ATU-R REPORT

relating to

REPORT ON STATUS OF SATELLITE SERVICES LICENSING IN AFRICA AND INTERNATIONAL TRENDS

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EXECUTIVE SUMMARY

This report provides insight into the design of satellite systems through a high-level description of the principles, technologies and operation of equipment related to satellite communication networks, services and applications.

Most of the key policy decisions relating to the development of the market structure ultimately determine the form of the licensing and authorisation regime chosen to implement the policy. Licensing frameworks are generally designed with a specific vision of the market structure in mind and cater to specific competition and consumer protection issues. The right balance between ease of market entry, competition between different access technologies, technical efficiency and customer protection must be struck. Since, the advantages of global mobility can be maximized by understanding some of the general regulatory and policy issues involved in licensing a satellite service, this report includes an overview of several issues raised, or faced, by government/regulators, operators, and prospective users.

Satellite networks and services licensing is a relatively recent development in many telecommunications markets. Looking at examples around the world, it is obvious that there is no one preferred model but rather various solutions to this issue. Each country chooses what fits best into its market reality, political and administrative tradition.

The national regimes need to consider satellite operators who are operating an infrastructure from outer space which naturally covers several countries at once. Thus, licensing and spectrum usage requirements need to be harmonized as much as possible to assist an operator to offer the full capabilities of its satellites in each of the covered countries, on the other hand satellite operators need to consider national requirement while providing a service in any country. In addition, national licensing regimes should take into account ITU related provisions and administrative regulations.

This report reviewed countries' experiences and regional organizations frameworks concerning access conditions for satellite operators and service providers in respective markets in order to better highlight the different national licensing practices and experiences and allow for consideration of avenues for common, harmonised approaches. Private-sector perspectives on satellite regulation were also considered.

The analysis and conclusions of the study is provided on the following areas:

a) Conditions for authorization and licensing of end-users of satellite services as well as of network operators and service providers/resellers;
b) The ability of network operators to enter a market directly, through a distributor, or resellers;
c) Regulatory requirements for, and ability of, end-users and/or resellers to access services offer from different satellite operators;
d) Licensing categories in existence;
e) Legislation, in the field of telecommunications and, when differentiated, in the field of satellite communications.

Several types of licensing requirements have been employed effectively by Administrations, both in Africa and elsewhere in the world. These licensing rules tend to focus either on: a) The "space segment" of a satellite network; or b) The terrestrial part or "Earth segment" of the network. Licensing requirements are seen and used to accomplish legitimate regulatory objectives. Generally, the service authorisation is used for the overall regulation of

telecommunications networks, for example the feasibility of establishing and operating a certain network from the standpoint of providing services. The radio licence is used to regulate the detailed technical aspects of radio networks. As far as terminals are concerned, various regimes may apply. These regimes range from an individual licence, class licence, or general authorisations to regimes where certain services or earth station types are exempted from licensing. The satellite Industry would like to have simpler and more harmonised licensing conditions than those currently exist in some countries.

Regulatory solutions need to take account of all relevant local factors, including the position of the existing market players and the needs of consumers and, importantly, cultural and economic and political differences. Although the objectives of satellite licensing policy may vary from country to country, this study sets out to identify several successful-practice elements that can be implemented to serve individual national requirements.

INTRODUCTION

Providing connectivity to all their citizens is a major goal for decision makers and regulators around the African continent. The African Telecommunications Union (ATU) Strategic Plan 2018 - 2022 includes a strategic objective to promote the harmonized and rational planning and use of radio spectrum and satellite resources to maximize its benefits. In particular, it is well known that access to information and communication technologies is difficult in rural or remote areas, due to several factors including terrain and their isolation, cost of providing service via terrestrial mobile networks yields a poor return on investment for sparsely populated areas as compared to urban areas. Satellite systems offer significant advantages for expanding broadband coverage: they provide instant-on coverage across wide geographies without regard to challenging topography; they are reliable and largely immune to many risks that other networks face, including accidental damage, theft, conflict areas and natural disasters.

New advances in satellite technologies could help bridge the digital divide more rapidly – and at a lower cost – than ever before. The introduction of the latest generation of geostationary satellites and the rapidly increasing use of non-geostationary satellite orbits (non-GSO), such as medium Earth orbits (MEO) and low Earth orbits (LEO), represent an important innovation in satellite technology and a potential breakthrough in connecting the unconnected so that they, too, can reap the benefits of today's digital economy. The geostationary and non-geostationary satellite systems together are opening the way to new applications, such as personal communications, fixed or mobile, innovative wideband data services, etc. Satellite connectivity is also important for the aviation and maritime sectors that operate aircraft and vessels out of reach of terrestrial networks during their journeys. Space-based connectivity is helping make smart societies a reality across all 17 Sustainable Development Goals (including intelligent transport systems, e-government, tele-education, e-health, e-logistics, smart energy, smart agriculture), in both developed and developing countries, and particularly in rural and remote areas.

Accordingly, ATU General Secretariat has initiated a work plan to develop a harmonized (model) framework for licensing of satellite services in Africa including recommendations. The harmonized framework would act as a reference for national and sub-regional frameworks across Africa, and foster the maximization of the benefit from the capacity available on satellite today and support the African digitalization agenda.

To conduct the study, an external consultant was recruited in April 2020. The preliminary draft report produced by the ATU consultant has been used as basis for the work of the ATU Task Group on Satellite Resources. The TG was mandated to develop a draft Model Framework for Satellite Licensing in Africa, using the preliminary draft developed by the General Secretariat via consultancy. The TG reviewed and further improved the document. This report summarizes the study results and the justification and rationale for the proposed guidelines.

1 BACKGROUND AND METHODOLOGY

1.1 Rationale of the mission

Some countries across the continent have developed and established their unique satellite licensing frameworks. In contrast, others work on an ad-hoc basis due to the lack of harmonised approach towards satellite service licensing, satellite equipment importation and type approvals.

In many cases this may have hindered the realization of maximum benefit from the capacity available on satellite due to some factors such as disproportionate taxes, license fees, delays in type approvals among others.

The ATU/ITU/ITSO workshop held in Nairobi in February 2018 recommended that such a framework borrow the good elements from African country frameworks that are considered best practices in satellite licensing. Further, the workshop recommended that such a framework ought to address, as a minimum, the following elements:

(i) blanket, streamlined and fairly priced licensing,

(ii) easy equipment importation and taxation, equipment type approval including mutual type approval recognition,

(iii) open, consultative and transparent rule making, such as satellite licensing regulations, type approval and equipment importation,

(iv) handling of security concerns as well as taming of illegal stations,

It is under this background that the consultant has been tasked with the delivery of this study. The outcomes are expected to serve as guidelines to support the contribution of satellite communications to the broadband development and spectrum harmonisation in Africa.

1.2 Methodology

The overall methodology for the project was grounded on the baseline, desk research and gap analysis. Baseline refers to the current situation: its strengths and weaknesses, bottlenecks and obstacles (the “as-is” situation). Desk research refers to the process of gathering and analysing already available information, such as reports, case studies and countries experiences (the “to-be” situation). A gap analysis will compare and define the gap between the current situation and the desired situation provided by desk research.

The recommendations for the draft harmonized framework for satellite licensing are crafted considering the appropriate provisions of the ITU Radio regulations, Recommendations, reports and hand books, ATU Recommendations, reports and handbooks, lessons learned from country experiences within and outside the continent, industry views and other region harmonisation frameworks.

To reach the required objective, the following approach has been followed:

1. Assessment of the current situation on regulation and licensing for satellite services in Africa. To carry out this task, a questionnaire was developed to collect information on regulations applicable to satellite communications, services subject to licensing and regulatory fees, requirements for licensing and type approval for terminal equipment. The questionnaire was circulated to Member States by ATU Secretariat General and relevant regulatory authorities who were requested to respond before 19th June 2020. Also, consultation was conducted with the industry to seek their views.
2. Literature review on country experiences, regional harmonization and global trends on satellite regulation and licensing.

3. Development of the guidelines for a Pan-Africa harmonized framework for licensing of satellite services.

The survey has helped collect information on the situation of the satellite communications market, the existing regulations for the provision of satellite services and use of terminal equipment, the main end-user applications, the main issues related to satellite spectrum in Africa and the concerns raised by the industry. The analysis of the information provided an overview on satellite licensing and related matters in Africa, highlighted what challenges remain to be addressed before the full potential of satellite-based solutions can be realized in Africa and drawn conclusions on whether there is a need for regulatory intervention or and where not to intervene.

The review of the existing literature on satellite regulations and technologies allowed to identify the appropriate provisions from the ITU Radio Regulations and relevant ITU-R documents (recommendations, reports, etc.) on technical, operational and regulatory aspects for the use of satellite applications and also examine some country experiences on satellite-licensing and the harmonization efforts undertaken within and in other regions on the topic. It has resulted in an in-depth assessment of international best practices from the region and other regions on licensing and access practices for satellite systems and earth stations.

Based on the findings of the assessment of the current situation and the literature survey, the guidelines on establishing harmonized licensing procedures for satellite service providers in Africa were developed to reference material in order to assist Administrations in establishing a suitable regulatory environment and licensing rules that could foster the take-up and increase the development of satellite-related services and applications in African countries.

2 STRUCTURE OF THE REPORT

Section 1 is the introduction which gives the project background, the rationale of elaborating a harmonized framework for satellite licensing in Africa, the methodology used to prepare the report.

Section 2 outlines the structure of the report.

Section 3 provides a snapshot of the main notables on the continent's geography and presents the Regional Economic Communities (RECs) and the Regional Regulatory Associations aiming to work towards harmonization of Telecommunication/ICT sector policies at a regional level. It also draws the benefits and challenges for the widespread access to broadband and the role of satellites to improve global connectivity in Africa.

Section 4 presents an overview of satellite communications, mainly basic facts about satellite communications. This section provides a brief on the basic principles, main components and technologies of communication satellite systems, operating mechanisms of equipment related to satellite communications and features of some specific satellite applications (MSS, EESS, GNSS, space research systems). The scenarios where satellite broadband provides great advantages were explored to help develop optimized telecommunications policies, strategies, and technical concepts for universal broadband access. Also some of the available satellite use cases are described recognizing that selecting of optimum network architecture is critical to the successful and cost-effective implementation and operation of satellite-based solutions (services, applications & systems). This section also addresses the principles governing spectrum allocation for satellite services and the main use in the allocated spectrum.

Section 5 addresses licensing aspects for the provision of satellite services in Africa. The focus is on key licensing and regulatory issues, that may affect licensing conditions in Africa recognizing that satellite poses various challenges to the different stakeholders including regulators, satellite operators and users, in particular:

(a) how to ensure fair competition among several satellite systems and their service providers;
(b) how to authorize satellite services including use of the applicable frequencies and user terminals;
(c) how to optimize the technical capability of satellite (e.g., global coverage to urban, rural, remote, and unserved areas) while supplementing the resources devoted to universal service obligations;
(d) how to safeguard national sovereignty and security;
(e) how to determine the applicable fees for the license and use the spectrum of frequencies (frequency assignment).

The key findings of the survey undertaken to assess the situation in Africa are detailed. This section lays out practical information guiding effective satellite communications regulations and policies addressing technical, operational & regulatory issues. The licensing regime for satellite services developed in four African countries (Nigeria, Egypt, Botswana, Cameroon) and the East African Region are well described.
Also, this section highlights the policy drivers for the African space programme as expressed through the African Space Policy which provides the guiding principles for a sustainable and fully effective space programme that will serve the needs of the African continent and also, the Digital Transformation Strategy for Africa (DTSA) that aims at boosting the development of Africa's digital ecosystem.

Section 6 explores the regionally harmonized framework for satellite services developed by the Inter-American Telecommunication Commission (CITEL) in the Americas and the European Conference of Postal and Telecommunications Administrations (CEPT) in Europe. It shows how these regional organizations are developing the regulatory environment for satellite-based solutions in their respective regions.

The report concludes with Annexes which contain a glossary giving the meaning assigned to some terms and expressions used in the report, a description of typical satellite frequency bands and services and a list of ITU-R Recommendations and Reports pertinent to satellite services.

3 AFRICA IN BRIEF

3.1 Geography and structure

Africa has a terrestrial mass of 30 million km^2. An equatorial and tropical Continent *par excellence,* the Continent is characterized by hot and dry weather (30% desert and 20% forest). The African population was 916 million in 2005, 1.039 billion in 2010, 1.182 billion in 2015, 1.340 billion in 2020. This figure will be around 1.508 billion by 2025 and 1.668 billion by 2030. For 2020 population estimates, the Africa population is equivalent to 16.72% of the total world population. Africa ranks second in the world after Asia. The population density in Africa is 45 per Km^2. 43.8 % of the population is urban (587,737,793 people in 2019). The median age in Africa is 19.7 years[1].

Africa is structured into five (5) geographical regions, which are: Southern Africa, Central Africa, East Africa, North Africa and West Africa. Several Regional Economic Communities (REC) and Inter-Governmental Organizations (IGO) have been established across the continent including:

1. Arab Maghreb Union (AMU) was established in 1989 and made up of five (5) States;
2. Common Market for Eastern and Southern Africa (COMESA) established in 1994 and made up of twenty-one (21) States;
3. East African Community (EAC) first created in 1967, disbanded and re- established in 1999 is made up of six (6) States;
4. Economic Community of Central African States (ECCAS) was created in 1983 and comprises eleven (11) States;
5. Economic Community of West African States (ECOWAS) was established in 1975 and made up of fifteen (15) States;
6. Southern Africa Development Community (SADC) was created in 1980 and made up fifteen (15) States.

Table **1** below features the distribution of Member States by REC.

Table 1: Repartition of countries, region and REC

N°	AFRICAN UNION Member States	COMESA (21)	EAC	ECCAS (11)	ECOWAS (15)	SADC (15)	UMA (5)	Total
NORTHERN AFRICA (06)								
1.	Algeria						✓	1
2.	Egypt	✓						1
3.	Libya	✓					✓	2
4.	Mauritania						✓	1
5.	Morocco						✓	1
6.	Tunisia	✓					✓	2
CENTRAL AFRICA (09)								
7.	Burundi	✓	✓	✓				3
8.	Cameroon			✓				1
9.	Central African Republic			✓				1
10.	Chad			✓				1
11.	Congo			✓				1
12.	Democratic Republic of Congo (DRC)	✓	✓	✓		✓		3
13.	Equatorial Guinea			✓				1
14.	Gabon			✓				1
15.	Sao Tome & Principe			✓				1

[1] Source: Worldometer (www.Worldometers.info)

N°	AFRICAN UNION Member States	COMESA (21)	EAC	ECCAS (11)	ECOWAS (15)	SADC (15)	UMA (5)	Total
SOUTHERN AFRICA (10)								
16.	Angola			✓		✓		2
17.	Botswana					✓		1
18.	Eswatini	✓				✓		2
19.	Lesotho					✓		1
20.	Malawi	✓				✓		2
21.	Mozambique					✓		1
22.	Namibia					✓		1
23.	South Africa					✓		1
24.	Zambia	✓				✓		2
25.	Zimbabwe	✓				✓		2
EAST AFRICA (14)								
26.	Comoros	✓						1
27.	Djibouti	✓						1
28.	Eritrea	✓						1
29.	Ethiopia	✓						1
30.	Kenya	✓	✓					2
31.	Madagascar	✓				✓		2
32.	Mauritius	✓				✓		2
33.	Rwanda	✓	✓	✓				3
34.	Seychelles	✓				✓		2
35.	Somalia	✓						1
36.	South Sudan		✓					1
37.	Sudan	✓						1
38.	Tanzania		✓			✓		2
39.	Uganda	✓	✓					2
WEST AFRICA (15)								
40.	Benin				✓			1
41.	Burkina Faso				✓			1
42.	Cape Verde				✓			1
43.	Côte d'Ivoire				✓			1
44.	The Gambia				✓			1
45.	Ghana				✓			1
46.	Guinea				✓			1
47.	Guinea Bissau				✓			1
48.	Liberia				✓			1
49.	Mali				✓			1
50.	Niger				✓			1
51.	Nigeria				✓			1
52.	Senegal				✓			1
53.	Sierra Leone				✓			1
54.	Togo				✓			1

Most of the REC are aiming to work towards harmonization of Telecommunication/ICT sector policies at the regional level and have created Regional Regulatory Associations with similar objectives that include, among other things, the following:

a) Harmonization of telecommunication policies and regulations;

b) Harmonization and maximization of the utilization of scarce resources – electromagnetic spectrum, numbering, etc.;

c) Identification and sharing of best practices within the region;

d) Contribution to the integration of their regions.

Some of the established Telecommunication/ICT regulatory associations in Africa are listed in Table 2 below.

Table 2: Regional Regulatory Associations / Organizations

Name of Regulatory Association	REC	Region/Sub-Region	Year of establishment
The Communication Regulators' Association of Southern Africa (CRASA)	SADC	Southern Africa	1997
The West Africa Telecommunications Regulators Assembly (WATRA)	ECOWAS	West Africa	2002
The Association of Regulators of Information and Communications for Eastern and Southern Africa (ARICEA)	COMESA	Eastern & Southern Africa	2003
The East African Communications entities Organisation (EACO)	EAC	Eastern Africa	2000
Assemblée des régulateurs des télécommunications de l'Afrique Centrale (ARTAC)	ECCAS	Central Africa	2004

3.2 Economic impact of widespread access to broadband

It is increasingly evident that widespread access to information and communication technologies (ICTs) is necessary for sustainable development. ICTs are a catalyst for enhancing economic growth, expanding productivity and competition, and aggregating knowledge. Therefore, ICTs, especially broadband, allow and increase participation in the global economy[2].

The transformative power of broadband as an enabler of economic growth has been widely recognized, and access to broadband connectivity has become a key priority of the twenty-first century. Through access to broadband, countries and isolated communities in Africa can better gain access to education, healthcare, and commercial services. In urban and rural areas alike, the implementation of a telecommunications infrastructure has become a major political and regulatory objective in many countries.

The technological revolution, referred to as the Fourth Industrial Revolution (4IR), is another important change which has important implications for education, employment, and the future of work. The 4IR is characterized by accelerating digitalization and the use of new technologies - including artificial intelligence, cloud computing, robotics, 3D printing, the internet of things, and advanced wireless technologies. Africa lags in digitalization and the technologies of the 4IR with many countries digitally under-connected. Like all regions, Africa needs to prepare for the implications of the 4IR[3].

Africa needs to build information and communication technology skills and science, technology, engineering, and mathematics. The Fourth Industrial Revolution (4IR) will place increasing demands on education systems that are not producing graduates versed in these skills. Investments in high-speed internet and the spread of smartphones make it possible for Africa to innovate on digital and mobile fronts. Innovation hubs are burgeoning, with more than 600 active tech hubs across the continent in 2019, up 40 percent from the year before.

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[2] World Bank, InfoDev, and the International Telecommunications Union, 2011

[3] African Economic Outlook 2020, Developing Africa's Workforce for the Future, African Development Bank Group

The digital economy can unlock new pathways for inclusive growth, innovation, job creation, service delivery, and poverty reduction in Africa. The continent has made great strides in mobile connectivity; however, it still lags the rest of the world in access to broadband. Only 27 percent of Africa's population has access to the internet., Few citizens have digital IDs, businesses are slowly adopting digital technologies, and only a few governments are investing strategically in developing digital infrastructure, services, skills, and entrepreneurship[4].

Access to broadband is critical but not sufficient to materialize these digital dividends. The digital economy also requires a strong analogue foundation, consisting of regulations that create a vibrant business climate and let firms leverage digital technologies to compete and innovate; skills that allow workers, entrepreneurs, and government officials to seize opportunities in the digital world; and accountable institutions that use the internet to empower citizens[4].

Closing the digital divide relative to other developing and advanced countries is needed for Africa to take advantage of the information and communications technologies opportunities. Yet, access to the internet remains unattainable for most people in the region; businesses are slowly adopting digital technologies to foster productivity; and few governments are investing strategically in developing digital infrastructure, services, skills, and entrepreneurship. Therefore, it will be necessary to plan, finance, implement, and operate an efficient combination of fibre optic cable systems, cellular/microwave wireless technology, and satellite telecommunications.

3.3 Satellite as a complement to terrestrial networks

All of Africa's international bandwidth is supplied by submarine cables, terrestrial networks connected to submarine cables, or satellites. Of the total bandwidth of 5.568 Tbps in Sub-Saharan Africa by December 2018, 5.077 Tbps (91.2%) was supplied directly by submarine cable, and 479 Gbps (8.6%) was supplied by terrestrial cross-border networks connected to submarine cables. The expansion of terrestrial transmission networks continues to bring additional countries, regions, cities and towns within reach of fibre networks for the first time. In June 2019, 584 million people lived within a 25-km range of an operational fibre optic network node, compared to 556 million in June 2018 and 259 million in June 2010[5].

Fortunately, telecommunications satellite technology can complement terrestrial networks. They can provide broadband access almost instantaneously and in any geographic location, reducing investment requirements largely to terminal and end-user equipment. While traditional, satellite-based systems used to have well-known limitations, notably in terms of capacity and latency, Currently, satellite operators are offering high speed broadband services to consumers and enterprises, anywhere in world. Currently a number of GEO and non-GEO High Throughput Satellite (HTS) and Very High Throughput (VTHS) systems are operating or are in the process of being deployed. Fibre optics offer vastly superior bandwidth and, therefore, transmission speed, and lower latency compared to traditional GSO satellite applications. However, novel non-GSO systems operating in lower altitude compared to that of GSO satellites deliver low latency applications, and through the use of frequency reuse schemes, GEO and non-GEO satellites could provide flexible capacity routed to users through steerable and shapeable beams, as well as optical inter-satellite links, and can offer unprecedented amounts of capacity.

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[4] Africa's pulse, An analysis of issues shaping africa's economic future, April 2019, volume 19, World Bank Group

[5] See http://www.africabandwidthmaps.com/?p=6158

Moreover, aeronautical (commercial and business aviation) and maritime (passenger cruise ship, merchant ship, fishing vessel, etc.) routes together with many rural/remote areas are out of reach of terrestrial networks and rely on satellite services. Therefore, there are a number of strong advantages to using satellite as a medium to bridge the digital divide in rural and low population-density areas. Thus, telecommunications policies, strategies, and technical concepts should incorporate satellite-based broadband access.

4 OVERVIEW OF SATELLITE COMMUNICATIONS

Satellites are artificial objects intentionally placed into orbit to collect information and for purposes related to communications. They are an integral part of everyday life because they enable important services, such as telecommunications, navigation, TV transmission, security, and reconnaissance missions, to function. The clear benefit of satellite systems is the large operational area as a single satellite antenna's beam covers whole nations and large areas that are not covered necessarily by any other means of communications.

Satellite communications rely more and more on the effective use of their specific characteristics:

a) multiple access capability, i.e. point-to-point, point-to-multipoint or multipoint-to-multipoint connectivity, in particular for small or medium-density scattered data or voice/data traffic between small, low-cost earth stations (business or private communications networks, rural communications, etc.);
b) distribution capability (a particular case of point-to-multipoint transmission), including: TV programme broadcasting and other video and multimedia applications;
c) data distribution, e.g. for business services, Internet wideband services, ubiquitous broadband connectivity on moving platforms (ships, aircraft, trains, vehicles), etc.;
d) flexibility for changes in traffic and in network architecture and also ease of operation and putting into service.

This section attempts to bring together basic facts about satellite communications. It covers the main principles, technologies and operation of equipment related to satellite communications.

4.1 Definition of satellite services and systems

A satellite system refers to a set of space stations and earth stations working together to provide radiocommunications. For the sake of convenience, a distinction is made in the particular case of a satellite system, or a part of a satellite system, consisting of only one satellite and the associated earth station which is called a satellite network. Satellite systems cover a wide range of publicly available wireless services, like radio and television broadcast, location-based services, data transfer services and delivery of telemetry data both from Earth and space, and various satellites and services for closed users groups like military groups, environment and scientific space investigation.

This section deals with the definitions of some of the satellite services currently in operation according to the ITU Radio Regulations.

a) Fixed-satellite services (FSS)

The FSS is a radiocommunication service between given positions on the Earth's surface when one or more satellites are used. These stations located at given positions on the Earth's surface are called earth stations of the FSS. The given position may be a specified fixed point or any fixed point within specified areas. Stations located on board the satellites, mainly consisting of the

satellite transponders and associated antennas, are called space stations of the FSS (see *Figure 1*).

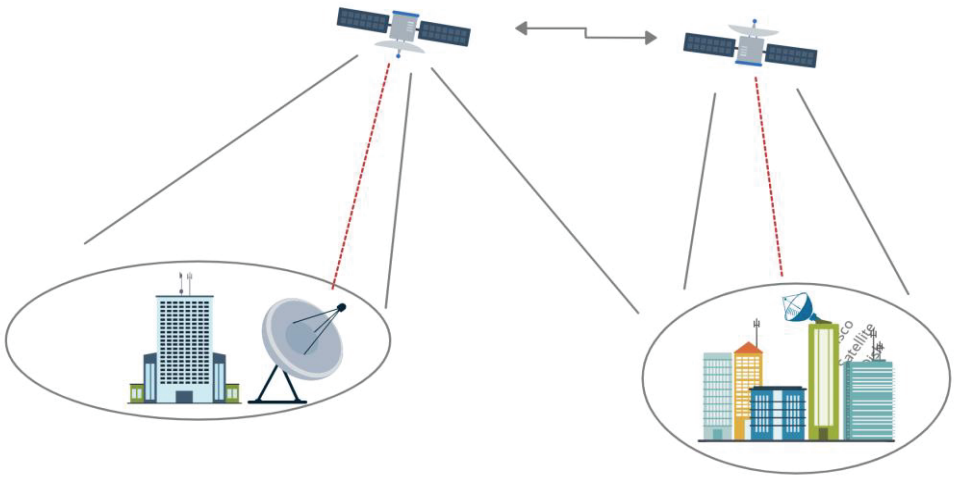

Figure 1: Communication links within a FSS system

Generally, links between a transmitting earth station and a receiving earth station are affected through a single satellite. These links comprise two parts, an uplink between the transmitting station and the satellite and a downlink between the satellite and the receiving station. When links between two earth stations use two or more satellites directly interconnected without an intermediate earth station, a link between two earth stations using satellite-to-satellite links is called a multi-satellite link. The satellite-to-satellite links will form a part of the inter-satellite service (ISS).

Inter-satellite links (ISL) of the ISS may be employed to provide connections between earth stations in the service area of one satellite to earth stations in the service area of another satellite, when neither of the satellites covers both sets of earth stations.

The FSS also includes feeder links, i.e. links from an earth station located at a specific fixed point to a space station, or vice versa, conveying information for a space radiocommunication service other than for the FSS. This category includes, in particular, uplinks to the satellites of the broadcasting satellite service (BSS) and up and downlinks between fixed earth stations and satellites of the mobile-satellite service (MSS).

All types of telecommunications signals can be transmitted via FSS links: telephony, data, multimedia, video, television and sound programmes, etc. Similar techniques are employed and many commonalities exist between the fixed-satellite service (FSS) and those of other satellite services.

b) Mobile-satellite service (MSS)

The MSS is a radiocommunication service between mobile earth stations and one or more space stations, or between mobile stations using one or more space stations (see Figure 2). There are several mobile satellite services, such as:

(i) Terrestrial (land) Mobile Service: the case in which stations in mobile communication are located on the Earth's surface.

(ii) Maritime Mobile Service: the case in which the stations in mobile communication are located on the Earth's surface and at least one of the stations is aboard a ship or a vessel.

(iii) Aeronautical Mobile Service: the case in which the stations in mobile communication are located on, or near, the Earth's surface and at least one of the stations is aboard an aircraft.

(iv) Mobile-Satellite Service: the case in which a station of a mobile service is located on the Earth's surface communicates with one or more satellites or when a station of a mobile service on the Earth's surface communicates with another mobile service station, located on the Earth's surface, using one or more satellites, or when two satellites communicate with each other.

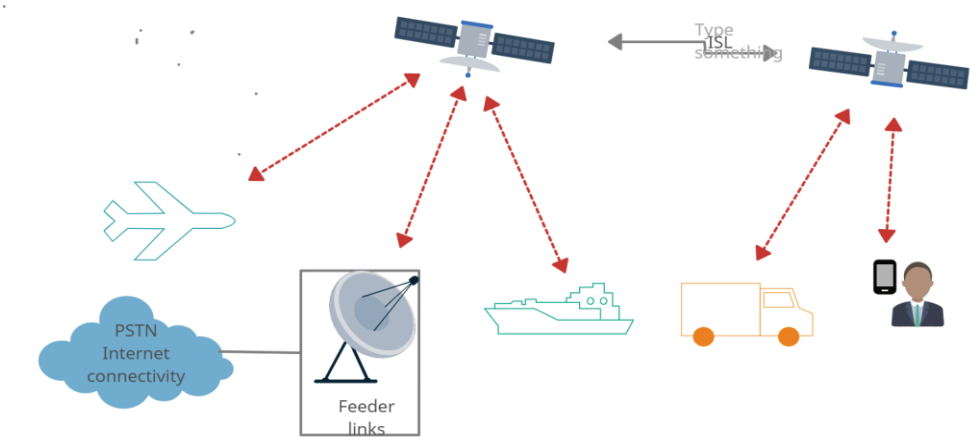

Figure 2: Communication links in the mobile satellite service

In some systems like the Global Mobile Personal Communications systems (GMPCS), the earth stations may consist of small, even hand-held, terminals.

c) Broadcasting-satellite service (BSS)

The BSS is a radiocommunication service in which signals transmitted or retransmitted by space stations are intended for direct reception by the general public using very small receiving antennas (TVRO). The satellites implemented for the BSS are often called direct broadcast satellites (DBS). The TVRO antenna needed for BSS reception should be smaller than the ones needed for operation in the FSS. The direct reception shall encompass both individual reception (Direct-to-home TV - DTH) and community reception (Cable television network - CATV and Satellite master antenna TV - SMATV) (see *Figure 3*).

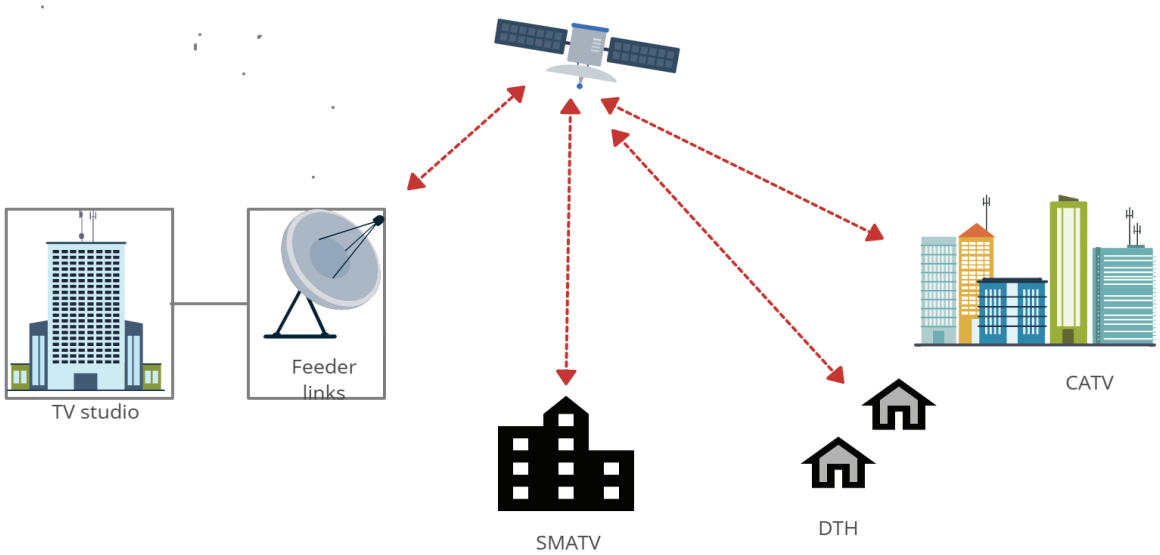

Figure 3: Applications of satellite broadcasting services

d) Earth Exploration-Satellite Service (EESS)

Earth exploration- satellites used for weather-related purposes are known as meteorological-satellites (MetSats). Earth exploration-satellite systems are used to gather data about the Earth and its natural phenomena. These satellites use active and/or passive sensors onboard the spacecraft to obtain data on the Earth's land, sea, and atmosphere to study and monitor the Earth's climate and environment, amongst many other related scientific applications. MetSats can operate within the Earth exploration-satellite service or their own more specialized service known as the meteorological-satellite service.

It should be noted that while "Earth exploration-satellites" is the terminology used in the ITU, the open literature will often refer to such satellites as "remote sensing satellites" or "Earth observation satellites". These terms are used interchangeably when discussing such Earth science applications.

e) Meteorological Satellite Service (MetSat)

The meteorological satellite service (MetSat) is defined as an earth exploration-satellite service for meteorological purposes. It allows the radiocommunication operation between earth stations and one or more space stations, which may include links between space stations, with links to provide:

(i) information relating to the characteristics of the Earth and its natural phenomena, including data relating to the state of the environment, obtained from active or passive sensors on Earth satellites;
(ii) information collected from airborne or Earth-based platforms;
(iii) information distributed to earth stations;
(iv) feeder links necessary for the operation of MetSat satellites and its applications.

MetSat system commonly collects a variety of data with visible and infrared imagers and with passive and active sensing instruments also using microwave frequencies allocated to that purpose. Meteorological satellites, geostationary and non-geostationary, also carry Data

Collection Systems (DCS), namely Data Collection Platforms (DCPs) on geostationary orbit (GSO) satellites and systems such as Argos on non-geostationary orbit (non-GSO) satellites.

The raw data gathered by the instruments on-board geostationary meteorological satellites are permanently transmitted to a primary ground station of the operating agency, processed, and distributed to various national meteorological centres, official archives, and other users.

f) Radiodetermination-satellite service

A radiocommunication service for radiodetermination involves the use of one or more space stations. This service may also include feeder links necessary for its operation.

g) Radionavigation-satellite service (RNSS)

Radionavigation-satellite service (RNSS) is a radiodetermination-satellite service used for the purpose of radionavigation. The ITU RR recognises a special status of radionavigation services providing that the safety aspects of radionavigation and other safety services require special measures to ensure their freedom from harmful interference. Member states should take all practicable and necessary steps to ensure that the operation of electrical apparatus or installations of any kind, including power and telecommunication distribution networks, does not cause harmful interference to a radiocommunication service and, in particular, to a radionavigation or any other safety service operating in accordance with the provisions of the RR.

The Radionavigation Satellite Service (RNSS) is part of the critical global infrastructure and probably the most active satellite service today, creating a big professional and public interest. RNSS receivers are used today for various applications, including safety-of-life, critical navigation on land, at sea, and in the air.

4.2 Role of satellite in providing broadband services – Considerations for policy objectives

Africa region encompasses enormous social, demographic, and geographic diversity, which challenges for the universal introduction of state-of-the-art broadband access. In this case, telecommunications satellites can successfully complement other technologies, especially in rural areas and underserved communities. This section explores the advantages of satellite broadband in certain scenarios to develop optimized telecommunications policies, strategies, and technical concepts for universal broadband access.

Considering the wide range of services offered to private and commercial consumers today, defining broadband simply as fast transmission speed is no longer adequate. Data transmission speed is not the only objective. Potential users are also interested in the services that any given broadband system can support. Service areas such as telemedicine, remote education, e-commerce, entertainment and TV streaming, fast videoconferencing, and a whole range of commercial and government-related services require faster speeds, higher data volumes, and improved service reliability.

Hence, in addition to transmission speed, the United Nations (UN) Broadband Commission added the following two additional requirements to the definition of broadband[6]:

6 See The State of Broadband 2014: broadband for all, report by the UN Broadband Commission

(a) A service that is always on (in contrast, for example, to switched and/or dial-up connections, which are temporary);
(b) The capability to provide multiple services simultaneously.

In addition, the growing need for access to truly global broadband connectivity, regardless of location should be addressed. Maritime and aeronautical ESIM, in addition to passenger connectivity, can allow increased efficiency of ships and airplanes by automating data processes and digitalizing operations.

This market has historically been partially served by systems operating in the mobile-satellite service, but these systems are mostly operating in L-Band and S-Band with limited capacity available. The rapid growth in demand for ubiquitous broadband applications can be met by allowing ESIM to communicate with space stations of the fixed-satellite service operating in higher frequency bands such as Ku or Ka-Band.

The main transmission technologies for broadband services are: (i) fiber optic cables, (ii) telecommunications satellites, and (iii) terrestrial microwave systems, such as cellular phone systems and broadband wireless access technology. Each of these technologies has strengths and limitations. They are not mutually exclusive and no technology will achieve universal broadband coverage by itself. Depending on the specific requirements of a given deployment, any combination of these technologies can lead to the optimum technical and financial solution.

Cable is the preferred medium in densely populated areas because of its superior transmission capacity and cost effectiveness in these cases. However, in rural settings, the cable is not cost-effective, and satellite broadband is the preferred medium. Unlike other technologies, satellite broadband connections can be set up immediately without a large investment in terrestrial infrastructure. Users only need a satellite antenna and a modem to obtain broadband access. Also, the advantage of telecommunications satellites over cable systems is that satellites generally represent point-to-multipoint systems. They do not end at a single, specific point; rather, they can reach all geographic targets within a given footprint. Consequently, establishing satellite coverage over a region instantly establishes the possibility of linking many customers to the broadband and Internet backbone network.

The use of satellite broadband technology offers the following advantages:
(a) Generic multi-point capability;
(b) Distance-independent capital expenditures (CAPEX);
(c) Fast implementation;
(d) High service reliability;
(e) Low risk of accidental or deliberate interruption. Typical interruptions of terrestrial links, like cables, include accidental damage during underground construction, natural disasters, vandalism and sabotage.

The main disadvantages of conventional satellite technology compared to fiber optic cables is latency, and usable bandwidth (and consequently limited transmission speed). However, the satellite communications sector is going through several major innovation trends. Non-geostationary (NGSO) constellations are being deployed with MEO and LEO systems. These state-of-the-art systems are capable of providing unprecedented amount of capacity, including for very high-throughput (Gpbs links) and low-latency applications. NGSO systems have been optimized to serve the fast-growing broadband connectivity requirements of fixed and mobile network operators, aeronautical and maritime users, enterprise customers and governments.

Therefore, satellite systems can play a vital role in overcoming isolation due to the absence or limited extend of terrestrial infrastructure, by providing broadband ubiquitous connectivity on the move (ships, aircraft, vehicles) and to unserved and/or underserved regions.

4.3 Satellite services and applications

The satellite communications industry supports a wide range of customers whose varying use cases and deployment locations place exacting requirements that must be fulfilled. There are several kinds of satellites, in many shapes and sizes operating in different altitudes, tailored to meet specific needs such as telephony, data and multimedia transmission, business services, mobile communications, cellular network services, cable restoration services, remote sensing, delivery of broadcast services, media links, distress and safety at sea, broadband communications (in the air, at sea, on land), weather forecasting, navigation, reconnaissance missions, other industry specific applications and military purposes, new emerging applications and services such as for in-flight connectivity and the connected car. Satellites also provide an 'invisible safety net', upon which most of today's communications services rely for a global and secure backbone.

This section describes some of the available satellite use cases noting that the selection of optimum network architecture is critical to the successful and cost-effective implementation and operation of a satellite-based solutions.

a) Direct-to-End-User satellite broadband systems

In this network architecture, end-users have direct access to broadband Internet data provided via satellite. The gateway station is typically located near an urban centre with access to broadband facilities via fibre optic cable, including the Internet backbone network. End-users access the satellite signals directly, using very small aperture antennas and a satellite modem box in their homes or offices.

b) Satellite links as feeders to remote hubs

A combination of satellite technology and terrestrial microwave systems can be used to expand existing broadband networks in a technically efficient and cost-effective manner. In this concept, the satellite link can bridge any sizable community and the Internet broadband backbone. Microwave links to user premises or cable can establish local and last-mile connections in cases where the proximity of end-users to the local hub station warrants the cost of implementing fibre optic systems.

c) Data transmissions and business services

Private dedicated networks are currently major actors in the field of satellite data communications. The large scale development of satellite data communications, and, more generally, the convergence of the technologies of telecommunications and data processing and explosive development of the Internet, has allowed for the provision of business services. The following are examples of use cases:

(i) Media links and resilient connections: providing high capacity and resilient network links for industries (media, banking, lotteries, etc.) with distributed sites and bespoke security requirements.
(ii) Offshore energy: customer platforms located at sea, and not connected by seabed submarine cables.
(iii) Onshore energy: even when within reach of terrestrial systems, there is a need for resilient communications to allow managed shutdowns and remote control of facilities.

d) Very small aperture terminals (VSAT) solutions

VSAT is a popular term for designating very small, low-cost earth stations directly connected to the users. The most important applications of VSAT systems are in the form of private, closed user-group communication networks. The remote VSAT is directly installed on the premises of each remote user. Most VSAT networks operate with a central, larger, earth station ("the hub"), which distributes, controls and/or exchanges the information towards or between the remote VSAT. The range of VSAT applications is continuously expanding. Some examples are listed below:

i) One-way applications; Data distribution: Distribution of information, in the form of digital signals, from the hub to all subscribers (data broadcasting), to a limited number or subscribers in the network (data narrowcasting), e.g. for news, press releases, weather information bulletins from meteorological agencies to airports, announcement displays, computer program remote loading, audio distribution, video distribution, etc.

ii) One-way applications; Data collection: This architecture is used in the reverse direction, i.e. from VSAT towards the hub, for data collection purposes. Some applications are meteorological or environmental monitoring, pipeline, electric power network monitoring from unattended stations, etc. However, in most cases, such an operation needs some form of control and management from the central facility, which means that the VSAT should implement a receive function and not really be considered one-way.

iii) Two-way applications: VSAT networks are commonly used for diverse types of two-way data transmission, particularly for all types of interactive or inquiry/response data interchange and file transfer. Some examples of applications are: financial, banking, insurance (for file transactions and bulk transfers from local agencies toward the central processing facility), point-of-sale operations, credit card verification, management and technical assistance, reservation operations for airlines, travel operators and hotels, electronic mail services, etc.

e) TV, video and audio distribution

The distribution of television is a major service provided by the FSS and BSS. This ranges from:

(i) conventional television programming (entertainment, news, special events);
(ii) distribution of radio programmes (e.g. high fidelity audio and stereo);
(iii) educational/instructional programmes to teleconferencing applications, where audio and visual information is required to enhance effective communication;
(iv) distribution of TV programming or video information directly to the general public for individual reception (DTH applications), and between locations for re-broadcasting over terrestrial stations or for redistribution through cable networks (CATV), etc.;
(v) processing of satellite news gathering (SNG).

The availability of satellite links for TV distribution eliminates the distance/cost relationship associated with the terrestrial delivery of signals. In some instances, satellites provide the only available, or cost-effective means of signal distribution.

f) Digital television broadcasting

The availability of multimedia applications and communications using digital video technology, at low cost, facilitated the introduction of satellite multi-programme television services ("bouquets"). Digital television offers new services to the users in addition to conventional TV services. The systems operating with digital television (DVB, etc.) use a similar network architecture and source coding (MPEG-2). Some of them are flexible systems that are designed to cope with a range of satellite transponder bandwidths (26 to 72 MHz for the DVB-S system).

g) Satellite news gathering

Satellite news gathering (SNG) allows organizations and broadcasters to pick up events, whenever they happen and to deliver their picture and sound to the studios for editing and/or broadcasting. SNG systems range widely in capacity, weight and cost depending on the characteristics of the service they must provide. Immediacy, availability of infrastructure and quality are elements to be considered when determining which kind of SNG system to be used. They can be classified into two groups:

(i) SNG Trucks and Trailers: They are transportable earth stations mounted on a truck, trailer or van. They can deploy antennas in the range of 3 m (C band) and 2 m (Ku band);

(ii) SNG Fly Away: These are free standing transportable stations that can be shipped by air on regular flights. The antennas are usually foldable for easy transport and range from 1.2 m to 1.8 m (Ku band).

Communication in the FSS is ideally suited for establishing temporary links for satellite news gathering (SNG) and locations hosting special events that require exceptional communications facilities and a high instantaneous traffic capacity, e.g. international meetings, sporting events, etc.

h) Emergency communication services

During times of natural disaster, civil disturbance or serious accidents, normal terrestrial-based communication facilities are frequently overloaded, temporarily disrupted or destroyed. The availability of satellite communication facilities ensures that one element of the system remains isolated from terrestrial-based disruptions, i.e. the satellite or space segment. Through the deployment of small transportable earth terminals to the emergency location, communications can be established and the process of restoring the necessary services (communications, aid, food/water distribution, etc.) assisted.

i) Cable restoration services

Traditional cable restoration service is designed for restoring services via satellite during outages of telecommunication cables. The cable restoration services are provided on an occasional use and on a longer-term basis when there is a planned outage.

j) Earth stations in motion (ESIMs)

Earth stations in motion (ESIM) are earth stations placed on moving platforms that communicate with the geostationary-satellite orbit (GSO) or non-GSO systems operating in the fixed-satellite service (FSS), for instance in some of Ku and Ka frequency bands The typical data rates currently provided by terminals operating in networks serving ESIM are around 100 Mbit/s - much higher, or faster, than those provided historically by mobile-satellite service (MSS), which use relatively low frequency bands (e.g. the 1.5 GHz, 1.6 GHz, 2.1 GHz, and 2.4 GHz bands).

The ESIM terminals have small directional antennas and may be mounted on aircraft, ships or land vehicles or transportable devices used in motion or at temporary halts. There are currently three types of ESIM: ESIM on aircraft (aeronautical ESIM), ESIM on ships (maritime ESIM) and ESIM on land vehicles (land ESIM).

Maritime ESIM (M-ESIM) can provide broadband communications for managing ship operations, such as for transmission of engine diagnostics, and for access to the corporate network and for crew and passengers communications. The strong growth of maritime vessels with a broadband connection by satellite has created greater demand for spectrum for ESIM[7]. Crews of fishing

[7] Report ITU-R S.2464-0

and merchant ships can also benefit from improved access to service such as remote medical services and communication with their family.

Land ESIM (L-ESIM) meets land vehicles' broadband connectivity requirements including trains, coaches, vans, trucks and motorhomes. They can provide connectivity throughout countries and are particularly useful in areas without coverage by terrestrial networks. Land ESIM can provide broadband communication services to individual subscribers and to a wide range of users such as emergency services, public transportation (bus, train), hydrocarbon exploration, mining and construction. L-ESIM use small, lightweight, high-efficiency antennas such as parabolic, low-profile, or phased-arrays.

When aircraft cross the oceans, they are out of reach of terrestrial networks. An aeronautical ESIM (A-ESIM) system can resolve this challenge by providing continuous broadband connectivity for passengers and crew on commercial, business, and general aviation flights for such crafts over vast oceans.

For some ESIM users, especially those on board ships and aircraft, the desired geographic coverage may virtually be the entire Earth, since the ships operate on almost any sea and aircraft operate over almost any location over land and sea. This leads to a need for ESIM systems to provide continuous and consistent service with very wide or global geographic coverage. Consequently, ESIM on aircraft and ships may operate in national airspace and waters, or operate in international airspace and international waters. ESIM applications also exist for government users and aid organizations with broadband communication needs for land vehicles, ships and aircraft. For example, Land ESIM can be vital when information and communication infrastructure is down in natural disasters.

k) Global mobile personal communications systems by satellite (GMPCS)

GMPCS is a personal communication system providing transnational, regional or global coverage from a constellation of satellites accessible with small and easily transportable terminals. Whether the GMPCS satellite systems are geostationary or non-geostationary, fixed or mobile, broadband or narrowband, global or regional, they can provide telecommunication services directly to end users. GMPCS services include two-way voice, fax, messaging, data and broadband multimedia.

GMPCS networks varied in the make-up of their components, and in the type of service provided, but generally shared a number of characteristics, with satellite constellations providing direct links to users, and interconnecting with existing terrestrial networks.

l) Earth science applications

The data from Earth exploration-satellites enable a diverse set of scientific applications which provide countless societal benefits to all humans. As a rule, the scientific data and the associated data products are shared with all nations, regardless of which nation built, launched, or operated the satellite. However, there are a growing number of commercial remote sensing missions that sell their data; however, during a disaster situation, they share their data with disaster response agencies.

Satellites provide the most cost-efficient way to monitor the entire Earth's land, sea, and air environment. Unique capabilities of Earth exploration-satellites include observing wide-areas non-intrusively and uniformly (by using the same instrument) with the ability to rapidly target any point on Earth, including remote and inhospitable places, and to continue with a series of observations over a long period of time.

Some of the benefits that EESS brings to the community are as follows:

1. Societal benefits in both the non-profit and commercial sectors which include inputs to weather forecasters, data products useful in alleviating the effects of natural and manmade disasters:
    (i) Coastal and maritime hazards (sea and lake ice, tsunamis and rogue (killer) waves);
    (ii) Atmospheric hazards (droughts, dust storms, extreme weather – cyclones, hurricanes, typhoons, etc., floods);
    (iii) Surface hazards (earthquakes, landslides, subsidence and avalanches, volcanoes, wildfires);
    (iv) Pollution detection and monitoring (atmospheric pollution, oceanic pollution, land pollution);
2. Benefits related to natural systems encompass biology (i.e., ecosystems and biodiversity), geology, hydrology, and meteorology, including climate change;
3. Benefits related to human endeavours encompass the areas where humanity makes use of the Earth: agriculture (raising food), cartography (mapping the Earth), communications[8], energy and resource exploration, and transportation;
4. Benefits related to humanity encompass elements of human history (archaeology), the human condition (health), and human distribution (population and urban studies).

m) Space research applications

Space research service systems enable a diverse set of scientific disciplines and technology programmes benefiting mankind. Scientific disciplines provide information regarding the solar system, the nature and structure of the universe, and the origin and fate of matter. They include: solar-terrestrial physics, space physics, planetary systems research.

Solar-terrestrial interaction programmes focus on studies of the Sun, solar activities, and its influence on the Earth. Studies are carried out using a network of scientific spacecraft located in many regions of interplanetary space, usually between the Sun and the Earth, and equipped with an array of scientific instruments to sense and detect solar electromagnetic radiation and plasma particles and waves.

Space physics research is dedicated to studying the fundamental laws of physics in our solar system and providing us with the information used to improve the design of a spacecraft, its instrumentation, and its navigational capabilities.

Planets, planets' moons, asteroids, and comets are studied to gain knowledge of the origin and evolution of our solar system. Spacecraft, probes, and planetary landers provide extensive information on the planets and their moons in our solar system.

n) Global Navigation Satellite System (GNSS)[9,10]

Global Navigation Satellite System (GNSS) is the infrastructure that allows users with a compatible device to determine their position, velocity and time by processing signals from satellites. GNSS signals are provided by a variety of satellite positioning systems, including global and regional constellations and satellite-based augmentation systems:

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[8] Satellite data are used by communications engineers to plan the location of new cell phone towers by using satellite-derived land change maps to show where the population is growing, and digital elevation models (DEM) to provide lines-of-sight.

[9] RNSS and the ITU Radio Regulations (https://insidegnss.com/rnss-and-the-itu-radio-regulations), Yvon Henri, January 2018 (,

[10] GNSS market report, Issue 6, 2019, European GNSS Agency (GSA)
https://www.gsa.europa.eu/system/files/reports/market_report_issue_6_v2.pdf

(i) Global constellations**:** GPS (USA), GLONASS (Russian Federation), Galileo (European Union), BeiDou (China).
(ii) Regional constellations**:** QZSS (Japan), IRNSS (India), and BeiDou regional component (China).
(iii) Satellite-based augmentation systems (SBAS)**:** WAAS (USA), EGNOS (EU), MSAS (Japan), GAGAN (India), SDCM (Russian Federation) and SNAS (China).

GNSS applications are integrated deeply into our daily lives and play a growing role within all areas of today's mobile society. Indeed, almost all critical infrastructures worldwide rely on satellite navigation applications, from our cell phones with more than one billion users to precise agriculture for better productivity, efficiency and environment protection, from power grid systems, banking operations, transportation systems (including hazardous or extremely valuable goods tracking), search and rescue operations, fleet and cargo management, and from the aviation to the latest location-based services.

GNSS-enabled consumer solutions comprise a multitude of applications, tailor-made to satisfy different usage conditions and needs. These applications are supported by several categories of connected devices: mainly smartphones and tablets, but also specific equipment such as personal tracking devices, wearables, digital cameras and portable computers. Nowadays, with a combination of technologies such as GNSS, 5G, and IoT, any physical device can become a connected device, enabling new applications to facilitate the end user's day-to-day life. On top of this, Artificial Intelligence (AI) provides an additional layer to this connectivity enabling greater capabilities and sophistication to these devices.

GNSS technology is used for many applications, covering the mass market, professional and safety-critical applications.

The following are some examples of GNSS applications for critical infrastructures :

a) Telecommunication applications: Telecom operators require accurate time and a consistent frequency at distant points of their networks to meet increasingly demanding broadband requirements, for instance:
    (i) Digital Cellular Network (DCN)**:** GNSS provides consistent frequency and time alignment between all base stations within the network.
    (ii) Public Switched Telephone Network (PSTN)**:** GNSS is usually a back-up to atomic clocks to manage time slots.
    (iii) Professional Mobile Radio (PMR)**:** GNSS is used for to synchronise time slots and handovers between base stations.
    (iv) Satellite Communication (SATCOM)**:** GNSS is typically used in satellite control stations and telecommunications gateways, mostly for frequency control.
    (v) Small cells**:** GNSS is used to provide frequency and phase alignment in small cell networks.
b) Energy applications: Energy operators require an accurate time source to monitor the energy flow of their networks.
c) Phasor Measurement Units (PMU): GNSS is used to provide a precise timing marker at nodal points of the networks to ensure monitoring and protection against failure.
d) Finance applications: Financial institutions are legally required to trace operations within a consistent and accurate time scale.
e) Bank applications: GNSS is used for time-stamping functions to log events in a chronological manner, and therefore be able to establish causal links.

f) Stock Exchanges: GNSS is used by stock exchange servers to apply time-stamps to the trades they execute and to the quotes they establish.

o) Next Generation Access Technologies (NGAT)

Next Generation Access Technologies (NGAT) is envisioned to be highly-advanced, ubiquitous, seamlessly integrated heterogeneous "network of networks" or "system of systems" conceived from the ground up and providing a wide range of services and applications. Rather than using the term NGAT, the 3rd Generation Partnership Project (3GPP) is standardising technical specifications related to satellites in 5G systems known as Non-Terrestrial Networks (NTN) which are defined as networks, or segments of networks, using an airborne or space-borne vehicle to embark a transmission equipment relay node or base station. Examples of usage scenarios are communications on the move, enhanced Mobile Broadband (eMBB), massive Machine Type Communications (mMTC) and Ultra-reliable and low-latency communications (URLLC).

Next generation satellites are currently operating, in the process of being deployed or being planned and their integration into NGAT is under development and being approved by the industry, academia and open standards development organizations. Significant advances in data rate and density, latency, virtualization, energy efficiency, security, resilience and other key performance indicators (KPIs) will enable new use cases and business models. The different scenarios have varying requirements for coverage, latency and bandwidth. Multiple technology solutions are expected to play various roles in addressing the vastly different demands of these scenarios.

Table 3 illustrates four main use cases identified for satellite-based solutions into NGAT: trunking and head-end feed, backhauling and multicasting tower feed, communications on the move and hybrid multiplay. These cases are characterised by their scale: from a few hundred or thousand sites for the trunking and head-end feed use case to potentially millions in the case of communications on the move and hybrid multiplay use cases, as well as the fixed or mobility abilities of the platform connected via satellite.

Table 3: Example of satellite-based use cases

Use cases	Examples	Number of sites
Trunking and head-end feed	Service to remote areas; special events	Limited to unserved areas in a carrier's network
Backhauling and Multicasting tower feed	Surge capacity to overloaded cells, plus content delivery (e.g. video) to local caches; efficient broadcast service to end-users	Thousands
Communications on move	In-Flight connectivity for aircraft; connectivity directly to land vehicles; broadband to ships and trains	Potentially millions
Hybrid multiplay	Video and broadband connectivity directly to a home or multi-tenant building with NGAT distribution in building	Potentially millions

4.4 Technology aspects

This section will address the main components of a communication satellite system, satellite telecommunication's basic characteristics, and the features of some specific satellite applications (MSS, EESS, GNSS, space research systems).

4.4.1 Main components of a communication satellite system

The main components of a communication satellite system comprise the space segment and the earth segment.

4.4.1.1 The space segment

The space segment of a communication-satellite system consists of the satellites and the ground facilities providing the tracking, telemetry and telecommand (TT&C) functions and logistics support for the satellites.

a) The satellite

The satellite is the core of the network and performs all the communication function in the sky using active elements. It is composed of an assembly of various telecommunication subsystems and antennas. The satellite is also fitted with service equipment to provide several functions: bus structure, power supply, altitude control, orbit control, thermal control, telemetry, telecommand and ranging.

The telecommunication equipment is composed of transponders. There are different kinds of transponders: transparent transponders and on-board processing (OBP) transponders. Transparent transponders perform the same functions as radio-relay repeaters; they receive transmissions from the Earth and retransmit them to the Earth after amplification and frequency translation. The antennas associated with these transponders are specially designed to provide coverage for the parts of the Earth within the satellite network.

OBP transponders mean they can perform one or more of the three following functions: switching (in frequency and/or space, and/or time), regeneration and baseband processing.

b) Tracking, telemetry and telecommand

These subsystems are used for carrying out from the ground the following operations for the logistics support of the satellites:

(i) tracking the position of the satellite (angular position, distance) and determining altitude while it is being placed in orbit and on station and then throughout its life to supervise the operation and transmit correction instructions;
(ii) telemetering of various on-board functions;
(iii) command of various on-board functions;
(iv) supervision of telecommunication functions, especially of the carriers in the various transponders. The latter operation is used to check the network's functioning and to ensure that emissions from different earth stations comply with specifications (power, frequency, etc.).

These operations are performed using a special earth station and are usually centralized at a network control centre. This centre and other specialized stations also control synchronization, demand assignment, etc.

4.4.1.2 The earth segment

Stations at both ends of the signal paths to and from the satellite to transmit signals to terrestrial communications systems and end-users, known as earth stations, ground stations, or simply terminals, generally consist of the following six main items:

1. the transmitting and receiving antenna, with a diameter ranging from 50 cm (or even less in some projected new systems, for example the diameter of A-ESIM can be 30 cm) to more than 16 m. Large antennas are usually equipped with an automatic tracking device which keeps them constantly pointed to the satellite; medium-sized antennas may have simple tracking devices (e.g. step-track), while small antennas generally have

no tracking device and although normally fixed, can usually be pointed manually; Antennas of earth station in motion (ESIM) terminals, have an antenna control unit (ACU) in order to maintain an accurate tracking of communicating with satellites.

2. the receiver system, with a sensitive, low noise amplifier front-end having a noise temperature ranging from about 30 K, or even less, to several hundred K;
3. the transmitter, with power ranging from a few watts to several kilowatts, depending on the type of signals to be transmitted and the traffic;
4. the modulation, demodulation and frequency translation units;
5. the signal processing units;
6. the interface units for interconnecting with terrestrial networks (with terrestrial equipment or directly with user equipment and/or terminal). This equipment includes coders, decoders, satellite modems, and others

The size of this equipment varies considerably according to the station capacity. Large earth stations capable of handling high traffic throughput are gateway stations. Large earth stations connect to the national or global Internet backbone network. In contrast, smaller stations serve as local hubs, using satellite connections as feeder links to and from a large gateway station.

The choice of equipment to be used is subject to many design parameters - operating frequencies, physical resilience, the need for intrinsically safe operation, cost performance factors etc. These can be replaced and upgraded, but since satellite services are often deployed in remote locations this is, where possible, avoided during the life cycle of the equipment.

A gateway typically serves a large number of user terminals located in one or several satellite beams. The combination of the feeder uplink and the user downlink provides outroute connectivity (called forward link) between the gateway and an user terminal. Conversely, the return link (user uplink and feeder downlink) allows inroute connectivity between the ground elements.

4.4.2 Basic characteristics of satellite communications

The most specific characteristics of satellite communications are described below.

a) Orbits for satellite systems

The main orbits for placing the satellites into the Earth's orbits are low-Earth orbit (LEO), medium-Earth orbit (MEO) and Geostationary Earth orbit (GEO). Each orbit has specific order of the orbits as well as special characteristics as explained below.

Geostationary earth orbit (GEO) lies about 36,000 km above the equator. Satellites located on this orbit, called geostationary satellites (GSO), offer the obvious advantage that the sending and receiving stations on the ground do not need to track them. They are at a virtual standstill. Limitations in the radiofrequency spectrum and available orbital positions on the GSO orbit limit data throughput capacity and the number of subscribers served.

Non-GSO systems using low-Earth orbit (LEO) satellites are designed to operate at altitudes between 400 and 2 000 km above the Earth. Some others use medium-Earth orbit (MEO) satellites orbiting at an altitude between 7 000 and 12 000 km above the Earth. These satellites are no longer seen as fixed by an earth observer, a given network needs multiple satellites, the number of satellites being an inverse function of their altitude. Since non-GSO satellites move across the sky during their orbit around the Earth, non-GSO operators must deploy a fleet of several satellites, generally called "constellations", to provide continuous service from these altitudes. Some advantages of the non-GSO systems are: lower propagation delay resulting in

lower latency applications which is desirable, especially for telephony and realtime services, higher elevation angle, a very useful feature for operation in urban areas unprecedented amounts of capacity revolutionizing available bitrates and costs, etc. But lower orbits imply a (much) greater number of satellites in the system and can make it more difficult to get compatibility with other GSO services. Also LEO and MEO systems imply complex operation and network management, especially when a global capability is aimed at. However, the satellites should be smaller and their launching cheaper.

b) Footprints, beams and coverage

Footprints, beams, and coverage are key technical and business characteristics of any telecommunications satellite.

The footprint is the area on the Earth's surface where the signal strength is functional for the successful communications. The signal level can be seen via EIRP contours of equal signal strengths as they cover the Earth's surface. It should be noted that different satellite transponders even within the same satellite may produce varying footprints and thus sets of received signal strength on Earth's surface.

Satellite antennas form beams that cover a certain geographical service area depending on the antenna pattern characteristics. The types of beams used, mainly distinguished by their shape and size, are the following:

(i) Global beams (with the footprint of the whole earth visible from the satellite);
(ii) Hemi beams (geographically roughly covering a hemisphere);
(iii) Zone beams (roughly half the size of hemi beams);
(iv) Spot beams (covering a country or several neighbouring countries);
(v) Pencil beams (used by the new high throughput satellites).

A smaller beam with a tighter footprint offers higher-power levels on the ground. This advantage reduces the size and cost of earth station antennas, increases data throughput, and improves service quality. Moreover, small beams pointed at different places on earth allow reuse of the same frequency segment, thus increasing the available spectrum resource. Spot beams are useful to cover geographically isolated areas like big islands and important parts of remote areas. In novel satellite systems independent agile beams each with steering and forming capabilities can be generated where and when required based on traffic demand.

Coverage defines the area from which stations can transmit to the satellite and receive signals from it. In the case of a GSO satellite, the points to be served must be situated, not only in the region of the Earth, visible from the satellite, but also within the geographical areas covered by the beams of the satellite antennas: these areas are called the coverage areas of the communication satellite system. The satellite antenna beams can be "shaped" to form specific coverage areas that are tailored to the region to serve.

Since the satellite is located at a great distance from the Earth (35 786 km vertically above the so-called "sub-satellite" point), the very high free space propagation loss (e.g. about 200 dB at 6 GHz) should be offset at the earth stations by:

(i) high-gain (i.e. large diameter, high performance) antenna with low susceptibility to noise and interference (the antenna is used for both reception and transmission);
(ii) high-sensitivity receiver (i.e. with a very low internal noise);
(iii) powerful transmitter.

In the case of NGSO satellites, satellites will be at a lower altitude compared to GSO satellites. Consequently the uplink transmitting power and the earth station antenna gain would be reduced due to a lower path loss. Moreover, since in most cases there will be several non-GSO space stations visible by the earth stations, the minimum elevation angle of operation would be typically higher than for an earth station operating with a GSO space station. Higher elevation angles have the potential for reducing interference to terrestrial systems.

From the point of view of coverage the satellite systems may be divided into three broad categories:

i) Global coverage systems*:* Global coverage systems are satellite communications systems designed to operate all over the world. They primarily carry international traffic, although they can also be used to provide regional and domestic services. Examples of global coverage system operator include Intelsat, SES, Inmarsat, Telesat.
ii) Regional and national systems **:** A regional communication satellite system provides international communication between a group of countries in geographical proximity or constitute an administrative or cultural community. Examples of regional satellite systems include the ARABSAT (League of Arab States), EUTELSAT (European Telecommunications Satellite Organization), ASIASAT, YAHYA Sat, Thuraya, Interspoutnik.
iii) National systems : A national communication satellite system that provides telecommunications within a single country. This type of system is used by many countries where satellite systems are economically competitive with terrestrial systems. Examples of national satellite systems include NIGSAT.

c) Multiple access

Multiple access is the ability for several earth stations to transmit their respective carriers simultaneously to the same satellite transponder. This feature allows any earth station located in the corresponding coverage area to receive carriers originated by several earth stations through a single satellite transponder. Conversely, a carrier transmitted by one station into a given transponder can be receive by any earth station located in the corresponding coverage area. This enables a transmitting earth station to group several carriers into a single-destination carrier. The most commonly used types of multiple access are frequency division multiple access (FDMA) and time division multiple access (TDMA). There are other types of multiple access, such as spread spectrum multiple access (SSMA), particularly, code division multiple access (CDMA). Multiple access can also result from various combinations of FDMA and/or TDMA and/or CDMA and can be performed or changed in the satellite by on-board processing (OBP).
In any case, multiple access processes can also be classified into two categories, referring to their assignment mode:

i) pre-assigned multiple access (PAMA), in which the various channels are permanently allocated to the users;
ii) demand assigned multiple access (DAMA), in which a transmission channel is assigned only for the period of a call (telephone call, data packet, etc.). The great majority of satellite telecommunication system use DAMA, but in the case of sporadic traffic varying in time, the concentration properties of the DAMA process considerably enhance the efficiency of the communication satellite system.

d) Frequency reuse and bandwidth utilization

It has become current practice to reuse the available bandwidth several times, thus considerably increasing the total effective bandwidth. This frequency reuse can be affected by two mutually compatible procedures:

i) frequency reuse by beam separation: the same frequency bands are transmitted by the satellite antennas using different transponders by means of directional and space-separated radiated beams;
ii) frequency reuse by polarization discrimination (also known as dual polarization frequency reuse): the same frequency bands are transmitted by the satellite antennas through different transponders using two orthogonal polarizations of the radio-frequency wave.

The total effective bandwidths available could be further increased by increased reuse of frequencies

e) Propagation delay

An important feature of satellite links is the propagation delay. In the case of GSO systems, to the geostationary satellite's distance from the Earth, the propagation time between two stations via the satellite can reach approximately 275 ms. Some telecommunication services are not affected by propagation delay, even in the case of multiple hops. Examples of these are television or broadcasting services and certain types of data services.
Satellite propagation delay in all media creates constraints in signalling and routing procedures for certain data transmission networks, especially in packet-switched transmission systems, if correct compensation measures are not adhered to.

Delays are greatly reduced in the non-GSO systems, in particular those implementing low-Earth orbits (LEOs). For example, the propagation time between two earth stations via satellite orbiting at 1 000 km is generally less than 10 ms.

f) Flexibility and availability

Satellite telecommunications have other particularly interesting operational characteristics:
(i) round-the-clock availability for 365 days a year with service continuity generally exceeding 99.99%;
(ii) rapid installation and bringing into service of earth stations, irrespective of the distance and accessibility of the area to be served;
(iii) great flexibility for changes of services and traffic plans and for all changes in the Earth segment (introduction of new stations, increased traffic capacity, etc.).

Implementing the ground segment of a satellite network is relatively simple because the number of physical installations is minimal. To install a satellite network, a planner need only consider the sites where service is required. In comparison, installing an optical fibre cable system or microwave links requires first that the right-of-way be secured from organizations such as governments, utility companies, and railroads.

g) Key innovation in satellite systems

Satellite technology has seen enormous innovation in recent years. Many elements of a satellite system can be optimized to suit specific client requirements and operating locations in the context of the latest generation of satellite systems. The overall performance of satellite systems depends on many factors – some determined by user requirements (terminals, operational customer locations) and some by the system overall design (satellite antenna configuration, spacecraft power, frequencies, etc.).

Numerous technological innovations have driven dramatic evolution in the satellite communications industry, such as:

(i) *Increasingly powerful satellites:* moving from just a few kilowatts of power in the early 2000s to greater than 20 kW at present. This has been made possible by using more efficient solar arrays (triple junction systems with efficiency close to 30% compared to about 12% for standard silicon ones), Li-ion batteries, mastering of thermal control, use of electric propulsion (plasma thrusters), etc.

(ii) *Improved payload technology:* multibeam antennas with large number of beams (up to a few 100 on a single satellite), light-weight shaped reflectors, more integration and processing power for on-board electronics, reduction in size and mass of RF components (e.g. Monolithic Microwave Integrated Circuits (MMICs)), increased efficiency of high power amplifiers, availability of Ka-band RF components, etc.

(iii) *Radio frequency link development:* better characterisation of propagation channels via improved channel models (including Ka-band and above); investigation and implementation of Fade Mitigation Techniques, etc.

(iv) *Enhanced digital communication techniques:* advanced digital modulations and more efficient channel coding techniques (Turbo-codes, Low-Density Parity-Check (LDPC), etc.), implementation of adaptive modulation and coding techniques (e.g. DVB-S2X standard), improvement of multiple access techniques, etc.

(v) *TCP acceleration techniques:* improved performance over satellite communications networks by utilising techniques such as TCP spoofing, window scaling, and alternative congestion avoidance mechanisms.

(vi) *Advances in satellite design, manufacturing and launch service capabilities:* They have enabled the design and future deployment of non-GSO fixed-satellite service (FSS) constellations. Constellations intend to cover the globe providing high-bandwidth connectivity, processing very high volumes of data with minimal delay. This could enable the fifth generation of mobile technologies (IMT-2020/5G) and the Internet of Things – a network of things to connect and share data – which in turn help build smart societies.

(vii) *Implementation of new technologies in the FSS at frequencies above 30 GHz:* The FSS systems based on the use of new technologies above 30 GHz and associated with both GSO and non-GSO satellite constellations are capable of providing high-capacity and low-cost means of communication even to the most isolated regions of the world.

(viii) *Ground terminals:* have also developed in parallel, but typically with a trend towards miniaturization and reduction in cost relative to performance characteristics. The advances in antenna and terminal technology have enabled the development of the usage of the 50/40 GHz frequency bands for both GSO FSS networks and non-GSO FSS systems.

4.4.3 Features of some specific satellite applications

This section describes features of some satellite applications/technologies including high throughput satellites (HTS), MSS systems, EESS satellites, Space research systems, and GNSS.

a) High Throughput Satellites

High throughput satellites (HTS) refer to a new concept for geostationary satellites, specifically for broadband services, which has been developed to overcome the capacity limitations of the frequency spectrum. These satellites carry antennas that generate a large number of very small, pointed beams (pencil beams) that are to some extent steerable. HTS systems represent a new generation of satellite communications systems, capable of delivering vast throughput compared to conventional fixed, broadcast and mobile satellite services (FSS, BSS and MSS). The one fundamental difference in the architecture of an HTS system is the use of multiple spot beams to cover the desired service area, rather than wide beams, which bring a two-fold benefit:

i) *Higher transmit/receive gain:* because of its higher directivity and therefore higher gain, a narrower beam results in increased power (both transmitted and received), and therefore enables the use of smaller user terminals and permits the use of higher order modulations, thus achieving a higher rate of data transmission per unit of orbital spectrum.
ii) *Frequency reuse:* when multiple spot beams cover a desired service area, several beams can reuse the same frequency band and polarization, boosting the capacity of the satellite system for a given amount of frequency band allocated to the system.

Several HTS systems have been placed into orbit and already supply many Gbps of capacity. Typically the Ku-band and Ka-band are used. However, it is less relevant to use HTS satellite to broadcast television over wide areas, because it would imply several beams transmitting the same information to cover large countries.
High-Throughput Satellites (HTS) provide gigabit connectivity today and will deliver Terabit solutions tomorrow. The satellite will be part of the 5G ecosystem, bringing reach, resilience, security and other network efficiencies from a space-based infrastructure.

b) MSS systems

Whether designed to address maritime mobile, aeronautical mobile, or land mobile-satellite services, MSS systems all have certain common characteristics. Likewise, the satellites employed in these MSS systems can be found in constellations using the geostationary-satellite orbit (GSO), low Earth orbit (LEO), medium Earth orbit (MEO), elliptical orbit (with widely differing perigees and apogees); or even some combination of these types of orbital configurations.

However, irrespective of which orbital configuration is employed, the MSS systems differ from fixed-satellite service (FSS) systems in one key respect. Specifically, the FSS uses one pair of frequency bands; one band for uplink and one for downlink, to connect fixed points via the satellite links. The MSS system employs two pairs of links: one set known as MSS service links and the other set designated as MSS feeder links.

Quite often, the MSS networks often utilize any of several conventional FSS bands – generally bands higher in frequency than the service link allocations themselves – to operate their feeder links. Thus, in any MSS network, the service links connect the mobile earth station or terminal to the satellite; whereas, the feeder links are used to connect the land-based gateway or feeder link station to the satellite. It takes two pairs of links to complete the full MSS circuit; i.e., the forward link (link from gateway out to the mobile) comprises (one feeder link + one service link) pair of links and return link (link from the mobile back to the gateway) comprises (one service + one feeder link) pair of links.

c) EESS satellites

EESS satellites are frequently divided into two parts – the satellite bus and the payload. The satellite bus includes the physical structure of the satellite and all the systems needed to support the instruments carried on board. The instruments are called the payload and include sensors of one of two types, active or passive.

Active sensors are radar-like measuring instruments in the Earth exploration-satellite service which obtain information by transmitting radio waves and then receiving their reflected energy. Passive sensors are very sensitive receivers in the Earth exploration-satellite service which measure the electromagnetic energy emitted, absorbed or scattered by the Earth's surface or atmosphere. In practice, they are instruments that measure the natural noise floor.

In addition to the data collected by satellites, data may also be collected from airborne or ground-based platforms to supplement and calibrate the satellite data. This collected data must also be transmitted to other platforms or earth stations for additional processing and distribution.

d) Space research systems

The different types of space research systems used to support scientific and technological research in both the near-Earth and deep-space regions include:

(i) manned missions (such as human exploration, transportation of crew and personnel to scientific outposts, conducting experiments and research from locations in space);
(ii) unmanned missions (such as using robotic spacecraft for collection of physical samples, supplying or servicing research spacecraft, and using spacecraft for collection of sensing and observational data);
(iii) communication networks on the surface of the Earth; and,
(iv) and communication networks in geosynchronous orbit or beyond.

Space research missions targeted for objectives beyond 2×10^6 km from the Earth are referred to as 'deep-space' missions. Conversely, missions closer than 2×10^6 km are commonly referred to as near-Earth missions. Due to their unique requirements, special spectrum provisions have been made for deep-space systems to communicate over the large distances required successfully. Due to mass, volume and cost reasons the same spectrum and equipment are used in all phases of deep space missions.

The Global Observing System (GOS) is the primary source of technical information on the world's atmosphere. It is a hybrid system of complex methods, techniques and facilities to measure meteorological and environmental parameters. The environmental and meteorological space-based Global Observing System includes constellations of operational geostationary and non-geostationary (mostly polar orbiting and at low altitude) observation satellites. A list of current operational meteorological satellites and their parameters is available at: http://www.wmo.int/pages/prog/sat/satellitestatus.php.

e) GNSS

Depending on user needs, important GNSS User Requirements are:

(i) Availability: The percentage of time the user can compute the position, navigation or timing solution. Values vary greatly according to the specific application and services used, but typically range from 95-99.9%.
(ii) Accuracy: The difference between true and computed solution (position or time).
(iii) Continuity: Ability to provide the required performances during an operation without interruption once the operation has started.
(iv) Integrity: The measure of trust that can be placed in the correctness of the position or time estimate provided by the receiver.
(v) Time To First Fix (TTFF): A measure of a receiver's performance covering the time between activation and output of a position within the required accuracy bounds.
(vi) Robustness to spoofing and jamming: A qualitative rather than quantitative parameter that depends on the type of attack or interference the receiver can mitigate.
(vii) Authentication: The ability of the system to assure the users that they are utilising signals and/or data from a trustworthy source, thus protecting sensitive applications from spoofing threats.

Other parameters which do not directly relate to the GNSS performance are also important for GNSS-based technologies. Key requirements in this aspect comprise power consumption, resilience, connectivity, interoperability and traceability.

4.5 Spectrum aspects

The two major physical resources used by satellites are the following:

1. those parts of the frequency spectrum allocated to this service by international convention;
2. the orbital positions occupied by the satellites.

The spectrum allocated for satellite may be shared with a number of non-satellite radiocommunication services and systems. For a full description of the allocations of the radio spectrum, see the relevant Radio Regulations Articles. This section provides a brief overview of the principles governing spectrum allocation for satellites services and their main utilization.

ITU allocates global radio spectrum and satellite orbits, develops the technical standards that ensure networks and technologies interconnect, and strives to improve access to ICTs to underserved communities worldwide. The ITU Constitution (CS), Convention (CV) and the Radio Regulations (RR) contain the main principles and lay down the specific regulations governing the following major elements:

1. frequency spectrum allocations to different categories of radiocommunication services;
2. rights and obligations of Member administrations in obtaining access to the spectrum/orbit resources;
3. international recognition of these rights by recording frequency assignments and, as appropriate, orbital information for a space station on board a geostationary-satellite or space station(s) on board non-geostationary satellite(s), in the Master International Frequency Register (MIFR) or by their conformity, where appropriate, with a plan.

The ITU grants international recognition, a level of protection conditioned by the provisions of the RR and by procedures to detect and eliminate harmful interference for registered assignments in the MIFR. The ITU also promotes the rational, efficient, economical, and equitable use of the radio frequency and orbital positions, which are limited natural resources and, as such, must be available for use by all Member States. In this regard, the ITU gives special consideration to the developing countries' future use of these resources.

The fact that the ITU CS and CV and the RR that complement them are intergovernmental treaties ratified by governments means that those governments undertake:

a) to apply the provisions in their countries; and
b) to adopt adequate national legislation that includes, as the basic minimum, the essential provisions of this international treaty.

This provides a guarantee of effective spectrum management and protects existing services from unacceptable interference.

The ITU Radio Regulations (RR) should enable the introduction of new applications of radiocommunication technology to ensure the efficient use of radio-frequency spectrum, i.e. the operation of as many systems as possible, without interference. Overall, satellite is one of many users of radio spectrum. The ITU RR has allocated parts of the spectrum range to specific categories of services, and has identified those frequencies best suited for transmissions via

satellite. As satellites transmit concurrently across borders and continents, instantly establishing connections over thousands of kilometres, the identified frequencies must also be available concurrently across the entire satellite footprint. While some bands are exclusively dedicated to satellite transmission, most are shared with terrestrial wireless services.

The available number of orbital positions, is even more contested than the frequency spectrum. The several hundred satellites lined up in geostationary orbit, have led to the current situation that satellites orbit at less than a 1-degree angle apart from each other. The signals from these satellites and the ground stations accessing them would cause extreme interference where it is not applied for the use of different frequencies and sharply pointing antennas towards and by neighbouring systems. Moreover, potential interference affects all satellites; it is not limited to satellites in geostationary orbit. The RRs include provisions that allow GSO and non-GSO satellite systems to operate without creating harmful radio interference to each other.

To avoid these conflicts, the ITU has established a set of rules for registration and intersystem coordination. An ITU member administration can register a satellite on behalf of an operator, using the satellite's technical and operational parameters. Due to the limitation of the orbital position resource, other systems are likely to challenge this registration. The following is a set of rules that apply in such a case:

1. A first-come-first-served principle governs positioning in a new, unchallenged position. Existing systems and their replacements with the same technical parameters have preference over new systems.
2. A registered orbital position that has been unused will fall back into the pool of available positions.
3. Systems competing for the same and the neighbouring orbital position(s) have to enter into intersystem coordination processes to find interference limiting operating conditions.

However, in practice, an existing system has a stronger position than a new system that has yet to be registered and placed in operation.

Satellite systems use a number of different frequency bands, or portions thereof, to address a variety of usage/markets. Different frequency bands are suitable for different types of markets. Lower frequencies (L-, S- and C-Bands) are less affected by the heavy rainfall in parts of Africa and can serve wide areas of the globe at a time. Higher frequencies (Ku-, Ka- and Q/V Bands) allow smaller antennas with more focused service beams on regions or sub-regional areas.

A summary of the example applications and satellite usage in various frequency ranges is given in Table 4 (note that the frequency ranges in the table are not necessarily associated with each usage/market).

Table 4: Example applications and satellite usage by frequency range

Band	Frequency range	Usage/market	Current and future applications
L	1.5250 - 2.000 GHz	Mobile satellite services	These frequencies are used for mobile data and voice communications to small user terminals. Global satellite phones, Machine-to-Machine/IoT, asset tracking, and aeronautical and maritime safety communications are examples of satellite applications in this band.
S	2.000 - 3.500 GHz	Mobile satellite services	These frequencies are used for mobile data and voice communications to small user terminals. Global satellite phones, Machine-to-Machine/IoT, asset tracking and aeronautical and maritime

Band	Frequency range	Usage/market	Current and future applications
			safety communications are examples of satellite applications in this band.
C **(6/4 GHz)**	3.400 - 4.200 GHz and 4500-4800 MHz (downlink), 5.725–7.075 GHz (uplink)	Cable head-end/ broadcasting / Video Trucking / VSAT/ National satellites (FSS Plan, RR Appendix 30B)	This band is heavily used for video distribution, VSAT and data communications over a wide area. This band is primarily used by satellites for hemispheric or continental coverage. While used mainly for service to fixed locations, it is increasingly used for data communications for in-motion services.
X **(8/7 GHz)**	7.250 - 7.745 GHz (downlink) 7.900 - 8.395 GHz (uplink)		Governmental and military satellites
Ku **(13/11 GHz)**	12.75 - 13.25 GHz (uplink) 10.7 - 10.95 GHz 11.2 - 11.45 GHz (downlink)		National satellites (FSS Plan, RR Appendix S30B)
Ku **(14-13/11-12) GHz**	10.700 -12.750 GHz (downlink) 13.750-14.000 / 14.000 -14.800 / 17.300 -18.100 GHz (uplink)	Direct to home broadcasting / Broadband / VSAT / In-motion services (ESIM) / Mobile Backhaul	Used for data communications to fixed and in-motion services. Global networks serving maritime, aviation and land based services, national and regional VSAT networks, Satellite News Gathering and video distribution. Recently used for High Throughput Satellite services for high speed capacity connections.
18/12 GHz		BSS bands	Feeder link for BSS Plan
Ka **(30/20 GHz)**	27.5 - 30.0 GHz (uplink) 17.7 - 20.2 GHz (downlink)	Broadband applications / VSAT / In-motion services (ESIM)/ Mobile Backhaul / Feeder links	Used to provide broadband communications. A number of national, regional and global networks have been put in place that can provide high-speed broadband connections to residential, commercial and mobile (ships, trains, aircraft) customers. Used for High Throughput Satellite services which have smaller CPEs providing reduced cost and higher data rates.
Ka **(40/20 GHz)**	42.5 - 45.5 (uplink) 18.2 - 21.2 (downlink)		Governmental and military satellites
Q		Broadband applications / VSAT / In-motion services / Mobile Backhaul / Feeder links	Future High Throughput Satellites used for additional feeder-link services. HTS will also be used to provide high-speed broadband communications to residential, commercial and mobile customers.
V		Broadband applications / VSAT / In-motion services / Mobile Backhaul / Feeder links	Future High Throughput Satellites used for additional feeder-link services. HTS will also be used to provide high-speed broadband communications to residential, commercial and mobile customers.

The space research service makes use of specific frequency allocations as documented in the ITU Radio Regulations (RR). The use of the space research service allocations is further refined in the SA Series of the ITU-R Recommendations (Space applications and meteorology), based on technical characteristics and operational procedures.

Specific issue: the case of ESIM operation

Operating on moving platforms, ESIM has the potential of causing harmful interference to other satellite networks, due to the possible mis-pointing of the terminal antenna to the intended satellite. However, advances in technology, particularly the development of stabilised earth station antennas, have allowed the development of mobile earth stations with very stable pointing characteristics, capable of maintaining a high degree of pointing accuracy even on rapidly moving platforms. One of the key components of ESIM is the Antenna Control Unit (ACU) which detects and cancels relative movements of the ship or airplane in any direction to ensure the antenna maintains an accurate pointing toward the satellite with which the ESIM communicates. Moreover, "Closed-loop tracking" function, implemented on ESIM and an automatic capability of muting transmission if mis-pointing towards the intended space station occurs or is about to happen, can ensure that ESIMs do not represent more risk than typical uncoordinated FSS earth stations, which are often deployed without satellite-tracking capabilities. Furthermore, it should be ensured that the aggregate interference caused to other satellite networks by ESIM would be no higher than the limits agreed in coordination between the relevant satellite networks. To meet these requirements, ESIM are required to be permanently connected to a Network Control Facility (NCF).

ESIM is being able to receive several types of commands from NCF, including "enable transmission" and "disable transmission" commands. This feature is particularly important to prevent a malfunctioning ESIM from causing interference into satellites of other networks or systems. ESIM would cease transmission immediately in case of risk of harmful interference should the NCF require them to do so. When properly managed and controlled by the NCF, the technical characteristics of these mobile earth stations are then indistinguishable from typical uncoordinated FSS earth stations in fixed locations from the perspective of inter-satellite network interference. Therefore, in the case of land based ESIM operating in the bands available for uncoordinated FSS earth stations, there is no change to the current interference environment since ESIM may operate in any location, just like uncoordinated FSS earth stations.

In the case of ESIM mounted on aircraft, regulatory provisions are required, since the geometry of the interference environment is different. An ESIM mounted on an aircraft and operating in the territory of one country could cause interference to terrestrial systems operating in a neighbouring country even when the separation distance is significantly larger than would be the case for an uncoordinated FSS earth station on land.

In addition, in the case of ESIM mounted on vessels, the interference environment is also different to that for land based ESIM in some respects. In particular, ESIM on vessels could operate in international waters (typically beyond 12 nautical miles from the low-water mark of any country). Hence, it is necessary to ensure that terrestrial systems, deployed in the same bands as those where ESIM operate, are also adequately protected from interference from these terminals.

ESIM is either identified in RR such as provision included in Resolution **902 (WRC-03)** (Provisions relating to earth stations located on board vessels which operate in fixed-satellite service networks in the uplink bands 5 925-6 425 MHz and 14-14.5 GHz), Resolution **156 (WRC-15)** (Use of the frequency bands 19.7-20.2 GHz and 29.5-30.0 GHz by earth stations in motion communicating with geostationary space stations in the fixed-satellite service) and Resolution **169 (WRC-19)** (Use of the frequency bands 17.7-19.7 GHz and 27.5-29.5 GHz by earth stations in motion communicating with geostationary space stations in the fixed-satellite service) which define technical and regulatory rules to allow GSO FSS networks to communicate

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with earth stations on aircraft or vessels to provide broadband communications or being under study for the use of ESIM under **Resolution 172 (WRC-19)** (Operation of earth stations on aircraft and vessels communicating with geostationary space stations in the fixed-satellite service in the frequency band 12.75-13.25 GHz (Earth-to-space)) and **Resolution 173 (WRC-19)** (Use of the frequency bands 17.7-18.6 GHz, 18.8-19.3 GHz and 19.7-20.2 GHz (space-to-Earth) and 27.5-29.1 GHz and 29.5-30 GHz (Earth-to-space) by earth stations in motion communicating with non-geostationary space stations in the fixed-satellite service).

5 LICENSING ASPECTS FOR PROVISION OF SATELLITE SERVICES IN AFRICA

Regulatory change is being driven by technological change, market innovation, and by the need for businesses to have access to sophisticated and seamless telecommunication services on a global and end-to-end basis. When the introduction of new and advanced technologies is coupled with liberalization, competition and a harmonized licensing process, it increases access and facilitates innovation. In the long term as markets liberalize, any service provider should be able to offer any communications service to anyone, anywhere, using any technology.

As contained in the Reference Paper of the Agreement on Basic Telecommunications (BTA), the World Trade Organization (WTO) Regulatory Principles form the basis of competition in telecommunications services. The Paper outlines the need for competitive safeguards, non-discriminatory and commercially reasonable interconnection agreements, publicly available licensing criteria, independence of regulators, and fairness in the allocation and use of scarce resources. These principles form the cornerstone for the transition from a monopoly market to a competitive one, and require that national regulatory authorities have transparent decision making procedures, and clear and efficient pro-competitive policies.

Nonetheless, many national regulatory authorities may face various challenges from the advent of satellite systems at national levels: which satellite systems should be licensed; whether there should be a limit to the number of licences; if so, how many systems should be licensed; how should licences be granted and so on.

This section will focus on key licensing and regulatory issues, recognizing that satellite poses various challenges not only to regulators, the relevant operators and also prospective users, including:

a) how to ensure fair competition among a number of satellite systems and their service providers;
b) how to authorize satellite services including use of the applicable frequencies and user terminals;
c) how to optimize the technical capability of satellite (e.g., global coverage to urban, rural, remote, and unserved areas) while supplementing the resources devoted to universal service obligations;
d) how to safeguard national sovereignty and security;
e) How to determine the applicable fees for the license and use of the spectrum of frequencies (frequency assignment).

5.1 Basic considerations

Although satellite opens up new dimensions of regulatory requirements, licensing is generally implemented in accordance with segment approaches, such as space, ground, and user segments, in addition to the service provision.

a) Space segment: Satellites

The space segment (i.e. satellites) licences for satellite systems are granted by the satellite operator's notifying Administration, which submits the appropriate notification of the satellite system to the ITU in accordance with the provisions of the Radio Regulations. This creates an effective way of balancing the needs of governments to monitor and manage the use of the radio spectrum, and the needs of satellite and other satellite operators to get spectrum assignments and succeed in the coordination of their systems. In addition, in some countries an authorization for satellite may be required to grant approval to allow service provision of this satellite in the national territory of that administration.

b) Ground segment: Earth stations

The ground segment refers to the network of gateways or permanent earth stations. Gateway earth stations link one or more terrestrial networks and satellites. The ground segment licences are granted by the countries in which gateways or earth stations are located. Most satellite systems have or will have such ground facilities in a number of countries depending upon each system's design or the services provided. In many cases, the local earth station operators will apply for the applicable authorizations or licences from the national regulatory authorities.

c) User segment: user terminals

Satellite user terminals can vary from handheld mobile, portable to fixed installations, for which the licensing requirements may differ. The method by which administrations implement their national regulations, or other relevant instruments specifying whether individual licences are required, can vary. Exempting terminals from individual licence when covered by a blanket licence or a class licence is suitable for systems in which the network can control user terminals.

Mobile and/or portable satellite terminals require a global regime to be used and carried anywhere. Given that satellite systems are offering, or intend to offer, regional and/or global services, creating a requirement for individual licences for these terminals may affect their unfettered circulation and use.

In particular, the introduction of earth station in motion user terminals (ESIM) raises the need to consider the establishment of commonly agreed regulations to address issues related to the free circulation of user terminals and their national authorisation.

This need has existed since the late 1990's, when the satellite industry started deploying global mobile-satellite systems, which provide direct-to-user telephony and low-rate data service, known as GMPCS.

Currently for GMPCS terminals, the detailed arrangements associated with the GMPCS Memorandum of Understanding established by ITU provide for a simple regime for their licensing, circulation, and use. These arrangements encourage administrations to:

a) recognize the licences for GMPCS terminals issued by other countries;
b) exempt GMPCS terminals from requiring an individual licence for those terminals covered by a blanket and/or class licences;
c) to facilitate circulation for the user terminals which are duly authorized by another administration, type approved and bear the GMPCS-MoU mark;
d) permit visitors to carry their terminals even if use is not permitted.

However, GMPCS operator shall comply with the following:

a) GMPCS System Operators and GMPCS Service Providers are subject to the national laws and regulations in each country in which GMPCS Services are being provided.

b) Each GMPCS System Operator shall take steps to inhibit the use of its system in any country that has not authorized its GMPCS service.
c) GMPCS Terminals brought into a country to be placed on the market are subject to applicable customs duties, if any, and the technical and regulatory requirements of that country.

Also, System Operators implementing the GMPCS-MoU Arrangements agrees to :
a) Comply with relevant provisions of the ITU Radio Regulations.
b) Obtain approval from each country before operating its system.
c) Activate only terminals authorized for connection to the system.
d) Inhibit use of its system and provide traffic data.

The mobile and/or portable GMPCS terminals can be exempted from the requirement for individual licensing using a "blanket" or "class" licence. However, administrations may impose conditions that must be fulfilled before GMPCS terminals will be exempted from this requirement. Such conditions may include:
a) type approval of the terminals to an agreed standard, marked with a certification mark, as appropriate;
b) compliance with frequency use as set by the administration;
c) authorization of the service with which the terminal operates;
d) protection of other services from harmful interference.

d) Service provision

The licence held by a service provider will authorize it to operate transmission lines (wired or wireless) necessary for the providing satellite services in the country that has issued the licence. This includes transmission lines which consist of the uplink from the satellite earth stations (ground segment) and/or the downlink (the connection from the space segment to the earth stations and/or the mobile/portable user terminals) respectively.

It is also necessary to determine whether scarcity of frequencies represents a constraint on the number of satellite services provided in a country, to be shared among future systems. To make frequencies available for satellite transmission lines, international and/or regional frequency harmonization is needed. For this reason, a licence for the operation of transmission lines for satellite services may not include a guarantee concerning the use of frequencies. It may, indeed, require a two-step process (granting of a licence and assignment of the frequencies). The degree to which international and/or regional frequency harmonization has been achieved by the time a licence is granted will have to be considered. The granting of licences and frequencies is done in the context and exercise of sovereign rights of the individual countries.

e) Spectrum availability and management

Deployment of satellite service requires enormous capital investments and demands long periods for development. Therefore, as with other aspects of licensing policy, spectrum allocation should be done without placing heavy burdens on operators that will inhibit service deployment.
Moreover, any procedures for allocating and using scarce resources, including frequencies, should be carried out in an objective, timely, transparent and non-discriminatory manner. The current state of allocated frequency bands should be made publicly available, but detailed identification of frequencies allocated for specific use is unnecessary.

5.2 Players in the satellite licensing framework

Each country has the sovereign right to regulate its telecommunications. According to national laws and policies, National Regulatory Authority (NRA) has generally the responsibility to grant the appropriate authorizations to allow satellite services in a country.

A number of different entities are involved in the offering of telecommunications services using satellite technology. The main players in the satellite community to consider within the licensing framework include Space Segment Operators (SSO), Satellite Network Operators, Service Providers and Subscribers/ Satellite terminal users. Table 5 summarizes the main players in the satellite licensing framework.

Table 5: Main players in the satellite licensing framework

Entities involved	Services	Examples	Authorization regime
Space Segment Operator (SSO)	Space segment provision	Iridium, Intelsat, Inmarsat, SES, Viasat, Eutelsat, Yahsat, Telesat	National notification to ITU (orbital position and co-ordination) National legislation on space issues In some countries licencing could be required for SSO
Satellite Network Operator (SNO) (which includes gateway operator)	Satellite Network (SN) The first group of networks: VSAT, SNG, MSS, GMPCS, ESIM		Harmonised licensing conditions and procedures
Service Provider (SP) (which generates services without its infrastructure or which resells services)	Telecommunications services (example of services included: voice-telephony, data, reselling of transmission facilities and services, Internet, etc.)	Retailers	The same licensing regimes must apply to services provided by satellite network operators and by other networks
Subscriber	Service access All services must be accessed by relevant terminal equipment connected at the termination point of the network (fixed or mobile) and provision of services requires contracts between subscriber and service provider even by electronic means	Individual subscribers Hotel chain	The licensing regime of the terminal equipment includes both type approval and frequency licence (if relevant) in accordance with national legislation

a) Description of the main players

Satellite system operator: It is the entity responsible for establishing and operating one or more space stations (and possibly for providing space segment). It has assumed all the financial, technical and commercial risks to develop a satellite system and seek harmonization of

procedures governing the provision of satellite services to avoid a proliferation of administrative impediments liable to constrain the development of the market.

Satellite gateway operator: It is the entity responsible, within a certain area, for the control of a configuration of one or more satellites that provide(s) radio transmission facilities and which interconnect(s) with earth stations. These networks consist, at the very least, in the establishment of transmission lines:

i) between space segment and fixed earth stations which provide the link to the terrestrial public networks (feeder links),
ii) between space segment and end-user earth stations which may be fixed or mobile (service links).

This entity may be either a company representing the SSO's interests in a region, or an entity independent from the SSO. Depending on the business structure of the satellite system, the earth station, in some cases, can be considered a part of the space segment, and be managed by the satellite system (satellite network) operator. For GMPCS and ESIM, gateways are the earth station link between the space segment, consisting of satellites in orbit (geostationary or non-geostationary), and terrestrial networks, which are the main sources from which satellite terminal traffic is drawn. Gateways are often equipped with Mobile Switching Centres (MSC), Home Location Registers (HLR), and a Visitor Location Register (VLR).

Local and/or Regional Service provider: It is the entity that is responsible within a certain territory for the provision of telecommunication services to subscribers. The services involved e.g. value added services, data services, voice telephony, Internet access and the reselling of these services. Local service providers are responsible for the local or regional provision of satellite services. Their activities may include identifying and managing subscribers, marketing services, distributing terminals, and billing customers. However, the service provider does not own the infrastructure. A satellite system operator or satellite gateway operator could also be a local or regional service provider.

Satellite terminal manufacturers: These are the companies that manufacture terminals for specific satellite systems.

Satellite terminal users/subscribers: These are the customers whom all the other players are called upon to serve. They should receive good quality service at the best possible price, within the strict confines of the laws and regulations of the host countries. A subscriber is defined as a person, a company or a group of people and companies located at a termination point of a network and which has subscribed to the services provided by a service provider.

b) Relationships between the satellite community players

The value-added chain requires that the players achieve a number of agreements and/or accept a minimum of rules to function properly. Table 6 indicates examples of the types of arrangements and issues that these players may have to address in order to implement satellite services. However, this table is only an indication of the various issues that should be addressed. It should be noted that some of these issues do not apply to all satellite systems, nor in conformity with applicable situations in each country.

Table 6: Relationships between the main players and the topics they address

PLAYERS	National regulator	Satellite network operator	Satellite gateway operator	Service provider	Satellite terminal user	Satellite terminal manufacturer
National regulator	- International coordination - Regional coordination					
Satellite network operator	- Coverage authorization - Agreement on frequency band - Agreement on access to traffic data - Agreement on the handling of unauthorized use of satellite terminals - Compatibility with other radio infrastructures	- Standardization and interoperability - Frequency coordination				
Satellite gateway operator	- Landing rights/ authorization - Frequency coordination (feeder links)	- Operating agreements - Technical coordination and qualification	None			
Service provider	- Fair competition - License for providing telecommunication services - Import authorization - license for terminals	- Operating agreement - Interconnection agreement	Agreement on local tariffs	- Roaming agreements - Coordination for type approval and authorization of terminals		
Satellite terminal user	Authorization to use a visiting terminal	- Confidentiality and security of communications - Protection against fraud	None	- Subscription - Billing and recovery	None	None
Satellite terminal manufacturer	Type approval of terminals	Contract for manufacturing	None	Contract for use	Use of terminal	None

5.3 Assessment of the situation in Africa

To carry out the current study, a survey was undertaken from May – June 2020. A questionnaire on satellite regulations was developed. The ATU Secretary General distributed it to the ATU Member States and other African countries. Upon receiving the responses, the consultant compiled and sorted them for analysis.

Table 7 provides a view of the number of responses received to the ATU satellite regulation and licensing survey:

Table 7: Overall response rate

Number of African countries	54
Number of Responses	30
Rate of response	56%

Table 8: Response rate relative to each sub-region

Sub-region	Responses	Countries
Central Africa	4	Cameroon, Central African Republic, Democratic Republic of Congo, Gabon
Eastern Africa	5	Burundi, Comoros, Mauritius, Seychelles, Somalia
Northern Africa	6	Algeria, Egypt, Mauritania, Morocco, Sudan, Tunisia
Southern Africa	9	Botswana, Eswatini, Lesotho, Madagascar, Mozambique, Malawi, Namibia, South Africa, Zambia
Western Africa	6	Côte d'Ivoire, Guinee Bissau, Liberia, Mali, Niger, Nigeria
Total	**30**	

The key findings of the survey are as follows.

a) General information

i) Entities responsible for satellite matters' regulation

The advent of competition and privatization has made most governments fully aware of the importance of effective, well-financed, and professionally-staffed regulatory authorities. These regulatory bodies have been mandated to implement fair competition to ensure that services are:

(i) extended to more people;
(ii) made more affordable, geographically and economically;
(iii) provided at high levels of service quality; and
(iv) relevant to, and understood by, a broad range of society.

As shown in Figure 4, survey results demonstrate that for 90% of the responding administrations the entities responsible for satellite regulation are the same entities responsible for general telecommunication regulation. The exceptions are Seychelles, Tunisia and Algeria. In Seychelles, the responsibility for satellite communications regulation rests with the policy maker since there is no separate ICT regulator. In Tunisia, the regulation of satellite communication lies under the national frequency spectrum Agency's responsibility. In Algeria, licensing of satellite services is shared between the telecommunication/ICT regulator (for public networks) and the frequency spectrum Agency (for private networks).

Status report on Satellite Services Licensing in Africa

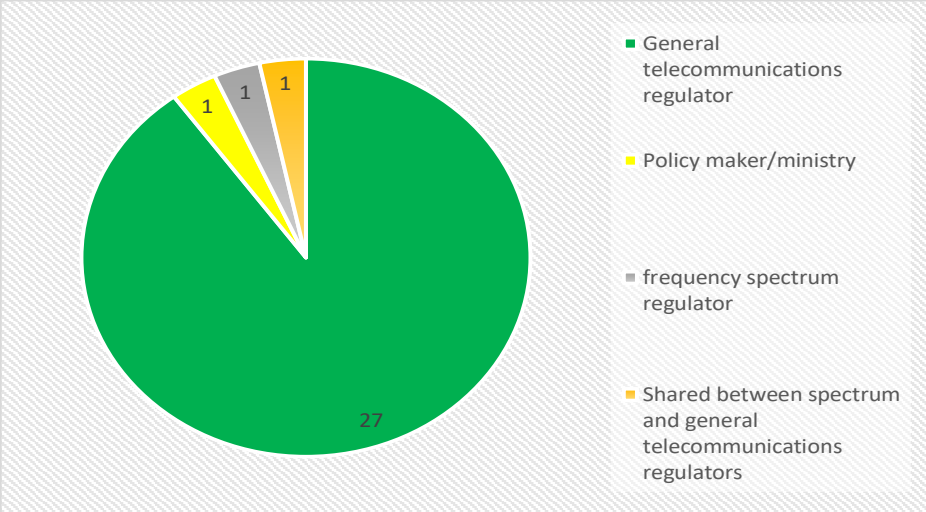

Figure 4: Entities in charge of satellite matters

The establishment of the proper legislative and regulatory environment is of utmost importance to attract private investment and promote competition. Without an appropriate legal framework for sustained infrastructure development, other efforts to bridge the "Digital Divide" may have a little long-term impact. Operators and investors will generally have greater confidence that an independent telecommunications regulatory authority will regulate a market objectively and transparently, which leads to increased investment in the sector and to related benefits that satellite services can provide to any economy.

ii) Availability of laws, decrees, legal instruments, or regulations apply to satellite communications

Transparent practices are critical to the success of satellite regulation, enabling parties to benefit in various ways. In recognition of this fact, administrations generally post their regulations and/or policies online.

With three exceptions (Guinea Bissau, Liberia, Seychelles), all respondents (90%) to the satellite regulatory survey indicated that their laws, decrees and legal instruments were publicly available and in many cases are posted on the web (see Figure 5).

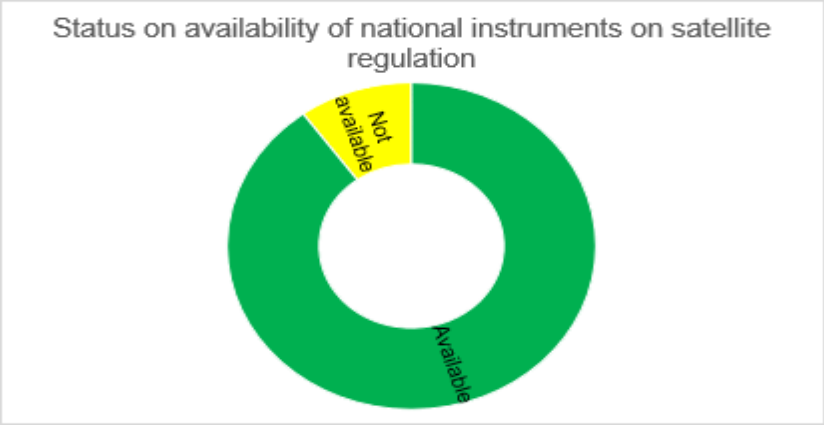

Figure 5: Status on availability of national instruments on satellite regulation

b) Space Segment

Licensing requirements on the space segment portion of a satellite network have focused on two areas – requiring authorisations for domestic landing rights and authorisations to use specific frequency segments. Both trends are discussed below.

i) Regulations that restrict or prohibit emissions to/from satellites (space stations) operated by foreign satellite operators

Tremendous demand for Internet, data, voice, video, and other services are best addressed by policies that permit open and direct access to all satellite resources assuming that they have been properly coordinated through the ITU. Some governments have developed policies to use only locally-owned satellite capacity when providing satellite-based services, or the space segment could only be bought via the incumbent public telecommunication operator.

The survey indicated that 22 of 30 (73,33%) responding administrations do not have regulations that restrict or prohibit emissions to/from satellites (space stations) operated by foreign satellite operators (See Figure 6). Administrations where limitations exist indicated that the emissions to/from satellites operated by foreign operators are subject to the applicable provisions of the Radio Regulations, including the agreement for inclusion in the service area, the regulation on landing rights and the licensing regime for the provision of telecommunications services.

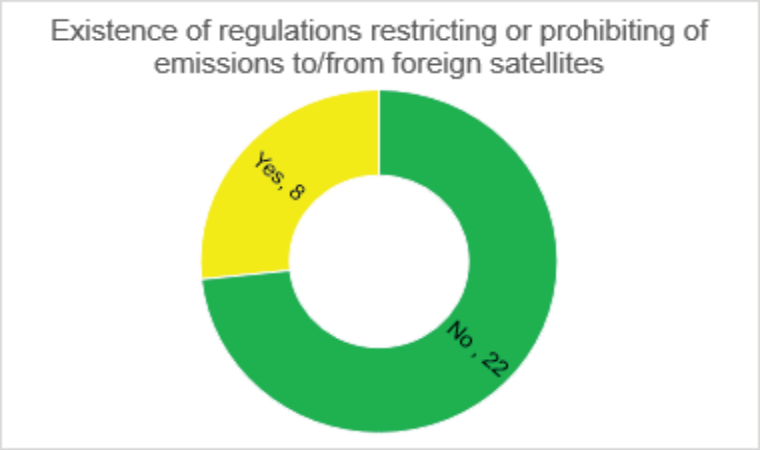

Figure 6: Existence of regulations restricting or prohibiting of emissions to/from foreign satellites

ii) Requirements for any additional authorizations for foreign satellite operators whose space stations have been coordinated and notified through ITU to provide their services in your country

To the question whether Administrations required additional authorizations for foreign space-segment operators of satellites, irrespective of prior coordination and notification, 16 (53%) responding Administrations require the procurement of additional authorizations such as landing rights or authorization to provide services in their countries, 14 do not.

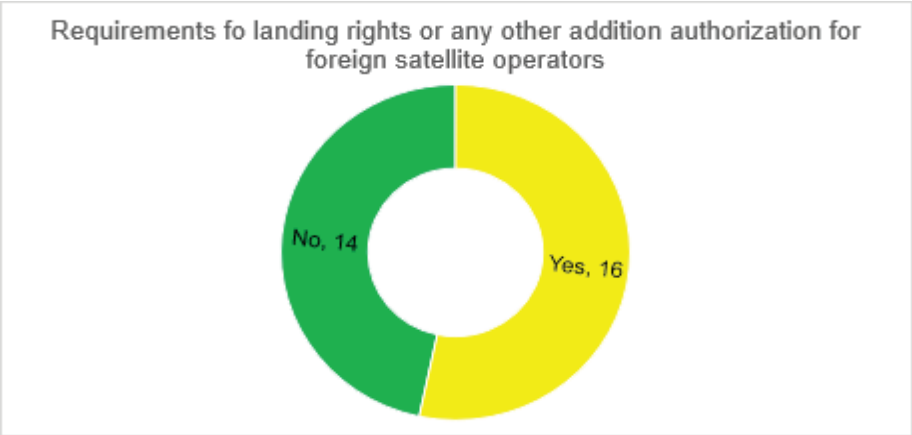

Figure 7: Requirements for landing rights or any other additional authorization for foreign satellite operators

This situation illustrates that many African Administrations typically regulate the ability of a ground segment operator to connect with a space network. This implies that there is requirement to demonstrate that a space network has landing rights or any other additional authorisation in the most countries.

iii) Requirement for commercial or legal presence in the country

A legal or commercial presence (defined as establishing a corporate subsidiary or having a local agent) is often required by administrations as a precondition for license issuance. When it comes to requiring space-segment providers to establish a commercial or legal presence in the country where it wishes to offer service, almost half of the surveyed countries – 13 out of 29 (45%) – require a local presence (see Figure 8). Therefore, the operator must have a contract with a locally licensed company or the operator itself will have to have a presence in the country for service provision.

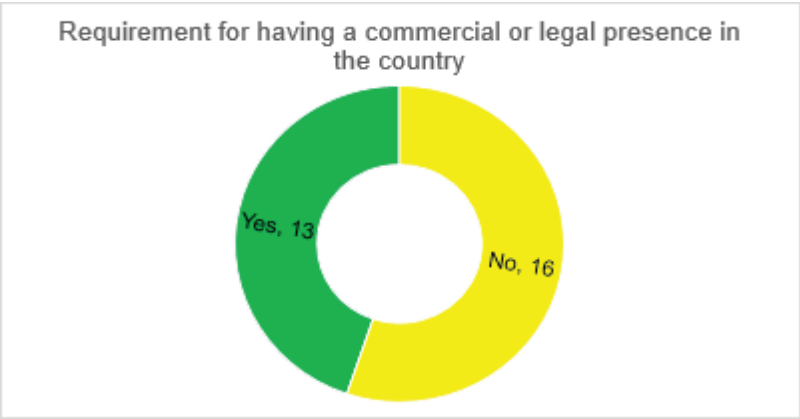

Figure 8: Requirement for having a commercial or legal presence in the country

For satellite operators, requiring a local presence for space-segment providers is a major obstacle to the effective roll-out of satellite communication services in the countries concerned, It increases costs to operators and decreases efficiency, thus forcing higher prices on consumers.

iv) Space segments (satellite) operators provide services direct to end-users

A major issue for many operators is the ability to provide services directly to end-users, without going through local entity. This ability allows for the lowest cost for consumers and the capability to roll out new services in a rapid fashion.

When asked if space segment operators are allowed to provide services directly to end-users, 16 out of 29 (55%) countries said that they were (see Figure ***9***).

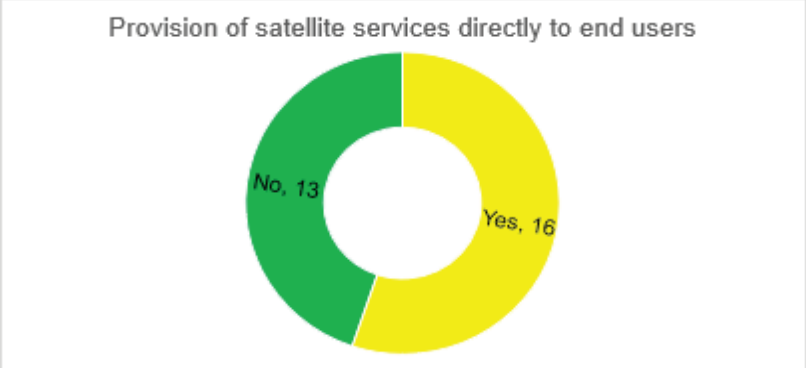

Figure 9: Provision of satellite services directly to end-users

For example, in South Africa, only entities who are holders of Electronic Communications Service licence are authorized to provide services directly to end-users. In Namibia, as per section 38 of the Communications Act telecommunications, services may not be provided nor may any telecommunications network be constructed, maintained and operated without a telecommunications service licence. End users access satellite through a licensed telecom operator in Nigeria. Also, some Administrations require a VSAT network operator's hub to be installed within their country's national territory such as Egypt.

c) Ground Segment

In addition to licensing the space segment, administrations have created licensing regimes for the terrestrial segment of satellite networks. Efforts to require licenses for the ground segment can be divided into authorisation requirements for satellite service providers and licensing regime for earth station facilities. Both approaches are discussed below.

i) Satellite services subject to licensing (per service)

The satellite applications that were considered for the survey are the following:

a) Broadcasting Satellite Service (BSS);
b) Fixed Satellite Service (FSS) including VSAT networks, Satellite News Gathering (SNG), Earth stations on motion (ESIM), Earth stations on board vessels (ESV), Direct to Home (DTH);
c) Mobile Satellite Service (MSS) including Global Mobile Personal Communications by Satellite (GMPCS);
d) Aeronautical Mobile Satellite Service (AMSS);
e) Earth Exploration Satellite Service (EESS) including Meteorological satellite service (MetSat), Space research service (SRS);
f) Radionavigation satellite service (RNSS).

Figure 10 below shows whether a range of satellite service types are subject to licensing procedures by Administrations in Africa. For each satellite service type, except for the science services and RNSS, the data reveals that a large majority of the respondents have implemented a licensing regime. The "Yes" responses are so significant because they reflect how many administrations have established variously codified licensing procedures for satellite services. In addition, the data shows that different types of satellite services are being licensed. So, BSS, FSS,

MSS, Private VSAT, PSTN-connected VSAT, GMPCS, SNG and AMSS services are subject to a licensing regime. Concerning the licensing requirements of FSS, BSS and MSS, the same trends can be seen. Overall, 22 of 30 countries surveyed required licensing for BSS, while 27 of 30 required licensing for FSS & MSS. Only a few administrations have established licensing requirements for science and RNSS services.

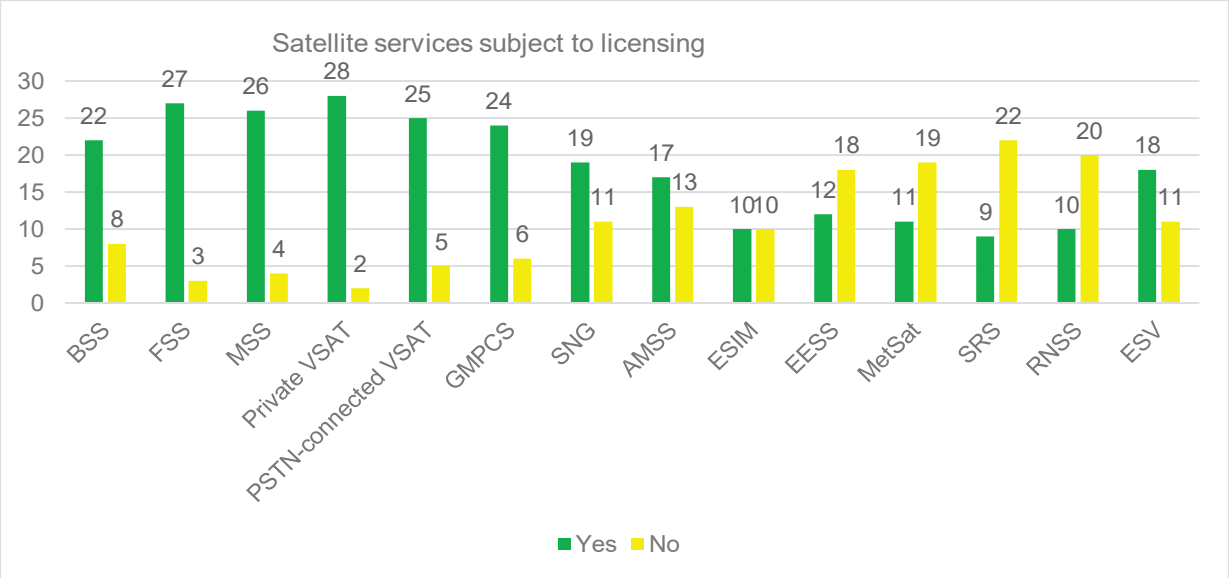

Figure 10: Satellite services subject to licensing

ii) License and/or spectrum fees

Regulatory transparency and responsible licensing fees are core aspects of an efficient, competitive satellite services marketplace.

For the operation of the satellite system, Administrations have generally charged two types of fees:

a) The licence fee for the service licence for operating a satellite network, providing services or operating a satellite/mobile network for public services (not including the use of spectrum);
b) spectrum fee for the assigned frequency.

Figure 11 shows survey results indicating whether Administrations in Africa apply license fee and/or spectrum fee for their satellite services/applications subject to licensing. Figure 12 presents for each type of considered satellite services/applications, the proportion of countries applying both licence and spectrum fees, only one the two (licence or spectrum fees) and none of.

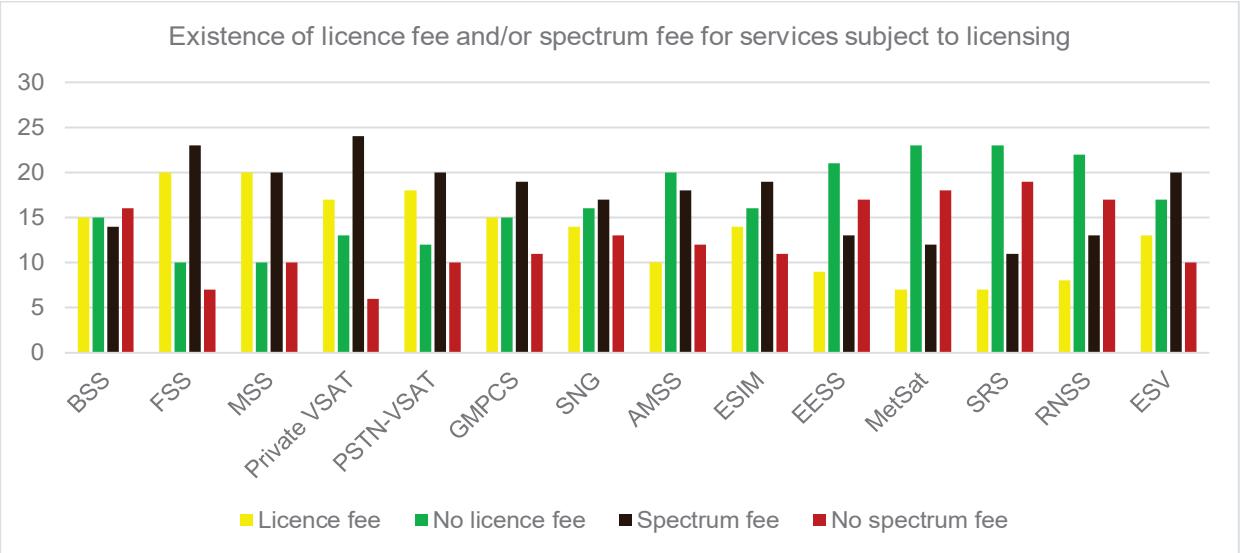

Figure 11: Existence of licence fee and/or spectrum fee for services subject to licensing

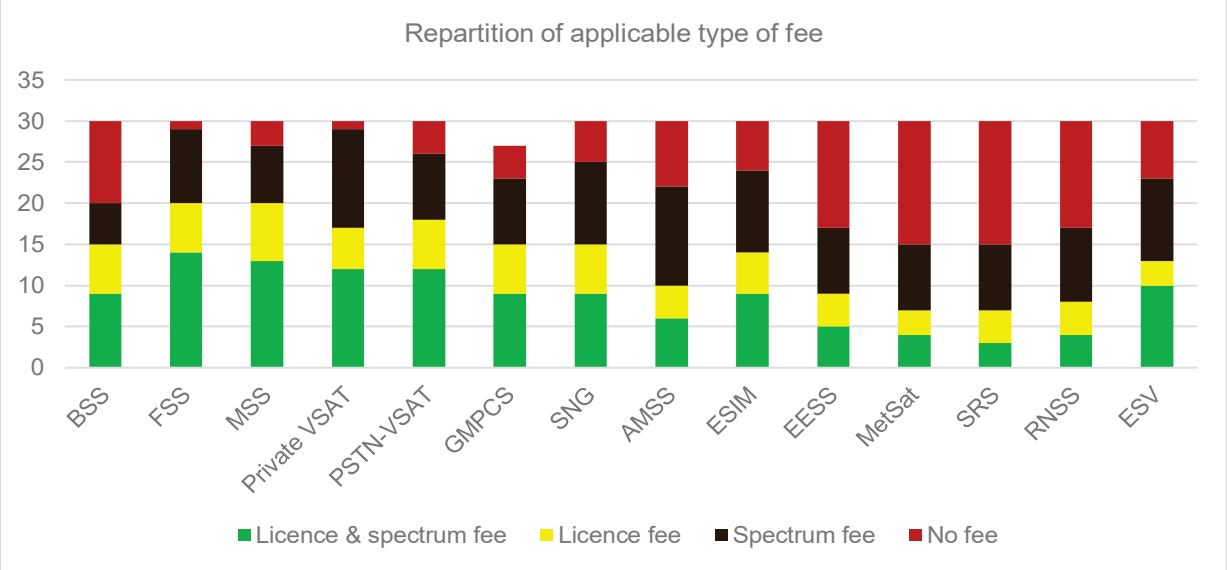

Figure 12: Status of the applicable type of fee as per satellite service/application

Nearly all the countries surveyed indicate charging fees for the FSS and MSS ground segment licensing, private VSAT and PSTN VSAT. Also, the survey did reveal that for science applications, in a handful of countries, licensing the ground segment is stated as being exempted from payment of licence and/or spectrum fees. The questionnaire did not request precise sums, and this is an area that warrants more in-depth examination.

iii) Commercial or local presence

A review of the requirements for network service providers shows that they face, overall, an even more restrictive environment than do the space-segment providers. Of the 30 countries that responded, 23 require network service providers to have a commercial or legal presence to provide service (See Figure 13). There can be little doubt that some countries have lost of potential satellite services due to the local presence that their current regulatory regime requires.

The situation is most positive regarding satellite network service providers being allowed to transmit and receive signals to and from foreign satellites. Only 4 of the 30 responding countries say that they do not allow such transmissions (See Figure 14). Placing restrictions on

transmissions to foreign-owned satellites will present a major regulatory hurdle for any commercial satellite operator looking to operate in one of these 4 countries.

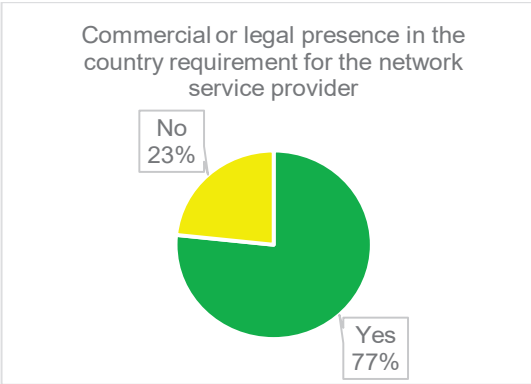

Figure 13: Commercial or legal presence in the country requirement for the network service provider

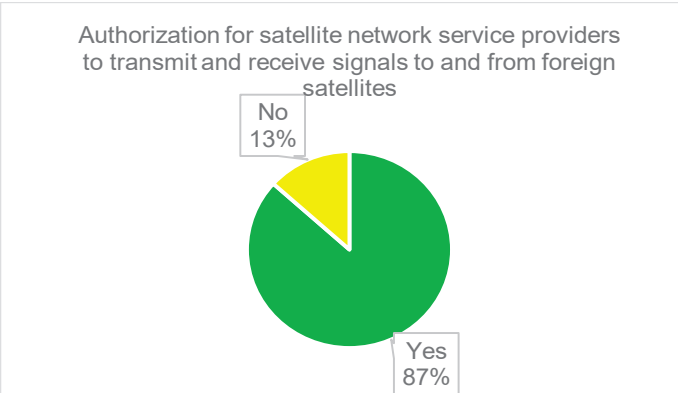

Figure 14: Authorization for satellite network service providers to transmit and receive signals to and from foreign satellites

d) Terminal equipment

i) Type Approval

The current state of type approvals and equipment registration requirements varies across the continent. *Figure 15* shows the results from the survey on the existing regulatory requirements applicable to the approval of satellite terminal equipment. It reveals that:

a) Almost all the countries requires type approval for terminals (28 of 30 respondents), while a slight majority requires type approval of terminal components (19 of 30 respondents).

b) The situation is similar when it comes to allowing the self-declaration of conformity by manufacturers. Overall, 19 of 30 countries allowed self-declaration by manufacturers. But it should be noted that most of the administrations require the self-declaration document as part of the application for the type approval.

c) The situation is more restrictive in terms of requiring the registration of equipment. Overall, 22 of 30 countries required the registration of equipment.

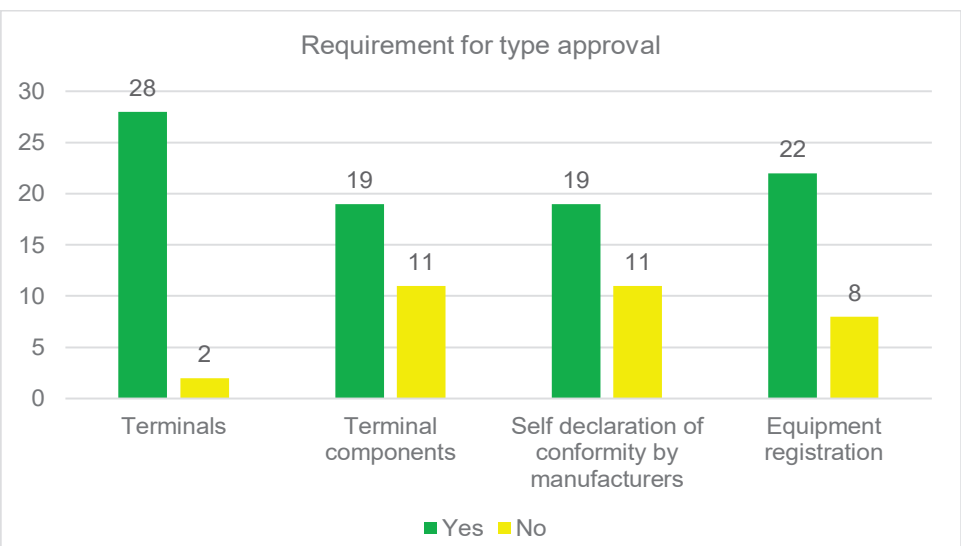

Figure 15: Status on regulatory requirements related to approval of terminal equipment

Responses indicate a trend towards accepting international or regional standards on unwanted emissions during the type approval of FSS and MSS earth station terminals. It is illustrated by the fact that most of the respondents (19 out of 30 countries) indicate acceptance of international/regional standards (See Figure 16). The main standards followed are those developed by ITU, ETSI, ANSI, ISO, CENELEC, IEC, etc.

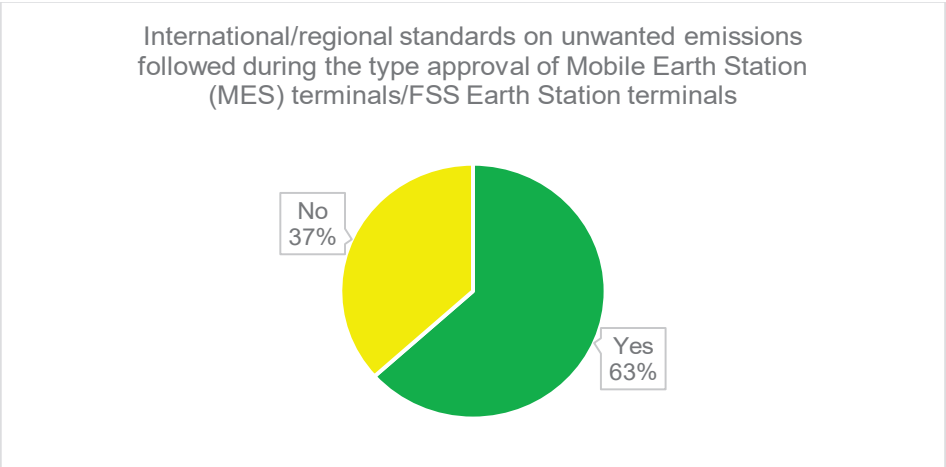

Figure 16: Status on acceptance by countries of international/regional standards for terminal equipment

When it comes to the implementation of satellite equipment mutual recognition agreements (MRA) the situation is much less positive. Of the respondents, the vast majority of countries surveyed, with a total of 25 out of 30 countries, have not implemented satellite-equipment mutual recognition agreements (See Figure 17).
The survey shows that most African Administrations do not accept type certification from other countries or recognized entities or even recognise the type-approval marks that apply elsewhere in Africa. Overall, just 12 of 30 countries indicated accepting such type certification (See Figure 18).

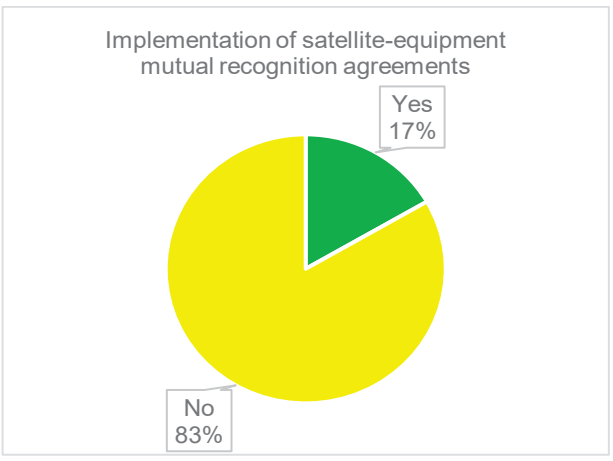

Figure 17: Status of implementation of satellite-equipment mutual recognition agreements

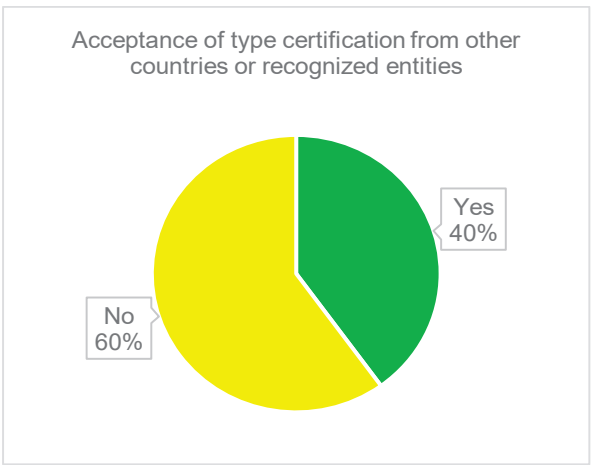

Figure 18: Status on acceptance of type certification from other countries or recognized entities

Several countries throughout the world shares interest in minimising costs associated with type approvals through mutually recognized type approvals issued by other Administrations – whether on the global level such as the ITU GMPCS-MoU or regional mutual recognition agreements such as those applied by the Asia Pacific Economic Co-operation group and the Inter-American Telecommunications Commission.

Also some administrations, e.g. in the European Union, are bypassing mutual recognition to go a step further, for example when applying self-declaration of conformity by manufacturers. This approach, which shifts responsibility for type-approval testing and certification from the administration to the manufacturer. The practise is seen to remove an unnecessary burden from Administrations, and enables all participants – manufacturers, Administrations and end-users – to avoid delays and added costs associated with traditional type-approval processes.

ii) Blanket licensing and general authorisations

Traditionally, most governments have required each VSAT or mobile satellite terminal to be licensed individually; this was in addition to requiring a network operator's license. But recently a new approach to regulating VSAT - "blanket licensing" – began to be implemented.

With this regulation, VSATs are configured based upon technical criteria – involving power level, frequency, etc. - that eliminate the risk of harmful interference. Thus, a single blanket license can be issued covering a very large number of VSAT terminals. Similarly, for mobile systems, international frequency co-ordination procedures, and the use of harmonized standards eliminated the risk of harmful interference. A growing number of countries were able to exempt the circulation of terminals from individual licensing requirements.

The graphs in Figure 19 and Figure 20 indicate by terminal those countries found to have provisions for blanket or class licenses. While approximately 57% of administrations responding to the survey question on the subject said blanket licensing is applied to two-way VSATs, 57% apply to GMPCS terminals, 40% apply to AMSS terminals, 43% apply to ESIM and 40% of the respondents apply blanket licensing to another type of terminals, for example GMDSS terminals. More than 60% of the survey respondents have applied some form of blanket licensing in Africa.

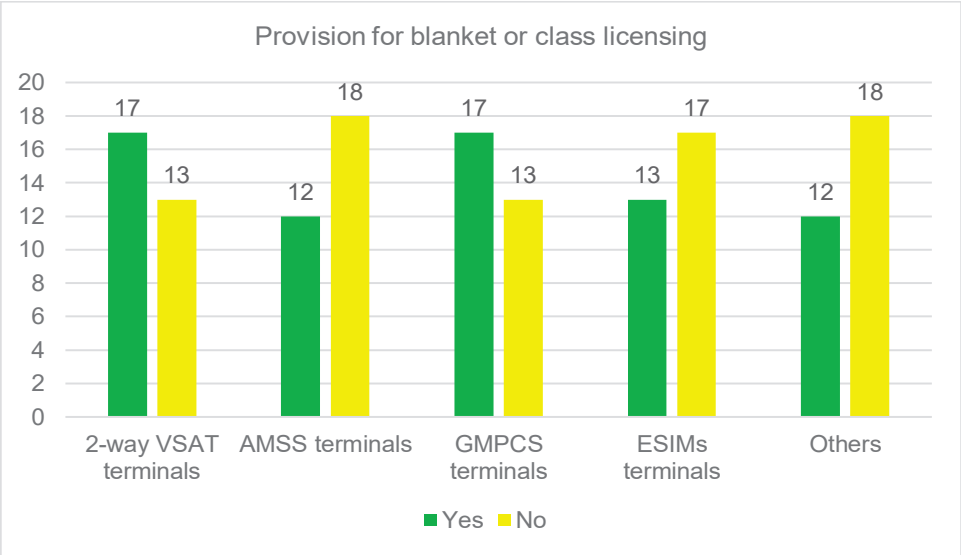

Figure 19: Status on countries with provisions for blanket or class licensing

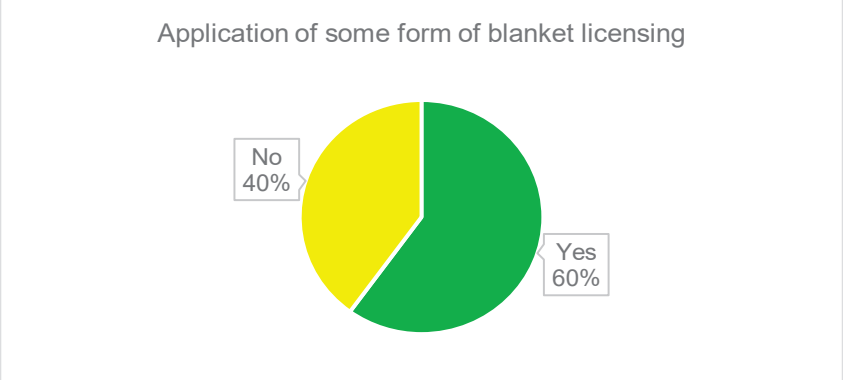

Figure 20: Status on countries applying some form of blanket licensing

Another finding of the survey is that the majority (73%) of the responding Administrations either do not apply any licensing to receive-only systems – whether they are used for video or data – or apply blanket licensing (see Figure 21). The rationale behind this fact is that, in theory, the verifiable purpose of licenses is public safety and preventing harmful frequency interference; receive-only systems, because they do not transmit, are incapable of creating interference or posing a radiation hazard, so licensing may not need to be applied.

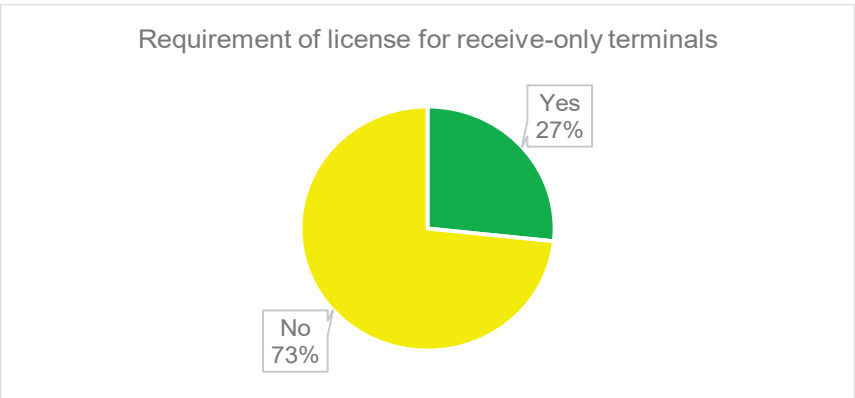

Figure 21: Status of countries with requirement of license for receive-only terminals

e) Trends and comments

As shown on Figure 22, half of the respondents to the survey have indicated that they are currently planning changes to their satellite regulation's approach. Moreover, only 2 out of 30 countries have responded that a regional/sub-regional harmonized framework for satellite matters has been established (See Figure 23). For the latter, references were made to the regulatory framework on ESIM under development within SADC and ECOWAS and also the UEMOA Directives supporting the harmonization of telecommunications policies in ECOWAS.

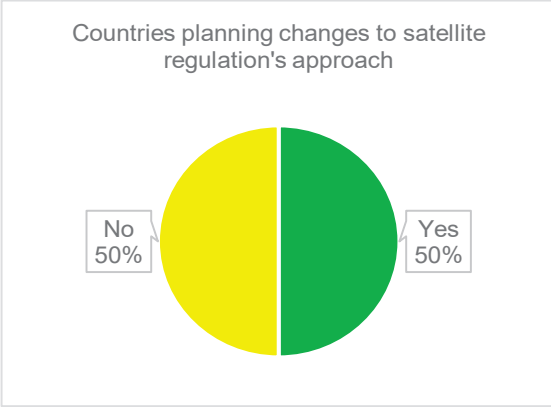

Figure 22: Status on countries planning changes to satellite regulation's approach

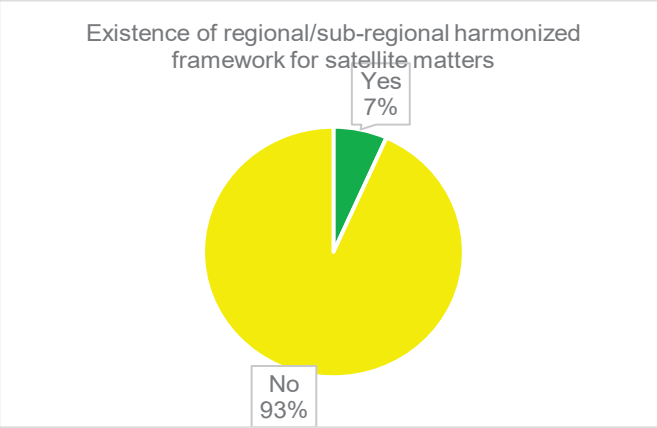

Figure 23: Status on existence of regional/sub-regional harmonized framework for satellite matters

5.4 Industry views

The views from the industry in this section were expressed through a publicly available position paper from Global Satellite Operators Association (GSOA), the association of the satellite industry GVF and comments received via E-mail from some satellite operators. The Industry is of the view that countries can only benefit from satellite services if they have favourable market access and regulatory policies in place. Therefore, the satellite industry support that governments and their National Regulatory Authorities (NRA) should consider adopting the following market access principles and licensing issues to maximise the positive impact of satellite services on their territories.

Facilitate the provision of bare satellite capacity

Satellites duly authorised by another country and coordinated through the ITU process carry capacity available for use in the countries they cover. There is no need to require further licenses or impose other regulatory requirements solely to provide satellite capacity to a licensed entity.

Treat all satellite operators equally

Exemptions to Most Favoured Nation (MFN) and any other limitations that put foreign satellite operators at a disadvantage should be avoided. Specifically, national governments should not give preferential or exclusive treatment to domestic satellite operators nor require foreign satellite operators to provide capacity with the domestic operator acting as an intermediary. Such requirements result in an uncompetitive domestic market, higher prices and little or no innovation.

Minimise local requirements

It is neither feasible nor necessary for a global satellite operator to establish a local presence in every country it covers. Foreign satellite operators should not be required to be licensed through a local company or legal representative; instead a workable registration system can be applied. Similarly, restrictions on foreign ownership or foreign direct investment in entities permitted to access foreign satellite capacity and services should be avoided.

Satellite operators do not require a physical presence in every country where they provide services. Their satellites can reach broad populations in multiple countries from a single point in space and with limited ground infrastructure. Satellite operators business models are built on this principle and do not factor in the high costs associated with establishing a local presence.

Technical or commercial local presence requirements for satellite operators, such as hub, gateway, control centre, subsidiary, local representative, are inconsistent with the characteristics and benefits of satellite technology and with the least burdensome principles of the General Agreement on Trade in Services (GATS).

Provide transparent, non-discriminatory authorisation procedures
Licensing procedures applicable to national service providers should be streamlined, transparent and the same for domestic or foreign satellite systems. Licensing fees and other regulatory/administrative charges should be cost-based rather than used as revenue generation mechanisms. Finally, the treatment of satellite technology should be comparable to the treatment of terrestrial communications technologies.

As a global infrastructure, their launch and operation are coordinated through the International Telecommunications Union (ITU) mechanisms. In addition, every satellite launched has been authorised by the satellite operator's home licensing administration. Therefore, there is no need for rights or licenses to access the space segment ("so-called landing rights") or to impose other regulatory requirements on satellite operators for the provision of satellite services.

In most countries, satellite communications are successfully and efficiently regulated by licensing transmitting earth stations. This approach addresses important regulatory requirements such as the location of antennas, monitoring of data traffic and regulatory cost recovery.

Permit transport of video & audio signals
Satellite terminals and other satellite end-user equipment should be exempted from customs duties, not subject to duplicative testing or type approvals and, to the greatest extent possible, be freely deployable within a country. Countries with a blanket licensing scheme benefit most as they allow most people to be connected.

Existing restrictions
Some countries impose restrictive regulatory procedures and unfair treatment on foreign satellite operators, including a preference for a national operator, burdensome licensing conditions, requirements for unnecessary and duplicative national infrastructure, changes in spectrum allocation decisions, disparate fiscal treatment, high equipment importation duties and type approvals, or requirements of national commercial presence. As a result, the evolution of their national communications system is slow and the benefits of satellite services that would otherwise be immediately available are lost or seriously diminished. Particularly troubling are countries where satellite coverage exists thanks to the substantial up-front investment of satellite operators, but market access is denied.

Address security concerns adequately
National governments sometimes fear that undesirable customers might transmit over foreign satellites and/or the traffic might not be controllable, leading them to impose additional market barriers such as installing costly local technical facilities in their territory, e.g. for lawful interception. The most recent technology developments enable regulators to effectively address concerns on the monitoring of data traffic or the unauthorized use of earth stations, without the need for local installations.

Adhere to the World Trade Organization's ("WTO's") General Agreement on Trade in Services ("GATS") Telecommunications Reference Paper
The 1997 WTO General Agreement on Telecommunications reference Paper and the principles embodied in the Chairman's Note on Scheduling allow all satellite communications for the transport of video and data to be covered without exemption.

Exchange on and follow best practices
NRA should work with other countries in their region to ensure an exchange of information on best practices to develop regionally harmonized approaches to licensing satellite systems.

Services in harmonized spectrum should be subject to a general authorisation and should not require explicit consent before commencing service. The European Union is a good example of an integrated regional policy; its telecommunications regulations have considerably evolved to be simpler and more open.

Adhere to the ITU Table of Frequency Allocations
NRA should ensure that existing ITU primary frequency allocations to satellite services are maintained and respected to benefit from available satellite services without interference.

Implement Mutual Recognition Agreement (MRA)
To help facilitate the use of the MRA process for satellite-based systems, the private sector has also offered a solution. A technical framework that enables Administrations to mutually recognise test results generated during the satellite operator type-approvals process.

This framework is encapsulated in GVF 101: "Mutual Recognition of Performance Measurement Guidelines and Procedures for Satellite System Operator Type Approvals" document. It defines a set of standardised measurements that can be used to check compliance of an earth station antenna model with applicable performance requirements. The procedure also provides for independent auditing of the accuracy and completeness of the data by authorised test entities, which satellite-operator members of GVF elect.

The availability of a standardised, audited data package alleviates the need for each country to maintain its testing and verification requirements, reducing costs for administrations and improving the quality and comprehensiveness of the data submitted to regulators as a part of the licensing or type approval process. At the same time, acceptance by domestic regulators of a standardized data package can greatly reduce costs for satellite service providers, by permitting them to use a single set of tests and data to demonstrate compliance with the technical requirements of both satellite operators and domestic licensing officials in multiple countries.

Level playing field
Foreign satellite operators should be able to compete on a level-playing field with domestic satellite operators and terrestrial communications systems so that government entities and nationally-licensed operators such as broadcasters, telecoms companies, internet service providers, corporation/enterprises, VSAT service providers can all enjoy the benefits of complete coverage and connectivity, anytime, anywhere.

Streamlining satellite licensing framework
The satellite industry would like to see development/ improvement when it comes to how Administrations can streamline licensing on the following applications within Africa :

1. Aeronautical Earth Stations (AES): Some African countries authorize AES only if they recognize the United states of America Federal Communications Commission (FCC) provisions for AES in the Ku band. However this only covers U.S.-flagged planes that operate satellite terminals licensed pursuant to a grant from the FCC. It would be useful to develop a harmonized African approach to allow authorization of AES services. Still this grant should not be limited to just "visiting" planes but also for African planes flagged by each of these administrations (e.g., locally flagged planes). One good fix would be to include AES services in the National Frequency Allocation Plan.
2. Earth Stations on Vessels (ESV): Industry see challenges in how ESV is licensed across the ATU in Ku band. It recommends the ATU to follow the Electronic Communications Commission (ECC) Decision (05)10 on licensing ESV services.
3. Flex ground products (Flex): There is a need to facilitate a streamlined licensing framework in the Ku band to allow satellite operators to go direct to providing services to customers and having a licensing of user terminals proposal for a commonly agreed approach.
4. Earth Station in Motion (ESIM): This new application is not well developed within the ATU administrations licensing framework, especially for Ku band ESIM. For example, how do you license ESIM and what does it cover, and for which bands. A harmonized licensing framework should be developed with respect to: a) user terminals governed at the domestic level by the conditions of a "blanket"/ "class"/ "general user" radio licence to avoid the burden of individual terminal-by-terminal licensing of user terminals and b) free circulation for foreign visiting ESIM based on the principles of mutual recognition of licenses issued by other jurisdictions. Related regulatory framework are already in place in Europe. ATU could use the guidelines in the recently approved regional ATU-R Recommendation 005 (https://atuuat.africa/wp-content/uploads/2021/08/En_ATU-R-Recommendation-005-0.pdf) to develop the licensing framework of ESIM in the Ka and Ku bands.
5. Very Small Aperture Terminal (VSAT): The main issue is still high licensing fees where some cases each terminal has to be licensed individually. The industry would recommend a streamlined approach whereby if each VSAT has the same characteristics, then there is no need to license individually and simply develop a network license that encompasses as many VSAT as necessary. ATU has already developed some guidelines and recommendations regarding the licensing approach for VSATs in its regional ATU Recommendation 005 (https://atuuat.africa/wp-content/uploads/2021/08/En_ATU-R-Recommendation-005-0.pdf) . In particular, ATU recommends Member States to establish a class, "umbrella" or "blanket" license approach on their territory for VSAT, without the need for cumbersome individual terminal-by-terminal licenses. Another example is related to an agreement to the free circulation of terminals: Free circulation would be permitted amongst signatories countries based on mutual recognition of domestic licensing. This would still provide scope for control by the individual regulatory body.
6. Direct to Home (DTH): For media customers, interference is a common theme but broadcasters do not received protection measures from regulators to ensure DTH quality of service (QoS) is in accordance to their service level agreement (SLA). Interference issue coming from fixed services in 10.7-11.7 GHz. The industry would welcome a provision to ensure that DTH services are protected and are recognized as a primary services within the FSS designation across African frequency allocation plans.
7. Type approval: Local type approval is still applied in some administrations across Africa. Industry recommend a harmonized type approval process that recognizes international

standards (e.g. ETSI, FCC) without the need for additional local type approval. For example operator equipment type qualifying standards, Recommendations, etc.

8. C band: The spectrum 3600-3800 MHz is used by FSS operators across Africa. Since this is a receive band, the industry would like to see specific provisions included in government policy to ensure protection to FSS from In-band Emissions (IBE) and Out of band Emission (OOBE) caused by the future use of high power IMT-2020 systems transmitting in the adjacent band 3400- 3600 MHz.

5.5 African Union policy for space services

The African Union (UA) has adopted the African Space Policy which provides the guiding principles for a sustainable and fully effective space programme that will serve the needs of the African continent. This policy identifies the key policy goals that will drive any formal space initiatives on the continent. The policy goals are supported by objectives and principles that articulate important aspects that need to be addressed in developing and maintaining a viable and sustainable space programme. These policy objectives and principles form the core building blocks and the basis for all decisions and actions of the African space programme.

The policy drivers for the African space programme are expressed through high-level policy goals, which are as follows:

a. To create a well-coordinated and integrated African space programme that is responsive to the continent's social, economic, political, and environmental needs, as well as being globally competitive.
b. To develop a regulatory framework that supports an African space programme and ensures that Africa is a responsible and peaceful users of outer space.

This policy emphasises that Africa has to build its capabilities in the following constellation programmes: Earth observation systems, navigation and positioning applications, and communications systems, since their space-derived products and services are crucial for the economic development of the continent. The policy also states that space presents a unique opportunity for cooperation in using and sharing enabling infrastructure and data towards the proactive management of disease outbreaks, natural resources and the environment, responses to natural hazards and disasters, weather forecasting, climate-change mitigation and adaptation, agriculture and food security, peacekeeping missions and conflict resolution. Satellite communication is recognized as a key technology that could enable developing countries to build global information infrastructure. Also, satellite television broadcasting is seen as another important application of space technology that will help in improving access to information and to make the African voice heard worldwide.

To achieve the objective of coordinating the African space arena, the following actions should be implemented among others:

i) **To regulate space activities.** A regulatory environment will have to be established to allow industrial entities to access space technologies and to promote African commercial private sector participation in the space arena. This regulatory framework will need to be developed and implemented to ensure effective compliance with international treaties and conventions, with the necessary levels of transparency.
ii) **To secure the space environment for Africa's use.** A prime responsibility in relation to continental space activities is to ensure that wavelength spectrums, orbital locations, quiet areas for radio astronomy and other assets and rights, are secured for current and future continental and national space activities in Africa. Representation on

international bodies such as the International Telecommunication Union will be important.

The African Union has stressed that harmonization of ICT policy, legal and regulatory frameworks is a prerequisite for creating a common Digital Single Market. Internet and Digital Infrastructure are essential component for the development of Africa's digital ecosystem. The African Union Commission has prepared the Digital Transformation Strategy for Africa (DTSA) endorsed by the ministers in charge of ICTs in October 2019 and adopted on 9 February 2020 by the AU Summit. This strategy has an overall objective to harness digital technologies and innovation to transform African societies and economies to promote Africa's integration, generate inclusive economic growth, stimulate job creation, break the digital divide, and eradicate poverty for the continent's socio-economic development and ensure Africa's ownership of modern tools of digital management. The strategy document brings together various pillars of the digital economy, including digital infrastructure, enabling environment, policy and regulation, digital platforms, digital financial services, digital skills, human capacity, digital innovation and entrepreneurship, as well as initiatives in key vertical sectors such as government, education, health, agriculture, industry, trade, and financial services. The strategy includes a roadmap and action plan for implementation.

Of particular relevance for the current study, it is useful to highlight the followings aspects of the DTSA :

a. Under the foundation pillar "Enabling environment, policy & regulation policy recommendations", one of the proposed action is the e*stablishment of harmonized policy, legal and regulatory frameworks* which includes promoting regional/continental licensing mechanisms to facilitate the establishment of regional/continental operators' networks and service providers.

b. Under the foundation pillar "digital infrastructure", some of the proposed actions are the following:
    1) *to promote a favourable regulatory environment for competitive and harmonised regional and continental connectivity markets* which entails to*:*
        (i) Develop a policy and regulatory framework that overhauls all infrastructure network, services and platforms to support a high-speed, multi-channel connectivity that will ensure ubiquitous, reliable, affordable access;
        (ii) Strengthen the capacity of policymakers and regulators to implement harmonised telecom rules at the regional and continental level;
        (iii) Foster transparent, predictable, pro-investment and pro-innovation regulatory frameworks.

    2) *to promote measures that increase the affordability of broadband and technology devices & services* which would need to:
        (i) Implement initiatives to help reduce the price of devices and services;
        (ii) Adopt appropriate policy and regulation in areas such as taxation to promote the affordability of Internet;
        (iii) Develop Digital platforms to serve people, businesses, and government agencies in all aspects of life, including healthcare, education, commerce, transportation, and public benefits.

5.6 Challenges for satellite services licensing in Africa

This section draws upon identifying some of the satellite regulatory and policy issues that may affect licensing conditions in Africa. It goes beyond the aspects which were discussed in section 5.3 above. It aims to provide practical information that would constructively guide the aspects relating to the formulation of effective satellite communications regulations and policies.

5.6.1 Technical issues

a) Issues relating to spectrum coordination

The use of certain frequency bands by satellite systems and other radiocommunication services and systems could cause interference to terrestrial networks. Satellite system operators will avoid harmful interference through frequency coordination and other mitigation techniques. The ITU Radio Regulation contains the applicable coordination principles and relevant provisions for satellite systems using geostationary satellites.

Given that non-geostationary systems (NGSO) systems operate at variable azimuths and elevation angles, the gateway operator, in cooperation with the satellite network operator, who is responsible for the coordination of the whole network (gateway- space station-user terminals), must ensure throughout the coordination process that the frequencies used do not cause interference to other radio network users beyond levels accepted in the Radio Regulations relevant provisions.

The successful recording of frequency assignment for a Space Station through ITU Member States for global and/or regional satellite systems shall not in any way imply licensing authorization to provide a service within the territory of another ITU Member states. These Member States notifying satellite network intended to provide public or private communications by means of fixed, mobile or transportable terminals, shall ensure, that space station and network can be operated only from the territory or territories of administrations having authorized such service and stations in compliance with relevant ITU Radio Regulations.

Meanwhile, the authorizing or licencing of a member state to a satellite network or space station to provide services in its territories must be established and operated in such a manner as not to cause harmful interference to the radio services or communication of other member states and which operate in accordance with the provision of the Radio Regulations. Moreover, when these installations take part of in the service of public correspondence or other services governed by the administrative regulation they must, in general, comply with the regulatory provisions for the conduct of such services.[11]

Furthermore, cooperation and coordination between satellite network operators based on the relevant provisions of ITU Radio Regulations are required to ensure equitable use of the frequency bands assigned to the services to safeguard the quality of the products offered and promote competition.

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[11] See also § 1 of Article 6 of the ITU Constitution (No. 37)

[11] See also § 1 of Article 45 (No. 197) and § 3 of Article 48 (No. 204) of the ITU Constitution

b) Access to traffic data

Consistent with applicable national legislation in the country where satellite service has been authorized, satellite system operators or service providers should provide to administrations and/or competent authorities, on a confidential basis, within a reasonable time to any authorized national authority which so requests, agreed satellite traffic data originating in or routed to its national territory; and will assist with measures intended to identify unauthorized traffic flows.

c) Unauthorized uses and users of terminals

Satellite system operators should take the necessary steps in their system design to prevent unauthorized uses and users. For example, some of the NGSO systems have been designed to detect the location of a subscriber and prevent that subscriber from gaining access to the system in territories where the service has not been authorized.

In particular, the conditions governing the entry, use and carriage of visiting terminals should be compliant with national regulations. For instance, this process could be facilitated by implementing the GMPCS Memorandum of Understanding (GMPCS-MoU) and its Arrangements.

d) Standards and interoperability

Satellite system operators should work together and with ITU to develop necessary requirements to ensure adherence to essential technical requirements. Satellite operators should endeavour to secure interoperability with other systems.

e) Numbering and routing

The ITU allocates international dialling codes for countries, geographic areas, and global services. To facilitate the implementation of GMPCS networks, the ITU assigned country code "881" for Global Mobile Satellite Systems (GMSS). Different GMSS operators share this code, and they are identified by the digit following “881”. These allocations and other numbering systems will enable the subscribers to be reached anywhere in the world through one number. In some scenarios, customers of terrestrial wireless networks can be reached through their national cellular number.

f) Confidentiality & security

Securing satellite networks is a complex undertaking given the nature and scope of the satellite ecosystem. As a result, the challenge is ensuring that the entire ecosystem has the right security posture to harden the users against the gamut of attacks that are pervasive in today’s environment. The user of a satellite terminal, particularly a mobile satellite terminal, must be protected against interception, tapping or unauthorized access to the information carried in his communications, subject to national laws. Satellite system operators should provide the necessary capabilities regarding the security of communications. In particular, the user of a satellite terminal must be protected against fraud. The ITU-T has studied methods for protecting confidentiality.

Many satellite systems have taken steps, such as implementing a complex authentication process, to minimize fraud and protect their customers from others who attempt to use the customer's identity. For many satellite systems, protection of personal privacy and security from the unauthorized release of data about an individual subscriber is provided at the same level of protection supplied in terrestrial mobile networks. Inherent in some satellite system design is a provision for user data protection. One method protects the identity of the user by using a

temporary identity. This prevents the association of intercepted data with a particular subscriber. Other methods may also be used to protect user data.

g) Terminal type approval and marking

Type approval, identification and authorization of terminals are fundamental features for the smooth operation of satellite systems.

For GMPCS systems, type-approval of terminals will be made much easier if national regulators, in cooperation with the other players involved in providing GMPCS services, apply relevant articles of GMPCS-MoU and its arrangements.

5.6.2 Operational issues

a) Revenue sharing

One of the keys to the success of satellite system operations will lie in the stakeholders ability to agree on equitable sharing of revenues between concerned players. On the other hand, the players must endeavour to keep tariffs as low as possible to benefit the end-user. According to the network architecture, the costs incurred in setting up a communication via satellite depend on how the communication is routed. Depending on the architecture and business relations, the following entities can share in the revenue, the Government, satellite operator, PSTN operator, gateway operator, and local service provider(s).

b) Local distribution of service

Satellite services should typically be distributed within a country by a commercial legal entity established under national law. The operating agreement between a satellite system operator and a service provider must comply with national regulations including the use of visiting terminals of the same system.

c) Tariffs and technical conditions for interconnection

Most satellite systems do not foresee any technical and/or operational limitations that would prevent interconnection. Interconnection of the NGSO and GEO-MSS systems to the Public switching telecommunication networks/Public land mobile networks (PSTN/PLMN) enable customers to communicate from their mobile terminals to PSTN/PLMN customers and to enable PSTN/PLMN customers to reach the satellite subscribers. MSS-satellite systems' calling patterns varied from calls originating or terminated on the PSTN/PLMN to traffic originating and terminating on a satellite system. Therefore, the PSTN/PLMN plays a significant role in the carriage and termination of traffic. NGSO systems may rely on the PSTN/PLMN to connect customers to the gateway earth stations and the gateway earth stations to connect to data destinations, such as the Internet.

In general, satellite system operators will need to work with the various PSTN/PLMN operators to establish the proper routing of calls from the PSTN/PLMN network to the satellite systems and billing for these calls. In addition, PSTN/PLMN operators will work with the various satellite service providers and operators to develop interconnection arrangements. Such arrangements will vary depending on the design of the various systems and the location of their gateways.

Broadband NGSO systems are designed to be a seamless extension of terrestrial networks. They will interconnect to the PSTN and data backbone (PSDN) to provide the "last kilometre" access link that constitutes the vast majority of network cost. greatest unmet demand lies where these systems can provide the greatest value. In line with national regulations, Satellite gateway

operators must negotiate agreements on tariffs and technical conditions for interconnection and transit agreements with PSTN/PLMN operators. All parties involved must endeavour to keep their cost components at the lowest possible levels, particularly for residential use of satellite services.

d) Domestic usage of satellite services

Although satellite services can be available anywhere, the different architectures of systems bear different cost elements. Identifying and billing such calls could require technical and/or operational agreements to lower those costs.

e) Government charges

In countries where the government imposes taxes on satellite services to their home service provider(s), it is expected that similar taxes, where applicable, will be paid by visiting (mobile) satellite subscribers through their satellite service provider(s), under the fair, transparent and non-discriminatory principles, and in accordance with the international accounting procedure described below. In particular, if applicable, the regulator may examine government charges to ensure fair competition between different systems operating in its country.

f) International accounting procedures

The accounting between service providers of the same satellite network will be determined through normal business negotiations among the interested parties. Satellite system operators will provide traffic data to their service providers to enable them to bill their customers. The satellite system operator should provide traffic data on visiting terminals to both the home service provider and the appropriate visited service providers. The application of the method of exchanging accounts foreseen in the ITU Regulation may be improved since traffic data are collected exclusively by the satellite system operator.

The satellite system operator should provide traffic data on visiting terminals to both the home service provider and the appropriate visited supplier simultaneously; this would enable the home service provider to bill its subscriber for any government charges, where applicable, and the visited service provider to reclaim the charges from the home service provider.

g) Affordable prices

For any telecommunication service to be a viable solution for a country's needs, the issue of the rate charged to the end-user is of obvious importance. For international or national business travellers, the convenience and benefit of communicating or being reached at practically any location will define the threshold of the rates acceptable to this market segment. The attractiveness of non-voice and non-mobile satellite systems lies in the terminal site's easy and cost-effective "construction" at unserved or underserved locations. The prices that the market is willing to pay for these services may vary from country to country, and from sector to sector.

Affordable prices are understood to mean: being at a level to make the services as widely utilized as possible in the country concerned. In a non-competitive environment the national regulatory body may have a significant role in setting the level of the service charges (tariffs). Whereas in situations where there is competition, the tendency is to leave it to market forces to arrive at the final figures. It seems clear that a number of charges, such as interconnection charges - which are external to the satellite system itself - could influence the price to the end-user. Regulators should take the appropriate regulatory decisions concerning interconnection fees, government charges and transit charges - if applicable - to enable satellite service providers to offer affordable prices.

The meaning of affordable prices is also relative, and connected to the affordability for individuals in relation to their income, especially when there are no alternative telecommunications services available. However, customers must be able to choose the most appropriate, lowest cost technology or system in achieving affordable prices. In this context, allowing competition among satellite systems will be instrumental in obtaining affordable prices.

h) Participation in ownership

Local involvement in the operation of satellite seems to be an attractive feature both for decision-makers and for the economic community in Africa. National and local bodies in Africa can benefit from involvement in satellite services through equity ownership in:

(i) the satellite entity;
(ii) local service providers;
(iii) gateways and gateway facilities;
(iv) distribution channels for terminals.

Satellite operators should facilitate participation in ownership by national (local) entities, including ownership in some component of the satellite system, through partnership investment or purchase of publicly-traded securities. However, it should also be clear that even without any capital outlay or participation in ownership of the space segment, countries or economies could be participants in virtually any system through the above-mentioned opportunities and can thus reap the benefits. Depending on each country's size, economy, and policy, the options for the national operators will vary.

i) Transfer of know-how

Transfer of technical and managerial know-how is an important matter for most countries in Africa. Depending on the prevailing local conditions, schemes and programs for transfer of knowhow can be developed between the satellite operator and the national authorities.

Transfer of know-how to the national service provider is in the general interest of the satellite system operators. Transfer of know-how in technical and managerial matters concerning satellite is both desirable and necessary for a country. Satellite entities should commit as part of the introduction of satellite in a country, to take place such transfers. Among the subjects are engineering, maintenance, operations, marketing and billing. Satellite operators should adopt ways and means to transfer know-how effectively and efficiently.

5.6.3 Regulatory issues

a) Universal service and universal access

The issues of universal access and service provision are a fundamental concern and need in most countries in Africa. The regulatory body should focus attention on the ways to implement universal service requirements from a legal perspective and the services covered, e.g., basic telephone service, internet access.

Governments can take two types of action to provide universal service. The first is to set universal service goals under telecommunication improvement plans, and the second is to impose legal obligations on telecommunication carriers to provide or finance universal service. No matter how universal service is financed, there should be transparency.

b) Enforcing compliance

All operators face the risk of fines, suspension or annulment of licences, and confiscation of their equipment if they are discovered to be operating without a licence, whether they are in an African country or elsewhere in the world. Most countries have little difficulty securing enforcement of telecommunications laws, regulations and licensing conditions, including regulations for the satellite sector. To maximize industry compliance, laws and regulations are being designed in recognition of the fundamental characteristics of the business community.

Like all mainstream businesses, satellite and other telecommunications service providers are highly risk averse. This means that business ventures seek, above all else, predictability and consistency. Recognising these basic principles, countries increasingly are developing laws and regulations for the telecommunications sector (along with all other business sectors) that are objective (non-discriminatory), easily understood (transparent) and highly predictable. Such laws and regulations also prohibit government actions that are arbitrary or discriminatory. For example, most mainstream telecommunications service providers would be willing to pay an annual licensing fee to provide satellite services in a country, as long as the fee was reasonable and consistent from year to year.

Mainstream businesses tend to avoid investing in countries that lack objective, transparent and predictable regulatory structures. Administrations are finding that the most sensible way for the government to discourage the development of non-mainstream businesses is to create legal and regulatory conditions conducive to the mainstream business community.

When given the option, consumers – particularly business customers – will purchase services from mainstream businesses instead of non-mainstream businesses. Furthermore, mainstream businesses are often willing to help the government regulate and "police" the participants in an industry segment to help eliminate unfair competition from non-mainstream business ventures. As a result, the best way Administrations have found to ensure compliance with laws, regulations and licensing conditions is to establish a strong mainstream business community through the adoption and use of objective, transparent and predictable laws, regulations and licensing conditions.

c) Fees and tariffs

Any fee associated with the required licences will inevitably be reflected in the cost to local and world-wide customers of satellite services. Therefore, policy decisions relating to licensing fees for frequencies, use of terminals, service provision, universal service funding or any other fee or charge must be evaluated carefully to avoid potentially undesirable consequences and must be carefully evaluated.

In a commercial or competitive environment where new entities are free to develop or provide a service, suitably rebalanced, cost-based tariffs (customer prices) will result. The satellite system operators and service providers, as private commercial entities, are likely to set tariffs according to their costs, and in response to competitive market conditions. By contrast, affordable rates are necessary to achieve universal service objectives. To be able to provide services at affordable tariffs in the context of universal service objectives, some satellite service providers may offer different or special tariff packages with various elements (e.g., local, international, handheld mobile, fixed village or community phones). The introduction of special rates for local communications inside a country (if the system design does not foresee a local gateway in each country, the costs for local communication will have to take routing agreements into account) or for community telecommunications centres, may be a remedy to this problem.

All in all, any fee or charge associated with the required licences will inevitably be reflected in increased charges to local and world-wide users.

d) Global and regional cooperation

Areas in which global and regional cooperation is beneficial or required include among others:

(i) approval of satellite terminals;
(ii) sharing a satellite gateway with a neighbouring country;
(iii) training and transfer of know-how on satellite.

Most sub-regions have one or more organizations devoted to telecommunications development. The work of these organizations is appreciated and should continue, to assist national regulators, satellite companies, and service providers in the region/sub-regions. Cooperation between countries of the region/sub-region is feasible in some situations, e.g., in type-approval of satellite terminals, in the shared use of a gateway, in education and training, etc.

5.7 National and sub-regional case studies in Africa

This section describes the licensing regime for satellite services developed in four African countries (Nigeria, Egypt, Botswana, Cameroon) and the East African Region.

5.7.1 Satellite licensing regime in Nigeria

The Nigeria Communications Commission (NCC) has issued guidelines on commercial satellite communications which regulate the provision and use of all satellite communications services and networks, in whole or in part within Nigeria or on a ship or aircraft registered in Nigeria. In addition to licensing the space segment, authorization requirements for satellite service providers and individual licensing for earth station facilities are mandatory before installing or using any satellite ground equipment.

Authorization of space segment satellite operators

If authorized by a foreign administration, a space segment satellite operator may on its own initiative request the authorization of the NCC to provide services in Nigeria. Upon the authorization of the NCC, the operator is eligible to provide service in Nigeria and the name of that satellite shall be included in the list of authorized space stations maintained by the NCC.

The operator shall also:

a) obtain a permit upon application for landing rights;
b) ensure that the NCC licences any person providing services using its space segment to do so;
c) maintain a database of all the service providers and submit a report to the NCC upon request.
d) submit technical information on the space station, indicating its possible uses, orbiting parameters, frequency bands and geographical areas to be covered (footprints) and any other relevant data;
e) ensure that power flux densities of its transmission signals are within the ITU specified limits when the band in question is shared with terrestrial services.

A single authorization shall be issued in respect of a hybrid satellite. However, such authorization shall be issued with different conditions for each band, for example C, L, Ku, Ka band, since operating conditions may vary from band to band. The tenure of a space segment authorization shall be satellite's life span in orbit as specified by the applicant. A licensee with

an earth station shall provide the location and technical parameters of its equipment. Individual users that are activated through the local representative in Nigeria are exempted from licensing.

Licensing of Earth Stations

a. Licensing of earth stations, space segments, VSAT terminals and landing rights shall be based on availability and in accordance with any licensing method as may be determined by the NCC.
b. Earth Stations in the country specifically used for Telemetry Tracking and Command (TTC) are exempted from licensing fees. Authorization is given for such earth stations after receiving and verifying all the technical information required.
c. A person seeking to establish an earth station shall be a body corporate registered to carry on business in Nigeria and obtain a licence before providing such service. He shall submit simplified technical information on the earth station, indicating its possible uses, frequency bands, the parameters of the space station it is working with and any other relevant data.
d. The licensee shall comply with the provisions of the Act and any other legal and regulatory conditions and standards governing satellite use.

Earth Station in Motion (ESIM)/VSAT

a. Any ESIM/VSAT operating in Nigeria permanently on-board an aircraft, ship or land mobile vehicle must comply with conditions on licensing of earth stations in addition to any other provisions in the Guidelines.
b. A local ESIM/VSAT service provider is licensed under an Individual licensee. The tenure of the individual and frequency licences for an earth station is ten (10) years each.
c. An ESIM/VSAT on board an aircraft, ship or land mobile vehicle requires no licensing where the ESIM/VSAT is within the territorial district of Nigeria for a period not exceeding six weeks provided that the ESIM has been duly registered in its country of origin. A visiting ESIM/VSAT exceeding six weeks temporary stay shall notify the Commission and obtain the necessary permit from the NCC. The visiting ESIM/VSAT shall not cause any interference to any radio system in Nigeria. An ESIM/VSAT must have Control and Monitoring Function to ensure interference free operation.

End-user Terminal

No operating licence is required for the use of portable terminal equipment by end-users. Corporate users with multiple VSAT terminals or ESIM terminals connected to a hub of a licensee are not required to obtain a separate licence for each earth station installed.
The user of a visiting portable terminal exceeding six weeks in Nigeria should notify the NCC of its presence with details of the connectivity of the service and period of stay conveyed.

Fees and charges

The NCC administers the following fees with respect to satellite licences:

a) There is no fee for the space segment landing rights, however, authorization shall be for the life span of the satellite.
b) Spectrum usage fee for earth station(s) registered in Nigeria is based on the economic value of the spectrum.

Type approval

a. All satellite ground stations equipment and portable terminals for end-users, must be type-approved by the NCC before being imported or placed on the market in Nigeria.

Manufacturers are allowed to obtain a general certification for each model, after which users will not be required to type-approve other purchased units of that model.

b. However, type approval maybe waived where the applicant or licensee satisfies the NCC that ITU certification has been given under GMPCS Memorandum of Understanding concerning the said equipment.
c. A visiting portable terminal for end-users or ESIM with type approval certificates from their country of origin are allowed based on mutual recognition of type approval certificates. However, portable terminals for end-users and ESIM permanently operating in Nigeria must be type approved.
d. Self-declaration of conformity by manufacturers is not tenable as an alternative to the requirement of type approval.

5.7.2 Satellite licensing regime in Egypt

The Egypt Telecommunication Regulation Law, Law No. 10 of 2003, is the main legal instrument that define the role of the National Telecom Regulatory Authority (NTRA) and the procedure and obligation on any entity that wants to provide any radiocommunication services. In addition, it is prohibited to establish or operate telecommunication networks without obtaining a license from the NTRA.

NTRA is planning that Foreign satellite operators whose space stations have been coordinated and notified through ITU need to have a license from NTRA for Service provision in Egypt. The emissions to/from satellite inside Egyptian territories need to follow the licensing regime defined for each service:

a. for VSAT services, the satellite operator need to work through an Egyptian service provider.
b. For other services such as ESV and ESIMs, the satellite operator needs to have a license from NTRA.
c. For GMPCS, satellite operator needs to obtain a license and provide the service through one of the Egyptian service provider.
d. Egypt has provision for blanket or class licensing of 2-way VSAT terminals, AMSS terminals, GMPCS terminals, ESIMs terminals.
e. For IoT, satellite operator needs to obtain a license and provide the service through one of the Egyptian service provider.

In addition, NTRA had issued regulatory framework for IoT services which include conditions for provision of service through satellite system. These information can be found from the following link: https://www.tra.gov.eg/wp-content/uploads/2022/03/IoT-Framework-En.pdf.

Type approval of terminals and equipment registration is required. NTRA accept a type of certification from number of labs around the world. These entities can be found from the following link: https://tra.gov.eg/en/regulation/type approval/Pages/Accredited-Bodies.aspx.

The terms and requirements needed to obtain the licence are as follows:

a. The company should have relevant previous experience in the field of provision of space service to be provided;
b. The Company should have adequate financial capacity and solvency to carry out all the terms, conditions and obligations outlined in the licences;
c. The company has entered into a contract with the mobile operator required to work with it (or it should submit a written consent of the operator to work with the company applying for the licence).

The structure of the request for a licence is as follows:

a) Detailed information about the company (in particular): (names of shareholders and percentage of their ownership, the company's address, the authorized person, telephone, fax, etc.).
b) Previous experience of the company:
   (i) Company's Profile;
   (ii) The organizational structure of the company and the names of the shareholders and the percentage of their shares;
   (iii) The company's previous experience in the Egyptian market;
   (iv) The company's experience in the field of provision of the requested space service;
   (v) The company's experience in project management;
c) The financial position of the company:
   (i) The financial capacity of the company;
   (ii) The approved financial statements for the last three years;
   (iii) The company's financing methods (in the past and the present);
d) The technical plan of the company to provide the requested space service:
   (i) The company's plan to implement the project;
   (ii) The technical solutions for emergency response;
   (iii) The technical solutions for securing devices and equipment of the company and the service under scope of this licence;
   (iv) The proposed service level agreement (SLA) with the service operator;
   (v) The contract or proposed contract is to be entered between the company and the operator of the service.
   (vi) The company's marketing plan to provide the services:
      - The size of the market in which the bidder will provide the services, and the competitors' acquisition shares;
      - The size of the market that is expected to be acquire by the bidding company;
      - The strategic marketing plans;
      - The prospective customers.
   (vii) The company's financial plan for the provision of the requested space service:
      - The pricing plan;
      - The expected costs;
      - The financing methods and values of the project;
      - The expected revenues.

The licensee obligation for space services are as follows:

1. The Licensee shall comply with all laws, regulations and decisions in force in Egypt, most notably Telecom Regulation Law No. 10/2003.
2. The Licensee shall provide the licensed services pursuant to the license throughout Egypt and provide them to every customer requesting them.
3. The Licensee shall comply with the NTRA regulatory framework and provide any information required by the NTRA to fulfil its obligations in a timely manner, including accurate information relating to the network systems, operations and subscribers, such as location, transmit power, etc. and any other information as may be required by the NTRA.
4. The Licensee shall ensure that no service is provided or connected to its network without a license or authorization from NTRA.

5. The licensee shall enter into an interconnection agreement with Telecom Egypt or any other Licensee licensed to provide fixed telephone services provided that the agreement includes the systems and bases of financial accounting of passing the traffic exchanged between them and any other interoperability issues, so that the agreement should be submitted to the licensor to approve it before signing it.
6. The Licensee shall abide by the license terms, license provisions and administrative resolutions issued by the NTRA concerning the company's implementation of its obligations outlined in the license.
7. The Licensee shall comply with all the internationally acknowledged standards/protocols, including the environmental and health requirements protocols for providing satellite services as per all standards and specifications.
8. The Licensee shall comply with all the technical standards, specifications and the National Frequency Allocation Table related as determined by the NTRA in addition to ITU recommendations regarding the space services.
9. The Licensee shall obtain all the licenses and the needed administrative approvals of the other official authorities.
10. The Licensee shall provide it's services without discrimination for any reason. It is not entitled to refrain from providing the service without giving reasons subject to the Licensor's estimation at its discretion.
11. The Licensee shall inform the NTRA of any planned change to the licensed activity (e.g. change of orbit, change of owner, replacement of the space station) and seek approval before the change is made.
12. The relevant satellite data shall have been submitted to the ITU in accordance with established ITU procedures.
13. The applicant must describe with the project, including:
    (i) List of frequencies requested and amount of spectrum requested in each band;
    (ii) Orbital location requested;
    (iii) for GSO, indicate the orbital position;
    (iv) for NGSO, the type of orbit (e.g. LEO, MEO, HEO);
    (v) Common name of the proposed satellite;
    (vi) Radio communication service (e.g. FSS, BSS, MSS, EESS, etc.);
    (vii) Nature of the services to be delivered to end users (e.g. broadband Internet; Direct-to-Home television);
    (viii) Intended service area;
    (ix) coverage maps and beam patterns;
    (x) Overall capacity of the satellite expressed in (MHz);
    (xi) Proposed date of entry into service, if applicable;
    (xii) location of the ground stations (e.g. gateways, earth stations);

Failure to comply with conditions of the license may result in the withdrawal of approval or the revocation of a license.

5.7.3 Satellite licensing regime in Botswana

The Communications Regulatory Authority Act, 2012, and the Spectrum Management Strategy reviewed in 2018 is the framework for regulating satellite communications in Botswana. Emission from satellites operated by foreign countries are regulated according to ITU Radio Regulation and its relevant Appendices like AP30, 30A and 30B.

Satellite operators must have commercial or legal presence in country depending on whether Botswana has allowed the satellite operator to include Botswana in its service area during coordination. If Botswana agreed to be included in the satellite service area, the service will be

protected. Therefore, the operator must have a contract with a locally licensed company or the operator itself will have to have a presence in the country for service provision. Provisions for blanket or class licensing of 2-way VSAT terminals and ESIMs terminals are available. Type approval of terminals and equipment registration are required. Type approval is based on type approval from approved laboratories in many European countries.

5.7.4 Satellite licensing regime in Cameroon

The regulations have defined two authorization regimes for the establishment and operation of radio networks: authorization and declaration. In general, the use of earth stations is subject to prior authorization. This authorization can either be a concession for nationwide electronic communications networks open to the public with national coverage or a license for local/regional coverage networks deployment. To provide electronic communications services using Global mobile satellite communication systems (GMPCS) terminals, a declaration to the regulatory authority is required. In addition to the above-mentioned authorization, the use of a radio equipment is subject to the prior obtaining of a frequency assignment from the regulator.

Satellite TV operators are subject to an authorization regime for the exercise of audiovisual activities. Foreign satellite television operators wishing to offer commercial audiovisual services are required to establish locally owned companies.

Very small earth station terminals and small earth stations must be connected to a hub station installed in Cameroon, unless a formal exemption has been issued on a case by case by the Administration in charge of telecommunications.

The regulator issues a frequency assignment for the operation of any type of satellite radio station. This includes earth stations, telemetry, tracking and command (TTC) stations, transportable satellite stations, VSAT, transportable satellite reception stations.

All earth stations must be type approved. Among the requirements for issuing type approval certificate for a given equipment, the type approval certificate issued by the competent authority from the country of origin of the equipment which approval is sought, is to be provided.

The annual fees levied for the use of satellite station includes station control fees, management and regulatory fees and frequency usage fees. The parameters used to calculate the frequency usage fee take into account the antenna's size and the capacity (data bit rates) of the links.

5.7.5 Satellite licensing harmonization in the East African region

The East African Communications Organisation (EACO) has established a framework within EACO for an harmonised approach to domestic licensing of ESIMs and mutual licence recognition (including type approval) of earth stations in motion (ESIMs). This recommendation aims to simplify the national licensing process and facilitate seamless movement of duly authorized/licenced ESIM within EACO to maximise benefit from the possibilities offered by the ESIM technology.

The main elements contained in the framework are as follows:

a) *Point 1. Licensing of ESIMs and Mutual Recognition thereof:*
   i) Licensing process of ESIMs to be harmonised, as much as possible, among the member countries.
   ii) ESIMs to be licenced without the need for individual terminal-by-terminal authorization (e.g. on a class licensing basis).
   iii) Licence is duly issued by EACO member country to be recognised within the territories of other member countries, to grant the possibility for ESIMs to circulate across borders.

b) *Point 2. Type Approvals of Terminals and Mutual Recognition thereof*
   i) ESIMs equipment to meet all specifications in Resolution 156 (WRC-15), Reports ITU-R S.2223, ITU-R S.2357 and, possibly, ETSI EN 303 978, ECC/DEC (13)01 or other mutually agreed specifications.
   ii) Such technical specifications to be the basis for the essential requirements necessary for the type approval of terminals, and the compliance with such technical requirements to be the basis for mutual recognition of type approval.
   iii) Type approval duly given by a member country to be recognised within the territories of other member countries

c) *Point 3. Inspection of ESIM and ESIM Licence and/or Type Approval Certificates*
   i) The aspect of inspection of ESIM to be included, for verification of compliance with applicable regulations.
   ii) The aspect of inspection of license/type approval certificates to be included, to curb abuse and illegal activities under the frameworks/agreements.

d) *Point 4. Customs Clearance for visiting terminals temporarily*
   i) Duly licenced ESIM terminals to be exempted from customs and taxes in the visited country, when they are to operate temporarily.
   ii) The timescale for such temporary use to be indicated, to curb abuse and illegal activities.

6 INTERNATIONAL TRENDS ON LICENSING

This section explores the regionally harmonized framework for satellite services developed by the Inter-American Telecommunication Commission (CITEL) in the Americas and the European Conference of Postal and Telecommunications Administrations (CEPT) in Europe. It shows how these regional organizations are improving the regulatory environment for satellite-based solutions in their respective regions.

6.1 Regulations for provision of satellite services in the Americas

Countries in the Americas have engaged in cooperation within CITEL to clarify and simplify rules governing the provision of satellite services in their countries. Also, they intend to promote the modernization and expansion of telecommunications infrastructure in rural and urban areas through the timely introduction of new technologies and services, particularly broadband technologies. The regulatory framework developed was guided by certain fundamental policy objectives in granting licences, such as:

i) Regulators seek to implement simplified, harmonized regulatory policies that will promote investment and deployment of satellite systems (VSAT, broadband, etc.), and that improve public interests, the economy and well-being of countries;

ii) Regulators grant licences to earth stations and try to ensure that licensees and users are protected from harmful interference;
iii) The information on policies, criteria, administrative procedures, standards and rates that the Member States of CITEL apply to grant concessions, licenses and authorizations for radio spectrum utilization and orbital positions of satellite networks should be provided through information media.

The major decisions of CITEL related to satellite services are presented below.

a) *Resolution PCC. III/RES. 107 (XVI – 00) - Information regarding landing rights granted by the administrations of countries in the Americas to space station operators in their territories*

This Resolution urges the CITEL Administrations to develop sections on their pages on the Internet related to "Space Station Landing Rights," containing at least the information indicated below, and inform the Secretariat of CITEL of the access addresses of their respective sites on the Internet.

Legal concepts applicable:
Permit, Authorization, Concession, License, Permission to operate;

Technical requirements**:**
Space station denomination, Space station's expected lifetime, Type of satellite service with which the space station is associated, Types of services to be provided through the space station, Owner of the space station, Country of origin of the space station, Documentation regarding the license granted by the "Regulatory Body" of the country of origin to the space segment provider, Documentation on the status of Advance Publication relative of the space station, Documentation on the status of technical coordination of the space station at the ITU.

b) *Recommendation PCC.II/REC. 6 (II-03) - Guidelines for the implementation of national regulations that facilitate the deployment of satellite services, particularly broadband services, in the Americas*

This Recommendation entails encouraging CITEL Administrations to develop broadband via satellite by implementing appropriate and flexible regulatory frameworks that will allow for the rapid implementation, access and use of broadband services. In particular, without prejudice to the application of the national regulations associated with the provision of services and the installation and operation of networks, administrations should consider the possibility of including in their national regulations concepts associated with:

i) <u>"Block" or "Generic" Earth Station Licensing</u>: To the extent possible, streamline licensing procedures to facilitate the rapid deployment of satellite earth stations and services. For satellite frequency bands that are not shared with other services, streamline satellite earth station licensing by establishing a mechanism to authorize large numbers of technically-identical satellite earth stations in a single license "blocks". Such a license could be site-specific or non-site-specific (the most efficient approach).

ii) <u>Regional or International Hub Requirements</u>: Permit, to the extent possible, the use of systems whose hub stations are located anywhere in the region, while recognizing the needs of some Administrations for user control and security.

iii) Availability of Procedures, Regulations, and Applications On-Line: In conformance with each nation's legislative and regulatory framework, make current regulations and regulatory requirements publicly available online, and establish mechanisms that permit the electronic application and licensing for satellite earth stations. Such licensing can accommodate site-specific and non-site-specific Block or Generic Earth Station Licensing.

iv) Landing Rights: Minimize regulatory requirements for landing rights, taking into account the technical information already publicly available from the ITU for satellite network coordination, and the space station licensing process undertaken by the notifying Administration.

v) Local Presence Requirements: To the extent allowed by national laws, minimize the local presence requirements in-country.

vi) Consumer Protection/Public Safety: Promote public information on customer rights, quality of service, authorized operators, public safety and health protection.

vii) Additional Means of Promoting Satellite Broadband Deployment: Develop programs to foster the deployment of satellite services to rural, remote, underserved communities, and for other special social purposes. Successful programs have included "capacity credits", tax incentives, loan programs, etc.

viii) Equipment Certification and Homologation: Increase awareness of and recognize the work done by PCC.I on the CITEL Mutual Recognition Agreement (MRA) seeks to eliminate the duplication of the homologation and certification processes in the Member States.

c) Recommendation PCC.II/REC. 14 (VI-05) - Procedures for operation of earth stations on vessels (ESVs) which aims to provide common procedures CITEL Administrations could use for the operation of ESV networks and the use of ESVs

This Recommendation guides the recommended provisions that licensing Administrations, license holders, and CITEL Administrations should apply or rely upon with regard to the operation within Region 2 of ESVs in the fixed-satellite service bands at 5925-6425/3700-4200 MHz and 14-14.5/10.95-11.2 and 11.45-12.2 GHz. These measures are designed to facilitate the introduction and regular use of ESVs within Region 2 while ensuring that such stations follow the applicable and appropriate guidelines (consistent with Resolution 902 (WRC-03)) and thus do not present any potential cause unacceptable interference to the services of other concerned Administrations.

The emissions of ESVs operating with ESV hub earth stations licensed by CITEL Administrations are controlled by a network control facility through an ESV hub earth station, without regard to the vessel's country of registration. To ensure adequate protection of co-frequency terrestrial and fixed-satellite service systems from harmful interference, this Recommendation sets forth the procedures for the use of ESVs that CITEL Administrations should follow when authorizing ESV network hub earth station operations within their territory or ESV terminal operations on board their registered vessels in the 5925-6425 MHz and 14-14.5 GHz bands. Also CITEL Administrations should take into account that the operation within the territory, including territorial waters, of a CITEL Administration, of an ESV network in the bands 5925-6425 MHz and 14-14.5 GHz in accordance with the provisions outlined in this Recommendation is adequate to protect co-frequency terrestrial and fixed-satellite service operations from harmful interference.

CITEL Administrations should also consider the possibility to make available their data base of terrestrial stations operating in the 5925-6425 MHz or 14-14.5 GHz bands or determine those that could be affected by ESV operations to identifying possible frequencies in those bands for ESV use that would avoid potential interference.

d) Recommendation PCC.II/REC. 2 (II-03) - Harmonized licensing of GMPCS service networks

Noting that many CITEL Administrations issue two separate licenses for each GMPCS network, namely use of spectrum and provision of services, this Recommendation endeavours CITEL member countries to develop a set of harmonized licensing guidelines for regional application. The guidelines should provide for ownership changes through the provision of a single set of information focusing on financial viability, rather than requiring the restart of the licensing process from the beginning, e.g.

(i) Full name, company address, and registration details of the company;
(ii) Principal officers of the company;
(iii) Name and address of contact person for licensing;
(iv) Name and address for billing purposes;
(v) Date for the start of service or transfer of responsibility for service;
(vi) Details of principal shareholders in the new company;
(vii) Summary of the current business plan.

When the ownership of the system changes but the technical and operational parameters of that system do not change, the guidelines will allow for "fast track" licensing by not requiring applicants to re-submit technical and operational information.

e) Recommendation PCC.II/REC. 12 (VI-05) - Procedures and guidelines for block or generic licensing for earth station operating in frequency bands not shared with other systems

This Recommendation guides the implementation of the "block" or "generic" earth station licensing as a mechanism to authorize large numbers of technically-identical satellite earth stations in a single license or in "blocks" which can allow the rapid implementation and use of earth stations. Guidelines for site-specific process and non-site specific process or spectrum licensing are provided.

For site-specific process, before beginning block licensing of Typical Earth Stations (TES) it is necessary to license the hub station. The hub station is licensed individually. The Service Provider (SP) sends to the National Administrations (NA) the application form with the TES technical characteristics. Below are presented some technical characteristics that the NA can request to the SP in the first filling:

(i) Name of the TES
(ii) Name of the space station used
(iii) Antenna data (gain, diameter, type and industry)
(iv) High power amplifier data (power, type and industry)
(v) Frequency data.

After the TES technical characteristics were filed and the beginning of the TES installation was authorized, the SP sends monthly to the NA, at the previously established date by the NA, information on the number of terminals having the same technical characteristics as the TES installed/uninstalled in the previous month. Below some information is included that can be sent monthly to the NA by the SP:

(i) Name of TES
(ii) Model of antenna
(iii) Number of TES installed in the previous month
(iv) Number of TES uninstalled in the previous month.

After the payment of the taxes (if applicable), the NA produces and sends to the SP the updated Block License reflecting the quantity of operating terminal with the revised TES characteristics up to the previous month. The SP sends to the NA, by the date established by the NA, complementary information/documents (if applicable) related to the TES installed/uninstalled in the previous month. The NA, after receiving this information, will send the document for the payment of the licensing rights (if applicable) associated with the balance resulting from the number of earth stations with the same TES characteristics that were installed/uninstalled in the previous month.

For non site-specific process or spectrum licensing, the Service Provider would submit to the National Administration an application that outlines the typical earth station characteristics. A spectrum license would be issued If the application is found complete and meets the National Administration requirements. The spectrum license would allow the service provider to install an unlimited number of typical earth stations. The Service Provider would pay a fixed annual fee for the spectrum license. The Service Provider needs only to return to the National Administration to change the typical earth station characteristics. A spectrum license is issued when the applicant accepts in writing the license conditions and pays the license fees.

f) Recommendation PCC.II/REC. 27 (XIV-09) - Notification of earth stations operating in the fixed-satellite service (FSS) (space-to-earth)

This Recommendation aims to encourage Administrations in the Americas to follow the notification procedures of the ITU-BR for FSS earth stations which are located, or planned to be located, within their territory and are operated in the fixed-satellite service (space-to-Earth), in bands that are shared with other services, and which could receive interference from transmitters located within the territory of other Administrations. The steps to be followed for notifying FSS earth stations are set forth as follows:

1. Obtain the receive characteristics of FSS earth stations operating or planned to operate as part of an existing or planned satellite network (e.g. in the 3400-4 200 MHz band);
2. Determine if these characteristics are already included in satellite network filings made to the ITU as typical earth stations;
3. Determine the locations of the existing or planned to receive earth stations to be notified. Ensure that the FSS earth station locations which are or may be located close to the boundaries of other countries are taken into account;
4. Make electronic filings to the ITU-BR which are in accordance with the provisions of the Radio Regulations using the BR software. Assignments to specific earth stations may reach the BR not more than three years before the assignments are brought into use and may be recorded in the master register only after the associated space station is recorded. RR Appendix **4** identifies what information must be filed to obtain notification under RR Article **11**[12];
5. Once an earth station is registered with the ITU, it will be taken into account in the coordination and notification processes.

Administrations are encouraged to develop bi-lateral agreements with neighbouring Administrations when implementing mobile and fixed-satellite services in contiguous countries. The recommendation contains a form that FSS satellite operators may use to collect and share

[12] Articles **9** and **11** of the Radio Regulations contain the procedures for effecting coordination or obtaining agreement and notification and recording of frequency assignments, including those applicable to specific FSS earth stations. Appendix **7** of the Radio Regulations establishes coordination distances of terrestrial stations from specific FSS earth stations.

information among themselves on interference events occurring to FSS receive earth stations as a basis for developing activities that result in the future protection of the stations.

It should be noted that when identifying any administration with which coordination may be required under RR No.**9.21**, the ITU BR will only be able to carry out such identification if a specific FSS earth station has been filed with the ITU BR. Therefore, it recognizes that registration of FSS earth stations at the ITU can provide a basis for protecting earth stations close to international borders.

g) *Recommendation PCC.II/REC. 36 (XX-12) - Facilitating the introduction of broadband FSS Ka-band systems in the Americas*

This Recommendation invites CITEL Administrations to implement national provisions and procedures to facilitate the implementation of Ka-band FSS systems intended to provide broadband services to ubiquitously deployed terminals in portions of frequency bands 17.7-20.2 GHz (space-to-Earth) and 27.5-30.0 GHz (Earth-to-space). In the development of these national provisions, Administrations should consider provisions to:

i) facilitate deployment of fixed-satellite service broadband services and the associated ubiquitously deployed earth stations in the frequency bands identified for high density FSS in Region 2 in ITU Radio Regulations 5.516B, specifically 18.3-19.3, 19.7-20.2, 28.35-29.1, 29.25-30 GHz, including class licensing[13];
ii) avoid unacceptable interference between different satellite systems and the ubiquitously deployed FSS by considering earth stations technical parameters;
iii) take into account the need for access to spectrum by hub or gateway FSS earth stations, including in bands shared with terrestrial services on a coordinated basis;
iv) take into account the need to share Ka-band spectrum between GSO and non-GSO FSS systems in order to benefit both types of satellite services to the countries of Region 2.

h) *Recommendation PCC.II/REC. 45 (XXV-15) - Provisions to prevent the illegal use of receiver devices for subscription satellite television*

This Recommendation invites Member States to set forth provisions to prevent importation, marketing and use of satellite receiver devices with decryption capabilities to illegally access signals from subscription satellite television systems without due authorization or which could be modified for that purpose. Subscription satellite television service providers should make every effort to keep technical means and procedures for conditional access to broadcast signals up-to-date.

It is acknowledged that the adoption of such measures at the regional level would help prevent cross border trade in this type of devices, and would consequently significantly discourage illegal access to signals destined to subscription satellite television, with a variety of inherent benefits.

i) *Recommendation PCC.II/REC. 50 (XXVII-16) - Authorization of earth stations in motion communicating with geostationary space stations in the fixed satellite service in the frequency bands 19.7-20.2 GHz and 29.5-30.0 GHz in the Americas*

This Recommendation addresses the issue of the increasing need for mobile communications, including global broadband satellite services, considering that some of this need can be met by allowing earth stations that can operate while stationary or in motion on platforms (such as ships, aircraft and land vehicles) to communicate with space stations of the FSS operating in the

[13] A "class" earth station license is a single authorization covering a large number of earth stations associated with a given satellite system.

frequency bands 19.7-20.2 GHz and 29.5-30.0 GHz. Therefore, CITEL Administrations are invited to adopt national provisions to facilitate the deployment of ESIM consistent with the framework adopted by WRC-15 in the band 19.7-20.2 GHz (space-to-Earth) and 29.5-30.0 GHz (Earth-to-space).

j) *Recommendation PCC.II/REC. 52 (XXVII-16) - Generic or blanket licensing regimes for ubiquitously deployed fixed satellite service earth stations*

This Recommendation urges CITEL administrations, in the preparation of their national satellite regulations, to implement provisions for generic or blanket (non-individual) licensing, for ubiquitously deployed two-ways FSS earth stations where feasible and according to their National frequency allocation tables. To obtain the full benefits of FSS applications, it is considered important that domestic licensing regimes allow a large number of two-way earth stations falling under defined technical criteria, to operate under one single license without the need to identify their specific locations.

k) *Recommendation PCC.II/REC. 58 (XXX-17) - Guidance on a licensing framework for authorization and operation of earth stations in motion communicating with geostationary space stations in the fixed satellite service in the frequency bands 10.95-11.2 GHz, 11.45-11.7 GHz, 11.7-12.2 GHz and 14.0-14.5 GHz in the Americas*

While noting that there is an increasing need for mobile communications, including satellite services, and some of this need can be in part met by allowing earth stations to operate while stationary or in motion on platforms (such as vessels, aircrafts and vehicles) to communicate with space stations of the FSS, this Recommendation encourages CITEL Administrations to implement a generic or blanket licensing framework to facilitate the deployment of earth stations on board vessels (ESV), vehicle-mounted earth stations (VMES) and earth stations aboard aircraft (ESAA) communicating with space stations in the fixed satellite service in the bands 10.95-11.2 GHz (space-to-Earth), 11.45-11.7 GHz (space-to-Earth), 11.7-12.2 GHz (space-to-Earth) and 14.0-14.5 GHz (Earth-to-space.

6.2 Harmonization of satellite regulation in Europe

Licensing is an appropriate tool for administrations to regulate radio equipment and the effective use of the frequency spectrum and avoid harmful interference. CEPT Administrations cooperate, in close consultation with their industries, to produce regulatory frameworks conducive to promoting the European communication industries while giving a fair deal to consumers.

6.2.1 Licensing policy

In general the *Conférence Européenne des Administrations des Postes et Télécommunications* (CEPT) administrations apply similar systems of licensing and exemption from individual licensing. However, different criteria to decide whether radio equipment should be licensed or exempted from an individual licence. CEPT support the development of One Stop Shop (OSS) for satellite licences and authorizations, common and simplified licensing application forms, and comprehensive licensing initiatives to streamline regulatory regime across Europe.

European Union (EU) countries are implementing a general authorisation system. As opposed to blanket licences - which are still administrative acts or explicit decisions – general authorisations no longer require license applications to be made prior to providing service or running a network. Administrations might require a notification, including basic information on the operator, the network location, the type of service provided, etc. However, the service can

be offered under general authorization and cannot be put on hold awaiting a reply or consent of the Administration.

Also, when radio equipment is subject to an exemption from individual licensing, anyone can have installed and use the radio equipment without any prior individual permission from the administration. Furthermore, the administration will not register the individual equipment. The use of the equipment can be subject to general provisions or general licence.

Over the years, the CEPT developed several regulatory measures (i.e. ECC Decisions etc.) to facilitate the exemption from individual licensing and free circulation and use of earth stations., These satellites earth stations included mobile earth stations and earth stations on mobile platforms (ESOMP/ESIM), which comply with a certain standards and operate within identified frequency bands. These measures are designed to simplify procedures for moving satellite terminals across country borders and using them without the need for individual licences. Three different levels of free circulation and use of radio equipment within CEPT member countries can be identified:
1. free circulation without permission of using the radio equipment;
2. free circulation with permission of using the radio equipment;
3. free circulation with the permission of placing the radio equipment on the market.

The regulatory frameworks established by the CEPT for earth stations were underpinned by the legal framework established by the European Union for licensing. Article 5 of the Authorisation Directive (Directive 2002/20/EC) requires the use of spectrum to be facilitated under general authorisations, where, amongst other things, the risk of harmful interference to other radio services is negligible. The Radio Equipment (RE) Directive (2014/53/EU) (including its forerunner Radio and Telecommunication Terminal Equipment (R&TTE) Directive (1999/5/EC)) ensures a single market for radio equipment by setting essential requirements for safety and health, electromagnetic compatibility, and the efficient use of the radio spectrum. The Radio Equipment Directive applies to all products using the radio frequency spectrum. The CEPT, in its ERC Recommendation 01-07, adopted in 1995 and revised in 2004, also recommended the harmonised criteria for exempting radio equipment from individual licensing. These regulatory frameworks, enshrined in many Electronic Communications Committee (ECC) Decisions, provided the basis for administrations to exempt many types of radio equipment, including satellite terminals, from individual licensing.

Also, the European Community has implemented legislation that eliminates government type approvals of satellite and other telecom terminals, introducing harmonized standards and certification procedures to be issued by independent laboratories. This change is being brought about with the RE Directive which introduces a system based on manufacturers' declaration of conformity and relaxation of the regulatory constraints on the free movement and using terminal equipment.

6.2.2 Framework for the deployment of satellite applications

The following ECC Decisions give the framework on how CEPT approaches satellite applications in certain frequency bands and how, in some cases, the exemption is warranted since the terminals share the same characteristics.

i) ECC Decision (03)04 - Exemption from Individual Licensing of Very Small Aperture Terminals (VSAT) operating in the frequency bands 14.25-14.50 GHz Earth-to-space and 10.70-11.70 GHz space-to-Earth

This Decision intends to provide for licence exemption of Very Small Aperture Terminals (VSAT) within the CEPT. The European Telecommunication Standards Institute (ETSI) provides specifications for the standardisation of the characteristics of VSAT operating as part of a satellite network (e.g. star, mesh or point-to-point) used for the distribution of information (see European Standard EN 301 428). This VSAT have the following characteristics:

1. They operate in one or more frequency ranges in the exclusive part of the following bands allocated to the fixed satellite services (FSS):
    a) 14.00 GHz to 14.25 GHz (Earth-to-space)
    b) 12.50 GHz to 12.75 GHz (space-to-Earth)

    or in the shared parts of the following band, allocated to the FSS and Fixed Services (FS):
    a) 14.25 GHz to 14.50 GHz (Earth-to-space)
    b) 10.70 GHz to 11.70 GHz (space-to-Earth);
2. They operate with geostationary satellites and the terminals are envisaged for unattended operation, having an antenna diameter up to 3.8 m;
3. The maximum e.i.r.p. of VSAT shall be limited to 50 dBW;
4. The maximum e.i.r.p. of VSAT operating within TDMA networks shall be respected after taking into consideration the duty cycle;
5. Where justified, administrations may require a simple form of registration.

ii) ECC Decision (06)03 - Exemption from Individual Licensing of high e.i.r.p. satellite terminals (HEST) operating within the frequency bands 10.70-12.75 GHz or 19.70-20.20 GHz space-to Earth and 14.00-14.25 GHz or 29.50-30.00 GHz Earth-to space

This Decision aims to exempt from individual licensing satellite terminals operating with geostationary satellites as part of the fixed satellite service (FSS) within the frequency bands 10.70-12.75 GHz or 19.7-20.2 GHz (space-to-Earth) and 14.00-14.25 GHz or 29.50-30.00 GHz (Earth-to-space), and the broadcasting satellite service (BSS) within the frequency bands 11.70-12.50 GHz (space-to-Earth). The satellite terminals are exempted from individual licensing because they fulfil the criteria for exemption listed in ERC Recommendation 01-07. They shall however comply with the following conditions:

a) operate under the control of the satellite system;
b) provide digital communications;
c) e.i.r.p. above 34 dBW and less than 60 dBW.

iii) ECC Decision (05)10 - Free circulation and use of Earth Stations on board Vessels (ESV) operating in fixed satellite service networks in the frequency bands 14-14.5 GHz (Earth-to-space), 10.7-11.7 GHz (space-to-Earth) and 12.5-12.75 GHz (space-to-Earth)

This Decision applies only to ESV operating in the frequency bands 14.0-14.5 GHz (Earth-to-space), 10.7-11.7 GHz and 12.5-12.75 GHz (space-to-Earth) fulfilling the following conditions:

a) complying with the relevant European Telecommunication Standard (EN 302 340);
b) having an antenna size of 0.6 m or larger;
c) operating under the control of a network control facility;
d) operating under a satellite network where the ESV network operator or other organisation with control over ESV transmissions has notified the European Communications Office (The Office) that those ESV operating within their system or under their control comply with all the requirements of this Decision, including any conditions notified to The Office by administrations, and has provided the required contact and technical information.

Administrations should make available the information which defines the geographic areas within which restrictions may apply to ESV to The Office. This information is then made available to ESV operators through the facilities of the Office web site. ESV operators are required to comply with the restrictions defined by the administrations and provided to The Office. They are also required to register their networks with The Office and provide certain technical and operational information about their networks.

iv) ECC Decision (19)04- The harmonised use of spectrum, free circulation and use of earth stations on-board aircraft operating with GSO FSS networks and NGSO FSS systems in the frequency bands 12.75-13.25 GHz (Earth-to-space) and 10.7-12.75 GHz (space-to-Earth)

The purpose of this Decision is to designate the frequency band 12.75-13.25 GHz for the use by earth stations on-board aircraft operating to GSO FSS networks and NGSO FSS systems, and to facilitate their free circulation and use, when such earth stations are licensed by the administration of the country where the aircraft is registered.

The AES have the following characteristics:

a) They operate under the control of a network control facility;
b) an e.i.r.p. not greater than 50 dBW;
c) Earth stations on-board aircraft that use closed-loop tracking of the satellite signal shall employ an algorithm that is resistant to capturing and tracking signals from nearby satellite. The earth stations shall immediately cease transmissions when they detect that unintended satellite tracking has happened or is about to happen;
d) Earth stations on-board aircraft shall be self-monitoring and should a fault which could cause harmful interference to the fixed service and/or unacceptable interference to other GSO FSS networks and NGSO FSS systems be detected, the earth stations on-board aircraft must automatically cease its transmissions;
e) The earth stations on-board aircraft either conform to the ETSI EN 302 186 for GSO FSS networks and ETSI EN 303 984 for NGSO FSS systems or to other conformity assessment procedures set out in the Directive 2014/53/EU (RED).

In return for complying with this Decision's requirements, AES are granted free circulation and use, and AES operators are exempted from the requirement to obtain licences from CEPT administrations. However, most CEPT administrations license radio equipment on-board aircrafts registered in their country and some may also require AES installed on aircrafts registered in their country to be licensed. This Decision retains the right of administrations to require individual AES terminals to be licensed or exempted from individual licensing.

v) *ECC Decision (05)11 - Free circulation and use of Aircraft Earth Stations (AES) in the frequency bands 14-14.5 GHz (Earth-to-space), 10.7-11.7 GHz (space-to-Earth) and 12.5-12.75 GHz (space-to-Earth)*

The purpose of this Decision is to designate the frequency band 14.0-14.5 GHz (Earth-to-space), 10.7-11.7 GHz and 12.5-12.75 GHz (space-to-Earth) for the use by Aircraft Earth Stations (AES) and enable operation within CEPT countries of AES that have been authorised by for the installation and for their operations by the national regulatory authority and/or civil aviation authority in the country where the aircraft are registered.

AES are mobile earth stations in the aeronautical mobile-satellite service located on board aircraft and operate in the secondary mobile satellite service (MSS) frequency allocations at 14 GHz. They are intended to provide non-safety related broadband data communication services

(e.g. internet and other type of data services) to on board aircraft using their own data equipment (e.g. laptop computer or PDA) or one provided by the airline.
The AES have the following characteristics:

a) They operate under the control of a network control facility;
b) an e.i.r.p. not greater than 50 dBW;
c) They operate with geostationary orbiting satellites;
d) The equipment is installed on board aircraft for unattended operation;
e) The AES emissions comply with the provisions of ETSI EN 302 186 or similar technical specifications;
f) The AES operations comply with the provisions of Recommendation ITU-R M.1643 to protect the fixed service (FS), FSS and radio astronomy service (RAS).

Administrations shall allow free circulation and use of AES that satisfy the provisions of this Decision. Some administrations may require that the AMSS network operator obtain a frequency authorisation is due to specific national requirements. In contrast other administrations may require some form of notification, or exempt the AMSS network operator from these two requirements. To resolve interference situations, AMSS network operators should provide a notification to the Office relating to the operation of their network.

vi) ECC/DEC/(18)04 - Harmonised use, exemption from individual licensing and free circulation and use of land based Earth Stations In-Motion (ESIM) operating with GSO FSS satellite systems in the frequency bands 10.7-12.75 GHz and 14.0-14.5 GHz

This Decision addresses the harmonised use, exemption from individual licensing, and free circulation and use of land based earth stations in-motion (ESIM) operating to Ku-band GSO satellite networks. It provides a regulatory framework for authorising land based ESIM because such deployment will not cause harmful interference to other authorised services. In particular, this decision establishes the technical conditions necessary to ensure harmful interference is not caused by land based ESIM to stations of the radio astronomy service (RAS) and fixed service (FS).
Land based ESIM operating to GSO FSS satellite networks in the frequency bands 10.712.75 GHz and 14.0-14.5 GHz shall comply with the following technical and operational requirements:

1. The land based ESIM shall operate under the control of a Network Control Facility (NCF);
2. The design, coordination and operation of the land based ESIM shall take into account the following factors:
    a. antenna mis-pointing;
    b. variations in the antenna pattern;
    c. variations in the transmit e.i.r.p.;
3. Land based ESIM that use closed-loop tracking of the satellite signal shall employ an algorithm that is resistant to capturing and tracking signals from the nearby satellite. The earth stations shall immediately cease transmissions when they detect that unintended satellite tracking has happened or is about to happen;
4. The land based ESIM shall cease transmissions in protection zones in frequency bands where FS and RAS stations are operated;
5. Land based ESIM shall conform to the Harmonised European Standard EN 302 977 for vehicle-mounted earth stations or EN 302 448 for earth stations on trains.
6. They shall operate on a non-protected basis with regard to the fixed service stations of the frequency band 10.7-11.7 GHz;
7. They shall maintain compatibility with fixed and radio astronomy services.

vii) ECC Decision (12)01 - Exemption from individual licensing and free circulation and use of terrestrial and satellite mobile terminals operating under the control of networks

The aim of this Decision is, with the exception of satellite terminals installed permanently on maritime vessels or aircraft, to exempt from individual licensing and allow the free circulation and use of the satellite mobile terminals operating under the control of satellite networks, capable of providing electronic communications services in the following frequency bands, or parts of the frequency bands: 1525 - 1544 MHz, 1545 - 1559 MHz, 1610 - 1626.5 MHz, 1626.5 - 1645.5 MHz, 1646.5 - 1660.5 MHz, 1670 - 1675 MHz, 2170 - 2200 MHz and 2483.5 - 2500 MHz identified for the satellite component of IMT-2000 in accordance with Resolution 212 (Rev.WRC-15) and Resolution 225 (Rev.WRC-12). Harmonised standards for the equipment operating in the above listed frequency bands are contained in the European Common Allocation (ECA) Table (ERC Report 25).

Some CEPT administrations may require that satellite network operator obtain frequency authorization due to national regulatory requirements.

viii) ECC Decision (13)01 - Harmonised use, free circulation and exemption from individual licensing of Earth Stations On Mobile Platforms (ESOMP) within the frequency bands 17.3-20.2 GHz and 27.5-30.0 GHz

The purpose of this ECC Decision is to:

a. harmonise the use and allow the free circulation and exemption from individual licensing of ESOMP of geostationary satellite networks operating within the frequency bands 17.3-20.2 GHz (receive band) and 27.5-30 GHz (transmit band);
b. apply the technical conditions necessary to ensure harmful interference is not caused by ESOMP to stations of the FSS, FS and other services.

This ESOMP shall comply with the following technical and operational requirements:

1. ESOMP networks shall operate under the control of a Network Control Facility (NCF);
2. In order to protect other satellite networks and systems, ESOMP networks shall be operated in such a manner that the aggregate off-axis e.i.r.p. levels produced by all co-frequency earth stations of each network are not greater than the levels that have been coordinated for the typical earth station(s) pertaining to fixed-satellite service networks where FSS transponders are used;
3. The design, coordination and operation of ESOMP shall, at least, account for the following factors which could vary the aggregate off-axis e.i.r.p. levels generated by:
    a. antenna mis-pointing;
    b. variations in the antenna pattern;
    c. variations in the transmit e.i.r.p..
4. ESOMP that use closed-loop tracking of the satellite signal shall employ an algorithm resistant to capturing and tracking adjacent satellite signals. ESOMP shall immediately inhibit transmissions when they detect that unintended satellite tracking has happened or is about to happen;
5. ESOMP shall be self-monitoring and should a fault which can cause harmful interference to FSS or terrestrial networks be detected, the ESOMP must automatically cease its transmissions;

6. ESOMP shall be in conformance with the Harmonised European Standard EN 303 978[14], which may also be demonstrated by compliance with equivalent technical specifications (in the sense of art. 3(2) of the Radio Equipment Directive);
7. ESOMP shall comply with the following requirements established to ensure compliance with aircraft high intensity radiated field (HIRF) protection criteria based on ECC Report 272, using a maximum HIRF field strength of 150 V/m:
    a. The maximum e.i.r.p. of ESOMPs installed on aircraft operating within the airfield boundary including operations on the ground shall be limited to 58.4 dBW;
    b. The maximum e.i.r.p. of land-based ESOMPs operating within the airfield boundary shall be limited to 52.4 dBW;
    c. The maximum e.i.r.p. of ESOMPs not covered in a) and b), outside the airfield boundary or on vessels, shall be limited to 60 dBW;
    d. The maximum e.i.r.p. of ESOMPs, as defined above, operating within TDMA networks shall be respected after considering the duty cycle (see section 3.3 and 3.4 of ECC Report 272).

ESOMP operating within the frequency bands 17.3-19.7 GHz and 27.5-29.5 GHz must also comply with the following additional technical and operational requirements:

1. In the territory of any administration, the off-axis[15] e.i.r.p. spectral density radiated by any ESOMP into the FS bands (i.e. 27.8285 - 28.4445 GHz, 28.8365 - 28.9485 GHz (where applicable) and 28.9485 - 29.4525 GHz) shall be limited to -35 dBW/MHz. This limit shall, in any case, be met by ESOMP on land, on territorial sea or on internal waters, at a direction of 3 degrees or less above the local horizontal plane at the ESOMP terminal;
2. In the territory of any administration, ESOMP shall not have their transmit occupied band edges closer than 10 MHz from the edges of the bands identified by that administration for FS operation;
3. The antenna elevation angle shall be higher than 3 degrees;
4. In the band 28.8365 - 28.9485 GHz, the PFD threshold values in paragraphs 6 and 7 shall apply to the territory of any administration which authorises FS systems in this band and shall not be exceeded, unless prior agreement has been given by the concerned administration(s) to exceed these values;
5. In the bands 27.8285 - 28.4445 GHz and 28.9485 - 29.4525 GHz, the PFD threshold values in paragraphs 6 and 7 shall apply to the territory of all CEPT administrations and shall not be exceeded, unless prior agreement has been given by the concerned administration(s) to exceed these values;
6. For ESOMP installed on aircraft the PFD values (dB(W/m^2) in a reference bandwidth of 14 MHz on the ground are the following:

$$
\begin{aligned}
&-124.7 \text{ for } 0° \le \delta \le 0.01° \\
&-120.9 + 1.9 \log10(\delta) \text{ for } 0.01° < \delta \le 0.3° \\
&-116.2 + 11.0 \log10(\delta) \text{ for } 0.3° < \delta \le 1.0° \\
&-116.2 + 18.0 \log10(\delta) \text{ for } 1.0° < \delta \le 2.0° \\
&-117.9 + 23.7 \log10(\delta) \text{ for } 2.0° < \delta \le 8.0° \\
&-96.5 \text{ for } 8.0° < \delta \le 90.0°
\end{aligned}
$$

where δ is the angle of arrival at the Earth's surface (degrees).

[14] "Satellite Earth Stations and Systems (SES); Harmonised EN for Earth Stations on Mobile Platforms (ESOMP) transmitting towards satellites in geostationary orbit in the 27.5 GHz to 30.0 GHz frequency bands covering essential requirements under article 3.2 of the Directive 2014/53/EU"

[15] Off-axis refers to angles greater than 7° from the axis of the main beam or to angles greater than the declared minimum elevation angle of the ESOMP, whichever is lower.

7. The PFD values above are not defined as under "free-space" conditions. Hence, when assessing ESOMP compliance with this PFD mask, atmospheric absorption and any attenuation due to the aircraft fuselage shall be taken into account [16];
8. For ESOMP installed on vessels, the PFD threshold value is -109 dB(W/m2) in a reference bandwidth of 14 MHz at the height of 20 metres above mean sea level at the low-water mark of the territory of the administrations defined in paragraphs 4 and 5 above [17];
9. For ensuring compliance with the above PFD provisions ESOMP shall have self-monitoring functions and automatic mechanisms (locally, or under the control of the NCF) to reduce its e.i.r.p. or cease transmissions;
10. National limitations applicable to uncoordinated FSS earth stations to avoid cross-border interference to fixed or mobile services in the same band in an adjacent country shall apply to land based ESOMP and ESOMP operating on territorial sea and on inland waterways in the same country as the uncoordinated FSS earth stations.

This Decision places an obligation on any ESOMP operator, intending to operate ESOMP within the framework of this ECC Decision, to submit a declaration to the Office that the operator's NGSO system complies with the requirements of this Decision, and provide details of a designated point of contact. Also, ESOMPs operating in international waters or international airspace (which may transmit within the range 27.5-30.0 GHz), shall ensure protection of fixed service systems in the CEPT.

ix) ECC Decision (15)04 - Harmonised use, free circulation and exemption from individual licensing of Land, Maritime and Aeronautical Earth Stations On Mobile Platforms (ESOMP) operating with NGSO FSS satellite systems in the frequency ranges 17.3-20.2 GHz, 27.5-29.1 GHz and 29.5-30.0 GHz

The purpose of this Decision is to:

a. harmonise the use and allow the free circulation and exemption from individual licensing of ESOMP of non-geostationary satellite networks operating within the frequency bands 17.3-20.2 GHz (receive band) and 27.5-29.1 GHz and 29.5-30.0 GHz (transmit bands);
b. apply the technical conditions necessary to ensure harmful interference is not caused by ESOMPs to stations of the FSS, FS and other services.

These ESOMP shall comply with the following technical and operational requirements:

1. They shall operate in non-geostationary satellite systems;
2. ESOMP networks shall operate under the control of a Network Control Facility (NCF);
3. The protection of GSO FSS networks operating in 27.5-28.6 GHz and 29.5-30.0 GHz from ESOMPs operating in NGSO systems shall be achieved by complying with the EPFD limits stipulated in No. 22.5D of the ITU Radio Regulations. The protection of FSS GSO networks and FSS NGSO systems operating in 28.6-29.1 GHz shall be on the basis of relevant coordination agreements reached between administrations and operators in accordance with No. 9.11A of the ITU Radio Regulations;
4. The design, coordination and operation of ESOMPs shall take into account the following factors to the extent that they ensure compliance with the conditions specified in paragraph 3 above:
    a) antenna mis-pointing;

[16] The baseline assumptions of these losses are given in ECC Report 184 Annex 1.

[17] The PFD values above are not defined as under "free-space" conditions. The percentage of time that should be used in the propagation model when assessing compliance with this PFD threshold should be 0.007%.

b) variations in the antenna pattern;
c) variations in the transmit e.i.r.p.;

5. ESOMP that use closed-loop tracking of the satellite signal shall employ an algorithm resistant to capturing and tracking signals from nearby satellite. ESOMP shall immediately inhibit transmissions when they detect that unintended satellite tracking has happened or is about to happen;
6. ESOMP shall be self-monitoring and should a fault which can cause harmful interference to FSS or terrestrial networks be detected, the ESOMP must automatically cease its transmissions;
7. ESOMP shall be in conformance with the Harmonised European Standard EN 303 979[18].
8. ESOMP shall comply with the following requirements that ensure compliance with aircraft HIRF protection criteria based on ECC Report 272, using a maximum HIRF field strength of 150 V/m:
    a) The maximum e.i.r.p. of land-based ESOMP operating within the airfield boundary shall be limited to 52.4 dBW;
    b) The maximum e.i.r.p. of land-based ESOMP operating outside the airfield boundary shall be limited to 70 dBW ;
    c) The maximum e.i.r.p. of ESOMPs on vessels shall be limited to 70 dBW;
    d) The maximum e.i.r.p. of ESOMP, as defined above, operating within TDMA networks shall be respected after taking into consideration the duty cycle (see section 3.3 and 3.4 of ECC Report 272).

ESOMP operating within the frequency bands 17.3-19.7 GHz and 27.5-29.1 GHz must comply with the following additional technical and operational requirements:

1. In the territory of any administration, the off-axis e.i.r.p. spectral density radiated by any ESOMP into the FS bands (i.e. 27.8285-28.4445 GHz, 28.8365-28.9485 GHz (where applicable) and 28.9485-29.1 GHz) shall be limited to -35 dBW/MHz. This limit shall, in any case, be met by ESOMP on land, on territorial sea or on internal waters, at a direction of 3 degrees or less above the local horizontal plane at the ESOMP terminal;
2. In the territory of any administration, ESOMP shall not have their transmit occupied band edges closer than 10 MHz from the edges of the bands identified by that administration for FS operation;
3. The antenna elevation angle shall be higher than 3 degrees;
4. In the band 28.8365 - 28.9485 GHz, the PFD threshold values in paragraph 6 shall apply to the territory of any administration which authorises FS systems in this band and shall not be exceeded, unless prior agreement has been given by the concerned administration(s) to exceed these values;
5. In the bands 27.8285 - 28.4445 GHz and 28.9485 - 29.1 GHz, the PFD threshold values in paragraph 6 shall apply to the territory of all CEPT administrations and shall not be exceeded, unless prior agreement has been given by the concerned administration(s) to exceed these values;
6. For ESOMP installed on vessels, the PFD threshold value is -109 dB(W/m^2) in a reference bandwidth of 14 MHz at a height of 20 metres above mean sea level at the low-water mark of the territory of the administrations defined in paragraphs 4 and 5 above;
7. For ESOMPs installed on aircraft the PFD values dB(W/m2) in a reference bandwidth of 14 MHz on the Earth's surface ground are the following:

[18] "Satellite Earth Stations and Systems (SES); Harmonised European standard for Earth Stations on Mobile Platforms (ESOMPs) transmitting towards satellites in non-geostationary orbit in the 27.5-29.1 GHz and 29.5-30.0 GHz frequency bands covering the essential requirements of article 3.2 of the Radio Equipment Directive"

$$-124.7 \text{ for } 0° \le \delta \le 0.01°$$
$$-120.9 + 1.9 \log10(\delta) \text{ for } 0.01° < \delta \le 0.3°$$
$$-116.2 + 11.0 \log10(\delta) \text{ for } 0.3° < \delta \le 1.0°$$
$$-116.2 + 18.0 \log10(\delta) \text{ for } 1.0° < \delta \le 2.0°$$
$$-117.9 + 23.7 \log10(\delta) \text{ for } 2.0° < \delta \le 8.0°$$
$$-96.5 \text{ for } 8.0° < \delta \le 90.0°$$

where δ is the angle of arrival at the Earth's surface (degrees);

8. The PFD values above are not defined as under "free-space" conditions. Hence, when assessing ESOMP compliance with this PFD mask, atmospheric absorption and any attenuation due to the aircraft fuselage shall be taken into account [19];
9. For ensuring compliance with the above PFD provisions ESOMP shall have self-monitoring functions and automatic mechanisms (locally, or under the control of the NCF) to reduce its e.i.r.p. or cease transmissions;
10. National limitations applicable to uncoordinated FSS earth stations to avoid cross-border interference to fixed or mobile services in the same band in an adjacent country shall apply to land based ESOMP and ESOMP operating on territorial sea and on inland waterways in the same country as the uncoordinated FSS earth stations.

This Decision places an obligation on any ESOMP operator, intending to operate ESOMP within the framework of this ECC Decision, to submit a declaration to the Office that the operator's NGSO system complies with the requirements of this Decision, and provide details of a designated point of contact. Also, ESOMP operating in international waters or airspace (which may transmit within the range 27.5-29.1 GHz), shall ensure protection of fixed service systems in the CEPT.

It is recognized that some administrations may require a frequency authorisation due to specific national requirements, in contrast, other administrations may require some form of notification, exemption, or mutual recognition of the licence issued in the country of registration of the ESOMP.

x) ECC Decision (05)09 - Free circulation and use of Earth Stations on board Vessels operating in Fixed Satellite Service networks in the frequency bands 5925-6425 MHz (Earth-to-space) and 3700-4200 MHz (space-to-Earth)

This Decision allow free circulation and use of ESV operating in fixed satellite service networks in the frequency bands 5925 - 6425 MHz (Earth-to-space) and 3700 - 4200 MHz (space-to-Earth) which fulfil the following conditions:

a) complying with the relevant European Telecommunication Standards which may be demonstrated by compliance with equivalent technical specifications (in the sense of art. 3(2) of the RE Directive);
b) operating under the control of a network control facility;
c) operating under a satellite network where the ESV network operator or other organisation with control over ESV transmissions has notified the Office that those ESV operating within their system or under their control comply with all the requirements of this Decision, including any conditions notified to the Office by administrations, and has provided the required contact and technical information.

Concerning ESV operations in the band 5925 - 6425 MHz, within the minimal distance of 300 km (antenna diameter ≥ 2.4 m) or 330 km (1.2 m ≤ antenna diameter < 2.4 m) from the low-water

[19] The baseline assumptions of these losses are given in ECC Report 217, annex 2

mark as officially recognised by the coastal State or within the territorial seas or internal waters, the concerned administrations shall inform the Office about any limitations (or changes to these), such as the areas where constraints are imposed, including areas where ESV operation is permitted or not permitted. This information is then made available to ESV operators through the facilities of the Office web site. ESV operators that operate within this Decision's scope are required to comply with the restrictions defined by the administrations and provided to the Office. ESV operators must register their networks with the Office and provide certain technical and operational information about their networks.

In return for complying with the requirements of this Decision, ESV is granted free circulation and use, and ESV operators are exempted from the requirement to obtain licences from CEPT administrations. However, most CEPT administrations license radio equipment on board ships registered in their country. Some may also require ESV registered in their country and some may also require ESV installed on ships registered in their country to be licensed. This Decision retains the right of administrations to require individual ESV terminals to be licensed or exempted from individual licensing.

For the purpose of resolving potential interference issues with terrestrial services in the band 5925 - 6425 MHz, some CEPT administrations may require that operators of ESV operating in this band obtain frequency authorisation due to specific national requirements, while other CEPT administrations may require some form of notification from the ESV operator, or exempt the ESV network operator from either of these requirements.

xi) ECC Decision (17)04 - Harmonised use and exemption from individual licensing of fixed earth stations operating with NGSO FSS satellite systems in the frequency bands 10.7-12.75 GHz and 14.0-14.5 GHz

The purpose of this Decision is to:

a) harmonise the use of the frequency bands 10.7 - 12.75 GHz (space to Earth) and 14.0 - 14.5 GHz (Earth to space) for the use of fixed earth stations operating with NGSO FSS satellite systems;
b) allow exemption from individual licensing of fixed earth stations operating with NGSO FSS satellite systems in the frequency bands 10.7 - 12.75 GHz (space to Earth) and 14.0 - 14.5 GHz (Earth to space).

CEPT administrations shall allow exemption from individual licensing of fixed earth stations that comply with the following technical and operational requirements:

1. The fixed earth stations shall operate under the control of a Network Control Facility (NCF);
2. The design, coordination and operation of the fixed earth stations shall take into account the following factors:
    a. antenna mis-pointing;
    b. variations in the antenna pattern;
    c. variations in the transmit e.i.r.p.;
3. Fixed earth stations shall use closed-loop tracking of the satellite signal shall employ an algorithm that is resistant to capturing and tracking signals from nearby satellite. Fixed earth stations shall immediately inhibit transmissions when they detect that unintended satellite tracking has happened or is about to happen;
4. Fixed earth stations shall be in conformance with the Harmonised European Standard EN 303 980;

5. Fixed earth stations shall use an equivalent isotropically radiated power (e.i.r.p.) not exceeding 60 dBW. When an antenna is coupled to more than one transmitter or a transmitter provides more than one carrier (multi-carrier operation), the above e.i.r.p. level is the sum of all simultaneous emissions from the antenna on the main lobe;
6. Fixed earth stations shall operate on a non-protected basis with regards to the fixed service stations of the frequency band 10.7-11.7 GHz;
7. Fixed earth stations shall operate with NGSO FSS satellite systems while maintaining compatibility with other services.

This decision lists the coordination areas that could be used for the protection of aircrafts in the vicinity of airfields from fixed earth stations working to a NGSO satellite system for which the coordination areas have been specifically determined using the methodology given in ECC Report 066.

ANNEXES

ANNEX 1

GLOSSARY

Administration - Every department or government service of a member country of the ITU that requests and processes a satellite network before it and is responsible for compliance with the obligations derived from said process in accordance with the Constitution, the Convention of the International Telecommunications Union and its administrative regulations.

Administrative fees - Administrative fees can be defined as fees charged independently of the type of licence (spectrum or service) for issuing of a licence. Further administrative fees are charged annually for control, monitoring, and enforcement. In some administrations the administrative fee is payable annually for the duration of the licence or initially for a specified period of a licence.

Aeronautical Mobile Satellite Service (AMSS) - A mobile-satellite service in which mobile earth stations are located on board aircraft.

Allocation of a frequency band - Entry in the table of frequency allocations of a given frequency band for the purpose of its use by one or more terrestrial or space radiocommunications services or the radio astronomy service under specified conditions. This term is also applied to the frequency band concerned.

Antenna - A transducer designed to transmit or receive electromagnetic waves. In other words, antennas convert electromagnetic waves into electrical currents and vice versa.

Antenna mount - The mechanism that supports ground-based satellite antenna. Aim of the earth station's antenna is that the mount should provide precise pointing angles towards the satellite. Furthermore, the mount should hold the antenna firmly so that only minimum deviations occur to the physical direction. For keeping track on the satellite's physical direction, the earth station's antenna mount should be constructed in such a way that the antenna element can move via two or more axes, in order to assure correct pointing towards the satellite in question. Antenna mounts can be constructed as fixed, or in such a way that the steering of the antenna is possible.

Aperture of satellite antenna – Satellite antenna cross-sectional area which is visible for the signal.

Applicant - Any person that submits a completed application form to the NRA in terms of regulation.

Application Form - A form prescribed for applying for the licence for the operation of satellite systems, networks and/or services.

Assignment of a radio frequency or radio frequency channel - Authorisation given by an administration for a radio station to use a radio frequency or radio frequency channel under specified conditions.

Authorization Rules - General rules that establish the terms and requirements for the granting of authorizations in the field of telecommunications established in the relevant law and regulations.

Azimuth - The horizontal rotation angle that a ground-based parabolic antenna must be rotated through to point to a specific satellite in a geosynchronous orbit. The azimuth angle for any particular satellite can be determined for any point on the surface of the Earth given the latitude and longitude of that point. It is defined with respect to due north as a matter of easy convenience.

Backhaul - Satellite system's terrestrial communications part between earth stations and local switching elements.

Backup Link - Alternative satellite link other than the normal satellite operator used by the licensee for uplink and downlink satellite television content.

Bandwidth Reseller - Vendor who sells satellite capacity.

Base station - Any station that is providing communications services to associated mobile earth stations or user stations and forms part of an electronic communications network.

Beam width - Angle or conical shape of the beam that the antenna projects. In general, the larger antenna is the narrower the respective beam width is, making it more efficient as energy can be concentrated more precisely towards the satellite, which in turn increases the transmitted and received power levels in that specific direction.

Beginning of operations - Moment in which orbital resources licensees or landing rights authorization holders are in a position to offer and provide the satellite capacity provision service.

Broadband Global Area Network - A global satellite internet network that includes telephony.

Broadcast Satellite - Any radio or TV broadcast satellite.

Broadcasting Satellite Service (BSS) - A radiocommunication service in which signals transmitted or re-transmitted by space stations are intended for direct reception by the general public.

C band - means the microwave frequencies allocation for satellite communications from 3.6 GHz to 8 GHz. C-Band uses 3.7-4.2 GHz for downlink and 5.925-6.425 GHz for uplink.

Cable Operator - Licensed operators as mentioned in the regulations for installing and operating cable television networks.

Carrier to Interference ratio C/I - The ratio of unfaded signal power to the noise-equivalent value of interference.

Channel - A compilation of programmes.

Close User Group (CUG) - Group of remote terminals that can only communicate within the group. Any other communication would be rejected.

Co-location - Positioning of two or more satellites in the same geostationary orbital position, in accordance with international regulations.

Commercial satellite - A satellite launched for profit making or business purpose.

Complementary Ground Component - Auxiliary system that is an integral part of a mobile-satellite system whose purpose is to complement the provision of satellite services with infrastructure deployed on the ground, which operates in the same segment of the radioelectric spectrum assigned to the satellite system.
Also means ground based stations used at fixed locations, in order to improve the availability of the mobile satellite service in geographical areas within the footprint of the system's satellite(s), where communications with one or more space stations cannot be ensured with the required quality.

Content - Any information including systematic audio, visual or audio-visual, live or previously recorded performance, presentation, films, features, dramas or advertisements transmitted, relayed or distributed.

Control and Operation Center - Earth stations that operate in an integrated manner and that have the associated telemetry, tracking and command equipment to control the operation of one or more satellites and/or space vehicles.

Coordination: Stage of the procedure for assigning satellite orbits with their respective associated frequency bands before the ITU, for frequency bands that require coordination, in order not to cause or receive harmful interference.

Customer - Any person who has entered into a contract with the licensee to receive the licensed services.

Data - Information represented in a manner suitable for automatic processing.

Direct-Broadcast Satellite Television (DBSTV) - Satellite television systems in which the subscribers, or end users, receive signals directly from geostationary satellites. Signals are broadcast in digital format at microwave frequencies.

Direct-To-Home (DTH) broadcasting service - The distribution of multi-channel TV programs in the Ku band by using a satellite system by providing TV signals directly to subscribers' premises.

Distribution - When the links are one-way and more precisely, when the information signal is emitted by a specific earth station towards stations which are often assigned for reception only (generally numerous and scattered throughout the coverage area), the distribution (broadcasting) capability of the satellite is used. This capability is particularly useful for television (transmission of television programmes) and for certain data transmission services (e.g. data banks).

Downlink - Transmissions from a base station or space station to a mobile earth station or user station.

Earth Exploration Satellite Service - A satellite radiocommunication service which obtains information relating to the characteristics of the Earth and its natural phenomena from active or passive sensors on the satellite and distributes this information to earth stations.

Earth Station - A station located either on the Earth's surface or within the major portion of the Earth's atmosphere and intended for communication with one or more space stations; or with one or more stations of the same kind by means of one or more reflecting satellites or other objects in space.
Also the earth segment is the term given to that part of a communication-satellite system which is constituted by the earth stations used for transmitting and receiving the traffic signals of all kinds to and from the satellites, and which form the interface with the terrestrial networks. An earth station includes the whole terminal equipment of a satellite link that consists of antenna, low-noise amplifier (LNA), downconverter and receiver. Its role is equivalent to that of a terminal radio-relay station.

Earth Station in Motion (ESIM) - Earth stations placed on moving platforms that communicate with geostationary-satellite orbit (GSO) or non-GSO systems operating in the fixed-satellite service (FSS).

Earth Station Provider- The operator of an earth station.

Effective Isotropic Radiated Power (EIRP) - The amount of power that a theoretical isotropic antenna would emit to produce the peak power density observed in the direction of maximum antenna gain.

Elevation - The angular position of a satellite above the horizon.

Elevation of the antenna - The uplink tilt toward the satellite. It is informed in degrees. At the elevation angle of zero, the antenna points to the horizon. On the other hand, the 90 degrees refers to the point directly upwards.

Emergency Call - A call made to designated emergency numbers such as police, fire, ambulance or other emergency services designated by the NRA.

End User – The individual or organization that originates or is the final recipient of information carried via a network (i.e. the consumer). Also any person including a customer who receives licensed services from the licensee.

Equivalent Isotropically Radiated Power (e.i.r.p.) - The product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna (absolute or isotropic gain).

Feeder Link - A radio link from a satellite earth station at a given location to a space station or vice versa, conveying information for a space radiocommunications service other than for a fixed satellite service. The given location may be at a specified fixed point, or at any fixed point within specified areas.

Final user - the "End user"

Fixed Earth Station (FES) - A fixed satellite earth station operated at a single specified location (i.e. a non-transportable satellite earth station).
Fixed Satellite Earth Station (FSES) - A satellite earth station operating in the fixed satellite service or as a feeder link in the mobile satellite service or broadcasting satellite service.

Fixed Satellite Service (FSS)– A radiocommunication service between earth stations at given positions, when one or more satellites are used. The given position may be a specified fixed point or any fixed point within specified areas. In some cases this service includes satellite-to satellite links, which may also be operated in the inter-satellite service. The fixed-satellite service may also include feeder links for other space radiocommunication service

Fixed Service - A radiocommunication service between specified fixed points.

Foreign Satellite Operator - Natural or legal person that operates a foreign satellite system.

Foreign Satellite System - Satellite system that operates under the cover of a satellite network notified by a foreign Administration. The term is used to refer to operators providing satellite connectivity in a country outside of the jurisdiction of the satellite operator's host country of ITU satellite's registration.

Frequency Allocation– Entry in the Table of Frequency Allocations of a given frequency band for the purpose of its use by one or more terrestrial or space radiocommunications services or the radio astronomy service under specified conditions.

Frequency Allotment (of a radio frequency or radio frequency channel) - Entry of a designated frequency channel in an agreed plan, adopted by a competent conference, for use by one or more administrations for a terrestrial or space radiocommunications service in one or more identified countries or geographical areas and under specified conditions.

Frequency Band - Portion of the radioelectric spectrum between two determined frequencies.

Frequency Spectrum Authorisation - An authorization which permits the use of radio frequency subject to terms and conditions as stipulated by the NRA.

Gateway - Gateway earth stations link one or more terrestrial networks and satellites.

General authorisation - A regime where the service provider need not take any action and need not await any decision from the NRA before launching the service. The legal form which regulates this authorisation consists of a set of conditions (rights and obligations) which can be found in general law, in telecommunications regulations, in a single document like a class licence order; or in all three. Breaches of these conditions may force the NRA to impose sanctions or to withdraw the permission to provide the service.

Geostationary Orbit (GSO) - The orbit of a spacecraft that lies on the equatorial plane of the Earth and at radius from the centre of the Earth of 42,164 km, and whose altitude from the mean sea level is 35,786 km. A space object on the GSO will have the same angular rotation with the Earth rotation and thus remain fixed in the sky as seen from someone on the Earth.
Also means a satellite location at 36,000 km above sea level, where an earth satellite has a period of revolution equal to the period of rotation of the Earth about its axis.

Geostationary satellite - A space object located on the geostationary orbit at a given longitude (the geocentric angle from the Greenwich meridian to the space object). A GSO satellite is seen to be remaining at a fixed position in the sky, usually measured by its azimuth (Az) and its elevation (el).

Geostationary Orbital Position (GOP) - Any location on the plane of the Earth's equator at approximately 36,000 kilometres of altitude, which allows a satellite to maintain a period of translation equal to the period of rotation of the Earth.

Global Mobile Personal Communications By Satellite (GMPCS) or Global Mobile Personal Communications Systems (GMPCS) - Any satellite system (i.e. fixed, mobile, broadband or narrowband, global or regional, geostationary or non-geostationary, existing or planned) providing telecommunications services directly to end-users from a constellation of satellites.
Also means a personal communication system providing transnational, regional or global coverage from a constellation of satellites accessible with small and easily transportable terminals.

Global Position System (GPS) - A satellite system which is used to identify the co-ordinate (longitude, latitude and altitude) of a position on the earth surface.

Ground Segment - The Ground Segment refers to the network of gateways. Gateway earth stations link one or more terrestrial networks and the satellites

Harmful Interference - Interference which endangers the functioning of radio navigation service or of other safety services or which otherwise seriously degrades, obstructs or repeatedly interrupts a radiocommunications service operating in accordance with the applicable national regulations.

High Altitude Platform Station - Apparatus for wireless communications located on an object at an altitude 20 km to 50 km and at a specified, nominal, fixed point relative to the Earth.

Highly Elliptical Orbit (HEO) - An elliptical orbit most typically with a perigee of 500 km or more and a apogee of 50 000 km or less altitude above the Earth’s surface with an inclination angle greater than 40° from the equatorial plane.

Hub - Master station which handles complete communications between micro terminals. It should be noted that mesh networks can replace the “old-fashioned” hub principle as they provide connectivity between all relevant points of the network via on-board processing.
Also means a central VSAT earth station operating within a VSAT, star or mesh in configuration, whose functions include control of networks operation, configuration, performance and traffic engineering.

Individual Licence - This is a regime which requires that the service provider send an individual application to the NRA, asking for an individual authorisation to provide the service or to operate the earth station. In this application form, the applicant has to provide the NRA with information based on a list, clearly stated and published in advance. The service provider or the earth station operator can begin providing the service immediately after the individual licence is granted. The legal form which regulates this authorisation consists of conditions (rights and obligations) set in general law and telecommunications regulation. Breaches of these conditions may lead to NRA imposing sanctions or withdrawing permission to provide the service.

Interconnection Exchange (ICX) - A switching system which provides interconnections among the existing/future telecommunication network of the operators and allows monitoring, Lawful Interception (LI) facilities.

Interference - (to a wanted signal) - Disturbance of the reception of a wanted signal caused by interfering signals, noise or electromagnetic disturbance.

International Data Access (IDA) - The process of linking data networks in a given country to the global Internet highway or other managed packet-switching IP-based international networks.

International Gateway - An earth station established in a given country to provide a communications link between the licensed network and the telecommunications network of operators outside the said country.

International Gateway Exchange (IGW) - A switching systems through which international voice traffic (VoIP and clear channel) is sent and received. IGW allows physical monitoring of the traffic flow.

Internet Service Provider (ISP) - Entity providing Internet services to the end users.

Landing Rights Permission/ Authorization - Administrative act by which the NRA confers the right to a natural or legal person to exploit the rights of emission and reception of signals, including broadcasting television content, and frequency bands associated with foreign satellite systems that cover and can provide services within the national territory of a given country.

Ka band - The microwave frequencies for satellite communications from 18 GHz to 40 GHz.

Ku band - The microwave frequencies primarily used for satellite communications from 11.2 GHz to 14.5 GHz.

Latitude - The angle from a point on the earth's surface and the equatorial plane, measured from the centre of the sphere. Lines joining points of the same latitude are called parallels, and they trace concentric circles on the surface of the earth, parallel to the equator.

Lawful Interception (LI) - Legal interception in any telecommunication network.

Lease – Lease means providing authority to others for using telecommunication transmission facilities for telecommunication purpose in consideration for a rental.

Licence (or **Authorizations**) - An authorisation means any permission setting out rights and obligations specific to the telecommunications sector and allowing undertakings to provide telecommunications services and, where applicable, to establish and/or operate telecommunications networks for the provision of such services, in the form of a general authorisation or individual licence as defined above. A general authorisation means an authorisation regardless of whether it is regulated by a class licence or under general national law and whether such regulation requires registration, which does not require the undertaking concerned to obtain an explicit decision by the national regulatory authority before exercising the rights stemming from the authorisation. Individual licence means an authorisation which is granted by a national regulatory authority and which gives an undertaking specific rights or which subjects that undertaking's operation to specific obligations supplementing the general authorisation where applicable, where the undertaking is not entitled to exercise the rights concerned until it has received the decision by the national regulatory authority.

Also means license issued or deemed to have been issued by the NRA in accordance with the relevant national regulations/Act for establishing or operating a telecommunication system or

for providing telecommunication service or for operating or maintaining such system or service or for using a radio apparatus or similar facility.

Licence for Terminals - An authorisation to carry and use an earth station. According to the national regime, the licence can be one of the following: An individual licence; whereby for each terminal a separate authorisation is issued; a general licence or class licence, whereby one generic authorisation is issued, which applies to all users and to all terminals of a given category; a licence exemption, whereby there is an exemption from requiring an individual licence for each terminal; a blanket licence, whereby an individual operator or service provider is authorised to use a certain number of technically identical terminals.

Licensed Network - The public telecommunications network used to provide commercial satellite services.

Licensed Service - A public telecommunications service authorized to be provided via the licensed network.

Licensee - The person who has obtained one or more general or individual licences to exploit or provide satellite systems, networks, services or applications, pursuant to the procedures outlined in the relevant regulation.
Also means a company registered in a given country that has been permitted and awarded a licence to develop, build, operate, maintain satellite network or related facility.
Also, in relation to downlink satellite television content, refers to the DTH operators, Multiple System Operator (MSOs), Distributors of Cable Television Network, national satellite television channel operators who are licensed from the competent authority to operate in a given country.
In relation to uplink satellite television content, it refers to the DTH operators, national satellite television channel operators who are licensed from the competent authority to operate in a given country.

Longitude - The angle east or west of north - south line between the two geographical poles that passes through an arbitrary point. Lines joining points of the same longitude are called meridians. All meridians are halves of great circles, and are not parallel. They converge at the north and south poles.

Low-altitude Earth Orbit (LEO) - A satellite circular or elliptical orbit of about 700 to 3 000 km altitude above the Earth's surface.

Medium Earth Orbit (MEO) - A satellite circular or elliptical orbit of about 8 000 to 20 000 km altitude above the Earth's surface. Satellites in this orbit travel higher than Low-altitude Earth Orbit (LEO) satellites, but lower than geostationary satellites.

Mesh topology - A network architecture in which devices are connected with many redundant interconnections between nodes.

Meteorological Satellite Service (MetSat) - An earth exploration-satellite service for meteorological purposes.

Military satellite - A satellite with payload for military applications.

Mobile satellite component - All elements required to provide a mobile satellite service which include the space station or stations required to provide the mobile satellite service and any gateway earth stations required for the delivery of mobile satellite services.

Mobile Satellite Services (MSS) - A radiocommunication service between mobile earth stations and one or more space stations or between space stations used by this service; or between mobile earth stations by means of one or more space stations and includes any feeder links necessary for its operation.

Mobile satellite systems - Electronic communications networks and associated facilities capable of providing radiocommunications services between a mobile earth station and one or more space stations, or between mobile earth stations by means of one or more space stations, or between a mobile earth station and one or more complementary ground components used at fixed locations. Such a system shall include at least one space station.

Mutual Recognition Agreements - An agreement among regulatory bodies to mutually recognise type approval of telecommunication terminals issued by other administrations that are party to the agreement, but that does not modify the authority of each regulatory body to set standards and requirements.

National Regulatory Authority (or Regulator) - This term is used to refer to the government agency, institution or official responsible for regulation of all or part of the telecommunications sector in a country. In some countries it is a National Regulatory Authority (NRA), an independent regulatory authority, or a Ministry of the Government. Sometimes one entity is the regulator for some purposes and another entity for other purposes.

National Table of Frequency Allocations (NTFA) - Administrative provision that indicates the radiocommunication service or services to which a certain frequency bands of the radioelectric spectrum is allocated, as well as additional information on the use and planning of certain frequency bands. Also means the table of allocation for use of frequencies and frequency bands in a given country developed and maintained by NRA.

National Satellite operator – It refers to the communication and broadcasting satellite launched by a given country. It will also refer to other upcoming communication and broadcasting satellites in its constellation.

National Satellite System – A satellite system that operates under the cover of a satellite network notified by the Administration of the concerned country.
National Satellite Television Channel – In a given country, it refers to the satellite television channel whose country of origin is the said country and which is duly licensed by the competent authority.

Network – A public and/or private communications transmission that provides interconnectivity among a number of local or remote devices (e.g. telephones, exchanges, computers, television sets). The Public Switched Telephone Network (PSTN) is operated by local Public Telecommunications Operators. Like the PSTN, other private and public networks can comprise many point-to-point transmission media, including wire, cable and radio-based ones.

Non-Geostationary Orbit (NGSO, or non-GSO) - An orbit that is not geostationary (GSO), and thus any space craft on such orbit will not be fixed with to the Earth's rotation. There are many types of NGSO, such as Low Earth orbit (LEO), Medium Earth orbit (MEO), High Elliptical orbit

(HEO). Some NGSO can also be circular (radius is constant, or eccentricity is zero), or elliptical (eccentricity is greater than 0 and no more than 1).

Non-Geostationary Satellite - A space object located at a non-geostationary orbit (NGSO). This means that the azimuth, elevation and distance from any point on the Earth surface change all the time.

Non-transportable Satellite Earth Station - A fixed satellite earth station operated at a single specified location (i.e. a fixed earth station).

Notification (ITU) - Final stage of the procedure for assigning satellite orbits with their respective associated frequency bands before the ITU, which is intended to be registered in the Master International Frequency Register.

Operator - An organization or a person licensed for establishing or operating a telecommunication system or providing telecommunication service or operating a system which is the combination or more than one of those facilities.

Orbit - A path of a satellite around the Earth.

Orbital Resource – Geostationary orbital position or satellite orbit with their respective associated frequency bands that may be the subject of a licence.

Out-of-block emissions - Radio frequency emissions generated by the radio equipment and radiated into the frequency bands adjacent (in terms of frequency) to the licensee's permitted frequency assignment.

Permanent Earth Station (PES): For the purposes of licensing by the NRA, an earth station:

i) whose antenna(s) is(are) fixed on the ground and are connected by appropriate radio spectrum to one or more satellites;
ii) whose transmit (Tx) and receive (Rx) frequencies conform to the National Table of frequency allocations and the ITU table of allocation (see Article 5 of the ITU Radio Regulations) and allocated to the Fixed Satellite Service (FSS), Space Operation Service (SOS), Mobile Satellite Service (MSS), Broadcasting Satellite Service (BSS), Earth Exploration Satellite Service (EESS) and Space Research Service (SRS);
iii) operating with the aim to provide either feeder-link connectivity to satellites (which offload/up-load data and information between the satellite segment and the ground network), or provide telecommand/telemetry communication for the health and control of the spacecraft;
iv) which provides a radio link to a single satellite or multiple satellites in the geostationary orbit (GSO), or non-geostationary orbit (NGSO) that have been brought into use as notified to the ITU, or intended to be in less than 2 years from the date of the application;
v) which may provide, in addition to feeder-link services or as a standalone, Telemetry, Tracking and Command (TT&C) capabilities, for the provision of position, health and manoeuvring of the spacecraft, or controlling the spacecraft payload.

Polarization - Antenna technique for increasing the capacity of the satellite communications by reusing the satellite transponder frequencies. In the linear cross-polarization case, the principle is simple: half the transponders can transmit the signals to downlink via vertical polarization whilst the rest of the signals are transmitted via horizontal polarization. The 90 degree difference in the transmitted signal's phase assured that the signals, althoug h transmitted in the

same frequency, will not interfere with each other. There are also solutions that provide simultaneous reception of vertical and horizontal transponder signals which are then fed into separate receiving circuits.
Circular polarization means that the antenna polarity is rotating constantly either clockwise (right-handed rotation) or counter clockwise (left-handed rotation). Sometimes right-hand and left-hand rotation is possible to transmit via the same frequency which in theory increases channel capacity by 100%.

Power Flux Density (PFD) - The amount of power flow through a unit area within a unit bandwidth. The units of power flux density are those of power spectral density per unit area, namely watts per hertz per square meter. These units are generally expressed in decibel form as dB(W/Hz/m^2), dB(W/m^2) in a 4 kHz band, or dB(W/m^2) in a 1 MHz band.

Private Networks - This classification is applicable to those who establish and maintain networks for their own use. These services should not be provided for commercial use and should exclusively serve the needs of natural and legal entities who install, operate, manage and use their own network. This classification excludes networks set up in a single dwelling or building, which are completely exonerated from regulatory licensing requirements.
International Best Practice shows that "Own use" is generally interpreted as including users which are engaged in a common business or activity and operators being in an organization formed by this group of users for the specific purpose of furthering such common business or activity that is the main business or activity.

Public Switched Telephone Network (PSTN) – The infrastructure of physical switching and transmission facilities that are used to provide the majority of telephone and other telecommunications services to the public. In a monopoly environment, one public telecommunication operator (PTO) owns and operates the PSTN. In a competitive environment, the PSTN typically comprises the interconnected networks of two or more PTOs.

Quality of Service (QoS) - QoS is evaluated on the basis of measures on the grade of service, calls lost due to wrong processing, bit error rate, response time, acceptable number of faults per unit subscribers served, and Mean Time To Restore (MTTR), faults carried over beyond the MTTR, etc.

Radiocommunication - Telecommunication by means of radio waves.
Note – The definition of the term "telecommunication" is included in Appendix 2 of Recommendation ITU-R V.662 dealing with general terms.

Radiocommunications Service - A service involving the transmission, emission and/or reception of radio waves specified for specific telecommunications purposes.

Radio Navigation Satellite - Any satellite that uses radio frequency to provide location-based services.

Receive-Only Terminals (or Send-Only Terminals) - Pertaining to a link where the transmission of users' information is possible in one pre-assigned direction only.

Receive Only Earth Station (ROES): For the purposes of licensing by the NRA, an earth station:

i) whose antenna(s) is(are) fixed on the ground and are connected by appropriate radio spectrum to one or more satellites;
ii) that uses spectrum only for receiving data/information from a space station;

iii) whose receive (Rx) frequencies conform to the National Table of frequency allocations and the ITU table of allocation (see Article 5 of the ITU Radio Regulations) and allocated to the Fixed Satellite Service (FSS), Space Operation Service (SOS), Mobile Satellite Service (MSS), Broadcasting Satellite Service (BSS), Earth Exploration Satellite Service (EESS) and Space Research Service (SRS);
iv) that operate with the aim to provide either receive feeder-link connectivity to satellites (which off-load data and information from a space station), or provides telemetry communication for monitoring the health and control of the spacecraft;
v) which provides a radio link to a single satellite or multiple satellites in the geostationary orbit (GSO), or non-geostationary orbit (NGSO) that have been brought into use as notified to the ITU, or intended to be in less than 2 years from the date of the application.

Registration - This is a regime which requires that the service provider make a declaration to the NRA of his intention to provide the service. In this declaration, the applicant has to provide the NRA with information based on a list, clearly stated and published in advance. The service provider can start to provide the service [four weeks] after the declaration at the latest. The legal form which regulates this authorisation consists of conditions (rights and obligations) set in general law and telecommunications regulations. Breaches of these conditions may lead to the NRA imposing sanctions or withdrawing permission to provide the service.

Regulation - Regulations made or will be made in the future by the NRA under the Act or the applicable regulations.

Regulatory Framework - The regulations, decisions, directives, regulatory policies, guidelines, recommendations and procedures made by the NRA or any other competent authority from time to time including any revisions or amendments made to them.

Remote Terminal (RT) - A VSAT/ESIM terminal which is linked with a VSAT/ESIM hub via satellite to be used in the remote or inaccessible areas within the national territory of a given country.

Satellite - Object placed in a satellite orbit, provided with a space station that allows it to receive, transmit or retransmit radiocommunication signals from or to earth stations or other satellites. Also means a specialized wireless receiver/transmitter that is launched by a rocket and placed in orbit around the earth.

Satellite Antennas - Antenna is a device for transmitting and receiving radiowaves, that is, they act in the radio interface transforming the signals into electromagnetic radio waves at the transmitting end, and collecting the electromagnetic energy back to the signal for processing at the receiver end.

Satellite Capacity - Quantity of radioelectric spectrum, quantified in hertz, capable of being supplied by a satellite system to carry traffic of satellite services.

Satellite Capacity Provision Service - Supply of bandwidth to third parties by the orbital resource licensee or landing rights authorization holder for the provision of satellite services, which can be quantified in Hertz or its equivalent in bits per second.

Satellite Communication - Emission, transmission or reception of signs, signals, audio signals or associated audio and video, data, writing, images, voice, sounds or information of any nature by means of radioelectric waves that travel through a satellite system.

Satellite Communication Service Provider (SCSP) - The provider of satellite communication and broadcasting services within the national territory of a given country through a VSAT hub operator or satellite teleport operator.

Satellite Earth Station (SES) - Apparatus for radiocommunication, located on the Earth's surface, intended for either the transmission of radio signals to a space station or the reception of radio signals from a space station, or both.

Satellite Network - Configuration of one or more satellites which provide(s) controlled radio transmission facilities and which interconnect(s) with earth stations. These networks consist, at the very least, in the establishment of transmission lines:

i) between space segment and fixed earth stations which provide the link to the terrestrial public networks (feeder links),
ii) between space segment and end user earth stations which may be fixed or mobile (service links).
iii) One or more fixed earth stations may have the function of controlling the system and/or to interconnecting with other networks.

Also means a satellite system or a part of a satellite system consisting of only one satellite and the cooperating earth stations.
Also means file with the technical characteristics of the satellite orbit and its respective associated frequency bands that is managed by the ITU.

Satellite News Gathering (SNG) - The temporary and occasional transmission with short notice of television or sound for broadcasting purposes, using highly portable or transportable uplink earth stations operating in the framework of the fixed-satellite service.

Satellite Operator - refers to the organisations which either own or operate communications satellites or market transponder capacity on behalf of operators. Also natural or legal person that operates a satellite system.

Satellite Orbit - The trajectory that a space station travels around the Earth.

Satellite Service - Radiocommunication service provided through a satellite system.

Satellite System - One or more satellites and their respective control and operation centres, which operate in an integrated manner. Also means a space system using one of more satellites

Satellite Teleport - Satellite teleports are permanent satellite uplink facilities located throughout the world. These teleports are the facilities that are built for the purpose of maintaining high quality communications with orbiting satellites.

Satellite Television Channel - Refers to the television program that is delivered to the viewers by relaying it from a communications satellite orbiting the Earth.

Service zone/area - Geographic area defined in a satellite network in which a radio communication with one or more earth stations can be established.

Signal - A physical phenomenon one or more of whose characteristics may vary to represent information.

Note – The physical phenomenon may be for instance an electromagnetic wave or acoustic wave and the characteristic may be an electric field, a voltage or a sound pressure.

Space Research Satellite - Any satellite for scientific research.

Space Research Service - A radiocommunication service in which spacecraft or other objects in space are used for scientific or technological research purposes.

Space Segment - In a communication-satellite system, it consists of the satellites and the ground facilities providing the tracking, telemetry and telecommand (TTC) functions and logistics support for the satellites.

Space Segment Provider - An owner of a satellite in space.

Space Station (SS) - Apparatus for radiocommunication, located on an object which is beyond the major portion of the Earth's atmosphere and which is not a high altitude platform.

Spatial station - One or more transmitters and/or receivers, with the necessary infrastructure to ensure a radiocommunication service, located on an object that is located, that is destined to go or that has already been, outside the main part of the Earth's atmosphere.

Spectrum – The radio frequency spectrum of hertzian waves used as a transmission medium for cellular radio, radiopaging, satellite communication, over-the-air broadcasting and other wireless services.

Spectrum related fees - Fees related to the spectrum, be it the use of the spectrum, the management of the spectrum or the value of the spectrum itself, may be called spectrum usage fee, spectrum use fee, frequency assignment fee or frequency use fee in various administrations. They are charged on the basis of the national regulation. As this type of fee is strictly related to spectrum as opposed to administrative or service licence fees, those fees can be called spectrum-related fees.

Star topology - An architecture in which all nodes are individually connected to a central connection point, like a hub or a router.

Telecommunications - All emission, transmission or reception of signs, signals, data, writings, images, voice, sounds or information of any nature that takes place through wires, radioelectricity, optical, physical or other electromagnetic systems, not including broadcasting.

Telecommunications Apparatus - Apparatus made or adapted for use in transmitting, receiving, or conveying any of the licensed services through the licensed network.

Telephony - A form of telecommunication primarily intended for the exchange of information in the form of speech.
Note – This is the definition given in the Constitution of the International Telecommunication Union (Geneva, 1992) (CS 1017) (RR No. 1.123).

Telecommunications Terminal (or Apparatus) – An equipment connected to a telecommunication network to provide access to one or more specific services.
Note – The term may be qualified to indicate the type of service or user, e.g. "data terminal" "subscriber's terminal".

Terminal - The equipment used by customers to access the licensed service.

Traffic - Data, written, images, video, voice, sounds or information of any nature that circulate through a telecommunications network.

Transmitter - Typically based on SSPA (Solid state power amplifier). It is gradually replacing older techniques based on travelling wave tubes of satellite communications systems because of lighter weight and higher reliability. The transmitted power of the satellite can be categorized into 3 levels: low, mid and high:

- Low-Power Satellite has transmitting RF power levels below 30 watts;
- Medium-Power Satellite has power levels between 30 and 100 watts;
- High-Power Satellite has power levels of 100 watts or more.

Transmitter Ground Station Authorization - Administrative act by which the NRA confers the right to a natural or legal person to install, operate and/or exploit earth transmitting stations.

Transponder - Set of equipment that consists of receiver, frequency converter and transmitter. This set forms physically part of the whole communications satellite. The power level of transponder is typically in range of few up to 10 watts. Transponders work typically in range of 36 -72 MHz bandwidth in the L, C, Ku and Ka Bands. The number of transponders within satellite oscillates in range of 12 - 24 although it can also be considerably higher like 50 transponders.
Also the Transmit/Receive part of a satellite and microwave repeaters carried by a communications satellite.

Transportable Earth Station (TES) - A fixed satellite earth station which is transportable, which operates at varying locations and which remains in a fixed location during operation, as for instance used in Satellite News Gathering.

Telemetry, Tracking and Command (TTC) - Subsystem for telemetry, monitoring and control of a satellite with facilities on the ground. Telemetry consists of monitoring the status of the satellite through the collection, processing and transmission of data from the various subsystems; tracking consists of determining the exact location of the satellite through the reception, processing and transmission of tracking signals; and the adequate control of the satellite through the reception, processing and implementation of commands transmitted from the Earth.

Two-Way Terminals - Pertaining to a link where the transmission of users' information is possible in both directions between two points.

Type Approval - An administrative procedure of technical tests and vetting applied to items of telecommunication equipment, involving verification of the equipment's compliance with the applicable standards and other regulatory requirements, before they can be sold, used, imported or interconnected with the public network. Also known as homologation.
Also means a process by which equipment or a device or system is authorized by the NRA to be used in a given country or imported into a country and involves verification of the equipment's compliance with the applicable standards and other regulatory requirements.

Uplink - A radio link between a transmitting earth station and a receiving space station.

Note – The term is also used in terrestrial communications for a link between a transmitting mobile station and a receiving base station.

Useful life - Estimated period in which a satellite can remain in operation.

Very Small Aperture Terminal (VSAT) - A satellite communications earth station used to provide broadcasting and/or telecommunications services, typically using an antenna measuring less than [2.4] [3.8] metres in diameter.
Also means any small two-way fixed satellite earth station used to link to satellites operating in C, Ku and Ka bands with a dish antenna that is smaller than [3] meters diameter.

Very Small Aperture Terminal-Hub (VSAT-Hub) - A two-way satellite ground station with a dish antenna that is around 9.3 meters diameter. It is used for overall control of the remote terminals network and manages the hub itself.

ANNEX 2

TYPICAL SATELLITE FREQUENCY BANDS AND SERVICES/SPECIFIC INTERNATIONAL OR OTHER REGIONAL REGULATIONS FOR SATELLITE COMMUNICATIONS

Ku band frequency usage table

TLC = Telecommand transmit signals; TLMR = Telemetry and Tracking receive signals; FL = Feeder-Link

Table 9: Satellite Ku bands frequency and services

Frequency Band Downlink (space-to-Earth)	Frequency Band Uplink (Earth-to-space)	Satellite Service	Type of use	Related International Regulations
10.70-12.75 GHz	12.75-13.25 GHz 13.75-14.50 GHz	Fixed Satellite Service	Satellite Earth Station (Gateway, Hub, etc.) FL / TLMR FL / TLC	Rec. ITU-R S.731-1 Rec. ITU-R S.732-1 Rec. ITU-R S.733-1 ERC/DEC/(00)08 EN 301 428 EN 301 489-12
10.70-11.70 GHz **12.50-12.75 GHz**	12.75 – 13.25 GHz 13.75-14.50 GHz	Fixed Satellite Service	Satellite Terminal (Uplink, SNG, flyaway)	ITU RR No 5.502 Rec. ITU-R SNG.770-2 Rec. ITU-R SNG.722 EN 301 430 ERC/REC 13-03 ERC/DEC/(00)08
10.70-12.75 GHz	12.75-13.25 GHz 13.75-14.50 GHz	Fixed Satellite Service	Satellite Terminal (VSAT)	Rec. ITU R S.726-1 Rec. ITU-R S.727-1 Rec. ITU-R S.728-1 Rec. ITU-R S.729 EN 301 428 EN 301 489-12 ERC/REC 13-03 ERC/DEC(00)08 ECC.DEC/(03)04 ECC/DEC/(06)02 ECC/DEC/(06)03 ERC/REC/01-07 ECC Report 66
10.7-11.7 GHz **12.5-12.75 GHz** **12.75 - 13.25 GHz**	14.0-14.5 GHz	Mobile Satellite Service	Satellite Terminal (AES) ESIM	Res. 172 (WRC-19) Rec. ITU-R M.1643 Rec. ITU-R S.728-1 ECC/DEC/(05)11 ECC/DEC/(19)04 ECC Decision (18)04 EN 302 186 EN 301 427
10.7-11.7 GHz **12.5-12.75 GHz** **12.75 - 13.25 GHz**	14.0-14.5 GHz	Fixed Satellite Service	Satellite Terminal (ESV)	Res. 172 (WRC-19) ECC/DEC/(05)10 EN 302 340
10,70-11,70 GHz **12,50-12,75 GHz**	14-14.50 GHz	Fixed Satellite Service	Satellite Terminal	ETS 300 255 ERC/DEC/(98)15 ERC/REC/01-07
10,7-12,75 GHz	14-14,50 GHz	Fixed Satellite Service	Satellite Terminal (Data Satellite Receiver)	ERC/DEC/(99)26 ERC/REC/01-07
11.70 - 12.50 GHz		Broadcast Satellite Service		

Ka Band Frequency Usage Table

Table 10: Satellite Ka bands frequency and services

Frequency Band Downlink (space-to-Earth)	Frequency Band Uplink (Earth-to-space)	Satellite Service	Type of use	Related International Regulations
17.7-19.7 GHz	27.5-29.5 GHz	Fixed Satellite Service	Fixed Satellite Earth Station (Gateway) FL / TLMR FL / TLC ESIM	Rec. ITU-R S.524-9 Rec. ITU-R S.580-6 Rep. ITU-R S.2261 ECC/DEC/(00)07 ECC/DEC/(05)08 ECC/DEC/(05)01 ECC/DEC/(13)01 ECC/DEC/(15)04 ECC Report 152 ECC report 272 EN 303 978 EM 303 979 EN 301 360
19.7-20.2GHz	29.5-30.0 GHz	Fixed Satellite Service	FL / TLMR FL / TLC Satellite Terminal ESIM	Rec. ITU-R S.524-9 Rec. ITU-R S.2223 Rec. ITU-R S.2261 Rec. ITU-R S.2357 EN 301 459 EN 301 489-12 EN 303 978 EN 303 979 ECC/DEC/(05)08 ECC/DEC/(06)02 ECC/DEC/(06)03 ECC/DEC/(13)01 ECC/DEC/(15)04 ERC/REC/01-07 ECC Report 152 ECC Report 184 ECC Report 272
	17.30-18.10 GHz	Fixed Satellite Service	BSS Feeder Links	
20.2 – 21.2 GHz		Fixed Satellite Service	FL / TLMR	
21.4 - 22.00 GHz		Broadcast Satellite Service		
	22.55 – 23.15 GHz	Space Research Space Operations Earth Exploration	TLC	
	24.65 – 25.25 GHz	Fixed Satellite Service	FL / TLC BSS Feeder Links	
25.5 – 27.0 GHz		Space Research Space Operations Earth Exploration	TLMR	
	30.0 – 31.0 GHz	Fixed Satellite Service	FL / TLC	

C Band Frequency Usage Table

Table 11: Satellite C-band frequency and services

Frequency Band Downlink (space-to-Earth)	Frequency Band Uplink (Earth-to-space)	Satellite Service	Type of use	Related International Regulations
5 091-5 250 MHz	6 875-7 055 MHz	Mobile Satellite Service	Fixed Satellite Earth Station (Gateway) Feeder Links	
3 400-4 200 MHz	5 725-6 725 MHz 7 025-7 075 MHz	Fixed Satellite Service	Fixed Satellite Earth Station Satellite Terminal (VSAT, ESV)	EN 301 443 EN 301 489-12 ECC/DEC/(05)09
4500-4800 MHz	6725-7025 MHz	Fixed Satellite Service	FSS Plan (RR AP30B)	
6700 – 7075 MHz		Fixed Satellite Service	FL / TLMR NGSO	
	5091 – 5250 MHz	Fixed Satellite Service	FL / TLC NGSO	

X Band Frequency Usage Table

Table 12 Satellite X- band frequency and services

Frequency Band Downlink (space-to-Earth)	Frequency Band Uplink (Earth-to-space)	Satellite Service	Type of use	Related International Regulations
7 250 -7 750 MHz	7 900 - 8 400 MHz	Fixed Satellite Service	FL / TLMR FL / TLC	
	7145 – 7190 MHz	Space Research Space Operations Earth Exploration	TLC	
	7190 – 7250 MHz		TLC	
8025 – 8400 MHz			TLMR	

L Band Frequency Usage Table

Table 13: Satellite L-bands frequency and services

Frequency Band Downlink (space-to-Earth)	Frequency Band Uplink (Earth-to-space)	Satellite Service	Type of use	Related International Regulations
1 518-1 559 MHz	1 610.0-1 626.5 MHz 1626.5 -1660.5 MHz 1668 - 1675 MHz	Mobile Satellite Service	GMPCS Satellite Terminal GMDSS	Res.225 (Rev.WRC-12) ECC/DEC/(04)09 ECC/DEC/(09)04 ECC/DEC/(12)01
2 483.5-2 500 MHz	1 626.5 -1 660.5 MHz	Mobile Satellite Service	GMPCS Satellite Terminal	Res.225 (Rev.WRC-12) ECC/DEC/(04)09 ECC/DEC/(09)04 ECC/DEC/(12)01

S Band Frequency Usage Table

Table 14: Satellite S-band frequency and services

Frequency Band Downlink (space-to-Earth)	Frequency Band Uplink (Earth-to-space)	Satellite Service	Type of use	Related International Regulations
2 170-2 200 MHz	1 980-2 010 MHz	Mobile Satellite Service	Complementary Ground Component (CGC)	ECC/DEC/(06)09
2 025-2 110 MHz	2 200-2 290 MHz	Earth Exploration Satellite Service		
	2025 – 2110 MHz	Space Research Space Operations Earth Exploration	TLC	
2200 – 2290 MHz		Space operation Earth Exploration-Satellite Space research	TLMR	

UHF Band Frequency Usage Table

Table 15: Satellite UHF band frequency and services

Frequency Band Downlink (space-to-Earth)	Frequency Band Uplink (Earth-to-space)	Satellite Service	Type of use	Related International Regulations
144-146 MHz	432.0-438.0 MHz	Amateur Satellite Service		
	399.9-400.05 MHz	Mobile Satellite Service	TLC / FL	
	401-406 MHz	Earth Exploration-Satellite Meteorological-Satellite		
	406-406.1 MHz	Mobile Satellite		
	399.9 – 400.05 MHz	Mobile satellite Service		

VHF Band Frequency Usage Table

Table 16: Satellite VHF band frequency and services

Frequency Band Downlink (space-to-Earth)	Frequency Band Uplink (Earth-to-space)	Satellite Service	Type of use	Related International Regulations
137 – 138 MHz	148 – 150.05 MHz	Mobile Satellite Service	TLMR / FL / TLC	

Examples of frequency bands considered for receive only earth stations

Table 17: Satellite receive only frequency bands and services

Band	Type of Use	Direction	Frequency range
L-band	Receive Earth stations of the Meteorological-Satellite Service	(space-to-Earth)	1690-1710 MHz
C-band	Receiver Earth stations of the Fixed-Satellite for monitoring purposes	(space-to-Earth)	3600-4200 MHz
X-band	Receive Earth stations of the Meteorological-Satellite, Earth Exploration and Space missions	(space-to-Earth)	7750-7900 MHz
Ka-band	Receive Earth stations of the Meteorological-Satellite, Earth Exploration and Space missions	(space-to-Earth)	25.5-26.5 GHz

Examples of sub-bands of FSS and BSS spectrum

Table 18: Sub-bands of FSS and BSS spectrum

Bands		Space-to-Earth	Earth-to-Space
FSS	C	3 400-4 200 MHz	5 725-6 725 MHz/ 7025-7075 MHz
		4500-4800 MHz	6725-7025 MHz
	Extended Ka	17.7-18.3 GHz	27.5-28.35 GHz
		18.3-18.8 GHz	28.35-28.6 GHz /29.25-29.5 GHz
	Ka	19.7-20.2 GHz	29.5-30.0 GHz
	Ku	11.7-12.2 GHz	14.0-14.5 GHz
	Extended Ku	10.95-11.2 GHz/11.45-11.7 GHz	13.75-14.0 GHz
		10.7-10.95 GHz/11.2-11.45 GHz	12.75-13.25 GHz
	Other Ka	18.8-19.3 GHz	28.6-29.1 GHz
BSS	X	7 250-7 750 MHz	7 900-8 400 MHz
	Ku	12.2-12.7 GHz	17.3-17.8 GHz
	Ka	17.3-17.8 GHz	24.75-25.25 GHz

ANNEX 3

ITU-R RECOMMENDATIONS AND REPORTS

Table 19 provides a list of related ITU-R recommendation and reports to facilitate the deployment of satellite services and applications.

Table 19: Overview of relevant ITU- R Recommendation and Reports

Recommendation	Title
ITU-R M.1643	Technical and operational requirements for aircraft earth stations of aeronautical mobile-satellite service including those using fixed-satellite service network transponders in the band 14-14.5 GHz (Earth-to-space)
ITU-R M.2047	Detailed specifications of the satellite radio interfaces of International Mobile Telecommunications-Advanced (IMT Advanced)
ITU-R S.524-9	Maximum permissible levels of off-axis e.i.r.p. density from earth stations in geostationary-satellite orbit networks operating in the fixed-satellite service transmitting in the 6 GHz, 13 GHz, 14 GHz and 30 GHz frequency bands
ITU-R S.580-6	Radiation diagrams for use as design objectives for antennas of earth stations operating with geostationary satellites
ITU-R S.726-1	Maximum permissible level of spurious emissions from very small aperture terminals (VSATs)
ITU-R S.731-1	Reference earth-station cross-polarized radiation pattern for use in frequency coordination and interference assessment in the frequency range from 2 to about 30 GHz
ITU-R S.1061-1	Utilization of fade countermeasure strategies and techniques in the fixed-satellite service
ITU-R S.1428-1	Reference FSS earth-station radiation patterns for use in interference assessment involving non-GSO satellites in frequency bands between 10.7 GHz and 30 GHz
ITU-R S.1587	Provisional technical characteristics of earth stations on board vessels operating in the frequency bands 5 925-6 425 MHz and 14-14.5 GHz which are allocated to the fixed-satellite service
ITU-R S.1594	Maximum emission levels and associated requirements of high density fixed-satellite service earth stations transmitting towards geostationary fixed-satellite service space stations in the 30 GHz range
ITU-R S.1709-1	Technical characteristics of air interfaces for global broadband satellite systems
ITU-R S.1711	Performance enhancements of transmission control protocol over satellite networks
ITU-R S.1782-1	Guidelines on global broadband Internet access by fixed-satellite service systems
ITU-R S.1855	Alternative reference radiation pattern for earth station antennas used with satellites in the geostationay-satellite orbit for use in coordination and/or interference assessment in the frequency range from 2 to 31 GHz
ITU-R S.1857	Methodologies to estimate the off-axis e.i.r.p. density levels and to assess the interference towards adjacent satellites resulting from pointing errors of vehicle-mounted earth stations in the 14 GHz frequency band
ITU-R SF.1006	Determination of the interference potential between earth stations of the fixed-satellite service and stations in the fixed service

Recommendation	Title
ITU-R SF.1486	Sharing methodology between fixed wireless access systems in the fixed service and very small aperture terminals in the fixed-satellite service in the 3 400-3 700 MHz band
ITU-R SF.1485	Determination of the coordination area for Earth stations operating with non-geostationary space stations in the fixed-satellite service in frequency bands shared with the fixed service
ITU-R SF.1585	Example approach for determination of the composite area within which interference to fixed service stations from earth stations on board vessels when operating in motion near a coastline would need to be evaluated
ITU-R SF.1648	Use of frequencies by earth stations on board vessels transmitting in certain bands allocated to the fixed-satellite service
ITU-R SF.1649-1	Guidance for determination of interference from earth stations on board vessels to stations in the fixed service when the earth station on board vessels is within the minimum distance
ITU-R SF.1650	The minimum distance from the coastline beyond which in-motion earth stations located on board vessels would not cause unacceptable interference to the fixed service in the bands 5 925-6 425 MHz and 14-14.5 GHz
ITU-R SF.1707	Methods to facilitate the implementation of large numbers of earth stations in the FSS in areas where terrestrial services are also deployed
ITU-R SM.329-12	Unwanted emissions in the spurious domain
ITU-R SM.1540	Unwanted emissions in the out-of-band domain falling into adjacent allocated bands
ITU-R SM.1541-5	Unwanted emissions in the out-of-band domain

Report	Title
ITU-R M.2398	Scenarios and performance of an integrated MSS system operating in frequency bands below 3 GHz
ITU-R S.2223-1	Technical and operational requirements for GSO FSS earth stations on mobile platforms in bands from 17.3 to 30.0 GHz
ITU-R S.2261	Technical and operational requirements for earth stations on mobile platforms operating in non-GSO FSS systems in the frequency bands from 17.3 to 19.3, 19.7 to 20.2, 27 to 29.1 and from 29.5 to 30.0 GHz
ITU-R S.2278	Use of very small aperture terminals (VSATs)
ITU-R S.2357-0	Technical and operational guidelines for earth stations on mobile platforms communicating with geostationary space stations in the fixed-satellite service in the frequency bands 19.7-20.2 GHz and 29.5-30.0 GHz
ITU-R S.2361-0	Broadband access by fixed-satellite service systems
ITU-R S.2460-0	Key elements for integration of satellite systems into Next Generation Access Technologies
ITU-R S.1782-1	Guidelines on global broadband Internet access by fixed-satellite service systems

ANNEX 4

LIST OF ABBREVIATIONS

In this document, unless the context otherwise requires, the listed abbreviations are to be read as having the meanings referenced below.

Acronym	Definition
ATU	African Telecommunications Union
AU	African Union
AUC	African Union Commission
CATV	Cable television network
CEPT	European Conference of Postal and Telecommunications Administrations
CUG	Close User Group
DTH	Direct-to-home TV
e.i.r.p. or EIRP	Effective Isotropic Radiated Power
ECC	Electronic Communications Committee
EESS	Earth Exploration-Satellite Service
EMC	Electro-Magnetic Compatibility
EMF	Electro-Magnetic Force
ESIM	Earth Station in Motion
ESOMP	Earth Station on Mobile Platforms
ESV	Earth Stations on board Vessels
ETSI	European Telecommunications Standards Institute
EU	European Union
FL	Feeder-Link
FS	Fixed Service
FSS	Fixed Satellite Service
GEO	Geostationary
GHz	One billion Hertz = 10^9 Hertz
GMPCS	Global Mobile Personal Communications by Satellite
GPS	Global Positioning System
GSO	Geostationary Orbit
HIRF	High Intensity Radiated Field
ICNIRP	International Commission on Non-Ionizing Radiation Protection
ICX	Interconnection Exchange
IGW	International Gateway
ISP	Internet Service Provider
ITU	International Telecommunications Union
ITU-R	International Telecommunications Union – Radiocommunication Sector
LEO	Low-altitude Earth Orbit
LI	Lawful Interception
MEO	Medium Earth Orbit
MHz	One million Hertz = 10^6 Hertz
MSS	Mobile Satellite Service
NCF	Network Control Facility
NCMC	Network Control and Monitoring Centre
Non-GSO or NGSO	Non-geostationary orbit
NRA	National Regulatory Authority
PES	Permanent fixed Earth Station

PSTN	Public circuit-switched telephone networks.
QoS	Quality of Service
ROES	Receive Only Earth Station
RR	ITU Radio Regulations
RT	Remote Terminal
RT User	Remote Terminal User
SCSP	Satellite Communication Service Provider
SES	Space Exploration Service
SES	Satellite Earth Station
SMATV	Satellite master antenna TV
SOS	Space Operations Service
Tbps	Terabytes per second
TLC	Telecommand signals
TLM	Telemetry signals
TLMT	Telemetry and Tracking
TT&C	Telemetry, Tracking and Command
UHF	Ultra-High Frequencies
VHF	Very-High Frequencies
VNO	Virtual Network Operator
VSAT	Very Small Aperture Terminal
VSAT-HUB	Very Small Aperture Terminal-Hub
WRC	World Radiocommunication Conference

ANNEX 5:

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