

# SATELLITES & COMMUNICATION

(summarized notes)

## For Lower Secondary Curriculum

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### What is a Satellite?

**Definition:** A satellite is an object that orbits around a planet or another large body in space.

These satellites can be natural or man-made; the figure above shows several examples of satellites orbiting around the earth.

# Types of Satellites

There are two main kinds of satellites; natural and artificial.

**Natural Satellites:** These are celestial (heavenly) bodies that orbit planets. The most common natural satellite is the Moon, which orbits Earth. Other planets in our solar system also have natural satellites, like Mars with its moons Phobos and Deimos, and Jupiter with its many moons including Europa and Ganymede.

**Artificial Satellites:** These are human-made satellites launched into space to orbit Earth or other planets. Artificial satellites are further classified based on their purpose, orbit, size, and launch vehicle.

## Types of artificial Satellites & their uses

Here, I have classified artificial satellites based on their purpose

### 1. Communication Satellites:

- **Purpose:** To transmit and receive signals for communication purposes.
- **Examples:** GPS satellites for navigation, weather satellites for forecasting, and TV satellites for broadcasting programs.

### 2. Observation Satellites:

- **Purpose:** Observe and gather data about Earth's surface, weather patterns, and environmental changes.
- **Examples:** Environmental monitoring satellites.

### 3. Navigation Satellites:

- **Purpose:** Provide accurate positioning and navigation services.
- **Examples:** GPS (Global Positioning System) satellites used in smartphones and navigation devices.

#### 4. Weather Satellites:

- **Purpose:** Monitor weather patterns, track storms, and provide data for weather forecasts.
- **Examples:** GOES (Geostationary Operational Environmental Satellite) series used by meteorologists.

#### 5. Spy Satellites:

- **Purpose:** Gather intelligence and surveillance information for military and security purposes.
- **Examples:** KH-11 series used for reconnaissance by governments.

### More on the uses of satellites

- **Research:** Satellites help scientists study Earth's atmosphere, climate changes, and natural disasters.
- **Navigation:** GPS satellites help in accurate navigation for vehicles, ships, airplanes, and even in locating lost items using smartphones.
- **Environmental Monitoring:** Satellites track changes in forests, oceans, and climate, helping scientists study environmental changes and plan conservation efforts.
- **Disaster Management:** They provide early warnings for natural disasters like hurricanes, earthquakes, and wildfires, aiding in evacuation and rescue operations.
- **Agricultural Monitoring:** Satellites monitor crop health, soil moisture, and land use, assisting farmers in improving crop yield and resource management.
- **Telecommunication:** Satellites enable global communication networks, supporting internet services, phone calls, television and data transmission for businesses and individuals worldwide.

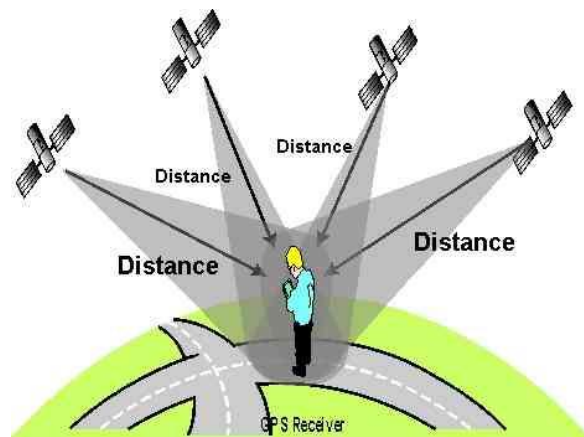
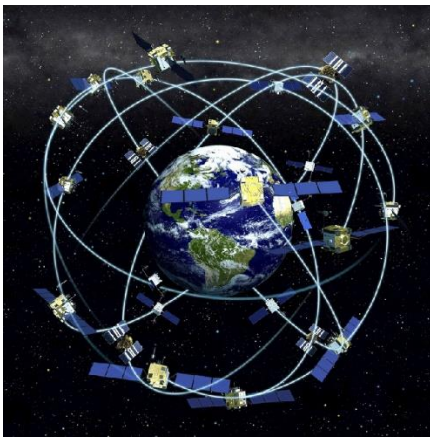
- **Space Exploration:** Satellites are used in astronomy to observe distant planets, stars, galaxies, and cosmic processes, advancing our knowledge of the universe.

## Satellites in modern technology

In this section, we shall describe in some detail, how satellites are used in modern technology, especially in devices we use in our everyday life.

### 1. GPS (Global Positioning System):

GPS, or the Global Positioning System, is a satellite-based navigation system that provides location and time information anywhere on or near the Earth provided there is a clear line of sight to four or more GPS satellites.



Here's a is how GPS works:

The GPS system consists of a group of 24 to 32 satellites orbiting the Earth. These satellites are positioned in such a way that at least four satellites are visible from any point on the Earth's surface at any given time.

Each GPS satellite continuously broadcasts signals containing information about its position and the precise time the signal was sent. The signals are transmitted in the form of radio waves at specific frequencies.

A GPS receiver, such as those found in smartphones, car navigation systems, or standalone GPS devices, picks up these signals. The receiver needs to have a clear view of the sky to receive signals from multiple satellites.

The GPS receiver calculates its distance from each satellite by measuring the time it takes for the signals to travel from the satellites to the receiver. Since the speed of electromagnetic waves is known, the receiver can determine how far away each satellite is based on the time delay of the signals.

By knowing the distances to at least four satellites, the GPS receiver uses some special geometry (known as trilateration) to determine its precise position on Earth in 2 or 3 dimensions.

### **Uses of GPS:**

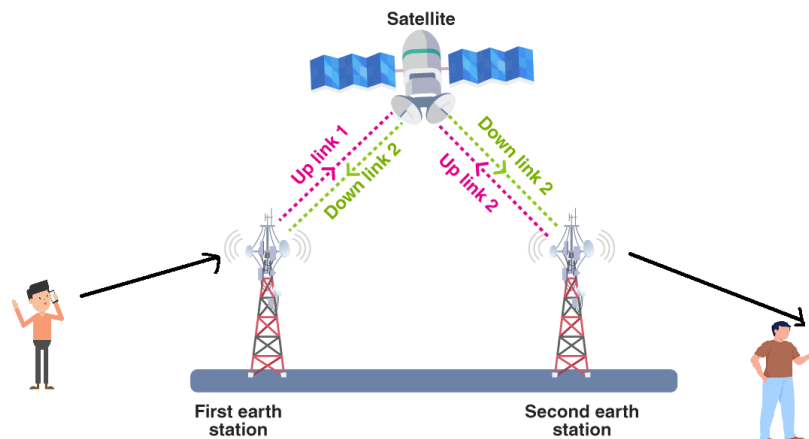
- **Navigation:** GPS is widely used for vehicle navigation, hiking, marine navigation, and aviation.
- **Surveying and Mapping:** GPS is essential for creating accurate maps, land surveying, and geocaching.
- **Time Synchronization:** GPS is used for precise timekeeping in telecommunications networks, financial transactions, and scientific experiments.
- **Tracking and Monitoring:** GPS is used for tracking vehicles, wildlife, shipments, and assets in logistics and transportation industries.
- **Emergency Services:** GPS helps emergency services locate callers in distress accurately.

- **Military and Defense:** GPS has critical applications in military operations, missile guidance, and intelligence gathering.

## 2. Telecommunication (Long Distance Telephone Calls):

Satellites allow us to make long-distance phone calls without wires, connecting people all over the world.

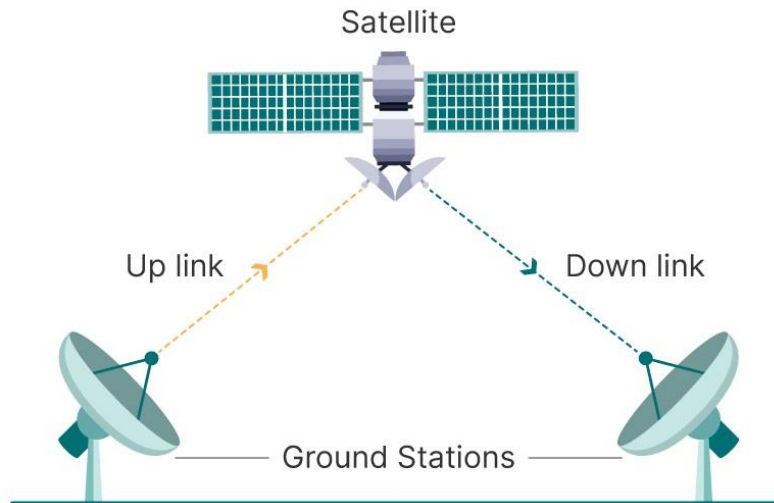
**How it Works:** When you make a phone call, your voice is turned into signals and sent to a satellite in space. The satellite then sends these signals to another satellite or a ground station closer to the person you're calling. From there, the signals are sent to the person's phone. This process happens quickly, allowing us to talk to anyone, anywhere.



## 3. Satellite TV (e.g., DStv):

Satellite TV services like DStv use satellites to broadcast television signals directly to satellite dishes installed at subscribers' homes.

**How it Works:** TV stations or providers transmit their programs to satellites directly that are always in a fixed position with respect to the earth. These satellites receive the signals and retransmit them back to Earth.



Viewers with satellite dishes and receivers can pick up these signals, the decoder converts the signals into images & sound and then display the TV channels on the screens. This technology allows for a wide range of channels and programming options accessible to viewers.

## SPACE EXPLORATION

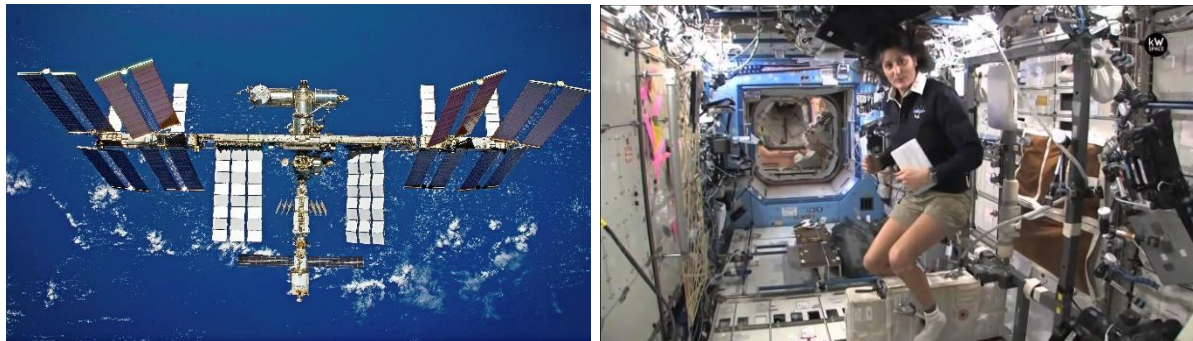
Space exploration represents humanity's desire and quest for knowledge about the universe we inhabit. From the first satellites launched into orbit to the monumental achievements of manned missions to the Moon and robotic probes exploring distant planets, space exploration has expanded our understanding of celestial bodies, their origins, and the vastness of space. Here are some reasons why space exploration is remains an important element of science;



- **Discovering New Frontiers:** Space exploration helps us learn about other planets, stars, and galaxies, expanding our understanding of the universe.
- **Technological Advancements:** Developing and launching satellites requires advanced technology, which leads to innovations in science and engineering.
- **Global Connectivity:** Satellites play a vital role in global communication, making the world more connected and accessible.
- **Origins of the universe:** Space exploration helps us to understand how certain objects in the universe such as stars and planets form, by harnessing this knowledge, we can best understand the planet on which we live.
- **Environmental Monitoring:** Satellites help monitor Earth's environment, contributing to conservation efforts and disaster management.

## The International Space Station (ISS)

The International Space Station (ISS) is a remarkable example of international collaboration in space exploration. Here are some brief notes about the ISS:



The ISS is a space laboratory where scientific research and experiments are conducted. This helps in advancing our understanding of various fields such as biology, physics, astronomy, and materials science.

The ISS was assembled in orbit through contributions from multiple space agencies, including NASA (United States), Roscosmos (Russia), ESA (European Space



Agency), JAXA (Japan Aerospace Exploration Agency), and CSA (Canadian Space Agency).

It consists of interconnected modules, laboratories, living quarters, and solar arrays for power generation, providing a habitable environment for astronauts to live and work in space for extended periods.

The ISS typically hosts a crew of astronauts from different countries who conduct scientific experiments, technology demonstrations, and educational outreach activities while onboard.

Research conducted on the ISS includes studies on human health in space, fundamental physics experiments, Earth observation, space technology development, and testing of spacecraft systems for future deep-space missions.

## **The Hubble Space Telescope (HST)**

The Hubble Space Telescope (HST) is a large space observatory used for observing distant celestial objects (stars, planets, galaxies, etc.).



Named after Edwin Hubble, it was launched into orbit in April 1990, as a joint project between NASA and the European Space Agency (ESA) with a primary mission to observe distant celestial objects without the distortion of Earth's atmosphere, providing high-resolution images and data across various wavelengths of light.

Since then, the telescope has captured stunning images of galaxies, nebulae, stars, and other astronomical phenomena, revealing details and structures not visible from Earth. Such observations have led to significant scientific discoveries, including the measurement of the rate of expansion of the universe (Hubble's Law), the discovery of exoplanets, the age of the universe, and the understanding of black holes and dark matter.

Over the years, the Hubble Space Telescope has undergone several servicing missions to upgrade its instruments, repair components, and extend its operational lifespan, ensuring continued scientific productivity.

Hubble's contributions to astronomy have revolutionized our understanding of the cosmos, inspiring awe and curiosity about the universe and its mysteries. In addition to its scientific achievements, Hubble engages the public through educational outreach programs, sharing captivating images and discoveries to inspire and educate people of all ages about the wonders of space.