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

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SCAN Testbed System Architecture

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

Tracking and data relay satellite (TDRS)

TDRS-W

TDRS-K/L

TDRS-E

Global Positioning System (GPS) Constellation

S/L-band
Ka-band
L-band

S-band

International Space Station

Control Center
Glenn Research Centre

Telemetry and control data path

Experiment data path

White Sands ground station

ground station
(Commercial, other)
Multiple reconfigurable components
Capable of 3 simultaneous links (combination of S- and Ka-band)
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

Ground Segment

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

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
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

**Application**
- CCSDS 734.2-R-3
- CCSDS Bundle Protocol Specification

**Transport**
- 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 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 911.2-B-2
- CCSDS 911.5-B-2
- CCSDS 912.11-0-1
- SLE—Forward CLTU
- CCSDS 912.1-B-3
- SLE—Forward CLTU Svc
- CCSDS 913.1-B-1
- SLE—IP for Transfer Svc

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