ELEMENTS OF ENGINEERING (ENGG111)

SURVEYING

Er. Sandesh Sharma Dulal
sandesh.sharma@ku.edu.np

Surveying

- **Surveying** is the science and art of determining the relative positions of points above, on, or beneath the earth's surface and locating the points in the field.

Contd…

- Distance, angles, directions, coordinates, elevations, areas and volumes are determined from data relating to survey measurements.
- Much of the information gathered from a survey is used in the preparation of plans, maps, charts and diagrams.
- Surveying is the first step for the execution of any project.

Primary divisions of surveying

Based upon the nature of the field

- **Control survey:** used to establish a network of horizontal and vertical control points which serves as a reference framework for other surveys

- **Topographic surveys:** used to determine the natural features of regions such as hills, rivers, lakes and artificial features such as towns, villages, building, roads etc.

Contd…

- **Cadastral surveys:** conducted for land systems to delineate and establish boundaries of fields, houses and other private or public systems

- **Engineering surveys:** undertaken specially for engineering purposes such as design of roads, bridges, dams, water supply etc.

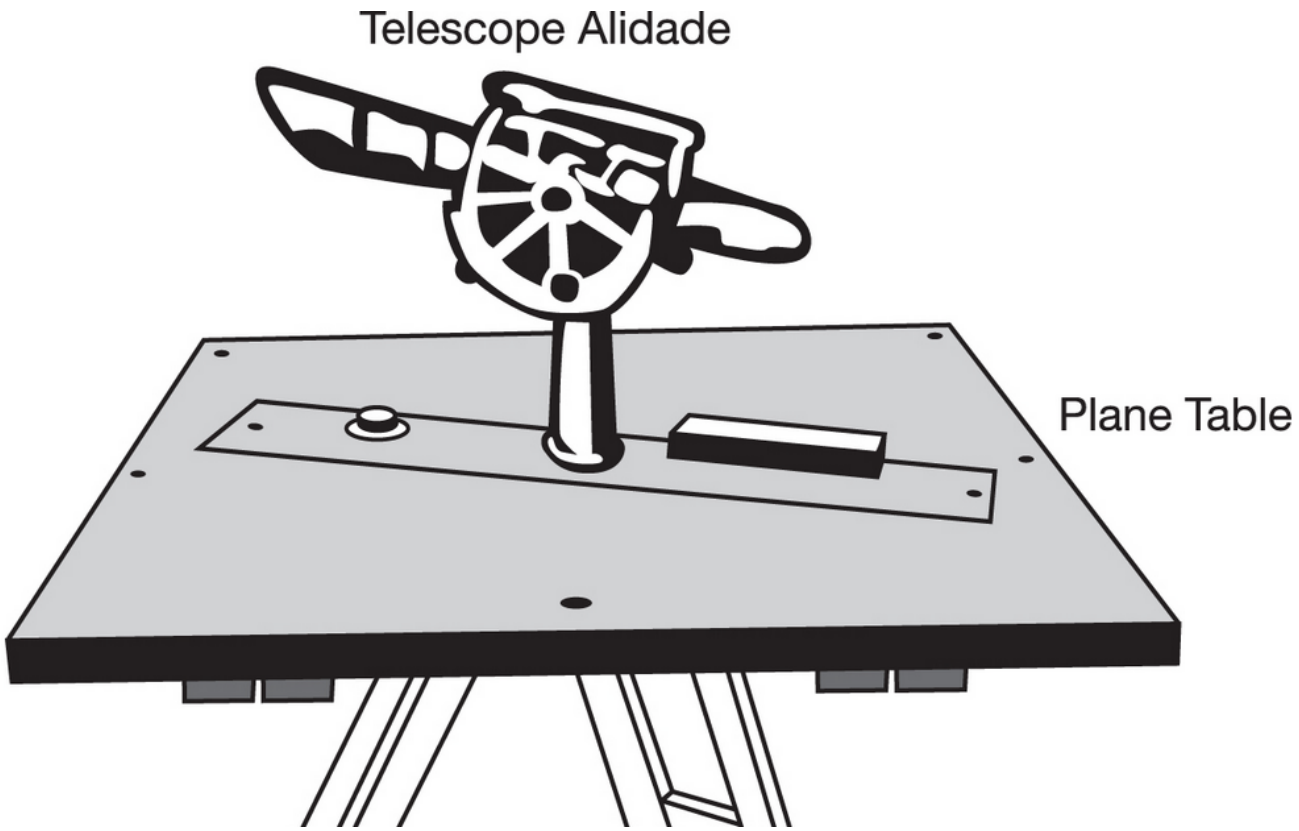
- **Route surveys:** conducted to plan, design and execute a railway, highway, canal, pipeline, transmission line and other linear projects.

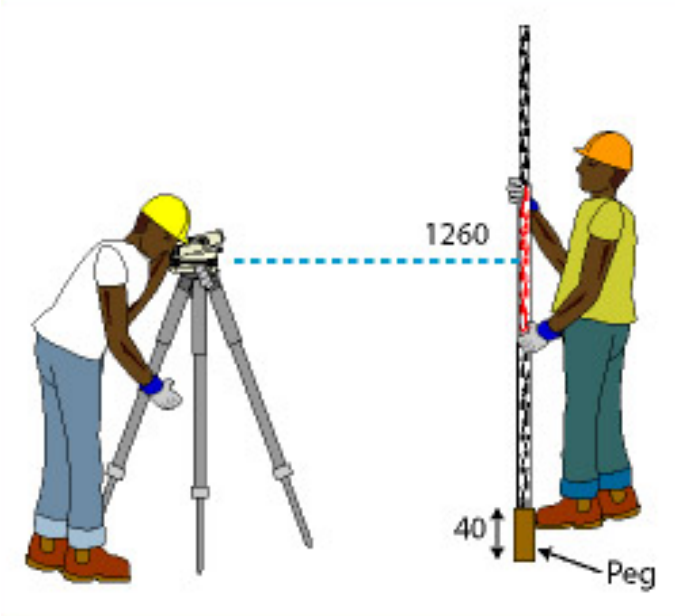
Contd…

- **Construction surveys:** carried to conduct various construction works that includes lay out of survey points and many other
- **Geological surveys:** can determine different strata of the earth's crust and other geological objectives and are used for geographical exploration
- **Mine surveys:** are directed towards the exploration of mineral deposits and to guide tunnelling and other operations associated with mining
- **Military surveys:** include all kinds of surveys conducted for military purpose.

Based on equipment used

- Chain survey
- Compass survey
- Plane table survey
- Levelling survey
- Theodolite survey
- Tacheometric survey
- Photogrammetric survey
- Electronic distance measurement survey
- GPS survey


Telescope Alidade
Plane Table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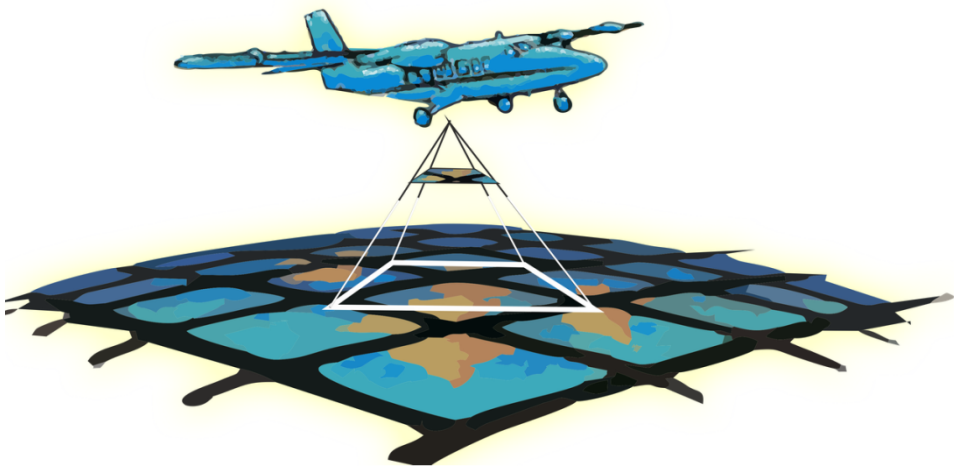


Principles of surveying

- Working from whole to part
- Consistency in work
- Fixing a point in relation to points already localized
- Economy
- Independent check (Survey should be conducted so that errors do not pass undetected)
- Up to date

Phases of good survey work

- Planning, analysis and decision making
- Care and adjustment of instruments
- Fieldwork and acquisition of data
- Office work (Computing and data processing)
- Setting out on the ground

Importance of surveying

- Establishing the property boundaries of private and public lands
- Preparing navigational charts for use on land, sea and air
- Mapping the earth above and below the mean sea level
- Determining the shape and size of the earth
- Preparing astronomical charts showing the location of sun, moon, planets, stars and other celestial bodies

Chain survey

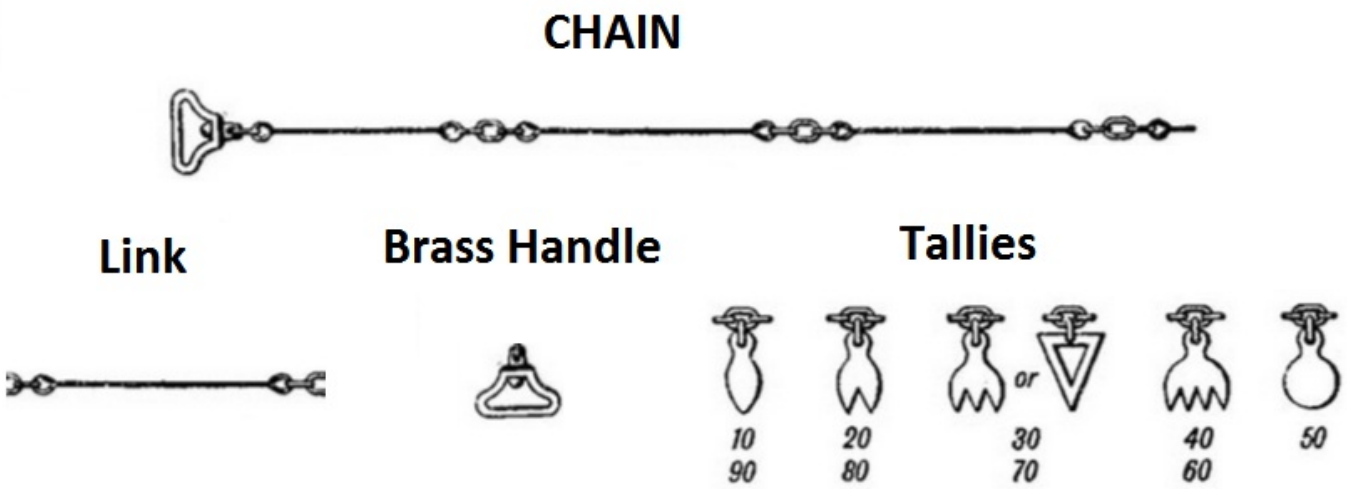
Introduction

- Only linear measurements are made
- Tape/Chain is used to make linear measurement
- This is the simplest form of survey and it is very much useful under the following conditions:

I. Area to be surveyed is flat, open and small
II. The details to be plotted are simple
III. The plans to be plotted are to be drawn on a large scale.

Chains

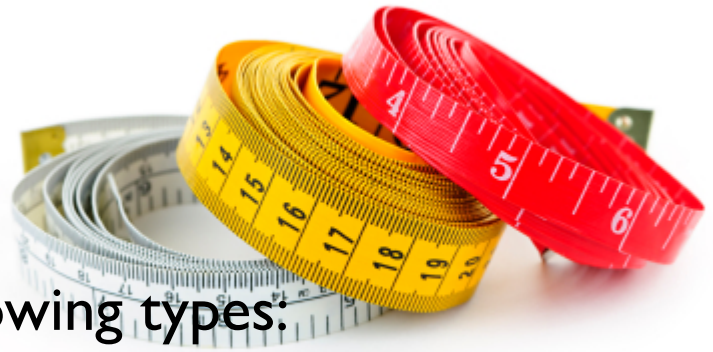
- Measure distance when very great accuracy is not required
- Replaced by tape
- Chain is easily read and easily repaired in the field if broken
- Weight is a disadvantage when the chain has to be suspended.
- Only measurements are taken in the field and rest work such as plotting, calculation etc. are done in the office.
- No angular measurements are made.



Types of surveying chains

- Metric chain
  - lengths of 20m and 30m
  - tallies are fixed at every 5m
- Gunter's chain
  - length = 66'
  - no of links = 100
  - each link = 0.66'
- Engineer's chain
  - length = 100'
  - links at each feet
- Revenue chain
  - length = 33'
  - no. of links = 16
  - commonly used for measuring fields in cadastral survey

Tapes



- Used for accurate work and are of following types:

Cloth or linen tape

- very light, easy to handle
- may be effected by moisture

Metric steel tape

- made of steel
- outer end is provided with a ring for holding

Invar tape

- used for high precision work
- made of alloy steel (35% Ni & 65% steel)

Principle of chain surveying

- To prepare a framework or network of triangles because a triangle is a figure which can be plotted on paper by measuring its sides only
- Formation of well conditioned triangle (no angle greater than 120 degree and smaller than 30 degree)
- Triangles formed should resemble to the shape of an equilateral triangle.

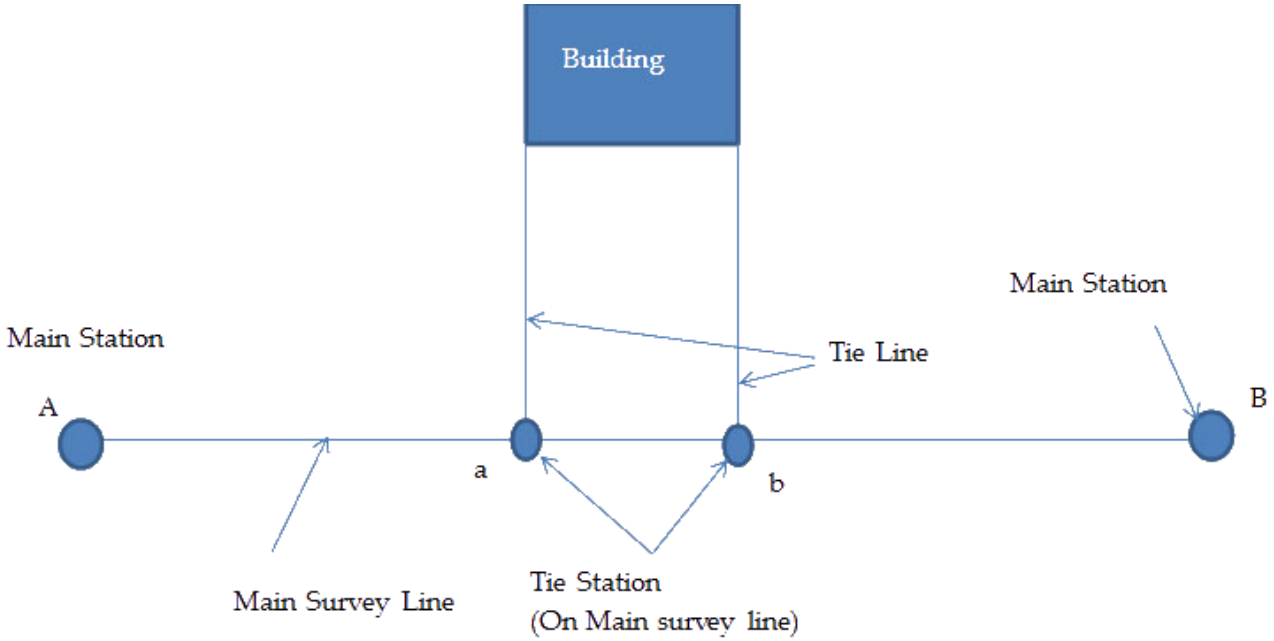
Survey stations

- A survey station in chain surveying is defined as the beginning point or end point.

Types

Main stations: are the end of lines which command the boundaries of survey and the line joining main stations are called main survey line or chain lines.

Subsidiary/Tie stations: are the point selected on the main survey lines, where it is necessary to locate the interior detail such as fence, buildings etc. These helps in running additional lines to locate the details which are away from the main survey lines


Building
Main Station
Main Station
Tie Line
A
B
a
b
Main Survey Line
Tie Station
(On Main survey line)

Survey lines

Base line:

- first line plotted on paper
- Should roughly be the longest line running through the centre of the area to be surveyed

Check line/Proof line:

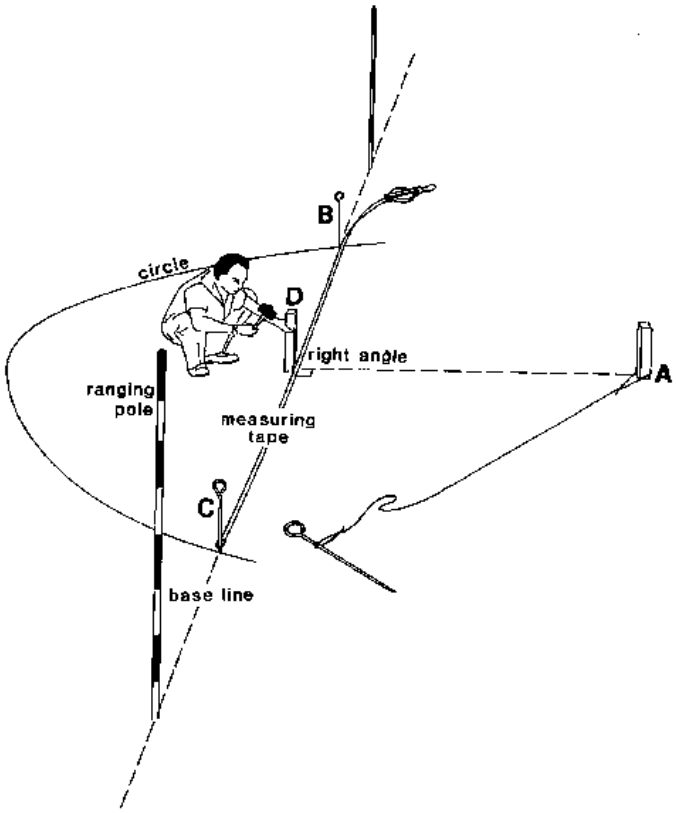
- Provided to check the accuracy of field work and plotting work since it is quite evident that length of line on ground should agree with its corresponding length on paper

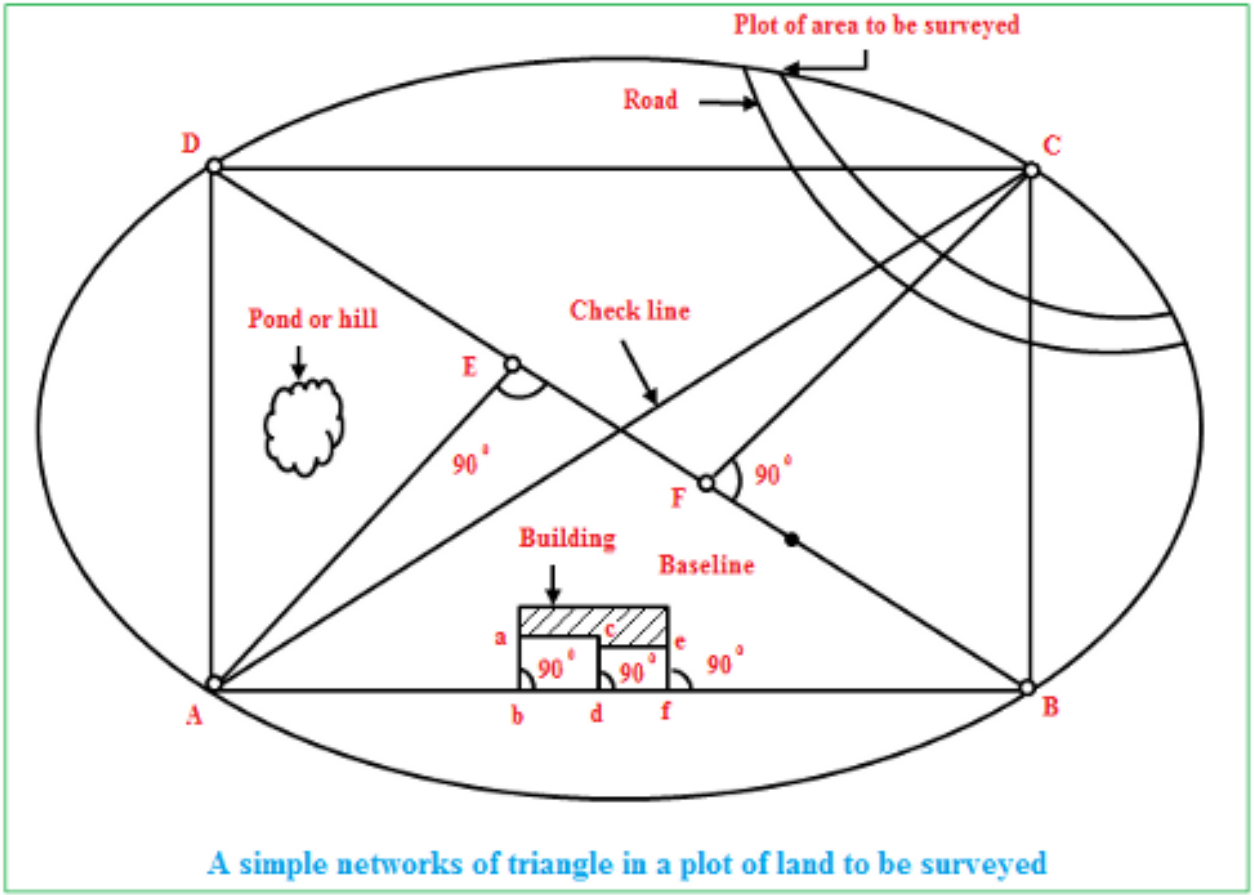
Tie line

- Connects two tie stations
- Checks the accuracy of fieldwork
- Helps in taking additional interior details which are far away from chain lines

Offsets

- Lateral measurements from the base line to fix the positions of the different objects of the work with respect to base line (check line)
- Removal of inaccessibility problem while surveying.





A simple networks of triangle in a plot of land to be surveyed

Field book

- All observations and measurements taken during chain surveying are to be recorded in the standard field book

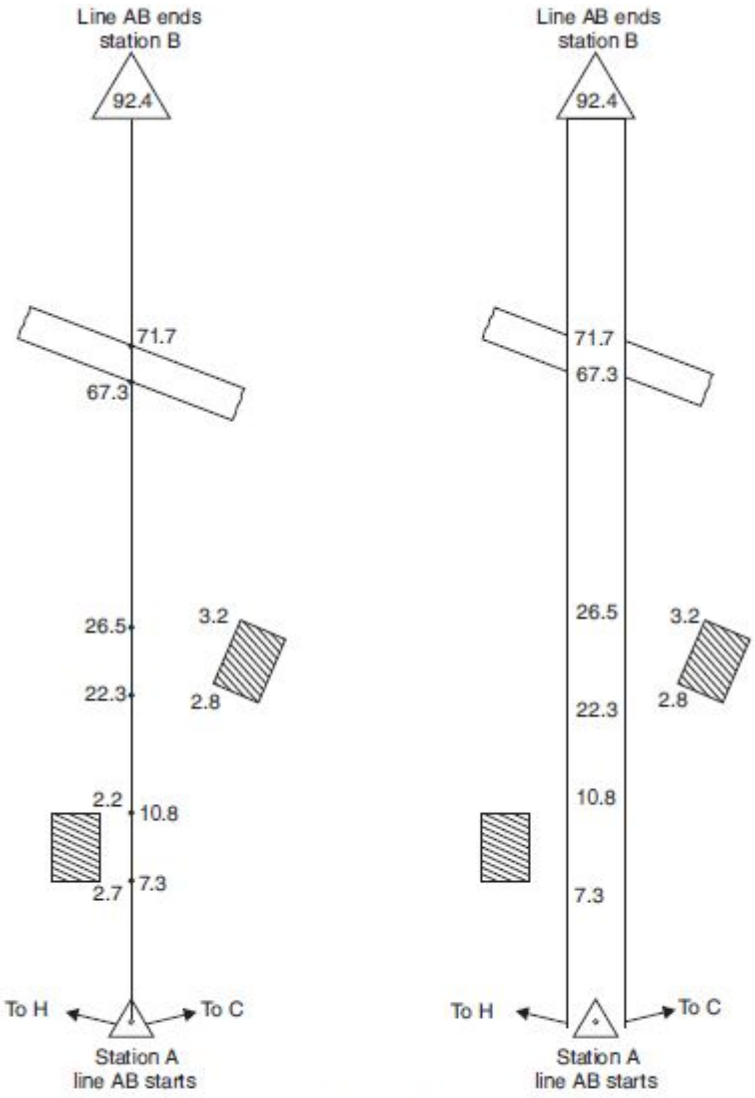


Fig. 12.17

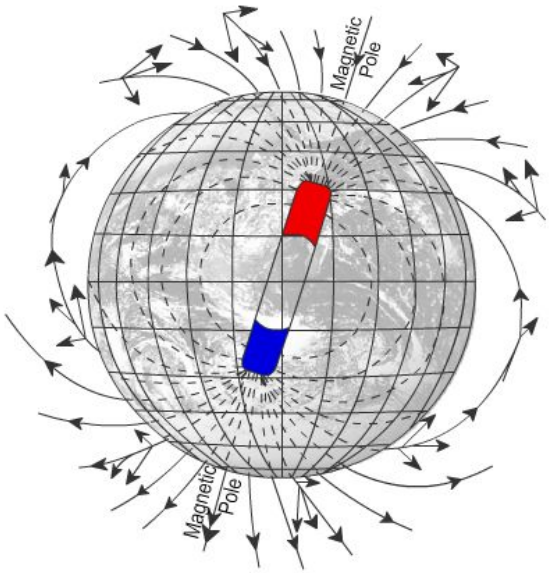
Compass Survey

Introduction

- Compass has been used by navigators and explorers for many centuries to determine directions.
- Compass surveying may be defined as that branch of surveying in which the position of an object is determined by angular measurements using a compass.

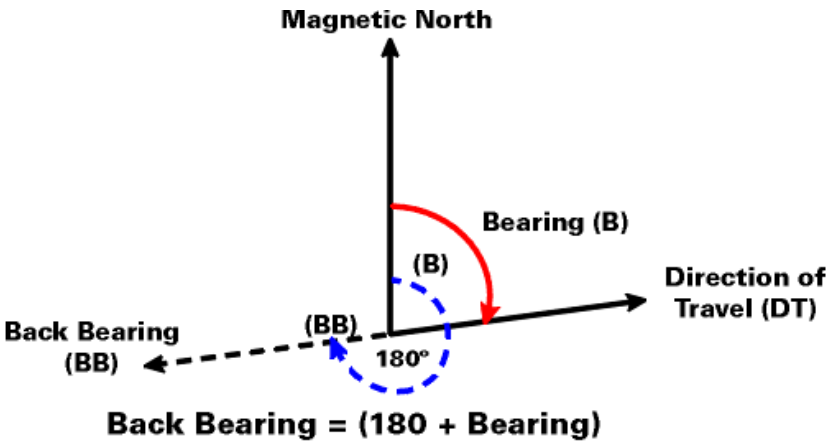
Principle of compass

- Earth acts as powerful magnet
- Freely suspended magnetic needle will align itself in a direction parallel to the magnetic lines of force of the Earth at that point and indicate the magnetic north.



Bearing

- The angle made by a line with the magnetic north in a clockwise direction is known as bearing.



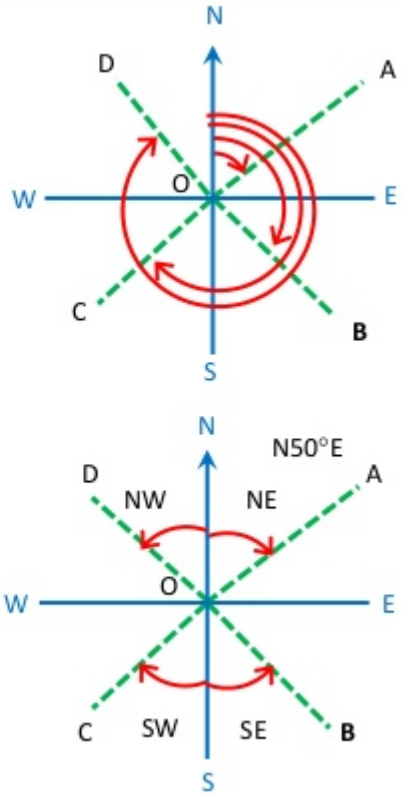
Designation of bearing

Whole circle bearing (WCB)

The magnetic bearing of a line measured clockwise from the North Pole towards the line is known as WCB. Varies 0-360°

Quadrantal bearing (QB)

The magnetic bearing of a line measured clockwise or anticlockwise from NP or SP (whichever is nearer to the line) towards the east or west is known as QB. This system consists of 4-quadrants NE, SE, NW, SW. The values lie between 0-90°

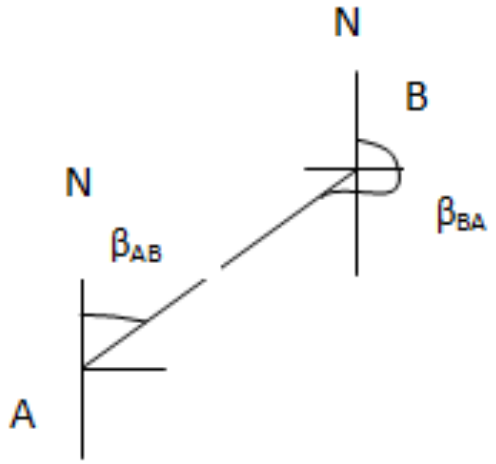


Difference between WCB and QB

WCB	QB/RB
• **Measured clockwise from north direction.** • **Value lies between 0^0 and 360°.** • **WCB is measured using prismatic compass.** • **Also known as Azimuthal Bearing.**	• Measured from North or South in clockwise or anticlockwise direction whichever is nearer • Value lies between 0^0 and 90°. • QB is measured using Surveyor compass. • Also known as Reduced Bearing.

Fore bearing and back bearing

- The bearing of a line in the direction of progress of survey is called F.B.
- The bearing of a line in the direction opposite to the direction of progress of survey is called B.B.



Conversion

TABLE 5.1. CONVERSION OF W.C.B. INTO R.B.

Line	*W.C.B. between*	*Rule for R.B.*	*Quadrant*
AB	0° and 90°	R.B. = W.C.B.	NE
AC	90° and 180°	R.B. = 180° – W.C.B.	SE
AD	180° and 270°	R.B. = W.C.B. – 180°.	SW
AF	270° and 360°	R.B. = 360° – W.C.B.	NW

TABLE 5.2. CONVERSION OF R.B. INTO W.C.B.

Line	*R.B.*	*Rule for W.C.B.*	*W.C.B. between*
AB	N α E	W.C.B. = R.B.	0° and 90°
AC	S β E	W.C.B. = 180° – R.B.	90° and 180°
AD	S θ W	W.C.B. = 180° + R.B.	180° and 270°
AF	N ϕ W	W.C.B. = 360° – R.B.	270° and 360°

Bearing of any line = B.B. of preceding line + included angle

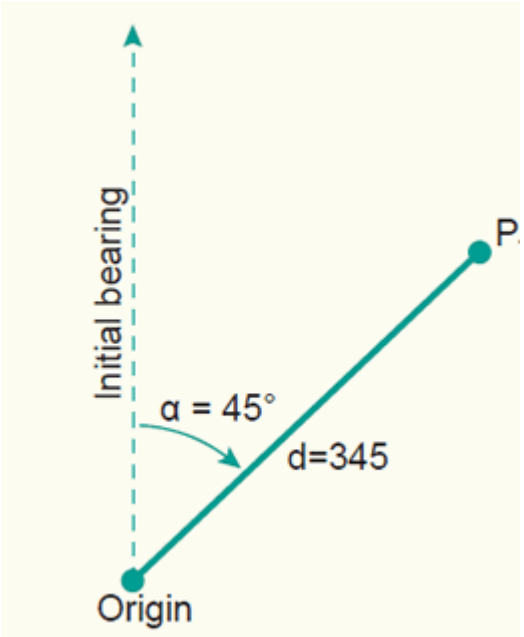
Example 8.5 Compute and tabulate the bearings of a regular hexagon given the starting bearing of side AB = S 50°10′E (Station C is easterly from B).

Q. The bearing of the side of AB of a regular pentagon ABCDE was found to be 54 degree. Compute the bearings of the remaining sides if the pentagon is run counter clockwise.

Local attraction

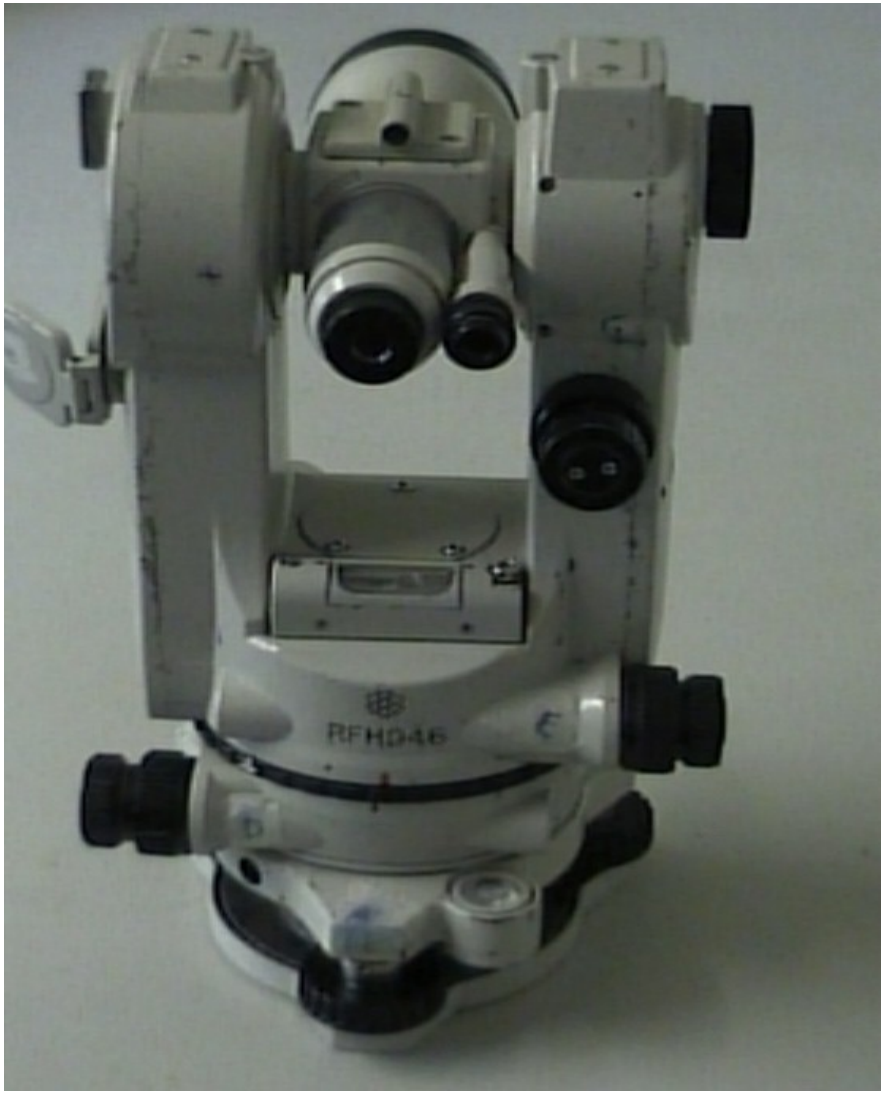
- Magnetic needle normally points towards magnetic north.
- If there are magnetite in the ground, wires carrying electric current, steel structures, iron pipes near a station, they deflect the needle and the needle no longer points to the true magnetic north
- The difference between true magnetic north and north pointed by the magnetic needle at a particular station is known as local attraction.
- F.B. and B.B. of a line should differ by 180 degree. If they do not it is due to local attraction

Coordinate calculation



Easting = Distance* Sin(angle)
Northing = Distance*Cos(angle)

Theodolite



Definition

- A surveying instrument and precision instrument for measuring angles in the horizontal and vertical planes.
- Theodolite is more precise than magnetic compass

Classification

- **Transit Theodolite: A theodolite is called a transit theodolite when its telescope can be transited i.e. revolved through a complete revolution about its horizontal axis in the vertical plane.**
- **Non-Transit type: The telescope cannot be transited. They are inferior in utility and have now become *outdated.***

Basic terms:

- **Vertical axis: It is the axis about which the telescope can be rotated in the horizontal plane.**

- **Horizontal axis: It is the axis about which the telescope can be rotated in the vertical plane. It is also called the *trunion axis*.**

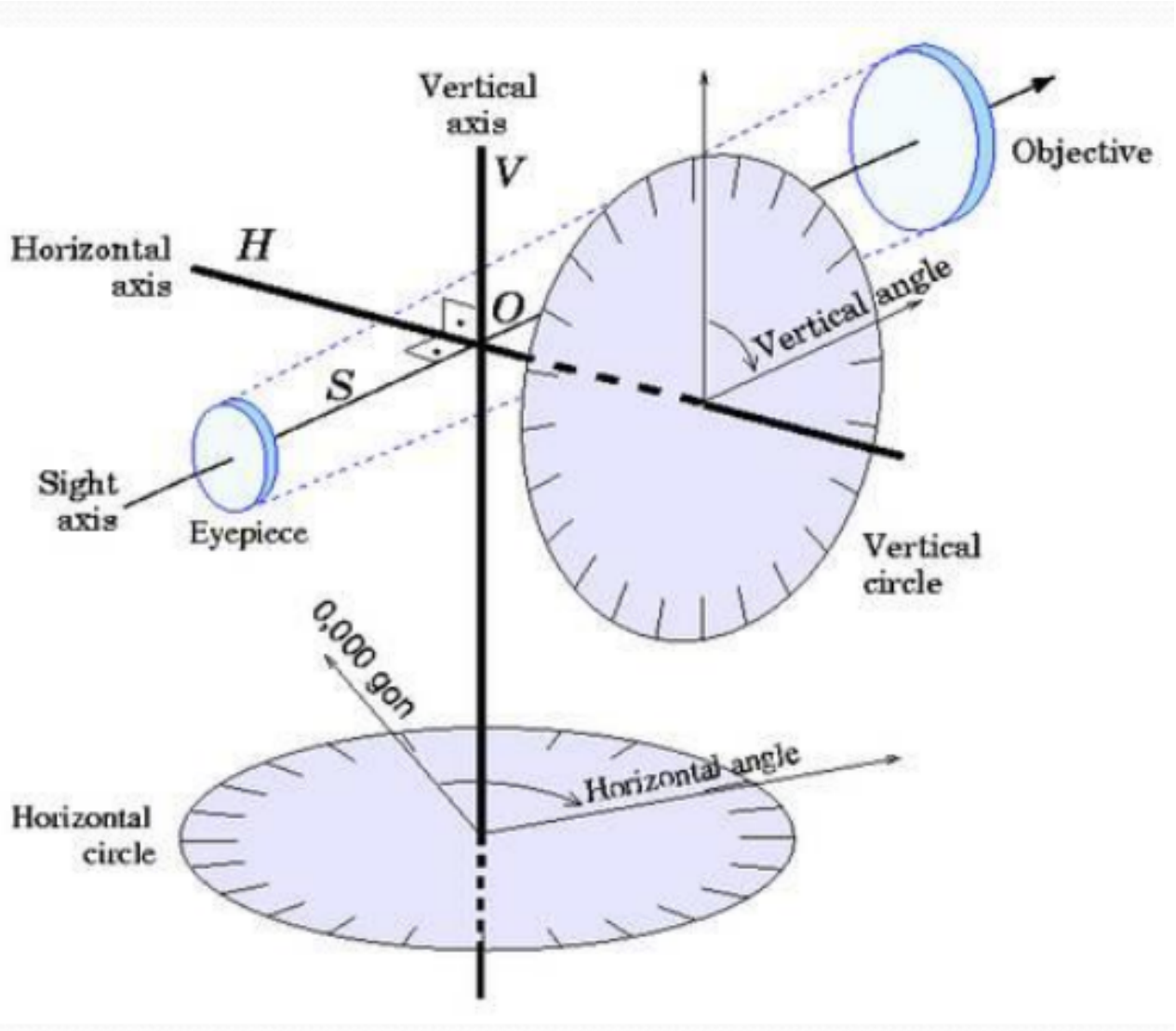
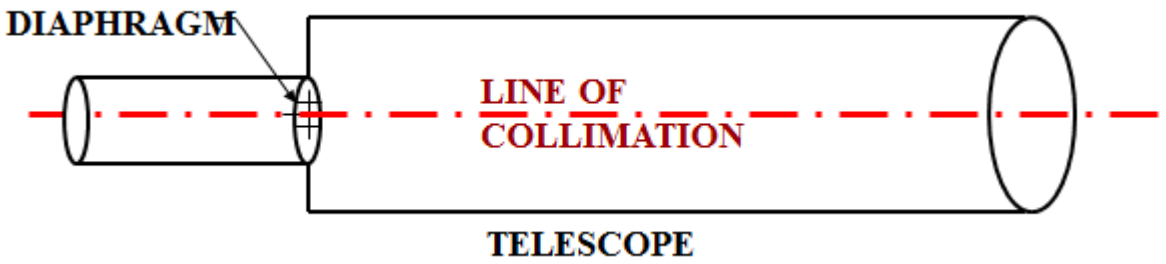


Fig: Axes of theodolite

Contd…

- **Line of sight/Collimation:**



It is also known as the line of collimation. It is an imaginary line joining the intersection of the cross- hairs of the diaphragm to the optical center of the objective and its continuation.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Contd…

- ***Centering:*** **Centering means setting the theodolite exactly over an instrument- station so that its vertical axis lies immediately above the station- mark. It can be done by means of plumb bob suspended from a small hook attached to the vertical axis of the theodolite.**
- ***Transiting:*** **Transiting is also known as *plunging* or *reversing*. It is the process of turning the telescope about its horizontal axis through 180^0 in the vertical plane thus bringing it upside down and making it point , exactly in opposite direction.**
- ***Swinging:*** **It means turning the telescope about its vertical axis in the horizontal plane. A swing is called *right* or *left* according as the telescope is rotated clockwise or counter clockwise.**

Contd…

- ***Face left:*** **If the vertical circle of the instrument is on the left side of the observer while taking a reading ,the position is called the *face left* and the observation taken on the horizontal or vertical circle in this position, is known as the *face left observation.***
- ***Face right:*** **If the vertical circle of the instrument is on the right side of the observer while taking a reading ,the position is called the *face right* and the observation taken on the horizontal or vertical circle in this position, is known as the *face right observation.***

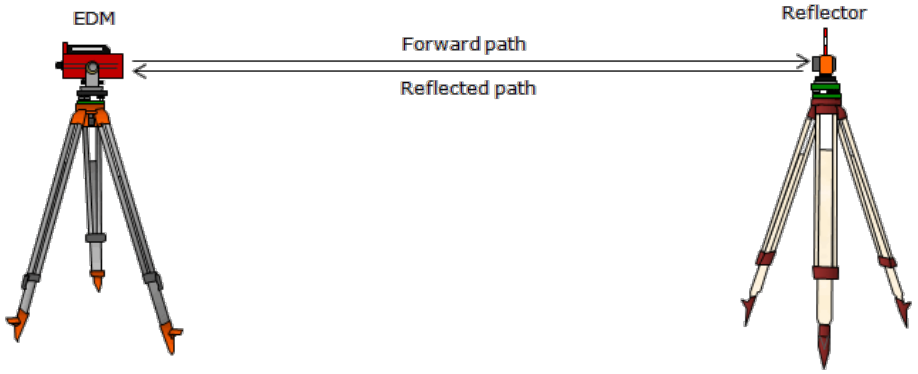
Uses of theodolite

- Mapping applications and in the construction industry…
- Measurement of Horizontal and vertical angle
- Measurement of magnetic bearing of lines
- Locating points on line
- Prolonging survey lines
- Determining difference in elevation
- Setting out curves
- Aligning tunnels
- Mining works etc.

EDM

- Electromagnetic Distance Measurement
- Utilizes electromagnetic energy for measuring distances between two points
- The energy originates at an instrument at one end of a line and is transmitted to a "reflector" at the other end from where it is returned to the originating instrument.

Basic Principle of EDM

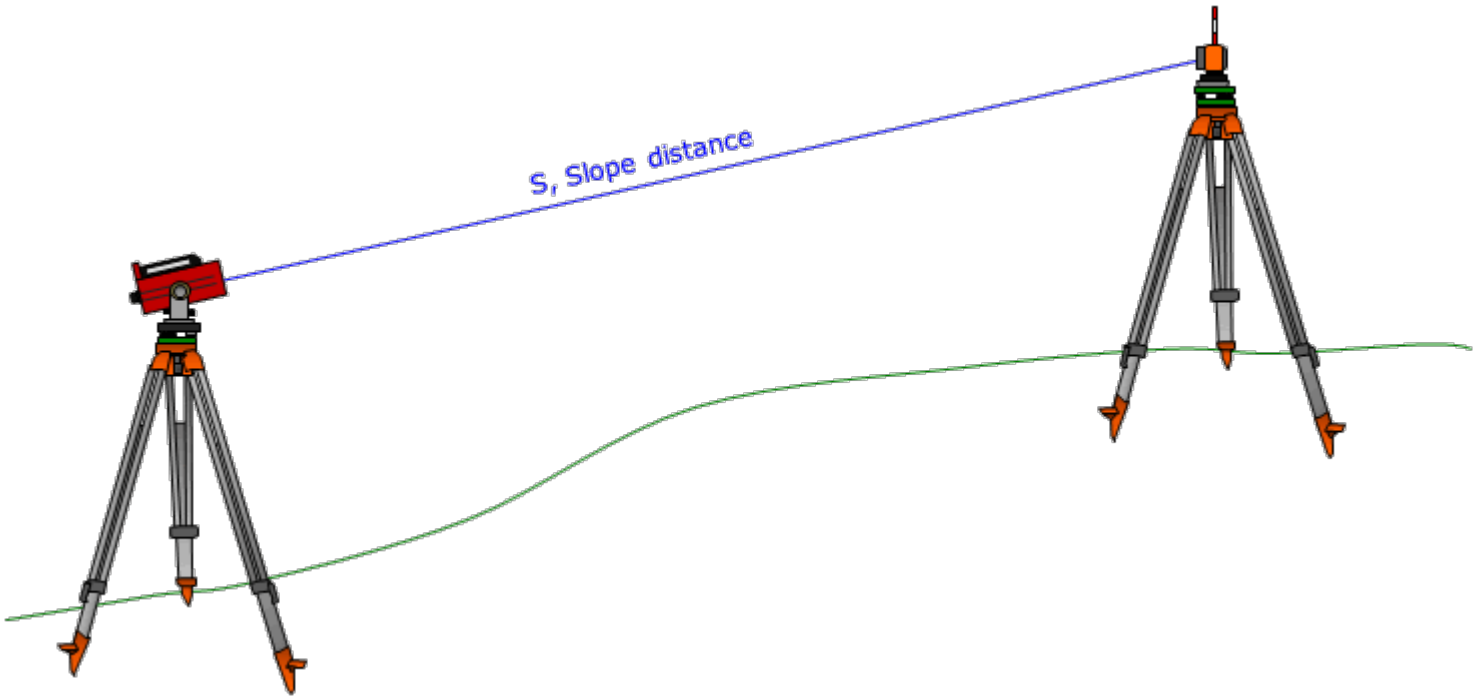


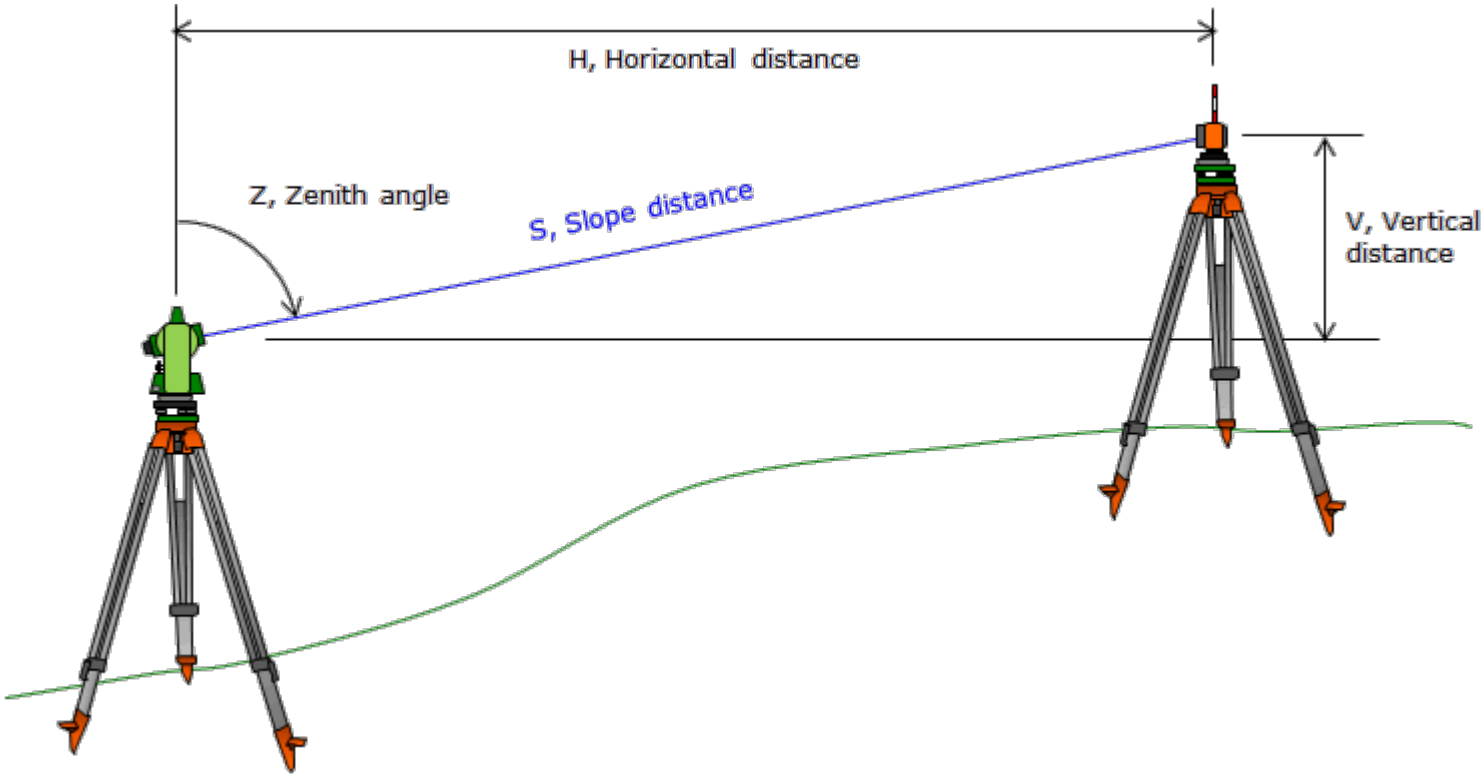
- EDM broadcast signals (EM radiation)
- Simple, distance calculation d = v*t
- Velocity = velocity of light 3*10E8 m/s
- Time is known (difference between sender and receiver)
- Distance is calculated

Total Station

- Modern surveying instrument
- Measure horizontal and vertical angles and slope distances in a single integrated unit.
- In operation total station is set up over the required point and its height over the survey station is measured.

Distance measurement





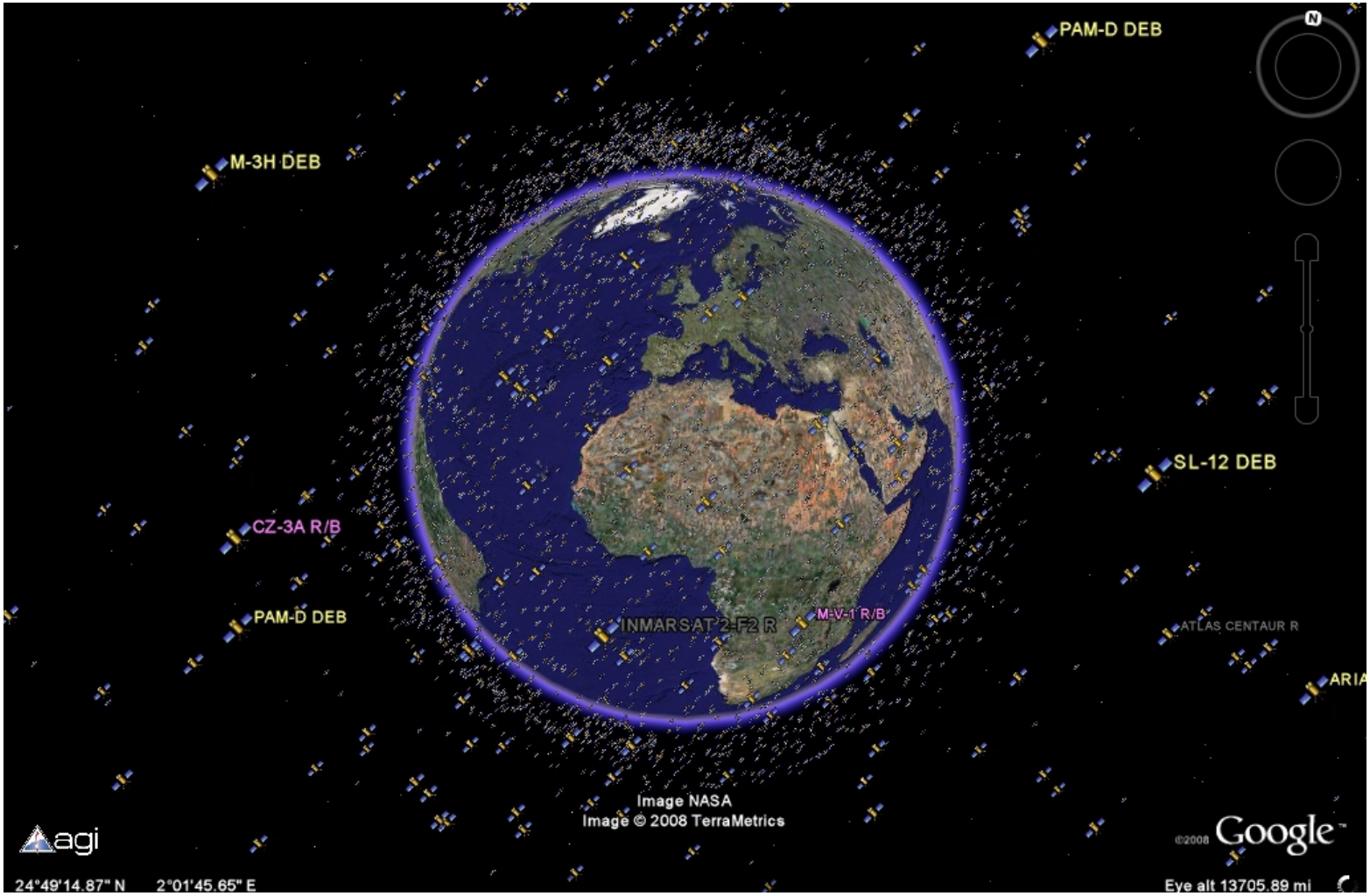
From these two measurements, the Horizontal and Vertical distances are computed by the instrument:

$$H = S \times \sin(Z) \qquad V = S \times \cos(Z)$$

GPS

GPS

- Global Positioning System
- GPS is a satellite based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defense.
- GPS was originally intended for military applications, but in the May 2000, the government made the system available for civilian use.
- GPS works in any weather conditions, anywhere in the world, 24 hours a day.

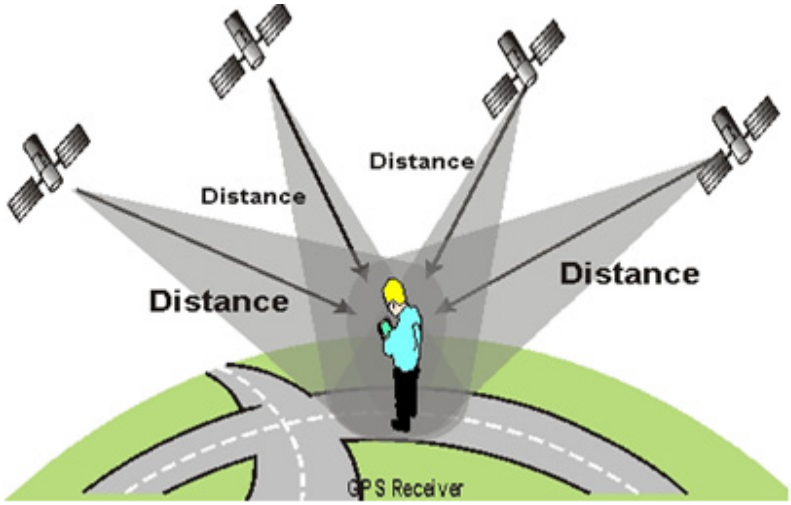

PAM-D DEB
M-3H DEB
SL-12 DEB
CZ-3A R/B
PAM-D DEB
INMARSAT 2-F2 R
M-V-1 R/B
ATLAS CENTAUR R
Image NASA
Image © 2008 TerraMetrics
agi
©2008 Google
24°49'14.87" N 2°01'45.65" E
Eye alt 13705.89 mi

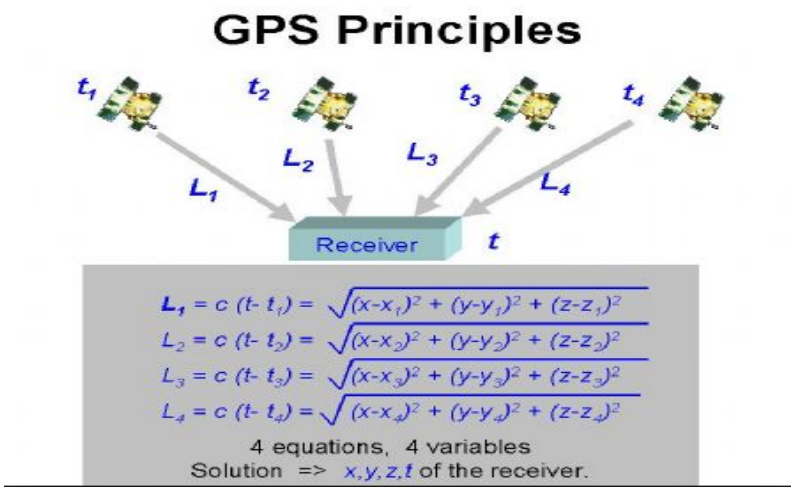
Working principle of GPS

- Each of the 24 satellites emits signals to receivers that determine their location or range by computing the difference between the time that a signal is sent and the time it is received.
  The signal contains data that a receiver uses to compute the locations of the satellites needed for accurate positioning.
- GPS satellites carry atomic clocks that provide extremely accurate time. The time information is placed in the codes broadcast by the satellite so that a receiver can continuously determine the time the signal was broadcast. With information about the ranges to three satellites and the location of the satellite when the signal was sent, the receiver can compute its own three-dimensional position.

- GPS provides specially coded satellite signals that can be processed in a GPS receiver, enabling the receiver to compute position, velocity and time.
- Four GPS satellite signals are used to compute positions in three dimensions.
- Navigation in all three dimensions is the primary function of GPS.

Coordinate calculation





Very famous ***resection*** principle in Surveying

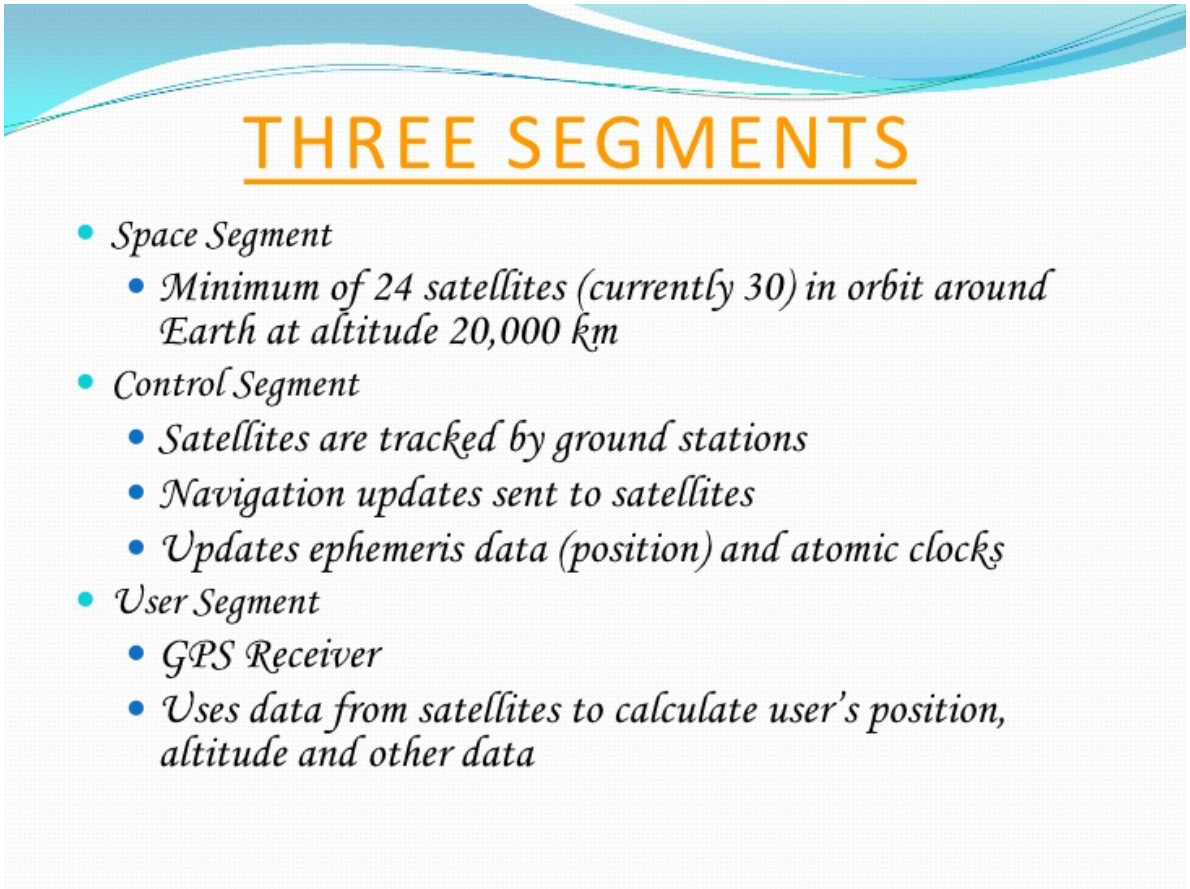
$$C(ts\text{-}to) = \sqrt{(xs - xo)^2 + (ys - yo)^2 + (zs - zo)^2}$$

Distance measurement by GPS

- Satellites broadcast radio signals (EM radiation)
- Simple, distance calculation d = v*t
- Velocity = velocity of light 3*10E8 m/s
- Time is known (difference between sender and receiver)
- Distance is calculated

Segments of GPS

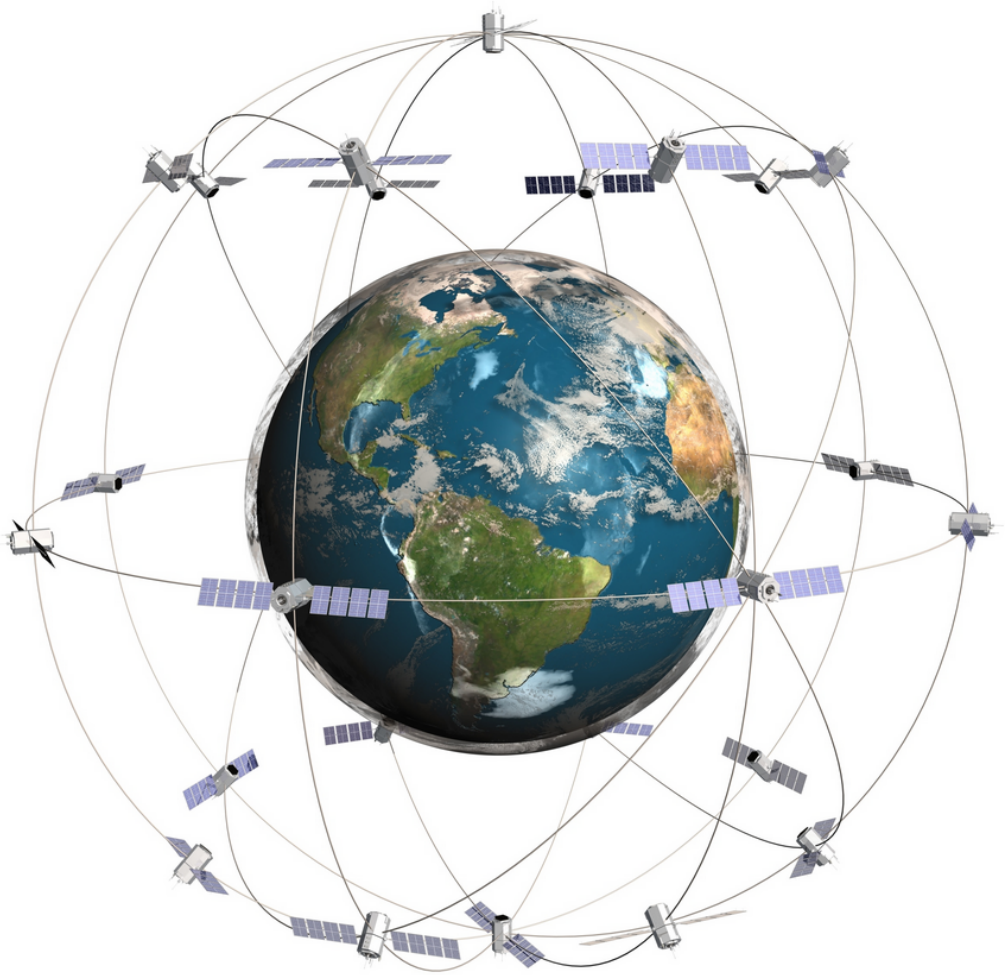
Segments of GPS

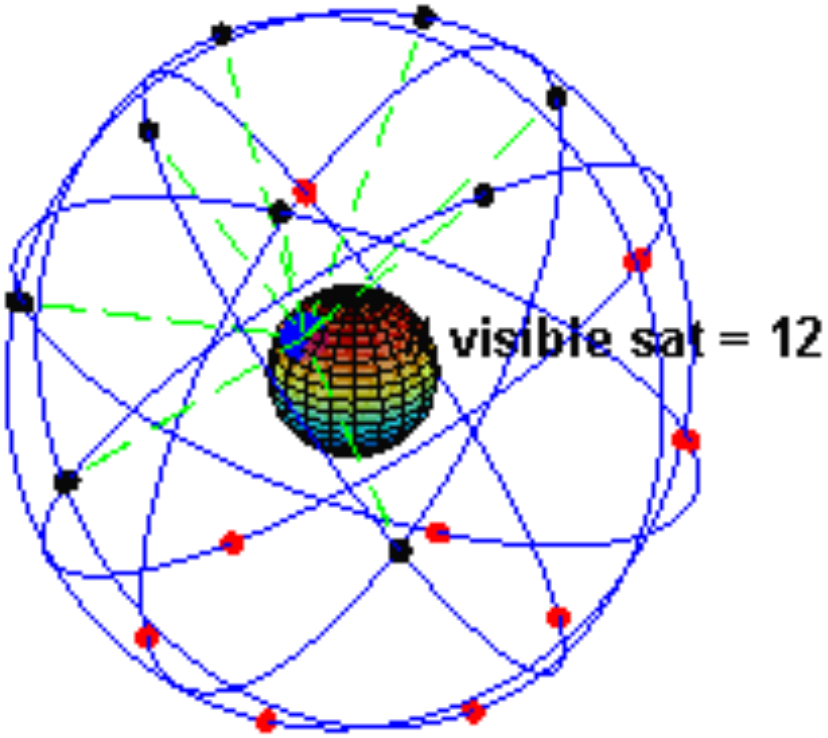


Other satellite systems

Other satellite navigation systems in use or various states of development include:

- **GLONASS** – Russia's global navigation system. Fully operational worldwide.
- **Galileo** – a global system being developed by the European Union and other partner countries, planned to be operational by 2014 (and fully deployed by 2019)
- **Beidou** – People's Republic of China's regional system, currently limited to Asia and the West Pacific
- **COMPASS** – People's Republic of China's global system, planned to be operational by 2020
- **IRNSS** – India's regional navigation system, planned to be operational by 2015, covering India and Northern Indian Ocean
- **QZSS** – Japanese regional system covering Asia and Oceania

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Uses of GPS

Location - determining a position
Navigation - getting from one location to another
Tracking - monitoring object or personal movement
Mapping - creating maps of the world
Timing - bringing precise timing to the world

Any Queries?


THANK YOU
for your attention!