

NASA/AFSCN/NOAA/Lockheed Martin Ground Network and Space Network Interoperability Plans

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Purpose



- First in a set of four presentations that describe the activities related to the NASA/Lockheed Martin SLE testing and prototyping
- Presents an overview of the NASA/AFSCN/NOAA/Lockheed Martin Ground Network and Space Network Interoperability (Cross Support) project, context, goals, scope, and plans
- Three related presentations will provide more detail on project activities:
 - **Lockheed Martin/CSOC SLE Test bed Status**
By Scott Jakl and Jeff Boxell
 - **Lockheed Martin/CSOC SLE Management Service Request Prototype**
By Andrew Schreckenghost and Steve Autry
 - **Proposal For The Application of CCSDS Space Link Extension to NASA Human Space Flight Missions**
By Larry Muzny and Jeff Boxell

Strategic Drivers



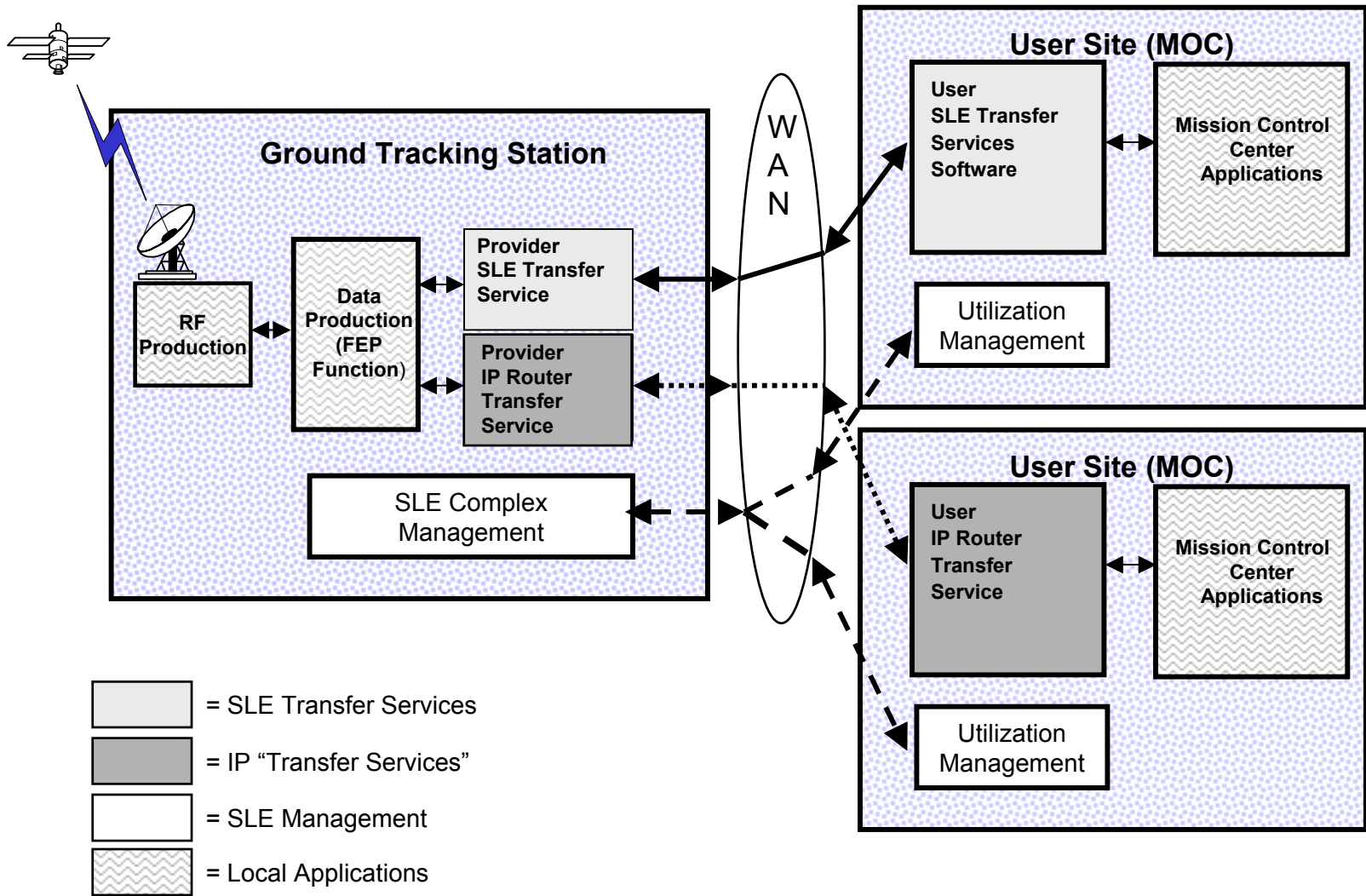
- Lockheed Martin has been supporting the development of plans for the evolution of NASA's Ground Network (GN) and Space Network (SN), and where possible, synchronizing those plans with plans for the evolution of the Deep Space Network (DSN)
- Key drivers in the evolution of a future network architecture are:
 - New missions will appear that have ground network requirements that are not supported by current networks
 - Aging network communications systems require upgrades and mission requirements are always evolving
 - Many current systems were designed independently and are not interoperable and thus cost more to operate
 - Across programs within NASA
 - Across agencies
 - Desire to increase the set of available satellite network resources
 - Phase-out of legacy NASA-unique communication services

Recommendations

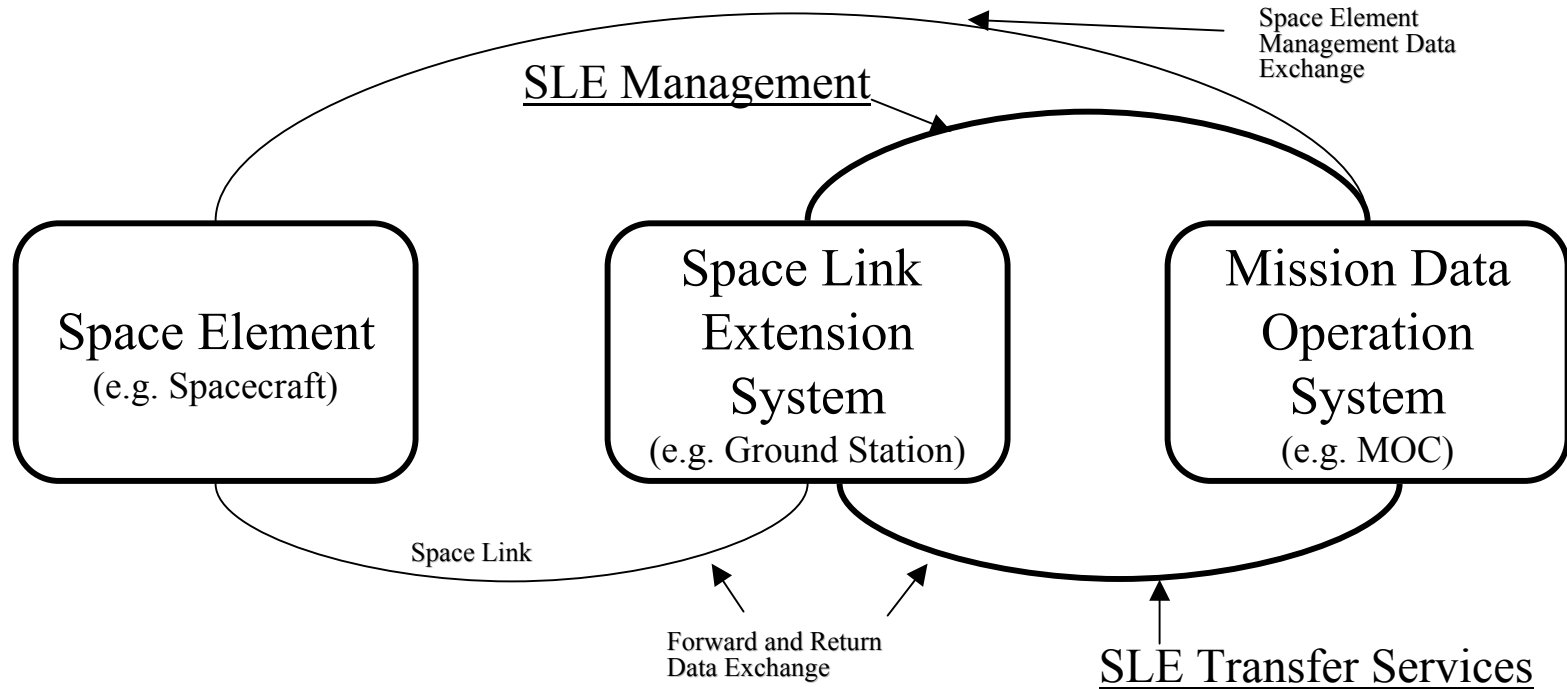


- Lockheed Martin led a multi-center study team that proposed potential solutions
 - Proposed that CCSDS Space Link Extension (SLE) is one of the small set of ground services that have the attributes required by NASA's future mission types (CCSDS, IP, TDM)
 - Recommended that NASA and Lockheed Martin set up an SLE interoperability testbed
- NASA's involvement with SLE started with its support for the development of SLE as the primary interface for future Deep Space Network missions
 - SLE protocols standardize the interfaces to NASA networks (SN, GN, DSN)
 - SLE provides interoperability through common interfaces across national agencies, international agencies, and commercial network providers
 - Missions using SLE can coexist with legacy missions until they are either converted to SLE standards or are decommissioned
 - Common SLE protocols can minimize risk to missions considering its use
 - Development, maintenance and operations of SLE solutions are cost effective compared to current alternatives
 - SLE Transfer Services have COTS products that are mature enough for operational missions

Recommended Communications Reference Model



SLE Reference Model



- **SLE Transfer Services** are concerned with control of the ground part of the transfer of forward and return data
- **SLE Service Management** specifies the means by which ground data systems can schedule, configure, operate, and monitor the provision of SLE transfer services for a space mission

SLE Transfer Service



SLE C = Control Information

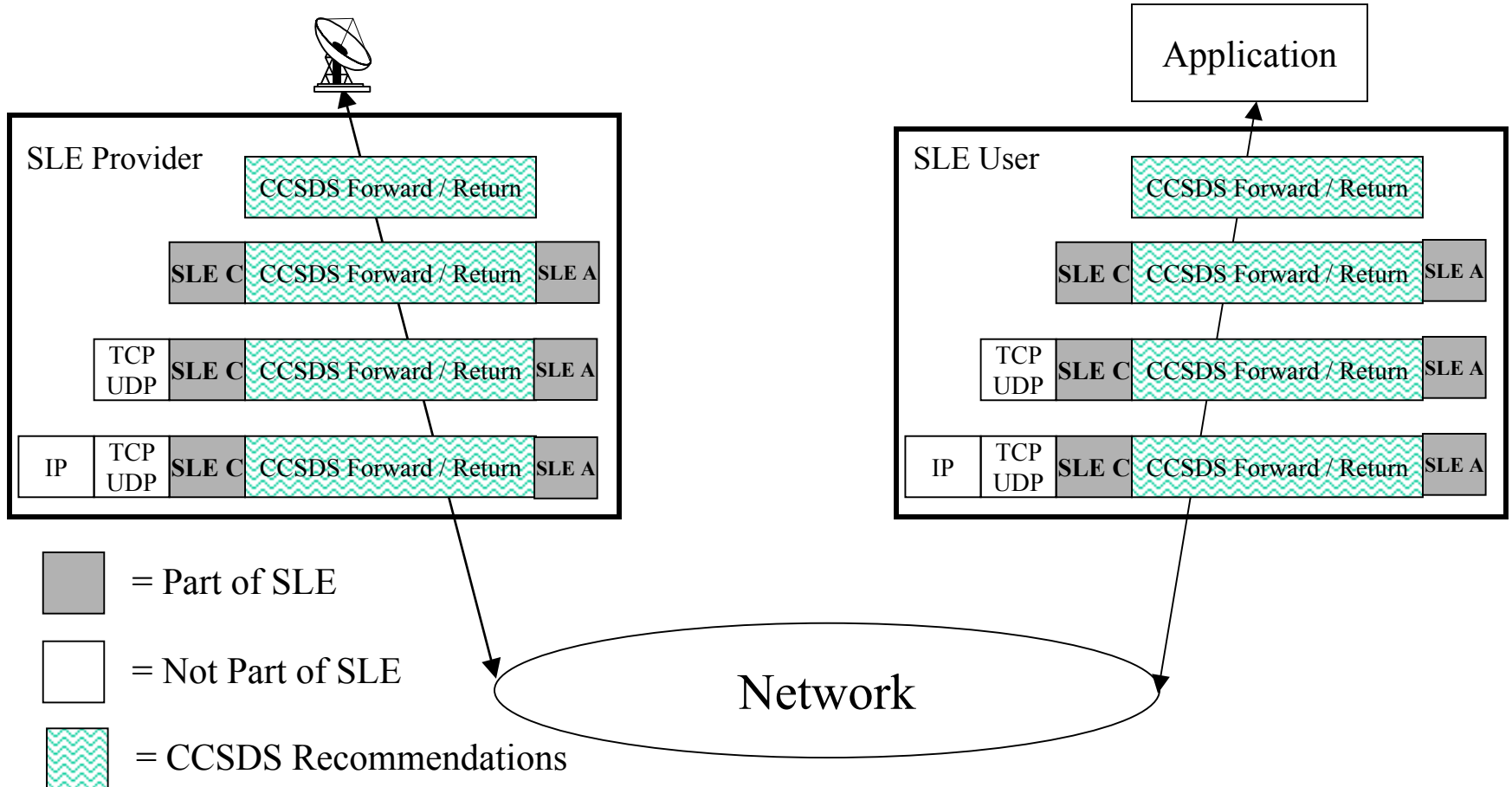
Examples of control are:

- loss-of-service indication
- recovery-of-service indication (return data)
- Directives related to the Command Operation Procedure (forward data)

SLE A= Annotation

Examples of annotation are:

- ground reception time
- quality indication (return data)
- requested transmission time,
- uplink path (forward data)



Lockheed Martin SLE Testbed Activities

NASA SLE Testbed Activities Context



CCSDS Standards	Products	Product Maturation Support Activities	Product Deployment
SLE Transfer Services Standards	Initial NASA/JPL ESA Avtec Anite Others	<ol style="list-style-type: none"> 1. Support completion of required SLE Specs 2. Complete COTS implementations 3. Test implementations 4. Expand COTS availability 	<div style="border: 1px solid black; border-radius: 50%; padding: 10px; text-align: center;"> DSN SLE Svcs Underway </div>
SLE Management Services Standards	Underway NASA/JPL ESA AFSCN/GST Vega Lockheed Others	<ol style="list-style-type: none"> 5. Implementation convergence 6. Interoperability among agencies 7. Compare spec to real ops systems 8. Define security implementation model 9. Acceptance by new missions 	<div style="border: 1px solid black; border-radius: 50%; padding: 10px; text-align: center; background-color: #e0e0e0;"> GN </div> <div style="border: 1px solid black; border-radius: 50%; padding: 10px; text-align: center; background-color: #e0e0e0;"> SN </div>

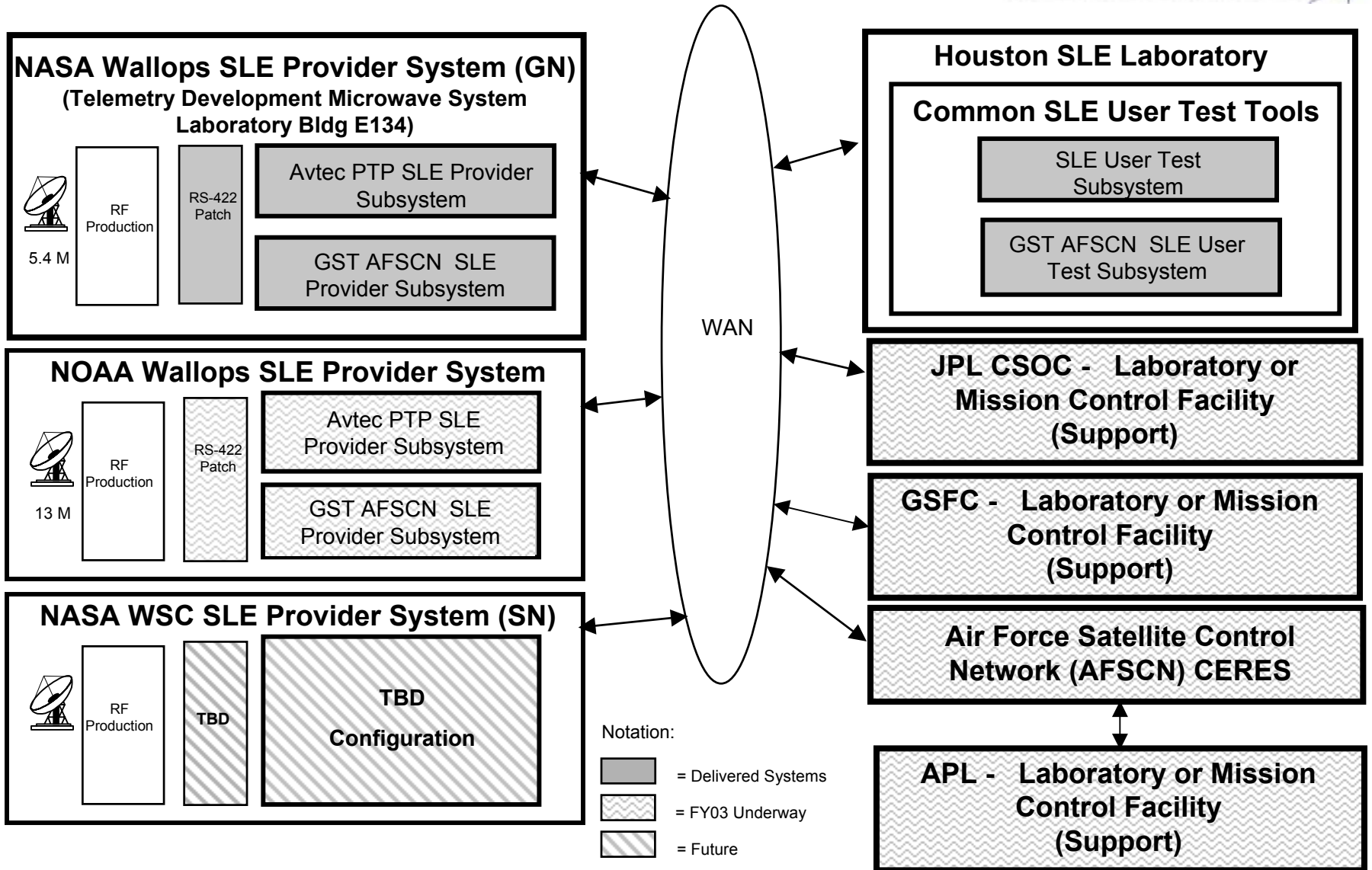
= Testbed Scope

Current SLE Activity



- Demonstrate and investigate CCSDS Space Link Extension
 - Implement a testbed to demonstrate CCSDS SLE based upon the design and products developed by JPL and ESA for the INTEGRAL mission as provided by Avtec Systems PTP SLE RAF, RCF, and CLTU COTS product
 - Proof of concept to show that SLE Transfer and Management Services can also be used for both legacy and future GN and SN science missions
- Establish an infrastructure for interoperability testing between NASA, Air Force Satellite Control Network (AFSCN)/DoD test satellites and the National Oceanic and Atmospheric Administration (NOAA)
 - Build a distributed testbed of SLE systems that include NASA Wallops Flight Facility (WFF), NASA White Sands Complex (WSC), NOAA ground station/Wallops, and AFSCN facilities
 - Support downlink tests between NASA WFF and AFSCN DoD test satellites
 - Conduct downlink and uplink tests with NASA test satellites (WIRE – CCSDS; COBE – TDM) through NASA WFF and NOAA Wallops
 - Investigate and prototype SLE Service Management with NASA WIRE S/C
 - Develop a SLE user test suite to support testing

SLE Testbed Architecture



Potential NASA/AFSCN Interoperability Scenarios



- NASA GN Scenarios - Demonstrate interoperability between NASA GN and DoD using CCSDS SLE
 - **SGLS TLM from DoD satellite to DoD SOC**
 - **Prototype bitstream service**
 - USB T&C of NASA Satellite with DoD SOC
 - USB T&C of DoD Satellite with DoD SOC
- NASA SN Scenarios - Demonstrate interoperability between NASA SN and DoD SOC using CCSDS SLE
 - S-Band (Single Access) T&C of NASA satellite
 - S-Band (Single Access) T&C of DoD satellite
- AFSCN Tests with NOAA site
 - Support ASFCN T&C through NOAA Wallops site
- AFSCN Scenario - Demonstrate interoperability between AFSCN and NASA using CCSDS SLE
 - USB T&C of NASA Satellite with NASA SOC

Bold and underline indicates current activity

Lockheed Martin SLE Service Management Service Request Prototype

SLE Services Management Prototype Purpose



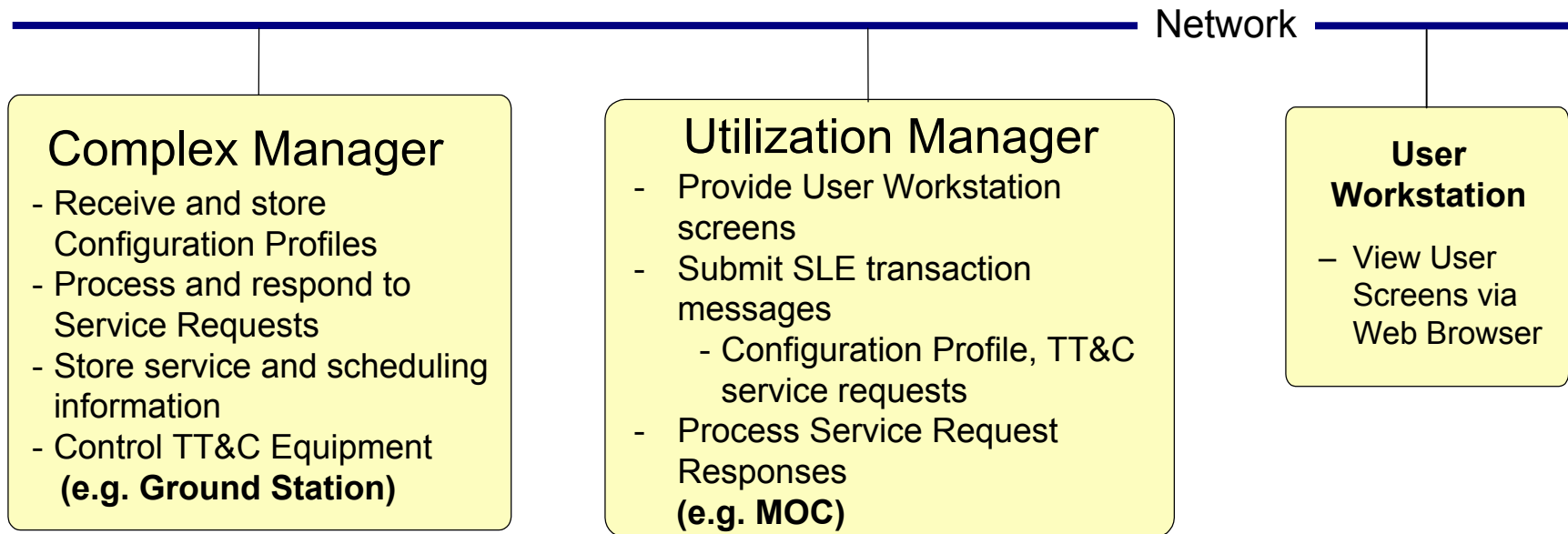
- Support the CCSDS Panel 3 committee by providing specific and timely 'lessons learned' from the implementation of proposed SLE Management XML Schemas and Operations Concepts in a state-of-the-practice mainstream environment
- Support NASA evaluation of SLE-SM through installation at NASA GSFC Wallops Flight Facility (WFF) ground station using the Wide-Field Infrared Explorer (WIRE) spacecraft as a test vehicle
 - Provide feedback on functionality, usability, and performance of proposed standards
 - Develop a flexible infrastructure that can be used to prototype and evaluate further CCSDS Panel 3 proposals and recommendations
 - Provide inputs on areas for future work including security, fault management, and accounting services
 - Support SLE Transfer Service prototypes through the early delivery of a web based service parameter exchange and basic scheduling capability

SLE Management Prototype

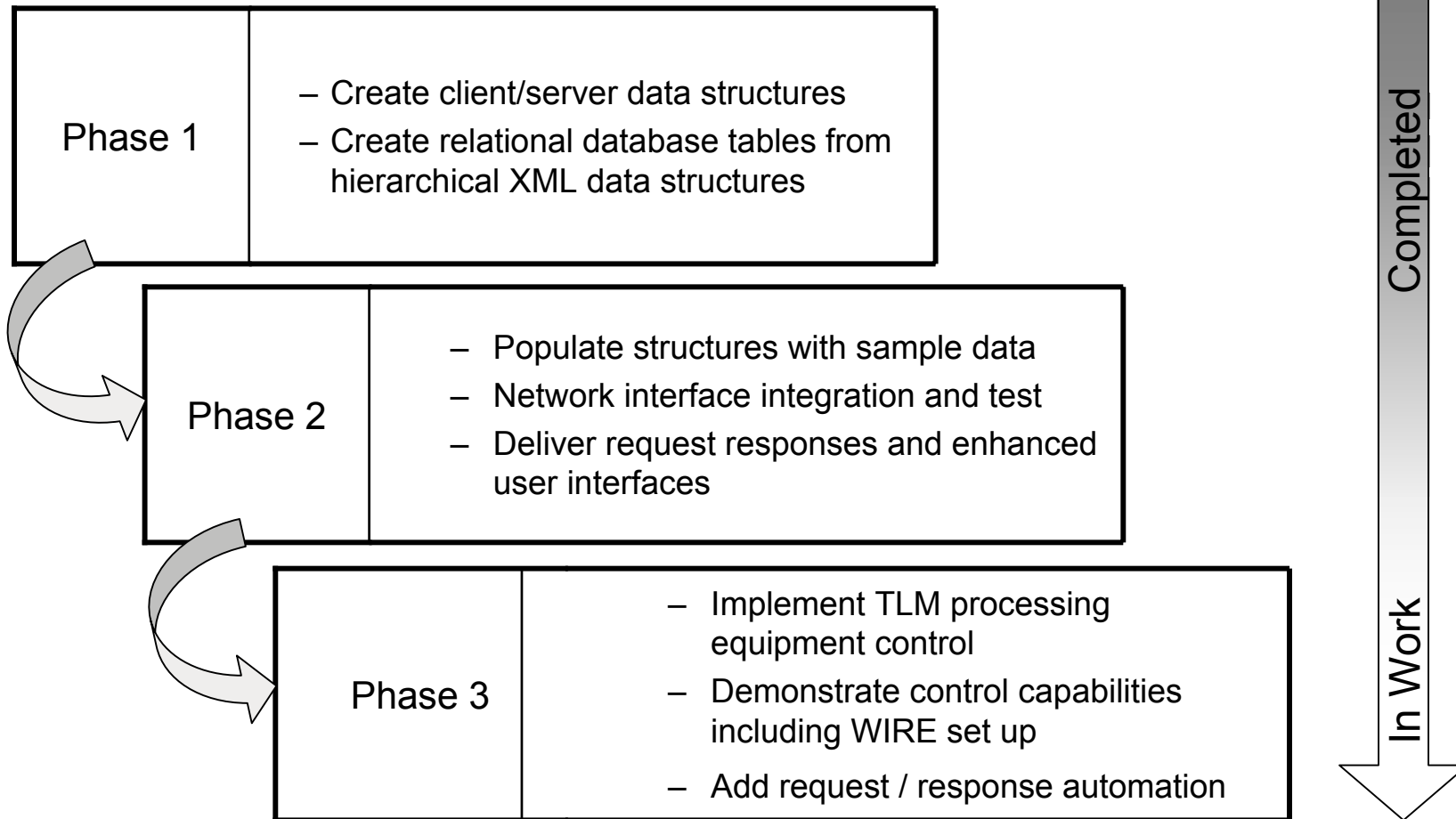


Approach

- Implement key functions of major SLE SM components
- Support SLE SM interaction across a Local and Wide Area Network



SLE Management Prototype



Conclusion



- **This Project Is:**
 - Supporting the development of a common, standards-based SLE architecture for NASA's Ground and Space networks
 - Demonstrating interoperability(Cross Support) between NASA, AFSCN/Air Force and NOAA using SLE
 - Testing current SLE Transfer Services COTS products
 - Advancing the state of SLE SLE Management Service Request specifications through prototyping
 - Building an infrastructure to allow GN and SN missions to evaluate CCSDS SLE
- **List of related presentations**

Lockheed Martin/CSOC SLE Testbed Status

Lockheed Martin/CSOC SLE Management Service Request Prototype

Proposal For The Application of CCSDS Space Link Extension to NASA Human Space Flight Missions