Space Internet

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Space Internet is an internet connection powered by satellites orbiting the Earth.These satellites send and receive signals that are then routed to **internet service providers** and then to users' internet modems. Satellite internet is going to provide internet access to rural areas where people don’t have access to other **broadband internet** options such as cable and fibre optics. Many projects, including **JioSpace Fiber**, **Starlink, Amazon's Kuiper project, and OneWeb**, will be the next big step in space internet service, each involving massive constellations of satellites in Low and Medium Earth orbit.

Working of Space Internet

Internet Service Providers (ISPs) transmit an internet signal to a satellite in space, which then returns to the users and is captured by their **satellite dish.**

- The dish is linked to the **user's modem,** which then connects their computer to the internet signal.
- This process then reverses back to the internet service provider and is repeated every time.

Space Internet in Low Earth Orbit

A LEO is an orbit that is relatively close to Earth's surface. This equates to up to **2,000 kilometers.** LEO is home to the vast majority of satellites, as well as the International Space Station (ISS)**.**

- Projects like Starlink and OneWeb are using a constellation of LEO satellites to provide broadband Internet access.

Advantages of Space Internet in Low Earth Orbit

- **Availability of more routes:** LEO satellites **do not** always have to **follow a particular path** around **Earth** in the same way; their plane can be tilted. This means there are more available routes for satellites in LEO.
- **Minimal latency:** Satellites' proximity to the ground enables them to communicate with **minimal time delay**.
- **Reliable linking:** The shorter distance to the Earth means that the **satellite-to-earth communication links** suffer less path loss, and hence a reliable link can be established with less power and/or reduced antenna size.
- **High-resolution images:** It is the orbit most commonly used for satellite imaging, as being near the surface allows it to take images of **higher resolution.**
- **Cost-effective:** Because of the lower orbit, **launch costs are also diminished** since smaller or less powerful launchers will be required.

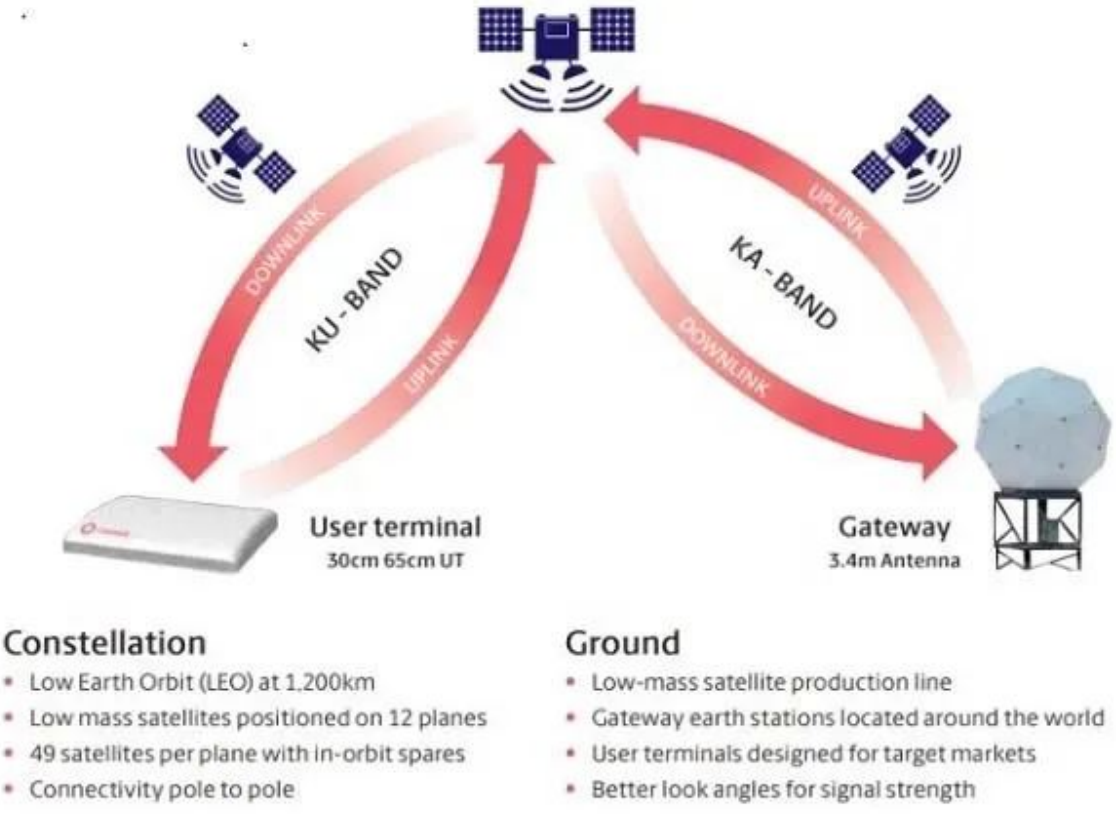
Disadvantages

- **Small coverage:** Owing to their **lower height**, their signals cover a relatively small area which requires more satellites in order to reach signals to every part of the planet.

- **Visibility of satellite:** LEO satellites, **orbital periods** are of the order of **90 minutes,** which means satellites will only be visible for 5-20 minutes per orbit. To ensure uninterrupted data transmission, more satellites are needed in networks.
- **Not stationary:** A satellite in LEO orbit is a **moving target for a ground station.** To keep transmitted power requirements low, both the satellite and the earth station antennas must be highly directional.
- **Difficult tracking:** Individual LEO satellites are less useful in telecommunication because they move so fast across the sky and therefore require a lot of effort to track from ground stations.

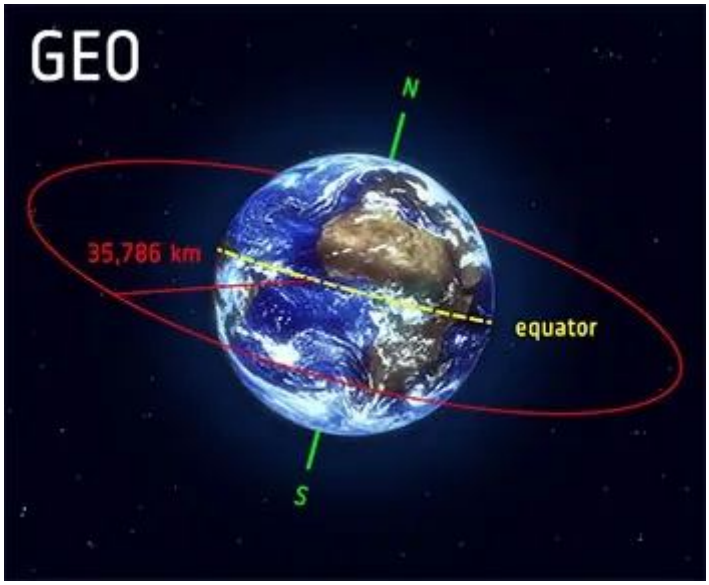
Space Internet Projects in Low Earth Orbit

- **Starlink Project:** It is the name of a **satellite network** developed by the private spaceflight company **SpaceX** to provide high-speed internet access anywhere on the planet using a **constellation of thousands of satellites.**
    - The satellites are launched in groups of 60, and they orbit the Earth at a **low altitude of approximately 550 kilometers.**
- **One Web:** OneWeb is a wholesale provider of Internet services via its constellation of satellites. OneWeb uses a constellation of low-earth orbit (LEO) satellites to provide broadband Internet access.
    - It is a collaborative project between the **UK-based OneWeb Group and the** Indian Space Research Organisation (ISRO), in partnership with **NewSpace India Ltd (NSIL).**
    - **ISRO’s Launch Vehicle Mark-3 (LVM3) rocket** launched the final 36 satellites for OneWeb's first-generation internet constellation. This launch marks a significant step forward for India in gaining access to the remarkable capabilities of LEO connectivity and the spread of space-based internet.



- **Project Kuiper:** Project Kuiper is an initiative of Amazon to increase global broadband access through a constellation of 3,236 satellites in low Earth orbit (LEO). Project Kuiper launched its first two prototype satellites in October 2023 and expected to provide service by the end of 2024.

Space Internet in Geostationary Orbit



Geostationary orbits of **36,000 kilometers from the Earth's equator** are most widely recognized for the many satellites used for various kinds of telecommunication, including television.

- Satellites in this orbit complete **one revolution of the Earth** at the same time that the **Earth rotates once on its axis**.
    - As a result, a satellite in a geostationary orbit **appears stationary** to a ground observer.

Advantages

Following are the advantages of using geostationary orbit for space internet:

- **Coverage and Linking: Beaming signals** from geostationary orbit can cover a significant portion of Earth, with one satellite covering about one-third and three to four satellites covering the entire planet.
- **Linking:** As they appear to be **stationary**, it is easier to link to them.
- **Simple and Affordable:** The satellite remains in the same relative position throughout the day, so antennas do not have to move; therefore, the **reception dish** does not require tracking, hence it’s simple and affordable.
- **Remote Sensing:** A **stationary satellite** always sees the Earth from the same angle, so it can record the same image at brief intervals**.**

Limitations

- **Latency:** Due to the huge **Earth-satellite-Earth distance,** there is a time lag called **latency** between a user seeking data and the server sending that data. The longer the distance that needs to be covered, the greater the time lag, or latency.
- **Low Spatial Resolution:** Due to the **high orbit (35,000 km) above the Earth**, the spatial resolution of the data is not as great as for the **polar-orbiting satellites.**
- **Monopoly:** Internet services are provided by large satellites in geostationary orbit which are monopolised by nations with well-funded programs that build large and expensive satellites.

India and Space Internet

The **Indian Space Policy-2023** allows **non-government entities (NGEs)** to provide national and international space-based communication services via self-owned, procured, or leased **geostationary orbit** and **non-geostationary satellite orbit satellite systems.**

- Only two firms have a **Global Mobile Personal Communication by Satellite (GMPCS)** license from the **Department of Telecommunications**; one is Reliance Jio and the other is Bharti Airtel Ltd. and the United Kingdom government’s OneWeb joint venture, which merged with the French firm Eutelsat.

JioSpace Fiber

Reliance Jio successfully demonstrated India's first satellite-based gigabit internet service, which has the potential to deliver high-speed internet access to inaccessible areas of the country.

- Jio will provide **medium Earth orbit (MEO) satellite** internet in collaboration with a **Luxembourg-based satellite communications company.**
- Jio has connected four remote locations with JioSpace Fiber, i.e., Gir in Gujarat, Korba in Chattisgarh, Nabarangpur in Odisha, and Jorhat in Assam.
- JioSpace Fiber promises **low-latency internet,** but its internet will likely have a much higher latency than other LEO services. This is because **MEO satellites** orbit at a much higher distance from the planet, and

therefore, radio signals take much longer to travel the distance.

- **JioSpace Fiber** is expected to offer **speeds of up to 100 Mbps**, while projects like Starlink offer speeds of up to 1 Gbps.

Limitations of Space Internet

While **satellite internet** does offer many **advantages**, it has some limitations, which include:

- **Space debris:** The launch of thousands of new devices at the same time will significantly increase the **load on near-Earth space**.
    - However, it is almost certain that some of them will crash and add to the space debris population.
- **Dangerous flights:** Starlink has frequently been accused of **risky flights near other satellites.**
- **Interference in the Universe:** Astronomers are concerned about the size and scope of projects like Starlink, fearing that the bright, **orbiting objects** will interfere with observations of the **universe**.
- **Climate:** The amount of metal that will be burned up in the Earth's atmosphere as old satellites are deorbited could cause unpredictability in the **planet's climate.**
