Huawei response to the Ofcom call for input: "5G spectrum access at 26 GHz and update on bands above 30 GHz"

Summary

Huawei welcomes the opportunity to comment on this important consultation on 5G spectrum access at 26 GHz and update on bands above 30 GHz.

With regards to the various authorisation models proposed by Ofcom:

- We are supportive of *exclusive national licences* at 26 GHz, as these would give mobile operators the freedom to deploy wherever there is demand for 5G, and would bring certainly for investment in 5G infrastructure and equipment.

- We believe that such investment by mobile operators in 5G is essential, not only for the provision of eMBB to citizens and consumers, but also for the provision of 5G services to the *Verticals*, who can gain access to 5G capacity through network slicing and benefit from the economies of scale in 5G infrastructure and devices.

- Where some Verticals might require *direct* access to 26 GHz spectrum, we note that these Verticals can lease spectrum from the licensees. The UK framework for authorisation of 26 GHz should facilitate, encourage, and incentivise leases, and remove any barriers to such market-led approaches for access to the band.

- We do not believe that *licence exemption* is appropriate at 26 GHz, on the grounds of unpredictable interference (in what is after all intended to be a pioneer 5G band in Europe), and that there are other mmWave bands available for licence exempt use.

- We also do not consider that *shared/coordinated licensing* (regulator coordinated licensing or concurrent self-coordinated licensing) is appropriate at 26 GHz. This is again on the grounds that the risks of harmful *co-channel* interference among independent parties can be disruptive (especially for those use cases with mission critical requirements), and together with the burden of coordination, can be a disincentive for investment in this band.

- We have considered Ofcom's proposed *area defined licences*, and the rationale that:

  > "5.21 *Area Defined Licence, awarded via auction, are most appropriate in locations where demand for spectrum is likely to exceed supply*".

  We have noted that Ofcom has correctly and helpfully categorised traditional exclusive national licences as a subset of area defined licences:

  > "*5.19 Such an operator may prefer an area defined licence which allows them to deploy cells wherever they choose within a defined geographic area and fully manage their inter-cell interference (and hence quality of service). Within their defined area the operator does not need to coordinate with any*

other operator. This has been our preferred approach for releasing mobile spectrum to date, awarding UK wide licences via auctions".

We have also noted with great interest Ofcom's acknowledgment of the challenges it will face in defining appropriate areas for such area defined licences, especially in light of how the diverse range of 5G use cases may develop and evolve in the future, and Ofcom's proposal that:

> *"5.23 An alternative way to ensure spectrum does not sit fallow, but avoid the risks of poorly defined licence areas, would be to issue UK wide area licences and then assess whether there are areas of unmet demand after a pre-defined period e.g. 5 years. Where unmet demand is identified, additional operators could be authorised to use the spectrum."*

We are **supportive** of the approach described in 5.23 in the context of exclusive national licences, and consider this to be a pragmatic way forward which strikes the right balance between heavy regulatory intervention and a market-led assignment of spectrum.

With regards to Ofcom's *hybrid authorisation approach*, we have certain reservations. The approach proposes that

a) in areas of *low demand* the whole 26 GHz band could be authorised via shared/coordinated licences, and

b) in areas of *high demand* part of the 26 GHz band could be authorised via area defined licences, with the remainder of the band authorised via shared/coordinated licences.

We are generally not supportive of *multi-tiered* authorisation models, which use a mixture of different authorisation models for the same frequencies (albeit at different locations). This is because we consider that the risk of co-channel harmful interference over large distances would be either disruptive (if left unchecked) or overly restrictive (if appropriately mitigated via technical conditions) for all parties. For this reason, we do not support (a).

On (b), we consider that there is risk of regulatory failure in allocating an inappropriate amount of the 26 GHz band for shared/coordinated authorisation, especially in light of uncertain demand for shared use of this band by the Verticals.

For the above reasons, we consider that the approach which enables the most optimum use of spectrum is for the whole 26 GHz band to be authorised via *area defined licences*, in the form of *exclusive national licences*, complemented by Ofcom's proposal to review unmet demand after 5 years, and to accordingly authorise additional users at various frequencies and geographic locations in response to market demand. We believe that the interests of the Verticals would be best served through access to 5G capacity via network slicing of licensed mobile operators, or the leasing of spectrum by the Verticals from the licensed mobile operators in this band.

We are encouraged by Ofcom's efforts in exploring various options in this call for inputs on 26 GHz, and we look forward to further engagements with Ofcom in discussions on the availability and authorisation for use of this important pioneer 5G band.

Consultation questions and our responses

Question 2.1: What are your planned timelines for commercial availability of network equipment and devices for the 26 GHz band? When will equipment for testing and trials be available? Please specify the specific mmWave tuning ranges supported and their timing.

We expect to make network equipment and devices commercially available by Q4 2018. These will have a tuning range of 26.5 – 29.5 GHz and an operational bandwidth of 1 GHz. We are also prepared to deliver commercial products with a tuning range of 24.25 – 27.5 GHz in Europe, when these frequencies are made available for 5G.

Question 2.2: Given the 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?

We have no current plans to support licence exempt operation or coordinated sharing in our 26 GHz equipment. This is for two reasons:

1) We believe that licence exempt operation or coordinated (co-channel) sharing will compromise the quality of service requirements which many 5G use cases rely on.

2) There are other mmWave bands, such as 57-66 GHz, which are available for licence exempt operation of wideband radio equipment.

Question 2.3: When do you expect to support standalone New Radio in the 26 GHz band in your products?

We expect to support standalone New Radio in our products by Q4 2018.

It is important to clarify the distinction between standalone and non-standalone New Radio. On a number of occasions Ofcom has stated in this CFI that the standalone mode allows mmWave small cells to be deployed, operating as a self-contained network, independently of any existing mobile network operator.

While the above is certainly true, this is not the fundamental distinction between non-standalone and standalone New Radio. Specifically, as also stated by Ofcom, the key difference is that non-standalone New Radio simply cannot operate without being coupled to a LTE network (in the sense that certain signalling will need to be carried by LTE), whereas standalone New Radio can.

As such, standalone New Radio should not be misunderstood as a technology exclusively intended for private networks and entities other than mobile network operators. In fact, it is our expectation that many mobile network operators will eventually deploy standalone New Radio in the course of their network evolutions.

Question 3.1: Are there any other aspects related to the existing use of 26 GHz not covered in this CFI that you believe need to be considered?

No comments.

Question 3.2: 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 you provide working in practice.

Clearance is the approach that regulators have successfully adopted in the past in the context of introducing new mobile services below 6 GHz, as the benefits of these services have been assessed to exceed the costs of clearing out and relocating the incumbents. Furthermore, exclusive allocations of spectrum to mobile networks provide appropriate incentives for MNOs to invest in deployments, thus facilitating fast take up.

However, it is recognized that the propagation conditions and intended use cases at mmWaves mean that coexistence between 5G networks and incumbents (in some specific cases) is more viable than compared to bands below 6 GHz.

In general, it is our 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), if they are located in remote areas. Coexistence with 5G networks can be achieved by defining appropriate exclusion/restriction zones of a few kilometers around these earth stations in rural and remote areas without impacting on the deployment potential of 5G at 26 GHz in urban and sub-urban areas. In practice, this means that 5G providers could be awarded national licenses with a number of well-defined zones around the earth stations, where 5G deployment is either not permitted or is severely restricted.

New earth stations should only be authorized following a commercial agreement between the earth station operator and the 5G licensees. We believe that these kinds of agreement can be achieved between 5G licensees and earth station operators, especially, at remote locations where 5G is unlikely to be deployed in the 26 GHz band.

It may not be feasible for 5G to share the 26 GHz band in the same geographical area as point-to-point links. Point-to-point links require a high reliability and it will be difficult to ensure this if the 26 GHz band is shared. We are 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 the release of the whole band for 5G. For this reason, it is recommended to first release 26.5 – 27.5 GHz to facilitate rapid 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 come to an agreement with the operators as to how they might be able to use the same frequency band for 5G access 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.

Question 3.3: Should a moratorium be placed on issuing new licences in the 26 GHz band for existing services? E.g.to ensure that the 26 GHz band is not unnecessarily encumbered prior to the development of a new authorisation / licensing approach for 5G services?

Yes. See above.

Question 4.1: What service would be delivered and to which consumers and/or organisations?

Huwaei expects the following three key services at 26 GHz

- Enhanced mobile broadband (eMBB).
- Fixed wireless access for residential and enterprise customers.
- Self-backhaul for mobile network operators.

In light of any arising demand for the use of 26 GHz by the Verticals, Huawei considers that *network slicing* technologies being developed by 3GPP will be a key enabler.

Network slicing allows the Verticals to avoid the capital and operating costs of dedicated physical infrastructure and devices, by creating a "network factory" whereby a mobile network operator can assign – via software – different slices of its network resources to a diverse range of Verticals and applications.

Network slicing is a major innovation in 5G which allows the Verticals to benefit from the huge economies of scale in equipment.

Question 4.2: Where in the UK would the 26 GHz spectrum be used to deliver services? For example, will deployments be focussed on:

a) Areas of existing high mobile broadband demand?

Areas of existing high mobile broadband demand are certainly the primary locations for the deployment of 5G infrastructure at 26 GHz. These include city centres, commercial business districts, train/tube stations, shopping malls, sports stadiums, densely populated residential areas etc.

b) Rural areas?

It is certainly true that the demand for eMBB capacity will be lower in rural areas. However, it can be readily envisaged that 5G may also be used to deliver eMBB in village centres and other clusters of population in the countryside.

Another important application of 5G deployments at 26 GHz in rural areas is for fixed wireless access (also known as called WTTx). Gigabit access is possible for those users who can install CPEs outside their premises in order to have line of sight connection with a 5G base station at an appropriate distance. Operators in the US and Canada have concrete

plans to deploy at mmWave for fixed wireless access to serve individual premises and apartments.

Finally, it should be noted that many Verticals who may benefit from 5G may very well be located in what could be categorised as rural areas, including factories and industrial complexes. Such Verticals would benefit from 5G through either slicing of the mobile operators' networks, and/or through leasing of 26 GHz from mobile operator licensees. See also our responses to Section 5.

c) Rail and road corridors?

It has been demonstrated that it is possible to deliver high performance and reliable communications to fast moving mobile equipment through the use of beam tracking technologies at mmWaves.

As such, serving rail and road corridors is certainly feasible at mmWaves, although the cost of contiguous coverage over long stretches of road/rail is an issue for consideration.

A suitable deployment for serving rail corridors would include the installation of CPEs on the roof of the train carriages to provide wireless backhaul, with wireless access inside the train via 5G small cell (in the same or different band) or Wi-Fi. Such a deployment would avoid the impact of the high outdoor-indoor penetration loss caused by the metal and glass structure of the carriages.

For similar reasons, in relation to road corridors, it is best for user equipment antennas to be installed outside the vehicles.

d) Specific types of enterprise or industrial sites?

5G is expected to deliver wireless services to a range of different Verticals (including enterprise and industrial sites) with a diverse range of requirements.

For enterprise use, outdoor CPE deployments at line of sight with a 5G base station can deliver Gigabit level throughput assuming a 1 GHz bandwidth at 26 GHz. This would readily meet a small enterprise's requirements. And even with foliage loss, 26 GHz can still perform well at reasonable distances.

For some industrial applications, ultra-reliable low latency communications (URLLC) can be important. Guaranteed quality of service can be mission critical in such use cases, which emphasises the importance of exclusive (non-shared) spectrum authorisation models.

e) Indoors or outdoors?

Both indoor and outdoor communications are feasible at 26 GHz.

<u>Outdoor</u>

Good outdoor coverage can be provided at 26 GHz by macro cells and lamppost cells in line of sight environments, although body loss can cause some degradation in performance. In non line of sight environments, Huawei tests have indicated that coverage cannot be guaranteed. In rich reflecting environments, users can still receive high throughputs, e.g., 2 Gbps for a channel bandwidth of 800 MHz. However, in poor reflecting environments, an obstruction can result in no service.

Indoor

Indoor coverage cannot be guaranteed by outdoor macro deployments. This is due to the very high penetration loss of concrete; around 60 dB at 26 GHz, which is substantially greater than building penetration loss at sub-6GHz.

Tests have indicated that the penetration loss at 26 GHz for a glass wall/window can be 3 to 20 dB depending on its thickness and the specific material used in its construction, and accordingly, it is still possible to provide indoor coverage via outdoor macro cells.

The same applies to wooden walls, where the penetration loss can be 15 to 30 dB.

For the above reasons, outdoor-indoor coverage at 26 GHz is not a realistic proposition in all circumstances.

The best way to provide indoor coverage at 26 GHz is through indoor small cells, or specific indoor coverage systems, such as Huawei's Lampsite solution.

f) Specific nations or regions of the UK?

5G can be used to deliver services everywhere in the UK.

Question 4.3: 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?

Both individual cells and clusters of cells can be deployed, depending on circumstances.

A typical contiguous coverage cell cluster might, for example, include deployments along both sides of the river Thames. Outdoor coverage of a 3 km stretch, with a typical inter-site distance of 100 to 200 meters would require a cluster of 20+ sites at 26 GHz.

One can envisage many city and town centres as candidates for contiguous coverage, starting with earlier deployments in the commercial and business districts and extending outwards. Aggressive operators may even consider contiguous outdoor coverage over larger areas, starting with smaller clusters of deployments along busy streets/roads and areas of high population.

In areas of low *average* population density, single cells or clusters of cells may still be deployed to provide high capacity services where the local population density is high and/or where there is demand.

Question 4.4: 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?

High peak throughputs directly affect user experience in many applications. Examples of high throughput applications include 4K video (20 Mbps), 8K video (100 Mbps), and virtual reality video (1 Gbps).

With regards to bandwidth requirements, consider the two scenarios below.

Fixed wireless access

According to operator return on investment (ROI) analysis, a FWA base station sector needs to serve somewhere between 50 to 100 subscribers, or even higher. If an operator plans to serve 50 subscribers in one sector, for a maximum user activity factor of 50%, and a guaranteed downlink throughput of 50 Mbps, then a total downlink throughput of 50 Mbps $\times$ 50 $\times$ 0.5 = 1.25 Gbps will be required.

System level simulations (see parameters in the annex) of outdoor FWA for a cell radius of 1.5 km indicate that an average downlink cell throughput of 1.45 Gbps can be achieved with a 800 MHz bandwidth.

Enhanced mobile broadband

Large amounts of bandwidth are required in order to reach the low latency high data rates of up to 20 Gbps envisaged in the 5G vision for eMBB. Using the peak spectral efficiency of 30 bit/s/Hz in the downlink for 5G New Radio (from draft New Report IMT-2020.TECH PERF REQ in ITU-R WP 5D), then around 700 MHz bandwidth would be required to achieve the peak data rate requirement of 20 Gbps in the downlink alone.

It is also interesting to assess the bandwidth requirements at 26 GHz in comparison with those at the other 5G pioneer band at 3400-3800 MHz. In order for operators to be willing to invest and deploy equipment at 26 GHz for eMBB, the cell capacity should be greater than at 3.5 GHz.

System level simulations (see parameters in the annex) of outdoor eMBB with an inter-site distance of 200 m indicate that in the absence of body-loss,

- the average downlink cell throughput at 26 GHz with a 450 MHz bandwidth (1.6 Gbps) is equal to that at 3.5 GHz with a bandwidth of 100 MHz, and

- the average downlink cell throughput at 26 GHz with a 312 MHz bandwidth (960 Mbps) is equal to that at 3.5 GHz with a bandwidth of 60 MHz.

The performance at 26 GHz will further reduce relative to 3.5 GHz if the effects of body loss are accounted for, as this is at least 5 dB greater at 26 GHz than at 3.5 GHz.

Question 4.5: What quality of service is required? How sensitive is the service being offered to variations in radio interference from other operator's 5G cells and other spectrum users?

Examples such as live video services and monitoring, virtual reality gaming, virtual reality video, virtual reality meetings, tactile internet, industrial control, autonomous vehicles, and others are some of the key use cases at mmWaves. These mostly require high throughputs, and are all sensitive to time delay and latency.

According to 3GPP definitions, for ultra-reliable low latency communications (URLLC), the target for user plane latency should be 0.5 ms for UL, and 0.5ms for DL. For enhanced mobile broadband (eMBB), the target for user plane latency should be 4 ms for UL, and 4 ms for DL. A general URLLC reliability requirement for transmission of a packet is $1 - 10^{-5}$ for 32 bytes with a user plane latency of 1 ms. For enhanced vehicle-to-anything (eV2X) communications, the delivery of a 300 byte packet is subject to the requirements of $1 - 10^{-5}$ reliability, and user plane latency of 3 to 10 ms, both for direct communication via sidelink (communication range of a few meters) and for relaying via a base station.

3GPP specifications (in the form of transmitter emission masks, receiver selectivity and blocking performance) ensure that interference between 5G operators in adjacent frequencies can be appropriately mitigated in order to meet the above service targets.

However, the achievement of such challenging performance targets in an environment of unpredictable *co-channel* interference from one or more other independent users of the band is simply not feasible, and would result is highly sub-optimal and inefficient use of the spectrum.

It is for this reason that we are not supportive of licence exemption or shared/coordinated licensing at 26 GHz. See also our responses to Section 5.

Question 4.6: Will end users be fixed or mobile?

End users in 26 GHz can be fixed or mobile users.

Mobile chipset and phone manufacturers (Huawei, HiSilicon, Qualcomm, Intel etc.) have taken great strides in ensuring the availability of mobile phones in time for the availability of mmWave spectrum.

Network equipment providers have also demonstrated via tests and trials the ability to achieve high data rates at high mobility.

For fixed applications, Huawei will provide the world's first 5G commercial CPE in 2017.

Question 4.7: 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?

The potentially wide bandwidths available at 26 GHz are naturally suitable for operators to solve capacity problems for eMBB in areas of high demand.

In this respect, aggregation of 26 GHz and sub-6GHz carrier are essential for operators to combine the seamless mobility and high reliability of communications at lower frequencies, with the very high throughputs at the higher frequencies.

However, due to constraints in the implementation of user equipment, such as antenna layout, chipset complexity, RF module complexity, and size, it is a challenge to support aggregation of sub-6GHz carriers with multiple mmWave carriers. Also note that bands above 26 GHz suffer from poorer propagation and higher penetration loss, and will imply higher deployment costs.

Question 5.1: Should Ofcom consider licensing options other than the 3 examples set out above (licence exempt, shared coordinated and area defined) for the 26 GHz band? If so, what other options do you consider should be included?

It is our view that the 26 GHz band should be made available via *exclusive national licences*. This is for the following reasons:

- Exclusive national licences give mobile operators certainty that they can deploy their networks when and where there is demand from their customers. Mobile networks

evolve as operators extend coverage to unserved areas, or increase capacity to locations with high traffic. This flexibility is key for a mobile operator's business and should be preserved in 5G spectrum.

- Predictable/reliable quality of service is the basis of demand for 5G spectrum. Exclusive licences give mobile operators the confidence that their service is not degraded by interference from third parties.

- 5G will extend the capabilities of mobile networks to provide new services beyond mobile voice and broadband data, and to serve vertical markets – such as the utilities or manufacturing sectors – that have not been traditionally the customers of commercial mobile networks. However, provision of 5G will not be substantially different from today's 4G or 3G services: operators will run the networks and provide services to end users. A change in the regulatory framework for 5G will introduce uncertainty for operators, which may decide not to invest in 5G network deployments and, as a result, the use of bands such as 26 GHz will fail to develop.

- Mobile network operators are well equipped to provide 5G services to vertical markets (so-called "Verticals"). This can be achieved through innovative 5G technologies such as Network Slicing which allows the Verticals to avoid the capital and operating costs of dedicated physical infrastructures and devices, by creating a "network factory" whereby a mobile network operator can assign – via software – different slices of its network resources to a diverse range of customers and applications. As such, there is no need for authorisation models which specifically target the use of the 26 GHz band by the Verticals.

- Where certain Verticals may require *direct* access to the 26 GHz band (as opposed to indirect access via network slicing), they may lease spectrum from the mobile operators. The UK framework for authorisation of 26 GHz should facilitate, encourage, and incentivise leases, and remove any barriers to such market-led approaches for access to the band.

In summary, we consider that the framework of exclusive national licences for the provision of mobile services should be maintained for 5G and adopted in the 26 GHz band. A different approach could disrupt a well-established regulatory framework and compromise the take up of 5G services.

Our views with regards to the licensing options set out by Ofcom are provided next.

Licence exemption

We do not consider that a licence exemption model is appropriate at 26 GHz. Whilst some operators have today deployed RLANs in the 2.4 GHz and 5 GHz bands, these are used in addition to their mobile networks and with the understanding that quality of service cannot be guaranteed under a licence exemption regime. We do not think that licence exemption, where interference among a potentially unlimited number of entities is mitigated by regulatory technical conditions to implement polite protocols, would be able to provide the interference free environment required by mobile networks to deliver many of the new (and often mission critical) 5G services.

Furthermore, there are other mmWave bands available for licence exempt use today (e.g., 57-66 GHz), and so the need for considering licence exemption at 26 GHz is not clear.

Shared/coordinated deployments

We also do not consider that shared/coordinated licensing (either regulator coordinated licensing or concurrent self-coordinated licensing) is appropriate at 26 GHz. This is on the grounds that the risks of harmful *co-channel* interference among independent parties can be disruptive (especially for those use cases with mission critical requirements), and together with the burden of coordination, can be a disincentive for investment in this band.

We also note that 5G is designed based on the assumption that any co-channel interference is fully under the control of the network operator and can be appropriately managed through radio system engineering.

Ofcome states that:

> *"5.11 A spectrum authorisation regime in which the deployment of each new 5G cell is coordinated with existing cells (and other spectrum users) is a commonly used approach to address the risks associated with licence exemption.* Requests to use spectrum are typically considered on a first come, first served Basis and are only approved if the deployment of the new cell will not unacceptably impact the performance of an existing cell."

We acknowledge that Ofcom has for some time been using databases to manage interference between multiple parties via shared/coordinated licences on a first come first served basis (e.g., for fixed links). However, we submit that such coordination among large numbers of 5G base stations and mobile devices with different users, different deployment geometries, and serving diverse applications is substantially more complicated than the coordination of fixed links. We are not convinced that Ofcom is best placed to undertake such coordination.

However, we consider that sharing and coordination *might* be more feasible under a concurrent licensing regime similar to what it is in place in the DECT guard band. Its key features – a limited number of national licences, and a coordination method that is agreed among licensees and not imposed by the regulator – make this approach more conducive to successful 5G deployments than other forms of sharing/coordination.

Nevertheless, given the importance of 26 GHz as one of the pioneer 5G bands in Europe, we urge Ofcom to exercise caution in defining non-exclusive authorisation models which – by definition – cannot guarantee an environment free from co-channel interference.

Area Defined Licences

We do not consider that area defined licences (where the area is smaller than the entire UK land mass) are suitable for 5G development and investment in this band, as they will restrict the ability of the mobile operators to deploy their networks when and where there is demand from their customers, including the Verticals.

If licence areas are pre-defined by Ofcom according to regional/local boundaries so as to cover the entire UK, we consider that this can be a problematic approach for the following reasons:

- It adds to regulatory complexity: Industry must apply, bid for, and manage multiple licences, and Ofcom must define boundaries, emission limits at the boundaries, and run a more complex auction.

- It is inefficient: Emission limits must be set at the boundaries between the areas to avoid co-channel interference between users at each side of the boundaries. This can result in potentially large zones which will be sterilised for use.

- It does not have a good track record: Past initiatives to allocate spectrum licenses on a regional or local basis (e.g., 3.5 GHz bands around 10 years ago in some countries) have not been very successful. Many small players acquired these regional licenses but did not deploy significantly.

- They do not necessarily facilitate access to new players: These new players may not seek access to a whole region or locality. Instead, they may wish to deploy at their premises or over a small area. Therefore, they are unlikely to bid for a regional or local licence.

Alternatively, Ofcom could define licence areas according to other considerations such as population density or likely hotspots. We consider that this carries a very high risk of regulatory failure as it will be difficult for Ofcom to predict in detail which areas will be subject to high demand, especially given the diverse range of applications and use cases which 5G is expected to support. We again emphasise that mobile operators will not simply be providing eMBB services to consumers, but will be engaged with a variety of Verticals in new and innovative wireless use cases. This underpins the promise of 5G.

We have noted that Ofcom has correctly and helpfully categorised traditional exclusive national licences as a subset of area defined licences:

> *"5.19 Such an operator may prefer an area defined licence which allows them to deploy cells wherever they choose within a defined geographic area and fully manage their inter-cell interference (and hence quality of service). Within their defined area the operator does not need to coordinate with any other operator. This has been our preferred approach for releasing mobile spectrum to date, awarding UK wide licences via auctions".*

We have also noted with great interest Ofcom's acknowledgment of the challenges it will face in defining appropriate areas for such area defined licences, especially in light of how the diverse range of 5G use cases may develop and evolve in the future, and Ofcom's proposal that:

> *"5.23 An alternative way to ensure spectrum does not sit fallow, but avoid the risks of poorly defined licence areas, would be to issue UK wide area licences and then assess whether there are areas of unmet demand after a pre-defined period e.g. 5 years. Where unmet demand is identified, additional operators could be authorised to use the spectrum."*

We are **supportive** of the approach described in 5.23 in the context of exclusive national licences, and consider this to be a pragmatic way forward which strikes the right balance between heavy regulatory intervention and a market-led assignment of spectrum.

Hybrid authorisation approach

We have certain reservations with regards to Ofcom's *hybrid authorisation approach.* The approach proposes that

a) in areas of *low demand* the whole 26 GHz band could be authorised via shared/coordinated licences, and

b) in areas of *high demand* part of the 26 GHz band could be authorised via area defined licences, with the remainder of the band authorised via shared/coordinated licences.

We are generally not supportive of *multi-tiered* authorisation models, which use a mixture of different authorisation models for the same frequencies (albeit at different locations). This is because we consider that the risk of co-channel harmful interference over large distances would be either disruptive (if left unchecked) or overly restrictive (if appropriately mitigated via technical conditions) for all parties. Furthermore, as discussed earlier, we see a high risk of regulatory failure in defining areas of high and low demand given the diverse range of applications targeted by 5G. For this reason, we do not support (a).

On (b), we consider that there is risk of regulatory failure in allocating an inappropriate amount of the 26 GHz band for shared/coordinated authorisation, again especially in light of uncertain demand for shared use of this band by the Verticals.

For the above reasons, we consider that the approach which enables the most optimum use of spectrum is for the whole 26 GHz band to be authorised via *area defined licences*, in the form of *exclusive national licences*, complemented by Ofcom's proposal to review unmet demand after 5 years, and to accordingly authorise additional users at various frequencies and geographic locations in response to market demand. We believe that the interests of the Verticals would be best served through access to 5G capacity via network slicing of licensed mobile operators, or the leasing of spectrum by the Verticals from the licensed mobile operators in this band.

Finally, we would like to highlight that operator buy-in will be crucial for the emergence of a healthy market of 5G network equipment and devices at 26 GHz in the first kick off phase – probably more the case for this band than other bands in the past. However, we have observed that some mobile operators are still uncertain of the business case in this band. We are concerned about the risk of regulatory failure that a disruptive authorisation framework could carry. Such framework could lead to operators not committing to deployment and investment in this band, and ultimately 26 GHz failing to develop as a successful 5G band.

Question 5.2: What methodologies could be used to pre-define 'high demand areas' for area defined licences?

As noted above, we do not think it is wise for Ofcom to engage in pre-defining high/low demand areas, as the risk of getting the area definition wrong is considerable, especially in light of the diverse range of applications and use cases targeted by 5G.

Question 5.3: What mechanism could be used to coordinate cell deployments by different operators in shared spectrum?

Our preference is for exclusive national licences. If sharing must be put in place, then we think that a regulatory framework similar to the DECT guard band is preferable; i.e., a limited number of concurrent national licences and a coordination method that is agreed among licensees and not imposed by the regulator.

Question 5.4: What methodologies could be used for determining the proportion of spectrum to allocate using area defined licences and coordinated deployment?

Our preference is for the whole 26 GHz to be authorised via area defined licences in the form of exclusive national licences. As noted earlier, we do not think it is wise for Ofcom to engage in defining the proportions of the 26 GHz bandwidth to be authorised via area defined vs. shared/coordinated licences. This is because the risk of getting the split wrong is considerable, especially in light of the diverse range of applications and use cases targeted by 5G.

Question 5.5: Do you agree that the 26 GHz band should be released progressively? What risks do you envisage with such an approach and how can these be best mitigated?

The first RSGP opinion on 5G argued for member states to make part of the band available before 2020. Huawei supports this phased approach and we think the 26.5-27.5 GHz block could be released before 2020. We also support that the band is made available for localised trials and pilots as soon as possible (and before release).

At a later date, the rest of the band should be also made available so that bandwidths of 800-1000 MHz for each licensee can be achieved. However, Ofcom should bear in mind the following considerations:

- Some operators, whose strategy does not involve early deployment at 26 GHz, might opt out of the first phase and bid only at the second phase. For such operators a two phased approach will be beneficial, provided that Ofcom gives clear guidance as soon as possible of when the rest of the band would be released. This would allow operators to choose between bidding at the early release or later at the time of release of the rest of the band.

- 400-500 MHz per operator is required in order to provide equivalent average throughput to 3400-3800 MHz band, and is the minimum bandwidth that mobile operators might be interested to invest in. However, under a phased approach, it will not be possible to achieve 400-500 MHz per mobile operator in the first phase. This may not be a problem provided that the lower block is released at a later, pre-arranged date.

- the main obstacle in the UK and many European countries is the high number of fixed links deployed in the 24.5-26.5 GHz block. We suggest that administrations serve notice of revocation to users of existing links, with a notice period agreed with the industry.

- A phased approach may result in fragmentation, when individual operators obtain spectrum blocks in both sub bands. A technology solution to this problem could be carrier aggregation, although this is likely to be suboptimal when compared to a contiguous block. A licensing solution could be a reshuffle of the band once the lower block is released. This could be market led, through a series of trades between

licensees that result in contiguous blocks. It could also be triggered or enforced by the regulatory authorities.

As seen here, a phased release has advantages but is not without costs. If Ofcom follows this path, it should not lose sight of the long term objective which is an efficient allocation of the whole 26 GHz band. In order to achieve this and also to remove regulatory uncertainty, it will be key to develop a release plan that clearly lays out when and how the lower block would be released, and how fragmentation will be dealt with.

Annex – Simulation parameters

The following table presents the simulation parameters for the FWA results presented in response to question 4.4

Carrier frequency	26 GHz
Bandwidth	0.8 GHz
Cellular layout	1BS 3Cell
Inter site distance	2250 m (cell radius 1500 m)
Antenna height	25 m
Propagation model	TR 38.900 (LOS), outdoor
Foliage penetration loss	17 dBi
gNB TRX configuration	4TRX (RF channels: hundreds)
gNB Tx EIRP	68 dBm
CPE height	3 m
CPE antenna gain	17 dBi
CPE TRX number	2T2R
DL:UL subframe ratio	3:1
Traffic model	Full buffer

The following table presents the simulation parameters for the eMBB results presented in response to question 4.4

Carrier Frequency	26GHz	3.5GHz
Total Bandwidth	1 GHz	100 MHz
Inter-site distance	200 m	200 m
DL:UL subframe ratio	3:1	3:1
Channel model	mmWave (38.900), outdoor	WinnerPlus-3GPP (36.873), outdoor
gNB antenna height	25 m	25 m
gNB TRXconfiguration	4TRX (RF channels: hundreds)	64TRX (RF channels: 64)
gNB max layers	4	24
gNB Tx Power	35 dBm	49 dBm
UE antenna configuration	2T4R	2T4R
UE distribution	Uniform	Uniform
Cell number	1BS 3Cell	1BS 3Cell
Traffic model	Full buffer	Full buffer