REPORT AND RECOMMENDATIONS:

COVID-19 Response

Disaster Response and Recovery Working Group

Presented to the Broadband Deployment Advisory Committee
of the Federal Communications Commission
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Contents

1 Executive Summary

The coronavirus disease 2019 (COVID-19) was first identified at the end of the 2019 calendar year and declared a global pandemic in March 2020. Because of the need for physical distancing and other preventative measures to curb transmission, the COVID-19 pandemic has made Americans more reliant than ever on broadband networks for work, education, healthcare, access to news and entertainment, and other aspects of everyday life. In light of this increased significance of broadband in Americans' lives, the Federal Communications Commission (FCC or Commission) charged the Disaster Response & Recovery Working Group (DRRWG or Working Group) of the Broadband Deployment Advisory Committee (BDAC) to examine how broadband networks aided those working and learning from home, how permitting challenges arising out of the pandemic may have affected broadband deployment, how providers sustained their networks in the face of increasing and shifting data demands, and ways that technology could be leveraged to mitigate similar challenges in the future.[1]

This Working Group consists of a broad range of stakeholders representing agencies, companies, and organizations from around the country that each offer their own perspectives on the deployment and uses of broadband in the face of the pandemic. The full impact of the pandemic will not be known for years to come and many lessons are still being learned. Nonetheless, as the FCC recognized in issuing its charges and seeking recommendations this year, the DRRWG's work to date offers recommendations and identifies best practices in a timely manner providing value even as much of the country continues to respond to the pandemic.

The report's principal findings include:

- Networks performed well overall during the pandemic.
- Availability and adoption challenges were intensified in a pandemic environment where many critical societal functions transitioned to online, changing consumer needs almost overnight.
- Municipalities were able to ensure that permitting generally was not an obstacle to maintaining and, as needed, expanding broadband networks during the pandemic.
- The national response to the pandemic prompted rapid and significant social changes, including remote work, distance education, and telemedicine, which are becoming ingrained and will likely lead to long-term changes in broadband usage and adoption.

The public health crisis brought on by the pandemic led to many teleworking situations, remote learning shifts, increased telehealth, virtualized events, and other changes aimed at minimizing the need for in-person activities. These changes in everyday activities in turn increased usage and demand on broadband networks across the country. Many employers transitioned workforces to telework where possible, and many governments implemented stay at home mandates or safer at home guidance, closed schools, and closed non-essential offices or delayed in-person activities such as applying for a driver's license or a library card. This shift in teleworking was more complicated for some due to factors such as limited space in living quarters and the presence of multiple residents in a single household all working

[1] *FCC Chairman Pai Announces New Charges and Solicits Additional Nominations for the Disaster Response and Recovery Working Group of the Broadband Deployment Advisory Committee to Address Challenges Presented by Covid-19*, GN Docket 17-83, Public Notice, 35 FCC Rcd 3553, 3553-3555 (2020), https://www.fcc.gov/document/fcc-tasks-bdac-working-group-addressing-covid-19-challenges.

and learning from home. Additionally, business and government transitioned services largely online, which introduced a new need and urgency to be able to access the internet.

The Working Group found two outstanding challenges associated with broadband: (1) availability – the lack of sufficient connectivity for users to participate as needed in teleworking or remote learning functions; and (2) adoption – the circumstance in which sufficient connectivity exists at a given location but the user does not subscribe. The challenge of adoption can be attributed to several potential barriers, including (a) the monthly cost of the service; (b) the cost of an internet capable device; (c) knowledge of how to use increasingly complex devices and services; and/or (d) lack of relevance from the user's perspective. While tackling availability requires substantial planning and significant capital investment, it must also be noted that, based upon current broadband coverage maps and estimates, there are approximately six times more Americans that have connections available but currently do not subscribe to broadband than are considered unserved at the minimum broadband speed metric used by the FCC today. This report includes recommendations on steps that might be considered to address both challenges, as well as measures to promote more effective teleworking and remote learning environments.

The DRRWG also examined the preparedness of local governments, focusing on how these entities can manage efforts in a mass teleworking environment and continue performing essential functions, such as permitting. This report contains several recommendations intended to provide guidance to local governments in the execution of these functions even in emergency situations like a pandemic.

This report finds that broadband networks in the United States performed well, especially as compared to networks in other parts of the world, despite significant increases in demand and marked shifts in usage patterns during the pandemic. The high performance of the networks resulted from several key factors, including the continuous investments made by providers to stay ahead of projected demands, networks engineered to handle peak demands, advancements in technologies that allowed for networks to adjust to new demands dynamically, and additional spectrum made available to providers by the FCC. The DRRWG also examined the innovative ways in which service providers continued to perform critical field installation and repair functions for users during the pandemic and early challenges in securing sufficient personal protective equipment. This report contains a series of recommendations for communications providers and federal, state, local, tribal, and territorial governments to adopt new policies and adapt existing practices as the pandemic continues.

Finally, the DRRWG evaluated ways in which technology might be used to mitigate the various challenges identified elsewhere in this report, identifying several promising technologies worthy of further consideration and development.

This report contains the following recommendations for consideration by the BDAC and the FCC:

<u>Recommendations to improve end-user resilience during pandemic response</u>
Recommendation 4.3.1: Take Steps to Improve Broadband Availability
Recommendation 4.3.2: Take Steps to Improve Broadband Adoption
Recommendation 4.3.3: Implement Distance Education Best Practices
Recommendation 4.3.4: Implement Virtual Workforce Best Practices

2 Introduction

2.1 Working Group Formation and Organization

In August 2018, the FCC sought nominations for the new Disaster Response and Recovery Working Group.[2] DRRWG members were announced by the FCC in November 2018,[3] and the group's initial report was approved by the BDAC on March 27, 2020.[4] This report responded to the FCC's charges for recommendations on measures to enhance the resiliency of broadband communications infrastructure before a disaster occurs, response strategies to minimize any disaster's impact on broadband communications services, actions that can be taken to more quickly restore broadband communications infrastructure during disaster recovery, and best practices for coordination among wireless providers, backhaul providers, and power companies during and after disasters.

A different kind of disaster than any seen in perhaps a century, however, struck the United States in early 2020. While the First DRRWG Report recognized that "no two emergencies or disasters are the same," consistent with charges focused on physical network infrastructure and service restoration, it focused primarily and logically on disasters such as "hurricanes, . . . tornadoes, earthquakes, and

[2] *FCC Solicits Nominations for New Disaster Response and Recovery Working Group of the Broadband Deployment Advisory Committee*, GN Docket No. 17-83, Public Notice, 33 FCC Rcd 8096, 8096 (2018), https://www.fcc.gov/document/fcc-seeks-applicants-bdac-disaster-response-and-recovery-group.

[3] *Chairman Pai Announces Members of BDAC Disaster Response and Recovery Working Group*, GN Docket No. 17-83, Public Notice, 33 FCC Rcd 11006, 1106-1108 (2018), https://www.fcc.gov/document/chairman-pai-announces-members-bdac-disaster-response-working-group.

[4] FCC, *Report and Recommendations*, Disaster Response and Recovery Working Group (Mar. 27, 2020) ("*First DRRWG Report*"), https://www.fcc.gov/sites/default/files/bdac-disaster-response-recovery-approved-rec-03272020.pdf.

wildfires" – the kinds of incidents seen most often in the United States over the course of many years.[5] Just as the First DRRWG Report was being finalized, however, the COVID-19 pandemic struck.

In April 2020, Chairman Pai announced new charges to the DRRWG aimed at assisting "the BDAC in documenting the various strategies and solutions that stakeholders are developing and implementing in real time to address the deployment-related challenges presented by the coronavirus (COVID-19) pandemic." At the same time, the FCC solicited nominations for additional DRRWG members to assist in carrying out these new charges,[6] and new members were announced in June 2020.[7] The members of the DRRWG are listed in Appendix A to this report.

This increased the DRRWG membership to 41 organizations, representing a comprehensive mix of governments, providers, associations, and other stakeholders. The Working Group created three subgroups to be as efficient as possible in focusing discussion on individual charges. We did not track membership of the subgroups as participation was encouraged across any or all of them based on individual members' interest in the topic. The subgroups are:

- Subgroup A – "Teleworking Challenges"
  Originally born out of the idea of addressing Charges 1, 2, and 5 as described further below, the subgroup focused primarily on end-user related challenges – including both residential and business end-users as they were forced to adapt to a remote-work and/or a remote-school environment. This group was co-led by Todd Gourd and David Hartshorn.

- Subgroup B – "Municipal Challenges"
  This group focused on Charges 3 and 5 as described further below, looking to address the challenges related to the continuity of government functions in the remote-work environment. This group was co-led by Andrew Afflerbach and Tony Fischer.

- Subgroup C – "Provider Challenges"
  This group focused on Charges 4 and 5 as described further below and examined broadband providers' efforts in the face of the pandemic. This group was co-led by Kayla Gardner and Melissa Slawson.

The DRRWG determined that Charge 5 in particular — ways that technology could be used to mitigate these and other similar challenges in the future — was relevant to the work of all three subgroups and spanned the scope of each. Moreover, the Working Group observed that certain other challenges, related specifically to network capabilities and resiliency and user access to broadband (incorporating both adoption and availability as separate issues), cut across many of the issues discussed by the various subgroups.

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[5] First DRRWG Report at 2.

[6] *FCC Chairman Pai Announces New Charges and Solicits Additional Nominations for the Disaster Response and Recovery Working Group of the Broadband Deployment Advisory Committee to Address Challenges Presented by COVID-19*, GN Docket No. 17-83, Public Notice, 35 FCC Rcd 3553, 3553 (2020), https://www.fcc.gov/document/fcc-tasks-bdac-working-group-addressing-covid-19-challenges.

[7] *FCC Announces Additional Membership of Broadband Deployment Advisory Committee Disaster Response and Recovery Working Group*, GN Docket No. 17-83, Public Notice, 35 FCC Rcd 5669, 5670 (2020), https://www.fcc.gov/document/new-bdac-disaster-response-and-recovery-working-group-members-released.

The DRRWG created a smaller fourth subgroup — an Editors' Subgroup — in July to assist specifically with preparation of this report. This subgroup would provide a rough outline for the report, manage the collaborative draft as members added content, review the various contributions for a cohesive flow, and ultimately format the report. This subgroup was co-led by Chris Anderson and Mike Romano.

The DRRWG conducted fortnightly conference calls to collaborate and hear updates from the subgroups. The subgroups established their own meeting cadence, with each meeting weekly during the months of July and August to produce this report by the requested deadline.

2.2 FCC Charges to the Working Group

In April 2020, Chairman Pai announced new charges for the DRRWG to consider: "Specifically, the Working Group will assist the BDAC in documenting the various strategies and solutions that stakeholders are developing and implementing in real time to address the deployment-related challenges presented by the COVID-19 pandemic. It will also enable the BDAC to report on best practices and lessons learned from the response to COVID-19 to help with the ongoing response to the pandemic, and to assist stakeholders, including the Commission, in preparing for and responding to any comparable future crises."[8]

The Working Group was tasked with considering and reporting on five charges:

1. *The challenges associated with shelter-in-place and stay at home environments;*
2. *Useful responses to a mass teleworking scenario, including any steps that can be taken in advance to prepare;*
3. *Best practices with regard to permitting challenges, including those caused by the physical closure of municipal offices, a shift to telework for municipal employees, and other complications arising from COVID-19 and similar emergencies;*
4. *Steps providers have taken to successfully address the physical impacts of the pandemic on broadband providers, including increased demand for bandwidth, limited staff availability, and limited ability to perform installations, maintenance, and repairs; and*
5. *Ways that technology could be used to mitigate these and other similar challenges in the future.*

The DRRWG was directed to address different challenges facing broadband providers, state and local governments, entities responsible for the construction of broadband infrastructure, the public, and other stakeholders. The Working Group was also asked to examine how all stakeholders could work together most effectively to ensure that broadband networks continue to serve vital functions and to include, to the extent possible, concrete steps and procedures that stakeholders, including the FCC, could adopt. Given the limited time available and high value of timely completion of its work, the Working Group was instructed to limit its report to the charges noted above and to be prepared to present its report to the full BDAC at that committee's final meeting of 2020.

2.3 Relationship to Previous Working Group Recommendations

The BDAC approved the initial Report and Recommendations of the DRRWG on March 27, 2020. In that report, based on the charges given, the DRRWG focused on disasters that affect the physical broadband infrastructure. The initial report was completed during the early days of the COVID-19 pandemic in the

[8] *See FCC Tasks BDAC Working Group with Addressing Covid-19 Challenges, 35 FCC Rcd* at 1.

United States when stay at home orders had not yet been issued; the report was finalized and submitted for consideration at the end of February to meet relevant deadlines for the March BDAC vote.

The DRRWG finds that the following five recommendations from the First DRRWG Report are relevant to a pandemic response.

- **Recommendation # 1** (PLAN 1) - **Relationship Building and Maintaining Formal Relationships** "Industry and government stakeholders should foster opportunities for ongoing relationship building activities between key personnel from all interested stakeholders, including informing public and private entities on disaster preparedness practices."[9]
- **Recommendation # 2** (PLAN 5) - **Government Approval Processes** "Industry and government stakeholders should continue to develop and utilize governmental processes to facilitate preparatory activities in advance of emergency or disaster events, including expedited permitting processes for the transport of fuel, generator operations, communications and construction supplies, and temporary housing and workforces. Such processes should also include procedures for obtaining event-specific, time-limited waivers and physical access to infrastructure."[10]
- **Recommendation # 3** (RESP 2) - **Emergency Operations Center (EOC) Coordination** "EOCs should include representatives from communications and power stakeholders in meetings and discussions related to service response and restoration activities to the extent possible. Robust participation in EOC coordination activities by all affected stakeholders is critical to ensuring timely maintenance and response activities."[11]
- **Recommendation # 4** (RCOV 1) - **After-Action Assessments** "After-action assessments are an important component of promoting broadband infrastructure resiliency. There is no substitute for real-world experience, which cannot be fully simulated in drills and exercises. Interested stakeholders should conduct individual, joint, and/or sector specific after-action reviews to help improve resiliency practices and policies, learn from event experience, and improve plans for future events. After-action assessments should be considered by stakeholders and implemented into emergency preparedness plans where appropriate. Any recommendations from after-action assessments should be considered by the relevant committees and stakeholders for implementation into future plans, trainings, and procedures."[12]
- **Recommendation # 5** (RCOV 3) - **Information Sharing** "Continuing after a disaster, communications and power stakeholders should participate in relevant sector coordinating councils to improve information sharing and decision-making. Robust participation will result in the sharing of information about key facilities and outage areas that need priority electric and communications support including the locations of hospitals, ECCs, police and fire departments, municipal EOCs, and shelters."[13]

[9] First DRRWG Report at 2.

[10] *Id*.

[11] *Id*. at 15.

[12] *Id*. at 20.

[13] *Id*. at 20.

In the conclusion of the First DRRWG Report, we stated that:

> *"We hope the discussions that occurred during the course of this Working Group can be used as a springboard to continue the dialogue between industry, government, and other stakeholders as we look towards the future of communications and power infrastructure and in maintaining a connected society."*[14]

We believe the charges from the FCC with respect to the COVID-19 pandemic and the opportunity to prepare a second report focused on the pandemic's impacts for our connected society represent just this kind of necessary continuing dialogue.

3 Background

3.1 COVID-19 in the U.S.

On December 31, 2019, the China Country Office of the World Health Organization (WHO) was informed of cases of pneumonia with unknown cause in Wuhan City in the Hubei Province of China.[15] Over the next several weeks the disease continued to spread in and around Wuhan, while additional cases were detected in Thailand, Japan, and South Korea. The Centers for Disease Control and Prevention (CDC) reported the first case in the United States on January 21. On January 31, WHO declared a Global Health Emergency, after which many countries began restricting global air travel. On March 11, the WHO declared the disease, by then designated COVID-19, a pandemic.

On March 13, the U.S. declared COVID-19 a national emergency. By then, many schools and businesses began planning for and transitioning to work from home and distance education. Over the next several months, states enacted various protective measures such as limiting gatherings, encouraging telework, and closing non-essential businesses, particularly those that required close interactions among employees and customers. New COVID-19 infections in the U.S. increased through early April, peaking at just over 32,000 new cases per day before dropping back to around 20,000 per day by early June. New case rates picked up in mid-June until hitting a second peak just under 70,000 new cases per day in late July. Johns Hopkins University reported, as of September 23, 2020, there had been over 6 million confirmed cases resulting in over 200,000 deaths in the U.S.[16]

3.2 Societal Impacts of the Pandemic

Unlike traditional disasters such as hurricanes, floods, or fires which have a span of days or weeks, the COVID-19 pandemic has already spanned months and there is no clear timeframe yet for the pandemic to end. Accordingly, American society could not simply wait for "the storm to clear or the floodwaters to recede" and return to normal. Instead, schools, governments, employers, and others needed to rapidly adapt to the challenges posed by the pandemic. Similarly, and unlike a hurricane, providers could not

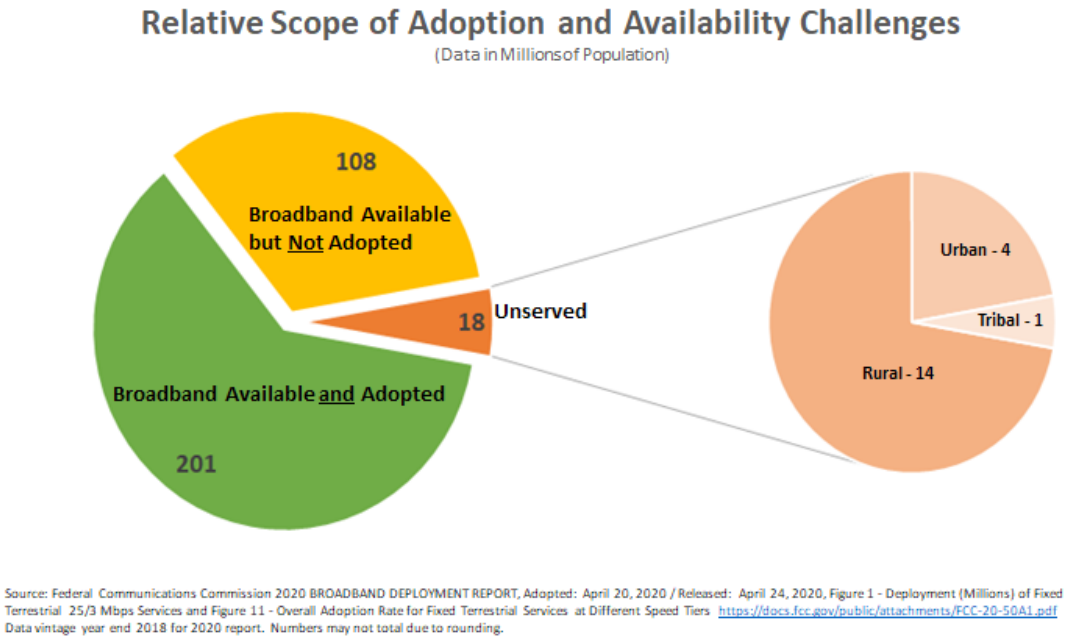
[14] *Id*. at 21.

[15] World Health Organization, *Novel Coronavirus (2019-nCoV) Situation Report-1*, (Jan. 20, 2020). https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200121-sitrep-1-2019-ncov.pdf?sfvrsn=20a99c10_4.

[16] *United States Overview*, JOHN HOPKINS UNIVERSITY, https://coronavirus.jhu.edu/region/united-states, (last visited Sept. 23, 2020).

and cannot suspend network buildout for the duration of time that COVID-19 may persist. As COVID-19 began to spread in the U.S. in March, many employers transitioned workforces to telework where possible. Many jurisdictions implemented stay at home guidance and closed schools, further pushing work, school, healthcare, consumer, and social interactions to remote and online virtual engagements. Over the following months, these trends continued as Americans adapted to the conditions of the pandemic. Remote work, distance learning, and telehealth saw profound changes over this period as detailed below. COVID-19 affected the African American community at a greater rate when compared to other racial/ethnic groups for many reasons that we do not want to diminish but fall outside of the scope of this report, including working in jobs that do not offer paid leave or lack the opportunity to work from home.[17]

As discussed in detail below, remote work, distance learning, and telehealth put a spotlight on the criticality of broadband internet access for societal resilience. Collectively, these require the capacity and latency to support multiple members of a household simultaneously learning or working online, which may require two-way, real-time video streams. Unfortunately, a digital divide persists; millions of American households do not have broadband service, either because their locations lack the infrastructure (availability) or because they have not subscribed and/or may be unable to subscribe to service where the infrastructure is available (adoption). The chart below helps to illuminate the relative estimated magnitude of these concerns based upon data set forth in the FCC's 2020 Broadband Deployment Report.[18]



[17] Tabia Akintobi, Theresa Jacobs, Darrel Sabbs, Kisha Holden, Ronald Braithwaite, L. Neicey Johnson, Daniel Dawes & LaShawn Hoffman,. *Community Engagement of African Americans in the Era of COVID-19: Considerations, Challenges, Implications, and Recommendations for Public Health,* CENTERS FOR DISEASE CONTROL AND PREVENTION *(*Apr. 13, 2020), https://www.cdc.gov/pcd/issues/2020/20_0255.htm.

[18] *Inquiry Concerning Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion,* GN Docket No. 19-285, Report, FCC-20-50 (Apr. 24, 2020), https://www.fcc.gov/document/new-fcc-report-shows-digital-divide-continuing-close-0.

Availability is a persistent and foundational concern that, as discussed elsewhere in this report, likely requires some combination of federal, state, and local governmental initiatives and private sector efforts to overcome — especially in areas where distance and density present significant and expensive challenges to both the business case for investment in networks and the sustained delivery of universal service. Meanwhile, non-adoption — based upon current mapping data and definitions of broadband — affects many more Americans than availability (measured at the FCC's current minimum broadband metric).[19] Adoption is itself a complex issue with multiple facets that likely require discrete and tailored solutions, including addressing a lack of interest or perceived purpose for broadband or an inability to afford service. Even as the solutions to each challenge must be tailored, this divide, whether availability or adoption-driven, largely has the same impact on people who lack the same ability to work, study, and manage healthcare needs online.

3.2.1 Remote Work

The response to the pandemic induced a massive surge of telework.[20] While many companies and workers had previously adopted telework to varying degrees, this rapid and sustained surge caused many organizations and individuals to struggle to implement teleworking in challenging logistical environmental circumstances. As the adage goes, necessity is the mother of invention; across the economy, companies large and small and governmental entities at all levels found that in practice, they could broadly engage large-scale and long-term telework effectively.

This telework shift has already had some radical, disruptive, and unforeseen societal impacts. The ability of a large segment of the workforce to work remotely lessened the economic downturn, relative to what it would otherwise have been. Work-from-home has substantially reduced automobile traffic and public transport use in many areas. Although telework had the desired effect of reducing population density in office buildings, this reduction had second order impacts to local service businesses surrounding those offices.

While telework was a boon to some workers and employers, many occupations and businesses by their nature require in-person, on-site presence, including manufacturing, services, healthcare, emergency services, and national security.[21] The inability of many workers to work remotely may ultimately result

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[19] As broadband availability maps improve to identify services available at individual locations rather than at the census-block level, it is expected that some Americans currently shown as not adopting will actually be shown to be limited by non-availability. Regardless of the exact ratio of availability and adoption as a root cause, the fact remains that more than 100 million Americans do not have broadband in the home based upon current definitions.

[20] *Supplemental Data Measuring the Effects of the Coronavirus (COVID-19) Pandemic on the Labor Market,* U.S. BUREAU OF LABOR STATISTICS (Sept. 4, 2020), https://www.bls.gov/cps/effects-of-the-coronavirus-covid-19-pandemic.htm#highlights.

[21] Rakesh Kochhar & Jeffery Passel, *Telework May Save U.S. Jobs in COVID-19 Downturn, Especially Among College Graduates*, PEW RESEARCH CENTER (May 6, 2020), https://www.pewresearch.org/fact-tank/2020/05/06/telework-may-save-u-s-jobs-in-covid-19-downturn-especially-among-college-graduates/ (citing Jonathan Dingel & Brent Neiman, *How Many Jobs Can Be Done at Home?*, NATIONAL BUREAU OF ECONOMIC RESEARCH (Apr. 2020) (estimating that 60% of jobs as of February 2020 could not be performed remotely), https://www.nber.org/papers/w26948.pdf).

in significant distributional impacts across the economy and society; generally white-collar occupations are more conducive to teleworking, while blue-collar and pink-collar jobs are less conducive. Unlike most disaster events which shortly allow for a return to normal, it appears that the shift to telework induced by the pandemic could have a substantial and permanent impact on society — becoming a significant part of a new normal.[22] This may have significant secondary effects on several sectors including transportation infrastructure, commercial real estate, and even housing patterns as telework de-links work from office location. Further, currently unseen effects may follow such as shifts in work skills demanded. Greater movement from dense urban cores to less densely populated areas may also be observed.

3.2.2 Distance Learning

COVID-19 significantly impacted school systems across the U.S. As social distancing requirements made remote learning a necessity, many schools and universities transitioned to remote learning models with little or no time for such a transition; indeed, many schools sent students home for an expected week of spring break who never returned to in-person classes for the remainder of the school year. As the 2020-21 school year begins, communities are again wrestling with opening schools safely and balancing pandemic risk mitigation through distancing against the benefits of in-person instruction and learning.

Unfortunately, the digital divide limited distance education opportunities for many Americans. In Los Angeles, for example, local officials stated that the lack of broadband access at home contributed to over 40,000 students in their municipality not complying with COVID-19 online learning mandates in Spring 2020. Students in Holland, Michigan who did not have readily available access to broadband at home were often forced to sit alongside the road or in school and library parking lots to get a signal to complete their homework. In Rochester, New York, where the homework gap has had a disproportionate impact on African American and Hispanic students, the city and school district partnered to provide both technology and connectivity solutions.

Despite many efforts to date to close these divides, they persist in many places. In Fort Collins, Colorado, where students in mobile home parks rarely have wireline broadband, the City distributed hotspots and other portable connectivity solutions to connect students to broadband. Local officials in Louisville, Kentucky, acknowledged that short-term digital inclusion programs, implemented in the wake of COVID-19, may ultimately be unsustainable if remote learning continues into the Fall. Unfortunately, students who could benefit from state, local, or federal broadband programs, such as Lifeline, may not even know that they are eligible; for example, in King County, Washington, where one in four households do not have minimum broadband speeds, 47% of households who would qualify for low-cost equipment and internet programs are simply unaware of them.[23]

While resolving limitations to availability and adoption are obviously critical to closing the digital divide, these are not the only obstacles. The need for broadband access devices, affordable service plans, and digital literacy training — in native languages — for teachers, students, parents, and grandparents must

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[22] Katherine Guyot & Isabel Sawhill, *Telecommuting Will Likely Continue Long After the Pandemic*" , THE BROOKINGS INSTITUTION (Apr. 6, 2020), https://www.brookings.edu/blog/up-front/2020/04/06/telecommuting-will-likely-continue-long-after-the-pandemic/.

[23] *A Spotlight on King County, Washington*, NEXT CENTURY CITIES (July 28, 2020), https://nextcenturycities.org/king-county-wa-where-digital-equity-is-fundamental-to-social-justice/.

also be engaged to increase opportunities for all Americans to benefit from effective distance learning. Additionally, sustainable distance learning will likely require substantial investments and upgrades in school system virtual private networks (VPNs) and other information technology (IT) resources, virtual helpdesks, internet security protections, and a means to communicate available resources, such as funding, maps, and internet usage plans, to support the online learning activities. As COVID-19 continues to impact communities throughout America, the communications industry has stepped in to help provide critical aid and support to those in need, including by providing access to distance learning technologies.

3.2.3 Telehealth

In response to COVID-19, the healthcare industry transformed aspects of its service delivery model. The traditional model of in-person patient and physician interaction elevated the risk of spreading COVID-19. By quickly adopting the use of existing technologies, healthcare providers accelerated solutions to increase remote visits to patient homes or at aggregation sites set-up at schools or workplaces. Additionally, the healthcare industry needed to quickly implement other virtual healthcare support functions, such as expanding insurance payments to cover virtual visits, enabling a remote administrative workforce, digitizing patient records, and adopting electronic signatures.

A May 2020 McKinsey report documented the growing reliance on telehealth during the pandemic. Overall adoption of telehealth surged from 11 percent of patients leveraging it in 2019 to 46 percent of patients now. Healthcare providers report they are seeing 50 to 175 times as many patients via telehealth as they did before the pandemic. Longer term, experts predict that annual telehealth revenue could grow from pre-COVID-19 $3 billion to $250 billion.[24]

As noted above for distance education and remote work, two-way video telepresence relies on broadband internet service. This made delivering telehealth services challenging, especially in rural, remote communities without or with limited broadband. While not the case for every rural area, too many rural communities did not have broadband infrastructure or services available to effectively deliver health services remotely. Based on the projected growth of telemedicine, there is a great need to ensure that affordable, reliable broadband connectivity is available to all Americans.

3.2.4 Other Societal Impacts

During COVID-19, broadband connectivity was not just critical for learning, working, and getting health care; broadband provided a critical mechanism for people to stay connected. When public health concerns ended hopes of high school graduation ceremonies, 2020 graduates from communities nationwide found a way to "Graduate Together" with a nationally televised ceremony that also streamed online.[25] Wedding ceremonies, once marked by large gatherings, forced couples in self-isolation to find new ways to share rituals with family and friends. Churches turned to social media to reach congregants

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[24] Oleg Bestsennyy, Greg Gilbert, Alex Harris & Jennifer Rost, *Telehealth: a Quarter-Trillion-Dollar Post-COVID-19 Reality?*," MCKINSEY & COMPANY (May, 2020), https://www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/telehealth-a-quarter-trillion-dollar-post-covid-19-reality#.

[25] XQ Institute, *Graduate Together 2020,* YOUTUBE (May 16, 2020), https://www.youtube.com/watch?v=MMBEdVG2P6Q.

for religious ceremonies such as weddings and funerals. Less connected populations, such as seniors[26] and the disabled,[27] who may struggle with isolation in normal times, were at heightened risk during this pandemic.

3.3 Local Jurisdiction Impacts of the Pandemic

Local governments are responsible for a variety of essential services that remain vital during a pandemic. In addition to these essential government functions, local governments also facilitate services and industries such as communications, financial, manufacturing, construction, transportation, and energy. In response to the pandemic, many local governments transitioned to telework and limited access to government buildings by visitors and non-essential staff. In adjusting to these changes, local governments have worked hard to balance the imperative to protect the public health and safety with the need to ensure that municipal services and processes continue to the extent reasonably possible under the circumstances.

3.3.1 Stay at Home Orders and Access Restrictions

Just as the pandemic required many businesses to close, it required many government buildings to close their doors to visitors and to transition non-essential government employees to telework. The transition required state and local governments to quickly establish new policies and procedures, including telework policies, remote access, and cybersecurity protocols, to ensure essential services remained available. For example, to continue to do business, local government councils and boards needed to figure out how to conduct meetings in compliance with open meetings requirements. This is particularly important because many existing local requirements could not be altered or implemented to address the pandemic without action by the council or board. In addition, the widespread closures and stay at home orders had economic consequences that impacted state and local government budgets. Many government agencies were or may be forced to furlough or lay off staff.

With respect to broadband deployment, stay at home orders required the transition of in-person activities, including permitting, payment, meetings, and inspections, to remote or socially distant processes. Where online permitting and payment processes already existed, this transition generally required little action, provided that government networks and employees' broadband services were sufficient to access and utilize the online system. Where such systems did not exist, local governments either implemented online processes or organized another permitting system, as described below. Across all government agencies, a critical factor is the ability for staff to securely access the network and have sufficient broadband access at home to complete necessary tasks.

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[26] Debra Berlyn, *Older Adults, Broadband and COVID-19*, MORNING CONSULT (Apr. 15, 2020), https://morningconsult.com/opinions/older-adults-broadband-and-covid-19/.

[27] Monica Anderson & Andres Perrin, *Disabled Americans Are Less Likely to Use Technology*, PEW RESEARCH (Apr. 7, 2017), https://www.pewresearch.org/fact-tank/2017/04/07/disabled-americans-are-less-likely-to-use-technology/.

3.3.2 Effect on Municipal Workforces and Processes

During the pandemic, many municipalities were faced with a variety of new challenges in addition to adapting to telework and other workplace changes necessitated by the pandemic. For examples, municipalities often were at the forefront of:

- Preventing the spread of COVID-19, particularly among at-risk and vulnerable communities.
- Addressing health care facilities, equipment and staffing shortages and needs in the evolving pandemic.
- Providing meals to students that rely on free and reduced-price meals at schools that are closed.
- Providing guidance, education, and resources for citizens about COVID-19.
- Helping citizens understand the benefits of social distancing, wearing face coverings, and other safety practices.
- Providing public safety, public health, and emergency personnel with the resources and tools to address this crisis while protecting their own health.
- Supporting, housing, and sheltering homeless families, veterans, and individuals.
- Ensuring utility and water resources.
- Delivering public works and transportation functions to maintain roads, remove trash, and manage the rights-of-way.

In addition to these pandemic-related services, local governments retained their day-to-day services, including permitting. Local governments handle many critical permits and processes for residents' daily lives: business permits and licenses, construction and renovation permits, animal licenses, among others. Continuing to accept, process, and issue locally-required permits is one aspect of teleworking that local governments had to address. In some communities, this process was largely online prior to the pandemic and thus little, if any, change was necessary. For others, limited access to buildings and staff required at least temporary changes to the typical permitting process to enable permits to be issued where appropriate.

With respect to permits related to broadband deployment, the vast majority of municipalities were able to transition to telework and make other process changes to ensure that permitting was not an obstacle to maintaining and, as needed, expanding broadband networks during the pandemic. Municipalities that faced more challenges in maintaining services generally were smaller jurisdictions with limited resources, resulting in delays when: (a) necessary staff became ill or were reassigned to other critical work and could not easily be replaced; (b) there was a lack of sufficient network capacity or hardware (e.g., laptops) for teleworking staff; (c) software and programs for online permitting were not yet implemented; and/or (d) budget impacts resulted in furloughed employees.

As described above, where online permitting processes already existed, the pandemic had little impact on many aspects of the permitting process. Where online processes did not exist, municipalities enacted a range of solutions, such as creating an email address to which permits should be sent, designating a staff member as the point of contact for all submittals, or establishing drop boxes outside government buildings to allow paper applications to be submitted, collected, and reviewed without contact or access to buildings. Inspections were able to be conducted using social distancing or, in some cases, videos/photos submitted by the applicant.

3.3.3 Work with Critical Infrastructure Owners/Operators

From the outset of the pandemic, state and local governments worked with critical infrastructure owners and operators to ensure broadband services remained available to residents, necessary upgrades could be accomplished, and services could be extended as needed. National municipal organizations, including the National League of Cities and the National Association of Telecommunications Officers and Advisors, worked with providers and their associations to discuss challenges in responding to the pandemic.

Stakeholders identified and worked to resolve deployment issues, including:

- **Changes to municipal codes and processes to address stay at home orders, teleworking and other pandemic-related impacts to existing programs:** Stakeholders recognized that facilitating government meetings that comply with open/public meetings laws, which often were necessary to change existing processes, generally required action at the state level to adjust open meeting requirements and new technical solutions to comply with those adjustments. Stakeholders also recognized potential limitations on resources, such as funding for legal counsel, to review and revise ordinances to address the new limitations.
- **Lack of capacity to create new online systems or alternative permitting processes:** Many industry representatives offered assistance and technical support to jurisdictions that lacked the resources to transition to online and offsite permit processes. For example, stakeholders recognized some local governments lacked the capacity to accept large files that are typical of documents required for siting applications and industry offered to establish cloud storage accounts to address this issue.
- **Prioritizing critical work:** Recognizing the many demands on government staff and the potential for immediate broadband needs for unserved residents, newly established field hospitals, and other temporary facilities to address the pandemic; stakeholders suggested that applicants implement a means of documenting permits that required expedited processing to address pandemic-related network issues that impact public health and safety. Close coordination between providers and municipalities helped ensure that all priority and critical work could get done in a timely and efficient manner. In some cases, mutually tolling shot clocks on permits allowed municipalities to prioritize work without concerns about missing deadlines or deemed-granted permits.
- **Deferring submission of some hardcopy documentation or fees:** Stakeholders recognized that, where consistent with local codes, documents that cannot be submitted electronically, such as original signatures or raised seals, could be submitted at a later date so that they do not delay necessary permits. Similarly, where there is no process for online fee payments or other available processes to submit permit fees, it may be appropriate to allow fees to be paid at a later date or to accept evidence that checks were sent to designated locations.
- **Safety and sufficient staffing for inspections:** Stakeholders recognized the need to continue inspections of sites selected by applicants and to continue the practice of considering and discussing alternative locations with applicants. Inspectors did not report delays or difficulties going to sites as this work and staff are considered essential, though some jurisdictions may have limited staff available due to illness, quarantine requirements, or other pressing assignments. Stakeholders recommended prioritizing inspections for infrastructure that serve emergency and public safety communications, mutually-tolling inspection deadlines, industry financial assistance to hire third party inspectors where appropriate, and/or in some circumstances, allowing inspectors to review the installation virtually from a remote computer terminal or through photos of the site.
- **Invoking local emergency work protocols:** Stakeholders recognized that federal, state, local, tribal and territorial governments determine if/when the pandemic constituted an emergency under existing ordinances, regulations, and agreements and worked to resolve novel questions

regarding emergency work protocol implementation. Stakeholders suggested that local governments consider guidance issued by the Cybersecurity and Infrastructure Security Agency (CISA) under the Department of Homeland Security (DHS) and National Coordinating Center for Communications (NCC) letters[28] to allow telecommunications technicians to access infrastructure to maintain service; however, this guidance does not relieve providers of the need to obtain required permits prior to performing work.

3.4 Impact to Networks and Infrastructure

While the transition of so many Americans to remote work, distance education, and telemedicine drove significant shifts in demand for network capacity, U.S. service providers' networks held up well. As noted below, independent third parties (such as SamKnows and others) were consistent in their results that U.S. broadband networks performed well despite significant increases in demand and marked shifts in usage patterns.

As detailed in the sections that follow, several factors underpinned the high performance of U.S. networks:

- U.S. providers make continuous significant investments in capacity and capability, generally planning to stay 12 to 18 months ahead of demand.
- U.S. networks are engineered and built to handle peak traffic, which has typically been driven by streaming video entertainment demands during the evening hours; remote work and distance learning demands were typically earlier in the day, resulting in a longer period of high demand and a larger average demand, but a more modest increase in peak demand.
- To re-balance traffic loads on the networks, U.S. providers leveraged traditional network traffic engineering as well as advancements in network engineering including software defined networks, network function virtualization, cloud and edge computing as well as artificial intelligence.

3.4.1 Overall Network Performance

Many news outlets, public policy organizations, and speed test companies analyzed U.S. broadband performance as the nation adapted to COVID-19. While specifics varied slightly based on methodology and different time periods used for benchmarks or comparisons, the consistent result was that U.S. broadband networks performed well despite significant increases in demand and marked shifts in usage patterns.

SamKnows, a partner with the FCC on Measuring Broadband America,[29] published the results for 500,000 homes running automated download speed tests where each speed test used 16 concurrent Transmission Control Protocol (TCP) sessions and measured the speed to a major U.S. Content Delivery Network (CDN) for the period March 12, 2020, to March 24, 2020. SamKnows reported that a majority

[28] *See* section 6.2.3.2 of this Report for more discussion of CISA Guidance and NCC Letters.

[29] *Measuring Broadband America - Open Methodology,* FEDERAL COMMUNCATIONS COMMISSION (2017, July 11), https://www.fcc.gov/general/measuring-broadband-america-open-methodology (last visited Sept. 8, 2020).

of the tests only saw about 1% decline in the download speed with the largest decline being 3.9% in Michigan.[30]

Similarly, Dr. Anna-Maria Kovacs, a Visiting Senior Policy Scholar at the Georgetown Center for Business and Public Policy, used Ookla data to conduct a comparative analysis of U.S. and European broadband networks during the response to COVID-19[31] and found:

- U.S. networks outperformed European peers in absolute download speeds across both fixed and wireless networks.
- U.S. networks suffered less congestion-based slowdown than European peers across both fixed and wireless networks.
- U.S. fixed and wireless networks maintained 97.5% and 100% of pre-COVID-19 baseline download speeds respectively during the period of March 2 through June 7, 2020.

BroadbandNow studied network performance in the 200 largest US cities during the key March 15-21, 2020 transition to stay at home engagements.[32] Some researchers argue that BroadbandNow's single-TCP connection methodology leads to lower than actual speed measurements[33] but even so their findings showed networks overwhelmingly met COVID-19-induced changes in demand:

- Users in most of the cities analyzed were experiencing normal network conditions, suggesting that Internet Service Providers (ISPs) (and their networks) held up to the shifting demand.
- Even for the cities that showed some decrease, the vast majority of them were still well within speeds that can support crucial remote work and learning tasks.
- Even in the cities they judged to have the biggest impacts, providers still maintained median download speeds nearly twice the FCC's 25 Mbps broadband threshold.

Additional sources corroborate effective performance of U.S. broadband networks in the face of shifting and increased overall demands. For example, data from "Smart Home" provider Plume shows that the number of U.S. consumers that were active online during the workday before COVID-19 jumped from an average 22.6 million to nearly 50 million consumers over the summer before declining to just under 40 million by the end of September.[34] Many cities including Los Angeles, San Francisco, Seattle, and Philadelphia have seen the number of users online increase by 80% or more during the workday.[35] In a Fiber Broadband Association March-April 2020 Pandemic Broadband Usage study, 90% of respondents reported the internet as either somewhat or very important to their household, citing using the internet

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[30] *SamKnows Critical Services Report: Fixed Speed (USA)*, SAMKNOWS (2020, April 14), https://www.samknows.com/blog/samknows-critical-services-report-fixed-speed-usa (last visited Sept. 8, 2020).

[31] Anna-Maria Kovacs, *U.S. Broadband Networks Rise to the Challenge of Surging Traffic During the Pandemic* (June 2020), https://www.ustelecom.org/wp-content/uploads/2020/06/PP-2020-06-Kovacs-internet-performance.pdf.

[32] Tyler Cooper, *Internet Speed Analysis: Top 200 Cities, March 15th – 21st*, BROADBANDNOW (Mar. 25, 2020), https://broadbandnow.com/report/internet-speed-analysis-march-15th-21st/.

[33] Doug Brake, *Lessons from the Pandemic: Broadband Policy After COVID-19*, INFORMATION TECHNOLOGY & INNOVATION FOUNDATION (July 13, 2020), https://itif.org/publications/2020/07/13/lessons-pandemic-broadband-policy-after-covid-19.

[34] *People Active Online at Home During the Work Day,* PLUME, https://discover.plume.com/wfh-dashboard (last visited Sept. 23, 2020).

[35] *Id*.

during the pandemic for communication, news and information, provisioning, entertainment and work.[36]

The emergence of the video teleconferencing phenomena was evident as internet usage shifts also occurred notably for applications that require greater use of two-directional transmission such as video conferencing for family connections, education, healthcare and business – up 10 to 20% and expected to continue to climb.[37] The Cleveland Clinic saw monthly telehealth visits jump from 3,400 to over 60,000 — an increase of more than 1,700%.[38] Traffic volume for Cisco's Webex web/video conferencing service spiked 24 times above normal.[39] One nationwide provider saw a 1,200% increase in online collaboration tools,[40] and educational application traffic jumped nearly 150%.

In addition to significant demand increases noted above, the pandemic also shifted the ratio of downstream-to-upstream traffic. Even after the shift, however, overall downstream traffic continued to far outpace upstream demands. OpenVault reported[41] that during the early transition to virtual presence during the stay at home phase of the pandemic, downstream-to-upstream traffic ratios decreased slightly from 20:1 to 16:1, likely attributed to the increased use of upstream video conferencing during the daytime hours for tele-work and tele-school, with a smaller shift during the peak busy hours likely due to increased upstream usage being offset by increased downstream video consumption. Open Vault also found in its report, however, that "consumers are continuing to increase reliance on upstream bandwidth and are opting for faster speeds to meet dramatically changing usage habits." Upstream consumption rose 5.3% from the end of the first quarter of 2020 to the end of the second quarter, likely reflecting increased use of videoconferencing for business, educational and lifestyle purposes during the COVID-19 pandemic."[42]

Within this general overall industry performance, industry segments saw various unique aspects to pandemic-induced network traffic shifts.

3.4.2 Wireless Network Performance

As noted above, COVID-19 prompted sudden and significant changes in how Americans live, work, and educate our children. Over approximately one week in mid-March, much of the U.S. — hundreds of millions of people — quickly transitioned from their normal lives to staying at home as much as

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[36] Fiber Broadband Association (FBA), *U.S. Broadband Internet Access in the 2020 Pandemic: Broadband Importance, Shifts, Differences, Stresses, and Divides* at 4 (Apr. 20, 2020),("FBA Pandemic Broadband Usage Study"), https://www.fiberbroadband.org/d/do/3791.

[37] FBA Pandemic Broadband Usage Study at 5.

[38] *Id.* (citing Mark Dzuban, *3 Telehealth Lessons Learned from COVID-19 Pandemic*, HIT Consultant (Apr. 10, 2020), https://hitconsultant.net/2020/04/10/telehealth-lessons-learned-from-covid-19-pandemic/).

[39] *Id.* (citing Alex Villela, *Online is the New Normal and Connectivity is King (Reader Forum)*, RCR WIRELESS NEWS (May 1, 2020), https://www.rcrwireless.com/20200501/opinion/readerforum/connectivity-amidst-covid-19-reader-forum).

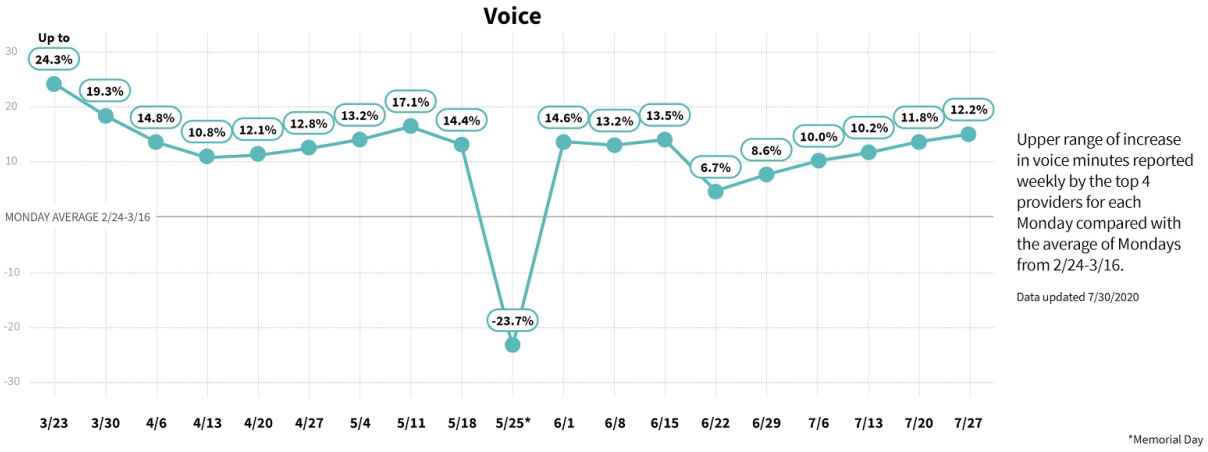
[40] I*d.* (citing Jacob Knutson, *Verizon Says Collaboration Tools Use up 1,200% during coronavirus*, AXIOS (Apr. 30, 2020), https://www.axios.com/verizon-says-collaboration-tools-use-up-1200-duringcoronavirus-0c94e19d-8335-43ea-8652-72302a1a796b.html).

[41] *COVID-19 Broadband Usage "Reaching a Plateau," says OpenVault,* OPENVAULT (Apr. 7, 2020), http://openvault.com/covid-19-broadband-usage-reaching-a-plateau-says-openvault/.

[42] *Broadband Insights Report*, OPENVAULT (2Q 2020), https://openvault.com/complimentary-report-2q20/.

possible. According to a wireless industry report,[43] this monumental shift, occurring over just a few days, meant a widespread and rapid transformation in how Americans used their wireless devices and networks.

- *Voice traffic and texting rose significantly.* Voice traffic increased from 20 to 40% on wireless networks.[44] This growth is all the more significant since nearly 80% of voice connections in the U.S. are wireless.[45] Major wireless providers also saw a 25% increase in texting.[46] The graphic below illustrates this rise in voice traffic and texting on wireless networks:



- *Mobile data use jumped.* COVID-19 drove significant increases in wireless broadband demand, with mobile data traffic up nearly 20%. For some wireless providers, that was like adding almost eight months of data increases practically overnight, yet U.S. wireless networks handled this abrupt spike in traffic with rapid reconfiguration of capacity. It is important to note that this COVID-19-traffic increase was on top of the regular rising mobile data traffic trends, which are significant in their own right. For instance, the increase in mobile data traffic in 2019 from 2018 alone was greater than the entirety of mobile data traffic just four years ago. The graphic below illustrates this rise in data use on wireless networks:

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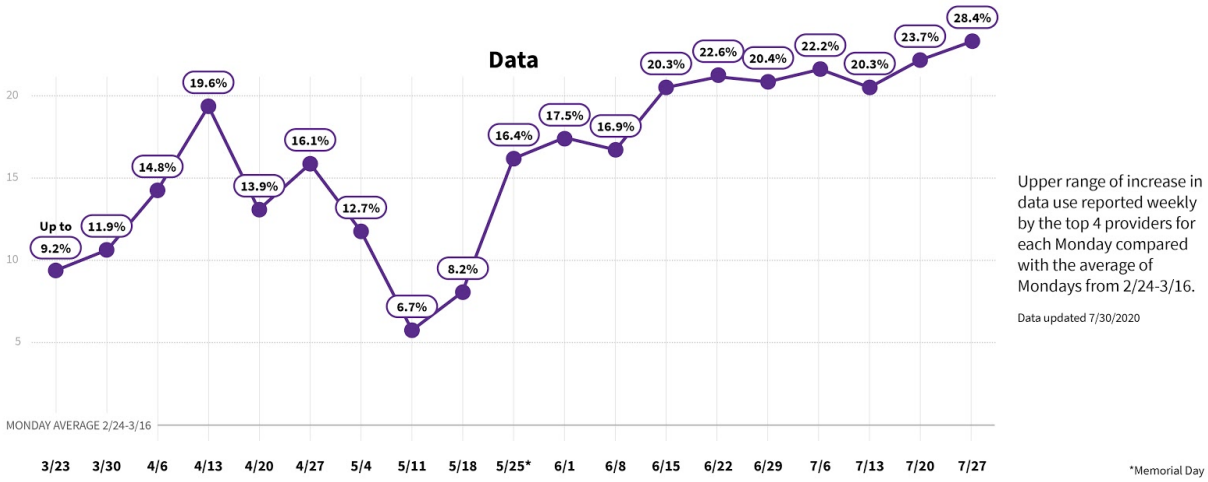
[43] *How Wireless Kept Americans Connected During COVID-19*, CTIA (June 23, 2020) ("*CTIA Report*"), https://www.ctia.org/news/report-how-wireless-kept-americans-connected-during-covid-19).

[44] *Id.* at 2 (citing Mike Dano, *US Wireless Networks are Holding Up to COVID-19*, LIGHT READING (Mar. 24, 2020), https://www.lightreading.com/4g-3g-wifi/us-wireless-networks-are-holding-up-to-covid19/d/d-id/758446).

[45] *Id.* (citing USTelecom, The Broadband Association, *USTelecom Industry Metrics and Trends* at 10 (Feb. 2020), https://www.ustelecom.org/wp-content/uploads/2020/02/USTelecom-State-of-Industry-2020.pdf).

[46] *Id.* (citing Mike Dano, *US Wireless Networks are Holding Up to COVID-19*, LIGHT READING (Mar. 24, 2020), https://www.lightreading.com/4g-3g-wifi/us-wireless-networks-are-holding-up-to-covid19/d/d-id/758446).



- *Traffic patterns changed overnight.* Wireless providers build networks on well-established traffic patterns; for instance, mobile data use flows into commercial districts in cities during business hours. 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.[47]

- *Mobile hotspot use soared.* One nationwide provider found customers were using their mobile devices' hotspots nearly 40% more than average to share those mobile data connections with other devices.[48]

Importantly, America's mobile speeds kept pace and consumers were able to maintain their wireless experience throughout the COVID-19 response. The nation's wireless networks fared well even as providers worked to keep consumers connected, offered more wireless data as demand surged, and provided support to millions of subscribers impacted by COVID-19's economic challenges. Notably, wireless networks in other countries strained to maintain quality and speed.[49] The wireless industry report also noted that:

- *U.S. mobile data speeds kept pace.* In fact, mobile download speeds in the U.S. went up slightly in April[50] and some researchers found that America's wireless networks actually had a "statistically-significant increase in download speeds."[51]

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[47] *Id.* at 3.

[48] *Id.*

[49] *Id.* at 2, 7.

[50] *Id.* (citing Ookla, Tracking COVID-19's Impact on Global Internet Performance (July 2020), https://www.speedtest.net/insights/blog/tracking-covid-19-impact-global-internet-performance/#/United%20States).

[51] *Id.* (citing George S. Ford, Covid-19 and Broadband Speeds: A Multi-Country Analysis, Phoenix Center Policy Bulletin No. 49 at 1 (May 2020), https://www.phoenix-center.org/PolicyBulletin/PCPB49Final.pdf).

- *Consumers satisfied with wireless.* 83% of Americans said their wireless/mobile internet service met their needs.[52]

- *Wireless considered a leader in responding to COVID-19.* Americans viewed the U.S. wireless industry as a leading industry handling COVID-19, alongside hospitals and the technology industry.[53]

The performance by U.S. wireless networks was particularly important for the nearly 20% of Americans who own a smartphone but do not subscribe to fixed broadband at home.[54] These individuals rely on wireless networks without easy access to additional options like Wi-Fi at home to keep them connected, and wireless providers worked hard to meet their connectivity needs. Wireless providers also competed to maintain subscribers during COVID-19. From waiving overage charges and adding data to many wireless plans, to providing service to kids who do not have internet access, and offering free service to front-line health workers, national and regional wireless operators delivered new or enhanced services to millions of wireless consumers.

Of note, the U.S. wireless industry has for years invested hundreds of billions of dollars to strengthen wireless networks, and as a result, wireless providers were already building for America's wireless needs in 2021 and beyond. In addition, with wireless use patterns shifting throughout the day and night due to a COVID-19-driven drop off in commuting times and a surge in telework and video conferencing, the importance of network traffic management became even more important. Wireless network engineers monitored network traffic 24/7 and shifted resources to optimize the network and to ensure connectivity that Americans need to live, work, and learn.[55]

Moving forward, wireless providers will continue to take steps to maintain networks as Americans increase their reliance on wireless service to stay connected, continue learning, and work from home. To provide insight into how networks are performing, CTIA has begun reporting changes in voice and data traffic on a weekly basis.[56] This information draws on the work of engineers at AT&T, T-Mobile, U.S. Cellular, and Verizon who are closely monitoring their networks and making adjustments to address shifting demand.

3.4.3 Cable Network Performance

During the COVID-19 pandemic, the nation's cable broadband networks continued to operate normally to meet subscriber needs. Over 72 million homes and businesses across America subscribe to broadband delivered by cable providers. As millions of subscribers began working from home — engaging in increased use of videoconferencing, distance learning, and streaming in general — cable operators met the increasing demand.

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[52] *Id.* at 4 (citing Morning Consult Survey, May 2-3, 2020 (2200 adults nationwide)).

[53] *Id.* (citing HarrisX COVID-19 Daily TMT Consumer Pulse Survey (Apr. 4, 2020)).

[54] *Id.* (citing Pew Research Center, Internet & Technology, *Mobile Fact Sheet* (June 12, 2019), https://www.pewresearch.org/internet/fact-sheet/mobile/).

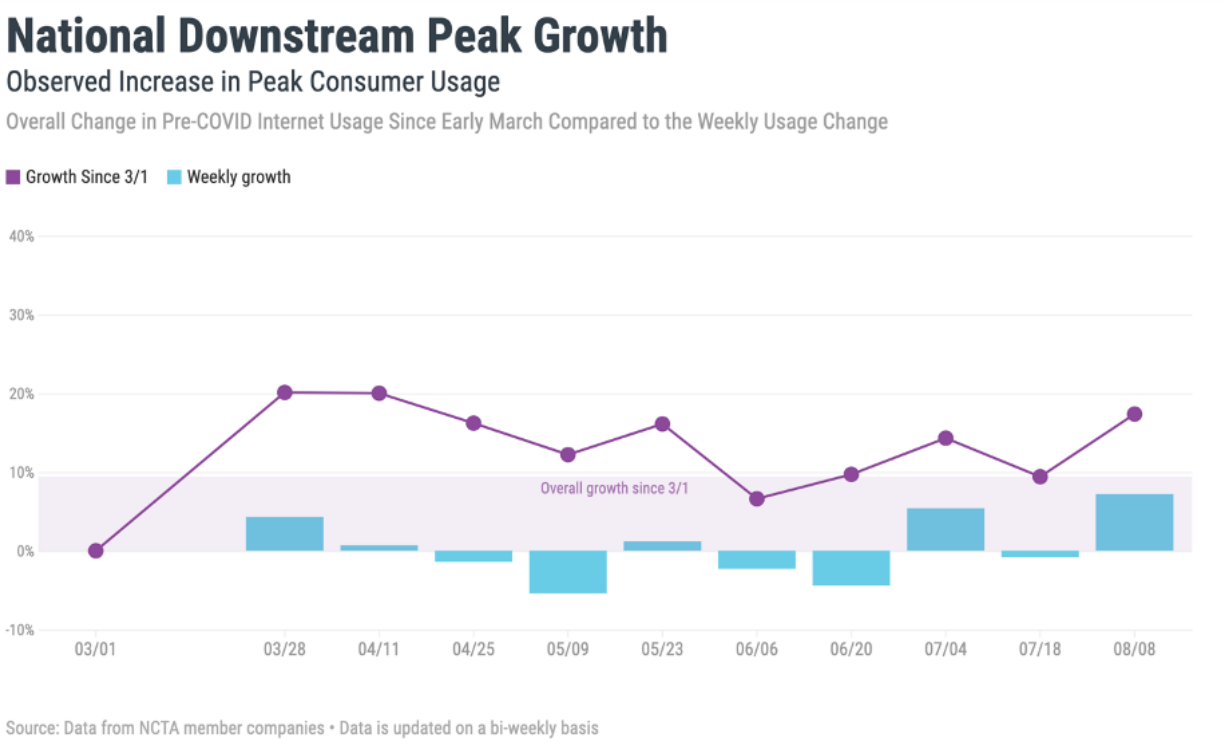
[55] *Id.* at 4-5 (noting wireless industry investment in strong and resilient networks and network management efforts).

[56] *See The Wireless Industry Responds to COVID-19*, CTIA CHANNEL (July 30, 2020) ("To provide insight into how these networks are performing, CTIA is now reporting changes in voice and data traffic on a weekly basis."), https://www.ctia.org/covid-19#network-performance.

As with other network providers, cable operators worked around the clock to maintain robust service quality and to ensure that consumers stayed connected. Engineers and technicians continuously monitored the demands placed on the networks, and when isolated issues arose during the initial months of COVID-19, operators already had processes and tools in place to ensure that they were quickly addressed. As a result, cable broadband networks provided excellent service, and continue to perform well in the face of COVID-19, despite changes in online activity.

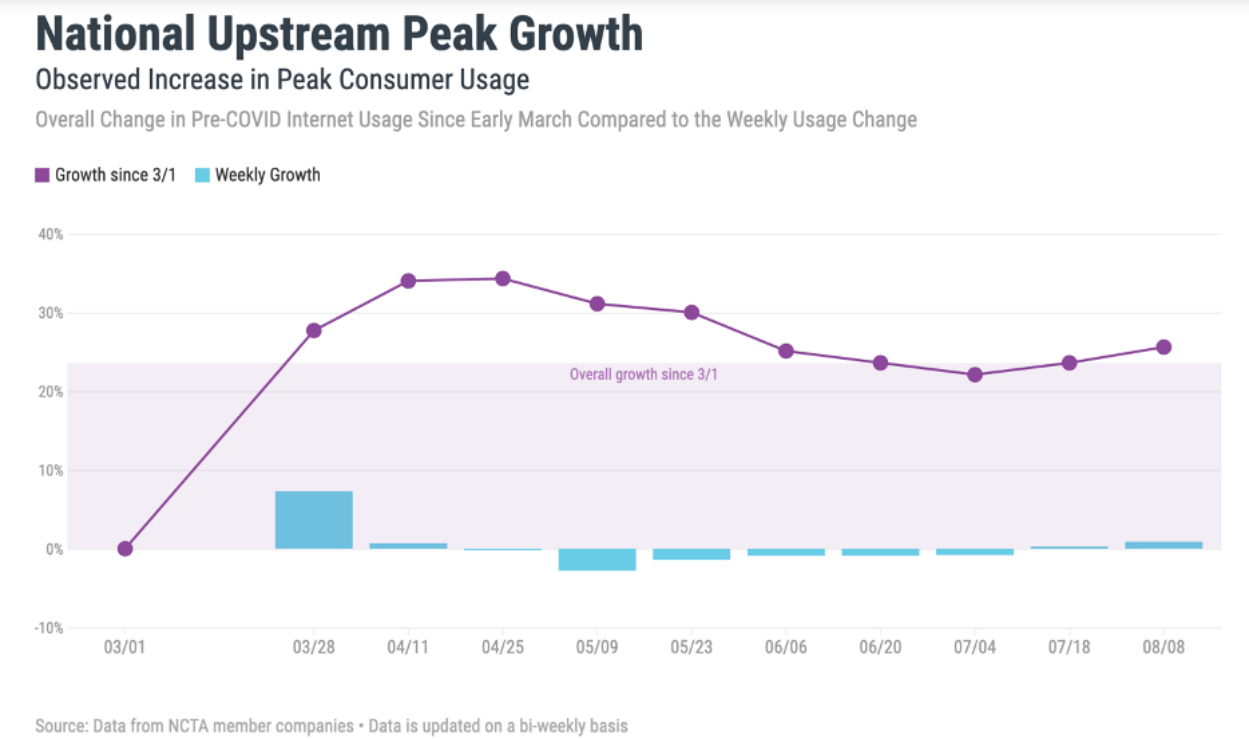
To better understand how consumer demand affected network usage and performance, NCTA members and other cable providers joined together to report key metrics in a COVID-19 dashboard to inform the public regarding usage trends and network performance.[57] The dashboard shows that in the early weeks of the pandemic, downstream peak traffic utilization grew 20.1% before slightly declining in early summer. Overall, since March 1, national downstream peak utilization has been up 9.1%. Similarly, upstream peak utilization initially surged 35.1% before declining slightly this summer, yielding an overall national upstream peak utilization up 22.1% since March 1.

NCTA's COVID-19 dashboard demonstrates that the networks continued to provide optimum performance during this time period. Two charts are shown from that data that illustrate changes in peak upstream and downstream utilization observed by NCTA member companies and other cable providers.[58] The purple line illustrates the net change in peak utilization since March 1, 2020 while the blue bar shows the week-over-week change.



[57] *Covid-19: How Cables' Internet Networks Are Performing Metrics, Trends &* Observations, NCTA https://www.ncta.com/COVIDdashboard (last visited Sept. 23, 2020).

[58] *Id.*

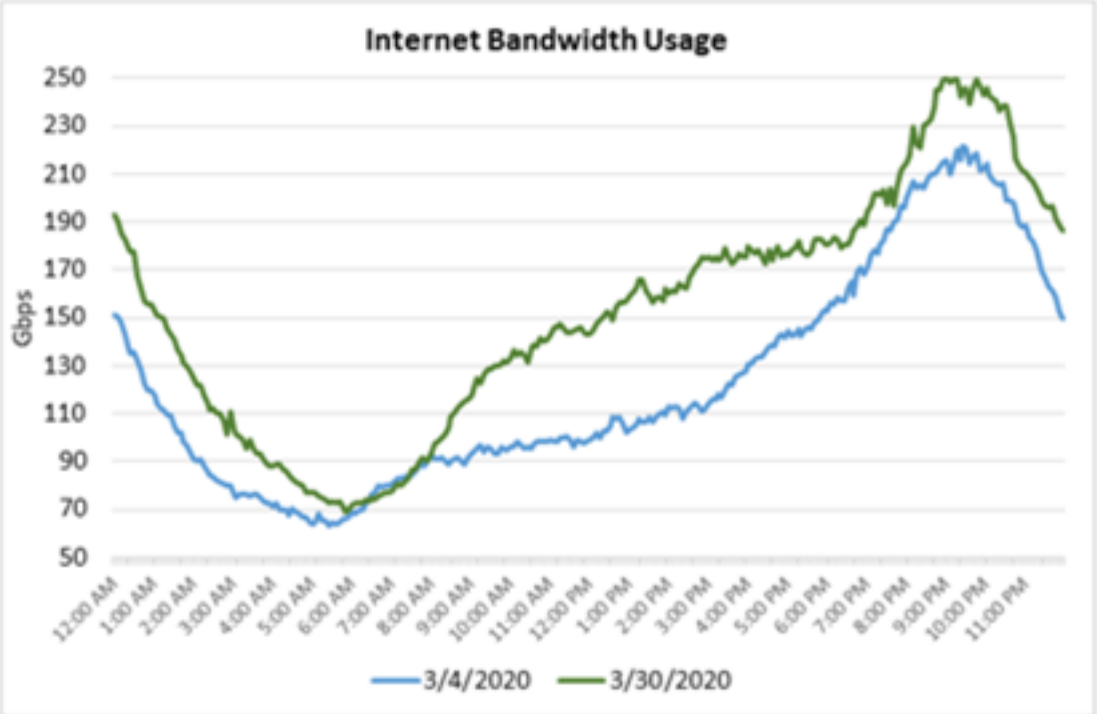


Cable networks are engineered to provide superior performance throughout the day, so measuring demand during times of peak usage is useful in making sure that consumers experience robust connections when traffic is heavy as well as when traffic is light. Wi-Fi data traffic and Wi-Fi calling increased as broadband networks continue to support the offload of mobile data traffic.[59] During the COVID-19 pandemic, the nation's cable broadband networks continued to operate normally to meet subscriber needs.

3.4.4 Wireline Broadband Network Performance

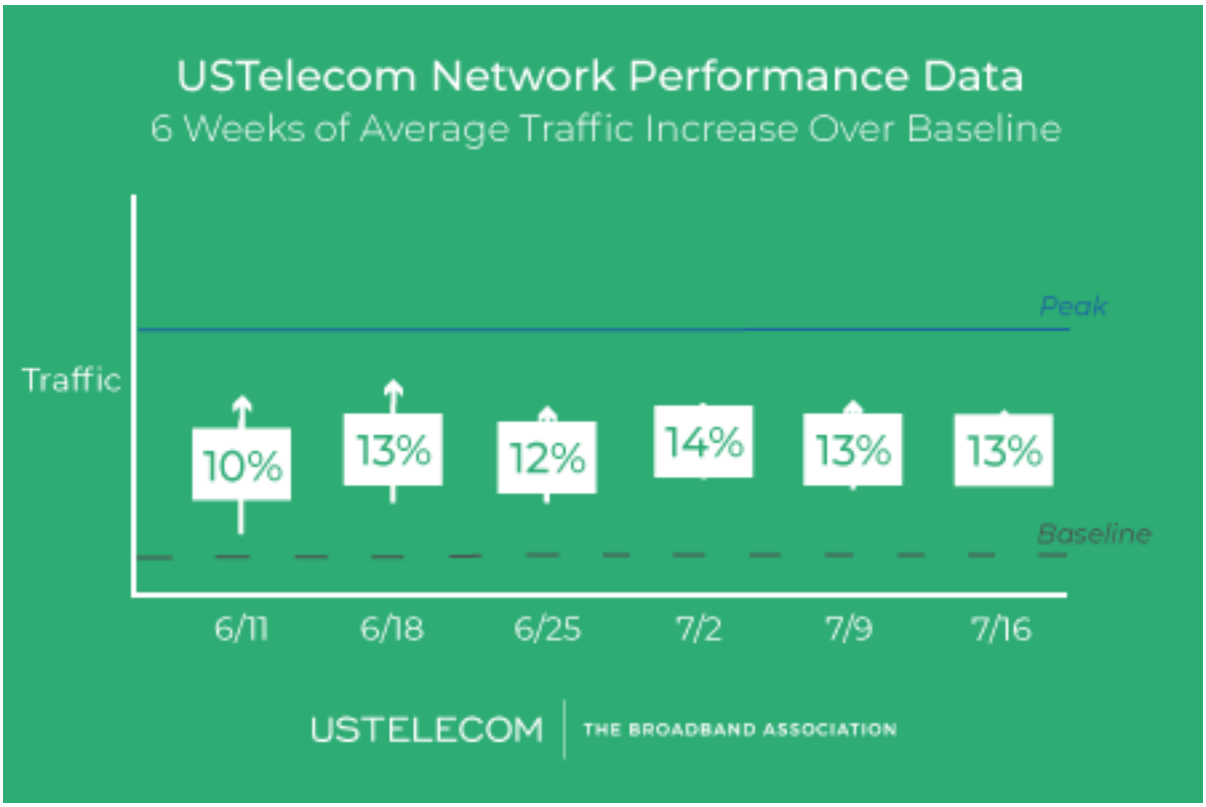
The pandemic significantly increased traffic across fixed residential networks, especially in the upstream direction, as family members who were previously at work and school stayed at home. EPB, a provider in Chattanooga, Tennessee, shows a representative example of this surge in the graph below comparing 24 hours of aggregate internet traffic over its network on March 4 before most Americans had shifted to working and studying from home, and March 30, after its customers began staying home in response to the pandemic.

[59] *Covid-19 Network Update*, COMCAST (May 20,2020), https://corporate.comcast.com/covid-19/network/may-20-2020.



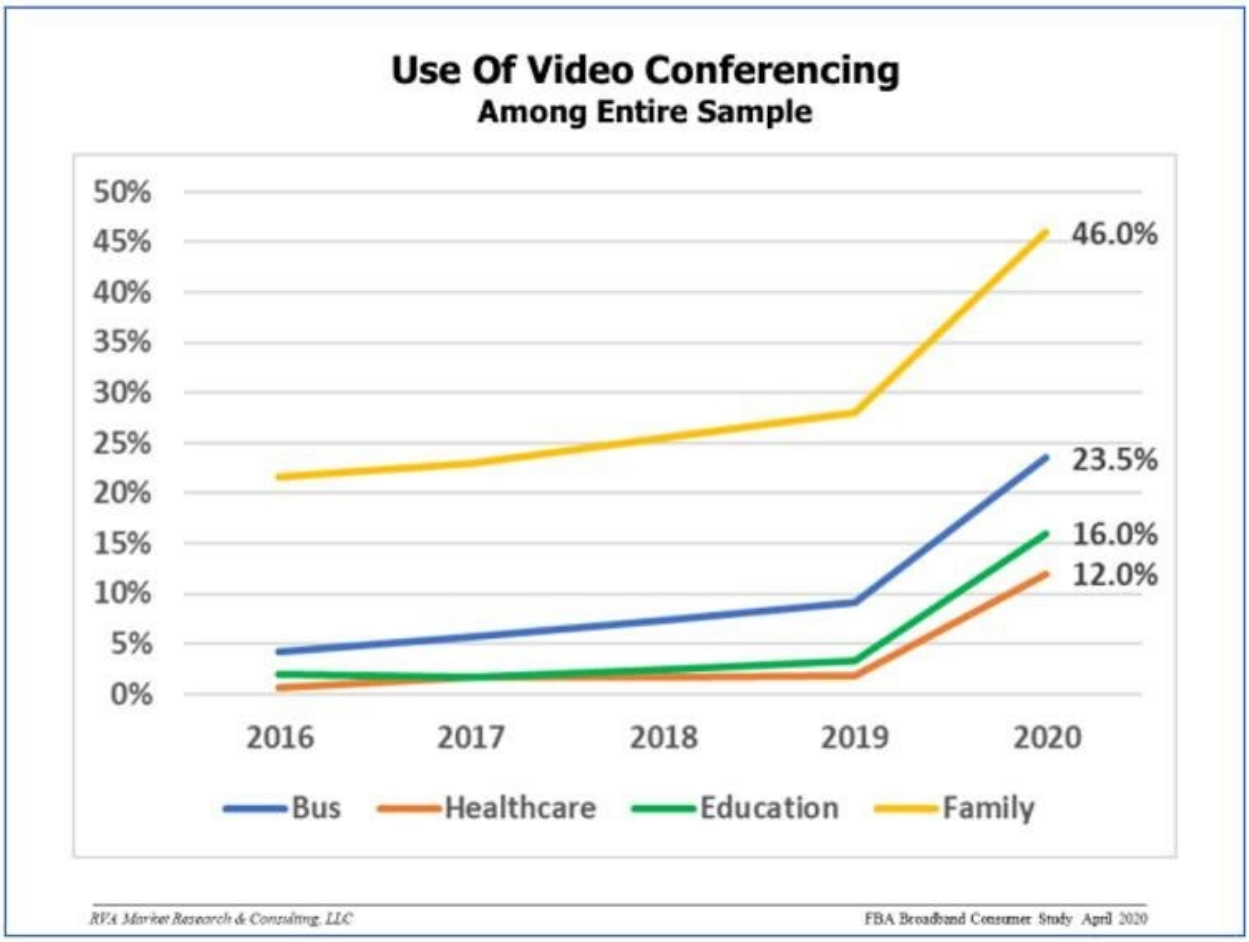
US Telecom and its members closely monitored network traffic growth on broadband networks during the COVID-19 crisis as the internet has emerged as the central means of keeping Americans connected. The resulting data[60] showed traffic increases over baseline reaching a high of 27% on April 16. Usage has since backed off of that peak, as shown in the chart below, with June and July usage ranging from 10% to 14% over the pre-COVID-19 baseline.

[60] *Network Performance*, USTELECOM, https://www.ustelecom.org/research/network-performance-data/ (last visited Sept. 23, 2020).



Fiber networks, with their high capacity, performed well and were able to easily absorb spikes in network traffic to meet these challenges quickly and with little interruption. As the chart below demonstrates, video conferencing from home nearly doubled during the pandemic.[61] Due to the symmetric nature of fiber, users reported neither degradation in the upstream nor bandwidth constraints. Because of characteristics of high bandwidth, reliable uptime and low latency, fiber networks' overall performance delivered full definition for at-home work and school experiences as well as video platforms, telemedicine, and other applications. In addition, many fiber-based providers, especially in rural and low income areas, were able to leverage the capacity of their networks to turn up service to new medical clinics, neighborhoods, and other places swiftly and enable more people to get online faster.

[61] FBA Pandemic Broadband Usage Study at 5.



Similarly, during the first month of the pandemic, INCOMPAS' fiber members saw a 25% increase in residential network bandwidth usage during the day compared to usage prior to COVID-19 disruptions.[62] Streaming and internet traffic increased during the pandemic. As the chart below demonstrates, streaming minutes increased significantly during the first month reflecting more Americans are working from home via video conferencing tools, moving to online groceries delivered through Amazon, getting health news via Twitter, connecting with loved ones over Facebook, or staying home with Netflix.

Like other network operators, rural broadband providers saw significant changes in their traffic patterns. From March 13 through March 31, NTCA members indicated on average their networks experienced:

- 23% increase in overall downstream bandwidth demand
- 24% increase in overall upstream bandwidth demand
- 21% increase in peak downstream bandwidth demand
- 21% increase in peak upstream bandwidth demand

[62] *Competition: We're BUILT for This: Broadband and Voice Network Performance During COVID-19 Crisis*, NETWORK PERFORMANCE, https://www.incompas.org/networkperformance (last visited Sept. 23, 2020).

Follow-up reports indicated that demand stabilized and even retrenched slightly after the initial few weeks following the declaration of a national emergency (although they were still higher than prior to the emergency); specifically, when asked about demand increases from March 13 through April 30, NTCA members reported on average:

- 20% increase in overall downstream bandwidth demand
- 17% increase in overall upstream bandwidth demand
- 15% increase in peak downstream bandwidth demand
- 17% increase in peak upstream bandwidth demand

NTCA noted 93% of respondents indicated no material shift in peak utilization windows, but nearly all respondents stated that the average utilization of their networks was much higher over the course of the entire day.

Finally, NTCA highlighted that more than 40% of respondents reported taking steps to augment capacity on middle mile, transit, or other backhaul connections to anticipate and accommodate increased overall demand, but there were no reports of congestion or disruption arising out of the increased demand.

4 Broadband User Preparedness and Response

In its first charge to the DRRWG, the Commission asked for review and recommendations with respect to "[t]he challenges associated with shelter-in-place and stay at home environments." In the Commission's second charge, the Working Group was tasked with identifying "[u]seful responses to a mass teleworking scenario, including any steps that can be taken in advance to prepare." In deciding how to address the Commission's five charges, the Working Group decided to pair these first and second charges together, given that both implicated the "end user experience." More specifically, taken together, these first two charges require consideration of how requirements to stay at home affected broadband users, what lessons can be learned from these user experiences, and what recommendations might help broadband users interact meaningfully with work, school, and other aspects of society in the face of such limitations in the future.

4.1 Pre-Incident Preparedness and Actions

The relatively sudden onset of the pandemic had varying implications and impacts among broadband users of all kinds — individuals, enterprises, and governments. For example, a shift to teleworking could be more complicated for individuals than it might have initially appeared for a number of reasons. Some workers had space in their home for a dedicated home office or learning area, while others in smaller spaces needed to carve out workspace at kitchen tables or in corners of bedrooms. Importantly for this report specifically, broadband connectivity to the home — and then distribution of broadband connectivity within the home, typically via Wi-Fi — varied in capability and reliability. Moreover, given the simultaneous shutdown of commerce, schools, and government, many home locations needed to support simultaneous broadband connections for concurrent users performing multiple functions. Further complicating matters was that some users decided to migrate from their usual home locations to secondary homes, shifting their requirements and connectivity needs to an out-of-the-ordinary, seasonal location. An additional complication still was that, in some cases, a broadband connection may have been available, but the user could not afford to subscribe despite needing to do so for work or other reasons.

Enterprises faced their own preparedness challenges. In some cases, organizations may not have had laptops or other devices for employees to use at home — or they may not have addressed use of personal home computers for work purposes, implicating complexities related to access to proprietary information or even public records access for government workers. Moreover, employers may not have been prepared to support widespread remote access by their workforce in the form of VPN, remote security tokens, and other remote network and capacity issues.

Similar considerations arise in connection with preparation for remote learning. Concerns about the availability of high-speed broadband, the ability to pay for service plans, access to the devices needed to learn remotely, and/or general digital literacy, all present challenges in transition to a learn-from-home environment. Moreover, as with teleworking, schools may not have been prepared in all cases for the strains that a wholesale migration in a very short period to remote learning can place on available bandwidth for the school system itself, cybersecurity practices, and internal network systems and IT infrastructure.

4.2 Pandemic Response

4.2.1 Transitioning to Work-from-Home

The work-from-home decision-making process varies across different governments and businesses. Many companies made decisions to transition to work from home in the first few weeks of March and quickly transitioned their workforce in a matter of days. To reach this decision, organizational leaders considered:

- Guidance from the CDC and state or local medical officials
- Governor or other state/local stay at home mandates
- Restrictions or limitations imposed by its landlord or building complex
- Location and logistics needs of the physical plant (e.g., the need for mass transit use by employees, use of common elevators and lobbies and stairwells)
- Availability of school and day care options; many employees simply had no realistic childcare options, driving work-from-home decisions from the "ground up" for many employers

While the initial transition to telework may have been rapid, one significant way the COVID-19 pandemic has differed from other recent disasters is its long and indefinite duration. Most disaster events last hours or a few days — perhaps a week at times — and the restoration duration is fairly predictable after assessment of the initial incident. Thus, when workers are sent or forced to stay home, there is a fairly good idea of the time horizon for a return to the office (e.g., when power is restored to an office building). But COVID-19, with no clearly defined timeframe yet for "restoration" and full resumption of the "normal course of business," left service providers, other kinds of businesses, governments, and organizations with little directly applicable experience on which to draw. Unquestionably, when organizations' leaders were considering the need to ask employees to work from home, few anticipated that major employers would subsequently announce that employees might not return to the office for an additional year.

The transition to large-scale telework also brought unique cybersecurity risks to enterprises.[63] Teleworkers generally connect over a home Wi-Fi or ethernet router, while often also using personal computing devices and phones. This "Bring Your Own Device" (BYOD) environment lacks the focus and discipline of regular system updates and patches characteristic of most corporate IT environments – and

[63] *COVID-19 Exploited by Malicious Cyber Actors*, CYBERSECURITY & INFRASTRUCTURE SECURITY AGENCY (Apr. 8, 2020), https://us-cert.cisa.gov/ncas/alerts/aa20-099a.

even well-patched home systems lack enterprise-level firewalls and other cyber threat detection and mitigation systems. In addition to these technical risks, the new telework environment opened up new social engineering opportunities as bad actors sent phishing emails, set up fake websites, and even made phone calls masquerading as company leaders, IT and human resources personnel, or COVID-19-related charitable organizations. To minimize these risks, many enterprises adopted a range of best practices,[64] including (1) adopted layered security controls such as multi-factor authentication and data-at-rest encryption for devices outside of corporate control; (2) conducted telework-specific training on best practices to mitigate cyber threats and remote work risks; and (3) carefully balanced operational needs and enterprise capacity with appropriate secure connections such as VPNs, portals, and cloud services for end users.

COVID-19 created a range of unique challenges to the public safety community, particularly in terms of working remotely or from home to enable social distancing in ordinarily densely spaced Emergency Communications Centers (ECCs).[65] E-9-1-1 call taking and communication with first responders requires priority access to network resources to ensure reliable connectivity without delay even during times of possible congestion. There are examples of ECCs that have proactively taken steps to utilize prioritized public safety networks to enable their staff to receive 9-1-1 calls from remote locations thereby freeing up space in the ECC[66] and providing a safer environment while still delivering an essential emergency service. To further assist ECCs in adapting to the pandemic environment, DHS/CISA released a set of guidelines to support public safety partners across all levels of government in developing plans and actions regarding governance, procedures, staffing, and cleaning and disinfecting in response to a pandemic.[67]

4.2.2 Deciding If, How, and When to Return to Work

Many businesses have announced criteria for if, how, and when they will allow employees to return physically to the office during the COVID-19 emergency, and the CDC has issued guidelines on this

[64] Karen Scarfone, Jeffery Greene & Murugiah Souppaya, *Security for Enterprise Telework, Remote Access, and Bring Your Own Device (BYOD) Solutions*, NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (Mar. 2020), https://csrc.nist.gov/CSRC/media/Publications/Shared/documents/itl-bulletin/itlbul2020-03.pdf.

[65] The Working Group notes that an "Emergency Communications Center" or "ECC" is a facility with capabilities that include intelligence collection and monitoring, 9-1-1 multimedia traffic processing, full scale dispatch, and incident command capabilities. The rules and regulations of the FCC often use the term "Public Safety Answering Point" or "PSAP." The literal language of the term "Public Safety Answering Point" has become outdated in a broadband environment, as 9-1-1 centers are increasingly and appropriately being called ECCs. The term Emergency Communications Center is indicative of the increased workload that a Public Safety Telecommunicator ("PST") faces as the 9-1-1 industry increasingly receives and processes more information.

[66] Lori Stone, *City of Alexandria, VA Utilizes FirstNet for 911 Remote Call Taking During Pandemic*, FIRSTNET (May 5, 2020) https://firstnet.gov/newsroom/blog/city-alexandria-va-utilizes-firstnet-911-remote-call-taking-during-pandemic.

[67] *Emergency Communication Pandemic Guidelines*, CYBERSECURITY & INFRASTRUCTURE SECURITY AGENCY, https://www.cisa.gov/emergency-communications-pandemic-guidelines (last visited Sept. 24, 2020).

topic.[68] Generally, the CDC has outlined engineering controls, administrative controls, and personal protective equipment (PPE) for employers to consider to help prevent the spread of COVID-19 in the workplace. The CDC also noted that those businesses seeking to resume normal or phased business operations should consider:

- Conducting daily health checks
- Conducting a hazard assessment of the workplace
- Encouraging employees to wear cloth face coverings in the workplace, if appropriate
- Implementing policies and practices for social distancing in and cleaning of the workplace
- Improving the building ventilation system

Additional factors must be considered as part of a return to work, especially in enterprises that are customer-facing. These include limitations on the number of visitors in the office, limitations or restrictions on meetings, the installation of dividers between workstations and sanitizer dispensers, and PPE for employees. Many businesses are also posting notices in office to remind their employees to follow the guidelines and/or public explanations of the steps they are taking to help prevent the spread of COVID-19. Such methods may help alleviate any fears for customers and other visitors regarding safe work practices and instill a sense of trust that the business will be able to operate and perform effectively in meeting customers' needs despite the pandemic.

As one example of return-to-work execution, a Washington D.C.-based association management firm asked employees to start returning to work in person in September 2020 but only at 25% capacity at a time — setting out a schedule for who could be in the office when to maintain social distancing. Moreover, the firm implemented other aspects of the CDC guidance for its employees in the new in-person work environment, including a requirement that masks be worn in the office; social distancing; limitations on the number of employees that can be located at the same time in elevators, conference rooms, and other common areas; increased and more frequent cleaning processes especially on high-touch areas; restrictions on office visitors; specified traffic flow throughout hallways and common areas; new clear signage announcing all changes/processes; and modifications to monitoring of building fresh air intake.
As another example, one tribal entity told its businesses that, when looking at whether employees should come back to the office, they should ask questions such as:

1) State/Local Community Status – Is our state/local community considered a "hot zone" or "closed for business"?
2) COVID-19 14 Day Trend – Looking at the 14-day trend of a 7 day-average, are we seeing an increasing trend in the number of cases within our state/local communities?
3) ICU Bed Availability Forecast – Does the forecast of available ICU/critical care beds show availability?

The tribal entity also made clear the need to protect employees at a greater risk (e.g., those with underlying health conditions or of higher age). Such individuals are being provided administrative leave or the ability to continue to work remotely.

[68] *Interim Guidance for Businesses and Employers Responding to Coronavirus Disease 2019 (COVID-19),* CENTER FOR DISEASE CONTROL AND PREVENTION (May 6, 2020), https://www.cdc.gov/coronavirus/2019-ncov/community/guidance-business-response.html.

Meanwhile, some companies such as Google, Sony Music, and Amazon Corporate have told their employees to not return to their offices until 2021.[69] Other companies, such as Twitter, have given employees the option to telework permanently.[70] Relatedly, given the long cycle of work-from-home anticipated for many, there are increasing signs of a systematic shift in employers' perspectives regarding the amount of office space needed to accommodate a changed workforce. It is possible that some significant portion of the employees who are currently working from home may never return to the office or at least not on a full-time basis. There may be significant effects from this paradigm shift, including effects on commercial real estate, transit and commuting patterns, and even the environment.

4.2.3 Remote Learning

During the pandemic, the need for a multi-modal approach to remote learning that capitalizes on existing infrastructure, innovative programs, and a combination of different learning mediums has become apparent. The World Bank Education Global Practice articulates the following[71] when it comes to executing effectively with respect to remote learning:

- **Develop a short- and long-term remote learning plan** that considers each educational system's capacity and resources to support a multi-faceted remote learning model, including a combination of technologies and delivery mechanisms. Policymakers should consult outside stakeholders, like ministries, broadcast regulators, and companies, to determine what resources are available for remote learning.
- **Implement a radio/television broadcast remote learning model** in contexts where broadband access is not widely available or where online learning is simply not a viable option; these mediums can be paired with other learning materials such as text messaging and digital downloads.
- **Increase access to digital resources** by partnering with mobile operators, telecom providers, and non-for-profits to increase access to digital resources.
- **Provide a consolidated, one-stop-shop to access content** that lists available content, tools, applications, and platforms, together with supporting materials and guidance for students, teachers and caregivers.
- **Make content available through a variety of devices** that run on a variety of operating systems and software applications.
- **Create a virtual helpdesk to support caregivers, teachers, and students**, enabling students and caregivers to ask questions, share feedback and communicate.

Moreover, while at first glance the migration to home-based learning environments might seem to relieve strains on bandwidth at schools themselves, remote learning has put greater pressure on the IT systems and bandwidth that schools need to provide their services for so many more remote users. As

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[69] *See* Alexis Beneveniste, *These Companies are Working from Home Until 2021 – or* Forever, CNN (Aug. 2, 2020), https://www.cnn.com/2020/08/02/business/companies-work-from-home-2021/index.html.

[70] *See* Rachel Sandler, *Twitter to Allow Employees to Work from Home After Coronavirus*, FORBES (May 12, 2020), https://www.forbes.com/sites/rachelsandler/2020/05/12/twitter-to-allow-employees-to-work-from-home-after-coronavirus/#54366eea3e9f.

[71] The World Bank Education Global Practice, *Guidance Note: Learning & COVID-19* (Apr. 7, 2020), http://documents1.worldbank.org/curated/en/531681585957264427/pdf/Guidance-Note-on-Remote-Learning-and-COVID-19.pdf.

such, if possible, schools may consider upgrading IT infrastructure by either adding more resources (e.g. bandwidth, VPN connections, servers, etc.) or moving to a cloud-based environment that more readily supports dynamic sizing to meet ever changing demands. Regardless, bandwidth needs should be assessed regularly.

Of course, broadband availability and adoption are important as well to make for successful remote learning. For some availability issues, parties made efforts to stand up public Wi-Fi hotspots for students in need, requiring students to drive to parking lots outside of libraries or schools to perform schoolwork, which was not an effective long-term solution to digital learning. As in the case of teleworking, deploying broadband to more American households, and increasing broadband adoption by households where it is available, must be seen as an essential part of a comprehensive strategy for remote learning during a pandemic.

Finally, much as in the context of teleworking, the number of teachers and students suddenly teaching and learning at home has raised several cybersecurity vulnerabilities to school districts and educational institutions. Law enforcement agencies have warned that school networks are widely considered to be the most vulnerable to attack of any large networks. Specifically, in the last few months during the pandemic, the Federal Bureau of Investigation issued warnings about ransomware,[72] unwanted intrusion by outsiders on distance learning sessions,[73] student data privacy concerns[74] and other overall security concerns due to the amount of student sensitive data held by educational institutions and the lack of defense mechanisms in place to ward off attacks.[75] Not only can more devices introduce more security risks, but schools often set up to tunnel all traffic back from students and teachers through the school network before it goes to the internet — so even where such capabilities exist, they may not be robust enough to accommodate all of the increased data traversing the VPNs. It is important to note that CISA specifically advises to use a split VPN tunnel to reduce this risk.[76]

4.2.4 Communication with Stakeholders

Good emergency management includes timely communication with key stakeholders — in this case, employees, students, or other stakeholders. Organizations should have an *emergency communications plan* that provides guidelines, contact information, and procedures for how information should be

[72] Catalin Cimpanu, *FBI warns K-12 schools of ransomware attacks via RDP*, ZERO DAILY (June 25, 2020), https://www.zdnet.com/article/fbi-warns-k12-schools-of-ransomware-attacks-via-rdp/.

[73] Kristen Setera, *FBI Warns of Teleconferencing and Online Classroom Hijacking During COVID-19 Pandemic,* FBI (Mar. 30, 2020), https://www.fbi.gov/contact-us/field-offices/boston/news/press-releases/fbi-warns-of-teleconferencing-and-online-classroom-hijacking-during-covid-19-pandemic.

[74] Elie Zimmerman, *FBI Issues Warning for K-12 Schools on Student Data Privacy*, EDTECH (Sept. 21, 2018), https://edtechmagazine.com/k12/article/2018/09/fbi-issues-warning-k-12-schools-student-data-privacy.

[75] Adinah Brown, *Schools on Red Alert After FBI Issues Cybersecurity Warning,* DEEPINSTINCT (Aug. 6, 2020), https://www.deepinstinct.com/2020/08/06/schools-on-red-alert-after-fbi-issues-cybersecurity-warning/.

[76] *Alter (AA20-073A) Enterprise VPN Security*, CYBERSECURITY & INFRASTRUCTURE SECURITY AGENCY (Mar. 13, 2020), https://us-cert.cisa.gov/ncas/alerts/aa20-073a.

shared during all phases of an unexpected occurrence that requires immediate action.[77] Communications must be inclusive and accessible to people with disabilities and, in many cases, multi-lingual.[78] At a minimum, such a communication protocol should:

- Be created and managed by a crisis communication task force;
- Identify who must be included in the hierarchy/chain of communication with roles mapped out in advance and with updated primary and secondary contact information of the participants;
- Determine when and what type of information will be shared with those in the communication chain; and
- Identify the platforms that will be used to convey the messages.

Because of the long-term nature of the COVID-19 pandemic, communications can be tailored to the medium that will be most effective in reaching all stakeholders, but the communication generally should be frequent with simple messages and updates and allow for two-way dialogue. Surveys and assessments can be sent to stakeholders to confirm that the information is communicated correctly and that every stakeholder receives and understands it; the surveys can help to address any gaps in the communication processes.

Effective communications must also guide toward credible sources, such as the CDC or state or local health officials, for accurate up to date information on the pandemic. Stakeholders are also helped most effectively when the organization can serve as a communication facilitator for non-work-related issues that affect employee well-being and productivity, like local resources for food supplies, childcare, or medical facilities, etc.[79]

4.3 Recommendations/Best Practices Related to End-Users

4.3.1 Take Steps to Improve Broadband Availability

Expanding the availability of high-quality broadband service at affordable rates has been a national goal for many years. Over the past decade, the FCC has updated all four of its universal service programs to reorient them for a broadband focus and has distributed billions of dollars to help make the business case for network investment and thereby connect and keep connected millions of Americans. Similarly, the U.S. Department of Agriculture (USDA) has distributed billions of dollars over many years to finance the construction of broadband-capable networks in some of the most rural parts of the United States through its various telecommunications programs, including the ReConnect initiative created in the past few years. Even with this progress, however, the pandemic has shown that too many Americans still do not have the broadband they need to work and learn at home.

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[77] Margaret Rouse & Paul Crocetti, *Emergency Communications Plan (EC Plan)*, SEARCHDISATER RECOVERY TECHTARGET (Jan. 16, 2020), https://searchdisasterrecovery.techtarget.com/definition/emergency-communications-plan-EC-plan.

[78] *COVID-19 Pandemic Operational Guidance for the 2020 Hurricane Season*, FEMA (Mar. 2020), https://www.fema.gov/media-library-data/1589997234798-adb5ce5cb98a7a89e3e1800becf0eb65/2020_Hurricane_Pandemic_Plan.pdf.

[79] *See also* Johanna Schneider, *Tips for Communicating to Employees During a Disaster*, BUSINESS ROUNDTABLE, https://www.businessroundtable.org/archive/media/news-releases/tips-for-communicating-to-employees-during-a-disaster (last visited Sept. 23 2020); Jen Ciraldo, *5 Actionable Tips for Communicating with Employees During a Crisis*, BEEKEEPER (Aug. 13, 2020), https://www.beekeeper.io/blog/5-actionable-tips-for-communicating-with-employees-during-a-crisis/.

Even as the FCC prepares to conduct its first Rural Digital Opportunity Fund auction later this year and the USDA continues to award loans and grants through ReConnect and other programs, it is clear that these mechanisms will not reach all of the Americans in need of broadband connectivity – and waiting decades to obtain broadband does not offer significant promise for those in need of better service now. The Fiber Broadband Association cost study found that it would cost $70 billion over a decade to reach the majority (90%) of the U.S. households with fiber.[80] Even assuming a mix of less costly broadband deployment technologies, more funding is clearly needed to complete the job in a timely and effective manner.

The most obvious and immediate means of infusing the necessary capital to address these availability challenges is for Congress to appropriate the additional funds needed to deploy broadband in unserved areas in a timely manner. A variety of proposals have been introduced to make substantial amounts of funding available, upwards of $80 to $100 billion, including proposals with bipartisan and bicameral support. Action on proposals such as these will be critical to help deploy and sustain broadband networks in rural areas where to date the economics of low density and long distances have precluding ensuring Americans have equitable access to online opportunities.

4.3.2 Take Steps to Improve Broadband Adoption

While broadband internet adoption has grown steadily over the last two decades, the pandemic highlighted a significant segment of the population that does not, and may be unable to, subscribe to broadband even where it is available. The economic crisis arising out of the COVID-19 pandemic, with a high of over 20 million Americans unemployed as of April, has only exacerbated such concerns.

The Pew Research Center recently estimated that 10% of U.S. adults still do not use the internet,[81] finding that internet non-adoption is linked to demographic variables including age, educational attainment, household income, and community type. Importantly, this metric has been heading steadily downward over time, falling from 48% in 2000, down to 10% in 2019, and falling across demographic variables. According to an April 2019 report from the National Telecommunications and Information Administration (NTIA), 22% of U.S. households, approximately 28 million households, still do not use the internet from home.

Closing the broadband adoption gap must be viewed as a critical component of achieving universal broadband. Paired with the efforts of service providers, a government focus on promoting broadband adoption can dramatically increase the number of households across the country participating in the educational, health care, civic, and commercial opportunities made available by internet access – functions that are particularly important when telework and remote learning are prevalent in the face of the pandemic.

Studies have shown that there are a variety of reasons why someone does not subscribe to already available broadband service — including, in roughly equal part: a lack of relevance, digital literacy, or the cost of service or a computing device.[82] Accordingly, as policymakers formulate programs to promote broadband adoption, a robust variety of programs and approaches should be considered,

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[80] FBA, *All-Fiber Deployment Cost Study 2019* (Sept. 10, 2019), https://www.fiberbroadband.org/d/do/3748.

[81] Monica Anderson, Andrew Perrin, JingJing Jiang & Madhumitha Kumar, *10% of Americans Don't Use the Internet. Who Are They?*, PEW RESEARCH CENTER (Apr. 22, 2019), https://www.pewresearch.org/fact-tank/2019/04/22/some-americans-dont-use-the-internet-who-are-they/.

[82] *Id*.

rather than a solution that only addresses one prong of the challenge. Importantly, programs should include education, outreach, awareness, training, and equipment, and should include partnerships with both providers and key community anchor institutions such as schools, libraries, and agencies serving vulnerable populations.

To tackle more specifically affordability concerns, Congress and the FCC should examine ways to enhance and improve the workings of the Lifeline program and/or consider supplementing that program through appropriated measures that would provide broadband benefits for more lower-income consumers adversely affected by the economic crisis arising out of the COVID-19 pandemic. Areas identified for review would be to consider how the program might be improved to allow participation by more broadband providers, streamlined to remove providers from verification processes, and how to implement a more direct consumer benefit structure.

4.3.3 Implement Distance Education Best Practices

To be prepared for and to respond effectively to a disaster such as the COVID-19 pandemic in the future, schools must make assessments among students and teachers of their access to high-speed broadband and digital devices and their ability to pay for service plans. One recent example of this is an initiative between NCTA, NTCA, USTelecom, and EducationSuperHighway to identify and fill connectivity gaps for K-12 school students in low-income families throughout the country so they can benefit from remote learning.[83] The wireless industry is also committed to connecting America's students, including through CTIA's Connecting Kids Initiative, a resource for schools and school districts to help keep kids learning in these unprecedented times.[84] Similarly, EPB, a provider in Chattanooga, recently announced it will work with local non-profits to provide Internet access for 100% of low-income children (measured by free and reduced lunch) in the county going forward.[85] School systems should develop short- and long-term remote learning plans that consider their educational system's capacity and resources to support a multi-faceted remote learning model, including a combination of technologies and delivery mechanisms. As part of this exercise, schools should create an inventory of existing content to be deployed via remote learning focusing on available/existing content and aligning it to the curriculum.

In addition to the core mission of teaching, in a remote learning environment, schools will be compelled to help students overcome technical and access challenges. Among measures that school systems should consider to aid in these functions is: (1) creating a "help desk" to support caregivers, teachers, and students to ask questions, share feedback, and communicate; (2) finding alternate methods – such as printed material and study guides, reading lists, radio, and television broadcasts – where students have limited technology or where broadband access is not widely available for online learning; (3) seeking out partnerships with non-profits, service providers, and other entities for access to internet service, discounted service plans or other arrangement to promote adoption, and as a source of computers, tablets and other digital equipment; (4) ensuring adequate VPN and other IT capabilities are in place to

[83] *Chairman Pai Welcomes Connectivity Initiative for K-12 Remote Learning*, News Release (2020), https://www.fcc.gov/document/chairman-pai-welcomes-connectivity-initiative-k-12-remote-learning; *see also, K-12 Bridge to Broadband,* DIGITALBRIDGEK-12, https://digitalbridgek12.org/k-12-bridge-to-broadband-program/ (last visited on Sept. 23, 2020).

[84] *Connecting Kids Initiative*, CTIA, https://www.ctia.org/the-wireless-industry/connecting-kids-initiative (last visited on Sept. 23, 2020).

[85] Monique Brand, *EFB to Provide Internet for Hamilton County Schools Students at No Charge for Low-Income Families*, TIMESFREEPRESS (July 29, 2020), https://www.timesfreepress.com/news/local/story/2020/jul/29/epb-provide-internet-hamiltcounty-schools-stu/528574/.

handle greatly increased remote student and teacher access; and (5) identifying federal, state, and local programs that can at least temporarily improve access to broadband where a more robust network cannot be immediately deployed, such as Wi-Fi hotspots and Wi-Fi on buses.

4.3.4 Implement Virtual Workforce Best Practices

For businesses and governments to function most effectively and protect employees and customers in the face of a pandemic or similar disaster incident, these entities should consider and address these aspects of managing the virtual workforce:

Staff/Personnel

- Establish an organization-wide plan or guidelines to assure both employee and customer safety including teleworking options, reduced travel, and the use of PPE by staff in all interactions with others;
- Regular communication between leadership and staff to cover related updates; e.g., bi-weekly or monthly check-up calls;
- Require employee participation in training sessions or presentations to review company protocol/changes (either in person or virtually); and
- Assign a contact person or task force for handling emergency response to the crisis, customer questions, and/or reviewing new policies.

Technology

- Work with broadband providers to ensure sufficient enterprise bandwidth capabilities and protected VPN server access on the business side to maintain day-to-day operations;
- Consider options to facilitate necessary broadband requirements for work-from-home employees;
- Provide necessary technology to ensure remote use for employees including laptops, monitor screens, tablets, cell phones, and other devices;
- Assign key contact personnel for virtual IT assistance; and
- Implement network safeguards to mitigate security threats and allow employees to use encrypted passwords for sharing information electronically.

5 Municipal Permitting Preparedness and Response

5.1 Pre-Incident Preparedness and Actions

Taking into account different sizes of and resources available to local governments, the following considerations and actions may help local governments prepare for a pandemic or similar emergency that requires a mass teleworking scenario:

- **Continuity of Public Meetings:** Municipalities should be prepared, consistent with applicable state laws, to continue holding public meetings without access to municipal buildings. Consider how to allow for public participation via telephone or a chat function for video conferences, providing toll-free dial-in access if needed, including how to recognize and give the floor to members of the public who are not in person; control background noise, securing the meeting so that participation is controlled and authorized participants can speak, allow for participation in video conferences by those without broadband, and create contingency plans should video conferencing or other technology be inoperable at the time of the meeting. Arrangements may

be needed to present meetings live for cable broadcast. Municipalities also must consider how to record and archive meetings if and as required.

- **Hardware Deployment Preparation:** Consider if/how/which staff members will have employer-issued hardware to use for teleworking and, where municipal hardware is not available, whether personal equipment will be used for work purposes. Consider how employee workflow processes will be impacted if they are unable to print/scan/fax from home. During the early stages of the pandemic, many hardware peripherals became difficult to acquire, in some cases because of enforced retail closings, and were out of stock so preparations should be made in advance where possible. Special consideration should also be given to having some arrangement for retail outlets to operate during pandemics, potentially with an appointment system.
- **Remote Access:** Establish a plan for access to municipal networks (e.g., VPNs, tokens) and for sufficient ingress bandwidth to the corporate data center(s) for the higher than normal VPN access with consideration given to the use of split VPNs to avoid disruptions to services and allow consistent connectivity to work materials. Prepare a cybersecurity plan to protect documents and provide network access to only those who are cleared for such access. Municipalities currently without online permitting processes and portals to allow for fully online acceptance, internal routing, review, and issuance of permits should also consider initiating processes to develop such services, including via public/private partnerships with industry stakeholders.
- **Telework Policies and Agreements:** Municipalities can draft telework policies and/or agreements that outline expectations of employees that address, among other issues:
    - Work schedules and availability
    - Production output
    - Response times
    - Working overtime and/or outside usual hours
    - Solution for clocking in and out remotely
    - Working appropriately with material that is subject to public records requests
    - Use of laptops, phones and other equipment necessary for telework
    - Protocols to ensure software updates are processed and guidelines regarding what software may be downloaded on employer-issued laptops
    - Subscribing to broadband and having technical support at a level needed to do their jobs; reimbursement policies regarding broadband plans, data caps, installation costs, etc.
    - Establishing rotating schedules for both presential and virtual work to maintain social distancing in jobsite and avoid burnout at home.
- **Information Sharing:** Government and industry stakeholders should continuously evaluate whether the existing venues and processes for collecting and sharing information (e.g., CISA's NCC, state level EOCs, and the Disaster Information Reporting System (DIRS)) are sufficient or should be adapted to meet the needs of the various stakeholder groups, while protecting the public's interest in protecting the security of communications infrastructure from bad actors and ensuring that consumer privacy and competitively sensitive information are protected. Information sharing processes should be continually developed for sharing of situational awareness among interested stakeholders, including communications providers, power companies, public safety officials, and federal, state, and municipal government stakeholders responsible for disaster preparedness and recovery.

5.2 Pandemic Response

Taking into account different sizes of and resources available to local governments, the following considerations and actions may help local governments continue permitting processes during a pandemic or similar emergency that requires a mass teleworking scenario:

- Assess needs and resources: Identify staff available to address permitting demands; provide them with appropriate resources for continuing permit processes while teleworking or maintaining appropriate social distancing or other safety measures.
- Communicate with stakeholders: Update websites with information about adjustments to permitting processes and contact information for staff designated to address permitting issues. Consider direct communication with providers regarding revised or updated processes where possible.
- Prioritize critical work: Work with applicants to implement a means of documenting essential permits that require expedited processing to address pandemic-related network issues that impact human health and safety, while communicating with applicants on the status of other pending permit applications.
- Address shot clocks: Work with applicants to toll shot clocks on some permits.

5.3 Recommendations/Best Practices Related to Municipal Permitting

The Working Group recommends the following best practices for state, local, and territorial governments and tribes to address broadband permitting challenges, including those caused by the physical closure of municipal offices, a shift to telework for municipal employees, and other complications arising from a pandemic and similar emergencies.[86] The Working Group recognizes that a variety of factors, including the size of and resources available to a municipality, will impact each jurisdiction's ability to implement these best practices and that some suggestions will be infeasible or ineffective in some communities. For example, online permitting may not be a feasible or effective solution for a community that lacks reliable broadband at its municipal offices and/or at employees' homes.

5.3.1 Establish Non-Emergency Permitting Practices that can Transition to Emergency Situations

To the extent possible, non-emergency practices that can easily transition to emergency situations, including telework and office closures, are recommended. For example:

[86] *See, e.g.*, Angelina Panettieri and Nancy Werner, *Keeping Local Permits and Licenses Moving During COVID-19*, NAT'L LEAGUE OF CITIES (May 4, 2020), https://citiesspeak.org/2020/05/04/keeping-local-permits-and-licenses-moving-during-covid-19/ ("identif[ying] some processes local governments have successfully implemented to enable the continued acceptance and processing of permits, as well as considerations for implementing similar processes and additional information related to telecommunications permitting").

- Online permitting processes and portals that allow for fully online acceptance, internal routing, review and issuance of permits;
- Electronic signatures;
- Electronic payment options;
- Identify staff necessary to support the process remotely and ensure that staff has hardware, software and access necessary to continue work; and
- Identify a "champion" or "czar" in the municipality to handle communications with industry, city staff, and other stakeholders (e.g., power company, pole owner) in emergency and non-emergency circumstances.

5.3.2 Identify Necessary Staff and Resources to Transition to Emergency Permitting Processes

Particularly where fully online processes are not available, municipalities should consider establishing plans that provide for the continuation of necessary permitting processes during a stay at home order or other limitations on access to municipal buildings. For example:

- Create a designated email address or portal to receive all permit applications;
- Consider drop boxes for permit applications, payment or other documentation that cannot be submitted online or electronically and designate staff who will check the boxes at appropriate intervals;
- Establish practices for inspections to continue, such as distancing requirements while inspecting or meeting applicants, so that pre- and post-work inspections may occur to verify the pre-construction and as-built conditions;
- Consider working with applicants to request tolling agreements on some permits to suspend applicable shot clocks during the emergency to prevent violations or deemed-granted permits; and
- Identify staff necessary to support any online aspects of the process and ensure that staff has hardware, software, and access necessary to work from home.

5.3.3 Foster Good Relationships and Communications with Other Stakeholders

Preexisting relationships with applicants and clear communication regarding any changes to the permitting processes during an emergency can ease the challenges during an emergency. For example:

- Establish a single point of contact at the municipality for permitting-related issues;
- Canvass city staff at the outset of an emergency to inventory what tasks can and cannot be done; communicate limitations to stakeholders and work to identify alternatives, if possible; and
- Communicate clearly about whether and when any emergency or *force majeure* clauses are in effect; often these types of provisions are not triggered by pandemics and similar emergencies.

5.3.4 Implement Steps Prior to the Pandemic or Related Emergency

The Pre-Incident Preparedness and Actions set forth in section 5.1 above provide suggestions for actions that can be taken in advance to prepare for telework and municipal building closures.

6 Provider Perspectives and Detail

6.1 Pre-Incident Preparedness and Actions

6.1.1 Network Overview

Network providers have invested an enormous amount of capital and technical expertise building flexible and resilient networks. At the backbone level, providers continually monitor their networks from virtual Network Operations Centers. Most providers have tremendous flexibility to add capacity, modify paths, and adjust traffic based on utilization, continually refining approaches minute-by-minute as traffic patterns change. CDNs operated by network providers and platform operators move huge amounts of traffic and cache content closer to the "edge" and the final users, avoiding potential bottlenecks on the core internet. Similar to core networks, CDN operators constantly monitor for potential bottlenecks, moving traffic to less congested routes or increasing capacity on commonly used routes.

Cable ISPs deploy a variety of network topologies including fiber, coaxial cable, and fixed wireless connections to the home. Traditional cable systems are based on a hybrid fiber coaxial network (HFC), that transports signals over fiber into subscriber areas to fiber "nodes." At the fiber node all signals are converted from light energy to electricity and then carried a short distance to the subscriber's home over coaxial cable. Cable operators continually adjust their networks to gain additional bandwidth advantages through various techniques such as node splitting, which decreases the number of subscribers being served from a single node by creating multiple service groups instead of one larger group. Cable operators are also driving fiber deeper into neighborhoods and physically closer to subscribers, decreasing the amount of coaxial cable required and reducing or eliminating any amplifiers in the signal path. Communications between subscribers and the network occur using cable modems and a protocol referred to as DOCSIS (Data Over Cable Service Interface Specification).

Fixed wireless networks operate in a similar fashion to a fiber or traditional wired network at backhaul/middle mile level in that connections are point to point. Using microwave and pinpointed wireless technology, wireless ISPs can transmit high speed broadband signals from fiber backends to fixed points within their networks and use additional point-to-point wireless connections to extend transmission to reach last mile connection points. Last mile services can be provisioned in a similar way or via point-to-multipoint connections, wherein broadband signals can be transmitted to numerous end user points from one last mile radio.

Smaller rural wireline providers have made efforts over the past decade to increase capacity in their last mile networks, typically in the form of fiber wherever possible, along with careful management of backhaul/middle mile and transit capacity. In most cases, providers are deploying Gigabit-Capable Passive Optical Network fiber-to-the-premise (FTTP) networks with dedicated fiber between centrally located Optical Line Terminations and the Optical Network Terminations at each customer premise in order to minimize the need for field electronics. As of 2019, for example, NTCA members reported that nearly 64% of their customers were served via FTTP connections, while 32% were served via DSL, 2% by cable modem technology, and 2% via fixed wireless; nearly three years earlier, reports indicated that 41% of customers were served via FTTP, 45% by DSL, 12% by cable modems, and 1% via fixed

wireless.[87] In more than two dozen states, small rural wireline providers have also banded together to form jointly owned statewide fiber networks that provide backhaul and middle mile capability.

Wireless providers likewise have invested heavily to strengthen wireless networks and prepare for 5G. Since the beginning of 2010, wireless providers have invested over $286 billion in America's wireless networks.[88] Notably, 5G-focused investment has helped prepare wireless networks to meet Americans' mobile connectivity demands during COVID-19. And 5G connectivity itself will boost network capacity and be much more efficient in how it uses spectrum. To optimize the network and ensure consumers get the connectivity they need to live, work, and learn, wireless network engineers monitor traffic 24/7 and shift network resources as necessary. Wireless engineers and technicians also continue to work tirelessly — and as safely as possible by taking important safety precautions and following CDC guidelines — to further optimize and add network capacity. That means continuing to deploy new wireless infrastructure including cell sites and additional spectrum assets quickly and efficiently.

6.1.2 Sector Coordinating Mechanisms

Private sector communications providers participate in a range of coordinating mechanisms facilitated through the U.S. Department of Homeland Security to help ensure secure and resilient communications for national security, emergency preparedness, and the overall economic and social well-being of all Americans. Presidential Policy Directive 21: *Critical Infrastructure Security and Resilience* and the National Infrastructure Protection Plan scope out a structure that includes communications-focused private sector and government coordinating councils to collaboratively address policy-level issues of security and resilience, as well as a more operationally-focused Communications Information Sharing and Analysis Center (COMM-ISAC). During steady-state conditions, these elements come together within the National Coordinating Center for Communications (NCC).

At the most tactical level, the communications sector's primary coordinating mechanism for "typical" incident response is Emergency Support Function (ESF) #2 (Communications) under the National Response Framework issued by the Federal Emergency Management Agency (FEMA). ESF#2 was not universally activated at all government levels as part of response to the pandemic, which may partly explain the lack of coordination on sector status reporting in certain jurisdictions discussed elsewhere in this report.

6.1.3 Pandemic and Business Continuity Planning

As operators of a designated "lifeline" critical infrastructure sector, communications providers have long invested considerable analysis, planning, and material effort in developing robust and resilient networks to provide reliable communications in the face of various threats to network performance — including the threat of pandemic disease. While each communications provider manages their business continuity processes based on their internal business judgment, there are resources each company can leverage to assist their planning and preparedness for a pandemic event. For example, the Alliance for Telecommunications Industry Solutions (ATIS) Network Reliability Steering Committee compiled a checklist of voluntary industry Best Practices and relevant links as a reference in preparation for a

[87] NTCA- The Rural Broadband Ass'n, *Broadband/Internet Availability Survey Report* (Dec. 2019), https://www.ntca.org/sites/default/files/documents/2019-12/2019%20Broadband%20Survey%20Report.pdf.

[88] *2020 Annual Survey Highlights*, CTIA (Aug. 25, 2020), https://www.ctia.org/news/report-2020-annual-survey-highlights.

pandemic event; the most recent "version 2" was last updated in 2015.[89] The FCC's Communications Security, Reliability and Interoperability Council (CSRIC), studied the impact of pandemic events on Priority Telecommunications Services in 2010.[90] And operators have incorporated numerous other industry and multi-stakeholder-recommended practices and recommendations into their internal policies.

6.2 Pandemic Response

6.2.1 Network Engineering and Optimization

As described earlier in this report, the pandemic gave rise to unprecedented changes in data demands on networks, and these shifts highlighted the essential importance of network traffic management. Even under normal conditions, providers monitor traffic 24/7 on their networks, grooming network resources and shifting resources to optimize networks and ensure consumers receive the connectivity they need to live, work, and learn. The technological tools and human expertise providers leverage every day proved the critical first line of defense to rapidly adapt networks to changing conditions.

The innovations that operators have been working on for several years have resulted in their ability to better handle peak demand. For example, providers leveraged CDN infrastructure to alleviate potential network strains and ensure that pandemic-related surges or shifts in demand would not affect user experience. Providers optimized traffic flow on networks from global to local by activating host circuits, upgrading capacity, revising data limits, strategically planning patch releases, utilizing overflow routing and rebalancing traffic as necessary to facilitate high performance on their networks. [91] In many cases this rapid flexibility was enabled by tools such as Software Defined Networking and Network Function Virtualization (SDN/NFV).

6.2.2 Capital Investment

Service provider investment in three critical areas led directly to meeting successfully the demands of the COVID-19 environment: (a) Sustained significant investment in capacity; (b) rapid incremental investments to head off pandemic-induced network congestion; and (c) long-term investments in technology and innovation.

- **Sustained Investment:** Perhaps the fundamental reason that existing broadband networks performed so well during COVID-19 was the continued investment in capacity and capability to stay well ahead of growth in demand. In the aggregate, U.S. broadband providers (wireline, wireless, and cable broadband) invest an estimated $70 to $80 billion annually to connect new communities, upgrade infrastructure, and innovate in their networks.[92] As examples, over the

[89] Alliance for Telecommunications Industry Solutions, *ATIS Standard On Network Reliability Steering Committee (NRSC) Pandemic Checklist* (Feb. 23, 2015), https://access.atis.org/apps/group_public/download.php/44316/ATIS-0100018.pdf.

CSRIC, *Planning for NSEP Next Generation Network Priority Services During Pandemic Events* (Dec. 2010), https://transition.fcc.gov/pshs/docs/csric/CSRIC_WG7_Final_Report_NGN_Priority_20101216.pdf.

[91] Andrew Dugan, *A New Type of Crisis: What Happens to a Network When We Unexpectedly Have To Stay at Home?*, LUMEN (Mar. 27, 2020), https://news.centurylink.com/index.php?s=34146&item=30584.

[92] Testimony of Jonathan Spalter, President and CEO, USTelecom – The Broadband Association, before the Senate Commerce Committee: *The State of Broadband Amid the COVID-19 Pandemic* (May 13, 2020) https://www.commerce.senate.gov/services/files/AA40703E-52A3-46C8-A6E7-FCD653D05B26).

past 20 years, the cable industry has invested $290 billion in infrastructure and networks,[93]and CTIA estimates that wireless providers have invested over $286 billion in America's wireless networks since the start of 2010. Many providers and associations described capital investment strategies as working in advance to build new capacity before it is needed, in some cases 18 months or more ahead of projected demand. Accordingly, the network capacity was largely already in place when pandemic-induced demand drove a year's worth of demand growth in just a few weeks.

- **Incremental Investment:** Providers quickly and efficiently deployed new infrastructure and augmented capacity where needed to promote continuity of service. For example, wireless providers have deployed new cell sites and additional spectrum assets in addition to regularly scheduled deployment activities. These included portable "Cell on Wheels" sites, known as COWs, that are normally used to keep people connected during natural disasters.[94] The FCC's prompt action to allow wireless providers additional spectrum resources — up to 100 megahertz, a nearly 14% increase in low-band spectrum availability — to boost capacity in key regions of the country. Importantly, wireless providers were already adding capacity and enhancing network resiliency in preparation for the deployment of 5G, and many providers increased capital spending to meet COVID-19-driven network demands.[95] Cable and fiber operators similarly augmented capacity to meet the growing needs of hospitals, temporary medical facilities, and COVID-19 testing sites to enable these facilities to function well starting in the early stages of the pandemic crisis. They also heightened coordination with state and local emergency managers to promote pandemic response.
- **Technology Investment:** Provider investments have not been limited to just building more wired and wireless connections, but also include fundamental investments in the technology that enables their networks. According to the Brookings Institute, while many industrial processes increase in incremental steps, networks largely improve through big transitions to next-generation technologies. For example, telephone companies that modernized from copper telephone lines to fiber increased bandwidth by 60 times; cable operators transitioning from DOCSIS 3.0 to DOCSIS 3.1, enabled a tenfold download speed increase; and wireless providers upgrading from 4G to 5G, should increase potential top speed by 100 times. Each step, however, requires significant upfront capital expenditures, which takes years to recoup.[96]

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[93] *Investing in America*, NCTA, https://www.ncta.com/sites/default/files/2019-07/investing_in_america_factsheet.pdf (last visited Sept. 23, 2020).

[94] *See infra* section 7 (discussing COWs, as well as technologies for additional capacity and connectivity).

[95] *How Wireless Kept Americans Connected During COVID-19* at 5, CTIA (June 23, 2020), https://api.ctia.org/wp-content/uploads/2020/06/How-Wireless-Kept-Americans-Connected-During-COVID-19-2.pdf.

[96] Blair Levin, *COVID-19 Proves We Need to Continue Upgrading America's Broadband Infrastructure*, THE BROOKINGS INSTITUTION (Mar. 30, 2020), https://www.brookings.edu/blog/the-avenue/2020/03/30/covid-19-proves-we-need-to-continue-upgrading-americas-broadband-infrastructure/.

6.2.3 Field Work

6.2.3.1 Necessary Field Operations

As providers of a designated "lifeline" critical infrastructure, communications providers have always understood the need to keep maintenance and repair field crews working during times of disaster to provide the resilient, stable, and reliable communications on which Americans rely. The COVID-19 response was no different, except the normal challenges of disaster response were complicated by the indefinite duration of the pandemic and the need to also build out capacity upgrades made necessary by the event itself.

Providers from major national operators to small rural operators reported increases in field activity in the wake of the pandemic for several reasons. As customers moved to work and learn from home, those that lacked broadband or required additional capacity needed service installed or upgraded rapidly. Business customers often required upgrades to support the enterprise side of employee virtual connectivity. Providers also built out core network capacity necessary to support the demand shifts of their residential and enterprise customers. Finally, with less traffic on roads as residents remained increasingly at or close to home, providers leveraged the opportunity to undertake outside plant network construction projects.

In carrying out field work, providers reported taking a range of safety precautions as detailed in the following sections, including dispatching technicians from home to minimize contacts at garages or service depots; eliminating or limiting technician entry into customer premises where possible; minimizing non-essential personnel in company facilities to increase social distancing; and providing PPE to field personnel.

6.2.3.2 Travel and Access Issues

During the early phases of the pandemic, as many states were instituting mandatory "Stay at Home" guidance, many providers reported concerns regarding their ability to move field crews to conduct necessary work. Since this issue affected a range of critical infrastructure sectors, DHS, through CISA, issued guidance to state and local authorities on "Essential Critical Infrastructure Workers."[97] The Communications Sector Coordinating Council (CSCC), the public-private partnership organization that coordinates with the DHS, worked with CISA to ensure that key communications employees were categorized as essential workers. CISA's NCC has produced official letters asking State, Local, Tribal, and Territorial (SLTT) governments to provide an exemption for communications critical infrastructure operations with regard to any restrictions imposed during a disaster or emergency since Hurricane Katrina. Supplemental to the CISA guidance, NCC issued these non-binding request letters to further facilitate travel and access by communications sector workers. On May 26, 2020, FCC Chairman Pai and CISA Director Krebs sent a letter to all 56 state and territory governors encouraging them to provide

[97] Memorandum from Director Christopher Krebs, CISA, on *Guidance on the Essential Critical Infrastructure Workforce* (Aug. 18, 2020), https://www.cisa.gov/publication/guidance-essential-critical-infrastructure-workforce.

necessary access and resources to communications providers during the pandemic to enable 9-1-1 service, telehealth, distance learning, and telework.[98]

While they proved to be effective, the CISA guidance and NCC letters have limitations. The letters are non-binding, and state and local authorities are under no obligation to honor them or may establish their own system for access and credentialing of critical infrastructure workers. Further, the letters are meant to facilitate access and freedom of movement due to physical or curfew restrictions, not as a substitute for other municipal requirements such as permits required to work in the right-of-way. Providers reported that the letters proved vital in a number of reported cases to help staff traverse state borders in an efficient manner. There is an opportunity for more outreach and coordination as some SLTT governments were not familiar with NCC letters. The Working Group recommends that SLTT governments incorporate the NCC Letters into their plans for any response as well as the specific COVID-19 related guidance released by CISA.

6.2.3.3 Minimal Touch Installation and Maintenance Procedures

Social distancing mitigations further complicated installation and maintenance procedures. Providers noted issues ranging from customers that cancel appointments due to health risk factors, state or local restrictions that initially put a pause on on-premise installs, difficulty navigating landlord or shared facility requirements, and access to PPE. Despite these challenges, service providers and install firms reported that with careful planning of and engineering of installation/repair activities, prior pre-existing good relationships and coordination with communities and customers, and flexible use of technology to assist completion, installation and repair work was mostly able to proceed.

Clear communications and expectations were essential to success, both internally so that employees fully commit to internal policies for safe installation procedures and with customers to set expectations before a minimum or no-touch install occurs. Communications should be clear and direct in outlining precautions being taken and optional methods for installs to meet employee or customer concerns. Additionally, communications should be ongoing; some installers conduct a pre-call screen to identify any customer health risks, with a confirmation screening the day of the install or call when the technician is on the way to the customer location. If a customer identifies health risks at any stage, the installation should be rescheduled.

The specific instructions on how to conduct safe minimum or no-touch installs have been described in two major buckets:

> 1) No entry/no contact installation: A self-installation or delayed installation (some work now and finish later) utilizing existing premises penetration points. Usually this would be a Network Interface Device, Optical Network Terminal, coaxial or phone point, but to minimize premises entry, sometimes even going through a window seal to get lines into the house. In some cases, a new penetration point would be required with assistance from the customer on the inside work. Some firms during the pandemic created home installation kits walking the customer through the install process with tech support, including live video chat with installation professionals and easy to follow pre-recorded installation videos.

[98] Letters from Chairman Ajit Pai, FCC, & Director Christopher Krebs, CISA, to Governors Kay Ivey ET AL. (May 26, 2020), https://docs.fcc.gov/public/attachments/DOC-364566A1.pdf.

2) Premises entry installation: This process requires technicians arriving at the customer home or business with CDC-compliant PPE and following social distancing guidelines. The technician can still communicate at a safe distance from the customer with everyone in masks; optionally the technician and customer are physically separated and use phone or video for communications.

Most communications sector entities followed one or both of these installation/repair paradigms, but with some specific modifications. Most fixed wireless installation and repair procedures do not require in-person contact as installation occurs on a roof or outside location and often applicable equipment is generally not housed inside a home or facility, so technicians could install or often make network repairs/maintenance as normal without the need for in-person interaction. Many providers initially severely limited or curtailed altogether entry into customer premises, especially in light of concerns about sufficient access to PPE. As of mid-April, for example, 25% of NTCA members reported ceasing entry into customer premises for installation activity, and 20% reported the same for repair activity as well. Others adopted policies only to enter in the event of service-affecting voice or broadband services (as compared to video outages, for example).

6.2.4 Shift to Telework for Non-Essential Personnel

As the pandemic spread across the U.S. in March, many network providers rapidly transitioned their workforces to maximize remote work wherever possible. Transitioning employees to work from home where possible reduced population density in office locations to allow greater social distancing for those employees who continued to work from office and field locations. Additionally, many providers restricted travel and limited in-person meetings, contributing to this virtualized remote work operational environment.

Robust cybersecurity practices for these dispersed workforces were critical in maintaining the confidentiality, integrity, and availability of provider internal and external networks. As CISA and others noted the uptick of COVID-19-related cyberattacks,[99] training for remote employees stressed the need to maintain "cyber situational awareness" and encouraged employees to identify suspicious cyber activity and refer it to their IT security teams for investigation. Providers leveraged layered security controls such as multi-factor authentication and data-at-rest encryption for devices outside of corporate facilities (e.g., desktop computers normally in company facilities). Finally, in the rapid transition to large-scale telework, companies tiered their functions to ensure the most secure connections are available for those who require them, conserving initially limited corporate VPN connections when necessary and leveraging IT resources via portals and/or cloud applications. Some providers further reduced strain on VPN resources by diverting non-secure traffic outside of the VPN, a technique known as split tunneling.

[99] *Defending Against COVID-19 Cyber Scams*, CYBERSECURITY & INFRASTRUCTURE SECURITY AGENCY (Mar. 6, 2020), https://us-cert.cisa.gov/ncas/current-activity/2020/03/06/defending-against-covid-19-cyber-scams.

6.2.5 Protective Measures for Essential Office and Field Staff

6.2.5.1 Physical Protective Measures

Many provider efforts regarding protective measures are discussed in more detail elsewhere in the report, but this section provides a recap of key protective measures put in place by providers.

For all workers:

- Minimize in-person contacts
- Provide appropriate PPE and guidance/training
- Give employees discretion to avoid circumstances where recommended safety procedures were not possible or if a customer was displaying any indication of or responded adversely to questions about COVID-19-related symptoms
- Establish company policies and enforce requirements for protective measures such as mask wearing, often as required by state and local direction
- Eliminate or severely limit non-essential business travel
- Implement regular pre-work symptom screening and reporting

Additional measures for office and retail locations:

- Use additional space from employees working from home to increase space for social distancing
- Implement additional cleaning and safety procedures
- Divide their workforce into shifts and, where they have allowed or required staff to return to offices, alternating in-office scheduling on a daily or weekly basis to limit contacts and promote tracing
- Close offices to visitors and customers where possible

Additional measures for field staff:

- Home garaging to avoid congregations at company facilities
- Limitations on employees per vehicle

Providers reported concerns with acquiring basic PPE (hand sanitizer, disinfectant wipes, masks, gloves) early in the pandemic. Small rural wireline providers in particular reported significant concerns with obtaining sufficient access to PPE and sanitizing/cleaning resources.

6.2.5.2 Alternative Scheduling and Logistics

Providers across industry segments took steps to ensure employee safety through alternative scheduling and logistical changes to help keep employees safer through social distancing. In some cases, communication providers updated policies to allow field operations staff to keep a company vehicle at their home rather than pick it up and drop it off each day at the job site. Crews needed to arrive in multiple vehicles rather than the same vehicle to limit transmission of the virus.

Providers staggered shifts for construction and installation crews to minimize overlap with other employees and ensure fewer people at a jobsite simultaneously. This was accomplished by adding more shifts or spreading shifts out to start earlier and end later. Office staff across all industry segments also reported staggering work schedules to facilitate social distancing. For commercial installs, coordinating with building management was critical to ensure avoiding other tenants of the building and minimizing

interaction. Outside plant construction teams such as in-ground fiber installation reported a better ability to minimize contact with other employees than teams conducting residential installs.

6.2.6 Retail Activities

Across industry segments, retail stores provide critical functions necessary to establish new or expanded service, repair or replace equipment, and facilitate bill payment. In rural areas, these storefronts provide important connections beyond their functional purposes, providing important presences in town centers in particular. As retail establishments, however, some locations were restricted from opening by state stay at home orders and business restrictions. Some brick-and-mortar retail stores remained open to varying degrees by state, but wireless stores in indoor malls and other pop-up locations in particular remained largely closed due to state stay at home orders.

Retail stores that remained open took protective measures to keep employees and customers safe. Many used curbside services and secured remote equipment drop-off locations to minimize customer traffic in the premises. Many reconfigured stores to maximize social distancing — installing plexiglass at customer-facing counters, designating socially distant waiting areas for customers, and provisioning PPE to employees staffing these areas. Many locations required that masks be worn by staff and customers, and some locations required gloves for certain staff members. Many providers reported regularly disinfecting the store as well as any devices received or bought.

6.2.7 Coordination Efforts

Interconnectedness is a fundamental part of the modern communications ecosystem, and accordingly providers regularly and routinely coordinate to resolve potential congestion points through expanding capacity at peering locations or other measures.

Technology subject matter experts from communication network service providers of the COMM-ISAC hosted bi-weekly industry-only calls with technology subject matter experts from platform provider companies. These calls focused on general updates from each company, and strategies for addressing operational and messaging related issues for COVID-19. Early on, information on experiences from international providers was extremely useful in projecting potential/real impacts before COVID-19 spread to the United States. These sessions helped to develop contacts between the two disciplines, which ultimately provided for increased awareness and solutions to technology issues.

Access to telecommunications equipment and supplies will be critical to ensure continued progress on broadband deployment objectives and to maintain services already in place. Earlier this year, more than 90% of NTCA members reported plans to continue construction consistent with initial capital budget plans for 2020 — although in a recent survey, more than 90% of providers reported increasing concerns about supply chain impacts since the start of the pandemic. For example, 32% of survey respondents indicated delays of greater than 12 weeks in obtaining fiber, and 58% reported delays of between 9 and 12 weeks in securing consumer premises equipment electronics. Continued coordination with suppliers and an industry-wide focus on supply chain impacts will be essential.

Even before the pandemic began to spread in the U.S., communications sector incident response processes swung into motion. Through routine weekly coordination calls with the NCC and the COMM-ISAC, government and industry were discussing preparations and potential response actions early in 2020. The CSCC was also engaged in developing sector consensus on policy-level perspectives on topics

ranging from Personal Protective Equipment sector needs to consolidating resources for "Return to Normal" planning.

6.2.8 Service Provider Community Support

During the COVID-19 pandemic, in addition to all of the significant efforts documented throughout this report to ensure their networks could support their customers and keep their employees safe, all industry segments took additional efforts to help national resiliency in the face of the global emergency. Notably, on March 13, 2020, in response to the pandemic and any challenges consumers may face, FCC Chairman Ajit Pai asked broadband and service providers to sign the Keep Americans Connected Pledge in order to ensure Americans remain connected during these unprecedented times. The pledge was later extended to June 30, 2020 with more than 800 companies signing on.[100] Many entities reported going "above and beyond" the pledge to help keep the communities in which they live and serve connected and safe during the pandemic.[101] Among other things, providers waived late fees and disconnect notices; provided free services, free upgrades and increased speeds; established needed community hotspots; established telework solutions; and accelerated construction and installation projects to connect new and/or critical businesses including remote and new health locations.

Indeed, all industry segments report voluntarily doing even more beyond ensuring needed communications services during the pandemic. Entities report, for example, establishing technical roadmaps for broadband providers and school districts as they switched to remote learning, funding community educational campaigns about the health impacts of COVID-19, and even stepping in to feed the food insecure and establish processes for check-ins on elderly and other vulnerable populations in their communities. Other providers took steps to support public safety officials and emergency/frontline personnel, delivering needed phone chargers or other devices to frontline workers and hospital patients or donating and supplying critical protective equipment, like face shields and other donated supplies for medical staff.

6.3 Transition to the "New Normal"

Even as the pandemic continues to represent a public health and economic crisis, providers have started to examine how to move from a disaster response and recovery operating status to a "new normal" in terms of operations and returning employees to the workplace – both during the pandemic itself and thereafter in terms of new practices and procedures that reflect lessons learned and/or efficiencies gained.

With such efforts in mind, on July 1, 2020, the CSCC released a document entitled "Return to Normal: Guidance and Resources for Communications Providers."[102] The stated purpose of the report is to "provide guidance to online resources available to assist communications providers establish and implement a plan as they consider returning to the workplace following COVID-19 closures . . . includ[ing] state and federal government recommendations, industry best practices, articles, and

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[100] *Chairman Pai Launches the Keep Americans Connected Pledge*, News Release (2020), https://docs.fcc.gov/public/attachments/DOC-363033A1.pdf.

[101] *Companies Have Gone Above and Beyond the Call to Keep Americans Connected During Pandemic*, FCC (Sept. 10, 2020), https://www.fcc.gov/companies-have-gone-above-and-beyond-call-keep-americans-connected-during-pandemic.

[102] Commc'n Sector Coordinating Council, *Return to Normal: Guidance and Resources for Communications Providers* (Sept. 2020), https://www.comms-scc.org/return-to-normal-guidance.

questionnaires that may be useful with efforts to create a safe work environment and mitigating the spread of COVID-19."

In addition to providing links to many resources that can assist providers in returning to the workplace, key recommendations of the report include:

- Identifying and designating a return-to-work coordination team
- Creating a plan that incorporates federal CDC and OSHA guidance and state and local guidance specific to the provider's business locations and addresses roll-back procedures and phase-in options.
- Considering the need for testing and defining protocols if it is determined that testing is necessary in any given case.
- Determining how to implement CDC guidelines with respect to social distancing in the workplace, including placement of workstations, interactions with customers, treatment of common areas, and limitations on face-to-face meetings.
- Implementing contact tracing protocols consistent with CDC guidance to mitigate employee transmission.
- Addressing compliance with any federal or state quarantine orders.
- Adopting policies with respect to supply and the proper use of personal protective equipment in company operations, including interactions with customers.
- Reviewing cybersecurity practices to mitigate against risks that bad actors use the new environment to exploit weaknesses.

The CSCC guidance also provides a sample framework for decision-making, showing how confirmation of certain critical decision points for each of six different workstreams – government, health and safety, facilities, ecosystem, business readiness, and employee readiness – should be obtained before moving to workplace re-entry.

In addition, providers are considering how to apply "lessons learned" from this period in a more regular course of operations moving forward. As one example, rather than requiring field operations staff to report to a centralized location prior to dispatching for customer service calls such as installations and repairs, a number of providers report migrating to a "dispatch from home" model. While originally implemented out of a desire to limit interactions between staff during the pandemic, providers are finding this to be an efficient practice that saves travel time for technicians and maximizes employee resources. Providers are similarly evaluating whether other operational changes driven by the pandemic — such as increased work-from-home capabilities for customer service representatives or other office personnel — can and will be sustained moving forward as part of "normalized" operations.

6.4 Recommendations/Best Practices Related to Provider Resilience

6.4.1 Consider Additional Expedited Use of Special Temporary Authorizations

The FCC should continue to look at Special Temporary Authorizations that can be expedited to support network deployments in spectrum that might only be available in limited areas, for a limited time, or contain other restrictions in order to help keep Americans connected.

6.4.2 Use Pandemic Response Funds Flexibly to Address Availability and Adoption Issues

The FCC and other federal agencies that have funding sources available for a pandemic response should use such funds flexibly to address the root issues of availability and adoption noted in this report.

6.4.3 Provide More Effective Coordination and Communications with Respect to Access Letters

Access letters are vital for critical infrastructure providers' teams to carry out their duties and services during disasters and pandemics when restrictions exist that could impede such work. As such, the Working Group recommends future DHS engagement with SLTT personnel on access letter qualifications and related rights for critical infrastructure providers through such programs or documents as the Interoperability Communications Technical Assistance Program, the National Emergency Communications Plan, and FEMA's National Response Framework. SLTT government should clearly communicate to providers the expectations and acceptable use of access letters from the NCC.

6.4.4 Continue Collaboration and Coordination Between Providers and Federal Stakeholders

The support the communications sector received from DHS and CISA through the NCC greatly facilitated sector response actions. DHS/CISA should continue supporting the communications sector through the NCC, and the NCC should continue to coordinate on communications sector preparedness and response with the Commission's Public Safety and Homeland Security Bureau (PSHSB). Close coordination between NCC and PSHSB is important and should continue as well.

6.4.5 Implement More Effective Use of ESF#2 Communications

State, tribal, and territorial governments should officially activate ESF#2 communications to coordinate any needs within the state, tribe, or territory. This activation could be done virtually and at a limited activation level that follows normal business hours but establishes a point of contact and process for coordinating communication needs being addressed due to the pandemic. This is especially helpful to address other communication needs that might arise due to a different disaster that occurs during the pandemic.

6.4.6 Update Emergency and Disaster Response Plans and Activities

Communications providers should update emergency and disaster response activities to respond to concurrent seasonal weather and pandemic events to account for pandemic-related factors (e.g., sheltering for workers, PPE availability, social distancing, etc.).

6.4.7 Continue Sound Traffic Engineering Practices to Manage Network Traffic

Communications providers should establish or continue traffic engineering practices to effectively manage network traffic as necessary on a case-by-case basis. Companies should review these procedures as a pandemic causes a shift in usage habits both for time-of-day and throughput needs.

7 Use of Future Technology and Innovations

In its the fifth charge to the DRRWG, the FCC asked the Working Group to evaluate "[w]ays that technology could be used to mitigate [the challenges identified in other charges, such as mass teleworking] and other similar challenges in the future." As noted in the introduction of this report, and as contemplated in the very wording of this charge itself, this fifth charge is inextricably linked with the other charges discussed in sections 4 through 6 of this report as those sections describe various ways in which end users, enterprises, governments, and service providers leveraged technology.

The following are examples where further analysis and investigation could be conducted. Some are already under investigation by other working groups or entities, such as the FCC Technological Advisory Council, the CSRIC, the DHS Information Communication Technology Supply Chain Risk Management Task Force (DHS ICT SCRM TF), and NTIA, or in the Department of Commerce's supply chain proceedings.

- **Increase Consumer Use of Videoconferencing and Virtual Private Networks** – As many workers and students were forced to telework and learn remotely, and as more patients elected to consult with medical professionals remotely, videoconferencing VPN applications became increasingly important. While VPN applications do not have any special requirements other than proper access through firewalls (e.g. proper ports open), videoconferencing often requires more bandwidth than a typical interactive web application. The bandwidth requirements for video conferencing by themselves did not necessarily increase bandwidth demands on the network in spite of video conferencing usage growing more than 350% after the first week of the shutdown and by as much as 700% on some networks.[103] As described earlier in this report, however, broadband networks in the United States proved largely up to the challenge, with prior investments, proactive engineering, and some new technologies described further below helped to ensure that the additional demands did not exceed underlying network capabilities. The practices and technologies that contributed to this overall record of success are discussed in these preceding sections, and these form the kind of best practices that the Working Group believes service providers can look to for future network planning. Yet, even in the face of this overall record of success, as described further below, individual users may still have experienced "connectivity" problems — that included either limited service availability or economic or other barriers to their ability to gain access to broadband connection to the internet.
- **Innovation in Installation and Repair Practices** – While the pandemic caused many providers to cease physical operations altogether or severely limit entry into customer premises for installation or repair activity, "necessity became the mother of invention." As described in section 6, many providers deployed and used video-assisted installation and repair capabilities or "contactless" broadband self-installation kits to enable continuity of operations and service delivery despite the pandemic and concerns about enough access to protective personal equipment for customer facing workers.
- **Supply Chain Resiliency** – The sustainability of advancements in network capabilities to keep pace with growing demands and to address geographies where networks must be upgraded to keep pace with growing demands could be adversely affected if any supply chain concerns came to fruition. Industry worked closely with DHS during the shutdown to monitor for any critical supply chain issues. There were no reports of critical supply chain issues, but this is one area to monitor going forward as reports of increased delays have been noted earlier in this report. The

[103] Craig Labovitz, *Pandemic Impact on Global Internet Traffic NANOG* (June 2020), https://storage.googleapis.com/site-media-prod/meetings/NANOG79/2208/20200601_Labovitz_Effects_Of_Covid-19_v1.pdf (last visited July, 17 2020).

DHS ICT SCRM TF chartered a fifth working group to do a post-mortem analysis of the ICT supply chain.

The new technologies the Working Group identified as worthy of such further consideration and development beyond those already highlighted above and in other sections of this report include:

- **Software Defined Networking and Network Function Virtualization** – Providers found that Software Defined Networking and Network Function Virtualization played important roles in maintaining network performance during COVID-19 as the technologies allowed operators to quickly scale and adjust their networks to meet the changes in demand. Networks operated and managed by software, coupled with evolving artificial intelligence capable of informing network management, can give service providers increasing ability to scale for demand in real-time and adapt to unexpected events that drive rapid shifts in customer demand. Software-defined networking (e.g., Temporospatial SDN) will also play an important role in enabling the flexible deployment and orchestration of emerging aerospace networks, such as high-altitude platform stations (HAPS) and non-geostationary satellite constellations, in response to emergency situations and changing demands.
- **Artificial Intelligence and Machine Learning** – Some operators reported using AI (artificial intelligence) to assist with detecting network anomalies and aiding in determining how to address them.[104]
- **Broadband Connectivity for Users** – As described elsewhere in this report, service provider networks were designed to meet and able to effectively manage the significant increases in the use of such applications prompted by stay at home orders and other pandemic-related demands. The pandemic exposed certain "connectivity" challenges faced by some end-users. As noted earlier, these "connectivity" challenges can be broadly characterized as issues of: (1) availability — the lack of sufficient connectivity for users to participate as needed in teleworking or remote learning functions; and (2) adoption — the circumstance in which sufficient connectivity exists at a given location but the user elected not to or is unable to subscribe. The pandemic changed perspectives for many who previously did not have an interest in or were unable to maintain a subscription to a broadband service were confronted with a pressing need.
- **Technologies for Additional Capacity and Connectivity** – Broadband providers, infrastructure providers, and equipment manufacturers are developing new technologies to provide continuous connectivity even during disasters. Broadband providers have worked diligently to make their facilities more resilient. Nevertheless, disasters can lead to a loss of connectivity. In these situations, especially if certain wireless antennas are not in service, wireless providers employ portable "Cell on Wheels" sites, known as COWs, as well as "Cells on Light Trucks," known as COLTs, to provide service until the tower comes back online. COWs and COLTs are often used by emergency services and first responders to provide additional capacity and connectivity as they perform their lifesaving operations. They are also used to serve the public for both emergency and non-emergency needs. New technologies, like aerostats, blimps, balloons, and unmanned aerial vehicles, can also provide connectivity in hard-to-reach areas.
- **Effective Use of Wireless Emergency Alerts** – As of July 2020, CTIA reports that more than 380 Wireless Emergency Alerts (WEAs) were sent to millions of wireless customers to provide critical information related to COVID-19. For example, alert originators used WEAs to inform consumers about stay at home orders, quarantine guidance, curfews, the availability of COVID-19 test and screening sites, and the locations of food banks and shelters. WEAs proved to be a critical tool in helping local public officials inform their citizens and encourage communities to minimize the spread of COVID-19. The use of WEA capabilities to respond to the pandemic also

[104] Jared Newman, *As Remote Work Exploded, Comcast Turned to AI to Keep the Internet Running*, FASTCOMPANY (July 24, 2020), https://www.fastcompany.com/90519167/as-remote-work-exploded-comcast-turned-to-ai-to-keep-the-internet-running.

suggests that additional best practices for alert originators may help maintain the effectiveness of WEA. While alert originators should have discretion to determine when and how WEA messages are appropriate for their jurisdiction and communities, alert originators should also consider best practices that minimize the risk of over-alerting and maximize the effectiveness of WEA.

8 Conclusion

Because of the need for physical distancing and other preventative measures to curb transmission, the COVID-19 pandemic made Americans more reliant than ever on broadband networks for work, education, healthcare, access to news and entertainment, and other aspects of everyday life. In light of this increased significance of broadband in Americans' lives, the FCC charged this Working Group with examining how broadband networks aided those working and learning from home, how permitting challenges arising out of the pandemic may have affected broadband deployment, how providers operated and sustained their networks in the face of changes in data demands caused by the pandemic, and ways that technology might be leveraged to address similar challenges in the future.

After thorough review of the FCC's charges and examination of information from a wide variety of sources, the DRRWG has put forth a series of recommendations and identified best practices that it hopes will provide value to stakeholders of all kinds even as the country continues to respond to the pandemic. This report finds that: (a) networks performed well overall during the pandemic; (b) availability and adoption challenges were intensified as critical societal functions transitioned online, almost overnight; (c) municipalities were able to ensure that permitting generally was not an obstacle to maintaining and, as needed, expanding broadband networks during the pandemic.; and (d) the rapid and significant social changes brought on by the pandemic, such as increased teleworking, remote learning, and use of telemedicine, are becoming ingrained and will likely lead to long-term changes in broadband usage and adoption.

Appendix A

Disaster Response and Recovery Working Group Members
***** *indicates a member of the Broadband Deployment Advisory Committee*
Alternate members of the Working Group are also provided below.

Chair:

Red Grasso, First Responder Emerging Technologies Program Director
North Carolina Department of Information Technology

Vice-Chair:

Jonathan Adelstein, President & Chief Executive Officer*
Alternate: John Howes, Government Affairs Counsel
Wireless Infrastructure Association

Members:

Andrew Afflerbach, Chief Executive Officer and Director of Engineering, CTC Technology and Energy
Alternate: Nancy Warner, General Counsel*
National Association of Telecommunications Officers and Advisors

Chris Anderson, Principal Advisor, National Security and Emergency Preparedness
Lumen

Allen Bell, Distribution Support Manager, Georgia Power Company*
Southern Company

Elizabeth Bowles, CEO & President*
Aristotle Unified Communications, LLC

Rob Cantu, Director, Cybersecurity
Alternate: Matthew Gerst, Vice President, Regulatory Affairs
Alternate: Ariel Diamond, Associate, DLA Piper
CTIA

Rick Carlisle, Director of Information Technology
Pueblo of Pojoaque

Michael Chauffe, Mayor
Village of Grosse Tête, Louisiana

William Check, Ph.D., Senior Vice President of Technology and CTO
Alternate: Matt Tooley, Vice President of Broadband Technology
NCTA - The Internet & Television Association

Skyler Ditchfield, Chief Executive Officer*
Alternate: Melissa Slawson, General Counsel, Vice President of Government Affairs and Education
GeoLinks

Alexandra Fernandez-Navarro, Commissioner
Puerto Rico Public Service Regulatory Board

Tony Fischer, Director, Information Technology
City of Germantown, Tennessee

Monica Gambino, Vice President, Legal
Crown Castle

Todd Gourd, Chief Information Officer & Senior Vice President
Cherokee Nation

Larry Hanson, Executive Director*
Georgia Municipal Association

David Hartshorn, Chief Executive Officer
Geeks Without Frontiers

Greg Hauser, Communications Branch Manager/Statewide Interoperability Coordinator
Emergency Management Division, North Carolina
National Emergency Management Association

Kurt Jacobs, Corporate Director, Emerging Technology & Solutions
JMA Wireless

Jeremy Johnson, CISA Telecommunications Specialist
Department of Homeland Security

Julie Kearney, Head of Regulatory Affairs*
Alternate: Jameson Dempsey, Government Affairs Counsel
Loon LLC

Richard "Kent" Kildow, Director of Business Continuity & Emergency Management
Verizon

Frank Korinek, Director of Government Affairs
Motorola Solutions

Wyatt Leehy, Information Technology Manager
Great Plains Communications

Steve Leese, Senior Consultant, Communication Center / 9-1-1 Services
Association of Public Safety Communications Officials (APCO)

Jim Matheson, Chief Executive Officer*
Alternate: Brian O'Hara, Director, Regulatory Affairs
Alternate: Martha Duggan, Senior Principal, Regulatory Affairs
National Rural Electric Cooperative Association

Kelly McGriff, Vice President & Deputy General Counsel*
Uniti Group

Andrew Mincheff, Government Relations Director
INCOMPAS

Chris Nurse, Assistant Vice President for State Legislative and Regulatory Affairs*
AT&T

Francella Ochillo, Executive Director
Next Century Cities

Frank Ramirez,
National American Indian Veterans

Eddie Reyes, Prince William County Emergency Communications Center
National Public Safety Telecommunications Council

Denise Riedl, Chief Innovation Officer, Department of Innovation and Technology
City of South Bend, Indiana

Mike Romano, Sr. Vice President – Industry Affairs & Business Development
NTCA–The Rural Broadband Association

Sanjay Saggere, Chief Information Officer
Confederated Tribes of the Colville Reservation

Rikin Thaker, Vice President, Telecommunications and Spectrum Policy*
Multicultural Media, Telecom and Internet Council

Pete Tomczak, Manager, Spectrum Coordination and Clearance
FirstNet

Rocky Vaz, Director of Emergency Management
City of Dallas, Texas

Joseph Viens, Senior Director of Government Affairs
Charter

Lisa Youngers, President & CEO
Fiber Broadband Association

Former Members:

Kayla Gardner, Senior Manager of Government Affairs
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Megan Bixler, Technical Program Manager
Association of Public Safety Communications Officials (APCO)