



Federal Aviation
Administration

GNSS Program Status and Future Plans

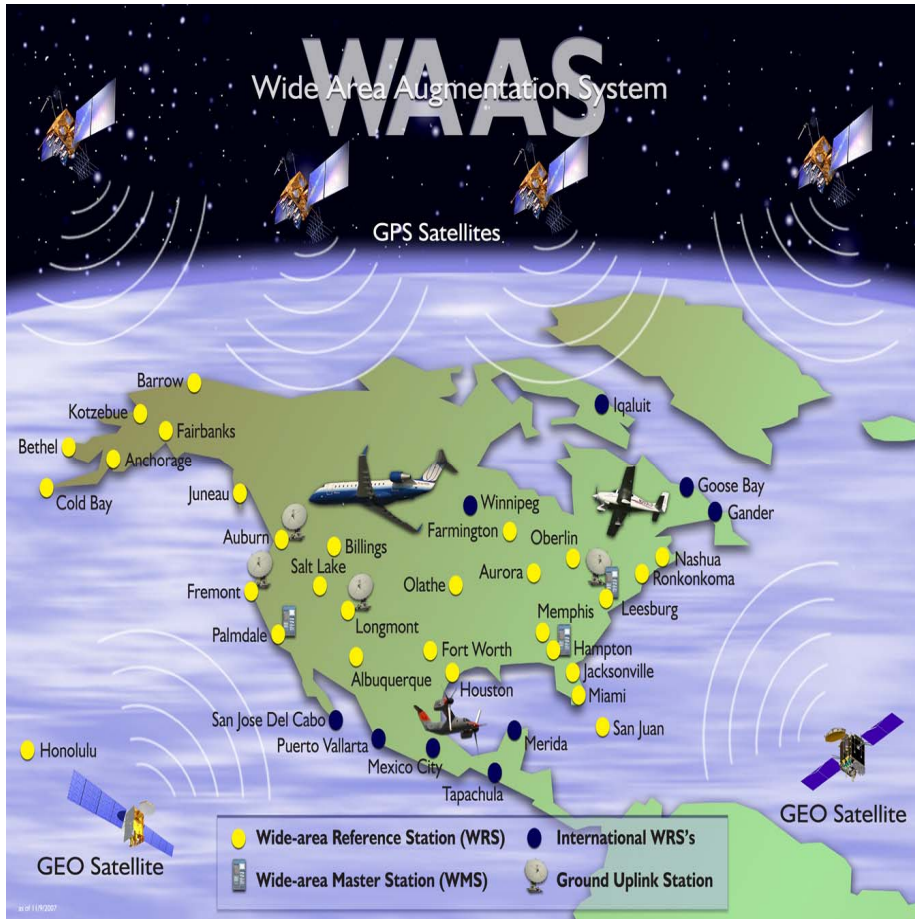
Presented To: CGSIC

Date: September 19, 2011

By: Leo Eldredge, Manager
GNSS Group, FAA



Wide Area Augmentation System - 2003



38 Reference Stations



3 Master Stations



6 Ground Earth Stations

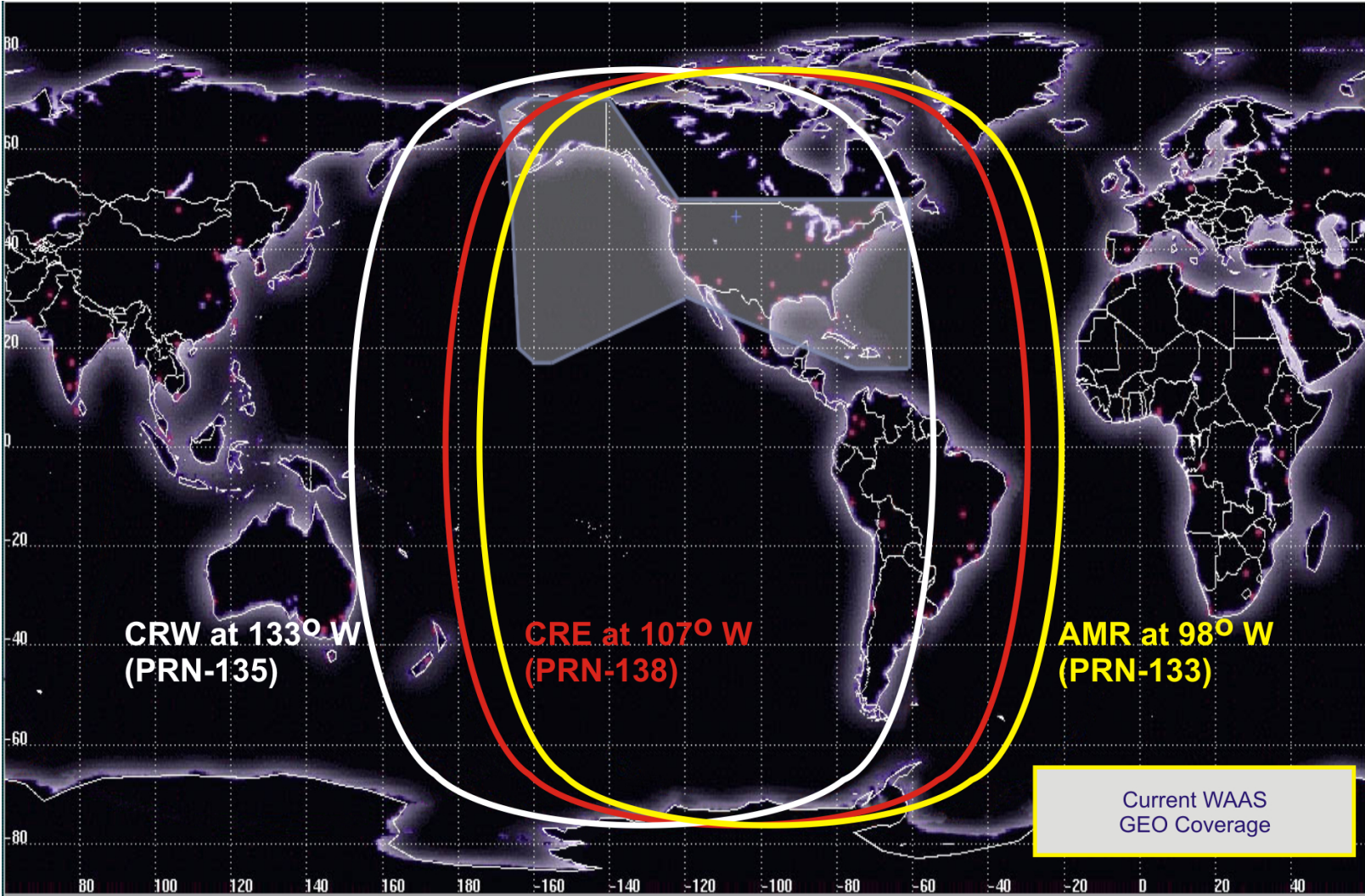


3 Geostationary Satellite Links



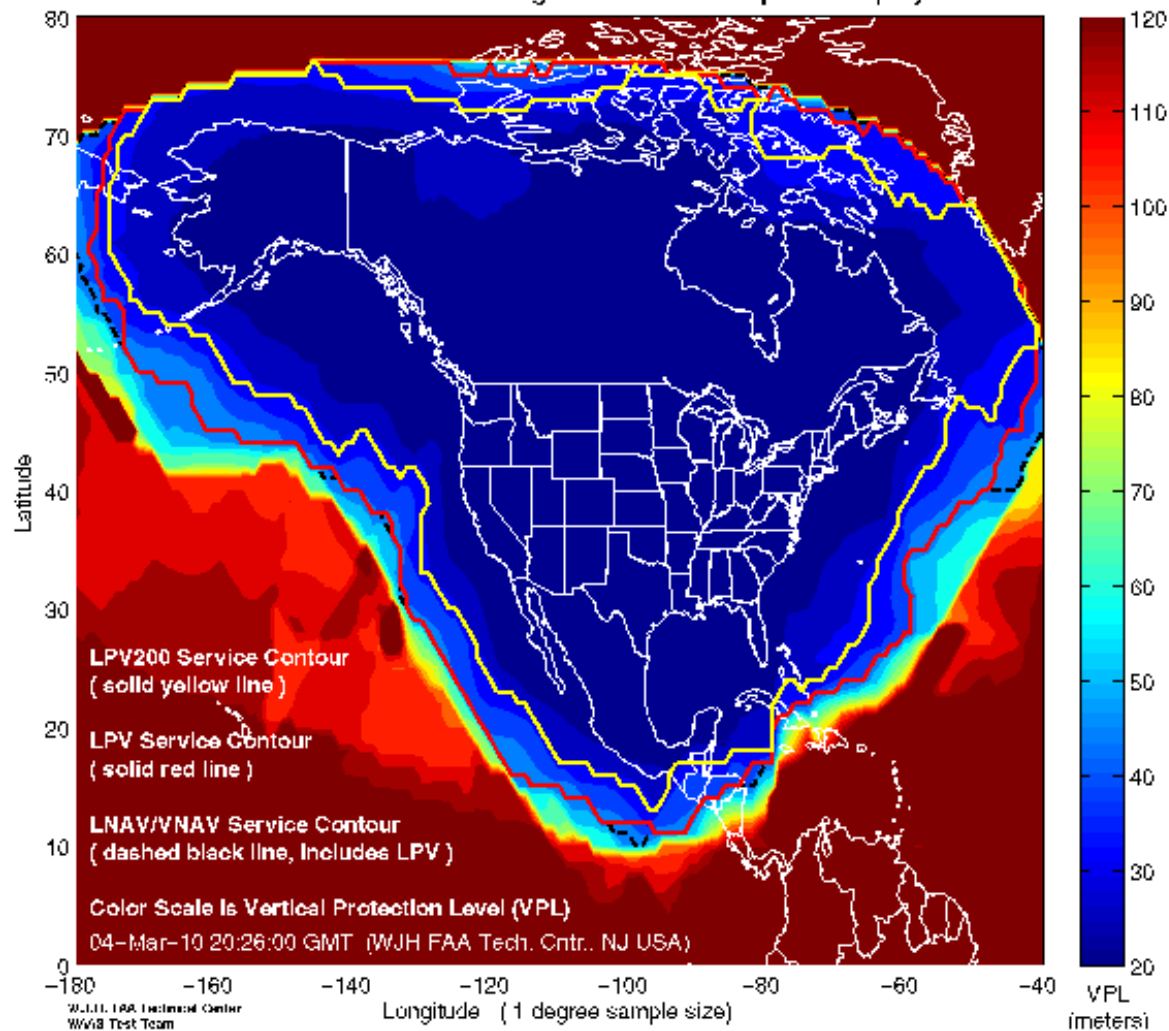
2 Operational Control Centers

Current WAAS GEOs

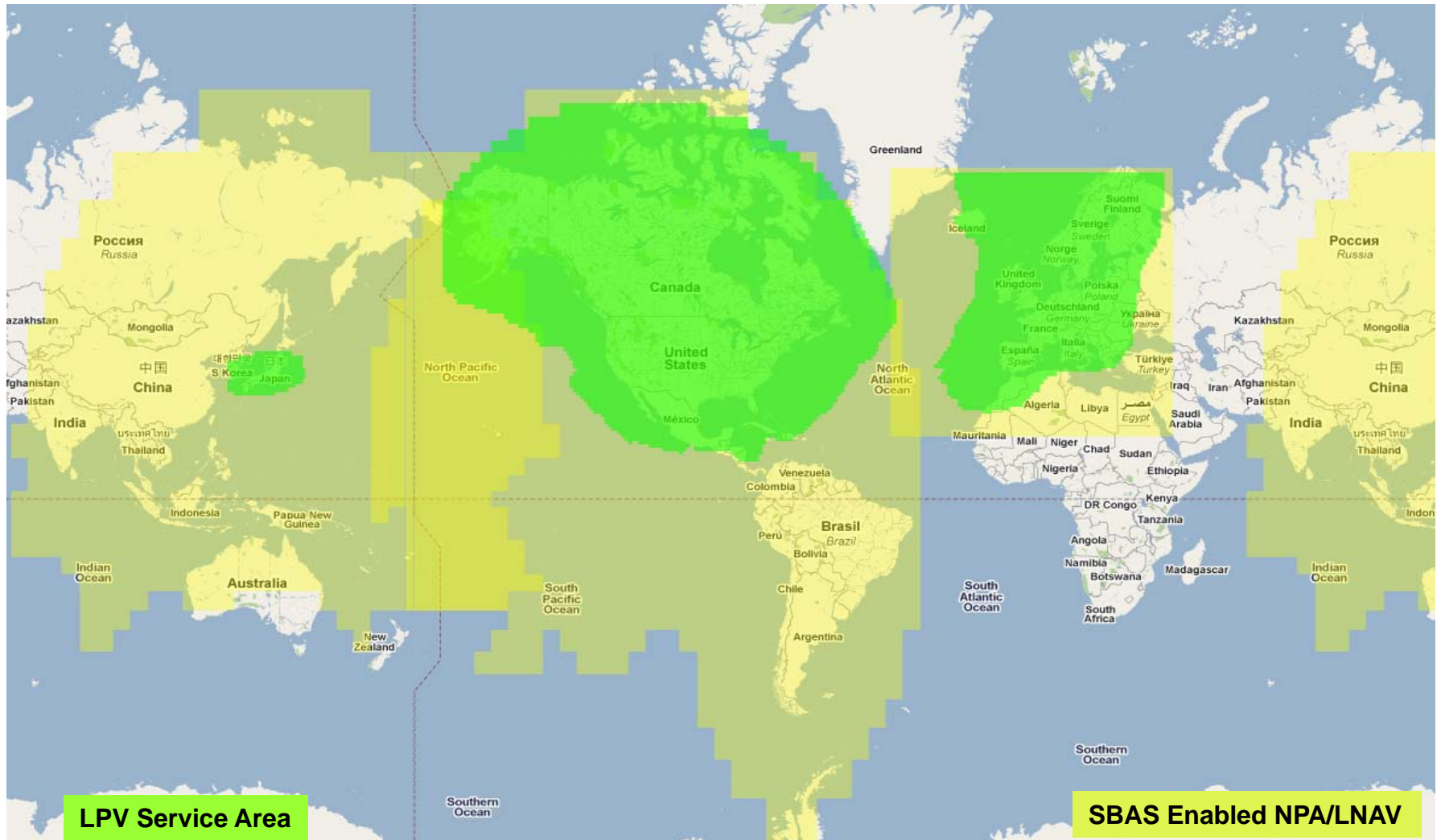


WAAS LPV Coverage

Current WAAS Vertical Navigation Service Snapshot Display



Combined SBAS Snapshot



Airports with WAAS LPV/LP Instrument Approaches



WAAS Avionics Status

- **Garmin:**
 - 64,000+ WAAS LPV receivers sold
 - Currently sole GA panel mount WAAS Avionics supplier
 - New 650/750 WAAS capable units brought to market at the end of March 2011 to replace 430/530W units
- **AVIDYNE & Bendix-King:**
 - 140 Avidyne Release 9 units sold to date
 - SmartDeck glass panel and KSN-770 certification pending
- **Universal Avionics:**
 - Full line of UNS-1FW Flight Management Systems (FMS) achieved avionics approval Technical Standards Orders Authorization (TSOA) in 2007/2008
 - 1800+ units sold
- **Rockwell Collins:**
 - Approximately 1900 WAAS/SBAS units sold to date
- **CMC Electronics:**
 - Achieved Technical Standards Orders Authorization (TSOA) certification on their 5024 and 3024 WAAS Sensors
 - Convair aircraft will have WAAS LPV capable units installed December 2011
 - Canadian North B-737-300 obtained STC for SBAS(WAAS) LPV using dual GLSSU-5024 receivers
- **Honeywell:**
 - Primus Epic and Primus 2000 w/NZ 2000 & CMC 3024 TSO Approval
 - Primus 2000 FMS w/CMC 5024 TSO pending



Aircraft Supplemental Type Certificates (STC): Completed & In-Work

Completed:

- Astra 1125
- ATR-42
- Beech: Be-400 KingAir- 200, 200GT, 200C, 200CGT, 350, 350C, 300 (special FAA config.), C90A, C90GTi, Premier 1/A
- Bell: 412, 429
- Boeing-737-200 (Northern Air Cargo & Canadian North),737-300, 727-200
- Bombardier: CL-600/601 (Universal Avionics company acft)
- Bombardier Challenger 300, 601-3A, 604
- Bombardier CRJ-200, 700, 900
- Bombardier Q-series, Q300, Q-400
- Cessna: Citation 501, 525, 550 Bravo Series, V 560 Series, 650, Excel & Encore +, Citation Jet CJ-1+, 2+, 3, Caravan
- DeHaviland: DHC-6,7-102,8 series
- Eclipse VLJ 500
- Embraer Phenom: 100, 300
- Falcon: 10, 20, 50, 50EX, 900B, 2000, 2000EX
- Gulfstream: G-II, G-III, G-100, G-150, G-450, G-550
- Hawker: 400, 700, 750, 800, 800XP, 900
- LEAR: 31A, 35, 35A, 40, 40XR, 45, 45XR, 55, 60
- MD-87
- PC-12
- S-76, S-76B, S-76C++
- SAAB: 340A/B
- Sabre 65
- Westwind 1124

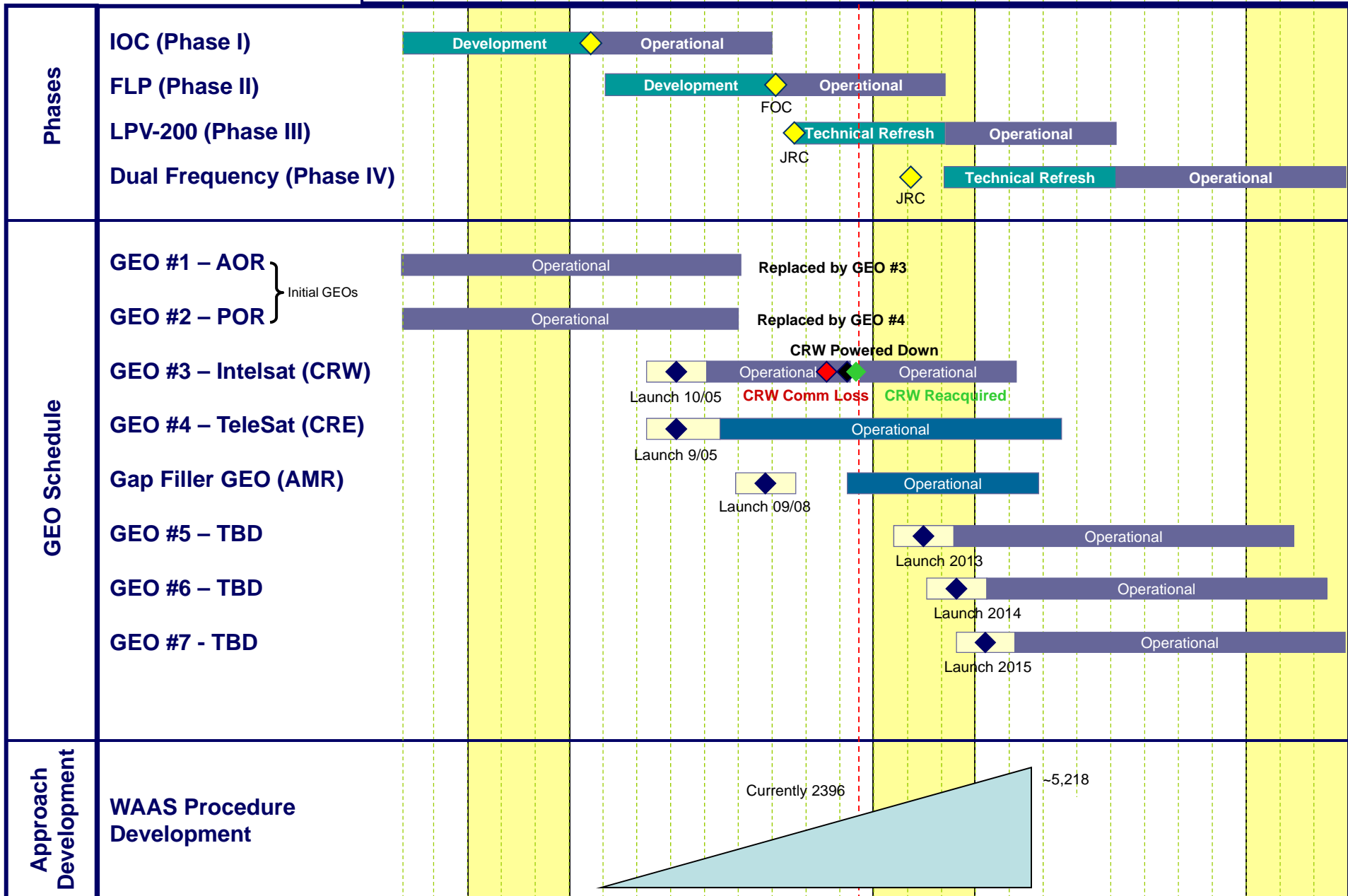
In-Work:

- Aerospatiale: SN 601 Corvette
- Agusta: A-109
- Airbus: A350, A400
- Astra SPX
- Beech: Be-200, Be-300, BeechJet 400A,
- Bombardier: Global 5000/Express,CL-300, CL-605, CRJ-700/900
- Cessna: Sovereign
- Cessna Citation: I/SP501, II, 560 XL/XLS, 650, VII, X
- C-9
- Dassault: EASy
- Embraer NB-145, 600/650
- Gulfstream: G-IV, G-100, G-200
- Hawker: 125-700B, 400XP
- King Air: RC-12
- LEAR: C-21A
- Lockheed Martin:
- Piaggio: P-180

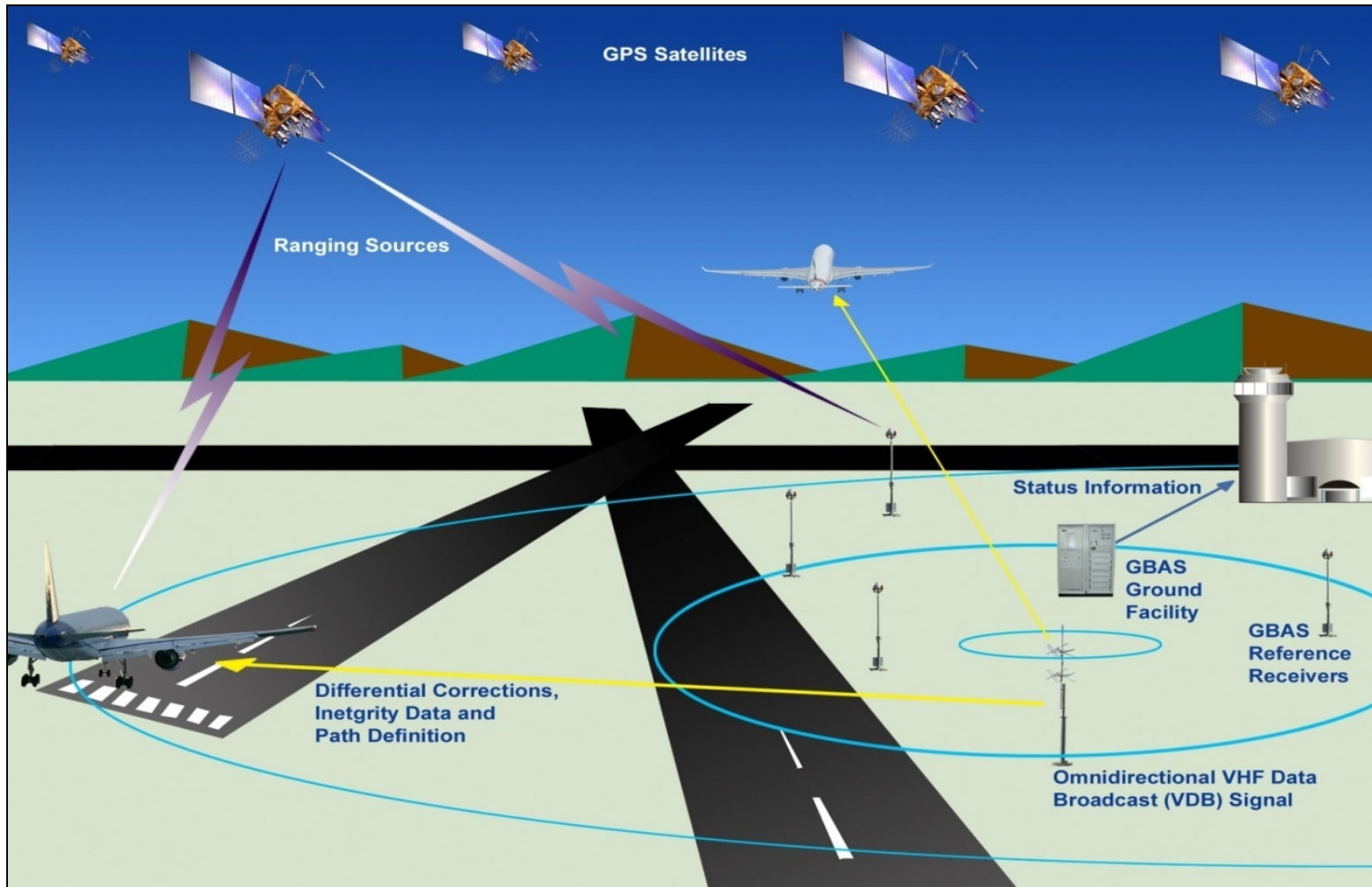


WAAS Enterprise Schedule

FY 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25



LAAS (Local Area Augmentation System)



GBAS Pathway Forward

- **Cat-I System Design Approval – Complete**
 - Enhancements based on EWR experience in work
- **Cat-III SARPs Baseline Development - Complete**
- **Cat-III Prototyping and Requirements Validation - 2013**
- **Final Investment Decision - TBD**



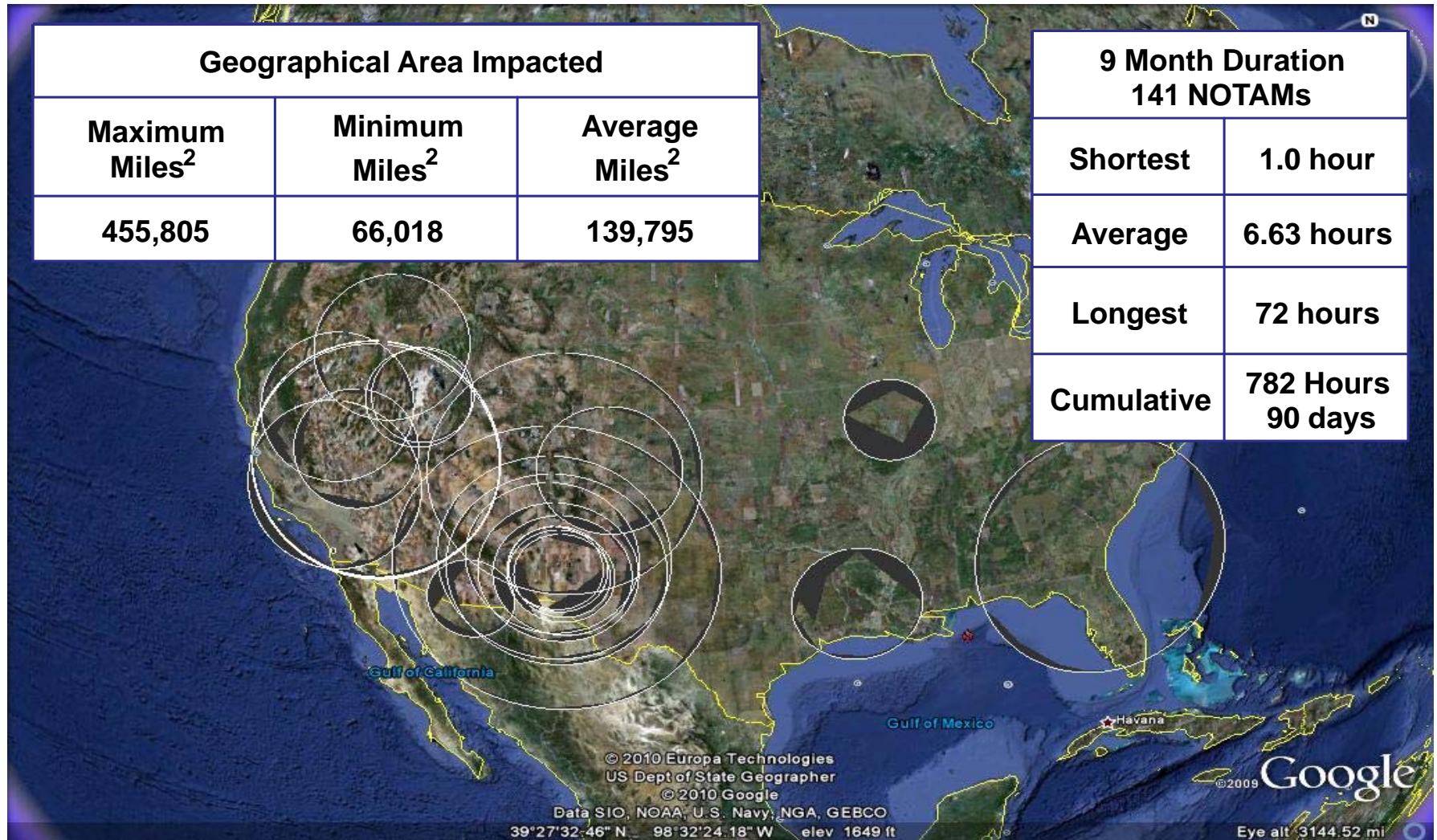
Alternative Positioning, Navigation & Timing (APNT) Study Update



Why APNT?

- **The transformation of the National Airspace System to the Next Generation Air Transportation System dependent on the availability of GPS-Based PNT services and suitable alternate PNT services**
 - RNAV and RNP procedures for trajectory-based operations (TBO)
 - Current ATC system cannot be scaled up to handle 2X traffic
 - 2X traffic is more than a controller can handle using radar vectors
 - Procedural separation with Conformance Monitoring *may be* used to separate aircraft performing trajectory based operations (TBO)
 - Controllers intercede to provide “control by exception”
- **TBO Operations may require PNT performance that exceeds DME/DME/IRU**
- **GPS vulnerability to radio frequency interference requires mitigation**
 - Waiting for the source of the interference to be located and turned off is not an acceptable alternative

GNSS Challenges: GPS Testing by DOD



... and a few more “Personal Privacy Devices”



\$110 Ebay



\$335 Ebay



\$92 Ebay



\$40 GPS&GSM
www.chinavasion.com



\$55 Ebay

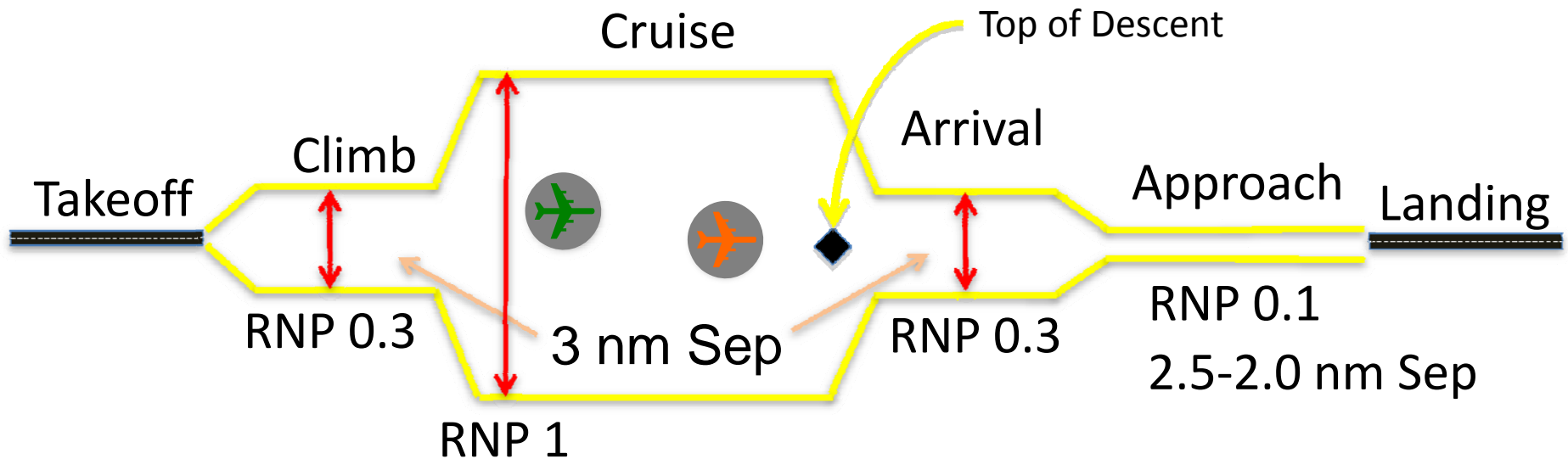


\$83 GPS&GSM
www.Tayx.co.uk



\$152 Ebay

2025 Nav Performance Envisioned for TBO

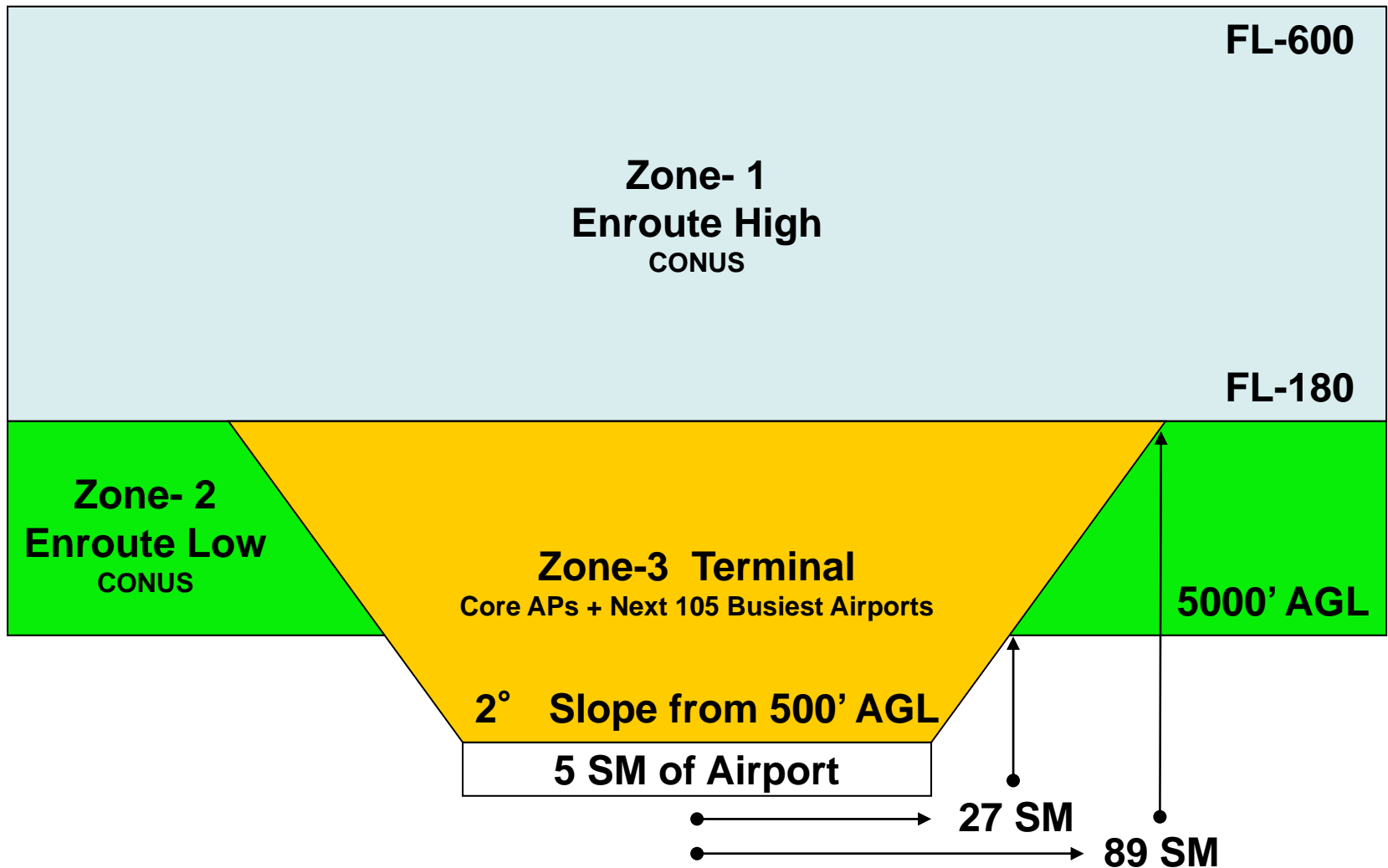


Primary PNT Service: GPS meets all Nav and ADS-B requirements

Alternate PNT Service: DME/DME/IRU won't support 92.6m for ADS-B

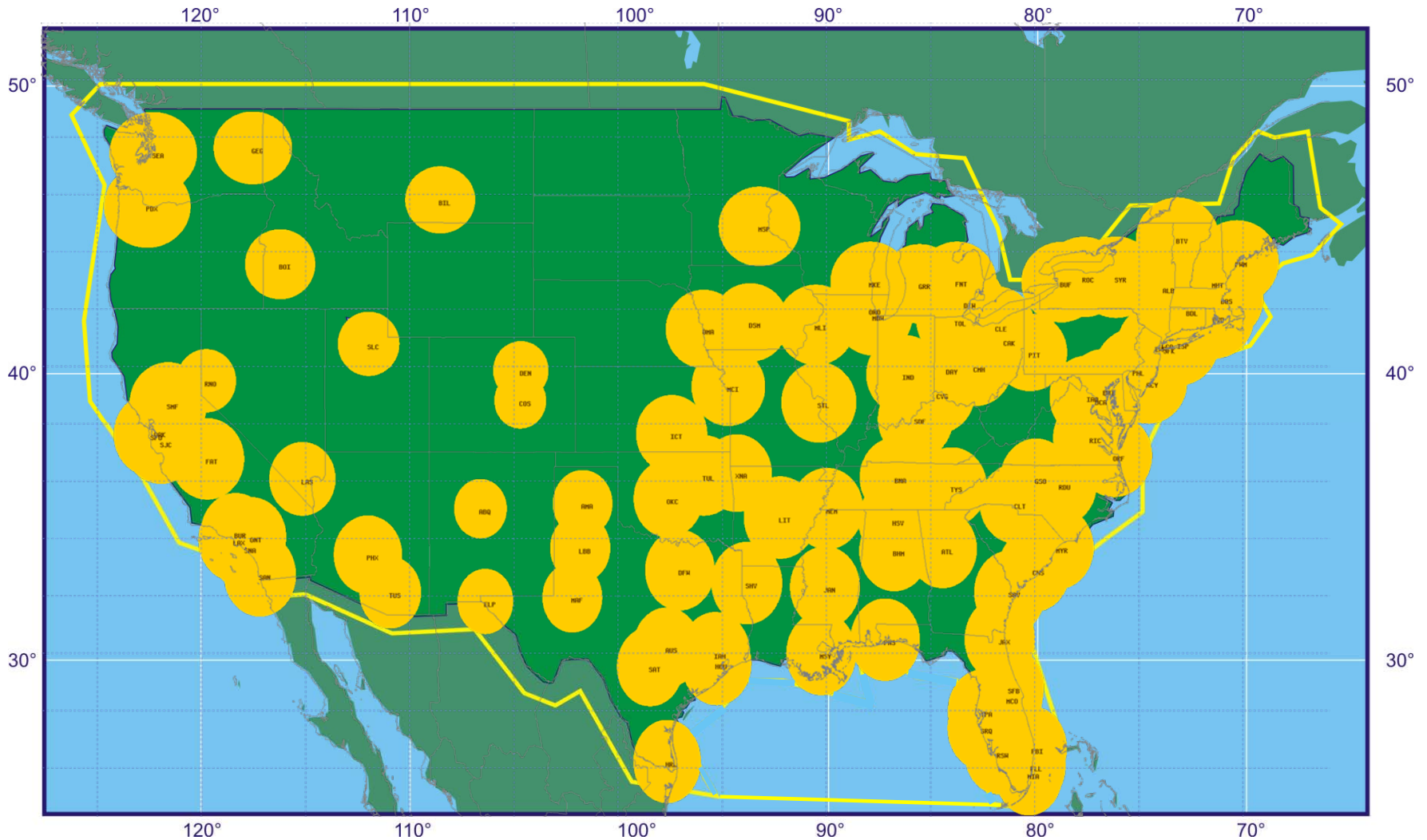
PNT Performance Zones

(Vertical Profile)



Performance Zones

(Horizontal View)



APNT Alternative 1

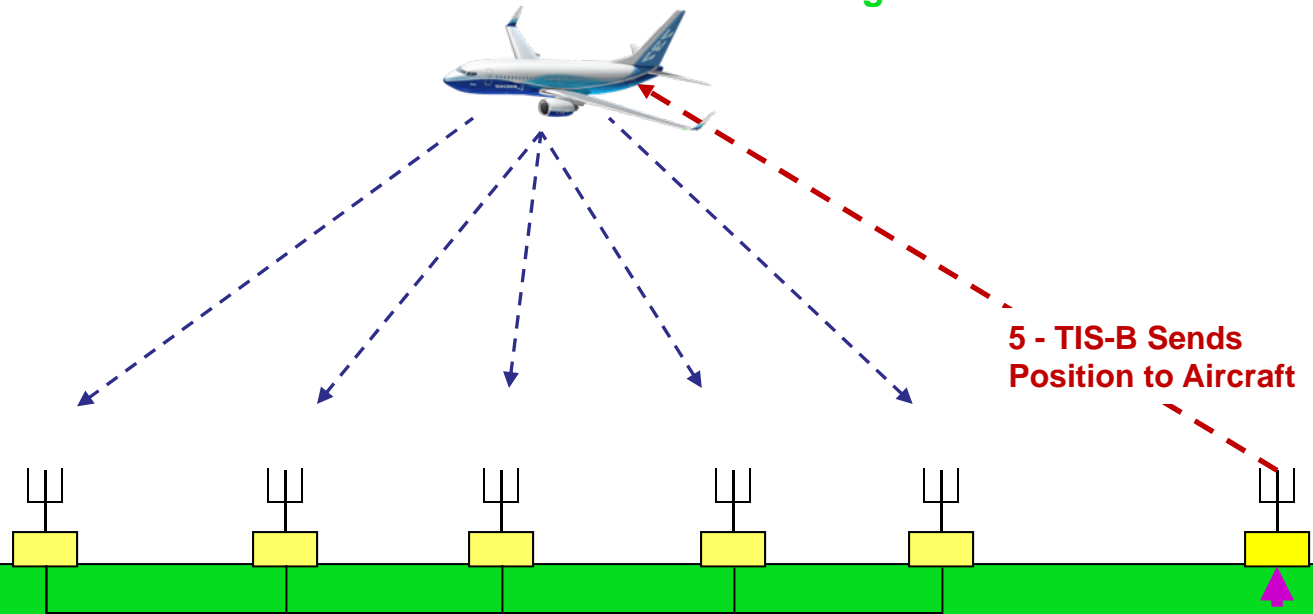
Optimized DME Network

1100 DMEs in Current Network



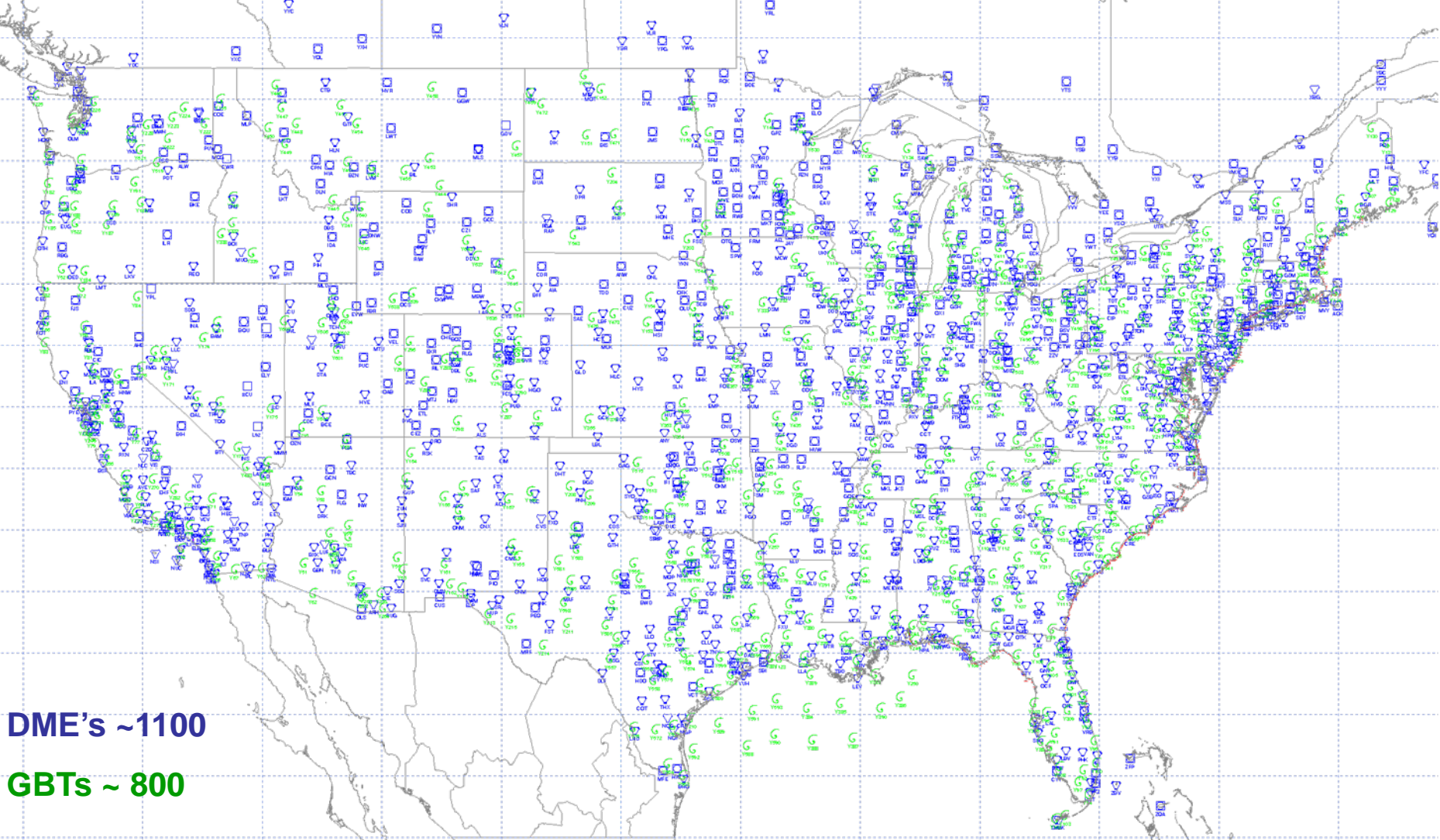
Passive Wide-Area Multi-Lateration (WAM)

- 1 – Aircraft Transmits ADS-B Signal
- 6 – Aircraft Uses Own Position for Navigation



Combined DME/GBT Network
2 - WAM Receives Signal
3 - Aircraft Position Determined
4 - Aircraft Position Sent to GBT's

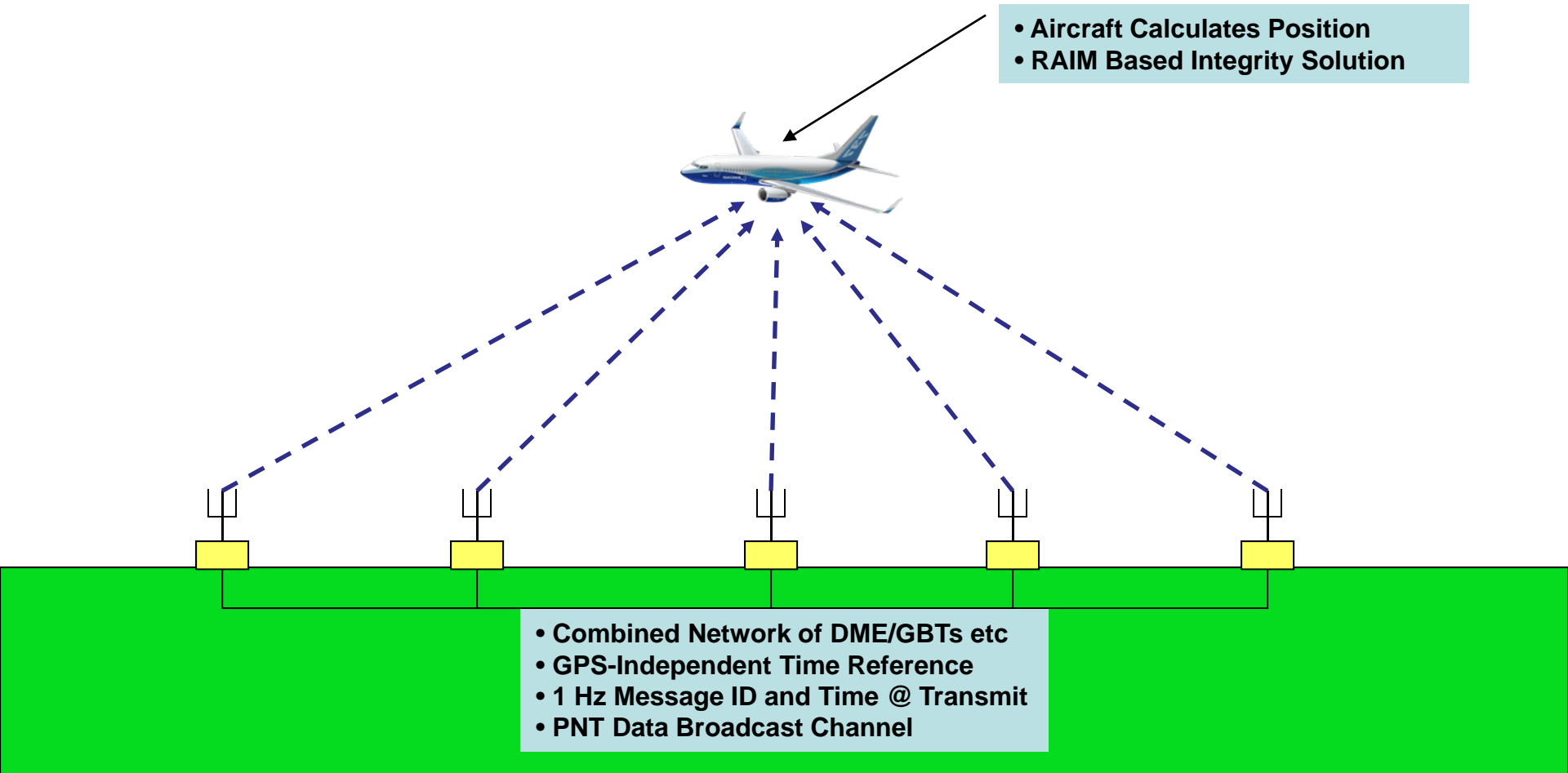
Combined Network of DMEs and GBTs



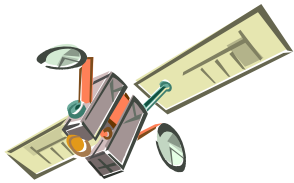
DME's ~1100

GBTs ~ 800

Pseudolite-Like Alternative Concept



Ground-to-Ground Time Synchronization



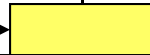
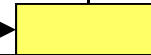
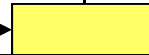
GEO: WAAS L5

MEO: GNSS

LEO: MSS



30 dB of processing gain



DMEs + Planned DMEs + GBTs

Summary

- **WAAS Development Completed**
- **Operational Implementation Underway**
- **WAAS Dual Frequency Upgrade for GPS Modernization by 2020**
- **GEAS Assessing Alternatives for Multi-GNSS**
- **GBAS Cat-I System Design Approved**
- **GBAS Cat-III R&D Underway**
- **Federal Acquisition of GBAS On Hold**
- **FAA Assessing Alternatives for Alternate PNT**

Questions