National Aeronautics
and Space Administration

What is GPS?

The Global Positioning System (GPS) is a space-based radionavigation system, owned by the U.S. Government and operated by the United States Air Force (USAF). It can pinpoint a three dimensional position to meter-level accuracy and time to the 10-nanosecond level, worldwide and 24/7. GPS is comprised of three different segments: the space segment, control segment and user segment.

GPS has its origins in the Sputnik era when scientists were able to track the satellite with shifts in its radio signal, known as the “Doppler Effect,” which became the foundational idea for modern GPS. Today the GPS satellite constellation (the space segment) consists of over 30 operational satellites, each equipped with redundant atomic clocks and tracked by a ground control network (the control segment). Each satellite transmits its position and time at regular intervals and those signals are intercepted by GPS receivers (the user segment). The receiver is able to determine its position by calculating how long it took for the signals to reach it.

NASA’s mission to pioneer the future in space exploration, scientific discovery and aeronautics research necessitates the proactive development and implementation of a number of GPS applications to enable greater spacecraft autonomy and more advanced space science and Earth monitoring applications. To accomplish this, NASA works alongside the USAF to continue improving GPS capabilities to support space operation and science applications.

GPS and NASA

Defining the "N" in Space Communications and Navigation

The Policy and Strategic Communications Division within the Space Communications and Navigation (SCaN) Program Office at NASA manages and protects NASA's GPS equities through policy development and advocacy. SCaN protects legacy GPS application investments while enabling new, improved techniques to be implemented by missions.

Spacecraft Orbit and Trajectory Determination: Traditionally, space missions have determined their orbit by using communications channel tracking, in which a Flight Dynamics Facility uses positioning information from two-way communication signals between the spacecraft and a ground station or relay satellite to calculate the spacecraft's orbit. Alternatively, missions that choose to use GPS to determine their position track radionavigation signals from GPS satellites and process these signals on-board to determine position and time. This increases spacecraft autonomy, enables new methods of spaceflight operations and reduces the burden on NASA's tracking stations.

Science Applications: GPS is used as a remote sensing tool to support atmospheric and ionospheric sciences, geodesy and geodynamics – from monitoring sea levels and ice melt to measuring the Earth's gravity field. SCaN and NASA's Science Mission Directorate have partnered to improve the performance of the GPS constellation through policy advocacy for modernization improvements via the GPS requirements process, the National Space-based Positioning, Navigation, and Timing (PNT) Executive Committee and the National Space-based PNT Advisory Board.

GPS Receiver Development: NASA has developed, and continues to improve, GPS flight and science receivers that are already in use.

Benefits of GPS to Users in High Earth Orbit

- Significantly improves real-time navigation performance from km-class to meter-class
- Supports quick trajectory maneuver recovery from 5-10 hours to minutes
- Timing capabilities reduce a spacecraft's need for expensive on-board clocks
- Supports increased satellite autonomy, lowering mission operations costs
- Enables new and enhanced capabilities and better performance for users in high-Earth orbit and Cislunar space

The Future of GPS

Worldwide government and commercial spacecraft launch projections over the next two decades show that approximately 60 percent of future missions will operate in low-Earth orbit and 95 percent of missions will operate at or below geosynchronous orbit. NASA will continue to protect current investments and improve upon existing capabilities by working alongside other U.S. Government agencies and pursuing compatibility and interoperability with other Global Navigation Satellite System (GNSS) constellations.

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