UNIT-III : GLOBAL POSITIONING SYSTEM

Navigation satellite timing & Ranging.
NAVSTAR → first GPS satellite – 1978 – U.S
Later it is converted to GPS satellite.

24 GPS satellites are launched by us.

4 satellite } → constellation
together }

Placed at 12,000 kms away from the surface of earth.

L2 : precise code (public use)
L1 : military code } ← L band

GPS is a space-based satellite navigation system

Galileo – European

Glonass – Russia

Navstar – USA

GPS satellite Vehicle

- 4 atomic clocks
- 3 Ni-cd battery
- Two solar panels
  → battery charging
  → silicon
  → power generation
- S band → satellite control

GPS signals:

- signals driven by an atomic clock.
  → fundamental freq at 10.23 MHz.
- 2 carrier signals (sine waves)
  → L1 : f = 1575.43 MHz (λ = 19 cm)
  → L2 : f = 1227.60 MHz (λ = 24 cm)

→ ephemeris → stores information in a tabular form.
→ almanac → status of satellite orbit

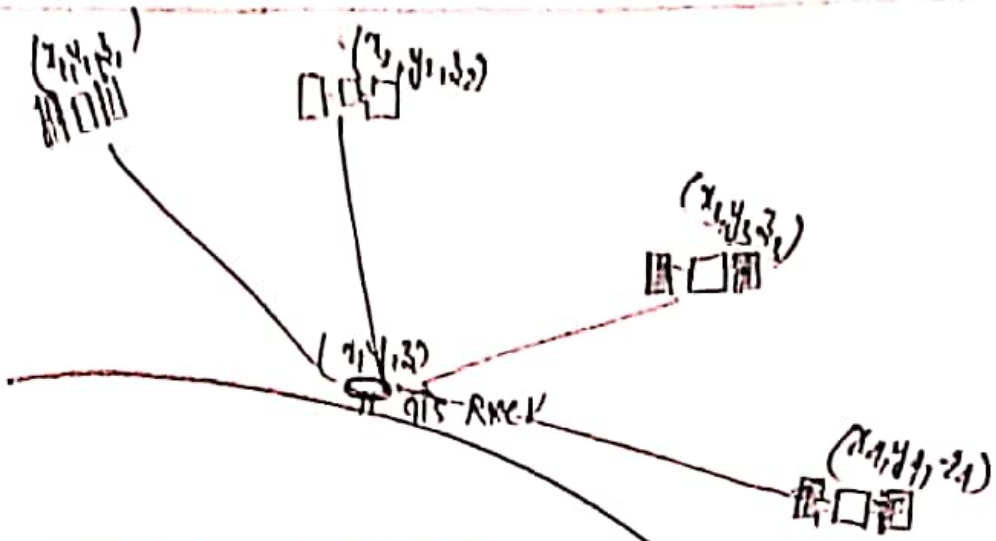
* GPS are made up of 3 segment
1. space segment → 6 orbital planes are placed with an inclination of 55°.
2. user segment.
3. control segment.

Y- 1 sidereal period = 2 [time of gps to rotate].

* CS consists of 3 entities
1. Master control system.
2. Monitor station.
3. End antennas.

• Rxcl performs following tasks:
1. selecting one or more satellites.
2. Acquiring GPS signals.
3. Measuring & tracking.
4. Recovering navigation data.

GPS provides
• SPS → standard positioning service → C/A code → used for general purpose. → civilian purpose
• PPS → precise positioning service.
• C/A → coarse/acquisition or clear/access. ← SPS
• PPS → both P code and C/A code.
• Trilateration method → method used to locate the user on the surface of the earth.



$$s_1 = \sqrt{(x_1-x)^2+(y_1-y)^2+(z_1-z)^2} + c\cdot\Delta t$$

$$s_2 = \sqrt{(x_2-x)^2+(y_2-y)^2+(z_2-z)^2} + c\cdot\Delta t$$

c = speed

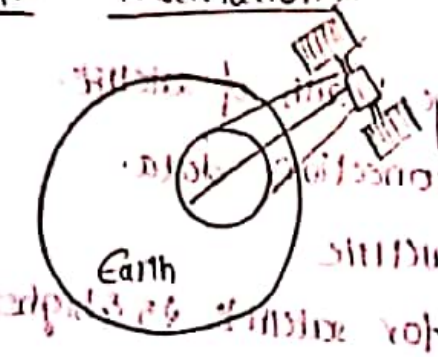
$$s_3 = \sqrt{(x_3-x)^2+(y_3-y)^2+(z_3-z)^2} + c\cdot\Delta t$$

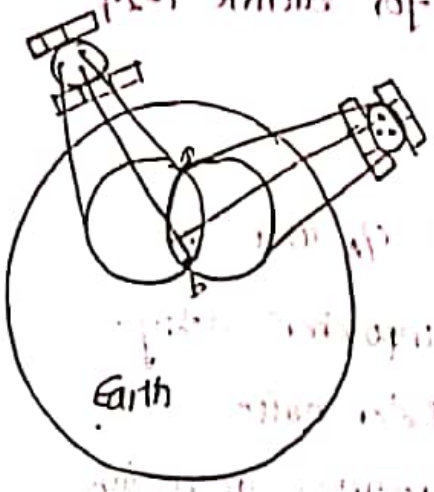
$$s_4 = \sqrt{(x_4-x)^2+(y_4-y)^2+(z_4-z)^2} + c\cdot\Delta t$$

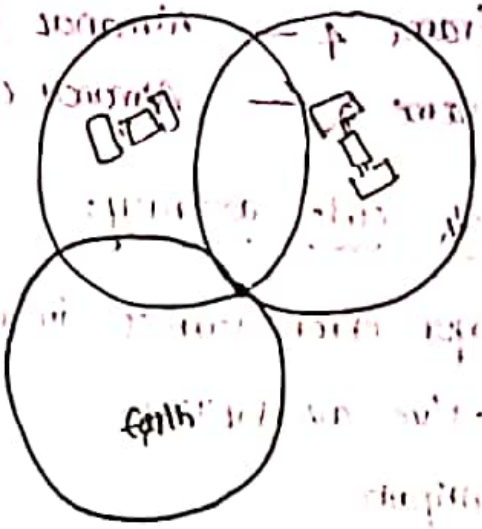
GPS Trilateration :-

eqn-

distance = speed x time



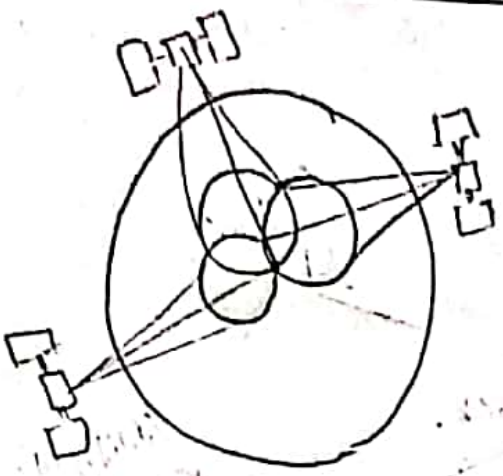




Distance of GPS satellites from surface of earth is 20,200kms

11,000 miles

placed in MEO orbit.



Milestones of satellite system:-

Introduction:

From invention to upto now. } 1st unit → history of satellite.

GPS navigation message:-

1500 bits → 12.5 minutes.

frame details:-

Header — Telemetry message health of satellite.

subframe 1 — satellite clock correction data.

subframe 2&3 — ephemeris for satellite

subframe 4 — Almanac data for satellite 25 & higher

subframe 5 — Almanac data for satellite 1-24

GPS C/A code accuracy:-

Major error sources in a GPS C/A code are:

a) selective availability.

b) Multipath.

c) satellite clock.

d) Ephemeris error.

e) Tonospheric delay.

f) Tropospheric delay.

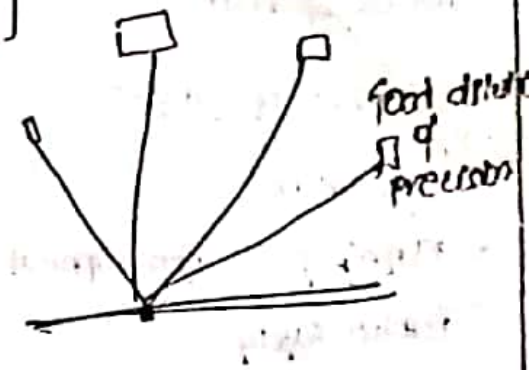
g) Rx'er noise.

h) Satellite geometry.

The selective availability was designed by US Department of Defense which deliberately degrades the signals and provides less accuracy in determining the position of a user on earth. It is switched off in May 1, 2000.

Ionosphere:- X-rays & UV rays present in ionosphere.

Dilution of precision:- [Satellite Geometry]



Four dilution of precision:-

GDOP :- A combination of navigational position & time error.
(Geometric)

PDOP :- The spatial geometrical quality of the positional solution.
(Positional)

HDOP :- Horizontal :- Measure of the quality of the horizontal position.

VDOP = Vertical :- Measure of the quality of the vertical position.

TDOP:- Time :- Mean error of the time estimation.

As DOP ↑, accuracy ↓

DOP —

DOP	Rating
1	Ideal
2-3	Excellent
4-6	Good
7-8	Moderate
9-20	Fair
20-50	Poor

Applications of GPS:-

Industry

1) Agriculture.
2) Mapping & Geographical Information system (GIS) data collection
3) Public safety.
4) Surveying.
5) Telecommunications.

Military

- Intelligence & Target location.
- Navigation.
- Weapon aiming & Guidance.

Transportation

- Aviation.
- Fleet tracking.
- Marine.

Science:-

- Archeology.
- Atmospheric science.
- Environmental.
- Geology & Geophysics.
- Oceanography.
- Wildlife.

SPADE:-

Single channel per carrier PCM multiple access demand assignment technique. It is an example of DAMA.

- With SPADE, 800 PCM encoded voice band channels separately QPSK modulate an IF carrier signal [Hence named as single channel per carrier].
- → Each 4kHz voice band channel is sampled at 8kHz rate and are converted into 8bit PCM code.
- ⇒ 50 64kbps PCM code for each voice band channel.
- → For QPSK, min req b.w = 1/2 bitrate = 32 kHz.
- → Each channel is allocated 45kHz with 13 kHz as GB.
- → 36MHz is divided producing 800 channel bands (each 45kHz)
- → 400 channels for Txion & 400 for Rxion.
- → Channels 1,2 & 400 are left unused. So used band channels are 397.
- → Centre of transponder band is marked by pilot freq - f(0kHz)
- → Each RF channel capacity is 397.
- → Each RF channel has CSC

  CSC code is used to establish or disconnect voice band link when a earth station: when demand alignment channel allocation is used.