CHAPTER - 3

Global Positioning System (GPS)

Learning Objectives

By the end of this chapter students would be able to understand:

3.1 Introduction about Global Positioning System (GPS)

3.2 GPC Accuracy and Accuracy Factors

3.3 Types of GPS

3.4 List of Global Navigation Satellite Systems

3.5 GPS Today & its Limitations

3.6 Uses of GPS Technology

3.1 Introduction

Since the beginning of time, mankind has been trying to figure out a dependable way to know answer Where am I? How do I get to my destination and get back? These questions are as old as the history of mankind. Stones trees, mountains are used as reference to Identifying and remembering objects and different landmarks. Major developments in navigation were the stones, star, radio, and satellite age based GPS.

GPS stands for Global Positioning System and it allows users to determine their location on land, sea and in the air using Satellite and receiver.

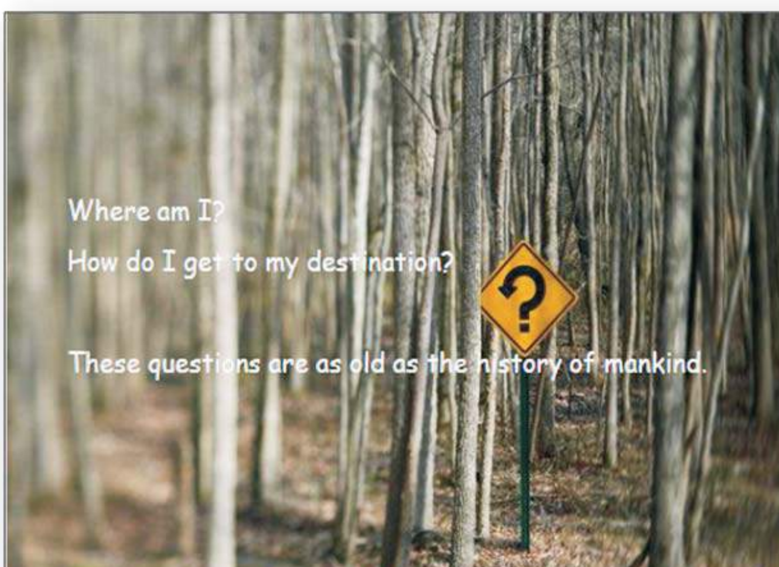

Fig. 101

The Stone Age man used to find his way through jungles and deserts. In stone age people navigated only by means of landmarks - mountains, trees, or leaving trails of stones. This would only work within a local area. Seamen followed the coastline to keep them from not getting lost. For traveling across the ocean a process called dead reckoning, which used a magnetic compass and required the calculation of how fast the ship was going. The measurement tools were crude and inaccurate. It was also a very complicated process.

Fig. 102

Stone Age Navigation
Courtesy: Sumit Sabarwal

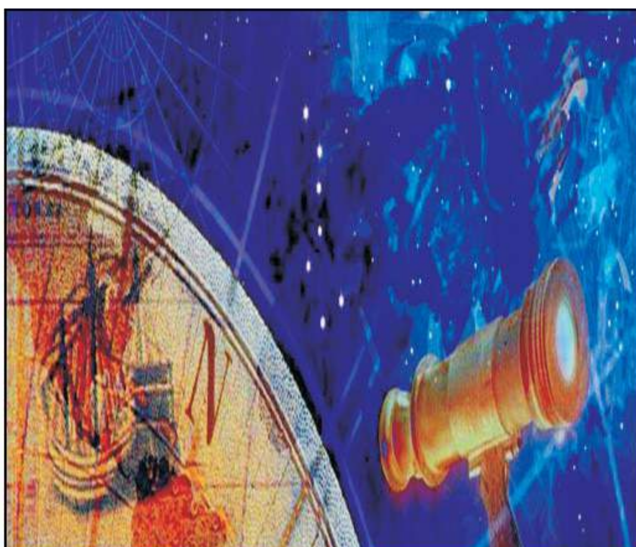

Fig. 103

Star Age Navigation
Courtesy: Sumit Sabarwal

In the Star Age man started exploring the oceans, where only visible objects are the sun, moon and the stars. The relative position of stars and shape of constellations look different from different locations on Earth. Major developments in early navigation were compass and the sextant. The needle of the compass always points north. So even if they did not know where they were, at least they knew in what direction they were travelling. The sextant measures the exact angles of stars, moon and sun above the horizon by the use of adjustable mirrors. Early sextant measures the latitude; it could not measure the longitude.

To overcome the problem of identifying location information in terms of longitude and latitude radio based navigation systems are discovered and used in World War - II. Both ships and airplanes were used in ground based radio navigation system. Radio Navigational System uses radio signals to measure distances from several transmitting towers located at known points. The first ground-based radio navigation system was developed after 20th century. The users (receivers) calculate how far away they are from a transmitting tower whose location is known. The accurate locations are calculated by using several towers.

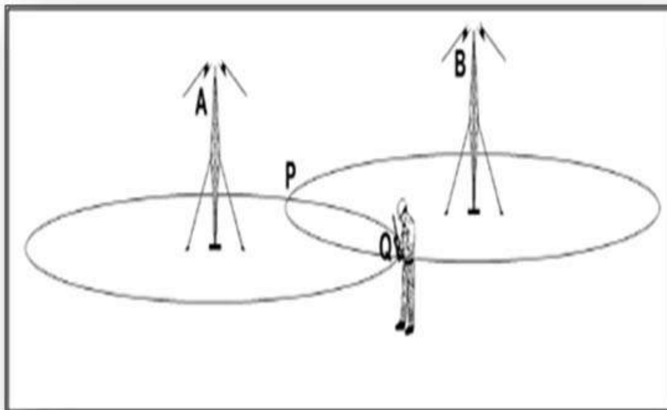

Fig. 104

Radio Navigation System

In the Satellite Age improved radio transmitters were put aboard satellites orbiting the earth to give wider coverage. A limitation of ground based radio waves is that it is difficult to make them accurate as well as provide wide area coverage. Therefore the only way to provide coverage for the entire world was to place high-frequency radio transmitters in space. Satellite navigation systems can provide high frequency signals allowing for high accuracy, as well as global access. The first satellite system developed was called Transit. It was made operational in 1964. Transit had no timing devices aboard the satellites and the time it took a receiver to calculate its position was about 15 minutes.

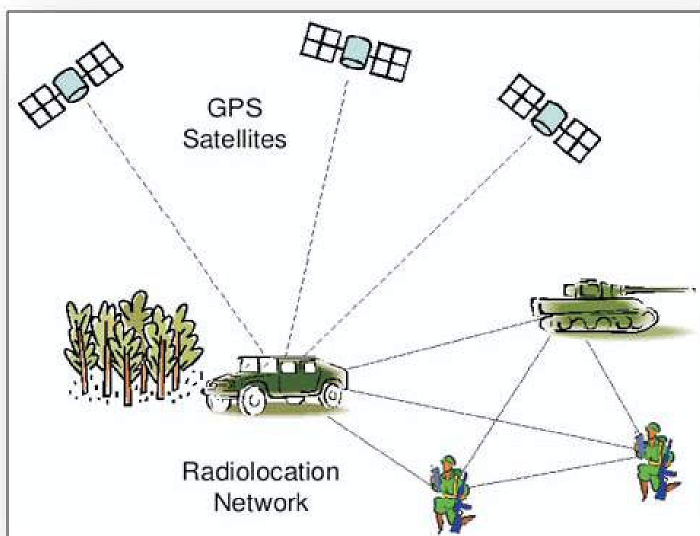

Fig. 105

Satellite Navigation System

The GPS was mainly used for military positioning, navigation, and weapons aiming system. It has higher accuracy and stable atomic clocks on board to achieve precise time transfer. The first GPS satellite was launched in 1978 and the first products for civilian consumers appeared in the mid 1980's. In 1984 the capabilities of GPS was available to the civil community. The system is still being improved and new, better satellites are still being launched to replace older ones.

Fig. 106

GPS

GPS is a network of satellites that continuously transmits coded information which makes it possible to precisely indentify location on earth by measuring distance from the satellites

In class XI we have discussed on basic fundamentals of GPS. GPS is a satellite-based positioning system operated by the United States Department of Defense (DoD). GPS include three segments

- Space Segment
- Control Segment
- User Segment

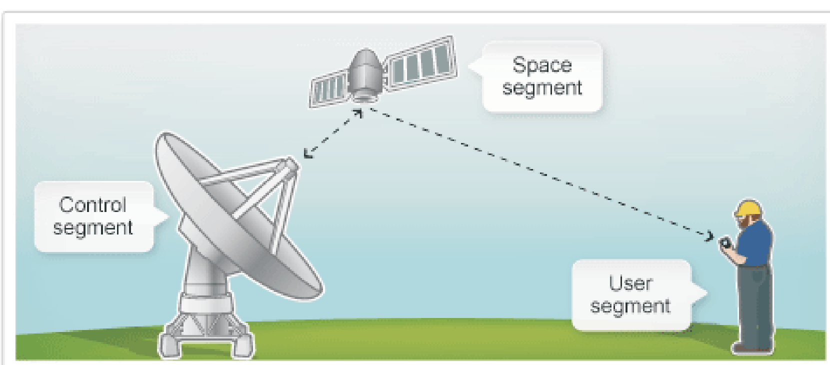

Fig. 107

Segments of GPS – Control, Space & User

The space segment includes the 24 operational NAVSTAR satellites that orbit the earth every 12 hours at an altitude of approximately 20,200 kilometers. Each satellite contains several high-precision atomic clocks and constantly transmits radio signals using a unique identifying code.

Control segment basically makes sure that the satellites are working properly. It includes one Master Control Station, five Monitor Stations and a Ground Antenna. The Monitor Stations passively track each satellite continuously and provide this data to Master Control Station. The Master Control Station calculates any changes in each satellite's position and timing. These changes are forwarded to the Ground Antennas and transmitted to each satellite daily. This ensures that each satellite is transmitting accurate information about its orbital path

The user segment, comprised of both civilian and military users worldwide, acquires signals sent from the NAVSTAR satellites with GPS receivers. The GPS receiver uses these signals to determine where satellites are located. With this data and information stored internally, the receiver can calculate its own position on earth.

Official name: Navigation System for Timing and Ranging (NAVSTAR)
Generic/common name: Global Positioning System (GPS)

Fundamental principle GPS is based on using radio waves received from multiple satellites to measure the distance to each satellite. A GPS receiver's job is to locate four or more of these satellites, figure out the distance to each, and use this information to calculate its own location. This operation is based on a simple mathematical principle called Triangulation or Trilateration.

Trilateration is a basic geometric principle that allows you to find the location of unknown place by knowing distance from known place.

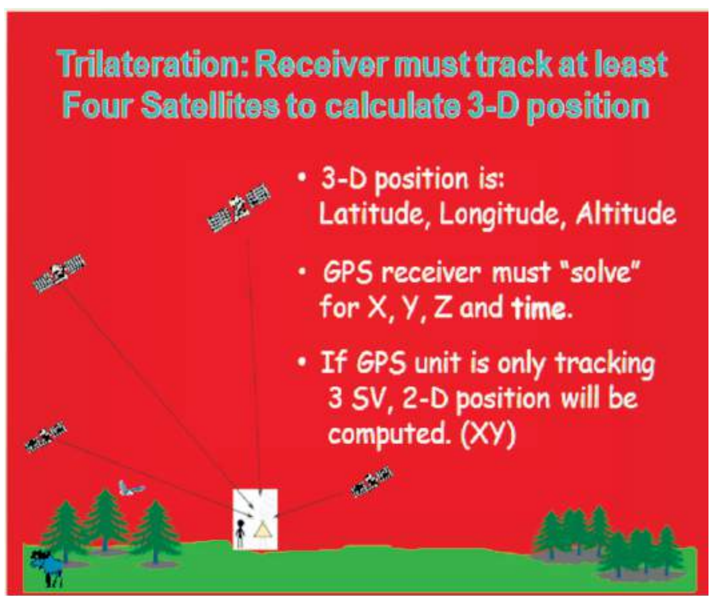

Fig. 108

Trilateration

Courtesy: Sumit Sabarwal

Trilateration uses electronic distance measuring equipment to directly measure the lengths of the sides of triangles from which the angles can be calculated. It is a very useful method for rough terrain where positions can be accurately carried forward and is seen as an alternative method to triangulation

The calculation process is as follows

- Receiver activates the GPS system
- The receiver picks up the signals from the satellites (minimum of four). If more than four satellites it increases the accuracy.
- Uses signal travel time to calculate distance to the satellites
- Triangulates to determine position of the receiver.

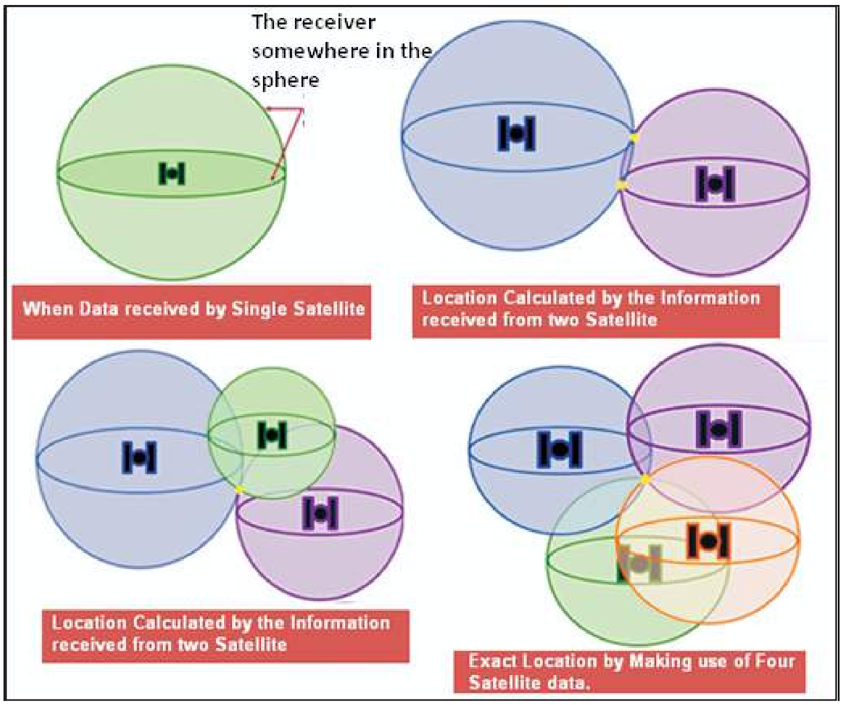

Fig. 109

Trilateration process

This positional information can be used in many applications such as mapping, surveying and navigation.

3.2 GPC Accuracy and Accuracy Factors

The position calculated by GPS is affected by several factors. Each of the following errors has an impact on the accuracy of our GPS positions. The GPS system has been designed to be accurate as possible. But still there are some errors occur which are added together, these errors can cause a deviation of **+/- 50 -100** meters from the actual GPS receiver position. There are several sources for these errors, the most significant of which are discussed below:

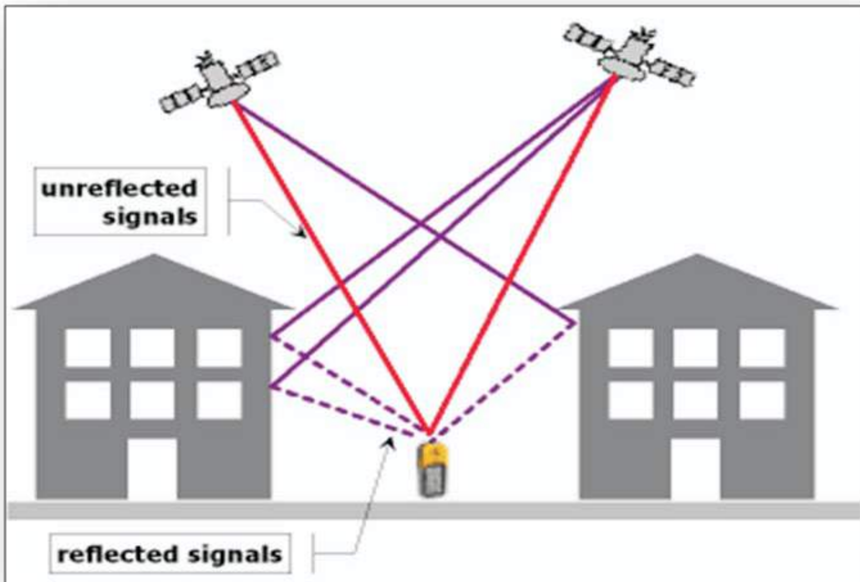

Fig. 110

Accuracy affected by atmosphere layers
Source: www.kowoma.de

Errors

- Minimum Number of satellites required
- Ionosphere - Change in the Travel Time of the Signal
- Troposphere - Change in the Travel Time of the Signal
- Satellite Geometry - General Distribution of the Satellites
- Satellite Health - Availability of Signal
- Signal Strength - Quality of Signal
- Distance from the Reference Receiver
- Radio Frequency (RF) Interference
- Loss of Radio Transmission from Base
- Orbital errors (ephemeris errors) these are inaccuracies of the satellite’s reported location.

- Satellite geometry/shading - poor geometry results when the satellites are located in a line or in a tight grouping.
- A receiver's built-in clock is not as accurate as the atomic clocks onboard the GPS satellites.
- GPS units typically will not work indoors, underwater or underground.
- Multipath - Reflection of GPS signals near the Antenna

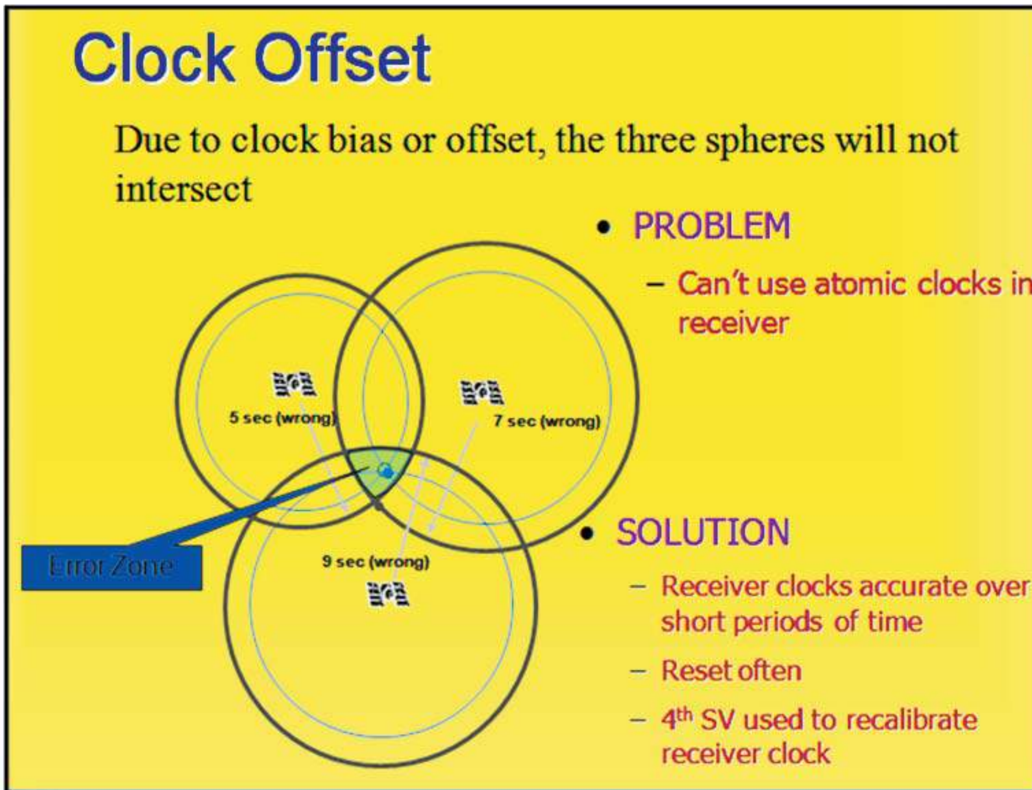

Fig. 111

Accuracy affected by Clock difference
Courtesy: Sumit Sabarwal

Details of these factors have been discussed in Class XI, Various types of GPS provides different levels of accuracy for exampleGarmin® GPS receivers can provide at accuracy within 15 meters on average. Newer Garmin GPS receiver with Wide an Area Augmentation System (WAAS) provides accuracy less than 3 meters. Below table shows the accuracy of GPS with various modes of operation

Table : 7	
Mode of operation	**Accuracy**
Autonomous	15 m – 100 m
Differential GPS (DGPS)	0.5 m- 5 m
Real-Time Kinematic Float (RTK Float)	20 cm – 1 m
Real-Time Kinematic Fixed (RTK Fixed)	1 cm - 5 cm

Accuracy of GPS reading with various modes

Fig. 112

Surveying GPS Instrument

The global positioning system (GPS) has become the most extensively used positioning and navigation tool in the world. The positional and elevation accuracy of any given GPS location is prone to error, due to a number of parameters. GPS accuracy can be significantly improved with additional data, possibly from multiple sources, and especially from multiple receivers. In the case of a single GPS receiver, its position and elevation can be considerably improved with the use of spatial data. In general, the position quality provided by GPS alone was extremely poor, due to multipath effects caused by the urban area.

Generally, altitude error is specified to be 1.5 x Horizontal error specification. This means that the user should consider + / - 23meters (75ft). Altitude error is always considerably worse than the horizontal (position error). These errors are due to the matter of geometry. If we consider just four satellites, the "optimum" configuration for best overall accuracy is having the four Space Vehicle (SV) at 40 to 55 degrees above the horizon and one in each general direction N, E, W, and S. The similar "best" arrangement for vertical position is with one SV overhead and the others at the horizon and 120 degrees in azimuth apart. This type of arrangement is very poor and not accurate because it is at horizontal position.

To improve the accuracy of GPS readings DGPS are used. The DGPS operation will dramatically improve the performance of even low cost GPS receivers. In DGPS we get the Horizontal accuracy of + / - 5 meters and altitude accuracy of + / - 10 meters.

3.3. Types of GPS

a) DGPS
b) Recreational
c) Mapping
d) Survey

a) Differential Global Positioning System (DGPS)

Differential Global Positioning System (DGPS) is an enhancement to GPS. It works by canceling out most of the natural and manmade errors. Enable precision applications by reducing the overall Errors

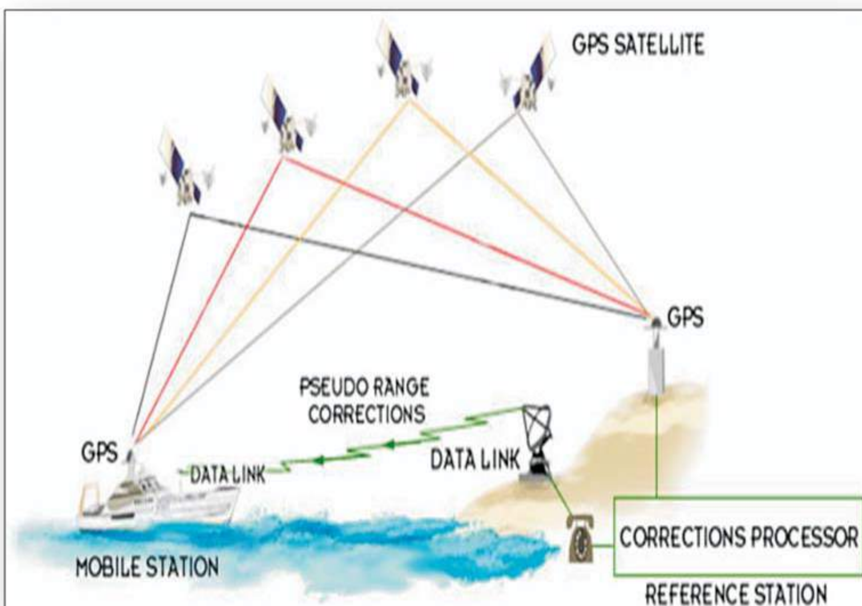

Fig. 113

DGPS System

Source: Blogspot.com

How does it work?

It uses a network of fixed, ground-based reference stations to broadcast the difference between the positions indicated by the satellite systems and the known fixed positions. Two GPS receivers are used for DGPS. A high precision "Base" GPS receiver (Base Receiver or Base Station) is placed at a known "controlled" point of reference such as a National Geodetic Survey marker.

DGPS is providing more accuracy than GPS system.

This receiver collects GPS signals and compares the results to the actual known coordinate of the Base. A "rover" receiver collects autonomous information in the field. Software / Hardware at the base station calculates the difference (differential) between the known position and the GPS position. This differential is an effective measurement of positional offset, in both direction and distance. The differential data can be used to correct the positional errors in the data collected from the Rover GPS receivers in either real-time or after the fact (post processing). This system works pretty well, but inaccuracies do pop up. For this method the radio signals cross through the atmosphere at a consistent speed of light. The electromagnetic energy passes through the Earth's atmosphere (Ionosphere and Troposphere) and slows down. DGPS can generate errors resulting from the distortions produced in the troposphere and ionosphere.

The ephemeris errors may also lead to the users receiving incorrect information. Thus, the information provided by the DGPS loses accuracy as it move away from the reference station. The errors in the DGPS may range from 0.22 to 0.67 km per 100 km. Problems can also occur when radio signals bounce off large objects, such as skyscrapers. Sometimes satellites send out bad almanac data, misreporting their own position. DGPS helps to correct these types of errors. DGPS already knows its own position at fixed station it can easily calculate its receiver's inaccuracy.

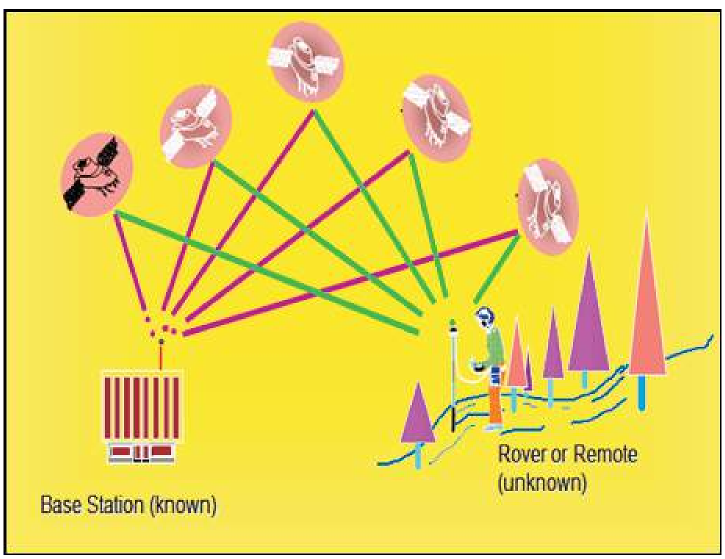

Fig. 114

Differential Global Positioning System (DGPS)
Courtesy: Sumit Sabarwal

The station then broadcasts a radio signal to all DGPS equipped receivers in the area, providing signal correction information for that area. Post Processing the DGPS system finds out the exact locations of unknown points by using reference points, known as 'survey markers'. This technique is called as Post - Processing. Depending on the amount of data being sent in the DGPS correction signal, correcting for these effects can reduce the error significantly offering accuracies of less than 10 cm. That is why DGPS has ability do make better decisions, in locating and improving survey cost effectiveness and time management. DGPS Technology has many other applications on Land Sea and in the Air.

b) Recreational Grade GPS

This unit is designed to acquire a location quickly without the need for pinpoint accuracy. Typically the accuracy is < 15 meters (49 feet) with no differential correction. Recreational products are not specifically designed for GIS mapping, they can be used successfully in some applications such as outdoor sports, hiking, geocaching, etc. It is comparatively cheaper than other GPS.

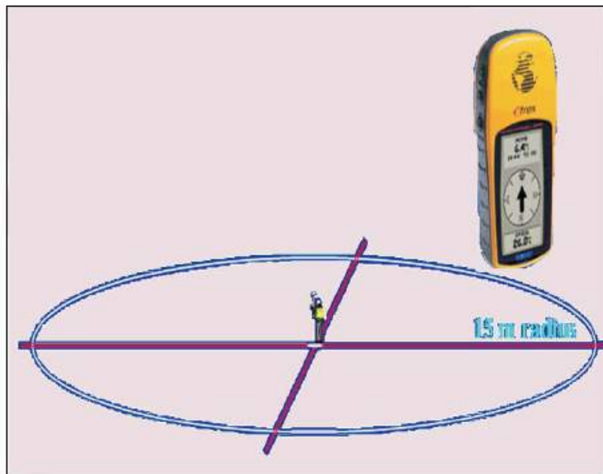

Fig. 115

Recreational Grade GPS
Courtesy: Sumit Sabarwal

c) Mapping Grade DGPS

These GPS receivers are typically less user-friendly than the recreational GPS, and they cost significantly more. Mapping grade GPS are more accurate than recreational units, commonly to within a meter (~3 feet). Mapping grade GPS receivers are most often used by government agencies, researchers, and other users who require more accurate and dependable coordinate fixes than a recreational GPS can provide.

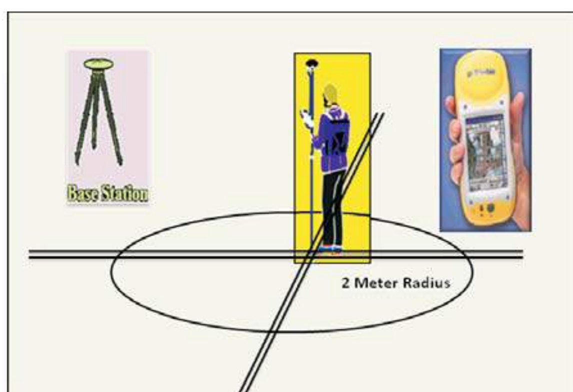

Fig. 116

Mapping Grade DGPS
Courtesy: Sumit Sabarwal

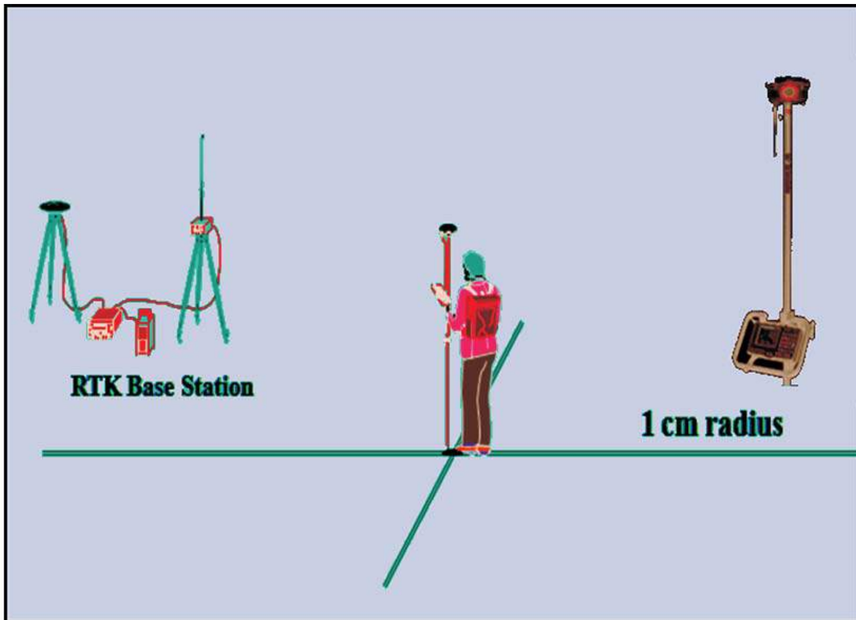

Fig. 117

Real-Time Kinematic (RTK)
Courtesy: Sumit Sabarwal

d) Survey Grade DGPS

Survey grade units are used where accuracy is crucial such as cadastral surveys, Highway construction and other engineering projects. They are capable of providing horizontal accuracy to within a centimeter. Survey grade GPS receivers are the most accurate and the most expensive. These GPS receivers are most often used by professional surveyors. It is more accurate. A survey grade GPS is used to establish a known point. From there, total station laser instruments are used to lay out measurements for other positions in the neighborhood of the known point.

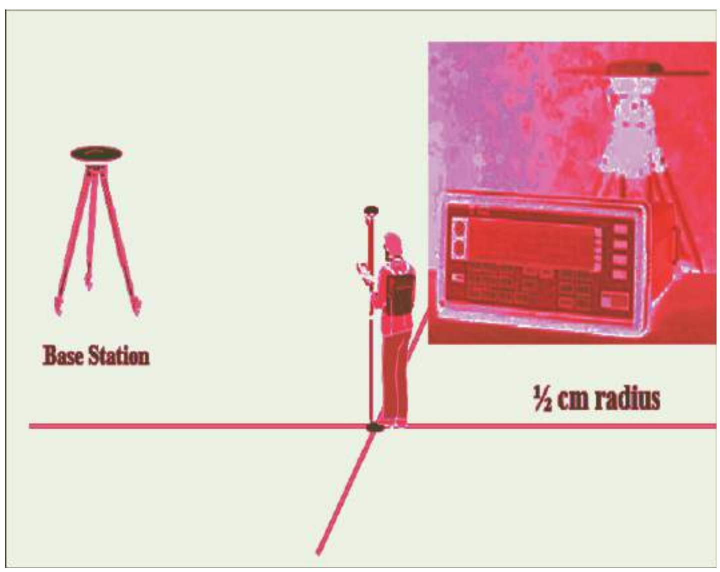

Fig. 118

Survey Grade DGPS
Courtesy: Sumit Sabarwal

3.4 List of Global Navigation Satellite System

There are currently three global navigation systems in operation

a) Navigation Satellite Timing and Ranging system (NAVSTAR)
b) GLONASS (Global'naya Navigatsivannaya Sputnikovaya Sistema)
c) GALILEO is under development by the European Community .

a) NAVSTAR:

NAVSTAR commonly referred to as the Global Positioning System (GPS) and owned by the United States of America. The NAVSTAR GPS was developed by the U.S. Department of Defense (DoD). It consists of a constellation of 24 to 27 satellites in operation and placed in six orbital planes. These satellites are orbiting the earth at a high altitude (approximately 20,200 meter). Each plane is inclined 55 degrees relative to the equator. The satellites complete an orbit in approximately 12 hours. The signal from the satellite requires a direct line to GPS receivers and cannot penetrate water, soil, walls, or other obstacles such as trees, buildings, and bridges.

b) GLONASS

GLONASS constellation is composed of 24 satellites in three orbital planes whose ascending nodes are 120 degrees apart. Each satellite operates in circular 19,100-km orbits at an inclination angle of 64.8 degrees, and each satellite completes an orbit in approximately 11 hours and 15 minutes. The spacing of satellites in orbits is arranged so that a minimum of five satellites is in view to users worldwide. The GLONASS constellation provides continuous and global navigation coverage. Each GLONASS satellite transmits a radio-frequency navigation signal containing a navigation message for users. The first GLONASS satellites were launched into orbit in 1982. The deployment of the full constellation of satellites was completed in 1996, although GLONASS was officially declared operational on September 24, 1993. GLONASS is managed for the Russian Federation government by the Russian Space Forces.

c) GALILEO

GALILIO is the global navigation satellite system being developed by an initiative launched by the European Union and the European Space Agency (ESA). GALILIO will be fully operable by 2014. The navigation system is intended to provide measurements down to the meter range including the height (altitude) above sea level, and better positioning services at high latitudes as compared to GPS and GLONASS. As a further feature, GALILIO will provide a global Search and Rescue (SAR) functions which is able to transfer the distress signals from the user's transmitter to the Rescue Co-ordination Centre, which will then initiate the rescue operation. At the same time, the system will provide a signal to the user, informing him that his situation has been detected and that help is on the way. GALILIO services will be free and open to everyone. The high-accuracy capabilities will be available for paying commercial users and for military use. Below figure shows all three types of Global navigation and Satellite System (GNSS)

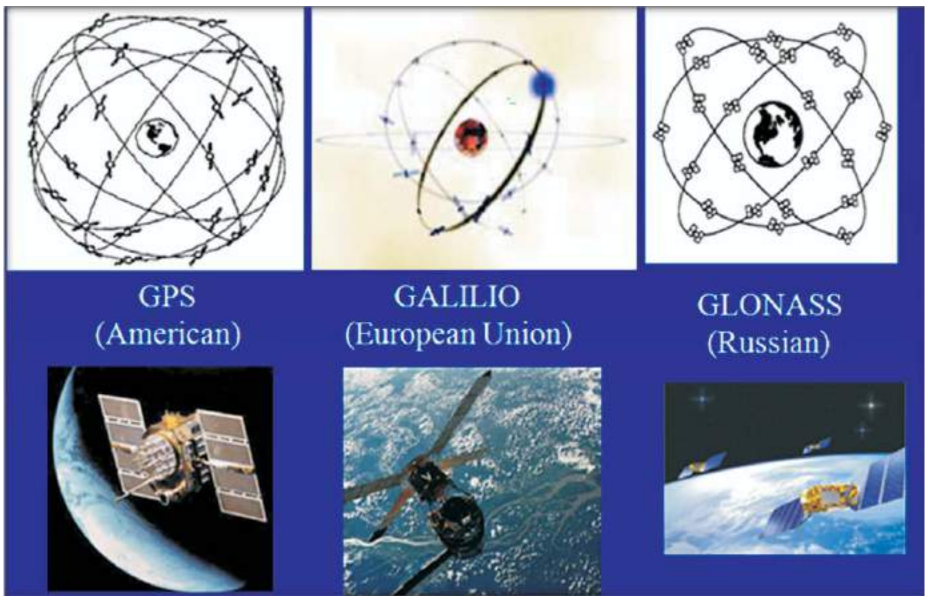

Fig. 119

Global Navigation Satellite Systems
Courtesy: Sumit Sabarwal

3.5 GPS Today & its Limitations

GPS technology has matured into a resource that goes far beyond its original design goals. Used by scientists, sportsmen, farmers, soldiers, pilots, surveyors, hikers, sailors, dispatchers, firefighters etc. GPS makes their work more productive, safer, and easier.

- It will not work in Tunnels, Underwater, Inside the building
- It needs Clear sky to see satellites
- It gives out coordinates in WGS 84, must be transformed to local datum
- It produces ellipsoidal not orthometric heights.

3.6 Uses of GPS Technology

GPS Today used by variety of professional to make the work more productive, safer and easier. Commonly GPS used in fields are listed below

i) Survey and Mapping

ii) Height and Location

iii) Vehicle Tracking

iv) Navigation

v) Timing

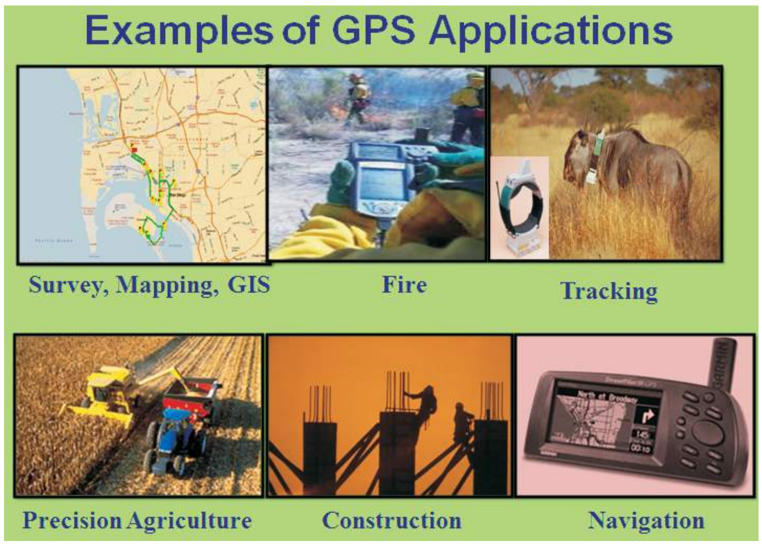

Fig. 120

B Areas of GPS application

- Precession Agriculture
- Geo tagging
- Vehicle tracking
- Construction
- Navigation
- Emergency services such as fire
- Survey mapping
- Fishing
- Security & Defense
- Utility management
- Geo tagging
- Forestry
- Public Safety and services

- Train Control
- Sport and Recreation
- Oil and mineral explosion
- Nature conservation and protection

Fig. 121

(i) GPS used for Survey and mapping

Surveying is the first and foremost step conducted before doing any large-scale activities, such as utilities, and civil construction. Traditionally surveying has been performed by highly qualified personnel and is a very tedious and labor intensive effort. Traditional methods are time-consuming and often require multiple trips to the same site to gather accurate data as human tends to make mistake. At the same time surveyors were not

Fig. 122

DGPS Receiver

always able to work under certain weather conditions, such as snow, rain, or extreme temperatures.

Fig. 123

GPS Survey

Survey teams had to work hard for months together in assessing the land. Use of modern technology such as GPS survey can enhance the quality and increases the productivity of conventional survey team, reduces data collection time, and improves survey accuracy. GPS provide a very accurate coordinates of the surveyed points and this can be transferred to any existing digital map database. This provide very precise digital survey record. This accuracy can be improved further to few centimeters by post processing GPS data through advanced surveying software. By using a single GPS receiver a surveyor can obtain the precise coordinates of a location within a minute and can move on to the next location. The coordinates then be stored and can be downloaded to a computer with Map database. The GPS coordinates can are be imported into the database and the survey report for the entire area is generated within a short time. GPS coordinates are obtained by mounting a GPS receiver on a vehicle and survey is performed as the vehicle moves. This provides a very dense survey coordinates with very little additional effort. GPS/ DGPS are an excellent data collection tool for creating and maintaining a GIS data.

(ii) Use of GPS in height and Location

Each GPS satellite broadcasts a high power, narrow bandwidth signal that may be received by receiver antenna. Receiver receives signals simultaneously from all the visible satellites. Each satellite has an on-board timing clock it is able to transmit signals down at exactly known instants. The signals come down to receiver at the speed of light and the time of arrival of the signals at receiver. A computer program in receiver notes the time of arrival of the signals received from the various visible GPS satellites and is able to work out latitude, longitude and height. If position is changing, by observing the changes it is possible to work out the speed of movement and the direction in which object is moving. The system needs at least 3 satellites to obtain a latitude and longitude. Fourth satellite determines the height. More satellites achieve higher accuracy of the results. The accuracy varies according to the location of the satellites. If satellites were visible but all close together in the sky then the accuracy would be worse. Many GPS receivers have an optional display that shows where the satellites are located. By keeping the receiver still, it will average readings over a long time to improve the accuracy. The above figure shows the measurment of height by using GPS reciever.

Fig. 124

Height and location by GPS

(iii) Use of GPS in Vehicle tracking

A vehicle tracking system combines the installation of an electronic device in a vehicle, with designed computer software, to enable, to track vehicle's location.

> Modern vehicle tracking systems commonly use GPS or GLONASS technology for locating the vehicle.

Today GPS are fitted in cars, ambulances, fleets and police vehicles such as Automatic Vehicle Locating System (AVLS), Vehicle Tracking and Information System (VTIS), Mobile Asset Management System (MAMS), these systems offer an effective tool for improving the operational efficiency and utilization of vehicles. A GPS tracking unit is a device that uses the Global Positioning System to determine the precise location of a vehicle, person, or other asset to which it is attached and to record the position of the asset at regular intervals. This device keeps server updated about the location of vehicle. The server maintains a record of these updates. The recorded location data can be stored within the tracking unit, or it may be transmitted to a central location data base, or internet-connected computer, using a cellular (GPRS or SMS), radio, or satellite modem embedded in the unit. At any point of time one can log into our portal to access this data in form of maps, charts and analytical reports. This allows the asset's location to be displayed against a map backdrop either in real time or when analyzing the track later, using GPS tracking software as shown in below figure. A GPS tracker essentially contains GPS module to receive the GPS signal and calculate the coordinates. For data loggers it contains large memory to store the coordinates. Further the GSM/GPRS modem to transmit this information to a central computer either via SMS or via GPRS in form of IP packets. Tracking systems enable a base station to keep track of the vehicles without the intervention of the driver where, as navigation system helps the driver to reach the destination. The navigation system will have a graphic, display for the driver which is not needed for a tracking system. Vehicle Tracking Systems (VTS) combine a number of well-developed technologies. Irrespective of the technology being used, VTS consist of three subsystems: a) In-vehicle unit (IVU), b) Base station and c) Communication link. The IVU includes a suitable position sensor and an intelligent controller together with an appropriate interface to the communication link. Network Overlay Systems use cell phone infrastructure for locating vehicles. In India GPS systems are used in various departments such as police, emergencies, jal board, transportation system for example bus and truck, Tsunami disasters.

Fig. 125

Real time fleet monitoring and analysis

(iv) GPS in Navigation

GPS helps to determine exactly where you are and to how to get somewhere else. This technology is very useful in Air and on the land.

(v) GPS in Timing

GPS can be used to determine precise timing, time intervals and frequency.

Let us wrap up what we covered in this chapter

- Stone Age people navigated by means of Landmarks
- Magnetic compass are used to travel across the ocean,
- People also used stars as guidelines to travel over the ocean
- The first ground-based radio navigation system was developed after 20th century.
- Satellite navigation systems provide high frequency signals allowing for high accuracy, as well as global access.
- The first satellite system Transit was developed in 1964.
- The GPS is mainly used for military positioning, navigation, and weapons aiming system.
- The first GPS satellite was launched in 1978 and maintained by DoD USA.
- After 1980 GPS would be made available to the civil community
- GPS encompasses three segments i.e. is space, control, and user.
- The space segment includes the 24 operational NAVSTAR satellites that orbit the earth every 12 hours at an altitude of approximately 20,200 kilometers.
- The global positioning system (GPS) has become the most extensively used positioning and navigation tool in the world.
- The position calculated by GPS is affected by several factors, such as Satellite Geometry, atmospheric layers, Number of Satellites, Satellite health, Signal Strength, Orbital errors, Multipath etc.
- Trilateration method is used to find the location in GPS system
- Trilateration uses electronic distance measuring equipment to directly measure the lengths of the sides of triangles from which the angles can be calculated. It is a very useful method for rough terrain where positions can be accurately carried forward and is seen as an alternative

- GPS accuracy can be significantly improved with additional data, possibly from multiple sources, and especially from multiple receivers.
- DGPS, Recreational, Mapping, Survey are four grades in GPS system
- Differential Global Positioning System (DGPS) is an enhancement to Global Positioning System that uses a network of fixed, ground-based reference stations to broadcast the difference between the positions indicated by the satellite systems and the known fixed positions.
- DGPS is providing more accuracy than GPS system.
- Use of modern technology such as GPS survey can enhance the quality and increases the productivity of conventional survey team, reduces data collection time, improves survey accuracy, and allows survey team to work under a broad range of weather conditions.
- Currently three global navigation systems are in operation those are NAVSTAR, GLONASS, and GALILIO.
- India has launched GAGAN navigation System
- Some of the limitations of GPS are it will not work in tunnels, underwater, inside the building, needs clear sky to see satellites, gives out coordinates in WGS 84, must be transformed to local datum, produce ellipsoidal not orthometric heights.
- GPS used for mapping. suveying, vehicle tracking, timing and to find the location.
- GPS provide a very accurate coordinates of the surveyed points which is transferred to any existing digital map database.
- A vehicle tracking system combines the installation of an electronic device in a vehicle, with designed computer software, to enable, to track vehicle's location.
- GPS is used in vehicles for both tracking and navigation. A device with GPS and Wireless communication capabilities are installed on vehicle.

Very Short Questions

1. What is GPS?
2. Name segments of GPS
3. What is the altitude of GPS satellites?
4. Height and Accuracy Estimation is possible: True\False?

5. GPS is used to find location information: True\False?
6. Surveying is the primary work for any Utility projects: True\False?
7. GPS cannot provide a very accurate coordinates of the surveyed points: True\False?
8. Name types of GPS system
9. Name currently operational navigation satellite systems

Short Questions

1. How people used to navigate in Stone and star age?
2. What is ground based navigation system?
3. What is Global Positioning System?
4. What is trilateration? Explain
5. Define the use of GPS in Vehicle tracking.
6. What is the GPS survey accuracy?
7. Define use of Surveyed points through GPS.

Long Questions

1. Explain the segments of GPS
2. Explain the factor affecting the accuracy of GPS
3. How DGPS does works?
4. Explain the difference between GPS and DGPS
5. Explain Global Positioning System (GPS) Survey.
6. What is NAVSTAR system?
7. What are different types in GPS system explain with application
8. How GPS work in survey and mapping?