



NGA Support to Civilian Positioning, Navigation, and Timing (PNT)

Presentation to Civil GPS Service Interface Committee at ION GNSS+ 2016

Adapted from NGA Briefing provided to U.S. Coast Guard HQ

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The overall classification of this presentation is:

UNCLASSIFIED

Outline

- NGA Agency Mission
- NGA's Role in Civil GPS
 - Support to OCS/2SOPS
 - Global reference Frame, Geophysical models
 - Precise Orbit Determination
 - Web Based PPP and Geoid Heights
 - Global Monitoring of Civil Signals (NAV/CNAV)
 - Laser Reflectors on GPS III
 - Contribution to ITRF

The NGA Mission

The **National Geospatial-Intelligence Agency (NGA)** provides timely, relevant, and accurate geospatial intelligence – or **GEOINT** – in support of national security objectives.



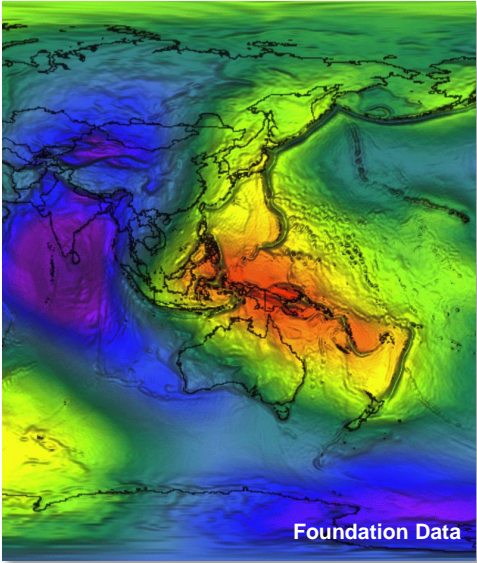
DoD photo



DoD photo

NGA's Mission Set

- Strategic Intelligence
- Warfighter Support
- Counterterrorism
- Counterproliferation
- Cyber Warfare
- Homeland Security
- Safety of Navigation
- Humanitarian Relief
- Foundation Data

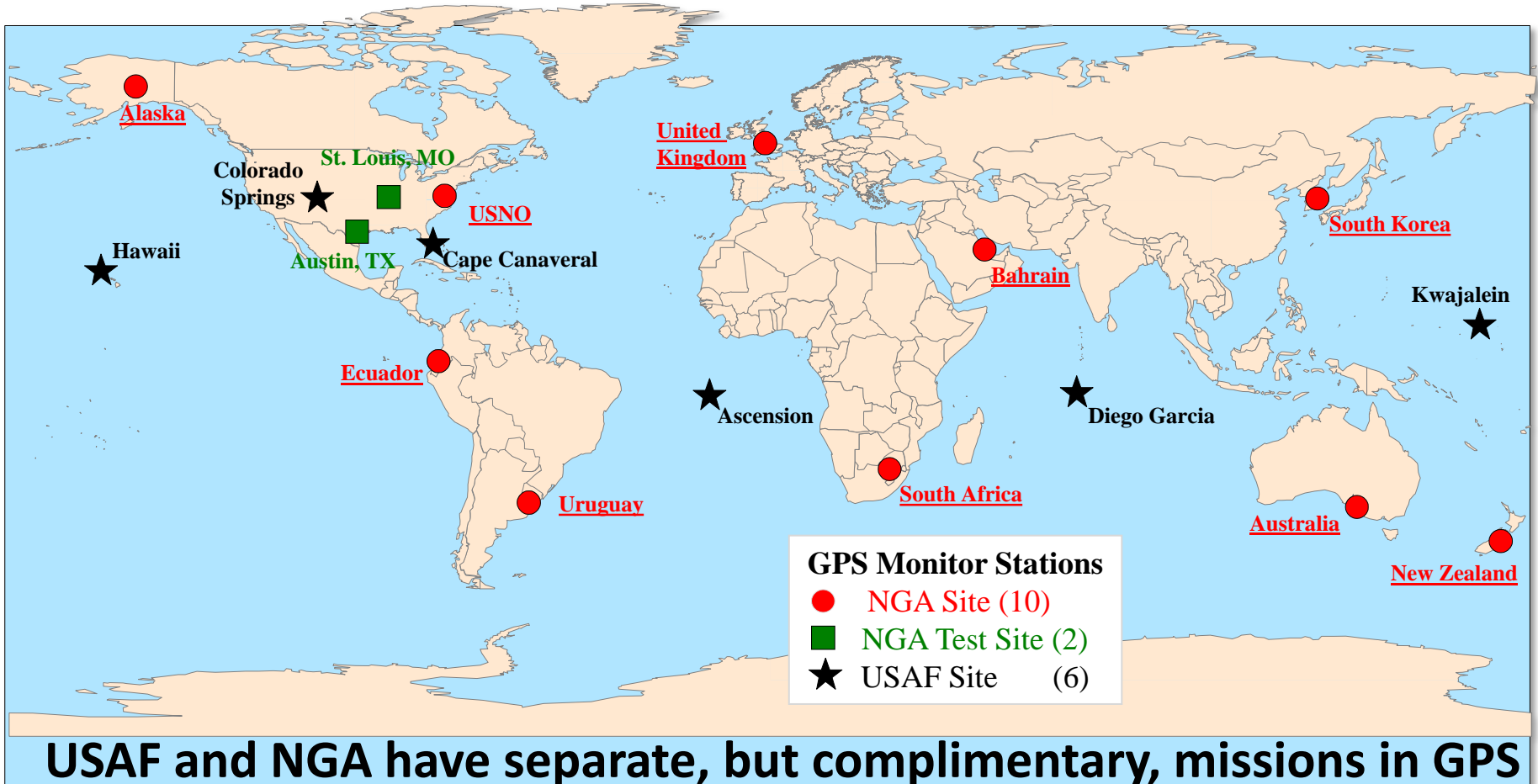


“NGA has grown into a critical link in America's intelligence apparatus and made a decisive difference to our national security and recent war effort.”

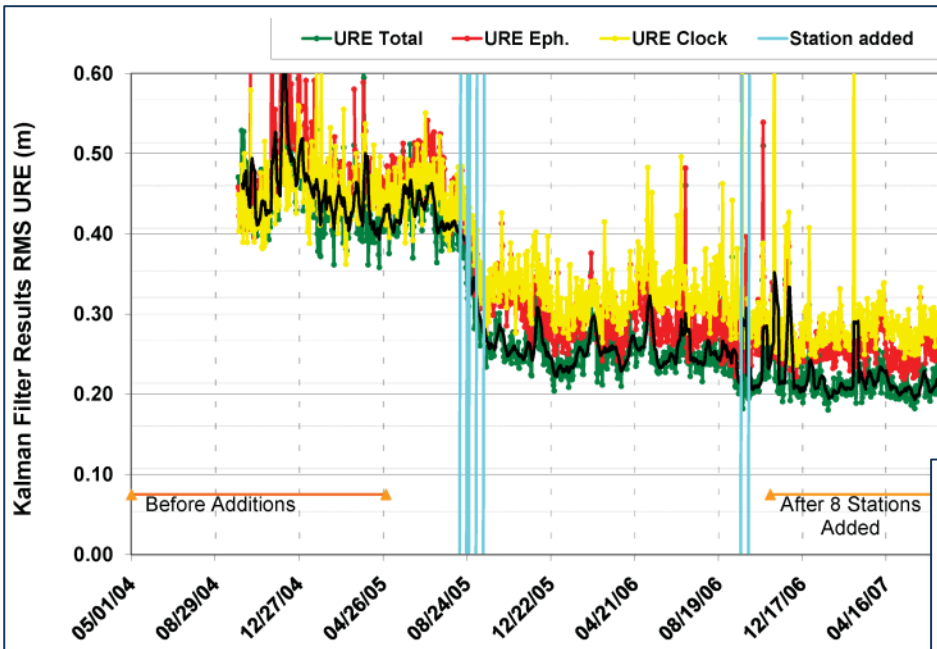
– Robert M. Gates, Former Secretary of Defense



The USAF and NGA GPS Monitor Station Network



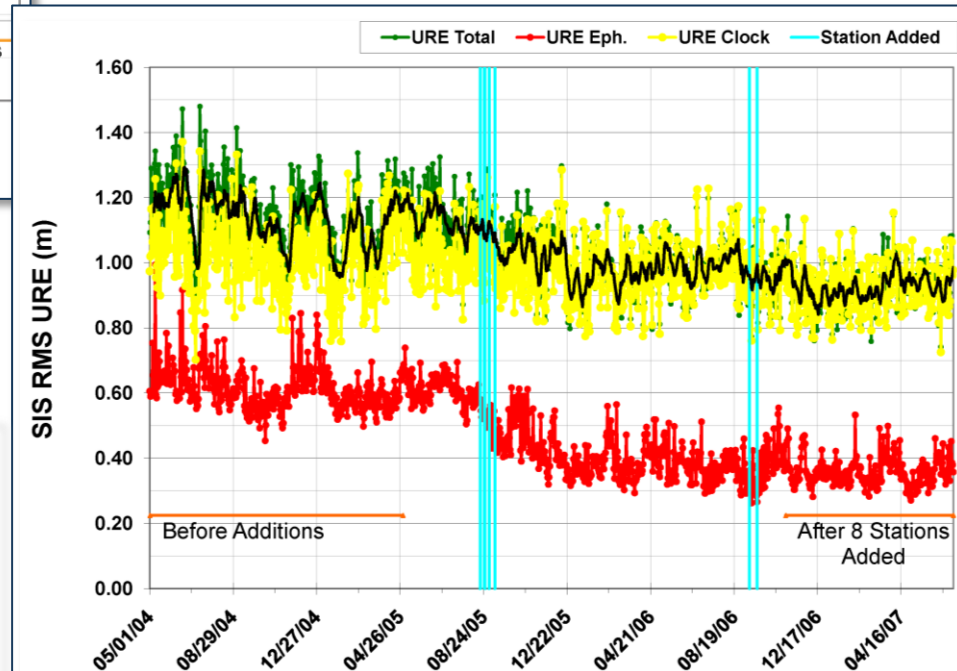
NGA Data Improves GPS Accuracy



- *Zero Age of Data URE*
- Additional stations results in 51% improvement

SIS RMS URE represents:

- Ephemeris and clock performance delivered to the user after the orbit predicted forward in time and broadcast from the SVs
- Improvement is more modest (about 19%)



NGA is a Robust Contributor and a Daily Consumer of GPS Data

We Contribute:

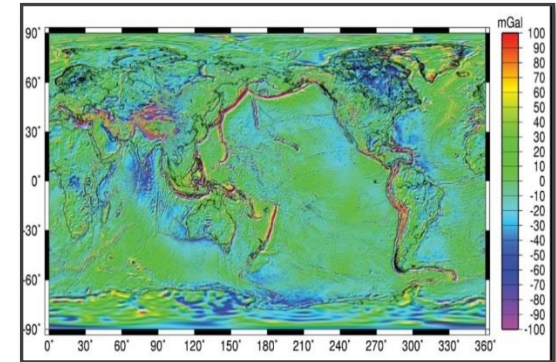
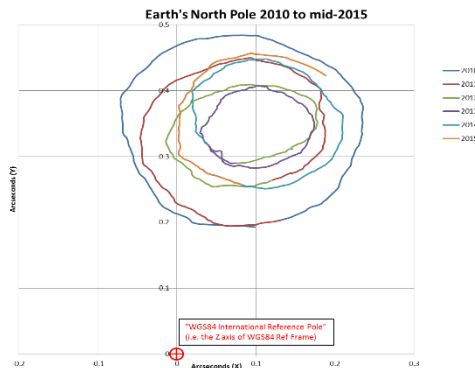
- Global Reference Frame (Coordinate System, WGS 84)
- All Required Global Geophysical Models
- 63% of all Tracking Data Used in GPS Control Segment
- Daily Predictions of Earth Orientation from USNO data
 - UT1-UTC (Δ Earth Rotation Rate), X_p , Y_p (Polar Motion)



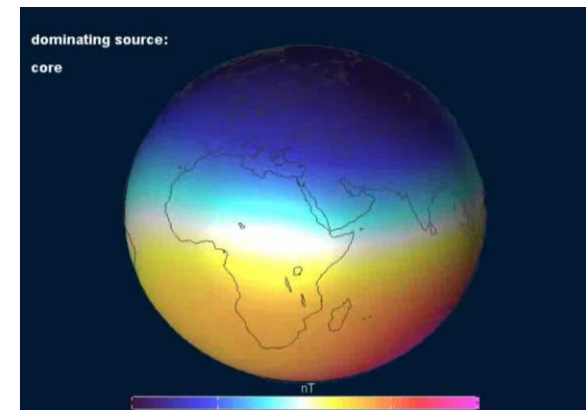
USNO = US Naval Observatory

(U) Earth Rotation – Based Time

(U) Atomic Clock – Based Time



Visual depiction of Earth Gravitational Model 2008 (EGM08)

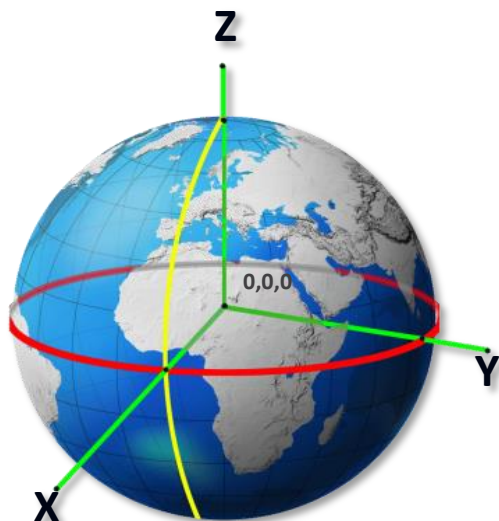


Visual depiction of World Magnetic Model 2015 (WMM15)



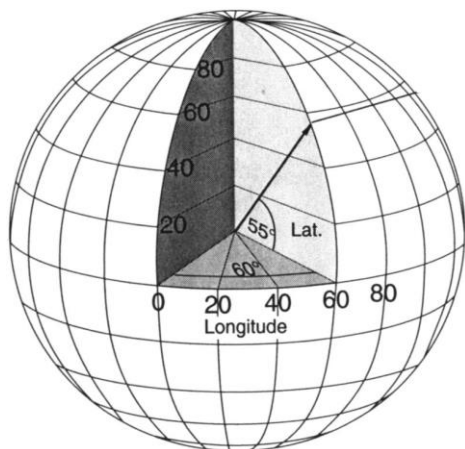
World Geodetic System 1984 (WGS 84)

NGA – Developed the First (1958) Global Reference Frame and Geophysical Models for Modern Geospatial Information



Origin for ALL modern Geospatial Data is at Earth's Center of Mass

Known in 3-D with uncertainty smaller than the size of a postage Stamp

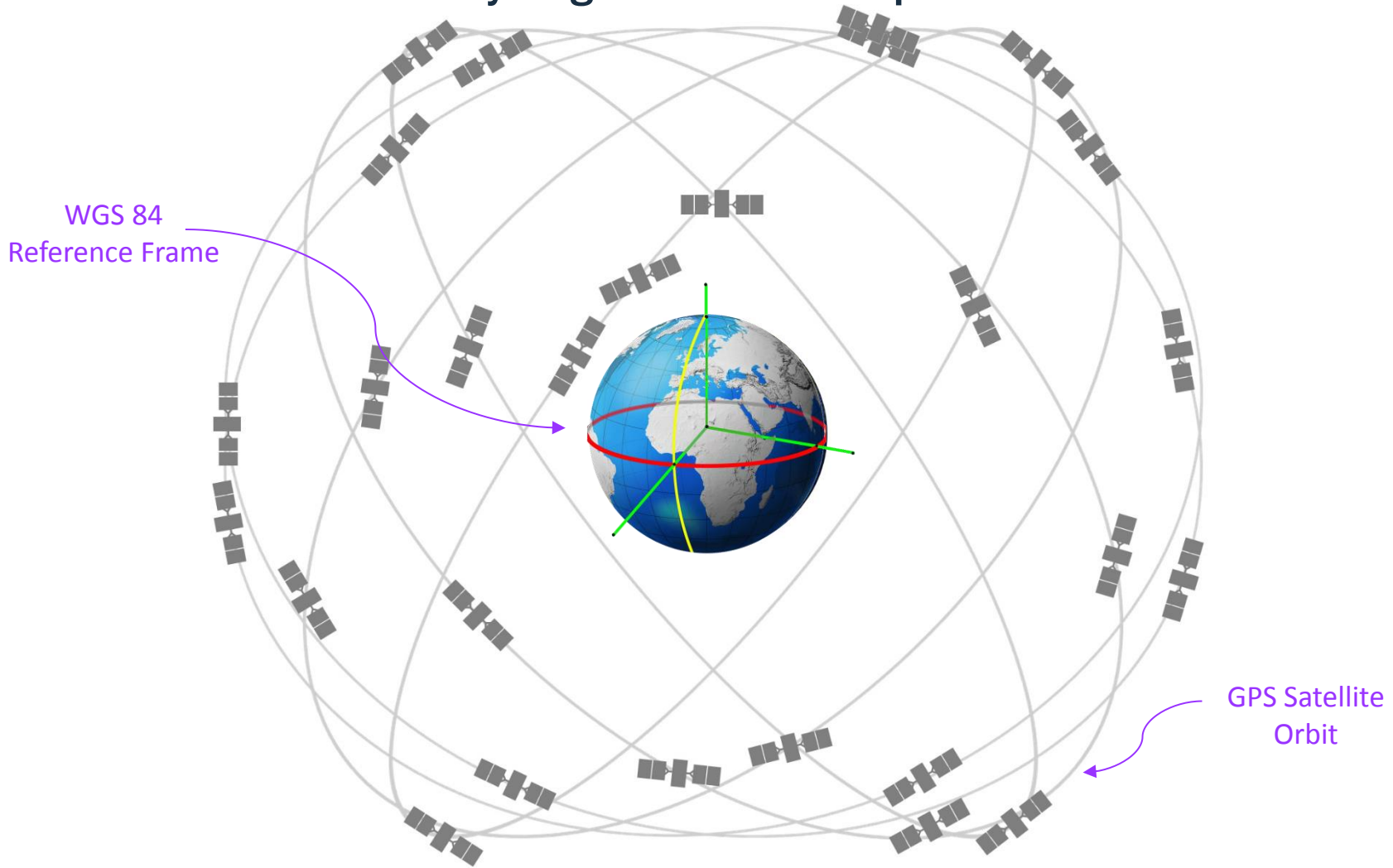


Recent WGS 84 Frame Realizations

Realization	Absolute Accuracy	Date
Original (TRANSIT)	1-2 m	Jan 1987
G730	10 cm	Jun 1994
G873	5 cm	Jun 1997
G1150	2 cm	Jan 2002
G1674	1 cm	Feb 2012
G1762	1 cm	Oct 2013



WGS 84 and GPS: A Synergetic Relationship



Note: Dimensions are not to scale!!



Office of Geomatics: Global Positioning System Division

GPS DATA

- [Ephemeris Data Page](#)
- [Earth Orientation Page](#)
- [Documentation Page](#)
- [Calendar Page](#)
- [IGS Comparison Page](#)

WGS 84

- [Earth Gravitational Model](#)
- [World Magnetics Model](#)
- [WGS 84 Online Geoid Calculator](#)
- [EGM96 Online Geoid Calculator](#)
- [Data Exchange](#)

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Coordinate Systems Analysis

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- [New Mexico Operations](#)
- [TAGGS Program](#)

Geotechnical Analysis

- [Geodetic Control](#)
- [Publications](#)

Today is: Saturday, 10 September 116

TECH NOTE 36 TRANSITION NOTICE 1: Earth Orientation Parameter Predictions (EOPP)
Transition to TechNote36 Notification

TECH NOTE 36 TRANSITION NOTICE 2: Orbit Determination Process Notification

NOTE:
A Positive Leap Second was applied on 30 June 2015
From 01 July 2015, 0h UTC, until further notice
TAI-UTC = 36 seconds ...and... GPS-UTC = 17 seconds
...TAI-GPS = 19 seconds continuously...

Welcome

.....Start Here - Product Information

Our Mission

.....Leading Edge GPS-Based Products

Space-Based PNT

.....The National Executive Committee

Related (External) Links:

Point of Contact: **NGA Public Affairs**

Phone Numbers:

Com. (571)557-5400

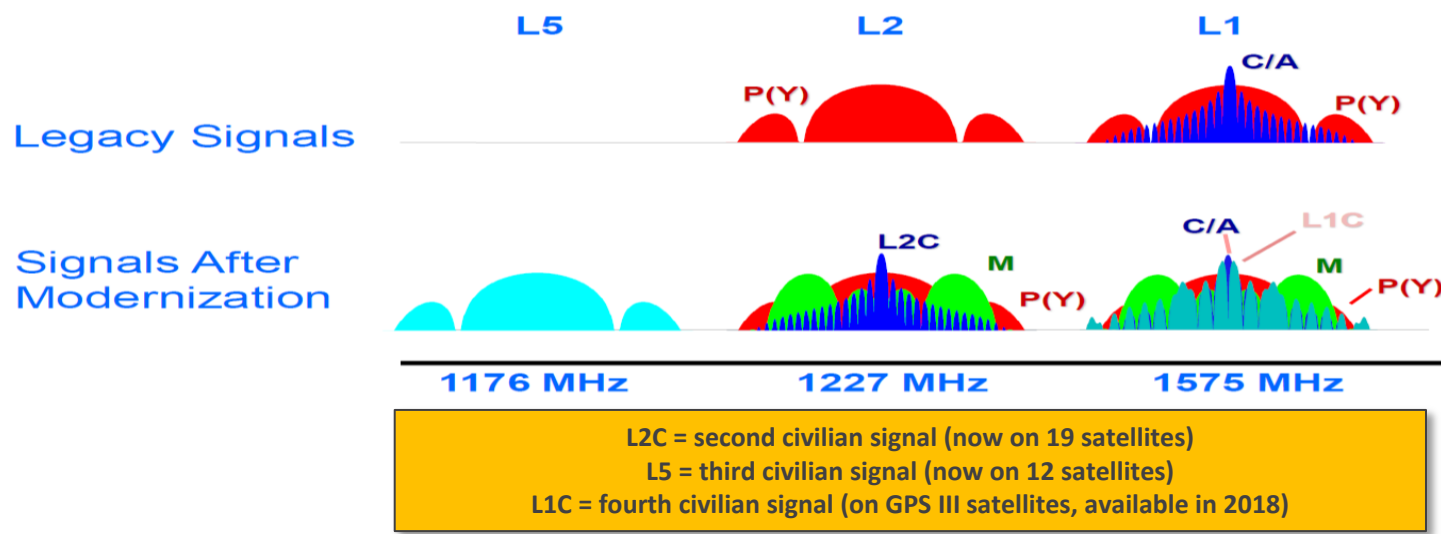
DSN 846-9140



NGA Support to Modernized Civilian Navigation (CNAV)

NGA GPS Data Supports L2C and L5 CNAV

- Support began in April 2014
- Enabled pre-operational use of CNAV
- **Provides global CNAV coverage from all 10 NGA monitor stations**
 - Data sent every five minutes starting in August of 2015
- Enhances USAF CNAV message validation

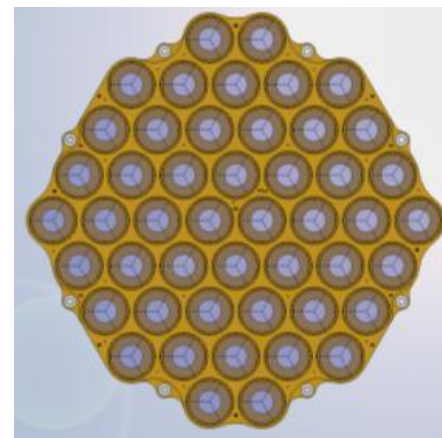


Graphic: MITRE Corporation, modified by NGA

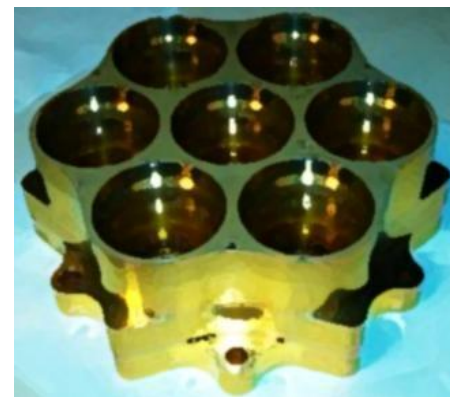


GPS-LRA Status and Plans

- ✓ LRA Requirements Review: Sept. 20, 2012.
 - ✓ LRA Preliminary Design Review: Apr. 25, 2013.
 - ✓ Sub-array successfully EMI compatibility test: Sept. 2013.
 - ✓ ICD completed (ICD-GPS-824) and approved by GPS Change Configuration Board: Jan. 23, 2014.
 - ✓ Assembly of EQM: Feb. 2014.
 - ✓ Sub-Array optical testing at GSFC Mar. 2014.
 - EQM environmental testing at NRL: Mar.-May 2015.
 - ▶ Design issues found during vibration testing.
 - ▶ Initial correction approaches did not resolving all issues.
 - ▶ NRL developed LRA redesigned – cube pattern unchanged, tray modified.
 - ✓ NASA approves NRL's new LRA design: Jun. 2016.
 - ▶ **NRL begins building new one piece cube tray.**
- Redesigned EQM environmental testing at NRL: Dec. 2016.
- EQM Optical testing at GSFC: Feb.-Mar. 2017.
- LRA Critical Design Review: May 2017.
- Flight check EQM on GPS Non-flight Satellite Testbed: Jul. 2017.
- CONOPS delivered: Early 2017.



Rendering of the flight model



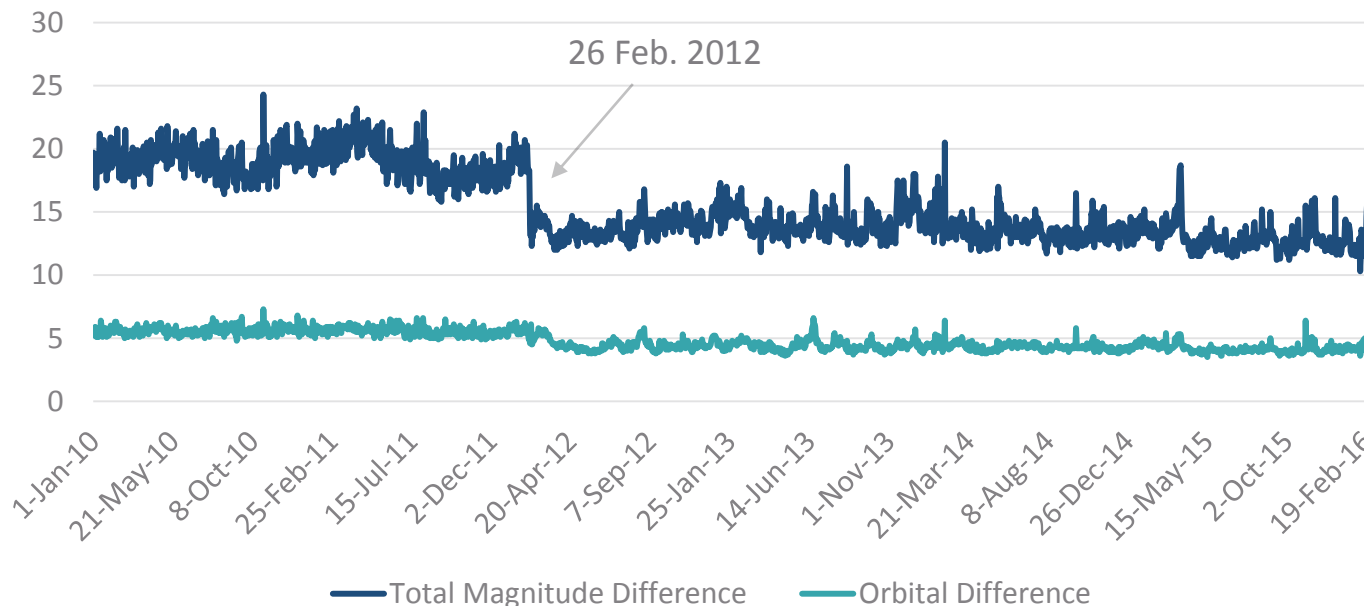
7-Aperture Sub-Array

NGA and IGS – Value for Both Sides

IGS: International GNSS Service

- NGA Station data is part of the IGS Network
- Data from other IGS Network Stations used in calculation of WGS-84 reference frame
 - Keeps WGS-84 and ITRF aligned

Daily GPS Ephemeris Solutions:
NGA vs IGS Differences (cm)





<http://earth-info.nga.mil/GandG/sathtml/>

