BT's response to Ofcom's Call for Input on:

Strategic review of satellite and space science use of spectrum

(Issued by Ofcom on 4th June 2015)

Submitted to Ofcom on 13 August 2015

Our responses to the consultation questions

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

BT welcomes and supports Ofcom's review of the satellite sector, especially its focus on end-user demand for applications and services. BT has over 50 years' experience in the development and deployment of satellite systems with a focus on delivering high quality and cost effective services to all customer sectors. BT is technology neutral and only deploys satellite capabilities where it is the most appropriate and cost effective solution for any given customer or market need. We therefore welcome Ofcom's balanced approach in reviewing the needs of the satellite sector alongside those of other technologies.

Satellite respondents

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 list of applications is quite comprehensive. However, there are three applications that, while possibly falling under one of the headings provided, are worth calling out specifically:

- ***Correspondent services***: these links provide international communications peering (typically between incumbent telco networks) for public telephony and data services. While small in volume these links can provide the only international connectivity for some nations, particularly in sub-Saharan Africa and some land-locked countries in Asia, where fibre networks have not yet arrived. These services might be included under "Legacy telephony and carrier" in the consultation document, but the wording makes no mention of connectivity between public networks or the critical nature of some of these links;
- ***Backhaul services***: these links can connect remote islands of terrestrial connectivity to the core network, e.g. cellular base stations, wireless hubs, broadband DSLAMs. Again, these may be notionally covered by the "Legacy telephony and carrier", but given that these links can provide a component of a nation's critical national infrastructure they need to be recognised as a discrete application;
- ***Continuity services***: these links provide back-up services in the event of terrestrial infrastructure failure. They can apply to individual business/consumer/government services and telco network infrastructure, e.g. backhaul links. Dedicated business or government service back-up could fall under the "Corporate Networks" heading and network overlay could fall under "Legacy telephony and carrier" but the current wording under those headings does not reflect the provision of resilience and redundancy capability provided by satellite, especially in relation to critical national infrastructure. The heading of "Disaster relief" does not cover these aspects because it focuses purely humanitarian relief services;
- ***Timing and synchronisation***: this application of GNSS signals is critical to fixed and mobile terrestrial network operation. Although not a 'paid for' service as such, it needs to be recognised as a key component for the operation of critical national infrastructure.

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 'value chain' provided in the consultation document is not a 'chain' in the sense of having a left-to-right flow for the delivery of all satellite services and applications, nor does it include all components for all services. It is accepted that the value chain provided is a simplification and that much effort could be expended identifying all possible value chains for all services. However, it is worth drawing out some specific issues and variants that can impact on market demand and development:

- More than one value chain can exist for a single application or service. This can give downstream players a choice of approach to some markets, e.g. satellite broadband;
- Vertical integration of key components can occur within the value chain. This can have a positive or a negative impact on spectrum utilisation;
- The dominant player in the value chain can vary between sectors depending on service characteristics. It would useful to construct value chains for the different sectors that help identify where the market power lies in each chain and how that might drive spectrum usage.

Telecoms satellite operators have a pivotal role in terms of defining satellite missions and capabilities. Operators select and work with satellite manufacturers, launch companies and (to a lesser extent) ground equipment providers to develop end-to-end system designs and business cases. Downstream service providers have limited input to mission design or the end-to-end business case and thus have to work with what the operators bring to market. More positively, for many applications, a service provider has freedom to select ground equipment suppliers that are not pre-selected or defined by the satellite operator at a point further up the delivery chain.

In the broadcast sector, the broadcasters can have far more influence over mission design than the downstream telecoms service providers due to their buying power and ability to sign-up to long-term capacity commitments.

In addition, there are two elements that are missing from the current value chain:

- The function of 'installer': companies that install user terminals for applications such as satellite TV and broadband access but play no part in service delivery. Sometimes this function is provided by the service provider, but not always;
- Consultancy: there is a very active consultancy sector that supports all elements of the value chain providing services from specific technology expertise through to applications development and marketing.

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

- use;

- provide: or

- help to deliver?

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

BT has been developing, operating and delivering satellite services for over 50 years. BT is technology neutral and only deploys satellite capabilities where it is the most appropriate and cost effective solution for any given customer or market need. BT provides a full portfolio of satellite services in over 100 countries around the world.

BT has over 20 years of corporate satellite network experience encompassing: broadband access, corporate VPN extension, closed corporate networks, IP and MPLS extension, business site resilience and recovery. BT's global satellite customer base includes the finance, energy, mining, oil & gas, retail, construction and media sectors for major multinational companies; plus UK and international governments and related agencies including the US government, the EU and Interpol. BT is also delivering a high availability, ultra-resilient VSAT network for the European Geostationary Navigation Overlay Service (EGNOS), called EGNOS Wide Area Network (EWAN). The network carries positioning data for safety critical applications in airline and ship navigation.

The following table summarises BT activities across the applications identified in the review document.

Application	BT role		
End-user applications	***Use***	***Provide***	***Help to Deliver***
Direct-to-Home Broadcast TV	✓		✓
Broadband internet access		✓	✓
Commercial Mobility		✓	
Corporate Networks #		✓	
Navigation including location based †	✓		✓
Other applications			
Distribution	✓	✓	✓
Contribution and OU TV	✓	✓	✓
Legacy telephony and carrier *		✓	✓
Military and government		✓	✓

Includes continuity services † Includes timing and synchronisation * Includes correspondent and backhaul services.

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.

BT is active in almost all applications identified in the review document. The following table summarises the key characteristics of BT's satellite spectrum usage.

Application	Characteristics		
End-user applications	***Service band (GHz)***		***Service geographic coverage***
	Uplink	Downlink	
Direct-to-Home Broadcast TV	Bought-in service		UK
Broadband internet access	27.5-30	17.7-20.2	UK and Europe
Commercial Mobility	Inmarsat, Iridium, Thuraya platforms		Global service reseller
Corporate Networks #	5.85-6.725 13.75-14.5	3.6-4.2 10.95-12.75 (11.7-12.2 Region 2 only)	Approx. 11% UK & Europe, 62% Latam, 27% AMEA.
Navigation including location based †	13.75-14.5	1.57542 10.95-12.75	Worldwide Europe
Other applications			
Distribution	13.75-14.5	10.95-12.75	UK hub serving Europe
Contribution and OU TV	5.85-6.725 13.75-14.5	3.6-4.2 10.95-11.7, 12.2-12.75	UK and Europe
Legacy telephony and carrier *	5.85-6.725 13.75-14.5	3.6-4.2 10.95-12.75	UK hub serving Africa and Asia. Turkey hub serving AMEA.
Military and government	5.85-6.725 13.75-14.5	3.6-4.2 10.95-12.75	UK hub

Includes continuity services † Includes timing and synchronisation * Includes correspondent and backhaul services. NB. Excludes services accessed in Asia and Pacific Rim region (typically bought-in).

The following commentary provides additional information on the two most significant application areas (by current volume) to illustrate the scale and scope of BT's of spectrum use.

Corporate Networks

Significant scale Ku- and C-band VSAT networks hubbed from the UK, especially into Eastern Europe, Africa, Middle East, Russia, the Caribbean and Central Asia. Key markets include the financial sector, oil & gas, construction, retail, pharmaceutical and manufacturing sectors.

Ku-band is extensively used by BT across the Latin America region. BT Latam is a major satellite service provider in the region, utilizing almost 900 MHz of Ku band satellite capacity for large VSAT networks and also SCPC circuits. This bandwidth is used primarily for corporate applications. C-band is also extensively used by BT across the Latin America region. BT Latam is a major satellite service provider in the region, utilizing almost 500 MHz of C band satellite capacity for large VSAT networks and also SCPC circuits. This bandwidth is primarily used for corporate applications requiring higher availability.

BT Turkey has been providing Ku-band VSAT services for over 20 years in Turkey Middle East and Eastern Europe as well as North Africa and CIS comprising SCPC and VSAT services for the financial sector, oil & gas, construction, retail, manufacturing sectors and GSM operators (see backhaul).

Legacy telephony and carrier

Extensive UK-based correspondent services (Private Circuits, telephony, IP, data) with telcos across the globe, especially land-locked African and Asian nations. These services are point-to-point links using fairly large antennas (Permanent Earth Stations) in the UK, with the distant end typically operating via a 2.4m antenna.

BT Turkey has been providing GSM Backhaul services over satellite since 2008. BT Turkey was one of the first operators in the world to implement DVB-S2 GSM backhaul solutions for major MNOs. Now we are in the process of providing backhaul services for 2G-3G fix and mobile remotes as well as 2G-3G maritime services. A significant market exists in rural infill and drive-away services for special events such as sports events, concerts and festivals, as well as emergency service restoration in the event of natural disasters like earthquakes.

Question 7: For each of the satellite applications you provide, please could 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).

Satellite telecommunications services provide connectivity where no terrestrial alternative is available. Therefore, a major benefit is that it enables people to live and work in locations that would otherwise be isolated or require the use of compromise solutions that diminish quality of life or reduce the effectiveness and efficiency of business, possibly to the point where they are unviable.

It is difficult to put a financial value on the benefits of satellite communications to UK citizens, but the following provides a small sample of qualitative benefits in sectors of interest to BT. For more information see "The Case for Space 2015" report by London Economics available here: http://www.ukspace.org/wp-content/uploads/2015/07/LE-Case-for-Space-2015-Executive-Summary.pdf

BT's satellite broadband internet access services can meet consumer and business needs where no terrestrial alternatives exist or they are not cost effective to deploy, e.g.:

- Consumer and business broadband services where terrestrial fixed, wireless or mobile alternatives are not available. It is estimated that some 300k premises could benefit from satellite broadband, but that number could reduce as advanced copper and wireless technologies come to market (see Q8);
- Rapid deployment to temporary business sites where mobile solutions (including satellite) that need internet access for a limited time period and where the lack of an appropriate connection drives additional costs and/or project delays;
- Disaster recovery/resilience overlay for business users in the case of terrestrial network outage. Benefit is accrued through avoiding lost trading hours.

The nature of BT's Commercial Mobility service benefits cover a range of industry and government applications where terrestrial solutions do not provide adequate coverage at both the national and international level, e.g. land fleet and workforce management in the haulage and utilities sectors; offshore support services management in the survey, oil & gas, science and renewables sectors; emergency services and major incident management.

Our Corporate Networks provide similar benefits to those identified above in terms of providing connectivity where none exists and/or resilience in the form of an emergency back-up facility. The market sectors that benefit directly include those captured above plus finance, manufacturing, retail and pharmaceutical.

GNSS systems provide vital timing signals that are used to stabilise and correct local timing sources to enable network synchronisation. Stable synchronisation ensures that wireless and fixed networks can optimise their traffic management and mitigate the impact of some forms of noise and interference.

Legacy telephony and carrier (correspondent services) are vital for providing links with nations with no other international telecommunications access. Connectivity enables business and family links to be made and maintained. This is particularly relevant to sub-Saharan Africa and some land-locked countries in Asia.

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

BT is a global telecoms network operator and service provider. BT is technology neutral and tracks developments and trends in all telecoms-related technologies, applications and markets. This enables us to select the most appropriate, sustainable and cost effective solution for any given customer or market need. In the telecoms sector, the most significant trends that will impact on future satellite service definition and use are:

- Ever increasing internet access speeds through the evolution of copper and wireless technologies (a benefit of 'Moore's Law') and pushing fibre deeper into access networks (a consequence of improving economics and increasing demand);
- New entrants (commercial and community based) in the fixed access infrastructure business targeting the last few percent of premises with new fibre and wireless network build in areas that were previously deemed uneconomic for deployment of Next Generation Access (NGA) services;
- The accelerated deployment of ultra-high definition TV services (4K and 8K) including broadcast, on-demand and catch-up services;
- The increasing consumption of video content through internet-based unicast and multicast mechanisms;
- The increasing use of 'companion screens', i.e. the simultaneous use of smartphone and tablet devices to consume secondary content (different camera angles, advertising etc.) associated with a TV programme *while that programme is being viewed on a TV*;
- Increased corporate and consumer consumption of cloud-based services, especially those consuming and generating 'big data' in all its forms;
- Proliferation of sensors and actuators as components of the Internet of Things (IoT), coupled with the development of new terrestrial wireless standards designed to support them, e.g. LTE-M and Low Power Wide Area (LPWA) technologies;
- Increased data consumption through mobile devices including streamed video and cloud-based applications such as augmented reality;
- The emergence of new technologies such as Network Function Virtualisation (NFV), Software Defined Networks (SDN), Quantum technology based security and communications mechanisms;
- Increasing end-user expectations for reduced file transfer times, irrespective of data type (e.g. video, OS updates, games, business data), time of day, location or device used.

The trends identified above will affect the satellite sector in a range of ways. Some applications will be more affected than others and some key areas of interest are discussed below.

Broadband internet access

The observed trends will change the market perception of what a broadband service should provide, i.e. ever faster headline speeds and a *per-user* (as opposed to per connection) sustained data rate during busy periods that is capable of supporting long-form video content of ever increasing quality and rapid massive file transfer, all of which will lead to higher data consumption per month. Current satellite platforms struggle to deliver a comparable customer experience to terrestrial platforms in terms of performance and price and increasing market expectations will make it harder still. The deployment of rural fibre and wireless broadband capabilities is also likely to impact the addressable market for satellite broadband services.

TV services (Direct-to-Home Broadcast TV, Distribution, Contribution and OU TV)

Higher quality video requires higher bandwidths – this requirement is likely to be only partially offset by improvements in encoding techniques. 4K unicast services are already available (albeit sometimes at less than full 4K quality) and 4K broadcast services will be launched this year. It remains to be seen if 4K device and service take-up and content/service creation is sufficient to fuel rapid deployment of the standard. Other factors are likely to play a role here, e.g. the cycle for primary domestic TV replacement (currently around 7 years) and the take-up of tablet size devices. In addition, the 8K standard has already been demonstrated and is likely to be showcased at the 2020 Olympics. The satellite sector will need to respond to the increasing demand for bandwidth for TV services that exploit higher picture quality.

Machine-to-Machine (M2M)

Satellite systems will need to be able to provide compelling M2M capabilities that can be integrated with terrestrial solutions. There is the potential for terrestrial technologies, such as G.fast+LPWAN, to encroach on some traditional satellite target markets with lower cost solutions.

Commercial Mobility

The satellite land-mobile market in developed countries could be under increasing threat from evolving terrestrial wireless standards for data heavy applications. In maritime and aeronautical markets, there will be less in the way of increased competition, but increasing demand for higher data speed and volume data transfer.

Corporate Networks

The Corporate Network market is similar to the broadband and mobility markets in that customer expectations will be driven by what is available over terrestrial networks serving the same sector. In particular, corporate networks are driving ‘big data’ applications and are demanding higher and higher

bandwidths, even if only for relatively short periods of time. Satellite platforms will need to evolve to be able to respond to massive, but intermittent and geographically distributed, bandwidth demand.

Generic impacts

Emerging technologies like NFV and SDN will impact telecoms network architectures and facilitate Network as a Service (NaaS) opportunities that enable operators and end-users to better manage network resources to deliver a dynamic set of services and applications. This could make it more viable and attractive to develop fully integrated end-to-end satellite-terrestrial networks capable of delivering far more versatile and responsive services than are possible with today's satellite infrastructure and business models.

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;

- 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;

- 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).

BT constantly reviews all of its areas of business and how they relate to each other. BT is currently conducting a refresh of its satellite services strategy due to the growth potential observed in several key market sectors and geographies. The response below is based on BT's own analysis of commercially available analyst reports, output from the UK government's Space Innovation & Growth strategy, and our own internal market and customer intelligence.

Broadband internet access

Our use of Ka-band broadband services in the UK and Europe has grown from nothing in the last 3 years, but not as much as originally predicted. Residential and business broadband access services in the UK are expected to grow further as our BDUK1 contract delivery nears completion. The number of end users is expected to rise from around 100 to a few thousand, possibly as many as a few tens of thousands, over the next 2-3 years. However, demand is likely to be suppressed by the expansion of BDUK1 contracts (funded by higher levels of take-up than originally predicted), deployment of 4G, BDUK2 contract evolution (new technologies and operators) and the emergence of G.fast technology. The evolving economics of terrestrial solutions means that smaller and smaller clusters of rural

premises are becoming viable for NGA deployment. This suggests that satellite is likely to be used only in the most isolated areas for lone properties or clusters of handfuls of premises.

In addition, the market expectation of broadband services in terms of sustained speeds and monthly data consumption may impact on customer perception of value for money of satellite services as fixed and wireless solutions become ever more capable.

This landscape suggests that demand for satellite broadband will not be large in the UK, although still potentially in the tens of thousands of units. Those units that are deployed are likely to be in service for a long time.

Machine-to-Machine (M2M)

M2M and wider IoT applications could be a significant growth area, but it is currently difficult to forecast the scale and scope of any satellite component. Satellite could offer a dual-path option for robust connectivity in areas where there is no alternative terrestrial path, e.g. in rural/remote agricultural, plus infrastructure monitoring and control applications (traditional satellite SCADA applications already). However, for volume deployment cost will be a key driver, so satellite solutions will need to minimise remote unit and airtime costs to fully capitalise on this market. In spectrum terms it is difficult to see the need for significant increase in total capacity in the medium term.

Corporate Networks

In Europe and the UK, the market for C and Ku-band VSAT services hubbed from the UK has been stable for several years. Demand for UK C-band VSAT hub services is expected to be flat over the next 3 years, despite some existing services migrating to Ku-band.

VSAT services in Ku and Ka-band both in the UK (primarily as a hub location) and globally are expected to see double-digit growth over the next 3+ years. This includes rapid deployment, transportable and vehicle mounted terminals as well as fixed locations. Demand is being driven by mining, oil and gas, pharmaceuticals and construction sectors. Applications include data and video backhaul, WAN extension and IP voice. Continued adoption of big data applications mean that data gathering and real-time analytics will continue to drive bandwidth demand, potentially in both upstream and downstream rather than just from data collection in the field. Key target markets include Eastern Europe into Eurasia, Africa (especially the sub-Sahara region), the Middle East and Asia Pacific.

In Latin America, over the last 5-10 years we have seen an increase in Ku-band VSAT network demand from the more robust Latam economies and there is an expectation of significant growth (possibly double digit) in those stronger economies over the next 5 years. However, the wider Latam market can be volatile and there is the possibility of reduction of demand in some of the less robust economies due to financial constraints. Due to the nature of the market, supported application types will vary from short transactions (EPOS, lottery) to bandwidth intensive data transfer and streaming, rather than being purely dominated by big data applications.

Navigation (including location based)

In terms of timing and synchronisation applications, it is possible that M2M and IoT application will drive an increase in use of GNSS timing sources. Conversely, over the longer term, it is possible that quantum timing sources could replace the use of GNSS locked local caesium sources for the synchronisation of fixed and mobile networks (cost dependent).

Contribution and OU TV

Ku-band TV services have grown as channels have proliferated, plus BT market share has grown from zero since re-entering the market in the last few years. We expect to see some growth due to demand for expat services in the UK and in Europe. Growth rate probably in single digits for the next 3 years.

Legacy telephony and carrier

C-band correspondent services in the UK have declined by around 20% over the last 3-5 years but this has now flattened out. BT expects to see stable demand for UK C-band correspondent services for the foreseeable future due to the requirement to maintain very high availability (there is even potential for some small growth).

Military and government

X-band VSAT service demand is expected to grow over the next 3 years, potentially in the tens to hundreds of links. Demand growth is expected in Africa, Middle East and Asia.

In Latam, the economic downturn has triggered some reduction of Ku-band VSAT networks from government customers in some countries. However, this is expected to be a temporary situation.

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.

BT has not experienced any shortage of capacity or spectrum in terms of being unable to acquire capacity in any band where and when required. The one exception to this is in the LatAm region where we are currently seeing demand growth outstripping supply due to recent launch failures. However, this has not caused BT any operational problems so far and should be a relatively short-term problem.

Access to interference free spectrum is an increasing problem that can lead to localised quasi-congestion where specific frequencies can become sterilised for satellite services through poor local enforcement. This is particularly so in C-band where terrestrial wireless systems are now allowed shared access. The problem is most acute in Africa where the wireless environment is not as well managed as it is in other parts of the world.

The key aspect which will impact on our ability to serve future market needs is cost per MHz or Mbit/s. While the cost of terrestrial bandwidth has plummeted in the last 10-15 years, the cost of satellite capacity has not reduced at the same pace. Therefore, any market where satellite is to be used to deliver a service that is typically delivered by terrestrial alternatives is currently suffering a market

disadvantage in price (for an equivalent performance service) or performance (for an equivalent price service).

One area where capability has struggled to meet market expectation is broadband internet access. The new Ka-band platforms, which are significantly cheaper than their Ku-band predecessors in terms of cost per MHz/Mbit/s, have not achieved the performance/price combination necessary to provide a compelling solution for rural broadband coverage. The cost of bandwidth leads to high contention levels in order deliver affordable retail price points and this leads to low sustained throughput per user during busy periods. This will be an increasing problem as broadband use includes increased levels of video consumption and cloud-based services requiring transmission of large amounts of data.

In addition, a satellite is a fixed cost item that will be in operation for 12-15 years, thus offering very limited pricing flexibility over the mission lifetime if the satellite is to achieve payback. Market expectations of performance will only increase over time and satellite solutions will have limited ability to respond.

There is a similar issue in the corporate VSAT market, particularly in the mining, oil and gas markets, although new MEO and proposed new LEO systems are starting to provide solutions in some geographies. The concern here is that these capabilities will not be widely available for several years.

Military and government services typically support the same applications as broadband and corporate VSAT networks, hence the same concerns apply in terms of the availability of bandwidth at an appropriate price point.

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?

The mitigations identified in the Review document have existed for some time in terms of technology availability. However, a combination of limited flight proving opportunities (becoming a precautionary rather than essential step given the level of modelling and testing that is undertaken) and the natural conservatism of most satellite operators means that the sector has been slow to adopt radically new technology approaches that could enable a significant shift in capability and cost points.

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?

Incremental technology upgrades can offer limited improvement in spectrum utilisation over time. However, big gains are only really achieved through radical changes in end-to-end system design, e.g. the move to spotbeam architectures in the current generation of Ka-band satellites.

There are several new LEO system proposals that could have a significant impact on spectrum requirements, especially in the broadband access and corporate network areas. LEO systems can use the same spectrum as GEO satellites (with appropriate interference mitigation techniques) and offer increased spectrum reuse compared to GEO systems over the same coverage area. In addition, LEO systems offer low latency that could prove to be highly attractive for carrier, corporate and broadband access applications. LEO systems also have the potential to open up new opportunities for the satellite

sector in delivering ultrafast speeds capable of supporting big data applications. This could make them highly attractive to service providers and drive new growth in the sector.

The downside is that individual LEO satellites are likely to be capacity constrained and so the local capacity density on the ground is likely to be limited. However, the net result could well be that some traffic types migrate from other platforms and free up GEO system capacity in Ku- and Ka-band.

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.

BT has operated satellite services in over 100 countries. In the vast majority of countries the licensing process and requirements are similar to those found in the UK although the authorisation process can take longer (up to several months) even for simple requests, plus the costs can be highly variable. Any action that could be taken at the international level to encourage all national regulators to offer a consistent and efficient licensing regime for satellite services would be welcome.

As discussed under Q10, access to interference free spectrum is an increasing problem that can lead to localised quasi-congestion where specific frequencies can become sterilised for satellite services through poor local enforcement. This is particularly so in C-band where terrestrial wireless systems are now allowed shared access. The problem is most acute in Africa where the wireless environment is not as well managed as it is in other parts of the world. Any action that could be taken at the international level to encourage and/or help some under-resourced national regulators to operate an effective coordination regime for shared satellite and terrestrial bands would be welcome.