

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

None.

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

The broad approach will likely neglect some users which are not large commercial operators.

The list encompasses my knowledge of satellite sectors, but it does not list completely the bands of some of the services my organisation is involved in.

**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?:**

We are a research organisation, and have some involvement in all parts of the satellite sector. The revenues never seem to be so clear cut. The value of the activities we undertake cannot always be measured by direct financial return.

**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.:**

Our role is principally in the space science sector, but we do operate several ground stations which support telemetry, tracking and command for a variety of academic, government and commercial customers.

**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.:**

We are a research organisation, hence our requirements can vary and often mean that we are working on the edge of changing boundaries.

Currently we support telemetry and control for a number of low earth orbiting satellites, operating in the following bands:

VHF downlink (amateur band)

UHF,

S-band uplink (2025 - 2110 MHz), downlink (2200 - 2300 MHz)

X-band downlink (8025 - 8400 MHz)

As communication requirements change, we anticipate work in the Ka band.

The impact on our operations is limited in region based on our visibility of the satellites as they traverse from horizon to horizon.

**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).:**

Since the data from these satellites is often imagery and science data, it feeds into numerous applications which are of significant benefit to a large number of people, both UK and international.

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

Our ground stations will need to be upgraded/replaced to keep pace with increasing frequencies required to support larger bandwidths for large data transfers.

**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):**

**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.:**

The significant challenge we face is a potential degradation of our system sensitivities due to interference from in-band and high power out of band sources. Since the receive bands are not currently registered, we are currently operating at risk.

**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?:**

Many of the mitigation techniques are effective when considering links to GEO satellites because the beams are effectively static. However, LEO satellite orbits mean that the satellites appear over a huge area of sky.

**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?:**

**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.:**

There needs to be a means of registering users who are receiving in bands that are allocated internationally for sat com purposes.

**Question 3: Do you have any comments on our broad overview of the space science sector? In particular, do you have comments on the completeness of the list of applications, their definitions and their use of the relevant radiocommunications service(s):**

The list doesn't include ground based services which use active techniques to study objects in space; such as using radar to detect and range satellite and debris (space surveillance and tracking).

**Question 14: Do you have any comments on our representation of the value chain for the space science sector? How do you think industry revenues are broken down between players at different positions in the chain?:**

It is often difficult to assess the economic impact of a science sector application as the full impact only comes years in the future.

With a space surveillance and tracking facility, the cost is generally not borne by the end user, but by government entities. As such, the value to the end users (satellite operators and owners) is not fully appreciated.

**Question 15: What is the extent of your organisations? role(s) in the value chain? Which space science applications (as summarised in Table 2 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.:**

We are developing a space surveillance and tracking facility which will form part of the UK national capability.

**Question 16: For each of the space science applications you use, provide or help deliver (as identified in Question 15), and taking into account your role in the value chain, where applicable please provide:**

- the specific spectrum frequencies used, distinguishing between the frequencies used for the science application, the frequencies use for downlinking data and, for TT&C
- whether the application is limited to use of specific frequencies and why (e.g. due to fundamental characteristics of the phenomena being measured and/or availability of technology designed for that frequency)
- whether the applications use continuous or intermittent measurements
- the typical resolution and associated measurement bandwidths, including an indication of any implication for spectrum requirements
- the geography this use extends over (e.g. land or sea, and regional or global)
- the location of the gateway station(s) for TT&C and downlinking data
- the estimated number of users.:

Currently we are operating a monopulse radar that operates at 3100 MHz. It doesn't meet aeronautical radar eligibility, hence doesn't have a suitable licence to provide protection against interference, or to prevent other users operating in band, hence interfering with them.

Future developments could include bistatic operations within the UK and within Europe. There is also interest in upgrades to Ku band for improved performance and capability.

**Question 17: For each of the space science 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 SST application will allow monitoring of UK space assets to provide warning of conjunctions, to allow operator action to protect the asset.

It can also contribute to re-entry observations which will provide detailed information to inform decision makers in the event of an object potentially re-entering over the UK.

**Question 18: From your perspective, what high level trends will affect the space science sector in the coming years?:**

Loss of affordable spectrum and constraints on power and energy limits.

**Question 19: For each of the space science application(s) your organisation uses or provides, what are the a) current trends, and b) likely future drivers of demand for spectrum?**

**Please include in your response:**

- the scale of the demand drivers
- the reason for additional demand (e.g. higher resolution radar data rates/bandwidth required) and whether this increased demand is for data delivery or for the taking of measurements
- whether increased demand can only be met at specific frequencies and why
- any variations in demand drivers by geography (i.e. regional or global), and why, and
- whether future demand is expected to be temporary or intermittent, and the reasons for this.

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

**Question 20: Taking into account the drivers you have identified in your response to Question 19 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.:**

**Question 21: Are there any future developments, such as the radio astronomy SKA, that could reduce the demand for space science spectrum in the UK?:**

**Question 22: 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? To what extent do you believe that these mitigations apply only to certain applications?:**

**Question 23: 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?:**

**Question 24: Beyond the activities already initiated and planned for the space science 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.:**