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

GSAW 2011

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Small Sat Missions

Cubesat technology developed at Universities
DoD is working to adopt this technology
Result – Combined Missions

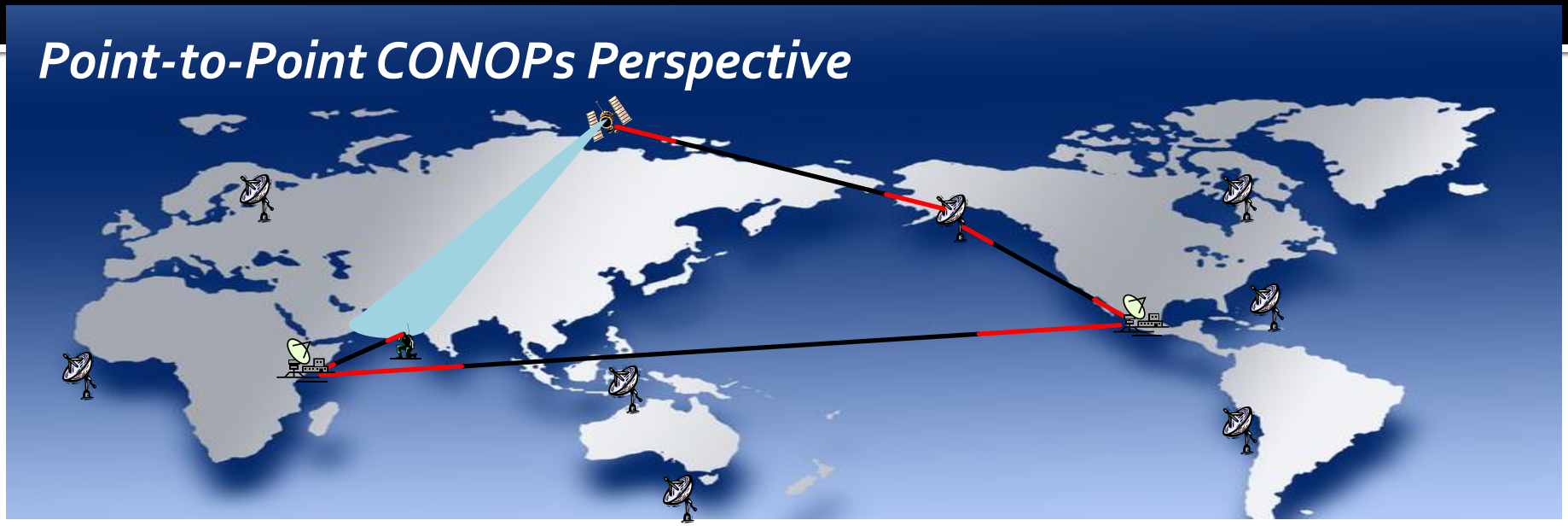
- DoD Objectives
  - Increase Reliability of Satellite
  - Military Utility Studies
  - Mature Payload technology
- Academic and Civil Agency Research
  - Develop Payload experiments
  - Share/use collected data

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

Secure Space Communications

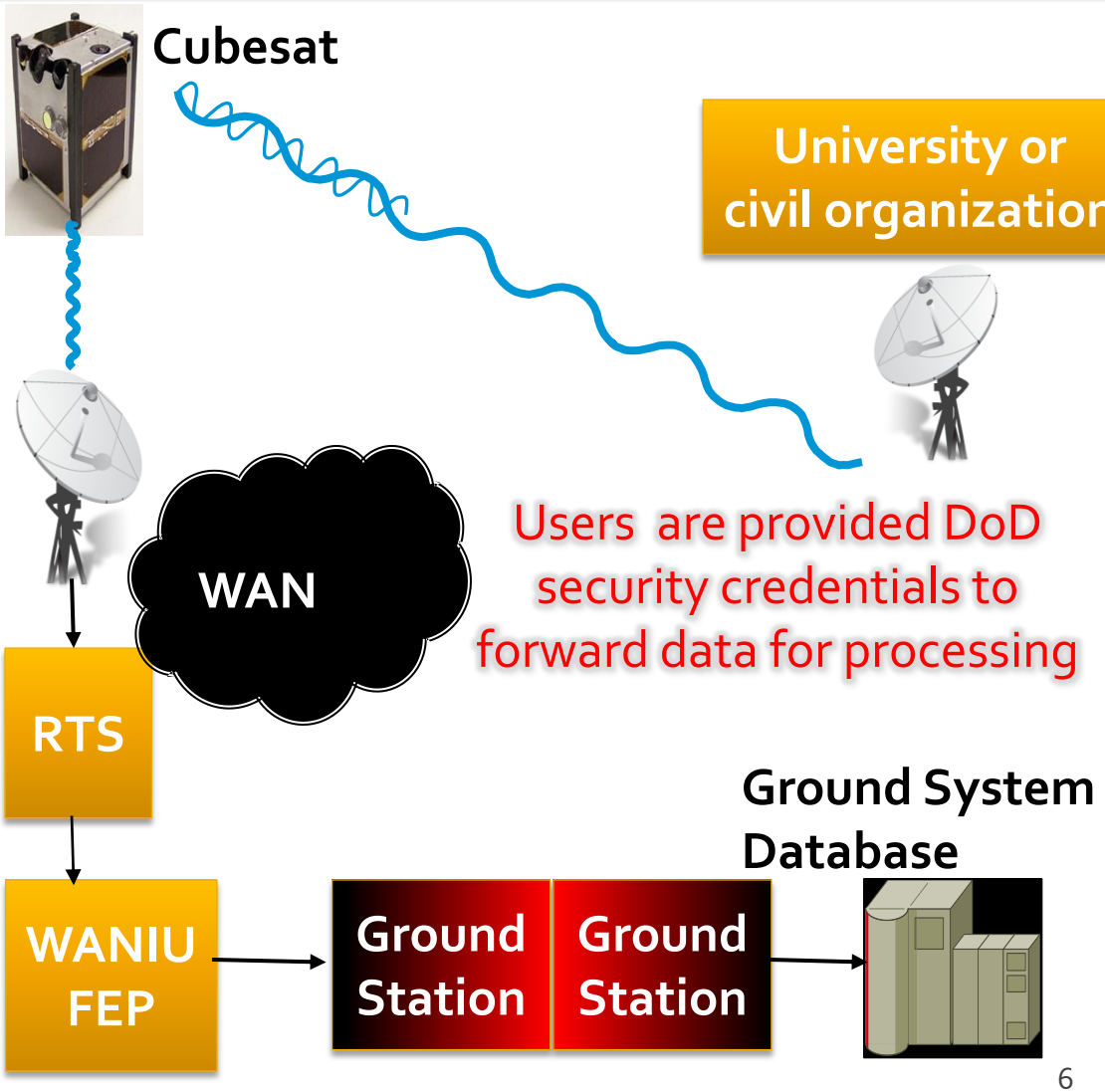


- Each communications session (from point x to y) contains a security exchange and translation
- Limited resources available and/or authorized to enable communications
  - Dedicated tracking stations built just for the program, or
  - Limited network of tracking stations available and have to fight for 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

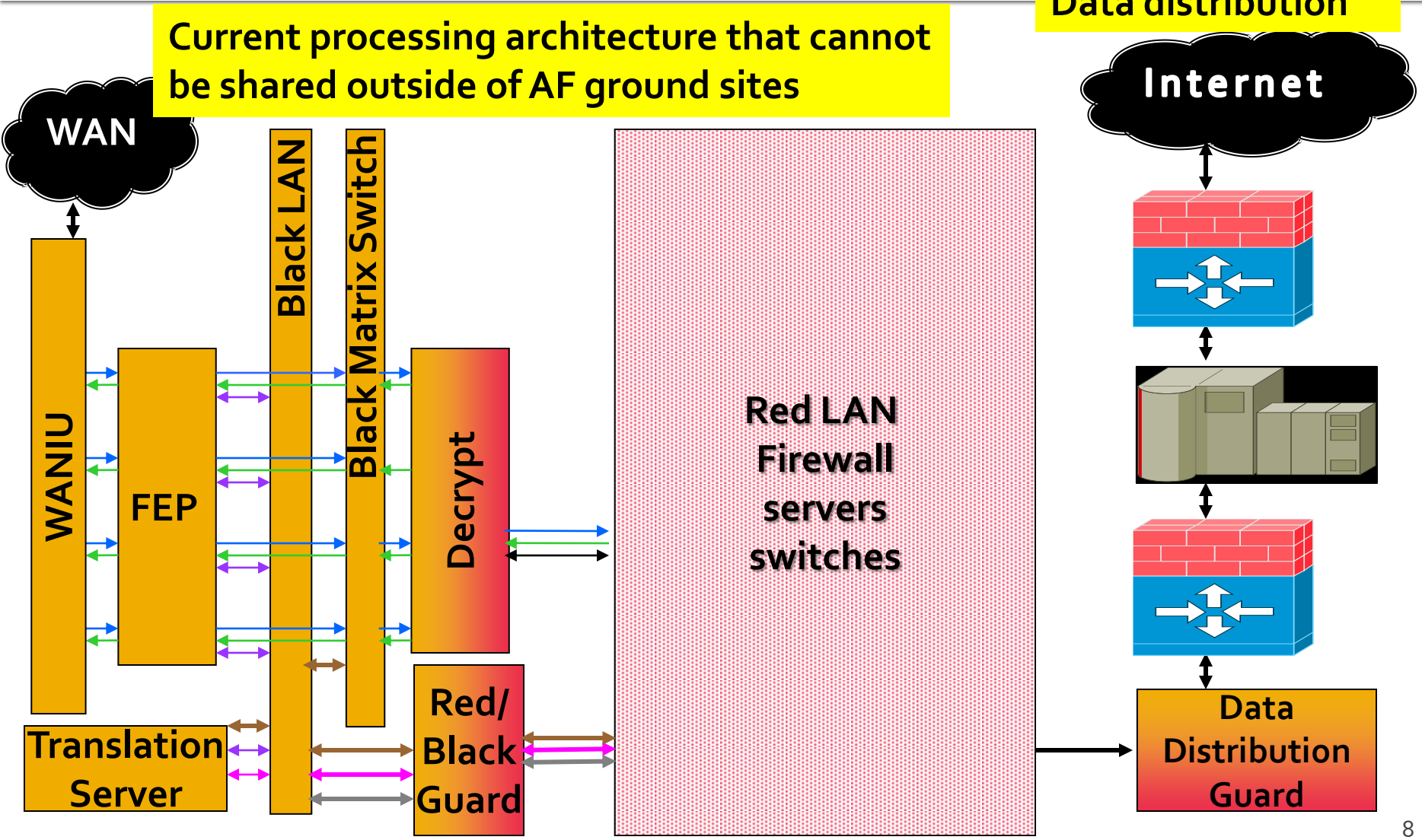


Barriers to Combined Mission Objectives

- **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



Provide Sensor Data to Users with Web Service APIs

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

Web Services Implementation

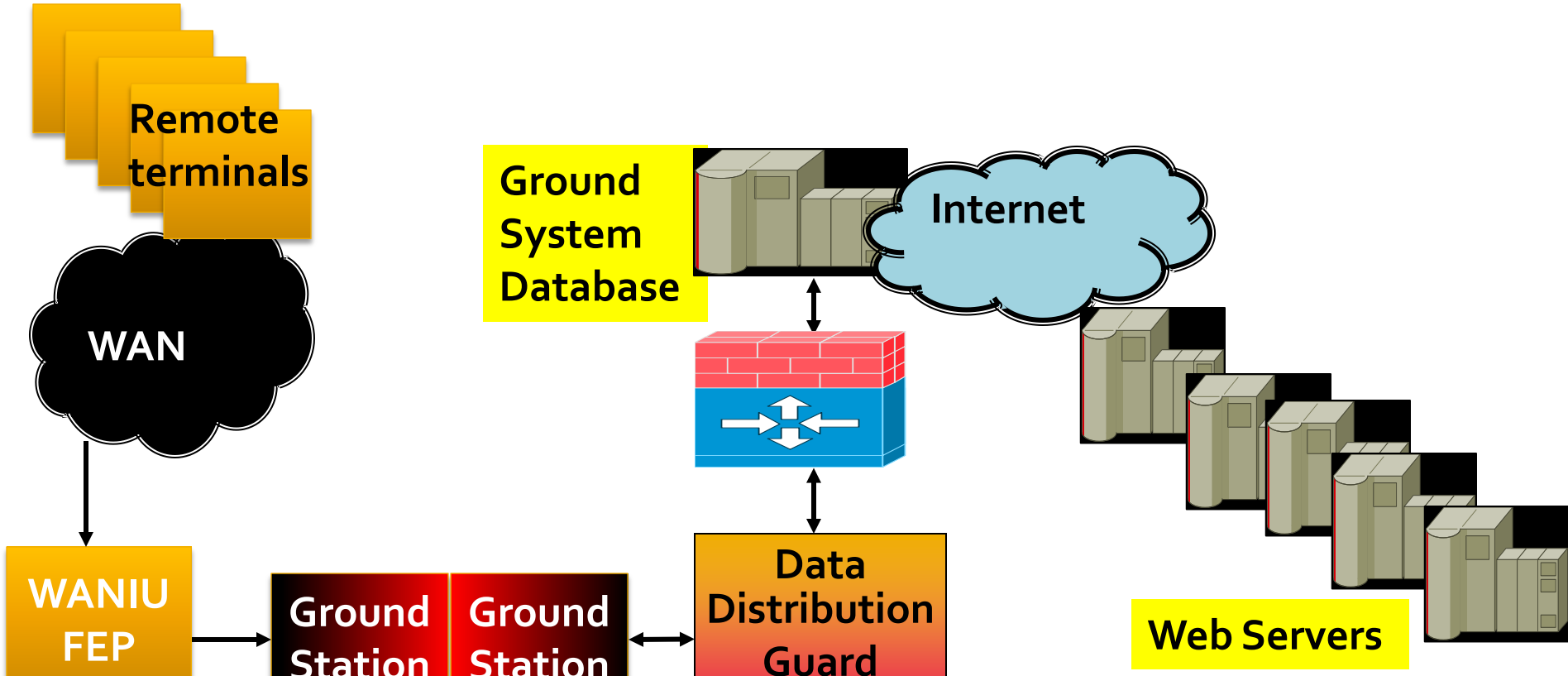
User representative would provide an interface for subscription to the satellite payload data

- 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

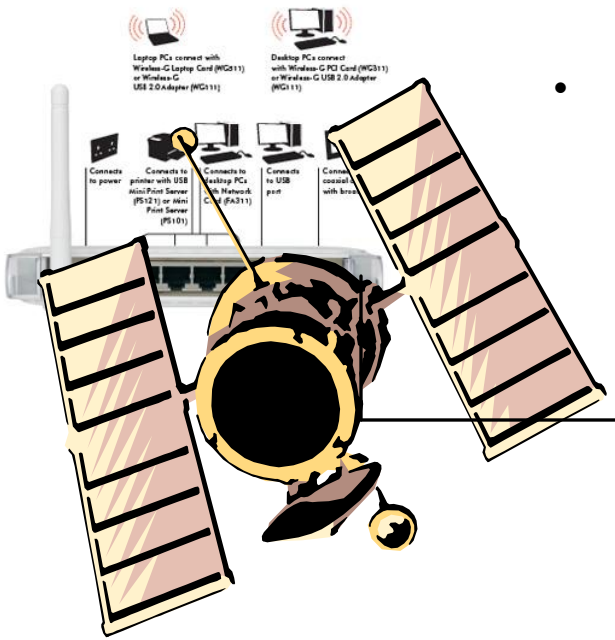


- Host servers at trusted sites
  - Universities, civil agencies
- Identical web services
- Redundant database storage

Network Architecture Approach

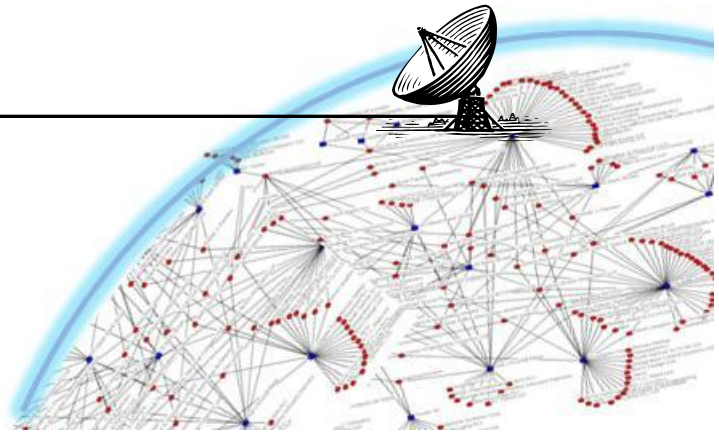
- Replace "ground site architecture" with Internet
  - Space Plug-n-Play Architecture (SPA) and Network-based Spacecraft
  - Extend the Network to Ground Systems and End User
    - Ground portions of existing communications architectures connect through adapters
    - Adapters are user transparent
    - More adapters provide users with more architecture options

Extending the GIG to Space



- 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®)[1] can be used since it is an existing NSA specification for secure transmission of network-based communications

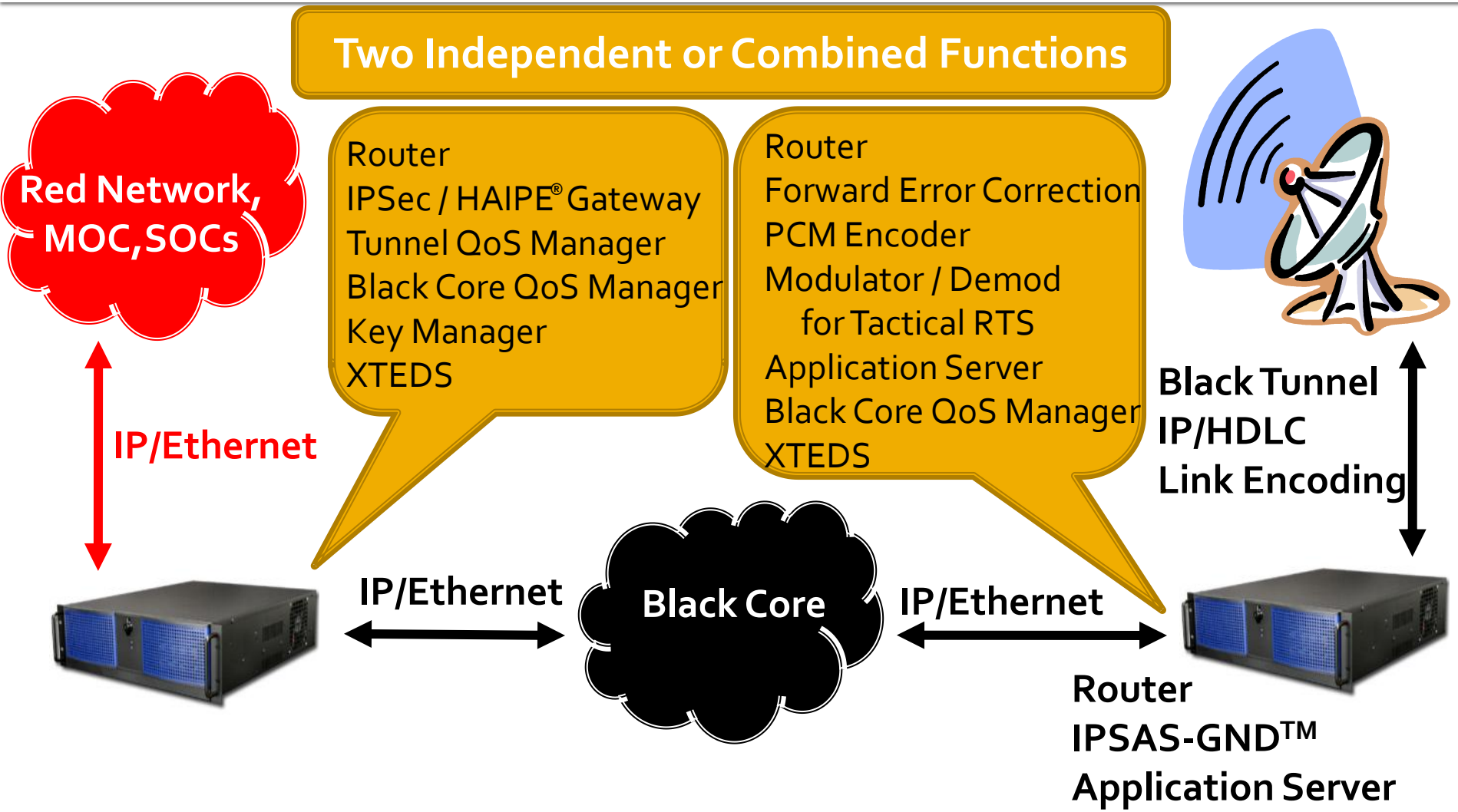


Network Approach - Secure End to End IP Space Communications

- *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 HAIPE® Gateway and/or HAIPE® 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

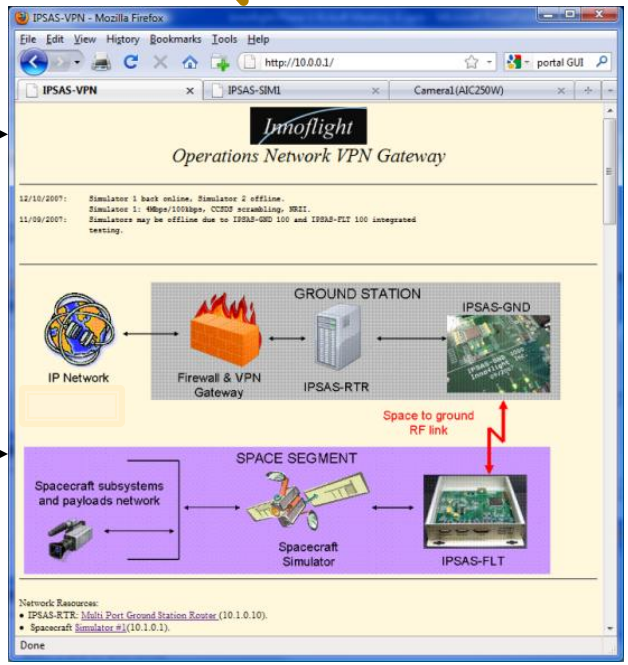


Enabling The Space Ops Portal

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

Future Small Sat Missions

- 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