Wide Area Augmentation System (WAAS) and Local Area Augmentation System (LAAS) Update

Federal Aviation Administration

Presented to: **CGSIC**

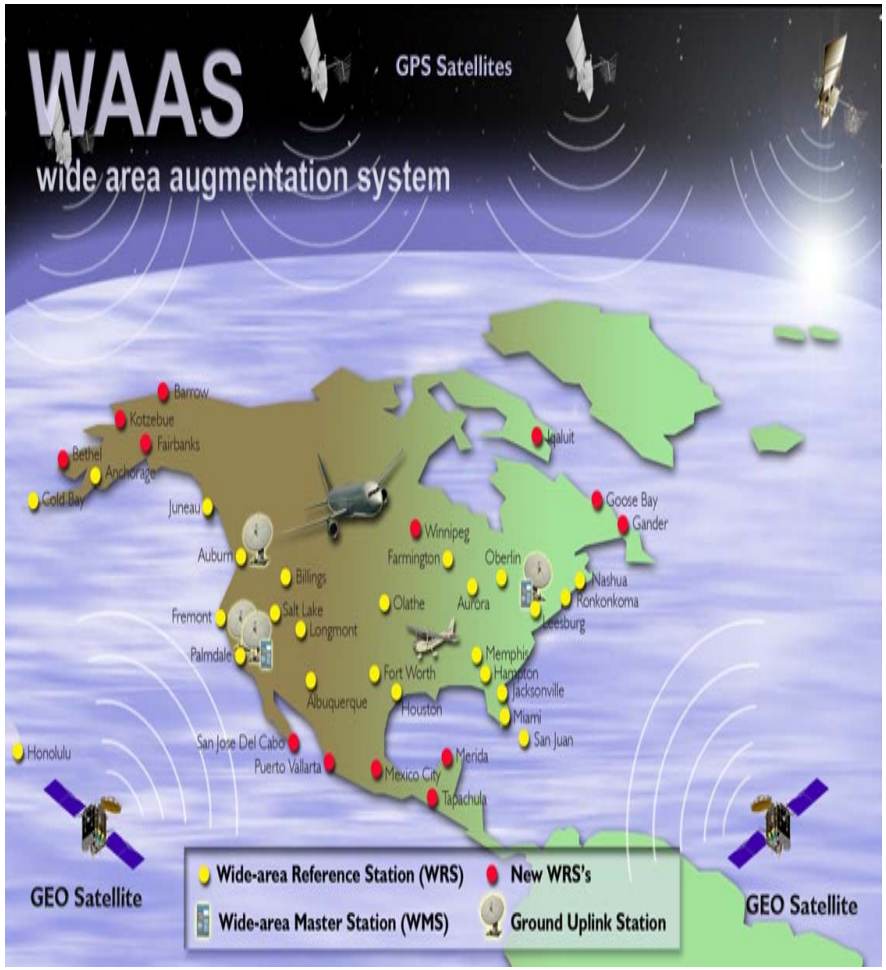
By: **Leo Eldredge, FAA**

Date: **September 24, 2008**

Agenda

- **WAAS Architecture**
- **WAAS Services Overview**
- **WAAS Program Status**
  - Phase II – Full LPV Performance
  - Phase III – Full LPV-200 Performance
  - Phase IV – Dual frequency Operations
- **WAAS User Segment Status**
- **LAAS Status**

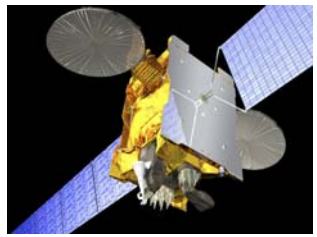
WAAS Architecture



38 Reference Stations

3 Master Stations

4 Ground Earth Stations



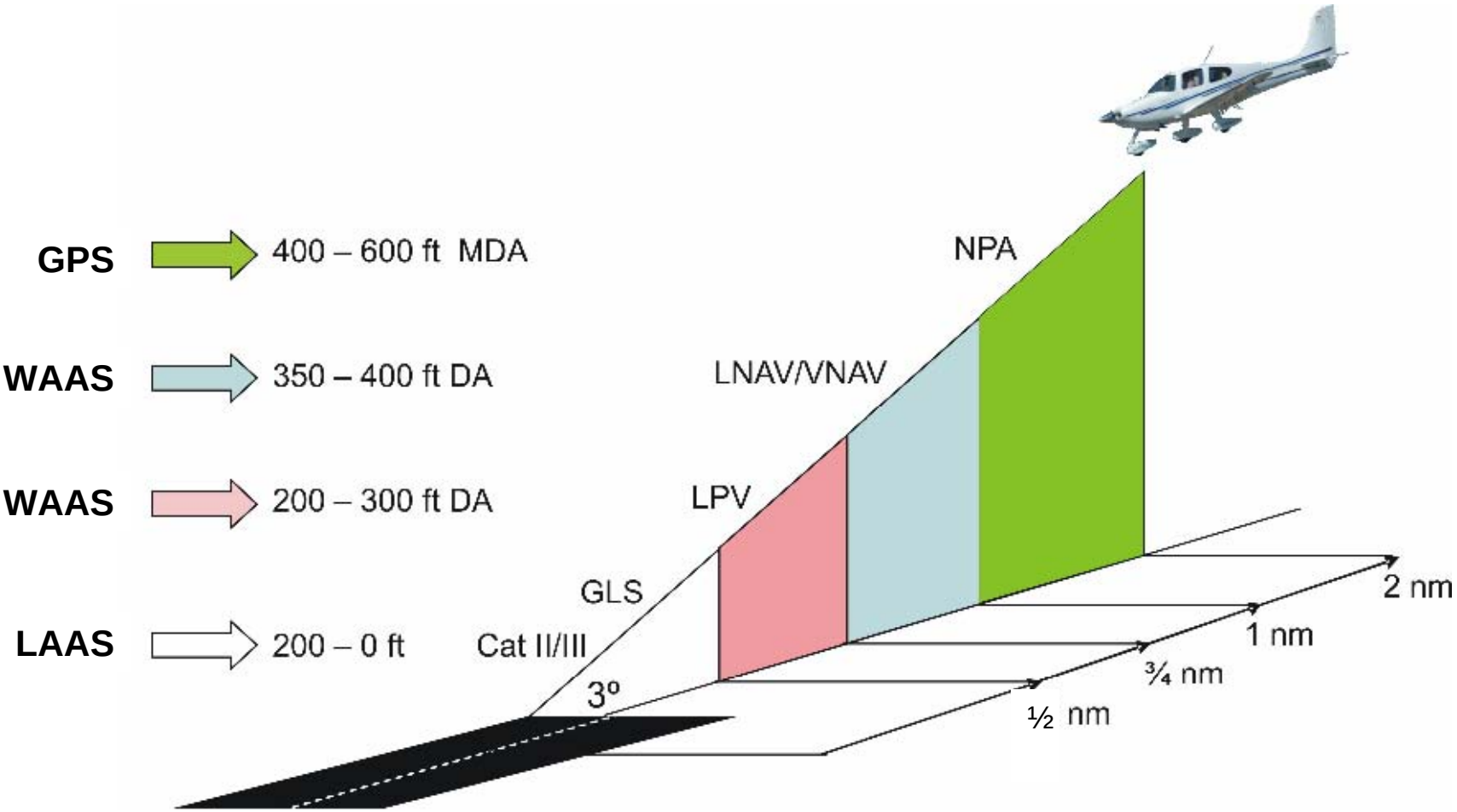
2 Geostationary Satellite Links

2 Operational Control Centers

WAAS Navigation Services

- **En Route and Terminal Area Navigation Services**
  - For Aircraft Departure, Arrival, and Domestic Airspace
  - Supports All RNAV Categories
- **Instrument Approach Services**
  - Lateral Navigation (LNAV)
    - Non-Precision Approach Guidance for Lateral Only Use
  - Lateral Navigation with Vertical (LNAV/VNAV)
    - Non-Precision Approach Service with Vertical Guidance Capable of Providing Service to ~350 Feet Above Runway Surface
  - Localizer Performance with Vertical (LPV)
    - Equivalent to Instrument Landing System (ILS)
    - Precision Approach Service With Vertical Guidance as Low as 200 Feet Above the Runway Surface

Instrument Approach Services



WAAS LPV Performance

	GPS Standard	GPS Actual	WAAS LPV Standard	WAAS LPV Actual
Horizontal 95%	36 m	2.74 m	16 m	1.08 m
Vertical 95%	77 m	3.89 m	20 m	1.26 m

WAAS Performance evaluated based on a total of 1,761 million samples (or 20,389 user days)

WAAS Program Phases

- **Phase I – Initial Operating Capability (IOC)**
  - **Completed July 2003**
- **Phase II - Full LPV Performance**
  - **On Track to Complete by September 2008**
- **Phase III - Full LPV-200 Performance**
  - **Planned for FY2009-2013**
- **Phase IV - Dual Frequency Operations**
  - **Planned for FY2014-2028**

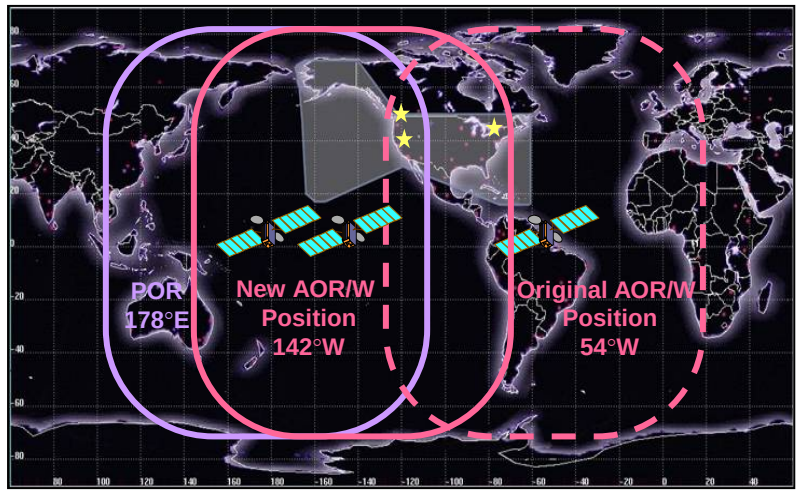
WAAS Phase II Status

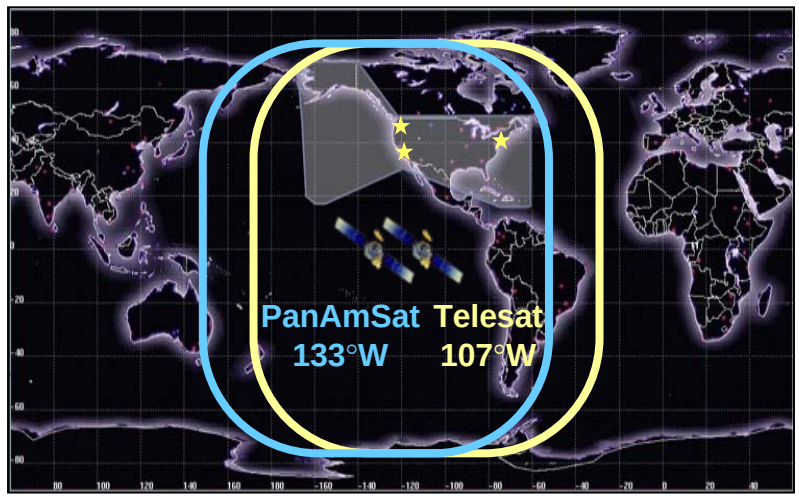
- **Expand LPV Service to all of CONUS and Significant Portions of Alaska, Canada, Mexico**
  - Install 13 Additional WAAS Reference Stations (WRS)
    - 4 Alaska – *Complete*
    - 4 Canada – *Complete*
    - 5 Mexico - *Complete*
  - Software Modifications - *Underway*
- **Provide Redundant GEO Coverage**
  - Replace Both GEO Satellites - *Complete*
- **Improve Service Reliability**
  - Add Third WAAS Master Stations (WMS) - *Complete*
  - Software Improvements To Broadcast Corrections - *Underway*
- **Approve LPV Service Down to 200 Feet**
  - Complete Safety Analysis to Approve WAAS Users For ILS Equivalent Service - ***Complete***

GEO Satellite Improvements

- **Phase I – IOC**
  - Inmarsat Satellites
    - AOR-W – 54W
    - POR – 178E
  - AOR-W Moved to 142W
  - Leases Expired July 2007

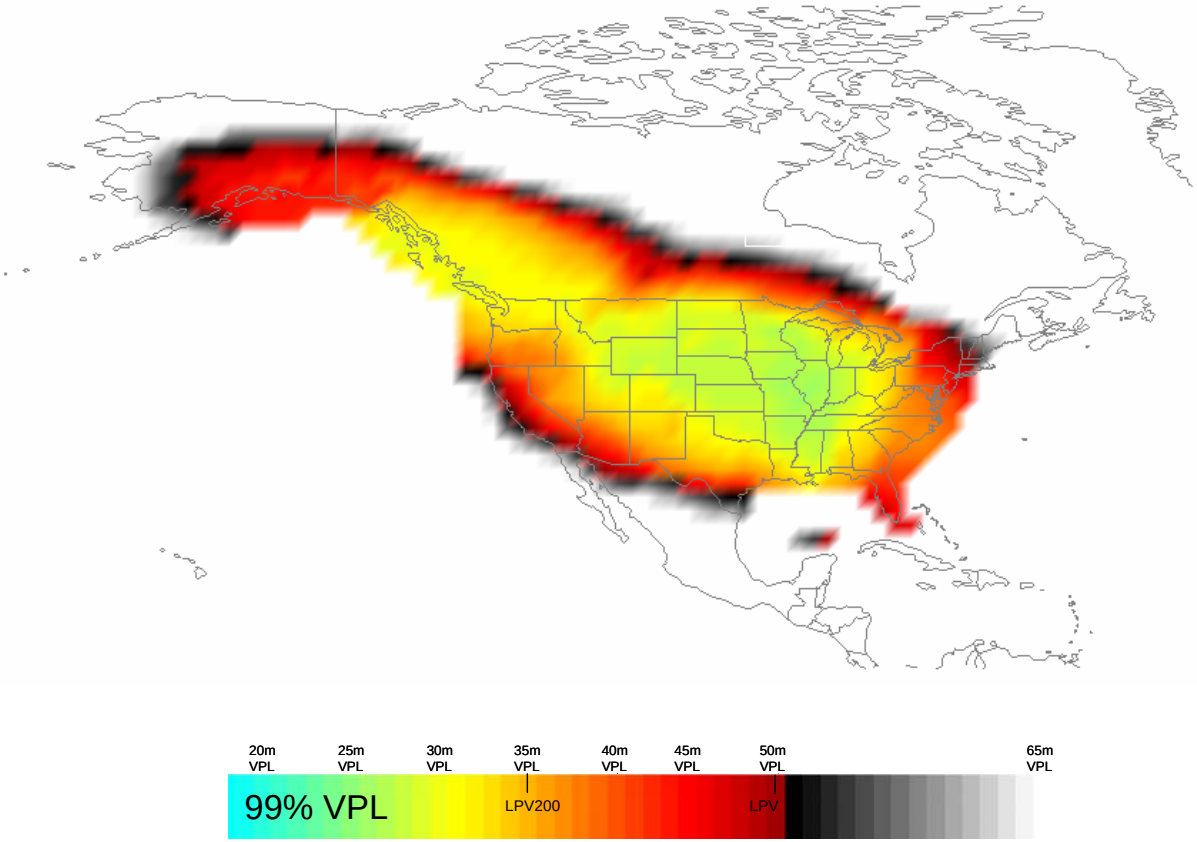
- **Phase II**
  - New GEOs
    - Panamsat (Galaxy XV) – 133W
    - Telesat Canada (Anik F1R) – 107W
  - Operational July 2007

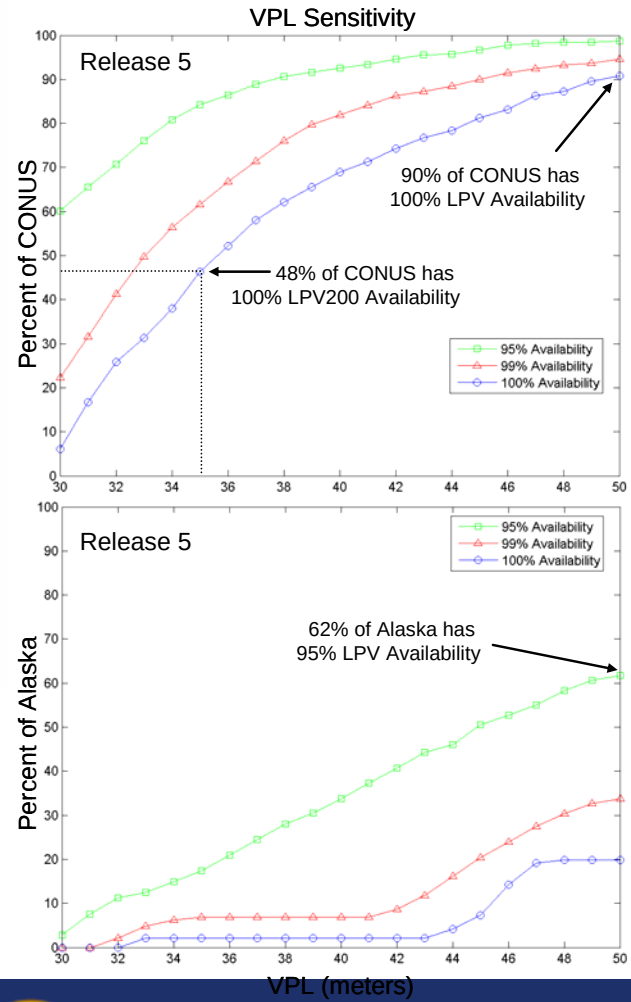




Phase II Software Release 5

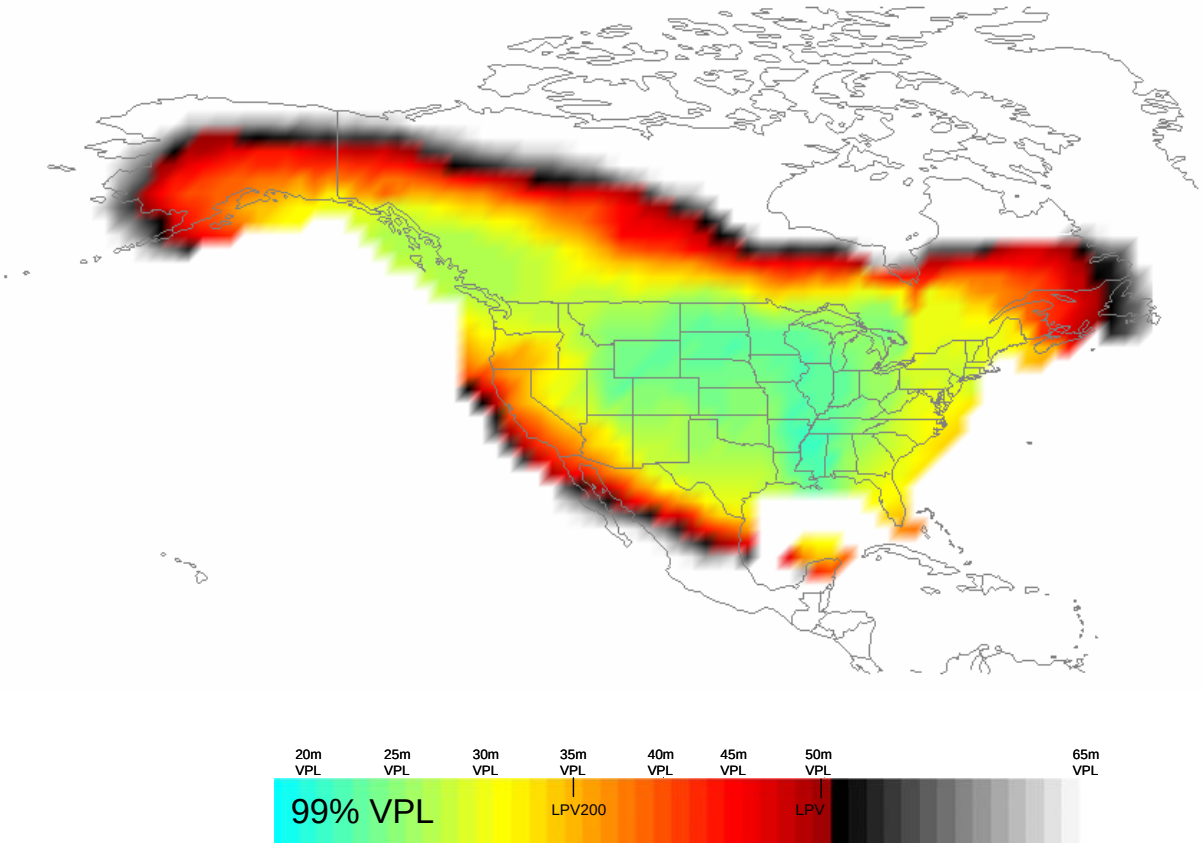
(Completed 2007)

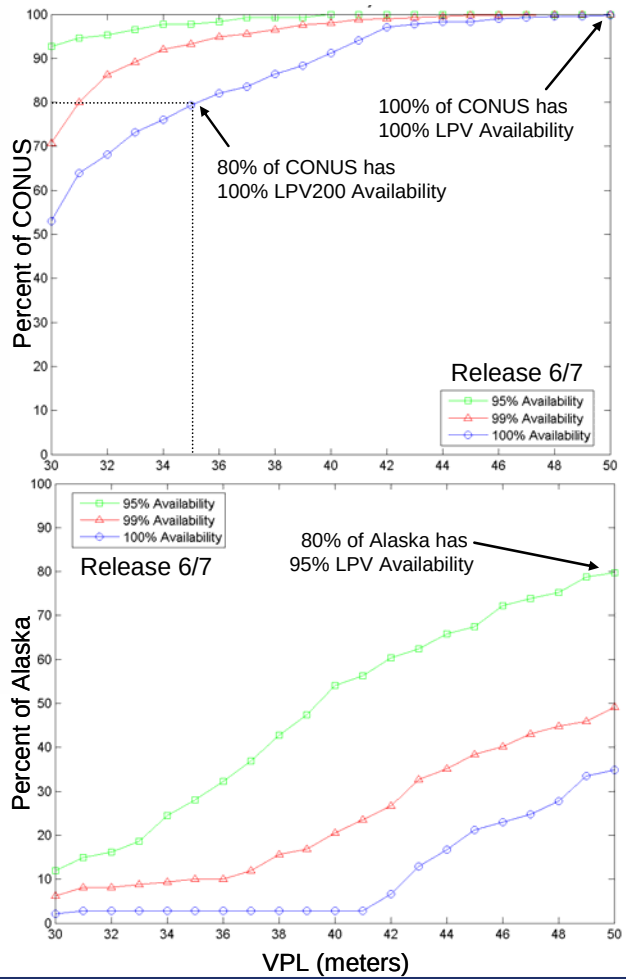




Phase II Software Release 6/7

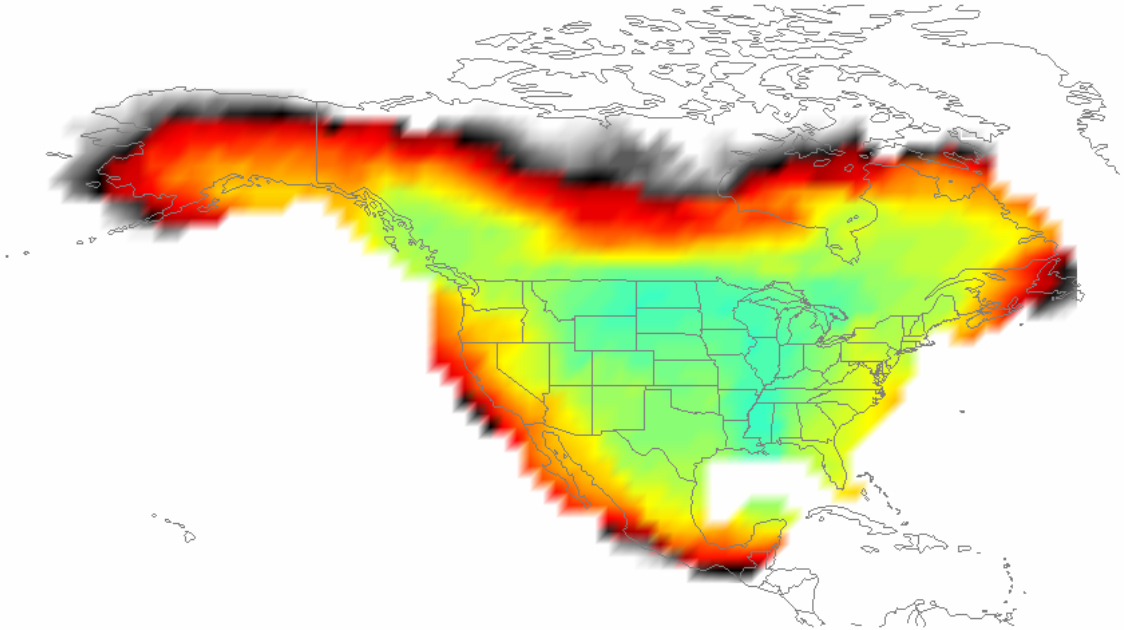
(Underway)

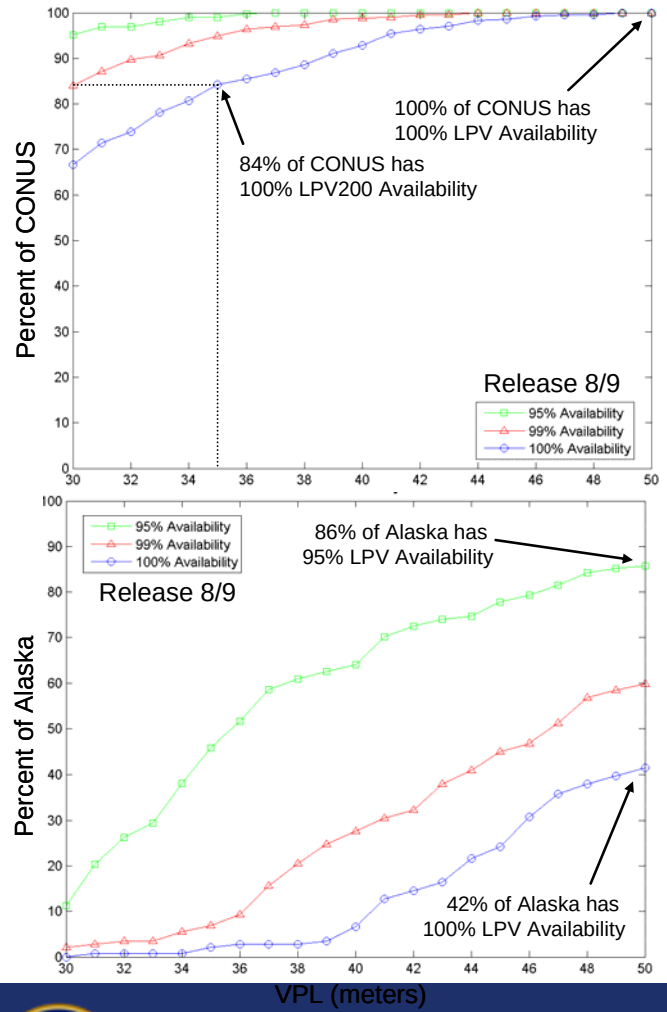




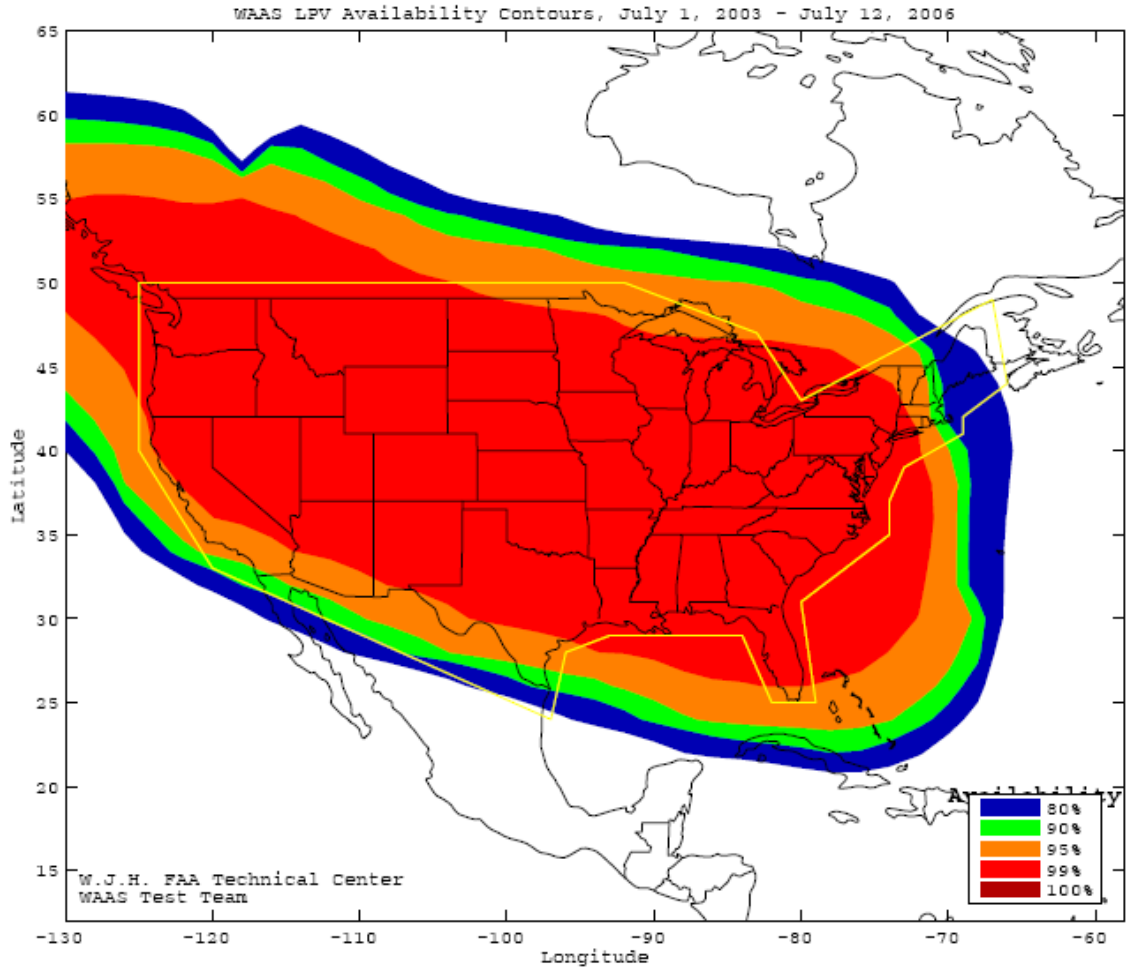
Phase II Software Release 8/9

(Planned for 2008)

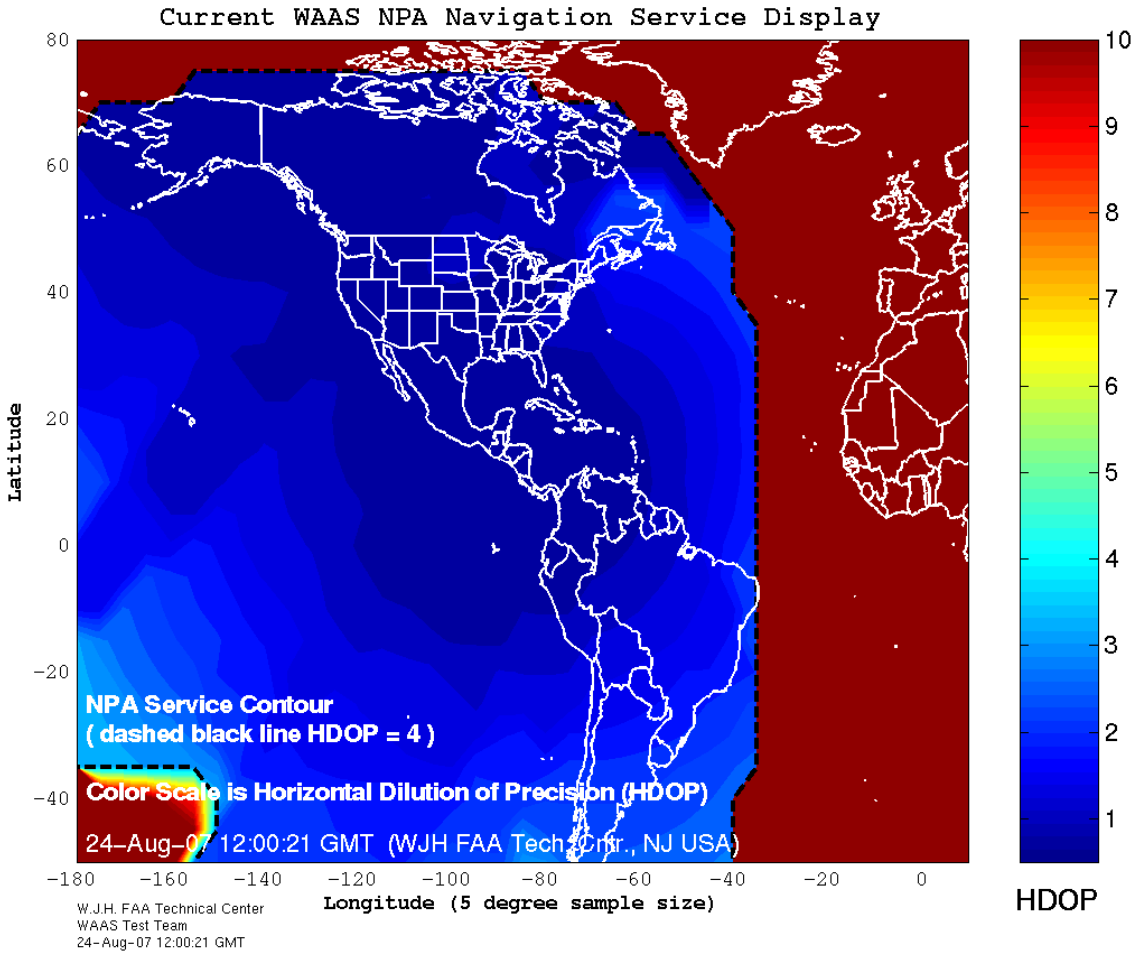




WAAS LPV Coverage



WAAS LNAV Coverage



WAAS Program – Phase III

(2009-2013)

Full LPV-200 Performance

- **Continue To Improve Service For LPV-200**
- **Support Transition Of WAAS Maintenance And Development Capabilities To The FAA**
- **Planned WAAS Algorithm Updates For Phase III**
  - Acquisition Of Additional GEO Satellite
  - Continued GIVE Algorithm Tuning to Maximize Availability During the Approaching Solar Maximum
- **Conduct Planning and Engineering Analysis to Prepare for Dual Frequency Operations**
  - GPS Evolutionary Architecture Study (GEAS)

WAAS Program – Phase IV

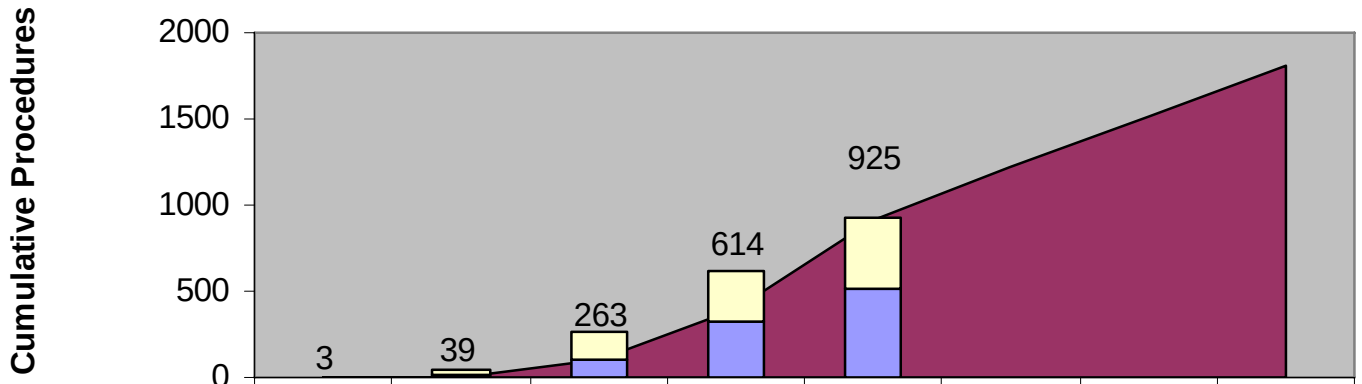
(2014-2028)

- **Dual Frequency Operations**
  - Maintain a robust, reliable, and sustainable LPV-200 capability
  - Support Single frequency WAAS users through end of Phase IV (2028)
  - Implement WAAS Changes Needed for Dual Frequency (L1/L5) GPS Operations

WAAS Avionics Status

- **Approximately 40% Of Est. 140,000 GA Aircraft Are Equipped With Garmin Receivers**
  - Total WAAS Equipped Users ~15,000
- **Rockwell-Collins: FAA Flight Inspection Challenger Aircraft Approval – August 2007**
- **Canadian Marconi: Contract To Integrate WAAS Sensor Into FAA Global 5000 Aircraft To Complete In 2008**
- **Universal Avionics: Developing WAAS Enabled Capability In Dual Thread UNS-1 Flight Management System Expected in 2007**

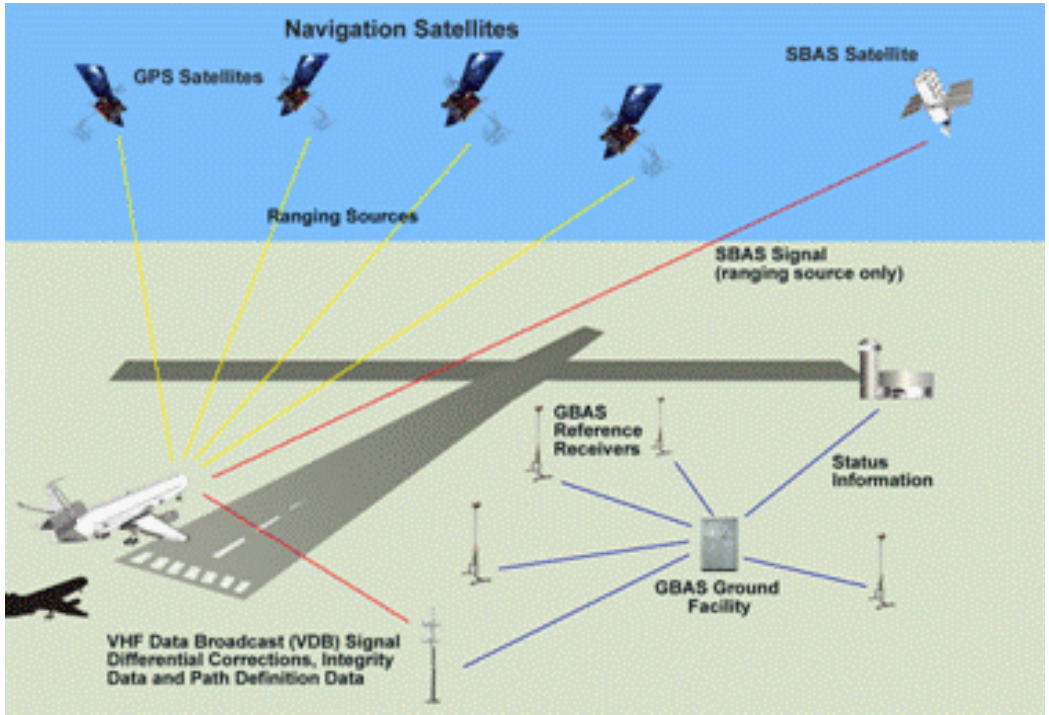
WAAS Procedure Production



	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10
CUMULATIVE LPV GOAL	0	0	100	400	914	1214	1514	1814
LPV to NON-ILS RWY ENDS	1	10	106	328	516			
LPV to ILS RWY ENDS	2	29	157	286	409			

Type of Approach	Procedures To Date
Total GNSS Approaches	4225
LNAV/VNAV	1121
LPV	925

Local Area Augmentation System (LAAS)



- **Precision Approach For Category I, II & III**
- **Multiple Runway Coverage At An Airport**
- **Terminal Area Procedures for Arrival and Departure**

LAAS Status

- **Integrity Analysis and Prototype Development**
  - FAA GBAS prototype work under Honeywell Contract
  - Hazardous Misleading Information (HMI) Analysis underway to validate GBAS architecture/design
- **GBAS CAT I Approval Process**
  - System Design Approval for Honeywell architecture (SLS 4000) Planned to Complete by 2008
- **GBAS Avionics**
  - GBAS/LAAS Standards (MASPS / MOPS / TSO / SARPS) completed
  - Boeing 737-800 series GBAS equipped
  - Airbus A320, A380 certification planned for 2007
- **CAT-III Research & Development Activities**
  - Continuing Work to Develop Requirements Compatible with Aircraft Operations and Approval Process
- **International GBAS Cooperation**
  - International GBAS Working Group
  - FAA Memorandum of Cooperation established with Australia, Brazil, Spain, Germany

Questions

Service Requirements

	En Route (RNAV-2)	Terminal (RNAV-1)	LNAV (NPA)	LNAV/ VNAV	LPV	LPV 200
Time To Alarm (TTA)	15 s	15 s	10 s	10 s	6.2 s	6.2 s
Horizontal Alert Limit (HAL)	2 nm	1 nm	556 m	556 m	40 m	40 m
Vertical Alert Limit (VAL)	N/A	N/A	N/A	50 m	50 m	35 m
Probability of Misleading Information	10^{-7}/hour	10^{-7}/hour	10^{-7}/hour	2×10^{-7} /approach	2×10^{-7} /approach	2×10^{-7} /approach
Horizontal Accuracy (95%)	0.4 nm	0.4 nm	220 m	220 m	16 m	16 m
Vertical Accuracy (95%)	N/A	N/A	N/A	20 m	20 m	4 m