Global Positioning System

What is GPS?

The Global Positioning System (GPS) is a satellite-based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defense. GPS was originally intended for military applications, but in the 1980s, the government made the system available for civilian use. US Dept. of Defense decided to form a worldwide positioning system. NAVSTAR (Navigation Satellite Timing and Ranging Global positioning system) provides instantaneous position, velocity and time information.

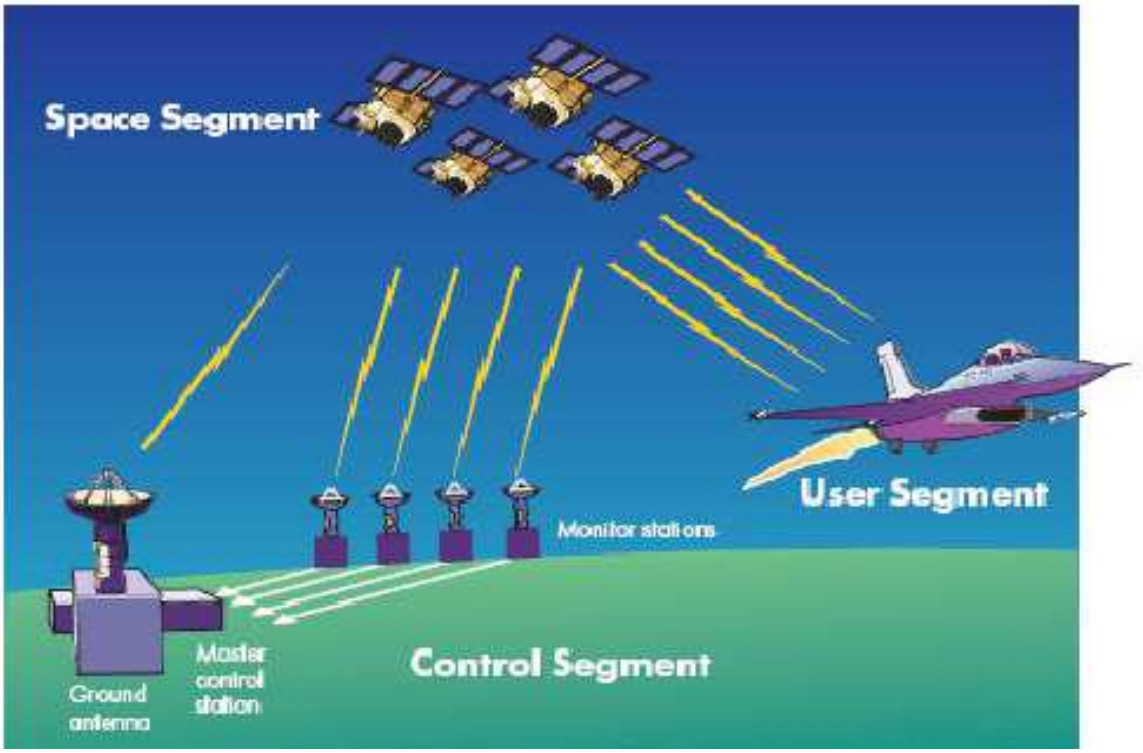
GPS works in any weather conditions, anywhere in the world, 24 hours a day.. The global positioning system is a satellite-based navigation system consisting of a network of 24 orbiting satellites that are eleven thousand nautical miles in space and in six different orbital paths. The satellites are constantly moving, making two complete orbits around the Earth in 24 hours i.e. 2.6 kilometers per second.The Global Positioning System is a space-based navigation and positioning system that was designed by the U.S. Military to allow a single soldier or group of soldiers to autonomously determine their position to within 10 to 20 meters of truth. The concept of autonomy was important in that it was necessary to design a system that allowed the soldier to be able to determine where they were without any other radio (or otherwise) communications. The GPS project was started by the U.S. Department of Defense in 1973, with the first prototype spacecraft launched in 1978 and the full constellation of 24 satellites operational in 1993. The system provides critical capabilities to military, civil and commercial users around the world. It is maintained by the United States government and is freely accessible to anyone with a GPS receiver.

What are the three elements of GPS?

GPS is made up of three different components, called segments, that work together to provide location information.

The three segments of GPS are:

1. **Space (Satellites) —** The satellites circling the Earth, transmitting signals to users on geographical position and time of day.
2. **Ground control —** The Control Segment is made up of Earth-based monitor stations, master control stations and ground antenna. Control activities include tracking and operating the satellites in space and monitoring transmissions. There are monitoring stations on almost every continent in the world, including North and South America, Africa, Europe, Asia and Australia.
3. **User equipment —** GPS receivers and transmitters including items like watches, smartphones and telematic devices



How does GPS technology work?

1. GPS works through a technique called trilateration. Used to calculate location, velocity and elevation, trilateration collects signals from satellites to output location information. It is often mistaken for triangulation, which is used to measure angles, not distances.
2. Satellites orbiting the earth send signals to be read and interpreted by a GPS device, situated on or near the earth's surface. To calculate location, a GPS device must be able to read the signal from at least four satellites.
3. Each satellite in the network circles the earth twice a day, and each satellite sends a unique signal, orbital parameters and time. At any given moment, a GPS device can read the signals from six or more satellites.
4. A single satellite broadcasts a microwave signal which is picked up by a GPS device and used to calculate the distance from the GPS device to the satellite.
5. Since a GPS device only gives information about the distance from a satellite, a single satellite cannot provide much location information. Satellites do not give off information about angles, so the location of a GPS device could be anywhere on a sphere's surface area.
6. When a satellite sends a signal, it creates a circle with a radius measured from the GPS device to the satellite.

   When we add a second satellite, it creates a second circle, and the location is narrowed down to one of two points where the circles intersect.
7. With a third satellite, the device's location can finally be determined, as the device is at the intersection of all three circles.

8. That said, we live in a three-dimensional world, which means that each satellite produces a sphere, not a circle. The intersection of three spheres produces two points of intersection, so the point nearest Earth is chosen.

What are the uses of GPS?

GPS is a powerful and dependable tool for businesses and organizations in many different industries. Surveyors, scientists, pilots, boat captains, first responders, and workers in mining and agriculture, are just some of the people who use GPS on a daily basis for work. They use GPS information for preparing accurate surveys and maps, taking precise time measurements, tracking position or location, and for navigation. GPS works at all times and in almost all weather conditions.

There are five main uses of GPS:

1. Location — Determining a position.
2. Navigation — Getting from one location to another.
3. Tracking — Monitoring object or personal movement.
4. Mapping — Creating maps of the world.
5. Timing — Making it possible to take precise time measurements

- **Emergency Response:** During an emergency or natural disaster, first responders use GPS for mapping, following and predicting weather, and keeping track of emergency personnel. In the EU and Russia, the eCall regulation relies on GLONASS technology (a GPS alternative) and telematics to send data to emergency services in the case of a vehicle crash, reducing response time. Read more about GPS tracking for first responders.
- **Entertainment:** GPS can be incorporated into games and activities like *Pokémon Go* and Geocaching.
- **Health and fitness:** Smartwatches and wearable technology can track fitness activity (such as running distance) and benchmark it against a similar demographic.
  Construction, mining and off-road trucking: From locating equipment, to measuring and improving asset allocation, GPS enables companies to increase return on their assets. Check out our posts on construction vehicle tracking and off-road equipment tracking.
- **Transportation:** Logistics companies implement telematics systems to improve driver productivity and safety. A truck tracker can be used to support route optimization, fuel efficiency, driver safety and compliance.
  Other industries where GPS is used include: agriculture, autonomous vehicles, sales and services, the military, mobile communications, security, and fishing.

How accurate is GPS?

GPS device accuracy depends on many variables, such as the number of satellites available, the ionosphere, the urban environment and more.
Some factors that can hinder GPS accuracy include:

1. **Physical obstructions:** Arrival time measurements can be skewed by large masses like mountains, buildings, trees and more.

2. **Atmospheric effects:** Ionospheric delays, heavy storm cover and solar storms can all affect GPS devices

3. **Ephemeris:** The orbital model within a satellite could be incorrect or out-of-date, although this is becoming increasingly rare.

4. **Numerical miscalculations:** This might be a factor when the device hardware is not designed to specifications.

5. Accuracy tends to be higher in open areas with no adjacent tall buildings that can block signals. This effect is known as an urban canyon. When a device is surrounded by large buildings, like in downtown Manhattan or Toronto, the satellite signal is first blocked, and then bounced off a building, where it is finally read by the device. This can result in miscalculations of the satellite distance.
