



# Global positioning system (GPS), components and its functions

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# Outline

- 1 Global positioning system
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- Global navigation satellite system (GNSS) determines the location of field-observed reference data.
- GNSS has applications in
  - ▶ navigating aircraft during sensor data acquisition
  - ▶ geometrically correcting and referencing raw image data
- US Global Positioning System (GPS) was originally developed for military purposes, but soon became ubiquitous in many civil applications worldwide – vehicle navigation, surveying, location based services and cellular phones.
  - ▶ The system consists of at least 24 satellites rotating around the earth in precisely known orbits
  - ▶ Typically, these satellites revolve around the earth approximately once every 12 hours, at an altitude of approximately 20,200 km.

- With their positions in space precisely known at all times, the satellites transmit time-encoded radio signals that are recorded by ground-based receivers and can be used to aid in positioning and navigation.
- A comprehensive European GNSS constellation, *Galileo* as well as the Russian *GLONASS* and Chinese *Compass* system are operational counterparts to the US GPS system.

- The means by which GNSS signals are used to determine ground positions is called *satellite ranging*.
- Conceptually, it involves measuring the time required for signals transmitted by at least four satellites to reach the ground receiver.
- Knowing that the signals travel at the speed of light ( $3 \times 10^8$  m/sec in vacuum), the distance from each satellite to the receiver can be computed using a form of three-dimensional triangulation.
- GNSS measurements are potentially subject to sources of errors such as clock bias, uncertainties in the satellite orbits (satellite ephemeris errors) and errors due to atmospheric conditions.
- In recent years, there have been efforts to improve the accuracy of GNSS positioning through the development of regional networks of high-precision base stations, generally referred to as satellite-based augmentation systems (SBAS).



**Figure 1:** The U.S. Space Force's Global Positioning System was the first global satellite navigation system and was the first to be provided as a free global service. Source: [https://en.wikipedia.org/wiki/Satellite\\_navigation](https://en.wikipedia.org/wiki/Satellite_navigation)



## Applications of GPS navigation

- Automobile
- Air navigation usually having a moving map display and often connected to the autopilot for en-route navigation
- Boats and ships (Maritime GNSS)
- Construction and mining
- Precision agriculture – Agricultural equipment may use GNSS to steer automatically, or as a visual aid displayed on a screen for the driver. This is useful for controlled traffic and row crop operations and when spraying. Harvesters with yield monitors can also use GNSS to create a yield map.
- Cycling and sports for touring and plotting the course
- Exploration, hiking and climbing make use of GNSS to enable locating precisely in isolated areas.
- Spacecraft GNSS

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## References