# Ofcom 5G 26 GHz spectrum Call For Inputs (CFI) September 2017
# GSA Submission

## 21st September 2017

### 1. About the GSA

The GSA (the Global mobile Suppliers Association) is a not-for-profit industry organisation representing companies across the worldwide mobile ecosystem engaged in the supply of infrastructure, semiconductors, test equipment, devices, applications and mobile support services. GSA actively promotes the 3GPP technology road-map – 3G; 4G; 5G – and is a single source of information resource for industry reports and market intelligence. GSA Members drive the GSA agenda and define the communications and development strategy for the Association. The Spectrum Group within GSA is the GSA focus group for global policy matters related to the radio frequency spectrum and radio regulatory matters pertaining to the successful evolution of International Mobile Telecommunication (IMT) of ITU and associated administrative, operational and technical aspects. This response is focused on and relevant to the European aspects of 5G spectrum and may not represent the position with other regions.

The GSA has recently produced a report on making a success of 26GHz for 5G in Europe and this can be found on the website www.gascom.com.

The GSA would like to extend its appreciation to DCMS and Ofcom for their proactive approach to the development of 5G in the UK and their efforts, together with other administrations across Europe, to secure a favourable licensing and spectrum regime.

### 2. Consultation Questions

**Q2.1: What are your planned timelines for commercial availability of network equipment and devices for the 26GHz band? When will equipment for testing and trials be available? Please specify the specific mmWave tuning ranges supported and their timing.**

Equipment is available now for trials and will be available for pre-commercial and commercial deployments in 2018 and 2019.

There are significant developments in Asia and North America regarding 5G trials and planned commercial deployments. The 26 GHz and 28 GHz bands will be specified in 3GPP for 5G New Radio in the 24.25-29.5 GHz frequency range: 24.25-27.5 GHz and 26.5-29.5GHz respectively with the

target for completion by December 2017 and the latest by June 2018 during Release 15. Korea, Japan and North America are releasing spectrum within the 28 GHz band and China has consulted on releasing spectrum within the 26 GHz band.

These two bands share 26.5-27.5 GHz in common. Equipment is available now for trials in the band 26.5-29.5 GHz . First commercial implementations in the UK and the rest of Europe can benefit from early deployments and commercially available 28 GHz equipment from these other countries within the 2018-2020 timeframe, e.g. through synergy effects in product development. This all helps to generate global economies of scale which are essential in the initial phase of establishing a competitive infrastructure and terminals market for 5G equipment. As the networks scale and more spectrum is made available, the previously established equipment market can then continue to grow.

Currently, the main focus for chipsets, terminals and infrastructure manufacturers, is to meet the demand within the 26.5-29.5 GHz band but it is recognized that the 24.25-26.5 band GHz up to 27.5 GHz is also vitally important. It is essential that Administrations in Europe, China and elsewhere, licence the 24.25-27.5 GHz band as soon as possible in order to generate sufficient demand and confidence for equipment manufacturers to produce equipment for the whole band.

A number of announcements have been made regarding commercial equipment availability.

- Intel's 5G Modem supports 5G operation in both sub-6GHz bands and 28 GHz mmWave spectrum in the U.S., Korea, and Japan with a single device implementation. It pairs the 5G RFIC with the 28 GHz RFIC—supporting 5G New Radio features including low latency frame structure, advanced channel coding, massive MIMO, and beamforming. In combining the capabilities of the 28 GHz RFIC, which is already commercially available, and the 5G RFIC, the Intel® 5G Modem delivers on critical 5G requirements for multi-Gbps throughput, hundreds of MHz aggregated bandwidth and ultra-low latency.
- Qualcomm has announced the availability of its X50 Snapdraggon modem which offers 28 GHz support, 4G/5G multi-mode with dual connectivity and up to 5 Gbps download speeds. The first commercial products featuring Snapdragon X50 5G NR modems are expected to be available in 2019.
- Samsung Electronics has unveiled its end-to-end portfolio of 5G mobile network products and solutions for 2017 which included chipsets, consumer devices for fixed wireless access connectivity, a 5G Radio Base Station (5G Access Unit) and Next-Generation Core Network infrastructure.

- Ericsson is planning to release 5G base stations for 24.5 – 27.5 GHz and 26.5 – 29.5 GHz by the first half of 2019.
- Huawei, will be ready to provide E2E 5G commercial products compliant with the 3GPP standard in 2018, including New Radio and New Core equipment.
- Nokia will implement early 5G specifications, enhancing 5G FIRST with the 3GPP 5G Phase I protocol. Equipment for 28GHz is already available for trials since early 2017 as part of the 5G FIRST solution and commercial availability is planned for 2019. This RF can also be used for early trials at 26 GHz in the upper 1 GHz of the band.

Terminals and devices usually lag the announcements from the chipset and infrastructure community and announcements on these are anticipated over the next 12-18 months.

**Q2.2: 3GPP studies into NR-based operations in licence-exempt spectrum, when (if ever), do you expect to support licence exempt operation and/or coordinated sharing in the 26 GHz band in your products?**

National exclusive licenced spectrum has been a key underpinning of the phenomenal success of mobile services. This regime should be maintained as the main solution for the 26 GHz band for 5G. A different approach for this 5G pioneer band could disrupt a well-established regulatory framework and delay the take up of 5G services.

**Q 2.3: When do you expect to support standalone New Radio in the 26GHz band in your products.**

There are significant developments in Asia and North America regarding 5G trials and planned commercial deployments. The 26 GHz and 28 GHz bands will be specified in 3GPP for 5G New Radio in the 24.25-29.5 GHz frequency range: 24.25-27.5 GHz and 26.5-29.5GHz respectively with the target for completion by December 2017 and the latest by June 2018 during Release 15. Korea, Japan and North America are releasing spectrum within the 28 GHz band and China has consulted on releasing spectrum within the 26 GHz band.

These two bands share 26.5-27.5 GHz in common. First implementations in the UK and Europe can benefit from early deployments and commercially available 28 GHz equipment from these other countries within the 2018-2020 timeframe, e.g. by synergy effects in developing equipment for these two adjacent and partly overlapping bands. This all helps to generate global economies of scale which are essential in the initial phase of establishing a competitive infrastructure and terminals

market for 5G equipment. As the networks scale and more spectrum is made available, the previously established equipment market can then continue to grow.

See also our reply to Q. 2.1

**Q3.1: Are there any aspects related to the existing use of 26 GHz not covered in the CFI that you believe need to be considered.**

3.8 None identified at present.

**Q3.2: What options for the existing services in the 26 GHz band do you believe need to be considered to allow for the introduction of new 5G services? Please give as detailed a response as possible along with all relevant information and explain how you would see any potential option your provide working in practice.**

Clearing is the approach that regulators have previously and successfully followed for bands for previous mobile generations, as the benefits of an exclusive 5G band are expected to exceed the costs to clear out the incumbents (who have to find an alternative arrangement). An exclusive band for 5G provides appropriate incentives to MNOs to invest in deployments, thus facilitating fast take up. However, it is recognized that the propagation and intended use cases above 6 GHz might enable coexistence with incumbents (in some specific cases), compared to co-existence in bands below 6 GHz.

In general, the GSA is of the view that it could be possible to preserve some of the existing earth stations in the Fixed Satellite Service (FSS), the Space Research (SR) service and the Earth Exploration Satellite Service (EESS), in case they are placed in remote areas. Coexistence with 5G networks can be achieved by defining separation distances of a few kilometers around these Earth stations in rural and remote areas without impacting on the deployment potential of the 26 GHz band for 5G in urban and sub-urban areas. In practice, this means that 5G providers could be awarded national spectrum blocks licenses with a number of well-defined exclusion zones around the Earth stations, where 5G use is not allowed or is severely limited. New Earth stations should only be authorized following a commercial agreement between the Earth station operator and the 5G licensee. The GSA believes that this kind of agreement can be achieved between 5G licensees and Earth station operators, especially, at remote locations where 5G is unlikely to be deployed in 26 GHz band.

It may not be feasible to share a 26 GHz band in the same geographical area between traditional ubiquitous point to point links and 5G. Point to point links require a high reliability and it will be difficult to ensure this if the 26 GHz band is shared. The GSA is of the view that planning for re-farming of fixed links should commence in advance of the spectrum being released for 5G. However, there are a high number of fixed links deployed in the 24.5-26.5 GHz spectrum, which can create an

obstacle in many European countries to release the whole band for 5G. For this reason, it is recommended to release first the 26.5 – 27.5 GHz to facilitate fast deployment of 5G in Europe and in the longer term, a solution is needed for the lower part of the 26 GHz band. It is also noted that, as the fixed link operators are often the same as the expected 5G operators, there may be ways to agree with the operators, how they can use the same frequency band for 5G in densely populated areas and for backhauling in other areas.

Administrations could take the following actions to mitigate disruption to fixed links users:

- Stop issuing new licenses for fixed links in this band as soon as possible
- Provide notice to the existing users of the revocation of licenses after a period of time
- Put in place a program of migration to other fixed service bands that could be well suited for 5G backhaul

3GPP is also developing 5G technology to enable the option for MNO in-band backhaul (self-backhauling) so that 5G base stations can be rapidly deployed and then the traffic backhauled by the MNO using the same spectrum. This enables base stations to provide communications between the end user device and also other base stations in the same spectrum.

**Q3.3: Should a moratorium be placed on issuing new licences in the 26GHz for existing services? E.g. to ensure that the 26GHz is not unnecessarily encumbered prior to the development of a new authorisation / licensing approach for 5G services.**

3.10 Yes.

**Q4.1: What service would be delivered and to which consumer and/or organisations.**

5G will support frequency bands within a very wide range (450 MHz to 86 GHz), exploiting the specific characteristics of the different bands.

**High Frequencies** such as 26 GHz provides complementary hot spot coverage to 5G in medium and low frequencies. 5G hot-spots in 26 GHz will enable high capacity and high density solutions to be dropped into an operator's network with up to 20 Gbit/s peak throughput.

**Medium Frequencies** (2 to 6 GHz) relies on the best compromise between capacity (strictly related with bandwidth availability) and coverage meeting a large portion of the 5G/IMT-2020 requirements. 5G in 3300-4200 MHz range will facilitate consistent user experience ranging from high capacity and high density to wider coverage, to also address suburban areas and small towns without requiring extra site densification compared to current deployments.

**Low Frequencies** (below 2 GHz) will ensure wide area, deep coverage for urban, suburban and rural areas: a fundamental complement to the higher frequencies ensuring consistent wide area services, including deep indoor coverage.

The diagram below describes the role of the different frequency ranges, with respect to the 5G usage scenarios as defined by the ITU-R ([1]).

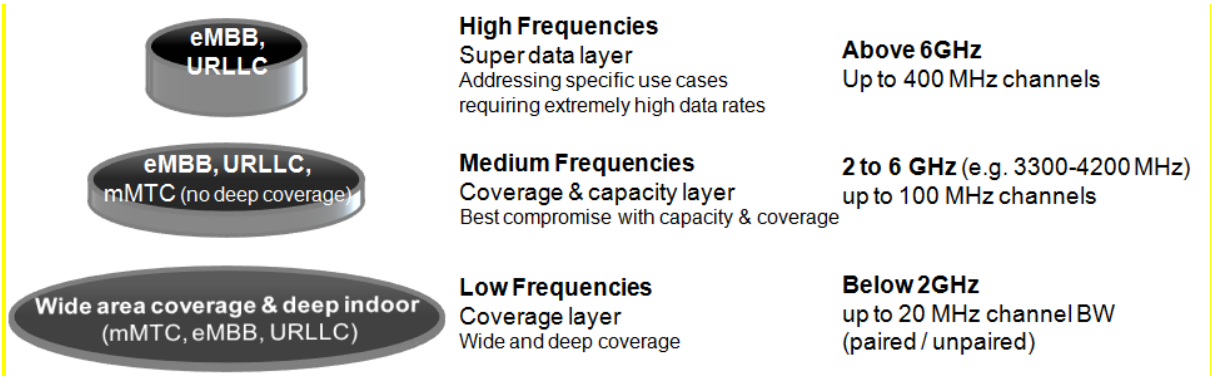


*Figure 1: the role of 26 GHz.*

In the first wave of 5G investments, it is expected that operators will focus on applications involving the enhanced Mobile Broadband (eMBB) and Ultra Reliable Low Latency Communications (URLLC) usage scenarios for dense urban, urban and suburban scenarios. Diversified rollout scenarios including indoor hotspot, dense urban, urban and rural macro will be addressed.

The following paragraphs briefly describe some of the foreseen applications that will benefit from the availability of 5G;

**Mobile Virtual / Augmented Reality and Ultra High Definition Video**

Ultra high definition (UHD) video represents the natural evolution of today's video-based services, in line with the continuous improvement of device capabilities. Delivery of UHD video will require throughputs in the order of 30-40 Mbit/s (4K) and 80-100 Mbit/s (8K) with latency in the order of 20 ms (end-to-end) ([2]).

There is high expectation on the future role of wireless video immersive experiences through augmented and virtual reality (AR / VR) that will be delivered with high-end 5G smartphone

[1] Recommendation ITU-R M.2083-0 (09/2015) – 'IMT Vision – Framework and overall objectives of the future development of IMT for 2020 and beyond'

[2] Huawei M-Lab 2016.

providing connectivity to glasses and 360 degrees cameras. Gaming ([3]), entertainment, tourism, education, live personal streaming of events are just initial examples among many.

AR / VR will lead to throughput requirements in the order of 50 Mbit/s to 1 Gbit/s and 10 ms latency (end-to-end) ([4]).

**5G fixed wireless access services and smart home**

In past years, mobile operators have successfully embraced new business models by adding fixed wireless access (FWA) to their mobile broadband (MBB) offer. Wireless customer premises equipment (CPEs), based on 4G and 4.5G, have received significant acceptance in the market, in addition to xDSL broadband modems: a complement to the operators' fixed broadband (FBB) offer or a means to compete with other existing FBB operators.

3300-4200 MHz is the best frequency range below 6 GHz, and 26 GHz and 28 GHz are the best available frequencies above 6GHz, to support the development of FWA services and to further support the development of FWA 'fibre-like' quadruple-play ([5]) services under the same infrastructure and commercial package. For example 26 GHz could provide the wireless link from the base station to the home and a 5G/Wi-Fi access unit in the house can then provide very high speed Wi-Fi broadband coverage within the home. Operators can also extend their FWA offer by including the Internet of things (IoT) smart home services based on 5G (e.g. video alarms offering, remote e-health services for elderly people, etc). There are opportunities to offer home gateways providing both short range connections (typically BT LE, Wi-Fi, Zigbee, etc.) to connect objects within the home and 5G access to connect the IoT platform in the home to the network.

**Smart manufacturing**

Cable-free robots will be connected to the manufacturing network with low latency and reliable 5G, with clear benefits in terms of manufacturing process flexibility and reduction of cabling costs.

Other aspects in the manufacturing process that will benefit from 5G include: management of local, national and international logistics, wireless data acquisition for mass industrial sensors in the factory, intelligent production scheduling, energy consumption control, real-time equipment monitoring, remote exception handling (AR technical assistance, HD video / VR spread to remote expert).

[3] Notably, the success of Pokémon Go illustrates an entertainment/gaming usage scenario that used augmented reality to disrupt mobile gaming.
[4] Huawei M-Lab 2016.
[5] Voice, video, data connectivity with mobility when required.

**Healthcare**

Remote mobile health care would allow individualized consultations, treatment and patient monitoring outside traditional healthcare institutions (hospitals and clinics): patients and practitioners could use video conferencing, telepresence, 3D hologram video facilities for remote consultations and visits, which would require live video feed (4K, 8K, 3D) in both uplink and downlink for remote healthcare (consultation, diagnosis, treatment, monitoring). Health sensors could be used to remotely monitor progress of treatment in real time. 26 GHz 5G hot-spots could be deployed in key areas of a hospital for example.

**Q4.2: Where in the UK would the 26GHz spectrum be used to deliver services? For example, will deployments be focussed on:**

**a) Areas of existing high mobile broadband demand?**

Yes, high mmW bands like 26GHz will be typically used in hotspots and indoors.

**b) Rural areas?**

Yes, in some selected (mainly hot spot) locations in rural areas. 5G coverage in rural areas and wide area mobility services will be provided by low band spectrum.

**c) Rail and road corridors**

Yes, but depending on propagation circumstances, e.g. in clear line of sight flat terrain, there might be some possibilities to serve road and rail corridors along with lower frequency bands.

**d) Specific types of enterprise or industrial sites?**

A very efficient way to address vertical markets is to have the service offered by MNOs through the network slicing functions. 5G networks are being defined to have the capability to serve different usage needs in terms of data rate, reliability, latency, number of devices, etc. MNOs can define slices that respond to the needs of specific vertical markets, and these slices could run over different frequency bands. For instance, a smart grid network would require ubiquitous coverage to be offered by low frequencies, but a smart factory might require very high data rates at a localised facility and hence a band above 6 GHz could be used.

Another approach is one where the vertical user leases spectrum from the MNOs and deploys its own network at its premises. In order to respond to vertical market's needs, it would be wise to remove all regulatory barriers from leasing/secondary markets in 26 GHz spectrum. Leasing has already been successful in facilitating access to 4G spectrum by verticals: for example, the Rivas city

council in Madrid has deployed a LTE private network for critical communications using spectrum leased from MasMovil, a Spanish MNO.

If the regulator determines that leasing is not happening in an effective and efficient manner (i.e. MNOs might not engage in leasing) and at fair and reasonable conditions, then it could consider "use-it-or-lease-it" clauses, or indicating upfront that it will take action ex-post if there is evidence that MNOs are not responding to leasing requests.

Finally, another approach could be to reserve a separate sub-band for geographic/local licences. Such authorisation would suit the requirements of verticals who wish to use the spectrum only in restricted geographic locations (ranging in size from regions to individual premises).

It is the view of the GSA that verticals, such as factories, stadiums, etc, can be served by MNO's networks using network slicing, sub-leasing and use-it-or-lease-it conditions within this spectrum. Once a competitive 5G market has developed and, at that point in time, if network slicing, leasing and use-it-or-lease-it conditions do not allow vertical markets to grow, then regulators could consider making dedicated spectrum available. This could strike a reasonable balance between establishing the 5G market with MNO's and providing a pragmatic solution for verticals

**e) indoors or outdoors?**

Both. Outdoor deployments will be typically for urban and suburban hotspots.

**f) Specific nations or regions of the UK?**

Cities, significant suburban & urban hot spot areas, some rural areas , industrial & research areas and transport corridors.

**Q4.3: Where 5G cells are deployed, are they expected to be individual cells or as clusters of cells required to give wider areas of contiguous coverage? What would be the area of a typical contiguous coverage cell cluster?**

3.13 It depends. Typical distances quoted are 100-300 metres depending upon the use case. The ongoing 5G FWA trial with Arqiva in London will give further information on the balance and real world relationship between coverage, data rates, capacity, power, etc. For smart cities applications such as video monitoring then 5G hot spots are envisaged initially in areas with high concentrations of people and vehicles. For mobile hotspots and taking London as an example the following provide useful potential examples of typical target areas; Oxford Street, Trafalgar Square, St Pancras Station, Heathrow, Wembley Stadium & Wembley Way for the European Football Championship Final in 2020, Silicon Roundabout, Imperial College Campus, Waterloo Bridge, British Museum, St Ormond

Street Hospital, O2 Arena Canary Wharf, all of the major rail routes, the M25, London Buses, etc. The size of cluster therefore varies from Wembley Stadium, Oxford Street, Fixed Wireless Access connectivity for the start-ups in Tech City around Silicon Roundabout, through to potentially the M25 and the London to Edinburgh East Coast Railway Mainline.

**Q4.4: What capacity and bandwidth (i.e. Channel Bandwidth in MHz) would be required at each cell to meet initial capacity requirements? How will this change over time?**

Large amounts of bandwidth are required in order to reach the low latency high data rates of up to 20 Gbits/s envisaged in the 5G vision. Table below shows the theoretical data rates that can be achieved for a given bandwidth.

| RF channel bandwidth | Peak data rates[6] |
|---|---|
| 200 MHz | 6 Gbit/s |
| 400 MHz | 12 Gbit/s |
| 800 MHz | 24 Gbit/s |
| 1000 MHz | 30 Gbit/s |

1000 MHz bandwidth would be required to achieve the Peak data rate requirement of 20 Gbit/s in the DL, assuming a 3:1 DL/UL ratio.

The mmWave spectrum, such as the 26 GHz band, which has up to around 3 GHz of spectrum earmarked, provides this large amount of spectrum. There is clearly a trade-off between higher frequencies and reduced range which is why mmWave spectrum is positioned as a hot spot solution to complement 5G networks in other lower frequency bands as well as an FWA enabler. 400 MHz to 1 GHz per network is envisaged although there are trade-offs between the amount of spectrum available, timings for availability and sharing with or clearing existing users, number of networks for competition purposes etc. In Europe, if the 1 GHz of spectrum, 26.5 – 27.5 GHz, is to be released in a first phase then it is recommended that 400 – 500 MHz per network strikes the appropriate balance between the amount of spectrum available in the first phase, the number of networks for competition purposes and sufficient spectrum per network to provide hot spot services.

[6] Peak spectral efficiency (SE) of 5G New Radio: 30 bit/s/Hz in DL (from draft New Report IMT-2020.TECH PERF REQ in ITU-R WP 5D).

The large bandwidths available are the key advantage of the 26 GHz (and other mmWave bands) when compared to bands below 6 GHz, and help compensate the strong disadvantage in terms of propagation. Where possible 800-1000 MHz bandwidth per operator, ideally contiguous, in the longer term could provide superior performance and will demonstrate fully the value of mmWave bands.

**Q4.5: What quality of service is required? How sensitive is the service being offered to variations in radio interference from other operators 5G cells and other spectrum users?**
No comment.

**Q4.7: What are the characteristics of 5G at 26 GHz which make this band particularly suited to the service you plan to deploy? What other spectrum bands could be used as an alternative, or in preference to, the 26 GHz band? To what extent could carrier aggregation and other techniques reduce your reliance on 26 GHz?**
5G will support frequency bands within a very wide range (450 MHz to 86 GHz), exploiting the specific characteristics of the different bands.

**High Frequencies** such as 26 GHz provides complementary hot spot coverage to 5G in medium and low frequencies. 5G hot-spots in 26 GHz will enable high capacity and high density solutions to be dropped into an operator's network with up to 20 Gbit/s peak throughput.

**Medium Frequencies** (2 to 6 GHz) relies on the best compromise between capacity (strictly related with bandwidth availability) and coverage meeting a large portion of the 5G/IMT-2020 requirements. 5G in 3300-4200 MHz range will facilitate consistent user experience ranging from high capacity and high density to wider coverage, to also address suburban areas and small towns without requiring extra site densification compared to current deployments.

**Low Frequencies** (below 2 GHz) will ensure wide area, deep coverage for urban, suburban and rural areas: a fundamental complement to the higher frequencies ensuring consistent wide area services, including deep indoor coverage.

The diagram below describes the role of the different frequency ranges, with respect to the 5G usage scenarios as defined by the ITU-R ([7]).

[7] Recommendation ITU-R M.2083-0 (09/2015) – 'IMT Vision – Framework and overall objectives of the future development of IMT for 2020 and beyond'

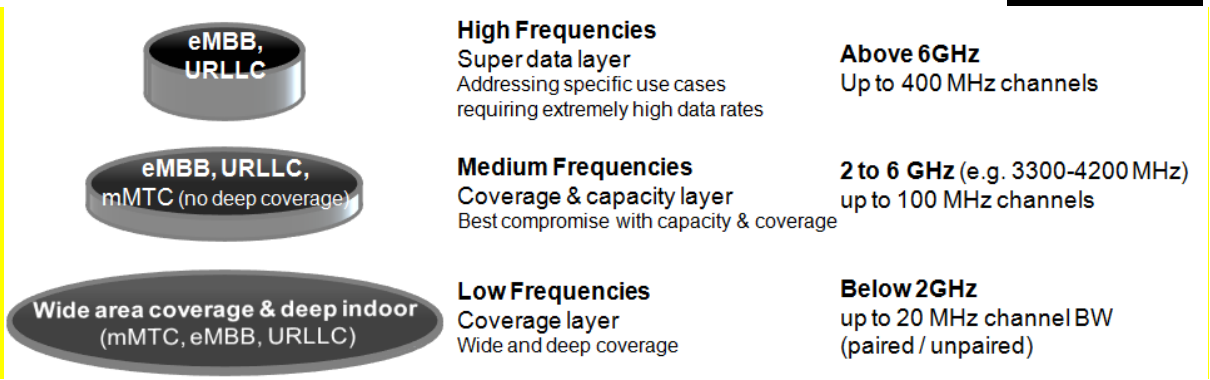


*Figure 2: the role of 26 GHz.*

In the first wave of 5G investments, it is expected that operators will focus on applications involving the enhanced Mobile Broadband (eMBB) and Ultra Reliable Low Latency Communications (URLLC) usage scenarios for dense urban, urban and suburban scenarios. Diversified rollout scenarios including indoor hotspot, dense urban, urban and rural macro will be addressed.

**Q5.1: Should Ofcom consider licensing options other that the 3 examples set out above (licence exempt, shared coordinated and area defined) for the 26Ghz band ? If so, what other options do you consider should be included?**

GSA recommends the following for 26 GHz in the UK and within the rest of Europe;

- Ofcom and DCMS should license 26 GHz as early as in 2018 in order to meet this commercial deadline and provide sufficient time for trials, for commercial arrangements to be put in place and getting the technology working in a real world environment
- The UK and other countries in Europe should do their utmost to make the whole 26 GHz band available for 5G use before ITU WRC-19
- In countries where the lower band has little use, the whole 24.25-27.5 GHz should be made available.
- Where the lower part of the band is heavily used, at least 26.5 -27.5 GHz as a minimum should be licensed in a first phase in 2018 as this is relatively underused and therefore easier to make available for 5G. This also benefits from other anticipated commercial deployments which operate at 28 GHz, such as in the US, Japan and Korea and therefore benefits from global economies of scale as this new technology is launched.
- The remainder of the spectrum, 24.25 to 26.5 GHz, which is more heavily used by other radio services such as fixed links and Wireless Local Loop (WLL) in a number of countries should be released in a second phase, but regulators should give clear guidance as soon as possible, when this spectrum could become available. In particular, regulators should commence planning for

national clearance measures/refarming already in 2017 to ensure that the essential regulatory conditions for 5G use are in place.

- That commercial 5G services at 26 GHz are launched in each of the stadiums and cities hosting the European Football Championships in 2020, UEFA Euro 2020. It would also be important to ensure that other European capitals not hosting football are not left behind, so 26 GHz spectrum should also be licensed there. This would mean that Wembley Stadium, which is hosting the final, and the area around the stadium could be ideal for a 5G showcase.
- Nationwide exclusive licenced spectrum has been a key underpinning of the phenomenal success of mobile services. This regime should be maintained as the main solution for 26 GHz band for 5G. A different approach for this 5G pioneer band could disrupt a well-established regulatory framework and delay the take up of 5G services.
- Where the lower part of the band is heavily used, licenses should be issued in the 26.5 – 27.5 GHz band. In this case, the recommended bandwidth in order to enable 5G services is at least 400-500 MHz per network. Where the lower part of the band is not heavily used and all of the 26 GHz band (24.25 – 27.5 GHz) is available then 1 GHz per network should be made available.
- Licenses should allow leasing. In addition, use-it-or-lease-it clauses attached to licensing conditions could be considered by regulators. These regulatory tools coupled with network slicing and other similar solutions can enable efficient spectrum utilization for both MNOs and verticals.
- These recommendations and proposed timings should be built into the European RSPG second opinion and national government and regulators 5G plans so that Europe is kept on top of the global 5G technology league.

**Q5.2: What methodologies could be used to pre-define 'high demand areas' for area defined licences?**

No comments

**Q5.3: What mechanism could be used for determining cell deployments by different operators in shared spectrum?**

No comments

**Q5.4: What methodologies could be used for determining the proportion of spectrum to allocate using area defined licences and coordinated deployment?**

Please see previous answers regarding the need for national licences to support 5G networks

**Q5.5: Do you agree that the 26GHz band should be released progressively? What risks do you envisage with such an approach and how can these be best mitigated?**

- national governments and regulators should license 26 GHz as early as in 2018 in order to meet this commercial deadline and provide sufficient time for trials, for commercial arrangements to be put in place and getting the technology working in a real world environment
    - Countries in Europe should do their utmost to make the whole 26 GHz band available for 5G use before ITU WRC-19
    - In countries where the lower band has little use, the whole 24.25-27.5 GHz should be made available.
    - Where the lower part of the band is heavily used, at least 26.5 -27.5 GHz as a minimum should be licensed in a first phase in 2018 as this is relatively underused and therefore easier to make available for 5G. GSA understands that the lower part of the 26 GHz band, 24.25 – 26.5 GHz, probably cannot be made available for 5G earlier than 2022/23 in the UK if the five year legal vacation notice period is served for existing users such as Fixed Links, which would lead to a considerable delay of 5G deployment unless a progressive release is applied. If 26.5 -27.5 GHz is licenced in a first phase this benefits from other anticipated commercial deployments which operate at 28 GHz, such as in the US, Japan and Korea and therefore benefits from global economies of scale as this new technology is launched. A risk with releasing the 26.5 – 27.5 GHz in a first phase, followed by a second phase releasing 24.25 – 26.5 GHz, is that base stations and terminals that operate in the 26.5 – 29.5 GHz band for this first phase would then not be able to operate in 24.25 – 26.5 GHz in a second phase. This has to be balanced against the advantages of being able to release 26.5 – 27.5 GHz early in 2018/19 to keep the UK as one of the 5G mmWave leaders. Early availability of equipment for 24.25 – 27.5 GHz may however enable deployment in the 2018/19 timeframe for 26.5 – 27.5 GHz without these issues, depending on the precise timing of the spectrum release. In particular, this possibility could be of relevance for base stations, considering the more long-term aspect of such investments. In case of an early release of 26.5 – 27.5 GHz, one option to consider is to include 24.25 – 26.5 GHz in the auction as well, together with provisions for reallocation of spectrum when the lower part becomes available. This will provide transparency for future availability of spectrum for licensees. A two stage process poses

challenges in the potential second award in that ideally the networks should end up with contiguous spectrum and go from 500 MHz of contiguous spectrum in a first award (from within 26.50 – 27.50 GHz) to 1GHz of contiguous spectrum following a second award (from within 24.25 – 26.50 GHz). This means that flexibility will need to be built in to both processes to enable band rearrangements to take place so that efficiencies from wider channel widths and reduced co-ordination requirements can be realised.

- In the spectrum, 24.25 to 26.5 GHz, which is more heavily used by other radio services such as fixed links and Wireless Local Loop (WLL) in a number of countries, regulators should give clear guidance as soon as possible, when this spectrum could become available. In particular, regulators should commence planning for national clearance measures/refarming already in 2017 to ensure that the essential regulatory conditions for 5G use are in place.