DAILY ASSESSMENT FORMAT

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FORENOON SESSION DETAILS
Image of session

Report – Report can be typed or hand written for up to two pages.

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 1980's, the government made the system available for civilian use Introduction to Global Positioning Systems 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 1980's, the government made the system available for civilian use. GPS works in any weather conditions, anywhere in the world, 24 hours a day, 365 days a year. The 24 satellites that make up the GPS space segment are orbiting the earth about 12,000 miles above us. These satellites are travelling at speeds of roughly 7,000 miles an hour. GPS satellites are powered by solar energy. They have backup batteries onboard to keep them running in the event of a solar eclipse, when there's no solar power. Small rocket boosters on each satellite keep them flying in the correct path. Each satellite weighs about 2,000 pounds and is built to last about ten years.

How Does GPS Work?

GPS satellites circle the earth twice a day in a very precise orbit and transmit signal information to earth. GPS receivers take this information and use triangulation to calculate the user's exact location. Essentially, the GPS receiver compares the time a signal was transmitted by a satellite with the time it was received. The time difference tells the GPS reciever how far away the satellite is. Now, with distance measurements from a few more satellites, the reciever can determine the user's position and display it on the user's electronic map. A GPS reciever must be locked on to the signal of at least three satellites to calculate a 2D position (latitude and longitude) and track movement. With four more satellites in view, the reciever can determine the user's 3D position (latitude, longitude and altitude). Once the user's position has been determined, the GPS unit can calculate other information, such as speed, bearing, track, trip distance, distance to destination, sunrise and sunset time and more.

What is WASS?

Wide Area Augmentation System (WAAS) is a system of satellites and ground stations that provide GPS signal corrections, giving you even better position accuracy. How much better? Try an average of up to five times better. A WAAS-capable reciever can give you a position accuracy of better than three meters, 95 percent of the time. As long as your GPS system is WAAS enabled you do not need any additional equipment or pay any service fees.

Introduction to GPS

The Global Positioning System (GPS) is a satellite-based navigation system that was developed by the U.S. Department of Defense (DoD) in the early 1970s. Initially, GPS was developed as a military system to fulfill U.S. military needs. However, it was later made available to civilians, and is now a dual-use system that can be accessed by both military and civilian users.GPS provides continuous positioning and timing information, anywhere in the world under any weather conditions. Because it serves an unlimited number of users as well as being used for security reasons, GPS is a one-way-ranging (passive) system . That is, users can only receive the satellite signals. This topic introduces the GPS system, its components, and its basic idea.

Overview of GPS

GPS consists, nominally, of a constellation of 24 operational satellites. This constellation, known as the initial operational capability (IOC), was completed in July 1993. The official IOC announcement, however, was made on December 8, 1993 . To ensure continuous worldwide coverage, GPS satellites are arranged so that four satellites are placed in each of six orbital planes With this constellation geometry, four to ten GPS satellites will be visible anywhere in the world, if an elevation angle of 10° is considered. As discussed later, only four satellites are needed to provide the positioning, or location, information.GPS satellite orbits are nearly circular (an elliptical shape with a maximum eccentricity is about 0.01), with an inclination of about 55° to the equator. The semimajor axis of a

GPS orbit is about 26,560 km (i.e., the satellite altitude of about 20,200 km above the Earth's surface). The corresponding GPS orbital period is about 12 sidereal hours (~11 hours, 58 minutes). The GPS system was officially declared to have achieved full operational capability (FOC) on July 17, 1995, ensuring the availability of at least 24 operational, nonexperimental, GPS satellites. In fact, as shown in Section 1.4, since GPS achieved its FOC, the number of satellites in the GPS constellation has always been more than 24 operational satellites.

GPS segments

GPS consists of three segments: the space segment, the control segment, and the user segment .The space segment consists of the 24-satellite constellation introduced in the previous section. Each GPS satellite transmits a signal, which has a number of components: two sine waves (also known as carrier frequencies), two digital codes, and a navigation message. The codes and the navigation message are added to the carriers as binary biphase modulations . The carriers and the codes are used mainly to determine the distance from the user's receiver to the GPS satellites.The navigation message contains, along with other information, the coordinates (the location) of the satellites as a function of time. The transmitted signals are controlled by highly accurate atomic clocks onboard the satellites.The control segment of the GPS system consists of a worldwide network of tracking stations, with a master control station (MCS) located in the United States at Colorado Springs, Colorado. The primary task of the operational control segment is tracking the GPS satellites in order to determine and predict satellite locations, system integrity, behavior of the satellite atomic clocks, atmospheric data, the satellite almanac, and other considerations. This information is then packed and uploaded into the GPS satellites through the S-band link.The user segment includes all military and civilian users. With a GPS receiver connected to a GPS antenna, a user can receive the GPS signals, which can be used to determine his or her position anywhere in the world. GPS is currently available to all users worldwide at no direct charge.

GPS satellite generations

GPS satellite constellation buildup started with a series of 11 satellites known as Block I satellites The first satellite in this series (and in the GPS system) was launched on February 22, 1978; the last was launched on October 9,1985. Block I satellites were built mainly for experimental purposes. The inclination angle of the orbital planes of these satellites, with respect to the equator, was 63°, which was modified in the following satellite generations [6]. Although the design lifetime of Block I satellites was 4.5 years, some remained in service for more than 10 years. The last Block I satellite was taken out of service on November 18, 1995.The second generation of the GPS satellites is known as Block II/IIA satellites. Block IIA is an advanced version of Block II, with an increase in the navigation message data storage capability from 14 days for Block II to 180 days for Block IIA. This means that Block II and Block IIA satellites can function continuously, without ground support, for periods of 14 and 180 days, respectively. A total of 28 Block II/IIA satellites were launched during the period from February 1989 to November 1997. Of these, 23 are currently in service. Unlike Block I, the orbital plane of Block II/IIA satellites are inclined by 55° with respect to the equator. The design lifetime of a Block II/IIA satellite is 7.5 years, which was exceeded by most Block II/IIA satellites. To ensure national security, some security features, known as selective availability (SA) and antispoofing, were added to Block II/IIA satellites [3, 6].A new generation of GPS satellites, known as Block IIR, is currently being launched These replenishment satellites will be backward compatible with Block II/IIA, which means that the changes are transparent to the users. Block IIR consists of 21 satellites with a design life of 10 years. In addition to the expected higher accuracy, Block IIR satellites have the capability of operating autonomously for at least 180 days without ground corrections or accuracy degradation. The autonomous navigation capability of this satellite generation is achieved in part through mutual satellite ranging capabilities. In addition, predicted ephemeris and clock data for a period of 210 days are uploaded by the ground control segment to support the autonomous navigation. More features will be added to the last 12 Block IIR satellites under the GPS modernization program, which will be launched at the beginning of2000. As of July 2001, six Block IIR satellites have been successfully launched. Block IIR will be followed by another system, called Block IIF (for "follow-on"), consisting of 33 satellites. The satellite life span will be 15 years. Block IIF satellites will have new capabilities under the GPS modernization program that will dramatically improve the autonomous GPS positioning accuracy.The first Block IIF satellite is scheduled to be launched in 2005 or shortly after that date.

Current GPS satellite constellation

The current GPS constellation (as of July 2001) contains five Block II, 18 Block IIA, and six Block IIR satellites (see Table 1.1). This makes the total number of GPS satellites in the constellation to be 29, which exceeds the nominal 24-satellite constellation by five satellites [8]. All Block I satellites are no longer operational.The GPS satellites are placed in six orbital planes, which are labeled A through F. Since more satellites are currently available than the nominal 24-satellite constellation, an orbital plane may contain four or five satellites. As shown in Table 1.1, all of the orbital planes have five satellites, except for orbital plane C, which has only four. The satellites can be identified by various systems. The most popular identification systems within the GPS user community are the space vehicle number (SVN) and the pseudorandom noise (PRN); the PRN number will be defined later. Block II/IIA satellites are equipped with four onboard atomic clocks: two cesium (Cs) and two rubidium (Rb). The cesium clock is used as the primary timing source to control the GPS signal. Block IIR satellites, however, use rubidium clocks only.

Control sites

The control segment of GPS consists of a master control station (MCS), a worldwide network of monitor stations, and ground control stations. The MCS, located near Colorado Springs, Colorado, is the central processing facility of the control segment and is manned at all times . There are five monitor stations, located in Colorado Springs (with the MCS), Hawaii, Kwajalein, Diego Garcia, and Ascension Island. The positions (or coordinates) of these monitor stations are known very precisely.

GPS: The basic idea

The idea behind GPS is rather simple. If the distances from a point on the Earth (a GPS receiver) to three GPS satellites are known along with the satellite locations, then the location of the point (or receiver) can be determined by simply applying the well-known concept of resection [10]. That is all! But how can we get the distances to the satellites as well as the satellite locations? As mentioned before, each GPS satellite continuously transmits a microwave radio signal composed oftwo carriers, two codes, and a navigation message. When a GPS receiver is switched on, it will pick up the GPS signal through the receiver antenna. Once the receiver acquires the GPS signal, it will process it using its built-in software. The partial outcome of the signal processing consists of the distances to the GPS satellites through the digital codes (known as the pseudoranges) and the satellite coordinates through the navigation message.

Theoretically, only three distances to three simultaneously tracked satellites are needed. In this case, the receiver would be located at the intersection of three spheres; each has a radius of one receiver-satellite distance and is centered on that particular satellite From the practical point of view, however, a fourth satellite is needed to account for the receiver clock offset The accuracy obtained with the method described earlier was until recently limited to 100m for the horizontal component, 156m for the vertical component, and 340 ns for the time component, all at the 95% probability level. This low accuracy level was due to the effect of the so-called selective availability, a technique used to intentionally degrade the autonomous real-time positioning accuracy to unauthorized users [3]. With the recent presidential decision of terminating the selective availability, the obtained horizontal accuracy is expected to improve to about 22m (95% probability level) .