Robert Kenny

The UK's broadband network in the time of COVID-19

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About the author

Rob Kenny is a co-founder of Communications Chambers, a consultancy specialising in telecoms, media and technology that advises on strategy, policy and regulation.

He has extensive experience on issues related to broadband, and has undertaken numerous projects in this area for governments, regulators, trade bodies and telcos around the world. Previously he headed strategic planning for Hongkong Telecom, and corporate development for Level 3.

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Introduction

A number of news outlets have suggested that the UK's broadband network may be unable to cope with increased demand due to COVID-19.[1] This paper sets out the impact of COVID-19 on people's internet usage, and explains why the UK's fixed broadband networks have been well placed to address increased demand.

Note that this paper does not address 'the last 5%', households typically in remote areas who may lack access to sufficient broadband even in ordinary times. Nor does it address mobile networks, which have somewhat different dynamics (though they have also proved relatively robust).

[1] See, for example: The Sun, *UK internet capacity could be RATIONED to prioritise 'critical' apps and websites, experts reveal*, 23 March 2020; Daily Mail, *Britain's broadband network 'won't cope' with millions of people self-isolating and working from home during the coronavirus crisis, experts warn*, 10 March 2020; Telegraph, *UK broadband 'won't cope with millions working from home in coronavirus outbreak*, 9 March 2020

Overview of the network

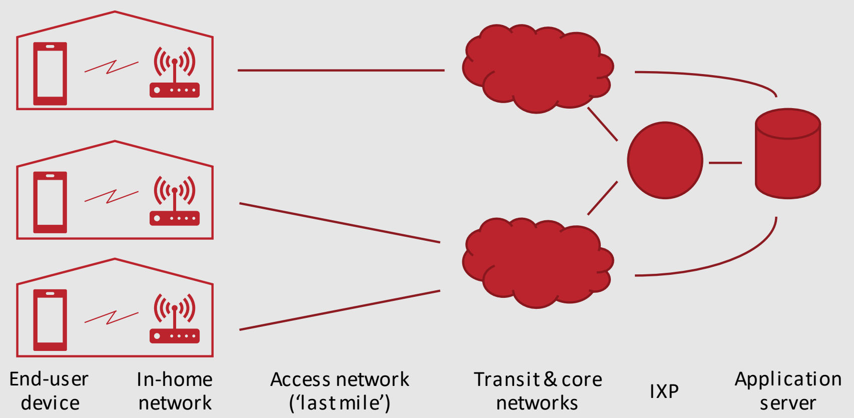
Network components

The broadband network is sometimes treated as a single entity that may be overloaded. In fact it is a mesh of different networks, and within each of those networks are quite distinct components.

This granularity matters because congestion can potentially appear in any one of these components, but this needn't mean other parts of the network are overloaded. To take a parallel, just because there is a traffic jam in London, this doesn't mean there's backed-up traffic in Norfolk.

Further, the drivers of traffic – and hence the potential for congestion – are quite different for different components.

Figure 1 Simplified network structure



For example, the in-home network and the 'last mile' (the link between a house and the nearest telephone exchange) are both exclusive to that home. Any congestion in these components will be a result of usage in that home, not the result of heavy usage in other households.[2]

By contrast, the core network, internet exchange points (IXPs) and application servers are shared resources.

Core networks carry the traffic from the last mile to wherever it needs to go on the internet globally (and vice versa). If the traffic is destined for a customer on another network, it will be passed on to

[2] There are some minor technical exceptions. If your neighbour's wifi network is heavily loaded, this could interfere with your own wifi. Cable networks do have some shared capacity in the last mile, although in practice this rarely leads to any degradation of performance.

that network, either directly or at an IXP. Application servers are the computers used by online providers to offer their services, such as online banking, streaming video and social media.

As shared resources, the core networks, IXPs and servers are used simultaneously by many users. As a result, the overall experience for any one user may depend on how many other users are online at that point in time, even if that one user's own last mile connection is uncongested.

Different parties are responsible for managing capacity in each of these different components. A household is responsible for the in-home wifi network, though of course many default to the wifi router and settings provided by their ISP.

While the last mile is physically provided by the ISP, its capacity is chosen by the end-user, who may decide ADSL is sufficient, or instead choose superfast or ultrafast (where available).[3]

The core network and application server capacities are set by telcos and online providers respectively.

Importance of the busy hour

A key concept for capacity planning is the 'busy hour' – the period in the day when demand is heaviest. Capacity must be able to meet this peak demand, otherwise users will face congestion. However, demand *outside* the busy hour is immaterial for the purposes of the capacity planning. Whether that demand is high or low, it is (by definition) lower than the demand in the busy hour. If there is capacity for the busy hour, then there will necessarily be sufficient capacity for other hours.

[3] Superfast is available in over 95% of the country, though 43% of those with access to superfast choose not to take it. Ofcom, *Connected Nations 2019*, 18 March 2020

Internet traffic in normal times

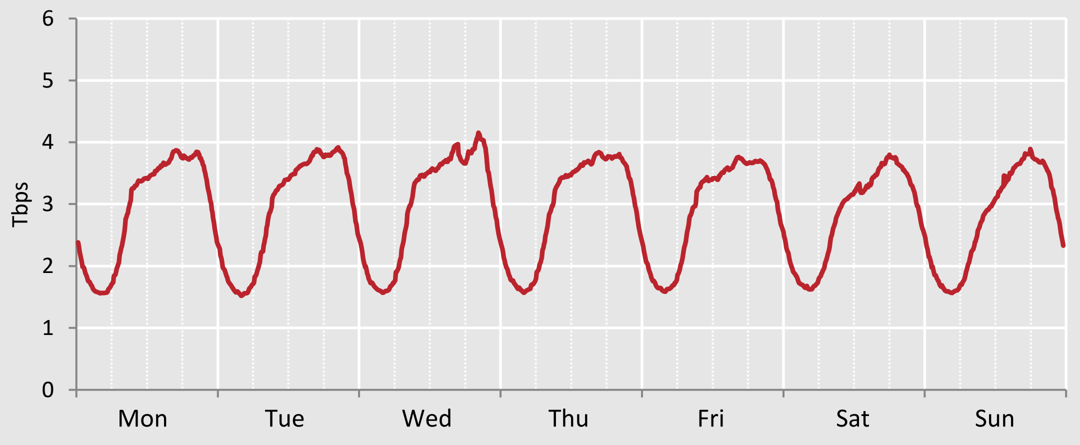
The profile of internet traffic depends very much on where you measure it. For a typical household, it is likely to peak in the evening, when occupants are all home. However, for a household occupied by someone who works nights, the profile may be very different, with (say) a peak at breakfast time when they get home.

If we measure traffic at the core of an ISP that mainly serves residential customers, these issues average out, and it will be the aggregated traffic of those typical households that are busy in the evening that drive the peak load for the ISP. However, an ISP serving mainly business users may have a quite different profile, with a peak in the early afternoon.

For internet exchange points (IXPs) where multiple ISPs and content providers of different types meet to exchange traffic, the busy hour may be different again, since it will blend both business and residential traffic.

Note that much internet traffic does not travel through IXPs. Crucially, major streaming services and games providers may host their content[4] at sites within the networks of ISPs, so it can directly travel to end-users without transiting an IXP. That said, traffic patterns at IXPs are *broadly* indicative of overall patterns. Figure 2 shows the traffic for the two London locations of the London Internet Exchange (LINX).[5]

Figure 2 London Internet Exchange traffic, week beginning 27 January[6]



[4] They may have their own servers on ISP premises, or use a Content Distribution Network such as Akamai
[5] LINX also operates a number of regional exchanges in the UK and one in Saudi Arabia. Throughout this paper we focus on the London exchanges, which comprise the vast majority of LINX's traffic
[6] LINX, LANS SNMP [accessed 31 March 2020]. Figures are total for the LON1 and LON2 IXs. Note that traffic will include some interconnect with international ISPs which may not be UK related

Traffic follows a regular rhythm. On weekdays it ramps up rapidly to 9am, and grows more steadily to a peak period between 4.30 and 8.30pm. In the example week shown, which was the busy hour within this range varied somewhat from day to day.

What drives this pattern is that individuals use roughly 2.2x more traffic per hour when they are at home than when they are at school or work.[7] (This does not mean that evening traffic is 2.2x workday traffic, because 40% of individuals are at home during the work day).[8] Thus the evening hours, when people are at home and awake, are the peak for the network as whole.

However, this general pattern sees significant variation. For example, usage tends to dip in the summer months, as people spend more time outdoors, and over Christmas.

There can also be short term spikes caused by individual applications. For instance, on March 11 Activision released *Warzone*, an expansion *Call of Duty*. Depending on a user's existing files and console, this was an 18 – 101 GB update.[9] The rush to download these very large files caused a significant spike in network traffic. They went on general release at 8pm UK time, and by 8:05 traffic on LINX had reached 4.5 Tbps,[10] a new high and appreciably above the 4 Tbps seen on a typical day. (Akamai, a leading content distribution network, has recently announced that to protect networks during COVID-19 they will shift games distribution to the early hours of the morning).[11]

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[7] Communications Chambers (for BSG), *The broadband requirements of small businesses in the UK*, August 2015
[8] Gershuny, J., Sullivan, O. (Centre for Time Use Research, University of Oxford), *United Kingdom Time Use Survey, 2014-2015*, 2017
[9] Dot eSports, *Call of Duty: Modern Warfare update version 1.17 is live, introduces Warzone*, 10 March 2020
[10] Across the two London exchanges, for comparison to Figure 2. Across LINX's entire network the total was 4.7 Tbps
[11] Akamai, *Working together to manage global internet traffic increases*, 24 March 2020

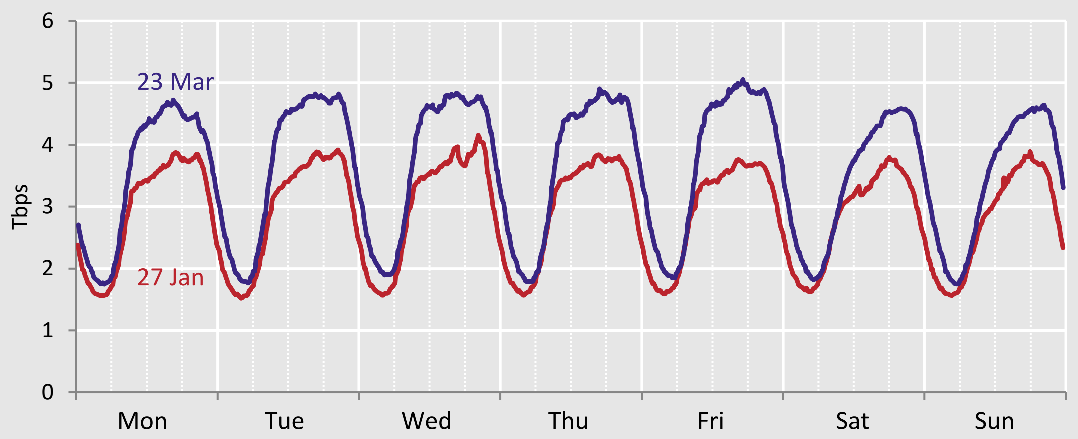
Internet traffic under COVID-19

COVID-19 has created a 'new normal' however. Internet traffic has been significantly changed by lock down, with more people at home throughout the day.

Core network traffic

Figure 3 adds the data for the week beginning 23 March (after the lock-down) to the pervious chart of LINX traffic:

Figure 3 London Internet Exchange traffic, weeks beginning 27 January and 23 March[12]



LINX traffic is up by around 25-30% throughout typical waking hours. Anecdotally, I understand ISP traffic is also appreciably up during the daytime, but much less so in the evening – likely because the ISPs already had a much higher 'base load' of on-net[13] video streaming traffic in the evening.

Daily peak LINX traffic continues to be in the period 4.30-8.30, and now typically about 5 Tbps. This is well up on the January figure of 4 Mbps, but less up on the previous exceptional peak of 4.5 Tbps driven by *Call of Duty*. Because the network was always configured for sudden spikes of traffic such as games releases (the 'busiest hours', as it were), it was relatively well placed for extra traffic driven by COVID-19. Again anecdotally, it appears some ISPs are seeing typical evening peaks now that are *below* previous exceptional peaks.

Further, while it is COVID-19 keeping us indoors currently, mass 'home staying' is not itself unprecedented. Bad snow storms can have the same effect. For example, on 1 March 2018 during the

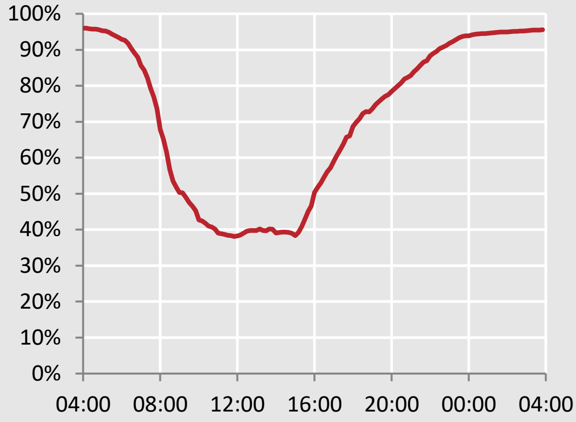
[12] LINX, LANS SNMP [accessed 31 March 2020]. Figures are total for the LON1 and LON2 IXs
[13] That is, traffic from major content providers hosted on the ISPs' networks

'Beast from the East', LINX traffic reached 4 Tbps at a time when the typical evening peak was 3.5 Tbps.

Indeed, one could say mass home-staying is a daily event. In ordinary times, by midnight on a weekday 94% of individuals are at home (Figure 4).

However, around midnight is when COVID-19 has caused the greatest proportionate increase in traffic - it is up 33% then. Clearly this is not because many more people are at home. Rather it is because they are home and awake. In normal times, 77% of individuals would be asleep at midnight, but without work to go to next morning, they are staying up and online longer.[15]

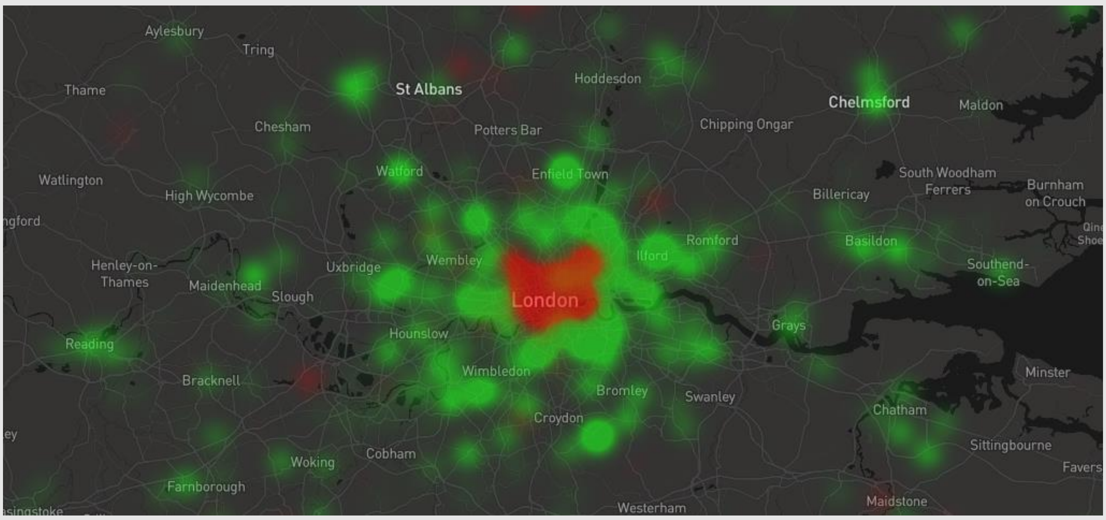
Figure 4 Portion of individuals at home by time of day (weekday)[14]



Location of traffic

COVID-19 is not uniformly increasing traffic. As might be expected, usage is up in residential locations, and down in business districts. Figure 5 shows traffic in and around London. Traffic is down in the West End and the City, and up in outer London and commuter belt towns such as St Albans and Chelmsford.

Figure 5 Cloudflare analysis of COVID-19 impact on traffic by region[16]



[14] Communications Chambers analysis of data from Gershuny, J., Sullivan, O. (Centre for Time Use Research, University of Oxford), *United Kingdom Time Use Survey, 2014-2015*, 2017. Includes time spent at second homes and other people's homes

[15] Ibid

[16] Cloudflare, How has the Coronavirus pandemic impacted Internet traffic? [accessed 31 March 2020]. Red indicates reduced traffic and green increased, late March vs early January

Impact of home working

Clearly home working contributes to this pattern. Someone with an office in London now working from St Albans will decrease traffic in the former and increase it in the latter. However, despite media concern about home working overloading the network, it is unlikely to cause material congestion.

First, likely less than half of employees have the kind of job that can be done from home. Analysis of data on the number of people in different types of job suggest that (generously) only 52% of people do the kind of work that can meaningful be done from home.[17] A hairdresser, waiter or nurse cannot be productive remotely.

Of course, some people who cannot work from home may be there anyway since their place of work has been required to close[18] – the hairdresser and waiter for example. A further 12% of employees may be in this category. This 12% may contribute to increased traffic, but not via home working. (Note that this leaves 36% of employees working in the types of premise that has *not* closed as result of COVID-19. A significant number are still going out to work.)

Second, as we have seen, working is not particularly bandwidth-intense. People at work are less likely to be streaming Netflix or downloading games. Home working may be somewhat more bandwidth intense, since it may involve video-conferencing and use of remote desktop software, for example. Zoom reports that daily meeting participants have jumped from 10m to 200m.[19] Microsoft says that use of Windows Virtual Desktop has tripled).[20]

But such applications are light in terms of bandwidth. A Zoom HD video group call requires just 1.5 Mbps.[21] For group Hangouts, Google suggests 3.2 Mbps.[22] For 'heavy' users (software engineers, content creators) Microsoft recommends 5 Mbps for its Remote

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[17] Based on an analysis of data from ONS, *EMP04: Employment by occupation*, September 2018. Note that these are necessarily rough estimates, in part because some occupation codes may be at their place of work or at home, depending on their employer. For instance, a kitchen assistant working in a hospital may be still at work, while a kitchen assistant at a restaurant will be at home

[18] Cabinet Office, *Closing certain businesses and venues*, 26 March 2020

[19] Zoom, *A Message to Our Users*, 1 April 2020

[20] Microsoft, *Update #2 on Microsoft cloud services continuity*, 28 March 2020

[21] Zoom, *System Requirements for PC, Mac, and Linux* [accessed 26 March 2020]. For higher quality 1080p HD video, 3 Mbps is required

[22] Google, *Prepare your network* [accessed 26 March 2020

Desktop.[23] This compares to a typical Netflix stream in the UK in the range of 4-5 Mbps.[24]

Thus home working is likely to have had only modest impact on the core network, both because its bandwidth requirements are modest, and because it is unlikely to occur during the 4.30 - 8.30 evening peak. Additional usage outside busy hours is essentially 'free' in capacity terms, unless it is sufficient to change the busy hour.

Last mile traffic

As we have seen, traffic in the core has increased by roughly a quarter (as measured at LINX). Since traffic must ultimately find its way to end-users, this means traffic (in GB) in the last mile will also have increased appreciably.

However, it doesn't follow that *bandwidth* (Mbps) requirements in the last mile have also increased.

Consider two households, A and B. Pre-COVID-19, Household A watches 4K video on Monday, and this sets their peak bandwidth requirement. Household B does the same on Tuesday.

Under lock-down both households are at home both Monday and Tuesday, and so each watches both nights. Core network traffic and required capacity doubles as a result – the core must be able to deal with two simultaneous 4K streams. *Traffic* in the last mile has also doubled – but required *capacity* in the last mile has not changed at all. Each household must have bandwidth for one 4K stream. The fact that this capacity is now used two nights per week instead of one is immaterial.

Thus while COVID-19 may be increasing traffic at the household level it is (for most households) less likely to increase bandwidth requirements. If the household already had enough bandwidth for its busiest hour across a month, it is unlikely that it will need more, since that busiest hour likely reflected a time when all occupants were home and online. The fact that those occupants are home and online all the time now doesn't change the peak requirement.

(By extension, home working also won't affect last mile capacity requirements – given its modest bandwidth requirements, periods when some occupants are online working will likely have lower

[23] Microsoft, *Remote Desktop workloads*, 12 February 2019
[24] Netflix, *ISP Speed Index (UK)*, [accessed 31 March 2020]

bandwidth requirements than times when all are online for entertainment).

Network operators' response to increased traffic

In summary, capacity requirements have likely increased only modestly in the last mile, but somewhat more so in the core (though the new 'typical peak' for UK ISPs still appears to below past exceptional peaks).

This is fortunate since upgrading the last mile – for instance by deploying full fibre – is expensive and time consuming.[25] By contrast, upgrading the core is relatively cheap. Core networks operate over existing fibre optic cable, and there is substantial unused capacity ready to be deployed. In most cases it is simply a matter of 'turning on' this capacity, though in some cases electronics may need to be upgraded or dark fibre 'lit' (that is, electronics connected to unused fibre strands).

Using such methods, in response to COVID-19 France Télécom has already doubled its capacity in international subsea cables, for example.[26] Fastweb in Italy has seen an increase in peak traffic from 2.89 to 3.9 Tbps, and has upgraded its capacity to 4.4 Tbps in response.[27]

Such upgrades are very much in the ordinary course of business for network operators, driven by many years of robust traffic growth. UK consumer internet traffic was up 30% last year.[28] While COVID-19 has accelerated some of these upgrades, it certainly does not represent an overwhelming increment of traffic for most networks.

[25] Here we refer to physically upgrading the maximum capacity of a line. If the consumer is currently not taking the maximum speed available, then an increase in speed is a matter of a phone call

[26] New York Times, *Surging Traffic Is Slowing Down Our Internet*, 26 March 2020

[27] Fastweb, *Fastweb: il traffico Internet cresce ma le reti sono dimensionate per supportare l'incremento dei dati*, 20 March 2020

[28] Ofcom, *Connected Nations 2019*, 18 March 2020

Network performance under COVID-19

The above analysis suggests that COVID-19 has only presented manageable changes in fixed broadband traffic. Of course the key test is how the network has been performing for users, and here too the evidence is reassuring.

Figure 6 EU5 broadband speedtest results[29]

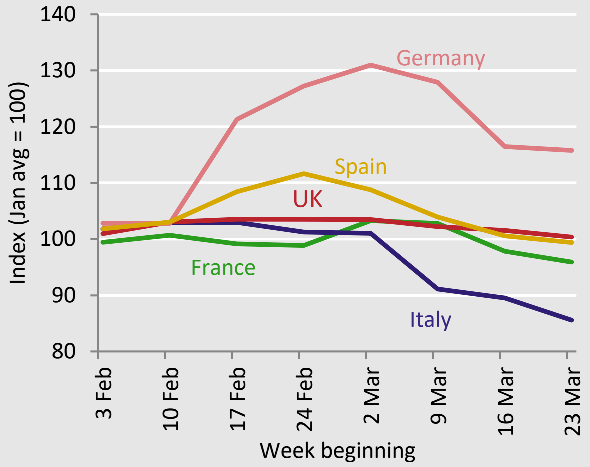
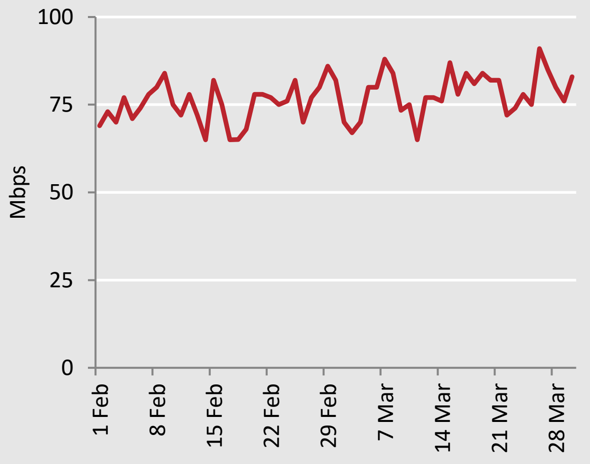


Figure 6 shows Ookla's speedtest results for the EU5, indexed to January. The UK, Germany and Spain have all seen recent network performance at or above January levels, even as traffic volume has increased substantially, and France is only slightly down.

Italy's performance *has* seen a significant drop since it went into nationwide lockdown on March 9th, perhaps because its pre-COVID traffic was so much lower than the UK's. Telecom Italia's per-line usage is roughly one third that of the UK,[30] and assuming its capacity was similarly lower, it may have been less resilient to a traffic surge.

UK-specific data from thinkbroadband tells a similar story. Virgin Media, for example, has seen its speedtest results hold steady in late March, despite increased traffic on the network (Figure 7).

Figure 7 Virgin Media median speedtest results[31]



These speedtests are run over a connection from the end-user device to thinkbroadband's servers at Telehouse in Docklands. This suggests that none of the intervening network elements (the in-home network, the last mile, the core network and so on) are suffering material congestion.

A further sign that UK fixed broadband operators are confident they can handle current traffic and indeed a further increase is that they have agreed to remove data caps during the lockdown, encouraging greater usage.[32]

[29] Ookla, *Tracking COVID-19's impact on global internet performance*, 30 March 2020. It is not clear what has caused the bump in Germany's performance
[30] Telecom Italia, *The Network for Italy* (accessed 1 April 2020). Telecom Italia has a greater percentage of slower ADSL connections than its competitors, so likely has somewhat lower traffic than the Italian average
[31] Adapted from thinkbroadband.com, *Virgin Media daily speeds during February and March 2020*, 31 Mar 2020
[32] Guardian, *Broadband providers to lift data caps during Covid-19 lockdown*, 29 March 2020

Conclusion

COVID-19 has had a significant impact on internet traffic, but at least for the UK fixed network this has not been particularly problematic. The network already had head room, and operators have experience in adapting to growing and occasionally volatile traffic.

Of course a lack of network congestion doesn't mean there are no challenges at all. For example, COVID-19 has caused surges in use for certain applications, such as video chat, gaming sites and so on. In some cases, these surges have overloaded the severs for applications, resulting in poor user experience. However, much like network operators, application providers are generally able to upgrade their capacity relatively quickly, and this congestion will in most cases be transient.

COVID-19 has significantly disrupted many aspects of life – but happily the fixed broadband network is holding up well under pressure.

Communications Chambers

+44 773 858 2227
info@commcham.com
www.commcham.com