

COSMO-SkyMed:

- **Mission Definition**
- **Main Application and Products**

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Summary

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- The PSN (National Space Plan)
- Our interest in polarimetric applications perspective

F. Caltagirone, ASI

- COSMO SkyMed Mission Definition

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Strategic Building Block of Italian PSN

- ❑ The development of public utility services
 - To promote and develop the EO data demand
 - To promote the creation of an EO data offer suitable for the demand
 - To acquire an international role in the public utility service.
- ❑ The development the scientific knowledge
- ❑ The development the technological research
- ❑ The national contribution to the European strategic independence
- ❑ The integration of application and technologies for dual (civilian/military) use.

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The PSN applicative products

- Applicative products in the PSN
 - environmental monitoring, surveillance and risk management
 - ✓ Landslides
 - ✓ Floods
 - ✓ Oil spill monitoring
 - ✓ Fires

- COSMO-SkyMed mission
- Scientific activities related to applicative and technological products

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COSMO SkyMed strong point

- ❑ Fast programming and response
- ❑ DEM generation capability
- ❑ Global coverage
- ❑ High-resolution capability
- ❑ Multimode/Multitemporal data acquisitions
- ❑ Robustness and operationality
- ❑ Revisit time and reactivity with a dedicate service to institutional entities

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SIASGE: an international cooperation

Under assessment

We are evaluating the Italy-Argentina System SIASGE devoted to emergency management

This initiative starts from the common interest of Italy and Argentina in the development of products and services for “risk and emergency management”

The SIASGE will include

- The COSMO-SkyMed system developed by ASI
 - 4 satellites equipped with X-band multipolarimetric SAR
- The SAOCOM system developed by CONAE
 - 2 satellites equipped with multipolarimetric L-band SAR

Objectives

- To exchange data acquired by the two systems for institutional use (and commercial perspectives)
- To jointly develop EO applications (products and services) maximizing the two bands X e L and the multipolarization

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SAR polarimetry and applications

Perspectives

- ❑ COSMO SkyMed is equipped with a polarimetric X-band SAR
- ❑ The applicative products of primary importance for ASI take a great advantage from the use of multipolarimetric X (and L) SAR data
 - For several applications like flood monitoring, topography soil moisture retrieval, terrain changes, oil spill detection it's clearly shown the increased value of multiparameter capabilities to characterize Earth's surface and vegetation cover and to generate geophysical products.

- ❑ This workshop has assessed the applicative capabilities of polarimetry and the large interest in this field
- ❑ ASI will exploit the polarimetry benefits in the application development.

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SAR polarimetry and applications

Perspectives

- ❑ The large interest of scientific community confirm how is promising the exploitation of this feature
- ❑ On the basis of PSN founds and of COSMO-SkyMed polarimetric capabilities we can consolidate the studies in this field opening an effective collaboration with this community.

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Mission statement

- ❑ COSMO-SkyMed is an end-to-end Earth Observation System dedicated to Earth remote sensing and data exploitation for Dual (military and civil) Use applications.
- ❑ Main mission objective is therefore the provision of data, products and services relevant to the:
 - ❖ monitoring, surveillance and intelligence applications of MoD entities;
 - ❖ environmental monitoring, surveillance and risk management applications of institutional entities;
 - ❖ environmental resources management, maritime management, earth topographic mapping, law enforcement, informative / science applications of other institutional, scientific and commercial entities.
- ❑ COSMO-SkyMed, funded by the Italian Ministry of Research and Ministry of Defence and conducted by the Italian Space Agency (ASI), appears to be the first System (and mission) capable to fully meet the requirements for management, control and exploitation of Earth resources – in a coordinated manner with Optical Satellites.

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COSMO-SkyMed Mission vs. Users and Market

⇒ COSMO-SkyMed System answers to Users/Application requirements and to market demand, being characterized by the following peculiar features:

- ❖ Dual Use
- ❖ Revisit time of few hours
- ❖ Response time of tens of hours
- ❖ Metric/Sub-metric resolution
- ❖ Imagery intelligence
- ❖ Night time sensing
- ❖ Penetration of cloud
- ❖ Interferometric applications
- ❖ Polarimetry
- ❖ Rapid distribution of images
- ❖ Low cost equipment and images
- ❖ Complete service

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Programme Origin and Heritage

- The Cosmo-SkyMed Programme initially was born as a civilian programme for the observation of the Mediterranean Basin Area and its realisation was assigned to the Italian Space Agency (ASI).
- In the meantime the IT – MoD was looking for/selecting a new observation satellite system, follow-on of HELIOS I (whose operational life is expected to end in 2004), with higher performances in terms of resolution and geo-location.

⇒ TODAY, THE COSMO-SKYMED PROGRAM IS:

- ❖ part of the National Space Plan
 - ❖ to supply remote sensing products and services for the monitoring and control and management of the risk relevant to Forest Fires, Floods, Landslides, Oil spills;
- ❖ the Radar Component (metric and sub-metric capabilities) of a “dual use” system including Radar and Optical Satellites;
 - ❖ developed under ASI responsibility in collaboration with the IT MOD;
 - ❖ part of an IT/FR Agreement on “Earth Observation”, open to third parties participation.

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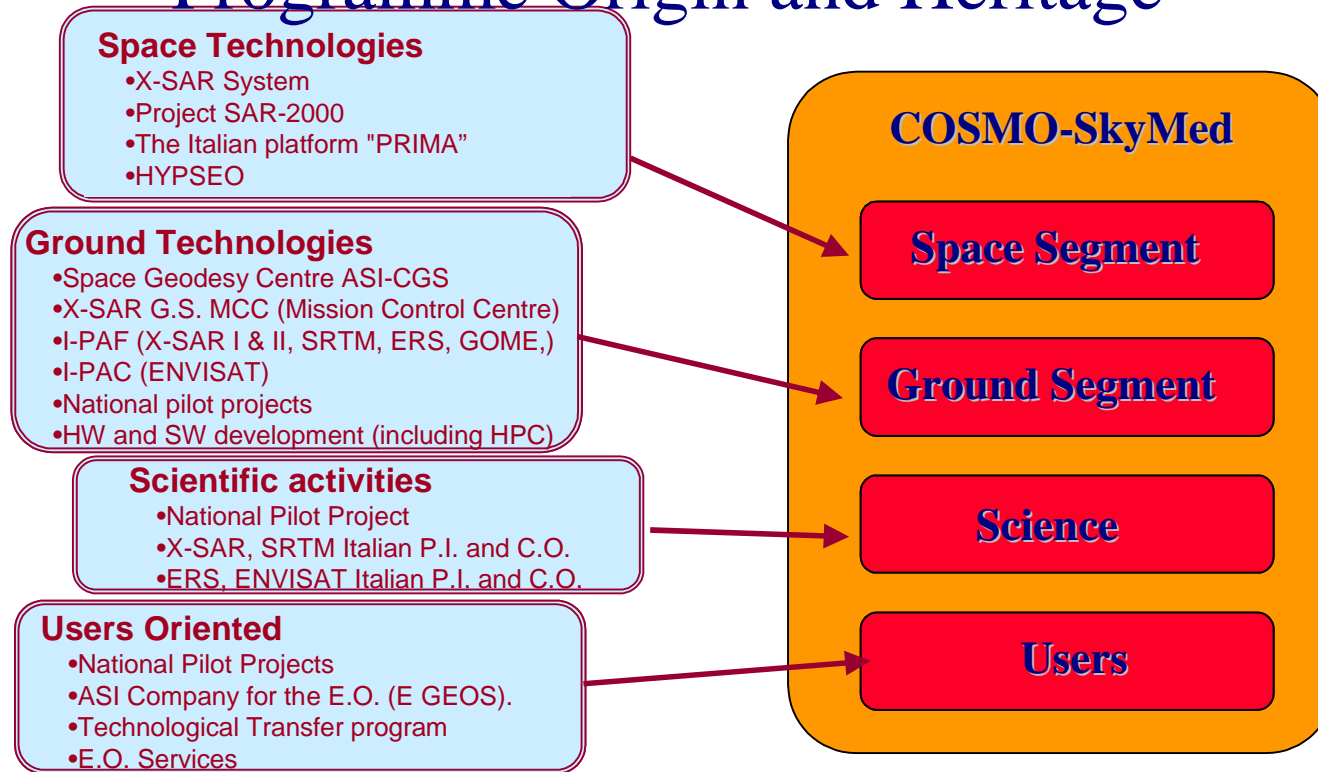
Programme Origin and Heritage

- The Cosmo-SkyMed Programme, contributes to:
 - finalizing space technology products to application
 - promoting and developing services of public interest
 - developing an Italian role in the international service market
 - increasing the national scientific base aiming at the excellence of various disciplines
 - fostering Italian technological excellence and industrial competitiveness
 - broadening and consolidating international cooperation

⇒ THE COSMO-SKYMED PROGRAM IS:

- ❖ strategic;
- ❖ compliant with Government PSN Strategies;
- ❖ flexible and suitable for enhancement, boosting new applications development
- ❖ supporting market development.

Programme Origin and Heritage



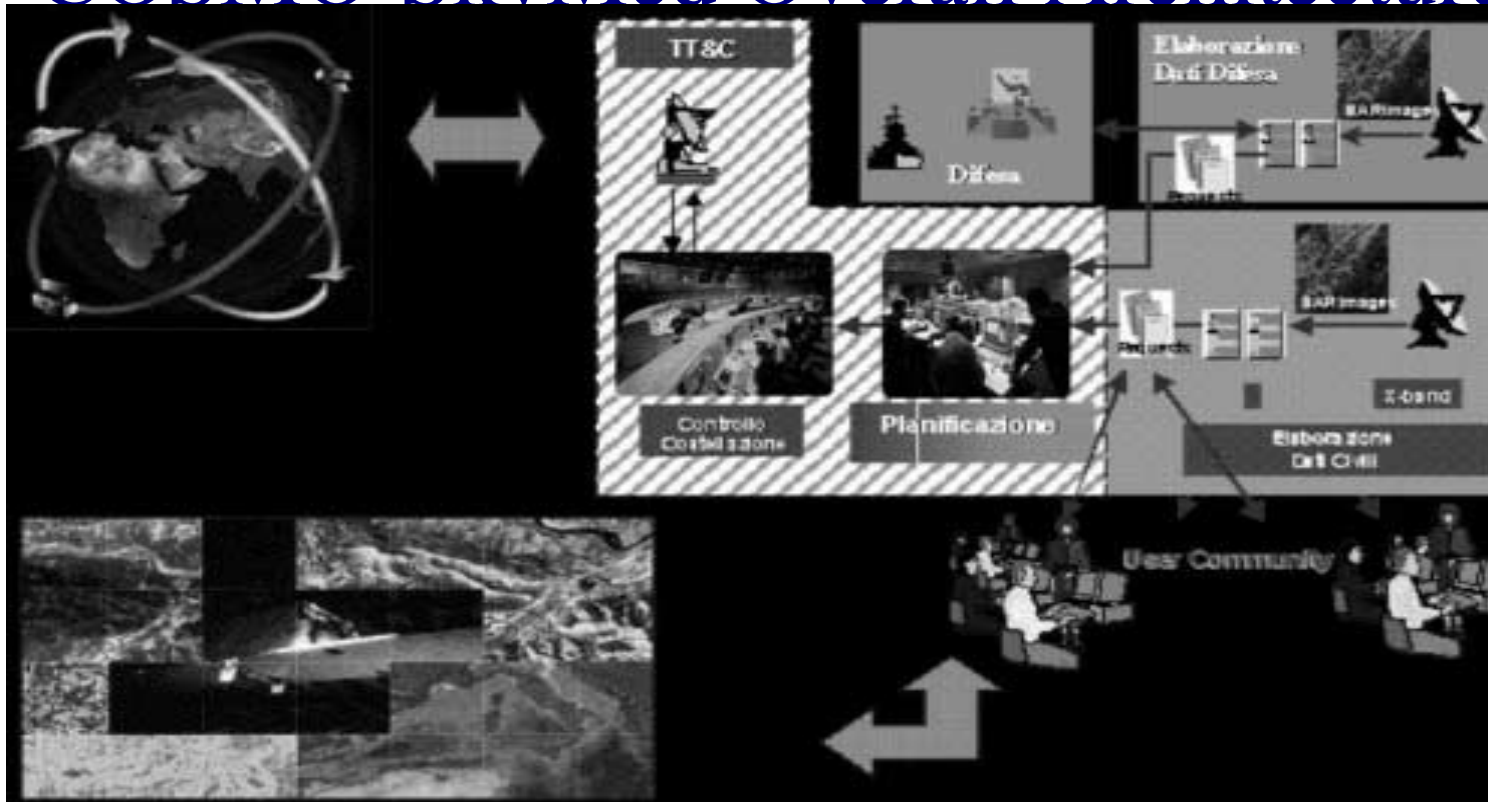
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COSMO-SkyMed - Features

Functional Requirement	Performance	Comments
Revisit Time	Up to few hours	A constellation of satellites is mandatory.
Coverage	Global	The system will be capable to acquire and furnish data world-wide.
Response Time	Up to tens of hours	From request to the final users standard products delivery
Observation capability	All weather, day/night	The availability of a system with an all weather day/night capability is crucial for most applications of the Defense and risk management discipline.
Interferometry	Dual pass Int. SAR	For interpretation purposes and Digital Elevation Model (DEM) production.
Polarimetry	Four Polarizations (HH, VV, HV, VH) are available	Data Takes with selectable polarization, and multiple polarizations on the same scene, using the Ping-Pong technique.
Spatial Resolution	Variable: from few meters to hundred of meters	To cover the wide range of applications
Swaths	Variable: from tenth of Km to hundred of Km	To cover the wide range of applications, ranging from local to regional scale phenomena
Incidence angles	Variable: Tens of degrees	To improve interpretability and to reduce casting shadows depending from the illumination vector angle.

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COSMO-SkyMed Overall Architecture



The Overall Architecture is fully compliant to the Mission Requirements

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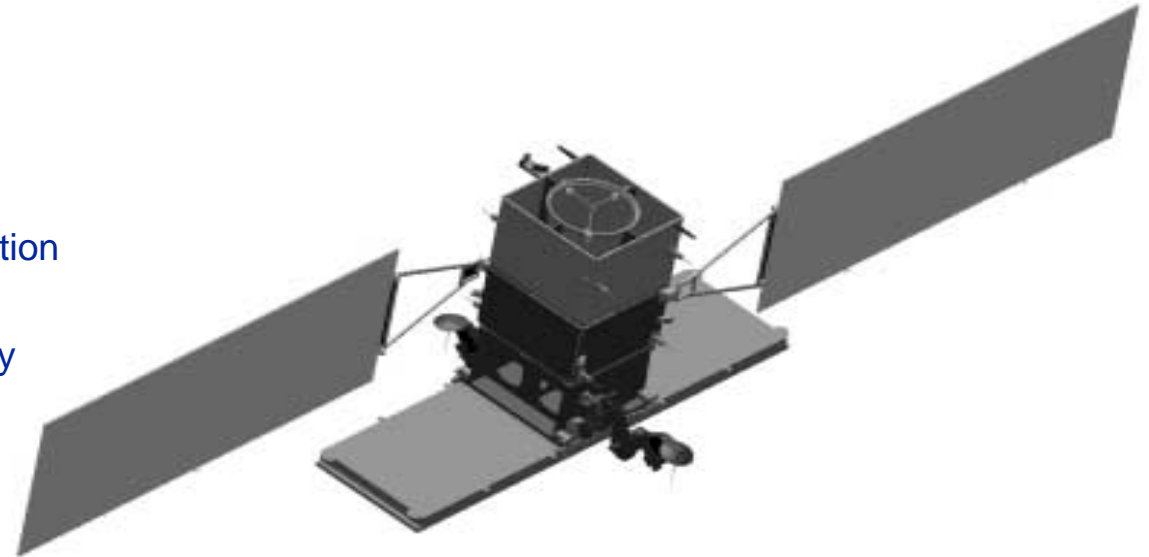
COSMO-SkyMed System - Space Segment

□ Orbit

- ❖ 4 satellites phased at 90°
- ❖ phased sun-synchronous 14+13/16
- ❖ altitude 619 km
- ❖ equator cross time around 6h00

□ Satellite Main Characteristics

- ❖ Mass: 1700 Kg
- ❖ 300 Gbit On-Board-Memory;
- ❖ On-board data compression and encryption
- ❖ 300 Mbps X-band down-link capability
- ❖ 24 hours on-board operational autonomy
- ❖ Three axis stabilized
- ❖ Very high pointing accuracy
- ❖ Right and Left Looking
- ❖ High GPS receiver and star tracker accuracy
- ❖ 5 years lifetime



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COSMO-SkyMed System - Space Segment

❖ SAR Payload General Characteristics

- COSMO SAR is a multi-mode sensor, a programmable system which is able to operate providing different performance in terms of swath dimension, spatial resolution and polarization.
- The radar transmitter and receiver operate through an electrically steerable multi-beam antenna which concentrates the transmitted energy in a narrow beam, along a direction normal to the satellite track, while the characteristics of the transmitted pulses and of the reception timing determine spatial resolution and coverage.
- COSMO SAR provides the user with a set of standard operational modes; nevertheless the operational policy is fully flexible and all the parameters which are necessary in order to define a beam are selectable by means of ground commands.

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COSMO-SkyMed System - Space Segment

❖ Main Performance Specifications

- ❖ X-band active antenna, electronic steering;
- ❖ Multimode SAR instrument from sub-metric to ScanSAR
- ❖ revisit time less than 12 hours
- ❖ Geolocation error less than 15 m
- ❖ Access area : 1300 Km ground cross track, corresponding to pointing angles between 20° and 60°, left and right looking;
- ❖ Swath width 10 to 200 Km

❖ SAR acquisition modes

Modes with one polarisation selectable among HH, VV, HV or VH:

- ❖ SPOTLIGHT
 - resolution: order of the m or less
 - spot area : tens of km²
- ❖ HIMAGE (Stripmap)
 - resolution: few meters
 - swath width: several tens of km
- ❖ WIDEREGION (ScanSAR)
 - resolution: few tens of meters
 - swath width: hundreds of km
- ❖ HUGEREGION (ScanSAR)
 - resolution: several tens of meters
 - swath width: few hundreds of km

Modes with two polarisation selectable among HH, VV, HV or VH:

- ❖ PING PONG (Stripmap)
 - resolution: few meters
 - swath width: several tens of km

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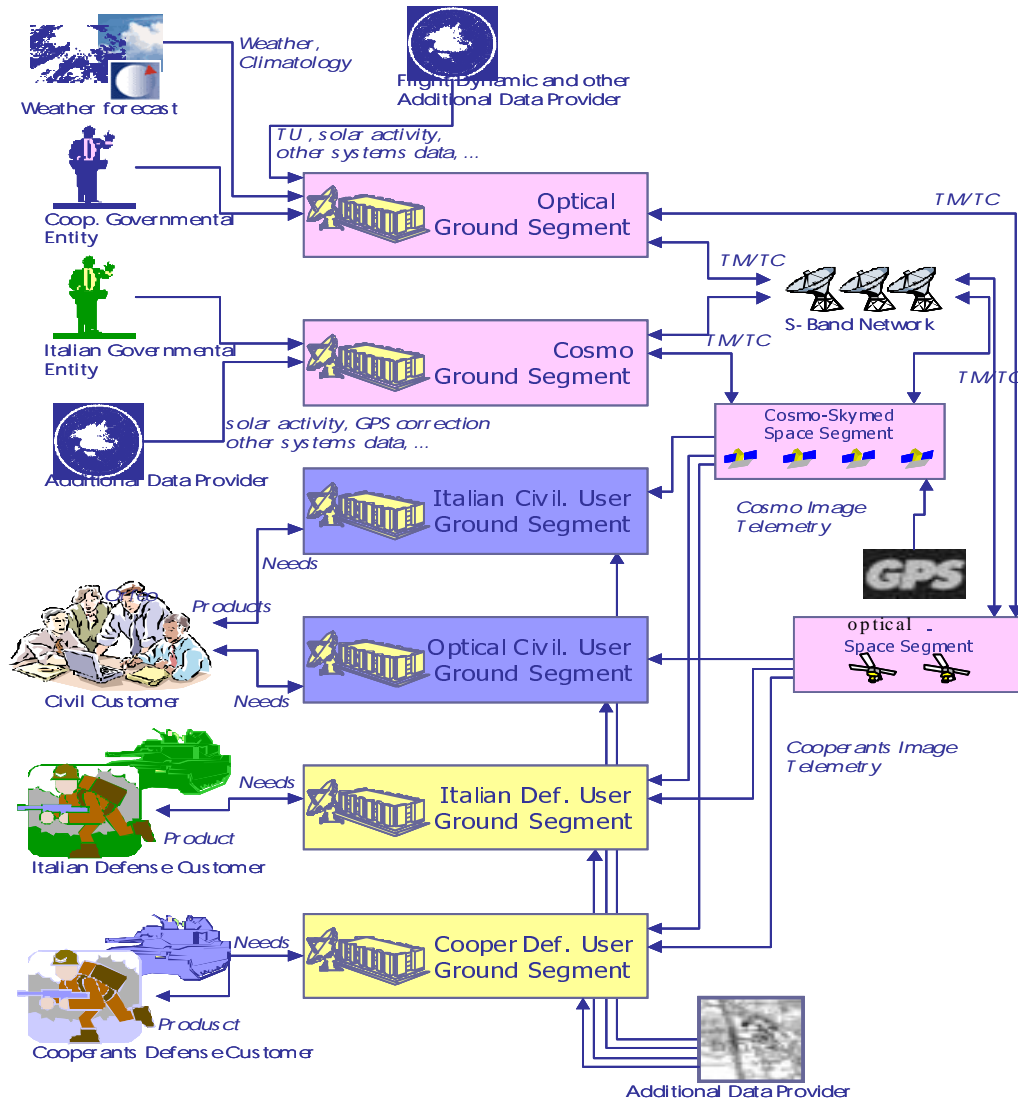
System Utilization Scenario

The COSMO – SkyMed is an operative mission:

- ❑ The system is able, on the basis of the various user requests and their priority, to build the best plan to accomplish the user needs.
- ❑ The originated products will be delivered, normally, to the end-user via the COSMO-SkyMed Ground Segment.
- ❑ The data provision to the *end user* is based on data sensed both by COSMO satellites as well as from other system and shall be reliable and delivered with a pre-defined and well-known delivery time.
- ❑ Fast delivery products can be one or more images (compatible with the link data rate) with a limited quality (raw images) to be delivered as soon as possible to mobile stations co-located with the acquired site.
- ❑ The user will receive the products in which they are interested as soon as they are available in the system (*Near Real Time*). Nevertheless the system shall be tailored to accomplish user request related to already processed data (*off-line products*).

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COSMO - SkyMed GS Overview



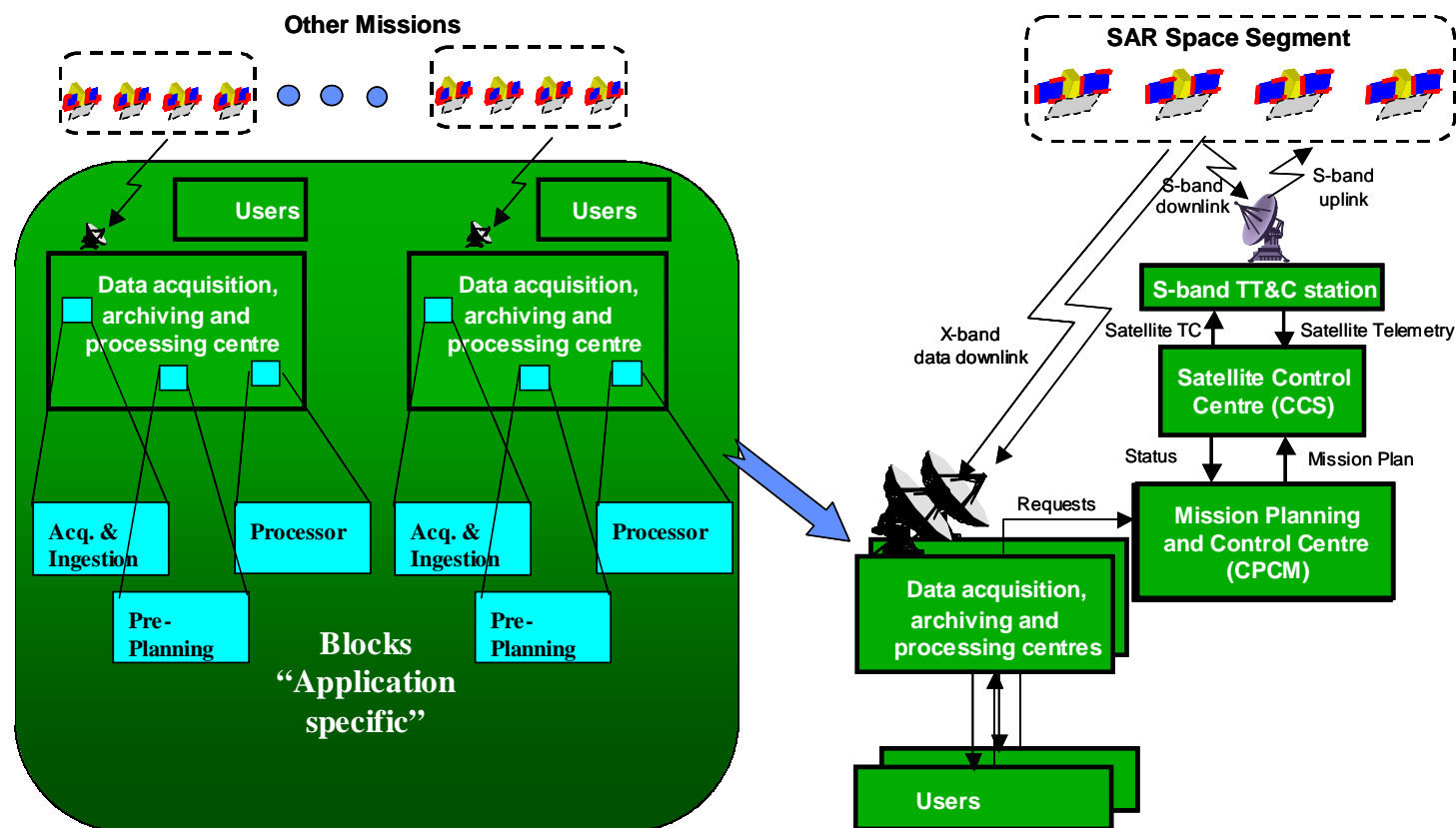
Cosmo Sky Med GS main drivers:

- Dual Use
 - Response time
 - Expandability/Interoperability
 - Availability / Operability
- ↓
- Security standards application
 - Geographical distribution
 - Polar stations utilization
 - World wide fiducial network
 - MAPS (mobile stations)
 - Continuous calibration
 - Modular architecture, with “plug and play” approach
 - Functional and physical redundancy
 - Use of TCP/IP protocols
 - Integrated Logistics Support policies

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COSMO – SkyMed GS Interoperability and Expandability

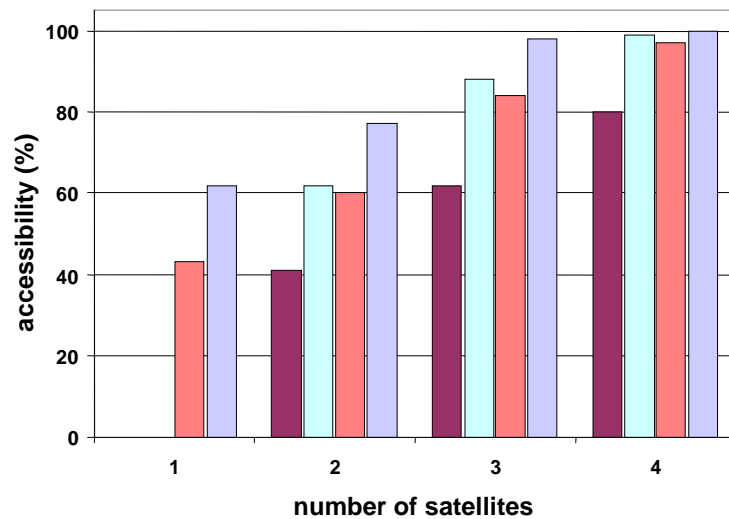
- Interoperability
 - Adoption of international standards
- Expandability, through integration of:
 - Acquisition and ingestion chain
 - Processors



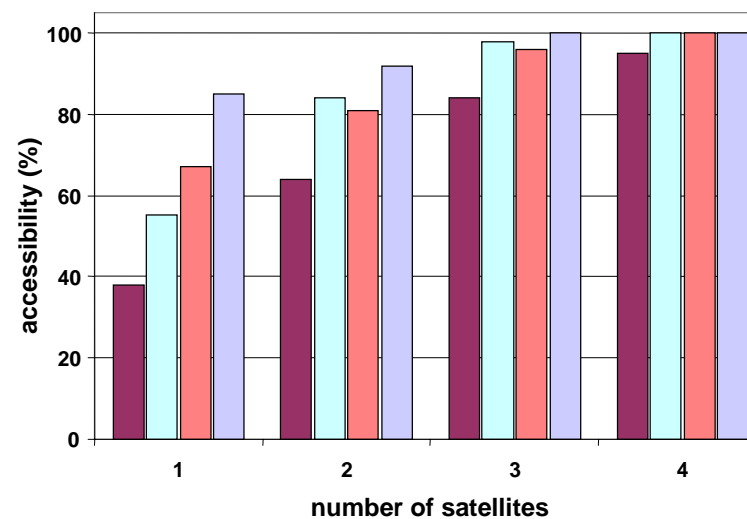
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COSMO-SkyMed System – Revisit Time

12 h accessibility



24 h accessibility

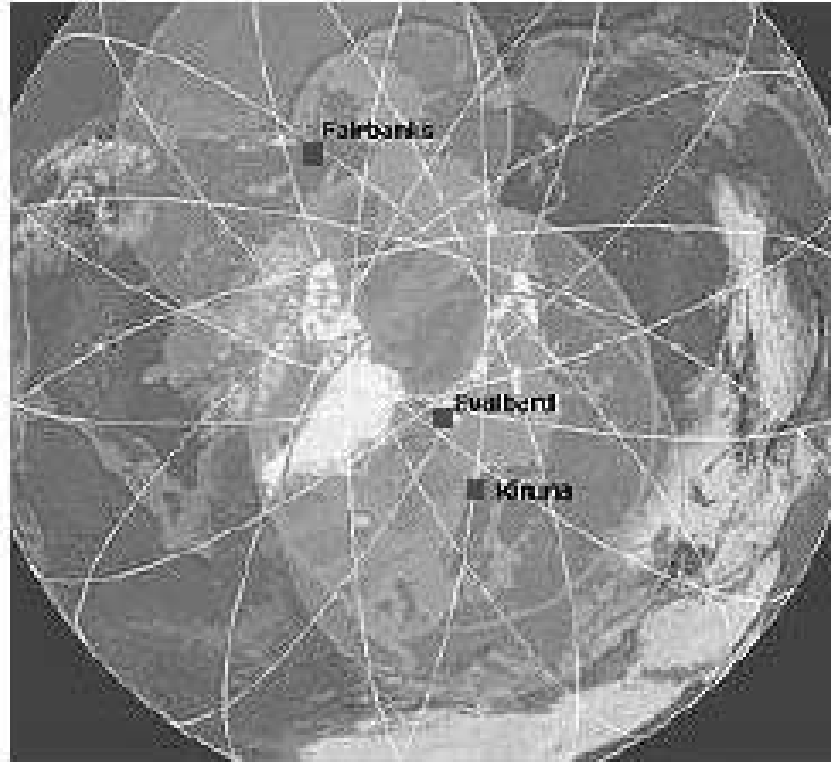


Right-Nominal
 Right-Extended
 Right&Left-Nominal
 Right&Left-Extended

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COSMO-SkyMed System – Response Time

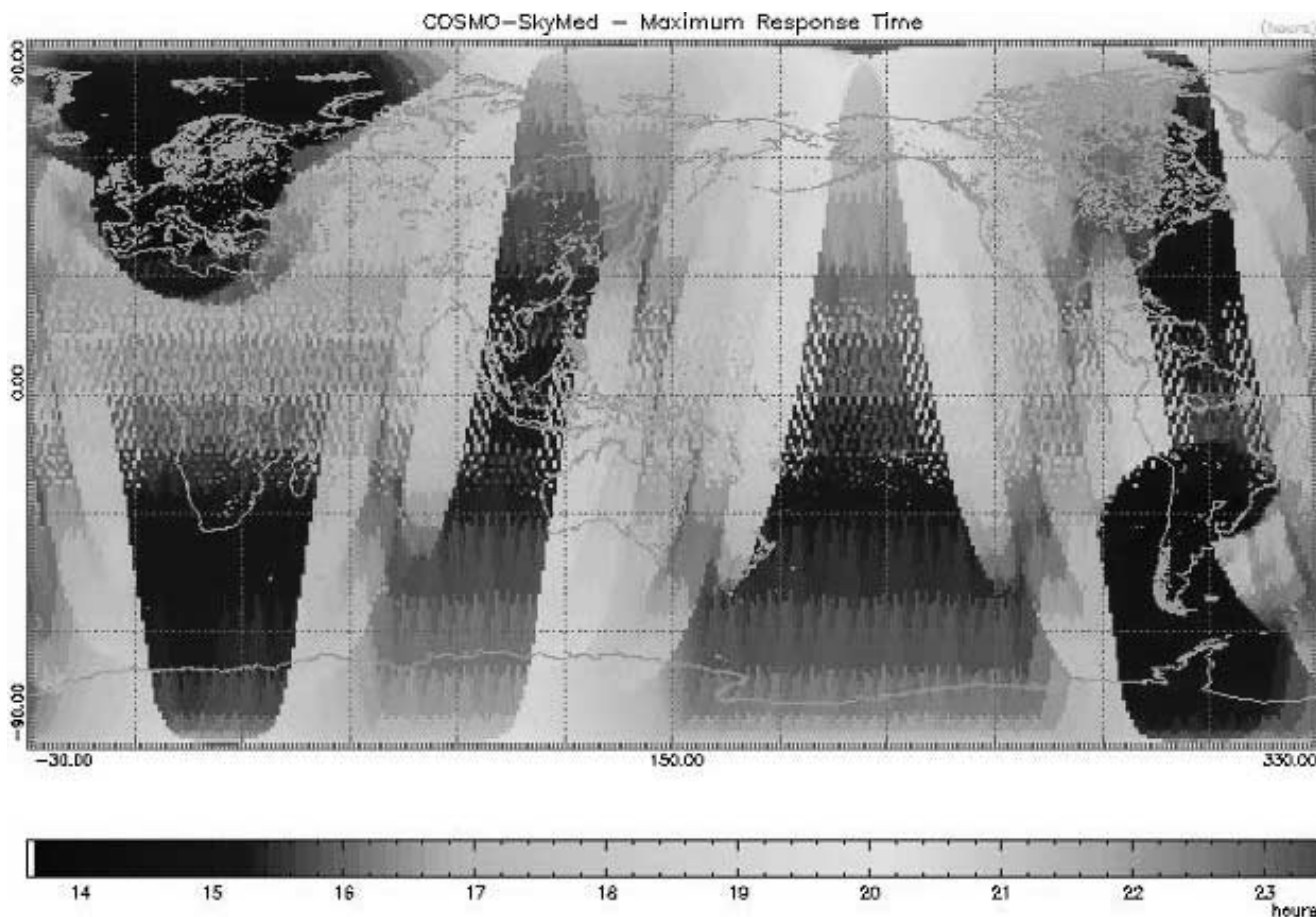


Visibility at high latitude stations

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COSMO-SkyMed System – Response Time

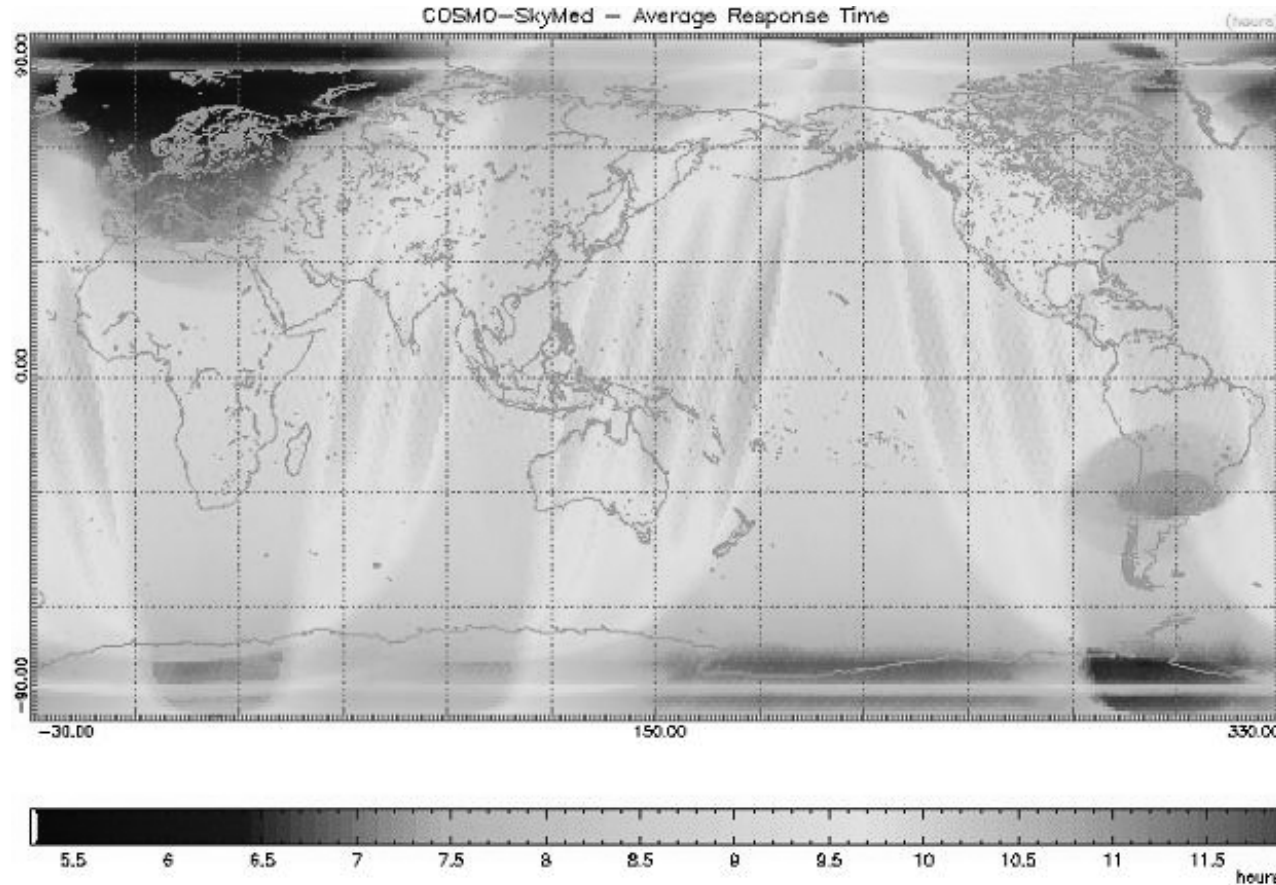


Basic Scenario + Kiruna + Cordoba - Maximum System Response Time

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COSMO-SkyMed System – Response Time



Basic Scenario + Kiruna + Cordoba - Average System Response Time

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Program Status and Key Events

PREVIOUS STEPS:

- End of Phase B1 1998
- Design and Bread boarding - Phase B2 1999
- Critical technological development 1998/2002

⇒ Currently the Satellite is under qualification

NEXT:

- Development - First sat. 2000/2003
- Launch of the first satellite begin of 2005
- Constellation completion end of 2006

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