



# ***GPS Modernization and Program Update***

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Munich, Germany**

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**Colonel Bernie Gruber  
Director  
Global Positioning Systems Directorate**



# Global Positioning Systems Directorate

## Mission:

Deliver sustained, reliable GPS capabilities to America's warfighters, our allies, and civil users



Col Bernie Gruber



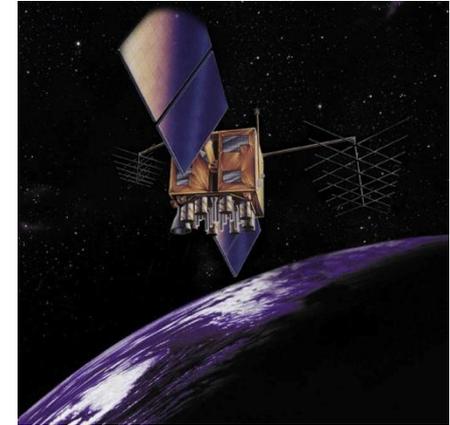
**Deliver and Sustain Global Navigation and Timing Service**



# GPS Enterprise

- **Very robust constellation**

- 31 space vehicles currently in operation
  - 11 GPS IIA, 12 GPS IIR, 7 GPS IIR-M, 1 GPS IIF
- 3 additional satellites in residual status
- 1 satellite set unhealthy– SVN 49



- **Extensive International and Civil Cooperation**

- Agreements with 53 international customers
- ¾ billion civil/commercial users
- Countless applications...and growing

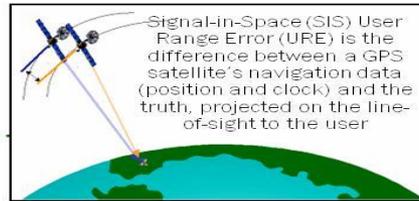
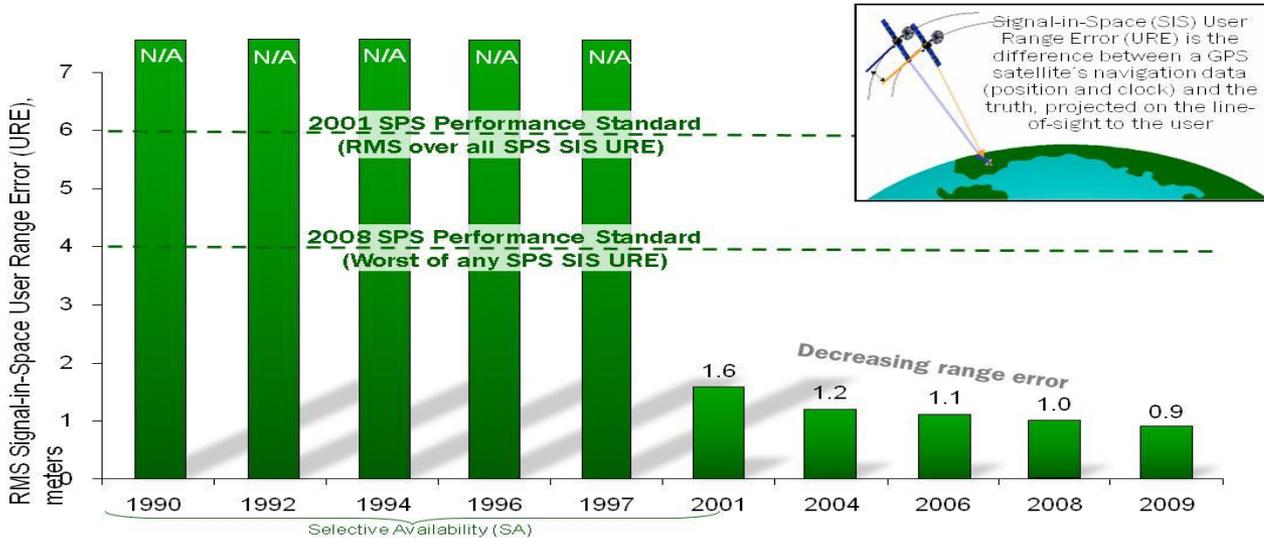


- **Global GPS civil service performance commitment met continuously since Dec 1993**



# GPS Signal in Space Performance

## Civilian Signal in Space Performance



Mining and Construction



Precision Agriculture

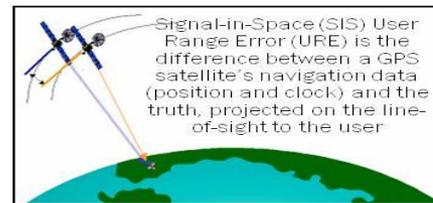
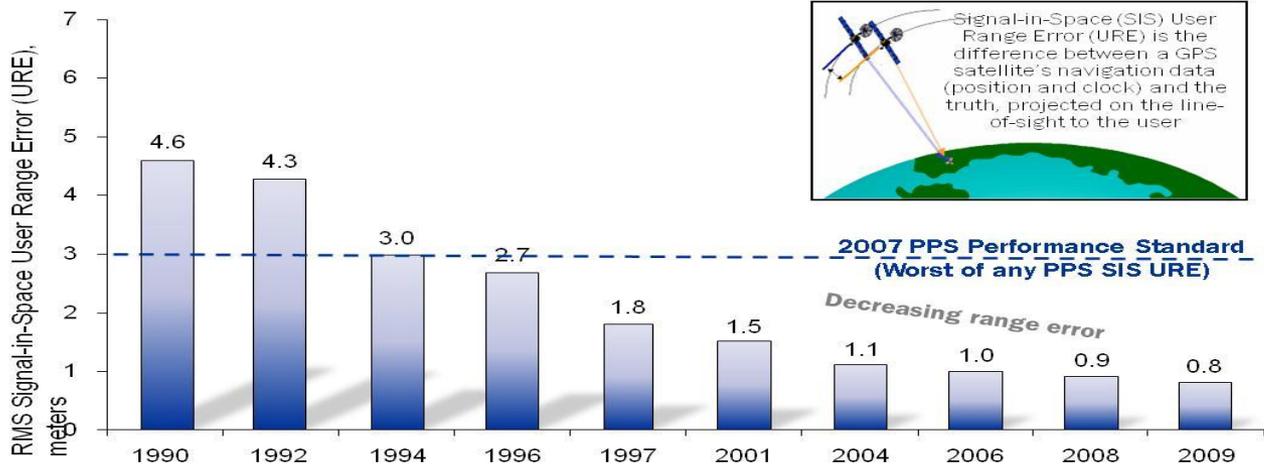


Wildlife Research



Aviation

## Military Signal in Space Performance



Precision Navigation



**System accuracy exceeds published standard**



# GPS Modernization

## Modernization is on track across the enterprise

### Space Segment (Satellites)

#### Legacy (Block IIA/IIR)

- Basic GPS
- Std Pos. Service
- Precise Pos. Svc



#### GPS IIR-M

- 2nd civil signal (Better Accuracy)
- New Military signal



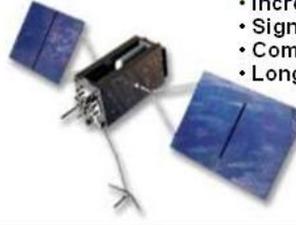
#### GPS IIF

- Longer Life
- Better Clocks
- 3rd Civil Signal (L5)



#### GPS III

- Increased Accuracy
- Signal Integrity
- Common L2C Signal
- Longer Life



Space Segment starting with IIRM (L2C), IIF (L5) and III (L1C)

### Control Segment

#### Legacy

- Mainframe System
- Command & Control
- Signal Monitoring

#### AEP

- Distributed Architecture
- Increased Signal Monitoring Coverage
- Security
- Accuracy
- Launch And Disposal Operations



#### OCX Block 1/2

- Control of Block III Satellites
- Net Centric Operations
- Upgraded Information Assurance

#### OCX Block 3/4

- Improved Integrity
- Improved Security
- Improved Performance



Ground Segment in OCX Blocks 2 and 3/4

### User Segment (Receivers)

#### Legacy

- First Generation System



#### User Equipment

- Improved Anti-Jam & Systems
- Reduced Size, Weight & Power



#### Upgraded Antennae

- Improved Anti-Jam Antennae



#### Modernized

- M-Code Receivers
- Common GPS Module



User Segment in MGUE

**Increasing System Capabilities ♦ Increasing Defense / Civil / International Benefits**



# GPS Modernization – New Civil Signals

- **Second civil signal “L2C”**

- Designed to meet commercial needs
- Available since 2005 without data message
- Phased roll-out of CNAV message
- Full capability: 24 satellites and full CNAV ~2016 \*



- **Third civil signal “L5”**

- Designed to meet transportation safety-of-life requirements
- Uses Aeronautical Radio Navigation Service band
- Available since 2010; 24 satellites and full CNAV ~2020\*



- **Fourth civil signal “L1C”**

- Designed for GNSS interoperability
- Specification developed in cooperation with industry
- Launches with GPS III in 2014
- Available on 24 SVs by ~ 2026\*
- Improved tracking performance



*Urban Canyons*

**Improved  
performance in  
challenged  
environments**

\* FOC dates are based on our best guess for launch schedule



# Space Segment

- **GPS IIR/IIR-M**

- All 20 satellites launched
- Excellent on-orbit performance - SIS URE of .50 meters
- L2C CNAV message type 0 capability deployed



- **GPS IIF**

- SV-1 set healthy 26 Aug 10
  - First operational L5
  - Excellent clock performance
- 11 more IIFs in production
- IIF SV-2 launch by summer 2011



- **GPS III**

- First satellite to broadcast common L1C signal
- Completed Critical Design Review for Block IIIA
- Completed Delta System Requirements Review for Block IIIB





# GPS Ground Segment



■ MCS at Schriever AFB, CO  
& Alternate MCS at VAFB



● 16 Monitor Stations  
6 OCS + 10 NGA



▲ 12 Ground Antennas  
● 4 GPS + 8 AFSCN





# *Pseudo-random Noise (PRN) Expansion*

- **Control segment is currently limited to 32 PRNs, limitation removed with OCX and expandable to 63 PRNs**
- **Legacy UE are limited to 32 satellites**
- **Current constellation has 31 operational satellites and 3 residual non-operational satellites**
- **Developing CONOPS and ICD changes to exploit additional PRN capability while remaining backward compatible with legacy UE**
  - Proposing to assign higher PRNs to the worst performing satellites
  - Soliciting feedback from user community



# Military User Equipment Paradigm Shift: The Common GPS Module (CGM)

## Commercial Paradigm

(GPS “engines” enable multiple applications)



Enablers Build  
“Engines”



Integrators Build  
Applications

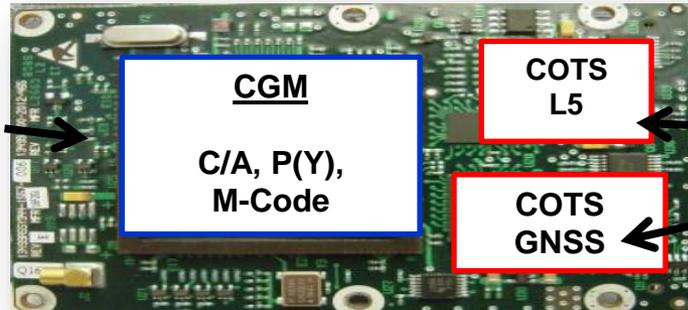


Global GPS  
Use

## MGUE Strategy

(Emulate commercial, Build the engine!)

CGM & MGUE receiver cards will include C/A, P(Y), and M-Code



Upgraded receivers may add L5, and other GNSS signals by integrating COTS chips on the receivers cards



GP Builds  
Enabling “Engines”



Integrators Build  
Applications



Global Military  
GPS Use

**Foreign PNT services “may be used to augment and strengthen the resiliency of GPS” - 2011 National Space Policy**



# Interface Specifications & Performance Standard

- **Interface Specifications (IS)**

- Defines the requirements related to the interface between the space segment of GPS and user equipment
  - IS-GPS 200 - L1 C/A, L2C
  - IS GPS 705 - L5
  - IS GPS 800 - L1C
  - <http://www.gps.gov/technical/icwg/>

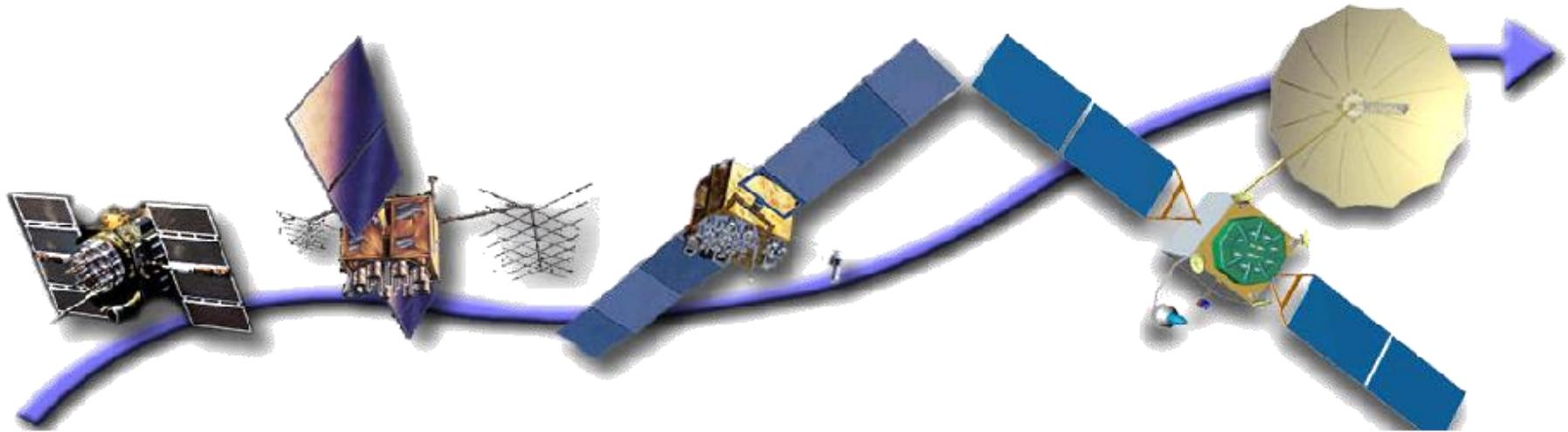
- **GPS Standard Positioning Service (SPS) Performance Standard**

- Defines the levels of performance the U.S. Government makes available to users of the GPS Standard Positioning Service
- Published November 1993
- Updated September 2008
- <http://www.gps.gov/technical/ps/>



# Summary

- Modernization of all GPS Segments is on track
- GPS continuous to meet its commitments to all users
- Striving to continually improve navigation and timing services while maintaining backward compatibility with legacy equipment
- New GPS Website: <http://www.gps.gov/>



**Maintaining And Improving GPS Services For All Users Is Job #1**



# Questions?





# *Back-Ups*

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- **SVN 49 was the 7<sup>th</sup> IIR-M, launched with demo L5 payload**
- **Exhibited signal distortion due to internal multipath between L5 filter and L1/L2 signals**
- **Removed from almanac while mitigations are developed and implemented**
  - 9 mitigation techniques investigated
  - No single solution identified which solves all issues for all users
  - Continuing to explore new mitigations
- **Goal is to make SVN-49 usable in the next 2 to 3 years**

