Application Layer Standards for Space
The OMG Connection

Overview

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Systems Standards
**Agenda**

- Briefly introduce the OMG organization
  - Describe OMG / CCSDS relationship

- Present Overview of Space Domain Reference Architecture
  - Body of presentation materials developed by Space Satellite Ground Systems Working Group (SSGS WG) under OMG auspices
Why OMG

- Organizational infrastructure in place
- Significant international vendor community
- Not for profit
- Frequent meetings worldwide (5/year)
- Credibility in technical community
- Leverage existing body of work
- Track record integrating technologies
Object Management Architecture

Non-standardized application-specific interfaces

Vertical domain-specific interfaces

Internet facility interfaces

Application Interfaces

Domain Interfaces

CORBAfacilities

Object Request Broker

CORBAservices

General service interfaces

Benefits of Space Task Force / CCSDS Relationship

- **SSGS WG provides**
  - Access to OMG processes
  - Access to OMG members (especially vendors, integrators and commercial end users)
  - Access to other OMG groups and standards

- **CCSDS provides**
  - Space domain expertise and standards
  - International standards organizations
  - Validation, verification, and testing

- **SSGS and CCSDS together provide a natural synergism to successfully develop “space” standards for distributed object computing**
Open Standard Interfaces for Space

Reference Architecture
Status and Recommendations

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Why OMG Space Standards Now?

- Shrinking Space Budgets
- Increasing Size of Market
- Increased Non-Government Share of Market
- Increased internationalization of the Market
- Reduced Technology Insertion Time Requirements
- Technology Advancements Facilitate Industry Development of Standards
Space Domain
(Information Flow)

Problem Space

Relay Satellite

Spacecraft and Scientific Instruments

Data Acquisition and Command

Mission Operations

Instrument / Sensor Operations

Data Processing

Data Archive

Data/Information Distribution

Data Analysis and Modeling

Science Team

External Science Community
Mission Control System Processes

Mission Operators

Science Users

Mission Operations System

Ground Terminal Systems

Spacecraft Systems

Ground Station Operations Complex Control Center Operations

S/C Planning & Control S/C Execution S/C Observation & Science

Science & Observation Planning Mission Planning & Operations Flight Analysis & Control Science Processing & Analysis
Reference Architecture
Generic Functional Structure

Mission wide (horizontal) monitor & control services

System and subsystem (vertical) control services

Space Domain unique vertical applications

Standard vertical apps used by many systems

Foundation distributed system services (include network, OS, CORBA, ...)

Hardware & Physical assets
### Space Domain
#### Mission Control Services

<table>
<thead>
<tr>
<th>Ground</th>
<th>Flight</th>
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<tr>
<td>- Plan &amp; Schedule</td>
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<td>- Control ground &amp; flight elements</td>
<td>- Control flight &amp; ground elements</td>
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<td>- Monitor (Flt &amp; Gnd)</td>
<td>- Monitor (Flt only)</td>
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- Top level overarching control services typically include planning and scheduling functions
- All of these overarching services include high level monitor & control functions
- Support for these monitor & control functions are required in subordinate service elements for full interoperability
- Control loops may be closed locally within a single system or amongst distributed elements
- Control loops may be closed by automated processes or manually or both, as required
Specific Space Application Services

- **Plan & Schedule**
  - LR planning
  - Event planning
  - Activity Scheduling

- **Control System Elements**
  - Control all exec elements (At all levels in system)

- **Monitor (Flt & Gnd)**
  - Mon gnd system
  - Mon flt systems
  - Trending and analysis
  - Fault detection & recovery (At all levels in system)

- **Navigation Plan & Analyze**
  - Traj/orbit estimate
  - Traj/orbit analysis
  - Maneuver directive

- **Guidance Plan & Analyze**
  - Attitude estimate
  - Attitude control directive
  - Pointing control directive

- **Command & Response**
  - Command load create
  - Command load uplink
  - Closed loop control

- **Telecommunications**
  - Communications sched & control
  - Communications execution

- **Data Management**
  - Object management
  - File management
  - Message management

- **Data Transport**
  - File delivery
  - Message delivery (Reliable & unreliable)
  - Data delivery (Stream & Packet, reliable & unreliable)

- **Time Synchronization**

- **Science processing**
  - Science extraction
  - Data compression
  - Data mining

- **Data Products & Distribution**
  - Product generation
  - Product distribution
Example of Telecommunications Services

Return Link (telemetry) Service

Forward Link (command) Service

Modified from CCSDS Panel 3
Service Management

- All conformant services must be managed
  - The exchange of management information can be implemented using a variety of technologies (e.g., management services and protocols, middleware technologies, simple file transfers, and/or human procedures)

- Aspects of service management
  - Scheduling and resource allocation (explicit services in OMG Space TF model)
  - Configuration and initialization
  - Control and monitor
  - Fault management (explicit services in OMG Space TF model)
  - Security
  - Performance management
  - Accounting
Interoperability Benefits

- **For interoperability and “plug-and-play”**
  - Well-determined components with well-defined interfaces
    - Interface specification and semantic specification
  - An architecture that can apply these interfaces
    - Support necessary in both the architecture itself and in the components

- **Interoperability infrastructure supports**
  - Component reuse and multi-vendor integration
  - User selection of component functionality (and cost)
  - System scalability and adaptation
  - Easier flight / ground integration
Life Cycle Benefits

- Mission Planning
- Science Planning
- Sensor / Platform Integration & Test
- End-to-End Integration & Test
- Pre-Launch Checkout
- Ascent / Deployment
- Operations
- Science Operations
- Science Production
- End of Life Activities
Summary

- The Space TF Reference Architecture provides a conceptual model of a distributed space system.
- The Reference Architecture defines a set of service categories and their interactions.
- The CCSDS developed SLE services provide a useful model for definition of a specific set of components that implement these services and their APIs.
- This component model and representational approach can be applied to the rest of the Space Application Services.
- Much work remains to be done to define the specific services, their interfaces, and functionalities.