Examining WIK's bandwidth demand forecast

As part of its wholesale local access market review, Ofcom recently published a bandwidth demand forecast by WIK.[1] This forecast claimed that 40% of UK households would require 1Gbps or more downstream in 2025, and 82% would require 300 Mbps or more.

These are strikingly high figures. For comparison, consider recent forecasts from the Australian government and Frontier.

The Australian Department of Communications just published a working paper on bandwidth demand[2] which found that just 2% of households would require more than 49 Mbps in in 2026. Thus there is more than a 20x difference between this and the WIK forecast.

Frontier, in a 2016 forecast for the NIC,[3] offered two scenarios, 'ambitious Innovation' and 'moderate evolution'. Even in the higher ambitious innovation scenario, only 35% of households required 1 Gbps or more, in *2040* (ie 15 years later than the WIK projection).

In this note I explore the drivers of WIK's claim that 40% of households will need a gigabit or more in 2025, and that the great majority will need hundreds of megabits.

WIK's methodology

WIK's methodology is bottom-up. That is to say, it builds up from application bandwidths, usage profiles and household types to create a picture of demand across these different household types.

Such an approach is widely used – indeed, both the Australian and Frontier forecasts as well as Communications Chambers' own forecasts have taken a similar approach.

In WIK's bottom-up approach, individuals are put into various categories such as 'digital professionals' and 'home office users', each of which uses a particular set of applications.

However, bottom-up approaches depend critically on two issues: the assumptions made regarding the bandwidth demands of applications, and how applications are combined to generate peak requirements. (Generally it is 'stacked' applications in a household that drive peak demand, rather than one killer app).

We discuss the bandwidth assumptions in more detail below. Regarding the combination of applications, WIK appear[4] to take an approach that any possible combination of usage, *no matter how unlikely*, must be accommodated. In other words, if a household contains two 'home office users' (say), then its bandwidth demand will be set by the sum of 2 x basic internet; 2 x VPN; 2 x video calls and 2 x mobile offloading.

From our own probabilistic analysis of usage,[5] we know that such simultaneous usage is in fact very unlikely – or, put another way, might only be experienced for a few seconds per month in such a household. To build a network for such extreme cases simply does not make economic sense.

To take a parallel, for good reason we do not build roads to ensure there is not even momentary congestion. Nor do we build stadiums to ensure every single fan who wants to see a given match in person can do so.

For this reason alone, WIK's demand forecast is a poor basis for decisions regarding broadband infrastructure, even if its other assumptions are correct. However, as we now discuss, WIK's assumptions are also puzzling

WIK's assumptions

WIK provide assumptions for current and future requirements of 11 different applications (Figure 1). They do not provide specific sources for each of these, but note that they have "been supported by a review of desk research on data requirements of individual applications". However, the examples of general sources WIK cites from its desk research[6] do not in fact support WIK's bandwidth assumptions. For example, WIK mentions the *FTTH Business Guide* and the *Cisco VNI Global Mobile Data Traffic Forecast*, but neither offers figures for speeds for applications.

Figure 1 WIK application bandwidth assumptions (downstream), Mbps

	2015	2025
Basic Internet	2	≈20
Home office/VPN	16	≈250
Cloud Computing	16	≈250
State of the Art Media & Ent (4k, 3D, UHD)…	14	≈90
Progressive Media & Ent (8k, Virtual Reality)	25	≈300
Communication	1.5	≈8
Video communication (HD)	8	≈25
Gaming	25	≈300
E-Health	2.5	≈50
E-Home/E-Facility	2.5	≈50
Mobile Offloading	2	≈15

Overstatement of current requirements

This lack of sources is particularly problematic, because the figures used by WIK are at odds with those from numerous third parties, in particular those who provide the applications in question.

For example, WIK use an initial figure of 8 Mbps for HD video communication. However, Skype suggests 1.5 Mbps for HD video calling.[7]

For gaming WIK starts at 25 Mbps. However, this seems to be based on a misunderstanding of how multiplayer games are delivered online. WIK say:

> "Games such as World of Warcraft enable the connection of hundreds of players around the world via different data centres. Today's networks already transmit high definition images to each player – consuming significant amounts of bandwidth and requiring low latency"

However, *World of Warcraft* (in common with virtually all multiplayer games) does not transmit video. Rather it primarily transmits changes in game state (such as the movements of players), with video rendered locally based on this information. This means the data requirements are minimal. Blizzard (publishers of *World of Warcraft*) say it will work on *any* broadband connection.[8] Average bit rates are around 90 **K**bps,[9] far below the 25 Mbps WIK suggest.

Even VR games have minimal bandwidth requirements – for example, popular VR multiplayer *Elite Dangerous* simply specifies any broadband connection, just as does *WoW*.

WIK defines 'Home office / VPN' as "file exchange and online usage of resources such as software in the context of teleworking". For this WIK calls for 16 Mbps today. Again, this is hard to reconcile with providers' figures. For example, Microsoft says of its Remote Desktop Service:

> "applications handling text processing and data input consume bandwidth of approximately 10 to 100 kilobits per second, whereas rich graphics and video playback cause significant increases in bandwidth usage".[10]

However, video via Remote Desktop is not notably more demanding than any other form of streamed video, suggesting a requirement for 3

Mbps even in this demanding use case, not 16 Mbps.

Much home office work may be of cloud based offers such as accounting services or CRM – but this uses no more bandwidth than any other kind of web browsing. (For browsing, WIK's figure of 2 Mbps may be too low – 5 Mbps may better ensure timely page loads).

Finally on Home Office / VPN, I note that WIK assumes that a home office user will simultaneously make use of basic internet, home office apps, a video call and mobile offloading. This suggests impressive multitasking.

Thus, as the above examples show, WIK appears to have significantly overstated the requirements of applications and users today.

Overstatement of future requirements

This overstatement is then greatly amplified because WIK applies substantial growth rates (20-30% in most cases) to these already too-high initial requirements.

The bandwidth requirement of an individual rises over time generally because she uses more demanding applications (HD rather than SD video, for example) or because she multitasks more (iPlayer on the TV plus browsing on a mobile, say). However, requirements for any given application in general *fall* over time, not rise. This makes WIK's application of substantial (and unsubstantiated) CAGRs puzzling.

Unsubstantiated CAGR

For example, WIK says:

> "The bandwidth requirements of applications such as progressive TV/VR, VPN, cloud and gaming are assumed to grow with a CAGR of around 30%. In the area of progressive TV, a significant increase in bandwidths [from 25 to 300 Mbps] is expected due to the introduction of new technologies such as 8K and Virtual Reality."

The logic of this is unclear. WIK's definition of progressive media is '8K and VR'. Thus the bandwidth required for progressive media can't be *increased* by the introduction of 8K and VR, since it doesn't exist before that introduction.

WIK increases the bandwidth for 'State of the Art Media and Entertainment (4K, 3D, UHD)' from 14 to 90 Mbps. It offers no explanation, but this is particularly puzzling, since this increase cannot be driven by a move to higher resolutions - 8K and VR are included in the progressive media category. If WIK believe 14 Mbps is enough for 4K TV today, why do they suggest delivering the same picture quality will require more than six times that bandwidth in 2025? (In reality, companies such as V-Nova are today offering codecs which support general 4K/UHD at 6 Mbps, or 10 Mbps for sports content).[11]

WIK increases the bandwidth requirement of 'Communication' (telephony and social network chats) from 1.5 Mbps to 8 Mbps by 2025. Chats require trivial bandwidth. For audio, the weak link in the chain is the human ear. For example, the Siren 22 codec delivers stereo, CD quality audio for speech and music, across a wider range of frequencies than the human ear can hear, all in just 128 Kbps.[12] Thus it is not clear why WIK expects requirements to increase to 8 Mbps.

Setting aside compression

Not only are WIK's claims for application bandwidth increases unsubstantiated, they set aside the impact of improving compression, which will actually *decrease* the requirements of given applications over time.

WIK says it has ignored compression[13] for five reasons.

First:

> "In this model there are no technical and commercial restrictions. Content providers which do not have to consider technical restrictions are likely to

> develop applications without the need to concentrate on reducing the bandwidth requirements of their innovative products."

There is a logic for bandwidth forecasts taking an 'unconstrained demand' approach, but here WIK takes that logic to a ludicrous extreme. If there was unlimited, end-to-end bandwidth globally, then incentives to invest in compression would be reduced. But that is a fantasy scenario. In reality, there will be constraints from wifi, from mobile network capacity and consumer data charges, from congestion in peering and transit, from networks in less developed markets and so on. These constraints, in addition to serving costs for application providers, will give those providers substantial incentives to invest in compression, even if the UK had 100% adoption of gigabit access. Thus there is no logic for WIK to assume away compression on this basis.

Second, WIK argue that improved broadband may encourage new applications. This is true, but is entirely irrelevant to the use of compression for existing applications.

Third, WIK argues that other technical parameters (such as packet loss) matter, and are less amenable to compression. Again, this is partly true[14] but irrelevant. WIK's forecast is of bandwidth, and this *is* amenable to compression.

Fourth, WIK claims:

> "Compression methods are not only detrimental to quality (signal quality and delay times) but also involve high costs themselves."

Compression may be detrimental to quality if service providers choose to heavily compress, and it may carry some cost. But this does not change the fact that delivery of a given quality requires less bandwidth over time. Further, the near ubiquitous use of compression suggests that provides consider these trade-offs to be well worthwhile.

Fifth and finally WIK says:

> "[T]he codecs of compression rates have grown at a lower rate than the growth rate of the data volume for audiovisual content (without compression)"

This is not entirely clear, but seems to mean that total AV data volumes have grown, notwithstanding compression. Again, this is true but irrelevant. Data volumes have been driven up by increased hours of usage and higher resolutions, only partially offset by compression. But that is no reason to exclude the benefits of compression in future.

In reality, compression is a vital component of forecasting bandwidth demand. A wide array of players (including Facebook and Google) are currently investing substantially in compression, across VR, video, audio and webpages. In part this is to support expansion into markets such as India and Africa (where consumers often face per-MB charges for internet use). Consequently there has been a substantial rise in the rate at which patents are granted in this area.

This suggests that the current rate of improvement may be higher than the 9% per year suggested by a 2012 study published by Ofcom.[15] However, even a 9% improvement annually implies a 60% drop in bandwidth requirements for a given application, over WIK's ten year horizon. Note that much of this improvement would derive from deployment of recent codecs that *already exist*, but have not yet been rolled out widely.

Summary re WIK's assumptions

Thus WIK:

- Makes assumptions about current requirements that are demonstrably significantly too high

- Makes assumptions about future requirements that are unsubstantiated and, in many cases, simply implausible
- Sets aside compression, on entirely unconvincing grounds, thereby ignoring a fundamental downward pressure on bandwidth requirements

WIK's 2011 forecast

For the above reasons, WIK's forecast appears to be too aggressive. However, WIK's current paper is based on a methodology originally developed in 2011 to forecast German demand for bandwidth in 2016.[16] Thus we have the opportunity to assess whether the methodology has produced accurate results in the past.

The 2011 study predicted that in 2016 16% of German households would need 200 Mbps or more, and 70% would need 60 Mbps or more. While this was a forecast of technical requirement rather than market demand,[17] it is nonetheless striking that just 44% of German households in superfast coverage areas were taking even speeds of 30 Mbps in 2016.[18]

Further, evidence from the UK suggests that consumers don't in fact have technical demand for speeds above 60 Mbps. If there *was* such demand, we would expect lines with speeds of 60 Mbps or more to have higher traffic volumes (since slower lines would be constraining usage). However Ofcom data shows that in 2016, usage of lines with speeds of 60 Mbps or more was virtually identical to those with speeds of 25 Mbps.[19]

One of the reasons for WIK's overestimate of 2016 demand is that – as with their current forecast – they made very aggressive assumptions for application bandwidth requirements. For instance, they assumed 30 Mbps for HD/3D Media and Entertainment in 2016. However, HD video needs around 3 Mbps,[20] not 30 Mbps. 3D technologies, which WIK said in 2011 were "about to make their breakthrough in the mass market",[21] have of course remained immaterial so far.

Turning to the supply side, in 2011 WIK wrote "requirements for the [200 Mbps] "top level" demand potential of innovative private and commercial clients can be realistically met only with FTTB/H access technologies."[22] In reality DOCSIS 3.1 was being used to deliver Gigabit broadband by 2016,[23] and Swisscom was using G. fast to deliver speeds up to 500 Mbps.[24]

Conclusion

Any model inevitably involves assumptions, and some of these will legitimately be matters of judgement rather that hard data.

However, the WIK model makes numerous assumptions where hard data *is* available, but has been ignored. Given that WIK has taken assumptions that are almost universally higher than actual bandwidth requirements for individual applications, this has the effect of greatly inflating household requirements.

This problem is exacerbated by the fact that the WIK model is designed to answer a question that no one should be asking – 'what is the bandwidth requirement to ensure that no individual experiences even momentary degradation of performance'. This extreme performance standard is simply not relevant to the economic decisions of the type Ofcom is making.

Unfortunately the WIK forecast is thus not informative for UK broadband policy or regulation.

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[1] WIK-Consult, *The Benefits of Ultrafast Broadband Deployment*, 20 February 2018

[2] Department of Communications and the Arts, *Demand for fixed-line broadband in Australia*, February 2018. This working paper drew on and extended previous work by Communications Chambers

[3] Frontier (for NIC), *Future Benefits of Broadband Networks*, 12 December 2016

[4] WIK provide only a limited description of their approach in their paper for Ofcom. However, the interpretation we set out here looks to be consistent with more detailed descriptions WIK has offered for previous versions of its model

[5] For a detailed discussion, see Robert Kenny & Tom Broughton (Communications Chambers for the BSG), *Domestic demand for bandwidth*, 5 November 2013

[6] See their Footnote 79

[7] Skype, *How much bandwidth does Skype need?* [accessed 1 March 2018]. Skype does recommend 8 Mbps for group video involving 7 locations or more, but this is likely to be an extremely unusual scenario, in either a home or work environment

[8] Blizzard, *World of Warcraft System Requirements* [accessed 1 March 2018]

[9] Communications Chambers calculation based on data from NBN,

[10] Microsoft, *Performance Tuning Remote Desktop Session Hosts*, 16 October 2017

[11] RapidTV News, *V-Nova unveils version two of Perseus*, 3 April 2017

[12] Broadconnect (for Polycom), *Music Performance and Instruction over High-Speed Networks*, October 2011

[13] Strictly, it says it has not included 'aggressive' compression, but since the requirements of all applications increase substantially in its assumptions, it would appear that no compression has been included at all

[14] Compression can help with packet loss indirectly – smaller data streams are less likely to overload buffers (which is what triggers packet loss)

[15] ZetaCast, *Technical Evolution of the DTT Platform*, 2012

[16] WIK, *Medium-term market potential for high speed broadband access in Germany*, September 2011

[17] Technical demand may exceed market demand if consumers choose not to pay for all the bandwidth they theoretically require. Conversely, market demand may be higher if consumers take a higher bandwidth than they need because it costs no more, if they perceive they need greater bandwidth than they actually do, and so on

[18] EC, *Digital Agenda Key Indicators* [accessed 1 March 2018]; Communications Chambers analysis.

[19] Ofcom, *Connected Nations 2016*, 16 December 2016

[20] For example, for iPlayer the BBC notes that its maximum stream speed is 2.8 Mbps. BBC, *What internet speed do I need for playing programmes?* [accessed 1 March 2018]

[21] Goole Translate of original German

[22] WIK, *Medium-term market potential for high speed broadband access in Germany*, September 2011

[23] Comcast, *Comcast to Deliver Gig Internet Over Existing Network Infrastructure, Chicago Area Trial Begins Today*, 17 August 2016

[24] Swisscom, *Swisscom to be the first European telecommunications service provider to launch G.fast*, 18 October 2016

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