ISCN
Top Down and Bottom Up
Architecture Implementation

# GSAW 2004

Presented by:

Dr. Richard A. Russel
SCNC Chief Architect
Northrop Grumman Mission Systems
Rich.Russel@AFSCN.COM

Integrated Satellite Control Network (ISCN) Notional Vision

Military Satcom

MDA/TMD

Relay

Space Based Relay (SBR),TCS, and TDRSS Technology Options

National

Navigation

R&D

Environmental

Multi-band (USB / SGLS), Phased Array, Multi-Contact, Automated and Remotely Configured Antennas, Software Programmable Transceivers, Centralized NMS, Priority driven for Scheduling, Monitoring, Management, and automated fault management

Dedicated DoD GN

Shared Ground Network (GN). See Figure 4 for Details

Dedicated Civil GN

Department of Defense (DoD) Dedicated Mission Centers

AFSCN Satellite Operations Center (SOCs)

Civil Dedicated

Establish an interoperable, shared ISCN based on ground elements of current DoD, NASA, NOAA, and other networks augmented by Government sponsored space-based assets

S030550

UNCLASSIFIED

2

Overview

- **ISCN can be developed by a combination of Top-down and Bottom-up architecture development and planning**

  - **Top-Down**

    - **The AFSCN is the first space system that has been fully characterized using the architecture views per the DoD Architecture Framework (DODAF)**

    - **SCNC Architecture Team is developing the ISCN views as part of FY05 task**

Overview

- **Bottom-Up**

    - **SCNC has developed an AFSCN Roadmap that characterizes all projects down to requirements, cost and schedule – this is being used for POM inputs by SMC/RN and AFSPC/DR**

    - **The Roadmap will sequence all projects leading to ISCN by a realistic sequencing of projects based on technical and fiscal constraints, and the relationship to current legacy installations**
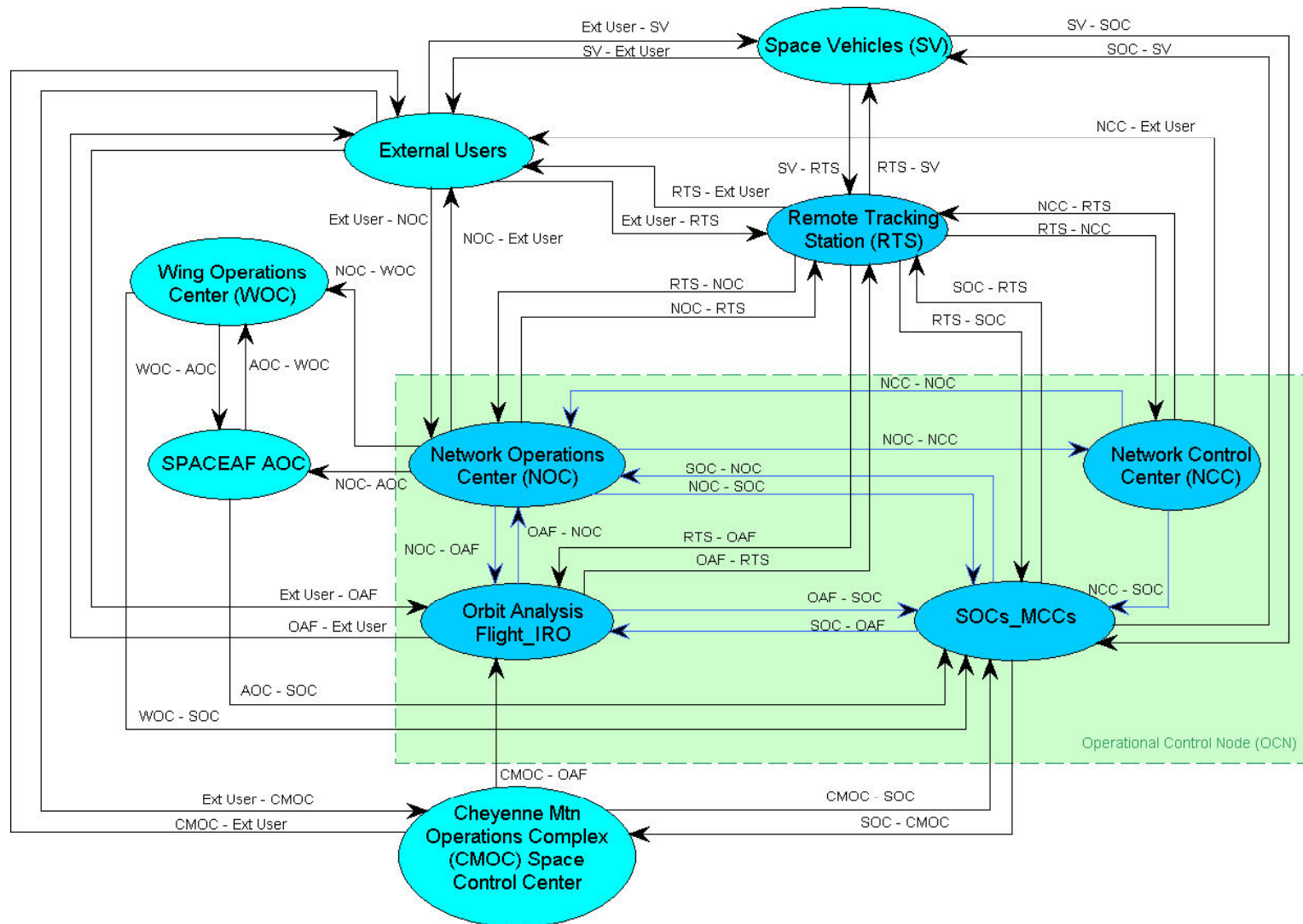
# SCNC Progress to Date – AFSCN DoDAF Products Top Down

Architecture View	Product Reference	Product Title	Essential or Supporting
All	AV-1	Overview and Summary Information	Essential
All	AV-2	Integrated Dictionary	Essential
Operational	OV-1	High-level Operational Concept Graphic	Essential
Operational	OV-2	Operational Node Connectivity Description	Essential
Operational	OV-3	Operational Information Exchange Matrix	Essential
Operational	OV-4	Command Relationships Chart	Supporting
Operational	OV-5	Activity Model	Supporting
Operational	OV-6a	Operational Rules Model	Supporting
Operational	OV-6b	Operational State Transition Description	Supporting
Operational	OV-6c	Operational Event/Trace Description	Supporting
Operational	OV-7	Logical Data Model	Supporting
Systems	SV-1	System Interface Description	Essential
Systems	SV-2	Systems Communications Description	Supporting
Systems	SV-3	Systems^2 Matrix	Supporting
Systems	SV-4	Systems Functionality Description	Supporting
Systems	SV-5	Operational Activity to System Function Traceability Matrix	Supporting
Systems	SV-6	System Information Parameters Matrix	Supporting
Systems	SV-7	System Performance Parameters Matrix	Supporting
Systems	SV-8	System Evolution Description	Supporting
Systems	SV-9	System Technology Forecast	Supporting
Systems	SV-10a	Systems Rules Model	Supporting
Systems	SV-10b	Systems State Transition Description	Supporting
Systems	SV-10c	Systems Event/Trace Description	Supporting
Systems	SV-11	Physical Data Model	Supporting
Technical	TV-1	Technical Architecture Profile	Essential
Technical	TV-2	Standards Technology Forecast	Supporting
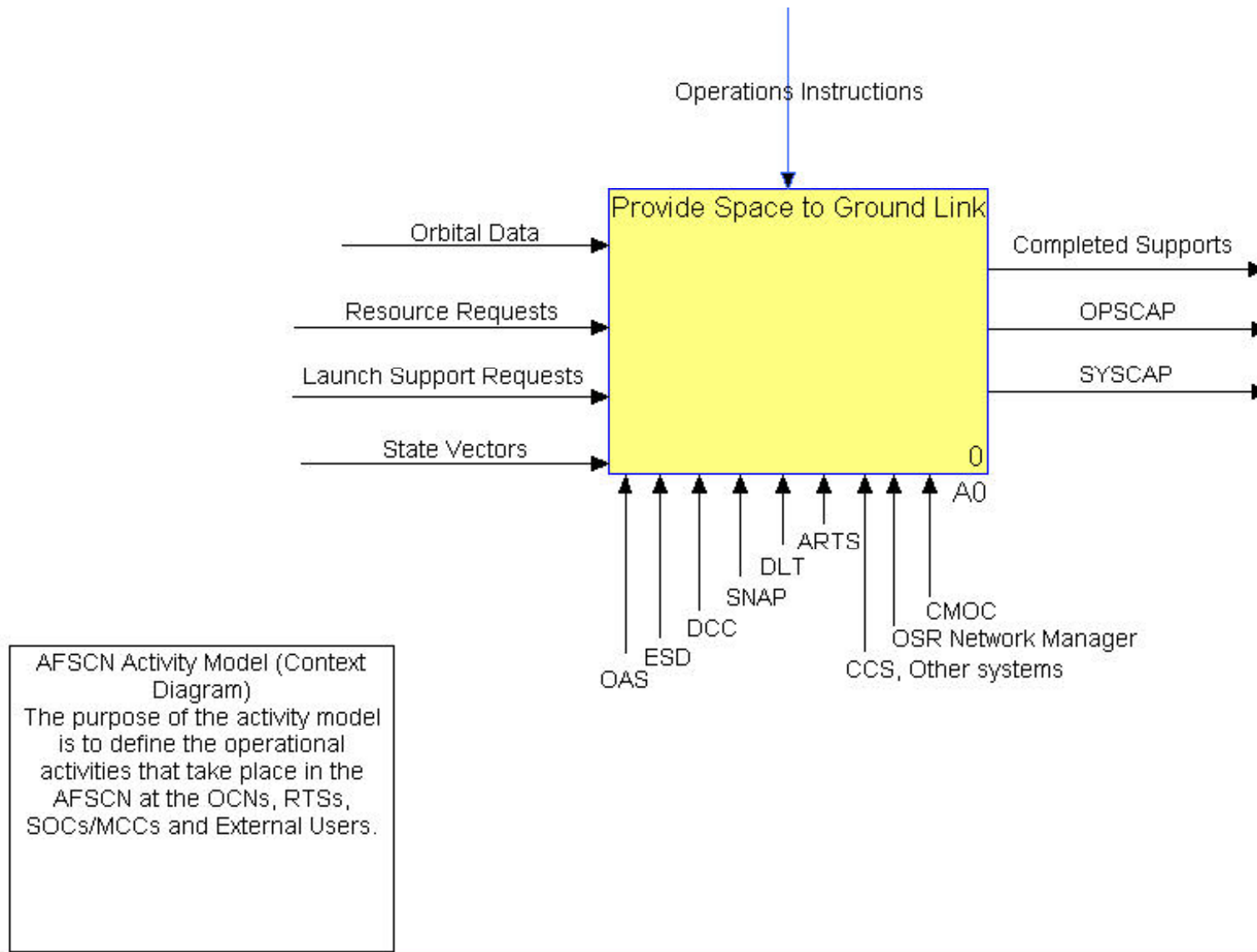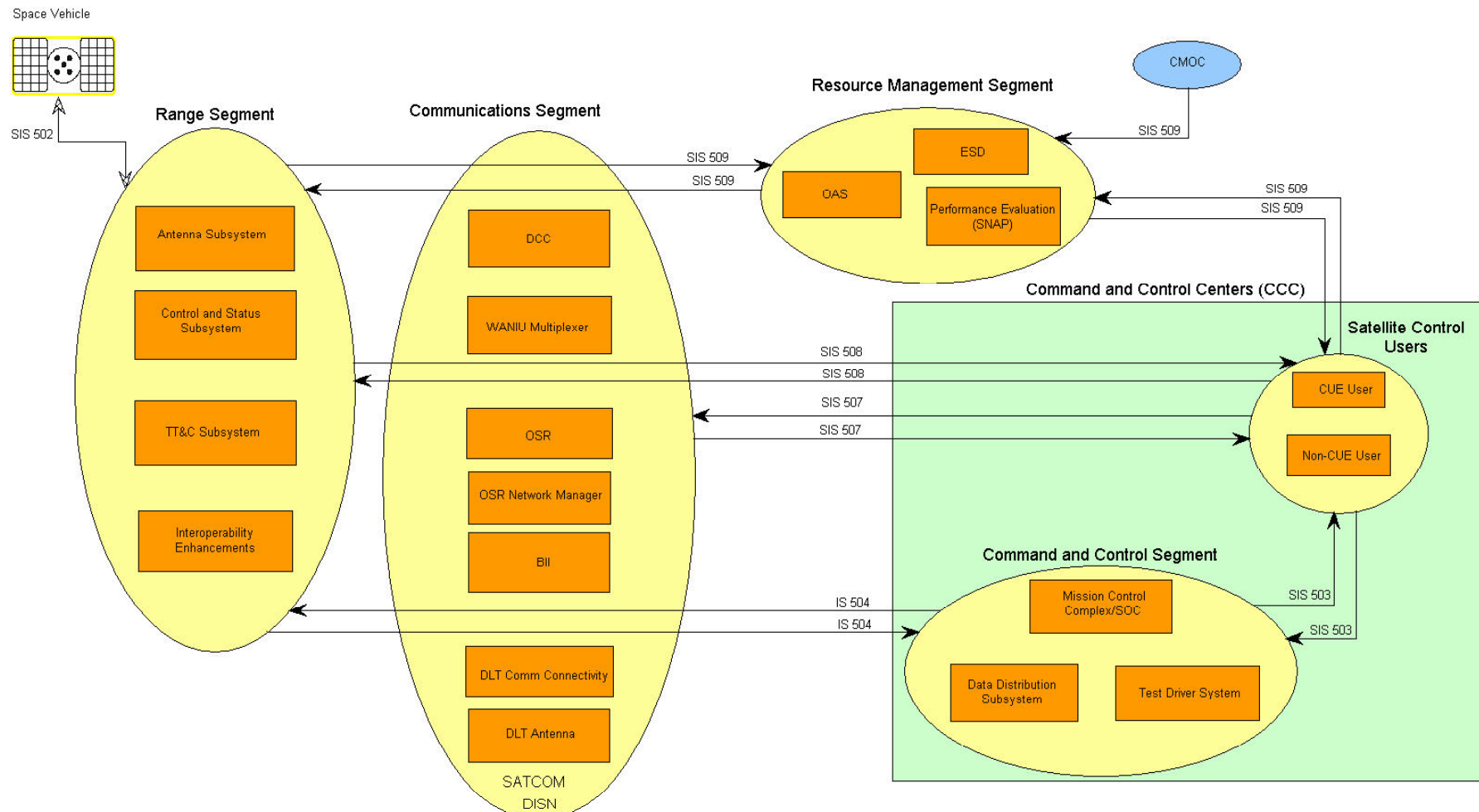
FY02 Views
FY03 Views
FY04 Views

UNCLASSIFIED

Operations Instructions

Provide Space to Ground Link

Orbital Data →

Resource Requests →

Launch Support Requests →

State Vectors →

→ Completed Supports

→ OPSCAP

→ SYSCAP

0

A0

ARTS
DLT
SNAP
DCC
ESD
OAS
CMOC
OSR Network Manager
CCS, Other systems

AFSCN Activity Model (Context Diagram)
The purpose of the activity model is to define the operational activities that take place in the AFSCN at the OCNs, RTSs, SOCs/MCCs and External Users.

UNCLASSIFIED

7

		Command and Control Segment			Communications Segment					Antenna Subsystem
		Data Distribution Subsystem	Mission Control Complex/SOC	Test Driver System	OSR Network Manager	WANIU Multiplexer	BII	DCC	OSR	Antenna Subsystem
Command and Control Segment	Data Distribution Subsystem		X	X						
	Mission Control Complex/SOC	X								
	Test Driver System	X								
Communications Segment	OSR Network Manager						X	X	X	
	WANIU Multiplexer								X	
	BII				X				X	
	DCC				X				X	
	OSR				X	X	X	X		
Range Segment	Antenna Subsystem									
	Control and Status Subsystem	X								X
	Interoperability Enhancements									
	TT&C Subsystem	X								X
Resource Management Segment	Performance Evaluation (SNAP)									
	ESD									
	OAS		X							
Satellite Control Users	CUE User									
	Non-CUE User		X							
CMOC	CMOC									

TV-1/TV-2 Views: AFSCN Combined Top Down
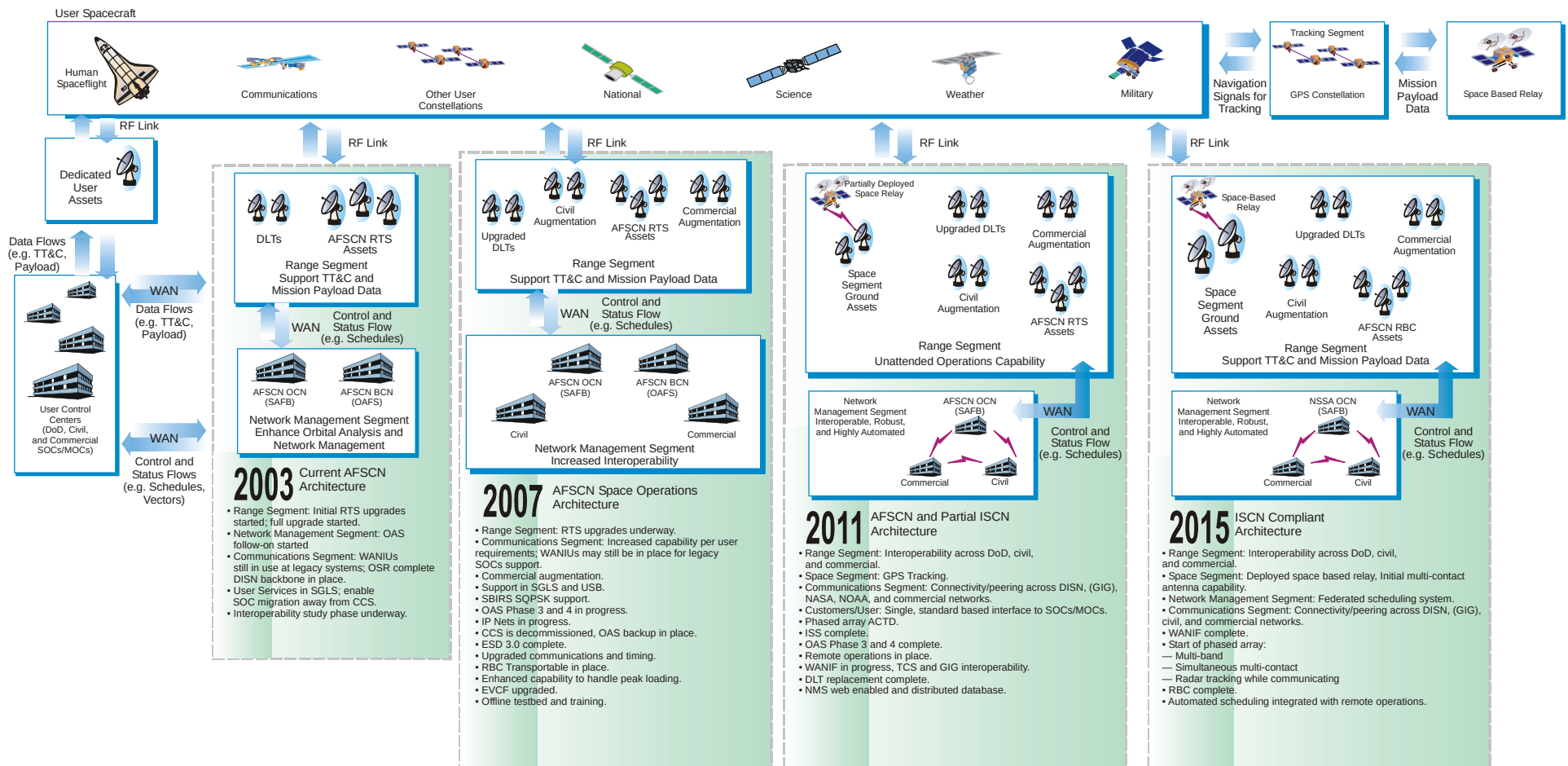
Service Area	Service	Mandated Standard/ Emerging Standard	Current Standard	Near-Term Standard	Mid-Term Standard	Far-Term Standard
Communication Services	Analog Facsimile Standards	EIA/TIA-465-A , Group 3 Facsimile Apparatus for Document Transmission, Jun 95	Resource Management Segment - OAS: Same as mandated standard	Resource Management Segment - OAS: TBD		
Communication Services	Analog Facsimile Standards	EIA/TIA-466-A , Procedures for Document Facsimile Transmission, May 97	Resource Management Segment - OAS: Same as mandated standard	Resource Management Segment - OAS: TBD		
Communication Services	Bootstrap Protocol	IETF RFC 1542, Clarifications and Exts for the Bootstrap Protocol, 27 Oct 93	Range Segment: Same as mandated standard Resource Management Segment - OAS: TBD	Resource Management Segment - OAS: Same as mandated standard Resource Management Segment - ESD: TBD	Resource Management Segment - ESD: TBD	
Communication Services	Bootstrap Protocol	IETF RFC 951, Bootstrap Protocol, 1 Sep 85	Range Segment: Same as mandated standard Resource Management Segment - OAS: Same as mandated standard	Resource Management Segment - OAS: Same as mandated standard Resource Management Segment - ESD: TBD	Resource Management Segment - ESD: TBD	

UNCLASSIFIED

- ## Maintain "As-is" Architecture
  - ### Incorporate any baseline changes
  - ### Add new DoDAF Products
    - SV-2 System Communication Description
    - SV-6 System Information Exchange Matrix

- ## Provide "To-Be" ~2011 Architecture
  - ### Uses AFSCN Roadmap as Driver
  - ### Uses "As-is" Architecture as starting point
  - ### Will show operational, system and technical architecture changes

User Spacecraft

Human Spaceflight · Communications · Other User Constellations · National · Science · Weather · Military

Navigation Signals for Tracking

Tracking Segment — GPS Constellation

Mission Payload Data

Space Based Relay

RF Link

Dedicated User Assets

Data Flows (e.g. TT&C, Payload)

WAN — Data Flows (e.g. TT&C, Payload)

User Control Centers (DoD, Civil, and Commercial SOCs/MOCs)

WAN — Control and Status Flows (e.g. Schedules, Vectors)

RF Link

2003 Column

DLTs · AFSCN RTS Assets

Range Segment Support TT&C and Mission Payload Data

WAN — Control and Status Flow (e.g. Schedules)

AFSCN OCN (SAFB) · AFSCN BCN (OAFS)

Network Management Segment Enhance Orbital Analysis and Network Management

2003 Current AFSCN Architecture

- Range Segment: Initial RTS upgrades started; full upgrade started.
- Network Management Segment: OAS follow-on started
- Communications Segment: WANIUs still in use in legacy systems; OSR complete DISN backbone in place.
- User Services in SGLS; enable SOC migration away from CCS.
- Interoperability study phase underway.

2007 Column

RF Link

Upgraded DLTs · Civil Augmentation · AFSCN RTS Assets · Commercial Augmentation

Range Segment Support TT&C and Mission Payload Data

WAN — Control and Status Flow (e.g. Schedules)

AFSCN OCN (SAFB) · AFSCN BCN (OAFS) · Civil · Commercial

Network Management Segment Increased Interoperability

2007 AFSCN Space Operations Architecture

- Range Segment: RTS upgrades underway.
- Communications Segment: Increased capability per user requirements; WANIUs may still be in place for legacy SOCs support.
- Commercial augmentation.
- Support in SGLS and USB.
- SBIRS SQPSK support.
- OAS Phase 3 and 4 in progress.
- IP Nets in progress.
- CCS is decommissioned, OAS backup in place.
- ESD 3.0 complete.
- Upgraded communications and timing.
- RBC Transportable in place.
- Enhanced capability to handle peak loading.
- EVCF upgraded.
- Offline testbed and training.

2011 Column

RF Link

Partially Deployed Space Relay

Space Segment Ground Assets · Upgraded DLTs · Commercial Augmentation · Civil Augmentation · AFSCN RTS Assets

Range Segment Unattended Operations Capability

Network Management Segment Interoperable, Robust, and Highly Automated · AFSCN OCN (SAFB)

Commercial · Civil

WAN — Control and Status Flow (e.g. Schedules)

2011 AFSCN and Partial ISCN Architecture

- Range Segment: Interoperability across DoD, civil, and commercial.
- Space Segment: GPS Tracking.
- Communications Segment: Connectivity/peering across DISN, (GIG), NASA, NOAA, and commercial networks.
- Customers/User: Single, standard based interface to SOCs/MOCs.
- Phased array ACTD.
- ISS complete.
- OAS Phase 3 and 4 complete.
- Remote operations in place.
- WANIF in progress, TCS and GIG interoperability.
- DLT replacement complete.
- NMS web enabled and distributed database.

2015 Column

RF Link

Space-Based Relay

Space Segment Ground Assets · Upgraded DLTs · Commercial Augmentation · Civil Augmentation · AFSCN RBC Assets

Range Segment Support TT&C and Mission Payload Data

Network Management Segment Interoperable, Robust, and Highly Automated · NSSA OCN (SAFB)

Commercial · Civil

WAN — Control and Status Flow (e.g. Schedules)

2015 ISCN Compliant Architecture

- Range Segment: Interoperability across DoD, civil, and commercial.
- Space Segment: Deployed space based relay, Initial multi-contact antenna capability.
- Network Management Segment: Federated scheduling system.
- Communications Segment: Connectivity/peering across DISN, (GIG), civil, and commercial networks.
- WANIF complete.
- Start of phased array:
— Multi-band
— Simultaneous multi-contact
— Radar tracking while communicating
- RBC complete.
- Automated scheduling integrated with remote operations.

S030552

AFSCN RTS Block Upgrade (RBC) Site Ordering Plan Bottom Up

As of: 21 August 2003

FY03 FY04 FY05 FY06 SBIRS GEO #1 Launch FY07 FY08 FY09 FY10 FY11 FY12

AFSCN PEAK LOADING

Potential Topics for Analysis:
1) Baseline Loading w/ new order
2) TCS-D or DGS-B?
3) NHS-A swap w/ CTS
4) HPA options for DGS-B

A. Sakamoto/SCNC SAE
21 August 2003
Version 1.6

Roadmap Timeline - Development Project Descriptions (PDs) Bottom Up

| Segment	Name	PD No.	WA No.	FY02	FY03	FY04	FY05	Current POM Cycle FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15
Development PDs																	
ALL	Interoperability	PD-0037,0211				Effort includes studies, demonstrations, and proof of concept activities												
	Baseline End-to-End Network Loading Study	PD-0003				Study												
	Obscura Study	PD-0205				Study												
	Automated IRON Database Management	PD-0219				Study												
	CRSS	PD-0221																
	DGS-B and LION-D Impacts	PD-0226				Study												
	Popkin/Rational Integration	PD-0227				Study												
	SA Tool for OCN Coordination	PD-0228				Study												
	Information Assurance	PD-0004					Study											
	I&TSF	PD-0043																
	ISCN Concept Refinement	PD-0052					Study											
	RBC Loading Analysis	PD-0053					Study											
	Next Generation Architecture Optimization F/O	PD-0111														Study		
NMS	NMS Evolution Study	PD-0026		Study													
	OAS F/O Phase 2	PD-0024																
	OAS Phase 3	PD-0190																
	OAS Backup	PD-0182								Note - DR to define requirement								
	OAS Training Suite Relocation	PD-0223																
	OAS Phase 4 - Guards	PD-0074																
	ISS	PD-0029																
	NMS Enhancement	PD-0191																
CS	AFSCN Comm Segment Evolution Study	PD-0039			Study													
	RBC Physical Interface IP Connectivity	PD-0186																
	KAFB External Comm Connectivity	PD-0020																
	Determine Bandwidth for RBC	PD-0224																
	Timing Comm Mod Kit Development and Installation	PD-0202,0203																
	VAFB External Users Connectivity	PD-0047																
	TCA/TDRSS Augmentation	PD-0057									Study							
	WANIF	PD-0097																
	Comm S&P Studies - Far Term	PD-0105														Study		
C&CS	SOC Interface Evolution	PD-0008																
	CCS Database Rehost	PD-0231				Study												
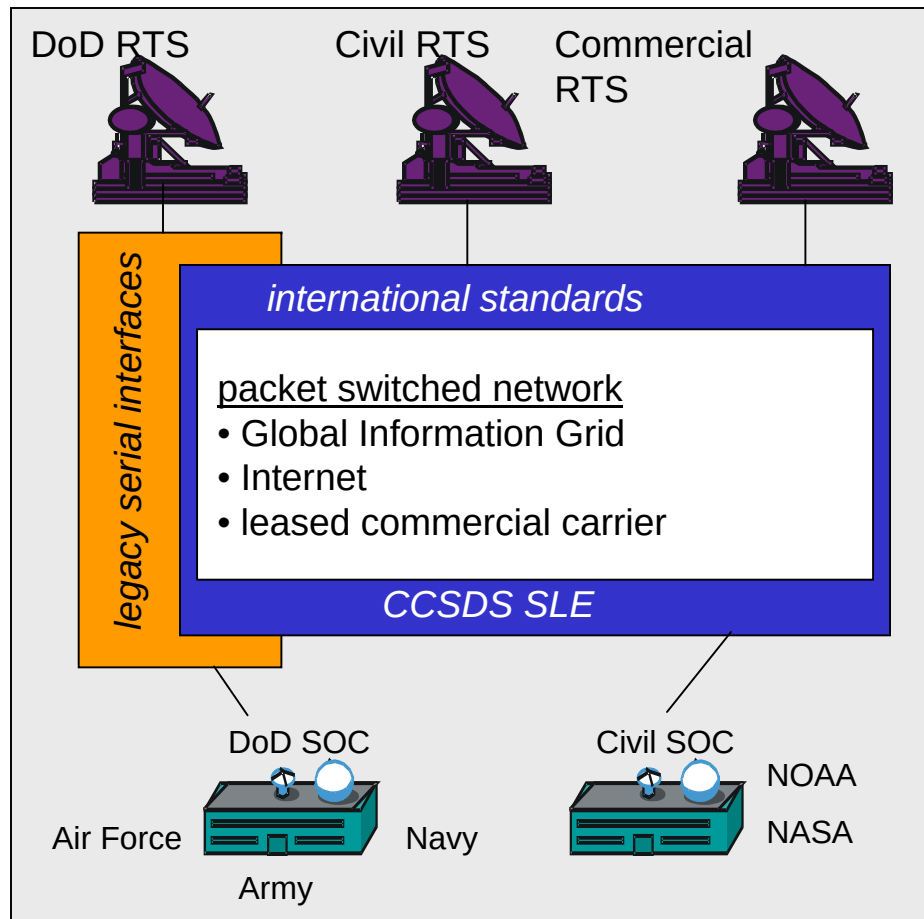
NMS – Enabler of ISCN
Bottom Up
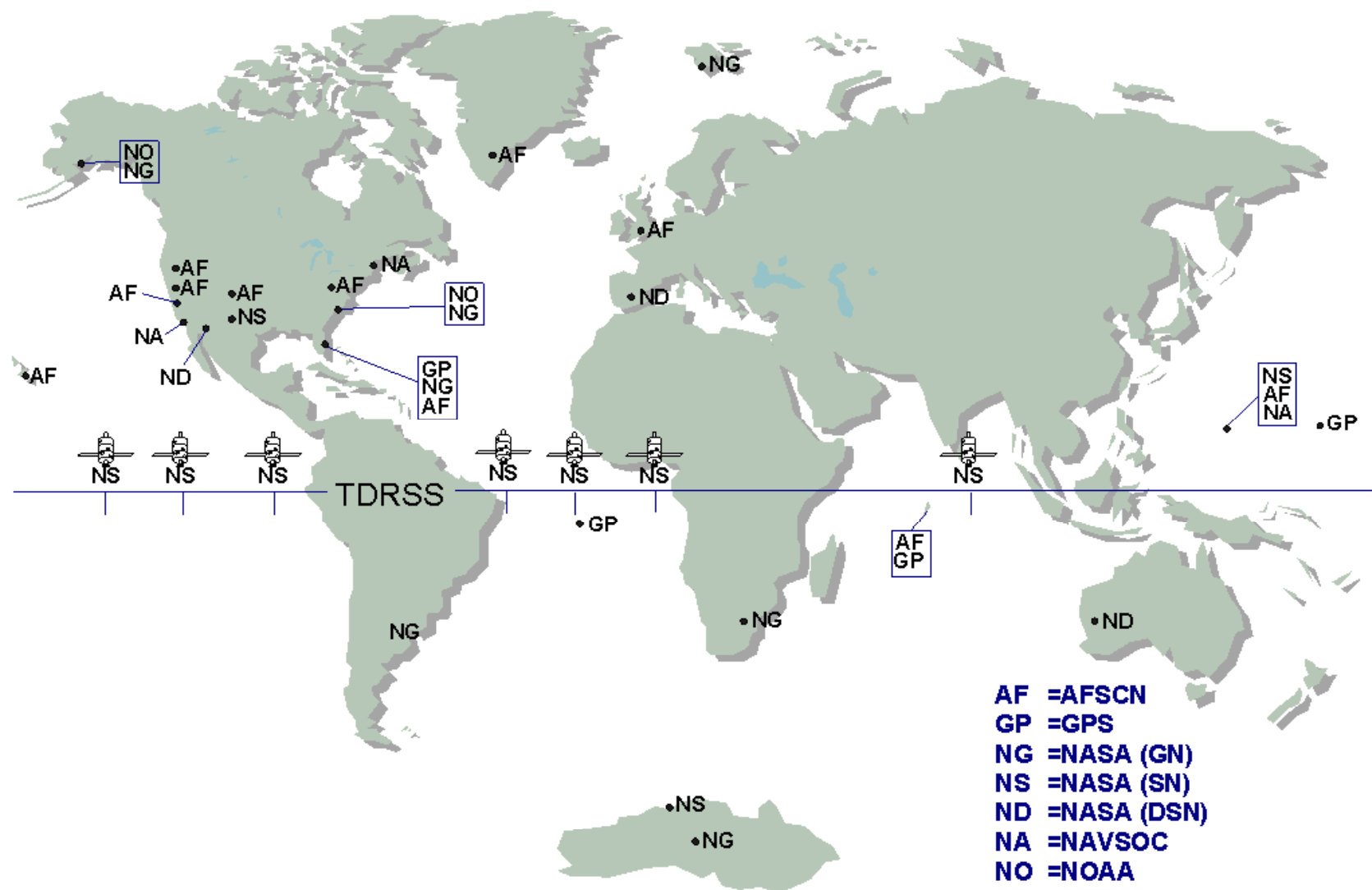
- **Enterprise "Services" Subsystem** (composed of "Services" and "Interface" hosts)

- **"Status" Subsystem** (all AFSCN status in one place)

- **"Remote" Subsystem** (extends EMS reach out to the remote sites)

- **EMS-capable Workstations** (simple browser-capable PCs bring the power of the enterprise solution to all user groups)

UNCLASSIFIED

Development of Interoperable Data Transfer Standards Bottom Up

DoD RTS Civil RTS Commercial RTS

legacy serial interfaces

international standards

packet switched network
- Global Information Grid
- Internet
- leased commercial carrier

CCSDS SLE

DoD SOC

Air Force Navy

Army

Civil SOC NOAA

NASA

- **Prototyping designs for future AFSCN interfaces that enable use of Internet protocols, while maintaining DoD-unique performance requirements**

- **Verifying emerging international ground segment standards for Air Force operations; providing inputs to evolve these standards**
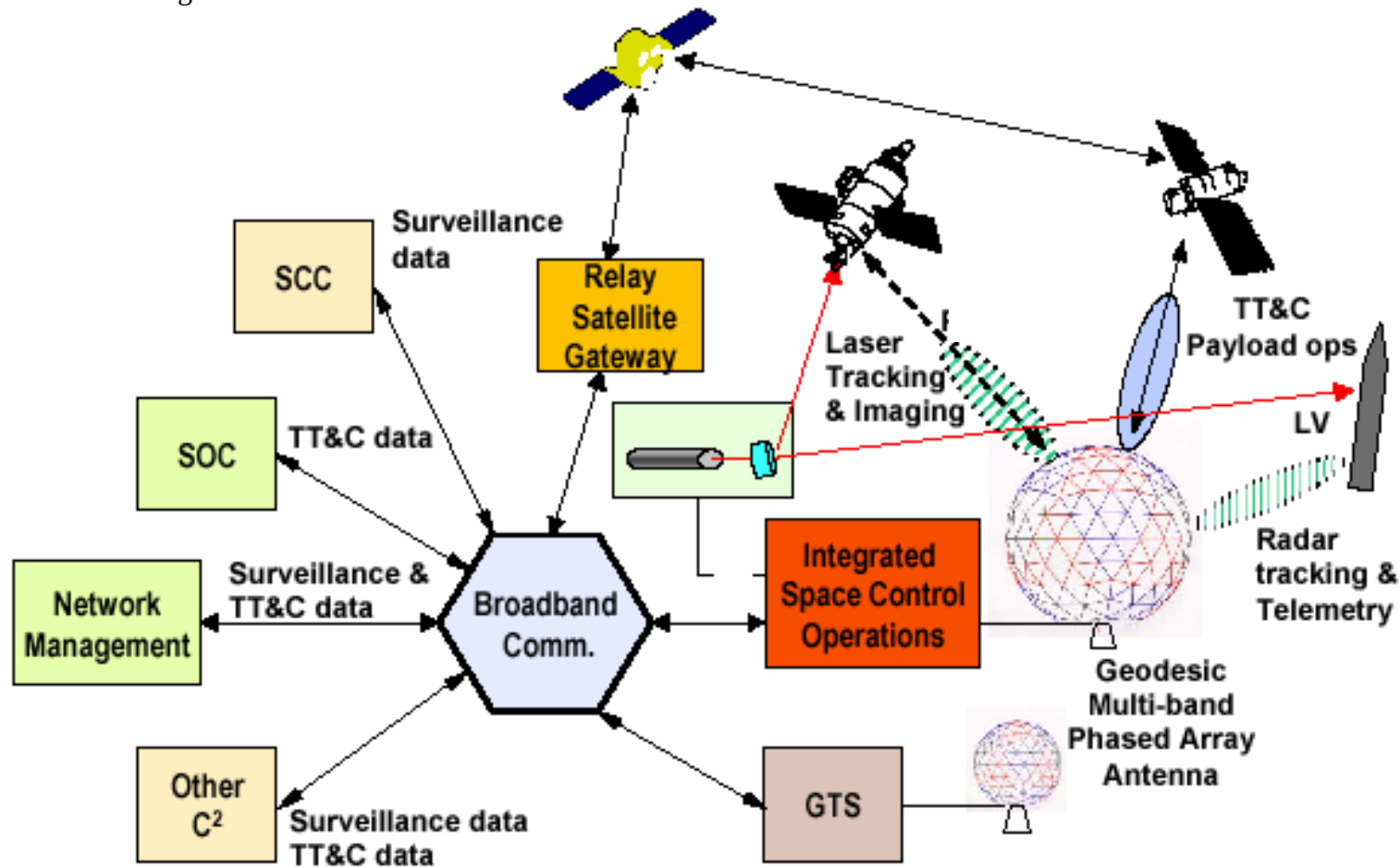
UNCLASSIFIED

ISCN Candidate Sites
# Bottom Up

AF = AFSCN
GP = GPS
NG = NASA (GN)
NS = NASA (SN)
ND = NASA (DSN)
NA = NAVSOC
NO = NOAA

Excerpt from Dr. Shiang Liu brief
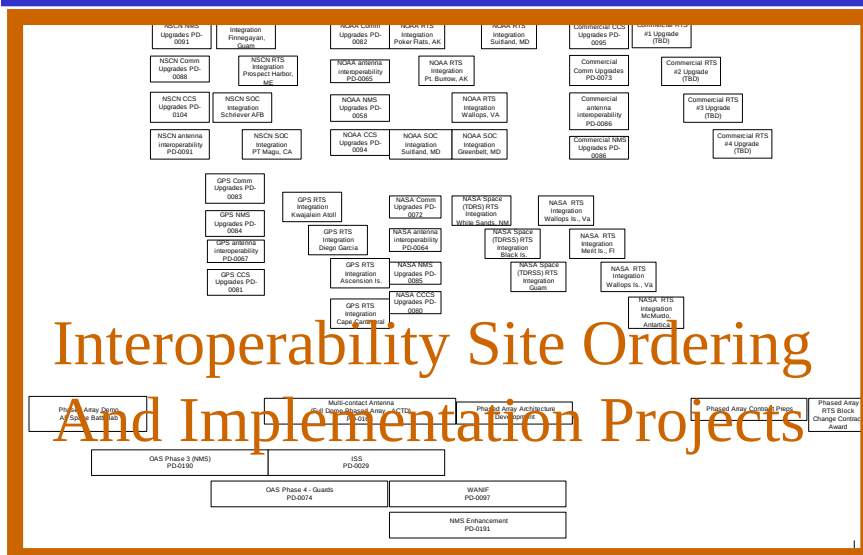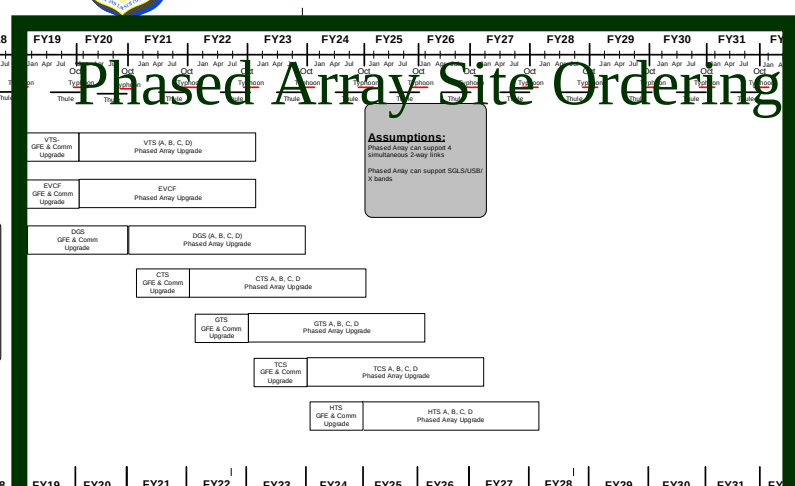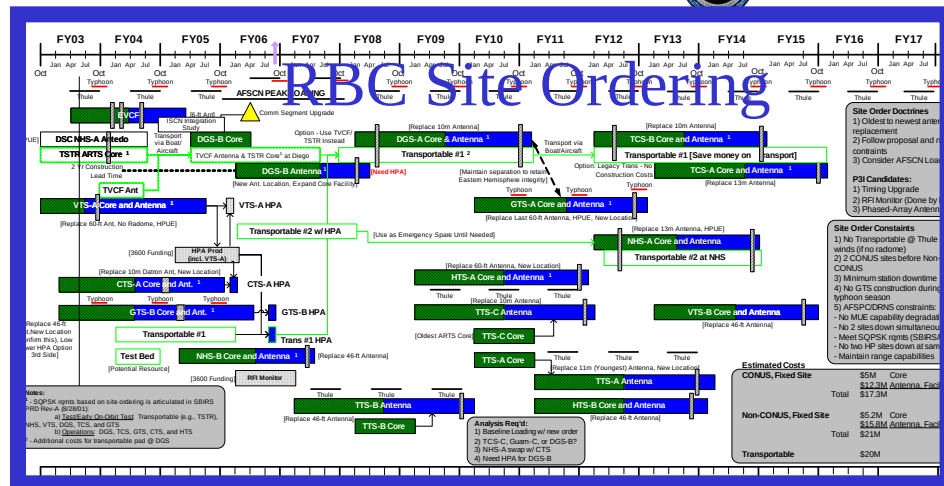
ISCN Site Ordering Planning Process
Bottom Up

ISCN SITE ORDERING CHART

Version 0.0
As of 11 Sept 2003

SCNC WORKING DRAFT

SCNC WORKING DRAFT

RBC Site Ordering

Phased Array Site Ordering

Interoperability Site Ordering And Implementation Projects

UNCLASSIFIED

19

The Way Ahead

- **ISCN Roadmap**
- **DoDAF Architecture Products (Future ISCN/Midterm)**
- **Network Management Segment Evolution**
  - **Integrated Scheduling System**
  - **Enterprise Management System**
  - **Guards**
- **Comm Evolution to IP WAN-based infrastructure**
- **Development of interoperable data transfer standards**
- **Architecture Sustainment Roadmap**

Way Ahead Recommendations

- **Establish ISCN Site Ordering Task Force to prioritize and coordinate integration of antennas and control nodes**
- **Architect Project Descriptions that implement the interoperability of the antennas with the control nodes based on DoDAF architecture and Roadmap**
  - **Implement low hanging fruit**
- **Submit updated POM/PBC input that accounts for the ISCN plan**