ITU News MAGAZINE

No. 2, 2019

Evolving satellite communications

ITU's role in a brave new world

Enabling the next generation of satellite services

Houlin Zhao

ITU Secretary-General

Satellites play a crucial role to improve lives in today's digital economy. Nearly every industry relies upon satellite technology in some way – from agriculture to banking to transportation.

Satellites help save lives in emergencies and provide critical knowledge about how to better protect the environment. They will be vital in accelerating progress on the United Nations Sustainable Development Goals – especially with new innovations that can offer more economical solutions to connect the unconnected and provide better services.

Small satellites, high-throughput satellites, satellites with all-electric propulsion and low-Earth orbiting (LEO) satellites are among the game-changing innovations enabling a range of solutions from digital financial services to better health care to smarter cities.

This October, over 3000 delegates from most of ITU's 193 Member States are expected to gather in Sharm El-Sheikh, Egypt, for ITU's World Radiocommunication Conference 2019 (WRC-19) to update the very important Radio Regulations treaty. It includes regulatory procedures for coordinating the orbital slots, ensuring that satellites operate free from harmful interference. There will be a number of important satellite issues on the agenda of this pivotal conference.

In this edition of the ITU News Magazine you will learn about the trends in satellites communications and ITU's key role in bringing all parties together to agree on successful ways forward.

"Nearly every industry relies upon satellite technology in some way — from agriculture to banking to transportation."

Houlin Zhao

Contents

Evolving satellite communications

ITU's role in a brave new world

Editorial

Introduction

Industry perspectives

Cover photo: Shutterstock

ISSN 1020-4148
itunews.itu.int
Six issues per year

Editor-in-Chief: Matthew Clark
Art Editor: Christine Vanoli
Editorial Assistant: Angela Smith

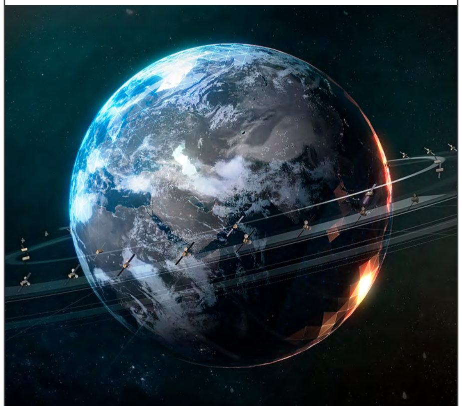
Editorial office/Advertising information:
Tel.: +41 22 730 5234/6303
Fax: +41 22 730 5935
E-mail: itunews@itu.int

Mailing address:
International Telecommunication Union
Place des Nations
CH-1211 Geneva 20 (Switzerland)

Contents







Satellite communications – An essential link for a connected world

Mario Maniewicz

Director of the ITU Radiocommunication Bureau

Satellite communications are everywhere but all too often remain invisible to the general public, which is both an indication of their successful integration into the overall telecommunication market, and sometimes an obstacle to a proper understanding of their vital importance for an interconnected world.

This year, more than 3000 delegates representing most of ITU's 193 Member States, along with representatives from among ITU's 800+ private-sector members, and international organizations, will gather in the city of Sharm El-Sheikh at the kind invitation of the Government of Egypt, for the World Radiocommunication Conference. This edition of the ITU News Magazine presents the variety of applications and services provided by today's communication satellites.

Satellite technologies are more and more diverse and pervasive but they all rely on the same core element: the availability of radio frequencies that can be operated free from harmful interference.

"Satellite communications are everywhere but all too often remain invisible to the general public."

Mario Maniewicz


Shutterstock

Radio frequencies – Radio Regulations: an enduring success

In order to ensure this availability, the Radio Regulations, the international treaty governing the use of the radio-frequency spectrum and the associated satellite orbits (both geostationary and non-geostationary), on the one hand allocate specific frequencies for various space applications, and on the other hand, contain detailed technical provisions and regulatory procedures to ensure the rational, equitable, efficient and economic use of spectrum/orbit resources.

These procedures are based on a cooperative system, whereby ITU Member States provide the characteristics of their intended use of orbit/spectrum resources, the ITU Radiocommunication Bureau examines their compliance with the Radio Regulations, and then publishes them so that they can be coordinated with other ITU Member States who have satellite projects that could be affected.

Once the above procedures are completed, satellite frequencies are entered into the Master International Frequency Register, where they enjoy the legal rights (mainly of operating free from harmful interference) obtained in conformity with the Radio Regulations.

Keeping pace with innovation: the role of World Radiocommunication Conferences

But, with rapidly evolving technologies, innovative applications and new business models recently blossoming in the satellite industry, this treaty needs to adapt and be regularly updated: this is the role of World Radiocommunication Conferences.

> *"Satellite technologies are more and more diverse and pervasive but they all rely on the same core element."*
>
> Mario Maniewicz

Such Conferences take place every four years and consider an agenda elaborated and agreed by the previous one. The various agenda items trigger three years of technical and regulatory studies performed within the ITU–R Study Groups to support the work of the Conference by providing possible alternative options to satisfy the needs expressed by the agenda item. Of particular relevance for the satellite communication industry is Study Group 4 (SG 4), whose Chairman has kindly agreed to provide insights on the work of the group (see next article).

As with every Conference, the agenda for this year contains several items related to satellite communications:

- providing additional spectrum for satellite broadband Internet access on moving platforms like ships, planes or trains;
- looking for a harmonized band for telemetry and telecommand of small satellites;
- setting the operational conditions of non-geostationary satellite systems in the 50/40 GHz range;
- providing additional spectrum in the same range for geostationary satellite systems;
- regulating the deployment of mega-constellations of non-geostationary satellite systems to prevent radio-frequency warehousing.

As you can read from this non-exhaustive list, the space industry is developing major innovative technologies that will be discussed in Sharm El-Sheikh, and I am sure that Member States will find consensual solutions to accommodate them in the Radio Regulations.

Traditional satellite applications like satellite television or satellite news gathering may not be on the agenda of the next World Radiocommunication Conference, but video is still a major satellite market, and you will be able to read in this edition about some innovations that can also be expected in this field.

Integration of satellite communications in the 5G ecosystem

The ITU Radiocommunication Sector (ITU–R) Study Groups not only conduct studies related to the agendas of World Radiocommunication Conferences but also elaborate a number of Recommendations, Reports and Handbooks (all of which are publicly and freely available) that contain global up-to-date technical standards related to satellite system equipment or best practices about spectrum/orbit resource management.

One of the current topics being studied by ITU–R SG 4 outside of the conference process relates to the integration of satellite communications in the 5G ecosystem. As it was noted in the report issued in September 2018 by the Broadband Commission for Sustainable Development on "The State of Broadband 2018: Broadband catalyzing sustainable development", "Satellite technology can also help relieve the congestion and overloading of networks. In future, it will support 5G and ensure connectivity in times or areas where terrestrial networks are unavailable." It is therefore now essential to undertake the necessary studies to ensure that satellite communications will integrate with terrestrial systems, to offer a seamless experience to the end-user.

Get involved!

I would like to conclude by reiterating that all space actors have a role to play in building a connected world, and I therefore invite you to get involved in ITU–R activities, not only in the coming months leading to the World Radiocommunication Conference, but also in the long term.

I hope that you find this edition — and the selection of articles from authors chosen by ITU's Radiocommunication Bureau — informative, interesting and useful.

■

ITU-R Study Group 4 – Satellite services at WRC-19

Chris Hofer

Chairman of the ITU Radiocommunication Sector Study Group 4

As we approach the World Radiocommunication Conference 2019 (WRC-19), some of the most important satellite issues the ITU Radiocommunication Sector (ITU-R) has been studying are addressed in WRC-19 Agenda items 1.5, 1.6, 7 Issues A and I, as described below.

The outcome of the discussions on these issues will most probably have a significant impact on bridging the digital divide to foster economic growth, social inclusion and meeting consumer demand. They will also help to provide broad-band services to billions of people that still do not have access to a broadband infrastructure, no matter where they live or travel.

"The global demand for broadband communications continues unabated, and is not location specific."

Chris Hofer

WRC-19 Agenda item 1.5

"To consider the use of the frequency bands 17.7–19.7 GHz (space-to-Earth) and 27.5-29.5 GHz (Earth-to-space) by earth stations in motion communicating with geostationary space stations in the fixed-satellite service and take appropriate action, in accordance with Resolution 158 (WRC-15)"

The global demand for broadband communications continues unabated, and is not location specific. Such demand includes requirements of connectivity for users on aircraft, ships and vehicles (including first responders) that operate at both fixed locations and while in motion. These three different platforms need continuous connectivity along their travel routes, which often take them through unserved parts of major metropolitan areas, as well as less-densely populated areas. ITU for many years has and continues to address ways of meeting this important need.

Today's 30/20 GHz geostationary orbit (GSO) fixed-satellite service (FSS) networks provide affordable and reliable connectivity that meet the broadband connectivity requirements of passengers and crew on aircraft, vehicles, and ships, including high-throughput (HTS) applications.

Advances in satellite manufacturing and directional earth-station technology, particularly the development of multi-axis stabilized earth-station antennas capable of maintaining a high degree of pointing accuracy, while stationary or on rapidly moving platforms, have made earth stations with very stable pointing characteristics both available and practical.

These earth stations can operate in the same interference environment, and comply with the same regulatory and technical constraints as typical GSO FSS earth stations. Satellite network operators are designing, coordinating, and bringing into use GSO FSS networks that can offer broadband services to both stationary and moving earth stations using a single stabilized directional antenna within existing GSO FSS technical parameters.

The ITU–R has been studying deployment of earth stations in motion (ESIM) communicating with GSO FSS space stations for many years. WRC-15 adopted regulatory provisions for the operation of ESIM communicating with GSO FSS space stations in the 29.5–30 GHz and 19.7–20.2 GHz bands under Radio Regulations (RR) No. 5.527A and Resolution 156 (WRC-15), and prior World Radiocommunication Conferences adopted provisions for operation of ESIM on maritime vessels communicating with GSO FSS space stations in lower FSS bands.

Bands being considered for earth stations in motion

The latest bands to be considered for ESIM communication with GSO FSS space stations are the 27.5–29.5 GHz and 17.7–19.7 GHz bands. These bands were considered separately from the "upper 500 MHz" of the 30/20 GHz band due to the fact that the upper bands are allocated predominantly to satellite services, while the lower portions of the 30/20 GHz bands are shared on a global basis with the fixed and mobile services as well as other users.

The sharing cases requiring study in the 27.5–29.5 GHz and 17.7–19.7 GHz bands were set out in Resolution 158 (WRC-15). Where provisions were shown to be required for the protection of existing services and applications — such as the mobile service, the fixed service, and non-GSO FSS systems in portions of the band subject to RR No. 22.2 — studies leading to the conditions necessary for such protection have been identified or are nearing conclusion.

The ITU–R determined that a resolution containing the regulatory, technical, and operational conditions for ESIM operation on aircraft, maritime vessels, and land vehicles could be developed and effectively implemented.

WRC-19 Agenda item 1.6

"To consider the development of a regulatory framework for non-GSO FSS satellite systems that may operate in the frequency bands 37.5-39.5 GHz (space-to-Earth), 39.5–42.5 GHz (space-to-Earth), 47.2–50.2 GHz (Earth-to-space) and 50.4–51.4 GHz (Earth-to-space), in accordance with Resolution 159 (WRC-15)"

WRC-19 agenda item 1.6 addresses the development of technical, operational and regulatory provisions in the 50/40 GHz frequency bands to facilitate sharing between non-GSO and GSO fixed-satellite service (FSS)/broadcasting-satellite service (BSS)/mobile-satellite service (MSS) systems.

There are currently no regulatory provisions for sharing between non-GSO systems and GSO networks in the 50/40 GHz frequency bands. In addition, there are no mechanisms in the Radio Regulations establishing coordination procedures applicable to non-GSO systems operating within the FSS and BSS allocations in frequency bands in the 37.5 to 51.4 GHz frequency range.

ITU–R studies in the 50/40 GHz frequency bands have been conducted on sharing between non-GSO systems and GSO FSS and BSS networks. These studies concluded that developing equivalent power flux density (epfd) limits based on the operational parameters for a single, specific, non-GSO system results in spectrum inefficiencies for other non-GSO systems.

On the other hand, these studies identify a more efficient sharing methodology in the 50/40 GHz frequency bands and conclude that the protection of GSO networks is possible based on an assessment of aggregate interference from multiple non-GSO systems, with different configurations and orbits.

While there may not be an agreement on epfd limits, there is general consensus that it is possible to achieve compatibility in the 50/40 GHz frequency bands that would allow non-GSO FSS systems to operate, while ensuring protection to GSO satellite networks in the FSS, MSS, and BSS, based on a decrease in availability and capacity loss.

WRC-19 Agenda item 1.6 also considers the protection of the Earth exploration-satellite service (EESS) (passive) and radio astronomy services in adjacent bands.

WRC-19 Agenda item 7 Issue A

"Bringing into use of frequency assignments to all non-GSO systems, and consideration of a milestone-based approach for the deployment of non-GSO systems in specific frequency bands and services"

The ITU–R has studied both the bringing into use of frequency assignments to non-geostationary satellite (non-GSO) systems, and the possibility of adopting a milestone-based approach for the deployment of non-GSO systems composed of multiple, multi-satellite constellations, in particular frequency bands.

The ITU–R studies have led to two general conclusions, one related to the concept of the bringing into use, and the other related to the milestone-based approach for the deployment of non-GSO systems, each with multiple options for implementation.

The first general conclusion is that the bringing into use of frequency assignments to non-GSO systems should continue to be achieved by the deployment of one satellite into one of the notified orbital planes within seven years of the date of receipt of the advance publication of information (API) or request for coordination, as applicable. This conclusion applies for frequency assignments for all non-GSO systems in all frequency bands and services.

However, three options are proposed with respect to the minimum period during which a satellite has to be maintained in a notified orbital plane: 90 days (as currently required for fixed-satellite service (FSS) and mobile-satellite service (MSS) non-GSO systems in the Rule of Procedure (RoP) for RR No. 11.44), some period less than 90 days or no fixed period.

The second general conclusion is that a new WRC Resolution should be adopted to implement a milestone-based approach for the deployment of non-GSO systems in specific frequency bands and services. This milestone-based approach would provide an additional period beyond the seven-year regulatory period for the deployment of the number of satellites, as notified and/or recorded, with the objective to help ensure that the Master International Frequency Register (MIFR – see sidebar) reasonably reflects the actual deployment of such non-GSO systems.

Master International Frequency Register

The Master International Frequency Register (MIFR) or the Master Register contains frequency assignments together with their particulars as notified to the ITU in accordance with Article 11 of the Radio Regulations (RR)

Status of a frequency assignment in the MIFR

The international rights and obligations of administrations in respect of their own and other administrations' frequency assignments shall be derived from the recording of those assignments in the the Master Register or from their conformity, where appropriate, with a Plan. Such rights shall be conditioned by the provisions of the RR and those of any relevant frequency allotment or assignment Plan.

Conform assignment

Any frequency assignment recorded in the Master Register with a favourable finding under RR 11.31 shall have the right to international recognition. For such an assignment, this right means that other administrations shall take this into account when making their own assignments, in order to avoid harmful interference. In addition, frequency assignments in frequency bands subject to coordination or subject to a Plan shall have a status derived from the application of the procedures relating to the coordination or associated with the Plan.

Non-conform assignment

A frequency assignment shall be known as a non-conforming assignment when it is not in accordance with the Table of Frequency Allocations or the other provisions of these Regulations. Such an assignment shall be recorded for information purposes, only when the notifying administration states that it will be operated in accordance with RR 4.4 (see also RR 8.5).

> *The successful and timely development and operation of non-GSO satellite systems with short-duration missions requires regulatory procedures that take account of the nature and timing for deployment of these systems.*
>
> Chris Hofer

Several options are proposed with respect to the number of milestones, the milestone periods, the required percentage of satellites deployed to satisfy each milestone, the consequences of failing to meet a milestone, and appropriate transitional measures to fairly and equitably address the case of the recorded frequency assignments to non-GSO systems already brought into use, and that have reached the end of their seven-year regulatory period, but where the non-GSO system has not been fully deployed.

WRC-19 Agenda item 7 Issue I

"Modified regulatory procedure for non-GSO satellite systems with short-duration missions"

The existing provisions of the RR for the advance publication and notification of satellites under Articles 9 and 11 do not take account of the short development cycle, the short lifetimes and the typical missions of non-GSO satellites with short-duration missions. Therefore, a modified regulatory procedure for the advance publication, notification and recording of non-GSO satellite systems with short-duration missions is required.

The successful and timely development and operation of non-GSO satellite systems with short-duration missions requires regulatory procedures that take account of the nature and timing for deployment of these systems.

Many of these non-GSO satellite systems are being developed by academic institutions, amateur satellite organizations, or by developing countries that are using these satellites to build their expertise in space capability. The current regulatory procedures for satellite networks and systems result in difficulties for non-GSO satellite systems with short-duration missions to be notified to the ITU. This can have adverse consequences in the management of interference, as these satellite systems currently provide a range of services, and are not confined to the amateur-satellite service, as was initially the case.

A draft new WRC Resolution, together with an associated regulatory procedure for non-GSO satellite systems with short-duration missions, has been developed to address this issue.

The ITU Radiocommunication Sector (ITU–R) Study Groups

World experts in radiocommunications, dedicated to studies in:

- The efficient management and use of the spectrum/orbit resource by space and terrestrial services
- Characteristics and performance of radio systems
- Operation of radio stations
- Radiocommunication aspects of distress and safety matters

plus:

- Preparatory studies for world and regional radiocommunication conferences
- Developing global standards (Recommendations)
- Publishing best practices, including reports and handbooks

More than 5000 specialists worldwide participate in the work of ITU–R Study Groups

1 Spectrum management

Spectrum management is the combination of administrative and technical procedures necessary to ensure the efficient utilization of the radio-frequency spectrum by all radiocommunication services defined in the ITU Radio Regulations and the operation of radio systems, without causing harmful interference.

3 Radiowave propagation

Propagation of radio waves in ionized and non-ionized media and the characteristics of radio noise, for the purpose of improving radiocommunication systems.

4 Satellite services

Systems and networks for the fixed-satellite service, mobile-satellite service, broadcastingsatellite service and radiodetermination-satellite service.

5 Terrestrial services

Systems and networks for fixed, mobile, radiodetermination, amateur and amateur-satellite services.

6 Broadcasting service

Radiocommunication broadcasting, including vision, sound, multimedia and data services principally intended for delivery to the general public.

7 Science services

"Science services" refer to the standard frequency and time signal, space research (SRS),space operation, Earth exploration-satellite (EESS), meteorological-satellite (MetSat), meteorological aids (MetAids) and radio astronomy (RAS) services.

ITU–R Study Group 4 (SG 4) Satellite services

Systems and networks for the fixed-satellite service

Mobile-satellite service

Broadcasting satellite service

Radiodetermination-satellite service.

Three Working Parties (WPs) carry out studies on Questions assigned to Study Group (SG) 4:

WP 4A

Efficient orbit/spectrum utilization for the fixed-satellite service (FSS) and broadcasting-satellite service (BSS)

Read more

WP 4B

Systems, air interfaces, performance and availability objectives for the fixed-satellite service (FSS), broadcasting-satellite service (BSS) and mobile-satellite service (MSS), including IP-based applications and satellite news gathering (SNG)

Read more

WP 4C

Efficient orbit/spectrum utilization for the mobile-satellite service (MSS) and the radiodetermination-satellite service (RDSS)

Read more

Satellite services and media contribution networks in the age of 'high throughput' satellites

Antonio Arcidiacono

Director, Technology and Innovation,
European Broadcasting Union

ITU has many roles but none more important than coordinating and regulating radio frequency usage across the world, which includes frequency bands used for both terrestrial and satellite services.

"ITU has many roles but none more important than coordinating and regulating radio frequency usage across the world, which includes frequency bands used for both terrestrial and satellite services."

Antonio Arcidiacono

ITU's prime challenge – enabling the next generation of satellite services

ITU faces many challenges today, but a prime one is to enable the next generation of satellite services, which will bring exciting new options for both satellite operators and users.

Satellite broadcasting via geostationary satellites will remain in widespread use. It will be a main source of revenue for satellite operators for the foreseeable future. But technology evolution in the coming years will also offer the possibility of new services via "very high throughput satellites (VHTS)" and "multispot" geostationary satellites.

In addition, there will be new non-geostationary satellites, low earth orbit (LEO) and medium Earth orbit (MEO), of different sizes and capabilities. Overall, there is likely to be major competition for services.

Market forces will bring service costs down. Furthermore, future user terminals will achieve a larger degree of flexibility, and lower costs.

Such a competitive environment will not only be good for operators and service providers; it will help organizations that provide services in multiple regions. In addition, it will reduce the number of intermediary organizations needed to do so.

A new age of 'satellite news gathering'

We can expect that the thousands of broadcast satellite TV channels will continue to be a major part of media delivery to the consumer, but the arrival of VHTS and non-geostationary satellites will open doors to new services and markets. As an example, among them will be a new age of "satellite news gathering".

Getting news stories back to the studio today is done in a variety of ways.

One, which is complex and expensive, when the location permits, is to use an "outside broadcast" vehicle, with microwave, fiber-optic, or other link back to the studio centre.

Shutterstock/Scarc

Another, now widely used, is to download or stream a news story video via mobile Internet. Reporters use "communications backpacks" and the best available local mobile Internet connections where they happen to be located. If it is available, today they will use a "4G" mobile broadband Internet connection. But there are limitations. As with all Internet connections, the bit rate that can be used is limited by the number of simultaneous users at any given time. Internet delivery can be limited by congestion and "contention".

> *"The positive evolution of new technologies and related services will only be possible if an 'easy-to-access' regulatory framework is put in place."*
>
> Antonio Arcidiacono

What the future may bring

The future may bring "5G" mobile Internet, which will bring significant improvements. But it will take time to roll out – network operators need a business case to make the transition. 5G offers the promise of much higher bit rates than 4G, and thus, all other things being equal, it will provide more consistent high bit rate links for reporters to use.

But such 5G services will probably be mainly available in urban rather than rural areas, although *ad hoc* networks in specific places such as sports stadiums may be possible.

Reporting in practice is needed any time, from any and every geographical location. Thus, for underserved areas, mechanisms other than mobile Internet for returning news to the studio will probably be needed.

Stepping up to the plate could be small and reliable radio links via satellites. Satellites will cover large geographic areas, and so can be accessed from both rural and urban locations.

Small and light satellite transmitters and aerials for reporters will be available, beaming up contributions to satellites in the Ku and Ka bands, where HTS and VHTS satellites will be available.

Of course, there would be limitations – such terminals could be more costly than mobile Internet terminals, and the satellite links may be subjected to rain fading in some regions. But having the terminals able to operate in multiple bands (i.e. C-band and K-band) will minimize the limitations that rain fades might cause.

The C-band would be less sensitive to rain fading. Using HTS for a C-band service would improve the overall performance in extreme weather conditions, and spread-spectrum techniques could be used to limit interference to adjacent satellites or any terrestrial services using C-band. Such systems could lower the "cost per megabit" and guarantee good service availability from locations where transmission could be impaired by rain.

The systems would also make use of the more advanced radio frequency (RF) modulation systems now possible, and fully digital aerial array terminals. The results would be sets of compact and light self-pointing systems that could be operated by the journalist alone, without special help.

Back to base multimedia content in real time

In summary, because of the global coverage of different satellite constellations, geostationary and non-geostationary based, the future ubiquitous presence of a satellite infrastructure will allow journalists, and any other professional operators, from security services to civil protection teams, to send back to base multimedia content, in real time. This will transform, even more than it is today, the world into a "global village". The reduced operational complexity and the lower cost of these terminals, and related services, will bring competing services not only in urban areas but also in rural areas, with a guaranteed high quality of service.

Coordination of new HTS networks — a challenge for ITU

The ITU Radiocommunication Sector (ITU–R) has played a crucial role for many decades in arranging fair regulation of satellite services. One of the challenges for ITU will be the coordination of new HTS networks in the C and Ka bands, which are "unplanned" bands. There are already a large number of submissions to ITU for different types of GEO and non-GEO satellites.

Another challenge will be to assure necessary rights in the various countries covered by given satellites, which must be done on a country-by-country basis. For HTS services, cross-border restrictions could be very limiting, in particular in those markets where local services need "proper" licences.

The need for an easy-to-access regulatory framework

The positive evolution of new technologies and related services will only be possible if an "easy-to-access" regulatory framework is put in place. This is our request to ITU.

General authorization regimes, combined with automatic and certified registration processes, will be important to ensure a smooth operation of services without generating interference to other terrestrial and satellite services operating in the same frequency bands.

Could, for example, an ITU central registration server be created where each terminal could register, by providing a required number of parameters (including the licensing details)? When a terminal goes live it will authenticate and provide key local parameters (certifying the position and other useful information).

It is important that adequate spectrum is available for satellite operations. In particular, the Ka and C bands must remain accessible to provide regulatory stability for current and planned investments in innovative satellite services.

The challenge is great but the men and women of ITU will surely rise to meet it.

WRC-19 – An opportunity to bridge the digital divide for 5G

Jennifer A. Manner

Senior Vice President, Regulatory Affairs, EchoStar/Hughes

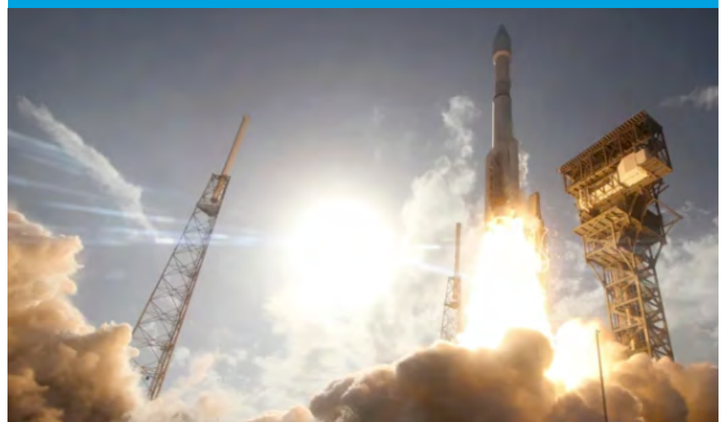
One of the important goals of the 2019 World Radiocommunication Conference (WRC-19) is to ensure that there is sufficient terrestrial spectrum available globally to allow the deployment of anytime, anywhere communications over 5G networks.

Such networks will transform our world to one where so much of what we depend on in our daily lives is connected, bringing us the latest in information to be productive at work, learn online, enjoy our leisure time, and so much more.

However, as the WRC makes these important spectrum allocations, it is critical that the Conference also makes sure that everyone benefits from 5G – whether served by terrestrial or non-terrestrial networks, namely satellites.

> *"Satellite networks are providing affordable high-speed broadband services to millions of users around the globe."*
>
> Jennifer A. Manner

The JUPITER System



An advanced VSAT platform, with single stream DVB-S2X wideband forward channel, for broadband services over both high-throughput and conventional satellites.

Read more here.

Reaching the globe beyond terrestrial 5G

With the availability of high-throughput, high-capacity broadband geostationary satellite orbit (GSO) networks, such as the Hughes JUPITER system, and pending deployment of mega constellations of non-geostationary satellite orbit (NGSO) systems, it is clear that the benefits of 5G can reach parts of the globe where terrestrial 5G networks may never be available.

Today, satellite networks are providing affordable high-speed broadband services to millions of users around the globe. Users are connected over satellite channels directly utilizing very small aperture terminals (VSATs), or by hybrid architecture, whereby VSATs provide a satellite backhaul of terrestrial wireless services delivered over cellular/WiFi devices. For example, in Brazil, Hughes has implemented such a combined satellite plus terrestrial network, to bring high-speed connectivity to community centres and schools in remote villages across the Amazon region.

The promise of next-generation networks

The next generation of these networks hold the promise to connect the billions unserved or underserved, with even higher capacity, higher speed services globally, opening up a world of opportunities to people everywhere.

To this end, the 3rd Generation Partnership Project (3GPP), a terrestrial standards body focused on developing the standard for 5G networks (in compliance with ITU's IMT-2020 requirements), has begun to work to develop standards that include satellite technology, ensuring that satellite will play an important role in 5G infrastructure.

Satellite frequencies — under threat

However, the essential satellite frequencies needed to realize this goal are under threat. It should be understood that these millimeter wave bands were made available a decade or more ago to ensure that future high-speed data satellite networks had ample spectrum — and in fact are the basis of products and services designed and built to operate today, to support hundreds of millions of users globally.

The efforts of the international mobile telecommunication (IMT) community to identify these bands under WRC-19 Agenda item 1.13 exclusively for IMT-2020 (terrestrial 5G), put this promise and investment at risk.

Protecting spectrum for primary services at WRC-19

As we head towards WRC-19, there seems to be a focus on making these bands available for IMT-2020, while ignoring the very clear guidance in the Agenda item to take "into account the protection of services to which the band is allocated on a primary basis." Many of these bands, including 37.5–42.5 GHz and 47.2–50.2 GHz are co-primary for fixed-satellite services, and satellite networks are being planned and constructed for operation in these bands globally. As a case in point, Hughes is actively expanding its broadband-satellite services across the Americas in these bands, developing a new ultra-high-throughput (HTS) satellite (JUPITER 3), to be launched in 2021, joining two existing HTS satellites.

SSL

> *"We have one chance at WRC-19 to make sure that we do not create an insurmountable digital divide for 5G."*
>
> Jennifer A. Manner

WRC-19 must make sure that there is adequate protected spectrum for these systems to enable them to develop and support 5G users, no matter where they may be.

While there is also a need for additional spectrum to be made available for terrestrial 5G, given there is a total of 33 GHz of spectrum being looked at for IMT-2020, it is more than feasible that the few GHz of spectrum required for satellite services be protected.

More importantly, failure to provide such protected spectrum for user devices and gateways would deprive hundreds of millions of potential users in ex-urban and rural areas access to 5G services, through cost-effective hybrid satellite-terrestrial architectures, as noted earlier.

Protecting satellite broadband at WRC-19

We have one chance at WRC-19 to make sure that we do not create an insurmountable digital divide for 5G.

Let's be smart and adopt appropriate protection for satellite broadband now as part of WRC-19 Agenda item 1.13.

In doing so, we will ensure that there is a world where all people, no matter where they are located, have the opportunity to be connected and enjoy the benefits of the digital world.

WRC-19 Agenda item 1.13

To consider identification of frequency bands for the future development of International Mobile Telecommunications (IMT), including possible additional allocations to the mobile service on a primary basis, in accordance with Resolution 238 (WRC-15);

Resolution 238 (WRC-15)

Studies on frequency-related matters for International Mobile Telecommunications identification including possible additional allocations to the mobile services on a primary basis in portion(s) of the frequency range between 24.25 and 86 GHz for the future development of International Mobile Telecommunications for 2020 and beyond.

Satellite – Indispensable in the new television revolution

Jean-François Bureau

Director, Institutional and International Affairs, Eutelsat

The profound changes that have swept through the satellite communication sector in recent years, caused not least by the emergence of new distribution and consumption models, solutions and players, are giving video applications a fresh boost. They represent 80 per cent of communication network traffic while remaining the foremost activity of global satellite operators like Eutelsat, accounting for the bulk of its turnover (66 per cent in 2017–2018). In 2016, video accounted for 60 per cent of the volume of the capacity offered by commercial communication satellites operating at 36 000 km above the Earth in geostationary satellite orbit (source: Euroconsult, 2018).

The rise in high definition

In developed countries, the market has now reached maturity, with global stability expected in the coming years due to a double phenomenon. On the one hand we are witnessing the rise in power of high definition (HD) and ultra high definition (UHD), which require greater capacity per channel, and should therefore drive growth (one satellite repeater can broadcast 20 channels with standard resolution and MPEG-4, or nine with HD and MPEG-4).

> *"The profound changes that have swept through the satellite communication sector in recent years, caused not least by the emergence of new distribution and consumption models, solutions and players, are giving video applications a fresh boost."*
>
> Jean-François Bureau

Eutelsat/Philippe Stroppa

Euroconsult also foresees the number of HD channels increasing at a weighted average annual rate of 10 per cent to reach over 11 000 channels in 2027. At the same time, technical advancement in terms of TV signal compression has a negative effect on demand. Deployment of the DVB-S2 standard and adoption of the MPEG-4 compression norm make it possible to broadcast up to twice as many channels per repeater, thus optimizing the use of bandwidth among TV channels and reducing the cost of access to satellite capacity for newcomers.

What is the main driver of growth?

In emerging economies, on the other hand, growth is stronger, with demand for volume rising steeply. The main driver of growth is the increased number of channels broadcast, which has more than doubled over the past five years.

The potential increase in the number of channels broadcast is highly significant for the years to come since, for example, at present there are only two channels per million inhabitants in sub-Saharan Africa, as compared with over 30 per million inhabitants in North America. Moreover, HD broadcasting in Africa is still far less prevalent than in the developed countries. HD penetration in Africa, for example, stands at just 5 per cent, as compared with 34 per cent in Western Europe (Euroconsult). Thus HD penetration, which is also set to increase in the emerging economies in the coming years, will impact the growth of satellite video.

In addition, satellite has a major role to play against the backdrop of rising digital terrestrial television (DTT) in emerging economies, especially in Africa, as the extended coverage it offers will allow it to feed DTT repeaters, and provide additional coverage serving homes beyond the reach of terrestrial networks.

> *"Satellite has a major role to play against the backdrop of rising digital terrestrial television in emerging economies."*
>
> Jean-François Bureau

Accelerating convergence of broadcast consumption

Over and above the rapid transformations accompanying the rise in power of new standards, the profound change affecting consumption models – with the rapid decline of linear television in favour of differed consumption or video on demand – is accelerating the convergence of broadcast consumption and the deployment of broadband networks, designed with digital services and the Internet particularly in mind. This means the historical division in the structure of the satellite telecommunication world is weakening fast, with all future activities in the area linked to the deployment of very high-capacity satellites dedicated to the Internet and transporting both image and text with equal ease, as it is all data. Moreover, this first transformation is coupled with a second, resulting from the fact that the preferred mode of consumption will be mobile, using portable terminals (smartphones) and mobile (autonomous cars and planes), and no longer the fixed service.

Enhancing the viewer's experience

This makes it hardly surprising that satellite operators like Eutelsat are also developing solutions which allow the complete integration of video consumption within the IP ecosystem, with a particular view to greatly enhancing the viewer's experience (connected TV and multi-screen solutions). In this vein, a few months ago Eutelsat launched CIRRUS, a hybrid satellite-OTT (over-the-top) technology allowing TV channels to accelerate deployment of their video services, reduce their operational costs, and combine quality of image with user experience.

Satellite solutions – relying on continued allocation of spectrum

By offering connectivity "anywhere and anytime", satellite, with its territorial coverage complementing that of terrestrial networks and the ever-increasing diversity of the services it offers, will become an indispensable component in the deployment of fifth generation (5G) networks, and mobile applications in particular. It will also provide the most effective arms in the fight to bridge the digital divide, in terms of service efficiency and deployment costs, thus justifying the continued allocation of the spectrum required by satellite solutions, without which they could not be deployed.

■

Next generation of satellites on the move

Julián Seseña

Consultant, EAN Regulatory, Inmarsat

Matt Evans

Manager, EAN Regulatory, Inmarsat

Inmarsat has been leading innovation in the mobile satellite communications sector ever since its inception by the International Maritime Organization (IMO), in 1979, with the objective of delivering the world's first satellite communications network dedicated to maritime safety.

Inmarsat was the first satellite operator to meet the stringent requirements of the Global Maritime Distress and Safety System (GMDSS), and subsequently the International Civil Aviation Organization (ICAO) for global aeronautical safety communications.

> *"With European air traffic forecast to double over the next decade, the European Aviation Network is designed to grow capacity to match accelerating demand."*
>
> Julián Seseña/Matt Evans


Inmarsat

Today, Inmarsat satellite communication networks and services are not only saving lives but empowering people and communities, enabling business and trade, serving governments and supporting remote humanitarian work throughout the world. Our wide range of solutions help deliver mission-critical connectivity to our customers, ranging from governments and aid agencies to ship owners and airlines, to name but a few, beyond the reach of terrestrial networks. The Broadband Global Area Network (BGAN) constellation of satellites (in L-band) offer seamless global mobile coverage, connecting people and machines in remote locations on land, at sea and in the air — enabling the Internet of Things (IoT), voice calls and Internet access. The Global Xpress (GX) network was the first and remains the only globally available mobile high-speed broadband network delivered by a single operator, offering exceptional throughput capabilities and enhanced solutions to our customers in the Ka-band.

Inmarsat aviation — safety and connectivity in the skies

Inmarsat has steadily set the bar for flight-deck communications, with over nearly three decades of commitment to aviation safety services. More than 90% of the world's aircraft crossing oceans use our safety and operational services for communication and surveillance today — over 12 000 aircraft in total. Most of the world's leading airlines have used Inmarsat Classic Aero services for over 25 years — as well as small-, medium- and large-business jet owners, general aviation and government agencies. Inmarsat's SwiftBroadband Safety (SB-S) service is the next generation of operations and safety connectivity, delivering game-changing visibility into airline operations. These services are provided by a fleet of Inmarsat satellites, which covers the world using spectrum in the L-band.

GX Aviation offers uninterrupted high-speed Wi-Fi. GX offers an alternative to the makeshift patchwork of Ku-band services, the vast majority of which have not been designed for mobility and do not meet the high standard of reliability for passengers and the aviation industry needs.

With European air traffic forecast to double over the next decade, the European Aviation Network (EAN) is designed to grow capacity to match accelerating demand. Initially combining Inmarsat's multi-beam S-band satellite with nearly 300 ground towers implemented by Deutsche Telekom, it is easily and cost-effectively scalable. Bandwidth is managed dynamically and so gives EAN the opportunity for flexibility to meet the pace of change in the future.

EAN, the pioneer implementation of dynamic spectrum assignments to satellite and terrestrial

The EAN represents a further major innovation by Inmarsat. It is the world's first fully integrated mobile satellite/terrestrial communications network, developed for providing high-quality broadband passenger connectivity to short-haul aircraft throughout Europe. The EAN successfully combines an S-band satellite providing full pan-European coverage with a network of ground-based long-term evolution (LTE) stations across Europe. EAN uses the spectrum ranges 1980–2010 MHz and 2170–2200 MHz. The combined satellite/terrestrial system efficiently utilizes and assigns the same S-band spectrum between both network components through a centralized and dynamic resource management mechanism controlled by Inmarsat as satellite operator.

> *"Potential revisions to the Radio Regulations should be developed to protect interference free operation of mobile satellite services."*
>
> Julián Seseña/Matt Evans

Developed in collaboration with Deutsche Telekom and other leading innovators in the European technology space, the EAN gives European aviation passengers a next-generation inflight connectivity experience, enabling a full range of applications from social media to video streaming, thus bringing the citizens on board aircraft to the connected world.

As well as technological, the EAN also represents innovation from the regulatory and licensing perspective. The system uses radio spectrum harmonized and awarded for the first time on a pan-European level by European Union (EU) Decisions. Under these EU Decisions, Inmarsat (as one of two operators selected) was entitled to deploy a mobile satellite system, which is composed of two components: a mobile satellite service link and a complementary ground component (a terrestrial mobile service).

The EU awarded rights for the implementation of the mobile satellite system in each of the 28 EU Member States, including for the associated ground component licences, providing the basis for the spectrum and service licenses to be granted by each Member State.

The ground component licensing was a more complex process, however, owing to the wider discretion afforded to Member States under the EU Decisions as to the specific licensing approaches taken and applicable fees.

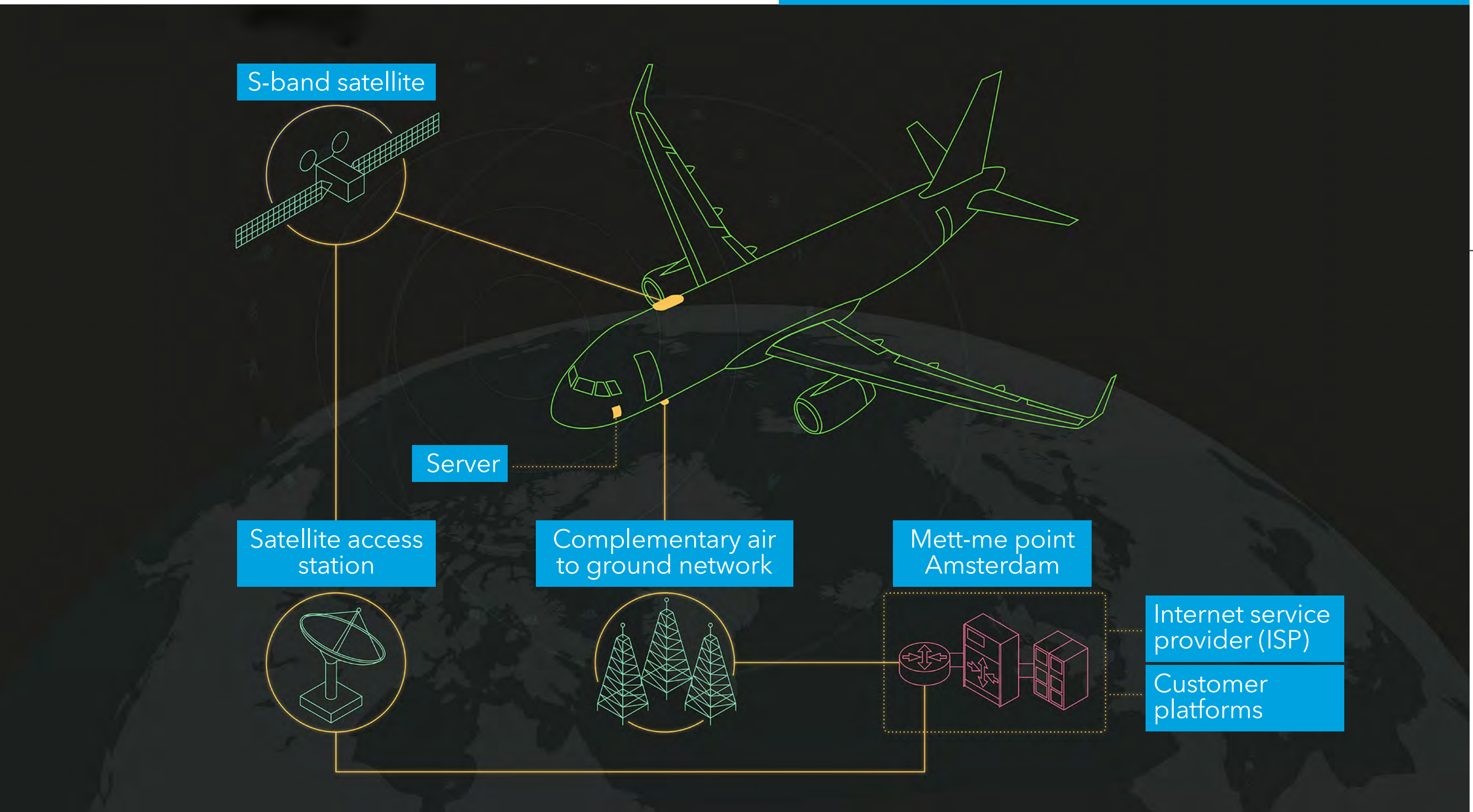
As a highly unique in flight connectivity network, several Member States even had to adapt new regulatory frameworks to accommodate the specific service being offered. Whereas the spectrum rights for the space component flowed directly from the EU Decisions, and in most cases were transposed into the national frequency plans without the need for individual licences. In addition to the EU, other countries (Norway, Switzerland) have also issued authorizations for the integrated satellite and terrestrial system.

Protecting MSS from co-frequency IMT terrestrial emissions

The task of international spectrum coordination has been another key element in the successful implementation of the pan-European EAN service, particularly as regards neighbouring non-EU countries.

It has been vital to ensure that systems of neighbouring non-EU countries (satellite or terrestrial) do not risk causing harmful interference into the EAN system, which could ultimately impact the provision of service within the coverage area.

The European aviation network



These problems are being addressed through a number of bilateral coordination studies. The European Conference of Postal and Telecommunications Administrations (CEPT) has also helped in so far as issuing recommendations for assigning the S-band spectrum to mobile satellite service (MSS) with complementary ground component (CGC) use, through ECC Decisions 06(09) and 06(10). These Decisions have now been implemented in a large number of countries.

While successful compatibility conditions have been derived for operation of EAN and other international mobile telecommunication (IMT) adjacent band users, and considering the experience of sharing EAN with other terrestrial services operation co-frequency, there is a crucial need to ensure adequate safeguards to avoid interference from IMT systems operating in the same band as EAN (1980–2010 MHz and 2170–2200 MHz). In this regard, WRC-19 Agenda item 9.1, issue 9.1.1, relates to this specific point.

The ITU Radiocommunication Sector (ITU–R) studies for this agenda item have examined all the different interference scenarios considering the situation where terrestrial IMT is deployed in one country and satellite IMT is deployed in another country.

It merits highlighting that for the scenario of potential interference from terrestrial IMT base stations to satellite space stations, the studies and Inmarsat's own operating experience, have shown that deployment of terrestrial IMT systems with certain configurations could cause extremely high levels of interference to MSS satellites.

The ITU–R studies have identified that the most effective means to avoid interference to MSS satellite receivers is to ensure that the band 1980–2010 MHz, if used for terrestrial IMT systems, is used for uplinks only (i.e. from transmitting mobile user terminal to base station receiver).

Potential revisions to the Radio Regulations (RR) should be developed to protect interference free operation of MSS, avoiding simultaneous and independent use by other IMT base station transmitters, or limiting the emissions from IMT base stations in the uplink band (1980–2010 MHz).
■

The Internet of Things through novel low Earth orbit satellites

Nicholas Spina

Director, Launch and Regulatory Affairs, Kepler Communications

Nearly three decades have passed since humanity started to envision the framework for modern global non-geostationary satellite communication networks. While history had these systems heavily focused on telecommunications, our world has progressed to not only connect humans by way of voice and video but machines, devices, and other "things" by way of data.

Most of us will associate the information Internet of Things (IoT) with a thermostat in our home, or the ability to receive a message when the door-bell rings. Within industry, IoT is the intersection of sensors, connectivity, and powerful data ana-lytics that promises to improve efficiencies across a variety of industries.

"Through direct support from ITU, Kepler and other small satellite operators have become increasingly engaged with the national and international regulatory framework."

Nicholas Spina

The reality of data blindness

Consider the transportation of temperature sensitive medication on an ocean liner from a pharmaceutical company to a disaster relief area thousands of kilometers away. The medication is required to remain within its strict temperature bounds along the multi-week transatlantic jour-ney, or risk spoilage.


AdobeStock

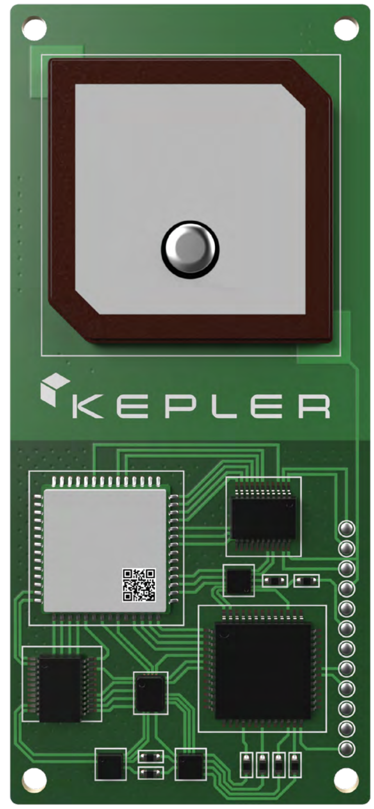
A lack of en route temperature data means that the pharmaceutical company is unaware if their products have spoiled, logistics companies are unaware that a new shipment is needed, and the healthcare provider on the receiving end is unaware if their upcoming shipment of life-saving medication will be ruined. Ultimately, this data blindness blocks the ability to act.

The root cause of this lack of data is not an inability to measure, but an inability to connect to the measurement device because there does not exist a globally unified and affordable connectivity network. These connectivity challenges are repeated across industries and applications; AECOM, a global construction company, is unaware of the location of all its tools and equipment; Porsche is unaware if its vehicles have been damaged during shipment; Deutsche Bahn is unable to determine if its shipping containers have been breached during transport.

Satellites — key to building the framework for a global IoT infrastructure

Regardless of the application, building the framework for a global IoT infrastructure results in positive socioeconomic economic externalities, and the simplest means by which this can be achieved is through the use of satellites.

Governing bodies that mandate the terms under which satellite networks can gain access to spectrum therefore have an obligation to ensure a fair, open, and competitive regulatory environment that works for both incumbents and new entrants.



Is the current regulatory framework for satellites outdated?

With traditional satellites taking a decade and hundreds of millions of dollars to develop and deliver into service, next-generation small satellites are delivered at 1/10th the time, and 1/100th the cost. Unfortunately, the regulatory framework that these satellites must abide by was developed for – and typically caters to – traditional satellites and their development cycle.

When a global satellite IoT service could be offered for USD2/year/device, but has a significant probability of facing substantial regulatory barriers, it goes without question that each of us must ask ourselves how we can facilitate such a development rather than stranglehold it by way of incumbent filings and regional rulings. With such a drastic change in technology, we must subsequently ask ourselves whether rules of priority and protectionism for spectrum allocations continue to be the best method by which innovation and investment can be encouraged in the realm of spaceborne infrastructures.

Moving large datasets, with small satellites

Kepler Communications is an example of a novel company that has secured investment to employ small satellites in the delivery of a global connectivity solution, for both low and high data rates. While it would be reasonable to assume that IoT is associated with small amounts of data, the same principle can apply to moving large amounts of data.

With Kepler's first-generation satellites in orbit, clients have the ability to move large datasets through their existing VSAT terminals, new flat panel antennas, or any Ku-based steerable antenna. Starting late 2019, clients will also have the ability to move small datasets through a device no larger than a cell phone, which includes a six-year operational battery life.

Through direct support from ITU, Kepler and other small satellite operators have become increasingly engaged with the national and international regulatory framework. Starting with the Santiago de Chile ITU symposium and Workshop on small satellite regulation and communication systems held in Chile in 2016, and again with the World Radiocommunication Seminars of 2016 and 2018, and the various working groups building up to WRC-19, the diversity of systems, wealth of knowledge and general understanding of these new systems has been flourishing.

In 2018, a group of small-satellite operators started the Commercial Small-Satellite Spectrum Management Association (CSSMA) to help share knowledge across new operators and ensure that the interests of these operators are represented in relevant forums.

Today, the association has several operators working on providing IoT-related connectivity in the mobile satellite service (MSS) bands, each facing their own regulatory challenges. In considering such systems, we should note that the majority operate below 650 Km, typically leading to their natural deorbit within around five years.

Consider for a moment that the aforementioned results in a new constellation with novel technology every five years, and contrast this to regulation that has closed innovation in specific MSS bands until 2027.

> *"Given the apparent ubiquity and progressive development of terrestrial-based IoT deployments, one might ask whether satellites play a significant role in facilitating our "data age"?"*
>
> Nicholas Spina

The answer for the 'data age' – novel purpose-built non-GSO satellite networks

Given the apparent ubiquity and progressive development of terrestrial-based IoT deployments, one might ask whether satellites play a significant role in facilitating our "data age"? Be it sensors in the middle of the ocean, global asset tracking, utility grid monitoring, autonomous mapping, polar research, health monitoring for deployed military assets, the list is endless.

When answering this question, ask yourself: What type of network would grant you the ability to do all of the above, globally, without any blind spots, moving large and small datasets, and with a single station?

The answer is simple: novel, economic, rapidly replenished and purpose-built non-GSO satellite networks.

■

Emerging challenges for satellite spectrum monitoring

Guido Baraglia

Director, Business Development and Sales, EMEA, Kratos

In recent years space has experienced an exponential growth, at a global level, of new platforms and services, causing an inherent threat to frequency spectrum availability and security. Current surveys shows this trend is not slowing down. The rapid rise in non-geostationary (non-GSO) constellations and associated earth stations, both fixed and mobile, the hybridization of communication platforms, the ever-increasing complexity of very high throughput satellites (VHTS) and, last but not least, more nations having the capability to access space through cheaper technology and launchers, should be a concern to the regulatory authorities. More in general, it should be a concern to the entire space industry.

Issues such as frequency spectrum being more and more congested, leading to a potential increase in interferences and less than scrupulous firms accessing space without proper coordination, thus jeopardizing orbits with the risk of exponential debris creation, are two of the main concerns.

> *"Mobile and airborne sensors will be the tools of the future allowing for distributed measurements over vast or hardly accessible territories."*
>
> Guido Baraglia

The need for new solutions

National administrations should strive to provide radio space monitoring capabilities to guarantee reliable licensing and orbital usage, as well as interference free operation for all the different services.

Basic fixed radio-frequency measurement sites are no longer enough to ensure the thorough test and verification of non-GSO and VHTS space stations. New solutions, sensors and measurement techniques need to be introduced. Mobile and airborne sensors will be the tools of the future allowing for distributed measurements over vast or hardly accessible territories.

As an example, the measurement of emissions from GSO and non-GSO space stations to verify compliance with the ITU equivalent power flux density (EPFD) recommendation is causing a lot of head scratching.

New algorithms and measurement techniques will have to be implemented, as well as new hardware capable of tracking fast moving space objects. The capability to measure and compensate Doppler Effects due to the objects' velocity, is definitely one of the main focal points. Accurate time stamping of data acquisition would allow correlation of data collected from a number of different ground stations facilitating the analysis tasks.

> *"National administrations should strive to provide radio space monitoring capabilities to guarantee reliable licensing and orbital usage."*
>
> Guido Baraglia

Future space constellations will add another aspect to the monitoring mission that have so far been consigned to a handful of space stations. This includes a dynamic and complex structure with transient conditions that could be detected only by deploying a much higher number of sensors.

As this is evidently not economically viable, more ingenious ways need to be used. The ability to collect and correlate data not only limited to the radio frequency (RF) elements, scalable and transportable sensors that could be dynamically reconfigured, and on-board signal processing capabilities are among the most promising developments to mitigate this.

The foreseeable congestion of the near and far orbit

The foreseeable congestion of the near and far orbit also brings more issues on the data collection and analysis front. Companies are announcing non-GSO constellations with hundreds if not thousands of satellites; this will reflect also in the amount of monitoring and control data each administration will have to collect.

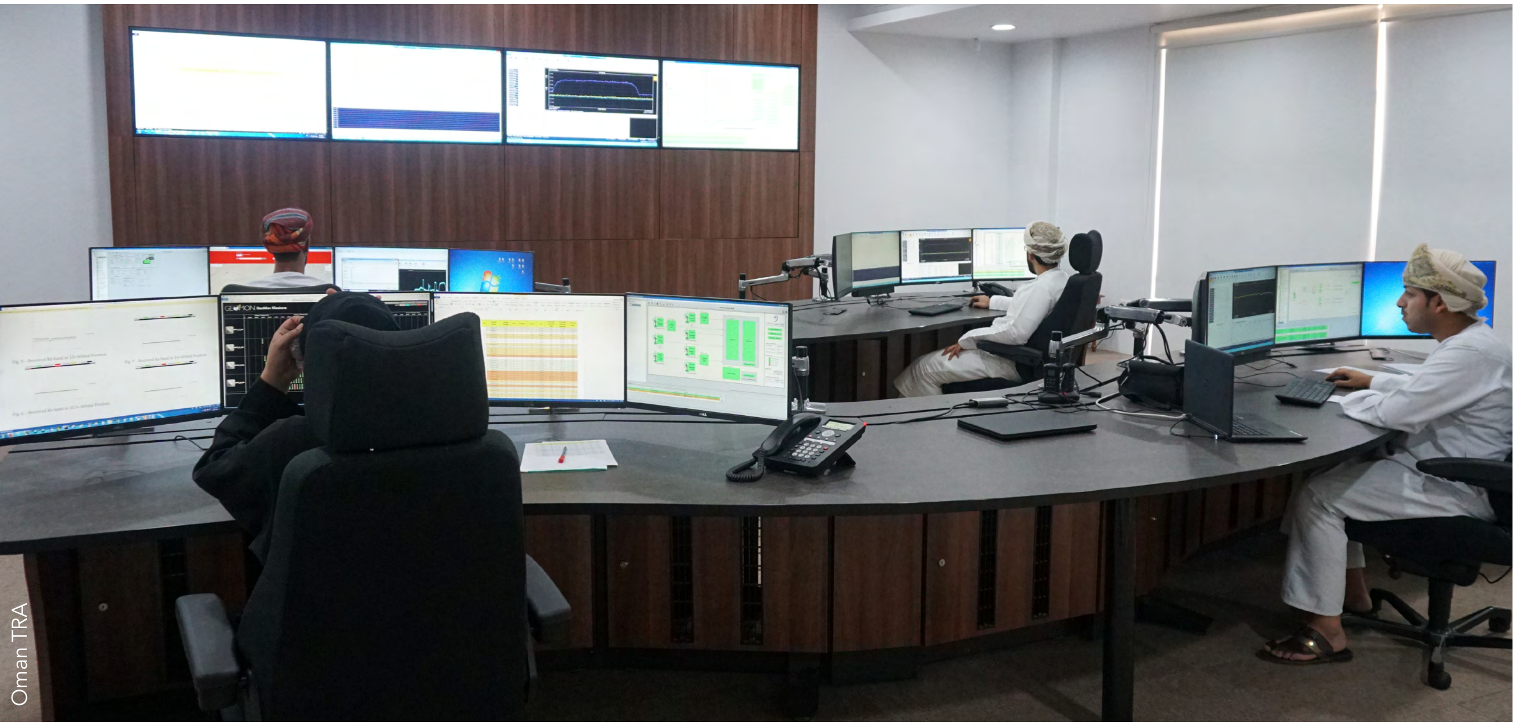
It is not unrealistic to think that administrations will be quickly overwhelmed by the burden of the collection and analysis of data, leading to much lengthier licensing processes or, in some cases, more deregulation.

Machines will have to support these operations, with a considerable interest in developing artificial intelligence (AI) capabilities, to correlate and predict environmental conditions in order to prevent service degradation, interferences or even collisions.

Centralization of collected data will be paramount, especially with non-GSO constellations only partially covering populated areas.

A new level of cooperation between administrations will have to be implemented to consolidate the collection and analysis of the data, and facilitate the correlation between similar events on opposite sides of the globe and prediction of future happenings.

Space Radio Monitoring Station located in Muscat, Oman



Oman TRA

Space Radio Monitoring Station control centre located in Muscat, Oman

It does not take a scientist to realize that the aforementioned challenges will need considerable investments from national administrations, both in terms of infrastructure and knowledge.

Selecting end-to-end solutions that can cover the entire scope of the agency mission with a defined training path and team support over longer periods after commissioning, would be a basic need.

Cooperation between administrations is also a possible way forward, similar to what was put in place many years ago by the European Conference of Postal and Telecommunications Administrations (CEPT), allowing administrations to share the costs of deploying such capabilities.

In addition, new technologies allow for scalable and distributed systems that could isolate databases from different administrations maintaining a common hardware and software infrastructure.

Adopting these methods, structured procedures, and a rigorous measurement process, will help national administrations address the new and growing threats to frequency spectrum security and availability.

■

Inter-satellite laser links for commercial communications

Diederik Kelder

Chief Strategy Officer, LeoSat

Data volumes are exploding, with more data created in the past two years than in the entire history of the human race. Communications networks are already carrying more than 1 Zeta Byte of traffic globally, and this is forecast to grow exponentially (source: Bell Labs).

Digital transformation is requiring many companies to review their strategies for capturing, accessing and transporting data. These developments are having a significant effect on the communications industry, with the need to invest in and deploy appropriate infrastructure seen as a priority, particularly as current satellite solutions remain suboptimal for data and are often seen as a last resort.

"'Always on' connectivity and smart data analysis and management require resilient and future-proof networks to deliver connectivity and services."

Diederik Kelder

Digital business models transforming the landscape

Companies and government organizations have already come a long way in digitizing their business processes, both the internal administrative and logistic processes but also in interacting with customers and suppliers. A second more recent trend is the move to cloud-based applications.

LeoSat

These trends mean businesses need reliable always-on connectivity wherever they operate. This can be particularly challenging for businesses with mobile and remote operations. Ships at sea, for instance, are becoming mobile offices which rely heavily on robust and reliable connectivity to the cloud.

Similar examples can be found in oil and gas where the latest trend is the transformation to the "digital oilfield". Automation of in-field processes in combination with shared services on-shore will significantly enhance efficiency. This increasing demand to move large quantities of data quickly and efficiently around the world is fast outpacing the infrastructure needed to carry it.

Building a new laser-connected infrastructure in space

The rapidly advancing price/performance capability of computing, storage, and bandwidth is contributing to an adoption rate for the digital infrastructure that is two to five times faster than previous infrastructures, such as electricity and telephone networks.

By 2020, there will likely be 50 billion Internet-enabled devices. Those 50 billion devices will become interconnected into a web of the "Internet of things" for the "intelligent home" and "smart cities". Businesses and governments are adapting to this Big Data environment and are becoming increasingly data driven, cloud based and trans-national.

LeoSat was established to deliver a viable satellite solution for enterprise data. Backed by SKY Perfect JSAT and Hispasat, our mission is to provide fast, reliable and ubiquitous data connectivity which will enable business growth worldwide.

To support the developing digital ecosystem, we plan to launch a constellation of up to 108 low-Earth-orbit, laser-connected satellites to provide the fastest, most secure, and the widest coverage international and intercontinental carrier-class, data network in the world.

Leveraging the latest developments in satellite communications technology, our unique architecture is effectively an optical backbone in space using lasers to interconnect satellites to deliver an ultra-secure and highly reliable global data network for business operations in telecoms, energy, government and maritime markets.

We will be able to implement point-to-point data connections to and from anywhere on the planet without needing any terrestrial touchpoint in between.

Unmatched reliability and security for enterprise communications

For the government and enterprise communications sector, with the need to move large amounts of sensitive data around the world, reliability and security are key components of a critical data network. LeoSat's advanced and unique system architecture is able to logically separate and route the data as it flows through the system allowing the system to deliver the highest performing, most secure, furthest reaching network in the world.

With LeoSat, data travels in its native form secure from end-to-end across an optical inter-satellite network, with no terrestrial touch points.

Enterprise communications can now rely on LeoSat for domestic and international data transport, communications backhaul or hosted solutions that are not only completely secure but delivered faster than on any other satellite or terrestrial network.

New opportunities for the telecom and media sector

Wired and wireless carriers are up against a rapidly shifting technology landscape. The transformational impact of digitization and the shift from 4G to 5G continues to drive telecommunications operators' most critical strategic and operational decisions. This trend governs how telecom companies try to put to use their infrastructure investments and exploding data traffic demand, boost newly needed capabilities, rationalize their product and service offerings, improve the customer experience, and evolve their asset portfolios and business models.

LeoSat

LEO satellites are able to provide true global coverage, ubiquity, and quick deployment.

Diederik Kelder

"Always on" connectivity and smart data analysis and management require resilient and future-proof networks to deliver connectivity and services. LeoSat will provide a new touchless architecture, an optical backbone in space which is 1.5 times faster than fiber backbones.

For telecoms operators and companies managing the shift to digital, and the need to extend existing network infrastructure, we can provide an instant digital infrastructure from anywhere to everywhere which is fast, secure and reliable, opening up a wide range of new opportunities for telecom and media companies.

Cybersecurity – capabilities beyond satellite and beyond fiber

The issue of cybersecurity has been highlighted as a critical feature of business communications. The LeoSat constellation is designed with absolute security and resiliency in mind. Data will travel end-to-end across a single network.

This physically separated network ensures security on the lowest networking level, additionally, the multi-satellite constellation provides inherent redundancy, should issues arise with a single satellite. At any one time, there are always 2–7 satellites in view, depending on the latitude of operation.

Regardless of technical or weather issues there are alternatives to route traffic. This underlines the myriad of safety options and high availability capabilities that the LeoSat constellation has inherently built in to ensure network resilience.

A new paradigm

LeoSat's system using inter-satellite laser links for commercial communications, is a departure from existing solutions today, pairing the speed of fiber with the ubiquity of satellite. LEO satellites are able to provide true global coverage, ubiquity, and quick deployment. Fiber provides high-throughput, low latency, and a growth path.

LeoSat's positioning between multiprotocol label switching (MPLS)/virtual private network (VPN) and traditional satellite and fiber markets, means that we are able to provide a unique offering which is already changing the perception of satellite infrastructure for data communications. And with over 1 billion USD in pre-launch customer agreements, there is clearly a commercial appetite for a laser-connected business backbone in space!

Our aim is to not only bring about a paradigm shift in the existing satellite communications sector, we also want to expand this sector, by enabling new opportunities through previously unavailable levels of performance combined with true worldwide reach.

Satellite broadband access for everyone

Chris Hofer

Director, Regulatory Affairs, Viasat

Affordable high-speed broadband is the most transformative technology of our time. Enabling high-speed satellite broadband access everywhere is not only an opportunity equalizer, but also an economic imperative.

Today, an estimated 3.8 billion people still do not have basic Internet access.

Satellite broadband investment and deployment is changing that by providing affordable and reliable broadband at up to 100 Mbit/s per user.

This unlocks opportunities in ways previously impossible — improving the way we live and work.

Because satellite broadband can connect anyone to everything, and anywhere, it is an essential tool for closing the digital divide — in urban and rural settings alike.

> *"ITU has played a critical role in making these opportunities possible through 28 GHz satellite broadband."*
>
> Chris Hofer

28 GHz satellite-powered Wi-Fi now connects millions living in urban and rural centres and villages

Critical 28 GHz spectrum to bridge digital divides

In November, the World Radio Conference (WRC-19) will address ways for satellites to continue and expand using critical 28 GHz spectrum to bridge digital divides by extending global broadband access. In the meantime, some national regulators are feeling the pressure to abandon the well-established international harmonization process in favor of *ad hoc* national decisions that would primarily benefit the already-connected, with little or no new coverage for those who have been left behind.

Various proposals have been made to have regulators end run a 2015 ITU WRC Resolution that declined to include 28 GHz spectrum as a candidate band for international mobile telecommunications (IMT)/5G, and to instead promote 5G services in that spectrum. Any such changes would only extend the existing digital divide by further separating the unconnected from the digital economy.

Today, a single 28 GHz band satellite can serve 1/3 of the Earth. The wide coverage provides all communities within a satellite's footprint access to service. Coupled with easy to deploy user terminals, this means that consumers and businesses have near-instant access to fast, affordable broadband, anywhere. People can stream their favorite videos at home, walking around town, and even on an airplane. 28 GHz satellite-powered Wi-Fi now connects millions living in urban and rural centres and villages – many for the first time.

Broadband connectivity – transforming economies and societies

Enabling connectivity transforms economies and societies. When satellite broadband connects underserved communities, students can use the same educational resources as a child in the most affluent community. The unemployed can search for and apply for jobs once unknown to them.

"The World Radiocommunication Conference this year will be even more pivotal."

Chris Hofer

Workers can develop new skills for better paying jobs. Farmers can plan for short-term weather and market changes. Local shops can reach global markets. Everyone can climb the economic ladder and build communities in place.

But it's not just about what satellite broadband empowers people to do, it's also about what policy-makers and society can achieve.

Satellite broadband unlocks new opportunities to solve problems in ways never imagined before. For example, many of the United Nation's Sustainable Development Goals, such as improving health, lifting people out of poverty, and boosting education, depend on universal and affordable access to broadband:

- **Boosting educational opportunities.** Many students around the world lack access to the foundational education they need, and can't do their homework, because they don't have broadband access. Today, 28 GHz powered satellites connect teachers and students in communities long left behind. This powerful educational equalizer transforms education across the world.

- **Helping improve health outcomes.** Too many people live in areas with sporadic and even diminishing access to quality health care. 28 GHz satellite broadband helps cost-effectively overcome rural health shortages – extending expertise to where it is most needed, and delivering critical care wherever the doctor and patient are physically located.

- **Supporting food production.** To feed rapidly-rising global populations, farmers will need to produce 70% more food by 2050. 28 GHz satellite broadband allows farmers to use precision farming technologies that will help boost global crop yields as much as 67%. This is particularly urgent for the 570 million small and family farms that operate 87% of global farmlands.

- **Cranking up the economic engine.** Access to high-speed broadband is not just an opportunity equalizer, it's an economic accelerator too. Extending broadband access helps boost competition and economic potential. For example, a mere 10% increase in broadband penetration can raise global economic growth by as much as 1.5% (Source: ITU, 2018: The Economic Contribution of Broadband, Digitization, and ICT Regulation).

ITU has played a critical role in making these opportunities possible through 28 GHz satellite broadband. Regulatory certainty has enabled billions of dollars investment in 28 GHz satellite infrastructure. The satellite broadband networks launched in the last four years using these bands, coupled with those under construction, have empowered hundreds of millions of the world's disconnected inhabitants to leap into the digital world, despite the longstanding failures of terrestrial networks to serve their needs.

WRC-19 — enabling continued satellite use for people's needs

The WRC this year will be even more pivotal. Leaders will address issues that are critical for shaping the scope and reach of the satellite-enabled digital opportunity. These decisions will further allow satellites to meet people's needs, extending digital opportunities into vital new realms like connected emergency vehicles, cars, aircraft, trains, buses, tractors and ships. These new opportunities — not achievable globally using any other technology — will create even more jobs and industries in sectors of the economy that have been disconnected for far too long.

A call for administrations to continue supporting satellite services in the 28 GHz spectrum

Administrations should continue to support the continued deployment of satellite services in the 28 GHz spectrum, and accommodate 5G spectrum needs in other frequency bands. Doing so is the only way to connect the three billion people who are otherwise being left behind.

Seamless connectivity across geostationary and non-geostationary satellite systems

Zachary Rosenbaum

Director, Spectrum Management and Development, SES

For over 50 years, geostationary (GSO) satellites have provided vital infrastructure to the global communications ecosystem. Hundreds of them are in orbit today, delivering services ranging from Internet connectivity to weather and mapping data and to distribution of digital video-on-demand, streaming and satellite TV channels globally. Because the antenna on the ground does not need to track the satellite in the sky, its design can be quite simple; and by virtue of its altitude, broadband service can be started with just a single satellite covering one third of the globe.

Due to their high altitude and wide field of view, it only takes about three GSO satellites to provide coverage that spans the entire Earth, which is far fewer than the number of satellites needed at non-GSO orbits for global coverage.

"All too often we hear the question of which technology will win over time."

Zachary Rosenbaum

Non-GSO satellites have been in operation for even longer than GSO satellites, and are in use today for a broad set of applications ranging from Earth observation to GPS and to voice and data services — just to name a few. At the beginning of the 21st century, a major effort based on ambitious plans for large non-GSO constellations to connect the world resulted in ITU agreeing regulatory frameworks for GSO and non-GSO systems to share use of the C-, Ku- and Ka-bands. A similar effort is underway in the lead up to World Radiocommunication Conference (WRC-19) to create a framework for GSO and non-GSO shared use of the Q- and V-band frequencies to meet the requirements of next-generation satellites.

Next-generation satellites — more capacity and flexibility

Under this shared use framework, SES's O3b non-GSO constellation has been providing since 2014 high-throughput, fibre-like connectivity to Internet service providers, government agencies and enterprises around the world using the Ka-band frequencies — ultimately connecting millions of end users. In 2021, SES will launch the next generation of O3b satellites, called O3b mPOWER, with terabit-scale capacity and even more flexibility than the current generation.

SES

Several other non-GSO satellite constellations are also planned to be in service in the coming years. Their closer distance to Earth compared to GSO satellites will support lower latency applications, but the coverage area of each satellite will be smaller. This is why some non-GSO constellations plan to launch hundreds — or even thousands — of these satellites into orbit to achieve global and continuous coverage.

Which technology will win?

All too often we hear the question of which technology will win over time. This presupposes that the two types of satellite infrastructure are mutually exclusive, which is not necessarily the case. First, different applications on the Internet have different requirements that can make GSO or non-GSO satellite solutions more appropriate. Non-GSO high-throughput, low-latency satellites are well suited to enable latency-sensitive applications.

However, if the end user is operating an "always on" low-data rate network spanning large areas (e.g. an Internet-of-Things weather sensor network), a GSO or hybrid solution with high availability (e.g. using C-band frequencies) may be more appropriate. Indeed, C-band satellites — all in GSO — are still the most reliable and most available form of satellite connectivity in the world today.

As an operator of both GSO satellites and the O3b non-GSO constellation, SES is also developing integrated GSO and non-GSO networks that will combine the advantages of both. High-throughput GSO satellites can deliver more than 100 Gbps of total capacity throughout their visible footprint — a tremendous reach capability. For non-GSO satellites, targeted high-throughput and low latency capacity can be delivered as needed to areas where there is specific demand for such connectivity.

An end user consuming data from the Internet needs only one piece of hardware to connect to a GSO or non-GSO satellite, as necessary, to meet connectivity requirements.

With seamless network integration, GSO and non-GSO satellites can adaptively react to this end user's real-time needs for connectivity through an efficient and optimized traffic management system. The metric of success here is whether the end user gets the promised data rate, and not the technology used to deliver it.

A number of SES customers around the world — from governments to mobile operators to cruise lines — have already early-adopted combined GSO/non-GSO solutions from SES to meet their differentiated connectivity needs.

Satellites for connecting people anywhere

Gone are the days when satellites were simply a "last resort" for connecting remote areas. Like traditional, terrestrial connectivity services, satellite is fast becoming a standardized and mainstream option for delivering high-speed broadband services to people anywhere in the world, whether on land, at sea or in the air. And as this new satellite ecosystem takes shape, the potential applications won't be constrained to one orbit. Constellations are already operating together across orbits today, and as we move forward, we'll see even more value created by optimized routing of traffic over multi-orbit networks. For example, the O3b mPOWER constellation will use software-defined networking with the ability to automatically switch between GSO and non-GSO satellites, as appropriate.

> *"Gone are the days when satellites were simply a 'last resort' for connecting remote areas."*
>
> Zachary Rosenbaum

We are likely to see combinations of GSO, non-GSO, and terrestrial technologies deployed to support the diverse latency and throughput requirements of native 5G networks.

As demand for data increases, the developing multi-orbit satellite universe is set to play a crucial role in delivering broadband access to connect the world in the cloud-scale era. An ITU framework that fosters such developments will be key to its success.

■

ITUNews WEEKLY

Stay current.

Stay informed.

The weekly ITU Newsletter keeps you informed with:

- Key ICT trends worldwide
- Insights from ICT Thought Leaders
- The latest on ITU events and initiatives

Sign up today!

ITU