**Consultation Paper No. 1/2021**

**Telecom Regulatory Authority of India**

सत्यमेव जयते

# Consultation Paper

# on

# Licensing Framework for Satellite-based connectivity for low bit rate applications

New Delhi, India

12th March 2021

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New Delhi – 110 002

**Written Comments on the Consultation Paper are invited from the stakeholders by 9th April 2021 and counter-comments by 23rd April 2021. Comments and counter-comments will be posted on TRAI's website www.trai.gov.in. The comments and counter-comments may be sent, preferably in electronic form, to Shri Syed Tausif Abbas, Advisor (Networks, Spectrum and Licensing), TRAI on the email ID** advmn@trai.gov.in.

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**ANNEXURE**

# Chapter 1
# Introduction

1.1 Satellite communication can provide coverage to the remotest and inaccessible areas of a geographically widespread country like India. The uniqueness and benefit of satellite technology cannot be underestimated. It can play an important role in enhancing crucial nationwide communication infrastructure. With the evolution of Satellite communication technologies, new types of applications based on low-bit-rate applications are emerging. Such applications require low cost, low power and small size terminals that can effectively perform the task of signal transfer with minimum loss.

1.2 Many sparsely populated areas, with important economic activities, do not have mobile terrestrial coverage or other forms of connectivity. Satellites can bridge this gap by providing coverage to even the remotest areas for low-bit-rate IoT applications.

1.3 Different IoT use-cases and solutions have different connectivity requirements. Currently, terrestrial services (cellular, Wi-Fi, Bluetooth, LoRA, Sigfox) are driving IoT deployments. The wider coverage of satellite-based solutions, however, can be a key enabler for the extension of IoT services in remote areas where cellular connectivity is unavailable or sparsely available.

1.4 The typical applications/use cases utilizing a satellite networking protocol and sensor connectivity solutions are envisaged in numerous sectors such as agriculture, smart farming, deep-water applications, mission-critical services, oil and gas, fisheries, forestry, logistics, mining, industrial logistics, railways, remote utilities, disaster preparedness, etc.

1.5 Some applications/use cases, utilizing low-bit-rate satellite-based communication, are briefly discussed as follows:

(i) <u>Supply Chain Management</u>

- Asset tracking: vehicle fleet management, on-time delivery, real-time location, inventory, cold chain management of refrigerated items like medicine/food, etc.

(ii) <u>Smart Grids</u>

- Remote transmission towers monitoring, load distribution, supply/demand management.
- Sensor-based applications for Remote Industries and Connected Healthcare, Supervisory Control and Data Acquisition (SCADA) and many more.

(iii) <u>Railways</u>

- Geo-location of rolling stock assets, monitoring of safety systems in a train, mission critical two-way data, etc.

(iv) <u>Disaster Management</u>

- Delivery of real-time and geo-location alerts in case of floods, landslides, etc., emergency alert broadcasts and SOS messaging for fishing vessels, real-time tsunami alerts from marine buoys, detection of fires in rural forests or strategic buildings, managing logistics of NDRF vehicles, boats, fire engines, ambulances, etc., during natural disasters and accidents.

(v) <u>Internal security</u>

- Tracking of patrol vehicles, monitoring of critical logistics supplies through remote areas;
- Connectivity among coast guard vessels and monitoring of vessels at sea.

(vi) <u>Fisheries</u>

- Sensor-based connectivity is used for location and vessel monitoring, maritime boundary alerts;
- Geo-fenced fishing zones, for monitoring the cold-chain of stored fish, two-way emergency messaging system for distressed vessels, inclement weather.

(vii) <u>Health services response mechanism</u>

- Ambulance and medical logistics tracking especially in rural areas, vehicle telemetry.
- Live monitoring of patients' diagnostics, etc.

(viii) Smart Agriculture:

- Monitoring soil conditions for critical inputs such as water, fertilizers and pesticides, etc.
- Harvest prediction, crop infestation/damage, yield, severe weather prediction, etc.
- Reaching out to remote villages, farmland.

1.6 Department of Telecommunications (DoT), in its reference has mentioned that the current licensing framework of DoT, for satellite-based services has limitations with respect to the proposed satellite-based low bit-rate services.

1.7 The Department of Telecommunications (DoT), through its reference vide letter dated 23rd November, 2020 (Annexure 1), under section 11(1)(a) of the TRAI Act, has requested TRAI to furnish recommendations on the Licensing framework to enable the provisioning of satellite-based low bit-rate applications for both commercial as well as captive usage.

1.8 Pointing out the constraints of the existing provisions in respect of the proposed Satellite-based low bit-rate services, DoT has stated that there is a need for suitable licensing framework for:

(i) Providing such services on a commercial basis.

(ii) Organizations like State transport Authorities, Indian Railways, other fleet owners, disaster management agencies, etc., which may need to setup a Captive network for their own use (and not for selling the service). These Captive networks may be of the following two types:

a) Government owned entities like Police & security Agencies/PSUs/boards

b) Private companies

1.9 DoT has requested TRAI to examine all the factors holistically and recommend enabling provisions under the existing licensing framework of DoT, or suggest new licensing framework which must include the entry fee, license fee, bank guarantee, NOCC charges, spectrum usage charges/royalty fee, etc.

1.10 In view of the above, this consultation paper has been prepared to discuss the issues involved. Chapter 1 provides the background information on the subject matter. Chapter 2 discusses certain issues involved and poses specific questions for seeking valuable inputs from the stakeholders. Chapter 3 discusses the current Licensing framework for satellite-based services, their scope and limitations for low-bit-rate applications and poses questions for inclusion of satellite-based connectivity for low-bit-rate applications. Chapter 4 summarizes the issues for consultation.

# Chapter 2

## Satellite-Based Connectivity for Low-Bit-Rate Applications

2.1 IoT based applications through satellite connectivity provides enterprises with newer opportunities to increase operational efficiency, reduce costs and simultaneously secure goods, personnel and assets. With the growing ubiquity of IoT, the satellite market is also evolving to enable IoT based applications through satellite connectivity. The value chain of the entire space industry is going through a change in terms of technologies and services, so as to cater to the increasing demand for IoT services. By providing a vital link to monitor anything to everything - from shipping containers, moving goods from factories, giving disaster related real-time alerts to monitoring numerous aircrafts flying across the globe daily - the satellite-based connectivity plays a very significant role.

2.2 To suit the IoT environment, new satellite-based solutions are being developed through collaborations across various sectors to implement innovative ideas and to cater to the increasing global requirements. New business models are emerging due to changes in the technology of satellite manufacturing, emergence of new system integration techniques and the growing range of new technology enablers. Innovations leading to cost-effective satellite services and amalgamation of technologies like AI, cloud and big data are gaining importance for exploring new prospects in the satellite IoT ecosystem.

2.3 The transformation has brought about changes in satellite classification in terms of size, cost, function and exploration of new orbits. Smaller satellites, often weighing as little as 10 kg, are replacing the larger conventional models that were in the range of 1,000 kg or more. Such solutions are eliminating the entry barriers for the space industry and driving the New Space era. Investment and funding in space research is shifting from public to private organizations, allowing private companies to enter the space industry in more numbers. This revolutionary phase is expected to result in incremental development with focus on disruptive technologies and commercial viability of satellite-based communication.

2.4 Long established firms such as Iridium, Globalstar and ORBCOMM are now being joined by many new entrants, equipped with a small number of satellites in orbit for under few million dollars. Some of the newcomers include Aistech, Astrocast, Hiber, Swarm, Karten Space, Sky and Space Global. These startup firms are focused on reducing costs of establishing the network solutions by utilizing small-sized satellites and using open standards.

2.5 These specialized firms can integrate their own unique space data collected from the constellation of their small satellites with data from other sources and applications and in turn deliver customized data and analysis that drive better decisions. Their unique sector-agnostic geospatial intelligence tries to address the gaps in the market with end-to-end data provisioning and solutions. Open standards and smaller hardware are the key enablers for launching these satellites. CubeSat standards enable startups to quickly build and test their satellites that have an approximate size of a shoebox or even smaller. Smaller size substantially lowers the associated costs of the satellite and their launch. The cube-shaped satellites[1] are approximately four inches long, have a volume of about one quart (approx. 1100 cubic cm) and weigh about 3 pounds (approx. 1.3 kg). A typical 3U (30 cm x 10 cm x 10 cm) CubeSat designed to relay data can be built and put into orbit for $1 million or less. A pair of satellites in the proper orbits can provide global coverage with a 12 hour or less service interval to pick up data from a remote location.

2.6 A few features of the satellite-based solutions which are ideal for IoT traffic are as follows:

[1] https://www.nasa.gov/mission_pages/cubesats/overview

(i) Satellite networks can have global coverage allowing the IoT to be connected to remote locations, where terrestrial connectivity is not reasonably accessible either due to cost or terrain constraints.

(ii) The IoT ecosystem needs ubiquitous, resilient and seamless connectivity for the devices to run efficiently. Satellites, in conjunction with terrestrial services, have a proven track record of resilient services..

(iii) Satellite communications have broadband, narrowband and broadcast capabilities. Accordingly, the global network of satellite operations can support the needs of IoT devices with different bandwidth and capabilities.

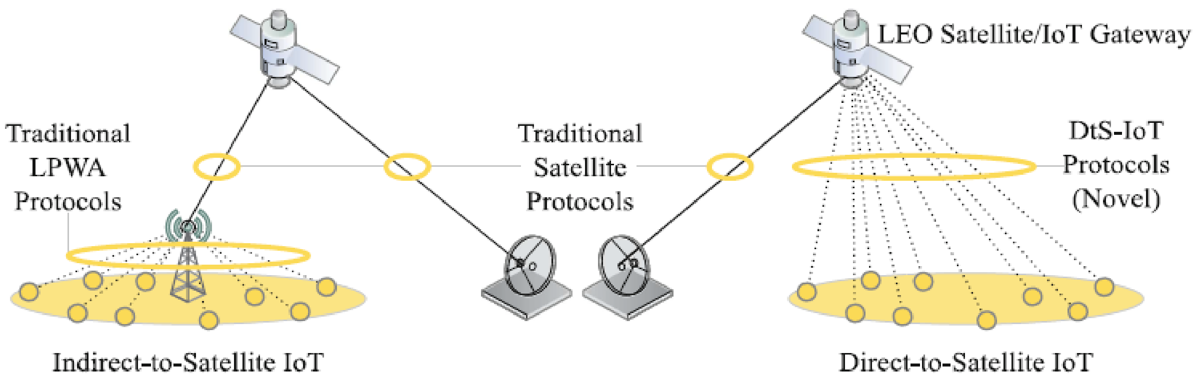
### A. Satellite Connectivity Models for Low-Bit-Rate Applications

2.7 There are two models, as shown in the figure 1, for provision of satellite-based connectivity for IoT and low-bit-rate applications:

(i) Hybrid model consisting of LPWAN and Satellite,

(ii) Direct to satellite connectivity.

*Figure 1[2]. Models for provision of Satellite based connectivity for IoT and low bit rate applications*




[2] https://www.researchgate.net/publication/336050788_Direct-To-Satellite_IoT_-_A_Survey_of_the_State_of_the_Art_and_Future_Research_Perspectives_Backhauling_the_IoT_Through_LEO_Satellites

**(i) Hybrid (LPWAN + Satellite) or Indirect Model**

2.8 In such an architecture, each sensor and actuator in a network may communicate with the satellite through an intermediate sink node, i.e., Low Power Wide-Area Network (LPWAN) or LPWA gateway. In LPWAN, a network server coordinates several gateways through a reliable backhaul and in turn gateways interact through wireless links with potentially billions of low power devices.

2.9 In this model, the LPWA gateway is equipped with traditional satellite terminal and a traditional LPWA Radio Interface to communicate with the sensor or actuator nodes in the area. These networks communicate with low-cost localized gateways to concentrate larger numbers of IoT devices in their vicinity, even thousands. But this limits the area of deployment as it is confined to the coverage of the gateway node on ground.

2.10 The LPWA technologies have been standardized by 3GPP[3]. The LPWA technologies possess several characteristics that make them particularly attractive for applications requiring low mobility and low levels of data transfer (100s of bps to several 100s of kbps).
Their main characteristics are as below:

- Low power consumption (to the range of nanoamp) that enable devices to last for 10 years on a single charge
- Optimized data transfer (supports small, intermittent blocks of data)
- Low unit device cost
- Simplified network topology and deployment
- Improved outdoor and indoor penetration coverage compared with existing wide area technologies
- Secured connectivity and strong authentication

[3]https://www.gsma.com/iot/wp-content/uploads/2016/10/3GPP-Low-Power-Wide-Area-Technologies-GSMA-White-Paper.pdf

- Integrated into a unified/horizontal IoT/M2M platform, where operators have this in place.
- Network scalability for capacity upgrade.

2.11 Some LPWA technologies suitable for IoT are LoRa, Sigfox, LTE-M or NB-IoT. These are specifically designed to share the properties of WPAN and cellular networks, i.e., low power and long range (more than 10 km). The NB-IoT technology operates on licensed spectrum, which is a subset of LTE Bands. On the other hand, LoRaWAN uses linear frequency modulation in the unlicensed frequency range in sub-1 GHz band. For example, it operates on unlicensed 900 MHz ISM frequency band in South America and unlicensed 868 MHz ISM frequency band in Europe[4].

2.12 Some of the features of these LPWA technologies are:

*Table 1. Lower-Power IoT Technologies' Comparison*[5]

| | **NB-IoT** | **SigFox** | **LoRaWAN** | **Wi-Fi 802.11ah** |
|---|---|---|---|---|
| Carrier Frequency | LTE Bands | Sub-1 GHz range | Sub-1 GHz range | 2.4 or 5 GHz |
| Channel Bandwidth | 180 KHz | 100Hz | >= 125 KHz | 1/2/4/8/16 MHz |
| Modulation Scheme | QPSK | BPSK | CSS | N-QAM/NPSK |
| Data Rate | DL: ~50kbps UL: ~50 for multi-tone, ~20 kbps for single tone | 100 bps (UL) 600 bps (DL) | 0.3 kbps–50 kbps | 150 kbps - 86.7 Mbps[6] |

[4]https://www.researchgate.net/publication/336050788_Direct-To-Satellite_IoT_-_A_Survey_of_the_State_of_the_Art_and_Future_Research_Perspectives_Backhauling_the_IoT_Through_LEO_Satellites

[5] https://www.mdpi.com/2072-4292/12/10/1666/htm

[6] https://www.wi-fi.org/download.php?file=/sites/default/files/private/Wi-Fi_HaLow_Technology_Overview_20200518_0.pdf

| | | | | |
|---|---|---|---|---|
| Power Requirements | Transmit: 23 dBm<br>Receive: -64 dBm | 20 dBm | 30 dBm | 30 dBm |
| Access Scheme | SR + ALOHA | ALOHA | ALOHA | CSMA/CA |

**(ii) Direct to Satellite Model**

2.13 This type of architecture allows devices to directly communicate with the satellite without the need of any intermediate ground gateway. The satellite receives data from IoT devices and transmits the data to the ground station nearest to the device and the data gets stored in the application server for further processing. This model can be used for wide area sensor network with sensors spread over wide geographical territory. Myriota (an Australian-based startup), Hiberband Direct (a Netherlands based startup), Astrocast, etc., are some of the global providers in low-cost, low-power, secure direct-to-orbit satellite connectivity for the Internet of Things.

2.14 Direct-to-satellite is a more preferred solution in challenging scenarios such as:

(i) During disaster or natural calamities in areas where fast deployments are required and not much hardware is available or possible to arrange

(ii) In areas where the devices are on the move, placement of a LPWAN node would not be economically viable and preferred.

(iii)In areas where only a few devices are to be connected and therefore, a LPWAN node is not economically viable.

2.15 However, many of the existing satellite networks are not commercially suitable for supporting millions of direct connections, which are required in IoT applications. For commercial applications that require numerous devices, it is desirable that the end device costs should be very low, they should consume very low power and should require very low maintenance. Many of the existing satellites may not be suitable for direct satellite to device connections. At present, only a few companies are looking to explore such direct satellite to device connections.

2.16 In view of the above discussion, the stakeholders are requested to provide their response to the following question:

**Q1. There are two models of provision of satellite-based connectivity for IoT and low-bit-rate applications— (i) Hybrid model consisting of LPWAN and Satellite and (ii) Direct to satellite connectivity.**

**(i) Whether both the models should be permitted to provide satellite-based connectivity for IoT devices and low-bit-rate applications? Please justify your answer.**

**(ii) Is there any other suitable model through which the satellite-based connectivity can be provided for IoT devices? Please explain in detail with justifications.**

**B. IoT Specific Satellite Constellations:**

2.17 Low-Bit-Rate Applications or IoT applications require low power, low cost and small size terminals that can effectively perform the task of signal transfer with minimum loss. The selection of satellite orbit depends on the requirements of the IoT application. Satellite orbits can be generally categorized as GEO (Geostationary Earth Orbit), MEO (Medium Earth Obit) and LEO (Low Earth Orbit).

2.18 LEO satellites are small satellites located at 500−1500 km from Earth and weigh <10 kg. They orbit the Earth multiple times a day (orbital time period — 10 to 40 minutes). GEO satellites, on the other hand, are traditional heavier satellites (weighing <10,000 kg), positioned at an altitude of more than 35,786 km from the Earth, resulting in a propagation delay of approximately 250ms (500ms for the round trip)[7]. They orbit the Earth once in every 24 hours. MEO is the space between GEO and LEO. Comparing to GEO satellites, MEO satellites are much easier to manufacture and to launch. LEO satellites have very low latency and low atmospheric path loss as compared to GEO and MEO satellites. However, the cost of operation for LEO satellites is more as compared to MEO and GEO satellites, due to inherent requirement of a greater number of satellites for LEO constellation. MEO and GEO satellites provide efficient density of coverage in comparison to LEO satellites.

2.19 The following table shows a brief comparison among the three satellite constellations:

*Table 2. Brief Comparison among the three satellite constellations*

| Parameters | LEO Satellites | MEO Satellites | GEO Satellites |
|---|---|---|---|
| **Distance from Earth** | 500-1500 km | 5000-12000 km | ~36,000 km |
| **Orbital Period** | 10-40 minutes (orbit the earth multiple times a day) | 2-8 hours | 24 hours |
| **Satellite Life** | Short | Long | Long |
| **Number of Satellites required** | More | More than GEO but less than LEO | Less |
| **Path Loss (Atmospheric)** | Low | Medium | High |
| **Latency** | Low | Medium | High |
| **Density of Coverage** | Low | Medium | High |
| **Cost of Operation** | Very high, with more number of satellites | High | Low, with less number of satellites |

[7]https://www.itu.int/en/ITU-R/space/workshops/2019-SatSymp/PublishingImages/Pages/Programme/R-REP-M.2460-2019-PDF-E.pdf

2.20 CubeSats are also IoT specific satellites. Owing to their limited power, costs and small size, they can be launched into Low Earth Orbit for remote IoT applications making satellite communication more economical and technically feasible. New CubeSats technology can be used in the range of UHF, VHF, S-band and Ku-bands to bring down the recurring service costs. CubeSats often use Binary Phase Shift Keying (BPSK) as a modulation technique because of its simplicity and robust performance compared to other modulation techniques. In spite of the limitation in amount of data that can be communicated using BPSK modulation, it is a suitable modulation technique for remote IoT applications as many of the IoT applications are required to send only small status update messages at periodic intervals.

**(i) GEO Satellites Enabling IoT Applications**

2.21 GEO satellites appear to be stationary when seen from a fixed point on Earth. They are very valuable for the applications that do not require mobility or near real-time connectivity as they provide more coverage in such situations when compared to LEO satellites that are continuously moving. GEO satellites can also be a good choice for the hybrid approach, where terrestrial networks can do data collection and satellites serve as the backhaul.

2.22 Due to their large distance from the Earth, the communication through GEO Satellites suffers from a major propagation delay which may limit their use for the IoT applications. To avoid this, large terminal antennas are required for increasing gain, directivity and for mitigating potential interference from the adjacent satellites. Further, a fixed number of satellites can be operated in the GEO orbit due to limited number of orbital slots. There are many organisations which use GEO satellites for IoT/M2M connectivity like Eutelsat (European Organisation of Telecommunications by Satellite S.A.), Intelsat, Inmarsat, etc. Eutelsat offers GEO-based IoT services with transfer speeds up to 1 Mbps in the satellite-to-ground communication (download) and up to 128 kbps in the opposite direction (upload)[8]. Inmarsat also uses ultra-reliable geostationary L-band network globally to connect mission-critical applications. Eutelsat and Inmarsat provide M2M services for applications with stringent timing requirements normally associated with massive synchronization of sensors and other devices. BGAN M2M, IsatM2M and IsatData Pro (IDP) are different M2M / IoT services being provided by Inmarsat using GEO satellites.

**(ii) LEO Satellites Enabling IoT Applications**

2.23 LEO satellites are deployed closer to the earth's surface and are much smaller than GEO satellites. Communication enabled by LEO satellites reduces path loss, requires less terminal power and needs less antenna directivity and antenna gain. These characteristics are well-suited for designing an IoT application around low cost, low power, low latency and small size terminal solutions.

2.24 Unlike GEO, the LEO satellites move speedily in reference to the Earth's ground surface and have small ground coverage in comparison to GEO. The continuous motion of LEO satellites poses a challenge in smooth signal transmissions for IoT applications and in forms of increased number of handoffs from one satellite to another for seamless connectivity. So, they require relatively dense constellation of satellites to ensure that any particular ground terminal is always covered by at least one LEO satellite of the constellation. Therefore, global commercial deployments usually consist of more than a hundred satellites. For example, Kepler, Telesat and Starlink constellations have planned 140, around 300 and between 12000−42000[9] satellites, respectively. IoT applications

[8]https://www.eutelsat.pl/files/PDF/brochures/Eutelsat_IoT_Services.pdf
[9]https://arxiv.org/pdf/1912.08110.pdf

leveraging LEO satellite communications require steerable antennas with designs optimized for specific use cases.

Few other complexities with the use of LEOs are as below:

- There is a need for developing techniques to manage complex frequency synchronization with large number of LEO satellites in the orbit.
- Antenna technologies and increased number of ground gateways will be required for the LEO ecosystem, which will add to the overall cost.

2.25 Some of the organizations currently using LEO satellites for IoT/M2M connectivity include Iridium, ORBCOMM and Globalstar. Other operators having LEO satellite constellations are OneWeb[10], Telesat and Starlink. Some startups, such as, Myriota, Beijing Commsat Technology Development Co. Ltd. (Commsat), Fleet Space Technologies, Kepler Communications, are also implementing a constellation of LEO satellites with a network of global gateway stations and a range of user terminals to provide IoT connectivity.

**(iii) MEO Satellites Enabling IoT Applications**

MEO satellites are located at an altitude of 2000 km to 35,786 km. They have wider service coverage area and longer orbital time period as compared to LEO satellites. They have the advantage of lower path loss and are less costly, lighter and have less latency as compared to GEO satellites. However, they also have a drawback that their location keeps on changing with respect to a point on earth. Hence, they give rise to a highly time variant communication channel and therefore need steerable antennas. A suitable antenna design is necessary for maintaining synchronization with the MEO satellites. The SES O3b[11] ('Other 3billion', referring to the world's population which do not have

[10]https://www.oneweb.world/media-center/onewebs-successful-launch-paves-the-way-for-commercial-services

[11] https://www.ses.com/networks/networks-and-platforms/o3b-mpower

access to broadband internet) network uses MEO constellation for IoT applications.

2.26 The MEO satellite constellation orbits at approximately 8,000 km above the Earth's surface which is less than a quarter of the altitude of GEO satellites. The O3b MEO constellation delivers low-latency satellite broadband/internet and mobile backhaul services to emerging markets in area within 50° north and 50° south of the equator.

**Integrated or Hybrid LEO/GEO constellation**

2.27 For mission-critical applications, some aspects such as low Signal to Noise Ratio (SNR), time variant channel and link budget need to be considered while finalising the communication standards. An integrated or hybrid LEO/GEO constellation can also be a potential solution for many applications. Hybrid systems may provide benefits of lower latency, flexibility and scalability of LEO satellites. It provides benefits of high-capacity and wide coverage of GEO satellites. However, such system will require an optimized routing system which manages routing to LEO when it requires low latency and routing to GEO when there is a need to transmit a large volume of data at any given time. For such system to be successful, dynamic routing must be in place.

2.28 Table 3 shows a brief comparison among Communication Satellite Constellations:

Table 3. A Brief Comparison Among Communication Satellite Constellations

| | Inmarsat[12] | Iridium[13] | O3b[14] | OneWeb[15] | Starlink[16] |
|---|---|---|---|---|---|
| Orbit Altitude | 35,786 km (GEO) | 781 km (LEO) | 8,000 km (MEO) | 1200 km (LEO) | 340 – 1,300 km (LEO) |
| Number of Satellites | 14 (Deployed) | 66 (Deployed) | 20 (Deployed) | 648 (Planned) 110 (Deployed) | 11924[17] (Planned) 1023 (Deployed) |
| Transmission Frequency | L-band | L-band | Ka-band | Ku-band | Ka/Ku Band |
| User Data Speed | 492 kbps | 128–704 Kbps | 2.1 Mbps | 50 Mbps | 50–200 Mbps |
| Year of Operation *(start)* | 1979 | 1998 | 2013 | 2019 | 2020 |

2.29 In view of the above discussion the following question is raised for the comments of the stakeholders:

**Q2. Satellite-based low-bit-rate connectivity is possible using Geo Stationary, Medium and Low Earth orbit Satellites. Whether all the above or any specific type of satellite should be permitted to be used for providing satellite-based low-bit-rate connectivity? Please justify your answer.**

## C. Possible frequency bands for Satellite-Based IoT Connectivity:

2.30 There are different frequency bands which are suitable for IoT connectivity such as L-band, S-band, C-band, Ku-band, Ka-band and other higher bands. All these bands are core frequency bands for satellite industry which are already in use today by many satellite systems.

[12] https://www.inmarsat.com/en/about/technology/satellites.html
[13] https://www.iridium.com/
[14] https://www.ses.com/press-release/o3b-satellites-roar-space-scaling-sess-meo-constellation
[15] https://www.oneweb.world/technology#rotatingContentModule
[16] https://core.ac.uk/download/pdf/188571367.pdf
[17] https://www.elonx.net/starlink-compendium/

- L-band (1GHz–2GHz) is viewed traditionally as the preferred option for applications involving small amounts of data transfer. Inmarsat uses L-band satellite network as it offers the lowest latency and thus provides resilient and flexible solution for IoT applications. Ligado plans to develop satellite supported 5G services using its L-band spectrum.
- S-band (2GHz–4GHz) can also be used for satellite data transmission owing to its advantage of easy transmission even during rain or adverse weather conditions. This ensures strong service without interruptions. For IoT services, S-band transmission is a cost-effective transmission frequency band compared to other methods. Helios Wire, a Canadian startup, offers bidirectional communication using S-band spectrum (30 MHz). It brings together satellite network, terrestrial network, IoT and blockchain as an efficient value proposition for the growing demand of IoT use-cases. The company's LEO satellite constellation works in combination with the existing terrestrial networks including LPWAN and LoRa allowing actionable insights as a service.
- The C-band frequency range (4GHz–8GHz) has been considered optimal for satellite broadcast operations as it enables lower cost per megabit compared to other frequencies and also offers less signal susceptibility to the effects of rain and interference from other climate-related factors, including sea spray in rough conditions. This band is also used for weather radars, the 802.11a version of Wi-Fi devices and Radio LAN in the 5 GHz range. Satellite network operators Intelsat and SES are two key providers of C-band space capacity. Other operators authorized to use portions of the C-band include ABS Global, Eutelsat, Globalstar, Leidos (providing RNSS only), New Skies Satellites and Telesat Canada[18].
- The Ku-band frequency spectrum (12–18GHz) for satellite communication is primarily used for maritime VSAT services. This band is a more economical and flexible means for obtaining a high-

[18] https://sia.org/wp-content/uploads/2020/05/SIA-Spectrum-Report-from-Strand-Consult-Final-003.pdf

throughput on smaller reflector dishes due to its wider capacity and high availability. Eutelsat Communications Paris has launched satellite based IoT connectivity service named as 'Eutelsat IoT FIRST' operating in Ku-band via Eutelsat's geostationary satellites.

- The Ka-band (26.5GHz–40GHz) satellites' architecture is such that it creates overlapping coverage which has opened a possibility of using smaller antennas on board while still maintaining a strong link. However, Ka-band networks are much more susceptible to rain fade – where moisture and humidity can interfere with the signal. Ka-band service for mobility applications requires a tracking antenna. It is used for satellite broadband by Hughes and Viasat.

2.31 Based on the above discussion, the following question is raised for the inputs of the stakeholders:

**Q3. There are different frequency bands in which communication satellites operate such as L-band, S-band, C-band, Ku-band, Ka-band and other higher bands. Whether any specific band or all the bands should be allowed to be used for providing satellite-based IoT connectivity? Please justify your answer.**

### D. Use of Foreign Satellites for Low-Bit-Rate Applications

2.32 The Department of Space, in partnership with the Department of Telecommunication and the Department of Science and Technology, framed the Satellite Communication Policy in 1997 (SATCOM Policy). Through the SATCOM Policy, the government aimed to develop a strong satellite communication service industry in India.

2.33 The following norms, guidelines and procedures[19] were approved by the Department of Space in the year 2000, regarding the use of foreign satellites:

[19] https://www.isro.gov.in/update/08-may-2000/norms-guidelines-and-procedures-satellite-communications-announced

- Limited use of foreign satellites was allowed in special circumstances for satellite communication services in India.
- The service licensing departments may allow the use of foreign satellites only in consultation with the Department of Space.
- If suitable capacity/capability is available in INSAT or Indian Satellite Systems, operations with foreign satellites would not be permitted.
- For the use of foreign satellites for Internet Service Provider (ISP) gateways, the existing procedures established by Telecom Commission would apply.

2.34 Furthermore, preferential treatment is given to Indian satellite systems over foreign satellite systems which aligns with the spirit of initiatives like 'Make in India' and 'Startup India'. According to the policy, foreign satellite operators are permitted to provide their satellite capacity in India only in the following cases:

- If International inter-governmental systems are owned and operated by Indian parties but are registered in other countries prior to the Indian state formulating rules for such registration, or
- Where Indian parties have participated in the foreign satellite system through equity or some other contribution.
- Where such permission is necessary to honour reciprocal arrangement with the country/countries of registration or ownership of such foreign satellite systems.

2.35 The Indian National Satellite (INSAT) system is one of the largest domestic communication satellite systems in Asia-Pacific with more than 200 transponders in the C, Extended C and Ku-bands providing services to telecommunications, television broadcasting, satellite newsgathering, societal applications, weather forecasting, disaster warning and Search and Rescue operations. In addition to the above, capacity on short-term lease from various international vendors is also provisioned by ISRO through its commercial and marketing arm, so as to cater to the needs of the Indian users. This is essential due to the disparity between the capacity available from ISRO and the growing demand. The growth in demand is driven by DTH TV broadcasting and increasing use of applications involving digitization. Also, the requirement of satellite capacity for low-bit-rate applications will be very large due to IoT use cases and domestic satellite capacity may be insufficient to cater to the likely large-scale communication needs.

2.36 Many Indian Companies and startups are working in this area to add to the satellite capacities. Bangalore-based startup, Pixxel has announced its collaboration with ISRO to launch its first satellite on a Polar Satellite Launch Vehicle (PSLV) rocket in early 2021. Chennai-based startup, Agnikul Cosmos Private limited has signed a non-disclosure agreement that will allow it to access ISRO's facilities and technical expertise to build its rocket and launch vehicles capable of taking micro and nanosatellites to the low Earth orbit. Several Indian startups, namely Pixxel, Agnikul, Astrome Technologies, Dhruva Space and Skyroot Aerospace have also sought permissions for space-based applications, satellite making and development and launch of rockets. Indian companies like Ananth Technologies Limited[20] and Astrome[21] are already developing satellite systems to meet the growing demand of satellite capacity in the country.

2.37 In August 2020, Department of Space has circulated Draft Spacecom NGP-2020[22], which proposes draft norms, guidelines and procedures for Implementation of Space-Based Communication Policy of India, 2020. As per the Draft policy, Indian entities, i.e. Indian government bodies, PSUs/CPSEs and Indian registered non-Government Private Entity (NGPE), can avail Indian as well as non-Indian orbital resources to establish their space-based systems for communication services over India and even outside India. It is proposed that Indian

[20] https://ananthtech.com/about-us/
[21] https://astrome.co/about-us/
[22] https://www.isro.gov.in/sites/default/files/draft_spacecom_policy_2020.pdf

or Non-Indian orbital resources can also be used for establishment and utilization of NGSO communication systems.

## E. International Scenario

2.38 The satellite-based IoT market is growing at a very fast pace globally in Europe, North America, Asia-Pacific and the rest of the world. However, Europe is leading in the global market in terms of IoT connectivity as many satellite IoT providers have a strong presence in that region. Satellite-based IoT solutions facilitate multiple public sectors and enterprises in the areas of transportation and logistics, telecommunication, military, aerospace, agriculture, healthcare and many other sectors leading to new avenues of expansion and growth.

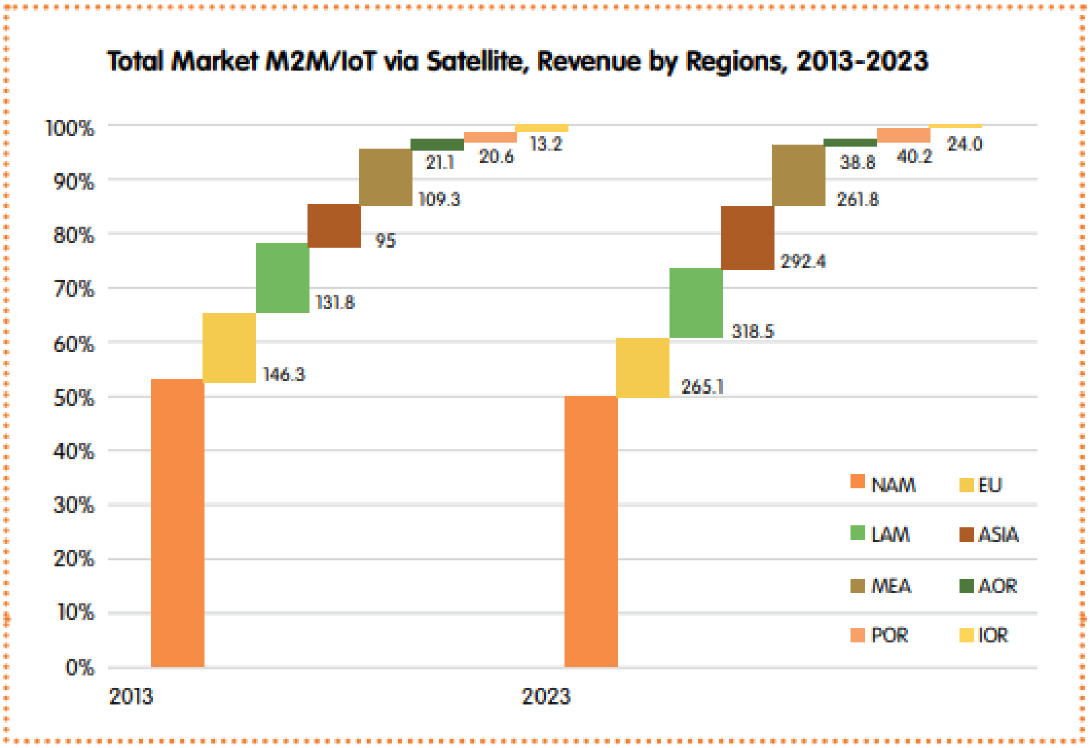
2.39 Below is the summarized study of some of the operational international organizations using satellites for low-bit rate applications:

| | Orbit | Frequency Bands | Service | Countries being Served | IoT Subscribers |
|---|---|---|---|---|---|
| **Inmarsat (UK)** | GEO | L/S/Ka | Voice, low bit rate and higher data rates | World-wide | >1.6 Million |
| **Globalstar (US)** | LEO | S-Band | Voice and low bit rate data | World-wide | 7,77,193 (as of 2020)[23] |
| **Orbcomm (US)** | LEO | VHF-Band | Low bit rate data | 130 countries | >2.4 million[24] |
| **Iridium (US)** | LEO | L/S Band | Voice and low bit rate data | Near World-wide | 9,62,000 (as of 2020)[25] |
| **Thuraya (UAE)** | GEO | L-Band | Voice and low bit rate data | Europe, North America, Africa, Asia, Australia | |

[23] https://www.businesswire.com/news/home/20201106005300/en/Globalstar-Announces-Third-Quarter-2020-Results
[24]https://www.orbcomm.com/en/partners/connectivity
[25] https://investor.iridium.com/2021-02-11-Iridium-Announces-2020-Results-Company-Issues-2021-Outlook

2.40 [26]The graph in the following Figure 2 show the total global market M2M/IoT via satellite, Revenue by region for the years 2013–2023.

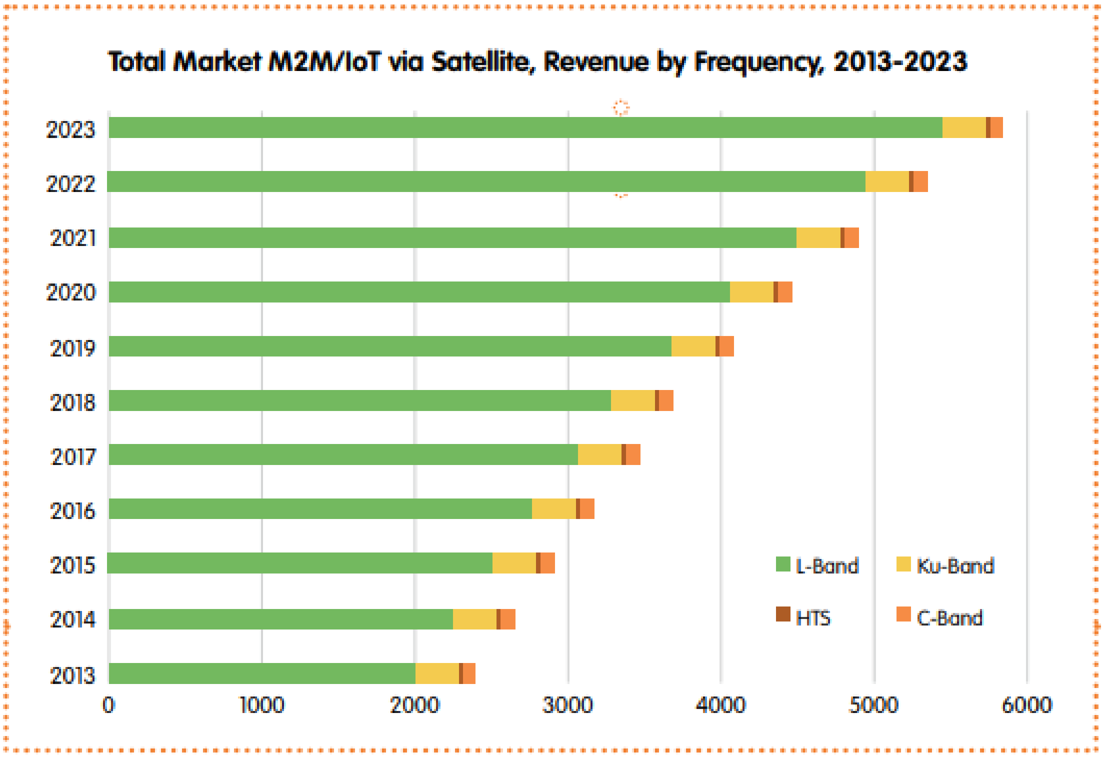
***Figure 2: Total Market M2M/IoT via Satellite, Revenue (in million $) by Region, 2013–2023***




2.41 The graph in the following figure 3 shows the total global market M2M/IoT via satellite by revenue (in million $) by frequency for the years 2013-2023.

[26] https://iotuk.org.uk/wp-content/uploads/2017/04/Satellite-Applications.pdf

*[27]Figure 3: Total Market M2M/IoT via Satellite, Revenue (in million $) by Frequency, 2013–2023*




2.42 As can be seen in Figure 2, the most significant growth is registered by North America (NAM), Middle East or Africa (MEA) and the Ocean Regions (POR, AOR and IOR). High demand for always-on Internet connection and data frequency is likely to make North America dominate the market with most in-service IoT units with a large and expanding installed base. However, Asia is likely to experience the highest growth over the forecast period which may be due to continued growth of populations and economies and Latin America is likely to follow in terms of revenue. Europe may show relatively modest but gradual growth, reaching just below a double digit by 2023, which may be due to the prevalence of competition amongst terrestrial networks that continues to grow.

[27] https://iotuk.org.uk/wp-content/uploads/2017/04/Satellite-Applications.pdf

### (i) United States

2.43 The Federal Communications Commission (FCC) granted OneWeb's market access to expand its Non-Geostationary Orbit (NGSO) satellite constellation to 2,000 satellites with a V-band payload to provide high-speed broadband internet. This is in addition to its Ku- and Ka-band constellation. According to the FCC order, OneWeb must launch and operate 50% of the maximum number of proposed space stations, or 1,000 satellites, by 26$^{th}$ August 2026. The remaining satellites must be launched and operated by 26$^{th}$ August 2029. OneWeb currently has 74 satellites in Low Earth Orbit (LEO). V-band is critical for next generation satellite broadband services and would facilitate low latency connectivity to communities, governments, businesses and people in the U.S. and around the world.

2.44 In March 2018, FCC authorized Space Exploration Holdings, LLC (SpaceX) to launch 4,425 satellites using Ku- and Ka-band. These satellites will be part of Starlink LEO constellation for provision of Fixed-Satellite Service (FSS) around the world. This was followed by another approval by FCC in November 2018 to launch 7,518 Starlink satellites using V-band. These satellites will provide high-speed, low-latency satellite internet service across the globe. SpaceX created a comprehensive ground network that currently communicates with over 1,000 Starlink satellites in orbit.

2.45 Kinéis[28] is an independent, private satellite operator in the U.S., which proposed an innovative global data connectivity platform for Internet of Things ("IoT") applications. The complete Kinéis IoT constellation of twenty-five (25) nanosatellites is expected to be in orbit by the second half of 2022. It will offer universal, simple, low-power consuming, reliable connectivity at an affordable cost. The use cases include a

[28] https://fcc.report/IBFS/SAT-LOI-20191011-00113/1950254.pdf

variety of applications for use in the maritime, agricultural, logistics, outdoor sports, security and scientific sectors.

2.46 In 2018, FCC granted the permission to Kepler Communications[29], which is licensed by Canada to use proposed constellation of 140 non-geostationary-satellite orbit (NGSO) satellites (LEO satellites) for providing global connectivity for IoT, especially sensors and other intelligent devices in the United States. Their proposed system will "make real-time connectivity available for devices both on and off the Earth's surface," and will "provide localized and extremely economic terminals that can aggregate data from IoT devices. Data from these IoT devices will then be backhauled to users through the Kepler space system. As per FCC Order, 50% of the maximum number of proposed space stations, are to be made operational by 2024 and rest of them by 2027. It will enable many IoT applications like animal monitoring, crop monitoring, seismic data collection, weather data collection and asset tracking in remote areas . The main features are:

- The satellites will operate under a license issued by Innovation, Science and Economic Development Canada (ISED).
- Frequency Bands: 14.0–14.5 GHz (Earth-to-space) and 10.7–12.7 GHz (space-to-Earth) — Ku Band.
- It plans to use "3U CubeSats" or "6U CubeSats".

2.47 The FCC has also approved Ligado Networks[30] in April 2020, (an American Satellite Communications Company) to use L-Band spectrum at 1.6 GHz to provide a low-power terrestrial network aimed at supporting private 5G and industrial internet of things services. To fulfill the 5G promise of highly reliable IoT, Ligado Networks is adapting 3GPP standard NB-IoT and LTE-M technologies to enable functional and economical 5G IoT service and device operation on both satellite and terrestrial networks. The Ligado SkyTerra 1 satellite

[29] https://docs.fcc.gov/public/attachments/FCC-18-162A1.pdf
[30] https://ligado.com/wp-content/uploads/Standards-Based-Satellite-IoT-Info-Sheet_0719.pdf

was specifically designed to provide robust mobile connectivity to small low-power devices throughout North America. This advancement will enable service to devices with mainstream, low-cost chipsets and support emerging IoT uses that require network redundancy and full coverage.

2.48 The Ligado satellite network[31] uses L-band, i.e., it leverages lower mid-band spectrum, which is not only less susceptible to rain fade and blockage from dense foliage but can also be tightly integrated with terrestrial networks to deliver seamless satellite and terrestrial coverage.

2.49 In July 2020, FCC granted approval to Amazon's 'Project Kuiper' to deploy and operate a NGSO constellation of 3,236 satellites to provide services using certain Fixed-Satellite Servce (FSS) and Mobile-Satellite Service (MSS) in Ka Band. The FCC authorization allows Project Kuiper to deliver satellite-based low-latency, high-speed broadband connectivity in the United States helping expand internet access to households and communities across the country. The initiative plans to launch a constellation of low Earth orbit satellites — including 784 satellites at an altitude of 590 kilometers; 1,296 satellites at a height of 610 kilometers and 1,156 satellites in 630-kilometer orbits. Once operational, it is expected that  will provide to unserved and underserved communities around the world.

**(ii) <u>United Kingdom</u>**

2.50 Satellite communications for IoT/M2M represent a particular complement to Low Power Wide-Area networks (LPWAN), given their low-power and low-data requirements. 862–870 MHz (UHF) frequency band is feasible from both a technical (need for non-interference) and regulatory (availability of spectrum allocation) perspective. However,

[31] https://ligado.com/technology/satellite/

interference may occur if both satellite and terrestrial networks operate in the same frequency in some geographies. The satellite must therefore be able to coordinate with terrestrial networks in these situations.[32]

2.51 UK is likely to see Low Earth Orbit (LEO) satellite constellations beginning to offer residential and business broadband to UK consumers at the earliest in the year 2021. In November 2020[33], the UK Government completed its acquisition of OneWeb, a constellation of LEO satellites. OneWeb has recommenced launching satellites in December 2020 and it is anticipated that it will start to offer its initial services by the end of year 2021.

2.52 Leading M2M/IoT players such as Vodafone of UK will continue to partner with Inmarsat I-4 satellite network to provide global L-band coverage through all weather conditions. This will allow for fixed-line and mobile connectivity far beyond the reach of terrestrial networks to suit requirements of many verticals, i.e., agriculture, utilities, oil and gas and transportation.

### (iii) France

2.53 The Autorité de Régulation des Communications Électroniques et des Postes (ARCEP), the telecom Regulator of France, has identified Internet of Things as one of the priority areas in its strategic review. It aims at ensuring the availability of scarce resources (numbering, IP addresses, network codes, access to frequencies, etc.) to support the emergence of networks for the Internet of Things and smart territories.

2.54 Internet-of-Things (IoT) market of France, which is driven by the booming IT & Telecommunication industry is segmented based on

[32] https://londoneconomics.co.uk/wp-content/uploads/2017/10/LE-CSL-IoT-M2M-Market-Sizing-Requirements-Report-FINAL_PUBLIC-S2C310817_FOR-WEBSITE_v2.pdf
[33] https://www.ofcom.org.uk/__data/assets/pdf_file/0024/209373/connected-nations-2020.pdf

platform, component, application, company and region. The major players[34] operating in the Internet-of-Things (IoT) market are Intel Corporation, Compagnie IBM France, Amazon Web Services France, Robert Bosch France SAS, Cisco Systems, SAP France SA, Microsoft France, Oracle France, SAS, General Electric Company, Hewlett-Packard France and others. Major companies are developing advanced technologies and launching new services to stay competitive in the market. Other competitive strategies likely to emerge include mergers and acquisitions and new service developments.

2.55 With the advancement of technologies and the IoT, Centre National d'études Spatiales (CNES), the French Space Agency and CLS (Collecte, Localisation Satellites) created Kinéis in 2019 to develop reliable technology that provides easy access to useful satellite data and extend it to the entire IoT market. Kinéis has announced production and launch into orbit, of 25 nanosatellites, installation of 20 ground stations around the globe expected to be operational by the year 2023. The IoT Kinéis constellation will be placed in orbit in 2021.

**(iv) <u>Canada</u>**

2.56 The Canadian Radio-Television and Telecommunication Commission (CRTC) granted Starlink's operator, SpaceX, a Basic International Telecommunications Service (BITS) license in October 2020. The license allows SpaceX to provide telecommunication services in Canada. Starlink aims to establish a global network by using a massive constellation of low earth orbit satellites to provide internet services to rural and underserved areas in Canada and the United States. It is currently extending beta testing offers in Canada, U.S. and UK.

[34] https://www.businesswire.com/news/home/20201110005698/en/France-Internet-of-Things-IoT-Markets-2020-2025---Focus-on-Device-Management-Application-Management-Network-Management---ResearchAndMarkets.com

2.57 Canada Satellite, Orbcomm, Kepler Communications are some of the satellite IoT service providers in the region, offering their range of satellite IoT devices for remote locations with limited or no cellular connectivity to create a truly integrated IoT solution via satellite.

2.58 Another Canadian Company named Galaxy[35] provides satellite coverage that offers the best speeds and throughput for optimum performance and complete redundancy. The frequency bands used are C, Ku and Ka Bands.

[35] https://www.galaxybroadband.ca/m2m-communications/

# Chapter 3

# Current Licensing framework for satellite services

3.1 IoT and M2M devices require connectivity to send the data to their application servers. IoT devices operate mostly on wireless connectivity as the number of devices is usually very large. The common terrestrial wireless network for IoT connectivity may be cellular networks operating in the licensed frequency bands and Low Power Wide-Area Network (LPWAN) operating in unlicensed frequency bands. TRAI in its recommendations dated 5$^{th}$ September 2017 on “Spectrum, Roaming and QoS related requirements in Machine-to-Machine (M2M) Communications” has recommended that access service providers and LPWAN service providers may provide terrestrial wireless connectivity for IoT/M2M devices.

3.2 However, for the remote areas where the terrestrial networks are not available or for such IoT devices which are on the move and frequently go out of reach of terrestrial networks, satellite-based connectivity plays an important role for providing crucial communication infrastructure. Satellite-based connectivity services are already being provided by various operators under the respective authorization of Unified License. Therefore, there is a need to examine the scope of various authorizations of Unified License which permit provision of satellite-based services.

3.3 It has been pointed out by DoT in its reference that there are limitations in the existing licensing framework in respect of the proposed satellite-based low bit-rate applications. Therefore, there is a need to examine that whether a new licensing framework will be required for the proposed satellite-based connectivity for low bit-rate applications or existing authorizations may be suitably amended with enabling provisions for providing such services on commercial as well as on captive basis.

3.4 In view of the above, the stakeholders are requested to provide their inputs on the following question:

**Q4. (i) Whether a new licensing framework should be proposed for the provision of Satellite-based connectivity for low-bit-rate applications or the existing licensing framework may be suitably amended to include the provisioning of such connectivity? Please justify your answer.**

**(ii) In case you are in favour of a new licensing framework, please suggest suitable entry fee, license fee, bank guarantee, NOCC charges, spectrum usage charges/royalty fee, etc.**

3.5 The scope of various UL authorizations dealing with provision of satellite-based connectivity and possibility of amendment are discussed below.

### A. Global Mobile Personal Communication by Satellite (GMPCS) Service Authorization

3.6 Global Mobile Personal Communication by Satellite (GMPCS) Service authorization envisages provision of satellite phone service. The scope of GMPCS Service authorization, as provided in Clause 2 of Chapter XII of Unified License, is as below:

> *Clause 2.1 The licensee may provide, in its area of operation, all types of mobile services including voice and non-voice messages, data services by establishing GMPCS Gateway utilizing any type of network equipment including circuit and/or packet switches.*
>
> *Clause 2.2 The Licensee shall establish Land Earth Station Gateway in India for the purpose of providing Global Mobile Personal Communication by Satellite (GMPCS) Service. GMPCS Service may be provided using one or more Satellite Systems provided that the Land Earth Station Gateway Switch is established separately in India for each Satellite System.*

3.7 The scope of GMPCS service includes voice and non-voice messages and data services. Therefore, GMPCS service provider may provide voice, SMS (text) and internet service (data services) on satellite phones using satellite system. Provision of connectivity to IoT devices is not mentioned in the scope of service. However, it will be easier for a GMPCS service provider, having a Land Earth Station Gateway in India, to provide connectivity to the IoT devices in its service area. Enabling provisions may easily be incorporated in the scope of this authorization to enable the licensee to provide IoT connectivity. The existing infrastructure, ground segment as well as space segment, may be effectively utilized to provide this niche service. By expanding the scope of GMPCS service authorization, it can be made more commercially attractive.

3.8 Based on the above discussion, the issue posed for consultation is:

**Q5. The existing authorization of GMPCS service under Unified License permits the licensee for provision of voice and non-voice messages and data services. Whether the scope of GMPCS authorization may be enhanced to permit the licensees to provide satellite-based connectivity for IoT devices within the service area? Please justify your answer.**

### B. Commercial VSAT CUG Service Authorization

3.9 The Commercial Very Small Aperture Terminal (VSAT) Closed User Group (CUG) Service authorization envisages to provide data connectivity service to Closed User Groups. The scope of Commercial VSAT CUG Service authorization, as enumerated in Clause 2.1 of Chapter XIV of Unified License, is as below:

> *Clause 2.1 (i) The scope of service is to provide data connectivity between various sites scattered within territorial boundary of India using VSATs. The users of the service should belong to a*

*Closed User Group (CUG). However, the VSAT licensee after obtaining ISP license may use same Hub station and VSAT (remote station) to provide Internet service directly to the subscribers and in this case VSAT (remote station) may be used as a distribution point to provide Internet service to multiple independent subscribers.*

*(ii) Long distance carriage rights, granted for NLD, ILD and Access service, are not covered under the scope of this service.*

*(iii) The Closed User Group Domestic Data Network via INSAT Satellite System using VSAT shall be restricted to geographical boundaries of India.*

*(iv) The Licensee can set up a number of CUGs using the shared hub infrastructure.*

*(v) PSTN/PLMN connectivity is not permitted.*

*(vii) Data Rate, as specified in TEC Interface Requirements No. TEC-IR/SCB-08/02-SEP.2009, is allowed, subject to the compliance of the Technical parameters as specified in TEC Interface Requirements No. TEC-IR/SCB-08/02-SEP.2009, as modified from time to time.*

3.10 The scope of the Commercial VSAT CUG service authorization includes provision of data connectivity between various sites. However, the user should belong to a Closed User Group. Therefore, it is already within the scope of Commercial VSAT CUG service authorization to provide satellite-based connectivity solutions. The satellite-based low-bit-rate connectivity for IoT devices may also be provided under the scope of this license. However, scope of services permitted under this authorization is to be made technology agnostic and data speed agnostic. VSAT is a specific technology through which the data connectivity solutions are being provided under this authorization. The service provider may like to use any other latest technology to provide data connectivity solutions and for any speed denominations.

3.11 Satellite-based IoT connectivity required in the hybrid model (LPWAN + Satellite) can easily be provided by the Commercial VSAT CUG service providers using the existing infrastructure of ground segment and space segment. For direct-to-satellite connectivity, the antenna size and the technology used may be different from VSAT technology. This will require liberal approach in prescribing the technology or antenna size. Requirement of 'antenna on moving platform' will also be needed to be considered under VSAT authorization. TEC's Interface Requirements (IR) too, as mentioned in the scope of service, need to be revised accordingly.

3.12 Currently, the Commercial VSAT CUG Service licensee is permitted to provide data connectivity solutions to a Closed User Group only. Even in CUG, the connectivity may be point to point for a single link or many links in single CUG. While envisaging satellite-based low-bit connectivity for IoT devices, there may be a CUG nature of user or it may be a non-CUG also. It will depend upon the architecture being followed by the IoT provider who will obtain the satellite-based connectivity to its IoT devices through satellite. For the sake of ease of doing business there should be an authorization, wherein all kinds of satellite-based connectivity solutions should be available under a single authorization. The Commercial VSAT service authorization may be considered for such kind of authorization. It will boost the effective utilization of existing infrastructure, avoid duplicity of creation of similar infrastructure, which can lead to cost reduction of satellite-based services. Enhancing the scope of VSAT operators, TRAI, vide its recommendations on 'Provision of Cellular Backhaul Connectivity via Satellite Through VSAT Under Commercial VSAT CUG Service

Authorization' dated 28th July 2020, has already recommended that the Commercial VSAT CUG Service provider should be permitted to provide backhaul connectivity for cellular mobile services through satellite using VSAT to the Access Service providers.

3.13 In view of the above, the following question is posed for inputs of the stakeholders:

**Q6. Commercial VSAT CUG Service authorization permits provision of data connectivity using VSAT terminals to CUG users.**

**(i) Whether the scope of Commercial VSAT CUG Service authorization should be enhanced to permit the use of any technology and use of any kind of ground terminals to provide the satellite-based low-bit-rate connectivity for IoT devices?**

**(ii) Whether the condition of CUG nature of user group should be removed to permit provision of any kind of satellite-based connectivity within service area? Please justify your answer.**

## C. Captive VSAT CUG Service License

3.14 DoT, in its reference, has also requested for recommendations for Captive use of satellite-based network for captive IoT devices. It has been stated that organizations like State transport Authorities, Indian Railways, other fleet owners, disaster management agencies, etc., may also need to setup a Captive network for their own use (and not for selling the service). These Captive networks may be of the following two types:

- Government owned entities like Police & security Agencies/PSUs/boards
- Private companies

Currently, the captive use of satellite-based connectivity is covered under the Captive VSAT CUG license. The scope of Captive VSAT CUG Service License is as below:

*1. The captive VSAT Closed User Group Domestic Data Network via INSAT Satellite System shall be restricted to geographical boundaries of India.*

*2. Network will be used only for internal communication and non-commercial purposes of Licensee.*

*3. Neither users other than Licensee shall be given access to the network, nor third-party traffic shall be carried on the network.*

*4. The intent of this License is not to grant long distance carrier rights.*

*5. The scope of the service is to provide data connectivity between various sites scattered throughout India using Very Small Aperture Terminals (VSAT5). However, these sites should form part of a Closed User Group (CUG).*

*6. Captive VSAT service licensees can set up only one CUG for their own use.*

*7. A maximum Data Rate upto 2 Mbps per VSAT for Star configuration and 4 Mbps for Mesh configuration (including all carriers) is permitted subject to the compliance of the Technical parameters as specified in TEC Interface Requirements No. TECIIR/SCB-08102 October 2013. The technical parameters mentioned in Interface Requirement for CUG Domestic VSAT Network namely No. TEC IR'SCB-08/02 Oct 2013 issued by T.E.C. to be strictly compiled with. Any other notification or modification thereof issued from time to time in this regard shall be binding.*

3.15 As examined in case of Commercial VSAT CUG service authorization, the Captive VSAT CUG service license too will require certain changes and amendments, to enable the provision of captive data connectivity for low-bit-rate applications and IoT devices. The terms and conditions related to scope of service, technology used, antenna size, data bit rate, mobility of antenna, TEC's IR specifications, etc. need to be examined and considered. Further, as the annual license fee for captive VSAT license is Rs. 10,000/- per VSAT Terminal/Earth Station and expected number of IoT devices would be too large, the issue of license fee needs to be examined and a mechanism is to be evolved for a reasonable license fee.

3.16 In view of the requirement for Captive use of satellite-based network for IoT devices, inputs of the stakeholders are requested on the following question:

**Q7. (i) What should be the licensing framework for Captive licensee, in case an entity wishes to obtain captive license for using satellite-based low-bit-rate IoT connectivity for its own captive use?**

**(ii) Whether the scope of Captive VSAT CUG Service license should be modified to include the satellite-based low-bit-rate IoT connectivity for captive use?**

**(iii) If yes, what should be the charging mechanism for spectrum and license fee, in view of requirement of a large number of ground terminals to connect large number of captive IoT devices?**

## D. INSAT Mobile Satellite System-Reporting (MSS-R) Service Authorization

3.17 The scope of INSAT Mobile Satellite System-Reporting (MSS-R) Service authorization, as enumerated in Clause 2.1 of Chapter XV of Unified License, is as follows:

*Clause 2.1 The scope of service is to provide INSAT Mobile Satellite System-Reporting service, which is a one way Satellite-based messaging service available through INSAT. The basic nature of this service is to provide a reporting channel via Satellite to the group of people, who by virtue of their nature of work are operating from remote locations without any telecom facilities and need to send short textual message or short data occasionally to a central station. The service provides one way message reporting (Transmit only) facility from anywhere in India (Restricted to Geographical boundaries of India). INSAT-MSS Reporting Service is a low speed data service with the maximum capacity limited to 300 bps.*

3.18 As mentioned in the scope of this authorization, it is only one way satellite-based messaging service. DoT, in its reference, has mentioned that this is a low speed data service with maximum capacity limited to 300 bits per second (bps). Only one such license was issued, which is non-operative since last 5 to 6 years. This authorization has several limitations if compared to the connectivity requirement of satellite-based connectivity for IoT devices.

3.19 Based on the above details of INSAT MSS-R service authorization, the question posed for inputs of the stakeholders is:

**Q8. Whether the scope of INSAT MSS-R service authorization should be modified to provide the satellite-based connectivity for IoT devices? Please justify your answer.**

### E. National Long Distance (NLD) Service Authorization:

3.20 The scope of NLD Service authorization, as enumerated in Clause 2.1 of Chapter X of Unified License, inter alia, includes provision of Leased Circuit/Virtual Private Network services. Accordingly, NLD service providers may provide point-to-point bandwidth or point-to-multipoint bandwidth using wireline or wireless media including satellite-based bandwidth. Such bandwidth or connectivity can be provided for connecting IoT devices too.

NLD service providers are already permitted to provide satellite-based bandwidth. However, the spectrum charges are very high as it is calculated on a formula basis involving the quantum of spectrum and number of terminals deployed. Accordingly, in its recommendations on 'Provision of Cellular Backhaul Connectivity via Satellite Through VSAT Under Commercial VSAT CUG Service Authorization' dated 28th July 2020, TRAI has recommended the following in respect of provision of satellite-based bandwidth by NLD service providers:

***a)*** *Replacing the existing formula-based mechanism, Spectrum usage charges for using satellite frequencies under the NLD service license/authorization should be prescribed as 1% of AGR excluding the revenue from the licensed services other than satellite-based services.*

***b)*** *The NLD service licensees should be asked to do the accounting separation and maintain the revenues accruing from the satellite-based services and other licensed services separately.*

3.21 Therefore, provision of satellite-based connectivity to IoT devices is well within the purview of scope of NLD service authorization. However, the licensee must have Hub station, that is, satellite Earth station in order to facilitate such connectivity. With the above details and for further clarity on the issue, the comments of stakeholders are invited on the following question:

**Q9. (i) As per the scope mentioned in the Unified License for NLD service Authorization, whether NLD Service providers should be permitted to provide satellite-based connectivity for IoT devices? (ii) What measures should be taken to facilitate such services? Please justify your answer.**

## F. Satellite Systems

3.22 The satellite systems, capable of providing connectivity to IoT devices, are operating in all the three orbits, that is, Low Earth Orbit (LEO), Medium Earth Orbit (MEO) and Geostationary Earth Orbit (GEO). These satellite systems are using various permissible satellite frequency bands for providing the satellite-based bandwidth and connectivity.

3.23 Under the GMPCS service authorization, the licensee is permitted to use any Satellite System (domestic or foreign satellite system) provided that the Land Earth Station Gateway Switch is established in India for each Satellite System.

3.24 Whereas, under the Commercial VSAT CUG Service authorization, the required space segment shall be obtained by the Licensee from Department of Space (DOS) on INSAT satellite on terms and conditions as specified by Department of Space (DOS) from time to time.

3.25 Further, as per Flight and Maritime Connectivity Rules, 2018, issued by DoT on 14$^{th}$ December 2018, the In-Flight and Maritime Connectivity (IFMC) service provider shall be permitted to use either Indian satellite system or foreign satellite system capacity duly authorized through the Department of Space and the satellite gateway Earth station should be located within India. It is also mentioned that spectrum neutral approach shall be adopted in satellite system being used for providing IFMC services.

3.26 TRAI has been advocating for an 'Open-sky policy' for more than last 15 years and had made recommendations in "Accelerating Growth of Internet and Broadband penetration" dated 29$^{th}$ April 2004. It was recommended that "An Open Sky policy should be adopted for VSAT operators and VSAT service providers should be allowed to work directly with any international satellite'. This view was further reiterated in recommendations on "Delivering broadband quickly: What do we need to do?" dated 17th April 2015. It was also recommended, inter alia, that "A decision on the recommendation of the Authority on 'Open Sky' policy needs to be taken in the next 6 months. This will allow TSP/DTH/VSAT operators access to International Satellite Operators. This is the only way forward if we are serious about delivery access to otherwise remote and inaccessible areas or those with difficult terrains."

3.27 As the satellite technology is evolving very fast, an important innovation in satellite technology is the increasing use of non-Geostationary Orbit satellites (NGSO), which is a potential breakthrough for connecting the unconnected. There is a requirement of a suitable regulatory framework for timely deployment and use of NGSO systems in different frequency bands in India.

3.28 The satellite-based connectivity for IoT devices is possible through both GSO and NGSO satellite systems. It is, therefore, necessary that adequate satellite resources should be made available, either through domestic satellite systems or through foreign satellite systems, so that the telecom service providers may obtain and use the desired bandwidth without delay and at a reasonable price. When the IoT device is on the moving platform, the device antenna may require moving from one beam to another beam of a satellite or may require to shift from one satellite to another satellite during its movement. Therefore, the issues related to inter-beam roaming and inter-satellite roaming need to be analyzed.

3.29 In view of the above discussion, the following questions are raised for the comments of the stakeholders:

**Q10. Whether the licensees should be permitted to obtain satellite bandwidth from foreign satellites in order to provide low-bit-rate applications and IoT connectivity? Please justify your answer.**

**Q11. In case, the satellite transponder bandwidth has been obtained from foreign satellites, what conditions should be imposed on licensees, including regarding establishment of downlink Earth station in India? Please justify your answer.**

### G. Making Satellite-Based Services Affordable in India

3.30 In order to make the satellite-based services affordable, a lot is required to be done at each stage. For example, if the capacity is hired from the satellite system for longer term period, the cost of satellite bandwidth will probably be lower than that for shorter periods. Providing choice to the VSAT operators to directly negotiate and execute agreement with the satellite system provider will also help in avoiding the intermediaries and making the satellite-based services affordable.

3.31 NOCC charges and other levies too need to be examined to move it to work-based charging. TRAI in its earlier recommendations of 3rd October 2005 on “Growth of Telecom services in rural India — The Way Forward” has recommended that for Commercial VSAT CUG service there should be a single rate of WPC fee (Spectrum Usage Charges) and the ceiling of 4% should be lowered to 1% to cover administrative charges only. Subsequently, TRAI reiterated its earlier recommendations that there should be a single rate of SUC and it should be only 1%, to cover the administrative charges vide recommendations dated 7th March 2017 on ‘Spectrum Usage Charges and Presumptive Adjusted Gross Revenue for Internet Service Providers and Commercial Very Small Aperture Terminal Service Providers’. It was reiterated again in TRAI recommendations on ‘Provision of Cellular Backhaul Connectivity via Satellite Through VSAT Under Commercial VSAT CUG Service Authorization’ dated 28th July 2020. In the same recommendations, it was also recommended that the NOCC charges should be rationalized and it should be independent of the number of carriers assigned.

3.32 In spite of the fact that cost of launching a satellite in India is the lowest globally, yet the licensing formalities, technical criteria, lack of 'Open Skies Policy' are significant barriers for the growth of satellite services in the country. The satellite services need to be made affordable for wider acceptability by price sensitive Indian industry and end-users.

3.33 In view of the above discussion, the following question arises and is raised for the inputs of the stakeholders:

**Q12. The cost of satellite-based services is on the higher side in the country due to which it has not been widely adopted by end users. What measures can be taken to make the satellite-based services affordable in India? Please elaborate your answer with justification.**

### H. Ease of Doing Business

3.34 To attract investment and new players in a sector, the most important characteristic is the 'Ease of doing Business'. The processes and permissions should be online, i.e there should be minimum physical interface, well defined processes with specific timelines and transparency for clarity and ease of operations. There have been long delays reported in procurement of satellite bandwidth through the existing processes and there is an involvement of multiple agencies for seeking various clearances and approvals. It would be convenient to the applicants if there is single window clearance for all kinds of satellite-based processes.

3.35 TRAI has earlier recommended several measures leading to simplification of processes and ease of doing business. In its recommendations on 'Ease of doing business' in telecom issued on 30$^{th}$ November 2017 as well as in broadcasting sector, issued on 26$^{th}$ February 2018, TRAI has recommended that the entire process of clearances, be it SACFA clearance or other approvals, as well as grant of all licenses and approvals, that are issued by WPC and various other agencies, should be made paper-less. There should be a single - window clearance system available and executed end-to-end through an online portal.

3.36 Further, there should not be any barriers to the carrier speeds. And therefore, higher data rates, which are now possible in satellite communications with the use of latest technologies, should be permitted without any restrictions.

3.37 In view of the discussion above, the issue posed for comments of the stakeholders are as below:

**Q13. Whether the procedures to acquire a license for providing satellite-based services in the existing framework is convenient for the applicants? Is there any scope of simplifying the various processes? Please give details and justification.**

**Q14. If there are any other issues/suggestions relevant to the subject, stakeholders are invited to submit the same with proper explanation and justification.**

# Chapter 4
# Issues for Consultation

**Q1. There are two models of provision of Satellite-based connectivity for IoT and low-bit-rate applications — (i) Hybrid model consisting of LPWAN and Satellite and (ii) Direct to satellite connectivity.**

**(i) Whether both the models should be permitted to provide satellite connectivity for IoT devices and low-bit-rate applications? Please justify your answer.**

**(ii) Is there any other suitable model through which the satellite-based connectivity can be provided for IoT devices? Please explain in detail with justifications.**

**Q2. Satellite-based low-bit-rate connectivity is possible using Geo Stationary, Medium and Low Earth orbit Satellites. Whether all the above type of satellites should be permitted to be used for providing satellite-based low-bit-rate connectivity? Please justify your answer.**

**Q3. There are different frequency bands in which communication satellites operate such as L-band, S-band, C-band, Ku-band, Ka-band and other higher bands. Whether any specific band or all the bands should be allowed to be used for providing satellite-based IoT connectivity? Please justify your answer.**

**Q4 (i) Whether a new licensing framework should be proposed for the provision of Satellite-based connectivity for low-bit-rate applications or the existing licensing framework may be suitably amended to include the provisioning of such connectivity? Please justify your answer.**

**(ii) In case you are in favour of a new licensing framework, please suggest suitable entry fee, license fee, bank guarantee, NOCC charges, spectrum usage charges/royalty fee, etc.**

**Q5. The existing authorization of GMPCS service under Unified License permits the licensee for provision of voice and non-voice messages and data services. Whether the scope of GMPCS authorization may be enhanced to permit the licensees to provide satellite-based connectivity for IoT devices within the service area? Please justify your answer.**

**Q6. Commercial VSAT CUG Service authorization permits provision of data connectivity using VSAT terminals to CUG users.**

**(i) Whether the scope of Commercial VSAT CUG Service authorization should be enhanced to permit the use of any technology and any kind of ground terminals to provide the satellite-based low-bit-rate connectivity for IoT devices?**

**(ii) Whether the condition of CUG nature of user group should be removed for this authorization to permit provision of any kind of satellite-based connectivity within the service area? Please justify your answer.**

**Q7. (i) What should be the licensing framework for Captive licensee, in case an entity wishes to obtain captive license for using satellite-based low-bit-rate IoT connectivity for its own captive use?**

**(ii) Whether the scope of Captive VSAT CUG Service license should be modified to include the satellite-based low-bit-rate IoT connectivity for captive use?**

**(iii) If yes, what should be the charging mechanism for spectrum and license fee, in view of requirement of a large number of ground terminals to connect large number of captive IoT devices?**

**Q8. Whether the scope of INSAT MSS-R service authorization should be modified to provide the satellite-based connectivity for IoT devices? Please justify your answer.**

**Q9. (i) As per the scope mentioned in the Unified License for NLD service Authorization, whether NLD Service providers should be permitted to provide satellite-based connectivity for IoT devices. (ii) What measures should be taken to facilitate such services? Please justify your answer.**

**Q10. Whether the licensees should be permitted to obtain satellite bandwidth from foreign satellites in order to provide low-bit-rate applications and IoT connectivity? Please justify your answer.**

**Q11. In case, the satellite transponder bandwidth has been obtained from foreign satellites, what conditions should be imposed on licensees, including regarding establishment of downlink Earth station in India? Please justify your answer.**

**Q12. The cost of satellite-based services is on the higher side in the country due to which it has not been widely adopted by end users. What measures can be taken to make the satellite-based services affordable in India? Please elaborate your answer with justification.**

**Q13.Whether the procedures to acquire a license for providing satellite-based services in the existing framework convenient for the applicants? Is there any scope of simplifying the various processes? Please give details and justification.**

**Q14. If there are any other issues/suggestions relevant to the subject, stakeholders are invited to submit the same with proper explanation and justification.**

**Annexure I**

Government of India / भारत सरकार
Ministry of Communications / संचार मंत्रालय
Department of Telecommunications / दूरसंचार विभाग
Satellite Division, DoT HQ
Sanchar Bhawan, New Delhi – 110001

No. 824-201/Policy/2020-SAT

Date: 23.11.2020

भारतीय दूरसंचार विनियामक प्राधिकरण
महानगर दूरसंचार भवन, नई दिल्ली-2
24 NOV 2020
डायरी सं. 5952

To

**The Secretary**
**Telecom Regulatory Authority of India,**
**Mahanagar Doorsanchar Bhawan,**
**Jawahar Lal Nehru Marg (Old Minto Road),**
**New Delhi-110002**

**Sub: TRAI recommendations on licensing framework for Satellite based low bit-rate applications**

With the evolution in Satellite Communication (SATCOM) technologies, new types of applications are emerging based on low bit-rate communications. The typical applications/use-cases utilizing a satellite networking protocol and sensor connectivity solution are envisaged in sectors like agriculture, fisheries, forestry, logistics, mining, industrial equipment, railways, remote utilities & infrastructure and disaster preparedness & response. A brief on such applications/use-cases utilizing low bit-rate satellite based communication is enclosed as Annexure-A.

2. The current licensing framework of Department of Telecommunications (DoT) with respect to satellite communication services and their limitations vis-à-vis the proposed satellite based low bit-rate services are as follows:

i. **Captive VSAT CUG License:** The scope of this license is to provide data connectivity between various sites scattered throughout India for captive use using Very Small Aperture Terminals (VSATs) which should form part of a Closed User Group (CUG). The licensees can set up only one CUG for their own use. The proposed low bit-rate services does not seem to fit suitably in this licensing framework because of the following reasons:

a. The remote terminals to be installed under the proposed low bit-rate services are of smaller size with typical antenna sizes less than 1 meter which is the least allowed size as prescribed in the applicable TEC IR.

b. The user terminal location is fixed in the Captive VSAT CUG service, whereas, the proposed low bit-rate service envisages possible deployments of remote terminals/sensors on moving platforms over

Page 1 of 3

land surface also. For such use-cases, no technical regulations exist as of now in the form of TEC IR/GR/standards.

c. This license is granted to establish, maintain and operate Captive VSAT CUG domestic data network via INSAT satellite system only, whereas, the proposed low bit-rate services can be used on other satellite systems as well.

d. For this license, the licensee has to pay license fee annually at Rs. 10,000/- per annum per user terminal installed. Since the proposed low bit-rate service envisages deployment of thousands of remote terminals/sensors as compared to VSAT terminals, the license fee may turn out to be exorbitantly high.

e. The WPC Royalty charge for this license is formula based and depends on the number of carriers. Applying the present formula for the present low bit-rate services may lead to exorbitant Royalty charges.

f. Also, NOCC charges are fixed at ₹ 21 lakhs per transponder (36 MHz) per annum and calculated on a pro-rata basis for a part of transponder.

ii. **Commercial VSAT CUG License:** The scope of this license is to provide data connectivity between various sites scattered throughout India using VSATs. The users of the service should belong to a CUG. This service is meant for commercial purpose and the license fee for this service is based on AGR. This license has limitations as stated in para 2.i.a, 2.i.b, 2.i.c and 2.1.f above.

iii. **Global Mobile Personal Communication by Satellite (GMPCS) License:** The scope of this license is to provide all types of mobile services including voice and non-voice messages, data services by establishing GMPCS Land Earth Station Gateway in India. At present, there is no GMPCS licensee. Only BSNL has been granted license for provision and operation of satellite based services using gateway installed in India under "sui-generis" category.

iv. **INSAT- Mobile Satellite System Reporting (MSS-R) License:** This is a commercial one way satellite based messaging service. This service provides one way message reporting (transmit only) facility from anywhere in India. This is a low speed data service with maximum capacity limited to 300 bps. Only one such license was issued which is non-operative since last 5-6 years. This license has following limitations:

a. INSAT MSS-R is a one-way reporting service only.

b. The data speed is limited to 300 bps.

c. There is no licensing framework for captive use of this service.

3. Considering the above, there is a need for suitable licensing framework in respect of the proposed satellite based low bit-rate services for:

i. Providing such services on commercial basis.

ii. Organizations like State Transport Authorities, Indian Railways, other fleet owners, disaster management agencies etc. which may need to setup a captive network for their own use (and not for selling the service). These captive networks may fall into two categories:
   a. Government authorities/Police & Security Agencies/PSUs/Board(s) which are government owned entities
   b. Private companies

4. TRAI is requested to examine all the above factors holistically and furnish their recommendations in terms of clause 11(1)(a) of TRAI Act 1997, as amended from time to time, to enable the provisioning of the proposed satellite based low bit-rate services under the existing licensing framework of DoT or suggest new licensing framework including the entry fee, license fee, bank guarantee, NOCC charges, spectrum usage charges/royalty fee etc. for such services for both commercial and captive usage.

Manish Singh
23/11/2020

(Manish Kumar Singh)
Asst. Director General (Satellite-I)
Satellite Division, DoT HQ
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Enclosed: As above.

**ANNEXURE-A**

## Brief on use-cases utilizing narrowband, low bit-rate satellite based communication

The applications/use-cases utilizing a satellite networking protocol and sensor connectivity solution are discussed briefly in the following paras.

**Logistics:** Fleet management including monitoring and tracking movement of goods and services, geo-location of vehicles, SOS functionality, temperature monitoring of cargo, monitoring of fuel level etc.

**Railways:** Geo-location of rolling stock assets, monitoring of safety systems in a train, mission critical two-way data etc.

**Disaster management:** Delivery of real-time and geo-location alerts in case of floods, landslides etc, emergency alert broadcasts and SOS messaging for fishing vessels, real-time tsunami alerts from marine buoys, detection of fires in rural forests or strategic buildings, managing logistics of NDRF vehicles, boats, fire engines, ambulances etc. during natural disasters and accidents.

**Internal security:** Tracking of patrol vehicles, monitoring of critical logistics supplies through remote areas, connectivity among coast guard vessels and monitoring of vessels at sea.

**Fisheries:** The sensor based connectivity is used for location and vessel monitoring, maritime boundary alerts, geo-fenced fishing zones, monitor the cold-chain of stored fish and two-way emergency messaging system for distressed vessels, inclement weather.

**Health services response mechanism:** Ambulance and medical logistics tracking especially in rural areas, vehicle telemetry, live monitoring of patients' diagnostics etc.

**Agriculture:** Monitoring soil conditions for critical inputs such as water, fertilizers and pesticides etc.

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