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Authors: Rajat Kathuria, Mansi Kedia,
Prateek Kukreja and Ujjwal Krishna

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Liberalising Satellite Communications in India: Opportunities for Enhanced Economic Growth

1. Introduction

The use of intercontinental ballistic missiles during the Cold War between the United States and the Soviet Union kicked off the space race. In October 1957, the Soviet Union set a historic landmark with the launch of the first Earth-orbiting satellite, Sputnik 1. By the end of 1958, the world's first active communication satellite, SCORE (Signal Communication by Orbiting Relay Equipment), was launched by the U.S. Air Force. National Aeronautics and Space Act (NASA) launched its first communications satellite, Echo 1, a passive communication device, in August 1960. In 1960, the U.S. Department of Defence also launched Courier, the world's first fully active communications satellite.

The proven success of early satellites stimulated private sector interest in communications satellites. By 1960, AT&T had filed for authorization to launch an experimental satellite. In the absence of a policy to govern such requests, NASA awarded, competitive contracts to the Radio Corporation of America (for a medium orbit active communications satellite), AT&T (for its own medium orbit satellite), and Hughes Aircraft Company (for a high-orbit satellite). In July 1962, NASA launched AT&T's Telstar, the world's first transatlantic private sector communications satellite. Voice, television, facsimile, and data were transmitted between the U.S. and various sites in Europe. Telstar's launch opened space to commercial users, sparking a communications revolution.

As new technologies were introduced, global communications grew exponentially. In the 1990s the near instant transmission of live news, sports, entertainment, and data brought the whole world to each of its inhabitants.1 Three of the most significant advances—cellular telephones, direct broadcast satellite television, and the Internet, led to rapid progress in the development of geostationary satellites2. In recent years, low earth orbit (LEO) satellite systems have become popular3. Hundreds of LEOs have been deployed, providing high-speed digital communications to the most isolated regions around the world. Satellite technology delivers e-mail, telemedicine, tele-schooling, and telecommuting to the masses—from China to the United States to Antarctica—permitting the continuous exchange of video, audio, and data information between distant locations around the earth.

1.1 Satellites and Space Activities in India

The evolution of space activities in India dates back to 1963, when the first sounding rocket was launched from the Thumba Equatorial Rocket Launching Station (TERLS) by the Indian National Committee for Space Research (INCOSPAR) under the leadership of Dr. Vikram Sarabhai. INCOSPAR, rechristened Indian Space Research Organisation (ISRO) in 1969, was delegated the task of utilizing space technology and its application to various tasks for the socio-economic benefit of the nation.

Since the inception of ISRO, the Indian space programme has been formally organized under the direct charge of the Office of the Prime Minister. The space program is placed among India's national development goals. ISRO, through its commercial arm, Antrix, has achieved several milestones in the space industry including the development of satellite applications such as telecommunications, earth observation, meteorology and navigation. Its state-of-the-art infrastructure provides an excellent end-to-end solution for many space products. Antrix also collaborates with prominent global players for marketing its space products, which has successfully seen the development of international ground stations for remote sensing satellites and an extensive reseller network. These efforts have also paid off commercially.

1 Marsden (2001). *The Evolution Of Satellite Communications.* Science and Its Times: Understanding the Social Significance of Scientific Discovery. The Gale Group.

2 Geostationary satellites are earth orbiting satellites placed at an altitude of roughly 22300 miles (35,800 km) directly over the equator, and revolves in the same direction as the earth rotates.

3 Low Earth Orbits (LEO) are satellite systems used in telecommunication, which orbit between 400 and 1000 miles above the earth's surface. They are used mainly for data communication. They move at extremely high speeds and are not fixed in space in relation to the earth.

According to a recent estimate, Antrix's turnover increased from INR 5 million in 1992 to INR 20.39 billion in 2018[4]. In March 2019, ISRO launched its new commercial arm, NewSpace India Limited. It has been incorporated to commercialise ISRO's research and development activities. We revisit the roles and responsibilities of NewSpace later in the report.

India's growing capacity of satellite communication can be harnessed to meet the country's communications demand in the future. This is especially true for India's remote and unconnected regions. For rural and remote areas, not only are the costs of technology deployment significantly higher, monetizing investments is also more challenging. According to a very popular estimate, it costs ten to twenty times more to connect the last 10 -20% of the remote and distant population through terrestrial technologies as compared to that using satellite[5]. The cost of roll-out of terrestrial technologies increases exponentially with the degree of remoteness. Satellite-based broadband is most suited for such topographies. New innovative satellite technologies offer solutions to provide broadband access directly to end users at home in addition to backhauling component for terrestrial technologies[6]. The Bharat Net project, India's infrastructure backbone project for universal broadband also relies on the use of modern satellite technologies to connect remote and rural areas in the country.

India has every reason to be proud of its achievement in launching numerous satellites across different orbital slots in an extremely complex manoeuvre[7]. ISRO's missions have increased India's attractiveness as a potential market for increased use of satellite communication. However, it lacks a comprehensive policy that simultaneously addresses the need for a dynamic commercial satellite communication system along with other strategic focus areas such as space security which can be achieved using satellite technology.

This report looks at the regulatory environment for satellite communication across several countries along with a discussion on how the market has evolved globally. Section 2 focuses on the potential demand for commercial satellite communications in India, with illustrations around current applications as well as future use cases. Section 3 provides a global comparison of policy frameworks for Satcom with an illustration of the current policy and regulatory framework in India. Section 4 summarises the report and offers policy recommendations that could help facilitate the growth of commercial satellite communications without affecting the strategic requirements from the sector.

4 Source: https://www.geospatialworld.net/blogs/antrix-corporation-the-commercial-arm-of-isro-completes-25-glorious-years-of-success/ and http://www.antrix.co.in/sites/default/files/article-attachments/ar-2017-18-eng_0.pdf

5 Average figure compiled from various stakeholder interactions

6 "Why Satellites Matter: The Relevance of Commercial Satellites in the 21st century – a perspective 2012-2020",Booz &Co, Available at https://esoa.net/Resources/Why-Satellites-Matter-Full-Report.pdf

7 https://www.livemint.com/Opinion/8O1fCl2ouwmcM8ZydZeJtI/Isro-has-impressed-now-for-policy-innovation.html

2. Evolution of Satellite Communication in India

India plays a leading role within the South Asian satellite communications sector. In 2017, India launched the South Asia Communication Satellite to provide communication and disaster support to nations in the region. Communication satellites can be classified into the classic (i) fixed satellite service (FSS) or widebeam satellite services and (ii) high throughput satellites (HTS).These satellites can be further classified based on technology and spectrum band used. In the FSS category, ISRO also acts as the sole re-seller of capacity for meeting the domestic needs of the country, and consequently influences market prices to a large extent.[8] Other international satellite operators such as SES, Measat and Intelsat also have significant market shares, though their capacity is leased through ISRO/Antrix.

The composition of market shares for the latest generation of satellites known as High Throughput Satellites (HTS)[9] is however different. ISRO has already launched its own satellites with significant HTS capacity, which is likely to expand in the future. Some international service providers are already providing HTS capacity in India.

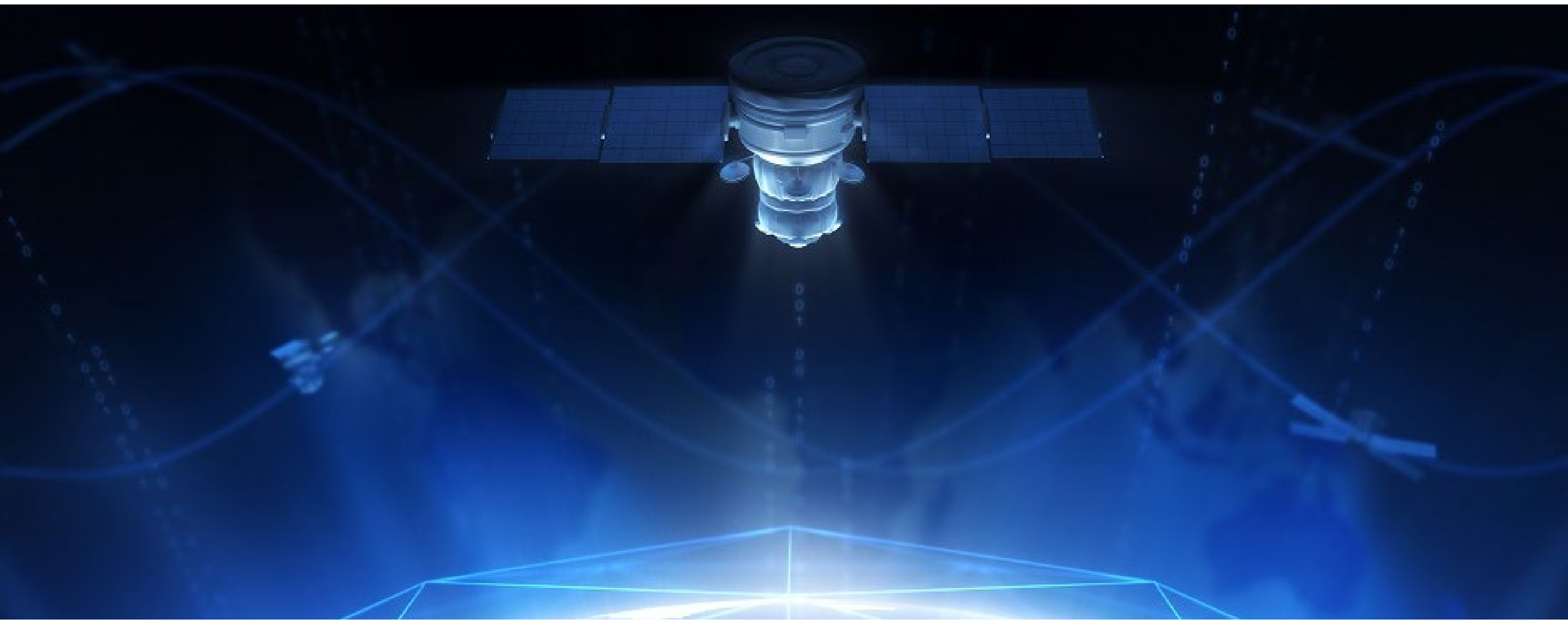
The price for Satellite bandwidth across all bands (C, Ku & Ka) has been progressively decreasing and is likely to decline further with the introduction of new technologies viz. Ka band & HTS Technologies The growing supply of HTS capacity (both from ISRO & foreign operators) is likely to lower these prices further.

8 NSR (2018).

9 The classification HTS primarily refers to a large jump in capacity ranging from twice as much, to more than 20 times as much capacity as a classic FSS (Fixed Satellite Service)

2.1 Current Applications of Satcom in India

Broadband connectivity in India is largely built using terrestrial infrastructure through a mix of optical fibre networks and wireless networks mounted on towers. Data is transmitted at high speeds through such networks to deliver broadband to homes and businesses in cities and towns. However, in countries such as India, with varying topographies and vast stretches of rural and remote areas, terrestrial technologies are often inadequate to achieve universal broadband access. Satellite technologies have the advantage of covering wide areas with either a single beam or a combination of multiple beams in cost effective ways, as compared to terrestrial technologies. In regions with



difficult terrains the cost of laying fibre increases substantially. Satellite technologies can circumvent mountain ranges or other geographical barriers and are arguably a better option for connecting remote locations such as the Andaman and Nicobar Islands or the mountainous Himalayan region as well as the North East in India. Moreover, satellite systems are universal and can provide internet on oceans and islands, and even to those in the sky, places almost unachievable through terrestrial technologies. They are also the most reliable network in case of natural disasters.

Satellite communication can therefore address infrastructure gaps and provide telecom operators and governments cost effective ways to extend essential telecom services to the remotest corners of a country. It would be incorrect to assume that these technologies are substitutable. Even a country such as the US with excellent wired broadband networks, boasts of the highest deployment of satellite broadband with over 4 million terminals[10]. For rural residents in the US, satellite internet/broadband is a viable alternative to mobile or fixed line networks. Most countries use a mix of terrestrial and satellite technologies to fulfill their socio-economic needs.

10 Krishna, K. (u.d.), Why is India not shining in the use of satellite broadband? Observer Research Foundation Working Paper

While satellite communications have been traditionally suited to broadcast applications that can afford low data caps and high latency; with the advent of 5G, satellite communication has been mainstreamed for provision of communication services. The global standards body 3GPP has included the role of satellite communication in its forthcoming release on 5G (Release 17).The use of High Throughput Satellites (HTS) has enabled satellite capacity to increase up to 1 Tbps[11]. This has drastically lowered the cost of delivering satellite broadband services. Designed to provide greater capacity and higher throughput rates, HTS serves as an attractive option for delivering enterprise network and consumer broadband applications. The concentrated spot beams of HTS have a throughput which is almost 20 times greater than that of wide beam satellites[12]. HTS also enables customized service delivery, which means that data services, catering to specific needs of different end users can easily be delivered within a single market. For example, localized content produced at a city or regional level, in case of video applications, can be delivered to specific areas on multiple spot beams. This application is known as Multicasting with Cached Content. With the explosion in video content, this bandwidth saving technology is being increasingly deployed as it enables the cheapest and fastest delivery of video content to the end consumers.

Aeronautical and maritime connectivity are other emerging areas for satcom application. Multiple airlines have signed up for inflight connectivity (IFC). List of companies which have procured the IFMC license till date can be found in Appendix 1.

11 https://www.ses.com/four-reasons-high-throughput-satellite-will-be-game-changer

12 https://www.ses.com/four-reasons-high-throughput-satellite-will-be-game-changer

The following sub-sections summaries the current commercial and non-commercial applications of satellite communications in India.

2.1.1 Commercial Applications

(a) Bank ATMs: Satellite communications play a crucial role in connecting banking networks. The government is focusing on connecting rural banking networks through satcom. It is the most cost-effective and reliable communication medium for remote banking solutions in India – superior to dial-up and wireless broadband. There are currently more than 100,000 terminals, affecting more than 4 billion ATM transactions annually[13]. The *Pradhan Mantri Jan-Dhan Yojana,* the Government of India's flagship program on financial inclusion, aims at opening a bank account for every citizen. This is possible by developing an ATM banking infrastructure connecting micro/ small bank branches in rural regions. Satellite communication technologies are an obvious choice for linking these channels to India's core banking network.

(b) Enterprise services: Enterprises, especially those located across multiple centres often interconnect using satellite networks for business intelligence and operations. Enterprises now use a mix of terrestrial and satellite communication to connect to remotely located offices across the globe. It is mostly used in industries such as telecom, healthcare, education and retail. The enterprise segment is the largest consumer of satellite broadband technologies. The role of satellite based communication has widened in recent years to include multicasting, videoconferencing and voice calling services. Enterprise clients mostly belong to industries such as banks, oil and gas, airlines, etc. According to TRAI estimates, the number of enterprises requiring satcom based services has grown annually by 5%.

(c) Satellite Backhaul: As mobile data traffic becomes increasingly data-driven, the throughput requirements for mobile networks has also grown exponentially. The backhaul transmission mechanisms must be significantly revamped and upgraded to meet the burgeoning data traffic. Capital expenditure on terrestrial backhaul consist of creating microwave links and laying fibre from the Points of Presence(PoPs) to the internet core. Building satellite backhaul includes purchasing and installing VSATs, antennas and a hub. The more rural the region, the less cost-effective terrestrial backhaul becomes. The high-performance system that backhauls all generations of cellular technologies is likely to deliver more than 200 Mbps of throughput per

13 Krishna, K. (2015), Hughes: https://trai.gov.in/sites/default/files/Hughes-Krishna.pdf

terminal and includes built in optimization capability that yields 30 to 60 percent bandwidth savings versus that of standard backhaul solutions. Very recently, a large Indian telco chose to partner with a prominent VSAT player to enable satellite connectivity to more than 400 4G/ LTE sites. The companies claim that satellite is the ideal technology to extend 4G/ LTE technologies to remote and rural communities. A competitive environment can enable such innovations, drastically improving the capability of telecom service providers to deliver high speed broadband in every corner of the country.

(d) Stocks and Equity Markets: Securities markets world over, have seen a paradigm shift in their operations. Developments in information, communication and network technologies have created new sources of competitive advantage for trading firms, enabled innovations in products and services, and created new business opportunities. The technology setup of India's National Stock Exchange is the largest in India. It uses 2500 VSATs across 200 cities to enable participation on its trading platform.[14]

(e) Rural Broadband: With approximately 665 million Internet users, as of June, 2019[15], India currently ranks second, only after China in terms of the size of the domestic user network. It simultaneously suffers from a relatively low level of Internet penetration (50.52 percent as on June 2019)[16]. This is much lower than other developed countries such as the US with an Internet penetration of 88.5 percent and Japan at 91.1 percent.[17] Moreover, the internet user base in India is still largely urban. Under the Bharat Net program, the government has connected at least a few thousand Gram Panchayats, located in relatively remote locations through satellite. In 2018, the Communications Minister made a statement to link Gram Panchayats in the North East using satellite at an estimated cost of Rs. 733 crore.[18]

(f) Direct to Home (DTH) broadcasting: Direct to Home (DTH) broadcasting is one of the primary applications of Satcom in India. India is the largest market of DTH subscribers in the world and is projected to grow at a CAGR of 10% until 2023[19]. DTH operators are permitted to lease foreign capacity only if it isn't available on an ISRO satellite. DTH operators are currently using satellites launched by ISRO as well

14 Dewangan and Ikhar (2018): http://www.isca.in/IJSS/Archive/v7/i6/7.ISCA-IRJSS-2018-032.pdf

15 TRAI Performance Indicators Report, June 2018

16 *Op Cit*

17 ORF (2017). *Exploring the potential of satellite connectivity for Digital India:* https://www.orfonline.org/expert-speak/exploring-the-potential-of-satellite-connectivity-for-digital-india/

18 https://telecom.economictimes.indiatimes.com/news/comprehensive-strategy-to-implement-bharatnet-in-ne-sinha/63934448

19 TechSci Research (2018): https://www.techsciresearch.com/report/india-direct-to-home-market/3162.html

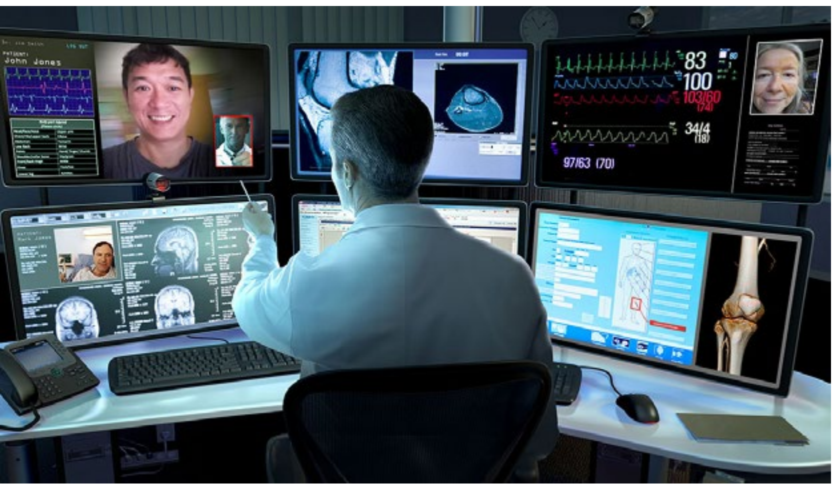
as Asiasat, Asia Broadcast Satellite, Eutelsat, Intelsat and other foreign satellite service providers[20]. While coverage is not a problem for most Indian DTH operators, capacity is. The capacity of a satellite depends on the number of transponders on it. However, hiring transponders can significantly increase costs for DTH operators who are already beginning to face stiff competition from IPTV and Over-the-top (OTT) services.

(g) Distribution of Cinema: For over a decade now, distribution networks in Indian cinema have adopted satellite delivery formats which address problems associated with film distribution and ensures that even the remotest part of the country can view all films. This format is similar to Video on Demand as it builds in a lot of flexibility with programming. Satellite film distribution models also helps combat piracy as prints of the film are no longer required to be physically delivered. The use of satellite networks to distribute digital cinema is now a popular trend in the Indian film industry.

2.1.2 Non-Commercial Applications

ISRO deploys satellite communication technology for a series of non-commercial applications which have a direct socio-economic benefit. Some of these applications include provision of tele-medicine, tele-education, railway signaling, navigation and disaster management services.

(a) Tele-medicine: ISRO's telemedicine programme started in 2001. It connects hospitals and mobile units located in remote rural areas to speciality hospitals in urban areas via satellites. The network currently connects 60 specialty hospitals to 306 remote/rural medical college hospitals and 18 mobile telemedicine units across Ladakh, Andaman & Nicobar Islands, Lakshadweep Islands, North Eastern States and remote areas in other mainland states. Many tribal districts of Kerala, Karnataka, Chhattisgarh, Punjab, West Bengal, Orissa, Andhra Pradesh, Maharashtra, Jharkhand and Rajasthan. The mobile telemedicine units cover diverse areas of healthcare including ophthalmology, cardiology, radiology, diabetology, mammography, general medicine, women and child healthcare.



20 http://cablequest.org/index.php/important-information/satellite-tracking

(b) Tele-education: EDUSAT in India's first thematic satellite, exclusively deployed for the provision of educational services. It is used to deliver a wide range of services including a one-way broadcast, video conferencing, computer conferencing, web-based instructions, etc. The network implemented under EDUSAT, comprise two types of terminals, namely, Satellite Interactive Terminals (SITs) and Receive Only Terminals (ROTs). Some dated estimates on the ISRO website report that a total of 83 networks were implemented until December 2012 which connected 56,164 schools and colleges (4,943 SITs and 51,221 ROTs) covering 26 States and 3 Union Territories. There are ongoing efforts to build tele-education networks in Uttar Pradesh. About 15 million students benefit through the EDUSAT programme every year[21]. *Private sector VSAT providers are also actively engaged in the provision of tele-education.*

2.2 Potential for Satellite Broadband in India

Demand for satellite communications in India will undoubtedly increase in the future. While FSS (Fixed Satellite Service) is likely to grow in the short and medium term, long-term prospects point towards an unprecedented rise in HTS. The immediate growth in FSS bandwidth will be driven by demand for cellular backhaul or social inclusion initiatives as evisaged in the Government's flagship Digital India program. India's share in global demand for FSS is expected to rise until 2024, and decline thereafter[22]. On the other hand, India's share in global demand for HTS, is expected to see a significant upturn in the future.[23] However, regulations can impede the uptake of these technologies.

The restricted use of VSAT licenses in India has limited its application to a few sectors. While the global satellite industry is in the midst of a significant transformation, India is struggling to keep pace. India launched its first HTS only in 2017, when the global industry has already evolved into innovative applications of HTS. India's current capability to design and manufacture geostationary communications has improved. However, not all of it is produced in India. Around 20 percent of the total value is estimated to be

21 BIF (2017) https://www.broadbandindiaforum.com/files/reports-and-publications/Satellite%20Broadband %20&%20Digital%20India.pdf

22 NSR (2018)

23 NSR (2018)

outsourced to foreign suppliers[24]. Moreover, while domestic capacity has multiplied with the launch of GSAT 19, GSAT 29 and GSAT 11, foreign outsourcing may still be necessary for some time to come [25].

Given the global innovations in satellite communication and ISRO finally venturing into the domain of HTS there will also be a widening of satcom applications in India. The projected demand for satcom technologies in South Asia shows withering of FSS and a sharp rise in the HTS category. The slowdown in distribution and DTH services in India is much more measured than the rest of the world. The growth in HTS driven enterprise data is much higher in India than the rest of the world. Other applications that are likely to be growth drivers in the future are broadband access and commercial mobility.

Market estimates suggest that satcom applications in India will largely move towards broadband, mobility and enterprise services. The potential use cases of satellite communication help illustrate latent demand of the sector and its potential to drive socio-economic benefits in the country. Some potential commercial applications are discussed below.

(a) **Consumer Broadband**: Simple back of the envelope calculations on the rural demand for broadband establishes that a substantial size of the market is likely to remain underpenetrated even if terrestrial technologies were to grow at their Business as Usual pace over the next few years. With 238.26 million rural internet subscribers as of June 2019, the rural internet penetration in India stands at 26.57 per cent[26]. The average quarterly growth in rural internet penetration during the period September 2016 and June 2018 was 1.02 per cent. If rural penetration continues to increase at the same rate, over 489 million rural Indians would continue to remain unconnected

24 Krishnan, D. (2014): https://spacenews.com/39541challenges-and-opportunities-in-the-indian-satcom-market/

25 Krishnan, D. (2014): https://spacenews.com/39541challenges-and-opportunities-in-the-indian-satcom-market/

26 TRAI Performance Indicators Report June 2019

over the next 5 years.[27] Given the constraints in network demand and the challenges to connect rural and remote areas using terrestrial technologies, rapid deployment of HTS technologies could lead to improvement in rural penetration

The recent increase in video traffic, and its strain on resources like access spectrum and legacy wireless backhaul solutions, have led to innovative solutions and applications such as multicasting and content caching. The ability of satellites to simultaneously broadcast to huge geographical areas makes it the most efficient method to deliver broadband content to the edge of the network. HTS satellite communication with applications like multicasting and caching will enable *off-line browsing*, completely revolutionizing rural India's internet access. [28] This capability will be extremely important in areas where ' always on' broadband connectivity is problematic due to limitations in infrastructure, extreme weather conditions, and frequent power cuts.

(b) Community Wi-Fi: VSAT providers are deploying community Wi-Fi hotspots for rural areas across several countries. A satellite antenna is installed at a central location that provides connectivity. In Mexico, for example, Facebook has partnered with Viasat to deploy community Wi-Fi hotspots which are managed by local business owners at a price point of 50 cents for an hour's usage or $1.60 for 200Mb of data[29]. Other examples include deployment of similar networks by Hughes in Russia and Indonesia[30]. Satellite based community Wi-Fi is a great opportunity for India to bridge its digital divide, especially in remote areas with challenging geographical terrain.

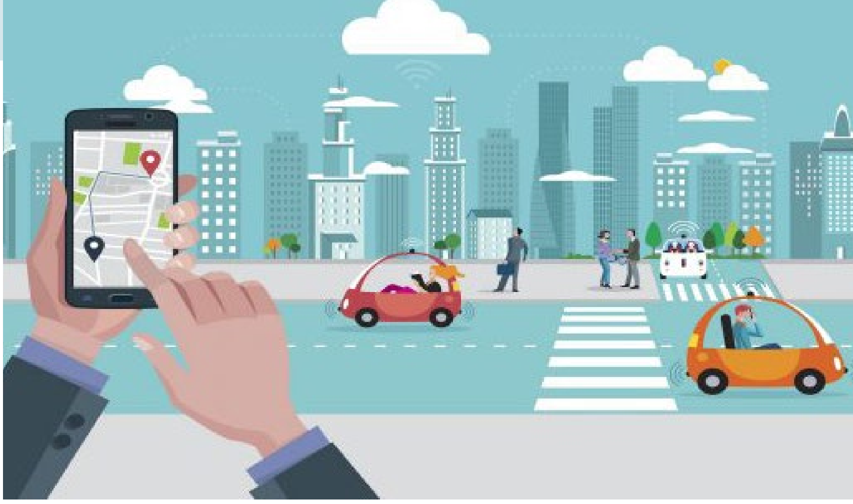
(c) Mobility: Some of the latest satellite innovations enable the "Internet of Everywhere'. Satcom technology is now able to deliver seamless high-speed broadband for users in maritime, aviation and the enterprise sector. A large proportion of the Indian population uses the public transportation system for their daily commute. These systems lack broadband connectivity in most rural and some urban areas. While there have been several attempts at evaluating satellite based mobile solutions, expensive bandwidth costs and the need for mechanically steered antennas to connect with the satellites have so far constrained such efforts. Mobile broadband connectivity on aircrafts, boats, trains, buses, taxis, trucks, and personal vehicles are common in North America and Europe and have recently found their way to Asia.

27 Viasat (2018).

28 https://www.broadbandindiaforum.com/files/reports-and-publications/SatCom%20Communiqu%C3%A9.pdf

29 https://venturebeat.com/2019/02/20/facebook-is-bringing-satellite-wi-fi-hotspots-to-rural-communities-starting-in-mexico/

30 https://www.worldteleport.org/news/403680/Community-WiFiWiFi-hotspots-with-satellite-backhaul-By-Vinay-Patel.htm



The Flight and Maritime Connectivity Rules notified in December 2018 by the Department of Telecom, Government of India allow only telecom operators to apply for an operating license for in-flight calling and internet surfing. While some private sector operators have either already been licensed, others are in the process of obtaining the license (*Refer Appendix 1*). These services would be permitted with a minimum height restriction of 3,000 meters in the Indian airspace to ensure that there is no interference with terrestrial mobile networks.[31] Both domestic and foreign satellites (which are coordinated through ISRO/DOS and have their Gateway in India) have been permitted. All traffic on board should be routed through the satellite gateway earth station within India, irrespective of the ownership of the satellite. The licenses have been granted for an annual fee of Re. 1 for a period of 10 years.

These provisions are likely to create a new revenue channel for airlines, even though it might be long before the income from this is substantial enough to make a difference. Many premier airlines are considering the provision of onboard Wi-Fi on wide-body aircrafts that fly medium to long haul international routes like those to US, Europe, Southeast Asia, and Australia. Business models of India's low-cost airlines are price-sensitive and are working out suitable business models to offer in-flight WiFi. Aircrafts need to be fitted with a radome and routers.

(d) Direct to Home (DTH) broadcasting: The DTH ROIS and Multicasting approach enables interesting new business models, where DTH operators that have substantial fallow capacity in the off-peak hours of the day can easily add a multicast extension service themselves, or sublease the required capacity during late night and early morning hours to companies that will be able to take advantage of these existing satellite networks for new multicast internet services[32]**.** However, DTH operators haven't been able to achieve the potential of this technology. Moreover, DTH operators in India largely operate on the Ku-Band. With an increasing number of TV channels in India, requirement for additional Ku-band transponders is escalating. A recent report of the Comptroller and Auditor General (CAG) of India on "Management of Satellite Capacity for DTH Service" reports that ISRO cannot meet the current backlog of demand either with its existing constellation of satellites or with its currently planned future programs. ISRO and ANTRIX have periodically, albeit informally, floated RFPs to lease capacity from foreign satellite system operators. More recently, however, DoS has requested the Ministry of Information and Broadcasting to ask broadcasters to migrate from foreign satellites without providing due consideration to the total bandwidth available of Indian satellites. Such a move, if mandated, could seriously hurt the potential of broadcasting sector.

31 Vahia, S. (2019). *After years of waiting, in-flight WiFi is soon coming to India.* Eoto.tech. https://eoto.tech/in-flight-wifi-india/

32 https://www.broadbandindiaforum.com/files/reports-and-publications/SatCom%20Communiqu%C3%A9.pdf

With advanced technologies on the ground and in space, satellite service providers are making communications more reliable and affordable. Innovations in Ka band, HTS with spot beams and frequency reuse, non-geo satellite (NGS) constellations, flexible payloads, flat panel antennas and several other developments are making satellite broadband connectivity more affordable globally. Given their low latency, commercial NGS satellites were initially aimed at delivering voice services. With data services exploding, new business models have emerged for NGS satellites. HTS NGS is used for trunking where launching GEO satellites may not be worthwhile. HTS NGS is also used to provide reliable global data connectivity to large corporates as well as IoT and M2M connectivity. Satcom is being used for M2M applications such as fleet management, asset monitoring. According to NSR, the global satellite M2M and IoT market will reach 5.96 million in-service satellite M2M/IoT terminals by 2025, corresponding to nearly $2.5 billion in annual retail revenue[33]. India is yet to make a mark by way of significant presence in the global commercial satellite communication ecosystem. Despite having a sixth of the global population, India owns only 3% of the commercial communication satellites[34]. As already highlighted, most countries moved to high capacity Ka band satellites long ago, while Indian satellites are still operating largely in the C and Ku band.

2.2.1 Availability of Adequate Spectrum for Satellite Communication

Traditionally, satellite communication has remained standalone and separated from the technical domain of mobile networking. It wasn't until recently efforts were made to embed satellite communication as an integral part of the 5th generation (5G) mobile networks. The performance benchmarks for 5G wireless services are high - user download speeds in excess of 1Gbps and uploads in excess of several 100 Mbps with a millisecond of signal lag. That's five times faster than the average household internet connection in the United States and Europe and 15 times faster than the global average. And all of this needs to be done with three times the spectral efficiency of 4G, effectively tripling the volume of data that can be sent over the same amount of spectrum. Satellites today are just starting to near those throughput markers. Viasat's ViaSat-2 offers 100 Mbps download speeds and Eutelsat and Hughes are building similarly capable satellites.

33 Machine to Machine (M2M) and Internet of Things (IoT) via satellite 7th Edition, NSR, November 2016

34 According to Euroconsult, close to 1020 communication satellites have been launched globally, while 40 communication satellites have been launched by India.

The most obvious application of satellite communication in the 5G delivery architecture is in the backhaul segment of the network. A more futuristic usage scenario of satellite is when it is deployed in the access network, communicating directly to the user terminal, possibly LEO satellites with some embedded facilities. With the advancement of satcom technology including storage, satellites may open up opportunities to place networking functionalities in space. This could include complete mobile base stations in space, flying on a low Earth orbit.

While most interests for satcom and terrestrial operators align around 5G, the eternal discussion for spectrum is hotter than ever. In the past, sluggish speeds, high latency and lower reliability confined satellite's role to being the last resort compared to other technologies, therefore serving only distant and remote areas, which were unviable for other technologies. This is no longer true today. **Satellite is now being mainstreamed into service provision**. However, it is important that spectrum be available for satellite operations, particularly in the Ka band. Over a decade ago, millimeter wave bands were allocated for high speed data on satellite networks. Operators committed investments in products and services on the promise of ample spectrum available to satellite networks. The industry has raised concerns over the threat to this spectrum from the international mobile telecommunication (IMT) community that wishes to secure spectrum in the frequency range between 24.25 and 86 GHz. Many of these bands including 24.25-27.5, 37.5 – 42.5 GHz and 47.2 – 50.2 GHz are assigned as co-primary for fixed satellite services along with Mobile Services by ITU-RR. Satellite operators have already invested in the roll out of broadband satellite services anticipating the availability of these bands. However, with the surge in the development of the 5G ecosystem in some of the millimeter wave bands viz. 26Ghz & 28Ghz, there is a global and a national imperative to strike a harmonious balance in providing additional spectrum for terrestrial 5G networks and protecting spectrum required for satellite services which have already been put in orbit or are in the process of being put up.

The proposal by the C-Band Alliance finds ways for terrestrial 5G and Satcom to work together. However, the proposals have to be worked out in detail to examine the implications of reallocation.[35] In India, the army and naval forces have also claimed 100 MHz in the C-Band, creating a three part divide for the available spectrum. However, the requirement of 25 MHz by the Department of Space in this band is unlikely to be contested. Technological solutions and discussions are being examined for the co-existence of both services in this band, maximizing the availability of this spectrum in India for existing and new services as have other countries[36].

The market outcomes are not independent of regulations and institutions governing them. With more flexibility in allocation of satellite capacity and increased private sector participation, the sector could achieve its due potential. The domestic applications of satellite communication offer opportunities that can significantly transform the digital potential of the country. In the next section we provide a global comparison of policies for satellite communication and identify best practices that can help create a vibrant ecosystem for India's commercial satellite communication sector.

35 https://c-bandalliance.com/#fcc-proposal-section

36 https://paragkar.com/26-28-ghz-map/

3. A Global Comparison of Policy Frameworks on Satellite Communication

Activities in space are broadly regulated through treaties between national governments, who are obliged to ensure that spaceflight originating from their countries follow basic rules of cooperation and coordination[37]. International Satellite Organisations (ISOs) such as INTELSAT, was established by treaties to increase connectivity among domestic telecommunications system. The International Telecommunication Union's (ITU) Constitution and Convention along with the Radio Regulations (RR) comprise several treaties ratified by various governments. ITU's space – related regulations are based on the guiding principles of efficient, rational and cost-effective utilization[38] of the orbit-spectrum. ITU allocates global radio spectrum and satellite orbit. It also develops technical standards that ensures networks and technologies interconnect seamlessly.

One of the fundamental regulatory principles for satellite operators around the world is the *Open Skies* policy. Open Skies allows licensed service providers to choose any satellite operator or satellite services required for their end users[39]. It implies that national regulators do not impose any additional requirements or restrictions on foreign satellite operator's vis-a-vis domestic/national operators. In other words, there are no artificial barriers to entry in the form of excessive licensing or unnecessary formalities, beyond registration of technical criteria. Despite the advent of private satellite companies, a majority of

37 https://qz.com/1226962/an-unauthorized-satellite-launch-in-india-threatens-us-regulatory-reform-in-space/

38 https://www.itu.int/en/ITU-R/space/snl/Documents/ITU-Space_reg.pdf

39 Regulation of Global Broadband Satellite Communications, Regulatory & Market Environment, ITU, April 2012 available at https://www.itu.int/ITU-D/treg/broadband/ITU-BBReports_RegulationBroadbandSatellite.pdf

the international satellite traffic until the 1990s was managed by intergovernmental satellite organizations. These *Closed Skies* policies required service providers to use only locally owned satellite capacity. Over time, the demand for Internet, data, voice and video led to open and direct access to all ITU coordinated satellite resources[40]. Open Skies provide avenues for new partnerships, that foster optimum profitability for operators and users[41]. It enhances competition among satellite operators and yields efficient outcomes.[42] Europe's success in achieving vibrant competition between terrestrial and satellite DTH and digital TV platforms, as well as for telecom backhaul, is indicative of the positive growth impact for Satcom that have been initiated through the shift to 'Open Skies' policy.

According to the EMEA Satellite Operator's Association, Open Skies is adopted by several countries around the world. Among Asian countries, Australia, Hong Kong, Indonesia, Japan, Malaysia, Philippines, Taiwan, have all adopted the Open Skies policy, outnumbering others with relatively restrictive environments such as China, India, Korea, and Thailand.[43] Thailand and Vietnam follow a limited skies policy with domestic preference. South Korea also adheres to a limited policy ensuring services are contracted by a small number of authorized carriers. China restricts services to only domestic and certain joint venture companies. India's ecosystem is perhaps the most restrictive. Regional satellite operators often experience short-term setbacks such as inconsistent levels of competition across countries with and without an Open Skies policy. It limits their ability to position products and services. Mitigation of these inconsistencies requires co-operation among countries.[44]

40 *Op Cit*

41 Satellite Industry Developments, Malaysian Communications and Multimedia Commission, 2008 available at https://www.skmm.gov.my/skmmgovmy/files/attachments/Satellite_Industry_Developments.pdf

42 ESOA (u.d.). *Open Skies Policy: Market Access Principles for Satellite Communications.*

43 Malaysian Communications and Multimedia Commission (2008). *Satellite Industry Developments.*

44 Malaysian Communications and Multimedia Commission (2008). *Satellite Industry Developments.*

Moreover, countries may diverge in their *de jure* (by law) versus *de facto* (in implementation) status of Open Skies. Countries may not always implement the entire suite of agreed-upon prerequisites of the Open Skies approach. Open Skies, such as in the case of satellite broadcasting, may be violated by invoking security concerns. Conflict-prone and conflict-ridden regions such as the Middle East and North Africa often witness unceremonious ejection of various TV channels. 'Jamming' is a political act, practiced by many administrations around the world - the United States is known to have jammed legal Cuban radio and TV news broadcasts; Indonesia jammed Tongan satellite signals in 1997; Cuba, Libya, Syria and Egypt have all reportedly jammed foreign satellite signals for ostensibly political motivations.[45] Our reporting on Open Skies is based on declared policy frameworks. We haven't accounted or introduced an appropriate deflator, for any potential gaps between the stated policy and its actual, on-ground implementation. *Table 1* presents a cross-country comparison of regulatory frameworks for provision of satellite based services.

Table 1: Comparison of Satellite Capacity and Regulatory Frameworks

Country	Number of Satellites[46]	Type of Regulatory Framework[47]
Vietnam	3	Limited Skies with Domestic Preference
Philippines	3	Open Skies
Malaysia	7	Open Skies
Singapore	10	Open Skies
Thailand	9	Limited Skies with Domestic Preference
Taiwan	10	Open Skies
Indonesia	17	Open Skies
Australia	20	Open Skies
South Korea	23	Limited Skies with services contracted by a small number of authorized carriers
United Kingdom	47	Open Skies (however open to interpretation post the UK's withdrawal from the EU on March 29, 2019 as the EU is the signatory and the UK is covered under it as an EU member state
India	88	Limited – services must be contracted through a government agency *from Indian & foreign satellites*

45 Charles Russell Speechlys (2010). *Bahrain: Open Skies - The Laws And Regulations Guiding Middle East Satellite Broadcasting*

46 Data source: N2YO.com (2018). *Satellites by Countries and Organisations*

47 Compiled from stakeholder consultations (2018)

The policy choices can be placed on a scale of regulatory restrictiveness with unrestricted Open Skies on one end and contract of services only through government agencies on the other other end. Other limiting options that include adequacy requirements such as certifications, licenses, preference frameworks lie in between (*Refer Figure 1*).

Figure 1: Scale for Regulatory Restrictiveness

There isn't a one-to-one relationship between the openness of the regulatory framework for Satcom and the economic indicators of a country. Since several reports find significant spillover benefits from communication technologies, one would expect that less regulated sectors, would see higher uptake of satellite services and consequently higher growth impacts. But isolating these impacts are extremely challenging. It is also possible that countries with Open Skies don't necessarily rely on Satcom for connectivity. Moreover, the number, type and capacity of satellites may vary significantly across countries. We have also pointed that the Open Skies policy may not in fact be implemented in its entirety in all countries.

The limitations of measurement aside, it would be rash to dismiss any association between the choice of policy framework and economic outcomes. While India has had a satcom policy since 1997 which contains provisions for private satellites, in spirit the policy has not been able to create a competitive ecosystem for the growth of private operators. Despite ISRO's efforts to enlarge its fleet of available satellites with the launch of new high throughput satellites (HTS), a bulk of the demand is still met by hiring/leasing capacity on foreign satellites. India relies on foreign private satellite providers for more than 50% of its capacity[48]. ISRO has however indicated a plan to migrate users from foreign satellites to domestic ones in the next couple of years. *Table 2* below lists the communication satellite launches in India including those scheduled until 2020. GSAT-19, GSAT-29, GSAT-11, and the advent of GSAT-20 marks India's entry into the High Throughput Satellite (HTS) category. ISRO claims that "The launch of four high-throughput satellites will provide the country broadband connectivity of over 100 Gbps by 2019/2020"[49]. Globally, with an average addition of 11 GEO-HTS during the period 2017-2025, the HTS led capacity supply is likely to reach roughly 3600 Gbps by 2020[50].

48 Compiled from stakeholder consultations (2018)

49 The Times of India (2018). *4 new satellites to provide fast internet speed by 2019: Isro chief.*

50 http://www.satelliteevolutiongroup.com/articles/HTS-2017.pdf

Table 2: Launch of Communication Satellites in India

Launch Year	Communication Satellite Name(s)[51]	Number of Communication Satellites Launched
2000	INSAT-3B	1
2001	GSAT-1	1
2002	INSAT-3C, KALPANA-1	2
2003	INSAT-3A, GSAT-2, INSAT-3E	3
2004	EDUSAT	1
2005	HAMSAT, INSAT-4A	2
2006	INSAT-4C	1
2007	INSAT-4B, INSAT-4CR	2
2010	GSAT-4, GSAT-5P	2
2011	GSAT-8, GSAT-12	2
2012	GSAT-10	1
2013	GSAT-7	1
2014	GSAT-14, GSAT-16	2
2015	GSAT-6, GSAT-15	2
2016	GSAT-18	1
2017	GSAT-9, GSAT-19, GSAT-17	3
2018	GSAT-6A, GSAT-29, GSAT-11	3
2020	GSAT-20	1 scheduled

Source: ISRO (2018)

A comparison of India with global averages for price and capacity finds that not only is the available capacity in India significantly lower than most other countries, the cost of bandwidth capacity in India is significantly higher than the global average. In an example of cost comparisons for capacity leased by BSNL in 2018, we find that BSNL pays less than half for bandwidth procured on foreign satellites (Thaicom) as compared to an Indian satellite (GSAT 8)[52]. Capacity available on Indian satellites is significantly lower than the cutting edge foreign HTS, with capacities of around 150 Gbit/s. India's GSAT 11, is expected to provide a throughput of 14 Gbit/s. The capacity from GSAT 11 and GST 19 is expected to increase bandwidth by 1160 MHz and 928 MHz respectively. However, estimates suggest that there will continue to be a shortfall of 510 MHz on GSAT 11 and 95Mhz on GSAT 19[53]. With the adoption of Ka band and LEO satellites, commonly deployed in several countries, we can expect an improvement in the domestic capacity available in India.

Countries have adapted their communication policies including that for satellite communications, to changing patterns in demand. A good example is the Satcom Policy of the European Union (EU), which has been updated to incorporate the growth in

51 ISRO (2018)

52 Telecom Live, November 2018

53 Telecom Live, November 2018

data transmission and other ambitious projects focusing on broadband and multimedia services in the region[54]. The Communications Satellite Act, 1962 of the United States also recognized that a commercial communications satellite system, must respond to public needs and national objectives.[55] The creation of the Communications Satellite Corporation (COMSAT), a private communications corporation intended to be a unique experiment in public and private ownership under supervision of the federal government.[56] The law also committed the US to building a global communications system.[57]

Meanwhile in UK, the potential impact of Brexit pushed the government to strengthen its own standing in space. Consequently, the UK government made efforts to create a regulatory framework for the expansion of commercial space activities and the development of a UK space port. It has now drafted The Space Industry Bill, 2018, which intends to cover both orbital and sub-orbital activities, and horizontal and vertical launches carried out in the UK. The Space Industry Bill is aimed to enable the first commercial space launch from UK soil. The passing of the Bill indicates that British businesses will soon be able to compete in the commercial space race using UK space

54 Liikanen, E. (2001). *Satellite Communications and EU Policies.* Brussels: Satellite Action Plan.

55 Smith, D.D. (1969). *The Legal Ordering of Satellite Telecommunication: Problems and Alternatives,* Indiana Law Journal: Vol. 44 : Iss. 3, Article 1.

56 Socol, S.K. (1977). *Comsat's First Decade: Difficulties in Interpreting the Communications Satellite Act of 1962.* Georgia Journal of International and Comparative Law. Vol. 7.

57 NASA (2017). *August 1962- Communications Satellite Act signed.*

ports. UK is already a global hub for satellite manufacturing, operation and application development. With one in every four telecom satellites, substantially built in Britain, UK businesses are at the forefront of hypersonic flight technology. Through its industrial policy, the government is working with the industry to increase its global share in the space sector from 6.5% today to 10% by 2030.

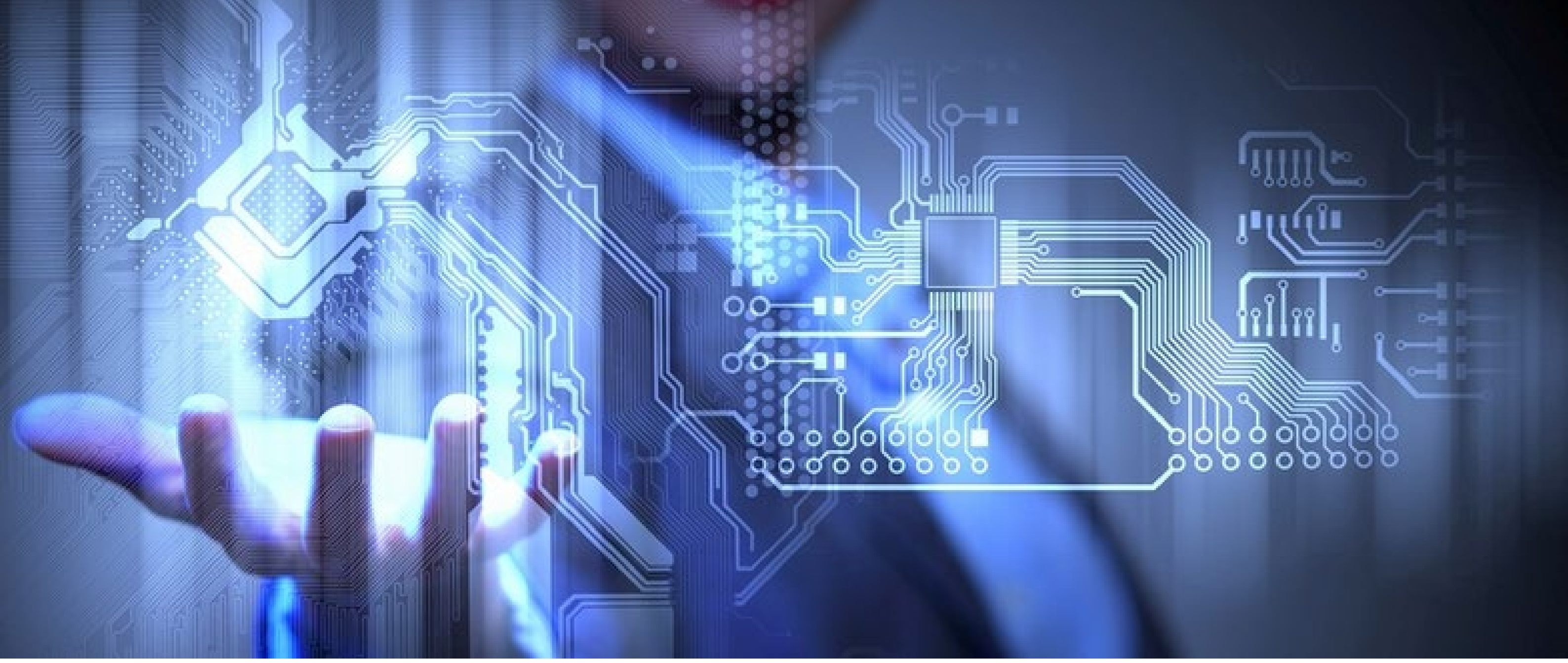
China also intends to enact its own Space Law in 2020. It encourages and supports Chinese enterprises to participate in international commercial activities in the space field. It has exported satellites and made in-orbit delivery of Nigeria's communications satellite, Venezuela's remote-sensing satellite-1, Bolivia's communications satellite, Laos' communications satellite-1 and Belarus' communications satellite-1.[58] Despite a closed ecosystem for Satcom services, China has created domestic capacity that out counts most others in the world. US is an outlier with over 1600 satellites. China is steadily increasing its involvement in every link of the satcom value chain. Its approach has been to leverage end-to-end deals covering funding, technical training, satellite manufacturing, and launch. Chinese technology has also gained the trust of a large number of emerging markets such as Bolivia, Nigeria and Cambodia. Many of these bilateral deals are tied to China's One Belt, One Road (OBOR) initiative, though satellite is a relatively minor part of the overall range of OBOR priorities.[59]

This discussion on regulatory frameworks does not necessarily establish that countries with an Open Skies policy will see flourishing market outcomes. It however, does emphasize on the catalyzing role it's likely to play in encouraging growth of the sector. Closer to home, we find such evidence in the growth of India's telecom sector. A fiercely competitive market for terrestrial technologies and the entry of a disruptive new entrant has lowered data tariffs in India to less than half of global tariffs[60]. For commercial satcom, while India has achieved price competitiveness in wide beam technologies, it has only recently started offering competitive prices for the broadband friendly HTS technology.

58 Paul, S. (2018). *What are the various space policies.* Geospatial World.

59 Compiled from NSR (2018), Global Satellite Capacity Supply & Demand, 15th Edition

60 In 2018, the price for mobile broadband (1 GB) in India was approximately USD 6.22 compared to the global average of USD 12.15



3.1 *Policy and Regulatory Framework for Satellite Communication in India*

The Indian Telegraph Act, 1885 along with the Indian Wireless Telegraphy Act are the principal statutes that continue to regulate both terrestrial and satellite telecommunications in India. The period of economic liberalization in the early 1990s also found satellite communication being designated as one of the key sectors in the country's overall growth agenda. The inception of Antrix, ISRO's first commercial arm for space related activities, coincided with the entry of private sector operators in telecommunication services and broadcasting. In June 1997, the Union Cabinet approved the framework for a satellite communications policy.[61] This policy notified as India's "Satcom Policy" is the only dedicated policy on space activities till date.

The fundamental aim of India's Satcom Policy was to develop a healthy and thriving ground equipment as well as satellite communications services industries in India. The objectives stated in the policy included:

- Developing Satcom, launch vehicles and ground equipment industry in India
- Making available and developing further the infrastructure built through the government-operated Indian National Satellite System (INSAT)
- Encouraging private sector investment in space industry, and
- Allowing, to a very limited extent, the use of foreign satellites for services in India.

In 2000, the Government framed norms and procedures for implementation of this policy emphasising on the preferred use of the INSAT network. The Department of Space (DoS) designated certain nodal agencies to function as licensing authorities. The Department

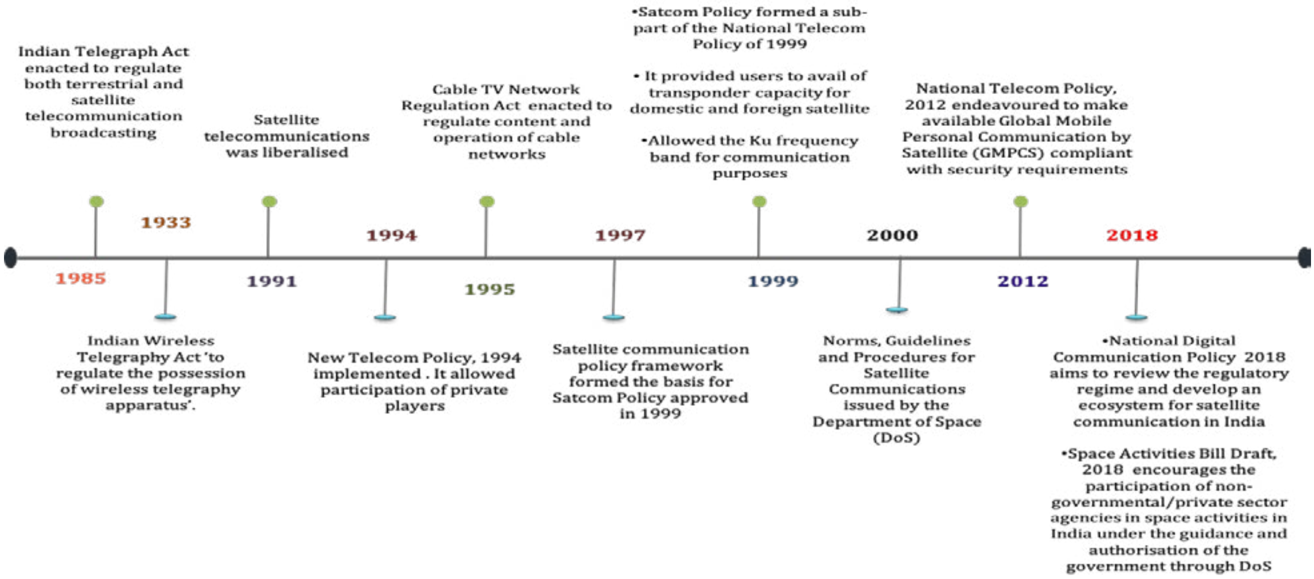
61 A policy framework for satellite communications in India: https://www.isro.gov.in/sites/default/files/article-files/indi-as-space-policy-0/satcom-policy.pdf

of Telecommunication (DoT) operated as the licensing authority for satellite along with terrestrial telecommunication, whereas, the Ministry of Information and Broadcasting (MIB) was made the nodal agency for satellite and terrestrial broadcasting. Satellite service providers were required to obtain authorisation from the DoS to own and operate an Indian registered satellite system, including the spacecraft control centre, authorisation by the Wireless Planning and Coordination Wing (WPC) of the Ministry of Communications, to operate a Space Station in accordance with the extant ITU Radio Regulations and operating licenses in accordance with the regulations in the particular sector.

The norms also specify the need for permissions prior to the use of foreign satellites. Permissions are granted in consultation with the Department of Space and only in special cases when adequate capacity is not available on an Indian satellite system. The DoS however, permits the use of foreign satellite transponder capacity for Internet Service Provider (ISP) Gateways.

As per the norms, only Indian registered companies are allowed to establish and operate an Indian Satellite System. The Foreign Direct Investment rules restrict foreign investments in such a company up to 74 per cent. Applications must be filed with the Committee for Authorising the Establishment and Operation of Indian Satellite Systems (CAISS) in order to register satellite systems belonging to such entities. Applications are then processed for approval by an Inter-Ministerial Committee under the chairmanship of the Secretary of the DoS. *Figure 2* provides a chronological illustration of policy interventions in this sector.

Figure 2: Chronology of Policy and Regulatory Interventions in India's Satcom Sector



Source: Compiled from DoS, DoT and TRAI

3.1.1 The Institutional Framework Governing India's Satcom Sector

The current institutional framework governing satellite communication is spearheaded by the Government of India's Department of Space (DoS) (which is headed by the Prime Minister), along with the Department of Telecommunication and the Ministry of Information and Broadcasting. DoS's operating arms ISRO and Antrix are tasked with managing satellite launches and transponder capacities and governing contractual arrangements for both domestic and international satellite capacity utilization. Its new unit NewSpace India Limited (NSIL) was established to commercially exploit the research and development work of ISRO centres and constituent units of DOS. It was set up to 'meet the ever-increasing demands of Indian space programme and to commercially exploit the emerging global space market' and 'spur the growth of Indian industries in the space sector and enable Indian industries to scale up manufacturing and production base'. Its mandate includes small satellite technology transfer to industry, wherein NSIL will obtain licences from DOS/ISRO and sub-licence it to industry, the manufacture of the Small Satellite Launch Vehicle (SSLV) in collaboration with industry, and the production of the Polar Satellite Launch Vehicle (PSLV) through Indian industry. It is unclear at this nascent stage how it would differ at a structural and organizational level from Antrix, however a new set-up offers an opportunity for appropriate structures to be put into place ab-initio to avoid the issues Antrix has faced.

The Wireless Planning Committee (WPC), a wing of the DoT, manages wireless communication and frequency spectrum, and the Telecom Regulatory Authority of India (TRAI) regulates certain aspects of Satcom operations in India. Moreover, India's ratification of the United Nations' Outer Space Treaty and the GATS Agreement, which contains the Annex on Telecommunications also requires adherence to specific international obligations. As a member of the International Telecommunications Union (ITU), India and its service providers need to submit a variety of filings in the multilateral agency to be allocated orbital slots and radio spectra.

This complex web of administrative requirements and the occasional unpredictability in policy making by DoS can often deter private sector operators from entering this market, despite its potential. The bureaucratic process requires approaching multiple administrative departments in order to secure frequency allocations, orbital slots, etc. in addition to other regulatory hurdles such as FDI restrictions and norms guiding foreign

equity infusion in domestic entities, which operators must navigate. While the norms and guidelines classify satellite communication services into two broad categories - domestic and international, it is strongly felt that the distinction between the two has been left vague and open to interpretation. Moreover, the norms severely limit the use of foreign satellites for domestic communication, and lack clarity on the use of foreign satellites for international communication[62]. As already highlighted the capacity available on Indian satellites, albeit better than earlier, is still significantly lower and not adequate to meet domestic communication & broadcasting demand. The pricing of commercial satellite bandwidth is completely controlled by ISRO/Antrix unlike the market-led price mechanism in most other countries.

The symptoms of regulatory failure are also noticeable in the rapid decline of India's traditional satcom industry, with private sector operators losing interest in an environment of uncertain and unpredictable government policy[63]. Industry interactions revealed that almost all SSOs, VSAT service providers and equipment vendors are operating at a low-level equilibrium, focusing on low-bandwidth satellite applications such as enterprise services and ATMs, and missing out on profitable opportunities to service India's latent demand in areas such as consumer broadband.

A large part of the problem is the institutional design (*Figure 3*) governing India's Satcom sector that leads to conflict of interest within government. The DoS along with ISRO currently engages in policymaking, licensing, operations and research. The policy structure is often defended as crucial to national security, it may be an attempt to protect bureaucratic turf[64]. The Government being the sole provider of space capacity for satellite

62 Singal, N. (u.d.), Lakshmikumaran & Sridharan Attorneys https://www.lakshmisri.com/News-and-Publications/Publications/Articles/Corporate/satellite-communications-policy-in-india-time-to-revisit-revise

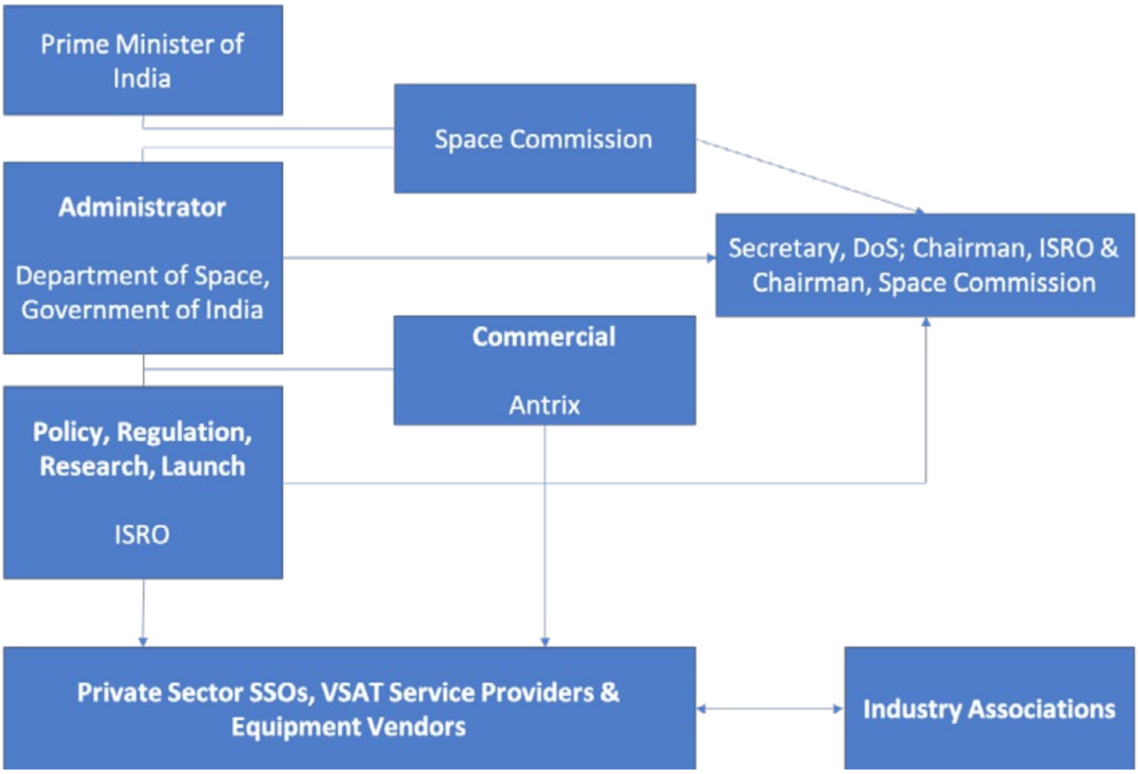
63 Based on industry interactions

64 The Wire (2017). https://thewire.in/space/devas-internet-dos-isro

communication, monopolises the supply of satellite bandwidth in India. Every time the Department of Space (DoS) or Antrix contract capacity, the opportunity to negotiate in a typical buyer-seller setting is completely lost. Being a government entity, neither ISRO nor Antrix are subject to scrutiny by competition authorities for misconduct or abuse of market power. Often the contracts offered by Antrix are not commercially viable and operators are left with no choice but to accept them.[65]

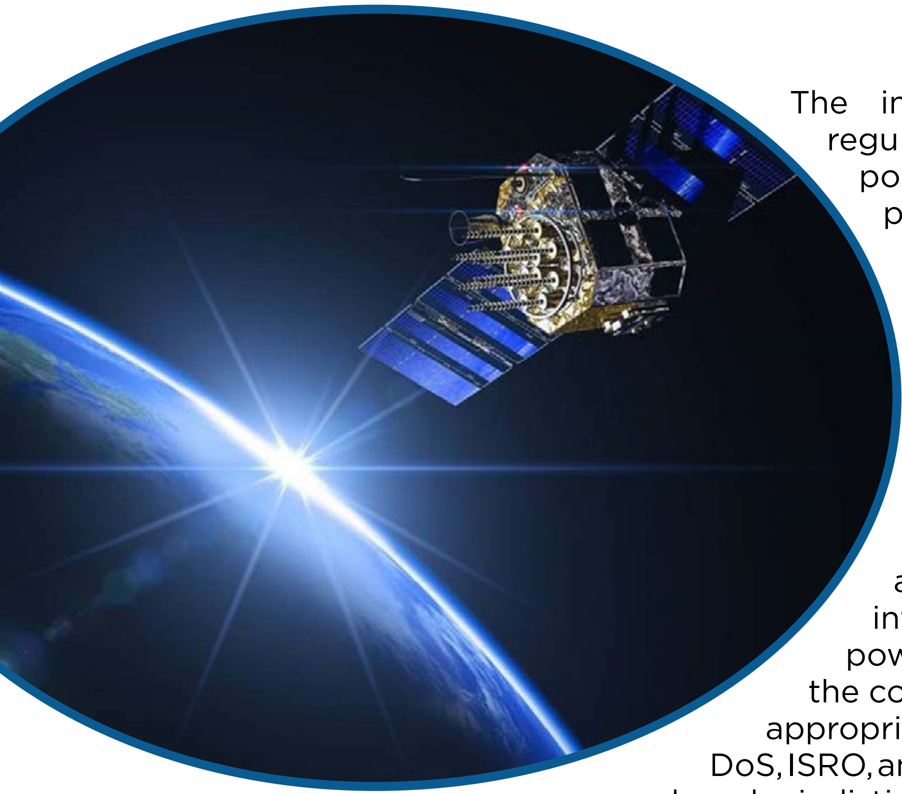
Industry stakeholders also reported the recent restriction on free availability of wide beam (FSS) satellite capacity. Until a few years ago, Antrix allowed industry operators to buy available foreign capacity, now all purchases have to be routed through Antrix. It is reported that operators are coerced into buying Indian capacity which may not be always the most suitable or competitively priced. Operators looking to scale satellite capacity on foreign satellites, are also forced to buy domestic capacity. This increases their costs as ground equipment needs to be realigned and reoriented. Other instances of ad hoc and indiscriminate policy are retrospective increase in bandwidth costs and other associated charges. In 2017, ISRO increased the price of satellite bandwidth by 20% for private sector operators, retrospectively. It also cut down discounts provided to bulk buyers of bandwidth. In the absence of checks and balances created by the separation of powers between the legislative, judiciary and executive, such outcomes are not surprising.

Figure 3: Regulatory Framework of Satcom in India



Source: Illustrated by authors

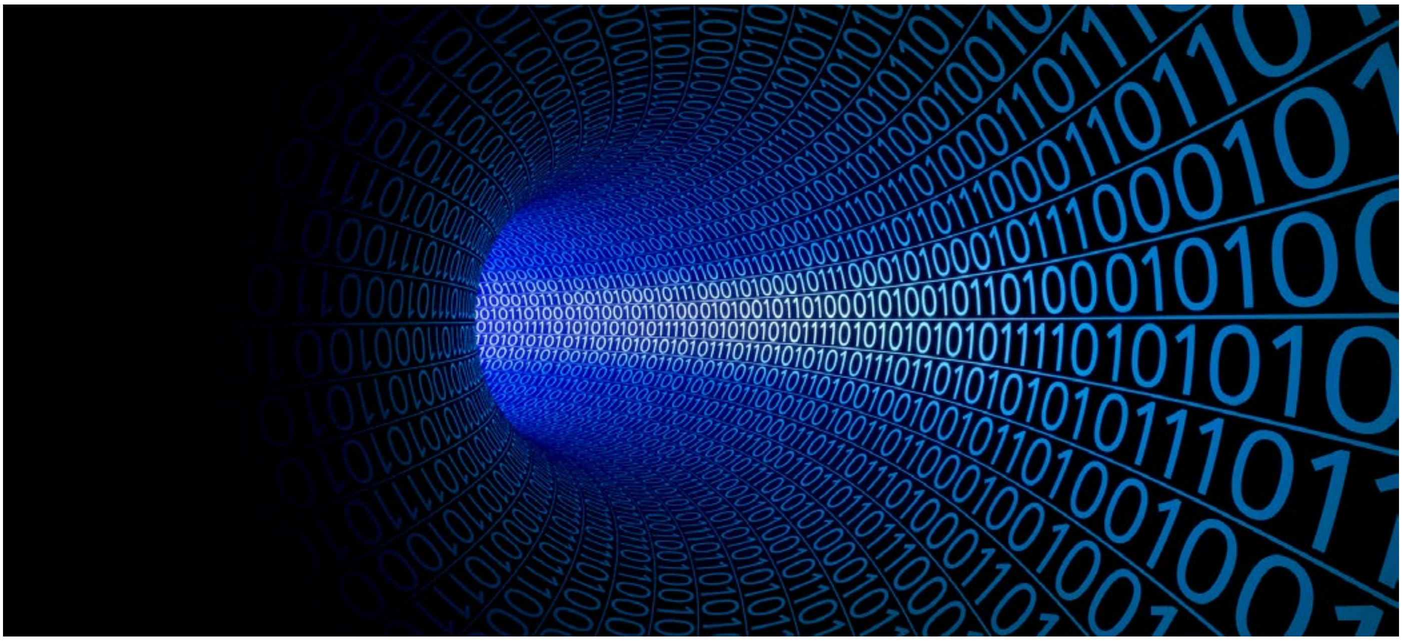
65 Krishna, K. (u.d.), *Why is India not shining in the use of satellite broadband?* Observer Research Foundation Working Paper



The institutional system governing any regulated sector should comprise the political, administrative and market processes that describe the logic for investments, the implementation of the plans through law and subordinate legislation, and through industry bodies, and consumer groups and other means. In his magnum opus titled 'Spirit of Laws', Montesquieu (1748) first coined the term 'separation of powers'[66], recommending that the political authority of the state be divided into legislative, executive and judicial powers. The intent therein was to prevent the concentration of power and provide for appropriate checks and balances. However, DoS, ISRO, and the Space Commission, constituting a largely indistinguishable unit that functions as a policymaking, regulating and commercial activity-overseeing supremo, are headed ex-officio by the same individual (Secretary, DoS; Chairman, ISRO; and Chairman, Space Commission), creating serious conflicts of interest, and puncturing important firewalls that ought to be built into the institutional design.

The onset of market friendly reforms in India's telecom sector that began in the early 1990s, was marked by the creation of institutions that significantly altered the regulatory landscape of the telecom sector. To permit companies registered in India to operate and to promote foreign investment in the sector, meant an end to the Department of Telecom's monopoly on access, setting up of an independent regulator and separation of DoT the service provider from DoT the policy maker. The spectacular rise of the telecom market in India embodies the success of an enabling policy environment. If the satcom sector is to make comparable advances, then ISRO must be shorn off its policy and regulatory powers and be restricted to its original mandate of research and development, as well as launching satellites, in order to achieve clear distinction of powers and functions. Concomitantly, policy and regulation of all commercial telecommunications services via satellite, needs to be brought under exclusive purview of DoT and TRAI respectively, on the lines of terrestrial services. In such a scenario, DoS and ISRO could play a consultative role with a view to identifying coordinated satellites and frequencies, in line with ITU procedures, to be used for telecom networks. This will go a long way in reducing the distortionary monopoly power of a single government entity in a critical sector such as satcom, and serve the need to reduce the multiple administrative departments that need to be approached in order for a private firm to secure frequency allocations and orbital slots.

66 Montesquieu, 1748



4. Concluding Remarks and Policy Recommendations

The report reassuringly finds potential for satcom applications in India's digital future. The government has also acknowledged the role of satcom to meet the demands of the emerging era of hyper communication and data utilisation. The DoT recognizes that meeting ambitious targets laid down in the National Digital Communications Policy (NDCP 2018) will require a mix of technologies. Over dependence on mobile wireless technologies may not be adequate to achieve the ambitious targets of 1 GB for every panchayat going up to 10 GB, at 50 Mbps speeds laid down in the policy. This report illustrates existing, as well as promising potential use cases for satcom in India, and has argued for satellites complementing terrestrial communications capabilities in extending connectivity to the most challenging geographical and topological terrains of the country. DTH RIOS and multicasting with content caching, flight and maritime connectivity, consumer broadband and satellite backhaul are among the key applications for satcom in the future. For this growth to be unleashed, we *recommend the following policy initiatives:*

(a) Moving towards market-led mechanisms for provision of satellite bandwidth: The comparison of policy architectures and regulatory interventions that govern satcom in India vis-à-vis other countries presents a case for moving towards a market-driven regime for satellite services in India. Global best practices find that bandwidth contracting is directly done between the supplier and user of B2B satellite services and in some cases directly with the enterprise/ end consumer in case of B2C services. Developing countries such as India with sizeable infrastructural deficits can realise both quantitative and qualitative improvements in their economic growth and quality of life by unleashing the innovative and efficient capacities of the private sector in satcom. *It is important to note that this proposed policy shift is being characterized as 'gradual' since it would be both feasible from a national security perspective, while at the same time beneficial for application to emerging services such as consumer broadband and mobility.* Opening the supply of satellite capacity to private players will improve access to latest and innovative technologies

at an affordable cost. Selective deregulation may not necessarily come at the cost of national security concerns, where possible the government must consider opening up satellite services for private participation that lowers cost of bandwidth and encourages its adoption across potential applications.

In order to address concerns related to security and loss of oversight on content transmitted over foreign satellites, the government can adapt alternate principles proposed by the EMEA Satellite Operators Association (ESOA) instead of imposing additional regulatory burdens such as the installation of costly local technical facilities. For example, in the case of fixed satellite services, the government can identify a non-discriminatory way (not distinguishing between domestic and foreign operators) of authorizing entities with appropriate permissions to 'uplink' to a satellite.

(b) Separation of regulatory powers and functions: In order to reap the benefits of India's telecoms revolution which, to a significant degree, were sustained and nurtured due to a clear separation of powers and functions between DoT, TRAI and TDSAT, liberalisation of satellite communication must be encouraged. ISRO's focus could be realigned to its original mandate of research and development, as well as launching satellites, in order to achieve a clear distinction of powers and functions. The commercial arms Antrix and NSIL if corporatized and spun off as separate public sector entities can compete alongside other private sector operators. A clear delineation of functions is necessary for the commercial units. Policy and regulation for all commercial telecoms via satellite could be brought under the purview of DoT and TRAI in consultation with DoS and ISRO to ensure coordinated satellites and frequencies. In mature policy regimes such as the US, the space agency NASA is more focused on research & development in strategic areas and does not interfere with commercial communications. Similarly, the European Space Agency, also focuses on strategic interests of the region, while the commercial satellite communications are left to the industry.

(c) Encouraging satellite broadband: A strategy of augmentation of existing terrestrial broadband capacity is much needed, especially in remote areas of the country where the connectivity spillovers leading to rapid economic growth are yet to be achieved. Moreover, there exist sizeable tracts of urban areas that are uncovered by terrestrial modes that could benefit from satellite connectivity. With technological advancements, satellite broadband may not necessarily be a substitute to terrestrial alternatives, but work together as complementary applications, especially in the deployment of 5G.

(d) Capacity augmentation through indigenous private satellite service providers: As highlighted above, India's satcom capacity is much lower than desirable for achieving the objectives of Digital India. While the Department of Space (DoS) has previously claimed that India has less than 50% of the satellite capacity it needs, the actual figures might infact be much lower. Private players must be allowed to set up India centric commercial broadband satellite systems to bridge the capacity gap. The government must encourage domestic companies to provide commercial broadband using emerging HTS technologies.

(e) Enabling In-Flight Mobile Connectivity through Satcom: With the notification of the Flight and Maritime Connectivity Rules notified in December 2018 the path has been laid out for airlines and telecom service providers to provide inflight connectivity in the Indian airspace. However, the commercialization and subsequent revenue generation from these services will be constrained by the costs of service provision. As highlighted above, increased participation from the private sector will help lower the cost of satellite bandwidth, make provision for adequate bandwidth and thereby make the cost of in-flight connectivity affordable for consumers.

(f) Encouraging non-commercial applications of Satcom: ISRO already deploys satellite communication technology for a series of non-commercial applications which have a direct socio-economic benefit. Some of these application include provision of tele-medicine, tele-education, railway signaling, navigation and disaster management services. Encouraging investments in such applications can have significant socio-economic impacts in a developing country such as India. It will exhibit the capacity of satcom for transformational interventions to the private sector, setting off a virtuous cycle of investments in satcom supported services and social infrastructure.

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APPENDIX 1: LIST OF IFMC SERVICE PROVIDERS (as on 1st November, 2019)

(A) List of India registered Airlines:

S. No.	Representative Name of Airlines
1.	Air India Ltd
2.	Interglobe Aviaion Ltd(Indigo)
3.	Spicejet Ltd
4.	Jet Airways (India) Ltd
5.	Go Airlines (India) Ltd
6.	Vistara, TATA SIA Airlines Ltd
7.	M/s Air Asia (India) Ltd

(B) List of concerned Service Providers providing Satellite and Terrestrial Services:

S. No.	Representative of Name of Company
1.	M/s Bharat Sanchar Nigam Ltd
2.	M/s Tatanet Services Ltd
3.	M/s Hughes Communications India Ltd
4.	M/s Bharti Airtel Ltd
5.	M/s Reliance Jio Infocom Ltd
6.	M/s Vodafone India Ltd
7.	M/s Idea Cellular Ltd
8.	M/s Infotel Satcom Pvt Ltd
9.	M/s Inmarsat