Dear Sir,

Please find below the UK Space Agency response to the fixed links spectrum review consultation. As there are a very large number of questions with many not immediately relevant to satellite systems, we have concentrated on responding only to those questions that we believe will have a direct bearing on space related applications. Therefore only questions 1, 5, 11 and 16 are addressed; the rest should be regarded as “no comment”.

The MET Office may be better positioned to comment on the requirements of the Earth Observation community so these aspects are also not commented upon here.

The bands noted in the consultation that are directly shared with space communications systems are “4GHz”, “5.8GHz”, “Lower 6GHz”, “Upper 6GHz”, “7.5GHz”, “13GHz”, “18GHz”, “23GHz” and ”38GHz”. This is a large proportion of the fixed link bands noted in the consultation. This reflects the compatibility between the services that has allowed sharing. Changes of use to, for example mobile systems or high density fixed links are likely to cause significant interference to satellite systems unless suitable sharing arrangements can be developed, we therefore welcome this opportunity to comment.

Regards

Dr Mike Willis

Head of Spectrum Policy, UK Space Agency

Question 1

What are likely to be the key underlying factors influencing changes in demand for this spectrum (in terms of quantity of spectrum or preferred bands) over the next 5 to 10 years? Please provide band specific evidence to support your view.

One of the issues that differentiate satellite systems from terrestrial systems is the development/deployment/operations timescale. This question illustrates that regulators in only looking forward 5-10 years, may not be fully recognising this. A minimum of 20-30 years is needed for space delivered services. For example, Ka band (~17-32GHz) geostationary Very Small Aperture Terminal (VSAT) systems have been in active development since the 1980s. They are only now taking off as a mass market, e.g. Ka-SAT, HYLAS-1 and are expected to feature significantly in enabling UK policy to provide broadband internet access to all citizens wherever they are in the UK. This band is also proposed to provide broadband services to mobile platforms. Meanwhile, in 2008 the UK auctioned part of the Ka-band spectrum around 28GHz intended for un-co-ordinated satellite terminals to terrestrial Broadband Fixed Wireless, making it harder for the now emerging ground stations to deploy as evidenced by recent discussions within CEPT over Earth stations on Mobile Platforms. This spectrum can be retrieved in 15 years but that may be expensive if there is significant terrestrial use. Regulators need to look much further ahead.

Demand for space services is likely to increase in all bands. There is a general move up in frequency for high capacity use but this is ultimately constrained by atmospheric losses. The main drivers for increased spectrum are likely to be high definition and 3D broadcasting, satellite broadband and satellite mobile, (including services to aircraft). This covers the “4GHz”, “5.8GHz”, “13GHz”, “18GHz”, “23GHz” and ”38GHz” bands.

1.4GHz

The new European GNSS, Galileo which is in the process of deployment uses additional spectrum (compared to GPS) adjacent to the “1.4GHz” band. GPS receivers have been shown to suffer interference from adjacent band users and changes at “1.4GHz” may affect Galileo. Future proposals to use spectrum at 5.01-5.03GHz will partly to overcome the interference problems at the lower frequencies, though this is a long term plan and the timescales and spectrum allocation are out of scope here.

4GHz

This is a primary fixed service and fixed satellite service band. Mobile only secondary in this band and must not cause interference, so demand for mobile services is likely to be limited by international agreements. The band has been identified for 4G services but is very much used in developing nations for satellite downlinks and interference has apparently already occurred. This was reported in a paper to the ITU news magazine [2007, Issue 8] by José Albuquerque, Senior Director, Spectrum Engineering, Intelsat, “Satellite operators challenge mobiles’ use of C-band” with a conclusion that “satellite operators are of the view that the frequency bands 3 400–4 200 MHz and 4 500–4 800 MHz (C-band) should not be identified for use by IMT systems, either globally or regionally.”

5.8 GHz

This band is allocated on a primary basis to fixed satellite and radiolocation. It is not allocated to point to point fixed links so we are not sure why it is covered in this review. The band is lightly used in the UK, it is a satellite uplink band but used less than the immediately band above due to the difference in allocation between region 1 and regions 2 & 3. In the UK parts of the band are used for WiFi, “Band C”, under a light license on a non-interference basis.

Lower 6 GHz and Upper 6 GHz

This spectrum is used for c-band satellite uplinks. C-band is used less in the UK than in other countries but it is still an important band, especially for developing countries where use is increasing and countries in the tropics that experience extremely heavy rain. The antenna onboard satellites tend to cover large areas of the globe including the UK. UK use can not therefore be isolated from use elsewhere in the world. There is also the potential for an extension of the 7.25-7.75 GHz FSS downlink band to include for 7.15-7.25GHz through a WRC-15 agenda item. Sharing studies undertaken in support of that agenda item will need to be aware of changes in the use of the bands at an early stage.

7.5GHz

Space science use of S-band (2-2.3GHz) for TT&C has now saturated and links are moving to x-band (7.9-8.4GHz) which is also likely to become saturated due to the greatly increased data transfer needs from higher resolution sensors, particularly imagers and radars. This congestion causing a move to Ka-band but an extension of the existing allocation is possible.

The MET Office may be better positioned to comment on the requirements for METSAT use. We are not able to comment on MOD use.

13GHz

The band 12.75-13.25GHz is allocated to FSS Uplinks. Even though parts of this band may not be extensively used in the UK, many satellite footprints do cover the UK so interference to FSS uplinks from other nations is possible and consequently care needs to be taken over the types of services licensed to use this band.

18GHz

Satellite use of this part of the spectrum is increasing rapidly, with Eutelsat Ka-SAT, Avanti HYLAS, SES Astra 3B, all launched since 2010 with Ka-band transponders covering the UK and using the 18.1-20.0GHz Downlink band. Inmarsat have announced 3 new Inmarsat-5-series will all carry Ka-band transponders from 2013. The 19.1-19.6GHz segment is used by the Iridium satellite constellation for links to satellite gateways, though none of these are in the UK.

23GHz

This is adjacent to a water resonance line vital to EO operations and to space research – The MET Office may be better positioned to comment on the requirements for this band.

38GHz

This band is the next step to provide additional bandwidth once the Ka band becomes full. ESA and Inmarsat have developed Alphasat due to launch this year which will carry a Q-V Band communications experiment to assess the feasibility of using the band for future commercial applications. Noting the long development cycles of the space industry and the development of Ka band, demand is unlikely in the next 5-10 years but highly likely in the 20-30 year time frame.

Question 5

(a) What are the main factors (technical or regulatory) that determine preferences for one band over another for satellite applications? Do these factors vary between different types of satellite applications (Mobile, Fixed, Broadcasting and Science services)? In which bands will we see the most significant changes in demand in the next 5 to 10 years, and why?

Choice of Band

For many satellite systems the band choice is a compromise between antenna size, onboard technology and propagation. The band choice is constrained by regulation due to the necessity to share with other spectrum users.

For geostationary systems, the higher frequency bands carry advantages in antenna directivity which means smaller antennas can be used and/or orbital slots can be closer together. However rain fading, gaseous absorption and RF power generation technology tend to limit the utility of the very high frequency bands. Geostationary satellite systems therefore have a “sweet spot” within the 3-30GHz range. Geostationary applications are varied but in this range include broadcasting, data services including broadband to remote areas, satellite news gathering and high power feeder links.

Non-geostationary systems require tracking, which becomes increasingly difficult as frequency and antenna size increases. Mobile systems often rely on omni-directional antennas on the ground supported by spot beams on the spacecraft. Therefore non-geostationary satellite systems often prefer the lower bands below 6GHz, typically 0.1-3GHz. The exception to this being mobile feeder links where high bandwidth is needed and relatively only a few expensive tracking stations are needed, inter satellite links which are constrained by antenna size and are not troubled by atmospheric impairments, and EESS systems and some science missions which make use of very large earth stations.

Space based services are global in nature, therefore standardisation of the ground and space segments and the use of the spectrum by other services is important. It is often not practical or beneficial for the UK to go in a different way to the rest of the world in regulating satellite bands.

Demand

The introduction of high definition and 3D is likely to increase the spectrum needs for DTH satellite broadcasting, feeder links and SNG. There is a large user base and expansion around the current Ku-band allocation is most likely with more use also at Ka band for DTH TV and demand for more spectrum for BSS feeder links. Spectrum demand for satellite return channels is also likely to increase, though the deployment of satellite based broadband may supplant this. UK industry is currently investing heavily in Ka band capacity in order to provide broadband to small terminals.

(b) A number of the frequency bands under review are currently used for satellite Permanent Earth Stations (PESs), for example to feed Direct to Home satellite broadcast services. What are the continued and future spectrum requirements for satellite PESs (E-s & s-E) likely to be and in which bands? Please provide evidence to support your views.

The continuing and further demand for DTH satellite broadcast services is demonstrated by the growth in transponder capacity announced by SES, Eutelsat and Intelsat, who are all investing in next generation satellites with enhanced capability, e.g. Astra 2 E/F/G each have 55 Ku-band transponders requiring corresponding uplink capacity. The current allocations are congested, especially for the uplink and in recognition of this item 1.6.1 in the WRC-15 agenda will consider an additional primary allocation to the fixed-satellite service of 250 MHz in the range between 10 GHz and 17 GHz in Region 1.

(c) During recent years, some commentators have forecast significant demand for spectrum to support satellite consumer terminals. To date this demand has been slow to materialise. Do you have information which would help inform a more accurate assessment of future demand for spectrum in bands currently shared with fixed links?

It is taken that this question refers to terminals that both transmit and receive. Demand for these services is now building. There are now several satellites in Geostationary orbit serving the UK with broadband. These satellites are using spectrum at Ka-band to provide internet access to areas without good terrestrial coverage and are a key item in UK broadband policy. It is notable that the new generation satellites being launched by the key industry players referenced above all include Ka-band transponders and Avanti in the UK have recently launched one Ka-band satellite and have raised capital to fund to two more. This band is shared with fixed links and it is unlikely such investments would be made if the operators did not intend to make use of them in the near term. Avanti are investing in their UK ground segment and this is being supported by regional development grants, particularly in the Southwest at Goonhilly Earth Station. The Department of Business, Innovation and Skills has recently awarded a grant of £1.1 Million in support of developing a rugged and lightweight portable Ka-band satellite terminal.

Demand is expected to increase. The current proposed satellite capacity will provide high peak data rates to rural users but this capacity is shared. If all rural users predicted to be served via satellite were to try and access the resource at the same time, the data rates will drop to speeds similar to dial up. As there service develops, there is likely to be additional demand for spectrum and geostationary slots.

(d) Are there factors specific to the satellite based communications sector which mean that it faces particular difficulties evidencing and satisfying demand for spectrum? If so, how might these be overcome?

Space systems traditionally have very long development cycles. They also have long life cycles due to the high cost launch and hardware. This means that future spectrum demands need to be determined many years in advance of a service deployment. A long view needs to be taken when managing spectrum that will be used by satellite communications.

As an investment in a new satellite communications service or facility cannot be made without a guarantee of future access to suitable spectrum. This applies to both space and ground segment. Satellite spectrum allocations are reserved through the ITU satellite filing system. Previously this system had several failings that lead to speculative filing that has made access to orbital slots especially difficult for new entrants. Allegations have been made that incumbent operators were able to play the system to their own advantage. Many of the problems were corrected at WRC-12 where the UK, through Ofcom took a lead in this activity. It is hoped Ofcom will continue to work to improve the system.

New spectrum allocations are developed through the ITU WRC process. If the UK space sector is to continue to expand the UK will need to put more resources into the ITU-R teams representing satellite communications interests. We would like Ofcom to continue to consult with industry and take account of industry views as well as those of citizens and consumers, and to continue to support UK interests in ITU activities related to space.

Co-ordination between the fixed service and the satellite service ensures mutual protection from harmful interference. Ground station co-ordination, if needed will become more difficult as the number of sharers increases. A change of use in fixed links spectrum, for example to a high density fixed network, may be managed through exclusion zones around existing ground stations and around known proposed ground stations. This co-ordination may prevent the use of license exemption for devices using shared bands. It is not clear how new ground stations could be introduced if they require new exclusion zones.

The default principle in the UK is that new spectrum awards should be satisfied through market mechanisms. This is a difficult process for the space sector to participate in. Space applications require global or at least regional access; the space sector cannot deal efficiently with market mechanisms that lead to fragmented allocations due to differing market conditions throughout Europe. The market forces led spectrum allocation process needs to take account of the global nature of the space industry, awards for spectrum only available in the UK are unlikely to be useful to space services. To date successful application of space opportunities have largely been achieved through making spectrum allocations to space services through international agreement and not through exposure to market forces.

Question 11

What issues relating to spectrum access for different services do you think Ofcom should review? How might Ofcom start to rely more on commercial decisions when determining allocations of spectrum in the bands covered by this review?

To enable Ofcom to rely more on commercial decisions it is necessary to solve the local/global dichotomy between terrestrial (local) and satellite (global) spectrum requirements. It is also necessary to understand how the value to the UK from a diverse community of users of space services can be realistically and effectively compared on a commercial basis against a single large competitor such as a mobile operator or a broadcaster.

Question 16

Is the proposed list of bands to be included within the review (as set out in Figure A.5.1 in Annex 5 appropriate?

While the list of bands presented in the document is appropriate, in the review Ofcom should continue to consider adjacent bands. While current Ofcom co-ordination has worked extremely well, a release of adjacent fixed service bands to mobile and broadband may be in future considerable commercial pressure from well funded mobile industry interests to relax necessary out of band limits. We have concerns in cases where the adjacent band is a passive band, or a band widely used for applications with high receiver sensitivity and poor tolerance of interference, for example remote sensing, deep space communications and radar. The onboard power limitations of space platforms dictate that practically all ground segment receivers must be of high sensitivity and that satellite communications links are most efficient when the operate close to the natural noise floor.

A further concern is the knock on effect on AIP that occurs when fixed service bands are released. Released bands must by definition become more valuable and the opportunity cost of maintaining the out of band limits and the guard bands needed to protect space users will rise. At C-band especially the license fees paid by operators of Earth stations requiring protection and co-ordination may increase. This is how AIP is supposed to work, but space systems have very long development and deployment cycles and can not quickly move to new allocations in less congested spectrum. We have already noted similar issues at 2GHz where the 3G allocations are adjacent to the important satellite S-band where highly sensitive receivers are required to receive data from science missions and at X-band where science cannot afford the proposed annual AIP fees demanded to deploy a space science Earth station in the UK.