



GPS Status and Modernization and GPS Signal Planning

14 October 2010

***Brigadier General Haywood
Director of Requirements
AFSPC/A5***



Overview

- Current Constellation
 - GPS Civil Focus Day
- Modernization
- Expandable 24
- Signal Planning





Current Constellation

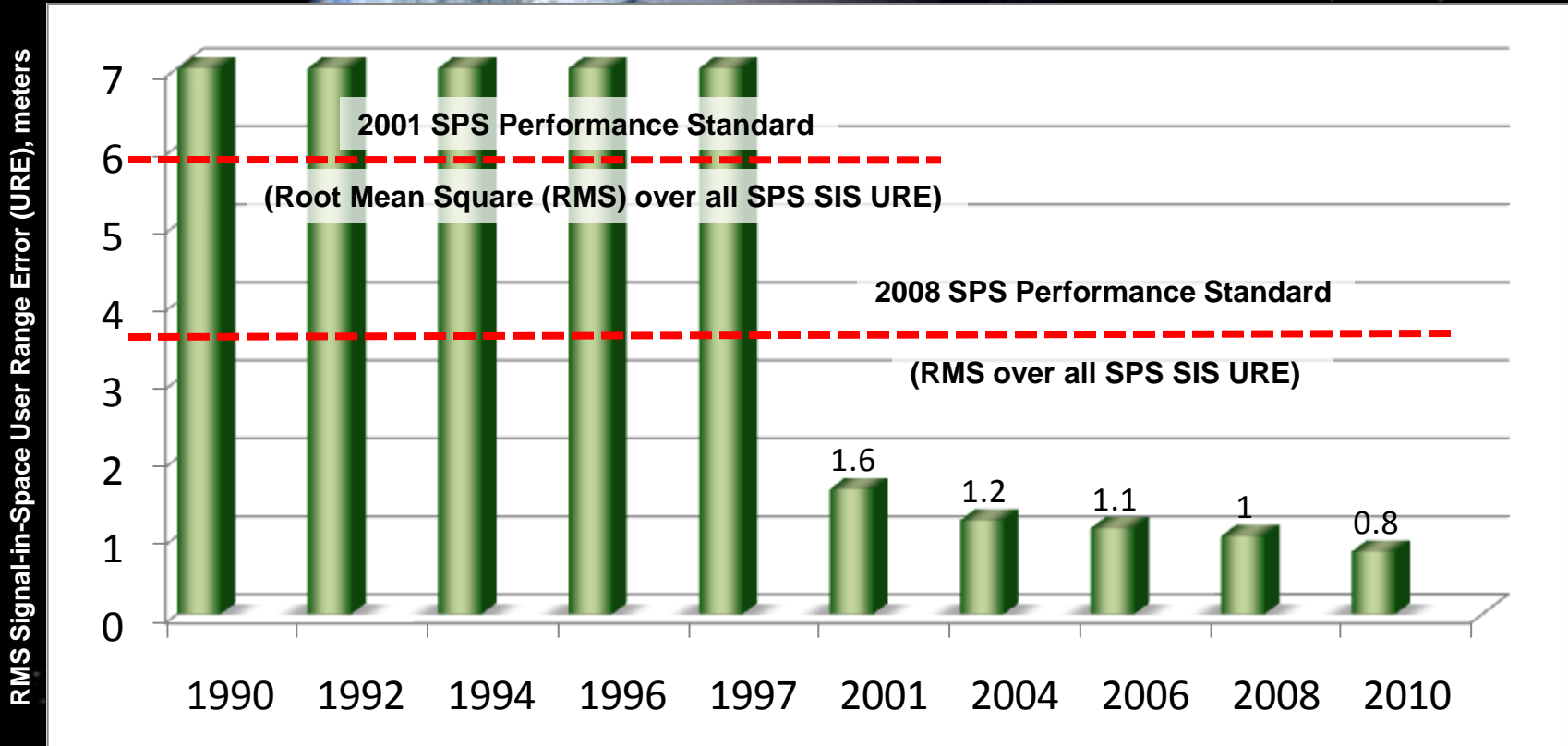
- Very robust constellation
 - 31 satellites currently set healthy
 - 11 GPS IIA
 - 12 GPS IIR
 - 7 GPS IIR-M
 - 1 GPS IIF
 - 3 additional satellites in residual status
 - 1 additional IIR-M waiting to be set healthy
- Next Launch – IIF-2, ~June 2011



Largest Constellation in History of GPS



Current Constellation - Performance



Selective Availability

Greatest Accuracy in History of GPS



GPS Civil Focus Day

- Inaugural meeting convened on 3 Feb 10 at HQ AFSPC, Colorado Springs, Colorado
- Military and Civilian attendees included:
 - DOT, STATE, DOI, DHS, DOC, FAA, NIST, NOAA, USNO, OSD/NII, SAF, AFSPC and USSTRATCOM
- Co-chaired at the senior level by AFSPC/CC and UST/Policy
- Objective: Fostered collaboration on key GPS issues with US civil agencies to ensure GPS remains the world's gold standard for PNT



Modernization – GPS Enterprise

1995

2005

2010

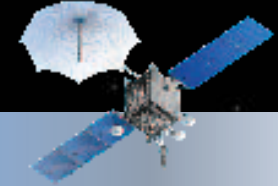
2014 - 2025

GPS IIA

GPS II R / IIR-M

GPS IIF

GPS III



Space Segment

- Standard Service
- Single frequency (L1)
- Coarse acquisition code navigation
- Precise Service
 - Y-Code (L1Y & L2Y)

- IIA/IIR capabilities plus
 - 2nd civil signal (L2C)
 - M-Code (L1M & L2M)

- IIR-M capability plus
 - 3rd civil signal (L5)
 - 12-year design life

- Backward compatible
- 4th civil signal (L1C)
- Increased accuracy
- Increased integrity

Control Segment

Legacy Control System

Architecture Evolution Plan (AEP)

Next Generation Control Segment (OCX)

User Segment

Legacy Specifications
Hundreds of thousands of Military and Civil* UE

Specifications SAASM UE
Civil* UE

Specifications Military GPS UE
Civil* UE



Modernization – Control Segment

- Architecture Evolution Plan (AEP)
 - Transitioned in 2007
 - Modern distributed system replaced 1970s mainframes
 - Increased capacity for monitoring of GPS signals
 - Increased worldwide commanding capability
 - Current software version (5.5D) enabled SAASM functionality
- Next Generation Control Segment (OCX)
 - Controls more capable GPS constellation, and monitors all GPS signals
 - \$1.5B contract awarded 25 February 2010
 - Capability delivered incrementally to reduce risk
 - On track for Preliminary Design Review in ~April 2011



GPS Modernization – User Equipment

- SAASM UE
 - First fielded in 2004
 - Enhanced security architecture
 - Able to receive GPS keying data over-the-air
- Military GPS UE
 - Approaching Milestone A decision in Nov 10
 - Technology Development Strategy approved by AFPEO/SP; entering Air Staff and OSD Coordination
 - Approval expected Nov 10
 - First fielding projected in FY16
 - Common GPS Module proposed to meet long term needs of US Military and authorized US Allies



Modernization – New Civil Signals

- Second civil signal “L2C”
 - Designed to meet commercial needs
 - Higher accuracy through ionospheric correction
 - 1st launch: September 2005 (GPS IIR-M); 24 satellites: ~2016
 - As of 4 May 2010, all IIR-M vehicles and IIF-1 broadcasting Type 0 message as a result recommendation by PNT Advisory Board
- Third civil signal “L5”
 - Designed to meet demanding requirements for transportation safety-of-life
 - 1st launch: 27 May 2010 (GPS IIF); 24 satellites: ~2018
- Fourth civil signal “L1C”
 - Designed with international partners for GNSS interoperability
 - Begins with GPS Block IIIA
 - 1st launch: ~2014; 24 satellites: ~2021



GPS Expandable 24

- Discussed by Lt Gen James in his November 2009 brief to Board
- Optimizes constellation to improve availability/coverage for global users & those in challenged environments
 - Feasible with robust number of satellites now on orbit
- Consistent with current Standard Positioning Service (SPS) Performance Standard
 - Adjusts position of satellites in 3 of 6 orbital planes to create expanded constellation
- Initiated first satellite re-phase in January 2010
- Expect last satellite re-phase to be complete in 2011



SIGNAL PLANNING





Signal Planning Overview

- Why do Signal Planning?
- Why Start Planning Now?
- What a Signal Strategy Might Look Like
- Way Ahead



Why Do Signal Planning?

- As signals accumulate over time, we may push the limits of power and frequency capability on GPS satellites
- Explore opportunities for increased flexibility and new capabilities, while preparing for significant changes already planned in on-going modernization efforts
- Ensure international constraints and cooperation are considered in determining required GPS capabilities
- Ensure GPS continues to be acknowledged as the global leader in PNT & signal of first use



Why Start Planning Now?

- Way ahead will be realized in years, not months...but we want to:
 - Provide a solid intellectual basis for way ahead that can be well understood by all
 - Ensure adequate time to plan and adapt...to whatever the outcome may be
 - Encourage compatibility and interoperability of foreign systems under development today with GPS
 - Preserve or create opportunities for GPS capabilities in a signal environment that will be increasingly constrained by foreign GNSS
 - Collaborate and communicate across a global PNT enterprise and community of stakeholders
 - Continue to build trust among military, civilian, commercial and international community



What a Signal Strategy Might Look Like

- Players--identifies roles and responsibilities
- Objectives, criteria and rationale for way ahead
 - Must address desired end state, dynamic nature of GPS (driven by technology, market, environment, threats, etc.), future use of software-defined capabilities
 - Considers effects on GPS segments (SWaP, etc.)
 - Policy implications (e.g., US global PNT leadership, commitment to maintain phase stability)
- Capabilities
 - How/when we turn on future capabilities, etc.
 - Future opportunities
- Tasks, milestones, schedule...at a minimum, must consider:
 - Timely documentation (JCIDS, FRP, performance standards, ITU filings and coordination, etc.)
 - Lead time for industry
- Marketing Plan
 - Target audience—all users, media, commercial world, international community
 - Must address timing, perception issues, possibility of negative response
 - Must be proactive, responsive, and flexible



Way Ahead

- Continue collaborative discussions on signals within National PNT structure
 - Use National PNT Structure to build and solidify the way ahead
 - Concentrate discussions on future signals and derived capabilities
 - Good discussion/buy-in at GPS Civil Focus Day, Interagency Forum for Operational Requirements (IFOR), and DoD PNT EXCOM
- IFOR forming working group to determine contents of strategic-level signal planning document, and map out detailed way ahead
 - Co-chaired by AFSPC and DoT
 - National PNT Engineering Forum provides technical support
 - Other interagency support as required
- Targeting next PNT ESG for presentation of detailed way ahead



Summary

- Largest constellation in history with best accuracy ever
- Continuing to optimize current performance through operational means
- Modernization continues to bring new capabilities, new opportunities
- GPS Civil Focus Day tremendous success – lays foundation for unprecedented collaboration and communication

GPS - Serving the World



BACKUPS

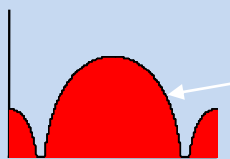




GPS Signal Modernization

GPS IIR

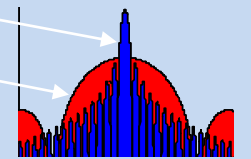
Launches completed
Nov 2004



L2
1227.6 MHz

P(Y)

C/A

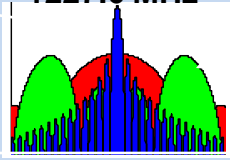


L1
1575.42 MHz

GPS IIR-M

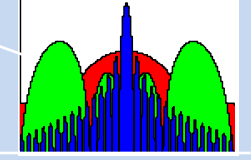
Launches completed
Aug 2009

L2C
Added



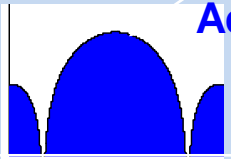
L2C
1227.6 MHz

M-code
Added



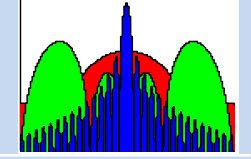
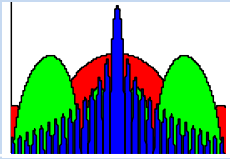
L1
1575.42 MHz

L5
Added



L5
1176.45 MHz

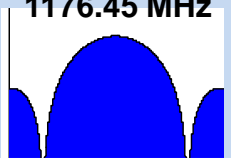
Launching
3QFY10 – 4QFY14



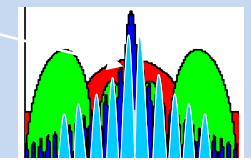
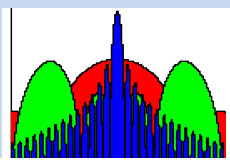
GPS III

Launching IIIA
3QFY14 – 2QFY18

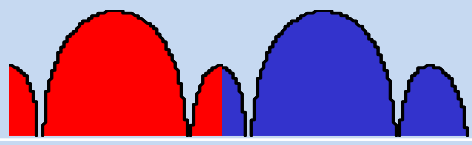
L1C
Added



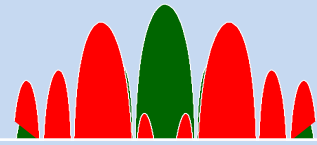
L5
1176.45 MHz



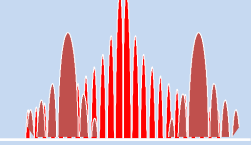
Galileo



E5a
1176.45 MHz E5b
1207.14 MHz



E6
1278.75 MHz



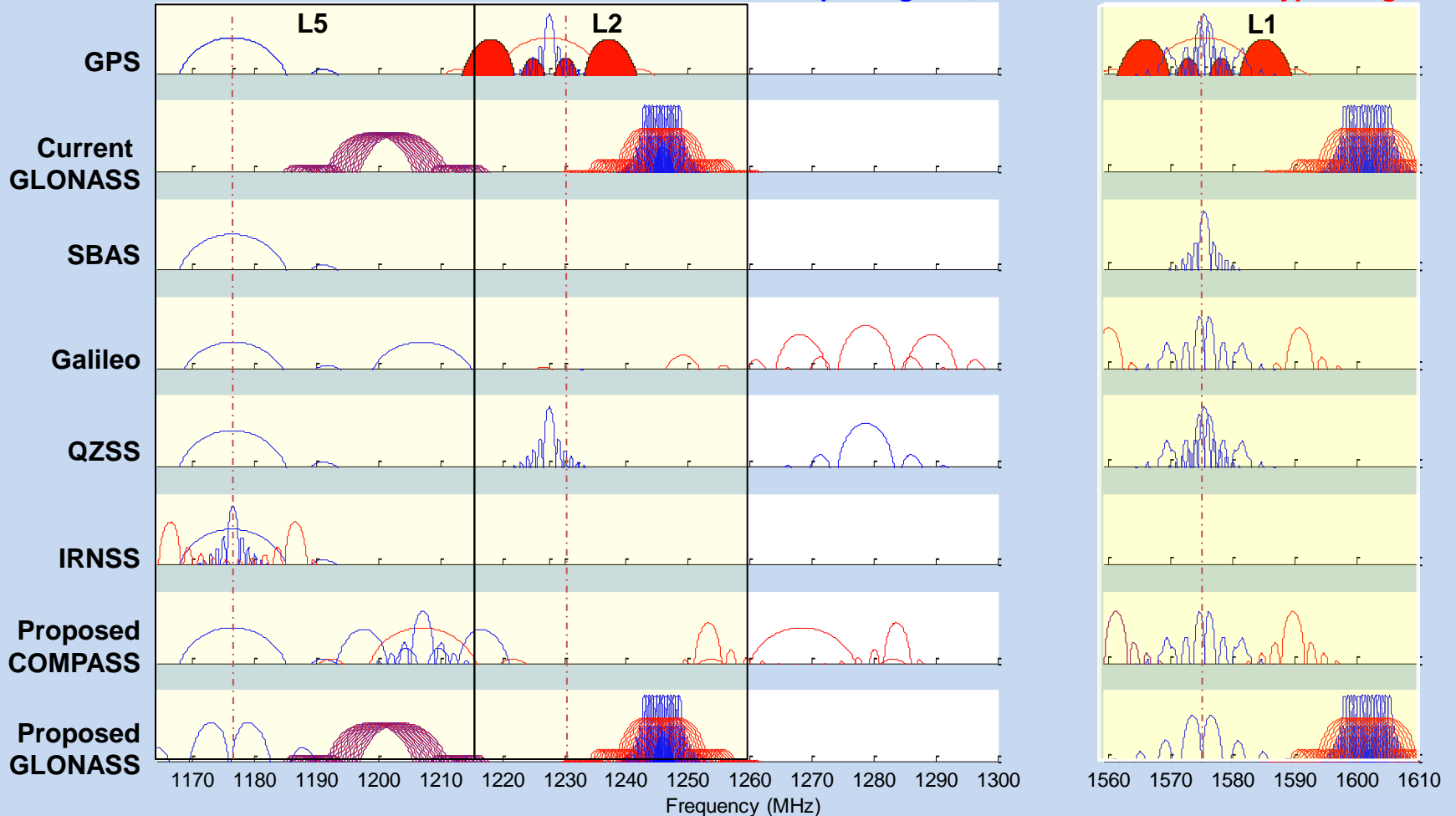
L1
1575.42 MHz

Modernized civil & military signals share L-band spectrum with developing systems



RNSS Signals are Proliferating

Color code: Blue—open signals, Red—restricted or encrypted signals



Every Signal Your Receiver Doesn't Want to Track is an Interferer

RNSS = Radio-Navigation Satellite Service