



Note: This file can not replace watching the video lecture. Because the video lecture contains more explanation through graphical elaboration.

Certified Junior Astronaut Training Course



Satellite Orbits (Part 3)





This lecture will answer the following inquiry:



What are the types of orbits? What is the suitable mission for each of them?



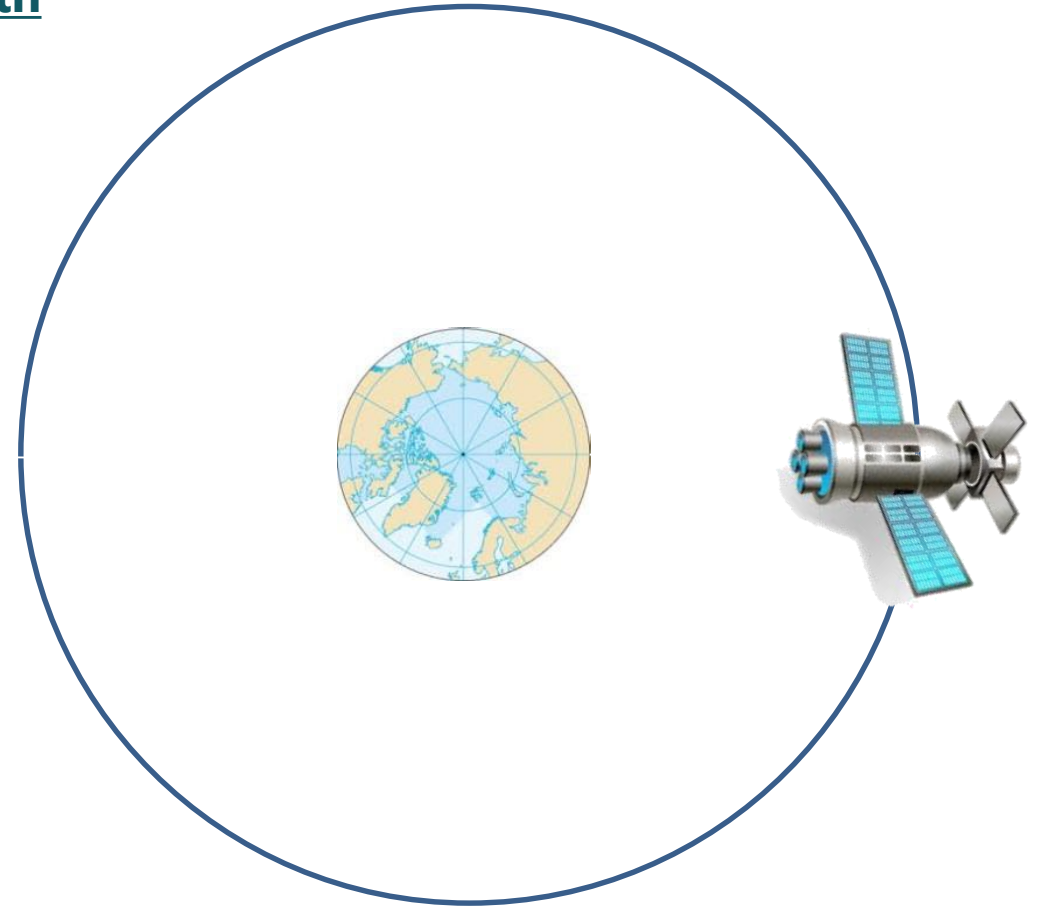


Cont.. What are the types of orbits? What is the suitable mission for each of them?



Third: classification according to synchronization with the earth or sun rotation:

- Regarding synchronization with earth rotation, **Geosynchronous Orbit** is the orbit where the time of a full satellite rotation around earth is equal to the time of one complete earth rotation around itself. Example includes the Geostationary Orbit that is used with the previously discussed Communication Satellites.





Cont.. What are the types of orbits? What is the suitable mission for each of them?



Third: classification according to synchronization with the earth or sun rotation:

Sun-Synchronous Orbit:

- It is an orbit that satisfies the best illumination conditions for imaging the earth.
- Before introducing the Sun-Synchronous Orbit, we should first introduce the effect of the sunlight on the quality of the image captured by the satellite.
- This will be clear by comparing the images shown in the following examples:





Cont.. What are the types of orbits? What is the suitable mission for each of them?



Third: classification according to synchronization with the earth or sun rotation:

Sun-Synchronous Orbit:

The first image was captured at noon when the sun was perpendicular over the earth, and there was no shadow on the ground that helps in interpreting its components. Accordingly; the image is unclear.

The second image was taken for the same location at 3:00 pm. The sun inclination on the ground was 45° ; leading to the presence of a suitable amount of shadows that clarifies its components. by analyzing the shadow, it shows two giraffes; one of them is eating from the ground and the other is raising its head up.

The comparison shows the effect of the sunlight on the image quality and the amount of information extracted from it.





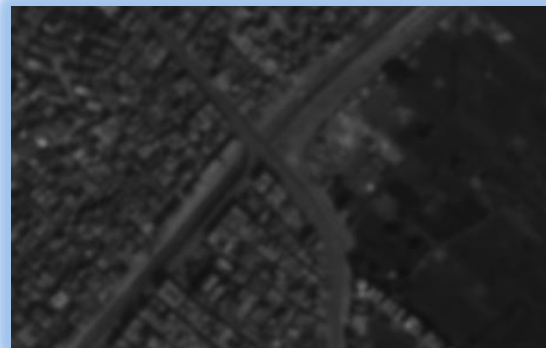
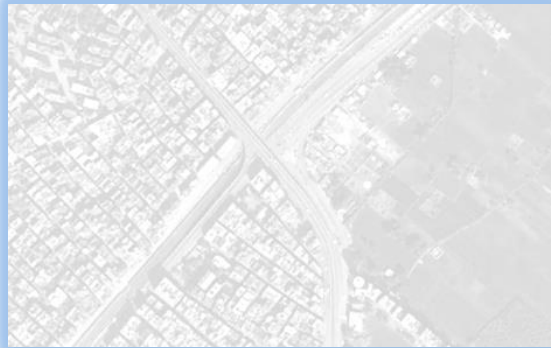
Cont.. What are the types of orbits? What is the suitable mission for each of them?



+ Third: classification according to synchronization with the earth or sun rotation:

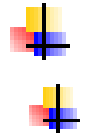
+ **Sun-Synchronous Orbit:**

- + If the image is taken during sunrise or sunset, the sun inclination angle will be large; making the image full of long inappropriate shades that cover or hide the near-by objects and eventually reduce the image quality.
- + Also, bad illumination conditions may lead to capturing a very blurred or bright image.



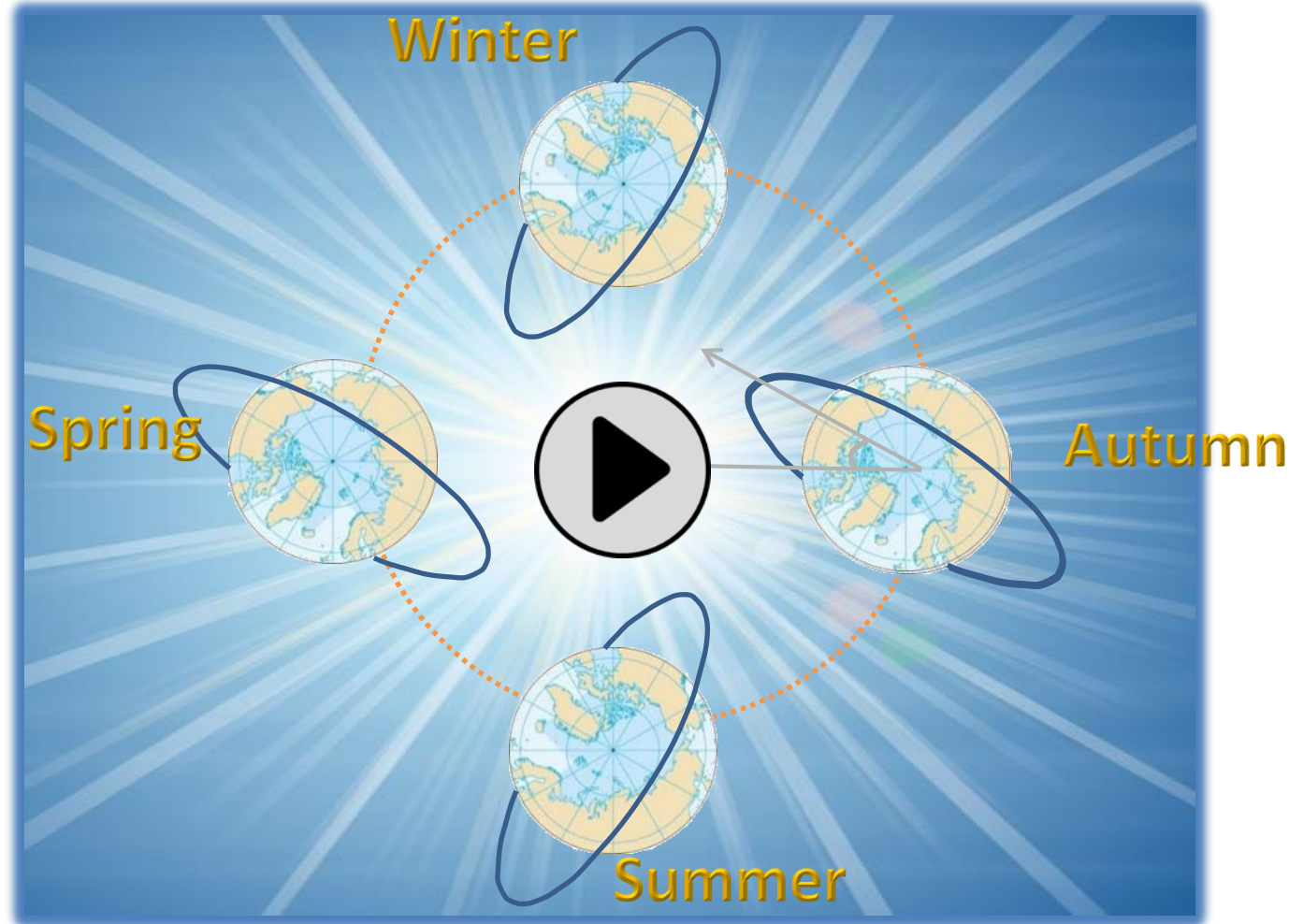


Cont.. What are the types of orbits? What is the suitable mission for each of them?



Sun-Synchronous Orbit:

According to what has been mentioned, the sun-synchronous orbit adjusts its position against the sun to keep a fixed inclination angle. This occurs daily and continuously at the earth rotation around the sun all year long. The satellite passes daily on every point on the earth at a local fixed time when the sun inclination angle on earth is about $45-50^\circ$ in order to set the best illumination conditions on the imaging area. Accordingly; the images will demonstrate a suitable amount of shadows that allows interpreting the image without hiding the near-by features.



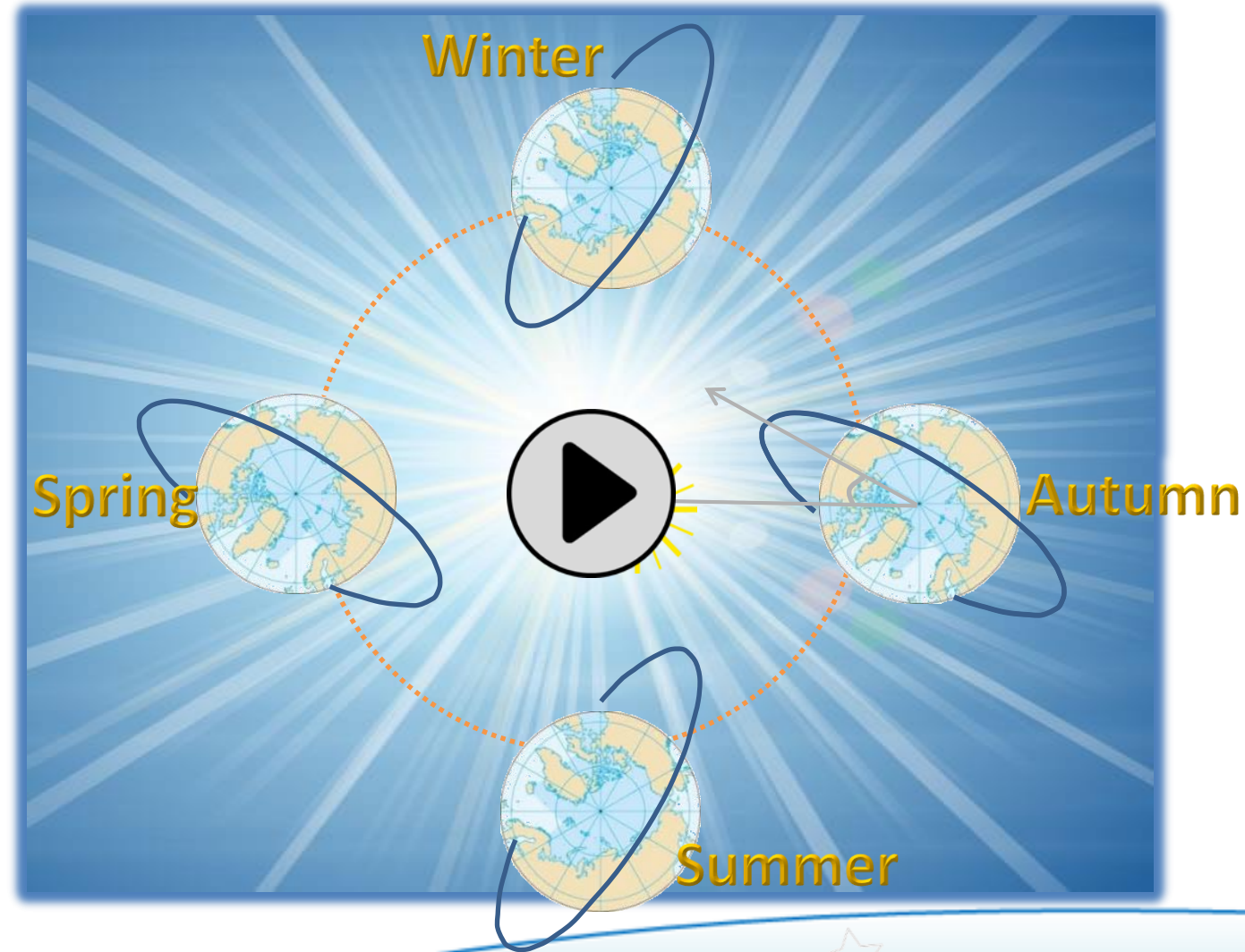


Cont.. What are the types of orbits? What is the suitable mission for each of them?



+ Sun-Synchronous Orbit:

- + The disadvantage of this orbit is that the number of satellite passages is only two times daily, once in the morning and once in the evening at the same timing. And it is impossible to capture an image of certain location; except once a day during the existence of the sun. Most of the imaging sensors cannot operate when the satellite is located in the dark hemisphere; except for satellites that carry radar imaging sensors.





Cont.. What are the types of orbits? What is the suitable mission for each of them?



Fourth: classification according to the orbit inclination:



The choice of orbit inclination on the equator is deemed as a primary factor for identifying several important things related to remote sensing satellites such as controlling the increase or decrease of coverage areas on the earth surface and the number of revisit times. Whenever the angle of inclination increases from 0 to 90 degrees, the ground coverage also increases from latitude 0 to 90 to the north and south. Whenever it decreases than 90 degrees, the coverage also decreases.

Latitude 90 north



Equator



Latitude 90 south





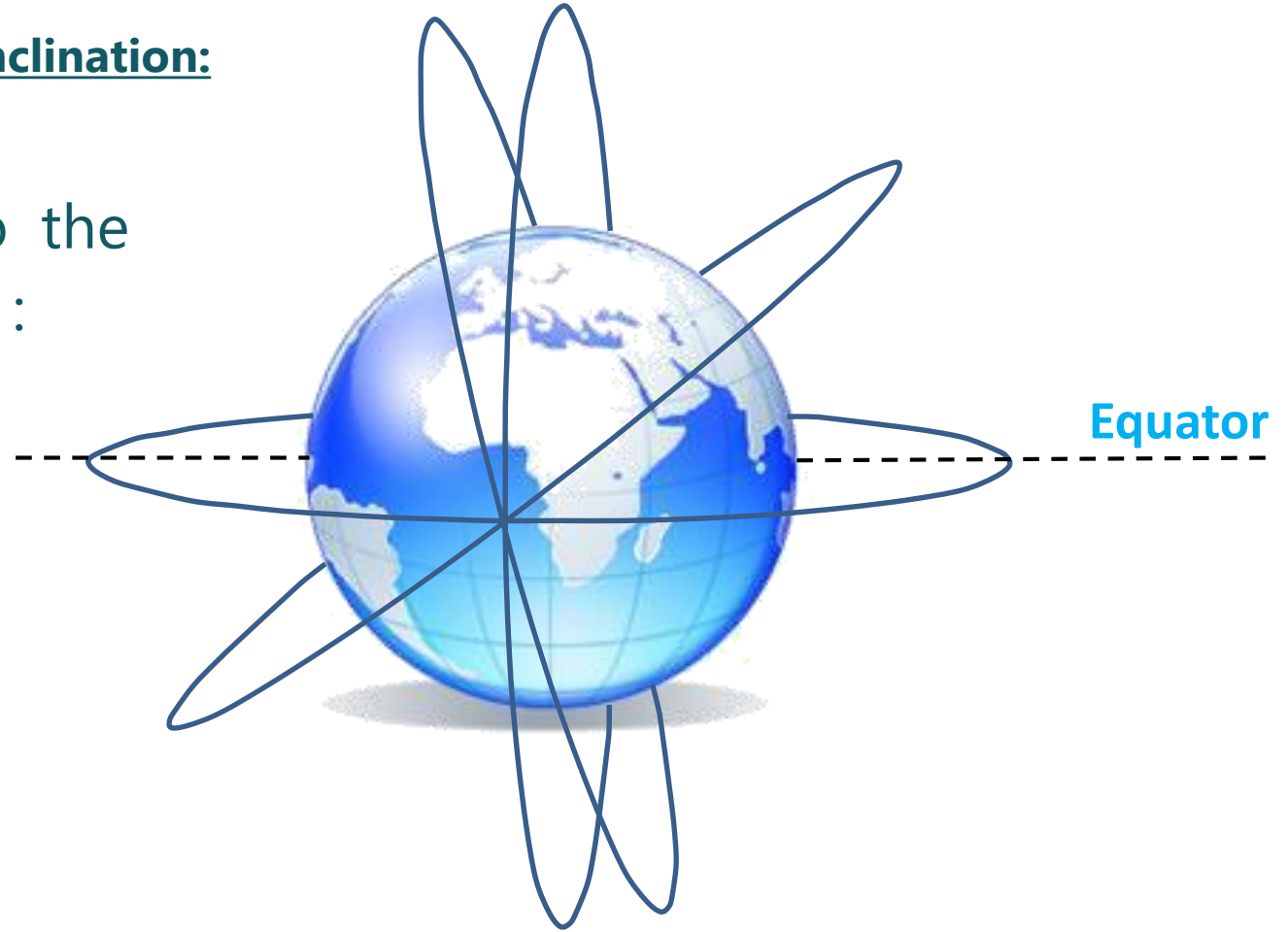
Cont.. What are the types of orbits? What is the suitable mission for each of them?



Fourth: classification according to the orbit inclination:

 Orbits are classified according to the angle of inclination into four types :

-  Equatorial Orbit.
-  Polar Orbit.
-  Near Polar Orbit.
-  Inclined Orbit .





Cont.. What are the types of orbits? What is the suitable mission for each of them?



Fourth: classification according to the orbit inclination:

Equatorial orbit: It is the orbit that rotates above the equator at a zero degree inclination angle. It is often used with Communication Satellites that are positioned at an altitude of 36000Km in order to be synchronized with the earth rotation. This orbit cannot be used for imaging due to its high altitude above the earth surface.

In case of positioning a satellite in this equatorial orbit, but at a low altitude appropriate for imaging, the coverage area will be only limited to the small middle segment of earth. However, the satellite revisit time over any location on earth will increase; reaching about 10 times during day time only. Whenever the coverage area decreases, the revisit time increases.





Cont.. What are the types of orbits? What is the suitable mission for each of them?



Fourth: classification according to the orbit inclination:

-  **Polar Orbit:** It is the orbit that inclines on the equator at 90 degrees angle of inclination. It is usually used with Weather Satellites due to its full coverage of the earth starting from cold locations in the North Pole, passing by hot locations at the equator and then cold locations at the South Pole. The satellite revisit time decreases at this orbit over any location on earth to be about once every 12 hours.





Cont.. What are the types of orbits? What is the suitable mission for each of them?



Fourth: classification according to the orbit inclination:

Near Polar Orbit: It is often used with Remote Sensing Satellites that work in Sun-synchronous orbits. It inclines on the equator at about 90 degrees inclination angle (usually from 97 to 100 degrees for imaging satellites). Satellites at this orbit have a coverage similar to the Polar Orbit.





Cont.. What are the types of orbits? What is the suitable mission for each of them?



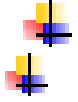
Fourth: classification according to the orbit inclination:

Inclined Orbit: It is the orbit that inclines on the equator at an angle of inclination located between the Equatorial Orbit and Polar Orbit. It is usually used with Military Reconnaissance Satellites. At this orbit, whenever the orbit inclination decreases, the coverage areas are focused in a smaller area and the number of revisit time increases in this area and varies with a different timing each day. This helps in the process of monitoring at various timings all day long.



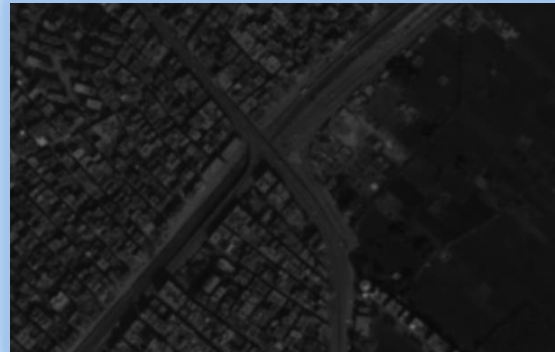


Cont.. What are the types of orbits? What is the suitable mission for each of them?



Fourth: classification according to the orbit inclination:

The disadvantage of this orbit is that the quality of the captured image is less than images captured from the Sun-synchronous orbit. This is due to the change of illumination conditions while imaging. The position of the sun changes due to the high inclination during sunrise and sunset; resulting in long shadows, also when the Sun is perpendicular on earth and at noon the shadow disappears. On the contrary, the Sun-synchronous orbit maintains the satellite rotation in the best illumination conditions that always satisfy the best quality of the captured images; except in the presence of clouds. Its only disadvantage is that the number of revisit times suitable for capturing images is only once a day.





Cont.. What are the types of orbits? What is the suitable mission for each of them?



The following is a summary for the aforementioned types of orbits and their appropriate missions:

Satellite Mission	Orbit Elevation
 Civilian Remote Sensing Satellites , Space Stations and Space Shuttle	Operate in the Low Earth Orbit LEO and are usually located at an elevation from 500 to 800 Km.
 Military Reconnaissance Satellites	Operate in the Low Earth Orbit LEO and are usually located at an elevation from 300 to 600 Km.
 Navigation Satellites	Operate in the Medium Earth Orbit MEO and are usually located at an elevation from 19000 to 22000 Km.
 Communications & TV Broadcasting Satellites	Operate in the Geostationary Earth Orbit GEO at an elevation of 36000 Km.
 Astronomy Satellites and Communication Satellites that cover Polar Regions	Operate in the Highly Elliptical Orbit HEO which has two altitudes: near altitude (about 1000 Km) and far altitude (more than 36000 Km).





Thanks for your undivided attention

