OFCOM SPECTRUM REVIEW
June – August 2015

The EMEA Satellite Operators Association (ESOA) and the Global VSAT Forum (GVF) have the honour of replying to Ofcom's Call for Input (CFI) on their Strategic Review of Satellite and Space Science Use of Spectrum.

ESOA is a CEO-driven association representing satellite operators in Europe, the Middle East, and Africa; the GVF is a non-profit organisation headquartered in the United Kingdom with 200+ members from every major region of the world, representing every sector of the satellite industry. Together, they are the leading voices of the international satellite community.

More information about the associations is available from: **www.esoa.net** and **www.gvf.org**

ESOA and the GVF welcome Ofcom's CFI, and respectfully provide the following responses to Ofcom's questions.

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

Our joint response will concentrate on commercial communications satellite services, both GSO and NGSO, noting that this commercial satellite capacity is also increasingly being used by government & institutions for civil or military applications.

We take good note that Ofcom's "*analysis will not only consider the interests of UK citizens and consumers, but also take account of the international nature of the satellite and space science sectors. We will, for example, consider how international developments could influence demand, supply and the available options for mitigating imbalances between demand and supply.*"

ESOA/GVF note that the questions raised by Ofcom are essentially focused on looking for data about the number of subscribers to the services provided by our sector, and for figures essentially showing the net revenue by such services. However this approach does not acknowledge that satellite contributes to the establishment and resilient provision of critical and unique communication links that enable to fulfill the UK government policy objectives in the 21St century, e.g. cost effect and sustainable broadband for all, vital international links to other continents, global maritime and aviation communications, 2G/3G/4G mobile backhaul, humanitarian and disaster relief communications, SNG, etc. Although essential, these services are immeasurable in purely economic terms.[1]

[1] www.esoa.net/upload/files/publications/SAT%20Gatefold%20Leaflet%20V2.pdf.

Another concern ESOA/GVF and their members have is the difficultly to share highly commercial sensitive information and data to the level of detail which Ofcom seems to expect (e.g. in Q6 and Q7). Not only is this information sometimes unavailable to satellite operators (e.g. as regards the ground component of our satellite business), but our commercial contracts often make it explicit that such sensitive information not to be disclosed unless it is explicitly required by an empowered government authority.

Last but not least, ESOA/GVF remain seriously concerned that when comparing this call for inputs (CFI) with similar ones in other sectors, in particular the Mobile Data Strategy run in 2013-2014, Ofcom makes assumptions essentially based on the following credo: *Mobile has very important spectrum needs vs. Satellite has very limited spectrum needs*. A reading of the texts of the CFI documents reveals a bias[2] potentially detrimental to our sector. Although the CFI claims to "complement" the work being done in other sectors [1.9], its language is phrased as how to "mitigate" demand for satellite spectrum [*see* "About this document"], whereas the language in the 2014 "Mobile Data Strategy" Consultation is phrased as how to "facilitate" those services [MDS at 1.1]. This subtle difference in approach implies that Ofcom may have already decided that the use of spectrum by space-based services is somehow not as "valuable" to the UK as is the use of spectrum by terrestrial-based services. ESOA/GVF can only (and again) repeat that spectrum needs claimed by the Mobile industry are far from justified.

For example, observations were made from several independent experts that the spectrum demand resulting from ITU estimates is grossly exaggerated.[3] As extensively demonstrated and publicised for months, the inputs to the ITU model are fundamentally flawed, in that the model uses a series of inputs which are orders of magnitude (factors of 10 or in some cases 100 times) different from real world values. Some of these values, in particular *population density* and *data traffic*, are demonstrably excessive and are apparently based on the highest possible population densities experienced anywhere in the world. In addition, other factors such as *spectrum efficiency* are also based on unrealistic assumptions.

Several industry voices as well as highly respected academic sources have analysed and seriously questioned the mobile spectrum demand resulting from the projections made on this respect. To quote one of them: "*Our findings suggest the mobile industry contains much higher levels of inherent demand uncertainty than is commonly estimated and that business and governments may not be fully factoring it into their policy decisions."* [4]

Ofcom itself, often cited as a reference source of data on mobile communications, identified a significant error in the modeling of the UK mobile spectrum demand, reducing the assumed values for the traffic density by a factor of 1000.[5] Thus, without this correction, the UK spectrum demand

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[2] http://stakeholders.ofcom.org.uk/binaries/consultations/mobile-data-strategy/summary/MDS_Condoc.pdf (section 6.50 page 49).

[3] http://www.lstelcom.com/fileadmin/content/marketing/Press_releases/IMT_Spectrum_Requirements_Final_Report_v107.pdf.

[4] From Overestimating Wireless Demand: Policy and Investment Implications of Upward Bias in Mobile Data Forecasts, at: papers.ssrn.com/sol3/papers.cfm?abstract_id=2418364 & http://satellite-spectrum-initiative.com/files/Mehta%20Musey%20Overestimating%20Wireless%20Demand%20Study.pdf.

[5] Ofcom, Future Demand for Mobile Broadband Spectrum and Consideration of Potential Candidate Bands (2013), available at: http://stakeholders.ofcom.org.uk/consultations/cfi-mobile-bb.

estimates, which are sometimes used to support the results in ITU-R Report M.2290, cannot be considered credible.

Interestingly, this evaluation has now reached the general public: The Economist released an article in July that forecasts that over the next few years, mobile phones will switch to sending most calls, texts and data via Wi-Fi hotspots, relegating the cellular network to mere backup status. It also quotes some telecom mergers and acquisitions in the UK and the US to support that point.[6]

On this regard, although "*the focus of this review is on longer term strategy and not on the issues being considered at WRC-15",* as Ofcom states, it is clear that the developments in ITU-RR can have a strong impact on the spectrum made available to satellite services in the UK.

It is also important to have in mind that this CFI is built over the Ofcom Spectrum Management Strategy from 2013 (stakeholders.ofcom.org.uk/consultations/spectrum-management-strategy/). Ofcom has specified that they will *"make use of relevant responses to the SMS for this review, as some of those responses raised developments in the satellite and space science sectors in greater detail than was needed for the SMS* ." (footnote 2)

As a reminder, ESOA commented on the SMS in 2013[7] and already made all key points on applications, spectrum needs, international dimension, WRC priorities and mitigation / sharing issues at that time.

ESOA at that time highlighted the following points:

> "The nature of satellite makes its spectrum use characterised by three aspects:
> 1. Offloading & connectivity to 'Out of Reach'
> 2. Global dimension
> 3. Coexistence needs
>
> Satellite communications are used for a wide variety of services. These first include video and broadband to homes. Satellite is to play a key role in future mix of technologies to address these needs (...)
> On top of these services, satellite communications are playing an increasing role in bringing communications to mobile users. (…)
> Satellite communications also play a continuous role in providing backhaul, not only for mobile networks in countries outside Europe or for the international distribution of TV material from studios to transmitter sites, but also to broadcast signals to local Wifi or to small cell hotspots in SOHOs (e.g. SAT>IP) (…)
>
> ESOA has well noted Ofcom's recognition that: "*The development of residential broadband propositions based on satellite delivery could place increasing demands on available spectrum, notably around 28 GHz, if satellite broadband becomes a more important means of delivering fast broadband services in rural areas as well as on aeroplanes and ships*." ESOA has also well noted

[6] www.economist.com/news/business/21654602-wi-fi-first-technology-will-be-great-consumers-disruptive-mobile-firms-change.

[7] http://stakeholders.ofcom.org.uk/binaries/consultations/spectrum-management-strategy/responses/ESOA.pdf.

Ofcom's view that: "*In addition, demand for spectrum for DTH TV could grow in future with the development of HD and UHD TV services over the long term. Such a trend would be likely to change requirements for spectrum for downlink broadcast and their feeder links. However, it is also possible that more advanced video compression technologies and smaller beam technologies could be developed to increase the spectral efficiency of HD and UHD TV*." (…)

As already stated above, guaranteeing growth and coexistence without harmful interference amongst wireless services / users (e.g. in C-band 3400-3800 MHz, but also between FS and FSS in Ka-band such as in the 18 and 28 GHz bands) will become critical and should be considered one priority for Ofcom. This is not only an equipment standardization issue, it is also a licensing issue as well as an issue where appropriate regulatory mechanisms should exist to ensure a transparent dialogue between existing users and newcomers, with Ofcom's support and arbitration.

- Migration of commercial communications satellites or other space systems using the 18-31 GHz Ka-band should not be considered, as satellites have already been built and launched that will operate in that band for decades, for the provision of a broad range of domestic & international, fixed and mobile communications. Approaching UK £ 5-6 billion in Ka-band space segment and associated ground segment investment has already been made by satellite operators with UK Ka-band satellite network filings. ESOA strongly opposes such an approach by Ofcom.
- In particular, extension of satellite TV broadcasting use is expected to be "important" in the 18 - 31 GHz Ka-band within the next few years (rather than just "possible" and rather than "up to 55 GHz", as qualified by Ofcom), given the shortage in C and Ku bands."

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)?*

Ofcom has listed the following non-exhaustive satellite communication applications:

- DTH
- BB Internet Access
- M2M
- Commercial mobility (ships, aircrafts, land mobile)
- Corporate VSAT
- Disaster relief
- Emergency
- Navigation (GNSS)
- Distribution of broadcast content
- Contribution and Occasional Use (including SNG)
- Legacy telephony and carrier
- UAVs
- Feeder links / TT&C

Other applications identified by ESOA/GVF include:

- Backhaul for terrestrial mobile networks, e.g. 3G, 4G and 5G in the future

- Governmental / institutional closed-user groups
- Oil & Gas services at fixed locations
- Trunking for large enterprises
- Distance learning, telemedicine
- VoIP

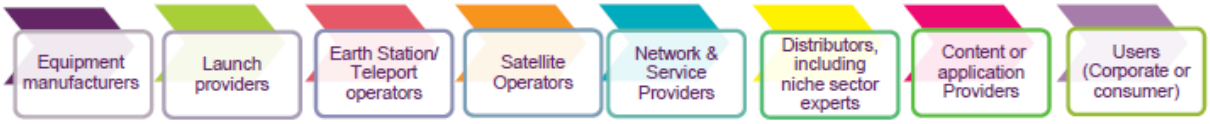
ESOA/GVF also have some comments on the Ofcom table below:

Table 1: Applications and corresponding services of the satellite sector

Application	ITU radiocommunications service(s)
End-user applications	
Direct-to-Home Broadcast TV	FSS, BSS
Broadband internet access	FSS
Machine-to-Machine (M2M)	MSS (including ISS) **Can be FSS also**
Commercial Mobility	MSS (including ISS), FSS[8], MMSS, AMSS
Corporate Networks	FSS (including ISS)
Emergency distress alert	MMSS (limited to the operation of the GMDSS), AMS(R)S
Navigation including location based	RNSS
Other applications	
Distribution	FSS, BSS
Contribution and OU TV	FSS, BSS
Legacy telephony and carrier	FSS
Telemetry, tracking and command	Space Operations, FSS
Military and government	FSS, MSS, ISS, MMSS (including the operation of the GMDSS), AMSS, AMS(R)S, RNSS

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?*

Figure 2: Satellite sector value chain



Based on this figure, it is important to highlight that UK's interests are to be driven by all components of this chain, considering that through Ofcom no fewer than 22 satellite operators have registered filings and the UK is the home country to satellite operators (e.g. Avanti, Inmarsat, O3b, Paradigm), network / service providers (e.g. , Bentley Walker, Highbeam, Europasat, Tigrisnet and many more) teleport operators (e.g. , GES Ltd operating Goonhilly & SMS Rugby, BT etc.), equipment manufacturers (e.g. ARM, Sematron, etc.), distributors (e.g. , Harris Caprock, Hughes, etc.), content providers (e.g. , BBC or Sky) and users (more than 12 million DTH households).

The current level of investment by 'UK filing satellite operators' in procured Ka-band satellite systems alone is worth several £billion e.g. Avanti has invested some £650M in building a fleet of satellites and establishing its resilient ground infrastructure, which includes it Gateway Earth Stations and Cloud based customer interface[8]; O3b has invested over £850M in a global constellation of 12 satellites, 9 gateways, and an increasing number of customers in remote and isolated communities;[9] including both its current and future Ka-band broadband satellites, Hughes has invested more than £575M

ESOA membership is made up of Satellite Operators (in some cases, Satellite Operators are also service providers), Equipment Manufacturers & Launch Providers.

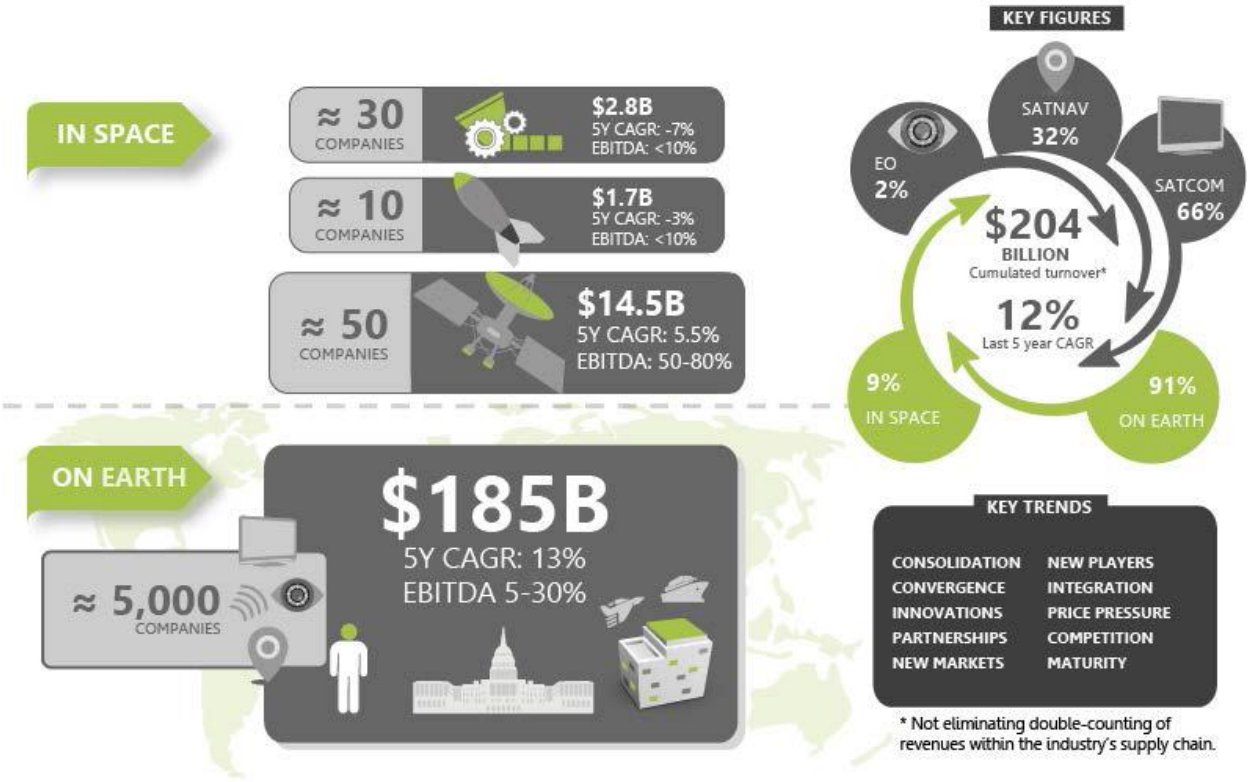
The GVF's 200+ members represent every sector of the satellite industry, including fixed and mobile satellite operators, satellite network operators, teleports, satellite earth stations manufacturers, system integrators, value-added and enhanced service providers, telecom carriers, consultants, law firms, and users.

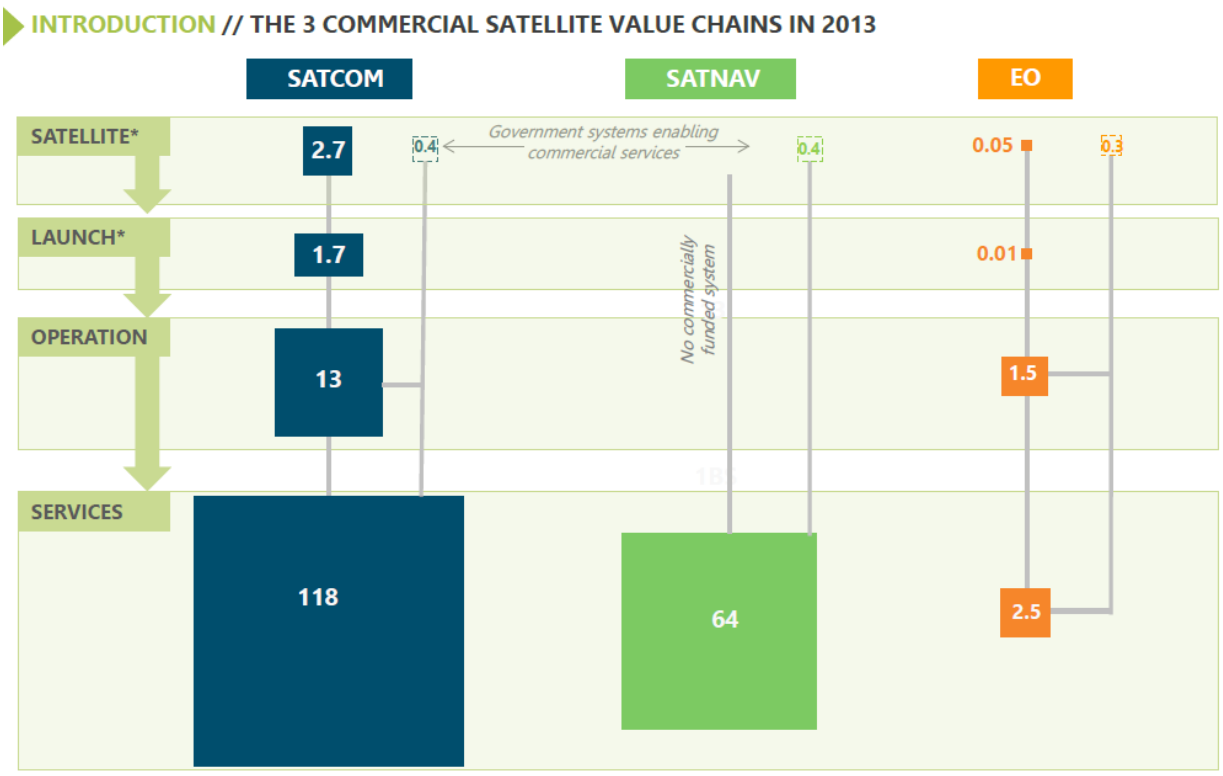
In terms of respective revenues of these elements of the value chain, ESOA/GVF invite Ofcom to examine the 2014 Euroconsult study on "Satellite Value Chain - The Snapshot"[10] which these two diagrams below are extracted from. These figures clearly show that most of the value comes from the Earth component (ground equipment and services), and Satellite Communications is by far the larger segment of the satellite industry in value terms.

[8] www.avantiplc.com/sites/default/files/avanti-results-presentation-h1-2015.pdf

[9] www.o3bnetworks.com

[10] www.euroconsult-ec.com/shop/satellite-communications/63-the-satellite-value-chain.html





(Figures are in US$bn)

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.

ESOA/GVF note that their individual members will provide more detailed answers to this question.

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 this may be relevant to UK use.

ESOA/GVF members may provide more specific information on their spectrum usage in response to this question. In general the main commercial satellite bands are used as follows:

L-band/S-band	1518-1559 MHz 1610-1626.5 MHz 1626.5-1660.5 MHz 1660-1670 MHz	Used for MSS systems, using low earth orbit and geostationary systems.
S-band	1980-2010 MHz 2170-2200 MHz	Being brought into operation by two operators in Europe selected through the EU selection process. Systems may include complementary ground components (CGCs)
C-band	3400-4200 MHz 5850-6725 MHz	Used for intercontinental links and links with high reliability requirements

		(including broadcast distribution, TT&C, feeder links for MSS systems)
Ku-band	10.7-12.75 MHz 13.75-14.5 GHz	DTH TV, VSAT systems, MSS feeder links
Ka-band	17.3-17.7 GHz	Feeder links for BSS
Ka-band	17.7-20.2 GHz 21.4 – 22.0 GHz 27.5-30 GHz	High Throughput Satellites, or "high density FSS", for broadband Internet connectivity for fixed and mobile satellite terminals, MSS feeder links, DTH and converged media services
Q/V band	37.5-43.5 GHz 47.2-50.2 GHz 50.4-51.4 GHz	Test and development applications. Likely to see use for feeder links and super high throughput satellites in the future for user terminals and gateways

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).*

The Space sector contributes £11.3 billion a year to the UK economy and has been growing at about 7% each year throughout the recession according to the UK Space Innovation and Growth Strategy (IGS), initiated in 2010 and refreshed in 2014. The same IGS is targeting a fourfold growth in the sector by 2030, to drive up the UK's share of the global space market to 10% over those two decades. ("A Space Innovation and Growth Strategy 2010 to 2030", UK Space, 2010[11] and "Government response to the space growth action plan"[12]). The space sector has been recognized a pillar for future growth by the UK government given its characteristics of high innovation & workforce qualification.

The sector also supports thousands of jobs as a direct result of its activities, with employee productivity more than four times the national average. It consequently contributes some £145,000 per worker to UK GDP. Significantly, both manufacturing and operations are capital intensive and require highly skilled people resulting in graduates filling nearly two-thirds of all jobs.

Ofcom on June 25, 2015 published its assessment and action plan for broadband services for SMEs in the UK[13], which was identified as an area to focus on the broadband market which is currently under delivering superfast broadband connectivity. Ofcom's analysis shows that by 2017 18% of SME premises will not have access to superfast broadband, contrary to 95% of consumers who are due to access it.

Private sector intervention such as broadband services via Ka-band delivery is required to ensure that all SMEs and households are able to access superfast broadband and to fill the gaps to address the hardest-to-reach areas for delivering superfast connectivity to all.

[11] http://www.parliamentaryspacecommittee.com/media/publications/Space%20IGS%20Main%20Report.pdf.

[12] https://www.gov.uk/government/publications/government-response-space-growth-action-plan.

[13] http://stakeholders.ofcom.org.uk/binaries/research/telecoms-research/sme/bb-for-smes.pdf.

Satellite DTH coverage in the UK is in excess of 99% according to the Digital satellite Coverage Study Group from 2000 and the trial undertook by BSkyB at the same time.[14] Cleary, Satellite enables delivery of TV to virtually all households in the country or elsewhere in Europe and the rest of the world.

The same applies with Satellite broadband services which are, or can be, delivered in all locations over Europe, Africa or Middle East, including the most remote rural areas or islands.

In addition, satellite has enabled the availability of a multiplicity of HDTV channels all over Europe, including in the UK, due to high capacity throughput dedicated to broadcasting services, and satellite is now pioneering the delivery of Ultra-HD video content that requires extensive capacity and more spectrum.

Commercial mobility: This application allows UK citizens to stay connected to their work and family when travelling or when working at sea (e.g. cargo vessels) and on aircraft. The recent developments of this application in the satellite industry has allowed for broadband type experience for travellers where previously no broadband communications was possible.

Corporate networks: This allows UK companies (e.g. BP) to operate worldwide and remain connected to retail sites (e.g. gas station) as well as remote offices. Satellite communications is essential to the oil, gas and mining industry, in which UK companies play key roles.

Distribution and contribution: Satellite distribution and contribution of TV is essential to the operations of the BBC, and has allowed the BBC to provide worldwide news and entertainment services, being able to keep citizens informed throughout the entire world.

Military and government: Satellite applications allow tactical coverage of conflict zones. Also, satellite links provide for much needed welfare for British troops that are stationed overseas, allowing them to stay connected to their families, and allows them to follow for example, their national sports team like the rest of the UK population can back home.

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

ESOA/GVF have listed the following non-exhaustive list:

- Universal delivery of TV services in digital and HD formats (in Central & Eastern Europe, in Africa)
- Deployment of Ultra-HD video services (in Europe, Middle East)
- Development of hybrid broadcast – broadband platforms based on a mix of satellite and terrestrial services (e.g. Sat>IP, Sat-LNB, HbbTV) all over EMEA
- 3G, 4G, and even 5G utilisation of HTS technology to provide Mobile backhaul services via Ka-band satellite systems providing a primary connectivity for base stations in poorly served or are under-served by terrestrial links in developed and developing regions.

[14] See ref to the Rutherford study at http://www.ofcom.org.uk/static/archive/itc/uploads/bskyb.doc.

- Development of High-Throughput Satellite (HTS) services (50+ Mbps two-way connectivity) all over EMEA
- Increasing reliance of governments & institutions on satellite communications for reliable, secure and resilient services all over EMEA
- Continued and increasing connectivity needs for backhaul services & corporate VSATs in Eastern Europe, Africa & Middle East
- Additional NGSO satellite systems providing broadband throughout the globe

The continued sustainable growth in such trends for the services in the above list would be severely affected if regulatory uncertainty is created within the spectrum used by satellite services and satellite spectrum needs are not carefully taken into account.

Ofcom suggests in this CFI that the demand for some satellite applications might decline, due to improvements to the coverage and quality of terrestrial services. We highlight to Ofcom that within its own assessment for broadband services for SME's in the UK which was published on June 25, 2015[15] that the following was highlighted by Ofcom:

- By 2017 18% of SME premises will not have access to superfast broadband via terrestrial means;
- This low availability is due to higher than average costs of deployment (provided by terrestrial technology)
- Terrestrial technology alone will not fill gaps where the market alone will not deliver superfast broadband, despite current investment and intervention through the connection voucher scheme
- Ofcom's research has found that there is dissatisfaction with the services.

On the other hand and over the next decade, demand for Ka-band satellite capacity is expected to grow both within UK and outside the UK. Communication applications including trunking and cellular backhaul services, broadband access, enterprise networks and government communications will demand more Ka-band capacity, opening up new satellite possibilities. We are seeing Mobile Network Operators (MNOs) in both developed and high growth economies facing many pressures to expand their network into sub-urban, rural and remote locations, and only satellite technology can provide this service cost effectively and on a sustainable basis, since satellite costs are independent of terrain and distance.

As a consequence, ESOA/GVF consider that almost all of the commercial satellite services applications listed above are likely to enjoy significant increases in demand leading to increasing spectrum needs. Even though we anticipate that greater use will be made of the higher frequency satellite bands in the future to address future demand, we do not anticipate a reduction in use in any band.

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?

[15] http://stakeholders.ofcom.org.uk/binaries/research/telecoms-research/sme/bb-for-smes.pdf.

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).

In addition to the elements noted above, the following points are critical:

Mobility: The greatest trend is to be connected at all times in all places. Space-based satellite services may be the surest way to provide that in the UK and the rest of the world. (UK citizens will want to keep their connectivity when they travel – perhaps even more so when they are away from home.) Satellite services will also continue to become increasingly important for car connectivity, PPDR, M2M, utilities and disaster response and recovery. The always on nature of data communications to provide updates and other important information to user terminals and the like, require multiple forms of communications links, with MSS being particularly useful for mobile applications in hard to reach locations, and FSS ESOMPs being increasingly used as well.

Broadband, as Ofcom noted, goes hand-in-glove with "mobility" so that consumers and businesses can complete their business and entertainment anywhere, anytime.

Convergence is another obvious trend. Distinctions between "FSS" and "MSS" for mobile services and between terrestrial and space-based allocations for fixed and mobile services are becoming less significant as technological advances find ways to merge the services.

"Non-geostationary" – the new satellite systems being announced are all non-geostationary, whether in medium Earth orbit (MEO) or low Earth orbit (LEO). This is because the lower orbit reduces latency, and allows the satellite systems to be used for interactive applications, possibly directly to the end-user.

On-demand video usage (e.g. OTT services Netflix or YouTube) is growing rapidly but is still relatively limited in absolute terms (In 2013 in the UK, OTT services represented 8% of total media consumption[16]). Even so, it is already a critical challenge for Internet networks: in Europe,[17] real-time video represents 42% of Internet traffic at peak hours, with 25% generated by YouTube and Netflix alone (resp. 67% and 50% in the USA). As the tide of video content flowing through the Internet continues to rise, the risk of streaming interruptions, inadequate picture quality and other poor experience issues will increase. The risk of a new video digital divide is also raised as service providers concentrate their infrastructure investment in areas with higher population density.

[16] Ofcom 2014 report

[17] Source: Sandvine Global Internet report 2H 2014

These trends lead to the following challenges:

- More stress on the last mile:
  - ➔ If High Definition quality TV and video content were only provided through the Internet each home would need a 30 Mbps[18] connection. For Ultra HD the requirement increases to 50 Mbps.
  - ➔ The reality is that we are very far from these levels of speed: homes in Europe currently have a measured average speed of 8.7 Mbps.
- A new digital video divide on the way:
  - ➔ Based on current figures[19], 38% of European homes are currently not in the reach of Next Generation Access services (i.e. 30 Mbps connection or more), meaning they are excluded from High Definition quality TV and video content and may be excluded for a long time.
  - ➔ The exclusion zone is higher for Ultra-HD: 75% of Europe's population is not in the reach of a 50 Mbps connection.
- More stress on the network:
  - ➔ Full OTT video consumption with HD quality would require 700 GB per month per home. Ultra HD consumption would require 2.2 TB per month.
  - ➔ This is 35 to 100 times the current average consumption in Europe i.e. ~20 GB a month[20].

A number of features point to "Broadcast" as a continuing key pillar:

- Aligned with mass-market habits: the majority of video content (live and catch-up) is consumed by most viewers in a very short timeframe (few days). Broadcasting, complemented by local storage, is particularly efficient from quality and cost perspectives for managing consumer trends.
- Bandwidth: a single satellite video neighbourhood can deliver up to 6 Gbps of broadcast video content with guaranteed and ubiquitous high quality.
- Multi-screen compatibility**:** as 80% of tablet viewing time[21] already takes place in the home, tablets can access broadcast-delivered live and On-Demand content.
- Ubiquitous service: ability to reach the broadest population with a constant and uniform quality.

A hybrid solution that combines satellite for linear television and non-linear high-demand content, with terrestrial broadband for interactivity and long-tail catalogue, will therefore contribute to meet the demand for video services in delivering state-of-the-art High Definition quality TV and video content

[18] Source: based on 3 concurrent HD streams. 20 Mbps sustainable correspond to ~30 Mbps advertised speed.

[19] Source: Digital Agenda Scoreboard 2014.

[20] Source: Sandvine 2014

[21] Source: Google/TNS

everywhere, including in geographical areas where fast broadband (viz. > 30 Mbit/sec) Internet connectivity remains limited or is unavailable.[22]

High throughout Satellites (HTS): Ka-band provides higher data throughput using higher frequency range and spectral efficiency carrying large data capacity with Lower cost/MB produced relative to competing offerings. HTS satellites can today deliver data rate services (> 100 Mbits/s – 1 Gbit/s) in 'broadcast / multi-cast' mode to small radio access points, and trunking applications can deliver >1.6 Gbit/s to large terminals (such as for MNO backhaul). By 2020 - 2025, HTS satellite systems can deliver (>1 – 10 Gbit/sec) services and will require sustainable and viable spectrum access to deliver existing and planned services. Some key advantages in higher frequency ranges of FSS satellite services is the high spectral efficiency which enables large data carrying capacity (Ka-band wide transponders (300–600 MHz) with a low-cost per MB produced.

Current HTS customer segments are as follows:

- Broadband: Enterprises / consumers where fast terrestrial broadband is not available;
- Carrier Services: Primarily connecting mobile phone base stations to core networks;
- Enterprise: High bandwidth broadband connections to link remote offices or businesses with machine-to-machine data communications needs;
- Government: Defence and security, schools, healthcare and regional government office.

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.*

Satellite players count on the continued long term availability of *existing* ITU primary allocated or co-primary allocated satellite spectrum to MSS, FSS and BSS in L, S, C, X, Ku, Ka and future Q/V-bands to enable the continued development of new innovative satellite systems capable of offering a wide range of advanced MSS / FSS / BSS services. Any suggestion of sharing studies within these bands would help create regulatory uncertainty which in turn would help create a negative environment for investment and would severely affect the continued sustainable growth in such spectrum bands.

ESOA/GVF and their members consider a key priority is the continued sustainable and viable spectrum access to MSS, FSS and BSS to deliver existing and planned services. The satellite industry is growing and requires full access to the spectrum it currently has access to and additional spectrum in the next few years. Existing satellite spectrum allocations must be protected, along with higher spectrum bands that have been identified for future satellite services. It is imperative that the needs of the satellite communications industry for viable access to C-band, Ku-band, Ka-band and future Q/V-band spectrum as allocated by the ITU to satellite services must be considered and addressed by Ofcom.

[22] More information available from: www.esoa.net/upload/files/publications/ESOA%20-%20Position%20Paper%20Hybrid%20HDTV%20Solutions.pdf.

Satellite players also seek access to *new* primary or co-primary ITU frequency band allocations to support the development of new and expanded satellite services. A key goal is to obtain at ITU WRC-2015 additional co-primary spectrum at X-band and Ku-band for FSS use. In addition, there is currently a proposal to the ITU for additional FSS spectrum which is critical to meet burgeoning demands of consumers for high throughput and similar services.

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?*

To address future demand for satellite services, Ofcom has highlighted in their consultation document (para 4.14):

1. Smaller beams to re-use frequency bands
2. New transmitter & receiver technologies
3. Increasing sharing efficiency
4. Change satellite network parameters to e.g. reduce orbital separation
5. Better coordination between satellite networks to avoid paper satellite
6. Make additional spectrum available in higher frequencies or "repurposing spectrum from other, lower value uses"

On 1 (small beams), spectrum re-use via spot beam architecture allows satellites to expand available capacity and reduce the transmission and equipment costs. Early satellites systems had wide downlink beams giving global or hemispherical coverage, so it was almost a case of one satellite per slot, and at 2 degrees spacing that would be 180 satellites in total. By employing frequency reuse such as in Ka-band satellites (using either linear or circular polarisation discrimination), a satellite can utilise up to the full 500MHz of traditional satellite bandwidth twice, giving a maximum capacity of 1GHz in a beam.

New small beam technology allows for the same frequencies to be used multiple times on the same satellite, giving a significant increase in the overall spectrum efficiency. This is one example of where satellite manufacturers and operators have made major investments in new technology to maximize the efficiency with which satellite spectrum is used. While further technology improvements can be expected, this will reduce the cost per MHz while also reducing equipment cost. This will also likely translate to more demand from consumers in different applications that can be served by such satellite technology which will nevertheless not reduce the demand for viable access to the spectrum used by such satellites.

On 2 (new receiver technologies), Ofcom is considering that "the introduction of receiver performance into the standardisation process for new and existing standards, and hence may facilitate greater spectrum sharing between different users in the future" (para 1.10) and "innovative and more spectrally efficient waveforms, better compression techniques and techniques to filter out unwanted signals" (para 4.14).

Satellite operators are always keen to introduce innovation and rely on state-of-the-art ground equipment. However, there is a critical legacy on receive-only terminals used as TVROs in the UK which are susceptible to interference from high-power and / or ubiquitous terrestrial services.

ESOA/GVF note that Ofcom has acknowledged this situation:

> "Whilst receivers with poor selectivity do not have rights to protection in the face of changes in spectrum use around them, spectrum policy needs to take account of the realities of pre-existing deployments, particularly where equipment is deployed in large numbers (for example, consumer SRDs or DTT receivers) or in safety of life applications (e.g. air traffic radars, Cospas Sarsat) or in cases where mitigation is impractical once costly deployments have been made (e.g. satellites). In these circumstances, it may be more effective to reduce the risks of future coexistence challenges by securing better receiver performance before widespread deployments have taken place. " (Statement on SMS, April 2014 - para 4.54)

It should also be kept in mind that implementing such protection is likely to be costly, and it may not guarantee effective protection against too powerful wireless systems.

On 3 (sharing), it is to be reminded that all satellite operators have shared spectrum with fixed terrestrial systems in several different bands for years, based on appropriate coordination. As noted recently by the UK Spectrum Policy Forum, globally, even though space services have primary allocations totaling 30% of all sub-3GHz spectrum, 65% of spectrum between 1GHz and 10GHz, and 82% of spectrum between 1GHz and 100GHz, only 3% is available on an exclusive basis for space/satellite services; and between 3GHz and 10GHz, no spectrum is allocated on an exclusive basis. Most commonly, allocations are shared with fixed and/or mobile terrestrial services. (UK spectrum usage and demand, March 2015 – UK Spectrum Policy Forum[23]).

Furthermore satellite operators already share these frequencies between them, by entering into carefully assessed coordination agreements, employing precise orbital spacing, coordination and directional antennas to avoid interference into each other. Satellite operators have developed a complex and functional framework to effectively utilise the same frequencies covering the globe.

Further, sharing or coexistence possibilities have been explored in several bands used for satellite communications. High density mobile service (2G, 3G, 4G and theoretically 5G) involving ubiquitous deployment of mobile terminals and base stations has put significant constraints on sharing with any other services. ESOA/GVF are not aware of any successful spectrum sharing on a sustainable basis between this mobile service and the satellite service.[24]

In C-band, for instance, several studies have been conducted to explore the latest ITU-R studies related to the bands 3400-4200 MHz and 4500-4800 MHz that can be found in the Draft New Report ITU-R [C-BAND DOWNLINK]: "Sharing studies between IMT-Advanced systems and geostationary satellite networks in the fixed-satellite service in the 3400-4200 MHz and 4500-4800 MHz frequency bands in the WRC study cycle leading to WRC-15"[25] (have concluded that FSS and IMT are not compatible. The entirety of this ITU report (including assumptions, modeling, results etc.) was not only agreed by all the

[23] Available from: www.techuk.org/insights/reports/item/3773-uk-spectrum-usage-demand-first-edition. This was made in reference to Ofcom's publications.

[24] The case / situation is different when the mobile service is a CGC that is treated as an integral component of MSS under the full control of a same and single operator.

[25] See Rev.1 to document 5/126: www.itu.int/md/R12-SG05-C-0126/en.

JTG participants but also by Study Group 5, the ITU expert group on terrestrial services, in November 2014.[26]

In Ka-band, the CEPT has studied the possibility of using the 27.5-29.5 GHz spectrum for ubiquitous FSS terminals using satellite Space-to-Earth communications to ensure further deployment of FSS services in this band, following the adoption of the Ka-band report on "THE USE OF THE FREQUENCY BANDS 27.5-30.0 GHz AND 17.3-20.2 GHz BY SATELLITE NETWORKS".[27] There again, it's been made clear that sharing spectrum for a mass market of users would practically be *not* feasible. In fact one must argue that Ka-band satellite systems need sustainable and viable access to spectrum to deliver existing and planned services.

On 4 (Change satellite network parameters to e.g. reduce orbital separation), ESOA/GVF don't see any prospect of a significant reduction in orbital separation, particularly while the trend is towards smaller earth station antennas.

On 5 (Better coordination between satellite networks to avoid paper satellite), steps to prevent paper satellites are certainly welcome and could improve efficiency use of the geostationary arc. In general, the approach in dealing with such issues is through the WRC agenda items as probably the best way.

On 6 (using frequencies in different bands), it should be reminded that preferences for use of one frequency over another are determined by a variety of factors. Different regions of the world and different types of service (DTH, Broadband, etc.) have differing frequency allocations, depending on pre-existing services and the equitable, interference-free sharing of bands with other services. In some cases, such as C-band, large coverage areas are required for long-distance or regional communications (*e.g.,* backhaul, international links, point-to-multipoint broadcast distribution). UK customers of satellite operators use C-band to provide services into Asia, Africa and Latin America, particularly into equatorial regions. C-band also enables coverage of almost one third of the Earth with a single beam. A customer with sites all over Africa can use one broadcast outbound carrier to cover all sites, reducing costs of having to uplink onto multiple beams. Weather may also play a determining factor in whether or not to choose a certain band. For example, customers serving areas of high rain or snow fall demand C-band as it is more resilient to interruptions due to precipitation.

It should be highlighted that, in the same vein, the Mobile terrestrial sector has also identified different bands for different needs. Clearly, the coverage needs for deploying 3G/4G networks has called lower frequency bands whilst 5G spectrum needs for very high capacity links that require large contiguous bandwidth naturally leads them towards mmWave bands in higher frequencies above 31GHz.

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.

[26] See also ESOA's views on the most recent Plum & Huawei studies on sharing in C Band from: www.esoa.net/upload/files/publications/C%20Band%20rebuttal.pdf.

[27] ECC Report 152 of September 2010

The Space Innovation and Growth Strategy 2014-2030 asked that "*Ofcom should prioritise the interests of UK satellite operator companies creating wealth, employment and taxes in the UK, in matters related to access to international satellite spectrum allocated by the International Telecommunication Union (ITU), treatment of satellite network filings by the UK to the ITU and to framing of international satellite regulations at the ITU"*.

To which Government agreed that "*Ofcom will continue to develop its approach to satellite and spectrum issues in close consultation with the UK space industry*". We therefore encourage Ofcom to ensure sustainable access and protection for existing and planned satellite services (e.g. FSS, MSS, BSS) and space services and urge Ofcom to adopt and promote spectrum management and use policies which do not fundamentally jeopardise the viability of existing and future use of ITU satellite service allocations by satellite and space services within the UK and internationally at the ITU and in EU/CEPT levels.