



# Civil GPS Service Interface Committee Timing Subcommittee

Co-Chairs:

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# Timing Subcommittee

*A forum for users of GPS timing applications.*

- ❖ Time Generation: Coordinated Universal Time
- ❖ Time Dissemination: Telecommunications, financial markets and power grid among others
- ❖ As a research and comparison tool: Earth observations, fundamental physics, support for space missions, etc.

# Highlights of this year's session

From timing laboratories:

## USNO

- 2 continuously-running Rb fountains at AMC in Colorado Springs, CO in addition to the 4 in Washington, DC;
- Continue to compute the offset UTC(USNO)-GPS System Time and deliver it to USAF
- Develop monitoring guidelines for Subframe 4, Page 18 (time and frequency offsets from GPS system Time to predicted UTC(USNO))
- Absolute calibration of GPS receivers to monitor UTC(USNO) as provided by GPS

## NIST

- Continued monitoring of UTC(USNO)-UTC(NIST), biannual calibrations of the TWSTFT and GPS link;
- Frequency and time dissemination services to all sectors of society
- DHS-funded work, in collaboration with MITRE towards a resilient timing infrastructure

# Highlights of this year's session

## From JPL

- Timing in deep space communications and navigation
  - Deep Space Network – Frequency and Timing System
  - JPL-Frequency Standards Test Laboratory
- Advanced atomic clocks for space applications
  - Deep Space Atomic Clock (a NASA technology demonstration mission)
  - Ultra-stable Hg+ clock for ground timing keeping (ESA/NASA-ACES)
  - Miniaturized and low power Hg+ clock (DARPA-ACES)

## From MITRE

- Development of approaches, technologies and test techniques to increase resilience for PNT
- Near-term improved robustness for timing receivers (blocking antennas, spoof-detection algorithms)
- Advanced Navigation and Timing Strategy for enhanced Robustness and Resilience (ANTSERR): development of a reference architecture
- GNSS Test Architecture (GNSSTA): SDR framework for experimenting with PVT receiver technology

# Highlights of this year's session

## From NASA-Goddard Space Flight Center

- Space use of GPS for timing and navigation
  - Terrestrial Service Volume (<3000km) - comparable to Earth use
  - Space Service Volume (3000-36000km) – higher Doppler and partial obscuration
  - Beyond SSV (>36000km) – mainly spillover and side lobes, weak signals
- Magnetosphere Multi-Scale mission validated GPS timing and navigation beyond SSV.

## Earth rotation prediction at USNO

- UT1 is the true measure of the Earth's rotation angle
- GPS data can help measure UT1
- Improved UT1 prediction with Kalman filter using inputs from VLBI, and Atmospheric Angular Momentum predictions.