.
6. Multiplexing at layer 2 on virtual connections.
7. An ideal access and migration to ATM.
8. A "standards based" service with recognised user and network interfaces.

Frame Relay services are designed to take advantage of high quality digital transmission and intelligent terminals. Low error rate transmission makes extensive network-based error correction (e.g. as provided in X.25) redundant. It then becomes feasible to restrict error correction to the users' terminal or DTE. Minimising processing by the network makes high speed and low delay possible. This is a common feature of all so called "Fast Packet" Networking, including ATM.

A Frame Relay service transports frames transparently, only the frame label and Frame Check Sequence (FCS) are modified by the network. Frame based communications are important because:

- All current communications devices generate frames (except for a few ATM equipments).

- Frame based communications are efficient because large payloads can be transmitted in one frame. For example, a 1500 byte LAN frame can be transmitted with an overhead of less than 1%. Using ATM the overhead would be about 18%.

- Frame Relay can carry all today's data protocols. Standards for Multiprotocol Encapsulation provide support for SNA, IP, OSI and LAN protocols.

Today, Frame Relay services provide logical connections based on Permanent Virtual Circuits (PVCs). **Figure 1** shows this. All the standards are in place for Switched Virtual Circuit (SVC) services and these may become available in the next year or two if the market demands them. PVCs are arranged by subscription but SVCs are provided on-demand using updated ISDN signalling (Q.933).

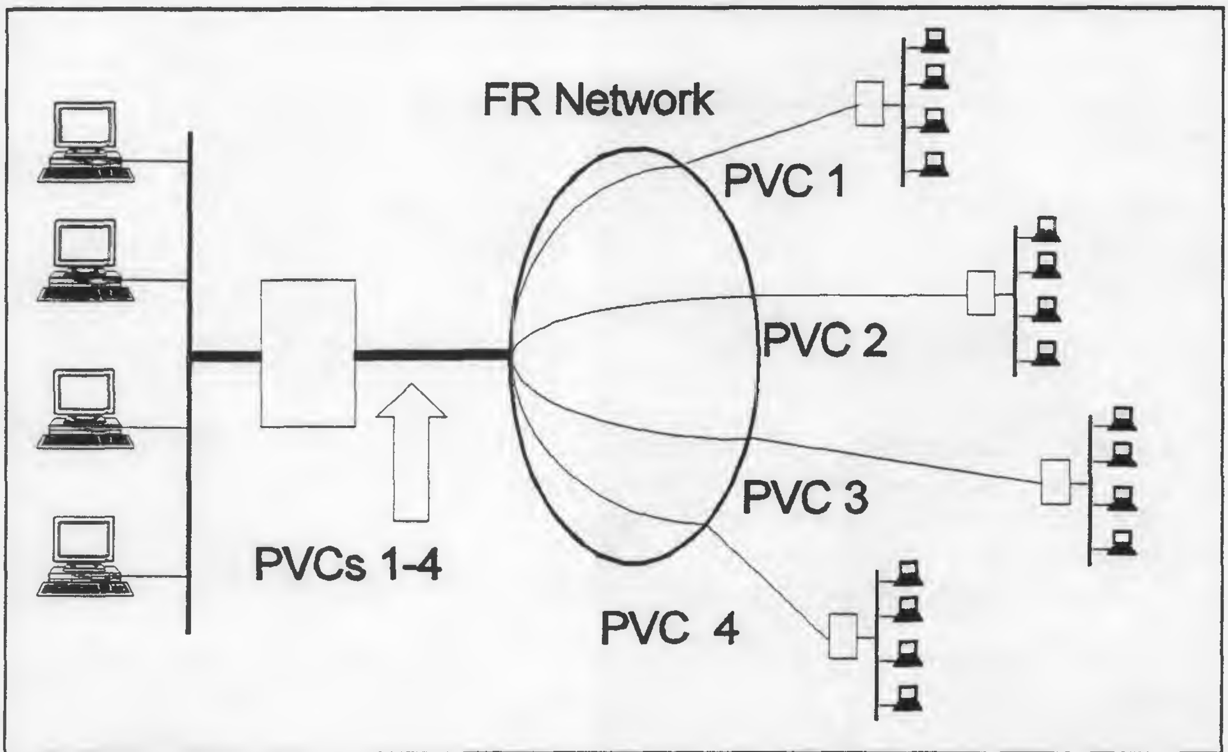

Figure 1: Frame Relay PVCs

The Speed Hierarchy

Frame Relay services can be positioned in a speed hierarchy. This is illustrated in **Figure 2**.

At the lower speed end, X.25 based packet services have proved very successful and popular. However, the error correction and window mechanism of X.25 leads to performance limitations and cost penalties for speeds much above 256 kbit/s. It is clear that Frame Relay and X.25 are complementary; X.25 comes into its own at lower speeds and when service is required to locations without digital connections.

Most Frame Relay services today are offered at speeds of up to 2 Mbit/s (4 Mbit/s in Finland), in line with market demands. Services operating in this speed range make practical and economic sense. Practical, because the majority of terminals and applications can make good use of such connections (whereas there are few terminals and applications that really need very high speeds). Economic, because digital transmission at speeds much above 2 Mbit/s is very expensive or not available. However, Frame Relay can operate at higher speeds, certainly to around 50 Mbit/s. (NB. Northern Telecom demonstrated 45 Mbit/s Frame Relay back in 1991). Depending on demand, higher speed Frame Relay may become available.

Cell based services such as SMDS/CBDS and ATM are better optimised for speeds of 34 Mbit/s and above.

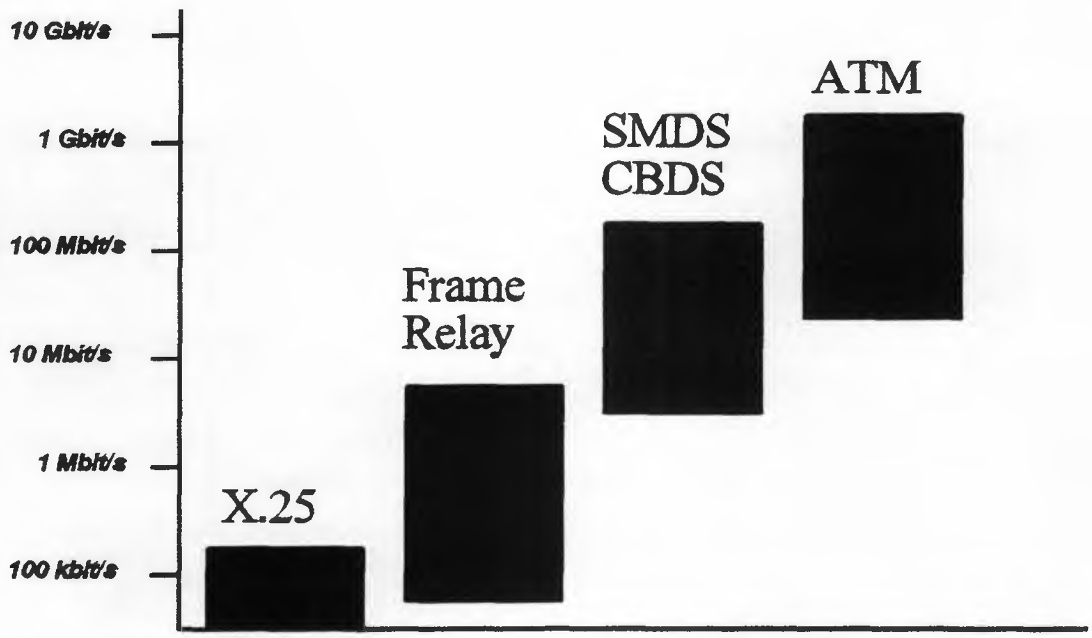

Figure 2: Speed Hierarchy for WAN Technologies and Services

Frame Relay is optimised for data transmission. It is different to conventional packet switching (X.25) because each logical connection can have a Committed Information Rate and Excess Burst Size defined. Because of the low delay characteristics it is also possible (and is being done today) to carry packetised voice and video over Frame Relay networks although ATM is better for such applications.

The Committed Information Rate (CIR) is the information rate that the network is committed to transfer under normal operating conditions. [Because information is transmitted in bursts, at parameter called the Committed Burst Size (Bc) is also defined]. The CIR parameter introduces an element of determinism to the Frame Relay service. Traffic within CIR should not be discarded in normal conditions.

The Excess Burst Size (Be) defines by how much the input information can exceed Bc. Information corresponding to Excess Burst is treated as lower in priority than CIR traffic.

These parameters allow virtual circuits to be adjusted to suit the information flows and to optimise costs. A low (or zero) value for CIR means that little bandwidth has to be reserved in the network. This should result in a lower tariff than for a high CIR. On the other hand, using a very low or zero CIR means that none of the traffic is committed. Uncommitted traffic is discarded in preference to committed traffic if the network suffers congestion.

Also, Frame Relay networks use Congestion Management as distinct from flow control used by packet (X.25) networks. Congestion management includes explicit notifications of congestion and as noted above, the discarding of uncommitted traffic during congestion.

Table 1 gives a brief comparison of some network technologies/services.

Table 1

	TDM	X.25	ATM	Frame Relay
Provides:	Dedicated circuits	Data service	Transport protocol	Data service
Statistical Multiplexing	No	Yes	Yes	Yes
Port Sharing	No	Yes	Yes	Yes
Bit rates	V.High but inflexible	Medium	V. High	High
Delay	Very Low	High	Very Low	Low
Protocol Transparency	Above Layer 1	Above Layer 3	Above ATM Layer	Above Layer 2 Core

Can it benefit me?

You should seriously consider the great advantages of using Frame Relay if your requirements include:

- A growth in the use of LANs and a need to interconnect them.
- The need to consolidate multiple applications, terminals and protocols. (Example applications could be the exchange of graphics, large file transfers, or interactive ones requiring a fast response.)
- A single consistent solution supporting data rates at circa 64 kbit/s to 2 Mbit/s now and possibly 35/45 Mbit/s in the future.
- A need to provide cost efficient access to a large host computer.
- A need for national and international connectivity.
- The provision of a managed network or need to outsource some or all of your data networking.
- The need to integrate private and public data networking.

Is Frame Relay available?

Yes. Frame Relay is growing fast.

- Global Service Growth between 1993 and 1994 was 550%.
- US Revenue from Frame Relay services is projected to double each year from 1994 to 1997.
- In 1993 European Frame Relay represent an £8M market. This is predicted to grow to over £600M in 1998. [Ovum Ltd].
- Organisations are taking Frame Relay seriously. The average number of sites per customer (US) jumped from 3 to 10 in the past year. Many users now have over 100 sites connected.
- 40% of US corporations are considering Frame Relay private networks. [Mc Quillan Consulting Services].
- Wide availability in the US, and increasing in Europe and Asia.

Frame Relay in Europe?

The number of service providers and service availability is growing all the time. **Table 2** gives a list of European countries where Frame Relay services are available. It should be noted that many of the service providers have extensive coverage in the USA and other parts of the world.

Table 2

	SERVICE PROVIDERS											
COUNTRY	AT&T	BT	C&W Mercury	Cserve	MCI	Scitor	Sprint	Telecom Finland	Temanet	Transpac	Unisource	Wiltel
AUSTRIA												
BELGIUM												
DENMARK												
FINLAND												
FRANCE												
GERMANY												
GREECE												

	SERVICE PROVIDERS											
COUNTRY	AT&T	BT	C&W Mercury	Cserve	MCI	Scitor	Sprint	Telecom Finland	Temanet	Transpac	Unisource	Wiltel
IRELAND	■		■	■		▒	■			▒	■	
ITALY	■	■	■	■			■			▒	■	
LUXEMBOURG	■						■				■	
NETHERLANDS	■	■	■	■	▒	▒	■		■	▒	■	
NORWAY	■					▒	■		■	▒	■	
PORTUGAL	■						■				■	
ROMANIA										▒		
SPAIN	■	■	■	■			■			▒	■	
SWEDEN	■	■	■	■		▒	■	▒	■	▒	■	
SWITZERLAND	■	■	■	■		▒	■			▒	■	
UK	■	■	■	■	▒	▒	■			▒	■	▒

Note: Unisource provides extended coverage through WorldPartners and SITA	Information direct from Service Provider	■	Information: Data Comms International, February '94	▒

Will it last?

Perhaps one question you may have is this; won't ATM soon replace Frame Relay? The short answer to this question is, NO. There are a number of reasons for this, including:

- Frame Relay is available now in North America, Europe and the Pacific Rim.
- Organisations are using Frame Relay for business critical communications.
- Frame Relay is a very efficient cost effective and realistic solution.
- Frame Relay is based on HDLC (frames) and is widely supported by terminal equipment.
- ATM requires new hardware because it is based on fixed size cells.
- ATM is designed to operate at very high speed and is inefficient for lower speed access.
- ATM is very useful for high speed backbone networks.
- Frame Relay is very useful as a service supported by an ATM-based backbone network.
- Finally, interworking between Frame Relay and ATM is defined in ITU-T recommendations, ANSI & ETSI standards and Frame Relay Forum Implementation Agreements.

Bandwidth in the Wide Area Network is still expensive and the current enthusiasm for very high bandwidth networks must be viewed in the light of the real demands of applications. In a recent prediction, AT&T stated:

- In the year 2000 there will be five times as many Frame Relay users as there will be ATM users.

Barriers to using Frame Relay

There are some barriers that need to be overcome. The main things that need to be addressed are:

- The need for clear pricing and tarriffs.
- Service offerings with clear and consistent Quality of Service options.
- Greater number of local points of presence to avoid long and expensive connections to a Frame Relay network.

Pricing and Tariffs

Tariff principles for Frame Relay

Approaches to tariffs vary. Some approaches involve customised packages that offer network design and various CPE options. Although some tariffs offer good saving over leased lines, the PTOs have a vested interest in not undercutting leased line services too much.

Tariff considerations in Europe are different to the US because of the large installed base of X.25 and the higher cost of leased lines in Europe. The cost of leased lines also varies considerably depending on the country considered.

Current frame relay tariffs can generally comprise three elements based on:

1 Port or access line speed.
2 Some measure of bandwidth utilisation.
3 Geography.

Port/access line charges

Most PTOs charge a monthly port or access charge based on access speed. The higher the access speed, the higher the charge. Charges vary quite widely; a ratio of 4:1 in charges for the same speed access is not uncommon.

Bandwidth Utilisation based charges

Two methods for bandwidth utilisation charges are common, they are based on ; (1) Committed Information Rate (CIR) and (2) Usage.

Committed Information Rate (CIR) based charges

Various rates are charged depending on the CIR allocated to each PVC. Again the charges for a given CIR vary widely. Due in part to limitations of the equipment platforms, early frame relay services have not been able to exploit pricing based on both CIR and Excess Burst size. This is because early services were very limited in the way they handled bursts. More modern equipment, particularly some of the platforms available for private enterprise networks offer better burst capabilities. Later generations of equipment used in the PTO networks are likewise improving in this respect.

Charging comparisons are also complicated by the practice of oversubscription of access lines. In this case the sum of the CIRs is allowed to exceed the total access line speed. Although this is a common practice, it should be pointed out that oversubscription is not strictly compatible with a standards compliant frame relay service. This is because the CIR represents a throughput rate that the network is committed to deliver and this is impossible to guarantee if the generated (CIR) traffic can overload the access link.

The matching of traffic requirements to frame relay parameters like CIR and Excess Burst size is not yet well understood by users. However, careful scrutiny of utilisation and changing traffic patterns will enable users to optimise the use of frame relay resources.

Usage

In this case charges are made on units such as megabytes or kilosegments transferred. Some PTOs charge on the basis of kiloframes transferred without reference to the frame size.

Geography

Charges may be based on the distance to the carriers nearest frame relay node or point of presence (POP). These charges may be based on access line length and may fall into distance-related charge bands. Other PTOs use tariffs based on the total length of the frame relay connection.

Another variation is to base charges on the type of area served. Areas may be classified as high or low density. Customers in low density areas are charged a premium (perhaps up to 25%) reflecting the higher cost of servicing the more remote areas.

Quality of Service

The main issue is the fact that service providers make offerings based on their own interpretations of the QoS parameters. Committed Information Rate (CIR) is a case in point. Some providers oversubscribe access and or trunk routes, thus the true meaning of CIR is somewhat compromised. (Although oversubscription can be effective, e.g. where the probability of access devices operating simultaneously is low) Also, for bursty traffic it is essential to be able to specify the burst size (both committed and excess). Some offerings are unclear in this area. Specification of other parameters such as end-end delay and delay variance are well supported. For example, the choice of CIR will depend on how the network treats excess data. Networks may:

1. Restrict the transmission of excess data.
2. Transmit excess data when not busy but may not transmit all excess data when busy.
3. Be dimensioned to support a high proportion of excess data.

In case (1) the CIR would need to be set equal to the burst data rate, in case (2) CIR can be set lower for off peak traffic and for case (3) CIR may be set even lower (or even to zero).

Because of these differences in network offerings, it could be useful from the users perspective, to have some agreed guidelines metrics and QoS values for a European Frame Relay service.

What is the Frame Relay Forum & how can it help?

The Frame Relay Forum is a non-profit making organisation dedicated to promoting the acceptance and implementation of Frame Relay based on international standards. The Forum's activities include work on technical issues associated with implementation, promotion of interoperability and conformance guidelines and market development and education. Forum membership is open to service providers, equipment suppliers, users, consultants and other interested parties. The Forum has been instrumental in reaching consensus on a set of Frame Relay Implementation Agreements. These agreements address the optional parts of the relevant standards and propose agreements among vendors/suppliers on which options to implement.

The Forum has a European Office. Sylvie Ritzenthaler of OST chairs the European Chapter. Sylvie is also a member of the World-wide Frame Relay Forum Board of Trustees and past Vice President of this board. Marion Lück (OST) provides secretarial support for the European Chapter.

Frame Relay Implementation Agreements

"Implementation Agreements are a true litmus test of a technologies maturity"; so said Rajiv Kapoor — chairman of the Frame Relay Forum's Technical Committee. By this, he meant that when industry is prepared to cooperate to reach consensus, then you have a truly workable solution. Implementation Agreements (IAs) worldwide in scope, based firmly on international standards and are ratified by the Frame Relay Forum:

User-to-Network Interface FRF.1 (UNI). It specifies requirements for the physical interface, for data transfer and congestion control, and management of PVCs across the interface.

Network-to-Network Interface FRF.2 (NNI). Provides an agreed way for any two frame relay networks to interconnect. This means that different public frame relay networks can connect to give world-wide coverage. It also enables private frame relay networks to interconnect to public networks. In common with the UNI agreement, the NNI agreement is based on the support of PVCs.

Multiprotocol Encapsulation FRF.3. This defines arrangements for carrying a wide range of protocols including SNA, over frame relay. Multiprotocol encapsulation procedures enable multiple protocols to be carried over a single frame relay connection. Note: Annex G to ANSI T1.617a also defines the encapsulation of X.25/X.75 over frame relay.

Switched Virtual Circuits FRF.4 (SVCs). Most applications of frame relay are well suited to the use of PVCs. As networks become larger and users require short-term access, some other arrangement is needed. SVCs meet this need. They enable frame relay "On Demand". As we shall see later, SVCs can simplify the addressing in large networks.

Frame Relay/ATM Network Interworking FRF.5. Asynchronous Transfer Mode or ATM is set to be the method for conveying all types of information at very high speed. It will be some time before ATM is available on a wide scale and even then frame relay will provide a natural data interface to ATM at more modest speeds, say up to 45 Mbit/s. The Frame Relay and ATM Forums worked jointly on this agreement. It will ensure that the frame relay user has a clear migration path.

Frame Relay Service Customer Network Management FRF.6.

Provides frame relay customers with the means to perform network management functions on the services provided to them. It is based on the use of the Simple Network Management Protocol (SNMP) and uses a Management Information Base (MIB) developed by the FRF and the Internet Engineering Task Force (IETF).

Multicasting FRF.7

A Multicast service accepts frames from one user and distributes (copies) them to a number of other users. Several variations of multicast are defined, including, one-way, two-way and N-way services.

Future technical work by the Frame Relay Forum includes:

Frame Relay/ATM Service Interworking

High Speed Frame Relay at UNI and NNI

Abstract Test Suites

Packetised Voice on Frame Relay

Frame Relay/ATM SVC Interworking

Information services

In order to make it easy for end users to investigate frame relay, the Frame Relay Forum has developed on-line information services to provide information about frame relay and its applications. These on-line services are co-sponsored by Communications Week and Data Communications to provide up-to-date information to their readers.

There are two parts to the on-line services: the Frame Relay InfoExchange, an electronic bulletin board; and Frame Relay Facts-by-Fax, a fax-on-demand service. In addition, Indiana University maintains an Internet USENET service on Frame Relay. Users can retrieve information using a personal computer or standard fax machine. Both services are available with NO usage charges or connect-time charges.

The Fax-by-Fax service.

Many documents are available from this service. Simply call +1-415-688-4317 from a standard fax machine handset and follow the spoken instructions.

How do I access the InfoExchange?

If you have a CompuServe account just type GO FRAME. If you don't use CompuServe, phone or E-Mail the Forum's US office with your contact details and ask for information on connecting to the InfoExchange.

The Frame Relay InfoExchange has two parts: a library containing documents and information and an interactive message section. Typically the library has copies of the Forum's Implementation Agreements, recent articles on frame relay and a directory of Forum Members. The message section offers users the opportunity of interaction. Questions can be asked and experiences shared. For example, a user considering frame relay might want to know how a particular application behaves when connected with frame relay instead of multipoint leased lines.

The USENET is also a very useful source of information and discussion. A mailing service is available.

Reply-To: comp.dcom.frame-relay@indiana.edu
Errors-To: owner-frame-relay@stone.ucs.indiana.edu
X-Info: submissions to comp.dcom.frame-relay@indiana.edu
X-Info: [Un]Subscribe requests to frame-relay-request@indiana.edu
X-Info: example- unsubscribe frame-relay somebody@somewhere.com
X-Info: archives (soon to be announced)

Contact addresses for the Frame Relay Forum

The Frame Relay Forum
303 Vintage Park Drive
Foster City, CA 94404
Telephone: +1 415 578 6980
Facsimile: +1 415 525 0182
E-Mail: frf@interop.com

Frame Relay Forum
European Office
c/o OST
B.P 158
35510 Cesson Sévigné Cedex
TELEPHONE: +33 99 51 76 55
FACSIMILE: +33 99 41 71 75

Harman H Hopkins
H3 Consultancy/ Vice Chair, European Frame Relay Forum.

13/12/94

The use of the frame relay protocol versus the use of X.25 protocol

P. Kargados MSc.

Telecommunications Services Manager

INTRACOM S. A.

HELLENIC TELECOMMUNICATIONS AND ELECTRONIC INDUSTRY

Introduction

The conventional data networks, which are using in their majority the packet switching technique, are designed for operation on already existing telephone lines, usually analogue lines, with low bit rate and enough noise.

This has led in complicated protocols, requiring enough processing in the intermediate nodes of the network, which introduces many difficulties in the realisation of high speed data networks. But the continuous evolution in optical fibers technology as well as their wide use as natural transmission means allows the use of a wide frequency band for correct, fast and advantageous, as far as the cost is concerned, digital communications .These properties may not be used only for the simplification of new protocols designing.

This presentation is limited in the Frame-Relay protocol which relies on the existence of best quality natural transmission means in order to simplify the switching procedure shifting the data correction procedures due to errors or traffic at the terminal systems, instead of the nodes of the network. A description of the protocol can not of course be made here, but the various fields of satisfactory or not application of the Frame Relay protocol are examined.

1. Excellent application field of the Frame -Relay protocol

As it is understood, the main target of the Frame Relay protocol design, was the realisation of a high throughput interface to the network, with small transmission delay, limited action field for error correction, based on the terminal systems for recovery in case of problems. The above targets are also required in the design of a Local Area Network (LAN). The main difference between the above two cases is that the Frame Relay is a Wide Area Network (WAN) protocol and not a LAN protocol. In this way the Frame Relay may be succesfuly used for the extension of a LAN in a wide area. The connection of two LANs through a WAN may be accomplished in various ways, ex. by bridging and routing. The two techniques used, mainly, for connection by bridging and routing are Time Division Multiplexing (TDM) and packet switching. In case the network is based on TDM, there is possibility to have enough frequency band available to perform the connection of two more LANs. The necessary capacity, thus, should be defined during the installation of the connection. This means, that the frequency band available by a time division multiplexer for the performance of a connection, is essentially wasted in the time intervals, during which the connection does not use the above mentioned frequency band.

So, though the TDM technique, may offer high throughput, is disadvantageous in case of applications with "*bursty*" traffic.There is better performance in case that the packet switching method is used for the connection of two LANs. This happens because there is the possibility of statistical multiplexing ie. the possibility to offer frequency band to the connection depending of the required frequency band during each time interval.

This technique is extremely advantageous in case of "bursty" trafic (as it is the trafic between two LANS), because there is no frequency band wasted. But, there is a problem in case the applications need high throughput, which is due to often big delays which may occur in a packet switching network.

The frame relay offers a mechanism of fast data transfer in parallel with the engagment of the frequency band depending on the connection. The mechanism of frame rejection is not a problem, because it may be considered, in a WAN, as the extension of the frame rejection mechanism in the LANs (as, for example, the packet rejection in case of collision when the LAN is operating with the CSMA/CD method).

Additionally to the above, big advantage of the frame relay are the Committed Information Rates (CIR). Because there is no local flow control, the users are able to introduce in the network as many data as they need in a specific moment. This, of course, may lead to trafic jums in the network since it is possible, in a specific moment , many users to decide to introduce much trafic in the network. In the Frame Relay there are no mechanisms to enforce the users to stop their data transmission, but there are only mechanisms to notify the user that there is a case to create a problem in the network, if the user continues the data transmission in the same (high) rate. The principle of CIR has been developed in order to avoid cases when a user refuses to conform to suggestions of the network continuing the data transmission without rate reduction.

2. Satisfactory application fields of Frame-Relay

The Frame Relay has been designed to serve data trafic and so it may easily be used as a data transfer mechanism for other protocols,additionally to those for LANs. In order to manage it , products must be constructed which will transform the data flow in a form of Frame Relay, allowing thus the trafic of data into the Frame Relay network. These products are named FRADs (Frame Relay Assembler/Diassemblers) and their technology will be continuosly developing as long as the Frame Relay protocol is accepttable in general.

For the service, of the data transmission today the X.25 protocol is used. The main reasons for the transition from the X.25 to Frame Relay are the demand for high throughput capacity, and very small delay in special occasions. These characteristics are offered through leased lines having however a quite high cost. The alternative solution that the Frame Relay offers instead of the leased lines is very attractive. As it was already been mentioned, the user of the Frame Relay network can transmit, through a WAN, data in a higher rate than his CIR for which he is being charged. But, in order to occur this, all the equipment should be modified in order to support the Frame Relay protocol, or the FRADs should be adopted.

The problems that faces the establishment of the Frame Relay in public networks are the following :

- The Frame rejection from the network enforces the user's terminal to apply correction techniques.
- There are no defined methods for the transformation of the data of various protocols in frames for the Frame Relay.
- The advantages in the performance of the Frame Relay can be balanced by the additional processing needed by the FRADs.
- A very careful planing, testing and control of the work is needed because the mixture of the trafic from the LANS with other data trafic of conventional type may lead to performance reduction for some users. This happens because of the fact that in many occasions LANs trafic is consisted of very big packets which can provoke big delays in the queues for the other trafic types.

The factors mensioned above make Frame Relay a good one but not a perfect technique for the transmission of data trafic of other than LAN types.

3. Fields of unsatisfactory application of the Frame Relay

Though the Frame Relay is a relatively fast technique of data transmission, it has some typical characteristics of the packet switching networks. Such a characteristic, that acts restrictively as far as the application fields of the Frame Relay are concerned, is the unconstant delays that the frames are subjected in the network. In case we have combination of various types of data trafic through the network, the unconstant delays may cause serious problems in some users.This can be directly seen in the case that a frame relay switch should input in the network packets from two sources, one of which mainly sends large packets (ex. LAN) and the other small ones. In the switch the frames are placed in a queue in their entrance order.

Because of the longer transmission time needed for the large frames, the small frames, are often liable to unacceptable delays. In case that all the frames are large the delays in the switch may be too long.

A solution to this problem is the creation of priorities for the various types of trafic. So the small frames having bigger priority will be able to jump over the big frames in the queue. In that way however, the delay of a small frame which is inserted in the switch, the moment that the transmission of a large frame is starting, is not reduced, because the priority algorithms do not reject data which are under processing, when other data of bigger priority arrive.

Because of the unconstant delays the Frame Relay cannot support services sensitive to delays, such as voice and videoconferencing. The insertion of unconstant delays in these occasions reduces a lot the quality of the services offered and so in this case the use of TDM, where there is insertion only of a constant delay due to routing , is more advantageous.

One possible solution of the problem would be the cutting of large frames in smaller ones (subframes) from the access switch or the FRAD. This solution may be applied in the case of X.25, where the protocol ensures that the subframes will be linked correctly at their destination. In the frame relay, however even if it's sure that the subframes will arrive in their sending order, it is not ensured that they all arrive, because of the rejection in case of error.

In addition, because there is no enumeration of the subframes during their transmission, the testing of correct linking in reception, cannot be made. A solution to this problem was the creation of a protocol on the Frame Relay which would be responsible for the management of the subframes as well as error correction. But this solution is not considered as satisfactory because it eliminates the advantages of the Frame Relay protocol making this way preferable the instalation from the beginning of an X.25 packet switching network.

Euro-ISDN : a factual reality

Dr. Roberto Carlini
European Commission
Directorate General XIII
Administrator
TEN-ISDN and TEN-IBC Section

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1. What is Euro-ISDN

Euro-ISDN is defined as the European ISDN platform, based on harmonised ETSI standards, providing the following minimum set of facilities:

- at the user/network interface : Basic rate access (BRA) and primary rate access (PRA)
- as international interface : ISDN user part Version 1 (ISUPv1)
- as bearer services : circuit mode 64 kbit/s unrestricted and circuit mode 3.1 kHz audio
- and as supplementary services : Calling line identification presentation (CLIP), calling line identification restriction (CLIR), direct dialling in (DDI), multiple subscriber number (MSN) and terminal portability (TP).

However, all these technical characteristics, implemented through a memorandum of understanding by 26 Public network operators (PNO), do not give a clear picture as the definition of Euro-ISDN contained in the so called "Bangemann report" does.

"Euro-ISDN is a first step for the infrastructure of the new Information society".

2. ISDN in the Union

ISDN is commercially available in all Member States (MS). More than 800.000 BRA have been sold, mainly to private customers and Small and Medium Enterprises. In addition, more than 40.000 PRA are active, mainly used by medium and large enterprises. This gives a total of abut 3 millions 64 Kbit/s channels actually used.

The territorial coverage for the availability of Euro-ISDN accesses is today, with a few exceptions, high. For the end of 1995, it has been reported that the geographic availability will be not less than 80% in each MS. As a title of example in Belgium it is reported at 100%, in Italy ISDN is available in 105 main cities and in Denmark at 100%.

Tariffs are changing rapidly toward a convergence for lower prices, however today it exists a large difference among Member States.
A basic access may cost double in Ireland than in Denmark, while a "normal" telephone line costs about the same.

For the benefit of application developers, two Application programming Interfaces (API) have been created (they are named CAPI and PCI). An important effort is today spent by the European Commission in providing the best environment for the industry in order to evolve those two interfaces to a new single interface of the next generation, including multimedia aspects.

More than 100 terminal manufacturers, mainly European, are present in the market, thus allowing the user to choose cost/effective solutions as needed.

A European ISDN User Forum (EIUF) has been created.
EIUF allows to customers, industry representatives and members of the European Commission to discuss trends in developments of ISDN and to assess user needs.

The next plenary meeting of EIUF will be in Berlin (D) on 22-24/05/95. More information can be obtained at the EIUF secretariat, tel. +32.2.2968628.

3. Embarking a new phase: ISDN as a Trans-European Network (TEN-ISDN)

In force since the 1st November 1993, the Treaty on the European Union gives in its Title XII a mandate to the Community to contribute to the establishment and development of trans-European networks.

Telecommunications is one of the sectors where such networks will be developed and three initial priority areas were selected :

- telematic networks between administrations : TEN-TNA/IDA;
- Integrated Broadband Communications : TEN-IBC and
- Integrated Services Digital Network : TEN-ISDN.

In relation to the main topic for this workshop, I will cover only the TEN-ISDN action.

However, potential synergy exists among the programmes and only a global positioning of the three topics will allow the full exploitation of the benefits of having a full and harmonised European platform for the business user.

Given its vocation as a general switched network, ISDN was a natural choice for development as a trans-European network.

The provisions in Title XII open up new possibilities for co-operation with the sector actors towards the achievement of the common objectives.

It was already on the 1st September 1993 that the Commission adopted its proposal for the development of ISDN as a trans-European network .

The main purpose of this communication was to propose a set of measures concerning the development of ISDN as a TEN, in order to support the availability of an advanced telecom infrastructure, so that all participants of the internal market, and notably the SMEs have better chances to exploit the benefits of the market without internal frontiers.

Moreover, the Commission prepared two proposals for Council and Parliament decision on a series of guidelines and a multi-annual community action for the development of ISDN as a TEN.

The first proposal, the so called "schéma directeur", defines the objectives, the priorities, the line of measures to be adopted and the projects of common interest to be carried out.

The latter defines the envisaged Community contribution and the framework for the implementation of the projects of common interest.

The main objective aims at the full coverage and rapid availability of Euro-ISDN conformant facilities in all MS, including a basic set of harmonised services.

The priorities are the rapid availability especially to SMEs, in maximising the usage of Euro-ISDN and in facilitating the access of peripheral regions by means of Euro-ISDN.

Both the proposals have been given a favourable opinion by the European Parliament, with the request for a number of amendments, apart of which has been accepted by the Commission and integrated in a modified proposal.

Concerning the European Council, the debate on the first decision has now led to a "common position" by the Member States on the 22 of December 1994.

4. Lines of action for developing ISDN as a TEN

Based on a close consultation with the Public Network Operators (PNO), the signatories of the Memorandum of Understanding on ISDN, four main action lines have been defined:

- elimination of bottle-necks in the roll-out of EURO-ISDN;
- ensurance of the end-to-end interoperability of telematic services;
- migration of public and private sector applications to EURO-ISDN and
- promotion of EURO-ISDN terminal availability.

4.1. Elimination of bottle-necks

One objective of the Community action is to accelerate the introduction of EURO-ISDN.

Particular attention is paid to the needs of the Small and Medium sized Enterprises (SMEs). In the Community we have 14 million SMEs.

Moreover, 10 of these 14 millions are micro enterprises, with no more than 10 employees.

SMEs can typically not afford to use dedicated network solutions, like for example corporate networks, and cannot request customisation of products on their particular needs.

Hence, SMEs depend to a large extent from a public service offering and from "ready of the shelf" business solutions.

SMEs are also not in the position to deal with interconnectivity problems as they often occur in private networks.

ISDN is not the most advanced technology of which we know today in the field of networking.

However, its particular value consists in its complete interconnectivity on the basis of a world-wide numbering plan and in its - hopefully soon - universal coverage.

If we want to offer to the 14 million SMEs a network which is more advanced than the telephone network and which is affordable for them, then it is hard to think of any alternative to ISDN.

In 1993 the EC has launched a feasibility study to investigate at a macro level a series of bottlenecks in the areas of technical, political, social and economic field.

This study has been carried out on behalf of the EC by a large and well know consultancy firm. The results have been presented in a open workshop in the month of October.

In synthesis, over a dozen of bottlenecks have been identified, classified in 4 level of priorities.

Although the relatively high number, many of them can be solved easily if the consensus of the sector actors will prevail over the close viewpoint of fragmenting the market on a national basis.

Among the bottlenecks at the highest level of priority, the most important are:

- the still not complete geographic availability of Euro-ISDN in all MS (only nine of the twelve MS will offer 100% availability of Basic Rate Accesses by the end of 1995)
- the absence of a fully defined and harmonised set of Quality Of Service (QOS) parameters , particularly on international routes
- the reduced availability of harmonised telematic services
- the absence of a certified interoperability of generic telematic services and applications
- the type approval procedures for terminals (cost, complexity, time scale)

- the PNO tariff policy for Euro-ISDN.

The EC is currently engaged in a number of these bottlenecks to put in practice the suggested action for their removal.

As examples of our present actions,

- a set of QOS will be studied in 1995.
- a concept for a voluntary Euro-Label for the certification of the interoperability of a number of generic telematic services is in study and will start in practice in 1995.
- a bridging measure for an unified type approval procedure in all MS for terminals has been agreed and will be published soon on the OJ of the European Commission.

4.2. Ensurance of end-to-end interoperability of telematics services

Services are the key issue within ISDN. The average user is not interested in the technical aspects of the network; he is interested in services which facilitate his business. Application developers are also interested in a core set of "frozen" service primitives on which to develop business solutions.

Which services are needed?

Certainly voice - but ISDN was not invented just to improve telephony. The interesting part of ISDN are the "new" non-voice services, based on a mix of media format (data, images, ...).

In our proposal TEN-ISDN, we have identified five of these services which are commonly recognised to be of general interest:

- file transfer
- electronic mail
- access to data bases
- videophony and
- facsimile group IV.

Although those services already exist notably in the computer world, their penetration into the world of telecommunications is quite insufficient.

What are the reasons for this situation?

Many of these services are - with regard to the end user - PC based. ISDN is ideally suited to support PC-PC interconnection. A 486 based PC, in terms of its processing power, can process around 50 kbit/s, and the basic capacity of ISDN is 64 kbit/s.

We have approximately 35 million PCs in the Community, but they are only to a small extent connected to the general telecommunications networks.

An ISDN based PC-PC file transfer could replace a lot of facsimile; file transfer is not only quicker and hence less expensive, it allows immediate post processing and does not present the environmental disadvantages of a fax-machine which produces quite some heat and uses a lot of paper which is often immediately photo-copied.
Moreover, facsimile contributes with about 60 % to the Community's 1.2 BECU trade deficit with Japan in telecommunications equipment.

If the advantages are so evident why does it not happen?

The crucial point of the matter is the requirement of "end-to-end compatibility".
Facsimile, although it is technically obsolete, is successful for two main reasons:

- full interoperability between all vendors and
- there is a mass population

A basic characteristic of telecommunications is that users does not know "today" with whom they will communicate "tomorrow". This implies, that they does not know what kind of equipment is connected to the other end of the network.

In spite of this, interoperability between the two end systems must be guaranteed.

If we now look to the existing offerings for file transfer, we will discover that there are products from around twenty different vendors which are in a large part incompatible with each other.

It is therefore imperative for the development of an open population of multi-vendor compatible file transfer systems, that there is not only a single standard which is option free, at least with regard to the core functionality, but that the single standard is also implemented by the various vendors.

Up until now, this was a major problem, certainly in the case of the services mentioned above. Standardisation cannot and has not overcome this problem.

In the context of ISDN, the EC has in close co-operation with ISDN operators and manufacturers of terminals promoted the achievement of such a consensus for the case of file transfer.

Almost any provider of ISDN application software in the Community offers today products referred to as EURO-File-Transfer and which are based on a recognised ETSI standard.

Under our programme of work within the action TEN-ISDN we will undertake similar efforts at least for electronic mail, access to data bases and videophony, for which the same problems exist.

These types of services have of course the additional complexity that they involve service related facilities like the "electronic mail box" (in correct technical terms the "message transfer agent") and the data base server. This will complicate the achievement of a consensus.

In order to generally promote this telecommunications specific requirement of end-to end system compatibility, the proposal TEN-ISDN contains an action-line for the creation of a voluntary based Euro-Label.

It is our firm intention to go ahead with the first steps in the implementation of the Euro-Label during the course of 1995.

4.3. Migration of public and private applications to EURO-ISDN

In the beginning I mentioned another TEN-action in the field of telecommunications, the so-called Telematic Networks between Administrations (TNA).

The essence of this action consists in the development of applications required for the management of the single market. Examples are the interconnection of the computers of the police services, of the VAT-services, of the sanitary control services, of the statistical offices and many more.

All these applications at Community, national or regional level require interconnection. Given the Community-wide repartition of the respective services and their high number of end systems, a network support by an advanced general telecommunications network is likely to offer the most economic solution.

We will therefore scrutinise the possibility of supporting the interconnection of those applications by EURO-ISDN.

Of course, there may be many other areas, in the public and in the private sector where European-wide networking is required. Examples are telemedicine, air traffic management, reservation systems, remote education and learning, images management etc..

In the context of the action TEN-ISDN, we will invite for proposals for applications which can migrate to EURO-ISDN. The framework of the action TEN-ISDN includes the possibility for support for such a migration.

We hope that the industry in Europe is taking up our offer.

4.4. Promotion of Euro-ISDN terminal availability

A study launched in 1994 by our directorate, shows that the today terminal market in Europe is fragmented and nationally based.

Three countries (France, Germany and UK) dominate the current European ISDN terminal market. The fragmentation analysis reveals that over 90% of products sold by these suppliers are destined for their home market.

Moreover, the existing ISDN terminal equipment market is today dominated by ISDN PC cards and terminal adapters, used for a range of unique applications. This is consistent with the relative immaturity of the ISDN marketplace at this time.

In many cases, substantial investments are in course for the development of new terminals (in exemplum, more than 100 MECU have been recently invested by the private sector for developing new ISDN based videoconferencing terminals).

So, this action line will try to focus Community resources on a harmonised and interoperable solution and will promote the availability of these terminals among users, mainly SMEs.

5. Trends and conclusions

Europe is on the way of developing a vision of the new Information Society.

The significance of the digital revolution and the potential synergy of integrating telecoms, information technologies and audio-visual systems need still to be fully recognised in Europe, while in other areas of the world is becoming a reality.

A first clear signposts for the way forward have been put up with the Bangemann Report and the subsequent Commission Communication on Europe's way to the Information Society.
During the second half of this year and the first half of 1995 concrete measures must be brought on its way.

The full availability of ISDN and its related business solutions will be the first step.

We are convinced that ISDN will become a success for Europe.

ISDN will develop into a "Universal Access and Delivery Platform" for all kinds of services in particular for the benefit of the Small and Medium sized Enterprises.

ISDN is not the state of the art of the technology in telecoms, indeed, it was a long way from the initial inception of the ISDN concept in the late 70ies until its present realisation in a harmonised manner.

However, it is the only technology which allows multimedia, today, with a so wide availability, at a reasonable cost, and with a general numbering schema.

Moreover, EURO-ISDN is built on the same pattern as GSM. Through a Memorandum of Understanding, 182 harmonised standards have been defined and a proven implementation practice exists in almost all West European countries. There is no reason, why ISDN should not be similarly successful as GSM, which is marketed in more than 70 countries around the globe, giving to Europe a strong competitive advantage to US and Japan.

6. Postscriptum

This postricptum has been written after the workshop and wants to try to fix some comments which came out for discussion.

The various contribution at the workshop have clearly shown that a large variety of technical solution exists today on the market.
So, it is not a technical problem but it is a matter of choice.

However, the complexity of a model for a self-sustainable market for the EEOS will be reflected in the networking system.
Therefore, more than one technology will have to be chose depending on the functions to be performed.

ISDN is obviously, in view of its limited bandwidth, inefficient as a large bandwidth network for transmitting large high quality colour images in a very low transmission time.

Nevertheless, it is evident that it can play a major role in many other areas :

- when requests for images are not continuos and do not pay back a leased line
- when costs have to be maintained low (compared for ex. to ATM)
- in interconnecting via a public network private LANs
- when only extracts are exchanged (like parts of images, or text associated, or messages)
- and finally, but very important, as the best fully digital access to Internet.

Data Communication over ATM: Trends, Architectures and Protocols

Nail Kavak
Telia Research, S-136 80 Haninge, Sweden
Tel: +46 8 7075565, Fax: +46 8 7075480, Email: Nail.Kavak@haninge.trab.se

Abstract

Although emerging high bandwidth multi-media applications are one of the major driving forces behind the B-ISDN initiative, its success or failure largely depends on how well currently used data communication applications can be supported in these networks. This paper analyzes architectures and protocols specifically designed for providing data communication services in ATM LANs as well as ATM wide area networks. Current trends and activities within standard bodies are outlined, the merits and weaknesses of each solution is given, the issues that still need to be addressed in the future are discussed.

0. Introduction

An increasing number of customers require LAN access with high bandwidth and low delay over long distances. To satisfy these needs, several high speed network techniques have been developed recently, offering data rates up to hundreds of Mbps. Typical examples are FDDI, Frame relay, Fast Ethernet, Ether switch and most recently Asynchronous Transfer Mode (ATM), all designed to satisfy connectivity requirements emerging from current LANs as well as high speed workstations in order to run powerful multi-media applications in a distributed manner.

Much interest has been expressed in ATM, due to its flexibility and its support of multimedia traffic. Although ATM was initially intended to be used in wide area networks, interest today is growing from LAN networking vendors. ATM is superior compared to other networking technologies as it offers high bandwidth and it is scalable in the sense that the bandwidth capacity of an ATM system is not fundamentally limited to the technology itself. Furthermore, it can support multimedia traffic offering seamless integration with wide area ATM networks, both public and private.

Initial ATM installations will operate as subnetworks of existing networks and MAC layer protocols. One of the main challenges in ATM is then the transparent support of existing connectionless services. Recently, several activities have been launched within international standard bodies and forums aiming to specify how to provide data communication services over ATM. Most notably are Switched Multimegabit Data Service (SMDS) and the similar Connectionless Broadband Data Service (CBDS) being supported mostly by public network service providers [1, 2], but also other approaches such as IP over ATM, and LAN emulation [3, 4] that show more adherence to the existing local and campus area networking environment.

In the following, chapter 1 addresses the requirements and the architecture of the LAN emulation service. Chapter 2 describes the alternative IETF methods for carrying IP packets over ATM. Public broadband service architecture and CBDS are subject of chapter 3. The conclusions are drawn in chapter 4. At the end of each chapter, the strength and weakness of each described solution is given.

1. LAN emulation

While it may be foreseen that ATM, and in general multimedia technology will drive the development of new networking interfaces, it is still required to support the existing networking interfaces. The majority of installed protocol stacks rely on facilities provided by today's LANs. In order to use the current base of existing LAN applications, it is necessary to define an ATM service, herein called LAN emulation (LE)*, that emulates services of existing LANs on an ATM network, and this without the need of any change in the ATM terminal equipment's interface to the MAC layer.

Providing the LE service at the MAC layer facilitates transparent support of many protocol stacks including IP, SNA/APPN, IPX, NetBios and AppleTalk. Alternative approaches, for example, IP layer emulation restricts support to only the IP protocol.

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* The LAN emulation service is specified by the LAN emulation subworking group of ATM Forum. The first draft of this specification is expected to be ready at the end of this year.

Nevertheless, existing LANs differ radically from ATM in several important aspects [1]. For example, ATM networks are connection-oriented in the sense that data transfer is proceeded by a setup phase and succeeded by a release phase. LANs are connectionless, i.e., data is transferred at any given time with no prior explicit warning.

Also, in LANs broadcast and multicast is easily achieved through the shared medium. Every packet, whether being unicast, multicast, broadcast packet, is broadcast to all stations which reside on the shared medium, and each station filters out the packets it wants to receive. In ATM, such a mechanism would lead to inefficient use of network resources.

Further, the address format supported by current LANs is based on manufacturing serial numbers and does not reflect the network topology, whereas ATM addresses are hierarchical. Since LAN and ATM addresses have different formats, address resolution functionality is required to associate LAN addresses with ATM addresses.

Another major problem associated with the provision of LAN services is that although "normal" ATM connection set-up procedure requires the specification of the user traffic characteristics, the vast majority of LAN applications are incapable of predicting their own bandwidth requirements in advance. Hence, an explicit guarantee of service cannot be given. A number of novel solutions to the congestion and flow control problem can be found in [5, 6, 7, 8, 9, 10, 11]. The traffic aspects of data services are not described in this paper.

In essence, the LE service needs to perform those functions that are required by traditional LANs but not directly supported by the ATM network.

1.1 Architectural issues

The LE service [12] is exclusively designed to support three configuration scenarios; ATM-ATM interworking (fig. 1a), ATM-LAN interworking (fig. 1b) and LAN-LAN interconnection (fig. 1c). Hence, the interconnection of existing LAN applications across an ATM backbone, to other, end user systems, both those which are ATM attached (servers, high end systems) and those which are on legacy LANs is possible by means of bridging methods. The aim is to enable ATM to be used seamlessly as a backbone technology for existing legacy LAN technologies. This will enable the end users to take advantage of the features that ATM offers as backbone technology, while offering them a migration path, to take advantage of native ATM facilities in the future.

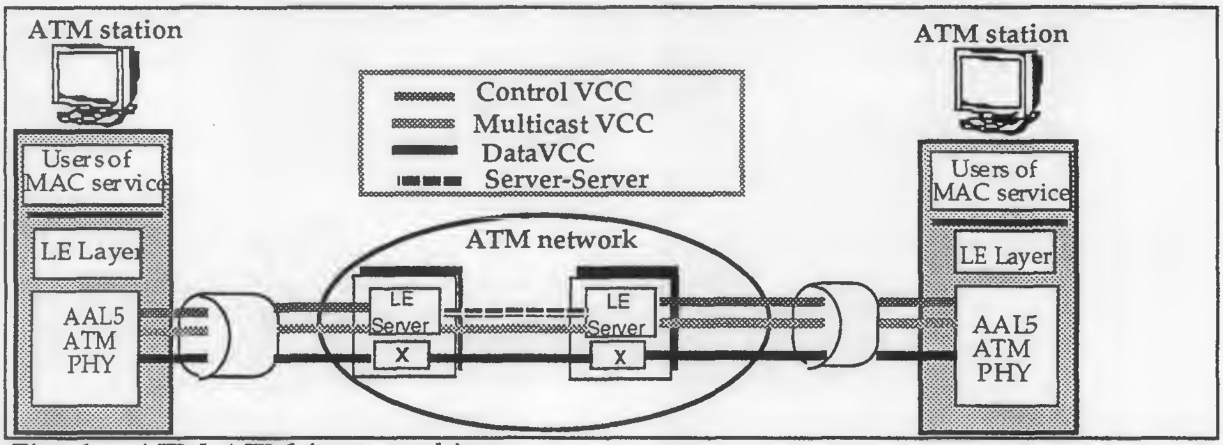

Fig. 1a: ATM-ATM interworking

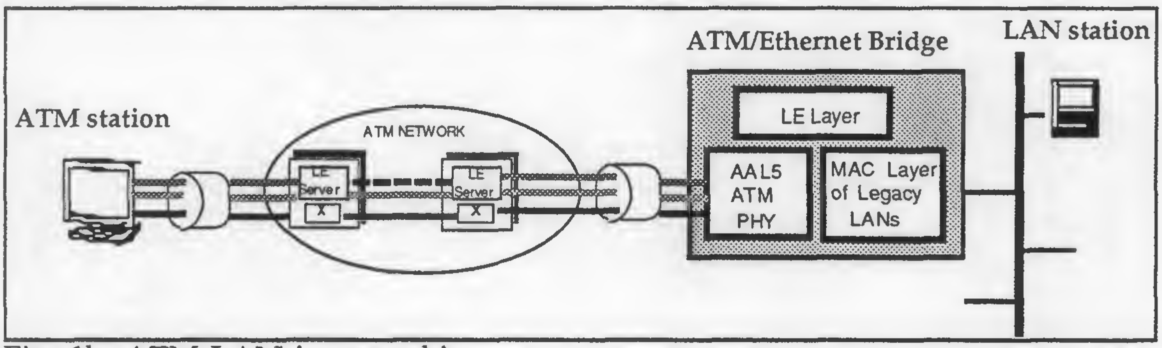

Fig. 1b: ATM-LAN interworking

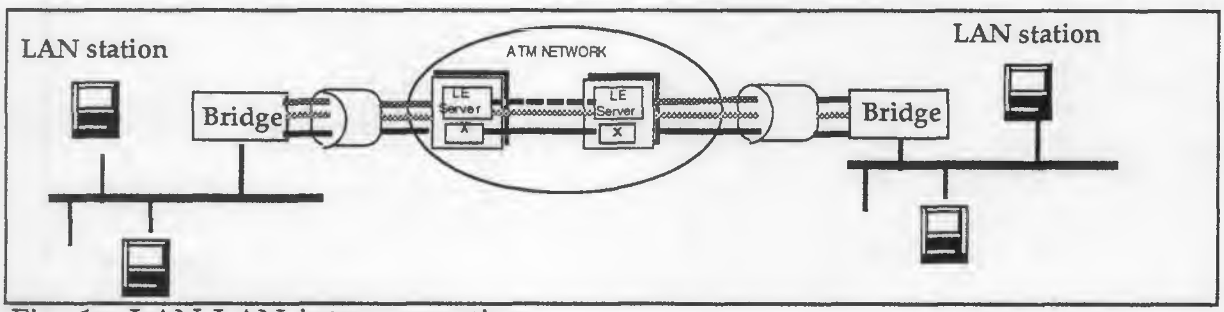

Fig. 1c: LAN-LAN interconnection

The LE service architecture is based on a client-server (query-response) model. The components of an emulated LAN include (fig. 2) ATM workstations and ATM/LAN bridges (i.e., clients). The components of the LE service include LE server (LES), LE configuration server (LECS) and Broadcast and Unknown server (BUS). However, LE architecture does not imply any particular implementation. In fact, any of the LE service components can be implemented distributed (for reliability or performance reasons) or centralized. All components may even be collapsed into a single physical entity (for economical reasons). To enable such an implementation flexibility, a number of virtual channels (VCC) are defined for the communication between LE clients and LE components. Normally, clients use control channels (e.g., configuration-direct VCC, control-direct VCC, etc.) for sending/receiving control messages to/from LE components and the data channel (data-direct VCC, multicast-send VCC) for sending/receiving only user data.

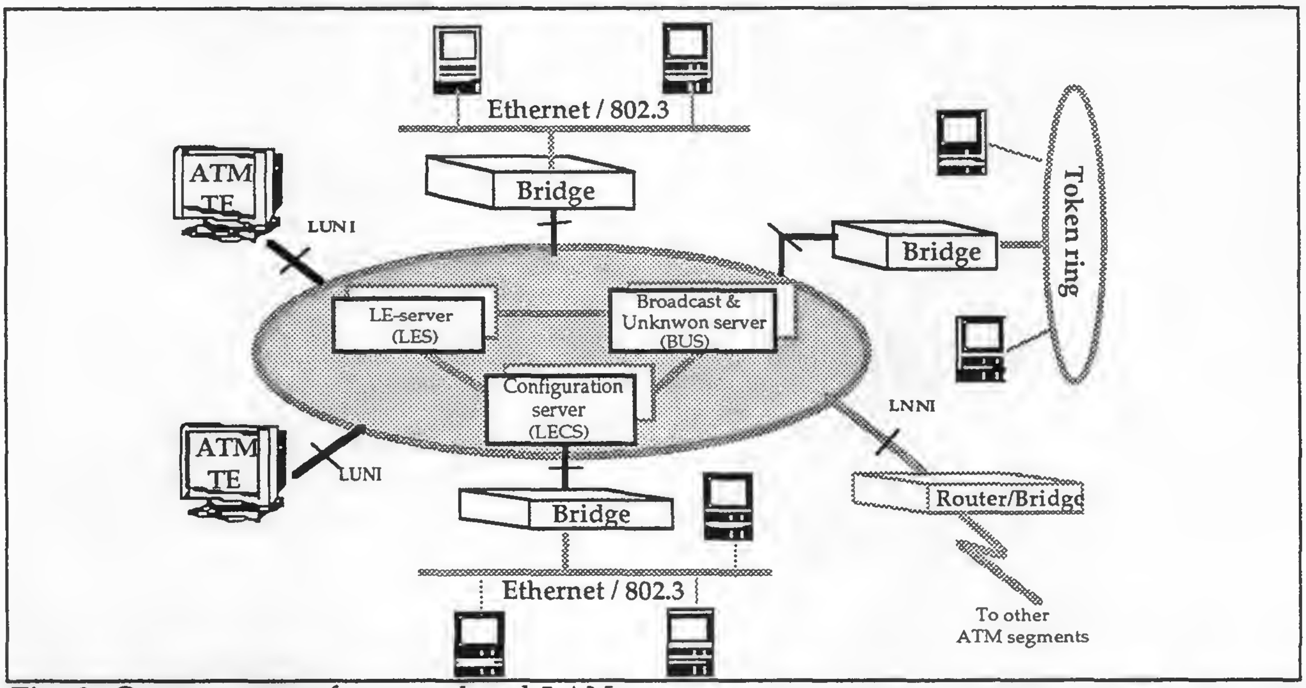

Fig. 2: Components of an emulated LAN

The LES provides a facility for registrating and resolving MAC addresses into ATM addresses. The LECS is used for locating the LES and obtaining configuration information for each ATM segment. BUS is mainly used for forwarding multicast/broadcast frames but also for delivering unicast frames targeted to the unregistred LAN stations, for which addresses can not be resolved yet.

The integration of LANs with ATM technology offers significant benefits of virtual networking. Virtual networking means complete separation of the physical and logical network infrastructure. ATM LANs can be virtually segmented into multiple segments which can be organized along administrative boundaries providing increased security and scalibility (fig 3).

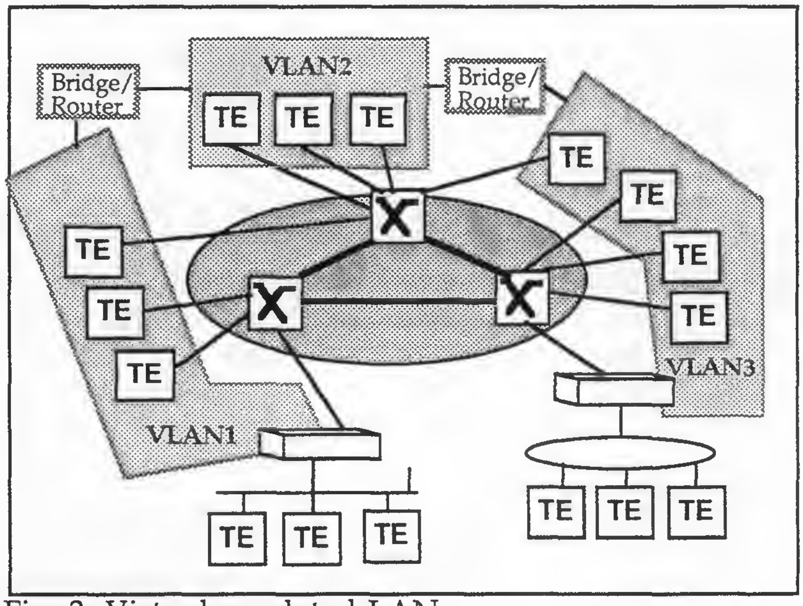

Fig. 3: Virtual emulated LANs

Connectivity between partitioned virtual ATM segments can be provided by means of bridging or routing methods. Unlike traditional LANs, membership in a virtual ATM segment is characterized logically rather than physically. This offers increased flexibility in terms of terminal movebility and network management [13]. A client may be a member of more than one virtual ATM segment via a single physical attachment and it can remain a member of the same virtual ATM segments, even if it moves from one physical location to another in the ATM network. Normally, clients belonging to the same emulated LAN would be connected to the same logical LES and BUS pair. Each emulated LAN with its own LES and BUS would provide service of either Ethernet/802.3 or Token ring segment.

The cost of such flexibility is, of course, the increased complexity within the network. The current ATM Forum specification covers only the interface between a client and a single ATM segment. However, it is envisioned that future work in this field will also cover the interface between multiple ATM segments.

Within ATM stations, the LE service is provided by a LE layer. The LE layer shields the higher layer protocol stacks from the characteristics of the ATM network and gives them the illusion of being attached directly to a traditional LAN. The LE service provides functions related to initialization, registration, address resolution, and forwarding of unicast or multicast frames. When designing the overall architecture, attempts have been made to cleanly separate control and data transfer paths. The primary goal has been to use the LE service mainly for control functions using the control channels whereas, the data would be transferred via data channels transparent to the LE service. This goal, as will be seen in the following sections is sometimes violated in order to achieve better throughput.

1.2 LAN emulation service functions

1.2.1 Initialization

When an ATM station is plugged into a switch port, it executes initialization, joining and registration procedures in order to have access to the LE service. At the end of this phase, the LE client should have initialized some parameters (e.g., the emulated LAN type, client id, connection timeout period, ageing time, forward delay time, etc.) and configured its own MAC and ATM address. Bridges can choose to register all LAN stations behind them (non-proxy bridge) or flood all frames it receives to the LAN segment it is connected to (proxy bridge).

1.2.2 Address resolution and Unicast

In order to set-up ATM connections, the clients need to maintain information about MAC to ATM address mappings. In the absence of such information, the address resolution function provides a method which allows a client to resolve MAC address into an ATM address using LES. The LES constructs a MAC to ATM lookup table upon the registration of the clients and this table is updated every time a client joins or leaves the network.

Initially, a client may not have any information about the MAC to ATM address mapping. In order to send a MAC frame, the client needs to find out which VPI/VCI to send the frame on. If such an entry does not exist, the client forwards a request to the LES to get the ATM address for a given MAC address. The LES may directly reply to this request, on behalf of the registrated clients, or it may choose to broadcast the request to other clients via point-to-multipoint connection, with the LES as root and the clients as leaves. The reply is also sent to the client via the LES.

While the address resolution progresses, the client may also send data frames to the BUS which will flood "unknown" unicast frames to all clients. The rationale behind performing data forwarding in parallel to address resolution is: first of all, without such a mechanism unregistered LAN stations would never be reachable, secondly, some LAN applications are delay sensitive and may not operate properly due to delay caused by address resolution and subsequent connection set-up procedure.

To avoid clients abusing the broadcast channel, a client is allowed to send only a limited number of broadcast frames within a given time. While such a limitation may be useful, the current ATM Forum specification does not make it clear as to how BUS polices "unknown" frames.

When forwarding unknown frames, the BUS can forward an unknown frame selectively to the target client (assuming the client is registered) instead of flooding to all clients. Selective forwarding would thus reduce the total amount of traffic within the network and the load on the clients. The current specification does not put any requirements on the BUS to have such intelligence. The argument against introducing such intelligence is that this would complicate and make the implementation of the BUS and the clients more expensive. Besides, the intelligent BUS provides negligible improvements in efficiency because the unknown traffic sent by a client to the BUS is insignificant, and most traffic flows over the direct data path between the clients.

1.2.3 Unicast/Multicast/Broadcast

Once the MAC address is resolved into an ATM address, the client initiates connection set-up procedure. Upon the completion of this phase, frames can be transferred directly to the receiver client, transparent to the server(s). Connections are torn down after a preconfigured idle time. Clients can cache the ATM connections in use, assuming that future communications to previous destinations are likely to arise.

The data frame format for an Ethetnet/802.3 emulated LAN differs from a Token-ring emulated LAN. What is common though is the absence of cheksum field in both. The advantage of having two different frame format for each emulated LAN is that it simplifies bridge implementation since, due to logical differentiation between emulated LANs, bridges, within a single emulated LAN, are not required to perform conversion between Token-ring and Ethernet/802.3 frames. Conversion mechanism would be necessary though if two different emulated LANs are interconnected via a bridge. Such a mechanism is currently beyond the scope of the LAN emulation service.

The procedure for sending and receiving multicast frames is slightly different than in unicast. The client will initially request the LES to return the ATM address of the BUS. The client will then establish multicast connection to the BUS in the sending direction. The BUS will, in turn, set up a multicast connection to the client on the return path to enable the client to receive multicast traffic.

The BUS has to reassemble and sequence multicast frames before forwarding them via either point-to-point or point-to-multipoint ATM connections. A client can identify and filter broadcast/multicast frames by comparing with its own LE client-id which is obtained during the join or registration phase.

1.2.4 Frame sequence integrity

Most LANs rely on in sequence delivery of frames. In an emulated LAN, clients are allowed to transfer frames through the BUS prior to establishing a direct data path, and when such a direct connection is established, the client may end up with having two data paths, one via the BUS and one direct. Switching between these paths introduces the possibility that frames may be delivered out-of-order. The problem of preserving the order of transmission of unicast frames across an emulated LAN has been solved by the flush protocol. The algorithm applied for the flush protocol is rather simple. When switching between the two paths, the sender client transmits a flush message down the old path and holds the frames for the given LAN destination until the receiving client transmits an acknowledgement that the old path is cleared and the new one is ready to use. Upon receiving the acknowledgement, the sending client dumps all frames that were held down to the new path.

There are some other alternative methods to deal with the out-of delivery of frames. One is to let the receiving client accepting frames only from the direct path and not from the BUS, which will result loss of initial frames. Another way is to let the sending client waiting for some period of time for address resolution to work before utilizing the BUS. In this way, out-of-order frames can be minimized at the cost of some delay. As a matter of fact, the flush protocol itself introduces some delay due to buffering of frames while waiting acknowledgement from the receiving client.

1.3 Discussion

As noted above, current LAN emulation specification covers only the interfaces of a single emulated LAN. Protocols for multiple emulated LANs are subject to future work. LAN emulation is well suited for small workgroups, due to its protocol independence and high speed. Multiple emulated LANs can be interconnected through traditional bridging, routing or brouting techniques. However, the inherent and well known limitations of bridging suggest that it would be impractical and imprudent to extend bridged virtual LANs beyond a local area or small number of workgroups. Interconnecting multiple emulated LANs through a wide area ATM network by means of traditional bridging techniques would also lead to performance limitations due to increasing broadcast traffic. In order to reduce the broadcast traffic, a router can be used instead to filter out unnecessary traffic. Alternatively, multiple emulated LANs can be interconnected by means of direct ATM connections. The main advantage would then be reduction of interconnection devices (e.g. bridges, routers) and thereby improved performance.

2. IP over ATM

While LAN emulation may suffice for workgroups, the interconnection of large scale LAN and WAN networks across ATM will require the development of native mode network layer protocols. This is essential, for instance, for the operation of ATM routers that will be used as the primary mechanism for interconnecting current LANs and WANs across ATM backbones, as customer premises networks evolve towards the widespread use of ATM. The early work on IP over ATM standards was largely done by the IP over ATM working group of the IETF. This work so far comprises encapsulation methods [RFC 1483], default maximum transmission unit, and address resolution method within a logical subnet [RFC 1577]. There are also working drafts specifying establishment of on demand connections [14]. Most of the work done so far does not attempt to change the fundamental nature of the IP protocol (hence the name "classical IP over ATM") [15]. However, more radical architectures are under discussion which cast out the traditional subnet architectures in favour of ATM internet model [16, 17]. The new model is called the peer model which means that ATM network and IP routers are considered as peers (i.e., they exchange routing information between them).

2.1 Classical IP over ATM

In the classical model, hosts connected to the same subnet communicates directly. But, communication between two hosts on different IP subnets is only possible through an IP router, regardless of whether direct ATM connectivity is possible between these two hosts.

Implementing IP over ATM will require mapping between IP and ATM addresses. In the classical model, IP addresses are resolved to ATM via ARP and vice versa via InARP, within a subnet. Initially, hosts are required to register their own addresses to an ARP server which is connected on a well known channel in the ATM subnetwork. The ARP server uses inARP to determine the IP and corresponding ATM address of the connected host. Thereafter, hosts can query the ARP server to get the ATM address of a given IP address. An ARP server resolves only IP host addresses connected to the same subnet.

In order to encapsulate different network layer protocols, hosts can apply two different encapsulation techniques [18]. The first method allows multiplexing of multiple protocols over a single ATM channel. The protocol of the carried protocol is then identified by prefixing LLC/SNAP header. The second method does higher layer multiplexing implicitly by assigning different channels for different protocols. Both methods are functionally equivalent. It is envisioned though that LLC/SNAP based encapsulation may be suitable, if the ATM network only supports semi-permanent ATM connections. Multiplexing per channel would be more suitable in those environments where dynamic creation of large numbers of ATM channels is fast and economical.

2.2 Non-Broadcast Multi Access (NBMA) networks

Although, the classical IP over ATM is conceptually very simple and does not require any changes to the existing systems it is very limited, since communication between different subnets must occur through a router. This is a significant limitation particularly for an ATM based network in which many subnets can be defined. In ATM, hosts connected to the same network are capable of communicating directly, without IP layer switching by routers. This presents an opportunity to optimize performance and perhaps lower cost by eliminating unnecessary hops through the medium.

In order to overcome this limitation, the Routing Over Larger Clouds (ROLC) working group at the IETF has been investigating the possibility to set-up direct connections across non-broadcast multi access (NBMA) networks such as ATM [19]. With this aim, the ROLC working group has proposed a new protocol named "Next Hop Resolution Protocol" (NHRP) which relies on the use of "super" ARP servers. Disjoint IP subnets are treated as one logical network, called NBMA network. For every NBMA, there is at least one NBMA-server which resolves addresses. If there are multiple NBMA-servers within one NBMA network, the servers resolve the addresses cooperatively using the traditional server to server protocols (e.g., IS-IS, OSPF, GGP, EGP). NBMA networks are, in turn, interconnected via IP routers (fig. 4).

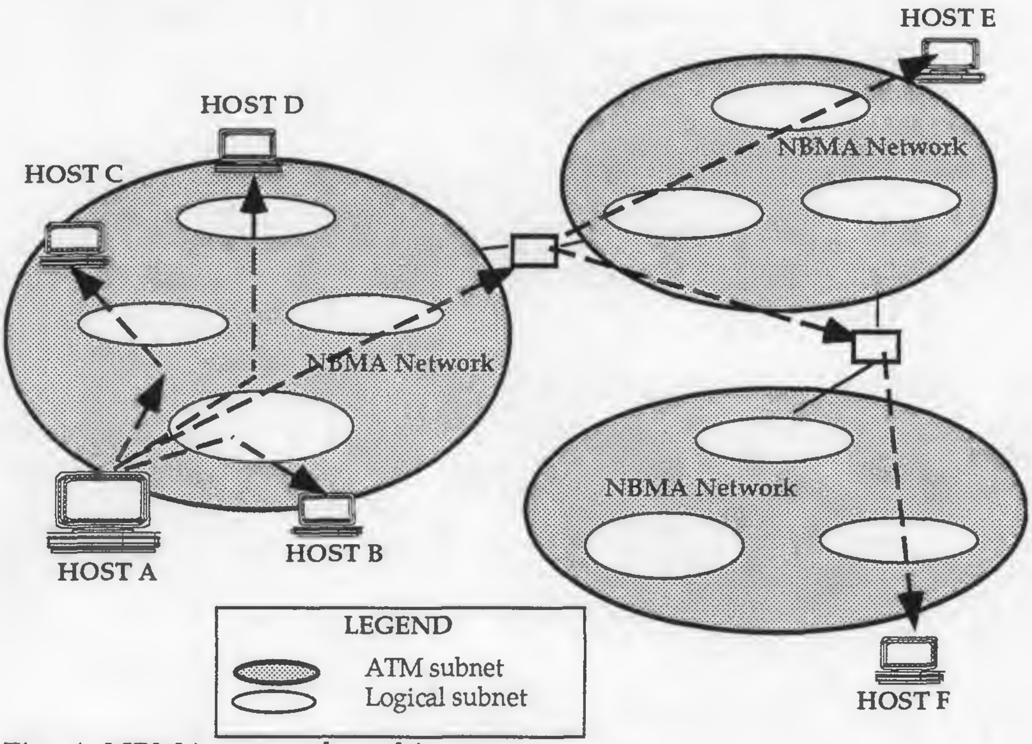

Fig. 4: NBMA network architecture

If source and destination host is connected to the same subnet, address resolution is performed by conventional means using ARP or pre-configured tables. If the destination host belongs to another subnetwork, an ARP request is sent to the NBMA-server. If the address entry is found, the server returns the ATM address of the destination host, otherwise the server forwards the query to the next hop towards the destination. A negative reply is sent back to the source, if destination cannot be found within the NBMA network. In order to increase the performance of the protocol, responses are also cached in each path on the return path.

2.3 Discussion

The Internet protocol family is one of the most important network protocols for ATM to support. The classical IP over ATM, being designed to allow rapid implementations, has a number of weaknesses. Firstly, end-to-end QoS can not be guaranteed as data traverses through several IP routers which do not allocate resources. Secondly, it does not scale well to the large size of the eventual ATM network due to large number of routers. Although NBMA servers reduces the number of hops, it may increase response times up to a round trip time, which may be critical for some applications. Besides, NBMA servers add complexity for network management, and introduce more network failure points.

In general, current IP over ATM solutions obscures the full power of ATM including scalability, performance, and guaranteed quality of service. Ideally, the Internet and ATM technology should be more tightly coupled such that direct ATM connectivity can be provided between two end-points without intervening external servers or routers. To this end, the future version of ATM internets need to address appropriate (or even elimination of) address resolution techniques, mapping of Internet multicasting with ATM multicasting, security issues, QoS connections and coherent routing policy in both ATM and Internet segments. In fact, the success of Internet in ATM depends largely on how well these two networking services can be integrated.

3. Connectionless Broadband Data Service (CBDS)

Unlike the previous architectures, ITU's connectionless service is provided at the user-network interface. The ITU-TSS draft recommendation I.364 identifies two different configurations [20] as depicted in figure 5, indirect and direct.

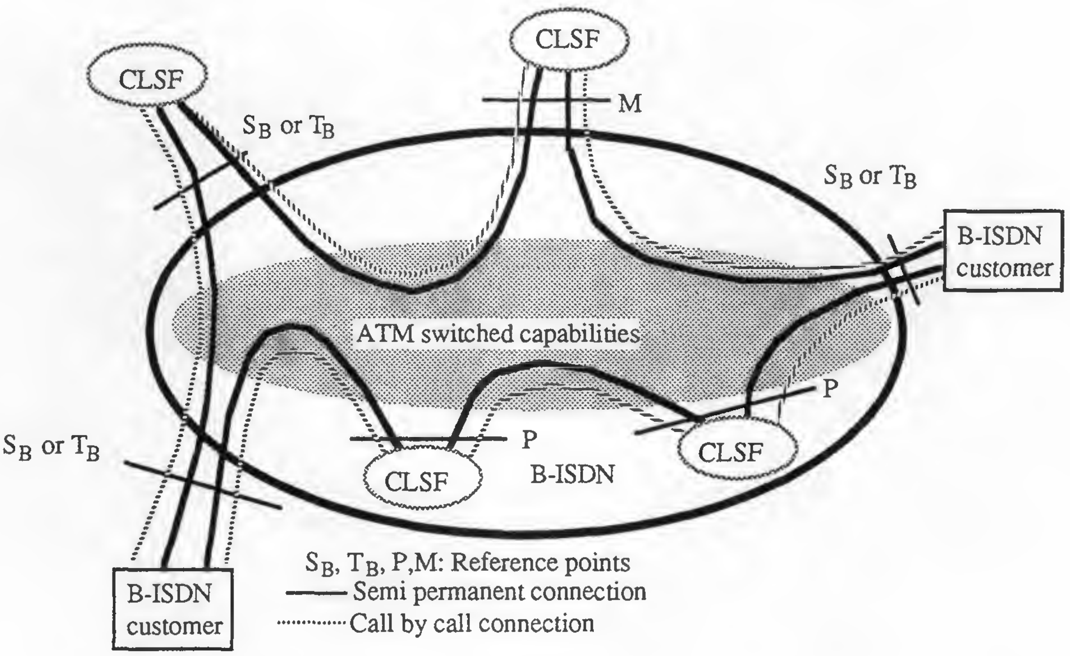

Fig. 5: Indirect Direct and connectionless service reference model.

3.1 Architecture

In the indirect method, the connectionless (CL) service together with associated adaptation layer (AAL) entities are installed outside B-ISDN. A transparent ATM connection, either permanent, reserved, or on demand, is used between B-ISDN interfaces. All connectionless service related functions are performed outside B-ISDN. This operation mode may be suitable when the network does not support signalling and when the number of connection end points are small enough to allow for a fully interconnected mesh [21].

In the direct method, a Connectionless Service Function (CLSF) is installed within B-ISDN. The CLSF terminates CL protocols and routes CL-packets to their destinations according to routing information included in CL-PDUs. The ATM connections between user and the CLSF, as well as the connection between the CLSFs can be either semi-permanent (PVC) or on-demand (SVC). The CL-servers can be installed at various ATM switches as well as ATM cross connect nodes. The connectionless user sends data to a well known CL-server, e.g., the closest one, to which it either signals or has a semi-permanent connection already established. The CL-server then forwards the data to the destination user possibly via a route of other CL-servers. The CL-servers may be interconnected by a "virtual overlay network" consisting of several Virtual Paths (VP) with preallocated bandwidth resources. The choice of PVC or SVCs depends on the user traffic characteristics and quality of service requirements. The use of CL-servers within the ATM network will lead to a reduction of the number of VPs needed (as compared to the full VP mesh) and thus to a concentration of connectionless traffic on fewer VPs. By statistically multiplexing several sources on the same VP, burstiness can be reduced (paradoxically, the losses due to buffer overflow may also increase). Furthermore, the number of connections each end point needs to set-up is reduced to only one.

Figure 6 depicts the protocol architecture of the CL-servers in the access (UNI) as well as between the network nodes (NNI).

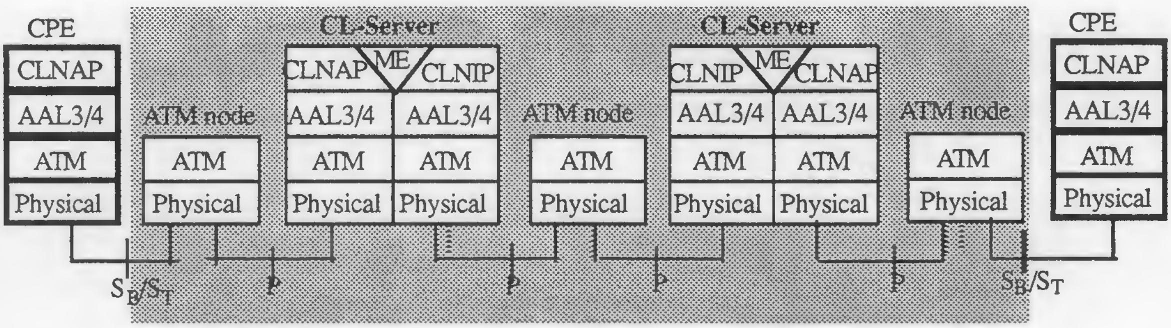

Fig. 6: Protocol architecture of the connectionless service using CL-servers.

The connectionless service function (CLSF) terminates the B-ISDN Connectionless Network Access Protocol (CLNAP) which includes functions for the mapping of connectionless protocol onto the connection-oriented ATM service by means of AAL3/4 entities. The CLNAP includes functions such as routing, addressing, multicasting, QoS selection, carrier selection, etc. Routing is performed based on the E.164 address information contained in the CLNAP-PDU header.

The Connectionless Network Interface Protocol (CLNIP) supports the CL-service between CL-servers inside a network operator domain as well as between two network operator domains. CLNIP provides for the transport of both encapsulated and non-encapsulated data units. Interworking functions between the CLNAP and the CLNIP are provided by a Mapping entity (ME) in CL-servers.

The CLNAP layer includes, among other things, functions for the routing [22] and addressing of variable length CBDS packets transferred between one source to one or more destinations without establishment of any ATM connection by the user. It also supports multiprotocol encapsulation and the QoS parameters: transit delay, cost and residual error probability. To achieve higher traffic concentration at CLSs, VPs between CLSs can be configured not to form full mesh connectivity. Alternatively, the CL-servers can be interconnected arbitrarily or by means of other topological schemes such as hierarchical tree, bus or ring [1].

Up to now, CBDS is the only ATM service which is specified on top of AAL3/4. It has been shown though that CBDS can be designed more efficiently [24, 25] making use of AAL5 instead. Also, AAL5 based CBDS service would be interoperable (at least with respect to AAL layer) with other data communication services such as Frame relay, IP over ATM or LAN emulation which all are designed on top of AAL5.

The CLSs can operate in message mode or streaming mode. In the first case, each CBDS packet received is completely reassembled by AAL3/4 and then passed to the CLNAP layer which performs the routing function based on the E.164 address and QoS requirements. The same packet is fragmented again to cells before being forwarded to the next hop. In the streaming mode, the AAL3/4 will pass only the first cell of the packet to the CLNAP layer which then establishes an association between destination E.164 address and incoming VPI/VCI/MID to the outgoing VPI/VCI/MID. All subsequent cells of the same packet will follow the same route.

Obviously, the message mode cause processing delays and requires large reassembly buffers. On the other hand, erroneous packets can be detected when reassembled such that if a single cell is damaged, the whole frame can be discarded.

There are two alternatives regarding the placement of CLSF in B-ISDN. One is to implement the CLSF integrated with the ATM node [23]. The other is to implement the CLSF in an unit externally attached to the ATM node [24, 25]. In the integrated approach, incoming connectionless cells which are identified by a special tag (e.g., the CLP bit or a special VPI) will be sent to a switching unit, which transfers cells directly to outgoing link. The integrated method performs better than stand-alone method at the cost of less flexibility.

The major drawback of having CLSF in an external unit is that every cell has to be switched twice. All connectionless cells will be switched to the CLS in which the routing decision for the outgoing link will be taken based on destination addresses along with the QoS requirements. The main advantage with the stand-alone approach is that the network designer can manage the CLSs, without intervening the underlying ATM network. In this way, addition of new CL-service related functions will not cause disruption to "pure" ATM switching services.

3.2 Discussion

As noted above, the ITU/ETSI architecture for the direct support of connectionless service make use of CLSs. The key distinction between LAN emulation and ITU connectionless service architecture is that in the latter every cell has to go through the CLS. This put very heavy requirements on the CLSs to have high speed packet (or cell) forwarding capability. Particularly, if the CLS is implemented in an external unit, the CLS may become performance bottleneck.

Also, although CBDS service is designed on top of AAL3/4, remaining data services are based on AAL5. This introduces, in the future, interoperability problems which are yet to be solved.

As of the time of writing, there is as yet no consensus on issues such as CLS streaming mode operation, accounting, CLS connection topology, resource and congestion management and inter-server routing.

4.0 Conclusions

This paper presented data communication service architectures designed for both private and public ATM networks. It is clear from the above discussions that different solutions will apply for different networking environments which will inevitably lead to interoperability problems. Up to now, such problems have not even been addressed in standards bodies. As far as the concepts described in this paper, even though some interim results exist that may lead to short term products, more work still needs to be done with respect to architectural scalability, address resolution, multicasting, resource management, and optimized routing.

5.0 Acknowledgements
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The Implementation of a High-Speed-Network for the DFN-Community

Peter Kaufmann (DFN-Verein)

(January 1995)

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2) Concept
3) Preparation Phase
4) Status
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5) Outlook

Appendix A: Involved Institutions
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1) Introduction

Within the DFN-community a number of regional high-speed networks have been implemented. This article will describe basic concepts, technical structure, status and future extension plans of this ongoing activity.

Before describing these new facilities some information on the current network status of DFN: Until now DFN has been providing the WIN (Wissenschaftsnetz) at user access capacities between 9.6 Kb/s and 2Mb/s. More than 400 sites are connected to the WIN, more than 50 sites have 2 Mb/s access. The WIN is connected to the rest of Europe via EuropaNet (2*2Mb/s) and a 1,5Mb/s line to ESNet provides the connection to the USA. Similar to all networks one finds a sharp increase of transferred bytes also in the WIN. Thus, an upgrade of all above mentioned network components is urgently needed.

DFN has discussed since some time possibilities to implement a high-speed network for the German research community. As preparation for such an upgrade several DFN-projects with high-speed-connections have been implemented already in the past (e.g. 34Mb/s between Erlangen an Munich). These limited projects had the task to test and understand the various techniques (e.g. SMDS/DQDB, ATM) and to enable applications to run within new test environments.

Now the time has come to provide such high-speed networks on a broader scale. They will form the extension component of the current WIN, i.e. the HS-WIN.

2) Concept

A major problem when realising high-speed networks in Germany are the enormous costs for the monopoly lines needed. This is also true for DFN as Deutsche Telekom (DT) is not allowed to directly give special rates to DFN, for example.

This cost problem limits the possibility to establish a national HS-WIN at one step: Neither DFN has currently the budget to subsidize such a national backbone, nor the potential users/customers have the budget to pay the charges needed then. In this context it is worth mentioning that DFN has to pay regular charges to DT for the current WIN and that these costs are covered by the overall (capacity dependent) charges of the customers of the WIN. No direct subsidary is involved in the provision of the WIN.

To overcome or at least minimize this cost problem a stepwise approach had been choosen. In the first phase regional high-speed networks should form the start-up solution. This reduces clearly the needed budget for the lines. Further on from the very beginning a number of dedicated users and advanced applications should be available which really need the new capacity. Thus, the implementation of the regional networks should be accompanied by projects which realize and use advanced applications.

The idea was that the actual use of the regional high-speed networks by new applications (beyond classical applications) would enlarge the visibility of the needs and of the possibilities. An increased visibility should form a better basis to get more money (from either source) for the implementation of an expensive national high-speed network. The next step after implementing the regional networks would then be the interconnection of these high-speed islands via a national backbone.

The time gap between the first and the second phase should result in:

- a prise drop for 34/155 Mb lines,
- a growing awareness within the customer organisation to increase their budgets,
- an inceased funding for DFN to allow subsidising (for a certain time) such a national high-speed backbone.

Hopefully a mixture of all three components will be the result and allow to enter actually the second phase as soon as possible.

For the technical implementation we discussed several possibilities. One idea was the usage of the MAN/DQDB-based Datex-M service of DBPT. But the combination of certain technical and performance restrictions and volume dependent charges finally led to the decision to implement a combination of ATM and router technology on top of leased lines.

This final technical concept is shown in fig.1. Each participating organisation will get a router. The interface of the router to the inner part of the RTB will provide ATM. Within the inner part of the RTB ATM-switches are used. The interface to the user will provide only IP (on a FDDI-interface) at the beginning. Thus, ATM is used at the beginning mainly as an invisible transport mechanism. Some users will get an ATM-access also from the beginning. But this is strictly experimental and it will be withdrawn if that experimental ATM-access disturbs the production IP-access. More details are discussed in chapter 4.

3) Preparation Phase

In spring 1993 DFN issued a “call for tender” for the implementation of “Regional Testbeds” (RTB). The proposals for such RTBs hade to include technical concepts for the implementation of the regional networks and advanced application projects in need of using these regional infrastructures.

In automn 1993 a number of good proposals were submitted to DFN. During winter a careful analysis and a further detailed specification of these proposals took place. Finally, in summer 1994, the process of technical tuning was finished. In the first run five RTBs will be implemented: Bavaria, Baden-Württemberg (BaWü), Berlin, North Germany and North-Rhine-Westfalia (NRW). In Each of these RTBs a number of application projects are funded by DFN (see below). Also the investment costs (router/switches) for all participating organisations in all RTBs are financed by DFN.

The line costs are handled differently in each RTB: In the RTBs of Bavaria, North Germany and NRW DFN is funding about 50% of the line costs for a period of two years, the other 50% must be paid by the participating organisations. The state of Baden-Württemberg finances all line costs of the RTB BaWü. In Berlin the participating organisations will use fibre optical lines of the City of Berlin (instead of lines of Deutsche Telekom) without any charges.

4) Status

4a) Status of Application Projects

There are about 35 application projects which are funded by DFN within the concept of RTBs. Most of these application projects can be grouped into the following categories :

*** Libraries and Journals**

One task is the provision of catalogue information on books and journals. These catalogue information shall be used for the exchange between libraries and for inquiries of end users. Such information are stored at distributed servers. Thus, easy and transparent search tools and user interfaces are needed. A significant problem is the agreement of different libraries on a powerful but easy to use catalogue scheme.

A second task is the provision of books and journals themselves (not only catalogue information). Additionally to the text information images, graphics and , later on, audio and video shall be presented. Full text retrieval must enable well-directed ?quering of certain parts of the document. Apart from technical problems accounting and copy right problems must be handled.

*** Medical Applications**

The whole area of health and medicine includes a very large range of many different aspects concerning networking. It is much to large to be covered by DFN projects. Thus, only some aspects in the field of image and signal processing were chosen as work items. Often special medical instruments are the source of data which then must be transferred to dedicated computers for evaluation and storage. Finally, users (physicians) at different locations must have access to data and results. The work items include for example:

- Planning data from a hospital for a radiation therapy will be transferred to the specialised radiation center. Thus, at the radiation center no further examination of the patient (e.g. X-Ray) must be done.
- Different techniques to take images of brains will be integrated for a common diagnosis.
- Results of computer tomography examinations will be 3D-visualised.

*** Distributed Teaching and Learning**

One goal is the interactive multimedia communication between teacher and students during a lesson. Another task is the provision of multimedia lectures that may be studied self-controlled by students.

*** Simulation and Visualisation**

In the field of natural science and engineering classicly two methods were applied in the past: theory and experiments. Often modern problems are much to complex, to expensive or to time consuming for experimental or theoretical analysis (e.g. climatic research, aero dynamic problems in car and airplane design). Thus, with growing computer power a third basis for research and understanding is formed by computer simulations.

Such simulation (often with visualisation afterwards) within distributed specialised environments (super computer, graphical work-station, render server, etc.) must be available also for remote users outside a LAN environment to exploit the expensive hard- and software. This creates a large need for high speed networks. Often also a real-time access into the simulation and visualisation process is needed for the adaptation of parameters to save expensive super computer time. Thus, apart from bulk transfer of resulting data also a high bandwidth access for the real-time interaction is necessary.

Distributed virtual reality forms a special application in this area. Here several participants of the same virtual reality interact in real time not only with the environment but also with each other.

* **Multimedia Teleservices**

This area covers the provision and adaptation of generic teleservices (multimedia-mail, video-conferencing, multimedia information server) into special user environments. Most of the above mentioned areas (teleteaching, health, libraries etc.) need one or several multimedia teleservices.

The table of projects funded within the concept of RTBs and a short description of their special tasks is presented in the Appendix.

All projects within the RTBs of Bavaria, Berlin, North Germany and NRW have been started in September and October 1994; the projects in BaWü will probably start in spring 1995. The usual project period is two years. DFN-funding for these application projects is about DM 3,5 mio. (ca. ECU 1,9 mio.) in 1994, about DM 6,5 mio. (ca. ECU 2,9 mio.) in 1995 and about DM 4,8 mio. (ca. ECU 2,5 mio.) in 1996.

More information about these projects and their ongoing activity are availabe via DFN-WWW (http://www.dfn.de/). There one finds further references to the different RTB-WWWs.

4b) Status of Network Implementation

In September 1994 DFN ordered the necessary line capacity from Deutsche Telekom for the RTBs in Bavaria, North Germany and NRW. At the beginning of 1995 the situation is as follws:

In Berlin almost all 155 Mb-lines are in operation. Also the 34 Mb-lines in Bavaria and North Germany are in operation. The 34 Mb-lines in NRW will be available in February 1995. In BaWü the contract between the state of BaWü and Deutsche Telekom about the ATM-based network must still be discussed, but in the meantime (since summer 1994) the eight universities use the Datex-M service (SMDS) of Deutsche Telekom.

Also in September 1994 DFN ordered 30 Cisco 7000-SSP routers and 15 Cisco (NEC) Hyperswitch A100 ATM-switches. In fig. 2a+2b the abstract topology of the RTBs and in fig.1 more specific technical details of the access properties are shown. As mentioned above, each participating institution gets a router with FDDI interface to the user side and with an ATM-interface to the network side. In the RTBs of Bavaria, of North Germany and of NRW 34 Mb PDH-interfaces are needed; in Berlin a combination of 155 Mb multimode/singlemode SDH-interfaces is needed.

The routers with SDH/multimode interfaces and with PDH interface are already delivered. The ATM-switches with SDH/multimode interfaces are also delivered. The ATM-switches with PDH interfaces will be delivered in January 1995 and the ATM-switches with SDH/singlemode interfaces will be delivered in February 1995. Thus, while this article is written some connections start already their operation and the others will follow stepwise within the next few weeks.

The ATM-switches are located in the following institutions:

RTB Bavaria: University of Erlangen, LRZ/Munich;
RTB Berlin: TU Berlin, FU Berlin, HU Berlin, FHG/ISST, LIT, HMI, ZIB;
RTB North: University of Hannover, DKRZ/Hamburg;
RTB NRW: University of Cologne, GMD/Birlinghoven,KFA/Juelich;

RTB BaWü: The final topology is not yet agreed.

These institutions may use in addition to the FDDI-interface at the router also a direct ATM-interface at the switches. Whereas the IP/FDDI-interface is for production service within the RTB the ATM-access will be at the beginning only for "experimental" purposes. That means that the institution will make this kind of access on their own risk and their own expense (e.g. additional interfaces). If the production service will be disturbed the direct ATM-connections may be withdrawn.

The startup funding for the network implementation is about DM 3,5 mio. (ca. ECU 1,9 mio.) for the equipment and about DM 3 mio. (ca. ECU1,6 mio.) for the lines.

5) Outlook

Of course, the current realisation phase is only the first step in an ongoing upgrade of the WIN.
Our stepwise approach includes four successive phases of implementation:

Phase 0: Start of the RTBs: Implementation of regional networks based on lines with 34- and 155 Mb/s. The participating institutions get IP-access for the production service. Additionally, they may use the ATM-access at their own risk and at their own expense. This phase is currently being implemented.

Phase 1: Start of the HS-WIN: The regional networks will be interconnected via a backbone. The probable topology of this backbone is shown in fig.3 with thin dashed lines. The production access is still IP; experimental ATM-access is possible. Additional institutions (outside the former RTBs) may participate. The new HS-WIN is integrated with the current WIN via gateways. This phase should be implemented after summer 1995.

Phase 2: ATM production service: Stability, interoperability and needed service features (e.g. flow control mechanism, PNNI-interface, ABR-service) are implemented and successfully tested. The HS-WIN provides production ATM-service. This phase might be implemented in the second half of 1995.

Phase 3: Integration of the telephone service into the ATM-based HS-WIN. Precondition for that phase is an overall upgrade to line capacities with 155 Mb/s. Experiments could start in 1996.

Regarding the technical network components and the availability of fibre optical lines in Germany the HS-WIN could be implemented very fast. But the further quickness of network upgrades in DFN is very sensitive to the evolution of charges. Both, the reduction of charges for high-speed lines by the (monopoly) Deutsche Telekom or the licensing of competitors will speed that process.

Appendix A: Involved Institutions

RTB Bayern: University of Erlangen, LRZ (Munich), TU Munich, University of Munich

RTB BaWue: Universities of Stuttgart, Mannheim, Freiburg, Karlsruhe, Konstanz, Ulm, Heidelberg, Tuebingen

RTB Berlin: TU Berlin, FU Berlin, HU Berlin, FHG/ISST, LIT, HMI (Hahn-Meitner-Institut), ZIB (Konrad-Zuse-Institut)

RTB Nord: TU Braunschweig, University of Hannover, AWI/Bremerhaven, DKRZ/Hamburg (Climatic Computer Center)

RTB NRW: RWTH Aachen, University of Bonn, University of Cologne, GMD/Birlinghoven, DLR/Cologne, KFA/Juelich

Appendix B: Application Projects within the RTBs

RTB Bavaria

* IRIS: Usage of a distributed editor within a video-conference.

* Collaboration of electronic libraries: Provision of electronic documents and electronic query tools.

* Tera-Back: Transparent back-up service for distributed fileservers. Central mechanism for the migration of data to cheap storage memory will be implemented.

* Clinical and histological conference: Physicians will use video-conference tools to discuss dermatological results and images (stored in image data bases).

* Multimedia-based teaching and information systems: Implementation of a WAN teleteaching infrastructure between Erlangen and Munich with integration of ISDN-based homework places.

* Distributed computing for engineering applications. Usage of work-station clusters for the computing of very large parallel algorithms.

* Processing of medical images and signals: Application of modern methods of image processing (analysis, image transformation, noise reduction) and image transfer in six different clinical areas.

* Visualisation of molecular models: Chemists in Erlangen will use the Cray in Munich (LRZ) for simulation and visualisation of electrostatic properties of molecules.

* Multimedia-based decentralisation of interdisiplinary teaching: Implementation of an infrastructure to perform looked-after computer trainings resp. practicals with a distributed group of participants from economic informatics.

RTB Berlin

* Visualisation of scientific data: Implementation of a center for visualisation (super computer, archive server, render server, video production) for users in different working areas of universities and research laboratories in Berlin (e.g. chemistry, astronomy, nuclear scattering, mathematics).

* Medical image processing: Resulting images of nuclear spin tomography procedures will be 3D-visualised and stored in a data base for tissue samples. The diagnosis of the results will be supported via multimedia teleservices (multimedia-mail, video-conference).

* Hypermedia-based lessons for student lectures: Development and provision of multimedia-based teaching material in the area of economic science.

* Hotline und consulting system: Provision of a help-desk system including fault data base and human on-line-support (video-conference).

* Unified data environment with heterogenious computers: Implementation of AFS (or DCE/DFS) for a distributed filesystem in Berlin with an unified name space.

RTB Nord

* Video production via networks: In an already existing service center the results of simulations are transferred into video movies. This process will be (partly) controlled by users and the resulting movies will be distributed to the users via the network.

* Distributed computing in the field of "Global Change Research": Users in the Alfred-Wegner research laboratory in Bremerhaven will make simulations and visualisations at the dedicated super computer (Cray) in the German Climatic Research Center (DKRZ) in Hamburg.

* Visualisation of hydro- and aerodynamical calculations: The simulations will be carried on at the super computer in Hannover, the results will be visualised in the University of Braunschweig.

* Calculation and visualisation of global climatic data sets: Simulation at the Cray in the German Climatic Research Center (DKRZ) in Hamburg with visualisation in the University of Hannover afterwards.

* Online-documentation: Multmedia documents and journals will be presented online (collaboration with a publisher). Short response times shall create an impression of leafing ("book paradigma").

* Multimedia collaboration in the field of climatic research: Users from that working area in different institutions in North Germany will apply multimedia teleservices (multimedia-mail, video-conference) for their cooperation.

RTB NRW

* Usage of the SNI super computer at the University of Aachen for other users in the state of NRW.

* Distributed (heavy parallel) super computer center: An Intel Paragon (at KFA) and the CM5 (at GMD) will be used as a virtual common super computer by certain applications (e.g. aerodynamic calculations).

* Interactive aerodynamic simulation for components of power plants: Simulation at the University of Cologne, visualisation on dedicated computers at GMD (St. Augustin), transfer of results to users at DLR (Cologne).

* Visualisation of large multi-dimensional parameter spaces: Meteorological data from the University of Cologne will be examined at the Cray of KFA (Juelich). The results are used in the KFA and in Cologne for further research.

RTB BaWü

* Implementation of a mutual backup service between several computer centers.

* Distributed provision of software routines which will be linked into software modules.

* Provision of user support for the DFN-RPC (Remote Procedure Call): This software tool is widely used by scientists for distributed applications running on different super computers and work-stations.

* Implementation of an distributed electronic library for scientific literature (PhD theis, diploma, "unpublished" papers, etc).

* Helpdesk: Implementation of a distributed online helpdesk for all universities in BaWü based on information servers and multimedia teleservices.

* Distributed numeric laboratory: Mathematicians from the University of Freiburg will implement their numeric algorithms at the parallel computer in the University of Stuttgart. Experts from the computer center in Stuttgart will interactively support this implementation by using the software tool PAGEIN.

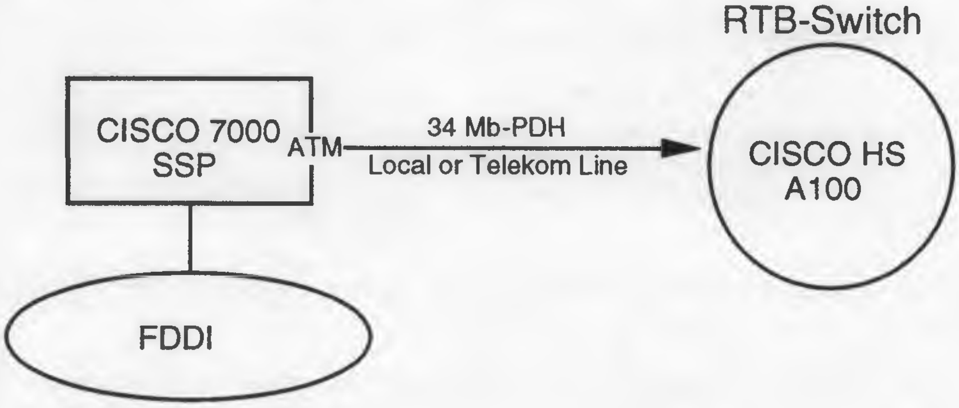
* Simulations in Computational Physics: The output of simulations on a super computer in Stuttgart shall be transferred directly to the work-station of the user instead using the expensive memory space temporarily at the super computer.in the meantime

* Distributed laboratory based on virtual reality: Experts from the computer center of the University of Stuttgart and different user groups (astrophysicists and biologists from Tuebingen) will implement application specific distributed virtual environments.

* Distributed provision of software: The access of arbitrary work-stations to distributed software servers shall be realized as automated as possible.

* Integration of services into the environmental information system of the state of BaWü.

a) Nord, NRW, Bayern



b) Berlin

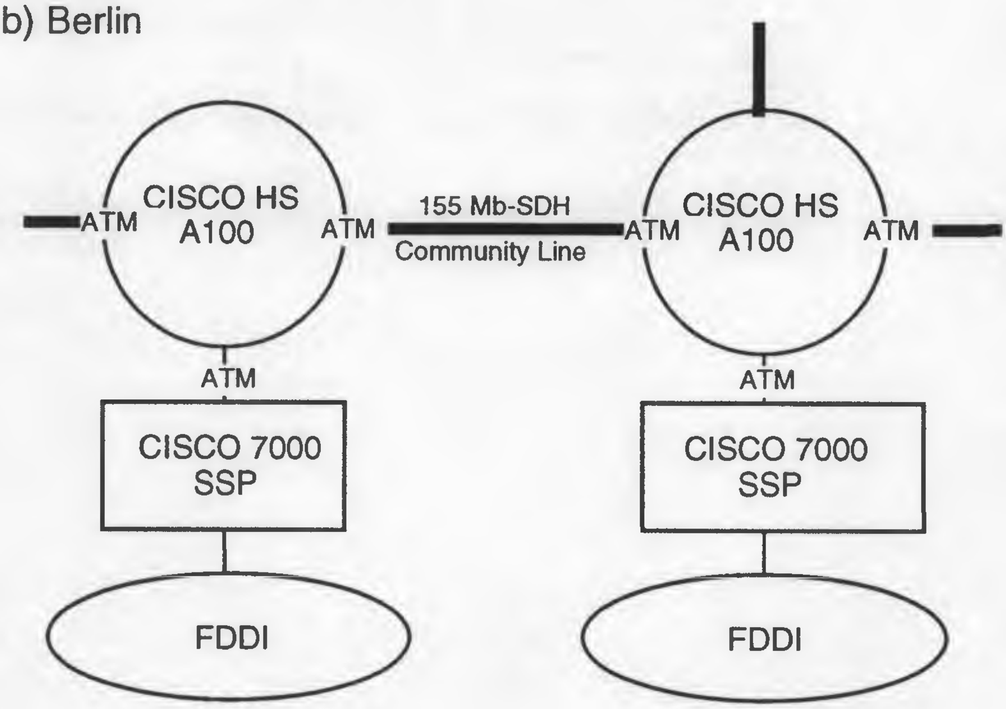


Fig.1: Technical Configuration

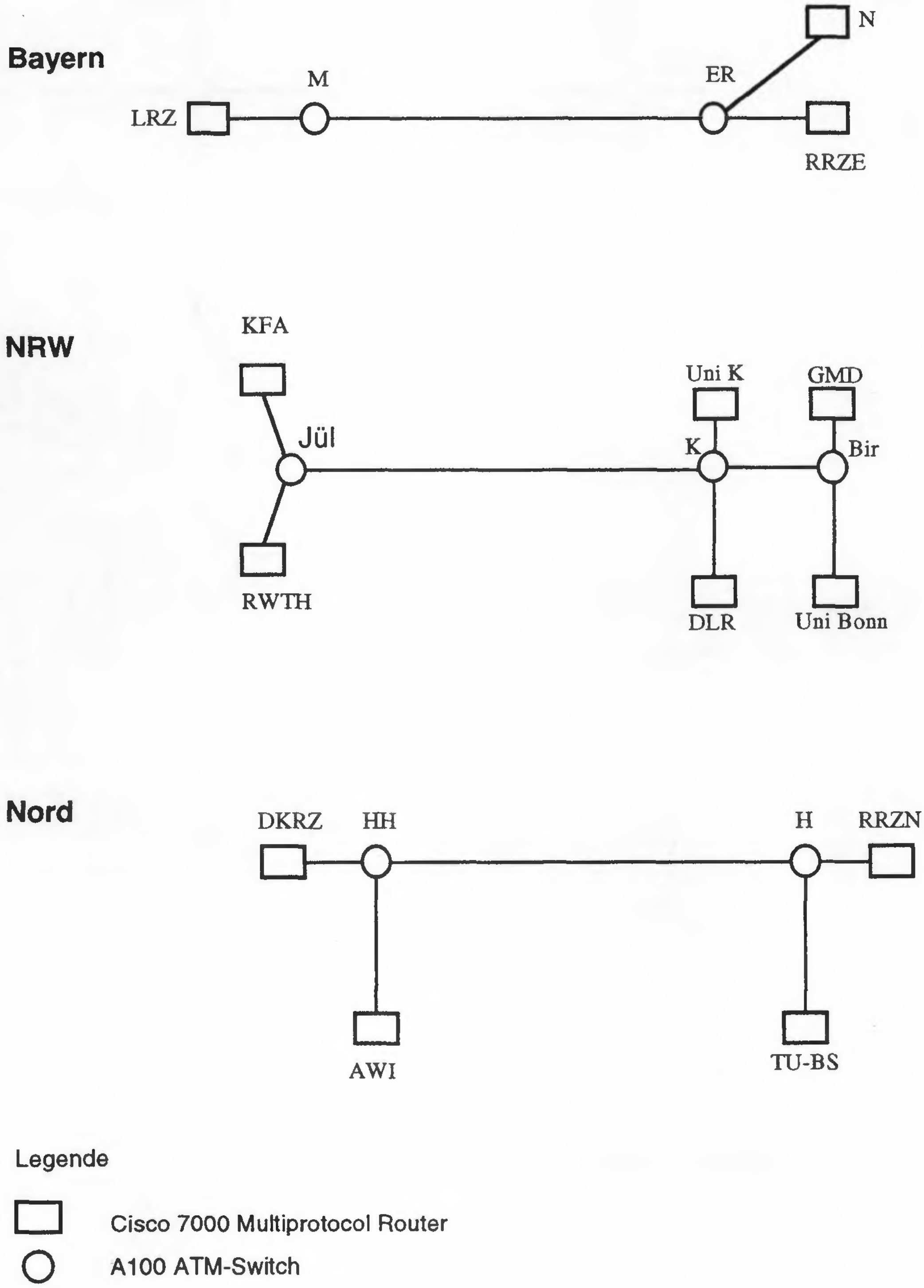


Fig.2a: Configuration of the Regional Testbeds of DFN

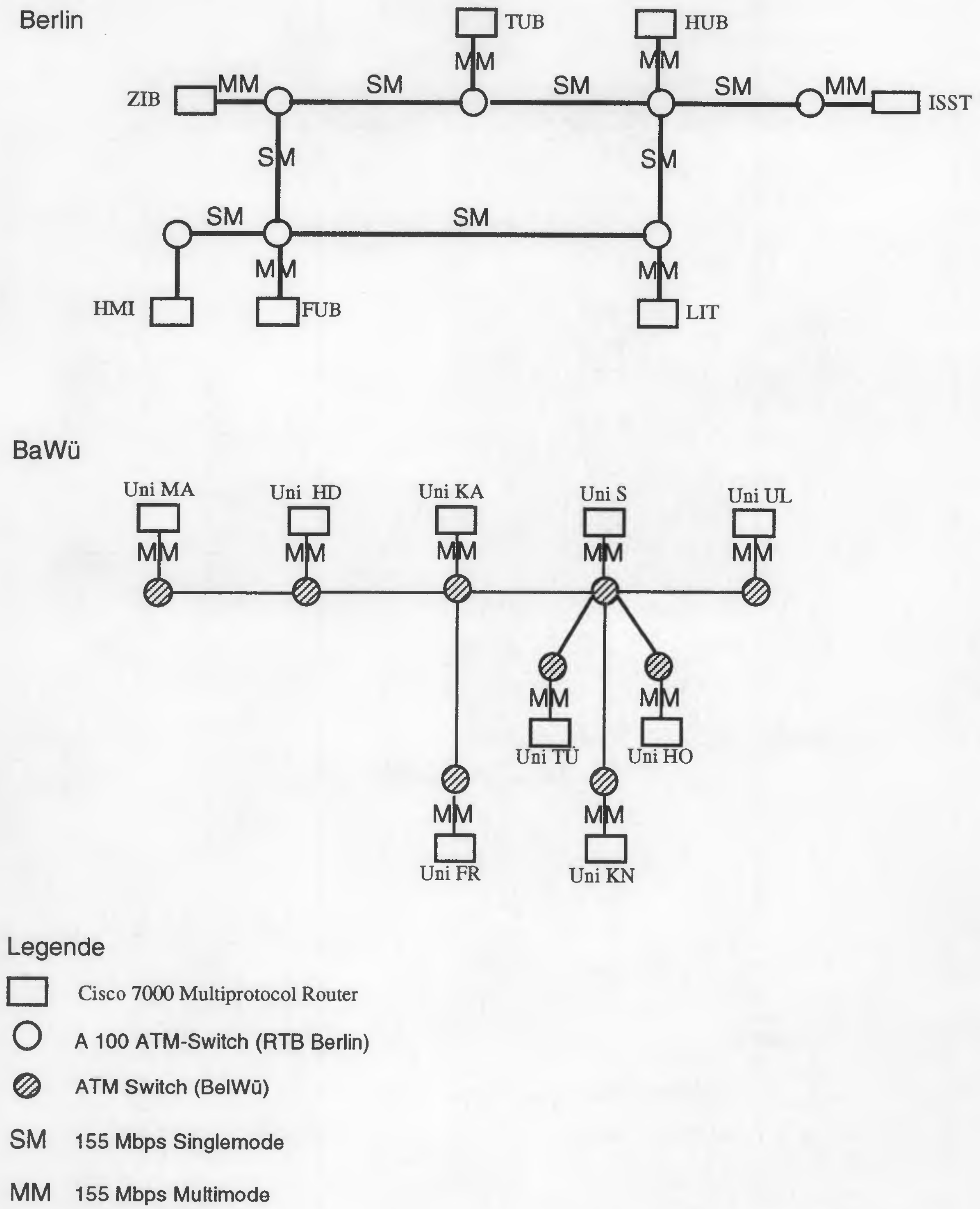
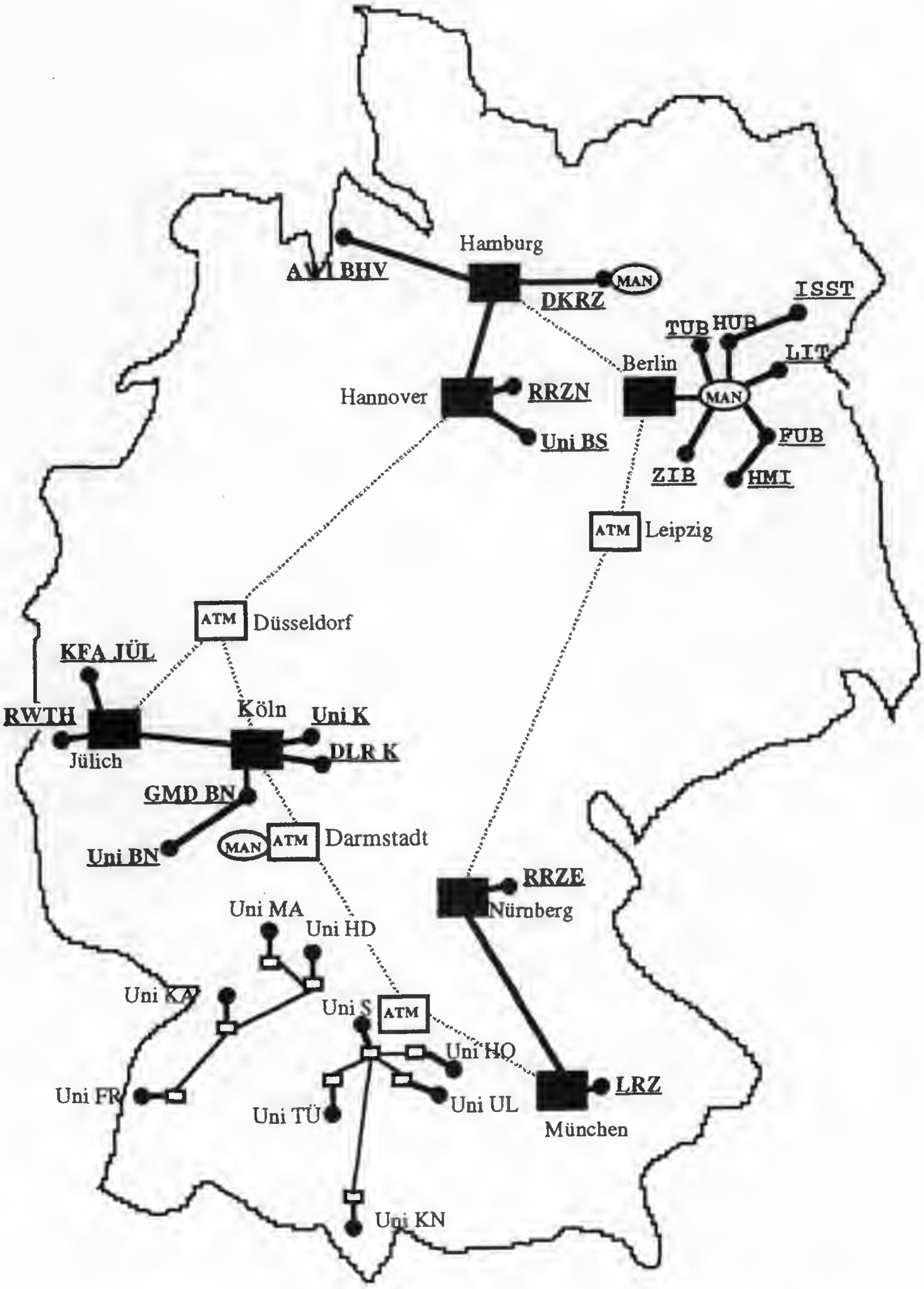


Fig.2b: Configuration of Regional Testbeds of DFN



ATM ATM-Backbone of the HS-WIN

34/155 Mb/s Access Lines with Routers

RTB Connection Line

RTB-ATM-Switch
(In Next Phase: ATM-Backbone-Switch)

BelWü-Switch

Fig.3: RTB-Connectivity (Phase 0) and HS-WIN Backbone (Phase 1)

13 Dec	Session B	• Keeping the Internet free (P Dawe, PIPEX)

Keeping the Internet Free

Peter Dawe
Managing Director
Unipalm Group/PIPEX

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Keeping the Internet Free

Peter Dawe

Managing Director, Unipalm Group plc.

Introduction

In this talk I will look at the factors behind the success of the global Internet and some of the problems it has had to overcome. I will also consider how we can apply the lessons learned from the growth of the Internet to date to the provision of a Europe-wide network infrastructure which will service projects such as EEOS.

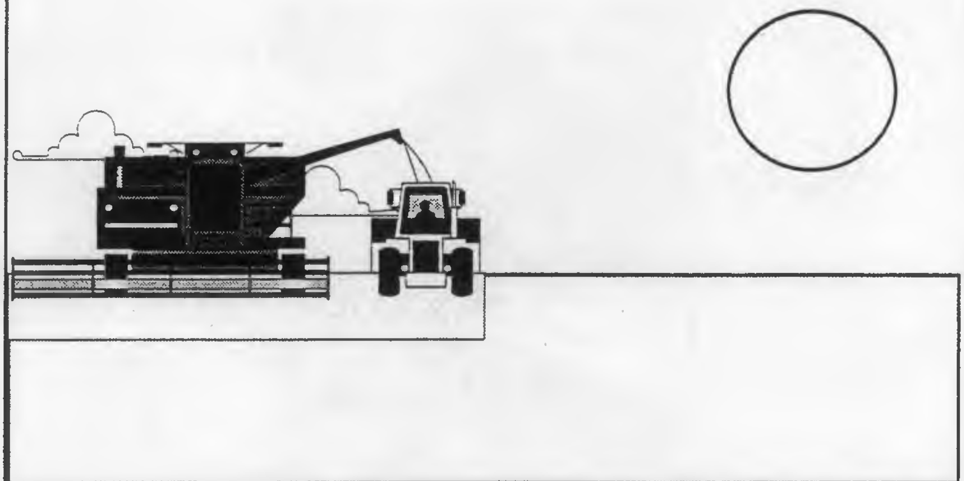
Keeping the Internet Free

 2 P·I·P·E X

We are at a critical juncture for the Internet and for data communications generally. The network infrastructure which has grown up over the last 25 years is being challenged by PTTs and Telcos who wish to impose their monolithic model, based on the voice communications system, on computer networking. Large user organisations are advocating a single network for Europe, despite the failure of similar projects (X.25 and ISDN) to deliver either cost benefits or quality of service. The Internet's core charging model is also under attack.

As an Internet Service Provider (ISP) I want to see the Net evolve to meet the growing need for data transmission, and to do so at a cost and in a manner which is truly accessible to everyone. I do not believe that a monoculture, like a meadow stripped of all its native species, can provide this. The Internet is built on diversity, and that diversity is its strength.

Monoculture?



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Monoculture

By "monoculture" I mean what we see in the fields around us: single crops grown year after year. This form of agriculture is only sustainable with massive inputs of fertilizer and the use of machinery. It is expensive, and inflexible - the overproduction of key crops has been a feature of the Common Agricultural Policy for many years. We are in danger of building a European network which cannot provide what the customer wants, of having to sell what we have built, rather than building what the customer needs.

A single European backbone would be like this: one supplier, no competition and no flexibility. It would distort the market and be unable to meet customer's real needs.

or Ecology?

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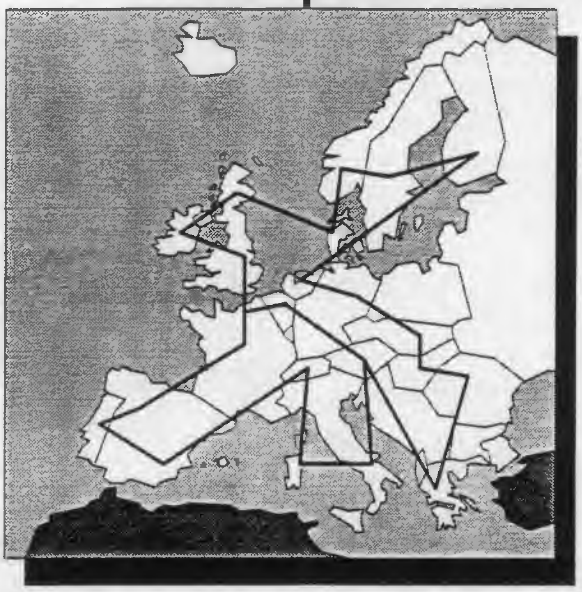
Ecology

In contrast, the natural environment abounds with species living in balance. A natural ecology will adapt quickly to changes in circumstances, and will endure even if the exact makeup changes over time.

The Internet is like a natural ecology - many ISPs occupying different niches, competing and cooperating to provide an environment in which data can flow freely.

A European Future?



The Single European Backbone
Monoculture

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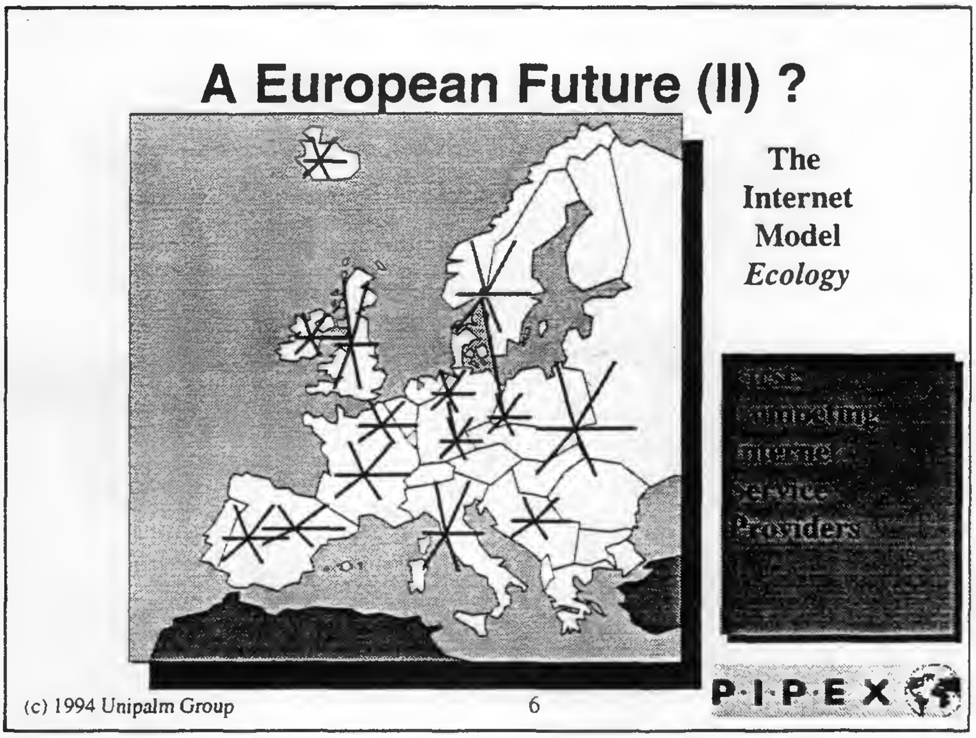
PIPEX

Single European Backbone

There is great pressure from certain quarters for a single European backbone - an "information superhighway" for Europe. The PTTs and Telcos advocate this approach because they see themselves as the natural choice to install and run such a system. They would also be able to make maximum profits from having a monopoly on data transmission within Europe.

Our experience of other PTT/Telco initiatives such as the overpriced X.25 services and ISDN should cause us to think seriously about their ability to run a European IP network. Acting as "natural monopolies" as they do, their understanding of markets, competition and customers is often lacking.

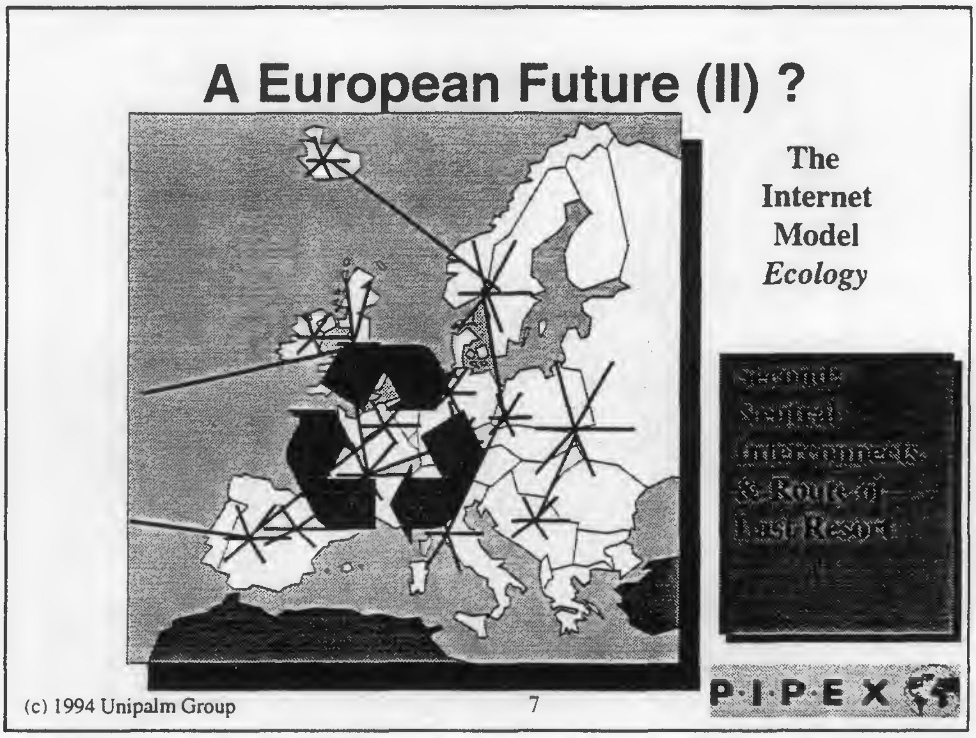


The Internet

The Internet model is based on having a multitude of service providers, none with monopoly rights. Each offers connectivity to its customer base.

Each ISP charges its customers on the basis of bandwidth not traffic: customers pay for the ability to move data around the ISP's network (both inbound and outbound data) on the basis of the size of their connection to that network. Since the bandwidth determines the maximum data flow, the fees paid set an upper limit on the use of the network.

Obviously each ISP can only provide direct connections to its customers - there must be some way to contact the customers of other ISPs.



Neutral Interconnects/RLR

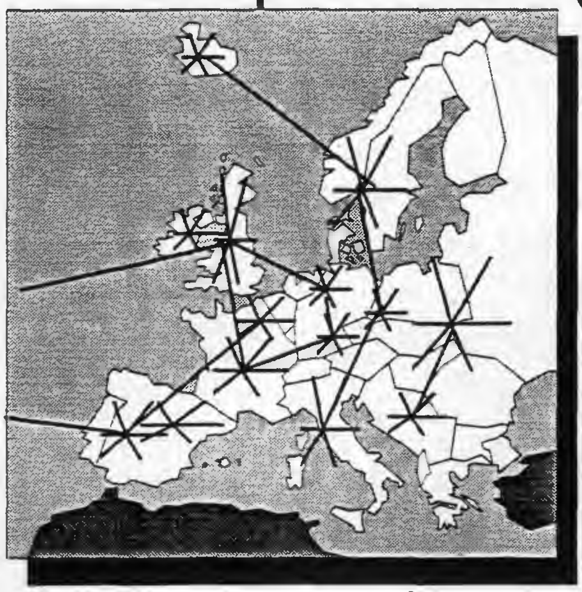
A number of sites have been established (CIX, Distributed Global Internet Exchange in Stockholm, London Internet Exchange and others) to offer "neutral" interconnection. These are sites which will let any ISP connect to them for interchange of packets with other ISPs at no additionl cost..

Neutral Interconnects underpin the Internet's free market nature: any provider can connect to any other provider via a neutral interconnect without having a formal agreement with that other provider.

Extending this idea, the Internet also relies on the existence of a "route of last resort" - a means of exchanging packets of data with another network that will always offer connections without settlement.

MAE-EAST, the East Coast Metropolitan Area Ethernet, is currently the Internet's route of last resort, offering a connection point through which any other network can be reached. If a supplier is willing to bear the costs of a link to MAE-EAST, then they can connect to the global Net.

A European Future (II) ?



The Internet Model *Ecology*

Third: Bilateral Agreements

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P·I·P·E·X

Bilateral Agreements

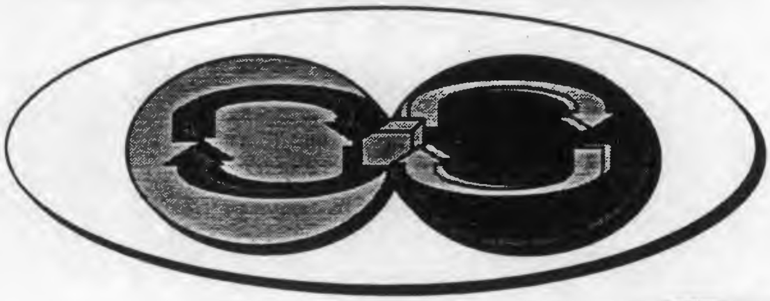
Bilateral Agreements between ISPs underlie the current Internet. They are contracts made between two parties, and the terms are entirely under the control of the parties. In conjunction with the availability of neutral interconnects, they enable the Net to grow and handle an increasing volume of traffic.

Since the costs of the links are generally shared between the two parties and passed on equally to their customers, the cost of the link is eventually shared by all of the people who might use it. Each ISPs customers pay for the cost of that ISPs infrastructure (including links), but there is no need for the ISPs to monitor the traffic between the two networks and charge each other accordingly, since the customers of ISP A are paying the cost of ISP A's connection to ISP B - and customers of B are paying for the infrastructure maintained by B.

This model is central to the Internet. For one thing, it obviates the need for complex accounting and charging mechanisms.

The Internet Settlement Model

- ✦ Customer pays for incoming and outgoing traffic
- ✦ ISP does not pass costs on
- ✦ Low interconnect cost between ISPs



 9 P·I·P·E X

The Internet's settlement model is a major factor in its success. Because the Net does not require ISPs to account for traffic and make payments to each other on the basis of usage, it has been able to grow and thrive.

Individual ISPs may negotiate bilateral agreements which require their peers to bear a high proportion of the costs, reflecting anticipate use of the lines - but the existence of neutral interconnects and RLRs mean that in the end an ISP can exchange data with every other ISP without having to pay them. It is this principle which underlies today's Internet and which must not be allowed to disappear.

Advocates of single European backbone are advocating the creation of a single network provider which would, by virtue of its size and market position, be able to compel other ISPs to pay for the privilege of peering with it. And if that provider were not compelled to peer neutrally then it could dominate the market and use its position to wipe out competition.

What We Need

- ✦ The Settlement Model is central to the Internet
- ✦ We must build on our previous history
  - ✦ ***and our previous success***

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The Net can continue to grow and to thrive - but certain conditions must be fulfilled if this is to happen.

Much of the future of data communications in Europe is in the hand not of the Governments or the Commission, but of the users. If the users of the data networks make appropriate demands of their suppliers, then the Net can continue to operate on its current basis. If the users seek to create a single European network then they will have to face the consequences.

What the Internet Needs

- ✦ Guaranteed Connectivity between non-monopoly suppliers
- ✦ No Cross Charging
- ✦ Access to Markets

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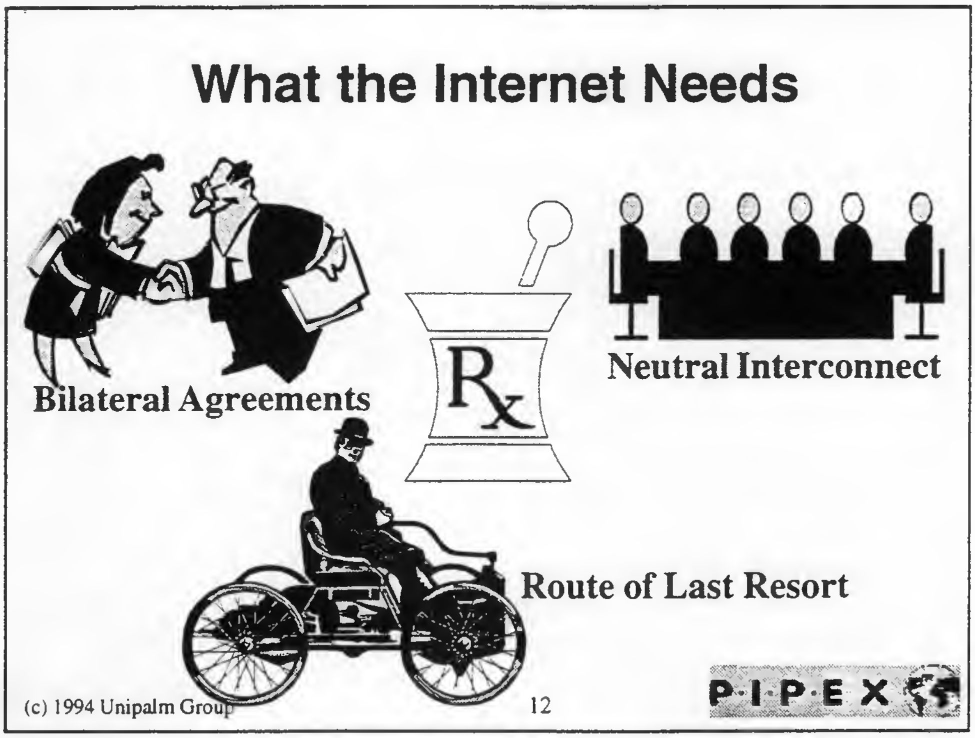
To continue to grow, the Net needs three things:

It is vital that connectivity is guaranteed. Every ISP, from the smallest to the largest, must be linked to a single global infrastructure.

Cross-charging, the abandonment of the current model, must be resisted. Not only would the need to introduce accounting mechanisms add to the total cost of providing the service, but the imbalances it would create between suppliers would fatally damage the current free market in networking services. As it is, the larger suppliers enjoy significant economies of scale on their networks - to give them even more power would be to destroy the innovative smaller suppliers.

Finally, suppliers need access to markets. The "bulk buying" deals and exertion of customer power by e.g. DANTE distort the market and will not lead to the desired outcome. By promoting a single European supplier, they will eventually result in higher costs and poorer service.



The Net needs three things to continue:

- Unfettered freedom for ISPs to make bilateral agreements on their own terms
- The continuance (and expansion) of neutral interconnects, where a number of suppliers agree to link their networks.
- The guaranteed availability of route of last resort so that all ISPs can route data.

With these three conditions met, the Net is well placed to grow and thrive

A Free Market?

- Some Examples
  - NSFNet and ANS in the USA
  - DANTE in Europe
- Distort the Market
- Damage the Prospects of an Internet-style Solution

 13 P·I·P·E·X

At the moment the market for IP services is "fairly" free. The experience of NSFNet in the US has demonstrated that State funding of an IP provider can only lead to market distortion and eventual imbalance - ANS, who managed NSFNet on behalf of the NSF, effectively used the dominant market position it gave them for a number of years.

Within Europe, the academic community is forming buying consortia and acting in ways that will quickly generate a European monolithic IP service provider able to use its own buying power and market presence to force other suppliers to buy connections or risk being unable to offer full Internet services.

We do not yet have a free market in IP services - it is close, and we are within sight of establishing it. But we must take action now.

A Free Market

- ISPs do not need massive resources
- They need a market
- They need to connect
- They need to work together

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The ISPs can manage with the minimum of Government regulation - the global Internet has been built on that basis.

Cable companies in the UK have demonstrated raising capital for major investment in infrastructure and services does not have to rely on the backing of a national PTT. Many ISPs have demonstrated that they can grow from entrepreneurial startups to national and international companies - Alternet and PSINet in the US, and PIPEX in Europe, provide good examples.

What we can't manage without are markets - people to buy our connections. If we are denied those markets through restrictive purchasing arrangements or other deals, then the current model of the Internet will disappear, to be replaced by one that more resembles the international phone system - of twenty years ago.

Freeing the Market

 15 PIPEX

The most significant thing that users of all sizes can do is to insist that their ISP plays a part in the global Internet, by:

- Offering at least one point of neutral interconnection with their network for other ISPs
- Supporting the establishment of routes of last resort
- Entering into bilateral agreements

If users, especially the larger users, are content to make deals with IP providers who do not regard these principles as important then they will pay the price.

It will be financial and also technical - what will force a pan-European monolith to offer connectivity to outlying regions? A local entrepreneurial provider with guaranteed access through a neutral interconnect might be able to make a business out of it - if given chance.

So - support your local provider, and resist the temptation to call for a single source of IP services. **Europe does not need it.**

VSAT Systems for Distribution of Earth Observation Data

presented at:

European Earth Observation System (EEOS) workshop on

Data Networks and EO User Information Services:

Survey and Consultation

Marino (Rome) 13-15 December 1994

by:

John Kjellevold
Section Manager
Business Communications
NERA AS
(Norway)

Abstract

This paper gives short general introduction to VSAT systems, followed by the principles and operational aspects of two European VSAT based EO distribution networks: IDUN and BDDN

Focus is then given to the opportunities soon arising for new high speed (12 Mbit/s) on-demand VSAT networks. By utilising digital TV transmission technology, cost efficient high capacity receive and transmit stations are feasible.

Introduction to VSAT systems

The term VSAT stands for Very Small Aperture Terminal and has become a standard phrase for small satellite earth stations for business communications.

As opposed to earlier satellite communication systems where the satellite earth stations where connected at the top level in the national terrestrial network. VSAT earth stations are directly connected to the users equipment.

VSAT Systems can be categorised as follows:

TDM Broadcast Systems

(TDM = Time Division Multiplex). These systems carry a broadcast addressed data frames from a single Hub to a group of remote earth stations (VSATs). Typical applications are distribution of data such as stock exchange data and distribution of digital encoded voice to shops etc. (MUSAK).

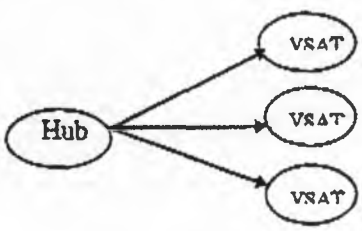

Figure 1: TDM Broadcast System

TDM/TDMA Systems

(TDMA = Time Division Multiple Access). In addition to the outbound TDM bearer these systems have an common inbound time division accessed channel for requests and confirmations. These systems can typically emulate an X.25 or SNA network; with the mainframe connected to the Hub and Terminals to the VSATs.

These networks became very popular in the United States during the 80's; but the same take-off has not occurred in Europe, although expected by many. Its limited success in Europe is explained with: Regulatory aspects at the time of introduction, Lack of pan-European companies, and transaction oriented data communications already solved by other means when regulations ceased.

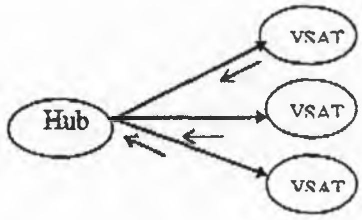

Figure 2: TDM/TDMA Network

Fixed

These systems provides fixed point to point (VSAT to VSAT) links, but are despite its simplicity very popular for a wealth of applications including "rural business communications" to East Europe. Common names for this functionality is MCPC (Multiple Channels Per Carrier) or SCPC (Single Channel Per Carrier) networks. As these VSAT systems undertakes only the physical (ISO level 1) function, they are protocol transparent and thus very easy to interface.

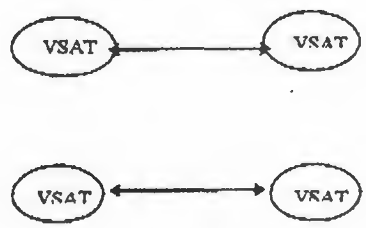

Figure 3: Fixed VSAT Network

On-demand networks

On-demand networks provides a circuit switched dial-up service. They may be implemented using TDMA (Time Division Multiple Access) or FDMA (Frequency Division Multiple Access) techniques.

A central Access Control Station (ACS) usually manages the network.

On-demand VSAT networks tends to be developed for two different markets: (i) Telephony Networks. Sub 64 kbit/s networks with telephone interface to support telephony in extremely rural areas, and (ii) Bandwidth-on-Demand Networks for high volume data transfer.

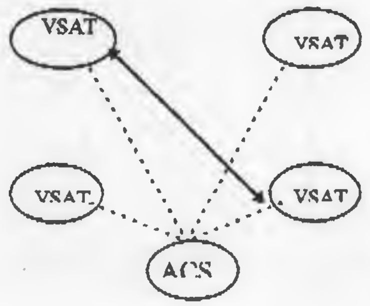

Figure 4: FDMA On-Demand network

The requirements we have seen for distribution of earth observation data usually have multiple data sources and multiple destinations (many-to-many relationships). The rest of this paper will therefore focus on VSAT networks with "meshed" topology. i.e. Fixed and On-demand networks.

The IDUN system

The IDUN (Image Distribution Using NORSAT B) network is an application within the Norwegian Telecom NORSAT B satellite service.

An application to provide secure store and forward broadcast was developed by a Norwegian consortium including: Spacetec, FORUT, Norwegian Computing Centre, Tromsø Satellite Station, ID Software and NERA AS.

Figure 5 below shows an overview of the IDUN system.

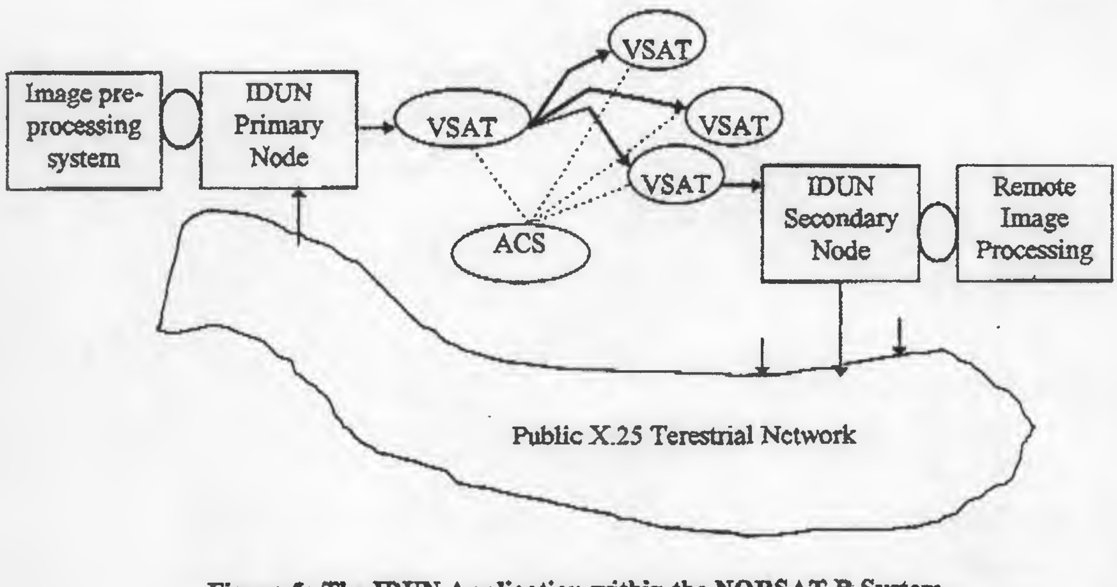

Figure 5: The IDUN Application within the NORSAT B System

Data is received from the polar orbiting Earth Observation satellite (not shown) and pre-processed into an e.g. 60 MByte image which is, via the Local Area Network, uploaded into the IDUN primary node. The IDUN primary node then activates a simplex point-to-multi-point call in the NORSAT B network.

Using the IDUN HDLC-based protocol; data is multi-casted to the receiving sites, with each block numbered. The secondary nodes will receive and log correctly received data blocks; and through the terrestrial X.25 network request re-transmissions of lost blocks from the primary.

Any block lost from at any secondary site will cause re-transmission via satellite from the primary. This will continue until all secondary nodes have received all blocks in the image.

Special filtering and alarm mechanisms ensure that processing is completed even when severe errors are present.

The IDUN primary and secondary nodes are implemented in a Personal Computer equipped with:

- Ethernet board for communication with image pre-processor/remote image processing system
- Hard-disk drive for intermediate storage of 2 images
- X.25 interface board for terrestrial return link
- SLIC (Satellite Link Interface Controller) board for satellite data transmission or reception
- OS/2 multitasking operating system

The IDUN system operates with 2048 kbit/s transmission speed.

IDUN has been in successful operation in Norway from Tromsø Satellite Station from 1990 to 1994; and appreciated by users for its technical stability and ease of use. However, high leasing cost for the up-link station and low demand for real-time images has caused the system to currently be out of operation.

The Broadband Data Distribution Network

Using the application software developed for IDUN. A similar system was launched for the European Space Agency for distribution of ERS-1 data. This was named BDDN (Broadband Data Dissemination Network). However BDDN runs with fixed satellite links instead of on-demand service causing considerable higher space segment cost.

At the time of implementation (1990) a central network Access Control Station was a multi-KAU venture, and the Access Control Station in operation by Norwegian Telecom on Intelsat V covered only northern Europe. Although an on-demand ERS-1 service originally was planned, an implementation on Eutelsat II without DAMA was finally decided.

Today (1994) this situation has changed. NERA can now offer 400 KAU Access Control Stations (ACS/2) for Eutelsat or Intelsat with a series of enhanced functions. As we shall see below this creates new opportunities for even higher speed data dissemination networks. Secondly, Norwegian Telecoms service is now moved to Intelsat VII and covers all ESA member states except Greek.

A future VSAT based EO distribution network

Technologies in digital television transmission

The technologies for digital television coding creates new opportunities for transmission via satellite. Huge R & D investments are now carried for digital television broadcast to cable-heads and direct to home.

Television transmission is however not only broadcasting; there is also a considerable equipment market for satellite news gathering, outside broadcasting, and inter-studio program transfers. These markets are as Earth Observation characterised by a need for on-demand set-up and clearing of satellite program links.

The MPEG 2 decoding standard gives broadcast quality at 4 Mbit/s and studio quality for 80% of programs at 8 Mbit/s.

With the broadcasting mass market in mind, major silicon foundries are developing chip-sets not only for MPEG 2 decoding; but also for high-bit-rate satellite carrier demodulation and coding. MPEG 2 requires almost error free communication channels. i.e. bit error rate = 10^{-12}. This is achieved by concatenated Viterbi and Reed-Solomon decoding with interleaving.

Synergy's with Earth Observation Networks

Digital television technologies brings to the EO world the following key elements:

Low bit error rate

10^{-12} corresponds to 1 bit error per 125.000 M Byte or 0.1% probability of error in a 125 M Byte file transfer. Re-transmission may not be required.

High data rates

The ESA-NERA implementation of digital television via satellite plans for 16 Mbit/s with 204/188 Reed Solomon Coding and 7/8 Viterbi Forward Error Correction. 13.5 Mbit /s with Reed-Solomon and 3/4 rate Viterbi and finally 9 Mbit/s with Reed-Solomon and 1/2 rate Viterbi

Low cost earth stations

The mass markets for digital TV brings to market inexpensive high quality silicon chips for low cost receiving earth stations.

The Need for a Protocol Handler

Few or no computer platforms have the capability of directly supporting 12 Mbit/s on-demand multi-cast services. A generic or an Earth Observation specific machine is thus required for a future network.

Potential candidates would be the ESA-SAIT/Radio Holland XVSAT system, or an enhancement of IDUN. One should bear in mind though, that re-transmissions are not necessarily required with the considered bit error rate, this simplifies the set-up.

Conclusion

This paper has given an introduction to VSAT networks and explained the principles of operational VSAT networks for Earth Observation.

ESA and NERA plan to bring forward technologies for on-demand digital TV transmission that are directly applicable to distribution of Earth Observation data. A future VSAT based EO network could have the following characteristics:

- Multiple up-links, on-demand capability.
- Very low cost receive stations
- Transmission rates up to 12 Mbit/s
- 99.9% of all images transferred without need for re-transmission

The audience comments are appreciated.

USE OF THE SWITCHED VSAT COMMUNICATION SYSTEM IN EARTH OBSERVATION NETWORKS

M. ERCULISSE, S. HULIN (SAIT Systems)

E. KOLDAL (ABB-Nera)

R. MWIKALO (MPR Teltech)

W. HANSTEEN (Norwegian Telecom Satcom)

A. NORDBOTTEN (Norwegian Telecom Research)

ABSTRACT

This paper describes the possible use of the Switched VSAT Communications System (X-VSAT) in support of Earth Observation electronic information transport.

The X-VSAT system is currently being developed under an ESA contract by a consortium consisting of SAIT Systems, ABB-Nera, MPR Teltech and Norwegian Telecom.

An overview of the major technical features of the system is presented including (1) LAN interconnection and circuit emulation; (2) bandwidth on-demand; and (3) bandwidth modification for LAN interconnection . The role of the NORSAT-B system is described. The ATM adaptation , multiplexing and transport facilities are outlined.

The distinctive features of the XVSAT Network Management and Call Handling Facilities are emphasized. Future enhancements are identified, particularly with respect to signaling, service adaptation and interoperability with terrestrial-based networks are identified

A review is given of the specific requirements of the Electronic Information Networks for Earth Observation that could be supported by the X-VSAT system is performed.

Specific advantages are discussed, including operational flexibility, and cost savings which result from the system's bandwidth-on-demand and bandwidth modification features for LAN interconnection.

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1. INTRODUCTION

The X-VSAT is a fully meshed hubless VSAT network based on Asynchronous Transfer Mode (ATM) switching and transport technology. Optimised to operate from 64 Kbps to multi Mbps data rates, X-VSAT allows small as well as large-sized businesses to support a wide range of voice, video and data applications.

X-VSAT offers flexible and economical real-time satellite bandwidth sharing, providing capacity based on the actual needs of the users. Request for bandwidth modification can be automatically invoked by a distributed traffic monitor and performance management function, or manually invoked from a call handling terminal.

This unique integration of technologies, developed under European Space Agency (ESA) contract, provides a flexibility not currently matched by terrestrial networks. It includes ease of expansion, dynamic bandwidth-on-demand, handling of mixed traffic sources.

It is important to note that the X-VSAT operation relies on the well proven satellite NORSAT-B services provided by Norwegian Telecom.

1.1. LIST OF ABBREVIATIONS

ACS	Access Control Station (of Norsat B system)
AAL	ATM Adaptation Layer
API	Application Programming Interface
ATM	Asynchronous Transfer Mode
BoD	Bandwidth-on-Demand
BSC	Broadcast Signalling Channel
BRA	Basic Rate Access
CBOS	Continous Bitstream Oriented Services
CH	Call Handling
CHES	Call Handling End Server
CHIS	Call Handling Intermediate Server
CHUA	Call Handling User Agent
CLPOS	Connectionless Packet Oriented Services
CM CompSys	Control & Management Computer System
CMS	Central Management System
CSC	Common Signalling Channel
EEOS	European Earth Observation System
FSD	Functional Specification Document
IP	Internet Protocol
ISDN	Integrated Services Digital Network
IWU	InterWorking Unit
MMI	Man Machine Interface
NM	Network Management
PABX	Private Automated Branch eXchange
RDBMS	Relational Data Base Management System
SA	Service Adapter
SNMP	Simple Network Management Protocol
SUS	Satellite User Station
TCP	Transmission Control Protocol
TBD	To Be Defined or Decided
TDM	Time Division Multiplex
TSD	Technical Specification Document
UDP	User Datagram Protocol
X-VSAT	switched VSAT

3. TECHNICAL DESCRIPTION

An overview of the system is presented in the figure below.

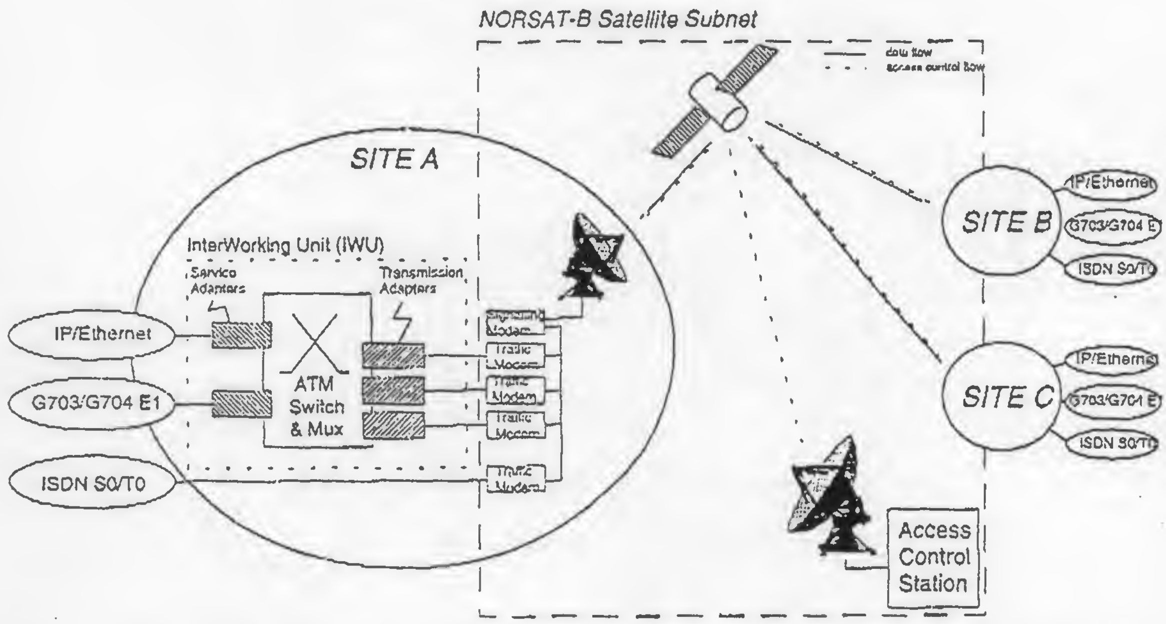


Figure 3 : X-VSAT System Overview

The X-VSAT system is composed in each site of :

- the InterWorking Unit (IWU);
- the Satellite User Station part of the Norsat-B satellite subnet;
- the Call Handling System (not shown in the above figure).

In one of the sites will be located the Central Management System (not shown on the figure).

3.1. THE ATM INTERWORKING UNIT

The role of the ATM InterWorking Unit is to support the simultaneous access to common transport connectivity over the satellite. The IWU is composed of five major components as described hereafter.

The **Connectionless Packet Oriented Service Adapter** is responsible for the conversion between IP packets carried over Ethernet and ATM cells. In addition it performs routing , flow control and the necessary management functions. The IP datagrams are carried over ATM using AAL 5. Each route to a remote CLPOS-SA uses a different VPI/VCI.

The **Continuous Bitstream Oriented Services Adapter** has for role to convert between the user access interface format and the ATM cell flow on the network access interface (

ATM TAXI interface operating at 100 Mbps). The conversion is performed using the AAL 1 protocol. The user access interface consists of a 2.048 kb/s E1 interface carrying one or more user channels in both directions. The transmit and receive channels are completely decoupled thus enabling the setup of either simplex or duplex channels.

The role of the **ATM switch** is to perform the connectivity routing between the VPI/VCI corresponding to the user access side and the VPI/VCI corresponding to the satellite subnet side.

The **ATM Satellite Transmission Adapter** is to convert between the ATM cells format transported over the TAXI interface and the HDLC format transported over the RS530 interface with the satellite modems.

The **IWU-Controller** has for role to control and command the various IWU components in cooperation with the Call Handling System and the Central Management System described in subsequent sections.

3.2. THE SATELLITE SUBNET

The Satellite Subnet is based on ABB Nera SuperViSAT products running under the Norwegian Telecom NORSAT B service provision. The SuperViSAT Satellite Communication System consists of the following network components :

- one or more transponders in geostationary communication satellite;
- a network Access and Control Station;
- several subscriber earth stations (VSATs).

From a signalling point of view, SuperViSAT is a "star" network with the ACS in the centre of the "star". From a traffic point-of-view, SuperViSAT is a meshed network, i.e. the traffic is conveyed directly between the VSATs.

The VSATs and the ACS together form a digital network offering connection-oriented services. Immediate switched as well as leased and pre-booked connections are offered to carry the multiplexed ATM traffic flows. The possible connection modes are point-to-point, point-to-multipoint and conference , simplex or duplex symmetric and asymmetric. Full use of these features within the X-VSAT allow an efficient transport of the users connections over the satellite connections.

The VSATs communicate with the ACS in the inbound direction using the Common Signalling Channels. The CSC is a random access (ALOHA) channel used for call requests and polling responses. In the outbound direction, the ACS communicate with the VSATs using a continuous Broadcast Signalling Channel (BSC), giving timing and frequency reference as well as transfer of call handling and supervision information.

The typical VSAT is composed of indoor and outdoor equipments (antenna and radio equipment). The indoor equipment for multicarrier is achieved by using a signalling channel modem and up to seven Traffic Channels M36 and channel combiner.

The traffic channels support Network data Rates at 1,2,3,4,5,6,10,12,15,20,30 and 32×64 kb/s.

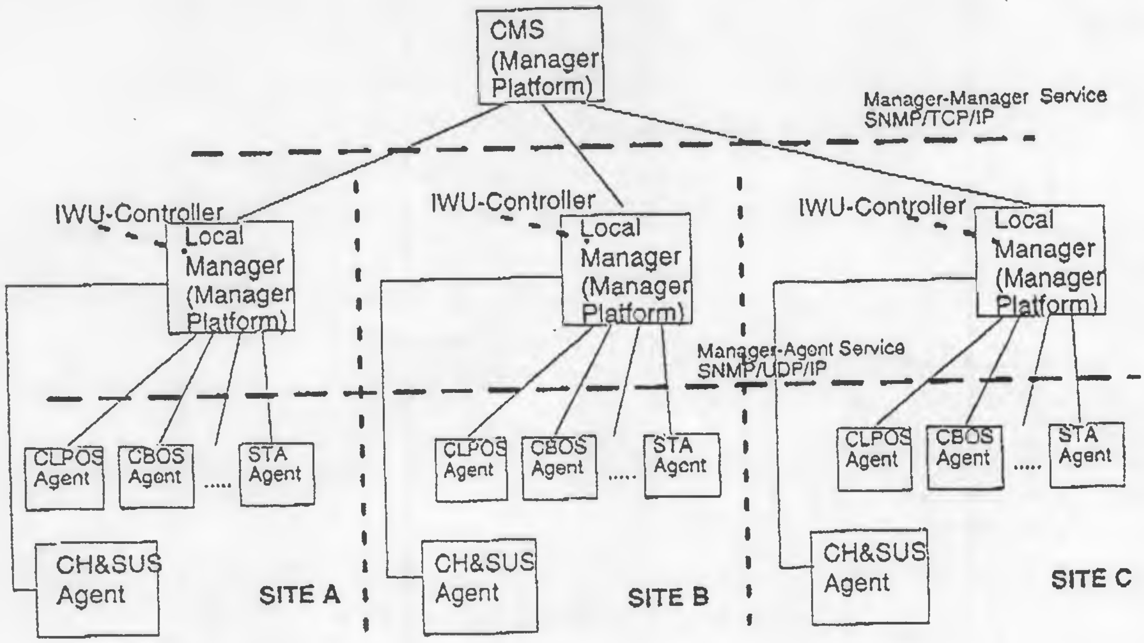


Figure 3.4 : Management Architecture

Each site has one local manager station. The manager-agent structure is applied between the local manager and (local) agents using the SNMP management protocol with UDP/IP as underlying protocol stacks. The manager-manager structure is applied between the (local or central) managers using the SNMP management protocol with TCP/IP as reliable underlying protocol stacks.

The local manager is located in the IWU-Controller. The local manager shares the management functionalities of the CMS in a distributed environment. The allocation of functionalities between the CMS and local managers (such as event management, alarm polling, data repository,...) will be examined during the system design phase, namely based on:

- the management robustness (minimise the loss of information management)
- the cost of the transfer of management information over the user network (minimise the satellite bandwidth use due to the polling of the agents), and
- the network performance (mixing the management information in the user one may reduce the performance of the services provided to the user).

4. MAIN FEATURES AND BENEFITS

To sum up the main features described in previous sections, the X-VSAT system is based on the Norwegian Telecom NORSAT-B satellite network which offers :

- "switched" as well as "fixed" or "permanent" connections;
- full mesh connectivity;
- point-to-point and point-to-multipoint connections;
- (n×64) kbps and 2 Mbps connections;
- symmetric or asymmetric circuits

and provides a European coverage through an INTELSAT 702 transponder (spot 2).

The specific specific features of the X-VSAT system are :

- (Automatic) **Bandwidth on Demand** capability, which permits to use the exact bandwidth needed, and avoid paying for unused capacity;
- **Multiplexing** capability;
- **Networking** capability.

Whereas it is quite difficult to compare communication services, as each one has its specific features and capabilities, we have tried in [1] to fairly determine the advantages of the X-VSAT system.

In order to perform that, we have combined the Norwegian Telecom NORSAT B service features with the X-VSAT specific ones.

To summarise the ideas developed in [1], we can say that :

- A satellite service, whether speaking of switched or fixed (booked) lines, is always more flexible than terrestrial leased lines or even than switched terrestrial services. This is the main reason why it is so difficult to compare satellite and terrestrial services, even providing the same objective advantages.
- Concerning the Norwegian Telecom NORSAT B satellite service :

  (1) **Satellite fixed connection service** provides a more flexible (compared to terrestrial leased lines) and cheaper solution (compared to PTT common satellite service) connecting European sites for a price just above the average line between European leased lines minimum (connected countries, e.g.Belgium-France) and maximum prices (e.g. Belgium-Portugal) (for bit rates higher than 256 Kbit/s).

  (2) For increasing bit rates, the break-even usage time necessary for **satellite switched connection service** to become more economical than ISDN (combined with inverse multiplexing) decreases rapidly.

  (3) The operation cost dependence of **both switched and fixed connection services** versus the bit rate is linear up to 640 Kbit/s, then sub-linear up to 2 Mbit/s.

Note that common PTT satellite services and terrestrial leased lines prices are also "sub-linear", but that ISDN prices are "linear" versus the bit rate.

(4) Above an average of 2 hours of communication per 24 hours (30 days months), or 3/24 hours (20 days months) (or 3630 communications of less than one minute), whatever the communication bit rate used, it is more advantageous to book a **fixed connection** than to use **switched one**.

- **X-VSAT Bandwidth on Demand capability :**

  Thanks to the sub-linear dependence of the price versus the bit rate, it is more interesting, for applications which do not impose the bite rate (e.g. files transmission), to transmit as fast as possible on both delay and financial planes.

  For those who use both applications requiring a fixed and relatively low bit rate (telephone, videoconferencing), and also other non-imposing rate applications, the BoD capability is indispensable to make profit.

- **X-VSAT Multiplexing capability :**

  when one has N different applications to transmit :

  - above a certain duration of utilisation per day (if the configuration that supports mux is more expensive than the one that does not) or independently of that duration (if it is the converse),
  - and if the equivalent aggregate bit rate goes over the price linear zone (in the sub-linear zone),

  then it is financially more interesting to use a single multiplex of the N applications rather than N separate flows.

- **X-VSAT Networking capability :**

  As already mentioned, the benefit is here difficult to evaluate because it depends on the network configuration, on the flows utilisation, ... Nevertheless, one can easily demonstrate that the combination of flexibility, switching, multiplexing and BoD benefits can only be profitable at a network level.

5. SPECIFIC REQUIREMENTS OF THE EEOS

The present section will aim to emphasise some of the specific requirements or applications that could benefit from the use of the X-VSAT for the deployment of the Electronic Information Network for Earth Observation.

It must first be noted that in addition to providing nominal on-demand interconnectivity between Data Centres or between Data Centres and User Facilities, the X-VSAT system can also be used due to its flexibility and cost attractiveness in providing backup of terrestrial connectivity or load overflow capacity.

In the load overflow and/or backup scenario, the X-VSAT IP/Ethernet interface could be connected to a main router. In the case of the backup scenario, the traffic could be re-routed from the failed WAN connection to the X-VSAT network which would set-up the requested connection; when the main router recovers the nominal WAN connection and the traffic is transferred on it, the idled X-VSAT connection would automatically be released. In the case of traffic overflow scenario, the part of the traffic causing congestion of the nominal resources could similarly be redirected on the X-VSAT network.

Time lining of the exchanges between centres coupled with the bandwidth-on-demand capabilities of the X-VSAT can provide significant cost-benefits. This is true for instance for Batch On-demand Delivery Services. Cost efficient use can be demonstrated to correspond to shorter transfer times performed at a higher capacity.

Also a distinctive advantage of the X-VSAT system is that it can provide asymmetric capacity i.e. large capacity from Data Centres to Users facilities and reduced capacity from User Centres to Data Centres.

The ISDN S0/T0 BRA interfacing capabilities could also be used to provide the connectivity between centers equipped with IWU and users facilities not able to afford or needing these capabilities but for which the right connectivity could thereby be established on-demand.

A more detailed analysis of the specific networking and operational requirements has obviously to be performed but we feel that the above examples provide an indication of possible areas where the use of the X-VSAT could prove beneficial

6. CONCLUSIONS

This paper has described the major features of the X-VSAT that could bring significant advantages when considered in the development of communication infrastructure for Earth Observation.

Unique flexibility of the satellite facilities associated with the cost advantages of bandwidth-on-demand and bandwidth modification/adaptation features contribute to the attractiveness of the solution with respect to or in complement of other terrestrial solutions.

In addition, the choice that has been made for the X-VSAT of the ATM technology protects the customer investments by allowing its future integration in ATM LAN and WAN networks.

SAIT-VIDEOHOUSE

LUCHTHAVENLAAN 22. B-1800 VILVOORDE. TEL 32 2 254 48 14. FAX. 32 2 253 34 34

EEOS WORKSHOP - 12-15 December 1995

DIGITAL DATA BROADCASTING FOR JUST-IN-TIME DELIVERY OF EARTH OBSERVATION IMAGES

CHRISTINE LEURQUIN

MANAGING DIRECTOR
SAIT-VIDEOHOUSE

I. INTRODUCTION

The ERS 1 satellite is collecting each year vast amounts of data to disseminate each year to the various groups of users in Europe. One of the possibilities existing today to allow for regular, easy to use and addressing of these data in Europe is the use of satellite technology.

Satellite technology is now well known as having some advantages on terrestrial infrastructure. It indeed allows for point-to-multipoint communications on a flexible and competitive way. Satellite transmission costs are independant from the distance and, remote regions can be covered simultaneously.

One of the satellite technologies used today is the D2-MAC packet which allows for the possibility to transmit in parallel to the TV signal quite a considerable amount of data using the digital sound/data multiplex.
The European Space Agency saw a great market potential in that technology and financed the development of a D2-MAC data receiver terminal and beyond that a fully operational databroadcasting system.

The system was developed by SAIT SYSTEMS, a Belgian telecommunications company, and is operated today by his daughter company SAIT-VIDEOHOUSE. SAIT-VIDEOHOUSE has recently developed a store-and-forward automatic multimedia server via satellite. This new development allows to migrate from the D2-MAC technology to the full digital technology.

II. GENERAL ARCHITECTURE OF A DATA BROADCAST SYSTEM

Data Broadcasting, or point-to-multipoint data distribution, has been in existence for many years, using a wide variety of communications channels : teletext lines within terrestrial TV services, FM radio, sound sub-carriers in satellite channels. Some of these ventures have resulted in highly profitable commercial operations mainly in the U.S.

Whatever the communications media employed, the common characteristic and major appeal of one-way point-to-multipoint systems is that the marginal infrastructure cost of one subscriber to the service is mainly confined to the cost of the end-user terminal. When, moreover, the same information is of interest to a large community of subscribers, substantial savings on communication charges over the transmission link used are possible.

The economics of the system compare favourably, in these respects, with the provision of the same service via land-lines. Satellites appear, in this perspective, particularly well suited to the purpose, provided several key components can be assembled into a system supporting a commercial offering of services.
The MAXICAST system commercialized by SAIT-VIDEOHOUSE enlights the interest of satellite for the dissemination of data. The general architecture of the data broadcast system as conceived by SAIT SYSTEMS, one of the mother companies of SAIT-VIDEOHOUSE, is outlined in the following figure.
The system comprises the following elements :

- The Data Sources, processing the data to be transmitted;

- The Transmit Front-End and terrestrial infrastructure, for transmitting the data from Data Sources to the data concentrator or DBTF (Data Broadcast Transmit Facilities);

- The data concentrator or DBTF itself, which performs the basic and value-added services;

- The Tandberg encoder, which multiplexes video, sound and data channels. The encoder also performs encryption of the data channel;

- The satellite link;

- The installed base of Data Receive Terminals.

THE SATELLITE LINK

The MAC family of television standards is well suited to the broadcasting of data because the sound is transmitted digitally, as well as the Service information related to conditional access. This standard is also paving the way to the full-digital technology and allows for a better understanding of the applications to develop and how to serve the potential customers in the "just-in-time" delivery concept.

The total capacity of the satellite channel for data is a little over 1.5 Mbits/s.

THE MULTIMEDIA SERVER

The Data Receiver Terminal (DRT) being the most widely installed item of the system, it was essential to provide a low-cost solution.

With the support of ESA, SAIT-VIDEOHOUSE developed the MAXICAST BOARD based on the following requirements :

- Low cost;
- PC-AT based;
- User friendly;
- Digital;
- Sustain high data rate;
- Support conditional access;
- Simultaneous acquisition of several (4) data services.

The board is then included in a PC which can also be equipped with audio or video compression boards (MPEG) and dial-up modems.
The main features of the multimedia server are the following :

- The conditional access technology chosen is the "EUROCRYPT M" standard, using smart cards;
- The application runs under MS-DOS on the PC and interfaces with the board using "Applications Program Interface" (API) performing functions such as "Automatic tune to satellite channel", "Get a specified data service", "Automatic reception of individual subscription list and playlist", "Creation of log file";
- The modem allows to log files back to the transmission center for acknowledgment.
- The MPEG card allows -if necessary- for decompression of audio or video files according to the last received playlist.

THE CENTER OF DATA TRANSMISSION (CDT)

ESA and SAIT identified the necessity of setting-up the specific infrastructure necessary at the transmit-end to support the features outlined above in an operational context. The main purposes of the CDT system are :

- To interface data providers via the terrestrial infrastructure;
- To offer services like scheduled broadcast, store and forward transmission, messaging, conditional access, logging of files via a return link; network control management;
- To broadcast the collected data via a satellite link;
- To check the correct reception of files.

The CTD is physically installed at Vilvoorde where the Uplink Stations are located. Along with the data, the following services are offered by SAIT-VIDEOHOUSE beyond the simple provision of a transmission channel:

- **Messaging :**

  File transfer : provides the user with the ability to identify a block of data within the overall data stream;

  Narrowcasting : provides the user with the ability to broadcast its data to identified groups or subsets of the audience, or individually (using the GPD feature and protocol);

- **Error protection via Golay coding : (10^{-10})**

- **Provision of check continuity :**
  Packet loss detection
- **Data scrambling :**

  Conditional access : the conditional access system realises "opacity" of the data using EUROCRYPT "M" and using a key, changed every 10 seconds;

- **Store- and forward services :** for downloading of batches of data in off-peak hours and remote storage of compressed video, audio, graphics and text.

ACCESSING THE CTD

To access the CTD, a computer called the Transmit Front-End can be installed on the premises of the data provider. Whatever the physical means of landline access, the structure of the software on this machine is the same, and relies on TCP/IP.

At a higher level, a protocol exists to manage the transfer of data from source to CTD, and notify the sender of its arrival.
A man-machine-interface enables the customer to organize the expedition of his data, within the registered features of each service. He will, for instance, select which files are to be sent out over which service, and how many times each file will be repeated. Or he can mark files for addressing to groups and individuals.

III. SAIT-VIDEOHOUSE SERVICES OFFERINGS

1. INTRODUCTION

SAIT-VIDEOHOUSE has almost two years of existence now and has been created to challenge the satellite offerings in Europe and to offer new services to enterprises and organisations in Europe among others the databroadcasting services. The MAXICAST System has been used in 1993 by ESRIN, the organisation within ESA whose role is to disseminate images from remote sensing satellites. During the trials, ESRIN operates the local transmit front end server for correct scheduling and forwarding of transmission requests originating from local data sources to two different data broadcast facilities, located in Belgium and in the Netherlands. Four stations located at ESRIN and two in Brussels with antenna diameters ranging from 90 to 120 cm, serving or receiving terminals.The trials exceeded their expectations and ESRIN was envisaging to operate the system on a full scale basis.
The MAXICAST databroadcasting allows for the dissemination of large files of different nature be it text, images or binary information. The data can originate from different data sources and serve multimission purposes.
Within one company or one organisation, multiple applications can be handled using the same network making it even more efficient.

2. TYPICAL APPLICATIONS

Typical applications for the Earth Observation could be batch and on-demand dissemination of images in reduced resduction and related data.
The files to be transmitted can go from a few MBYTE to several hundreds MByte/day (for example one Earth Observation image is = ca. 1MBYTE). The delivery time is negociated at the subscription with the customer. It goes from a few minutes or hours to a few days.

3. SERVICES OFFERED

SAIT-VIDEOHOUSE can offer a turn-key system from the desk of the customer to the end-users. The customer can register for a number of data services which he will be able to handle from its Transmit-Front-End. Typically this registration defines the overall characteristics of each service namely :

- Whether it is a store-and-forward application or not;
- The type and data rate of landline access. Today SAIT-VIDEOHOUSE offers different accesses via ISDN;

- The data rate over the satellite link;
- Whether the service data is formatted into files or whether it is a simple data stream;
- Whether the service is scrambled or not;
- Whether use is made of grouping and addressing services;
- Whether Golay-protection and / or CRC are used;
- Whether the log-service is required or not.

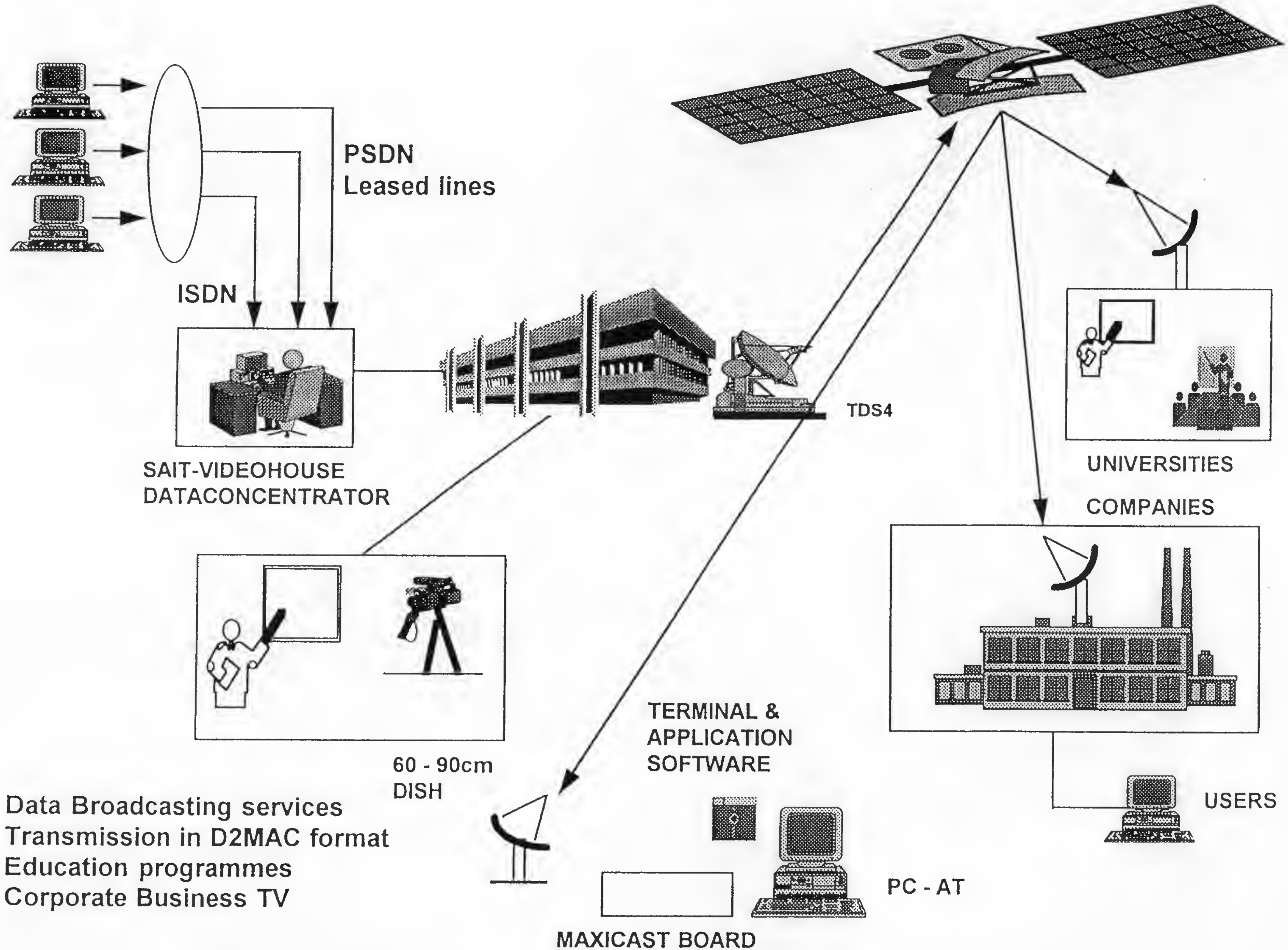
These features determine the corresponding service charge (price per bit, per rate and/or subscription fee). SAIT-VIDEOHOUSE proposes to take care and guarantee the whole chain of transmission from the data provider to the end-users. Each part of the system is taken care of by SAIT-VIDEOHOUSE: the TFE, the link from the data provider to the DBTF, the uplinking of data to the satellite, the access to satellite guaranteed for 3 years at least (reversable), the installation, maintenance and help-desk services for the receiver stations, and the encryption services.

IV. CONCLUSIONS

SAIT-VIDEOHOUSE provides :

- One stop shopping service;
- A full turn-key Data Transmission Service;
- Pan-European coverage;
- Multiplexing of various data sources;
- High data transmission capacities;
- High service quality & highly secured transmission (trough backlog controlling system);
- Addressing of data;
- Flexible access control to CTD;
- High degree of customisation of service;
- Bandwidth on demand;
- Multimedia server.

The use of the digital capacity of the MAC standard makes it possible today to offer one of the most cost-efficient and unique solutions to image or data dissemination in Europe at high speed rate and with high flexibility.


PSDN
Leased lines
ISDN
SAIT-VIDEOHOUSE
DATACONCENTRATOR
TDS4
UNIVERSITIES
COMPANIES
USERS
TERMINAL &
APPLICATION
SOFTWARE
60 - 90cm
DISH
PC - AT
MAXICAST BOARD
Data Broadcasting services
Transmission in D2MAC format
Education programmes
Corporate Business TV

Panel 1, session C: "Networks for Research and Development in Europe

"The Trans-European Research and Education Networking Association (TERENA) and the status of R&D networking in Europe"

Sven Tafvelin
Vice President Terena

Professor at Chalmer University of Technology
Department of Computer Engineering
S-412 96 Gothenburg
Sweden.

TERENA

Terena was formed in October 1994 as a merger between RARE and EARN.

The goal of TERENA is ... "to promote and participate in the development of a high quality international information and telecommunications infrastructure for the benefit of research and education" as is written in its Statutes.

Terena is an association and is working for the benefit of networking. Terena does not intend to be a service provider. There are a number of them already.

At the moment Terena has about 38 national members which are reserach and education networks in various European countries. Furthermore there are a few international members (ESA is one) and about 10 associate members.

In general Terena is a concensus building organisation. Despite the varying networking situation in the various countries every attempt is done to get the networking situation to improve and the cooperation between the networks to increase.

Terena has an important technical program managed by Terena Technical Committe (TTC). The key part of the program is a number of working groups. There a number of experts and soon-to-be experts meet and discuss and learn about their chosen subject and decides on how to improve the services. In this way the concensus is built between the experts and consequently between the networks. It is also the starting point for improvements of the networks services and the international cooperation.

Most of the work in the working groups is done using the network,primarily by electronic mail. Therefore the membership of the working groups is to a large extent defined by the mailing lists. The membership is open to any one interested. To become a member you only need to send a request to be added to the mailing list.

The working groups just now are:

- WG-I18N Internationalisation. This working group is working with the difficult but important problem on how to make it easy to use the national characters in networking.

- WG-ISUS Information Services and User Support. This working group is working in a very important field. It has attracted very many participants and is very active.

- WG-LLT Lower-Layers Technology. This working group is focusing on the lower layers in the protocol stack. It has two active subfields. One is the ATM technology and the other one is local access primarily between homes and offices.

- WG-MSG Mail and Messaging. This group is working on the various problems which happen in the electronic mail environment. One such problem is the mapping of mail addresses when mail is transferred from X.400 to RFC mail or vice versa. Another issue is the operation of servers getting requests over e-mail and typically responding over e-mail.

- WG-NAP Network Application Support. This group has concentrated on X.500 services, its contents and how it can be reached from World Wide Web.

- WG-NMA Networked Multi-Media Applications. This group is working on how to introduce multimedia applications in the European networks.

-WG-NOP Network Operations. This working group is currently under reconstruction caused by the merger of RARE and EARN.

- WG-SEC Security is a working group working in an area which is becoming more and more important. The networks have to introduce more and more security features to keep pace with those wanting to break the network or the computers attached to it.

The approximate membership in the working groups are just now:

WGI18N	Internationalisation	50
WG-ISUS	Information Services and User Support	320
WG-LLT	Lower Layers Technology	100
WG-MSG	Mail and Messaging	180
WG-NMA	Networked Multimedia Applications	180
WG-NOP	Network Operation	70
WG-SEC	Network Security	110

Terena and the 4th framework programme

Terena is working hard to help consortia in the 4th framework programme, Telematics for research to produce as good proposals as possible. While supporting the formation of good consortia and helping them when possible to get as good contents as possible Terema will not be a member of any of these consortia. The current situation can be seen in the Terena file store (WWW: http://www.terena.nl)

Terena projects

Most of the networking activities in Europe are being done by the national networks themselves. But sometimes it is to the advantage of all to pool resources to address common problems. Then Terena is a suitable framework to have the work done.

Terena is not a service provider in general but just now Terena manages both RIPE NCC and the previous EARN NJE service.

The Status of networking in Europe

- The technology competence is good as proved by

    - Some national networks are already using 34 Mbit/s or higher speed.

    - The routing technology in the Global Interchange (GIX) in Washington is European

    - The European technology for route management seems to become used all over the globe.

- The European international networking situation is very bad. Some reasons:

    - The international lines are extreamly expensive in Europe

    - Sometimes they are 20-30 times as expensive as the corresponding national lines.

    - An international European 2 Mbit/s lineis about 10 times as expensive as a corresponding 45 Mbit/s line in USA.

- The fragmented PTT structure causes problems:

  - It is difficult to get the European PTTs to even quote an international 34 Mbit/s line

  - It is difficult/impossible to get the European PTTs to cooperate on building a pan European high speed network.

A consequence of this is that networking in Europe is lagging behind when compared with the situation in USA for example. This is definitely hampering the cooperation between European researchers.

Are there any solutions to these problems? I can see at least two of them:

- Solution 1 (long range): Wait for more competition to force the costs to be reduced. This will take 8-15 years.

- Solution 2 (short range): Someone (= the Commission of the EU) realises the very high costs for Europe falling behind in research and accepts the high costs for a European high speed backbone. This could be done in 1-2 years. In the long range the solution 1 above will reduce the burden of the networking cost.

EuropaNET

H E Davies, J Bersee*

DANTE

* Postal address: DANTE, Lockton House, Clarendon Road, Cambridge CB2 2BH, UK, Tel +44 1223 302992, email: H.E.Davies@dante.org.uk, J.Bersee@dante.org.uk

1. DANTE and EuropaNET

The European Multi-Protocol Backbone (EMPB) was launched in 1992 as part of the COSINE project, which concluded in 1993. Securing the continuation of EMPB was one of the main reasons why the national research networks in Europe decided to establish DANTE. Providing a secure organisational and management framework for the pan-European backbone as well as some other international services was one requirement while the company would also be in charge of developing and procuring new international network services for the research community.

DANTE was set up in July 1993 as a not-for-profit limited liability company where the shareholders directly control the company. Research networks or organisations of the following countries currently hold DANTE shares[1] : Germany, Greece, Hungary, Italy, Netherlands, NORDUnet (Denmark, Finland, Iceland, Norway and Sweden), Portugal, Slovenia, Spain, Switzerland and the UK.

In the last year and a half, DANTE has supplemented the pan-European EMPB service by the addition of transatlantic and other intercontinental links. The integrated set of services is offered to national networks under the name of EuropaNET.

[1] Four sizes of share holdings exist, based on a country's GNP.

2. EuropaNET facts and figures

The EuropaNET service covers three major elements. First, the panEuropean backbone part of the service, EMPB, interconnects nodes in 18 European countries. It offers X.25, IP and CLNS services with access speeds up to 8 Mbps and guarantees of performance and availability. Second, current intercontinental capacity to the US (and to the global Internet) is 5 Mbps; in addition there is a direct 64 kbps connection to Korea, set up in the context of the EC EKORN project. As a third element DANTE organises interconnect arrangements with other networks in Europe with whom there is an interest to communicate, such as Ebone and EUnet.

EuropaNET is by far the largest Internet backbone in Europe. Network nodes are installed in each country where there is a point of attachment while each node location is connected to at least two other node locations. Currently, in Western Europe The Netherlands uses a total access capacity of 5 Mbps, the UK has 4 Mbps access, 7 countries have 2 Mbps access (Belgium, Switzerland, Germany, Italy, Spain, the Nordic countries and Spain), CERN has 1 Mbps access and there are 64 kbps connections in 19 countries. In Central and Eastern Europe the Czech Republic (512 kbps), Hungary (128 kbps) and Romania (9.6 kbps) were provided with connectivity under the EC PHARE programme.

3. Plans for the near future

The current organisational and commercial arrangement whereby EMPB services are provided through a framework contract with Unisource Business Networks will change next year. The contract expires in September 1995 and DANTE has recently issued an open tender for the replacement/ continuation of the backbone.

In addition DANTE is working to increase the intercontinental capacity of the service substantially to match the ever-increasing traffic load from and to the United States. So far this has resulted in an upgrade in total US connectivity from 2.5 to 5 Mbps, while another 3 Mbps will be added to this in the next few months.

Whereas in the immediate future some connections within the EuropaNET backbone will be upgraded to 4/8 Mbps, DANTE is also investigating ways to provide a 34 Mbps backbone service - initially to those countries already deploying a national 34 Mbps infrastructure - as soon as possible. The 34 Mbps service will be set up separately from the current service but integration of the two will be vital so that full connectivity is maintained between all subscribing networks.

4. The commercial setting of the service

Charging for the EuropaNET service is based on access capacity, regardless of the amount of traffic that is sent over the network. To ensure a reasonable performance and reliability for all EuropaNET customers there is, however, an obligation for them to upgrade their access capacity if the traffic load exceeds certain defined levels. This arrangement has worked very well and has resulted in a steady growth of the access capacity in most countries.

In principle there is a single charge for intra-European, intercontinental and gateway access. For countries who have their own intercontinental access an alternative allows them to buy intra-European and gateway access only. Countries requiring additional intercontinental capacity pay a supplementary fee. The price for the different EuropaNET access capacities is calculated by applying a standard multiplier to a basic rate for a 64 kbps access.

5. Acceptable Use Policy

The AUP issue has been much discussed lately. In October 1994 DANTE was able to announce a liberalisation of the EuropaNET Acceptable Use Policy which, rather than indicating a radical shift in policy, accommodated to an already existing situation. Previously the network was dedicated to research-related traffic only, a provision derived from the policies of most of the national networks as well as originating in (for the EMPB component) the contract with UBN. Now, EuropaNET customers are allowed to send any traffic over the network which is acceptable according to their own procedures. The change reflects the increasing commercial nature of the Internet and the difficulties of distinguishing traffic from different sources.

In the meantime DANTE's mandate remains exactly the same as before: organising and procuring international services for the research networks and benefiting from economies of scale by exploiting their joint buying power. Interconnect arrangements with commercial networks are established where they serve the interest of the research community. Transit traffic between commercial networks will not normally be allowed; the provision of such services is not currently a priority for DANTE.

6. Summary

Since 1992 the European research community have had at their disposal a stable and reliable pan-European network service, EuropaNET. The number of countries connected to the network and the total traffic load on the network have seen a steady growth. DANTE, the company set up and responsible for organising international services for the national research networks, is currently involved in various activities to respond to the growing demand for a much higher speed infrastructure. On the basis of the progress made so far DANTE is formulating plans for a first set of 34 Mbps connections in Europe to be delivered in the course of 1995.

EBONE the European Backbone
By Isabelle Morel, Renater France
14/12/1994

Needs

Research community needs international services as mail, remote intensive computing, group multimedia communication, access to large databases, information servers for science, and technology, for culture, for edition, press etc, that means transport of text, pictures and voice beyond many frontiers.

In Europe, network service providers chose to create Ebone, a European backbone, in response to this strong need for interconnection.

Ebone is a consortium of contributing organizations, and it has decided to re-model it into an association to provide further stability in legal terms.

Services

Ebone federats IP and ISO CLNS networks within Europe. The international infrastructure is shared and co-managed, and this allows every participating organization to have exchange points with other large networks such as NSFnet, EUnet, Europanet, etc .

Ebone admits all types of traffic : public, private, research, education, industry, business,....

Topology

Its infrastructure is organised around a few major nodes called EBS (Ebone Boundary System). To these nodes, nation-wide networks of all nature may connect through a RBS (Regional Boundary System).

EBS links are actually :

October 94	Paris - Geneva 2M **
	Paris - Stockholm 1M*
	Paris - Vienna 1M
	Paris-13 RBS ≈ 2M

* The node in Stockholm allows peering between Nordunet & Ebone
** Europanet is actually peering with Ebone through the Geneva node.

US accesses are :	Paris - US 3.5M
	Stockholm - US 2M×2 with agreement for rerouting in case of failure.

Costs

The cost for academic network is 15 KECU per year for each 64Kbps , and 33 KECU for commercial networks.

Future

The next configuration planned for January 1995 will include upgrade Paris - Vienna up to 2M and a new EBS in Munich (RBS until now) ,

Paris - Munich 2M
Munich - Vienna 2M
Munich - US 2M

with modification of routing policy between Vienna and Munich. The nodes Paris, Vienna, Munich and Stockholm are equipped actually with routers able to support ATM or 34Mbps speed, so evolution is possible as soon as needed.

Next connections on Ebone will be :

Moscow 256Kb,
Telecom IT 256Kb
Cyprus 64Kb , being done already
Peering with EUnet through Vienna.

New services are :

- multicast supported by the Ebone nodes using PIM (Protocol Independent Multicast)
- very high speed up to 34Mbp on the backbone in the next 2 years.

Conclusion

Ebone enjoys a rapidly expanding membership, both in terms of capacity and in terms of new members organisations.

Financial situation is stable. Ebone association is in progress, studying all legal aspects.

New memberships are possible for sharing transatlantic links or peering with the Paris node.

For more information, please contact: Christian MICHAU

RENATER
Université P&M curie
4 place Jussieu - Tour 55/65
75252 Paris Cedex
Tel: 33 1.44 27 42 60 Fax: 33 1.44 27 42 61
e-mail: michau@urec.fr
WWW:http://web.urec.fr/Ebone

NORDUNET

Sven Tafvelin
Professor
Department of Computer Engineering
Chalmers University of Technology
S-412 96 Gothenburg
Sweden .

NORDUnet is a collaboration between the national academic and research networks in the five Nordic countries:

SUNET - Sweden
FUNET - Finland
UNINETT - Norway
DENet - Denmark
SURIS - Iceland

NORDUNET started as a collaboration technology project in the middle of the 1980s and after a few years the network activities began.

Since fall 1993 it is a limited company, NORDUnet A/S, owned by the governments or their organisations in the five countries. NORDUnet A/S is a contracting organisation. All real technical work is done by people on contract staying in their normal organisation.

NORDUnet is working on interconnection of the Nordic national networks and connections from the area outside. NORDUnet is peering with other networks and has expecially contributed to networking in the Baltic states but also to the international connections to Poland and other countries.

Sometimes NORDUnet is also representing the Nordic national networks as in Dante, the RIPE NCC contributer Committee etc.

The NORDUnet network is organised as a star with Stockholm as the focal point. The intra-Nordic network speed is 2 Mbit/s to Norway and Denmark while the speed to Finland is 2x2 Mbit/s and to Iceland it is 128 Kbit/s.

To USA NORDUnet has a capacity of 3.8 Mbit/s, to EMPB 2 Mbit/s and to Paris a 1 Mbit/s line is shared between a number of participants. The speed to Poland is 2 Mbit/s and to the Baltic states it is in general 64 Kbit/s.

NORDUnet is continuously working on upgrading the lines. The intra Nordic lines will be upgraded soon. The proposals are being evaluated just now. The USA line need to be upgraded just as the Paris line and the EMPB capacity.

NORDUnet has always had a liberal attitude towards cooperation with others. "Working together is better than working separate". A typical example was IBM and its Easynet where NORDUnet and IBM cooperated to get the most results out of the availabel funding. Another example is SWIPNET and the USA line. We are sharing the lines which is advantagous to both of us.

NORDUnet has a networking conference each year which is circulating in the Nordic countries. It attracts 200-400 participants and is still growing. When the conference series started it attracted networking people but nowadays it attracts also people working with applications and ordinary users of the network.

The internal situation in the Nordic countries are good. Let us take the Swedish situation as an example:

- SUNET is a 34 Mbit/s network connecting all major universities in Sweden. Colleges are connected with 2 Mbit/s lines.

- There are pilot experiments with the Swedish PTT (Telia) on 155 Mbit/s ATM.

- The national Hosts proposed from Sweden have agreeed to point to SUNET as their network connection for ordianary high speed traffic.

What experience can we draw from the NORDUnet work:

- We have a very easy atmosphere since we know each other since years and we want to do something together.

- I think it was a splendid idea to keep NORDUnet as a contracting only organisation. We find it easy to contract the right people when needed and to terminate the contract when it is not needed any more.

- It is very easy to be convinced on the efficiency of NORDUnet. Now more than 80% of the budget is for line costs. Unfortunatly it can also be regarded as a "proof" of the high international costs in Europe.

Roberto Saracco
CSELT S.p.A., Turin, Italy.

ItalHost

1. GENERAL

The Italian Host (referred also as ItalHost in the following) is the experimental platform made available by the Italian Administration according to the guidelines of ACTS Program. It is able to host the experiments of projects coming from ACTS, but also from other EU specific programmes and international/national R&D programmes.

ItalHost will be managed by a non–profit Consortium called **ITINERA** (**IT**alian **IN**fostructure for **E**uropean **R**esearch towards **A**dvanced communications) reflecting the view of the major actors in the Italian telecommunication sector.

ItalHost is conceived as based on a set of logical laboratories (Labs), supporting a variety of accesses requested by the experimental projects. An Advanced Telecommunication Network distributed on the whole territory is able to provide the requested interconnection services between the Labs and between other National Hosts.

A sample of the Labs offered is represented by:

- the CSELT laboratories in Turin with the CNR–CSELT **ATM Test–bed**, the **OS and SW Technologies** Labs and the **Advanced Transmission Lab**;
- the Labs connected to the CNR–TELECOM ITALIA **Tuscany MAN** experiment;
- the Labs connected to the CNR–TELECOM ITALIA Naples ATM experiment (**NeaNet**);
- the RAI **Digital Broadcasting Test–bed** in Valle d'Aosta.

CNR (Consiglio Nazionale delle Ricerche) is the National Research Council, the Italian organisation co–ordinating and supporting the scientific research in the country. Within the scope of this document, CNR is in relation with the "Telecommunication Project" (TLC Project), an Italian research program promoted, organised and supported by CNR, whose results are used in the frame of ItalHost. The TLC Project is a five years (1989–93) duration research program involving national manufacturing industries, operating companies, public and private research centres and university laboratories, with the aim of acquiring the know–how needed to develop broadband communication network and services. TELECOM ITALIA is the Italian public operator for telecommunication services. CSELT is the research centre of STET Group, whilst RAI is the Italian public broadcaster.

The number of Labs is foreseen to increase also due to the contribution of other members of the Consortium managing ItalHost. In the following a description of the four Labs mentioned above will be given.

The ATM Test–bed is a flexible environment set up to study the critical aspects related to the introduction of the ATM technique. It is located in a Show–Room conceived as an open laboratory for integrating advanced telecommunications systems, like innovative equipment, software platforms and end–user applications, used to assess the new services capabilities and features offered by an integrated broadband network.

The whole of the ATM Test–bed, the OS Laboratory, the Software Technology Laboratory and the Advanced Transmission Laboratory inside the CSELT premises allows to experiment new network services and applications, network management solutions and advanced transmission systems.

Tuscany MAN and NeaNet are broadband telecommunications infrastructures in the metropolitan areas of Florence/Pisa and Naples respectively. They have the purpose of experimenting high speed services and applications in a real user environment. The Tuscany MAN is based on the QPSX technology (standard IEEE 802.6), while NeaNet is based on the ATM technology.

The trials involve more than sixty active users selected from the scientific community, under the consideration of the fundamental role they can play in suggesting and using new services and applications.

The realisation and the utilisation of Tuscany MAN and NeaNet have been performed in the framework of a co–operation between TELECOM ITALIA and CNR.

The RAI Digital Broadcasting Test–bed allows to investigate the technical feasibility of new broadcasting systems and to identify the user requirements of the relevant services (e.g. Multi–programme, television, mobile radio, data and multimedia), the economy and the commercial aspects.

- 1.1. User communities on the ItalHost
- 1.2. Sponsoring Partnerships
- 1.3. The potential for synergy effects
- 1.4. R&D areas that can be supported
- 1.5. Interworking with other National Hosts
- 1.6. Possible relations to other Programmes and policies
- 1.7. Facilities for hosting visiting project teams

ItalHost

2. TECHNICAL

ItalHost is able to host the experiments of the projects coming from ACTS, but also from other EU specific programmes and international/national programmes.

The experiments carried out by these projects fall into two main categories summarised in the following:

- **B.** Projects that elect ItalHost as the platform to use for **developing, experimenting, and trialling leading edge applications and services** for business, public, academic, and/or residential users.
  The relevant activities concern:
  - development of applications and services
  - development and/or tuning–up of terminals
  - operations trials, including management aspects
  - tests and verifications of usability and acceptability.

  These projects may involve network operators, service providers, manufacturers, research centres, academies, and users.

- C. Projects that are developing **highly innovative hardware and software technologies** and want to use ItalHost facilities to **experiment highly innovative solutions on field** in order to prove basic concepts, evaluate technology, evaluating interworking capabilities, evaluate the consistency between applications and network support.
  Examples of issues to be trialled in the field through the NHs could be:
  - distributed software architectures
  - information networking architectures
  - advanced switching capabilities
  - advanced signalling and control applications
  - server modules
  - customer control
  - user mobility and ubiquity
  - photonic network architectures
  - multipurpose multimedia–hypermedia terminals
  - evaluation of Digital Audio Broadcasting (DAB), advanced Data Broadcasting and future digital TV broadcasting services including multimedia applications.

  These projects may involve mainly network operators, manufactures, academies, research centres, service providers, and users.

Concluding, the Advanced Telecommunication Network, based on consolidated or consolidating technology, is able to interconnect the experiments by supporting different kinds of network services, according to the needs and the experiments planned by the hosted projects. The network services are mainly based on ATM–VP, SMDS, CBRs and the transport networks are those available during ItalHost life: ATM Pilot, QPSX–MAN gathering systems, etc.

The Labs offered are described in the rest of the Section, providing an overview of the kind of the experiments that are currently carried on.

- the CSELT Labs in Turin with the CNR–CSELT ATM Test–bed, the OS and SW Technologies Laboratories and the Advanced Transmission Lab;
- the RAI Digital Broadcasting Test–bed in Valle d'Aosta;
- the CNR Tuscany MAN experiment;
- the CNR NeaNet experiment.

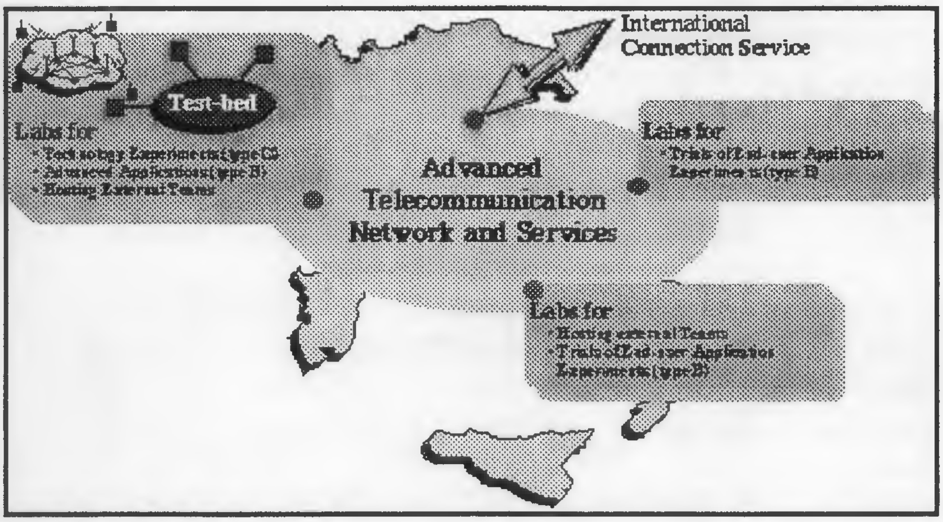


Fig. 2.1 – Proposed logical structure of ItalHost .

Both types of projects will be funded by the European Union or by National Public Institutions, and will pay the ITINERA consortium for the use of ItalHost facilities according to a negotiation between ITINERA, and the consortium that manages the hosted project. Different level of charges will be applied according to the technical maturity of the network, the required/offered quality of service, and the required/offered geographical coverage. A particular kind of agreement, which provides a special charge for the use of the platform, could be reached when the ITINERA Consortium is also a partner in the hosted project.

General Configuration

On the basis of the above foreseen client projects, ItalHost is conceived as based on a set of logical laboratories (Labs), supporting the different requested accesses by the experimental National and European projects (see Fig. 2.1). Taking into account the types of project that can be hosted (Type "B" or "C") and the capabilities of hosting external project teams, the Labs, are designed to host

- type "B" Projects and to be used for developing, experimenting, and trialling leading edge applications and services for business, public, academic, and/or residential users;
- type "C" Projects, that is to experiment highly innovative solutions, in real environment but in laboratory, in order to prove basic concepts, evaluate technology, evaluating interworking capabilities, evaluate the consistency between applications and network support. This Labs can also host the first type of projects ("B" types).

The requested **interconnection services** between the Labs and between other National Hosts is achieved through the services delivered by an Advanced Telecommunication Network.

The considered Telecommunication Network is based on Advanced Infrastructures allowing for a progressive Optical Fibre Deployment through:

- the development of Optical Fibre for Selected Customers (START Project) providing High Quality/High Flexibility Connections;
- the development of Synchronous Optical Rings (SDH);
- Field Trials on Passive Optical Network (PON) in Specific Areas.

Considering the Italian territory, the networks and services are sketched in Fig. 2.2, that describes the present status, that is:

- ATM Pilot Network for ATM Services
- MAN for CLS Service (2 and 34 Mbit/s)
- C–LAN for Frame Relay Service (up to 2 Mbit/s).

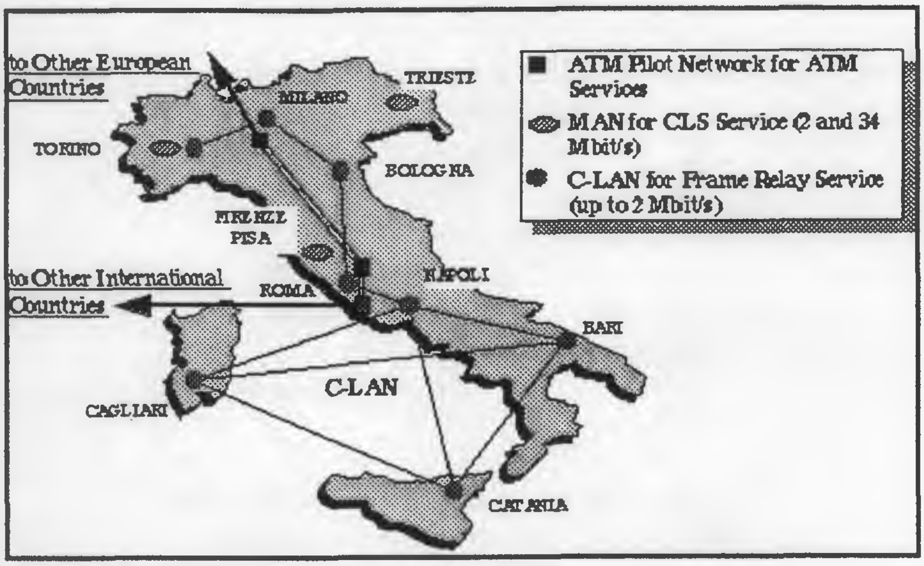


Fig. 2.2 – ItalHost: Advanced Telecommunication Networks and Services in Italy (1994).

THE BELGIAN RESEARCH NETWORK

BELNET

P. Bruyère[1]

Preamble

In November 1992, the Belgian government decided to financially support the implementation of a Research Network called BELNET.

The objective of BELNET can be summed up as follows: "To improve the means of communication of all the research cells in the country with each other and with those abroad." The first aim of BELNET is therefore to solve the problems of connecting the research teams. That is to say, to effect the interconnection of the various research sites and to connect this infrastructure to foreign networks of the same type. Moreover, the network must be open and meet the real needs of users.

I. DESCRIPTION OF BELNET

I.1. Scope

The network offers an IP service and connects almost all the universities and some national research centres. The chapter on beneficiaries which follows shows the institutions concerned.

The following services are covered by BELNET:

- a network service as specified at level 3 of the ISO model, connecting all institutions;
- Connections with international networks: EARN, EBONE, EUnet, EUROPAnet, all part of the big Internet;
- The applications necessary for a network environment: management, directory services.

Network Service

The network service contains the IP protocolset. BELNET does not impose any obligation on the use of certain applications on top of the network service. However, only some application gateways are provided (NJE-mail - SMTP, X.400 - SMTP (mime), TELNET - sessions XXX).

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[1]Pierre Bruyère is Chargé de Mission in the Belgian Office for Scientific, Technical and Cultural affairs (OSTC). He is the project manager of the BELNET programme and the chairman of the BELNET Policy Board.

In future, other network services may be offered by BELNET, depending on demand.

Connections with other networks

The international connections currently offered by BELNET are EARN, EBONE, EUnet, EUROPAnet, all part of the Internet.

In future, connections may be provided with the Belgacom DCS, the telephone network, ISDN, ATM, MAN or other public networks.
If needed, an application gateway will be supplied for some of these connections.

I.2 BELNET Services

Even if the basic service remains the network service, many services are offered by BELNET, including:

- a helpdesk function;
- registration of IP addresses and domain names;
- set up, management and development of various network application services:
  - ARCHIE server;
  - File server (mirror site);
  - DNS secondary Name server;
  - Lists of discussion;
  - Gopher, World Wide Web;
  - Gateway SMTP-X400;
  - Usenet News;
- users support;
- a directory service for users, systems and applications;
- the distribution of an electronic newspaper;
- documentation and reports.
- a CERT (Computer Emergency Response Team)

Other applications of the network are monitoring, network management and planning, but these are invisible to the end user.

I.3 Implementation

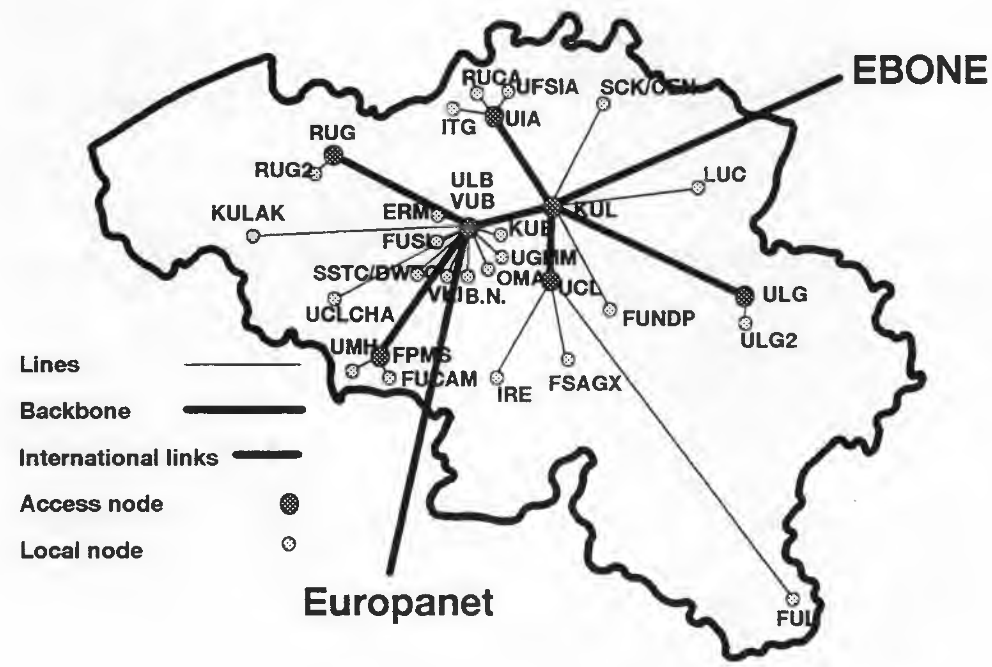
The network has been established in two phases. Installation of phase 1 began in November 1992. The phase 2, a full operational network, has started in September 1994.

The first phase of BELNET was a transitional phase which aimed to offer good IP connectivity while awaiting the attainment of the fully operational version of BELNET (phase 2).
For this purpose, 64 and 128 kbps lines have been installed to connect the institutions. The routers have been rented or placed partially at the disposal by the institutions for the duration of phase 1 and the access equipment was provided by the institutions connected.
In addition, two international connections have been made.

With the starting of phase 2, BELNET became a complete network comprising lines, routers, access points, control and services.

From the users' point of view, this phase has been characterized by a growth in line capacity, the development of services and a more centralized management.

The actual topology of the network is shown in the figure below.



With 28 sites connected, BELNET does indeed cover the whole of the country and shows a double-star topology centred on Brussels and Louvain.
From these two centres go the two connections with the international networks: EUROPANET (at 2 Mbit/s) and EBONE (at 512 kbit/s) respectively.

The lines' capacities are 64 kbit/s, 256 kbit/s for the backbone and 2 Mbit/s for the line Brussels-Louvain.

In 1995, seven new sites (mainly located in the Brussels area) will be connected to the network.
The lines' capacity will be progressively increased in function of the users demand. In that concern, the only limit is the budget constraint.

I.4. Beneficiaries

As indicated in the objective, BELNET is aimed at those involved in research in Belgium, whether they are from Universities or public institutions.
There are however some restrictions with regard to its use and the terms and conditions of access.
The first restriction concerns its use: it is a network for supporting research, with any other use being prohibited. (See point 4 below). Furthermore, as the budgets allocated for BELNET are limited, it has been necessary to limit the number of institutions whose access to the network has been undertaken by the OSTC. These are all the Belgian Universities and some national research centres covered by the Ministerial decision relating to the creation of a communication network in Belgium (see Appendix 1).

This does not mean that other public institutions may not be connected to BELNET, but they have to support the cost of their connection to the network (i.e. local router, leased line and BELNET access cost)

As the BELNET infrastructure is fully subsidized by the government, private or commercial institutions may not be directly connected to the network. Those institutions have to contact commercial service providers to receive Internet access (see ISP list in appendix 2).

I.5. Policy regarding the acceptable use of BELNET (AUP of October 1993)

Introduction

This document states the Acceptable Use Policy (AUP) of the BELNET service. The BELNET network interconnects other networks and, in general, does not have end-user systems connected to it.
The BELNET service consists of the data communication capabilities offered by the BELNET network, complemented with operational support structure and specifically defined higher-level applications or services.

The management of a connected network is responsible for providing their end users or further connected networks with all information, network management service, and operating procedures related to BELNET. The BELNET Service Support Team will normally only communicate with the contact persons of the connected networks.

Permitted Use of the BELNET Service

Use of the BELNET service is restricted to the community of researchers and academic institutions. Governmental agencies and agencies of the Commission can use the BELNET service for their programmes concerned with research and development.

Use of the BELNET service is permitted only for instruction, research and development (including the dissemination of results) and for administration and direct support of such uses.

It is not permitted to use the BELNET service for any activity which purposely:

- seeks to gain unauthorised access to the resources of the connected networks;
- adversely affects the operation of the BELNET service or jeopardises the use or performance for other users;
- wastes resources (people, capacity, computer) through such activity;
- destroys the integrity of computer-based information;
- compromises the privacy of users.

Use for commercial activities is not permitted.
Extensive use for private or personal business is not permitted.

It will be up to the networks and institutions connected to BELNET to restrict traffic according to their own norms and legal requirements and to secure themselves against the misuse of BELNET.

Where traffic is being sent via BELNET that breaches the Acceptable Use Policy, connected institutions agree to actively and in a timely manner cooperate in action against the source and sinks of such traffic. Such action would include initially an explicit demand to the source of such traffic to observe acceptable use statements, subsequent monitoring to ensure that any breach of acceptable use is remedied and in the event of continuing breach taking further steps including if necessary disconnecting offending parties.

If an application for connecting to BELNET cannot be agreed according to these guidelines, a separate agreement may be concluded between the organization in question and the Belgian Office for Scientific, Technical and Cultural affairs (OSTC).

II. ORGANISATION OF BELNET

To ensure the accomplishment of the BELNET objectives and its future developments, a suited organisation has been set up. The diagram below summarizes the relationship between the various players. The role of each is described below.

II.1. The OSTC

The Belgian Office for Scientific, Technical and Cultural affairs (OSTC) is a federal administration.
The premier role of the OSTC in BELNET is of a financial order. In fact, it is they who take on all the costs directly associated with the implementation and the operation of BELNET, and this for a period of four years.

The second role of the OSTC is of an operational order; in its decision of 27th November 1992 the Government did in fact entrust them with definition, implementation and operation of BELNET.

Finally, the third role of the OSTC is that of centralisation and coordination among users.
In fact, this function may more easily be accomplished by a third party, neutral with regard to the expression of requirements in matters of the network.

II.2. The Policy Board

The Policy Board is an advisory organisation whose mandate consists in advising the OSTC in the choice of medium and long-term options with regard to the development of the BELNET network.
The Policy Board is therefore led to pronounce on the organisational, operational, technical, strategic and budgetary aspects of BELNET, as well as possibly on its pricing tariffs.
The Policy Board carries out its role with the wish to ensure optimum development of BELNET, i.e: corresponding as far as possible, in view of the budgets available, to the real needs of all its users.

It is made up of research network experts. Its members are appointed, on a personal basis, by reciprocal agreement with their respective administrative authorities and the Secretary General of the OSTC.

Today it consists of:
- an expert from the following Universities: FUNDP, KULeuven, RUG, UCL, UIA, ULB, ULg and VUB;
- one representative from Belgacom;
- one representative from the OSTC who acts as chairman.

II.3. The Service Support Team (SST)

The Service Support Team is responsible for supporting the services offered by BELNET. This implies all the services described in point I.2. above.

II.4. The User Forum

The User Forum is an association of BELNET users. Its role is to provide a channel back to the Policy Board and the OSTC for the desiderata of users. It will thus provide a feedback to the network managers.
The association will be given complete liberty to arrange for its own structure and organisation (election of officers and a chairman, creation of subgroups, frequency of meetings, etc.). The OSTC provides however logistic support for meetings.

Appendix 1 : BELNET sites

Acronym	Institution
OSTC	Belgian Office for Scientific, Technical and Cultural affairs
FPS	Faculté Polytechnique de Mons
FSAGX	Facultés des Sciences agronomiques de Gembloux
FUCAM	Facultés Universitaires Catholiques à Mons
FUL	Fondation Universitaire Luxembourgeoise
FUNDP	Facultés Universitaires Notre-Dame de la Paix à Namur
FUSL	Facultés Universitaires St-Louis à Bruxelles
IRE	Institute for Radio Elements
ITG	Prins Leopold Institute for Tropical Medecine
KBR	Royal Library Albert I
KUBRUSSEL	Katholieke Universiteit Brussel
KULEUVEN	Katholieke Universiteit Leuven
KULAK	Katholieke Universiteit Leuven, afdeling Kortrijk
LUC	Limburgs Universitair Centrum
MUMM	Management Unit for the Mathemathical Modeling of the North Sea
OMA	Observatory, Meteorology & Aeronomy at Ukkel
RMA	Royal Military Academy
RUCA	Universitair Centrum te Antwerpen
RUG	Universiteit Gent
SCK	Study Centre for Nuclear Energy
UCL	Université Catholique de Louvain
UFSIA	Universitaire Faculteiten St.-Ignatius te Antwerpen
UIA	Universitaire Instelling Antwerpen
ULB	Université Libre de Bruxelles
ULG	Université de Liège
UMH	Université de Mons-Hainaut
VKI	Von Karman Institute
VUB	Vrije Universiteit Brussel

Appendix 2 : Belgian Internet Service providers

BELnet (not for commercial institutions)
DWTC - SSTC
Wetenschapsstraat, 8
1040 Brussel
E-mail:helpdesk@belnet.be
Tel: ++32(0)2-2383470
Fax: ++32(0)2-2311531

EUnet Belgium NV/SA
Stapelhuisstraat 13
B-3000 Leuven
E-mail: info@Belgium.EU.net
Tel: ++32(0)16-236099
Fax: ++32(0)16-232079

Infoboard Telematics
Buro & Design Center
Esplanade du Heisel 75
1020 Bruxelles
E-mail: info@infoboard.be
Tel: ++32(0)2-4752531
Fax: ++32(0)2-4752532

INFONET
Interpac Belgium
Avenue Louise 350 Box 11
1050 Brussel
E-mail:
Tel: ++32(0)2-6466000
Fax: ++32(0)2-6403638

INnet
Postelarenweg 2 bus 3
2400 Mol
E-mail: info@inbe.net
TeL: ++32(0)14-319937
Fax: ++32(0)14-319011

Telecom Finland International n.v./s.a.
127-129 rue Colonel Bourg
B-1140 Brussels
e-mail: info@tfi.be
Tel: +32 2 726 8655
Fax: +32 2 726 9852

RENATER the French R&D network
By Isabelle Morel, Renater France
14/12/1994

Introduction

In June 1992, RENATER (the French network for research , education and technology) was created by its founding organisms (CEA, CNES, CNRS, EDF, INRIA and the Universities).

Its aims were to interconnect all higher education and research centers, and to provide connectivity with research, education and industry networks of other countries.

GIP

The founding organisms decided to put together their resources and a GIP (Groupement d'Intérêt Public=a non profit organisation between public entities) was created.

They also chose France Telecom as the operator of the network. Actually, most of french organisms dealing with research, technological developments or with higher education use Renater.

Since 1994, the minister for Higher Education and Research added to the mission already assigned to Renater that of opening to industrial traffic. So, now, research and technological development, services of large and small industry firms are connecting to Renater.

Architecture

Renater is basically an IP service. IP is the protocol used on the whole Internet constituted of networks from all countries, interconnecting supercomputers, scientific workstations as well as microcomputers.

Renater is organised in 3 levels :

1) The campus or site networks operated by users, and to which workstations and computers are linked .

2) Regional networks to which the campus or site networks are connected. Sites from the same regions can communicate through the regional network.

3) The national interconnection network (RNI) which links the regional networks. Links with research and industry networks from Europe and the US are connected to this national network, by means of the international gateway (NTI).

Renater has a backbone operational at 34Mbps with transit routers connected on FDDI rings, more than 300 sites are connected today; most of them have high speed access point at 2Mbps, but six are at 34Mbps.

About 1400 network sites have internet connectivity through Renater which transports 2 terabytes of data each month. This volume of traffic is increasing at a sustained rate of 15% per month.

International Gateway

Renater is linked at high speed (6 Mbps) to the european EBONE network whose major node EBS (Ebone Boundary System) is in Paris. The international gateway, included EBS, are managed by France Telecom with a contract for round-the-clock coverage throughout the year.

Renater benefits also, within the Ebone framework , from a high speed transatlantic link (3.5Mbps) from Paris with rerouting via other links in case of failure of that link.

Prices

A site connected to a regional network is charged by France Telecom only for the access to this regional network.

Costs associated with the national and international connectivity are paid by the participating organisations of GIP, or through specific contracts for others.

In any case, the costs are proportional to bandwidth of the link between the site and the regional infrastructure National and International connectivity, and associated services as security services are all at inclusive prices. Services is connectivity; any application can be set up over it by users.

Users

Renater is particularly well suited for developing and using the most modern applications (client-server systems and services, multimedia databases, large scientific or technological databases, commercial data bases and information servers).

A spectacular example is the Internet book, or World Wide Web (WWW). It is a client-server system, with text, images, voice and video, for accessing in a coherent, transparent and very convivial way a huge number of information databases which are distributed all over the world. The WWW servers access can be public or restricted.

The future

The founding organisms of Renater specified that it should have powerful links with other research networks and with the Internet; they added that it should also move towards very high speeds.

Significantly high rate of traffic growth (15% per month) on the Renater backbone needs to be watched, which is done today; and it could point to the need for upgrading the 2Mbps link to 4-8-16 or 34Mbps and the 34Mbps links to 150Mbps, in the next 2 years. As well, the international links from Paris could be upgraded quickly if needed, to 8 or 16 Mbps for US access or 34Mbps for European access through Ebone. Renater is ready to carry out these upgrades, and will do it as soon as needed.

Besides the operational network, an experimental very high speed backbone is being set up between Paris Grenoble-Marseille - may be Toulouse if needed - with 150Mbps to 600Mbps link (ATM).

Renater will be a telecommunication platform within the 4th framework programme of the EU, called Advanced Communication Technologies and Services (ACTS) between 1994 and 1998. Renater, as the French national host, is proposing a platform oriented towards tests and pre-operational evaluations of new services and products, in a context of demanding and highly competent user groups.

Renater is actually proposing a response to the French information highway, so once again, highly competent and demanding users groups are welcome.

For more information, please contact: Michel LARTAIL

RENATER
Université P&M curie
4 place Jussieu Bât A - 7e
75252 Paris Cedex 05
Tel: 33 1.44 27 26 12 Fax: 33 1.44 27 26 13
e-mail: Lartail@renater.fr
WWW:http://web.urec.fr/Renater

GARR

THE SCIENTIFIC RESEARCH NETWORK IN ITALY

E. VALENTE
INFN & UNIV. OF ROME
member of GARR COMMITTEE

MARINO, 14 DEC. 1991
EEOS WORKSHOP

GARR INTERCONNECTS

65 UNIVERSITIES

12 ASTRONOMICAL OBSERVATORIES

SEVERAL NATIONAL RESEARCH ORGANIZATIONS:

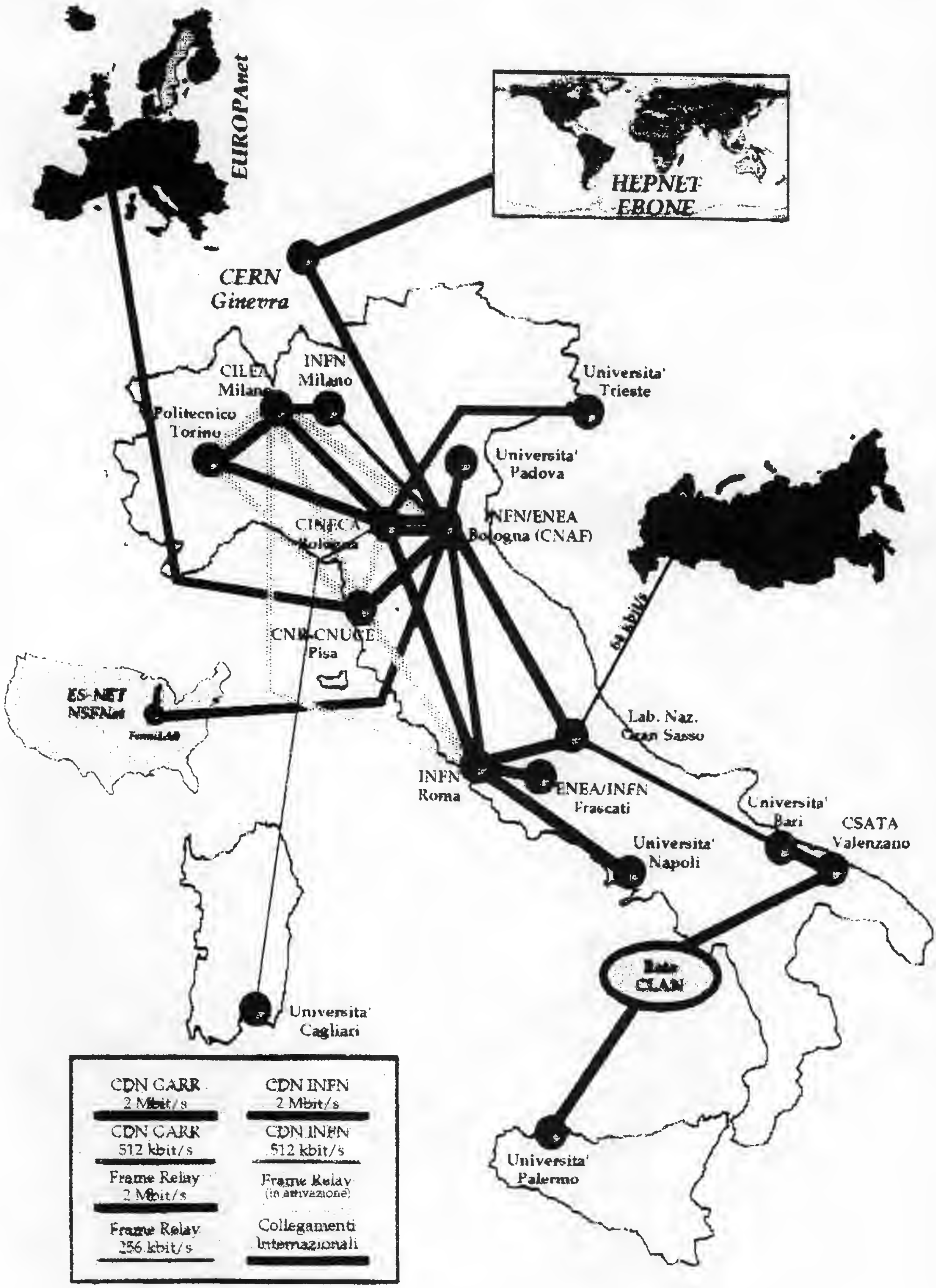
CNR
ENEA
INFN
INFM
ASI
...

SEVERAL ACADEMIC AND RESEARCH FOREIGN INSTITUTION BASED IN ITALY (ESA-ESRIN included)

n PUBLIC INSTITUTIONS AND MINISTRIES MURST, MBCA, MPI...

n INDUSTRY RESEARCH GROUPS (non commercial/administrative)

Dorsale della rete GARR



Protocols (OSI layer 3) over the GARR WAN (in order of importance):

1- IP;
2- CLNP (mainly used for Decnet-OSI);
3- X25 and SNA embedded in IP or over Frame relay circuits.

Services:

1- Distributed Network Management (including protocol support, routing, future developments);
2- Distributed Network Operations (including fault reporting, trouble ticketing, domain name service, host name registration)
3- Distributed Electronic Mail Gateway System (Decnet, BITNET, Internet and X400);
4- Distributed Document Retrieval System based mainly on FTP and WWW;
5- Distributed Directory Services, based on WWW and X500;
5- Centralized Network Information System (based on X500) mainly for network and domain name registration and documentation;
6- Centralized coordination for videoconferences (MBONE tunneling, ISDN, etc.);
7- Centralized coordination for access to Libraries and 'Grey Literature' data bases.

"The italian scientific research network GARR is based on a backbone interconnecting, by means of several 2 Mbit/sec leased lines, 12 infrastructural nodes (NAP's).

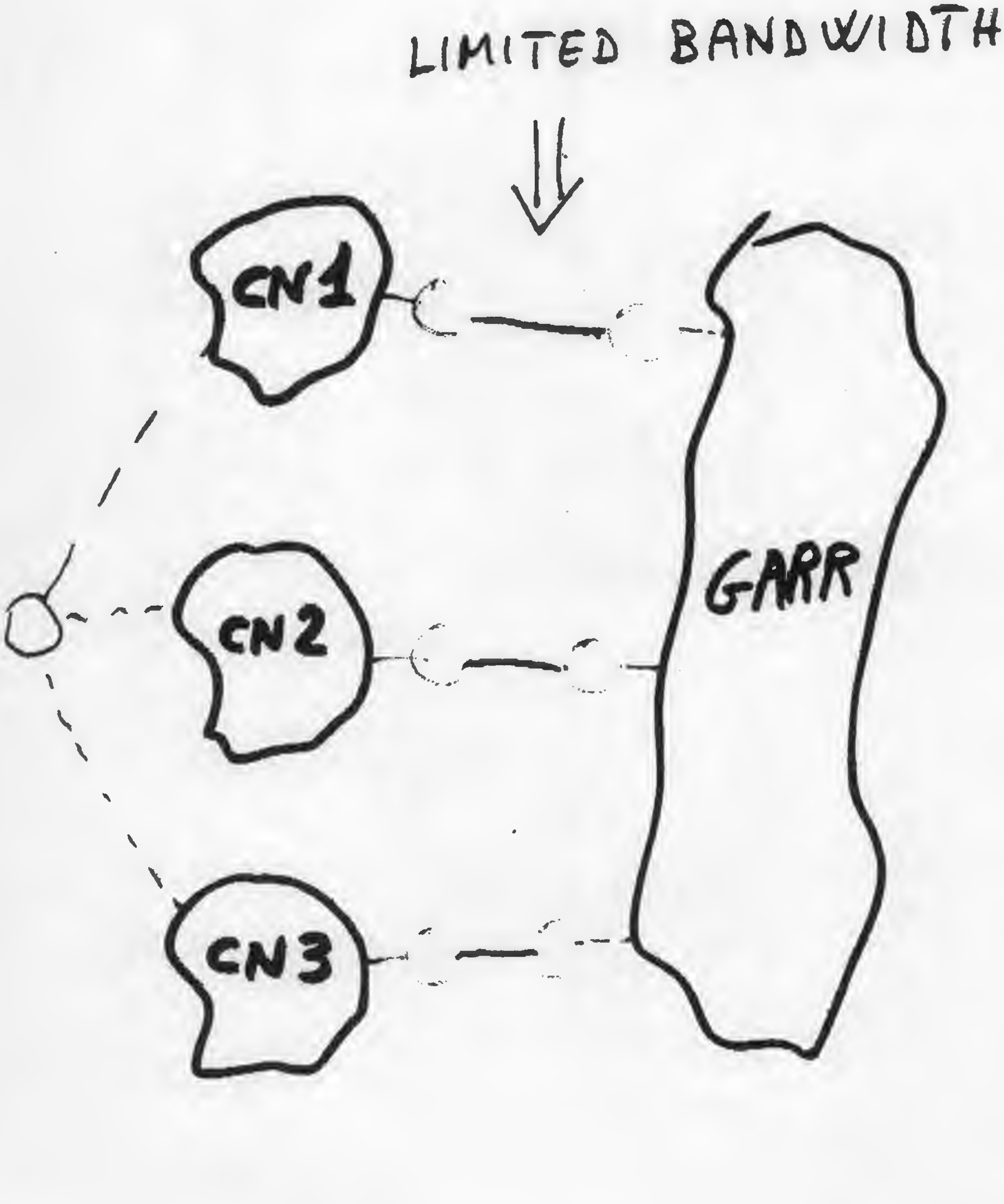
Around 1000 sites of more than 200 academic and industrial scientific research organizations are connected, directly or indirectly, to the backbone, making possible the interworking between 50,000 italian researchers and scientists.

The backbone is connected to the international networks by means of the following links:

1- from CNUCE-CNR in Pisa to EuropaNet by means of a direct access to EMPB;
2- from CNAF-INFN in Bologna to:
   a) Euro-HEPnet and Ebone by means of a direct line to CERN in Geneva;
   b) ESnet and NSFnet by means of a direct line to PPPL in Princeton (USA);
3- from LNGS-INFN in Assergi to JINR and other russian Laboratories by means of a satellite line to Dubna (120 Km. from Moscow)
4- from ENEA-INFN in Frascati to ESA and NASA networks by means of a local line to ESRIN.

Communication tools (OSI layers 1 and 2) are:
1- point-to-point leased lines up to 2 Mbit/sec between pairs of multiprotocol routers;
2- private Frame Relay circuits, based on cell relay technology, over 2 Mbit/sec leased lines, both national and international;
3- Permanent virtual circuits, up to 2 Mbit/sec, over TELECOM ITALIA Frame Relay public service;
4- (Euro-)ISDN circuits (mainly for non-extremely-demanding videoconferencing);
5- MAN based on 34 Mbit/s and DQDB technology in a few cities and regions;
6- ATM at 155 Mbit/sec and FDDI at 100 Mbit/sec over tens of university and laboratories campus-wide LAN's.

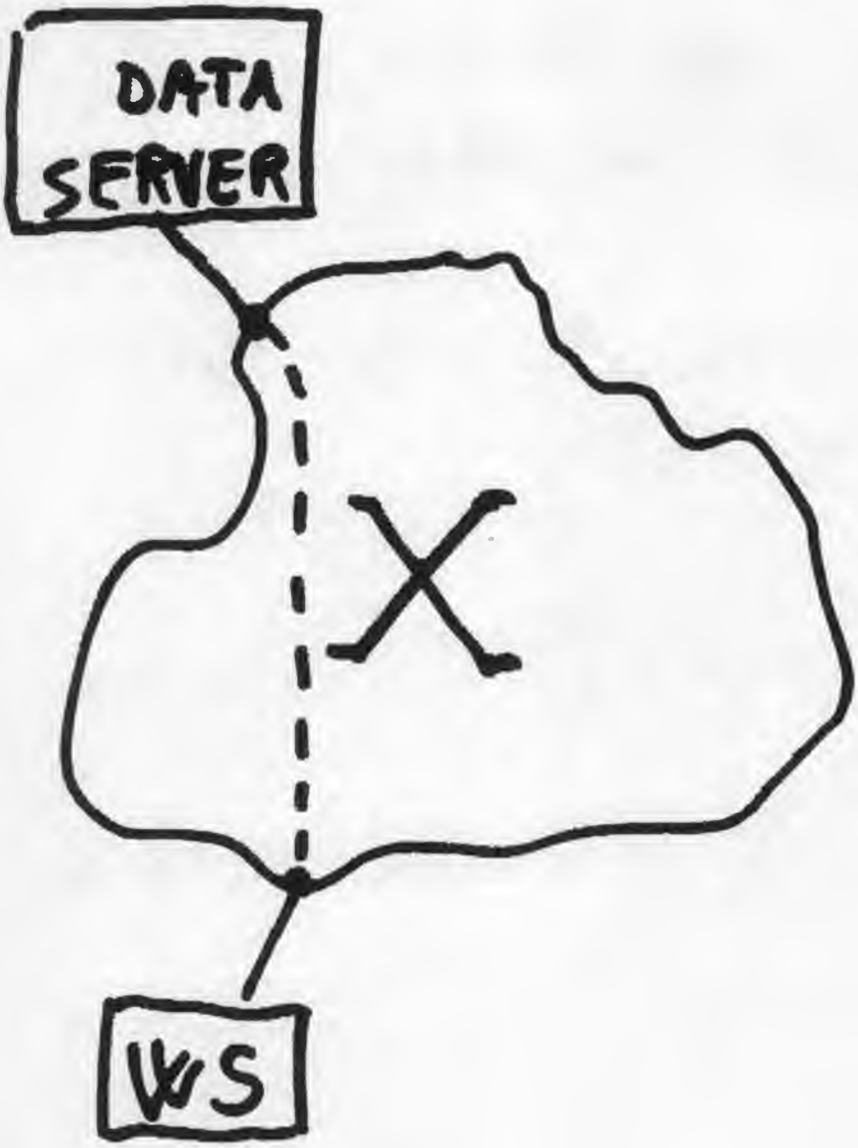
GARR ENCOURAGES THE SETTING UP OF COMMERCIAL NETWORKS



Why higher bandwidth

- INCREASING NUMBER OF USERS
- ACCESS TO SITES WHERE DATA ARE STORED
- INTERACTIVE ACCESS WITH FEW MS DELAY
- VIDEO- STUFF (WHAT IS WORKING ON LAN ALREADY)
- NEW APPLICATIONS DISCIPLINE-DEPENDENT (HEALTH CARE, HEP

THE GOAL (OR THE DREAM)



SWITCH

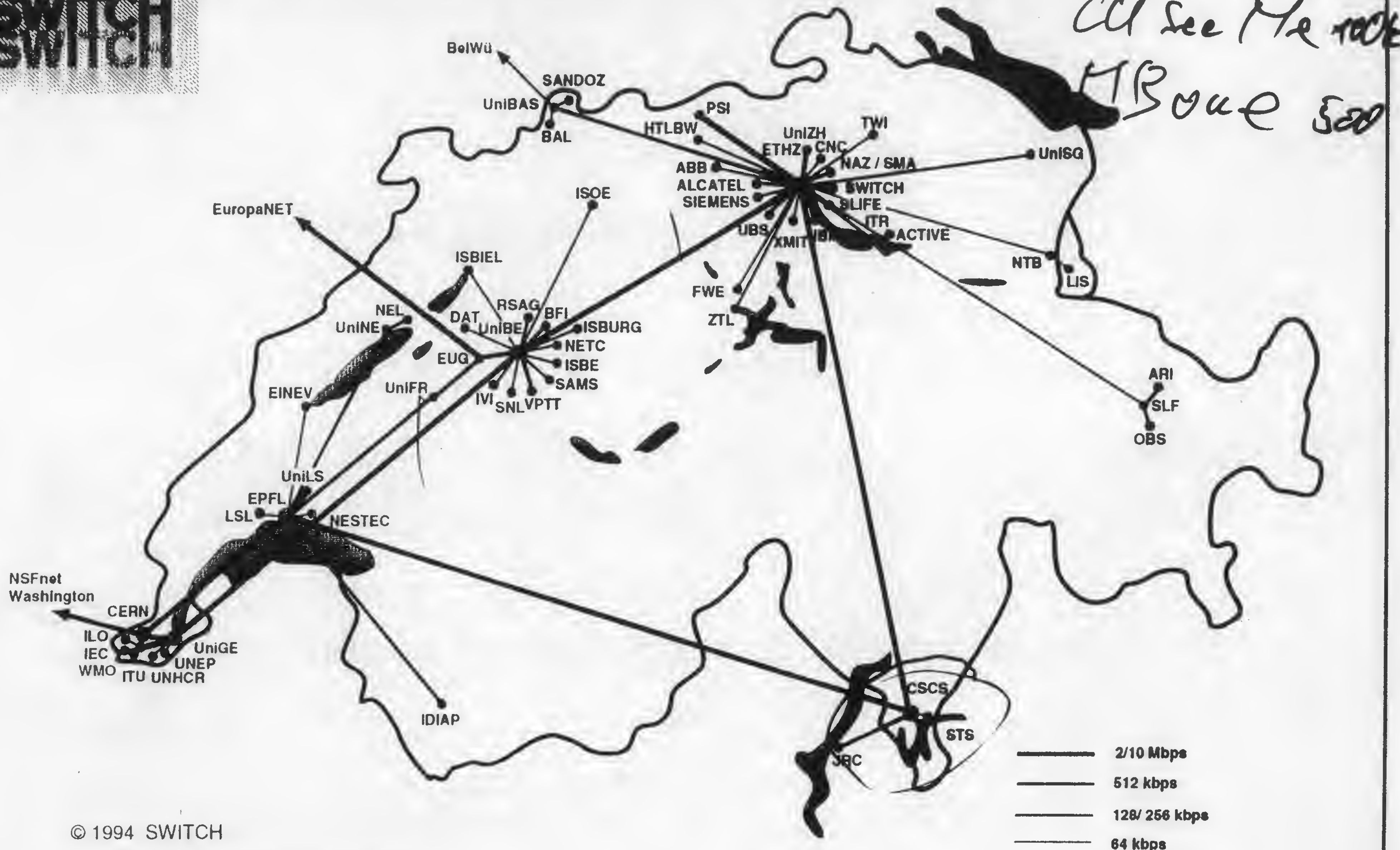
- Foundation by Government and Cantons
- User Requirements Driven
- Head Office with 14 Engineers
- Application Services on 10 Servers
- Connectivity with 90 routers and 70 leased lines

Directory
Telephone books
registry
file store

2.5 MECU
→ 1.2 MECU
0.8 staff
0.5 infra.

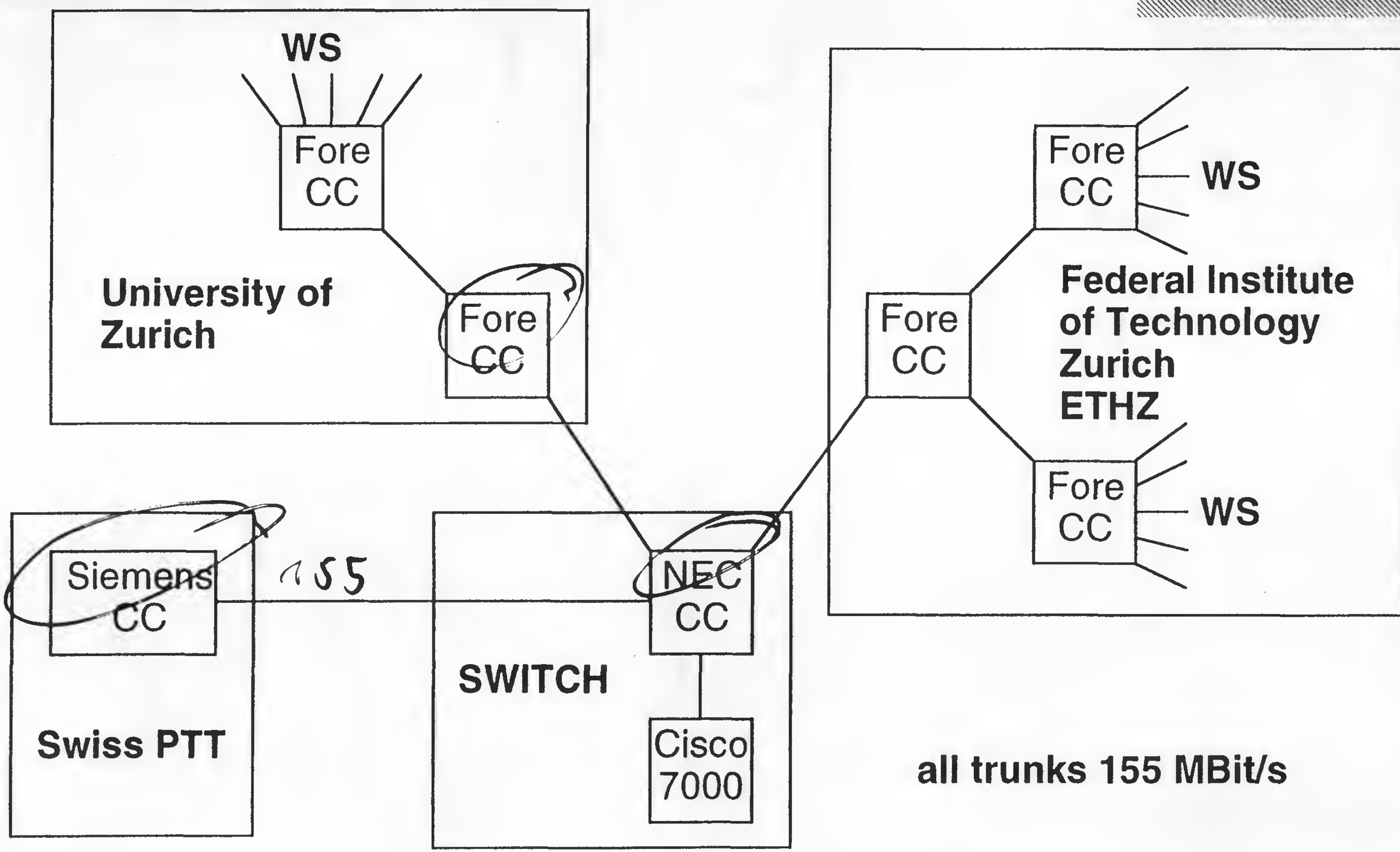
Swiss Academic and Research Network

SWITCH



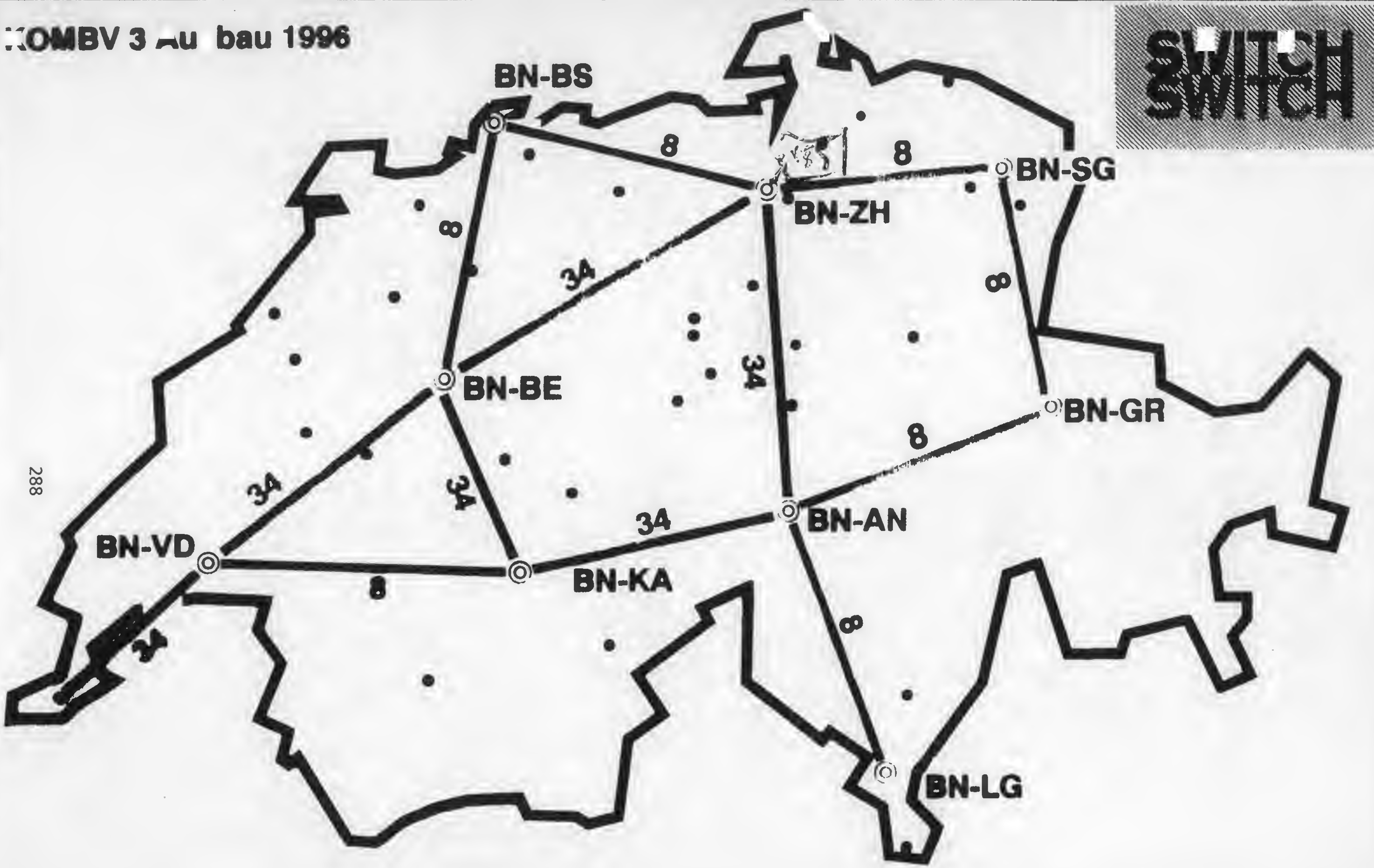
The PostScript™ version of this map can be fetched by anonymous ftp from nic.switch.ch [130.59.1.40] in the directory /network/SWITCHlan/map

SWITCH ATM Pilot



SWITCH, Limmatquai 138, CH-8001 Zürich
Urs Eppenberger | 13.12.1994

KOMBV 3 Ausbau 1996

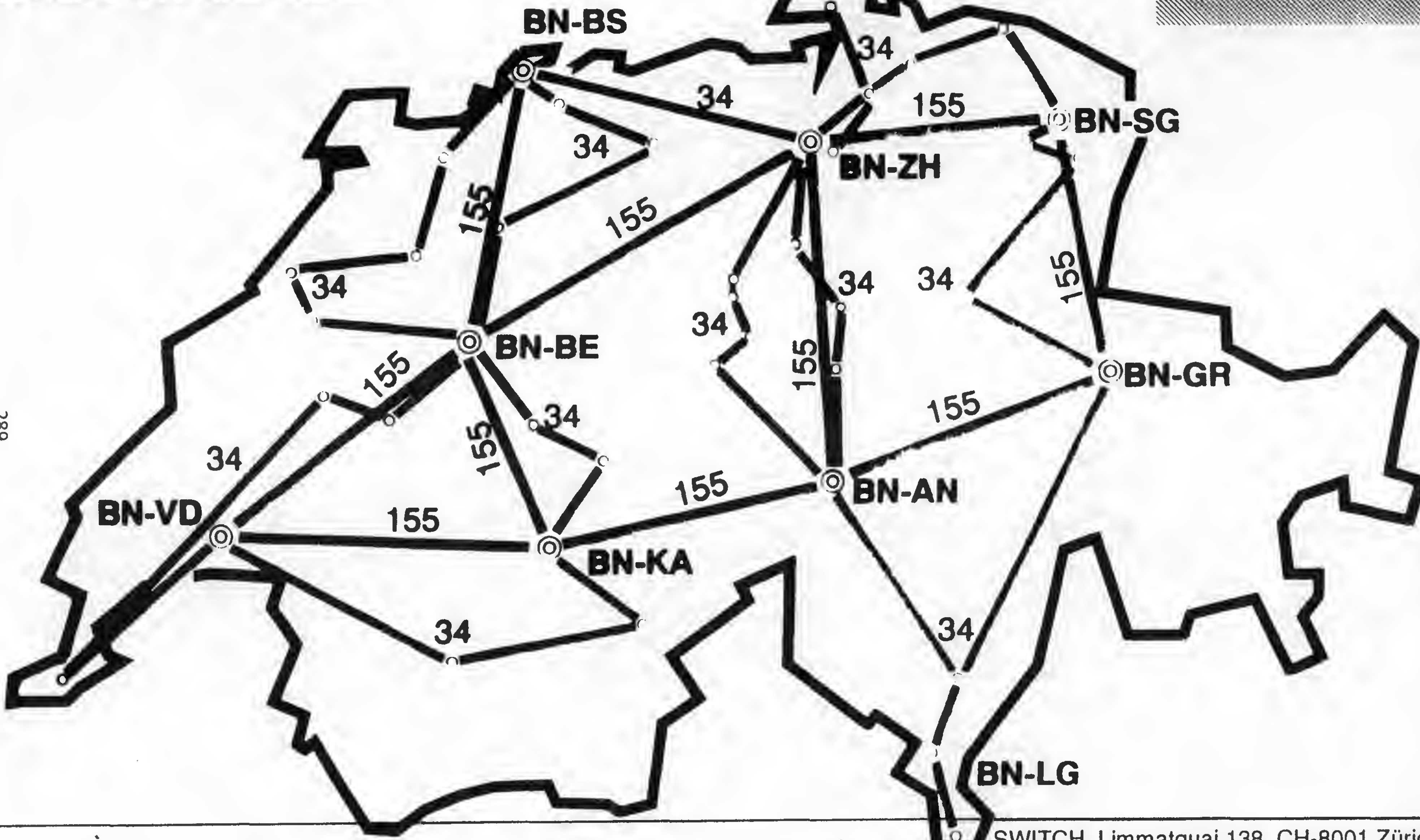


Telecommunication Services for Research & Development

SWITCH, Limmatquai 138, CH-8001 Zürich
Urs Eppenberger 13.12.1994

KOMBV 3 Ausbau 2000

SWITCH



Telecommunication Services for Research & Development

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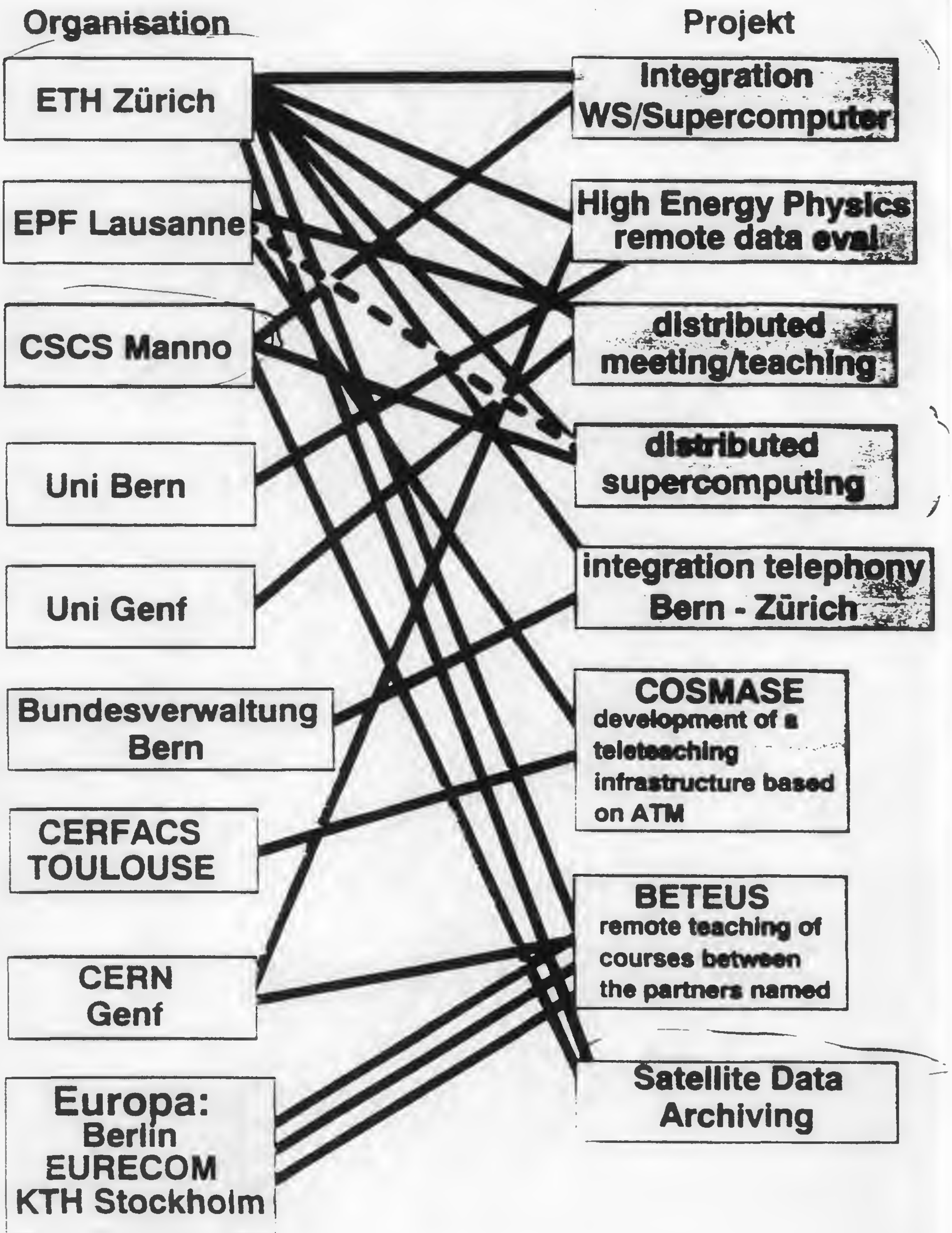
ATM-PILOT



Organisation
Projekt
ETH Zürich
EPF Lausanne
CSCS Manno
Uni Bern
Uni Genf
Bundesverwaltung Bern
CERFACS TOULOUSE
CERN Genf
Europa: Berlin EURECOM KTH Stockholm
Integration WS/Supercomputer
High Energy Physics remote data eval
distributed meeting/teaching
distributed supercomputing
integration telephony Bern - Zürich
COSMASE development of a teleteaching infrastructure based on ATM
BETEUS remote teaching of courses between the partners named
Satellite Data Archiving

TELECOM NMC Basel - Phone: +41 61 285 6262 / Fax: +41 61 272 2342

ATM-Pilot - Order

Form 1

---

1. Origine User

Name/Enterprise ....
Phone ....
FAX ....
Contact person ....
Phone ....
FAX ....
E.164-ID ....

Destination User

Name/Enterprise ....
Phone ....
FAX ....
Contact person ....
Phone ....
FAX ....
E.164-ID ....

2. Connection Information

○ New connection ○ Modification ○ Release ○ Cancellation

Virtual path identifier VPI (Proposal): ....

3. Subscription Mode

Application/Service: ....

Schedule Boundaries: Start date/time: .... End date/time: ....

○ permanent ○ daily ○ weekly ○ occasional

Local Time	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
MON																									
TUE																									
WED																									
THU																									
FRI																									
SAT																									
SUN																									

Place/date/time: .... Signed: ....

My Businesscard

SWITCH

Urs Eppenberger

dipl El. Ing. ETHZ

SWITCH Head Office
Limmatquai 138
CH - 8001 Zurich

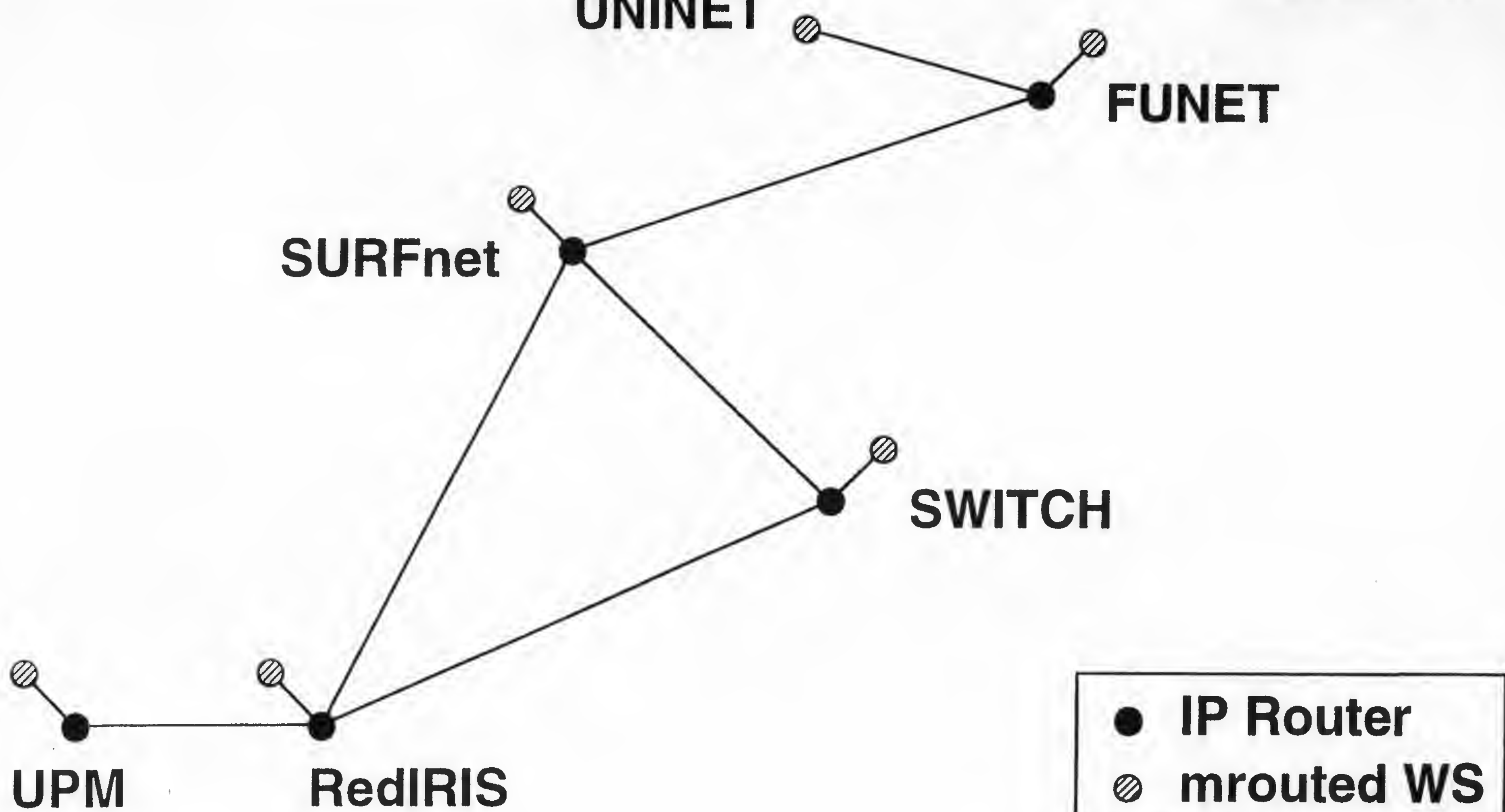
Phone: +41 1 268 1550
Hotline: +41 1 268 1500
Telefax: +41 1 268 1568

C = ch
A = arcom
P = switch
O = switch
S = eppenberger

Eppenberger@switch.ch

IP Multicast over ATM

SWITCH



Telecommunication Services for Research & Development

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Urs Eppenberger
13.12.1994

ESRIN EEOS Workshop on Networks - Panel 1, Frascati, Italy
13 -15 December 1994

DATA COMMUNICATIONS IN AUSTRIA A REMOTE SENSING PERSPECTIVE

F. Leberl[1] and F. Haselbacher[2]
Graz University of Technology
A-8010 Graz, Austria
E-Mail leberl@icg.tu-graz.ac.at

ABSTRACT

There exists a modern R&D data network in Austria denoted as ACOnet. It currently uses a 34 Mbit/sec backbone infrastructure offered by the Austrian PTT. Participating Universities and research institutes have access to this infrastructure via a 2 Mbit/sec connection. Via Vienna each node in ACOnet is connected to other international nodes. A backup consists of an ISDN network at 128 Kbit/sec. The international connection is through E-BONE as the "European Backbone"-network for the R&D-community.

The future is with ATM. First experiments are being performed with ATM at 140 MBit per second. However, these experiments are performed locally at this time. It is to be expected that large scale availability of ATM will materialize by 1997. These ATM-experiments may include studies about the access to large remote sensing data bases (400 GByte of image data).

Rural areas dominate the Austrian scene. These will continue to be accessed by ISDN, although fiber glass lines are currently being put in place across all of Austria at a rapid pace. We will discuss the details of the Austrian data networks, the current pricing strategies for services on these lines, and we will examine their roles for future remote sensing applications, in particular in local districts and provincial monitoring tasks.

1. INTRODUCTION

The transfer of data via public communication lines is currently a monopoly of the Austrian PTT, a nationalized organization whose employees are civil servants. The situation does not differ significantly from that in most European countries. It is the major factor for the complaint that in Europe the use of communication lines costs a user approximately 10 times more than it would in the United States where competition in the offering of communication services has become possible many

[1]Institut für Computerunterstützte Geometrie und Graphik (Institute for Computer Graphics).
[2]Manager of Networks, University Computer Center.

years ago. But plans in the European Union will change the situation in Europe too. Concerning Austria, plans call for a termination of the PTT-monopoly by 1998.

The perhaps largest issue in future data transfer discussions may be less the data rates as the pricing policies. It is for this reason that the termination of PTT-monopolies will also have an impact on the policies for remote sensing data bases and transfer methodologies.

We will present in this paper a review of current networking capabilities in Austria and its connection to the international scene. We will also sketch a requirement for Austrian future data transfer services as they may evolve through the applications of satellite remote sensing data streams.

Austria is a highly regionalized country with a considerable autonomy of its 9 provinces, more than 60 districts and more than 2000 municipalities. This may lead to requirements for networking of remote sensing data that are different from those that may exist in countries with a tradition of centralized management and decision making. In Austria, networks may have to carry large data quantities even into the smaller towns since many environmental decisions are being taken there, and it is in those towns that agriculture, forests and water are being managed.

2. CURRENT AUSTRIAN NETWORKS

2.1 The Major Network and its Access

The major communications network in Austria today is offered by the PTT. It has been installed in the spring of 1994 as a ring connecting 7 nodes in some major cities (see Anon., 1993 a,b). These are the provincial capitals with universities. Figure 1 illustrates the situation. The primary net is denoted as Metropolitan Area Network (MAN), a name chosen by Austria's PTT independent from the broader meaning of this term. This major net offers data rates at 32 MBits per second.

MAN is used by the universities via local access connections at a rate of 2 MBit per second. The resulting service is denoted as ACOnet. Its individual users are universities or semi-public research organizations. ACOnet uses the TCP/IP protocol for mail, telnet and ftp services.

All data are routed via the node in Vienna. Therefore a bottleneck may exist at the Vienna node's 2 MBit access rate. Access to the network is the result of a contract between the Ministry of Science and Research in Vienna and the national PTT.

A back-up system consists of an ISDN network at a data rate of 128 KBit per second.

2.2 International Access

The international connection is through the E-Bone network at a data rate of 1 MBit per second. This connects to Paris. Other European networks, for example DANTE, are not relevant.

Internationally, Vienna is a central connecting point for Eastern European capitals. International connections in Eastern Europe are at a rate of 9.6 KBit to 128 KBit per second. In Western Europe the connections are at 256 KBit to 2 MBit per second.

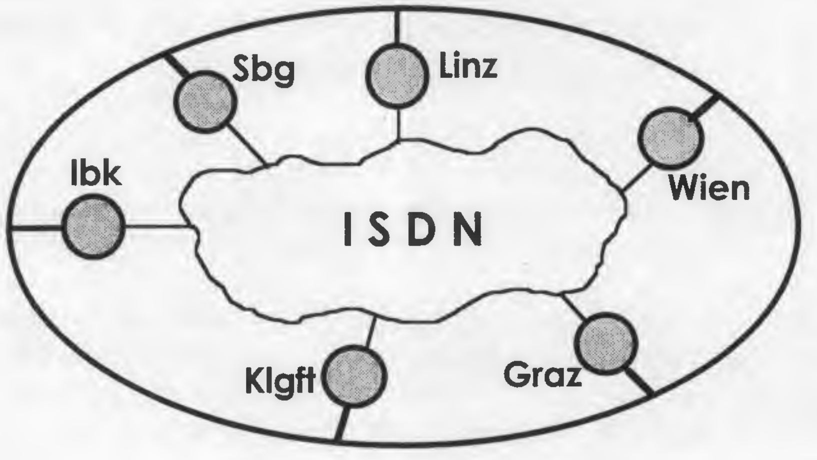

Figure 1: Major Austrian network, the Metropolitan Area Network MAN, at 34 MBit per second, operated by the PTT. ACOnet is the R&D service using this net and offering local access at 2 MBit per second.

2.3 Pricing

Users of the MAN-service offered by the PTT are being charged per volume of use, plus a flat monthly access charge of about öS 16,500.-- which includes about öS 3000 of usage. The charge increases if MAN is used at rates higher than 2 Mbit per second. Access at fullcapacity of 34 MBit/s costs an access fee of öS 57,200.-- per month. For Universities this would result in an unpredictability of its data services budgets. Successful negotiations between the Ministry of Science and Research and the PTT have resulted in an exception for R&D use of the MAN: the network is available for a fixed fee per year paid at ministerial level; the individual user at Universities is not being charged for the use of the net.

The back-up service through ISDN is available for a load price, just as is the case with conventional telephone services. For inner-Austrian calls across distances greater than 100 km, the Austrian PTT charges öS 6 per minute. International calls cost between öS 8.67 and öS 28.-- per minute.

2.4 Other Networks

Of course there exists also commercial access to international networks. This access is being offered by the PTT as well as by commercial vendors such as EUNet GmbH, CompuServe, Sprint and others. These vendors have to use PTT services, for example in the form of leased lines.

3. REGIONAL NETWORK ACCESS WITHIN AUSTRIA

3.1 Example in a Metropolitan Area

Fig. 2 presents a metropolitan network in the city of Graz, capital of the province of Styria and site of three Universities. The network consits of a 100MBit/sec FDDI ring and connects the three universities and two other research organisations. It also connects all organisations in the FDDI-ring to the MAN-service of the Austrian PTT via a 2 Mbit/sec connection (Theurl and Haselbacher, 1990).

3.2 In a Small Town

In principle, the PTT offers now ISDN connections to all major cities in Austria, and there is plan to set up an ISDN infrastructure for the entire country by the end of 1996. That means that nearly every telephone number will have the option of migrating to an ISDN-connection by 1997 (Anon., 1994).

Therefore any data services user in any city, town or village in Austria will have access to data rates supported by ISDN at 128 KBits per second.

4. FUTURE CAPABILITIES

4.1. Cabling the country

At this time, the Austrian PTT is actively placing fiber optic cables throughout Austria. Current plans call for a completion of an initial effort by 1997/8 to reach nearly every small town in Austria (Anon., 1993a). Efforts exist also in the private sector, for example with the railroads, the electric utilitities and the cable television providers, to put fiber optic cables into their right of ways. This may be for their private use, or it may be in preparation for the time when the PTT-monopoly falls.

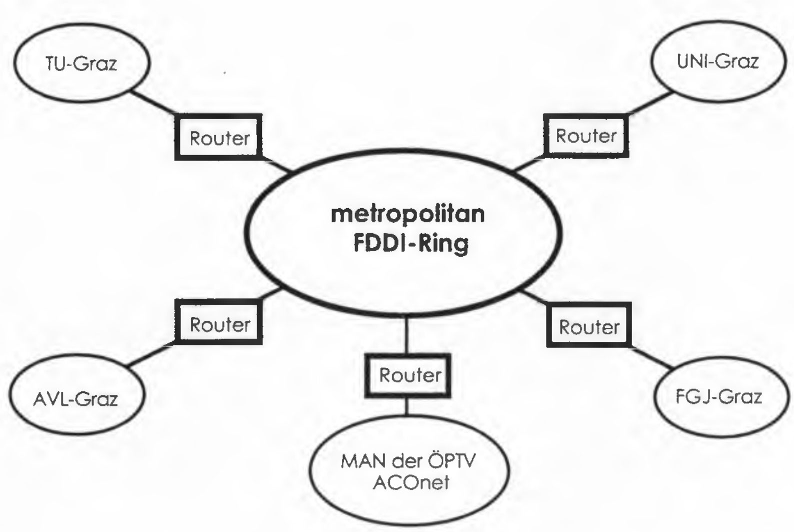

Figure 2: Example of a high data rate urban network in the city of Graz, capital of the province of Styria. A 100 MBit/Second FFDI ring connects all research and development organisations in the city, and provides access tio the national MAN-servide of the PTT. All physical wiring is based on fiber glass lines owned and operated by the PTT.

4.2 ATM

The Asynchronous Transfer Technology ATM is on its way into Austria. This is a switching technology which supports transfer speeds from 100 Mbit/sec to Gigabits/sec. It is based on fiber optic cables for long distances and can also operate on twisted pair cables (category V) for short distances of up to 100m. The international consensus about the future acceptance of ATM as the basis for all future high speed services makes it the central tool for the information highway; it will support interactive TV, video on demand and the like.

ATM is on its way to become the basis for Austria's university campus networks and for the broadband ISDN services offered by the PTT. It will be the first technology that will be used both in local or campus networks as well as in wide area networks. It will also be the first service to meaningfully transmit many different high volume types of information to include video, audio, graphics, still pictures, data, movies and the like.

At the current time the PTT is testing an ATM connection from Vienna to Switzerland (CERN). The PTT is also testing some ATM-connections inside Austria. The interest to familiarize the PTT and pioneering users with issues of such high performance networks is the motivation for other ATM-tests with partners inside Austria, for example employing remote sensing image data.

5. NETWORKING REQUIREMENTS FOR REMOTE SENSING

5.1 Types of Users

We may find four types of users of remote sensing data with a need for significant data transfer services:

* the user concerned with global phenomena and therefore seeking access to data from large portions of the entire globe, for example from all of Europe;

* the user concerned with data about all of Austria, an area of 82.000 square kilometers, or areas about this size;

* the user concerned with a province's surface which may be in the range of 10.000 square kilometers;

* the user in charge of a small area; given Austria's surface area and more than 60 districts, the average district's surface area is about 1.000 square kilometers.

The complete coverage with remote sensing images of each of these areas is presented in Table 1. The data quantities in this table reflect the number of "pixels" recorded, not the number of Bits or Bytes. These are a product of the number of bits or bytes that a pixel may contain. In the case of the US's Landsat program, each pixel holds 7 bytes; France's SPOT holds 4 bytes per pixel. Future satellite sensors from the Earth Observation System EOS may contain 200 bytes per pixel. The German-Russian MOMS-Priroda project intends to cover Austria at a resolution of 5 meters to 15 meters per pixel with either 3 or 4 bytes per pixel. Planned US commercial satellite coverages promise resolutions of 1 meter per pixel at 1 byte per pixel.

Table 1 presents a range of data quantities that may be processed by a single user in a project or in routine operations. This then means that such data quantities may have to be transferred during a short time, say an hour or so, and at reasonable cost commensurate with the benefits derived from the data.

Image Resolution in Meters per Pixel	Austria 82.000 sqkm	Province 10.000 sqkm	District 1.000 sqkm
10 (SPOT-France)	900 MPixel	100 MPixel	10 MPixel
5 (MOMS-Germany)	3 GPixel	400 MPixel	36 MPixel
1 (Eyeglass-USA)	90 GPixel	10 GPixel	1 GPixel

Table 1: Review of single image coverage per area, in pixels. Each pixel may consist of 1 byte as in a black and white image, or of multiple bytes, such as in multi-spectral images. In brackets are indicated which ongoing or soon to be current satellite imaging project would typically produce the geometric resolutions reported here.

It is somewhat misleading to present only the pixels that cover all of a territory once. In reality, any imaging sensor will cover a given area multiple times with overlaps. These are not considered in the current discussion. Oftentimes the true, original data set will be larger and will will have to be processed into the minimum needed to cover an area. The overlap factor may be 2 to 3 and therefore the data can be expected to reduce by this factor if one were to simply avoid image overlaps.

5.2 Types of Data Uses

Users may want to process data physically at their desk top and lock the results away locally. These users will have a requirement for bulks of data to be transferred to their data base, possibly in a batch mode and during non-work hours. High data transfer rates will mainly help to hold the costs of such services down; but the speed itself is not the central issue for the user. The following reviews the quantities of data in such applications.

A user in charge of covering all of Austria with images at a pixel size of 5 meters will need to cope with 3 to 10 Gigapixels to cover the entire area once. If each pixel contains 3 to 7 bytes that user may have to process 10 to 70 GBytes of images.

In a local area, say a province, the resolution may increase to 1 m per pixel, but the spectral information may be less important at that pixel size. If we assume that each pixel holds 3 bytes we need to transfer 30 Gigabytes.

On the level of a local district, remote sensing coverages may only be of interest if the resolution is at 1 meter. A single coverage of such a district will represent data quantities of several Gigabytes if we assume that the relevant images have multiple spectral bands.

Another approach may be that the data physically are stored, maintained and backed up at a remote location. In that case the user may need data access within minutes or seconds. Now the high data rates are of interest not only for the reduction in transfer cost, but also because large data quantities can be used interactively without the data being physically at the user's desk.

Table 2 presents the cost of transferring remote sensing images when using today's telephone charges as they apply to ISDN and MAN services in Austria. We also extrapolate these costs into the future when ATM-services will be available. Table 3 summarizes the transfer times. We see that transfer costs and the duration of the transfer vary greatly between ISDN and ATM since we assumed that ATM charges should at one point approximate those for ISDN per second. We need the capabilites of ATM and a willingness of the ATM-provider to be reasonable in the cost issue to make the large scale transfers of remote sensing data feasible at low cost.

			Costs in öS	
Pixel Size (m)	Service	Austria 82.000 sqkm	Province 10.000 sqkm	District 1.000 sqkm
10	ISDN	5,625	624	63
	MAN	5,616	624	62
	ATM	5	1	0
5	ISDN	18,750	2,500	224
	MAN	18,720	2,496	224
	ATM	17	2	0
1	ISDN	562,500	62,500	6,250
	MAN	561,600	62,400	6,240
	ATM	514	57	6

Table 2: Cost in öS for the transfer of typical remote sensing data sets. Assumed is a transfer within Austria across a distance greater than 100 km at current charges of öS 6 per minute for ISDN-services by the PTT in Austria. Commercial MAN service is assumed at 2 MBit/s. This is available in Austria for a monthly base charge of öS 16,500.-- and a load charge of öS 0.78 per MBit. Costs change to öS 57,200.-- for the base charge plus a load charge of öS 0.48/MBit if the rate is at a full 34 MBit/s. Note that for R&D the MAN service is accessible through ACOnet and is "free". ATM-pricing is entirely open at this time. We simply assume that prizes should be related to costs and speculate that under this asumption the rate per time for ATM should be about the same as for ISDN.

		Data Transfer Time in Seconds		
Pixel Size (m)	Service	Austria 82.000 sqkm	Province 10.000 sqkm	District 1.000 sqkm
10	ISDN	56,250	6,248	632
	MAN	3,600	400	40
	ATM	51	6	0
5	ISDN	187,496	25,000	2,248
	MAN	12,000	1,600	144
	ATM	171	23	2
1	ISDN	5,625,000	625,000	61,496
	MAN	360,000	40,000	4,000
	ATM	5,143	571	57

Table 3: Same as Table 2, but presenting transfer times in seconds for remote sensing data sets at the given resolutions, using a single black and white coverage at 1 byte per pixel. ISDN transfer is assumed at 128 kbits per second for the individual user, MAN at 2 MBits per second, ATM at 140 MBit per second.

6. OUTLOOK AND CONCLUSIONS

The Austrian PTT is currently offering a 34 Mbit/sec infrastructure for data transfer in all major provincial capitals. The universities in Austria have 2 MBit/sec access to this service. The access to Internet is via Vienna to Paris at 1 Mbit/sec. The Ministry of Science and Research has entered into an agreement with the PTT for a fixed annual fee to use this infrastructure.

By the end of 1996 the Austrian PTT expects to begin the extension of the 34 Mbit/sec infrastructure to an ATM-based service with much higher data rates. Pricing for this new service will still need to get resolved.

Data transfer reqirements in remote sensing may differ among users by the size of the geographic area of interest and by the responsibility as well as the type of data processed for a specific application. We find that the largest use of remote sensing data may occur if applications penetrate to the local government levels. At that time data may be useful at a rate of perhaps 1 GByte per week. The time of about 17 hours it will take to transfer such data quantities to each town may be acceptable if done by ISDN; however, the cost may not be acceptable. The way to bring costs down is of course the installation of an ATM service at prices for the user commensurate with the costs of such service. It will be a central issue in the future to insure that pricing for data transfer services are structured favorably for the applications in remote sensing.

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Panel 1, session D: "European Information System Initiatives"

"Hyper-G: A Distributed Hypermedia System of the Second Generation"

K.Andrews, F.Kappe, H.Maurer, K.Schmaranz

IICM, Graz University of Technology, Austria

fkappe@iicm.tu-graz.ac.at

ɜtract

In this paper we claim that the navigational and structural tools currently available on the Internet are not sufficient to fully exploit the tremendous power of the largest information and communication ressource mankind has ever had. We contend that current hypermedia systems and its most prominent specimen WWW do not have enough functionality to provide the power that is needed. We explain important features that are absent, claim that "second generation" hypermedia systems incorporating such features are essential and mention a first such second generation hypermedia system called Hyper-G, which is just becoming available and is starting to be used for a wide variety of applications.

1. Introduction

ɜ steady growth of the Internet [Fenn et al 1994] has made resource discovery and structuring tools increasingly important. Historically first was the introduction of various dictionary servers, Archie [Deutsch 1992] being probably the first and most prominent. As an alternative to having servers that need constant updating, WAIS [Kahle et all 1992] introduced a powerful search engine permitting full-text searches of large data-bases and returning a ranked list, the ranking based on a heuristic approach. Although directory servers like Archie (to locate a database) and search engines like WAIS (to locate a desired item in that database) alleviated the problem of finding information in the Internet somewhat, it soon became apparent that other techniques would also be necessary.

The most important such technique is to emphasise the a-priori organisation of information, rather than try to search for information in a universe of completely different databases. Two efforts in this direction have proved particulalry successful: Gopher, originally developed at the University of Minnesota [Alberti et al 1992] and the World-Wide Web (WWW, W3, or "The Web" for short) originally developed at CERN in Geneva [Berners-Lee et al 1992].

In both cases information is stored in a simple structured fashion on servers, and can be accessed via clients, with clients available for most major hardware platforms. Over 3000 Gopher and WWW servers are currently reachable in the Interent, albeit most of them with little more than token presentation of the institution running the server. There are some very notable exceptions, however. Examples of substantial Gopher and WWW databases include the EARN ("European Academic & Research Network") Gopher server (gopher.earn.net), the ACM Siggraph Gopher server (siggraph.org), he CERN WWW Server - the birthplace of WWW (http://www.cern.ch), MUSE - a Hypermedia Journal from the Johns Hopkins University (http://muse.mse.jhu.edu), Nando ("News and Observer") News net (http://www.nando.net), and The Canadian Internet Handbook WWW Server (http://www.csi.nb.ca/handbook/handbook.html).

Information in Gopher is structured in a hierarchical fashion using menus, an access technique which, though simple to use, has many well-known weaknesses. Information in WWW is structured in documents; documents are linked together according to the hypertext-paradigm (see [Conklin 1987], [Tomek et all 1991] and [Koegel-Buford 1994] for a general and thorough discussion of hypertext and hyperemdia). "Anchors" within documents are associated with "links" leading to other documents. Although many stand-alone systems using the hypertext-metaphor have emerged since the introduction of HyperCard on the Mac in 1987, WWW can claim to be the first wide-spread hypertext system whose component servers are accessible via the Internet. Indeed, WWW is not just a hypertext system but a hypermedia system, i.e. documents can comprise text, image, and audio and film clips.

WWW servers are easy to install and clients are available on all major platforms. All software is free and sources are available. The node-link technique for navigating and finding information is quite appealing at least for small to medium amounts of data, and the mix of media makes the use of WWW aesthetically pleasing. All this has contributed to the proliferation of WWW, recently overtaking Gopher in terms of number of installed servers. Indeed there is no doubt that WWW is not only the first widespread hypermedia system available through the Internet, but that WWW has actually replaced some earlier more traditional information systems. The success of WWW, the number of WWW proponents and freaks, and its publicity even in non-scientific publications like Time magazine may create the impression that WWW is the solution for most information needs and will remain the dominating system for the forseeable future.

The reality is different, however. Whilst WWW is undoubtedly a big step forward compared to pre-WWW times, experience shows that much functionality required for sizeable applications is missing from WWW. In this sense, WWW should be considered a first generation networked hypermedia system. More advanced "second generation" hypermedia systems are required to cope with the problems currently being encountered on the Web. Just to give one example, while pure node-link navigation is satisfactory in small systems it tends to lead to confusion and disorientation, if not chaos, when applied to large ounts of data [Conklin 1987]. For substantial applications, some additional structuring and searching facilities are clearly required. That links may actually be more harmful than useful has been already pointed out in [Van Dam 1988] and elaborated in [Maurer et al 1994]. Similarly, the necessity to keep links separate from rather than embedded in documents as is the case in WWW has already been demonstrated in the pioneering work on Intermedia at Brown University [Haan et all 1992].

In Section 2, we concentrate on features we find desirable in second generation hypermedia information systems. We compare the features found in the first generation hypermedia system WWW with those found in what might be the first second generation hypermedia system, Hyper-G. This is not to belittle WWW or to glorify Hyper-G, but rather to clarify why certain facilities are needed. In Section 3, we briefly look at communicational and cooperational features that will have to be integrated in hypermedia systems if they are to be successful: such atures are currently scarcely supported by any hypermedia system, they are often dealt with in the context of computer supported cooperative work, rather than hypermedia. In Section 4 we look in a little more detail at Hyper-G: it provides a smooth transition from WWW and hence from the first generation to the second, its increased functionality supporting a range of new applications.

2. Hypermedia Information Systems: Why First Generation Features are not Enough

In this section we explain some of the properties of first generation hypermedia systems, using WWW as the most prominent example. We contrast them with those of Hyper-G, the first second generation model. We confine attention to networked hypermedia systems with a client/server architecture.

Information in a hypermedia system is usually stored in "chunks". Chunks consist of individual documents which may themselves consist of various types of "media". Typically, a document may be a piece of text containing a picture. Each document may contain links leading to (parts of) other documents in the same or in different chunks. Typical hypertext navigation through the information space is based on these links: the user follows a sequence of links until all relevant information has hopefully been encountered.

In WWW, a chunk consists of a single document. Documents consist of textual information and may include pictures and the (source) anchors of links. Pictures and links are an integral part of the document. Pictures are thus placed in fixed locations within the text ("inline images"). Anchors can be attached to textual information and inline images, but not to parts of images. Links may lead to audio or video clips which can be activated. The textual component of a document is stored in so-called HTML format, a derivative of SGML.

In Hyper-G the setting is considerably more general: chunks, called "clusters" in Hyper-G terminology consist of a number of documents. A typical cluster may, for example, consist of five documents: a piece of text (potentially with inline images), a second piece of text (for example in another language, or a different version of the same text, or an entirley different text), a third piece of text (the same text in a third language perhaps), an image and a film clip. Anchors can be attached to textual information, to parts of images, and even to regions in a film clip. Links are not part of the document but are stored in a separate database. They are both typed and bidirectional: they can be followed forward (as in WWW) but also backwards. The textual component of a document is usually stored in so-called HTF format, also a derivative of SGML, but can also be stored as a PostScript file.

The support for multiple pieces of text within a cluster allows Hyper-G to handle multiple languages in a very natural way. It also elegantly handles the case where a document comes in two versions: a more technical (or advanced) one and one more suitable for the novice reader. As indicated, pictures can be treated as inline images or as separate documents. Often, inline images are convenient, since the "author" can define where the user will find a picture in relation to the text. On the other hand, with screen resolution varying tremenduously, the rescaling of inline images may pose a problem: if a picture is treated as separate document, however, it appears in a separate window, can be manipulated (shifted, put in the background, kept on-screen while continuing with other information, etc.) independent of the textual portion (which in itself can be manipulated by for example narrowing or widening its window). Thus ,the potential to deal with textual and pictorial information separately provides more flexibility when required. As has been mentioned,text can be stored in Hyper-G not only in HTF, but also in PostScript format. Since most printers are geared towards printing PostScript files, almost all word processing packages are capable of producing PostScript files as output: thus, all word processing packages can be used to prepare data for Hyper-G using this approach. Also, PostScript files allow the incorporation of pictures and formulae; they offer the user the possibility to view documents exactly as if they were printed iven high enough resolution screens), and such Hyper-G documents can be printed with the usual professional PostScript quality. For one of the major applications of Hyper-G, the Journal of Universal Computer Science (see Section 4), a full-text search engine has been implemented for PostScript files as well as full hyperlinking facilities. The use of standard compression techniques allows the PostScript files to be compacted to about the same size as equivalent HTF and HTML files. Thus, the use of PostScript with high-quality PostScript viewers built into the native Hyper-G clients Amadeus and Harmony (for MS-Windows and X Windows respectively), gives Hyper-G the necessary professionalism for high quality electronic publishing of journals, books, and manuals.

In addition to the "usual" types of documents found in any modern hypermedia system, Hyper-G also supports 3D objects and scenes. The native X Windows client for Hyper-G (Harmony) provides four different ways to navigate within such 3D models. Finally, Hyper-G allows the e of documents of a "generic" type. This permits future extensions and the encapsulation of documents otherwise incompatible with Hyper-G.

Let us now turn to the discussion of the philosophy of links in WWW versus Hyper-G. The ability to attach links to parts of a picture is clearly desirable, when additional information is to be associated with certain sub-areas of an image. That links are bidirectional and not embedded in the document has a number of very important consequences: first, links relating to a document can be modified without necessarily having access rights to the document itself. Thus, private links and a certain amount of customisation are possible; second, when viewing a document it is possible to find all documents refering to the current one. This is not only a desirable feature as such, but is of crucial importance for being able to maintain the database. After all, when a document is deleted or modified, all documents refering to it may have to be modified to avoid the "dangling link syndrome", or to avoid being directed to completely irrelevant documents. Hyper-G offers the possibilty of automatically notifying the owner of a document that some of the documents that are being refered to have been changed or deleted, an important step to "automatic link maintainance". Thirdly, the bidirectionality of the links allows the graphic display of a "local map" showing the current document and all documents pointing to it and being pointed at, an arbitrary number of levels deep. Harmony makes full use of this fact and provides local maps as an invaluable navigational aid that cannot be made available for WWW databases ([Andrews et al 1994], [Fenn et al 1994]). Finally, the fact that links can have types can be used to show to the user that a link just leads to a footnote, or to a picure, to a film clip, or is a counter- or supporting argument of some claim at issue: typed links enhance the perception of how things are related and can be used as tool for discussions and collaborative work.

Navigation in WWW is performed solely using the hypertext paradigm of anchors and links. It has become a well accepted fact that structuring large amounts of data using only hyperlinks such that users don't get "lost in hyperspace" is difficult to say the least. WWW databases are large, flat networks of chunks of data and resemble more an impenetrable maze than well-structured information. Indeed every WWW database acknowledges this fact tacitly, by preparing pages that look like menus in a hierarchically structured database: items are listed in an orderly fashion, each with an anchor leading to a subchapter (subdirectory). If links in WWW had types, such links could be distiguished from others. But as it is, all links look the same: whether they are "continue" links, "hierarchical" links, "referential" links, "footnote links", or whatever else.

In Hyper-G not only can have links a type, links are by no means the only way to access information. Clusters of documents can be grouped into collections, and collections again into collections in a pseudo-hierachical fashion. We use the term "pseudo-hierarchical" since ,technically speaking, the collection structure is not a tree, but a DAG. I.e., one collection can have more than one parent: an impressionist picture X may belong to the collection "Impressionist Art", as well as to the collection "Pictures by Manet", as well as to the collection "Museum of Modern Art". The collection "hierarchy" is a powerful way of introducing structure into the database. Indeed many links can be avoided this way [Maurer et al 1994], making the system much more transparent for the user and allowing a more modular approach to systems creation and maintainance. Collections, clusters and documents have titles and attributes. These may be used in Boolean queries to find documents of current interest. Finally, Hyper-G provides sophistacted full-text search facilities. Most importantly, the scope of any of such searches can be defined to be the union of arbitrary collections, even if the collections reside on different servers. (We will return to this important aspect of Hyper-G as a distributed database below).

Note that some WWW applications also permit full-text searches. However, no full-text search engine is built into WWW. Thus, the functionality of full text search is bolted "on top" of WWW: adding functionality on top of WWW leads to the "Balkanisation", the fragmentation of WWW, since different sites will implement missing functionality in different ways. Thus, to stick to the example of the ll text search engine, the fuzzy search employed by organisation X may yield entirley different results from the fuzzy search employed by organisation Y, much to the bewilderment of users. Actually, the situation concerning searches in WWW is even more serious: since documents in WWW don't have attributes, no search is possible on such attributes; even if such a search or a full text search is artificially implemented, it is not possible to allow users to define the scope for the search, due to the lack of structure in the WWW database. Hence full-text searches in WWW always work in a fixed, designated part of the WWW database residing on one particular server.

As was mentioned before over 3000 WWW servers are currently installed, and are accessible via the Internet. However, there is no coherence bewtween the servers: if a user wants to search for an item in a number of WWW servers the user has to initiate a new search for each server. This problem is compounded by the fact that WWW knows only two types of access rights: everything allowed (webmaster) or read-only access. Neither are there shades in between, nor is it possible to allow certain users to edit some parts of a WWW server, other users to edit other parts.

In contrast Hyper-G provides various types of access rights and the definition of arbitrarily overlapping user groups. Hyper-G is also a genuine distributed database: servers (independent of geographical location) can be grouped into collections, with the hyperroot at the very "top". Thus, users can define the scope of searches by defining arbitrary sets of collections on arbitary servers. Different groups can work with the same server without fear of interfering with someone else's data. To be more concrete, suppose 10 departments within a university intend to operate a WWW database. If they operate one server together and if all want to input their own data, the data of department X is not protected from any kind of access or change by department Y! Hence the tendency would be to operate 10 different servers. (Indeed, there are many more WWW servers than there are server sites, clearly demonstrating this phenomenon.) However, if the 10 departments operate 10 different servers and a user from outside wants to look up a person without knowing the department, the user is forced to query all of the servers, one after the other.

Hyper-G, being a distributed database with well-defined access rights of fine granularity, offers a much more satisfactory solution: the 10 departments operate a single server, different users have different access rights: not only can department X not influence the information of department Y, certain parts of the database may have even their read access restricted to certain groups or even to single individuals ("private collections"). Hyper-G may be used anonymously, but if users identify themselves they will automatically be shown their "home collection", where they have collected the information most important for them, and from where they can enter all those parts of the database to which access is permitted for them. Continuing the earlier example, suppose an outside user looks for a certain person. Accessing the single Hyper-G server operated by the 10 departments with a full-text search will find the information, assuming it is present. However, suppose the departments insist on each operating their own Hyper-G server: by simply defining a collection "servers of this university", a single Hyper-G search will still examine all of the 10 databases (assuming they are in a LAN or on the Internet). Even now, the servers offer possibilities not available without proper access control: members of the departments may keep some information just for themselves, or for a group they collaborate with, etc.

If one has access to a local Hyper-G server, all accesses to other Hyper-G servers, but also WWW, Gopher and WAIS sites are routed through the local Hyper-G server. Documents retrieved once are automatically cached (for all users of that server), so they will no longer be retrieved from the remote database next time around. Using the separate link database, it can be assured that new versions of a cached document are automatically retrieved when a request for accessing the document is issued. Although recent WWW servers also support caching, the consistency of cached documents cannot be guaranteed. As we will discuss in Section 4, caching in Hyper-G applies equally to documents from non-Hyper-G servers. Hence, using a local Hyper-G server may be quite valuable, even if that server is used for nothing much beyond caching!

The acceptance of a hypermedia system is certainly not only dependent on deep technical features, but above all on the information content and the ease of use. Due to the fact that large hypermedia systems tend to lead to disorientation, second generation hypermedia systems have to try very hard, both at the server and at the client end, to help users with navigational tools. Some navigational tools, like the structuring and search facilities have already been described; others, such as maps, history lists, specific and personal collections can also be of great help and are available in Hyper-G; a particular speciality of the Harmony client (assuming an OpenGL environment) is a 3D browser: the "information landscape" depicts collections and documents (according to their size) as blocks of varying size spread out across a three-dimensional landscape, over which the user is able to fly.

3. Hypermedia for Communication and Collaboration

First generation hypermedia systems like WWW have traditionally been seen mainly as (simple) information systems. Most applications currently visible support this view: very often WWW servers offer some pleasantly designed general information on the server-institution, but only rarely does the information go much deeper. If it does, usually a "hybrid" system is used, WWW with some add-ons using the scripting interface of WWW.

It is our belief that hypermedia systems acting as simple information systems, where someone inputs information to be read by other users, do not offer much potential: they will disappear into obscurity sooner rather than later. To ensure the success of a hypermedia system, it must allow users also to act as authors, allow them to change the database, create new entries for themselves or other users, create a personal view of the database as they need it, and, above all, allow the system to be used also for communication and cooperation.

First generation hypermedia systems like WWW almost entirly lack support for such features. Emerging second generation hypermedia systems are bound to incorporate more and more features of the kind mentioned; Hyper-G provides a start.

The native Hyper-G clients Amadeus and Harmony are designed to allow the easy import of data into the server. (Note: At the time of writing not all functions desirable are available yet. They will be by the end of 1994). They are also designed to allow point-and-click link generation: select the source anchor location with a mouse-click, select the destination anchor with a mouse-click and confirm that a link should be created.

Hyper-G supports annotations (with user-definable access rights): in contrast to some WWW clients which also allow annotations which are then kept locally, Hyper-G annotations become part of the database, i.e. are also available when working with other clients, or from another user account or machine. Annotations can themselves be annotated; the network of annotations can be graphically displayed using the local map function of Harmony. Thus, the annotation mechanism can be used as the basis of (asynchronuous) computer-conferencing, and has been sucessfully employed in this fashion. The client-server protocol in WWW is "static" in the sense that the server can only react to requests by the client, but cannot become active itself. In Hyper-G the client-server protocol is "active" in the sense that the server can contact the client: this can be used for example to send update notification to a client, and provides the first (rudimentary) possibillities for client-client communication for synchronuous communication, conferencing and cooperation.

We believe that many of the features discussed in the area of computer supported cooperative work [Dewan 1993] will eventually be incorporated into second generation hypermedia systems. This approach is also planned for Hyper-G, but will not be fully supported for some time yet.

Some of the most widely used functions of the Internet are file transfer (FTP) and electronic mail. Hence, second generation hypermedia systems have to support both FTP and particularly email. Without leaving their hypermedia environment, users must be able to edit, send, and receive email. Email should automatically be presorted by criteria such as subject, author, date, etc. Related pieces of email can be linked together, the local map feature presenting a good graphical overview of the flow of the email discussion pertaining to a certain subject. The hypermedia system should also have the possibility to send mail with delays or on certain dates to act as reminder and as an active personal scheduler. A number of relevant ideas are collected in [Kappe et al 1993b] and are currently under implementation for Hyper-G.

4. Hyper-G: A Smooth Transition from First to Second Generation Hypermedia Systems

As has become clear from the above discussion, first generation hypermedia systems such as WWW do not have enough functionality to serve as a solid and unified basis for substantial multi-user information systems with a strong communicational component.

Hyper-G is a first attempt to offer much more basic functionality, yet to continue the path started by WWW and remain fully interoperable with WWW: every WWW client can be used to access every Hyper-G server, albeit occasionally with some loss in functionality; a Hyper-G client may, through a Hyper-G server, access WWW, Gopher, and WAIS servers without any loss of functionality, indeed providing "free" caching as a by-product.

The compatibility of Hyper-G with WWW and Gopher actually goes much further: tools to import complete WWW and Gopher databases into Hyper-G without manual intervention are in preparation. Thus, users of WWW can migrate up to an environment allowing all kinds of searches, access control, etc., without being forced to abandon their current database or their favourite WWW client.

Hyper-G was released in July 1994, and already has substantial following. A slate of further tools to make working with Hyper-G even easier will be completed by the end of 1994.

Hyper-G is the most powerful networked multimedia system currently available, and is free of charge for all educational institutions. The source code of the major clients (with the exception of some proprietory segments) is or will be available for developers.

Due to its functionality, Hyper-G is used for a wide variety of applications:

- As a basis for university information systems (with substantial information content at Graz University of Technology and The Univesity of Auckland, and in experimental use at a number of other universities)

- As an organisation-wide information and communication system (the European Space Agency, ESA, being the largest user sofar)

- As a multimedia infrastructure for museums and exhibitions (MONZ, the new Museum Of New Zealand, the Interactive Information Center in Styria, and the AEIOU project as three major examples)

- As an infrastructure for teleteaching experiments (the University of Auckland in cooperation with NZ Telecom as a first test-site) o As an infrastructure for electronic publishing (with a German publishing consortium including Meyer/Brockhaus/BI/Langenscheidt for reference books, and Springer in connection with the new Journal of Universal Computer Science with a backbone of 65 Hyper-G servers as examples)

o As an infrastructure for the cooperation amongst mathematicians in Germany (as recommended by the "Deutsche Mathematiker Vereinigung")

Whether Hyper-G will ever be as wide-spread as Gopher still is and as WWW has started to be, nobody can know. What is clear, is that time is working against first generation systems and in favour of the increased functionality and universality, of second generation systems. Hyper-G will certainly contribute to and speed up developments in this direction by demonstrating the feasability of new concepts and of a new generation of networked multimedia systems.

More information and software concerning Hyper-G is available by anonymous FTP from "iicm.tu-graz.ac.at" directory "pub/Hyper-G". For more information on J.UCS, send an email with the subject "[info]" or the word "info" as first and only line of your message to "jucs@iicm.tu-graz.ac.at" or look on the above FTP server in directory "pub/JUCS".

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Panel 2, session E: "Networks related to Earth Observation in Europe" and "Earth Observation Providers View"

Paper to be presented by ECMWF
at the EEOS Workshop to be held at ESRIN on 13-15 December 1994

Experience of using pan-European Research Networks within an ESPRIT project

R.M. Dixon, G-R Hoffmann and T. Stanford
European Centre for Medium-Range Weather Forecasts
Shinfield Park, Reading, Berkshire RG2 9AX

D.Dixon@ecmwf.co.uk, G.Hoffmann@ecmwf.co.uk, T.Stanford@ecmwf.co.uk

Abstract

This paper reviews the experience of using the pan-European research networks in order to develop and test parallelized versions of weather and climate models on various MPP platforms as part of the ESPRIT GP-MIMD2 project (P7255).

ECMWF, based in the UK and its GP-MIMD2 Workpackage 6 partners, DKRZ and DWD in Germany, Météo-France and the UK Met. Office used the pan-European research networks to access MPP systems at CERFACS in Toulouse, CERN in Geneva, GMD in Sankt Augustin and Southampton University, and cooperated closely with the network providers in measuring and analysing the network performances of those connections.

This paper will present some of the performance statistics in order to illustrate how the pan-European network performance has been improved during the course of 1994 and how there is still scope for further improvement, both in reliable bandwidth and organisational support. The paper will also attempt to make an assessment of the future use of pan-European research networks once their services have caught up with today's technical possibilities.

Introduction

The GP-MIMD2 ESPRIT P7255 project started in March 1993 with the goal of demonstrating the feasibility of using a European massively parallel supercomputer, the Meiko CS-2, in two different production environments such that remote European scientific users could access the machines and fully exploit the facilities in the same way as local users.

The two CS-2 systems were to be installed at CERN in Geneva, to be used by a large number of High Energy Physics users, and at CERFACS in Toulouse. to be intensively used by a small number of weather and climate centres, the so-called Workpackage 4, which required the migration and production mode running of existing weather and climate models on the CS-2 system installed at CERFACS, and then the development of complete forecasting systems on that system by the remote centres: ECMWF in Reading, UKMO in Bracknell, DKRZ in Hamburg, DWD in Offenbach and Meteo-France in Toulouse.[1]

Between December 1993 and June 1994, both GMD in Sank Augustin and the University of Southampton provided the Workpackage 4 partners with access to MPP platforms for the initial development and testing of the weather and climate models. Since June 1994 the Workpackage 4 partners have been using a CS-2 system at CERFACS to make initial performance tests of the parallelized models. ECMWF also ran some performance tests on the CERN CS-2 system during September 1994.

[1] Annex 1 lists all the organisations involved in the networking part of the GP-MIMD2 project.

Networking Requirements

In order to fulfil the aims of the project within the international networking capacities of the public networks, the Workpackage 4 part of the GP-MIMD2 project was viewed as having four phases, each of approximately 9 months duration:

Initial phase	-	Initial development and testing on local mpp platform
Interim phase	-	Remote development and testing on small scalar CS-2 system with minimal interaction and file transfer
Production phase	-	Remote production running of models on large vector CS-2 system with more intensive interactive use of debugging and performance tools and increased file transfer load
Operational Phase	-	Production mode running of full operational forecasting suites on a very large vector CS-2 system with a need for high speed file transfers

A series of measurements was made in order to determine the average sustained network throughput needed to support an interactive session during the different phases of the project. Then, taking the predicted file transfer load , and assuming two analysts working in parallel for each remote partner, it was possible to calculate the average network load that would be generated by each partner throughout the working day for each phase of the project.

As experience has indicated that a bandwidth of at least 5 times the sustained throughput is required in order to avoid excessive latency or delays during peaks of network utilisation, the required bandwidths needed to support the different phases of the project are summarised below:

Interim Phase (from late 1993)

256 Kbits/s effective bandwidth to each partner

1 Mbits/s bandwidth into CERFACS

Production Phase (from mid-1994)

2 Mbit/s effective bandwidth to each partner

8 Mbit/s bandwidth into CERFACS

Operational Phase (from Mid- 1995)

10 Mbit/s effective bandwidth to each partner

40 Mbit/s bandwidth into CERFACS

Network Connection Status

At the time the GP-MIMD2 project was set up, it was expected that the various EC networking initiatives, especially the ECFRN initiative, would come to fruition in time to provide the high bandwidth connections between the Workpackage 4 partners and CERFACS required during the latter stages of the project. Unfortunately, the delay in the implementation of those initiatives until 1996 meant that it was necessary to pursue the provision of alternative networking solutions during the course of the project.

The first task entailed upgrading the connections of the partners to the national networks as necessary in order to have a minimum 256 kbit/s bandwidth by March 1994 for the Interim phase of the project.

The network connection status by March 1994 was:

DKRZ and DWD had 2 Mbit/s connections to the DFN/WIN network (only 64 kbit/s and 2 Mbit/s connections available from the Deutsche Telekom);

ECMWF had a 256 kbit/s connection to the JANET network;

UKMO had a 64 kbit/s connection to the JANET network;

Southampton University had a 256 kbit/s connection to the JANET network;

Météo-France had a local high speed connection to CERFACS;

CERFACS had a 2 Mbit/s connection to the RENATER network;

GMD had a 2 Mbit/s connection to the DFN/WIN network and a 256 kbit/s connection to the Amsterdam Ebone gateway;

JANET and DFN/WIN were directly connected to the 2 Mbit/s London-Amsterdam-Düsseldorf trunk of the EMPB (European Multi-Protocol Backbone), which formed the pan-European component of EuropaNET;

CERFACS was connected through RENATER to the Ebone European backbone;

There was a temporary gateway between EuropaNET and Ebone in Amsterdam, running at 2 Mbit/s which would continue until 30 June 1994, when Ebone would be reconfigured following the connection of the Nordic countries to EMPB at 2 Mbit/s.

Between March and October 1994, the following major changes have been made which affect the performance of the network connections used by the project :

26 April 1994	Private 256 kbit/s link established between JANET and RENATER;
~1 June 1994	Routers in DFN Dusseldorf gateway were upgraded;
	Southampton University installed a 10 Mbit/s SuperJanet connection;
3 July 1994	The Amsterdam EMPB-Ebone gateway was terminated;
	The 1.5 Mbit/s Amsterdam-CERN link was retained, a new 512 kbit/s gateway installed at CERN and a direct CERN-Paris link established;

~15 July 1994	The UKMO connection to JANET was upgraded to 256 kbit/s.

Annex 2 provides a diagrammatic illustration of the topology of the above network connections as at 4 March 1994 , and Annex 3 the topology as at 1 October 1994 .

Gathering Network Performance Statistics

In order to assess and report the performance of the network connections to the various MPP platforms, since January 1994, network performance statistics were gathered using a common methodology of running periodic round-trip ftp transfer tests to lightly loaded servers using 256 Kbytes data files which are not readily compressible.

The precise methodology used for these tests is :

take timestamp; send 256kB file; take timestamp; receive same file ;
take timestamp; verify length of received file is same as that sent;
calculate line data rate from elapsed times; delete temporary files;

To ensure that tests do not interfere with one another:

there is only one test id defined at each installation;
the tests must handle the case where another test is already running;
the tests should not comprise a significant workload on the servers;

It has also proven to be useful to periodically monitor the network routing to the remote installations.

The validity and correct interpretation of the results has been challenged on occasion by the network operators. However, the results are clearly reproducible and show similar characteristics being maintained on any given route for a long period. The results, using a standard application package, also have the advantage that they are easy to relate to performance of other applications. Measurements more directly reflecting network characteristics - such as packet round-trip delay - are much more difficult to use to predict network behaviour.

Attached as Annex 4 are the performance statistics gathered for the network connections between ECMWF and CERFACS, CERN, GMD and Southampton University during the months of March, May, July and September 1994.

Attached as Annex 5 are the performance statistics gathered for the network connections between DWD and CERFACS, CERN, GMD and Southampton University on one typical day during the week commencing 1st August 1994.

Attached as Annex 6 are the comparative performance statistics gathered for the network connections between both DWD and ECMWF and the remote MPP platforms at CERFACS, CERN, GMD and Southampton University during the week commencing 14 November 1994.

Analysis of Network Performance Statistics

The availability of the network connections was found to be very good, and in most cases where network connections have been down, this was found to be due to local problems at one of the two end-sites concerned.

The following general comments can be made on the statistics:

1. The effective bandwidth within the national networks has remained consistently very satisfactory throughout the working day.

2. The effective bandwidth to CERN has generally been adequate; from GMD it has increased over the reporting period, whereas the ECMWF statistics show a marked deterioration in effective bandwidth over the period, with the diurnal pattern becoming much more marked as it falls well below the 50 kbit/s threshold during the working day.

3. The effective bandwidth to CERFACS from both DWD and ECMWF has been consistently totally inadequate throughout the working day and increasingly inadequate outside of normal working hours.

4. The effective bandwidth to GMD from ECMWF and to Southampton University from DWD has been generally inadequate throughout most of the working day.

Experience has shown that the networking bandwidth needs to remain above 50 Kbit/s in order to be able to support any reasonable service for remote testing and development of the climate and weather models, and that bandwidth is regarded as the minimum bandwidth needed to support the interim phase of Workpackage 4.

Although bandwidths far exceeding this minimum are seen on all connections overnight and at weekends, the diurnal variation of the effective bandwidth, with very slow transfers and long response times during the working day, makes many of the international connections virtually unusable for the applications programmers trying to use the remote MPP systems. This can be seen clearly on the international connections to CERFACS, GMD and Southampton University.

Measurements from all installations revealed significantly consistent disparities between the data rates achieved on sending and receiving data. There are currently no satisfactory explanations for these disparities.

Response of Network Providers

The network providers have made the following comments on the various inconsistencies the performance statistics had revealed:

> A round-trip time of around 200 ms can be expected on the international connections being tested;
>
> Peak throughputs are limited by the protocols employed;

Some nodes are not well tuned for TCP/IP. Those using 4 Kbyte windows will have a maximum throughput of 200 Kbit/s and those using 8 Kbyte windows will have a maximum throughput of 400 Kbit/s;

The diurnal effects of the network throughput will be addressed. It is clear that the international networks are overloaded during the daytime, and the network providers will address any particular bottlenecks;

The reasons why transfer rates in one direction are much greater than those achieved in the other direction are being investigated.

Suggested Improvements to the present pan-European Network Services

The experience of using the various remote MPP systems within the GP-MIMD2 project clearly demonstrated that it becomes impracticable to interactively develop and test programs once the effective bandwidth falls much below 50 kbit/s. The gateways and routers providing the international connections to the national networks need to be upgraded such that the effective bandwidths on international connections remain adequate throughout the working day, as they do within the national networks.

In particular, the experience of trying to remotely access the CS-2 system at CERFACS illustrates the urgent need for a coordinated pan-European high performance networking infrastructure which provides adequate effective bandwidth between the national networks.

Some means of prioritising and restricting international network traffic during the working day would help alleviate the very marked diurnal pattern of the effective network bandwidth. It remains unclear whether networks operating without volume charging can offer adequate service internationally, where communications bandwidth remains very expensive and hence in short supply.

It would be very helpful to have access to an up-to-date status of the pan-European network connections indicating availability, loading and configuration changes.

Future Use of pan-European Networks

ECMWF, in conjunction with meteorological and industrial partners, is considering submitting a proposal for a project under the EU 4th Framework programme. which would require far higher international bandwidths to be available. Some provision of additional international capacity, which would be sufficient for the establishment of a pilot service, is anticipated as part of the 4th Framework infrastructure provision.

At the present time, ECMWF expects that this service will be based on protocols from the DCS/DFS family. The intention is to build a cooperating hierarchy of information servers which can help to use network bandwidth more effectively by anticipating requirements for certain data, and by caching data close to the requester wherever possible.

Summary

The GP-MIMD2 project provided a valuable opportunity to assess the effectiveness of remotely using high performance computer systems across the pan-European research networks, and to address the deficiencies in the performance and services provided by those networks.

The network providers valued the performance analyses made by the GP-MIMD2 partners, as it provided, together with feedback from the High Energy Physics community, the only meaningful information they receive on international networking performance. They were therefore pleased to co-operate with the Workpackage 4 partners and to take the necessary steps to address the performance bottlenecks that were identified.

Much higher bandwidths for international research traffic are expected to become available as part of the developments under the EU 4th Framework programme. ECMWF intends to participate in developing services and techniques which are only feasible with these bandwidths and can use them effectively.

Acknowledgements

The authors wish to thank those colleagues from the WP4 partners, the MPP host installations and the network operators who have cooperated in the provision of these statistics and, in particular, Hans Janssen of DWD for providing the statistics included in Annexes 5 and 6.

Annex 1 Organisations involved in the GP-MIMD2 networking

The GP-MIMD2 Workpackage 4 Partner installations were:

DKRZ	The German Climatic Computing Centre in Hamburg, Germany;
DWD	The German Weather Service in Offenbach, Germany;
ECMWF	The European Centre for Medium Range Weather Forecasts in Reading, UK;
Météo-France	The French Weather Service in Toulouse, France;
UKMO	The UK Meteorological Office in Bracknell, UK.

The locations of the MPP platforms accessed and to which network performance statistics have been gathered were:

CERFACS	The European Centre for Research and Advanced Training in Scientific Computing in Toulouse, France.
CERN	The European Organization for Nuclear Research in Geneva, Switzerland;
GMD	The German National Research Center for Computer Science in Sankt Augustin, Germany;
SUCS	Southampton University Computing Services in Southampton (Soton), UK.

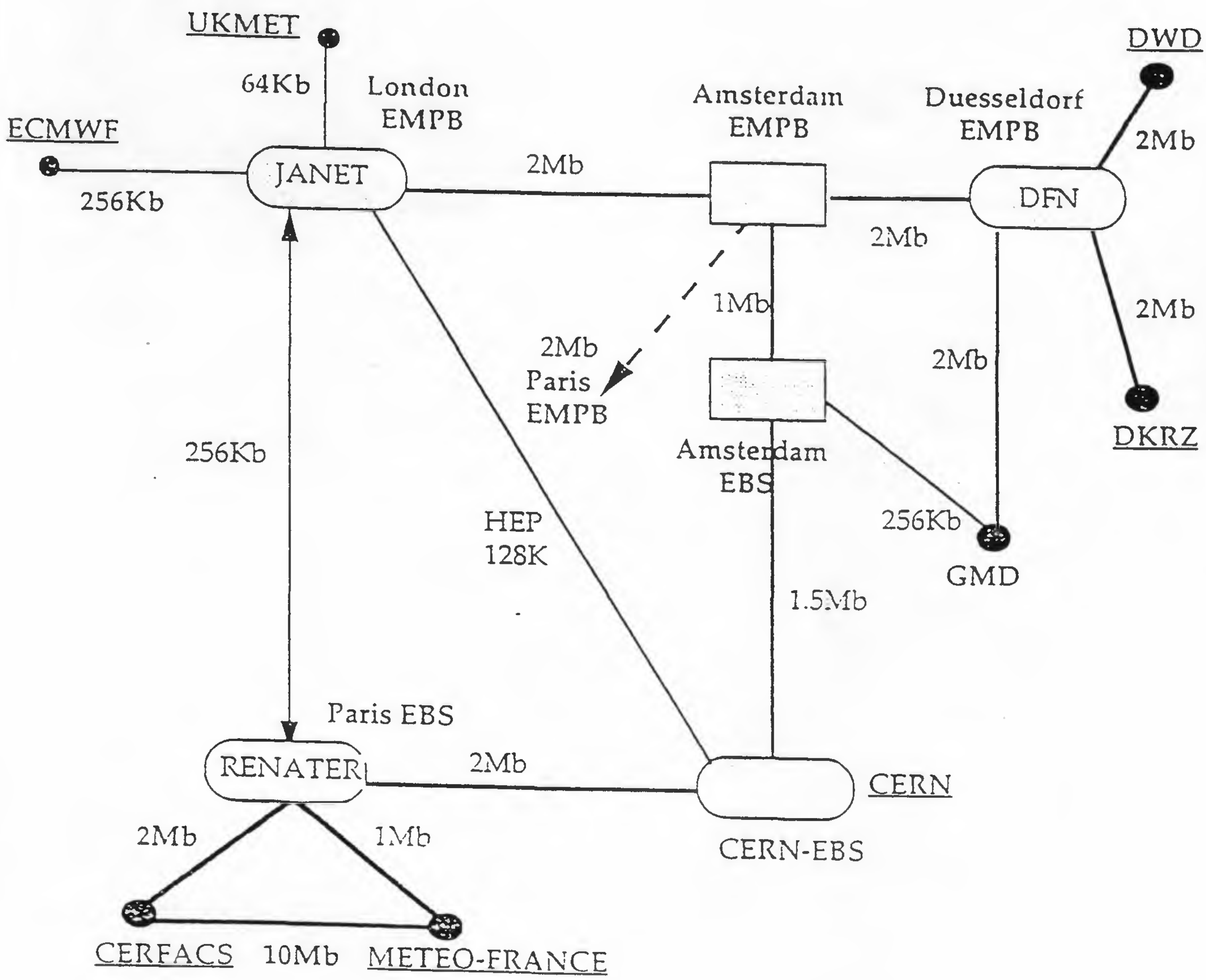
The Network Operators involved in the Project were:

DANTE	Delivery of Advanced Network Technology Ltd based in Cambridge, UK;
DFN/WIN	The German Scientific Research Network
JANET	The UK Joint Academic Network
RENATER	The French National Network for Technology, Education and Research.

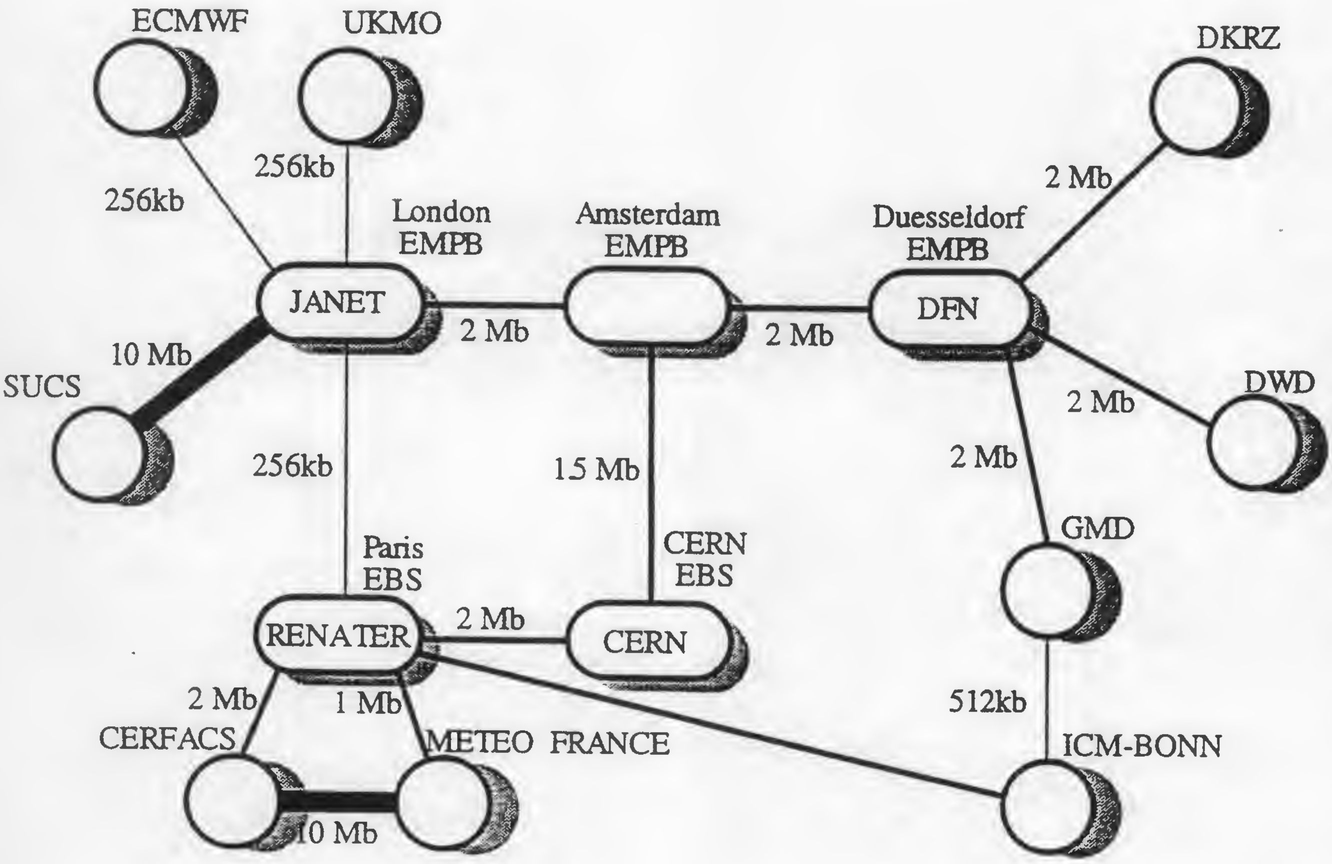
The European backbones used by the project were:

EBS	The European Backbone Services which provides the Ebone backbone
EMPB	The European Multi-Protocol Backbone which forms the pan-European component of EuropaNET

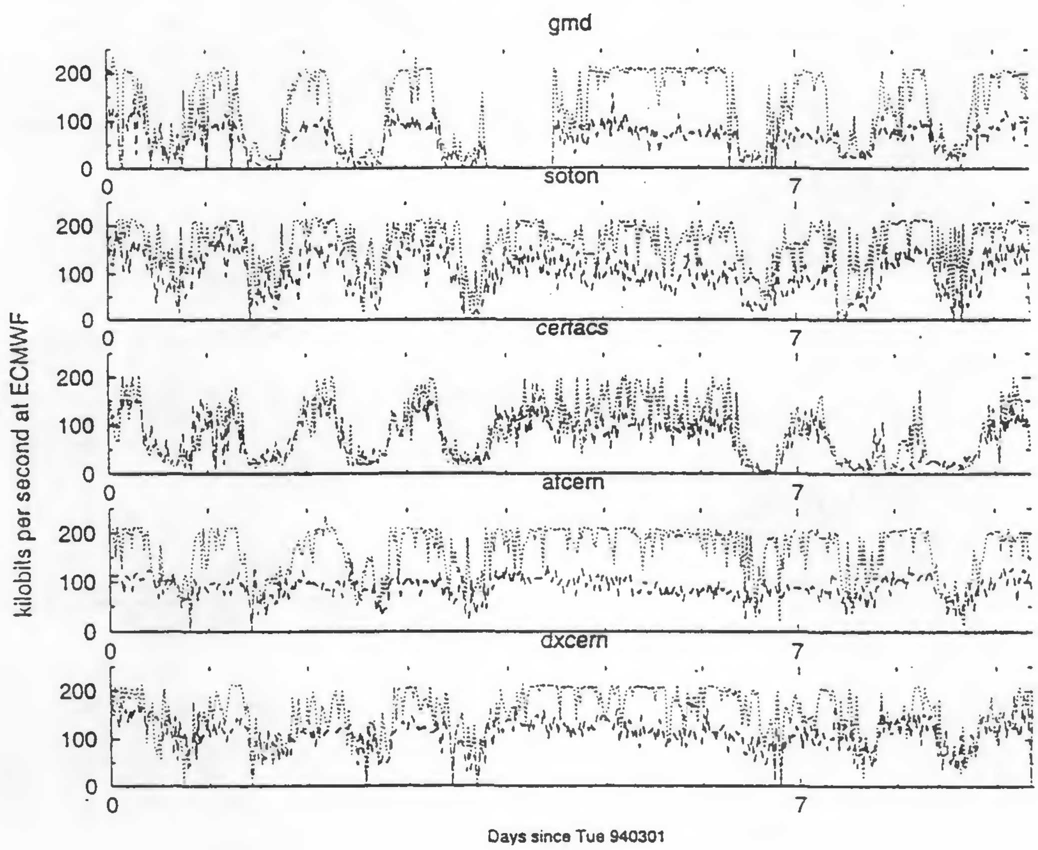
Annex 2 Network Topology available to GP-MIMD2 as at 4 March 1994.

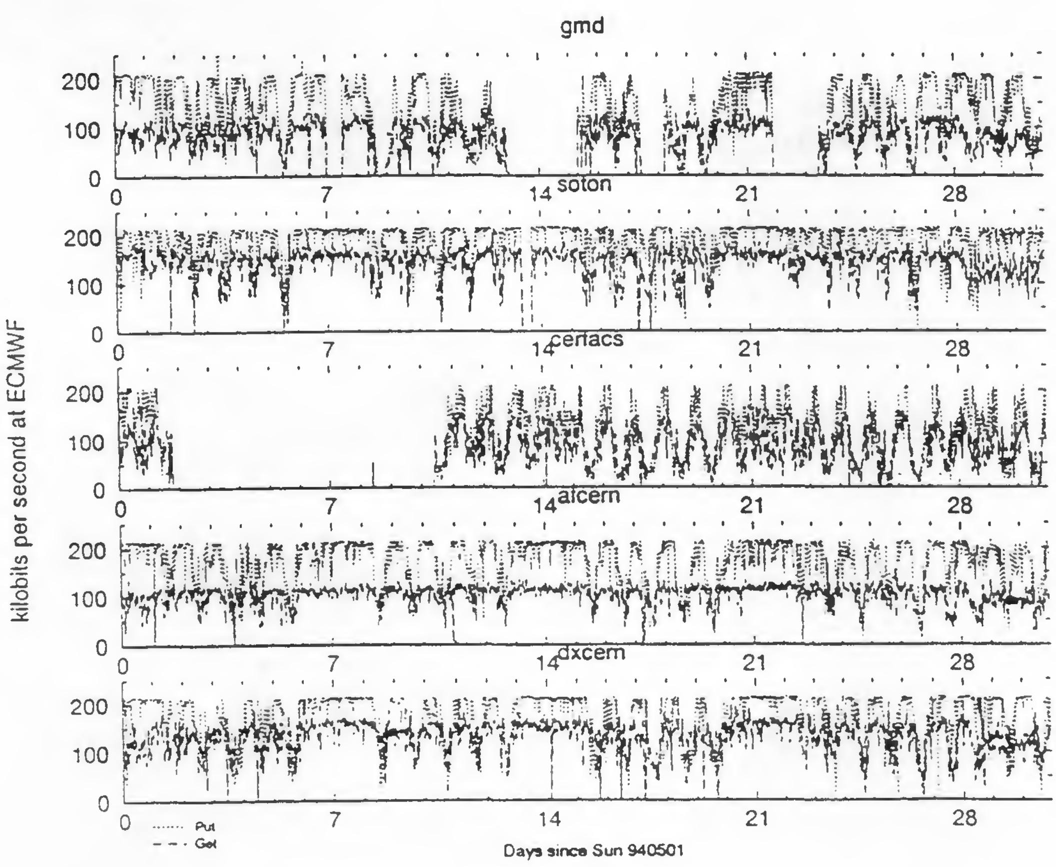


Annex 3 Network Topology available to GP-MIMD2 as at 1 October 1994.

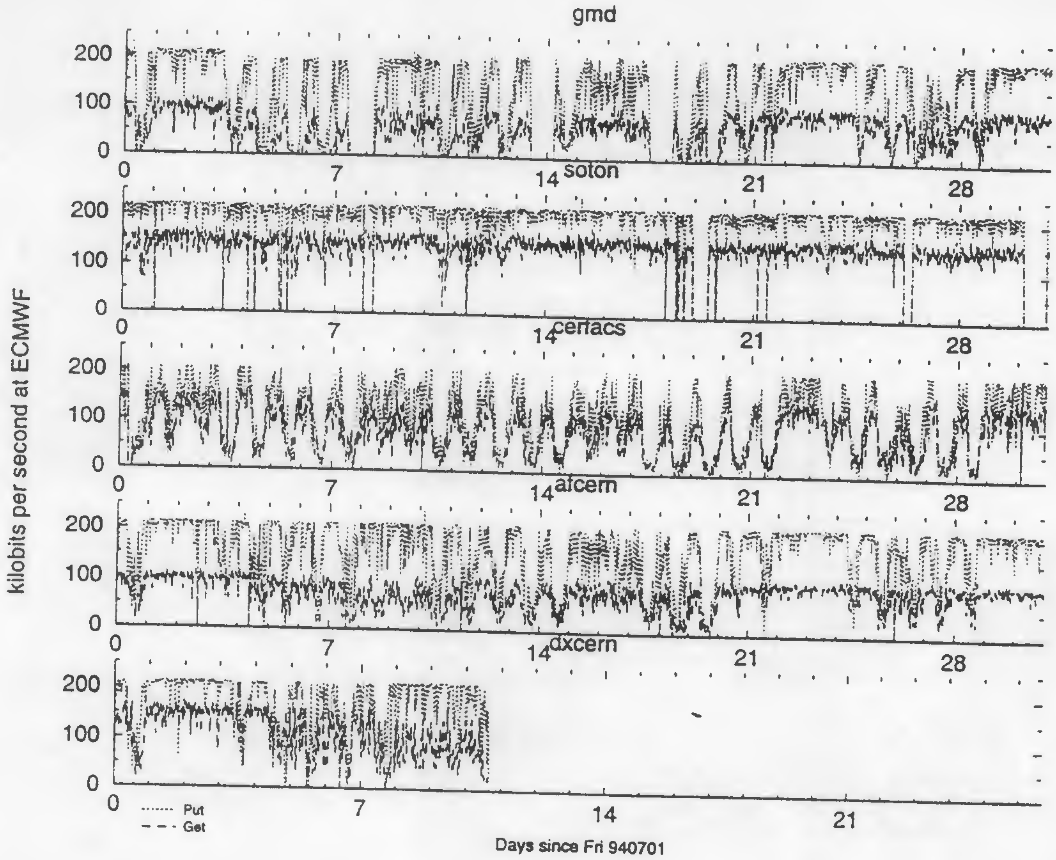


Annex 4 Network Performance Statistics between ECMWF and remote MPP platforms





Page 11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soton
cerfacs
afcern
dxcern
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28
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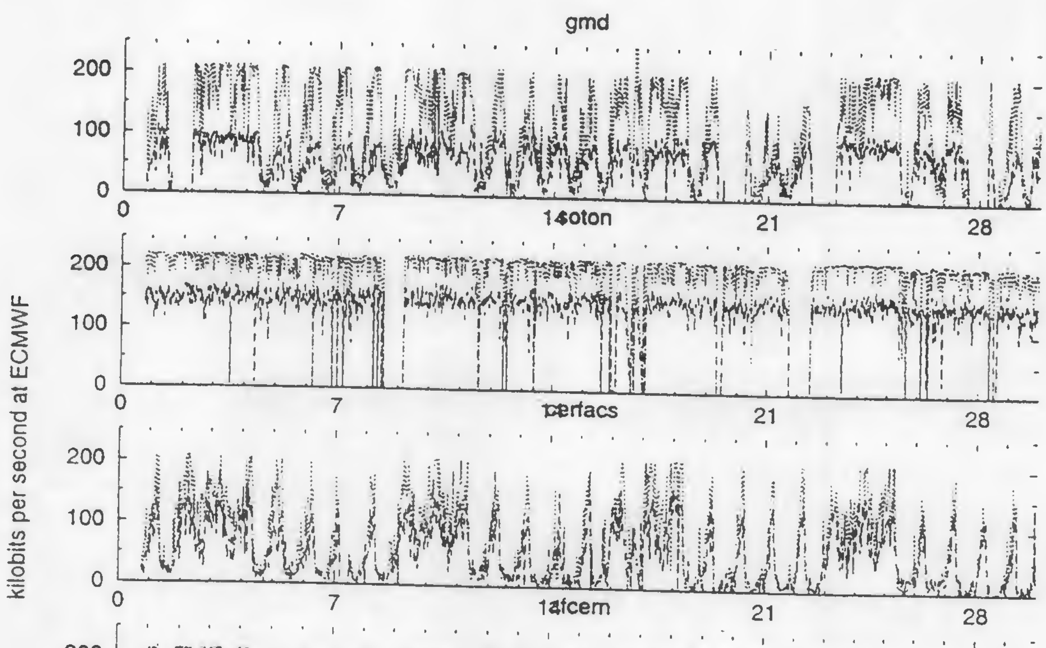
Get
Days since Fri 940701


gmd
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afcern
kilobits per second at ECMWF
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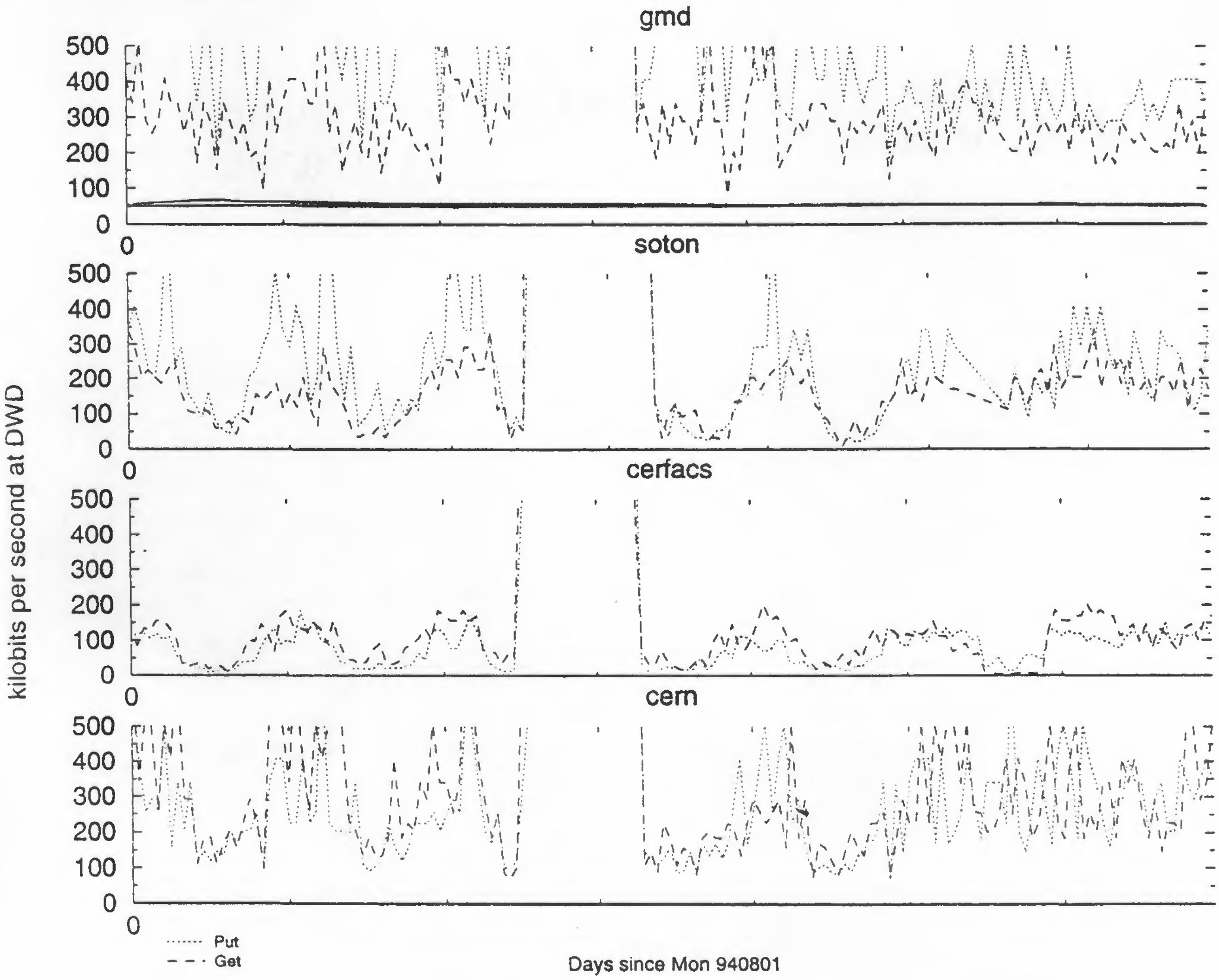
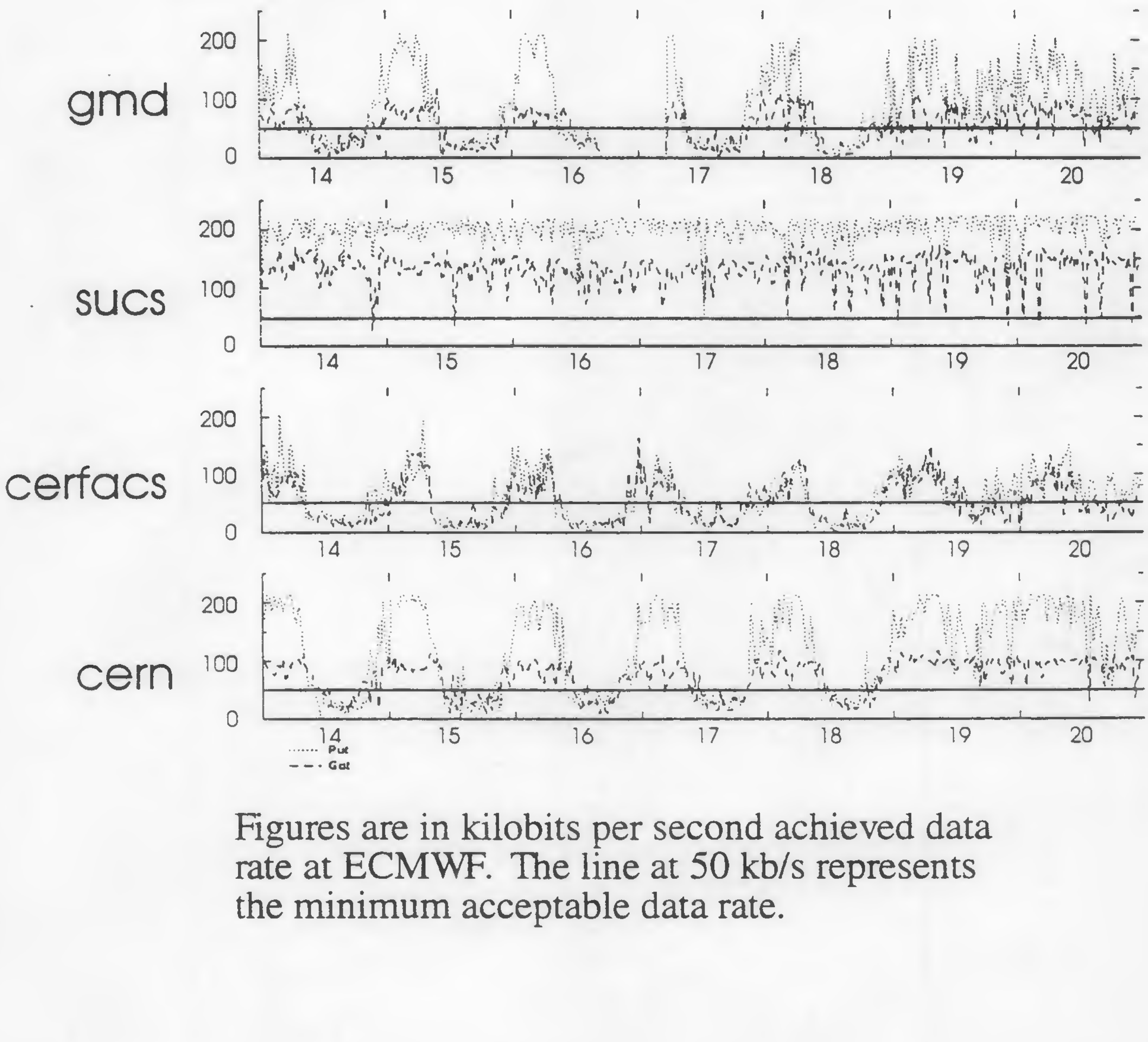
Annex 5 Network Performance Statistics between DWD and remote MPP Platforms during the week commencing 1 August 1994



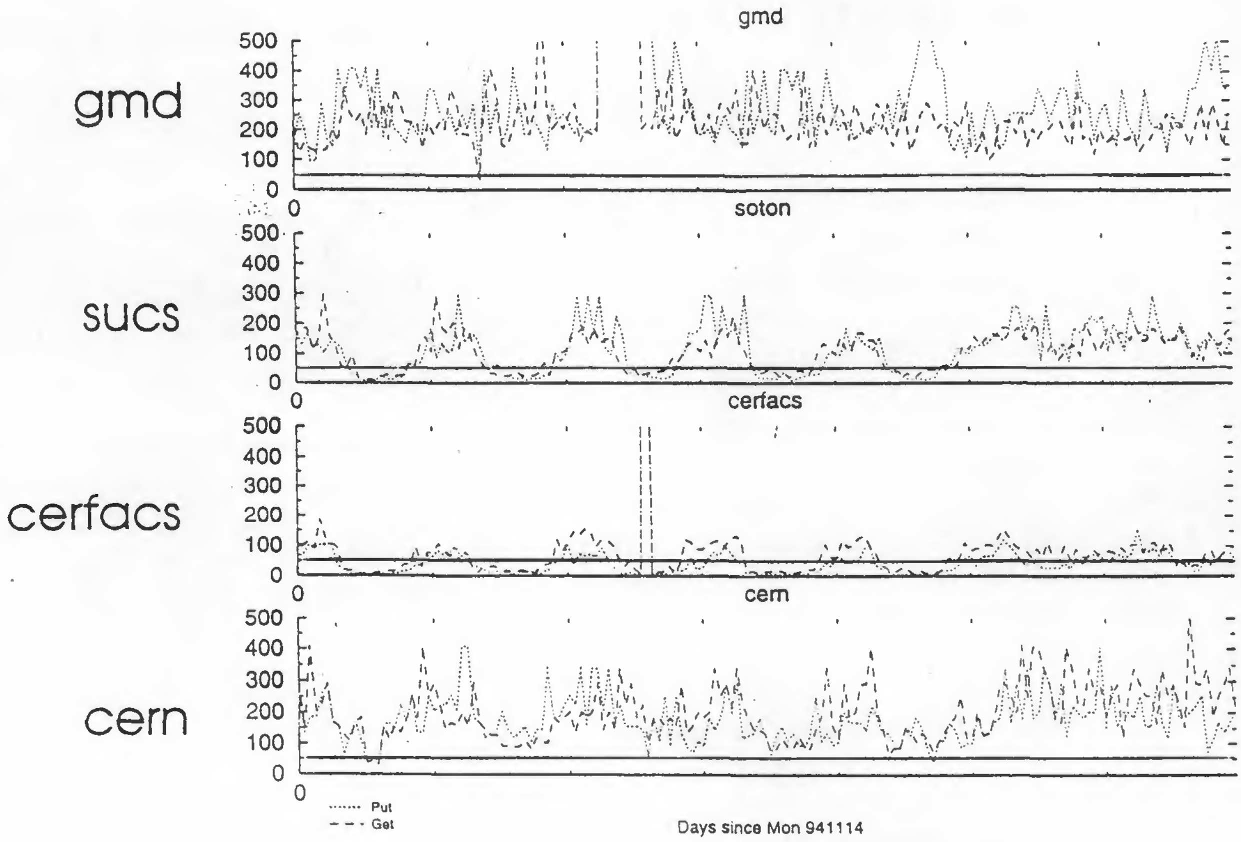
Annex 6 Comparative Network Performance Statistics between DWD and ECMWF and the remote MPP Platforms during the week commencing 14 November 1994

Showing data rates achieved during a sample week, Monday 14th - Sunday 20th November 1994



Figures are in kilobits per second achieved data rate at ECMWF. The line at 50 kb/s represents the minimum acceptable data rate.

Showing data rates achieved during a sample week, Monday 14th - Sunday 20th November 1994



Figures are in kilobits per second achieved data rate at DWD. The line at 50 kb/s represents the minimum acceptable data rate.

EUMETSAT

EUROPEAN DATA NETWORKS AND
EARTH OBSERVATION USER INFORMATION SERVICES
ESRIN, FRASCATI
13-15 December 1994
R. Wolf

EUMETSAT DATA NETWORKS AND USER INFORMATION SERVICES

1. Introduction

In January 1987, EUMETSAT took over responsibility for the continuation of the Meteosat Operational Programme started by ESA. Since then it funds all of the Meteosat activities, although ESA continues to integrate, launch and operate the satellites on behalf of EUMETSAT. Presently METEOSAT operations are performed by ESOC but EUMETSAT will take over all operations from 1 December 1995 onwards.

EUMETSAT also has the responsibility to provide users of the Meteosat system with image data and observational products derived from satellite data and to develop new services. The other main activities of EUMETSAT are the development of future systems of meteorological satellites in both geostationary and polar orbit, and their respective ground segments, to provide for the distribution of data from all the new instruments which will be carried by these satellites, to develop new products and the necessary data processing techniques and, of course, to provide the infrastructure for EUMETSAT.

1.1 The Meteosat Operational Programme (MOP)

The successful series of geostationary satellites has been in operation since 1978 with the pre-operational phase providing Meteosats-1 and 2. The latter satellite, which was still capable of imaging, was removed from geostationary orbit in accordance with our international obligations, in December 1991, after just over 10 years of reliable service. Meteosat-3, a refurbished pre-operational prototype satellite was launched in 1988 to continue this service.

To continue the initial programme the EUMETSAT Member States decided to fund the Meteosat Operational Programme (MOP) which included the manufacture, launch and exploitation of 3 satellites up to the end of 1995. The first satellite in this series was Meteosat-4, which was launched in March 1989, followed by Meteosat-5 in March 1991. Meteosat-6 was launched in November 1993. There are currently one pre-operational satellite (Meteosat-3) and three MOP satellites in orbit: Meteosat-4, originally the primary satellite, because of the deteriorating seasonal image anomaly called "fish", where at its worst, each image is affected by many tens of thousands of short interferences, is now relegated to the role of a standby satellite positioned at around 10°West. As a replacement, Meteosat-5 became the operational satellite early in February 1994, located at 0°W. Meteosat-6 is also located around 10°W, as a standby satellite. This satellite has completed all of its commissioning tests except for the radiometer, because the IR and WV images from the radiometer are periodically affected by a variation in gain of around 5-6%. The anomaly is most likely caused by a combination of a rotating cold optics lens and a damaged support assembly for the radiometer detector cooler, caused by a combination of ageing of the support materials and the launch environment. Radiometer contamination appears to further aggravate the anomaly. As a consequence, further tests will be carried out during the winter months to try to better determine the effects of contamination. In the meantime, we are actively seeking ways of compensating for the anomaly on ground.

This type of activity has already very successfully been carried out by ESOC for Meteosat-5, which also suffers from a different rotating lens anomaly.

1.2 MTP, MSG AND EPS

Looking beyond the first series of MOP satellites, EUMETSAT is developing a second generation series of satellites, Meteosat Second Generation (MSG), which is planned to come into service around the year 2000. To ensure that there is no gap between the MOP satellites and MSG, a Meteosat Transition Programme (MTP) satellite is being fabricated, and which will be launched in the second half of 1997. The MTP satellite will be of similar design to the current series and provide identical services. As an insurance policy against a possible future launch or satellite failure, the requirement and cost of launching a further Meteosat satellite (MOP-4), based on the integration of the MOP satellite spares, is currently being studied.

EUMETSAT is presently planning a polar orbiting meteorological satellite system (EPS) which will be based on the ESA METOP satellite. It is planned that three EPS satellites will be launched and operated by EUMETSAT, commencing around the year 2001. The EPS system will compliment the existing NOAA polar orbiting satellite system by providing the morning platform in addition to NOAA´s afternoon platform.

1.3 The METEOSAT Missions

It may be recalled that the main payload on board Meteosat is a high resolution radiometer which allows continuous imaging of the earth in three spectral bands (visible (VIS), Infra red (IR), and water vapour (WV). A full earth disc is created every 25 minutes. At the end of the 25 minute full earth scan, the radiometer telescope is rotated to its starting position, calibration and stabilisation operations are conducted within the next 5 minutes and earth scanning starts again for the next image. Communication of the raw image data to the ground processing facilities is conducted as each line is scanned, stretched using memory buffering on board the satellite during the time when the satellite is not viewing the earth and then transmitted to the primary ground station at a data rate of 333 kb/sec. Following reception at the Primary Ground Station and processing by the Meteosat Computer System in Darmstadt, image data are immediately transmitted back to the satellite for relay to users with receivers within the field of view (normally up to around 78° great circle arc from the sub-satellite point). The dissemination schedule is designed to ensure that national meteorological services receive regular half hourly imagery in all available spectral channels within a few minutes of being scanned by the radiometer.
The various User services provided by the METEOSAT system are described at the specific section of this document.

1.4 Atlantic Data Coverage

Within the framework of a tripartite agreement with NOAA and ESA, EUMETSAT has been operating Meteosat-3 at 75° West in support of the extended Atlantic Data Coverage (X-ADC) mission. Up to January 1993, the satellite was located at 50° West whilst additional communications facilities were installed at the NOAA ground station in Wallops Island, on the east coast of the USA. A two way data relay between ESOC and NOAA Wallops Island was established to allow the direct communication with the satellite and image data processing from ESOC. Whilst Meteosat-3 is used to support this mission interleaved ADC WEFAX and high resolution images are disseminated on the one functioning dissemination channel (1691 MHz). Once GOES-8 assumes its role as the east satellite, the image data, in the new GVAR format, will be received, as before, at our ground station CMS Lannion, in Brittany, NW France, where the image data will be reformatted for dissemination via Meteosat-5 to the user community.
It may be recalled that 75° is the GOES-east location. GOES-8, the first of a new series of three axis stabilised satellites with advanced imaging and sounding capabilities was successfully launched in April 1994 and is currently in an intensive commissioning phase. Progress of the various tests has been good and, so far, the quality of imagery looks excellent. NOAA hopes to move GOES-8 to the East location at 75° West in February 1995, at which point in time Meteosat-3 will commence a well deserved retirement at a standby location nearby until the launch of GOES-9, currently scheduled for late Spring 1995. Meteosat-3 will have to be de-orbited, to free the geostationary belt of unnecessary hardware clutter, by November 1995 as there will be no further control of this satellite possible by ESOC or EUMETSAT.

1.5 Meteosat Operational Systems for data Acquisition and InterChange (MOSAIC)

Meteosat missions can be combined within a user station to provide a cost effective integrated meteorological data access system. This system is known as Meteosat Operational System for data Acquisition and InterChange (MOSAIC). This enables the combination of satellite imagery, meteorological bulletins from the DCS and a range of conventional meteorological charts, forecasts and other weather bulletins obtained from MDD within a single work station. Various modes of operation are available ranging from the simplest equipment, based on an SDUS front end, to a multi-function powerful PDUS system using digital imagery and which could be connected to other local meteorological data distribution facilities (e.g. GTS message switching system).

1.6 Meteorological Products

Many meteorological parameters are routinely extracted from Meteosat image data. This will, in future, be carried out in the Meteorological Product Extraction Facility which forms part of the new Meteosat ground segment located in Darmstadt. A highly automated system of work stations will be used for the regular production of meteorological information. This is complemented by an interactive man-machine interface by which a meteorologist can monitor and control the quality of the products generated by the automated system.

Most of the meteorological products are converted into standard WMO coded messages and passed along a direct link between Darmstadt and the Regional Telecommunications Hub of the German Weather Service at Offenbach ready for distribution to the world-wide meteorological community over the WMO global transmission system (GTS). These products are also archived on cartridge magnetic tapes in Darmstadt. The Cloud Top Height product is distributed as a map via the Meteosat analogue WEFAX image dissemination system.

In addition to these parameters used in support of operational meteorology, other data are extracted and archived for use in climate studies. The information is stored as a compact summary of results in a reduced resolution format required by the International Satellite Cloud Climatology Project (ISCCP). In this format, one month of data can be provided on a single computer magnetic tape, making it ideal for climate studies of cloud distribution. Bi-dimensional histograms from image data are also prepared for the Global Precipitation Climate Project (GPCP) for the estimation of global precipitation patterns in ocean and data sparse regions of the globe.

1.8 International Cooperation

The Meteosat system present and near future, forms part of a global observing system. Weather satellites continue to play a very important role in the provision of important data to meteorologists around the world. There is currently a system of four geostationary meteorological satellites operated and maintained by the USA, EUMETSAT, India and Japan. Further geostationary satellites are expected to be provided by Russia and China in the coming years. Information from these satellites is complemented by data from the polar orbiters operated by the USA, Russia and China. A credible degree of standardisation of some of the services provided by these satellites has been achieved through the efforts of an international group called the Coordination Group for Meteorological Satellites (CGMS). This Group came into being in 1972 and the current membership includes China, EUMETSAT (with ESA), India, Japan (with NASDA), Russia, USA-NOAA (with NASA), and the WMO. The Charter of CGMS mandates it to address technical problems and developments related to both geostationary and polar orbiting meteorological satellite systems. EUMETSAT currently performs the Secretariat duties for the CGMS. Since its creation, the CGMS has successfully coordinated ideas on basic meteorological satellite design, meteorological satellite radio frequencies, data formats e.g. WEFAX and the new digital equivalent Low Rate Image Transmission (LRIT) which will eventually replace the analogue WEFAX image format and the International Data Collection System (IDCS).

CGMS is currently actively considering the means of ensuring operational continuity and reliability of global coverage by meteorological satellites. In particular, a "help your neighbour" concept is being encouraged. This involves the deployment of spare in-orbit satellites to neighbouring areas in a time of need caused by, for example, the failure of an existing satellite or one of its functions. In this situation, the control of the "loaned" satellite would normally remain with the owner.

2. EUMETSAT Data Networks

2.1 Present Implementation

EUMETSAT policy demands a network approach in the ground segment allowing decentralized facilities in addition to a core ground segment at the Headquarters in Darmstadt (Germany). This is reflected in the presently integrated MTP system and in all future ground segment implementations.

Network management will be performed by the centralized Mission Control Center in Darmstadt.

EUMETSAT presently implements the facilities to operate MTP and MOP satellites. This includes the "Mission Control Center (MCC)" located at the new headquarters building of EUMETSAT in Darmstadt (Germany) and a "Primary Ground Station (PGS)" at TELESPAZIO´s facilities in Fucino (Italy). The "Back-up Ground Station (BGS)" facilities will be made available by Deutsche Telekom and DLR under EUMETSAT contract.

The Primary Ground Station in Fucino (Italy) is connected via two fully redundant 640 kbit/sec high speed data links to the MTP Mission Control Center in Darmstadt. One link is switched via commercial satellite, the other one via standard high speed terrestrial line. These connections are point to point only. The links are used to transmit the raw image data, housekeeping telemetry, data collection platform data and ground station monitor data in direction Fucino to Darmstadt and makes use of the backchannel for image dissemination data for both High Resolution Data Transmissions and WEFAX. The BGS at Weilheim (Germany) is also connected to the MCC via a point to point terrestrial line.

The MCC combines spacecraft and mission control facilities as well as image processing, dissemination, archive and meterological processing facilities.

Meteorological products which are processed at the Meteorological Product Extraction Facility (MPEF) are injected to the Global Telecommunication System (GTS) of the World Meteorological Organisation (WMO) for further distribution. There are plans to make meteorological products also available via INTERNET as part of the MOSAIC system.

METEO France is hosting a facility which receives data from other meteorological satellites (GOES and TIROS) and transmits subsets of these data via METEOSAT as part of the two dissemination missions via METEOSAT spacecraft. The uplink station is located in Lannion (France).

Furthermore there are three MDD uplink stations at Bracknell (UK), Rome (Italy) and Toulouse (France) which transmit data received from the "Global Telecommunication System (GTS)" of the "World Meteorological Organisation (WMO)" and other meteorological information via MOP or MTP spacecraft. The transmission speed is 2400 bit/sec per channel. This service is mainly installed to provide meteorological data to African Users. Present integration, testing and validation activities are scheduled in such a way that the complete system will be ready to take over METEOSAT operations from 1 December 1995.

2.2 Future EUMETSAT Networks

2.2.1 METEOSAT Second Generation

EUMETSAT presently performs an in-house phase B study for the MSG Ground Segment. The results of this study will be used to initialize procurement activities for the future ground segment facilities. It will have to be decided whether existing MTP facilities could be re-used or if totally new facilities have to be procured. The main system architecture of the MSG ground segment is similar to MTP.

In addition to the main system facilities of MSG it is foreseen to install a network of so-called "Satellite Application Facilities (SAF)" which will make use of existing facilities and know-how at meteorological services and other scientific entities. These SAF´s will be supplied with data using EUMETSAT´s data dissemination and direct readout data transmissions and, in some cases, special data connections from the centralized data processing center. Several proposals concerning the tasks of SAF´s are under evaluation with the aim to define a set of SAF´s to be implemented as part of the MSG application ground segment.

Meteorological products generated by the centralized MSG MPEF or by SAF´s will be distributed using the EUMETSAT satellite broadcast capacity and the GTS.

It is also foreseen to make use of other existing data networks (such as INTERNET) to distribute meteorological products derived from EUMETSAT data to specialized user communities.

Network management will be performed by the centralized Mission Control Center.

2.2.2 EUMETSAT Polar System

It is foreseen that EUMETSAT will be responsible for the definition, the development, the procurement and the operations of the EPS Ground Segment. The EPS Ground Segment shall be designed as an operational ground segment answering operational requirements such as meteorological data availability and timeliness.

The EPS Ground Segment will be autonomous with respect to the other European Polar Orbiting Systems ground segments; but not isolated as additional services might be requested from others and as an exchange of science data is foreseen with NOAA, ESA, and emerging systems of the European Union (e.g. CEO). The payload will be in constant and regular operation on a regular orbit and as such the control of the satellite will be simplified during routine operations. The adaptation of the Ground Segment definition to the exact needs of the mission should lead to dedicated functional facilities at reasonable costs. Such systems are already available today for other operational missions like the SPOT mission, despite more complex mission plans, and for the Canadian RADARSAT mission.

The data acquisition concept is based on operational requirements and relies on the utilisation of an on-board tape or solid state recorder combined with a data acquisition station located in northern Europe. The possible use of the Data Relay Satellite (DRS) and the associated impacts on the system architecture has been assessed during the phase A feasibility study. The implementation of the DRS earth facilities is not considered for METOP 1 and 2 in line with the retained satellite configuration.

The EPS Ground Segment will be part of an integrated system of meteorological polar satellites providing users in Europe with data and products from both morning (EPS/METOP) and afternoon

(NOAA) polar orbiting environmental satellites.

The EPS Ground Segment will be responsible for the operation and for the global data acquisition of the EPS/METOP satellite(s) while the NOAA Ground Segment is performing the same functions for the NOAA satellite(s). In addition, the two ground segments will exchange the global data from their respective satellites and will provide each other support for blind orbit data acquisition. The exchange of data between EUMETSAT and NOAA will provide a global earth coverage every six hours. Each ground segment will distribute to its own user communities the global data and products corresponding to both satellites at high data rates of 8 Mbit/sec per data stream.

The EPS Ground Segment will be divided into two parts, the Operation and Control Segment and the Application Segment. The Operation and Control Segment will be responsible for the satellite control and overall mission management, including the raw data acquisition via the Polar Command Data and Acquisition Stations (PCDA S), and the delivery of calibrated and earth located data to the Application Segment. The Application Segment is then responsible for the generation of level 2 and level 3 products, for data and products archiving and for the product distribution to the user community. Different categories of users are considered.

Global data users are defined as European centres running operational Numerical Weather Prediction (NWP) models to produce global forecasts. Centres in Europe currently considered as global data users are: the U.K. Meteorological Office (Bracknell), Deutscher Wetter Dienst (Offenbach), Météo France (Toulouse) and ECMWF (Reading). Developments in other centres may be added to this list within the time-frame of EPS. Regional data users are EUMETSAT Member States' centres who run operational NWP models for regional rather than global areas. There are more users of this type than global data users. The last category comprises the local data users. They are distributed globally and have LRPT and / or HRPT terminals to receive direct broadcast data. The number of HRPT users worldwide is more than 200 and is growing. These users include both major forecast centres and small forecast offices many of whom are subsidiaries of main national centres.

3. Earth Observation User Information Services

3.1 Present EUMETSAT User Services

Since the beginning of METEOSAT operations in the year 1977 User services were supported by the METEOSAT spacecraft.

Presently EUMETSAT is operating the following User Services:

- WEFAX Transmissions
- High Resolution Data Transmissions
- Meteorological Data Distribution (MDD)
- Data Collection Data Retransmission Service
- Meteorological Archive and Retrieval Service

3.1.1 WEFAX Transmissions

WEFAX is a transmission service via the spacecraft transponder using an analogue modulation scheme with a bandwidth of 2400 Hz. The corresponding reception equipment is called "Secondary Data User Station (SDUS).

The WEFAX standard is supported by all meteorological satellite operators which are members of the "Coordination Group of Meteorological Satellites (CGMS)". This service is very popular due to the low costs of user station equipment. In the METEOSAT area there are more than 1200 registered user stations.

The content of WEFAX transmissions are sectors of METEOSAT images in all three spectralbands, sectors of other satellite data, selected weather charts, "Cloud Top Height" products originated in the meteorological product processing facilities (MIEC at ESOC and MPEF in MTP), as well as administrative messages which are used to inform users on operational news.

3.1.2 High Resolution Data Transmission

The "High Resolution Data Transmission" service is using the spacecraft transponder. The corresponding reception equipment is called "Primary Data User Station (PDUS)". Digital modulation is applied, the transmission speed is 166 kbit/sec. Presently there are more than 150 registered PDUS stations operating int the METEOSAT operations area., The digital broadcasts are subject to encryption. Only authorized Users have access to these broadcasts.

3.1.3 Meteorological Data Distribution (MDD)

The Meteorological Data Distribution (MDD) mission is supported by all MOP and MTP satellites. The transponders include capacity for four data transmission channels supporting digital transmissions at a speed of 2400 bit/sec each. MSG will also provide a similar service, but using more advanced telecommunications techniques, which will be described later.

MDD primary objective is to improve the exchange of meteorological information, both graphical and alphanumeric, particularly in Africa where current telecommunications systems are frequently slow and unreliable. The meteorological information is currently transmitted to Meteosat via two up-link stations, one located in Bracknell (United Kingdom) and the other in Rome (Italy). A third uplink station will commence operations at the beginning of 1995, to be located in Toulouse, France, providing a schedule of products specially designed for use by African National Meteorological Services and meteorological data processing Centres such as ACMAD, AGRHYMET, the drought and locust monitoring centres.

The content of MDD transmissions are meteorological observations and forecast data, weather charts and aeronautical data. This service has become very popular within a short time period and serves as the main data source for many african weather services. Presently there are more than 50 MDD User stations installed at National Meteorological Centers and Regional Telecommunication Hubs (of Met. services) mainly in Africa.
MDD transmissions are encrypted and access is only given to Users authorized by EUMETSAT.

3.1.4 Data Collection Platforms and DCP Data Retransmission

Data Collection System (DCS) supports the relay of environmental data from remote observation platforms, via the satellite and the ground station to the user community, through the use of conventional meteorological and other communication lines, or via the satellite, interleaved with WEFAX imagery, directly to suitably modified SDUS stations. Coordination of this system with other operators of geostationary meteorological satellites enables the use of mobile platforms installed, for example, in aircraft, balloons, ships and on floating or moored ocean buoys, for the reporting of environmental data anywhere in the world. This is accomplished using the International

Data Collection System communications facilities provided by the geostationary meteorological satellites of USA and Japan in addition to Meteosat. Furthermore, it is already agreed that future Chinese and Russian geostationary meteorological satellites will support IDCS communications channels. The Meteosat-based DCS is also used to receive weather reports from both manually operated and automatic weather stations located in remote and often inhospitable locations within Africa and the surrounding regions under programmes coordinated by the World Meteorological Organization (WMO).

Nominally DCP reports are distributed via the GTS. A retransmission system for those Users which have no access to the GTS has been introduced. This system makes use of the satellite transponder. A digitally modulated transmission scheme was introduced in time sharing mode with WEFAX transmissions. The transmission speed of 19,2 Kbit/sec allows to transmit all received DCP reports during the time remaining between consecutive WEFAX format transmissions.

3.1.5 Meteorological Archive and Retrieval Service

From 1978 Meteosat images and derived products have been stored at ESOC on computer compatible magnetic media. Standard 6250 bits per inch (bpi) tapes were used until January 1990 when high density cartridge storage was introduced. Individual Meteosat images or image sectors can be retrieved from the archive on computer compatible tape or as high quality black and white photographic prints. Some 27000 tapes have been archived to date. A copy of all archived data will be retained by EUMETSAT at its Darmstadt facility. After take over of the archive from ESOC in 1995 data will be stored on optical discs.

The MARF User Services provide facilities to browse through the MARF product catalogue and to place orders for MARF products.

The MARF products encompass images and associated meteorological products. Digital products may be delivered either on-line using file transfers or off-line using tapes.

External customers are connected either by a Public Data Network (X.25) or by a dial-up modem connection. The customers may be operating on a variety of different platforms, but will all be served by the same standard terminal interface in order to get access to the available MARF functions. The Man Machine Interface will be identical to what is available to local MARF customers.

Following User Services are available to all MARF customers:

- Interactive dialogues
    - Catalogue request and display.
    - Ordering of meteorological image products.
    - Ordering of derived meteorological products.
    - Access to/transfer of account info.
    - Access to mail, read and write.
    - Access to read bulletin board.

- Online transfer of catalogue information:
  - Catalogue queries
  - Despatch notes
  - Bulletin Board Note
  - Account status

- Online transfer of digital products:
  - Images
  - Meteorological products

- Offline transfer of digital products:
  - Images
  - Meteorological products

- Non - electronic reports
  - Order confirmation
  - Invoice
  - Reminder
  - Subscription Renewal Reminder
  - Credit note

In order to create a session and start the User Services process on the MARF, the customers software must support TELNET on TCP/IP based systems. VT220 terminal emulation for customers connecting to the MARF via modems. VT220 terminal emulation is provided by a wide range of third part communication software packages. For file transfers, the customers software must support FTP, KERMIT and compatible products.

For users using TCP/IP, FTP software must conform to RFC 959 and the customers software must support server capabilities for online transfer between MARF and customers via FTP.

For users using modems, the communication software used for normal session dialogue must provide the file transfer protocol KERMIT in order to transfer files from MARF to the customers local workstation/PC. Furthermore the customers line setup must be identical with the configuration of the MARF 's line setup.

3.2 Future EUMETSAT User Services

3.2.1 METEOSAT Second Generation User Services

The MSG missions will be similar to present MOP /MTP missions with the understanding that enhanced imagery will be supported and data communications including DCP will have advanced quantity and quality.

Products derived from the MSG radiometer (SEVIRI) will be produced at the centralised "Meteorological Product Extraction Facility (MPEF)" which will be located at the new EUMETSAT Headquarters and at decentralized "Satellite Application Facilities (SAF)". Products form MPEF and SAF´s will be distributed via the GTS, the MSG satellite and other existing data networks.

Future data broadcasts from MSG will be "High Rate Information Transmission" at a speed of 1 Mbit/sec and "Low Rate Information Transmission" at a speed of 128 kBit/sec. Both broadcasts could be encrypted and only available to authorized Users. The broadcasts will include image data, data from Data Collection Platforms and meteorological products. Data will be merged in a packetized data stream based on CCSDS standards.

The corresponding User stations will be called "High Resolution User Station (HRUS)" and "Low Resolution User Station (LRUS)".

The information distributed via the two broadcast services will include imaging data from MSG, selected imagery from other meteorological satellites, meteorological products, Data Collection Platform data, calibration and administrative information. The data are distributed in specialized packages. HRIT and LRIT include present MDD and DCPRS services as well as WEFAX and present High Resolution Data Transmissions.

The Meteorological Archive and Retrieval Facility will provide a follow on service to the present MARF. Present data formats and catalogue data are specific to METEOSAT. For the future it is foreseen to adopt international standards (such as CEOS, CCSDS) for data and catalogue information which will allow to exchange data with other archives and to provide data via international networks. Part of the data exchange on networks will be the provision of meteorological products. It is expected that data from other agencies will be made available in exchange.

3.2.2 EPS User Services

EPS will support two digital direct readout broadcasts , "High Rate Picture Transmission (HRPT)" and "Low Rate Image Transmission (LRPT) similar to broadcasts of US NOAA spacecraft. The data formats used for HRPT and LRPT are or will be coordinated by CGMS . They will use the same basic structure as HRIT and LRIT on geostationary spacecraft.

The EPS application segment performs all the functions related to the generation of the level 2 and level 3 products, to the maintenance of the archive for all data and products; and interfaces with the user community. The Application segment functional breakdown is based on a network concept for meteorological processing with a central node located in the EUMETSAT Headquarters. The decentralisation leads to the establishment of centres of excellence. These centres may be housed in the National Meteorological Service of EUMETSAT Member States. In the terminology of the EPS Ground Segment, these centres of excellence are named Satellite Application Facilities (SAF).

A centrally located Polar Product Extraction Facility (PPEF) will generate key (To be decided) level 2 and level 3 meteorological products for general distribution. The PPEF will distribute and guarantee the availability of all required auxiliary data required by all product generation facilities inside the Application segment.

Several centres (SAF) will be established in EUMETSAT member states, each one dealing with a specific domain of expertise, to provide level 2 meteorological products not generated by the PPEF. The collection of all products derived by all the PPEF and the SAF will fulfil the operational requirements of the user community. Each SAF will then be responsible for the distribution of the products to the user community through data distribution networks.

The EPS archive will store all data and all level 2 and 3 products from both METOP and NOAA satellites for the whole duration of the mission. This function is performed by the Polar Archive and Catalog Facility (PACF). Besides the storage of all data and products, the PACF maintains the archive catalog and provides for the archive consultation and data ordering. The user community will access the archive facilities through a user interface accommodated on the data distribution networks.

Different options for the EPS archive and retrieval system have been studied in order to optimise the archive concept in the light of the decentralised architecture of the Application segment. The options studied included a fully centralized archive, plus various level of decentralisation of the archive, the catalogue and users services. The trade-off were performed keeping into account the technical complexity, the development and operation cost and the efficiency of the service provided to the users.

The result of the trade-off recommends to follow a decentralised approach parallel to the SAFs concept. The products will be archived at the place of their generation, while the information to access the data, catalogue and users service, will be provided centrally. This solution optimises the users access procedure, reduces the complexity and volume of data exchange resulting in an increase of the overall system reliability. The level 1a i.e. with a reversible format to level 0 data will be archived at the place of their generation, at the central facility.

The archive implementation will comply with international standards and recommendations.

The end user community comprises global data users running operational NWP models to produce global forecast, and regional data users running NWP models for regional rather than global areas. These NWP models require level 1b data transmitted from the Polar Communication Network (PCN). All products generated by the SAF will be made available to both global and regional users via the Data Distribution Network (DDN).

The end user community constitutes a part of the Application Segment. It is therefore the responsibility of EUMETSAT to define the appropriate tools for the end users to interface with the EPS Ground Segment. These tools comprise the equipment for the reception of the level 1b data and meteorological products, up to an agreed interface; plus the communication package for the access and the consultation of the EPS archive.

The end users considered in the Application Segment are either running global prediction models or regional models. Local users which receive the direct broadcast from the HRPT/LRPT, are not represented here. However, EUMETSAT will undertake a similar work for the definition of the equipment and for the development of the algorithm(s) required by these local users.

A selection of the meteorological products generated by the EPS Ground Segment are transmitted to the Global Telecommunication System (GTS) for the World Weather Watch (WWW) users.

The Role of Networks on the Earth Observation Community

Roberto Monaco, Eurimage Scrl

ABBREVIATIONS AND ACRONYMS

EO Earth Observation

EO Products data or images obtained from satellite or aerial remote sensing instruments, usually available through commercial distribution

EO Users Earth Observation (EO) User Community, those individuals that currently make use of EO products, such as satellite images, in their work

EO Information Providers Entities or companies that produce or distribute Earth Observation (EO) products

Browse Products visual EO products accessed from an inventory, intended to visualise its contents, such as Quick Looks of satellite images

ABSTRACT:

Eurimage is a major European distributor of Earth Observation products. We see a need to provide EO users with fast access to Inventory and Browse Services right at their desks. And we are taking a step in this direction by starting "EiNet" in January '95, a specialized on-line Inventory and Image Browse Service accessible from Internet and dial-up, for all data provided by Eurimage. Also, in 1995 we will set-up a Web-server with corporate and commercial information, as we recognise that Guide and Directory Services are a major source of information to EO Users. With regard to Data Dissemination, our market feedback tells us that speed of delivery is an important factor only to those using EO data for monitoring purposes, and that the existing network infrastructure is adequate for electronic distribution of low-resolution data which is most commonly used for monitoring. However, when it comes to dissemination of full-resolution data the bandwidth becomes a serious limiting factor. The situation should not change with the arrival of high-resolution satellites for which we expect similar volumes of data transmission.

INTRODUCTION:

Eurimage is a major European distributor of Earth Observation products from diverse satellites that cover the whole world. We operate through a network of 39 distributors in 28 countries in Europe, North Africa and the Middle East. Through a number of agreements at international level with satellite operators and receiving stations, Eurimage is able to provide data not only from Europe, but from all over the world. In particular, within Europe, North Africa and the Middle East, Eurimage is the European Space Agency (ESA) distributor of days for the data to be delivered, except in the urgent monitoring cases mentioned above. The actual bottle-neck for data dissemination is network traffic. Current networks are saturated, and it becomes unfeasible to transfer high volumes of data such as high-resolution images over them. Only through the use of special set-ups such as satellite data transmission, of which ESA's BDDN is an example, or high throughput network backbones such as Internet Multicast Backbone (MBone), can data be disseminated in near real-time. These set-ups are often expensive. Users that are currently connected to networks usually use low speed links, sometimes dial-up to a network provider. Even if they could use a high speed data link such as T2 they would still have to go through saturated backbones that would decrease the capacity by several orders of magnitude. The way around this is to improve the network infrastructure (faster backbones), and we already see initiatives in this respect, such as the so called "information highway" in the USA. If there is no great need for the near real-time dissemination of high-resolution data, it is also true to say that existing networks can cope with current low-resolution data requirements, such as Browse products. But between low-resolution and high-resolution data, a whole new category of mid-resolution products could arise as the market expands, and these of course would put more stress into network capacity.

EURIMAGE INITIATIVES ON INFORMATION SYSTEMS:

Inventory and Browse Services:

In January '95 we are starting a new service, EiNet, which is an on-line Inventory and Image Browse Server. By the use of specialised interfaces users can efficiently obtain images for their zone of interest by remotely querying our database. In a matter of seconds they see the images at their terminals, which connect from Internet and direct dial-up. It will be also possible to access the database from Mosaic clients.

Guide and Directory Services:

In January we are also starting to operate a Web-Server, with corporate and commercial information. This machine will be linked to other WWW related information servers and to our Inventory and Browse Server, EiNet. We plan to gradually include all the documentation that we currently distribute to the EO user community, such as Product & Services Guide, Step-by-Step Purchasing Guide, Price List and Newsletters.

Data Dissemination:

We are looking into ways of using current network infrastructures and special set-ups to find alternative ways of data transmission that tend to lean towards "near real-time".

Earth-Watch:

In December '93, when the flooding in Camargue (France) and Cologne (Germany) took place, at Eurimage we started a program called Earth Watch. It is intended to disseminate information in near real-time so that EO users and decision makers can monitor emergencies, and other events that need satellite data, as they occur. The program provides a package of low-resolution data, image interpretation, background information and special full-resolution data offers, related to such events. With the co-operation of ESA staff at ERSIN, in Frascati (Italy), we search for images of the involved area, we process those images as appropriately and promptly as we can and place them on a server

EASY ACCESS TO THE DATA :
The prime characteristic of a business oriented distribution.

Author : Philippe Delclaux, SPOT IMAGE

INTRODUCTION :

The commercial approach for distributing Earth Observation data strongly requires that the access to the data is made as easy as possible. The main reasons are dictated by the absolute necessity to maintain the company in business and thus to develop the market. This can be turned into :

- need to satisfy the existing users who are more and more demanding,
- necessity to capture new users who are still comfortable with good old non Remote Sensing technics,
- necessity to maintain a high quality service in a competitive environment.

This "easy access" to the data can be translated into :

- making information available and easily accessible,
- speeding up the delivery of products,
- making the products convenient to use,
- facilitating the ordering process.

1. EASY ACCESS TO INFORMATION :

1.1. Information on the SPOT System, the products and the services :

Such information, today, is mainly available on paper ; leaflets, brochures, handbooks are the traditionnal media commonly used to carry the technical and commercial information.

New technologies are being used to develop tools facilitatating the access to these information. They include *Multimedia CD-ROM* and a public *World Wide Web*, and should be available by mid 1995.

1.2. Information on existing data : *DALI*.

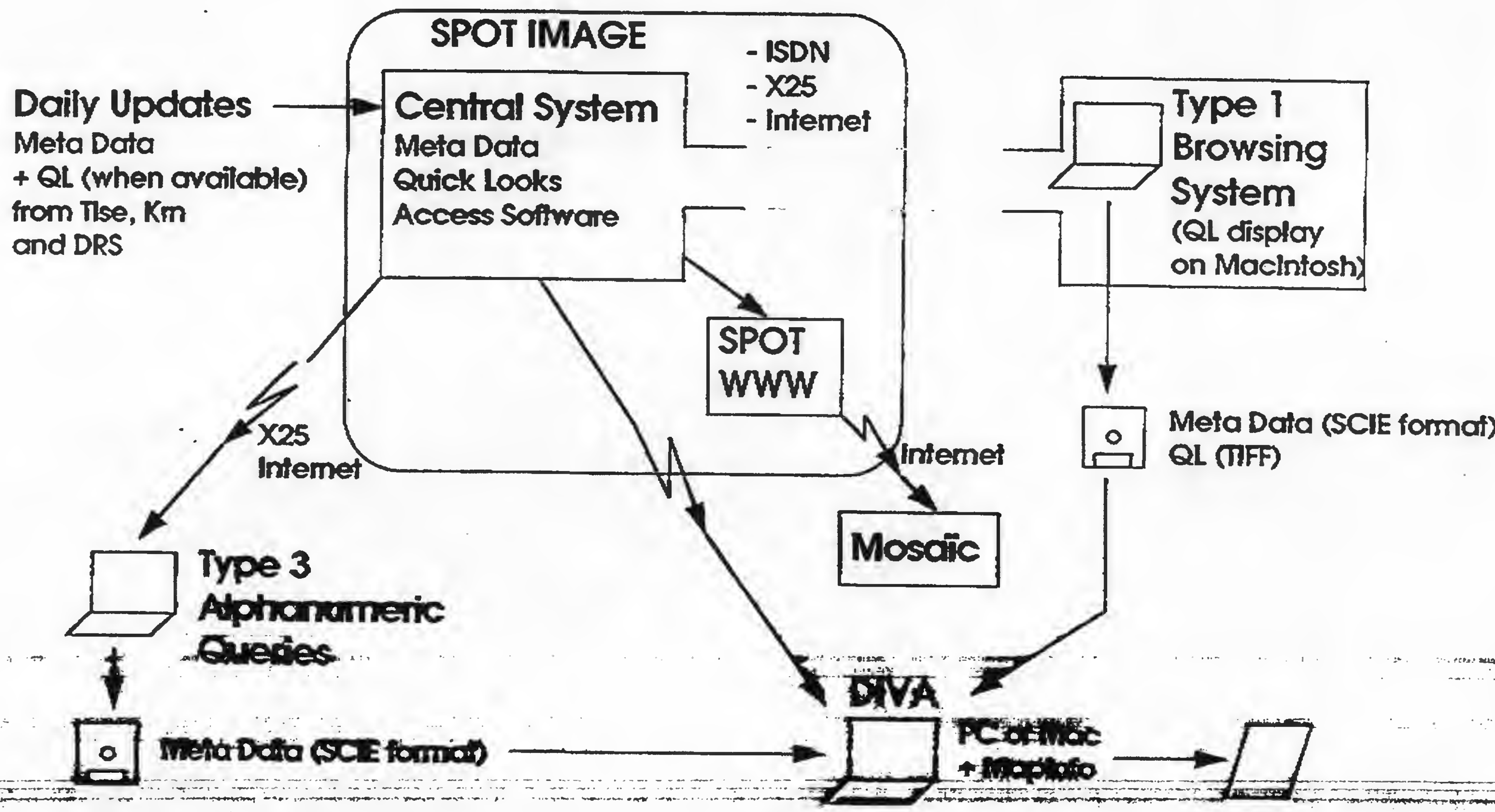
From a user's point of view, getting data from satellite sensors may take two different ways :

- either the data are not existing, and then one has to request a specific acquisition by the satellite sensors ; this could introduce some delays and a certain level of uncertainty due to weather conditions (for an optical sensor) or to conflicts in sharing the satellite ressource,

- or the data are there, and getting them is a straightforward operation.

In this perspective, the knowledge of what has already been acquired by the satellites is essential to the distribution process.

The DALI Environment

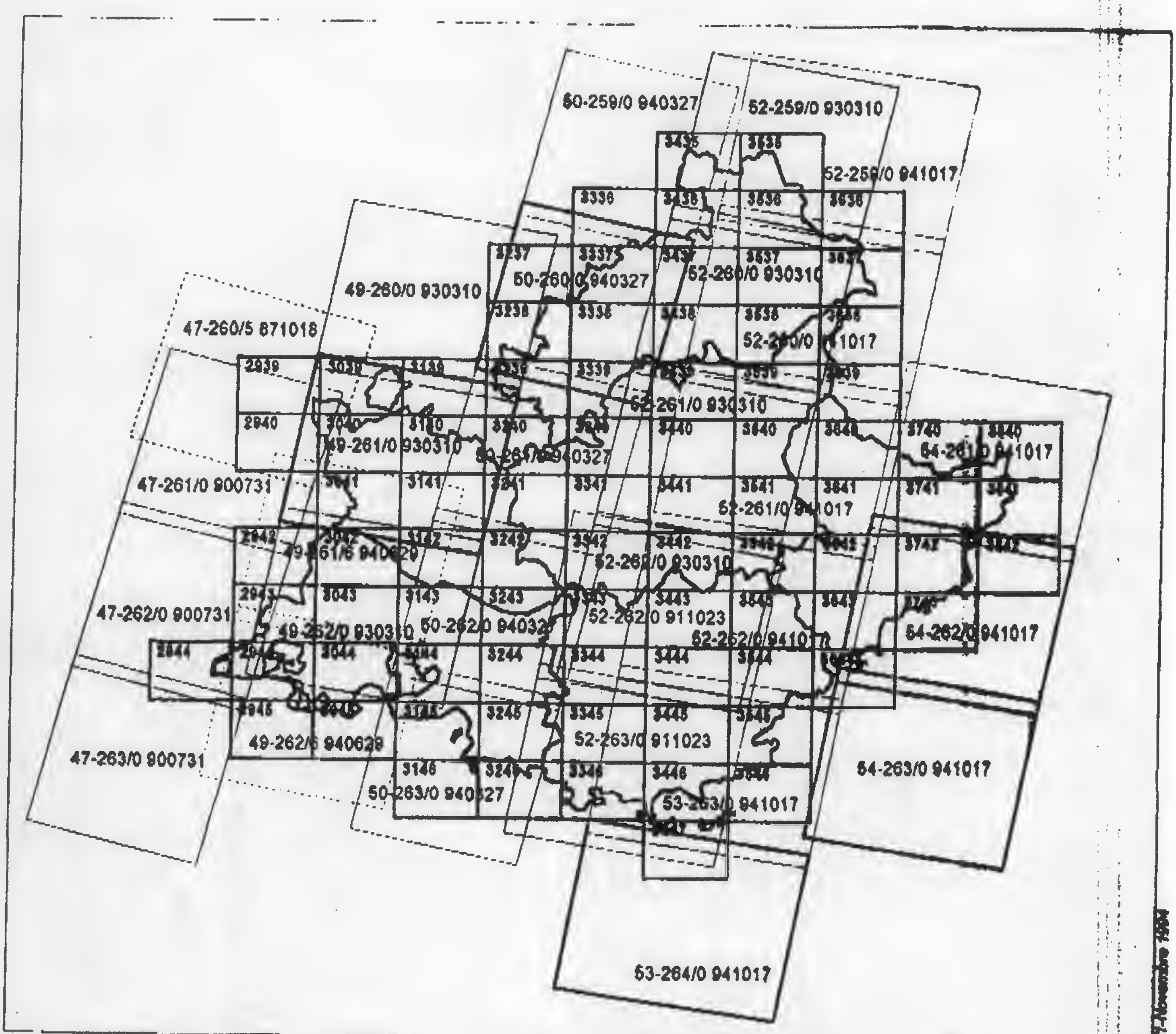


SPOTView® BD Carto®

SPOT IMAGE

Tableau d'assemblage des coupures I.G.N. 1/50 000 et des scènes SPOT PA utilisées

Région Provence-Alpes-Côte d' Azur



scènes au contour vert : scènes de 1994
scènes au contour bleu : scènes de 1993
scènes au contour magenta : scènes de 1992
scènes au contour cyan : scènes de 1991
scènes au contour rouge : scènes de 1990
scènes au contour noir : scènes de 1987

figuré en trait discontinu : scènes shiftées
figuré en trait gras : scènes partiellement utilisables

SPOT IMAGE

Friday, 29 July 1994

6:00 pm SICORP orders 4 scenes over RWANDA for the US Air Force,

6:30 pm SPOT IMAGE orders :

- 1 scene from CNES, Toulouse,
- 3 scenes from Satellitbild, Kiruna,

8:00 pm SPOT IMAGE receives the CNES scene,

Saturday, 30 July 1994

3:00 am SPOT IMAGE has received the 3 swedish scenes sent by line,

9:30 am final products are available,

1:00 pm delivery to the US Air Force at Toulouse airport (special flight from Ramstein Air Force Base, Germany).

The central SPOT catalogue, named *DALI*, is located in Toulouse SPOT IMAGE premices. It contains meta-data for all the scenes which have been received by the Toulouse and Kiruna stations since the launch of SPOT 1 (february 1986), and by most of the 15 Direct Receiving Stations all around the world.

In addition, it holds Quick Looks, available for browsing purpose, of all the SPOT scenes received at Toulouse and Kiruna stations since 1991. In 95, several Direct Receiving Stations will start delivering Quick Looks to the central catalogue, on top of meta-data.

On December 1st 1995, the content of the DALI catalogue was as follows :

- meta-data for 3,736,858 SPOT scenes,
- 897,809 of which with Quick Looks (i.e. 24%),
- 57% from Toulouse or Kiruna receiving stations, 43% from Direct Receiving stations.

The updating of DALI is performed

- daily, through dedicated lines (64 Kbits/s), for Toulouse and Kiruna (same day as the reception of the telemetry by the stations),
- daily or weekly, through X25 network, for some Direct Receiving Stations,
- weekly or monthly, on CTT or Exabyte shipped from the other Direct Receiving Stations.

Accessing the DALI catalogue can be done using three possibilities (see the figure "The DALI environment") :

- using the *DALI Type 1* browsing capability which consists in a software, distributed by SPOT IMAGE, running on a Macintosh or a PowerPC workstation. It assists the user in formulating a query, manages the communications with the central catalogue, retreives and displays the meta-data (alphanumeric and graphic), retreives and displays the Quick Looks. The connection to SPOT IMAGE can be made through ISDN, X25 or Internet. Today, about 10 stations of this type are installed worldwide (mainly distributors or big clients), and the number is increasing.

- using the meta-data search capability (DALI type 3), which is a pure alphanumeric mode (VT 100 emulation) with a specific querying language *(L.A.S.)* allowing geographical searches. The results can be retrieved under a standard SPOT IMAGE format *(S.C.I.E. format)* : this offers capabilities for importing the results on a computer, handling the results, creating local data bases, etc... The connection to SPOT IMAGE can be done through a regular phone line with a modem, X25 network or Internet. Today, about 140 persons are connected all around the world.

- using the meta-data handling capability, ***DIVA***, which consists in a software based on the MAPINFO geographic information system running on PC, Macintosh or SUN workstations. Sorting the meta-data, displaying the scene footprints over cartographic layouts (DCW, for example), help the users solving problems such as *"what is the best coverage without holes over my area of interest" (see the figure "SPOTView BD Carto")*. In addition, the software allows to get connected to the central catalogue of SPOT IMAGE, formulate queries using graphical tools and maps, and retrieve the results. The connection can be done through phone line and modem, X25 or Internet.

The future developments include :

- seting up a SPOT World Wide Web, as a gateway to access the central DALI system from a standard Mosaïc interface (by the end of 1995).

- making the catalogue interoperable with other systems such as IDN-GEODIS, etc...

- making CD-ROMs with meta-data and/or Quick Looks for distribution.

1.3. Information about existing "On The Shelf" products :

The process of making an Image Map requires most of the time to perform some feasibility study (what are the SPOT scenes suitable for making this given Image Map ?, are maps available for extracting ground control points ?, etc...). This complicates the ordering process, introducing some technical dialogue with a user who is not often very familiar with such cartographic technics. For this reason, it has been felt important to anticipate such an ordering process and to propose already made (or "ready to be made") collections of Image Maps on area over which some demand is expected.

This leads to setting up a catalogue of "on the shelf" products which is in preparation at SPOT IMAGE.

2. SPEEDING UP PRODUCT DELIVERY :

Our world is more and more demanding for fast delivery. This apears in a variety of fields in the regular distribution (mail shopping offers rush delivery options) and the custommers get more and more used to be served quickly. In addition, some applications using Earth Observation data require a near real time delivery.

2.1. The service to be offered :

Delivery time is a real concern for a commercial distributor, and a lot of efforts are made to constantly monitor and improve the performances. Today, when the data are already in the Toulouse or Kiruna archives, more than 75% of SPOT standard products (regular SPOT scenes at level 1A or 1B) are shipped less than 5 days after the order has been placed. This figure includes the shipping of OCTs or CD-ROMs from Kiruna to Toulouse, when the data are in Kiruna. Unfortunately, these kind of performances cannot be achieved today, for data being archived in the Direct Receiving Stations ; shipment and customs issues are significantly contributing to this situation, and we believe that transmission by lines could bring a great improvement (when this becomes affordable).

A rush option has been offered in the SPOT IMAGE price list : for an additionnal fee, the standard products are shipped the day, or the day after the order is placed. Again, this applies to data being archived in Toulouse or in Kiruna. We see more and more custommers using this kind of service (and paying for it) – see last page.

2.2. The means to be implemented :

Speeding up the delivery of products requires a growing use of transmission facilities. They can be split into two categories : "production network" and "distribution network" .

Production networks :

"Production network" refers to the transmission facilities to be implemented between the production entities for data exchanges. Today, SPOT IMAGE can offer a "Rush Order" service because there is a dedicated line between Toulouse and Kiruna which is used for transmission of products ; it is a 64Kbits/s leased line and it takes 1 hour to transfer a full SPOT scene (with a compression rate of 2).

Distribution network :

Within this context, "Distribution network" refers to the transmission facilities to be implemented for the product delivery to the end user. Today most of the deliveries are done by shipping OCT or CD-ROMs. The CD-ROMs brought a significant improvement (light, equivalent of 10 CCT, and can be used as a storage medium by the end user). Transmission by line to SPOT Distributors has started ; products are regularly transferred to SPOT IMAGE Corporation (in USA) using an existing dedicated 64 Kbits/s line.

Electronic delivery to the end user has been implemented in US by SPOT IMAGE Corporation, for a few clients ; however this is not yet affordable in Europe.

2.3. Anticipating production :

Some categories of products require a production time which is sometimes greater than what the custommer could expect . Image Maps enter into this category. A way to reduce the delivery time is to anticipate the demand, and to create "on the shelf" products, as already mentionned in § 1.3.

3. PRODUCTS CONVENIENT TO USE :

In order to expand the distribution of earth observation data, we have to adress new custommers who are not familiar with space technology, with remote sensing, or even with image processing. One of the biggest challenge that we are facing is to make our products easy to use for an increasing variety of persons who are comfortable with traditionnal technics and who show a normal resistance against moving to new technologies.

For that purpose, we believe that we have to devolop more and more products like the geocoded products (Image Maps) which look like the traditionnal maps that people are used to work with.

The setting up of standard format which allow to easily import earth observation data into systems commonly found on the market is also a necessity : a "load and go" format like *"GIS-Geospot"* has been defined in coordination with the main GIS manufacturers in the world ; they now offer the *"GIS-Geospot"* import capacity on their systems.

4. EASY ORDERING PROCESS :

The ordering of earth observation data, in general, is sometimes a painfull experience for persons who are not familiar with the satellite systems. A significant effort must be done in this domain because, most of the time, this is the unique contact with the user.

A Customer Service, a "human" Distribution Network (78 SPOT distributors or agents all over the world) are the key actors, but they need to be assisted by performant tools in order for them to focus on the human contact with the users, to supply reliable information regarding delivery times or status of an order.

Electronic ordering facilities (EDI, E-Mail, etc...) are already used within the SPOT family. Some of these capabilities will be opened outside in the future.

CONCLUSION :

The whole story of SPOT has been to move from a "technological driven approach" to a "market driven approach".

This has led us to focus on developping a "service oriented approach" which, we believe, is essential to foster the growth of satellite earth observation data utilisation.

To support this development, there is a tremendous need for affordable electronic communication networks.

14 Dec	Session E	• Finnish Data Networks related to EO (J Hyyppa, TEKES, Finland)

FINNISH DATA NETWORKS RELATED TO EARTH OBSERVATION

Juha Hyyppä[1], Einar-Arne Herland[2], Pirkko Pylkkö[3] and Juhani Talvela[4]

[1] Technology Development Centre, P.O. Box 69, FIN-00101 HKI
Phone: 358-0-69367853, Telefax: 358-0-69367795, Internet: Juha.Hyyppa@tekes.fi
[2] VTT Automation, P.O. Box 13031, FIN-02044 VTT
[3] Finnish Meteorological Institute, P.O. Box 503, FIN-00101 HKI
[4] Baudia Communications, P.O. Box 18, FIN-02151 Espoo

This paper describes present and future Finnish commercial data networks (technology, services, pricing) and their possibilities for Earth Observation (EO) data distribution. Two EO data distribution applications and technology used are reported as examples.

The data network systems in Finland are of high international standard. The public telecommunication networks in Finland are built by the private regional telephone companies (Telegroup) and by Telecom Finland (PTT). The telephone network of Telegroup comprises 3/4 of the subscriber line and 1/4 of the geographical area of the country. Traditionally, the rest is taken care of by PTT, which also handles long distance traffic. [1]

Until 1985 the same operators also operated data communication services in their traditional areas. In 1985, Telegroup with large customers founded the long distance carrier company Datatie Ltd., which was able to interconnect services between the telephone companies' areas by-passing PTT. This lead later to full duopoly competition in data communication services and in digital mobile communications. [1]

Within the GSM business Telegroup and customer companies founded a company called Radiolinja Ltd., which was the first company in Europe to open GSM network service, in 1991. At the beginning of 1994, local telephony and long distance telephony was fully liberalised. [1]

I TECHNOLOGY, SERVICES AND PRICING OF FINNISH DATA NETWORKS

The Helsinki Telephone Company has started the following data services during the last decade:

- the public FinPak X.25 network in 1983
- the public Elisa e-mail in 1986
- the X.400 ADMD Elisa400 in 1988
- the 64 kbps switched pre-ISDN Diginet service in 1986
- an ISDN trial in 1988
- the DigiLink dynamic leased line service in 1989
- the public FDDI service in 1989
- the LanLink public/corporate IP-WAN service in 1990 [1].

DigiLink provides leased line services for data communications and PABX-networks. DigiLink is a software-controlled dynamic system. Network maintenance and operation is centralized. The system consists of multiplexors located throughout the country. Customers bit/s, the connection charge is 13133 FIM and monthly charge is 10112 FIM for Ethernet and 10506 FIM for Token Ring. [3]

The FDDI service can be used to implement a company's basic network within a city area. The service is based on the FDDI standard and operates at a speed of 100 Mbit/s. Prices are on an individual basis. [3]

Connection to the LanLink Frame Relay service occurs at 64, 128, 256, 512 and 2048 kbit/s. [3]

Helsinki Telephone Company, in co-operation with other Finnish Telcos has been running SDH trial networks since mid-1992. Before the end of 1993, all major cities (around 10 systems) in Finland were connected through STM-16 in commercial telephony and GSM service. [2]

An ATM trial network is running since the end of October 1993 interconnecting first Helsinki and Tampere areas. The trial lasted until November 1994, after that national commercial ATM-based LAN interconnection was started. Applications in the ATM-network have been LAN-interconnection, circuit emulation, videoconferencing, frame relay applications and multimedia applications. Telcos ATM trial is part of the Pan European ATM-pilot starting November 1994. [2]

FastNet is Telecom Finland's nation-wide service that provides tailor-made permanent linkis. FastNet is an acronym for the words: Flexible Access System for Tele NETwork. FastNet links are centrally managed and controlled from altogether three operationally diversified network management centres. The network management system covers Telcom Finland's trunk network, customer nodes and system baseband modems. Should the customer's need require an installation of a customer node, FastNet service features a high-capasity node with n*64 kbit/s, 2 or Mbit/s customer connection (copper, optical fibre, link) or their multiples, installed to the customer. Through the customer connection FastNet service provides access to all Telecom Finland's Data Services, Voice Network Services, Mobile Telephone systems etc. Customer applications typically included in FastNet are: fixed data links, virtual and fixed voice network services (privatel, VipGate, PABX networks), LAN interconnect service (DataNet) and links to Telcom Finland's other services (Datapak, Datex, DataNet, crossboundary links to Sweden). [4]

II EO DATA DISTRIBUTION APPLICATIONS

In the field of EO data distribution, two good examples can be highlighted, i.e. meteorological data networking and satellite images sent digitally to ice breakers.

Case 1: Meteorological data networking

The meteorological institute around the world are the first ones to utilize global computer networks. The World Meteorological Organisation (WMO) is responsible of co-ordinating a world-wide meteorological telecommunication network GTS (Global Telecommunication Network). The GTS has been operational for several decades and it is used for distributing weather observations, data from numerical forecasts and products from meteorological satellites to all WMO member states. Finnish Meteorological Institute (FMI) has a national

Earth Observation User Information Services in Germany

H.J. Lotz-Iwen
German Remote Sensing Data Centre DFD
German Aerospace Research Establishment DLR
D-82234 Oberpfaffenhofen

Abstract
This paper gives a rough overview on the recent status of activities, systems and projects in Germany, related both to Earth observation data and user support. The survey covers industrial services as well as those being offered by research and administrative institutions. Special emphasis is dedicated to the description of the Intelligent Satellite Data Information System ISIS of DLR, representing the only operational User Service providing online access to remotely sensed data.

1 Overview on Services

Until now, the use of Earth observation data is rather a subject of the scientific community than a subject of industrial application or operational use in Germany. Hence the number of archives holding such data is restricted, and most of these organisations do not offer access to their data. In the following overview the term "Earth Observation Data" relates to data from spaceborne and airborne sensors and all value added products derived from them. To some degree also ground measurement data and topographic databases (DEM and maps) are being covered. Many archives are shielded from public access and built only for internal use.

1.1 Industry

As there is no operational German Earth Observation satellite, industry is mainly engaged as contractor in data distribution or active in value adding and application:

- DORNIER Systems (Friedrichshafen) is the German representative in the EURIMAGE consortium, distributing satellite data for ESA and SPOT Image through its EDS service. There is no public network access to the EDS catalogue, which is connected to LEDA and DALI.
- The "Gesellschaft für angewandte Fernerkundung" GAF (München) is contractor of EOSAT, EURIMAGE and SPOT Image, but also strongly engaged in national and international application projects.
- GEOSPACE (Bonn) is also contractor of EOSAT and SPOT Image, application activities are focused on public relations (atlases) and school education.
- Kayser–Threde (München) is distributing photographic data from the Russian sensor KFA1000
- "The Weltraum Institut Berlin" WIB holds an archive FEDAT of photographic products from Shuttle missions and also of Russian missions such as KFA1000. FEDAT is based on PC, it can be accessed by ISDN and offers catalogue query and quicklook display.
- EUROSENSE (Köln) and ESRI (Kranzberg) are involved in the field of value adding and application using satellite data. In addition there is a couple of engineering bureaus providing services in this domain.
- HANSA Luftbild (Münster) and some other smaller firms keep archives of aerial remote sensing, both from their own surveys and from historical sources.

Accessible Earth observation databases and user services are *nearly exclusively provided* by the members of the Association of National Research Centres AGF.

- The German climate computer centre DKRZ (Hamburg) is recently building up a climate database, including a directory on climate relevant datasets in Germany, and a catalogue system covering climate model data of DKRZ as well as data from external organisations. Access will be realised by a WWW interface on the Internet.
- The Alfred Wegener Institute for polar research AWI (Bremerhaven) is about to reorganise its various databases on polar research in order to make them compatible for access through the DKRZ catalogue. Other info–systems are the meteorological data system MISAWI, SEDAN and the hydrographical database "Southern Ocean".
- The geo–research centre GFZ (Potsdam) keeps a couple of historical archives of geophysical ,geodetical and geological data. For the purpose of adequate data management and directory structure, GFZ is developing a generalised metadata approach. Data from ERS altimetry will be made accessible through the user interface ISIS of DLR.
- The GKSS research centre (Geesthacht) is operating information systems on the Wadden Sea (WATIS) and the Elbe river (ELBIS). Users can log in to both systems via Datex–P (X–25), a WWW server is under construction.
- The KfK research centre (Karlsruhe) holds data on atmospheric pollution and atmospheric constituents. The institute for meteorology and climate IMK is going to build a directory on climate relevant data and data centres throughout Germany ZEKLIS (will be integrated in the DKRZ directory).
- The environmental research centre UFZ (Leipzig) is building up databases on environmental pollution and recultivation, including satellite and airborne imagery, soil probes etc. Until now (December 1994) there is no external access to data.
- The research institute for environment and health GSF (Neuherberg) holds databases on chemicals and toxides. Within the project UFIS, ecological models will be described in terms of metadata, and shall be made retrievable by public users.
- The German remote sensing data centre DFD (Oberpfaffenhofen) of DLR operates its Intelligent Satellite data Information System ISIS, offering public users free access to DFD catalogues via Modem, ISDN, X–25 and Internet. ISIS also provides online browse quicklook and data transfer and an order service. The system will be described in detail in chapter 2.

In January 1994 the AGF has established a Working Group on Environmental Data Management, headed by DLR. The goals of the working group is to harmonise the various relevant activities going on at the research centres. Based on the internet the group has forced the installation of WWW servers at all centres such enabling interconnection. The present activity is dedicated to the convergence of metadata models, used or being recently designed on the basic subset of the Data Interchange Format DIF. As result compatibility of the national directories with the GCMD (IDN) will be achieved. The next step will be the improvement of existing user guide systems, by using toolsthesauri, map browsers, names databases and other tools for directory as well as for database retrieval.

2 The Intelligent Satellite data Information System ISIS

The German Remote Sensing Data Centre of DLR has developed and operates the information system ISIS as central user interface for its Data and Information System [2].

agencies and industry, followed by detailled interviews at the respective organisations. From this unique survey of user requirements appropriate system design specifications have been derived. Consequently, in addition to local inventory retrieval, the ISIS user guide supports the search of datasets in globally distributed archives, the provision of supplementary textual information, and the use of a Thesaurus through

- the International Directory Network IDN-node,
- an infoboard of texts,
- a Thesaurus-navigator for infoboard retrieval.

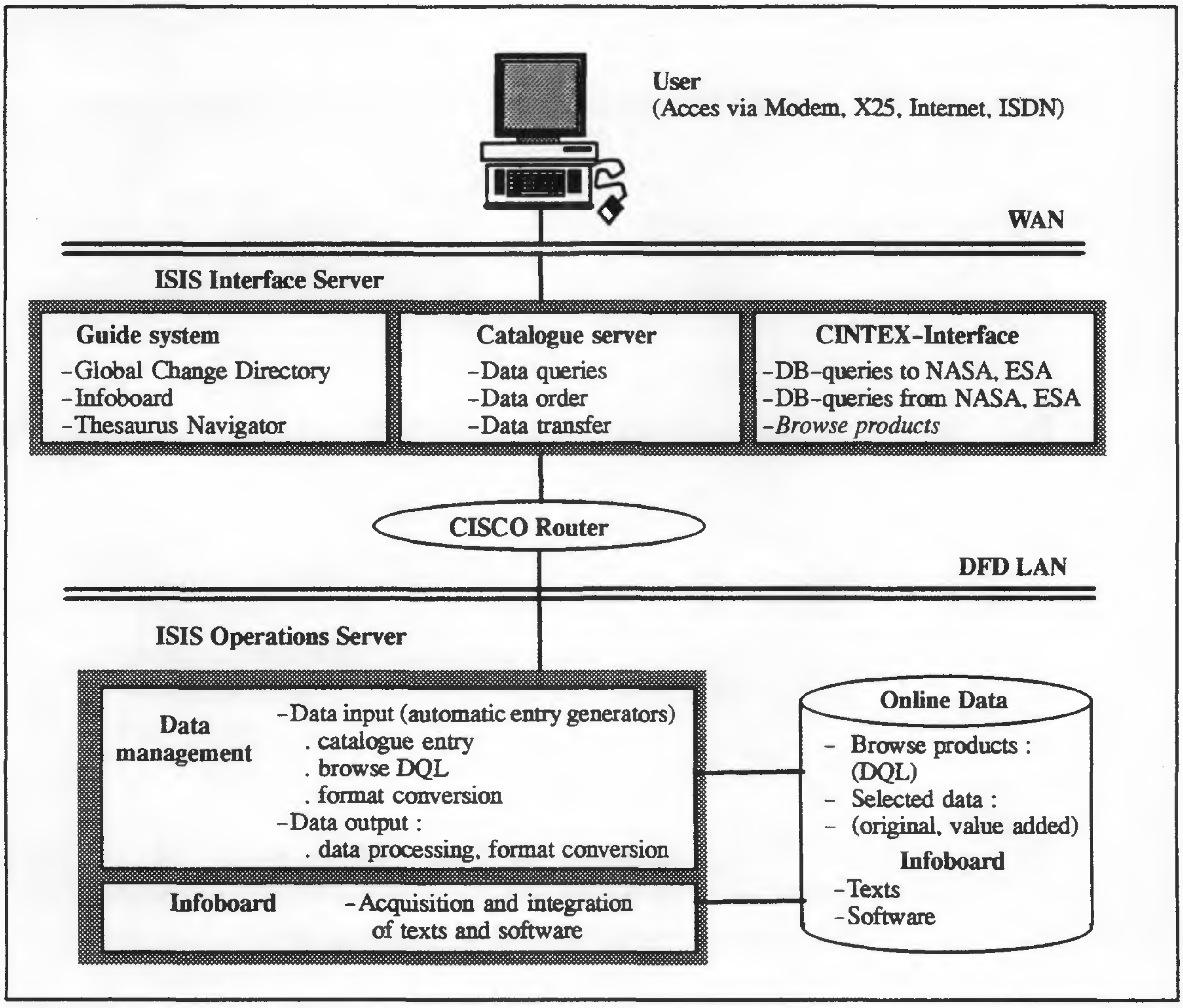


Figure 1 : The configuration of ISIS

2.2.1 The IDN-node (Global Change Master Directory)

DFD operates a cooperating node of the International Directory Network (IDN) of the Committee on Earth Observation Satellites (CEOS), that can be accessed within the ISIS menu. The IDN comprises a global archive-inventory for various scientific disciplines (e.g. Earth science, solar-terrestrial physics, planetary science, astro-

- graphical input of geographical coordinates on digital maps, coupled with names input;
- display of dataset footprints on digital maps;
- a calendar tool for the input of the acquisition time frame,
- selection of data sources from a list of sensors/products

The dilemma of using an object–oriented database (user friendly, but too slow) or a relational database (well introduced and quick, but complicated user queries) has been solved in an elegant manner: the user formulates his query in an object–oriented format (user layer), the query is then translated to an SQL query, that will be sent to the underlying relational data bases (data layer). For this purpose DLR has developed the high level language DOOR, such ensuring as well flexibility with respect to configurating the catalogue interface for different databases, as fast response times.

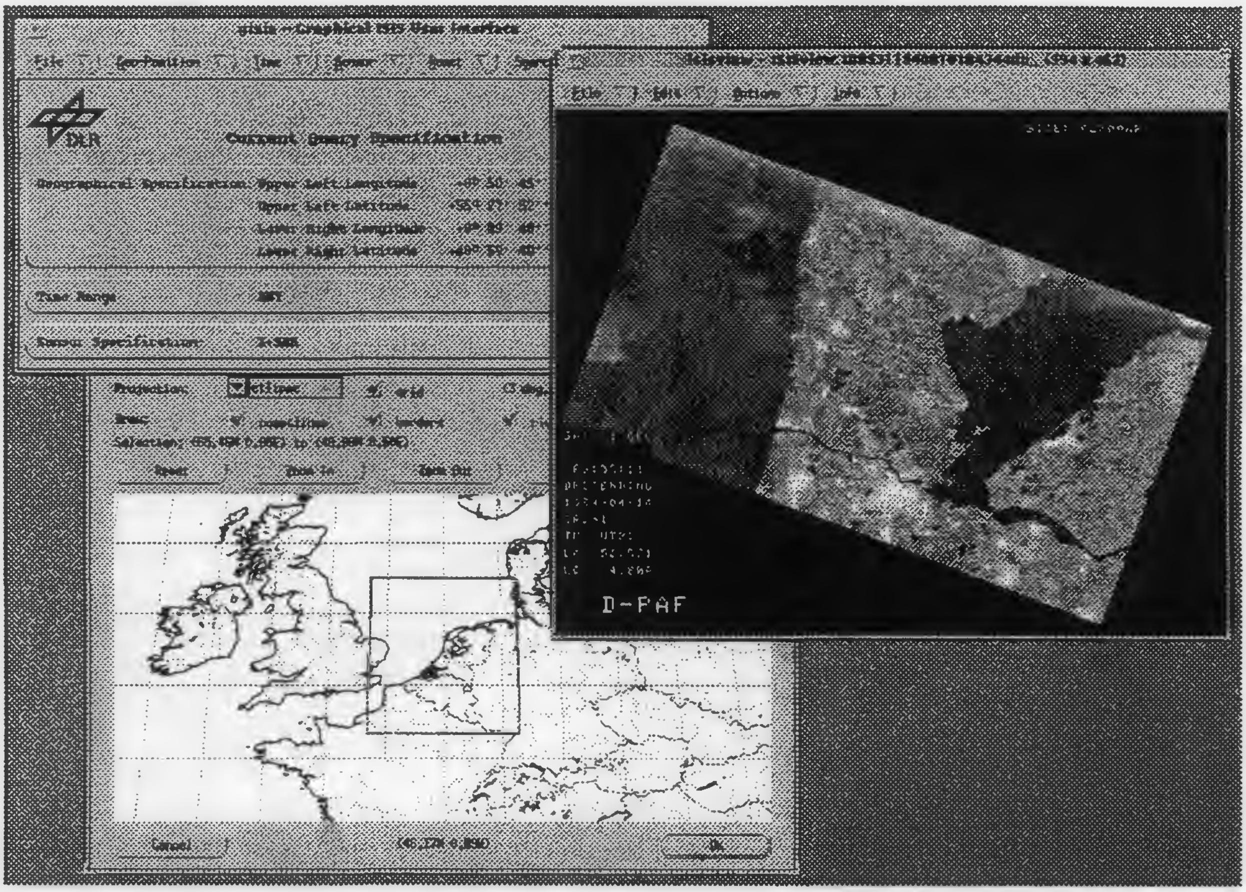


Figure 2 : The graphical interface of ISIS (query menu, map browser, quicklook display)

The search results and additional information on the available data sets, (receiving station, image quality, cloud coverage or a list of data products) are being displayed. The catalogue browser allows interactive data search within distributed DFD inventories of ERS–1 SAR, NOAA/AVHRR, Landsat TM, SPOT, TOMS (NIMBUS and METEOR), Sea Surface Temperature, NDVI, X–SAR, MOMS02 and other data. As for December 1994 more than 30,000 image scenes can be retrieved from the catalogue. The DFD operates receiving facilities for METEOSAT and NOAA, a receiving station in Antarctica for ERS–1 and NOAA and a mobile X–band receiving station. Due to the flexible conception of ISIS, the catalogue system can be easily extended to further data types, such as GOME or data from the PRIRODA mission.

data and research results as well as for the effective distribution of the information to the multidisciplinary users. With the development of ISIS the German Remote Sensing Data Centre has entered the process of overcoming the handicaps of traditional archive systems.
ISIS is the user-interface of the data and information network of DFD, being recently built up for the ERS-2 and ENVISAT missions. Data will be stored in a robot archive handling a variety of storage media (DLT, Exabyte, CD-ROM etc.) in the order of hundreds of Terabytes. This archive will be part of the future Global Environmental Data Network of the space agencies.

Based on the experience gained both in the course of the development of ISIS, and also from user response, ISIS has reached the operational status of being the central national point of access to remotely sensing data, and has become a valuable tool for international users.

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A UK OVERVIEW OF THE EUROPEAN EARTH OBSERVATION SYSTEM.

Roger Robinson - British National Space Centre.

0. Introduction.

When addressing the role of the European Data Networks and EO User Information Services as part of an EEOS, there is a need to keep in mind the reasons why an EEOS is necessary and who the players are, before deciding how it is to be set up, what it will comprise and what the nature of the facilities will be. These aspects will shape issues such as the role of the institutions, the nature of the infrastructure needed to service demand and how the naive user will access information relevant to his needs. An understanding of these issues will help to draw out the form of the EEOS.

1. Why does Europe need an Earth observation system?

There is a need to strike a balance between creation of data and facilities for users to easily find, obtain and use the type of EO data they need. This means easy access for traditional users, for those putting EO data to work in new ways and most importantly for new users. If the infrastructure does not address users' needs the market will remain stunted and the justification of the vast investment in the supply side will not be possible.

Easing access to EO data is not enough. It will also be necessary to promote the supply and to encourage new applications. Because the market is immature help is needed to build up the demand side to reach a critical mass that ensures continuing expansion and diffusion through its own momentum.

2. EEOS issues.

A number of key issues need to be addressed.

2.1 The Range of EO users.

The EEOS will serve users with widely differing needs and knowledge. For example, there is the degree to which groups of users are organised. The meteorological community is well established and knows what it wants from EO data. This group is capable of satisfying its needs using existing infrastructure but there will be a growing number of groups whose experience of EO data is more recent and they need far more help to access the most appropriate sources and in interpreting and using the data.

These groups of users are spread across a diversity of subjects handled in academia, public services and commerce. This will reflect in the variation of services they need in the EO market. Studies in the preparatory phases will have to draw out these differences to be accommodated by the EEOS.

This lack of homogeneity highlights the need for the EEOS to spread a wide net. If the exploitation of EO data could benefit a small firm how would the staff be aware of it? Potential users have no traditional or natural route to the supplier and are not on the dissemination network. What could the EEOS do to fill this gap?

This impacts on accessibility, the rate of development of communications technology, the volume of stored data and the transport and copying of electronic data.

2.2 Volume of data available.

The volume of EO data collected on a daily basis continues to rise and the costs and capacity of archiving facilities have to be addressed on a long term basis. The justification for this bit-mountain can only be satisfied by demand and this will only grow if more people and organisations are aware of it through promotion activities and if the infrastructure is in place to give easy access, delivery and use. As this becomes established there will be greater confidence for widening the investment in facilities needed to handle and exploit greater quantities of data.

2.3 Accessibility.

An EEOS must be helpful to those having no knowledge of data archives and how to access them. Should there be an assumption that all data will be ordered and transported electronically? If so how will it help those who are not hooked into the system?

The EEOS must ensure visibility to all potential users in a way that by-passes the need to have prior awareness of EO data. Potential users must not be turned-off by the prospect of having to come to terms with technology or an area of science new to them. The EEOS must be user friendly.

2.4 Information highways.

Information highways are an aspect of the infrastructure needed for an EEOS that will not only be important but contrarily will not be dedicated to the EO community. These networks will be part of a much wider service and as such the EO community must be prepared to ensure its needs are met during network development.

Information superhighways have high profile in the USA, Japan and here in Europe and it is the bandwidth implied by these and their global development that will be needed to handle the movement and copying vast amounts of EO data. Representing the CEC, the Bangemann Report on the information society is widely respected for its vision. Many of the topics it highlights have strong association with likely issues for the EEOS. Ready examples are teleworking, networks for universities and research centres, telematics services and public administration networks.

This area of technology and infrastructure development is progressing very fast and there could be significant benefits from synergy if the EEOS definition and implementation keeps pace with it.

2.5 Facilities.

There are important policy issues for creation and use of facilities. The EEOS must utilise and build on facilities that already exist and must take care not to undermine establishments that already provide services that fulfil a user need. Further facilities should only be through initiatives that are demand led and not be the exclusive right of specific organisations.

2.6 Intellectual property rights.

The EEOS might need to be a contributory fora for IPR issues particularly if these are seen to be a barrier to access and use of EO data and undermine the objectives of the EEOS. Established fora are the European Centre for Space Law (ECSL) established by ESA and the World Intellectual Property Office (WIPO). The latter being aware of the potential problems in the dissemination of EO data.

3. Features of an EEOS.

These points are not intended to anticipate or presume the results of the preparatory work for the EEOS. They are needs that will have to be addressed in some form. As back-cloth to this the attached diagram is an aid to show ease of entry, movement within and exit from the market for:

- all users including recipients of applications.
- suppliers of all levels of products and information.
- all types of agents providing services.

Institutional and regulatory barriers must be minimal in the EEOS structure.

3.1. Catalogue system.

The EEOS must make searching easier and quicker with a proven catalogue and browse facility. An on-line, interactive system will ease access for traditional users and enable service organisations to satisfy a much wider market.

3.2. Quality.

The quality of data and services is very important but must again be driven by users' needs. It should enable fundamental safeguards for tracing the origin and identification of data just like an audit trail but should not otherwise constrain innovation. Quality does not mean best possible. The basic concept is to provide a product or service that satisfies a customer and it is for the suppliers to gauge the market in accord with their own business plans.

Standards making might well play a role in this and the EEOS could play a role as a co-ordinating forum for the needs of the EO community.

3.3. Interoperability.

Aspects of interoperability and interconnection have to be addressed because of the different operating systems for data handling world-wide. Harnessing networks will bring a new dimension to this. The Committee for Earth Observation Satellites (CEOS) has been addressing this since 1993 and the results are a good base for the EEOS and other regional organisations to build on.

4. Activities in the UK.

The following are examples of existing facilities, services and initiatives in the UK that are good candidates for the basis of an EEOS.

4.1. ERS PAF/ ENVISAT PAC.

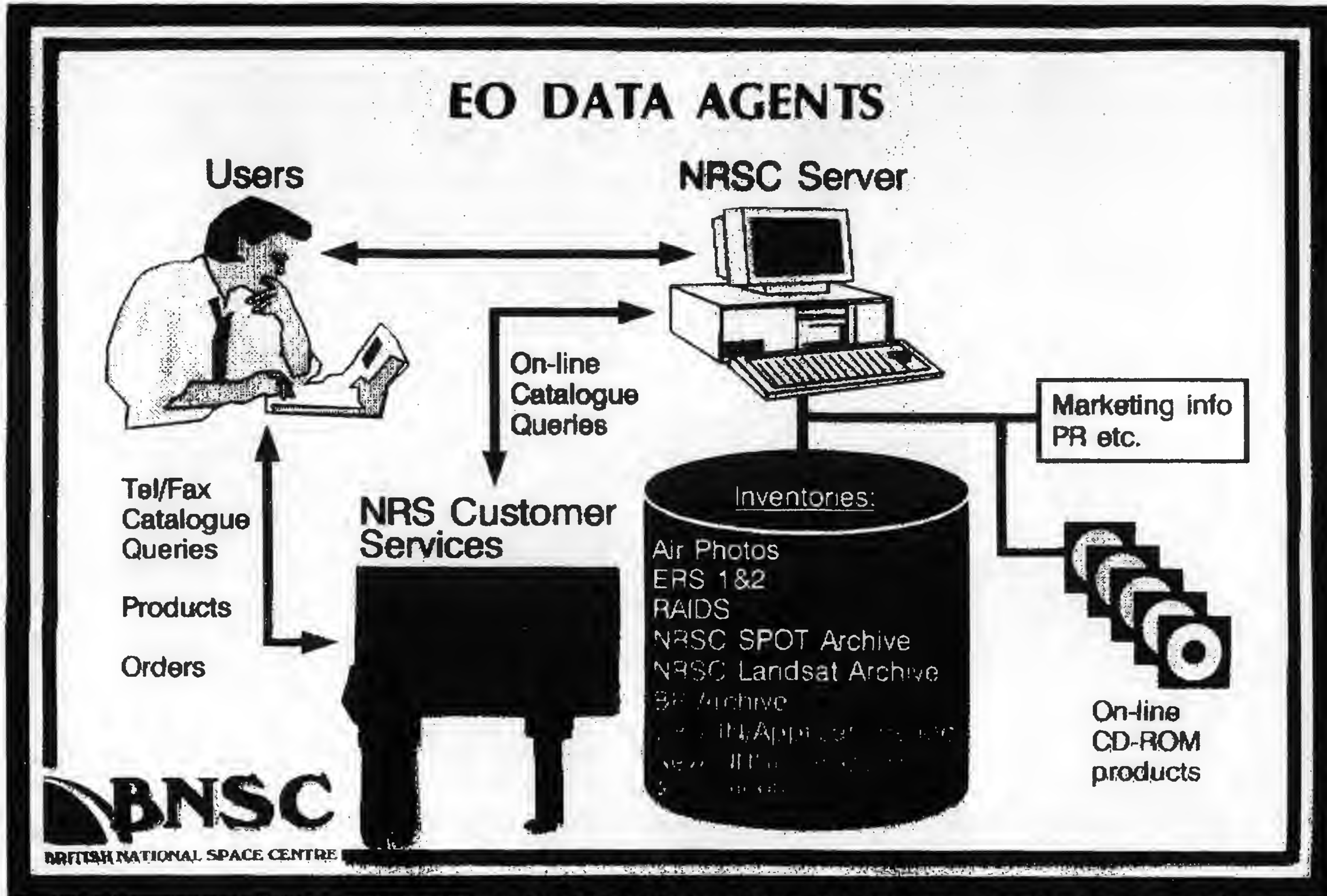
Set up to process, archive and distribute data from the ESA ERS-1 mission, the UK Processing and Archiving Facility (PAF) is located at the Earth Observation Data Centre (EODC) and run independently by the National Remote Sensing Centre Limited (NRSCL). This role will continue under the ERS-2 mission due for launch in the spring of 1995 and it is working on the needs for the UK Processing and Archiving Centre (PAC) for the ESA ENVISAT-1 mission to be launched in 1998.

NRSCL has the objective of expanding the market for EO data and would be one of the fundamental facilities in the EEOS. The attached diagram shows how such an agent would have a role by linking into the EEOS at different levels to serve different needs. Current developments include plans for a wide range of EO value added products, arrangements to access other archives and to bring a catalogue on-line in 1995 for browse and ordering.

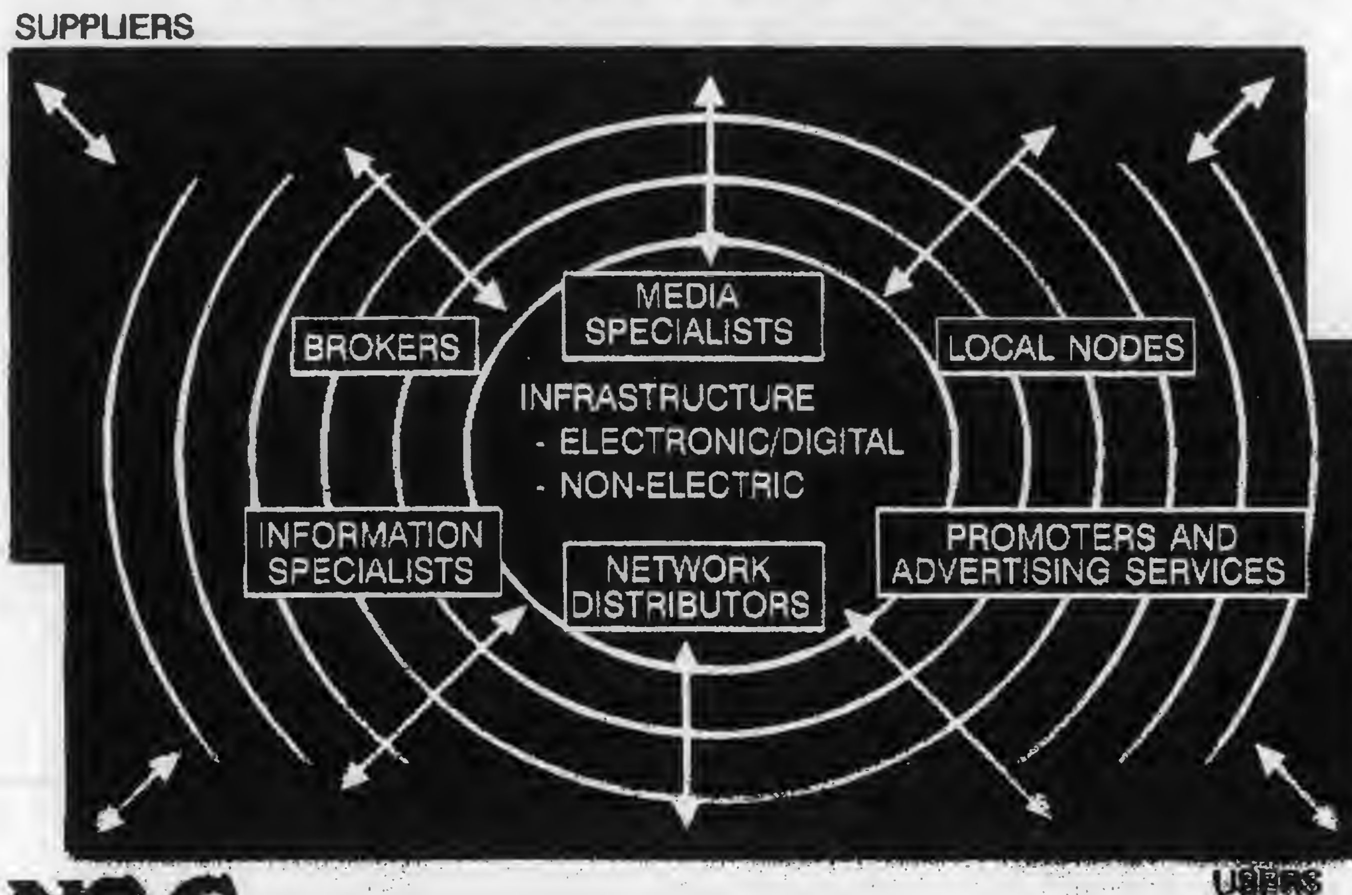
4.2. GENIE.

The Global Environmental Network Information Exchange is a metadata system based on a master directory set up by the UK Research Councils. Focused on the scientific community dealing with global environmental change, it has no central facility but is a tool for use with networks to help locate information in other sources.

Features such as this will be a useful tool for users of data in an EEOS. Due to be operational in Spring 1995 one of GENIE's notable features is a self learning facility. Through this its store of reference or key phrases will grow with use so that subsequent users will find what they need more quickly. It will primarily serve the


EO DATA AGENTS
Users
NRSC Server
On-line
Catalogue
Queries
Tel/Fax
Catalogue
Queries
Products
Orders
NRS Customer
Services
Inventories:
Air Photos
ERS 1&2
RAIDS
NRSC SPOT Archive
NRSC Landsat Archive
Marketing info
PR etc.
On-line
CD-ROM
products
BNSC
BRITISH NATIONAL SPACE CENTRE

A VIEW OF THE EEOS STRUCTURE



BNSC
BRITISH NATIONAL SPACE CENTRE

major data centres associated with environmental science centres and expand by hooking in organisations such as NRSCL.

4.3. SUPERJANET.

SuperJANET is an academic network covering universities and other research centres. With a maximum capacity of 150 Mbits/sec it has multimedia capabilities. It is already famed for its use for (interactive) medical seminars covering live surgery. Currently covering over 50 sites it is intended to extend to all the sites (approximately 200) served by the preceding system (JANET) by 2000.

SuperJANET is capable of satisfying many of the needs of EO researchers and opening possibilities for new ways of exploiting data. There is an ever growing need to deliver large quantities of data at rates that enable its use in near real time. Possibilities are being sought for much wider exploitation of SuperJANET to cover such needs by groups outside of the research community.

5. The Time-Frame.

An EEOS is needed as soon as possible. There are compelling reasons for the EO community to make sure it keeps a high priority.

We are seeing the fast developing world of superhighways that have huge impetus. The EEOS must harness these and keep pace with developments to ensure that its own needs are met. Examples of initiatives in this area are the European Union's (EU) programme for a Trans-European Network System and under the Framework IV Programme funding for projects on telematics, advanced communications technology and information technology.

Perhaps of greatest urgency is the need for timely action to boost exploitation of EO data and expand the market for it. It is only this that will balance ESA and national investment in Earth observation and satellite telecommunications. Figures are difficult to attribute specifically but it has been estimated that funds to the order of 2.6 BECU have been invested in the ERS & ENVISAT programmes alone.

ASI VIEWS ON EUROPEAN GROUND SEGMENT EVOLUTION

by

Giovanni SYLOS LABINI

Abstract:

The efficient use of space data, and generally the improved access of the user to EO data is in the headline agenda of the Italian Space Agency (ASI).

Italy has contributed in the past to the European Earth Observation Ground Segment through a number of facilities: Data acquisition and distribution facilities as the Fucino Ground station, data processing centres such as the ASI/CGS "G.Colombo" at Matera hosting processing and archiving facilities for National, Bilateral and ESA mission. This infrastructure plays a decisive role in the EO mission nowadays operational and will have a clearly defined role in the ground segment of the missions planned before the end of the decade.

User service and data distribution have been several times indicated as strategic issues in order to provide novel data products, prepare user to new data and missions, rationalise facilities.In this respect Italy and ASI has strongly supported the evolution of ground infrastructure and the development of space borne dissemination facilities (like the DRS system).

A close interaction on these themes with ESA, other national space Agencies, the European Community have been undertaken by ASI.

Moreover several activities are ongoing on national base, as well as in the framework of international co-operative efforts in order to improve user access to data.

National Strategy in EO

Earth observation activities have been developed in Italy by Research Organisations, Operational Entities and Industrial and commercial Operators. Since early 70' several efforts have been devoted to the ground segment development. In the 80's, with the establishment of the National Space Program, have been started several activities in the space segment area.

Although this paper will focus mainly on the evolution of Italian EO ground segment, some hint on general strategy on EO will be useful in order to clarify the reference scenario.

Space Segment

On space segment national, multilateral and bilateral co-operation programs, have been confined in an "ecological" niche delimited in the range of microwaves spectral range and in the area of high resolution optical spectrometers.

The more relevant examples are :

On bilateral co-operation:

X-SAR (ASI/DARA)
IASI (ASI/CNES)

And a relevant contribution trough national industries in ESA programs:

ERS Radar altimeter
GOME on ERS-2
MIMR on metop
ASAR on Envisat
RA-II and MWR on Envisat

Furthermore must be mentioned the solid earth activities on the following missions:

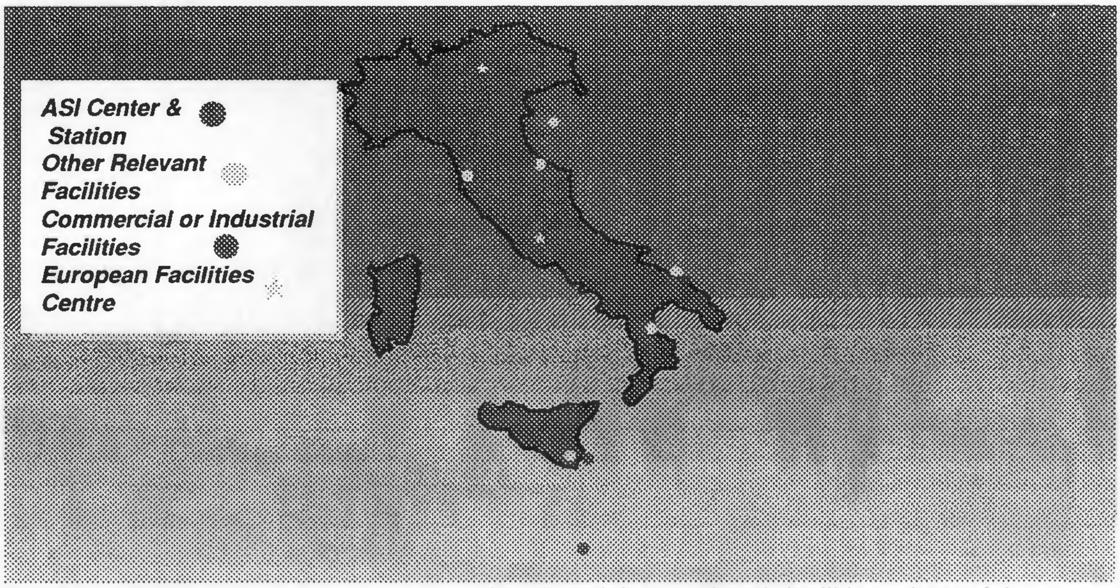
IRIS/LAGEOS (ASI/NASA launched in 1992)
Aristoteles (phase A study performed in ESA)
LAGEOS-III (feasibility study)
TOPSAT (Global Interferometric Mission feasibility study)

Ground Segment

On the ground segment the ASI activities have a more user oriented approach.

The goal is provide access to the national user community efficient and easy access to EO space data. At this purpose have been established

National Facilities



In the figure are represented several national and international facilities hosted in our territory that are relevant for the national, European and world Earth Observation user community.

Among these are relevant processing archiving and acquisition facilities operated directly or on service basis for ASI and ESA :

- The Scanzano Ground Station
- The Fucino Ground Station

• The Centre for Space Geodesy in Matera.

The **Scanzano Ground Station** has been established in Sicily by Telespazio S.p.A, a commercial service company, on the basis of an agreement with the Regional Government. The station acquires and process data from NOAA polar orbit satellites and from airborne multispectral scanners.

The **Fucino Ground Station** Owned and operated by Telespazio S.p.A, is one of most important station for satellite data-acquisition and operation. Act as ESA station for ERS series and Envisat assuring direct reception of SAR data acquired over the Mediterranean area, moreover assure the acquisition and archiving of:

- Landsat
- J-ERS
- NOAA
- ERS (LBR,HR)
- ERS Fast Delivery Dissemination via BDDN

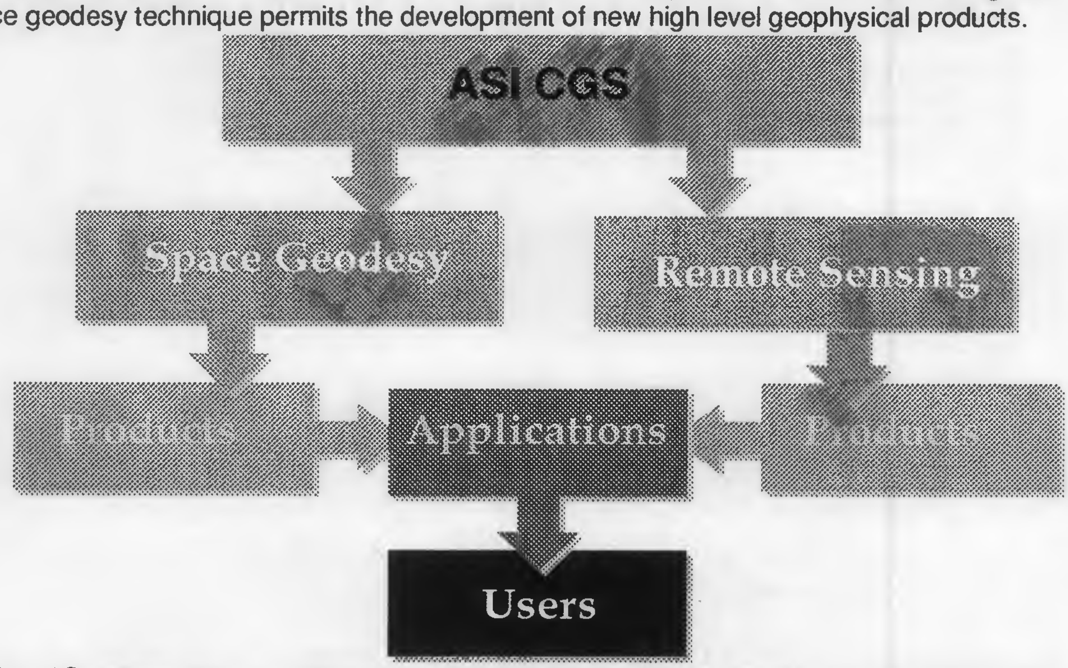
The role of Fucino will be extended during the next years on the operation of communication infrastructure and via the improvement of direct communication link with ESRIN and the ASI/CGS centre for space Geodesy.

The **ASI Centro di Geodesia Spaziale (CGS) "G. Colombo"** is the main operational facilities owned by the Italian Space Agency. Founded in the 1983, is one of the few fundamental stations for Space Geodesy and hosts the Italian Processing and Archiving facility for ERS and X-SAR. In the following we further describe the capabilities of this facility and the expected Italian contribution to the future European EO Ground Segment.

Italian contribution to the EEOS

Trough the ASI/CGS Italy provide a relevant contribution to the processing and distribution of EO products in Italy and Europe. Finally the CGS is co-ordinates the major effort of development of new products and the exploration of advanced space based application.

A shown in the above figure the rare combination of capabilities in remote sensing and space geodesy technique permits the development of new high level geophysical products.



The ASI plans are to further integrate these capabilities in the overall Italian EO community improving the access to the Centre of Scientific, Operational and Commercial users.The implementation rationale toward the future European missions is the following

❑Continuity with ERS
❑Preparation of Future Polar Orbit Missions
❑Preservation of National User Requirements
❑Protection of Investiments
❑Avoid duplication of Efforts
❑Exploit Complementarity with other PACs

The core of I-PAC will remain in the High Rate Data processing with the extension to the MERIS high resolution products production, and the exploitation of the ASAR henaced capabilities, but a great attention will be devoted to high level products development also in cooperation with EC/ESA action in this area. Furthermore the high precision orbit estimation and high precision laser tracking capabilities will be further exploited.

The tendency to extend synergism with mature science and operational National capabilities will be pursued trough co-operation with the Universities and CNR (National Research Center) also in the field of Atmospheric Chemistry and Global Change studies.

An example already operational is the involvement of the I-PAF on GOME , in co-operation with the IMGA/CNR of Modena. This approach trough proper negotiation with the relevant involved parties, will be extended to **schiamachy** on **Envisat**.

In conclusion must be recalled the important contribution of Italy to the development of the European "Info-Ban", and the relevance of these developments for the Earth Observation Community. Data circulation and Data Access will be the key component of a fruitful exploitation of the EO investments in space. The vigorous support of ESA to the development of the Data Relay Satellite will then guarantee to Europe global access to data acquisition essential to the global Earth Studies.

Conclusions

In this paper a limited presentation of the Italian effort in Earth Observation has been presented. Even from these outline we believe that is evident the interests of our Country in co-operating and then benefits from a co-ordinated approach in Europe to EO. This interest is not only symbolically underlined by the presence on our territory of ESA/ESRIN in Frascati and CE/JRC in Ispra. Last but not least our geographical position in the Center of Mediterranean sea makes Italy a key partner in the European environmental programs.

Network connectivity in Sweden and Swedish Information Providers

- Stefan Zenker (sz@ssc.se) and
- Örjan Vretblad (ovr@ssc.se)

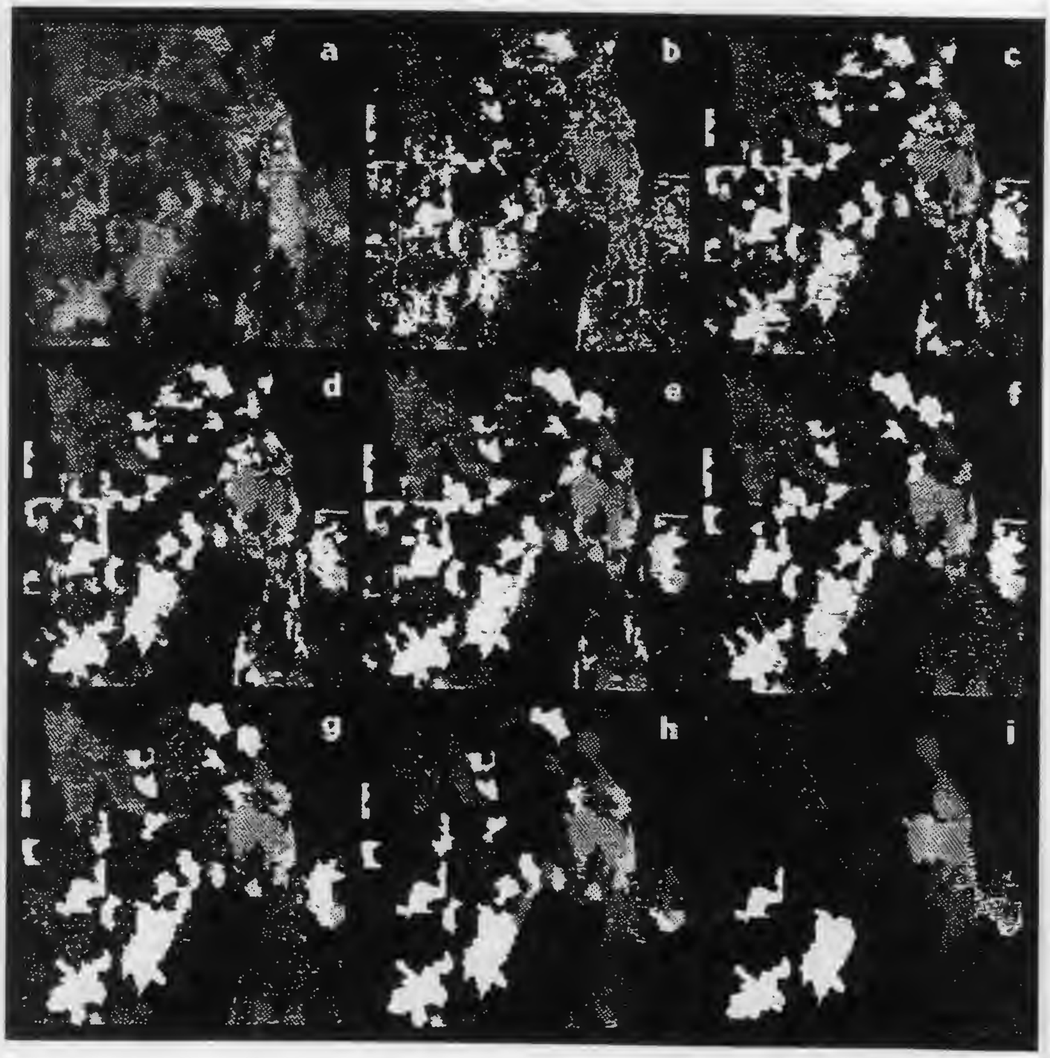
Swedish Space Corporation

EEOS Workshop December 13-15 , 1994

Centre for Environmental Data from Satellites

M D C

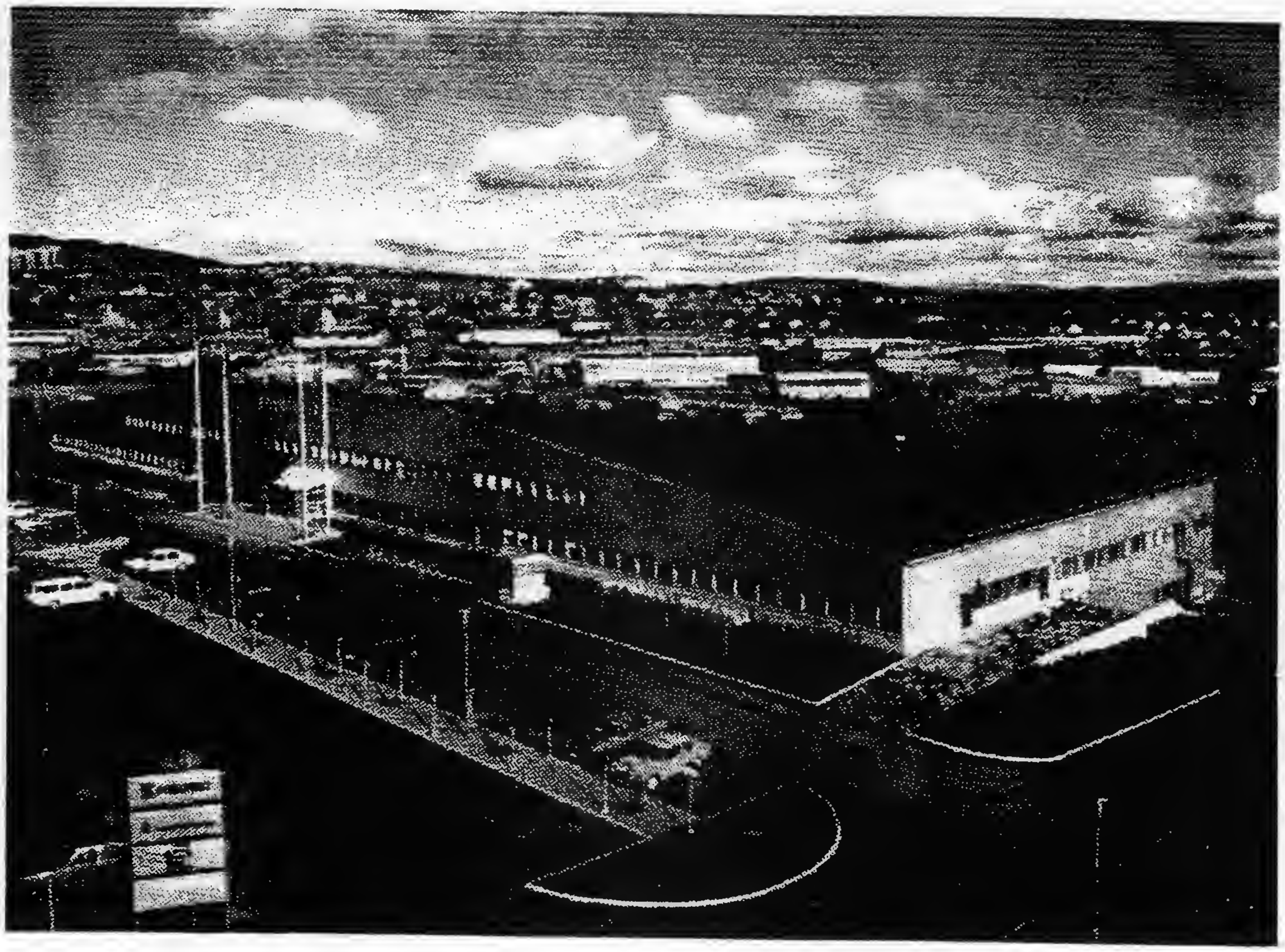
CORINE LAND COVER



Kiruna Ground Segment for ESA Third Party missions

- Processing and archiving of Landsat MSS and TM data, and of MOS and JERS data.
- Digital Quick Looks Landsat TM and JERS OPS data
- Transcription of MSS data to modern high-density media to start in early 1995
- Future transcription of Landsat TM and JERS-1 data to modern high-density media

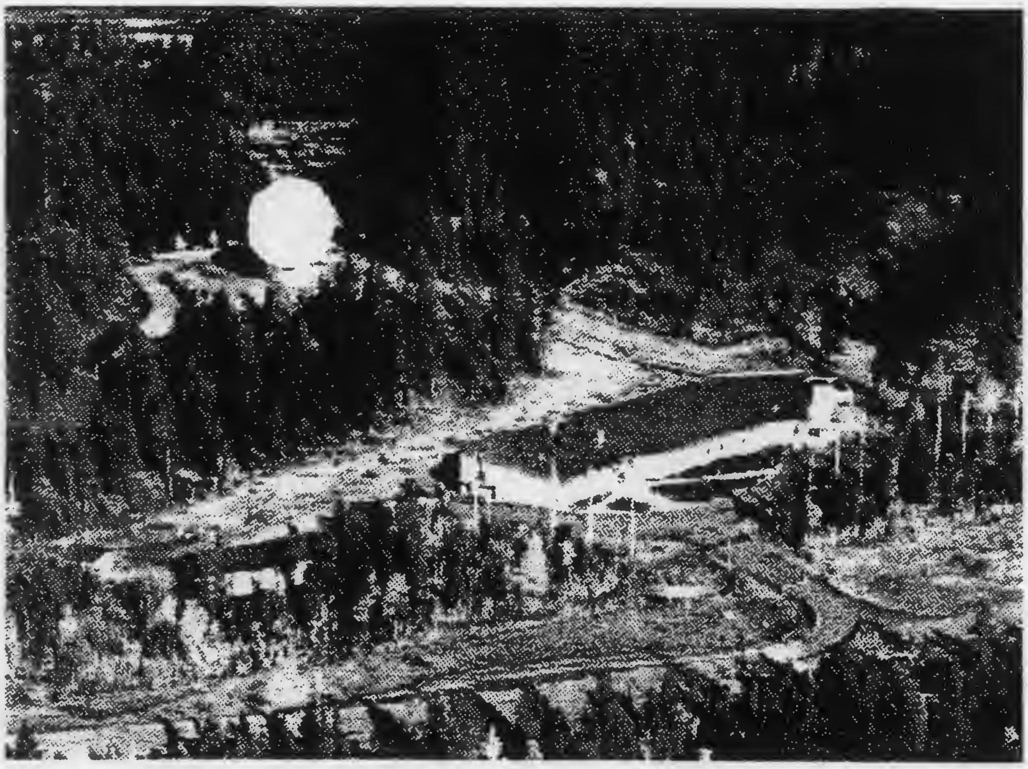
Satellitbild in Kiruna



- Operates one of the two principal SPOT stations in the world.
- Reception of SPOT data at Esrange (global and direct mode)
- Processing and Archiving
- "Value-Added" processing: rectification, mosaics, DTM extraction, Satellite Image Maps ...
- Data sources: SPOT, Landsat, ERS, Radarsat, Resurs (Russian) etc.

Kiruna - Salmijärvi Station

ESA facility outside Kiruna



ERS-1 and -2

- Telemetry, Tracking and Command
- Reception of payload data
- Near Real-Time processing and delivery
- Offline delivery to Processing and Archiving Facilities

ENVISAT - 1

As above *plus*

- Low Bit Rate Reference Archive (LRAC)

Kiruna ENVISAT MERIS Low-Rate Processing and Archiving Centre

- Operated under national responsibility on behalf of ESA
- Archiving of global low bit-rate data
- Production of standard geophysical products

VEGETATION

SPOT vegetation

- **Main receiving station of X-band data in Kiruna**
- **Data transmission - utilization of high data rate links.**
- **Data source for Environmental Data Centre**

940128/CEO_Swed/CAN

SWEDISH ENVIRONMENTAL DATA CENTRE

Centre for Environmental Data from Satellites

M D C

Principal Tasks

- Environmental Data Bases
  Production and Updating
  Development in Cooperation with Users
- Environmental Monitoring
  Monitoring Present Status and Changes in the Natural Environment
- Environmental Research
  Development of Methodology and Models

Centre for Environmental Data from Satellites

M D C Key features

- Cooperation with users. User driven.
- Data bases from satellite data
- Wide geographical coverage
- National and international scope
- Node within EEOS Network
- Long term relationships
- High data quality and easy access via electronic networks.
- Raster and vector data in GIS
- R&D focussed on data sources, data quality
- Environmental monitoring tasks.

Centre for Environmental Data from Satellites

MDC

Will be in operation in Kiruna beginning in 1995.

Connectivity with the outside world:

- Internet access
- Quicklook presentation and ordering will be done using Internet WWW.
- ISDN access

M D C CANDIDATE PRIMARY DATA SETS

Europe

- Land cover (AVHRR/VGT/RESURS/MERIS) - Baltic GIS and European classification
- High resolution data of environmentally sensitive areas in the Baltic Sea Basin
- AMAP - Arctic Monitoring Assessment Programme
- The Barents Sea region
- SeaWIFS for the Baltic Sea/North Sea
- Data Pool for IGBP Core Projects
- Databases for EU Centres-of-Excellence/Topic Centres

Global

- VGT (global 1 km, NDVI)
- MERIS
- AATSR

Research and development

Centre for Environmental Data from Satellites

MDC CANDIDATE PRIMARY DATA SETS

To be defined by various user groups

Sweden

- CORINE Land Cover (5 and 25 hectare pixels)
- MSS-EPOCH (1972-)
- Systematic complete acquisition (every 3 years if Corine Land Cover is done every 6 years) - SPOT/Landsat
- Vegetation classification above the polar circle every 5 to 10 years (climate change research).
- Water quality monitoring

cont'd

Telecom liberalization in Sweden.

- Sweden has never had a formal monopoly for telecom Services

- Sweden has never had a formal monopoly for the establishment of the physical Network.

- The monopoly for equipment connected to Telia (Swedish PTT) was completely abolished 1 July 1993.

- Government has decided on full liberalization of third party traffic.

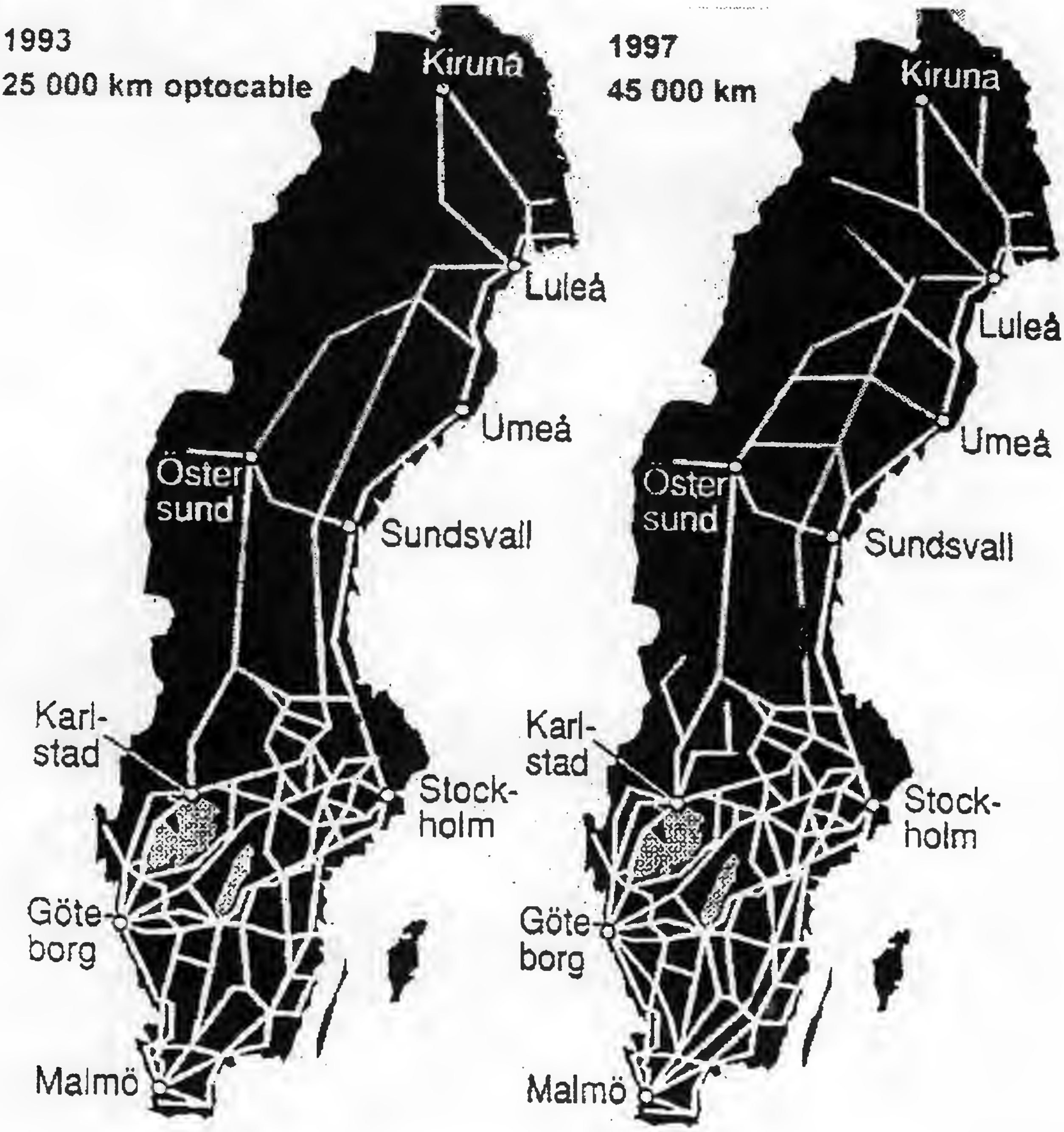
- *The Swedish Telecom law principle:* Price of the interconnection should cover the actual costs, write-offs, and interest on capital, as well as the maintenance and R&D costs which can be attributed to the actual interconnection.

Telecom Operators in Sweden

- Unisource
  - Telia Sweden
  - PTT Telecom (Netherlands)
  - Swiss Telecom
  - PTT Spain
- Transpac Scandinavia
  - France Telecom 60%
  - Dafa 40%
- Tele2
  - Kinnevik 60%
  - Cable and Wireless 40% (England)
- BT
- Telegate
- Infonet
- ...

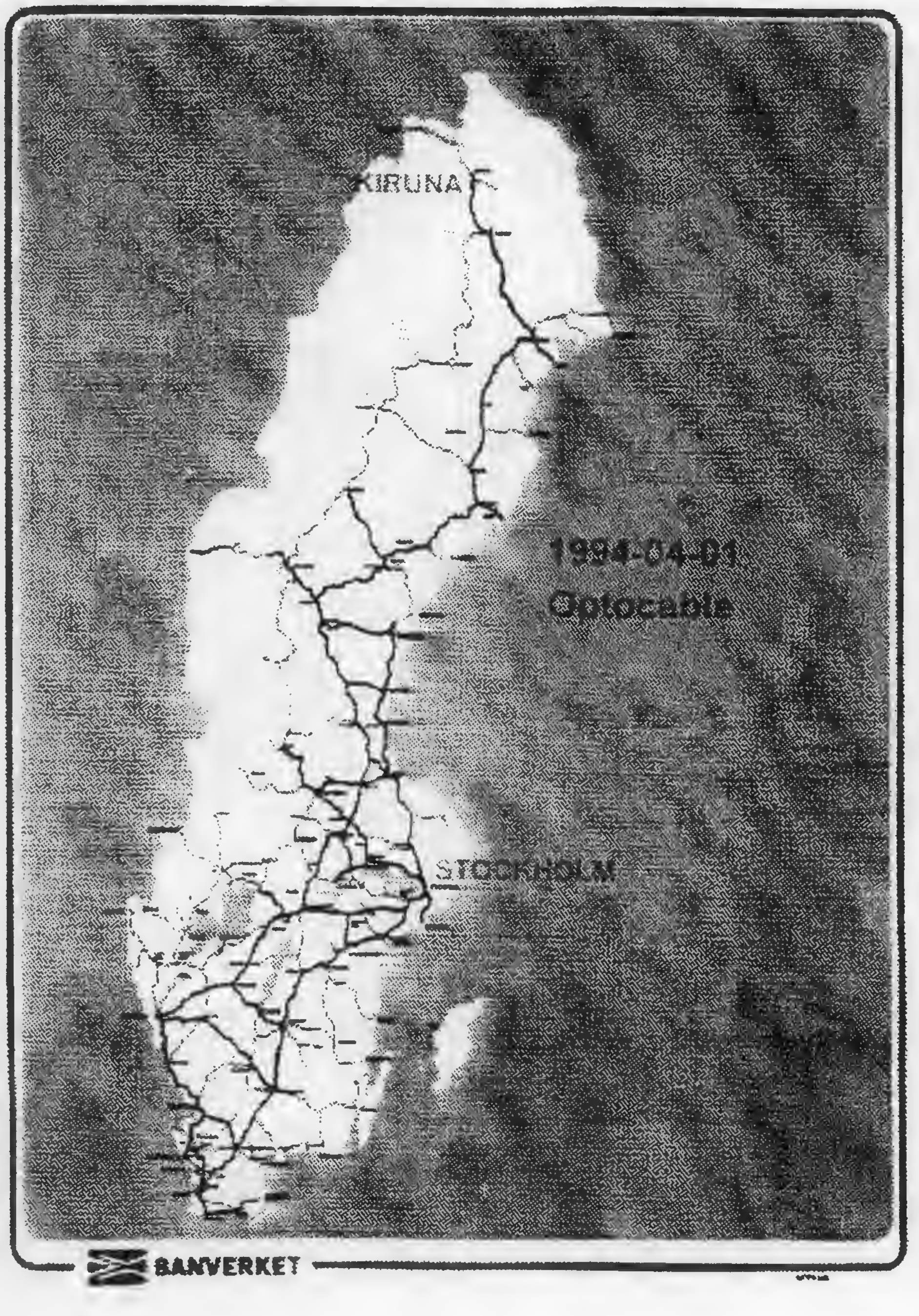
Telia AB

Telias Optonet in Sweden



Swedish National Rail Administration

- 2300 km long fiber network.



GIX, Global Internet eXchange - Internet Marketplaces

- **At the Royal Institue of Technology, Stockholm**

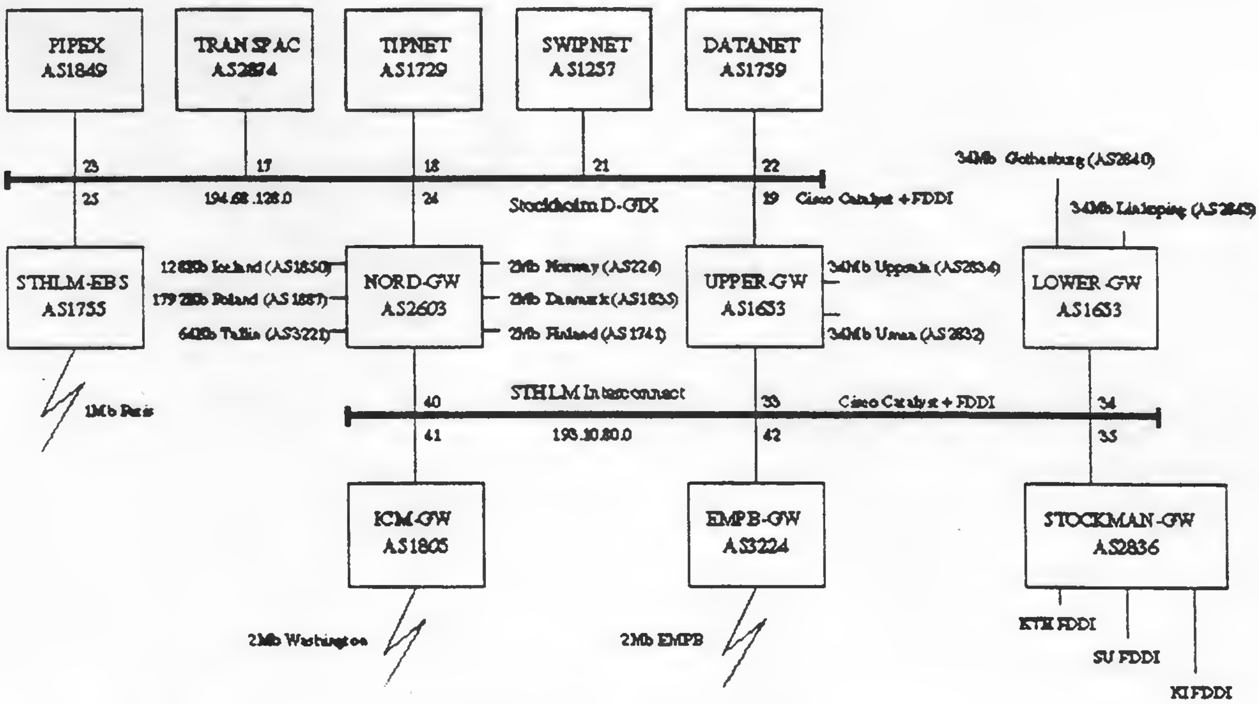
Other GIX points:

- **Paris**
- **Washington DC**
- **US Westcoast**

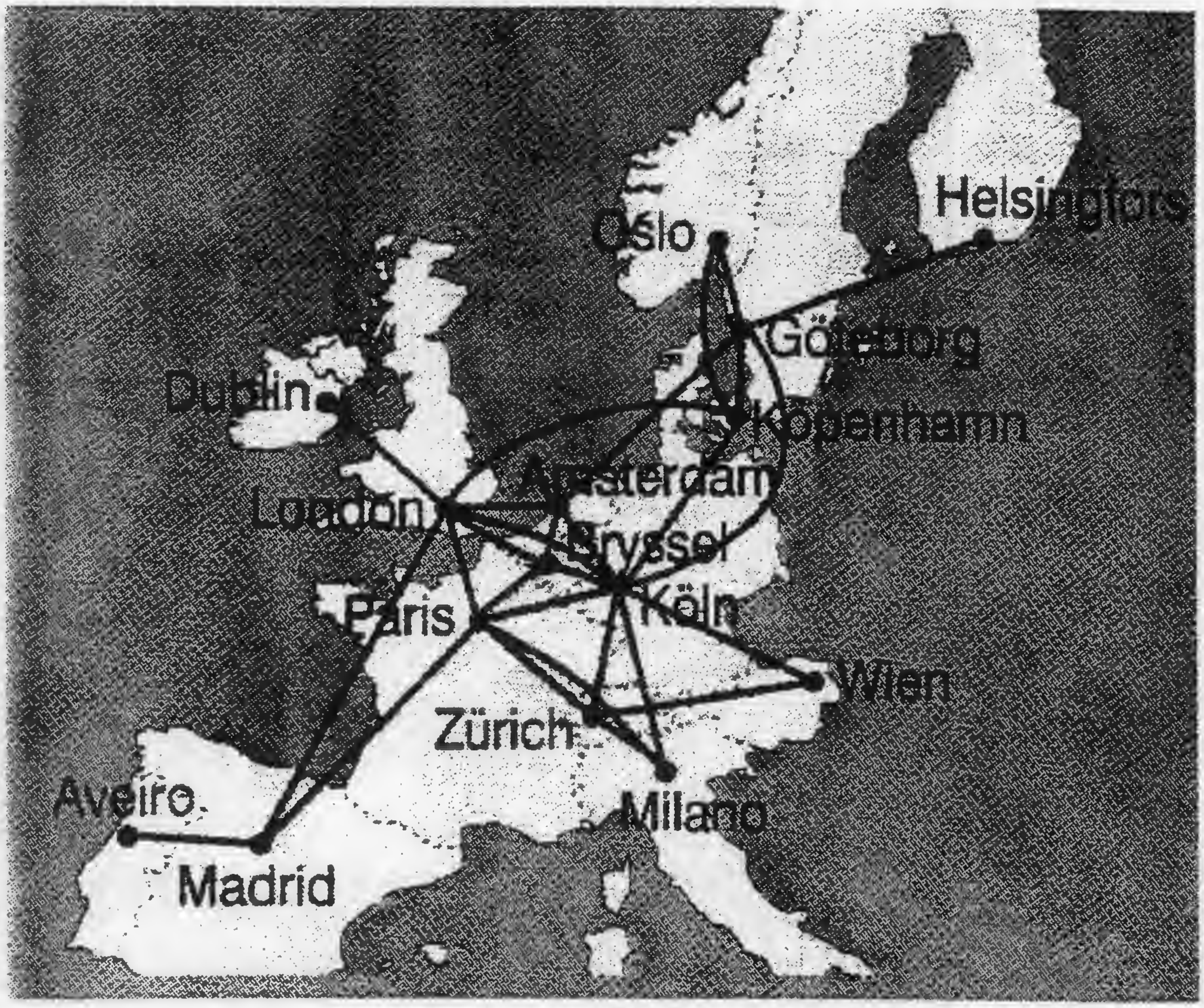
GIX - Internet Marketplaces

- GIX:es today in Stockholm, Paris, Washington DC, US Westcoast
- Global Internet eXchange proposal worked out during 1991/1992 by IEPG
- GIX is supported by CIX
- Intention: To specify interconnection points where multiple providers can connect in a well managed way.
- Possibility for users to negotiate at the GIX point with multiple providers for different demands.
- The traffic passing the GIX is routed depending on policy.
- Internet is ONE address space. Compare: A telephone is used to call all over the world.
- No restrictions what data is allowed to pass the GIX.

GIX, Global Internet eXchange in Stockholm, Sweden



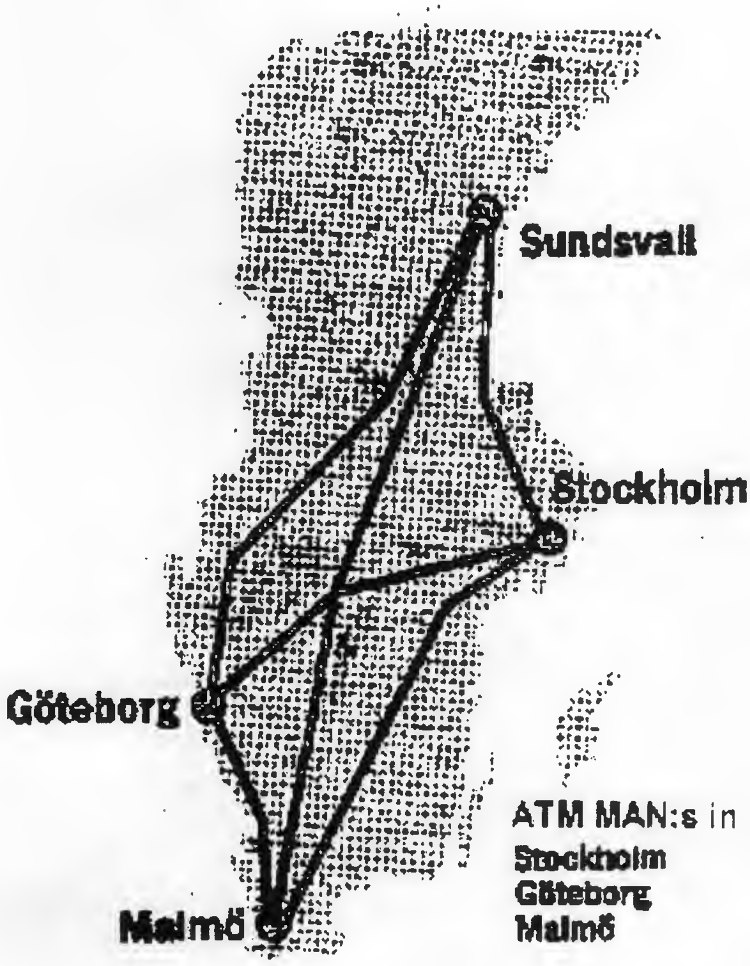
"53 BYTE ACTIVITIES" (ATM) IN SWEDEN



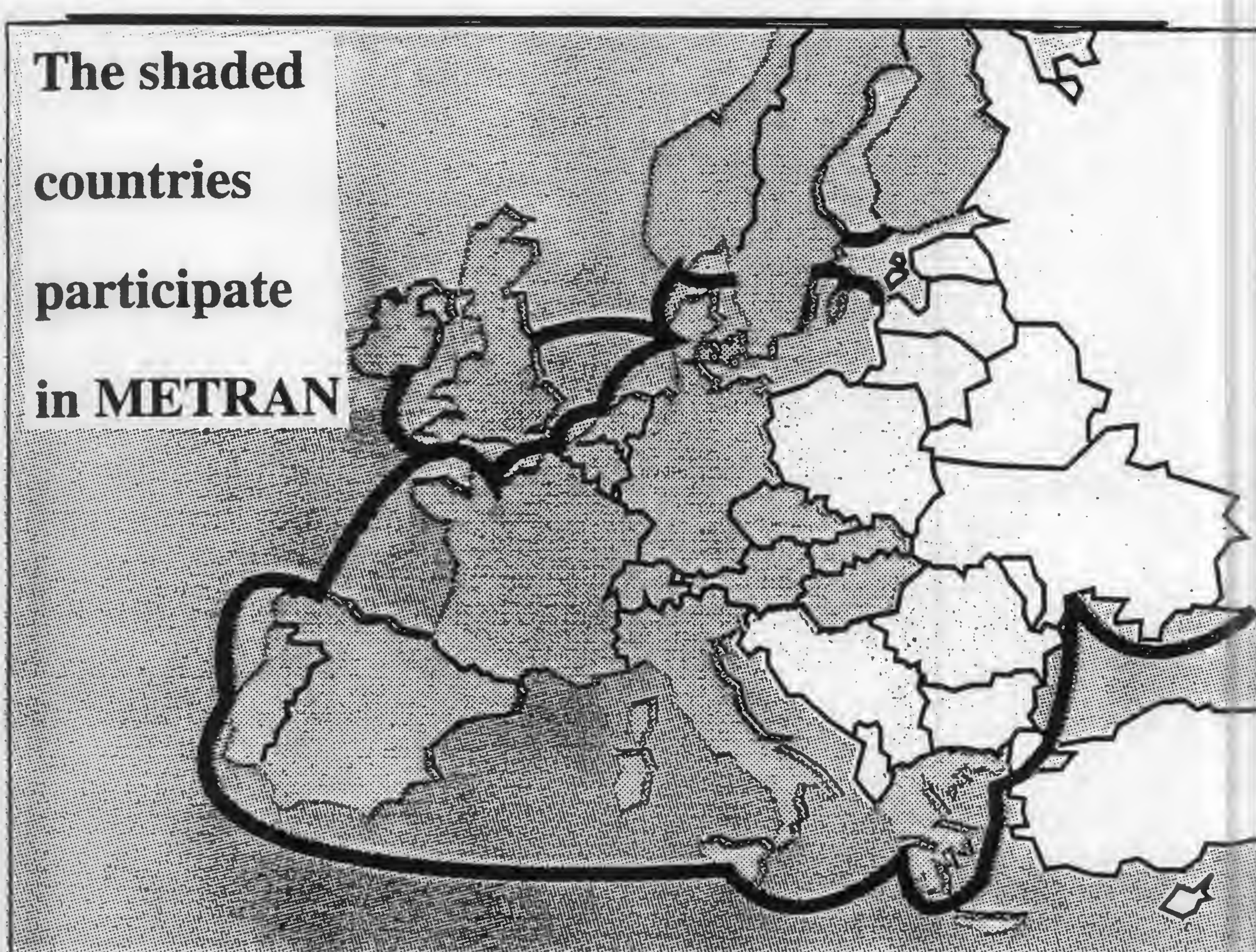
- Telia participant in ATM Pilot Test - Opened 24 nov 1994
- SAS running Pilot ATM test Arlanda, Stockholm - Kastrup, Copenhagen
- Telegate has started to sell ATM connections in the Stockholm Area
- SUNET is starting an ATM-based-net Uppsala-Gothenburg

Telia ATM plans for 1995 cont'd

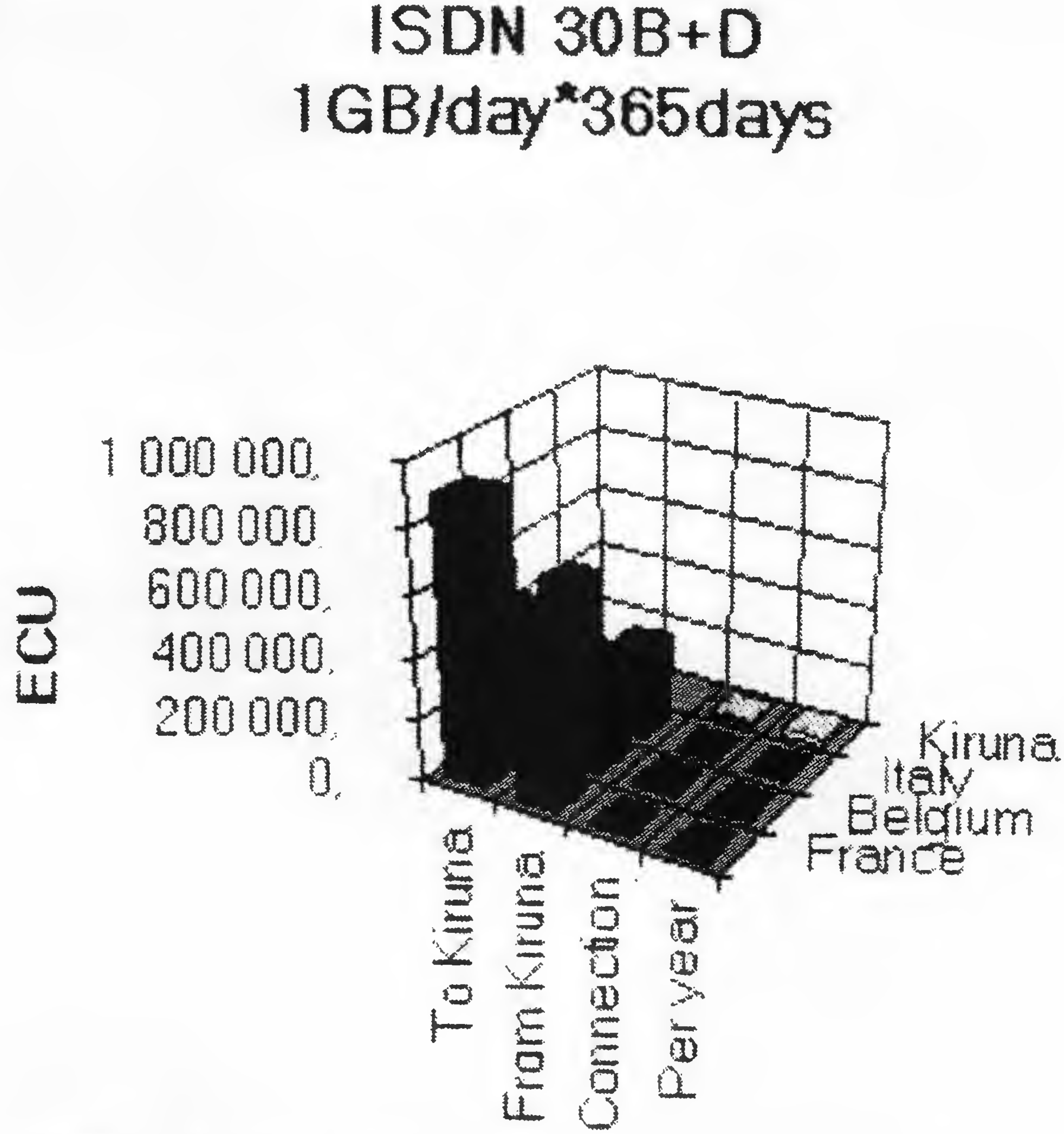
- ATM connections between these cities under 1995:



- ATM MAN:s in Stockholm, Gothenburg and Malmö in spring 1995
- ATM MAN:s in Gävle, Linköping, Ronneby and Uppsala later 1995.


The shaded countries participate in METRAN

Cost using ISDN 30B+D to transfer data from Kiruna - depending on from where the connection is made



Panel 2, session F: "Earth Observation User Views"

An EARSeL Perspective on Contemporary European Initiatives Designed to Promote Increased Utilisation of Space-based Data

By

Dr D. R. Sloggett
Editor-EARSeL Newsletter
2, avenue Rapp-Bureau-418
F-75340 Paris Cedex 07
France

Abstract

Heightened public and political awareness of the impact of anthropogenic related activities on the environment have led to a number of activities aimed at increasing our understanding of the physical, chemical and biological processes that exist at the heart of the Earth's ecosystem. In broad terms these activities have two major objectives. The first is to increase our ability to understand the current state of the environment – in order that short-term responses designed to improve the environment are implemented as efficiently as possible. The second is to develop improved predictive techniques that will help us understand the socio-economic consequences of any changes that might occur, such as a rise in sea levels or alterations to climate patterns. This improved understanding will assist governments, working at local, regional and global levels to formulate policies that will encourage the *sustainable* development of natural resources in the future.

In order to increase our knowledge of the processes that control our ecosystem we need to increase our observations of the Earth at a variety of scales, from the local to the global, using in-situ, aircraft and satellite instruments. Analysis of these observations will allow the development of improved models of the processes, at a range of scales, which will provide the foundations on which future predictions and policies can be made. Increasingly it is being accepted that such observations have to be multi-disciplinary in nature, in order to understand the coupling between the physical, chemical and biological processes involved. This is also reflected in one of the key trends in scientific research to emerge in the last decade, i.e. the move towards inter-disciplinary investigations into, *inter alia*, the coupling between the ocean and the atmosphere, the land and the ocean and the exchanges that occur between the atmosphere and the land.

Space has long been recognised as an important place from which to view the Earth using satellite-based instrumentation. Satellites, such as the NOAA polar orbiting spacecraft – with the ubiquitous Advanced Very High Resolution Radiometer (AVHRR) instrument, Landsat, SPOT, J-ERS1 and the European ERS-1 programme, have increased our understanding of the interactions between some elements of our ecosystem. Notable achievements have included the preparation of global vegetation maps, observations of activities in the tropical rain forests, monitoring of the famous El Nino or southern oscillation, studying the by-products of several volcanic eruptions in the atmosphere, and the assessing of the extent of the ozone thinning that is occurring in northern Europe and in the southern hemisphere. Many of these activities are providing important insights into the way our ecosystem operates. However access to these datasets is often complex. There is an urgent need to increase the *accessibility* of the observations to the widest possible scientific community to encourage their widest possible use in inter-disciplinary research programmes.

These research activities, and the planned launch of a large number of satellites over the next decade, such as the European Envisat spacecraft, require the development and commissioning of an infrastructure that provides scientists with means of accessing the data and models arising from these activities. The infrastructure must provide facilities, on a global, regional and local basis, to: advertise the location of datasets, information and models; search for specific instances of data, information and models that are relevant to a particular research activity; and access those items identified in the search process.

This paper outlines some of the elements of a global data network and highlights important European initiatives aimed at contributing to its development. It also uses an example of a Coastal Information Service (CIS) to illustrate key characteristics of the network which provides access to the research and operational user community. The paper also offers suggestions as to key areas where developments should be undertaken to help improve the accessibility of data, such as the introduction of techniques designed to screen datasets and create high level (meta-data) descriptors of the contents of the data and the development of multi-disciplinary thesauri designed to create applications interoperability when searching datasets stored in different geographical locations.

1. Introduction

1.1 Background

The thinning of the ozone layer over parts of northern Europe, the increased levels of carbon dioxide reaching the atmosphere in the last century, the effects of acid rain on the forests of the Baltic countries and southern Germany, and the changes in the quality of water in some of Europe's maritime basins, such as the Baltic, the Adriatic and the Mediterranean, have highlighted the potential of anthropogenically related sources to alter the balance of the Earth's complex ecosystem.

This heightened awareness of the effects mankind is able to have on the environment is illustrated by a number of developments. These include: increased public awareness of the issues; the growing number of international agreements and protocols related to the climate, such as those agreed in Montreal and at the Rio Earth Summit; increased levels of scientific research and cooperation between scientists across the world, such as the activities carried out by the Intergovernmental Panel on Climate Change (IPCC) and the International Geosphere-Biosphere Programme (IGBP); and the increased political emphasis on the concept of *sustainable* development of economies and the socio-economic consequences of these changes. Agreements related to the environment are not a new political response to public pressure. The 1978 Barcelona Convention covering the monitoring of discharges into the Mediterranean Sea was one of the first agreements to follow from the 1972 Helsinki accords in which the foundations for environmental management were laid through the linkage of the security of states with the need to consider the local environment. In the future, concern also exists about the socio-economic implications of climatic change, such as increased sea levels, extreme climate events, modifications to patterns of agriculture and fisheries, and increased desertification, for the population.

For some years research scientists have been aware of trends in climate patterns, such as the periodic advance and retreat of ice, from examination of Antarctic ice cores. Some of these are believed to be induced by subtle variations in the orbit of the Earth around the Sun. This alters the level of energy received by the Earth's ecosystem from its main source. In trying to identify if mankind's activities are having an effect upon our environment there is a need to establish the background levels of change, which are part of natural processes, in order to distinguish any fingerprint or signature that is indicative of anthropogenic activity.

In trying to detect small changes in the physical, biological and chemical processes that control our planet research scientists need access to a time series of observations on a variety of scales from local, through regional, to global. Contemporary observations of many key geophysical parameters are limited in time and spatial coverage. Over many parts of the world, such as the Southern Ocean, observations are restricted to point measurements. These limitations restrict scientists who are trying to use real world observations, in tandem with models of the processes that control our ecosystem, to forecast future climatic changes.

Information on the implications of future climate change is of interest to a wide range of decision makers concerned with establishing policy on, *inter alia,* emission levels of harmful gases, the levels and fate of pollutants reaching the coastline, future coastal defence projects, and sustainable development of resources – such as the tropical rain forests. What is needed is an infrastructure of instruments and data management facilities that will enable policy makers and planners to have access to high quality datasets and information about the current perspective on the environment and predicted changes and their socio-economic implications.

This fusion of real world observations – derived from a number of sources, predictive models, and socio-economic forecasts will provide scientists and decision makers with the information they require to derive policies that are based upon the principle of the most effective and sustainable use of resources. This paper considers such an infrastructure. It takes account of the proposed development of the European Earth Observing System (EEOS) and the European Commission Centre for Earth Observation (CEO) Project. It also recognises important initiatives such as the Global Environmental Data Network (GEDN), the Global Ocean Observing System (GOOS) and the Global Climate Observing System (GCOS). Through an application in the coastal zone, the paper illustrates the type of infrastructure that could be established over the next decade to provide information services to research groups and decision makers around Europe.

1.2 Contemporary Environmental Pressures

Today there are many pressures that exist in our environment. Mankind, through economic and social activities, has the potential to become a major forcing function within the global ecosystem. The paper 'Europe's Environment: The Dobris Assessment (see EEA 1994) has been prepared by a European Commission task force in cooperation with a number of organisations including the United Nations Environmental Programme (UNEP), the Organisation for Economic Cooperation and Development (OECD) and the World Health Organisation (WHO). This combination of agencies covering such subjects as health, economic development and the environment illustrates the recognition that now exists in many organisations of the need to foster multi-disciplinary approaches to studies of the global ecosystem. A good example being the concern expressed by many scientists on the possible linkage of increased occurrences of skin cancer and the depletion of the ozone layer.

The Dobris Assessment highlights a number of key changes that have occured over the last one hundred years such as:

- the three fold increase in the world's population
- the clearance of over 6 million km^2 of the world's forest - an area larger than Europe
- the thirty fold increase in the consumption of fossil fuels
- the twenty fold increase in the world's economy.

The report lays out in detail the key characteristics of the European environment. It points out that Europe occupies only 7 percent of the Earth's land area with a population density 2 to 3 times that of the United States and Africa, but only half as much as Asia. Europe has a dynamic landscape where forest cover varies from 66 percent in Finland to 6 percent in Ireland. The proportion of land devoted to agriculture varies from less than 10 percent in Finland to more than 70 percent in Hungary, Ireland, Ukraine and the United Kingdom.

Consideration is given to a summary of the current state of the environment in Europe under headings which include: air; inland waters; the seas; soil; landscapes; nature and wildlife; the urban environment and human health. The assessment of the trends in air quality in Europe was carried out at three scales: local; regional and global. The report emphasizes the impact of air pollution on human health and the urgent need to establish conventions and regulations on emission levels. In order to establish such regulations on the basis of the best available quantified data this paper contends that it is important to access measurements on the environment that are derived from a number of sources, including: space observations, in-situ measurements and airborne surveys.

Studies initiated through the auspices of the IPCC have highlighted the potential difficulties that might arise for mankind if the present rates of increase of emission of carbon dioxide remain unchecked. These studies have considered a number of different scenarios for future emissions. The first of these is the IPCC 'business-as-usual scenario' – in which man-made carbon dioxide emissions rise from 7-8 Gtons per year at the turn of the century to over 20 Gtons per year by the year 2100. Other scenarios consider varying degrees of controls on emissions of gases such as carbon dioxide (CO_2), methane (CH_4), chlorofluorocarbons (CFCs), carbon monoxide (CO), and nitrogen oxides (NO_x), with one scenario envisaging emission levels at 50% of the 1985 levels by the middle of the next century.

In addition to the levels of emission of potentially harmful gases into the atmosphere mankind has also been disturbing the balance of nature in other ways. The rapid depletion of the tropical rain forests is steadily reducing the biomass that is available for photosynthesis. In areas which have been cut there is evidence of significantly increased levels of soil erosion. Evidence is also growing of the by-products in the coastal zone of intensive farming – with higher levels of nitrates being recorded in many European maritime basins. Population growth is another factor which is causing localised pressures, as is economic activity in coastal regions, where the spillage of oil from tankers is seen to be an on-going problem.

Results from the studies, (see Houghton et al, 1990 and 1992), have revealed a range of potential changes that might occur in the environment. These include: alterations in agricultural practices; more frequent occurrences of extreme climatic events; increases in sea level, as a result of melting ice; higher recorded levels of skin cancer, as a result of the decreasing concentrations of ozone in the atmosphere; and relocation of fishing grounds, due to modifications in ocean and coastal circulation patterns.

Politicians, through the Montreal accord concerning the emission of CFCs and Agenda 21 of the Rio Summit, have recognised the need to address these potential changes and to quantify their potential socio-economic implications for mankind. They have decided to take action to develop sustainable policies concerning the exploitation of renewable and non-renewable resources and to adopt measures to reduce emission levels of harmful gases, such as carbon dioxide.

In order to refine and monitor the effect of such policies environmental managers require access to data on a variety of scales. These range from the global scale – where access to concentrations of phytoplankton enable scientists to postulate the level of carbon dioxide draw-down into the ocean that is happening on a seasonal and annual basis; to the local scale where riverine discharges need to be monitored for sources of phosphates and nitrates that can have a major impact in a limited area. Applications vary from monitoring the dispersion of sewage outfalls, to observing the area affected by the emissions from a power station, through land-use studies (including urbanisation), to agriculture and studies of the coastal zone.

1.3 Natural Phenomena

The Earth is a complex planetary ecosystem where physical, chemical and biological processes sustain a diverse range of life forms and habitat. Many of these processes arise as a direct result of the large quantities of energy that we receive from the Sun and, to a lesser extent, forces that arise due to the alignment of the Moon and the planets in our solar system, such as tides. Evidence derived from Antarctic ice cores, going back over 160,000 years, show that the Earth's temperature closely tracked levels of methane and carbon dioxide in the atmosphere. Whilst the exact nature of the mechanisms that create this high degree of correlation is poorly understood they do reveal links to subtle alterations in the orbit of the Earth around the Sun. The theory behind these observations is known as the *Milankovitch hypothesis*. This suggests that over periods of 96,000 years – where the eccentricity of the Earth's orbit changes, through periods of 40,000 years – where the tilt of the Earth's axis of rotation varies (referred to as the obliquity of the eccentric), to the periodic precession of the equinoxes (21,000 years) the levels of radiation received by the Earth is altered.

These differences in the levels of energy entering the planetary system effect the processes that control our ecosystem, such as ocean circulation patterns, climate and sea levels. They also create a background of continuous climate change that occurs as a result of natural forces. In addition to these periodic and relatively slow changes to our climate system, events – such as large scale volcanic eruptions, earthquakes and severe floods – have the ability to have devastating short term implications on the environment and a local economy. Famous events, such as the El Nino Oscillation in the southern hemisphere, also serve to heighten our awareness of the potential economic consequences of climate change; where clear evidence exists of the local impact on fisheries. These examples illustrate the need to understand these processes in more detail, to forecast their occurrence and likely effects (risk assessment), and devise suitable approaches to minimise their economic and environmental consequences.

1.4 Anthropogenically Induced Changes

In recent years anthropogenic changes have been recognised as having the potential to significantly increase the rate of change of warming of the Earth – over and above that already occurring due to natural phenomena. Reports published by the IPCC, (see Houghton et al, 1990 and 1992), suggest that global sea levels have risen by 10-20 cm and the mean surface air temperature has increased by 0.3 °C to 0.6°C over the last 100 years. These changes are broadly consistent with those that would be expected from climate models using known levels of carbon dioxide emissions since the time of the industrial revolution. However, these changes are also within the bounds of natural climate variability. Our challenge is to isolate the changes that are caused by natural causes and those which are linked to anthropogenic forcing. To do this we need access to a long time series of observations made on a global basis.

Concerns over the potential long term impact of anthropogenic-induced changes to our planet at local, regional and continental scales have resulted in governments all over the world approving budgets for long term space missions that are capable of monitoring any changes that might occur. These space missions will deploy a variety of sensor systems. Some will be linked to previous missions. Others will be steps into new domains where repetitive global measurements have previously not been available. These sensors will operate on a global scale to monitor, at scales hitherto not available spectrally and spatially, changes in: atmospheric chemistry, biodiversity, sea levels, sea surface temperature, ice sheets, tropical rain forests, the extent of deserts and coastal regions. The scale, frequency and resolution of these observations poses significant challenges for technologists. Their task is to design the ground-based infrastructure that allows operational, research and commercial users to access the data in ways that will enable them to use it effectively.

2. A Global Environmental Monitoring Network

2.1 Application Networks Operating at a Global, Regional and Local Scale

Internationally, governments are showing signs of recognising that the formulation of effective and sustainable environmental policies requires access to long term datasets, predictive models and socio-economic forecasts, that describe and assess the interaction of the physical, chemical and biological processes that control our planetary ecosystem.

Whilst important, long-term monitoring is not the only use of environmental data that can be made by decision makers. Often access to data is required in near-real-time in order to respond to disasters that can have a big effect upon the local population. These include: flooding events, volcanic eruptions, earthquakes, tidal surges - that are coincident with low pressure areas, and large scale pollution incidents, such as the recent Braer disaster. There is also a growing interest in government agencies in the potential use of near-real-time data to assist in the monitoring of coastal areas. Using the 'polluter pays' principle there is a great deal of interest in establishing networks that can assist in the effective deployment and operation of airborne based sensor systems whose task is to monitor coastal zones. In the wake of Lord Justice Donaldsons Report on the Braer disaster research has been initiated into the potential use of satellites for monitoring Marine Environmentally High Risk Areas (MEHRAs), see Sloggett (1994c). This aims to use Synthetic Aperture Radar (SAR) data from ERS-1 satellite to monitor maritime areas that are deemed to be important biomes, such as wildfowl wintering habitats, fishing grounds etc. The aim is to establish, in the future, dedicated satellite missions with an optimised sensor suite, perhaps comprising a SAR and an imaging spectrometer, to monitor these key areas routinely. Such a mission could well fall within the framework of the Earthwatch concept outlined by the European Space Agency (ESA), see EARSeL (1994).

To support effective decision making, data and information derived from in-situ, satellite and airborne sensors, needs to be integrated with models to provide nowcasts or forecasts of the development of different types of event. In this way decision makers can be provided with information that enables them to take effective decisions in a timely way.

Initiatives, such as GEDN, GOOS and GCOS, are designed to be part of a global monitoring network that would be able to provide secure archives for historical data and access to near-real-time observations of the environment in those applications where it would be useful, such as disaster monitoring.

Whilst many initiatives exist to help increase access to data on a global scale the agencies tasked with their development face many problems. Budgetary limitations pose the most serious constraints on the planners. The lack of any significant new sources of finance for these projects requires that the maximum use be made of existing and planned infrastructure developments on a national and regional scale; a case in point being the development of proposals for the EuroGOOS project; (see Flemming et al, 1994). Global networks will evolve from the interoperability of regional networks that are being established in, for example, Europe, Japan and the United States.

2.2 The European Earth Observing System (EEOS)

The joint ESA and European Commission initiative on the EEOS is hoped to be one element of the GEDN. At a recent Workshop in Cambridge, organised by the British Association of Remote Sensing Companies (BARSC), Sloggett (1994a) suggested a potential mission statement for the EEOS. This was:

> *'The European Earth Observing System is the infrastructure that enables the operational, research or commercial use of information derived from Earth observation data by organisations responsible for the development of policies or activities concerning the sustainable exploitation of renewable and non-renewable resources in Europe and its international economic and cultural partners.'*

This proposed mission statement highlights a number of key points that are important for the development of the EEOS element of the GEDN. The first of these recognises that the EEOS should provide an infrastructure that can supply a wide range of different user communities. The second point highlights the utilisation of information derived from the data. The third point emphasises the role of the EEOS in formulating effective approaches to resource management and the last point draws attention to the need to work within an international context. The four elements of the proposed mission statement establish some necessary drivers for the design and development of the EEOS.

In common with our international partners needs to build upon existing projects and infrastructure the EEOS will have its roots in a number of established activities. These include the current ESA ground segment for missions such as ERS-1, NOAA AVHRR, Landsat and Coastal Zone Colour Scanner (CZCS). In the case of the ERS-1 mission important facilities include the Processing and Archiving Facilities (PAFs), the user services at ESRIN and the network of ground station facilities; see Sloggett (1989). In the case of the other missions the archives of CZCS, Landsat and AVHRR data at ESRIN are also important.

ESA is also planning to build upon these facilities as it creates the ground segment for Envisat. Once developed this ground segment will also become part of the EEOS. It is therefore possible to envisage that ESA will be responsible for establishing the data provider side of the EEOS, concerned with the access to data derived from satellites. They may also provide the facilities required to support the near-real-time users of the EEOS where data will be turned into information once it reaches the ground.

With ESA providing access to the satellite data, and in some cases the near-real-time applications infrastructure, the European Commission has to address the facilities required to support the users who wish to gain access to non-satellite-based data. This is one of the roles of the proposed CEO project planned within the Fourth Framework Programme of the European Commission.

2.3 The Centre for Earth Observation Project

The European Commission and ESA have agreed that the element of the EEOS that will be provided by the Commission is the CEO project, see Churchill and Hubbard (1994). This project is currently being coordinated by a team drawn from all over Europe that is located at the Joint Research Centre at Ispra, Italy. The project is currently in a pathfinder phase where a number of studies are being undertaken to build upon a feasibility study contract that was undertaken by an industrial team in 1993. These more focused study programmes are based upon a two-pronged attack on the users requirements for access to data and information that is available from a CEO system. The first of these has taken four application-based areas covering the coastal zone, marine radar altimetry, forestry and agriculture and the atmosphere and is studying the service provisions that should be made available by the CEO to each of these communities. The second line of attack is to undertake a series of horizontal studies – that reflect economic and regional groupings of countries – to analyse more general requirements for access to Earth observation (EO) data.

In undertaking all of these studies the CEO team hopes to build up a more complete understanding of the characteristics of the infrastructure required to encourage and support the widest possible use of EO data, and the information derived from it, across Europe. This desire reflects concerns within the European Commission on the level of exploitation of EO data that has been achieved to date. It also recognises the increased volumes of data that are going to be available over the next decade as missions such as Envisat are launched.

In seeking to establish an infrastructure designed to encourage greater use of EO data the CEO team has to balance the needs of operational uses of information derived from EO data with those of the research community. This poses some interesting problems for the CEO team. At one end of the spectrum there will be a need to exploit data from a variety of sources to generate information in both near-real-time and off-line. At the other end of the spectrum there is a need to support research groups who wish to access data sources, such as meteorological data over a test site. One typical example would be to have access to atmospheric pressure, temperature, wind speed and direction information. These are important geophysical parameters for a wide range of applications subjects.

Operational users, such as agencies of the European Commission, will require a range of services from the CEO. The near-real-time services include monitoring oil spills and Harmful Algae Bloom (HAB) events, flooding, active volcanoes and forest fires. The off-line monitoring networks would still cover some of these applications areas. For example it is possible to envisage that the frequency of monitoring of an area, such as a volcano or coastal region, would increase when indications, derived from other sources, showed increasing probability of an event occurring. Interferometric SAR observations of the swelling of a volcano prior to its eruption, indications of the existence of the right conditions for a HAB to occur, and knowledge of high levels of rainfall could all be used as external indications of the need to activate a near-real-time service to the appropriate authorities.

One of the founding concepts for the CEO project outlined by Simpson and Elkington (1993) has been the concept of a *federated* architecture. This envisages an infrastructure where any research group, operational or commercial user can join the CEO as an equal partner both in terms of data provision and data consumption. In publishing their own datasets a user adds value to the network by allowing other users to access measurements of the environment that have been made, often in a restricted area. Research scientists gain value from comparing and contrasting results they obtain with those observed by other groups working in similar fields. Often they are looking for validation, or confirmation, of their own findings and conclusions. In those cases where the findings may differ they seek to understand the physical, chemical and biological processes that might explain contrasting results. It is envisaged that the CEO can be an important framework that will support research groups working together in this way. The aim must also be to ensure that the maximum benefit is obtained around Europe in this regard as budgetary pressures require that limited resources are spent wisely.

Another important development in contemporary science is the need for researchers that have traditionally been associated with a specific field of science to understand external forcing functions and factors that effect their own area. In the coastal zone interfaces exist with the atmosphere, the oceans and the land. Research groups working in the coastal zone have to understanding the effects each of these interfaces can have as they seek to understand the processes involved in their application. As we consider the Earth as a global ecosystem it is important to recognise that this is linked with land-air, ocean-air and land-ocean interfaces that control the movement of natural and anthropogenic sources of materials through our environment. This is one area where the CEO project can help provide important new interfaces that cross the boundaries of traditional disciplines.

2.4 Some Fundamental Features of an EEOSt

In analysing the likely final operational and research goals for the EEOS it is clear that there are a number of fundamental principles that must be taken into consideration. The first of these is the recognition that operational services will require the integration (or fusion) of data from several sources in order to provide access to reliable information sources. Often the approach outlined in this paper of using models and observations of the environment in tandem requires that the models use data from a number of sources, notably meteorological data. In areas such as – forecasting crop growth, the movement of oil on the surface of the sea, predicting the area affected by a release of chemicals from an industrial plant, and deciding upon the scale of floods that might occur in a given river basin – a common theme emerges – access to up-to-date meteorological data. Our analysis suggests that this is one of the fundamental data sources that will be required to support operational and research activities within Europe.

A second principle is that of adopting standards to the way in which data is documented and catalogued within the EEOS environment. The creation of a federated or even semi-federated architecture of data suppliers and consumers and information consumers requires that a high degree of interoperability be established within the network that supports the EEOS. In attempting to implement such an infrastructure one is bound to be constrained by a large number of factors, such as the existing investments in database systems and technologies made in a number of the data suppliers that might join the network.

A third principle is the need to recognise the requirement for locally-based services that can take account of local phenomena. Variations in bathymetry, meteorological conditions, upwelling, the position of the thermocline, concentrations of nutrients and other sources of food, levels of salinity and oxygen in the water and the local nature of aerosols in the atmosphere all represent examples of very localised effects that must be taken into consideration when generating information from data. If, for example, we take the case of measuring accurately the levels of chlorophyll in the water using an ocean colour instrument, such as the CZCS, we need to take account of localised atmospheric conditions – ozone concentrations, aerosols and air pressure – in order to remove the 90% of the signal that originates from the atmosphere and access the 10% that is derived from the ocean surface.

A fourth principle applies to both the EEOS and the CEO. This is one of making data more easily accessible to users, see Gudmansen *et al* (1994) and Sloggett *et al* (1994b). It is possible, within the context of EEOS and CEO to envisage several developments that will help users gain access to data that is *relevant* to their needs. This paper proposes three that could be important.

The first of these is the introduction of advertising agencies (or data brokers) for data. These data brokers would be facilities who hold catalogues (or summaries) of data held in specific locations or archives. Their task would be to link users - who may place a fairly general query for data with the network - with archives (or data providers) who can supply data that meets their query. It is worth noting that this may require data queries to be broken down into parts that might be answered from different archives. A second element that should be urgently addressed in the need to generate high level descriptions of data that is stored within archives. These high level descriptions should indicate, *inter alia,* if features exist in the image and measures of the quality of the image, such as cloud cover.

Sloggett (1994a) and Sloggett *et al* (1994b) have suggested that it might be possible to develop algorithms that filter the data as it is received at the ground station to detect key features of interest in a scene. These algorithms are known as *agents*. Their task is to detect specific features in an image, such as an algae bloom, an excessive level of sediment, a forest fire, a significant change in the land surface etc. Once detected the data descriptors for the image would be updated to reflect the content of the scene. Users would then be able to search archives and catalogues using queries that relate to their real wold problems. It is possible to envisage a user query containing the following 'please supply me with all data of the English Channel between March and April 1994 that contain an oil slick'. This query has several key components. The first is the location - the English Channel. The second is the dates of interest - between March and April 1994. The third is the feature that is of specific interest - an oil slick. Contemporary cataloguing systems would not be able to handle such a query as the data stored in them would not enable an intelligent match to be carried out. There is a very real need for initiatives, such as EEOS, to address how users could readily structure such a query and have systems respond to it quickly and effectively.

These key elements of a query, the area, time and type of feature of interest, are all part of the definition of an Area of Scientific Interest (AoSI) suggested by Sloggett (1994a and 1994b). Scientists working in a variety of applications areas often conduct their research in limited geographic regions and between key dates, such as in the spring - when phenomena they are interested in occur. It is proposed that the EEOS should allow users, such as scientists, to define their AoSI once and then the system should filter out data that meet that specification. When data are located that match the users needs they should be forwarded to the user, perhaps in the form of a browse image, for the user to confirm interest and order the data. Above all else the EEOS should provide facilities that provide users with new means of accessing data. This will require some fairly fundamental reconsiderations of traditional approaches to cataloguing systems and some innovation on the part of users who wish to use the systems. If this can be achieved the EEOS will most certainly assist in the promotion of the uses of satellite-based data.

3 Environmental Research and Operational Services

3.1 The Role of Research Groups

Research in several of the applications areas discussed so far has highlighted the potential use of EO techniques in monitoring the environment. The European Association of Remote Sensing Laboratories (EARSeL) is one of the leading pan-European bodies coordinating research into the environment across a broad range of applications areas, see EARSeL (1994a).

Research undertaken by EARSeL members often involves studies carried out using a combination of in-situ, aircraft and satellite data over a key test area. Results are analysed to gain insights into the physical, chemical and biological processes involved in the region concerned. The outcome of the research is then often expressed in the form of models of the basin and regional scale effects. Once refined these models can form the basis of an operational infrastructure which uses satellite, in-situ and airborne observations of specific instances in time to initialise the model and enable nowcasts to be made of the future development of a process being studied. This linkage of intensive monitoring of the processes involved in a local area, through model development and exploitation, is a classic evolution of scientific understanding into operational use of observations from a number of sources. It also highlights key ingredients of the EEOS infrastructure.

Following a grant from the European Commission EARSeL established a working group under the leadership of Professor Gudmansen of the Technical University of Denmark to look into the users views on satellite data accessibility and archiving, see Gudmansen *et al* (1994). Their study used a number of test cases covering a number of applications areas to investigate the issues arising for users in the development of infrastructures such as the EEOS and CEO. Key drivers that emerged from the study included a need to recognise the distributed nature of data in Europe, the need to develop standards for data and information exchange, the need to establish long-term archives for data in Europe and the development of standard user terminals that provide common toolkits for data location and processing.

3.2 Priorities for the European Commission

The European Commission (1992), through its paper COM (92) 360 Final concerning future space policy and actions has established its priorities for the use of EO data. These priorities have been agreed with the European Parliament. They aim, through a number of initiatives contained within the Fourth Framework Programme, to demonstrate the role of EO data in the daily lives of the European tax payers, who have funded space research to date. The emphasis is on the operational uses of EO data that assist in the development of policies and procedures for the effective deployment and use of resources in the environment.

Contemporary public opinion on the state of the environment is often linked to the pictures that we see on television each night and to the public's perception of localised 'changes' in our environment, such as water rationing due to a lack of rain, 'warmer' summers, and extreme events – such as the famous storm that occurred in the United Kingdom in the late 1980s.

In order to respond effectively to increasing public concern on the state of our environment, governments, their agencies and pressure groups require access to quantified and validated observations of the environment on a routine basis. Research groups need to know of the results of other groups work in order to decide what new vistas to explore in their own local activities. Government agencies require long term *operational* access to information that provides quantifiable insights into changes that are occurring in the environment. This is where EO has a real role to play.

The effective use of data from a variety of sources, such as satellites, in-situ observations, and aircraft is fundamentally dependent upon the existence of an infrastructure that provides users with an ability to easily access data stored in a number of geographically disparate locations, see Black et al (1992). The CEO project is one element of such an infrastructure. Elkington and Simpson (1992) have recognised this need and proposed the development of what they referred to as a *federated* architecture.

This argument has been developed further by Sloggett et al (1994b) in the course of the OCTOPUS study contract undertaken for the Space Policy Unit of the Commission's DG XII. Some of the ideas from the study were presented at a BARSC workshop on 'Exploiting the data explosion' in Cambridge (September 1994) and developed into a full scale proposal of a Coastal Information Service (CIS) at an EARSeL workshop on the coastal zone in Delft (October 1994).

3.3 The Information Requirements of Decision Makers

Decision makers require access to quantified *information* about the nature of the changes that are occurring within our environment. Agencies, such as the recently formed European Environmental Agency (EEA) are mandated to collect information on the state of the environment and report this to the European Parliament in order for them to enact policies that will encourage sustainable development of key resources (see EEA 1994a).

Recently particular concerns have been voiced over the increasing level of development that is occurring within the coastal regions of Europe – with over 50% of the population living within 50 km of the coast and serious socio-economic pressures likely to occur along the southern rim of the Mediterranean Sea.

The European coastline is over 143,000 km long and is very diverse. Ranging from the northern Arctic shores of Norway to the the Mediterranean Sea and from the eastern Atlantic to the Black Sea, the European coastlines are subject to a variety of pressures, both from the climate and from mankind. The Dobris Assessment (see EEA 1994b) and the European Land-Ocean Interaction Studies (ELOISE) Science Plan, (see Cadee et al, 1994) have highlighted some of the specific details of the pressures on the coastal zone.

The EEA Dobris Assessment highlights the lack of an effective coastal management strategy and points to increasing levels of coastal pollution, eutrophication, the conflict of uses in the coastal zone, over-exploitation of resources, and lack of control of off-shore activities. The ELOISE Science Plan highlights similar areas with an emphasis on the development of sustainable approaches to the management and exploitation of the coastal zone. However, in order to derive an effective approach policy makers require access to accurate and quantified assessments as to the extent of the problem and the socio-economic consequences resulting, in order that they can make informed decisions that encourage a sustainable approach. One way to do this would be to develop within Europe a Coastal Information Service that provides access to the information required by policy makers.

3.4 A Coastal Information Service

Given the emphasis upon the coastal environment it is appropriate to consider the role satellites might play in providing operational services to users with responsibility in coastal management. Their interests can be broadly classified into one of two areas. The first group is concerned with near-real-time use, for example sediment transport. The second group are interested in long term changes such as in levels of eutrophication, pollution, sea level and water quality.

Satellite-based instruments have been shown (see ESA, 1994), to offer an important source of data on coastal regions. Sensors such as the Along Track Scanning Radiometer (ATSR) offer important insights into the thermal structures that exist in the sea. This is known to be of importance for applications in fisheries. Ocean colour sensors, such as those proposed for the SeaWiFS and Envisat missions, will provide access to information on water quality and sediment transportation processes in coastal regions. Radar altimetry has been shown to provide important insights into tidal processes and currents. SAR data has also been shown to provide important insights into local bathymetric conditions, pollution and wave structures.

It is possible to consider establishing a European-wide Coastal Information Service that combines satellite data, in-situ measurements, models of the physical, chemical and biological processes in the coastal region, and airborne sensors. This combination or fusion of data would provide a range of information streams to end user agencies. Some would provide near-real-time services, providing for example information on the location and extent of a pollution event, whilst others would provide long term statistical summaries that would be of use to agencies, such as the EEA, whose task is to take a slightly longer term look at trends, as part of a process of quantifying the state of the environment. The Coastal Information Service envisaged would be one example of the types of services that could emerge from the EEOS and CEO projects.

4. An Operational Coastal Pollution Monitoring Network

In formulating the approach to the CEO, the European Commission project team has considered very carefully the methodology that should be adopted for the current pathfinder phase of the project. Instead of adopting a traditional system engineering approach the CEO project team has decided to embark upon a number of experiments or demonstration activities that connect together data providers, such as satellite ground stations and their associated archives, processing chains (that are capable of extracting accurate geophysical parameters from a combination of data providers), and end users of the information derived through this process.

An example of a potential demonstration activity will illustrate this philosophy. Sloggett (1994c and 1994d) has outlined the concept of a European Oil Spill Monitoring Network as one element of an overall CEO infrastructure; see Figure 1. It is envisaged that this is based upon a number of existing facilities that are able to interoperate through the infrastructure provided by the CEO. A single ground station would be used to receive raw ERS-1 SAR data. The raw data would be reduced to an image using a SAR processor at the ground station. This would then be passed, within the satellite ground station, to an automated processing capability where oil spills would be reliably identified. Information on the location and size of a spill would be passed directly to end-user pollution monitoring agencies. It would also be transmitted, see Figure 2, over a network, to national modelling centres – with access to meteorological and coastal information (tides, currents, bathymetry, etc.) – that are capable of forecasting the trajectory of the slick and assessing its potential threat to beaches, wildlife reserves, fisheries and aquaculture facilities and areas of outstanding natural beauty, etc., see Figure 3. End user agencies, such as those charged with coastal protection, would receive this information and integrate it, within a workstation environment, with data describing local habitats. In the UK, the Royal Society for the Protection of Birds (RSPB) is known to have created such a database of the main bird wintering areas and breeding grounds in our coastal waters. This database in addition to those created by organisations such as the Institute of Terrestrial Ecology (ITE) and within the European CORINE programme (see Wyatt, 1994) – would provide an excellent basis for such an analysis of the sensitivity of each coastline.

Research reported by Sloggett (1994c and 1994d) is providing evidence that such an oil spill monitoring infrastructure may be feasible. Algorithms have been devised that locate areas in the sea with reduced radar cross sections. These are then screened using contextual data within an overall framework based upon evidential reasoning. This screening process is the major component of the algorithm, as it removes areas of reduced radar cross section that are not oil slicks. These arise due to, *inter alia,* wind shadowing effects, surface films – such as fish oils and algae, and wakes from ships in the area. These areas could, if not eliminated in the process, create false alarms that would be reported to the agencies concerned. This would not be acceptable to them as they require reliable information on the location and size of spills.

A key parameter that is also of great interest to the agencies concerned, and one that effects directly their response strategy, is the *type* of oil. Experiments reported to date by Sloggett (1994c and 1994d) have shown that it is difficult to envisage how the type of oil could be directly derived from the ERS-1 SAR observations. With its single frequency of operation and single polarisation it is not a sensor with a wide spectral coverage. However, Sloggett (1994d) has suggested that it might be possible to *infer* the type of oil through a combination of models and observations. This research is just starting. Its aim is to discover features within a slick that might indicate, albeit on a coarse scale, the type of oil; for example in the range light, medium or heavy crude. It is possible that by combining the way the oil is dispersing with a knowledge of the local wind/wave forcing we can assess what type of oil would respond to such an environment.

This combination of satellite data, an oil spill prediction model and access to local tidal and meteorological data contains the classic ingredients of a demonstration activity that would form one element of an overall CEO capability in the future. This integration of data to produce a reliable information stream has been referred to as a Value Added Centre (VAC) which, in many ways similar to the CEO, is not a centre *per se* but an amalgam of data, services and projects working together in concert to supply an end-user with a very specific stream of information.

5. Acknowledgements

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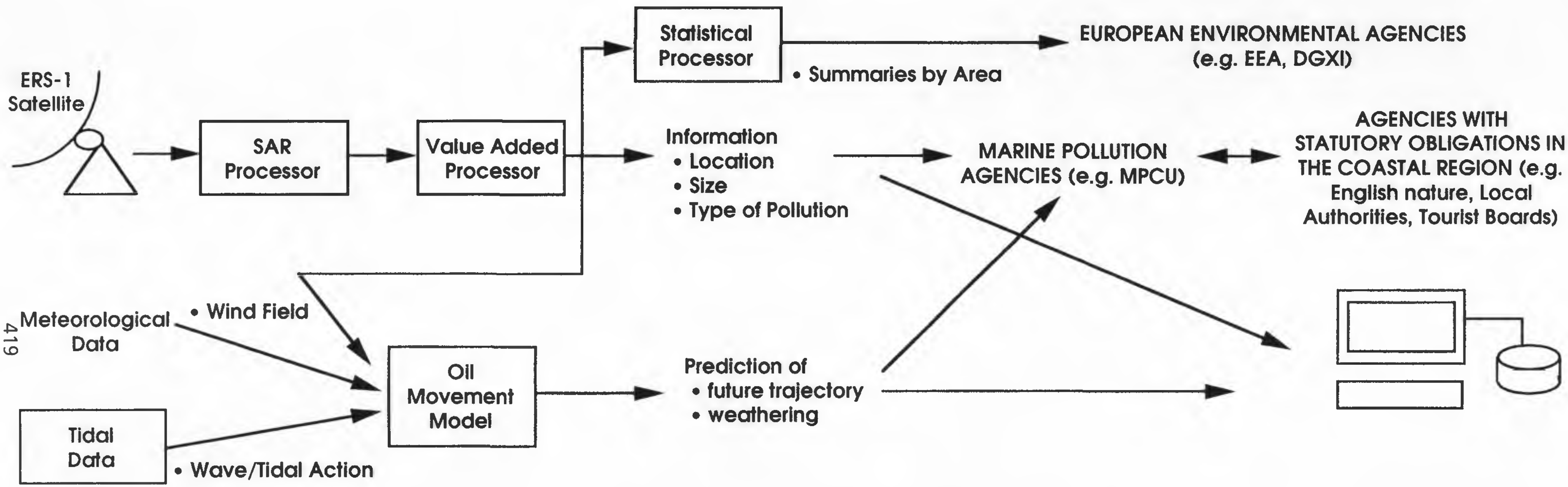

Figure 1: A Schema of a European Pollution Monitoring Network

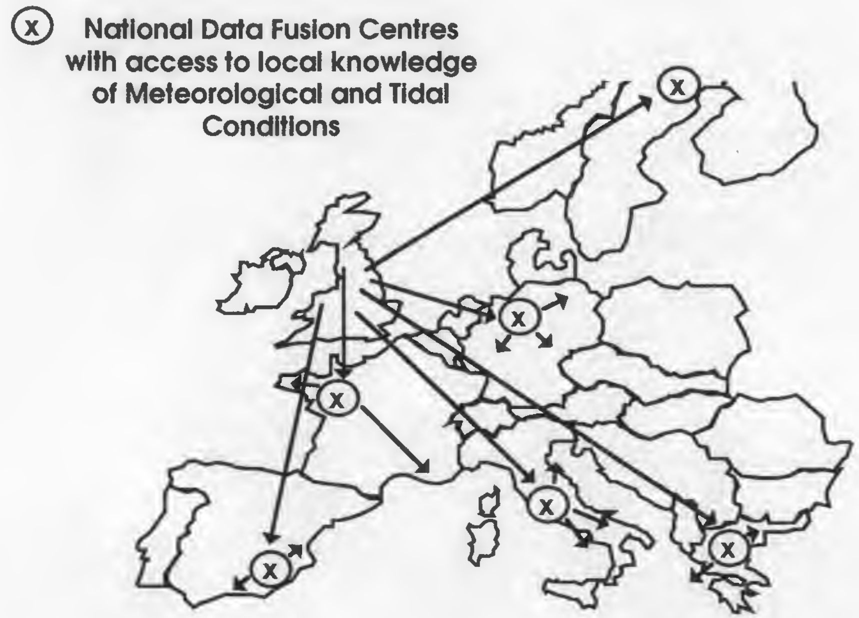

Figure 2: An Illustration of Information through National Value Added Centres

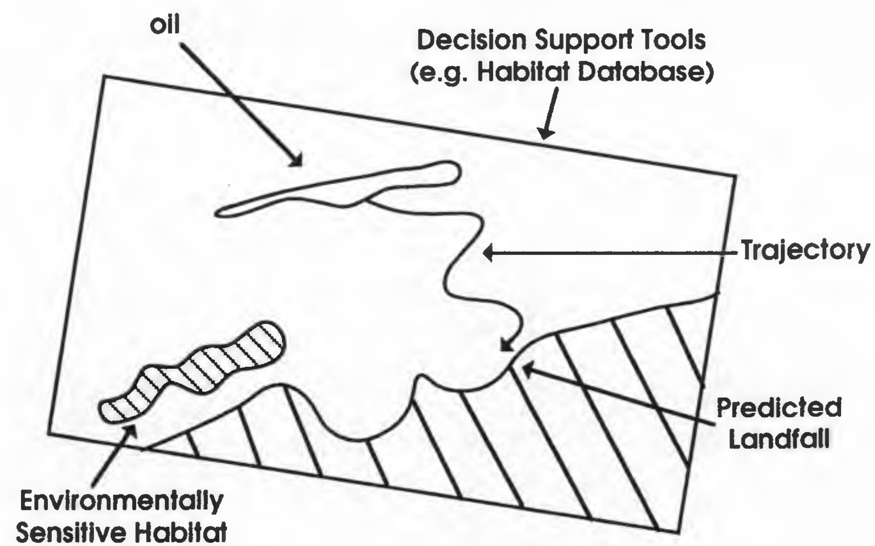

Figure 3: An illustration of the local information required in a Pollution Monitoring Network

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Data and Communications Requirements of the ICSC-World Laboratory Mediterranean Research Centre

J K Daniel Söderman, ICSC-World Laboratory, Erice

1. INTRODUCTION

The ICSC-World Laboratory Mediterranean Research Centre, hosted by the Centro di Cultura Scientifica 'Ettore Majorana' (CCSEM) in Erice (near Trapani, Sicily) comprises ICSC-World Laboratory Project EMME-1 ("Emergency Meteorology Centre for Developing Countries of the Mediterranean Area") and Project LAND-3 ("Protection of Coastal Marine Environment in the Southern Mediterranean Sea").

Projects EMME-1 and LAND-3 are funded by the Italian Ministry of Foreign Affairs from its voluntary co-operation funds. They are therefore primarily concerned with science and technology transfer to developing countries in the Mediterranean region, and associated education and training.

During the last few years a state-of-the-art computing and visualisation laboratory in support of the R&D and training activities has been established in Erice. The main components of the UNIX-based computing facility are a Convex C220 mainframe, five high performance graphical workstations and an Ethernet-based local area network with a number of X-terminals and PCs for access to the C220 and the workstations. In addition there are permanent external links to the European Centre for Medium-Range Weather Forecasts (ECMWF) via ITAV - Servizio Meteorologico in Rome, and to the INTERNET.

3. PROJECT LAND-3

The following hydrodynamic and ecological models have been or are being implemented on the Erice computing facilities for application to the Mediterranean Sea as a whole and/or to limited areas of particular interest:

(i) the Princeton Ocean Model (POM), developed by George Mellor and collaborators at Princeton University

(ii) the Ocean Isopycnal Model (OPYC) developed by J.M.Oberhuber at the Max-Planck Institute for Meteorology in Hamburg

(iii) the FINEST ecosystem and water quality model originally elaborated by Finnish and Estonian scientists for the Gulf of Finland

(iv) the EIA (Environmental Impact Assessment Centre of Finland) integrated hydrodynamic and water quality model.

Interfacing between hydrodynamic and ecological ocean models should be particularly stressed.

Projects EMME-1 and LAND-3 work in close collaboration in a number of areas, such as the simulation of the uptake, transport and deposition into the Mediterranean Sea of Saharan dust and the planned joint establishment of an environmental data base for the Mediterranean area using the NEONS system developed by NRL Monterey as the foundation.

4. EMME-1 EXPERIMENTAL PRODUCTS (TARGET DATE 1 JUNE 1995)

It is envisaged that the Project EMME-1 product set to be produced in Erice for the benefit of Project LAND-3 and, as required, for other centres in the region, will include:

6. COMMUNICATIONS REQUIREMENTS

The communications requirements include appropriate links to the WMO/GTS, the INTERNET and to ESA/ESRIN for selective data acquisition in almost real-time. As regards the data to be produced by the World Laboratory Mediterranean Research Centre in Erice, there is a need to disseminate, with minimal delays, typically 50-500 grid point products in standard WMO/GRIB form to some 30 centres in the Mediterranean region. The volume of one WMO/GRIB product is typically 5,000-10,000 Bytes (octets). However, in the short term this information will in fact in most cases be disseminated in chart form by telefax. Some of the more interesting products (such as forecasts of the movements of Saharan dust and high resolution forecasts for Mediterranean sub-areas) will most probably also be made available by means of the World Wide Web over the INTERNET.

GOOS Perspectives on Earth Observation Data

Name: J.Withrow (E-mail:J.Withrow@omnet.com; J.Withrow@gateway.omnet.com)
Affiliation: Intergovernmental Oceanographic Commission of IOC/ UNESCO

Abstract:

The Global Ocean Observing System (GOOS) is conceived as a global framework for systematic ocean observations to meet the needs for forecasting climate variability and change; for assessing the health or state of the marine environment and its resources, including the coastal zone; and for supporting an improved decision-making and management process - one which takes into account potential natural and man-made changes in the environment and their effects on human health and resources. GOOS will utilize operational observing methods including both remote sensing and in-situ measurements. Since it is global it will and must rely heavily on remotely sensed (satellite) data using presently available parameters and encouraging continued technological development of additional sensors and applications. GOOS is based on operational, oceanographic observations and analyses, timely distribution of data and products, data assimilation into numerical models leading to predictions, and capacity building within participating Member States, especially in developing countries, to develop analysis and application capability.

Full paper:

Introduction

Earth observation by satellite is becoming an essential tool in the management of the Earth's ocean resources, and for the study and monitoring of climate. Space-derived information is also of increasing value for the implementation of public policy with regard to the ocean, especially in coastal areas. While the potential and importance of Earth observation to contribute to the understanding and management of the Earth's resources are very high, there is at present potentially incompatible or conflicting policies regarding the management, supply and exchange of data.

Today we are experiencing unprecedented pressures on our natural resources. Sustainable development of these resources is hindered by our inability to detect emerging environmental problems at an early stage when remedial measures are still possible. Nowhere is this inadequacy so pronounced as in the marine area. Global energy cycles and the biological processes upon which all life depends are critically influenced by the ocean. Governments collectively are only now beginning to recognize the complexity and interdependence of all aspects of the system. This complexity and interdependence is a key issue in addressing the coastal zone as noted by intergovernmental and scientific discussions and workshops. Systematic global observations of the world oceans are required to improve our knowledge and predictive capabilities which will be the basis for more effective and sustained use of the marine environment, with the associated economic benefits.

The late 80's and early 90's have seen a tremendous evolution in our way of thinking about oceanography: in addition to pursuing research, we are entering the era of operational oceanography, which we now call GOOS or the Global Ocean Observing System. This, of course, has a large impact on the way we envisage the observation of the ocean, including from space. We will need, more and more, repetitive satellite missions, and we will need such missions for decades to come. We must be able to move quickly from experimental satellite sensing activities to operational activities. We simply do not have years to mull over the results of a mission such as SeaSat before launching the next. In some cases, such as TOPEX-POSEIDON, we are looking for a follow-on mission right now even though the platform has only been in space for a little over two years. Unfortunately, it is not sufficient to say that we need all that: behind such a request, a pretty large amount of money is involved and we have to convince politicians and decision-makers to make this money available. To do that, we have to be imaginative and use present day research results that show where we are going and why it is important to go there.

The oceans and coastal terrestrial areas interact intimately. The ecological systems of the coastal areas, as well as the socio-economic development of these areas, are heavily influenced by the conditions created by the proximity of the oceans. Nowhere is this mutual interdependence and influence more evident than in the coastal and near-shore zones of the Tropics. Population density and population growth are highest near the coastal zone. In southeast Asia, 65% of all major cities are located on the coast. In the case of many small island countries such as those surrounded by the Pacific Ocean, the Indian Ocean or the Caribbean Sea, the entire land area can be classified as a coastal zone. By the year 2000, it is estimated that the world population will double to some 10 billion people and that 75% will live within 60 kilometers of the coast.

Food from the sea contributes to national food security and a healthy diet. Sixty percent of those in developing countries obtain the majority of their protein from fish; in Asia, over one billion people depend totally on fish for animal protein. Coastal industrial and economic development expand as nations seek higher standards of living, and populations look to the sea as an invaluable and seemingly plentiful source of food to harvest. But degradation of critical habitats by over-fishing, land reclamation, drainage and coastal construction threaten marine fisheries and the health of the ocean. Destruction of these habitats and ecosystems in the Tropics has been compared to the deforestation of the tropical rain forest. Much of the mangrove forests in tropical countries such as Ecuador, Indonesia, Thailand and the Philippines has been destroyed in the past ten years. In the 1980's, the Philippines lost 108,000 of its 146,000 hectares of mangroves. Data indicate that coral reefs are also severely stressed. A coral reef survey in the Philippines found only 5-6% in good condition in 1985. There is a direct correlation between the quantity of fish yields and the state of coral reefs.

Recognizing the importance of international cooperation in research and monitoring, the IOC promotes marine scientific investigations and related ocean services with a view to learning more about the nature and resources of our oceans and coastal areas.

The Commission focuses on three major objectives:

> To promote and coordinate multinational, cooperative investigations in the broad fields of oceanography and marine science;
>
> To provide ocean services to Member States, including data exchange networks, observing and monitoring stations, and analysis and forecasting of oceanic conditions that affect coastal areas, such as tsunamis, storm surges and El Nino episodes;
>
> To foster national capacity building in marine sciences and oceanography through education and training, voluntary cooperation and partnerships.

Climate

In addition to coastal resource development, it is now acknowledged that a key to resolving the uncertainties of climate change lies in the long memory of the oceans. Any possibility of predicting the evolution of climate beyond a few weeks demands that ocean behavior be taken into account. This recognition is reflected in the decisions of the United Nations Conference on Environment and Development, and plans are now being made to address these uncertainties.

There is still much that we do not know about the ocean and its role in the earth's climate. Uncertainties surrounding climate change are interrelated and therefore have to be considered as a whole. This approach is reflected in the Framework Convention on Climate Change which calls for "...research, systematic observation and development of data archives related to the climate system and intended to further the understanding and to reduce or eliminate the remaining uncertainties...". As for the ocean, we do not know exactly what needs to be measured on a sustained long-term basis and where. But government leaders have agreed that we cannot wait for all of these answers before embarking on the GOOS effort.

The oceans are both a source and a sink for carbon dioxide and other "greenhouse' gases. The response of the atmosphere to increased greenhouse heating is clearly tempered by the uptake of heat and carbon dioxide by the ocean. The ocean also drives the global cycle of evaporation and rainfall. Any possibility of predicting climatic variability requires that ocean conditions be taken into account. While some progress is being made in understanding the role of the ocean in climate variations, more attention must be given to observations of properties and processes in the upper ocean, in the mid-depth regions and at great oceanic depths to improve climate change predictability. The effect of the ocean on the atmosphere can be either to moderate or intensify change or variability in the climate. Global ocean observations will reveal the ocean's memory. They will provide, for example, a description of the global circulation of heat and water in the ocean and their exchange with the atmosphere.

Climate change and variability occur over a broad range of time scales from seasons to decades and centuries. Variability in the atmosphere and the oceans has been measured over time scales of hours to days to weeks to seasons to decades. Natural variability in the climate is so extensive that it has so far masked changes caused by the anthropogenically enhanced "greenhouse" effect. Natural changes are also extremely important economically and socially, and their impacts are especially strong in poorer regions of the world. These changes call for improved monitoring on a global scale.

Decadal-scale changes in the ocean have recently been identified which may be the effect of greenhouse warming. Because of the lack of adequate historical data, we are only now recognizing this variability. We need records of all parts of the climate system over decades to answer these questions with any assurance. Each year meteorologists receive over 20 million sets of data describing the atmosphere. The picture for the ocean is, by contrast, quite bleak. Huge areas of the ocean are "datafree".

Changes inside the ocean - at all depths - must be observed in order to predict changes in sea surface temperatures which provide an important boundary condition for the atmosphere. We also have to know more about the ocean margins and the land-sea interface. Adequate predictive capability here is especially important. In planning GOOS, we have to keep in mind that the scales of ocean and atmospheric forcing are quite different for shallow and for deep water. For successful climate forecasting, we need to know more about coastal processes and coastal ecosystems.

The most well-known example of climate variability is the "El Niño" phenomenon regionally, or what is known as ENSO globally. It is now recognized as the most dominant element of the interannual variability in global climate. In 1982-83 effects of the strongest ENSO event of this century were felt world-wide. Droughts and floods caused crop failures in many countries. Under the Tropical Oceans-Global Atmosphere Program, an extensive ocean observing network has been set up in the tropical Pacific which accurately predicted the onset of the last El Niños. Peru, concerned with the impact of El Niño events on its economy because of extensive losses suffered in previous El Niño periods, is making certain crop decisions based on these climate forecasts in order to at least sustain crop yields. This national experiment is an example of the use which may be made of adequate ocean data when retrieved on a permanent and a global basis. Recent TOGA reports have identified a negative correlation between the Indian summer monsoon precipitation and the sea surface temperature in the equatorial Pacific. How will ENSO phenomena change if heating patterns change due to greenhouse gas concentrations?

The Global Ocean Observing System

Remote sensing is an essential part of the Global Ocean Observing System and it is essential that we start developing GOOS now as a global framework for systematic ocean observations to meet needs for detecting and forecasting climate variability and change; for assessing the health or state of the marine environment and its resources, including the coastal zone; and for supporting an improved decision-making and management process--- one which takes into account potential natural and man-made changes in the environment and their effects on human health and resources. The planning presently encompasses five modules: (i) Climate Monitoring, Assessment and Prediction; this module is common with the ocean component of GCOS-the Global Climate Observing System; (ii) Monitoring and Assessment of Marine Living Resources; (iii) Monitoring of the Coastal Zone Environment and Its Changes; (iv) Assessment and Prediction of the Health of the Ocean; and (v) Marine Meteorological and Oceanographic Operational Services. The major elements of GOOS are operational, oceanographic observations and analyses, timely distribution of data and products, data assimilation into numerical models leading to predictions, and capacity building within participating Member States, especially in developing countries, to develop analysis and application capability. GOOS will be developed in a phased approach: (i) a planning phase including conceptualization, design and technical definition; (ii) operational demonstrations for each of the five modules; (iii) implementation of permanent aspects of the Global Ocean Observing System; and (iv) continued assessment and improvement in the individual aspects of the entire system.

As envisaged, this comprehensive and integrated system will provide a mechanism for the coordinated management of data generated from regular satellite and in situ observations of major physical, chemical and biological properties of the ocean, including the coastal zone and enclosed and semi-enclosed seas. It will involve the coordination and distribution of data, information and products to allow for the understanding of ocean processes, in particular those relevant to global climate change and climate variability, research and prediction, as well as to global environment changes and the management and protection of ocean and coastal resources. The system will be based on the principle of free and open exchange of data and the resulting information and benefits. The development and application of ocean observing systems must link the data to solutions of problems at global, regional and local levels.

The systematic coastal information basis to be provided through GOOS will feed directly into coastal area management. Without such an information basis, there will be no dynamic management. As part of GOOS, the IOC is also developing a cooperation with UNEP, WMO and IUCN on coastal zone observations of particular relevance for impact assessments of changes induced by climate variations and other disturbances. Pilot experiments, including coral reefs mangroves, coastal and shelf seas circulation are underway in different regions. GOOS comprises a Global Framework for data assembly and dissemination and a number of modular elements that are both providers and recipients of data to and from the core Global Framework. Four of these modules are Coastal Area Management, Living Resources, Climate Change and the Health of the Oceans, all of which have direct relevance and potential interconnections with integrated coastal zone management.

Documenting changes in coastal and near-shore areas has to have a global and interdisciplinary and intersectoral approach that integrates physical, chemical, biological and geological observations as well as remotely sensed and in-situ measurements with modelling and socio-economic uses of the coastal zone.

The coastal module will look at the area most likely to be affected first by human influences and where we know changes are occurring fairly rapidly. It will also complete the suite of observations necessary for global numerical models. The system will draw on existing and planned data collections and exchange systems, adding complementary measurements not now take such as biological and chemical observations. A series of demonstration pilot projects will measure key variables initially. These variables my include:

sea-level changes and coastal flooding
coastal circulation
international mussel watch
assessment of organic carbon accumulation in coastal sediments
river inputs of pollutants
Changes in plankton community structure
benthic communities: coral reef ecosystems
terrestrial vegetation: mangrove communities

Satellite Sensors of Interest

The following chart gives a summary of the sensors, the parameters on interest to the ocean communtiy and the programs involved.

Measurements	Instruments	Programs
Surface Wind Wind Stress	Scatterometer	WCRP, GOOS, GCOS, Ecosystems dynamics, Harmful Algal Blooms, GiPME, LOICZ
Sea Level Waves Sea Ice Extent Ocean Currents	Altimeter	WCRP, GOOS, GCOS
SST Radiation Precipitation Sea Ice Extent Ocean Currents Water Mass Identification Suspended Matter	VIS/IR	WCRP, GOOS, GCOS, Ecosystems dynamics, Harmful Algal Blooms, GiPME, LOICZ

Atmospheric Water Sea Ice Extent	Passive Microwave	WCRP, GOOS, GCOS
Sea Ice Drift Waves	SAR	WCRP, GOOS, GCOS
Chlorophyll Productivity Marine Pollution Suspended Matter	Ocean Color	WCRP, GOOS, GCOS, JGOFS, CPR/ Plankton, Ecosystems dynamics, Harmful Algal Blooms, GiPME, LOICZ

WCRP - World Climate Research Program
GIPME - Global Investigation of Pollution in the Marine Environment
JGOFS - Joint Global Ocean Flux Study

Pilot Projects

Indian Ocean

A pilot activity in the Indian Ocean will address three key problems: storm surge statistics, mean sea-level rise and coastal erosion in three specific areas. The objective is to develop local awareness and skills so that countries in the region can work together to tackle these problems. At the same time the quality and availability of the data will be enhanced for regional and global studies.

The system resulting from the project is a response to the requirements identified and actions endorsed in Chapter 17 on Oceans of Agenda 21 of the United Nations Conference and Development (UNCED), which repeatedly calls for the collection of systematic observations for integrated management and sustainable development of the marine and coastal areas, in order to address critical uncertainties related to these areas and to climate change impacts on them. It further calls for development of procedures for comparable analysis, information exchange and strengthening of national scientific and technological oceanographic commissions, and stresses the importance of international co-operation in these fields, fostered by relevant international organizations such as the IOC and UNEP.

The long-term objective of the pilot activity on sea-level change and coastal flooding of the Long-Term Global Monitoring System is to understand the factors that control the variations in sea-level in the different regions of the world ocean. In particular, it aims at identifying those factors that are closely related to climate change, and to study the likely impact of these factors on coastal areas.

From the remote sensing point of view there is a strong need for a sea level product coupled with the availability of the corresponding altimeter data sets such that the decision makers and managers in the region can benefit immediately from the product and the scientists can benefit from the use of the data sets. The products and data sets alone will not benefit the region unless there is a coordinated training program within the region to educate the decision makers and the managers in the use of the products and information and the researchers in the use of the data. The ideal program establishes a link between the scientists and managers within the developing countries and those in the developed countries such that each benefits from the others experience. Without a balanced program of development on both sides there will not be sustainable development which is the goal. Complementary to the sea level product could be an sea surface temperature project. This could be accomplished through the extension of the Global 1 km AVHRR project into the coastal zone. Sea Surface temperature can often give clues to coastal circulation in addition to other valuable information on fisheries, river plumes, etc. The development of a network for the utilization of this data would lay the groundwork for the distribution and utilization of ocean color data as soon as it is available. This effort would be of interest to both GOOS and the IGBP Land Ocean Interaction in the Coastal Zone (LOICZ) project. Similar projects are anticipated in South East Asia and South America.

Conclusions

Remote sensing is an essential part of the Global Ocean Observing System and it is essential that we start developing GOOS now as a global framework for systematic ocean observations to meet needs for detecting and forecasting climate variability and change; for assessing the health or state of the marine environment and its resources, including the coastal zone; and for supporting an improved decision-making and management process--- one which takes into account potential natural and man-made changes in the environment and their effects on human health and resources. Merely flying the sensors will not automatically translate into efficient and effective use of the information. Programs must be put in place to develop the networks to get the data to the potential users and to train them such that they receive maximum benefit from the information. The goal is sustainable management of our environment.

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"Remote Sensing, Geographical Information Systems and the European Statistical System"

Names: Rainer Muthmann, Andre Mangin
Affiliation: Eurostat

Abstract:

Remote Sensing Technics aud Geographical information System (GIS) are important tools for capturing, storing, retrieving, handling, analysing and displaying localised data (i.e. data with a fairly precise geographical position). Their use has developed enormously In the last 10-15 years. They are now being used by statistics offices. This use allows official statisticians to respond to information needs ul many areas where the spatial aspect is important. They also help in the execution of surveys and censuses. Issues considered are the organisational implications of this extension to statistical work, geocoded data, the supply of "mapping" data and the expertise of geographers and map-makers.

Full Paper:

The Geographical Dimension of official statistics

Traditionally, the geographic dimension has not been very present in official statistics. The main contribution has been from census data where the local detail is naturally available, although there are issues of confidentiality and of how to handle and deliver the data to users in an efficient way. Usually such sub-national data as there are, have been forced into a straight jacket of standard regions. The reasons for this comparative neglect can be seen in :

- the focus on macro-economic management around a theory of economics which largely disregards the spatial element ;
- pressure on resources leading to sample surveys, the results of which are only valid at national or broad regional level ;
- the difficulty in obtaining and managing geo-referenced data ;
- some neglect of the local repercussions of national policies.

In recent years however political debate has taken up numerous issues where the situation in specific places has to be considered. Environmental, regional, urban and rural policies are being developed, each with a powerful component of essentially local problems. These issues also require that account be taken of the local impacts of other policies such as agriculture, tourism, transport, energy and industry. Objective, verifiable criteria are sought for the disbursement of a substantial volume of funds. Furthermore, it has been seen that for tackling many issues, new geographical groupings are needed e.g. thematic regions such as travel-to-work areas for analysis of unemployment or drainage areas for water pollution. These require that information be available relating to small areas which can then be aggregated in different ways. Particularly environment statistics bring new requirements for integrating statistics from different sources in a geographical context.

RS & GIS, a new tool for official statisticians

Remotely sensed (RS) data are by their nature geo-coded. The effective use of RS data is facilitated by the availability of GIS. In general the (pixel) RS data in raster form are product either in raster form or in the more usual vector representation (and so more easily comparable with other data although at the risk of some loss of information). Image analysis systems (working on RS data in raster format) exist which function in conjunction with vector GIS. Raster format has advantages for modelling work and data analysis and vector format has advantages for data presentation.

In official statistics until recently not much importance has been paid to geo-referencing apart from population censuses (and in a number of statistical offices the adoption of GIS technology is essentially bases on census work).

However recently greater general attention is being paid reflecting :

- the usefulness of the data ;
- the ability to manage, analyse and present such data ;
- developments in statistical analysis methods ;
- the use of post-codes as an handy device for geo-referencing ;
- increased interest in area frame sampling
  - where no up-to-date register of respondents exists from which samples can be drawn (informal economy, countries moving from a planned to a market economy especially for agriculture etc...) ;
  - where data collected by officials is a useful way of avoiding burdening respondents or being vulnerable to respondent bias.
- use of GIS in surveys e.g.
  - to optimise area frame samples or as an adjunct to register-bases sampling,
  - in survey management e.g. interviewer instructions and deployment,
  - in cross checks on data entry and in better imputation of missing values,
  - for analysis (interpolation, spatial autocorrelation testing, Poisson mapping, buffer zones...).
  - pressure from local agents to benefit from data relevant to them.

Eurostat "Remote Sensing and Statistics" programme

Eurostat has defined, for several years, a programme of "Remote Sensing and Statistics" whose main aim is to encourage the integration of Remote Sensing into the European Statistical Information System.

The programme receives financial support from DG XII (Directorate General for Research) and is defined in close co-operation with the Joint Research Centre (JRC) Ispra. The National Statistical Institutes are involved in defining the actions undertaken under this programme and largely participate in its implementation.

From the beginning the programme has been based on three main work topics:

- statistical work related to information needs concerning the knowledge of Land use/cover development of project activities (e.g. transboundary projects)
- activities aimed at awareness raising and promotion of remote sensing among statisticians (e.g. organisation of a seminar in Villefranche sur Mer in October 1994)

The functioning of the Eurostat "Remote Sensing and Statistics" programme can be divided into two distinct parts:

- "internal" activities (e.g. statistical study activities related to land use: statistical framework, quality plan; activities in the field of awareness raising and training)
- "external" activities: generally, activities of a "project" nature, developed in close co-operation with the national statistical services and according to orientations laid down by Eurostat.

STATISTICAL WORK ON LAND USE

Statistical and spatial information on land use is becoming a fundamental element in the development of numerous applications, whether they be for statistical purposes or not. Remote sensing is tending to become a source of information that is being increasingly used in this knowledge of land use, in addition to more traditional sources. Mastering the work linked to the elaboration of this information is a task of primordial importance, both for reasons of cost and efficiency.

In fact, the production of a both statistical and spatial on land use must meet the requirements in terms of pertinence and quality of the results of a community of users which is as wide as possible. It is therefore important to master the process of production of this type of information, not only to enable development of specific applications (statistical or not) but also to ensure harmonisation of the results between different projects and to allow comparisons at the European level.

Many sets of land use / land cover data cannot be readily compared one with another because of different nomenclatures and methodologies each optimised for a specific purpose and data capture approach. A desirable development currently being explored is the development of a pivot or framework nomenclature which would enable:

different data sets to be merged to obtain the most robust collective figures or,
use of a particular data set in another context where a different nomenclature is required.

This is an example of a general requirement to build up nomenclatures relevant to geographical statistics to match the extensive work in other fields.

Development of a statistical framework for projects and its application:

The results of the pilot project "Remote Sensing and Urban Statistics" showed that the exploitation of satellite images to create land use maps would provide results that would be reliable and useful by a large community of users thanks to the application of an appropriate framework (nomenclatures, observation and classification principles, data collection methods, application of appropriate quality control procedures). Activities to develop this framework have been continued this year, especially regarding the nomenclature and the quality assurance plan for the results. The implementation of this improved framework is in progress for environmental and regional planning projects (especially transboundary projects) as well as the "Lisbon Agglomeration" project.

Co-ordination work on land use:

Statistical and spatial information on land use / land cover is essential for conducting numerous policies in such diverse areas as agriculture, forestry, the environment, urban areas or national and regional development. However, the existing information systems have difficulty in meeting all these needs. A global approach is therefore deemed necessary and co-ordination activities are in progress at a national, community and international level.

Eurostat again participated this year, thanks to the experience gained in the field of land use, in the current round of deliberations (participation to different work groups, reactivation of a specific "Land Use" work group) and at an international level (contacts with the FAO, UNEP and ECE Geneva).

PROJECT ACTIVITIES IN EUROSTAT

REMOTE SENSING AND URBAN STATISTICS

PILOT PROJECT ON DELIMITATION OF URBAN AGGLOMERATIONS BY REMOTE SENSING

Eurostat, in concertation with National Statistical Institutes (NSIs) (DoE in United Kingdom, INSEE in France, CBS in Netherlands, StaBu in Germany) launched in April 1993, four invitations to tender with a view to using satellite data to define the limits of agglomerations in the following urban regions: Ashford, Bordeaux, the Maastricht region (southern area of the province of Limburg) and the region east of Wiesbaden (Main-Taunus Kreis).

The objective of this project was very precise: it consisted in devising and testing a method for delimiting urban agglomerations by remote sensing and processing geographic information. The project was based on a harmonised statistical framework. It was designed to offer a base for comparison of the results thus obtained with those acquired by more traditional methods.

Site_Contractor_____Ashford_University College London - Remote Sensing Unit_____Bordeaux_ Geoimage_____South Limburg_DHV Consultants_____Main Taunus Kreis_Gesellschaft fur Angwandte Fernerkundung GAF__

In conclusion, the following points can be noted:

Most of the work was carried out in accordance with the planned schedule, co-operation between all parties involved in the project (Eurostat, National Statistical Services and private enterprises) was excellent.

The results offered a degree of quality and precision commensurate with the specifications given.

On completion of the project, a meeting was organised in Paris on November 8 1993 with all the parties concerned (Commission services, statistical institutes, companies and university departments). This meeting provided a general technical overview of the work done and the results obtained. It also gave the opportunity, thanks to the close co-operation with all the parties potentially interested by this work (statisticians, but also various Commission departments and space agencies), to explore the various directions for following up the project.

Finally, mention should be made that the digital results of the pilot project are managed within Eurostat's Geographical Information System for the Commission (GISCO).

COMPLEMENTARY STUDIES

Complementary studies have been conducted in addition to the pilot project "Delimitation of urban agglomerations by remote sensing":

Application of methods developed under Action IV of the MARS project to study changes in the city limits of Seville between 1988, 1990 and 1992. The work done during this study showed that new image segmentation techniques used during the MARS project were still appropriate for urban applications.

Prospective applications of remote sensing in Urban statistics (in collaboration with the University of Liege). The work undertaken showed that the statistical analysis of land use maps is useful in calculating environmental indices or population density referred to built-up areas.

APPLICATION OF THE METHODS "REMOTE SENSING AND URBAN STATISTICS" TO THE CITY OF LISBON

In view of the World Fair to be held in Lisbon in 1998, the Portuguese National Statistical Institute (INE), in collaboration with the National Council for Geographic Information (CNIG), would like to apply these methods in order to monitor the statistical and spatial development of the agglomeration of Lisbon.The initial work plan drawn up by INE aimed at satisfying two objectives:

the analysis by remote sensing of the development of the Lisbon agglomeration during the last years using RS techniques

monitoring the effect of the Fair's large building sites on the urban make-up of the city of Lisbon.

These monitoring tasks will last several years. Eurostat will bring technical and financial support to this project.

REMOTE SENSING IN ENVIRONMENTAL AND REGIONAL PLANNING

DEVELOPMENT OF A STATISTICAL AND GEOGRAPHICAL INFORMATION SYSTEM ON LAND USE (CROSS-BORDER PROJECT FRANCE/ITALY - PROVENCE ALPES COTE D'AZUR; PIEMONT; LIGURIA)

Last year, Eurostat supported the publication of a statistical yearbook for this region ("Pour une economie transfrontaliere integree : Piemont, Ligurie, Provence Alpes Cote d'Azur"). This yearbook is the result of a collaboration between regional partners and National Statistical Institutes: INSEE (France) and ISTAT (Italy).

During an event organised at Genoa on 10 March 1994, following this operation, the Director General of Eurostat proposed to include a remote sensing component in future work on this yearbook. We suggested that a remote sensing project aiming at preparing a land use map be undertaken in this region. Contacts have been made especially with the following authorities: Province of Cuneo and Imperia, the Conseil Ġeneral des Alpes Maritimes, to follow-up this proposal.The proposal was favourably received and work has started at the end of 1994.

COASTAL URBANISATION OF THE "GRAND ESTUAIRE NORMAND"

The French Ministry of Building (Ministere de l'Equipement) showed interest in the results of the "Remote Sensing and Urban Statistics" project. More especially, it wants to apply the techniques used in the pilot project on urban statistics for analysing coastal areas (the Normandy coast). The project is undertaken in collaboration with the CETE (Centre d'Etudes Techniques de l'Equipement) at Rouen and is aimed at providing statistical and pertinent georeferenced information regarding urbanisation of the coast along the Great Normandy Estuary.

REGIONAL GEOGRAPHICAL STATISTICAL INFORMATION SYSTEM IN THE RHONE VALLEY

On the initiative of the French Ministry of Building (Ministere de l'Equipement), a project is being planned with the help of the Centre d'Etudes Techniques de l'Equipement (CETE) of Lyon and various institutions (Communaute Urbaine de Lyon, Compagnie National du Rhone, Ministere de l'Environnement, Communauteé Urbaine d'Arles, region Provence Alpes Cote d'Azur). This project aims at carrying out a study on the use of satellite images on the Rhone valley in order to quantify the population subject to pollution (including noise) caused by transport infrastructure in transport corridors. Eurostat is supporting this project in order to help prepare a statistical land use map.

ANALYSIS OF THE AGGLOMERATION OF TOULOUSE BY REMOTE SENSING

Close co-operation has been established with the Centre National d'Etudes Spatiales (CNES) in the field of remote sensing and statistics. In the framework of this co-operation, Eurostat is supporting a follow up project on remote sensing and statistics defined together with CNES and the "Agence d'Urbanisme de l'Agglomeration Toulousaine" (AUAT). The action has been started and results are expected by the beginning of 1995.

CONTRIBUTION TO THE MARS PROJECT, SUPPORT FOR PROJECTS IN EASTERN EUROPE

MARS PROJECT AND CO-OPERATION WITH EASTERN EUROPEAN COUNTRIES

The global objective of co-operation actions within the context of the MARS project is to provide remote sensing methods and tools in order to evaluate agricultural production in Eastern European countries.

On request of JRC Ispra, the Eurostat remote sensing programme operates within this context providing assistance in the implementation and monitoring of contracts in the following countries:

Work in the Czech Republic (improvement in community knowledge of agricultural statistics)
Work in Romania (setting up a sampling base and field surveys, implementation of a small experimental information system)
Work in Russia (analysis of applied methods for monitoring and evaluating the main cereal crops, comparison with the MARS project).

MARS PROJECT - SOIL DATABASE

Historically, the construction of a European soil database started in 1986 with the digitalisation of Soil Maps by the Directorate General XI (CORINE programme). This database was upgraded in 1992 by the addition of data contained in the soil map archives at the University of Gent.

On request of JRC Ispra, a contract was awarded in 1993 to INRA in order to start work on setting up a new version. Details of the work done in 1994 are indicated below. As in 1993, the Eurostat remote sensing programme furnished the contractual support for this work.

Countries of the European Communities and harmonisation of frontiers,l.

1.Incorporation of latest modifications (checking and additions by national officials)
2. Harmonisation of frontiers
3. First attempts at harmonisation between East and West, in particular thanks to work performed in Germany.

Central and Eastern European countries

1. Checking data relative to the database provided by the various countries
2. Establishing contacts and review of data available for Albania and ex Yugoslavia
3. Co-ordination of activities of the heads of national soil mapping departments

Other countries

1. Harmonisation of work in Switzerland and Austria with a view to their digitalisation, subject to acceptance by these countries (unofficial agreement of Austria)

2. Establishing contacts and review of the data available for Northern European countries (Norway, Sweden and the Baltic states)

3. Checking against the rest of the European soils databaseAn end of project meeting was held at Hannover from 12 to 16 September 1994 with the support of Eurostat.

REMOTE SENSING AND AGRICULTURAL STATISTICS

AGRICULTURAL INVENTORIES WITH USE OF SIMULATED DATA OF THE FUTURE SATELLITES SPOT 5 AND SPOT 6

During summer 1993 CNES launched a call for proposals with a view to inviting interested organisations to participate in a programme of experiments and use of remote sensing data simulating the data that would be produced by the future SPOT 5 and SPOT 6 satellites. The simulation data are compiled from aerial photographs. They are, then, manipulated to produce synthetic images simulating the features of images to be supplied by the future satellites.

SCEES (Service Central des Enquetes et Etudes Statistiques) of the French Ministry of Agriculture proposed a plan destined to test the use of new data in the case of activities using the tools and methods of the Community project MARS Action 1. It asked Eurostat to join in this plan.

There are two objectives:

to evaluate the impact of a higher-resolution image on the compilation of regional statistical inventories.
to evaluate the impact of new images on the study of complex agricultural fragmentation (e.g. the parcels of land in southern Europe with very fine strip farming where crops have until now been difficult to identify by remote sensing, e.g. vines, orchards, etc.)

Portugal, which intends to promote a national remote sensing programme by developing statistical applications especially in environment and agriculture, has showed interest in this action and has asked to be involved in the work planned with CNES by the SCEES and Eurostat. A contract has therefore been concluded with CNES in order to have a plane fly over the regions to be studied in Portugal. This plane would be equipped with aerial photography equipment allowing the subsequent simulation of data produced by the future SPOT 5 and SPOT 6 satellites.French authorities have financed the same type of operation on their own territory.

Plane flights were satisfactorily conducted in May 1994. The simulated data, which is at present being produced, will be supplied to INE and Eurostat in October 1994. From that time, work can be started in parallel in France and Portugal on regional inventories using these data.

SUPPORT FOR AGRICULTURAL STATISTICS IN GERMANY THROUGH THE USE OF REMOTE SENSING

On the initiative of the "Statistisches Landesamt Baden-Wurttemberg" and the "Ministerium fur Landlichen Raum, Ernahrung, Landwirtschaft und Forsten Baden-Wurttemberg" a programme of agricultural statistics using remote sensing has been developed in close collaboration with the University of Stuttgart (Institut fur Navigation). Eurostat supports one of the projects in this programme, namely: the determination of the main agricultural land uses using satellite images. This study is taking place in the "Ostalbkreis" region of Baden-Wurttemberg.

TERRITORIAL SAMPLING FOR SHORT-TERM STATISTICAL CROP MONITORING IN SPAIN

In the framework of an agricultural statistics programme developed by the Technical Secretariat General of the Ministry of Agriculture, Fisheries and Food in Spain (MAPA), Eurostat is supporting a project for application of remote sensing to short-term monitoring of harvests in 27 Spanish provinces. The aim of this project is to facilitate and improve the production of monthly data on the area and the kind of land cultivated in Spain. This work follows on from a pilot project conducted by MAPA in 1993 on a limited number of provinces that had given entire satisfaction.

AGRICULTURAL INVENTORIES USING REMOTE SENSING IN IRELAND

The Central Statistics Office (CSO) in Dublin commissioned the Irish Institute UCD-FIRST (University College of Dublin's Forest Institute of Remote Sensing Technology) to carry out in 1993 an agricultural statistics inventory using remote sensing (MARS Action 1 type). This inventory concerns the Countries of Carlow and Kildare in Ireland. CSO appealed to Eurostat to contribute towards the acquisition of the remote sensing data necessary for this operation. The results of this work were delivered in February 1994.

SUPPORT FOR SIMILAR WORK IN GREECE

In addition to the agricultural inventory work carried out in Greece in 1992, a contract was concluded in 1993 by Eurostat, at the request of JRC Ispra, with the Greek company Tele-expert. The work is continuing in 1994.

AWARENESS RAISING AND PROMOTION OF REMOTE SENSING AMONG STATISTICIANS

ORGANISATION OF SEMINARS

"REMOTE SENSING AND CROP YIELD FORECASTS" VILLEFRANCHE SUR MER, OCTOBER 1994

In the framework of scope of the "Remote Sensing" programme, Eurostat helps to organise the technical and administrative side of a meeting on crop yield forecasting by remote sensing methods to which various international experts are invited. The meeting was jointly organised by the Joint Research Centre of Ispra, the FAO in Rome and the Directorate General VI (Agriculture). It took place on 24 to 27 October 1994 at Villefranche sur Mer (F)

"APPLICATION OF REMOTE SENSING TO AGRICULTURAL STATISTICS", BELGIRATE, NOVEMBER 1993

The "Remote Sensing and Statistics" programme was involved in organising the conference "Application of Remote Sensing to Agricultural Statistics" with the JRC Ispra in Belgirate (Italy) on 17 and 18 November 1993. This event marked an important milestone in the development of the MARS project: the transition from Phase 1, which had started in 1987-1988, to Phase 2 (consolidation of many tasks and the start of operational activities) planned to run until the end of 1997.The participation of experts from Eastern Europe and Northern Africa (statisticians and representatives of Ministries of Agriculture) was financed under the "Remote Sensing" programme and supported by Eurostat.

STUDY ON TRAINING REQUIREMENTS

Numerous "remote sensing and statistics" activities have been undertaken in Eastern European countries, the former USSR or in developing countries. Many of these have been supported or aided by Commission services, based on the experience gained in the large European projects such as MARS. Eurostat proposed launching research with a double-pronged aim:

1. to better cater for the need for training in remote sensing
2. to subsequently influence training or awareness raising programmes targeting statisticians.

This proposal was backed by the Directorate General XII and JRC Ispra. Eurostat suggested that this study should be organised according to the following premises.

1. involving Commission departments likely to be interested in this training problem.

2. setting up a work group to supervise the research study. This could include persons appointed by the statistical institutes and representatives of the various Commission departments involved.

Definition and conceivable lines of work

The specification for the study as well as the procedures for its implementation are yet to be determined. The following approach is suggested :

drawing up a list of co-operation initiatives involving a "remote sensing" component defined for statistical purposes,
contacting the statisticians of countries concerned to analyse the needs in training generated by these actions,
making proposals and subsequently defining elements complementary to current training programmes.

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ESA/ESRIN, Frascati, 13/15 December 1994.

An Operational User Perspective on Current and Future EO User Information Services.

B. P. Blaydes, F. Bonnet, P. Lingk, G. Prisco and W. Tack,
Western European Union Satellite Centre (WEUSC), Madrid.

Abstract.

The Western European Union Satellite Centre (WEUSC) is a WEU subsidiary body in charge of interpreting (extracting information from) Earth Observation (EO) data for security-related tasks. For its critical operational missions WEUSC exploits a range of EO data products with sharp requirements concerning data access and retrieval. Most requirements and solutions suggested in this work should also apply to many operational users of EO data.

A typical WEUSC task includes (after the choice of the most suitable type of data) data query, selection, order, retrieval, processing,(de)archiving and interpretation. Requirements relevant to the object of this Workshop are mainly placed on the first four topics (remote processing being also applicable as discussed in the text). European Data Networks (EDNs) are currently able to meet demands for online accessing and retrieving sensor, catalogue, browse, physical and ancillary data (metadata) but generally not the real data of full scenes on a routine basis. Consequently, this work divides operational end-user requirements into current requirements that can be met by existing EDNs and future requirements that must wait for improvements in EDN bandwidth, access modalities, new compression techniques and reduced cost. Intermediate options are also discussed.

Current requirements concern online metadata retrieval and visualization, scene selection and order. WEUSC exploits EO data from a wide range of suppliers and makes extensive use of existing on and offline EO User Information Services (EO UISs). A specific requirement not met by existing services is a uniform geographically based Graphical User Interface (GUI). WEUSC is developing for internal use a flexible EO UIS operating on top of existing online catalogues which merges EO metadata from different suppliers with user managed, task specific geo/thematic data into a common format used in a GIS for scene selection. The

1) Operational applications of EO data at WEUSC.

WEUSC is a subsidiary body of the Western European Union (WEU) entrusted with the mandate of:

- Demonstrating the value of EO data for applications in:
  - Treaty Verification.
  - Crisis Monitoring.
  - Environmental Monitoring.
- Developing new interpretation techniques for EO data.
- Training EO data interpretation analysts.
- Delivering information products (Dossiers) in response to Tasks issued by the WEU Council or by member Nations.

WEUSC has a permanent staff complement of 50 plus temporary personnel typically hired on a few months contract. Approximately half of the permanent staff are image interpretation specialists. Support in Informatics, Communications, Science and Administration is provided by dedicated Divisions.

WEUSC has sophisticated data processing and support equipment meant to ensure a smooth and traceable flow of EO data into complete information products. The operational system includes powerful CPU, I/O and storage resources linked by an internal network. The major software components are an Oracle RDBMS and image interpretation environments such as Imagine (ERDAS Inc.) and Ocapi (Fleximage) linked by custom software permitting interoperability. The system has been procured by a consortium of European firms led by Cray Systems Ltd. The operational system is complemented by a development system installed on a separate but fully compatible hardware platform and based on 4th Generation Language (4GL) environments such as MatLab (The Math Works, Inc.) and IDL (Research Systems Inc.). The development system is used to explore new techniques, prototype new tools and generate Intermediate Data Products (IDPs) as outlined below.

WEUSC is not tied to any preselection of EO data suppliers but operates by selecting and purchasing the data sets most appropriate to a given Task or institutional undertaking. It should be noted that, contrary to what the Centre´s name seems to imply, EO data from airborne sensors are a key input in many cases. WEUSC expertise in exploiting airborne remote sensing will be enhanced by actively participating in the EARSEC (European Airborne Remore Sensing Capability) led by the Joint Research Centre (JRC) of the EU.

Spaceborne sensor data have mainly consisted of Spot and Landsat tool is described in this work and used to suggest features for implementation in established or experimental EO UISs.

Future requirements are discussed here by assuming realistic projections for next generation EDNs and will include efficient online retrieval of operationally exploitable (parts of) scenes from an increased range of suppliers by using the best combination of telecom platforms and EO UISs. WEUSC welcomes current EU and ESA initiatives such as EEOS aimed at establishing advanced EDNs and standard EO UISs, and believes that long term planning should be complemented by early efforts at prototyping next generation EO UISs on top of existing EDNs and dedicated links. A useful additional approach would be investigating on the operational use of remotely driven processing and compressed scenes.

images up to the time of writing (November 1994). The last few months have seen a gradual increase in both the interest and the capability to exploit operationally radar data from the ERS 1 SAR sensor. The use of radar data both on its own and after merging it with other sensor data as outlined below is expected to increase. At the same time WEUSC is evaluating the interest of other existing data such as from the JERS 1 sensors and Russian sensors of the KFA series. Concerning future sources, WEUSC is also following with keen interest ESA programmes such as Envisat, other space agencies programmes and emerging commercial initiatives for radar (Radarsat) and high resolution optical (Eyeglass, Worldview) sensors.

WEU has a Memorandum of Understanding (MoU) with the three Nations (France, Italy and Spain) participating in the Helios programme for the supply of Helios imagery to WEUSC. Also, WEU is currently evaluating the interest of building up an autonomous multisensor spaceborne monitoring system. These topics have been mentioned for the sake of completeness but will not be touched any further due to their being outside the scope of the Workshop.

The importance of collateral and geographic data on top of EO data must not be overlooked. Collateral data includes treaty databases, infrastructure information and open source reports. Useful geographic data consists of map (paper or digital), GIS databases (see later), Digital Elevation Models (DEMs) and Fixed Points. Fixed Points are Earth features with known accurate geographic location and easily recognisable in image data, a typical example being intersections of roads.

The ultimate users of sensor and collateral data are WEUSC Image Interpreters (IIs) responsible for extracting from the imagery information relevant to political or military decision making processes carried on elsewhere. IIs are skilled in the interpretation process but not necessarily so in advanced data processing techniques aimed at creating or enhancing image or complementary data for visual or partly automated interpretation. This leads to decoupling the interpretation process from the generation of Intermediate Data Products (IDPs). IDPs can be either directly suitable for interpretation (e.g. processed SAR images from raw data) or useful as collateral data (e.g. Digital Elevation Models). IDPs currently being generated or planned for the short term include:

- Processed SAR images from raw data. WEUSC is not a typical user of EO data with a scientific or environmental mission. On the contrary, it is an operational user focused on the detection of often small artificial structures. Consequently, it is necessary to enhance the detectability of structures and objects specifically relevant by fine tuning the processing of raw data. The in-house SAR processing chain is currently implemented on top of a processor developed by DLR. A processor developed by the JRC for the EARSEC programme will be installed soon.

- Fused images from optical and SAR data. The visual interpretation of SAR images is made more difficult (for specialists with a background in optical image interpretation as is typically the case) by the presence of speckle, the on-sensor illumination and the spectral ranges. On the other hand SAR data present an operational interest due to their night/weather independance and the fact that some security relevant targets have a strong radar return. SAR/optical fusion is a mean to import specifically interesting features from SAR data onto a more familiar background.

- Interpherometric products from SAR data. There are several applications of the phase information in SAR data to topography (DEMs, slope maps) and change detection (coherence maps, differential interpherometry). In some cases interpherometric products and techniques permit detecting changes on a scale much lower than pixel size and DEM vertical resolution.

- Accurately (geo)registered images. Data fusion, interpherometric or change detection applications require two or more data sets to be registered to a sub-pixel accuracy. In addition, at times it is necessary to geographically locate each image pixel precisely (georegistration). This may be achieved by processing the image data with accurate sensor flight parameters, Fixed Points of known locations or a combination of both. A DEM is to be used for accurate georegistration over high reliefs.

- Digital Elevation Models (DEMs). DEMs built by stereo matching or interpherometry (for SAR) are an essential tool for accurate georegistration. In addition a DEM with good horizontal and vertical resolution can contain useful information in itself (DEM interpretation).

- Three Dimensional views. Overlying an image onto a DEM permit creating visually efficient views for interpretation and pictorially appealing views for presentations.

Geographical Information System (GIS) technology is another powerful aid to operational applications of EO data. For the present discussion a GIS can be concisely described as a user friendly computer based system for storing, retrieving, analysing and displaying geographically related data. A fundamental concept in both GIS applications and data structures is that of layering data in such a way as to include in an analysis all and only the relevant data items. The central importance of geographic data in EO UISs, discussed later in the text, points to the key role of GIS technology in mature systems. Each GIS having its own native data format, it is important to define a sufficient set of standard data structures and formats to permit exchanging geographic data by including the appropriate import/export tools in GISs. One such standard is DIGEST, which defines exchange formats for several data structures. The Digital Chart of the World (DCW) is a good example of generally available geographic database for GISs. DCW is delivered in VPF, the DIGEST format for topological vector data. It is important to note that the definition and adoption of standards must be encouraged to permit efficient exchange and dissemination of geographic information.

One GIS being studied by WEUSC is ARC/INFO (ESRI Inc.). ARC/INFO has features to handle most GIS data structures and a comprehensive set of import/export tools such as for DIGEST VPF. It has an internal 4th generation programming language (AML, Arc Macro Language) enabling an expert user to rapidly build applications and GUIs. The experience with ARC/INFO has been rather positive and it can be expected that the need for and use of GIS databases at WEUSC will increase. Being GIS technology in a rapid development phase, it can be expected that new ideas and tools will appear. For example there are studies aimed at merging GIS and hypermedia technologies in order to create distributed "hyperGISs" with high potential for EO data users. A hyperGIS user can select and combine data layers from different remote servers each specialising on one or more geographic or thematic areas. It should be noted that though no hyperGIS exists on the commercial market there are several interesting initiatives in this direction.

The central operational concept at WEUSC is that of task. A task is issued by WEU or national authorities and typically identifies specific pieces of information to be extracted from EO data. After prior identification of the data type(s) to be used, most tasks can be decomposed as:

Data query. Obtaining accurate information on available EO data sets. The information retrieved (EO metadata) is used in the selection process. Relevant EO metadata for each scene includes sensor, spectral range(s), platform, viewing angle, geographic location, time, scene id in supplier catalogue, cloud cover (for optical sensors), browse image (quicklook) and ordering information.

Data selection. Selecting the EO data set(s) suitable for the task. All parameters retrieved from the data query are taken into account in a comparative analysis. The central importance of GIS data in this process is discussed below.

Data ordering. An order form for the EO data set(s) selected is filled and issued to the supplier.

Data retrieval. Currently most suppliers ship data on a physical media (Exabyte, DAT or CD/ROM) via a courier service (UPS, DHL). The process takes few days in the best case. A receiving station is not currently installed at WEUSC but will be an interesting option for the future. Experiments in network based data transfers are being initiated. It is to be expected that some combination of telecom technologies will become the standard channel for data retrieval at some point in the future. For network transfer, this will demand a significant upgrade in bandwidth for the local link, a general upgrade in the EDN infrastructure and advances in data compression techniques.

Data processing. Basic image enhancement processes are considered as part of the interpretation process and performed by the IIs themselves. More computationally intensive or conceptually complex data processing jobs are performed separately as outlined above (IDPs).

Data (de)archiving. All EO data are quality controlled on receipt and placed in the archive. Different types of internally derived data products and collateral data are also archived. The archive management software runs on top of the Oracle RDBMS and handles a task oriented three-layer data model. The top layer contains the single data object "Dossier", the middle layer contains internally generated data products and the bottom layer stores data as received from suppliers. Browse software also running on top of Oracle is used to query the archive at different levels.

Data interpretation. This process performed by qualified IIs extracts information from EO data. The tools in the Erdas and Ocapi systems (including basic image enhancement, georegistration, map composition and annotation) are employed. Interpretation results are collected in a Dossier delivered to the user together with supporting data and illustrative high quality printouts.

The first four topics in the list above are specifically relevant to the Workshop.

A critical part of the operational concept is that of response time. Due to the ongoing migration of WEUSC towards an operational Centre, no user has issued time-critical tasks yet. On the other hand this is likely to be the case in the future. For example, a change from crisis monitoring to crisis management would demand collapsing the turnaround time for a typical task to a few days. It is consequently important to streamline all the processes outlined above to minimize turnaround time while preserving reliability. The techniques and initiatives discussed at the Workshop have a high potential in this regard.

2) Available EDNs, EO UISs and current operational user requirements..

Shortly after its commissioning, WEUSC has installed a low bandwidth online link to the outside world on an experimental basis. The current setup is hosted on a PC with 9.6 kbps modem dialup capability. This permits logging on systems allowing external dialup access. Internet access is obtained through a dialable Unix host at a service provider (Goya Servicios Telematicos, Madrid) premises. Internet costs during the initial experimental period are reduced by decoupling non-interactive services (electronic mail, news bulletins) from interactive services (file transfer, remote login, Internet surfing). The PC host at WEUSC has a DOS partition and a Unix partition (Interactive Unix). Non-interactive Internet services are available on top of the Unix partition for a standard multi-user domain (weusc.es). Interactive services are available on a single-user basis on top of the DOS/Windows partition through a communication tool based on a serial line TCP/IP interface (Chamaleon, NetManage Corp.). Chamaleon includes a GUI based version of all standard TCP/IP utilities as well as popular Internet surfing tools such as a Gopher client and a Mosaic WWW browser.

This rather basic setup should not be interpreted as a lack of interest for modern network technology and services. On the contrary, it has been selected for a cost-effective first step in the network world which has permitted identifying and evaluating available services and useful improvements. As a result, WEUSC is determined to play the role of "advanced user" of data networks by selecting the most efficient use patterns for existing services and providing constructive feedback to technology developers and service providers.

In the near future WEUSC will upgrade its network connectivity by switching to a Unix workstation host and a dedicated high bandwidth line. It should be noted that security concerns, which in WEUSC case are comprehensively much more important than for operational EO data users in most other application areas, will in the foreseeable future prevent from integrating the outside gateway into the operational data processing environment.

WEUSC is using routinely a number of EO UISs. The discussion below is not aimed at providing a complete list of available systems, but rather at giving operational user comments on a few examples in terms of functionality and useability.

The Dali catalogue of Spotimage has the complete coverage of the Spot sensor. It is accessible via a direct modem link by using either a generic terminal emulator or a GUI (only running on MacIntosh computers) which also permits visualizing browse images. Since the Spot sensor is the main data source for the time being, Dali is used quite frequently at WEUSC. It has a consistent command language and a useful set of selection criteria that can be cascaded. The experience with Dali at WEUSC has been quite good. It is also useful to mention some disadvantages of the system. There being no GUI for Unix or MS Windows environment, potential users are forced to buy a MacIntosh computer. There is no visual representation of scenes on top of a geographic background. Dali is not accessible from the Internet at time of writing, which forces users to install a dedicated consultation post with modem link. Concerning Spotimage policy, the company seems reluctant to make its catalogue available within multimission EO UISs such as those discussed below. Consequently, users are deprived of the benefits of a comparative analysis.

ESA distributes the ERS 1 catalogue and the Desc access software on magnetic support shipped to users periodically. The current version of Desc for MS Windows has a very good GUI with visual representation of scenes and geographic background. Scenes can be selected and their attributes displayed. The main disadvantages of the current Desc are the poor geographic background, the difficulty of adding metadata from other catalogues and the offline nature of the system. However, ESA has online UISs also covering ERS 1.

The Guide and Directory Service (GDS) of ESA is a mature EO UIS. It is based on the Hypertext Transport protocol (HTTP) of the World Wide Web (WWW) and accessible from popular Internet browsers such as Mosaic. It is worth remembering that this very recent technology (the WWW project started at CERN in 1991 and the first Mosaic browser was released by NSCA in 1993) has had an explosive growth and is now a de facto standard for networked information exchange. In our opinion, this approach should prevail in future EO UISs. GDS has a vast repository of information on EO sensors, campaigns, projects and laboratories. Concerning EO metadata, ESA is implementing the Multi Mission Inventory System (MMIS) on GDS through a network interface. The system offers currently the NOAA AHVRR catalogue with geographic background and browse images, and ESA has announced the upcoming availability of ERS 1, JERS and Landsat metadata. The major shortcoming of the system for the operational user is that the coverages are not complete. This will prevent GDS from being the first "one stop shop" for EO metadata.

Other EO UISs have not been evaluated by WEUSC at time of writing. Other systems are probably being announced at the Workshop. A proliferation of EO UISs, each with its own data format and user interface, would not be recommendable because it would force users to divert resources (manpower, training and subscription costs) from their core business. On the other hand it does not seem very practical to enforce standards on existing and future EO (meta)data suppliers. An interesting approach is that of the CEOS Interoperability Experiment (Cintex). Cintex users will be able to query and search a virtual distributed EO

UISs by interfacing directly to only one system with familiar syntax and data format. The system would convert user commands to a neutral format and broadcast them over the Internet to other servers. Once received search results, the system would convert them to its native format and present them to the user with its native (graphical) user interface. From the user point of view this means having a single access point to a virtual "one stop shop". Access to Cintex prototypes is currently available only to institutions formally participating in the experiment. Software used is the IMS v0 (Information Management System version 0) developed by NASA for the EOSDIS system and UIT (User Interface Terminal) developed by ESA.

3) The WEUSC Data Locator: a prototype EO UIS.

WEUSC is not tied to any EO data supplier but operates by selecting the most suitable data for each task. Criteria used for selecting data are geographic (area of interest specified by the user), thematic (natural or cultural features such as rivers, bridges, roads, railways or airfields specified by the user), temporal and sensor related. Standardization, reliability, use of resources and turnaround time for the data selection process can be improved by an operational EO UIS able to cope with all the parameters above. Experience at WEUSC has shown that it is essential for the user to create a task specific geographical based background prior to starting to search for available data. The features selected for the background depend on the nature of the task. In addition the user needs to be able to mark specific areas and locations onto this backround. No such tool being available, WEUSC has chosen to develop its Data Locator (DL). The development methodology has been to develop a first prototype in-house, then contract the development of a pre-operational version (DL v0, demonstrated at the Workshop) to ESRI Spain. Future fully operational versions discussed below will most likely be carried out in collaboration with other partners.

The DL is an AML application in the ARC/INFO environment. The main function of DL v0 is to display geographic extent and attributes of EO data sets available from a set of suppliers in a standardized way on top of a DCW geographic background. In more detail, DL v0 permits to:

- Display DCW data for a selected geographic area. The DL uses a version of DCW developed by ESRI and already converted to the ARC/INFO native format (coverage) for topological vector data. The operator can choose one or more from several data layers such as populated places, roads, railways, airfields, hydrography, hypsography and many others. The data layers displayed can be reset by the operator at any moment.

- Display EO metadata on top of DCW. EO metedata is converted from its native format (whatever that may be) to ARC/INFO coverage format. That is to say, there is no structural or format related difference between DCW data and EO matadata and the process of adding the latter to the database may be though of as adding just another vector data layer. Consequently different EO metadata layers (for different sensors, suppliers, ...) can be switched on and off by the operator. Scenes are displayed with their rectangular contours on the geographic background. Scene attributes are accessible to the application as outlined below.

- Perform all usual display manipulation and editing functions (zoom in/out, colour map definition and editing, geographic coordinates query, text and graphics entry, export to PostScript level 2 for high resolution reproduction).

- Select one or more scene(s) of those currently displayed by using logical operators on scene attributes. Scene attributes are centre and corner geographic coordinates, date, cloud cover (for optical data), viewing angle and others that can be sensor specific).

- Highlight selected scenes and display a selection of their attributes in a reserved sector of the screen.

The GUI has a professional look and feel and, in particular, there is a context sensitive legend permitting easy identification of graphic objects.

The DL modules for importing EO metadata currently operate on ASCII files with the format used in online catalogues (such as DALI for SPOT). The current operational procedure is to use EO UISs to obtain data files in a native format, then convert the data to ARC/INFO coverage format. A more efficient operational procedure could be to couple the DL to EO UISs online and perform the format conversion on the fly. This way, the DL could be operated as a local browser for remote EO UISs, offering the additional possibility to convert all EO metadata to a standard format for use within an offline database at the user premises.

It should be noted that the modular architecture of the DL will permit adding to the geographic database (currently DCW alone) by converting to ARC/INFO coverage format any new relevant geographic data sets (higher resolution local charts, land use charts, classified databases of military installations, ...) that could become available through commercial purchase or other procurement strategies. Once imported, new data would be structurally identical to other DL data. This feature leaves the DL user in complete control of the geo/thematic database contents. The user can then select task-specific data layers for an analysis.

In summary, the DL approach presents some interesting design choices for future EO UISs. These are:

- A single data structure (topologic vector data) flexible and powerful enough to accommodate all disparate sorts of geo/thematic data and EO metadata.

- A standard internal format (ARC/INFO coverage) with importers from the principal formats used for EO metadata and the option to develop new importers as needed.

- A firm root in one of the leading commercial GISs with power and flexibility adequate to support future development.

- The possibility to integrate EO metadata from a remote link on top of the local GIS and geo/thematic data. This avoids wasting network bandwidth, leaves the user in control of collateral data to support the selection of EO scenes, and frees the service provider from having to support too specific user requirements.

4) Future outlook for EDNs.

Being this the main focus of other Panels and Sessions of this Workshop, this Section is deliberately short. It summarizes the information used by WEUSC in planning the future use of advanced EDNs and as a basis upon which to issue recommendations to EO UIS developers and providers.

European governments and the EU have realized the central importance of information exchange for industrial competitivity and quality of life. The Bangemann report on the "Information Society" describes areas of necessary growth and formulates an action plan. The main policy related component of the action plan aims at furthering the deregulation of national telecom industries, the target being completing the process by 1998. Deregulation is seen as the only way for ongoing technical advances to be exploited by market forces to the benefit of the European consumers.

The connectivity model envisaged for the future consists of a very high bandwidth backbone comparable to a highway network (Information Superhighway) and local links to the backbone comparable to highway on-ramps. Current discussion for on-ramps technology focuses on ISDN (Integrated Services Digital Network) connectivity being offered by most telecom operators. Current ISDN links carry voice and data (including multimedia) in digital format at 128 kbps. Backbones will be built upon a mix of fiber optics and satellite links. Most projections indicate an increased use of fiber optics compared to satellites for fixed sites. Fast switching technologies such as ATM (Asynchronous Transfer Mode) are being developed for backbones or individual sites with very high bandwidth requirements. First applications will be in broadband ISDN services quoted at hundreds of Mbps. Assuming a uniform scaling of user links and backbones in the next few years as well as a drop in cost per unit bandwidth due to deregulation and competition, it seems realistic that before the turn of the century most EO data users will be able to download scenes (few hundred Mbytes) in a reasonable time (one hour or less) and at a reasonable cost.

In parallel with the top-down approach of planning bodies, there has been a bottom-up explosive growth in Internet connectivity and useability. As a result, even if the underlying technologies and communication protocols are still to be improved, the logical structure of the Information Superhighway is already in place. This is demonstrated by the tens of thousands of information providers and millions of users on the distributed WWW information system, now a de facto standard. The inertia already accumulated by the Internet is such that any attempt to replace it will probably fail in spite of the fact that its communication protocol (TCP/IP, built in all Unix systems and future MS Windows PCs) is more than twenty years old and at times in conflict with the recommendations of standardization bodies. For technology planning bodies such as ESA and the EU, a more effective approach would be to ride on the spontaneous growth of the Internet and make new technical solution gradually available to current Internet users by promoting the development of interfaces to and from TCP/IP enabling Internet data packets to ride on ATM based EDNs.

It should be noted that the requirements in data bandwidth of the EO user community are high but not so high as those of future users of next generation services such as video on demand. The size of the user community itself is fair but much smaller than a general consumer market segment. Analogously, issues like pricing and invoicing can be faced with less effort than that required for general consumer services. Consequently, the EO community could be a useful testbed for next generation EDN aimed at more general user communities.

5) Future outlook for EO UISs, projected requirements and way ahead.

The data presented in last Section support the belief that by the turn of the century most operational users of EO data will be able to afford online retrieval of operationally exploitable data sets on a routine basis. This Section is aimed at discussing user, and in particular operational user, requirements for EO UISs running on top of future EDNs.

Of course, all requirements concerning metadata access as discussed in previous Sections will remain in place. The need for uniform GUIs, data structures and formats will be felt even more as the number of commercial EO data suppliers and operational EO data users will increase. Enforcing standards on existing and future commercial suppliers, although essential, might not be feasible. The catalogue interoperability approach seems more appropriate.

This approach will lead to physically distributed but logically integrated "one stop shops" for EO data. It can be expected that these will be accessible on the Internet by general purpose protocols such as HTTP and browsers such as Mosaic. The rather primitive geographic background built in current EO UISs will evolve into a more powerful and flexible geo/thematic data handling system, which should in our opinion be based on GIS and client/server technology. Three different approaches seem applicable:

- A basic GIS on the server side. The advantage is to permit operating a client without data other than that supplied by the server. The disadvantage is that the choice of the contents of the GIS is arbitrary and may not correspond to the requirements of a specific user.

- A local GIS accessible by the client. This approach permits analysing EO metadata from the remote server on top of geo/thematic data sitting on the local GIS. The user has the advantage of being in complete control of the geo/thematic part of the data. This is specially relevant for users having their own data or access to classified data.

- A distributed hyperGIS accessible by the client. This approach requires advances in hyperGIS technology but offers the highest power and flexibility in the long run. The user may choose EO metadata from one or more remote EO data servers and geo/thematic data from one or more remote hyperGIS servers on a task-specific basis. Of course the local GIS may still be used preserving all the advantages of the local GIS approach.

Some of the requirements on data retrieval already apply to the current practice of shipping data on magnetic support. Standard data formats should be adopted and complied with in order to avoid wasted resources on the user side due to having to cope with different formats or, even worse, noncompliances with declared formats. For example ERS 1 data users face the problem that, though the standard CEOS format is mandated by ESA for ERS 1 data products, not all national PAFs comply with the format specification strictly. These shortcomings need being eliminated to bring pre-operational data product distribution services up to a commercial quality level.

Other requirements will emerge with online scene retrieval becoming a commonplace process. Once identified one or more EO base data sets appropriate to the intended application, many users will demand more control options on the derived data products. Options should not be restricted to preprocessing levels but include value added products. Other users with substantial in-house data processing capability and expertise may choose to perform in-house a large part of the data processing chain. Even in such cases, many operational users will only be interested in a sharply defined geographic area much smaller than a scene. The requirement for microscenes cut around a user specified geographic point will grow.

It will not be practical to produce and store all different data products that might be requested by all users. A better option is to enable users to remotely control the processors at the EO data supplier site and "tailor cut" a product to download. This approach demands substantial computing power on a supplier premises but permits committing to permanent storage only raw data sets and generating derived products on demand.

Data compression permits reducing network load at the expense of off-line host computer load at both transmitting and receiving sites. It should be noted that most compression/decompression techniques are asimmetric and only the compression half is computationally intensive. Data compression has not been used extensively for EO data due to users being reluctant to accept lossy compression techniques. Lossless compression techniques permit reconstructing the input data without information loss but perform poorly on high-entropy EO data and images. Lossy techniques such as the standard JPEG or those based on wavelets and fractals permit very high data volume reduction (between one and two orders of magnitude) at the expense of irreversibly losing those information components deemed less interesting for the intended application. For example JPEG compresses significantly (by a factor up to 25) images intended for visual processing by the human eye-brain system by discarding features which would not be visually evident. The output is virtually identical to the original (this applies to visual inspection and not necessarily to image enhancement filters). The operational applicability of compressed data is a subject of current research.

Finally, it should be noted that data security will become a significant issue as the EO data community shifts to commercial marketing and operational users. Several encryption schemes are suitable for network transfer of EO data. Of course, standards should be adopted and enforced.

References.

The assumption that most readers have access to a WWW browser is made here. This Section provides a list of convenient entry points to information relevant to the subjects discussed in the text.

For general EO related information (physics, sensors, projects, research, data and processing issues, EO UISs) access the ESA GDS at:

http://tracy.esrin.esa.it/ROOT

This is the most comprehensive list of EO related information resources. The Multi Mission Inventory System is accessible through GDS for users of a graphical browser such as Mosaic.

For telecommunications related information access the Telecom Info Resources server at:

http://www.ipps.lsa.umich.edu/Telecom-info.html

For information on European programmes in Information Technology access the I'M EUROPE server at:

http://www.echo.lu/

This server also contains Calls for Proposals and several documents used as a basis for political decision making such as the Bangemann report and Action Plan.

For information on the Centre for Earth Observation (CEO) programme of the EU, access the CEO server at:

http://ceo-www.jrc.it:80/

For information on analogous initiatives in the US access the Earth Observation System (EOS) server at:

http://eos.nasa.gov:80/

For information on Geographic Information System (GIS) technology access the GIS server at:

http://info.er.usgs.gov/research.gis/title.html

Panel 2, session G: Round table "Earth Observation User Views: National priorities and status of significant activities"

ESRIN EEOS Workshop on Data User Service Requirements - Panel 2,
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EARTH OBSERVATION DATA SERVICES FOR USERS - AN AUSTRIAN PERSPECTIVE

F. Leberl and R. Kalliany
Technical University Graz
Münzgrabenstraße 11, A-8010 Graz, Austria
E-Mail leberl@icg.tu-graz.ac.at

ABSTRACT

In order for Remote Sensing, in particular from orbital platforms, to fulfill its promise in a small, land-locked country like Austria, it must become relevant to small regions and rural areas; these are the elements that dominate the highly decentralized Austrian scene.
Users in this case are persons with responsibility over an aspect of a small land area; they operate well-established current data sources.

A successful user service therefore must be scaled by the needs of these users.
We propose that data become available as a finished product for easy assimilation into a routine application at the user's desktop computer. Therefore higher level products and only geographically relevant data are needed for this case. If responsibility exists over only a district, then only district data should be made available. A set of information products needs therefore to be defined for use in these regional and local applications. Remote Sensing from space offers the advantage of regular repeat coverage of an area. This advantage must be brought to bear.

In this paper we first describe the current state of remote sensing and its applications in Austria. Then we sketch a desirable user service that would be relevant for Austria through an offer of subscriptions to information and its changes.

1. BACKGROUND

Remote Sensing developed an identity in Austria in the late 1970's with the creation of a group for Satellite Cartography at the Austrian Academy of Sciences and with the forming of an Institute for Image Processing and Computer Graphics at the Research Center Graz (*Leberl, 1984*). This forceful beginning was followed by a series of cooperative applications and research projects. Two practical applications were country-wide inventories to assess the state of vineyards and for studying damages to forests (see 2.1); typically they were carried out solely based on CIR aerial photography. A more general research-project, covering and sponsoring various activities at the universities was the "Forschungsschwerpunkt Fernerkundung" from 1985 to 1991 (*Kraus et al., 1991*).
Under a Russian-Austrian cooperation, in 1991 an Astronaut was sent into orbit (project "AUSTROMIR"). Within the framework of scientific experiments at this occasion, also the remote sensing experiment FEM was carried out, and focused on geocoding, radiometry and land use studies (*Kalliany, 1992; Kalliany et al., 1992*).

However, this beginning was not followed by ongoing development. Currently the funding for remote sensing activities in Austria has gone to an all-time low (*Leberl and Kalliany, 1995*). A serious objection to satellite remote sensing is the large pixel size at 10 to 30 meters diameter, which is too large to make sense over Austrian territory for national or regional applications. Inventories for practical applications are performed using aerial photography, where a single house or tree as well as most parcel-boundaries may be addressed. It is no surprise then to find the recent Russian KFA-1000, KFA-3000 or KWR-1000 often to be considered the only useful space imagery in Austria; this imagery has geometric resolutions in the range of 2 to 5 meters.

Using high-resolution photographic imagery requires only fairly conventional skills in visual image-interpretation and (if geometric information has to be obtained) photogrammetry. There also exists a lack of experiences in the community in Austria with the vast range of Earth observation technologies based on digital sensors, with the only exception of the observation of snow and ice. In fact, research in this area has developed to a leading international standard, as exemplified by studies at the University of Innsbruck (*Rott and Nagler, 1993*). One phenomenon in the application of remote sensing is the absence of global research participation. The prevailing mood in the community is that remote sensing must prove itself within Austria, or it will be disqualified from further consideration.

We will therefore develop a sketch of a user scenario for remote sensing for application in Austria. We hope to show that an opportunity exists to build a valid remote sensing activity in Austria.

2. CHARACTERISTIC PAST REMOTE SENSING PROJECTS IN AUSTRIA

We briefly describe three of the most important and very typical remote sensing projects and efforts carried out in Austria within the past years. This should show that high resolution is a basic requirement, but also that the integrated use of different sensors is a prerequisite for some of the potential applications.

2.1 A Countrywide Forest-Damage-Inventory

After some years of developing and testing methodology, this project started in 1989. It used aerial CIR-photographs at a scale of 1:15,000 with 60% stereoscopic overlap. The photographic scale was the smallest at which one may still address and rate the single crowns of trees. The methodology required that every 500m a sample of trees had to be classified with respect to the vitality of every single crown. Since this was accomplished in an analytical photogrammetric plotter, exact coordination could be assigned to each tree. The initial plan was to observe the same trees every five years (*Mansberger et al, 1991*).

Because large parts of Austria are covered with wood, nearly half of the country had to be imaged, requiring up to 10,000 photos. There were also constraints on image acquisition: The imagery was to be taken only from May to August and the sun had to be high enough to avoid long shadows. Of course, also weather-conditions had to be good - without clouds and only limited haze in the atmosphere. Due to those constraints, the task of imaging such a large area could not be fulfilled totally (employing three aircraft over two years !). The large cost of image-acquisition and -exploration, has caused funding problems; therefore stage two of this investigation will be performed only for some specific sites.

2.2 Inventory of Waste-Disposal-Sites

A pilot-study (*Zirm et al, 1987*) could show that the locations of possible buried waste-disposals (in most cases being former gravel-pits) may be assessed by reviewing historic aerial photographs which are available in Austria since 1950 at intervals of at least every ten years. Following the experiences of the pilot study, similar investigations have been performed in various parts of Austria affected by the problem of unknown waste-disposality possibly threatening the groundwater. Of course it would be beneficial to continue those inventories with regular up-to-date information which is showing immediately when a new pit is opened or an old one is being filled. The latter would represent a "red flag" for a local officer to investigate those sites.

2.3 Observation of Snow- and Icecover, Especially in Mountainous Terrain

Work is being done on an experimental basis by Innsbruck University to analyze SAR-images and calibrate them with reference-measurements from a field-portable microwave-radiometer. The application is to predict at any time the actual snow coverage and to assess its water content for managing the numerous hydro-power-stations in Austria. This is hoped to support the current dense network of ground-observation-stations of snow. The use of continuous updated satellite imagery would offer the advantage of more detailed information in between the groundstations. However, the fusion of imagery from SAR or other sensors with information from different services are not yet fully developed.

3. PROVIDERS OF REMOTE SENSING IN AUSTRIA

Table 1 represents a summary of most user-oriented activities in remote sensing in Austria. These include providers of basic remote sensing data, value added products and services. Since we restrict the term "remote sensing" to spaceborne imagery, in Table 1 we do not consider activities in the field of photogrammetry, photo-interpretation and mapping from aerial photographs.

The third column in Table 1 is giving a rough estimate of the number of academic staff involved in user-services according to the topics mentioned in 2nd column; staff working on general administration or scientific projects was not considered (see also Table 1 in *Leberl and Kalliany, 1995*)

Nearly all applications mentioned in our survey are either research-projects, or studies performed by or under contract for ministries or provincial governments. Most of them represent research & development expenditures and often also are meant to demonstrate the innovative attitude of the customers. Only very seldom do such studies have a real impact in decision-making processes; instead they merely serve to support already formed opinions. Due to a lack of relevant administrative structures, conclusions from such projects nearly never actually are forwarded to district-level-offices.

On the other hand, Table 1 also presents evidence that there exists remote sensing expertise in Austria, which should be upgraded and integrated in networks of national and international cooperation.

Institution, Department	Services	Personnel
Joanneum Research, Graz Image Processing	Geocoding optical and SAR data, Classification, Application Studies	4.00
Agricultural University, Wien Surveying and Remote Sensing	Rural classification, Forestry, Radiometric correction (optical)	0.50
Austr.Research Center Seibersdorf Environmental Planning	Land use classification, GIS-relevant information analysis	0.75
Technical University Vienna Photogrammetry & Remote Sensing	Geocoding of optical data, Land use classification	1.25
Technical University Graz, Photogrammetry & Cartography	High Mountain Cartography (using high resolution imagery)	0.50
Technical University Graz, Computergraphics	Processing Synergetic Data, Network Server for large Datasets	0.25
Klagenfurt University Geography	Satellite Image-Maps, Land-use interpretation & GIS	0.50
Academy of Sciences, Vienna Cartography	Classification for assessing High Mountain ecosystems	0.50
Austrian Space Agency, Vienna	Distribution of Landsat Data	0.10
Zwittkovits Inc., Wiener Neustadt	Posters from Russian Imagery	0.50
Gepard Inc., Vienna	Parallel Computing Architectures	3.00
Geospace Inc., Bad Ischl	Image-atlases & posters, vendor for various kinds of imagery	4.00

Table 1: Austrian institutions providing remote sensing data, products and services in 1993/94

4. CONCEPT FOR USER SERVICES IN AUSTRIA

4.1 The Political District as a Driving Factor

The whole of Austria has more than districts (400 to 2,000 km² each) and larger cities, with more than 20,000 inhabitants (Figure 1). These local bodies have a considerable responsibility for managing the land, especially in the field of agriculture, forestry and regional planning. Districts are organized into 9 independent states or federal provinces. Provinces have their own elected parliament with legislative power for most issues in agriculture and forestry, regional planning, health and environment as well as other topics like education and culture. The provincial government has the relevant administrational bodies to cope with these tasks and to advise and supervise the district-offices. Of course, the federal government in Vienna also holds some administrative responsibility over Earth and land issues. It is especially at this level that additional funds for inventories, investigations and sponsorship of specific activities can be made available.

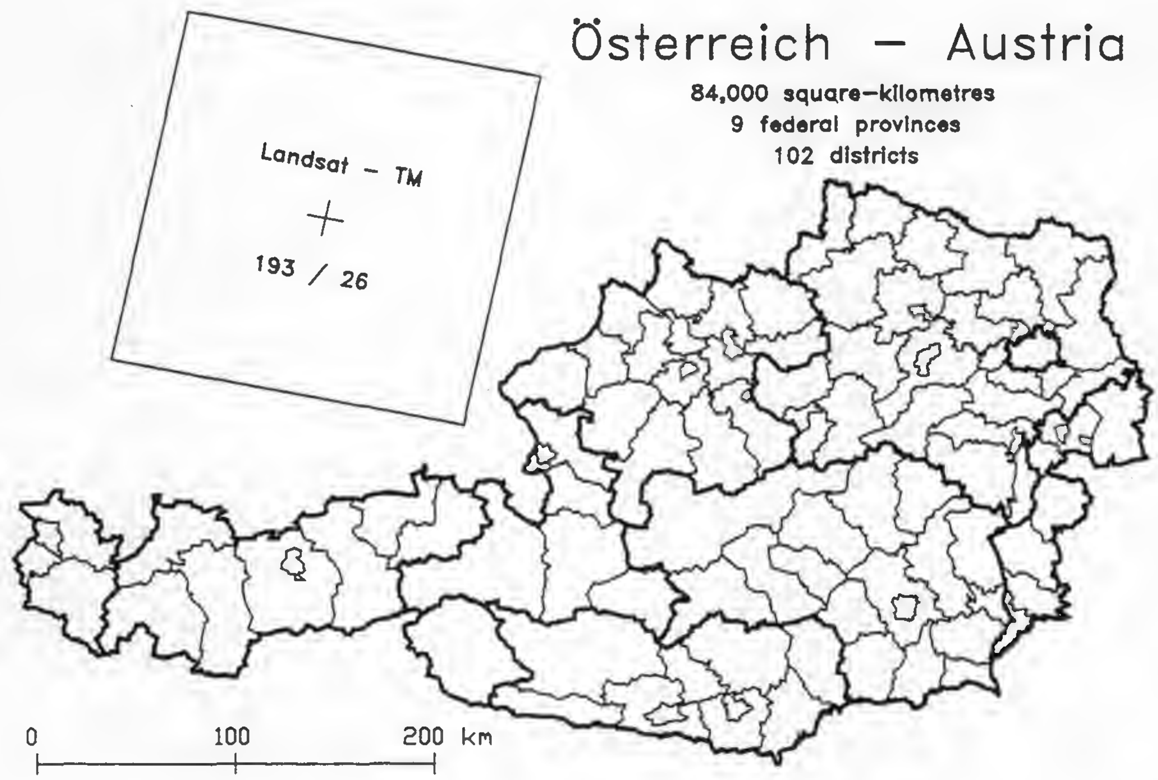

Figure 1: Austria is split into 9 provinces and more than 100 districts. For estimating the relevant areas, the coverage of a full TM-scene (180 x 180 km) is shown as well.

We submit the premise that in Austria remote sensing can be useful from an applications point of view only if it solves issues at the level of districts. If it were to accomplish that then the applications at the higher levels of responsibility would be a matter of course. If remote sensing were not applicable at this district level, then it may not evolve to any significant level of interest in the country and funding for projects will not evolve.

Dataset	Characteristics	Updates
Topographic map	1:50,000 (or enlarged 1:25,000), also in digital raster-format	every 8 years
Regional development plan	1:10,000 (for every community)	edited once; updates on occasion
Cadastral map	1:1,000 to 1:5,600 (partially in digital form)	about 2-3 years
Parcel-inventory "Grundbuch"	computer-based, online	frequently updated
Statistical demographic data	printed compendium	every 10 years
Agro-statistical data	by local agricultural chamber	annually

Table 2: Primary data products at the district level

We believe that the "user" is at a district office, be it for the general administration, or for agriculture, forestry or for environmental protection issues. We expect that some typical and often-used tools at district level would be those listed in Table 2. Currently, for decision-making purposes, some offices may acquire (more or less elaborate) additional data from central agencies (Table 3).

Dataset	Characteristics	Updates
Orthophoto-Map	1:10,000 (not always available)	up to 10 years
Aerial photographs	Copies of Black & White or CIR at 1:5,000 to 1:30,000	for 1:30,000 at least every 10 years
Geological maps	1:50,000	edited only once
Soil-maps	1:25,000	edited only once
Printouts from the GIS maintained at provincal level	corresponding mid-scale (1:100,000 to 1:200,000)	irregular, on occasion

Table 3: Some additional (secondary) data products for district level offices

Satellite imagery would currently be available to local administrations only with very much effort (and therefore will not reach interested citizens): If by chance the relevant section at a provincial government has acquired such imagery as a supplement to their GIS, then it may get forwarded on request to a local district-office. But such imagery in most cases will date back some years and, because local district-offices currently are not equipped for image-processing, the data would be forwarded in analogous form, e.g. as a low-quality paper-print.

4.2 A Specification

A local office needs tools that are easy to operate for people not specialized in remote sensing. We believe that local offices will accept remote sensing data if they are:

- easily and routinely available,
- holding information that occasionally provides for great value,
- of predictable quality, resolution,
- taken at the right time and
- inexpensive.

Currently, remote sensing is none of the above. It is not routinely available, almost never contains relevant new information, nearly always is taken at the wrong time and by no means can be addressed inexpensively.

The paradigm for future remote sensing data transfers can be modeled after the newspaper habits we all have: we throw the old newspaper away and wait for a new issue the next day. Old newspapers are merely kept for historical reference. The continuous updated use of remote sensing data can be viewed in a similar manner.

4.3 Scenario for Data Services

The next regular update of computing- and communications-hardware at the level of district-offices presumably lead to graphic workstations, connected to the emerging high-performance data-networks. Because of increasing capabilities of even low-priced equipment, all prerequisites are available to link the equipment into the Center for Earth Observation CEO, the remote sensing data network currently planned by DG-XII of the European Union. CEO is expected to provide various remote sensing data as they are being produced by orbiting satellites, as well as photographic imagery which is to be digitized as soon as it is acquired.

Needless to mention, the diversity of data will have to be geocoded before being distributed to users at the local level (Table 4). However, such a demand is much easier to define than to satisfy. We believe that a CEO must cope with that requirement. Based on already existing terrain models, good knowledge of the satellite-orbit and software for automatic recognition of control-features, or by matching with already rectified imagery, geocoding should become a routine-task. This work must be split among a certain number of processing-centers; careful planning and regular quality-control will be necessary.

Geocoding will be needed to unlock the main benefit of CEO: The synergetic exploration of data at various resolutions and with spectral diversity. That is also why - even for a 1000 km² district - we propose the use of images of mid- or low-resolution. We expect that if high-resolution imagery with pixels of 1m to 5m is at hand, the user will also want to employ images of reduced resolution or with different radiometric properties. For instance, a local office may want to track the frequently updated AVHRR-coverage by NOAA-satellites to check the development of crops if (and only if !) one can superimpose this material with high-resolution images showing the relevant field-patterns. Because all data would be co-registered to the same geometric reference, one will be able to spot what is "really" behind a particular low-resolution-pixel.

Sensor / Source	Characteristics	Resolution	Repetition
KFA-1000,KFA-3000,KWR-1000	Photographic/Optical	1-5 m	irregular
SPOT / panchromatic	Scanner/Optical	10 m	~ 5 days
SPOT/XS	Scanner/Optical	20 m	~ 5 days
Landsat/TM	Scanner/Optical	30 m	16 days
NOAA /AVHRR	Scanner/Optical	1 km	twice a day
ERS, JERS	SAR	25 m	~ 20 days
Digitized Orthophotography	Optical	0.5 m	~ 8 years
Digital Elevation Models (DEM)	Photogrammetry, Maps	50 m	long-term
Digital Cadastral Map	Field Surveys	50 to 0.1 m	~ 3 years
Local GIS-databases	Various Sources	various	arbitrary
Value-added products	Remote Sensing Data	various	on demand

Table 4: Examples of Data with Relevance for an Austrian CEO-Work environment. Data in the upper part of the table have to be provided regularly by subscription service; others are acquired by the users from other sources, according to their requirements.

Geocoding will support the positioning of specific phenomena which are apparent in one image but not in others; and it will help fieldwork. Relevance may develop for detecting soil-moisture by microwave-data and to monitor crops using high-repetition/low-resolution optical data. Additionally, geocoded data can be referred to other land-related databases like land-use-plans, soil-maps or the cadastre linked to the on-line real estate register. An office may address on the spot the owner of each site; a possibility which is essential at the local level if concrete action is more important than a general statistical evaluation.

While we have great hopes for the use of synergetic data, we are concerned that so much still is unknown. Considerable research is still to be done to develop the synergetic use of remote sensing data.

4.4 Data Quantities

The diversity of data of Table 4, requires a network to collect, process, archive and forward the relevant data products to the users. An office at the provincial level may expect data once a week and tailor them to the needs of the districts. At a desktop-terminal, an officer may operate the software to visually display, merge and render the data in various combinations.

Table 5 presents the amount of data for each of the at present most important sensors. Neglecting 1m-imagery (which we suppose being acquired only once a year) the annual coverage is 111 kB per square-kilometer. For a district of 30 by 30 km² this would make 100 MByte per year, or an average of 2 MByte of data to be forwarded every week. The high-resolution image included, the annual amount increases by a factor of 10 to 1 GByte.

Sensor	Pixelsize	Bands	kByte / km²	scenes / year	kByte / year
KFA-3000	1 m	1	1,000	1	1,000
SPOT-P	10 m	1	10.0	3	30
SPOT-XS	20 m	3	7.5	2	15
Landsat-TM	30 m	7	7.8	6	47
ERS	25 m	1	1.6	12	19

Table 5: Amount of data per square-kilometer from them most important sensors. Acquisitions per year are estimated (see also *Leberl F. and Haselbacher, 1994*).

5. COSTS OF THE SERVICES

An early CEO-study concluded that Europe may have 10,000 potential users of remote sensing data (*NRSC, 1993*). This would place Austria in a range of 2% of this total, at 200 users. A subscription for basic data services, if it were at 1000 ECU per year, would be low enough to entice all potential users to get involved. This cost is granted presumably only feasible if the space and primary segment is financed from the general tax fund. This would be analogous to current funding of aerial surveying data in national programs.

The transfer of remote sensing data should be supported by fast data networks. However, an issue of overwhelming concern is the cost of data network services. Pricing at this time far exceeds the cost per minute for conventional telephone service. We would agree that the cost of transferring data should be a fraction of the cost of data. This would easily be accomplished if ATM were priced per minute at the level of ISDN services (*Leberl and Haselbacher, 1994*).

6. CONCLUSIONS

We argue that a successful future of remote sensing data in a small alpine country like Austria may depend on:

- the ability to develop uses at the level of district offices;
- the availability of high resolution imagery;
- successful geocoding;
- updated data as soon as new images are available;
- augmenting the offering by application-oriented products.

These requirements can be met at reasonable costs only within the framework of a European network; CEO is therefore an important initiative.

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SERVICES DU PREMIER MINISTRE

BELGIAN OFFICE FOR SCIENTIFIC, TECHNICAL AND CULTURAL AFFAIRS

15 Dec	Session G	• **Belgium (EO User's View: the Belgian view-point. Preliminary results, survey analysis in progress: A Osterrieth)**

Doc.: telsiii\d\esa61294

Earth observation data and services : the Belgian users' viewpoint

1. Background

Belgium is a member of the European Space Agency since its beginning. It is also a partner of CNES in the SPOT programme and has a bilateral agreement with the Russian space agency concerning MIRAS (earth athmospheric chemistry). OSTC is in charge of the Belgian contribution to the space endeavour. In parallel to its participation to these international infrastructure programmes, OSTC conducts several national research programmes related to earth observation :

TELSAT (research in remote sensing)
Global change
EUROTRAC
Marine sciences

OSTC is also in charge of BELNET, the national research network infrastructure (see infrastructure presentation).

2. User communities

Discussion with the research community has shown that needs were quite different according to thematic groups.

In general, the Global change researchers do not wish to become remote sensors, given the already complex tasks of their modelling research. Their wish is for reliable data with specific accurary ranges, without needing to use remote sensing technology. The computing costs in these researches can be quite high and there is a consensus that data should be free. Data pools is probably a solution but access to real time or near real time data is also demanded by some scientists.

Atmospheric chemistry and radiation budget
Scientists in this domain are in close contact with space agencies. They are interested by instrument design, involved in CAL/VAL activities and related research.

The marine science community has recently adopted remote sensing as an investigative technique. It is not yet widely used. However, multi-team research allows for inclusion of remote sensing experts in large research projects and this should stimulate the use of

Rue de la Science 8 - B-1040 Bruxelles 4 - Téléphone 02/238.34.11 - Télex 24501 prosci b - Téléfax 02/230.59.12

space data. The R.S. laboratories are currently involved in research and pre-operational research. It is expected that some institutions will develop operational services based on multisource data, including space data. In that framework, access to real time or near real time data will be necessary.

The terrestrial applications community is the most developed users' community in Belgium. The number of projects which have been undertaken since 1985 is estimated at 170 within the universities (not counting the private sector). Some 30 laboratories are active in the field. Here, projects run from basic research to pre-operational and operational research.

The government and private sector. Given the small size of the country, the incentive to use R.S. data has been weak. The first offical map based on space data (LANDSAT TM 1989) dates from 1991.
However, there is now a growing interest on the part of the public sector, expressed by requests for information and for R.S. pilot projects, and there are new companies entering the market.

A **survey** has recently been conducted within the E.O. user community; most of responses from the users with image processing capacities ("remote sensing group") have been received. An "end user" questionnaire has also been designed; responses are expected in the next few weeks.

3. Preliminary results

The elements of responses given here only portray the data and services aspects of the first questionnaire (addressed to the "remote sensing group").

Identified problems (in descending order):	possible solution:
unproven robustness for wide application (mostly indicated by people involved in operational applications)	documented methodology; automatized production procedures; quality control;
satellite RS capabilities remain too confidential for wide usage	user guide to satellite data, products and services (OSTC product) multimedia demonstration products
price of data (terrestrial applications and private sector)	special pricing for scientists; data sharing
low availability of collateral (non space) data	links to environmental information networks
problems linked with data identification and delivery delays	multimission ephemerids and catalog search
spatial resolution (terrestrial applications mainly)	very high resolution sensors of the future
data ownership, copyright and protection of derived products (terrestrial applications mainly)	adaptation necessary for a larger diffusion of products and services
time aspects (programming, acquisition to delivery...)	better service from overseas stations; increased programming capacity; near real time capacity;

compatibility of data from different captors	conversion algorithms ? geocoding ?
spectral aspects (radiometric resolution and radar band, mostly)	future sensors

Interpretation :

For most EO activities, and in particular for operational applications, several problems are encountered. Existing data identification, acquisition and delivery delay appear to be very time consuming and difficult processes; these difficulties are mentionned for EO collateral (non space) data. For space data, distribution problems are low, given the already available commercial infrastructure, except when data acquisition must be programmed; the situation is worse when multisensor data are required. Cataloguing of collateral data and networking of these catalogues, multimission ephemerids and catalogue search are then keywords to overcome these bottlenecks for operational applications.

Technical problems identified depend on the user's community: terrestrial applications community is interested by better spatial resolution of data, scene quality, unsuitability of spectral bands. EO community, depending on application field, has a mixed feeling on data adequation in terms of localisation precision, acquisition repetivitiy and reliability, radiometric resolution and precision. When needed, multisensor data integration presents a non negligible technical problem, and radar images processing implies rather complex methods.

EO data users involved in semi-finished and finished products (within the satellite remote sensing data value adding chain) point out the legal aspects of data ownership, copyright and protection of derived data has important issues for developping their activities. A larger diffusion of EO products and related services should require present rules homogeneisation and simplification. For the same users, the very little or the absence of data or product quality control throughout the complete value adding chain should also be a major issue to consider if true operationalisation of the technology is targeted; there are no widely accepted standards, noms and procedures to perform data or products quality and reliability assessment.

Infrastructure: all the organisations surveyed own or have access to up-to-date hardware and software facilities; most of these organisations are already connected to X.25 and value-added networks; an initiative of the Belgian OSTC, BELNET, will even reinforce the community networking capabilities and potential national collaboration and data dissemination.

Services: within the remote sensing value adding chain, the Belgian EO community is offering all the processing services. Support services sush as technical assistance, cataloguing, help desk ... and access to collateral data are however far less developed. These services are mostly performed by users themselves for their own needs. Value-adding industry is emerging in fields such as software engineering anddevelopment, consultancy, geomanagement...

Products: it is difficult to evaluate the true market value of the so-called "reusable products", clearly, the number of "products" generated by the research community is not negligible, but their development and that their maintainablity can not be ensured. A few number of Belgian innovative and commercial products (Cartography, Geomanagement Information System ...) are on the market but have difficulties to reach a true business critical mass.

CEO projects could help in setting up structured datatabes and support services. The European dimension could provide the business critical mass necessary.

4. Recommendations expressed by the remote sensing community

Suggestions made by the Belgian remote sensing community are the following :

concerning the development of the overall usage of EO space data:
. to improve the "meta"marketing of the RS potentialities for EO activities:
- by disseminating general information on space data usage
  - in specialised (engineering, agriculture, environment...) publications,
  - in the general public press,
  - by increasing the availability of a general information guide on the space data usage (OSTC is presently developping an electronic user guide, hypertext, open and maintainable to integrate additional useful information (ex: projects synoptic, EO organisations synoptic,...) and will make it available on Internet),
- by creating information centre, help desk, hot line system at focal point of contact (documentation system type);
- by offering data delivery delay guarantee (in particular for operations)

. to clarify and simplify the legal aspects of the space data usage across the agencies:
- by uniformising royalties and ownership principles and policy (simplified and standardised copyright rules),
- by supplying legal services support (insurance for data reception delay, image quality...);

. to develop adequate RSS data pricing policy by supplying cost sharing possibilities for multi-user of multi-usage of image, or cost adaptations for type of usage, depending on image quality, delivery delay, geographical coverage, quantities to be handled...

concerning imaging products:

. as already mentioned, to promote the development of high definition products, and all-weather capacity,
. to ensure increased availability of geocoded and terrain geocoded products,
. to shorten data acquisition and delivery time from stations

concerning service development:

. to facilitate access to information:
- by making available a catalogue of EO data catalogues,
- by facilitating interoperability of catalogues, databases and archives

. to provide typology of products and services for progressive standardisation ensuring true comparability of solutions technical and financial merits;
. to provide incentive for services and products cataloguing;
. to promote quality control and reporting on high level (value added) products

5. Conclusions

These results are only preliminary and have to be taken with great caution.

Once overall results will be available, prioritization of issues still has to occur and be balanced against financial resources availability.

EEOS - A Danish View Point

by

Preben Gudmandsen

Technical University of Denmark

DK-2800 Lyngby, Denmark

Telephone 45 4288 1444, Telefax 45 4593 1634, e-mail pg@emi.dtu.dk

Abstract

This note presents an attempt of defining Danish requirements to the future European Earth Observation System (EEOS). It addresses the expected use of the information system of EEOS and the likely requirements for acquisition of data via EEOS. The latter is worked out on the basis of knowledge the European sensors which will be in operation after 1998 and the present and possible future use of these data for monitoring of the environment in Denmark and in Greenland. It is expected that monitoring in the Greenland area will be carried out as at present, i.e. by institutions placed in Denmark with communication of interpreted data to the area by a suitable data information system, cable and/or satellite.

Introduction

Most present day investigations and monitoring of the environment using satellite data are multi-mission and multi-sensor undertakings. This will certainly also be the case in the future in a number of applications where data from instruments covering the entire electromagnetic spectrum will be exploited. The users may be categorized as Research Users and Operational Users, the latter being establishments that carry out measurements on a routine basis often involving the use of great quantities of data. Although a great deal of research has already been carried out in order to investigate the utility of remote sensing data and to develop analysis methods using existing remote sensing data it is expected that for a very long time to come there is still need for such research in order to improve present techniques, develop new applications, often closely connected to the monitoring agencies, and of course to exploit new types of data. However, this activity is not likely to use great amounts of data and presents therefore not a great load on EEOS. On the other hand Research Users may need a close contact with other users including the staff of EEOS through its Information System.

It is not possible at this moment in time to define the level of processing of data that will be required. The current thinking goes in the way that users will carry out any analysis beyond Level 1b (radiometrically and geographically corrected data) by themselves. This consideration is based on the systems in place and the current experience that in order to take full advantage of the information content of remote sensing data interpretation invariably involves local knowledge of the area in question and often also auxiliary data acquired by the users themselves. Future operational applications may thus be supported by a system of specialized buoys and ground stations, for instance. Also, the synergism obtainable by use of a variety of remote sensing data may be a result of developments carried out to solve specific local problems.

Experience has shown that in most cases meteorological data are needed to carry out a successful interpretation of the phenomenon being studied, scientifically as well as in operational applications, and that the data shall be available for analysis at the same time as the remote sensing data to be fully useful. Therefore, to fully support European users EEOS should preferably have free access to these data to enable timely dissemination to them.

EEOS Information System

In order to satisfy users the Information System shall be able to handle queries related to missions and instruments and to give full information about data availability and quality at a given point or in a given geographical area. In order to ease the work of the users the Information System shall be able to handle a series of instruments simultaneously with overlay to show relative coverage of the different instruments and to list the time difference between acquisitions.

The Information system shall have sufficient capacity to be able to respond to queries by many users simultaneously including dissemination of Quick Looks. This is of importance to Research Users but may also be of interest to operational entities.

Research Users

Research users are scientists concerned with the development of new ways of analyzing data, algorithms and methods, and other scientists dealing with studies of geophysical processes often in support of numerical modelling in climate change research. This category of users need information about data availability, quality, frequency of observation, orbit and instruments data etc. They will take advantage of the EEOS Information System by frequent interaction.

Mostly, delays in data delivery are not critical and for development of methods archived data will often be sufficient. This may also be the case in most studies of geophysical processes except when ground measurements and/or underflights are involved. In some cases ground measurement teams may take advantage of current data for guidance of collection of data, for optimum sampling and in studies of special phenomena including unpredictable phenomena. Known examples are investigations carried out by shipborne teams and field parties involved in geological prospecting.

Operational Users

Operational Users are establishments that carry out routine measurements of the environment over a longer period often counted in years. Their use of data is based on internal studies carried out in order to ascertain to what extent remote sensing data may replace or what is more often the case to what extent they may complement current data. They will subscribe to data from specific instruments acquired at regular interval as the case may be. Data are normally needed at minimum delay. In particular, this is the case when data become part of a forecast activity. Due to the variability of the atmosphere meteorologists consider data "historical data" if they are more than three hours old, but also in monitoring of sea ice delays of more than three to six hours may be critical, especially in connection with ship routing.

As mentioned above, this category of users is likely to perform data analysis by themselves, including own ground or other data, as a part of a well-established analysis system which may handle large volumes of data.

The EEOS Information System will be exploited by these users to obtain status reports of instruments and data quality in cases where they are not part of the routine delivery of data .

Data Applications In Denmark

In this section we shall review applications of remote sensing data for monitoring purposes in Denmark as they appear from a recent study and current activity. Three application areas will be dealt with: Sea Ice Monitoring, Coastal Zone Management and Environment Survey.

Sea Ice Monitoring

Sea ice reconnaissance has been carried out in Greenland Waters since 1959 mostly from aircraft by visual observation with trained pilots. In recent years this activity has been extended to include satellite remote sensing data on a semi-operational basis, mostly AVHRR data (Advance Very-High Resolution Radiometer) acquired at ground stations in Greenland and Denmark. The analysis of the data takes place in Copenhagen by the Danish Meteorological Institute where ice charts are produced on a weekly basis. In some cases shipping is supported. Current studies are made to see to what extent other types of data may be useful for monitoring, including passive microwave radiometer (SSM/I) data, ERS SAR data and in the future also Radarsat data.

The most important parameters derived from remote sensing data are ice extent, ice concentration, ice velocity field, and on-set of melt. Some of these may be obtained from AVHRR data with sufficient accuracy, but due to the frequent cloud cover they are often complemented by SSM/I and ERS SAR data. It is expected that with the improved capabilities which materialize with Radarsat and the Envisat ASAR, first of all the wider swath, microwave data will be used extensively in the future. Experience has shown that with a spatial resolution of 100 meter a very useful monitoring may be carried out in most Greenland Waters. An exception may be on the west coast of Greenland in shipping periods where full-resolution data (30 meter) will be necessary. It is not expected that data of the Landsat type will not be used except in very special cases, but MERIS data will be analyzed in connection with environmental studies.

The Greenland Waters, i.e. the Greenland Sea, the souteast and the southwest coast of Greenland, cover a very large area and for general sea ice monitoring including climate research the estimated volume of SAR and MERIS data becomes large, even at 100-meter resolution for the SAR data. Assuming that ascending and descending passes are exploited with three observation per week in order to determine motion vector fields the total volume becomes circa

6 Gbytes per week, in the period October to April

This number may be considered a maximum number. In view of the present experience with application of AVHRR data for the purpose of general monitoring it may be expected that SAR data are used in this context only to complement AVHRR data when and where clouds prevent observation. However, this requires that a suitable selection mechanism of SAR data acquisition or dissemination be developed and operated in close contact with EEOS. Studies will show whether this will be feasible. If so, the number is likely to be reduced. Also adjustments may take place in almost real time to fit the actual ice situation. Research has shown that the sea ice extent may vary more than a factor of two from year to year so that in some years the data required will be very much less than the maximum numbers arrived at. The study may also show that the task of monitoring could be done with less frequent observation so that a reduction by a factor of two may result, for instance.

The support of shipping especially at the west coast of Greenland which requires a spatial resolution of 30 meter. With the same assumptions as above the volume becomes

9.4 Gbytes per week, in the period May to September

including general surveying of the Greenland Sea and the southeast coast of Greenland. However, a very great part of the volume stems from the requirement to spatial resolution on the west coast which accounts for 2.7 Gbytes.Also this volume is a maximum volume which may be adjusted in the same way as described above.

Assuming 16 bit words as with ERS SAR and that data transmission is accomplished in the course of the three observation days at a bit rate of 2 Mbits/sec the transmission takes 7 hours per day. However, it should be recalled that observations of the Greenland Sea and the west coast of Greenland are probably not made on the same day so the transmission may be extended over all days of the week.

Coastal Zone Management

Coastal Zone Management is the responsibility of two entities in Denmark, the National Environmental Research Institute and the Royal Administration of Navigation and Hydrography, for the near coast areas and the open sea, respectively. In a future monitoring system exploiting remote sensing data the two organizations will work closely together.

Parameters that are of interest are coastal currents, coastal erosion, sediment transport, sea state and sea level (storm surge), plankton bloom, oil pollution and sea surface temperature. It is expected that the larger part of these parameters may be derived from remote sensing data in some cases supported by buoy measurements. Due to the nature of the Danish coastal area fine-resolution data are required in all cases and a frequent coverage is needed - also during winter where sea ice may occur.

In order to cover all coastal areas within one week, exploiting ascending and descending SAR passes in order to obtain different look angles and with a spatial resolution of 30 meter the data volume is estimated at

3.9 Gbytes per week

mostly determined by the SAR data volume. MERIS only accounts for 10 Mbytes per week.

Environmental Monitoring

The monitoring of the environment in Denmark is the responsibility of the National Environmental Research Institute who is overlooking the activities carried out be teams on the county level. Although not established presently, the agricultural monitoring is closely related to that of the environment at large, especially when satellite data are involved. A close cooperation between NERI and the Department of Land Data, the Danish Institute of Plant and Soil Sciences, Ministry of Agriculture, is expected since they are going to largely exploit the same data sets. This is assumed in the estimate of data volume below.

It is suggested that a satellite map of Denmark is produced twice per year to be used as a reference by the county authorities. It will be based mainly on Landsat-type of data supplemented by SAR data at 30-meter resolution when necessary, i.e. during cloud conditions and otherwise. For this purpose the volume has been estimated at:

9.2 Gbytes, twice per year.

In the growing season visual and microwave data are required as follows:

7.7 Gbytes, every second week in the period April to August.

In the other period, September to March, monitoring shall be made only every third week:

7.7 Gbytes, every third week in the period September to March.

It should be noted that the estimates given here and in the previous section did not take into account that by nature there is some overlap between the data required for coastal zone management and those of environmental monitoring. Involving the same authorities these activities will undoubtedly be coordinated so that the total volume of data required will be less than the sum of the data. On the other hand, the coastal zone data are needed every week all year around so that the overall reduction may only account for about 25%. This requires more in depth studies. Although the data volumes are not excessive a sampling scheme may be of advantage in order to reduce the costs.

Network

The physical network needed to transmit volumes of data as those stated above will be in place in Denmark when needed. The maximum transmission required is about 400 Gbits during a number of weeks in a year. Assuming that they are distributed evenly over the days of the week and a transmission rate of 45 Mbit/sec the data may be transferred in about 20 minutes.

Although not directly related to the subject of this note it is worth mentioning that even if data may reach the analysis centre in question within a reasonable time interval there might be a problem in communicating interpreted data to the end user in the Greenland area. Experience has shown that it is often difficult to establish contact with a ship operating at high latitudes and that special measures shall be taken to improve the situation.

Conclusions

This note present some general views as to application of remote sensing data in research and in routine monitoring of the Earth surface and some regards as to the use of the EEOS Information System. Subsequently it presents considerations as to the use of data by Danish operational entities responsible in various fields such as sea ice observation in Greenland Waters, coastal zone management, and monitoring of the environment in Denmark. The data requirements by scientists will undoubtedly be small in comparison with the operational activities.

The data volumes are determined on the basis of known activity in the first field, extrapolated by the author into the future where more advanced instruments become available with Envisat.

The two other fields are considered from recommendations in a recent study of the possibilities of using remote sensing data for environmental monitoring. This is also extrapolated into the future, although it shall be noted that the activities only will be initiated after further studies have confirmed the utility of the data.

The data volumes estimated for the three fields may be considered maximum numbers. Detailed studies are likely to lead to a reduction when overlap between data are taken into account and when synergy with other types of data are considered. It may be concluded that the data transmission rates calculated for the "maximum numbers" do not appear excessive although they require improved communication systems at higher rate than the present European level of 2 Mbit/sec.

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15 Dec	Session G	• **Finland (Data and related information needs in sea ice mapping, hydrological forecasting, crop yield estimation and forest management, R Kuitteninen)**

Risto Kuittinen
Finnish Geodetic Institute
Ilmalankatu 1 A
FIN-00240 Helsinki

Abstract

The premises for operational use of remotely sensed data in sea ice mapping, hydrological forecasting, crop yield estimation and forest inventory are good availability, applicability and response times between 2 hours and 3 weeks. Information needs are concentrated in availability and quality of the data as well as preprocessing and calibration information. An interactive information system and distributed receiving stations are a necessity for operational applications.

Key words: Operational remote sensing, data dissemination.

1. INTRODUCTION

Satellite based remote sensing technology has been developing since the 1960's. The goal has always been the operational use of remotely sensed data to obtain in a cheap way necessary information for many applications. For many reasons remotely sensed data is widely in operational use only in the meteorological user community . In other fields of application there is a lot to do to achieve operational applications. In this paper the different aspects of data and information needs are described. As examples of applications are presented sea ice monitoring, hydrological forecasting, crop yield estimation and forest inventory. These fields have been selected because they reflect the different aspects which are relevant for planning the CEO activities for the benefit of all satellite data users in Europe.

The sea ice mapping community consists mainly of governmental institutes which make ice forecasts for icebreakers and ships. For this work there are needed a long experience and besides remotely sensed data a lot of surface information collected using a permanent observation network.

Hydrological forecasts are made mostly by governmental institutes but also hydropower companies use hydrological forecasts. The basic data for these forecasts come from the data observation networks which mainly are owned by governmental institutes. In most cases the companies do not like to develop their own expertise in satellite based measurements but are willing to purchase the processed data.

Private companies and governmental institutes make crop yield forecasting for commercial and statistical purposes. The development of this field of application is in Europe closely connected with the development of the MARS-programme and the remote sensing control of acreage subsidised arable land and forage areas.

Forest inventory is mainly carried out by national forest institutes and administration. These institutes develop and use remote sensing mainly for nationwide inventories. Private forest companies are more interested to buy the inventory results for optimising the delivery of wood rather than to develop their own expertise in remote sensing.

2. DATA NEEDS

2.1 The basic regulators of data collection frequency

Remote sensing is usually only one source of information for most of the inventory and monitoring tasks in which remote sensing is used. Thus this information must be consistent with the other relevant information used in the task. The need for remotely sensed and other data is regulated by the following basic factors which vary from one application to an other:

a) The natural phenomenon which is being measured or studied. Because in most cases the interest concentrates in changes, the development of the phenomen determines how frequent the need for information is. It is optimal if the development can be monitored in all of its relevant phases but it is in some cases useful also to obtain at least some data from which the phase of the development can be interpreted.

b) Human activity affects nature in many ways and man is dependent very much upon natural conditions. This is besides the first mentioned the other basic thing which regulates the frequency of information needs.

c) The methods used in information processing give requirements for the quality, quantity and timing of the information. As an example hydrological models can be mentioned because besides remotely sensed data a lot of field measurements are used. Table 1 presents the main factors which regulate the frequency of data needs in sea ice mapping, hydrological forecasting, crop yield estimation and forest inventory.

Table 1. The factors regulating the frequency of data needs in some applications.

Application	Natural phenomenon	Human activity
Sea ice mapping	Freezing, ice movement	Transportation, ship routing
Hydrological forecasting	Precipitation, snow melt	Energy production
Crop yield estimation	Plant growth, weather	Agricultural policy
Forest inventory	Forest growth	Forest management

The demand of data frequency is in practice met by the following parameters of the satellite and sensor: repeat cycle, orbit parameters, sensor swath, and used regions of the electromagnetic spectrum. Furthermore the cloud cover defines the availability of data which means that remotely sensed data is available as frequent as is needed for the application. At this moment this is the main limiting factor for operational applications because if there is no guarantee for regular availability of data there will be no operational users for it.

2.2. Premises for operational data use

When the demand of data frequency is fulfilled then the following characteristics of remotely sensed data and its dissemination become important.

a) Applicability which means that a developed remote sensing technique can give relevant information. This can be the final information needed e.g. in snow cover mapping the snow water equivalent or supporting information e.g snow albedo which can be used to derive snow water equivalent. Without this knowledge there will be no use for the remotely sensed data at all but this is not the only presumption for operational applications.

b) Response time which determines the time which is acceptable to obtain the received data from a receiving station. If the response time is too long there will be no possibilities for operational applications. In general when the response time increases the amount of operational applications decreases. A good example is the use of Landsat and Spot data in sea ice mapping. The data could be useful if it could be disseminated very fast even if the frequency of the imaging is low.

c) Processing time becomes seldom a limiting factor for operational applications. The time needed for processing must however be taken into account because it is a part of the total time needed before the data is in a suitable form for users.

d) Local dissemination time which is needed in some applications.

There are many reports and plans dealing with the observational requirements for satellite data for different applications. These requirements give usually the frequency of imaging. This is not enough for operational applications because data dissemination, processing and local distribution may take so much time that the benefits of the original observation frequency are lost. This was e.g. the case in the operational sea ice mapping experiment in the Gulf of Bothnia. The BDDN dissemination of ERS-SAR data was too slow from Fucino to Helsinki.

Response, processing and local dissemination times together with the frequency of imaging determine the total time used to deliver the data to end users. This time is different for different applications and is presented in Table 2. Some minimum conditions can be determined for each application because these conditions can be derived from the facts presented in the chapter 2.1.

Table 2. Average minimum observational frequency and maximal acceptable time for data dissemination and processing for some applications.

Application	Observation frequency	Maximal acceptable time for dissemination and processing		
		b	c	d
Sea ice mapping	1 day	2 hours	1 hour	0.5 hour
Hydrological forecasting	1/2 days	2-4 hours	1 hour	0.5 hour
Crop yield forecasting	1/3 weeks	1 week	2 days	
Forest inventory	1 year	3 weeks	2 weeks	
b=response time	c=processing time	d=local dissemination time		

2.3 Basic and complementary data

The remotely sensed data used in a method can be divided into two groups, basic data and complementary data. If basic data are missing, complementary data can be used. The reasons for data missing are usually cloud cover but sometimes also inadequate possibility to collect data e.g. due to the restrictions of the imaging or image errors. Operational remote sensing methods should be planned so that all available relevant remotely sensed data are used if it is economically possible. However in many cases only data collected by one sensor is used. The designer of an information system must be aware that in many applications it is possible to compensate the missing basic data with other data even if the result in this case is not as good as with the basic data.

Data compensation increases the possibilities for operational applications but it also increases the demands for the data dissemination system. Table 3 shows an example how different kinds of data can be used in some application at the end of this decade when besides the present type of satellites ENVISAT and RADARSAT are in use.

Table 3. Basic and complementary data for some applications.

Application	Basic data	Complementary data
Sea ice mapping	SAR, ASAR	AVHRR, MERIS
Hydrological forecasting	AVHRR	AASTR, MERIS, VEGETATION
Crop yield estimation	XS, pzn, TM	MERIS, VEGETATION
Forest inventory	XS, TM	ASAR

The possibility to obtain complementary or compensating data means usually an increased frequency of getting data which during frequent cloud cover conditions is very helpful for the operational applications.

3. INFORMATION NEEDS

3.1 Availability and quality of data

Information about the availability and quality of data can be characterised by the following parameters.

a) Areas where data will be obtained. This information is very helpful in planning the tasks and could be available 1 - 2 weeks in advance. Even the orders that have been made by other data users. If this information is confidential, information about the orbits of the satellites should be available for the users. By knowing the orbits it is possible to look for e.g. compensating data in sea ice mapping and hydrological forecasting.

b) Areas which have been observed Fast information about this is very valuable for two reasons. In some applications there are some field works (e.g. crop yield forecasting and forest inventory) needed and in some applications this information is needed for looking for complementary or compensating data.

c) The quality of data consists of two aspects; cloud cover and data errors. If information about these things is available at the same time as the information about measured areas it is very informative and valuable for users. It is very important to develop fast methods for getting quick look images because finally only the user can decide if the data is useful or not. A good example of this is snow cover mapping. If e.g. in a period of one week all cloudless parts of AVHRR-images over a certain area are combined it is very probable that the snow cover can be mapped even if the single images are more or less cloudy.

These information needs require an interactive service between the users and the data distributors.

3.2 Preprocessing and calibration information

The main task in remote sensing is to interpret objects and derive their characteristics. The possibilities to use algorithms for these purposes depend very much on the preprocessing of the raw data. For users a good correction of data errors caused by the sensor is a necessity and it must be done by the data receivers. But how the data is processed is of great interest to data users. These methods should be exactly defined and they should be available for the users. The users could then decide if they can use the preprocessed data or if they have to preprocess the data themselves. Preprocessing information should be available when the image is ordered.

The calibration is especially important in those applications where data from different dates are used. Elsewhere it is not possible to get comparable results. This means in hydrological forecasting calibrated data for deferming snow covered area, for crop yield estimation calibrated data for deferming weather conditions and crop growth indices and in forest inventory comparable reflectances of different forest areas.

4. CONCLUSIONS

To develop the CEO for an effective system in Europe the following aspects must be fulfilled:

- The data provided must give more information about the data preprocessing methods and calibration possibilities than which is known today. This information must be available for users upon request all time.

- Data dissemination to users must be much faster than today. This refers to all satellite data because the number of application increases when the total time for data dissemination decreases.

- Information about the availability of data and its quality should be provided for users quickly upon request. This also increases the number of applications.

The CEO must be based as planned on an interactive information system in which data users can inquire information and data for their applications. Fast data dissemination can only be quaranteed if local and centralized receiving stations are used.

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Earth Observation in Greece: Status, prospects and needs with respect to local and regional environmental characteristics

Constantinos CARTALIS * and Michalis PETRAKIS **

Department of Applied Physics, University of Athens *
Institute of Meteorology and Physics of the Atmospheric Environment, National Observatory of Athens **

1. INTRODUCTION

In recent years, considerable activity is developed in Greece with respect to Earth Observation.

According to the analysis of a recent inventory by the Hellenic Space Committee (hereinafter referred to as HSC) twenty eight (28) Public institutions and fifteen (15) private enterprises reported activities in Earth Observation (EO), in vastly different application areas such as geodesy, marine research, land cover/use, forest mapping, cadastral mapping, meteorology, upper air studies, climatology, etc.

It should be mentioned that HSC was established in 1991 by the Ministry of Industry, Energy and Technology, in an effort to coordinate space related activities - including Earth Observation - in a more efficient way.

2. COOPERATION AGREEMENT WITH THE EUROPEAN SPACE AGENCY

In July 1994, a Cooperation Agreement was signed between the Goverment of the Hellenic Republic and the European Space Agency.

The cooperation agreement consists of the transfer of know-how, as well as the development of common projects between the Greek authorities and ESA.

In this context two research proposals were defined and are now close to completion:

a. Oceanographic applications in Greece using ERS-1 data
b. Development of Data Processing Units and VLSI for Space Instruments and

Systems

3. STATUS OF SIGNIFICANT ACTIVITIES IN THE FIELD OF EARTH OBSERVATION

3.1. Operation of high resolution satellite receiving stations

• The PROTEAS Project of the National Meteorological Service

The PROTEAS (Primary research and Operations Tele-detection Environmental Archiving System) project of the National Meteorological Service consists of a Primary data user station for METEOSAT, a High resolution Picture transmission for NOAA and a Meteorological Data Distribution receiving station.

The PROTEAS System is complemented with a network for the dissemination of meteorological images and products to interested parties. This will be accomplished by means of a router of two lines X.25 WAN and two lines V.22 bis. The same router will allow the connection of the PROTEAS System to the Message Switching System of NMS.

The PROTEAS System will enhance satellite related research in Greece. It is anticipated that several Govermental Agencies (Ministry of Agriculture, Ministry of National Economy, Ministry of Environment, Plannning and Public Works, Ministry of Mercantile Marine and Ministry of Energy and Technology) will use the products of the PROTEAS System. However the pricing and dissemination policy is still under consideration.

• **The University of Thessalia satellite station**

At present, the University of Thessalia (Laboratory of Agrometeorology) operates a NOAA HRPT station and a METEOSAT PDUS station. The main application of the stations is research in the field of physical environmental dangers and in agrometeorology.

• **The National Observatory satellite station**

At present the Ionospheric Institute of NOA is installing - within the Athens area - a third NOAA HRPT station to be used mostly for marine research applications. The Station complements the NATO SFS Programme THALASES.

3.2 The National Network for the Environment

The Ministry of the Environment, Planning and Public Works is responsible for the National Informatics Network for the Environment. At present three regions and five prefects are connected in the Network, with their responsibility being the provision of information and measurements for the state of the environment of each respective area.

In a second phase, all thirteen regions and fifty prefects will be connected. The Network will provide the grounds for the exchange of scientific information and know how among Public entities, Universities and Research Institutes.

The overall budget for the Network is approximately 3 billion drs. (or 11 million ECUs) for a period of 5 years.

3.3 The National Cadastral Programme

The Hellenic Mapping and Cadastral Organization has initiated the implementation of the National Cadastral Programme.

The Programme aims at the definition of land use and the registration of property at the National level. For the Programme to be accomplished, satellite images and aerial photographs will be also used.

The Programme will be concluded in 1999, with a total cost of 50 billion drachmas (or approximately 160 million ECUs).

(a full list of relevant to EO activities is given in the APPENDIX).

4. NATIONAL PRIORITIES

National priorities in Earth Observation may be defined with respect to the existing and projected social and economic conditions and on the basis of several interelated needs such as:

- the local and regional environmental characteristics such as the long coastlines, the wide variation of the physical lanscape, the surroundings seas, the large number of cultivated areas, the large number of wetlands, etc.

- the responsibility of Greece to implement Community oriented environmental regulations

- the need to assist selected environment-related strategies, such as the integrated coastal zone management in the Mediterranean basin

- the need to support sectoral policies, of considerable interest with respect to the National economy, such as agriculture, fisheries, industry, etc.

- the need to support physical planning in urban and rural areas

- the need to improve the scientific background of human resources

In this framework the National priorities for Earth Observation in Greece may be:

- The development of a National Earth Observation network with special care given to the dissemination of Earth Observation data, to the communication of EO user communities, and to its integration to the decentralized CEO network, the National Environmental Network and the EIONET network of the EEA.

- The enhancement of the Cooperation Agreement with ESA

- The involvement of Industry in Earth Observation activities both in terms of research and development

- The inclusion of Earth Observation in the National Research Policy

- The definition of programmes for improving the connectivity of Universities to Industries on matters such as Earth Observation

- The development of programmes/missions with emphasis given to monitoring and studying the specific environmental conditions of the Mediterranean area

APPENDIX: STATUS OF GREEK EO USER COMMUNITIES

Remote sensing research and product development is conducted in many Universities and Institutes in Greece. In addition several private companies have been also involved in the field of RS with emphasis given to land resources.

1. Goverment Agencies, Universities and Research Institutes

1.1 Meteorology - Atmospheric Sciences

Greece is a member of EUMETSAT since 1988, being represented by NMS. NMS also participates in the scientific and technical committees of EUMETSAT and is also an active participant of the current METEOSAT Operational Programme (MOP).

NMS has the overall responsibility of meteorological issues in Greece. It operates a wide number of meteorological stations, dispersed in the Greek territory and connected to the Central Meteorological Office in Athens via a telecommunications network.

Meteorology, climatology and atmospheric sciences are also pursued by several Universities and research centers. Emphasis is given to the study - by means of satellite data - the atmospheric phenomena that influence diffusion and dispersion patterns in the lower atmosphere, as well as in the definition of the concentrations of chemical species in the upper troposphere and in the stratosphere.

The Laboratory of Meteorology of the University of Athens pursues research activity in the fields of satellite meteorology, air quality, stratospheric/tropospheric ozone, energy budget, cloud analysis and motion patterns of air masses. The Laboratory participates in several international campaigns for the study of the ozone concentration and also operates - for educational purposes - a secondary satellite station for low resolution images from METEOSAT and NOAA satellites. Special emphasis is given in the use of satellite data (TOVS, SAGE I,II, LIMS, SBUV, etc.) for the definition of the chemical structure of the troposphere and stratosphere in the South East Mediterranean and for the operational monitoring of the distribution of aerosols in urban areas.

The Institute of Meteorology and Physics of the Atmospheric Environment of the

National Observatory of Athens performs regular meteorological and solar energy observations. Specific projects relate to the use of infrared imagery for the study of thermal loss in urban areas and the use of NOAA satellite images for the operational definition of cloud systems.

Finally relevant research is also performed at the University of Thessaloniki where ground based measurements as well as satellite data are used on periodic base for the production - within a United Nations programme - of global ozone maps.

1.2 Geodesy and Geodynamics

Since 1965, the National Technical University of Athens operates the Satellite Observatory at Dionysos (northern suburb of Athens). The Observatory is equipped with a Bakker-Nunn camera, laser ranging Doppler, GPS and Doris system and focuses on applications within the fields of geodesy and geodynamics.

The University of Thessaloniki is also involved in similar satellite based GPS activity, with emphasis given to the seismological investigation of Central and Northern Greece.

These two Universities are also involved in research work in precise orbit determination using laser ranging and satellite altimeter data. Altimeter data are also used to determine the mean sea level as well as the ocean variations on a global scale.

1.3. Other activities in the field of remote sensing

The Hellenic Mapping and Cadastral Organization is responsible under the CORINE Land Cover EC Program to produce maps of land cover for the Greek territory. In addition, HMCO is responsible for the Cadastral Programme described in Section 3.3.

The Ministry of Agriculture is involved in two projects in the field of RS. The first project aims at the re-evaluation of the agricultural statistics; the project started in 1991 and 100,000 hectares of land have been examined so far. The second project aims at the monitoring the agricultural types at national level.

The Institute of Geology and Mineral Exploration (IGME) uses remote sensing techniques and data for applications in Hydrogeology, Geology and Tectonics.

LANDSAT and SPOT images as well as photographic data are used in this direction. Specific projects include the investigation of the structural controls of mineralization in the Eastern Rhodope region in NE Greece.

Finally, the National Foundation for Agricultural Research is involved in the agricultural monitoring and land use mapping.

Remote Sensing Laboratories have been also established at the National Technical University of Athens, and the Universities of Athens, Thessaloniki and Aegean.

Activities at NTUA include the development of an integrated cadastral information system, the establishment of methodologies for agricultural land use mapping, the mapping of wetlands and the study of coastal zones.

The University of Athens (Department of Geology) is involved in land use mappings and geological studies. It has also participated in the European Collaborative Programme "Remote Sensing in the Management of less favoured areas".

The University of Thessaloniki concentrates in the areas of Forestry, Agriculture and Geology. Thematic maps of agricultural regions as well as geologic maps are produced with the use of Landsat and SPOT images. In addition the Laboratory of Agriculture uses remote sensing for the management of less favoured areas within the relevant EC programme.

The University of Aegean emphasizes in the use of satellite images from NOAA, Landsat and SPOT in an effort to re-evaluate maps of medium scales and to monitor the oceanic environment and to also assess the forest conditions.

The Demokritos University of Thrace applies remote sensing for both land and ocean applications and is also invloved in manufacturing of space technology. It cooperates with the Institute for Ionospheric and Space Research of the National Observatory of Athens (NOA) which has developed a dedicated remote sensing laboratory, with full digital image processing facilities, for ocean applications. A relevant programme of NOA, the SFS NATO THALASSES, has aim the study of the marine environment of the Aegean Sea.

Other research centers that are involved with remote sensing are the National

Center for Marine Research (NCMR) and the Institute of Marine Biology (IMB):

NCMR uses NOAA-AVHRR and Nimbus-7 CZCS data to study the temperature profiles and chlorophyll contents of the sea surface layer. These data are complemented by Landsat data for off-shore stuides as well as by in situ ship measurements.

d) Education and training in Earth Observation

Courses in the field of Earth Observation (principles, technology, etc.) and its applications are included in the Academic Programmes of several Universities in Greece. However a dedicated postgraduate (MS) programme in Earth Observation is missing.

In addition continuning education programmes in Earth Observation are performed in the framework of the European Social Fund and COMETT by the Universities of Athens and Thessaloniki, the National Technical University of Athens, the National Observatory of Athens and Greek Center for Productivity.

B. Private enterprises

The private sector demonstrates a considerable involvement in Earth Observation, although mainly through the production of dedicated software, such as sw for image processing, and through selling acitivities on the basis of imported hardware and software for Earth Observation (including relevant data). The majority of the private enterprises may be classified as small-medium ones with objectives environmental studies or applications of informatics.

It is anticipated that considerable thrust will be given to the private industry in the following years on the basis of the Operational Programmes for the Environment, for Research and Technology, the Cooperation Agreement of the Hellenic Republic with ESA and the relevant to Earth Observation Community actions or programmes.

Magnzs Gupmundsson, Iceland Geodetic Survey

Iceland is 103,000 km2 in size, and has a population of 260,000. Located in the middle of the Atlantic Ridge, the country is young from a geological standpoint. Volcanic activity and earth tremors and quakes are common, and glaciers are constantly in flux. The largest environmental problem facing Iceland is soil and vegetation erosion, and since the country's settlement over 1100 years ago a major portion of the original vegetation has been lost. Iceland is in one of the areas of the world where weather and ocean conditions are highly changeable. The ocean surrounding the island, with its fishing banks, is the main natural resource that the nation depends on. Yet fish stocks have depleted in recent years. Fishing is dependent on various aspects of the environment: sea temperature, ocean currents and ice flows. It is therefore clear, then, that remote sensing will become of increasing importance. The Icelandic economy also depends on the production of power, both hydro-electric and geothermal. By systematically incorporating remote sensing in those areas, it will be possible to increase our knowledge of these energy resources, which in turn will help us to harness them more efficiently.

Large cloud cover over Iceland has made earth observation less effective, but with the new satellites that see through clouds, some of the research restrictions have been eliminated.

In Iceland, the Ministry of Education, assisted by the Icelandic Council of Science and the National Research Council, is responsible for matters that link science and technology in the European Economic Area treaty between EFTA and the EEC. Work in connection with the CEO (Centre for Earth Observation) and EEOS (European Earth Observation System) falls under this category, and the institute in Iceland that has played the most important role in developing remote sensing in Iceland is the Iceland Geodetic Survey. The University of Iceland also works at fundamental research in this area.

The National Research Council, an agency responsible to the Ministry of Education, has twice organised special earth observation committees that published policy-making reports in this field; first in 1976 and again in 1986. The goal was to strengthen remote sensing in Iceland, but unfortunately capital to expand capabilities has been in short supply.

The Iceland Geodetic Survey, the nation's institute for cartography, is responsible to the Ministry of the Environment. The operation is divided into three areas: surveying, cartography and aerial photography. The aerial photography and remote sensing department has a staff of six (two photographers, an engineer and three geographers). The department's responsibilities are divided into four main areas:

a. Aerial photography from aircraft
b. Photographic services

c. Image processing of remote sensing data
d. Data storage and information services

Since 1986 the processing, cataloguing and distribution of the remote sensing data has been performed by Iceland Geodetic Survey which is distributor for Eurimage in Iceland and also in good co-operation with SSC Satellitbild in Kiruna. The institute has also been responsible for aerial photography in Iceland since 1950. Last year (1993) the institute distributed three different digital products using satellite data of Iceland and Erdas Image processing system:
1. Vegetation image in 100 X 100 meter pixel size. 2. Infrared composite colour image in 100 X 100 meter pixel size 3. Black & white composite image in 30 X 30 meter pixel size. These images are already used in some GIS systems.

The plan is to put on the market soon two composite Landsat images in 30x30 meter pixel size in true colour and infrared colours. We believe that these value added products will be very important in near future in the environmental management and for the GIS market.

Several organisations utilise remote sensing from satellites for practical purposes but users of remote sensing data from satellites are only at five to six institutions; the Iceland Geodetic Survey, The Agricultural Research Institute, The Soil Conservation Service, the Icelandic Meteorological Institute, Marine Research Institute and the National Energy Authority. These institutes use remote sensing data briefly or to some extent and their approaches have been more of less qualitative for mapping and monitoring purposes adding value to various ground truth data. T

The main reason for the current stage of the remote sensing user environment in Iceland is that the research and application community is below critical mass and it has not yet joined forces to work for its advance and attendance of the required critical mass. The population of experts and scientists in the field of environmental research and monitoring is small.

The long term repeat coverage from satellites of whole Iceland and the surrounding ocean will probably be interesting for the users together with better resolution of the images and radar images because of the cloud cover problem. Value added data will also be important specially for the GIS market. Price of the data is a barrier for a small community that has to be mentioned and will be very important element in the future. Most users think today that the price of the data is to high compared to other methods used.

The potential usefulness of remote sensing techniques in Iceland is probably among the highest in Europe relatively speaking. The transparency of this society makes it an interesting and the country is very interesting from the scientific point of view.

Many fields are important for example. monitoring of volcanism, research and monitoring of the snow cover and glacier accumulation/ablation rates and movements. Also monitoring and research of sea-ice extent and motion, monitoring and research on vegetation and soil erosion. Marine applications are important for monitoring and research using remote sensing for revealing physical conditions, e.g. sea surface temperature, sea--state, currents using altimetry and various studies related to primary production and dynamics in coastal areas.

This year (1994) Iceland was connected to a fibre optic link between North America and Europe. Iceland will then become closer to Europe in the areas of telecommunications and computer link-ups than ever before and have the same possibilities as other European countries to build up high speed networks. There is also already existing fibre optic link around Iceland making all connections very fast and powerful.

Last years there has been major movement in Iceland in initiating new working methods. It is very important to build up an infrastructure and a long term national program for remote sensing in Iceland. We also have to increase education and flow of information to the users, possible users and decision makers and we have to build up a better system for funding programs in this relatively new field. The European Unions focus on data networks and data access will hopefully stimulate the market in Iceland and create new and better use of already exiting data resources. There is not doubt that linking Iceland with the EEOS and CEO will be very beneficial to many, as this opens up an avenue of information and data that at present is not very accessible and the human part of the network will probably be very important.

Magnus Gudmundsson

15 Dec	Session G	• Ireland (the main EO Data User Requirement in the Republic of Ireland, S A Bonyard)

Integration Earth Observation (EO) Databases and Linear Classification Functions for Forest Inventory and mapping.

Seyed Amir Bonyad M.Sc. (Forestry)
Mairtin Mac Siurtain M.Sc. (Forestry)
Forestry Dept., Faculty of Agr., UCD
Belfield, Dublin 4. Ireland.
(T) +353-1-706 7757 (F) +353-1-283 7328

Abstract

Forestry and Agriculture and the Environment are primary EO data users in the Republic of Ireland. All EO data users have requirements for up-to-date data and reliable georeferenced value added mapping products. A fundamental requirement of all EO users in the future will be the definition of rigorous technical specifications associated with EO and GIS mapping products. In particular, rigorous mathematical and statistical analysis of EO data is essential to define the level of confidence with which spectrally unique classes can be defined and interpreted.

New rigorous statistical EO classification techniques have been developed based on multivariate discriminant analysis for the isolation of pure spectrally homogeneous classes. These new image processing techniques are polygon by polygon based rather than the current traditional unreliable pixel by pixel techniques. The new methodologies rigorously define the level of confidence associated with the spectrally distinct classes within EO databases. Furthermore, the derived integrated EO and map define the classes which can be interpreted with specified level of confidence typically in the range 0.95 to 0.999.

This major technical advance in EO image processing for the first time provides a rigorous mathematical basis for meeting the most important requirement of EO data users. The requirement being a rigorous statement of the level of statistical confidence associated with interpretation of EO derived mapping products. These techniques were initially developed for forest inventory in the Republic of Ireland. However, the methodologies will have very far reaching practical application for in forestry, agriculture and environmental management, planning and monitoring. Adaptation of these new rigorous techniques will result in the exponential expansion of the use of EO databases internationally.

1-Introduction.

Land use remote sensing data are compiled in order to determine trends in land utilisation required to make production, marketing and policy decisions. The usual method used to obtain these data are by national census, which produces a detailed classification. This method may be supplemented by EO database which has recently become more practicable with advances in resource satellite technology. Remote sensing refers to the use of electromagnetic radiation sensors to record images of the environment which can be interpreted to yield useful information (Curran, 1985). Three main forest species Sitka spruce (*Picea* *sitchensis* Bong. Carr.), Lodgepole pine (*Pinus contorta* Loud.) and Japanese larch (*Larix kaempferi* Sargent.) were chosen for this study.

The objectives of this research are to develop polygon by polygon (group of pixels) classification using spectral remote sensing database and multivariate regression modelling (linear discriminant function) to produce forest probability inventory map.

2. Methodology

2.1 Test site and available Satellite Imagery.

The test site of study are Clonaslee Forest, which are located in the northern limit of the Slieve Bloom Mountain region of central Ireland. All satellite data presented in this study are of the national Landsat and SPOT satellite image database developed by the Forest Institute of Remote Sensing Technology (UCD FIRST), Forestry, University College Dublin. The specific test site was 7.5x7.5km and was covered two Landsat TM and two SPOT XS and P imaging dates:

Landsat TM	02.05.90
Landsat TM	17.10.93
SPOT XS + P	07.08.88
SPOT XS + P	14.10.88

2.2 Multivariate analysis variance techniques.

Within the realm of multivariate statistical analysis there are a large number of advanced mathematical techniques for the analysis of p dimensional data. Multivariate analysis techniques The multivariate analysis of variance MANOVA techniques including Hotelling T_2^2 test, wilks' test, Bartlett's test discriminant analysis and principal component analysis (PCA) and classification are widely used in the educational and psychological research but have not been widely applied or evaluated to the analysis of remote sensing data on a polygon by polygon (group by group) basis. These techniques are characterized by group by group decision statistical criteria.

3. Results of Landsat TM 02.05.90

The results of the statistical analysis or satellite data from Landsat TM 02.05.90 including; Hotelling's T_2^2, Homogeneity of variance-covariance matrices, Multivariate Analysis of Variance (MANOVA), Discriminate are presented as follows:

3.1 Hotelling's T_2^2 test.

Hotelling's T_2^2 was used to test the equality of mean spectral reflectance vectors for all pairwise groups of three forest species (SS, LP and JL). All these three species were compared using Hotelling's T_2^2 test on the TM database 02.05.90. The results of this analysis is summarised and presented in Table 1

Table 1 Results of Hotelling's T_2^2 test on the TM data 02.05.90

Species	Statistic	Value	Num. df	Den. df	Comp. F	Tabul. F	Pr > F
SS & LP	Wilk's Lambda (Δ)	0.280996	6	222	93.0518	3.74	0.001***
SS & JL	Wilk's Lambda (Δ)	0.328229	6	149	50.5424	3.74	0.001***
LP & JL	Wilk's Lambda (Δ)	0.267776	6	150	68.3762	3.74	0.001***

Inference:

Pairwise comparison of mean vectors of spectral reflectance for Spruce, Lodgepole pine and Larch stands differ very significantly on the TM satellite image database.

3.2 wilks' test

wilks' test was used to test the equality of mean spectral reflectance vectors for three forest species (SS, LP and JL) on the TM database 02.05.90. The results of this analysis is summarised and presented in Table 2.

Table 2 Result of Wilks' test on TM image data 02.05.90.

Species	Spectral bands	MANOVA computed statistic	Computed F	Tabulated F	Pr > F
SS, LP & JL	1,2,3,4,5,7	Wilks' Lambda(Δ)	78.6224	2.74	0.001***
		Pillai's trace	67.3651	2.74	0.001***
		Hotelling's-lawley trace	76.674	2.74	0.001***
		Roy's greatest root	108.942	2.74	0.001***

Inference:

The mean spectral reflectance of Spruce, Lodgepole pine and Larch stands are highly significant on the TM satellite image database.

3.3 Bartlett's test

Bartlett's test was used to test the equality of covariance matrices of spectral reflectance for between and within three forest species (SS, LP and JL). The results of this analysis is summarised and presented in Table 3

Table 3 Results of Bartlett's test on TM image data 02.05.90.

Species	Spectral bands	MANOVA computed statistic	Computed F	Tabulated F	Pr > F
SS, LP & JL	1,2,3,4,5 and 7	Wilks' Lambda(Δ)	78.6224	2.74	0.001***
		Pillai's trace	67.3651	2.74	0.001***
		Hotelling's-lawley trace	76.674	2.74	0.001***
		Roy's greatest root	108.942	2.74	0.001***

Inference:

The covariance matrices for forest stands of Spruce, Lodgepole pine and Larch differ very significantly on the TM satellite database using the polygon by polygon sampling methods and six TM spectral bands.

3.4 Discriminate analysis.

Rejection of MANOVA tests was followed of significance by discriminant analysis to find out a set of linear combinations of the quantitative original predictor variables (spectral bands) that the best reveals the differences among the forest species on the satellite remote sensing data. The statistical analysis successfully were carried out a set of linear combinations of the quantitative the six TM variables that the best reveals the differences among the three species on the TM satellite imagery. This analysis performed by computing the standardised weights of discriminate functions v_1 and v_2 by using the root of the variance in each bands the results are shown as follows:

$$v_1^{*} = \begin{bmatrix} 3.277 \\ 0.874 \\ -6.060 \\ 2.122 \\ 1.614 \\ 1.729 \end{bmatrix} \qquad v_2^{*} = \begin{bmatrix} 5.926 \\ 1.558 \\ -11.073 \\ -1.435 \\ 0.015 \\ 5.641 \end{bmatrix}$$

The elements of the v_1^{*} and v_2^{*} are the relative contributions of $\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5,$ *and* λ_7 six TM bands to group differentiation along each of the two dimensions (linear function). Thus contributions to be in the proportion roughly 3: 1: -6: 3: 2: 2 for the first dimension. The results this analysis indicated TM bands $\lambda_3, \lambda_4, \lambda_5,$ *and* λ_1 are more effected to differentiation and determinant of three forest specie on the satellite imagery. The λ_1 corresponding to TM blue band 0.3 -0.4µm. The light in this blue band gets reflected by particles present in the atmospheres before reading the earth's surface. For this reasons it is not important TM band for determinant of vegetation. It is apparent that Landsat TM bands $\lambda_3, \lambda_4,$ *and* λ_5 corresponding to bands red, near infra-red and mid near infra-red are the most important TM band combination for discrimination and inventory of vegetation and forest species on the TM image data.

3.4.1 Linear Discriminant Functions (LDF) for SS, LP and JL.

The Linear Discriminant Functions (LDF) or linear classification functions successfully were computed in this study. The mean of the spectral reflectance of polygon of six TM bands were used for forest inventory and mapping of forest species SS, LP and JL on the satellite image database are shown as follows:

$$Y_{SS} = -687.16359 + 21.10744\,\lambda_1 + 8.5871\,\lambda_2 - 6.59305\,\lambda_3 + 0.0191\,\lambda_4 - 3.04734\,\lambda_5 + 6.0599\,\lambda_7$$
$$Y_{LP} = -690.3295 + 21.28484\,\lambda_1 + 9.69071\,\lambda_2 - 6.84665\,\lambda_3 - 0.7773\,\lambda_4 - 2.90686\,\lambda_5 + 6.75414\,\lambda_7$$
$$Y_{JL} = -732.2745 + 21.46929\,\lambda_1 + 10.47463\,\lambda_2 - 8.56227\,\lambda_3 - 0.1950\,\lambda_4 - 2.46905\,\lambda_5 + 6.7057\,\lambda_7$$

Inference:

- LDFs define the spectral reflectance models for classification of forest stands (polygons) using spectral data for forest inventory and mapping.

- LDFs provide the mathematical basis for new image processing techniques.

3.5 Classified remote sensing TM data for inventory using computed LDF's.

The satellite image TM database were classified using the computed LDF's for forest inventory and mapping. The 271 polygons on TM image database for SS, LP and JL were classified before filtering spectral reflectance data into one of three groups using the mean vectors of the polygon as input to the computed LDF's. The probability of the group membership was computed for each polygon sample. The detailed of the these test are summerized and presented in Table 4.

Table 4 LDF's classifications results and probability of group membership

Satellite data	Species	No. of polygons	Correctly classified	Prob <0.80	Prob 0.80 - 0.90	Prob 0.90 - 0.95	Prob 0.95 -0.999
TM	SS	114	103	8	13	21	61
TM	LP	115	101	5	6	11	79
TM	JL	42	41	5	5	-	31

Inference:

LDFs classification results

- Probability of group membership defined for all polygons.
- Levels of confidence defined for stand mapping in forest inventory

3. 6 Statistical inference to population.

The new forest inventory map presented in Figures 1 was produced for population (entire of Clonaslee forest of Slieve Bloom mountain) on the TM image database. For produce this Probability inventory map the TM image database and the LDF classifications, multivariate regression model were used. Field validation of 70 stands provided the results of field validation is shown 97.5% for Spruce, 95.2% for Lodgepole pine and 100% for larch stands are correctly classified. The area and proportion of forest stands for test area by Level of Probability are shown in Table 5.

Table 5 Area and proportion of forest stands for test area by Level of Probability.

Species	1994 LDFs	% Area	Level of
	Area (ha)	by LDFs	Probability
JL	32.64	3.67	0.95-0.999
SS	472.15	53.14	0.95-0.999
LP	275.34	30.99	0.95-0.999
Mixed	108.39	12.20	
	888.52	100.00	-

Inference:

LDFs classification results

- The area and proportion of Spruce, Lodgepole pine and Larch in Clonaslee Forest are estimated with levels of confidence in between 0.95-0.999.

- Field validation of 70 stands provided classification accuracies of:
  97.5% for Spruce ;
- 95.2% for Lodgepole pine and
- 100% for larch stands in Clonaslee.
- Forest Inventory Probability Map

The results of the field validated of the new inventory forest map are absolutely satisfactory and extremely important for the utilization of satellite remote sensing data in forest inventory and management. This statistical analysis using the mean vector and covariance matrix of the spectral reflectance of polygon (group of pixels) method on the six spectral TM bands and the LDF multivariate regression model and polygon sample method have not been previously used for determinant and differentiation forest species on the satellite database for forest inventory and management. The result of this study will use satellite data for forest inventory of forest species and growth potential, yield class and classification. These technique will be absolutely indispensable for fully stocked pure coniferous plantations. The results indicated in this study are extremely important and will have enormous practical implications for the utilization of satellite remote sensing data in forest inventory, production forecasting, management, planning and monitoring. This methodology will allow the grater application of satellite image data for future experiments designed to relate spectral reflectance to forest growth and yield parameters. This result would have major implications for the use of satellite remote sensing data in forest inventory in future.

Figure 1 The new forest inventory Probability map based on Satellite TM database, statistical MANOVA test, Polygon by polygon sampling method and image processing.

4. Conclusions.

1. New image processing techniques have been developed, applied and checked for Clonaslee Forest.

2. Spruce, Lodgepole pine and Larch stands are spectrally unique with very high levels of probability.

3. Forest inventory probability maps provide unprecedented levels of confidence.

4. For the first time foresters can have statistical confidence in Forest Inventory Maps derived from satellite remote sensing data..

5. The new multivariate image processing techniques are equally applicable to all spectrally homogeneous clusters, classes and or individual polygons including agricultural parcels.

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Norway

Name: L.Seljelv (E-mail: lill@tss.no)
Affiliation: Tromso Satellite Station
Title: Norwegian near real-time services, requirements and priorties

Abstract:

Due to Norway's long coastline and the surrounding ocean areas including the Arctic, national priority has been given to establish operational near real-time ocean monitoring services based on EO data.
Operational monitoring of the ocean generates near real-time requirements on the services and the infrastructure providing the services, in terms of:

Data processing
Value adding and service production
Distribution of products
Scheduling and interconnection with satellite mission control centre

Services that are under development include:

Oil spill detection
Ice monitoring
Sea state mapping and monitoring
Ship detection

The services will be described with focus on the near real-time requirements listed above. In addition requirements regarding use of additional input sources (other than EO data) and service quality will be addressed.

A discussion of future plans and requirements related to value added services, distribution systems and integration of EO and other data sources will finalise the presentation.

Full Paper:

1. Introduction

Norway has a long coastline and large territorial waters. The need for efficient monitoring and surveillance of these marine areas has led Norway to establish monitoring services. Data from Earth observation satellites have been demonstrated as one of several important data sources in selected marine services.

Such monitoring and surveillance service often requires fast actions. Oil spill pollution control, wave forecast and ice monitoring for ship navigation are examples where data are needed immediately in order to take the right action, As a consequence, the delivery time of the service is important. For Norway it has therefore been important to establish infrastructure capable of offering services in near real-time.

A national receiving station, at almost 70=B0N in the city of Tromso has recently been upgraded to supply Earth observation data services to customers in near real-time. The main emphasis is towards use of data from radar satellites, also a natural consequence of the surveillance and monitoring user requirements. Norway and the surrounding oceans are often covered by clouds, and several months during the winter the light conditions are so bad that traditional optical sensors can not be used.

2. Near Real-time Requirements

from one application to another. However, based on the experience we have gained through developing marine services we define near real-time as processing and distribution within 1-2 hours after acquisition.

3. Demonstrations and Pre-operational Services

The Norwegian Space Centre (NSC), is a foundation under the Ministry of Industry and Energy, and governs national funds for developing earth observation services.

NSC has since 1989 been co-ordinating a national programme for developing operational services based on Earth observation data. Focus is on SAR data, and work is undertaken in the following applications where the objective is to establish operational services by the end of the century :

1. Ice, both ice monitoring and ice database
2. Oil spill detection
3. Wave forecast
4. Ship routing
5. Coastal zone monitoring

In addition to the national programme, there are being developed services= for :

6. Snow monitoring
7. Meteorology

3.1 Ice

Pilot demonstrations of ice monitoring services has been done by Nansen Environmental and Remote Sensing Centre (NERSC). The processing and distribution of earth observation data is performed by Tromso Satellite Station (TSS).

Several users have participated in these demonstration ie, shrimp trawlers, airport weather services and the coast guard. Input to the service so far has mainly been ERS-1 SAR data, but also NOAA AVHRR and SSM/I data have been used.

A major requirement for this application is near real-time processing and distribution of the data. That is delivery of data for analysis within 2 hours after acquisition. In order to reduce the time delay between the reception and the analysis, a pre-operational service will be established in connection with the ground station as a joint project between NSC, NERSC and TSS. This will also reduce the data volume transferred on data networks.

Another important requirement for the ice monitoring service is access to other relevant information, ie. meteorological data, numerical models and earth observation data from other ground stations and/or satellite sensors.

In addition to this near real-time ice service there will be established an ice database for research and statistical purposes. According to the plans for the database, additional data, ie. in situ data from ship observations and buoy data could be integrated into the database.

3.2 Oil Spill Detection

In close cooperation with the Norwegian Pollution Control Authority, the oceans near the coast of Norway has been regular monitored using ERS-1 SAR data. During the past two years demonstrations and a pilot service have shown that the combination of satellite SAR and airborne SAR reconnaissance could give the authorities an improved oil spill detection service. A pre-operational service is now operated by Tromso Satellite Station. National as well as international oceans are monitored regularly. Since the station is manned 24 hours a day all year, pollution control authorities can be alarmed 1-2 hours after acquisition of the satellite data.

The user require frequent and continuous monitoring of high priority coastal areas, ie. coverage once every 24 hours. However, this do not imply that the user always will request coverage of the total area of interest. Furthermore, the user wants the possibility to make "last minutes request" whenever there is an emergency situation, ie. spill from an oil tanker.

The service also require data from other sources, ie. meteorological data, and use of numerical models.

3.3 Wave Forecast

The Norwegian Meteorological Institute develops, operates and distributes a wave forecasting service where they make use of different data sources combined with numerical models. They are assimilating ERS-1 AMI Wave mode data into their service. In addition wave spectra extracted from ERS-1 AMI Image mode data will be used as a complementary data source. Use of wave spectra in the models will improve the quality of the current service.

Tromso Satellite Station has recently implemented algorithms for extracting wave spectra from SAR images.

3.4 Ship Routing

A national project utilising ERS-1 Wind data has demonstrated a ship routing system to support ship navigation. The service is designed as a tool for the captain to make him able to choose the best possible route.

In order to improve this service other information could be included, such as wave, current and ice forecast.

3.5 Coastal Zone Monitoring

A project is planned for a Coastal Monitoring service. Parameters to be monitored are biomass, algae, ship detection, sea surface temperature and ocean features. The oil spill detection service will be considered integrated in this service.

The plans for this service includes several earth observation data sources like ERS-1 SAR, SeaWIFS, ERS-1 ATSR, NOAA AVHRR together with other data sources and models.

Users of such a service will be governmental institutions responsible for coastal zone monitoring and management, and commercial companies with activities in the coastal zone, ie. fish farmers and oil companies.

3.6 Snow Monitoring

A national hydroelectric power production company use AVHRR data when planning their power production. Weekly data give information about the snow cover at the different magazines during the snow melting period at spring and early summer. A system providing snow cover maps has been developed by the Norwegian Computing Centre in close cooperation with the user.

The user requires both information on relevant data browsing, and near real-time processing and distribution of the products. Unlike the marine applications, they require precision images, that is geocoded data.

3.7 Meteorology

The Norwegian Meteorological Institute has its own receiving and processing system for AVHRR and Meteosat data. A dedicated workstation MISAT, for processing and integration of earth observation data with data from other sources has been developed by a Norwegian company, Spacetec.

In addition to the earth observation data received by the institute itself, they receive data from ERS-1 through the meteorological network, and also from the national receiving station for ERS-1 data in Tromso.

4. Future Plans

Norway will continue to develop operational monitoring services. Since data volume seems to be increasing, ie. ScanSAR will cover larger areas than ERS-1 SAR, more analysis will be done to the data at the receiving station in Tromso rather than distribution large volume data over networks.

Operational radar satellites must be available before an operational service could be fully established.

5. Conclusions and Recommendations

For marine applications, that often are action-demanding, it is important that the information is provided in near real-time. Processing and distribution systems must be established taken these requirements into account.

For marine applications the time aspect is often more critical than the accuracy of the information.

Land applications often require precision products.

Many services requires access to other data sources in addition to EO data, and an EEOS system should take that into account.

15 Dec	Session G	• Netherlands (The NEONET project, R Van Swol)

R.W. van Swol, W.J. Looyen
National Aerospace Laboratory NLR
P.O. Box 153, 8300 AD Emmeloord, The Netherlands

S.J.M. Barlag
Royal Netherlands Meteorological Institute (KNMI)
P.O. Box 201, 3730 AE De Bilt, The Netherlands

R. Allewijn
Survey Department Rijkswaterstaat (MD/RWS)
P.O. Box 5023, 2600 GA Delft, The Netherlands

Presentation at the EEOS Workshop, Rome, 13-15 December 1994

Introduction

During 1993 and 1994, Phase I of the Feasibility Study for a Netherlands Earth Observation NETwork (NEONET) has been carried out on behalf of the Netherlands Remote Sensing Board (BCRS) and the Space Research Organization Netherlands (SRON). In continuation of these activities the NEONET Project has been defined, containing phase II of the feasibility study and in addition covering the realization, at prototyping level, of some components of NEONET. The NEONET Project will be carried out by National Aerospace Laboratory NLR in cooperation with the Royal Netherlands Meteorological Institute (KNMI) and the Survey Department of Rijkswaterstaat (MD/RWS).

Study rationale

Presently, several studies (CEO, EEOS) are conducted on international data infrastructures forming together an end-to-end Earth observation system. These studies concentrate on either the data application oriented problems (CEO) or on user-space system interfacing. Topics covered in these studies relate to the use of data links, organisational aspects, the user of science centres, data processing requirements etc.

Also in The Netherlands the need for a well organised data infrastructure has been recognised. This national infrastructure should enable the Netherlands user community to access in an easy way the data products form the various earth observation missions, taking into account the diverse requirements of that community. Moreover, a national infrastructure which is part of the international network would allow the Netherlands to play an active role in the global earth observation system.

Therefore, the main role of a Netherlands Earth Observation NETwork (NEONET) is to provide a national infrastructure for the Netherlands scientific and operational user community, which meets the long-term demand of the users in terms of data availability, data processing and data storage and which, as part of the international network, allows an active participation of Dutch user groups in international earth observation activities.

Study Approach
The adopted study approach is based on a highly simplified but clarifying description of the 'earth observation world'. The space system world comprises satellite systems, ground stations, processing facilities and data dissemination networks. This world mainly operated by space agencies and aerospace industries, performs measurements of the processes at the earth's surface or in the atmosphere. These measurements become available as validated data products after conversion of the data from engineering units to geophysical parameters.

The geophysical interpretation of the measurements is done by the other world: 'the 'user world'. The measurements are incorporated in the scientific research and operational tasks of a wide variety of user groups. Many applications areas can be distinguished e.g. meteorology, atmospheric research, agriculture, oceanography and forestry. Interpretation of the earth observation data requires expertise, computer models, assimilation techniques and so on.

On historical and organisational grounds another cross section of the earth observation world can be made by making the distinction between operational meteorology and climate research and monitoring on the one hand and other earth observation applications on the other. And again, also the meteorological world has a space system component (geostationary satellites, EUMETSAT) and a user component (meteocentres).

Based on the description of the earth observation world presented above, making the distinction between space systems and user community and between space systems and user community and between meteorology/climate monitoring and other earth observation applications, the NEONET feasibility study will be carried out. The two main objectives of this study are:

- to define the scope of NEONET (considering number, type and size of datasets, range of applications, requirements of scientific and operational users, interfaces to other systems)
- to propose an implementation plan of the NEONET concept.

Results NEONET feasibility study, phase 1

During Phase I of the NEONET Feasibility Study, an inventory was made of the international and national activities with respect to earth observation. A complex picture emerges of space agencies operating a range of satellite systems and a very broad user community comprising many different disciplines. Several international programmes have been initiated with the objective to improve the data infrastructure, in order to realize a global earth observation system.

The Netherlands initiative to develop a Netherlands Earth Observation NETwork (NEONET) has been presented at the CEO workshop at JRC, Ispra in February 1994. The approach of NEONET to base the European CEO on national infrastructures was generally appreciated. For the NEONET study, the development of CEO should be closely followed. The bottom-up approach, i.e. from the user point of view, highly corresponds to the NEONET approach.

Based on a simplified picture of the earth observation world, comprising a 'space system world' and a 'user world' and identifying different user categories, the Netherlands activities and interests can be summarized as follows.

Within the 'space system world', The Netherlands are currently not part of the ground segment infrastructure as far as operational processing of satellite data is concerned. However, a significant contribution to precise orbit determination of satellites in relation to radar altimeter processing is given by the TU-Delft.

Interests to participate in the ground segment infrastructure in the future are expressed by TNO-FEL and KNMI; TNO-FEL expressed its ambition to set up a facility for the processing of airborne and spaceborne SAR data. KNMI would like to operate as a SAF within the EUMETSAT ground segment.

Operation of airborne sensors and processing of airborne data is provided by NLR (optical data processing) and TNO-FEL (SAR processing).

Through the mechanism of Expert Support Laboratories (ESLs) and Science Advisory Groups (SAGs), Dutch researchers will have the opportunity to give scientific support on the development of algorithms for the extraction of geophysical data from raw satellite data. In particular, this interest has been expressed in The Netherlands with respect to atmospheric chemistry products from the GOME (on ERS-2) and SCIAMACHY (on ENVISAT-1) instruments and radar altimeter products.

Within the 'user world', users from many different application areas were interviewed. In general, requirements on data availability, data processing level, data delivery time, etc., differ for the various users categories (i.e. scientific and operational users). The need for an adequate infrastructure for meta-information is generally expressed. Information is required about data availability, data product quality, data formats etc. On-line browse and catalogue facilities would be welcomed.

With respect to the European activities, such as ERS and ENVISAT-1 Ground Segments (ESA) and CEO (EC) and EUMETSAT Ground Segment, in relation to the Netherlands interests the following observations can be made:

- The majority of the users is interested in only high level information about ERS and ENVISAT, i.e. instrument and data product descriptions. Detailed descriptions of the ground segment architecture are considered irrelevant, except for a few user groups (with scientific background) who are interested to participate in the ground segment of ENVISAT-1 as ESL.

- Many users are not actively preparing for future missions such as ENVISAT-1. They are occupied with understanding the data and learning how to apply the data of the present missions, i.e. ERS-1.

A special case within the user world is formed by the user groups interested in the atmospheric chemistry products of, in particular, GOME. An infrastructure related to the use of these data is quasi non-existent. Therefore, in view of the forthcoming launch of ERS-2 in December 1994, this situation deserves particular attention. The main interest in The Netherlands is of a scientific nature (KNMI, RIVM, SRON, TNO, IMAU) and up to level 2 products are required. KNMI shows a strong interest in routinely generating and distributing higher level products. Several users emphasized on the importance of fast delivery products, which are currently not foreseen within the ESA GOME services.

Interfacing of the 'space system world' to the 'user world' is provided through the space agency facilities (e.g. EECF, Central User Services, ERS-1 BDDN,) and the national facilities of KNMI and NLR. KNMI operates Meteosat PDUS and SDUS reception stations. It also has a NOAA reception facility. Through the GTS, ERS-1 LBR FD products are received at KNMI. NLR operates as an intermediate (NPOC) between data users and data providers for many different satellite products. NLR is also responsible for reception of ERS-1 SAR FD images over a satellite communication link. In addition, many users receive their data from partners within a collaboration, through personal contacts or, as is the case for PIs within ERS-1 AO projects, directly from the space agency.

From these observations one may conclude, that with respect to data infrastructure the emphasis is slightly shifted to the infrastructure required *within* the user world. The infrastructure required to interface to the space world can be considered as less problematic.

Although the word *network* has a wider meaning than electronic network, it became clear during the Phase I study that the state-of-the-art of electronic networks offer a excellent possibility to realize some functional elements of NEONET. In particular, the developments with respect to the use of Internet (i.e. World Wide Web and NCSA Mosaic) were used to demonstrate a mock-up of the *electronic* NEONET during the NEONET workshop in Zoetermeer.

The NEONET Project

Based on the results and the experience gained from the feasibility study phase 1, the NEONET Study was slightly redefined. During execution of the Phase I activities, NEONET became more than a feasibility study. Many national users and also international organisations (ESA, JRC) looked upon the NEONET activities as an already existing or developing infrastructure rather than a feasibility study. At the same time, the need for living examples of what NEONET might be was felt by users and the study team. This can be translated into the requirement for *prototyping*, as a means to identify and understand the problems and possibilities related to the realization of a data and information infrastructure.

One of the topics that looks very appropriate for prototyping is providing meta-information and data products over electronic networks. At the NEONET Workshop in Zoetermeer, it was demonstrated how currently available Internet facilities (i.e. World Wide Web, NCSA Mosaic) can be used to set up a meta-information system according to a client/server approach.

The prototype meta-information system will be of a general nature, i.e. not application specific. However, it will be also very useful to prototype an application oriented data and information infrastructure. In the past, it was already pointed out that in view of the forthcoming launch of ERS-2 early 1995, the development of national facilities for reception and processing of GOME data should have high priority. The GOME instrument on board ERS-2 will be one of the most important data sources for the atmospheric chemistry user community. GOME facilities can be incorporated in the prototype atmospheric chemistry data infrastructure.

Another user area that could serve as a test-bed, is the water quality user community. Initiatives with respect to the required infrastructure (i.e. REWANET) were developed already within this community and therefore, it seems very appropriate to coordinate a part of these activities within the NEONET Project and to develop a prototype water quality infrastructure.

Finally, the need for *co-ordination* of activities has been identified. NEONET activities have a strong relationship with international programmes. In particular, the developments within the CEO project will strongly influence the NEONET activities or, to put it even stronger, there is a bi-directional interaction between the projects. Moreover, also coordination at internal or national level is required. This type coordination of the NEONET infrastructure will be a permanent one and therefore, will be continued also after the here proposed activities.

From the above, the following project approach can be formulated:

- All proposed activities are carried out as *The NEONET Project*.
- The NEONET Project consists of two main actions: *Definition of the NEONET Concept* and *Prototype Development*.
- Prototyping relates to: *Prototyping of the Electronic NEONET*, *Prototyping of an Atmospheric Chemistry Data Infrastructure* and *Prototyping of a Water Quality Data Infrastructure*.
- There will be the new element of *NEONET Co-ordination (International and Internal)*.
- A *NEONET Workshop* will be organized.
- An *Implementation Proposal* will be formulated.

The NEONET Project Team has started its activities in September 1994. By the end of 1995, the NEONET Concept will be defined and the Implementation Proposal will be presented.

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Title: TELEMATICS APPLICATIONS ROLE IN THE EARTH OBSERVATION NETWORKING

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Author(s) and Affiliation(s):

Morais, Carlos Campos - Principal Research Officer (*)
Henriques, Rui Gonçalves - Senior Research Officer (***)
Pina, Heitor - University Professor (**)
Ferreira, João Nuno - Computation and Systems Engineer (****)

(*) FCCN Board of Directors, Lisbon, Portugal
(**) FCCN Board of Directors, Lisbon, Portugal - Chairman
(***) President of the CNIG, Lisbon, Portugal
(****) FCCN - Technical Manager of RCCN

FCCN - Fundação para a Computação Científica Nacional (National Foundation for Scientific Computation)

CNIG - Centro Nacional de Informação Geográfica (National Center for Geographical Information)

RCCN - Rede da Comunidade Científica Nacional (National Scientific Community Network, the *Portuguese Academic Network*)

Email: Carlos.Morais@FCCN.PT

Adress: FCCN - 101, Av. do Brasil 1799 Lisboa Codex Portugal

Telephone: - 351 1 848 19 06

Fax: 351 1 847 21 67

ABSTRACT

A telematics applications system approach and environment is depicted. Telematics Applications Programme (European Commission - DGXIII) is referred under the philosophy of building specific applications over networks providing basic services (DNS, Email, file transfer, etc.).

The Network of Remote Sensing Thematic Nodes of the SNIG - Sistema Nacional de Informação Geográfica (National Geographical Information Systems) is described. Its main objective is to promote the use of Earth Observation Data among the portuguese research groups and institutions and to link them to the geographical data bases that exist in several disciplines and areas, such as environment, statistics, agriculture, forestry, topography etc.

RCCN, as a nation-wide academic network with a high growing rate, connecting, in Portugal, all state universities and research laboratories and institutions, is an infrastructure relevant to important and major geographical actors. Some indicators on the quality of services (through an *help desk* quality measuring orientation) are introduced.

What we are commited to do (FCCN/RCCN and CNIG/SNIG) is to callaborate actively in a scientific and pragmatic basis, in order to implement a network for geographical informations (using the existent RCCN/FCCN`s know-how, experience, connections, both national and international, and tools), on one hand, and on the other hand, to study and select the most feasible telematics applications for geographical information purposes, aiming to make Earth Observation Networking a local, national, and global reality.

CNIG/FCCN, gathering joint efforts, are involved in the design and implementation of an appropriate network resources to support a higher level geographical information applications.

TELEMATICS APPLICATIONS ROLE IN THE EARTH OBSERVATION NETWORKING

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Annex: SHORT DESCRIPTION OF MAIN AREAS OF ACTIVITY OF SOME OF THE DIGITAL IMAGE PROCESSING THEMATICAL NODES OF SNIG

1 THE PRESENT CONTEXT OF TELEMATICS APPLICATIONS.

The globalisation of economy and communications is closely associated with the emergence of world wide computer networks. The concept of network layers is largely disseminated and very popular and so, in a simplified but pragmatic first look it is important to split the layers pile in two main sets: that of an internal, infrastructures set, providing **basic services** and another of **applications**, following the specificity of different fields. Earth observation is a very broad field, generating huge amounts of data, demanding sophisticated image treatments and processing. As user's pertain to a wide, clued and exigent community, they are supposed to be feeded according to modern quality standards, in a cost-effective way, with an adequate satisfaction to every market segment. This implies:

- robust, flexible, modern and efficient network infrastructures providing **services** of good quality

- the design of adequate user-oriented **applications**

To be user-oriented and cost-effective rather than technology-driven is one of the *ten commandments* of the Telematics Applications Programme, one of the most important of the 4th RTD Framework Programme.

Within the 2nd RTD Framework, *ESPRIT* and *RACE* were essentially technology driven Programmes, and *Telematics of General Interest* consisted merely on application's first trials. In the 4th RTD Framework the prime focus is on having appropriate combinations of those earlier two types of Programmes:

- INFORMATION TECHNOLOGIES PROGRAMME/ESPRIT, covering Multimedia (Domain 3) and HPCN (High Performance Computing and Networking- Domain 6);

- ACTS, aiming to facilitate the evolution on broad band and ATM which are vital for data transmission and visualisation;

- TELEMATICS APPLICATIONS PROGRAMME including *Telematics for Urban and Rural Areas* (Sector 6, Area C), *Telematics for the Environment* (Sector 9, Area C) and *Information Engineering* (Sector 13, Area D).

In order to provide efficient resources and services to all earth observation data user's it is necessary to guarantee the quality on the different levels of:

(i)- Network basic services (FTP, SMTP, DNS,...)

(ii)- Telematics applications tailored to earth observation data

(iii)- New tools for team work using CSCW- Computer Supported Cooperative Work), namely in group design, group debate, etc.

(iv)- Acquisition and continuos learning of technologies like ATM, broad band, IP-next generation protocol and multimedia.

2. THE PORTUGUESE NETWORK OF REMOTE SENSING THEMATIC NODES

2.1. THE NETWORK OF REMOTE SENSING THEMATIC NODES OF THE SNIG SYSTEM

In June 1993, under the joint initiative of the Secretary of State for Science and Technology and the Secretary of State for Land Use Management and Local Administration a major step was undertaken by the National Council for Scientific and Technological Research (Junta Nacional de Científica e Tecnológica - JNICT) and the National Centre of Geographical Information (Centro Nacional de Informação Geográfica - CNIG), towards the establishment of a *network* of Portuguese remote sensing research groups and institutions, as part of the network of georeferenced data basis, linking together cartographic data banks, satellite imagery and statistical and descriptive type of information related to specific locations in the country, within the scope of the National Geographical Information System (Sistema Nacional de Informação Geográfica - SNIG).

The SNIG system, that has been implemented since 1990, is the computer network that, using the public communication data network (Telepac), links any GIS user to CNIG, to the main geographic data producers, (namely those that have organised the data within Database Management Systems), to the Regional (5) Geographic Information System and eventually to the Municipal (305) Geographic System. The Telepac bandwidth for the most common interconnection links is, at present, a limitation for the efficient use of the network.

SNIG is then an Information System that includes Local, Regional and National GIS as *nodes of the system*, plus the sectorial data bases of geo-referenced information (environment, statistical, cadastral, etc) implemented at each of information producing agency. This network is available for any user interested in getting access to multi-sectorial data for its GIS applications.

Besides the institutional role of coordinator of the National Geographic Information System, CNIG is a research agency, currently active in several research domains, as remote sensing applications, GIS interfaces with alphanumeric databases, cartographic databases, mathematical modelling of spatially distributed phenomena using GIS and digital multimedia technologies.

A formal agreement for the creation of the network of the Digital Image Processing Thematical Nodes of SNIG was signed by about 20 remote sensing research groups belonging to several Portuguese Universities and research agencies from the Public Administration. Indeed a growing number of scientific and academic institutions have been integrating remotely sensing technology within their scientific and academic programmes in Portugal, namely the Technical Engineering Institute (IST-Instituto Superior Técnico) and the Agronomic Engineering Institute (ISA-Instituto Superior de Agronomia), both from the Technical University of Lisbon, the Faculties of Sciences and Technology, and of Social and Human Sciences (both from the New University of Lisbon) (UNL-Universidade Nova de Lisboa), the Faculty of Sciences and the Geographic Department (both from the University of Lisbon), the University of Porto, the University of Trás-os-Montes e Alto Douro, and the University of Beira Interior, just to mention the most active ones. This has substantially strenghted the capabilities of such institutions to contribute to better and deeper knowledge on the environment.

It was also recognised, however, that one of the major bottlenecks preventing most of this groups from more active participation in research and development activities concerning the use of earth observation data were the problems of the availability and conditions of access to such data.

The objective of the network of Thematical Nodes on Digital Image Processing is just to promote the use of Earth Observation Data among the Portuguese research groups and institutions as a contribute to overcome the type of problems that are preventing Earth Observation Data from being fully explored, namely in the fields of environment and land use planing and management. For such purpose digital satellite data will be made available through to public communications network, and CNIG will take in charge the responsibility of the purchase of the corresponding satellite images for the National Geographic Information System. The images made available to the research groups and research institutions can only be used within the framework of this agreement for research and development purposes.

As part of SNIG, the integration of the Earth Observation Data with exogenous data is automatically guaranteed, as SNIG is the network that links any user to the geographical data bases existent in several disciplines and areas, such as environment, statistics, agriculture, forestry, topography, etc.

2.2. THE NATIONAL GEOGRAPHICAL INFORMATION CENTRE

The National Geographical Information System is the network created in 1990 for the integration in the public communications network of the different geo-databases being built with the framework of the Portuguese Public Administration. Its coordination has been assigned to CNIG, the National Geographical Information Centre.

Besides the institutional role of coordinator of the National Geographical Information System CNIG is a research agency currently active in several research domains, as remote sensing applications, GIS interfaces with alphanumeric databases, cartographic databases, mathematical modelling of spatially distributed phenomena using GIS and multimedia technologies.

In Annex there is a short description of activity of some of the digital image processing thematical nodes of SNIG

3- RCCN: THE PORTUGUESE ACADEMIC NETWORK

The **National Foundation for Scientific Computation, FCCN (Fundação para a Computação Científica Nacional)**, is a private not-for-profit institution, legally registered in 861223 and declared as public utility institution in 870715. At the present the founders are:

- The National Council for Scientific and Technological Research, JNICT (Junta Nacional de Investigação Científica e Técnica)
- The Council of Rectors of the Portuguese Universities, CRUP (Conselho dos Reitores das Universidades Portuguesas)
- The National Laboratory of Civil Engineering, LNEC (Laboratório Nacional de Engenharia Civil)

The main objective of FCCN is to promote scientific computation infrastructures to the *scientific and technical community* (CCN- Comunidade Científica Nacional) namely Universities, R&D Laboratories and Centres, etc.

FCCN's main projects are:

RCCN - The National Scientific Community Network
CCCN - Computing for the National Scientific Community
SCCN - Software for the National Scientific Community
ICCN - Information for the National Scientific Community

RCCN - The National Scientific Community Network

The establishment of the National Scientific Community Network (*The Portuguese Academic Network*) is one of the most important projects of FCCN. This project was initiated in 1990, with the planning and development of a data communications academic network.

At the present, RCCN is a country-wide network with a high growing rate, connecting all public universities, major research laboratories and important research institutions.

RCCN's organisation, within FCCN's, is based on four distinct levels of action: Board of Directors, Technical Board, Management Centre, Network Operation Centres (NOCs), and the *contact points* of each access point.

RCCN's architecture

RCCN is a private digital network based on dedicated lines and multiprotocol *Cisco Systems* routers with two different types of lines: backbone lines that interconnect the NOCs and access lines that link these NOCs to the institutions.

NOCs

The NOCs are geographically dispersed through four cities: Braga, Porto, Aveiro and Lisboa. Lisboa and Porto's NOCs are connected through two 64K lines that operate as regional concentrators (Porto's NOC for the north, and Lisboa for the southern region and portuguese atlantic islands). Aveiro and Braga NOCs are connected to Porto's NOC through 64K lines.

International connections

RCCN has two connection groups for international networks: one for EBONE, established through a 64K line that goes from the Braga NOC to Paris, another to EuropaNet, made up by two 64K lines going from the Lisboa NOC to the Europanet's presence point in Portugal.

The line to Paris and one of the EuropaNet lines are utilised with native IP. The other line to EuropaNet uses the X.25 protocol and IP encapsulated in X.25 packets.

EuropaNet is the network that serves the major academic european networks, specially in the European Union countries. Following IXI structure, EuropaNet has been largely developed. At present, it already has a connection to South Korea. Since the summer of 1994, EuropaNet has settled its own intercontinental resources, and a firm named DANTE was created to manage it and to defend the interests of european academic networks.

Ebone is another european network formed in 1991 after the end of the IXI project. It is constituted by a consortium of organisations that contribute for the management, operation and financing of the network. Its services are strongly oriented towards IP network protocols and to other Internet services. Ebone has its own resources for intercontinental connection (USA). At the present Ebone's physical structure is based on two concentrating stars of connections: one in Paris and another in Viena.

Connections to other national networks

Through the Lisboa NOC RCCN has connection to other two networks: one Public Telecommunication Operator (PTO) named TELEPAC and the PUUG (Portuguese Unix User's Group) network.

Types of access ports to RCCN

Access through dedicated lines

Public Telecommunication Operators (PTOs) provide the leasing of dedicated analogical or digital circuits to interconnect RCCN to the institution. Digital circuits provide a wide range of capacities and have a superior quality compared to the analogical circuits. These in turn have considerable lower prices than the digital circuits.

Access through PSDN (Public Switched Data Network)

In this case TCP/IP can be encapsulated on X.25 protocol which is the base protocol of the PSDN. The high prices charged by the national PSDN and the losses caused by the encapsulation are the reasons why this type of access is considered to be convenient only for small quantities of traffic. On the other hand, as there is an additional variable cost to FCCN, this type of access is limited.

Access through PSDN (Public Switched Data Network) using asynchronous mode.

Individuals can have an account in a FCCN's server that allow them to receive and send e-mail in the Internet through this type of access provided by PSDN.

Access through the Public Telephone Network.

Small institutions and even individual researchers can have access to RCCN via modem connected to the Public Telephone Network.

Short term alternative accesses:

- frame-relay
- ISDN (basic rate)

Services provided by RCCN

IP network services

IP is an open protocol used by the networks that constitute the Internet. It is connectionless and became a *de facto* standard. Utilised along with TCP, some examples of services that can be offered are: TELNET, FTP, e-mail, NEWS, WWW/Mosaic, Gopher, etc.

National connectivity via RCCN is made according to the rules defined by RIPE (*Reseaux IP Europeenes*).

X. 25 network service

RCCN also provides national and international services for this protocol: electronic mail X.400, Directory Service X.500, PAD, and FTAM. All the Registry X.25 functions are guaranteed.

News

Subject articles services are commonly named News. They are composed by discussion groups organised according to a subject hierarchy. Any user can participate either passively, by only reading the other user's articles, or actively if they submit their own. All the information is kept in News server systems connected with each other via the IP service. RCCN provides this service in each access port.

Helpdesk service

In order to improve the quality of RCCN, a helpdesk service was made available to all users.

The help desk uses three management systems (trouble ticket, accounting, network management), one e-mail address and one direct telephone line, in order to collect operational information available in the network to the users.

The Help Desk is kept in the centre of the dynamic structure of RCCN, this is, in the centre of the other services provided. From them, the Help Desk receives, keeps and processes the information to make it readily accessible to anyone who needs it.

There are four main functions guaranteed by the Help Desk:

1. Centralise the information generated by the other services of RCCN
2. Provide the information to the users, national or international, though taking into consideration aspects of confidentiality.
3. Act with efficiency when anomalous events occur.
4. Produce periodic reports, statistics and procedures based on the data collected.

Basically the Help Desk is implemented with the use of four tools:

1. Trouble Tickets System (TTS)
2. Accounting system
3. Network management system
4. One mail box an a direct telephone line

Electronic Mail Gateway Service

The two most used protocols for e-mail are: X.400 and SMTP (Internet).
The various european academic networks of X.400 e-mail have defined an operational model where each network handles one central commutation node of messages for their users, named WEP (Well-known Entry Point). RCCN operates its WEP according to the international standards.

Another function that is generally associated with WEP is the *gateway* between the X.400 and SMTP protocols, allowing users to send and receive e-mail to others that use the other system, in a transparent way. This function has also been ensured by RCCN.

X.500 Directory service

Computer networks provide such a large variety of resources that it becomes necessary to develop services to assist the organisation, search and use of those resources. X.500 Directory Service has been designed, in part, for this function. Alike the Domain Name System, X.500 adopts the form of a world wide scale distributed data base, though it is more flexible in what concerns to the storage of information.

One of the most important aspects of the Directory Service is the role that it can have in the implementation of security services due to its internal organisation and information representation capacities.

National DNS service

There is the need for a mechanism that allows the translation of names into addresses and vice-versa. In the Internet this is done by the Domain Name System- DNS.

DNS is hierarchically organised by domains. A domain corresponds to an entity that administrates a collection of resources. For this reason it was necessary to create a DNS to represent Portugal. Below this DNS it is possible to register all the portuguese domains.

In 1990 FCCN asked InterNIC (Internet Network Information Centre) for the creation and delegation of the DNS in Portugal: the PT domain. Since then, FCCN has the responsibility for the management of this domain. This service is provided to any national organisation.

Internet Registry of Last Resort service

All computing resources in a network have to have a single identification. In Internet this is named IP address.

The main functions of the network administration service concern: the space management, attribution and registry of IP addresses. These functions are commonly known as Internet Registry.

Until recently, IP addresses were requested to InterNIC in the USA. Nevertheless, after the constitution of RIPE (Reseaux IP Europeens) InterNIC decided to credit this organisation with a bloc of IP addresses to be attributed to European institutions. In its turn RIPE has divides the addressing space given into 256 addresses that were later attributed to the different european network services providers.

Information Systems

ftp anonymous server

Accessible through ftp://info.fccn.pt, this server keeps all the information concerned with FCCN projects and user tools.

World Wide Web service

This server address is http://info.fccn.pt and is generally accessed through the *Mosaic* application. The information contained in this server relates to the internal organisation of FCCN. It is also possible to have access to information on Trouble Tickets mechanisms and to visualise accounting diagrams. The access to the gopher and ftp servers is of great utility to the users.

Gopher server

Gopher://info.fccn.pt is the address of this server that is connected to other gophers and to the RCCN's ftp anonymous server. The information available through the World Wide Web can also be accessed via the gopher server.

Lists server

The main function of a List server is to administrate distribution lists by e-mail. These lists are used to broadcast the e-mail sent to the list, to the addresses that subscribe that same list. This service provides a convenient form to exchanging ideas and information among the members of the list.

Security services

The resources of a local network are always under constant threat due to data corruptions, non authorised accesses to resources, incorrect use, etc. motivating a loss of credibility of the institution that administrates the network.

The organisations in charge for these kinds of problems are called CERTs (Computer Emergency Response Teams).

FCCN has recently begun to take initiatives on security activities namely by:

- keeping contacts with some european CERTs in order to learn about the methodologies used in this area
- participating in an european project on security services
- promoting technological research

4- WHAT IS CHANGING IN NETWORKS TECHNOLOGY THAT AFFECTS THE ISSUES

OSI versus IP debate, broad band, media integration, Internet growing use and expansion are some important changes directions that will affect the short/medium term of network development and, consequently, our current concern on earth observation data.

(i)- **OSI versus IP debate.**

Some years ago, CEC adopted and imposed the use of OSI protocol. The reality demonstrates that OSI protocols happen to be expensive and not as efficient as they would be expected. It can be infered from Microsoft announcement concerning the interaction of TCP/IP in the next WINDOWS versions that IP has to be a *de facto* mandatory option despite the OSI implementations investments that have already been made.

(ii)- **Evolution to broadband.**

While responsible for the management of RCCN, FCCN has adopted two strategic options in order to ensure that the portuguese academic network will evolve in the right direction, concerning the broadband technologies:

- At the national level, FCCN makes part of the National Host RIA together with Portugal Telecom, Marconi and Europarque. This will grant laboratorial facilities for broad band pilot projects in the near future.
- At the european level, FCCN participates in EUROCAIRN which is the European Union project for a broad band european academic network. Soon, this network will have 34 Mb dedicated lines.

(iii)- **Media integration.**

ATM (Asynchronous Transfer Mode) is taken as the technology of the future throughout the two banks of the Atlantic, though there are still important technical details that have not yet been standardised. Nevertheless, it is undoubtedly the most feasible solution for total integration: TV, telephone, fax, mail, communication via computer, video on demand, etc.

(iv)- **Internet growing use and expansion.**

Partly as a consequence of (i) the demand for Internet connection is growing in an extremely accelerate rate. New applications becoming popular are big consumers of resources specially those that are image oriented like WWW or Multicas Video (Mbone). This puts a lot of pressure on the evolution to (ii).

Many users also mean many security threats. The need to provide secure network services will be a major issue in the short-medium term. The technological problems of todays implementation of IP (end of address space, no traffic classes, etc) will put a stronger pressure on the evolution to IP next generation (IPng)

5- CNIG/FCCN COOPERATION. THE ROLE OF RCCN IN THE RAISE OF SNIG's NETWORK

CNIG has built the institutional and technical base for the Geographical Information Network, as it was already referred (see chapter 2).

Following a straight cooperation strategy for the creation of SNIG's Network, RCCN's role is seen as:

(i)- **To design the new network**

(i.1)- To produce a study with detailed information regarding the following aspects of CNIG related institutions:

- level of expertise in networking
- geographical positioning
- status of infrastructures to use for networks
- status of internal LANs
- number and type of users
- applications required

(i.2)- To produce a study of the available technologies, their costs, advantages and disadvantages.

(i.3)- To produce a proposal for CNIG's network.

(ii)- To provide consultancy support and training in order to make it possible to transfer technological know-how, vital for the establishment of an adequate technical staff.

(ii.1)-To produce a report of the required human resources to maintain CNIG's network, covering the following items:

- people that need to be employed by CNIG to run it's network
- people already working for CNIG that can be used for the network
- people working for other institutions that could be contacted by CNIG.

(ii.2)-To produce a report of the different levels of expertise needs to run CNIG network

(ii.3)-To promote training courses on network technology to achieve know-how transfer.

(iii)- To bridge the two networks and establish adequate interconnection links. This should cover all aspects of networking.

(iv)- To make national services like DNS available

(v)- To provide pilot experiments on RCCN and to study the possibility of using the National Host

ANNEX

SHORT DESCRIPTION OF MAIN AREAS OF ACTIVITY OF SOME OF THE DIGITAL IMAGE PROCESSING THEMATICAL NODES OF SNIG

1.-The Meteorological Institute (IM-Instituto de Metereologia), which has been long using, in a systematic basis, satellite imagery obtained from meteorological satellites for its weather watch and nowcasting, is developing projects for application of remotely sensed data agricultural, forestry and fishery activities

2.-The Scientific Tropical Research Institute (IICT- Instituto de Investigação Científica Tropical), with a large experience and tradition in carrying out cooperation activities related to tropical research with developing countries, is carrying on several projects on the use of GPS for geodesy purposes, and satellite imagery for the production of basic and thematic cartography.

3.-The National Institute of Industrial Engineering (INETI-Instituto Nacional de Engenharia e Tecnologia Industrial), and GEOMETRAL (associated, in a consortium, SATCART) formed in 1987, are developing significant projects on the use of remotely sensed data and satellite image processing for several types of applications, namely the ones concerned with the field of agriculture and forestry, as well as software developments in remote sensing and GIS environments; the main users of these technologies are governmental and CEC specialised agencies.

4.-The Group of Oceanography of the Sciences Faculty of Lisbon (UL-Universidade de Lisboa - Faculdade de Ciências de Lisboa), is using remotely sensed data from meteorological satellites applied to sea studies, namely up welling phenomena, identification of best suitable location for fisheries exploitation, on a near-real-time basis, and sea water pollution characterisation, namely modelling of oil spills drift in the ocean; it has operating its own satellite receiving facility for NOAA/HRPT. Also the Group of Ecology is using digital image processing of earth observation data in the environment and land use planning.

5.-The National Laboratory of Civil Engineering (LNEC-Laboratório Nacional de Engenharia Civil) is carrying on projects using remotely sensed earth observation data on water resources and land use assessment for developing countries and dam reservoir inventory in Portugal.

6.-The National Geographical Information Centre (CNIG), the coordinating agency of the National Geographical Information System (SNIG) is carrying on the study and application of satellite imagery in the environmental characterisation, land use assessment and agriculture applications, namely within the scope of several projects.

7.-The Portuguese Institute for Cartography and Cadastre (IPCC- Instituto Português de Cartografia e Cadastro), as well as the Army Cartography Institute (ICE-Instituto Cartográfico do Exército) are developing activities on specific projects, aiming, for IPCC and IGE, the use of satellite imagery in the production and updating of cartography maps and the use of GPS for geodetic purposes.

8.-The Hydrographic Institute (IH-Instituto Hidrográfico) is using satellite imagery in the planning and conduction of oceanographic cruises aimed to collected oceanographic data.

9.-The Institute for Geology and Mines (IGM-Instituto de Geologia e Minas) is carrying out projects concerning the use of remote sensing earth observation data for geological mapping.

10.-The University of Trás-os-Montes e Alto Douro (UTAD-Universidade de Trás-os-Montes e Alto Douro) is developing research projects involving digital image processing of earth observation data in the fields of forestry and land planning.

11.-The University of Aveiro (UA-Universidade de Aveiro) is developing research projects involving digital processing of earth observation data in the fields of environment and land use planning and management.

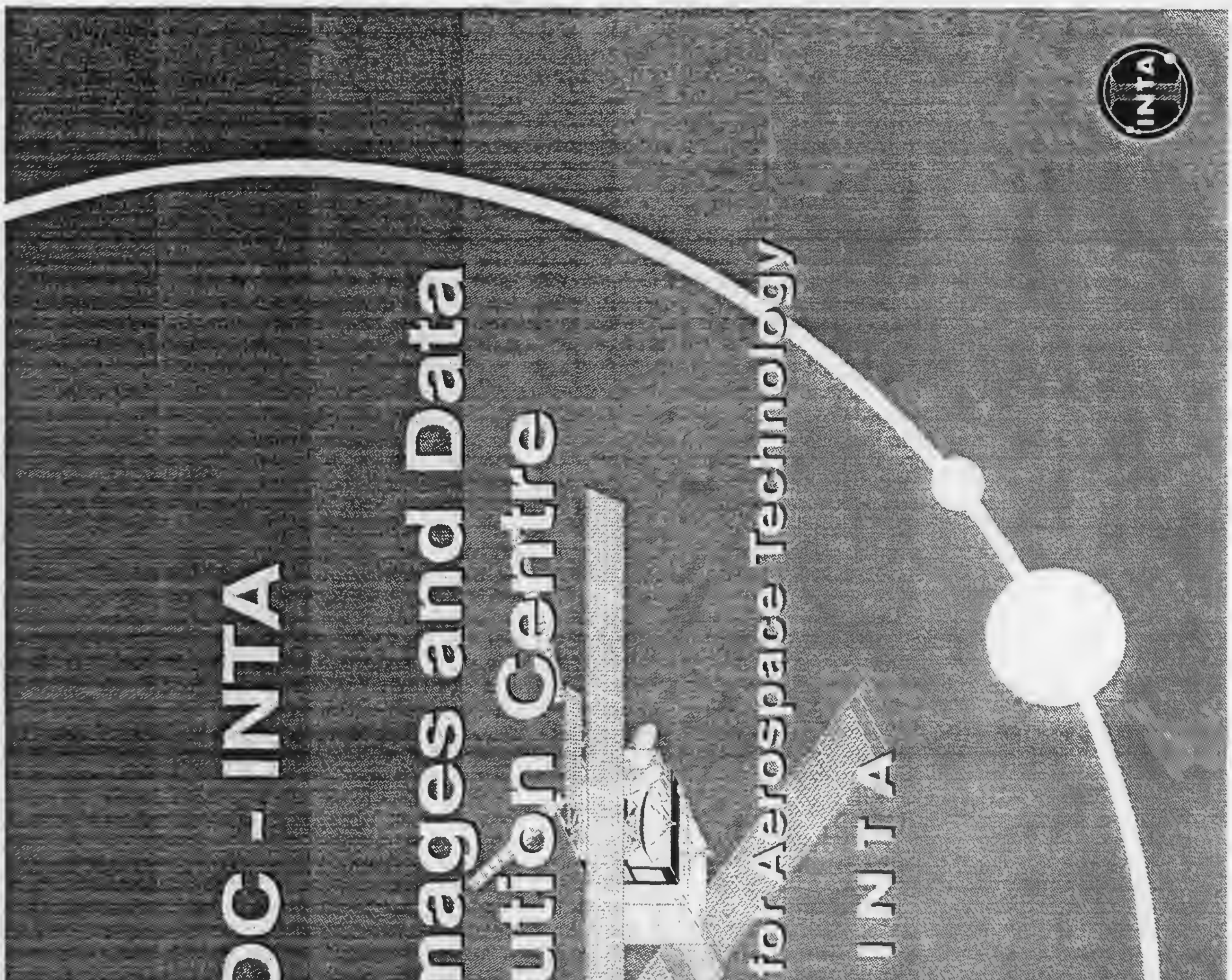
12.-The University of Évora (UE-Universidade de Évora) is developing projects involving digital image processing of earth observation data in the fields of agriculture and environment.

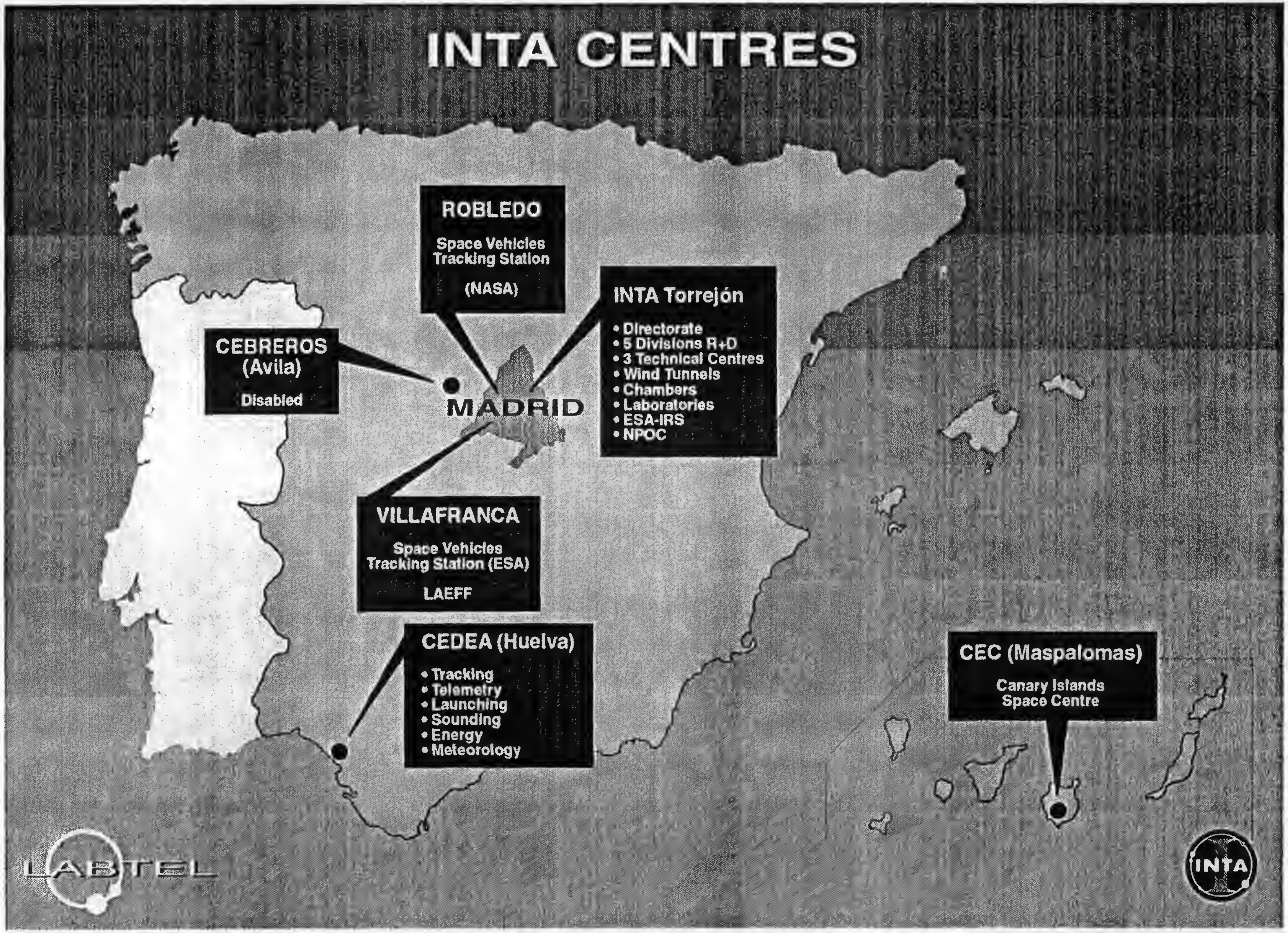
13.-The Department of Mines and the Department of Civil Engineering of the Instituto Superior Técnico from the Technical University of Lisbon (UTL-Universidade Técnica de Lisboa) are developing projects involving digital image processing of earth observation data in the fields of mining, environment and land use planing and management.

14.-The Department of Forestry and the Department of Landscape Architecture of the Instituto Superior de Agronomia of UTL are developing research projects involving digital image processing of earth observation data in the fields of forestry, agriculture, environment and land use planning.

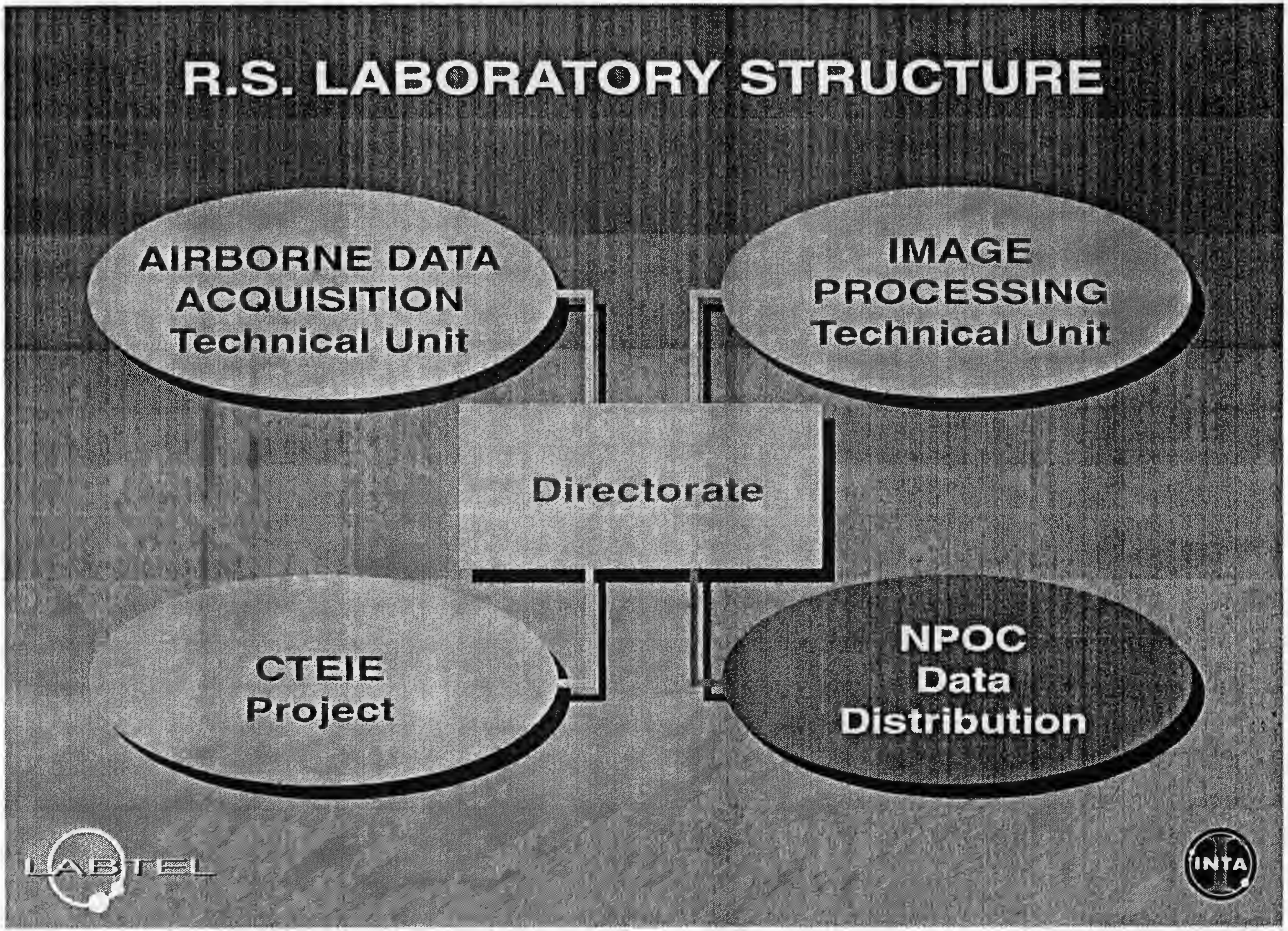
15.-The Faculty of Sciences and Technology of the New University of Lisbon (UNL-Universidade Nova de Lisboa) is developing projects involving digital image processing of earth observation data in the fields of environment and land planning and management.

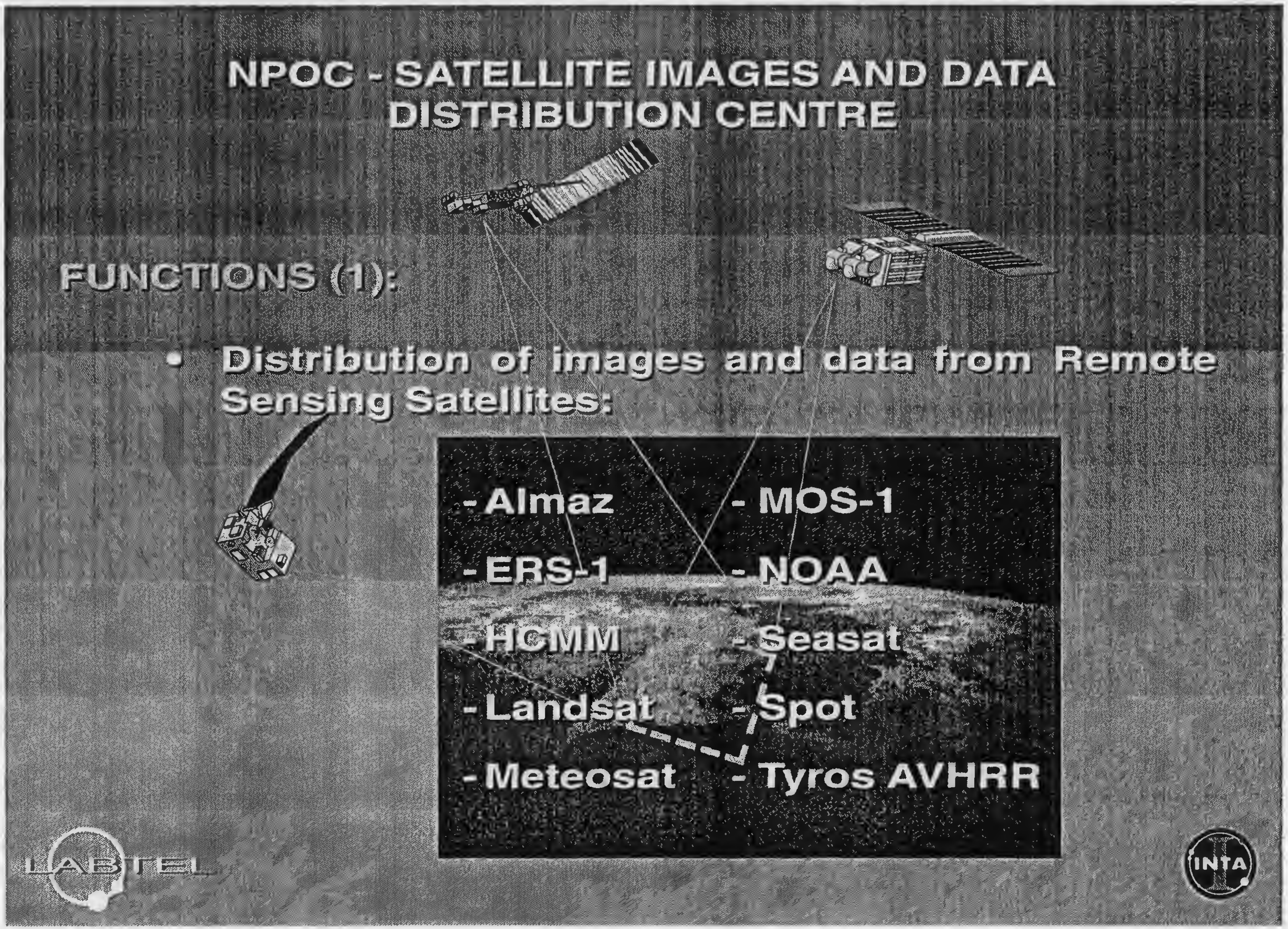
15 Dec	Session G	• Spain (INTA-National Point Of Contact)




INTA CENTRES
ROBLEDO
Space Vehicles Tracking Station
(NASA)
INTA Torrejón
• Directorate
• 5 Divisions R+D
• 3 Technical Centres
• Wind Tunnels
• Chambers
• Laboratories
• ESA-IRS
• NPOC
CEBREROS (Avila)
Disabled
MADRID
VILLAFRANCA
Space Vehicles Tracking Station (ESA)
LAEFF
CEDEA (Huelva)
• Tracking
• Telemetry
• Launching
• Sounding
• Energy
• Meteorology
CEC (Maspalomas)
Canary Islands Space Centre
LABTEL
INTA

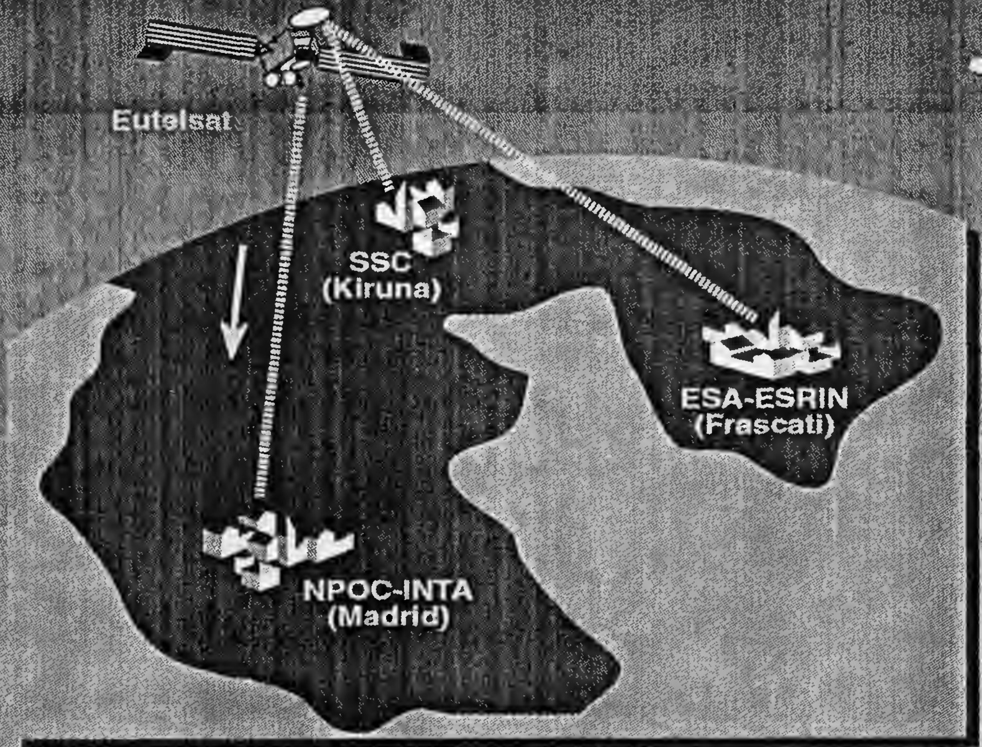

INTA's OBJECTIVES
IN REMOTE SENSING
• Create and maintain a group of experts in R.S. Techniques using airborne and satellite sensors.
• Operate its own airborne data acquisition system, applied to the whole community of researchers' needs.
• Distribute all the images and data available from R.S. satellites, as well as all the documentation related with it.
LABTEL
INTA


R.S. LABORATORY STRUCTURE
AIRBORNE DATA ACQUISITION Technical Unit
IMAGE PROCESSING Technical Unit
Directorate
CTEIE Project
NPOC Data Distribution
LABTEL
INTA


NPOC - SATELLITE IMAGES AND DATA DISTRIBUTION CENTRE
FUNCTIONS (1):
• Distribution of images and data from Remote Sensing Satellites:
- Almaz
- ERS-1
- HCMM
- Landsat
- Meteosat
- MOS-1
- NOAA
- Seasat
- Spot
- Tyros AVHRR
LABTEL
INTA

NPOC - SATELLITE IMAGES AND DATA DISTRIBUTION CENTRE

FUNCTIONS (2):



- As National Point of the ESA's BDDN, the NPOC operates the receiving station and archives the FD products which are sent through the network.

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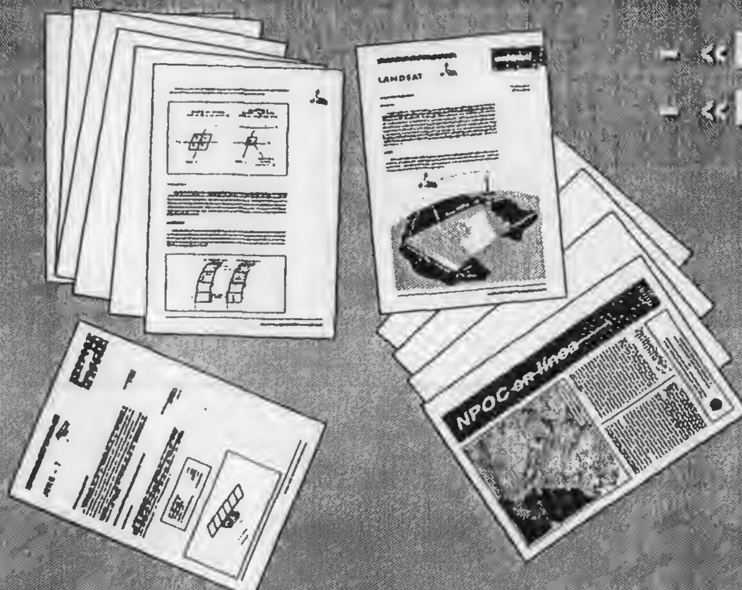
INTA

NPOC - SATELLITE IMAGES AND DATA DISTRIBUTION CENTRE

FUNCTIONS (3):

- Information and support to users and customers.
- Edition and distribution, free of charge, of:



- «NPOC on line»
- «NPOC Documents»

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INTA

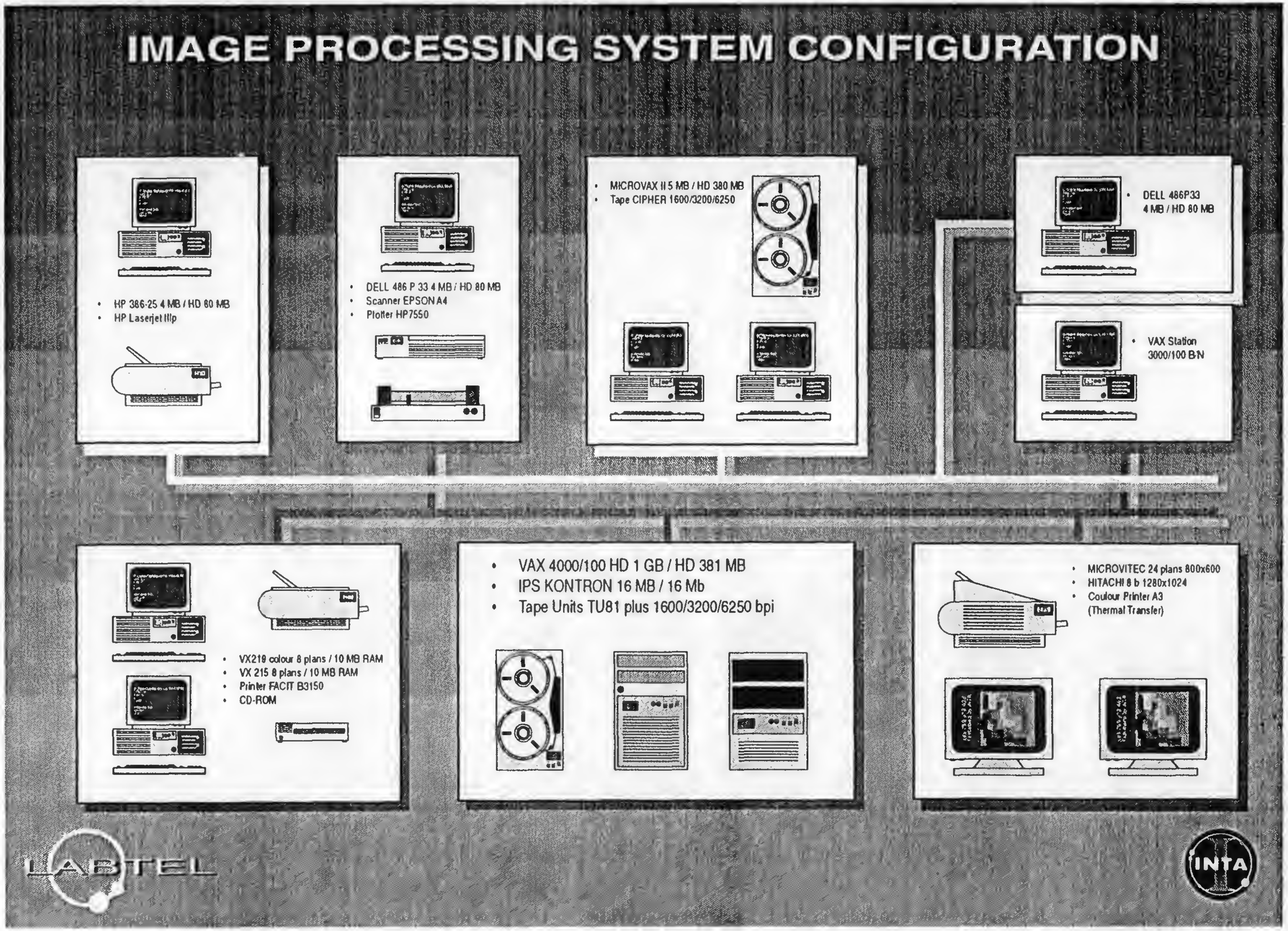


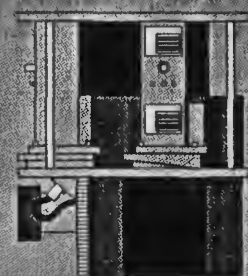
IMAGE PROCESSING SYSTEM CONFIGURATION
• HP 386-25 4 MB / HD 80 MB
• HP Laserjet IIIp
• DELL 486 P 33 4 MB / HD 80 MB
• Scanner EPSON A4
• Plotter HP7550
• MICROVAX II 5 MB / HD 380 MB
• Tape CIPHER 1600/3200/6250
• DELL 486P33
4 MB / HD 80 MB
• VAX Station
3000/100 B/N
• VX219 colour 8 plans / 10 MB RAM
• VX 215 8 plans / 10 MB RAM
• Printer FACIT B3150
• CD-ROM
• VAX 4000/100 HD 1 GB / HD 381 MB
• IPS KONTRON 16 MB / 16 Mb
• Tape Units TU81 plus 1600/3200/6250 bpi
• MICROVITEC 24 plans 800x600
• HITACHI 8 b 1280x1024
• Coulour Printer A3
(Thermal Transfer)
LABTEL
INTA

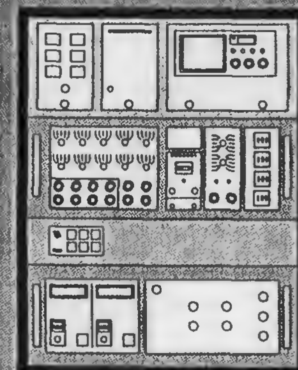
AIRBORNE MULTISPECTRAL SCANNER
« DAEDALUS 1268 »

TECHNICAL ASPECTS

- SPATIAL RESOLUTION
  - Selectable with IFOV and height
  - Máx.: 0,8 x 0,8 m2 of pixel

- TIME RESOLUTION
  - Selectable (day / hour)





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AIRBORNE MULTISPECTRAL SCANNER
« DAEDALUS 1268 »

OPERATIONAL ASPECTS

- **PLATFORM**
  - CASA 212 aicraft from Cartographic & Photographic Centre from Spanish Air Forces.
  - Now in project: CESSNA Citation V also from CECAF.

- **OPERABILITY**
  - Whole covering of Spain and its islands.
  - Planning "à la carte" of each campaign of data acquisition.

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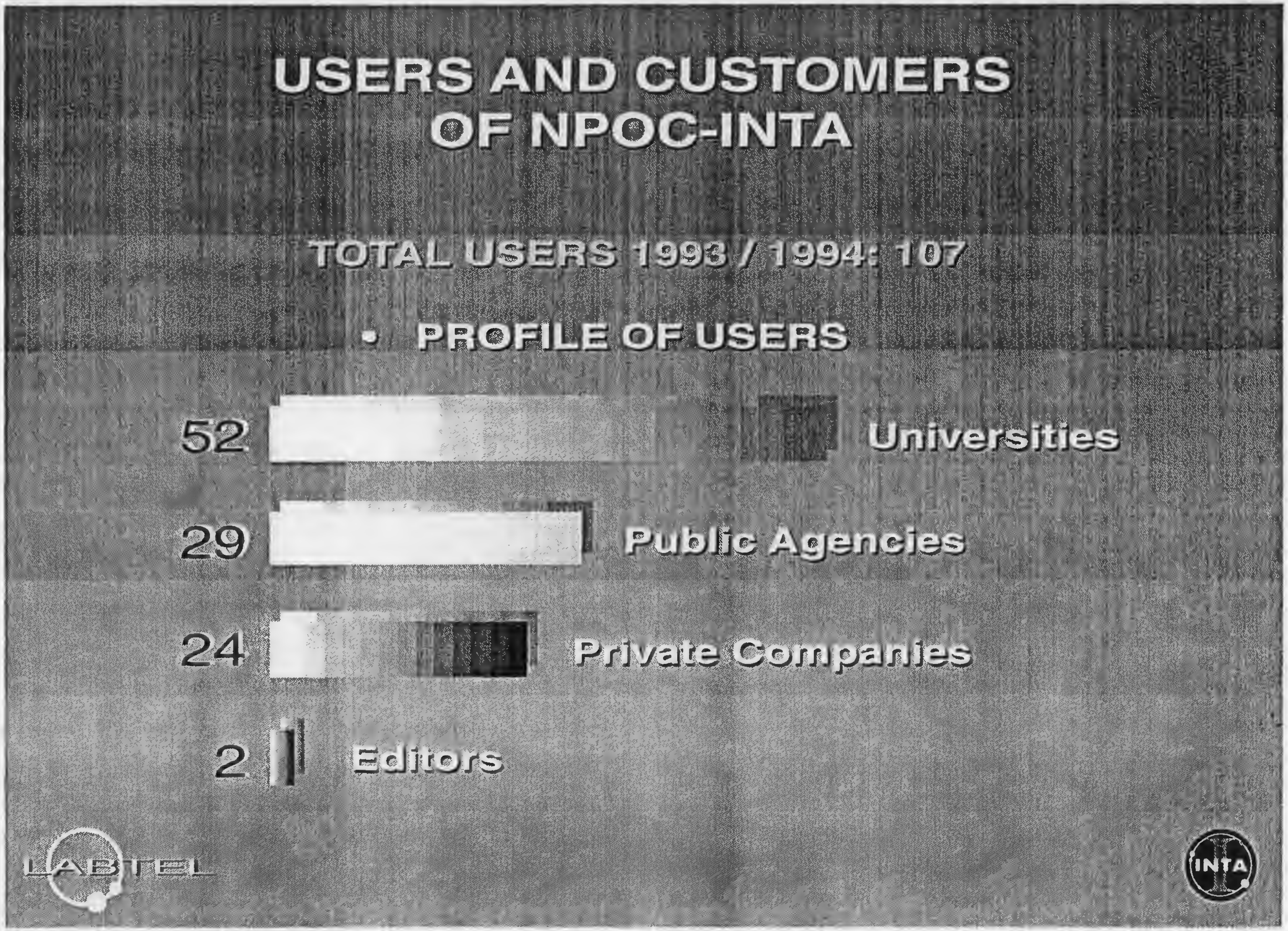
USERS AND CUSTOMERS
OF NPOC-INTA
TOTAL USERS 1993 / 1994: 107
• PROFILE OF USERS
52
Universities
29
Public Agencies
24
Private Companies
2
Editors
LABTEL
INTA

Remote Sensing Image Archive for National User Requirements

Klaus Seidel
Institute for Communication Technology ETHZ
Image Science Division
CH 8092 Zürich/Switzerland

and

Jean-Pierre Therre
Swiss Scientific Computing Center ETHZ
CH 6928 Manno/Switzerlandand

Abstract

Switzerland is participating in a variety of ESA programmes dedicated to Earth Observation missions. Modern sensor systems have and are continuing to acquire data which serve as valuable information sources for scientists in research and application disciplines.

The growing amount of data asks for adequate storage and retrieval facilities. We are in favour of distributed archiving facilities put under the responsibility of national authorities. In addition, historical data sets in Switzerland of about 50-100 Gbytes are in danger of getting destroyed due to the limited life time of conventional magnetic tape media used.

From the users point of view operational monitoring applications need to be based on fast data validation and distribution tools. In order to satisfy in future specific user requirements the archivation technique will be based beyond that on picture content retrieval.

Existing operational catalogue systems are rather primitive and a far away to be a standard.

Storage capacities and computer communication techniques becoming now available are promising prerequisites for the envisaged networking requirements.

1 Present status in remote sensing image archivation and distribution

"The typical configuration of an end-to-end EO [Earth Observation] payload data handling facility has not changed since the first EO missions, more than 20 years ago, although technology has made incredible improvements in computing power, network speed, storage capacity. By the end of the century all planned missions (e.g. ENVISAT and Third Party Missions) will mixed. A relational language is extended to include picture manipulation operations [2].

In the field of Remote Sensing, both data acquisition and user application deal with huge amounts of high intrinsic complexity image data. The user application interest is for multitemporal, multisensor and thematic analysis. In the last years research activities aimed at the design of dedicated systems for archivation and distribution of remotely sensed images. The developed facilities are retrieval by geographic coordinates, click-on-map, sensor type, acquisition time, quick-looks previsualization and intelligent systems that accept query procedures based on meta-knowledge describing the required inputs and possible outputs [3,4]. The diagram in figure 2 presents such a system architecture.

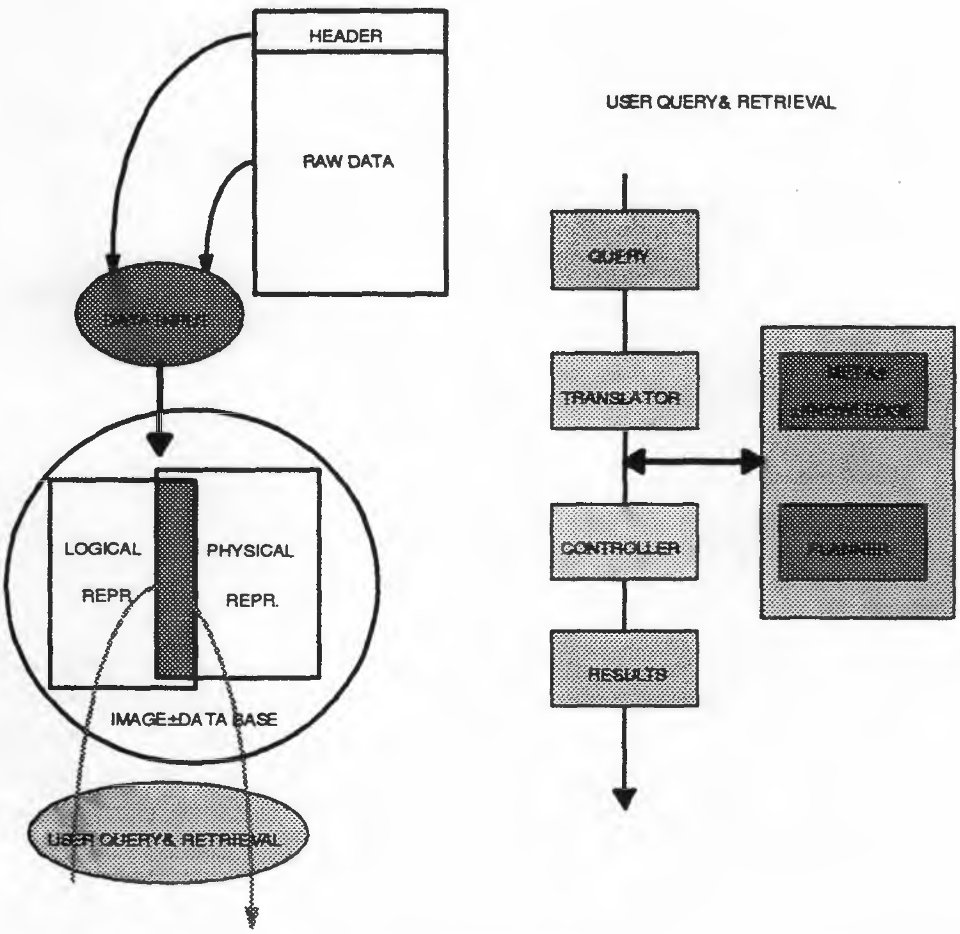

Fig. 2: Image-data base that accept query procedures based on meta-knowledge describing the required inputs and possible outputs. The logical and physical representations of the image-data are intersecting allowing better identification of the user needs.

Existing operational catalogue systems are rather primitive and far away to be considered as a standard. These systems do not provide sufficient description of the content of the data, so new systems are being designed which use content-based analysis of the image-data for object and scene identification and description. Both data insertion and retrieval procedures are modified and add new dimensions to the data base.

software costs associated to the implementation of a national archiving center.

The following diagram, figure 3, presents the facilities, and the architecture of the RSIA.

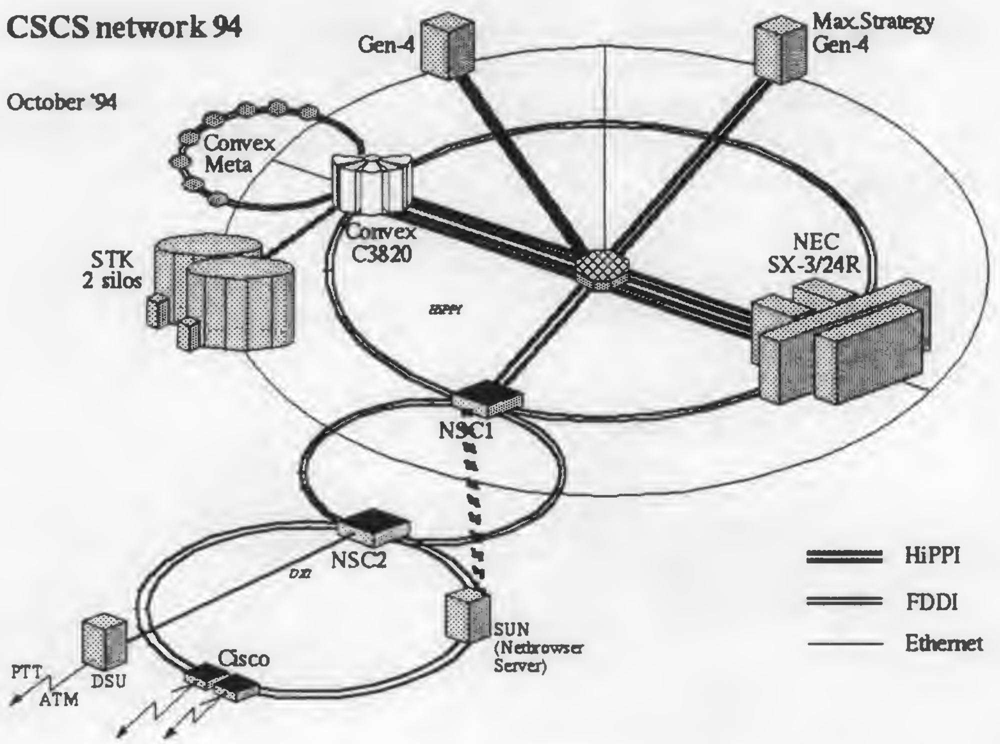

Fig. 3: Configuration of CSCS network (status: 10'94)

One of the major concerns at CSCS is networking capacity and sustained performance. In this perspective CSCS is deeply involved on various national pilot projects focussed on new network technologies like the ATM one. Such project are targeted to enable a high speed interconnection framework between CSCS and other major research institutions in and outside Switzerland. This pilot network represents a strategical access path for the implementation of a national RSIA facility.

A dedicated interconnection scheme is being planned in order to allow external remote-located users to retrieve and manipulate the images and corresponding data through a dedicated but publicly accessible network gateway. This system is intended to be used as a net-browser server and its overall throughput performances will have to be targeted according to the expected customer load. Based on the "client-server" model, this system will forward the image and data queries, as expressed by the authorized users, to the highly securized hierarchical storage environment (the CONVEX server with its attached disks and the STK silos) via a dedicated high-speed link (HiPPI or FDDI-based technology).

The hierachical storage and retrieving functionalities, including a convenient automatic migration/demigration capacity of the acquired images and data, are fully and nicely handled by a specialized integrated software called UniTree. This software is already implemented on the CSCS's computing environment and is used on a daily basis by the community of CSCS users.

[2] N. Dal Degan, et al, "Still Images Retrieval from a Remote Data Base: The System Imagine", Signal Processing: Image Communication 5, pp. 219-234 Elsevier, 1993.

[3] D. Charlebois, et al, "Machine Learning from Remote Sensing Analysis", Proc. IGARSS'93, pp. 165-172, 1993.

[4] D. G. Goodenough, D. Charlebois, St. Matwin, D. MacDonald and A. J. Thomson, "Queries and Their Application to Reasoning with remote Sensing and GIS" in Proc. IGARSS'94, pp. 1199-1203, 1994.

[5] D. Swanberg, et al "Knowledge guided parsing in video data bases", Proc. of IS&T/ SPIE Symposium on Electronic Imaging: Science and Technology, January 31- Febr 4 San Jose Ca, 1993.

[6] A. Gupta, et al "An extended object oriented data model for large image data bases", Proc. 2nd Symposium SSD'91 Zurich, August 1991.

[7] F. Mungo, O. Arino, J-M. Melinotte and Z. Bjelogrlic, "Iona 1-km Net-Browser", ISPRS Val d'Isere 17th to 21th January 1994.

/home_OD/lfusco/CEC-COORD/EEOS/WORKSHOP_N94/Participants/Full_contributions/Seidel_EEOS_paper.doc