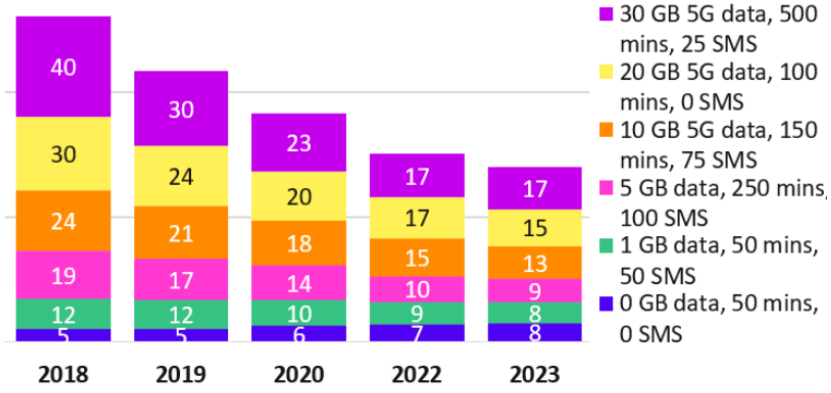
Response from Prof Stephen Temple CBE to the CMA issues statement dated 5th May in respect of the anticipated joint venture between Vodafone and CK Hutchison Holding.

1. Introduction

The welfare a consumer gets from a national mobile broadband network is "the data they want *where they want it* at the most competitive unit price." If all consumers wanted was the data they wanted at the most competitive unit price, they do not need a mobile network, as they can already get that connecting their smartphones to their WiFi at home. Therefore the unique welfare contribution being sought by consumers from a mobile network is the "where they want it" quality and that is maximised when the coverage (*with sufficient data capacity*) has been maximised. The word "coverage" does not appear anywhere in the CSA statement of issues to be considered.

Retail competition alone cannot dramatically drive down the unit price per bit of mobile data. This other important consumer welfare benefit also critically depends upon a mechanism that continuously drives up *national* mobile network data capacity to bring down the unit cost of data. *It is the combination of the two working together that has enabled consumers to use 249% more data in 2023 than in 2018 at a lower retail price.*



Source: Ofcom / TechInsights.

Figure 1 - Weighted average monthly prices of standalone mobile services (£ per month, excluding handset cost) (Ref 1)

Thus, the consumer welfare benefit of a decision that best sustains this data capacity enhancing mechanism significantly outweighs the benefits from just sustaining the current intensity of retail competition. The CMA's decision on the merger will impact this mechanism for better or worse, and this can only be tested if it is included in the Phase 2 investigation.

2. The mechanism driving down the unit cost of data

The mechanism comprises four component parts:

1. *Cooperation on Higher Capacity Next Generation Technology*: This operates in ten-year leaps with ever-wider transmission bandwidths. There has been a 20-fold increase in the widest usable bandwidths from 3G to 5G generations. (See Annex 3). Global technical standards deliver vast equipment economies of scale behind each leap.
2. *New Spectrum Bands*: Each new generation of mobile technology has had a new spectrum band able to accommodate wider and wider carrier bandwidths. But Ofcom recently announced that their spectrum auction pipeline is almost exhausted for the coming decade, putting mobile operators on notice of a more expensive approach to generating more network data capacity (Ref 2 and Annex 3).
3. *Mobile Infrastructure Competition*: This drives the next leap in data network capacity across the country. However, the effectiveness of infrastructure competition has been in decline (See Annex 2). Rolling out high-capacity 5G at scale appears to have stalled.
4. *Mobile retail competition* – This drives the benefits of lower network unit data cost per bit into the hands of consumers through ever larger data bundles for the same price. But the question for the CMA is whether the intensity of retail competition is having a detrimental effect on the effectiveness of infrastructure competition driving investment in more data network capacity across the country?

3. Is there an end is sight of the continuous growth in consumer demand for data?

Ofcom is not foreseeing an end to the rise in demand from consumers for more mobile data. See figure 2. Ofcom's wide ranging discussion paper identifies many use cases (ref 3).

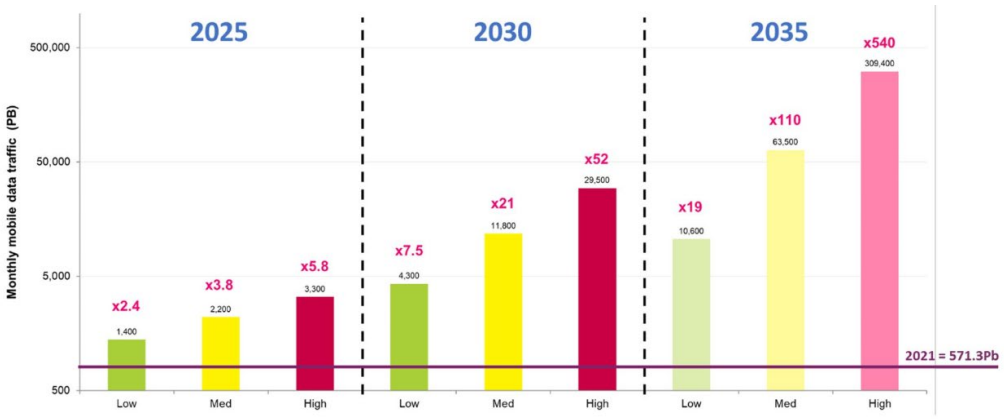


Figure 2 – Traffic growth scenarios given in the conclusions to Ofcom's Future approach to mobile markets and spectrum

New use cases are likely, including:

- Driverless cars generating a leap in mobile data usage – what is today occasional hands-free telephone calls from vehicles are likely to be replaced in time by far more demanding access to the Internet as drivers use idle time to carrying on in the car what they were doing at home or at the office.

- Artificial Intelligence always within reach - AI will augment human capabilities, assist in decision-making, contribute to wellbeing and productivity. If all the coming AI systems (large language models and associated data sets) collectively are thought of as the nation's brain, then the national mobile infrastructure will be its central nervous system.
- Disaster recovering from extreme climate change events - Our mobile networks will experience a surge of data capacity demand when climate change driven disasters strike, and they can strike anywhere

4. Destruction of consumer welfare from congestion

If network capacity does not increase proportionately with growth in demand for data, the outcome will be network congestion. Consumers may have a strong signal but insufficient data throughput, leading to apps failing or performing poorly. *Congestion therefore destroys consumer welfare*.

This impact will not be uniform:

- Consumers will pass through many cells on their journeys, all in various states of congestion at various times of the day.
- around 70% of the UK's land area currently has wafer thin data capacity and is therefore most susceptible to rising congestion and that is what under investment, before the event, results in.

The 70% is a broad-brush estimate (Ref 4) of how much of the UK is dependent solely on low bands and therefore *with inherently low data capacity* (see annex 2). The significance of the number is that the problem is much more extensive than the old "urban majority versus rural minority" issue. The area embraces tens of thousands of transport route miles.

5 How to re-energise mobile infrastructure competition to drive data capacity upgrades?

This is a critical question for the CMA because:

- There is no prospect of new market entry.
- EE and VMO2 have both national mobile and fixed infrastructures, and Ofcom's success in re-energizing fibre to the home competition creates differential competitive pressure with the relatively weak mobile infrastructure competition.
- Vodafone and Three alone are not covering the cost of their capital.

The proposed merger, subject to binding investment commitments, is the only plausible option to re-energize mobile infrastructure competition. (See Annex 2)

6. Conclusion

The CMA's decision will be a watershed moment for the future quality of the UK's mobile infrastructures, affecting different consumer cohorts in various ways. Those most reliant on dependable, universal quality of coverage could be most affected. A continued decline in

mobile infrastructure competition at the current rate of descent is also very likely to lead to a de facto "monopoly mobile infrastructure" in the long term. Some experts see that as the inevitable future linked with intense retail competition between MVNOs. Annexes 2 and 3 show this is not a fanciful prediction over much of the UK. But this would be the worst of all worlds for consumers based upon the UK’s dismal experience of monopoly utilities.

7. About Stephen Temple

Relevant to this submission, I was the senior civil servant (then in the DTI) who persuaded Ministers that the UK could support four competing Mobile Operators. I also played a central role in developing some of the mechanisms described in Section 2, and thus able to provide insights into its operation, weaknesses, and practical options for revitalization. (Ref 5)

I am not employed in any capacity by any company or organisation. Whilst I am an active visiting professor at the University of Surrey 5G/6GIC, the views I have expressed are entirely my own and not those of the university.

8. Acknowledgement

Ofcom for the data sources

Annex 1 - Reference

Annex 2 - Trends in the effectiveness of mobile infrastructure competition

Annex 3 – Technical background briefing in support of this submission

Annex 1 - References

1. https://www.ofcom.org.uk/__data/assets/pdf_file/0024/273138/Pricing-Trends-report-23.pdf

2. https://www.ofcom.org.uk/__data/assets/pdf_file/0017/232082/mobile-spectrum-demand-discussion-paper.pdf

3. https://www.ofcom.org.uk/__data/assets/pdf_file/0017/232082/mobile-spectrum-demand-discussion-paper.pdf

4. https://www.surrey.ac.uk/sites/default/files/2023-11/from-patchy-to-powerful-white-paper.pdf

5. https://www.stephentemple.co.uk/about/

Annex 2 - Trends in the effectiveness of mobile infrastructure competition

From 1985 to about 2004, mobile infrastructure competition was effective, with a race to cover various parts of the country and stay ahead of congestion. However, since 2004, the effectiveness has gradually declined. The notable milestones are:

- Allowing/encouraging mast sharing – Driven by public opposition to mast proliferation
- Telecoms bubble bursting. The 3G spectrum auction excesses led to a pause in competition and the end of international interest to enter the UK market.
- More extensive Infrastructure sharing (now all but the radio access networks).
- The Home Office Emergency Communications Network gave EE an unbeatable competitive advantage on national mobile coverage that disincentivised other MNOs from competing on basic coverage.
- Shared Rural Network. Its performance is poorly specified with only a single user at a time able to get a 90% probability of 2 Mb/s at network edge.
- Rising economic forces tearing away at both sides of the mobile operator's investment business case

Those rising economic forces playing havoc with the infrastructure investment business cases include:

- Pressures on the cost side:
    - Ofcom's financially extractive spectrum policy that has taken £5 billion in 4G and 5G auction fees, £2 billion in annual license fees over the past 10 years and a likely £3 billion over the next ten years.
    - The wider bandwidth to be supported for each new mobile generation can only be accommodated in higher spectrum bands. These are ever more costly for achieving national coverage. (see annex 3)
    - Higher energy costs, cost of building resilience to meet climate change extremes and higher cost of ensuring security.

- Pressures on the revenue side:
    - Internet big tech companies cannibalising mobile operator telephone and messaging revenues
    - Net Neutrality regulation blocking securing carriage fees (common in other infrastructures)
    - The intensity of retail competition based upon a principle of "one more player than the market can bear"
    - No prospect of any significant taxpayer subsidy to plug the substantial investment gap (due to the hugely challenging state of public finances)

Five of those seven forces are policy choices. Each has a case for its contribution towards the investment squeeze. Each can legitimately claim that it is not their bit causing the ship to slowly sink. But the seven item, taken together, paint a picture of an overall industry/market heading into an investment crisis in being able to maximise consumer welfare and the CMA's choice, for better or worse, will be one of them.

Annex 3 – Technical background briefing in support of this submission

DATA

Data transport is usually characterised by the number of bits of data (a bit being a "1" or a "0") that can be transported in one second.

The data capacity available from an individual tower must be shared between all concurrent users. The gross data speed deliverable from that tower is a broad measure of its capacity. That is set by the total bandwidth from all the spectrum available to be used at that tower.

However, this data capacity is not uniformly available across the coverage delivered from a tower. At the far distance, a lot of capacity is lost due to the transport having to be made more robust. Up to twenty times more data capacity is consumed delivering the same data to the furthest distances compared to delivering it close to the tower.

One manifestation of insufficient capacity is a slowing up of everyone's data speeds. A worse manifestation is that IP (internet protocols) keep re-sending a packet of data that failed to get through. That can drive an IP network into acute congestion.

RADIO SPECTRUM

Mobile spectrum bands can be broadly divided into "coverage" bands and "capacity bands." The economics are vastly different as shown in Figure 3.

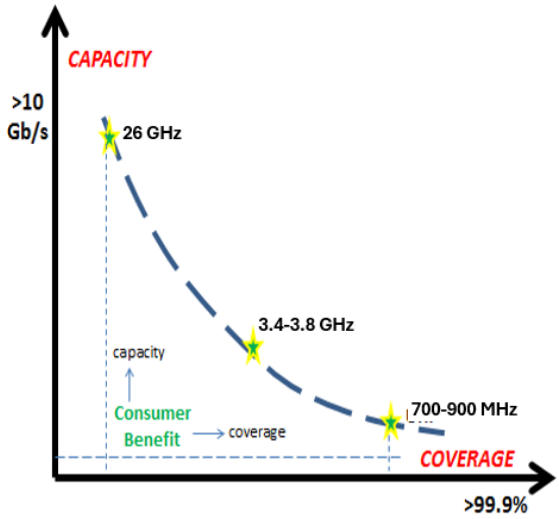


Figure 3 – Maximising coverage and maximising capacity pull in opposite directions in selecting a mobile band

The curve conceptually brings together the laws of physics and economics. What it is saying is that covering dense urban areas (3-5% of the UK) with very high data speeds can be done

relatively cheaply using “capacity bands”. Trying to lift the minimum data speed everyone gets in every part of the UK, even by a modest 10-20 Mb/s, is hugely expensive. The 3.4 – 3.8 GHz band was chosen for the main 5G pioneer band as the optimal compromise between maximising coverage and maximising capacity.

MOBILE TOWERS

An oft repeated mantra is that radio spectrum is a finite resource. That is not entirely true for mobile. The innovation that gave birth to cellular mobile was re-using the same frequency ever more densely. So fresh spectrum and numbers of new mobile towers are interchangeable and can both deliver extra network data capacity. But every tower must have an air-conditioned building, power supply, and means of back hauling the data. It attracts business rates. So in addition to the capital costs, the total number dominates the mobile operator’s running costs. This is the economic significance of the recent Ofcom announcement of the mobile spectrum auction pipeline being almost depleted.

TECHNOLOGY

The technology generation milestones can be summarised as: 1G (cell splitting to generate telephone capacity); 2G (digitalisation, international roaming, and global scale economies); 3G (mobile broadband to support multimedia); and 4G (same but putting right the shortcomings of 3G).

The maximum carrier bandwidths are: 1G (25 kHz), 2G (200 kHz), 3G (5 MHz), 4G (20 MHz) and 5G (100 MHz recommended)

5G is a pandora’s box of what it is supposed to do. The public mobile network version most relevant for this case is delivering enhanced mobile broadband capacity. It cannot do that on its own but only when it is linked with the 3.4 – 3.8 GHz band able to support the essential wide bandwidth carrier. 5G is also being rolled out in lower bands (because coverage is much cheaper to provide) but, as figure 3 shows, it cannot provide much capacity relief. Therefore 5G coverage maps (or statistics) that do not specify the 5G band of use are highly misleading in knowing how far data capacity upgrades are occurring across the country.