Huawei response to the Ofcom public consultation document: "Public sector spectrum release award of the 2.3 GHz and 3.4 GHz bands"

Introduction

Huawei welcomes the opportunity to provide feedback on this very important consultation on the award of the 2.3 GHz and 3.4 GHz bands. Ofcom has performed some comprehensive and detailed studies, and has set out sound proposals for the auction process, and the various technical and non-technical licence conditions. This effort is greatly appreciated.

Huawei agrees with many of Ofcom's proposals, although we have recommendations on a number of specific issues which we have summarised below. We have also provided responses to Ofcom's specific questions in the remainder of this document.

Summary of Huawei's recommendations

Huawei appreciates that radio spectrum is a major asset to the UK, providing a critical input to a wide range of services, and securing the optimal use of this scarce asset is the primary consideration when awarding new spectrum licences.

Evidence of IMT networks deployed at similar frequencies worldwide (see response to Question 4.1) strongly suggests that the utility of unpaired spectrum diminishes considerably for bandwidths of less than 40 MHz.

We believe that — based on the currently proposed auction design — there is a substantial risk that the 2.3/3.4 GHz bands in the UK might be fragmented into awarded blocks of 20 MHz or less. This would result in sub-optimal assignments which most likely would remain unused post-award (as observed in certain past auctions of unpaired spectrum), and if used would provide inferior capacity as compared to deployments in other markets, placing the UK consumers at a long term disadvantage.

Accordingly, and in light of the predicted increase in demand for mobile data over the proposed licence period of 20 years, we strongly recommend that Ofcom designs the auction in such a way so as to

a) award a single block of 40 MHz in the 2.3 GHz band, and

b) award the 3.4 GHz band as either three blocks of 40 MHz and one block of 30 MHz, or as alternative assignments which result in block sizes of 40 MHz or greater.

In addition to the benefits outlined above, this would greatly simplify the auction process for the bidders, and allow more efficient outcomes.

On the issue of synchronisation, we strongly recommend that Ofcom mandates synchronisation among the operators through the proposed Option 2, where operators are required to frame align and use the same uplink/downlink frame configuration as pre-specified by Ofcom. International experience indicates that where there is a *real willingness* to use the spectrum, full synchronization between operators is a key enabler in the successful deployment of IMT networks in unpaired spectrum. We think that Option 2 — combined with Ofcom's proposed Inter-operator Synchronisation Procedure — achieves the right balance of providing immediate certainty and future flexibility.

We agree that TD-LTE configuration 2 is a good candidate for the default frame configuration, as evidenced by many recent global deployments. This is with the proviso that alternative configurations can be used in the future if mutually agreed by the licensees. Furthermore, we strongly recommend that synchronization (Option 2) is mandated for all cells irrespective of their dimension, from macro to femto.

Finally, we have concerns that the proposed base station out-of-band emission limits below 2340 and 3400 MHz are over stringent, and recommend that these be relaxed for macro cells, and then also further relaxed for micro, pico, and femto cells. We are hopeful that Ofcom and the MoD will specify *least restrictive* technical conditions which avoid costly IMT equipment costs, yet which provide reasonable and realistic levels of protection to MoD systems.

Consultation questions and our responses

Question 4.1: Do you agree with our proposals for categories and lot sizes in the auction? If you disagree please provide evidence for your position.

We broadly agree with the proposed availability of two categories, one for each of the 2.3 and 3.4 GHz bands.

However, we would emphasise that evidence (see below) suggests that the utility of unpaired spectrum for IMT deployments diminishes considerably for bandwidths of less than 40 MHz. Note that for a 3:1 downlink/uplink ratio, this corresponds to effectively only 30 MHz of downlink and 10 MHz of uplink.

The issue is the ability of mobile operators to extract value from the awarded spectrum versus the cost of network deployment. An inadequately small carrier bandwidth implies prohibitively dense network deployments in order to meet capacity targets.

We note that there are currently no nationwide macro-cell TDD deployments anywhere in the world where the carrier bandwidth is 5 MHz.

Where we have seen 10 MHz carrier bandwidths, these relate to cases of technology migration such as transitions from TD-SCDMA to TD-LTE or WiMAX to TD-LTE, where the legacy technology is required to share the spectrum with TD-LTE during the transition period.

Examples of Band 38/40/41/42 unpaired spectrum holdings in some of the global markets are presented in the following table:

Country	Description of awarded spectrum
China (Bands 40/41)	China Mobile: 2320-2370 MHz (50 MHz) China Unicom: 2300-2320 MHz (20 MHz) China Telecom: 2370-2390 MHz (20 MHz) China Mobile: 2575-2635 MHz (60 MHz) China Unicom: 2555-2575 MHz (20 MHz) China Telecom: 2635-2655 MHz (20 MHz)
India (Band 40)	Licences were awarded for a total of 22 geographic service areas, with each licence corresponding to a 20 MHz contiguous block of spectrum.
Japan (Band 41/42)	Softbank: 2545-2575 MHz (30 MHz) KDDI: 2595-2625 MHz (30 MHz), 2625-2645 MHz (20 MHz) Docomo: 3480-3520 MHz (40 MHz) KDDI: 3520-3560 MHz (40 MHz) Softbank: 3560-3600 MHz (40 MHz)
USA (Band 41)	Clearwire has regional holdings of up to 160 MHz, with a minimum contiguous bandwidth of 154 MHz (2496-2650).

Country	Description of awarded spectrum
Saudi Arabia (Bands 40/41)	STC: 2306-2318 MHz, 2346-2386 MHz (52 MHz) Mobliy: 2582-2602 MHz, 2614-2624 MHz (30 MHz)
Australia (Band 40)	Optus: 2302-2400 MHz (98 MHz)
South Africa (Band 40)	Telkom Mobile: 2300-2360 MHz (60 MHz)
Malaysia (Band 40)	YTL Communications: 2300-2360 MHz (60 MHz)
Sri Lanka (Band 40)	Axiata: 2300-2360 MHz, 2385-2400 MHz (75 MHz)
Belgium (Band 38)	BUCD: 2575-2620 MHz (45MHz)
Finland (Band 38)	Ukko Mobile: 2570-2620 MHz (50 MHz)
Norway (Band 38)	Cayman Spectrum: 2570-2620 MHz (50 MHz)
Estonia (Band 38)	TeliaSonera: 2575-2615 MHz (40 MHz)
Latvia (Band 38)	TeliaSonera: 2570-2620 MHz (50 MHz)
Poland (Band 38)	Midas: 2570-2620 (50 MHz)
Slovakia (Band 38)	Slovak Telekom: 2570-2620 MHz (50 MHz)
Sweden (Band 38)	3 (Hutchison): 2570-2620 MHz (50 MHz)
Switzerland (Band 38)	Swisscom: 2570-2615 MHz (45 MHz)

Note that in all the above examples the awarded licences are for contiguous spectrum blocks of

- 20 MHz or greater in the 2.3 GHz band (Band 40), and
- 40 MHz or greater in the 3.4 GHz band (Band 42).

Given the predicted increase in the amount of mobile data over the next decade, it is very likely that even 20 MHz will soon become inadequate and bandwidths of 40 MHz and greater are more appropriate in the context of the proposed 20 year period of the 2.3 GHz and 3.4 GHz licences in the UK[1]. We believe it is important to account for the longer term evolution of demand for mobile data in awarding the spectrum in these two bands.

Importantly, there is a substantial risk that the 2.3 GHz band might be fragmented into awarded blocks of 20 MHz or less as a result of the UK auction and that these remain unused post-award, as has indeed been the case for the 2.6 GHz TDD band (Band 38) in the UK (despite the award of 25 MHz blocks).

[1] For the purpose of comparison, one can refer to the award of paired spectrum in the nearby 2.6 GHz band in the UK, where three licences were issued for 2×35 MHz, 2×15 MHz, and 2×20 MHz. Note that 15 MHz of uplink with a 3:1 downlink/uplink ratio would translate to 60 MHz of unpaired spectrum.

Based on the evidence presented, and in light of the predicted increase in demand for mobile data over the proposed licence period, we strongly recommend that Ofcom designs the auction in such a way so as to

c) award a single block of 40 MHz in the 2.3 GHz band, and

d) award the 3.4 GHz band as either three blocks of 40 MHz and one block of 30 MHz, or alternative assignments which result in block sizes of 40 MHz or greater.

Question 4.2: Do you have any other comments or views relating to the overview of the spectrum?

We agree with Ofcom's overview.

Question 5.1: Do you agree with our proposals for achieving contiguity, and if not please provide further explanation.

We agree with Ofcom's approach.

Question 6.1: Do you agree with our recommendation for an SMRA? If not, please explain why.

No comment.

Question 6.2: Do you agree with our proposals for the SMRA (including withdrawals, minimum requirements and waivers)? Do you have any other comments or views on this proposal?

No comment.

Question 6.3: Do you agree with our proposals for the CCA? Do you have any other comments or views on this proposal?

No comment.

Question 6.4: Do you agree with our proposals for the assignment stage? Do you have any additional views or comments?

Regarding the 2.3 GHz band, we welcome Ofcom's approach of only considering assignment plans in which each bidder is assigned a contiguous frequency block that corresponds to the bandwidth they won in the principal stage, and ensuring that any unsold spectrum will form a contiguous block.

However, as highlighted in our response to Question 4.1, evidence suggests that a minimum bandwidth of 40 MHz is essential for exploiting the full long-term potential of the 2.3 GHz band. As such we recommend that the 2.3 GHz band be awarded as a single block of 40 MHz, in which case an assignment stage would be unnecessary. This also eliminates the risk of any unsold spectrum.

Regarding the 3.4 GHz band, we again welcome Ofcom's approach of prioritising assignment plans in which each winner is assigned a single contiguous frequency block and ensuring that any unsold spectrum would form a contiguous block.

However, as highlighted in our response to Question 4.1, evidence suggests that a minimum bandwidth of 40 MHz is essential for exploiting the full long-term potential of the 3.4 GHz band. As such we recommend that the 3.4 GHz band be awarded in as many blocks of 40 MHz (or greater) as possible. For example, three blocks of 40 MHz and one block of 30 MHz, or three blocks of 50 MHz. This also eliminates the risk of any unsold spectrum.

Question 6.5: Do you have any other comments on auction design?

No comment.

Question 6.6: Do you agree with our proposals for the reserve prices? If so, where in the range we propose should the reserve price for the 2.3 GHz band be? Do you have any other views or comments?

No comment.

Question 7.1: Do you agree with our approach to considering what spectrum is relevant to this competition assessment? Please give reasons for your views.

No comment.

Question 7.2: Do you agree with our view that spectrum at 800 MHz, 900 MHz, 1.4 GHz, 1.8 GHz, 2.1 GHz (paired only), 2.3 GHz, 2.6 GHz and 3.4 GHz is relevant for this competition assessment? Please give reasons for your views.

No comment.

Question 7.3: Do you agree that very asymmetric spectrum holdings could give rise to competition concerns? Please give reasons for your views.

No comment.

Question 7.4: Do you agree with our proposal to impose an overall spectrum cap in the auction equivalent to the overall spectrum cap in the 2013 auction? If our assessment of what spectrum is relevant is correct, do you agree with the proposal for an overall spectrum cap at 310 MHz? Please give reasons for your views.

No comment.

Question 7.5: Do you agree with our proposals to amend the Mobile Trading Regulations shortly before the PSSR award so as to include relevant spectrum at 1.4 GHz, 2.3 GHz and 3.4 GHz? Please give reasons for your views.

No comment.

Question 7.6: Do you have any other comments on our assessment of competition effects from the award?

No comment.

Question 8.1: Do you have any comments on the proposals relating to the duration of the initial licence period, our rights to revoke the licence during this period, the charging of licence fees after the end of the initial period and our additional revocation powers following the initial period?

No comment.

Question 8.2: Do you have any comments on our proposals relating to the territorial extent in the award licences?

No comment.

Question 8.3: Do you have any views on the merits of the proposed approach to information provision; in particular concerning the type of information that may be helpful and any impacts that publication of information might have both on licence holders and the wider spectrum market?

No comment.

Question 8.4: Do you have any comments on other proposed non-technical licence conditions and the draft licences at Annexes 8 and 9?

No comment.

Question 9.1: Of our two possible options to encourage or mandate synchronisation do you prefer Option 1 or Option 2? Please explain your preference for the option and let us know if you have other comments or suggestions.

We believe that in practice synchronisation among TDD operators is essential for efficient use of the radio spectrum, and the efficient mitigation of base-to-base and mobile-to-mobile harmful interference in the 2.3 GHz and 3.4 GHz bands.

This is evident from the following examples of recent awards of unpaired spectrum in three major national markets:

- We cite the experience in China where operators of TDD networks have synchronised in Band 40 (2.3 GHz) and Band 41 (2.6 GHz), both based on TD-LTE frame configuration 2 (3:1 downlink/uplink ratio).

- We also cite the recent award of Band 42 spectrum in Japan, where again the three licensees intend to synchronise based on TD-LTE frame configuration 2 (3:1 downlink/uplink ratio).

- Finally, we cite the experience in New Delhi-India following the award of licences for Band 40 (2.3 GHz), where disagreements on coordination between the two TDD licensees resulted in a delay of 6 months in delivering TD-LTE services. The two

licensees eventually agreed on a common synchronisation pattern and roll out commenced shortly thereafter.

Experience over time has demonstrated that where there is a *real willingness* to use the spectrum, full synchronization between operators is a key enabler in the successful deployment of IMT networks in unpaired spectrum.

Furthermore, we do not think that Option 1 can work in practice. We note that Ofcom's proposed Option 1 gives an operator the option to not synchronise with other operators (i.e., to not frame align or to use a frame structure that is different from that specified by Ofcom), but to use a restrictive emission mask (high ACLR) instead. We note that unless a victim operator also has base stations with very high receiver selectivity (ACS), the use of a restrictive emission mask by the unsynchronised operator will not mitigate harmful base-to-base interference. For this reason, we believe that Option 1 would in practice result in non-synchronised and high-cost networks.

As such, while Option 1 affords operators the flexibility of choosing to synchronize or to not synchronize, and appears only to penalise the non-synchronised operator (via the restrictive baseline block edge mask), in practice it penalises all operators; that is, a single non-synchronized (perhaps un-cooperative) operator would impose increased equipment costs (receive filtering) on all adjacent UK operators.

Based on the our experience of international deployments on the ground, we <u>strongly</u> recommend Ofcom's proposed Option 2 which mandates synchronisation among TDD operators; that is frame alignment and the use of a pre-specified frame (UL/DL) configuration. Combined with Ofcom's proposed Inter-operator Synchronisation Procedure, Option 2 achieves the right balance of providing immediate certainty and future flexibility.

Question 9.2: Do you agree with our proposed frame structure of LTE configuration 2 or equivalent?

A downlink/uplink ratio of 3:1 (configuration 2 in TD-LTE) is currently the mainstream configuration for commercial LTE TDD deployments, and adapts well to real world traffic environments. Globally, there are very few operators which use other configurations. One example is Sprint in the US which currently uses configuration 1 (2:2), but plans to switch to configuration 2 (3:1) due to asymmetric traffic in its network.

Accordingly, we agree that TD-LTE configuration 2 is a good candidate for the default downlink/uplink frame structure. This is with the proviso that alternative configurations can be used in the future if mutually agreed by the licensees. We understand that this can be implemented either through Ofcom issuing an update of the Inter-Operator Synchronisation Procedure, or though temporary bi-lateral or multi-lateral agreements between the licensees.

Question 9.3: Do you agree with our proposal that indoor small cells, with power levels up to 24 dBm, do not need to synchronise?

We disagree with the proposal that indoor small cells with power levels up to 24 dBm do not need to synchronise.

We foresee scenarios where multiple operators will deploy small TDD cells within the same building and this will result in high levels of mutual base-to-base and terminal-to-terminal harmful interference due to a lack of synchronisation.

Furthermore, a protection distance of 100-300 metres between an indoor femto base station and an outdoor macro base station (see Annex 10 of the consultation) required for the mitigation of base-to-base interference is quite large, and would be even greater when aggregation of harmful interference from multiple femto cells is taken into account.

For the above reasons, we recommend that synchronization (Option 2) is mandated for all cells irrespective of their dimension (macro to femto).

Question 9.4: Do you agree with our approach in the Inter-operator Synchronisation Procedure?

We broadly agree with the proposed Inter-Operator Synchronisation Procedure. However, we note that it is essential that efficient administrative mechanisms are put into place by Ofcom to allow various details of the Procedure to be modified in an efficient and timely manner following the award, where those modifications are agreed by the licensees.

On the issue of timing accuracy of ±3 µs, TD-LTE allows for a worst case timing error of 3 µs between two adjacent channel base stations. For this reason, we believe the synchronization requirement should specify a timing accuracy of ±1.5 µs with respect to a common clock reference, thereby dividing the burden of timing equally between two licensees.

Question 9.5: Do the parameters to be provided in the Inter-operator Synchronisation Procedure give you sufficient certainty at the time of the award for your future deployments? If not can you provide further information on what extra detail information would need to be covered?

We believe the parameters provide sufficient certainty.

Question 9.6: Would any of the potential changes to the procedure that we have considered made within the first 12 months following the award have a significant impact to a network that has been deployed in the interim? If so please explain any concerns.

This very much depends on the specific nature of the change. In any case, the impacts of any modifications are likely to be more severe in the context of femto cell base stations. This is because they are in the possession of the consumer and are also more cost-sensitive.

As an example, if initially low power base stations are not required to synchronise, and subsequently it is found that synchronization is an essential requirement, the retro-fitting of large numbers of femto cells with synchronisation technologies can be prohibitive and/or costly.

Question 9.7: Do you agree with our approach for power control for femto cells?

We agree with Ofcom's proposal that femto cells should use power control in both the 2.3 and 3.4 GHz bands.

Question 9.8: Do you agree with our position to adopt the new power limits above 2403 MHz?

We agree with the new power limits. We understand that the base station baseline out-of-band limits are per cell/sector (and not per antenna).

Question 9.9: Do you agree with our position with regard to the out of block levels applicable in UK Broadband's spectrum holding of 3605 – 3689 MHz?

We broadly agree with Ofcom's proposals regarding UK Broadband's out-of-block levels.

However, we would like to re-emphasize the importance of synchronization (see Question 9.1), and — with a view to the future use of the 3600-3800 MHz band — we strongly recommend that IMT use of unpaired spectrum in the 3600-3800 MHz band also be subject to Option 2; i.e., frame alignment and the use of the same pre-specified frame (UL/DL) configuration as used in the 3.4 GHz band.

Question 9.10: Do you have any other comments on the proposed technical licence conditions and the draft licences attached at annexes 8 and 9?

Please find below a number of comments on the technical licence conditions and the draft licences.

<u>SECTION 9, FIGURE 14</u> (base station in-block limits)

We understand that the base station in-block power limits in Figure 14 of Section 9 are defined per cell/sector (and not per antenna). This should also be clarified in the licence conditions.

<u>SECTION 9, FIGURE 14</u> (base station permissive baseline and transitional limits)

We understand that the transitional levels and the permissive baseline limits in Figure 14 of Section 9 are based on ECC Decision (14)02 for the 2.3 GHz band, and the EC Decision 2014/276/EU for the 3.4 GHz band.

We note that in the context of interference between frame-aligned operators using the same UL/DL frame configuration, the transitional levels and the permissive baseline limits must be no more restrictive than implied by the 3GPP specifications. This is because the 3GPP limits adequately mitigate the risk of mobile-to-base and base-to-mobile interference that is characteristic of synchronised base stations in adjacent channels. Furthermore, the 3GPP specifications describe limits for wide area, local area, and home base stations.

Accordingly, it is important that the transitional levels and the permissive baseline limits in the draft licences be defined so as to be no more restrictive than the 3GPP specifications for 20 MHz carriers.

SECTION 9, FIGURE 14 (base station levels to protect MoD systems)

We are encouraged that Ofcom and the MoD are exploring the possibility of relaxing the out-of-band emission limits below 2340 and 3400 MHz, as we have serious concerns regarding the feasibility and cost of compliance with these limits.

Specifically, the level of -59 dBm/MHz below 3400 MHz is very stringent and difficult/costly to achieve, particularly for the larger carrier bandwidths. For an in-bock EIRP of 65 dBm/5MHz, the above limit represents an ACLR of 65-(-59+7) = 117 dB at only a 10 MHz frequency separation from the band edge at 3410 MHz.

The technical constraint here is not only the large value of the ACLR, but the required sharp roll-off over 10 MHz. Accordingly, we recommend a relaxed level of -50 dBm/MHz (as per Option B in EC Decision 2014/276/EU) but applied below 3390 MHz, allowing a 20 MHz roll off from the band edge. Appropriate values can then be specified over 3390-3400 MHz to account for the reduction of the emissions from the transition levels down to -50 dBm/MHz.

We note that in specifying out-of-band emission limits, it is important to account for the limited selectivity of receivers. In other words, if the ACS of a receiver is not sufficiently high (perhaps because of wideband tuning) then large and stringent values of ALCR will not mitigate harmful interference.

Furthermore, we note that the deployment geometries of low-power (femto/pico/micro-cell) base stations are different from those of higher-power (macro cell) base stations, and that the former group will almost certainly represent a lower likelihood of harmful interference to MoD systems due to the absence of line of sight and the more challenging propagation conditions. As such, we recommend that Ofcom considers relaxing the out-of-band emission limits below 2340 and 3400 MHz for micro, pico and femto cells.

We are hopeful that Ofcom and the MoD will specify *least restrictive* technical conditions which avoid costly IMT equipment costs, yet which provide reasonable and realistic levels of protection to MoD systems.

SECTION 9, FIGURE 15 (terminal in-block limits)

We understand that the terminal in-block power limits in Figure 15 of Section 9 are defined per device (and not per antenna). This should also be clarified in the licence conditions.

SECTION 9, FIGURE 16 (base station out-of-band limits above 2403 MHz)

We understand that the base station baseline out-of-band limits are per cell/sector (and not per antenna). This should also be clarified in the licence conditions.

DRAFT LICENCE, SCHEDULE 1, SECTION 9
Maximum power within the permitted frequency blocks

See comments above for in-block power limits.

DRAFT LICENCE, SCHEDULE 1, SECTION 9

Maximum power outside the permitted frequency blocks

There appear to be some ambiguities in the description of the out-of-block power limits in the draft licences. We describe these below in the context of Option 1 and 2.3 GHz (similar comments apply to Option 2 as well as 3.4 GHz):

- The text in clause (a) appears to contradict clause (c), and suggests that the restrictive baseline limit applies outside the band. We understand that the restrictive baseline limit only applies inside the band. We recommend clarification that clause (a) only applies inside the band.

- For the case of offsets of 10 MHz or greater, the text in clause (b) appears to contradict the conditions in clause (c), suggesting that the baseline limit applies outside the band. We understand that the baseline limit only applies inside the band. We recommend clarification that clause (b) only applies inside the band, whereas clause (c) applies outside the band.

- Clause (c) does not describe the limits over 2400 to 2403 MHz.

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