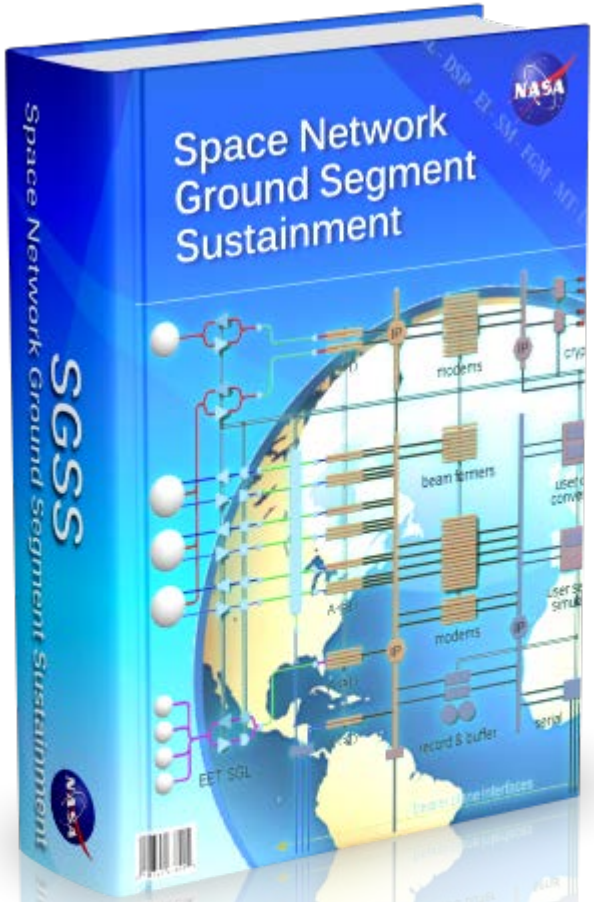


Space Network Ground Segment Sustainment (SGSS)

Customer Forum #1

October 21, 2011

Version 2 - 10/25/11: Updated SGL/DSP element functions, annotated schedule

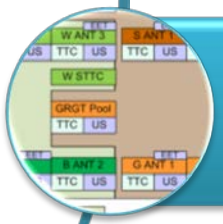
Agenda

Welcome and Project Introduction

Tom Gitlin / NASA, SGSS Deputy Project Manager - Technical

Architectural Overview and Interfaces

Dean Vanden Heuvel / General Dynamics, Chief Architect



Transition Approach

Phil Boss / General Dynamics, Transition Manager

Next Steps

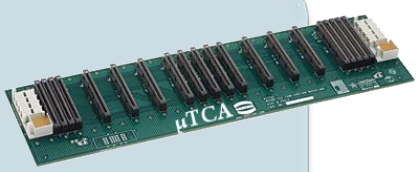
Customer Forum Purposes

- Describe ***at a high level*** the SGSS goals and objectives, schedule, architecture, user interfaces and transition concept to the user community
  - ***This is an introductory meeting*** - we will not 'dive deeply' into interface details or operational concepts
  - Future forums will cover the status of user interfaces and transition topics in more depth; interface details and issues will be worked in individual SGSS-to-User working group meetings
  - Note that ICDs and IRDs form the basis for designing SGSS system interfaces to legacy users; GD will document the details where new interfaces are being created (e.g., Web-based HTML scheduling portal, packetized IF)
- ***Obtain Customer points of contact*** for the following disciplines:
  - Data Interfaces
  - Service Management
  - Operations
- ***Gather any user concerns associated with the SGSS system*** – particularly cases where the legacy (largely analog) system may perform differently than the (highly digitized) SGSS system

SGSS Goals and Objectives

Implement an extensible, flexible and scalable architecture that satisfies all service agreements

- Develop an architecture using state of the art technology with periodic refresh capabilities
- Simplify the expansion process for adding SN assets
- Provide homogenous ground assets across facilities



Meet or exceed the existing SNGS proficiency, performance and availability requirements

- Achieve ≥ 99.99%* operational availability for user services
- Increase data throughput capabilities
- Provide the capability for additional automation to simplify operations

Provide a low risk integration and transition into the Space Network

- Fully test the system, integrate it offline
- Shadow the TDRSs and users for further confidence
- Incrementally switch support to SGSS-supported TDRSs

* - Includes all ground terminal equipment, less the antennas

SGSS Goals and Objectives (Cont'd)

Reduce the lifecycle cost of SNGS operations and maintenance

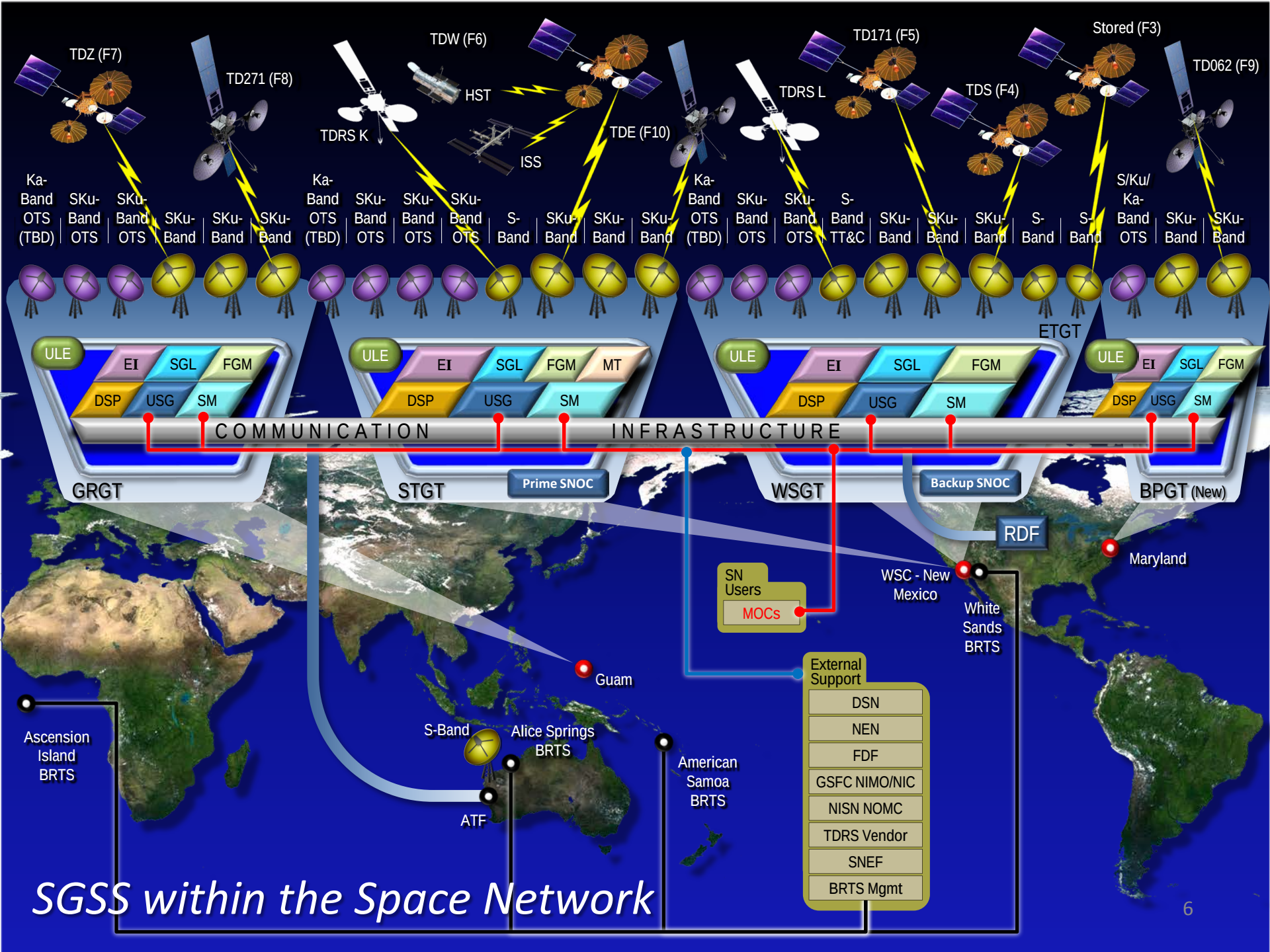
- Reduce the number of units to maintain
- Enable staffing reductions and maximize the efficiency of the O&M workforce
- Incorporate COTS products to a very large extent
- Maximize equipment commonality

Continue to provide legacy SN functionality

- Monitor and control SN flight and ground segments
- Perform service planning, scheduling and monitoring
- Provide data, tracking and clock correlation services
- Exchange user data over NISN and local interfaces
- Provide test and simulation capabilities

Provide for continuity of operations after deployment

- Implement a local backup control center
- Option exists for a remote backup control center

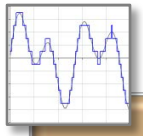


SGSS within the Space Network

Added SGSS Capabilities

General

- Ground Segment scalability and extensibility
- Enhanced Continuity of Operations
- Extensive COTS usage
- Standardized interfaces
- Distributed intelligence



DSP

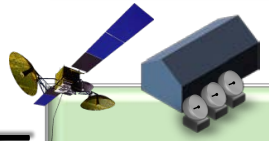
- Ability to easily add future waveforms
- Early signal digitization for lossless distribution
- High speed packet switching
- New coding schemes: Low Density Parity Check encoding/decoding (Rate 1/2 and Rate 7/8), Rate 7/8 Turbo Product Codes, Modulo-4 differential decoding
- 8-Phase Shift Key (PSK) Modulation
- Ka one way tracking services
- Data Rate Increases - 50Mbps Forward, >1 Gbps Ka Return , 600Mbps Ku Return

SGL

- Addition of S-Band capability to the WSGT main mission antennas
- Radial combining technology
- Back-end switching of equipment to any antenna

SM

- Service Optimization
- New scheduling interfaces – CCSDS SM, Web based and others



FGM

- Automation level control
- TDRS and ground segment coordinated commanding
- Remote TDRS telemetry access
- Enhanced situational awareness for ground terminal operators

SM – Service Management, DSP – Digital Signal Processing, SGL – Space Ground Link, FGM – Fleet Ground Management

Added SGSS Capabilities (cont'd)

EI

- Service Oriented Architecture
- IP V6
- Compliance with new security standards
- Extensive use of Virtual Machines (VMs)

USG

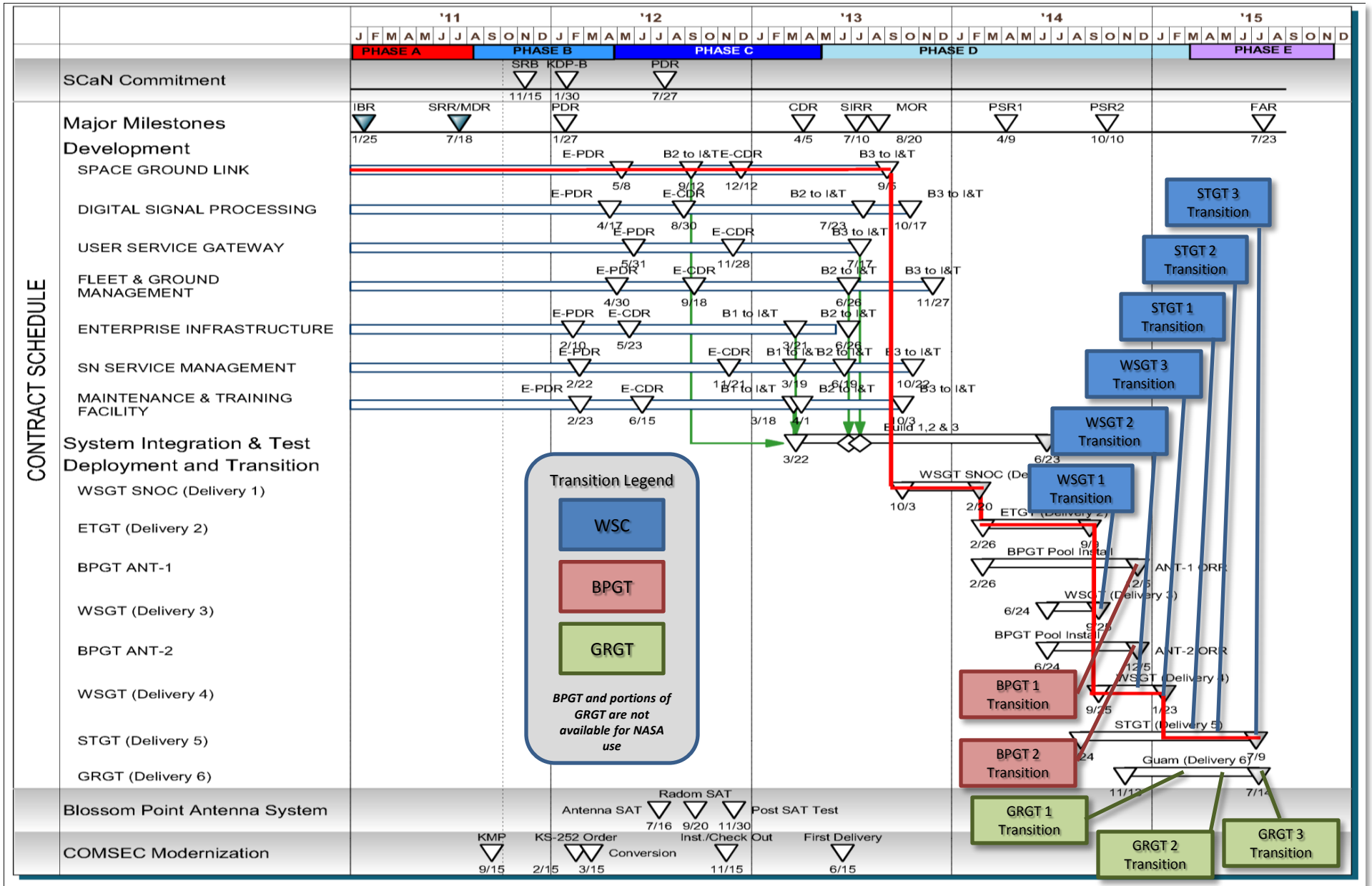
- CCSDS, Advanced Orbiting System (AOS) / encapsulation
- Rate Buffering
- Space Link Extension (SLE) Services

MT

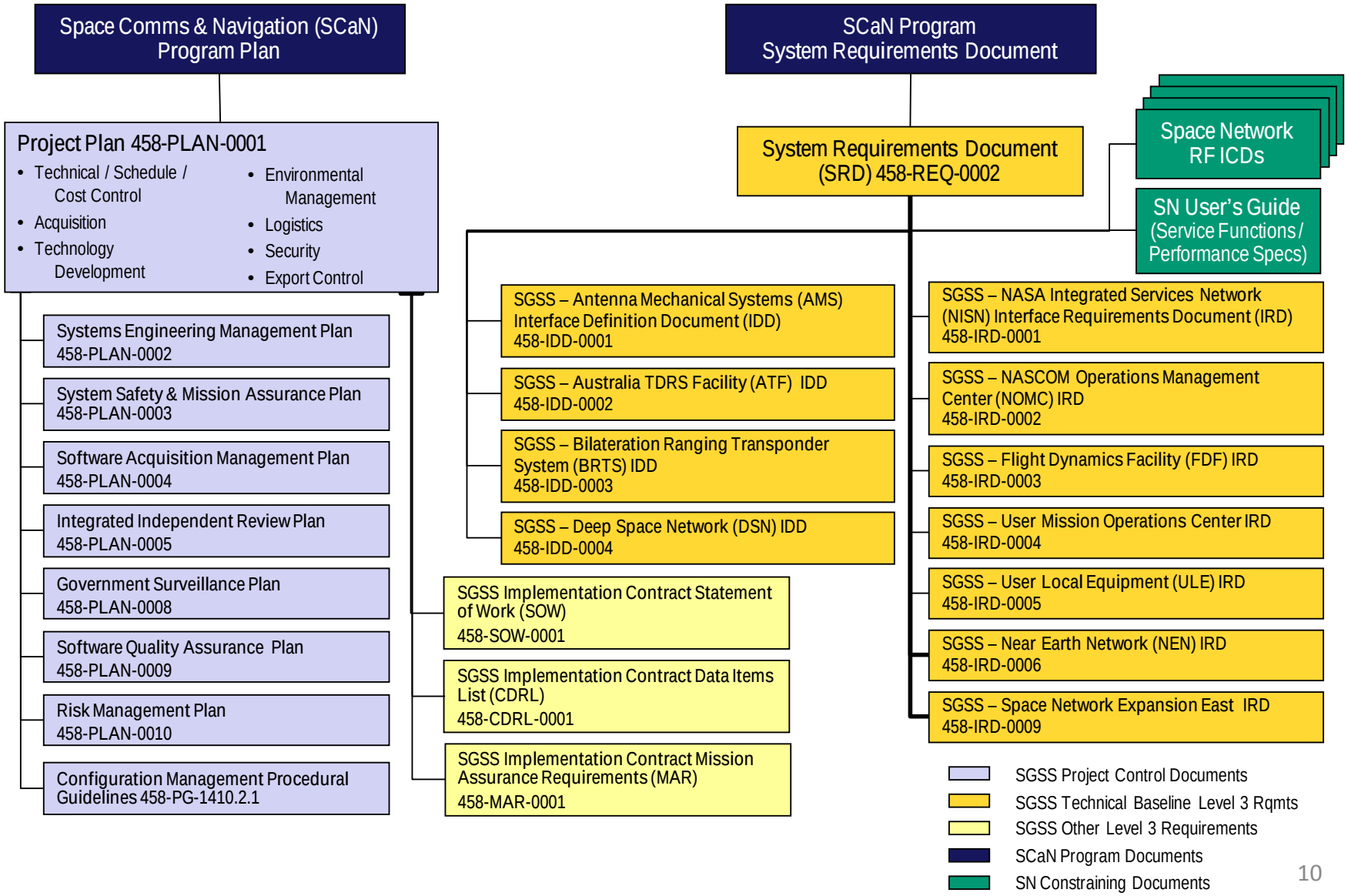
- System Modeling
- Development, test and training environments
- Enhanced TDRS simulators
- Simplified maintenance

EI – Enterprise Infrastructure, USG – User Service Gateway, MT – Maintenance and Training

SGSS Contract Schedule



Project Documentation



Implementation Responsibilities

Company		Efforts	Element
GENERAL DYNAMICS C4 Systems	**General Dynamics – C4S**	***SGSS Prime Contractor***: Overall program management, systems engineering, integration & test and verification and validation.	All
HARRIS	**Harris**	Delivery of the USG and SGL elements, including all associated hardware and software design. Development and testing through Level 3. Installation at site and support of Level 4, 5 and 6 testing. Delivery of the high speed LAN. SE support within the DSP Element	SGL, USG, DSP
gmv INNOVATING SOLUTIONS	**GMV Space Systems**	Delivery of flexPlan, hifly®/archiva COTS software modified for SGSS requirements to support TDRS realtime telemetry, command processing, mission planning & scheduling, trending and analysis	FGM, SM
a.i. solutions	**a.i. solutions**	Delivery of FreeFlyer® COTS Flight Dynamics software modified for SGSS requirements to provide TDRS attitude determination and analysis, maneuver planning & scheduling, trending and analysis	FGM
Rincon Research Corporation	**Rincon**	Delivery of firmware associated with the ADCs, DACs, Sub-band tuners and combiners	DSP
Qwaltec	**Qwaltec**	Delivery of the training plan, training materials and operations documentation and procedures. Delivery of classroom and online training. System engineering support	Various
RT LOGIC an Integral Systems Company	**RTLogic**	Delivery of the firmware and software for the forward, return and TT&C modems. Delivery of the COTS Consultative Committee for Space Data Systems (CCSDS) software	DSP, USG
GENERAL DYNAMICS Advanced Information Systems	**General Dynamics - AIS**	Delivery of hardware, software and firmware for the Multiple Access beamformers	DSP
LOCKHEED MARTIN	**Lockheed Martin**	Delivery of the SGSS mission simulators [external interlace simulators and TDRS simulators] & procurement of select material	MTF

Next Steps

- NASA SGSS POCs are:

Discipline	Contact	Phone
Interfaces and Other Questions	Colleen McGraw - colleen.a.mcgraw@nasa.gov	301.286.9941
Transition / Test Activities	Tony Foster - anthony.w.foster@nasa.gov	301.286.0611
Operation Concepts	Mike Prior - michael.w.prior@nasa.gov	301.286.8078

- Follow-up with individual customers to discuss specific items in more detail
  - Scheduling interface details and operation(s)
- Follow-up on any actions from this meeting

Future SGSS Customer Forums will be scheduled next year

Acronyms

A-D	Analog to Digital
Amp	Amplifier
ANT	Antenna
ATF	Australian TDRSS Facility
BPGT	Blossom Point Ground Terminal
BRTS	Bilateration Ranging Transponder System
BSNOC	Backup Space Network Operations Center
CCSDS	Consultative Committee for Space Data Systems
CDR	Critical Design Review
CSM	Customer Service Management
D-A	Digital to Analog
DAS	Demand Access Service
DMZ	Demilitarized Zone
DSN	Deep Space Network
DSP	Digital Signal Processing
EET	End to End Test
EI	Enterprise Infrastructure
Enet	Ethernet
EPS	External Processing System
ETGT	Extended TDRSS Ground Terminal
FAR	Final Acceptance Review
FDF	Flight Dynamics Facility
FGM	Fleet and Ground Management
FTP	File Transfer Protocol
GHz	Gigahertz
GRGT	Guam Remote Ground Terminal
GSFC	Goddard Space Flight Center
GT	Ground Terminal
HMI	Human-Machine Interface
HTTP	Hypertext transfer Protocol
HW	Hardware
Hz	Hertz
ICD	Interface Control Document
IF	Intermediate Frequency
IP	Internet Protocol
IRD	Interface Requirements Document
KHz	Kilohertz
KTTC	K-Band Tracking Telemetry and Command
LAN	Local Area Network
LRU	Line Replaceable Unit
M&C	Monitor and Control
MA	Multiple Access
MHz	Megahertz
MM	Main Mission
MMI	Man-Machine Interface
MOC	Mission Operations Center
MT	Maintenance and Training
MTF	Maintenance and Training Facility

NCCDS	Network Control Center Data System
NEN	Near Earth Network
NIC	Network Integration Center
NIMO	Network Integration Management Office
NISN	NASA Integrated Services Network
NOMC	NISN Operations Management Center
OS	Operating System
OTS	Operational Test Services
PDR	Preliminary Design Review
PKI	Public Key Encryption
POC	Point of Contact
PSNOC	Primary Space Network Operations Center
RDF	Remote Development Facility
RF	Radio Frequency
SA	Single Access
SCCS-SM	Space Communications Cross Support – Service Management
SGL	Space Ground Link
SGSS	Space Network Ground Segment Sustainment
SM	Service Management
SN	Space Network
SNAS	Space Network Access System
SNEF	Space Network Engineering Facility
SNGS	Space Network Ground Segment
SNOC	Space Network Operations Center
SSC	Service Specification Code
STGT	Second TDRSS Ground Terminal
STTC	S-Band Tracking Telemetry and Command
SW	Software
TCP	Transmission Control Protocol
TDRS	Tracking Data Relay Satellite
TTC	Tracking Telemetry and Command
UDP	User Datagram Protocol
ULE	User Local Equipment
UPS	User Planning System
US	User Services
USG	User Services Gateway
VITA-49	VITA Technologies Radio Transport Standard V49
VMS	Virtual Memory System
WAN	Wide Area Network
WSGT	White Sands Ground Terminal
XML	Extensible Markup Language
µTCA	MicroTelecommunications Core Applications (MicroTCA)

http://esc.gsfc.nasa.gov/space-communications/sgss.html

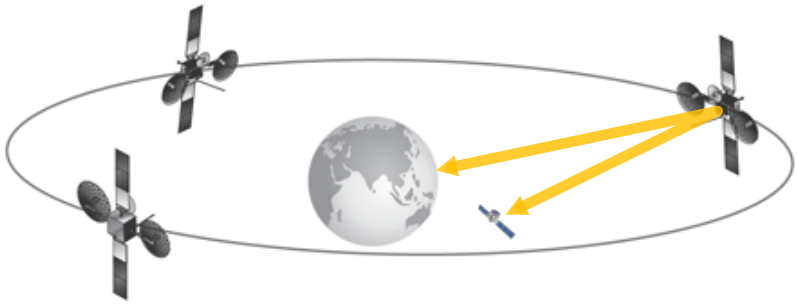
SGSS Introduction

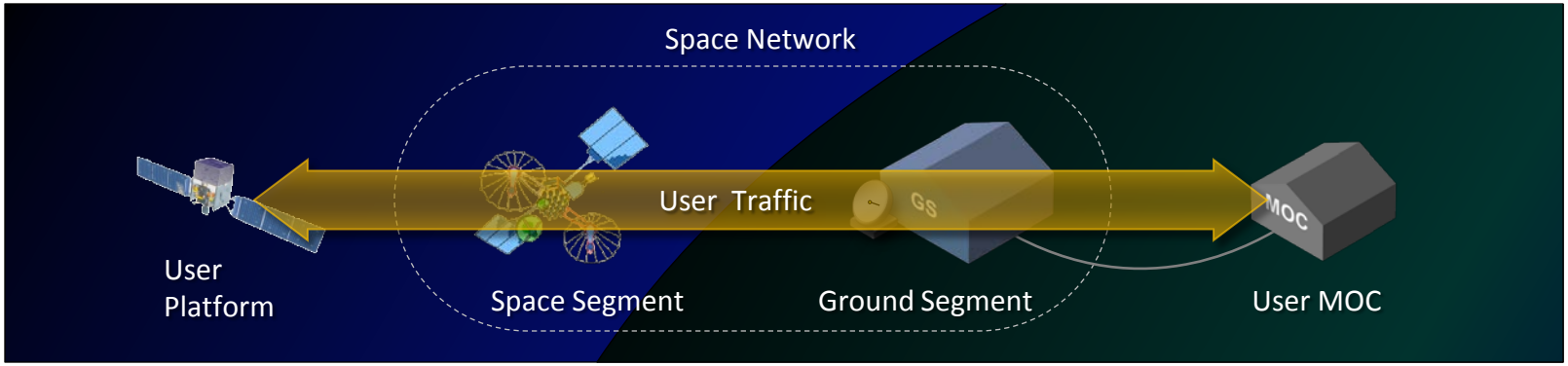
Dean Vanden Heuvel

GENERAL DYNAMICS
C4 Systems

SGSS Mission

- The Space Network Ground Segment Sustainment (SGSS) implements a flexible, extensible, scalable, and sustainable SN ground segment, which:
  - maintains existing SN capabilities, interfaces, and high level of service,
  - accommodates new users and capabilities
  - reduces the effort required to operate and maintain the system, and
  - transitions operations from legacy without disrupting service
- What is the Space Network?
  - Communications relay and tracking system
  - Space Segment consists of TDRS Fleet
  - Ground Segment includes multiple ground terminals (GT)
  - Provides user space platform to mission operations center (MOC) connectivity
  - User platforms include Shuttle, ISS, science platforms, other

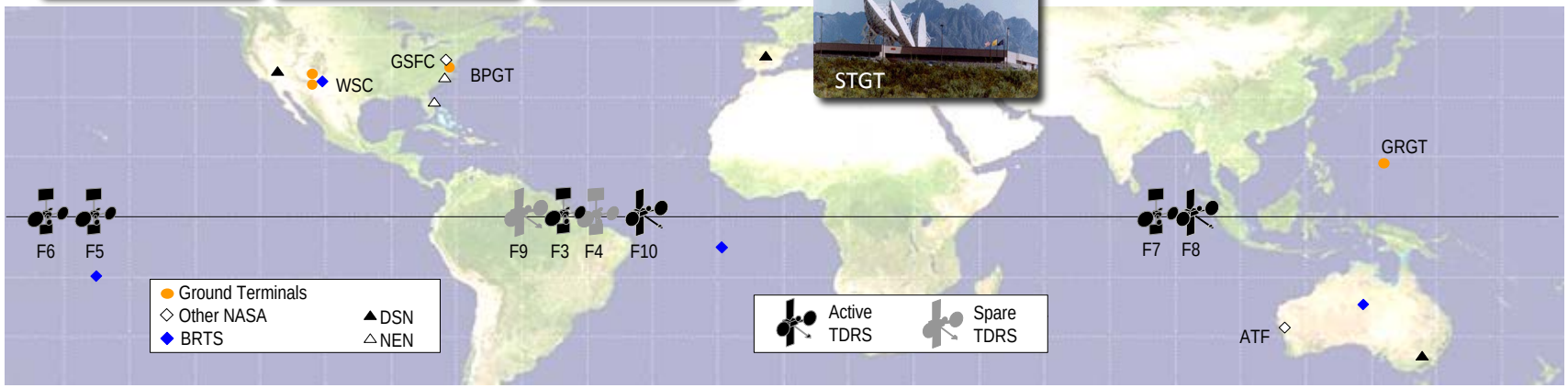




Space Network Characteristics

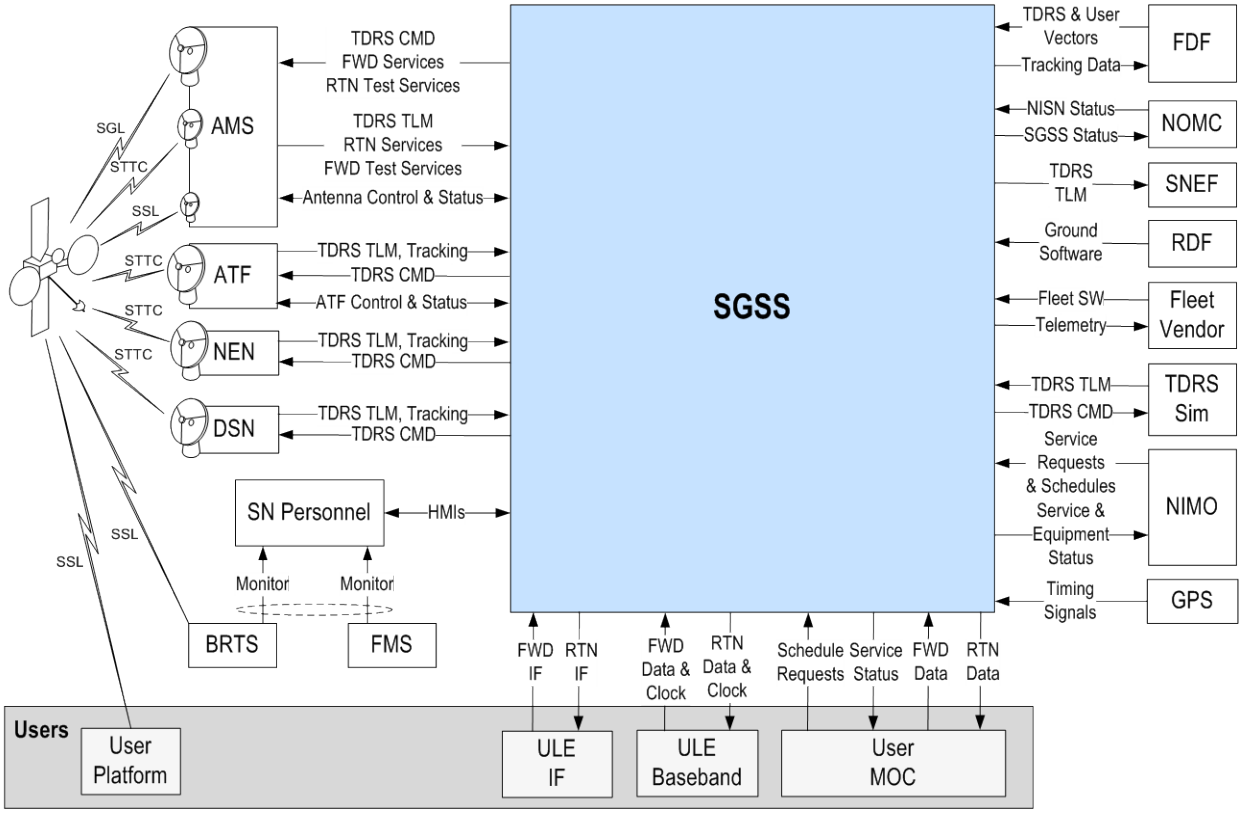
Space Segment				
Asset	Gen	status	location	User service support
F3	1	active	east	• Up to 4 single-access (SA) services per TDRS • MA services per TDRS IAW ground beam-formers
F4	1	spare	east	
F5	1	active	west	
F6	1	active	west	
F7	1	active	IOR	
F8	2	active	IOR	• Up to 4 single-access (SA) services per TDRS • Up to 6 multiple-access (MA) services per TDRS
F9	2	spare	east	
F10	2	active	east	

Ground Segment					
Asset	S/Ku Terminal	S-TTC	EET	BRTS	Active TDRS
White Sands GT (WSGT)	3	1	3	1	2
Second TDRS GT (STGT)	3	1	4		2
Extended TDRS GT (ETGT)		2			
Guam Remote GT (GRGT)	2+		3		2
Blossom Point GT (BPGT)	1+		1		
Australian TDRS Fac. (ATF)		1			
Other (AMS, AI, AS)				3	



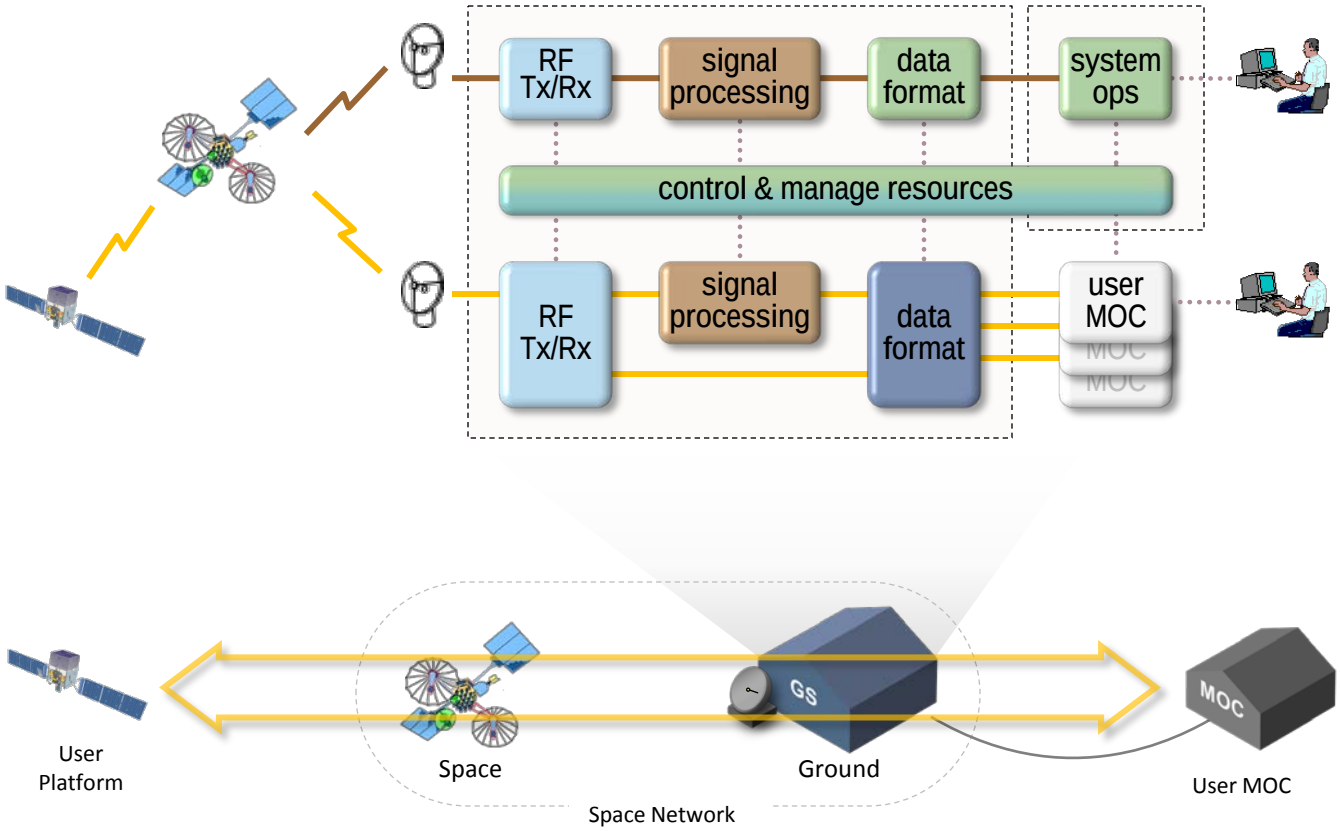
SGSS System Context

- The SGSS system must live within a context characterized by existing SNGS-internal and external physical and functional interfaces
- SGSS "modernizes" a major portion of the existing SNGS…but not all



GENERAL DYNAMICS
C4 Systems

SGSS Functional Architecture



SGSS functional architecture is consistent with SN Legacy

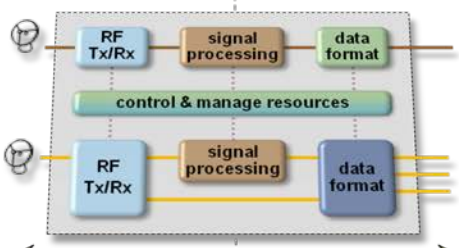
SNGS vs. SGSS

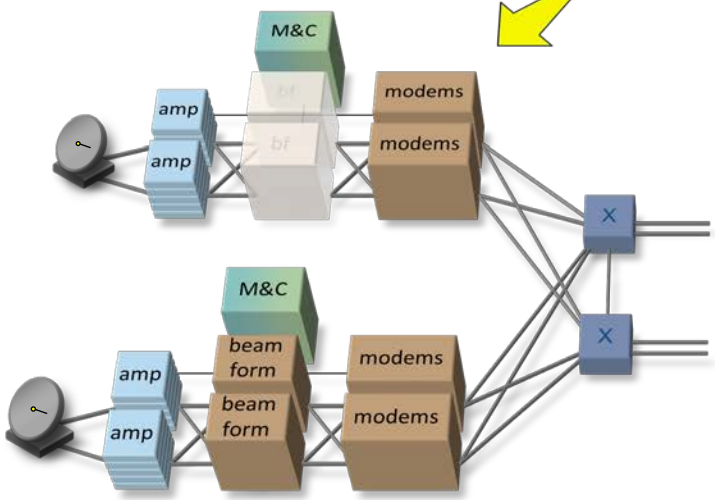
Legacy SNGS

- Analog signal distribution
- Dedicated 2x signal and baseband processing (per satellite)
- User data uses serial circuits to on-site interfaces
- Application SW (Ada) tightly coupled with VMS OS and HW

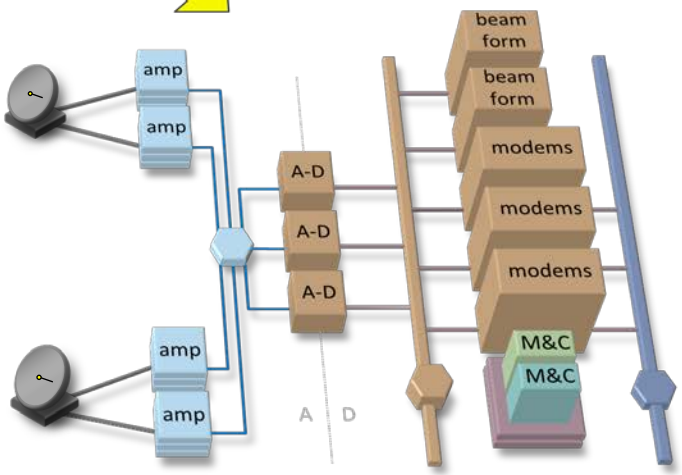
Updated SGSS

- Digital signal distribution
- Pooled signal and baseband processing (per site)
- IP LAN/WAN for internal system M&C and user data transport
- Service-oriented SW architecture, independent of HW



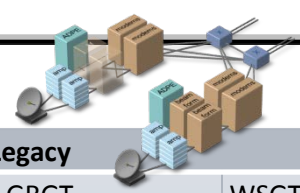


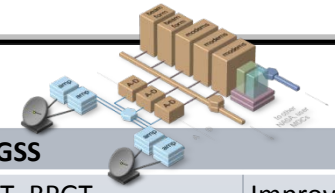
SNGS



SGSS

SNGS vs. SGSS

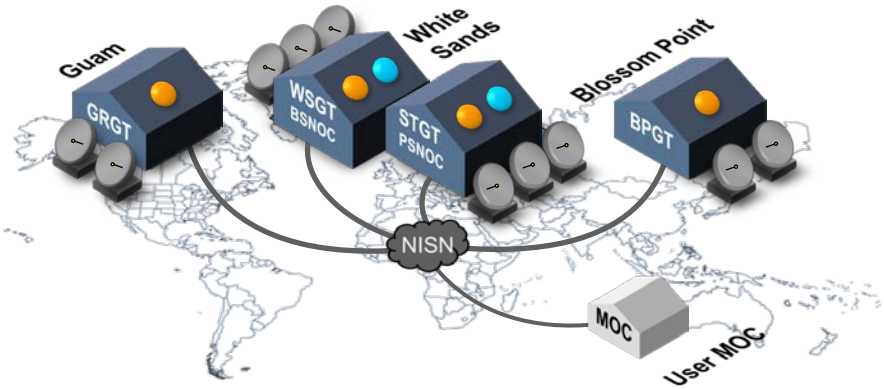




	Legacy	SGSS	Benefit
Ground Terminals	WSGT, STGT, GRGT	WSGT, STGT, GRGT, BPGT	Improves coverage, expands services
TDRS support	SGLT configured to support specific TDRS	Consistent support for any TDRS via any antenna/terminal	Improves agility, removes fleet-ground pairing limitations
SGLT topology	dedicated signal, information processing and transport, per antenna	pooled signal and information processing resources per GT (allows pooling across IFL)	Provides more service with less HW, improves fault tolerance
Signal distribution	Analog, confined with GT or complex	Digital, distribution limited only by available inter-facility bandwidth	Unlimited replication, storage, distribution
Fault tolerance	one failure per SGLT, limited by fundamental architecture	multiple failures per GT, limited by equipment population	Improves continuity, reduces required maintenance staffing
M&C processing	Monolithic ADPE, dedicated subsystem controllers	distributed intelligence, within sites, system-wide	Improves scalability, maintainability, reduces complexity per node
M&C communication	Heterogeneous, some IP	enterprise messaging, TCP/UDP/IP	Improves performance, extensibility
User information plumbing	generally serial switched internal to SNGS	all IP internal to SGSS, adapt to legacy interface at the demarcation	Stable internal transport, remove adapters as users evolve
SW architecture, implementation	monolithic, tightly coupled, HW-dependent, Ada/VMS	distributed, loosely coupled, SOA C, C++, Java, Linux, Windows	Improves maintainability, portability. Extended maintainer base
Enterprise management	Multiple, independent , dispersed mgmt domains	Managed as a single enterprise, using industry-standard tools, protocols	Improves system visibility/availability, reduces required staffing
Processing platforms	VMS-compliant (VAX, Alpha)	Any x86 compatible (x86, x86-64)	Multi-vendor, extends longevity
Modem technology	analog signal, serial baseband, aging platform, limited upgrade possibilities	digital signal over IP, IP baseband, telco-standard uTCA platform, upgradeable SW waveforms	Extensible at the SW, FW, and interface levels. Enables waveform and/or device insertions

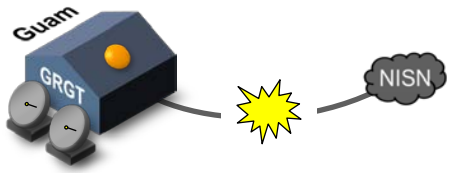
SGSS Global Perspective

- SGSS consists of globally-networked Ground Terminals (GT ●) and Operations Centers (SNOC ●)
  - GT located at Guam (GRGT), White Sands (WSGT, STGT), and Blossom Point (BPGT)
  - Primary SNOC at STGT, Backup at WSGT
  - NISN IONet provides reach to user MOCs, NASA Support facilities, vendor support



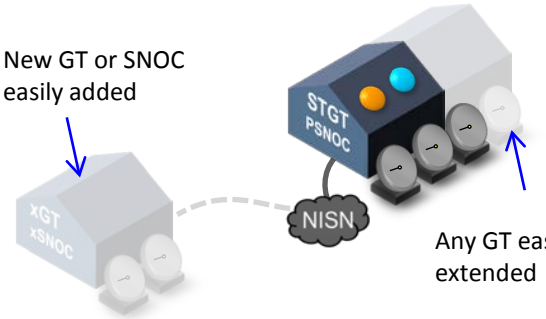
- GT continues local operations when contact with SNOC is lost
  - Distributed intelligence, local control, mgmt

GT operations continue when disconnected



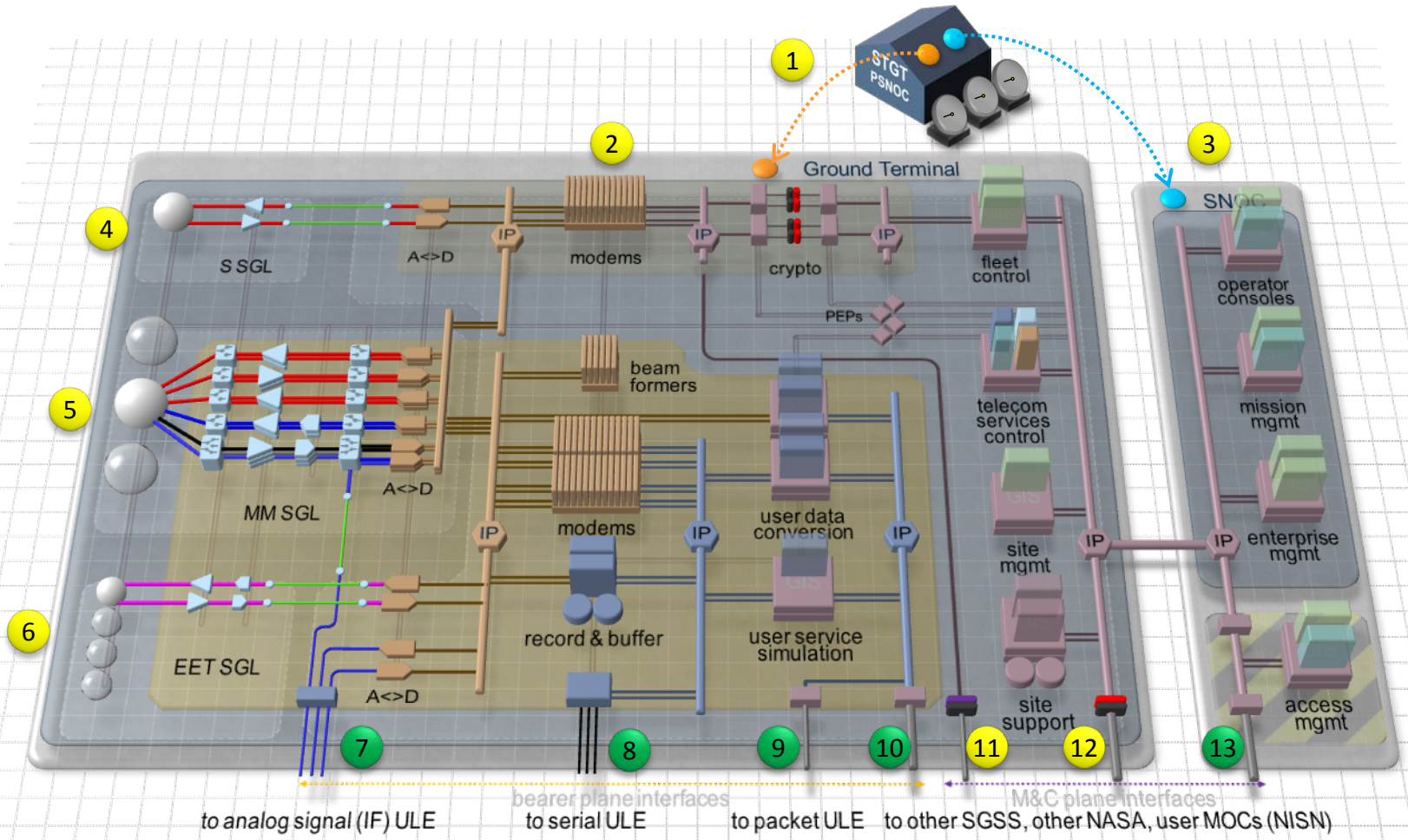
- SGSS can be extended simply
  - GT or SNOC added anywhere within the NISN reach
    - Each site includes operational independence improving scalability
  - Any GT can be extended due to its standard network construction
    - Modular processing and pooled resources yield simple extension without disruption or application SW upgrade

New GT or SNOC easily added



Any GT easily extended

Physical Architecture Perspective



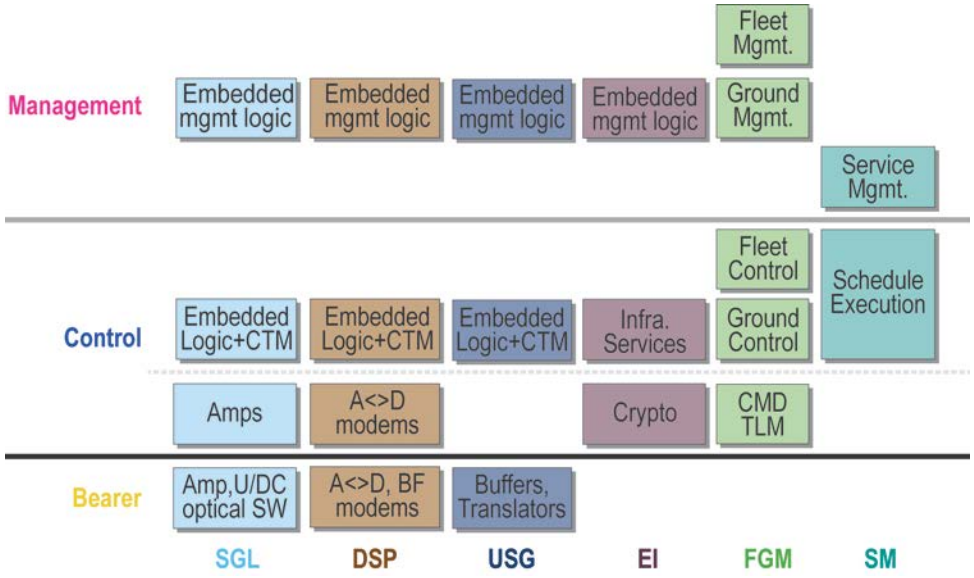
GENERAL DYNAMICS
C4 Systems

Physical Architecture Perspective

1	SGSS forms a global communications network consisting of consistent, repeatable Ground Terminal (GT) and Operations Center (SNOC) building blocks.
2	GT can be scaled, replicated, and located anywhere with NISN connectivity, growing the ground system in step with the fleet. Initial SGSS includes 4 GTs (WSGT, STGT, GRGT, BPGT)
3	SNOC can be located anywhere with NISN service. Complete SGSS network is operable from any SNOC site. Initial SGSS includes a primary SNOC and a backup SNOC, both located at WSC
4 5 6	Fleet interfaces include stand-alone s-band (4), combined Ku-band+S-band main mission (5), and Ku, S, and Ka band end to end test antennas (6)
7	User Local Equipment (ULE) interfaces for delivery (ingress and egress) of intermediate frequency (IF) analog signal data.
8	User Local Equipment (ULE) interfaces for delivery (ingress and egress) of serial baseband information.
9	User Local Equipment (ULE) interfaces for delivery (ingress and egress) of packet information, including digitized IF signal traffic , and baseband information traffic.
10	Packet interface for user traffic to user MOC via NISN IOnet.
11	TTC Network interface reaching to off-net NASA apertures. Protected connection allows TTC of TDRS via NEN and DSN
12	SGSS M&C network extension (via dedicated links) connecting all SGSS GTs and SNOCs. This connection is encrypted between sites
13	External access to SGSS planning, scheduling, awareness information via NISN IONet. M&C interfaces to support facilities, etc., use this entry. Entry uses a DMZ to allow only limited access to SGSS resources.

Information Plane Architecture

- Applies to functions and information flows
  - Simplifies component functionality
  - Simplifies development and integration
  - Defines, limits regression testing scope, context
- Preserves performance, Quality of Service
  - Flows isolated to applicable components and networks
- Supports Information Assurance objectives



Management describes the process of preparing the system to perform its mission, sustaining that preparedness, and measuring performance of mission execution. Management data includes configuration, performance, and historical information used to improve and evolve the system. All non-inert SGSS components are managed. Management data flows on the conceptual "management plane".

Control describes the process of operating the system in the performance of its mission, and monitoring that operation. This includes information used to setup, modify, status, and teardown a provided service. A small subset of SGSS components are controlled. Control data flows on the conceptual "control plane".

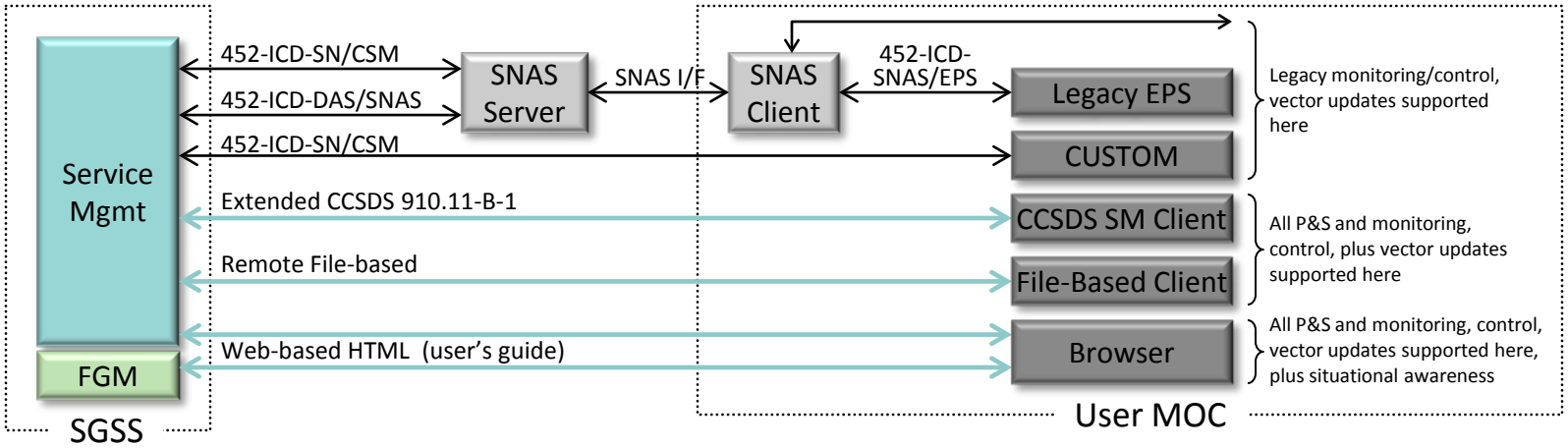
Bearer describes information "product" that is transported through the system. This includes traffic between user platform and user MOC, and any traffic which might be played-back from system internal buffer/storage. Bearer information flows on the conceptual "bearer plane".

End-user Interfaces

- Management Plane
  - Planning & Scheduling
  - User Service Accounting
  - TDRS/User SC vector I/O
  - Situational Awareness
- Control Plane
  - User Service Control & Monitor
  - System Timing and Frequency references
- Bearer Plane
  - User traffic
    - Local Equipment
    - NISN IONet
  - In-Band Service Control

End-user external interfaces are defined as E-03, E-04, E-05, and E-06. More detail for these can be found in the backup material at the end of this package

User MOC M&C Interfaces



- All existing interfaces are maintained
  - SN/CSM and DAS interfaces
  - SNAS client applications will perform without change

- New interfaces added
  - Secure Web-based MMIs – Extension of CCSDS SCCS-SM and File-based
    - Clients talk directly to the SN MMIs – no need for SNAS client
    - All features of SGSS planning and scheduling and service performance and control

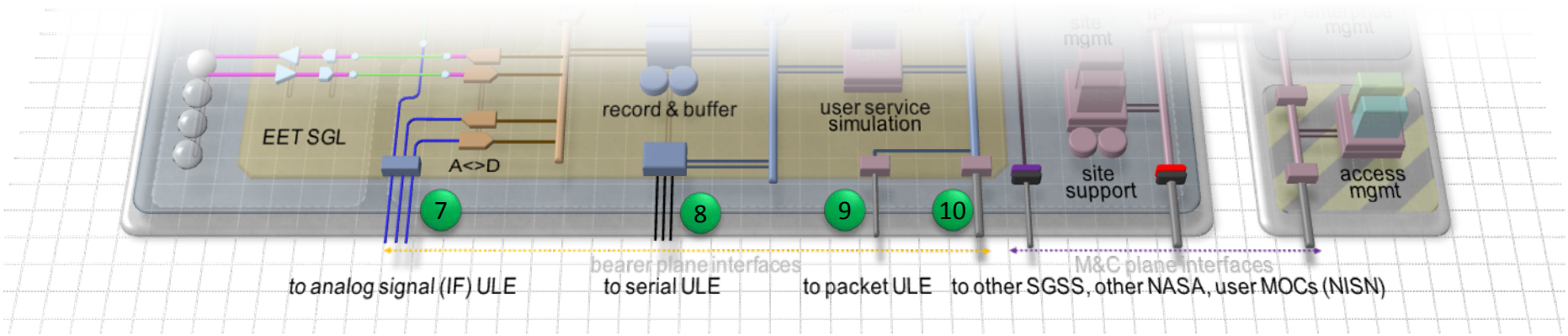
- New interfaces added
  - Secure Web-based HMIs - SNAS in a browser, plus…
    - SN resource planning calendar (up to 3-months out)
    - Additional options for recurrent scheduling
    - New scheduling features for events - multi-event binding/coupling, continuous events (DAS TDRS-Any for any service)
    - modify service profile and mission scheduling constraints
    - Access to modern reporting tools for service performance and SN planning reports

User Traffic Interfaces

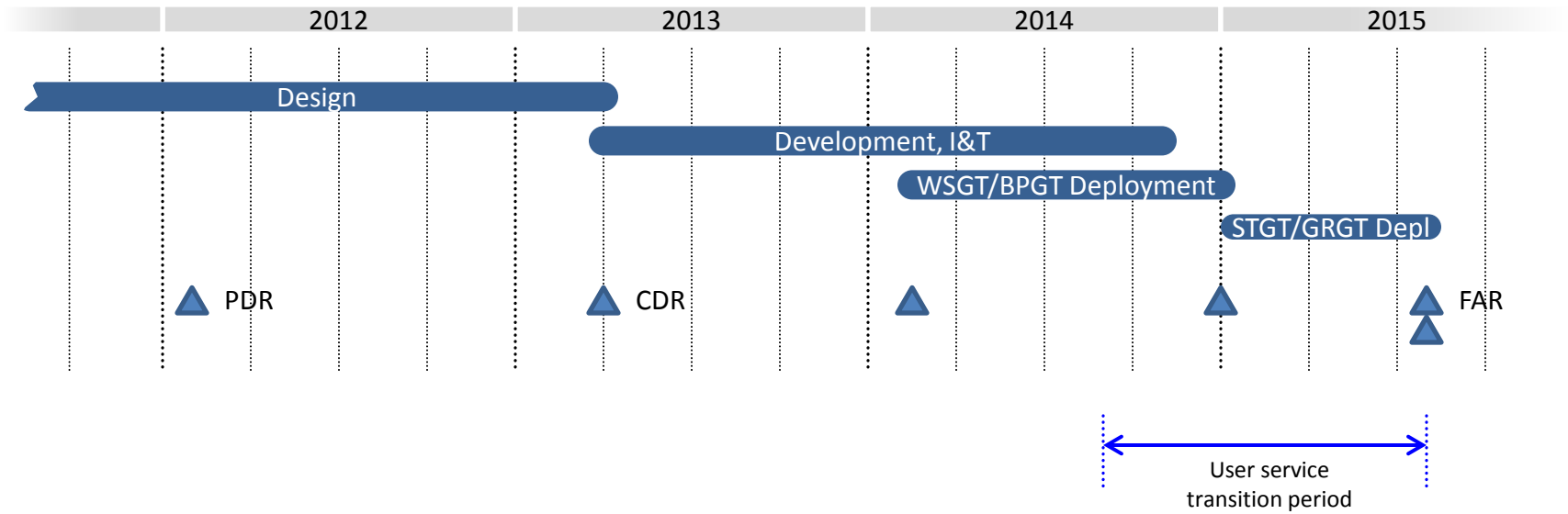
- Existing interfaces maintained
- New interfaces added…opportunity to advance

		Signal		Baseband Data		
		Digital	Analog			
		User Local Equipment				Network
		Packet	IF/Coaxial	Serial	Packet	Packet
KSA	FWD & RTN	VITA-49 /IP	370 MHz 1350 MHz	RS422, ECL	Multi/IP	Multi/IP[2]
SSA						
MA				RS422		
Wideband[1]	RTN only		1345 MHz			
Channelized MA		VITA-49 /IP				
Time & Freq	out		10 MHz, 1PPS, IRIG-B,G			

[1]No digital processing for Wideband Analog service. All other analog signals are processed digitally.
[2]High rate services may be limited by NISN-provided network bandwidth



High-Level Program Schedule



- First SGSS control of TDRS satellite – early 2014
- First SGSS user service support – mid/late 2014

SGSS challenges

SGSS.001025 SNGS Extensibility

The SNGS shall accommodate the inclusion of the legacy capabilities and interfaces currently provided by the component networks (SN, NEN, DSN) until they are decommissioned at the dates mutually agreed to by the SCaN and legacy User missions.

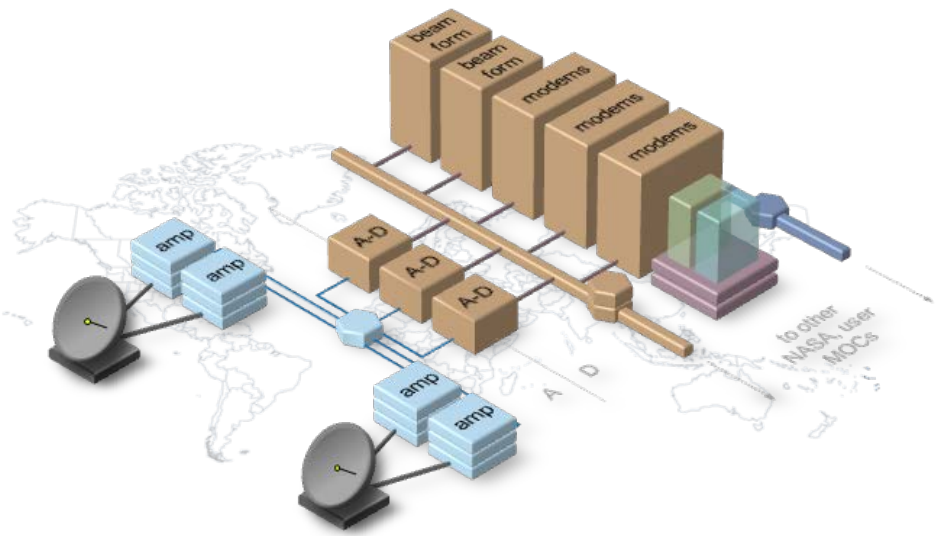
SGSS.001030 Legacy External Interface Support

The SNGS shall allow the use of legacy electronic interfaces to external entities.

- Items of specific interest include:
  - User traffic latency, jitter
  - Specific ULE interfaces
  - Resource apportionment

Summary

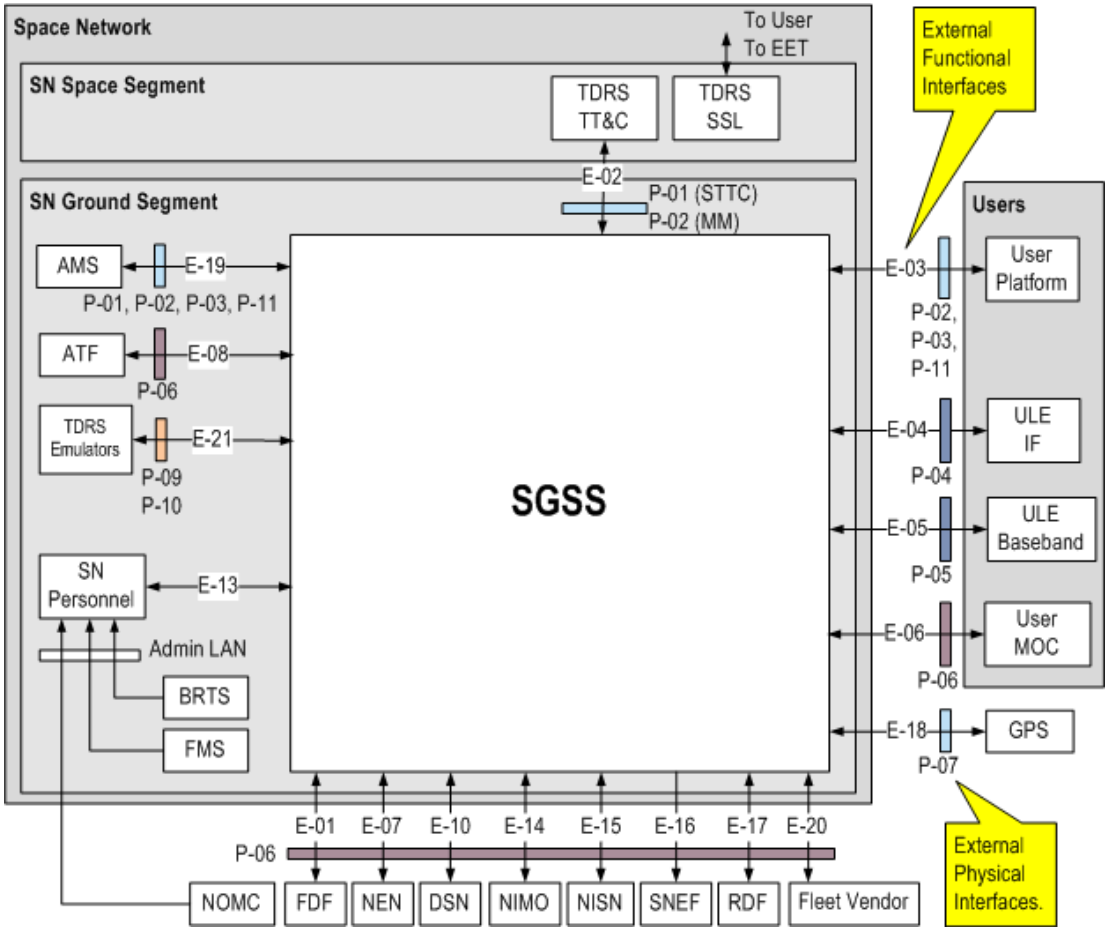
- Low-loss signal distribution and unlimited lossless replication
  - Digital signal transport, storage at IF
- Improved resource utilization, system & service availability
  - Pooled processing architecture allows SGSS to do more with less, and scale easily
  - Multi-failure tolerance…maintenance becomes routine, not emergency
  - Shared-aggregate virtual processing
- Reliable internal communications
  - Consistent IP transport throughout
  - Isolated information planes
  - Integrated security strategy
- Improved maintainability
  - Decoupled application SW from operating platform, extending longevity
  - Distributed Intelligence
- Controlled life-cycle costs
  - Low LRU count reduces required sparing
  - Modern Enterprise Management improves system availability, visibility, while reducing required staffing



- SGSS can be always current
  - Modularity, extensibility, SW architecture, and application isolation support non-disruptive upgrade, enabling a continuous refresh cycle
  - Networked architecture, distributed intelligence improve scalability
  - Significantly reduces maintenance costs associated with system or component obsolescence

Backup

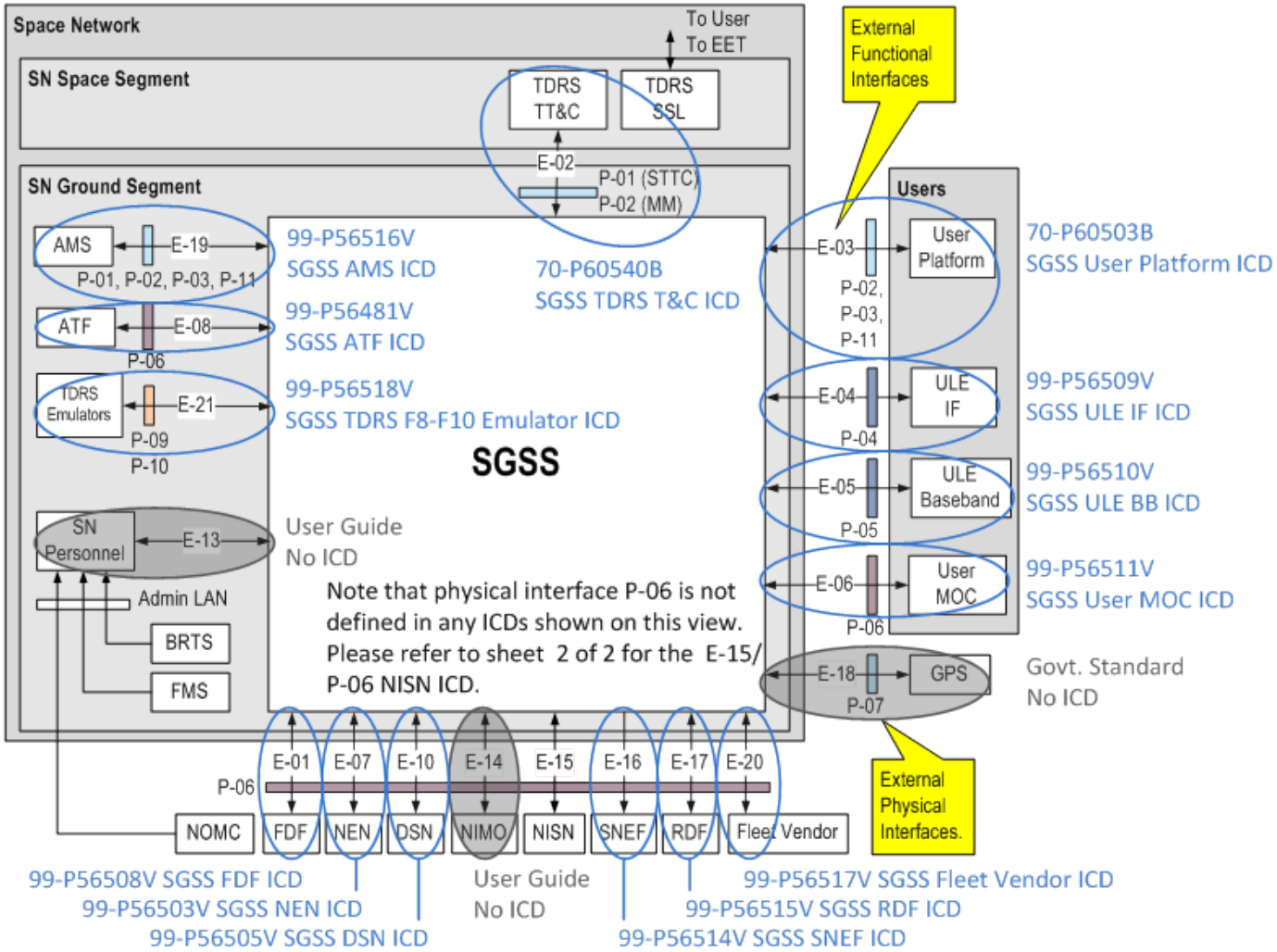
SGSS System Context



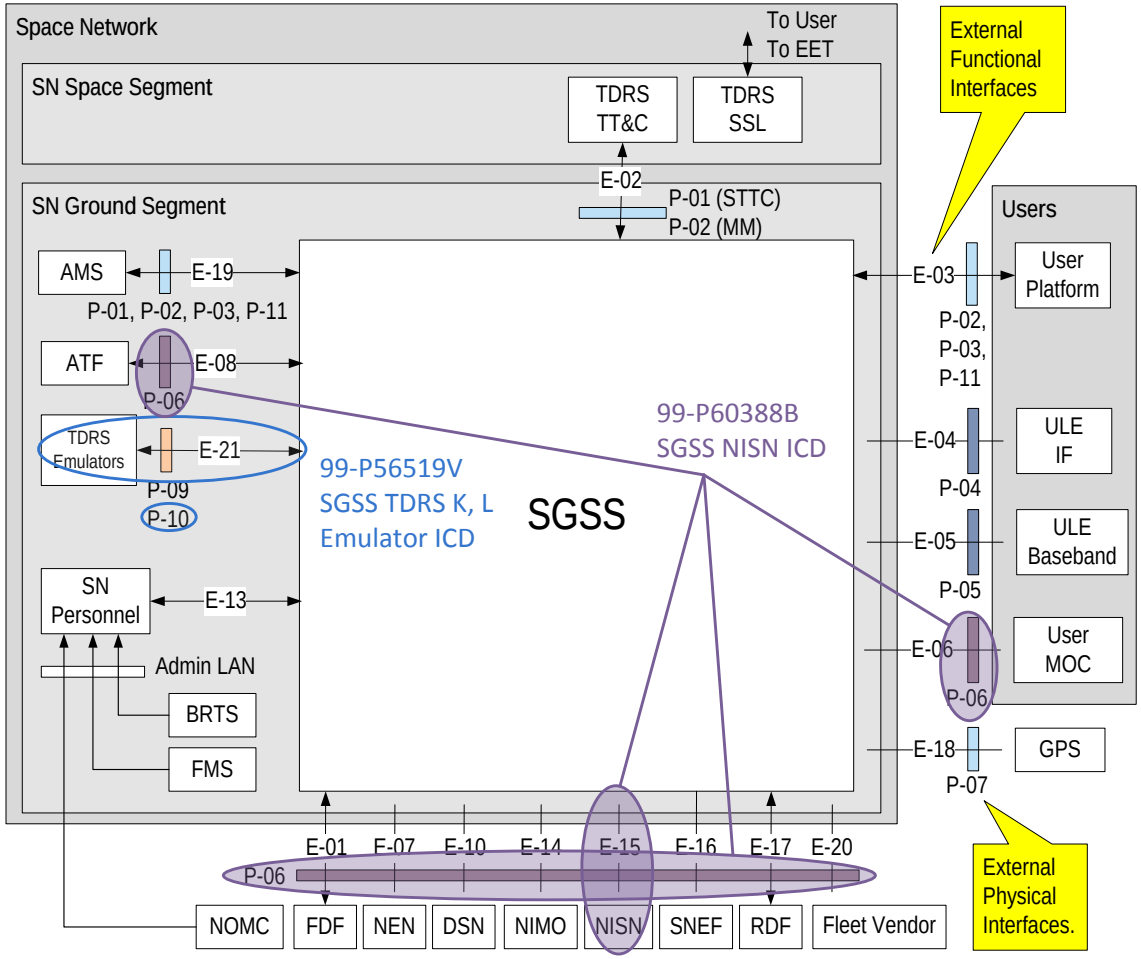
Physical Interfaces

- P-01 : STTC Antenna (SGL)
- P-02 : MM Antenna (SGL)
- P-03 : S/Ku EET Antenna (SGL)
- P-04 : IF Local Interface (USG)
- P-05 : Baseband Local Interface (USG)
- P-06 : NISN (EI)
- P-07 : GPS RF (SGL)
- P-09 : TDRS F8-F10 Emulators (MT)
- P-10 : TDRS K/L Emulator (MT)
- P-11 : Ka EET Antenna (SGL)

SGSS External Interface ICDs (1 of 2)



SGSS External Interface ICDs (2 of 2)



External Interface CDRLs

External ICD Name	Functional/Physical Interfaces Defined in ICD
Space Network (SN) Ground Segment Sustainment (SGSS) to Australian TDRSS Facility (ATF) Interface Control Document (ICD)	E-08
Space Network (SN) Ground Segment Sustainment (SGSS) to Near Earth Network (NEN) Interface Control Document (ICD)	E-07
Space Network (SN) Ground Segment Sustainment (SGSS) to Deep Space Network (DSN) Interface Control Document (ICD)	E-10
Space Network (SN) Ground Segment Sustainment (SGSS) to Flight Dynamics Facility (FDF) Interface Control Document (ICD)	E-01
Space Network (SN) Ground Segment Sustainment (SGSS) to User Local Equipment (ULE) Intermediate Frequency (IF) Interface Control Document (ICD)	E-04, P-04
Space Network (SN) Ground Segment Sustainment (SGSS) to User Local Equipment (ULE) Baseband Interface Control Document (ICD)	E-05, P-05
Space Network (SN) Ground Segment Sustainment (SGSS) to User Mission Operations Center (MOC) Interface Control Document (ICD)	E-06
Space Network (SN) Ground Segment Sustainment (SGSS) to Tracking and Data Relay Satellite (TDRS) Telemetry and Command (T&C) Interface Control Document (ICD)	E-02
Space Network (SN) Ground Segment Sustainment (SGSS) to Space Network Engineering Facility (SNEF) Interface Control Document (ICD)	E-16
Space Network (SN) Ground Segment Sustainment (SGSS) to Remote Development Facility (RDF) Interface Control Document (ICD)	E-17
Space Network (SN) Ground Segment Sustainment (SGSS) to Antenna Mechanical System (AMS) Interface Control Document (ICD)	E-19, P-01, P-02, P-03, P-11
Space Network (SN) Ground Segment Sustainment (SGSS) to Fleet Vendor ICD Interface Control Document (ICD)	E-20
Space Network (SN) Ground Segment Sustainment (SGSS) to TDRS F8-F10 Emulator Interface Control Document (ICD)	E-21, P-09
Space Network (SN) Ground Segment Sustainment (SGSS) to TDRS K,L Emulator Interface Control Document (ICD)	E-21, P-10
Space Network (SN) Ground Segment Sustainment (SGSS) to NASA Integrated Services Network (NISN) Interface Control Document (ICD)	E-15, P-06
Space Network (SN) Ground Segment Sustainment (SGSS) to User Platform Interface Control Document (ICD)	E-03

External Functional and Physical Interfaces

ID	Ext. End	Dir	Elmt	Information		Plane	Physical	Interface Requirements (IRD/IDD)	Interface Control Document (ICD)
E-01	FDF	---->	SM	TDRS Vectors (Message Based)	E-01.1	Mgmt	P-06.01	458-IRD-0003_SGSS Flight Dynamics Facility (FDF) IRD	452-ICD-SN-FDF_ICD between the Space Network and the Fligth Dynamics Facility
		---->	SM	User Vectors (Message Based)		Mgmt	P-06.01	458-IRD-0001_SGSS NASA Integrated Services Network (NISN) IRD	Physical EI interface
		---->	SM	TDRS Vectors (FTP)		Mgmt	P-06.01		
		---->	SM	User Vectors (FTP)		Mgmt	P-06.01		
		<--->	SM	TDRS Vectors (Web Portal HMI)		Mgmt	P-06.01		
		<--->	SM	User Vectors (Web Portal HMI)		Mgmt	P-06.01		Schedule requests and schedule status (SN/CSM)
		<--->	SM	BRTS Schedule Requests & Status (Web Portal HMI)		Mgmt	P-06.01		Schedule requests and schedule status (SNAS/DAS)
		<----	SM	TDRS Maneuver Schedule		Mgmt	P-06.01		Schedule requests and schedule status (CCSDS)
		<----	USG	Tracking Data Messages (TDM for some Users and TDRS)	E-01.2	Control	P-06.01		
E-02	TDRS TT&C	<--->	FGM/ EI	TDRS T&C data (EI provides Crypto and Fill)	E-02	Control			
				F3-F6 T&C Data			P-01.01		STDN No.220.29_Interface Control Document for the TDRSS Spacecraft - Ground Segment
							P-02.01		
				F7 T&C Data			P-01.01		405-F7-ICD-001_ICD for the TDRS Spacecraft - Ground Segment
							P-02.01		
				F8-F10 T&C Data			P-01.01		DS80409-H00-003_TDRS H,I,J Space - Ground ICD
							P-02.01		
				TDRS K/L T&C Data			P-01.01		454-KP-SYS-ICD-001_TDRS K Program Spacecraft - Ground Segment RF ICD
							P-02.01		

External Functional and Physical Interfaces

ID	Ext. End	Dir	Elmt	Information		Plane	Physical	Interface Requirements (IRD/IDD)	Interface Control Document (ICD)
E-03	User Platforms	<--->	USG	User real (MM) and simulated (EET) non-CCSDS data physically carried through TDRS and SGSS.	E-03.1	Bearer	P-02.01	See SNUG and SLAs.	Need to determine what CCSDS information is applicable
						Bearer	P-03.01		
						Bearer	P-11.01		
		<--->	USG	User real (MM) and simulated (EET) CCSDS data physically carried through TDRS and SGSS.	E-03.2	Bearer	P-02.01		
						Bearer	P-03.01		
						Bearer	P-11.01		
E-04	ULE IF	<----	USG	Non-Digitized Analog IF (Pol1 or Pol2)	E-04.1	Bearer	P-04.01	458-IRD-0005_SGSS User Local Equipment (ULE) IRD	
		<----	USG	Analog Narrow IF (RTN)	E-04.2	Bearer	P-		
		---->	USG	Analog Narrow IF (FWD)		Bearer	P-		
		<--->	USG	Digital Narrow IF (RTN & FWD)	E-04.3	Bearer	P-04.03		
		<--->	USG	IF ULE Equipment Status, NTP (Packet), TDMs	E-04.4	Control	P-04.04		
		<----	USG	10 MHz Frequency Reference	E-04.5	Control	P-04.05		
		<----	USG	IRIG-B	E-04.6	Control	P-04.06		
		<----	USG	IRIG-G	E-04.7	Control	P-04.07		
		<----	USG	1 PPS	E-04.8	Control	P-04.08		
E-05	ULE Baseband	<----	USG	Serial Data (RTN)	E-05.1	Bearer	P-		
		<----	USG			Bearer	P-		
		---->	USG	Serial Data (FWD)		Bearer	P-		
		---->	USG			Bearer	P-		
		<--->	USG	Packet Data (FWD & RTN)	E-05.2	Bearer	P-05.02		
		<--->	USG	Baseband ULE Equipment Status, NTP (Packet), TDMs	E-05.3	Control	P-05.3		
		<----	USG	Serial Clock (RTN)	E-05.4	Control	P-		
		<----	USG			Control	P-		
		---->	USG	Serial Clock (FWD)		Control	P-		
		---->	USG			Control	P-		
		<----	USG	10 MHz Frequency Reference	E-05.5	Control	P-05.05		
		<----	USG	IRIG-B	E-05.6	Control	P-05.06		
		<----	USG	IRIG-G	E-05.7	Control	P-05.07		
		<----	USG	1 PPS	E-05.8	Control	P-05.08		

External Functional and Physical Interfaces

ID	Ext. End	Dir	Elmt	Information		Plane	Physical	Interface Requirements (IRD/IDD)	Interface Control Document (ICD)
E-06	User MOC	<--->	SM	User Service Management (Web Portal HMI)	E-06.1	Mgmt	P-06.01	458-IRD-0004_SGSS User Mission Operations Center (MOC) IRD	451-ICD-NCCDS-MOC_Network Control Center Data System to MOC ICD
		<--->	SM	User Service Management (SN/CSM)		Mgmt	P-06.01		456-ICD-SNE-CSD_ICD between SNE Ground System and Customers for Service Data
		<--->	SM	User Service Management (DAS/SNAS)		Mgmt	P-06.01		456-ICD-SNE-CSD_ICD between SNE Ground System and Customers for Service Data
		<--->	SM	User Service Management (Extended CCSDS)		Mgmt	P-06.01		456-ICD-SNE-CSD_ICD between SNE Ground System and Customers for Service Data
		---->	SM	User Vectors for S/C not supported by FDF (FTP)		Mgmt	P-06.01		Need to see if this is a complete list.
		<----	SM	TDRS Vectors (FTP)		Mgmt	P-06.01		
		<--->	SM	User Service Management (File Based)		Mgmt	P-06.01		456-ICD-SNE-CSD_ICD between SNE Ground System and Customers for Service Data
		<--->	SM	User Service Control & Monitor (Web Portal HMI)	E-06.2	Control	P-06.01		Need to see if this is a complete list.
		<--->	SM	User Service Control & Monitor (SN/CSM)		Control	P-06.01		Need to see if this is a complete list.
		<--->	SM	User Service Control & Monitor (DAS/SNAS)		Control	P-06.01		Need to see if this is a complete list.
		<--->	SM	User Service Control & Monitor (SGSS/CSM)		Control	P-06.01		Need to see if this is a complete list.
		<--->	SM	User Service Accounting (Web Portal HMI)	E-06.3	Mgmt	P-06.01		
		<--->	SM	User Service Accounting (SGSS/CSM)		Mgmt	P-06.01		
		<--->	USG	User non-CCSDS SLE data (e.g., current MDM, DAS, WDISC)	E-06.4	Bearer	P-06.01		
		<--->	USG	User CCSDS SLE data; In-band status and control (incl. TDMs)		Bear/Ctl	P-06.01		
		<----	FGM	System and User Situational Awareness	E-06.5	Mgmt	P-06.01		Need to see if this is a complete list.

External Functional and Physical Interfaces

ID	Ext. End	Dir	Elmt	Information		Plane	Physical	Interface Requirements (IRD/IDD)	Interface Control Document (ICD)
E-07	NEN	<--->	EI	CMD & TLM Physical Transport	E-07.1	Control	P-06.01	458-IRD-0006_SGSS Near Earth Network (NEN) IRD	See NENUG for more information. Probably need ICD for SN developed.
		---->	FGM	NEN tracking data (FTP)	E-07.2	Control	P-06.01		
		<----	FGM	TDRS State Vectors/Pointing Angles		Control	P-06.01		
E-08	ATF	<--->	EI	CMD & TLM Physical Transport	E-08.1	Control	P-06.02	458-IDD-0002_SGSS Australian TDRS Facility (ATF) IDD	
		---->	FGM	ATF Tracking Data (FTP)	E-08.2	Control	P-06.02		
		<--->	FGM	ATF Management & Control Data	E-08.3	Mgmt/Ctl	P-06.02		
E-10	DSN	<--->	EI	CMD & TLM Physical Transport	E-10.1	Control	P-06.01	458-IDD-0004_SGSS Deep Space Network (DSN) IDD	
		---->	FGM	DSN tracking data (FTP)	E-10.2	Control	P-06.01		
		<----	FGM	TDRS State Vectors/Pointing Vectors		Control	P-06.01		

External Functional and Physical Interfaces

ID	Ext. End	Dir	Elmt	Information		Plane	Physical	Interface Requirements (IRD/IDD)	Interface Control Document (ICD)
E-13	SN Personnel	<--->	FGM	Enterprise Management/Internal Portal (Ground Operator)	E-13.1	Mgmt	n.a.	User Guide	
		<--->	FGM	Local EM User Interface (Ground Operator)	E-13.2	Mgmt	n.a.	User Guide	
		<--->	SM	Service Management/Internal Portal (Web Portal HMI)	E-13.3	Mgmt	n.a.	User Guide	
		<--->	FGM	Flight Dynamics (TDRS Analyst)	E-13.4	Mgmt	n.a.	User Guide	
		<--->	FGM	Fleet Control (TTC Client HMI) (TDRS Operator)	E-13.5	Control	n.a.	User Guide	
		<--->	USG	System Measurement and Test (Test Operator)	E-13.6	Control	n.a.	User Guide	
		<--->	EI	Key Management (Security Operator)	E-13.7	Mgmt	n.a.	User Guide	
		<--->	SM	Service Management (Planning Client HMI - Planner-Scheduler)	E-13.8	Mgmt	n.a.	User Guide	
		<--->	EI	Infrastructure HMI (Network Admin)	E-13.9	Mgmt	n.a.	User Guide	
		<--->	MT	MT HMI (Maintainers, Analysts)	E-	Mgmt	n.a.	User Guide	
		<--->	MT	Training Services HMI (Trainer)	E-	Mgmt	n.a.	User Guide	
		<--->	MT	Simulation HMI (Test Operator)	E-	Control	n.a.	User Guide	
		<--->	SM	Service Accounting Reports	E-	Mgmt	n.a.	User Guide	
		<--->	SM	Real Time Execution Control	E-	Control	n.a.	User Guide	
		<--->	MT	Infrastructure HMI (Network Admin)	E-	Mgmt	n.a.	User Guide	
		<--->	SGL	SGL Equipment Local Maintenance Interfaces (Maintainer)	E-13.16	Mgmt	n.a.	User Guide	
		<--->	DSP	DSP Equipment Local Maintenance Interfaces (Maintainer)	E-13.17	Mgmt	n.a.	User Guide	
		<--->	USG	USG Equipment Local Maintenance Interfaces (Maintainer)	E-13.18	Mgmt	n.a.	User Guide	
		<--->	EI	EI Equipment Local Maintenance Interfaces (Maintainer)	E-13.19	Mgmt	n.a.	User Guide	
		<--->	MT	MT Equipment Local Maintenance Interfaces (Maintainer)	E-13.20	Mgmt	n.a.	User Guide	
		<--->	SGL	RF Spectrum Analyzer Operator Interface	E-13.21	Mgmt	n.a.	User Guide	
		<--->	DSP	Digital IF Spectrum Analyzer (Ground Oper	E-	Mgmt	n.a.	User Guide	

External Functional and Physical Interfaces

ID	Ext. End	Dir	Elmt	Information		Plane	Physical	Interface Requirements (IRD/IDD)	Interface Control Document (ICD)
E-14	NIMO	<--->	SM	User Service Management (Web Portal HMI)	E-14.1	Mgmt	P-06.1	458-IRD-0004_SGSS User Mission Operations Center (MOC) IRD	Primarily liason between users and SN. Aids in monitoring user tests.
		<--->	SM	User Service Control & Monitor (Web Portal HMI)	E-14.2	Control	P-06.1	User Guide	
		<--->	SM	User Service Accounting (Web Portal HMI)	E-14.3	Mgmt	P-06.1	User Guide	
		<----	FGM	System and User Situational Awareness	E-14.4	Mgmt	P-06.1	User Guide	
							P-06.1		
E-15	NISN	<--->	EI	NISN Services (DNS)	E-15	Mgmt	P-06.01		
E-16	SNEF	<----	EI	TLM Physical Transport	E-16.1	Control	P-06.01		
		<----	FGM	System Situational Awareness	E-16.2	Mgmt	P-06.01		Need to see if this is a complete list.
E-17	Remote Dev. Fac.	---->	MT	Ground system software and patches to MTF EM.	E-17	Mgmt	Media		
		<----	MT	Current ground system configuration data		Mgmt	Media		
E-18	GPS	---->	SGL	GPS Signal	E-18	Control	P-07		ICD-GPS-200_Navstar GPS Space Segment and Navigation User Interfaces ICD

External Functional and Physical Interfaces

ID	Ext. End	Dir	Elmt	Information		Plane	Physical	Interface Requirements (IRD/IDD)	Interface Control Document (ICD)
E-19	AMS & Feeds	<--->	SGL	Antenna Management and Control (STTC AMS)	E-19.1	Mgmt/Ctl	P-01.02	458-IDD-0001_SGSS Antenna Mechanical System (AMS) IDD	
		<--->	SGL	STTC Antenna Feeds		Control	P-01.01		
		<--->	SGL	Antenna Management and Control (MM AMS)	E-19.2	Mgmt/Ctl	P-02.02	458-IDD-0001_SGSS Antenna Mechanical System (AMS) IDD	
		<--->	SGL	MM Antenna Feeds		Bear/Ctl	P-02.01		
		<--->	SGL	Antenna Management and Control (S/Ku EET AMS)	E-19.3	Mgmt/Ctl	P-03.02	458-IDD-0001_SGSS Antenna Mechanical System (AMS) IDD	
		<--->	SGL	S/Ku EET Antenna Feeds		Bearer	P-03.01		
		<--->	SGL	Antenna Management and Control (Ka EET AMS)	E-19.4	Mgmt/Ctl	P-11.02	458-IDD-0001_SGSS Antenna Mechanical System (AMS) IDD	
		<--->	SGL	Ka EET Antenna Feeds		Bearer	P-11.01		
E-20	Fleet Vendor	---->	MT	TDRS Flight Software loads to MTF EM.	E-20.1	Mgmt	Media		
		<----	EI	TLM Physical Transport	E-20.2	Control	P-06.01		
E-21	TDRS Eimulator	<--->	FGM	TDRS F8-F10 Emulator CMD & TLM	E-21.1	Control	P-09		
		<--->	FGM	TDRS K,L Emulator CMD & TLM	E-21.2	Control	P-10		
E-22	Legacy NCCDS	<--->	SM	User Service Management	E-22.1	Mgmt	P-15.01		
		<--->	SM	User Service Control	E-22.2	Control	P-15.02		
E-23	Legacy SNGS	---->	SGL	Placeholder for Legacy Ku-Band Uplink	E-23.1	Bearer	P-12.01		
		<--->	SGL	Legacy ACU Control/Status	E-23.2	Mgmt/Ctl	P-12.02		

Local Interface (other info)

- Timing and Frequency signals provided by Timing and Frequency Reference subsystem
  - Cesium Frequency Reference
  - GPS receiver
- Timing
  - 1 PPS – 20 µs wide, +5V TTL compatible, into 50Ω
  - IRIG-B – serial time data, 100 bps
  - IRIG-G – serial time data, 10 kbps
  - NTP - digital packet data, Ethernet over Fiber or Copper
- Frequency
  - 10 MHz reference - Sinusoidal, $1V_{rms}$ into 50Ω

SGSS Transition Introduction 10/21/11

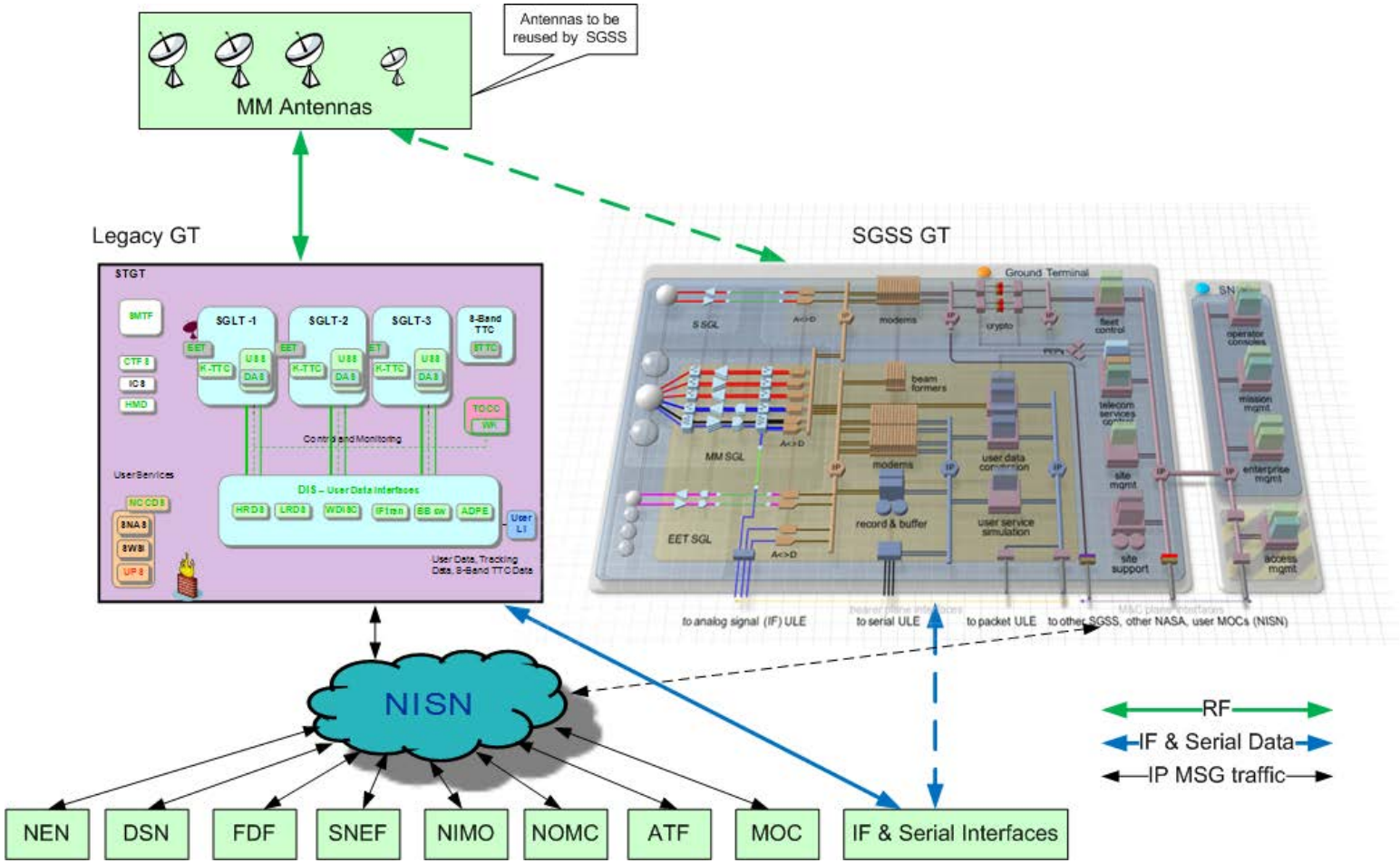
Phil Boss

GENERAL DYNAMICS
C4 Systems

Transition approach

- Transition of operations from the current Legacy system to SGSS will be performed incrementally
- Requires that both the Legacy system and SGSS be in operations concurrently with designated satellite assignments

Architecture Transition



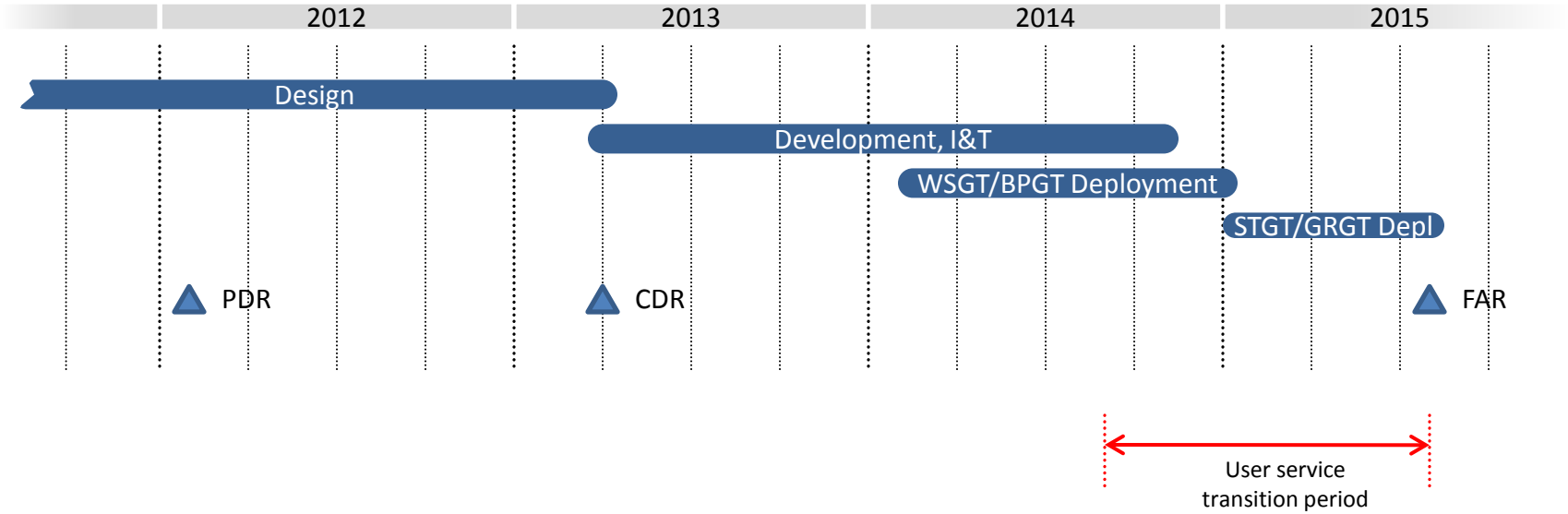
Representative GT Transition

GENERAL DYNAMICS
C4 Systems

Transition approach

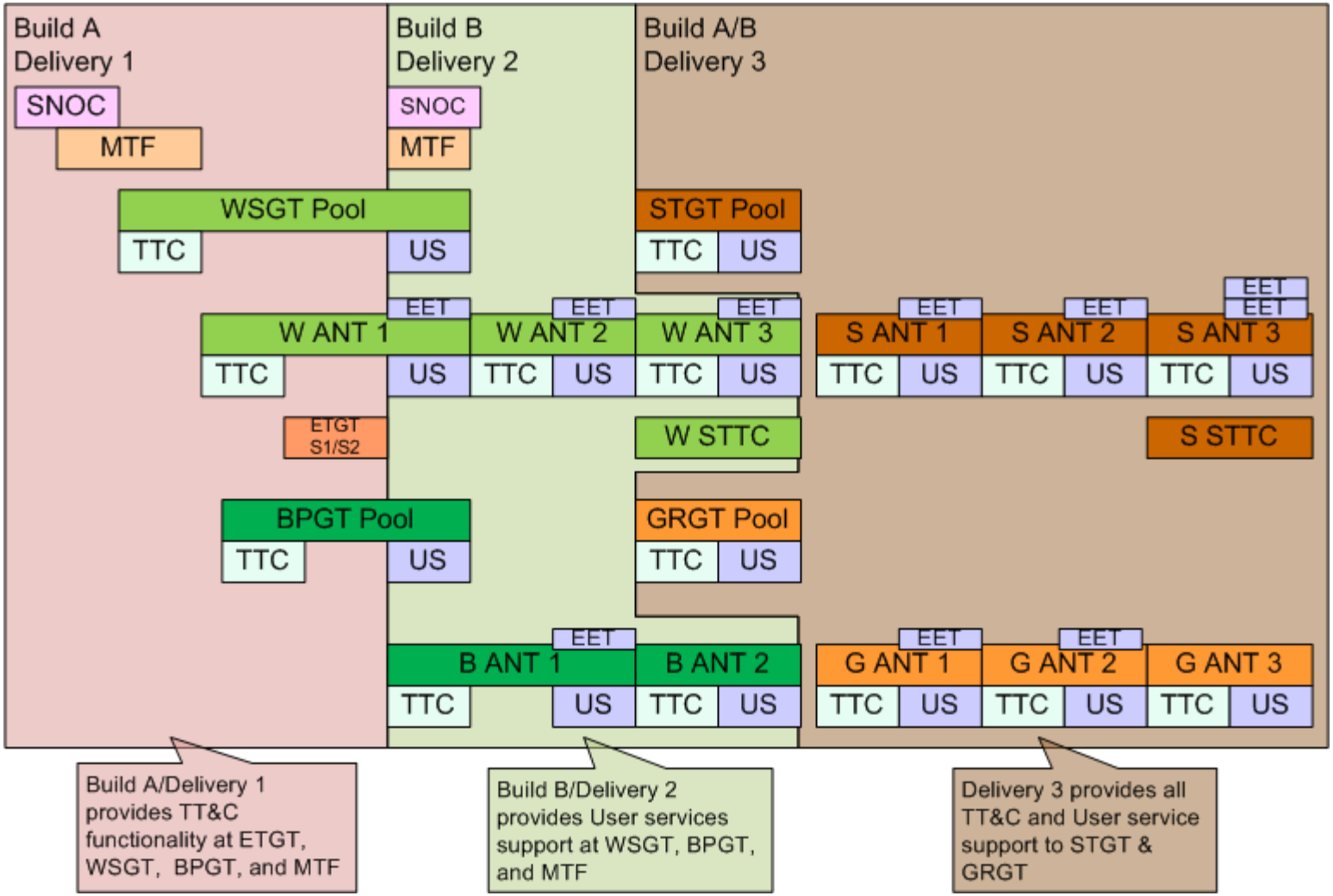
- Transition activities with a Ground Terminal will be performed incrementally by SGL antenna along with potential satellite assignment
- Ground Terminal transition sequence
  - Start with ETGT/WSGT first – leave STGT as primary Operations site
  - Deploy BPGT in parallel with WSGT – non-operational; green field
  - STGT/GRGT follow completion of WSGT/BPGT
- Transition increments to occur over about a 1 year period

High-Level Program Schedule



- First SGSS control of TDRS satellite – Mid 2014
- First SGSS user service support – Mid/Late 2014
- TDRS's transitioned from the legacy system to SGSS one at time during the user service transition period.

Transition approach



GENERAL DYNAMICS
C4 Systems

Minimize risk/impact to Legacy OPS

- Goal is to minimize disruption to currently operational systems
- Install SGSS Equipment pool in open floor space without disruption of current GCE equipment
- Incrementally transition Antennas within a ground terminal – with potential fall-back.
- Establish new interfaces to external entities when possible (FDF, DSN, NEN, etc) without disrupting current interfaces
- Ensure management of interfaces that need switching or routing functions (Scheduling and Planning, User Data delivery)
  - Functions to arbitrate which system supports scheduled services and reports service status based on TDRS assignment
  - Functions to ensure data paths/data routing is managed to ensure data delivery

Ongoing SN operations are Priority #1

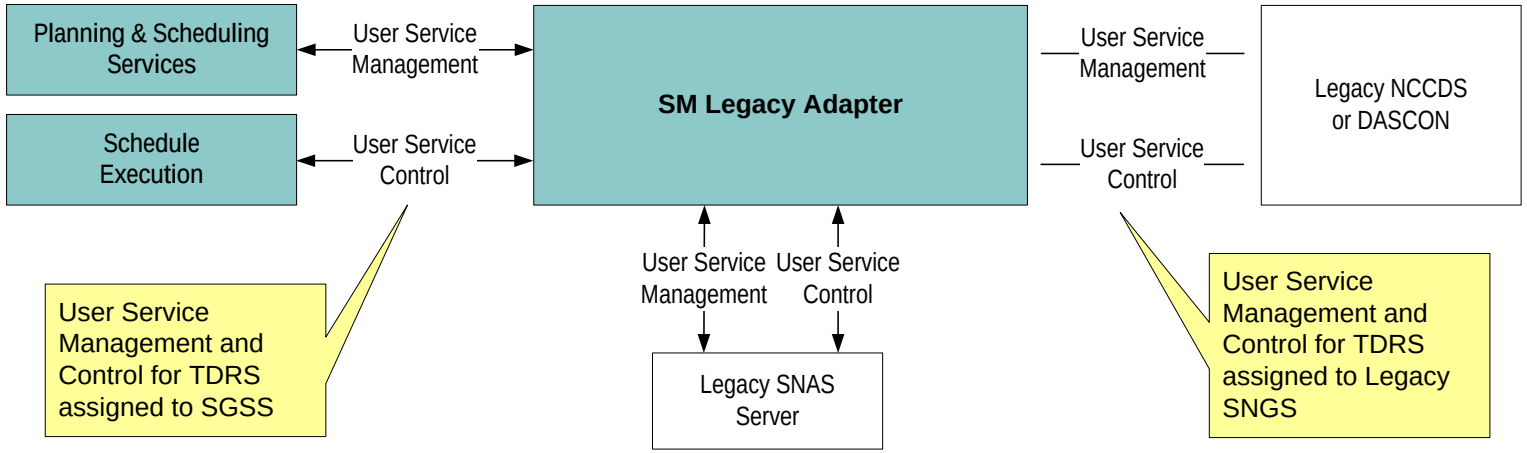
Interfaces to Transition

Ext. IF #	Interface	Comments
E-13	SN Personnel	Legacy and SGSS MMI need to coexist
E-18	GPS	Establish new interface for SGSS
E-17	RDF	Establish new interface for SGSS
E-19	AMS (antennas)	Switch from Legacy to SGSS
E-07	NEN	Establish interfaces from both legacy and SGSS to NEN
E-10	DSN	Establish interfaces from both legacy and SGSS to DSN
E-21	TDRS SIM	Connect SIMs as needed to Legacy or SGSS
E-20	Fleet Vendor	Establish new interface for SGSS
E-16	SNEF	Route IP TDRS TLM from both Legacy and SGSS to SNEF
E-15	NOMC	Establish new interface for SGSS
E-01	FDF	Establish interfaces from both legacy and SGSS to FDF
E-04	ULE IF	Switch interface between Legacy and SGSS
E-05	ULE Baseband	Switch/route interface data between Legacy and SGSS
E-06	User MOC	Manage message traffic between Legacy and SGSS such that the Users see a unified interface
E-14	NIMO	Establish new interface for SGSS
E-08	ATF	Migrate interface from legacy to SGSS during GRGT transition

Transition of all external interfaces is required

Interfaces Approach (cont)

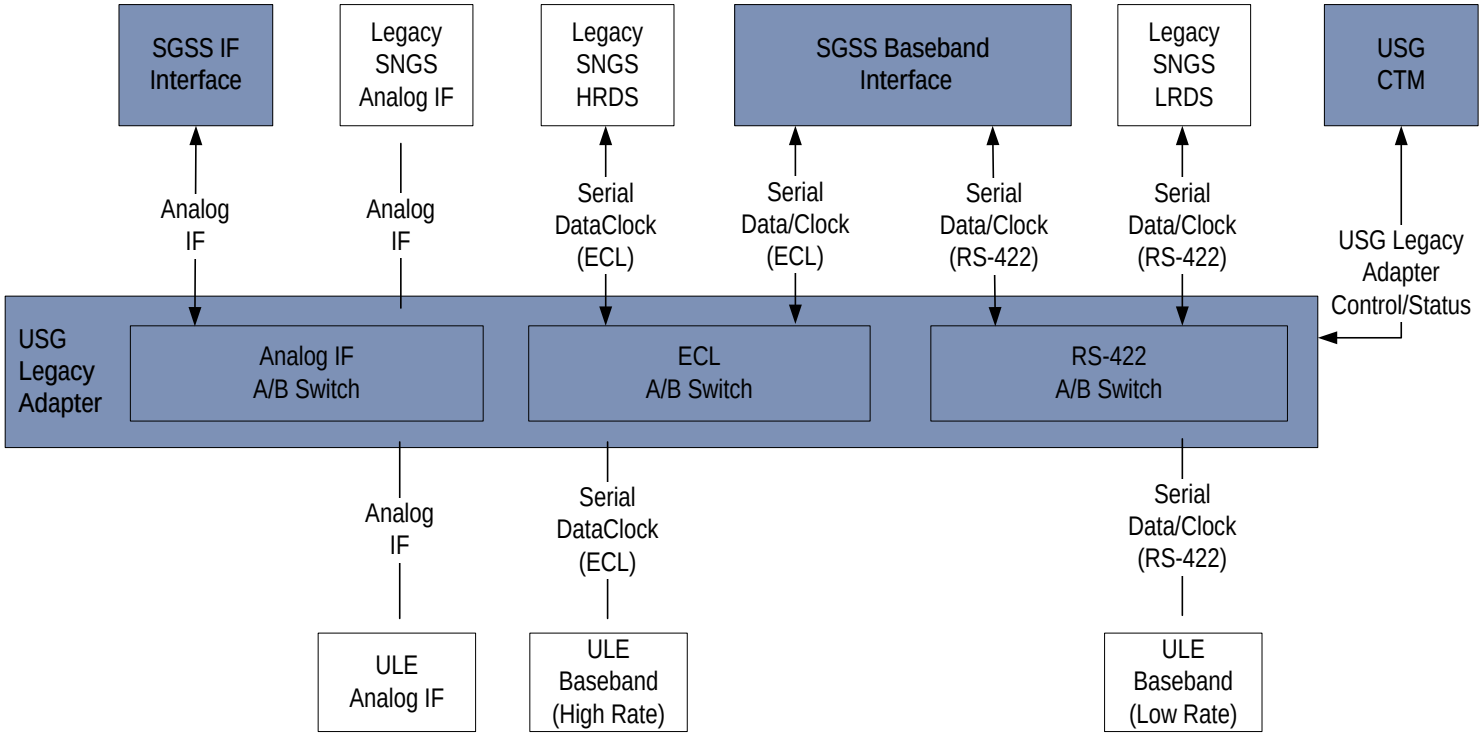
- User MOC message interface
  - SGSS will implement functionality necessary to allow customers to utilize existing service management interface for both Legacy and SGSS services.
  - Message traffic management function required to ensure correct routing to/from the legacy and SGSS systems based on TDRS satellite assignment.
  - Initially tested/demonstrated in the ANCC environment



Unified SN interface to the customer

Interfaces Approach (cont)

- User serial and analog data/IF interfaces
  - SGSS will implement and manage additional serial and analog interface switching to ensure customer data interfaces are not impacted
  - Additional A/B switching of these interfaces required to support selection of Legacy or SGSS interfaces through transition period.



Interface management will be transparent to users

System Testing

- Post installation Level 4 regression testing precedes Level 5
- Level 5 testing includes shadowing of TDRS telemetry and return user services (built on Level 4 Procedures)
- Level 6 testing includes control of a TDRS satellite and demonstration of user service support
- Customer participation during Level 6 testing.
- Level 5/6 test results provided at ORR as part of evidence for readiness to transition to operations

Summary – next steps

- SGSS Transition being planned with goal of minimizing disruption to customers
- Detailed plans for transition of Operational interfaces is in work
- Potential transition period network operational constraints being analyzed
- Opportunities to migrate to new (network based) interfaces being assessed
- Input from the stakeholders/customers required to ensure effective/efficient transition
- Future targeted technical discussions planned to discuss
  - Customer Conops
  - Management interfaces
  - Data interfaces