
CCSDS Space Link Extension (SLE)

Proposal for a NASA Wide Ground Data Service Standard

Nascom Block Phase Out Work Group Team

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Background

Nascom Block Phase Out Introduction

- **NASA and CSOC formed a study team to investigate the phasing out of NASA ground communications services based on Nascom blocks and to propose a new replacement data service for all NASA ground facilities and commercial ground facilities**
- **Team Members included representatives from**
 - Jet Propulsion Laboratory (JPL)
 - Goddard Space Flight Center (GSFC)
 - Consolidated Space Operations Contract (CSOC) (Also represented Human Space Flight Interest)
- **Study Team concluded that CCSDS Space Link Extension (SLE) meets the objectives for future science missions (based on CCSDS Space Links) for SN, GN, and DSN**
 - SLE could provide the first step to phasing out communications based on Nascom Blocks for SN, GN, and DSN
 - SLE could provide cross support (interoperability) among NASA sites and International Agencies

Background

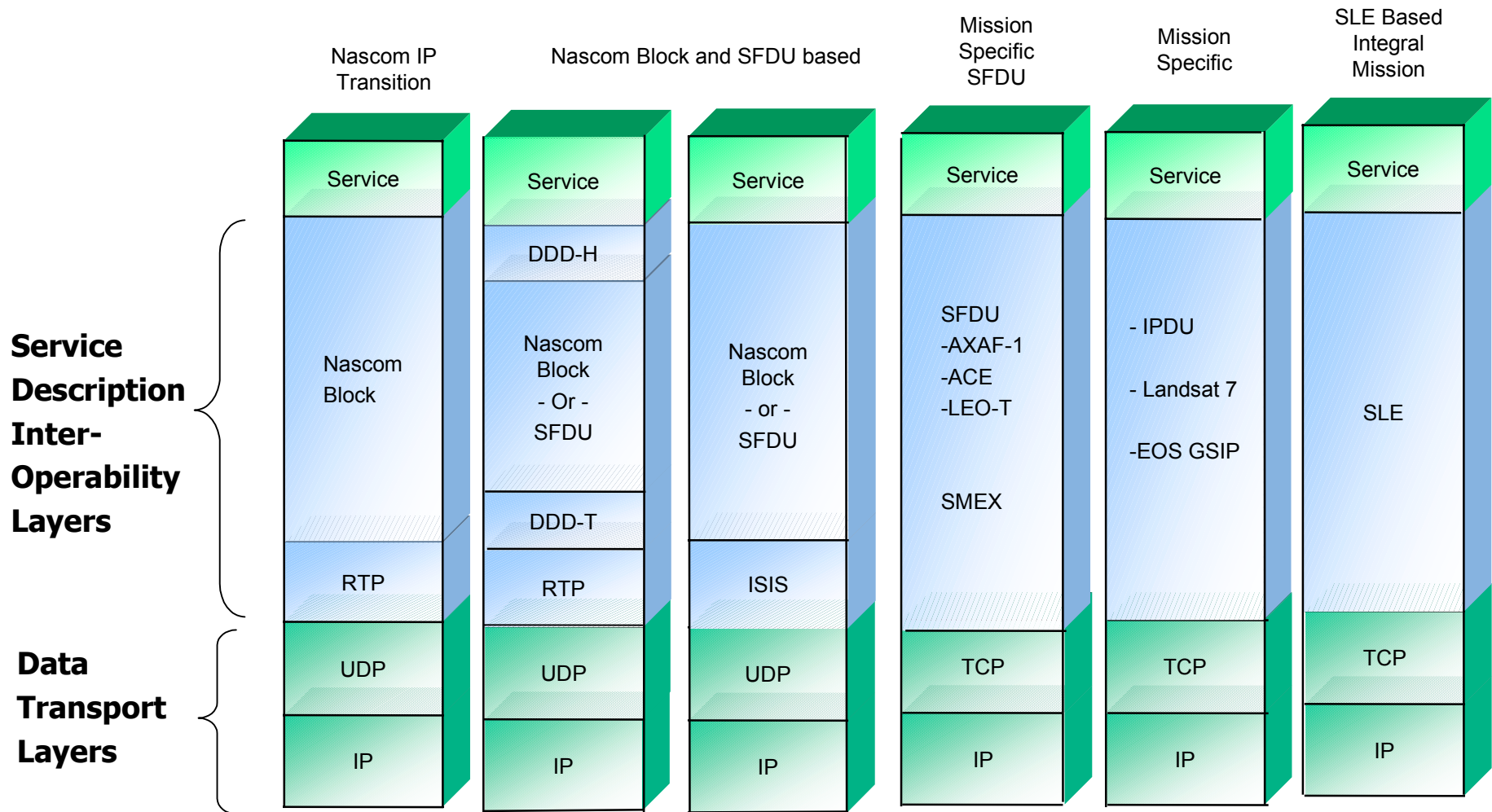
Problem Statement

- **The current Nascom IP Transition (IPTX) Multicast standard is a custom design and is outdated**
 - Continued use of the Nascom block standard requires that NASA maintain custom hardware and software to handle its unique data structure
 - Hampers transitioning to a more robust COTS based ground data communication architecture
- **Many recent missions are proceeding to implement custom data communication designs using a more reliable data service.**

Many Protocols/Data Structures – Not Interoperable

Background

Ground Data Structures and Protocols In Use Today Include:



Background

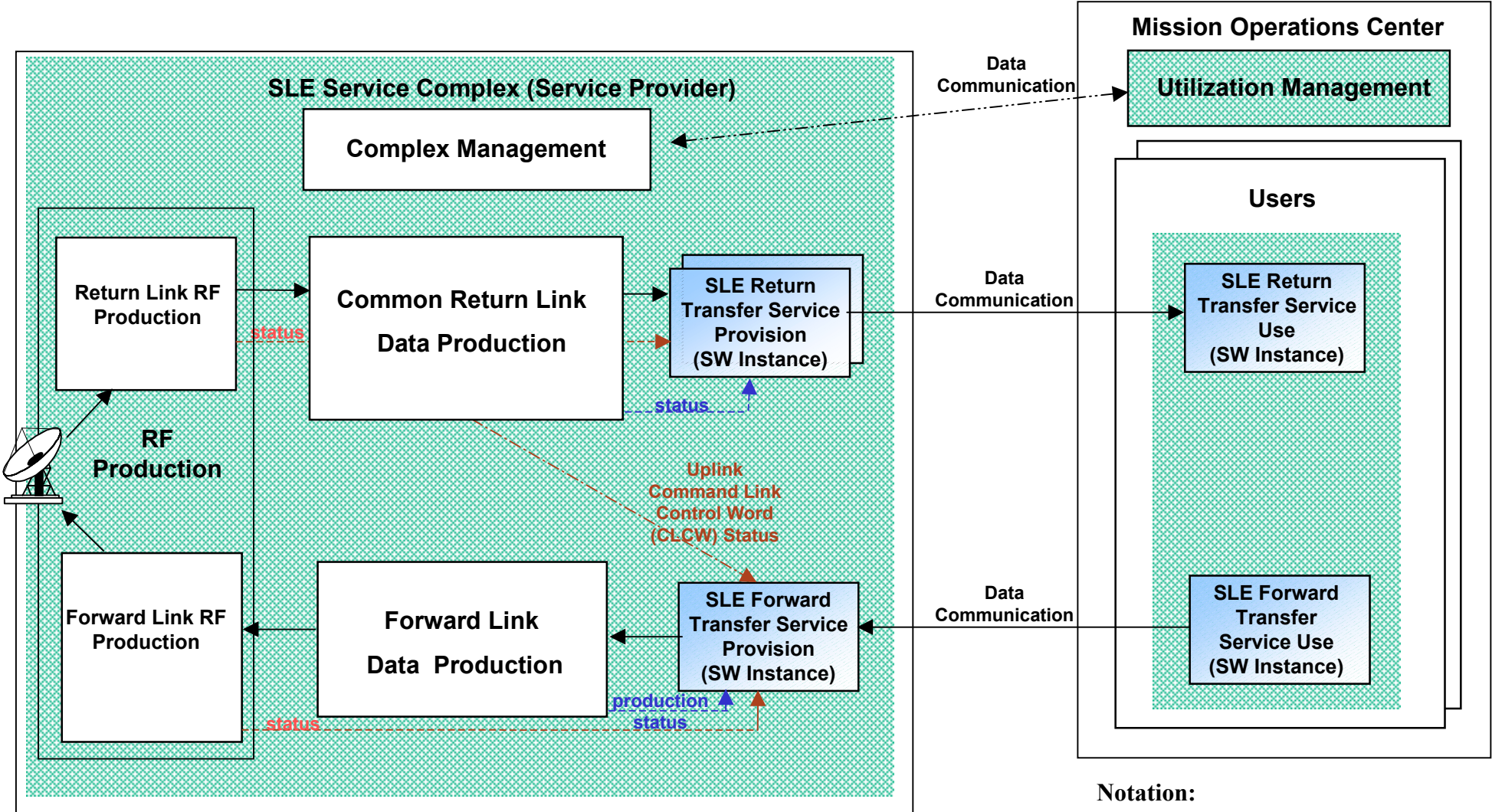
Nascom Block Phase Out Status

- **Nascom Block phase out team conclusions:**
 - CCSDS SLE met requirements for future science missions using CCSDS compliant space links
 - CCSDS SLE could support legacy missions with space links using TDM, CCSDS AOS forward service, and encrypted unframed synchronous bit streams with requirement extensions
- **Drafted a three part draft roadmap plan to phase out Nascom Block Protocol**
 - Part 1: Implement CCSDS SLE Services for future science missions
 - Part 2: Develop, test and implement extensions to SLE Service implementations to support legacy missions using TDM, CCSDS AOS, and encrypted bit stream space links
 - Part 3: Develop plan to complete Nascom Block Phase-Out for remaining ground communications
- **Team developed a common proposed SLE Service Architecture Model for SN and GN based on the DSN SLE Implementation for the INTEGRAL Mission**
- **Developing a proposed NASA-wide Ground Data Service Specification to implement CCSDS SLE Services at all NASA and Commercial ground tracking stations**

SLE Benefits

- **Offers first step to phasing out of Nascom Blocks communications**
- **Offers a common ground data service standard for future science missions**
- **Offers cross support (interoperability) among NASA sites and with international space agencies**
- **Builds on the wide spread adoption of many CCSDS recommendations already in use and in operation**
- **SLE is an accepted standard by the national and international space agencies**
- **SLE places no additional requirements on spacecraft that are already using CCSDS space link protocols**
- **Standardized services increase potential for more customers for space-ground network service providers**
- **Offers cost-savings potential**
 - Common equipment at all ground tracking stations
 - Standard user interface (CCSDS processing is not needed at the user facility)

CCSDS SLE Reference Model



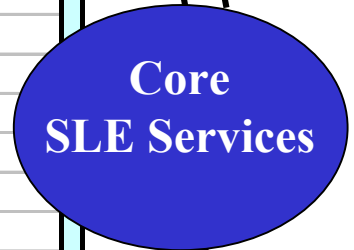
Notation:

-  SLE Environment
-  SLE Data Transfer Service

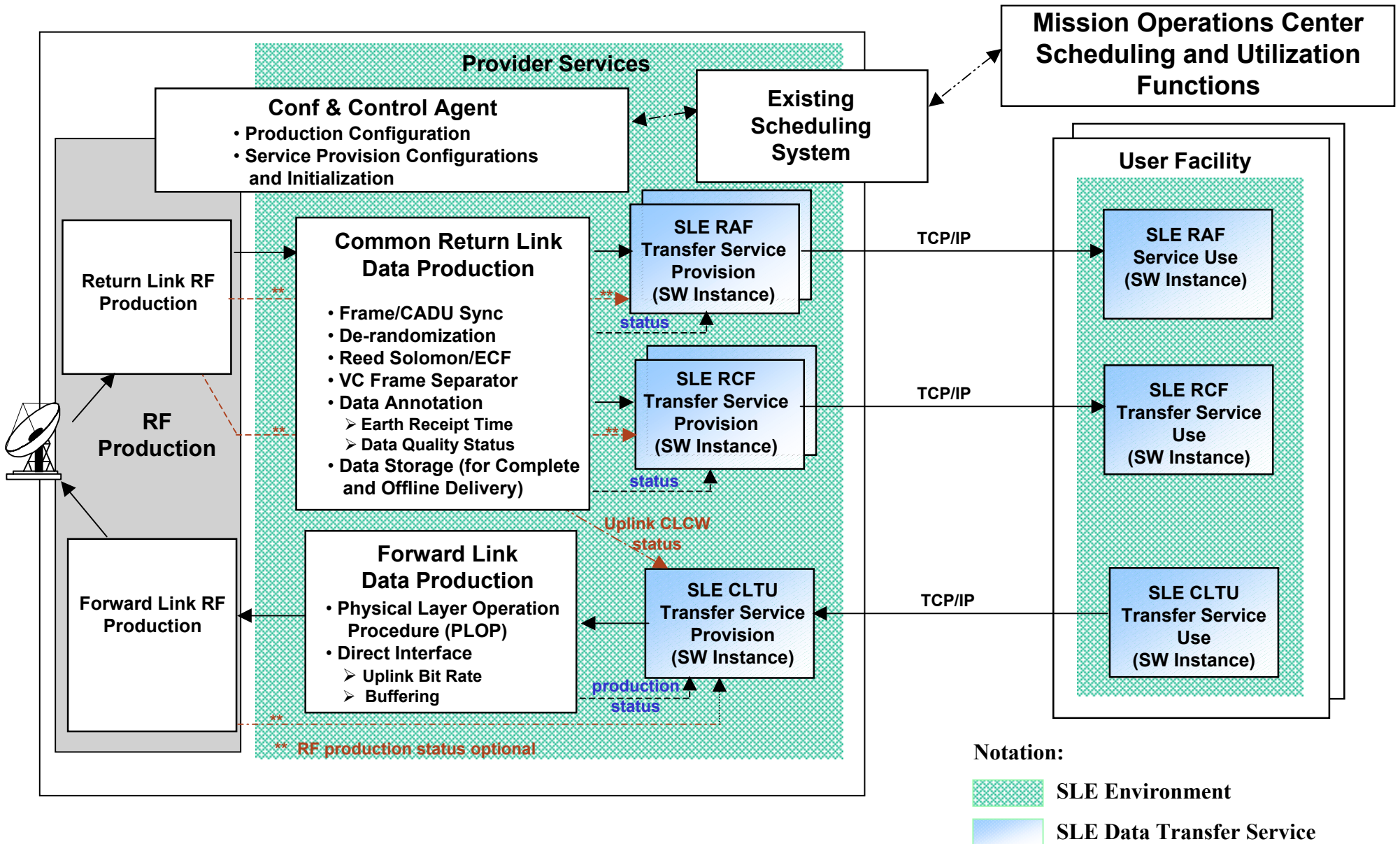


CCSDS SLE Reference Model

Cross Support Reference Model Part 1, SLE Services	910.4-B-1 May 1996 Blue Book
SLE Transfer Services:	
Return SLE Transfer Services:	
* Return All Frames (RAF) Service	911.1-R-2, Red Book
- Return Insert Service (CCSDS AOS Only)	
- Return Master Channel (MC) Frame Service	
- Return Master Channel Operational Control Field (MC-OCF) Service	
- Return Master Channel Frame Secondary Header (MC-FSH) Service	
* Return Virtual Channel Frame (RCF) Service	911.2-R-1.7, Red Book
- Return Virtual Channel Operational Control Field (VC-OCF)	
- Return Virtual Channel Frame Secondary Header (VC-FSH) Service	
- Return Bitstream Service (CCSDS AOS Only)	
- Return Space Packet (RSP) Service	
Forward SLE AOS Transfer Services	
- Forward Bit Stream Service	
- Forward Virtual Channel Access (VCA) Service	
- Forward Space Packet Service	
- Forward Proto VCDU Service	
- Forward Insert Service	
- Forward Coded/Virtual Channel Data Unit (C/VCDU) Service	
Forward SLE Telecommand Transfer Services:	
- Forward Virtual Channel Access (VCA) Service	
- Forward Space Packet Service	912.3-R-1, Red Book
- Telecommand Frame Service	912.2-W-3.0, White Book
* Command Link Transmission Unit (CLTU)	912.1-R-2, Red Book
SLE Service Management Specification	
	910.5-R-2, Red Book



Proposed NASA SLE Service Model (Nascom Block Phase Out Part 1 – Initial Phase)



Proposed NASA SLE Service Model (Nascom Block Phase Out Part 1 – Initial Phase)

- **Proposed NASA SLE Model allows deviation from the following standard CCSDS SLE requirements for the initial delivery**
 - Compliance with SLE Management requirements is not required
 - RF production status available via the SLE Data Transfer service is optional
 - SLE data transfer specifications allows RF status parameters to be set to “unknown” or “not in use”

Proposed NASA SLE Service Model (Nascom Block Phase Out Part 1 – Initial Phase)

- **Initial phase requires that SLE Provider ground sites either have or be upgraded to support the following CCSDS requirements**
 - Return Link Data Production Service Requirements
 - Telemetry Channel Coding (101.0-B-4)
 - Packet Telemetry (102.0-B-4)
 - Packet Telemetry Services (103.0-B-1)
 - SLE Return Link Provision Services Requirements
 - SLE Return All Frames (911.1-R-2) - See Note
 - SLE Return Channel Frames (911.2-R-1.7) - See Note
 - Forward Link Data Production Service Requirements
 - Telecommand, Part 1 Channel Services (201.0-B-3)
 - Only Physical Link Operation Procedure (PLOP) applies
 - Telecommand Data Routing Service Part 2 (202.0-B-2)
 - Only Command Link Control Word (CLCW) requirements applies
 - SLE Forward Link Provision Services Requirements
 - SLE Forward CLTU Service (912.1-R-2) - See Note

Note: These CCSDS SLE Transfer specifications are in process of being advanced to the CCSDS Blue Book Status (approved CCSDS recommendation)

Proposed NASA SLE Service Model (Nascom Block Phase Out Part 1 – Initial Phase)

- **Initial phase will implement RAF, RCF, and CLTU transport services using the API developed by ESA and JPL jointly and which are being proposed as CCSDS Recommendations**
 - SLE - Core API for Transfer Services (913.1-W-1)
 - SLE API for Transfer Services – Technology Mapping (913.2-W-1)
 - Specifies lower layer communication service based on TCP/IP
 - SLE – API for Return Services (914.1-W-1)
 - SLE – API for Forward Service (915.1.W-1)

Note: These SLE APIs are currently preliminary CCSDS White books status (draft documents still in development). These need to be advanced to the CCSDS Blue book status (approved CCSDS recommendation).

Proposed NASA SLE Service Model (Nascom Block Phase Out Part 2)

- **Develop, test, and implement optional addendum requirements to augment SLE service specifications to support legacy missions using TDM, encrypted unframed data, and CCSDS AOS space links**
 - Proposed addendum requirements are part of the NASA implementations and are not part of the CCSDS SLE Specifications
- **NASA Proposed Return All Frame Service (RAF) addendum requirement**
 - Support TDM by blocking on TDM Frames into SLE Protocol Data Units (PDUs)
 - Support encrypted bit streams by blocking unframed data units into SLE PDU format
 - Option to send complete space link frame (with error control field and/or Reed Solomon check symbols) to the user unaltered as it was received from the space link.
 - Required for TDM and encrypted streams
 - Support mission users who wants to perform error processing

Proposed NASA SLE Service Model (Nascom Block Phase Out Part 2)

- **NASA proposed forward CLTU service addendum requirements for supporting encrypted bit stream, TDM, or Advance Orbiting Systems (AOS) forward link**
 - Forward CLTU Provider Requirement Addendum
 - Specify a forward service data production “physical layer operations procedure” (PLOP) option to support sending data blocks (contained within the SLE PDU data space) continuously back to back with no idle sequence or fill bits and to drop RF modulation if data is not available
 - Forward CLTU User Requirement
 - Add requirements to pack synchronous forward link data (at the data link layer) into data blocks as SLE PDU data messages
 - Provide sufficient buffering and configuration to maintain a continuous steady stream forward link which accounts for variations in the ground communication (latencies, congestions, etc..)

Open Items with SLE for GN and SN

- **SLE has been developed by ESA and JPL for the INTEGRAL mission, but SLE is not yet available as a turn-key implementation**
 - COTS products are expected in the future
 - Several companies offer SLE products today as a special procurement
 - ESA and JPL SLE APIs require additional software integration for specific site architectures and requirements
- **SLE has not been tested to support missions with high data rate return and forward links (EOS missions, ISS Ku-Band, etc.)**
- **Multicast routing of mission data has not been developed for CCSDS SLE transfer services**
- **SLE Management specification is still in development**
- **Use of SLE at GSFC are still under investigation**
 - White Sands Complex (WSC) Space Network (SN)
 - Ground Network (GN)
 - Commercial ground station providers
- **Issuance of a NASA Wide Policy Statement is pending**
 - The Nascom Block Phase out group is recommending NASA issue a policy statement that states “SLE Transfer services is the preferred ground data service”

Plan Forward

- **Proceed with Nascom Block Phase Out Roadmap**
 - Conduct tradeoff studies for initial deployment at SN, GN, and Commercial sites (Nascom Block Phase Out Roadmap)
 - Release proposed NASA Wide Data Service Specification
 - Encourage/foster issuance of a NASA Policy Statement
- **Investigate opportunities for an SLE test-bed at key sites to promote SLE for new missions**
 - Test for compatibility and interoperability among SLE implementations
 - Demonstrate that SLE implementation will lower risk to future missions with lower cost
 - Evaluate and invite commercial providers (product and services) to participate in testing and analysis
 - Evaluate capability to support high rate return links and recorder dumps
 - Evaluate capabilities to support legacy missions
 - Evaluate need for and capabilities of an SLE technology mapping API for reliable, scalable, and efficient multicast transport protocol