



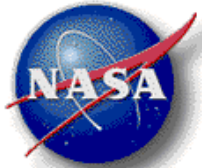
Delay Tolerant Networking on NASA's Space Communication and Navigation Testbed

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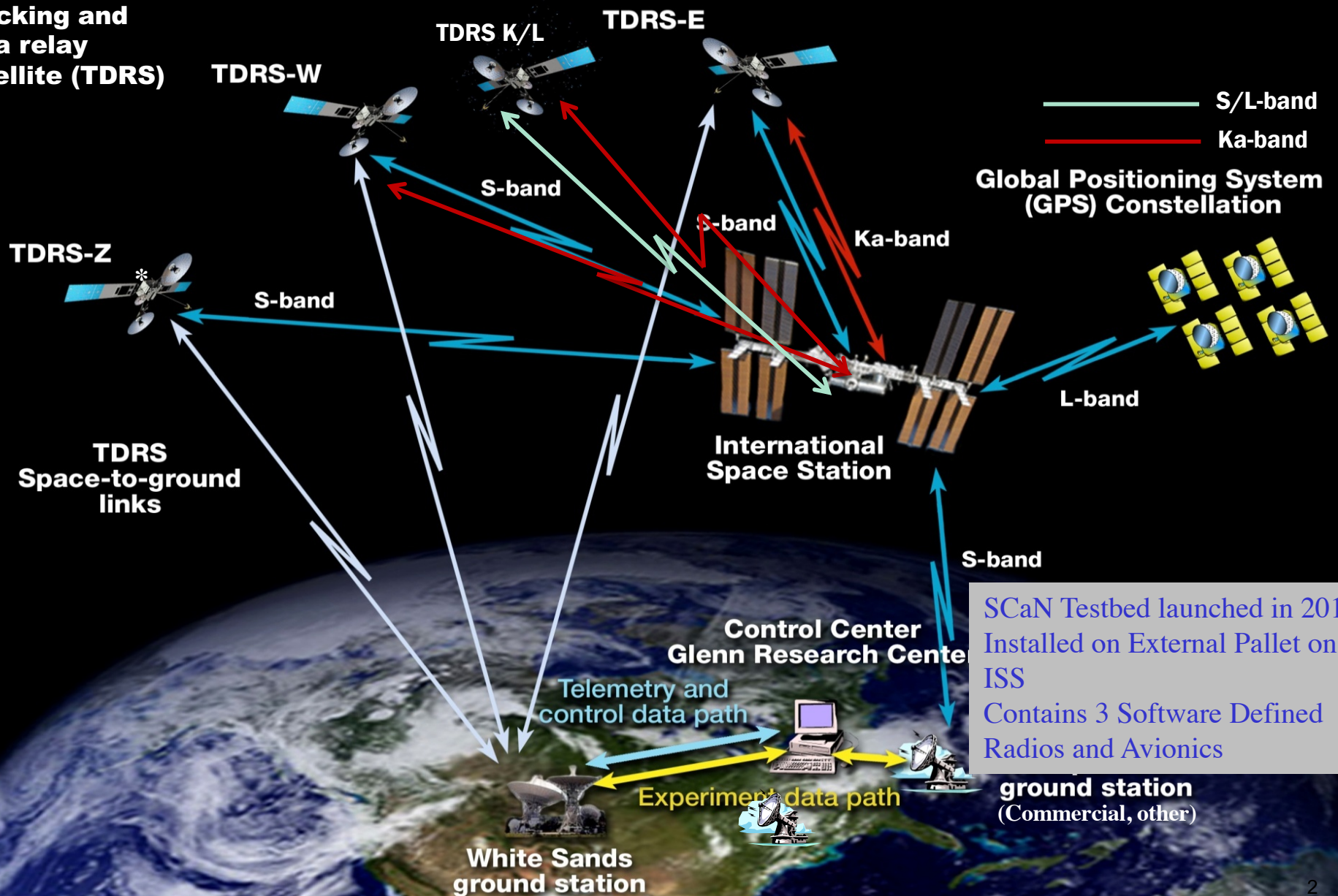
CCSDS DTN Working Group

October 2016



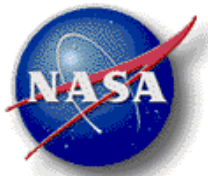
SCAN Testbed System Architecture

Tracking and data relay satellite (TDRS)

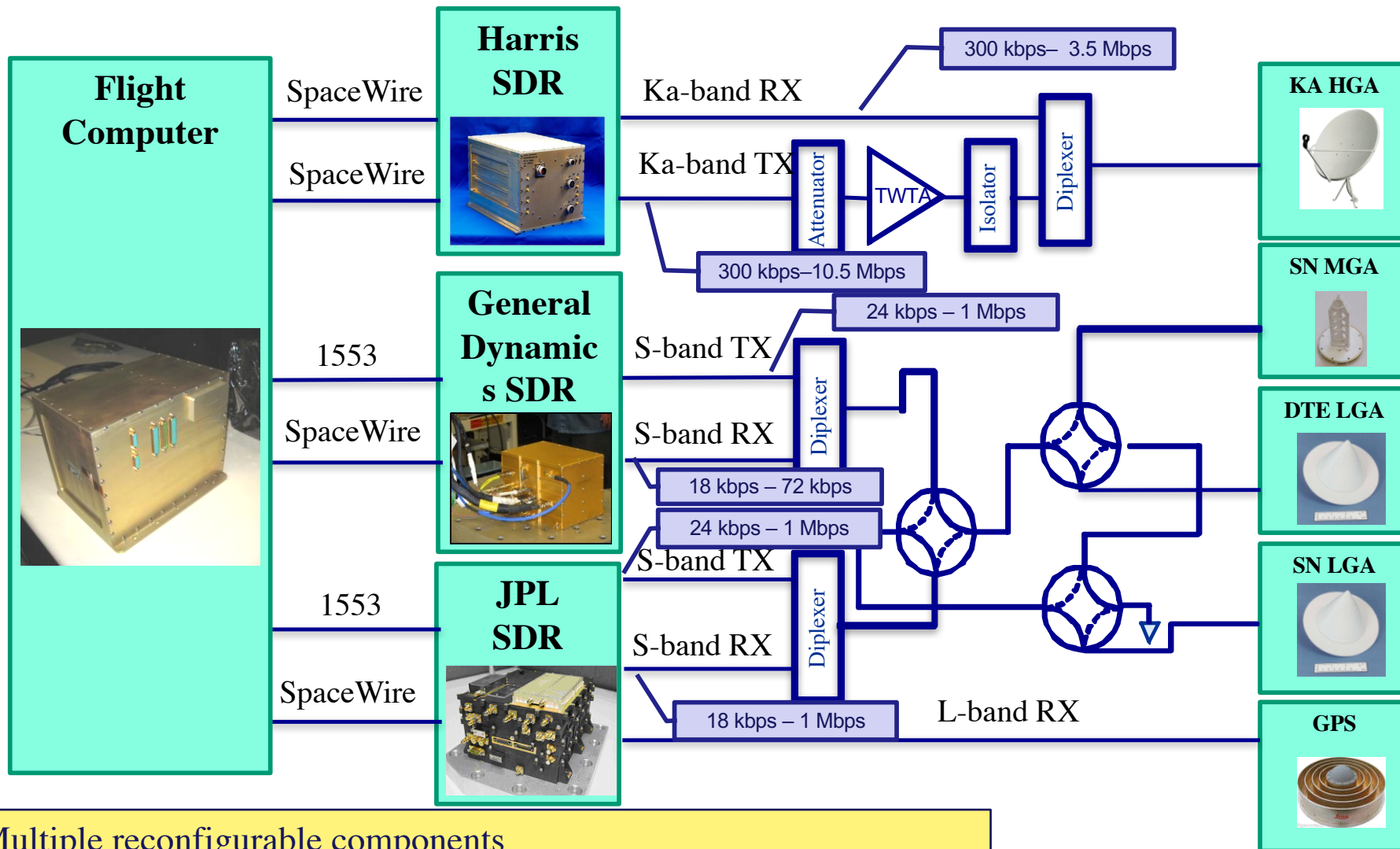


SCaN Testbed launched in 2012
Installed on External Pallet on ISS
Contains 3 Software Defined Radios and Avionics

ground station
(Commercial, other)

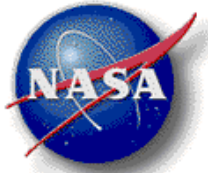


SCAN Testbed Flight System



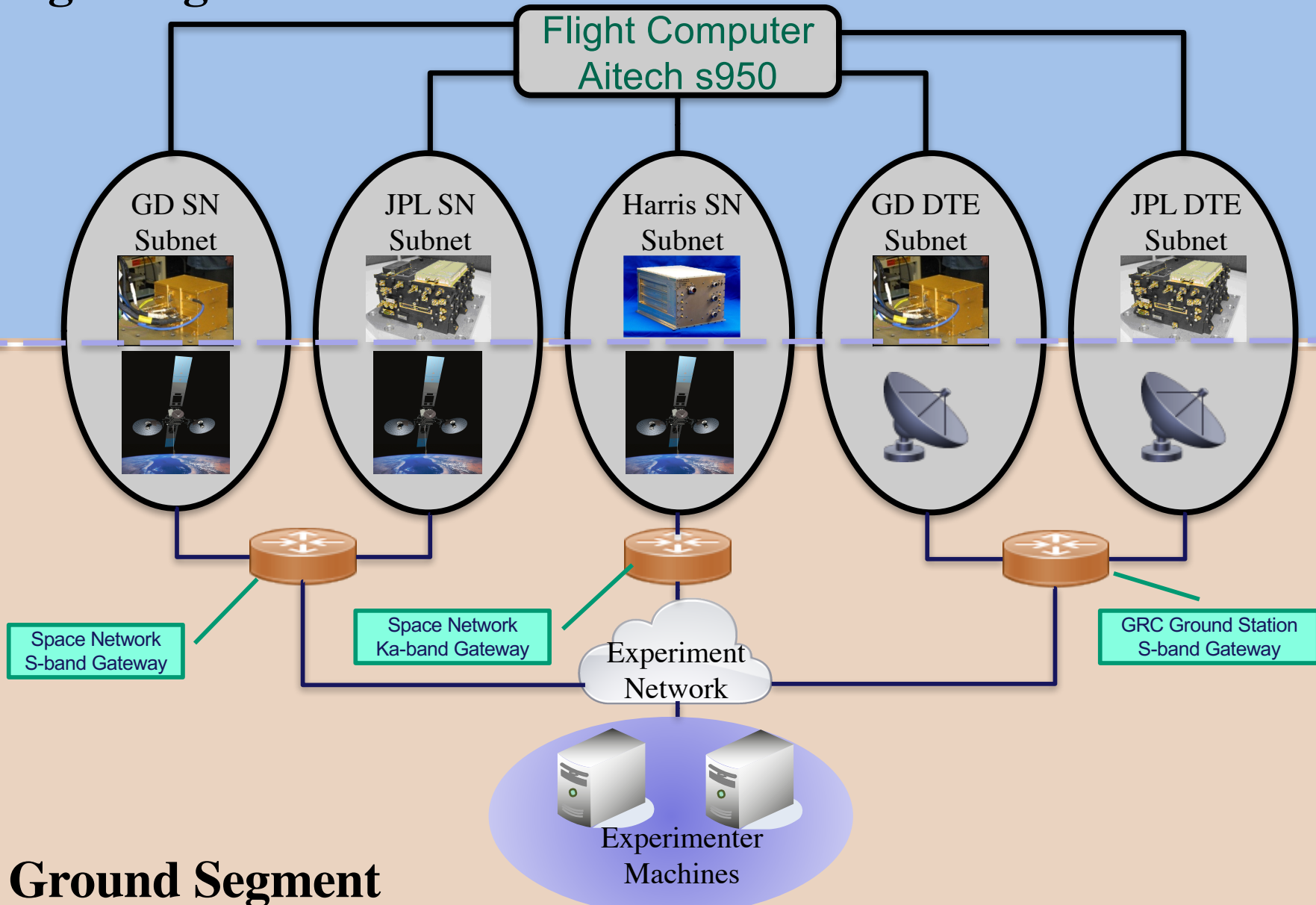
Multiple reconfigurable components
Capable of 3 simultaneous links (combination of S- and Ka-band)

Rates available for Networking configurations



Point to Point Link Overview

Flight Segment



Ground Segment



Implementation Summary

Space Platform

- Aitech s950
- Operating System: VxWorks 6.3
- 733 MHz
- 64 GB of flash memory

DTN

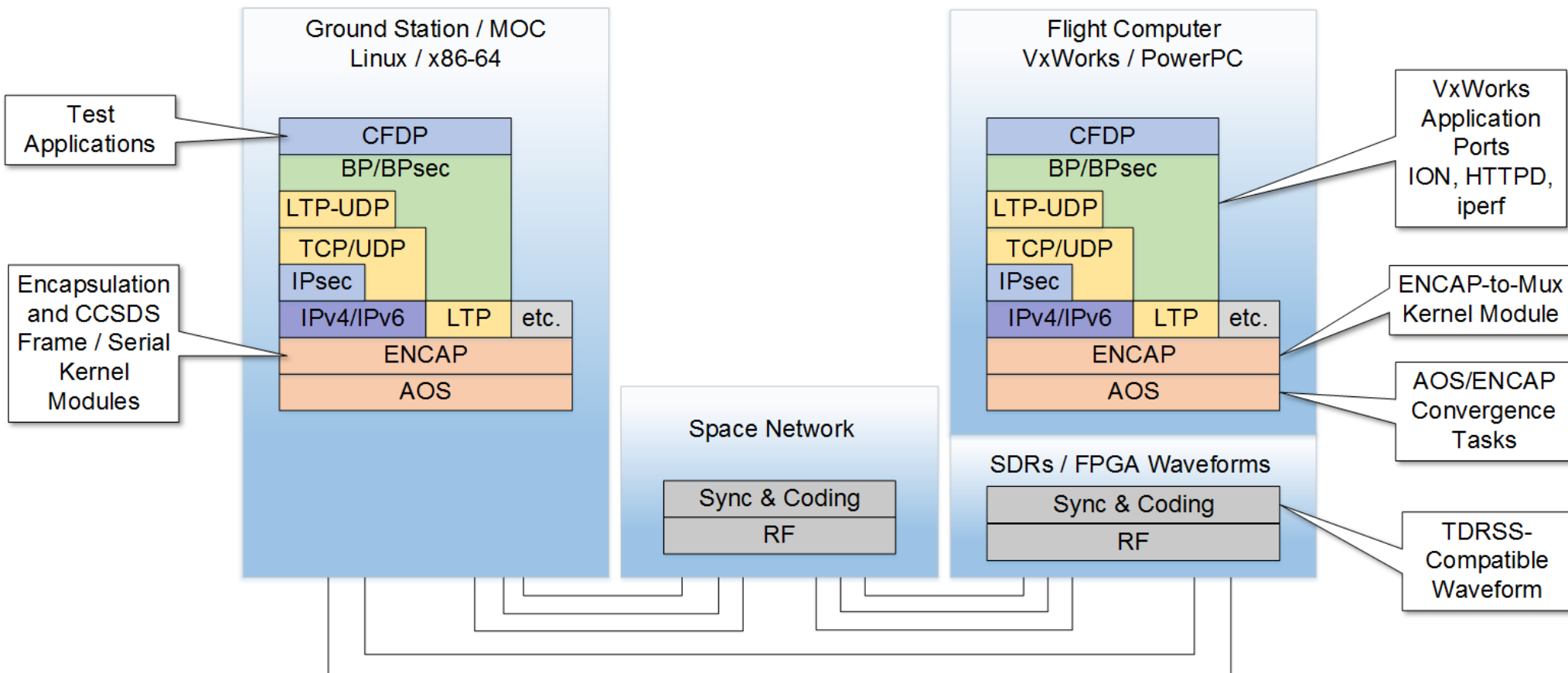
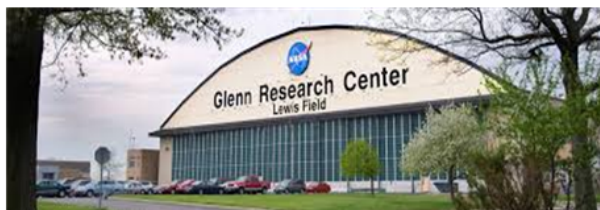
- ION 3.3.1 + Bpsec + Network Management patches
- Some bugs found. Contributed back to open source
- Used IPN endpoint IDs
- Static routing and CGR
- Applications: bping/bpecho, CFDP
- Convergence Layers: IPsec/IPMEIR, TCP, UDP, LTP/UDP, and LTP/ENCAP



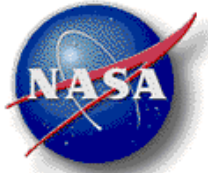
Flight-spare
Avionics Unit



Protocol Stack Design and Reuseable Software Components

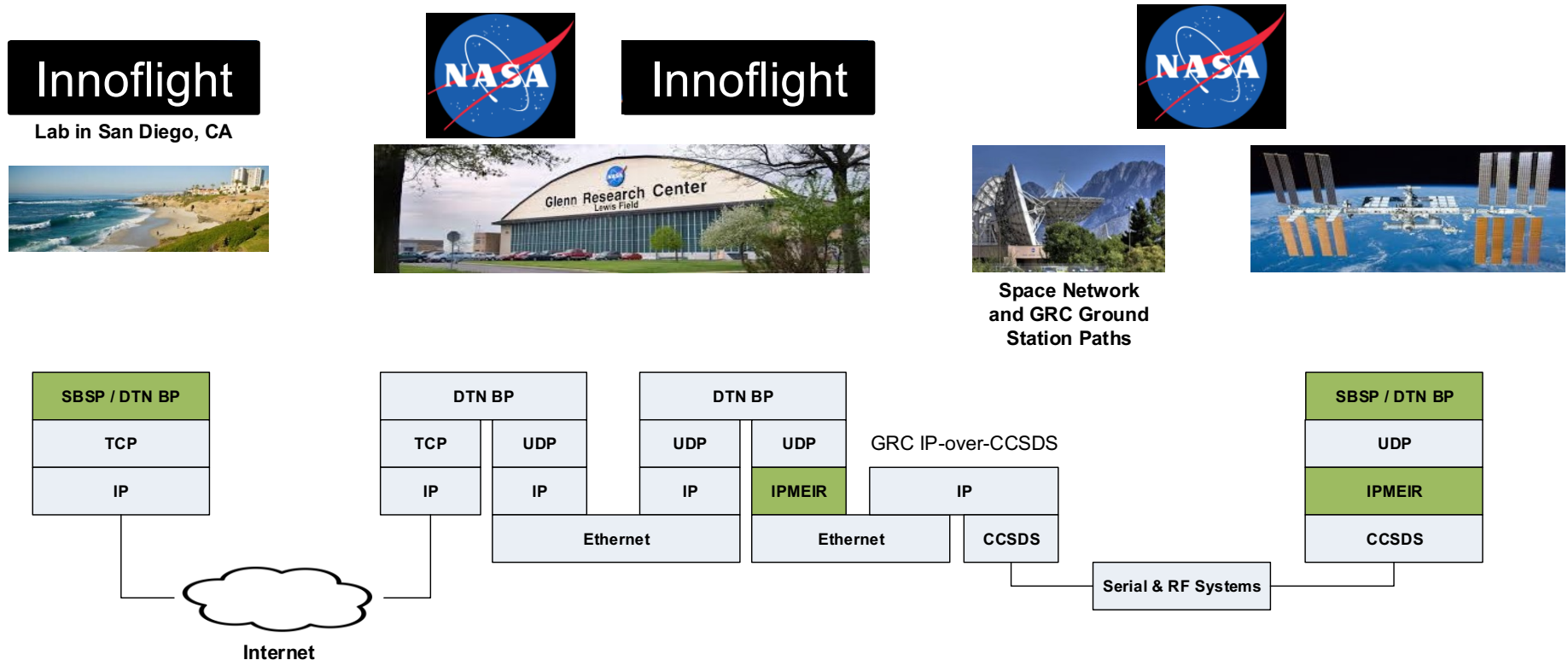


Implemented LTP over either IP-over-CCSDS or direct over AOS



Network Security

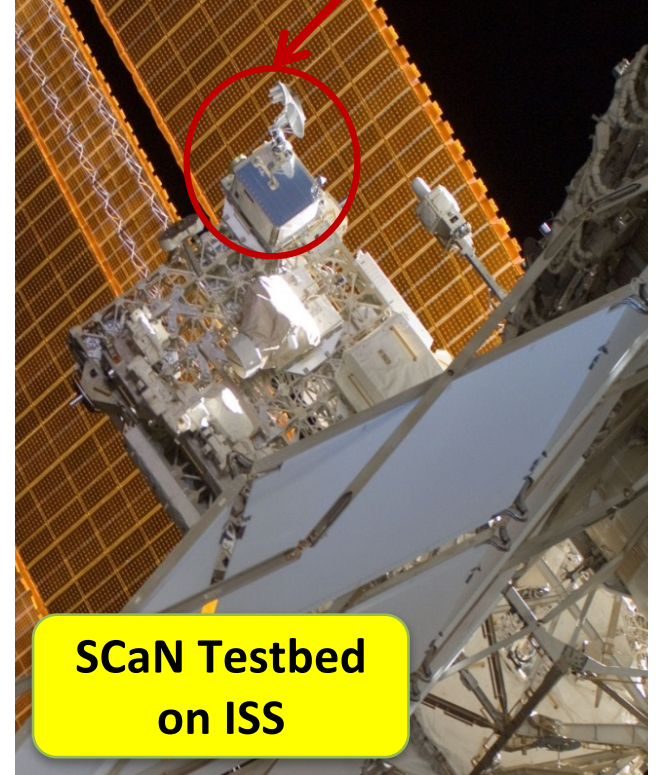
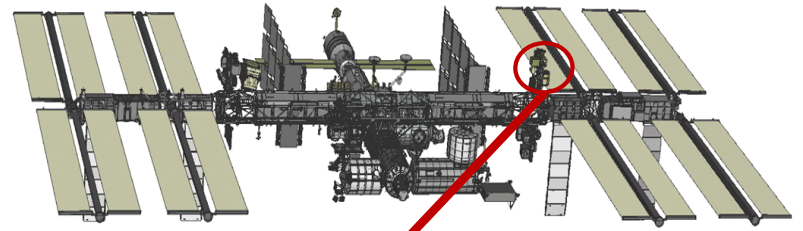
- SBIR Phase 2 added NSA Suite-B crypto and combination of bundle and IP-layer security to DTN / ION
- Completed successful on-orbit testing on SCA_N Testbed in June of features in **green** in diagram below
 - End-to-end security at the DTN bundle layer using new Streamlined Bundle Security Protocol (SBSP)
 - Hop-by-hop security using the NSA IP security standard (IPMEIR)





Space Protocol Research on the SCaN Testbed

Application	<p>CCSDS 734.2-R-3 CCSDS Bundle Protocol Specification</p>	<p>Network Management Protocol Key Distribution Protocol Bundle Protocol Security (BPsec)</p>	
Transport	<p>CCSDS 727.0-B-4 CCSDS File Delivery Protocol</p>	<p>CCSDS 734.1-B-1 (LTP)</p>	
Network	<p>CCSDS 702.1-B-1 IP over CCSDS Space Links</p>	<p>CCSDS 133.1-B-2 Encapsulation Service</p>	
Data Link	<p>CCSDS 131.0-B-2 TM Synchronization and Channel Coding</p>	<p>CCSDS 732.0-B-2 AOS Space Data Link Protocol</p>	
Physical	<p>CCSDS 131.3-B-1 CCSDS Space Link Protocols over ETSI DVB-S2 Standard.</p>	<p>CCSDS 131.5-M-1 Variable Coded Modulation Protocol</p>	
	<p>CCSDS 401.0-B-25 RF Earth Stations and Spacecraft</p>	<p>CCSDS 415.1-B01 Data Transmission and PN Ranging for 2 GHz Link via Data Relay Satellite</p>	
Cross Support SLE	<p>CCSDS 911.1-B-3 Space Link Extension—Return All Frames</p>	<p>CCSDS 912.11-0-1 SLE—Enhanced Forward CLTU</p>	<p>CCSDS 912.1-B-3 SLE—Forward CLTU Svc</p>
	<p>CCSDS 911.2-B-2</p>		<p>CCSDS 913.1-B-1 SLE – IP for Transfer Svc</p>
	<p>CCSDS 911.5-B-2</p>		



**SCaN Testbed
on ISS**