STUDY NOTES · BASIC CONCEPT

What is satellite internet? Why is satellite internet important for India?

Science & Technology

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A. What is satellite internet?

Satellite internet is a communication service in which data travels between users, ground infrastructure and satellites orbiting Earth. Instead of relying exclusively on fibre-optic cables or mobile towers, the service uses radio signals transmitted to and from satellites.

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Starlink thí điểm tại Việt Nam: Bước đột phá cho kết nối không giới hạn

Starlink Installation in Berkshire & Surrey | Berkshire WiFi

Infraestructures

A typical satellite internet connection involves three main elements:

1. User terminal: A satellite dish or other compatible equipment installed at the user's location.
2. Satellite constellation: Satellites that relay communication signals across the network.
3. Ground infrastructure: Gateways and network facilities that connect satellite communications to the wider internet.

For example, a household in a remote mountain village may use a satellite terminal to connect to a satellite overhead. The signal is relayed through the satellite network and ground infrastructure to reach the requested

internet service.

Satellite internet is particularly useful where terrestrial connectivity is weak. However, it still depends on electricity, appropriate equipment, available satellite capacity and regulatory permissions.

B. What is Starlink, and how does it differ from traditional satellite internet?

Starlink is a satellite broadband service operated by SpaceX, the space technology company founded by Elon Musk.

Its main technological distinction is the use of a large constellation of satellites in Low Earth Orbit (LEO).

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ACJ cockpit and cabin connectivity | Airbus

Satelitarna usługa internetowa Starlink

Inmarsat GX5 Satellite Enters Commercial Service - Via Satellite

LEO versus geostationary satellites

Feature	Low Earth Orbit (LEO)	Geostationary Earth Orbit (GEO)
Approximate altitude	Commonly a few hundred to around 2,000 km	Approximately 35,786 km above the equator
Signal latency	Generally lower	Generally higher

Feature	Low Earth Orbit (LEO)	Geostationary Earth Orbit (GEO)
Satellite movement relative to Earth	Satellites move across the sky relative to a ground user	Satellite appears nearly stationary relative to Earth
Coverage	Requires many satellites and coordinated handovers	A single satellite can cover a large area
Infrastructure requirements	Large constellation and sophisticated network coordination	Fewer satellites can cover broad regions
Typical applications	Low-latency broadband, mobile connectivity and other communications	Broadcasting, weather-related applications and communications

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The principal advantage of LEO satellites is that signals travel a shorter distance, reducing latency. This can improve video calls, online gaming and other interactive applications.

However, LEO systems require many satellites, complex tracking and handover mechanisms, and continuing investment in launches and replacement satellites.

Important distinction: Low latency does not automatically mean unlimited speed or universal coverage. Actual performance depends on satellite capacity, network congestion, weather, user equipment and the quality of the ground network.

C. Why is Elon Musk picking fights over Starlink?

The dispute described in the news reflects several overlapping commercial and regulatory conflicts. These should be understood as reported business developments and competing claims, rather than as proof that any one party has acted unlawfully.

Elon Musk asegura que no se vacunará contra el coronavirus | Independent en Español | Independent Español

Starlink connections among latest round of tribal broadband funding for Alaska

Wizz Air Joins United, Lufthansa, IAG in Starlink Wi-Fi Revolution—2027 Fleet Rollout Begins

1. The Indian market is commercially important

India has a very large population of internet users and a substantial rural connectivity challenge. Established operators such as Reliance Jio and Bharti Airtel dominate large parts of the terrestrial telecom market.

Starlink argues that satellite broadband can expand access, particularly in areas where conventional networks are difficult to deploy. Existing operators, meanwhile, have invested heavily in telecom infrastructure and have their own interests in how satellite services are regulated.

The dispute has involved Musk's allegations that powerful business interests are obstructing Starlink's entry into India. The Indian government has rejected claims of discriminatory treatment, stating that satellite operators are subject to regulatory and security requirements. Reliance has also said it welcomes competition and is itself awaiting applicable clearances for its satellite service.

The important policy question is whether all operators are assessed under transparent, consistent and legally justified rules.

2. Spectrum allocation affects business economics

Satellite operators need access to radio-frequency spectrum to communicate with user terminals and ground stations.

The method of assigning spectrum can influence the cost of entry, the pace of deployment and the competitive position of satellite providers relative to traditional telecom operators.

The controversy is therefore not simply a personal dispute between business leaders. It concerns how a scarce public resource should be allocated and how different technologies should be regulated.

3. Starlink needs new customers and markets

Satellite networks involve substantial expenditure on satellites, launches, ground stations, software and user equipment. To make these investments commercially sustainable, an operator needs a sufficiently large and growing subscriber base.

The news report also describes Starlink's efforts to secure major airline customers. Airlines need reliable in-flight internet, and satellite providers compete on speed, price, coverage and service quality. Delta's reported choice of Amazon's satellite service illustrates how competition for large corporate customers can trigger public disputes.

4. Competition is expanding beyond Starlink

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Starlink faces competition from other satellite operators, including Amazon's developing Leo constellation and Eutelsat OneWeb. These firms compete for customers, spectrum access, regulatory approvals and partnerships.

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Consequently, Starlink's expansion depends not only on technology but also on the commercial and regulatory decisions made in each market.

D. What is spectrum, and why is its allocation controversial?

Spectrum is the range of electromagnetic radio frequencies used for wireless communication, including mobile networks, satellite services, broadcasting, aviation and emergency communications.

Electromagnetic Radiation Explained for Kids | EM Spectrum Science

Elektromagnetiske bølger - Artikkel - Tek.no

Spectrum is considered a scarce public resource because different services must share limited frequency ranges without causing harmful interference.

Governments establish rules governing which frequencies can be used, by whom, for what purpose and under what technical conditions.

Two broad approaches to spectrum assignment

Feature	Auction	Administrative assignment
Basic method	Eligible entities bid for specified spectrum rights	The government assigns spectrum according to a defined legal and policy framework
Potential advantage	Can reveal market valuations and generate public revenue	Can accommodate technical, public-service or international coordination requirements
Potential concern	High bids may increase costs or favour firms with greater financial resources	Poorly designed discretion can raise concerns about transparency or preferential treatment
Key policy question	Does the auction design encourage efficient and competitive use?	Are eligibility, pricing and allocation criteria transparent and fair?

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Neither method is automatically superior in every situation. The appropriate mechanism depends on the nature of the spectrum, applicable law, technical characteristics, demand and the public interest.

For example, an auction may be appropriate for certain commercial spectrum rights, while some satellite spectrum arrangements may be coordinated through administrative processes shaped by international and technical requirements.

The key distinction is between the method of assignment and the safeguards governing it. Whatever the method, allocation should be transparent, technically sound and consistent with the law.

E. Why do telecom companies and satellite operators disagree?

Terrestrial telecom operators and satellite broadband providers can both supply internet connectivity, but their infrastructure and cost structures differ.

Fibrus hits Project Gigabit milestone in its Cumbria Contract | thinkbroadband

Telecom tower with 5G and 4G network, telecommunication base station

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Conecta | Internet Rural y TV Satelital

Issue	Terrestrial telecom operators	Satellite broadband providers
Core infrastructure	Towers, fibre-optic networks, base stations and local networks	Satellites, ground gateways and user terminals
Strength	High capacity in densely populated areas and established urban markets	Potential reach in remote, mobile and geographically difficult areas
Main costs	Network deployment, spectrum, equipment, maintenance and backhaul	Satellite manufacture, launch, gateways, terminals and network operation

Issue	Terrestrial telecom operators	Satellite broadband providers
Regulatory concerns	Spectrum rights, network security, service quality and competition	Spectrum access, security clearances, gateways, cross-border services and orbital coordination
Main policy challenge	Sustaining investment while providing affordable services	Scaling coverage and capacity while making service affordable

The two models can compete, but they can also complement one another.

For instance, fibre and mobile networks may be more cost-effective in dense urban areas, while satellite connections may be valuable for remote villages, disaster zones, ships and aircraft.

A sound policy should compare services on their actual costs, capabilities and obligations rather than assuming that one technology should replace the other.

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F. Why is satellite internet important for India?

1. Bridging the digital divide : The digital divide refers to inequalities in access to digital infrastructure, devices, affordable data and the skills needed to use online services.

Satellite broadband can help connect areas where conventional networks have not reached, including remote villages, islands, mountainous regions and sparsely populated settlements.

2. Disaster management : Earthquakes, floods, cyclones and landslides can damage fibre cables and mobile towers. Satellite connectivity can provide an alternative communication channel for emergency teams and affected communities, provided the terminals and power supplies remain available.

3. Education and healthcare : Remote schools may use satellite connectivity for digital learning, while health centres can use it to support telemedicine and remote consultation.

4. Economic activity : Reliable internet can help remote enterprises access digital payments, online marketplaces, government services and business information.

5. Strategic connectivity : Satellite communication can support maritime operations, aviation and other activities where terrestrial networks are unavailable.

Limitations to remember : Satellite internet is not a complete substitute for terrestrial infrastructure. High equipment costs, service pricing, capacity limits, power requirements and regulatory restrictions can limit adoption.

India therefore needs a hybrid connectivity model combining fibre, mobile networks, fixed wireless access and satellite services.

G. National security and data sovereignty : Satellite internet is not merely a commercial technology. It can involve foreign-controlled satellites, ground stations, network-management systems and cross-border data transmission.

Governments therefore assess whether service providers can meet national security and lawful compliance requirements.

Important considerations include:

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- Lawful interception: Whether legally authorised agencies can obtain access in accordance with applicable law.
- Data protection: Whether personal information is collected, stored and processed securely.
- Network resilience: Whether connectivity can be maintained during emergencies.
- Ground infrastructure: Where gateways are located and how they are secured.
- Foreign control: How ownership, operational control and jurisdiction affect security and continuity.
- Cybersecurity: Whether the network is protected against unauthorised access and disruption.

These concerns can justify regulation, but security requirements should be clearly defined and consistently applied.

UPSC perspective: National security and commercial openness are not necessarily contradictory. Transparent requirements can protect security while giving legitimate operators a predictable path to market entry.

H. What is regulatory fairness, and why does it matter?

Regulatory fairness means that firms operating under comparable circumstances are subject to consistent, transparent and legally justified rules.

It does not necessarily mean that every operator must face identical technical requirements. Different technologies may require different rules, but those differences should have a defensible basis.

A fair regulatory system should include:

1. Published eligibility and licensing criteria.
2. Clear timelines and procedures for approval.
3. Objective security and technical requirements.
4. Transparent spectrum assignment mechanisms.
5. A process for resolving disputes and reviewing decisions.
6. Safeguards against favouritism, arbitrary delay and regulatory capture.

What is regulatory capture?

Regulatory capture occurs when a regulator's decisions become unduly influenced by the interests of the industry or powerful entities it is supposed to regulate, rather than by the public interest.

An allegation of regulatory capture is serious and requires evidence. A delay or a disagreement over policy does not, by itself, prove capture.

In the Starlink debate, the appropriate response is to examine the legal requirements, the status of approvals, the treatment of comparable operators and the reasons for any delays.

I. Competition policy: monopoly, oligopoly and consumer welfare

An oligopoly is a market structure in which a small number of firms account for a substantial share of supply. A monopoly exists when one supplier dominates a market in the relevant economic sense, subject to the applicable legal test.

India's terrestrial telecom market has a small number of major private operators. Satellite internet introduces additional potential competitors, although it does not automatically eliminate concentration in the wider broadband market.

More competition can produce benefits:

1. Lower prices.
2. Better service quality.
3. Greater innovation.

4. Expanded geographical coverage.
5. More choices for consumers and businesses.

However, competition also requires scrutiny of market conduct. Dominant firms may possess advantages in distribution, financing, infrastructure and customer acquisition. New entrants may have technological advantages but still face high costs and regulatory barriers.

The objective of competition policy is not to favour a domestic company or a foreign entrant merely because of its identity. It is to promote effective competition, prevent unlawful anti-competitive conduct and protect consumer welfare.

J. Space sustainability: the less visible challenge

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Large satellite constellations also raise environmental and operational concerns in Earth's orbital environment.

□□ Ariane 6 just raised the stakes in LEO broadband - with IP□□1□ Yesterday, Ariane 64 lifted off from Europe’s Spaceport an

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Charting Satellite Courses in a Crowded Thermosphere - Eos

Sentinel-1 on Soyuz | Copernicus

Challenge	Explanation
Space debris	Defunct satellites and fragments can collide with functioning spacecraft
Orbital congestion	Large constellations increase the number of objects requiring tracking and coordination

Challenge	Explanation
Collision risk	Satellites must manoeuvre to avoid potential collisions
Atmospheric effects	Satellite re-entry and launch activity raise scientific questions about atmospheric impacts
Long-term sustainability	Operators must plan satellite disposal and avoid creating persistent orbital hazards

Satellite internet policy must therefore balance connectivity benefits with responsible space operations, coordination and debris mitigation.

K. Key Indian laws and institutions to know

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Law or institution	Relevance
Telecommunications Act, 2023	Provides the statutory framework for telecommunications, including spectrum-related provisions
Department of Telecommunications (DoT)	Responsible for telecommunications policy, licensing and relevant regulatory processes
Department of Space	Oversees India's space programme and associated policy framework
Indian National Space Promotion and Authorisation Centre (IN-SPACe)	Promotes, facilitates and authorises relevant non-government space activities under its mandate
Telecom Regulatory Authority of India (TRAI)	Makes recommendations and performs regulatory functions assigned under the TRAI Act
Indian Space Research Organisation (ISRO)	India's national space agency, responsible for space missions and associated technology development
Competition Commission of India (CCI)	Enforces competition law and addresses specified anti-competitive conduct and combinations

These bodies have distinct responsibilities. Their roles should not be conflated: a telecom licence, a space-sector authorisation, spectrum assignment and security clearance are separate regulatory questions.

L. A way forward for India

India's approach should focus on predictable regulation, effective competition and universal connectivity.

First, establish transparent spectrum rules. The criteria for allocation, pricing and use should be clear and consistent with applicable law.

Second, make security requirements predictable. Operators should know the relevant conditions, timelines and compliance standards.

Third, promote fair competition. Regulation should neither unfairly protect incumbents nor give new entrants unjustified advantages.

Fourth, improve affordability. Satellite broadband can be useful in underserved areas, but equipment and subscription costs may remain prohibitive for low-income households. Shared access models and targeted public-service use may help.

Fifth, develop hybrid infrastructure. Satellite services should complement fibre and mobile networks rather than be treated as a universal replacement.

Sixth, protect space sustainability. Operators should comply with debris mitigation, orbital coordination and other relevant technical standards.

Seventh, strengthen consumer protection. Service quality, pricing transparency, grievance redressal and data security should be integral to the framework.

M. Quick revision table for UPSC

Concept	One-line definition
Satellite internet	Internet connectivity delivered through satellites and associated ground infrastructure

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Concept	One-line definition
Starlink	SpaceX's satellite broadband service using a large LEO constellation
LEO	Low Earth Orbit; an orbital region extending up to approximately 2,000 km altitude
GEO	Geostationary Earth Orbit; approximately 35,786 km above the equator
Latency	The time taken for data to travel between communicating points
Spectrum	Radio-frequency resources used for wireless communication
Spectrum auction	Competitive bidding for specified spectrum rights
Administrative assignment	Allocation by the government under a defined legal and policy framework
Digital divide	Unequal access to digital infrastructure, devices, affordability and skills
Regulatory capture	Undue influence of regulated interests over regulatory decision-making
Oligopoly	A market dominated by a small number of firms
Data sovereignty	The principle that data and its processing are subject to the relevant jurisdiction's laws
Space debris	Non-functional human-made objects and fragments in space
Universal connectivity	The goal of ensuring that people can access useful and affordable communication services

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Conclusion

The Starlink controversy demonstrates that the expansion of advanced technology is shaped not only by engineering but also by competition, public policy, national security and the management of scarce resources.

For India, satellite internet offers a way to extend connectivity beyond the reach of conventional infrastructure. Yet its benefits will depend on affordable services, transparent spectrum allocation, proportionate security requirements and a competitive market.

The central lesson for UPSC is that technology regulation must balance innovation, consumer welfare, national security and the public interest. Satellite internet should form part of an integrated digital infrastructure strategy that expands access without compromising fair competition or long-term space sustainability.

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