NEO (NextGen 4D TM) Provided by SWIM's Surveillance SOA (SDN ASP for RNP 4D Ops)

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By: Jim Dieudonne, FAA, Chief Engineer Data and Communications Services

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Surveillance System for NextGen 4D Ops - Bottom Line

- **A Surveillance Service Oriented Architecture (SOA) via SWIM will be required**
- **Tighter Separation Standards will be required**
- **New Tools for the Traffic Management Team (TMT) will be required**
  - Conformance Monitoring Automation
  - Displays
  - Surveillance Information - Highly Accurate and Timely from Multi-Sensor Trackers with inputs from all types of Surveillance Sensors
  - Data Links of Aircraft State, Intent, and 4D Trajectories
  - Real-Time System Certification
- **GOOD NEWS - ALL REQUIRED ELEMENTS HAVE BEEN DEMONSTRATED, REQUIREMENTS ANALYSIS CONDUCTED, AND INITIAL NETWORKING AND INTEGRATION HAS YIELDED POSITIVE RESULTS**

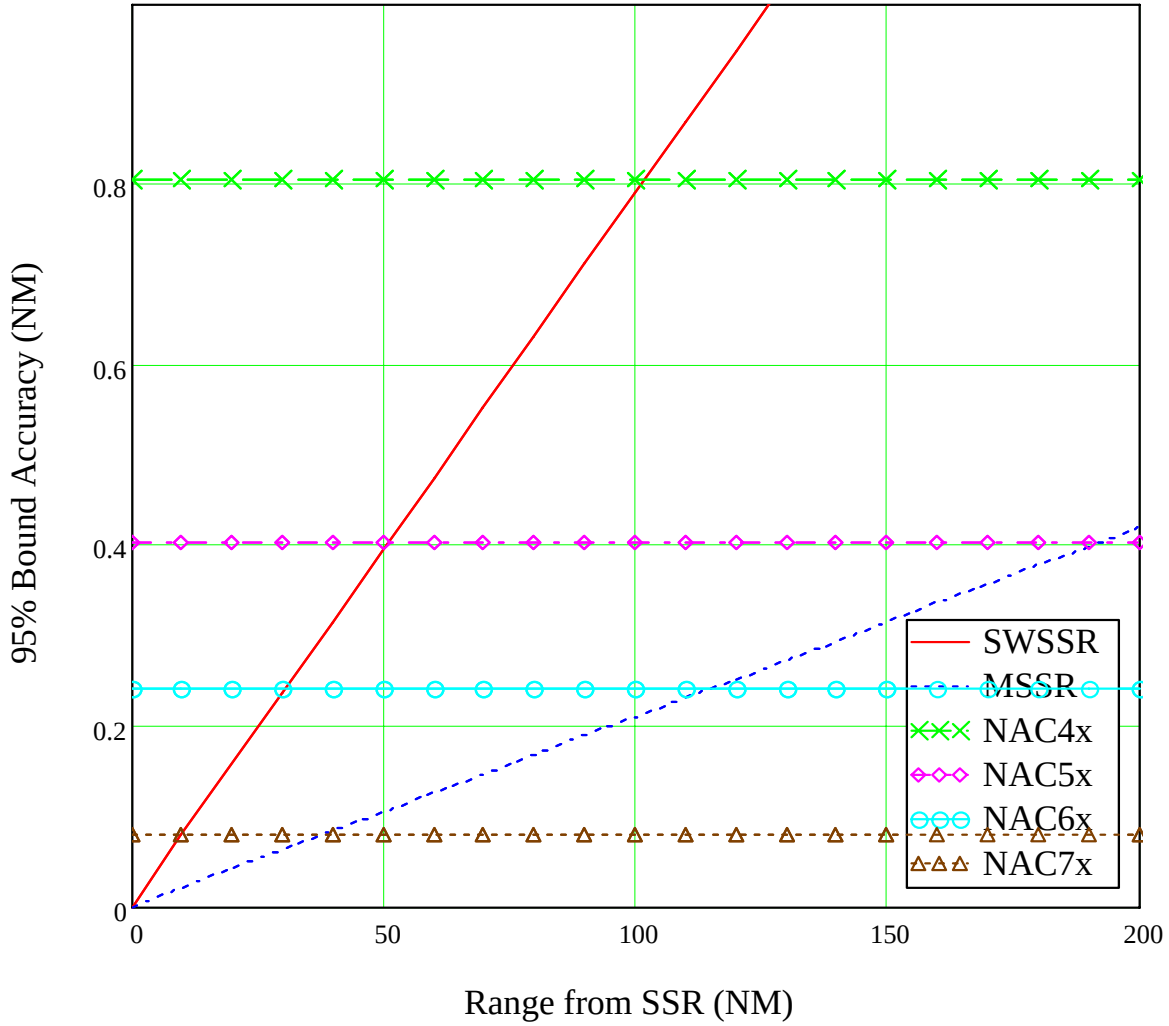
4D Operations Required Navigation Performance (RNP)

- **Over Decades the Aviation Community has defined RNP for many flight operations**
- **Improvements in FMS and the use of GPS, WAAS, LAAS, etc. have enabled very precise navigation**
- **RTCA has documented these requirements**
- **Future FMS will contain algorithms to calculate the aircraft's current Actual Navigation Performance (ANP)**
- **DL will be used to transfer this information to TM automation**
- **RNP for each 4D Operation must be defined**
  - reduced lateral separation requirements for operations to parallel runways
  - merging and spacing
  - reduced separations
  - time-based ATM
  - more efficient use of terminal airspace through dynamic routings
  - improved surface traffic management
  - high-density en route corridors
  - oceanic pair-wise maneuvers, and
  - certified sensor monitored airport surface movement

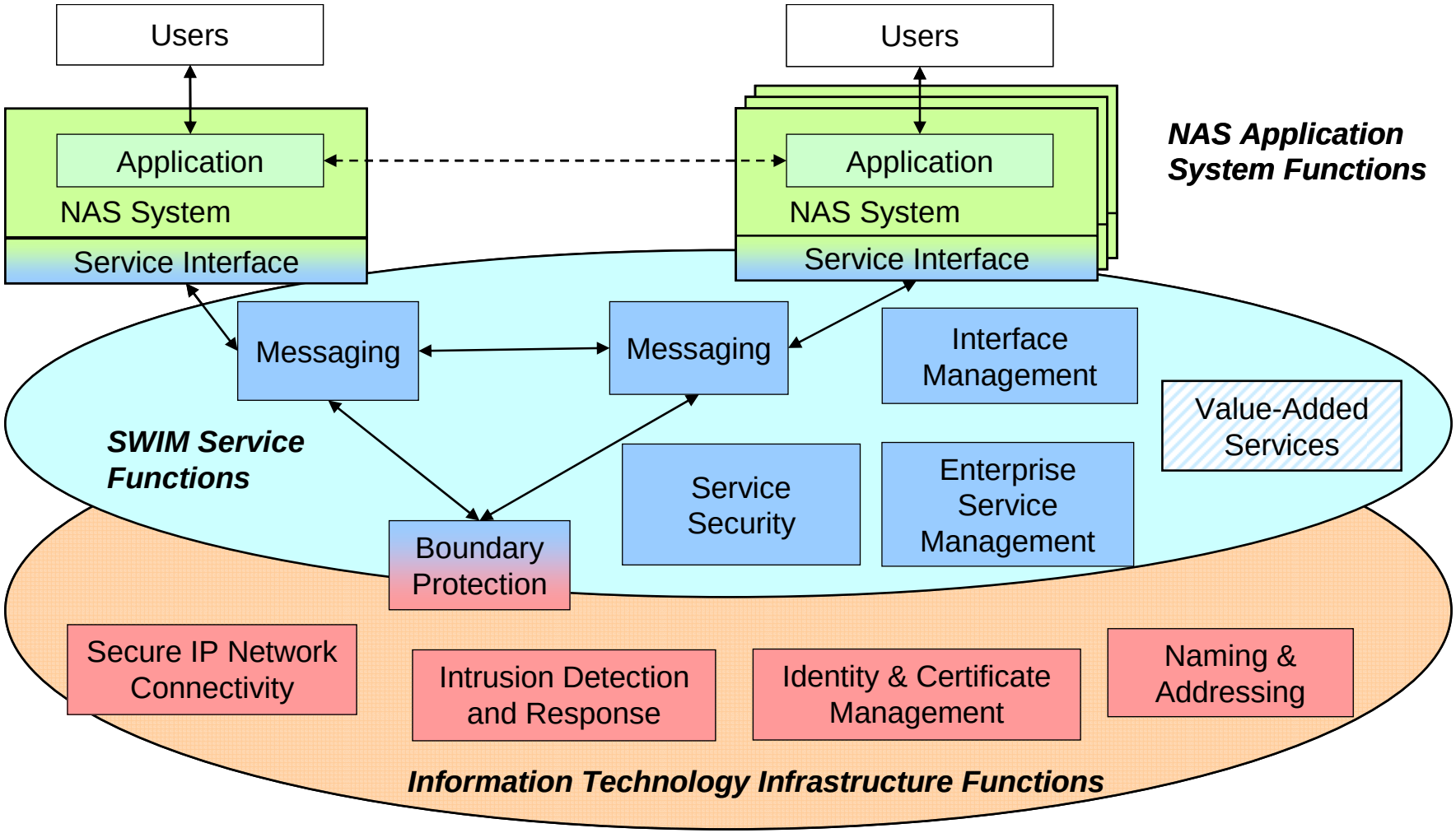
Required Surveillance Performance (RSP) for the 4D Ops RNP

- **RSP for 3 nmi and 5 nmi separation standards has been expressed in an RNP metric of NAC position (see next chart)**
  - Enroute – NAC position – 5 (RNP-1)
  - Terminal – NAC position – 4 (RNP-0.5)
- **RSP for future reduced separation**
  - Terminal, 2 nmi separation requires a NAC position of 6 (RNP-0.3)
- **RSP for 4D Ops**
  - Electronically monitored airport surface movement may required a NAC position of 11 (LAAS, EPU of less than 3m, VEPU of less than 4m)

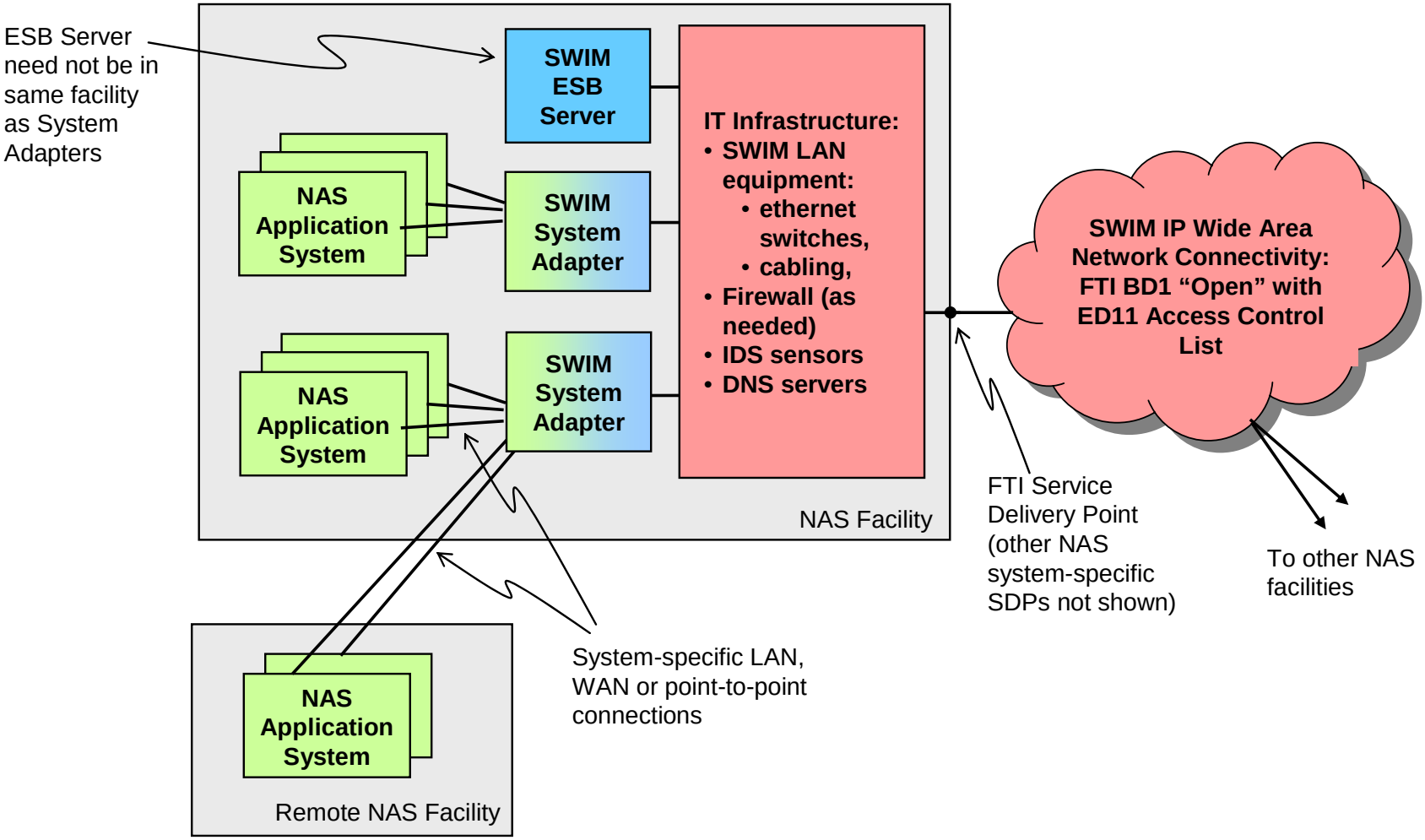
Comparison of Error Bounds for SWSSR, MSSR, and Several NACp Values



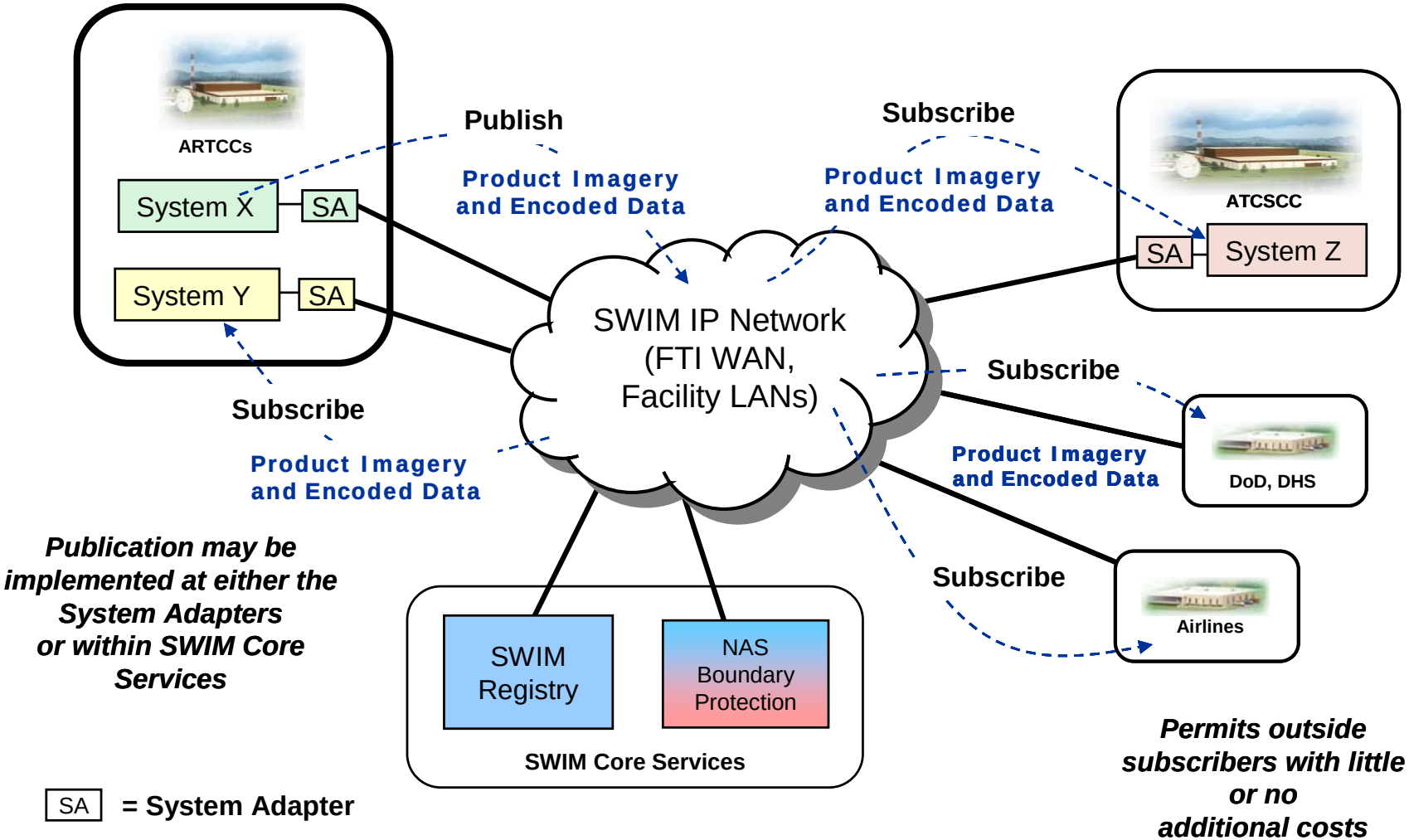
SWIM Functional Architecture



SWIM Physical Architecture Mapped to NAS Facilities



Notional SWIM-based Architecture for Weather Systems



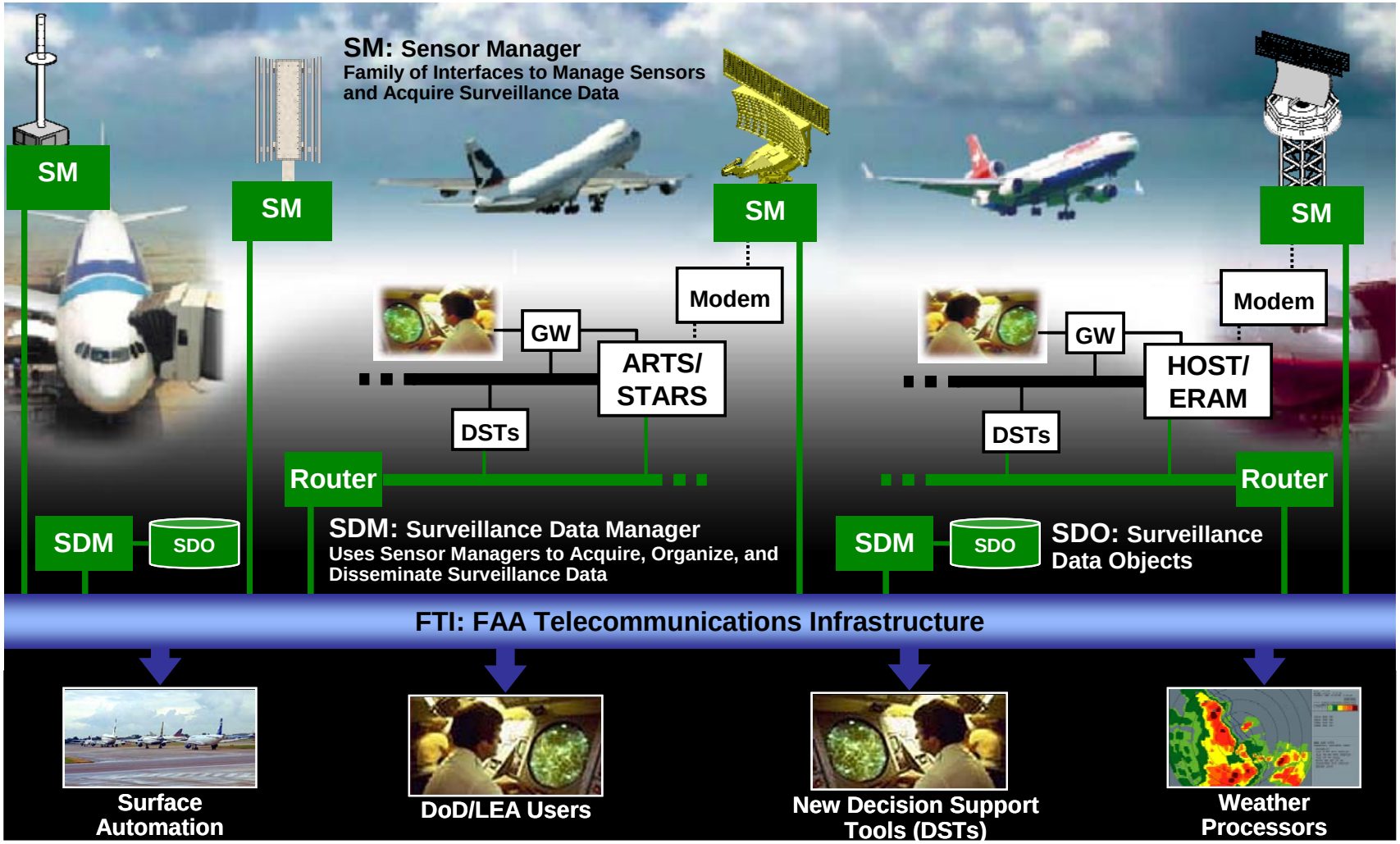
Publication may be implemented at either the System Adapters or within SWIM Core Services

Permits outside subscribers with little or no additional costs

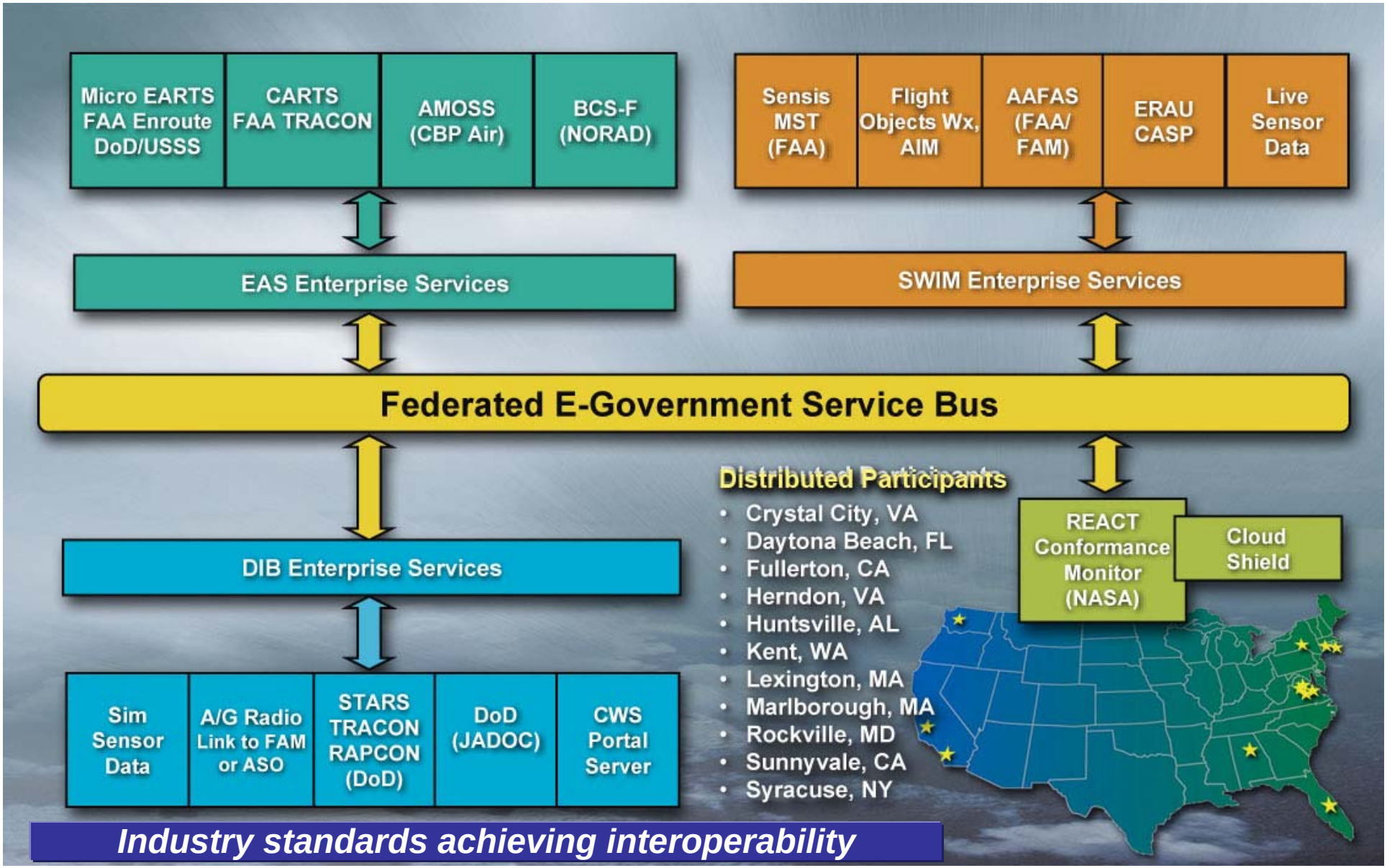
SA = System Adapter

Surveillance Data Network (SDN)

(Diagram provided courtesy of Lincoln Laboratory)



NEO Project - All Systems Share Information



Industry standards achieving interoperability

NEO Project Connectivity

En Route air traffic control

Microprocessor En-Route Automated Radar Tracking System (FAA)

Terminal air traffic control

Standard Terminal Automation Replacement System (FAA & DoD)

Terminal air traffic control

Common Automated Radar Terminal System (FAA)

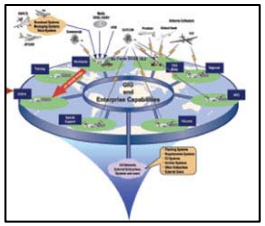
Military situation awareness and response

Battle Control System – Fixed (DoD/NORAD)

Civil interdiction and apprehension

Air Marine Operations Center (DHS)

DOD Global Information Grid

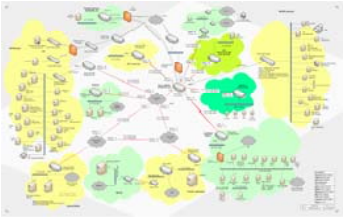


Distributed Information Backbone (DoD)

National Capital Monitoring and defense

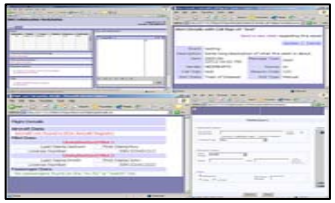
Joint Air Defense Operations Center (DoD)

FAA System-Wide Information Management



SWIM Testbed (FAA)

Real time collaborative tools



Collaboration Workstation (Developed for NEO)

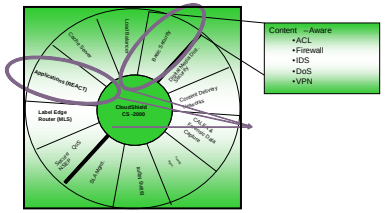
Wireless Connectivity

Mobile Devices (FAM PDA)

Advanced Conformance Flight Monitoring

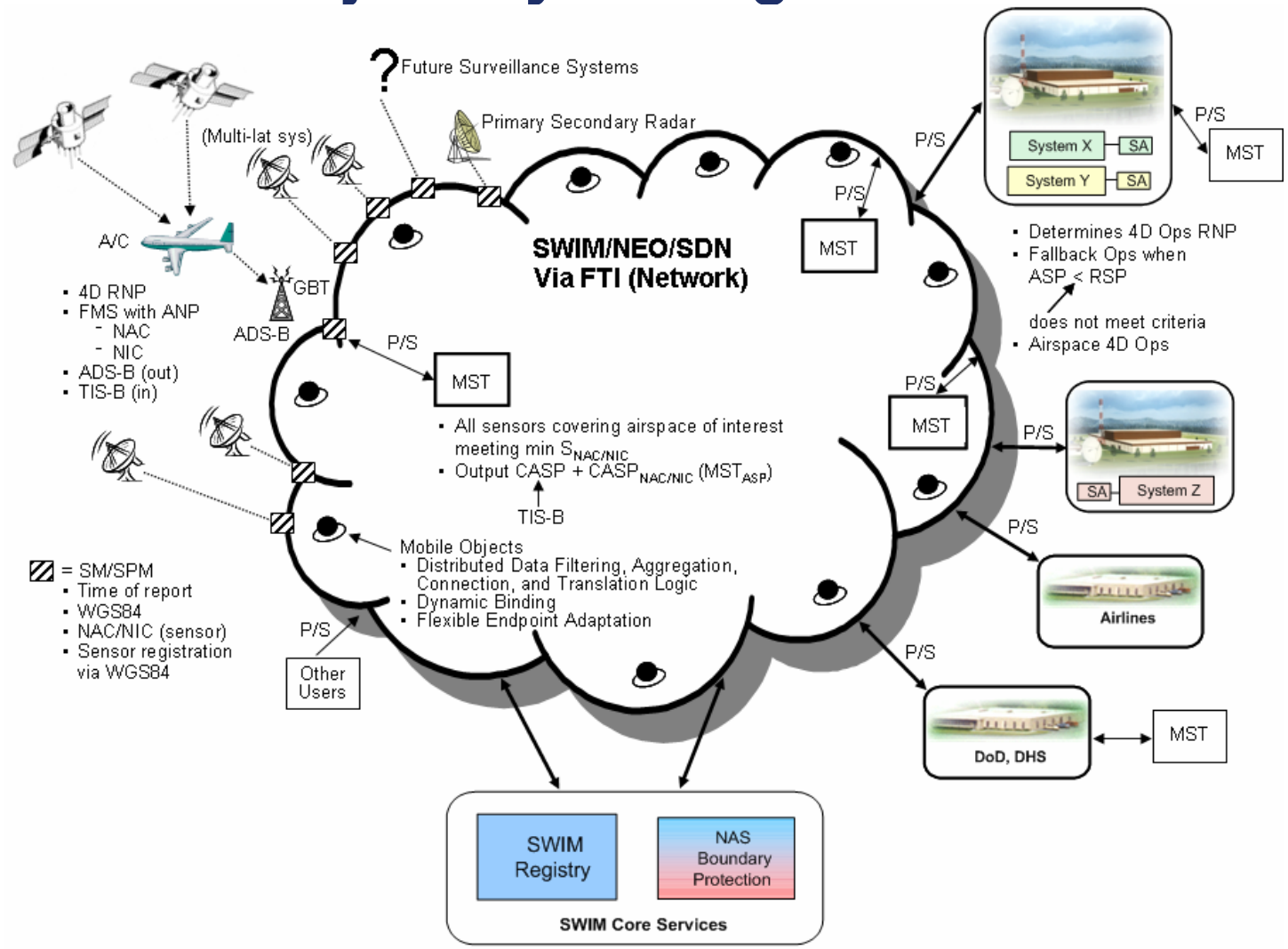
REACT (NASA)

Multi-Level Security Tools



Cloud Shield (COTS)

Service Oriented Architecture (SOA) Approach to NEO 4D Trajectory Management



Required Characteristics of the Surveillance SOA Elements

- System Wide Information Management (SWIM)
- Surveillance Data Network (SDN)
- Sensor Manager/Surveillance Performance Monitor (SM/SPM)
- Multi-Source Tracker (MST)
- Traffic Information Service – Broadcast (TIS-B)
- Kolona Mobile Objects
- Data Link for 4D Operations
- 4D Operations Required Navigation Performance (RNP)
- Required Surveillance Performance (RSP) for the 4D Ops RNP
- Surveillance Community of Interest (COI)

Backup Slides

Navigation Integrity Categories (NIC)

NIC	Horizontal and Vertical Containment Bounds	
0	R*c* ≥ 37.04 km (20NM) Unknown	*Rc – Radius of Containment* *VPL – Vertical Protection Limit*
1	R*c* < 37.04 km (20NM)	
2	R*c* < 14.816 km (8 NM)	
3	R*c* < 7.408 km (4 NM)	
4	R*c* < 3.704 km (2 NM)	
5	R*c* < 1852 m (1 NM)	
6	R*c* < 1111.2 m (0.6 NM)	
7	R*c* < 370.4 m (0.2 NM)	
8	R*c* < 185.2 m (0.1 NM)	
9	R*c* < 75 m and VPL < [112 m]	
10	R*c* < 25 m and VPL < [37.5 m]	
11	R*c* < 7.5 m and VPL < [11 m]	

Navigation Accuracy Categories for Position (NACP)

NAC_P	95% Horizontal and Vertical Accuracy Bounds (EPU and VEPU)	Comment	Notes
0	EPU ≥18.52 km (10 NM)	Unknown accuracy	EPU – Estimated Position Uncertainty
1	EPU < 18.52 km (10 NM)	RNP-10 accuracy	VEPU--
2	EPU < 7.408 km (4 NM)	RNP-4 accuracy	Vertical
3	EPU < 3.704 km (2 NM)	RNP-2 accuracy	Position
4	EPU < 1852 m (1NM)	RNP-1 accuracy	Uncertainty
5	EPU < 926 m (0.5 NM)	RNP-0.5 accuracy	SA--
6	EPU < 555.6 m (0.3 NM)	RNP-0.3 accuracy	Selective
7	EPU < 185.2 m (0.1 NM)	RNP-0.1 accuracy	Availability
8	EPU < 92.6 m (0.05 NM)	e.g., GPS (with SA)	
9	EPU < 30 m and VEPU < 45 m	e.g., GPS (SA off)	
10	EPU < 10 m and VEPU < 15 m	e.g., WAAS	
11	EPU < 3 m and VEPU < 4 m	e.g., LAAS	

Navigation Accuracy Categories for Velocity (NACv)

NAC_P	Horizontal Velocity Accuracy (95%)	Vertical Geometric Velocity Accuracy (95%)
0	Unknown or ≥ 10 m/s	Unknown or ≥ 50 feet (15.24 m) per second
1	< 10 m/s	< 50 feet (15.24 m) per second
2	< 3 m/s	< 15 feet (4.57 m) per second
3	< 1 m/s	< 5 feet (1.52 m) per second
4	< 0.3 m/s	< 1.5 feet (0.46 m) per second