INTRODUCTION

The Global Positioning System (GPS) is a space-based fully functional global navigation satellite system (GNSS) involving satellites and computers that can determine the latitude and longitude of a receiver on Earth by computing the time difference for signals from different satellites to reach the receiver. Thus, it provides reliable location and time information in all weather and at all times and anywhere on or near the Earth when and where there is an unobstructed line of sight to four or more GPS satellites. It is actually a navigation and precise-positioning tool.

The GPS uses a constellation of at least 24 (32 by March 2008) Medium Earth Orbit satellites that transmit precise microwave signals, that enable GPS receivers to determine their location, speed, direction, and time.

Developed by the United States Department of Defense, it is officially named NAVSTAR GPS (Navigations Satellite Timing And Ranging Global Positioning System).It is freely accessible by anyone with a GPS receiver. GPS provides scientific study of earthquakes, synchronization of telecommunications networks, weather forecasting, and global climate studies.

WHAT IS GLOBAL POSITIONING SYSTEM (GPS)?

The Global Positioning System, commonly known as GPS, is a network of satellites that determines a ground based user's specific latitude, longitude, and altitude. GPS devices have become more integrated in our daily lives through navigation computers in cars to emergency locators in cellular phones. GPS can even keep the time accurate on watches and VCRs. *Portable GPS receivers* are becoming increasingly popular for young and old alike. For the GPS to work there are twenty-four satellites in Earth's orbit. Each satellite is spaced so that at least four can be used by any given receiver on the ground. The satellites each contain a computer, radio, and an atomic clock. Because it uses the frequency of atom rather than quartz or gears to keep time, an atomic clock is more accurate than a normal

clock. The satellites transmit radio signals to a receiver on the ground and the receiver calculates its position in relation to the satellites. A minimum of three satellites are needed to provide latitude and longitude information using a process known as triangulation. If a fourth satellite is in range, then the user's altitude can also be determined. The more satellites that are available, the more accurate the receiver's calculation will be. GPS receivers come in a variety of technologies, from handheld devices to geological monitoring stations.

GPS was created and realized by the U.S. Department of Defense (USDOD), it is officially named **NAVSTAR GPS** (**Nav**igation Satellite Timing And Ranging Global Positioning System). The satellite constellation is managed by the United States Air Force Space Wing. GPS has become an indispensable aid to navigation around the world, and an important tool for map-making and land surveying. GPS also provides a precise time reference used in many applications including scientific study of earthquakes and synchronization of telecommunications networks. Despite this fact, GPS is free for civilian use as a public good.

HISTORY OF GLOBAL POSITIONING SYSTEM (GPS):-

Global positioning grew from the use of radar tracking at the end of World War II when radar stations were placed along the coastlines and inshore for ships and planes to orient themselves. But data and distance were limited and subject to weather and atmosphere interference. With the launch of the Sputnik man-made satellite program by the Soviet Union in the late 1950s, American scientists learned they could precisely locate the satellite by the frequency of its signal. The Doppler effect of the signal grew stronger as the satellite approached and grew weaker as it flew away. They also realized that the opposite would be true and several satellites would be able to precisely locate items on the ground.

Through the 1960s, the first navigation systems went into orbit but were limited in function and accuracy. In 1978, the first of several NAVSTAR GPS (**NAV**igation **S**ignal **T**iming **A**nd **R**anging **G**lobal **P**ositioning **S**ystem) satellites was launched with military use as the primary purpose. NAVSTAR proved to be more accurate and resilient than radar and unlike radar, NAVSTAR did not rely on ground stations being nearby. It was not hampered by weather and was also harder for enemy units to jam the signals. The full constellation of satellites as we know them today was achieved in 1994. Although originally designated for military use only, GPS was later opened for civilian use with restrictions on usage and accuracy.

GOALS OF GPS ??

The goals of Global Positioning System are:

- Localization
- Navigation
- Tracking
- Mapping
- Timing

Localization:

This category is for position determination and is the most obvious use of the Global *Positioning* System. GPS is the first system that can give accurate and precise measurements anytime, anywhere and under any weather conditions. Some examples of applications within this category are:

1. Measuring the movement of volcanoes and glaciers.
2. Measuring the growth of mountains.

3. Measuring the location of icebergs - this is very valuable to ship captains helping them to avoid possible disasters.
4. Storing the location of where you were - most GPS receivers on the market will allow you to record a certain location. This allows you to find it again with minimal effort and would prove useful in a hard to navigate place such as a dense forest.

Navigation

Navigation is the process of getting from one location to another. This was the what the Global Positioning System was designed for. The GPS system allows us to navigate on water, air, or land. It allows planes to land in the middle of mountains and helps medical evacuation helicopters save precious time by taking the best route.

Tracking

Tracking is way of monitoring people and things such as packages. This has been used along with wireless communications to keep track of some criminals. The suspect agrees to keep a GPS receiver and transmitting device with him at all times. If he goes where he's not allowed to, the authorities will be notified. This can also be used to track animals.

Mapping

This is used for creating maps by recording a series of locations. The best example is surveying where the DGPS technique is applied but with a twist. Instead of making error corrections in real time, both the stationary and moving receivers calculate their positions using the satellite signals. When the roving receiver is through making measurements, it then takes them back to the ground station which has already calculated the errors for each moment in time. At this time, the accurate measurements are obtained.

Timing

GPS brings precise timing to the us all. Each satellite is equipped with an extremely precise atomic clock. This is why we can all synchronize our watches so well and make sure international events are actually happening at the same time.

GPS ARCHITECTURE:

The GPS is a universal positioning or navigation system that provides three-dimensional positions accurate to within a few metres, velocity accurate to 0.03m/s, and time accurate to within a few nanoseconds. It performs three major tasks:

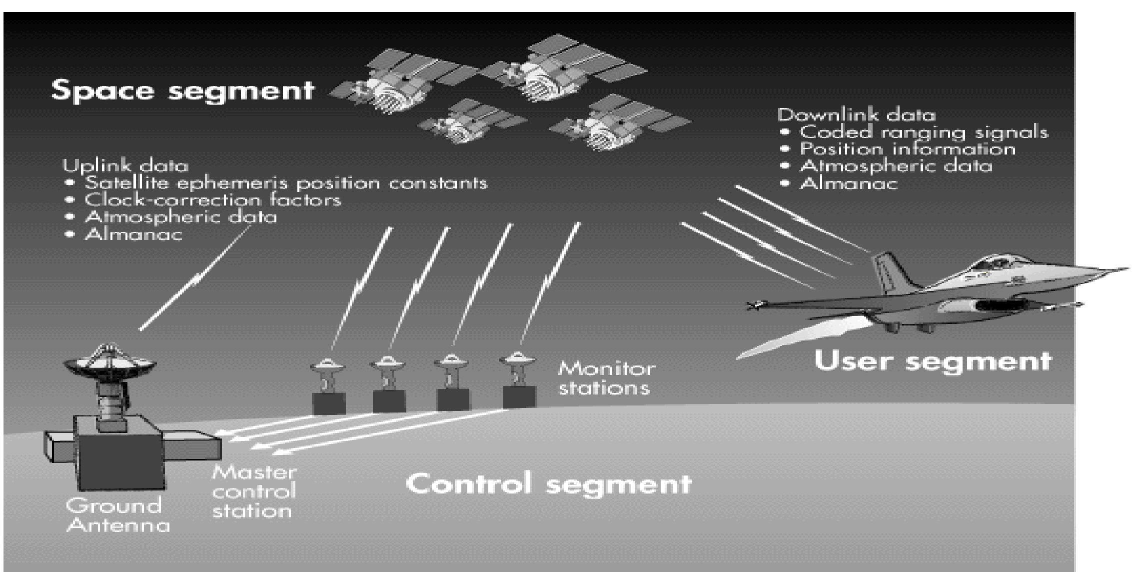
1) Acquire signals from the four geometrically optimum satellites.

2) Process the satellite data, determine the position of the receiver and transform that information into a coordinate system (latitude, longitude and altitude) that is familiar to the operator.

3) Interface to the user and his vehicle by providing a means to receive signals from other vehicle systems in both digital and analogue forms, a command output to the user's vehicle (such as steering signals), and an interaction with the operator through a control and display unit.

To perform the above functions and for better understanding , GPS contains mainly three segments -

- ✓ Space segment,
- ✓ Control segment and
- ✓ User segment.



Space segment deals with GPS satellites systems, Control segment describes ground based time and orbit control prediction and in User segment various types of existing GPS receiver and its applications.

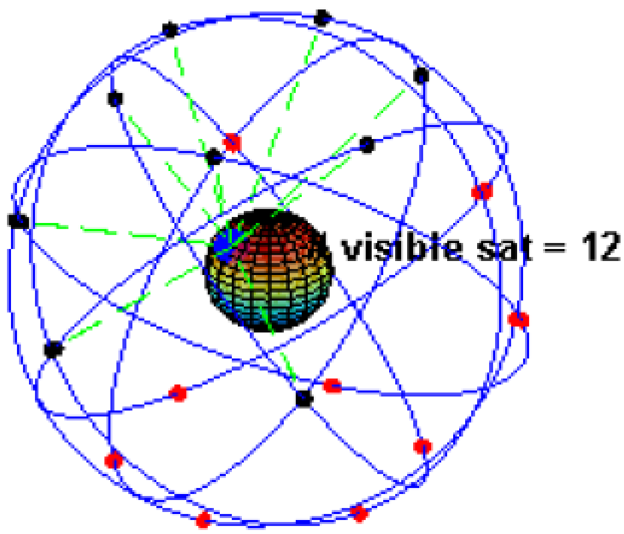
Below table gives a brief account of the function and of various segments along with input and output information.

Table: Functions of various segments of GPS

Segment	Input	Function	Output
Space	Navigation message	Generate and Transmit code and carrier phases and navigation message	P-Code C/A Code L1,L2 carrier Navigation message
Control	P-Code Observations Time	Produce GPS time predict ephemeris manage space vehicles	Navigation message
User	Code observation Carrier phase observation Navigation message	Navigation solution Surveying solution	Position velocity time

Space Segment:-

The space segment (SS) comprises the orbiting GPS satellites, or Space Vehicles (SV) in GPS parlance. The GPS design originally called for 24 SVs, eight each in three circular orbital planes but this was modified to six planes with four satellites each. The orbital planes are centered on the Earth, not rotating with respect to the distant stars. The six planes have approximately 55° inclination (tilt relative to Earth's equator) and are separated by 60° right ascension of the ascending node (angle along the equator from a reference point to the orbit's intersection). The orbits are arranged so that at least six satellites are always within line of sight from almost everywhere on Earth's surface.



Visual example of GPS constellation in motion with earth rotating.

Orbiting at an altitude of approximately 20,200 kilometers (12,600 miles or 10,900 nautical miles; orbital radius of 26,600 km (16,500 mi or 14,400

NM)), each SV makes two complete orbits each sidereal day. The ground track of each satellite therefore repeats each (sidereal) day. This was very helpful during development, since even with just four satellites, correct alignment means all four are visible from one spot for a few hours each day. For military operations, the ground track repeat can be used to ensure good coverage in combat zones.

As of September 2007, there are 31 actively broadcasting satellites in the GPS constellation. The additional satellites improve the precision of GPS receiver calculations by providing redundant measurements. With the increased number of satellites, the constellation was changed to a non uniform arrangement. Such an arrangement was shown to improve reliability and availability of the system, relative to a uniform system, when multiple satellites fail.

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Control Segment:-

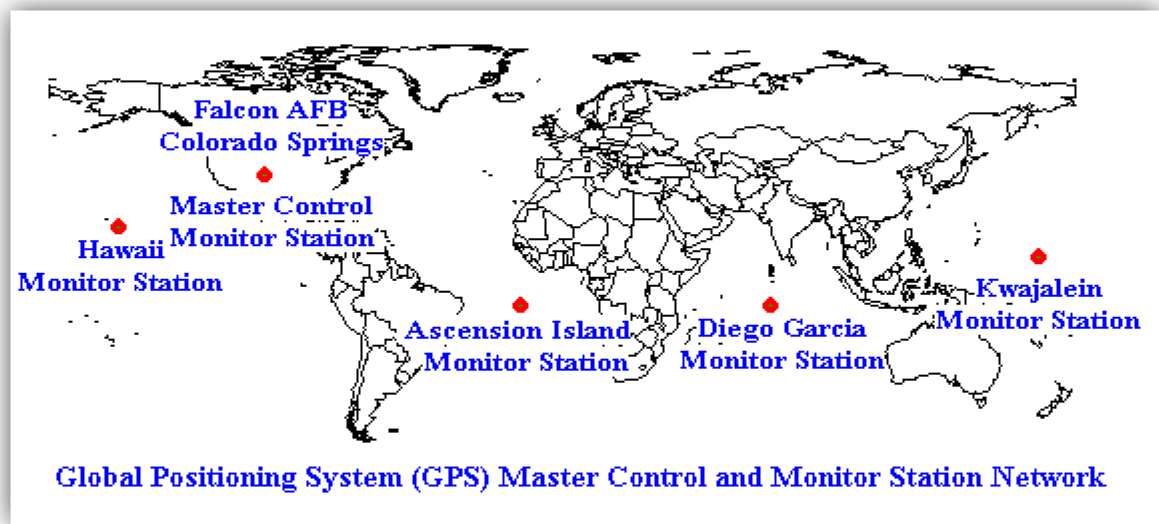
The control Segment of GPS consist of:

- A Master Control Station (one station):- The master control station is responsible for overall management of the remote monitoring and transmission sites. As the center for support operations, it calculates any position or clock errors for each individual satellite from monitor stations and then orders the appropriate corrective information back to that satellite.
- A Monitor Stations (four stations):- Each of monitor stations checks the exact altitude, position, speed, and overall of the orbiting of satellites. A

station can track up to 11 satellites at a time. This check-up is performed twice a day by each station as the satellites go around the earth.

The most important tasks of the control segment are:

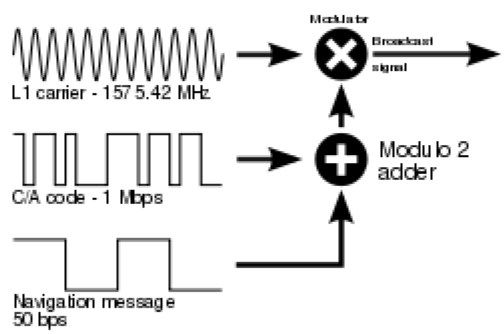
1. Observing the movement of the satellites and computing orbital data (ephemeris)
2. Monitoring the satellite clocks and predicting their behavior
3. Synchronizing on board satellite time
4. Relaying precise orbital data received from satellites in communication
5. Relaying the approximate orbital data of all satellites (almanac)
6. Relaying further information, including satellite health, clock errors etc.



The flight paths of the satellites are tracked by US Air Force monitoring stations in Hawaii, Kwajalein, Island, Diego, and Colorado Springs, Colorado, along with monitor stations operated by the National Geospatial-Intelligence Agency (NGA). The tracking information is sent to the Air Force Space Command's master control station at Schreiber Air Force Base, Colorado Springs, Colorado, which is operated by the 2d Space Operations Squadron (2 SOPS) of the United States Air Force (USAF). 2 SOPS contacts each GPS satellite regularly with a navigational update (using the ground antennas at Ascension Island, Diego Garcia, Kwajalein, and Colorado Springs). These updates synchronize the atomic clocks on board the satellites to within one microsecond and adjust the ephemeris of each satellite's internal orbital model. The updates are created by a Kalman Filter which uses inputs from the ground monitoring stations, space weather information, and other various inputs.

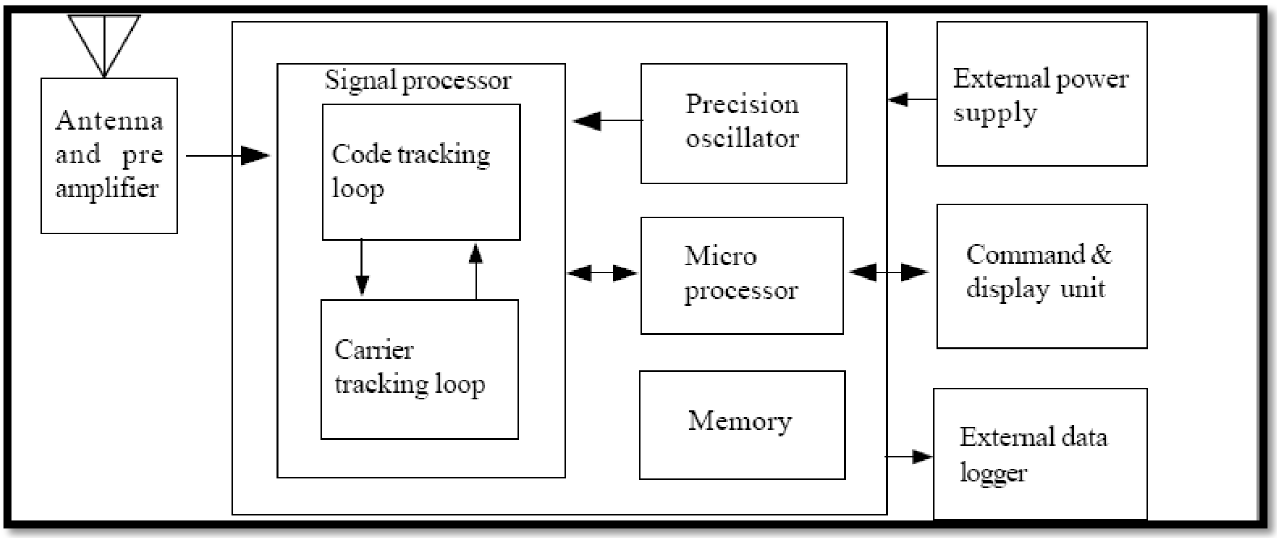
User Segment:-

The user's GPS receiver is the user segment (US) of the GPS. In general, GPS receivers are composed of an antenna, tuned to the frequencies transmitted by the satellites, receiver-processors, and a highly-stable clock (often a crystal oscillator). They may also include a display for providing 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. Originally limited to four or five, this has progressively increased over the years so that, as of 2007, receivers typically have between 12 and 20 channels.



GPS BROADCAST SIGNAL

GPS receivers may include an input for differential corrections, using the RTCM SC-104 format. This is typically in the form of a RS-232 port at 4,800 bps speed. Data is actually sent at a much lower rate, which limits the accuracy of the signal sent using RTCM. Receivers with internal DGPS receivers can outperform those using external RTCM data. As of 2006, even low-cost units commonly include WAAS receivers.



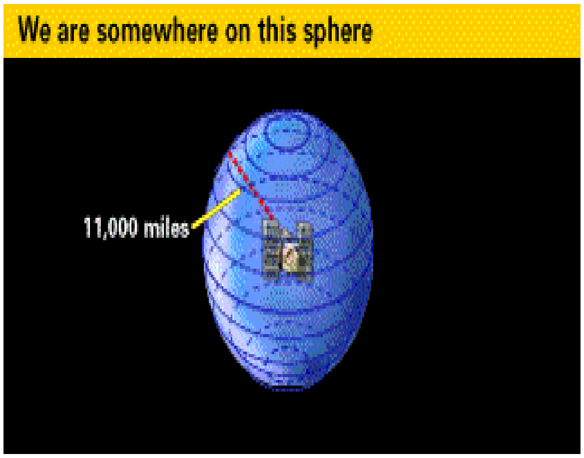
Major components of a GPS receiver

Many GPS receivers can relay position data to a PC or other device using the NMEA 0183 protocol. NMEA 2000[10] is a newer and less widely adopted protocol. Both are proprietary and controlled by the US-based National Marine Electronics Association. References to the NMEA protocols have been compiled from public records, allowing open source tools like GPS to read the protocol without violating intellectual property laws. Other proprietary protocols exist as well, such as the SIRF protocol. Receivers can interface with other devices using methods including a serial connection, USB or Bluetooth.

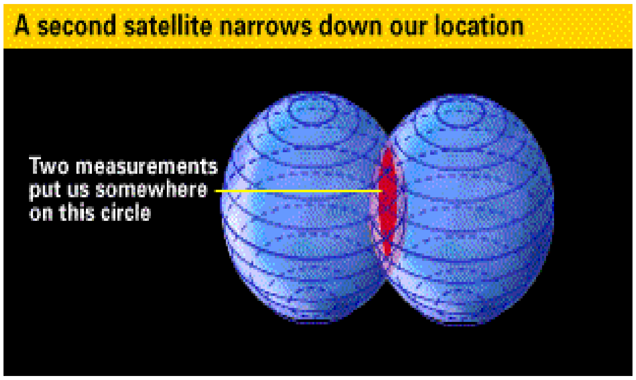
WORKING OF GLOBAL POSITIONING SYSTEM:-

GPS operation is based on triangulation of satellite signals. Basically, it implements the time-difference-of-arrival concept using precise satellite position and on-board atomic clocks to generate navigation messages that are continuously broadcast from each of the GPS satellites. These messages can be received and processed by users anywhere in the world to determine their position and time accurately. The whole idea behind GPS is to use 24 satellites in space as reference points for locations here on earth. Accurately measuring our distance from three satellites we can "triangulate" our position anywhere on earth.

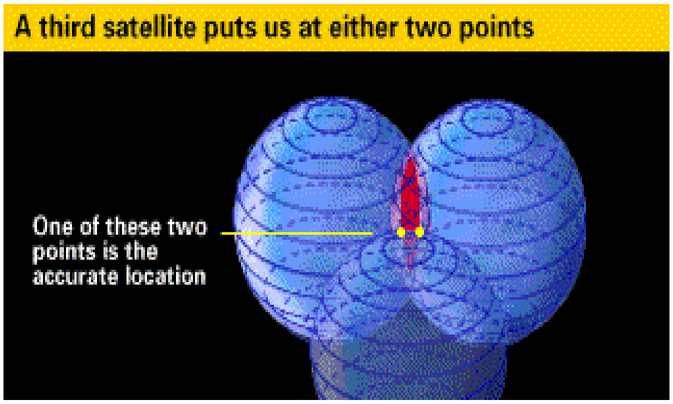
Suppose we measure our distance from a satellite and find it to be 11,000 miles. Knowing that we're 11,000 miles from a particular satellite narrows down all the possible locations we could be in the whole universe to the surface of a sphere that is centered on this satellite and has a radius of 11,000 miles as shown in the following Fig:



Let the distance from second satellite is 12,000 miles, then we're somewhere on the circle where these two spheres intersect as shown in the following Fig:



We then make a measurement from a third satellite and if found that we're 13,000 miles from that one, that narrows our position down even further, to the two points where the 13,000-mile sphere cuts through the circle that's the intersection of the first two spheres as shown if the following Fig.

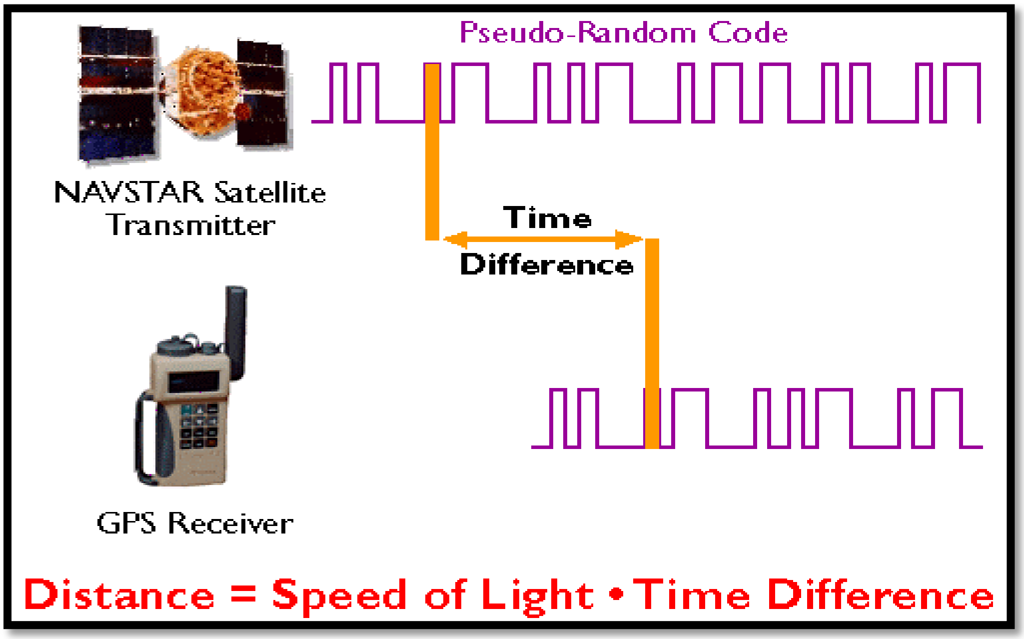


Even though there are two possible positions, they differ greatly in longitude/latitude position and altitude. To determine which of the two common points is our actual position, we'll need to enter our approximate altitude into the GPS receiver. This will allow the receiver to calculate a two dimensional position (latitude, longitude). However, by adding a fourth satellite, the receiver can determine our three dimensional position (latitude, longitude, altitude). Let's say our distance from a fourth satellite is 10,000 miles. We now have a fourth sphere intersecting the first three spheres at one common point.

We measure the distance to something that's floating around in space by timing how long it takes for a signal sent from the satellite to arrive at our receiver. The whole thing boils down to those **"velocity times travel time"**. **(d= v x t)**. The case of GPS we're measuring a radio signal so the velocity is going to be the speed of light. (30,000 kmps)

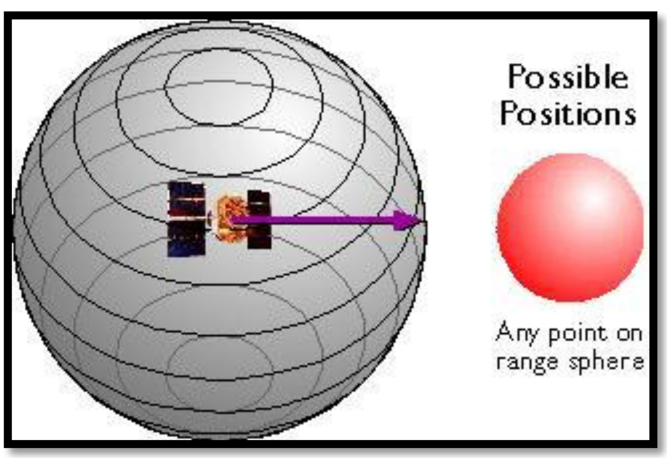
MEASURING DISTANCE FROM A SATELLITE:-

GPS receivers calculate distances to satellites as a function of the amount of time it takes for satellites' signals to reach the ground. To make such a calculation, the receiver must be able to tell precisely when the signal was transmitted, and when it was received. The satellites are equipped with extremely accurate atomic clocks, so the timing of transmissions is always known. Receivers contain cheaper clocks, which tend to be sources of measurement error. The signals broadcast by satellites, called "pseudo-random codes," are accompanied by the broadcast ephemeris data that describes the shapes of satellite orbits.



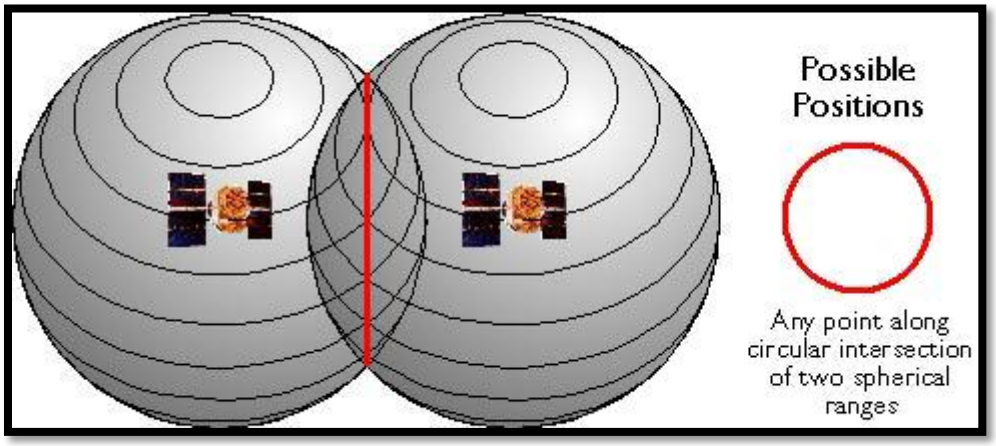
GPS receivers calculate distance as a function of the difference in time of broadcast and reception of a GPS signal.

The GPS constellation is configured so that a minimum of four satellites is always "in view" everywhere on Earth. If only one satellite signal was available to a receiver, the set of possible positions would include the entire range sphere surrounding the satellite.



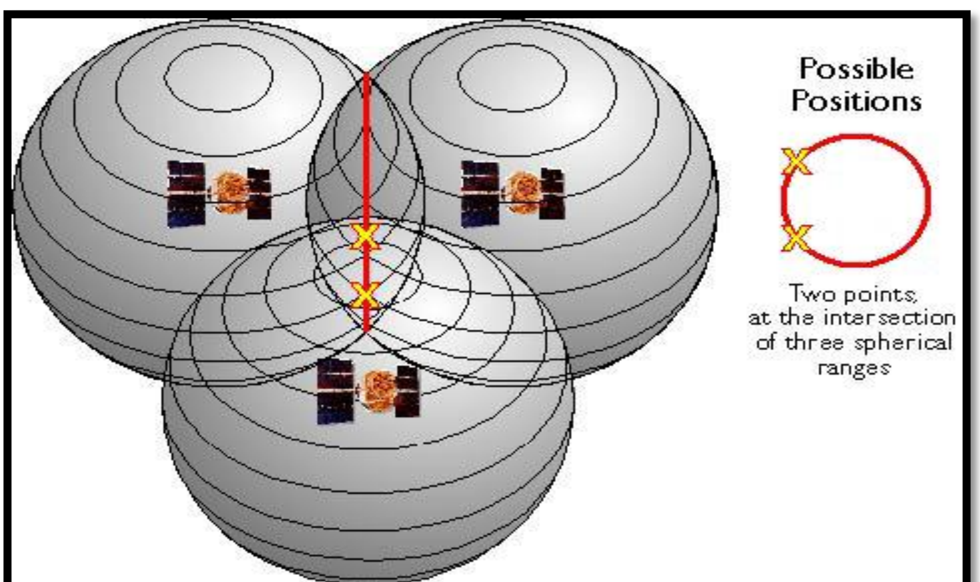
Set of possible positions of a GPS receiver relative to a single GPS satellite.

If two satellites are available, a receiver can tell that its position is somewhere along a circle formed by the intersection of two spherical ranges.



Set of possible positions of a GPS receiver relative to two GPS satellites

If distances from three satellites are known, the receiver's position must be one of two points at the intersection of three spherical ranges. GPS receivers are usually smart enough to choose the location nearest to the Earth's surface. At a minimum, three satellites are required for a two-dimensional (horizontal) fix.



Set of possible positions of a GPS receiver relative to three GPS satellites.

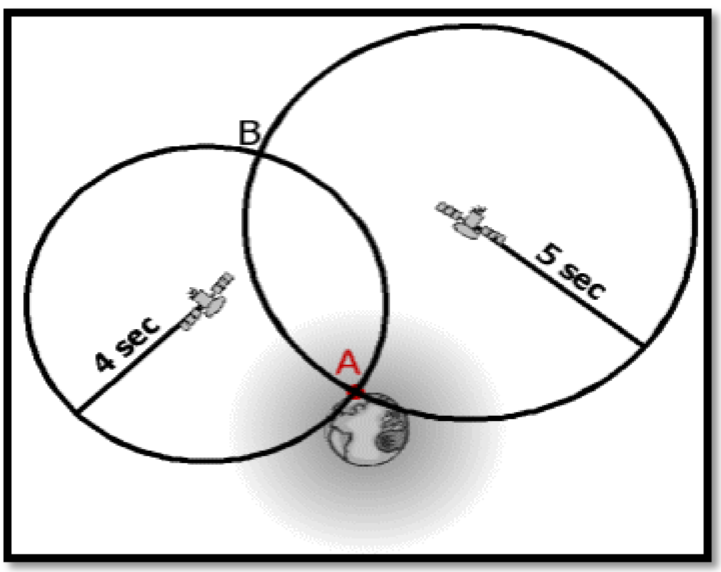
Satellite ranging is similar in concept to the plane surveying method **trilateration**, by which horizontal positions are calculated as a function of distances from known locations. The GPS satellite constellation is in effect an orbiting control network.

Position Determination with GPS:-

- To use the satellites as references for range measurements we need to know exactly where they are.
- GPS satellites are so high up their orbits are very predictable.
- Minor variations in their orbits are measured by the Department of Defense.
- The error information is sent to the satellites, to be transmitted along with the timing signals.

Discussion:-

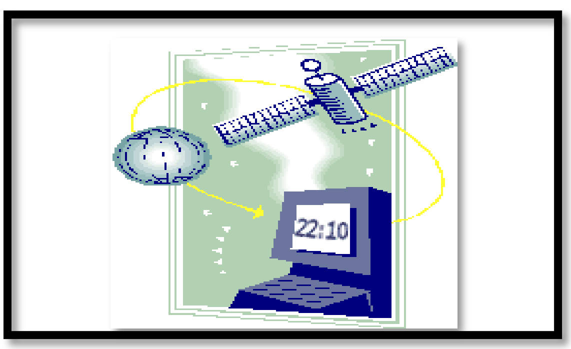
Thus far we've been assuming that we know where the GPS satellites are so we can use them as reference points. But how do we know exactly where they are? After all they're floating around 11,000 miles up in space. That 11,000 mile altitude is actually a benefit in this case, because something that high is well clear of the atmosphere. And that means it will orbit according to very simple mathematics. The Air Force has injected each GPS satellite into a very precise orbit, according to the GPS master plan. On the ground all GPS receivers have an almanac programmed into their computers that tells them where in the sky each satellite is, moment by moment. The basic orbits are quite exact but just to make things perfect the GPS satellites are constantly monitored by the Department of Defense. They use very precise radar to check each satellite's exact altitude, position and speed. The errors they're checking for are called "ephemeris errors" because they affect the satellite's orbit or "ephemeris." These errors are caused by gravitational pulls from the moon and sun and by the pressure of solar radiation on the satellites. The errors are usually very slight but if you want great accuracy they must be taken into account. Once the Department of Defense has measured a satellite's exact position, they relay that information back up to the satellite itself. The satellite then includes this new corrected position information in the timing signals it's broadcasting. So a GPS signal is more than just pseudo-random code for timing purposes. It also contains a navigation message with ephemeris information as well. With perfect timing and the satellite's exact position you'd think we'd be ready to make perfect position calculations. But there's trouble afoot.



Position determination with two satellites (in a 2-dimensional world)

Timekeeping - *Bringing precise time to the world:-*

Although GPS is well-known for navigation, tracking, and mapping, it's also used to disseminate precise time, time intervals, and frequency. Time is a powerful commodity, and exact time is more powerful still. Knowing that a group of timed events is perfectly synchronized is often very important. GPS makes the job of synchronizing our clocks easy and reliable There are three fundamental ways we use time. As a universal marker, time tells us when things happened or when they will. As a way to synchronize people, events, even other types of signals, time helps keep the world on schedule. And as a way to tell how long things last, time provides and accurate, unambiguous sense of duration. GPS satellites carry highly accurate atomic clocks. And in order for the system to work, our GPS receivers here on the ground synchronizes themselves to these clocks. That means that every GPS receiver is in essence, an atomic, accuracy clock.

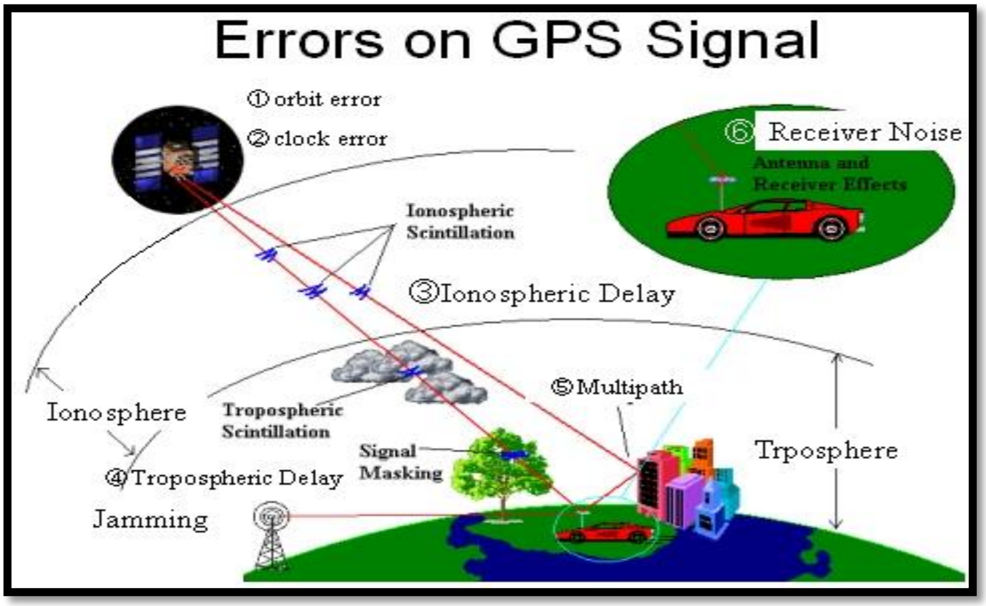


Astronomers, power companies, computer networks, communications systems, banks, and radio and television stations can benefit from this precise timing. One investment banking firm uses GPS to guarantee their transactions are recorded simultaneously at all offices around the world. And a major Pacific Northwest utility company makes sure their power is distributed at just the right time along their thousands of miles of transmission lines.

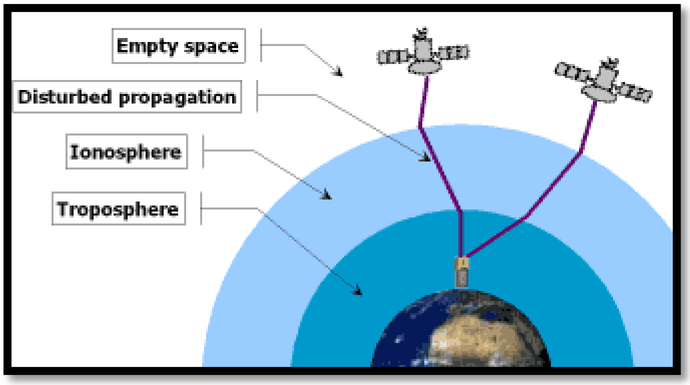
ERRORS ON GPS SIGNAL:-

First let's get one thing straight. All GPS positions are not 100% accurate and thus must have some error in them. Now we do have a couple of options open to cut down these errors depending on our needs. They involve using different GPS receivers and different methods of getting our positions. For example, surveyors may need very high accuracy, the kind needed to measure the size of a quarter. On the other hand, to locate your house on a map, a far less accurate position will do nicely.

Before we turn our attention to just how accurate our GPS positions are, we should have a quick look at some of the errors that affect the positions we get from the GPS. Each of the following errors has an impact on the accuracy of our GPS positions.



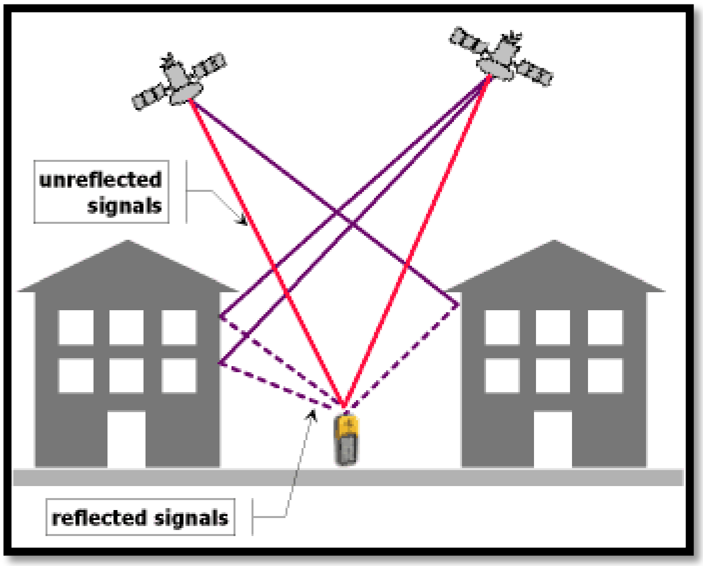
- **Orbital error :** The positions of the satellites obtained from the signal information are really a prediction of where the satellite should be at a given moment, and can differ slightly from the actual position. While steps are taken to predict the best positions (or orbits), they can't be predicted perfectly all the time.
- **Clock errors :** The satellites and receivers both need very good clocks to do their job. The smallest error can throw off the "range measurement" from the receiver to the satellite by many 10's, 100's or even 1000's of meters. For example a 10 nanosecond (0.00000001 sec) error would cause a 3-metre error in the range.
- **Ionospheric and Tropospheric Delay :** This occurs when the signals from the satellite are delayed in their journey to the receiver by traveling through an area of charged particles, called the ionosphere, above the earth and through our atmosphere.



Influenced propagation of radio waves through the earth's atmosphere

- **Receiver Noise :** This is a function of how well a GPS receiver can measure the signal coming from the satellite. Some are better at it than others.

- **Multipath errors :** The GPS signal may bounce off a nearby object. Imagine measuring the length of your living room by stretching a tape from one end to the other, but over the top of the sofa. You wouldn't get a very accurate measurement would you? Well, a range measurement to a satellite by way of a nearby stop sign would, for example, certainly throw off our GPS position.



Interference caused by reflection of the signals

GPS ERROR CORRECTION:-

GPS receiver calculates its position on earth based on the information it receives from four located satellites. This system works pretty well, but inaccuracies do pop up. For one thing, this method assumes the radio signals will make their way through the atmosphere at a consistent speed (the speed of light). In fact, the Earth's atmosphere slows the electromagnetic energy down somewhat, particularly as it goes through the ionosphere and troposphere. The delay varies depending on where you are on Earth, which means it's difficult to accurately factor this into the distance calculations. Problems can also occur when radio signals bounce off large objects, such as skyscrapers, giving a receiver the impression that a satellite is farther away than it actually is. On top of all that, satellites sometimes just send out bad almanac data, misreporting their own position.

Differential GPS (DGPS) helps correct these errors. The basic idea is to gauge GPS inaccuracy at a stationary receiver station with a known location. Since the DGPS hardware at the station already knows its own position, it can easily calculate its receiver's inaccuracy. The station then broadcasts a radio signal to all DGPS-equipped receivers in the area, providing signal correction information for that area. In general, access to this correction information makes DGPS receivers much more accurate than ordinary receivers.

The most essential function of a GPS receiver is to pick up the transmissions of at least four satellites and combine the information in those transmissions with information in an electronic almanac, all in order to figure out the receiver's position on Earth.

ADVANTAGES OF GPS SYSTEM:-

The advantages of Global Positioning System are-

❖ Easy Navigation System:

Now you don’t need worry about deviating from your path while you are hiking or if you are lost in a strange town and don’t know the way out just relax because you have the GPS. The navigation system in a GPS device can provide you with turn-by-turn directions even if you are in a car as there are GPS devices available for cars as well and it could be a very useful feature in a strange town or place.

❖ Nearby Area Search:-

Some GPS systems allow you to search the local area for nearby amenities, such as hotels, restaurants and gas stations. This is extremely helpful in some situations. For example, if you are driving cross-country and realize there is a problem with your car, you can search for nearby auto mechanics and select one that is along your route. Your GPS system will show you exactly how to get there.

❖ Navigation over Water:-

GPS devices can work perfectly for water navigation. In the past, boaters had to use a compass and a map in order to determine where exactly they are heading and with somewhat vague results as there were no landmarks in the large bodies of water. However, the arrival of GPS systems allowed them to find out their exact location on the map. Underwater hazards are always a problem; here GPS devices can allow boaters to steer around hidden dangers under water.

DISADVANTAGES OF GPS SYSTEM:-

The disadvantages of Global Positioning Systems are-

❖ Cost:-

Purchasing a GPS based on price can be a major disadvantage. If you purchase a "bargain GPS," you will get what you pay for, and features such as traffic and up-to-date maps could be lacking.

❖ Reception:-

GPS devices are limited by having clear access to the satellites that provide the tracking. In locations with tall buildings or sparse coverage, reception can be poor.

❖ Directions:-

Turn-by-turn directions are not available on every type of GPS device. Some will give very little advanced notice before an upcoming turn.

❖ Accuracy:-

Maps on GPS devices are not updated in real time for all models. This means that it is possible a GPS device will direct you onto a road that is closed or no longer exists. It could also miss new roads and businesses.

❖ Battery Life:-

GPS units that are not plugged into a power source, and rely on batteries, which can drain quickly. This can increase the cost of owning a GPS unit significantly.

APPLICATIONS OF GLOBAL POSITIONING SYSTEM:-

GPS technology has many amazing applications on land, at sea and the air. You might be surprised to learn about the following examples of how people or professions are already using GPS technology.

❖ AGRICULTURE:-

In precision farming, GPS technology helps monitor the application of fertilizer and pesticides.GPS technology also provides location information that helps farmers plow ,harvest, map fields, and mark areas of disease or weed infestation.

❖ AVIATION:-

Aircraft pilots use GPS technology for en route navigation and airport approaches. Satellite navigation provides accurate aircraft location anywhere on or near the earth.

❖ MARINE:-

GPS technology helps with marine navigation, traffic routing, underwater water surveying, navigation hazard location, and mapping. Commercial fishing fleets use it to navigate to optimum fishing locations and to track fish migrations.

❖ MILITARY:-

Military aircraft, ships, submarines, tanks, jeeps, and equipments use GPS technology for many purposes including basic navigation, target designation, close air support, weapon technology, and rendezvous.

❖ PUBLIC SAFETY:-

Emergency and other specialty fleets use satellite navigation for location and status information.

❖ SPACE:-

GPS technology helps track and control satellites in orbit. Future booster rockets and reusable launch vehicles will launch, orbit the earth, return and land, all under automatic control. Space shuttles also use GPS navigation

❖ SURVEYING:-

Surveyors use GPS technology for simple tasks (such as defining property lines) or for complex tasks (such as building infrastructures in urban centers). Locating a precise point of reference used to be very time consuming. With GPS technology two people can survey dozens of control point in an hour. Surveying and mapping roads and rail systems can also be accomplished from mobile platforms to save time and money.

❖ TIMING:-

Delivering precise time to any user is one of the most important functions of GPS technology. This technology helps synchronize clocks and events around the world. Pager companies depend on GPS satellites to synchronize the transmission of information throughout their systems. Investment banking firms rely on this service every day to record international transactions simultaneously.

FUTURE OF GPS:-

While the use of Global Positioning has expanded within the last decade, there are many new uses being still being developed. Some new GPS products are being marketed to parents to track their teenage drivers. This allows parents to know if they really went to see a movie or if they went to a party at a friend's house. And since a GPS can determine speed, parents can also know if the teens are engaged in any dangerous driving. GPS can also come in handy in emergency situations such as carjacking. This technology is becoming available as a transponder for cars, an add-on for phones, or as carry-along units.

Many cell phones are now coming with limited GPS receivers to help with Enhanced 911. Enhanced 911 sends the caller's address to emergency operators, but to date it has only worked with traditional land line phones. Since a cell phone can be used to make a call from anywhere, global positioning is being added to quickly locate distressed cell phone callers.

CONCLUSION:-

Global positioning has grown from a military feature to a must-have electronic gadget. Although the possibilities for use are still growing, today GPS and navigation is still an add-on feature but within a few years it could become standard equipment. The tech savvy generation growing up today will probably look at the compass and think it ancient the same way previous generations looked at the sextant.

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