Automation in Space Network Access System (SNAS) for NASA's Tracking and Data Relay Satellite System (TDRSS)

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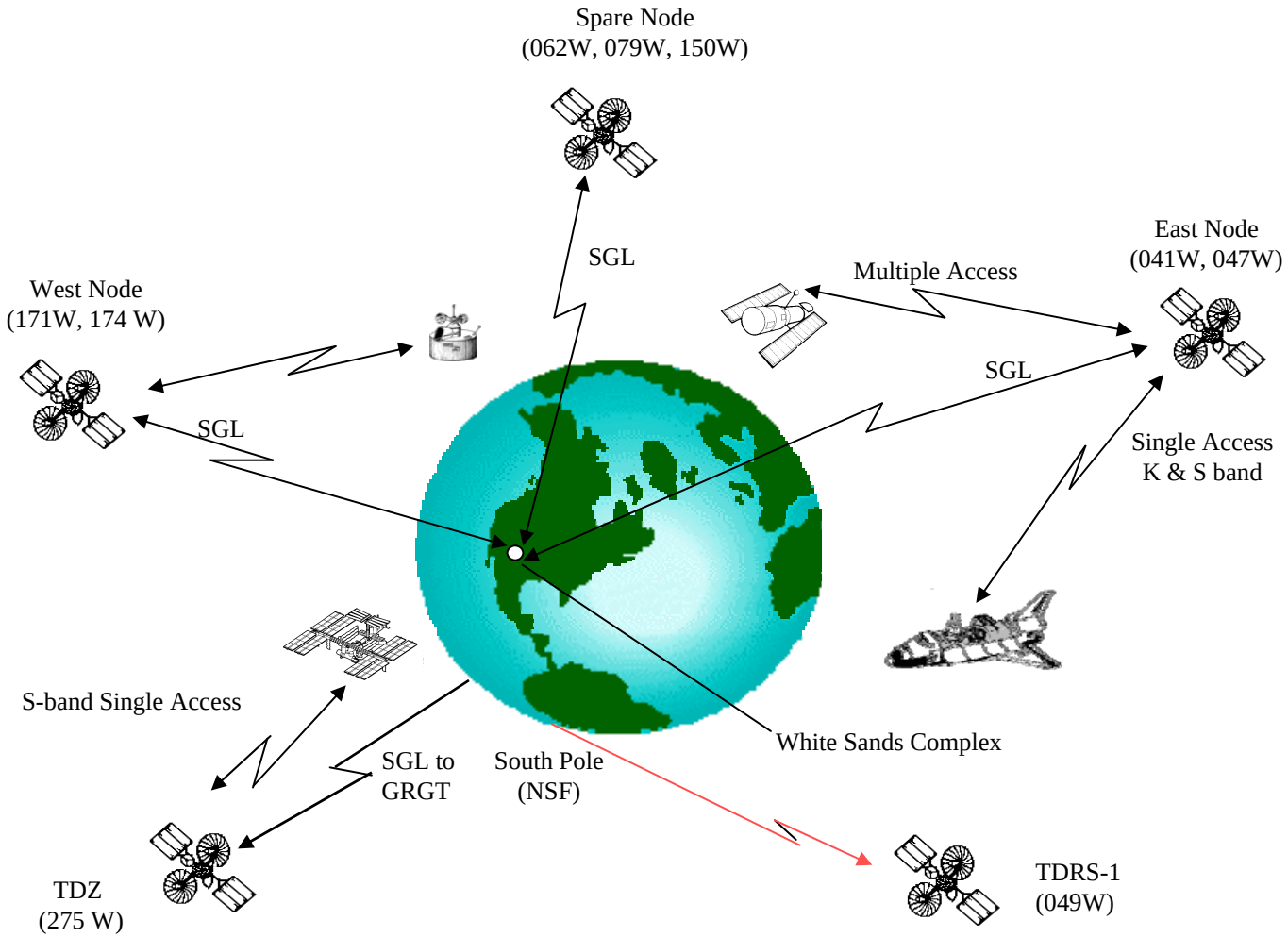
Tracking and Data Relay Satellite System Baseline Configuration



White Sands Complex

A major element of the ground segment is the White Sands Complex (WSC) which is located near Las Cruces, New Mexico. It consists of two functionally identical ground terminals, the White Sands Ground Terminal (WSGT) and the Second TDRSS Ground Terminal (STGT). Each ground station employs three 18/19m diameter high-gain antennas.

TDRSS scheduling is carried out at the Data Systems Management Center at WSC.

Another component of the WSC is the Guam Remote Ground Terminal (GRGT). The GRGT allows for the closure of the Zone of Exclusion.

Space Network Service Summary

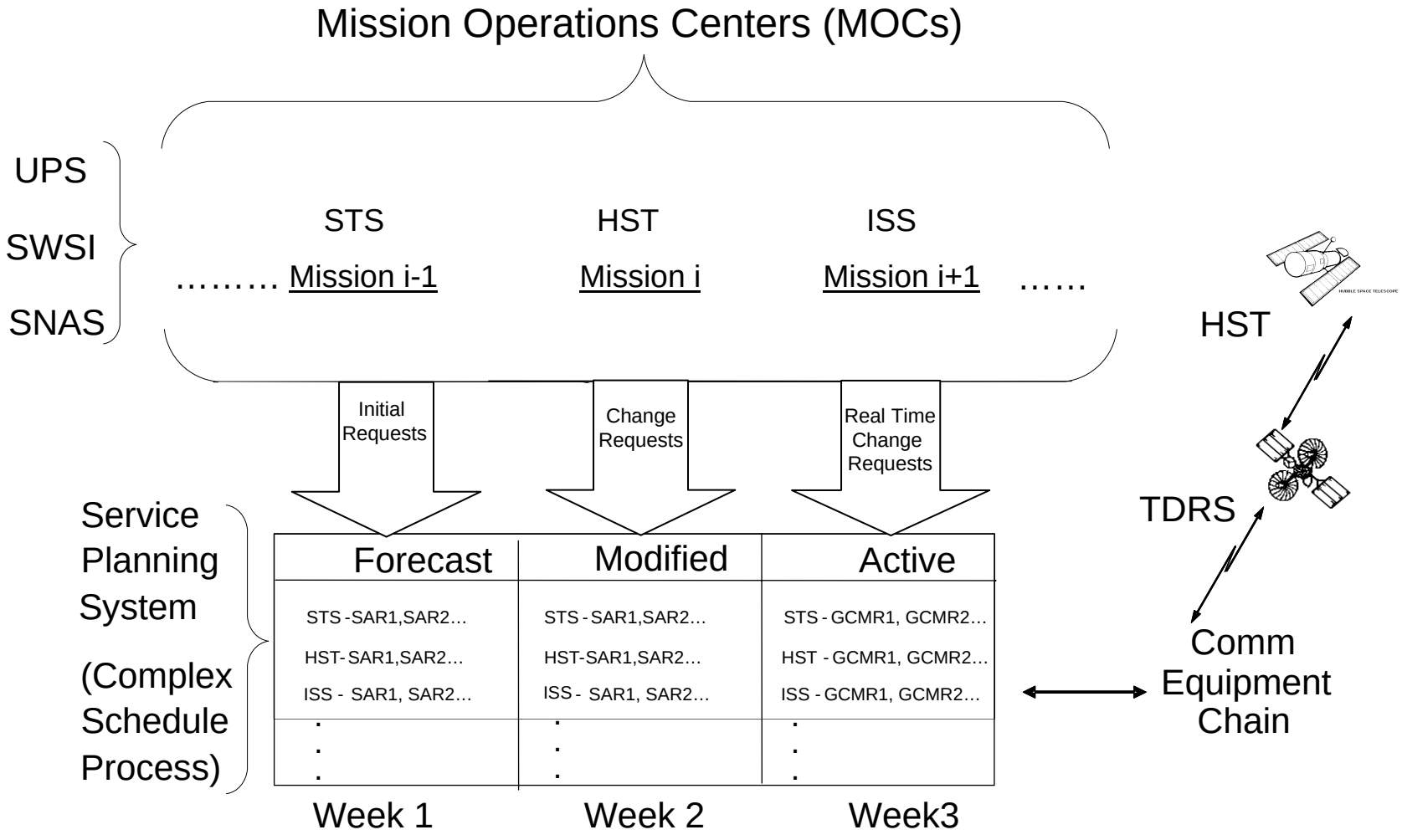
SERVICE			TDRS 1-7	TDRS 8-10	NOTES
SINGLE ACCESS	S-BAND	FWD	1 kbps – 7 Mbps	1 kbps – 7 Mbps	No Change
		RTN	1 kbps – 6 Mbps	1 kbps – 6 Mbps	
	Ku-BAND	FWD	1 kbps – 25 Mbps	1 kbps – 25 Mbps**	
		RTN	1 kbps – 300 Mbps	1 kbps – 300 Mbps	
	Ka-BAND	FWD	N/A	1 kbps – 25 Mbps**	23/25-27 GHz frequency band
		RTN	N/A	1 kbps – over 1.2 Gbps*	
	NUMBER OF LINKS PER SPACECRAFT		2 SSA 2 KuSA	2 SSA 2 KuSA 2 KaSA	For TDRS 8-10 Simultaneous Operation of S & Ku or S & Ka Services, a Single SA Antenna are required.
MULTIPLE ACCESS	NUMBER OF LINKS PER S/C	FWD	1 @ 100 bps – 10 kbps	1 @ 100 bps – 10 kbps (8 dB over TDRSS)	Anticipated SSA Users less than 3 Mbps offloaded to TDRS 8-10 MA
		RTN	5 @ 150 kbps (Limited by Ground Equip Only)	6 @ 3 Mbps (Onboard Beamforming)	
DEMAND ACCESS SYSTEM (Full period coverage 24x7)			6 Expandable to 50/TDRS Return Services @ 150 kbps/Channel	Not Available	Initial Ops Capability
CUSTOMER TRACKING			150 meters 3 sigma	150 meters 3 sigma	No Change

* Beyond 300 Mbps requires ground station modifications ** There is a 7 MB limit on the forward service due to a constraint with the WSC DIS

Schedule Driven Operations

- TDRSS is a schedule driven network
  - The SN Priority List provides strict guidelines for mission support in the event of service request conflicts during the forecast period and is used to resolve conflicts.
  - Each service request is completely described by a Schedule Add Request (SAR).
  - SARs are then transformed into Scheduling Orders (SHOs) for configuring the equipment chain for the start of an event (a pass).
- Constrained Scheduling
  - User specifies exact time and spacecraft to use to support the event.
- Flexible Scheduling
  - User requests a specified number of minutes of contact from any TDRS in a specified cluster within a specified window of opportunity.

Schedule Generation, Regeneration & Real Time Support



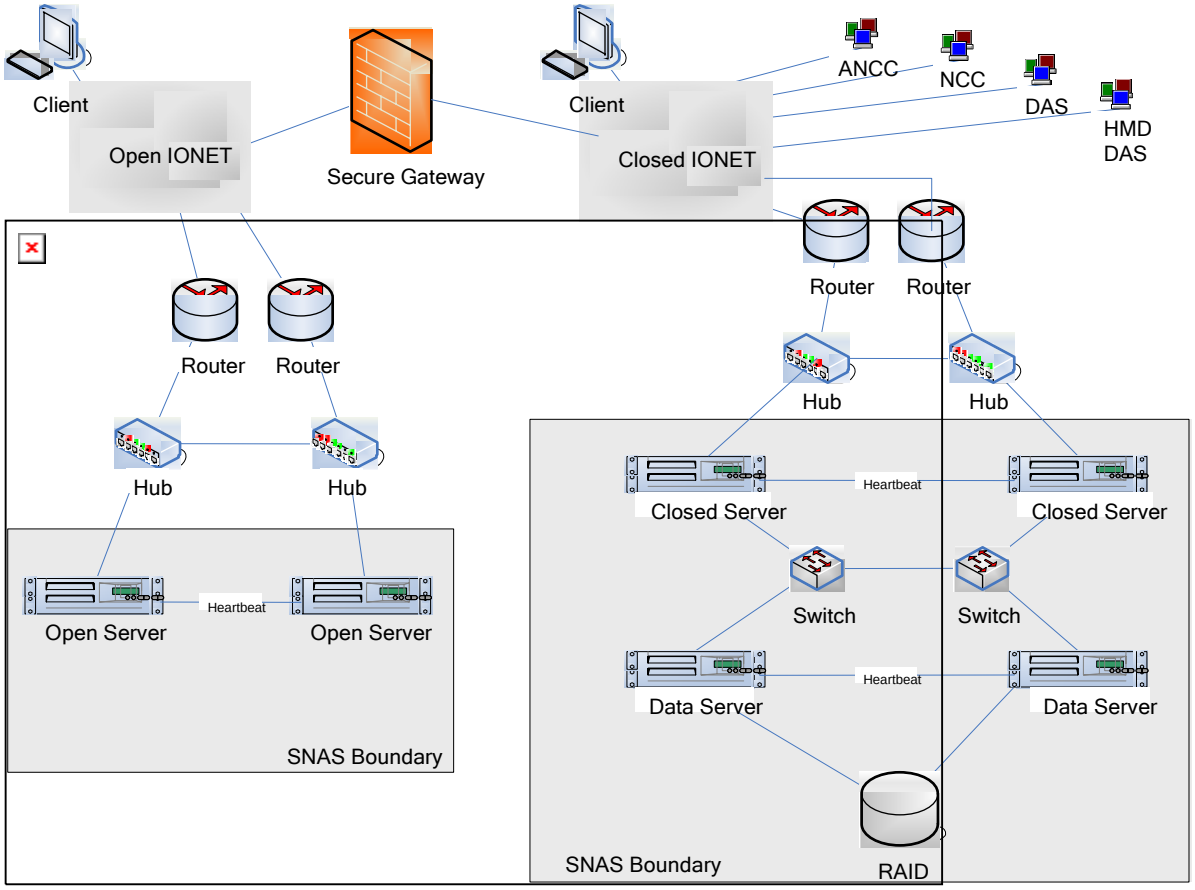
SN Scheduling Users

- **MOCs: use a variety of tools to produce scheduling requests**
  - Scheduling interfaces: currently: UPS, SWSI; SNAS in 2007
  - Electronic Processing Systems (EPSs)
    - Orbit/attitude propagators
    - Instrument constraint checkers
    - Expert/AI tools for combining criteria (from SC and onboard instruments) into a schedule request
  - Phone, FAX, and paper delivery between groups
    - Forecast and Active scheduling operations may not be co-located
- **WSC Ground Ops: 24/7 setup/scheduling/event support**
  - Phone, FAX and paper delivery between WSC operators
    - Customer mission services configuration and user setup
  - SNAS (in 2007) to interface between MOCs and scheduling systems

Space Network Access System (SNAS)

- The Space Network Access System (SNAS) will consolidate the functionalities of the UPS and SWSI into a single system, and will replace the UPS and SWSI as the primary scheduling interface between the SN customer and the SN.
- SNAS Capabilities:
  - Provides a network-based (server-client relationship) customer **interface** to SN scheduling, real-time control and monitoring system
  - Accessible from the Internet and the NISN Open and Closed IONet
  - Provides for easy system setup and workstation independence for the SN customer (the SNAS client software runs on any type of personal computer or workstation)
  - Interfaces with customer EPS to support elements of “lights out” operations
  - Reduces need for FAX and phone communications

SNAS Architecture



- **Client**: Software resides on MOC workstation or PC; not dedicated hardware
- **Servers**: Act as proxies to route requests from the client to the SN scheduling, real-time control and monitoring systems, and return responses to the client
- **Database**: Operates on the Closed IONet side of the NISN Secure Gateway; holds static data, semi-static data & dynamically updated data; SNAS customers will be granted access privileges depending upon their roles

Customer-centric Development Approach

- SNAS Team surveyed & visited MOCs
  - Identified requirements as well as most wanted & least used features
  - Gathered key reports
  - Surprised by amount of manual data transmission (FAX, phone, walking paper)
- End users involved throughout to address customer requirements and to support
  - MOC operations and legacy MOC components
  - Various MOC configurations
  - O&M operations
- SNAS GUI prototype was presented to illustrate and negotiate design features
- SNAS Release 1 defined to address UPS and SWSI replacement requirements
  - Limited “lights out” functionality
  - Future releases to address “Wish List” items including additional “lights out” features

Automated Functionality for SNAS Release 1

- **At the Customer's MOC**
  - At Login: sets appropriate user access privileges/menus by role: Mission Manager, Planner/Scheduler, Controller, Reporter, Observer
  - At the Backend EPS: supports "What if" scheduling exercises
  - During Forecast/Active Scheduling
    - Scheduling patterns / recurrent scheduling
    - Bulk scheduling
    - Workspace concept links a series of forecasts across schedulers
  - During Real-time operations
    - Common GUI facilitates MOC interface w/ WSC
    - Alerts sent to remote Mission controllers
      - Customized color-coded
      - Tied into e-mail/text messaging systems
- **At the SN Ground Terminals**
  - Initial mission setup and configuration data processed electronically
  - Automatic logging of all SNAS system and database changes
  - Common GUI facilitates WSC interface w/ MOC

Summary

- Customer involvement throughout SNAS development
- Start beta testing in March 2007 with small set of users
  - Using customer-provided data for testing
  - Validate EPS interfaces with existing MOC components
  - Resolve transition to operations issues early
- SNAS operational efficiencies
  - Automated support for complex scheduling functions
  - Common GUI among MOCs and WSC
  - Significant reduction in manual data transmission
  - Increased electronic logging functionality
  - No dedicated hardware
- End result: cost savings for SN and SN Customers