InterPlanetary Network & Information Systems Directorate

CCSDS and NASA Standards for Satellite Control Network Interoperability

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The Fundamental Question

Everyone wants interoperability between satellite control networks, but what will it take to get?

Are there standards and architectures that can meet both military and civil space needs?

Will they emerge through the invisible hand of the market place, or do we need government planning and direction to achieve interoperability?

Will it bring cost savings or cost increase?
Space Domain
Functional Elements

Problem Space

Relay Satellite

Spacecraft and Scientific Instruments

Spacecraft / lander

Data Archive

Data/Information Distribution

Data Analysis and Modeling

Mission Operations

Instrument / Sensor Operations

Data Acquisition and Command

Science Team

External Science Community
View of CCSDS Space Communications

- SLE → SLE Management
- Data Compression
- Time Maintenance
- Radio Metrics
- Monitor & Control
- Information Architecture

"Messaging"

CCSDS File Delivery Protocol (CFDP)

TCP, SCPS-TP

FTP, SCPS-FP

Internet IPSec

SCPS-SP Space Security Protocol

SCPS-NP Space Network Protocol

Internet Protocol (IPv4, IPv6)

Space Data Link Protocol

Communications Operation Procedure 1

Space Data Link Security Mechanisms

Convolutional Coding

Reed-Solomon Coding

Turbo Coding

TLM Frame Sync.

CLTU and PLOPs

BCH Coding

Modulation

Radio Frequency

Onboard LLC

Space Packet Protocol

AOS Space Data Link Protocol

Proximity 2 Space Data Link Protocol

TC Space Data Link Protocol

Onboard PHY

Synchronous Links

Asynchronous Links
Current JPL Program Content
FY 02

CCSDS File Delivery Protocol (CFDP)
- Reliable file delivery over disjoint networks

Proximity 1 Link Protocol
- Dynamic link establishment and negotiation

Space Communication Protocol Standard (SCPS)
- Internet protocols augmented for near Earth use in space

Space Link Extension (SLE)
- Transfer services, service requests & management

Spacecraft Onboard InterFace (SOIF)
- Message Transfer Layer, inter-S/C messaging

And several other tasks
- Navigation interchange standards
- Bandwidth & power efficient coding and modulation
- Object Management Group (OMG) Space Domain Task Force
- XML Space Application Study
INTERPLANETARY NETWORK AND INFORMATION SYSTEMS

Proximity - 1 Link Protocols

Future Mars Environment

- Multiple Mission Support
  - Orbiter to Lander
  - Lander to Rover
  - Constellation / Formation
- Link Management
  - Hailing/Operating Frequencies
  - Dynamic Link Establishment
- Supports Reliable Data Delivery
  - Sequence Controlled Mode
  - Expedited Mode
  - Simplex/Half/FullDuplex Modes

Greg Kazz
13 February 2002

JPL Standards Program
CCSDS Space Link Extension (SLE)
Domain of SLE Services

Domain of Space Link Services

CCSDS Panel 1 has provided Recommendations for Space Link Service that terminate at the ground station.

Domain of Space Link Extension Services

CCSDS Panel 3 is addressing the extension of Space Link Services across the ground.
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CCSDS PROTOCOLS

TEST RANGE COMMUNICATIONS

- Source Packets (data structuring)
- SCPS Network (on-board & link)
- SCPS Security (on-board & link)
- CCSDS Frames (comm link)
- Internet Packets (ground links)

Diagram:

- Test Range A
  - Range Safety
  - Processing Station
- Test Range B
  - Range Safety
  - Processing Station
- LAN

Network:
- Internet
- Developer’s Facility

Diagram elements:
- Commutated Data Streams
- Control Data Streams
- Fault Analysis Data Messages
- Range Safety Data Messages
- Multiplexed Data Stream
- Vehicle Communications

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PMBS 8
CCSDS / OMG
Space Domain Task Force

Mission Operators

Science Users

Mission Operations System

Service Operators

Ground Terminal Systems

Spacecraft Systems

Space Link

OMG SSGSWG, with acknowledgements to JPL / MDS
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JPL Standards Program
Communication Network Layer Implementation

User Applications

SOIF C&D Service
SOIF File Service
SCPS-NP Service

Network Sublayer: "IP Subnetwork Drivers"
unique for each Data Link implementation

Transport Layer

Application Layer

Messaging Transfer
File Transfer

Transport Layer: TCP/UDP or SCPS-TP

Network Layer

Network Layer: IP or SCPS-NP

Intra Processor Communication

Data Link Layer

IEEE-1394, SpaceWire, MIL-STD-1553B, OBDH, etc.

Physical Layer

IEEE-1394, SpaceWire, MIL-STD-1553B, OBDH, etc.

NOTE: No security protocol is shown in order to simplify this diagram
NASA interoperability standards for space communications can be applied to military spacecraft and their satellite control networks.

COTS products that implement these standards are available from more than 60 vendors.

New standards that support applications in stressed environments are in development.