Service Support Environment Architecture, Model and Standards

White Paper
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INTRODUCTION

Purpose of this document

This document presents the Service Support Environment (SSE) model, architecture and applied standards. The Service Support Environment was designed and implemented for ESRIN by a consortium around SPACEBEL (Belgium), also consisting of GIM (Belgium) and Intecs (Italy). The same consortium, complemented by Telespazio (Italy), VITO (Belgium) and Kongsberg Spacetec (Norway) ran the original MASS GSTP project where much of the SSE functionality was prototyped and refined.

This document is meant as an introductory document. It aims to give a high level overview of the SSE concepts and its top-level architecture. It is recommended to read this document before reading the more technical documents that were produced as part of various SSE-related projects MASS, MASS-ENV and ISAC.

Scope

Ongoing efforts to broaden the European Earth Observation (EO) market highlight the need for EO services and "information products" closer to customer expectations and processes (easily understandable and ready-to-use without further manipulations).

Today the transformation from basic products (e.g. images) into information is performed by a small number of specialised companies operating independently in specific application domains. This separation increases costs and leads to a time consuming process, which prevents the optimization of allocated resources. The problem limits the deployment of cost effective EO services, in particular when efforts must be spent not in the own core business / expertise, but in repeating basic processes, which are efficiently performed by specialised companies. Setting up strategic partnerships for providing synergic services could reduce the overall costs, increase the performances, permit to offer the same service to more users, and to enlarge the service offering with new services.

To this end, the identification of a set of common EO business related standards and the support of a neutral and open service-enabling environment becomes mandatory.

The Service Support Environment (SSE) developed for the Ground Segment Department at ESA-ESRIN aims to identify a path to solve the above problems, by implementing an open service-oriented and distributed environment among business users (service users and service providers), enabling the integration of EO, meteorological and GIS data. The SSE service-enabling environment facilitates service provision and orchestration, allowing each organisation to exploit the service know-how and provision ability of the others, also for the creation of new services from a horizontal set of basic services supplied by multiple service providers.

The main objectives of the SSE are to:

- provide an infrastructure enabling the business to business interactions among service providers (B2B) and with users (B2C),
- allow basic and end-to-end services to remain on the service provider infrastructure,
- allow for easy plug-in and plug-out of services to/from the SSE environment,
- allow chaining of services into more complex ones,
- support "subscription" type services (e.g. fires active monitoring and alerting),
- support the evolution and maintenance of services,
- allow easy identification of, and access to requested services, with progress follow-up until completion,
- integrate services from multiple domains, to exploit multi-domain synergies.

The SSE infrastructure was initially developed in the MASS GSTP project in the period 2001-2003. Due to the interest the GSTP project has generated, ESRIN has decided to enhance the initial system and upgrade it to an operational system which is now known as the ESA "Service Support Environment" and available at http://services.eoportal.org.

SYSTEM SPECIFICATION

System Overview

The Service Support Environment (SSE) provides a reusable architecture for the integration of services in the Earth Observation (EO) and Geography Information Systems (GIS) domains. The main entry point of this architecture is the SSE Internet Portal where users, EO and GIS service providers and EO data providers are integrated in a coherent supply chain. *Figure 1* shows the top-level view of the SSE Portal and its external interfaces.

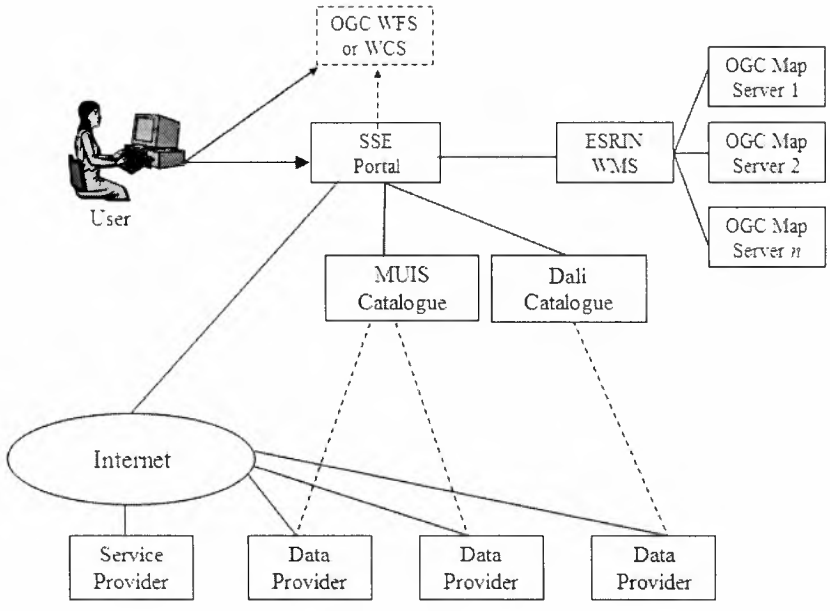


Figure 1: Top-level view of SSE Environment

The SSE provides access to numerous distributed services based on existing or new applications. These services are related to environment, science, decision making (e.g.: before, during and after a crisis), public or commercial activities etc.

The MASS GSTP project has demonstrated that the SSE system can be used to provide access to different kinds of "services":

- Processors: e.g. Spacetec's oil spill processor, the interferometry processor DISP, SAR processors from Spacetec, a fire risk index processor from Telespazio (TPZ) etc.
- Archives: Spot Végétation S10 archive (VITO), Geosuccess product archive (VITO), Radarsat, ERS and Envisat products (Spacetec) etc.
- Catalogues: ESA Multi-Mission, SpotImage Dali/Sirius.
- Mission planning: Gael service (MERIS), Spacetec MEOS M&C system
- Utilities: image reprojection, generalisation, raster and vector format conversions, clipping etc.

In addition, these "services" can be combined by creating "chains" of services, or by overlaying service results with layers coming from other sources as illustrated by *Figure 2*.

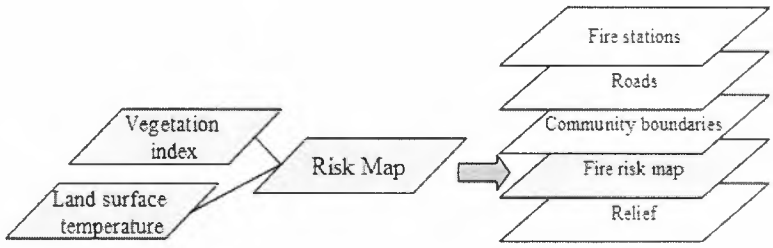


Figure 2: Combining Services with the SSE

The SSE places no restrictions on the granularity of a (Web) service that can be integrated. The grain size can range from small (for example a component that must be combined with others to create a complete business process), to large (for example an application). We identify two main categories of services:

- Basic Services: these are limited services running on the service providers' local infrastructure. They are connected to the Infrastructure over the Internet as web services, using the Simple Object Access Protocol (SOAP) [RD4], the Web Service Description Language (WSDL) [RD6] and FTP for large data flows. Both specifications are supported by the World Wide Web Consortium (www.w3c.org). Basic services may be requested (ordered) via the Portal's user interface, or from within a workflow.
- Complex Services: they are services consisting of a combination of basic services or other complex services. A service provider using the graphical workflow definition tools provided by the SSE system can model complex services. Complex services can comprise services provided by different service providers.

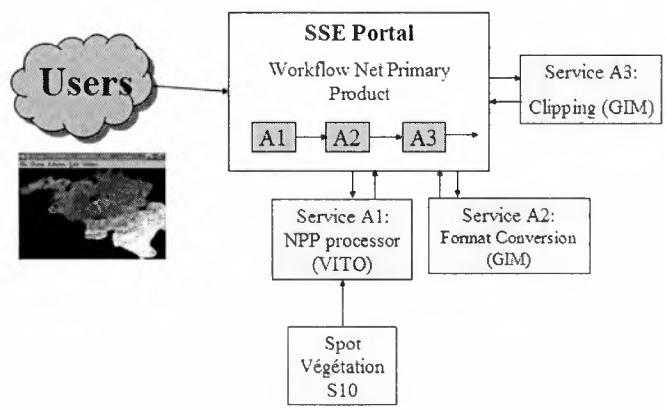


Figure 3: Conceptual View of Service Chaining

Figure 4 shows an example of a typical workflow modeled using the SSE workflow tools. In this example, the VITO Net Primary Productivity service, which is

available per continent (e.g. Europe), is combined with basic services to convert the image format and perform clipping to offer a product in GeoTIFF format covering Belgium, while the original service only offered HDF files covering the whole of Europe. The user can also graphically select his area of interest while the original service has a textual interface.

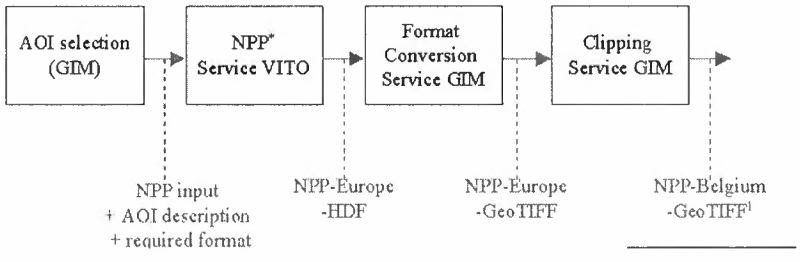


Figure 4: Service workflow modeled using the SSE.

As the SSE has to support multiple business scenarios, we envisage to eventually have three variants of the SSE system. This will allow the SSE system to be deployed at different scales as depicted in *Figure 5*: European, national, regional or local.

- A Central SSE Portal (at services.eoportal.org) is installed at ESRIN (Frascati, Italy). This Portal will become an integral part of ESRIN's EO Portal (www.eoportal.org).
- Regional SSE Portals, similar to the Central Portal, but integrating services covering a specific region or country. The regional Portal will offer a localised user interface. An example of a thematic portal may be the EOLES "disaster" Portal being set up in the frame of the EC IST project EOLES (See www.spacebel.be/eoles.html).
- Access Points are simplified versions of the SSE system based on freely available software only. They will typically be used by an organisation wishing to organise its internal services in an SSE-like fashion. This organisation can use the Access Point as an Internet, Intranet or Extranet Portal, while the Portal may only integrate services over the organisation's Intranet.

The SSE may become an ESA service element network or an ESA standard Internet interface to EO thematic applications. It supports cost effective and easy production of thematic products that integrate EO products and geodata from different providers.

A single service may be accessible from several SSE Portals. This is depicted in *Figure 5*.

The main components of the SSE system are the SSE Portal, the AOI tool which allows the users to select an area of interest in a consistent way and the SSE Toolbox which facilitates integration of a service considerably (See *Figure 6*).

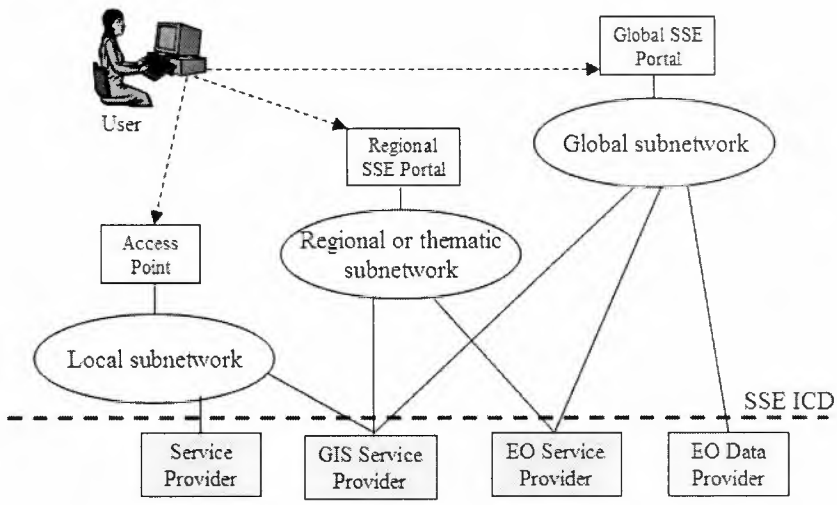


Figure 5: Global SSE Portal, Regional Portals and Access Points

Each of these components has a separate specification document, but for clarity their top-level design and their interactions is summarised in the diagrams in the remainder of the current document. For the details, we refer to the corresponding specification documents.

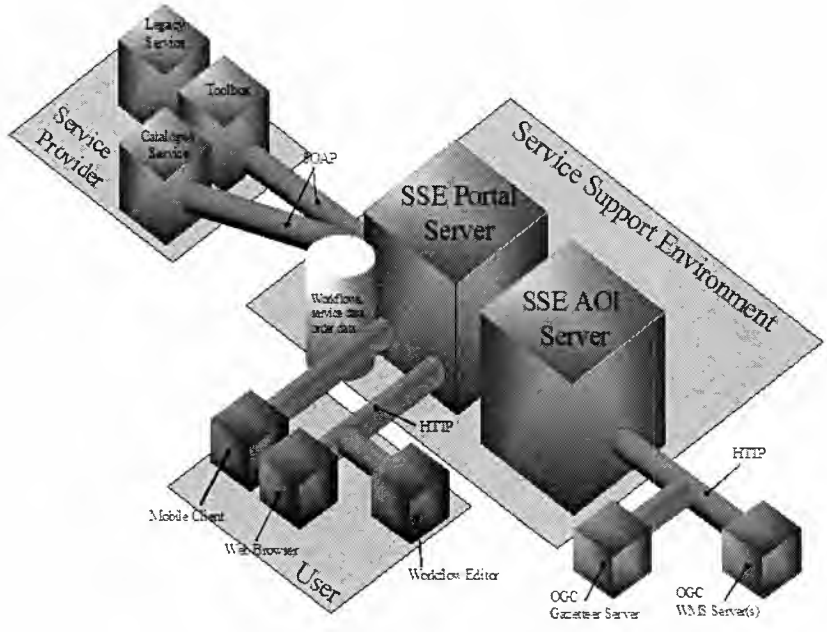


Figure 6: SSE Main Components

In *Figure 6*, a user accesses the SSE Portal using his Web browser over the Internet (using HTTP or HTTPS). There are 4 types of users, each with specific access rights:

- Anonymous users or service consumers can order SSE services that are free of charge.
- Registered users are users or service consumers whose identity is known by SSE. They can request quotations for services and order paying services.
- Service providers are allowed to make their services available through the SSE Portal. They can also combine existing services using the SSE workflow capabilities to offer added-value services.
- The SSE administrator and help desk manage the SSE Portal and publish news items on the SSE Portal.

SSE is based on a non-proprietary, open, and scalable architecture for the development, implementation and deployment of services. The SSE environment provides various functionality, useful for users as well as service providers. Its main functions are:

- User Registration
- Service registration,
- Service directory with browsing and search functionality,
- Support for free as well as paying services (simulated),
- Request for Quotation and Order management,
- Cross catalogue searches,

- Workflow graphical editing,
- Workflow monitoring,
- Module for AOI selection,
- Module for layered service result visualisation,
- Service and company category management,
- News item management via browser and email,
- Notification by email of new service availability,
- Service subscription,
- Consultation of order list via a mobile device.

Service Interaction Model

Operations

In the most general case, a basic service exposes the following operations as part of its SOAP interface. These operations are available from web pages on the SSE Portal, and from within workflows:

- Request for Quotation (RFQ): the service provider can define the content of an RFQ request and RFQ result. Typically, it will return a list with possible matches, availability information, or price information.
- Order: The service provider can define the content of an Order request and Order result. In some cases, the complete information can be contained in the XML message. In other cases, the result message will contain an FTP URL, with optional user name and password to allow the user to download the actual result file.

To support the integration of catalogue services, two additional operations are supported:

- The "search" operation is used to perform a query on a remote catalogue. It returns the meta-data available in the catalogue for images matching the search parameters such as area of interest and time interval. The SSE Portal presents the search results in textual (list) format, and graphically on a map.

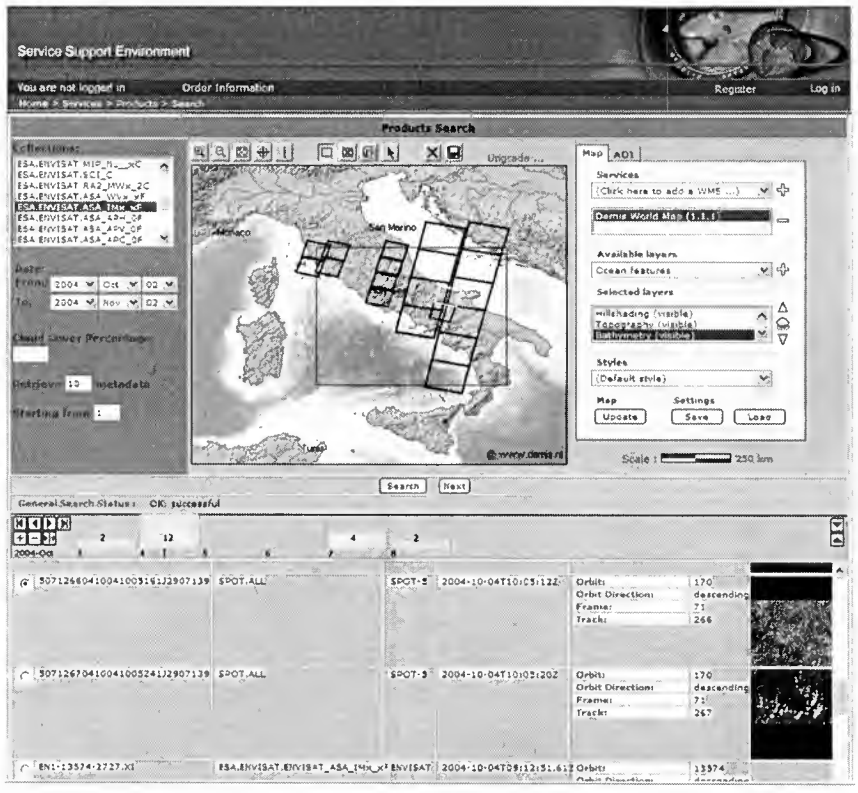


Figure 7: Result of a cross-catalogue "search" operation

Figure 7 illustrates that the SSE infrastructure can be used to integrate complex data catalogues, and display search results graphically as well as in textual format. It shows the result of a simultaneous query on the ESRIN MUIS catalogue and the Spot Image Dali catalogue.

Figure 8: Result of "present" operation

- The "present" operation allows requesting detailed information about a single search result (See *Figure 8*). The metadata returned may be different depending on the catalogue.

The interface for the last two operations is compatible with the EOLI XML ICD [RD18] defined by ESA. This ICD defines a stateless interface for catalogues.

Interaction Model

The SSE infrastructure does not make an assumption about the time needed by the remote service provider to generate or return a service result. Some services may require days, others such as data access may be almost instantaneous. The SSE Portal keeps results of orders (i.e. the XML message) in a database until the user accesses the Portal again. The actual data in most cases remains available a number of days on the service provider side for the user to download.

SSE supports two interaction models. The service provider decides at service registration time which mechanism should be applied for each of the four operations: i.e. search, present, RFQ or Order.

- Asynchronous operations: this model is used when an operation may take too long for a user to get the result immediately displayed in his browser. The result of the RFQ or Order is stored in the SSE database and is available in the user's order list when he logs in the next time.

- Synchronous operations: this model can be used when the service will immediately return the result (See *Figure 9*). The SSE Portal then visualises the result on the Web page. E.g. a catalogue search may take a number of seconds. SSE can thus display search results on the same page where the user entered the search criteria. This interaction model corresponds to the WS-I "Synchronous Request/Response" usage scenario defined in [RD26].

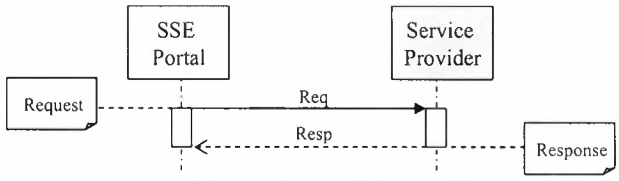


Figure 9: Synchronous or Request/Response Usage Scenario

The possible variations that will be supported are summarised in the table below:

Operation / Model	*Asynchronous (i.e. response via order list)*	*Synchronous (i.e. immediate response)*
Search	Not foreseen	Yes
Present	Not foreseen	Yes
Request for Quotation	Yes	Yes
Order	Yes	Yes

The "asynchronous" communication model with the service back-end is supported in two ways:

- Push mechanism: Both the SSE Portal and service backend (i.e. Toolbox) are SOAP server as well as SOAP client in this configuration (See *Figure 10*). The SSE Portal makes an order via sendOrder and the service backend replies with a sendOrderResult. This interaction model corresponds to the WS-I "Basic Callback" usage scenario defined in [RD26]. The ws-addressing standard [RD8] is used to avoid content-based correlation of the asynchronous communication.

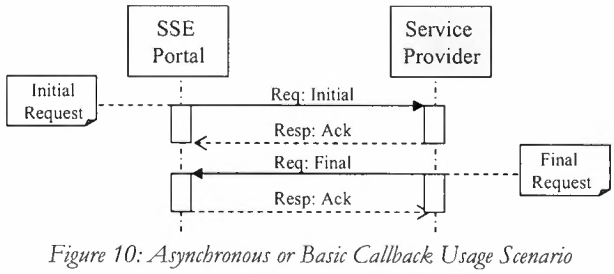


Figure 10: Asynchronous or Basic Callback Usage Scenario

- Pull mechanism: The SSE Portal uses polling to fetch operation results via SOAP messages called sendOrder, checkOrder and getOrder. The SSE Portal is the SOAP client, and the service backend (usually the Toolbox) is a SOAP server. Use of this mechanism is discouraged and may no longer be supported by future version of the SSE software as it doesn't scale well due to the overhead. Also the Access Points cannot support it.

Data Delivery Methods

Depending on the service, service results can be large multi-megabyte files (e.g. raster images), smaller vector images or just textual information. The SSE does not make any assumption about the format or type of a service result. The way information is presented on the Portal is defined by the service provider.

The SSE will support various data (i.e. service result) distribution mechanisms:

- data included in SOAP message, textual or graphical (SVG),
- data via FTP (URL in SOAP message),
- data via HTTP (URL in SOAP message),
- vector data via an OGC WFS server,
- raster data via an OGC WCS server.

Also a combination of these data delivery methods can be used. Figure 11 shows the result of the Spacetec oil spill detection service. Data present in the SOAP message is displayed below the map in a table, while the user also has access via FTP to the original GeoTIFF image.

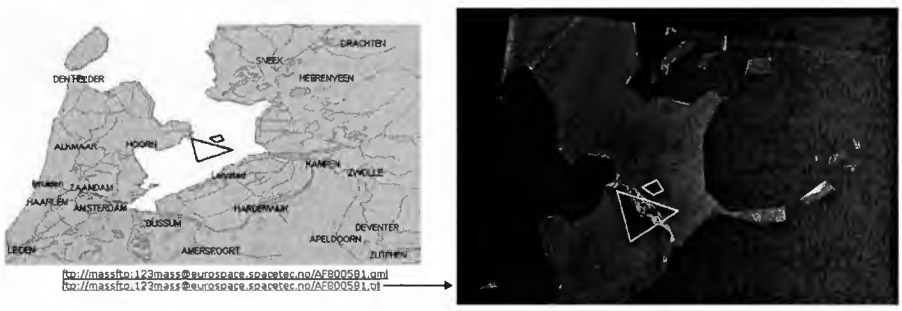


Figure 11: Oil Spill Service Result Page

Other services such as the Landsat data service from NEODC (Figure 12) provide access to service results via a WCS.

Figure 12: NEODC Landsat data distribution via WCS

Figure 13 presents the SSE concept for data access and data distribution using FTP, for a simple case where a service "A" is "ordered" by the user which consists of a "chain" of two other services, called "S1" at VITO and "S2" at GIM. Data access

and data distribution for the simpler case (without workflow), where a service "S1" is called works in a similar way.

The process comprises the steps below. The numbers refer to the numbers indicated on the figure above.

1. The user accesses the SSE Portal to find the service or data service he is interested in. He can for that use the service directory where the services are organised according to service categories and subcategories. The user sees the detailed service page, fills in the necessary service parameters to order the service "A".

2. The workflow engine which is part of the SSE infrastructure knows that the service requires the "ordering" of a first service S1 at service provider "VITO", and forwards the ordering information (as XML payload of a SOAP message) to the service provider concerned.

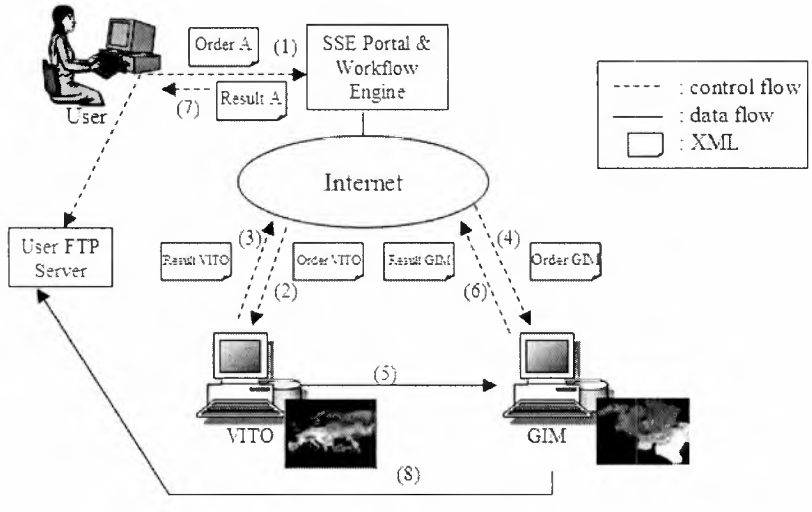


Figure 13: Control flow and data flow for a chained service.

3. The service provider receives the order and decodes it. He then performs the required processing. When the processing is done he sends back the order result, in this case a message indicating where the order result can be downloaded from (e.g. FTP address) to the SSE Portal. Please note that data services may not require any processing, but should only return the FTP address of the data ordered. If the size of the data is small, then the data can be contained in the XML message itself.

4. The SSE workflow engine knows that the next step in the process is the ordering of the second service S2 at GIM, which may use as input the

output of S1, and some information contained in the original order "A". The order information is sent to the corresponding service/data provider.

5. As the output of the previous step of the chain is required as input for this service, these data are downloaded from the S1 (VITO) FTP server. The service provider finds this address and possibly also the user name and password required to access the data in the order information XML message.

6. When the service provider has completed the processing, he sends back the service result of service S2 (GIM) to the SSE workflow engine.

7. The SSE workflow engine knows that the service "A" is now completed, and sends the service result to the end user.

8. The user can see that the result is available in his order list on the SSE Portal, or gets notified by email that the result is available. He can then see the result on the Portal, or in case of large data use the URL contained in the result message to download the result from the FTP server (from the last service provider in the chain).

The SSE Portal does not archive the actual data, and the SSE server is not responsible for data archiving. Data flow does not pass via the Portal, except for data that is included in the SOAP XML payload. These XML payloads are archived. The data that is referred to from inside the XML messages, e.g. via an FTP address resides at the service provider and is not archived by the SSE Portal.

COMPONENT DESCRIPTION

The SSE system consists of two central servers called "SSE Portal server" and "AOI server" which together implement the SSE Portal with which the end-user interacts. The SSE Portal communicates with remote services via the Toolbox, and with OGC compliant WMS [RD11], WFS [RD12] and WCS [RD13] servers for visualisation of layers and distribution of data. An off-line tool, the workflow editor is made available to service providers to model service workflows. The main components are described in more detail in the following sections.

SSE Portal Server

The infrastructure is based on a J2EE Application server. A J2EE-based architecture is a component-based architecture for enterprise applications that brings a lot of benefits for applications such as SSE:

- Simplified architecture and development,
- Scalability to meet demand variations,
- Integration with existing information systems,
- Choices of servers, tools, components,
- Flexible security model,
- Support for standard protocols and languages,
- Portability of components without recompilation.

These characteristics were essential for a successful implementation of the infrastructure. The SSE Portal user interface is implemented using JavaServer Pages technology and the Apache Struts framework.

We have selected the open-source JBoss application server (http://www.jboss.org). The application server runs on Linux Redhat.

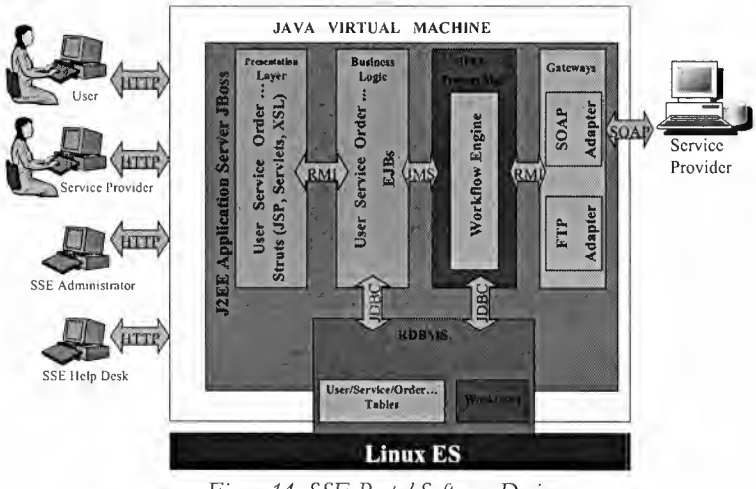
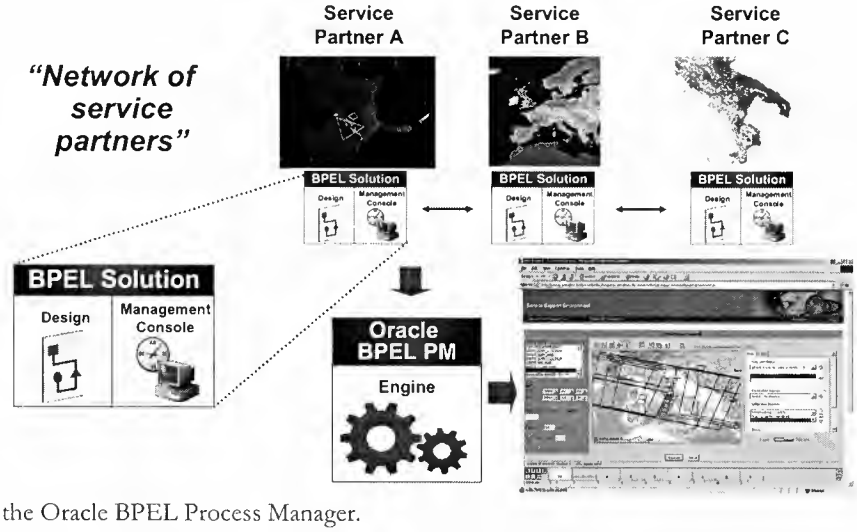


Figure 14: SSE Portal Software Design

The core of the SSE Portal is the workflow engine. The workflow engine is the component executing the workflows within a Service-Oriented Architecture. It executes business processes based on the Business Process Execution Language for Web Services (BPEL) standard. When the Portal goes down, and comes back up, active workflow instances are resumed automatically. The workflow engine utilises the RDBMS for workflow persistency. The workflow engine is implemented with



the Oracle BPEL Process Manager.

Figure 15: SSE Network of Service Partners

SSE provides a workflow management console (See *Figure 16*), that can be used by each service provider belonging to the SSE "Network of service providers" to monitor execution of his workflows. This tool is Web-based and integrated in the SSE Portal. It gives the service provider a complete overview of active workflows (top) and completed flows (bottom), gives access to all input and output messages. In addition, it allows the service provider to deploy new workflows he has prepared off-line with the workflow editor.

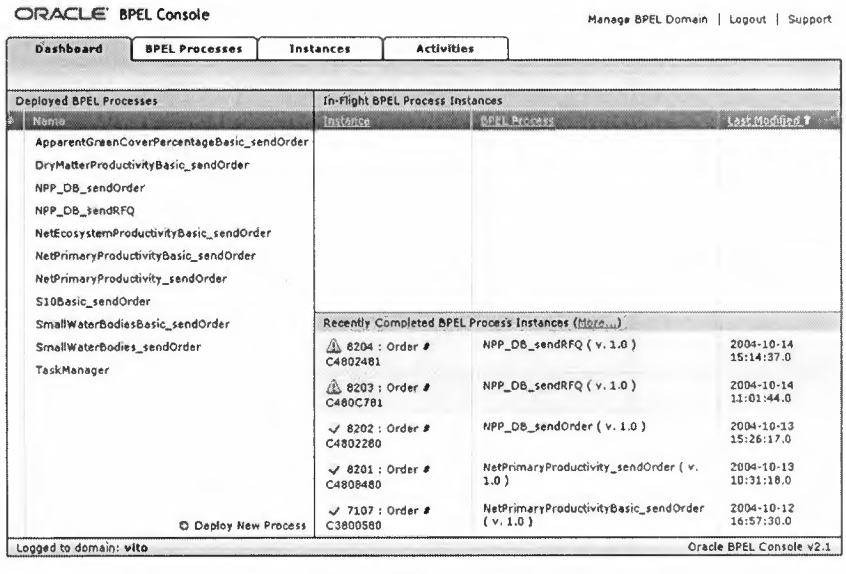


Figure 16: SSE Workflow Monitoring Application

The SSE Infrastructure uses the following open protocols and standards for its internal interfaces. Please refer to the SSE ICD [RD16] for an in depth description of the application of these protocols and standards.

- The user connects to the SSE Portal via a Web browser. HTTP and HTTPS (using certificates) are supported. The user registration for instance is done via HTTPS to keep the user information confidential. FTP is used by the user in case he has to download or upload large amounts of data as input or output of a service.
- The Business Process Execution Language (BPEL) [RD7] is currently being standardised by Oasis. It provides a vendor independent format to orchestrate web services. The workflows tools, i.e. workflow editor, workflow engine and workflow monitoring console use this open standard.
- Message-based SOAP (Simple Object Access Protocol) [RD4] over HTTP or HTTPS for secure communication is used as protocol between the SSE Portal and the service providers. In some cases, this may be simplified and FTP or (structured) email communication may be used instead. SOAP is firewall-friendly, and platform independent. It is thus well-suited to integrate services in a heterogeneous environment.

- WSDL (Web Services Description Language) 1.1 [RD6] is used to define the SOAP interface of a service in a formal way that can be processed by the workflow editor. It is equivalent to CORBA IDL.
- XML Schema (from W3C) is used by the Service provider to define the structure of the RFQ and Order input and output XML messages. The SSE Portal provides a predefined XML schema. However, some service may have service specific input/output parameters that the service provider can then model by providing an XML schema. When registering his service on the Portal, the service provider gives the URL of the XML schema (and WSDL file) which are then uploaded by the SSE Portal. We refer to the SSE ICD [RD16] for a more detailed description of the use of XML Schema.
- XSLT [RD3] (from W3C) is used by the SSE Portal to render RFQ and service outputs as HTML on the SSE Portal. XSLT is also used to render the data entry forms.
- XPath (from W3C) defines "expression" notation allowing to extract an element from an XML (DOM) object. It is used to extract information from XML messages inside workflows.
- Open Geospatial GML (Geography Markup Language) [RD10] is used where needed to encode geolocation information.
- Ws-inspection [RD9] is used to allow for service discovery. The workflow editor can discover the services and associated XML schemas which are deployed on the SSE via a WSIL file published on the SSE Portal.
- Ws-addressing [RD8] is used to correlate asynchronous message exchanges in a standard way instead of an ad-hoc content-based mechanism.
- The usage of ws-security standards is still to be analysed.
- SSE news items will be made available in RDF Site Summary (RSS) [RD14] format for easy integration in news aggregators.
- The on-line help system is provided as an Eclipse Infocenter [RD31] plugin which uses an XML notation to define the structure of the HTML documentation.

The figure below is a refinement of Figure 6. It shows the various building blocks of the SSE Portal (middle), and the AOI Server (right). The AOI Server is discussed in more detail in the next section. The SSE Toolbox (left) is shown as a single block. It is decomposed in components in a similar way in Figure 23.

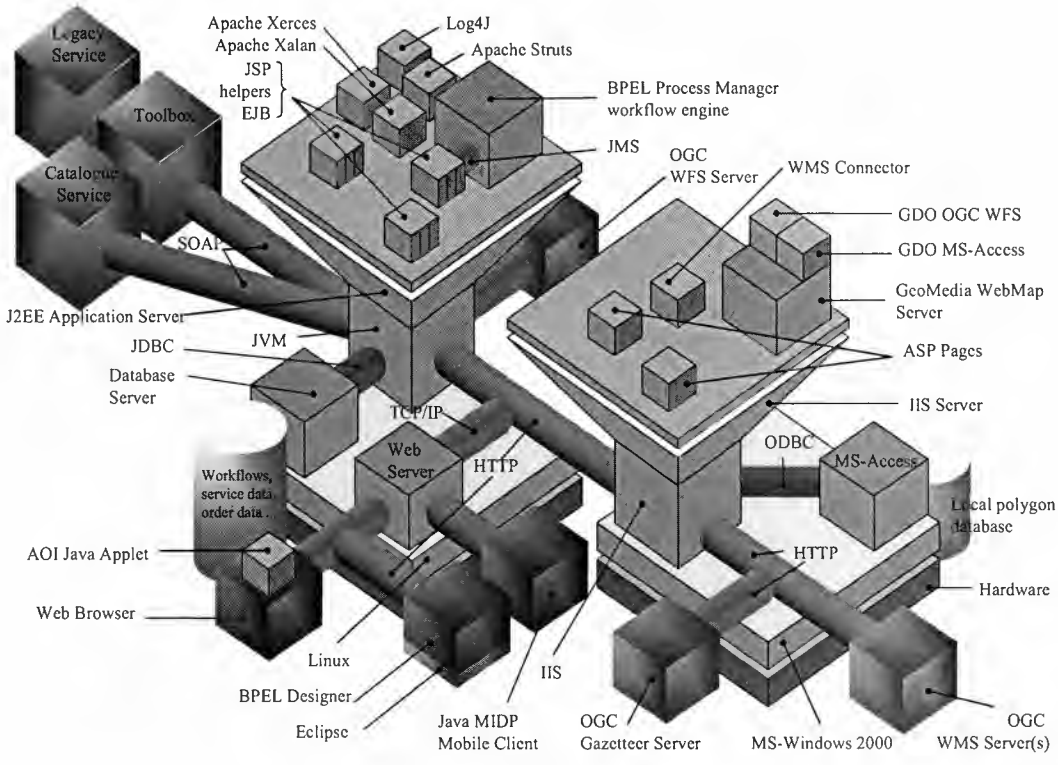


Figure 17: SSE Portal Server and AOI Server Component View

SSE AOI Server

The "SSE AOI server" is a Windows 2000 machine which is tightly integrated with the SSE Portal via HTTP. In fact, it is designed to be able to communicate with multiple "SSE Portals" simultaneously.

The main component of the software is the Geomedia WebMap GIS tool from Intergraph.

It allows a service provider to configure the area of interest (AOI) selection for his service and offers functions to select an area of interest and visualise service results on maps. Both functionalities are explained in more detail in subsequent subsections.

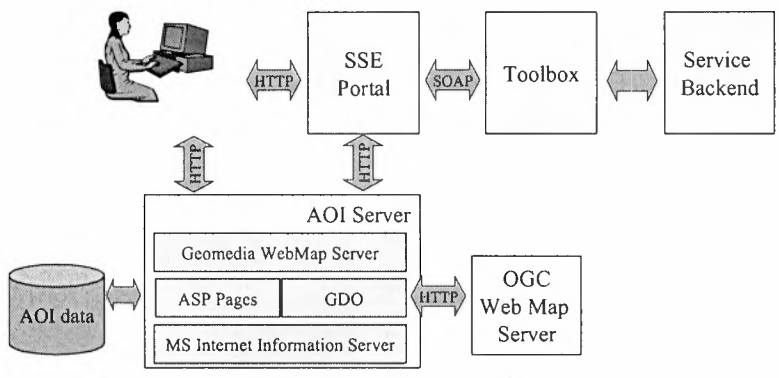


Figure 18: AOI Server Design

Area of Interest Selection

As many Earth Observation services require as input the definition of a geographical area, the SSE Portal provides special support for this. This allows for a consistent approach across services.

At service registration time, the service provider can choose to use or not the AOI tool (i.e. an applet residing on the AOI server). He can configure his service in various ways.

The area within which the user should select the AOI can be limited, and the selection methods that the user will be presented with can be limited. In the most general case, the user will be able to select it from a list, to select it on a map, to enter a bounding box using coordinates, draw a polygon on a map or upload a file defining the AOI. The service provider also configures the elements that describe the AOI: label, code, bounding box and/or polygon co-ordinates.

When the user "orders" the corresponding service, the SSE Portal uses the applet downloaded from the "AOI server" to present a graphical user interface to the user corresponding to the selection methods defined by the service provider. This AOI selection component generates a description of the AOI in the Open Geospatial GML (Geography Markup Language) [RD10] format. These descriptions are automatically included in the SOAP message payloads sent to the service provider by the SSE server.

The mapping interface of the AOI tool takes advantage of the opportunities offered by the OGC WMS [RD11] services. Instead of using locally stored information, the SSE allows connecting to OGC WMS compliant servers that offer world-wide mapping services. While the SSE AOI tool already offers a number of WMS background layers, users can add additional WMS layers which are specific to their domain and which make it easier to define accurately an area of interest.

The user can store and retrieve personal OGC Web Map Context (WMC) [RD29] files containing WMS services and layers to be displayed as background of the Web Map Viewer. The WMC files are stored on his local machine.

The AOI tool uses a gazetteer interface based on the Alexandria Digital Library gazetteer service protocol V1.2 protocol [RD30] to allow for user-friendly selection of area of interest for instance based on names of cities or regions.

Viewing of Service Results on Maps

Users can use this functionality to view SSE service results on top of layers served by Open Geospatial-compliant Web Mapping Servers. *Figure 19* shows an example where a fire risk map is overlaid with layers providing additional information. The resulting products are useful for producing vulnerability maps, hazard maps, rescue resources map, crisis map etc.

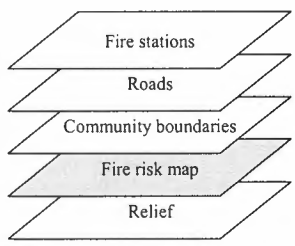


Figure 19: Viewing service results combined with external map layers

To be able to use this functionality, the service results must be made available to the SSE in GML [RD10] or Shape file format, as defined in the SSE ICD [RD16]. *Figure 20* and Figure 21 show how this applet is integrated in the SSE Portal to visualise the result of a ship detection and tidal current service. The features (e.g. ships) on the map can be selected with the mouse and the user can visualise its attributes. The service provider can define which attributes should be attached to a feature.

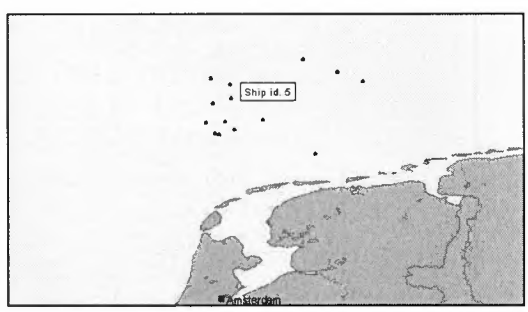


Figure 20: Result of the Ship Detection service using the SSE Web Map Client

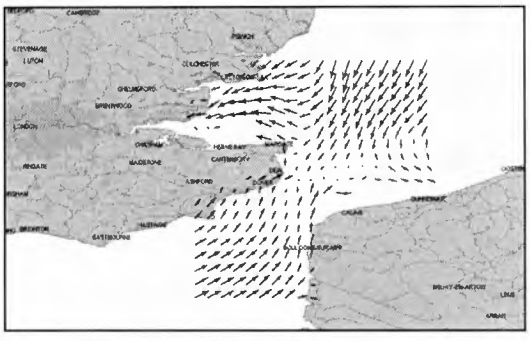


Figure 21: Result of tidal current service

The same GML format is used to visualise footprints of catalogue search results on a map.

All services integrated in the SSE can take advantage of this functionality if they respect the constraints defined in the SSE ICD [RD16].

WFS and WCS Server

Other future activities of SSE in the domain of OGC interoperability are related to the use of Web Feature Services (WFS) [RD12] and Web Coverage Services (WCS) [RD13]. Unlike Web Mapping services, which are about publishing "maps" - a "visual representation" of geospatial data - Web Feature and Web Coverage services allow for sharing the geospatial data itself. Web Features services publish geographic features that contain "geometry" (represented by points, lines or polygons), while Web Coverage services give access to grid-like data such as imagery, scanned maps and digital elevation data.

The SSE wants to set up a Web Feature Server where Service Providers can publish their service results. End-users will be able to access the information directly via WFS-compliant GIS clients. Most GIS software vendors are currently adding WFS functionality to their packages, this means that end-users can use their traditional GIS software to work with SSE service results, without having to download and convert the data.

The Web Coverage Service specification is a very important one in the domain of EO services, as it will allow on-demand, user-specific access to remote sensing and multi-dimensional data. In combination with Catalogues, this specification will become a very powerful instrument to ensure interoperability between Service Providers, and thus the chaining of services. Future activities include setting up prototype services that make use of WCS services.

Some services available in the SSE, e.g. NEODC's Landsat data service, already allow for data distribution via WCS (See Figure 22).

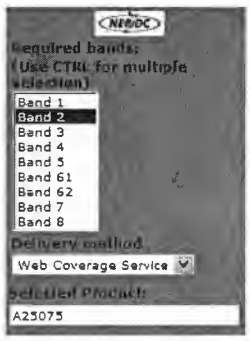


Figure 22: NEODC Landsat service using WCS

It is still to be decided whether the SSE will have a separate WFS and WCS server or whether the SSE should only interface with the existing WFS/WCS infrastructure at ESRIN.

SSE Toolbox

The SSE Portal connects to different EO and GIS services over the Internet using SOAP over HTTP or HTTPS, as specified in the SSE ICD [RD16].

The SSE Toolbox can be installed locally at the service provider's site to facilitate integration with the SSE. It runs on any platform which has a Java Virtual Machine installed. All toolbox components are freely available software. Its main components are depicted on *Figure 23*.

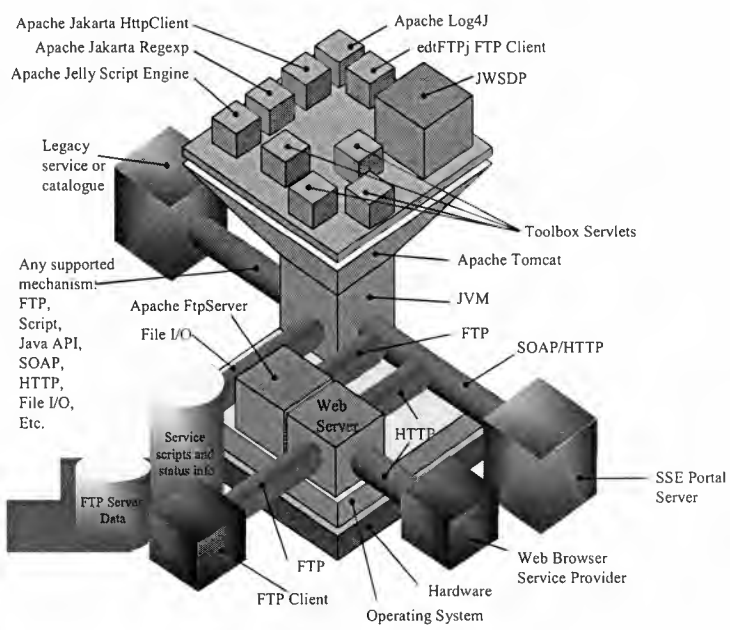


Figure 23: SSE Toolbox Component View

The Toolbox supports "out-of-the-box" a number of mechanisms to connect with the service backend, such as scripting, FTP, Java API, JDBC, SOAP etc. *Figure 24*

shows the internal structure of the Toolbox. For more design details, we refer to the Toolbox' specification document.

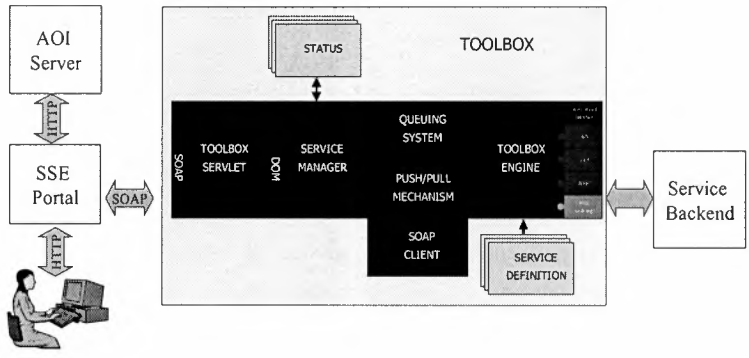


Figure 24: SSE Toolbox Design

When using the Toolbox, the complexity of integrating a service in the SSE system is reduced to the creation of a "toolbox script".

A rich Toolbox XML scripting language is available supporting the above mentioned integration mechanisms. It is the intention to also support the use of the Jelly (http://jakarta.apache.org/commons/jelly/) scripting language in the near future.

The current Toolbox XML scripting language provides a set of tags (about one hundred) that can be composed in a very flexible and powerful fashion, allowing to define the operation needed to implement the service on the backside when a Search, Present, RFQ or an Order operation is received by the SOAP layer. The tags can be grouped into three main categories:

- Flow control: a set of tags supporting standard programming language techniques (variables, flow control, modularity, etc ...), moreover it allows using the full potential of any available Java library.
- Communication: a set of tags allowing the communication between the Toolbox and the service resources (e.g. FTP, HTTP, file exchange, script call, method invocation).
- Data manipulation: a set of tags allowing the extraction of information from the XML file exchanged with the SSE and the XML or text files exchanged with the service resources

The base data manipulation mechanisms offered by the Toolbox are based on XSLT transformations, XPath extraction, text navigation and information extraction (e.g. find, extract, replace), XML templates with variable parts (to build the response).

The Toolbox is an open-source application and can be downloaded from the SSE Portal.

SSE Workflow Editor

The service provider can download the workflow editing tool (See *Figure 25*) from the SSE Portal. It is based on the Eclipse environment and does not require a license. The service provider can use it to define a complex service, i.e. a chaining of services available on the SSE Portal. The tool exports the defined workflow in the Business Process Execution Language (BPEL) [RD7].

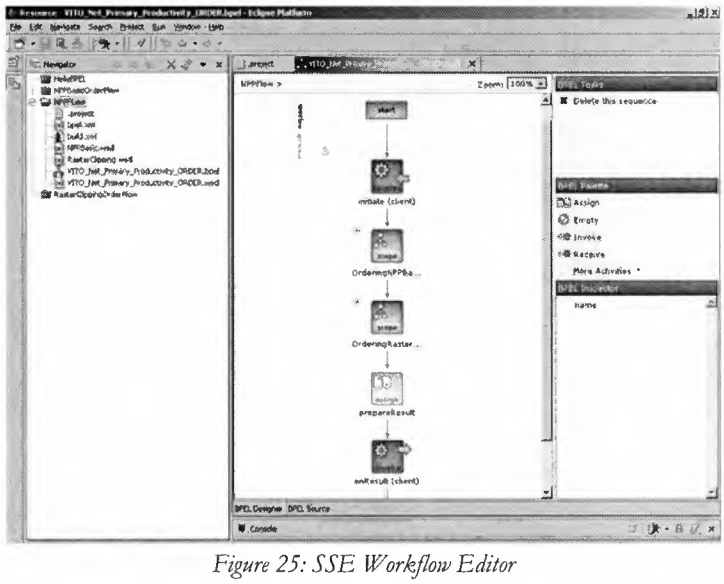


Figure 25: SSE Workflow Editor

The workflow editor connects to a SSE Portal to discover the services available on the Portal. A ws-inspection [RD9] repository on the Portal points to the various WSDL and XML schema files defining the various services. The workflow editor interprets these files and allows the service provider to easily add invocations of these services using a graphical interface.

OPEN DESIGN BASED ON STANDARDS

To meet its design objective as an open, extensible and scalable service integration platform, the SSE environment is based on a series of standards. As described in the previous chapters, the adoption of these standards allows for the integration of heterogeneous service provider environments with a minimum of effort. The current chapter summarises the standards supporting the design presented in the previous chapters. The chapter ends with an overview of additional standards that might be supported in the near future.

Java Standards

The design of the SSE central server is based on widely supported Java-related standards defined by Sun Microsystems and the Java Community Process (www.jcp.org). Besides being platform-neutral, these standards allow for a design integrating COTS tools as well as open-source software seamlessly without being locked in a vendor-specific solution. COTS tools such as application server,

RDBMS or workflow engine may be replaced with equivalent COTS tools or open-source components without impact on the design.

- The SSE server design is based on a Java 2 Enterprise Edition (J2EE) Application server. A J2EE-based architecture is a component-based architecture for enterprise applications, which is highly scaleable and platform independent. Application servers implementing this specification are available from many vendors (e.g. BEA, IBM, Oracle etc.), or are available as open-source software (e.g. JBoss, Apache Geronimo etc.). The SSE server software has been shown to run on BEA WebLogic, JBoss and RedHat Linux, Solaris as well as Windows 2000.
- Java ServerPages (JSP) technology is used to implement the presentation layer of the application. The Apache Struts framework was used in addition. This framework is a major input for an emerging Java ServerFaces specification which is currently being defined by Sun Microsystems. We may support this specification when implementations become available.
- The Java Message Service (JMS) API is an asynchronous communication mechanism that the SSE business logic uses to communicate with the workflow engine. It would in principle allow for the workflow engine to be run on a dedicated server.
- A Java Database Connectivity (JDBC) interface between the SSE software and the RDBMS which implements the object persistency allows for easy replacement of the RDBMS component.
- The AOI and Map viewer interface, which is also used as part of the catalogue search interface, is implemented as a Java applet. The user needs to install the Java plugin 1.4.2 from Sun Microsystems to use this applet in his Web browser. This Java applet solution is more portable than the ActiveX solution used during the early stages of the project.
- A mobile application was developed using the Mobile Information Device Profile (MIDP 1.0) specification which is part of the Java 2 Micro Edition (J2ME) platform. This prototype application allows a registered user to consult his SSE order list on a mobile device such as a mobile phone.

World Wide Web Standards

The World Wide Web Consortium (www.w3c.org) has published several recommendations which are used extensively:

- XML [RD2] and derived standards are used extensively in the SSE design: for communication (WSDL, SOAP, XML Schema, XML), workflow definition (BPEL), data transformation (XSLT, XPath), geographic information representation (GML), toolbox scripting etc. These specific XML vocabularies are described separately below.

- Message-based SOAP (Simple Object Access Protocol) [RD4] over HTTP or HTTPS for secure communication is used as protocol between the SSE Portal and the service providers. In some cases, this may be simplified and FTP or (structured) email communication may be used instead. SOAP is firewall-friendly, and platform independent. It is thus well-suited to integrate services in a heterogeneous environment.
- WSDL (Web Services Description Language) 1.1 [RD6] is used to define the SOAP interface of the SSE services in a formal way that can be processed by the workflow editor. It is equivalent to a CORBA IDL.
- XML Schema is used by the Service provider to define the structure of the RFQ and Order input and output XML messages. The SSE Portal provides a predefined XML schema. However, some service may have service specific input/output parameters that the service provider can then model by providing an XML schema. When registering his service on the Portal, the service provider gives the URL of the XML schema (and WSDL file) which are then uploaded by the SSE Portal. We refer to the SSE ICD [RD16] for a more detailed description of the use of XML Schema.
- XSLT [RD3] is used by the SSE Portal to render Search, Present, RFQ and service outputs as HTML on the SSE Portal. XSLT is also used to render the data entry forms. The XSLT stylesheet to be applied for a service is supplied by the service provider.
- Cascading Stylesheets (CSS) [RD22] allow for the presentation of various style elements, e.g. fonts, colours, sizes etc. on the Portal to be defined in a single location. By using similar CSS stylesheets being used by ESA's EO Portal (www.eoportal.org) where possible, we can have a SSE Portal user interface which is almost identical to the one of the main EO Portal.
- Scalable Vector Graphics (SVG) [RD23] technology is used to present vector graphics on the Portal in a portable way. The timeline shown on the catalogue search interface and the different bar charts, pie charts etc. generated from the service order data are presented as SVG objects.
- XPath [RD24] defines an "expression" notation allowing to extract an element from an XML (DOM) object. It is used to extract information from XML messages inside workflows.
- The SSE user connects to the SSE Portal via a Web browser. HTTP and HTTPS (using certificates) are supported. The user registration for instance is done via HTTPS to keep the user information confidential. FTP is used by the user in case he has to download or upload large amounts of data as input or output of a service. The HTTP specification is controlled by the Internet Engineering Task Force (http://www.ietf.org/).

- SSE news items are made available in RDF Site Summary [RD14] format for easy integration in news aggregators and RSS-aware Web browsers such as Mozilla Firefox. The RSS version is configurable by the SSE administrator.
- XHTML [RD19] will be used in a future version of the Portal Web pages to facilitate access to the SSE Portal from mobile clients.

Emerging Web Service Standards

To reduce the dependency on a particular workflow tool and make asynchronous communication and service discovery application independent, we also applied the following emerging standards:

- The Business Process Execution Language (BPEL) [RD7] driven by the OASIS standards body provides a vendor-independent XML-based format to model service workflows. The SSE workflow tools, i.e. workflow editor, workflow engine and workflow monitoring console use this open standard. BPEL has the support of major infrastructure and application vendors such as Oracle, Microsoft, IBM, SAP, and Siebel. Software (i.e. workflows) developed using this language is thus reusable if the workflow engine or workflow editing tool would be replaced.
- Ws-addressing [RD8] is used to correlate asynchronous message exchanges in a standard way instead of an ad-hoc content-based mechanism. Ws-addressing is being standardized by the W3C Consortium.
- Ws-inspection [RD9] is used for service discovery. The workflow editor can discover the services and associated XML schemas which are deployed on the SSE via a WSIL file published on the SSE Portal.

Also the following standards are currently being analysed:

- It is our intention to apply the ws-security standard when tool support becomes available (TBC).
- The Web services Interoperability Basic Profile 1.0 (WS-I) by ws-i.org is a set of guidelines and conventions which aim to improve interoperability of the web services standards such as WSDL, SOAP, XML, XML Schema and HTTP. The SSE workflow component supports the WS-I Basic Profile 1.0a [RD25] with the exception of the RPC encoding which is not used in the SSE design.

Open Geospatial Standards

As explained above, the SSE is a service integration framework for Earth Observation and GIS services. Therefore, the Open Geospatial specifications by the Open Geospatial Consortium or OGC (www.opengeospatial.org) are of particular importance.

- Open Geospatial GML 2.0 (Geography Markup Language) [RD10] is used where needed to encode geolocation information. Area of interest information defined by the user is encoded in this XML format and automatically included in the SOAP messages before being sent to the service provider. Service providers can also return service result information in this format which is then visualised by the SSE Portal combined with WMS map layers. The SSE will support the richer GML 3.0 as soon as the Intergraph Geomedia WebMap software supports it.
- The adoption of the Web Mapping Services (WMS 1.0.0 and 1.1.0) specification [RD11] allows the user to select an area of interest on top of a map served by an external WMS server or to visualise service results with a location component (e.g. oil spills, ships, satellite image footprints etc.) combined with various map layers. Many organisation maintain WMS servers which are publicly available, for instance:
  - Canada Centre for Remote Sensing WMS server
  - DEMIS World Map Server
  - ESA WMS Server

The SSE Portal does not expose WMS interfaces, but uses the WMS interfaces published by external servers on the Internet. It is thus not a WMS server, but a WMS client.

- The SSE will be able to publish service result data in vector format on an Open Geospatial WFS server as described in section 3.3.
- The SSE will be able to publish service result data in raster format on an Open Geospatial WCS server as described in section 3.3.
- The AOI selection tool allows a user to define an area of interest by selecting a place name. The SSE therefore allows interfacing to any gazetteer server compliant with the Alexandria Digital Library gazetteer service protocol V1.2 protocol [RD30] (See section 3.2.1).
- The user is be able to store and retrieve personal OGC Web Map Context (WMC) [RD29] files containing WMS services and layers to be displayed as background of the Web Map Viewer. The WMC files are stored on his local machine.

ESRIN Internal Standards

ESRIN is developing internally SOAP interface definitions for catalogue searching and an XML message structure for on-line ordering. For consistency, the SSE support these (still evolving) ESRIN 'standards":

- The ESRIN EOLI XML ICD [RD18] defines a stateless catalogue interface protocol based on SOAP. It was originally developed for the ESA Multi-Mission catalogue MUIS. The message structure is based on

the ISO standard [RD27] and [RD28]. The SSE Portal is able to connect to catalogues supporting version 1.7 of this protocol in two different ways:

- Indirectly (e.g. via the Toolbox): in this variant, the SOAP messages exchanged with the remote catalogue for "search" and "present" contain as submessage these defined in the EOLI XML ICD, but extend them with additional information. In the search request, the AOI is added in GML format which allow for AOI defined as one or more polygons, instead of the simple bounding box defined by the EOLI XML ICD. The search response contains also additional information such as a reference to a GML file with image attributes and footprints.
- Directly: in this variant, the SOAP messages exchanged with the remote catalogue for "search" and "present" operations are identical to these defined in the EOLI XML ICD.

ESRIN might harmonise this interface with the Open Geospatial stateless catalogue interface specification 2.0 which was recently released by the OGC.

- ESRIN is currently developing a (satellite image) ordering SOAP interface. Service providers using the current SSE Portal can choose to include ordering data organised according to the ESRIN eoli.xsd schema in the messages exchanged with the SSE Portal.

CONCLUSION

The Service Support Environment described in this paper provides an overarching infrastructure neutrally managed by the European Space Agency which is easily extensible in response to service partner requirements.

It empowers service partners by providing them a rich business process management platform allowing them to automate and integrate their business processes (i.e. services) with partner service provider processes. Full visibility in the running processes is achieved through in-flight process activity monitoring.

Service providers maintain full control on their own IT infrastructure and intellectual property rights (IPR). Through the use of open, simple, standard technologies, the SSE allows its service partners to easily integrate their services, in a cost-effective way with minimal upfront investment.

The Service Support Environment is pre-operational since October 2004 and available at http://services.eoportal.org. As of December 2004, over 20 service partners from 10 countries have made services and applications accessible through this environment covering various subjects such as multi-catalogue access, on-line data access, oil spill detection, fire risk, Kyoto protocol verification, desert locust, land use, snow cover, tidal currents, etc.

REFERENCES

[RD1] INSPIRE Architecture and Standards Position Paper http://inspire.jrc.it/reports/position_papers/inspire_ast_pp_v4_3_en.pdf.

[RD2] Extensible Markup Language (XML) 1.0, W3C Recommendation 10 February 1998, www.w3.org/TR/REC-xml.

[RD3] XSL Transformations (XSLT) Version 1.0, W3C Recommendation 16 November 1999, www.w3.org/TR/xslt.

[RD4] Simple Object Access Protocol (SOAP) 1.1, W3C Note 08 May 2000, http://www.w3.org/TR/2000/NOTE-SOAP-20000508/

[RD5] Hypertext Transfer Protocol -- HTTP/1.1, RFC 2616, U.C. Irvine, DEC W3C/MIT, DEC, W3C/MIT, W3C/MIT, January 1997, http://www.normos.org/ietf/rfc/rfc2616.txt

[RD6] Web Services Description Language (WSDL) 1.1, W3C Note 15 March 2001, http://www.w3.org/TR/wsdl

[RD7] Business Process Execution Language for Web Services, Version 1.0, 31 July 2002, http://www-106.ibm.com/developerworks/webservices/library/ws-bpel1/

[RD8] Web services addressing, ws-addressing, 13 March 2003, ftp://www6.software.ibm.com/software/developer/library/ws-addressing.pdf

[RD9] An overview of the Web Service Inspection Language, IBM developerWorks, June 2002, http://www-106.ibm.com/developerworks/library/ws-wsilover/

[RD10] Geography Markup Language (GML) 2.0, Open Geospatial Implementation Specification, 20 February 2001, OGC Document Number 01-029, http://www.Open Geospatial.net/gml/01-029/GML2.html and http://Open Geospatial.net/schema.htm.

[RD11] Open Geospatial Web Map Service (WMS), Version 1.1.1, 27/11/2001, http://www.Open Geospatial.org/docs/01-068r2.pdf.

[RD12] Open Geospatial Web Feature Service (WFS) Implementation Specification, Version 1.0.0, 19/09/2002, http://www.Open Geospatial.org/docs/02-058.pdf.

[RD13] Open Geospatial Web Coverage Service (WCS), Version 1.0.0, 27/08/2003, http://www.Open Geospatial.org/docs/03-065r6.pdf

[RD14] An Introduction to RSS news feeds, IBM DeveloperWorks, November 2000, http://www-106.ibm.com/developerworks/web/library/w-rss.html?ca=dnt-416

[RD15] Internet Assigned Number Authority, Port Numbers, http://www.iana.org/assignments/port-numbers superseding http://www.ietf.org/rfc/rfc1700.txt.

[RD16] Interface Control Document for Multi-Application Support Service System Environment, ME-ICD-0001-SPB. Available from the ESA RTD Web site

http://earth.esa.int/rtd/Documents.

[RD17] "Earth Observation and GIS Services Integration Approach in MASS", Proceedings of DASIA 2003, Prague (Czech Republic), June 2003, http://www.eurospace.org/presentations_dasia2003/dasia2003_presentation_20.pdf and http://earth.esa.int/rtd/Articles/MASS_DASIA_2003.pdf

[RD18] Earthnet On-line XML Front-End Interface Control Document, EOLI-XML-006-ICD, Issue 1.7, 02/12/2003. Available from the ESA RTD Web site http://earth.esa.int/rtd/Documents.

[RD19] XHTML 1.0 The Extensible HyperText Markup Language, W3C Recommendation 26 January 2000, revised 1 August 2002, http://www.w3.org/TR/xhtml1/

[RD21] An Environment Supporting Earth Observation and GIS Service Orchestration: the MASS Project, IEEE Geoscience and Remote Sensing News Letter, December 2003, page 19-22, http://www.ewh.ieee.org/soc/grss/newsletter/grs1203_final.pdf.

[RD22] Cascading Style Sheets, Level 2, CSS2 Specification, W3C Recommendation 12 May 1998, http://www.w3.org/TR/CSS2/.

[RD23] Scalable Vector Graphics (SVG) 1.1 Specification, W3C Recommendation 14 January 2003, http://www.w3.org/TR/SVG11/.

[RD24] XML Path Language (XPath) 1.0 Specification, W3C Recommendation 16 November 1999, http://www.w3.org/TR/xpath.

[RD25] WS-I Basic Profile Version 1.0a Final Specification, Web Services Interoperability Organization, 08 August 2003, http://www.ws-i.org/Profiles/Basic/2003-08/BasicProfile-1.0a.htm.

[RD26] WS-I Usage Scenarios Final Specification Version 1.01 , Web Services Interoperability Organization, 09 December 2003, http://ws-i.org/SampleApplications/SupplyChainManagement/2003-12/UsageScenarios-1.01.pdf

[RD27] ISO/TC 211, Geographic information – Metadata, ISO/FDIS 19115, 23/01/2003.

[RD28] Content Standard for Digital Geospatial Metadata: Extensions for Remote Sensing Metadata, FGDC-STD-012-2002.

[RD29] Open Geospatial Web Map Context, Version 1.0.0, 12/06/2003, http://www.OpenGeospatial.org/docs/03-036r2.pdf.

[RD30] Alexandria Digital Library gazetteer service protocol, V1.2, http://www.alexandria.ucsb.edu/gazetteer/protocol/

[RD31] Help in the Integrated Solutions Console, 20 February 2004, ftp://www6.software.ibm.com/software/developer/library/ac-help.pdf

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