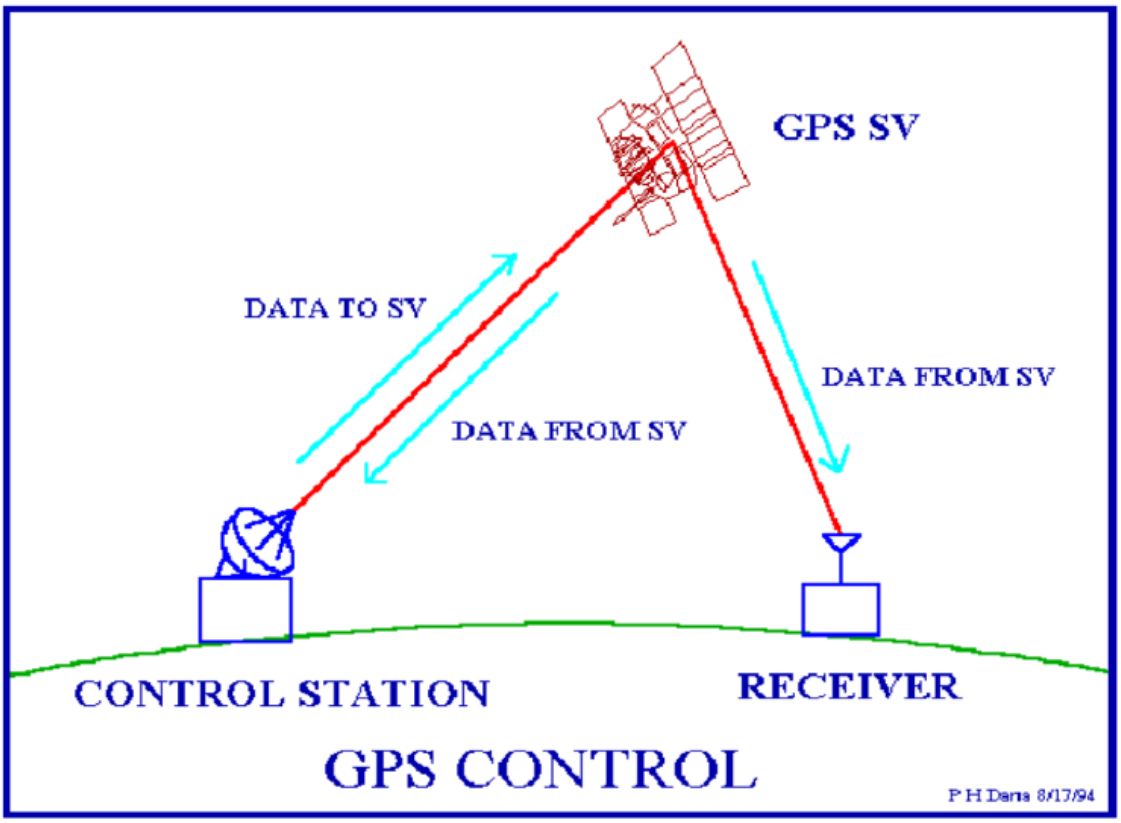
Sagar Mozumder,
Part-time Faculty, ESDM, DIU
Department of Environmental Science and Disaster Management, DIU

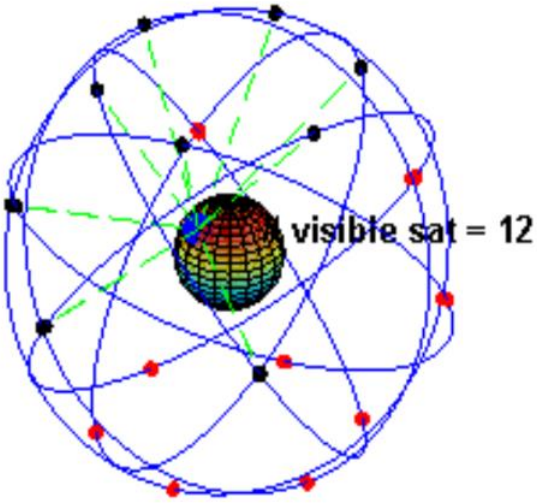
Component parts/ segments

1. Space segment (SS)
2. Control segment (CS)
3. User segment (US)



Sagar Mozumder,
Part-time Faculty, ESDM, DIU
Department of Environmental Science and Disaster Management, DIU

Space segment



Space Segment— (contd..)

- The GPS uses a constellation of 24 satellites that orbit the earth at about 11,000 nautical miles, once every 12 hours
- The orbital position is constantly monitored and updated by the ground stations
- Each satellite is identified by number and broadcasts a unique signal
- The signal travels at the speed of light
- Each satellite has a very accurate clock, 0.000000003 seconds

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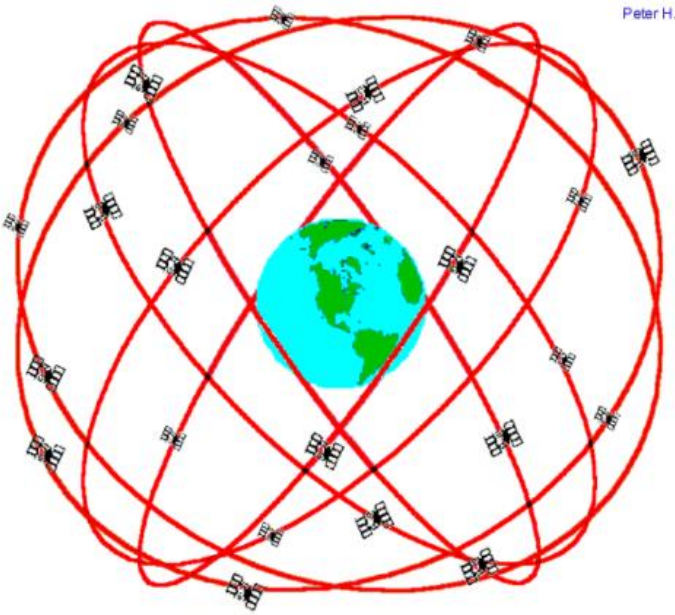

GPS Nominal Constellation
24 Satellites in 6 Orbital Planes
4 Satellites in each Plane
20,200 km Altitudes, 55 Degree Inclination

Space Segment--Satellite Signals

- Because the GPS receiver calculates its location by trilateration, the task of the receiver is to determine its distance from multiple satellites.
- The GPS system uses two types of signals to calculate distance.
  - Code-phase ranging
  - Carrier-phase ranging

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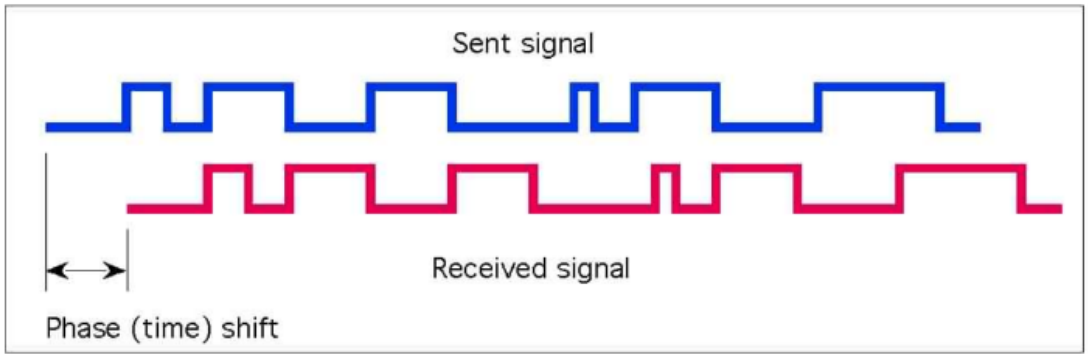
Space Segment--Satellite Signals--Code-Phasing Ranging

- Each satellite has a unique signal
- It continuously broadcasts its signal and also sends out a time stamp every time it starts
- The receiver has a copy of each satellite signal and determines the distance by recording the time between when the satellite says it starts its signal and when the signal reaches the receiver



Space Segment--Satellite Signals--Code-Phasing Ranging – cont.

- Distance is calculated using the velocity equation.

$$\text{Velocity} = \frac{\text{Distance}}{\text{Time}}$$

- **Rearranging the equation for distance:**

$$\text{Distance} = \text{Velocity} \times \text{Time}$$

- **If the system knows the velocity of a signal and the time it takes for the signal to travel from the sender to the receiver, the distance between the sender and the receiver can be determined.**

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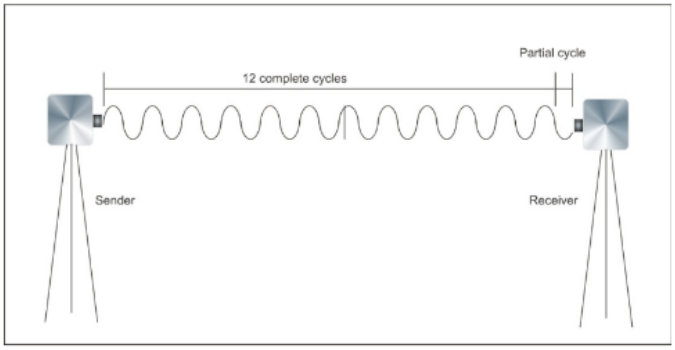
Space Segment—Carrier-Phase Ranging

- Surveying quality receivers use the underlying carrier frequency
- Easy to determine number of cycles



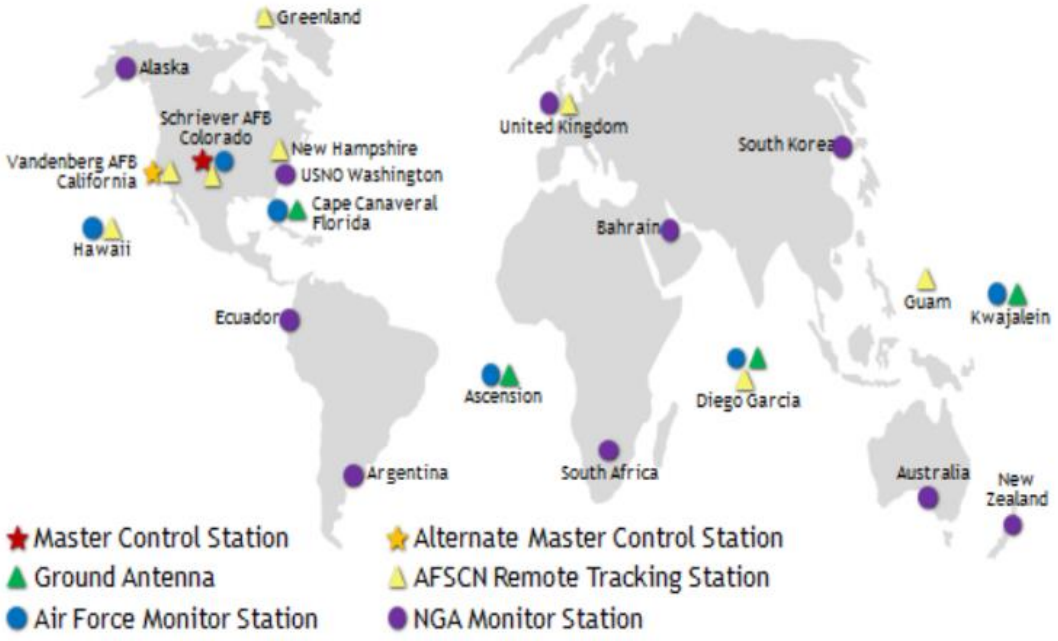
- The proportion of a partial cycle is difficult to determine
- This is called phase ambiguity
- Phase ambiguity error is resolved by comparing multiple signals from multiple receivers

Control segment

The control segment is composed of:

- a master control station (MCS),
- an alternate master control station,
- four dedicated ground antennas, and
- six dedicated monitor stations.

Sagar Mozumder,
Part-time Faculty, ESDM, DIU
Department of Environmental Science and Disaster Management, DIU



User segment

- Hundreds of thousands of U.S. and allied military users of the secure GPS Precise Positioning Service, and tens of millions of civil, commercial and scientific users

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Part-time Faculty, ESDM, DIU
Department of Environmental Science and Disaster Management, DIU

Position Fix

- A position is based on real-time satellite tracking.
- It's defined by a set of coordinates.
- It has no name.
- A position represents only an *approximation* of the receiver's true location.
- A position is not static. It changes constantly as the GPS receiver moves (or wanders due to random errors).
- A receiver must be in 2D or 3D mode (at least 3 or 4 satellites acquired) in order to provide a position fix.
- 3D mode dramatically improves position accuracy.

Waypoint

- A waypoint is based on coordinates entered into a GPS receiver's memory.
- It can be either a saved position fix, or user entered coordinates.
- It can be created for any remote point on earth.
- It must have a receiver designated code or number, or a user supplied name.
- Once entered and saved, a waypoint remains unchanged in the receiver's memory until edited or deleted.

Sagar Mozumder,
Part-time Faculty, ESDM, DIU
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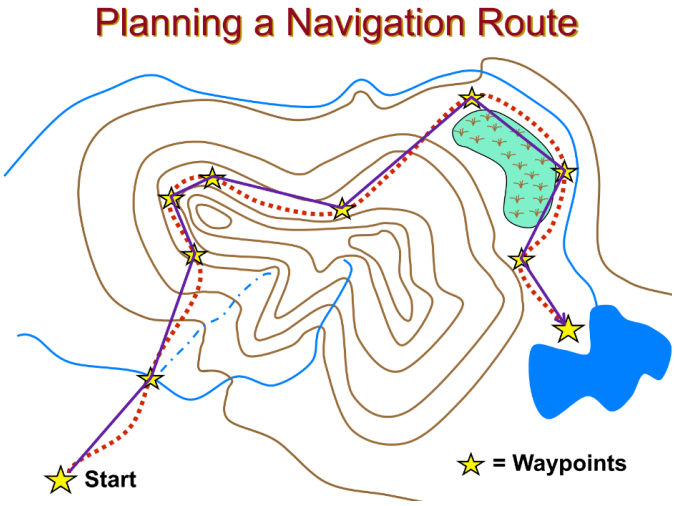

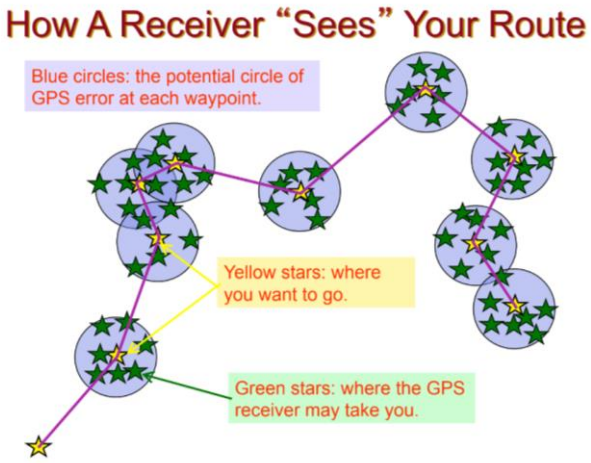

GPS Dilution of Precision and it's Effects on GPS Accuracy

- Satellite geometry can affect the quality of GPS signals and accuracy of receiver trilateration.
- Dilution of Precision (DOP) reflects each satellite's position relative to the other satellites being accessed by a receiver.
- Position Dilution of Precision (PDOP) is the DOP value used most commonly in GPS to determine the quality of a receiver's position.
- It's usually up to the GPS receiver to pick satellites which provide the best position triangulation.
- More advanced GPS receivers can filter out poor DOP values.

Sagar Mozumder,
Part-time Faculty, ESDM, DIU
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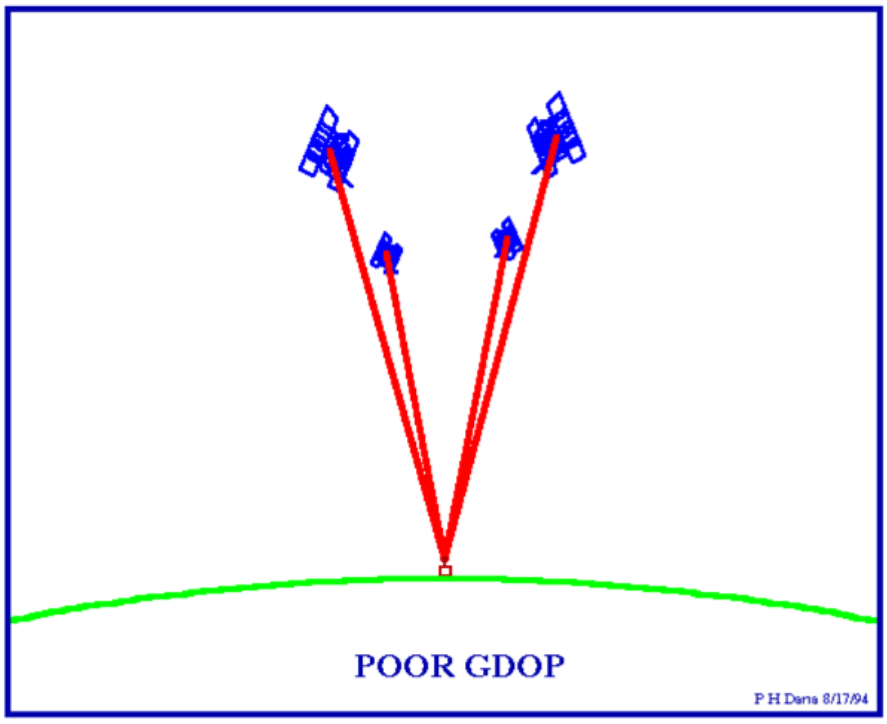

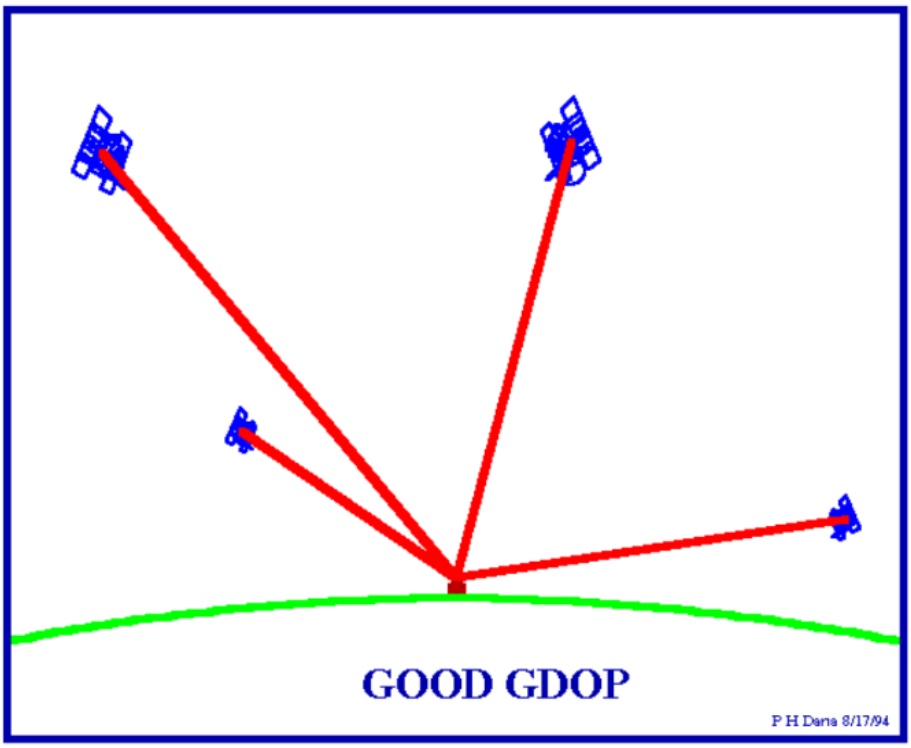

Sagar Mozumder,
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Factors affect GPS Accuracy

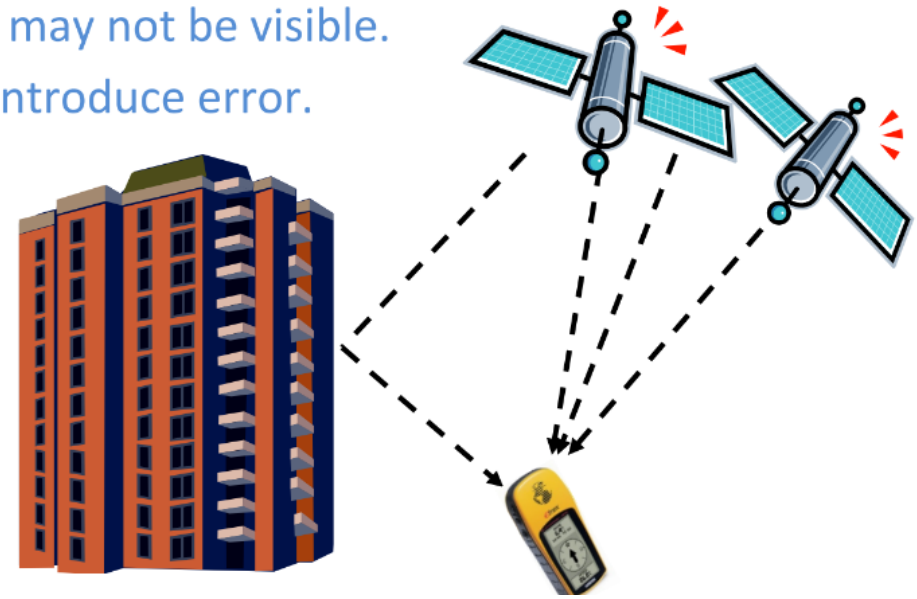
	Factors	Potential Error	Common error
Local effects	Receiver clock error	0 - 10000 m	3 - 10 m
	Percentage of sky visibility	0 - 100 m	5 m
	Satellite geometry	0 - 20 m	5 m
	Multi path error	0 - 10 m	<5 m
	Ellipsoid	5 – 10 m	5 m
Atm. effects	Ionospheric effect	2 – 30 m	5 – 10 m
	Tropospheric effect	0 - 5 m	< 2 m

MultiPath Errors

Try and stay away from buildings and other structures when using a GPS receiver

Satellites may not be visible.

This can introduce error.



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