Award of the 700 MHz and 3.6-3.8 GHz spectrum bands

Telefónica UK Limited's Response to Further Consultation on Modelling and Technical Matters – Dynamic Spectrum Sharing

12 June 2020

1. This paper sets out Telefónica UK Limited's ("**TUK**") consultation response on the issue of Dynamic Spectrum Sharing ("**DSS**"), in response to Ofcom's Further Consultation on Modelling and Technical Matters of 15 May 2020 (the "**Further Consultation**"). Ofcom's 13 March 2020 Statement (the "**Statement**") contains a competition analysis which concluded that there was a low risk of competition concerns arising from asymmetry in the 3.4 – 3.8 GHz bands even in the event that MNOs other than H3G win no additional spectrum.[1] This led it to consider that there was no more than a low risk of competition concerns if mobile network operators ("**MNOs**") won additional spectrum in the forthcoming auction but had fragmented holdings in the 3.4 – 3.8 GHz band.[2] [✂] TUK considers that Ofcom's analysis in this regard is seriously flawed. [✂]

2. It is central to Ofcom's analysis that it considers that MNOs are likely to be able to support a wide range of 5G services to consumers without 80 – 100 MHz of contiguous bandwidth.[3] The report of Professor Webb explains why the Single User Throughput ("**SUT**") analysis that forms a key premise of that conclusion is unfit for purpose.

3. A further key premise of Ofcom's analysis is that the MNOs will be able to refarm their existing holdings to support 5G, including over time the 2.3 GHz band awarded to TUK.[4] In Annex 7 to the Statement, Ofcom rejected TUK's explanation that "operators with modest capacity spectrum holdings will not have the flexibility to refarm from 4G to 5G", stating that DSS could facilitate such refarming.[5]

4. [✂] this is incorrect. Ofcom's mistake has far reaching consequences for its analysis. As a result, it has failed to take into account the real limitations affecting TUK's ability to provide a competitive 5G offering and the competition risks posed by the proposed auction rules.

DSS is not a viable option for TUK

5. Ofcom acknowledges the industry wide drawback in using DSS, namely that it requires part of the available capacity to be sacrificed. It estimates that "DSS might reduce capacity by 7 to 10% when compared with a 4G-only carrier".[6] [✂]

6. In addition, for TUK there is an even bigger problem in that DSS cannot be used at all for one of its critical spectrum bands (the 2.3 GHz band) – as Ofcom now appears to acknowledge.[7] Despite this, in the Further Consultation Ofcom

1 Statement, 4.203 (confidential version) / 4.203 (public version).

2 Statement, 4.287 (confidential version) / 4.287 (public version).

3 Statement, 4.211 (confidential version) / 4.211 (public version).

4 Statement, 4.240 (confidential version) / 4.240 (public version).

5 Statement, A7.35-A7.36 (confidential version) / A7.35-A7.36 (public version).

6 Further Consultation, 1.51; see also, Statement, A6.57 (confidential version) / A6.57 (public version).

7 Further Consultation, 1.52-1.53.

maintains its conclusion that "DSS could facilitate refarming of most 4G bands to 5G, and so is likely to be an option for operators to consider."[8]

7. The 2.3 GHz band is critical for TUK's current 4G capacity, [✂].

8. The reason the 2.3 GHz band cannot be used in conjunction with DSS to provide connectivity between 4G and 5G is that 2.3 GHz is a Time Division Duplex ("**TDD**") band, whereas DSS currently only works with Frequency Division Duplex ("**FDD**") bands.[9]

9. TUK understands that other UK MNOs tend to use FDD bands, which are also far more common across 4G European networks. Vendors have focused on designing DSS to work with FDD bands. TDD bands are not currently supported. [✂]. Moreover, devices need to be compatible to fully take advantage of DSS. As far as TUK is aware, there are no devices currently planned to be compatible with DSS using TDD spectrum, as the base station equipment does not exist, and as such there is no demand for the capability.

10. Ofcom must therefore proceed on the basis that DSS will not be available in TDD bands. Ofcom appears to recognise this (at least implicitly) in the Further Consultation, which states that DSS "is likely to be available in a number of current 4G FDD bands including 800 MHz, 900 MHz, 1800 MHz, 2.1 GHz and 2.6 GHz."[10]

11. Even in respect of TUK's 2x5 MHz of 1.8 GHz spectrum, DSS is not viable as it requires at least 2x10 MHz of FDD spectrum.

12. This means that the only bands where DSS would be available for TUK are 800 MHz, 900 MHz and 2.1 GHz. [✂].

13. Thus, TUK's ability to refarm 4G spectrum is far more limited than Ofcom assumed in the Statement.

<u>The adverse impact of refarming without DSS</u>

14. In the Statement, Ofcom took the view that use of the 2.3 GHz band would enable TUK to provide a competitive 5G offering.[11] [✂]

    [✂]

15. [✂] In the Statement, Ofcom referred to Cisco's forecast that "total mobile traffic by 2022 will include 71% of 4G traffic, with 12% 5G traffic".[12] Therefore, whilst 5G usage will increase in the next few years, 4G usage will continue to grow in parallel and will still account for the majority of demand in this period. [✂].

8 Further Consultation, 1.53.

9 Further Consultation, 1.53. TDD is seeing increasing use in the first 5G deployments, as well as use by some operators (including TUK) for 4G. It uses only a single spectrum channel, and instead uses time slots to separate downlink signals from uplink – switching back and forth between downlink and uplink every few milliseconds. This has the advantage that it can be configured to give more capacity to downlink, making it more spectrally efficient in typical data networks where, on average, users download much more data than they upload.

10 Further Consultation, 1.53.

11 Statement, 4.208 (confidential version) / 4.208 (public version).

12 Statement, A7.7 (confidential version) / A7.7 (public version).

16. MNOs would look to use their spectrum to provide sufficient capacity to meet both 4G and 5G demand. However, when spectrum is limited MNOs have to choose how to allocate their spectrum between providing 4G capacity and 5G capacity. As explained above, in the near-term, 4G will account for the majority of demand. [✂]

17. [✂]This adverse impact, and the consequences it could have on competition within the industry, has not been properly taken into account by Ofcom in reaching its conclusions.

18. This is particularly important given the very large increases in demand that have been forecast.

The expected growth in demand

19. Ofcom previously found that "there is a broad consensus that mobile data consumption will increase sharply over the next decade – potentially by a factor of 10 to 100. Such a rapid growth in demand places pressure on mobile network operators (MNOs) to increase their capacity in order to meet growing consumer expectations."[13]

20. In the Statement, Ofcom referred to a Cisco forecast of average data usage growing to 11.4 GB per mobile-connected end user device per month in 2022, as against just 2.3 GB in 2017.[14] TUK considers this to be too conservative and notes that there are a wide range of higher demand forecasts.

21. Ofcom has previously considered a possible usage of 40 GB per user in 2025[15] and a recent forecast by CCS suggested that average usage could reach 33 GB by 2024.[16] Based on Ofcom's own analysis, Three have stated that their customers are expected to use on average 90GB per user per month by 2025.[17]

22. In 2019, Unlimited data tariffs were launched by O2[18], Vodafone[19] and EE[20]. [✂]These unlimited data allowances have enabled customers to grow their data usage further. [✂]

23. Experience in other countries, where 5G is more established, points to large growth in customers' average usage once 5G is available – for example, evidence from South Korea suggests that 5G leads to a trebling of data usage by consumers.[21] Such trends indicate rapid acceleration in demand and therefore support forecasts at the higher end of the range than that relied upon by Ofcom.

24. In light of the above, TUK considers that forecasts of user demand closer to 40 GB per user per month by 2025 are a distinct and realistic possibility.[22] This possibility should be reflected by Ofcom in its regulatory decision making, rather than basing its decisions only on a particularly conservative forecast.

13 Statement of 11 July 2017 "Award of the 2.3 and 3.4 GHz spectrum bands", 1.6.

14 Statement, 4.24 (confidential version) / 4.24 (public version).

15 Mobile Data Strategy, June 2016, 3.14.

16 CCS Insight – Market Landscape and Forecast: Telecom Operators, UK, 2019-2024 (December 2019 Update).

17 Three Media Centre, 22 July 2017 – see: https://www.threemediacentre.co.uk/content/three-uk-continues-5g-network-preparation/. (Accessed 9 June 2020)

18 Launched on 13 September 2019 – see: https://news.o2.co.uk/press-release/o2-goes-limitless/. (Accessed 9 June 2020)

19 Launched on 10 July 2019 – see: https://newscentre.vodafone.co.uk/press-release/unlimited-data-over-5g-and-4g-from-today/. (Accessed 9 June 2020)

20 Launched on 28 August 2019 – see: https://newsroom.ee.co.uk/ee-launches-truly-unlimited-plans-on-the-uks-bets-mobile-network/. (Accessed 9 June 2020)

21 CCS Insight – Market Landscape and Forecast: Telecom Operators, UK, 2019-2024 (December 2019 Update).

22 Not least given the difficulties Ofcom has acknowledged in respect of accurate forecasting of demand once 5G becomes widely deployed.

25. Assuming Ofcom's previously considered usage of 40 GB per customer by 2025 proves accurate, this would amount to an increase of 1,379% in absolute data usage per user between 2018 and 2025. In the same period, the total spectrum available would have expanded by only 18% (i.e. the auctioned spectrum). Whilst average spectral efficiency will undoubtedly improve from a transition of 4G to 5G, [✂]. Even on the more conservative forecasts, there is a significant imbalance between potential growth in demand and additional spectrum.

26. In the circumstances, efficient use of spectrum is paramount across the industry. TUK utilises a wide range of means to use its spectrum holdings efficiently, as Ofcom is aware. [✂].

27. [✂].

Capacity consequences

28. The impact of this on TUK and its customers is particularly pronounced given the current asymmetry in overall spectrum holdings. As noted by Ofcom in the Statement,[23] TUK is the largest provider of wholesale mobile services (with a 34% share of subscribers) but has the least spectrum across all mobile frequencies (holding just 18% of currently allocated spectrum),[24] with "particularly little spectrum in the mid frequency bands (1800 MHz to 3.8 GHz included)".[25] Ofcom has accepted that if TUK fails to win any spectrum in the forthcoming auction it could have "considerably lower capacity than its rivals".[26]

29. As the operator with the greatest share of subscribers but the smallest amount of spectrum, TUK is especially vulnerable to network congestion issues.[27] [✂]The current asymmetry in the 3.4 – 3.8 GHz band is particularly concerning for TUK in light of the accepted advantages that a large contiguous spectrum holding has for the provision of 5G.[28] [✂].

30. [✂]

31. [✂].

32. [✂] TUK has taken measures to improve the capacity delivered by its relatively small spectrum holdings, particularly densification in dense urban areas like Central London. Ofcom's approach to defragmentation implies a further loss of effective capacity on the assumption that it can somehow be mitigated. In practice, as TUK has previously explained, the mitigating measures Ofcom referred to are not readily available and/or come at a severe capacity detriment and/or are likely to be used in any event. Ofcom has simply assumed this detriment can be afforded. TUK's concern is that this capacity is likely to be needed. [✂]

23 Statement, 4.4 (confidential version) / 4.4 (public version).

24 Statement, 4.62 (confidential version) / 4.62 (public version).

25 Statement, 4.12 (confidential version) / 4.12 (public version).

26 Statement, 4.65 (confidential version) / 4.65 (public version).

27 TUK December 2019 consultation response of 9 December 2019 ("**TUK December 2019 consultation response**"), 82 (confidential version).

28 TUK notes that in its July 2019 consultation response it estimated that H3G's contiguous block would mean speeds of 1,875, Mbps "in real world, ideal conditions", as against 940 Mbps for an operator with no contiguous block larger than 50 MHz. TUK accepts that those numbers are higher than would be achieved in "real world" conditions, but the general point made in its consultation response, that there would be a substantial difference between the speeds attainable with those different holdings, remains correct.

Other means to meet demand

33. [✂]. In particular, Ofcom proceeded on the basis that the absence of a large contiguous block of spectrum in the 3.4 – 3.8 GHz range could be addressed through various mitigation measures. It concluded that in the absence of large contiguous bandwidths of 5G spectrum, there was a low risk that the necessary performance to provide 5G services could not be achieved through alternative means.[29]

34. TUK has addressed these in its previous submissions, which it reiterates and updates in the context of this Further Consultation, as follows. [✂], Ofcom must have regard to this context.

35. The essential problem is that Ofcom assumes that these measures will be available to meet demand, but without analysis, and even though its own approach sacrifices capacity.

36. Ofcom acknowledged that mobile networks will need to expand their capacity and 5G deployments in the 3.4 – 3.8 GHz band to meet the increase in demand.[30] In Ofcom's view, there are "different ways" in which operators could potentially achieve this, but "deploying additional spectrum is likely to be very important".[31] [✂]

37. [✂].

[✂]

38. [✂]. The other alternatives put forward by Ofcom suffer from significant limitations in terms of practicality and effectiveness.

Massive MIMO not viable with 2.3 GHz or 2.6 GHz

39. Ofcom suggested that MNOs can use massive MIMO with their existing 2.3 GHz or 2.6 GHz holdings to increase capacity to achieve a comparable experience to that which could be obtained by 3.4 – 3.8 GHz.[32] TUK accepts that massive MIMO can greatly improve the capacity that can be delivered from spectrum. However, Ofcom is mistaken in assuming that massive MIMO could provide an alternative means for TUK to address its capacity concerns without holding a large contiguous block of 5G spectrum.

40. Massive MIMO equipment is not currently viable to be deployed with all bands. When 2.3 GHz massive MIMO is available, the size of the 64x64 equipment required may mean that it will not be viable to include it on all sites as there is simply not enough space. This issue was raised by TUK as part of its previous consultation responses.[33] These space restrictions would mean that TUK (and other MNOs) are forced to deploy lower order MIMO

29 Statement, 4.258 (confidential version) / 4.258 (public version).

30 Statement, A7.7 (confidential version) / A7.7 (public version). See also 4.25 (confidential version) / 4.25 (public version).

31 Statement, 4.25 (confidential version) / 4.25 (public version).

32 Statement, 4.240 (confidential version) / 4.240 (public version).

33 TUK July 2019 consultation response, Annex 1, 11 and 25(d) (confidential version).

equipment (e.g. 16x16 or 32x32), which reduces the size of the equipment needed but also reduces the overall capacity that can be delivered by the same volume of spectrum (i.e. the spectral efficiency reduces).

41. Figure 3 below shows the scale of the capacity loss if 80 MHz of 3.4 – 3.8 GHz spectrum used 32x32 equipment, instead of 64x64, [✂].

[✂]

Carrier Aggregation

42. Intra-band carrier aggregation was suggested by Ofcom, for TUK, Vodafone and/or BT to combine any newly acquired spectrum with their existing 3.4 – 3.6 GHz spectrum. Carrier aggregation allows for MNOs to combine fragmented holdings, but is most beneficial when a cell is under limited load. Under high load, the impact of needing extra resources for carrier aggregation offsets the advantages. In some cases the feature is switched off on congested sites for this reason. Thus Ofcom cannot assume carrier aggregation will be appropriate as demand continues to rise. In any event such an approach would entail significant capacity losses and its availability remains speculative.

43. Ofcom itself indicated a capacity loss of up to 15% depending on various factors, noting that there were even circumstances in which the figure may be higher than this.[34] [✂]

44. The impact of a 15% loss in spectral efficiency, against TUK's existing 40MHz of 3.4 GHz, is the equivalent to removing 6MHz of spectrum. Against 80MHz, the impact of a 15% loss is the equivalent of 12MHz being lost. Therefore, at auction an MNO buying new spectrum will need to account for the effect of Ofcom's decision on the value of spectrum. TUK acquiring further spectrum will provide some capacity, but the issue over fragmentation and risk that sufficient capacity cannot be provided remains. Ofcom's approach introduces significant uncertainty about how much capacity can be generated from the spectrum which a bidder is awarded. The significance of this varies as between the MNOs, depending upon their existing holdings. This serves to increase the likelihood of an inefficient allocation of spectrum.

45. Ofcom contrasted this capacity loss with the gains that may be made from massive MIMO.[35] Where possible, TUK expects to deploy massive MIMO to meet expected demand forecasts. However, as already explained, there are severe limitations upon MNOs' ability to use massive MIMO across different sites, especially if the total level of traffic in an area requires multiple bands to be deployed with massive MIMO equipment to provide sufficient capacity.

46. Further, as Ofcom itself acknowledged, there remains a risk as to if and when carrier aggregation features are ever supported.[36]

34 Statement, A7.68 and footnote 380 (confidential version) / A7.68 and footnote 377 (public version).

35 Statement, 4.267 (confidential version) / 4.267 (public version).

36 Statement, A7.74 (confidential version) / A7.74 (public version).

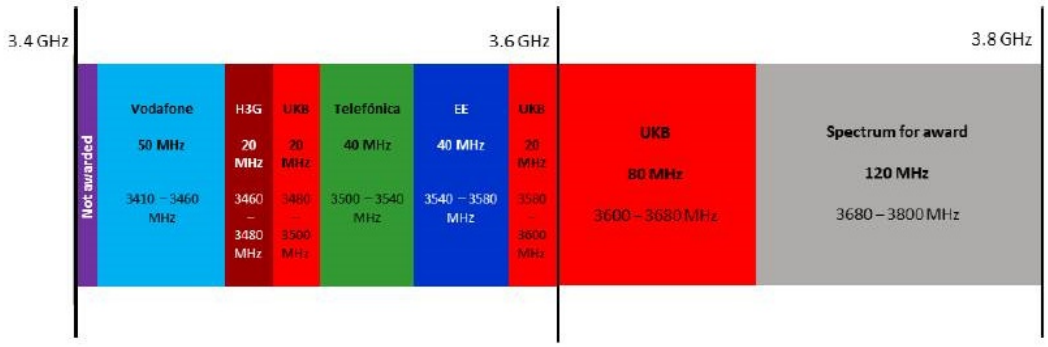
47. Inter-band carrier aggregation between 2.3 GHz and 3.4 GHz is not currently supported in devices but may begin to be from next year (2021+). [✂]

48. Intra-band carrier aggregation has not yet even been defined in the standards, and will not be supported for some time yet, if at all. Even if the 3GPP introduces the standards, there is no guarantee that original equipment manufacturers ("**OEM**s") will adopt it. This is particularly a risk for the UK, as it may be one of the only markets in Europe where operators have discontiguous spectrum. As such, intra-band carrier aggregation will not be in any early 5G devices.[37] Moreover, as TUK has previously explained[38] and as accepted by Ofcom, there is a risk that even if intra-band carrier aggregation does arrive, it could be limited to a subset of the market, namely high end, expensive, devices.[39] Nonetheless, the risk that intra-band aggregation never arrives for 3.4 – 3.8 GHz remains a serious concern.

49. For intra-band carrier aggregation to be viable and cost effective, both parts of fragmented spectrum need to be delivered by the same antenna system and to be usable by existing network site equipment, the radio equipment would need to use a large enough instantaneous bandwidth ("**IBW**") to cover the bottom-most spectrum holding and the upper-most spectrum holding.

50. As shown in Figure 4, following the auction the maximum bandwidth between MNOs holdings could be: Vodafone – 390 MHz, TUK – 300 MHz and BT – 260 MHz.

Figure 4: Current 3.4 – 3.8 GHz Band Plan



51. [✂].

52. TUK consider it highly unlikely that antennas which cover the entire band (400MHz IBW) will ever be available.[40] TUK's understanding is that it does not remain on the confirmed plans of either Nokia or Ericsson. This is due to the technical complexities and filtering requirements needed to cope with large gaps between spectrum.

37 TUK March 2019 consultation response, 159 (confidential version) / 158 (public version).

38 TUK March 2019 consultation response, 160 (confidential version) / 159 (public version).

39 Statement, A7.76 (confidential version) / A7.76 (public version).

40 TUK March 2019 consultation response, 158 (confidential version) / 157 (public version).

53. The only vendor who has suggested to TUK that it may be able to produce 400 MHz IBW equipment is Huawei, which is designated a High Risk Vendor.[41] As such, the government has imposed deployment limits on its equipment, and there is no certainty over it being viable in the long-term as an equipment vendor in the UK. There remains political uncertainty as to the use of its equipment.

54. Ofcom cannot therefore simply proceed on the basis that 400MHz IBW capability will become available within the UK or be viable to deploy or use.

55. If equipment to cover the whole of an MNO's IBW holding is not available, operators will not be able to use intra-band carrier aggregation and instead will have to rely on a number of other options to be able to use any newly acquired spectrum:

    55.1. Use split mode.

    55.2. Add duplicative antenna equipment onto a site.

    55.3. Build incremental macros, if a site has no further space.

    55.4. Not use the spectrum on the macro layer.[42]

56. As explained above, given that the spectral efficiency of MIMO reduces as the number of transmit and receive antennas are reduced, split mode would also lead to a capacity loss in the same region as discussed above [✂]. Ofcom acknowledged a potential capacity loss attributed with split mode in its analysis, but the total impact figure is redacted.[43] It is therefore unclear to TUK whether Ofcom has appreciated the extent of the capacity loss arising from split mode.

57. Adding duplicative equipment on sites has two drawbacks: firstly, it is highly expensive and is a poor use of scarce budget resources, secondly there may not actually be space on sites to include a second antenna. TUK's internal estimates, as referenced in analysis previously shared with Ofcom,[44] are that only around [✂]% of sites can fit a second antenna.

58. If there is no further space on a site for an extra antenna, MNOs could look to densify. Densification is already a technique TUK uses in its highest demand dense urban areas to manage current 4G demand. However, there is a limit to how far this method can be used as ultimately it would not be possible to add further sites or sectors, and therefore further densification would become infeasible. In fact, there are already some TUK sites in dense urban areas such as London where densification has been exhausted.

<u>Wi-Fi offload</u>

41 A High Risk Vendor is a vendor whose presence in UK telecoms networks poses a cyber security risk. The National Cyber Security Centre gave guidance in January 2020 with regard to the involvement of HRVs in UK telecoms. See: https://www.ncsc.gov.uk/guidance/ncsc-advice-on-the-use-of-equipment-from-high-risk-vendors-in-uk-telecoms-networks. (Accessed 9 June 2020)

42 As to the limitations of small cells, see the report of Prof. Webb, in particular at §35-8.

43 Statement, A7.103 (confidential version) / A7.103 (public version).

44 TUK July 2019 consultation response, Annex 1, 23 (confidential).

59. TUK is a 'mobile only' operator, which does not offer retail Wi-Fi services. As such, it has no control over its customers' decisions regarding whether and how much they use Wi-Fi rather than mobile phone data. In any case, across the industry, c.80% of data usage on a mobile device is already over Wi-Fi but there is nonetheless significant growth in the mobile use of data. In the circumstances, Wi-Fi offload does not present a viable mitigation measure for TUK.

mmWave spectrum

60. In the statement, Ofcom acknowledged that mmWave spectrum "is not seen as a substitute for sub-6 GHz spectrum and there is currently considerable uncertainty around how and when it will be used for mobile."[45]

Dual connectivity

61. Dual connectivity allows for MNOs to deploy 5G in the near-term using non-standalone ("**NSA**") 5G standards. The benefit of dual connectivity is that the device can receive 4G and 5G at the same time. However, NSA is likely to only be a relevant technology for a very short period until standalone ("**SA**") becomes relevant. Once SA has been deployed, SA compatible devices will connect to this network, and the relevance of dual connectivity will fall away. Some devices are already SA compatible, and TUK expects all vendors to support SA from 2021. Thus, dual connectivity may assist in meeting demand for at most a short period.

Conclusion

62. Ofcom's error in respect of DSS exemplifies a systemic flaw in its analysis: it has proceeded on the assumption that an inefficient approach to spectrum allocation will suffice to meet demand and provide a basis for effective competition in 5G services. It has done so without any adequate analysis of the impact of its measures on the ability of MNOs (and TUK in particular) to meet that demand. This wider failing serves to explain why the error on DSS is of such significance and undermines Ofcom's competition analysis and approach to defragmentation.

63. Ultimately this will lead to detriment to consumers in terms of inferior service and increased costs.[46]

64. TUK respectfully submits that the Statement requires a far-reaching reconsideration.

45 Statement, 4.16 (confidential version) / 4.16 (public version).

46 See TUK's previous submissions on cost modelling, in particular the TUK July 2019 consultation response.