



**NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY**  
Know the Earth... Show the Way... Understand the World

# **GPS SVN59 Satellite Anomaly**

## **17 June 2012**

Stephen Malys

NGA Senior Scientist for Geodesy and Geophysics

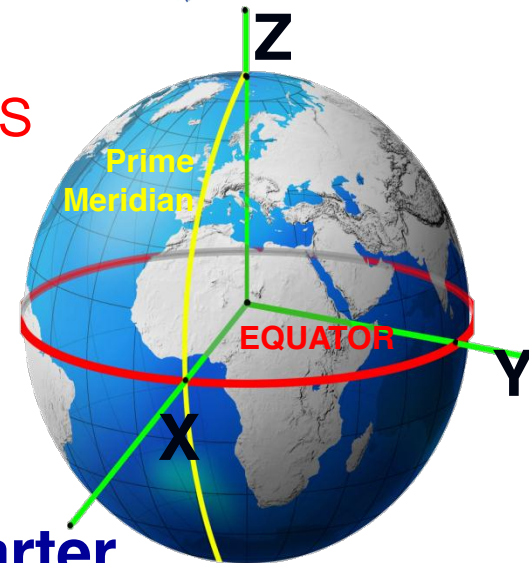
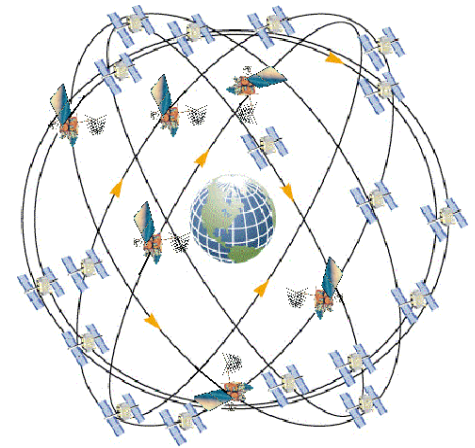
29 May 2013





# NGA's Role in GPS

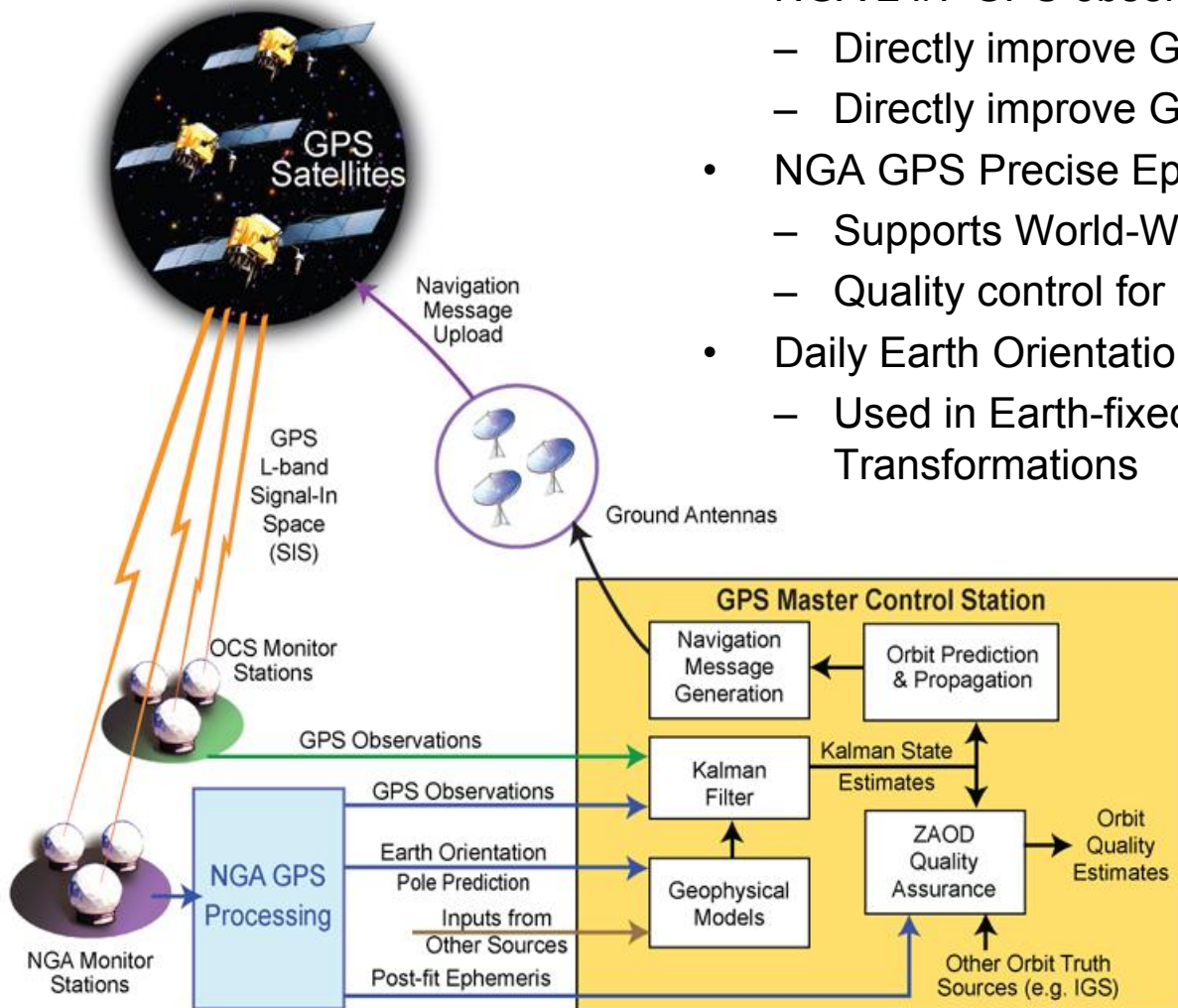
- NGA's mission is to provide timely, relevant and accurate geospatial intelligence in support of national security objectives
- NGA's GPS Mission
  - Provide global geodetic reference frame and geophysical models (WGS 84)
  - Provide satellite tracking data to GPS OCS
  - **Provide Earth Orientation Predictions to GPS OCS**
    - UT1-UTC,  $X_p$ ,  $Y_p$
  - Generation and distribution of GPS precise ephemerides and GPS clock solutions
    - Precise geodetic surveying world-wide
  - GPS contributes to the determination of WGS 84



**Signatory (as DMA) on 1975 GPS JPO Charter**



# NGA & GPS Operations



- NGA 24/7 GPS observations
  - Directly improve GPS Broadcast Accuracy
  - Directly improve GPS Integrity Monitoring
- NGA GPS Precise Ephemeris
  - Supports World-Wide Geodetic Surveying
  - Quality control for GPS operations
- Daily Earth Orientation Predictions and Post-fit estimates
  - Used in Earth-fixed to Inertial Reference Frame Transformations

- Collaboration
  - Sharing of data
  - Anomaly resolution
  - Real-time support
  - Provide GEOINT technical assistance to the USAF



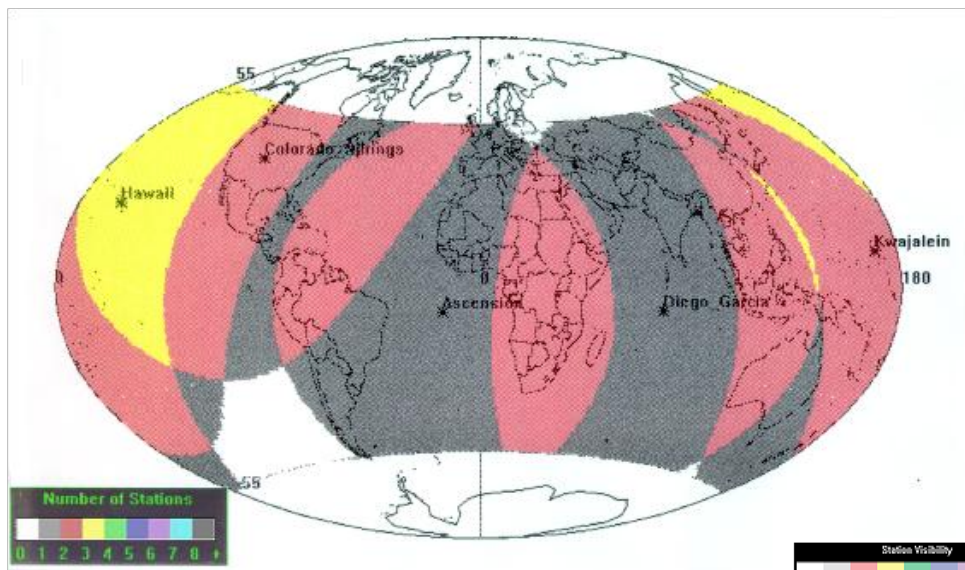
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# NGA Network





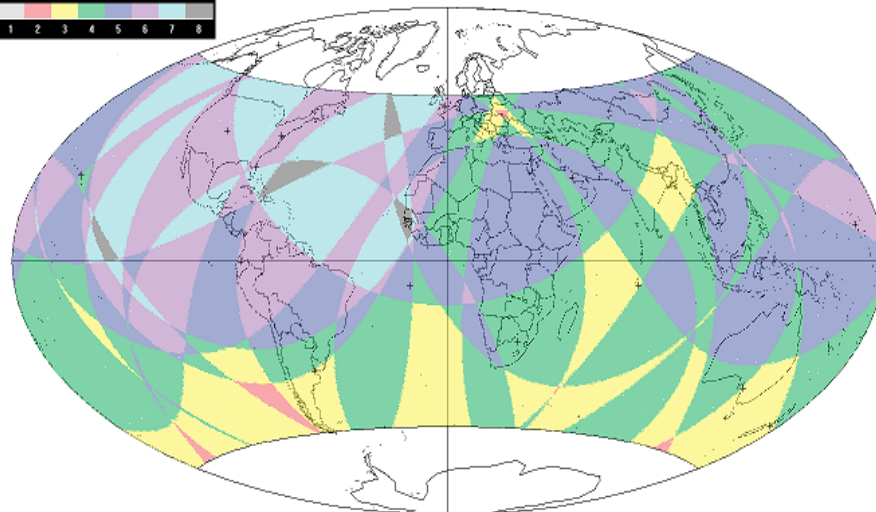
# Impact on Satellite Visibility



Co-visibility plotted along ground track projection of SV orbit

Co-visibility plot for five original OCS monitor stations

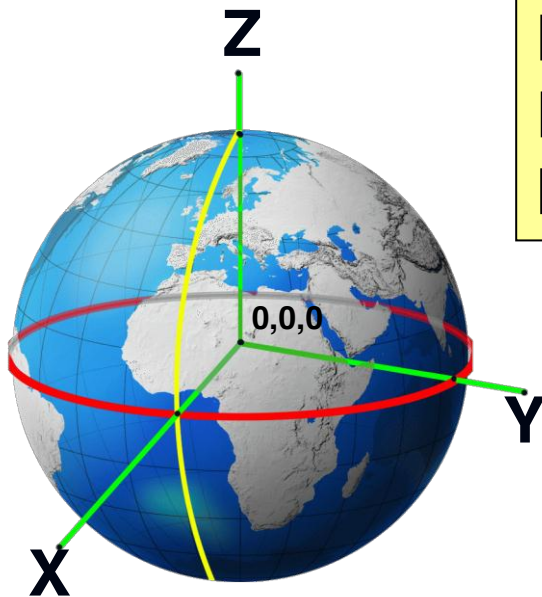
Co-visibility plot for 6 OCS + 10 NGA station network





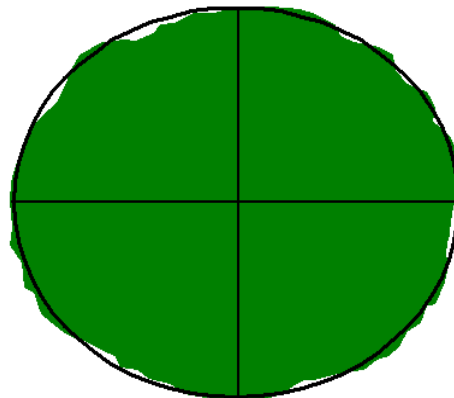
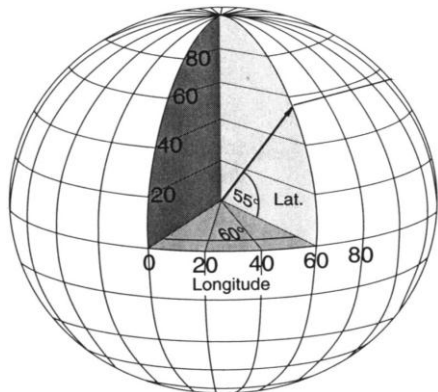
# World Geodetic System 1984

NGA – Developed the Global Reference Frame and Geophysical Models for all Modern Geospatial Information



## Global Reference Frame Accuracy

|                     |                 |
|---------------------|-----------------|
| Transit (1 - 2 m)   | Jan 1987        |
| G730 (10 cm)        | Jun 1994        |
| G873 (5 cm)         | Jun 1997        |
| G1150 (1-2 cm)      | Jan 2002        |
| <b>G1674 (1 cm)</b> | <b>Feb 2012</b> |



The geoid is used as a surrogate for mean sea level, the vertical datum for traditional 'elevations'



# NGA Procedural Failure

- **16 June 2012**, NGA **accidentally applied a leap second** into the standard Earth Orientation Parameter Predictions (EOPP) product
  - Product delivered to USAF/2SOPS for use in generating Integrated reference trajectories
  - Reference trajectories are used with tracking data in the Kalman Filter Process
- **The EOPP containing the premature leap second created a single erroneous upload to SVN59 on 17 June**
  - **Resulting in** an erroneous broadcast message from SVN59
  - **The condition lasted for 27 minutes** (0009Z to 0036Z) before it was corrected
- NGA's After-Action Review has led to revised and redundant quality control procedures

Earth Orientation Parameters are critical to GPS operations



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