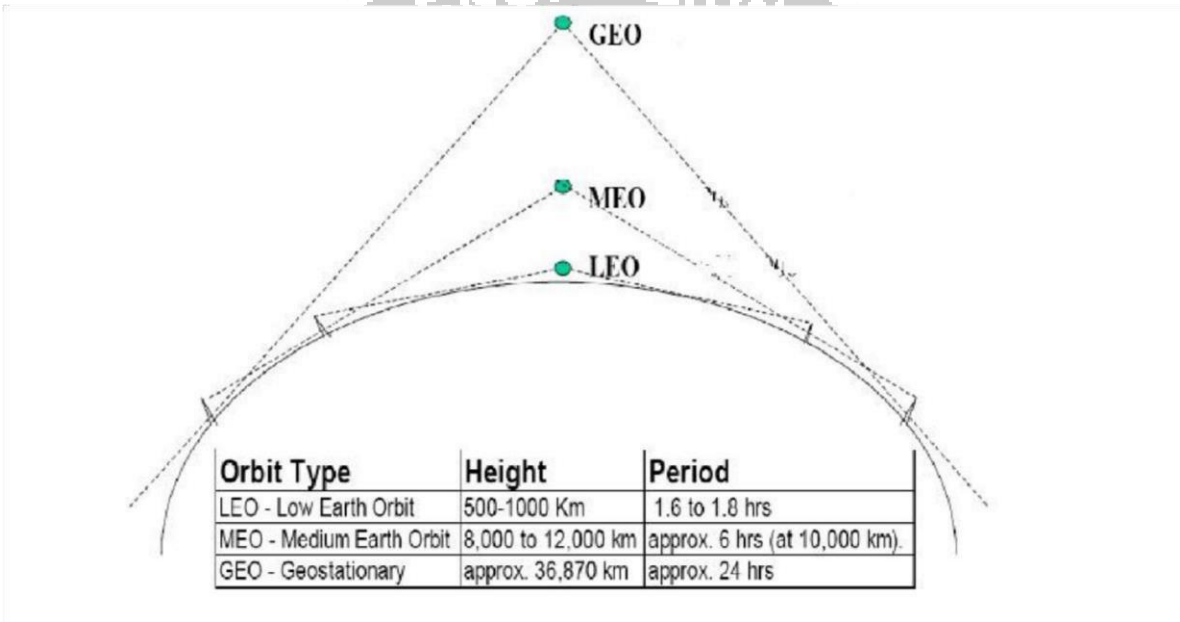
1. LEO: Low Earth Orbit satellites have a small area of coverage. They are positioned in an orbit approximately 3000km from the surface of the earth

- They complete one orbit every 90 minutes
- The large majority of satellites are in low earth orbit
- The Iridium system utilizes LEO satellites (780km high)

The satellite in LEO orbit is visible to a point on the earth for a very short time



Orbit Type	Height	Period
LEO - Low Earth Orbit	500-1000 Km	1.6 to 1.8 hrs
MEO - Medium Earth Orbit	8,000 to 12,000 km	approx. 6 hrs (at 10,000 km)
GEO - Geostationary	approx. 36,870 km	approx. 24 hrs

Figure LEO, MEO & GEO range

MEO: *Medium Earth Orbit* satellites have orbital altitudes between 3,000 and 30 ,000 km.

- They are commonly used used in navigation systems such as GPS

GEO: *Geosynchronous (Geostationary) Earth Orbit* satellites are positioned over the equator. The orbital altitude is around 30,000-40 ,000 km

- There is only one geostationary orbit possible around the earth
- Lying on the earth's equatorial plane.
- The satellite orbiting at the same speed as the rotational speed of the earth on its axis.

- They complete one orbit every 24 hours. This causes the satellite to appear stationary with respect to a point on the earth, allowing one satellite to provide continual coverage to a given area on the earth's surface
- One GEO satellite can cover approximately 1/3 of the world's surface

They are commonly used in communication systems

- Advantages:
  - Simple ground station tracking.
  - Nearly constant range • Very small frequency shift
- Disadvantages:
  - Transmission delay of the order of 250 msec. • Large free space loss.
  - No polar coverage

- Satellite orbits in terms of the orbital height:
- According to distance from earth:
  - Geosynchronous Earth Orbit (GEO) ,
  - Medium Earth Orbit (MEO),
  - Low Earth Orbit (LEO)

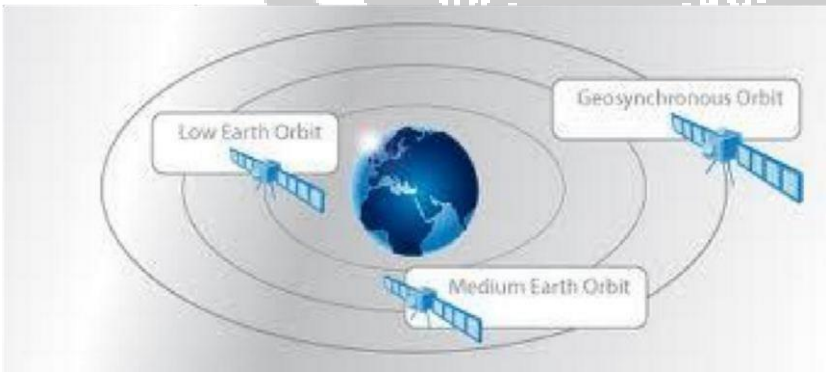
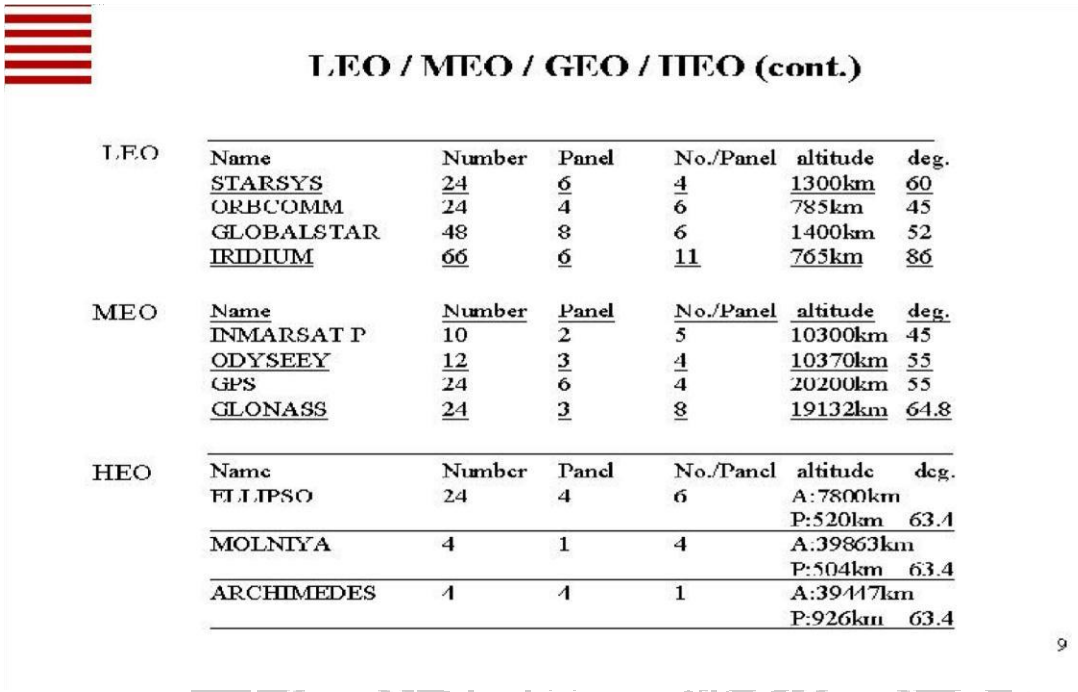


Figure LEO, MEO & GEO Orbits



LEO / MEO / GEO / HEO (cont.)

LEO

Name	Number	Panel	No./Panel	altitude	deg.
STARSYS	24	6	4	1300km	60
ORBCOMM	24	4	6	785km	45
GLOBALSTAR	48	8	6	1400km	52
IRIDIUM	66	6	11	765km	86

MEO

Name	Number	Panel	No./Panel	altitude	deg.
INMARSAT P	10	2	5	10300km	45
ODYSEEY	12	3	4	10370km	55
GPS	24	6	4	20200km	55
GLONASS	24	3	8	19132km	64.8

HEO

Name	Number	Panel	No./Panel	altitude	deg.
ELLIPSO	24	4	6	A:7800km P:520km	63.4
MOLNIYA	4	1	4	A:39863km P:504km	63.4
ARCHIMEDES	4	4	1	A:39447km P:926km	63.4

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Figure Diff b/w LEO, MEO & GEO Orbits GEO: 35,786 km above the earth, MEO: 8,000-20,000 km above the earth & LEO: 5002 ,000 km above the earth.

Satellite Navigational System:

Benefits:

- Enhanced Safety
- Increased Capacity
- Reduced Delays

Advantage:

- Increased Flight Efficiencies
- Increased Schedule Predictability
- Environmentally Beneficial Procedures

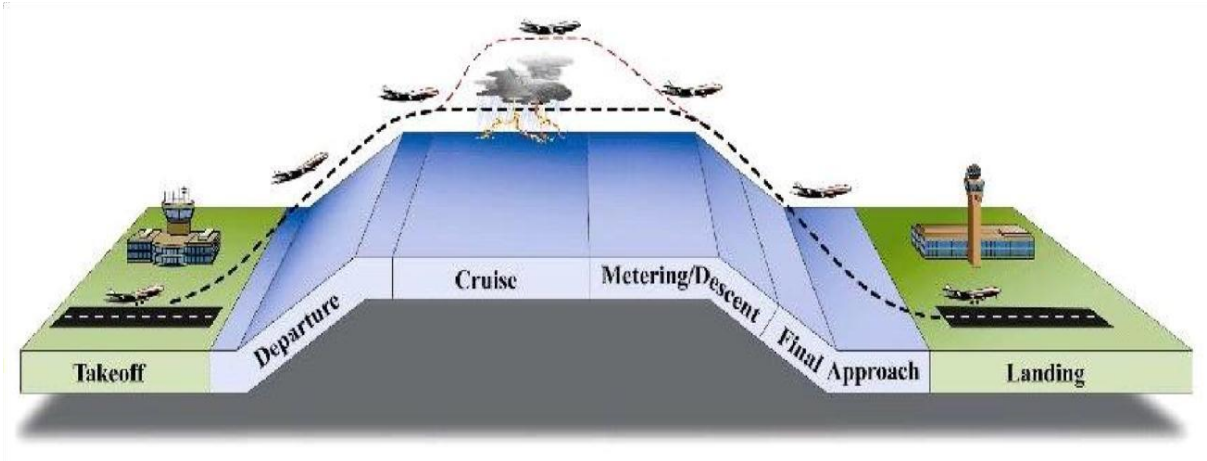

Figure LEO, MEO & GEO Orbits

- Using ICAO GNSS Implementation Strategy and ICAO Standards and Recommended Practices
- GPS Aviation Use Approved for Over a Decade
  - Aircraft Based Augmentation Systems (ABAS) – (e.g. RAIM)
    - Space Based Augmentation System (SBAS) since 2003
  - Wide Area Augmentation System (WAAS) augmenting GPS
- Development of GNSS Ground Based Augmentation System (GBAS) Continues
  - Local Area Augmentation System (LAAS)
    - CNSS is Cornerstone for National Airspace System