Small Satellite Ground Systems Architecture for Combined DoD and Non-DoD Users

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Small Sat Missions

Cubesat technology developed at Universities DoD is working to adopt this technology

Result – Combined Missions

- DoD Objectives
  - Increase Reliability of Satellite
  - Military Utility Studies
  - Mature Payload technology

- Academic and Civil Agency Research
  - Develop Payload experiments
  - Share/use collected data

DoD Ground Systems Do Not Facilitate Data Availability and Access For Non-DoD Users
Barriers to Combined Mission Objectives

- **Not Enough Data**
  - Limited use of DoD ground sites with encryption and processing
  - Multiple downlink receivers at non-DoD ground sites – but no access to DoD ground site data processing
Each communications session (from point x to y) contains a security exchange and translation

- Limited resources available and/or authorized to enable communications
  - Dedicated tracking stations built just for the program, or
  - Limited network of tracking stations available and have to fight for priority
  - Dedicated lines and dedicated network infrastructure for ground relay

- Operations centers are physical locations (as opposed to virtual) and limited in number due to non-standard protocols and the high costs associated with processing equipment

- Transmission of data requires manual intervention and/or unique translation and forwarding

*Depicted sites are notional*
Maximize Communications - Increase Trusted Connectivity

- Increase trusted connectivity with remote antennae sites
- Works within current ground and internet architectures
- Requires establishing security credentials with limited number of sites

Cubesat

University or civil organization

Users are provided DoD security credentials to forward data for processing

Ground System Database
Barriers to Combined Mission Objectives

- No Services to Provide Data
  - Data files provided via request only
  - Data files copied to servers accessed only by DoD users
  - Data copied to CD and mailed to other users
Secure Ground Architecture & Small Satellite Data Distribution

Current processing architecture that cannot be shared outside of AF ground sites

WAN

Data distribution

Internet

Red LAN
Firewall servers switches

Data Distribution Guard

Translation Server

Red/Black Guard

Black LAN

Black Matrix Switch
Web Service APIs

- Publish frequently updated information in a standardized format
- Subscribers are provided a feed of website content
  - Subscribers notified of data updates
- Aggregate data for other applications
- Implement Secure APIs
User representative would provide an interface for subscription to the satellite payload data

- Users subscribe to a payload data feed
  - RSS/XML pages are read through an RSS reader or a standard Internet browser
  - Website RSS feeds are provided through the recall of an RSS file, which is then used to display the RSS content

- RSS feeds are displayed by Internet Explore, Firefox, and Safari
  - RSS reader may also be installed with Windows, and Mac OS X, Linux
  - RSS feeds available as website aggregation e.g., Google Reader
Barriers to Combined Mission Objectives

- **No user service management**
  - Each ground site has “standalone” server
  - Firewalls and site specific network rules inhibit sharing beyond local users
  - DoD processing sites do not have the mission or resources to expand services to non-DoD users
Provide a Network of Servers to Host Web Services

- Host servers at trusted sites
  - Universities, civil agencies
  - Identical web services
  - Redundant database storage
Replace “ground site architecture” with Internet

- Space Plug-n-Play Architecture (SPA) and Network-based Spacecraft
- Extend the Network to Ground Systems and End User
  - Ground portions of existing communications architectures connect through adapters
  - Adapters are user transparent
  - More adapters provide users with more architecture options
By using IP as the space communications transport, a satellite bus network and/or network of spacecraft can transparently “connect” to the Global Information Grid (GIG) and any certified ground user.

For secure space communications, High Assurance Internet Protocol Encryption (HAIPE®) can be used since it is an existing NSA specification for secure transmission of network-based communications.
**Network Approach - Secure End to End IP Space Communications**

- *Any* tracking station or network of tracking assets (AFSCN, TDRSS, Commercial, Portable, University, etc.) with Internet connectivity can store/forward and route black data to HAIP® Gateway and/or HAIP® endpoint.
- Gateway is a virtual ops center in a secure location with ability to decrypt and access/route to any trusted IP network.
- Endpoint can also directly receive and decrypt black data if equipped with space appliance COMSEC technology.
- Operator/user only needs network access to establish seamless and instantaneous secure IPSec tunnel connection (including authentication) to any IP address on the spacecraft.

*Depicted sites are notional*
System Requirements - Ground

Red Network, MOC, SOCs

Two Independent or Combined Functions

Router
IPSec / HAIPE® Gateway
Tunnel QoS Manager
Black Core QoS Manager
Key Manager
XTEDS

Router
Forward Error Correction
PCM Encoder
Modulator / Demod for Tactical RTS
Application Server
Black Core QoS Manager
XTEDS

Black Tunnel
IP/HDLC
Link Encoding

IP/Ethernet

Black Core

IP/Ethernet

IP/Ethernet

IP/Ethernet

Router
IPSAS-GND™ Application Server
Enabling The Space Ops Portal

Tactical Users with Secure Tactical Communications

User Portal for Command Scheduling

HAIPE® Tunnels to RTS’s Using Existing IP Networks

AFSCN
USN
TDRSS
Tactical
University
Small Sat missions will increase
- Mission flexibility, lower cost and shorter schedules

Small Satellites will continue to be a DoD and non-DoD collaboration
- Increase satellite reliability
- Mature payload technology
- Expand use of data within tactical timelines

Establishing Data Dissemination architectures will increase Small Sat mission effectiveness
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Thank you

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