

# GP PLAYBOOK

Thematic Goal:

Deliver Modernized Military and Civil GPS Capabilities

IMPLEMENT M-CODE  
AVAILABLE FOR USE  
(4QF415)

GPE

DELIVER BLOCK 0  
FOR GPS III LAUNCH  
(2QC416)

GPG

AWARD GPS III  
CONTINGENCY OPS CONTRACT  
(2QF416)

GPG

EXECUTE OCK BLOCK 1  
TO SCP BASELINE

GPG

CERTIFY AT LEAST ONE  
MGUE COMPONENT  
FOR PRODUCTION  
(2QF416)

GPV

COMPLETE FLYOUT  
OF ALL GPS III SVs  
(3QF416)

GPV

DELIVER GPS III SV-01  
AVAILABLE FOR LAUNCH  
(4QF416)

GPV

AWARD PHASE I GPS III  
FOLLOW-ON PRODUCTION  
(2QF416)

GPV

Defining Objective:

Become the Gold Standard Program!

# Space and Missile Systems Center



## Global Positioning System Directorate

GPS Update  
Partnership Council 2015

29 Apr 2015

Brig Gen Bill Cooley  
Director, Global Positioning Systems Directorate



# Global Positioning Systems Directorate

SPACE AND MISSILE SYSTEMS CENTER

## Mission:

Acquire, deliver and sustain reliable GPS capabilities to America's warfighters, our allies, and civil users



From left to right, a GPS IIA, IIR, and IIF satellite



BGen Bill Cooley  
Director



2SOPS Ground Control  
(Schriever AFB)

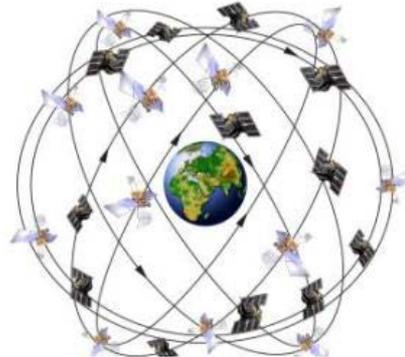
# GPS Overview

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## Civil Cooperation

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



**39 Satellites / 31 Set Healthy**  
**Baseline Constellation: 24 Satellites**

Satellite Block	Quantity	Average Age	Oldest
GPS IIA	3	21.5	24.4
GPS IIR	12	13.3	17.7
GPS IIR-M	7	7.7	9.6
GPS IIF	9	1.8	4.9
Constellation	31	9.5	24.4

AS OF 20 APR 15

## Department of Defense

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

## Maintenance/Security

- All Level I and Level II
  - Worldwide Infrastructure
  - NATO Repair Facility
- Develop & Publish ICDs Semi-Annually
  - ICWG: Worldwide Involvement
- Update GPS.gov Webpage
- Load Operational Software on over 970,000 SAASM Receivers
- Distribute PRNs for the World
  - 120 for US and 90 for GNSS

## Spectrum

- World Radio Conference
- International Telecommunication Union
- Bilateral Agreements
- Lightsquared

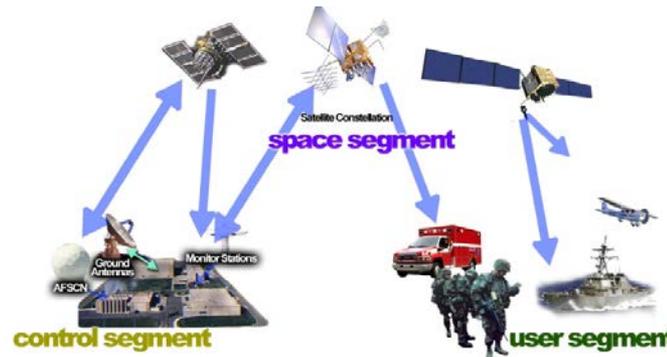


## Department of Transportation

- Federal Aviation Administration

## Department of Homeland Security

- U.S. Coast Guard



## International Cooperation

- 56 Authorized Allied Users
  - 25+ Years of Cooperation
- GNSS
  - Europe - Galileo
  - China - COMPASS
  - Russia - GLONASS
  - Japan - QZSS
  - India - IRNSS



# GPS Constellation Status

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## 31 Operational Satellites (Baseline Constellation: 24+3)

- Robust operational constellation
  - 3 GPS IIA – L1 C/A, L1 P(Y), L2 P(Y) signals
  - 12 GPS IIR – same signals as IIA
  - 7 GPS IIR-M – adds L2C, L1M, L2M signals
  - 9 GPS IIF – adds L5 signal
- 7 additional satellites in residual/test status
- Modified Battery Charge Control has extended GPS IIR and IIR-M life by 1-2 years per SV
- Global GPS civil service performance commitment met continuously since Dec 1993 (IOC)
  - Best performance 43.8 cm User Range Error (URE) 1 Jan 15; best weekly average 52.7 cm URE 23 Nov 14; rolling quarter (as of 15 Apr 15) 59.6 cm
  - Performance improving as new satellites replace older satellites





# Accuracy: Military Commitments

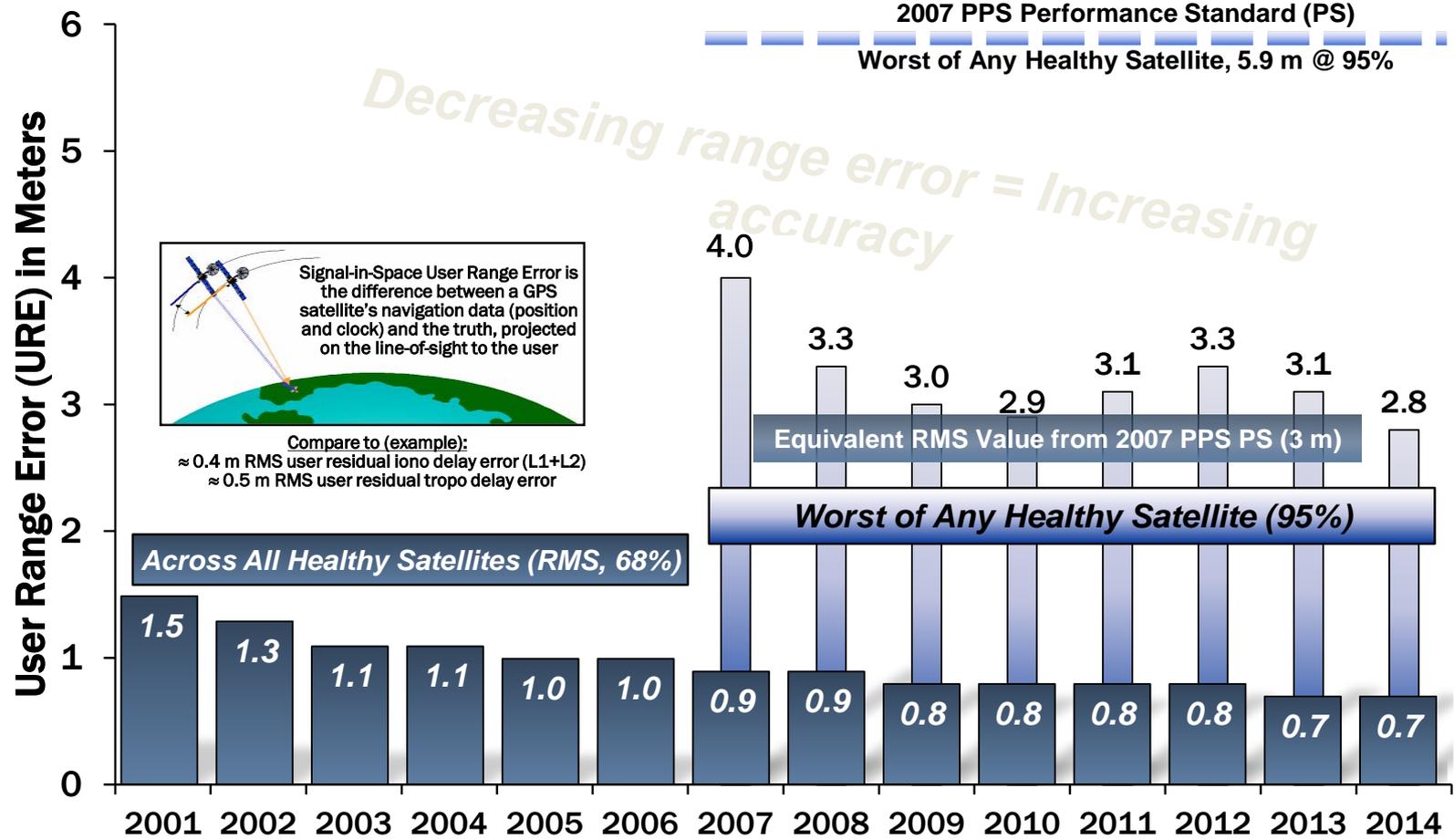
## Precise Positioning Service (PPS) Performance Standard

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### Precise Positioning Service (PPS) Signal-in-Space Performance

2007 PPS Performance Standard (PS)

Worst of Any Healthy Satellite, 5.9 m @ 95%



System accuracy better than published standard

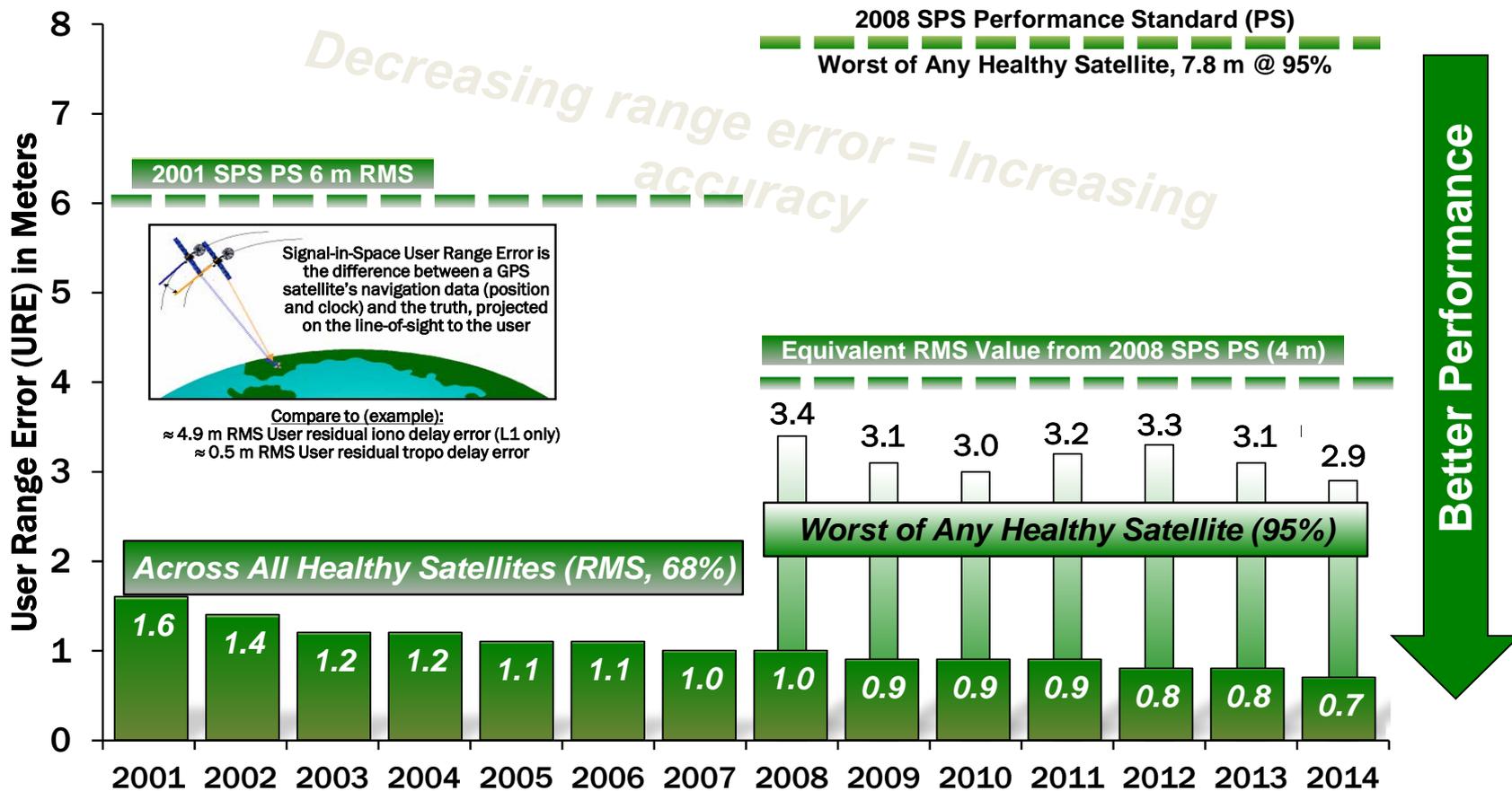


# Accuracy: Civil Commitments

## Standard Positioning Service (SPS) Performance Standard

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### Standard Positioning Service (SPS) Signal-in-Space Performance



**System accuracy better than published standard**



# GPS Modernization Program

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## Legacy GPS IIA/IIR

- Single Frequency (L1)
- Coarse acquisition (C/A) code
- Y-Code (L1Y & L2Y)

## GPS IIR-M

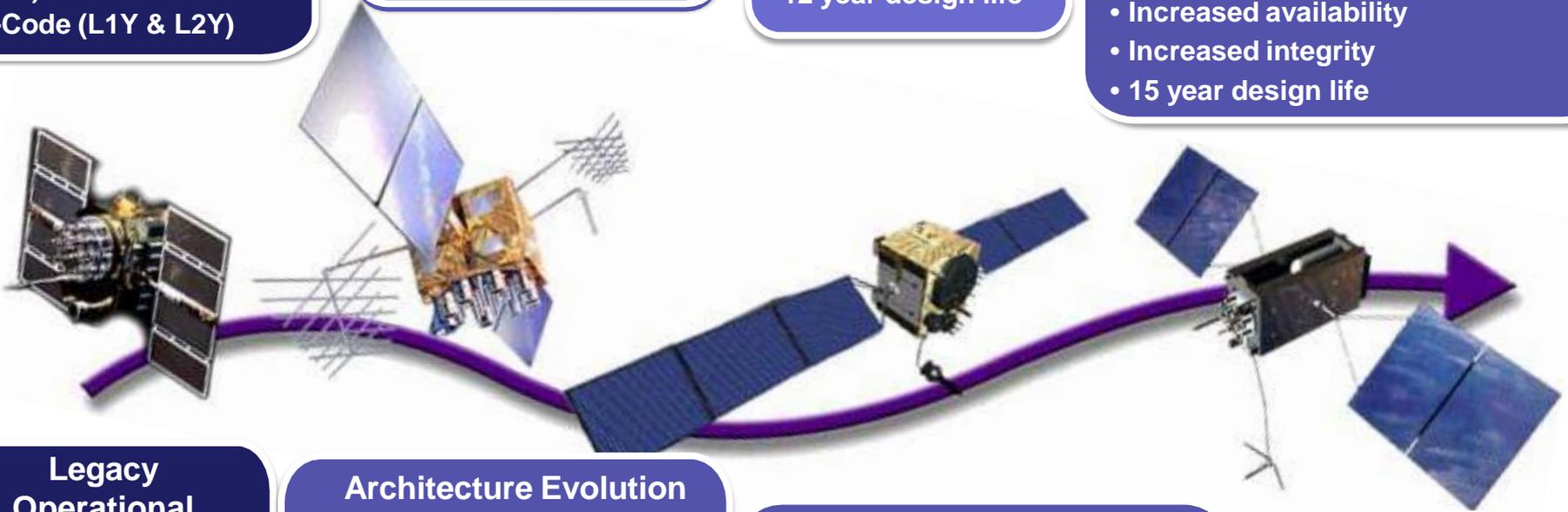
- 2<sup>nd</sup> Civil Signal (L2C)
- M-Code (L1M & L2M)

## GPS IIF

- 3<sup>rd</sup> civil signal (L5)
- 2 Rb + 1 Cs Clocks
- 12 year design life

## GPS III

- 4<sup>th</sup> civil signal (L1C)
- 4x better User Range Error than GPS IIF
- Increased availability
- Increased integrity
- 15 year design life



## Legacy Operational Control Segment (OCS)

- Mainframe system
- Command & Control
- Signal monitoring

## Architecture Evolution Plan (AEP)

- Distributed architecture
- Increased signal monitoring
- Security
- Accuracy
- Launch and disposal ops

## Next Generation Operational Control System (OCX) Block 0

- Launch & On-Orbit Checkout of GPS III

## OCX Block 1

- Transition to OCX for all GPS command and control operations

**Increasing system capabilities - Increasing user benefit**

# GPS IIF Status

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- 9 total GPS IIFs on-orbit
- 3 more GPS IIFs in the pipeline
  - SVs 9 and 12 are in storage
  - GPS IIF-10 (SV 11) Launch Scheduled for 16 Jun 15



16 May 14: IIF-6

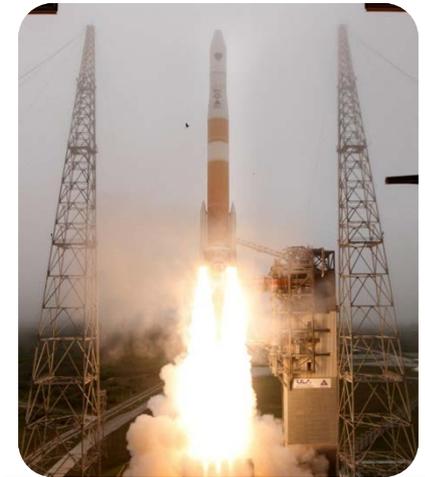
SVN 66 thru 69



1 Aug 14: IIF-7



29 Oct 14: IIF-8



25 Mar 15: IIF-9



# GPS III Status

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- Newest block of GPS satellites
  - 4 civil signals: L1 C/A, L1C, L2C, L5
    - First satellites to broadcast common L1C signal
  - 4 military signals: L1/L2 P(Y), L1/L2M
  - Three improved Rubidium atomic clocks
- Received approval to procure SV09/10 under current Lockheed contract
- Navigation panel delivered 1 Nov 14
- Mission Data Unit delivered 9 Mar 15
- SV01 System Module Core Mate completed 9 Apr 15
- GPS III SV01 available for launch Aug 2016



Lockheed-Martin (Waterton, CO) – Prime



# Ground Segment Status

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- Current system Operational Control Segment (OCS)
  - Flying GPS constellation on Architecture Evolution Plan (AEP) and Launch & early orbit, Anomaly, and Disposal Operations (LADO) software systems
  - Cyber security enhancements in progress
- Next Generation Operational Control System (OCX)
  - Modernized command & control system with M-Code, modern civil signal monitoring, info assurance infrastructure & improved PNT performance: Raytheon (Aurora, CO) - Prime
  - Successfully completed four GPS III launch exercises
  - OCX Block 0 supports launch & checkout for GPS III; currently in integration & test; delivery expected May 2016
  - OCX Block 1 supports transition from OCS in 2019
  - Civil Signal Performance Monitoring capability scheduled for OCX Block 2 in 2020



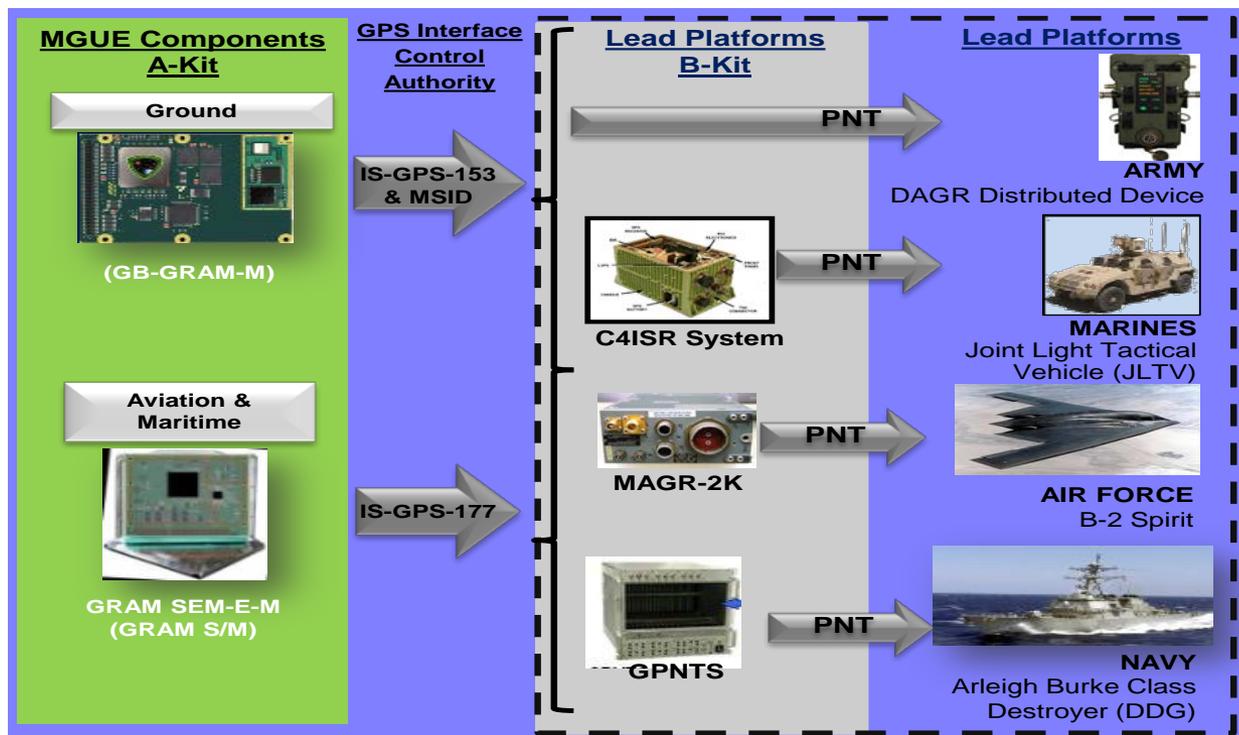
**Monitor Station**



**Ground Antenna**

# Military User Equipment Status

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Raytheon

Rockwell Collins



- Commercial market driven acquisition approach
- Accelerated from TD phase into testing and lead platform integration
- Inc 1 Milestone B approval is pending documentation to OSD(AT&L)



# Now on The Air: Modernized Civil Signals

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- The United States initiated continuous CNAV message broadcast (L2C & L5) on 28 Apr 14; began with twice-a-week uploads and moved to daily (nominal) uploads on 31 Dec 14
  - Position accuracy not guaranteed during pre-operational deployment
  - L2C message currently set “healthy”
  - L5 message set “unhealthy” until sufficient monitoring capability established
- User-Range Error (URE) CNAV Performance Post
  - Daily uploads consistent with or exceed LNAV performance\*
  - Inter-signal corrections enable single point positioning competitive with P(Y) receivers



\* Data from “Performance Evaluation of the Early CNAV Navigation Message”, Pstreigenberger, O. Montenbruck, U. Hessels; Study conducted in Europe.

H O M E O F T H E



# GPS GREEN MONSTERS

*To Success!!*