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## Global Navigation Satellite System

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Global Navigation Satellite System (GNSS) plays a main role in high precision navigation, timing, positioning and scientific questions connected with precise positioning. This is a highly precise, all-weather, continuous, and real-time technique. GNSS is used to determine the position of a receiver on land, at sea, or in space by means of constellation of multiple artificial satellites.

The GNSS satellites have atomic clocks, radio transceivers, computers and supporting equipment used for operating the system. Modern satellite navigation is based on the use of no-request range measurements between navigational satellite and the user. It means that the information about the satellite's coordinates given to the user is included into navigation signal. The signals of each satellite allow the user to measure an approximate distance from the receiver to the satellite, which is called the pseudorange. The pseudorange is calculated from the signals time of travel from a satellite to the receiver.

Every satellite has calibration oscillator of the reference frequency f0 = 10,23 MHz, which forms the signals from its oscillation, named L1 and L2. They are used as encoded signals transmissitters and data senders, they are also used for the most precise ranging between the user and the satellite.

The GNSS consists of three main satellite technologies: GPS, Glonass and Galileo. Each of them consists mainly of three segments: constellation of satellites (space segment); ground-based control facilities (control segment); user equipment (user segment). Space segment consists of many satellites that are placed above the Earth in nearly circular orbital planes. Control segment is responsible for controlling the whole system including the deployment and maintenance of the system, tracking of the satellites in their orbits and the clock parameters, monitoring of auxiliary data, and upload of the data message to the satellites. User segment consists of passive receivers able to decode received signals from satellites. These segments are almost similar in the three satellite technologies, which are all together make up the GNSS.

Global Positioning System (GPS) had reached the full military operational capacity in 1995. The US congress took actions to make the global positioning service available for civilians in 2000, since that time DoD is offering unlimited access of GPS service to the civilians in all over the world free of charge. The space segment of GPS system consists of 24 active satellites, which are placed in MEO at an altitude of 20,200 km above the earth. The control segment consists of a network of monitoring stations that are responsible for satellites' tracking, monitoring, and maintenance. The master control station gets data from each of the monitoring stations, which are distributed around the world, and determines both the data to be uploaded and the ground stations that will transmit this control data to the satellites. The user segment consists of handset radio receivers that receive signals from GPS satellites available in the view. Signals are transmitted to the user segment at frequencies L1 = 1575.42 MHz, and L2 = 1227.60 MHz. Both the civilians and USA military can access L1, but L2 is only accessible by US government and military. GPS positioning is based on trilateration method, which is a mathematical calculations to find out the position of something by knowing its distance from a number of known points. In reality a position has to be determined in three dimensional space, so 3D trilateration requires to know 3 points lie on the surfaces of three spheres to determine the position, which coordinates (X, Y, Z).

Space segment of GLONASS consists of 24 satellites in three orbital planes. Among these satellites there are 21 active satellites, while the other three satellites are used as spares. Control Segment consists of the system control center located in Krasnoznamensk Space Center. The center is connected with 8 tracking stations distributed across Russia. These stations are responsible for tracking and monitoring the satellites status in the orbits. GLONASS provides high accuracy signal for military use and standard accuracy signal for civil use. The used carrier frequencies are L1(1602 − 1615.5 MHz) and L2(1246 − 1256.5 MHz). The signals are modulated by two binary codes, the standard accuracy signal (C/A code) and the high accuracy signal (P code); the C/A code is only modulated onto L1, while P code is modulated onto L1 and L2. The navigation message includes information about the satellites orbits, satellite health status, correction data, and the almanac data about all satellites within GLONASS constellation. Almanac - is a package of ephemeris of all the satellites belong to global navigation system. Ephemeris - a coordinates package, which uniquely determine the satellites position and velocity.

Space segment of Galileo includes a constellation of a total of 30 satellites, 27 are operational and 3 spare satellites. These satellites are spaced around the plane in three circular medium earth orbits (MEO) with 23.600 km Altitude. Ground segment consists of two ground control center responsible for Central Processing Facility; they are located in Oberpfaffenhofen-Germany and Fucino-Italy. Moreover, the control centers are connected with five tracking and control stations, 9 C-band uplink stations, and about 40 Galileo sensor stations. User segment of Galileo must be developed in parallel with the core system to ensure that the receivers and users will be available in time when the Galileo reach its full operational capabilities.

Each satellite system has specific signal characteristics, but each system attempts to be compatible with the others in order to prevent the interferences and attenuation between the signals.

Precision conditions of navigation satellite systems are formed by the main failures level and geometrical disposition of the used satellites and the user. Geometrical factor (or Dilution of Precision) is a recalculation coefficient of the sporadic error of the radionavigation parameter into the error of the corresponding parameters determination.

Global Navigation Satellite Systems (GNSS) technology has become vital to many applications that range from city planning engineering and zoning to military applications. It has been widely accepted globally by governments and organizations. Different GNSS systems are designed to be compatible, which enable using more than one GNSS system to calculate the position. The combined signals will improve the code measurements and reduce the code noise level.

All in all, along with the development of GNSS satellite constellations proactively updated are the technology, equipment and software for the ground –based complex of reception, processing and interpretation of satellite data designed to tackle an ever-expanding array of applications. In the near future global satellite navigation systems are set to become an integral part of the infrastructure of any state and will directly impact not only the security but also the economic progress and social sphere.

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