Consultation Response to Mobile Spectrum Demand Discussion Paper by Disruptive Analysis Ltd

Overview

This document covers a range of issues relevant to the Ofcom consultation on future spectrum demand for mobile. It has been prepared by Dean Bubley. Director of Disruptive Analysis. He is an industry analyst and observer, with industry insights as @disruptivedean (link[1]) and via a LinkedIn Newsletter (link[2])

It is submitted in addition to a panel contribution by Dean Bubley on Ofcom's spectrum webinar (link[3]) on 16th March 2022 - the slides and recorded audio discussion should also form a part of Disruptive Analysis' consultation response, as well as various articles linked in the document.

It should be noted that the comments here apply as much to how spectrum demand growth is modelled and understood, as to specific technologies such a MIMO or new GHz/THz spectrum bands needed to satisfy that demand. It also covers some of the fallacies that are prevalent in some 3rd-party models for spectrum demand, and how these could be better critiqued in future.

There is no linear narrative thread in this document – it is a collection of standalone observations and inputs, based on a diverse set of perspectives.

Limitations of spectrum models

It is common for industry groups, individual companies and lobbyists to create demand models for mobile services, and extrapolate the findings to implied spectrum requirements.

While acknowledging the complexity of such estimations, it should be noted that many such efforts:

- Put much more emphasis on the propagation models of radio, than they do in validating underlying assumptions about application or device behaviour (eg how and where they consume mobile data), or economic factors such as demand elasticity with pricing.

[1] https://twitter.com/disruptivedean
[2] https://www.linkedin.com/newsletters/dean-bubley-s-tech-musings-6697508805867003904/
[3] https://www.eventbrite.co.uk/e/ofcoms-evolution-of-mobile-networks-to-meet-future-demand-virtual-event-tickets-288548726007

- Rely on arbitrary "requirements" such as ITU's early expectations of 5G/IMT2020 peak throughput rates, and use these as a baseline for future spectrum needs. There is little attempt to revisit the original assumptions in the light of observed usage patterns, or critique the methodology involved.
- Use multipliers or other arbitrary variables that are asserted, rather than explored or justified. To be somewhat cynical, these could be construed as "fiddle-factors" used to create a desired quantitative outcome of the model. Again, there is often far less work done on justifying these (highly significant) multipliers than on areas such as replicating the same basic analysis for different countries or cities.
- Do not use any mechanism for peer review or public comment

A specific example of questionable forecasts is the upper-6GHz demand work conducted/commissioned by GSMA, and discussed in these LinkedIn posts & associated comment threads:

- https://www.linkedin.com/posts/deanbubley_regulatory-mwc-mnos-activity-6902983611298234368-YTp8/[4]
- https://www.linkedin.com/posts/deanbubley_spectrum-6ghz-5g-activity-6910148320246001664-txmE/[5]

Recommendation: Ofcom should treat spectrum forecasts/models with significant skepticism, and invite commentary and feedback where such estimates have not been peer-reviewed.

Application design and behavioural issues

Many models and projections of mobile demand (and thus spectrum) do not adequately consider trends in application/web design, and the inventiveness of software developers in dealing with limited bandwidth, or network not-spots.

Most mobile applications and many IoT devices will have "fallbacks" to cope with network constraints – reducing video resolution or frame rate, using different compression techniques, switching process between cloud vs. edge vs. on-device and so on. There may be 100s of such approaches – and most software developers would rather create clever workarounds than have to deal with 100s of MNOs' QoS platforms, SLA policies and legal/commercial rules.

An example: an augmented-reality training company (Kognitiv Spark) creates applications for industrial and enterprise use, which use a MicroSoft HoloLens 2 headset and only 256kbit/s of bandwidth[6]. It is unlikely to derive 1000x – or even 10x – the value, if the speed was 256Mbit/s

More focus should be given to video streaming resolutions and codecs, and their impact on mobile data usage or creation, and thus spectrum needs. Some codecs will ratchet up resolution and/or frame rate if there is enough "headroom", even if it doesn't have an impact on user experience. That is not a justification for service providers to do traffic-

[4] https://www.linkedin.com/posts/deanbubley_regulatory-mwc-mnos-activity-6902983611298234368-YTp8/
[5] https://www.linkedin.com/posts/deanbubley_spectrum-6ghz-5g-activity-6910148320246001664-txmE/
[6] https://twitter.com/disruptivedean/status/1511991266199969801?s=20&t=2gR2nSt_TrN42DhZ9pcM_w

shaping or active video "optimisation", but is an important factor to understand a proportion of reported data traffic growth.

Recommendation: Ofcom should consider the dependencies and variables between application design and implied mobile data/spectrum demand. This is particularly relevant in determining the economic value of spectrum for specific use-cases.

Spectrum / mobile demand in a context of distributed cloud & compute

Some assumptions for spectrum demand, especially for IoT and vehicles, but also areas like augmented reality and Metaverse applications, overlook the role of on-device compute and data storage, or more broadly the shifting nature of cloud, edge and other distributed compute and storage resources. Over time, many applications will be able to adapt to the availability, performance or cost of mobile data, by shifting the locus of data and compute. We can expect AI-based tools to assist and automate this process to an ever greater extent. There may also be regulatory, commercial or privacy reasons driving the choices.

One oft-cited study suggests that autonomous cars' cameras and sensors may generate terabytes of data per day. What they fail to note is that perhaps 99.9% of this never leaves the vehicle, which essentially has an onboard "edge" supercomputer with more compute resource than a typical cell-tower or Open RAN node. Cars will not stream 4K video of a garage wall, 24x7 over a 5G/6G network, or the 1000s of telemetry data points that essentially report normal operation. They'll transmit the exceptions, or the tiny subset that is needed in realtime.

Similar trends occur in areas such as video surveillance, where many of the cameras themselves are "smart". They can spot a suspicious package, identify a product flaw on a production line, or identify a possible shoplifter, without the network or cloud being needed – and then just transmit an alert, or perhaps upload the archived video segment later, on request. See this article on "Edge AI" – (link[7])

There are various other reasons why "network-aware applications" may process data on-device or on-premise rather than sending it to the cloud over a public 5G/6G network, such as privacy (eg voice recognition), commercial sensitivity (eg manufacturing IoT / factory private data), energy consumption optimisation and so on.

A related theme is understanding *where* future applications will likely be used, and what that will likely mean for connectivity and therefore spectrum choices. A good example is the much-discussed "metaverse" trends, which is likely to be mostly an indoor phenomenon, and use local networks (typically fixed broadband + WiFi) and compute resources, rather than public networks and MEC. See this article (link[8]).

[7] https://www.linkedin.com/pulse/edge-ai-network-may-less-important-than-you-think-dean-bubley/
[8] https://www.linkedin.com/pulse/metaverse-killer-app-5g-dean-bubley/

Recommendation: Ofcom should consider the dependencies and variables between emerging and predicted trends in cloud/edge and distributed computing, and implied mobile data/spectrum demand.

Granular data on mobile demand

Regulators should look to obtain – or use sensible mechanisms to estimate – more granular data on actual mobile data usage today, and going forward. At the moment, gross figures of GB per user per month, or PB/EB of aggregate usage, do not reveal the true picture of mobile network demand – and thus spectrum use.

There is some data available at a geographical level about network utilisation, but further "double-click" layers are needed beneath that. It is hard to project demand – and ascertain the elasticity – without better understanding of existing usage and how forecasts fit into that context. In particular, it would be good to separate out:

- Indoor vs. outdoor mobile use (or better, by type of building – dwelling, public site like shopping malls or sports stadia, offices, schools, factories etc)
- Public vs. private property – including industrial campus sites, outdoor street areas, parks, private dwellings, government land etc. There is a fundamental paradox of providing public MNO services on private property, as there is no clear demarcation of responsibility for coverage & capacity.
- Modality - Mobile use (eg smartphone used on-street) vs. fixed-wireless access (static and likely mirroring fixed broadband patterns) vs. nomadic (eg smartphone used on the sofa / in an office) etc. Given that FWA may generate 10x usage than MBB, it could significantly skew figures, especially as it has very different spectrum needs (eg maybe geo-specific).
- Uplink vs downlink volumes are rarely quoted, or the trends observed & expected.
- How outliers (eg top-1% superusers, or zero-usage dormant devices used for backup) skew average/mean mobile data usage volumes.
- Macro vs. small cell data volumes
- Usage delivered via shared vs. non-shared networks, including indoors or on neutral-host networks

Recommendation: Ofcom should ask for more granular data from MNOs (and private network owners with licensed spectrum) about data consumption, and use estimates or models to derive further detail. Spectrum policy (eg on national vs local, or public- vs private- centric allocations and authorisation) should flow from better understanding of real-world usage patterns and trends.

Other considerations

- Ofcom should drill into the nature of mobile network latency & how this impacts spectrum demand (eg wide channels or dedicated bands). It should consider

latency in the context of overall end-to-end delay budgets, rather than just over-the-air latency. Cellular networks often add significant latency because of a lack of "local breakout" in the architecture, that far exceeds the theoretical milliseconds on the air interface. See this article (link[9]) by Dean Bubley and comments for further discussion

- In the long run, it would be desirable to have some spectrum available "as a service" or "as a marketplace", in a similar fashion to cloud compute or other resources. Ofcom should consider the trajectory towards "fungibility" of spectrum on various timescales, and how that could be automated to enhance mobile network creation and operation
- Mobile spectrum should be considered in the context of the desirability of "network diversity" and "technology diversity". There should be adequate spectrum to drive scale economies in mobile networks/devices, but not so *much* scale that it crowds out alternatives. There should be an active policy to avoid creation of technology "monocultures". See this article (link[10]) by the author for further thoughts:
- Much of the discussion about spectrum for IMT pre-supposes that mobile connectivity is delivered as a "service" (ie an MNO-type model). This should be revised to consider alternative ways to deliver mobile capabilities – service, private, amenity, community, decentralised, personal and so forth. WiFi already has this broad range of delivery mechanisms, and it is increasingly possible to imagine 5G/6G networks being similarly diverse.
- mmWave repeaters and extenders seem to be more viable than previously considered. Ofcom should consider the possible trajectories for these to be deployed in the market and how that could increase capacity.
- There should be deeper analysis of the implications of mobile data use on energy demand, both in the network operation and the wider scopes (eg network construction, application demand etc). While it is also useful to consider CO2 savings that may arise from 5G/6G mobile application or device use (eg in IoT and Industry 4.0), it is important to be aware of widespread "double-counting" in many "enablement" estimations. Mobile networks (and spectrum) are not responsible for 100% of savings (eg travel vs. videoconferencing) – a large amount is attributable to the cameras, displays, backbones, servers, semiconductors etc.
- When considering the role and value of mobile data vs. other technologies (and spectrum demand for licensed/unlicensed or national/local use), it is important to recognise the impact of non-cellular devices such as TVs, PCs, game consoles, smart-home gadgets and so forth. The low likelihood – for many reasons - of such products adopting certain wireless technologies en masse (eg 5G or satellite modems) should be borne in mind & perhaps detailed through research.

[9] https://www.linkedin.com/pulse/end-to-end-latency-which-ends-dean-bubley/
[10] https://www.linkedin.com/pulse/geopolitics-war-network-diversity-dean-bubley/