“GOVERNMENT DEGREE COLLEGE ANANTAPURAMU”

(AUTONOMOUS)”

Submitted

by

NAME OF THE STUDENT :

GROUP :

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SUBJECT : PHYSICS

PROJECT NAME : GPS (GLOBAL POSITIONING SYSTEM)

Submitted

To

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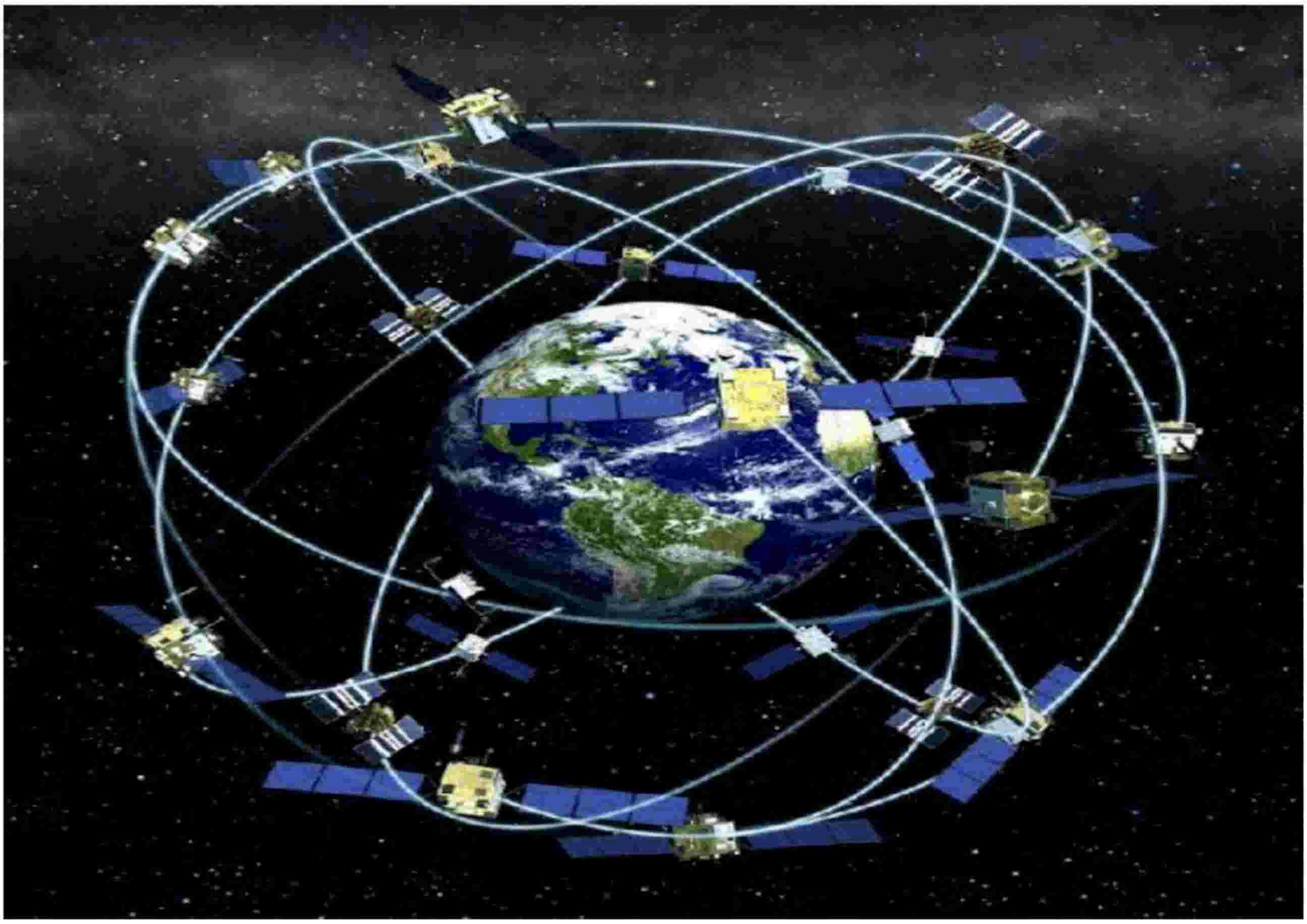
Government Degree College (A) Anantapuramu

INTRODUCTION



GPS(GIobaI Positioning System) is a satellite-based navigation system. It provides time and location-based information to a GPS receiver, located anywhere on or near the earth surface. GPS works in all weather conditions, provided there is an unobstructed line of sight communication with 4 or more GPS satellites. GPS is managed by the US Air Force.

A GPS operates independently of the user's internet connection or telephone signal. However, their presence increases the effectiveness of GPS positioning. GPS was initially developed by the US government for military purpose, but currently, anyone with a GPS receiver can receive radio signals from GPS satellites. Note:

Initially when GPS was developed for military use, there were 24 GPS satellites orbiting the earth every 12 hours at a height of 20, 180 km.

4 GPS satellites were located in each of the 6 orbits with 60 degree orientation between each other. These orbital planes do not rotate with respect to any star.

Later, the number of satellites were increased to 32, to improve location accuracy. Localization of any GPS receiver is done through time of flight measurement.

The greater the number of satellite in line of sight to a GPS receiver, the greater is the accuracy in determining the position of the receiver.

Sources of GPS Error

GPS receivers have potential position errors due to some of the following sources:

User mistakes account for most GPS errors. Incorrect datum and typographic Introduction to Global Positioning System

What is the Global Positioning System

The Global Positioning System was conceived in 1960 under the auspices of the U.S. Air Force, but in 1974 the other branches of the U.S. military joined the effort. The first satellites were launched into space in 1978. The System was declared fully operational in April 1995.

The Global Positioning System consists of 24 satellites, that circle the globe once every 1 2 hours, to provide worldwide position, time and velocity information. GPS makes it possible to precisely identify locations on the earth by measuring distance from the satellites. GPS allows you to record or create locations from places on the earth and help you navigate to and from those places.

Originally the System was designed only for military applications and it wasn't until the 1 980's that it was made available for civilian use also.

The 3 segments of GPS

The Space segment: The space segment consists of 24 satellites circling the earth at 12,000 miles in altitude. This high altitude allows the signals to cover a greater area. The satellites are arranged in their orbits so a GPS receiver on earth can always receive a signal from at least four satellites at any given time. Each satellite transmits low radio signals with a unique code on different frequencies, allowing the GPS receiver to identify the signals. The main purpose of these coded signals is to allow for calculating travel time from the satellite to the GPS receiver. The travel time multiplied by the speed of light equals the distance from the satellite to the GPS receiver. Since these are low power signals and won't travel through solid objects, it is important to have a clear view of the sky.

The Control segment: The control segment tracks the satellites and then provides them with corrected orbital and time information. The control segment consists of four unmanned control stations and one master control station. The four unmanned stations receive data from the satellites and then send that information to the master control station where it is corrected and sent back to the GPS satellites. The User segment: The user segment consists of the users and their GPS receivers.

The number of simultaneous users is limitless.

errors when inputting coordinates into a GPS receiver can result in errors up to many kilometers. Unknowingly relying on less than four satellites for determining position coordinates can also result in unreliable position fixes that can easily be off by a distance in excess of a mile. Even the human body can cause signal interference. Holding a GPS receiver close to the body can block some satellite signals and hinder accurate positioning. If a GPS receiver must be hand held without benefit of an external antenna, facing to the south can help to alleviate signal blockage caused by the body because the majority of GPS satellites are oriented more in the earth's southern hemisphere. A GPS receiver has no way to identify and correcting user mistakes.

Satellite clock errors: Caused by slight discrepancies in each satellite's four atomic clocks. Errors are monitored and corrected by the Master Control Station. Orbit errors: Satellite orbit (referred to as "satellite ephemeris") pertains to the altitude, position and speed of the satellite. Satellite orbits vary due to gravitational pull and solar pressure fluctuations. Orbit errors are also monitored and corrected by the Master Control Station.

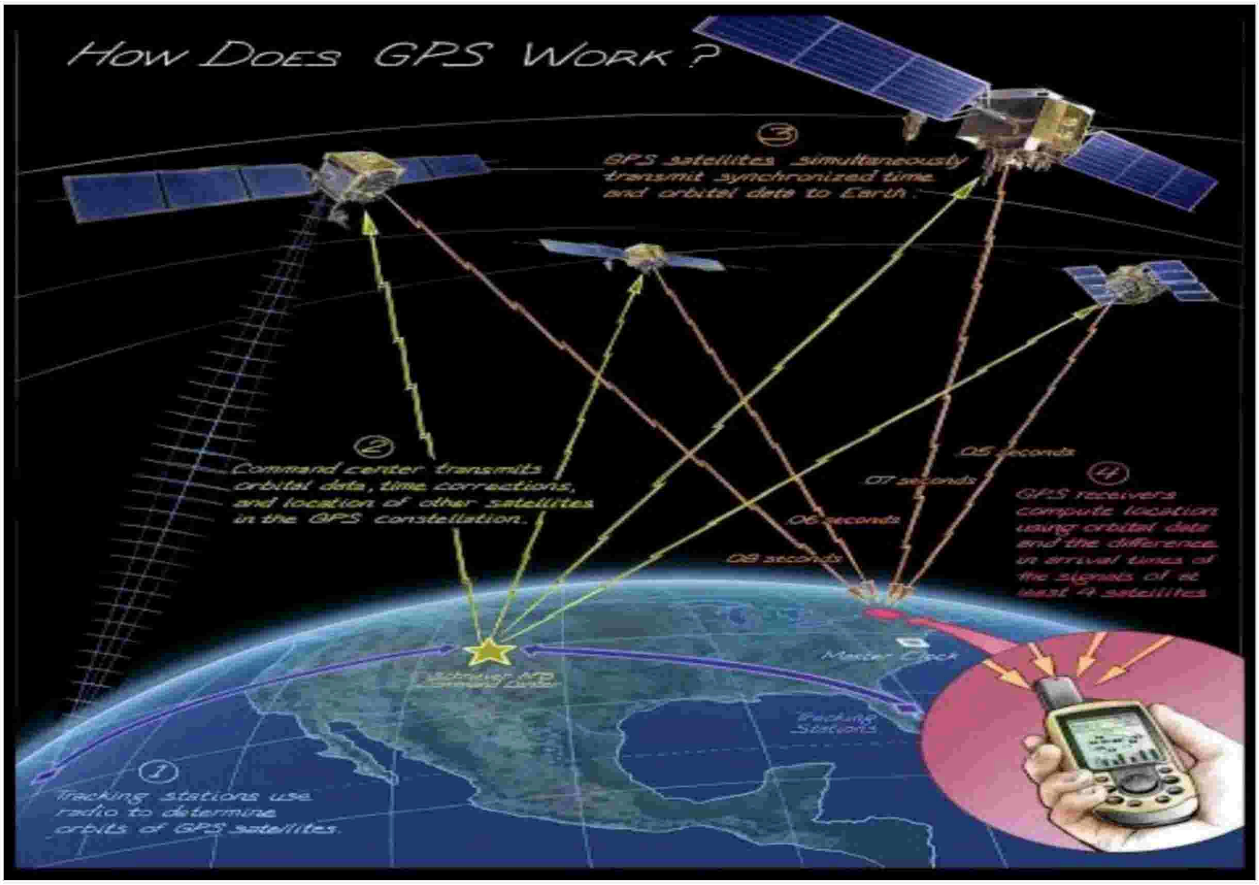
Ionospheric interference: The ionosphere is the layer of the atmosphere from 50 to 500 km altitude that consists primarily of ionized air. Ionospheric interference causes the GPS satellite radio signals to be refracted as they pass through the earth's atmosphere - causing the signals to slow down or speed up. This results in inaccurate position measurements by GPS receivers on the ground. Even though the satellite signals contain correction information for ionospheric interference, it can only remove about half of the possible 70 nanoseconds of delay, leaving potentially up to a ten meter horizontal error on the ground. GPS receivers also attempt to "average" the amount of signal speed reduction caused by the atmosphere when they calculate a position fix. But this works only to a point. Fortunately, error caused by atmospheric conditions is usually less than 10 meters. This source of error has been further reduced with the aid of the Wide Area Augmentation System (WAAS), a space and ground based augmentation to the GPS (to be covered later)Tropospheric interference: The troposphere is the lower layer of the earth's atmosphere (below 13 km) that experiences the changes in temperature, pressure, and humidity associated with weather changes. GPS errors are largely due to water vapor in this layer of the atmosphere.

How GPS Works

How GPS Works

When a GPS receiver is turned on, it first downloads orbit information of all the satellites. This process, the first time, can take as long as 12.5 minutes, but once this information is downloaded, it is stored in the receivers memory for future use. Even though the GPS receiver knows the precise location of the satellites in space, it still needs to know the distance from each satellite it is receiving a signal from. That distance is calculated, by the receiver, by multiplying the velocity of the transmitted signal by the time it takes the signal to reach the receiver. The receiver already knows the velocity, which is the speed of a radio wave or 1 86,000 miles per second (the speed of light).

To determine the time part of the formula, the receiver matches the satellites



transmitted code to its own code, and by comparing them determines how much it needs to delay its code to match the satellites code. This delayed time is multiplied by the speed of light to get the distance.

The GPS receivers clock is less accurate than the atomic clock in the satellite, therefore, each distance measurement must be corrected to account for the GPS receivers internal clock error.

Triangulation

Once both satellite and position are known for at least 4 satellites, the receiver can determine a position by triangulation. We are somewhere on the surface of this sphere.

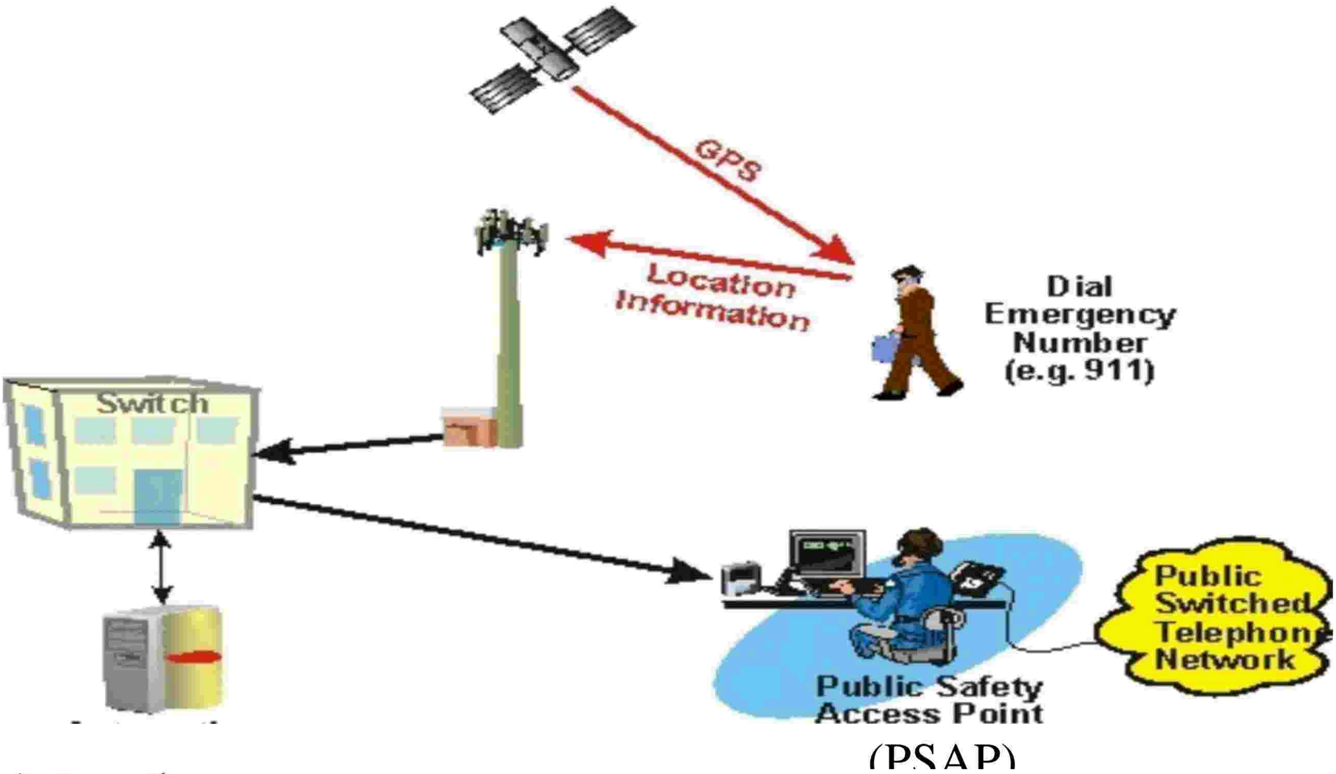
One measurement narrows down our position
to the surface of a sphere. Trimble Navigation

1 1,000 miles
Second measurement narrows it down
to the intersection of two spheres.
Intersection of

two spheres is
a circle.
Trimble Navigation

1 1,000
miles
12,000 miles

. GPS is a satellite-based navigation system that allows ground users to provide their exact location, velocity, and time 24 hours a day, in all weather conditions, all over the world. GPS developed by the U.S. Department of Déefense. It was basically designed to assist soldiers and military



Automatic
Location
Identification
Database (ALI)

vehicles but after some years it's available to anyone having a GPS receiver. GPS is a common system that most of us are using to reach from one location to Another location.

The GPS systems are a Combination of a network of satellites that are constantly sending coded information in the form of radio signals. After that receiver received the signals and interprets the transmitted information from the satellites to locate the position on earth accurately. This satellite system is congestive of 29 satellites situated at almost 20,000 kilometers above the Earth's surface. The GPS satellites are located at 6 earth-centered orbital planes and travel at a speed of 14,000 km/hr. The GPS was first time used in combat during the Gulf wars.

Global Positioning System

Functionality of GPS:

The GPS device will first establish a connection with 3 to 4 satellites. After that GPS satellite broadcasts a message including the location of the receiver. If the GPS receiver receives a Group of messages from different satellites to calculate the exact position using the process called triangulation.
GPS satellites need an unobstructed line of sight for the broadcast. Hence, this technology is not only for indoor but also for use in a wide area. There some devices use nearby cell towers and open-source Wi-Fi signals. Then technology is called LPS (Local Positioning System) and is a substitute for GPS.

Architecture of GPS:

GPS Architecture is basically divided into three segments.

Space segment: The GPS satellites fly in circular orbits at an altitude of 20000 km and with a period of 12 hours. It's powered by Solar cells. The GPS satellite Continuously orients themselves to point their solar panels toward the sun and their antenna. Towards the earth. Orbital planes are centered on the earth. Orbits are designed so that, at least, Six satellites are always within a line of sight from any location on the Planet. The GPS System Consist of 24 satellites (in present 32) Established in near-circular orbits arranged in 6 orbitals Placed at 55 Degree Inclination to the Equator at 20200 km height and 26600 km orbital Radius. The Period of Revolution is 12 Hours. So that at least 4 Satellites are available for observations at any time throughout the year anywhere in the World.

Control Segment: The second component of GPS is the Control segment. It's further divided into three sub-components.

Master Control System

Monitor Station: The monitor station checks the exact latitude, Position, Speed, and overall health of the orbiting satellites. The control segment ensures that the GPS and Clocks remain within acceptable limits. A station can track up to 1 1 satellites at a time. This "check-up" is performed twice a day, By each station.

Ground Antennas: The ground Antennas monitor and track the satellites from horizon to horizon. They also transmit correction information to individual satellites. Communication with the GPS satellites for command and control purposes.

User Segment: The Master Control Station is located at Falcon Air Force base in Colorado Springs. Responsible for the overall management of remote monitoring and transmission sites. Check-up is performed twice a day, by each of the 6 stations as satellites Complete their Journey around the earth. Mater Control can reposition satellites to maintain an optimal GPS Constellation. It also includes a display for showing location and speed information to the user. A receiver is often described by its number of channels (this signifies how many satellites it can monitor simultaneously). As of recent, receivers usually have between twelve and twenty channels. There are five stations for satellites signal Receivers:

Indian GPS(NAVIC) NAVIGATION WITH INDIAN CONTELLATION

with the operational name NavlC (Navigation with Indian Constellation), is a system of 7 satellites, 3 in geostationary orbit and 4 in geosynchronous orbit. This is a satellite navigation system, like GPS, that provides positioning and timing services with very high accuracy in realtime. The need for developing a homegrown GPS has arisen due to the geostrategic and

military importance of such a system, though most of its use will be in the civilian domain.

Satellite navigation has its origin in the "Space Race" of the Cold War era between the United States of America (USA) and the Soviet Union (USSR). The USA started experimenting with satellite navigation in the 1960s by tracking their own nuclear submarines using the phenomenon of the "Doppler Effect". The project gained prominence in the mid-70s and the USA was able to perfect the Global Positioning System (GPS) by the year 1993 with the launch of the 24th satellite of the system, which allowed complete global coverage at all times.

Though GPS has been considered a reliable navigation system, it has been alleged that the USA can deny the service to a particular area or feed wrong coordinates to an enemy nation. It was reported that during the Iraq war, the Iraqi military was fed wrong coordinates of the location of the USA army, and hence all the attacks against America were rendered ineffective. Again, it has been alleged that the USA denied the military-grade GPS signals to India during Kargil War. This may become a major problem in the long run if countries controlling the satellite navigation systems refuse to help India in hostile and critical situations.

With this thought in mind, India embarked on the journey of creating its own homegrown Indian Regional Navigation Satellite System (IRNSS). How Does IRNSS Help in Navigation?

IRNSS satellites continuously emit microwave radiation. The microwave signals contain information about the position of satellites and precise time from atomic clocks. The signals from at least four satellites are received by ground receivers, which then triangulate their own position using the position of satellites and the time taken for the signals to reach the receiver. Out of the four satellites, three are used for calculating the position in space (latitude, longitude, and altitude) and the fourth one is for timing correction. These receivers, if integrated with maps, can be used for turn-by-turn navigation guidance as is the case with Google maps.

Some of the uses of the Indian Regional Navigation Satellite System

1 . Strategic Significance

As we have already seen above, dependency on foreign power-operated navigation systems may prove fatal in situations of war. IRNSS will ensure that Indian defense forces receive accurate information regarding the enemy positions and precisely track their own troop movements. All three Indian defense forces are in the process of integrating IRNSS into their aircraft. With a resolution of 20 meters, IRNSS will reduce dependence on GPS for accurate targeting and positioning. The weapons can be fired with high precision and cavalry attacks can be launched efficiently. The operationalization of IRNSS could not have come at a better time. Under Atmanirbhar Bharat and Make in India initiatives, the government is giving a push to the indigenization of defense forces. A lot of Indian-made platforms and equipment like weapons, fighter jets, drones, and submarines are beginning to bear fruit. All these can use a navigation system that is under India's control and will ensure signal availability and accuracy under critical political and military situations.

2. Disaster Management

India is a country prone to numerous natural disasters like earthquakes, tsunamis, floods, landslides, and cyclones, as well as man-made disasters like mine collapse and breaking of dams. During extreme events, communication and transport systems break down. In such a scenario, the disaster response team can use NavlC for navigating w

Russia gps

GLONASS (Global Navigation Satellite System, Russia)

GLONASS was developed by the Soviet Union as an experimental military communications system during the 1 970s. When the Cold War ended, the Soviet Union recognized that

GLONASS had commercial applications, through the system's ability to transmit weather broadcasts, communications, navigation and reconnaissance data.

The first GLONASS satellite was launched in 1982 and the system was declared fully operational in 1993. After a period where GLONASS performance declined, Russia committed to bringing the system up to the required minimum of 1 8 active satellites. Currently, GLONASS has a full deployment of 24 satellites in the constellation.

GLONASS satellites have evolved since the first ones were launched. The latest generation, GLONASS-M, is shown in Figure 30 being readied for launch.

GLONASS System Design

The GLONASS constellation provides visibility to a variable number of satellites, depending on your location. A minimum of four satellites in view allows a GLONASS receiver to compute its position in three dimensions and to synchronize with system time.

Satellite
Table 4: GLONASS Constellation

Satellites24 plus 3 sparesOrbital planes30rbital inclination64.8 degreesOrbit radiusl 9,140 km

The GLONASS space segment consists of 24 satellites, in three orbital planes, with eight satellites per plane.

The GLONASS constellation geometry repeats about once every eight days. The orbit period of each satellite is approximately 8/17 of a sidereall day so that, after eight sidereal days, the GLONASS satellites have completed exactly 17 orbital revolutions.

Each orbital plane contains eight equally spaced satellites. One of the satellites will be at the same spot in the sky at the same sidereal time each day.

The satellites are placed into nominally circular orbits with target inclinations of 64.8 degrees and an orbital radius of 19,140 km, about 1 ,060 km lower than GPS satellites.

The GLONASS satellite signal identifies the satellite and includes:

Positioning, velocity and acceleration information for computing satellite locations.

Satellite health information.

Offset of GLONASS time from UTC (SU) [Coordinated Universal Time Russia].

Almanac of all other GLONASS satellites.

GLONASS Control Segment

The GLONASS control segment consists of the system control center and a network of command tracking stations across Russia. The GLONASS control segment, similar to that of GPS, monitors the satellites health, determines the ephemeris corrections, as well as the satellite clock offsets with respect to GLONASS time and UTC (Coordinated Universal Time). Twice a day, it uploads corrections to the satellites.

GLONASS Signals

Table 5 summarizes the GLONASS signals.

Table 5: GLONASS Signal Characteristics

Designation FrequencyDescriptionL1 1 598.0625 - 1609.3125 MHzL1 is modulated by the HP (high precision) and the SP (standard precision) signals.L21242.9375 - 1251.6875 MHzL2 is modulated by the HP and SP signals. The SP code is identical to that transmitted on Ll.

Satellite

Each GLONASS transmits on a slightly different Ll and L2 frequency, with the Pcode (HP code) on both Ll and L2, and the C/A code (SP code), on Ll (all satellites) and L2 (most satellites). GLONASS satellites transmit the same code at different frequencies, a technique known as FDMA, for frequency division multiple access. Note that this is a different technique from that used by GPS.

GLONASS signals have the same polarization (orientation of the electromagnetic waves) as GPS signals, and have comparable signal strength.

The GLONASS system is based on 24 satellites using 12 frequencies. The satellites can share the frequencies by having antipodal satellites transmitting on the same frequency. Antipodal satellites are in the same orbital plane but are separated by 1 80 degrees. The paired satellites can transmit on the same frequency because they wi

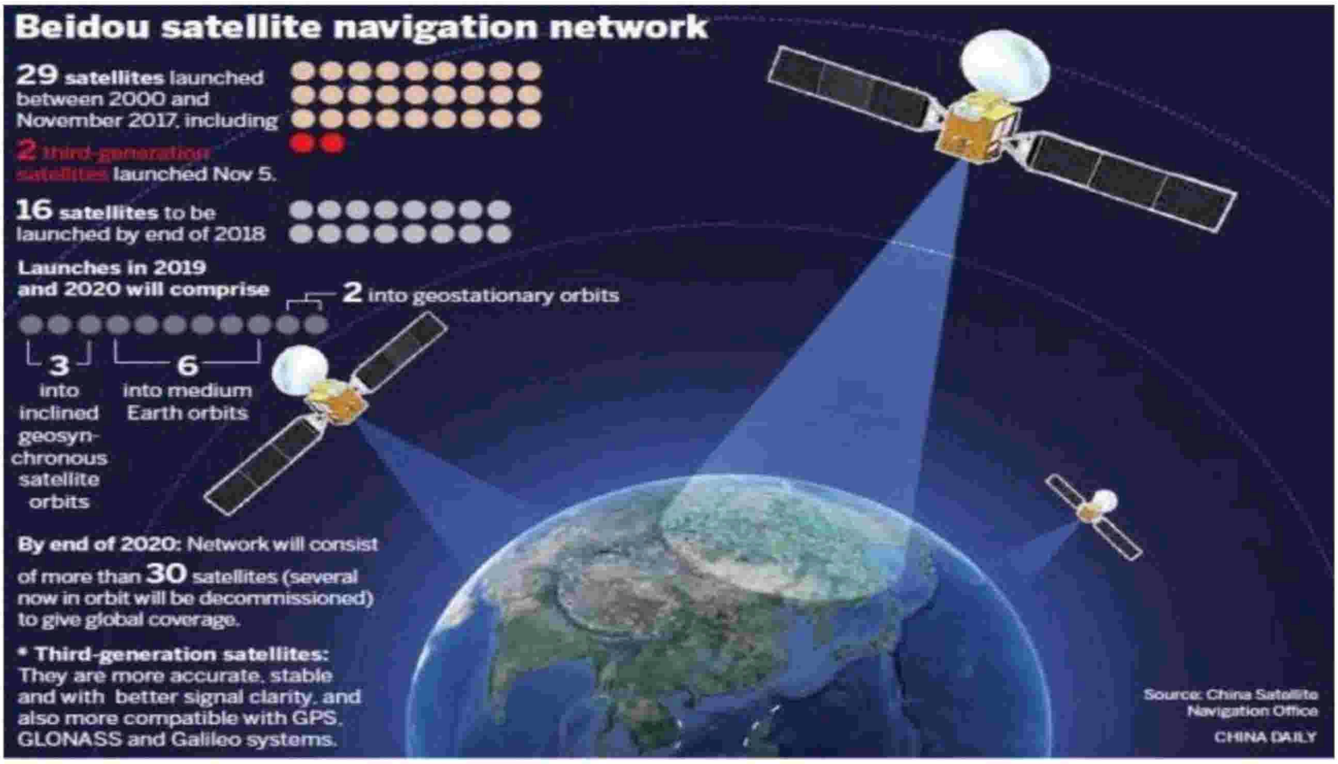
Chinese

The BeiDou Navigation Satellite System (BDS; Chinese: 北斗卫星导航系统; pinyin: Béidöu WéixTng Däohång Xitöng) is a Chinese satellite navigation system. It consists of two separate satellite constellations. The first BeiDou system, officially called the BeiDou Satellite Navigation Experimental System and also known as BeiDou-1, consisted of three satellites which, beginning in 2000, offered limited coverage and navigation services, mainly for users in China and neighboring regions. BeiDou-1 was decommissioned at the end of 2012. On 23 June 2020, the final BeiDou satellite was successfully launched, the launch of the 55th satellite in the Beidou family. The third iteration of the Beidou Navigation Satellite System provides for global coverage for timing and navigation, offering an alternative to Russia's GLONASS, the European Galileo positioning system, and the USS GPS.

BeiDou Navigation Satellite System
Beidou logo.png

Country/ies of origin
China
Operator(s)
CNSA
Type
Military, commercial
Status
Operational
Coverage
Global
Accuracy
3.6 m (global, public)

Satellite



2.6 m (Asia Pacific, public)

They are more æcurate. stable and with better signal cianty. and also more cornpatibbe with GPS, GLONASS and Galileo systems.

10 cm (encrypted)[ll

Constellation size

Total satellites

35 (2020)

Satellites in orbit

35

First launch 31 October 2000

Last launch 23 June 2020[2]

Total launches

59[31

Orbital characteristics

Regime(s)

GEO, IGSO, MEO Website

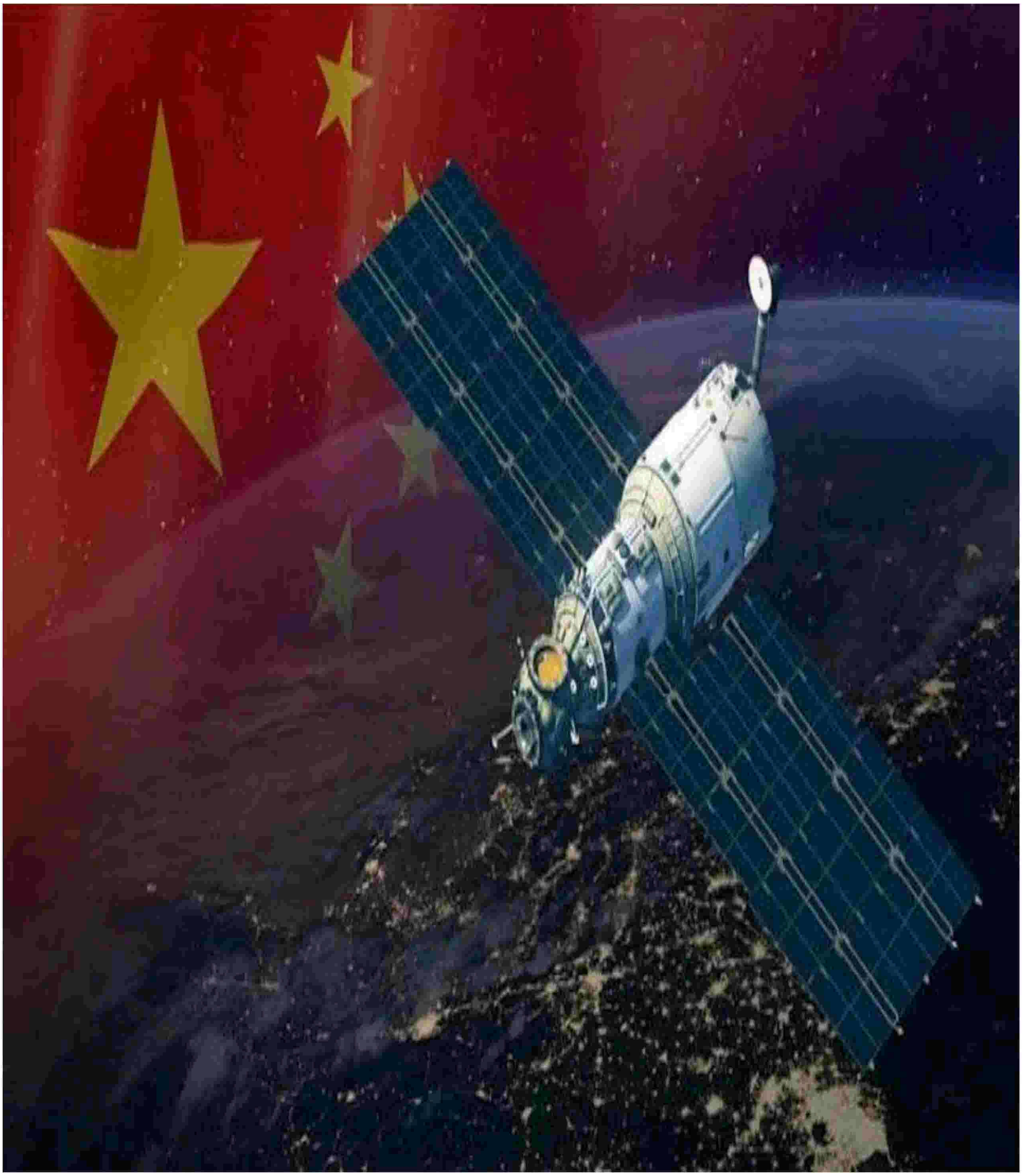
en.beidou.gov.c
n

The second generation of the system, officially called the BeiDou Navigation Satellite System (BDS) and also known as COMPASS or BeiDou-2, became operational in China in December 201 1 with a partial constellation of 10 satellites in orbit.[4] Since December

Satellite

2012, it has been offering services to customers in the Asia-Pacific region.[51

In 201 5, China launched the third generation BeiDou system (BeiDou-3) for global coverage. The first BDS-3 satellite was launched on 30 March 201 5.[61 On 27 December 201 8, BeiDou Navigation Satellite System started providing global services.[7][8] The 35th and the final satellite of BDS-3 was launched into orbit on 23 June 2020.[9] It was said in 2016 that BeiDou-3 will reach millimeter-level accuracy (with post-processing).[l



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