Your response

Question	Your response
Question 1: Do you agree with the prioritisation of the agenda items, as shown in Annex 5, and if not why?	It should be noted that some agenda items which are rated LOW or MEDIUM by Ofcom are high priority agenda items for GSOA, particularly WRC-23 Agenda Items 1.15, 1.16, 1.17, and the verification of Article 21.5 limits.
Question 2: What are your views on the continued need to protect global aeronautical and maritime services, in the 4.8 – 4.99 GHz band, under this agenda item?	GSOA expresses no view on this question.
Question 3a: Do you agree that the UK interest in the bands 3 600-3 800 MHz and 3 300-3 400 MHz in Region 2 (North & South Americas) should be limited to any impacts on UK operational use in those areas?	Protection of FSS earth stations of satellite operators is required.
Question 3b: Do you agree that the UK should maintain its objections to changes to the regulatory environment for the band 3300-3400 MHz (in Region 1, Europe, Africa, Middle East), noting UK has interests in use of radar for both ground and airborne operations?	GSOA expresses no view on this question.
Question 3c: What is your view on the use of 6425-7025 & 7025-7125 MHz, and what evidence do you have to support this view? How does that inform your views on a IMT identification in these bands?	GSOA stresses that there are multiple satellite systems which make intensive use of the 6 425-7 025 MHz frequency band. There are numerous operational FSS networks with coverage not only in Region 1, but with coverage on a global basis. These networks require protection against interference from terrestrial services. This band is expected to continue to be used by FSS systems for uplinks and downlinks that require protection. Part of this band is used for MSS systems' feeder uplinks on a global basis, including the Inmarsat network, which provides critical communications to citizens, businesses and government users. The Inmarsat system is, for example, vital to maritime operations in Region 1 and the rest of the world. This includes provision of satellite communications for the GMDSS, which could be unable to operate

	if interference was to occur to the Cband satellite uplinks, placing lives at risk. In addition to Inmarsat's maritime users, MSS services are extensively used by aircraft, for aircraft operations and for passenger communications. The aviation industry also relies on MSS satellite connectivity for the safe operation of aircraft. Through the European SESAR project and the ESA IRIS programmed, Europe is developing enhanced aviation safety systems, that will see more extensive use made of MSS satellite connectivity for aircraft, which is reliant on the use of the upper 6 GHz band. Furthermore, the band is also used to support the uplink of signals associated to the satellite-based navigation augmentation services (SBAS) in Region 1, such as EGNOS and the Nigerian Satellite Augmentation System (NSAS), having global or near global L-band ser-vice coverage. These navigation services use the C-band uplink range, with hemispherical and global coverages. The band is also intensively used for and is essential to telecommand and control signalling for station keeping and safely manoeuvring spacecraft to ensure compliance with international treaty obligations. With the increasing concern for the proliferation of space debris, interference from terrestrial systems that could compromise station keeping and safely manoeuvring spacecraft should be at the forefront of UK's policies. Also, the use of the frequency band 6 725-7 025 MHz by GSO FSS (Earth-to-space) networks is subject to the provisions of Appendix **30B** (RR **5.441**) whose objective is to guarantee in practice, for all countries, equitable access to the geostationary-satellite orbit in the frequency bands which is important for developing countries. While the Appendix 30B allotments are not extensively used in Europe, they are high importance for some other regions, in particular developing countries. Taking into account the above factors, it can be seen use the band 6 425-7 025 MHz for satellite uplinks, and the band 6 700-7 075 MHz for satellite downlinks provides significant societal benefits to Region 1 and the wider world. The continued use

	of this band for satellite services should be considered as baseline to the UK position for this agenda item. *Sharing studies* GSOA studies show that aggregate interference from IMT base stations exceeds the criteria of FSS receivers for all cases, i.e. for both the highest and lowest terrestrial IMT deployment densities and all types of satellite beams/positions considered. The ITU studies are still in progress in Working Party 5D. Currently, there is a range of results, with some studies showing interference below the FSS protection criterion and others showing interference well above the FSS protection criterion. The studies have used common assumptions for many of the parameters, but different results occur due to divergence in the assumptions for some parameters. Furthermore, the modelling of interference for these studies is limited to complex computer simulations, which cannot practically be validated by other stakeholders. Some studies – in particular those that suggest interference below the FSS protection criterion, have been implemented by cumulative cherrypicking of assumptions favourable to terrestrial IMT to ensure that cases with small positive interference margins are identified. Those studies have, for example, deliberately and artificially minimised terrestrial IMT deployment within satellite coverage, modified previously agreed FSS system characteristics, and chosen orbital positions with the least land area in visibility, amongst others. Such studies are not realistic or technically correct and the results are therefore not a sound basis to permit the use of IMT in this band. Given the criticality of the use of the upper 6 GHz for satellite services in Region 1 and the questionable nature of the favourable studies, the UK should not consider opening the band to terrestrial IMT. The baseline assumptions used in almost all studies assume only very limited deployment of IMT in the 6 GHz band. Those assumptions assume IMT deployment in this band only in a limited part of urban and suburban areas. In

	aggregate, these assumptions are equivalent to coverage by IMT systems of only 0.15% of land, on average[1]. If the 6 GHz band was to be used by terrestrial IMT systems, the density of deployment in Europe would need to remain close to this figure, i.e. IMT deployment covering no more than approximately 0.15% of the land of Europe. This constraint would severely limit the benefits that would result to citizens from the use of the upper 6 GHz band for IMT. There is also no clear benefit that would come from IMT use of the 6 GHz that cannot be achieved by use of the other bands – higher and lower in frequency – already identified for IMT. GSOA is of the view that there is much better scope for shared use of the upper 6 GHz band with the use of WAS/RLAN systems – a decision already taken by several countries, including the United States, Brazil and Korea. Europe has already adopted regulations for WAS/RLAN in the adjacent band 5 945-6 425 MHz. Similar regulations would be required in the upper 6 GHz band to enable WAS/RLAN operation while providing adequate protection of satellite uplinks. By introducing WAS/RLAN on a shared basis with the FSS in the upper 6 GHz band, it is possible to achieve an effective and efficient long-term use of the band. Since the upper 6 GHz band is already allocated to the mobile service on a primary basis in all three Regions in the Radio Regulations, the UK would retain the flexibility to deploy mobile systems even with No change to the Radio Regulations. Considering the current results of sharing studies and the apparent lack of an actual need to identify the band for IMT, there appears to be no justification for the UK to consider an IMT identification. GSOA recommends "No IMT identification" in these bands and suppression of the Resolution **245 (WRC-19)**.

[1] Based on parameters: Rb = 1%, Ra_urban = 10%, Ra_suburban = 5%.

Question 3d: What are your thoughts on the current UK view that IMT should not be identified in Region 2 in the band 10-10.5 GHz in order to ensure the protection of the globally operating EESS (active) systems and airborne & vessel mounted radars?	GSOA is OK with this view.
Question 4: Do you agree that, where no additional technical limitations are placed on mobile services, the UK can support an upgrading of the mobile allocation, in 3600 - 3800 MHz, from secondary to primary?	In 4.3.3 Ofcom states that the UK does not need the mobile service allocation change from secondary to primary as the band is already nationally authorised in a technology neutral manner. Ofcom therefore concludes to be relatively indifferent as to whether an upgrading of the allocation is agreed at WRC-23. As was highlighted in the GSOA White Paper distributed in May 2022, the largest impact of the outcome of WRC-23 Agenda Item 1.3 will be felt by African administrations whose reliance on C-band satellite services is more pervasive than in Europe, as well as on the European and UK based satellite industry, for which C-band is a cornerstone of many of the services offered. Majority of C-band satellite operators in Europe provide services to African countries. Massive investments have been made by the industry stakeholders and there are currently more than 50 satellites with C-band payloads capable of providing services to Africa. Return of these investments rely on continued access to spectrum resources. Noting both the view conveyed by Ofcom as well as the potential business impact to UK satellite stakeholders, it remains unclear why the UK has been one of the most vocal participants in CEPT and ITU-R advocating for the upgrade of mobile service in this band. There seems to be a steep contrast between the Ofcom position described and actions from the UK delegation in these international meetings.
Question 5: What are your views on the development of regulatory conditions to facilitate deployment of high altitude IMT base stations in IMT identified bands below 2.7 GHz?	GSOA expresses no view on this question.

Question 6: Do you agree that a formal modification to the Radio Regulations is not needed for fixed service applications that use IMT technologies?	This matter is addressed in WRC-19 Agenda Item 9.1, topic c and Resolution **175 (WRC-19)**. GSOA agrees with Ofcom that fixed service applications do not require similar global ecosystem than mobile applications for roaming, economies of scale and interoperability of equipment. GSOA also concurs with Ofcom that considering technology neutrality of the Radio Regulation allocations, emphasising a specific technology for a specific frequency band is likely to limit the flexibility of using variety of Fixed Service technologies and frequency bands in the future. GSOA agrees with Ofcom to provide information and guidance for the use of IMT technologybased systems for fixed wireless broadband, in the form of revisions to, or updates of, appropriate existing ITU-R Recommendations/Reports/Handbooks (if necessary), however this should be conducted under the course of the regular activities of the ITU-R Study Groups. In consequence, regarding WRC-19 Agenda Item 9.1, topic c, GSOA supports No Change and suppression of the Resolution **175 (WRC-19)** and encourages Ofcom to adopt this approach at WRC-23. In addition, GSOA kindly invites Ofcom to oppose any proposals that seek further action at WRC-27 with regards to the use of IMT for fixed wireless broadband in the frequency bands allocated to the fixed service on a primary basis.
Question 7: What are you views on the proposed approach for 470-694 MHz, recognising the national decisions already in place and taken for DTT multiplex licensing in the band, and the additional and supplementary spectrum made available for UK PMSE usage?	GSOA expresses no view on this question.

Question 8: What are your views on the need to establish an international regulatory environment that provides adequate protection of UK fixed links from earth stations in motion, in the band 12.75 – 13.25 GHz, which is also practicable from an enforcement/implementation perspective?	GSOA agrees with Ofcom that there is a need for an international regulatory environment to provide adequate protection of UK fixed links from earth stations in motion. However, GSOA has concerns regarding the fact that Ofcom does not agree with the protection limits or the harmonisation regime in the Decision (19)04 and would like to understand why there has not been activity from Ofcom to ensure that the CEPT framework in this band is suitable for implementation also in the UK. Noting that UK has the largest aviation network in Europe and the third largest in the world, as well as the fact that the full British Airways long-haul fleet and the full fleet of Virgin Atlantic are equipped with in-flight connectivity, it is clearly in the best interest of UK stakeholders and airlines beyond satellite industry to improve this service. GSOA would like to encourage Ofcom to evaluate and take appropriate steps to open the frequency band for operation of earth stations in motion in the near future.
Question 9: Do you agree that the UK continues to support the maritime distance figure for ESIMs that work to nongeostationary satellites and to test the other conditions agreed at WRC-19 for ESIMs working to geostationary satellites to ascertain whether these remain appropriate for non-geostationary satellites?	GSOA supports, as part of AI 1.16, the adoption of technical conditions similar to those of Resolution 169 for the protection of terrestrial services based on the results of sharing studies. GSOA notes that the sharing studies concluded similar conditions as those in Resolution 169 would also protect terrestrial stations from nonGSO ESIM
Question 10: What are your views on whether an allocation to inter satellite links is necessary for existing satellite allocated bands and whether this would provide benefits internationally?	GSOA is of the view that inter satellite links would help Earth Observation missions to relay data back to Earth in a larger volume and faster, and would therefore increase the quality of EESS and SRS observations. GSOA is of the view that satellite-to-satellite communications is an application of the FSS. Sharing and compatibility with other services is being carefully examined. GSOA notes that an ISS allocation is also underconsideration. Noting that the UK Earth Observation Technology Strategy aims to position the UK as a world leader in new EO technologies, GSOA believes that both satellite commercial services and scientific observations UK stakeholders

	would benefit from such an allocation to inter satellite links. GSOA supports the operations of satellite-to-satellite links under WRC-23 Agenda Item 1.17 provided that adequate protection of other services and other applications of the FSS is ensured. Consistent with OFCOM's view, GSOA agrees that any allocation to inter satellite links through this agenda item should not introduce additional constraints to the other services in these bands At the same time, GSOA supports that any regulatory limits applied on non-GSO space station transmissions in the 27.5-30 GHz band should be sufficient to allow space-to-space communications with both GSO satellite networks and non-GSO satellite systems, while protecting incumbent FSS uplinks.
Question 11: What are your views on the need for additional satellite allocations in support of narrowband IoT "M2M" type applications, noting that there remains the continued use of PMSE for wireless cameras in the band 2010 – 2025 MHz?	GSOA is of the view that there is an extensive need for additional allocations to the Mobile Satellite Service (MSS) on a global basis, however any allocations should not be limited to specific applications and/or for the exclusive use of operators providing these kind of application services. The use of narrowband IoT "M2M" type applications can be accommodated in present and/or futures spectrum allocated to the MSS. WRC-19 Agenda Item 1.18 has proved that including very specific technical limits in a WRC Resolution before the actual sharing and compatibility studies take place will only end up in failure. This was the case of the technical restrictions included in recognizing c of the Resolution 248 (WRC-19), which limit the studies to *"(…) those systems with space stations that have a maximum equivalent isotropically radiated power (e.i.r.p.) of 27 dBW or less, with a beamwidth of no more than 120 degrees, and earth stations that individually communicate no more than once every 15 minutes, for no more than 4 seconds at a time, with a maximum e.i.r.p. of 7 dBW"*. Given these limitations, during the study cycle it was not even possible to agree on the technical parameters and the operational characteristics of the systems, situation that led to the impediment of completing the necessary

	studies to protect the existing services in the bands considered in Resolution 248 (WRC-19) in due time. In addition, with regards to WRC-19 Agenda Item 1.18, GSOA supports No Change and suppression of the Resolution **248 (WRC-19)** and encourages Ofcom to adopt this approach at WRC-23.
Question 12: What are your views on the proposed approach to this agenda item concerning the fixed satellite service in 17.317.7 GHz in Region 2?	GSOA supports the allocation to the fixed satellite service in the space-to-Earth direction in the frequency band 17.3-17.7 GHz in Region 2 and the proposed regulatory solution to this agenda item which considers both GSO and nonGSO operations. Studies conducted at the ITU-R have developed appropriate sharing mechanisms with existing services. It could also be beneficial to explore whether a future agenda item to align this identification for Region 3 is possible as well.
Question 13a: On Topic B, what are your views on the post milestone procedures for non-geostationary satellite systems?	GSOA supports a clear regulatory text for the post-milestone period as proposed in Method B of the draft CPM text with Option A2 (applicability only to Res 35 frequency bands) and Option B1 (fixed value of 95%): - Possibility to operate a minimum 95% of the number of satellites notified in the MIFR without regulatory impact to allow some operational flexibility. - Possibility to operate less than 95% of the number of satellites notified in the MIFR for a maximum period of 3 years without regulatory impact. - Support a reduction in the number of satellites notified in the MIFR if the deployed number of satellites falls below 95% of that which was notified in the MIFR for a continuous period exceeding 3 years. GSOA considers the application of only No. 13.6 by the BR insufficient as a solution for this Topic.

Question 13b: On Topic L, what are your views on regulatory conditions for Telemetry, Tracking and Command (TT&C) for NGSO inorbit servicing?	ITU-R WP-4A at its May 2022 meeting had identified Topic L under WRC-2023 agenda item 7 which relates to developing regulatory provisions to enable TT&C frequencies for non-GSO On-Orbit-Service (IOS) space systems. Such non-GSO IOS space systems, which are being developed in Europe, North America and the Far East, would enable de-orbit of LEO satellites at the end of their operational life or to deorbit space debris objects in LEO orbits. In the context of promoting innovative space solutions which would facilitate sustainable use of important LEO orbital resources, CEPT CPG PTB has at its June 2022 meeting developed a preliminary brief on this topic and some initial options to progress this matter were considered. The UK then submitted an input document to the ITU-R WP-4A September 2022 meeting with a proposed Method to be included under agenda item 7 Topic L. The UK proposal was not supported at ITU-R WP4A. Some discussions then also took place with the BR Director on this matter; the summary outcome of which may be reflected the ITU-R WP-4A Chairman's Report. GSOA proposes that Ofcom continue to engage on this matter with the ITU and other relevant CEPT and other Administrations so that WRC2023 would consider in an appropriate way under a relevant WRC-2023 agenda item to adopt new regulations or clarify existing regulations to facilitate use of TT&C frequencies for non-GSO IOS space systems in relevant bands allocated to FSS and SOS or other relevant services. Such ITU WRC-2023 action will substantially enable investments in European Non-GSO IOS space system development and implementation and de-risk critical frequency access issues for the TT&C and other functions of such IOS space systems. Furthermore, such ITU / WRC-2023 activities should be consistent with the UK's overall National Space Strategy goals to promote space sustainability goals and UK IOS space industry via relevant regulatory actions.

Question 13c: What are your views on the remaining topics currently listed for Agenda Item 7?	GSOA is heavily involved in many Agenda Item 7 Topics and would be happy to provide its detailed positions on all of them if Ofcoms so wishes. In general, GSOA prefer that AI 7 Topics to review specific RR provisions which can bring accurate solutions to specific detected inconsistencies and develop new improved provisions. As an example of this, GSOA is therefore satisfied by the latest development on Topic H restricting its scope into two specific regulatory options, in which GSOA supports that the elements of implicit agreement could apply the solution on Topic I of specific agreements and thereby even establish harmonization throughout the Planned Band Appendices through different AI 7 Topics. In addition, on the many Planned Bands Topics like E, F and H GSOA also supports exploring if bilateral coordination solutions or national licensing conditions can address encountered problems on a case-by-case basis and would therefore encourage affected administrations to actively undertake and cooperate in coordination discussions to resolve any potential interference cases in addition to consider RR changes. Under AI 7 Topic J GSOA supports on-going work to develop a Recommendation to appropriately calculate aggregate EPFD from multiple non-GSO systems into GSO networks and supports the concept of consultation meetings. In accordance with Resolution 76, the development of a Recommendation to evaluate aggregate EPFD limits in accordance with Article 22 should be based on accurate modelling of non-GSO systems. GSOA also supports development of a Terms of Reference and Recommendation containing procedures for administrations to expeditiously reduce aggregate EPFD levels to those given in Table 1A to 1D, if aggregate EPFD limits are exceeded. However, such procedures are dependent on development of the aforementioned Recommendation to accurately calculate the aggregate EPFD from multiple nonGSO systems

Question 14: Noting that any UK position will be developed only after the ITU Plenipotentiary Conference, do you have any comments relating to the use of Article 48 that may be addressed at WRC-23?	GSOA is of the view that the sovereign right of each Member State to regulate its telecommunications needs to be fully recognized. The ITU Constitution further recognizes the rights of member states for complete freedom in matters related to National Defence as enshrined in Article 48 of the ITU Constitution. Nonetheless, it is also recognized that Member States are bound to abide by the spirit and the provisions of the ITU Constitution, and are strongly encouraged to observe the provisions of the Administrative Regulations concerning the types of emission and the frequencies to be used, according to the nature of the service performed by such installations.
Question 15: What are your views on the need to establish an international regulatory environment for sub-orbital vehicles, which at the same time does not limit flexibility of spectrum options, and retains international safety considerations?	Agenda item 1.6 aims to respond to the communication requirements for suborbital vehicles, which include satellite launch vehicles, rockets for sub-orbital space tourism and space planes. These applications have a wide range of communication requirements that are not able to be accommodated by the current Radio Regulations, in particular because suborbital vehicles may be both space stations and terrestrial stations, and do not fit within the current regulatory framework for satellite or terrestrial systems. Satellite systems already provide various communication services to aircraft, and satellite systems are well placed to support future suborbital vehicle communication requirements. An internationally agreed regulatory framework would support the development of UK proposed launch operations. GSOA therefore supports Ofcom's proposed approach, to support the creation of an international regulatory environment. This should be sufficiently flexible to cover a wide range of categories of suborbital vehicle, including space launch vehicles and vehicles which may or may not operate in shared airspace with conventional aircraft.

Question 16: Do agree that where the adjacent band compatibility issues are addressed and ICAO coordination processes are not compromised, that the addition of an aeronautical satellite (AMS(R)S) allocation to the band can be supported?	GSOA expresses no view on this question.
Question 17: Do agree that functions related to international aviation safety are a matter for ICAO? On this basis, and absent any contrary information from ICAO, should the UK support the development of an international spectrum regulatory framework for UA use of FSS that would support efficient use of spectrum?	Yes, GSOA agrees that functions related to international aviation safety are a matter for ICAO, and UK could support such a regulatory framework as long as it doesn't not adversely affect the regular FSS coordination and regulatory situation. However, so far that insurance is not evident in ITU-R noting the status of the partial draft CPM text with a modified Resolution 155.
Question 18: Recognising the recent diminishing industry interest in this item relating to possible modification of the aeronautical HF assignment plan, and the general lack of global interest, do you agree that UK move towards a No Change proposal under this agenda item?	GSOA expresses no view on this question.
Question 19: What are your views on the need for additional spectrum, specifically in the 15 and 22 GHz bands, for non-safety aeronautical use?	GSOA believes that sharing difficulties could arise in bands shared with the fixed-satellite service (e.g., 17.3-21.2 GHz).
Question 20: What are your views on Agenda Item 1.11 and the proposed UK position to support modernisation of GMDSS?	Satellite systems have long held a major role in the GMDSS and that role will continue in the future with the modernization of the GMDSS and with the potential new MSS system, "Beidou". Regarding issue A, GSOA agrees with and supports the proposal that Member States should support the possible regulatory actions needed to implement the modernization of the Global Maritime Distress and Safety System in the RR. As identified by Ofcom, one of the issues currently under discussion relates to the future use of the band 1645.5-1646.5 MHz, which is no longer required for satellite EPIRBs, following a recent decision by the IMO to remove them from the GMDSS. GSOA recommends that this band, which is allocated to the MSS (Earth-to-space) should continue to be available to support

	maritime satellite communication requirements. To ensure the band is used efficiently, GSOA supports that going forward, the band may be used GMDSS communications requirements and for general communications for ships operating in the GMDSS. GSOA agrees that no action needs to be taken under Issue B. Regarding issue C, it should be ensured that the potential new MSS operator complies with the standard ITU requirements for coordination with other satellite operators.
Question 21: What are your views on the approach to the review of 1240-1300 MHz, recognising that discussions concerning future satellite navigational needs for the UK are a matter for Government?	GSOA expresses no view on this question.

Question 22: What are your views on a new spectrum allocation in the 40-50 MHz range to support and enhance climate monitoring, such as, environmental shifts in ice sheets?	GSOA expresses no view on this question.
Question 23: What are your views on upgrading the Space Research Service allocation, from secondary to primary, in the 14.8-15.35 GHz band?	GSOA expresses no view on this question.
Question 24: What are your views on the potential for defragmentation in this band to facilitate both EESS (passive) use and provide for larger contiguous blocks for fixed & mobile allocations?	GSOA expresses no view on this question.
Question 25: Do you agree that formal international recognition for Space Weather Sensors should be implemented in the Radio Regulations?	GSOA agrees that space weather sensors are important applications, not least since space weather events can sometimes affect communication satellites. Space weather sensors should be recognised and included in the Radio Regulations. GSOA has noticed that a wide range of frequency bands are potentially of interest for space weather sensors, but currently no sharing studies have been conducted with the existing allocated services. The introduction of new allocations or revised allocations to support space weather sensors could have some repercussions on the existing services, potentially introducing new constraints on the use of the band by existing services. Hence it is important that the necessary sharing and compatibility studies are carried out before any changes to the Articles of the Radio Regulations are introduced.
Question 26: What are your views on the limits proposed to protect EESS (passive) under Agenda Item 9.1 topic d) and do you have any views on which of these limits might be accommodated in the Radio Regulations and how?	GSOA believes that this item should not result in any regulatory action which would create undue constraints on non-GSO FSS systems. GSOA notes that sharing studies conducted in the ITUR have shown that when proper operational characteristics of non-GSO systems are taken into account, there is no exceedance of EESS protection criteria.

Question 27: Do you agree that the formalised time reference in common global use, is not a matter of spectrum regulation?	GSOA expresses no view on this question.
Question 28: Do you have any comments concerning the Standing Agenda Items, where not covered elsewhere in this document?	GSOA supports retaining the current process of continuing evolution at successive WRCs with the existing standing agenda items generally and in particular the development regarding the regime governing space services.
Question 29: Do you have a view on any of the footnotes to which UK is a party?	GSOA expresses no view on this question.
Question 30: Are you aware of any specific issues, not covered elsewhere in this document, which are likely to be raised in this part of the Director's Report and of which you think Ofcom should be aware?	GSOA notes that there is on-going work at the ITU-R concerning the scaling factor in No. 21.16.6. This work was based on an invitation from WRC-19 to study the appropriateness of the equations in No. 21.16.6 when applied to large NGSO systems with a number of satellites > 1000. GSOA recognizes that studies at ITU-R WP4A have conclusively recognized that the equations in No. 21.16.6 are inappropriate when applied to NGSO systems with N>1000, and studies are on-going to develop a solution. As this issue was recognized by WRC-19, but not as an associated WRC agenda item, GSOA supports

	the discussion of this item and potential solutions at WRC-23.
Question 31: Do you have any comments on Agenda Item 9.3 considering Resolution 80?	Not yet other than supporting the useful standing Agenda Item summarizing the RRB work, but GSOA would be happy to provide comments once the Resolution 80 is available for review.
Question 32: What changes to the Radio Regulations have you identified that would benefit from action at a WRC and why? Do you have any proposals regarding UK positions for future WRC agenda items or suggestions for other agenda items, needing changes to the Radio Regulations, that you would wish to see addressed by a future WRC?	WRC-19 allocated 51.4-52.4 GHz for GSO FSS gateway links. GSOA believes that it may be necessary to investigate the possible use of this band for NGSO FSS, ensuring the protection of the GSO FSS networks and associated gateway earth stations operating in this band. In the case of considering potential new candidate frequency bands for allocation to the mobile service and/or new identifications to IMT in a future WRC, GSOA encourages Ofcom to exclude any frequency band currently allocated to satellite services or under discussion for potential new allocations to satellite services at the WRC-27. As mentioned under Question 12 above, it could also be beneficial to explore a future agenda item to align the new allocation to FSS downlinks in 17.3-17.7 GHz in Region 2 with a similar allocation for Region 3 as well to achieve a global allocation.
Question 33: What are your views on the use of IMT stations that use antennas that consists of an array of active elements, in bands shared with satellite services?	**Correct application of RR21.5 to IMT/mobile stations that use an array of active elements (AAS)** Discussions and proposals in WP 5D on these issues are currently grouped into two approaches. With one approach focusing on a total radiated power (TRP) approach (for the entire antenna array of active elements) possibly with a reference bandwidth, and another approach based on conducted power delivered by a single transmitter or a single radiating element.

- Approach 1: Apply the RR No. 21.5 limit to the TRP of the entire antenna array of active elements, with two alternatives:
  - Alternative 1 that applies the bandwidth Adjustment Factor (BAF) As noted above, there is a need to update Table 21-2 to include frequency bands, where reception by space stations is to be protected when these frequency bands are shared with equal rights with the fixed or mobile services (including for IMT stations), and not yet included in Table 21-2.

The following frequency bands should be added to Table 21-2:

- FSS allocations in 24.65-25.25 GHz (Region 1), 24.75-25.25 GHz (Region 2), 42.543.5 GHz, 47.2-50.2 GHz, 50.4-51.4 GHz and 81-86 GHz.
- MSS allocations in 43.5-47 GHz, 66-71 GHz, and 81-84 GHz.

The need to protect both the GSO orbit and NGSO systems in multiple orbits.

There are frequency bands (e.g. Ka-band, Q/V bands) shared between terrestrial services and satellite uplinks that are used for NGSO systems operating in multiple orbits.

Protection of satellite services (uplinks) from aggregate interference from mobile/IMT systems is necessary for both the GSO orbit and NGSO systems in multiple orbits.

A correct application of the RR21.5 limit to IMT/mobile stations that use an array of active elements (AAS) together with the necessary update of Table 21-2 is crucial to ensure protection of both the GSO orbit and NGSO systems in multiple orbits.

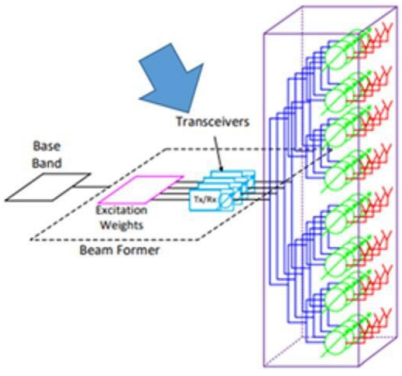
CONCLUSIONS

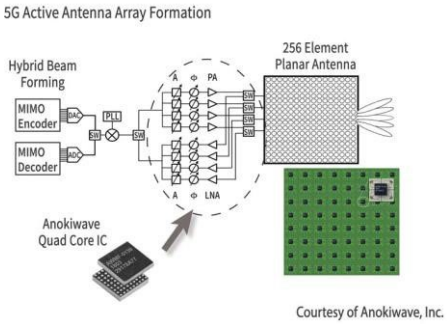
- The RR21.5 limit determines the sharing environment between terrestrial services and receiving space stations. It is an overarching principle of the Radio Regulations for both terrestrial and space services.

	• For AAS, the radiating elements behave as a single antenna and the RR21.5 limit should be applied to the TRP of the entire antenna array of active elements. • Approach 1 (RR21.5 limit applied to the TRP of the entire antenna array of active elements) is the only approach that can ensure protection of space services (Approach 2 cannot protect space services). • It allows for high power/eirp levels, higher than IMT parameters assumed in TG5/1 or WP5D studies and thus does not constrain IMT deployment nor performance, and even provides margin for future development of IMT. • Consistently with the RR definition, Table 212 should be updated to include frequency bands, where reception by space stations in these frequency bands are shared with equal rights with the fixed or mobile services (including for IMT stations). • There are frequency bands (e.g. Ka-band, Q/V bands) shared between terrestrial systems and satellite uplinks that are used for NGSO systems operating in multiple orbits. Protection of satellite services (uplinks) from aggregate interference from mobile/IMT systems is necessary for both the GSO orbit and NGSO systems in multiple orbits. A correct application of the RR21.5 limit to IMT/mobile stations that use an array of active elements (AAS) together with the necessary update of Table 21-2 is crucial to ensure protection of both the GSO orbit and NGSO systems in multiple orbits. For the 26 GHz band, GSOA supports the use of TRP and a reference bandwidth of 200 MHz. The consultation document states that the use of 200 MHz many unnecessarily impact the deployment of IMT systems. This is certainly not the case for the 26 GHz band, where use of 200 MHz reference bandwidth (and retaining the current power limit of +10 dBW) allows for an increase of around 12 dB in the powers that were considered in the TG5/1 studies conducted prior to WRC-19.

	To properly protect satellite receivers, the reference bandwidth should be used as a scaling factor for IMT stations with bandwidths higher and lower than 200 MHz. GSOA notes that Ofcom sees a need to carefully consider this issue, over a time not necessarily set by WRC-23. However, if no urgent action is taken to ensure the correct application of the RR No. 21.5 limits and the necessary update of Table 21-2, this could in the long term render some satellite uplink bands as unusable due to excessive uplink interference. Therefore Ofcom should prioritise seeking a resolution to this issue, for the 26 GHz band and for other satellite uplink bands, if necessary with a new agenda item for WRC-27.

Technical annex on RR21.5 for AAS

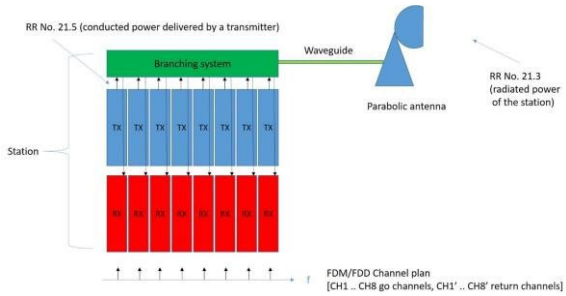
Single transmitter/radiating element approach arguments	**GSOA view**
There is no need to make any changes to RR No 21.5 for the notification process, as the AAS antennas can be considered to be covered already under the FXM guidelines (based on the quotes “In fact, there is no limit concerning the number of ‘antennas’ for a notice, and no limit concerning the number of receiving sites per antenna.” and “there is no limit concerning the number of transmitting ‘antennas’ for a notice.”.	This argument is highlighting that the current process of notification for terrestrial stations allows for each radiating element to be considered as a separate antenna. For example, an 8x8 array would be submitted as a single station with 64 separate “antennas”, and the power of each individual element would be checked by the BR against the RR 21.5 limit. This approach, if it were to be followed by administrations, would allow IMT stations to transmit at power levels 10s of dBs higher than the current sharing environment, which will cause interference to space stations. Such a huge increase in power for IMT stations is not acceptable in the context of interference to satellite uplinks and would even exceed human exposure limits for some antennas. The radiating elements in an AAS antenna do not operate in isolation but work in unison to create a single beam. Therefore, for the purpose of notification and for the purpose of checking with compliance with power limits, the AAS as a whole should be treated as single “antenna”. There is the need to clarify that for AAS the RR21.5 limit is to be applied to the TRP of the entire array of active elements.
The RR No. 21.5 limit should be applied to each single transmitter within the AAS	AAS antennas typically contain multiple transceivers. In some designs, the transmitter Power Amplifier (PA) is placed before splitter and phase shifters (see example in figure below which has four transmitters).  In some other designs, the transmitter PA is placed after the splitter and phase shifters (see for example the figure below, which has 256 transmitters, one for each element).

	 Courtesy of Anokiwave, Inc. In both examples, a single radio frequency channel, or single frequency assignment, undergoes amplification by multiple power amplifiers. In the first example (4 transmitters), the power measured at the output of a “single transmitter” is one quarter of the total transmitter power experienced by the frequency assignment. In the second example (256 transmitters), the power measured at the output of a “single transmitter” is 1/256th of the total transmitter power experienced by the frequency assignment. Two different designs of AAS can perform identically in terms of the EIRP, antenna gain and beamwidth, but have very different values of “single transmitter power”. These examples illustrate two important points: 1. In antennas which contain multiple transmitters, measuring the power of “each single transmitter” can significantly underestimate the actual transmitter power experienced by the frequency assignment. 2. Different internal designs will produce different values for the power of “each single transmitter”, even for antennas that have the same critical characteristics (antenna gain, beamwidth, EIRP). A solution is required that is independent of the internal design of the AAS antenna, and the use of TRP meets this requirement.

RR No 21.5 is not the right 'vehicle' to protect space services, since without having information about antenna performance knowing the antenna gain towards the satellite, it is not possible to assess the protection of space services (or interference towards the satellite receiver)	This statement is contradicting an overarching principle of the Radio Regulations. The RR No. 21.5 limit determines the sharing environment between terrestrial services and receiving space stations. It cannot be dependent of each and every satellite system / orbital position / types of orbit. The RR No. 21.5 limit is relevant and useful because the power delivered to an antenna of a fixed or mobile station is equivalent to the average power radiated in all directions, and so is useful in particular when aggregate interference from a large number of terrestrial stations needs to be considered, which is the case here. That is why this parameter was adopted in the 1960s or 70s when the limit was first added to the RR.

If the number of antenna elements is increased, the interference to the satellite uplink will not increase proportionally to the total power increase of the base station. Hence, the power limit defined in No. 21.5 is not the interference power 'seen' by the satellite receiver	Studies in WP5D have shown that for some AAS antenna designs, increasing the number of antenna elements does not lead to a one on one dB increase on the interference level, but rather a 1-0.5 dB increase. To address this comment, a proposal was made in WP5D to take this into account through an antenna array factor (in addition to the bandwidth adjustment factor). This comment also does not address the fact that for some other AAS antenna designs, increasing the power of each radiating element, but keeping the number of elements unchanged, does indeed increase the interference radiated towards a satellite proportionally (1 dB for 1 dB). This design also needs to be considered, but seems not to be addressed by the single transmitter proponents

On potential impact on IMT: As technologies evolves, the number of antenna elements could increase as could the bandwidths (especially at higher frequencies). Incorrect application of the power limit in No. 21.5 could stifle innovation and development in other frequency bands. Coverage and data throughput will be severely hampered	This statement is in contradiction with statements regarding the IMT parameters and assumptions made during the TG 5/1 studies, which in particular gave an assurance that any changes to IMT base station characteristics would not lead to increased EIRP. There is no evidence/proof/study that supports the statements made about “stifling innovation” and “severely hampering” data and throughput. Some of the hypothetical antenna designs put forward by the mobile industry would lead to such high EIRP that they could not be deployed without exceeding human exposure radiation limits. The RR No. 21.5 limit applied to the TRP of the entire AAS array allows for high power/eirp levels, higher than IMT parameters assumed in TG5/1 or WP5D studies. It does not constrain IMT deployment nor performance in view of IMT parameters in WP5D, and even provides some margin for future development of IMT.
The TG 5/1 studies are based on a set of parameters which are inter-related, whether they are derived from radio specifications or the envisaged typical 26 GHz deployment. Modifying any of these parameters in isolation could be misrepresentative of how IMT is to be deployed worldwide	There is no proposal to modify the TG 5/1 parameters. The proposal to use TRP, supported by many administrations and the satellite industry, would however give some flexibility for mobile operators to diverge from the TG 5/1 parameters if they choose to do so.
Some technical assessments extended the TG 5/1 aggregated interference studies to satellite by increasing only the number of antenna elements of all IMT BS beyond the sensitivity analysis agreed. Therefore, the assessment is not entirely representative of IMT deployments for this frequency band	Similar counter-argument as before. The contradiction is that on the one hand the IMT community does not want to accept studies that deviate from the TG 5/1 baseline parameters, but on the other hand, they want to have the full flexibility for diverging from such parameters in real life.
FS systems in the 50s/70s used multiple transmitters feeding a single antenna.	Reference is sometimes made to FS systems, as a historical example where a station contains multiple transmitters. The example used shows

	multiple TX/RX pairs, connected to the same antenna, through a “branching system”.  Leaving aside the apparent error in the definition of the reference point of No. 21.5 (which should be the power delivered to the antenna, rather the power delivered to the branching system), the example illustrates a case where each of the 8 TX/RX pairs is fed from a <u>different</u> channel. In this example, the 8 channels (CH1 to CH8) correspond to 8 separate frequency assignments, each of which is treated separately for the purpose of notification and for compliance with No. 21.5. The situation is quite different to the case of IMT systems using AAS antennas, where each TX/RX pair operates on the <u>same</u> RF channel and the <u>same</u> frequency assignment. This example is therefore not a relevant comparison to the situation for IMT stations using AAS antennas.
Resolution 242 applies adequate protection limits to protect satellite services in 26 GHz	It is sometimes argued that Resolution 242 (WRC-19) contains sufficient regulations to protect satellite services, implying that compliance with RR No. 21.5 is not necessary in any case. The provisions contained in Resolves 2.1 and 2.2 are not hard limits, but can be considered more as “guidelines”, using language such as “...are normally pointing below the horizon...” and “as far as practicable...”. Even if these requirements were applied by IMT operator without exception, they would not on their own provide adequate protection to satellite reception. For example, AAS antennas with much higher transmitter power per element could be deployed, while still meeting the conditions in resolves 2.1 and 2.2, but leading to increased interference due from the AAS antenna sidelobes. The need to study the application of No. 21.5 to AAS antennas was agreed at WRC-19 as part of the compromise agreement on conditions to allow the identification of the 26 GHz band for IMT. Furthermore, there are frequency bands (e.g. Kaband, Q/V bands) shared between terrestrial services and satellite uplinks that are used for NGSO systems operating in multiple orbits.

	Protection of satellite services (uplinks) from aggregate interference from mobile/IMT systems is necessary for both the GSO orbit and NGSO systems in multiple orbits. A correct application of the RR21.5 limit to IMT/mobile stations that use an array of active elements (AAS) together with the necessary update of Table 21-2 is crucial to ensure protection of both the GSO orbit and NGSO systems in multiple orbits.