



Global Science & Technology

**CCSDS Space Link Extension
Service Management Standards
and Prototyping Activities**

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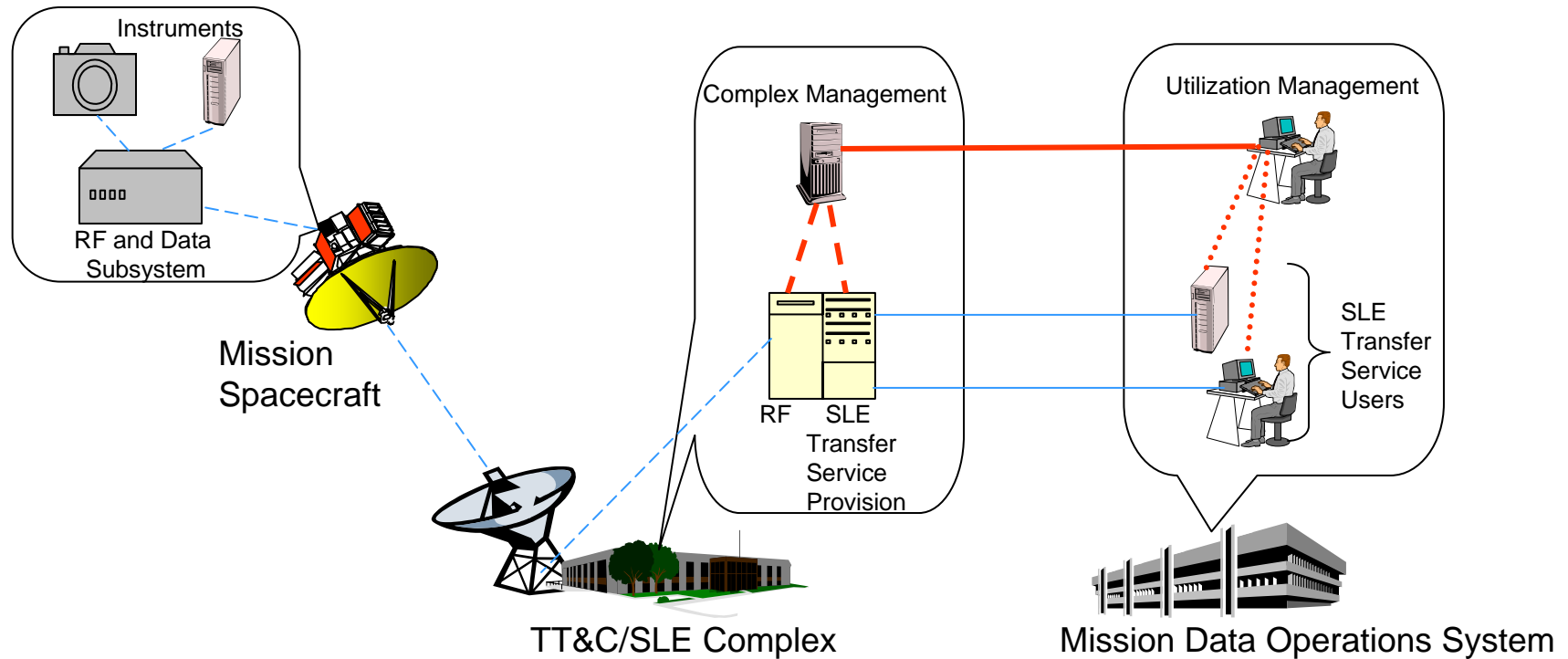
Outline

- **Background and motivation for Space Link Extension (SLE) Service Management (SM)**
- **SLE-SM context**
- **CCSDS SLE-SM specification overview**
- **International prototyping efforts: status and plans**

Background and Motivation

- **Creation of SLE data transfer services**
 - **Need to manage the configuration of those services**
- **Standard management of standard SLE services as alternative to ad hoc management methods**
- **“While we’re at it”, address long-standing lack of standards for TT&C service management (e.g., scheduling)**

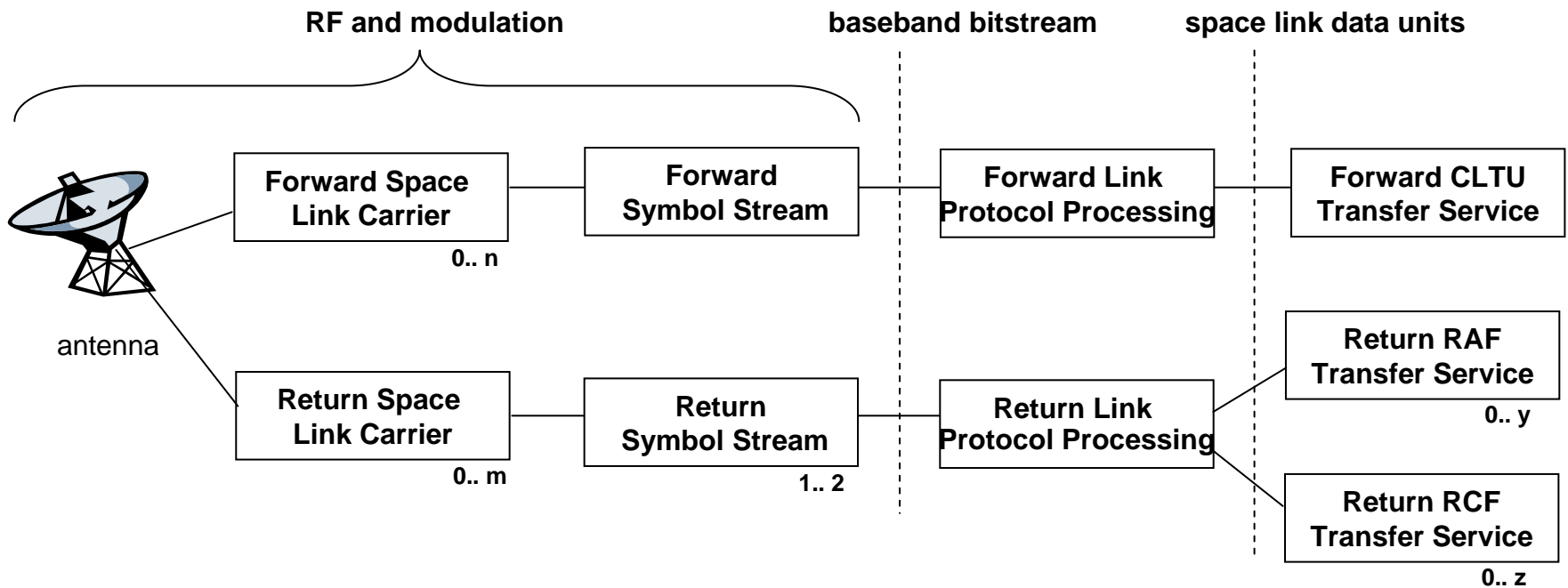
SLE-SM Context



Utilization Management and Complex Management Roles

- **Utilization Management (UM)**
 - The function(s) within spaceflight mission management that are responsible for acquiring and operating TT&C and SLE service on behalf of the mission
- **Complex Management (CM)**
 - The function(s) of the Complex that are responsible for:
 - » Establishing the TT&C/SLE service relationship with the mission
 - » Negotiating length and levels of service (*service agreement*)
 - » Responding to *service requests* for individual contacts
 - » Responding to requests to change service configuration
 - » Responding to requests for service status information
 - » Issuing service status reports
 - » Translating and actuating the service requests on the Complex's resources, and collecting status from those resources to synthesize service status

CCSDS SLE-SM Resource Model



SLE-SM Specification Overview

- **Focus on the interface by which UM requests services for individual contacts (*service request* subset of SLE-SM)***
 - SLE-SM information model
 - SLE-SM transactions
- **Representation of the associated management information in eXtensible Markup Language (XML) schema**

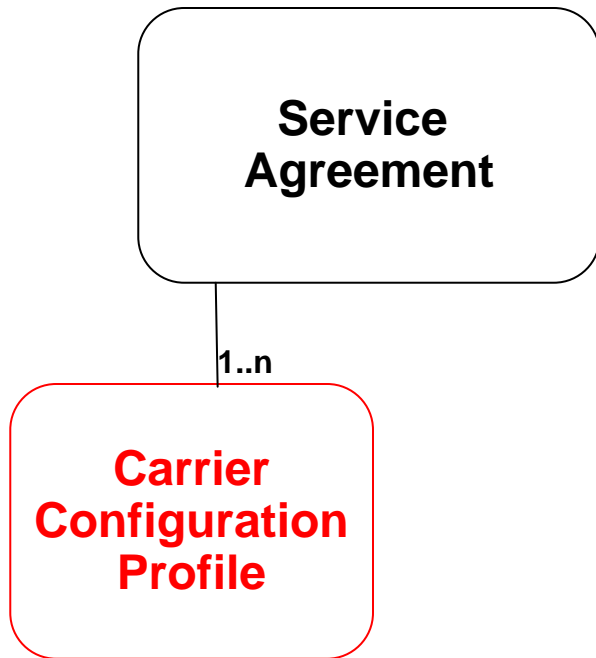
***Other UM-CM interactions are potential topics of future standardization**

SLE-SM Information Model: Service Agreement

**Service
Agreement**

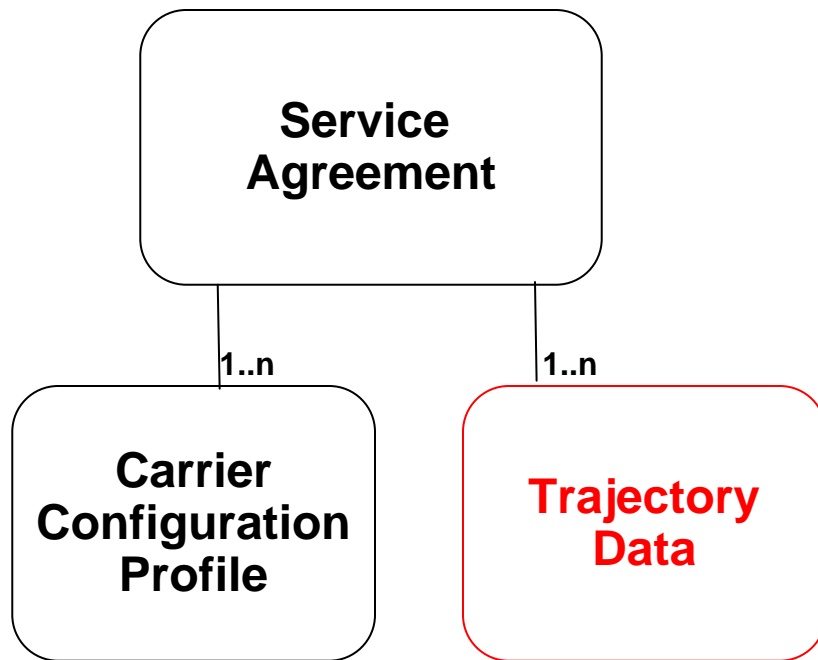
- **Long-lived (conceptual) repository of rules and constraints against which configuration profiles and service requests can be validated**
 - Frequency ranges
 - Possible modulations
 - Possible coding options
 - Maximum number of type XXX data transfer service instances
 - Possible transfer service delivery modes
 - Etc.
- **Provides an “namespace” for interactions between UM and CM**

SLE-SM Information Model: Carrier Configuration Profile



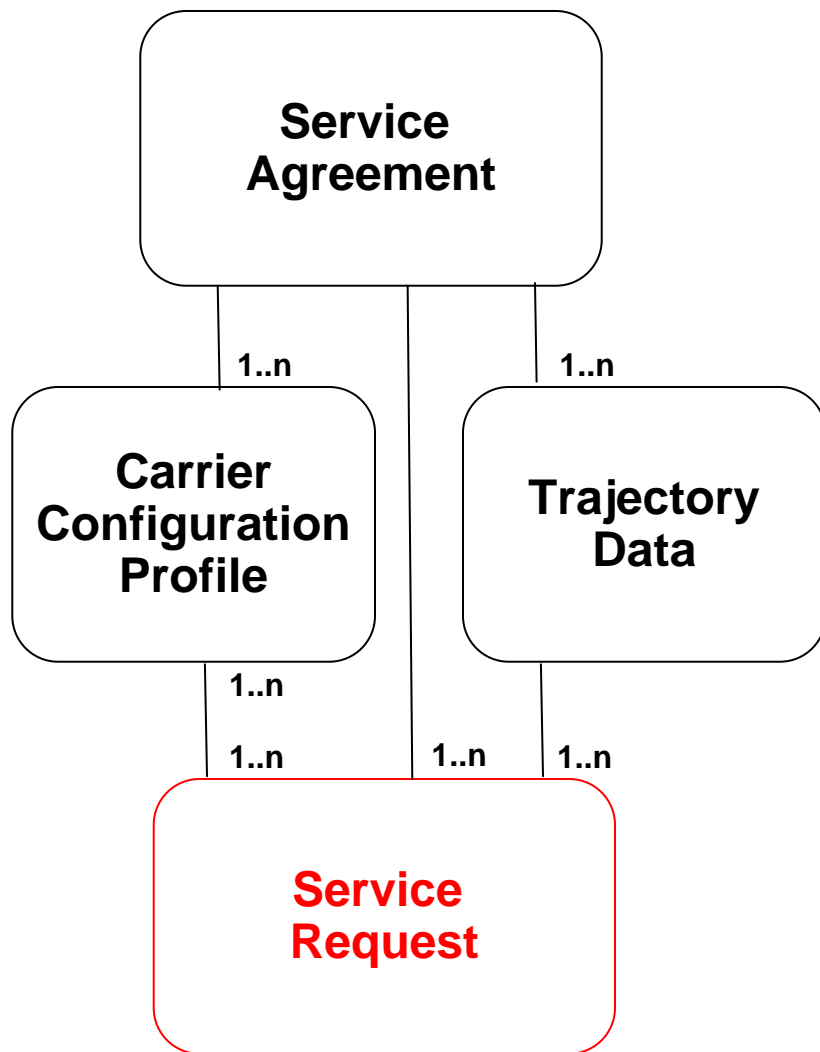
- **Parameter values for a single RF carrier configuration**
 - Forward or return
 - Modulation
 - » Number of symbol streams
 - Frequency
 - Coding
 - Etc.
- **Contains one or more transfer service profiles per symbol stream**
- **Must be valid with respect to the Service Agreement**
- **Multiple configuration profiles may exist for a Service Agreement**

SLE-SM Information Model: Trajectory Data



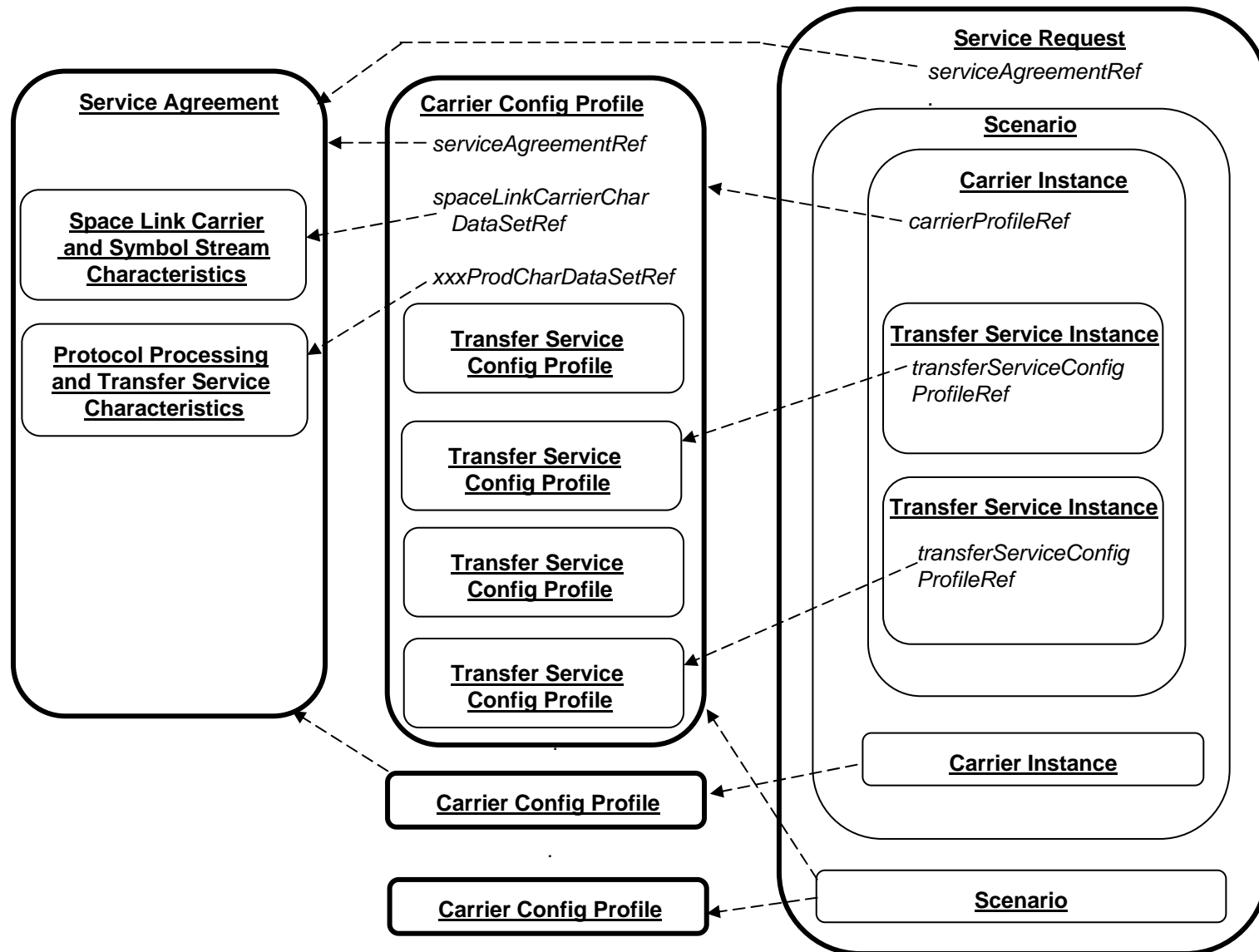
- Predictive information used to derive pointing angles and Doppler compensation
- Time-dependent
- Multiple predictive data sets may exist for the same time
 - E.g., launch/maneuver contingencies
- Stable state vectors
 - CCSDS Orbit Parameter Message (OPM)
- Ephemeris
 - CCSDS Ephemeris Parameter Message (EPM)

SLE-SM Information Model: Service Request



- Request for TT&C and SLE services for a specific period of time (contact, pass)
- Composed of references to (multiple) existing carrier and transfer service configuration profiles
 - Specifies preferred start and stop times for each RF carrier, plus acceptable lag and lead times
- May include multiple *scenarios*
 - Alternate sets of carrier configurations that may be invoked on short notice
- References an existing trajectory data file
- Must be valid with respect to the Service Agreement

SLE-SM Information Model: Referencing Framework



Service Request Transactions

(1 of 2)

- **Service Request**
 - **New service request**
 - » **Result: *acknowledged, accepted, or rejected***
 - **Replace service request**
 - » **Only replaces in-place request if success is guaranteed**
 - » **Makes possible incremental scheduling of resources**
 - » **Result: *acknowledged, accepted, or rejected***
 - **Delete service request**
 - » **Result: *acknowledged, deleted, or deletion failed***
 - **Invoke alternate scenario**
 - » **Result: *successful or failed***
 - **Query service request**
 - » **Result: *successful or failed***

Service Request Transactions

(2 of 2)

- **Configuration Profile**
 - New configuration profile
 - Delete configuration profile
 - Query configuration profile
- **Trajectory**
 - New trajectory
 - Replace trajectory
 - Delete trajectory
- **Service Agreement**
 - Query service agreement

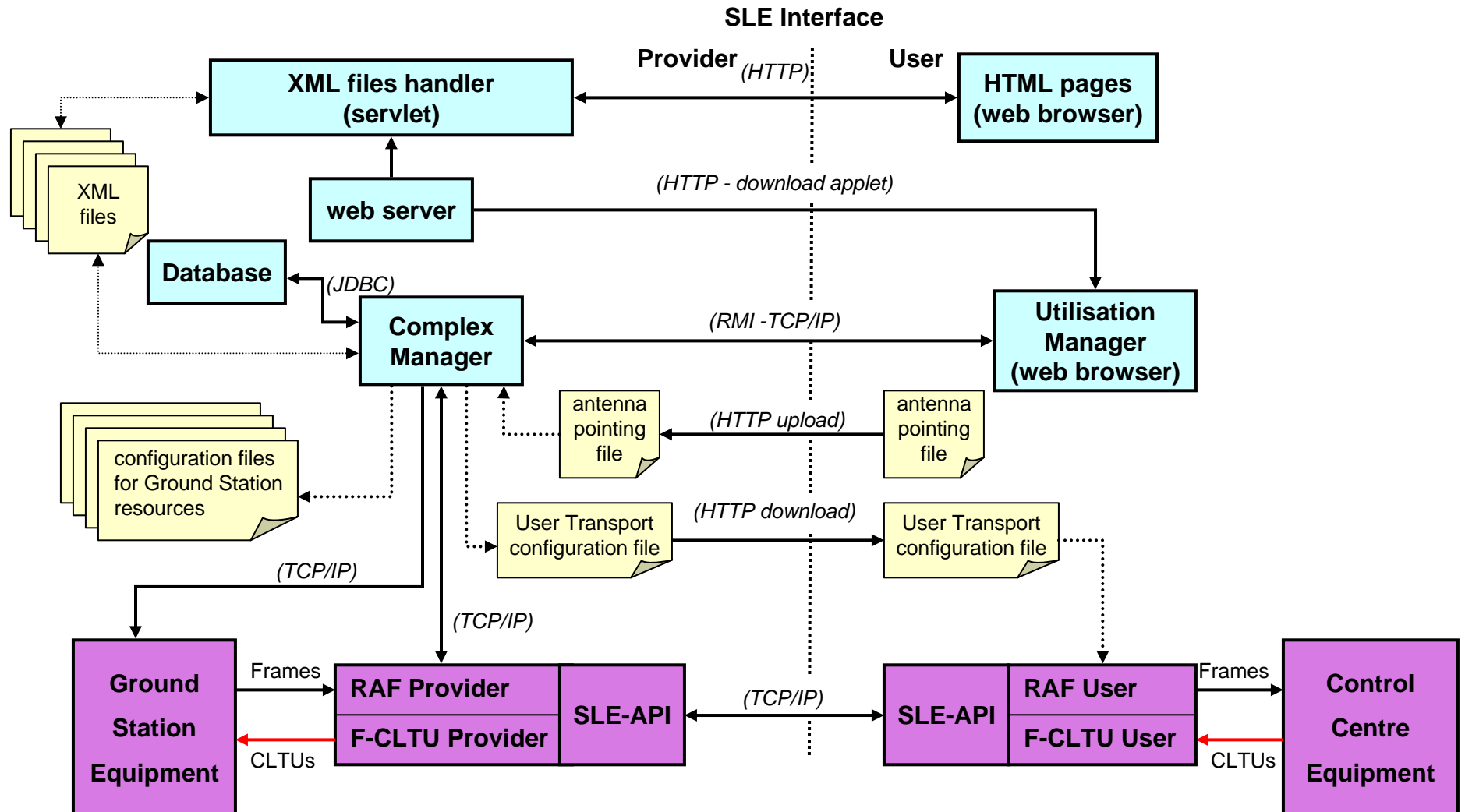
Extending SLE-SM Service Request Framework

- **SLE-SM standard is currently “CCSDS centric”**
- **Extension points for management of non-CCSDS standard services**
 - **Plug in additional or replacement types for components of the resource model**
- **Adaptation of the referencing framework to allow hybrid standard/legacy implementations**
 - **Use of legacy aspects subject to bilateral agreements**

SLE SM Prototyping Activities

- **Round 1 – Stand-alone prototype implementations**
 - **2000 – Spring 2003**
 - **Developed against previous SLE-SM specifications and early draft schema**
 - **Local extensions/modifications/interpretations of standards needed to bring prototypes to fruition**
 - **The prototypes have provided valuable feedback to the evolution of the SLE-SM concepts, requirements, and schema**
- **Round 2 – Interoperability among the prototypes**
 - **Late fall 2003 – CY2004**
 - **Different development teams creating prototype UM and CM implementations against a common subset of “stable” draft version (V0.1.2) of SLE-SM XML schema**

BNSC/Vega SLE-SM Prototype

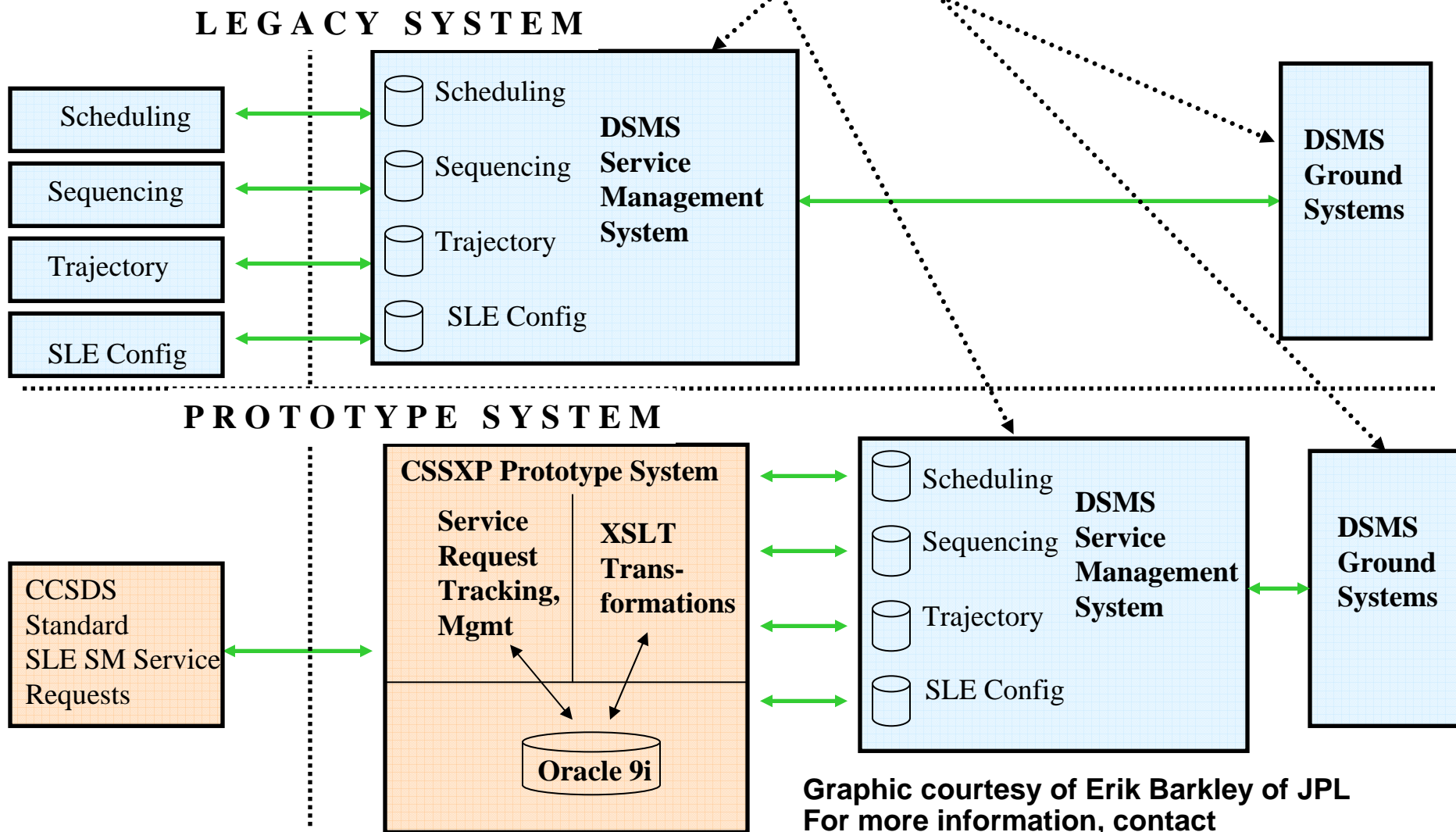


Graphic courtesy of Paula Quintela of Vega Group plc
 For more information contact Paula (Paula.Quintela@vega.co.uk)

NASA/Jet Propulsion Laboratory (JPL) CCSDS SLE SM XML Prototype (CSSXP)



1st Order Test: Equivalent Inputs. 2nd Order Test: Shadow track Mission.

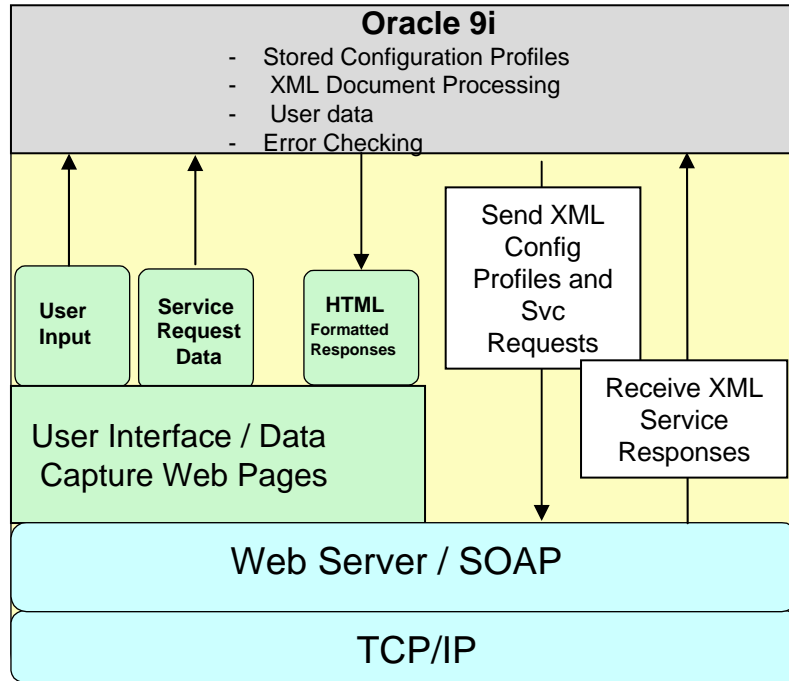


Graphic courtesy of Erik Barkley of JPL
For more information, contact
Erik.J.Barkley@jpl.nasa.gov

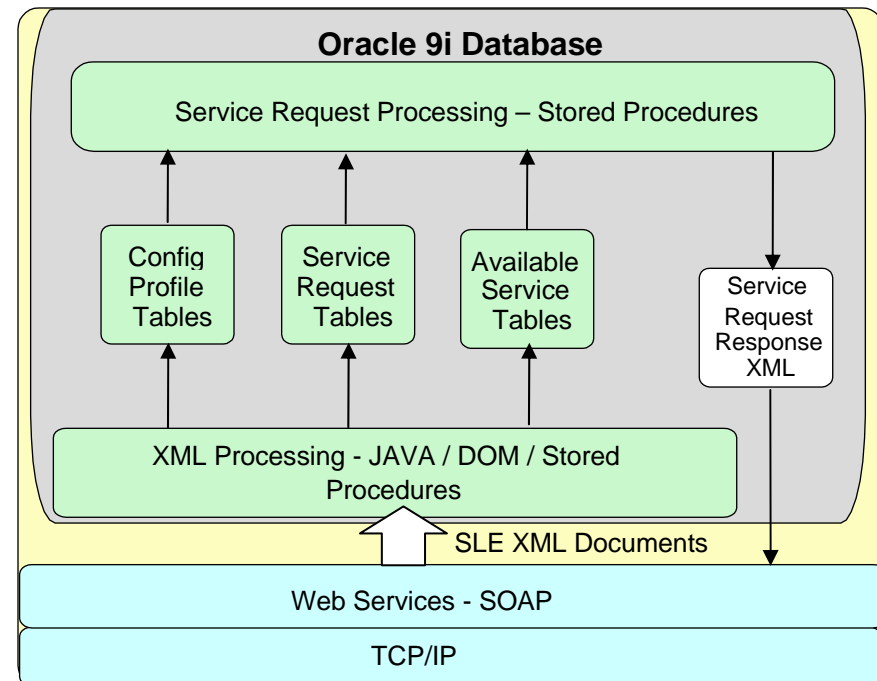
NASA Consolidated Space Operations Contract (CSOC)/Lockheed Martin SLE Management Prototype



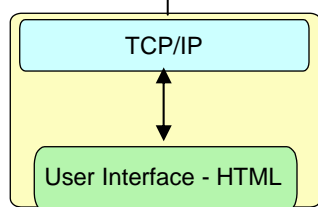
Utilization Management



Complex Management



TCP/IP Network



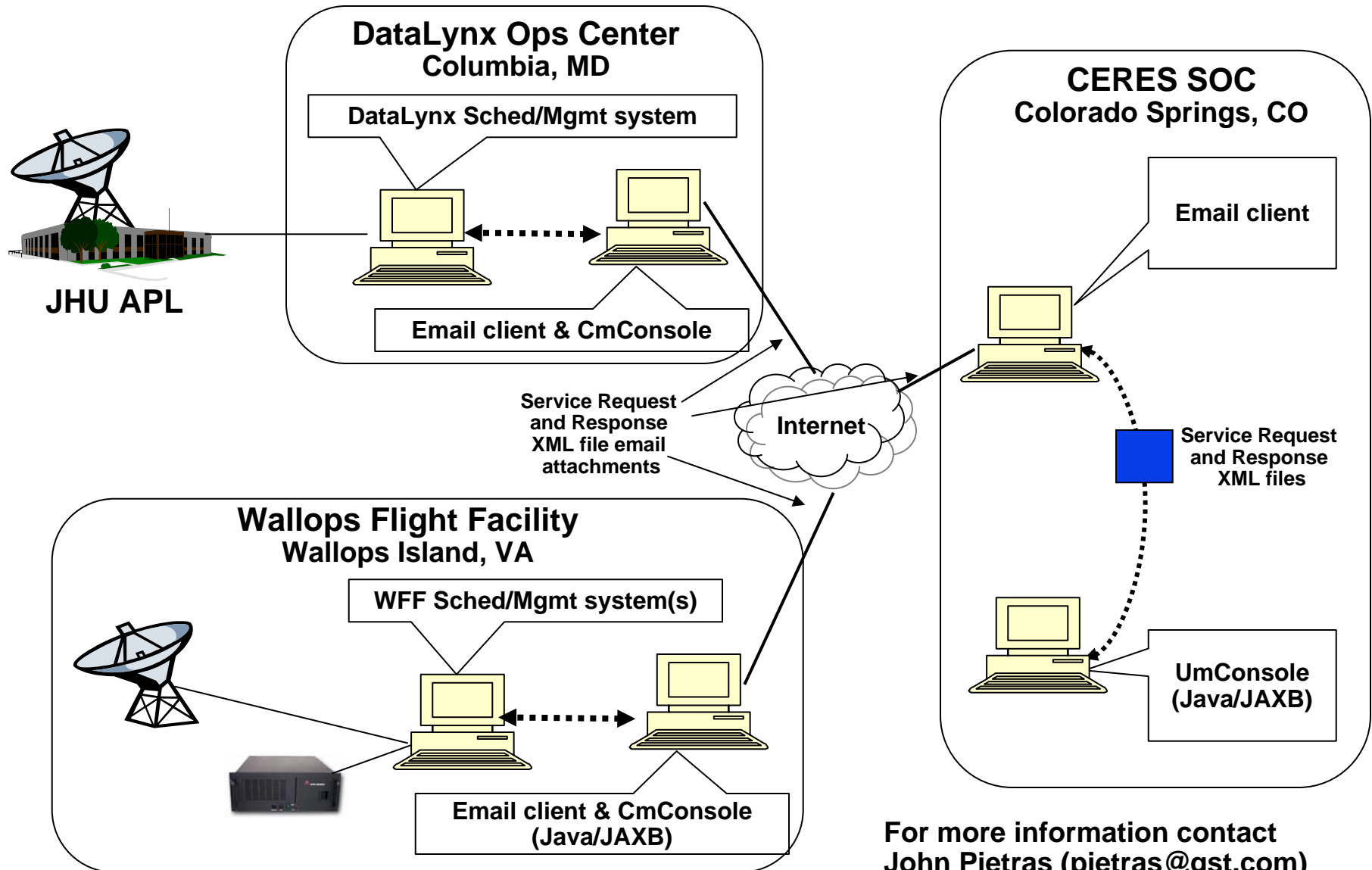
User Workstation

- COTS Communications and Web Services
- SLE SM Prototype Developed Software
- CCSDS P3 Defined XML Data Formats
- COTS client and server platforms
- Oracle 9i Relational Database

Graphic courtesy of Andy Schreckenghost of Lockheed -Martin

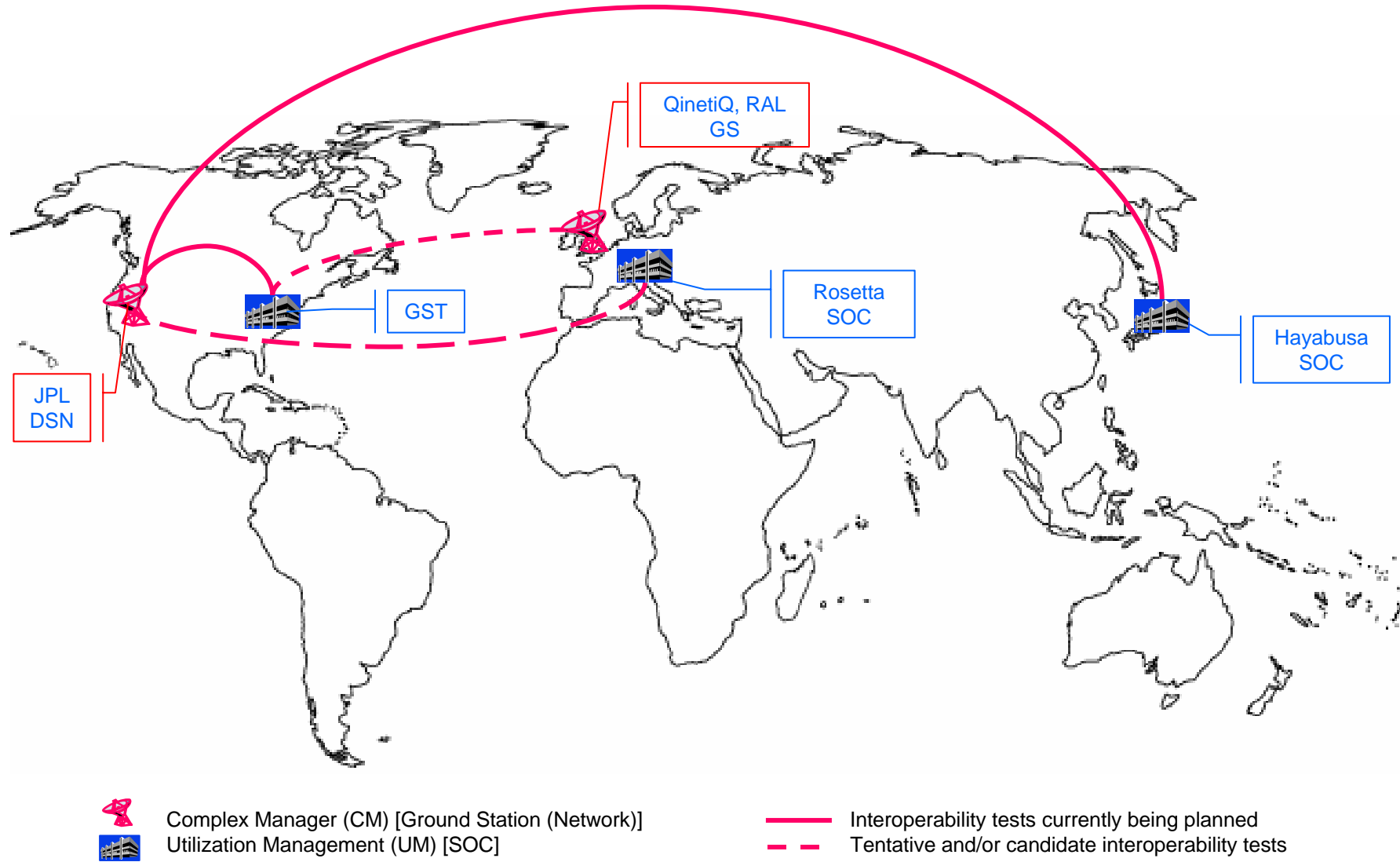
For more information contact Lindolfo Martinez of Lockheed-Martin
(Lindolfo.Martinez@csoconline.com)

Air Force Satellite Control Network (AFSCN)/ GST Interoperability Project Phase 3 SM Prototype



For more information contact
John Pietras (pietras@gst.com)

Round 2: SLE-SM Prototype Interoperability Tests



AFSCN/GST UM – JPL DSN CM

- **Purpose**
 - Demonstrate interoperability of independently-developed implementations of SLE-SM standards
 - Expose unforeseen implementation dependencies
- **GUI UM application generates New Service Request, Replace Service Request, Delete Service Request, Invoke Alternate Scenario, and Query Service Request invocations**
- **JPL CM application receives and validates service requests, generate DSN support products, and generates XML responses to invocations**
- **Configuration profile instance documents generated by hand to enable validation of service requests**
- **Messages exchanged as text attachments to email messages**
- **Interoperability tests to begin in November 2003**
- **Possible future enhancements**
 - On-line email access
 - SOAP over SMTP
 - UM generation of configuration profiles

JAXA Hayabusa UM – JPL DSN CM

- **Purpose**
 - **Validate JPL DSN SLE-SM prototype processes in the context of an operational spacecraft**
 - » **Japan Aerospace Exploration Agency (JAXA) Hayabusa (formerly Muses-C), launched in May 2003**
 - **Expose SLE-SM to ISAS/Hayabusa mission operators for insight and feedback**
- **Hayabusa mission operators generate SLE-SM-compliant XML representations of real operational requests for DSN support**
 - **These may be generated by hand, or perhaps by a prototype UM application**
 - **Transferred using SMTP**
- **JPL DSN CM prototype validates service requests, generates DSN support products, and generates XML responses to invocations**
- **JPL and Hayabusa personnel compare operational and prototype support products to validate correctness of support products generated by prototype**
- **Testing with Hayabusa-generated messages to begin November 2003**

European Space Agency (ESA)/Vega UM – JPL DSN CM (Tentative)

- **ESA funding of Vega development of UM currently in negotiation**
- **Purpose**
 - **Prototype UM application for possible use in support of future ESA missions**
 - » **ESA Rosetta is the prime candidate**
 - **Expose SLE-SM to ESA mission managers and operations community for insight and feedback**
- **ESA/Vega UM generates service requests for JPL DSN support**
 - **Exact catalog of SLE-SM interactions to be supported still under consideration**
- **JPL DSN CM prototype validates service requests, generates DSN support products, and generates XML responses to invocations**
- **SLE-SM products and process evaluated by ESA mission managers and operators**
- **Interoperability testing could begin sometime after April 2004**
- **Shadow-mode testing using Rosetta would likely follow**

GST UM – BNSC/Vega CM (Candidate)

- **Could be executed in CY2004**
- **Purpose**
 - **Provide additional assurance through use of second CM implementation**
- **Replicate capabilities exercised in tests with JPL CM**
 - **Ensure global support of a common core set of capabilities**
- **Additional capabilities and applications TBD**
- **Could involve QinetiQ, RAL, or both**

Acknowledgements

- **NASA (HQ) Data Systems Standards Office**
- **Goddard Space Flight Center Data Systems Standards Office**
- **Jet Propulsion Laboratory Data Systems Standards Office**
- **U.S. Air Force Space and Missile Systems Center (SMC)/Range Network (RN)**

- **Erik Barkley, JPL**
- **Andy Schreckenghost, Lockheed-Martin**
- **Paula Quintela, Vega Group plc**
- **Hugh Kelliher, Space ConneXions Limited**



Backup Slides



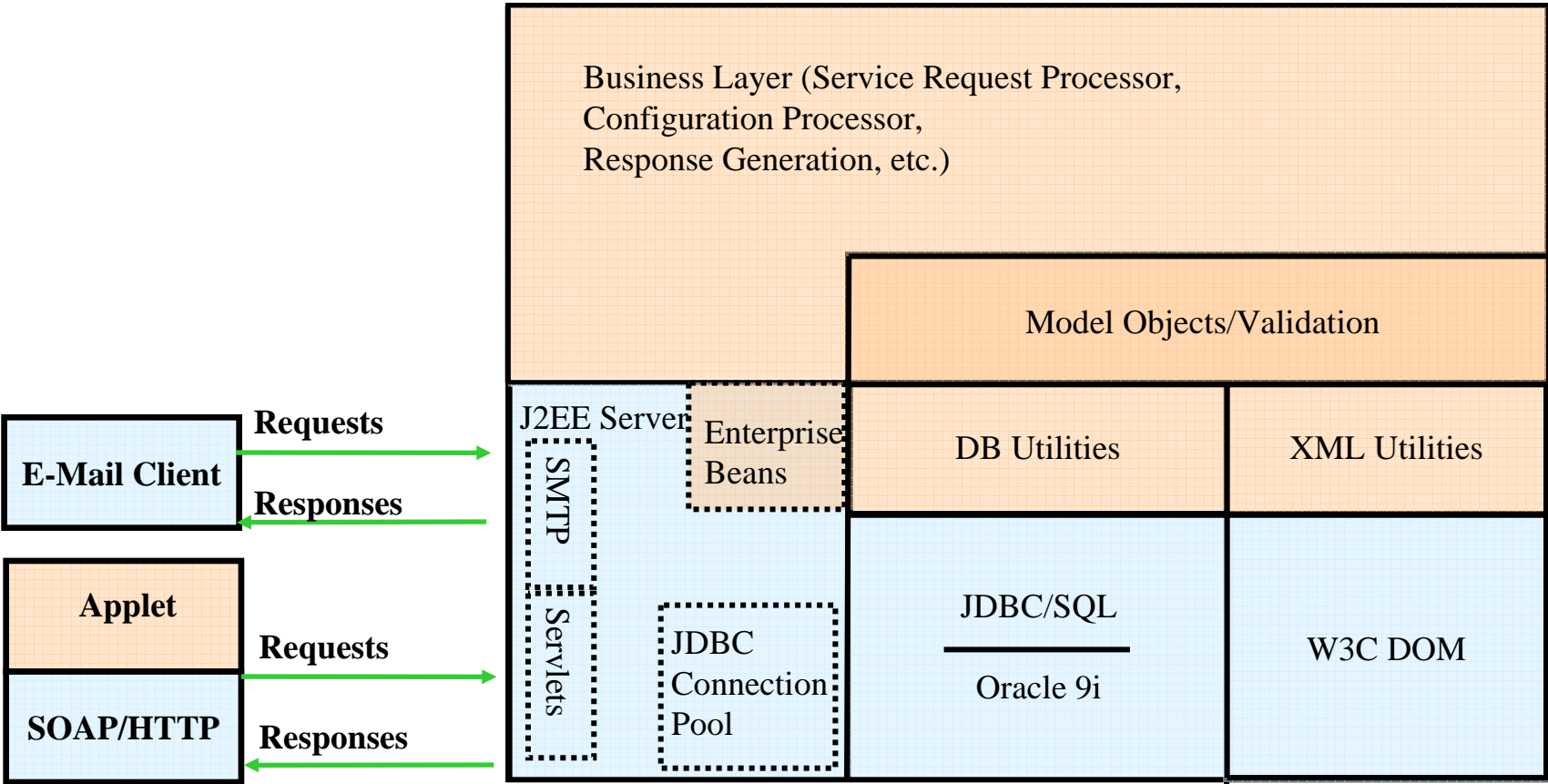
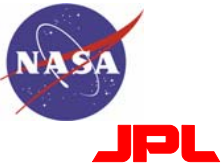
British National Space Centre (BNSC)/Vega SLE-SM Prototype

- **CM (provider-side) system is currently installed at QinetiQ ground station in West Freugh, UK**
 - **Based on earlier (pre-XML) SLE-SM managed object model**
 - **Web browser-based UM interface**
- **Vega is currently re-implementing CM system in compliance with latest-version SLE-SM XML schema V0.1.2**
 - **First release will receive and respond to service requests**
 - » **Service agreement and configuration profile information loaded locally**
 - **To be installed at both the QinetiQ ground station and the Rutherford-Appleton Laboratory (RAL) ground station in Oxfordshire, UK**
- **For more information, contact Paula Quintela of Vega Group plc**
 - **Paula.Quintela@vega.co.uk**

NASA/Jet Propulsion Laboratory (JPL) CSSXP

- XML/SOAP/HTTP/SQL/JDBC/Oracle-based CM prototype provides SLE-SM front-end to existing Deep Space Network (DSN) TT&C scheduling and configuration system
- Combined prototype/legacy system ingests SLE-SM service requests, generates support products used by DSN, and generates SLE-SM responses
- No UM (user) prototype: service request and configuration profile XML instance documents generated by hand using XMLSpy
- For more information, contact Erik Barkley of JPL
 - Erik.J.Barkley@jpl.nasa.gov

NASA/Jet Propulsion Laboratory (JPL) SLE-SM Prototype



Legend:
CSSXP Java code
COTS/Public Domain Code

Graphic courtesy of Erik Barkley of JPL

NASA CSOC/LM SLE Management Prototype



- Complete CM and UM prototype applications based on web services (XML/SOAP/HTTP) communications combined with SQL/ODBC/Oracle database relational processing
- Web-based end user screens supported via Apache webserver and JSP on the UM server
- Testing completed for most SLE Management features using latest available XML schemas
- Standalone effort completed September 30, 2003
 - Products transitioned to GSFC engineering
- For more information please contact Lindolfo Martinez of Lockheed-Martin
 - Lindolfo.Martinez@csocoonline.com

Air Force Satellite Control Network (AFSCN)/GST Interoperability Project Phase 3 SM Prototype

- **Java-based SLE-SM applications developed to schedule contacts from Johns Hopkins University Applied Physics Lab (APL) and NASA GSFC WFF ground stations in support of AFSCN Interoperability Project Phase 3**
 - **UM software installed at USAF Center for Research Support (CERES) SOC**
 - **CM generation software installed at Honeywell DataLynx Operations Center (control point for APL ground station) and WFF**
- **Draft SLE-SM schema extended to support Phase 3-unique aspects**
- **No integration with operational systems**
 - **Short implementation time (~1.5 months)**
 - **Limited duration of Phase 3**
 - **Security isolation requirements**
- **For more information please contact John Pietras of GST**
 - **pietras@gst.com**