GNSS

Civil Engineering - Year 3

(Engineering Surveying)
CEP 311

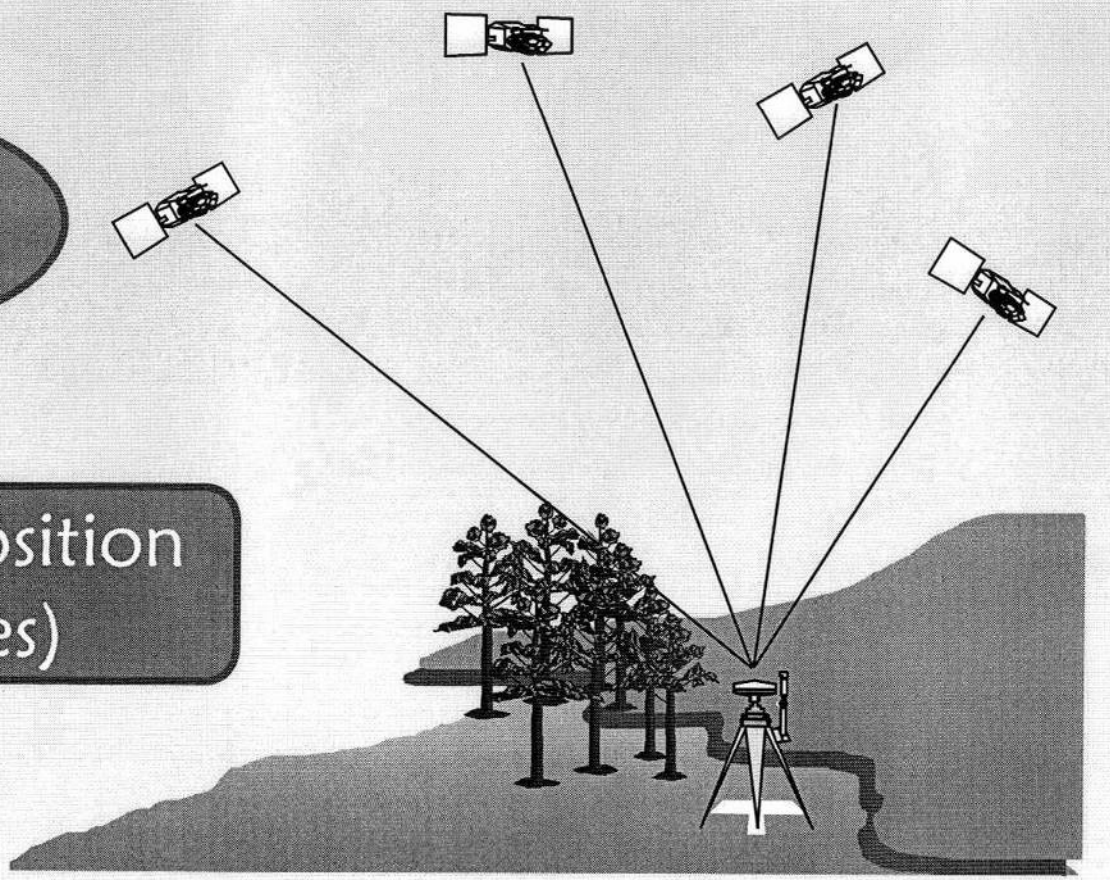
Dr Ahmed Ragheb

GNSS Basic Idea

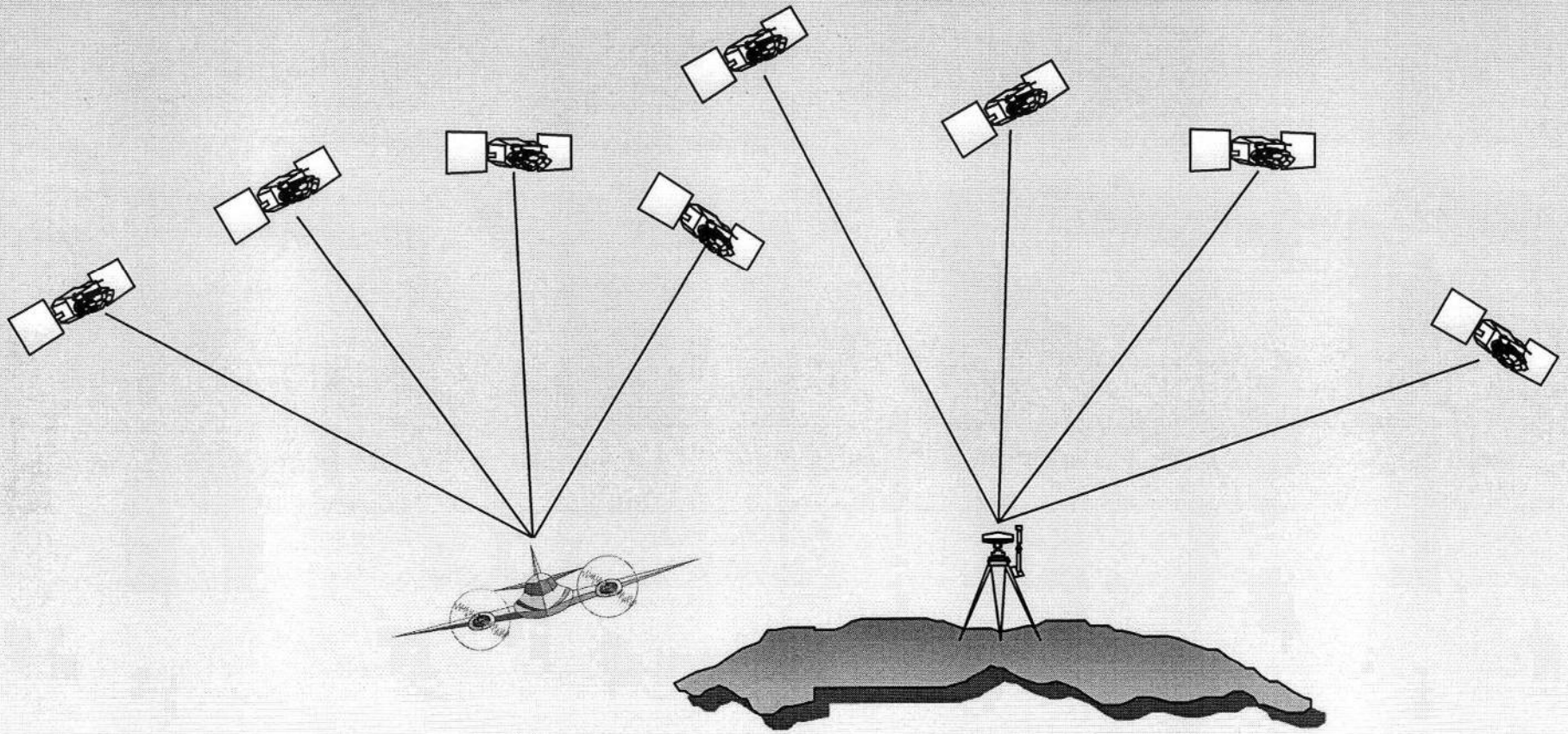
Receive Satellite Signals

Processing

Obtain receiver position (3D coordinates)



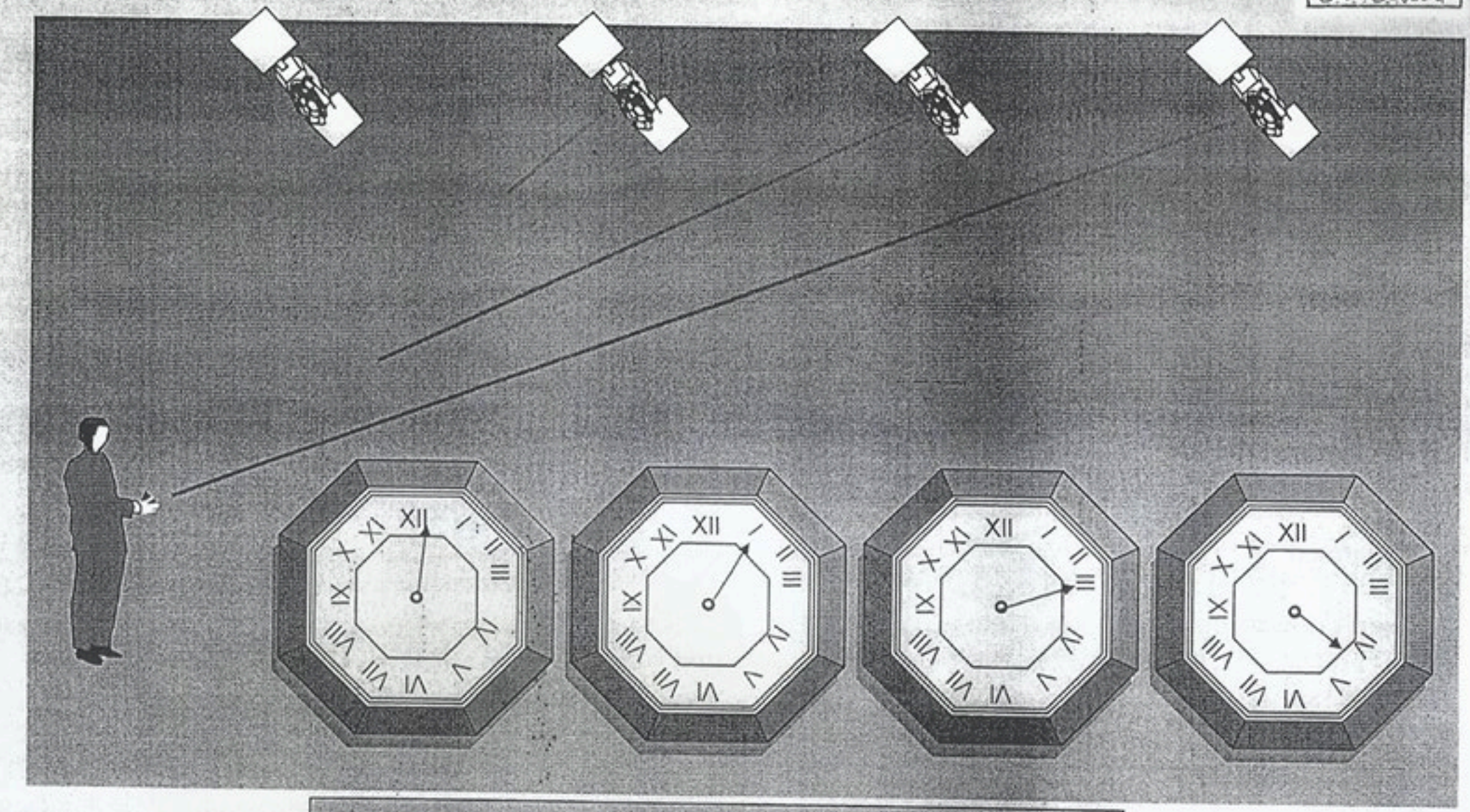
GNSS Basic Observations



4 Ranges to solve for Latitude, Longitude, Height and Time

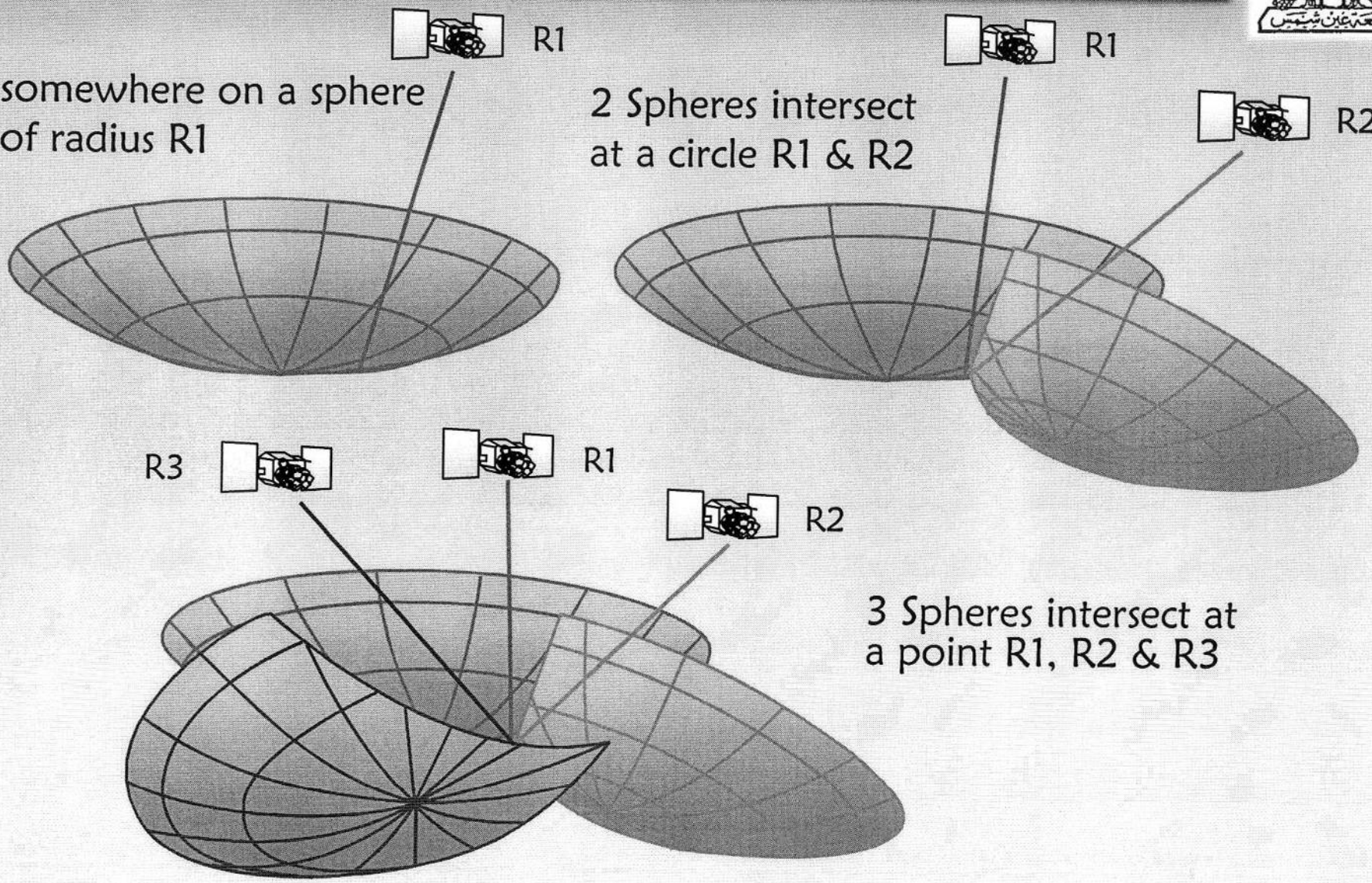
This technique is famously called a **RESECTION** problem

GNSS Range Measurement

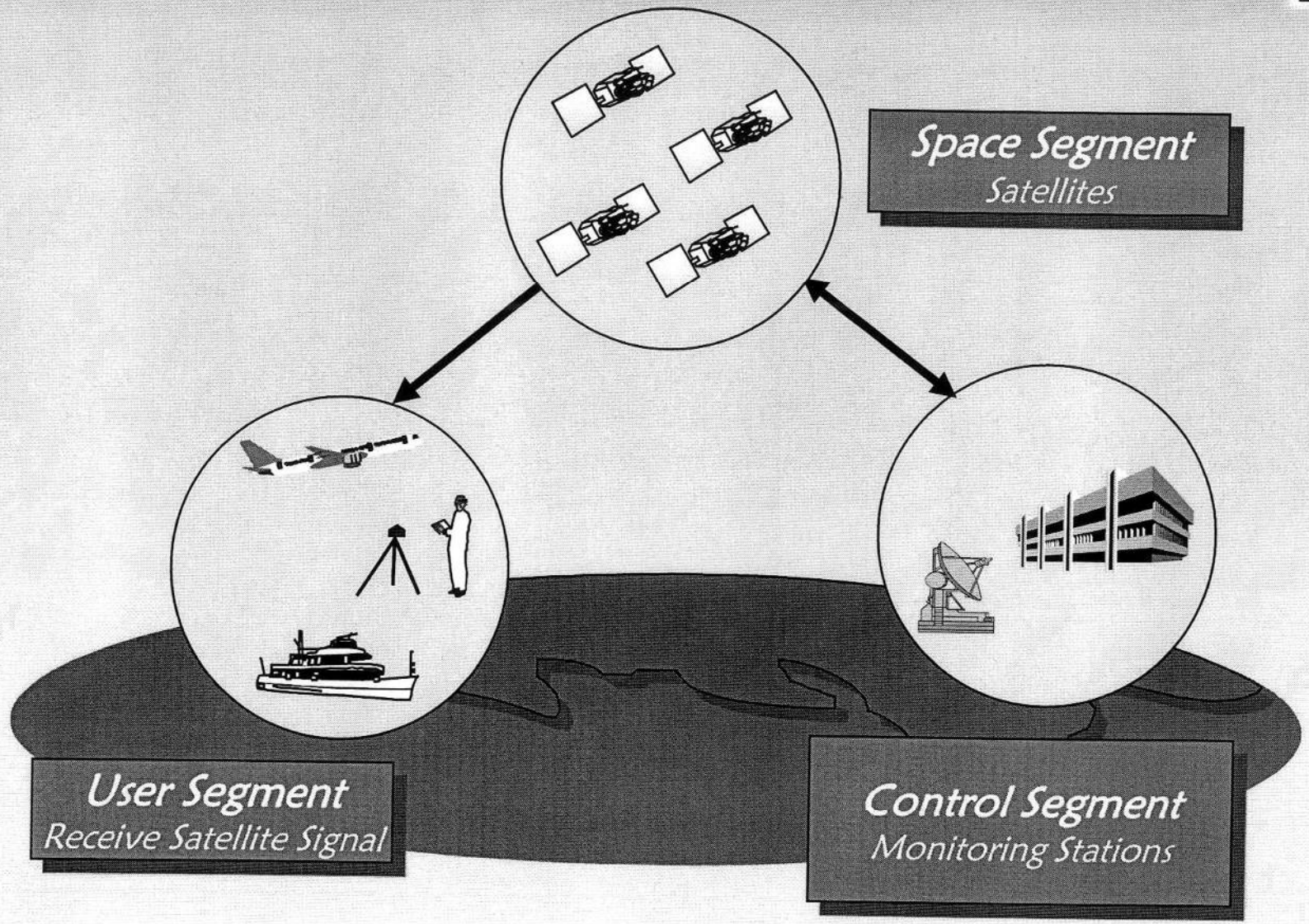


Range = Time Taken x Speed of Light

GNSS Basic Concept Graphically

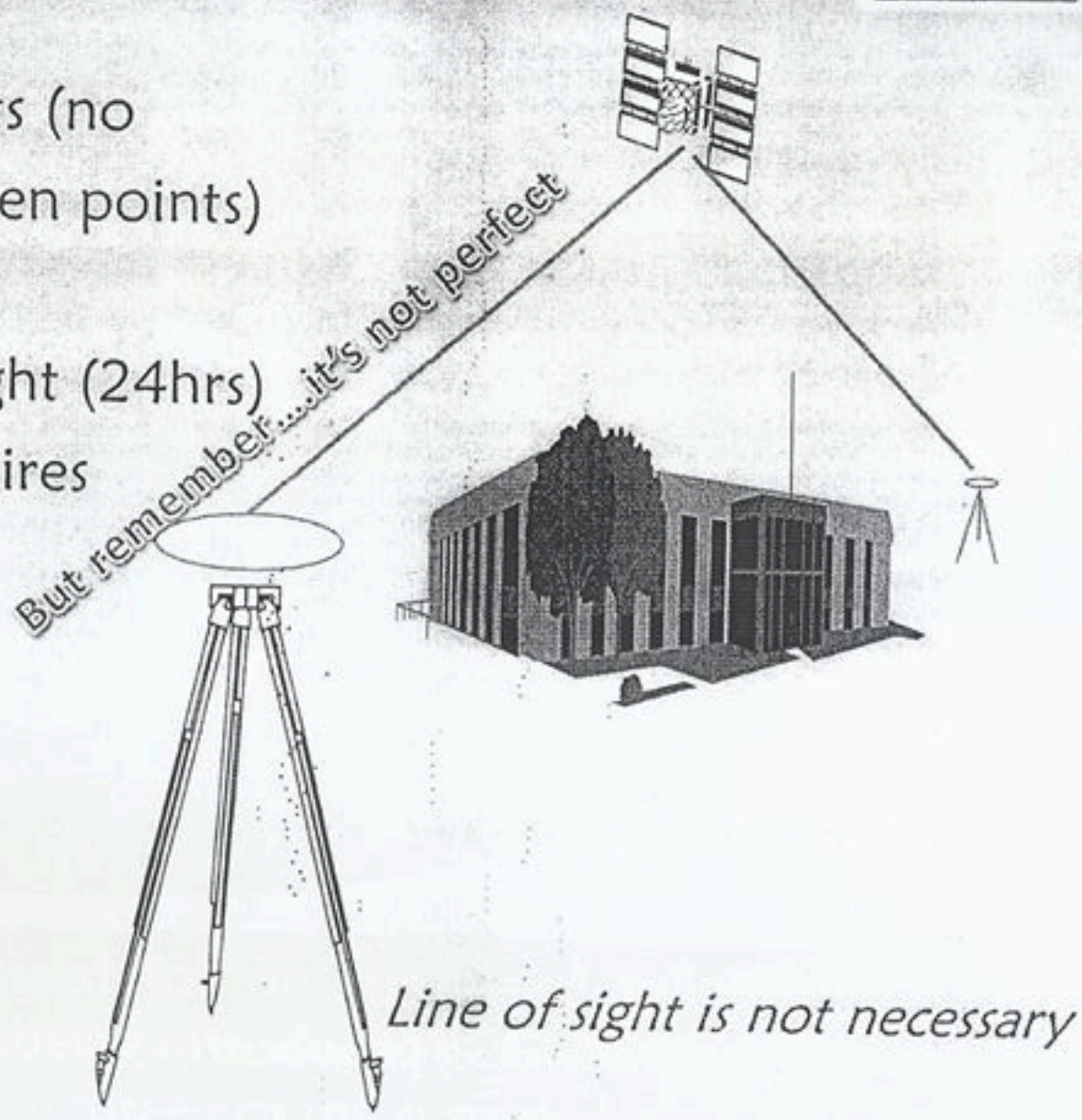


GNSS System Components



GNSS Benefit of GNSS?

- Weather Independent
- Does not require line of sights (no need for intervisibility between points)
- High Geodetic Accuracy
- Can be operated day and night (24hrs)
- Quick (time saving) and requires less Manpower
- Economical advantages
- Common Coordinate System
- Wide Range of Applications (land, marine, navigation)
- Competitively Priced
- No distance limitations



Line of sight is not necessary

Why GNSS?

To have a choice and not to be completely dependent on GPS

Benefiting the society of tomorrow

GPS suffers from a total absence of reliability guarantee

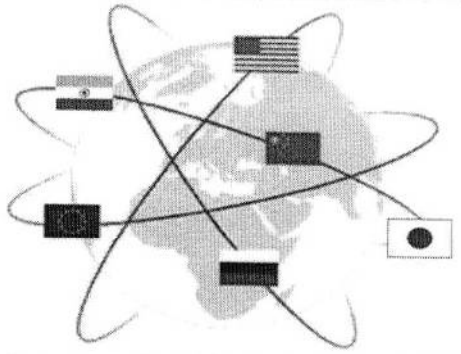
Any intentional or unintentional GPS service disruption will generate economic, organisational and military problems. Several cases of GPS service disruption is continuously reported over the years

Due to the continuous need for precision and reliability improvement, updates are being introduced in GNSS aimed at improving the accuracy of the system

GNSS Available Systems

GLOBAL NAVIGATION SATELLITE SYSTEM

- GPS (USA)
- GLONASS (RUSSIA)
- GALILEO (EU)
- CNSS (CHINA)
- QZSS (JAPAN)
- IRNSS (INDIA)



GNSS

GPS

Global Positioning System

Developed by the US Department of Defense (DOD) early 1970s initially for military use only.

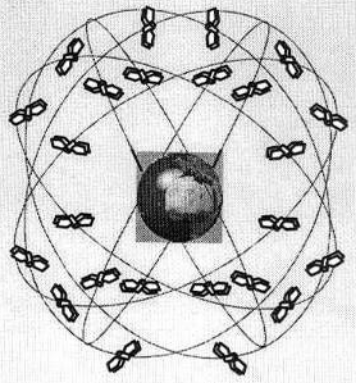
- Nowadays, accessible for Civil and Military users

- Most widely used system

Coordinate System: WGS84 (location of the North Pole in 1984)

Signals: L1, L2, (**NOW** L2C, L5, **NEXT** L1C)

Satellites: 31 (29 Operational and 2 maintenance (March 2015)



Orbits: 6 orbital planes

Altitude: 20200 km, completing one cycle approximately every 11h 55m

Applications: Military and Civil

GNSS

GLONASS

GLObal NAvigation Satellite System

Managed by Russian Federation Government, Russian Space Forces and Ministry of Defense of the Russian Federation

First launch 1982. Full constellation of satellites was not completed until 1996

Coordinate system : PZ-90 (Parameters of the Earth 1990) average North pole position from 1900 to 1905

Signals: L1, L2 and L3

Satellites: 28 satellites, including (24 operational, 1 under maintenance, 2 under test, 1 under check) (March 2015).

Orbits: 3 orbital planes separated 120 degrees with 45 degrees inclination.

Altitude: 19100 km, completing one cycle approximately every 11h 15m

Applications: Standard (SPS) and Precise Positioning service (PPS)

GNSS

GALILEO

The Galileo programme is jointly managed and financed by: EC (European Commission) and ESA (European space Agency)

Expected to be fully operational by 2020

GALILEO is expected to be reliable, as it includes a signal **"integrity message"** informing the user immediately of any errors

Coordinate system: WGS84

Signals : E5a band, the E5b band, the E6 band , the L1 band and E1 band

Satellites: Now 4 Validation satellites, expected 18 in 2015 and rest in 2020, providing more signals in northern and southern latitudes

Orbits: 3 orbital planes at 56° inclination. Each plane will contain 9 operational satellites, equally spaced, 40° apart, plus one spare satellite

Altitude: 23222 km, completing one cycle every 14h 6m

Applications:

Open Service (For applications targeted at regular civilian user)
Commercial Service (Professional users)
Safety Of Life (For safety critical applications in air, sea and land)
Public Regulated Service (governmental bodies)
Search And Rescue (Reception of emergency messages for air / sea rescue)

Compass Navigation Satellite System

Coordinate system: (China Geodetic Coordinate System CGCS2000).

Signals: B1,B2,B3 and L5

Satellites:

2000-2003: experimental consisting of 3 satellites with limited coverage and applications in China and neighboring countries (Compass Beidou 1)

By 2011: 10 satellites offering services for the Asia-Pacific region (Compass Beidou 2)

2012: 5 more satellites for Beidou 2 have been launched

By 2020: 35 satellites, Full global Beidou navigation system coverage

Orbits: 3 orbital planes, each plane will eventually contain 9 satellites, equally spaced plus one spare satellite

Altitude: 20000km, completing one cycle every 12h 36m

Applications:

1- Open service (positioning)

2- Authorized service (higher accuracy for authorized users)

GNSS — IRNSS

Indian Regional Navigational Satellite System

Joint between Indian Space Research Organization and Indian Government

Satellites: 3 (2015), expected to be 7 satellites in 2016

Altitude: 24000 km

Orbits: 29 degrees inclination.

Applications:

1- Standard Positioning Service (civilian users)

2- Restricted Service (authorised users)

Military purposes especially if other systems are encrypted)

GNSS QZSS

Quasi Zenith Satellite System (Michibiki)

Operated by JAXA : Japan Aerospace Exploration Agency, covering East Asia and centered on Japan

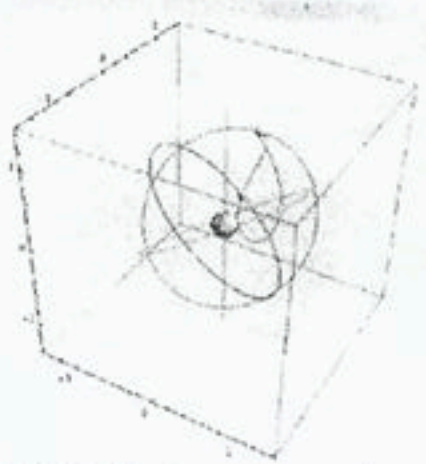
First satellite launched in 2010

Coordinate system: [Japanese Geodetic System (JGS)]

Signals: L1 , L2, L2CL5, L1-SAIF and LEX (to improve accuracy)

Satellites: 3 satellites in 3 orbital planes
(4 in 2018, 7 in the future)

Orbits: 3 orbital planes, each plane containing one satellite inclined at ≈ 45 degree and 120 degree apart so that at least one satellite can be observed near zenith over Japan



Altitude: 42164 km

Applications:

Expand area and time duration of positioning service in mountainous and urban regions in Japan and enhance GPS services regarding satellite availability and accuracy

SBAS

Satellite Based Augmentation Systems

Correction signals transmitted from special satellites improving the accuracy of GNSS receivers, mainly for safety for aviation

- **WAAS** (Wide Area Augmentation System) North America
- **SNAS** (Satellite Navigation Augmentation System) China
- **GAGAN** (GPS Aided Geo Augmented Navigation) India
- **MSAS** (Multi-Functional Satellite Augmentation System) Japan and other Asiatic countries
- **SDCM** (System for Differential Correction and Monitoring) Russia
- **EGNOS** (European Geostationary Navigation Overlay Service) European community