GLOBAL POSITIONING SYSTEM

OVERVIEW

- WHAT IS GPS
- EVOLUTION OF GPS
- THREE SEGMENTS OF GPS
- INFORMATION IN A GPS SIGNAL
- HOW GPS WORKS
- ERRORS IN GPS
- DIFFERENTIAL GPS
- ADVANTAGES
- DISADVANTAGES
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WHAT IS GPS

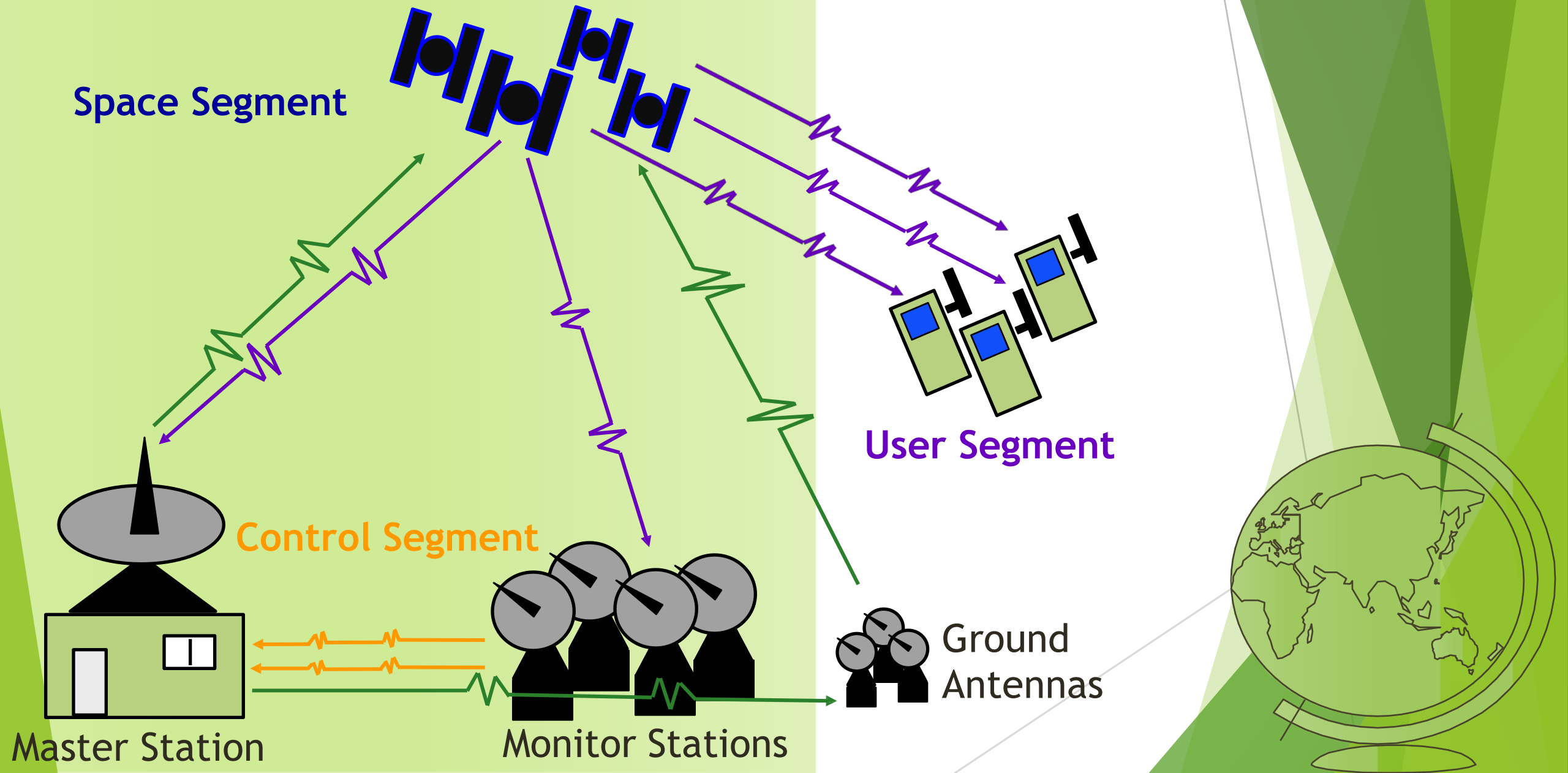
- The Global Positioning System (GPS) is a satellite-based Navigation system developed and operated by the US Department of Defense.
- GPS is the shortened form of NAVSTAR GPS. This is an acronym for NAVigation System with Time And Ranging Global Positioning System.
- GPS uses constellation of 24 satellites to determine the accurate three-dimensional position of the user on the earth.
- GPS was originally designed for military use at any time anywhere on the surface of the earth but soon after proposals it is made available to civilian users also.

EVOLUTION OF GPS

- The GPS project was proposed in 1973 to overcome the limitations of earlier navigation systems.
- First satellite was launched in 1978 but It became fully operational with launching of 24th satellite in 1995.
- Advances in technology and new demands on the existing system have now led to efforts to modernize the GPS system and implement the next generation of **GPS III** satellites.
- In addition to GPS of US, other systems are also in use or under development, like
  - RUSSIAN's - Global Navigation Satellite System (GLONASS)
  - EUROPEAN's - Galileo positioning system
  - INDIA's - Indian Regional Navigational Satellite System
  - CHINA's - Compass navigation system

but these systems are suffered from incomplete coverage of the globe and failed to

THREE SEGMENTS OF GPS



Space segment

- GPS Satellite constellation composed of 24 operational satellites in space.
- These 24 satellites are placed in 6 circular orbits of period equal to 12hrs and these orbits are equally spaced with 60 degrees apart and at an inclination angle of 55 degrees to equator

Control Segment

- The control segment comprises of 5 ground stations located on equator.(4-monitor and 1-master station)
- Monitor stations measure the distances of the overhead satellites every 1.5 seconds and send the corrected data to Master station.
- In Master station the satellite orbit, clock performance and health of the satellite are determined and determines whether repositioning is required.
- This information is sent back to the satellites using ground antennas.

User Segment

- The User Segment consists of all earth-based GPS receivers.
- The user segment is totally user community, both civilian and military.

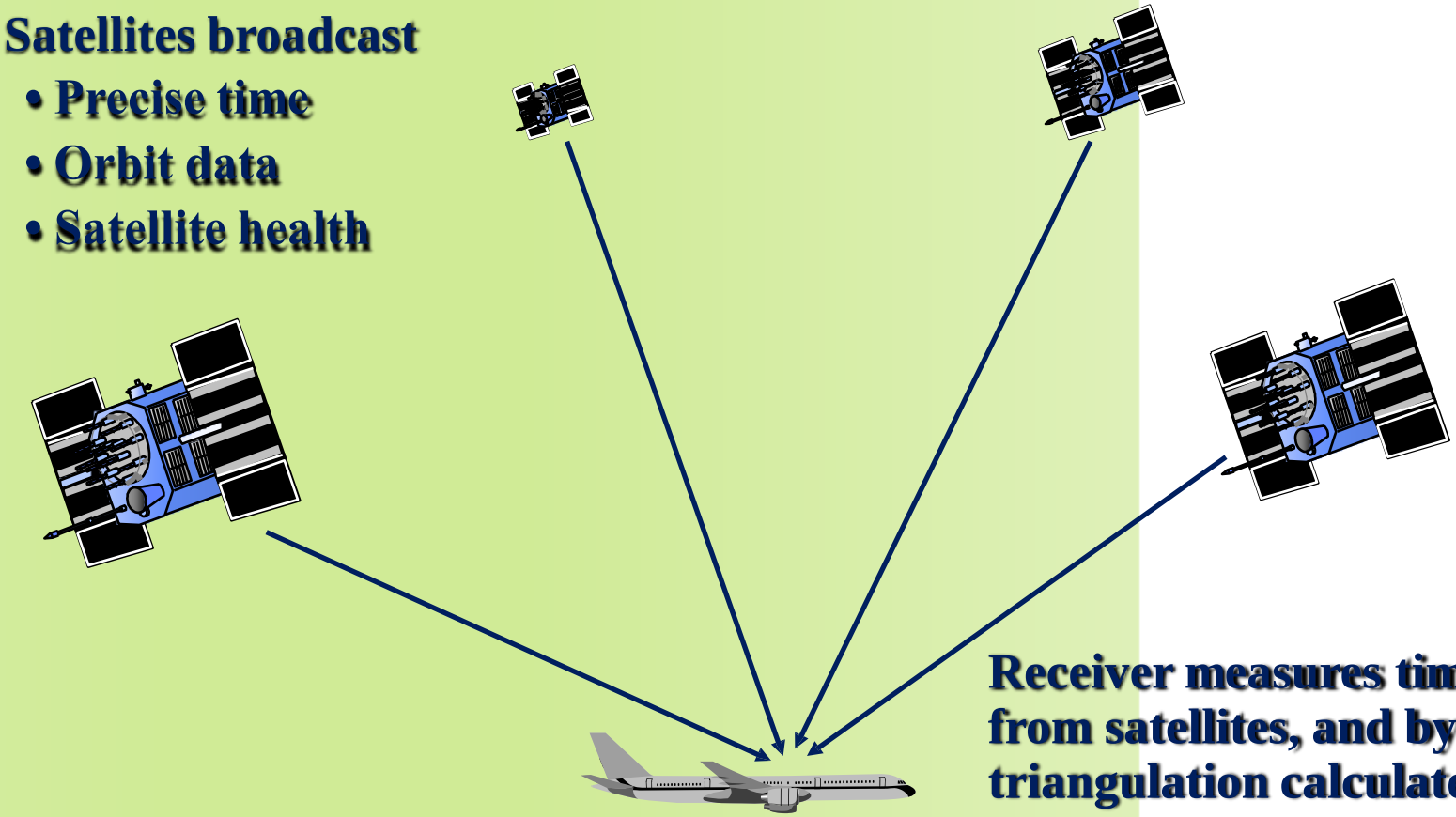
INFORMATION IN A GPS SIGNAL

- The GPS signal contains mainly two types of data, they are:
  - **Ephemeris data**
  - **Almanac data**
- Ephemeris data is constantly transmitted by each satellite and contains important information such as status of the satellite (healthy or unhealthy), current date, and time. This part of the signal is essential to determining a position.
- Almanac data tells the GPS receiver where each GPS satellite should be at any time throughout the day. Each satellite transmits almanac data showing the orbital information of that satellite.

HOW GPS Works

Satellites broadcast

- Precise time
- Orbit data
- Satellite health



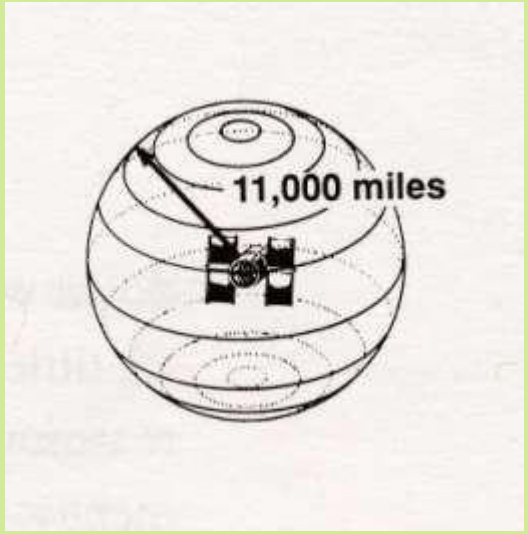
Receiver measures time delay from satellites, and by triangulation calculates

- Location
- Elevation
- Velocity

HOW GPS WORKS(continue)

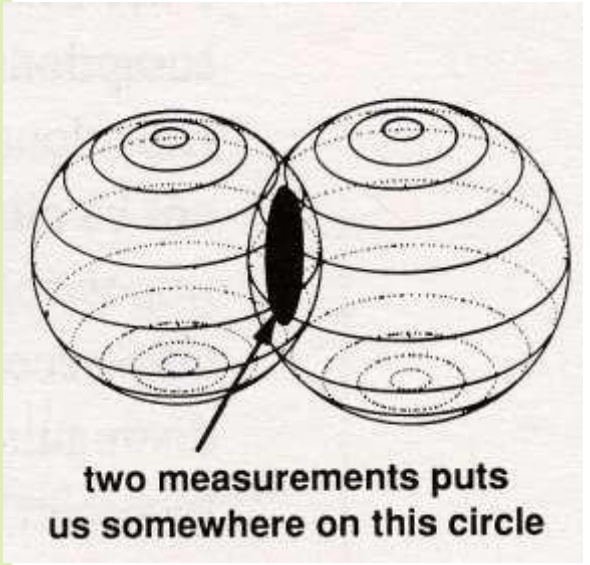
- The GPS uses technique of "triangulation" to find location.
- To "triangulate," a GPS receiver measures distance from the satellite using the travel time of radio signals.
- To measure travel time, GPS needs very accurate timing, which is provided by atomic clocks used in the satellites.
- Along with distance, we need to know exactly where the satellites are in space. This information is obtained by Almanac data transmitted by satellites.
- Finally we must correct for any delays the signal experiences as it travels through the atmosphere.
- To compute a positions in three dimensions. We need to have four satellite measurements. The GPS uses a trigonometric approach to calculate the positions

TRIANGLATION

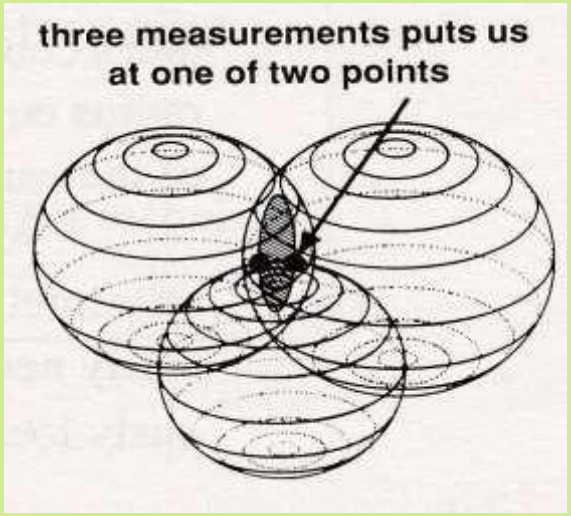


The receiver is somewhere on this sphere.

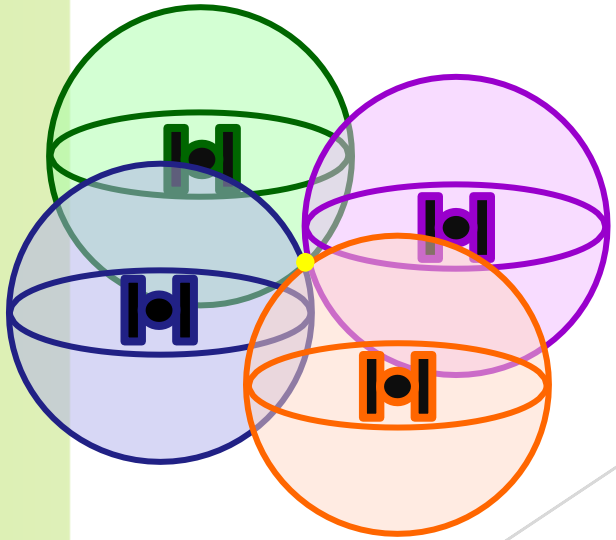
Signal From One Satellite



Signals From Two Satellites

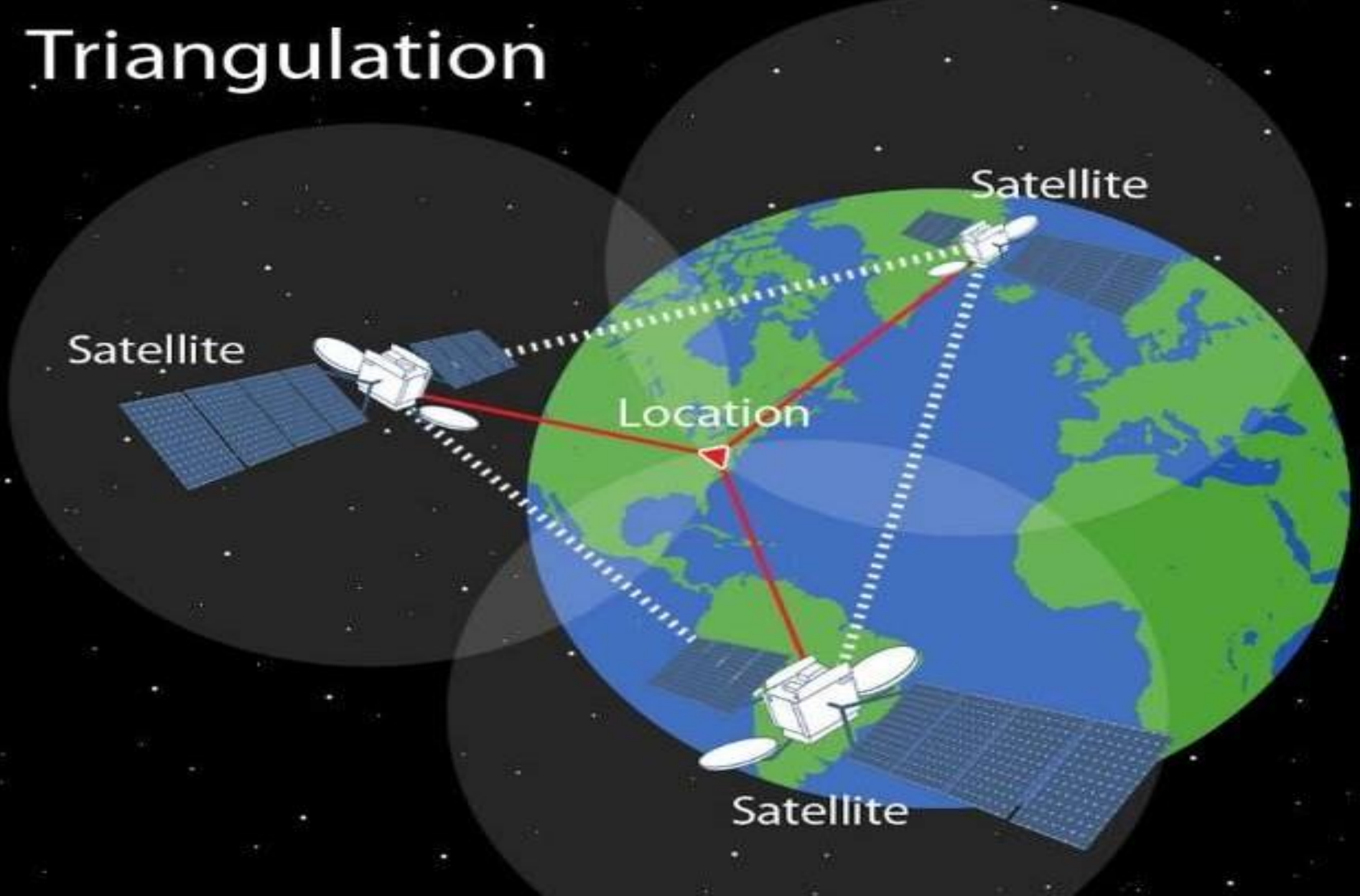


Three Satellites (2D Positioning)

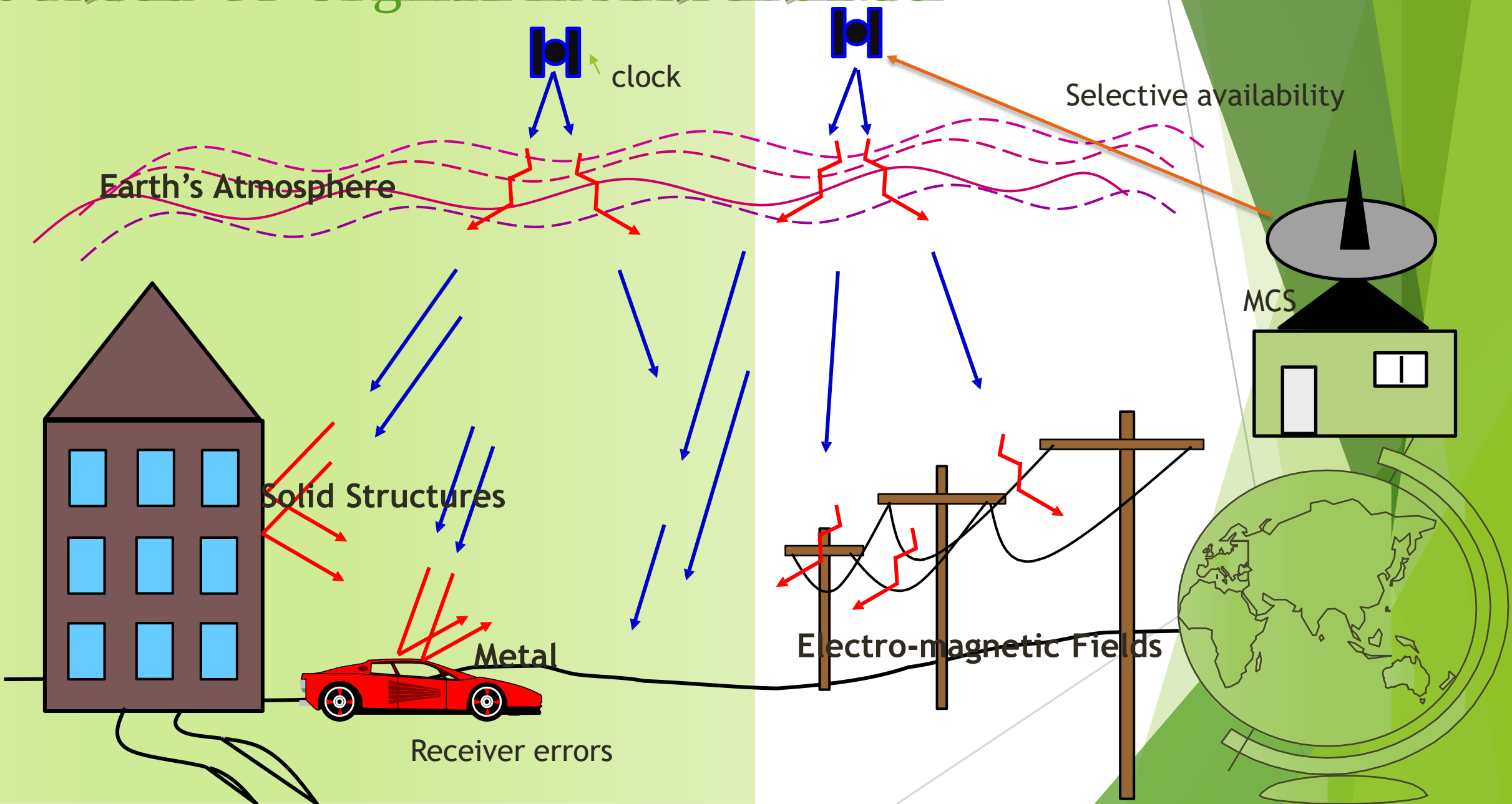


Three Dimensional (3D) Positioning

Triangulation



Sources of Signal Interference



ERRORS IS GPS

Ionosphere: Electrically charged particles 80-120 miles up;affects speed of electromagnetic energy
…amount of affect depends on frequency …look at differences in L1 and L2
(need “dual-frequency” receivers to correct)

Tropospheric water vapor: Affects all frequencies; difficult to correct

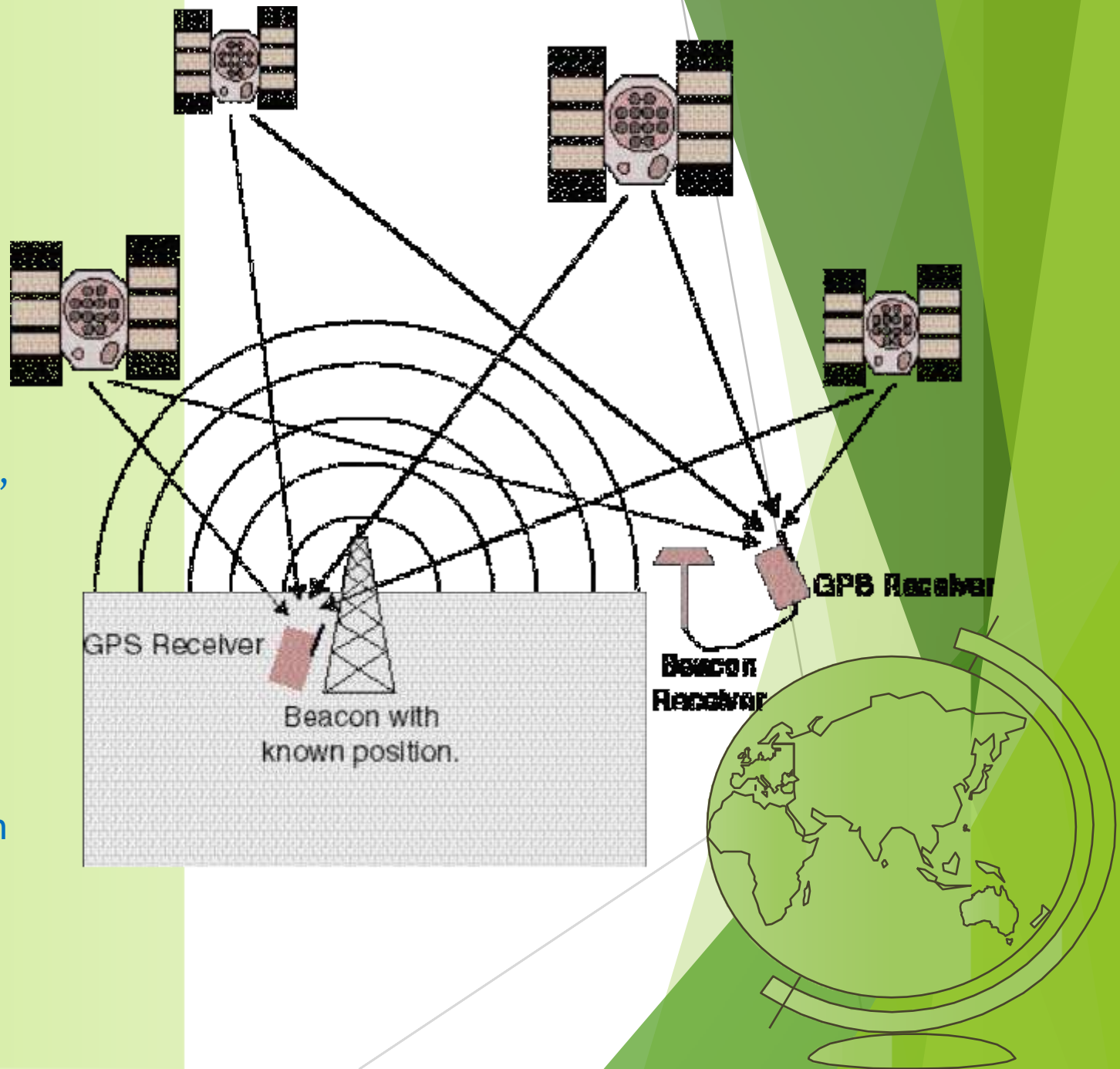
Multipath: Reflected signals from surfaces near receiver
Poor visibility: Due to trees, mountains, buildings, etc..

Noise: Combined effect of PRN noise and receiver noise

Bias: SV clock errors; ephemeris errors
Blunders: Human error in control segment;
…..user mistakes (e.g. incorrect geodetic datum)…more on this in a minute receiver errors
Selective availability: SA; error introduced by DoD.
Geometric Dilution Of Precision (GDOP)

Differential GPS

- To obtain more accurate measurements than a single GPS unit, In DGPS systems, The GPS receiver broadcasts the signal it receives from a known position. The GPS unit in the field simultaneously receives data from the GPS satellites and the other GPS receiver on the ground through a radio signal. The GPS error from the known position is compared to that of the GPS receiver in the unknown location.



ADVANTAGES

- GPS is extremely easy to navigate as it tells you to the direction for each turns you take or you have to take to reach to your destination.
- GPS works in all weather so you need not to worry of the climate as in other navigating systems.
- The GPS costs you very low.
- The most attractive feature of this system is its100% coverage on the planet.
- It also helps you to search the nearby restaurants, hotels and gas stations and is very useful for a new place.
- Due to its low cost, it is very easy to integrate into other technologies like cell phone.
- The system is updated regularly by the US government (as compared to other navigations systems by other countries e.g. GLONASS) and hence is very advance.
- This is the best navigating system in water as in larger water bodies we are often misled due to lack of proper directions.
- Accuracy can vary from millimeters to several meters depending on the technique that is used.

DISADVANTAGES

- GPS satellite signals are weak, so it doesn't work as well indoors, underwater, under trees, etc.
- The highest accuracy requires line-of-sight from the receiver to the satellite, this is why GPS doesn't work very well in an urban environment
- The US DoD (dept. of defence) can, at any time, deny users use of the system (i.e. they degrade/shut down the satellites)
- If you are using GPS on a battery operated device, there may be a battery failure and you may need a external power supply which is not always possible.
- Sometimes the GPS signals are not accurate due to some obstacles to the signals

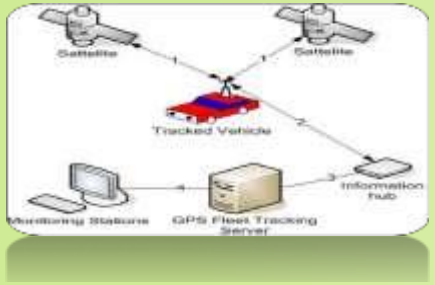
APPLICATIONS

- Location

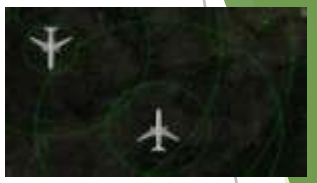
- Navigation

- Mapping

- Tracking



- Airways and military



- Timings synchronizing

- Search and Rescue

- Marine

CONCLUSION

- GPS is a network of satellites that continuously transmit coded information, which makes it possible to precisely identify locations on earth by measuring distance from the satellites.

- GPS although was developed for military purposes, but the number of civilian users of GPS already well far exceeds than number of potential military .

- As discussed in previous topic, its application field is vast and new applications will continue to be created as the technology evolves.

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- *http://garmin.com*
- *http://colorado.edu/geography/gcraft/notes/gps*
- *http://trimble.com*
- *http://www.slideshare.net/gps*


THANK
YOU

Early navigation systems:

early solutions:

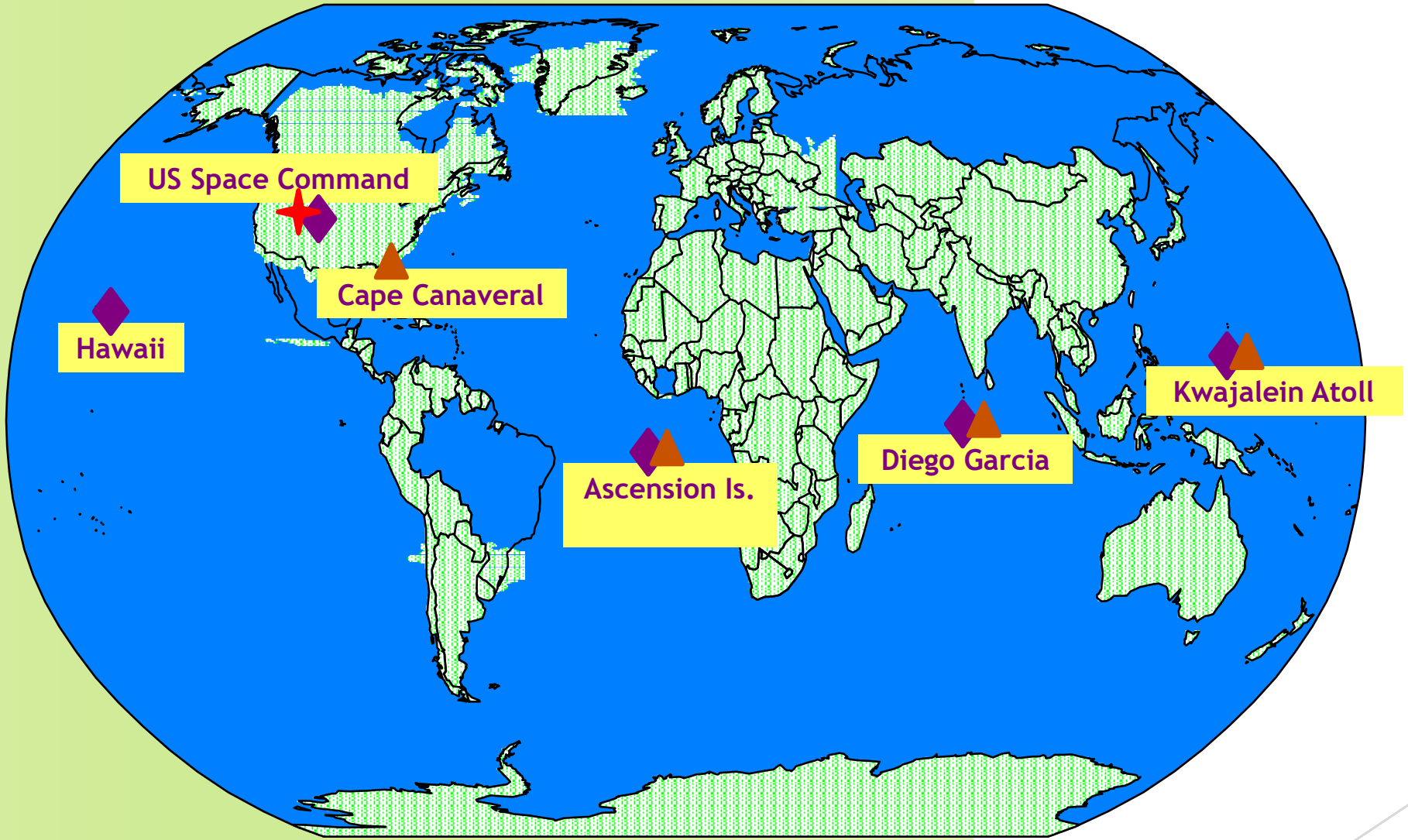
- marking trails with piles of stones
  (problems when snow falls…or on ocean)
- navigating by stars
  (requires clear nights and careful measurements)
  most widely used for centuries
  …location within a mile or so
- navigating by compass
  …….some errors due to change in earth magnetic fields

modern ideas:

- RADIO: radio-based; good for coastal waters
  …limited outside of coastal areas
- Sat-Nav: low orbit satellites; use low frequency Doppler
  …problems with small movements of receivers

Click here to evolution of GPS

Control Segment

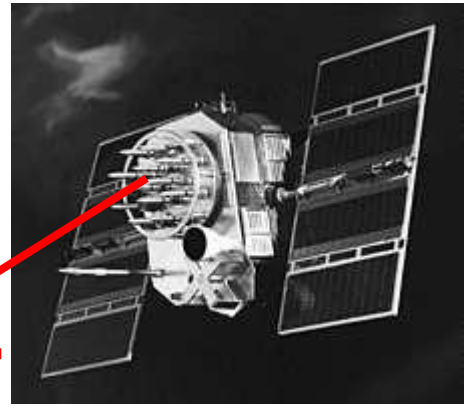


Master Control Station Monitor Station Ground Antenna

Click here to segments of GPS

Position is Based on Time

Radio waves travel at the speed of light. If GPS signal leaves satellite at time “T”…



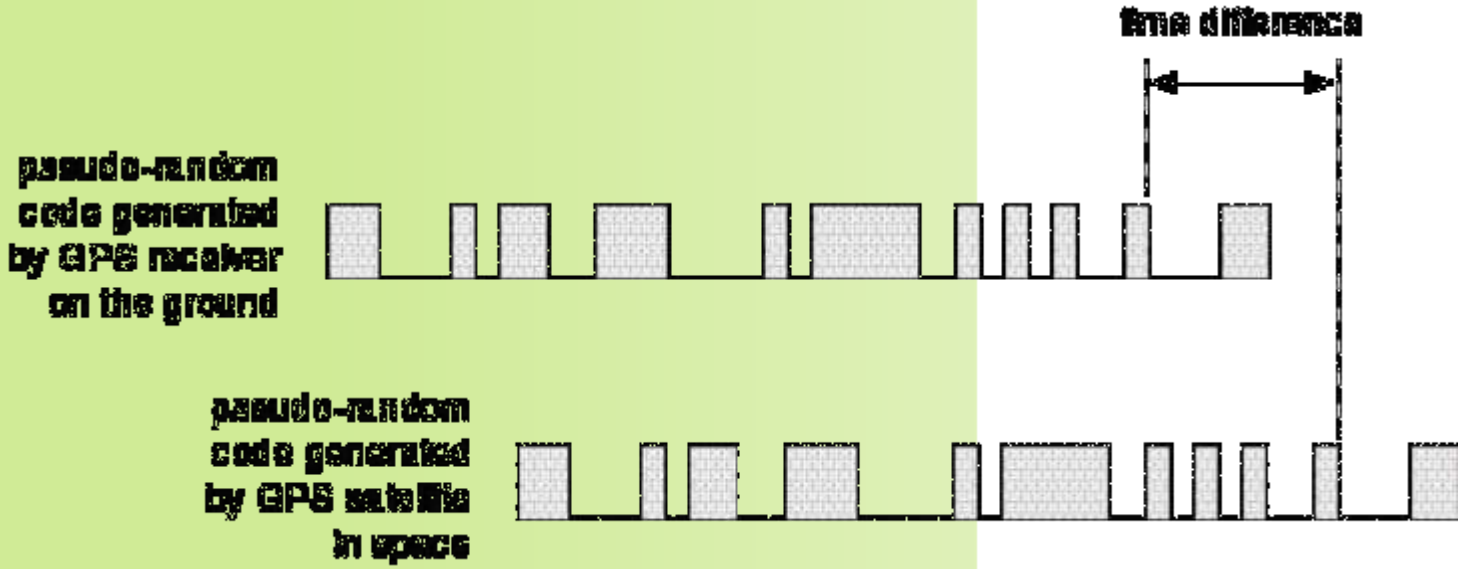
T

T + 3

…and is picked up by the receiver at time “T + 3.”

Then distance between satellite and receiver = “3 times the speed of light”

PSEUDO-RANDOM NOISE



- The GPS receiver and satellite generate the same pseudo-random code at exactly the same time. When the code arrives from the satellite, the time difference is compared to the same code generated by the receiver. This difference is multiplied by the speed of light (186,000 miles per second) to determine the distance to the satellite

Click here to How GPS works

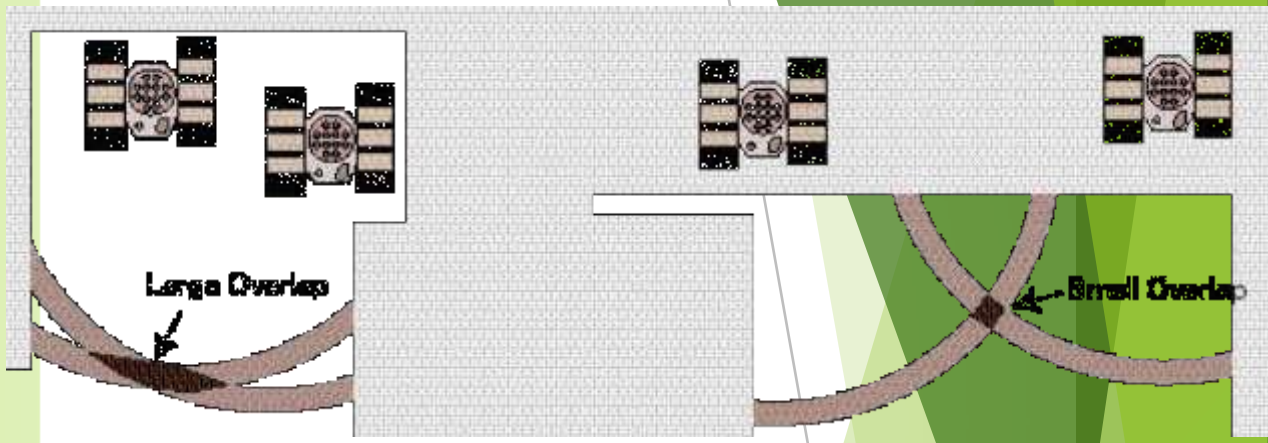
SELECTIVE AVAILABILITY

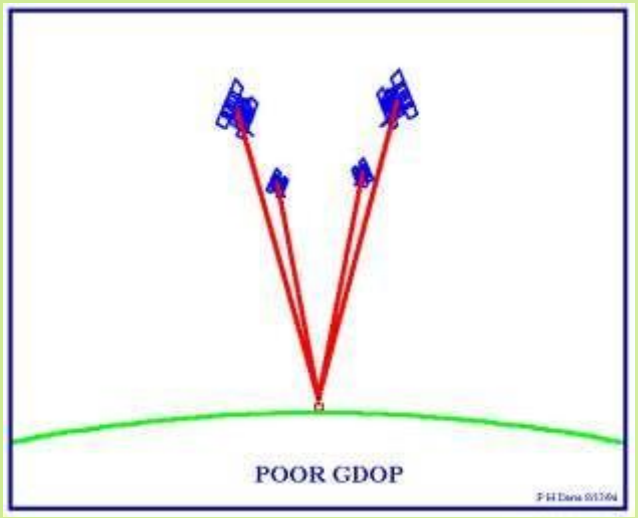
- Selective Availability (SA) was an intentional degradation of public GPS signals implemented for national security reasons.
- S/A was designed to prevent America's enemies from using GPS against us and our allies.
- SA errors are actually pseudorandom, generated by a cryptographic algorithm with decryption key available only to authorized users with a special military GPS receiver.
- In May 2000 the Pentagon reduced S/A to zero meters error.
- S/A could be reactivated at any time by the Pentagon

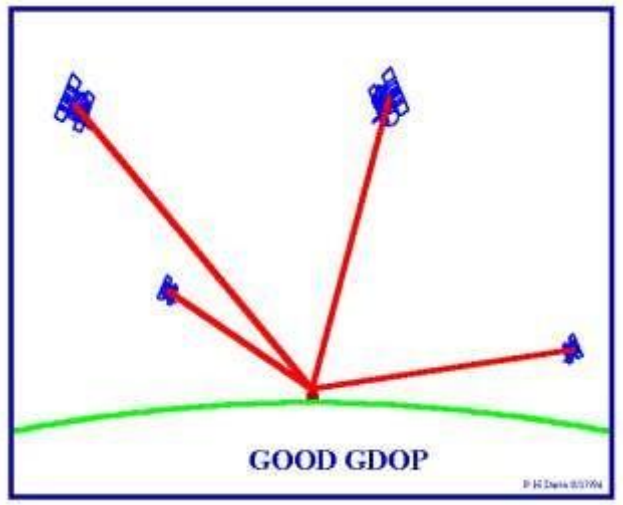
Click here to Errors in GPS

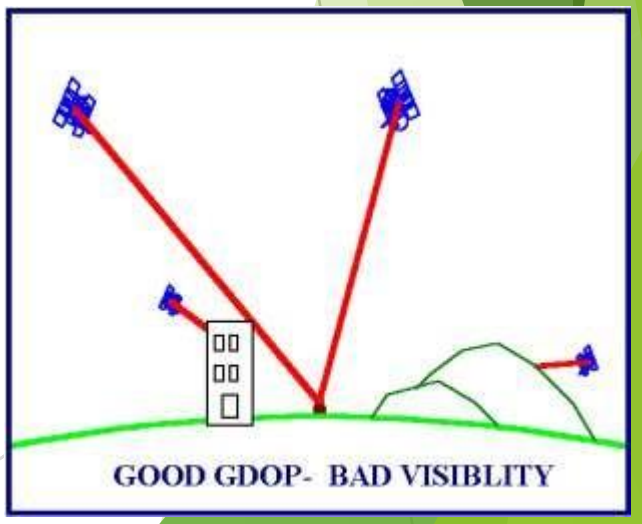
GDOP:

Geometric Dilution of Precision (GDOP). When the satellites are close together, the overlap between the estimated distances is larger than when the satellites are far apart. More accurate GPS measurements are possible when the available satellites are further apart.









Click here to Errors in GPS