

Space & Missile Systems Center



GPS Status and Modernization

Munich Satellite Navigation Summit 2019

27 Mar 2019

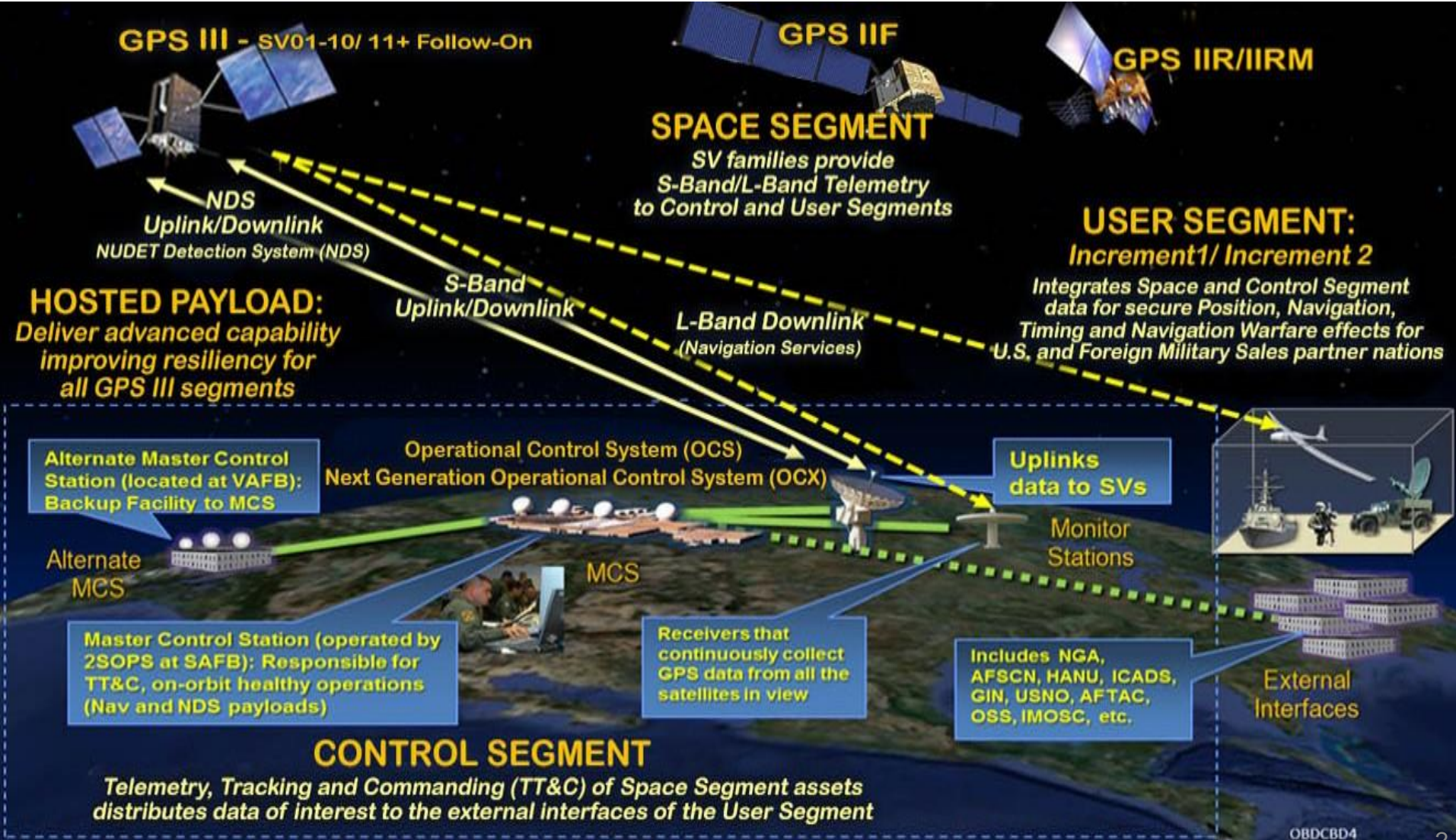
Lieutenant Daniel Barnes

Spectrum Management, GPS Directorate



GPS Enterprise Operational View

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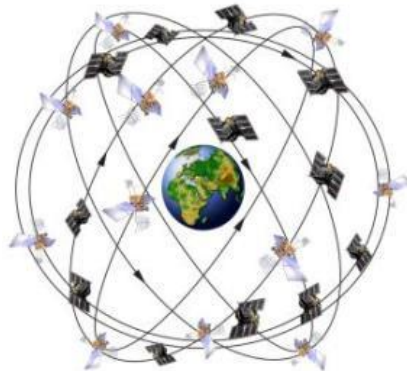
GPS Overview

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Civil Cooperation

- 3+ Billion civil & commercial users worldwide
- Search and Rescue
- Civil Signals
 - L1 C/A (Original Signal)
 - L2C (2nd Civil Signal)
 - L5 (Aviation Safety of Life)
 - L1C (International)



Spectrum

- World Radio Conference
- International Telecommunication Union
- Bilateral Agreements
- Adjacent Band Interference



Department of Transportation

- Federal Aviation Administration

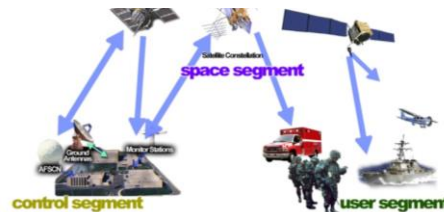
Department of Homeland Security

- U.S. Coast Guard

34 Satellites / 31 Set Healthy Baseline Constellation: 24 Satellites

Satellite Block	Quantity	Average Age	Oldest
GPS IIA	1	25.4	25.4
GPS IIR	11	17.1	21.6
GPS IIR-M	7	11.6	13.4
GPS IIF	12	5.1	8.8
Constellation	31	11.5	25.4

AS OF 6 MAR 19



Department of Defense

- Services (Army, Navy, AF, USMC)
- Agencies (NGA & DISA)
- US Naval Observatory
- PNT EXCOM
- GPS Partnership Council

Maintenance

- Develop & Publish ICDs Annually
 - Public ICWG: Worldwide Involvement
 - Materials Available at: gps.gov/technical/icwg
- Update GPS.gov Webpage
- Distribute PRNs for the World
 - 120 for US and 90 for GNSS

International Cooperation

- 57 Authorized Allied Users
 - 25+ Years of Cooperation
- GNSS
 - Europe - Galileo
 - China - Beidou
 - Russia - GLONASS
 - Japan - QZSS
 - India - NAVIC



GPS SIS Performance Scoreboard

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GPS SIGNAL IN SPACE (SIS) PERFORMANCE (CM) (VS. JPL, RMS, URE, CM)

BEST WEEK*

BEST DAY*

WORST DAY*

ENDING

URE

ENDING

URE

ENDING

URE

ROLLING YEAR

8 DEC 18

45.7

14 MAR 18

37.5

27 AUG 18

73.2

BEST WEEK EVER

29 NOV 16

44.1

**ROLLING YEAR*





GPS Modernization

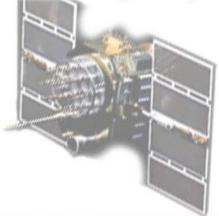
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Space Segment

SV families provide L-Band broadcast to User Segment

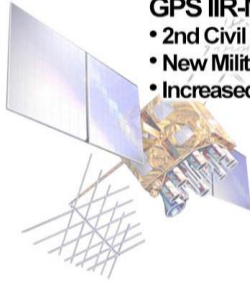
Legacy (GPS IIA/IIR)

- Basic GPS
- NUDET (Nuclear Detonation) Detection System (NDS)



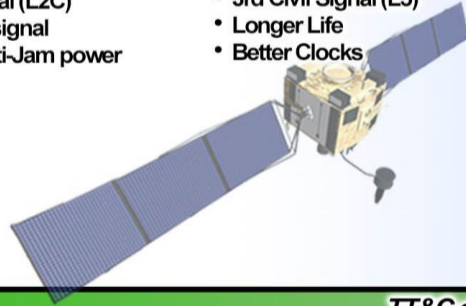
GPS IIR-M

- 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
- Common L1C Signal
- Longer Life



GPS III (SV11+)

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

Ground Segment

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

Legacy (OCS)

- Mainframe System
- Command & Control
- Signal Monitoring

AEP

- Distributed Architecture
- Increased Signal Monitoring Coverage
- Security
- Accuracy
- Launch And Disposal Operations



OCX Block 1

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

OCX Block 2+

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

OCX Block 0

- GPS III Launch & Checkout

GPS III Contingency Ops (COps)

- GPS III Mission on AEP

User Segment

Applies Space and Control Segment data for PNT applications

Modernized Civil Signals

- L1C
- L2C
- L5



Continued support to an ever-growing number of applications

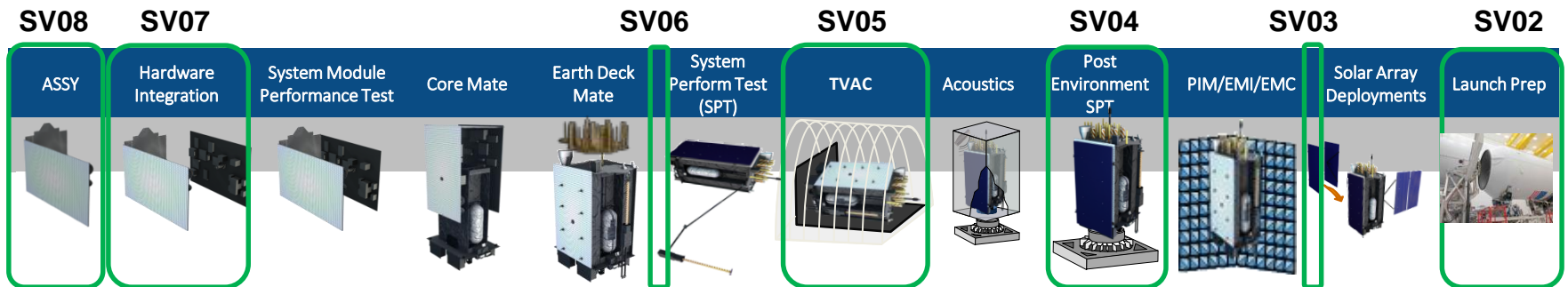
- Annual Public Interface Control Working Group
- Imminent update of SPS Performance Standard
- Sustained commitment to transparency, renew focus on agility



GPS III Space Vehicles (SVs)

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- GPS III features
 - Increased accuracy and power
 - Inherent signal integrity
 - New L1C signal
 - Longer design life (15 years)
- SV01 launched 23 Dec 18; currently undergoing on-orbit test
 - Expected to be operational in early 2020
- SV02 is in launch preparation; targeting a 25 Jul 19 launch date
- SV03 -10 are in different phases of production



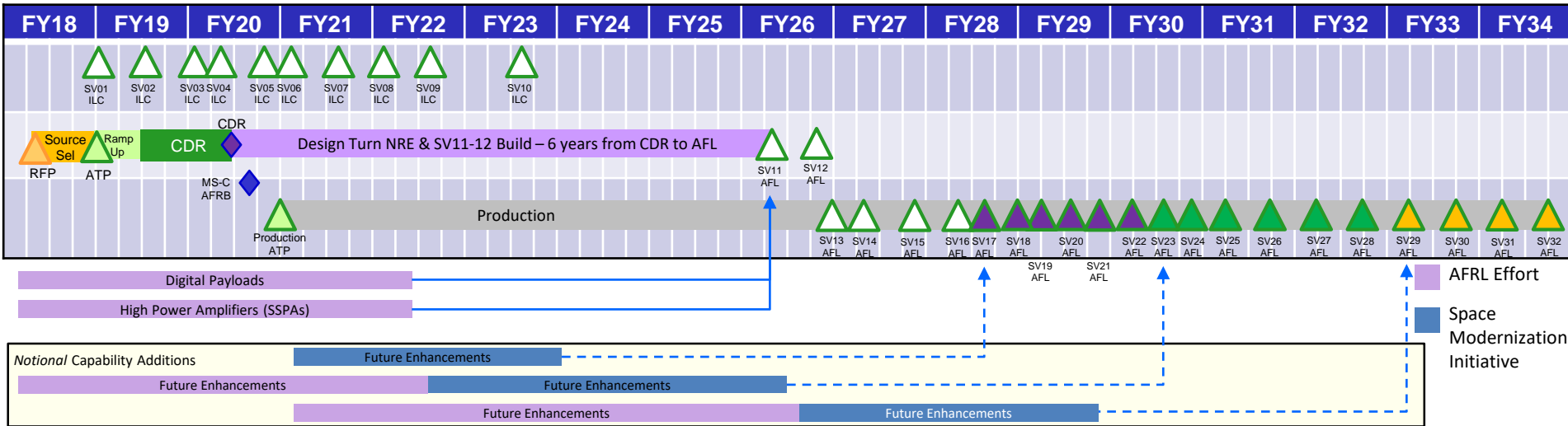
First GPS III satellite successfully launched in Dec 2018



GPS IIF Acquisition Strategy

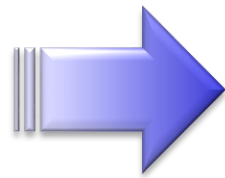
Modernization, Recapitalization, and Resiliency

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- Focused on ability to deliver capability with high production maturity
- Continued partnerships with AFRL for technology insertion and path to flight
 - Digital Payloads
 - High Power Amplifiers
 - Advanced Clocks
 - Near Real-Time Commanding/Crosslinks
 - Signal Upgradeability

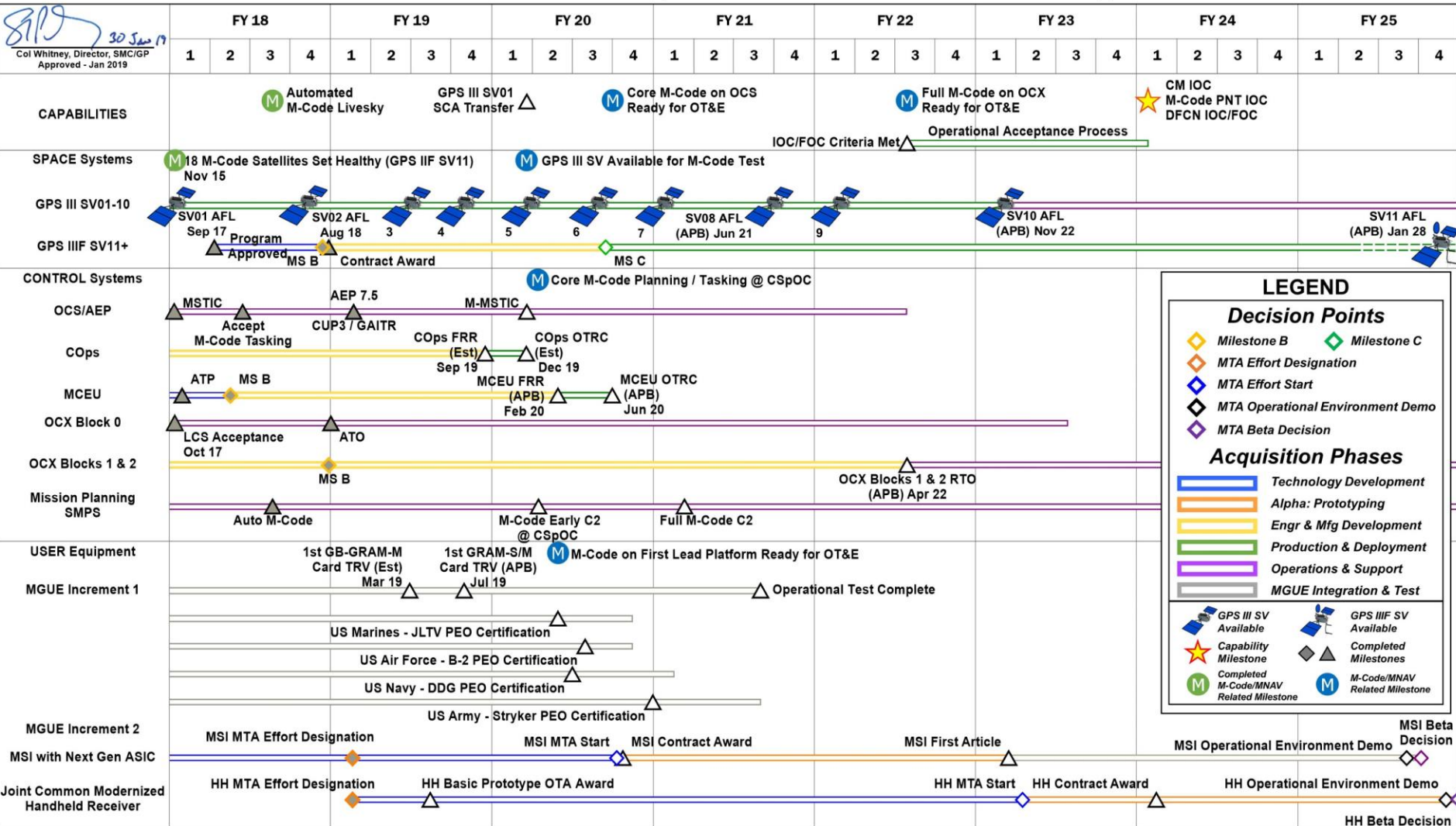
AFL – Available for Launch
 ATP – Authority to Proceed
 CDR – Critical Design Review
 ILC – Initial Launch Capability
 NRE – Non-recurring Engineering
 RFP – Request for Proposal
 SV – Space Vehicle



Ensuring the Gold Standard today and into the future

GPS IIF contract awarded to Lockheed Martin on 26 Sep 18

GPS Enterprise Roadmap



AEP	Architecture Evolution Plan	CSpOC	Combined Space Operations Center	GB-GRAM-M	Ground Based GPS Receiver Application Module – Modernized	MGUE	Military GPS User Equipment	OT&E	Operational Test and Evaluation
AFL	Available for Launch	CUP	COTS Upgrade Project	GRAM-S/M	GPS Receiver Application Module – Standard Elec Module/Modernized	M-MSTIC	Modernized-Monitor Station Tech Improvement & Capability	OTRC	Ops Test Readiness Certification
APB	Acquisition Program Baseline	DDG	Arleigh Burke Guided Missile Destroyer	HH	Handheld	MS	Milestone	PEO	Program Executive Officer
ASIC	Application-Specific Integrated Circuit	DFCN	Dual-Frequency Civil Navigation	IOC	Initial Operating Capability	MSI	Miniature Serial Interface	PNT	Positioning, Navigation & Timing
ATO	Authority to Operate	FOC	Forecast Estimate	JLTV	Joint Light Tactical Vehicle	MTA	Middle Tier Acquisition	RTO	Ready for Transition to Ops
ATP	Authority to Proceed	FRR	Fielding Readiness Review	LCS	GPS III Launch & Checkout System	OCX	Operational Control System	SCA	Spacecraft Control Authority
C2	Command & Control	GAITR	Ground Antenna Interface	MCEU	M-Code Early Use	OTA	Other Transaction Agreement	SMPS	SAASM Mission Planning System
CM	Constellation Management		Technical Refresh					SV	Space Vehicle
COps	GPS III Contingency Operations							TRV	Technical Requirements Verification



the men and women of the
GLOBAL POSITIONING SYSTEMS DIRECTORATE

home of the gps green monsters

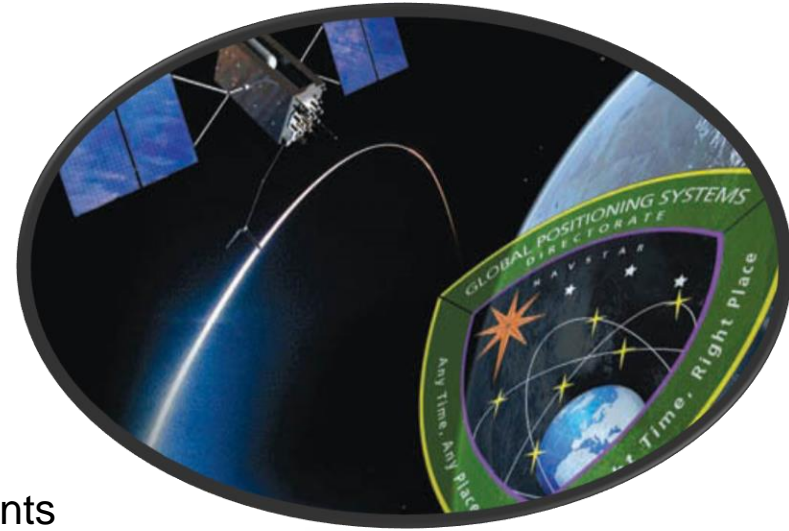
Acquisition professionals delivering the Gold Standard in Space-Based PNT & NDS Services



GPS Director's Perspectives

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- GPS is the Global Utility
 - Committed to maintaining uninterrupted service
 - “The Gold Standard”
- Continue to enhance GPS resiliency by:
 - Addressing near-term needs with current efforts
 - Identifying opportunities for resiliency improvements
 - Maturing technical needs for future use
- Appreciate the need for alternative PNT sources, and challenge the community (labs, industry, others) to propose & explore solutions
- Exploring & expanding multi-GNSS potential





Next Generation Operational Control System (OCX)

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- Incremental Development
 - Block 0 Launch and Checkout System (LCS)
 - Block 1/2 Operational Control System
- Current Status
 - LCS supported GPS III SV01 launch on 23 Dec 18
 - Continues to function nominally during SV01 on-orbit checkout and testing (OOCT)
 - Preparing to support SV02 launch in 4QFY19
 - Block 1/2 development continues to meet milestones
 - Ready to Transition to Operations: 2Q 2022
- Enhanced command and control capability
- Modernized, agile architecture



OCX program continues to execute and meet schedule



GPS III Contingency Operations (COps)

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- Limited operations for GPS III SVs until OCX Block 1/2 delivery
 - Provides legacy and modernized civil signal operations
 - Uses OCX Block 0 for GPS III launch, major anomaly, & disposal capabilities
- Software Development
 - Risk reduction modification to current control system
 - Four incremental software builds
- Current Status
 - Software development completed Jun 2018
 - Operational Acceptance: Apr 2020

COps is a critical bridge, enabling sustainment of legacy signals for GPS III