

Achieving Interoperability in Satellite Control Networks

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Goals for Use of Standards

- **Reduce risk, cost, and time for upgrades**
 - Use proven, efficient, standards-based solutions
 - Share development costs of COTS equipment and services over wider user base
- **Enhance Interoperability**
 - Move toward Integrated Satellite Control Network with DoD, NASA, NOAA, commercial
 - Increase sharing to broaden access and/or reduce total costs

Key Interfaces

- **1. Remote Tracking Station to Satellite Operations Center**

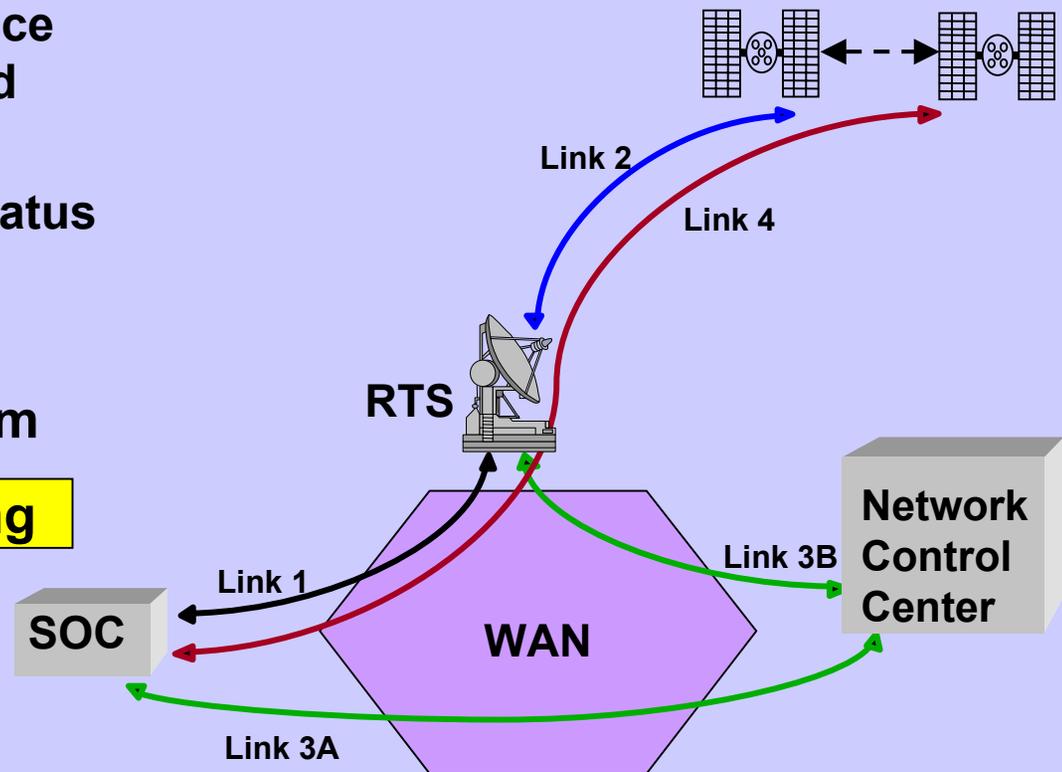
- A. “WAN hop” for Space Vehicle commands and telemetry
- B. RTS Control and Status

- **2. Space-Ground Link: “Space hop” for Space Vehicle commands, telem**

- **3. Status and Scheduling**

- A. SOC-NCC
- B. RTS-NCC

- **4. Space Vehicle-SOC (end-to-end) Commands, status, data**



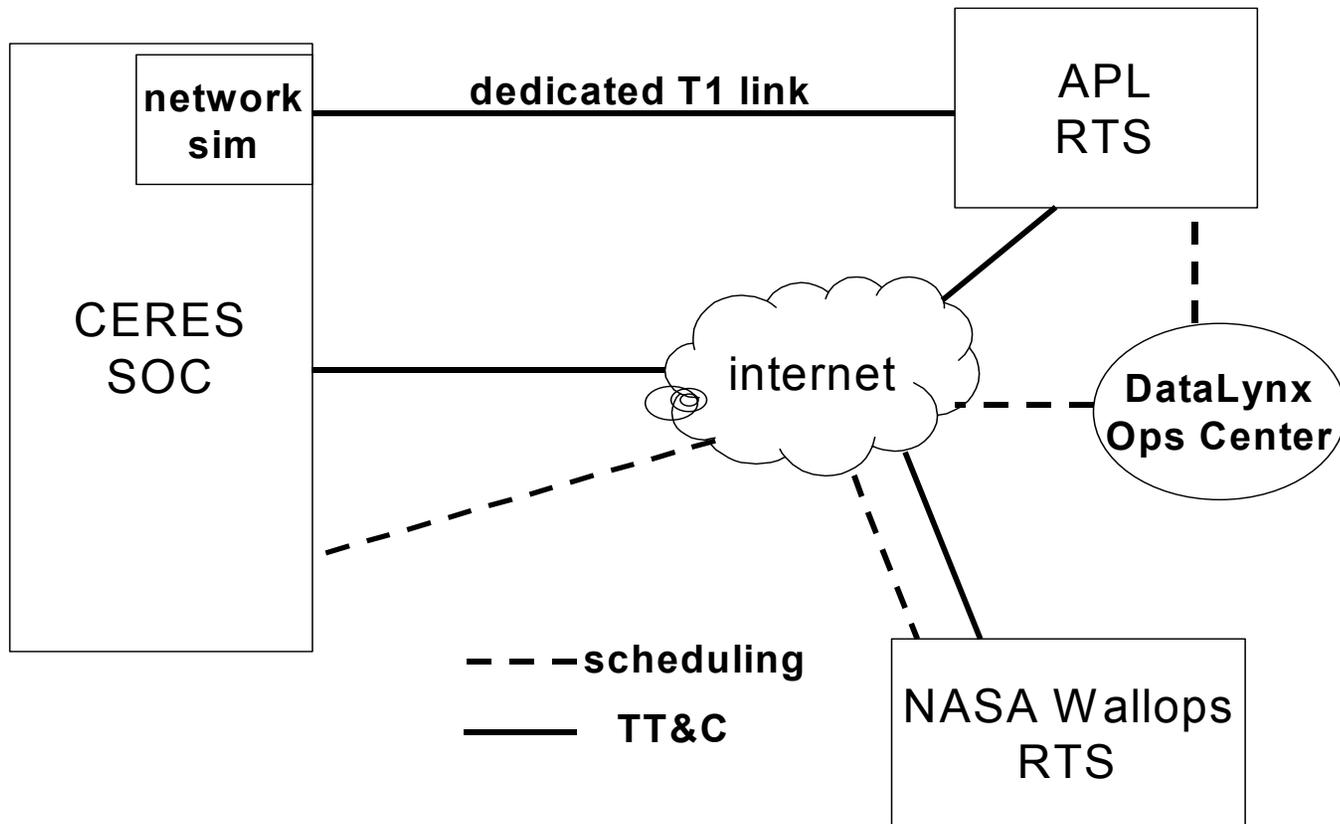
Space Link Extension

- **Extension to the widely-adopted CCSDS space link standard**
 - Extends link from RTS to SOC
- **Block oriented Telemetry (RAF) and Commanding (CLTU) services**
 - Adopted for ESA missions, NASA DSN
 - Not directly applicable to AF bitstream services
- **Service Management (SM) services**
 - Configuration definition, scheduling, status
 - Implementation just beginning

Interop Project Overview

- **Review, evaluate, and select protocols, WAN services and COTS products available to support AF Satellite Control Network (AFSCN) evolution**
 - **Focus on stressing time-data correlation and commanding needs**
 - **Include management functions (scheduling, RTS configuration, exchange of orbit, track, and status data)**
 - **Include security equipment (crypto, firewalls)**
- **Demonstrate effectiveness of selected standards, and assess utility of commercial equipment and services**
 - **Start in lab setting, then R&D ops, then actual ops**
 - **Exploit existing assets (CERES, NASA CSOC, existing SGLS sites)**
 - **Enhance standards or COTS equipment where necessary and affordable**
 - **Feed back to standards groups and vendors to achieve greater support**

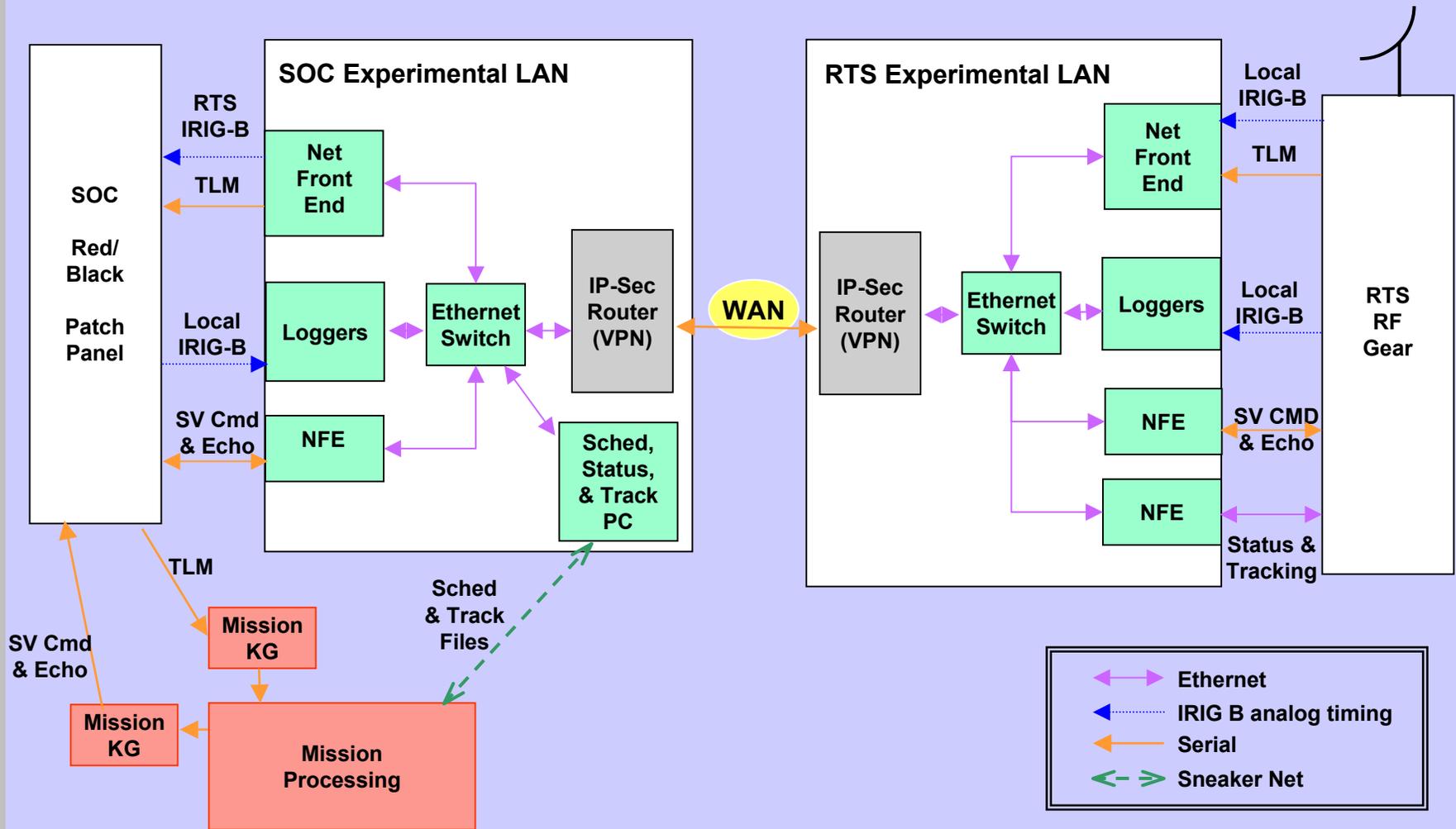
Phase 3 Configuration



Main Equipment

- **Near-COTS mux/demux**
 - Specialized for isochronous telemetry and legacy time data formats
 - Uses TCP/IP but no SLE
- **COTS Workstations with SLE software**
 - Added telemetry blocker and serializer
 - Added commanding reformatter
- **Separate Workstation for Service Management**
 - Eases security concerns
 - SLE standard schedule requests
 - Tracking data via SLE RAF and status via TCP

Phase 3 Architecture (Simplified)



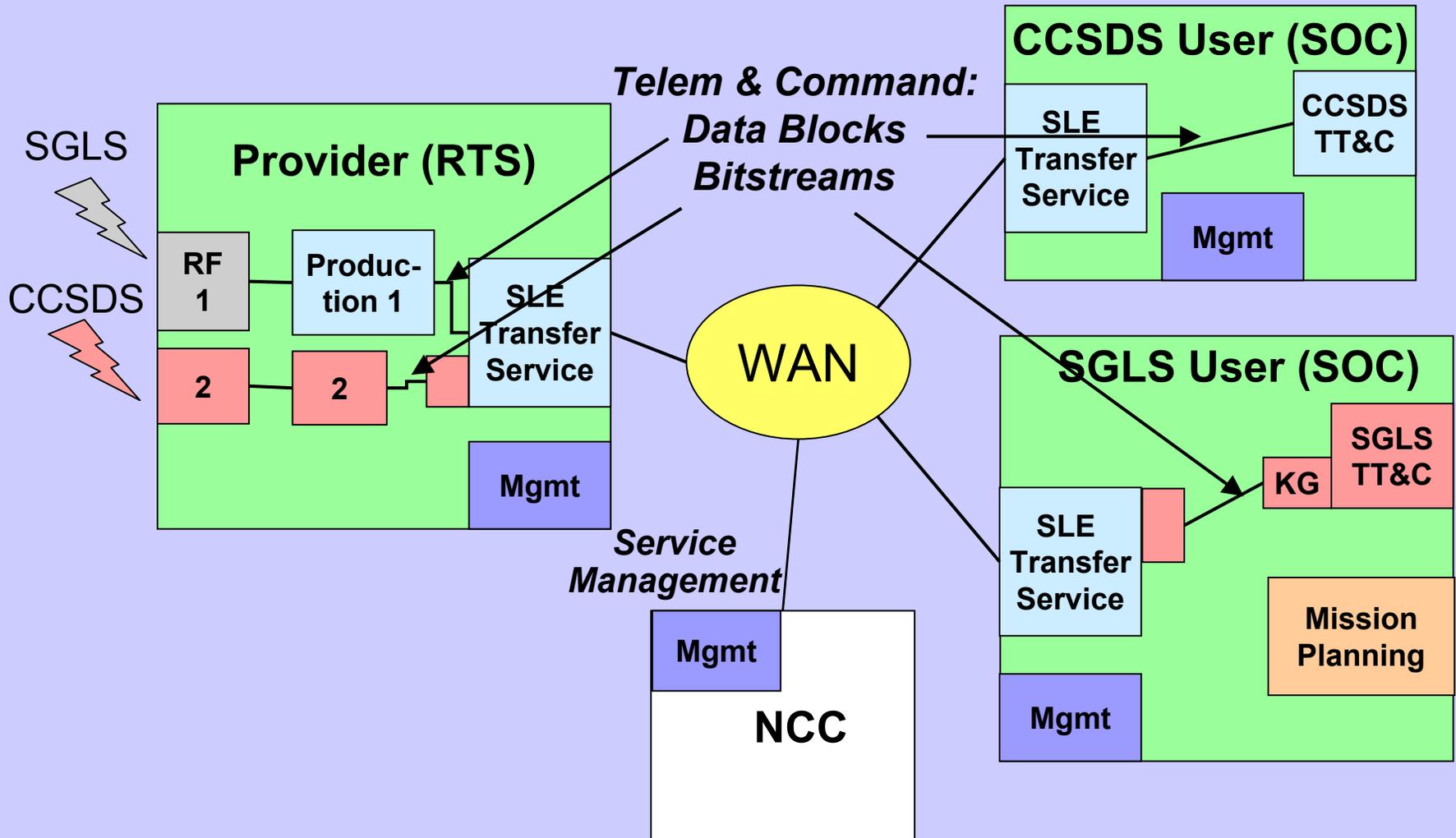
Test Bed Objectives

- **Test DoD satellite control using Internet based protocol standards over WAN**
 - ✓ **Assess alternate protocol options (UDP, TCP, SLE)**
 - ✓ **Transmit encrypted serial bitstream telemetry and commands**
 - ✓ **Accuracy, error rate**
 - ✓ **Delay and delay variation**
 - ✓ **Assess inclusion of COTS IP security software**
 - **Assess utility of SLE Management Services**
 - **Provide RTS status and tracking data**
- **Demo support for both SGLS and USB contacts from same ground station**

Preliminary Findings

- **Standards can support most DoD TT&C needs**
 - Need extensions for bit stream interfaces
 - Precision of time stamping still uncertain
 - Still need bounds on WAN Quality of Service
- **COTS equipment not yet fully supportive**
 - Standards support and compatibility issues
 - Tailoring to AFSCN needs for legacy interfaces
- **Service management standards are key to operational support**
 - Need easy scheduling, config, tracking
- **Security needs further exploration**
 - COTS secure gateways OK for R&D

DoD-NASA Interoperability Concept



Acknowledgements

- **Honeywell SCN Contract and DataLynx net**
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- **Veridian Information Systems for net integ.**
- **AVTEC for network front ends**
- **AF CEnter for REsearch Support for test SOC**
 - **STEC and EDS support contracts**
- **Applied Physics Lab & NASA Wallops for RTS**
- **NASA CSOC (LM) for Wallops equipment**