HMA Follow On. Task 2: Feasibility Analysis Service

(Sensor Planning Service)

HMA-FO Feasibility Analysis Service

USER REQUIREMENTS DOCUMENT

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1. INTRODUCTION

1.1. Purpose

This is the User Requirements Document (URD) for the HMA-FO project **Task 2: Feasibility Analysis Service (Sensor Planning Service).**

The requirements cover the work corresponding to an open source Sensor Feasibility Reference Environment (SFRE) that will be used by ESA for the testing and demonstration of the SPS Profile for Earth Observation OGC 07-018 [RD 1]. There are requirements applicable to SF Client and Server systems which send and receive programming requests for EO products to support access to data from heterogeneous systems dealing with derived data products from satellite based measurements of the earth's surface and environment. Requirements have been sourced from Operational Scenarios Technical Note [RD 8], and the HMA-FO Statement of Work [AD 1] and the consortium's proposal [RD 7].

The document contains:

Functional and performance requirements for the SF client and server systems

Interface requirements

1.2. Scope

This document is produced as part of the Requirements Baseline that shall be subject to review at PM1. Therefore, it is applicable to the project from PM1 onwards. Following this there will be a Software Requirements Document (SRD) produced which will contain a functional decomposition, and software requirements. The SRD will also have forward and backward traceability matrices between the requirements listed in this document and it's software requirements.

2. RELATED DOCUMENTS

2.1. Applicable Documents

The following table specifies the applicable documents that shall be complied with during project development.

Table 1: Applicable documents

Reference	Code	Title	Issue
[AD 1]	SGSE-DFPR-EOPG-SW-08-0001	Statement of Work – HMA Follow on activities	1.2
[AD 2]	Appendix 3 to ESRIN/AO/1-5949/09/I-LG	Special Conditions Of Tender	-
[AD 3]	RES-POE/2009/34/LG/cb	Letter with the Invitation to Tender AO/1-5949/09/I-LG – HMA Follow On	-
[AD 4]	Appendix 2 to ESRIN/AO/1-5949/09/I-LG	Draft Contract – HMA Follow on activities	-
[AD 5]	ECSS-E-ST-40C	Software general requirements standard ECSS-E-ST-40C tailored to small software projects	-
[AD 6]	HMAFO-MOM-0001-SPB	Minutes of the negotiation meeting held at ESRIN on 24 June, 2009	-
[AD 7]	HMA-FO-DMS-PMD-PMP01-E-R	Project Management Plan	1.0

2.2. Reference Documents

The following table specifies the reference documents that shall be taken into account during project development.

Table 2: Reference documents

Reference	Code	Title	Issue
[RD 1]	OGC 07-018	OpenGIS® Sensor Planning Service Application Profile for Earth Observation	2.0
[RD 2]	OGC 09-000	OpenGIS® Sensor Planning Service Implementation Standard	2.0
[RD 3]	OGC 06-126	Compliance Test Language (CTL)	Draft 0.1
[RD 4]	WS-BaseNotification	Web Services Base Notification OASIS Standard	1.3

Reference	Code	Title	Issue
[RD 5]	OGC 05-008	OpenGIS® Web Services Common Specification	1.0
[RD 6]	HMAT-TN-0001-IGN	HMA-T Phase 2 Testing Policy	1.1
[RD 7]	HMA-FO-DMS-LTR-001	DEIMOS' proposal for HMA-FO Feasibility Analysis Service	13/03/2009
[RD 8]	HMA-TN-ASU-EN-0001	Operational Scenarios Technical Note	1.8

3. ACRONYMS, ABBREVIATIONS AND DEFINITIONS

3.1. Acronyms and Abbreviations

The acronyms and abbreviations used in this document are the following ones:

Acronym	Description
AD	Architectural Design
AR	Acceptance Review
ATS	Abstract Test Suite
CCN	Contract Change Notice
CDR	Critical Design Review
CFI	Customer Furnished Item
CITE	Compliance & Interoperability Testing & Evaluation Initiative
CM	Configuration Management
COTS	Commercial Off-The-Shelf
CPU	Central Processing Unit
CR	Change Record
CTL	Compliance Testing Language
CVS	Concurrent Versions System
DB	Data Base
DDD	Detailed Design Document
DDF	Design Definition File
DJF	Design Justification File
DMS	DEIMOS Space
ECSS	European Cooperation on Space Standardization
EO	Earth Observation
EO-DAIL	EO Data Access Integration Layer
EOEP	Earth Observation Envelope Programme
ESA	European Space Agency
ETS	Executable Test Suite
FP	Final Presentation
FTP	File Transfer Protocol
GMES	Global Monitoring for Environment and Security
GUI	Graphical User Interface
HMA	Heterogeneous Missions Accessibility
HMA-I	HMA Interoperability
HMA-T	HMA Testbed
HMI	Human Machine Interface

Acronym	Description
HW	Hardware
ICD	Interface Control Document
IDE	Integrated Development Environment
IPR	Intellectual Property Rights
ITT	Invitation to Tender
KOM	Kick-Off Meeting
N/A	Not Applicable
NCR	Non Conformance Report
OGC	Open Geospatial Consortium Inc.
OO	Object Oriented
PA	Product Assurance
PAP	Product Assurance Plan
PDR	Preliminary Design Review
PMAC	Payment Milestone Achievement Certificate
R&D	Research and Development
RB	Requirements Baseline
RID	Review Item Discrepancy
SFRE	Sensor Feasibility Reference Environment
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
SOW	Statement of Work
SPR	Software Problem Report
SR	Software Requirement(s)
SRD	Software Requirements Document
SVV	Software Verification and Validation
SW	Software
TBC	To Be Confirmed
TBD	To Be Defined
TS	Technical Specification
UML	Unified Modelling Language
WBS	Work Breakdown Structure
WP	Work Package
WPD	Work Package Description
XML	Extensible Markup Language
XSD	XML Schema Definition

4. GENERAL DESCRIPTION

4.1. HMA Project Background and Perspectives

In 2005 the Agency launched the Heterogeneous Missions Accessibility (HMA) project. The aim of the HMA project was to involve the stakeholders, namely national space agencies, satellite or mission owners and operators, in a harmonization and standardization process of their ground segment services and related interfaces.

HMA Follow On Activities cover 4 tasks related to completing specifications and creating implementations.

Task 2: Feasibility Analysis Service (Sensor Planning Service) includes the design, development, testing and documentation of an open source Sensor Feasibility Reference Environment (SFRE) that shall be used by ESA for the testing and demonstration of the OpenGIS® Sensor Planning Service Application Profile for EO Sensors (OGC 07-018) [RD 1] specification. To support uptake, demonstration and testing of the profile an open source implementation of both sides (ie client and server) is to be developed.

4.2. OGC Specification Background and Perspectives

The functionality that OCG has targeted within a sensor web includes:

Discovery of sensor systems, observations, and observation processes that meet our immediate needs

Determination of a sensor's capabilities and quality of measurements

Access to sensor parameters that automatically allow software to process and geolocate observations

Retrieval of real-time or time-series observations and coverages in standard encodings

Tasking of sensors to acquire observations of interest

Subscription to and publishing of alerts to be issued by sensors or sensor services based upon certain criteria

Within the SWE group, the enablement of such sensor web service is pursued through the establishment of several standard interface definitions. The services are the following:

1. **Observations & Measurements (O&M)** – The general models and XML encodings for observations and measurements made using sensors.
2. **Sensor Model Language (SensorML)** – standard models and XML Schema for describing the processes within sensor and observation processing systems; provides information needed for discovery, georeferencing, and processing of observations, as well as tasking sensors and simulations.
3. **Sensor Observation Service (SOS)** – An open interface for a service by which a client can obtain observations and sensor and platform descriptions from one or more sensors.
4. **Sensor Planning Service (SPS)** – An open interface for a service by which a client can
   - determine the feasibility of collecting data from one or more sensors or models

- submit collection requests to these sensors and configurable processes.

5. **Sensor Alert Service (SAS)** – An open interface for a web service for publishing of and subscribing to deliverable alerts from sensor or simulation systems.
6. **Web Notification Service (WNS)** – An open interface for a service by which a client may conduct asynchronous dialogues (message interchanges) with one or more other services.

The Sensor Planning Service Application Profile for Earth Observation in particular is concerned with:

1. Getting the list of parameters that can be specified for programming a specific sensor;
2. Verify the feasibility of the request that is going to be submitted;
3. Submit the request and then check its progress;
4. If necessary to cancel the submitted request;
5. Retrieve the sensor's acquired data.

This document, along with the updated OpenGIS® Sensor Planning Service Application Profile for Earth Observation [RD 1] specification, constitutes the Requirements Baseline for this Sensor Feasibility Reference Environment (SFRE). The version of this profile specification we shall implement is 2.0.

4.3. SFRE Function and Purpose

The main purpose of the SFRE is the implementation and testing of the interfaces to Sensor Planning Services dedicated to the EO Sensor domain complying with specification OGC 07-018.

The implementation of two different systems shall be carried out:

Sensor Feasibility Client (SF Client)

Sensor Feasibility Server (SF Server)

They will both support the full range of operations described in the specification. Note that user management/authorisation/authentication is not considered in scope for these systems. Requirements for the Sensor Feasibility Interface are relevant to both SF Client and Server.

4.4. SPS Interface Operations

The operations belonging to this interface are aimed at determining the feasibility of an intended sensor planning request, for submitting such a request, for inquiring about the status of such a request, for updating or cancelling such a request, and for requesting information about further OGC Web services that provide access to the data collected by the requested task.

Figure 4-1 shows the UML context diagram including all operations of the interfaces. The entities "SF Client" and "SF Server" refer to any software component that can invoke/be invoked to carry out an SPS operation. In particular the systems built in this project will support the full set of operations.

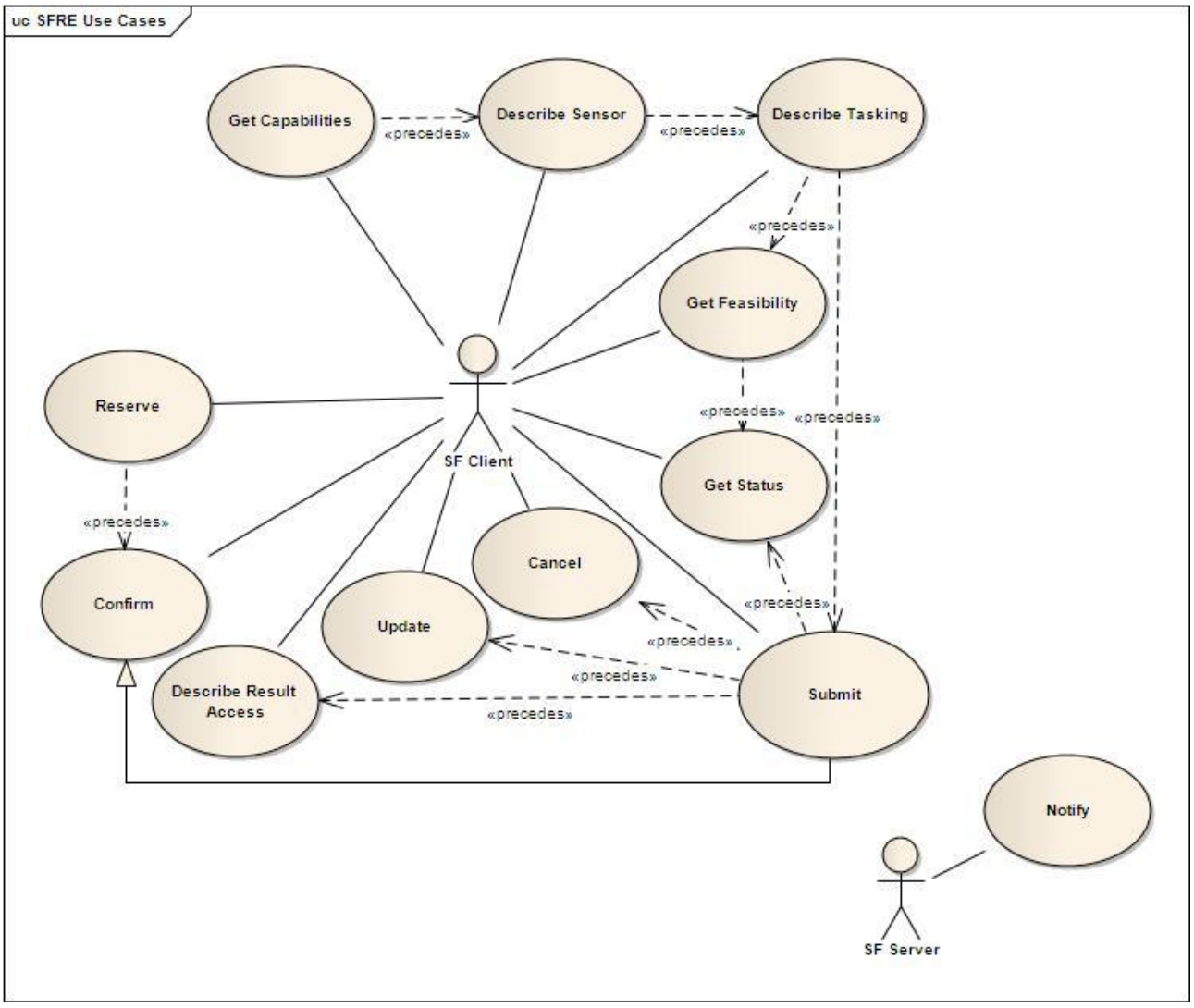

Figure 4-1: SPS interface use case diagram

The Use Cases above correspond to the Operations specified in the SPS EO application profile which can be requested by a client and performed by SF server. In addition, the triggering of notifications based on certain internal state changes of the SF Server are indicated.

The SPS EO application profile specifies 13 operations that can be requested by a SF Client and performed by a SF Server. Those operations are:

a) GetCapabilities – This operation allows a client to request and receive service metadata (or Capabilities) documents that describe the abilities of the specific server implementation. This operation also supports negotiation of the specification version being used for client-server interactions. Moreover, the content section of this operation contains the list of sensorID provided by the service.

b) DescribeSensor – This operation allows the client to obtain a description of the sensors supported by the current SPS. The mission can decide on the amount of details provided in such a description (The use of hyperlinks can help keep the initial document size small and simple while still allowing the client to go fetch more detailed information).

c) GetSensorAvailability (optional) – This operation provides information on the availability of the sensor.

d) Validate (optional) – Several acquisition attempts are sometimes necessary to obtain a satisfying result (case of optical satellites on zones with cloudy tendency for example). The Validate operation can be used by the customer to indicate to the server that an acquisition is satisfactory and thus to stop collecting new images for this area.

e) DescribeTasking – This operation allows a client to request the information that is needed in order to send GetFeasibility (for a feasibility study), Submit, Update and Reserve (for tasking the asset) requests. The response contains a description of the input (tasking parameters) and optionally the output parameters included in status reports.

f) GetFeasibility – This operation is to provide feedback to a client about the feasibility of a programming request. Depending on the sensor type offered by the SPS, the SPS server action may be as simple as checking that the request parameters are valid, and are consistent with certain business rules, or it may be a complex operation that calculates the usability of the sensor to perform a specific task at the defined location, time, orientation, calibration etc.

g) Submit – This operation submits the programming request. Dependent on the selected sensor, it may perform a simple modification of the sensor or start a complex mission.

h) GetStatus – This operation allows a client to receive information about the current status of the requested task. The response contains a progress report which content is defined by each service instance in the DescribeTasking response.

i) Cancel – This operation allows a client to request cancellation of a previously submitted task.

j) Update – This operation allows a client to update a previously submitted task.

k) DescribeResultAccess – This operation allows a client to retrieve information how and where data that was produced by the sensor can be accessed. The server response may contain links to any kind of data and not necessary through an OGC Web services nevertheless OGC Web services such as SOS, WMS, WFS or WCS are desirable.

l) Reserve – This operation reserves a task. A reservation lasts for a certain amount of time and can be committed during this timeframe.

m) Confirm – This operation is used to commit a reserved task. By committing a reserved task the SPS starts execution of the task.

The last two operations enable clients to reserve a task instead of directly submitting it. These operations have many similarities to other OGC® Web Services, including the WMS, WFS, and WCS. Many of these interface aspects that are common with other OWSs are thus specified in the OpenGIS® Web Services Common Implementation Specification [OGC 05-008] [RD 5].

The encoding of operation requests shall use HTTP GET with KVP encoding and HTTP POST with XML, SOAP, and/or KVP encoding as specified in [RD 5]. Some operations will need to support both methods, as detailed in the finalised SPS specifications ([RD 2] and [RD 1]).

The SFRE will support all the operations, and all methods for the operations.

4.5. SFRE Testing

A complete set of verification activities shall be performed upon the interfaces development.

Unit tests shall be designed, implemented and executed to test each individual software component composing the SPS and OP interfaces. Stubs shall be used in case of component interactions.

Integration tests shall be designed, implemented and executed to mainly verify the interfaces between software components.

Finally, **system tests** shall be designed, implemented and executed to validate the whole software.

It is to be noted, that these system tests are also to be used for the acceptance, where a subset of tests is selected for the testing. System tests shall be carried out following the same approach as the unit and integration testing. Thus, test procedures shall be written referencing the SPS specification, and they shall test the involved operations by setting the input conditions, invoking the operation(s) subject to the test and verifying its response or outputs produced.

Many (and possibly all) of the system tests for the SF Server will be encapsulated in the Abstract Test Suite written for the OpenGIS® Sensor Planning Service Application Profile for EO Sensors (OGC 07-018) [RD 1]. They will be carried out in an automated fashion using the associated Executable Test Suite.

4.6. Environmental Considerations

For the **SF Server development** the following environment shall be used:

Operating system: Linux.

Development language: Java using the JNI library for the interaction with the Earth Explorer CFI (written in C), or a native Java implementation of Earth Explorer CFI.

Essential libraries/software for the software development will be:

- Apache Tomcat webserver
- Axis2 SOAP framework
- XML libraries for reading/writing XML files

For the **SF Client development** the following environment shall be used:

- Operating System: Linux (Fedora 9)

Essential libraries / software for the SF Client development are:

- Apache Tomcat 6 webserver
- Axis2 SOAP framework
- XMLBeans for databinding
- Development language: Java 6.
- WorldWind Java library
- Google Web Toolkit

For Configuration Management the following software shall be used:

- CVS
- SubVersion

For **Project Management** the following software shall be used:

- Microsoft Project for planning and reporting of Project Management tasks.
- Microsoft Excel 2007 (Compatible with MS Excel 97-2003) for managing data such as RIDs

For **Documentation** the following software shall be used:

- Microsoft Word 2007 (Compatible with MS Word 97-2003) to generate the documentation.
- Adobe Acrobat (v7) to generate the PDF format to deliver the documentation via electronic media.

5. SYSTEM REQUIREMENTS BASELINE

5.1. Requirement Naming Conventions

The following conventions will be used for the derived system requirement naming:

All system requirements will be named as

REQ–XXX–NNNN/VER

where:

XXX represents the type of requirement, which for this document, are the following:

FUN – Functional

INT – Interfaces

PER – Performance

NNNN Is a number providing an ordering within each requirement type. It starts at 0010 and two consecutive requirements are increased in 10 to allow the introduction of additional requirements in later versions of the document.

VER Is the issue of this document where the requirement was introduced or last changed.

Each requirement is presented in a tabular form constituted by four fields:

1. System requirement identifier
2. Requirement title
3. Validation method for the requirement:
   - **Test** (T) – Execution of the element under certain conditions to check the outputs corresponding to particular inputs;
   - **Inspection** (I) – Exhaustive evaluation of the code by manual reading;
   - **Analysis** (A) – Deduction method applied to documentation, code, test results, etc; it is partially or totally automated;
   - **Review** (R) – Review of project documentation.
4. Requirement text. Where the requirement has been sourced from the Operational Scenarios Technical Note [RD 8] then the identifier is indicated in brackets and the text of the requirement repeated. Where there are any additional comments these are added as a "note" after the unchanged requirement text. The terminology of the requirements has been updated in order to avoid ambiguous term *Order* and make clear that the requirements cover Feasibility Analysis rather than Product/Coverage Ordering. For example, the term "HM Ordering Function" has been replaced with "SF Client" (Sensor Feasibility) and "the mission GS" with "SF Server".

5.2. Functional Requirements

REQ-FUN-0010/1.0 SPS Application Profile for EO T

The Sensor Feasibility Client and Server shall provide compliant implementation of the Feasibility Analysis Service operations following the OpenGIS® Sensor Planning Service Application Profile for EO Sensors (OGC 07-018) [RD 1] specification:

GetCapabilities (Mandatory)

DescribeSensor (Mandatory)

DescribeTasking (Mandatory)

GetFeasibility (Optional)

Submit (Mandatory)

GetStatus (Mandatory)

Cancel (Optional)

Update (Optional)

DescribeResultAccess (Mandatory)

Reserve (Optional)

Commit (Optional)

GetSensorAvailability (Optional)

Validate (Optional)

In case the SPS server encounters an error while performing one of its operations, it shall return an exception report message as specified in OpenGIS® Sensor Planning Service [RD 2].

(sourced from US3_1_GS_2422/Online Ordering)

The Sensor Feasibility interface shall offer an interface compliant with the agreed HMA standard.

REQ-FUN-0020/1.0 Feasibility Analysis Options retrieval T

(sourced from US3_1_GS_2419/Online Ordering)

The Sensor Feasibility interface shall provide a function to retrieve the options and parameters to provide for the Feasibility Analysis from a given product collection (US3_1_1, option 2).

REQ-FUN-0030/1.0 Feasibility Analysis Options semantics T

(sourced from US3_1_GS_2420/Online Ordering)

The Sensor Feasibility interface shall use an HMA agreed semantic to define its Feasibility Analysis options when interfacing with an HMA function.

REQ-FUN-0040/1.0 Feasibility Analysis assessment T

(sourced from US3_1_GS_2421/Online Ordering)

The Sensor Feasibility interface should provide a function to allow a user to assess an order prior to submitting it (ie a Feasibility Analysis). In case of failure of the assessment, the SF Server should provide a clear explanation of the rejection.

REQ-FUN-0050/1.0 SF Client repository of mission Feasibility Analysis options T

(sourced from US3_1_HM_2430/HM Ordering)

The SF Client shall keep a repository of mission GS's Feasibility Analysis options up-to-date by collecting the regular updates provided by the mission GS's. This repository shall be used to answer user requests for HM Feasibility Analysis options (US3_1_1, option 1).

Note: The options will be part of SF Client configuration and not dynamic or automatically updating.

REQ-FUN-0060/1.0 SF Client to access multiple missions T

(sourced from US3_1_HM_2431/HM Ordering)

The SF Client shall split a user request for Feasibility Analysis options into mission specific requests, send them to the respective mission GS's and collect the responses to answer the user request (US3_1_1, option 2).

Note: SF Client will not split automatically, it will allow the operator to choose which mission(s)

REQ-FUN-0070/1.0 Feasibility Analysis assessment prior to submission T

(sourced from US3_1_HM_2432/HM Ordering)

The SF Client interface shall provide a function to allow a user to assess a Feasibility Analysis prior to submitting it. In case of failure or part failure of the assessment, the SF Server should provide a clear explanation for the rejected parts.

REQ-FUN-0080/1.0 Feasibility Analysis using SPS specification T

(sourced from US3_1_HM_2433/HM Ordering)

The SF Client interface shall place mission-specific Feasibility Analysis on the respective mission GS's (eg SF Server) using the HMA agreed standard.

(sourced from US4_1_GS_2445/Online Ordering)

The SF Server interface shall offer an interface compliant with the agreed HMA standard.

REQ-FUN-0090/1.0 SF Client Feasibility Analysis monitoring/search T

(sourced from US3_1_HM_2435/HM Ordering)

The SF Client shall manage the Feasibility Analyses and provide Feasibility Analysis monitoring resources to the user.

(sourced from US13_1_HM_2677/HM Ordering)

The SF Client shall provide Feasibility Analysis search functions.

The search criteria will select a set of Feasibility Analyses for which the Feasibility Analysis Statuses will be returned.

REQ-FUN-0100/1.0 Loosely defined Feasibility Analysis T

(sourced from US4_1_GS_2440/Order Handling)

The SF Server shall be capable of managing loosely defined Feasibility Analysis, e.g. ROI, time span.

(sourced from US4_1_GS_2443/Online Ordering)

The Sensor Feasibility interface shall accept loosely defined Feasibility Analysis types, e.g. ROI, time span.

(US4_1_GS_2444/Online Ordering)

The Sensor Feasibility interface shall use the HMA agreed definitions of the loosely defined options.

REQ-FUN-0110/1.0 Feasibility Analysis Statuses using SPS specification T

(sourced from US13_1_GS_2670/Online Ordering)

The Sensor Feasibility interface shall use the HMA agreed set of Feasibility Analysis statuses to respond to Feasibility Analysis status requests coming through the HMA environment.

(sourced from US13_1_GS_2671/Online Ordering)

The Sensor Feasibility interface shall put all non standard statuses in the text field specially allocated in the SPS specification. It states: "the StatusReport provides an extension point that allows adding domain specific properties (extension)."

(sourced from US13_1_GS_2672/Online Ordering)

The Sensor Feasibility interface shall direct all unsolicited Feasibility Analysis statuses to the HM Feasibility Analysis function that issued the Feasibility Analysis on behalf of the user.

(sourced from US13_1_HM_2674/HM Ordering)

The HM Feasibility Analysis function shall compile all unsolicited Feasibility Analysis statuses into a HM Feasibility Analysis status report sent to the user automatically.

REQ-FUN-0120/1.0 SF Server Configuration for simulation scenarios T

SF server configuration shall include the modelling of:

- Sensor unavailability: periods where the sensor is identified as unavailable.
- Weather conditions: a simple weather forecast, based on the data typically extracted from a Weather

Research and Forecasting (WRF) model

- Station unavailability: periods where the relevant ground stations are identified as unavailable.

REQ-FUN-0130/1.0 Web Service Notifications T

Some SF server configurations shall allow subscription to get notifications about the progress of certain SF Server operations.

5.3. Performance Requirements

REQ-PER-0010/1.0 Installation on Linux OS R

The SF Server shall be installed on a single server using a Linux OS within ESA for demonstration purposes.

REQ-PER-0020/1.0 SF Server response times R

The SF Server shall respond rapidly enough to all message receptions that sensible time-out parameters can be set for any client software. 60 seconds is the anticipated value, although this may be changed during testing if necessary.
This is the benchmark when a single message is being processed at once. In case of multiple clients connecting at the same moment it is permissible (though not expected) that one should be given a time out by the SF Server in the understanding that the client shall retry later.

5.4. Interface Requirements

REQ-INT-0010/1.0 SPS Application Profile for EO R

The SF Client and Server shall communicate following the OpenGIS® Sensor Planning Service Application Profile for EO Sensors (OGC 07-018) [RD 1] specification which forms the ICD for the SFRE.

REQ-INT-0020/1.0 Operation encodings R

The encoding of operation requests shall use HTTP GET with KVP encoding and HTTP POST with XML, SOAP, and/or KVP encoding as specified in [RD 5]. Some operations will need to support both methods, as detailed in the finalised SPS specifications ([RD 1] and [RD 2])