

**Standards-Based TT&C
Service Management:
Prototype Applications
and
User Involvement**

John Pietras, Global Science and Technology, Inc.

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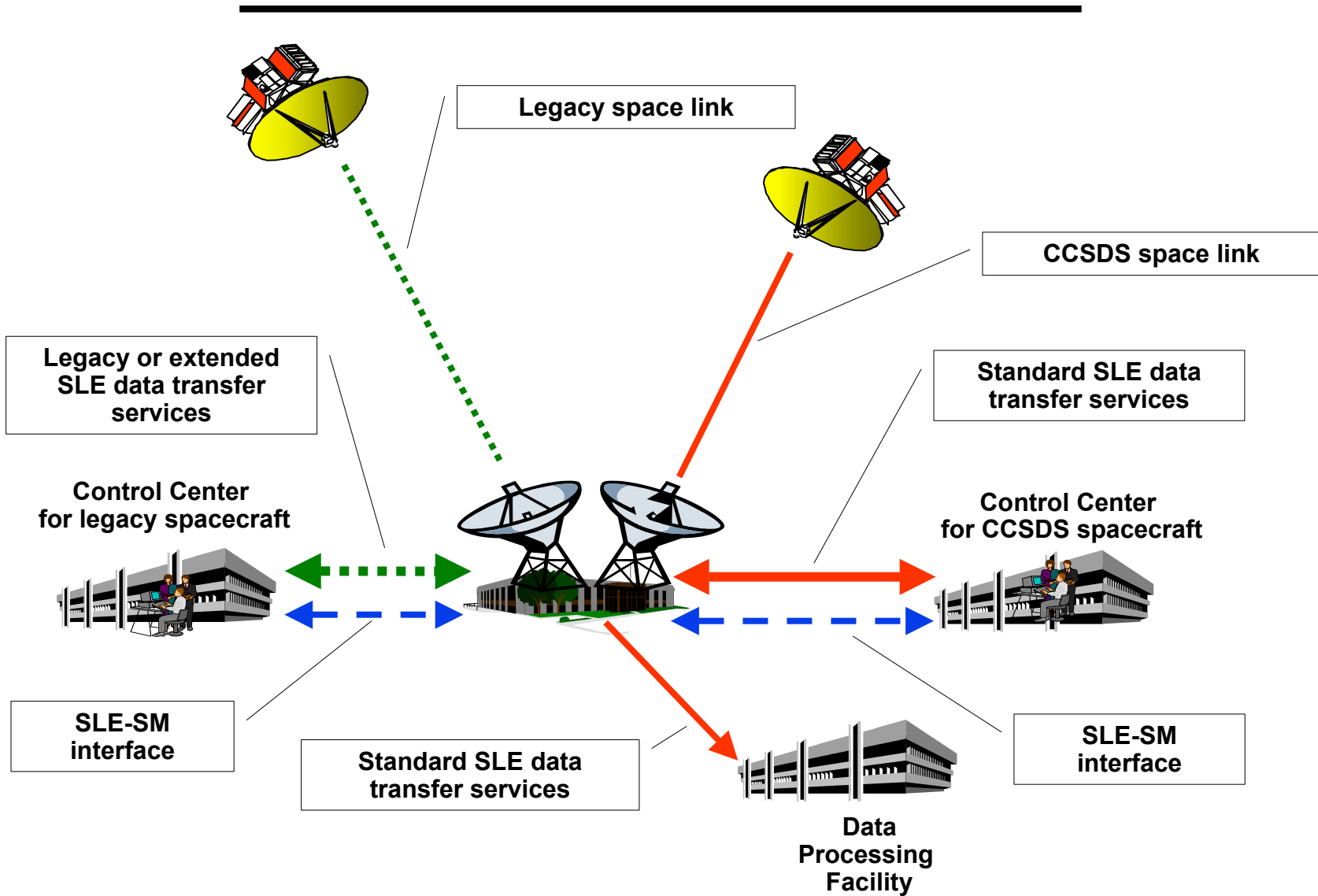
Agenda

- **CCSDS Space Link Extension Service Management (SLE-SM) scope and current status**
- **Current SLE-SM prototype implementations**
- **Expanding user involvement in the space data standards process**

Scope of CCSDS SLE-SM

- **Encompasses the interactions between spaceflight mission and TT&C service provider to:**
 - **Commit to support the mission**
 - **Acquire specific support periods (aka passes or contacts)**
 - **Monitor and control TT&C service parameters**
 - **Monitor and control SLE transfer services (RAF, RCF, CLTU)**
 - **Exchange spacecraft trajectory (acquisition) data**
 - **Exchange service accounting information**
- **Enables TT&C and SLE transfer services to be managed in a unified way**
- **Standard is extensible to support management of legacy space link protocols and data transfer services**

Support for CCSDS and Legacy Spacecraft



Current Status of CCSDS SLE-SM

- **Current focus on using the eXtensible Markup Language (XML) for the near-term realization of SLE-SM**
- ***SLE-SM Service Request Operations Concept Green Book and Service Request Specification White Book* are in-progress**
 - **First version of specification focuses on the Configuration Profile and Service Request transactions**
- **Emphasis on prototyping in support of specification development**



- **At least 5 groups working on related prototypes**

Prototyping Participants and Contributors

- **Hugh Kelliher –VEGA Group plc/UK**
 - hugh.kelliher@vega.co.uk
 - *Progress Report on the UK SLE Prototype*
- **Erik Barkley – NASA Jet Propulsion Laboratory (JPL)**
 - Erik.J.Barkley@jpl.nasa.gov
 - *JPL SLE Service Management XML Prototype*
- **Andy Schreckenghost – Lockheed-Martin/NASA Consolidated Space Operations Contract (CSOC)**
 - Andy.Schreckenghost@csoconline.com
 - *Lockheed-Martin/CSOC SLE Management Service Request Prototype*
- **John Pietras – Global Science and Technology, Inc. (GST)**
 - pietras@gst.com
- **Francois Jocteur Monrozier – Centre National D'Etudes Spatiales (CNES)/France**
 - jocteur-monrozier@cnes.fr

UK/VEGA Group plc

SLE-SM XML Prototype (Target)



SLE Interface

Provider

User

(HTTP)

(HTTP - download applet)

(RMI - TCP/IP)

(HTTP upload)

(HTTP download)

(TCP/IP)

(TCP/IP)

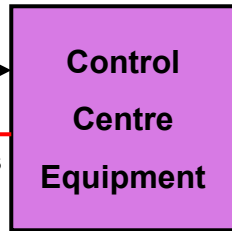
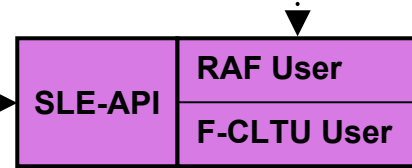
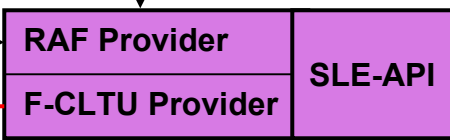
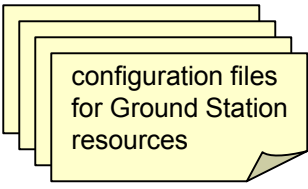
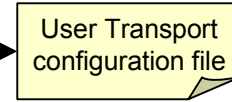
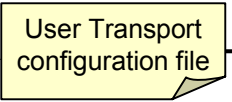
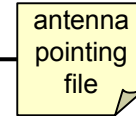
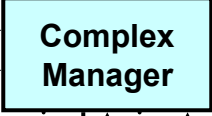
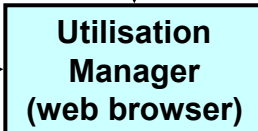
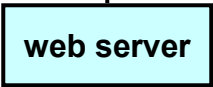
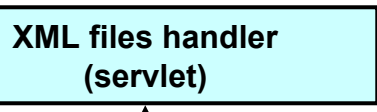
(TCP/IP)

Frames

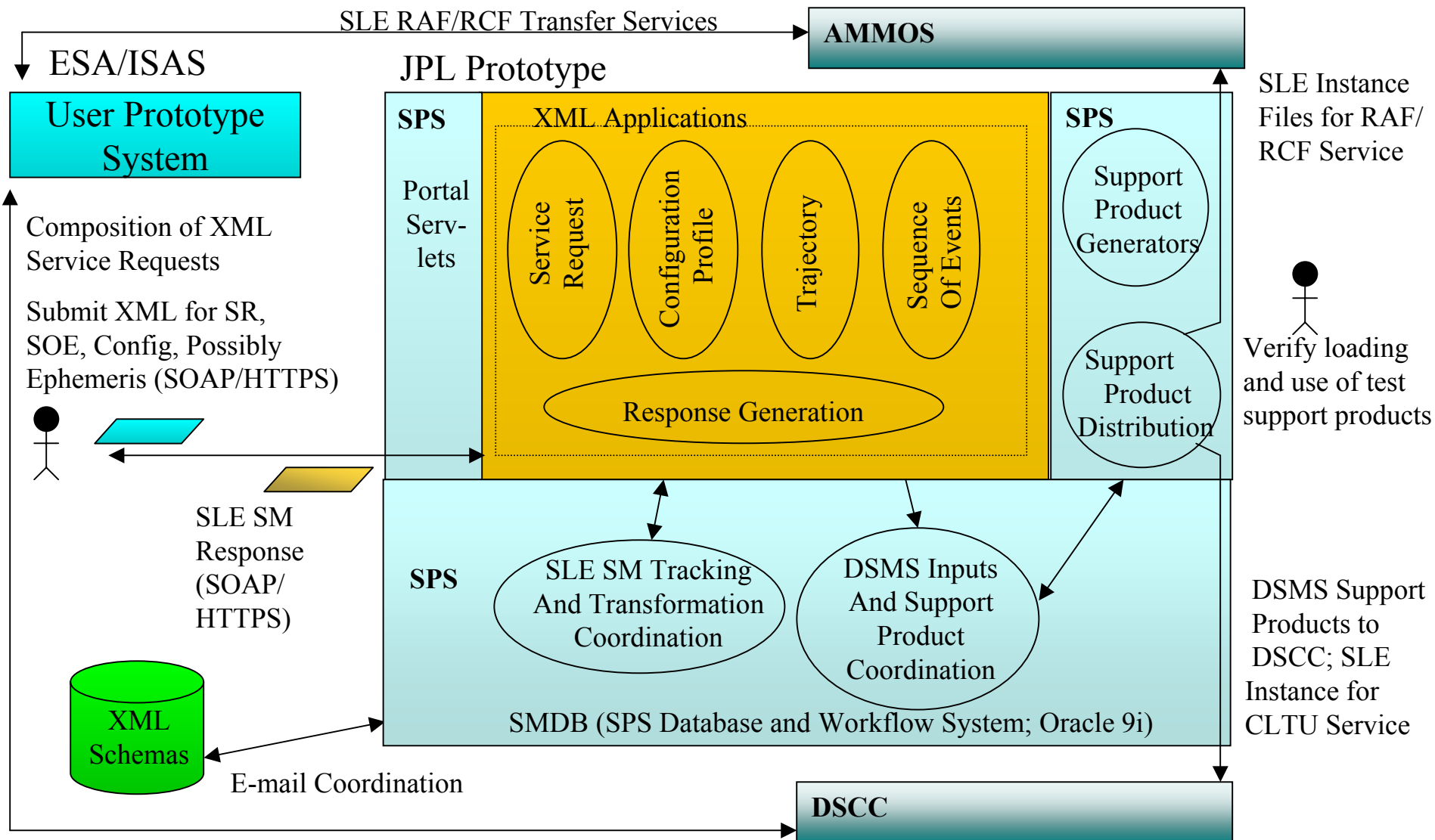
CLTUs

Frames

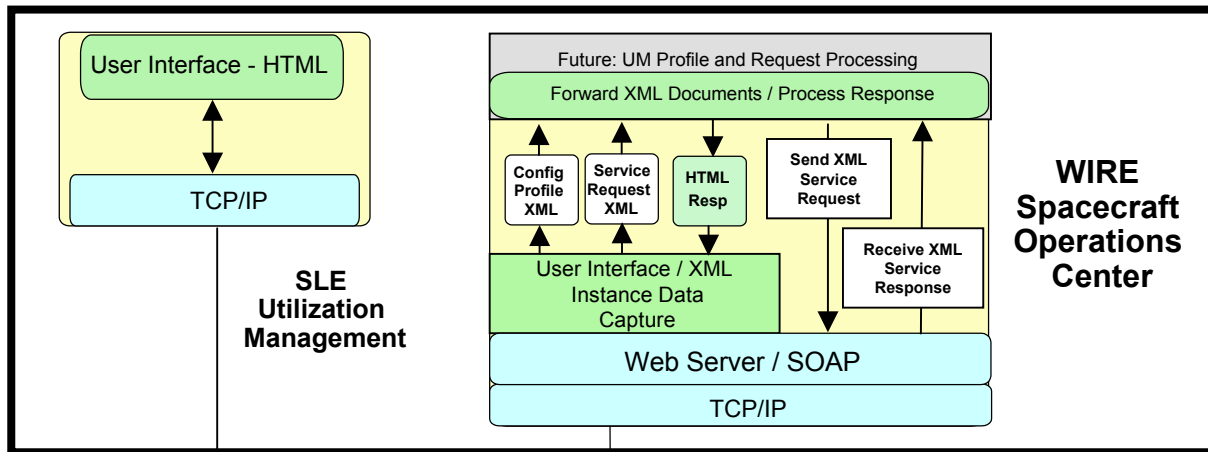
CLTUs



NASA JPL SLE-SM Prototype

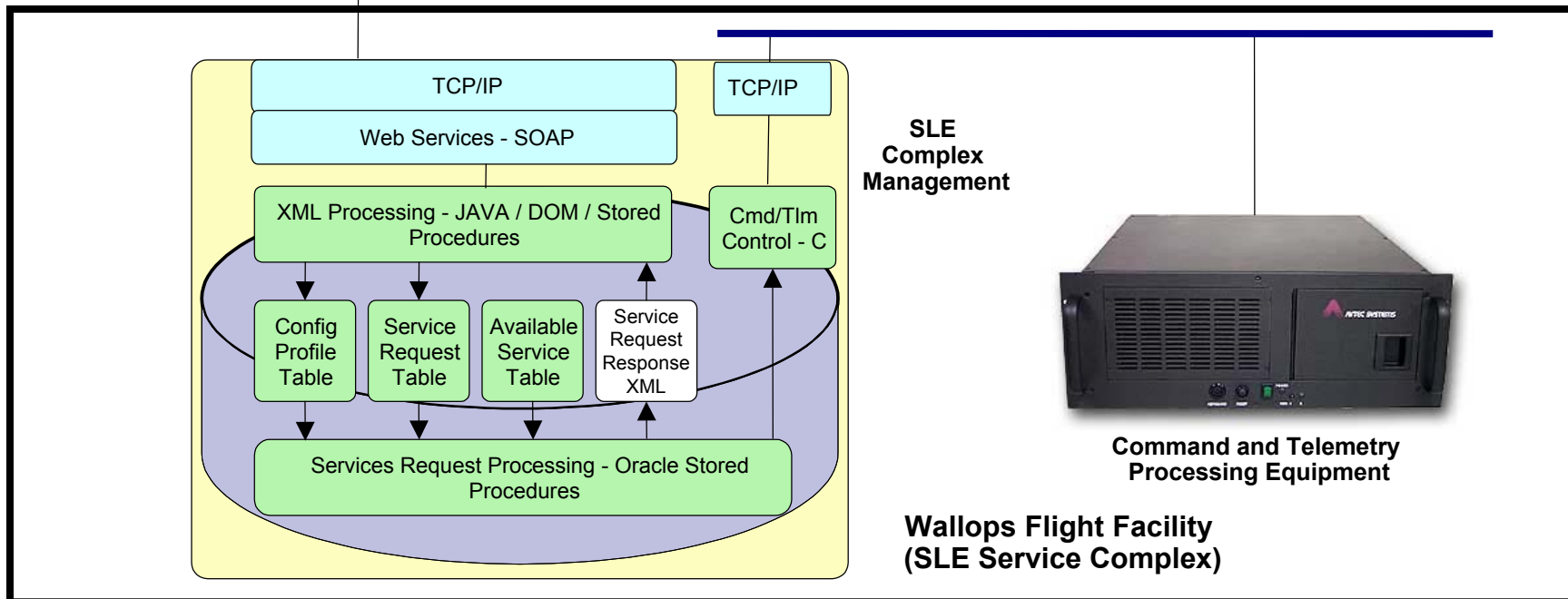


NASA CSOC/LM SLE Management Prototype



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

LAN or WAN



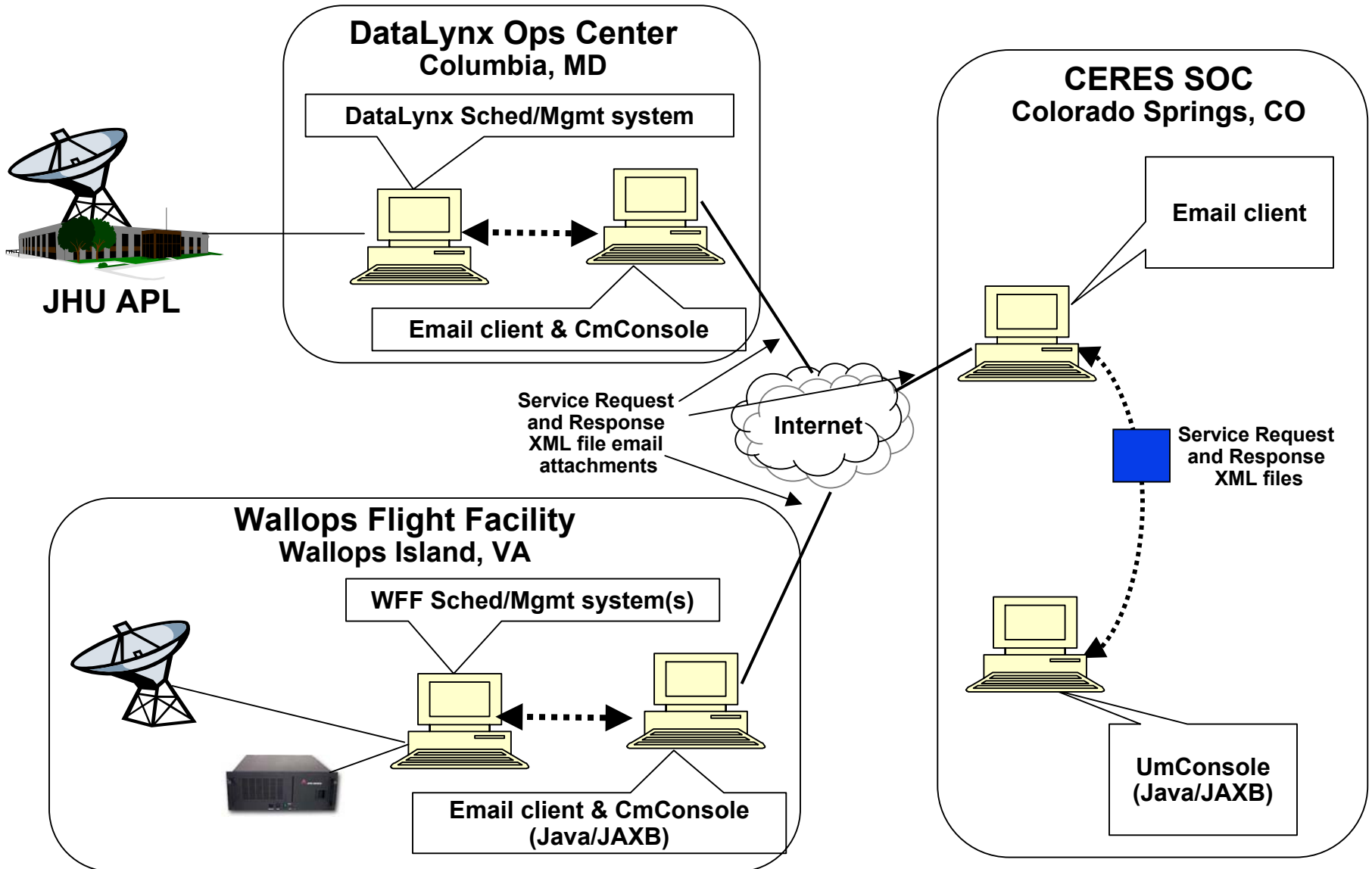
Command and Telemetry Processing Equipment

Wallops Flight Facility (SLE Service Complex)

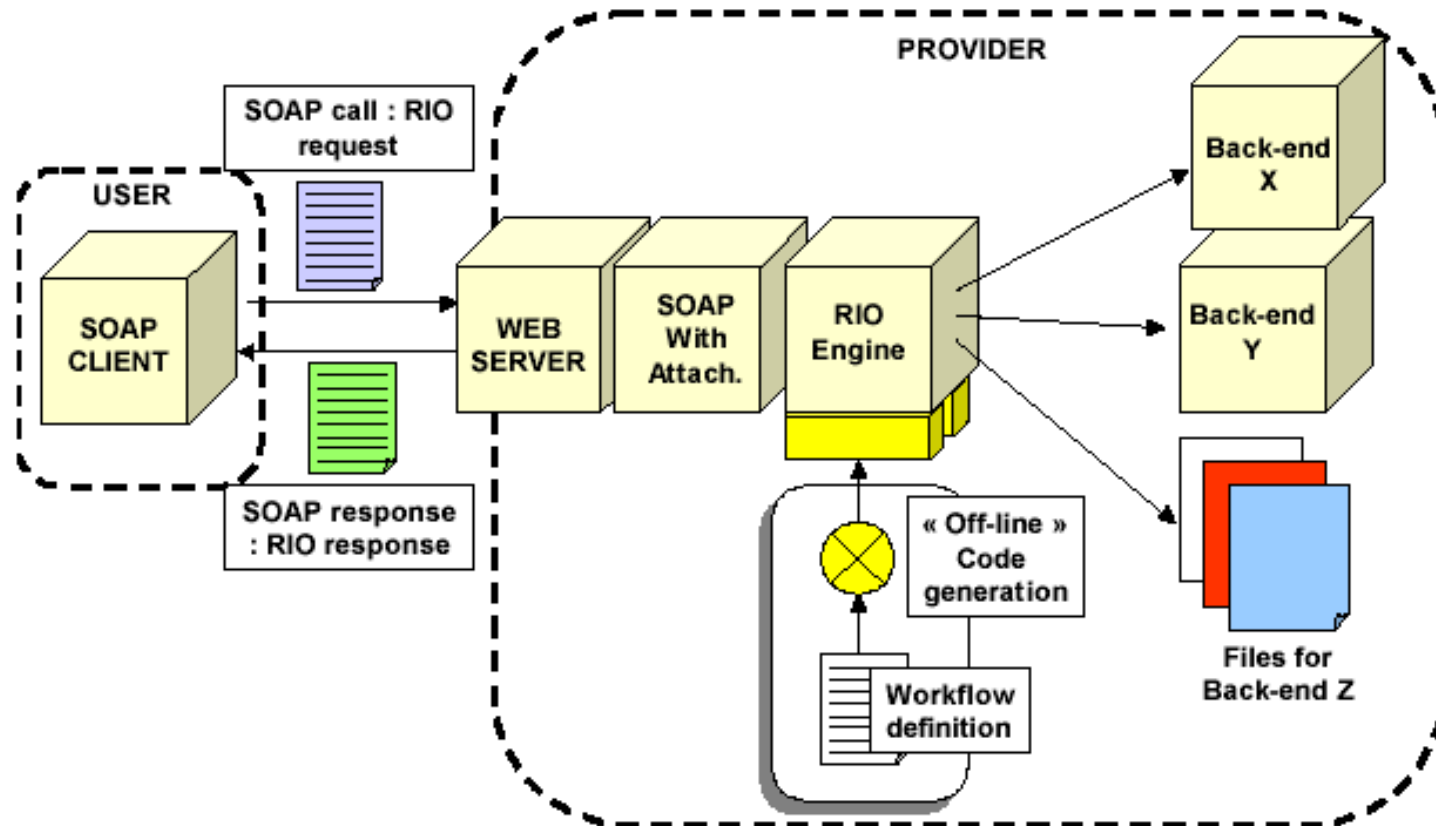
AFSCN/GST Interoperability Phase 3 SM Prototype



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CNES Request Interface for Operations (RIO)



Summary of SLE-SM Prototyping Efforts



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- **The prototypes have multiple purposes**
 - Expose mission operators, TT&C service providers, and implementers to the emerging standards – feedback wanted!
 - Test specifications before final standardization
 - Controlled/limited use for requesting real spacecraft contacts
- **Common foundation in draft CCSDS SLE-SM XML schema for service request and configuration profile transactions**
 - Experimental extensions for service agreement, trajectory data, and real-time monitoring data transactions
- **Support for the standard CCSDS F-CLTU, R-AF, and R-CF transfer services**
 - Experimental extensions for command and telemetry bitstream transfer services
- **Varying degrees of integration into operational systems**
 - Shadow mode, manual translation, automated interfaces
- **Multiple transport technologies in use**
 - XML/SOAP/HTTP, email attachments, Java RMI

SLE-SM Prototyping: Future Directions

- **Interoperate some or all of the prototypes**
 - Selection of common transport technologies
 - Common support for service request and configuration profile transactions
- **Increase integration into operational systems**
- **Continue to feed back prototyping results into the standardization process**

Expanding User Involvement in the Space Data Standards Process (1 of 2)



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- **SLE transfer services are being exposed to potential users both through adoption by “trailblazer” operational spacecraft and prototyping activities using SLE reference implementations and commercial products**
- **Evolving SLE Service Management standards are being exposed to potential users (spacecraft operators and TT&C service providers) through the prototyping efforts briefly described in this presentation**
- **Potential and current users of these standards in the civil space community can influence the course of their development through their Agencies’ participation in CCSDS**
- **How can non-CCSDS member organizations – DOD in particular – ensure that space data standards meet their needs?**

Expanding User Involvement in the Space Data Standards Process (2 of 2)



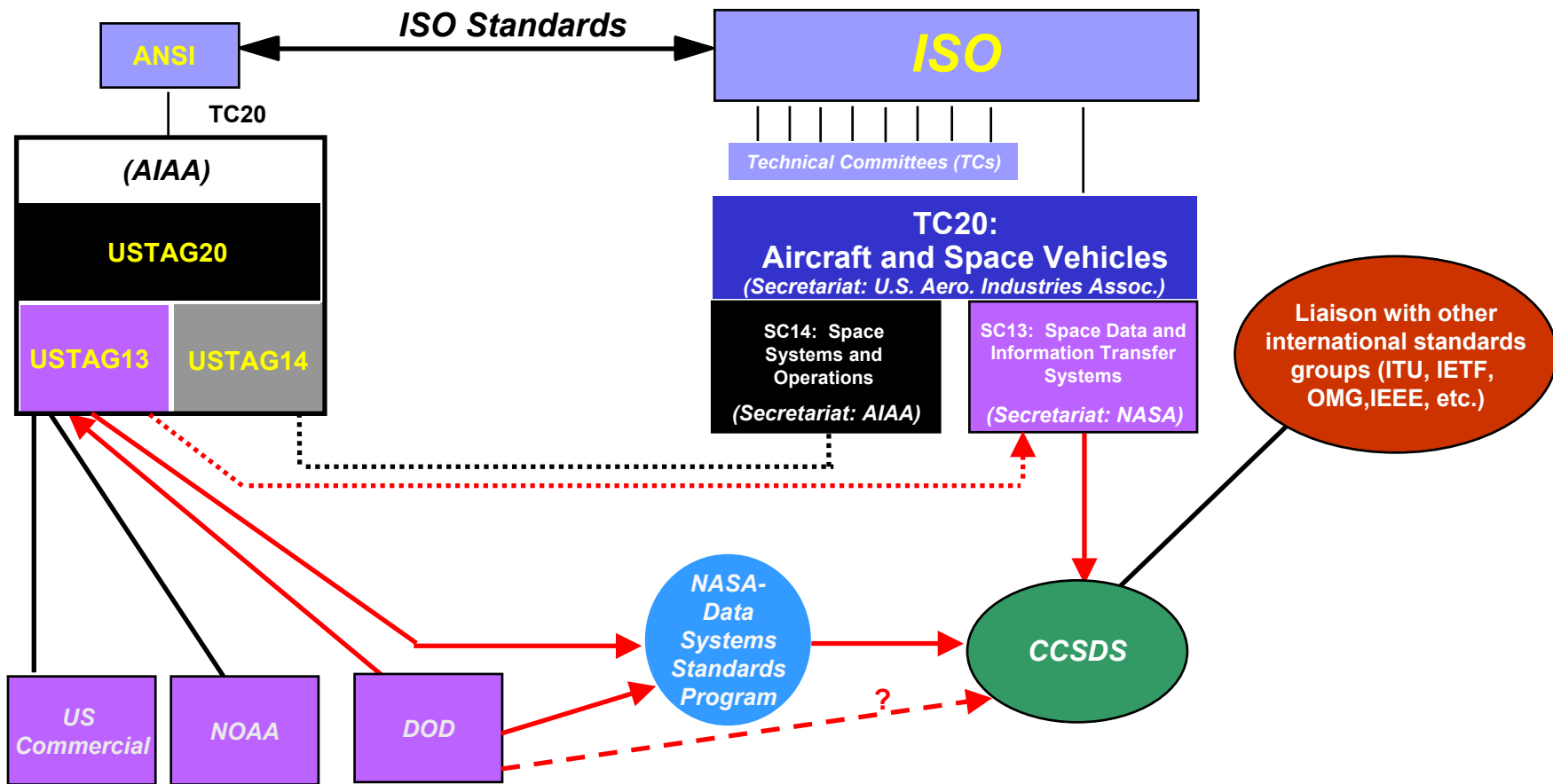
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- **Informal working-level influences**
 - Networking of knowledgeable NASA and DOD personnel
 - Use of contractors with feet in both domains
 - So far, this is how AFSCN feedback has been entering the SLE standards work
- **Joint standards activities established by DOD and NASA in areas of mutual interest**
 - Results evolve into formal US positions/proposals that NASA takes to CCSDS
 - The CCSDS Space Communication Protocol Specifications (SCPS) are an example of a joint NASA-DOD initiative
- **ANSI TC20/USTAG13**
 - Formulate national position/proposals for submission to ISO TC20/SC13 (Space Data and Information Transfer Systems)
 - TC20/SC13 can influence both CCSDS Recommendations and the ISO standards that result from them
 - Adrian Hooke (JPL - adrian.j.hooke@jpl.nasa.gov), USTAG13 chair, is planning for a series of workshops (beginning ~ May/June) to establish US priorities for space data standards
- **CCSDS re-organization under discussion**
 - Proposals on the table would open CCSDS standards process to direct participation by organizations other than the national space agencies

International Space Data Standards Relationships



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Based on a vugraph created by Adrian Hooke (JPL/USTAG13 chair)

Acknowledgments



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 - **The Phase 3 Interoperability Demonstration project, through the Air Force Satellite Control Network Contract (SCNC)**
 - **The NASA Data Systems Standards Program and Goddard Space Flight Center Data Systems Standards Office**

Standards-Based TT&C SM: Prototype Applications and User Involvement

SLE Background and Reference Material

SLE Background

- In 1991, the Consultative Committee for Space Data Systems (CCSDS) began an initiative to standardize the transfer of spacecraft command and telemetry data among ground stations, mission operations centers, data processing facilities, and other parties that communicate with the spacecraft
- The resulting *Space Link Extension* (SLE) service architecture has two components
 - *SLE transfer services* that move CCSDS-standard space link data units (e.g., packet telemetry frames, command link transmission units)
 - *SLE service management* to facilitate the requesting of services from a SLE/telemetry, tracking, and command (TT&C) service provider
- To-date, 3 SLE transfer services have been implemented for operational missions
 - Forward Command Link Transmission Unit (F-CLTU) – Blue Book (2002)
 - Return All Frames (RAF) – Blue Book (2002)
 - Return Channel Frames (RCF) – Red Book (Blue in 2003)
- SLE transfer services are being adopted as the standard for future civil space mission support

VEGA Group plc

SLE-SM Prototype



- **Purpose**
 - Initially, to demonstrate implementability and features of SLE-SM
 - Currently provides SLE-SM interface for TT&C and SLE services provided by the QinetiQ ground station in West Freugh, UK
- **Capabilities and services managed**
 - CCSDS F-CLTU and R-AF SLE transfer services (automated)
 - RF transmitter (automated) and receiver (manual translation)
- **SLE-SM transactions supported**
 - Service agreement development
 - **Service package creation (equivalent to combined configuration profile and service request creation)**
 - » Adheres to earlier CCSDS SLE-SM specification
 - Trajectory (acquisition) data exchange
- **Status**
 - Provider-side system is currently operating at QinetiQ ground station; web browser interface makes any computer a potential user workstation
 - VEGA has recently received British National Space Centre funding to support configuration profile and service request transactions, XML representation of management information, and addition of the R-CF SLE transfer service

NASA JPL SLE-SM Prototype



- **Purpose**
 - To serve as a validation platform for the development of the XML-based SLE-SM specification
 - To gain insight into ramifications of integrating SLE-SM into JPL Deep Space Network (DSN) operations, and eventually completely migrating to SLE-SM
 - To gain spaceflight mission user insight and feedback from “shadow mode” operations with the Muses-C spacecraft operations center (Japan ISAS)
- **Capabilities and services managed**
 - CCSDS F-CLTU, R-AF and R-CF SLE transfer services (initially shadow, eventually automated)
 - RF transmitter and receiver (initially shadow, eventually automated)
- **SLE-SM transactions supported**
 - **Configuration profile**
 - **Service request**
 - Trajectory (acquisition) data
- **Status**
 - XML/SOAP/HTTP/SQL/JDBC/Oracle architecture in place in prototype system
 - Configuration profile transactions currently supported
 - Service request transactions to be supported by early March 2003

In scope of the current version of the Service Request Specification

NASA/CSOC/LM SLE Management Prototype



- **Purpose**
 - Support CCSDS Panel 3 by providing specific and timely ‘lessons learned’ from the implementation of proposed SLE Management XML Schemas and Operations Concepts in a state-of-the-practice mainstream environment
 - Support NASA evaluation of SLE-SM through installation at NASA GSFC Wallops Flight Facility (WFF) ground station, using the Wide-Field Infrared Explorer (WIRE) spacecraft as test vehicle
- **Capabilities and services managed**
 - CCSDS F-CLTU, R-AF and R-CF SLE transfer services on Avtec PTP (automated)
 - RF transmitter and receiver (initially by manual translation)
- **SLE-SM transactions supported**
 - **Configuration profile**
 - **Service request**
- **Status**
 - Oracle database table design complete and implemented
 - Parsing and processing software in place for server database
 - Components integrated across a TCP/IP network including basic XML viewing capability to verify transaction results

AFSCN/GST Interoperability

Phase 3 SM Prototype



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- **Purpose**
 - To provide a mechanism for scheduling TACO contacts at the JHU-APL ground station and WFF in support of the AFSCN Phase 3 Interoperability Demonstration project
 - To expose SLE-SM concepts to AF user community (represented by CERES personnel) and TT&C service providers (represented by Honeywell DataLynx Operation Center and WFF)
 - To discover and explore extensions to the CCSDS SLE-SM standard needed to support a larger (i.e., non-CCSDS) user community
- **Capabilities and services managed**
 - BitCommand at APL (shadow) and Return Unframed Telemetry at WFF (manual translation) SLE transfer services
 - IOnet command and telemetry transfer services at APL (shadow)
 - RF transmitter and receiver (manual translation)
- **SLE-SM transactions supported**
 - **Service request**
 - Trajectory (acquisition) data
 - Real-time service monitoring
 - **Configuration profile** in Phase 4?
- **Status**
 - Service request generation software installed at CERES SOC and is being used for scheduling Phase 3 TACO contacts at APL and NASA/USAF Interoperability contacts at WFF
 - Service request response generation software installed at Honeywell DataLynx Operations Center and WFF and is being used to support contacts

In scope of the current version of the Service Request Specification

CNES Request Interface for Operations (RIO)



- **Purpose**
 - To automate the implementation of operational workflow by:
 - » Providing interoperable cross-support applications
 - » Managing cross-support agreements
 - » Managing authentication of users
 - » Providing the “glue” software in order to plug the framework onto legacy and back-end systems.
- **RIO provides a formal and automated approach to define and implement the (state) behavior associated with the *transactions* that transpire in the various *processes* that make up a cross-support *workflow***
- **In the RIO model, SLE Service Management represents one cross support workflow**
 - RIO will be able to support (but not be limited to) the SLE-SM service request transactions that are being specified and prototyped
- **SLE-SM transactions supported**
 - **Configuration profile**
 - **Service request**
 - Trajectory (acquisition) data
- **Status**
 - Prototype will be available in May 2003
 - Following validation of the RIO approach, CNES intends to propose it for CCSDS standardization