



***U.S. Space-Based Positioning,  
Navigation and Timing (PNT)  
Policy Update***

*Robert Wray*

*16 October 2023*



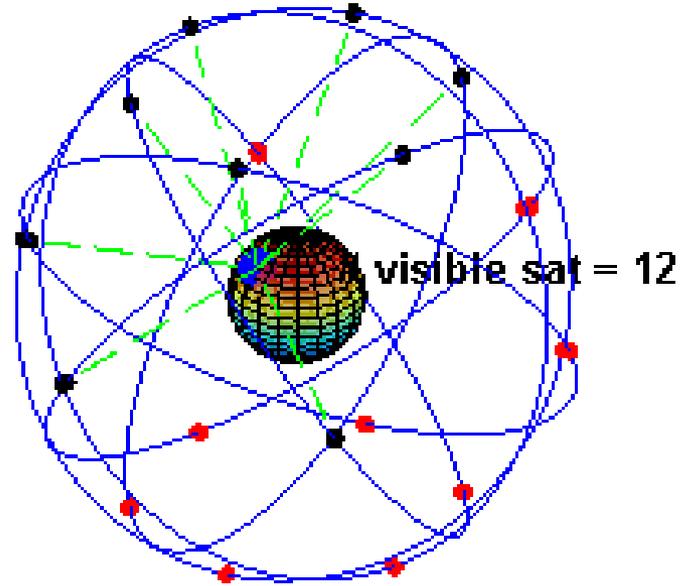
# GPS Constellation



## GPS Signal in Space Performance

From 01 Jan 23 to 12 Oct 23

Satellite Block	Quantity	Average Age (yrs)	Oldest (yrs)
GPS IIR	7	21.7	26.1
GPS IIR-M	7	16.1	17.9
GPS IIF	11	9.6	13.3
GPS III	6	2.9	4.7



\*All User Range Errors (UREs) are 95% Root Mean Square values

Average URE*	Best Day URE	Worst Day URE
48.4 cm	34.1 cm (23 Jun 23)	163.7 cm (25 Jan 23)

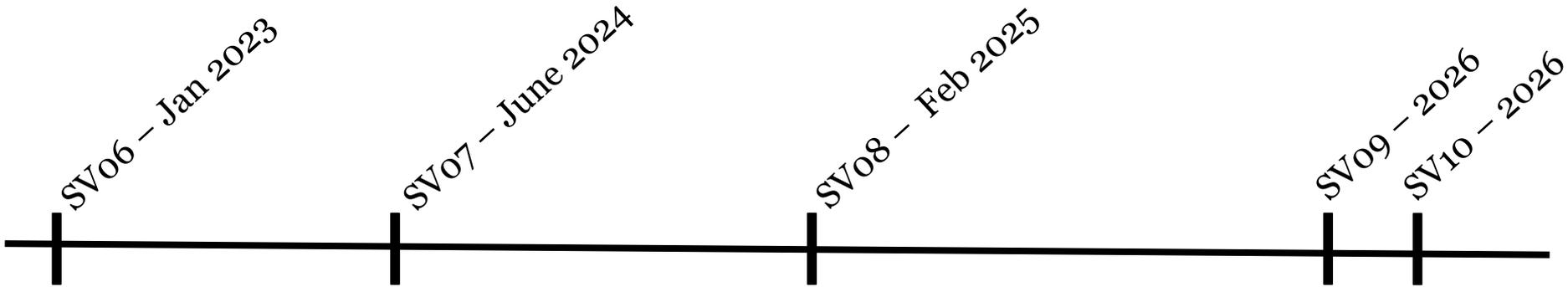
- 6 Additional satellites in test/residual configuration
- GPS Operates in 6 Planes, at an altitude of 20,200 km
  - 12 hour orbit
  - 100% global coverage



# Launch Schedule



- **The U.S. will launch (4) GPS-III satellites over next 2 years**
- **GPS III-F satellites will begin launch in 2026**

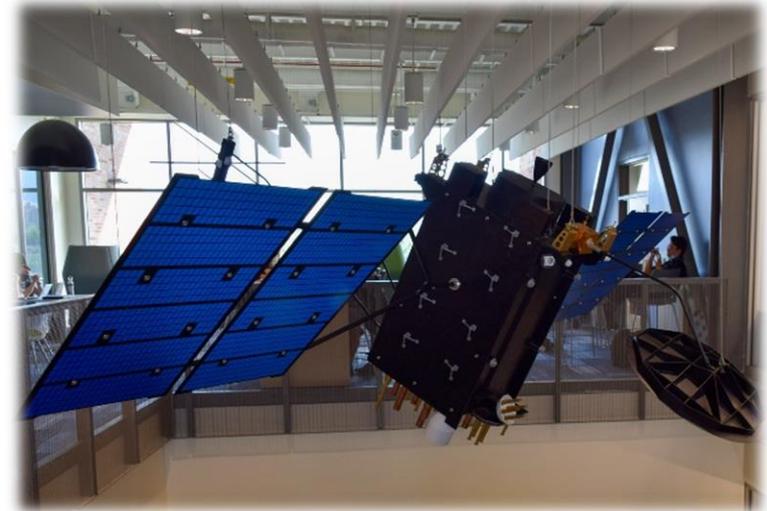




# *GPS IIF Program*

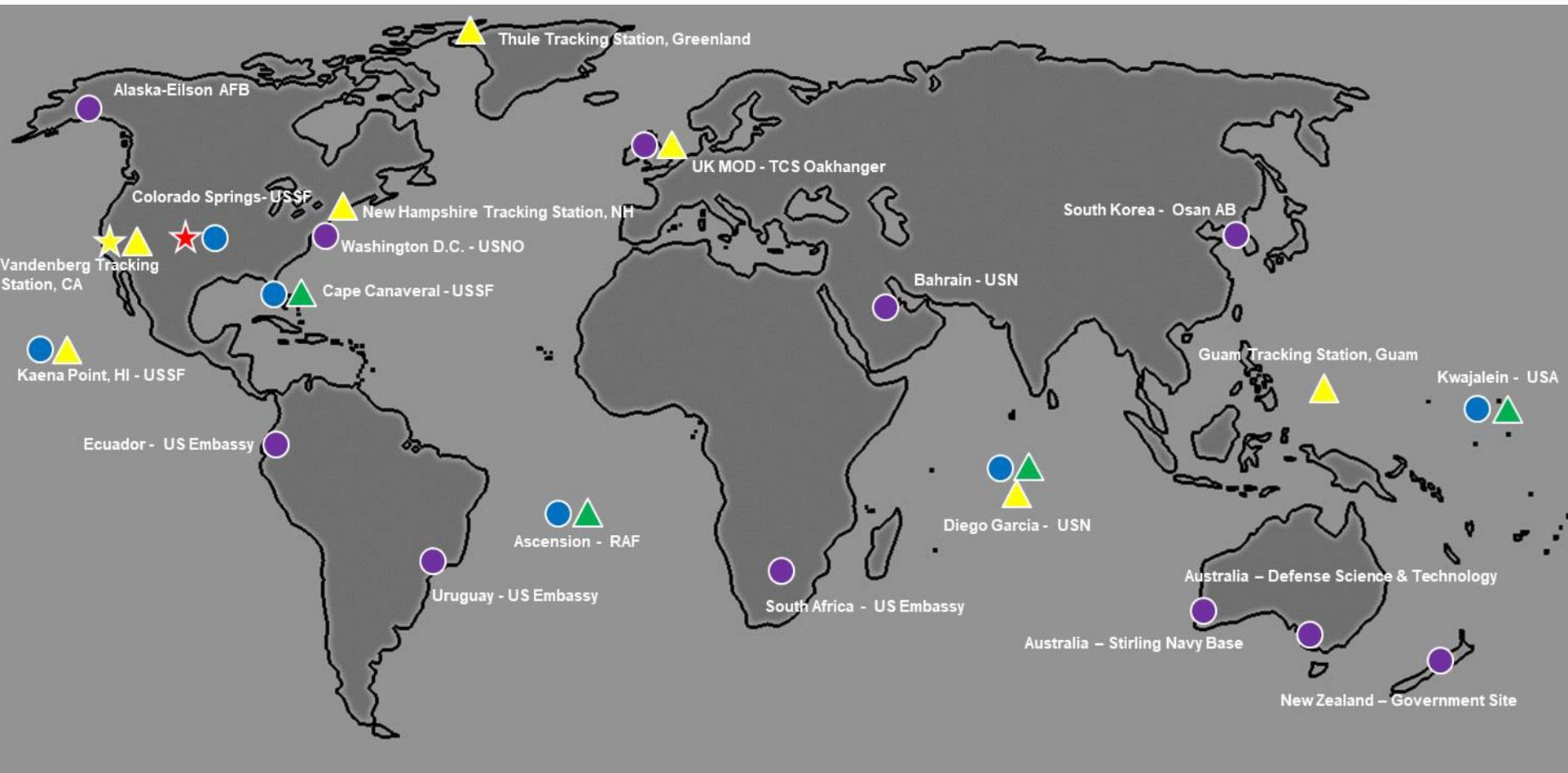


- **Continues GPS III modernization efforts, provides backwards compatibility and includes:**
  - **Regional Military Protection (RMP) for boosted M-code signal**
  - **M-code power increased by 8x in localized area to give resiliency in disadvantaged areas**
  - **Re-designed Nuclear Detection suite**
  - **Canadian-built search and rescue (SAR) payload**
    - **Up to 85% faster detect and locate of distress signals**
  - **Laser Retro reflector Array (LRA)**
- **Status: Purchased SVs 11 thru 20**
  - **GNST+ assembly complete 2QFY24**
  - **GPS IIF SV11 AFL planned for 2026**





# GPS Global Architecture



- ★ Master Control Station (MCS)
- ★ Alternate Master Control Station (AMCS)
- ▲ Ground Antenna
- ▲ Satellite Control Network (SCN) Remote Tracking Station
- Nat. Geospatial Intelligence Agency Monitor Stations
- Space Force Monitor Station





# WAAS Avionics Equipment Status



## Procedures:

- **4,127 Localizer Performance with Vertical Guidance (LPV) approaches in the NAS**
- **1,116 provide CAT I (200') equivalent performance**

## Equipage

- **General Aviation:**
  - **Over 131,000 equipped aircraft in the NAS**
  - **All classes of aircraft / all phases of flight**
- **Commercial Aviation:**
  - **Avionics currently available for Boeing 737-600/700/800 and Airbus A220 & A350**

## Enabling technology for NextGen Programs

- **Automatic Dependent Surveillance Broadcast (ADS-B)**
- **Performance Based Navigation (PBN)**





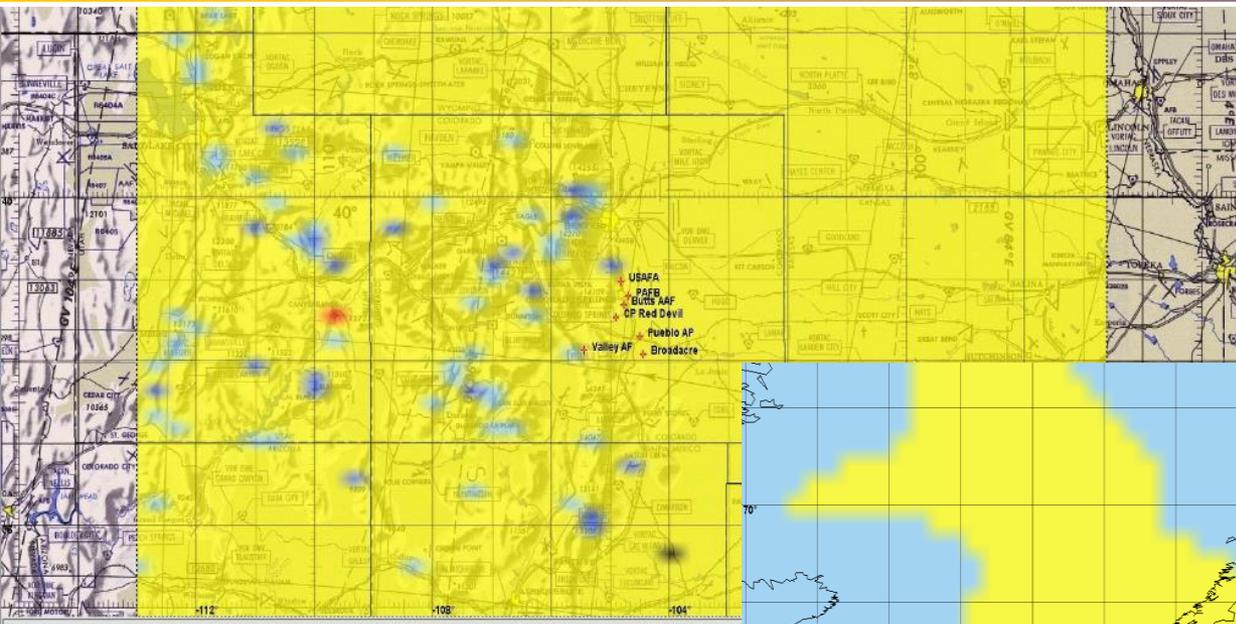
# *New Civil Signals*



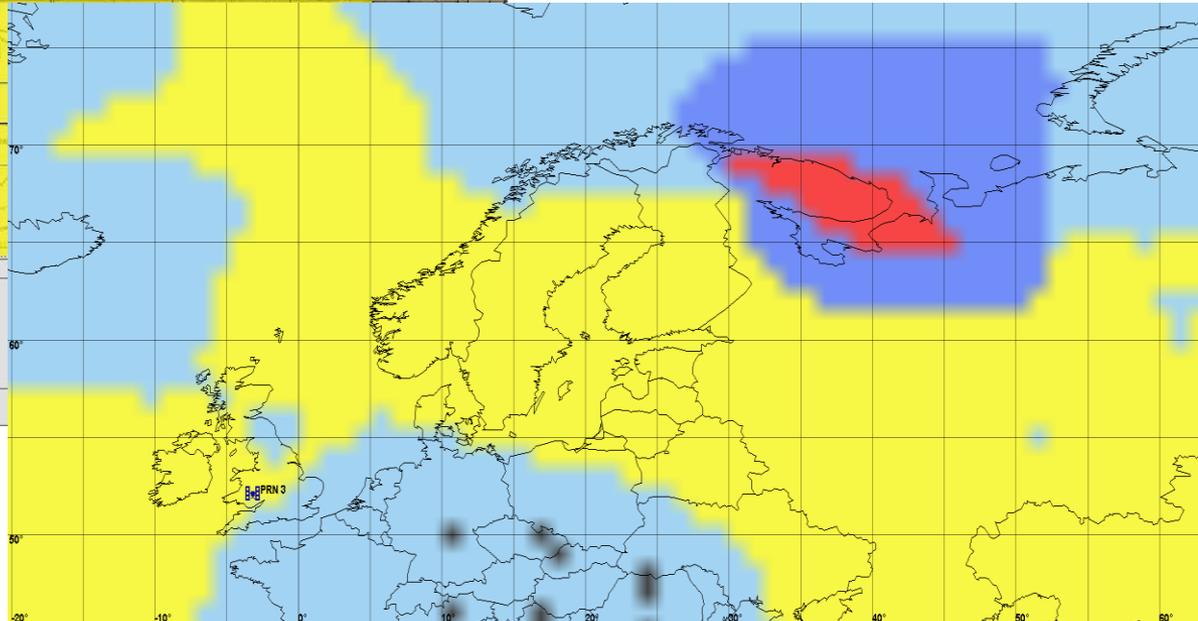
- **New: L1C Signal**
  - Enable interoperability
  - Common civil signal for GPS and Galileo
  - Japan's Quasi-Zenith Satellite System (QZSS) and China's BeiDou system are adopting L1C-like signals
  - Improve GPS reception in cities and other challenging environments
- **New: L2C Signal**
  - When combined with L1 C/A in a dual-frequency receiver, L2C enables ionospheric correction, which can increase accuracy; civilians with dual-frequency GPS receivers may achieve the same accuracy as the military user
- **Improved: L5 – Safety of Life Signal**
  - Safety-of-life transportation and other high-performance applications
  - Improved signal structure for enhanced performance
  - Higher transmitted power than L1/L2 signal (~3 dB, or 2× as powerful)
  - Wider bandwidth provides a 10× processing gain at the receiver
  - Signal in protected International Telecommunications Union and Aeronautical Radionavigation Services (RNSS) band



# Sample Analysis Support Products

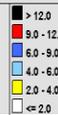


**Contour Legend**  
Metric: PDP Max  
Start Time: 23 Jul 2022 00:00:00Z Altitude: 5 ft AGL  
End Time: 23 Jul 2022 23:00:00Z Number of Channels: 4  
Almanac Filename: current.a4 Latitude Increment: 00° 09' 10.8" Mask Angle: 5°  
SOF File: 2022\_195\_222300\_v02 Longitude Increment: 000° 20' 06" Terrain Blockage Type: FTM  
PSF File: 2022\_201\_000000\_v02  
Production Date: 07/22/2022 18:21:24  
No Outages



**Contour Legend**  
Metric: PDP Max  
Start Time: 16 Nov 2022 00:00:00Z Altitude: 0 ft HAE  
End Time: 16 Nov 2022 23:59:00Z Number of Channels: 4  
Almanac Filename: current.a4 Latitude Increment: 01° 00' 00" Mask Angle: 5°  
SOF File: 2022\_320\_202900\_v02 Longitude Increment: 001° 14' 13.2" Terrain Blockage Type: FTM  
PAF File: 2022\_320\_v03  
Production Date: 11/23/2022 16:18:40

PRN:15 Outage: 16 Nov 2022 11:18:00 to 16 Nov 2022 20:19:59 PRN:18 Outage: 16 Nov 2022 00:00:00 to Until Further Notice  
PRN:26 Outage: 16 Nov 2022 00:00:00 to Until Further Notice





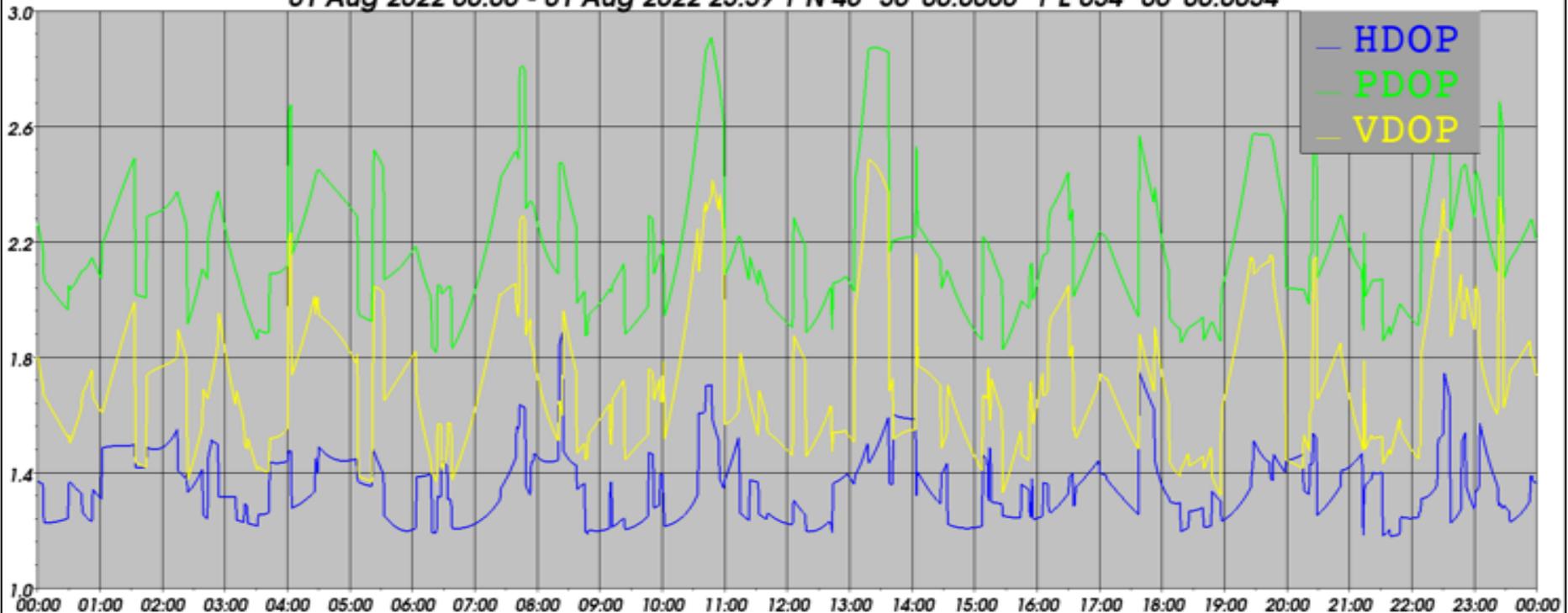
# Sample Analysis Support Products



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## Dilution of Precision (DOP) Spike Chart

GPS Accuracy Prediction  
01 Aug 2022 00:00 - 01 Aug 2022 23:59 | N 48° 30' 00.0000" | E 034° 00' 00.0034"



Product Generated on Thu Jul 28 23:16:40 2022	Outages:		
Terrain: Off	Altitude: 5 (ft) AGL	Number of Channels: 4	Receiver Mask Angle: 5 (deg)

UNCLASSIFIED



# GPS as a Global Utility



GPS is utilized across multiple infrastructures and impacts almost every industry. Some of these industries include:

- Agriculture
- Maritime
- Public Safety
- Recreation
- Space
- Aviation
- Finance
- Telecommunications
- Telematics
- Oil/Gas

US GPS economic benefit ~\$1.4 Trillion



*30 Years of GPS Reliability = Dependability for Carbon Cutting Strategies and Technologies*



# GPS CO<sub>2</sub> Reduction



## Total Cost of Fleet Operation



Fleet Telematics seen as a 'Productivity Tool' is best placed to support Transport companies to optimise and maximize their fleet better.

## Benefits After Effective Deployment of Fleet Management System



**10-15%**  
Increase in  
Productivity



**10-15%**  
Overtime  
Reduction



**20-25%**  
Reduction in  
Fuel Expenses



**5-10%**  
Reduction in  
Total Miles



**20-30 minutes**  
Day/Driver  
Labour Savings



**15-20%**  
Increase in  
Vehicle Utilization



**20-30%**  
Reduction in  
Vehicle Idle Time



# GPS CO<sub>2</sub> Reduction



## • **Agriculture**

- GPS enables a controller to keep a machine on course from pass to pass, 95% of the time perfectly parallel in a field.
- Yields increase up to 20%, but waste less fuel, reducing CO<sub>2</sub> emissions
- Precision agriculture has a projected growth rate of 12.8% globally.
- Environmental Benefits:
  - Up to 25% less water
  - Up to 20% less pesticides, herbicides



# GPS CO<sub>2</sub> Reduction



## • Maritime

- Marine operations such as search and rescue, underwater surveying, buoy placement, and hazard navigation have been vastly improved with GPS.
- Container management in port facilities have seen a 4-8% decrease in costs, and a 5-10% increase in efficiency.
- Most of the world's cargo transits via commercial shipping
  - Greater efficiency = reduced CO<sub>2</sub> output
  - Houston, Texas (2022) increased its volume 34%, but did not create a backlog of idling ships or trucks





# GPS CO<sub>2</sub> Reduction



## • Aviation

- Helps improve flight efficiency by allowing aircraft to fly user preferred direct routes waypoint to waypoint without depending on ground infrastructure.
- GPS driven networks installed on aircraft saved an estimated 5.3 billion liters of fuel and 12.7 billion kilograms of carbon emissions during 2020 alone.
- Commercial crashes have been significantly reduced in the last 20 years with accidents being cut upwards of 75%.





***Thank you!***

***1973-2023: Honoring 50 Years of GPS Program***

***1993-2003: Celebrating 30 Years of GPS Full Operations***

***2003-2023: Celebrating 20 Years of WAAS Commissioning***