Application Layer Standards for Space
The OMG Connection

Overview

JPL

Presented by:

Peter Shames, NASA / JPL
Manager, JPL Information Systems Standards

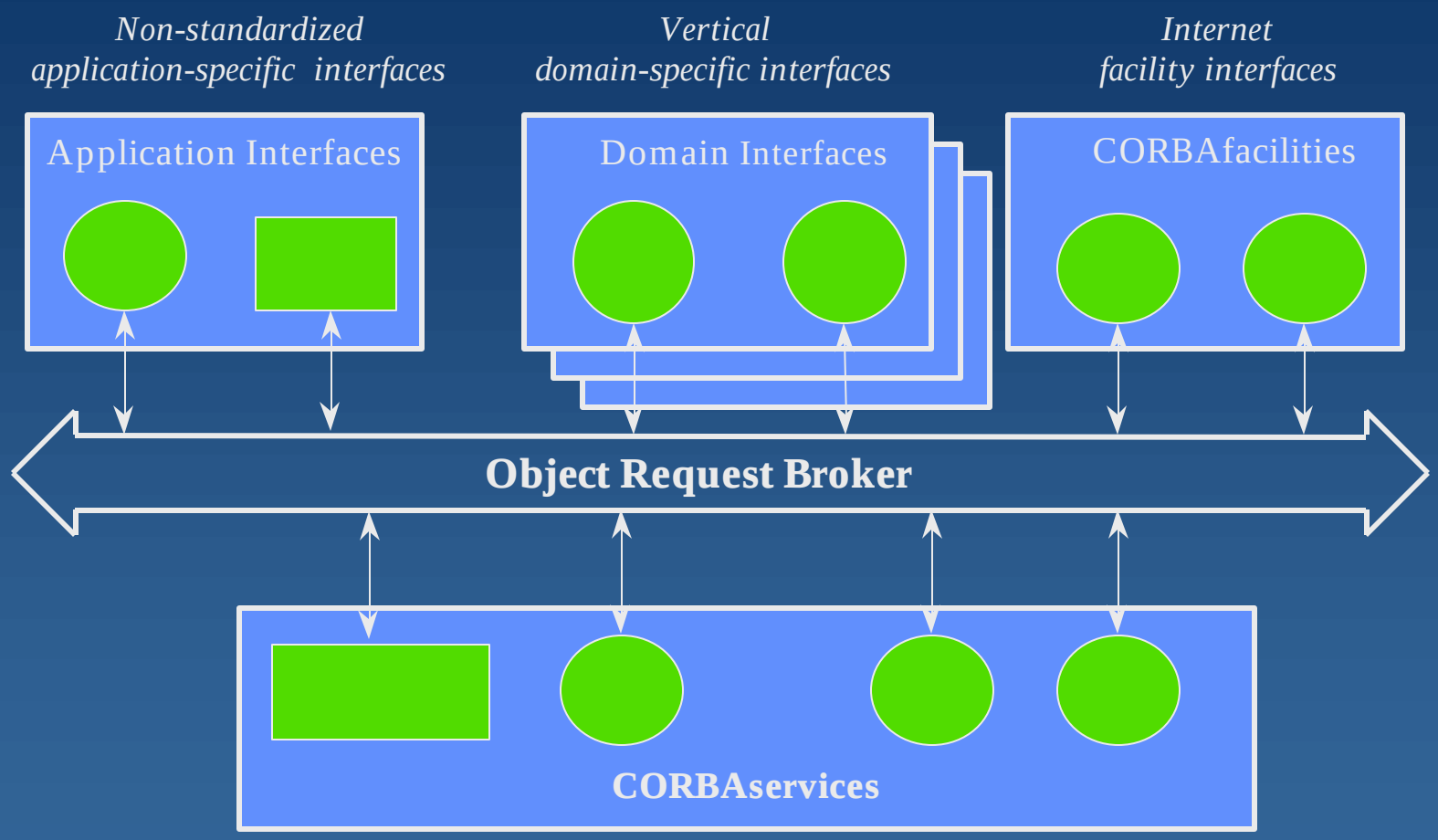
Agenda

- 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



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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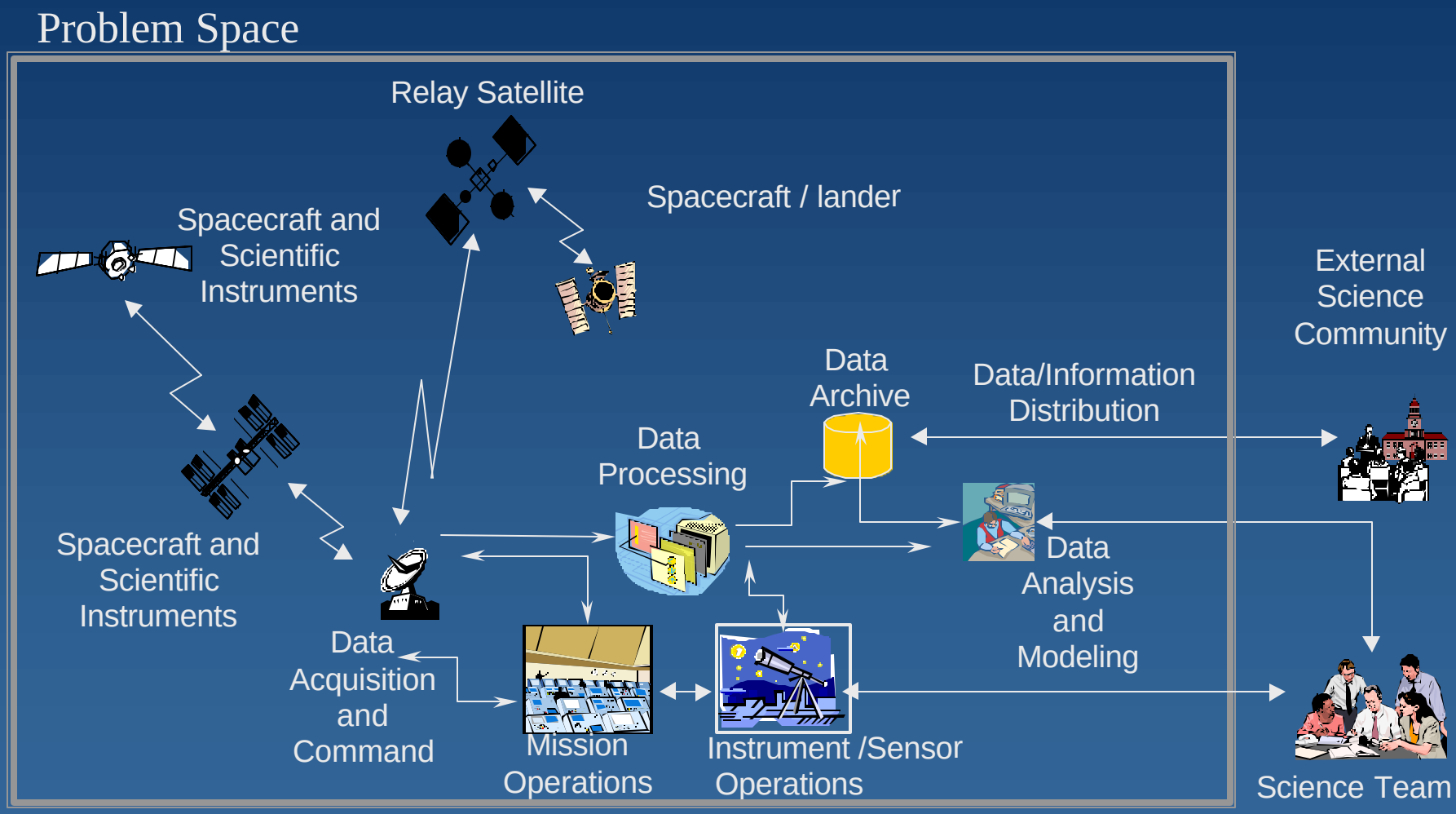
Prepared by:

Bill Branch, CSC
Alan Jeffries, VEGA
Henry Rothkopf, MITRE
Peter Shames, JPL
Jim Wetherbee, Altair

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)



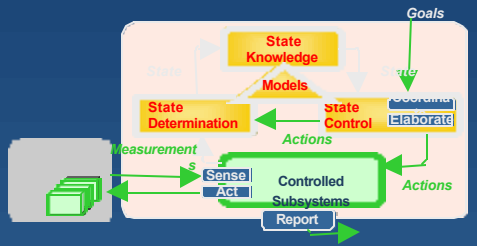
Mission Control System Processes

Mission Operators

Science Users

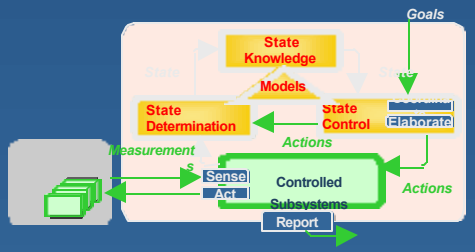
Mission Operations System

Science & Observation Planning
Mission Planning & Operations
Flight Analysis & Control
Science Processing & Analysis

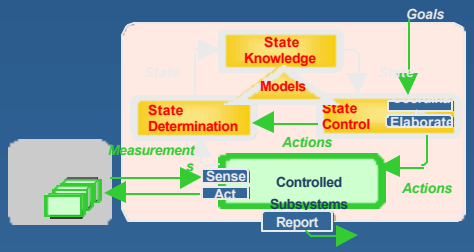


Service Operators

Ground Terminal Systems



Spacecraft Systems



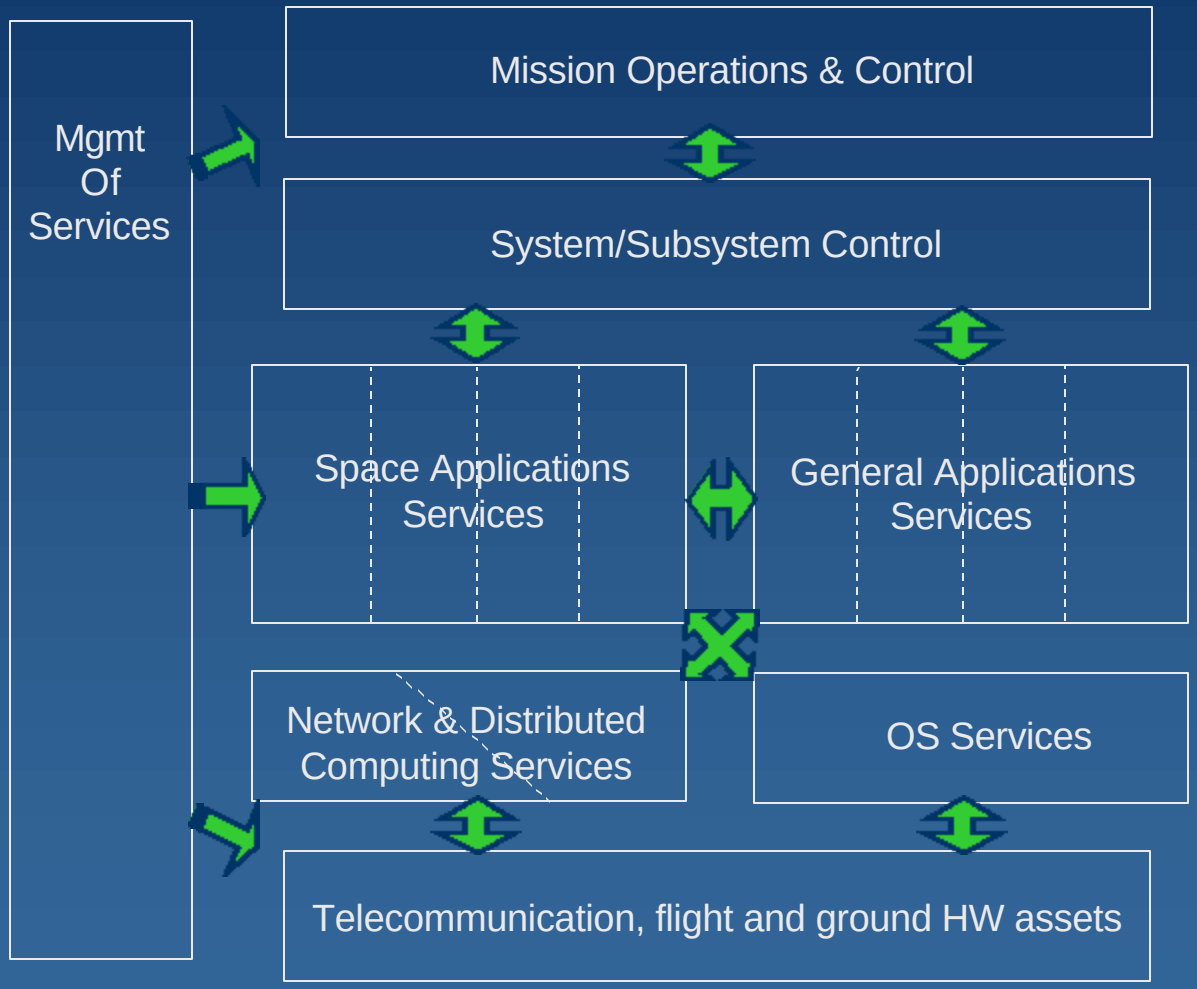
Space Link

Ground Station Operations
Complex Control Center Operations

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

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

Ground

- Plan & Schedule
- Control ground & flight elements
- Monitor (Flt & Gnd)

Flight

- Plan & Schedule
- Control flight & ground elements
- Monitor (Flt only)

Mission Control Services

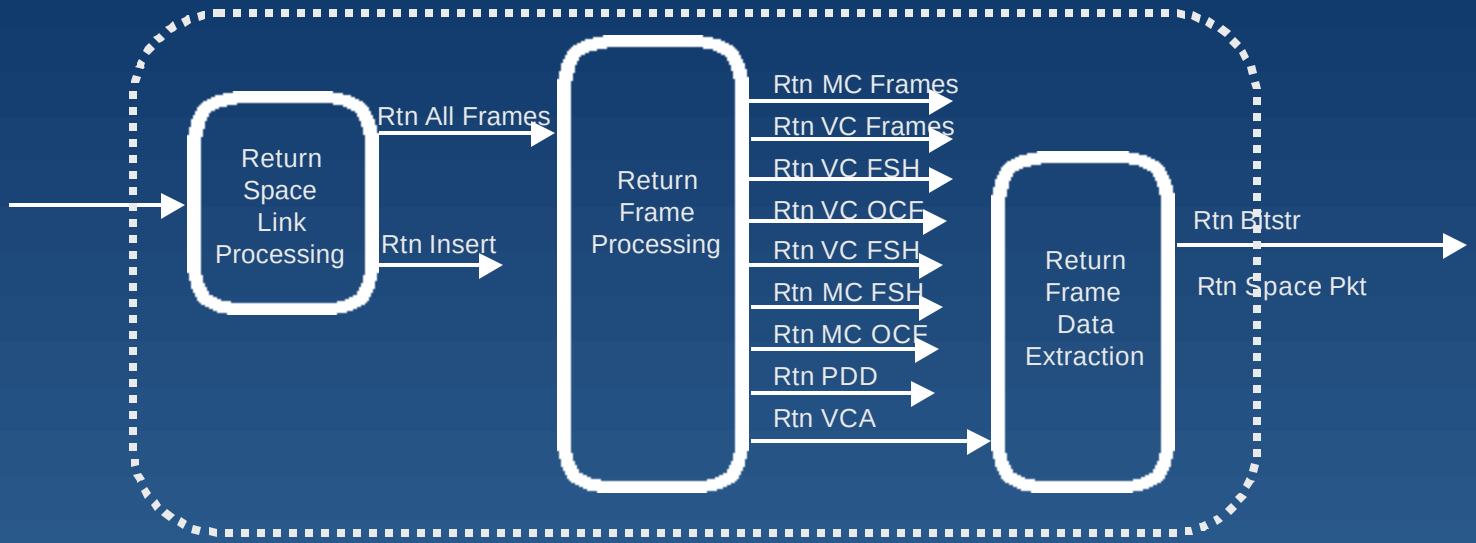
- Top level overarching control services typically include planning and scheduling functions
- All of these overarching services include high level monitor & control functions
- Support for these monitor & control functions are required in subordinate service elements for full interoperability
- Control 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

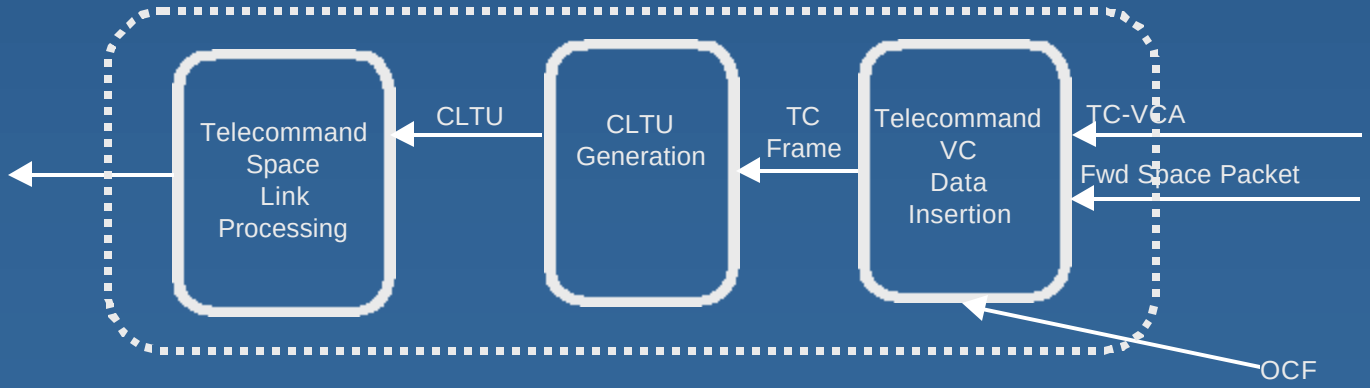
- Plan & Schedule
  - LR planning
  - Event planning
  - Activity Scheduling
- Control System Elements
  - Control all exec elements (At all levels in system)
- Monitor (Flt & Gnd)
  - Mon gnd system
  - Mon flt systems
  - Trending and analysis
  - Fault detection & recovery (At all levels in system)
- 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