Global Internet Through Microsatellite Constellations

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Internet has impacted almost all aspects of life on the planet. It has been enabling for scientific and economic development, empowering for communities and has even revolutionised warfare. The applications continue to increase with ever-improving technological capabilities and growing connectivity. However, as the current market reaches saturation, further growth would necessitate more affordable access and tapping markets in rural and remote areas where it is still not cost effective to take the terrestrial and fibre optic network.Internet service providers seeking expansion of their high-speed data market as well as governments looking at connecting to its remotest communities are on the lookout for novel technologies and applications to make broadband internet services more widely accessible and affordable.

The most promising method is to place a large number of interconnected transmitters in space (or sky) to beam down services. Using satellites for providing internet is not a new concept. Using communication satellites placed in geosynchronous orbit (GEO), however, suffers from problems of latency[i] resulting in lower speeds, is restricted in its coverage and also tends to be expensive. In the 90s, the concept of using satellite constellations in Low Earth Orbit (LEO) for communication to provide efficient global coverage was mooted. However, existing technology of the time could not provide cost effective solutions and companies like Iridium and Globalstar that sought to provide global communications could not hold out against the cellular communication technology and had to file for bankruptcy. Teledesic and Skybridge constellations for broadband connectivity, despite evoking adequate interest and funding,failed toeven materialise.

Advanced technologies are now allowing development of smaller and cheaper satellites, which designers and engineers are endowing with capabilities matching those of conventional, larger satellites. Furthermore, mass production of microsatellites, rationalisation of costs of related systems and availability of cheaper dedicated launch options can be leveraged to provide constellations of small satellites. Sufficient number of satellites deployed in optimum orbits would enable seamless global line of sight internet coverage and with the necessary technology internet speeds equalling those provided by fibre optics could be achieved.The global hunger for internet-based services is driving investment in these next generation satellite systems.

O3b Networks,[ii]through its constellation of 12 satellites in Medium Earth Orbit (MEO)(8,062 km altitude), intends to provide high-speed, medium latency fixed and mobile Internet links through Ka band. Deployed in an equatorial orbit, the optimum coverage is limited to 45 degrees north and south of the equator, the ground terminals are relatively large and the services still fairly expensive.

In June, OneWeb Ltd, commissioned Europe's Airbus to design and mass produce 900 micro-satellites, each weighing 150 kilograms.Qualcomm Inc and Hughes Network Systems, both of USA, will contribute the hubs, user terminals and gateways. Starting end 2017, a total of 648 satellites will be deployed in 20 different orbital planes at two altitudes of 800 kilometres (500 mi) and 950 kilometres (590 mi) to provide consistent global coverage.A total of 60 satellite launches have been contracted for - Arianespace will manage 21 Soyuz launches and Virgin Galactic’s under development Launcher One[iii] is expected to undertake 39 missions.The first Soyuz launch is expected to carry 10 technology proving satellites and will be followed by 20 launches carrying between 32 and 36 satellites each. Additional satellites for spares and launches to respond to emerging contingencies have also been catered for. The satellites have on-board electric propulsion for debris avoidance and for end of life de-orbiting to ensure debris mitigation. The constellation is expected to deliver affordable 10 terabits per second of low-latency, high-speed broadband.The company has emphasised that there would not be an internet service provider but its 36 centimetres by 16 centimetresground user terminals would receive the signals and would in turn create LTE, 3G, 2G and Wi-Fi signals to which computers or cell phones could be connected. They would thus extend the networks of existing mobile operators and internet service providers.The low cost terminals would be either electric or solar-powered. The mobile version would enable providing internet access to platforms such as aircraft, ships and emergency vehicles.

There are other companies that share the vision of providing universal, affordable high-speed Internet in a similar fashion or through alternative methods and technologies. Elon Musk's company SpaceX, which has been in the news because of its success in space launch systems, is also investing in a global satellite internet project through a network of 4,000 satellites in LEO. Facebookintends to use solar powered drones as atmospheric Internet nodes to provide similar access while Google's Project Loon aims to provide internet via stratospheric balloons.

Such revolutionary projects would face significant challenges – technical, economic, regulatory and spectrum-related. These would require large investments in development of key technologies and innovative solutions that have to be equally cost effective. For example, the International Telecommunication Union (ITU), the United Nations agency that regulates orbital slots and radio spectrum, while allotting license for a non-geostationary global Ku-band networkto OneWeb,[iv] demanded that its operations not interfere with those of GEO-based communication satellites operating in the Ku band. In response, the company claims to have developed a key enabling technology called‘Progressive Pitch’ that tilts the satellites gradually and slightly as they approach the equator to avoid interference.

Critics, quoting past failures, remain sceptical of the economic viability of these projects in face of fierce competition from existing players. Their promoters on the other hand are projecting them as digital inclusion projects aimed for public good and hope the financial benefits would flow from the increased internetusage. The practicability of this approach is demonstrated by the investments from leading global satellite communication operators, who would otherwise have been potential adversaries, in these projects – SES in O3b and Intelsat in WebOne.Such alliances would result in integration of capabilities across orbits and systems, so that they can complement each other, allow more extensive coverage, provide additional applications and services as also enable redundancies.

It is equally heartening to see that the list of promoters and sponsors includes tech visionariesand even some of the larger space companies which have traditionally been known to be averse to such radical changes.[v]WebOne has found support from Coca Cola and Ricardo B. Salinas, a telecommunication mogul from Mexicoand also from Indian telecommunications network provider Bharti Enterprises that has interests in the Indian subcontinent and Africa.The French space agency, CNES, is partnering with Google for its Project Loon,[vi] while Google itself has invested heavily into the SpaceX’s project.The interest is also evident from the number of registrations at the ITU[vii]for LEO based constellations since November last year.[viii]

Global internet initiatives that augment the existing capacity to enable equitable and universal access throughout the world offer huge potential benefits,particularly in emerging economies. They offer larger user-base for companies, better connectivity and services for the new consumers and increased access for the governments. Such an affordable global gateway would be of immense help in the aftermath of natural calamities that affect the terrestrial infrastructure by providing internet to first responders, humanitarian workers and medical personnel.While not all envisaged projects may prove to be entirely successful, progressive achievements might still present innovative technologies and transformative applications.

References

[i]Geosynchronous (GEO) satellites operate approximately 36,000km away from Earth. As a result, round-trip data transmission times significantly exceed 500 milliseconds. Satellites in Medium Earth Orbit (MEO) can reduce this to less than 150 milliseconds. LEO based satellites are expected to provide 30 milliseconds latency.

[ii]O3b" stands for "Other 3 Billion", referring to the population of the world where broadband Internet is not available without help

[iii]Virgin Galactic announced plans to develop LauncherOne in July 2012. The two-stage vehicle, launched from the company's WhiteKnightTwo aircraft, is designed to place payloads weighing up to 225 kilograms into low Earth orbit.

[iv]Although SkyBridge failed to take off, it did secure regulatory approval from, for non-geostationary-orbiting satellite communications networks. OneWeb has acquired the same Ku-band spectrum initially planned for SkyBridge.

[v]Elon Musk, the leader of SpaceX has even gone on to say that he would create his own satellite production plant in Seattle because he did not trust established satellite manufacturers to be able to engage in serial production in the way SpaceX wants.

[vi]Peter B. de Selding, "CNES Partners with Google on Internet Balloon Project", Space News, 12December 2014, accessed athttp://spacenews.com/cnes-partners-with-google-on-internet-balloon-project/#sthash.y2WpvXDS.dpuf

[vii]As ITU works on a 'first come first serve' principle, these initiatives might just be aimed at reserving orbital slots and frequencies, while the developments in the sector are closely monitored for technical and economic viability. This increased interest might not fructify into viable projects.

[viii]Peter B. de Selding, "Signs of a Satellite Internet Gold Rush in Burst of ITU Filings", Space News, 23January, 2015, accessed at http://spacenews.com/signs-of-satellite-internet-gold-rush/#sthash.GngTvJTc.dpuf

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