Strategic review of satellite and space science use of spectrum

About Arqiva

Arqiva is a communications infrastructure and media services company operating at the heart of the mobile and broadcast communications industry. Arqiva provides much of the infrastructure behind television, radio, mobile and other wireless communication in the UK. We are at the forefront of network solutions and services in an increasingly digital world. We provide much of the infrastructure behind television, radio and wireless communications in the UK and have a growing presence in Europe.

Arqiva is a major player in the UK's satellite communications business, operating over 80 antennas to geostationary satellites, providing telemetry, tracking and command support services to some of the leading satellite operators. We are a major provider of permanent satellite services to both Freesat and Sky customers. We also provide global satellite based services to the broadcast, communications, security, oil/gas, and exploration sectors, using our five UK teleports as well as facilities in the Middle East, Asia and the Americas. Our satellite customers include Turner and NBCU.

We are active in the telecommunications sector, providing access to over 8,000 sites and infrastructure for mobile phone operators. We are building and running a national Internet of Things ("IoT") network which is now live, starting with 10 of the UK's largest cities. In addition, our smart metering communications service, connecting 10 million homes using long-range radio technology, will be one of the UK's largest machine-to-machine deployments. This will require sites across northern England and Scotland.

Arqiva is a founder member and shareholder of Freeview. We broadcast all eight Freeview multiplexes and are the licensed operator of four of them. We own Connect TV, the first company to launch a live IP streaming channel on Freeview. In terms of radio delivery, we are the licensed operator of Digital One – the national commercial DAB multiplex. We are also a member of the Digital Two consortium which will be launching the second commercial DAB multiplex in 2016.

Our other major customers include EE, BT, H3G/Three, Telefónica/O2, Vodafone, BBC, ITV, Channel 4, Five, Sky, Classic FM, Airwave, Heathrow and Premier Inn.

Arqiva is owned by a consortium of long-term investors and has its headquarters in Hampshire, with major UK offices in London, Buckinghamshire and Yorkshire and operational centres in Greater Manchester, West Midlands, and Scotland.

Responses to questions

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

The approach to this review, taken in isolation, is broadly sensible. However, we are concerned that there appears to be an uncoordinated approach between this project and other ongoing initiatives within Ofcom. Our concerns relate to:

- The recent Initial Consultation, *Review of spectrum fees - For fixed links and satellite services*. We have set out our concerns in our response to that document but to repeat here, Ofcom appears to have missed the important potential interplay between that Initial Consultation and this Call for Inputs. In particular, Ofcom is seeking to establish in this project the extent to which demand for spectrum is likely to increase over the next ten years. However, it is also seeking to assess congestion in satellite spectrum in its spectrum pricing project with a view to linking any congestion to changes in fee levels. In the event that this project exposes likely future increased congestion in a spectrum band used by satellite, one would reasonably expect to see related proposals for increased AIP. Ofcom needs to be clearer about this connection; and

- Ofcom is aware that there is a proposal to introduce an agenda item at the World Radiocommunications Conference in 2019 (WRC-19) to identify spectrum for future 5G services. The proposed agenda item focusses on spectrum above 6 GHz. In January this year, Ofcom published a consultation, *Spectrum above 6 GHz for future mobile communications*, with an update following in April, *Laying the foundations for next generation mobile services: Update on bands above 6 GHz*. Given the uncertainty that has been introduced for the satellite sector by this new WRC agenda item we require more clarity on how this project fits into the broader WRC process (if at all). For example, if Ofcom were to identify spectrum currently allocated for satellite but with likely low future usage, how would that influence its thinking ahead of WRC-19 discussions.

In terms of the second bullet point above, we would add that we welcome Ofcom's continued attempts to focus future international activity (including at WRC-19) on identifying additional spectrum for mobile services on examining specific spectrum 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 services?

The breakdown of the satellite sector is sensible and deliberately partitions "end user services" (such as UKDTH) and "other services" (including data trunks and TV distribution and contribution.) The terminology used is relevant and meaningful. For completeness, it may be sensible to add a new sub-section describing non-real time and/or carousel

services. This could include, for example, markets such as DTH push VOD and Digital Cinema, of which there are indications of significant future growth.

Question 3 refers to Space Science and is for those relevant stakeholders to answer

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?

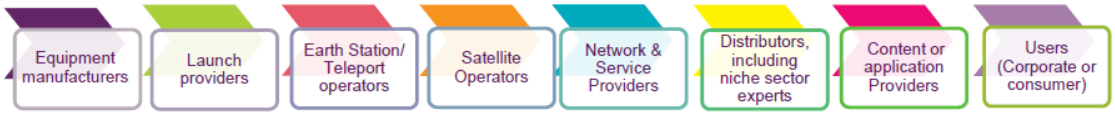
The value chain as presented is broadly correct, although, in reality and increasingly, any one entity may well end up providing services at two or more points in the flow of the value chain. For example, a Teleport Operator may well procure satellite capacity from a satellite operator and provide bundled services.

On a point of detail, we are unclear as to why, logically, the Earth Station/Teleport operator would come before the Satellite Operator in this value chain.

According to Euroconsult, breakdown of revenues along the value chain is:

- Manufacturing - $2.7bn
- Launch – $1.7bn
- Operators - $13bn
- Service providers - $122bn, of which
    - Video - $105bn
    - Telecoms – $17bn

We also note that the investment in space hardware at the left hand end of the chain is fundamentally a capital dominated spend, with operating expenditure becoming more prevalent towards the right hand side.



Question 5: What is the extent of your organisation's role in the value chain? What satellite applications (as summarised in Table 1 in section 3) does your organisation use, provide or help to deliver?

Arqiva owns, manages and operates teleports giving access to key global locations. Our satellite network is connected to major points of presence and telehouses, using a diverse and high-capacity managed fibre network.

We have invested heavily in UK infrastructure at our primary locations, supplementing this with long term commitments to satellite and fibre operators for the supply of raw bandwidth on an opex cost basis.

Arqiva's role in the value chain also extends to the following satellite applications where its role varies from teleport operator to network & service provider. Arqiva provides and helps to deliver:

- DTH and broadcast television (FSS and BSS in the UK and internationally);
- TV, radio and data distribution (FSS and BSS in the UK and internationally);
- Broadband internet access (C & Ku bands FSS outside UK in developing countries);
- Commercial mobility (C & Ku bands FSS connectivity to the UK and international energy sectors);
- Corporate networks (Ku band FSS connectivity for UK Energy sector and C & Ku bands internationally for a variety of sectors including energy, telecoms and Government);
- Contribution & OU TV (FSS UK and internationally);
- Legacy telephony & carrier (C band FSS internationally including international cellular backhaul landing in the UK);
- Military (C & Ku bands FSS internationally); and
- TT&C and carrier monitoring.

Question 6: For each of the satellite applications you use, provide or help deliver (as identified in Question 5) 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 service links; or in the case of TT&C and feeder backhaul links, the location of the gateway stations;*
- *the estimated number of users (eg MSS terminals, DTH subscribers, FSS earth stations);*
- *an estimate of the average use by end user (for those applications that are driven by end user traffic);*

- *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 (eg for DTH TV, the number of 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.

And

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).

We attach our response to this question in spreadsheet submitted with this response – "Question 6 & 7 – Ofcom review of satellite".

In addition to this, our provision of satellite services benefits users most notably with distribution of live TV and push VOD TV. This delivers over 400 TV and radio channels into over 12 Million homes in the UK. Our 24/7 distribution of content by satellite to terrestrial transmitters and contribution of programme content into broadcasters (typically, news and sports events) indirectly benefits the same numbers of homes and viewers.

For users in rural locations, where fibre and copper infrastructure is inadequate, broadband by satellite now offers a real and credible solution. We predict a significant and rapid growth in this area.

Because of the UK's importance in the global TV and media market, teleport operators play a significant role in uplinking to overseas broadcast markets. This is both in terms of contributing feeds and direct distribution into overseas DTH networks.

In terms of commercial mobility, Arqiva directly and indirectly provides Ku band connectivity to approximately 60% of the UK offshore oil and gas exploration and production vessels and their offshore employees (which could have hundreds of operational staff on board).

In terms of corporate networks, Arqiva provides Ku band VSAT based telemetry networks to approximately 1500 remote site gas, electricity and transmitter outstations ensuring the underlying performance and integrity of these critical national infrastructures (which typically require a high availability of spectrum).

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

<u>Live TV</u>

There is a current trend towards HD and, with the trend of falling prices of TV sets over 32 inches, the quality provided by SD may become increasingly unacceptable to many viewers.

With that in mind, we note that SD to HD transitions requires approximately a fourfold increase in bandwidth.

UHD and 4k are now being promoted and TV sets are retailing in higher volumes, though from a low base. At the same time, content will increasingly be delivered over the internet using connected TVs. There will still, however, be growth potential for satellite platform operators for essential live programmes, such as events and sports. With that in mind we note that viewer appetite for the DTH platform remains strong with forecasts suggesting that Sky will retain its UK subscriber base of 9 million for some time to come.

Non-real-time TV and Push VOD

There is clear growth in this area, some of which will be delivered over the internet, but a growing amount of which will be delivered over satellite, particularly for UHD/4k.

Broadband

The two principal offerings currently to UK customers are fibre or ADSL. While speeds are continuing to increase, this is focussed on already reasonably well connected and densely populated areas. Satellite is a plausible technology for infill of coverage gaps, particularly in low density or rural areas. Whilst MNOs have pledged to extend their coverage to harder to reach areas, government initiatives (notably BDUK) are also considering the role that satellite broadband provision could have in achieving ubiquitous broadband.

More satellites

From a satellite operator's point of view, the UK is pivotal as a TV and media hub for sports and entertainment. Its role as a contributor to overseas DTH will continue to grow. While downlinks frequencies used in other countries can adopt spectrally efficient re-use techniques, there will nevertheless be a continued significant demand for uplink frequencies.

We note that multi beam satellites will have the effect of increasing throughput, thereby lowering costs on a per bit basis.

Question 9: For each of the satellite applications you use, provide or help deliver what do you see as the current demand trends and underlying likely future drivers of demand for satellite applications your organisation uses or provides?

DTH

The next five years may see a significant change in the UK DTH market, with a switch in transmission of SD channels from MPEG2 to MPEG4 technology standards, made possible by the introduction of boxes which swap-out older MPEG2 technology.

Once the customer set top box base is exclusively (or largely) based on MPEG4 standards, broadcasters could take a commercial decision and take advantage of the 33%-40%

reduction in Mbps capacity needed to broadcast a SD channel. It could do this by switching transmission from MPEG2 (the current compression for most SD channels) to MPEG4 standards (the reduction varies depending on channel genre/specific Mbit need).

For example, once “Q boxes” (previously known as Ethan) are introduced by Sky, a complete swap-out of older MPEG2 technology STBs will occur at some point. Our best estimate for this happening is 2018/19. Whenever this occurs, we believe that most of the SD market will switch from MPEG2 to MPEG4 transmission. In addition we believe that, at that point, most or all SD simulcast channels (i.e. channels that are broadcast in both SD and HD versions) could be switched off by broadcasters as they will have no reason to continue incurring costs for both.

The net result is that demand from broadcasters for Mbps on UK DTH is likely to fall. While the effect of the SD switch from MPEG2 to MPEG4 may be significant, this would be partially netted off against a continuing market trend of SD to HD channel migration, plus introduction of some UHD1 channels.

By 2018/19 at latest we also believe that virtually all transponders in the UK DTH market will have switched from DVB-S to DVB-S2 transmission, which allows greater Mbps per transponder.

Broadband

High Throughput Satellite (HTS) constellations which, through the use of geographic frequency re-use, can offer over 10 times as much capacity as conventional satellites are now being launched. We are already seeing HTS being implemented in Ka-band. HTS is feasible in Ku-band too and some operators already have this on their road maps.

Because the effects of rain fade at Ka-band are significant, these frequencies are widely viewed as less suitable than Ku-band for the broadcasting of conventional, one-way, linear television. However, for on demand services, including catch up TV and push VOD, Ka-band remains a suitable option.

In its *Review of spectrum fees - For fixed links and satellite services*, Ofcom correctly identified Ka band as having the potential to face increased demand within the coming ten years. Additionally, the vast majority of 180 satellite launches (expected between 2016 and 2020 are likely to fully or partially adopt HTS technology - albeit not all in Ka-band. Lower costs (per Mbps) will likely generate intense interest and demand from existing and new satellite data users - both B2B and consumer broadband providers. By the early to mid-2020s, we expect the GEO HTS market to have increased significantly.

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.

Our principal concern relates to ensuring that there is sufficient spectrum to meet the expected growing demand for UHD (4k) services, push VOD and satellite broadband as set out above.

Current Ku-band downlinks (10.7-12.75 GHz in region 1) allow for combining the FSS and BSS bands. However, this offers a maximum of 2.05 GHz per polarisation at ITU Region 1 orbital slots. Between around 8 West and 36 East, these are already very heavily loaded and, in some cases, at saturation point.

Another concern is related to intercontinental connectivity. HTS at Ku-band may appear to resolve some congestion issues. The reality is, however, that Ku-band capacity servicing Europe is delivered using frequencies on pan-European beams. These are limited by aperture sizes on board spacecraft. As a result, there is little opportunity for frequency reuse. In contrast, a similar total bandwidth at Ka-band is barely utilised at present and would largely be provisioned on smaller spot beams than in Ku-band. This would allow multiple frequency re-use opportunities. Ka-band, therefore, offers the sector significant growth potential in presently uncongested spectrum.

However, the introduction of HTS, particularly at Ka-band, is a longer term prospect and it is unclear, at this stage whether it will provide ubiquitous coverage.

We also note the continuing moves internationally to make increasing parts of C-Band available for mobile services. Ofcom is aware that satellite use of C-Band is critical to sustaining a number of key existing services and any developments that further reduced availability of these frequencies could cause significant costs and disruption.

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? Eg, what order of magnitude increases in frequency re-use might be achieved? To what extent do you believe that these mitigations apply only to certain applications?

We set out our observations below on the proposed mitigations:

<u>Improvements to satellite antenna beam focussing technologies, enabling a satellite to use smaller beams so that frequency bands can be reused through geographical discrimination, thereby increasing the capacity of the satellite</u>

This is possible with Ka-band, although (and as discussed earlier) Ka-band comes with new challenges, not least the issue of rain fade. HTS solutions at Ku-band are attractive but the beams will not be larger. As a result, the frequency reuse factor will be less favourable. In

the meantime, we wait to see whether high risk antenna technology could be deployed in space.

New transmitter and receiver technologies and standards that could enable better use of spectrum. These include innovative and more spectrally efficient waveforms, better compression techniques and techniques to filter out unwanted signals

We always strive to take the rational step to migrate to more efficient modulation and coding schemes. However, we need to take into account the significant cost and timescales involved with the necessary replacement of consumer set top boxes in DTH networks.

Increasing the efficiency by which satellite networks share spectrum resources with other users (eg terrestrial applications)

For transmit frequencies, this is a sensible approach although it would require careful coordination. For receive frequencies, continued operation where protection was previously assumed but never formalised would need to be carefully managed with the incumbent licensee of that downlink frequency.

Change to satellite network parameters, such as the minimum diameter of the transmitting earth station or limits on the power flux density radiated towards other satellites that could reduce the orbital separation between GSO satellites

This may be feasible with Earth Stations at transmitting sites. However, reducing from a nominal 3 degree separation to 2 degrees will have a significant impact on receive antennas. This is particularly the case with consumer antenna products where service degradation (due to increased adjacent satellite interference) can only be overcome by dish replacement. In reality, this would be through the use of larger device (requiring planning permission issues in many countries) and/or improvements in the antenna design. Inevitably, costs (driven largely by home visits) would be significant and there would be a great deal of viewer disruption.

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 improvements are they likely to deliver?

We have no further comment on this.

Question 13: Beyond the activities already initiated and planned for the satellite sector (eg as part of WRC-15), do you think there is a need for additional regulatory action that may, for example, help address the challenges it faces?

There are three specific areas that Ofcom could take regulatory measures to assist the satellite sector with its substantial challenges over the coming years. These are:

- We welcome Ofcom's current position that, at WRC19, future bands for 5G should focus only on those which already have a mobile allocation in the Radio Regulations. However, it should also signal at an early stage that it will robustly oppose any proposals in the lead up to WRC-19 to introduce new mobile allocations in spectrum currently allocated for satellite. We note that this would be consistent with the sensible current approach taken by Ofcom;

- To meet growing demand for satellite services in the future - especially for those satellite broadband services mentioned above – spectrum licensees may need to enter spectrum trades with each other to ensure that sufficient bandwidth is available in particular locations to provide services to their customers. Ofcom should ensure that the regulatory framework is flexible enough to ensure such trades can happen. We look forward to exploring this further with Ofcom as part of its recently published consultation *A framework for spectrum sharing*; and

- As referenced above, Ofcom is currently considering revising spectrum fees for satellite. As we argued in our response to that document, any proposals brought forward by Ofcom should not adversely impact upon the satellite's sector ability to invest in critical infrastructure underpinning services of economic and social importance.