

Global Positioning System Status and Modernization

PNT Advisory Board – 1 July 2020



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PNT Mission Integration
Space and Missile Systems Center

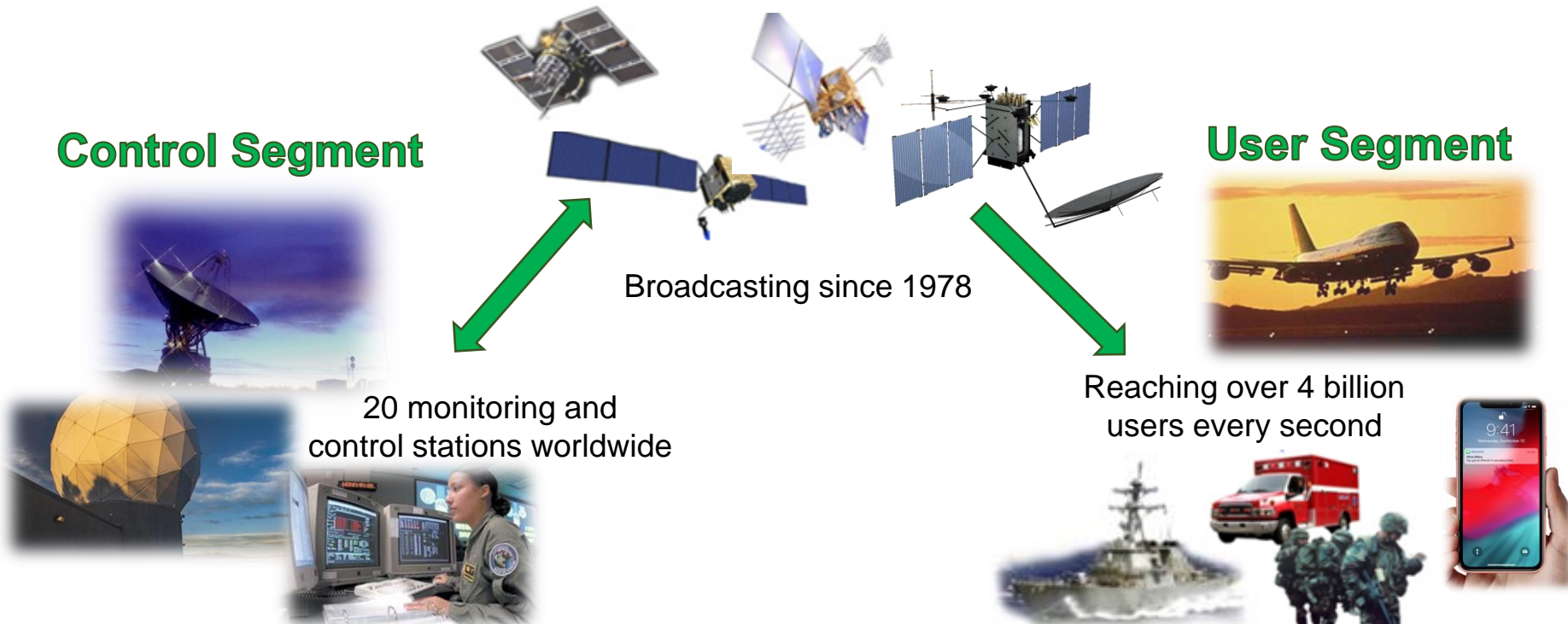


GPS Overview

Space Segment

Control Segment

User Segment



Committed to Cooperation

Department of Defense • Army • Navy • Air Force • Space Force • USMC • NGA • DISA • USNO • NSA • **PNT EXCOM**
 National Nuclear Security Administration (NNSA) • **Department of Transportation** • Federal Aviation Administration
Department of Homeland Security • U.S. Coast Guard • **International Civil Aviation Organization**
Global Navigation Satellite Systems • Galileo • Beidou • GLONASS • QZSS • NAVIC
International Committee on GNSS • **International Telecommunication Union**



GPS Modernization

Space Segment

SV families provide L-Band broadcast to User Segment

GPS IIA/IIR

- Basic GPS
- Nuclear Detonation Detection System (NDS)

GPS IIR-M

- 2nd Civil Signal (L2C)
- New Military Signal
- Increased Anti-Jam Power

GPS IIF

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

GPS III (SV01-10)

- Accuracy & Power
- Increased Anti-Jam Power
- Inherent Signal Integrity
- 4th Civil Signal (L1C)
- Longer Life
- Better Clocks

GPS IIIF (SV11-32)

- Unified S-Band Telemetry, Tracking & Commanding
- Search & Rescue (SAR) Payload
- Laser Retroreflector Array
- Redesigned NDS Payload

Control Segment

TT&C of Space Segment assets & distribution of data to user interfaces

Legacy (OCS)

- Mainframe System
- Command & Control
- Signal Monitoring

Architecture Evolution Plan (AEP)

- Distributed Architecture
- Increased Signal Monitoring Coverage
- Security
- Accuracy

OCX Block 0

- GPS III Launch & Checkout System

GPS III Contingency Ops (COps)

- GPS III Mission on AEP

M-Code Early Use (MCEU)

- Update OCS to operationalize Core M-Code

OCX Block 1/2

- Fly Constellation & GPS III
- Begin New Signal Control
- Upgraded Information Assurance

OCX Block 2+

- Control all signals
- Capability On-Ramps
- GPS IIIF Evolution

User Segment

Applies Space and Control Segment data for PNT applications

Continued support to an ever-growing number of applications

- Annual Public Interface Control Working Group (ICWG)
- Standard Positioning Service (SPS) Performance Standard Updates
- Precise Positioning Service (PPS) Enhancements
- Sustained commitment to transparency
- Visit GPS.gov for more info

Modernized Civil Signals

- L2C (Various commercial applications)
- L5 (Safety-of-life, frequency band protected)
- L1C (Multi-GNSS interoperability)



GPS Constellation Status

34 Satellites • 31 Set Healthy
Baseline Constellation: 24 Satellites



Satellite Block	Quantity	Average Age (yrs)	Oldest
GPS IIR	10 (2*)	18.4	22.9
GPS IIR-M	7 (1*)	12.7	14.7
GPS IIF	12	6.4	10.1
GPS III	2	1.2	1.5

*Ops capable; not set healthy

As of 23 Jun 20

GPS Signal in Space (SIS) Performance

From 21 Jun 19 to 20 Jun 20

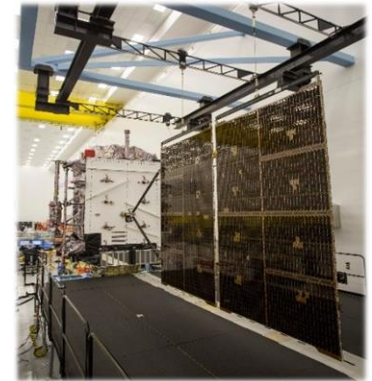
Average URE*	Best Day URE	Worst Day URE
52.8 cm	38.5 cm (1 Jun 20)	74.1 cm (2 Aug 19)

*All User Range Errors (UREs) are Root Mean Square values



GPS III

- SV01 Set healthy and available for use on 13 Jan 20
- SV02 Set healthy and available for use on 1 Apr 20
- **SV03 Launched on 30 Jun 20**
 - **First NSSL mission on a recoverable Falcon 9**
- SV04 Launch scheduled for no earlier than 30 Sep 20
- SV05 Declared Available for Launch 7 May 20
- SV06 TVAC completed 27 Nov 19
- SV07 Core Mate completed 11 Dec 19
- SV08 Core Mate completed 15 Apr 20
- SV09-10 Component deliveries in progress



Third GPS III satellite launched on 30 June



GPS III Follow-On (GPS IIIF)

- GPS IIIF additional features
 - Regional Military Protection (RMP) and redesigned Nuclear Detonation Detection System (NDS)
 - Search-and-Rescue (SAR) payload - faster detection and location of distress signals
 - Laser Retroreflector Array (LRA) - provides more precise ranging data
- Partnering with Air Force Research Laboratory (AFRL) for future technology opportunities
 - Digital Reprogrammable Payloads
 - Demo on Navigation Technology Satellite (NTS-3)
 - Near Real-Time Commanding/Crosslinks
- Status: Completed CDR in Mar 2020; SV11 launch forecasted for 2026



Ensuring the Gold Standard today and into the future



Next Generation Operational Control System (OCX)

- Next-generation command, control and cyber-defense for GPS
 - Enhanced command and control capability
 - Modernized architecture
 - Robust information assurance and cyber security
- Incremental Development
 - OCX Block 0: Launch and Checkout System (LCS) for GPS III
 - OCX Blocks 1 and 2: Operate and manage modernized GPS constellation, control and monitor modernized signals
- Current Status
 - LCS successfully supported GPS III SV01 and SV02 Launch and Checkout
 - Exceeding operational requirements for availability and dependability
 - OCX Block 1 software coding complete – 12 Aug 19
 - System integration and verification ongoing
 - Ready to Transition to Operations: 2Q 2022



OCX program continues to execute and meet schedule



GPS III Contingency Operations (COps)

- Upgrade to current control system that enables limited operations on GPS III vehicles until OCX Block 1/2 delivery
 - Provides legacy and modernized signal (L2C, L5, M-Code test) operations
 - Uses OCX Block 0 for GPS III launch, major anomaly, and disposal capabilities

- COps Status
 - Space Force formally Operationally Accepted COps on 27 Mar 20

**COps is an important bridge enabling
Command and Control for GPS III satellites**



Military Code Early Use (MCEU)

- **Description**
 - Provide early use of GPS M-Code signal from 2020 until OCX Block 1 Ready for Transition to Operations
 - Enable and operate M-Code messaging on all M-Code capable satellites, including GPS IIR-M, GPS IIF, and GPS III (at a GPS IIF performance level)
- **Software Development**
 - Updates to current Operational Control System (OCS)
 - Integration of M-Code Keying and Modernized Monitoring Stations
- **Current Status**
 - MCEU AEP 9.0 fielding completed 25 Jun 2020
 - Developmental and operational testing targeted for Aug-Oct 2020
 - Operational Acceptance Target Date 18 Nov 2020


MCEU is operationalizing Core M-Code in 2020



Military GPS User Equipment (MGUE)

- MGUE Increment 1 involves three vendors developing modernized receiver cards (Ground and aviation/maritime form factors)
- MGUE Increment 2 addresses GPS receiver card obsolescence and extends M-Code to space receivers, Precision-Guided Munitions, and a joint, common modernized Handheld Receiver
- Current Status:
 - Increment 1 on track to support Core M-Code Operations in 2020
 - Increment 2 Acquisition Strategy approved in Nov 2018 as two Middle Tier Acquisition rapid prototyping efforts:
 - Miniature Serial Interface (MSI) receiver card w/ Next Generation Application-Specific Integrated Circuit (ASIC) with projected contract award in 1QFY21
 - Joint Modernized Handheld Receiver in prototyping phase

MGUE core technologies prime market for 2M+ receivers



global utility
uninterrupted service
strength through partnership
gold standard

GPS