GLOBAL POSITIONING SYSTEM

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The idea of satellite navigation appeared in the 50-ies. At the time when the Soviet Union launched the first satellite, American scientists led by Richard Kershner, saw the signal coming from the Soviet satellite, and found out that due to the Doppler effect the frequency of the received signal increases as the satellite approaches and decreases with its distance. The message of the discovery is that if someone accurately knows his position on the Earth, it becomes possible to measure the position and velocity of the satellite and vice versa, knowing exactly what position the satellite possesses one can determine its speed and the position of the object on the Earth.

This idea was implemented in 20 years. In 1973 the program DNSS was initiated, later it was renamed Navstar-GPS and then GPS. The first test satellite was launched into orbit in July 14, 1974 and the last of the 24 satellites required for full coverage of the earth's surface, was launched in 1993, thus, GPS got on board. It became possible to use GPS to target precisely missiles to fixed and then onto the moving objects in the air and on the land.

Originally, GPS is a global positioning system, and it was developed as a purely military project. But after the 1983 it was shot down after the invading the airspace of the Soviet Union by Korean Airlines plane with 269 passengers on board, the U.S. President R. Reagan authorized the partial use of the navigation system for civil purposes. In order to avoid the use of it for military needs the accuracy was reduced by a special algorithm

Then it was reported that some companies have deciphered the reduction algorithm accuracy at frequency L1 and successfully compensate for this component of this error. In 2000, the coarsening of accuracy was abolished by the decree of the USA President.

The system is based on the network deployed in a constellation of satellites around the earth's orbit, they are "covering" the entire earth's surface. The orbits of the satellites are calculated with a very high degree of accuracy, so at any time it is possible to know the coordinates of each satellite. The transmitter of each satellite continuously emits signals toward the Earth. These signals are received by GPS-receiver, located at some point on the Earth's surface, the coordinates of which must be determined.

The signal propagation time from the satellites in GPS-receiver is measured and the distance to satellite receiver is calculated. To calculate this distance, the following property is used: a radio signal travels at the speed of light. In order to determine the location of the point one needs to know three coordinates (two flat coordinates X, Y and height H), then the receiver computes the distance to three different satellites. Obviously, using this method of radio navigation the precise definition of the signal propagation time is possible to determine only if time-scales of the satellite and the receiver synchronize.

Therefore, in the satellite and in the receiver equipment a reference clock is included, and the accuracy of satellite time standard is extremely high. The onboard clocks of all satellites are synchronized and linked to the so-called "system time". The time standard of GPS-receiver is less accurate, in order not to increase unreasonably the cost of it.

In practice, the dimensions of time is always a mistake, caused by mismatch of time scales and a satellite receiver. For this reason, the receiver computes a distorted value range to the satellite, or "pseudorange." Measuring the distances to all satellites, with which the

receiver currently operates, takes place simultaneously. Consequently, for all measurements of time inconsistency it can be considered as a constant.

If the receiver is fixed on a moving object and, along with the pseudorange measure the Doppler frequency shift of radio signals and the velocity of the object can be calculated. Thus, to perform the necessary navigational calculations the point must be provided with continuous visibility of at least 4 satellites. After the full deployment of the constellation of satellites, anywhere in the world from 5 to 12 satellites can be seen at any given time.

Current GPS-receivers have from 5 to 12 channels, they can simultaneously receive signals from 5 to 12 satellites. Reception of more than four satellites naturally help improve accuracy of a position and ensure the continuity of navigation.

A GPS receiver calculates its position by precisely timing the signals sent by GPS satellites high above the Earth. Each satellite continually transmits messages that include:
- the time the message was transmitted;
- precise orbital information;
- the general system health and rough orbits of all GPS satellites.

The receiver uses the messages it receives to determine the transit time of each message and computes the distance to each satellite. These distances along with the satellites' locations are used to compute the position of the receiver. This position is then displayed with a moving map display or latitude and longitude; elevation information may be included. Many GPS units show derived information such as direction and speed, calculated from position changes.

Three satellites seem to be enough to determine the position since space has three dimensions and a position near the Earth's surface can be assumed. However, even a very small clock error multiplied by the very large speed of light results in a large positional error. Therefore receivers use four or more satellites to determine the receiver's location and time. The very accurately computed time is effectively hidden by most GPS applications, which use only the location. A few specialized GPS applications use the time; these include time transfer, traffic signal timing, and synchronization of cell phone base stations.

Although four satellites are required for normal operation, fewer are implemented in special cases. If one variable is already known, a receiver can determine its position using only three satellites. For example, a ship or aircraft may have known elevation. Some GPS receivers may use additional clues or assumptions (such as reusing the last known altitude, dead reckoning, inertial navigation, or including information from the vehicle computer) to give a less accurate position when fewer than four satellites are visible.

Nowadays a lot of countries are developing their own global navigations systems. The examples are:
- Galileo – a global system being developed by the European Union and other partner countries, planned to be operational by 2014;
- Beidou – People's Republic of China's regional system, covering Asia and the West Pacific;
- COMPASS – People's Republic of China's global system, planned to be operational by 2020;
- GLONASS – Russia's global navigation system;
- IRNSS – India's regional navigation system, planned to be operational by 2012, covering India and Northern Indian Ocean
- QZSS – Japanese regional system covering Asia and Oceania.