



In-Space Networking On NASA's SCAN Testbed

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Agenda

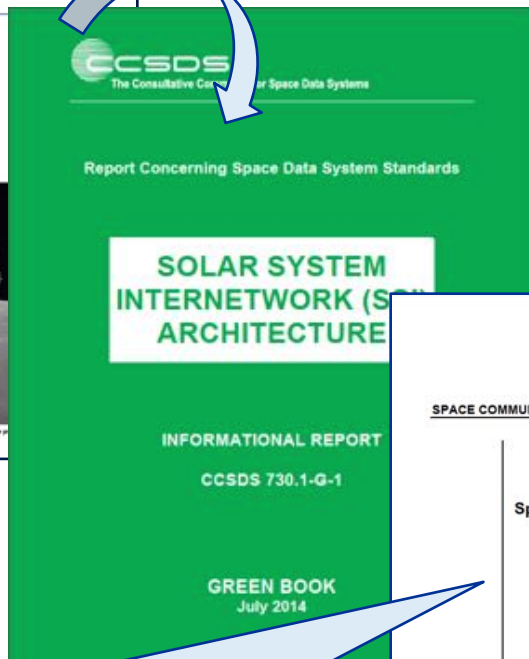
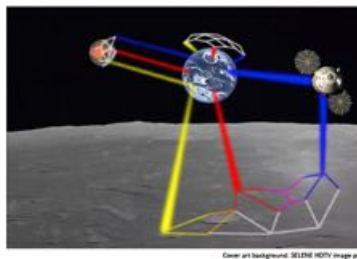
- Motivation and Goals/Objectives
- Overview of SCan Testbed
- Design Implementation Details
- Software Instrumentation
- Summary and Future Work

Report of the
Interagency Operations Advisory Group
Space Internetworking Strategy Group



Recommendations on a Strategy for
Space Internetworking

November 15, 2008



SCaN shall “provide Space Internetworking services to mission users” and “interoperate with external space networks that are compliant with space internetworking standards.”

Motivation

SGSS Requirements:
CCSDS AOS Protocols
Return AOS Frames
Forward AOS Frames
Forward Service ENCAP
Processing
Return Service ENCAP Processing

SPACE COMMUNICATIONS AND NAVIGATION PROGRAM

Space Communications and Navigation (SCaN) System Requirements Document (SRD)

Revision 3

Effective Date: September 29, 2014

Expiration Date: September 29, 2019



NASA Headquarters
Washington, D. C.

CHECK THE SCaN NEXT GENERATION INTEGRATED NETWORK (NGIN) AT:
<https://scandocs.nasa.gov/>
TO VERIFY THAT THIS IS THE CORRECT VERSION PRIOR TO USE.

458-REQ-0002

458 / SPACE NETWORK GROUND SEGMENT SUSTAINMENT PROJECT

Space Network (SN) Ground Segment Sustainment (SGSS) System Requirements Document (SRD)

Revision 1 w/DCN 009

Effective Date: June 23, 2011

Expiration Date: June 23, 2016



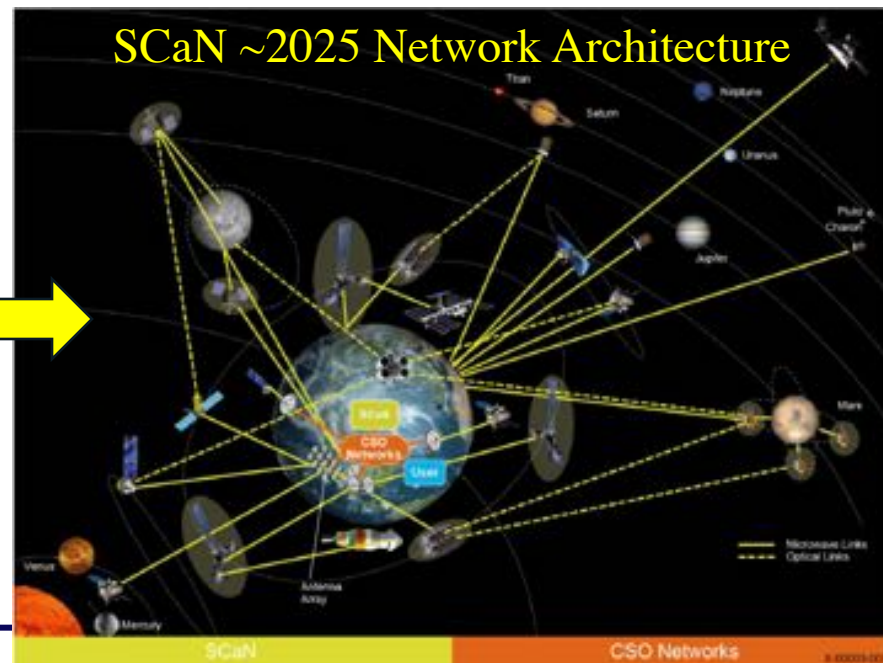
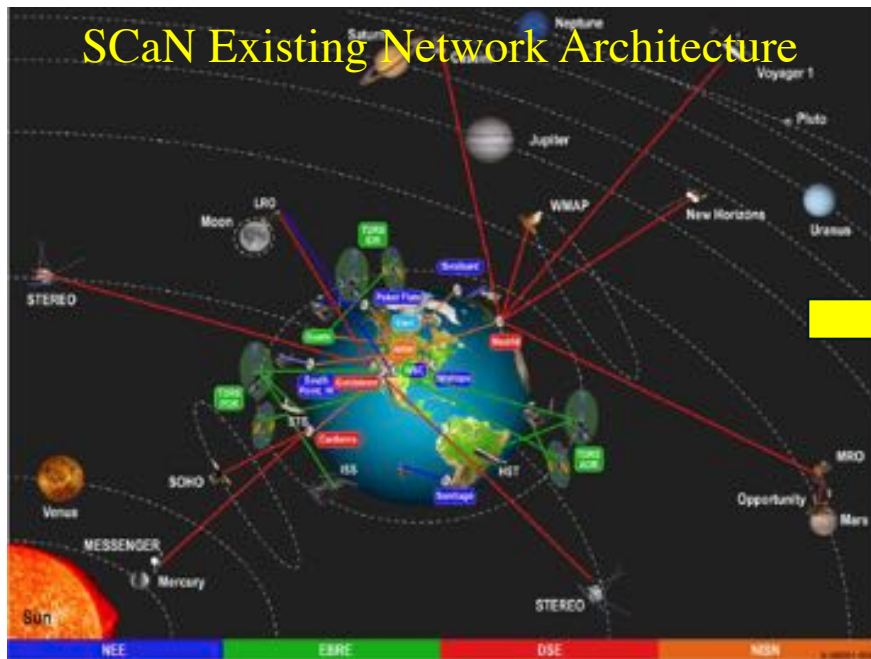
National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

CHECK THE SGSSC NEXT GENERATION INTEGRATED NETWORK (NGIN) AT:
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Solar System Internet Implementation Challenges

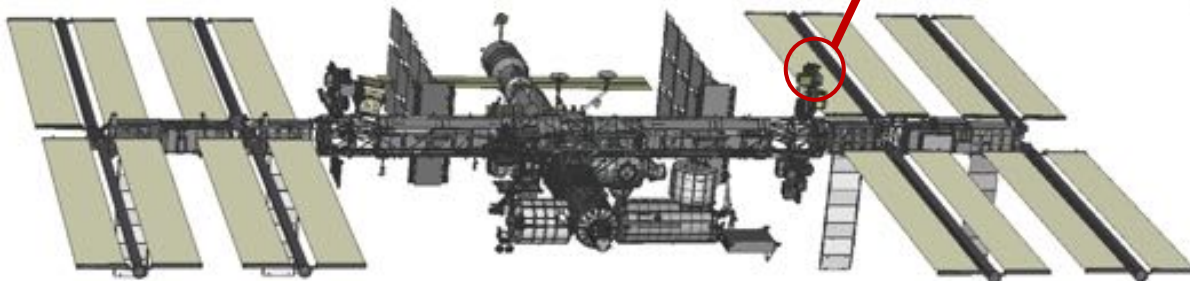
- Requires protocol support across mission-developed and SCaN elements
- Limited number of reusable flight or ground software components
- Necessary standards still under development
- Commercial IT products do not support space mission needs
- Different operations concept between networking and legacy point-to-point communication services.



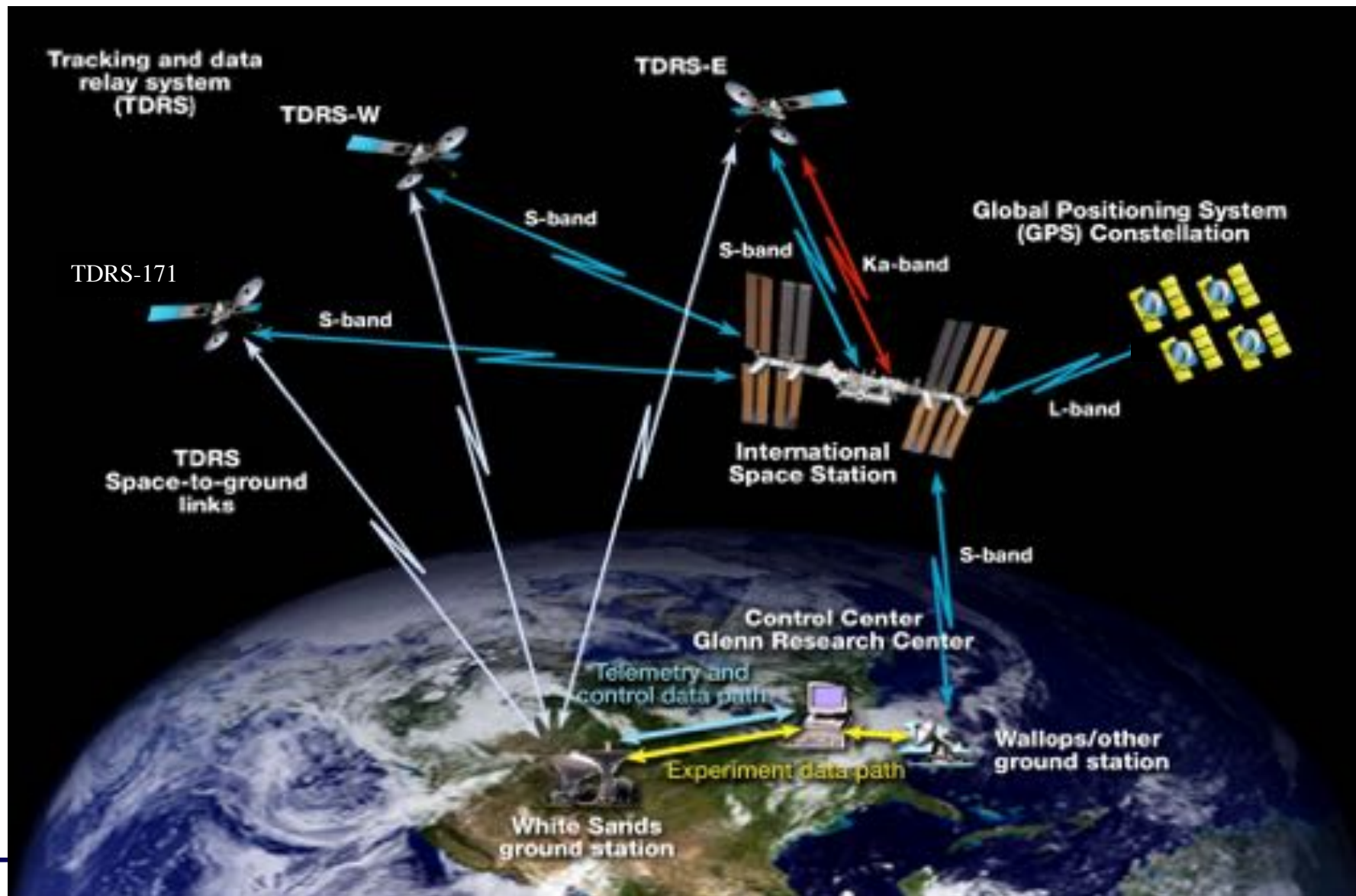
Goals and Objectives

SCaN Testbed Networking Portfolio

- Gain long-term operations experience with Space Internet
- Produce robust, flexible implementations for future missions
- Support network topologies that represent future mission complexity
- Mature the operational concept
- Integrate networking with realistic on-board data interfaces
- Include native support for security protocols operating across multiple layers



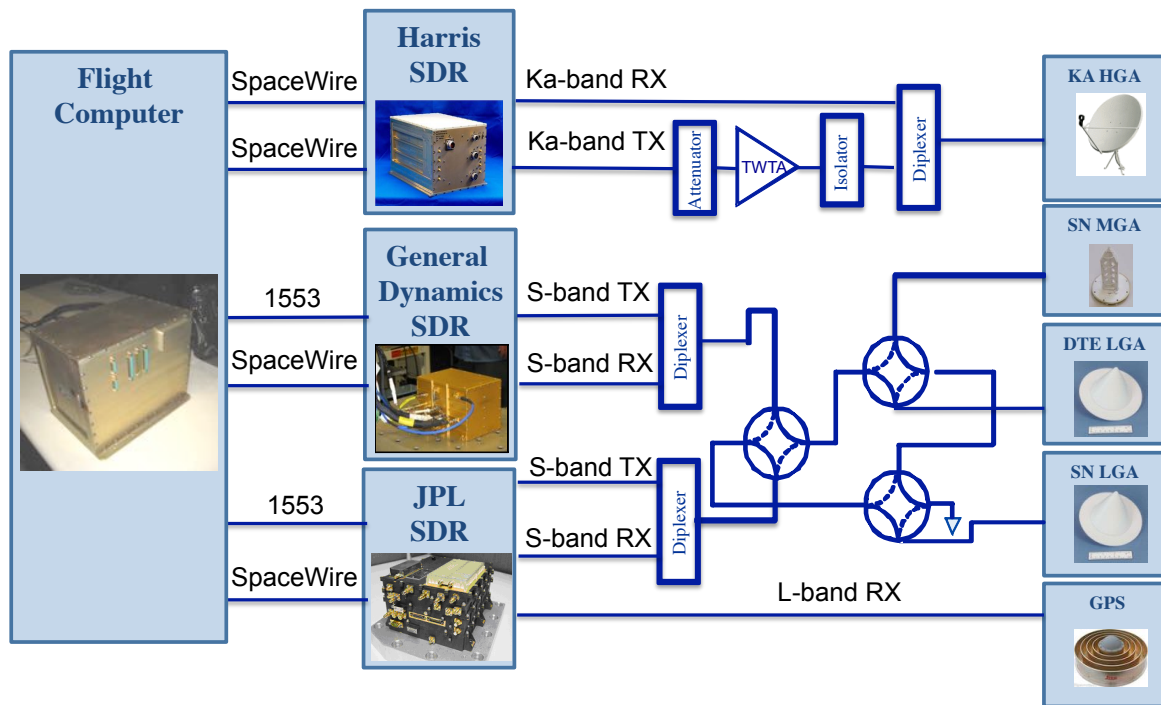
SCaN Testbed System Overview - Architecture



SCaN Testbed Overview - Flight System & Initial Capabilities

Comprehensive testing of:

- Ability to perform on-orbit updates
- RF and physical layer development platform
- Point-to-point physical and bit layer services between Software Defined Radios and Mission Operations Center
- Command and telemetry services

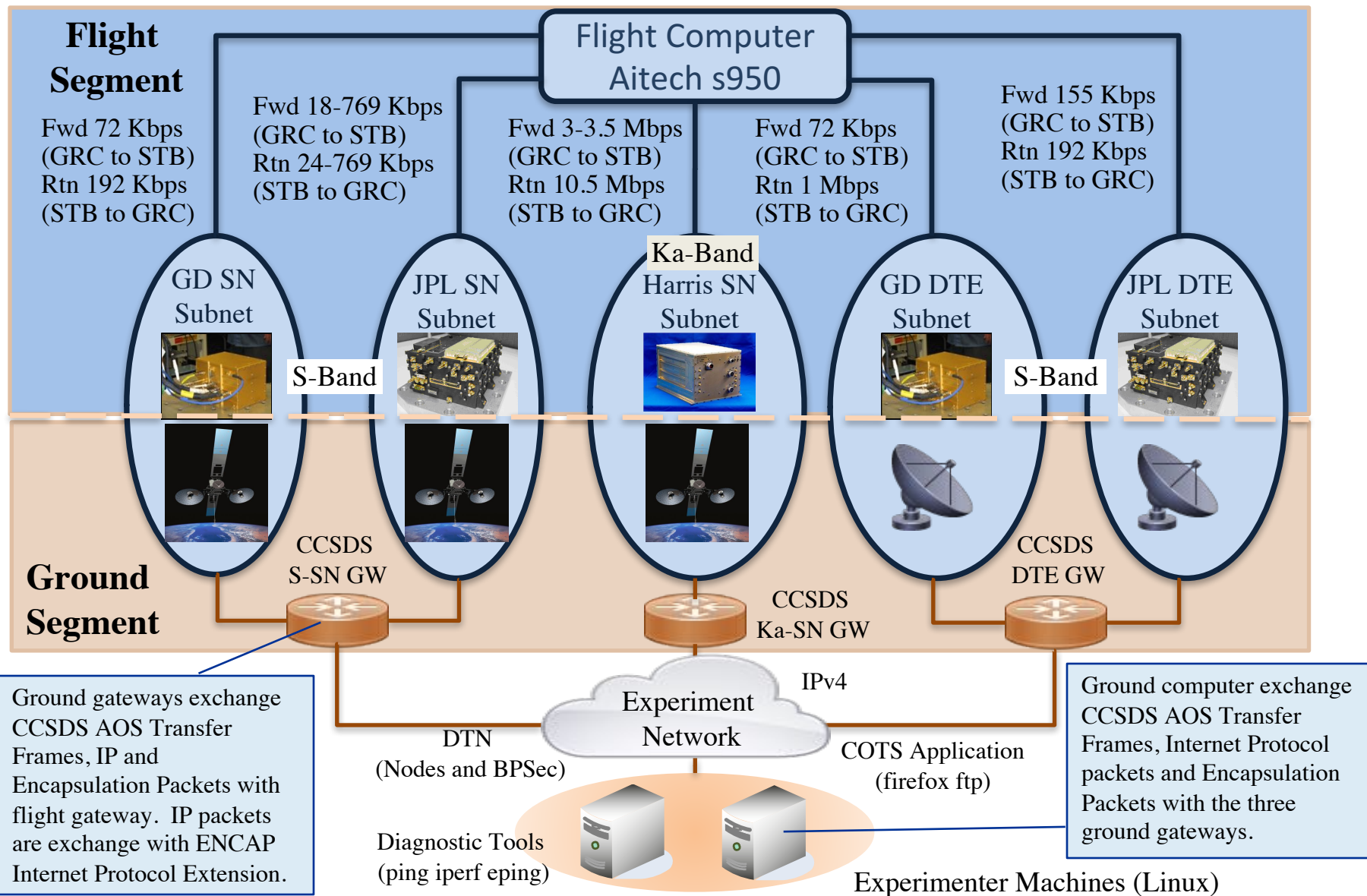


Launch Software Capabilities

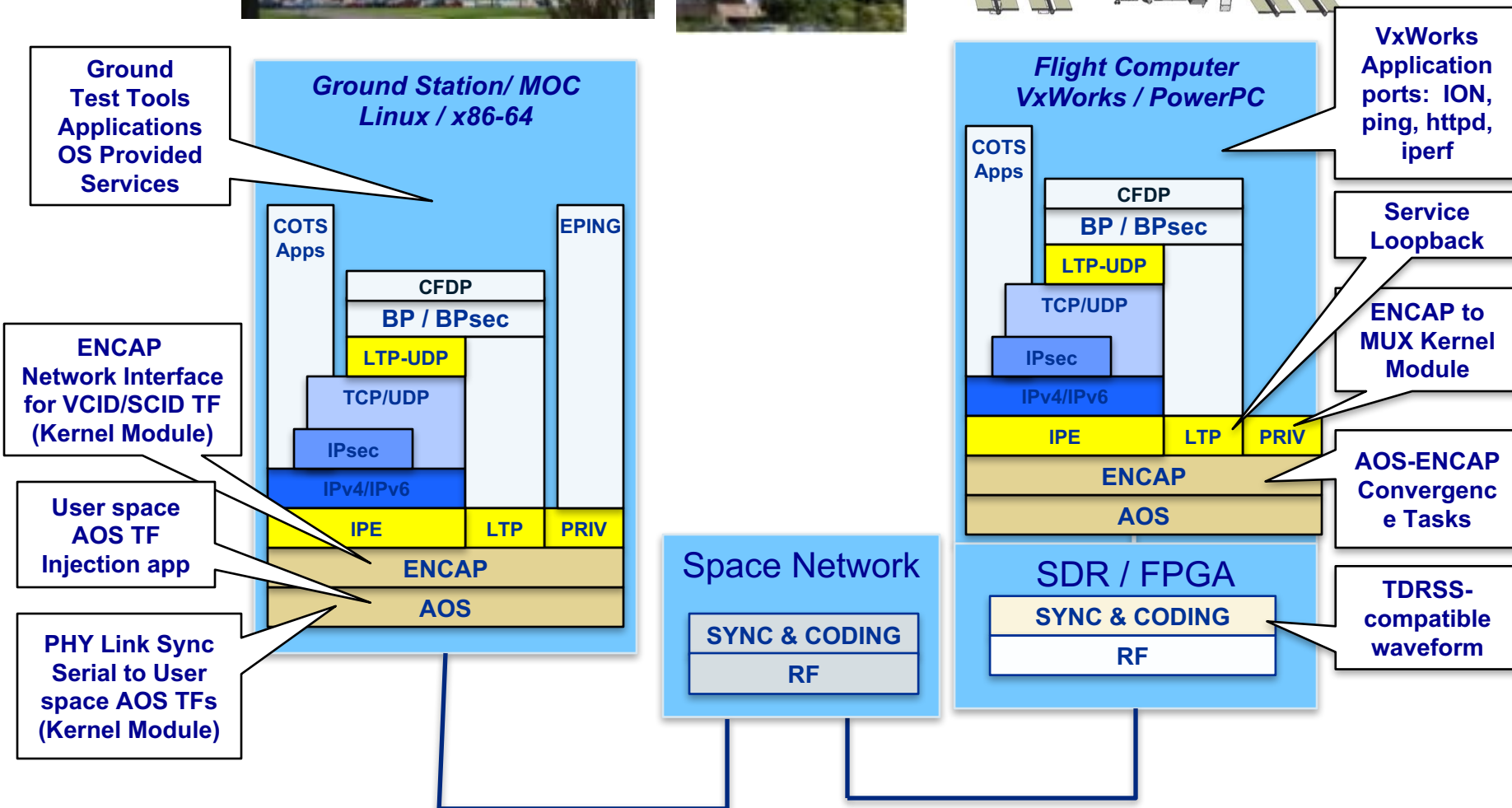
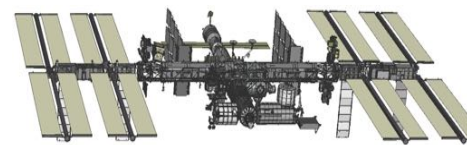
- Launch waveforms: Compatible with the TDRS Space Network. Limited CCSDS Advanced Orbiting System (AOS) implemented.
- Avionics software: Focus on system control.

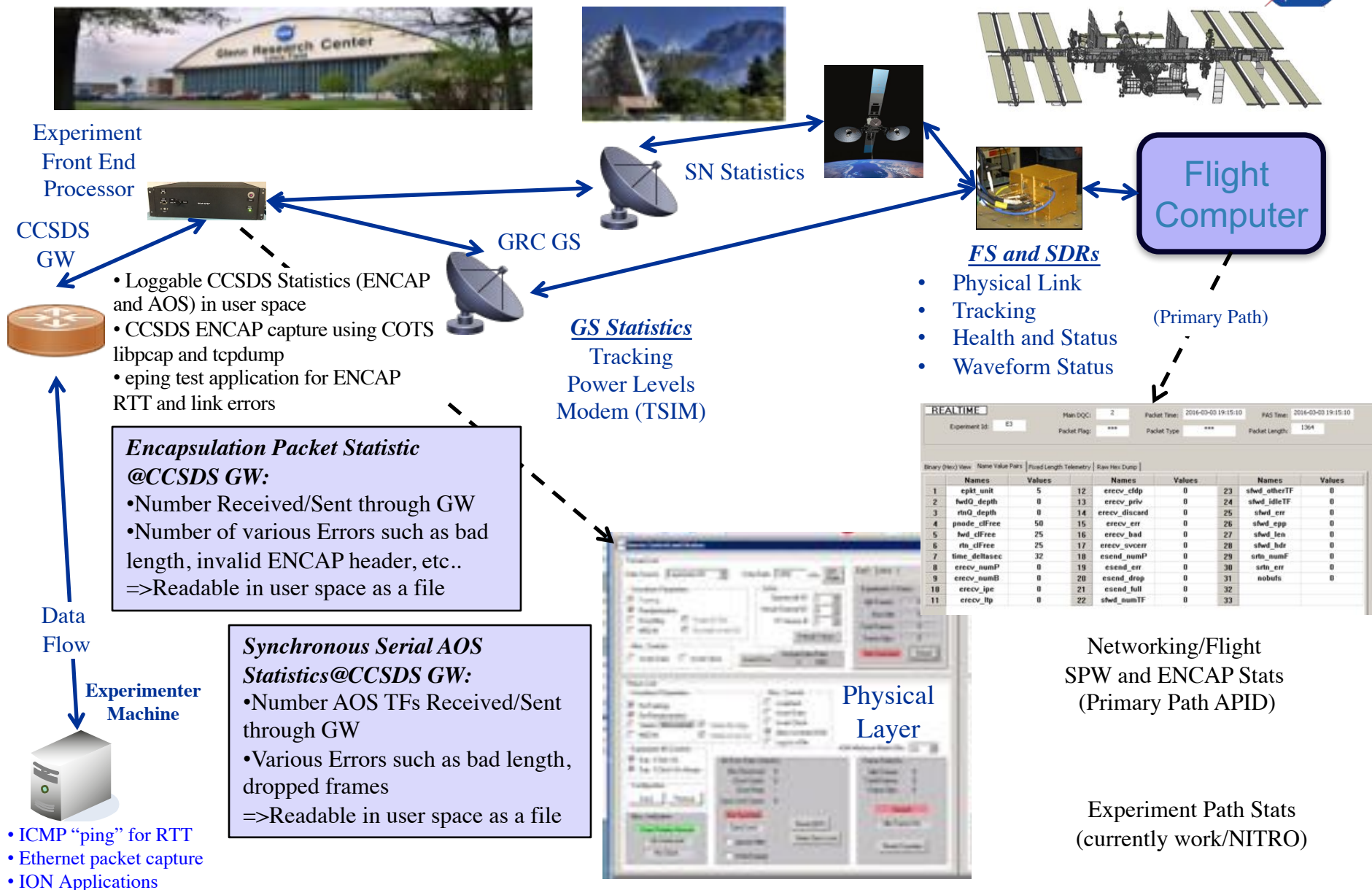
Launched with minimal software to meet schedule constraint

Baseline Network Point to Point Links Overview



Reusable Software Components



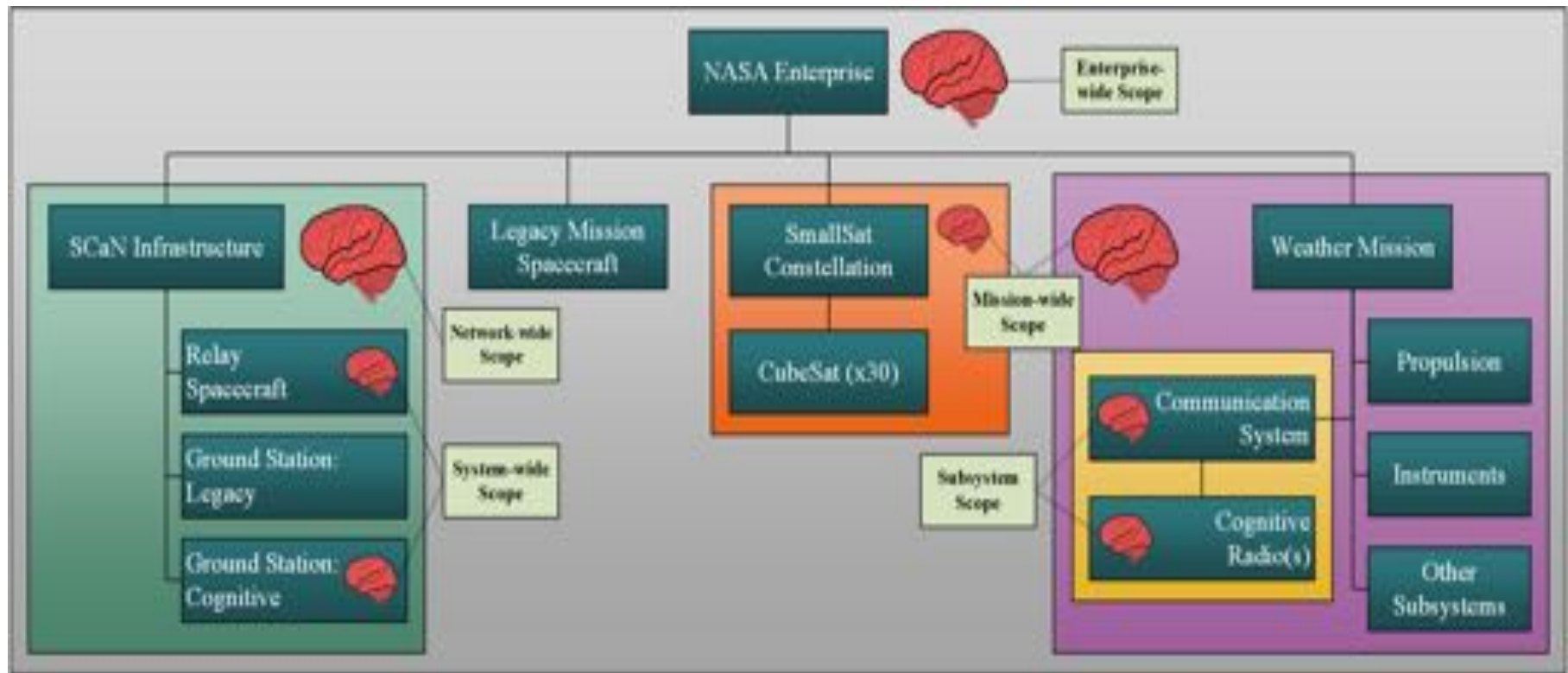




- **SCaN Testbed networking implementation and knowledge gained will enable NASA's transition to Solar System Internet. This include demonstrating IPv4 routing on a CCSDS reusable ground and flight software components that served to:**
 - **Produce a robust, flexible implementations for future missions**
 - **Create a baseline topology with CCSDS that integrates with future complex missions**
 - **Help to mature the operational concept by integrating CCSDS with a space testbed**
 - **Integrate networking with realistic space on-board data interfaces (Spacewire)**
 - **Include native support for security protocols operating across multiple layers (Secure DTN)**



- Foundation has been laid for cognitive networking capabilities research and development activities such as NASA Intelligent Routing(NITRO), Cognitive Networking(COGENT) and SCaN Testbed that evolves to Cognitive Communication project



Space Protocol Research on the SCan Testbed

Application
Transport

CCSDS 734.2-R-3
CCSDS Bundle Protocol
Specification

Network Management Protocol
Key Distribution Protocol
Bundle Protocol Security (BPsec)

CCSDS 727.0-B-4
CCSDS File Delivery Protocol

CCSDS 734.1-B-1
(LTP)

Network

CCSDS 702.1-B-1
IP over CCSDS
Space Links

CCSDS 133.1-B-2
Encapsulation Service

Data
Link

CCSDS 131.0-B-2
TM Synchronization
and Channel Coding

CCSDS 732.0-B-2 AOS Space Data
Link Protocol

Physical

CCSDS 131.3-B-1 CCSDS
Space Link Protocols over
ETSI DVB-S2 Standard.

CCSDS 131.5-M-1 Variable Coded
Modulation Protocol

CCSDS 401.0-B-25
RF Earth Stations
and Spacecraft

CCSDS 415.1-B01
Data Transmission and PN Ranging for 2 GHz Link
via Data Relay Satellite

Cross
Support
SLE

CCSDS 911.1-B-3
Space Link
Extension—Return All
Frames

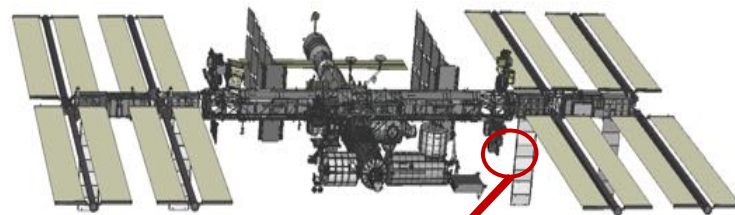
CCSDS 912.11-0-1
SLE—Enhanced
Forward CLTU

CCSDS 912.1-B-3
SLE—Forward CLTU Svc

CCSDS 911.2-B-2

CCSDS 913.1-B-1
SLE – IP for Transfer Svc

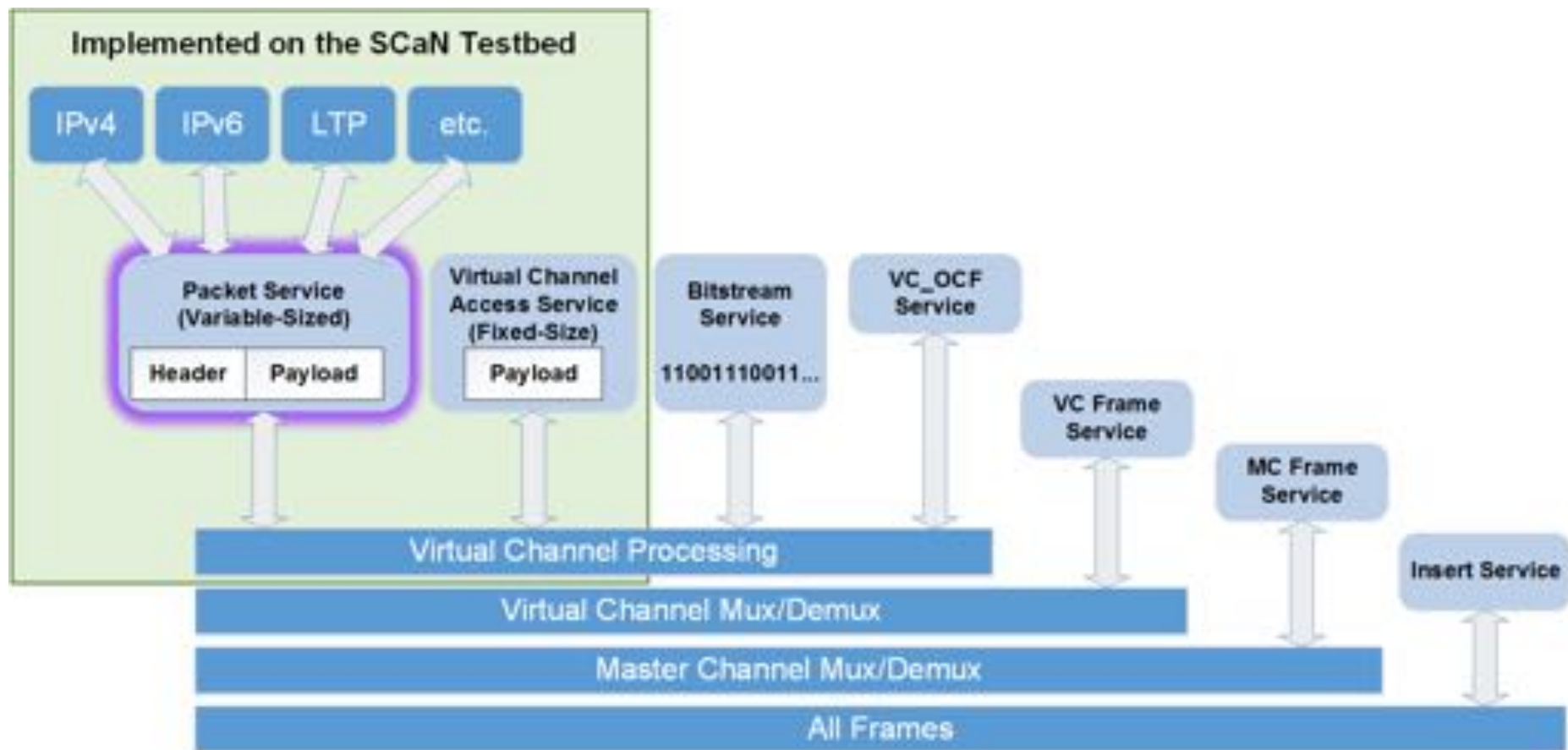
CCSDS 911.5-B-2



SCaN Testbed
on ISS



AOS and ENCAP on SCaN Testbed





Acronym List

- AOS – Advanced Orbiting Systems
- BP– Bundle Protocol
- CCSDS – Consultative Committee for Space Data Systems
- CSO – Communication Service Office
- DSE – Deep Space Element
- DTE – Direct to Earth
- DTN – Delay Tolerant Networking
- EBRE – Earth-Based Relay Element
- ENCAP – Encapsulation
- Fwd – Forward service
- GRC – NASA's Glenn Research Center
- GS – Ground Station
- GW – Gateway
- ION – Interplanetary Overlay Network
- ISS – International Space Station
- LTP – Licklider Transport Protocol
- LTP – Liklikder Transport Protocol
- NASA – National Aeronautics and Space Administration
- NEE – Near Earth Element
- NISN – NASA Integrated Services Network
- NITRO – NASA Intelligent Routing
- OS – Operating System
- Rtn – Return service
- RTT – Round Trip Time
- SCan – Space Communication and Navigation
- SGSS – Space Network Ground Segment Sustainment
- SN – Space Network
- SPW – SpaceWire
- STB – SCan Testbed
- TDRS – Tracking and Data Relay Satellite
- TSIM – TDRS Simulator
- TF – Transfer Frame