INTRODUCTION

- The Global Positioning System (GPS) is a technology which provides unequalled accuracy and flexibility of positioning for navigation, surveying and GIS data capture.
- The GPS NAVSTAR (Navigation Satellite Timing and Ranging) is a satellite-based navigation, timing and positioning system.
- GPS provides continuous 3D positioning 24-hrs a day throughout the world.

INTRODUCTION

- The technology is beneficiary to the GPS user community in terms of obtaining accurate data up to about 100 meters for navigation, metre-level for mapping, and down to milli-metre level for geodetic positioning.
- The GPS technology has tremendous amount of applications in GIS data collection, surveying, and mapping.

Geopositioning - Basic Concepts

Positioning relates to the determination of position of stationary or moving objects.

This can be determined :

i) In relation to a well-defined coordinate system, usually by three coordinate values, or

ii) In relation to other point, taking one point as the origin of a local coordinate system.

Geo-positioning - Basic Concepts

The first mode of positioning is known as point positioning, while the second mode is known as relative positioning.

If the object to be positioned is stationary, it is known as **STATIC POSITIONING.**

When the object is moving, then it is known as **KINEMATIC POSITIONING**.

Usually, the static positioning is used in surveying, while kinematic position is used for navigation purposes.

GPS - Components and Basic Facts

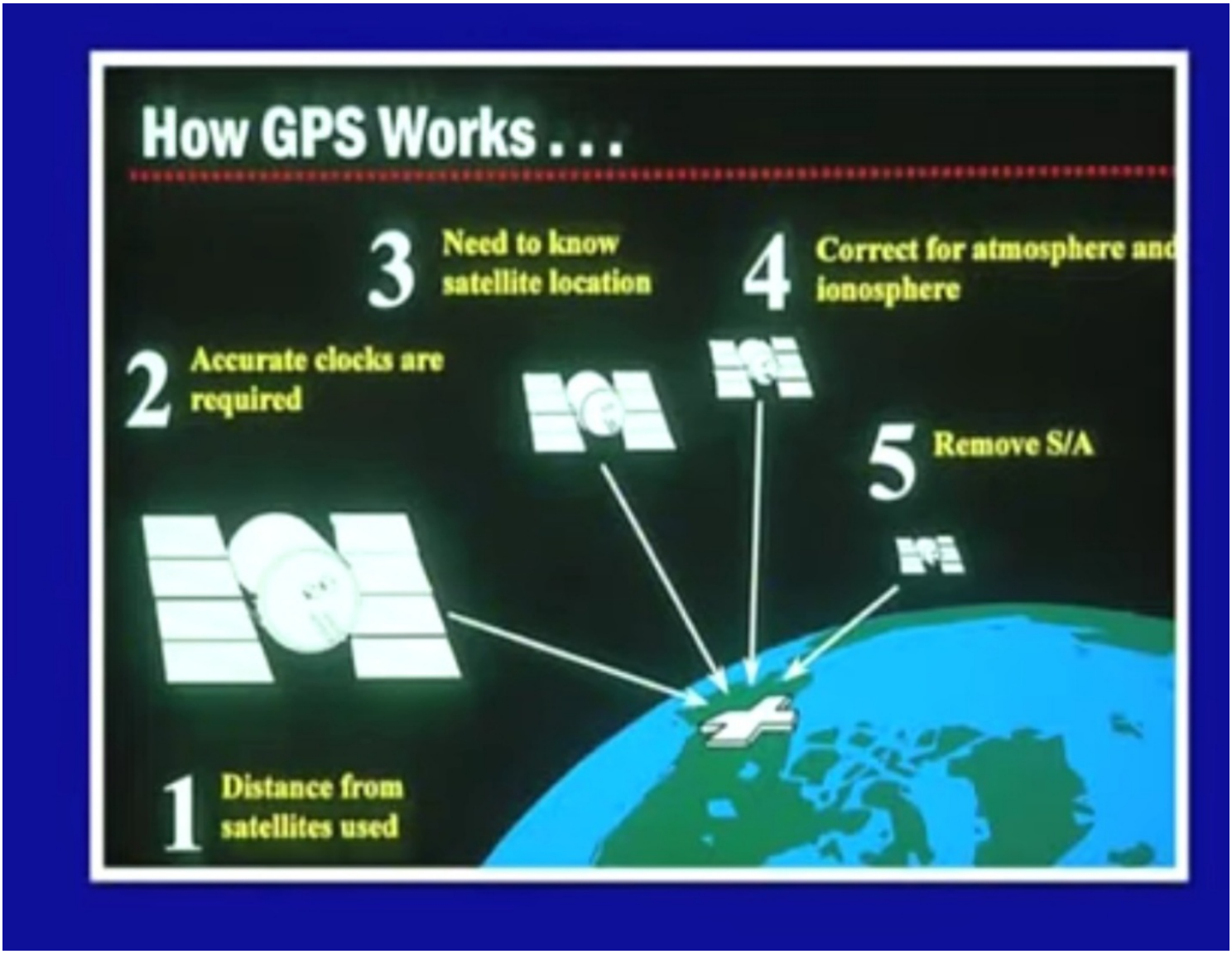
The GPS uses satellites and computers to compute positions anywhere on earth and is based on satellite ranging.

This means that the position on the earth is determined by measuring the distance from a group of satellites in space.

GPS - Components and Basic Facts

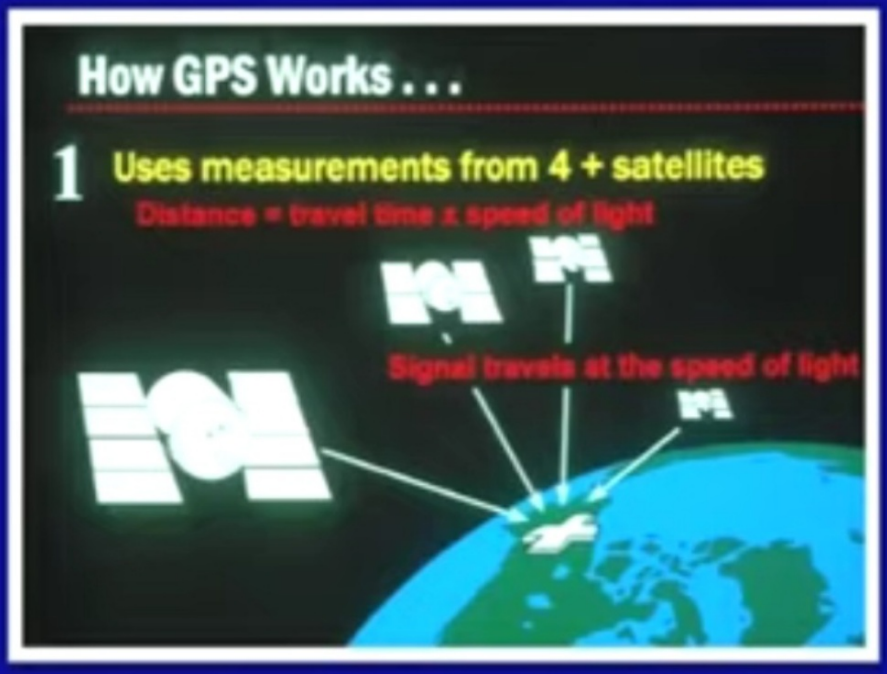
The basic principle behind GPS is really simple, even though the system employs some of the most high-technology based equipment ever developed.

In order to understand GPS basics, the system can be categorised into **FIVE logical Steps**


How GPS Works . . .
3 Need to know satellite location
4 Correct for atmosphere and ionosphere
2 Accurate clocks are required
5 Remove S/A
1 Distance from satellites used

STEP I

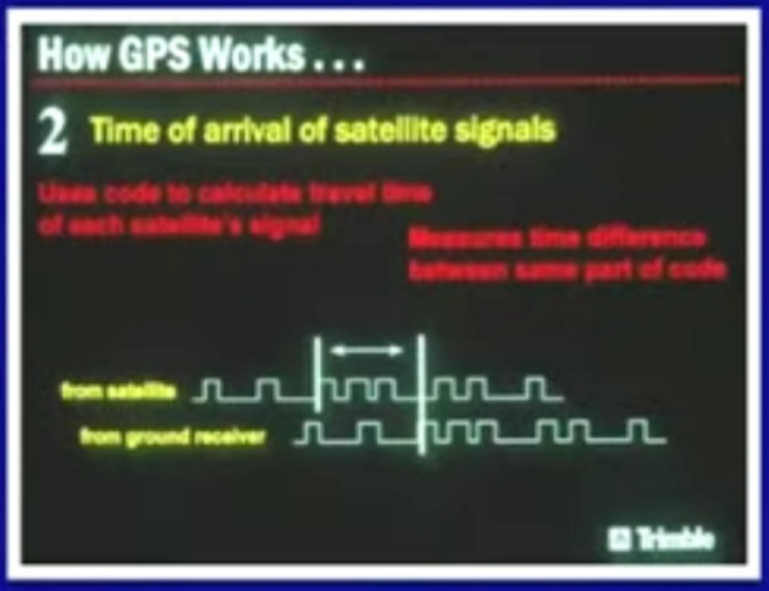
- To compute a position in three dimensions, a minimum of four satellites have to be observed.



STEP II

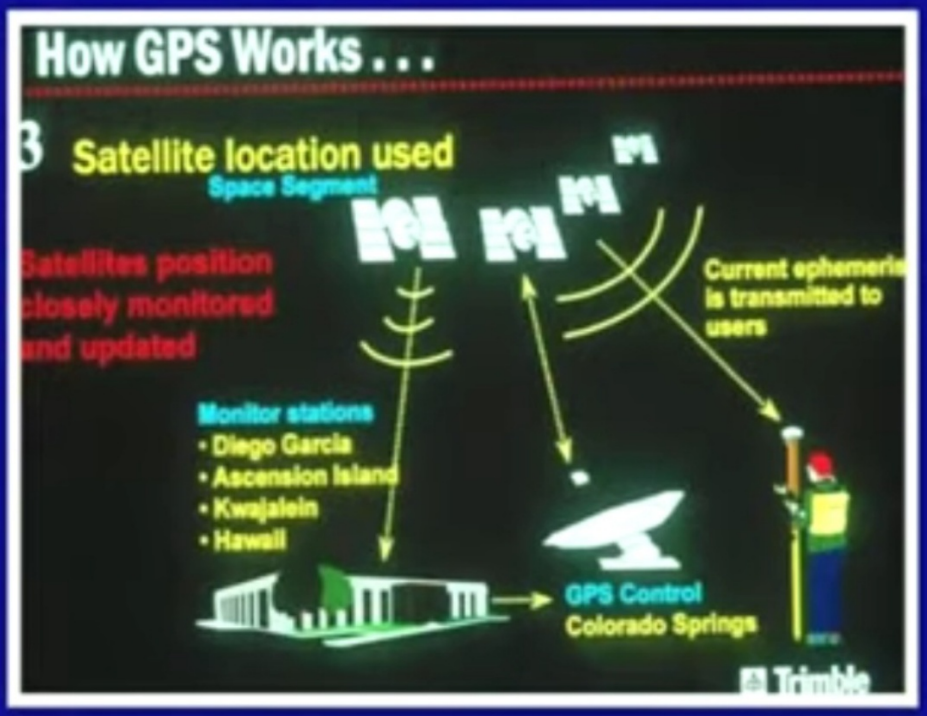
(i) To triangulate, the GPS measures the distance using the travel time of the radio message.

(ii) To measure this travel time, it requires a very accurate clock.

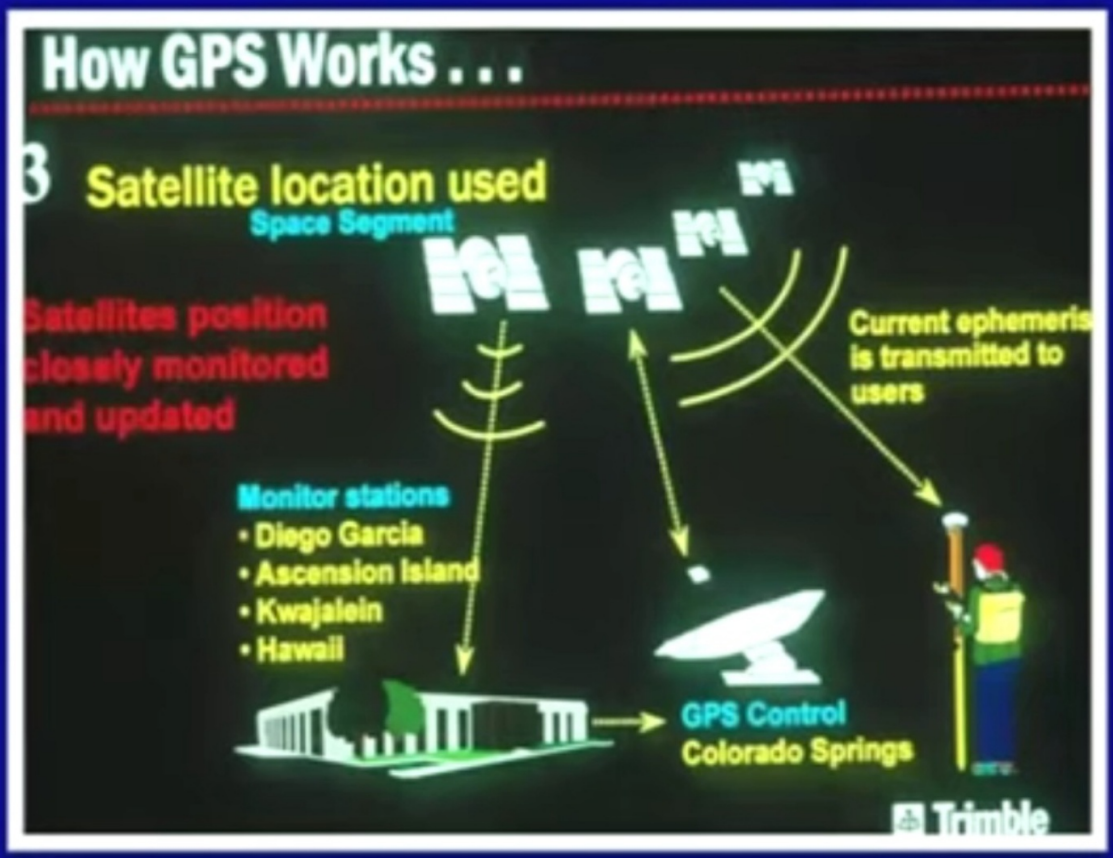


STEP III

- Once the distance to a satellite is known, then location of the satellite in space is required.

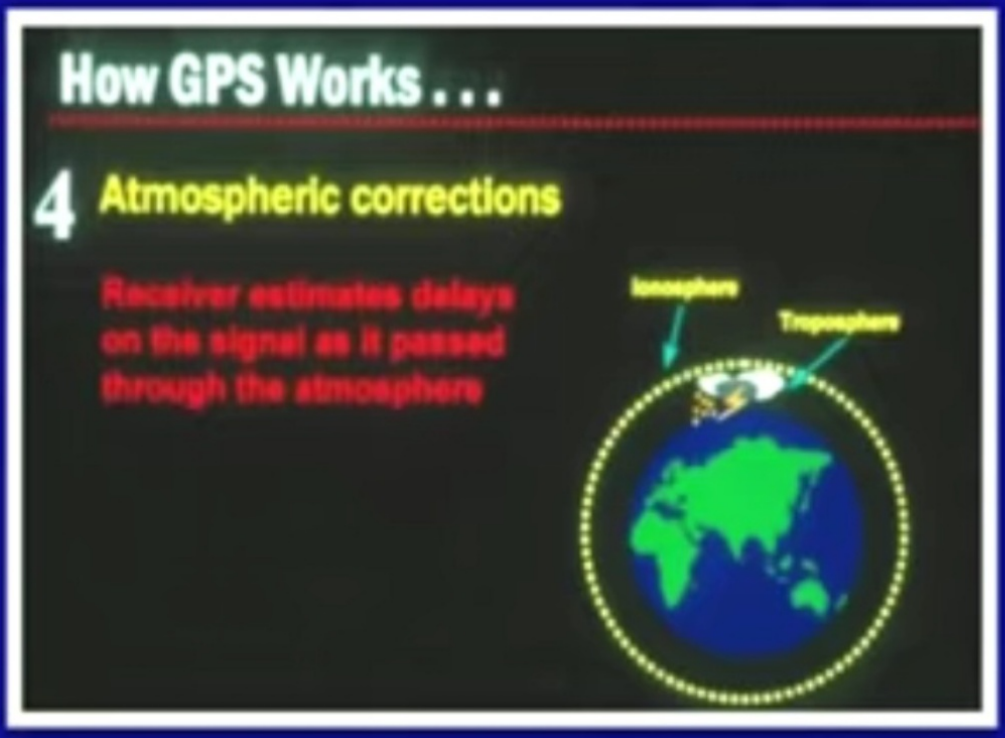


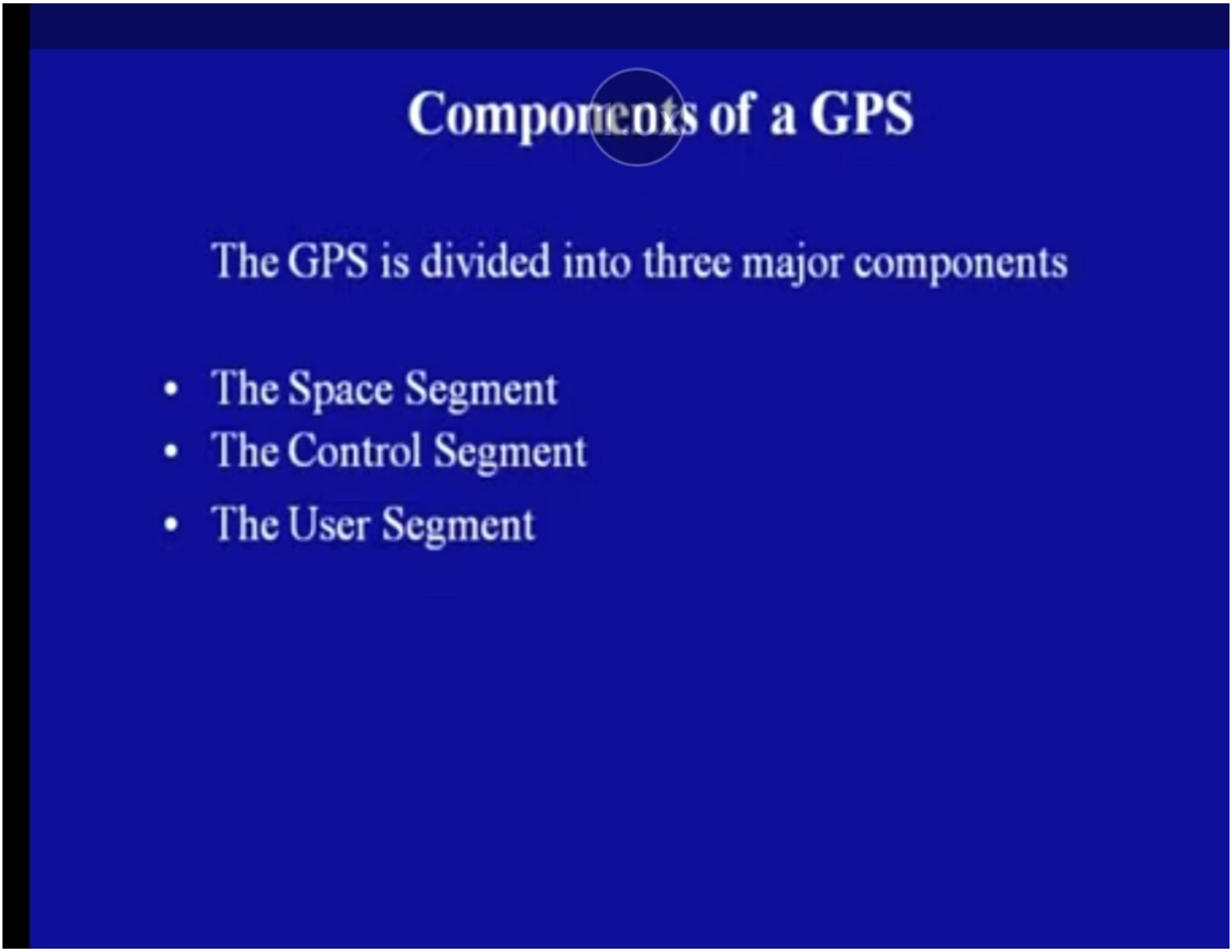
of the satellite in space is required.



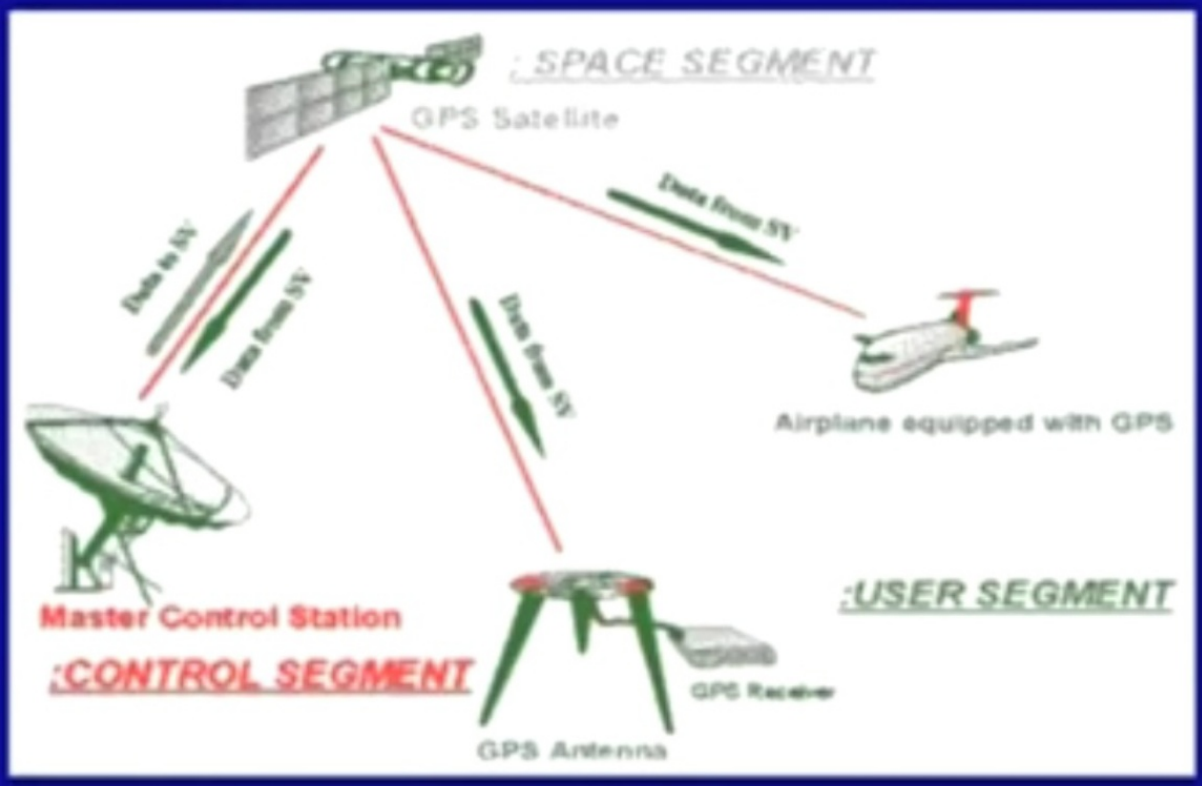
STEP IV

- As the GPS signal travels through the ionosphere and the earth's atmosphere, the signal is delayed.




Components of a GPS
The GPS is divided into three major components
• The Space Segment
• The Control Segment
• The User Segment

COMPONENTS OF GPS



CONTROL SEGMENT

- The Control Segment consists of five monitoring stations
  - Colorado Springs,
  - Ascension Island,
  - Diego Garcia,
  - Hawaii, and
  - Kwajalein Island.

CONTROL SEGMENT

- Ascension, Diego Garcia, and Kwajalein serve as uplink installations, capable of transmitting data to the satellites, including new ephemerides i.e. satellite positions as a function of time, clock corrections, and other broadcast message data.

- Colorado Springs serves as the Master Control station.

CONTROL SEGMENT

- The Control Segment is the sole responsibility of the Department of Defence (DoD) who undertakes construction, launching, maintenance, and virtually constant performance monitoring of all GPS satellites.
- The DoD monitoring stations track all GPS signals for use in controlling the satellites and predicting their orbits.

Control Segment

- Meteorological data are also collected at the monitoring stations, thus allowing for an accurate evaluation of tropospheric delays of GPS signals.
- Satellite tracking data from the monitoring stations are transmitted to the master control station for processing.
- This processing involves the computation of satellite ephemerides and satellite clock corrections.

SPACE SEGMENT

- The Space Segment consists of the Constellation of NAVSTAR earth orbiting satellites.

- The current Department of Defence plan calls for a full constellation of 24 Block II satellites (21 operational and 3 in-orbit spares).

- The satellites are arrayed in 6 orbital planes, inclined 55 degrees to the Equator.

- These orbit at altitudes of about 12000 miles each, with orbital periods of 12 sidereal hours (i.e., determined by or from the stars), or approximately one half of the earth's periods i.e 12 hours.

SPACE SEGMENT

- The next block of satellites known as Block IIR.
- These satellites are expected to provide improved reliability and better capability to range between satellites in order to increase the orbital accuracy.
- Each satellite contains four precise atomic clocks (i.e. Rubidium and Cesium standards) and has a microprocessor on board for limited self-monitoring and data processing.
- The satellites are equipped with thrusters which can be used to maintain or modify their orbits.

USER SEGMENT

- The user segment consists of both civilian and military users.
- It consists of all earth-based GPS receivers which can vary greatly in size and complexity, though the basic design is rather simple.

USER SEGMENT

- A typical receiver is composed of an antenna and preamplifier, radio signal based microprocessor control and display device, data recording unit, and power supply.
- The GPS receiver decodes the timing signals from the 'visible' satellites (generally four or more) and after having calculated the distances from each satellite, computes its own latitude, longitude, elevation, and time.

USER SEGMENT

- This is a continuous process and generally the position is updated on a second-by-second basis.
- This is then sent to the receiver display device and, if the receiver provides for data capture capabilities, it is then stored by the receiver's data logging unit.

SATELLITE RANGING

- GPS positions are based on the measurement of the distance from the satellite to the GPS receiver on earth.
- The GPS receiver can determine the distance to each satellite.
- The basic idea of determination of position is that of resection or trilateration, which many surveyors use in their daily work.

SATELLITE RANGING

- If the distance of three points relative to unknown position is known, then the position of unknown point relative to these three points can be determined.
- Similarly, if the distance of one satellite is known, then the position of the receiver must be at some point on the surface of an imaginary sphere of radius equal to that distance with origin at the satellite.
- By intersecting three imaginary spheres the receiver position can be determined accurately.