Response to Ofcom's Strategic Review of Satellite and Space Science Use of Spectrum

Intelsat is pleased to respond to Ofcom's Strategic Review of Satellite and Space Science Use of Spectrum Call For Input (the "Consultation") on behalf of Intelsat Global Sales & Marketing Limited ("IGSML"), a company incorporated under the laws of England and Wales (Company Number: 04098445). Intelsat's exceptionally flexible global network provides critical communications infrastructure in the United Kingdom ("UK") and worldwide. This response reflects both satellite capacity used by Intelsat as a UK licensee as well as capacity as a provider of satellite communications services that use, but are not limited to, frequencies authorized through UK filings.

Ofcom's strategic review of satellite spectrum is timely. As the satellite industry faces increasing demand for data intensive services, additional spectrum will need to be found to ensure customers are able to benefit from the anticipated range of new applications.

Satellite services play an important role in enabling the applications that are often taken for granted today. Although not always providing the "last-mile" connectivity, satellite plays a critical role in making it possible for people to access reliable communications services anywhere, any time. The benefits of satellite communications include ubiquitous coverage; consistent high quality of service; traffic bypass; cost predictability; scalability and responsiveness; point-to-multipoint architecture; and instant infrastructure, among others. Unless additional spectrum is found for satellite services at the International Telecommunications Union ("ITU") 2015 World Radiocommunication Conference ("WRC-15") and at future WRCs, the industry faces the risk of a "spectrum crunch," which will delay the roll-out of new services and reduce consumer choice.

In this response, Intelsat highlights the existing and planned services it provides to customers in the UK and around the world, the lengths the company goes to ensure that spectrum is used in the most efficient manner, and some of the regulatory concerns it faces in the UK and abroad.

Question 1: Do you have any comments on our approach to this review?

Intelsat is deeply concerned by the approach taken by Ofcom in this review. The methodology used in the Consultation, which was used for the strategic review of mobile spectrum, is ill-fitted for use in the satellite sector and therefore unlikely to provide Ofcom with the necessary information to make evidenced policy on satellite spectrum.

Specifically, Intelsat is concerned with Ofcom's use of mobile as a template. Due to the discrete natures of mobile and satellite technologies, the satellite sector is *de facto* disadvantaged when a method designed to analyse the use of mobile technology is applied to the satellite industry. In addition, the terms of reference for the Mobile Data Strategy[1] rely on assumptions around the rapid growth of mobile data traffic, assumptions that have been proven to be inaccurate,[2] while the current review appears to falsely assume an overall reduction in demand for spectrum by the satellite and space science sectors in the UK in the

[1] *Mobile Data Strategy*, Ofcom (Jan. 2014).

[2] *Mobile Spectrum Requirement Estimates: Getting the Inputs Right*, LS Telcom & TMF Associates, (Sept. 2014).

near future. This could not be further from the truth, as competition for spectrum, use of spectrum, and the need for additional spectrum continue to grow in the satellite sector.

Most satellite operators provide service in multiple countries simultaneously, and have numerous of customers in each country -- these customers of satellite operators, such as Direct-to-Home ("DTH") providers, can have millions of customers in turn. Each customer, in part because of the variety of services satellite can provide, also has their own unique and shifting spectrum requirements. Identifying specifically how much spectrum each customer is using and whether their demand for spectrum is constant or if it fluctuates due to the services they provide requires a significant amount of time to collect and verify, and is often extremely commercially sensitive.

Given the highly competitive nature of the satellite market, disclosure of this type of information to third parties would be detrimental to Intelsat's business not just in the UK, but across Europe and potentially further afield. Furthermore, the disclosure of sensitive commercial information has not been a requirement of similar sector reviews, including the 2014 Strategic Review of UHF Spectrum 420-470 MHz: UHF Bands 1 and 2 and the 2015 Strategic Review of Digital Communications. Intelsat therefore believes that the methodology proposed for this review is not sufficient to provide a fair analysis of the satellite sector's current and future need for spectrum.

In addition, even if operators were comfortable with disclosing the volume of detailed information sought in this Consultation, the necessary time needed to collect and review this information, especially for larger companies such as Intelsat, is significantly more than the amount provided to respond to Ofcom's queries. Even with additional time, it would likely be impossible for Intelsat to provide Ofcom with a complete breakdown of how Intelsat's capacity is used in the UK. The complexity of the value chain means that Intelsat is often two, three, or more steps removed from the end user. Intelsat simply does not have access to all the information Ofcom requires. Unless Ofcom undertakes a campaign to contact and interview all satellite service providers, information gathered solely from satellite operators and the operators of large earth station facilities is unlikely to provide a complete view of how satellite spectrum is used in the UK.

Intelsat notes with concern that many downstream companies have no engagement with Ofcom on spectrum matters. Without their input, there is a real risk that Ofcom could significantly underestimate the number of people who benefit from satellite service and the amount of satellite spectrum in use across the UK and the world. Future policies that reduce the available amount of satellite spectrum will unintentionally create spectrum scarcity for satellite services, driving up costs for users, and depriving UK consumers and businesses access to services critical to their daily lives, and adversely affecting essential emergency communications services.

Intelsat is also concerned by the comments made by Ofcom at the stakeholders' workshop with regards to the use of the data Ofcom is seeking. The Consultation requests that satellite industry stakeholders provide Ofcom with a voluminous amount of commercially sensitive data about their operations, yet fails to provide any information on how Ofcom plans to analyse the data to develop policy. At the relevant workshop, Ofcom demonstrated that it did not have clear plans about how it plans to analyse the data it receives. Intelsat supports evidence-driven spectrum policy, and is happy to engage with Ofcom to help it better

understand the future needs of the satellite industry. However, Intelsat is understandably wary of providing commercially sensitive data without understanding how the data will be disclosed, evaluated, and the desired resulting metrics. Intelsat is also concerned that if the same analysis techniques used for the terrestrial sector are used for the satellite industry, the results will not fairly represent the importance of satellite communications in the UK.

In response to this Consultation, within in the short time provided, and with trepidation, Intelsat has undertaken best efforts to gather information that will help inform Ofcom on how satellite spectrum is used in the UK, to benefit UK citizens, and to benefit citizens around the world. Intelsat looks forward to discussing spectrum strategy and the needs of the satellite industry in the coming months.

Question 2: Do you have any comments on our broad overview of the satellite sector set out in this section? In particular, do you have comments on the completeness of the list of applications, their definitions and their use of the relevant ITU radiocommunications service(s)?

The broad overview of the satellite sector covers services provided by the satellite industry at a high level, is brief, and groups together applications under a single heading that the satellite industry would often view as separate applications.

To help inform Ofcom's thinking on this issue, Intelsat divides its business into three business units: Government Services, Network Services, and Media Services. Satellite services offered in these business units include broadband, cellular backhaul, mobility (including maritime, aeronautical, and terrestrial), corporate enterprise, disaster recovery, media distribution and contribution, and government networks, among others. All three business units offer these and other services primarily in the C- and Ku-bands within the UK and abroad.

Notably, Ofcom's list of applications omits cellular backhaul, government users, oil and gas services at fixed locations, distance learning, telemedicine, and VoIP.

Intelsat provides below a breakdown of the top applications globally, and in Western Europe, for all satellite operators:[3]

[3] Global Satellite Capacity Supply & Demand, NSR (July 2014).

	Top Applications Global	Top Applications Western Europe
C-Band	• Video Distribution • Legacy Telephone & Carrier • Enterprise Data (Backhaul)	• Legacy Telephone & Carrier • Commercial Mobility (Maritime)
Ku-Band	• DTH • Video Distribution • Enterprise Data (VSAT Networking)	• Video Distribution • DTH • Commercial Mobility (Aeronautical, Maritime)
Widebeam Ka-Band	• Government/Military Services (Bulk Leasing)	• Government/Military Services (Bulk Leasing)
HTS	• Broadband Access • Enterprise Data (Backhaul, VSAT Networking)	• Commercial/Military (Cruise Ships) • Government/Military Services (Maritime)

Question 4: Do you have any comments on our representation of the value chain for the satellite sector? How do you think industry revenues are broken down between players at different positions in the chain?

The graphic provided in the Consultation document is a fine attempt to simplify the value chain for the satellite industry. In general, Intelsat agrees with the placement of each element in the graphic. However, it may be misleading to group all equipment manufacturers together as the role and economics vary widely between different types of manufacturers, for example, a manufacturer of a satellite and of a set-top box.

While recognizing the utility of a high-level overview, Intelsat suggests Ofcom review the more detailed value chain included in the UK Space Agency review of the size and health of the space industry in 2014,[4] which benefits particularly from breaking down the overall space value chain into three constituent parts: upstream, downstream, and the wider space economy. This breakdown allows for a more careful delineation of the various actors within the value chain. Intelsat would encourage Ofcom to consider adopting some features of the UK Space Agency value chain in its own work.

Existing research finds that 75% of the turnover of the satellite industry, encompassing more than just the parts of the industry that rely on spectrum, comes from space applications segment, and that Direct-to-Home ("DTH") broadcast services account for 57% of the segment's gross value added ("GVA").[5] Based on this, it is clear that Ofcom needs to fully understand how the space applications industry makes use of spectrum before making any decisions on policy.

Question 5: What is the extent of your organisations' role(s) in the value chain? Which satellite applications (as summarized in Table 1 in section 3 [of the consultation document]) does your organisation:

[4] Executive Summary: The Size & Health of the UK Space Industry, London Economics (Oct. 2014).

[5] *Ibid.*

-use;
-provide; or
-help to deliver?

Please list all applications that apply and your role in each in your response.

In the provided value chain Intelsat primarily occupies the "Earth Station/Teleport operators" and "Satellite Operators" categories. Intelsat helps to deliver, through our customers media distribution and contribution, including DTH; broadband internet access; commercial mobility (including maritime, aeronautical, and terrestrial); corporate network solutions; legacy telephone and carrier; telemetry, tracking, and command ("TT&C"); military and government services; cellular backhaul; and disaster recovery. Intelsat also provides launch and early orbit phase ("LEOP") support for third-party satellites.

Question 6: For each of the satellite applications you use, provide or help deliver (as identified in Question 5), and taking into account your role in the value chain, where applicable please provide:

-the specific spectrum frequency ranges used for each application, distinguishing between the frequencies used for service provision, for the feeder / backhaul links and for TT&C;
-the coverage area for services links; or, in the case of TT&C and feeder / backhaul links, the location of the gateway station(s);
-the estimated number of users (e.g. MSS terminals, DTH subscribers, FSS earth stations);
-an estimate of the average use by end user (for those applications for which the demand for spectrum is driven by end user traffic); and
-for applications for which the demand for spectrum is driven by other factors, please state what the factor is and the scale of the factor (e.g. for DTH TV the number of TV channels broadcast by format).

Please provide your response with respect to the UK, the rest of Europe, and other parts of the world where this may be relevant to UK use.

As addressed in the response to Question1, Intelsat is concerned about the commercially sensitive nature of the information Ofcom is seeking in this inquiry and the limited time provided for a response. Intelsat looks forward to discussing this issue in a different forum.

Intelsat's global fleet, approximately 50 in-service satellites, covers 99% of the Earth's populated regions. All of the services/applications Intelsat provides, outlined in Question 5, are delivered in C- and Ku-bands (including extended C- and extended Ku-bands), and our individual services are tailored to our customers' needs. This information is extremely commercially sensitive.

Question 7: For each of the satellite applications you provide, please could you indicate how UK consumers and citizens benefit from their use? Where possible please also provide an indication of the scale of the benefits (either qualitatively or quantitatively)

A 2012 report Commissioned by the UK Government found that the economic value of spectrum to the UK economy was £52 million in 2011, with satellite services accounting for 7% of this figure, and broadcasting, which is heavily reliant on satellite, 20%.[6] However, Intelsat is concerned that when reviewing responses to this question Ofcom will not take into account the indirect benefits of the services offered by the satellite industry, which are far greater, and much more difficult to calculate. Intelsat addresses these under the heading "catalytic effects," a term which effectively conveys the role played by our fixed-satellite service ("FSS") offering in stimulating productivity and efficiency across a number of sectors. It is no exaggeration to say that our service plays an enabling or enhancing role in each of the UK's nine critical national infrastructures: communications, emergency services, energy, financial services, food, government, health, transport, and water.

Below, Intelsat provides some detail on the broadcasting and communications services it helps to provide in the UK.

Broadcasting

As a whole, broadcasting dominates the total turnover generated by the UK space sector per year (roughly £11.8bn).[7] Intelsat's media customers include household names, including the BBC, Disney, HBO, and CBS, among others, and the UK's leading broadcasters, content providers and DTH platforms each use our solutions for the transmission of their programing. For UK citizens and consumers, this enables access to high quality news, sporting, and entertainment content.

The strength of the UK creative sector is well documented, with recent government estimates putting the GVA of the creative industries at £76.9bn in 2013, accounting for 5.0% of the UK's gross domestic product ("GDP").[8] The role of broadcasting in disseminating and stimulating demand for creative content should not be underestimated. In addition, satellite is a critical part of the content delivery chain for Digital Terrestrial Television ("DTT"). Intelsat already carries many national channels across Europe and can leverage premium private content on its fleet to create expanded DTT channel line-ups for those citizens and consumers in the UK, which in turn drives demand for much of the UK's premium television and film production.

Communications

Satellite communications make up the second-largest share of the space sector's overall contribution to the UK economy, at 20% of annual turnover.[9] Every day telecommunications service providers across the UK lease capacity on Intelsat's global network to operate their

[6] *Impact of radio spectrum on the UK economy and factors influencing future spectrum demand,* Michael Kende, Philip Bates, Janette Stewart, Mike Vroobel (Nov. 2012).

[7] *The Case for Space 2015, The Impact of Space on the UK Economy*, London Economics (July 2015).

[8] *Creative Industries Economic Estimates*, Department for Culture Media & Sport (Jan. 2015).

[9] *The Case for Space 2015, The Impact of Space on the UK Economy*, London Economics (July 2015).

broadband networks. UK citizens benefit from satellite communications services in a variety of ways: in rural and hard to reach areas, beyond the reach of fibre broadband networks, satellite connectivity is very often the only viable means of providing access to high speed broadband. At the enterprise level, our satellite services are used to provide the backbone communications network for a variety of industrial sectors, often serving mission critical functions.

The list of sectors which rely on satellite capacity to provide connectivity is extensive, from agriculture and manufacturing through to transport, public administration, and defence. For example, it is estimated that in the transport and storage sector alone, the GVA of satellite services in 2013 totalled £7.7mn.[10] UK citizens feel these benefits in a number of ways, providing them with the connectivity to stay in touch with friends and families and to benefit from the increasingly digital by default nature of government and commercial services and supporting the industrial sectors they work in, creating jobs and boosting productivity. A few more detailed examples are included below.

Oil and Gas

Intelsat is one of the largest providers of connectivity for offshore communication – a vital function for the oil and gas industry. The UK has a significant oil and gas industry, with over 1,100 companies generating revenues of £27bn and employing 93,000 people.[11] The industry is a particularly heavy user of satellite communications throughout the process, from exploration to extraction, refinement, transportation and beyond. During exploration, Earth Observation satellites are used to identify areas of oil reserves deep below the ocean's surface which would otherwise be very difficult to detect. Once the drilling phase has commenced, satellite communications are used in providing operation support with real-time data on the drill, allowing timely operational adjustment and decisions to be taken. Once operational, oil rigs rely on satellite for weather forecasting and to provide Internet and broadcasting requirements to stay connected. Finally, the tankers that transport oil from the rigs to onshore refineries rely on maritime broadband connectivity, which is provided by satellite.

Transport

Satellite communications play a vital role in underpinning transport infrastructure, and are set to deliver significant end-user benefits in the future through the development of intelligent transport systems and autonomous vehicles.[12] This cutting-edge technology, which is already a reality, relies on satellite communications, alongside a number of other technologies (radar, lidar, ultrasound, video, etc.) to provide self-driving capability. Satellite navigation and satellite broadband connectivity are important enablers of this technology.

A London Economics study estimates that if driverless cars become a reality and reach full penetration, UK drivers will be able to spend less time behind the wheel, and more time on

[10] *Ibid.*

[11] *Review of the UK oilfield Services Industry*, Ernst & Young (2012).

[12] *The Pathway to Driverless Cars, Summary report and action plan*, Department for Transport (2015).

more productive activities. The boost to the economy would be massive: labour supply increasing by 1.7% of the current workforce and creating a £900mn industry by 2020.[13]

Agriculture

Satellite services are heavily employed in the agriculture sector. Agriculture science and technology (agri-tech), enabled by satellite, is one of the world's fastest growing sectors and is identified amongst the UK's "eight great technologies" in which the UK aims to be a global leader. Satellite services can directly increase the yield of UK farms by improving farming efficiency and assisting in what is known as geo-positioning (also referred to as "precision farming"), a market which is growing at 13% per annum. In the UK, auto steering and guidance mechanisms, which rely on satellite connectivity, are already used by over 20% of farms, leading to improved accuracy, reduced input costs and improved soil conditions, all of which increases marginal productivity for farmers, and reduced prices for consumers.[14]

Emergency Services

Intelsat is proud to offer backbone communication services to the UK's emergency services. The societal contribution of emergency services in the UK is obvious, driven by urgent need and often where human life is at stake. It is no exaggeration to say that these services would not be able to function without vital communications networks, in which satellite plans an important part.

Because satellite technology is unaffected by terrestrial events, satellite solutions play a critical role in supporting first responders in the wake of natural disasters. The importance of satellite services for emergency operations was shown earlier this year in the immediate aftermath of both Cyclone Pam in Vanuatu and the earthquake that hit Nepal in April. After Cyclone Pam devastated Vanuatu, Intelsat worked together with BT to provide satellite solutions for critical restoration and relief efforts.

Similarly, in less than two days after the 7.8 magnitude earthquake in Nepal, the ITU was able to deploy 35 satellite mobile phones and 10 satellite Broadband Global Area Network terminals along with solar panels and laptops to support relief coordination efforts. This effort helped to provide vital assistance to more than 1 million people affected by the disaster, including hundreds of UK citizens in Nepal at the time. Intelsat donated satellite services to the American Red Cross working in partnership with the International Federation of Red Cross and Red Crescent Societies ("IFRC") and Team Rubicon. Red Cross relief teams, such as the joint American/New Zealand Red Cross IT/Telecoms Emergency Response Unit ("ERU") were able to quickly deploy VSAT terminals to communicate with backup agencies while national infrastructure was being repaired. Satellite communications were also crucial for informing UK citizens' families on the progress of rescue operations, with real time updates from regions as inaccessible as the Langtang valley in Northern Nepal.

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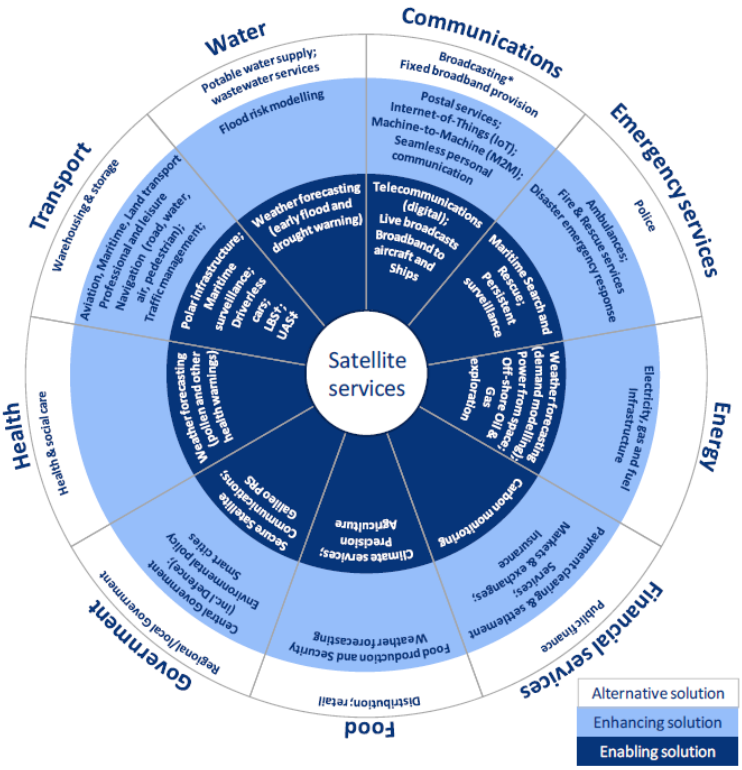
[13] *The Case for Space 2015, The Impact of Space on the UK Economy*, London Economics (July 2015).

[14] *Farm Practices Survey Autumn 2012*, Department for Environment Food and Rural Affairs (DEFRA) (2013).

Turning to the importance of satellite services for emergency communications in the UK, a study by the London School of Economics calculates consolidated annual socioeconomic value of £5 billion that would accrue from the allocation of 2 x 10 MHz in the 700 MHz band specifically for public protection and disaster relief (PPDR) across the European Union.[15] These statistics show the value to the UK of a highly functioning communications network for emergency services, and the role of satellite in ensuring the network can function in all conditions should be fully assessed before any decision are taken over the future use of existing satellite spectrum in the UK.

Catalytic Effects

Over and above the immediate and quantifiable benefits that are derived from satellite services described above, there are a variety of indirect benefits, which are necessarily harder to quantify and elaborate in this response to the Consultation. The charts below, taken from a 2015 London Economics study entitled *The Case for Space*, begin to demonstrate the downstream applications that depend on satellite connectivity for optimal performance which have both indirect benefits and positive externalities for UK citizens and consumers.



Indirect benefits to subscribers or equipment users include: i) efficiency gains, defined as better use of time, fuel, and other resources; ii) access to information, and improved decision-

[15] *Socioeconomic Value of Mission Critical Mobile Applications for Public Safety in the EU*, London School of Economics (Dec. 2013).

making, and entertainment via satellite; and iii) price reductions, derived from fairer insurance premia based on insurance telematics and flood modelling.

Positive externalities for UK citizens who are not necessarily direct users of satellite include: i) lower prices on consumer goods and energy resulting from demand modelling and more efficient distribution; ii) increased national security derived from more efficient management of the armed forces; iii) enhanced quality of life as a result of better responses to floods and infrastructure problems; iv) competitive media pricing; and v) reduced taxation as the provision of government services is made more efficient.[16]

Question 8: From your perspective, what high level trends will affect the satellite sector in the coming years?

Consumers are expecting higher bandwidth and easy to use applications. In response, Intelsat has strived to ensure that satellite communications integrates seamlessly with core telecommunications networks, improves the user experience, and deliver tailored customer services. Demand for satellite services, including broadband, backhaul, government and emergency communications services, video distribution/contribution and newsgathering, private network services for enterprise, and services on moving platforms, continue to increase significantly every year. As this demand continues to grow, advances in satellite technologies are allowing a variety of new and cost effective services around the globe. In certain areas, satellite remains the only technology able to provide critical connectivity to communities and regions not served by terrestrial networks. Without satellites, these areas would lack access to even the most basic communications services. In areas with abundant communications options, satellite remains an important part of the communication ecosystem.

The increasing demand for FSS has required satellite operators to develop technologies that ensure the most efficient use of the FSS spectrum – enabling operators to offer more capacity. The satellite industry uses the most advanced methods, including spot beam technologies and frequency-reuse, in order to operate as efficiently as possible.[17] In a number of bands, satellite networks also share frequencies with non-ubiquitous terrestrial services, such as fixed microwave, which results in additional spectrum efficiencies. However, despite all of these efficiencies and innovation, there is a demand for FSS that is surpassing the amount of spectrum available. Today, satellite bands are reaching capacity and the existing spectrum that still remains available, such as in the V-band, is expected to become heavily utilized in the near future.

In addition, the trend towards high power and high throughput capacity, with associated deployment of tailored services for specific applications and customer markets, will drive

[16] *The Case for Space 2015, The Impact of Space on the UK Economy*, London Economics (July 2015).

[17] *See Airlines Work to Supply Better In-Flight Wi-Fi with Satellite Services*, Thomas Black and Jennifer Surane, Bloomberg, 7 August 2013; *Innovations in Satellite Communication and Satellite Technology* 102, Daniel Minoli, John Wiley & Sons eds., Science, 2015

demand. Intelsat has responded to this by developing its High Throughput Satellite ("HTS") Epic^{NG} platform[18] that will use C-, Ku-, and Ka-bands to deliver more throughput per unit of spectrum than is possible with the current generation of satellites. Epic^{NG} combines wide beams, spot beams, and frequency re-use technology to support broadband, media, and mobility solutions. This platform provides an unprecedented adaptability for a customer's network configuration and topography. HTS systems will not replace traditional wide-beam satellites, but instead provide customers with additional service options, as some types of applications are best served by HTS and others by wide-beam solutions.

According to a Northern Sky Research ("NSR") study, it is believed that the global market for HTS is in its emerging phase: projected HTS demand growth rate is expected to rise above 30% annually with broadband access services to be the mainstay of demand. Overall, NSR forecasts that HTS capacity demand will surpass 1,000 Gbps by 2023.[19]

Enterprise and Rural Broadband

A key factor for these figures is represented by the growing demand for enterprise data services, primarily serving backhaul and VSAT services. Furthermore, the increasing demand for rural connectivity – a core commitment within Ofcom's mission – could be effectively met by making use of these innovative technologies, offering consistent quality of service across the country, shorter activation periods, and lighter environmental impact.

Demand for satellite broadband services will also be supported by the public sector: in the digital communication infrastructure strategy, published earlier this year, the UK government commits to act quickly to help households and businesses in the hardest to reach areas.[20] Starting with premises experiencing the lowest speed broadband, the government will launch a scheme with local bodies across the UK to subsidise the costs of installing satellite services to deliver superfast broadband. This will build on the government's commitment to enable broadband for at least 95% of UK residents by 2017 using satellite solutions to help ensure that no one is left behind.

Maritime Connectivity

iDirect predicts that by 2023, of the 49,855 VSAT-connected vessels at sea, roughly 33% will be on HTS.[21] The prediction takes into account the growing demand for bandwidth to be used for commercial shipping in order to improve operations, productivity and crew welfare (including for activities of route planning, engine diagnostics, and weather applications). Tourist services at sea will also contribute to the growth in demand, as cruise ships passengers want to stay connected after they have left port.

Aeronautical

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[18] For more information on HTS and EPIC^{NG} visit http://www.intelsat.com/videos/a-high-throughput-satellite-teach-in/ and http://www.intelsat.com/infrastructure/intelsat-epicng/.

[19] *Global Satellite Capacity Supply and Demand*, Northern Sky Research (2014).

[20] *The Digital Communications Infrastructure Strategy*, HM Treasury and Department for Culture, Media & Sport (18 March 2015).

[21] *HTS hits on the Horizon*, iDirect (2015).

Euroconsult predicts that over the next 10 years we will see an increase in the number of commercial aircraft connected, from just over 3,000 aircraft today to more than 13,000. This is driven by an exceptional growth in passengers' demand for in-flight connectivity using satellite technologies. The increased amount of bandwidth available on HTS will not only help meet the growing need for on-board communication, but also help airlines improve operational functions. Intelsat recently introduced IntelsatOne Flex[22] to better serve these mobility customers.

Government and Military

According to a study produced by the UK Spectrum Policy Forum, Defence and Homeland Security Services will require speeds of 50 Mbps/sec - 5 Gbps/sec to efficiently operate their services by 2024-2025.[23] This represents an impressive growth in demand over a ten-year span when compared to the currently offered speeds of 10 - 100 Mps/sec.

Militaries are investing in VSAT to increase battlefield intelligence and strengthen mission coordination between the national headquarters and the region where they operate. HTS will provide the UK Ministry of Defence with higher flexibility, providing choices of using various WGS, new Ka- and traditional C-, Ku- and X-band constellations to select the most effective service for any specific operation.[24]

Broadcast

On the broadcast side, the increasing demand for high resolution broadcast content, including 4K and 8K, is leading to an increase in demand for additional satellite capacity. Euroconsult predicts the number of satellite TV channels will grow to 39,000 in 2016 and 47,000 in 2022. HDTV channels will reach 10,000 in 2016 and 20,000 in 2022.[25]

Sky has recently announced that it has beaten its yearly forecasts with broad demand across Europe, including continued solid growth in Britain, and has plans to launch a number of new services in the near future.[26]

Question 9: For each of the satellite applications you use, provide or help deliver what do you see as the a) current demand trends; and b) underlying current and likely future drivers of demand for the satellite application(s) your organisation uses or provides?
Please include in your response for both a) and b) above:

-the scale and future impact of the trends/drivers on demand;

[22] For information on IntelsatOne Flex for Aero Mobility visit http://www.intelsat.com/services/mobility-services/intelsatone-flex/.

[23] *UK Spectrum Usage and Demand (First Edition)*, UK Spectrum Policy Forum (26 March 2015).

[24] *HTS hits on the Horizon*, iDirect (2015).

[25] *Trends & Prospects for Emerging Space Programs*, Euroconsult (Aug. 2013).

[26] *Sky beats year forecasts with broad demand across Europe*, Kate Holton, Reuters (7 July 2015).

-any variations in the type and scale of trends/drivers by geography (i.e. in the UK, the rest of Europe, and other parts of the world where this may be relevant to UK use) and why; and
- whether future demand is expected to be temporary or intermittent, and the reasons for this.

In your response, please provide any evidence which supports your position on the drivers of demand (e.g. forecasts, studies and statistics)

Intelsat foresees future decline in demand in the UK/overseas in point-to-point transoceanic trunking, analogue voice applications, and analogue video. However, the decrease in needed spectrum for these services is overshadowed by the growth and demand for spectrum in the UK/overseas for the following applications/services:

Machine-to-machine/Internet of Things ("IoT")

In 2015, Ofcom recorded over 40 million devices connected via the IoT in the UK and has forecasted that this figure will grow more than eight-fold by 2022, with hundreds of millions of devices carrying out more than a billion daily data transactions.[27]

Cisco forecasts that by 2020, there will be an estimated 50bn Internet connected devices worldwide, including computers, smart phones, tablets, as well as the traditional corporate M2M/IoT and SCADA units. This represents roughly a 400% growth as compared to the 2013 estimations. And NSR expects that, by 2023, there will be 5.8 million satellite machine-to-machine ("M2M") and IoT connections globally.

Satellite services are also expected to expand in backhaul-type solutions where M2M/IoT data is aggregated via a satellite network, either in a consumer's residence, or aggregated regionally. There is also a role for satellite networks in acting as a backup for terrestrial networks failures -- especially in developing regions where cellular networks can be significantly less reliable or in critical applications such as in healthcare.

Finally, HTS applications are expected to be an indispensable instrument to bring IoT in mobility applications.

Mobility

One of the key identified mobility trends is the growing adoption of robust communications-on-the-move solutions to allow remote users to collaborate reliably and efficiently while in transit. This will cause a steady increase in the demand of satellite terminals specifically developed for rapid installation on any vehicle to acquire and track satellite signal while on the move.

Cellular backhaul

Demand for cellular backhaul provided by satellite is expected to experience a significant increase in the next decade, as a response to the great opportunity represented by the deployment of HTS technologies. By 2023 it is expected that the revenue generated from HTS capacity for mobile backhaul will be twice as big as that generated by traditional FSS capacity.

[27] *Ofcom sets out plans to support the Internet of Things*, Ofcom (27 Jan. 2015).

Tele-health

With many governments, including the UK, strongly committed to offering a high quality service to every citizen without geographical discrimination, it is expected there will be a sharp increase of tele-health applications using satellite technologies. Satellite networks can guarantee the necessary, consistent, quality of service across the whole national territory, including remote and undeserved areas.

Connected transportation

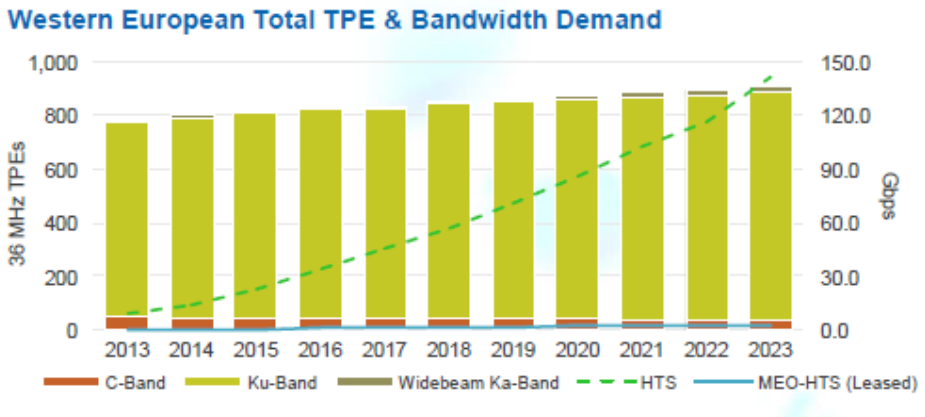
The demand for always-on communications is ubiquitous to all types of transportation. Airlines, shipping operators, and car manufacturers are equipping their next generation of planes, ships, and cars with more complex technology than ever before. Over the next few years Intelsat expects to witness an increased demand for applications for connected transportation. This demand that can be fruitfully met by the satellite industry that is already strongly present in the sector.

Furthermore, there are innovative proposals to use satellite connections to increase communication with ground-based medical personnel to provide tele-medicine services for passengers on board of aircrafts.

Enterprise data

According to a study produced by the UK Spectrum Policy Forum, enterprise data VSAT networks will be required to run speeds of 50 Mbps-1 Gbp/sec to efficiently operate their services by 2024-2025.[28] This represents a significant increase from the currently offered speeds, ranging from 1 to 50 Mbp/sec.

NSR states that overall a large increase in HTS demand from 2013-2023 will be driven by broadband access. In particular, enterprise data services are expected to record solid gains, primarily serving backhaul and VSAT services. Demand is expected to further increase as HTS come online and deliver an immense wave of new capacity.



[28] *UK Spectrum Usage and Demand (First Edition)*, UK Spectrum Policy Forum (26 March 2015).

TPE = 36 MHz transponder equivalents

Western Europe Ku-Band Supply and Fill Rates

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	CAGR
Total Supply	848.6	885.8	965.9	1,002.3	981.3	1,000.9	980.9	1,000.5	1,010.5	1,030.7	1,035.9	2.0%
Est. Commercialized Supp	806.2	841.5	917.6	952.2	932.2	950.8	931.8	950.5	960.0	979.2	984.1	
Ku-Band Demand	724.1	745.2	761.5	778.5	786.6	801.1	809.9	823.6	830.9	842.6	852.6	1.6%
Fill Rate Est. (Total)	85%	84%	79%	78%	80%	80%	83%	82%	82%	82%	82%	
Fill Rate Est. (Com.)	90%	89%	83%	82%	84%	84%	87%	87%	87%	86%	87%	

Note: TPE = 36 MHz transponder equivalents
Source: NSR

Question 10: Taking into account the drivers you have identified in your response to Question 9 above, what (if any) challenges is your organisation concerned about in meeting potential future demand?
Please provide the information by application and band, along with any supporting evidence, if available.

Intelsat is concerned that, with the current spectrum shortage the satellite industry is facing and the increasing demand for satellite services arising in several sectors, if regulators do not allocate additional spectrum to satellite then the resulting "spectrum crunch" will harm satellite consumers and end users for decades to come. Because satellite planning, procurement, launch, and lifespan result in a 20-30 year cycle per satellite deployment, it is extremely important that Ofcom provides satellites with spectrum certainty and additional spectrum well in advance of deployment.

Intelsat is also concerned about the lack of knowledge about satellite amongst UK decision-makers, and sees this as a major challenge to meeting future demand. Many senior officials have out-dated views of the quality of services delivered by satellite. As such, satellite is not always properly considered in the planning stages when government analyses how to support new technologies. Intelsat encourages Ofcom to champion the unique attributes of satellite services throughout government to ensure the potential role of satellite to in new projects is better understood.

Another major challenge is that the focus of Ofcom and others on the economic benefits of satellite services for the UK ignores the non-economic benefits. As noted above, satellite services play a critical role in delivering emergency communications across the UK and the world. These services are often infrequently used, but it is vital that the spectrum is available when required. Ofcom must make efforts to better understand how it can quantify non-economic benefits, and ensure that satellite spectrum is not reduced due to a perceived more economically beneficial alternative technology. Otherwise, Ofcom could inadvertently significantly increase the cost, or potentially imperil, communications across the UK.

Question 11: Do you have any comments on the list of potential mitigations we have identified? What likely impact would each of the mitigations have on spectrum demand? E.g. what order of magnitude increase in frequency re-use might be achieved? To what extent do you believe that these mitigations apply only to certain applications?

Intelsat generally agrees with Ofcom's proposed mitigation measures, and looks forward to working with Ofcom to ensure that spectrum in the UK is used as efficiently as possible by the satellite industry.

Demand for FSS has ensured that operators, and other parts of the ecosystem, including equipment manufacturers and service providers, has resulted in the development of technologies that enhance the customer experience and make the most efficient use of spectrum. Such technology advances have allowed FSS operators and service providers to deliver relevant services with limited capacity. The satellite industry collectively utilises state of the art antenna technology to facilitate frequency re-use,[29] and continued improvements in high power amplifier performance ensure that higher order modulation techniques are employed to maximise spectral efficiency. In other bands, satellite services also share frequencies with non-ubiquitous terrestrial services where technically possible. However, even with these efficiencies, demand for FSS continues to outstrip the amount of spectrum available and efficiencies alone will not be enough to keep up with consumer demand.

Improvements in antenna technology will continue to accelerate the spectral efficiency of satellites in the same way as they have since satellites were first used for communications. However, demand for capacity at least matches improvements in efficiency, and Intelsat would expect this to continue to be the case. Antenna performance is not the only limiting factor, with the spacecraft and payload systems capability also playing an important role. These include restraints on battery size, the efficiency of the solar arrays, the capability of the spacecraft to dispense of heat generated by high power amplifiers, and the efficiency/linearity of the high power amplifiers. Intelsat expects that there will continue to be advances in the efficiency of all aspects of the payload and spacecraft performance, but this change is unlikely to match the need for access to additional spectrum to meet growing demand.

Advances in transmitter technologies, such as more efficient hardware or more spectrally efficient wave forms, will increase the overall spectrum efficiency of overall satellite systems, but it is not expected that this will result in order-of-magnitude improvements. Improvements in spectral efficiency are, however, often accompanied by increased demands on the system's power resources. Improvements in receiver technologies and standards will also improve the systems spectrum efficiency and improve the link margins and thus reduce the demand on the systems spectrum and electrical power resources; however, this too is not expected to provide order-of-magnitude improvements in efficiency.

Limiting the power flux density radiated towards other satellites could lead to a reduction in the orbital separation between geostationary ("GSO") satellites. However, such restrictions would likely have a detrimental impact on important applications requiring smaller antennae, including maritime and aeronautical connectivity that typically utilize smaller antennae while demonstrating that their emissions comply with existing standards relating to off-axis power flux density. Improvements in antenna performance are the most likely sustainable source of reduced orbital separation distances between satellites.

[29] *See Airlines Work to Supply Better In-Flight Wi-Fi with Satellite Services*, Thomas Black & Jennifer Surane, Bloomberg, 7 August 2013; *Innovations in Satellite Communication and Satellite Technology* 102, Daniel Minoli, John Wiley & Sons eds., Science (2015).

Improved coordination of existing systems in some situations could lead to more efficient utilisation of the GSO arc, particularly in the form of steps to prevent paper satellites. However, the GSO arc is already crowded, and improved coordination will not provide order-of-magnitude improvements in efficiency, and is unlikely to lead to a reduction in the number of satellite filings.

Question 12: What other mitigation opportunities do you foresee that we should consider? For what applications are these likely to be applicable and what scale of improvement are they likely to deliver?

Improvements in the electrical, thermal and propulsion subsystems of satellites will continue to increase spectrum efficiency in the coming years, although the precise scale and timing of such improvements is difficult to quantify at this stage. Such improvements will benefit all applications supported by the satellite.

Question 13: Beyond the activities already initiated and planned for the satellite sector (e.g. as part of WRC-15), do you think there is a need for additional regulatory action that may, for example, help your organisation to address the challenges it faces? In your response, please indicate what type of action you consider may be needed and why, including any evidence to support your view.

Uncertainty around which radio services and spectrum bands will be impacted by 5G systems dampens the mood for investment in satellite and other radio services. If the candidate bands for the proposed WRC-19 agenda item looking at spectrum above 6 GHz are not swiftly defined, there will likely be at least a four year delay in investment. With the long lead times required for planning and launching a satellite for even an established operator like Intelsat, this could cause a decrease in new satellite capacity launched, leading to increased costs for users as demand for spectrum by all communications technologies increases.

Intelsat strongly believes that WRC-19 is too soon for an agenda item looking for 5G spectrum for IMT systems. Before identifying any potential spectrum for 5G, the IMT community should first define what 5G is, and develop harmonized standards for its development within 3GPP, ITU-R and other relevant standards bodies. Intelsat suggests that Ofcom adopt this position for their engagement in the WRC-19 study cycle.

13 August 2015