COTS Implementation of a Sensor Planning Service GetFeasibility Operation - Interim Status

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Abstract—This paper reports on the progress of the design and implementation of a Web-based Sensor Planning Service (SPS) that discovers sensors, formulates sensor collection tasks, and determines feasibility of collection tasks for optical and radar Earth imaging spacecraft. [1 2] The design is founded on Commercial off the Shelf (COTS) mission modeling capabilities from Analytical Graphics, Inc. (AGI).

An SPS providing a COTS GetFeasibility operation will make it easier for users to discover sensors that fulfill their needs. A COTS common interface will provide the user with one well-known set of operations for the initial discovery of candidate sensors. A final selection of sensors can be carried out using the SPS operations of the individual Data Providers.

The first step is a Proof of Concept Sensor-Planning Service (PoC-SPS). It includes the design and implementation of a Standard Object Catalog (SOC) and the design and prototyping of the work flow.

The work flow prototyping also supports the design of an interface between System Modeling Language (SysML) system modeling and AGI mission modeling capabilities.

The SOC is a community driven library of spacecraft, facilities and other assets with accurate and thorough descriptions of mission capabilities. The SOC is initially populated with optical and radar Earth imaging spacecraft and sensors.

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1. INTRODUCTION

Sensor system architecture and design is transitioning from project-unique specifications to open-source specifications. This supports the sharing and integration of sensor tasking and observations. This also enables the development of COTS capabilities.

The transition to open-source specifications is enabled by the Open Geospatial Consortium (OGC®) Sensor Web Enablement (SWE) initiative that provides a collection of standards for interacting with a network of Web-connected sensors and sensor systems. The sensors can be: 1) fixed or mobile, 2) space, air, land, or sea-based, and 3) environmental, scientific or surveillance.

The OGC standards cover: 1) discovery of sensors and sensor capabilities, 2) planning and tasking of sensors, and 3) storing, discovery and retrieval of sensor observations.

Figure 1 shows the sensor web services and schema. Figure 2 shows the flow of messages and data between the services.

Sensor Planning Services (SPSs) provide a series of capabilities for users, including: 1) discover sensors and receive sensor descriptions, 2) formulate and determine the feasibility of a collection task, and 3) submit a collection task and locate the results. Each SPS operation has request and response components. The user sends a request message to the service and the service returns a response message.

Sensor Observation Services (SOSs) provide the capability for users to discover and receive sensor descriptions and to request, filter, and retrieve sensor observations. The filtering can be on time, sensor, and phenomenon. The sensor observations can be retrieved from an observation repository or streamed real-time from a sensor. There is also the capability for Sensor Management Systems to register and to publish sensor observations to the SOSs.

Sensor Alert Services (SASs) provide the capability for users to discover sensor alerts and to register for and receive sensor alert messages. An alert is a notification that a certain observation event occurred at a feature of interest. There is also the capability for Sensor Management Systems to

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[1]978-1-4244-3888-4/10/$25.00 ©2010 IEEE.
[2] IEEEAC paper #1275, Version 2, Updated January 3, 2010

register and to publish observation event messages to the SASs.

Users discover SPSs, SOSs, and SASs via a series of registries.

Web Notification Services provide for the asynchronous delivery of messages and alerts.

Sensor Modeling Language (SensorML) consists of models and eXtensible Markup Language (XML) schema for describing sensors. It supports discovery and tasking of sensors as well as requesting, processing, and geolocation of sensor observations.

Observations and Measurements (O&M) consists of models and XML schema for encoding of sensor observations and measurements. The encoding includes identifying the sensor reporting the observation, time period of observation, phenomenon being observed, geographic region containing the sensor, and the geographical region containing the features being observed.

Transducer Markup Language (TML) consists of models and XML schema for describing transducers, either transmitters or receivers. The description includes the phenomenon being measured by a transmitter or being produced by a receiver, transportation of data, processing of the data, and exploitation of the data.

2. COTS GETFEASIBILITY OPERATION

This paper is reporting on the current state of design of a COTS Sensor Planning Service, in particular the GetFeasibility operation, based on the capabilities of AGI Components. The COTS GetFeasibility operation accommodates geometrical and temporal collection tasking requirements.

The GetFeasibility operation does not implement a detailed ground coverage simulation, such as modeling a collection payload that is configured on an image by image basis for a range of quality collections, nor does it attempt to model multiple overlapping ground coverage images. This level of GetFeasibility simulation is best provided by the individual Data Providers, such as Spot.

The benefit of a COTS GetFeasibility operation is that the first level of interaction with a Data Provider can be common to all Data Providers. The user populates one set of common XML documents that are applicable to each participating Data Provider in order to produce an initial list of potential sensors. Otherwise, the user would populate sets of XML documents, with each set unique to each Data Provider. Once a short list of sensors has been down-selected from the initial list, the user populates a set of XML documents unique for each Data Provider for a final selection of sensors.

This COT GetFeasibility operation can support data providers that have implemented SPSs and those that have not, as illustrated in Figure 3.

A user interacts with the COTS SPS to discover a list of candidate Data Providers (DPs) that have the potential of satisfying a particular collection task: DP#2, DP#4, DP#5, DP#7, DP#10 and DP#12. Based on the determine feasibility results provided by the COTS SPS, DP#2 is not selected due to insufficient ground resolution and DP#4 is not selected due other DPs having nearer-term access.

DP#5 and DP#7 have implemented SPSs. The User interacts with DP#5 to formulate a collection task and to determine feasibility but does not select DP#5 since the DP is not able to incorporate the collection task into a near-term schedule. The User interacts with DP#7 and submits a collection task after finding satisfactory collection feasibility and scheduling opportunity.

DP#10 and DP#12 have not implemented SPSs. The User submits orders to both DPs. The User specifies task acquisition time to DP#12 in order to force desired acquisition conditions reported by the COTS SPS.

Foundation of COTS GetFeasibility Operation

The COTS GetFeasibility operation is based on OGC 07-014r3, Sensor Planning Service Implementation Specification [2], as are the corresponding COTS GetCapabilities and DescribeTasking operations.

The GetCapabilities operation provides a list of sensor IDs and a description of each sensor, including the phenomena that can be measured, the region the sensor operates in or can be tasked to observe, and the location of a detailed description of the sensor.

The DescribeTasking operation provides the input parameters list needed by the GetFeasibility and the Submit operations.

The SPS documents include a description of SPS operations, parameter definitions and encodings, XML schema, and example XML documents. The XML schema provides the structure of the data passed between the user and the SPS. The XML documents are the instantiation of the schema.

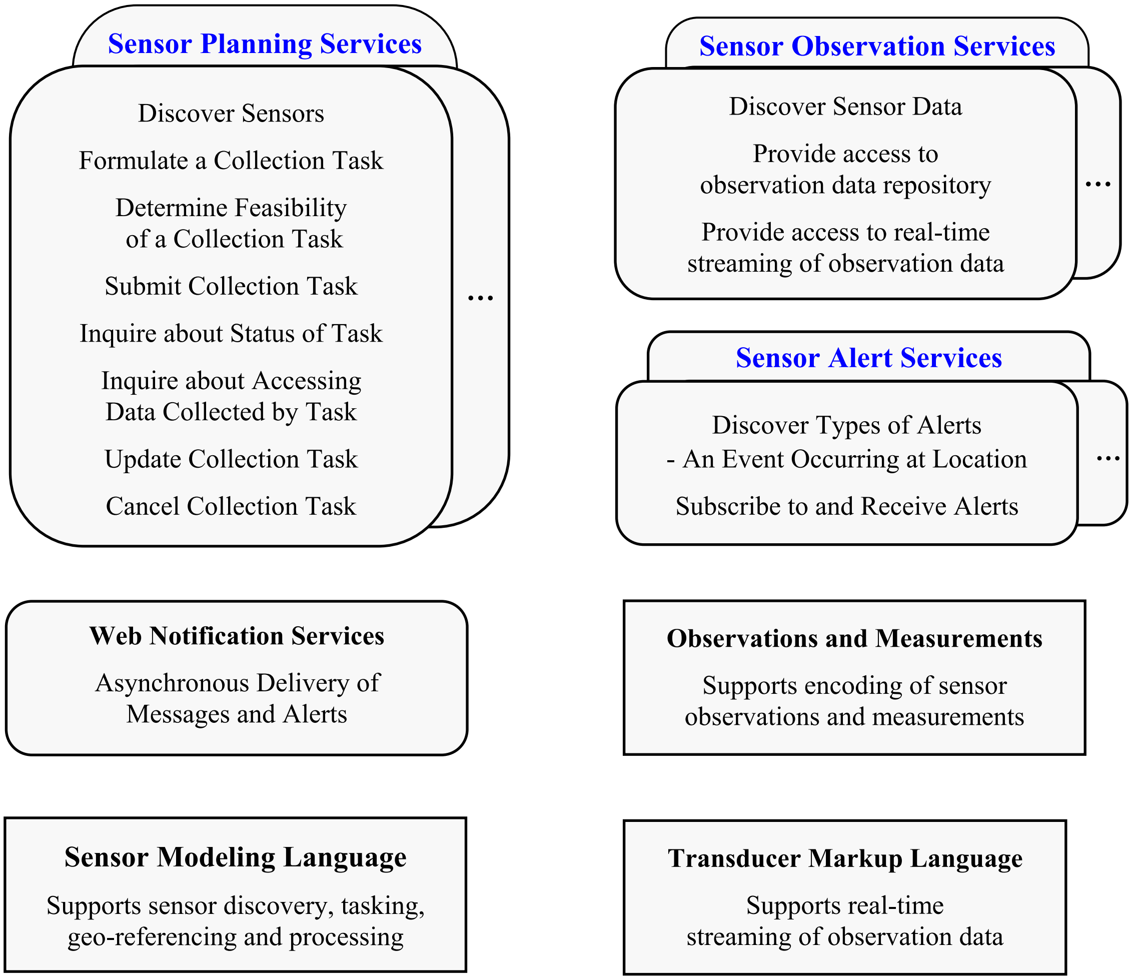


Figure 1. Sensor Web Services and Schema

Sensor Web Enablement (SWE) open source specifications for interacting with a network of Web-connected sensors and sensor systems

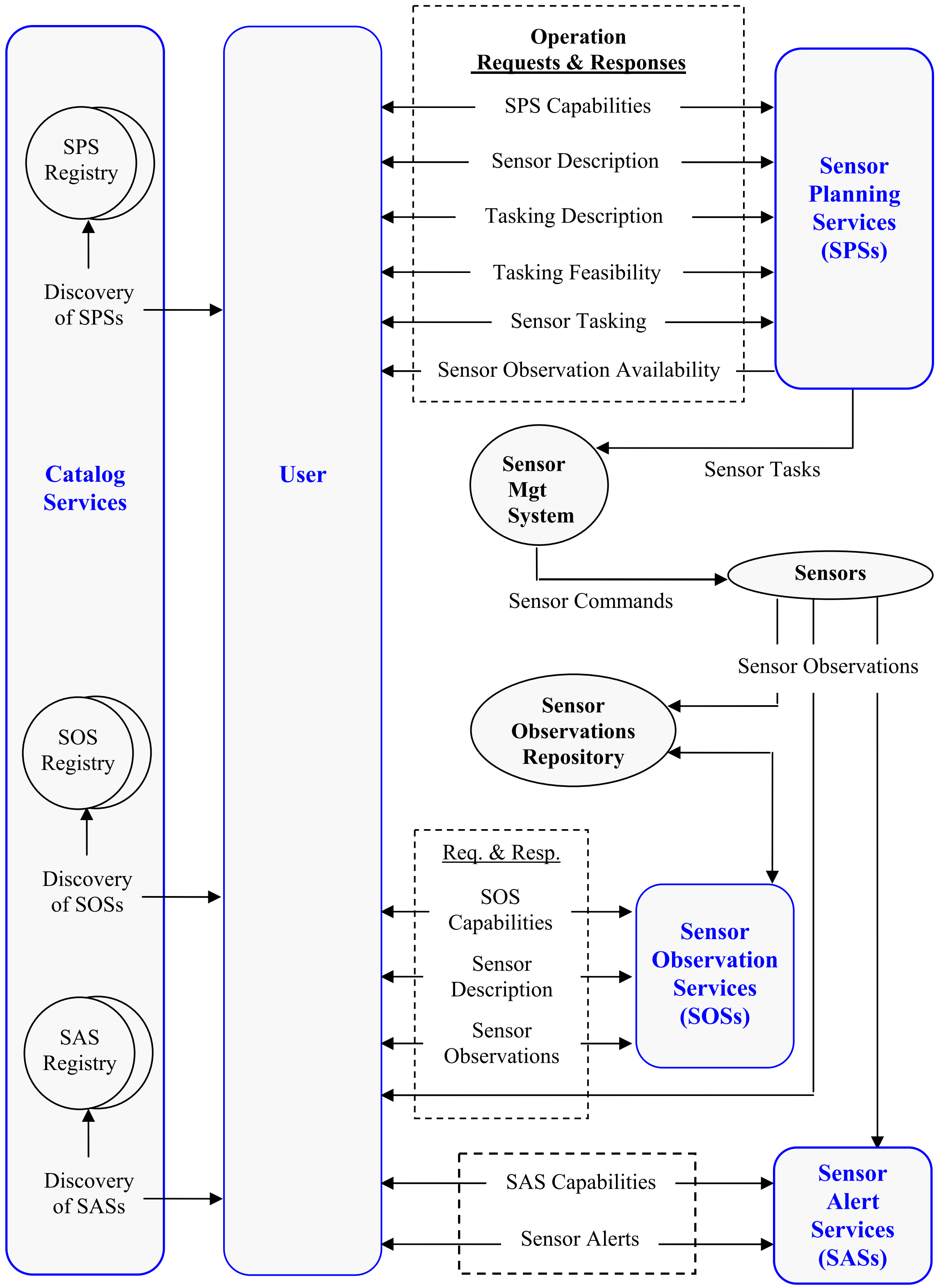


Figure 2. Sensor Web Services Message Flow

SWE discovery of sensors and capabilities - planning and tasking of sensors - storing, discovery and retrieval of sensor observations

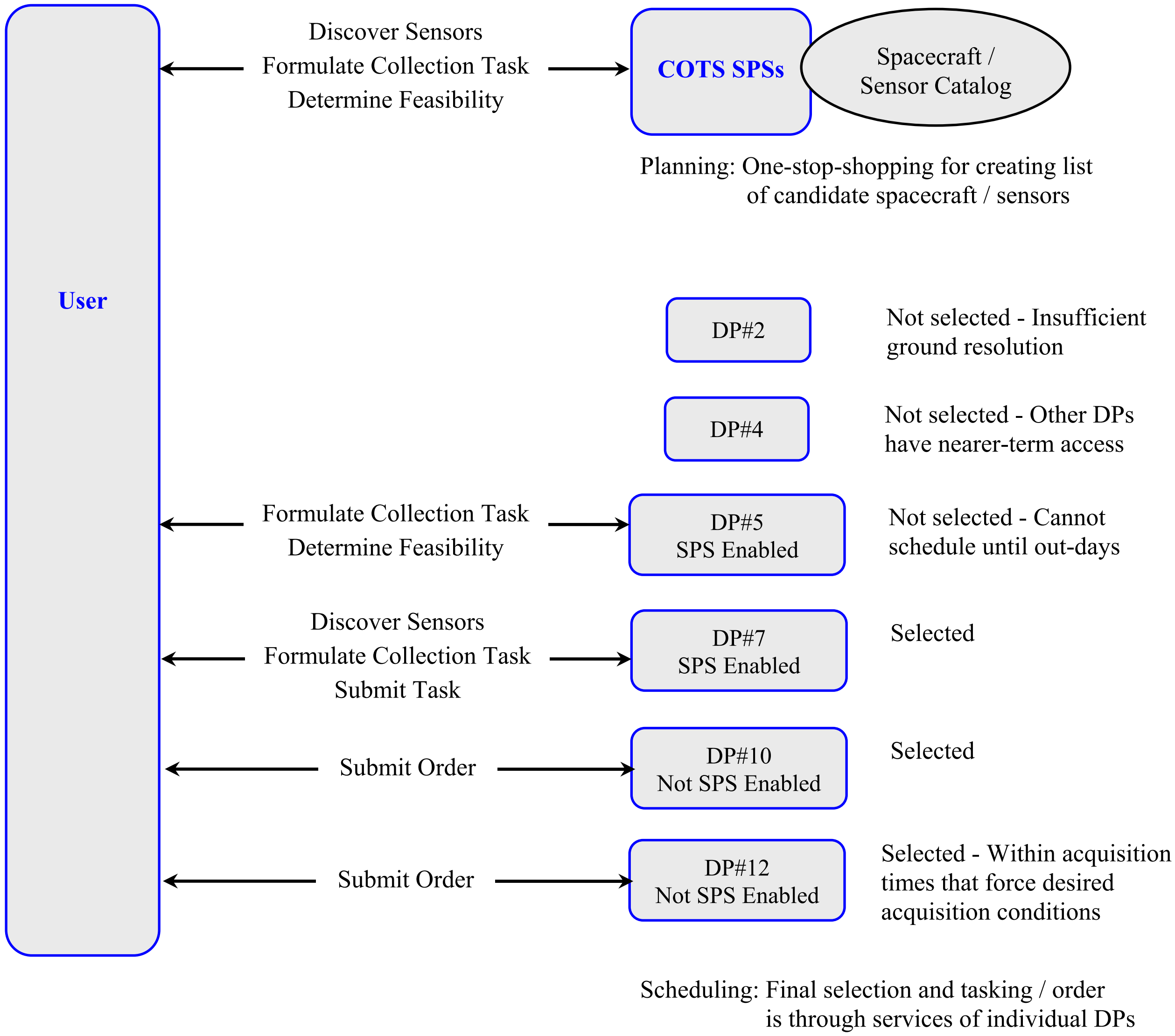


Figure 3. Application of COTS GetFeasibility Operation

COTS GetFeasibility operation can support data providers that have implemented SPSs and those that have not

For example, the user populates a GetFeasibility-Request XML document according the GetFeasibility schema and sends the document to the SPS. The SPS receives and parses the XML document, determines collection feasibility, populates a GetFeasibility-Response XML document, and sends the document to the user.

A sparse schema is used for the first prototyping steps. The schema will be brought into compliance with the Sensor Planning Service Implementation Specification in the final steps of prototyping.

3. PROTOTYPING

Prototyping is being carried out in steps to arrive at the prototyping plans presented in reference 1.

The first step is a Proof of Concept-Sensor Planning Service (PoC-SPS). It includes the design and implementation of a Standard Object Catalog (SOC) and the design and prototyping of the work flow of the functionality need for the COTS implementation of an SPS.

The SOC contains the equivalent of the Sensor Spacecraft Catalog of reference 1. The SOC is a community driven library of spacecraft, facilities and other assets with accurate and thorough descriptions of mission capabilities. The SOC is initially populated with optical and radar Earth ground imaging spacecraft and sensors. Each SOC entry consists of a searchable description and an STK scenario containing the spacecraft and its sensors.

Figure 4 is an overview of the prototype work flow functionality needed for a COTS implementation of the GetCapabilities, DescribeTasking and GetFeasibility operations of an SPS.

Data exchanges between a User and an SPS are by way of XML documents. The prototype employs SpacecraftCapabilities, TaskingDefinition, and AcquisitionFeasibility XML documents. These XML documents are not intended to be one-off versions of the GetCapabilities, DescribeTasking and GetFeasibility XML documents. They are sparse XML documents that support design of the data exchanges needed for employing AGI mission modeling capabilities.

SpacecraftCapabilities

The SpacecraftCapabilitiesRequest sequence, illustrated in Figure 5, is made of Country and PayloadType elements. These are the elements defined in the Spacecraft schema - SpacecraftClassification sequence.

If the User does not specify a Country the search will include all countries. The PayloadType can be Optical Imager or Radar Imager. If a PayloadType is not specified, the search will include both imagers.

The User populates the SpacecraftCapabilitiesRequest XML document and sends it to the PoC-SPS where is received and parsed. The PoC-SPS searches and retrieves from the SOC, populates the SpacecraftCapabilitiesResponse XML document, and sends it to the User.

The SpacecraftCapabilitiesResponse sequence contains the Spacecrafts sequence which consists of a number of Spacecraft sequences. The Spacecraft sequence is made up of SpacecraftClassification, SpacecraftOrbit, and Payload sequences, as defined in the Spacecraft schema.

Only spacecraft with a SpacecraftStatus of Active are included in the response. The Payload sequences are for Optical Imager and/or Radar Imager in compliance with the Request.

TaskingDefinition

The User receives and parses the SpacecraftCapabilitiesResponse XML document and selects the applicable spacecraft and sensors. The User populates the TaskingDefinitionRequest XML document and sends it to the PoC-SPS.

The TaskingDefinitionRequest sequence, illustrated in Figure 6, contains the SpacecraftSensorPairings sequence, which contains a number of SpacecraftSensorPairing sequences.

The SpacecraftSensorPairing sequence is made up of SpacecraftCommonName from SpacecraftClassification sequence, CatalogNumber from SpacecraftOrbit sequence, and PayloadName from Payload sequence. The sequence also includes the RadarOperationName from RadarPayloadOperation sequence if the imager is a Radar Imager.

The TaskingDefinitionResponse sequence contains the TaskingDefinitions sequence, which contains a number of TaskingDefinition sequences.

The TaskingDefinition sequence is made up of the FeatureOfInterest and AcquisitionConstraints sequences. TaskingDefinition sequence also contains the SpacecraftSensorPairing sequence which was provided in the Request.

A FeatureOfInterest can be defined by a ground point, line, or polygon. The PoC-SPS is initially designed for a ground point feature. The design will eventually incorporate a polygon feature.

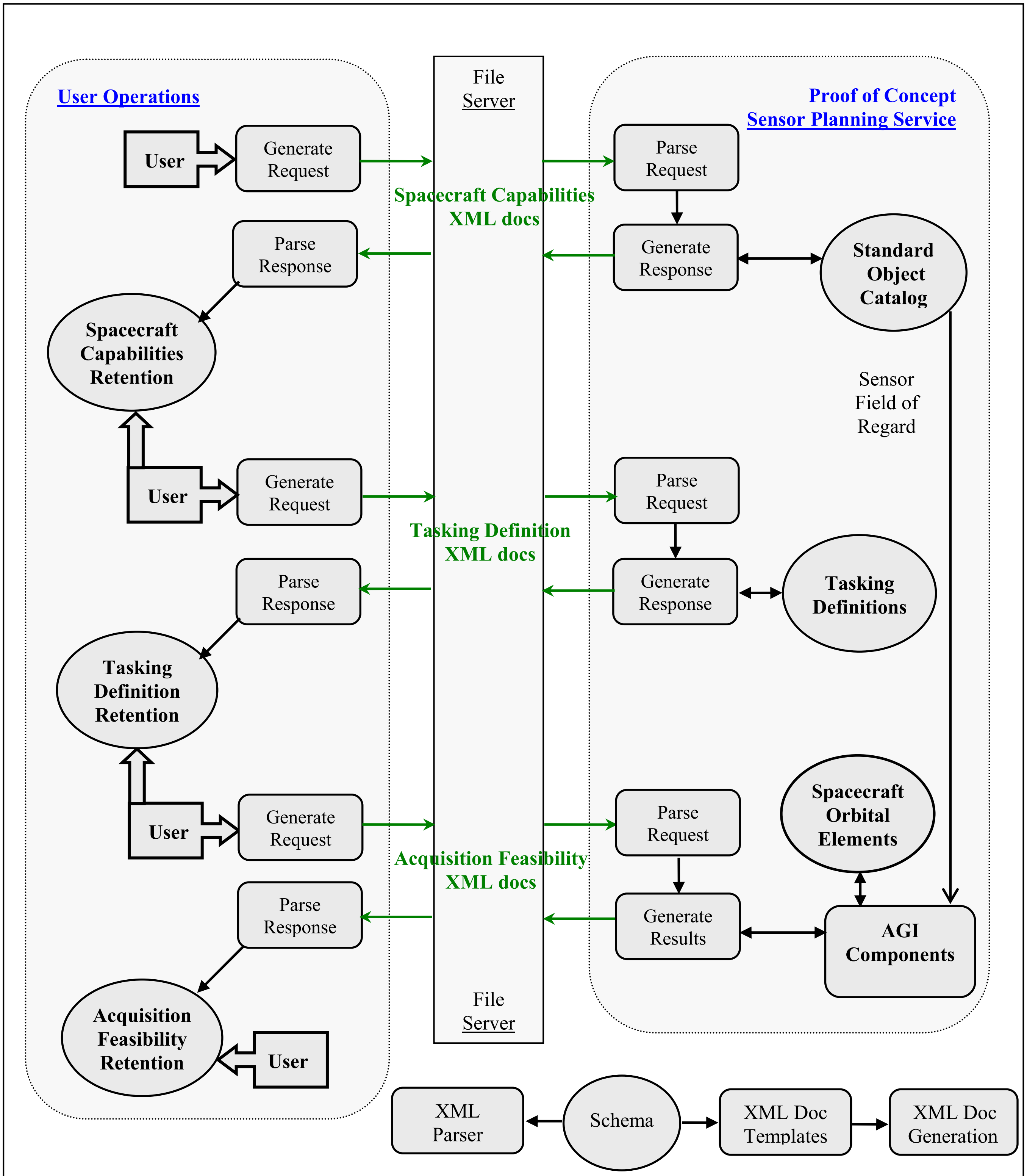


Figure 4. Prototype Work Flow of Functionality Needed for Sensor Planning Service

XML document interchanges - User generates requests - Sensor Planning Service generates responses

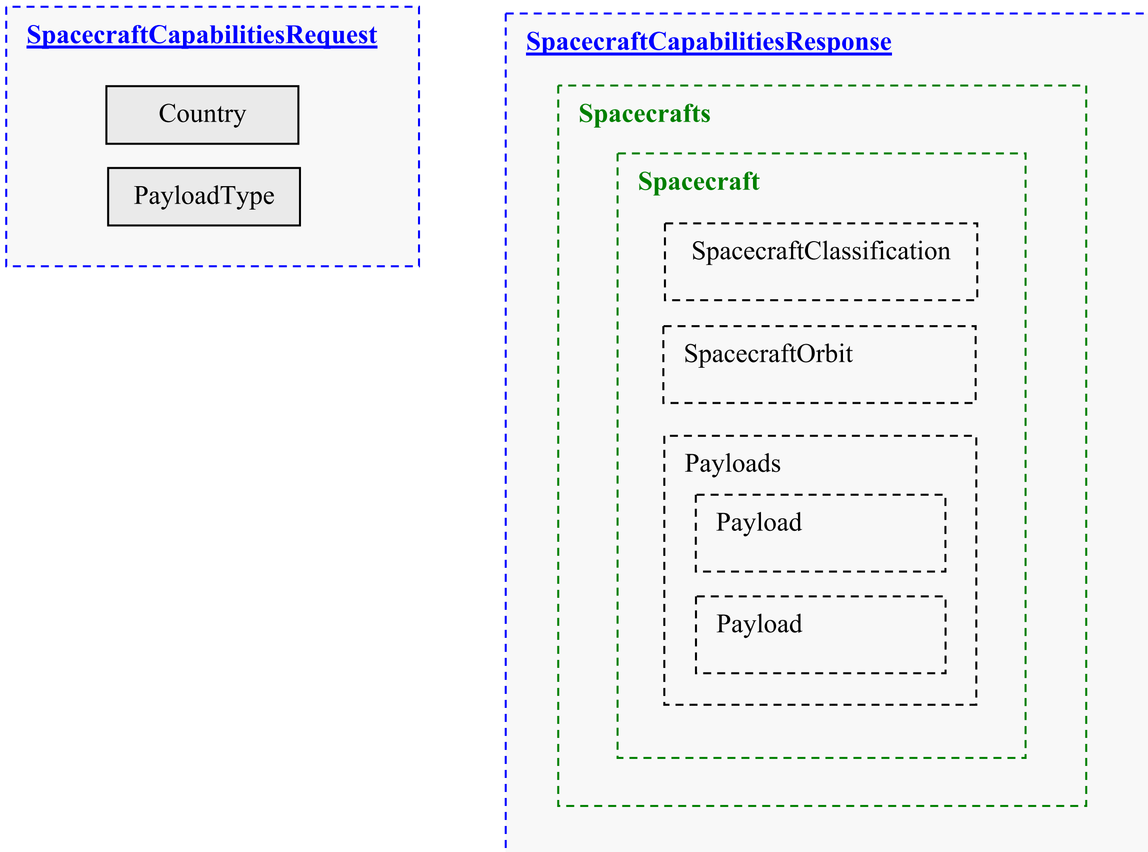


**Figure 5. Schema Overview of Prototype of
Spacecraft Capabilities Request and Response XML Documents**

User discovers spacecraft - sensor capabilities

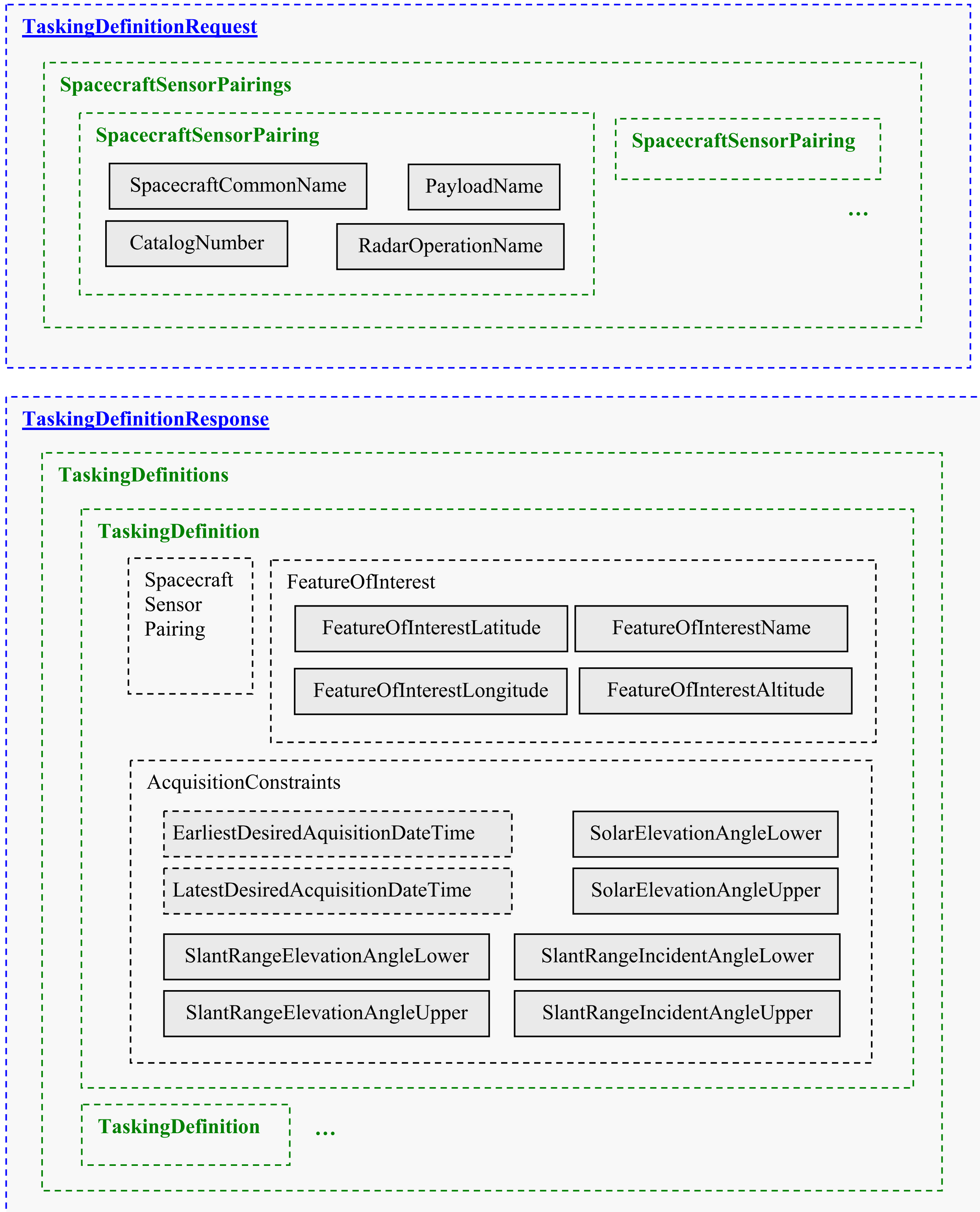


Figure 6. Schema Overview of Prototype of Tasking Definition Request and Response XML Documents

User down-selects from spacecraft - sensor capabilities and requests tasking parameter lists

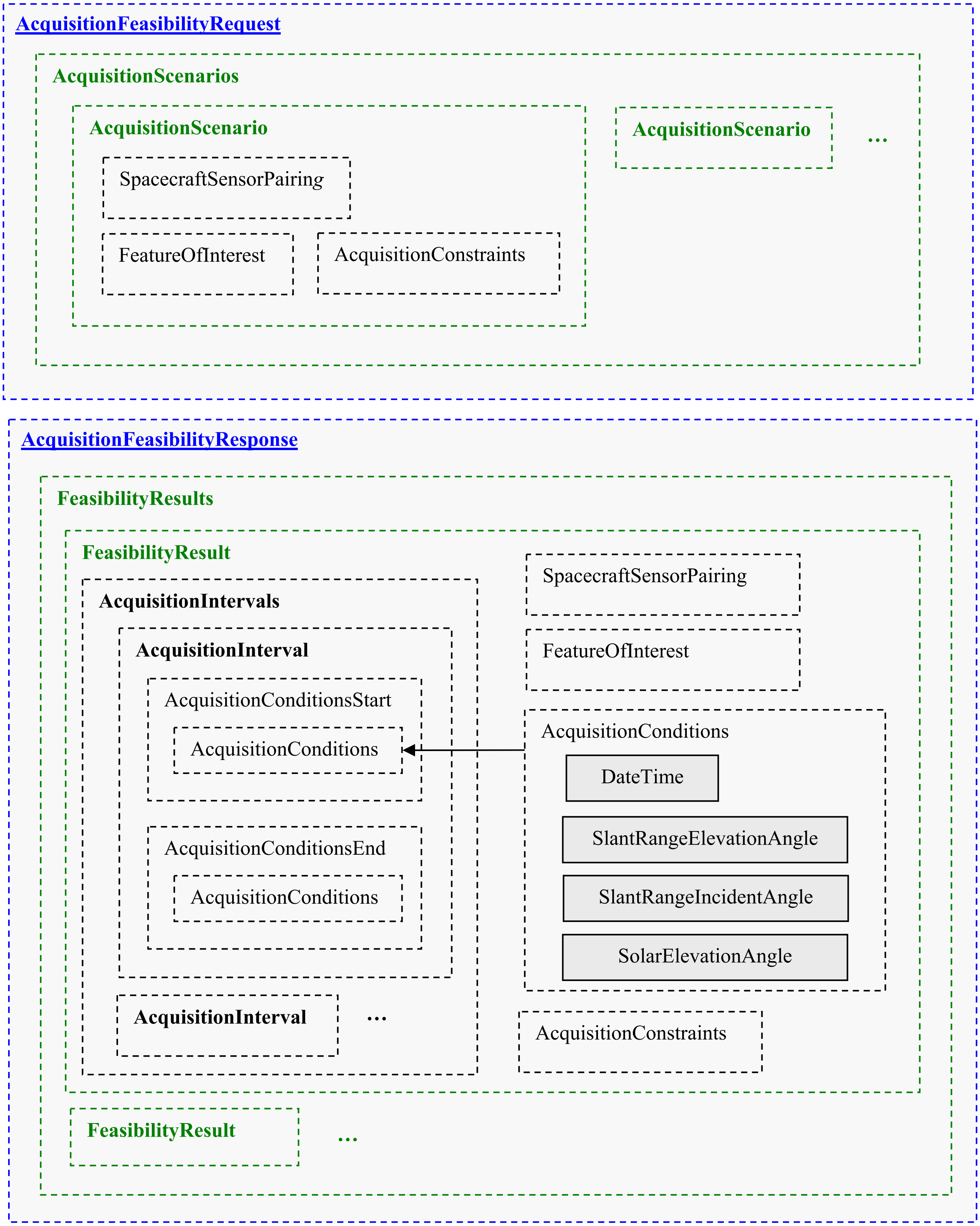


Figure 7. Schema Overview of Prototype of Acquisition Feasibility Request and Response XML Documents

User populates tasking parameters and requests collection feasibility metrics

A full set of acquisition constraints includes geometric, temporal, environmental, and quality. Examples of acquisition constraints for an Optical Imager are: geometric - slant range elevation angle range, temporal - time of day interval, environmental - solar elevation angle range, and quality - ground sample resolution range.

The PoC-SPS does not incorporate ground sample resolution since it requires knowledge of the detector configuration. For example, an optical detector would require, at a minimum, detector focal length and pixel width. However, a User can select a sensor based on its ground sample resolution provided with Payload sequence.

The PoC-SPS retrieves the Tasking Definitions, populates the TaskingDefinitionResponse XML document, and sends it to the User.

AcquisitionFeasibility

The User receives and parses the TaskingDefinitionResponse XML document. Then the User populates the AcquisitionFeasibilityRequest XML document and sends it to the PoC-SPS where it is received and parsed.

The AcquisitionFeasibilityRequest sequence, illustrated in Figure 7, contains the AcquisitionScenarios sequence, which contains a number of AcquisitionScenario sequences. The AcquisitionScenario is made up of SpacecraftSensorPairing, FeatureOfInterest, and AcquisitionConstraints sequences, as provided in the TaskingDefinitionResponse XML document and populated by the User.

The PoC-SPS processes each AcquisitionScenario. The SpacecraftSensorPairing elements are used to retrieve the SensorFieldOfRegard from the Standard Object Catalog and the Spacecraft Orbital Elements. Then the AGI Components are activated to determine the FeasibilityResults.

The AcquisitionFeasibilityResponse sequence contains the FeasibilityResults sequence, which contains a number of FeasibilityResult sequences. The FeasibilityResult sequence is made up of the AcquisitionIntervals sequence, which contains a number of AcquisitionInterval sequences. The AcquisitionInterval sequence contains the AcquisitionConditionsStart sequence and the AcquisitionConditionsEnd sequence. The AcquisitionConditions sequence is made up of DateTime, SlantRangeElevationAngle, SlantRangeIncidentAngle, and SolarElevationAngle.

The AcquisitionFeasibilityResponse sequence also contains the SpacecraftSensorPairing, FeatureOfInterest, and AcquisitionConstraints, which were provided in the Request XML document.

The PoC-SPS populates the AcquisitionFeasibilityResponse XML document and provides it to the User.

4. Standard Object Catalog Data and Objects

The Standard Object Catalog (SOC) consists of a data partition and an object partition as illustrated in Figure 8.

The object partition of the SOC resides on a Data Federate server. The objects are components of AGI mission modeling capabilities. Examples of objects are scenarios, spacecraft, facilities, and aircraft. The scenario, the highest level object, contains other objects and is the outline for a series of actions that can be visualized.

The data partition of the SOC resides on a database server and contains descriptions of the objects. The front-end of the server provides access to the data as XML documents, database queries, and database forms.

The SOC currently contains spacecraft and ground facilities and there are plans to include aircraft and unmanned aerial vehicles in particular.

The SOC is currently populated with Earth ground imaging spacecraft. Navigation spacecraft are next to be added, followed by communication spacecraft. Ground facilities are those that support spacecraft launch and operations.

The SOC data partition contains spacecraft description and spacecraft modeling parameters used to generate the spacecraft scenarios.

For an Earth ground imaging spacecraft, the description of the optical and radar imaging payloads includes sensor field of view and sensor field of regard models that are used by the mission modeling capabilities to determine target access and coverage metrics.

Spacecraft and Sensor Modeling

The capability has been developed to 1) populate an XML scenario generation document with spacecraft and imaging sensor modeling parameters residing in the SOC data partition, 2) import the XML document into STK, 3) create a scenario containing the spacecraft and sensor and 4) populate the scenario into the SOC object partition.

This capability is being expanded to 1) populate an XML tasking feasibility document specifying a) spacecraft and imaging sensor capabilities and b) tasking feature of interest and acquisition conditions, 2) import the XML document into STK, 3) create and execute a tasking acquisition feasibility scenario, and 4) export the feasibility results as an XML document.

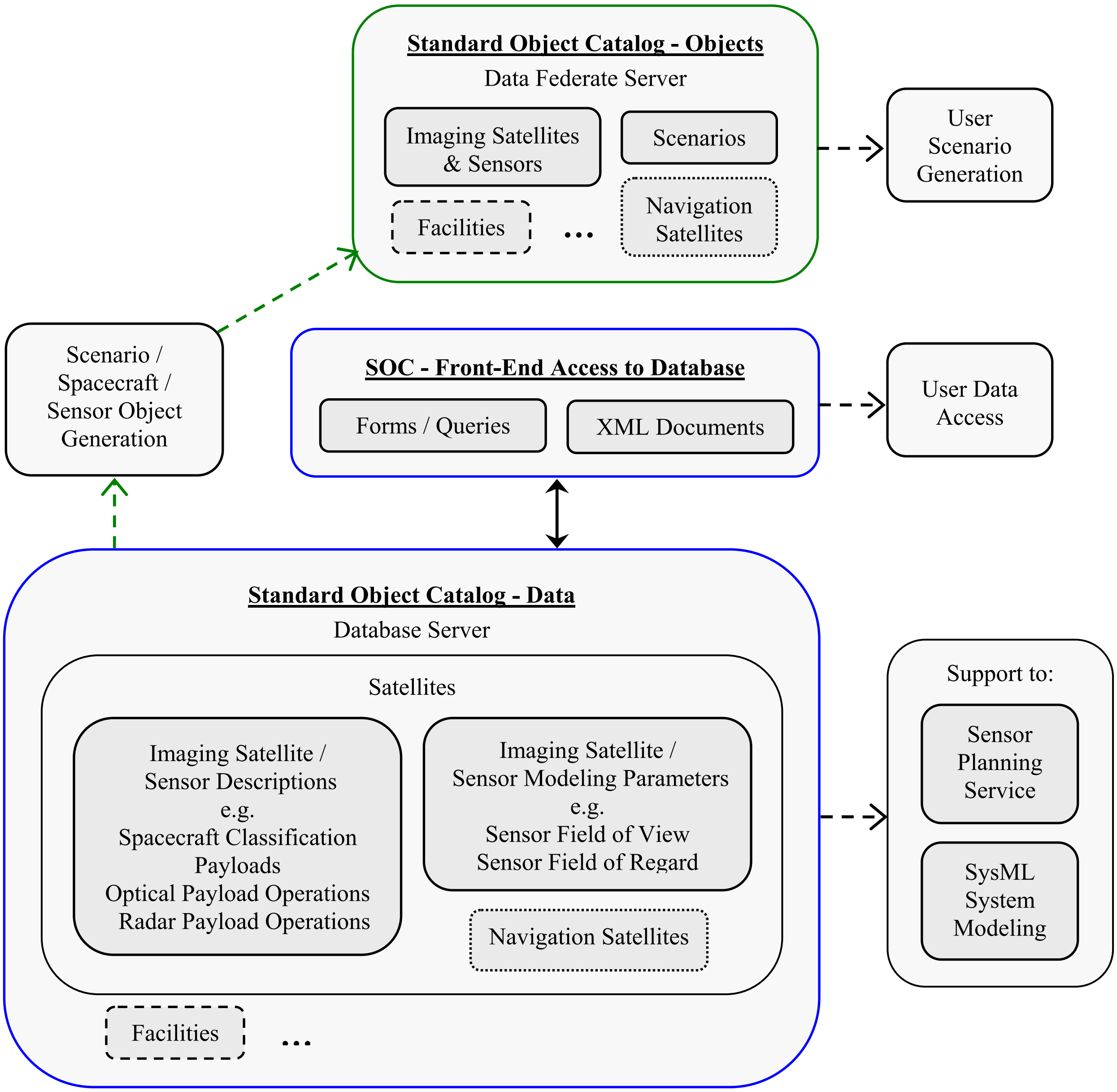


Figure 8. Standard Object Catalog

A community driven library of spacecraft, facilities and other assets with accurate and thorough descriptions of mission capabilities

Initially populated with optical and radar imaging satellites

Once this expanded capability has been prototyped, it will be modified, as necessary, to support Sensor Planning Service and System Modeling Language (SysML) system modeling.

SOC Access and Data Maintenance

The SOC supports two types of users as illustrated in Figure 9. The STK Public Users have access to SOC data and objects through a Web interface. The objects can be downloaded across the Web into an STK file. From there the objects can be inserted into a scenario.

The AGI Community Users access SOC data and objects through a network interface. In addition the Community Users can directly incorporate the objects into a scenario through a STK plug-in.

The maintenance of the data and object in the SOC partitions is illustrated in Figure 10. A user can provide additional data entries to the data by populating and submitting the database form or XML document. A user can provide comments and corrections for data and objects of the SOC through an on-line log.

The additional entries, comments and corrections are adjudicated with feedback to the user and updates to the SOC. Additionally, updates to the data can result in updates to the scenarios and objects

5. SPACECRAFT SCHEMA

Figure 11 is an outline of the spacecraft schema elements that define the spacecraft description XML document and are the basis of the spacecraft database.

An element represented by a dashed-box is defined by a sequence of elements. Element names are expressed in upper camel case, e.g. MissionClass. Some element values are restricted to those in an enumeration list.

Some schema elements have an associated reference token element. The reference token provides the source of the value of the element. The source is generally a link to a web site. Some elements have associated units. The capability to specify a unit is through an attribute of the schema element which is then specified in the XML document and the database.

The SpacecraftClassification sequence contains the following elements: SpacecraftCommonName, CivilianMilitary, SpacecraftStatus, Missions, Countries, Systems, and AlternateNames. The Missions element sequence contains a MissionClass element and a MissionType element. If the spacecraft has multiple mission payloads then there are multiple pairs of MissionClass and MissionType elements.

Examples of MissionClass elements are Earth Observation, Communications, and Navigation. Examples of MissionType elements are Ground Imaging, Ground Observation, Ocean Observation, and Atmospheric Observation.

The LaunchInformation sequence consists of the LaunchDate, LaunchVehicle, and LaunchSite. The LaunchDate is identified as Planned or Actual.

The MissionLife sequence contains MissionDesignLife, SpacecraftDesignLife, and MissionEndDate. The MissionEndDate is identified as Planned or Actual.

The SpacecraftOrbit sequence contains the InternationalId, CatalogNumber, OrbitType, OrbitInclination, OrbitPerigeeAltitude, and OrbitApogeeAltitude. Examples of OrbitType are Low Earth Orbit and Geosynchronous Orbit. The inclination and altitudes are nominal values.

The SpacecraftPlatform sequence consists of PrimeContractor, PlatformManufacturer, LaunchMass, DryMass, and Size. The Size sequence is up to three Dimension elements.

The DataRecordUpdates sequence consists of a number of DataRecordUpdate sequences. A DataRecordUpdate sequence contains UpdateDate, UpdateAuthor, and UpdateDescription.

The References sequence contains RefToken, RefSource, and RefDescription.

Payloads

The Payloads sequence consists of a number of Payload sequences. A Payload sequence is made up of PayloadType, PayloadName, PayloadManufacturer, PayloadStateOfHealth and PayloadOperations.

Examples of PayloadType are Optical Imager, Radar Imager, Radiometer, Spectrometer, Solid State Data Recorder, Laser Communication Terminal, and C-Band Antenna.

PayloadOperations contains a short description of payload operations. In the case of a mission data payload, such as a radiometer, PayloadOperations contains a description of the phenomenon measured or observed by the payload.

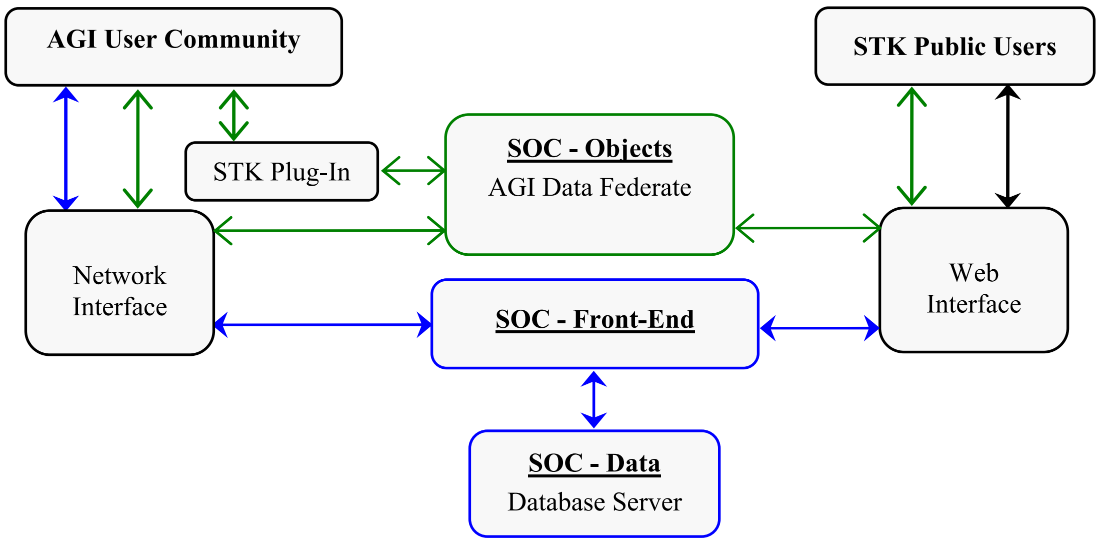


Figure 9. Data Access - Standard Object Catalog

Users have access to both descriptions of spacecraft and sensors as well as executable objects

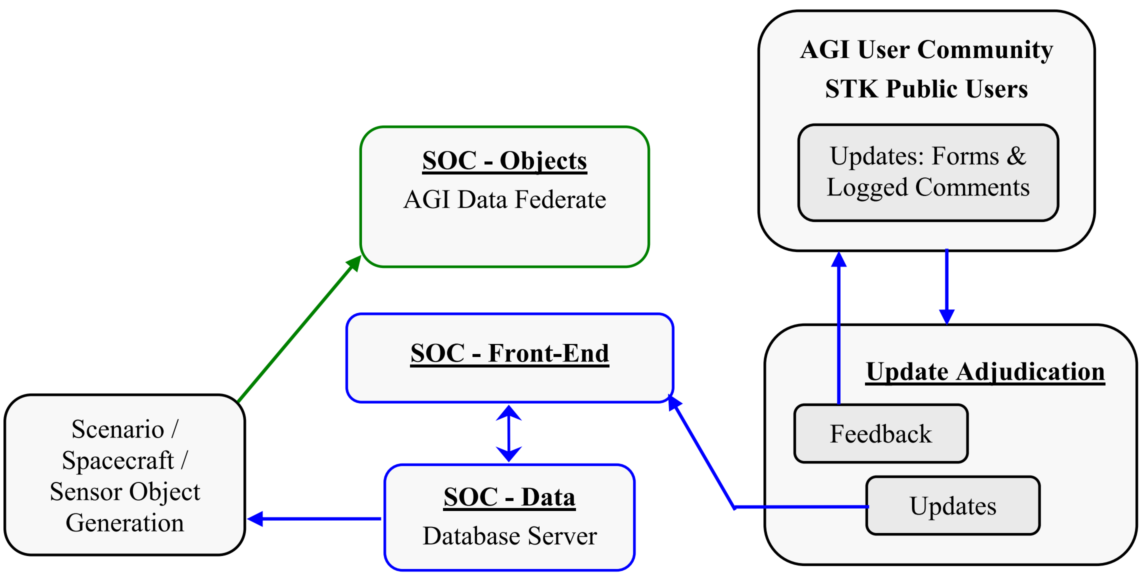


Figure 10. Data Maintenance - Standard Object Catalog

Users can correct and add to content

Optical Imager Payload

The Payload sequence for an Optical Imager also contains an OpticalPayloadOperations sequence.

The OpticalPayloadOperations sequence is made up of OpticalPayloadAgility sequence, a number of OpticalPayloadOperation sequences, PayloadFieldOfView sequence, and PayloadFieldOfRegard sequence.

The OpticalPayloadAgility sequence contains AgilityType and up to two Agility Extent sequences, which are made up of AgilityDirection and AgilityRange. AgilityType is Mirror-Pointing, Gimbal-Pointing, Body-Pointing, or Fixed-Pointing.

The OpticalPayloadOperation sequence contains two sequences. The SpectrumCharacteristics sequence contains SpectrumType and several SpectrumBand sequences made up of Color, LowerWaveLength and UpperWaveLength. The OpticalImageCharacteristics sequence contains SceneSizeWidth, SceneSizeLength, and several Resolution sequences made up of ResolutionType and ResolutionValue.

Examples of SpectrumType are Visible, Visible - Near IR, Short-Wave IR, and Thermal IR. ResolutionType is Cross-Track Resolution, In-Track Resolution, or just Resolution.

The PayloadFieldOfView sequence is calculated from the SceneSizeWidth and OrbitPerigeeAltitude. The PayloadFieldOfRegard sequence is calculated from the OpticalPayloadAgility.

Radar Imager Payload

The Payload sequence for a Radar Imager also contains a RadarPayloadOperations sequence.

The RadarPayloadOperations sequence is made up of RadarPayloadType and a number of RadarPayloadOperation sequences. Examples of RadarPayloadType are SAR C-Band and SAR X-Band.

The RadarPayloadOperation sequence contains RadarPayloadOperationName, RadarImageCharacteristics sequence, PayloadFieldOfView sequence, and PayloadFieldOfRegard sequence.

Examples of RadarPayloadOperationName are Spotlight and Stripmap.

The RadarImageCharacteristics sequence contains SceneSizeWidth, SceneSizeLength, IncidentAngleLower, IncidentAngleUpper, and several Resolution sequences made up of ResolutionType and ResolutionValue. ResolutionType is Range Resolution, Azimuth Resolution, or just Resolution.

The PayloadFieldOfView sequence is calculated from the SceneSizeWidth and OrbitPerigeeAltitude. The PayloadFieldOfRegard sequence is calculated from the IncidentAngleLower and IncidentAngleUpper.

Mission Modeling

The PayloadFieldOfView and PayloadFieldOfRegard are used by AGI's mission modeling capabilities.

The PayloadFieldOfView and PayloadFieldOfRegard sequences contain SensorObjectName, SensorPattern, HorizontalHalfAngle, VerticalHalfAngle, ConeHalfAngle, PointingAzimuth, PointingElevation, and SensorLocation sequence.

The SensorObjectName for an Optical Imager field of view is an under-score upper camel case concatenation of SpacecraftObjectName, PayloadName, SpectrumType(s), AgilityType, and "FieldOfView".

The SensorObjectName for an Optical Imager field of regard is an under-score upper camel case concatenation of SpacecraftObjectName, PayloadName, and "FieldOfRegard".

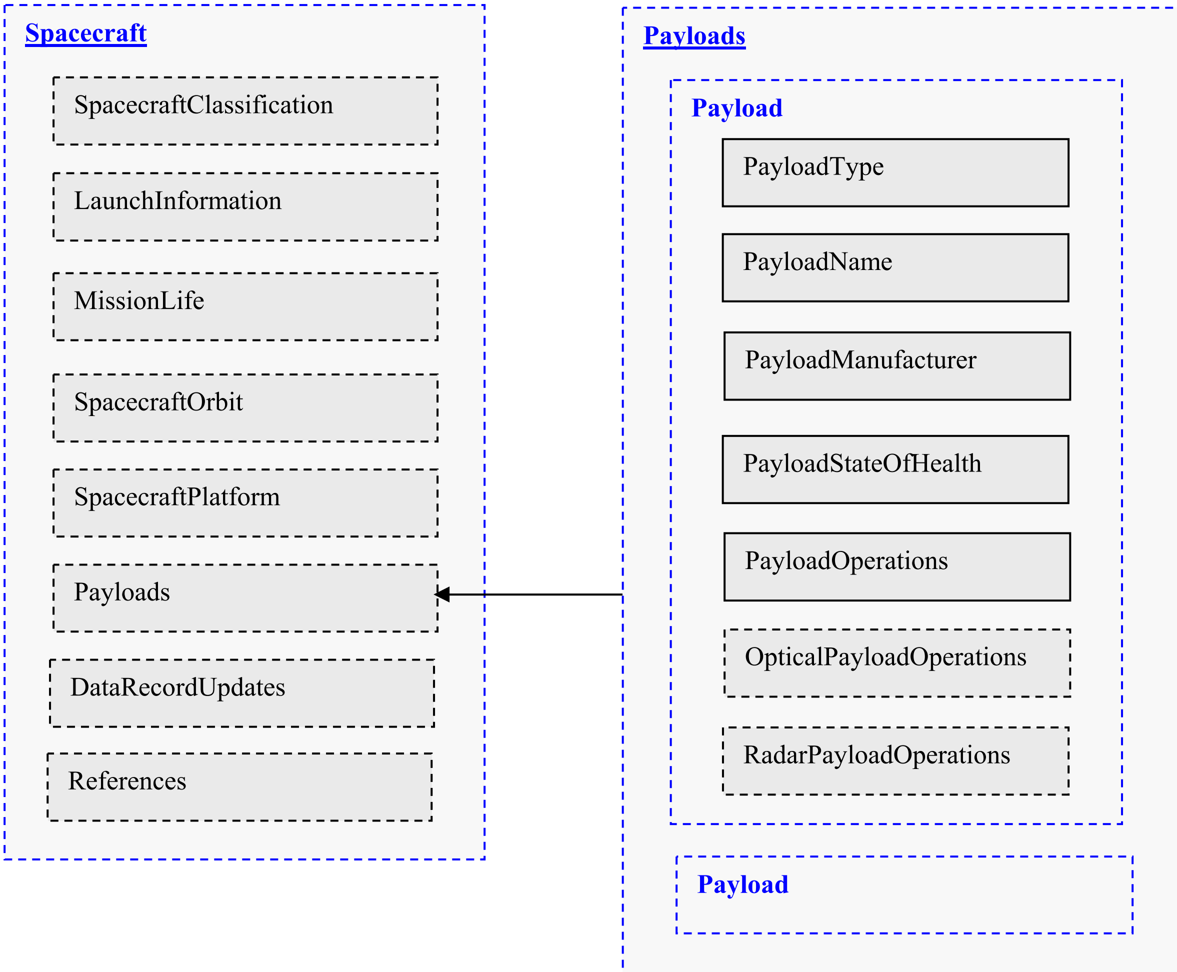
The SensorObjectName for a Radar Imager field of view is an under-score upper camel case concatenation of SpacecraftObjectName, RadarPayloadOperationName, and "FieldOfView".

The SensorObjectName for an Optical Imager field of regard is an under-score upper camel case concatenation of SpacecraftObjectName, RadarPayloadOperationName, and "FieldOfRegard".

Database versus Wiki

The SOC data container is a database. An earlier design used a wiki as the container. A wiki was chosen because it is an easy-to-use mechanism for allowing public users to update the spacecraft data entries. However a wiki has several drawbacks. Adding to the spacecraft elements in a particular wiki page or changing the appearance of the wiki page requires changing all the pages for all the other spacecraft in order to maintain a consistent content and appearance.

Another drawback is the exporting of data from the wiki page to the XML document that is used to create SOC objects. This would require writing code to extract the data from the wiki page to populate the XML document or viewing the wiki page and entering the data manually. Both approaches were viewed as cumbersome.



Payload Types

Optical Imager   Radar Imager   Radiometer   Spectrometer   Polarimeter
Sounder   Altimeter   Radar   Lidar   Solid State Data Recorder   Hard Drive Data Recorder
Magnetic Tape Data Recorder   Orbit Determination   GPS Receiver   Laser Retro-Reflector
Laser Communication Terminal   L-Band Antenna   S-Band Antenna   C-Band Antenna
X-Band Antenna   Ku-Band Antenna   Ka-Band Antenna …

Figure 11. Spacecraft Schema Overview (Part 1 of 2)

Spacecraft schema elements define the spacecraft description XML document and are the basis of the spacecraft SQL database

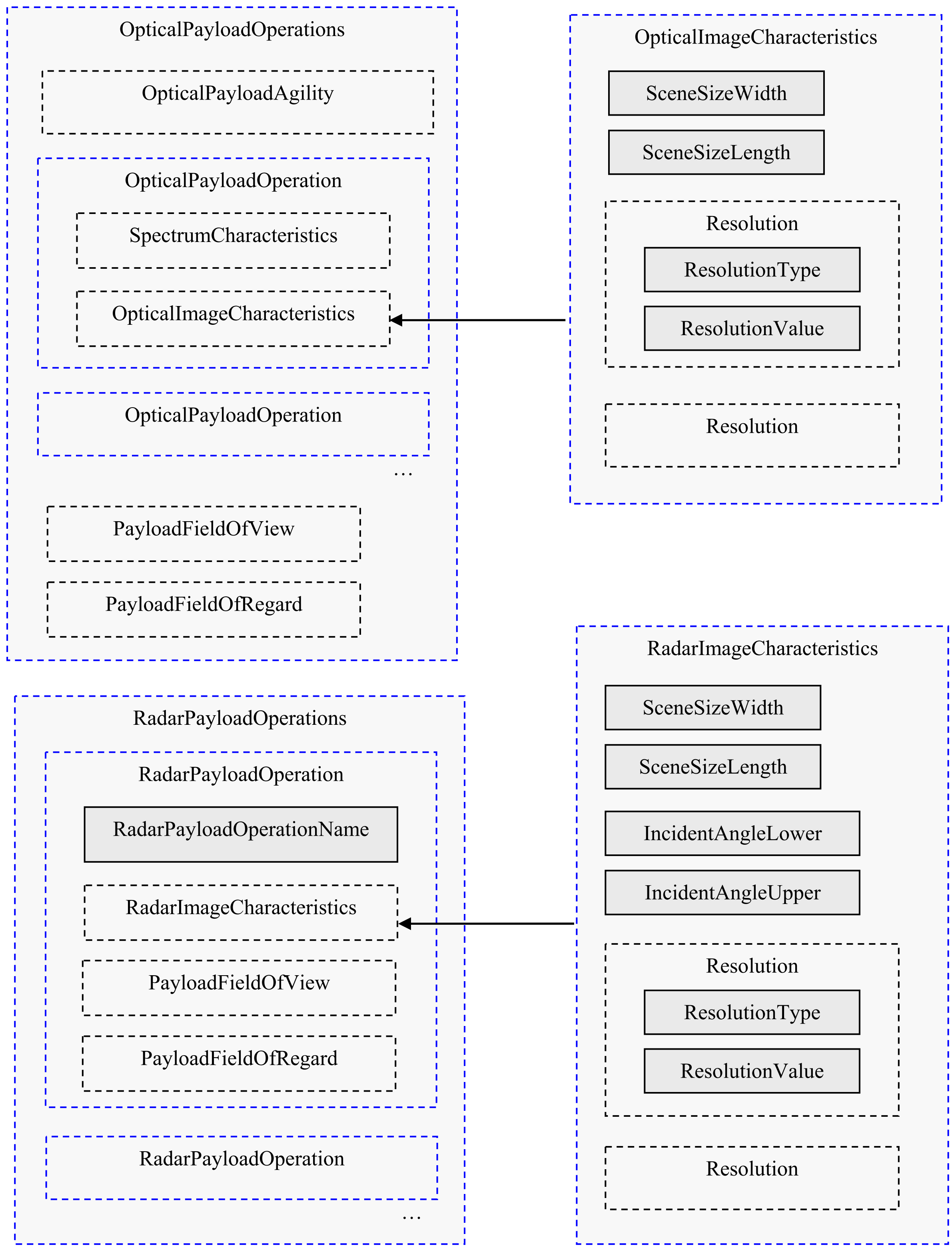


Figure 11. Spacecraft Schema Overview (Part 2 of 2)

ImageCharacteristics determine FieldOfView and FieldOfRegard which are used to generate spacecraft scenarios and mission modeling capabilities

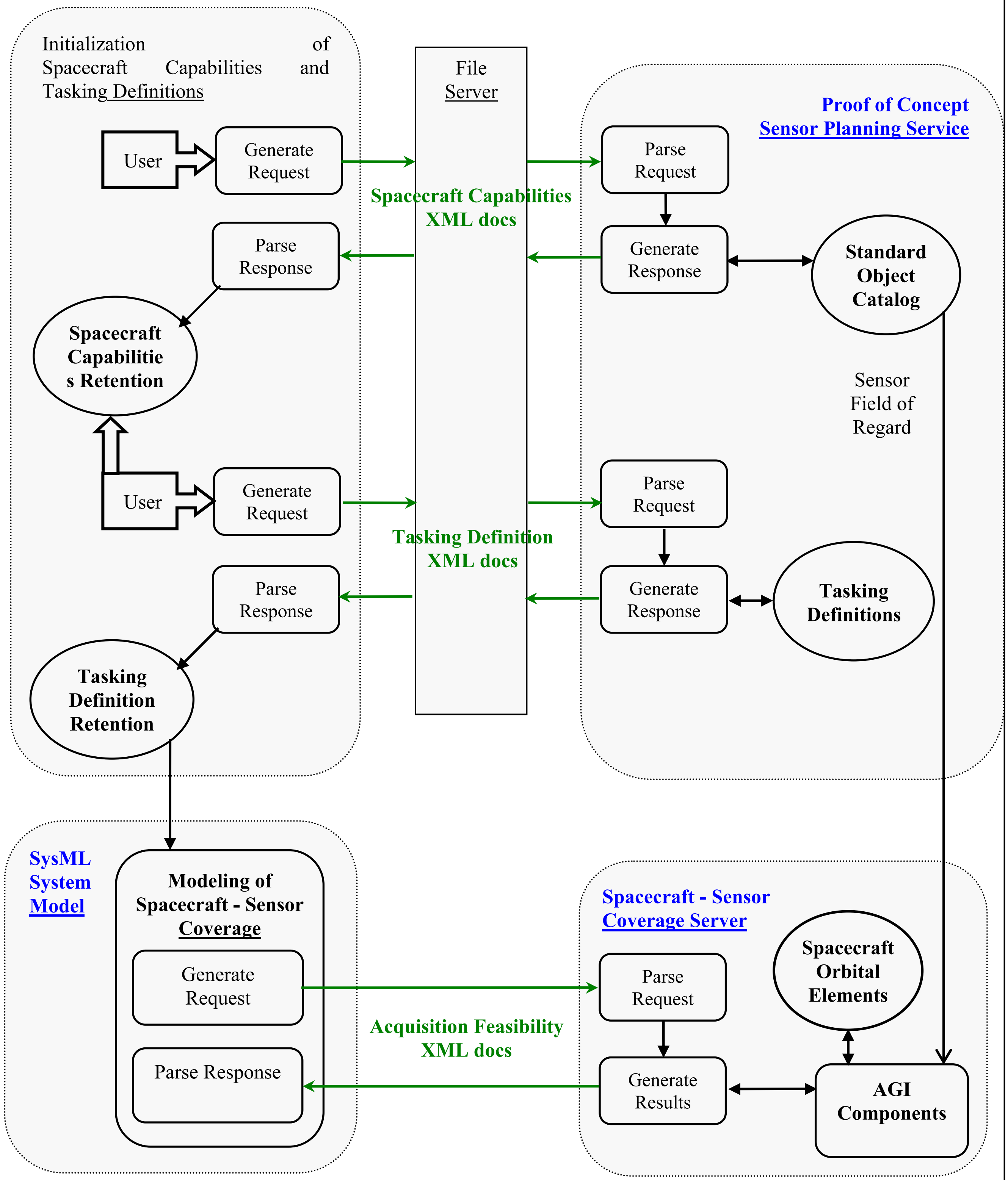


Figure 12. Work Flow Needed for AGI Components to Support SysML Modeling

Mission modeling capabilities can be used to evaluate SysML generated spacecraft scenarios

Additionally, the wiki became more cumbersome to use as the spacecraft descriptions became more detailed and structured with nested elements.

Finally, the wiki does support entering data using an enumeration list to assure uniformity of names in support of database searches.

6. SysML System Modeling

Figure 12 shows the work flow prototyping that supports the design of an interface between SysML system modeling and AGI's mission modeling capabilities. The setup of the SpacecraftCapabilities and TaskingDefinition is as previously outlined.

The SysML System Model has code that generates an AcquisitionFeasibilityRequest XML document for specified SpacecraftSensorPairings and FeatureOfInterest, sends the Request to the Spacecraft - Sensor Coverage Server, and receives back the AcquisitionFeasibilityResponse XML document.

This work flow prototyping is carried out in conjunction with the International Council on Systems Engineering (INCOSE) Space Systems Working Group SysML modeling of a FireSat system. The FireSat system is a hypothetical space-based system for detecting, identifying, and monitoring forest fires.

7. Future Work

The PoC-SPS will be enhanced to include a polygon FeatureOfInterest. The AcquisitionFeasibilityResponse sequence will be enhanced to include percent coverage statistics. The prototype will be hosted on-line. The design will be brought into compliance with the SPS Implementation Specification.

The beta version of the Standard Object Catalog contains 59 optical and radar imaging satellites with 78 unique sensors and 149 unique operating modes. The spacecraft and sensor descriptions will be added to and updated based on user community inputs that have gone through vetting procedures. A potential application to be investigated after the sensor descriptions have been well-vetted is the application of these COTS SPS capabilities in international disaster monitoring services.

8. Conclusions

An SPS providing a COTS GetFeasibility operation will make it easier for users to discover sensors that fulfill their needs. A COTS common interface will provide the user with one well-known set of operations for the initial discovery of candidate sensors. A final selection of sensors can be carried out using the SPS operations of the individual Data Providers.

Additionally, an SPS server containing a catalog of sensors can be created to provide the users with one-stop-shopping for the initial discovery of candidate sensors.

The operations being developed now are for optical and radar sensors, but are extensible to Earth observation scientific sensors.

References

[1] David Kaslow, "COTS Implementation of a Sensor Planning Service GetFeasibility Operation", 2009 IEEE Aerospace Conference Proceedings, March 7-14, 2009.

[2] Document #07-014r3 at http://www.opengeospatial.org/

Biography

Dave Kaslow is Director, Product Data Management at Analytical Graphics, Inc. He has thirty-six years of experience in both the technical and management aspects of developing ground mission capabilities.

He is also editor of Spacecraft Digest, www.stk.com/scdigest, which tracks current and future spacecraft and spacecraft missions.

He is co-author of "Defining and Developing the Mission Operations System", "Activity Planning", "FireSat" and "Spacecraft Failures and Anomalies" in Cost-Effective Space Mission Operations.

He is also the author and co-author of papers for the International Council on Systems Engineering (INCOSE) Annual International Symposiums and for the IEEE Aerospace Conference.

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