Ofcom may publish a response summary:

Yes

I confirm that I have read the declaration:

Yes

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

I would have expected OFCOM to have had an initial baseline view of spectrum usage which could have been published with requests for updates.
The review is not very precise in parts as to the actual information requested.
It was noted that R&D were not included as a sector for inputs despite the fact that they have much to contribute.

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)?:

Areas that are not mentioned are;
*Earth resources and the comms elements of these systems
*Hybrid satellite and terrestrial systems
*Satellites as a compliment to 4/5G
*Massive non GEO constellations

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?:

R&D is missing.
Upstream and downstream is not really distinguished.
I think that there are different models of value chain that apply to different applications and that there is not one that fits all cases.

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.:

We are an R & D organisation but have involvement in all of the application areas in Table 1. We participate with ESA and EU projects and with satellite companies directly.

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.:

*Frequency bands in our studies
DTH broadcast--Ku/Ka
M2M--L/S/Ka
Mobility-L/S/Ka
Emergency--L/S/Ka
positioning--uhf/L/S
*BB access studies in EU BATS project (www.batsproject.eu) has indicated 5Tbps satellite required fixed BB market by 2020 (Analysys Mason Study) in EU.
*Studies in the ESA Terabit/s satellite have indicated greater than 1 Tbps for BB access by satellite by 2020.
*Both above projects assume satellite designs that use the exclusive plus the shared Ka band down link spectrum.
*This indicates demand for more spectrum at Ka band for fixed BB access.
*EU CoRaSat project (www.ict-corasat.eu) has demonstrated that can use shared bands with no interference to incumbent FS using a data base scheme.--CEPT taking this forward.
*For 2020 and beyond feeder links need Q/V bands to accommodate the Gbps capacity--issues with allocation and sharing with mobile!

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).:

*BB access by satellite served by Eutelsat, Avanti, and SES as well as intelsat. Note EUtelsat Ka beam over Ireland has now saturated and UK beams will be saturated shortly--evidence of demand.
*BATS project using AM data has shown that UK will be in hot spots for 2020 satellite coverage.

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

* Increase in the need for Ka band spectrum for BB and TV distribution.
*Need to share Ka band with several services.
*Increased use of S band for hybrid systems.
*Very large constellations of non GEO satellites--spectrum issues.
*Increased use of higher bands Q/V/W and up to optical.
*Satellites with more digital processing and flexibility.
*HAPS and UAV's for M2M and IoT.
*5G mobile in millimetre bands --incorporating satellites but with sharing issues.
*Many cellular technologies being applied to satellites.

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).:

(a)Demands in BB access and TV broadcast
Capacity in L/S for hybrid systems
Non GEO systems and IoT applications
(b)Drivers of demand
Higher speed internet with more video
Higher resolution TV and multiscreen
QoE and resilience improvements
Lower latency
spectrum shortages and ways to overcome.
Evidence see BB traffic studies in BATS and in ESA Terabit/s. Non GEO systems eg Oneweb,Leosat, Spacex and Eu companies such as Airbus and TAS involvement.

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.:

Challenges:
*Spectrum availability-how to coexist
*IoT and M2M --coverage and latency
*Hybrid systems-integration eg Europasat
*Resilience and reliability--integrated systems
*Providing QoE to users

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?:

Mitigation:
*Sharing spectrum--eg using cognitive techniques as in CoRaSat.
*Beam forming and switching--allowing much more flexibility
*Non GEO systems designed for lower latency and higher bandwidth.
*More mobile technologies in satellites--massive MIMO, FDR etc.
*More intelligent integration--eg BATS project integrating DSl/LTE and satellite

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?:

*Need to look at millimetre wavebands and small MS cells coexisting with satellite and FS. Important in 5G systems. How can satellite extend 5G?
*OFCOM could be more proactive in CEPT fora

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.:

* Need to push the data base scheme in Ka band via CEPT and see appointment of a trusted third party for Europe wide maps.
*Free up geographical regional use of uncoordinated earth stations.
*Study higher frequency bands for satellite applications and coordinate with 5G mobile.
*Be more proactive in 5GPPP programmes in looking at coexistence in millimetre bands.
*Open up studies for spectrum coordination for large non GEO constellations and impacts on GEO and other systems.

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)?:

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?:

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.:

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.:

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).:

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

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.: