US broadband network performance during COVID-19 and beyond

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Executive Summary

In early 2020, the Covid-19 pandemic hit the United States. By March 8, 2020 the first companies issued work at home orders. By April, 44 states issued stay at home orders or advisories. Almost two-thirds of employees worked from home, 80% of students used online resources, and 97% of college students were engaged in online education. The U.S. economy and the lives of Americans reconfigured themselves in record time – and turned to the internet to do so.

This unique situation presented an unprecedented stress test of America's broadband networks, but they proved capable of handling the increased traffic load in a manner that was seamless for the average user and that ultimately enabled consumers to use their broadband connections in ways they had not thought possible. Internet traffic increased significantly: fiber/copper traffic peaked at 27.3% above pre-pandemic levels; mobile internet traffic hit the highest point at 22.6% above pre-pandemic levels; and cable internet peak utilization crested at 22.1% above pre-pandemic levels.

America's broadband networks withstood the sudden shift and increase of demand remarkably well. Wireless download speeds are twice as fast as they were before the pandemic. Fixed download speeds are now up more than 30%. While the surge in data initially had an insignificant effect on performance of fixed and mobile data speeds, over time the strong performance of those networks enabled Americans to use their data connections in the way they used it prior to the pandemic—but even more intensely.

U.S. broadband networks, be it cable, fiber/copper, or wireless, handled the dramatic increases/shifts in data use from COVID with relative ease and that's because of the pro-consumer, pro-investment policy regime that has resulted in $317.1 billion of investment since 2017. Comparing American network provider investment among the 38 OECD countries, the United States represents 48% of the broadband capital investment, but only 25% of the people. This represents a U.S. broadband capital investment overindexing of 192%, which directly helped ensure Americans could rely on their internet connectivity to help navigate a global pandemic.

In sum, U.S. broadband networks were able to meet the sudden surge in traffic that was caused by Americans turning to Internet-based services, such as video conferencing, throughout the worst phases of the pandemic. Years of investment, innovation, and regulatory flexibility enabled broadband providers to deliver the capacity that Americans needed to stay connected to family, communities, health care, work, and school. Under a light-touch regulatory framework, U.S. broadband providers are poised to continue investing in networks that will deliver on even higher demand for broadband services.

Key Findings

- In the early months of the Covid-19 pandemic, Internet traffic increased by more than 20%.
    - Fiber/copper broadband traffic peaked at 27.3% above pre-pandemic levels
    - Mobile internet traffic hit the highest point at 22.6% above pre-pandemic levels
    - Cable internet peak utilization crested at 22.1% above pre-pandemic levels
- US performed very well during the pandemic as its networks have been prepared. The network performance change was imperceptible to the average daily user.
    - Wireless download speeds have doubled since the pandemic began
    - Fixed download speeds initially stayed within 3.5% of pre-pandemic performance and now far exceed pre-pandemic levels four months later
- While video conferencing use became widespread, video streaming increased substantially as well. As a result internet traffic still continues to be 93% downstream and 7% upstream.
- A light touch regulatory framework has incented investment in forward-looking network planning.
    - Investing more than $70 billion per year since 2013
    - Consistently spending twice as much as the OECD country average
    - US capital investment represents 48% of all telecommunications investment among OECD countries

Introduction

During the last year and a half, American broadband networks have been more important for the economic, educational, and personal well-being of Americans than ever before. They were and are the lifeline that kept America running. Broadband in the pandemic has enabled students to continue their education, employees to continue working remotely, patients to communicate with their doctors, neighbors to maintain connections to their communities, and people to be entertained in their homes.[1]

The transition to an online life came quickly. In an effort to stop the spread of COVID-19, states began issuing stay-at-home orders, starting with California on March 19, 2020, and with others quickly following suit. By the end of March 2020, most educational institutions had transitioned to virtual instruction.

With so many Americans now working, studying, socializing, and playing exclusively online, many feared that the massive increase in internet traffic and bandwidth consumption would bring data speeds to a screeching halt and negatively impact workplace productivity and efficiency. There was a widespread perception that the increased demand for video conferencing, streaming video, and other data-heavy applications represented a tsunami that the existing Internet infrastructure could not handle.[2]

This scenario did not occur. Instead, U.S. broadband networks capably handled the rapid shift and significant surge in data traffic. Indeed, broadband speeds in the U.S. have increased during the pandemic while demand was increasing.[3]

In this paper, we analyze how American broadband providers kept the country going both economically and emotionally as most in-person interactions were replaced by digital communications. We examine how download and upload speeds in the United States performed during the pandemic and show the rise in the number of households served by high-speed data connections. We demonstrate how light touch regulation allowed the telecommunications industry to make significant capital investments before and during the pandemic to develop a robust infrastructure that was able to quickly and efficiently answer increased demand during an unexpected crisis.

In sum, US broadband networks were able to meet the sudden surge in traffic that was caused by Americans turning to Internet-based services, such as video conferencing, throughout the worst phases of the pandemic. Years of investment, innovation and regulatory flexibility enabled broadband providers to deliver the capacity that Americans needed to stay connected to family, communities, health care, work and school. Under a light-touch regulatory framework, US broadband providers are poised to continue investing in networks that will deliver on even higher demand for broadband services.

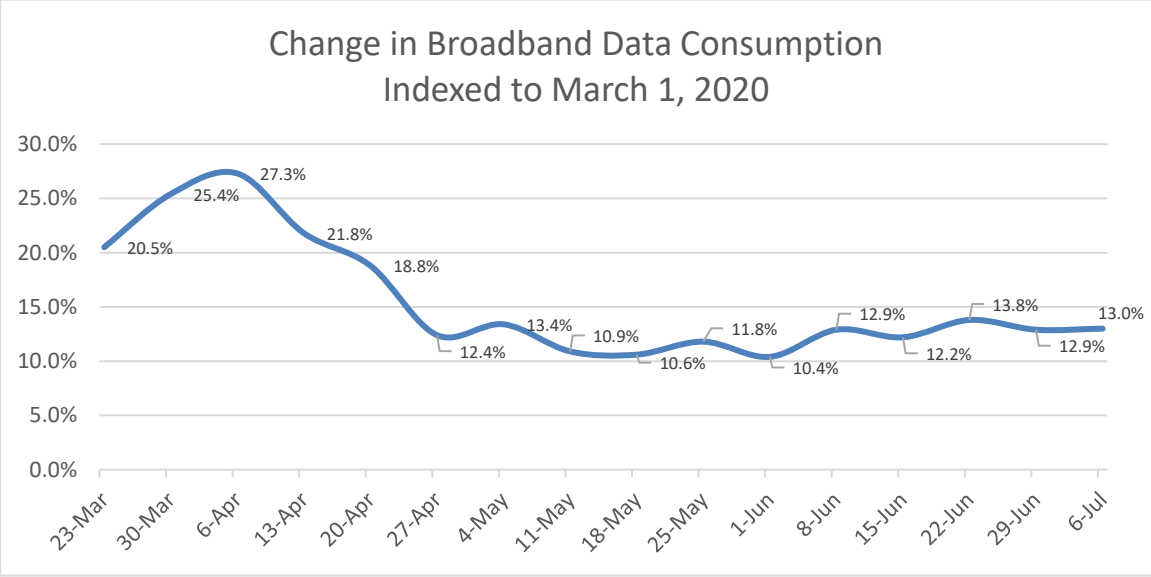
[1] https://www.nytimes.com/interactive/2020/04/07/technology/coronavirus-internet-use.html
[2] So We're Working From Home. Can the Internet Handle It? - The New York Times (nytimes.com)
[3] https://www.whistleout.com/Internet/Guides/pandemic-internet-speed-changes

The impact of stay at home and work at home orders on data traffic

As the pandemic came to the United States, the largest economy in the world very quickly changed how it operated. By March 24th, 2020, 14 states issued a Stay at Home order or advisory.[4] By March 31st, the number rose to 32, and by April 7th, 44 states had issued Stay at Home orders or advisories. Within three weeks of the first Stay at Home orders, the number of Americans working from home doubled from 31% to 62%. By April, 70% of employees worked some or all of the time from home.[5] The vast majority (93%) of households with school-age children were engaged in distance learning during the pandemic with 80% using online resources.[6] Almost all college students (97%) shifted to online study[7], with two-thirds spending at least some time in live real-time video sessions.[8] The internet became the primary method for working, learning, and entertainment as Stay at Home orders came into effect.

Increases in data traffic on broadband networks became instantly notable as shown in the following four exhibits. As shown in Exhibit 1 below, the impact of working remotely from home along with increased data consumption from video streaming, online gaming and other online activities drove internet data consumption on fiber/copper broadband networks up by 27.3% within a few weeks of the pandemic.[9]

Exhibit 1: Increase in Data Consumption of Fiber/Copper Broadband Networks Over Time

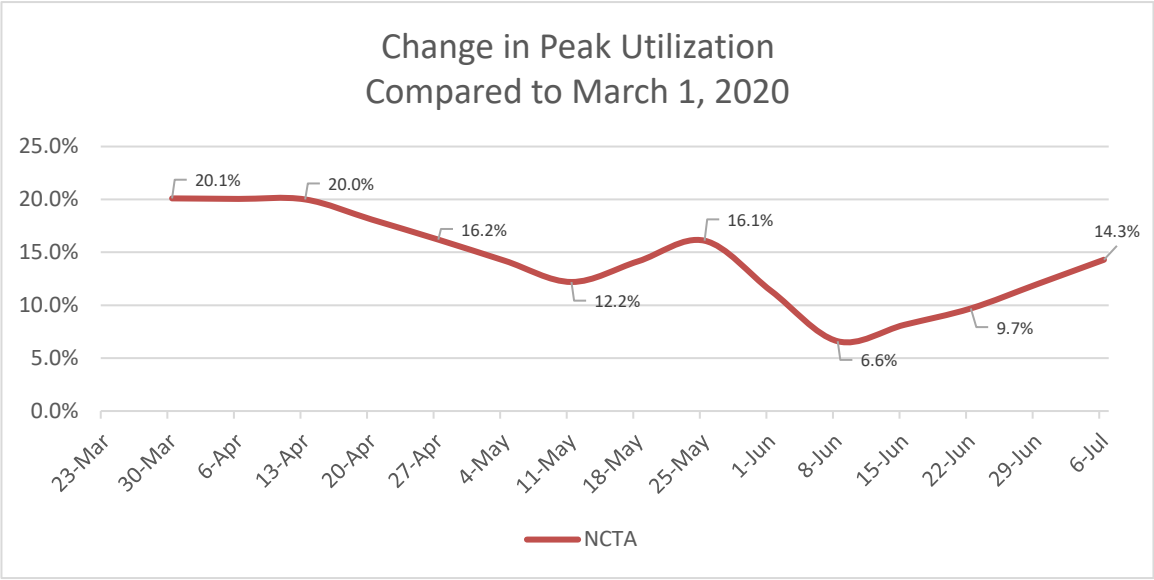


Source: USTelecom

As we can also see in Exhibit 2, cable networks saw a similar increase in peak utilization over the same time period. The Stay at Home orders led to an increase in usage throughout the network in a similar magnitude to that of fiber/copper networks.

[4] https://www.nytimes.com/interactive/2020/us/coronavirus-stay-at-home-order.html
[5] https://news.gallup.com/poll/339824/pandemic-affected-work-life.aspx
[6] https://www.census.gov/library/stories/2020/08/schooling-during-the-covid-19-pandemic.html
[7] https://blog.otter.ai/distance-learning-statistics/
[8] https://digitalpromise.org/wp-content/uploads/2020/07/ELE_CoBrand_DP_FINAL_3.pdf
[9] For purposes of this report, the notation "fiber/copper" refers to data from members of USTelecom—The Broadband Association; "cable" refers to data from NCTA-The Internet & Television Association; and "wireless" or mobile" refers to data from CTIA.

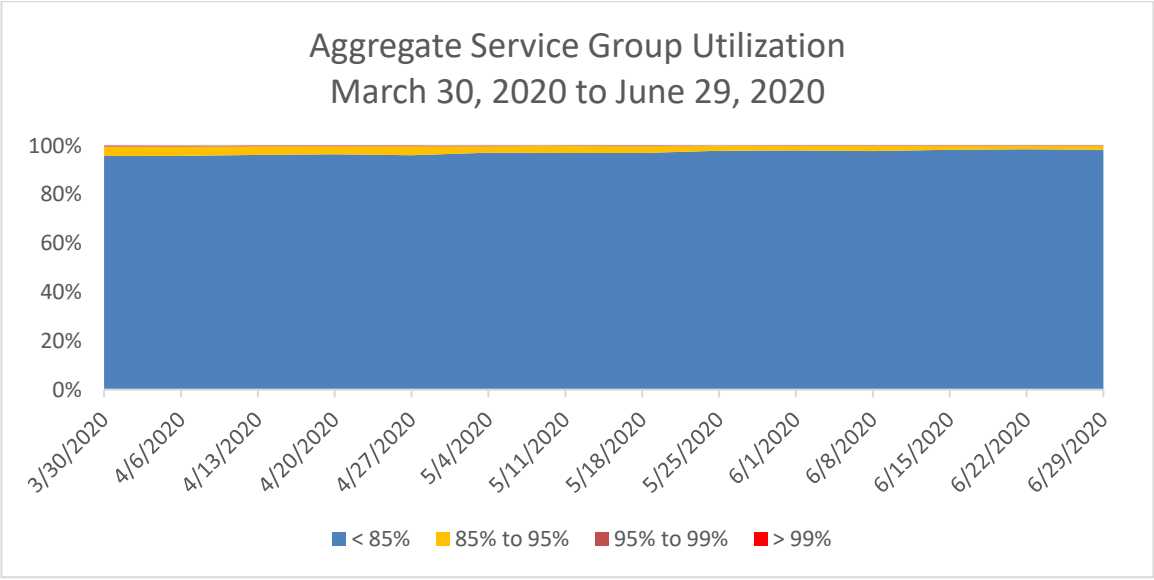
Exhibit 2: Cable Broadband Network Change in Peak Utilization Over Time



Source: NCTA[10]

As we can see in Exhibit 3, while cable network peak utilization increases of 20% are significant, those increases did not lead to network congestion that might have caused the consumer experience to suffer. During the height of the pandemic, peak network utilization exceeded 95% in only 0.35% of service groups in the highest traffic week of the period. In weeks such as May 25th, 2020, peak network utilization exceeded 95% in only 0.09% of the cases, and it never exceeded 99%. These figures demonstrate that the increased usage on the network did not adversely affect the ability of consumers to use the network.

Exhibit 3: Cable Network Peak Utilization Over Time

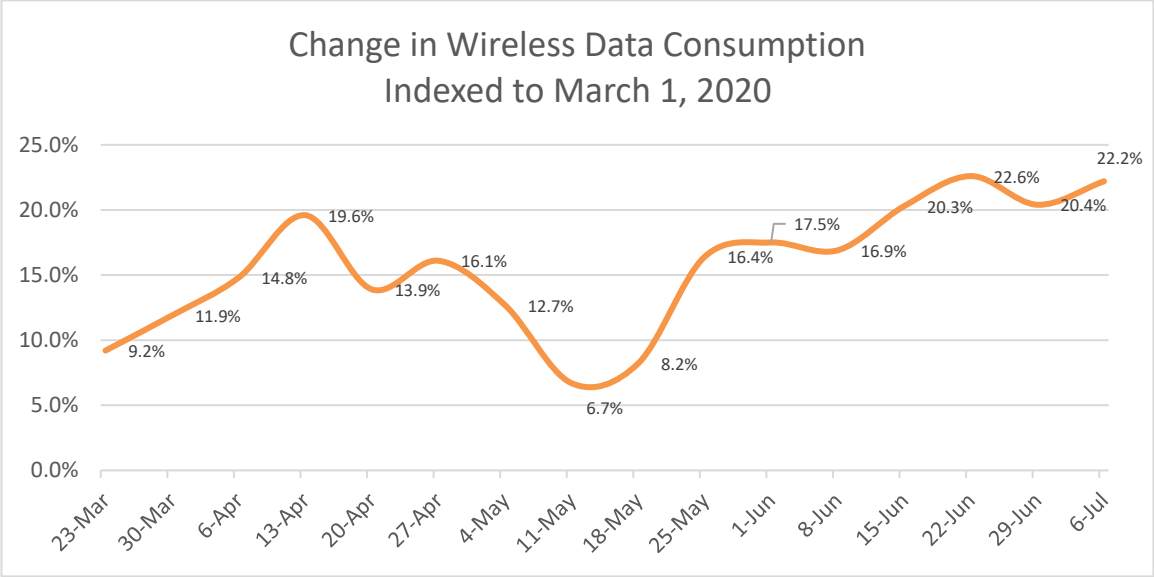


Source: NCTA[11]

[10] www.ncta.com/coviddashboard
[11] https://www.nctatechnicalpapers.com/Paper/2020/2020-tele-everything-and-its-impact-to-the-network

As is clearly visible in Exhibit 4, mobile data consumption also increased immediately after the onset of the Covid-19. Even during the peaks of lockdowns, wireless providers increased mobile hotspot data amounts to reflect consumers' demand for more broadband data. One provider found consumers were using their mobile device's hotspot ability nearly 40% more than average so they could share that mobile data connection with other devices. Over time, mobile traffic increased as the Stay at Home orders were lifted beginning in late April 2020. Nine states lifted their Stay at Home orders between April 26th and April 30th, 11 in May, and three in June. The effect was that the increase in fixed network traffic stabilized at an elevated level, whereas mobile network traffic rose as Americans increasingly emerged from their homes. By July, wireless data traffic was up nearly 25% from its pre-pandemic level.

Exhibit 4: Increase in Wireless Data Consumption Over Time



Source: CTIA

The impact of video conferencing

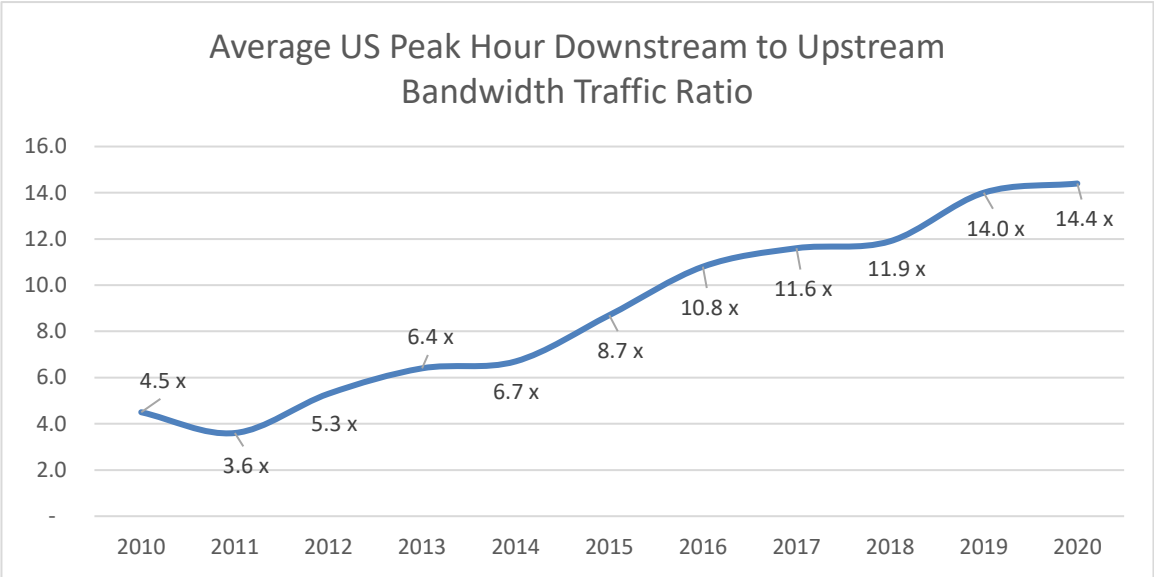
One of the watershed developments that occurred during the Stay at Home and Work from Home phase of the pandemic is the large-scale adoption of video conferencing technology. Zoom, Webex, GoToMeeting, and Microsoft Teams were adopted more quickly in these few weeks than in the years before, as they acted as the necessary replacement for personal interaction.[12] While usage of these conferencing services increased significantly, video streaming also increased as watching entertainment online became the go-to-activity of Americans stuck at home.

As screen resolution increases so does the bandwidth consumption. Standard definition video uses 1 to 3 Mbps, high-definition video uses 5 Mbps and 4K video uses 8 to 20 Mbps. Video conferencing apps consume about as much as standard definition video streaming. Since the video goes both ways, the usage is symmetric when it comes to upload and download. Microsoft Teams uses between 0.5 to 1.5 Mbps, Zoom between 0.6 and 1.8 Mbps and WebEx uses 0.5 to 3 Mbps. However, video streaming is highly asymmetric. HD video streaming uses about 19 times more download bandwidth than upload (7.6 Mbps down and 0.4 Mbps up), live online gaming about 15 times more download bandwidth than upload (1.5 Mbps down and 0.1 up) while video conferencing on average uses 4.2 times more download bandwidth than upload (2.1 Mbps down and 0.5 Mbps up).[13]

We can see the effect of this in Exhibit 5. The asymmetry of internet traffic has actually increased as video streaming traffic has grown on an absolute basis faster than any other kind of traffic. Therefore, concerns about an increased use of upload capacity creating bottlenecks for the user never materialized.

[12] https://digitalintheround.com/video-conferencing-statistics/
[13] https://www.ncta.com/whats-new/new-study-examines-internet-traffic-patterns-and-bandwidth-requirements

Exhibit 5: Downstream to Upstream Bandwidth Ratio over time



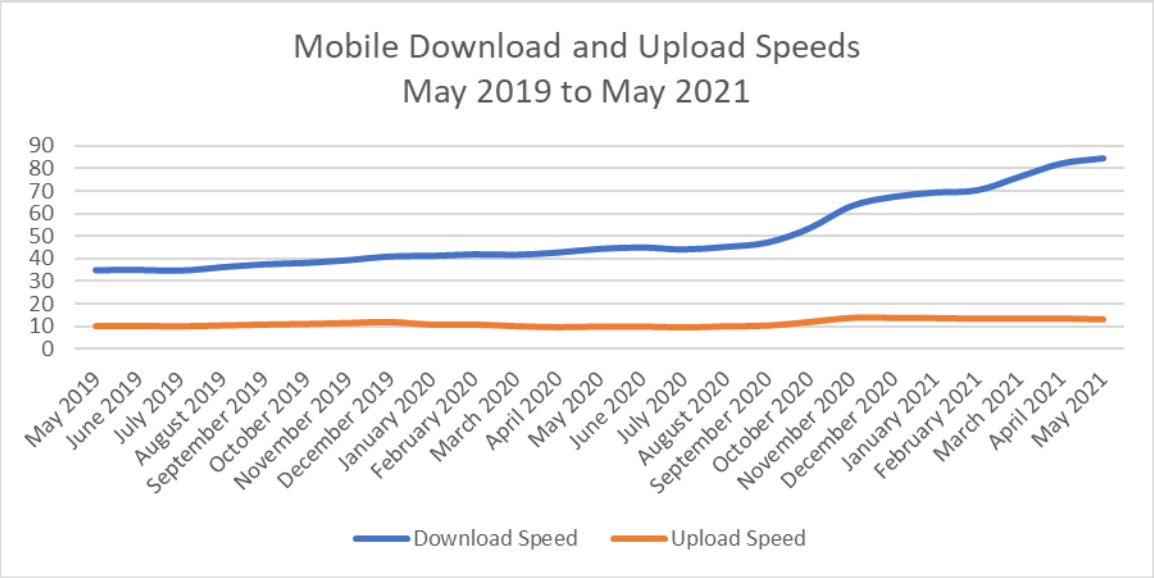
Source: CommScope

During the Pandemic, U.S. Broadband Network Speeds Increased Even As Data Demand Escalated

As we have discussed, broadband traffic significantly increased when the country went into lockdown. In this segment, we discuss the impact that the traffic increase had on the download and upload speed that consumers experienced. As we observe in Exhibit 6, over the course of the pandemic, mobile data speeds more than doubled. During the initial months of the pandemic, U.S. wireless networks showed their resiliency, with speeds maintaining and even improving—all the while as network demand increased significantly.

This performance is particularly notable, since with so many people staying home, data traffic patterns often shifted—quite rapidly—from dense business areas to other areas such as residential locations, without degrading the network. One wireless provider saw an 86% jump in subscribers connecting to cell sites only in their primary location—like someone's home—and another provider saw a nearly 30% decline in mobile handoffs, which occur when consumers' data connections shift cell sites.

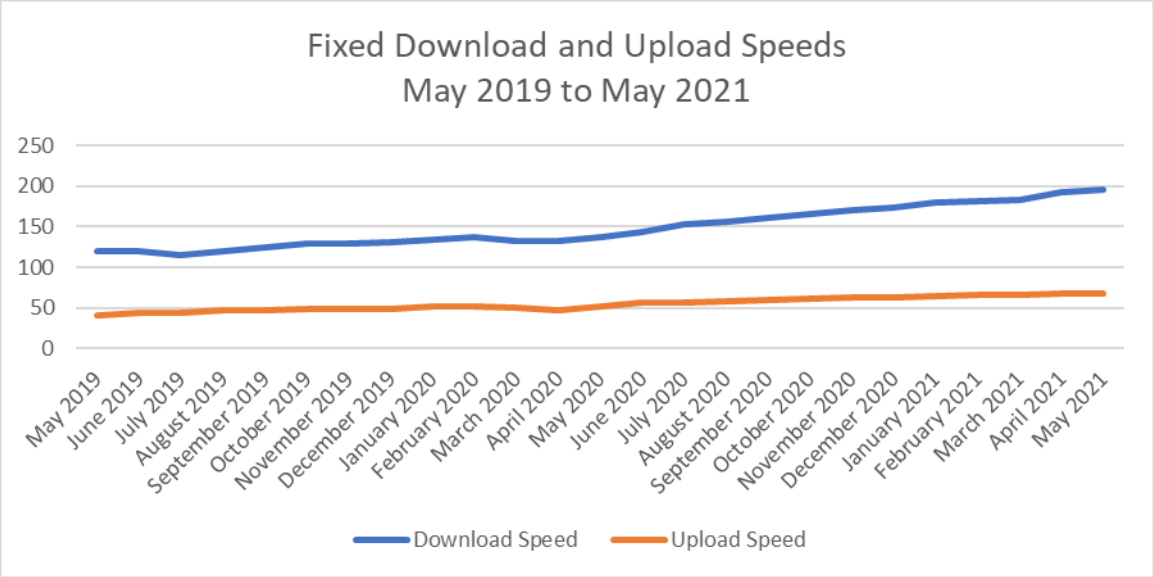
Exhibit 6: Mobile Download and Upload Speeds



Source: Ookla

As shown in Exhibit 7, under the pressure of a nearly-overnight 20% surge in traffic, fixed networks (cable, fiber, and copper) performed at levels very close to pre-pandemic levels. According to one source, average measured download speeds declined for two months, from 137.4 Mbps in February to 132.5 Mbps in both March and April 2020, a decline of 3.5% (although it is not clear whether these declines reflect a decline in performance or simply an increase in testing by homes with slower connections). By June 2020, average measured download speeds exceeded pre-pandemic levels again with 137.9 Mbps and have successively increased. In May 2021, average measured fixed download speeds were 194.8 Mbps, or an increase of 42% over pre-pandemic levels. It took the fixed networks only four months – until June 2020 – to exceed pre-pandemic levels of upload speeds again as they fell by 8% between February 2020 and April 2020, from 51.9 Mbps to 47.5 Mbps. It is remarkable that the networks absorbed a one- to two-year demand increase in only a few weeks so well. By May 2021, upload speeds increased to 68.2 Mbps, an increase of more than 31% over pre-pandemic levels.

Exhibit 7: Fixed Download and Upload Speeds



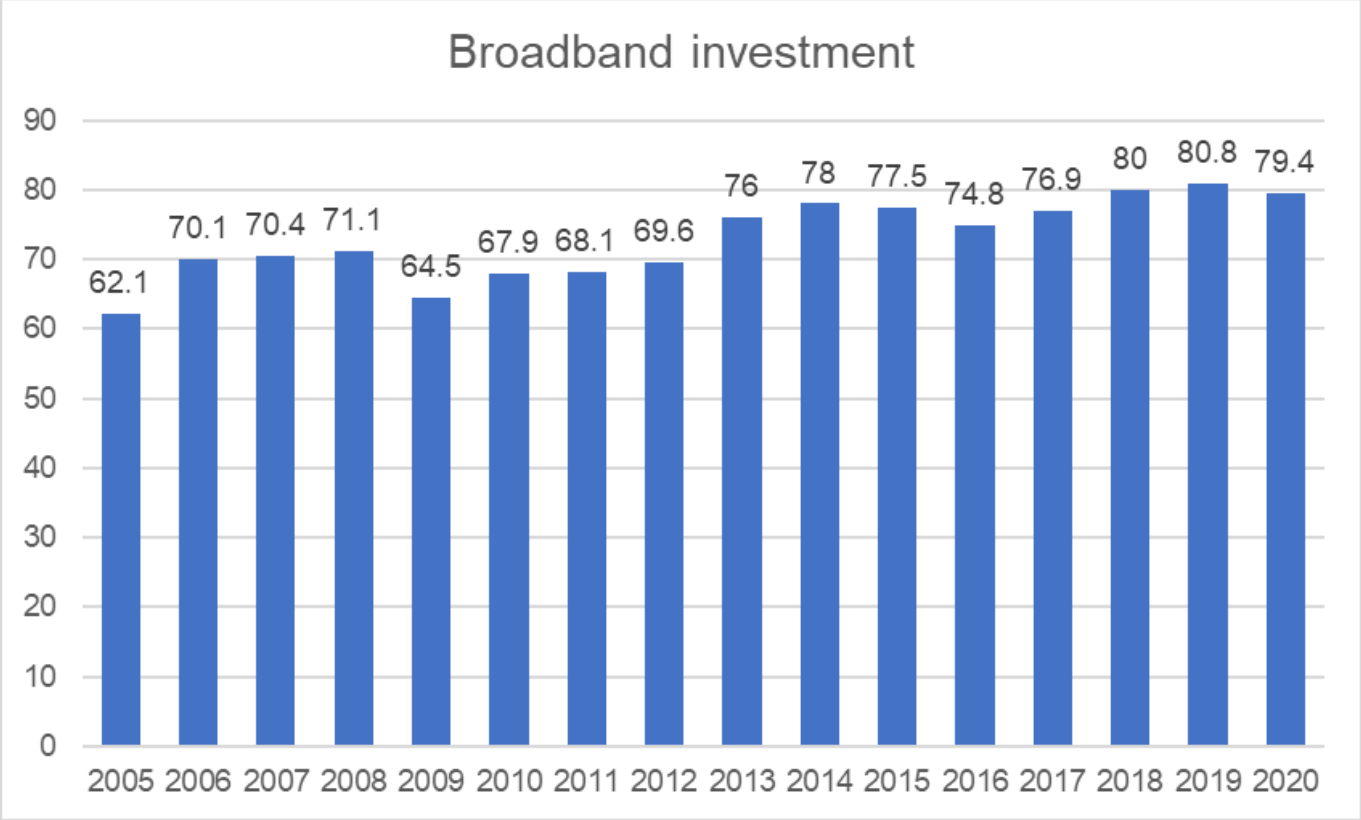
Source: Ookla

Mobile and fixed networks have absorbed the significant step change in demand with the unexpected onset of the pandemic-related lockdowns very well. When looking at the independent published data, it becomes apparent that during COVID-19, U.S. consumers experienced strong broadband network performance, whether fixed or mobile—performance that actually improved over the course of the pandemic.[14]

American Broadband Network preparedness for the expected and unexpected

The unexpected jump in internet usage due to Americans staying at home and working from home washandled smoothly because for the last decade and a half, U.S. broadband providers have spent between $62.1 and $80 billion per year to improve their networks for the ever-increasing level of demand.[15]

Exhibit 8: Broadband Capital Expenditure over time



Source: USTelecom

According to the OECD, US telecommunications providers (fixed and mobile) have steadily increased their investment in their networks from 2010 to the most recently available data from 2018.[16] The OECD, representing the 38 most economically advanced democratic countries, tracks telecommunications investment in its member countries. Of the 30 OECD countries that we have data for, the United States represents approximately 29% of the population of OECD countries but the percentage of telecommunications investment made by US telecommunications providers increased from 38% in 2009 to 47% in 2018.[17]

[14] https://itif.org/publications/2020/07/13/lessons-pandemic-broadband-policy-after-covid-19; https://www.ustelecom.org/wp-content/uploads/2020/06/PP-2020-06-Kovacs-internet-performance.pdf; https://www.ncta.com/covid-19-overview
[15] 2020 Broadband Capex Report – USTelecom
[16] OECD: https://www.oecd.org/sti/broadband/9b.Investment.xls
[17] https://data.worldbank.org/indicator/SP.POP.TOTL?locations=OE

This unrivaled level of investment allows American fixed and mobile broadband providers to build networks today that are designed to easily handle future traffic volume. This level of foresight has enabled providers to weather the data tsunami that was unleashed by the pandemic.[18] Considering the steady growth of internet traffic of 35% to 50% per year in the United States, broadband providers are investing significantly, both in absolute terms and comparatively to other countries, bringing more broadband to more people and enabling them to consume more data than ever.[19]

Supported by light touch regulation

American broadband providers invest more than their peers [on a per capita basis]. American investment exceeded that of 36 out of the other 37 OECD members. American operators spent twice as much per person as what is spent in the economies of other OECD countries.[20]

The US investment paradigm is founded on a free-market approach according to which providers can compete against each other where it makes economic sense, framed in a light touch regulatory system. While traditionally fixed operators competed solely against fixed operators and wireless operators only competed against wireless operators, those days are in the past. Cable, wireline, wireless, fixed wireless and satellite broadband providers are all competing against one another.

Without a consistent and predictable light touch regulatory regime, the type of investments that let much of the US economy seamlessly switch from a largely at the office business model to a fully distributed work at home model would be difficult to imagine.

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[18] OECD: https://www.oecd.org/sti/broadband/9b.Investment.xls
[19] https://internetinnovation.org/general/research-peek-of-the-week-u-s-broadband-networks-outperformed-other-countries-during-covid-19-crisis/
[20] Ibid