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

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**SCAN Testbed System Architecture**

**Tracking and data relay satellite (TDRS)**

- **TDRS-K/L**
- **TDRS-W**
- **TDRS-Z**

**Global Positioning System (GPS) Constellation**

**International Space Station**

**Telemetry and control data path**

**Experiment data path**

**Control Center**

- **Glenn Research Center**

**White Sands ground station**

**Ground station**

(Commercial, other)

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

Flight Computer
Aitech s950

GD SN Subnet
JPL SN Subnet
Harris SN Subnet
GD DTE Subnet
JPL DTE Subnet

Space Network
S-band Gateway
Space Network
Ka-band Gateway
GRC Ground Station
S-band Gateway

Ground Segment

Experiment
Network
Experimenter
Machines
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
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 SCaN 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

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

**SLE (Space Link Extension)**
- Forward CLTU
- Forward CLTU Svc
- IP for Transfer Svc

CCSDS File Delivery Protocol
- Data Transmission and PN Ranging for 2 GHz Link via Data Relay Satellite

**SCaN Testbed on ISS**

CCSDS Space Link Protocols over ETSI DVB-S2 Standard.

CCSDS TM Synchronization and Channel Coding

**Physical**
- RF Earth Stations and Spacecraft
- Data Transmission and PN Ranging for 2 GHz Link via Data Relay Satellite

**Cross Support SLE**
- SLE—Return All Frames
- SLE—Forward CLTU
- SLE—IP for Transfer Svc