Understanding space Internet

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"SpaceX shot 60 satellites into orbit last week, and will keep doing so until it has a 12,000-strong constellation in place. In two years, it hopes to supply non-stop, low-cost Internet everywhere on Earth."

The SpaceX, the world's leading private company in space technology, last week fired a spray of 60 satellites into orbit, the first operational batch of what is intended to eventually evolve into a constellation of nearly 12,000 satellites aimed at providing low-cost and reliable space-based Internet services to the world. The Starlink network, as the project is called, is one of several ongoing efforts to start beaming data signals from space, and also the most ambitious.

The first batch of Starlink satellites — also numbering 60, and similar in configuration to the ones launched on November 11 — went up on May 24, but they will not be part of the network. SpaceX announced the satellite Internet constellation in January 2015, and launched two test satellites in February 2018. Following last week's launch, the company has now deployed 122 satellites in orbit.

In October, SpaceX appeared ready to scale up its ambition, telling the International Telecommunication Union (ITU) in filings through the United States Federal Communications Commission (FCC) that it intends to deploy another 30,000 Starlink satellites in Low Earth Orbit (LEO) in coming years.

The ITU is the United Nations specialised agency for information and communication technologies, with a membership of 193 member states, some 900 companies, universities, and international and regional organisations. The FCC is the statutory communications regulator of the US.

Why is it necessary to launch satellites in order to provide Internet services?

This is mainly to ensure that reliable and uninterrupted Internet services — now part of humanity's basic infrastructure and an important means of delivering a wide variety of public services to the world's peoples — are universally available in every part of the globe.

Currently, about 4 billion people, more than half the world's population, do not have access to reliable Internet networks. And that is because the traditional ways to deliver the Internet — fibre-optic cables or wireless networks — cannot take it everywhere on Earth. In many remote areas, or places with difficult terrain, it is not feasible or viable to set up cables or mobile towers.

Signals from satellites in space can overcome this obstacle easily.

How old is this idea of space Internet?

Space-based Internet systems have, in fact, been in use for several years now — but only for a small num-

ber of users. Also, most of the existing systems use satellites in geostationary orbit. This orbit is located at a height of 35,786 km over the Earth's surface, directly above the Equator. Satellites in this orbit move at speeds of about 11,000 km per hour, and complete one revolution of the Earth in the same time that the earth rotates once on its axis. To the observer on the ground, therefore, a satellite in geostationary orbit appears stationary.

So how will placing satellites in lower orbits help?

One big advantage of beaming signals from geostationary orbit is that the satellite can cover a very large part of the Earth. Signals from one satellite can cover roughly a third of the planet — and three to four satellites would be enough to cover the entire Earth. Also, because they appear to be stationary, it is easier to link to them.

But satellites in geostationary orbit also have a major disadvantage. The Internet is all about transmission of data in (nearly) real time. However, there is a time lag — called latency — between a user seeking data, and the server sending that data. And because data transfers cannot happen faster than the speed of light (in reality, they take place at significantly lower speeds), the longer the distance that needs to be covered the greater is the time lag, or latency.

In space-based networks, data requests travel from the user to the satellite, and are then directed to data centres on the ground. The results then make the same journey in the reverse direction. A transmission like this from a satellite in geostationary orbit has a latency of about 600 milliseconds. A satellite in the lower orbit, 200-2,000 km from the Earth's surface, can bring the lag down to 20-30 milliseconds, roughly the time it takes for terrestrial systems to transfer data.

The LEO extends up to 2,000 km above the Earth's surface. The Starlink satellites — the 12,000 for which SpaceX has permission, as well as the other 30,000 that it wants to launch — will be deployed in the altitude band of 350 km to 1,200 km.

But lower orbits have their own problem.

Owing to their lower height, their signals cover a relatively small area. As a result, many more satellites are needed in order to reach signals to every part of the planet.

Additionally, satellites in these orbits travel at more than double the speed of satellites in geostationary orbit — about 27,000 km per hour — to balance the effects of gravity. Typically, they go around the Earth once every few hours. To compensate for the fact that they cannot be seen from a terrestrial location for more than a few minutes, many more satellites are needed in the networks, so that there are no breaks in the transmission of data. That is the reason why the Starlink network is talking about 42,000 satellites.

By when will Starlink be able to provide its space-based Internet service?

Starlink aims to start service in the northern United States and Canada in 2020, and expand to cover the whole world by 2021. The current plan is to deploy satellites in two constellations of around 4,400 and 7,500. Launches — 60 satellites at a time — will take place at frequent intervals now onward. SpaceX says it can start services on a small scale once 400 satellites join the network.

Several other private companies too, have plans for space-based Internet services. These include Amazon, OneWeb and O3B (apparently named for the 'Other Three Billion'), each involving large constellations of satellites in lower and middle Earth orbits — but these projects are very small compared to Starlink.

Once operational, space-based Internet networks are expected to change the face of the Internet. Services

such as autonomous car driving are expected to be revolutionised, and the Internet of Things (IoT) can be integrated into virtually every household, whether urban or rural.

Is there a downside to this projection?

Three issues have been flagged — increased space debris, increased risk of collisions, and the concern of astronomers that these constellations of space Internet satellites will make it difficult to observe other space objects, and to detect their signals.

To put things in perspective, there are fewer than 2,000 operational satellites at present, and fewer than 9,000 satellites have been launched into space since the beginning of the Space Age in 1957. Most of the operational satellites are located in the lower orbits. On September 2 this year, the European Space Agency (ESA) had to perform, for the first time ever, a "collision avoidance manoeuvre" to protect one of its live satellites from colliding with a "mega constellation".

Astronomers and scientists have also complained about increased "light-pollution", a reference to light reflected from the man-made satellites that can interfere with — and be mistaken for — light coming from other heavenly bodies.

Expected Questions (Prelims Exams)

1. With reference to the Starlink Network project consider the following statements:

1. Under this project, SpaceX company can install 12000 satellites
2. 70 satellites have been launched in the first phase of Starlink project
3. Under the Starlink project, space based internet service is to be provided all over the world by 2022.

Which of the above statements are correct?

(a) 1 and 2

(b) Only 1

(c) 2 and 3

(d) Only 3

Expected Questions (Mains Exams)

Q. 'Satellite technology may be the best option to make the Internet universally accessible, but this technology has complexities as well as some fundamental concerns.' Review the recent efforts made by SpaceX in light of this statement. (250 words)

Note: Answer of Prelims Expected Question given on 18 Nov., is 1 (d).