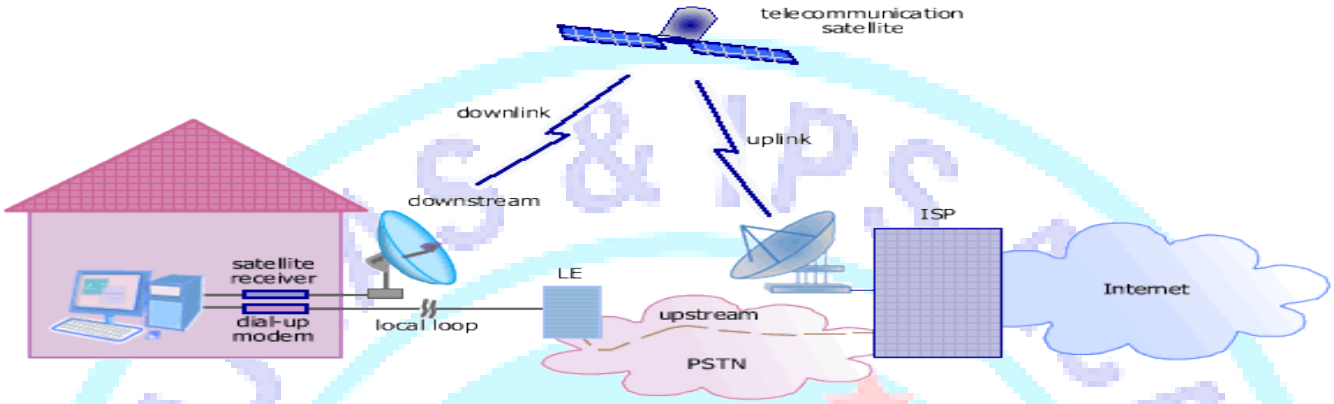
SATELLITE INTERNET – SCIENCE & TECHNOLOGY

Starlink has received a Unified Licence to provide satellite internet services in India.

Satellite internet is a form of broadband technology that uses orbiting satellites or mega-constellations (hundreds to thousands of satellites at varying altitudes) to provide internet connectivity. It transmits data signals between user terminals on Earth and space-based infrastructure, allowing access even in remote or underserved regions.



Working Mechanism

Two-Segment System

The system comprises the space segment (satellites) and the ground segment (user terminals and ground stations).

Space Segment

Satellites are equipped with communication payloads that receive, process, and transmit data signals. Traditional systems relay data via ground stations, but LEO mega-constellations integrate advanced features such as On-board signal processing – improves data handling in space, reducing dependence on Earth-based routing. Optical inter-satellite links (OISLs) – allow satellites to communicate directly with each other, creating a mesh network in orbit. This reduces latency, improves resilience, and allows data to bypass congested ground infrastructure.

Ground Segment

User Terminals Include antennas and modems that connect to satellites, usually small and easy to install. Ground Stations (Gateways): Connect satellites to the internet backbone. Process,

1. User sends request via terminal to satellite.
2. Satellite routes the request to other satellites (via OISLs) or ground station.
3. Data travels through the internet backbone, returns via the same route to the user.

Orbital Deployment of Satellites

Geostationary Earth Orbit (GEO)

1. ~35,786 km above equator.
2. A single satellite covers ~1/3 of Earth.
3. Provides wide coverage but high latency (~600 ms).
4. Unsuitable for real-time gaming or video conferencing.
5. Example: Viasat Global Xpress.

Medium Earth Orbit (MEO)

1. Altitude: 2,000–35,786 km.
2. Lower latency (~150 ms) compared to GEO.
3. Requires multiple satellites for global coverage.
4. Example: O3b MEO by SES.

Low Earth Orbit (LEO)

1. Altitude: <2,000 km.

2. Provides very low latency (20–40 ms), comparable to fibre broadband.
3. Each satellite covers a smaller area, requiring thousands of satellites for global reach.
4. Example: SpaceX Starlink with 7,000+ satellites (planned 42,000).

Key Potential Applications of Satellite Internet

Connectivity & Communications

Provides broadband access in remote, rural, and underserved regions where laying fibre is difficult. Future direct-to-smartphone services aim to provide universal connectivity without dedicated terminals. Enables the Internet of Everything (IoE), integrating homes, devices, vehicles, and industries.

Transport, Logistics & Public Services

Supports autonomous vehicles with low-latency communication. Improves supply chain management by enabling real-time tracking of goods. Facilitates smart cities with connected sensors for traffic, utilities, and security. Provides early warning systems for natural disasters and efficient disaster coordination.

Healthcare & Agriculture

Enables telemedicine, remote consultations, and remote patient monitoring in areas with no medical infrastructure. Supports precision agriculture through satellite-enabled IoT sensors for soil moisture, crop health, and irrigation. Optimises fertiliser and pesticide use, improving productivity while reducing environmental impact.

Strategic, Industrial & Environmental Uses

Strengthens defence and military operations by enabling secure battlefield communication. Assists energy exploration, offshore drilling, and monitoring of pipelines. Enhances environmental monitoring by tracking deforestation, pollution, and climate change impacts. Its dual-use nature (civil + military) makes it crucial for national resilience and strategic dominance.

Disaster Response & Emergency Communication

Provides instant connectivity in disaster-hit regions where terrestrial networks are destroyed. Example: During Hurricane Harvey (2017) in the US, satellite internet supported emergency rescue operations when telecom networks collapsed. Ensures continuity of critical communication for first responders and relief teams.

Key Satellite Internet Projects

Starlink (SpaceX, USA)

Began in 2019, aims for a 42,000-satellite LEO mega-constellation. Already operational in many countries with 7,000+ satellites in orbit.

Project Kuiper (Amazon, USA)

Plans to deploy over 3,200 LEO satellites for affordable global broadband.

OneWeb (Eutelsat, France)

Second-largest constellation after Starlink. Provides global LEO-based internet coverage.

Qianfan / G60 Starlink Constellation (China)

Proposed mega-constellation by Shanghai Spacecom Satellite Technology. Aims to provide global coverage and counter Western dominance in space internet.

India's Status in Satellite Internet

Commercial satellite internet is not yet operational in India.

Players with permits

Eutelsat OneWeb, Reliance Jio–SES JV, Starlink (SpaceX) (awaiting spectrum allocation), Government Role: Spectrum allocation and national security vetting are in finalisation stages. Once operational, satellite internet could help bridge India's rural–urban digital divide and strengthen digital inclusion.

Source: https://www.thehindu.com/sci-tech/technology/how-does-satellite-internet-work-explained/article69924030.ece