



GPS Modernization and Program Update

**Munich Satellite Navigation Summit
Munich, Germany**

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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
- $\frac{3}{4}$ billion civil/commercial users
- Countless applications...and growing

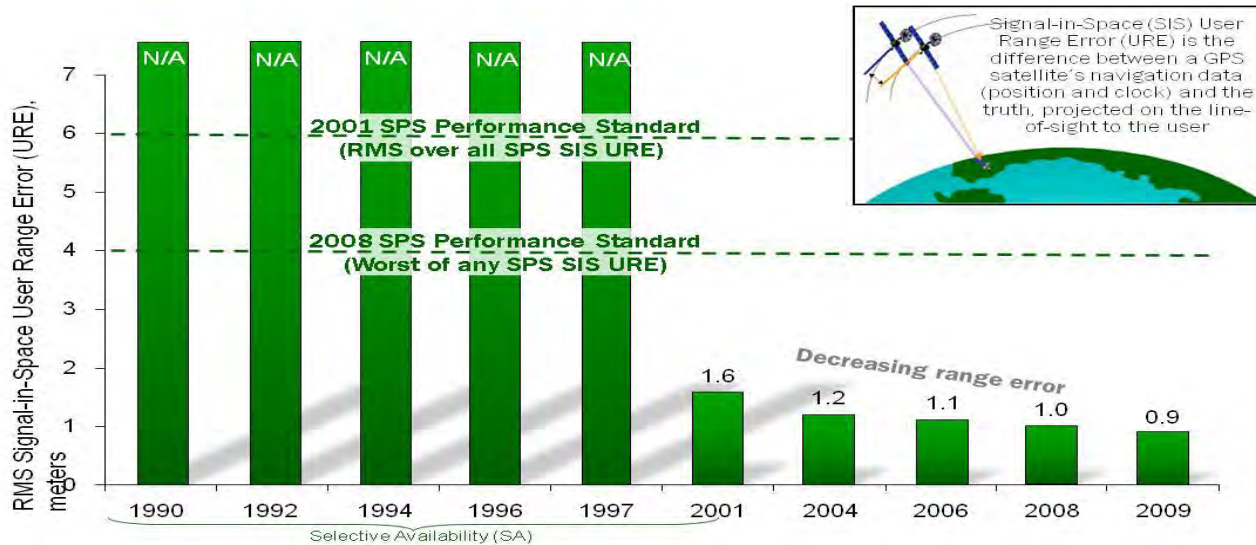


- **Global GPS civil service performance commitment met continuously since Dec 1993**



GPS Signal in Space Performance

Civilian Signal in Space Performance



Mining and Construction



Precision Agriculture

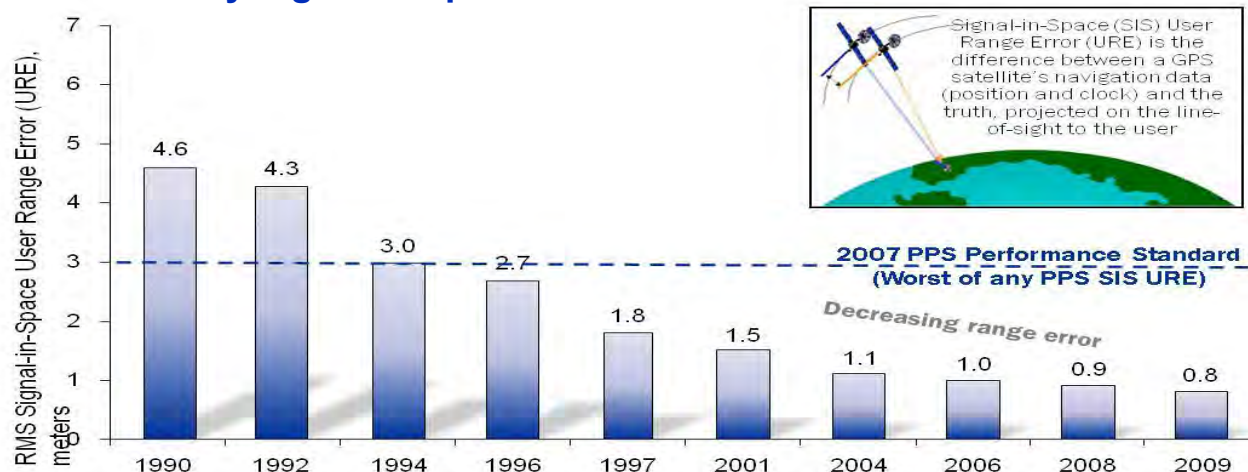


Wildlife Research



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



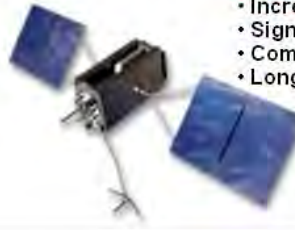
GPS IIF

- 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

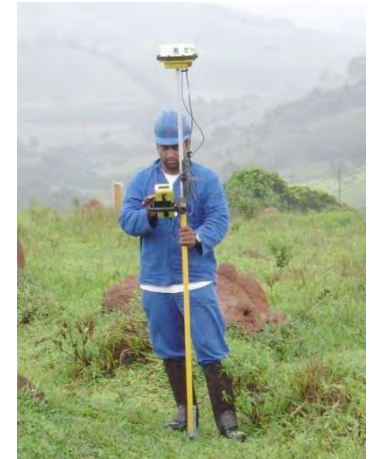
- **Second civil signal “L2C”**

- 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

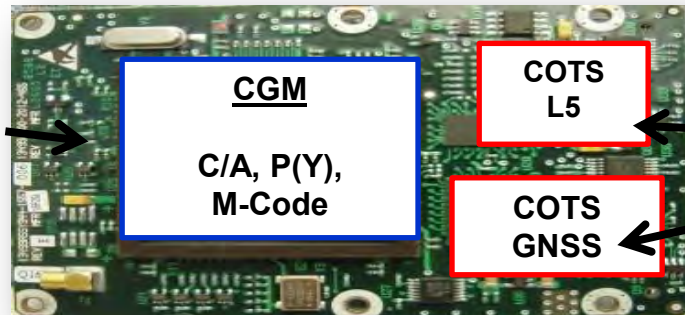


Global GPS
Use

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/>

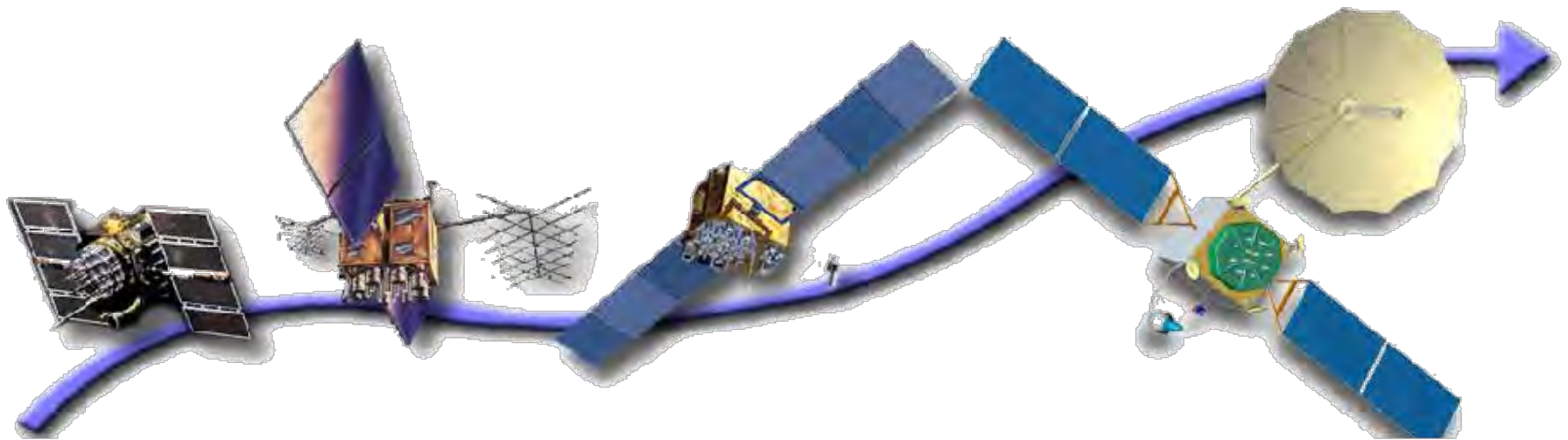
- **GPS Standard Positioning Service (SPS) Performance Standard**

- 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



- **SVN 49 was the 7th 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**

