OQ Technology Reply to:

Public consultation on the Drat RSPG Opinion on assessment of different possible scenarios for the use of the frequency bands 1980-2010 MHz and 2170-2200 MHz by the Mobile Satellite Services beyond 2027

Introduction

OQ Technology (OQ Tech) welcomes this latest Call for Comments on the RSPG's assessment of the different possible scenarios for the use of the frequency bands 1980-2010 MHz and 2170-2200 MHz beyond 2027. As RSPG points out, this initiative is key to maximising the efficient use of these important spectral resources across the EU and unlocking their potential socio-economic benefits across the region through a coordinated assignment model among the Member States. Indeed, the original spectrum award in Europe could not have foreseen the evolution of important technological and market developments we are seeing in the satellite industry today, which are intensifying the demands on this prime spectrum in Europe.

As RSPG is already familiar, OQ Tech is an EU company based in Luxembourg and has for several years been developing its business as a global-leading satellite 5G IoT operator, for next-generation IoT and machine-to-machine (M2M) communication solutions beyond terrestrial reach. OQ Tech has been growing its satellite constellation with several satellite launches since 2021, starting with the successful launch and tests of the OQ Tech Tiger-2 nanosatellite and subsequent launch of Tiger-3 in April 2022 and Tiger-4 in June 2023. Most recently, in November 2023, Tiger-5 and Tiger-6 were launch aboard SpaceX's Falcon 9 rocket (rideshare mission Transporter-9). The latest two satellites join the OQ Tech satellite constellation which now has a total of 8 satellites. The eventual OQ Tech satellite constellation will comprise of hundreds of satellites.

The OQ Satellite constellation can provide full coverage of the EU territory. Depending on the location of the specific end user customer in Europe, the satellites could be accessed anywhere while the satellite is passing over the territory. Such locations would typically be in remote or low-density areas where terrestrial network coverage does not sufficiently reach and given the targeted use cases for OQ Tech's satellite IoT service (oil and gas, energy, agriculture, logistics, maritime, etc.). The OQ Tech network is ready for services as of today and could be made available to the EU market upon the regulatory approvals being granted at EU and national level.

In November 2023, OQ Tech also proudly announced the signing of a Memorandum of Understanding (MoU) with o2 Telefónica, ushering in a new era of global IoT Satellite connectivity. Commencing in Q2 2024, o2 Telefónica will roll out global 5G roaming, enabling Narrowband IoT (NB-IoT) solutions deployment worldwide. This collaboration empowers businesses with reliable IoT services, even in previously inaccessible areas. OQ Tech's satellite network will integrate seamlessly with Telefónica IPX Cloud and Kite, o2 Telefónica's award-winning IoT connectivity management platform, offering business customers real-time SIM card monitoring and control globally.

On the technology side, OQ Tech has implemented and proven NB-IoT technology over the LEO nanosatellites, as standardised in 3GPP Releases 13 - 17 and considered for 5G massive machine communication (mMTC). OQ Tech has also developed a patented chip that can be easily integrated with existing 5G terrestrial devices, to allow billions of users globally to have ubiquitous IoT connectivity anywhere and roam seamlessly onto the OQ Tech satellite network (direct-to-satellite connectivity): OQ Tech's dual-mode satellite-cellular IoT modem and tracker is a plug and play small, low cost, and low power solution that can collect data from more than 1000 sensors, has built-in GPS, and supports 5G NB-IoT, GSM, LTE-M and bi-directional Satellite links.

As highlighted in previous RSPG consultations on this matter, OQ Tech is very interested in the 2GHz MSS bands to deploy its next-generation Satellite 5G IoT communications service and hardware to key industry segments in Europe, as described. As RSPG notes, under 3.2.3.2.2 "Further benefits/incentives to the EU", the benefits of satellite-based IoT solutions like OQ Tech's to the European market are clear and envisaged for powering and optimising its key national industries, such as Smart Grid/ Energy, Logistics, Agriculture, Maritime, Transportation, Oil and Gas, among others, for enabling mission-critical applications, remote asset monitoring and sensor-based connectivity beyond the European terrestrial networks. Significant IoT growth is coming from European

industry sectors, as stakeholders are increasingly looking to IoT to drive greater efficiencies, manage costs and improve the bottom line through real-time monitoring of thousands of assets, which should lead to better asset utilisation, reduced waste, increased output and improved safety. These ambitions also fit within the national and EU policy goals together aimed at fostering digital transformation across different sectors and increase investments in this field.

As RSPG recognises, under Section 3.2.3.1.1 "Spectrum requirements", the 2GHz MSS frequencies have a unique status allocated to Mobile Satellite Service on a global basis and is also shared on a primary status with Fixed service and Mobile service. This provides an excellent opportunity to offer improved interoperability between space and ground networks while not over complicating the ground segment or the space segment, and making the most efficient use of the spectrum. The 2GHz MSS spectrum also offers a good compromise between propagation condition and spectrum bandwidth. For these purposes, OQ Technology is targeting those bands for its planned satellite system.

OQ Tech provides some input and comments below on the Sections 3.2 and 3.3 of the RSPG Draft Opinion dealing with the technical criteria and band segmentation Scenarios under consideration for the 2 GHz MSS frequency band beyond 2027.

Technical scenarios and criteria (Section 3.2)

The OQ Tech service and technology fits primarily into Scenario 3 of the different possible scenarios assessed by RSPG for the use of the 2 GHz MSS frequency band beyond 2027 (under Section 3.2) – that is, "**M2M/IoT ecosystem**" (Scenario 3). As above, OQ Tech is pioneering the NB-IoT technology in particular, as a 'standards-based' sub-category of M2M/ IoT services. Under this model, the OQ Tech radio air-interface is compatible with the NB-IoT which was standardised in 3GPP Releases 13 – 17. OQ Tech have also published patents on NB-IoT implementation over LEO satellites.

OQ Tech concurs with RSPG's core view that, in order to allow for an adequate assessment of the current and possible future technology uses/scenario(s) for the 2 GHz MSS bands, there should be appropriate, clear and concise assessment criteria applied under each Scenario: both from the technical and procedural (administrative) standpoints. The prime goal of any new framework should be to ensure best quality of services and platforms being offered to the EU market for the technology deployed and in conformity with harmonised technical standards guaranteeing interference free and safe operations environment, among others. As a standards-based technology, OQ Tech's NB-IoT platform allows backwards compatibility and interoperability between multiple devices and verticals. This improves competition and innovation by giving consumers and providers alternative solutions than proprietary (non-standardised) satellite technology. In terms of the specific criteria raised by RSPG under the present Consultation, OQ Tech has several comments as follows.

Concerning the bandwidth requirements (3.2.3.1.1), while some M2M/IoT devices require only uplink transmissions (such as sensors), it should be noted that the OQ Tech's NB-IoT system requires bi-directional transmissions for serving both data connection from terminal devices (uplink) and overall network control functions (downlink). This means the following channelisation options are required:

- Uplink: 3.75 kHz, 15 kHz, 30 kHz, 60 kHz, 90 kHz or 180 kHz
- Downlink: 200 kHz

The NB-IoT terminal devices deployed under OQ Tech's system would operate within the same assigned bandwidths above via frequency re-use and the downlink will be operated as a single 200 kHz channel for the network control functions. Any scenario 3 usage opted for should therefore require adequate frequencies in both the forward (1980 – 2010 MHz) and receive (2170 – 2200 MHz) terminal directions from adjacent assignments. The OQ Tech satellites are equipped with a state-of-the-art software defined radio ("SDR") payload that can be configured 'in-flight', meaning that the filters for Rx and Tx are easily software configurable. Through such capability OQ Tech can hereby guarantee that there will not be any issue in configuring OQ satellites and terminals to the precise spectrum bands assigned, anywhere within the 2GHz MSS bands 1980 – 2010 MHz (UL)/

2170 –2200 MHz (DL). This practise of software configurability of spectrum assignments is already standard practise for OQ Tech's network functions in other countries.

In any case, OQ Tech agrees with the proposed Technical Criteria (3.2.3.1) that a minimum of 200 kHz bandwidth is required in the downlink, and typical implementations for operating NB-IoT in Europe require 0.5 MHz of spectrum in the 2GHz MSS range, i.e. 2x250 kHz.

In order to ensure adequate protection measures under satellite NB-IoT assignments, the technical criteria and conditions can also include the technical parameters of the 3GPP NTN NB-IoT which are based on the essential 3GPP standards under Release 17 (which OQ Tech perfectly comply with and have been actively participating in 3GPP to create such standards). OQ Tech proposes that RSPG could spell out related provisions under the Technical Criteria for NB-IoT. The core elements are summarised as follows:

- Stations not permitted on aircraft
- An EIRP spectral density limit of -66 dBW/MHz applies at the band edge (2010 MHz) in order to protect adjacent services
- Permitted NB-IoT terminals EIRP density up to 18.3 dBW/MHz, and duty cycles of up to 10%

At minimum across the EU region, interested operators for NB-IoT should also be required to comply with relevant current or future MSS Decisions of the CEPT/ ECC/ ERC and have equipment certified with the CE mark and EU radio equipment directive 2014/53/EU (RED) where applicable. The RED establishes a regulatory framework for placing radio equipment on the market. It ensures a single market for radio equipment by setting essential requirements for safety and health, electromagnetic compatibility, and the efficient use of the radio spectrum. It also provides the basis for further regulation governing some additional aspects. These include technical features for the protection of privacy, personal data and against fraud. The terminals should also comply with the Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS) Directive 2011/65/EU, among others. As illustration, below is a summary of key certifications and standards followed by OQ Tech NB-IoT equipment:

CERTIFICATIONS	FCC CFR Parts 15 and 25 CE Red
STANDARDS	3GPP (Rel. 13 - 17) compliant RoHS compliant Up to IP68

Scenarios on possible band segmentation of the 2 GHz MSS frequency band beyond 2027 (Section 3.3)

In order to foster satellite services competition in the EU market place, it is clearly important that a variety of operators and technologies can access the 2 x 15 MHz bands. As RSPG points out, the status quo referred to under Scenario 1 (3.3.2), of retaining the two exclusive licensee assignments, is not optimal for delivering the maximum benefits of these scarce frequency resources across EU and would risk falling short on delivering the wider European Commission and Member State competition objectives according to which new entrants and technologies can be accommodated. OQ Tech therefore agrees with the RSPG draft opinion (0.4 - 10) that the "continuity scenario" (Option 1) is not a preferred scenario as this would limit competition in MSS service provision, for future technology and services innovation and associated parties like OQ Tech.

OQ Tech is pleased to see that RSPG's draft recommendations are modelled on the preferred band segmentation approach, with focus on a limited number of specific usage options when considering the future common scenario. OQ Tech outlined in detail the merits of such an approach in its previous comments to RSPG. Of the Options 2 – 4 put forward by RSPG in the current Draft Opinion (Section 3.3), OQ Tech supports the notion of *Option 2* in particular, i.e.

- 2 operators with each 2 x 10 MHz
- 2 operators with each 2 x 5 MHz

As well as enabling access to more operators (4 vs. 3), this scenario recognises the importance of segmentation between narrowband and Broadband types, where same band operations and sharing is not technically feasible, and also follows the model adopted elsewhere globally for the 2GHz MSS bands following detailed technical analyses.

The approach of dedicated narrowband assignments within the 2 x 5MHz spectrum, set aside and licensed for narrowband MSS systems under Scenario 2, gives a more proportionate and technically feasible solution for accommodating NB-IoT MSS services in Europe alongside the other service types. The segmentation approach not only makes sharing easier but it also allows more efficient use of the band and the spectrum, in keeping with the central spectrum strategy objectives at both EC and Member State level.

In OQ Tech's response to the RSPG Questionnaire on the 2 GHz MSS (April – June 2023), we provided detailed analysis to illustrate how this method enables making available a sufficient, but modest, portion of the 2GHz spectrum for NB-IoT MSS, while effectively removing the potential for interference caused by the technical disparities of NB-IoT MSS systems versus the other licensee systems, such as Broadband MSS, which could be deployed in the adjacent 2 x 10 MHz spectrum. As RSPG well notes, narrowband MSS, in particular Satellite IoT, have become widely deployed and are recognised as an important service within the NGSO MSS spectrum bands allocated under ITU Article 5 Table of Allocations (UHF, L, S-bands primarily). As previously highlighted, and recognised here under the RSPG Draft Opinion, NB-MSS IoT systems like OQ Tech's have intrinsic operational features, such as low form factor, power, etc. making such systems difficult to find suitable technical arrangements to enable adequate protection from interference by other licensed systems/services into NB-MSS operating in the same bands (i.e. under the same narrowband frequency block), at least under any co-frequency sharing basis. This technical difficulty, if not impossibility, of same frequency co-existence between Mobile, MSS and A2G/CGC was backed by ITU Resolution 212 (WRC-19) and ECC Report 233.

OQ Tech detailed in our previous response to the RSPG Questionnaire some examples of countries, outside of Europe, where a dedicated 2 x 5 MHz segment has been allocated for licensing narrowband systems. One such example is Australia where the regulator decided upon a dedicated a 2 x 5 MHz segment specifically in the 2 005 – 2 010 MHz (space-to-earth) and 2 195 – 2 200 MHz (earth-to-space) ranges. Similarly to RSPG here, ACMA also considered an alternative Scenario to segment the 2 GHz band into 2x15 MHz pairs, with no dedicated shared segment for narrowband applications. However, the ACMA considered far greater benefits in dedicating the restricted 2 x 5 MHz segment for narrowband MSS applications on a shared basis between NB-IoT MSS operators. In the absence of such a segment – whereby use of the same spectrum is authorised under an exclusive licensing arrangement – this portion of the band would still require some restrictions to provide protection for adjacent services. In addition, authorising this segment for shared non-exclusive access would also enable more intensive use of the spectrum resource. The ACMA's review also identified supporting documents from the Electronic Communications Committee (ECC), the United States Federal Communications Commission (FCC) and the International Telecommunication Union (ITU) as containing information relevant to the development of technical parameters for narrowband MSS systems. In the case of the ECC, ACMA referenced among others ECC Report 305 which discusses M2M/IoT operation via satellite. It notes for example: "[e]xisting market studies show that the bulk of satellite M2M/IoT services are based on mobile solutions with relatively low throughputs and are predominantly deployed in MSS frequency bands below 3 GHz". The report shows examples of current M2M terminals and small satellite transceiver modules available on the market and supports the possibility of narrowband MSS co-existing with adjacent-band terrestrial services.

By keeping the wider 2 x 10 MHz frequency segments used by other applications like Satellite IMT (Broadband) entirely separate from NB-IoT/ M2M IoT applications, while ensuring adequate protection measures, a guaranteed co-existence and low interference/noise environment can be ensured. Indeed Broadband MSS and NB-IoT MSS have intrinsically very different characteristics and concept of operations (power, e.i.r.p, duty cycle, multiple access mode…) whereby spectrum sharing in the same sub-band is virtually impossible. RSPG acknowledges this under Section 3.2.3. The segmentation approach would nonetheless imply adjacent band

sharing measures to protect the 2 x 10 MHz users (and vice-versa), but considering the very narrow carriers by which NB-IoT MSS systems operate, OQ Tech believes this can be perfectly achieved, even without the use of a guard-band.

Aside from the above remarks about the segmented approach under Scenario 2, OQ Tech has doubts about the RSPG proposed limitation to 2 operators only (each with 2 x 5 MHz spectrum). As RSPG itself notes M2M IoT narrowband operators require significantly smaller portions of Spectrum, i.e. 250 KHz typically in the uplink and downlink. It follows from the underlying spectrum policy and goals, that any selected future operators should be required to justify the amount of spectrum requested for operating their services. Opening one segment of 2 x 5 MHz to multiple M2M/IoT narrowband operators under much lighter conditions than the 2 x 10 MHz (broadbands) would allow the narrowband to be used to its maximum potential. According to this model, each interested operator would be granted exclusive rights to 2 x 250 KHz of dedicated frequencies, until the band would be fully occupied. RSPG is correct in noting that for NB-IoT (M2M/IoT) it is not possible to share bands and rather this dedicated assignment approach (segmentation) is more feasible because of the narrow frequencies used compared to broadband services.