



***United States Global Positioning  
System (GPS) and Augmentation  
Systems Update***

***Provider's Forum of the  
International Committee on GNSS***

***Vienna, Austria***

***18 February 2008***



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David Turner

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Jules McNeff

**WAAS/LAAS**

Hank Skalski



# *Services and Provision Policies*



- The U.S. supports free access to civilian GNSS signals with public domain documentation necessary to develop user equipment
- GPS is a critical component of the global information infrastructure
  - Compatible with other satellite navigation systems and interoperable at the user level
  - Guided at a national level as multi-use asset
  - Acquired and operated by Air Force on behalf of the USG
- U.S. Government policy promotes open competition and market growth for commercial GNSS

**GPS is a Global Public Service providing consistent, predictable, dependable performance**



# *International Cooperation Update*



- **Multi-lateral**

- ICAO General Assembly in mid-Sept. 2007 – U.S. Transportation Secretary Peters announced that Selective Availability would not exist in new GPS III satellites
- Providers Forum and ICG Planning meetings
- ICG-3 to be hosted by the U.S. at Pasadena, California in December 2008
- The U.S. will also participate in ICG working group meetings

- **Bi-lateral**

- EU: Next radiofrequency compatibility and interoperability working group to be held in April in France
- Japan: Working to establish QZSS Monitoring Stations at Hawaii and Guam
- India: U. S.-India meeting at Bangalore, January 22-24 on GPS & IRNSS compatibility, interoperability, spectrum issues, and ITU coordination requirements
- South Africa: Sept. 2007 discussions on coordination and co-location of GPS instruments throughout Africa to provide data streams for geologic research, space weather observations, and geodetic reference



# ***Global Positioning System (GPS) Status***

***Jules McNeff***

*representing*  
*Office of the Assistant Secretary of Defense*  
*Networks and Information Integration*  
*U.S. Department of Defense*



# *Overview*



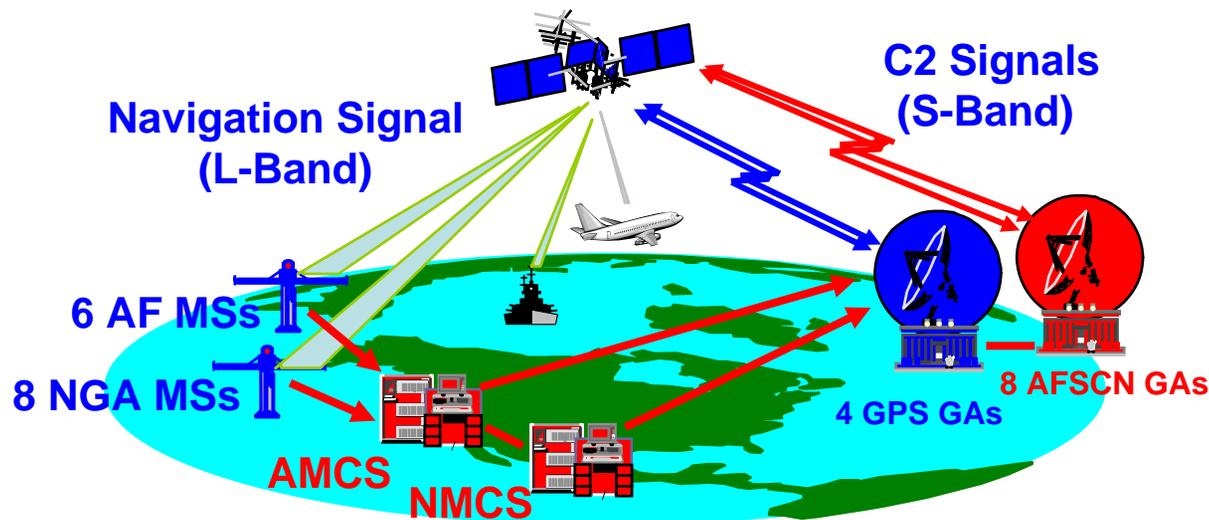
- System Update
- Current Status
- Near-Term Plans



# Operational Control Segment (OCS) Modernization: Architecture Evolution Plan (AEP)



- **Transitioned to the new AEP OCS (10-14 Sep 07)**
- **IIR-17(M) launched 17 Oct 07 was controlled by new system**
  - Replaced previous Command & Control System (CCS)





# GPS Constellation Status & Availability as of 11 Jan 08



## 30 Healthy Satellites

Baseline Constellation: 24

- 13 Block IIA satellites
- 12 Block IIR satellites
- 5 Block IIR-M satellites
  - **3 additional IIR-M satellites to launch**
- Since Dec 93, U.S. DoD met/exceeded GPS service performance commitments
  - **SPS & PPS Performance Standards**
- U.S. DoD committed to improving GPS service





# *GPS Launch Update*



- **Most Recent Launch**
  - IIR-18(M) – 5<sup>th</sup> modernized SV
    - Launched Wednesday, 20 Dec 07
    - SVN 57, PRN 29, slot C1
    - Set healthy on 2 Jan 08
- **Next Launches**
  - IIR-19(M) – Mar 08
  - IIR-20(M) – Jun 08
    - L5 demo payload
  - IIR-21(M) – Sep 08
- **IIF-1 launch in 2009**





# GPS Modernization



## Space Segment

### Block IIA/IIR

- Basic GPS
- Std Pos. Service
  - C/A civil signal (L1C/A)
- Precise Pos. Service
  - L1 & L2 P(Y)

### Block IIR-M

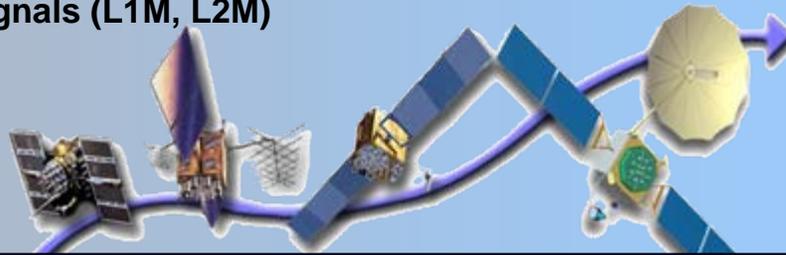
- 2nd civil signal (L2C)
- M-Code signals (L1M, L2M)

### Block IIF

- 3rd civil signal (L5)

### Block III

- Increased accuracy
- Increased power
- Signal integrity
- Search and Rescue
- Common signal with Galileo (L1C)



## Control Segment

### Legacy OCS

- TT&C
- L1 & L2 monitoring



### AEP

- IIR-M IIF TT&C
- WAGE, All, LADO
- SAASM
- New MCS/AMCS

### OCX V1

- New Architecture
- Signal Monitoring

### OCX V2

- GPS III TT&C
- L1C, L2C, L5
- Real-Time C2



**GPS modernization process looks ahead beyond 2020**

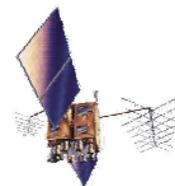


# GPS Modernization - Spectrum

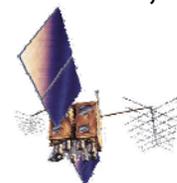


Block IIA  
1990

Block IIR  
1997



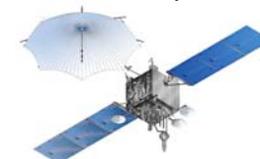
Block IIR-M, 2005



Block IIF, 2009

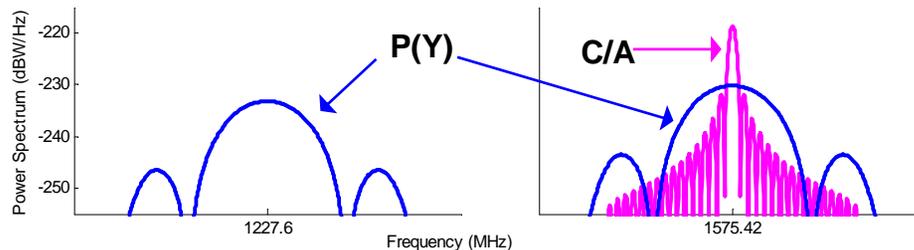


Block III, 2014

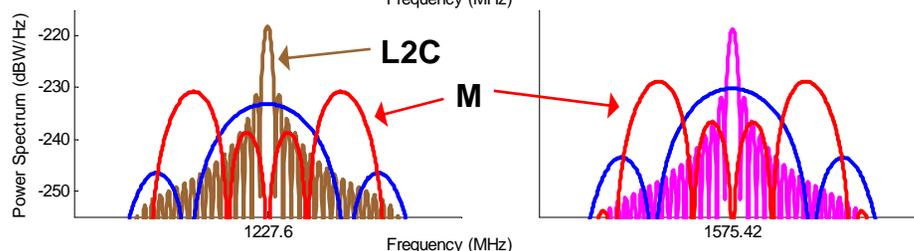


(artist's concept)

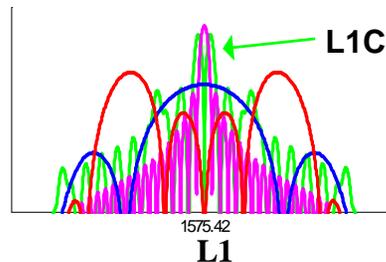
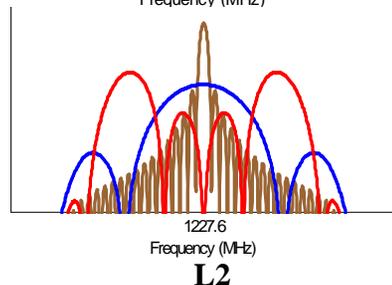
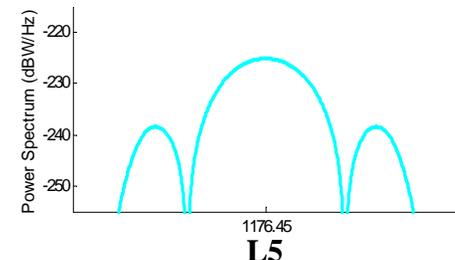
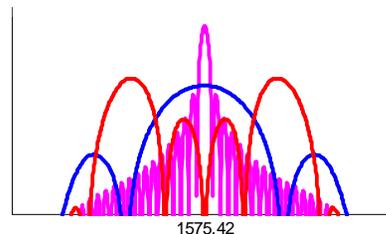
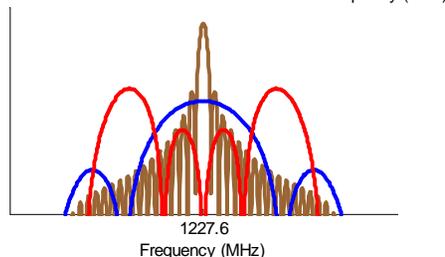
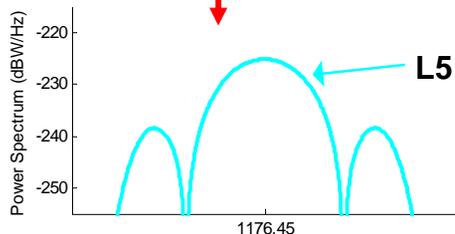
Previous →



since Dec 2005 (5 SVs) →



Planned ↓



ARNS Band

RNSS Band

ARNS Band



# *New Block III Signal for Civil Users – L1C*



- L1C will have the following benefits compared to L1 C/A:
  - Separate pilot carrier without data (75% of L1C power)
    - Pilot carrier provides 4.8 dB better code & carrier tracking threshold
  - Advanced FEC – 1.4 dB better data demodulation threshold
  - Ability to demodulate messages down to carrier tracking threshold
  - More precise message structure (as with L2C and L5)
  - Longer PRN codes (better correlation performance)
  - Min L1C power specified to be 1.5 dB higher than C/A
  - EU & US teams designed new MBOC power spectral density
    - GPS TMBOC: BOC(1,1) chips time-multiplexed with BOC(6,1) chips
    - Provides more code transitions to enhance multipath mitigation
  - L1C draft specification, IS-GPS-800, available
    - Final approval is expected soon
    - Wait for approved version before committing to silicon



# *Summary*



GPS has been operational and has met its civil service performance commitment continuously since Dec 1993

- Performance continues to exceed standards
- GPS modernization is underway
  - New civil signals being launched
  - Modernized control capabilities being implemented



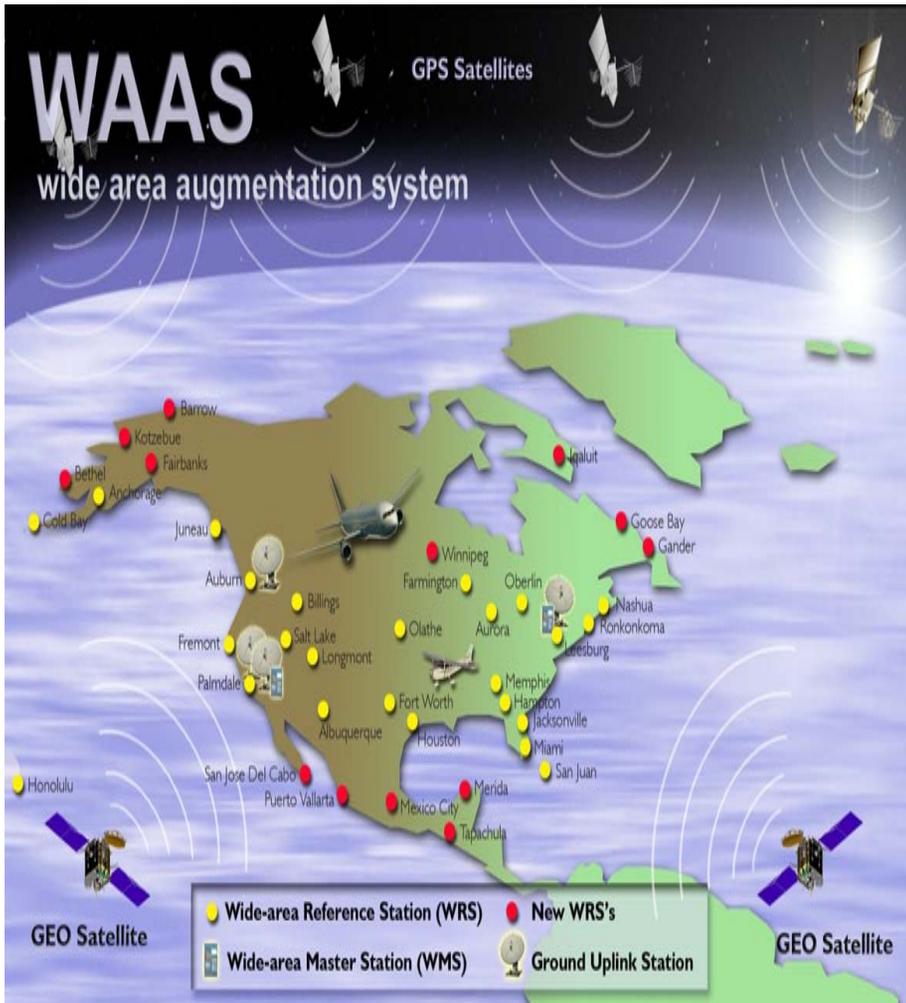
***Wide Area Augmentation System  
(WAAS) and Local Area  
Augmentation System (LAAS)  
Update***

***Hank Skalski***

***DOT/FAA Liaison to  
Air Force Space Command***



# WAAS Architecture



**38 Reference Stations**



**3 Master Stations**



**4 Signal Generator System/ Ground Earth Stations**



**2 Geostationary Satellite Links**



**2 Operational Control Centers**



# ***WAAS Performance***

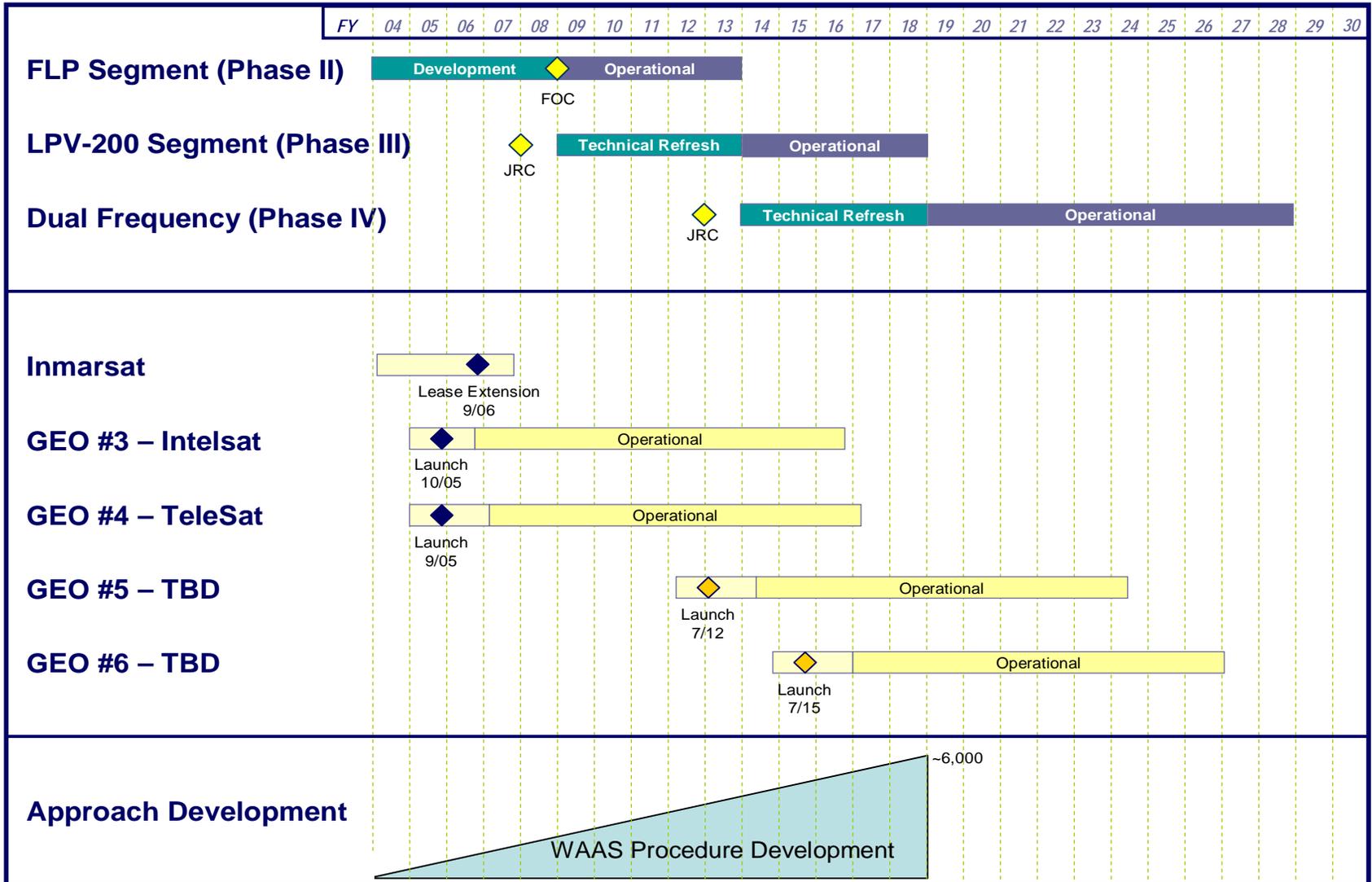
	GPS Standard	GPS Actual	WAAS LPV-200 Standard	WAAS LPV-200 Actual
Horizontal 95%	36 m	2.74 m	16 m	1.08 m
Vertical 95%	77 m	*3.89 m	4 m	1.26 m

*\* Use of GPS vertical not authorized for aviation without augmentation (SBAS or GBAS)*

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



# WAAS Enterprise Schedule

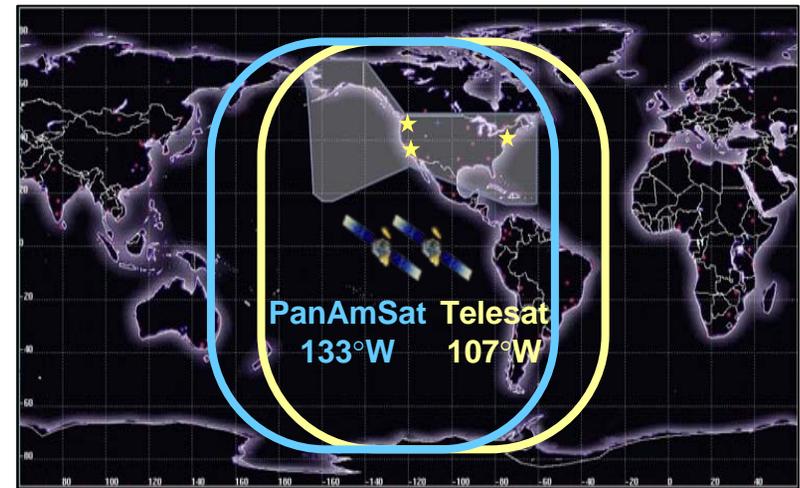
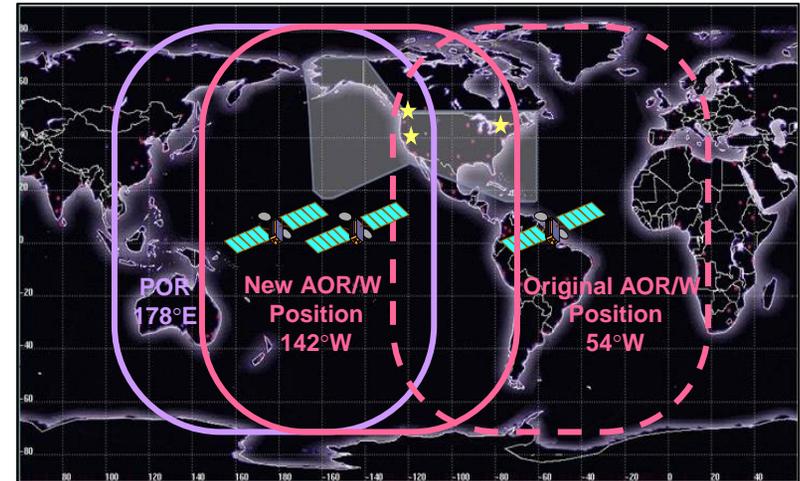




# GEO Satellite Improvements

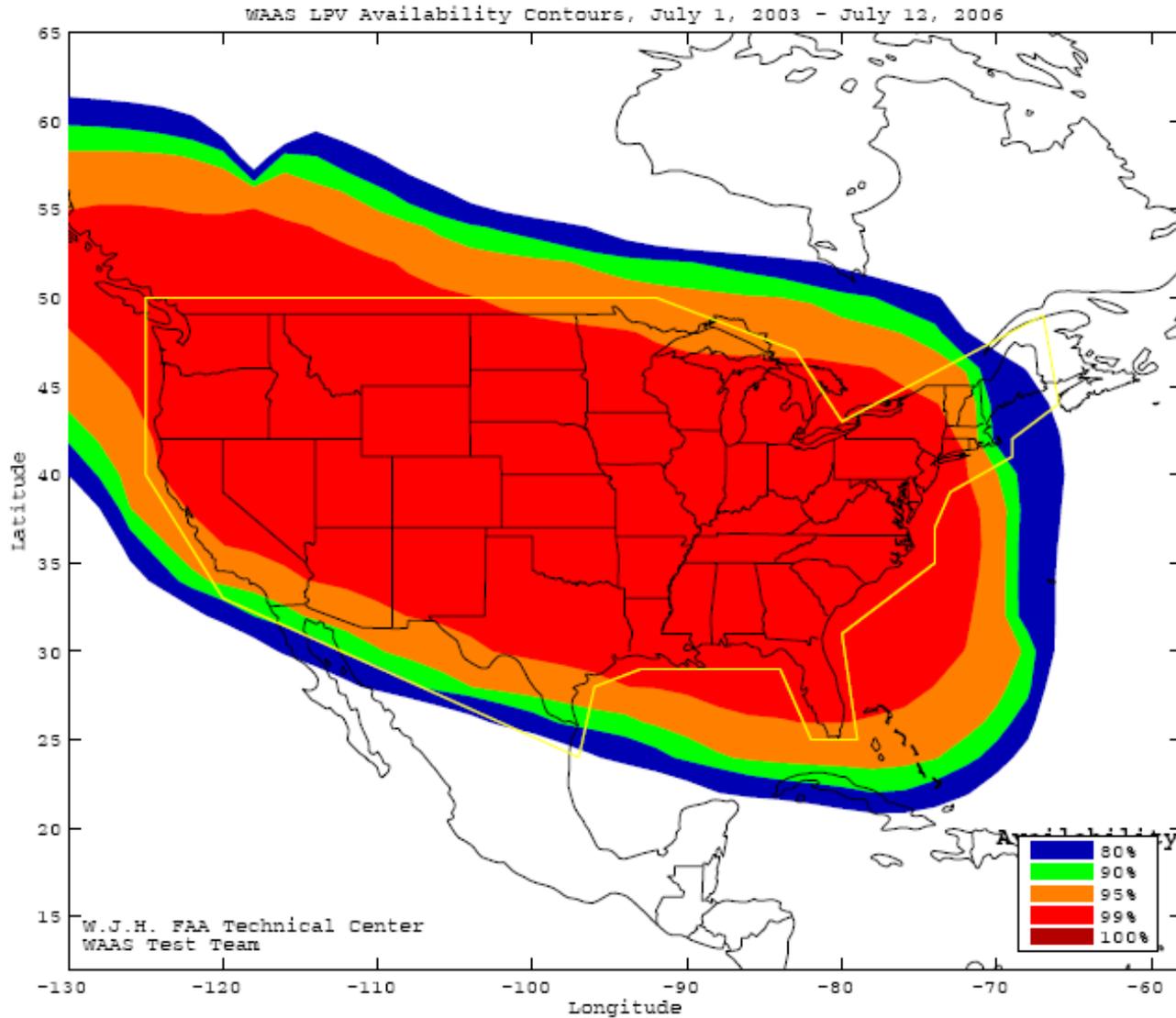


- Phase I – IOC
  - Inmarsat Satellites
    - AOR-W – 54W
    - POR – 178E
  - AOR-W Moved to 142W
  - Leases Expired July 2007
- Phase II - FLP
  - New GEOs
    - Intelsat (Galaxy XV) – 133W
    - Telesat Canada (Anik F1R) – 107W
  - Operational July 2007
  - 10 Year Lease



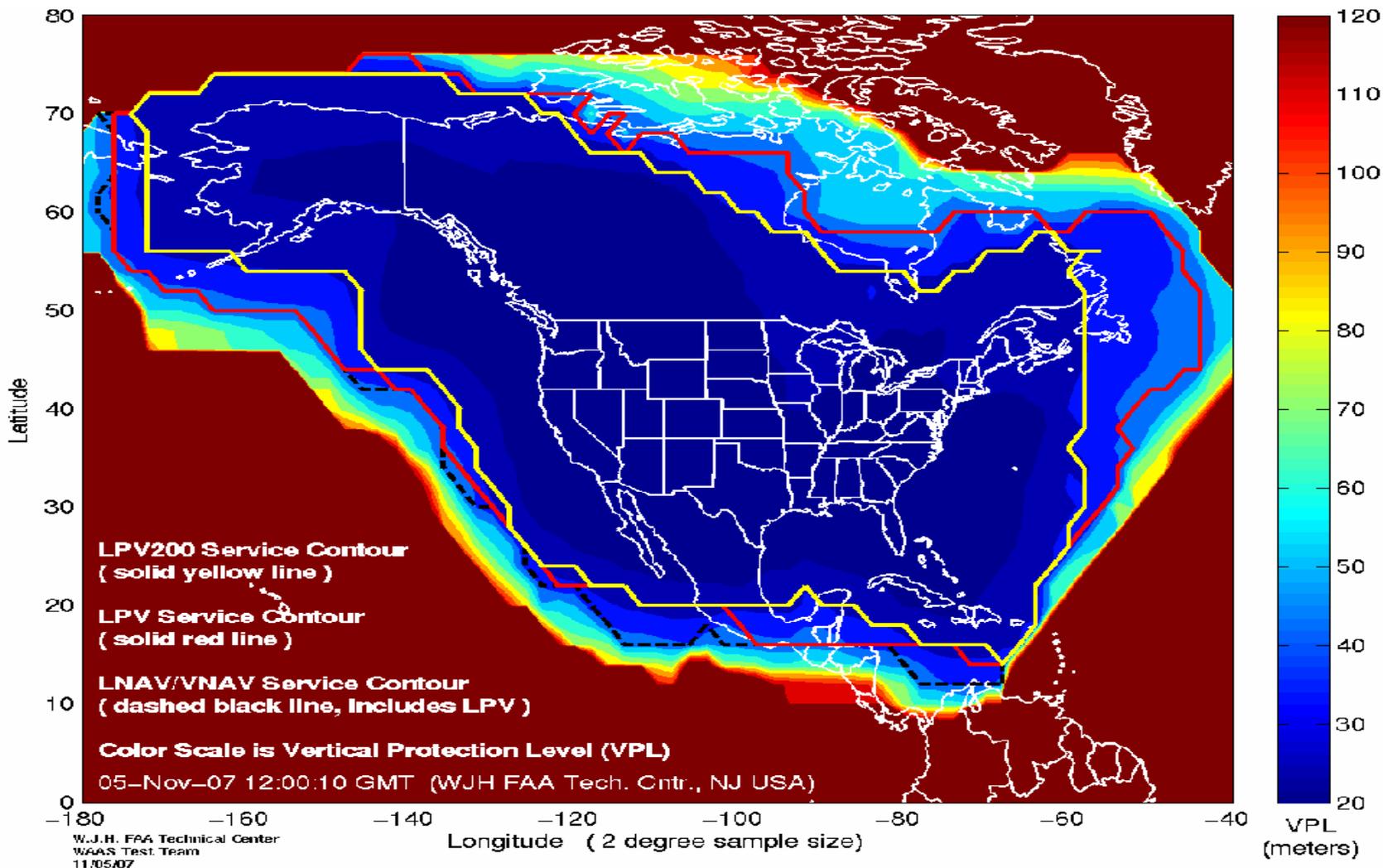


# WAAS LPV Coverage - Initial Operating Capability -



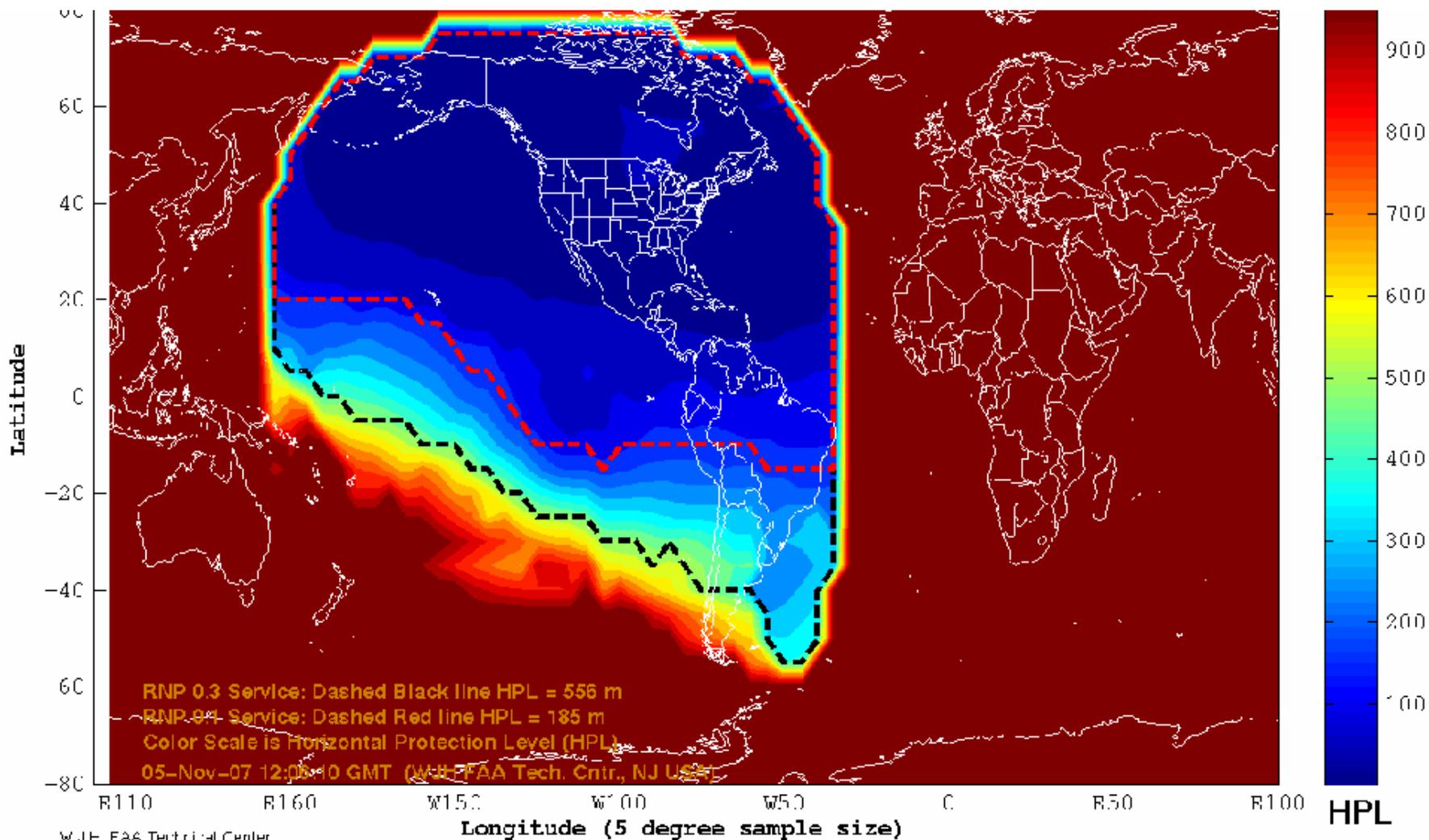


# WAAS LPV Coverage - Current 2008 -





# WAAS RNP Coverage - Current -



W.J.H. FAA Technical Center  
WAAS Test Team  
05 Nov 07 12:05:10 GMT