International GPS Service

The Global Positioning System (GPS) provides unprecedented potential for precise ground- and space-based positioning, timing, and navigation anywhere in the world. Extremely precise use of GPS, particularly for earth sciences applications, stems largely from activities of the International GPS Service (IGS). More than 200 organizations in 75 countries contribute daily to the IGS, which is dependent upon a cooperative global tracking network of over 300 GPS stations. Data are collected continuously and archived at distributed data centers. Analysis centers retrieve the data and produce the most accurate GPS data products available anywhere. IGS data and data products are made accessible to users, reflecting the organization's open data policy. The IGS, a scientific service of the International Association of Geodesy, is a highly successful scientific federation and a model of international cooperation.

History. A number of factors led to the formation of the IGS. By the late 1980s many geodynamics and geodetic organizations recognized the potential uses of this affordable technology for scientific research (such as earthquake studies, fault motion, and plate tectonics) as well as other applications. The motivating goal for the earth sciences was millimeter-level positioning anywhere in the world. However, a single civil organization could not assume the capital investment and recurring operations costs to install and maintain a globally based system. At this point, international groups considered entering into joint partnerships for collecting data, making observations, developing cooperative approaches, and defining standards to ensure that future activities would be driven by science requirements.

The idea for an international GPS service began to crystallize at the 1989 International Association of Geodesy (IAG) Scientific Assembly in Edinburgh, United Kingdom. It was here that people recognized that a standardized civilian system for using GPS would be universally beneficial. Subsequently, a planning committee was established within IAG to transform this recognition into action.

In 1991 a Call for Participation was organized by this IAG Planning Committee, seeking participants to form a demonstration campaign to help develop the "proof of concept" for an international service. It requested interested groups to assume the roles of station operators, networks, data centers, analysis centers, and a Central Bureau for coordination. The pilot activity took place from June to September 1992 and was highly successful, demonstrating IGS viability. The IGS was officially established as an IAG international service on January 1, 1994.

The IGS, as a completely voluntary organization, continues to operate the global civilian GPS tracking system for science and research. Since the pilot project in 1992, the network has grown from approximately 30 permanent GPS stations to more than 300 and the accuracy of the IGS orbits has improved an order of magnitude, from 50 cm (20 in.) to less than 5 cm (2 in.). The IGS continues developing and improving traditional products such as orbits, clocks, station positions, and velocities, as well as fostering projects and working groups that produce additional data products, such as precipitable water vapor (a valuable input into weather forecasting), and total electron content (useful for ionospheric space weather research). Some current IGS projects and working groups are shown in the **table**.

How the IGS works. The IGS functions via a global complex of tracking stations, data analysis centers, working (research) groups, projects, and administrators.

Network of tracking stations. All components of the IGS are critically dependent on the global network of precise GPS tracking stations. Recognizing the fundamental requirement for consistent, coordinated, and high-quality network operations, where different receivers are fielded by more than 100 organizations, a Network Coordinator position resides within the Central Bureau. The IGS network includes over 300 stations that operate continuously, delivering data

IGS science applications

Projects and groups	Purpose
Precise Time and Frequency Transfer Project	Global subnanosecond time transfer; joint with the Bureau International des Poids et Mésures (BIPM)
Low Earth Orbiter (LEO) Pilot Project	Orbit determination of LEO satellites that carry on-board precise GPS receivers (CHAMP, SAC-C, GRACE, Jason, etc.)
International GLONASS Service Pilot Project (IGLOS-PP)	Includes data from the Russian GLONASS system into the IGS processes, producing GLONASS orbits, clocks, station positions, etc.
Tide Gauge Benchmark Monitoring Project	Monitors long-term sea-level change; attempt to decouple crustal motion/subsidence at coastal sites from tide gauge records
IGS Reference Frame Working Group	Global reference frame; Earth orientation; station positions and velocities determined by GPS
Ionospheric Working Group	Ionospheric science research; global ionospheric maps
Atmospheric Working Group	Water vapor in the atmosphere can be estimated from the propagation delay encountered by the GPS signal; useful parameters for weather forecasting
Real-Time Working Group	Investigates methods for IGS real-time network operations
Global Navigation Satellite Systems (GNSS)	Determine actions necessary for IGS to incorporate new GNSS. European Union Galileo system

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