

PNT Interference Detection

U.S. Organization and Operating Concepts



Civil Users Need A Means For:

Provider officials to disseminate system information (system status, health and modernization plans).

Worldwide user input/feedback (feedback on adequacy of signals for user needs, new applications).

Global industry participation.

Interference/outage reporting mechanism (process for interference detection and mitigation).

User advocacy (a means by which system users can be represented in all parts of the system planning and operation).



Assignment of Civil Interface Duties

- 1986 – When GPS became a dual-use (Military/Civil) system, DOD formed an MOU with DOT for GPS Civil Interface.
- DOT assigned operational interface to U.S. Coast Guard for dissemination of GPS operational information
- Civil GPS Service Interface Committee (CGSIC) was formed. This is now a DOT RITA responsibility as liaison between world's civil GPS users and U.S. GPS authorities

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**United States
Coast Guard**



CGSIC Charter

Civil GPS Service Interface Committee was chartered to be that forum.

Recognized worldwide forum for effective interaction between all civil GPS users and the U.S. GPS authorities.

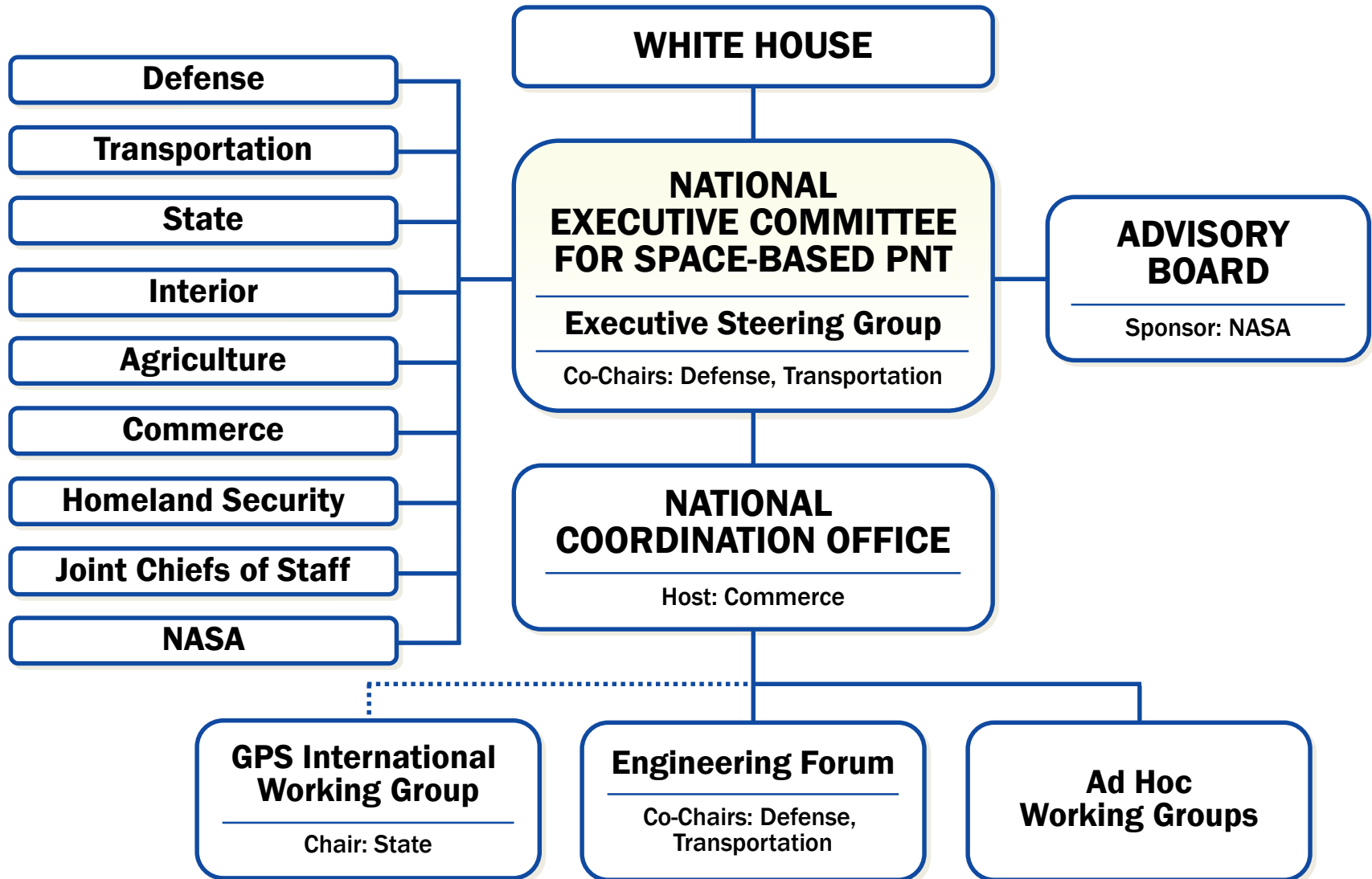
Established and chartered to identify civil GPS user needs (e.g. navigation, timing, and positioning).

Exchange information concerning GPS with the worldwide civil user community.

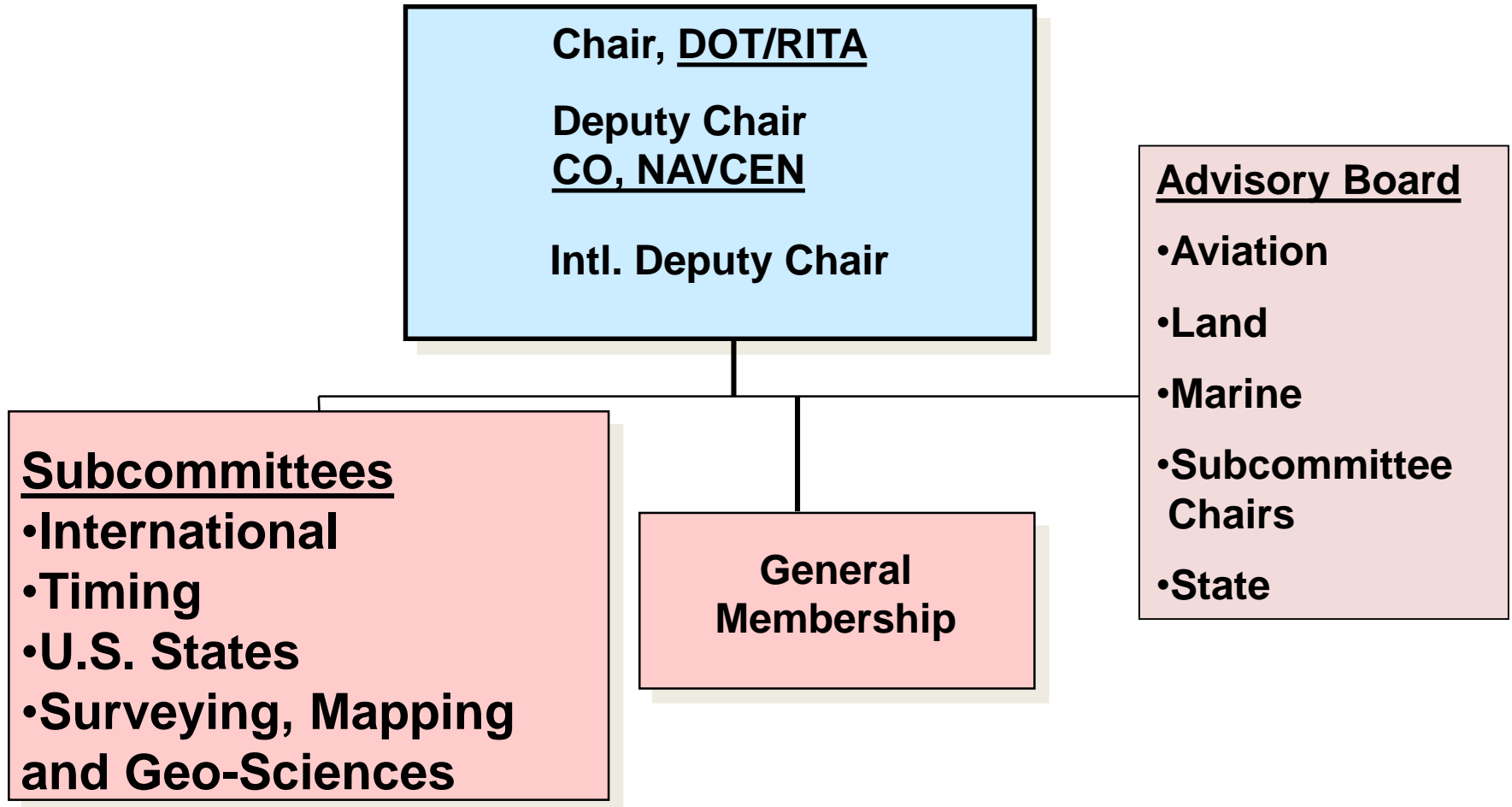
Reports activities to the Office of the Assistant Secretary for Transportation.



U.S. Space-Based PNT Organization Structure



Civil GPS Service Interface Committee (CGSIC)



**CGSIC is the World-Wide Forum Between Civil
GPS Users and U.S. Government Service Providers**

Civil Liaison

DOT Research and Innovative Technologies
Agency assigned responsibility as PNT Lead for
Civil GPS

Civilian liaison positions were established
throughout the GPS program to safeguard civil
interests:

- GPS Directorate Liaison
- Civil liaison at U.S. Space Command
- U.S. Coast Guard Navigation Center
Committee Co-Chair
Executive Secretariat
Coast Guard liaison at 2SOPS



NAVCEN Liaison to USAF GPSOC

- Attends Air Force Undergraduate Training for Space (5 wks)
- Provides the civil interface to GPS Operations Center.
- Works closely with DOD staff to monitor GPS satellite operations and maintenance to safeguard civil interests.
- Coordinate issue resolution between the GPS user and the DOD service providers.
- Supports civil users in resolving GPS outages by facilitating reports, coordinating findings, and disseminating results.
- Attends DOD Constellation Sustainment Assessment Team (CSAT) meetings to represent civil user input on GPS launch decisions.



Outreach

Annual meeting co-located with ION

Subcommittee Meetings:

- International Information Subcommittee (UK Chair)
Annual European and Asia meetings
- Timing (BIPM Chair)
- Survey, Mapping and Geo-sciences (NGS Chair)
- States and Local Government (FHWA Chair)
Two meetings annually in different cities around the country

Annual GPS Industry Partnership Day (LA AFB)

Conferences:

- Institute of Navigation (ION) GNSS Conference
- ION Joint Navigation Conference
- European Navigation Conference
- Munich Satellite Navigation Conference



Civil GPS Representation

NAVCEN provides for civil representation and advocates for civil use of GPS at government meetings:

- GPS Constellation Sustainment and Assessment Team (CSAT)
- GPS Interagency Forum for Operational Requirements (IFOR)
- Civil GPS Program Management Review (PMR)
- National PNT Engineering Forum (NPEF)
- DOS GPS International Working Group (GIWG)
- GPS Information Dissemination Coordination Team (IDCT)
- United Nations International Committee on GNSS (UN-ICG)
- DOT and DHS POS-Nav and Extended POS-Nav Committees
- GPS Joint Service Review
- Interface Control Working Group (ICWG)

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Information Flow

- Performance Standard and Interface Control Documents (ICD) provide technical information necessary to build equipment.
 - IS-GPS-200 Navstar GPS Space Segment/Navigation User Interfaces
 - IS-GPS-800 Navstar GPS Space Segment/User Segment L1C Interface
 - IS-GPS-705 Navstar GPS Space Segment/User Segment L5 Interface
 - ICD-GPS-060 GPS User Equipment (Phase III) Interface Control Document for the Precise Time and Interval (PTTI)
- ICD-GPS-240 details flow of operational information from 2SOPS to Triad.
- Triad operations centers disseminate information through a variety of web-sites and notification methods

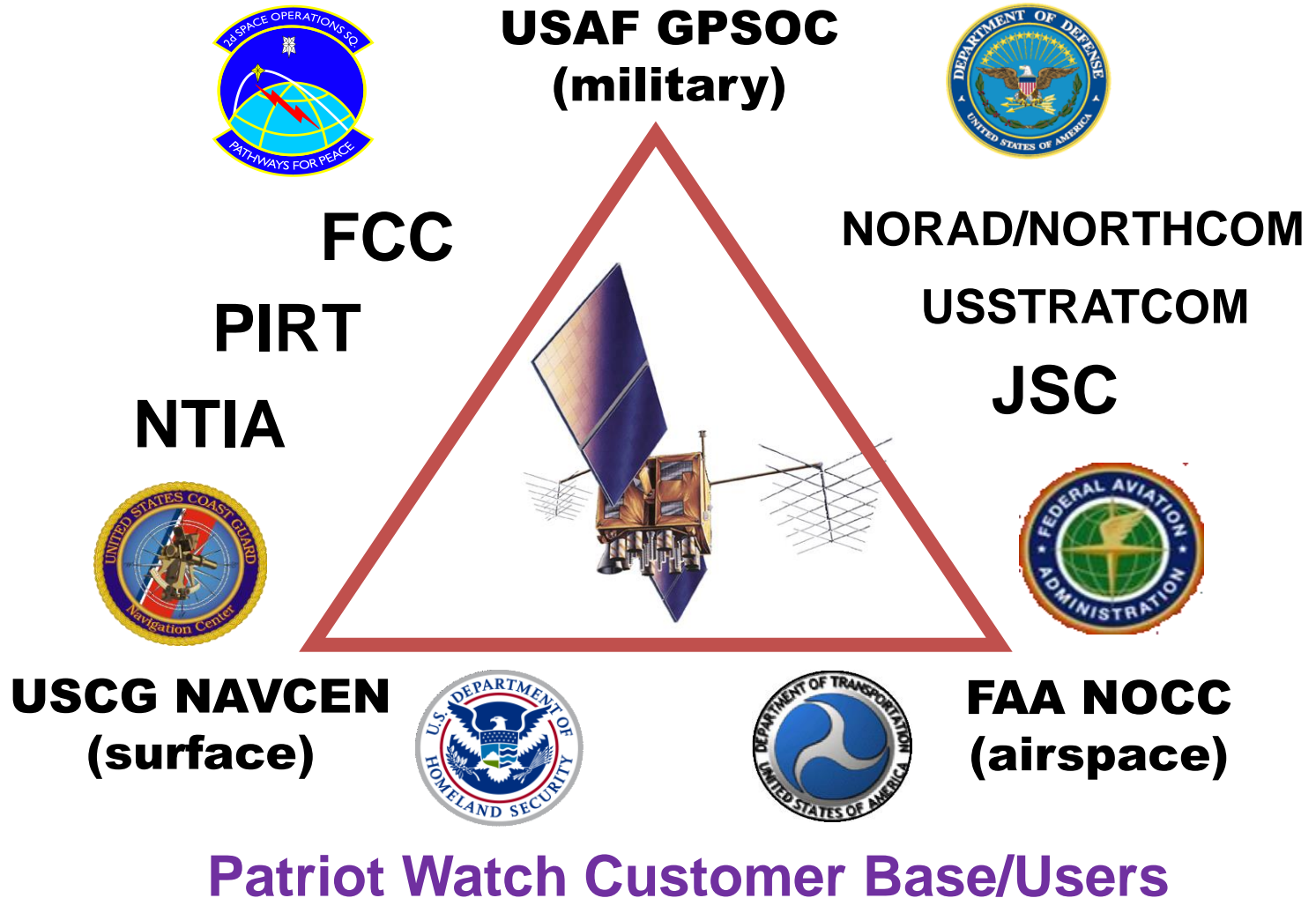
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The GPS Triad

Joint GPS User Support Service



Maritime Information Operations Center Responsibilities

- **24/7 Operation:**
- Web based Information Services
- Navigation Information Service (NIS)
- GPS Civil Interface
- Long Range Identification and Tracking (LRIT)
- DGPS Monitor & Control.
- Nationwide Automatic Information System (AIS).



GPS CIVIL NOTIFICATION

- The TRIAD uses working relationships with partners to disseminate operational information
- NAVCEN has working relationships with
 - Japan DGPS Center
 - GLONASS Analysis Center
 - Korea DGPS Center
 - Canada: Nav Canada
 - Trinity House, UK
 - Australia Air Services
 - Et al
- Information is shared when it indicates effect to systems operated by other countries or areas of responsibility held by these organizations.

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GPS Civil Performance

- The TRIAD uses DOD developed tools to predict GPS performance impacts due to planned changes to the satellite constellation status
- Enables prediction of Dilution of Precision (DOP); measure of GPS user accuracy.
- High DOP triggers a coordinated regional user notification
 - Notice to Mariners (NTM)
 - Notice to Airman (NOTAM)
 - CGSIC List Server Membership

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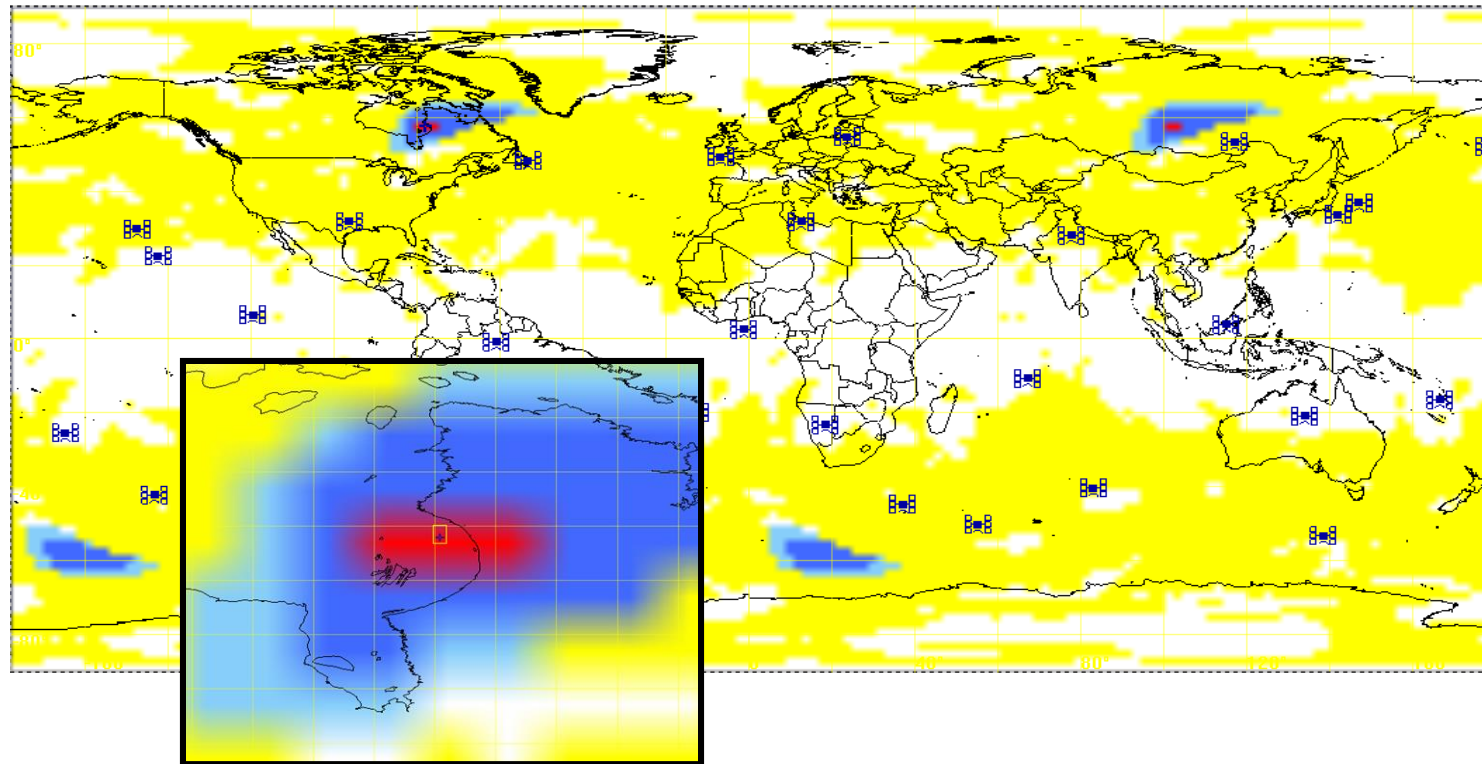




NAVCEN DAILY SYSTEMS BRIEF

16 AUG 2010

GPS HDOP Prediction

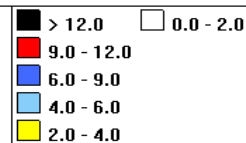


Contour Legend

Metric: HDOP Max

Scenario: 16AUG10

Latitude Increment: 02° 00'



Production Date: 08/15/2010 20:44:44

Route: World - 4 channels

Longitude Increment: 002° 00'

Almanac File: 227.AL3

Start Time: 16 Aug 2010 00:00:00Z

Number of Channels: 4

SOF File: 2010_225_214929_v02

End Time: 16 Aug 2010 23:59:00Z

Mask Angle: 5°

PSF File: N/A

Altitude: 0 ft HAE

Signal Modulation: BPSK

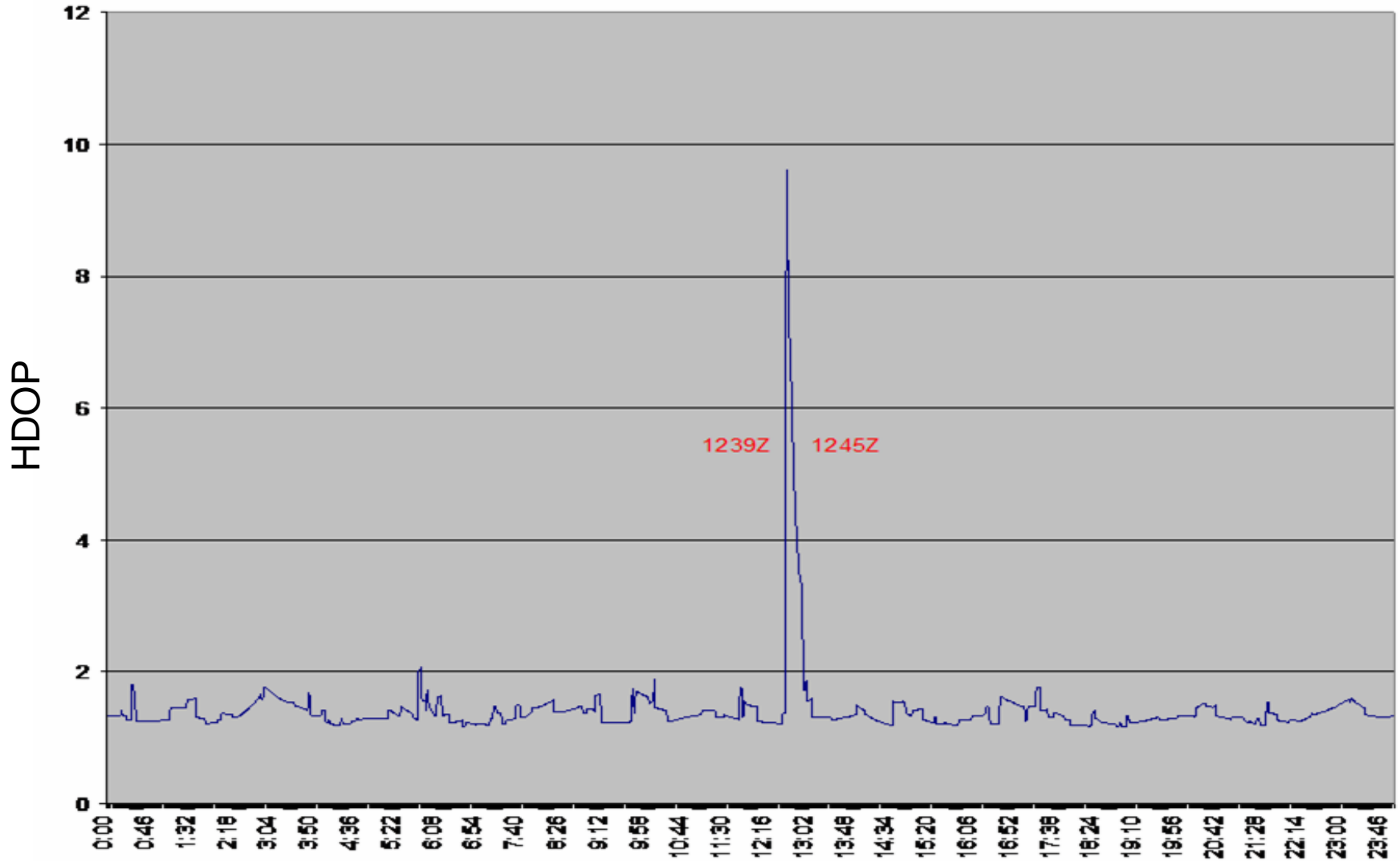
PRN: 25 Outage: 28 May 2010 03:00:00 to Until Further Notice

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HDOP Hudson Bay 16Aug2010



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GPS

- [GPS General Information](#)
- [GPS Status and Outage Information](#)
- [GPS Ops Advisories](#)
- [GPS Ops Advisory Tutorial](#)
- [NANUs & NANU Information](#)
- [GPS Service Interruptions](#)
- [GPS Almanac Information](#)
- [Precise Ephemeris Info](#)
- [Subscribe to List Serve Msgs](#)
- [Space Weather Information](#)
- [Selective Availability](#)
- [Report a GPS Problem](#)
- [Frequently Asked Questions](#)
- [GPS Acronyms and Abbreviations](#)
- [Augmentation Systems](#)
- [Reference Information](#)
- [GPS Modernization](#)

GENERAL INFORMATION ON GPS

The Global Positioning System (GPS) was designed as a dual-use system with the primary purpose of enhancing the effectiveness of U.S. and allied military forces. GPS is rapidly becoming an integral component of the emerging Global Information Infrastructure, with applications ranging from mapping and surveying to international air traffic management and global change research. The growing demand from military, civil, commercial, and scientific users has generated a U.S. commercial GPS equipment and service industry that leads the world. Augmentations to enhance basic GPS services could further expand these civil and commercial markets.

GPS is managed by the National Space-Based Positioning, Navigation, and Timing (PNT) Executive Committee, supported by the PNT Executive Secretariat (<http://www.pnt.gov>). The PNT manages GPS and U.S. Government augmentations to GPS, consistent with national policy, to support and enhance U.S. economic competitiveness and productivity while protecting national security and foreign policy interests.

The basic GPS is defined as the constellation of satellites, the navigation payloads which produce the GPS signals, ground stations, data links, and associated command and control facilities which are operated and maintained by the Department of Defense; the Standard Positioning Service (SPS) as the civil and commercial service provided by the basic GPS; and augmentations as those systems based on the GPS that provide real-time accuracy greater than the SPS. GPS permits land, sea, and airborne users to determine their three dimensional position, velocity, and time, 24 hours a day in all weather, anywhere in the world.

From our site, you may view or download current and [archived](#) GPS satellite information such as status messages, precise ephemeris data, and almanacs.

Specific, operational GPS information may be obtained from the links below or from the links on blue navigation bar at the left.

- [Subscribe to the GPS Status Message and/or the NANU List Serve](#)
- [GPS Performance Reports](#) (clicking on this link will open a new browser window showing the U.S. Air Force GPS Operations Center website)

GPS Status Messages

- [Latest GPS Status Message](#)
- [GPS Status Message Archives](#)

Report GPS Problems

www.navcen.uscg.gov

Primary Mission Areas:

- [Global Positioning System](#)
- [Differential GPS](#)
- [Nationwide DGPS](#)
- [LORAN C](#)
- [Inland River Vessel Movement Center](#)
- [Long Range Identification and Tracking](#)
- [Civil GPS Service Interface Committee](#)
- [Automatic Identification System](#)
- [Nationwide AIS \(NAIS\)](#)

RAA2012-002: Boston Light Buoy, GPS Outage

GPS Performance Analysis

0000z - 2359z, 09 Jan 12

Analysis Overview / Assumptions

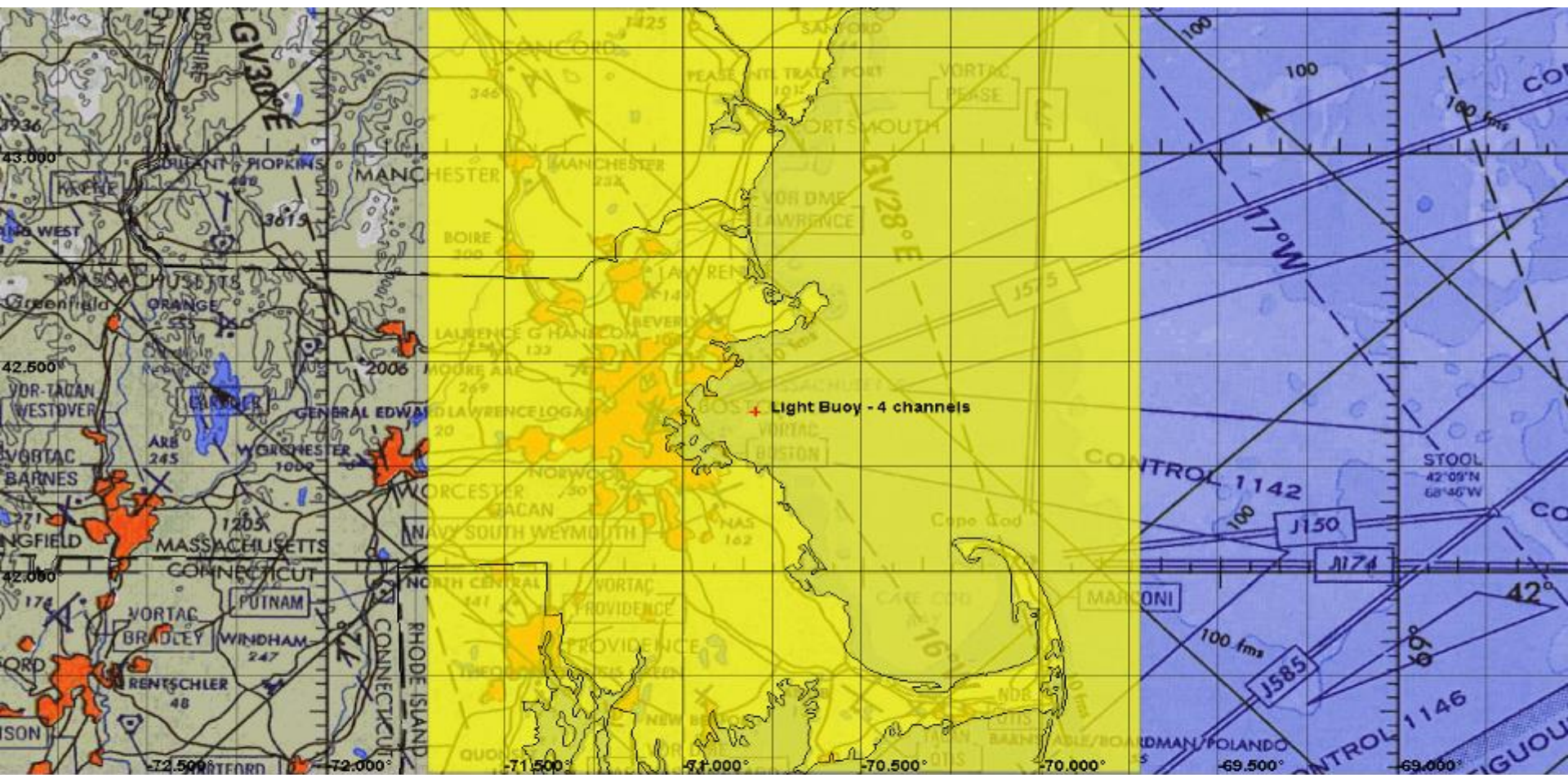
- Location of Incident:
 - Boston Light Buoy
- Coordinates:
 - Location N 42.2282° W 070.4171 °
- Date of Incident:
 - 2000z, 09 Jan 12
- Number of Incidents:
 - 1
- Mask Angle:
 - Visibility Charts - 0°
 - Contour and Spike Charts - 5°
- Caveats:
 - None

Summary of Findings

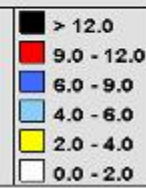
- GPS Performance:
 - Best-4 PDOP at 2000z, 09 Jan 12 in AOI was less than 3
 - Best-4 Position Error at 2000z, 09 Jan 12 in AOI was less than 3 meters
 - All In View PDOP at 2000z, 09 Jan 12 in AOI was less than 2
 - All In View Position Error at 2000z, 09 Jan 12 in AOI was less than 2 meters
- Satellite Outages:
 - No outages
- Solar and Geophysical Weather:
 - Energetic Events: Nothing significant
 - Proton Events: Nothing significant
 - Space Environment Analysis: Nothing significant
 - X-Ray Flux: Nothing significant
- EMI/RFI
 - No EMI/RFI events were observed at or near the locations in question.
- Other Analysis/Findings:
 - No other factors were found indicating a possible cause for loss or degradation of the GPS signal over the requested area.

PDOP Max | Best 4 | Boston Light Buoys

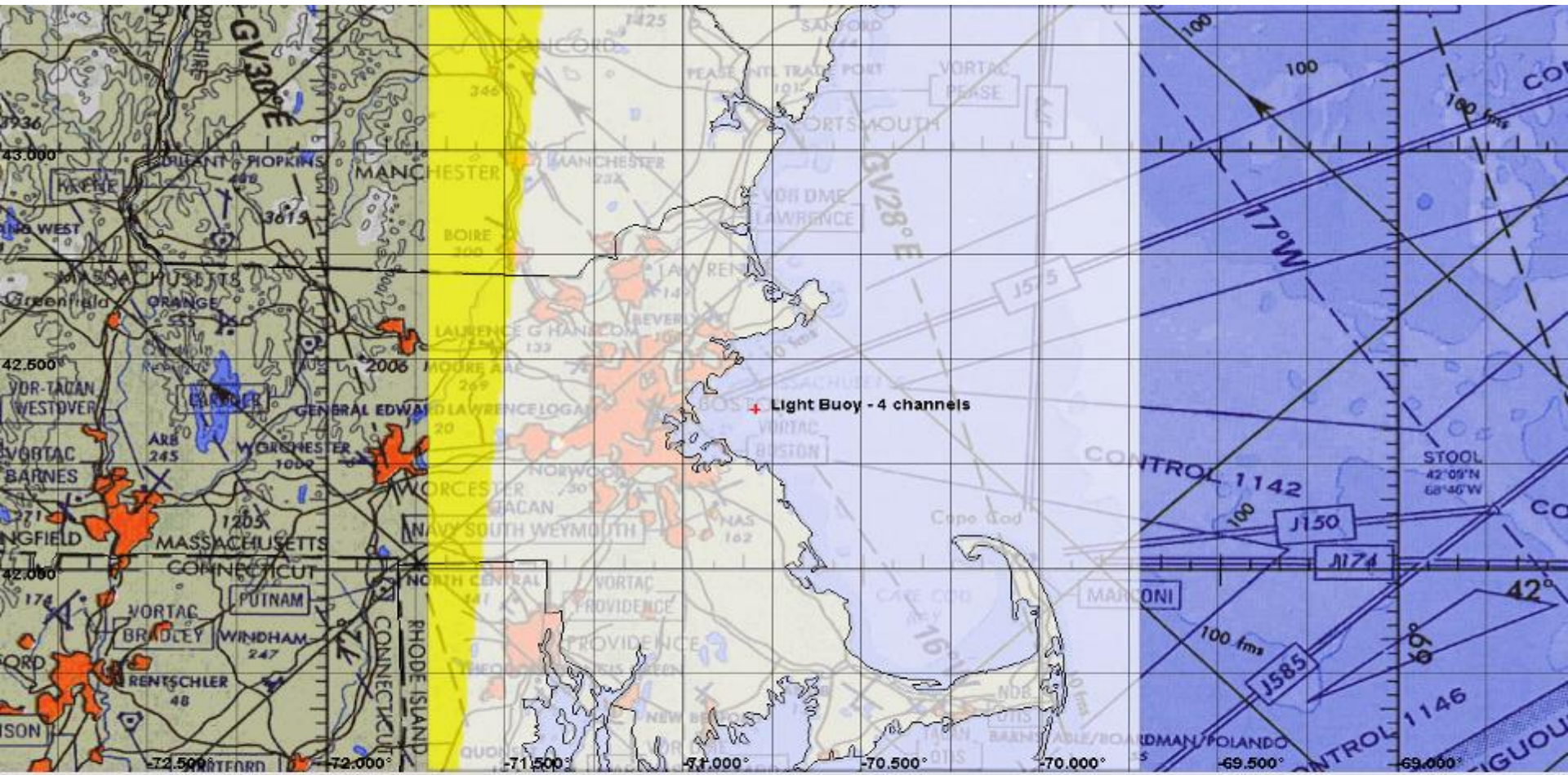
0000z-2359z, 09 Jan 2012



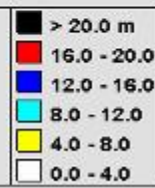
Contour Legend	
Metric: PDOP Max	Start Time: 09 Jan 2012 00:00:00Z Altitude: 0 ft HAE
Almanac File: current.al4	End Time: 09 Jan 2012 23:59:00Z Number of Channels: 4
SOF File: 2011_354_052313_v02	Latitude Increment: 00° 01.2' Mask Angle: 5°
PAF File: 2012_009_v03.paf	Longitude Increment: 000° 00.66' Terrain Blockage Type: None
Production Date: 01/13/2012 03:47:31	
No Outages	



Position Error Max (m) | Best 4 | Boston Light Buoys 0000z-2359z, 09 Jan 2012

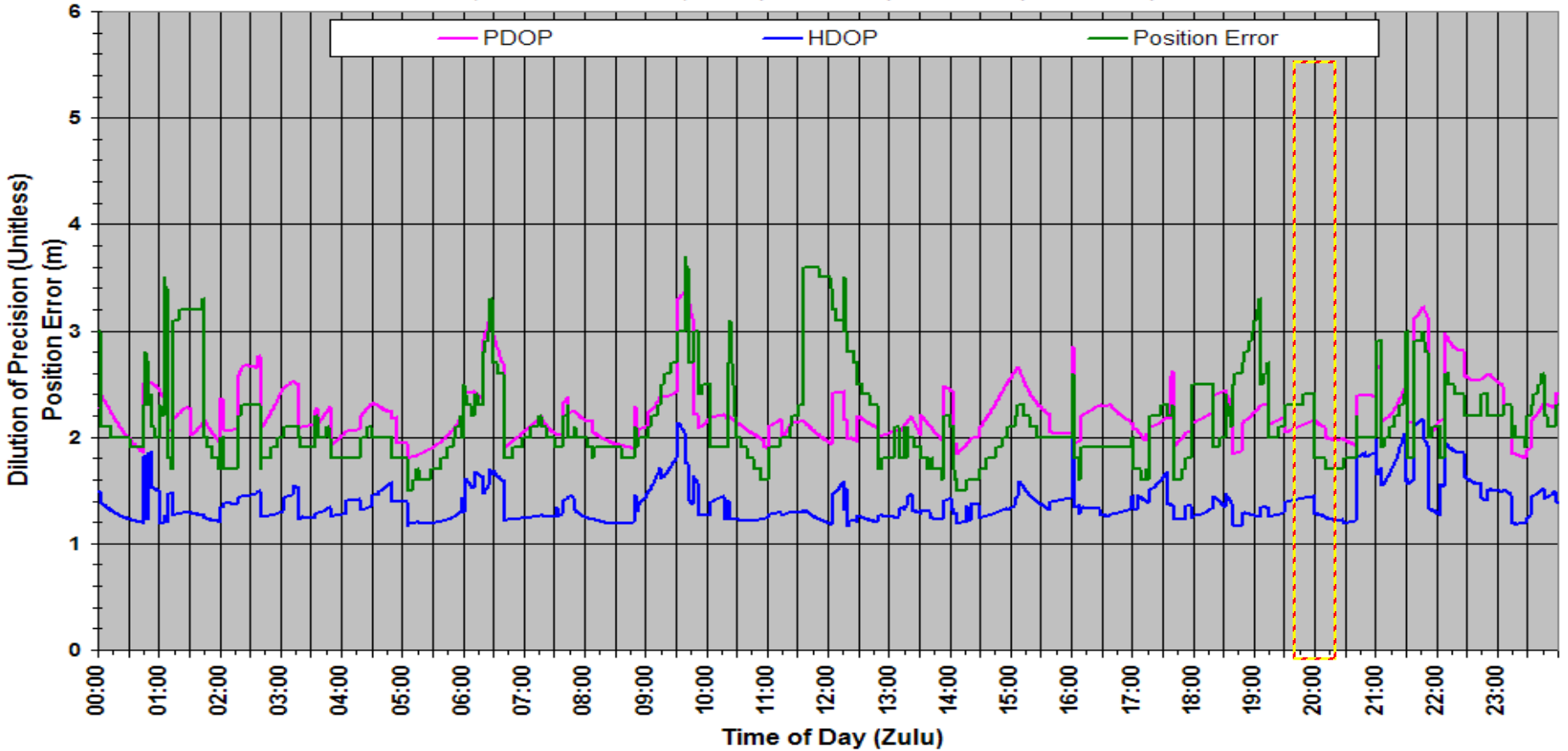


Contour Legend			
Metric: Position Error Max(m)	Start Time: 09 Jan 2012 00:00:00Z	Altitude: 0 ft HAE	
Almanac File: current.a14	End Time: 09 Jan 2012 23:59:00Z	Number of Channels: 4	
SOF File: 2011_354_052313_v02	Latitude Increment: 00° 01.2'	Mask Angle: 5°	
PAF File: 2012_009_v03.paf	Longitude Increment: 000° 00.66'	Terrain Blockage Type: None	
Production Date: 01/13/2012 03:47:31			
No Outages			



PDOP/HDOP/Position Error Chart | Best-4 | Boston Light Buoy 0000z-2359z, 09 Jan 2012

Light Buoy - 4 channels - DOP/Position Spike Chart
09 Jan 2012, 0000z - 09 Jan 2012, 2359z | 42° 22.82'N | 70° 12.28'W | Terrain Off | Best 4 Solution



No Satellite Outages

DOP Threshold Limit: 6
Nothing over the 6 threshold

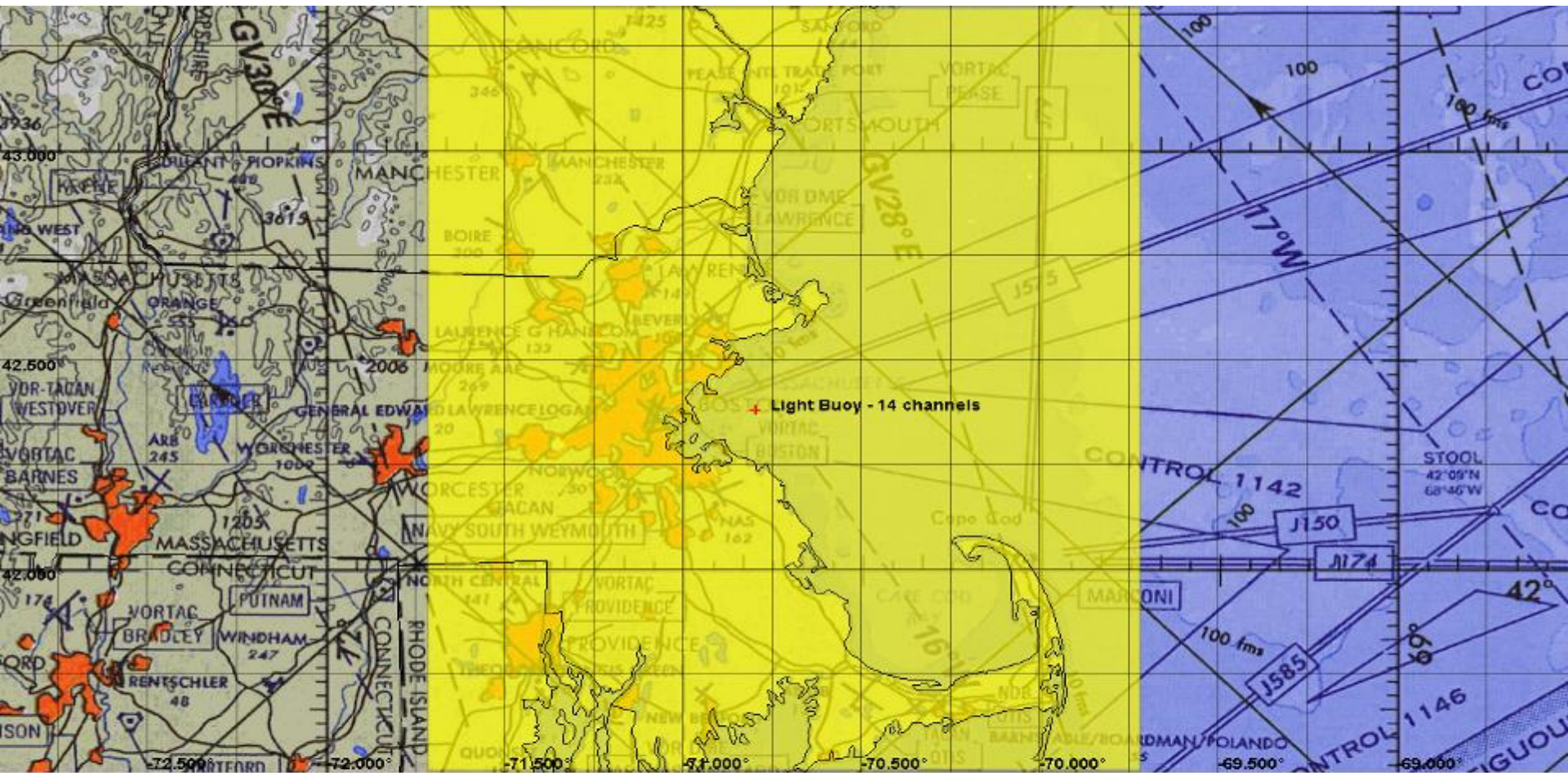
Max PDOP: 3.37 at 09:38z
Min PDOP: 1.74 at 05:05z
RMS PDOP: 2.23

Max HDOP: 2.18 at 21:46z
Min HDOP: 1.16 at 12:19z
RMS HDOP: 1.39

Max Pos Error(m): 3.70 at 09:39z
Min Pos Error(m): 1.50 at 05:05z
RMS Pos Error(m): 2.19

DECLASSIFICATION: DOP is not inherently classified. Declassify per sensitivity of date, time, or location.

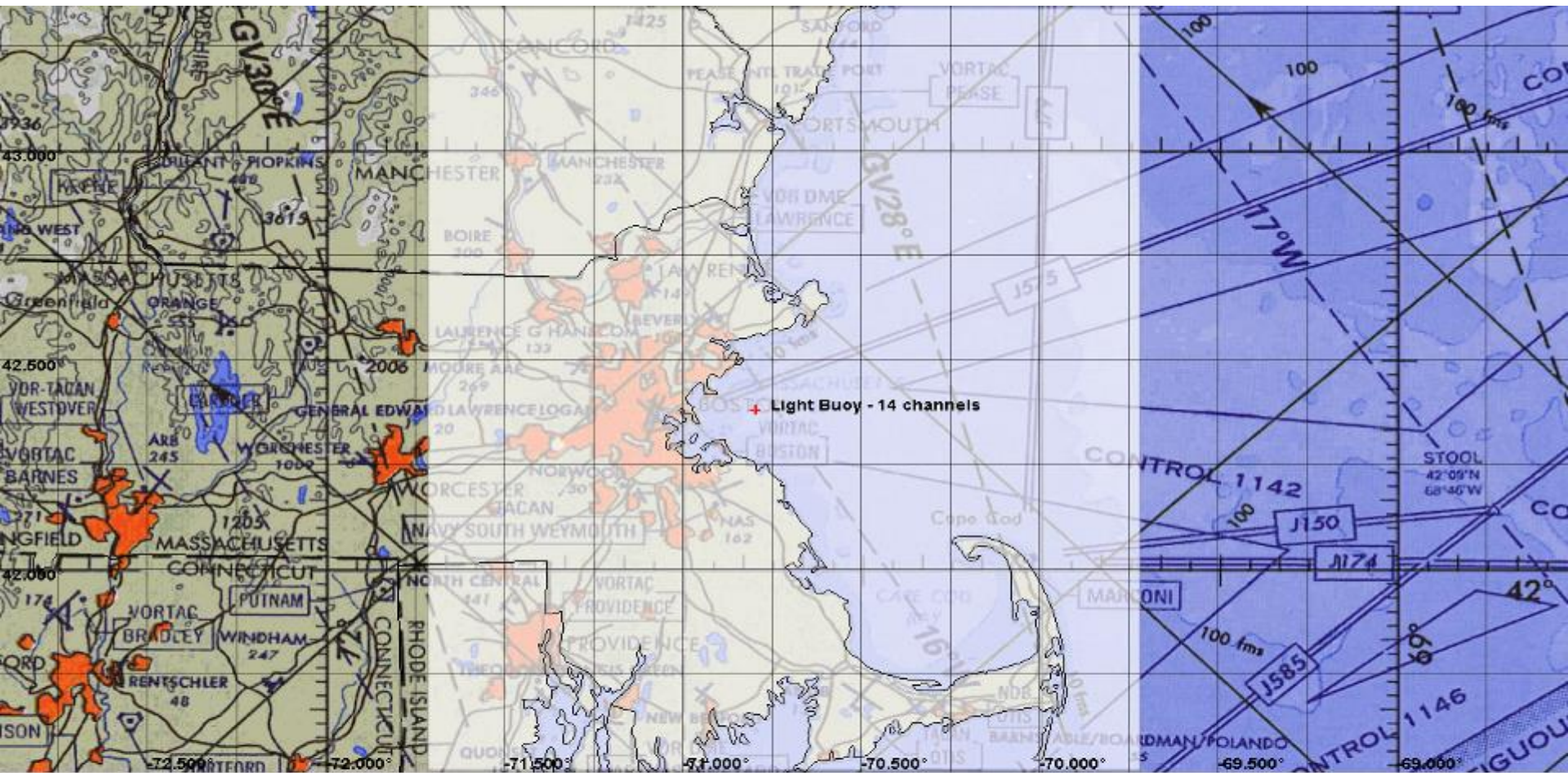
PDOP Max | All In View | Boston Light Buoy 0000z-2359z, 09 Jan 2012



Contour Legend		Start Time: 09 Jan 2012 00:00:00Z Altitude: 0 ft HAE	
Metric: PDOP Max		End Time: 09 Jan 2012 23:59:00Z	Number of Channels: All In View
Almanac File: current.al4		Latitude Increment: 00° 01.2'	Mask Angle: 5°
SOF File: 2011_354_052313_v02		Longitude Increment: 000° 00.66'	Terrain Blockage Type: None
PAF File: 2012_009_v03.paf			
Production Date: 01/13/2012 03:48:57			
No Outages			



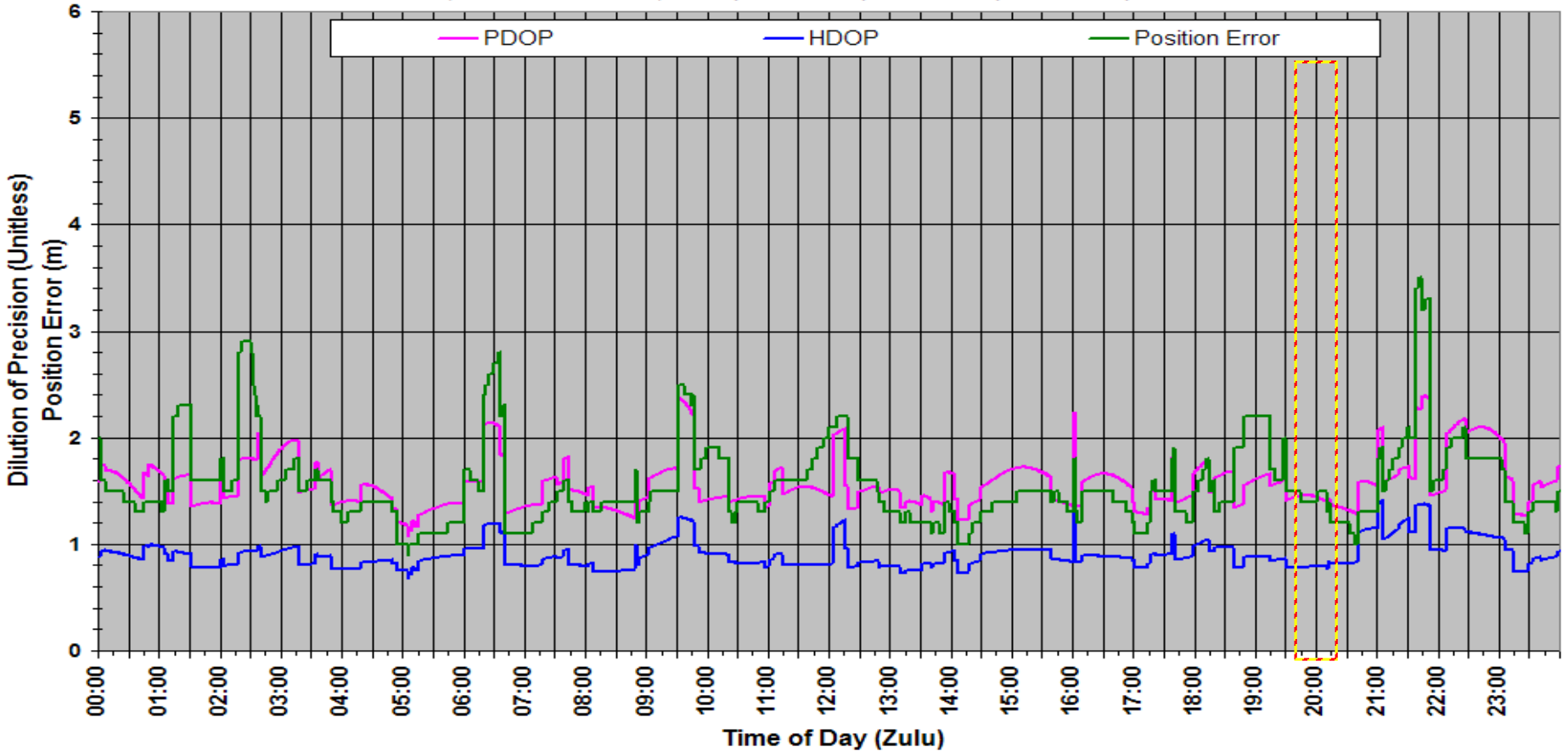
Position Error Max (m) | All In View | Boston Light Buoys 0000z-2359z, 09 Jan 2012



Contour Legend				
Metric: Position Error Max(m)	Start Time: 09 Jan 2012 00:00:00Z	Altitude: 0 ft HAE		 > 20.0 m
Almanac File: current.a14	End Time: 09 Jan 2012 23:59:00Z	Number of Channels: All In View		 16.0 - 20.0
SOF File: 2011_354_052313_v02	Latitude Increment: 00° 01.2'	Mask Angle: 5°		 12.0 - 16.0
PAF File: 2012_009_v03.paf	Longitude Increment: 000° 00.66'	Terrain Blockage Type: None		 8.0 - 12.0
Production Date: 01/13/2012 03:48:57				 4.0 - 8.0
No Outages				 0.0 - 4.0

PDOP/HDOP/Position Error Chart | All In View | Boston Light Buoy 0000z-2359z, 09 Jan 2012

Light Buoy - 14 channels - DOP/Position Spike Chart
09 Jan 2012, 0000z - 09 Jan 2012, 2359z | 42° 22.82'N | 70° 12.28'W | Terrain Off | All In View Solution



No Satellite Outages

DOP Threshold Limit: 6
Nothing over the 6 threshold

Max PDOP: 2.39 at 21:44z
Min PDOP: 1.07 at 05:05z
RMS PDOP: 1.59

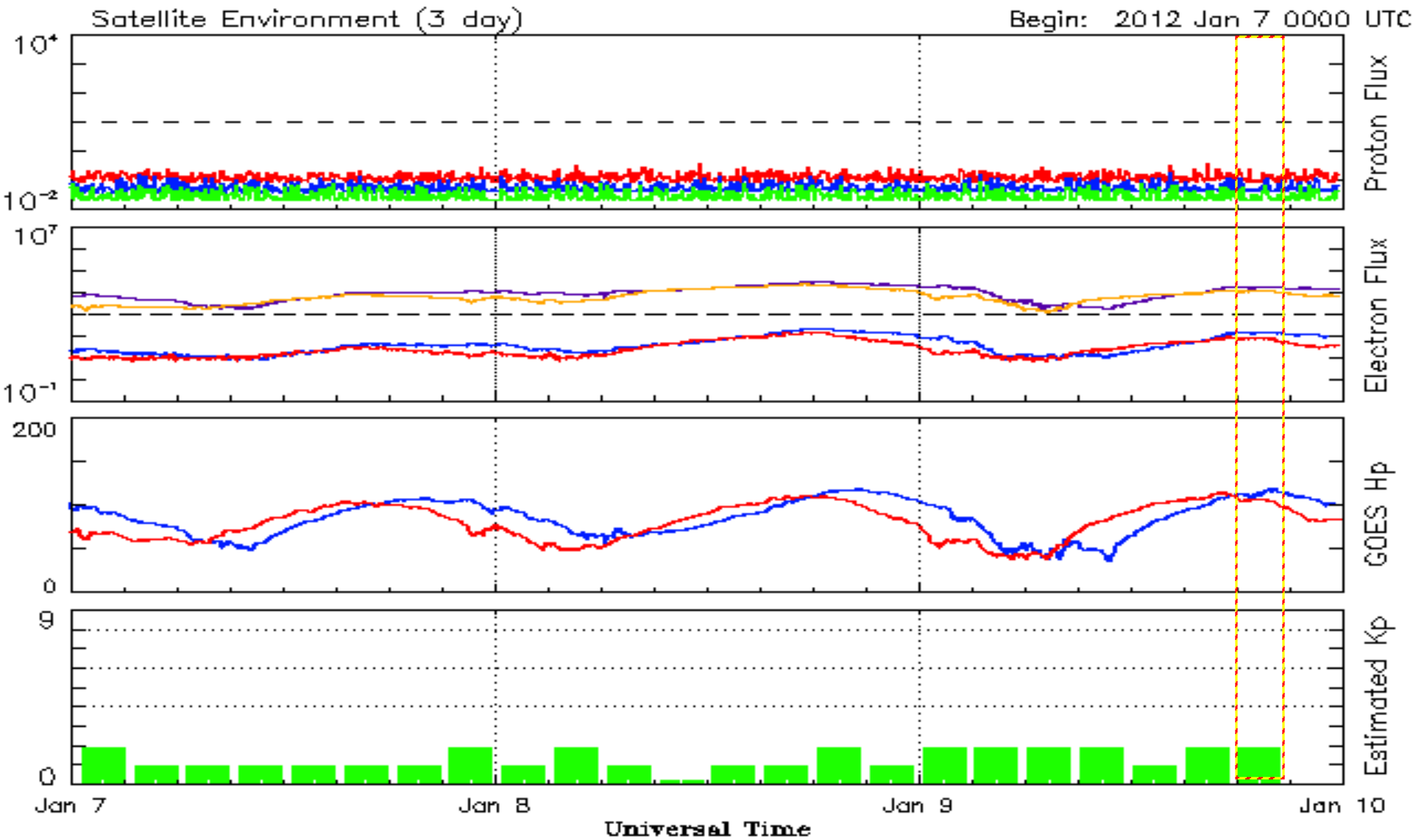
Max HDOP: 1.46 at 16:01z
Min HDOP: 0.68 at 05:05z
RMS HDOP: 0.91

Max Pos Error(m): 3.50 at 21:41z
Min Pos Error(m): 0.90 at 05:05z
RMS Pos Error(m): 1.60

DECLASSIFICATION: DOP is not inherently classified. Declassify per sensitivity of date, time, or location.

Space Environment Analysis

09 Jan 2012

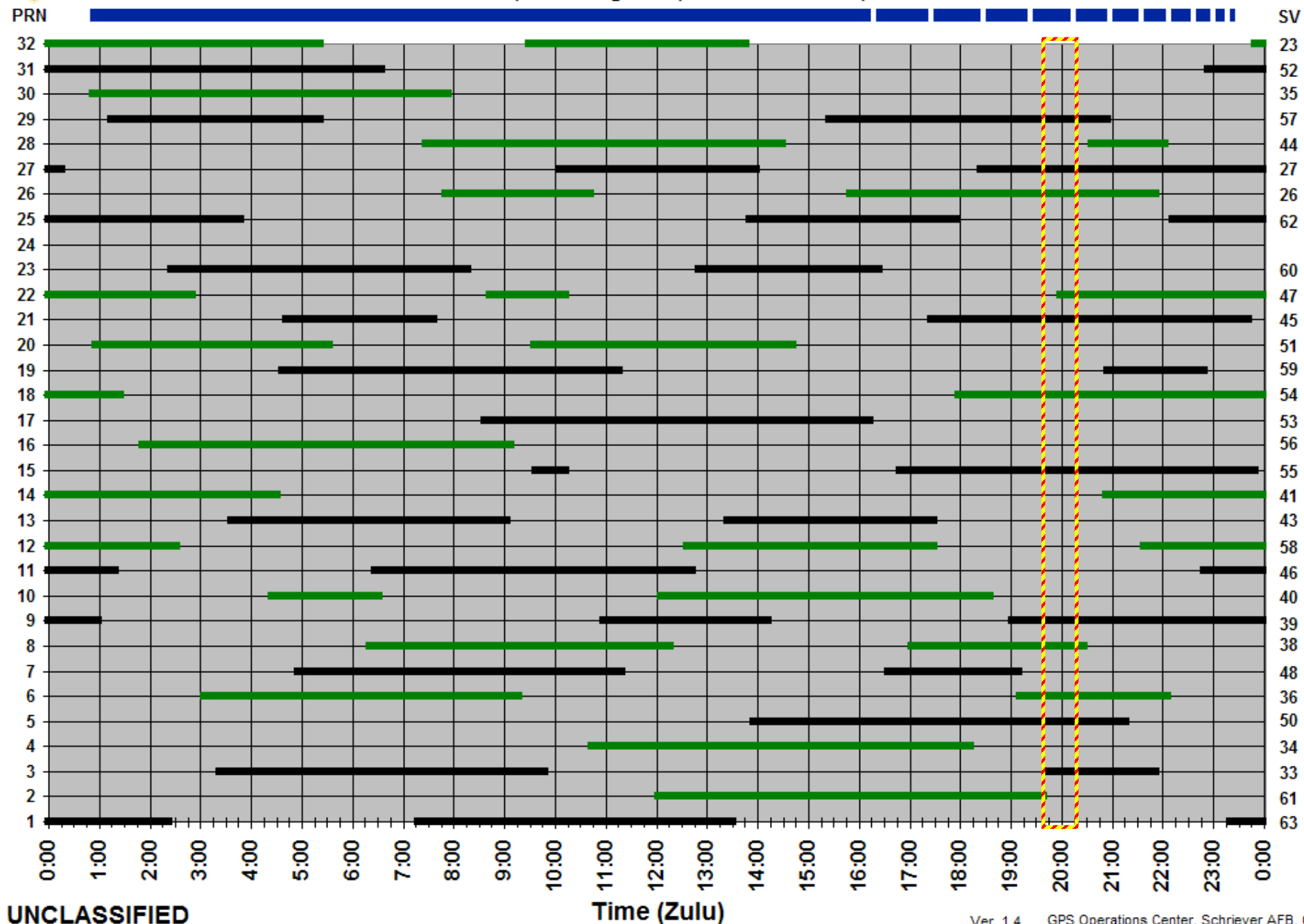


Updated 2012 Jan 9 23:56:05 UTC

NOAA/SWPC Boulder, CO USA



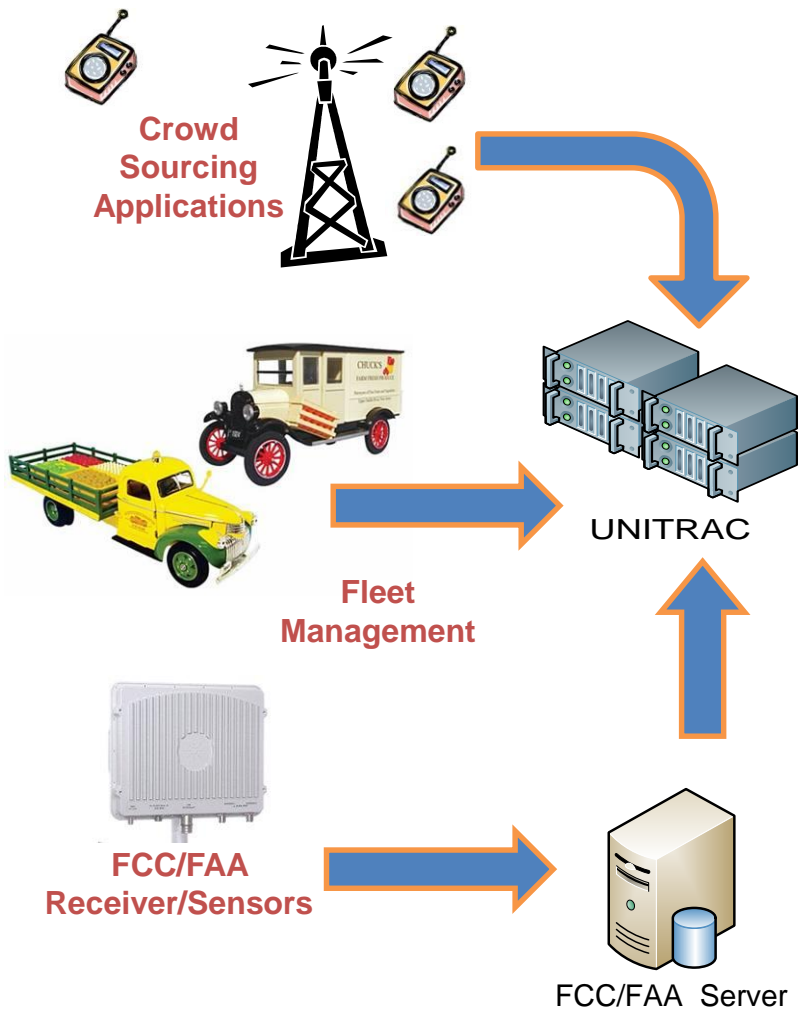
Light Buoy - 14 channels - GPS SVNs in View
09-Jan-2012 | Mask Angle: 0° | N 42.38 W 070.80 | 0 ft MSL



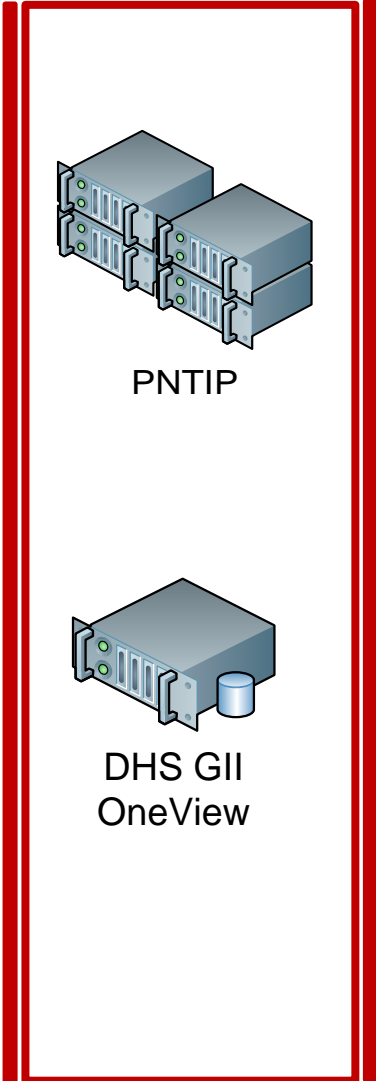
Back up slides

- Protect the Nation's 18 Critical Infrastructure & Key Resource Sectors
- System-of-Systems, open architecture, multi-phased/multi-layered approach
- Near real-time situational awareness of PNT Interference
 - Leverage existing mature capabilities & focus on the data, less on system/device
 - Common Data Structure for Information Sharing
 - Persistent monitoring for situational awareness

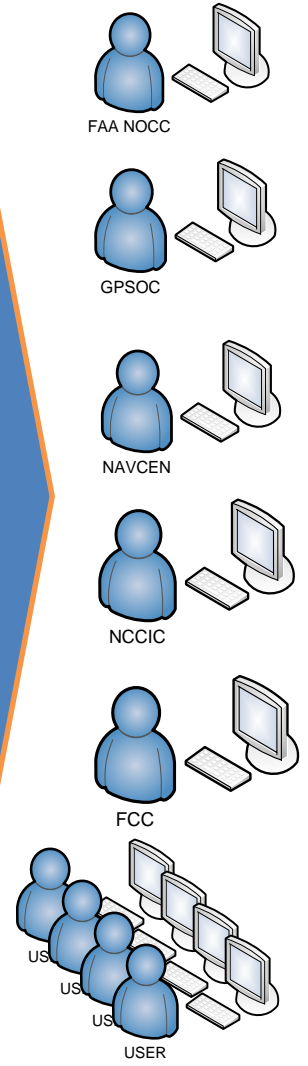
Monitoring & Data Collection



Processing



Analysis & Evaluation



Mitigation -- Resiliency

- Master Clock Distribution via Optical Networks
 - Utilize existing fiber infrastructure
 - Successful prototype
 - Long-haul test between pre-determined sites to evaluate physical capabilities, baseline
 - Distribution of Master Clock to specific demarcation

Department of Homeland Security
PNT Program Management Office

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202-731-9628 (M)