# Global Communications, Navigation, and Surveillance System (GCNSS) Flight Demonstrations

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Air Traffic Management

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**Bob "Prof" Struth**
**(703) 584-2951**
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PHANTOM WORKS

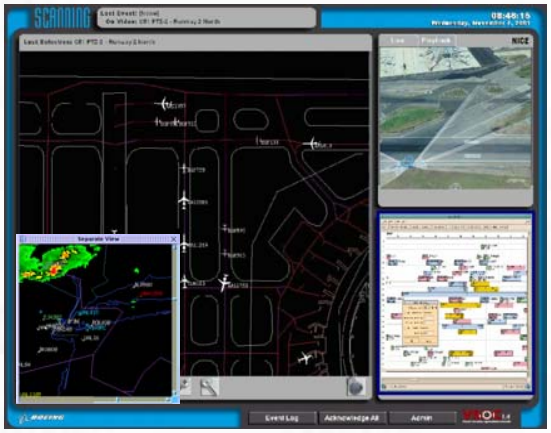
# GCNSS Three-Segment Demonstration Program

**A: Security-Oriented**

- *Satellite-based navigation/surveillance, broadband comms/cabin video, flight conformance monitoring, trajectory prediction, situational awareness*

**B: Gulf of Mexico ATC-Oriented**

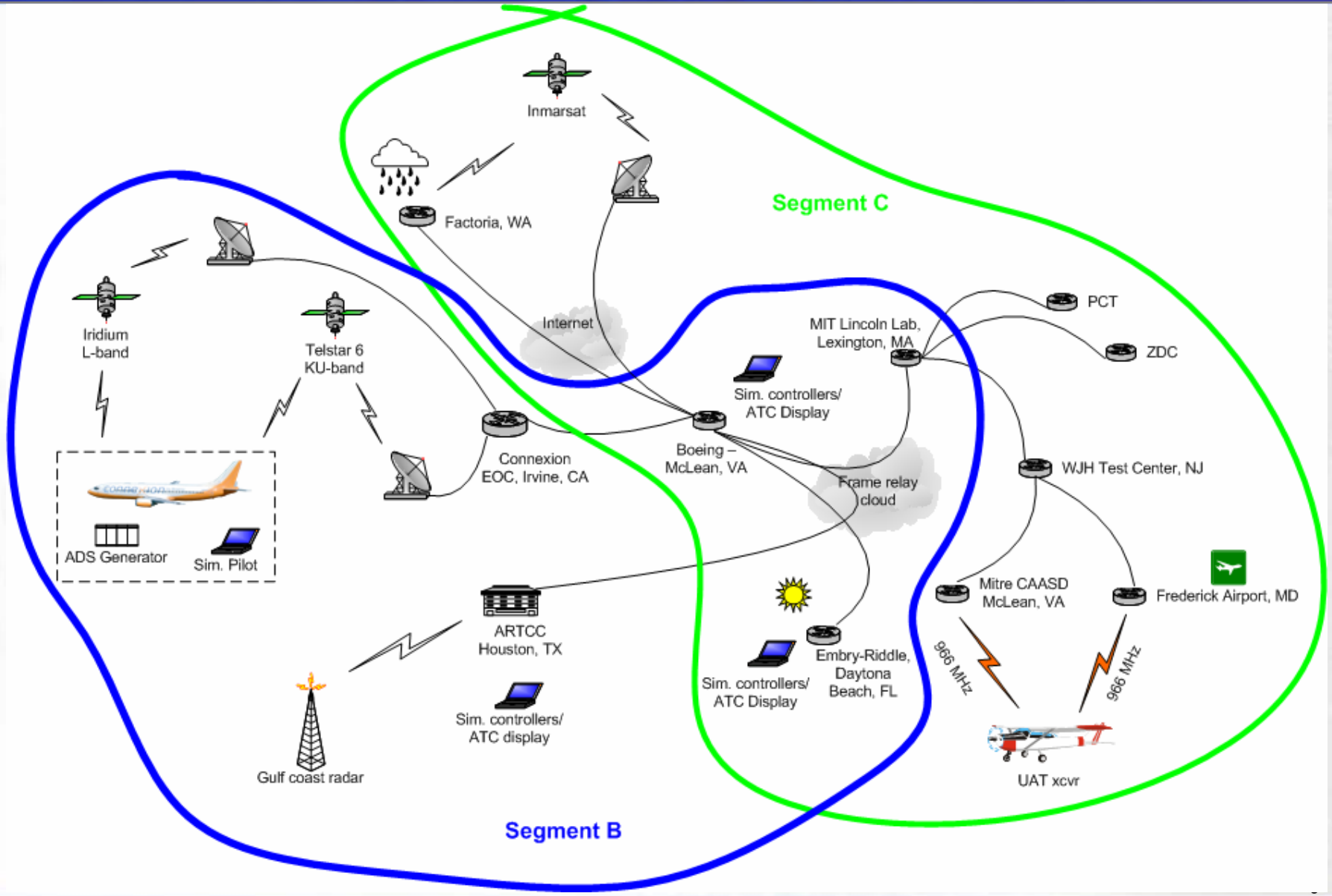
- *Provide ATC capability in area of no VHF/radar coverage via: CIN/SWIM Architecture and digital sat-comm voice & data.*
- *Provide "seamless" oceanic – domestic transition.*



**C: SWIM - Surveillance Data Network (SDN) – Oriented**

- *Architecture and Multi-Sensor Tracker (MST) to fuse radar and ADS-B data to produce a Common Air Surveillance Picture (CASP)*

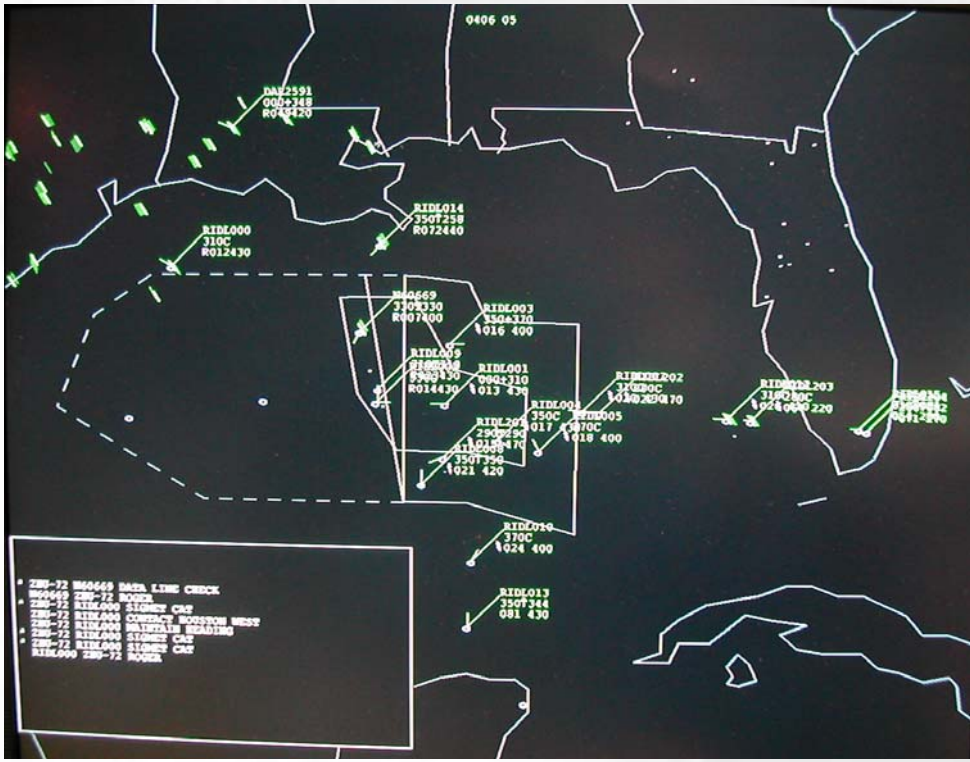
# Segments B & C Network Topology



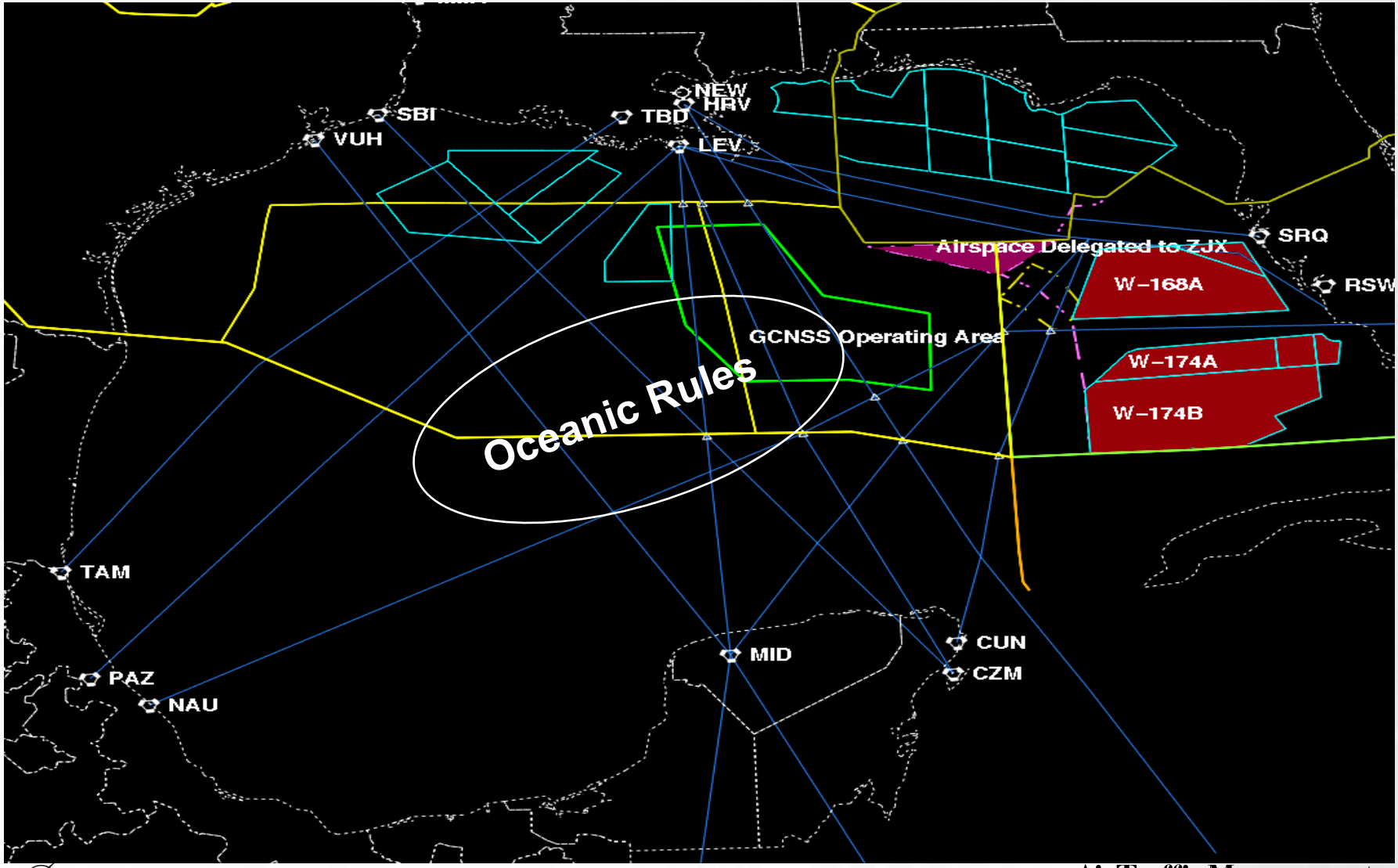
# Demonstration Segment B Scenarios

1. Baseline – “The Hole”
   - *Show CBB1 leaving VHF/radar coverage*
2. Add SATCOM links for voice/data/ADS
3. Flight plan changes
4. Vector/altitude changes
5. Share weather information
6. Sector handoff
7. Transition between VHF/radar and SATCOM environments
8. Combined “realistic” scenario
   - *Houston to Miami flight being diverted south into the “hole” for weather*

**Using:**
- **Live radar data from ZHU**
- **CBB1 ADS data**
- **Simulated ADS and radar traffic**



# Flight Demonstration Operating Area
# FL310 to FL370 10:00pm – 4:00am CST

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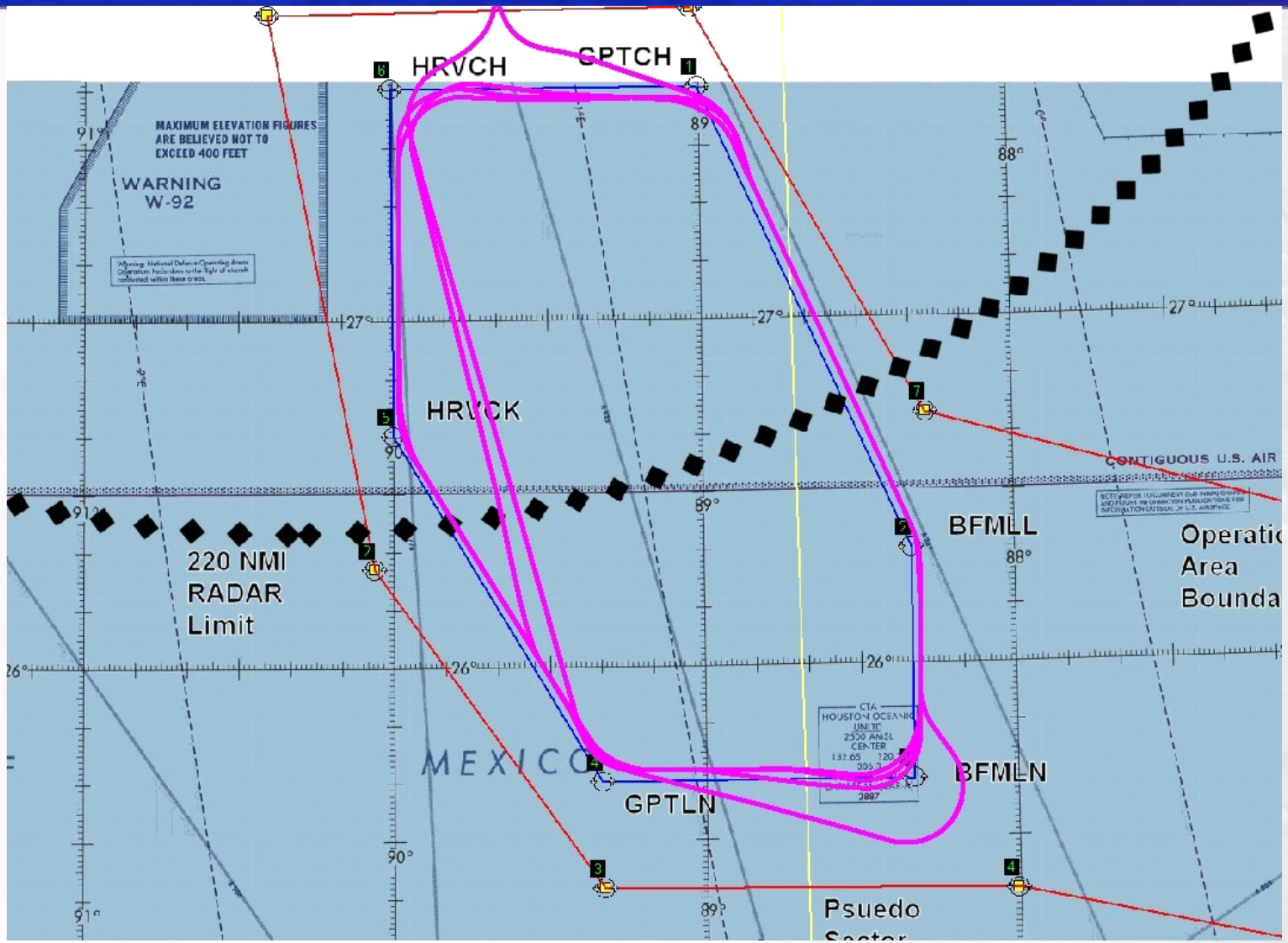
# Demonstration Flight 2 Operating Area & Flight Path



# Information Provided in the Segment B CIN/SWIM

| Activity | Method 1 | Method 2 |
|---|---|---|
| ADS from CBB1 | Ku-Band satcom | L-Band satcom |
| ZHU live radar | Via MITLL into SWIM/CIN | |
| CBB SIP Voice | Ku-Band satcom | L-Band satcom |
| CBB SIP D/L | Ku-Band satcom | L-Band satcom |
| ERAU VOIP Voice | Ku-Band satcom | L-Band satcom |
| ERAU VOIP D/L | Ku-Band satcom | L-Band satcom |
| FlightViz | Visualization display Via downlink of CBB1 flight data | |
| Simulated ADS & Radar traffic | Generated by ERAU Provided to SWIM/CIN | |
| Pseudo Pilots | Controlled by simulated ZHU controllers Via GCNSS workstations at ZHU | |

# Segment B Demonstration Accomplishments

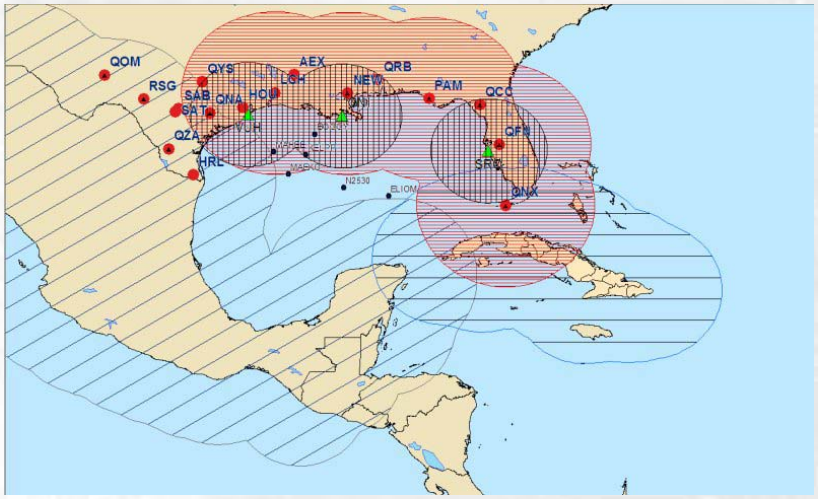
- Secure Common Information Network connectivity established between BATM McLean, ERAU, CBB Irvine, CBB1 airplane, MIT/LL, and Houston ARTCC – SIX geographic locations – ONE secure, broadband, integrated SWIM/CIN
- Segment B laboratory demonstrations successfully accomplished
- Three Segment B flight demonstrations successfully performed, achieved all objectives showing:
  - Successful transmission and integration of ADS via satellites (L-band and KU-band) into CIN/SWIM
    - 2-way controller-pilot digital voice and data communications over L-band and KU-band satellite links
    - Uninterrupted transition between radar and oceanic air traffic domains, over both satellite links
    - Secure, filtered live radar feed from ZHU successfully integrated into SWIM/CIN

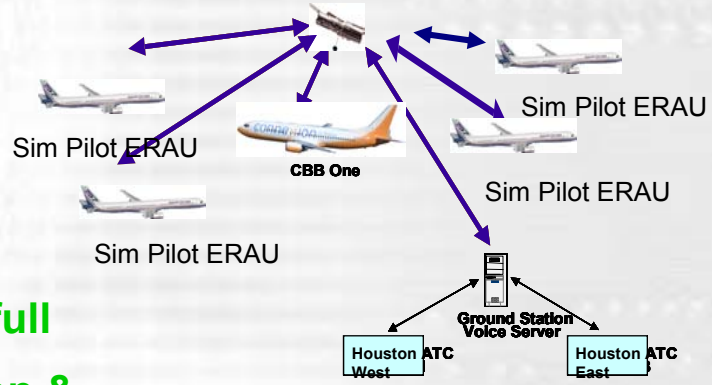
# Segment B Demonstration Accomplishments (cont.)

- Two digital voice and data communications technologies demonstrated – SIP and ERAU IP multicast
- Pilot/controller communications at 10,000 feet over GOMEX non-radar/non-VHF area
- Digital voice and generic CPDLC with ZMA message set used in vector, climb and descent commands to CBB1 and simulated aircraft within ATC Block Clearance Area
- Simulated two ZHU Oceanic Sectors in demonstration area (DySim Lab) at ZHU facility
- Simulated sector hardware included 2K X 2K Barco displays with “ATC-Like” traffic display, touch screen input panels and press to talk headsets
- Demonstrated “ATC-like” hand off between sectors
- Demonstrated an in flight simulated weather diversion from west to east sectors in the GOMEX non-radar/non-VHF area

# Demonstration Segment B Qualitative Results

- Surveillance
  - Coverage – **full coverage in the "hole"**
  - Accuracy – **good match btwn ADS and radar**
  - Timeliness – **ADS = 1 Hz; radar = 12 sec. with dropouts**
- Digital Voice and Data
  - Potential methodologies – **demonstrated two**
  - Communications procedures – **worked well**
  - Quality and Latency – **"5X5"; latency = no noticeable impact**
  - Coverage – **full, even down to 10,000 ft./250+ nm**
- Bandwidth Requirements
  - Narrowband and Broadband – being analyzed
  - Data capacity – **Iridium (narrowband) can provide full voice/data/surveillance capabilities); certification & equipage issues for implementation**

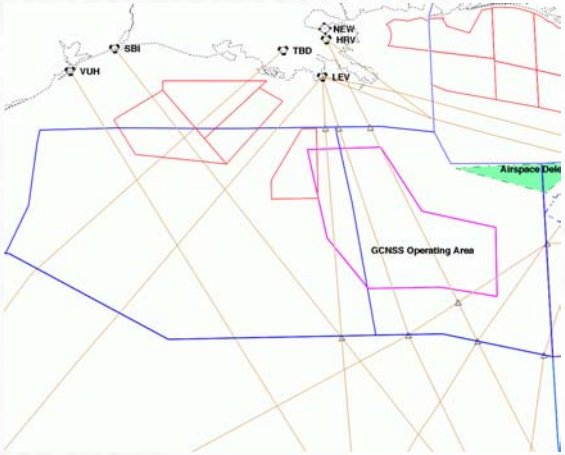


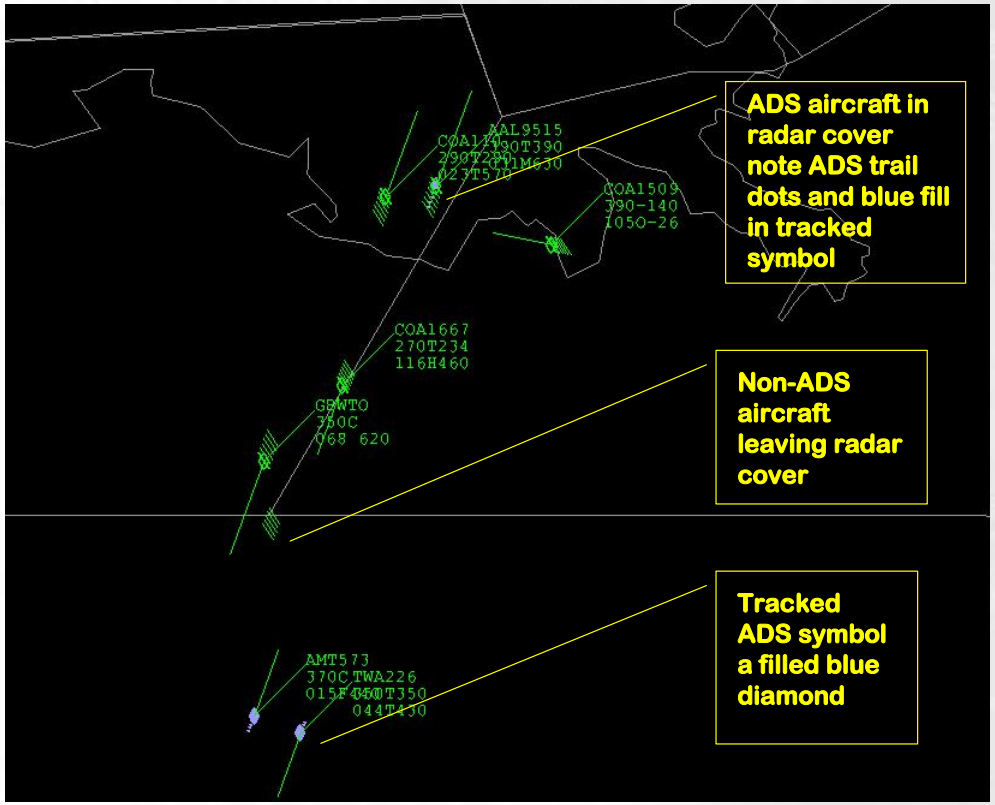
# Demonstration Segment B Qualitative Results (cont.)

*Demonstrated Potential Options Potentially Enabling Decreased Separation In Oceanic-type Environment*

- **Provided "Seamless" Domain and Sector Transition**
  - Oceanic (non-radar/satcom) / Domestic (radar/VHF)
  - Transition procedures proven




- **Provided Data Display Integration**
  - Multiple sources (ADS, radar, CPDLC)

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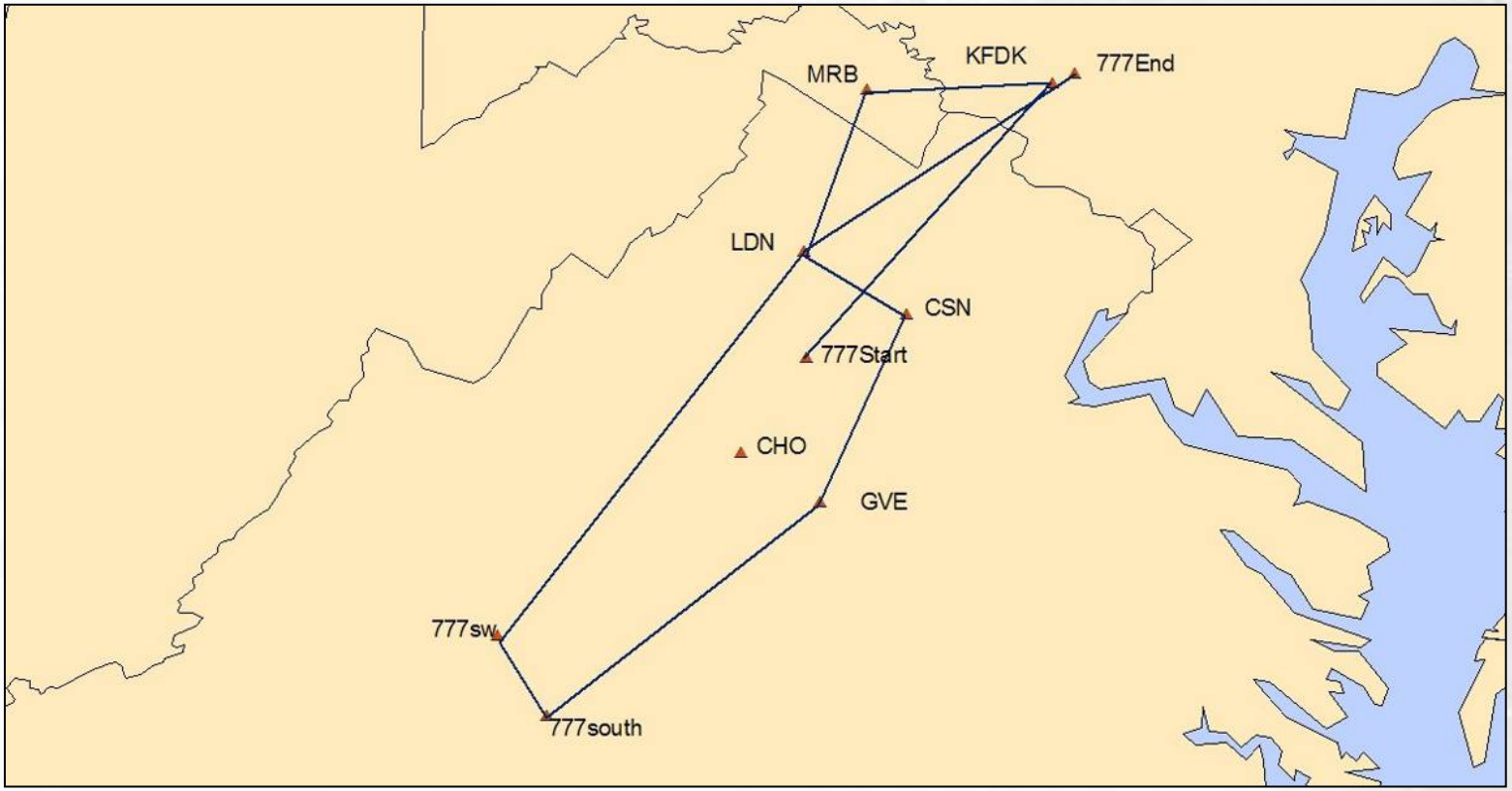
# SWIM/CIN Hardware-in-the-Loop Demo

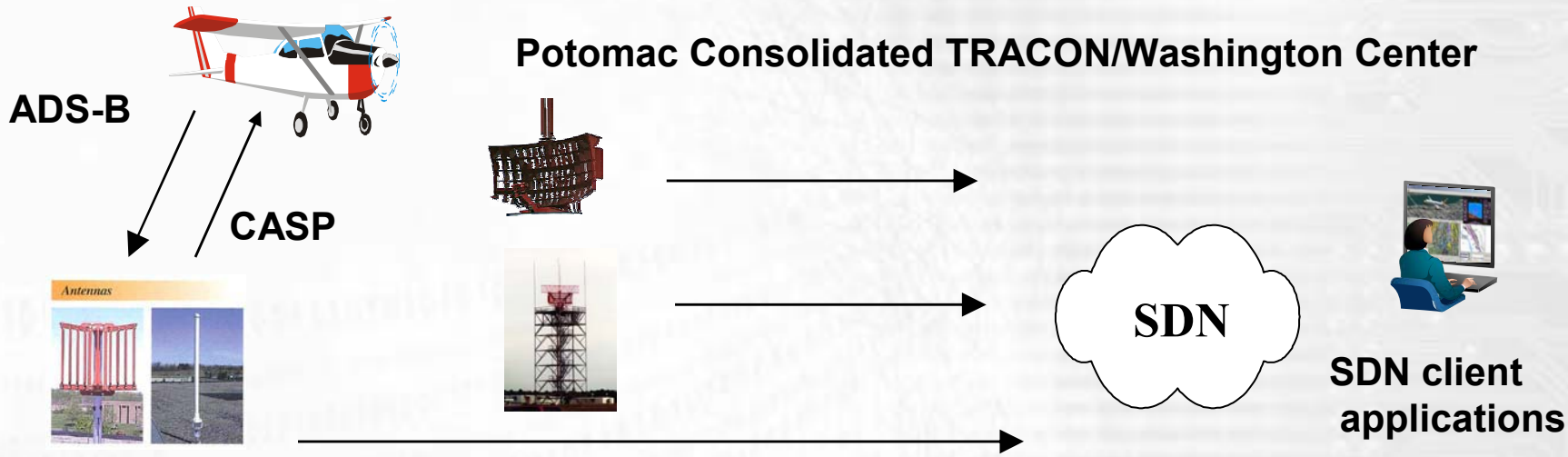
- Segment C SWIM/CIN hardware-in-the-loop (HITL) demonstration illustrated Common Information Network (CIN) connectivity between an emulated aircraft network & a surveillance data network (SDN) gateway
- Read & extracted Satellite Data Unit (SDU) messages from a Boeing 777 ADS simulation
  - ADS data created at Boeing *Integrated Aircraft Systems Laboratory* (IASL)
    - Actual 777 avionics in a bench configuration
  - Extracted position reports & transmitted EUROCONTROL ASTERIX Cat 033 messages over INMARSAT from Factoria, WA to Mclean, VA Laboratory for inclusion on SDN network
  - IPSec & VPN tunnels to provide security for transmitted data

# SWIM/CIN Hardware-in-the-Loop Demo Results

- Successfully “flew” Boeing 777 in Potomac TRACON; transmitting a secure airborne avionics data stream over INMARSAT & into GCNSS ground network



# GCNSS Segment C Flight Demonstrations Objectives




- **Objectives**
  - Demonstrate use of ADS-B and SDN in multi-radar terminal and en route areas
  - Demonstrate a surveillance picture consistent with 3-mile en route spacing
  - Integrate multi-sensor tracking capability (fused radar & ADS-B)
  - Use SDN to provide a “Common Air Surveillance Picture (CASP)” for use by Air Traffic and in support of FAA Advisory Services

# GCNSS Segment C Planned Flight Route With MITRE 2 GBT Coverage

| FDK | MRB | LDN | CSN | GVE | CHO | LDN | FDK |
|---|---|---|---|---|---|---|---|
| > NMdist | 29 | 35 | 21 | 40 | 17 | 44 | 50 |

> FDK -- Frederick Airport

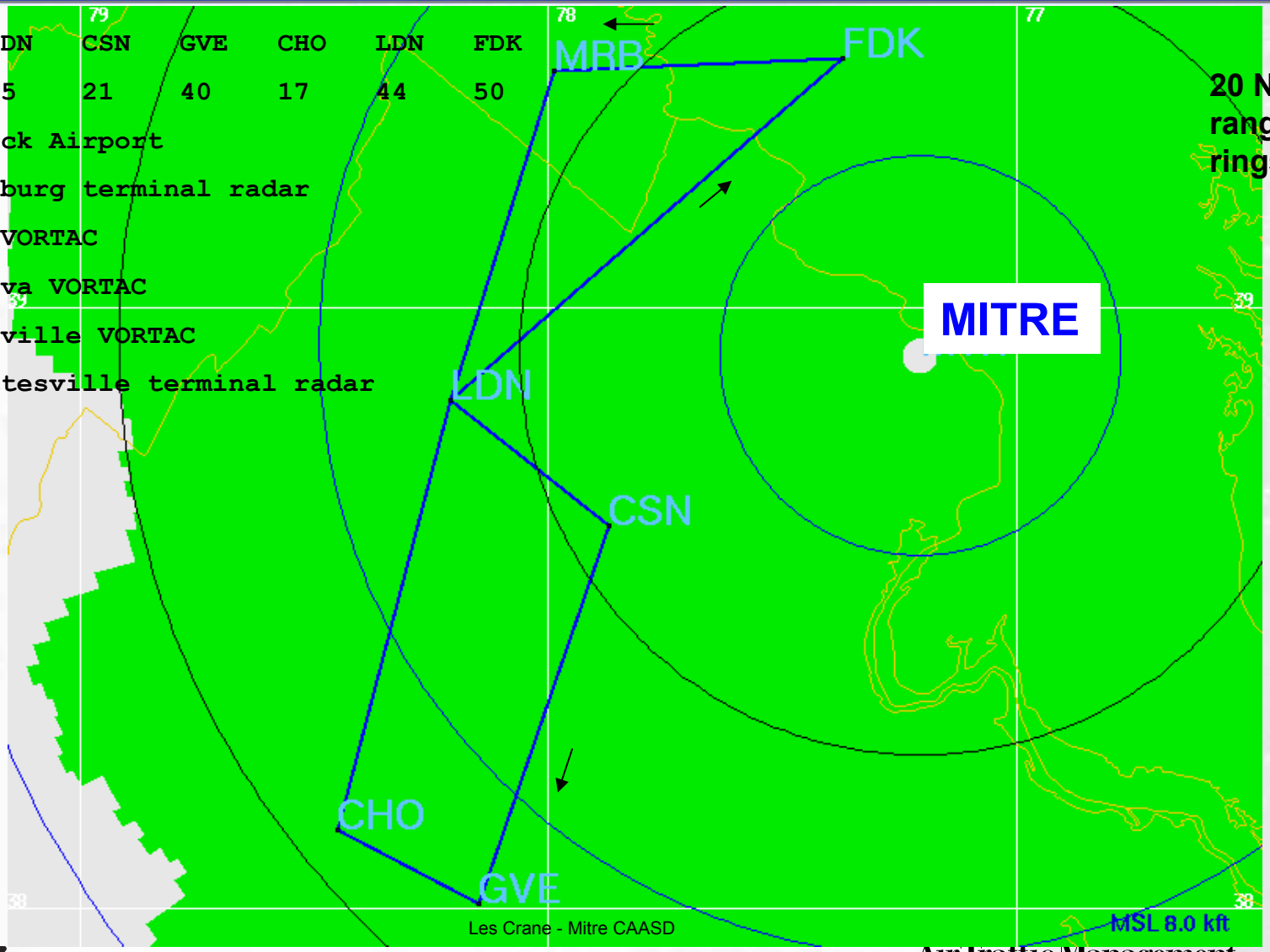
> MRB -- Martinsburg terminal radar

> LDN -- Linden VORTAC

> CSN -- Cassanova VORTAC

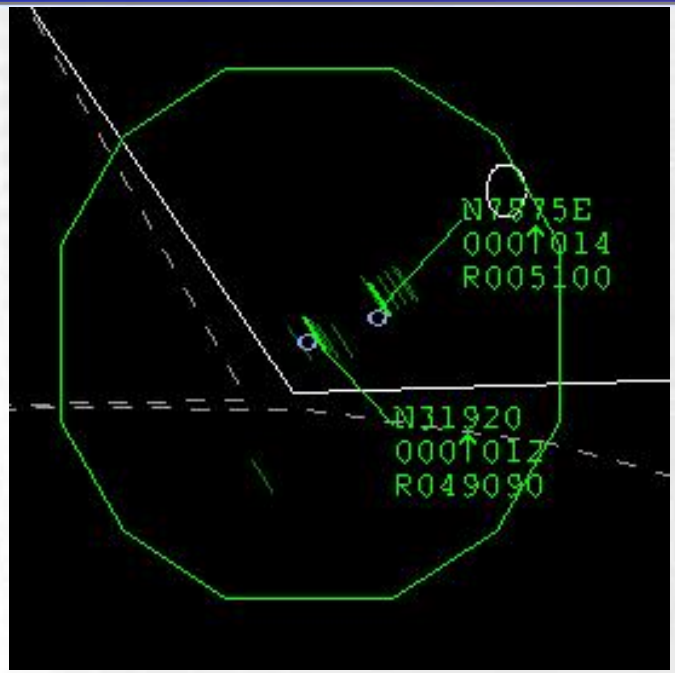
> GVE -- Gordonsville VORTAC

> CHO -- Charlottesville terminal radar



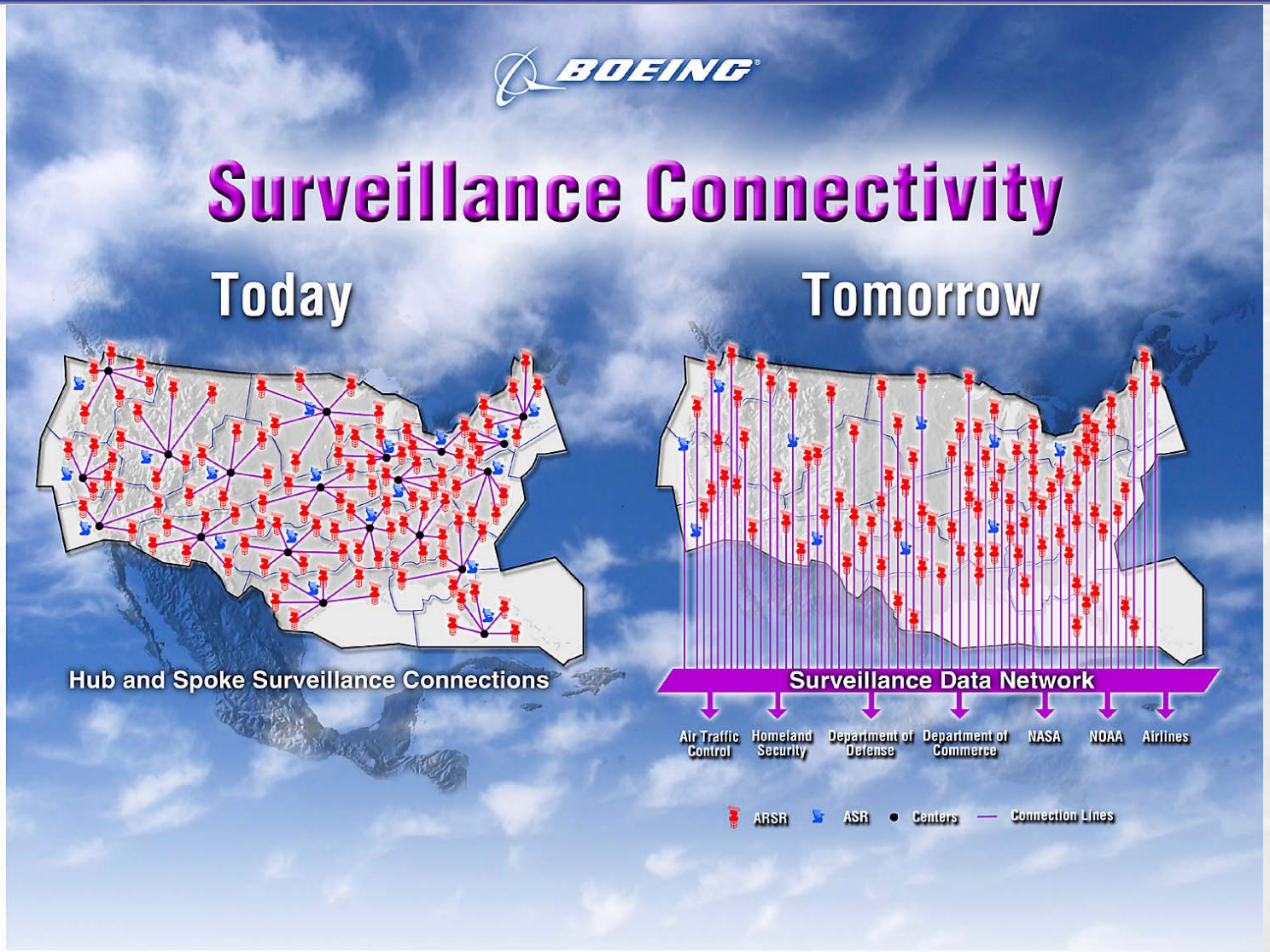
# Segment C Flight Test Results

- **Demonstration Flights Feb 19 and 23 2004**
  - **Flew with 2 GA aircraft ADS-B/UAT equipped**
  - **Potomac Consolidated TRACON/Washington ARTCC radars integrated into the SDN**
    - **9 Short range**
    - **4 Long range**
  - **FAA SafeFlight 21 Ground Based Transceivers integrated into SDN**
    - MITRE CAASD, McLean, VA
    - Frederick, MD
    - WJHTC Atlantic City, NJ




- **Successfully demonstrated:**
  - **Integration & data distribution of multiple surveillance assets**
    - Output of multi-sensor tracker (MST) is a realization of a “Common Air Surveillance Picture” (CASP)
    - Cooperative targets only
  - **Traffic picture sent via network and TIS-B to demonstration aircraft**
  - **SDN netted outputs consistent with FAA surveillance requirements for 3-nm separation in En Route airspace**

# Potential Surveillance Connectivity



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