GPS Modernization and Program Update

Munich Satellite Navigation Summit
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Global Positioning Systems Directorate

Mission:

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

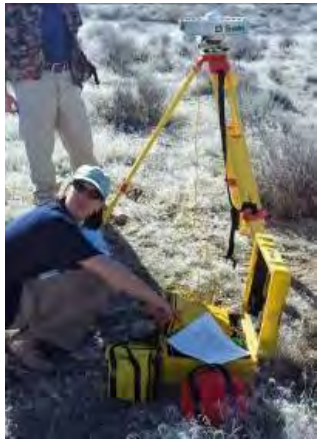
Col Bernie Gruber

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

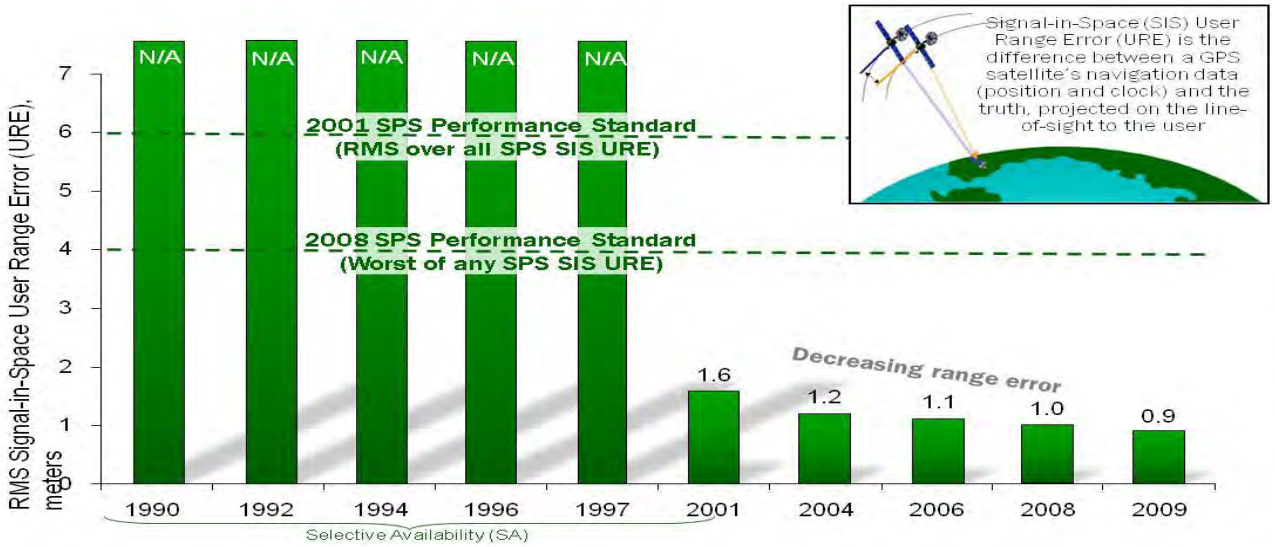
- **Extensive International and Civil Cooperation**
  - Agreements with 53 international customers
  - ¾ billion civil/commercial users
  - Countless applications…and growing



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

GPS Signal in Space Performance

Civilian Signal in Space Performance



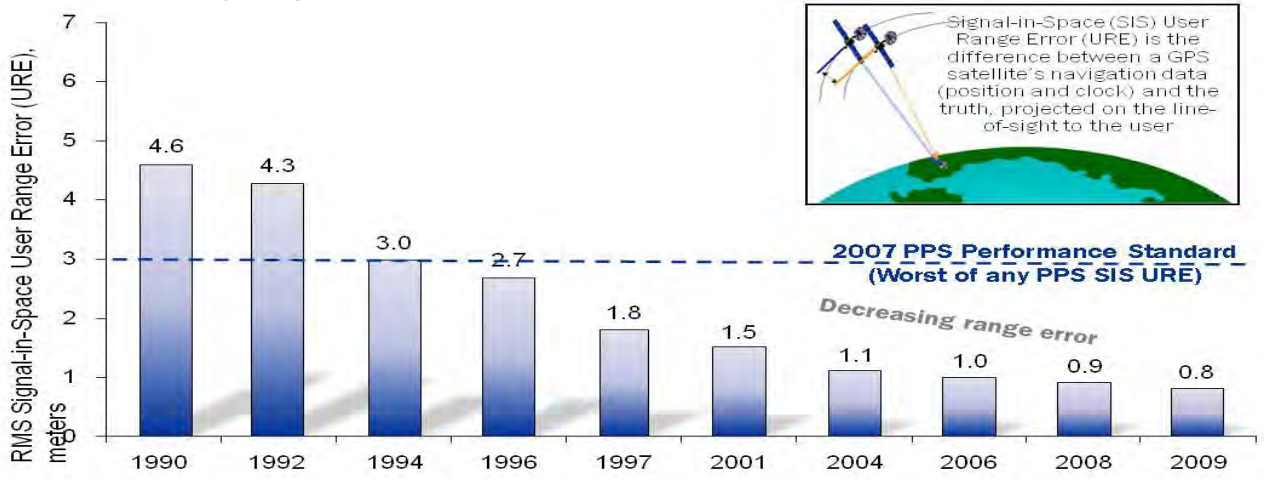

Mining and Construction


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

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

User Segment (Receivers)

Legacy
- First Generation System

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

Upgraded Antennae
- Improved Anti-Jam Antennaes

Modernized
- M-Code Receivers
- Common GPS Module

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

Ground Segment in OCX Blocks 2 and 3/4

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

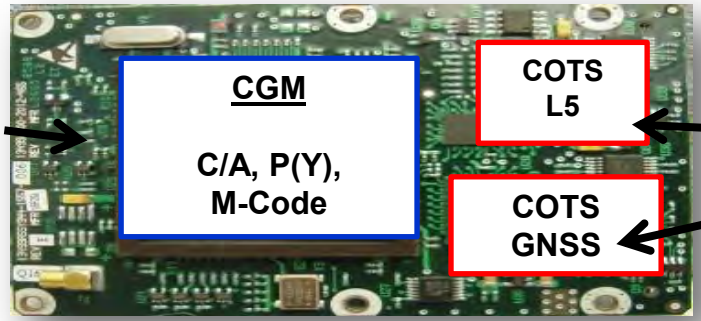
(GPS "engines" enable multiple applications)

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

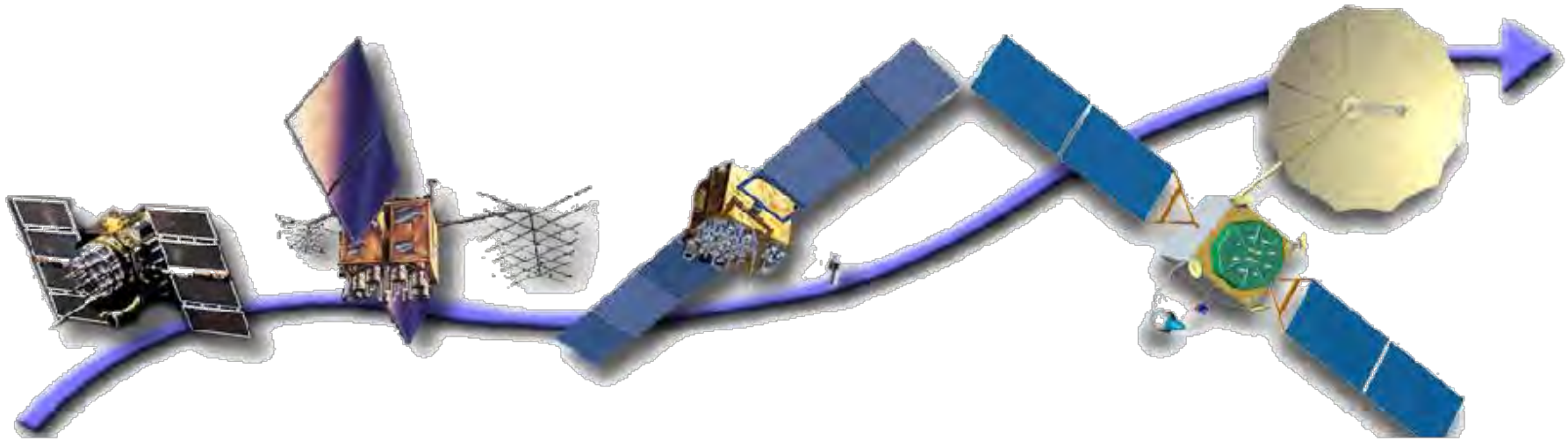
Interface Specifications & Performance Standard

- **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?


GLOBAL POSITIONING SYSTEMS
DIRECTORATE
NAVSTAR
Any Time, Any Place
Right Time, Right Place

Back-Ups

SVN-49

- **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**