Modernization of the U.S. National Airspace

Presented to: ICAO Workshop, Chile April 2008

By: Dave Peterson for

Daniel Salvano, Director Navigation Services

Date: 15 April 2008

Federal Aviation
Administration

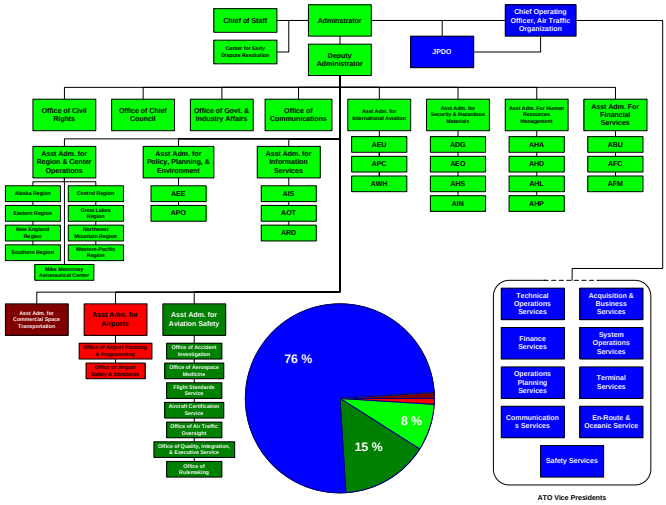
Vision: To improve the safety and efficiency of aviation, while being responsive to our customers and accountable to the public

Air Traffic Organization

Safety. Service. Value.

Leading Aviation Services into the Future

FAA Organization



Navigation Services Vision

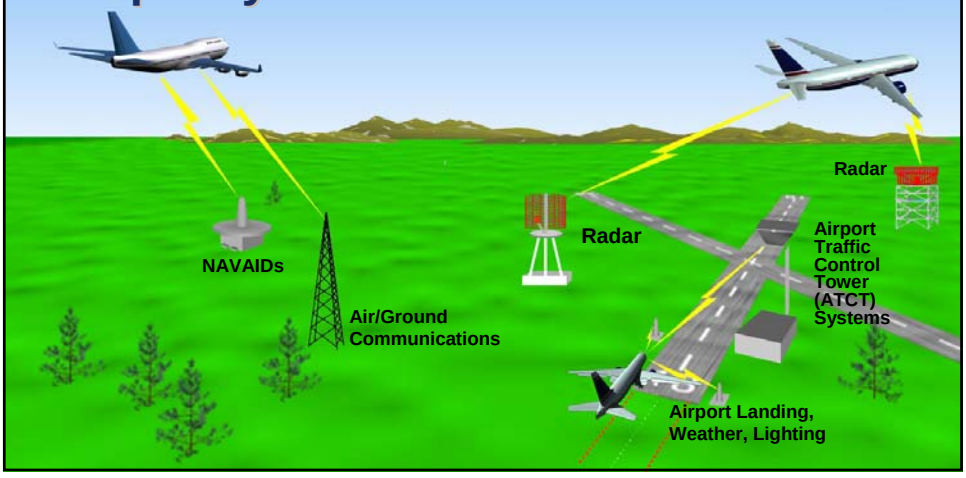
- **Provide safe, cost effective position, navigation, and timing services to meet operational needs of aviation customers**

Note – Navigation services vision serves the FAA Mission and ATO Corporate Principles

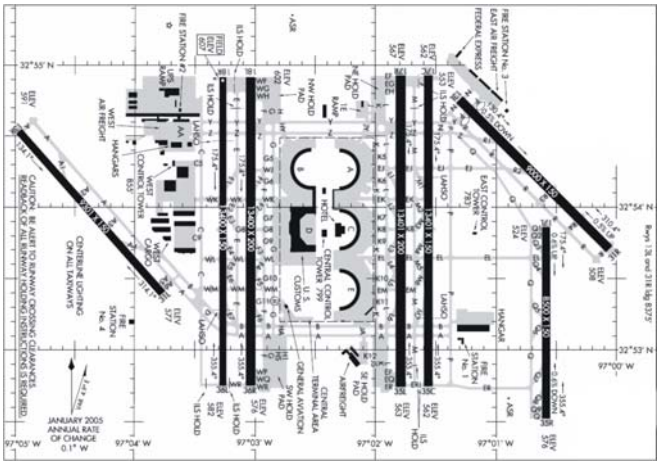
Navigation Operational Benefits Hierarchy

Operational Benefit	**IMC Operations, Gate Management**
Navigation Services	**Departure, Enroute, Approach, Surface**
Navigation Capability	**Category I/II/III, RNAV SIDS, RNAV STARS, Q Routes**
Navigation Systems	**DME, VOR, ILS, WAAS, GPS, MALSR**

Today's *ground based, human-centered* Air Transportation System is reaching its technological and capacity limits

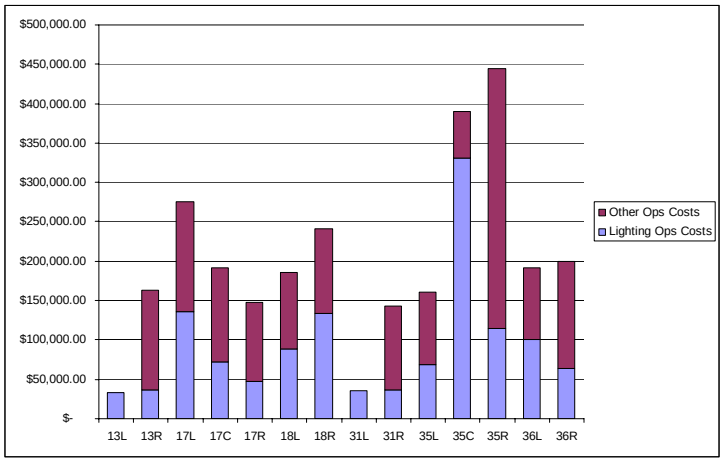


Dallas Fort Worth International



- **World's 3rd Busiest Airport by Traffic**
  - ~ 700,000 Movements
- **14 Runway Ends**
  - 2 Non Precision
  - 7 Cat I
  - 5 Cat II/III

Annual Ops and Maintenance Costs DFW - 2005



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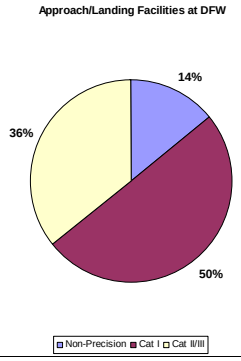
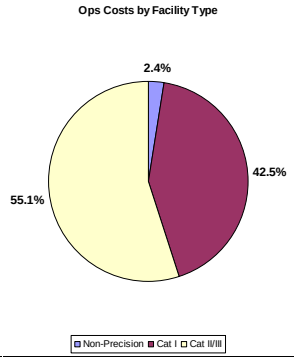
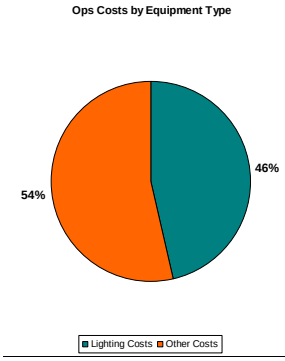
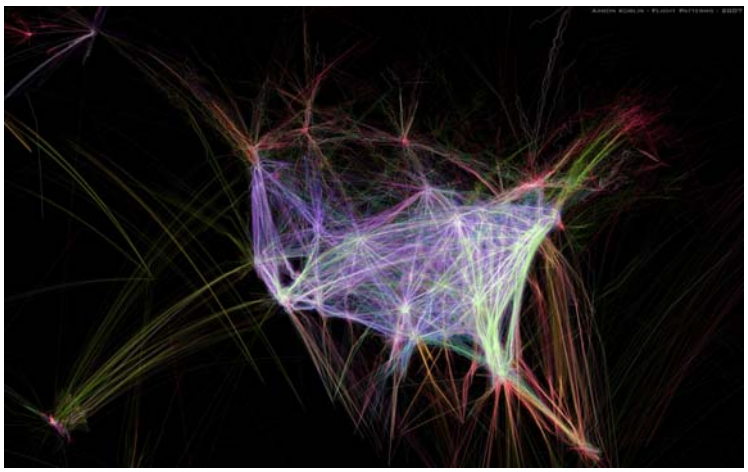






Daily Flight Traffic Over the U.S.



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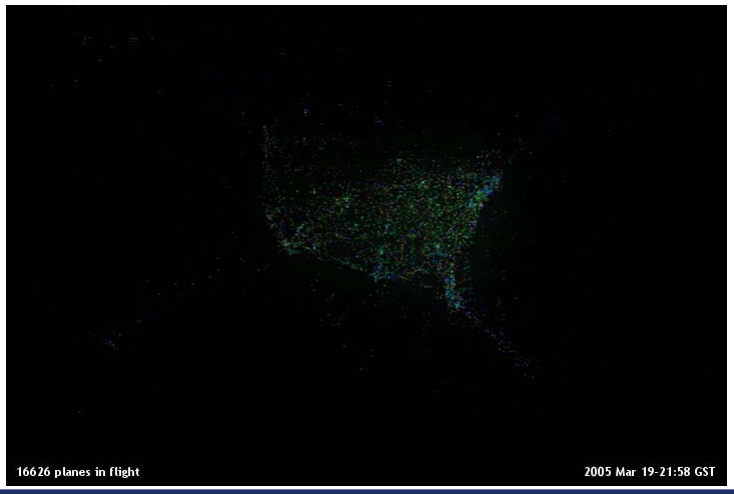


NextGen Senior Policy Committee

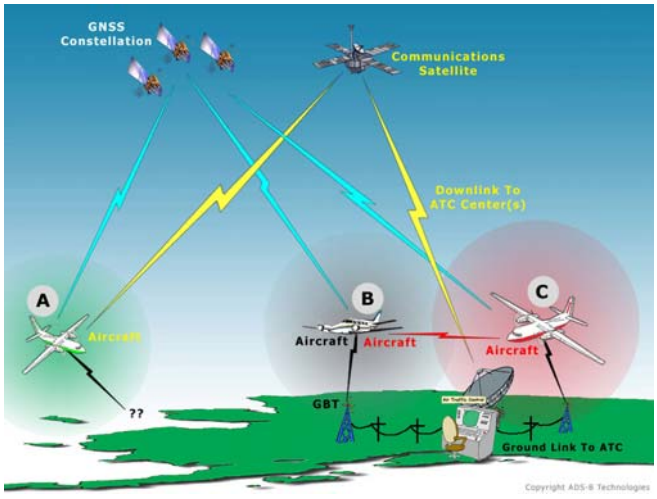
- **Department of Transportation**
  - Mary E. Peters, Secretary of Transportation
  - Jeffrey N. Shane, Under Secretary for Policy
- **Department of Defense**
  - Michael W. Wynne, Secretary, United States Air Force
- **Department of Commerce**
  - Vacant, Deputy Secretary
- **Department of Homeland Security**
  - Paul A. Schneider, Acting Deputy Secretary
- **White House Office of Science and Technology Policy**
  - Dr. John Marburger, Director
- **NASA**
  - Dr. Michael Griffin, Administrator
- **FAA**
  - Robert Sturgell, Acting Administrator

The Next Generation Air Transportation System (NextGen) Plan Defines A System That Can Meet Demands For The 21st Century

Capabilities

- Trajectory-Based Operations
- Performance-Based Operations and Services
- ***Precision Navigation***
- Weather Integration
- Network-Centric Information Sharing
- ***Surveillance Services***
- Equivalent Visual Operations
- Super Density Operations
- Layered, Adaptive Security

Automatic Dependent Surveillance (ADS-B)

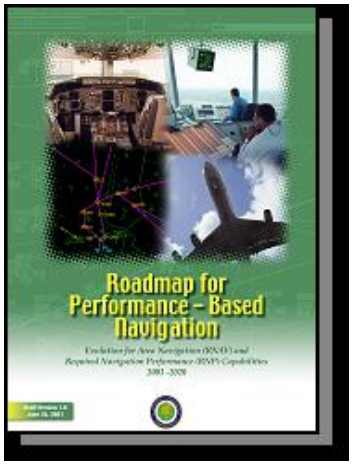


ADS-B Program

- **Benefits**
  - Safety Improvements By Increasing Situational Awareness Both In-flight And On The Ground
  - Increased Operational Efficiency Through Higher Air Traffic Throughput
- **Schedule**
  - Final Rulemaking Issued 2010
  - Avionics Implementation 2010-2020
  - Ground Infrastructure Completion 2013
- **FAA Lifecycle Costs To 2035 ~ $2.4B**

ADS-B is a Primary Building Block for NextGen

Roadmap for Performance-Based Navigation



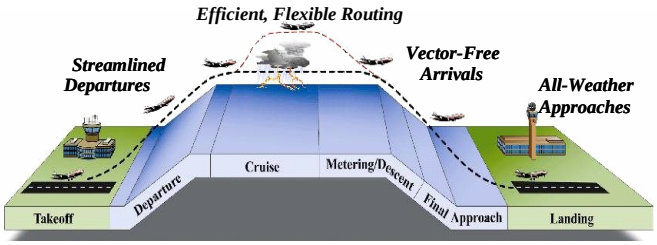
- **The Roadmap for Performance-Based Navigation v2 was published in 2006**
- **FAA Navigation Services has developed the Navigation Evolution Roadmap that defines the infrastructure now and in the future for implementation of RNAV, RNP and NextGen**

What Is "Performance-Based" Navigation?

- **An End-to-End Air Transportation System Based On Performance Standards Rather Than Specific Technologies Or Equipment**
  - Area Navigation (RNAV)
  - Required Navigation Performance (RNP)
- **Recognizes The Ability Of Modern Aircraft To Operate Safely And Efficiently Using A Variety Of On-Board Systems and External Signals**

Performance-Based Navigation in the United States

- **Complete Transition By 2025**
- **Consistent With ICAO Global Vision**
- **Operational Capability Based On GPS And Augmentations**
- **Enhance Safety, Capacity, Efficiency**
- **Reduce Cost For Legacy Navigation Systems**



ICAO: Basic Elements of PBN Implementation (RNAV or RNP)

NAVAID INFRASTRUCTURE

Possible Systems
GNSS, DME/DME, DME/DME/IRU, ...

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NAVIGATION SPECIFICATION

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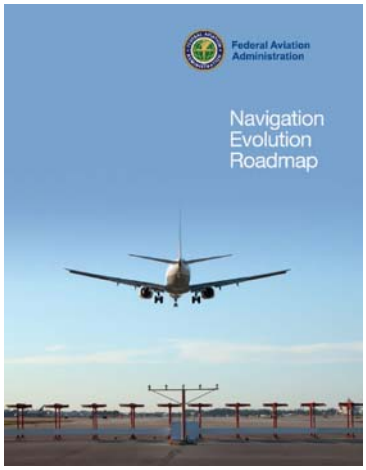
NAVIGATION APPLICATION

Air Traffic System Airspace, Routes and Instrument Procedures

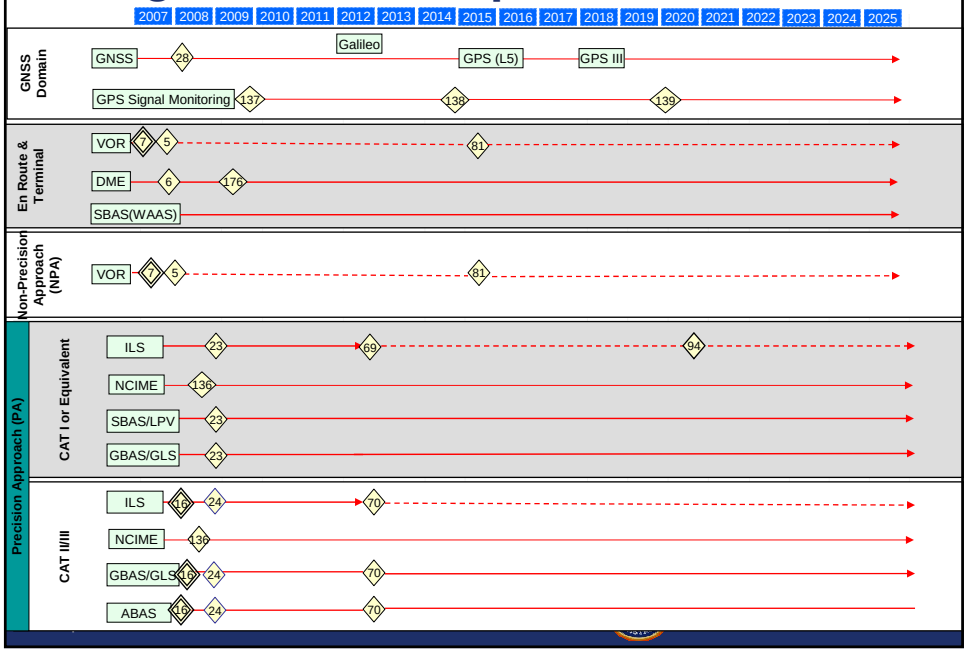
Airworthiness and Operator Requirements

Navigation Evolution Roadmap



- In formal coordination for signature by FAA Administrator
- Provides a high-level framework for transition to performance-based navigation from navigation services primarily based on terrestrial-based systems
- Collaborative effort with aviation community
- Companion business plan

Navigation Roadmap



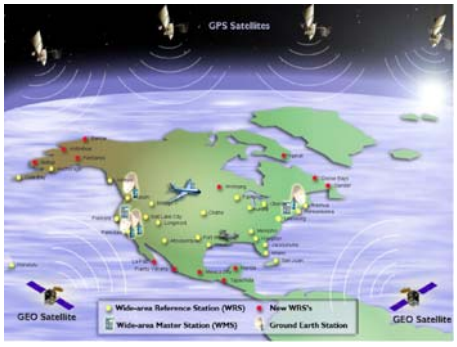
Navigation Roadmap Decisions

- 5 **2007 - VOR decision for drawdown based on GNSS**
- 6 **2007 - Develop rightsizing DME Requirements, e.g., service volume, architecture, pathway**
- 23 **2008 - Decision on NextGen CAT I landing system**
- 24 **2008 - Decision on NextGen CAT II/III service, pending feasibility & schedule of potential ABAS/GBAS solutions and risk mitigation strategies**
- 69 **2012 - Begin ILS CAT I drawdown - limited backup at OEP airports**
- 70 **2012 - Determine if CAT II minima is the appropriate requirement at specific airports**
- 81 **2015 - VOR decision on complete drawdown**
- 94 **2020 - Decision on complete ILS CAT I drawdown**

Navigation Roadmap Decisions (cont.)

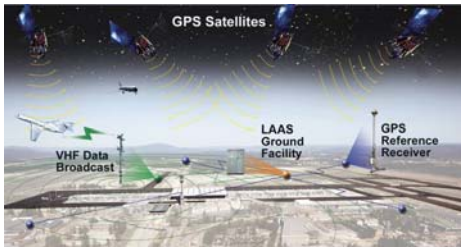
- 136 **2008 – NCIME Acquisition Decision**
- 137 **2009 – GPS Signal Monitoring Acquisition Decision**
- 138 **2014 – Signal Monitor Integration with GPS OCX Acquisition Decision**
- 139 **2019 – GPS Integrity Message Service ISD and WAAS Transition Decision**
- 176 **2009 - Develop phased approach for DME service to support RNAV/RNP**
- 7 **2007 – See Surveillance Roadmap**
- 16 **2007 - See Aircraft Roadmap**
- 28 **2008 – See Aircraft Roadmap**

Status of SBAS and GBAS Programs

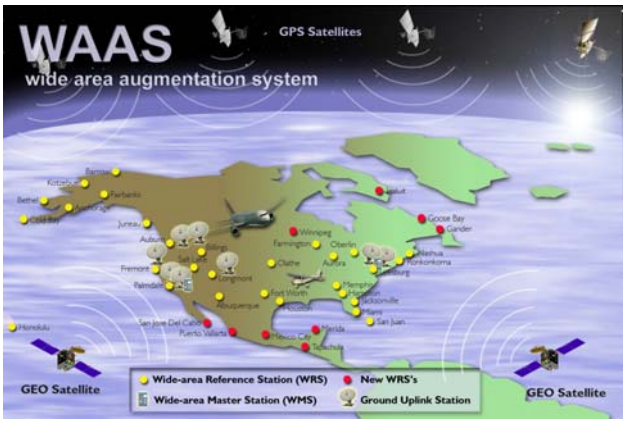


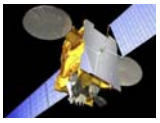
Wide Area Augmentation System (WAAS)

Local Area Augmentation System (LAAS)



WAAS Architecture





2 Geostationary Satellite Links

4 Signal Generator System/ Ground Earth Stations

3 Master Stations

38 Reference Stations

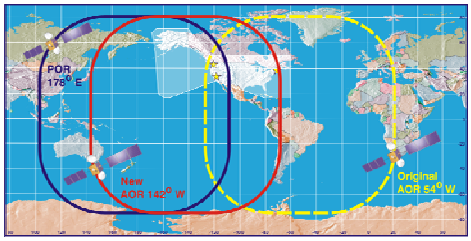
2 Operational Control Centers

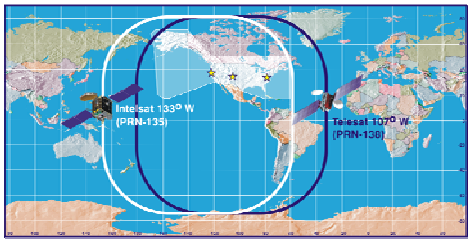
WAAS Phases

- **Phase I: IOC (July 2003)**
  - Provided LNAV/VNAV/Limited LPV Capability
- **Phase II: FLP (2003 – 2008)**
  - Improved LPV availability in CONUS and Alaska
  - Consists of additional WRS, hardware updates, software optimization, improved human factors, and GEO replacement
- **Phase III: Full LPV-200 (Cat I Equivalent) Performance (2009 – 2013)**
  - Development, modifications, and enhancements to include tech refresh
  - Steady state operations and maintenance
- **Phase IV: Dual Frequency Operations (2013 – 2028)**
  - Originally scheduled for 2009
    - Delayed to align with DoD's GPS Modernization Program (L5)
  - Will significantly improve availability and continuity during severe solar activity
  - Provide additional protection against unintentional GPS interference
  - Will continue to support single frequency users
  - Steady state operations and maintenance

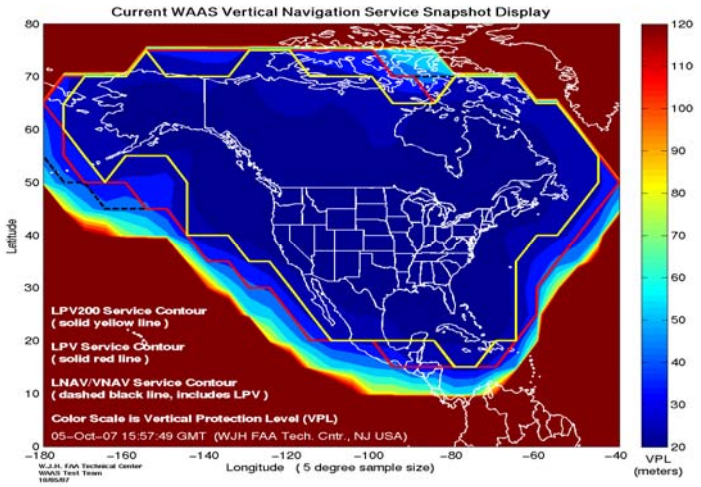
GEO Satellite Improvements

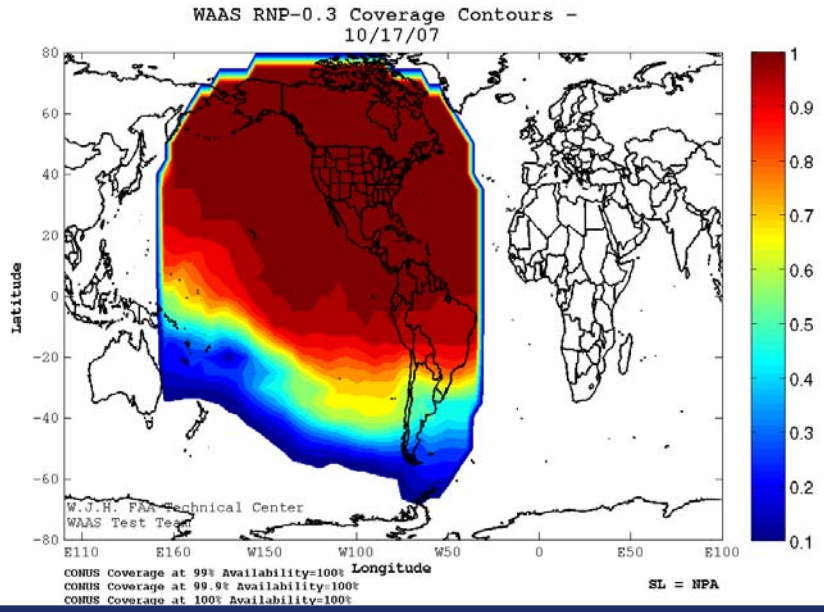
- **IOC WAAS (Commissioned system) utilized two Inmarsat satellites**
  - Provided single satellite coverage over the majority of the U.S.
  - Relocated to the west by owner
    - Lost coverage in New England
  - Inmarsat satellites removed from operational WAAS July 2007
- **Two replacement satellites launched in 2005, operational in July 2007**
  - Intelsat (Galaxy XV)
  - Telesat Canada (Anik F1R)

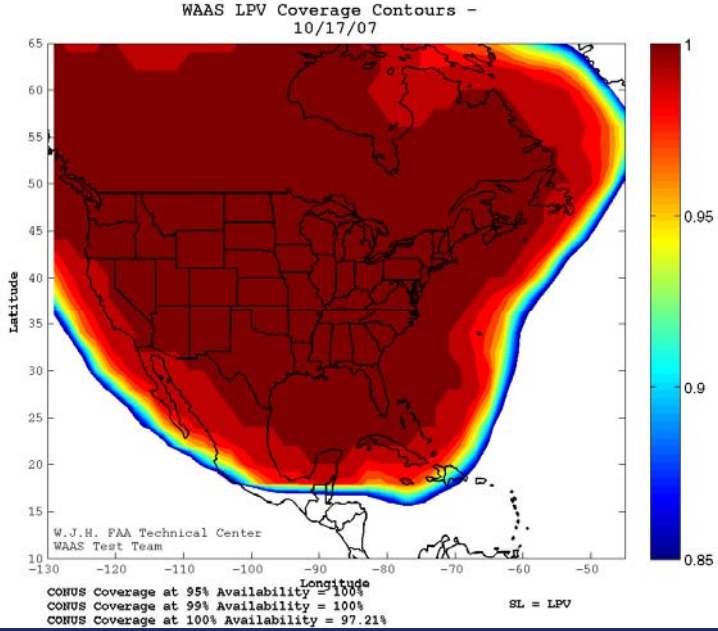


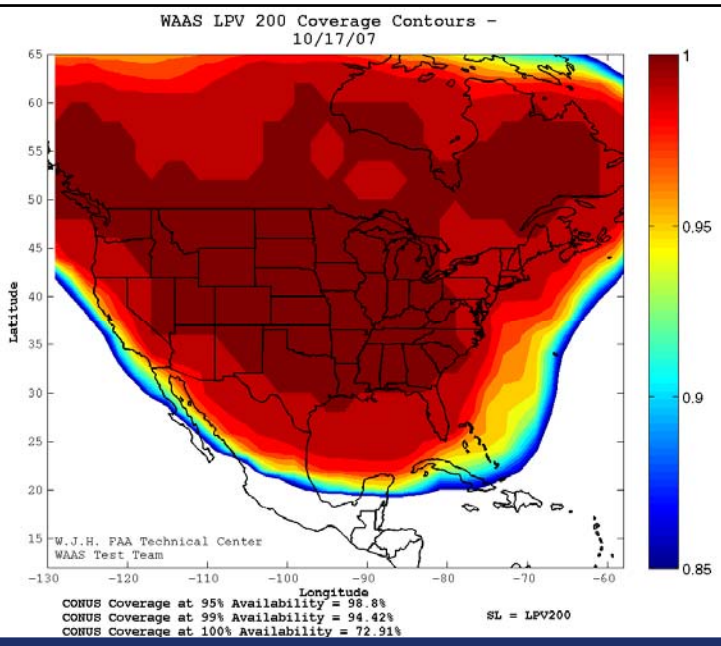


WAAS Performance

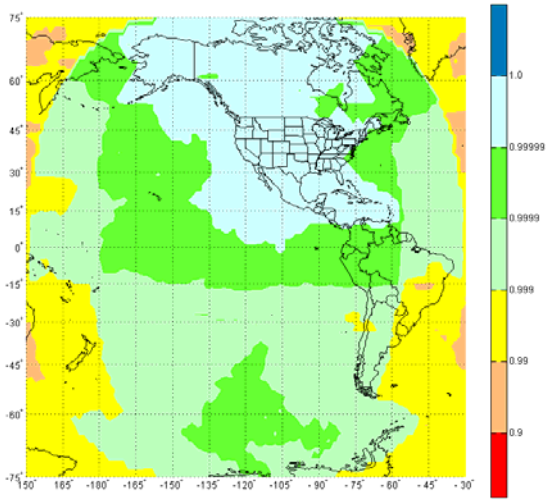



WAAS RNP-0.3 Coverage Contours -
10/17/07
Latitude
Longitude
W.J.H. FAA Technical Center
WAAS Test Team
CONUS Coverage at 99% Availability=100%
CONUS Coverage at 99.9% Availability=100%
CONUS Coverage at 100% Availability=100%
SL = NPA

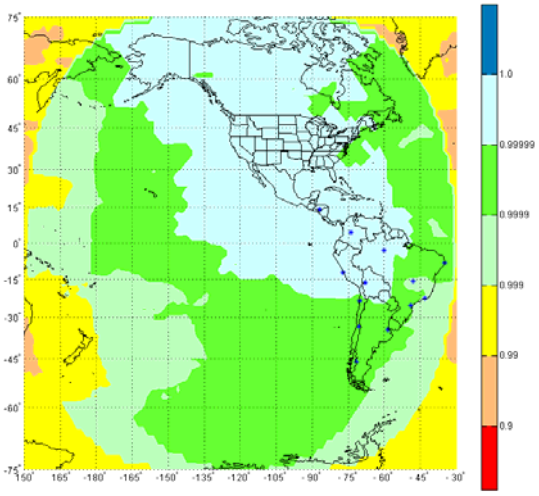

WAAS LPV Coverage Contours -
10/17/07
Latitude
Longitude
W.J.H. FAA Technical Center
WAAS Test Team
CONUS Coverage at 95% Availability = 100%
CONUS Coverage at 99% Availability = 100%
CONUS Coverage at 100% Availability = 97.21%
SL = LPV



Expected RNP .3 Performance at the end of WAAS Phase II Development (Sept 2008)



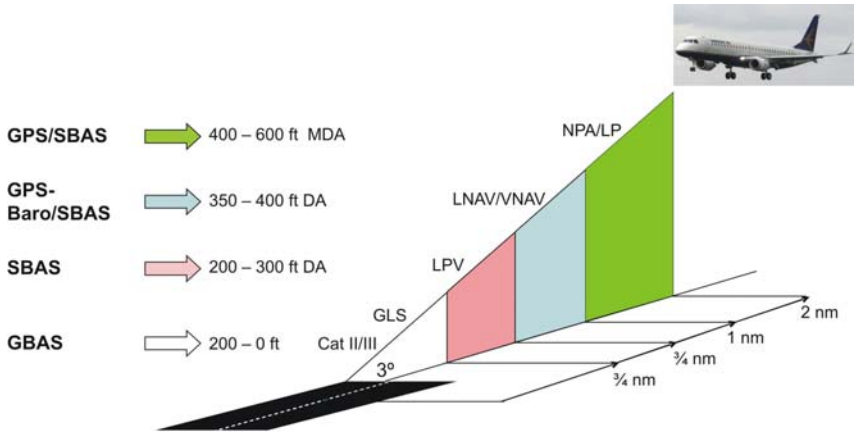
Theoretical Coverage of RNP .3 with 13 South American Reference Stations



New WAAS Procedures

- **LPV-200' Minimum**
  - Minimum decision height of new LPV approaches lowered 250' → 200'
  - First approach published in 2006
  - Will re-evaluate LPVs' for lower decision height after flight inspection aircraft upgrade (2011)
- **LP Approach**
  - Flown like a Localizer approach
  - Can be developed at approaches that fail to meet LPV criteria due to obstacle clearance surface (OCS) penetrations (same TERPS for ILS)
  - Criteria development in formal coordination; Publication starting in 2008
  - Unlike an ILS, will have LPV or LP on approach chart, but not both.
  - If WAAS correction is lost, avionics defaults to LNAV procedure

Approach Procedures



LAAS

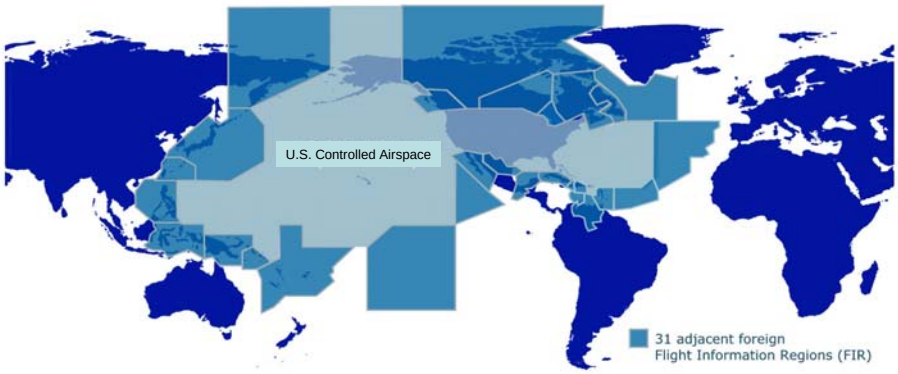
- The Local Area Augmentation System (LAAS) Represents the U.S. Approach to the International Goal of an Interoperable GBAS Capability
- LAAS Provides a Navigation Signal That Supports the Most Demanding RNP Requirements
- LAAS is complementary to SBAS
- One LAAS Can Cover the Entire Terminal Area and Enables Precision Guidance
  - Precision approach for Category I, II & III
  - Multiple runway coverage
  - Complex procedures Guided missed approaches and departure procedures
  - Aircraft surface navigation
- GBAS/LAAS CAT I avionics documents (MASPS / SARPS/ MOPS / TSO) complete

Summary

- The U.S. is transitioning to a performance based CNS/ATM system
- GNSS is one of the cornerstones of NextGen
- RNAV/RNP is being implemented throughout the U.S. National Airspace
- SBAS (WAAS) will complete LPV development in September 2008
- GBAS (LAAS) will complete Cat-I development in December 2008
- The United States will continue its multilateral and bilateral efforts

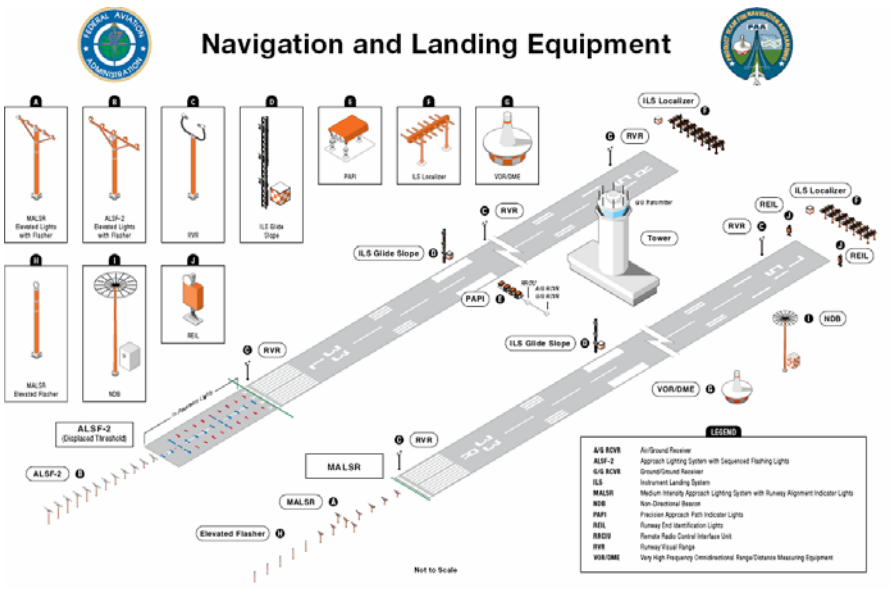
Backup

Int'l Cooperation… A Necessity

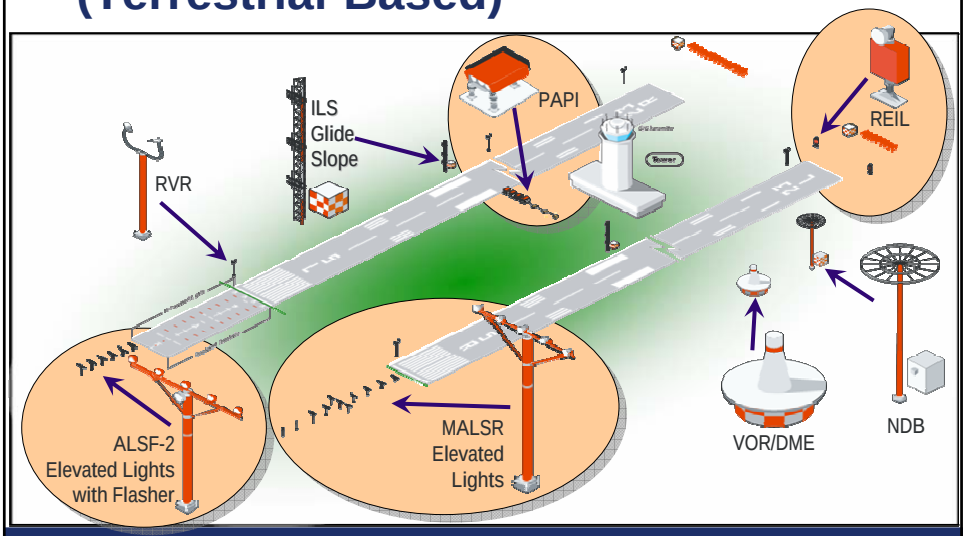


- **U.S. Assigned Airspace Equals 77 Million Square Kilometers**

Navigation and Landing Equipment



Navigation and Landing Facilities (Terrestrial-Based)



Navigation Service Roles & Responsibilities

- **Provide safe, cost effective position, navigation, and timing services to meet the needs of aviation customers**
- **Provide precision approach and landing capability to runway ends in the National Airspace System**
- **Provide non-precision approach and landing capability to runway ends in the National Airspace System**
- **Provide missed approach capability to runway ends in the National Airspace System**
- **Provide navigation capability to aircraft flying in the National Airspace System**
- **Support the operational availability of navigation services/systems in the National Airspace System**