



Global Positioning Systems (GPS) Wing

***Enhancing Satellite-Based PNT
for the Warfighter, the Nation
and the World***



***Col David Madden
Commander, GPSW***



Preeminence in PNT is a National Objective

For the warfighter:

- **Space based PNT has revolutionized military operations**
 - Reduced collateral damage (people, infrastructure)
 - Limits friendly fire vulnerability
 - Higher accuracy munitions
 - Fewer sorties to accomplish mission needs (reduces exposure)
 - Aircraft standoff capability minimizes exposure to highly defended environments
 - Enhanced warfighter situational awareness & Blue Force tracking

***Saves
Warfighter
Lives***

For the Nation and the World:

- **Space based PNT has also significantly enhanced civil use**
 - Air traffic Control
 - Commercial navigation
 - All Cellular Communication rely on GPS
 - Timing of critical financial transactions
- **Demand will continue to grow well beyond next decade**

GPS is essential for the conduct of any war--and an integral part of day-to-day life



Air Force's Plan to Enhance GPS

Space Segments (Satellites)

Legacy (Block IIA/IIR)

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

Modernized (Block IIR-M)

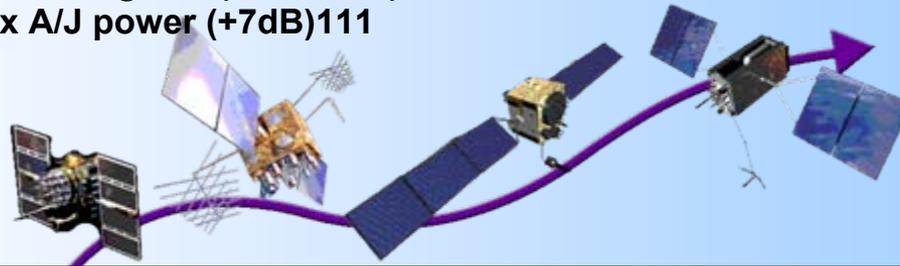
- 2nd civil signal (L2C)
- M-Code signals (L1M, L2M)
- Flex A/J power (+7dB)111

Modernized (Block IIF)

- 3rd civil signal (L5)

GPS III

- Increased accuracy
- Increased A/J power (up to 20 dB)
- Signal integrity
- Common Galileo L1C signal



Control Systems

Legacy

- TT&C
- L1 & L2 monitoring
- WAGE All

Upgraded (AEP)

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

Modernized (OCX Block 1.0/2.0)

- New Architecture
- GPS III C2
- L2C, L5, M-Code
- Flex Power
- L1C



Future Blocks (Notional)

- NAVWAR
- Mission Planning
- Effects Based Ops
- GIG Enabled
- Improved Integrity
- IPN Crosslinks
- Advanced GA
- Enhanced MS

User Segment (Equipment)

Legacy

- Man Pack
- MAGR, PLGR
- RCVR-3A, 3S
- OH, UH
- FRPA, CRPA

Upgraded UE

- CSEL
- DAGR
- GB-GRAM
- MAGR2K



Upgraded Antennae

- GAS-1
- ADAP



Modernize

- MGUE





Current On-Orbit Constellation Status

31 Operational GPS Satellites

15 IIAs:

- 13 Single String
- 10 Final Clock*
- 2 will be decommissioned Spring 09
- 2 Residual Status (no nav)

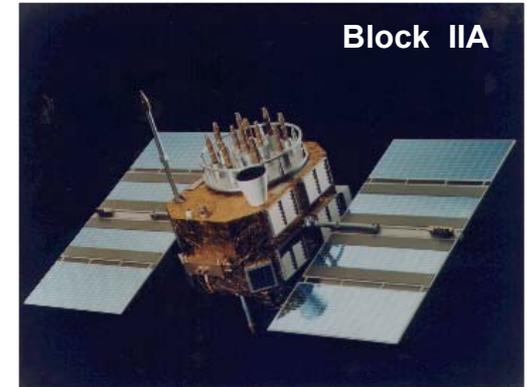
12 IIRs:

- 6 Single String
- No Clock Issues

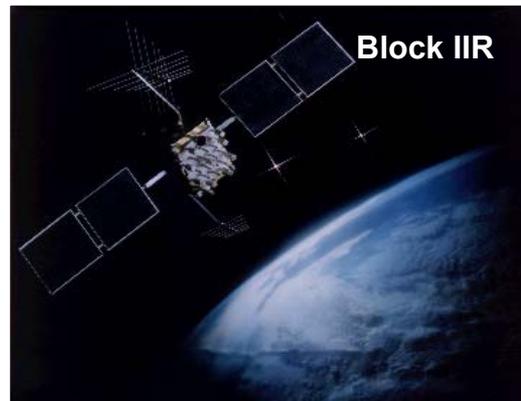
6 IIR-Ms:

- 0 Single String
- No Clock Issues
- IIRM-20 Mar 09
- IIRM-21 Aug 09

* Loss of final clock results in PNT mission end of life



First IIA Launch 26 Nov 90



First IIR Launch: 22 Jul 1997



First IIR-M Launch: 25 Sep 2005



GPS Block IIF SV



Completed Integrated System Test

- Comprehensive performance and functional testing performed on all subsystems
- Increases confidence in system design

Flight S/W Formally Qualified

Current Status

- Complete environmental Nov 08
- Complete FIST & Ship to Cape Feb 09
- Launch Aug-Oct 09



Next-Generation GPS Control Segment (OCX)

OCX Mission Description

- Migrate from C2 to mission effects focus
- Flexible Service Oriented Architecture
- Enable PVT effects-based operations via enhanced situational awareness tools
- Modernized Block II features (M-Code, L2C, L5)
- Capability to launch & operate GPS Block III & future GPS SVs
- Integrate current GPS ops center capabilities
- Consolidate and evolve interfaces for efficient exchange of PVT products (Global Information Grid enabled, net centric focused)



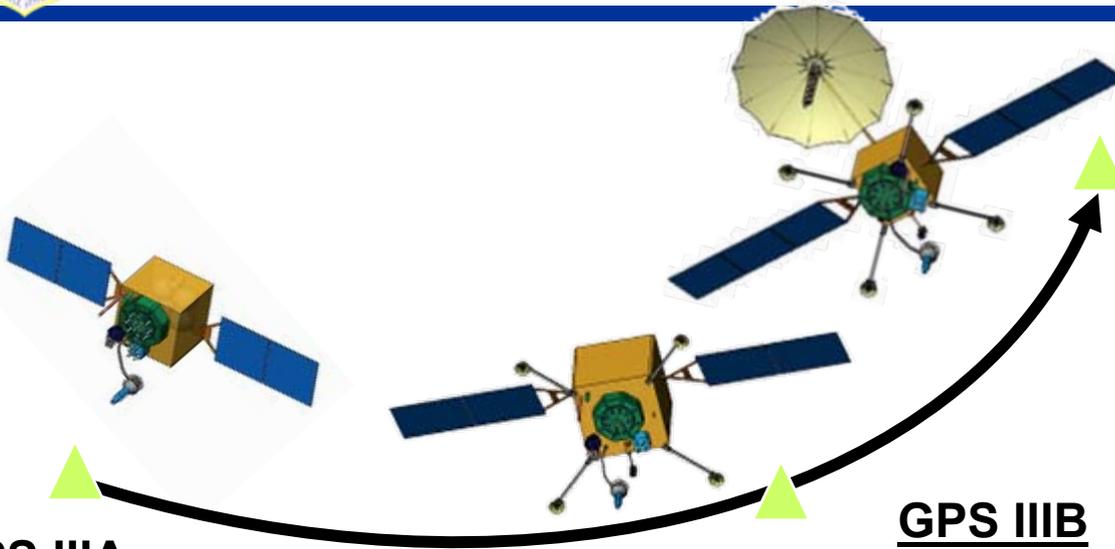
Program Status

- Acquisition Strategy approved on 22 Feb 07
 - Two contractors through KDP-B
 - Update synchronizes with space and user equipment
- 2 Phase A Contracts Awarded on 21 Nov 07
 - System Design Reviews Dec 08 and Jan 09
 - Engineering Model Demonstrations Dec 08
- Award Phase B contract 3QFY09





What GPS III brings to the Constellation



GPS IIIA

- IIR-M / IIF capabilities
- Enhanced Earth Coverage M-Code
- International Civil Code (L1C)
- IIIA bus: foundation for IIIC

GPS IIIB

- GPS IIIA capabilities
- Near Real-Time C2 (crosslinks)
 - Improved Positional & Time Transfer Accuracy
- High-speed uplink/downlink antenna

GPS IIIC

- GPS IIIB capabilities
- NAVWAR
- Flexible payload
- Integrity monitoring

Program Status

- Completed System Requirements Review and System Design Review
- Integrated Baseline Review completed in Oct 08
- Preliminary Design Review scheduled for May 09
- KDP-C Defense Space Acquisition Board (DSAB) scheduled for Oct 09

GPS III is fastest, lowest risk path to satisfy sustainment needs, international agreements, and critical new user capabilities



Modernized GPS User Equipment (MGUE)

MGUE Mission Description

- Develop production ready form factors for service lead platforms meeting MGUE CDD requirements
 - Air – F-15E & Small Diameter Bomb
 - Maritime – Arleigh-Burke Destroyer
 - Ground – Raven SUAS (USA) & Expeditionary Fighting Vehicle (USMC)
 - Space – Leverage ongoing effort
 - Handheld

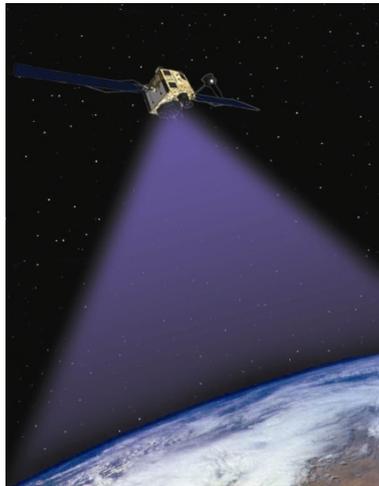


MGUE Status

- Tech Demo contracts
 - Thru 2 Critical Design Reviews (CDR), Rockwell CDR ongoing
 - Tech Demo hardware due EOY 2009

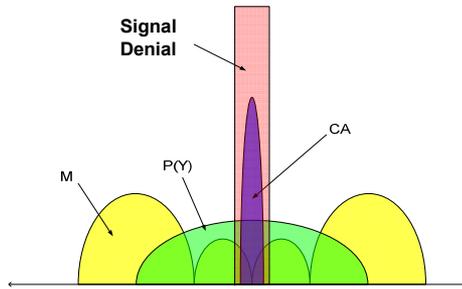


Military GPS User Equipment (MGUE) provides M-Code to the Warfighter



Anti-Jam

Utilizes higher satellite power on M-Code signal



Military Exclusivity

Enhances military use without impeding civil applications



GPS Navigational Warfare

Enables US electronic attack capability and protection of US military signal



Anti-Spoof

Enhanced assurance that warfighters receive the "right" GPS



GPSW controlled security architecture
Protection of Navigation (PRONAV)



Anti-Tamper

Greater protection of military data



MGUE Completes the M-Code Capability



GPS Modernization – New Civil Signals

Second civil signal “L2C”

- Designed to meet commercial needs
- Higher accuracy through ionospheric correction
- Available since 2005 without data message
- Phased roll-out of CNAV message starting in 2009
 - Deploying CNAV message type 0 in Fall 09
 - Full CNAV signal capability in CY11/12 timeframe



Third civil signal “L5”

- Designed to meet safety-of-life requirements
- Uses highly protected Aeronautical Radio Navigation Service (ARNS) band
- GPS must transmit L5 from its operational orbit to bring filing into use by Aug 09
- GPS failure to meet L5 deadline could require bi-lateral coordination with multiple nations
- Current launch manifest:
 - IIRM-20 modified to include carrier for L5 (March 09)
 - IIF-1 launch: NET Oct 2009



Fourth Civil Signal (L1C)



Under Trees

- **Designed with international partners for interoperability**
- **Modernized civil signal at L1 frequency**
 - More robust navigation across a broad range of user applications
 - Improved performance in challenged tracking environments
 - Original signal retained for backward compatibility
- **Specification developed in cooperation with industry, recently completed**
- **Launches with GPS III in 2014**
- **On 24 satellites by ~2021**



Urban Canyons



GPS Wing's Top Priorities

- **Assured Availability of GPS signals**
 - GPS satellites built to survive hostile MEO environment
- **Resistance to Interference whether intentional or unintentional**
 - Spectrum management minimizes interference from GNSS & non-GNSS sources
 - Flex power can boost military signals, Higher power M-Code on GPS III
 - Better UE AJ requirements (DAGR, MGUE) and antennas CRPA, ADAP, etc.
 - Spectral separation and diversity from civil signals; L1C, L2C, L5, L1 C/A
 - Cooperation with other GNSS 
- **Continuous Accuracy Improvements in performance** 
 - Improved clocks on IIR spacecraft, fewer/shorter SV outages
 - Legacy Accuracy Improvement Initiative; Measurements from 21 NGA MSs
 - Differential correction data in GPS msgs, MNAV msg with higher precision
- **Bounded Inaccuracy preventing collateral damage or fratricide**
 - Fewer/Minimizing DOP spikes, Exceed 21 of 24 primary slot 98% req't
 - IIR & IIIA internal clock error check – switch to NS code
- **Integrity eliminating non-standard and local errors** 
 - IIR Time Keeping System, NGA stations, AEP AFSCN uplink



- **Success in GPS sustainment & modernization**
 - New capabilities delivering enhanced performance
 - Developments on track to enhance space and control segments
- **GPS is an excellent global navigation utility**
 - Excellent cooperation with augmentation service providers
 - Improving interoperability/compatibility for GNSS
- **GPS is boldly moving forward into the future**
 - To remain the pre-eminent space-based PNT service
 - GPS will continue to lead the future GNSS system-of-systems

...the ultimate judges
of our success...

