Public Knowledge

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Subcommittee on Communications, Media, and Broadband

Building Resilient Networks

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Chairman Lujan, Ranking Member Thune: Thank you for inviting me to testify on this important topic. My name is Harold Feld and I am the Senior Vice President of Public Knowledge, an organization that is celebrating its 20th anniversary this year, and is dedicated to promoting freedom of expression, an open internet, and access to affordable communications tools and creative works.

Consumers and businesses expect a reliable communications network. In fact, our economy depends on it. But our very *lives* depend on reaching emergency responders every time we call 911. In disasters, the ability of first responders to communicate instantly with the public and with each other can mean the difference between life and death.[1] In theory, upgrading our nation's communications networks to internet protocol (IP) should enhance resiliency because the protocol allows information to be broken up into packets, transmitted across multiple networks using different physical media (such as fiber and wireless), and reassembled at the endpoint. The protocol also establishes and confirms that packets are sent and received, and provides mechanisms for adjusting to congestion.

Instead of proving more resilient, our networks have grown increasingly fragile. A 2018 report by the Government Accountability Office (GAO) noted that "from 2009 to 2016, about one third of all wireless outages reported to [the] FCC (6,002 of 18,325) were attributed to physical incidents."[2] These outages have also grown longer in duration, especially when they are

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[1] Lisa Krieger, *911 Failure During California Wildfire Prompt Changes*, The Mercury News, June 2019 ("When lives are at risk, communication is critical, said Christina Taft, 25, a business student at CSU Chico who lost her mother, Victoria, in the fire. She and her mom received no emergency warnings. And she was unable to get help for her mother after repeatedly calling 911. She is researching new approaches to emergency communications — calling the proposed platform "Victoria" after her mother — so others don't suffer the same fate.").

[2] GAO, Telecommunications: FCC Should Improve Monitoring of Industry Efforts to Strengthen Wireless Network Resiliency at 10 (2018), available at https://www.gao.gov/assets/690/688927.pdf. Accidents accounted for 75% of outages; natural disasters accounted for 24% and manmade incidents accounted for 1% of outages during the period of 2009-2016. *Id*. at 12.

the result of a natural disaster or involve a concurrent failure of the electric grid.[3] In addition to outages caused by natural disasters such as wildfires and hurricanes, outages can occur when telephone infrastructure is targeted in physical attacks, or from cybersecurity attacks.[4]

Unfortunately, outages can occur as a consequence of technical issues and carrier neglect, as well as from external events. In 2014, a "preventable coding error" in a single router in Washington State resulted in a 911 failure covering more than 11 million people.[5] In 2020, a server failure in Georgia resulted in a multi-state blackout of T-Mobile's network.[6] In other places, carriers have allowed legacy infrastructure to rot.[7] In too many rural areas and small towns in America, people cannot reliably reach 911 on a good day, let alone in the wake of a catastrophe. In the 20th century, our telecommunications infrastructure was the envy of the world. We reached 98% of the population with reliable, affordable voice service. Today, we have communities that lack basic phone service, and those who have access to modern networks can wake even on a sunny day to find themselves cut off from vital services for no apparent reason -- and for an unknown time.

In addition to these nationwide problems, specific geographic areas and Tribal lands may face unique challenges. As we saw in the aftermath of Hurricane Maria, restoring service to islands presents a set of challenges not shared by mainland communities. This includes reliance on undersea cables, which may be damaged in a disaster, and the high cost of transporting equipment and supplies to the impacted area. Extreme temperatures in desert Tribal lands can range in excess of 59 degrees in a day.[8] The stress these temperature swings put on networks creates challenges for maintaining connectivity and requires additional hardening to withstand

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[3] *Id*. at 14-15 (From 2009 to 2016, the annual median duration of wireless outages attributed to accidents ranged from 8 hours to 16 hours, compared to natural disasters, which ranged from 19 to 36 hours.)

[4] *Id.* at 10. *See also* Mariah Timms, *AT&T Outage: Internet, 911 Disrupted, Planes Grounded, After Nashville Explosion*, Nashville Tennessean (january 5, 2021).

[5] April 2014 Multi-State 911 Outage: Cause and Impact, *Report and Recommendations*, PS Docket No. 14-72 (Pub. Safety Bur. 2014), 29 FCC Rcd 9327 (2014). Bishr Tabbaa, *Busy Signal: Behind CenturyLink's 911 Service Outage of 2014*, Medium, April 2019 ("On the early morning of April 9 2014, more than 6000 calls to 911 failed to reach call centers during a system outage that lasted more than six hours and affected a population of 11 million US residents living in 60 counties across seven states including Washington, North Carolina, South Carolina, Minnesota, California, Florida, and Pennsylvania. Networks owned by CenturyLink, Verizon, and others were involved with the outage, and the root cause of the failure was related to a software defect in the call routing service of Intrado, a 3rd party contractor used by the telecommunication providers.")

[6] Jon Brodkin, T-Mobile Screwups Cause Nationwide Outage, but FCC isn't Punishing Carrier, *ArsTechnica,* Oct. 23, 2020.

[7] *Kristina Panos, DSL is Hanging on the Line as Telcos Stop Selling New Service,* Hackaday, Oct. 29, 2020. In re Technology Transitions, Policies and Rules Governing Retirement of Copper Loops by Incumbent Local Exchange Carriers, Special Access for Price Cap Local Exchange Carriers AT&T Corporation Petition for Rulemaking to Reform Regulation of Incumbent Local Exchange Carrier Rates for Interstate Special Access Services, WC Docket No. 05-25, GN Docket No. 13-5 RM-11358 RM-10593, *Report and Order, Further Notice of Proposed Rulemaking, and Order on Reconsideration*, 30 FCC Rcd 9372 (2015) at ¶¶ 90-92.

[8] *Weather and Climate Inventory National Park Service Sonoran Desert Network*, National Park Service Sonoran Desert Network at 10 (2007).

these ranges. Additionally, challenges exist in communities where terrain such as mountains or forests may hamper post-disaster restoration efforts, or in sparsely populated rural areas. In urban areas, it is imperative that providers and local governments invest equally in traditionally marginalized communities such as minority and low-income neighborhoods. Tribal authorities need to be empowered and resourced to restore communications on Tribal lands and to coordinate as equals with state and federal authorities.

Only Congress can remedy this situation. For reasons I will discuss in greater detail below, it is unrealistic to expect the market to solve this on its own. Public safety has always been regarded as a classic case of "market failure," because market forces alone cannot ensure the optimal result. Widespread deregulation of IP-based services at the state level and by the Federal Communications Commission (FCC) has had the unintended consequence of muddying the overall authority of the agency and the states to ensure network reliability as they traditionally did for the analog phone network.

Additionally, post-disaster restoration of modern communications networks requires coordination across multiple industries, federal agencies, and local authorities, further diluting the ability of a single agency such as the FCC to address these resiliency problems without new Congressional authority. A GAO report released this month found that the failure of the Department of Homeland Security (DHS) to clarify the FCC's role in network restoration post-disaster significantly impeded the restoration of communications networks in Puerto Rico.[9] Disaster relief has not traditionally prioritized restoration of communications. Federal and state agencies have not uniformly recognized the vital importance of restoring communications to the overall disaster recovery. Restoring communications to the public, not merely to first responders, is critically important to modern public safety and disaster response. The Wireless Emergency Alert System (WEAS) and the Integrated Public Alert Warning System (IPAWS) are the most obvious examples of the need to restore communications to the public as well as maintain communications for first responders. But the flow of communications in an emergency is two-way, especially as telemedicine becomes more integrated into our healthcare system and emergency response. Restoring communications to everyone needs to be fully integrated with disaster response efforts in the same way restoring power or clean water is prioritized. Only a clear mandate from Congress can make this happen across federal, state, and local authorities.

Happily, the current transition of our national wireline networks to all-IP systems, and our deployment of 5G wireless networks, provides an ideal opportunity for Congress to act. As we upgrade to an all-IP framework, retire legacy copper networks, and build out 5G, we can upgrade our resiliency standards to take advantage of the new technical capacities of these networks. In the days of the AT&T monopoly, we could require the network be hardened to

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[9] GAO, Telecommunications: FCC Assisted in Hurricane Maria Network Restoration, but a Clarified Disaster Response Role and Enhanced Communication Are Needed, available at https://www.gao.gov/assets/gao-21-297.pdf (Apr. 2021).

99.999% ("five 9s") reliability and incorporate the added cost into the regulated rate. That approach is simply not viable today. We enjoy the fruits of competition enabled by IP-based services. We welcome the ability to break up functions and aggregate functions in ways that were impossible using older technologies, because, when done correctly, doing so enables providers to offer better service more efficiently. IP-based services can allow local providers to offer their communities the same level of service as in larger markets at an affordable cost, taking advantage of the economies of scale from a world-wide market in IP-based and mobile equipment.

At the same time, we must recognize the inherent weaknesses of IP-based and mobile technologies. First and foremost, these systems need power. Not merely power to cell phone towers and network operating centers, but power in the home. The traditional copper landline system was self-powered. It could operate even when the electric grid went down. Modern IP-based landlines and mobile networks are not self-powered. Mandatory back-up power requirements must include mandatory back-up power in people's homes as well as to cellular towers.

Moreover, the traditional landline network had clear lines of responsibility for maintaining reliable communications. Modern systems may be distributed among numerous vendors and network operators without a clear understanding of the architecture. As a result, it can take hours for a network operator to become aware of the scope and extent of an outage, and even more time to find the source of the outage. Cheap off-the-shelf equipment dramatically lowers cost, but may not be as reliable as custom-built equipment.

Finally, for competition to work, markets need information. If we want carriers to prioritize resilience and reliability, we must make it possible for them to reap the rewards of these efforts. The current reporting requirements treat network outage information as confidential business information. Publicly available information, such as the Disaster Information Reporting System (DIRS), suffers from being voluntary and from homogenizing the information to prevent comparison in performance between carriers. As a result, subscribers who wish to prioritize reliability over cost savings have no information on which to make that choice. Investment in reliability will produce no reward, and failure to invest in reliability will have no lasting consequence. Carriers are therefore disincentivized from investing in resilience and reliability.

Public Knowledge has several specific recommendations that address these factors, which I provide at the end of my testimony.

I.   WHY CONGRESS MUST ACT

In the days of traditional landline networks, Congress typically left issues of reliability to the states, with broad support from the FCC under Section 1 and Section 214 of the Communications Act.[10] This approach made sense at a time when the primary communications providers were closely regulated monopolies with self-powered networks. But today's universe is radically different. Some of these differences reflect changes in technology. Some differences reflect the increased centrality of communications in all aspects of our lives, including disaster recovery. Some differences are the result of deliberate policy choices that have allowed our communications infrastructure to grow increasingly fragile. Only Congress can provide the necessary guidance, authority, and resources to ensure that our national communications infrastructure can reliably meet our needs -- whether in times of crisis or in our daily lives.

It is worth noting that Congress has, in the past, stepped in where necessary to create national policy and provide funding for implementation. For example, as part of the 1996 Act, Congress established the 911 system as our national emergency number, creating needed uniformity.[11] In 2008, Congress required all providers of public safety access points (PSAPs) to interconnect with providers of advanced communications services regardless of regulatory classification.[12] Congress has provided funding for the national first responder network, FirstNet, as well as funding for E911.[13] While the scope of the challenge here is significantly greater, it is not unprecedented.

A. Moving From a Single, Regulated Monopoly Network to Multiple, Competing Networks Has Fundamentally Altered the Communications Landscape.

To appreciate why our communications networks have gone from robust and resilient to fragile and unreliable, we must briefly review how our modern network ecosystem evolved. In the 1990s, two technologies began mass deployment: mobile networks and the internet. These technologies were in their infancy and therefore we expected only "best efforts" service. To be clear, "best efforts" does not mean that the providers are cavalier about the quality of their service. Best efforts means that customers are not entitled as a matter of right to a particular quality of service. Instead, all the provider promises is to make best efforts to deliver the message. For the vast majority of uses in life, "best efforts" is good enough. This is particularly true because IP-based technologies are designed to deal with the lack of reliability in best efforts

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[10] 47 U.S.C. §§ 151, 214.
[11] Codified at 47 U.S.C. § 251(e)(3).
[12] *New and Emerging Technologies 911 Improvement Act of 2008*, Pub. L. No. 110-283, 122 Stat. 2620 (2008) (NET 911 Act) (amending Wireless Communications and Public Safety Act of 1999, Pub. L. No. 106-81, 113 Stat. 1286 (1999) (Wireless 911 Act)).
[13] *Middle Class Tax Relief and Job Creation Act of 2012*, Pub. L. No. 112-96, Title VI (Spectrum Act of 2012), § 6409(a), 126 Stat. 156, 232-33 (Feb. 22, 2012) (codified at 47 U.S.C. § 1455(a)).

networks. Packets are broken up and can move along multiple pathways and multiple networks. Wireless networks must move from tower to tower without dropping the call, and between networks for roaming when the carrier lacks sufficient capacity.

This inherent flexibility not only produced cheaper service but also allowed new, competitive offerings. It enabled carriers to break up functions that traditionally had to be done in the "core" of the network and allowed these functions to take place at the edge. For example, in the traditional network, the local incumbent telephone network maintained the local PSAP networks. As networks evolved, new companies emerged capable of managing PSAPs on multiple networks. Packet switching allowed carriers to employ multiple routes for the same transmission instead of relying on and using a single circuit for each call. It also allowed them to outsource routing to specialized companies that could find the most efficient and least expensive routes. New services, such as video and geolocation, were easy and cheap to support when compared to the traditional regulated public switched telephone network (PSTN). Best efforts allowed these technologies to grow and proliferate.

These advantages also gave rise to significant issues. First, packet-switched technologies and mobile technologies are not self-powered. When the power goes out, communications stop. But as recently as 2019, the Senior Director of Emergency Preparedness for California's electric utility PG&E advised people to use landlines to communicate during power blackouts without any apparent awareness that modern landlines are not self-powered.[14] Networks have grown so complex that *even the companies themselves* cannot predict how a failure in one part of the network impacts another part of the network. Nor is it clear whether a service is being provided by the carrier itself or by a contractor. This can make it difficult to trace the source of an outage, or take the needed steps to resolve the outage.[15]

As long as self-powered traditional copper networks provided a reliable service alternative, the policy of treating competing networks as best efforts was manageable from a public safety perspective. Any traffic too important for best efforts went over the telephone networks. The failure of a dial-up internet service provider might be an inconvenience, but hardly a matter of life and death. As long as people kept a traditional copper landline, they could guarantee themselves reliable access to 911 and to communications even during a power outage.

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[14] Jonathan J. Cooper and Julliet Williams, *Anger Grows as Utility Struggles to Get Its Blackouts Right*, Associated Press (Oct. 31, 2019) (quoting PG&E Senior Vice President for Disaster Recovery as urging people to get blackout information "the old fashioned way, through calling on a landline").
[15] *See* Tali Arbel, *Over 12,000 Calls to 911 Failed in AT&T Outage*, Baltimore Sun (March 23, 2017) (network configuration error); December 27, 2018 CenturyLink Network Outage Report (single server generating malformed packets disabled the entire network); April 2014 Outage Report *supra* note 5 ("preventable coding error" in contractor's router created multi-state 911 outage).

Today, however, mobile networks and IP-based networks have long displaced traditional copper as the primary communications networks for the majority of the public.[16] Indeed, it has become our national policy to sunset the traditional PSTN and transition to an all IP-based communications network. Additionally, the services that used to be considered secondary to voice, such as video communications and data transmission, have now become critically important. In 2002, when a peering dispute between Cogent and America Online caused a severe slowdown of internet traffic in the D.C. region, it was an inconvenience.[17] Today, a comparable slowdown of internet traffic to the D.C. region would result in severe impacts on schools, businesses, and government operations.

B. Deregulation and Preemption Have Eliminated Needed Oversight By the FCC and the States.

Clearly we can no longer afford to treat these networks as best efforts. But neither federal nor state policy has kept pace with these changes. Despite debate over the growing use of voice-over-IP technologies and their potential to displace the traditional telephone network as early as 1998,[18] and a study of the impact on resilience from the phase out of the PSTN by the FCC's Technical Advisory Committee in 2013,[19] the FCC and the states have moved in the opposite direction. The FCC has imposed no reliability obligations on providers of broadband service -- not even outage reporting requirements. Most states have divested themselves of authority over IP-based services.[20] Even where states have retained (or reclaimed) authority over reliability requirements for voice service, the FCC has repeatedly acted to broadly preempt state authority to regulate either IP-based voice services or mobile voice services.[21]

The FCC has imposed certain limited obligations on interconnected VOIP providers and mobile voice providers (but not on their data or text messaging services). Mobile voice providers and interconnected VOIP providers must comply with the FCC's discontinuance notification rules under Section 214 of the Communications Act. In theory, this requires providers to

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[16] Federal Communications Commission, Communications Marketplace Report, GN Docket No. 20-60, 35 FCC Rcd 13188 at para. 147, Dec. 2020 ("as of December 2019, residential fixed voice connections were about 30% switched access and 70% interconnected VoIP, with residential switched access connections comprising only 14.4% of all fixed retail voice connections.").

[17] 'Peering' Dispute With AOL Slows Cogent Customer Access, *The Washington Post,* July 2012.

[18] *Federal-State Joint Board on Universal Service*, CC Docket No. 96-45, Report to Congress, 13 FCC Rcd 11501(1998) (Stevens Report).

[19] Post-PSTN Public Network Resiliency: FCC Technological Advisory Council: Communications Resiliency Working Group, Dec. 2013.

[20] Telecommunications Oversight 2017: A State Perspective, National Regulatory Research Institute (2018) ("As of December 2017, 35 states had passed legislation limiting direct oversight of the retail wireline telecommunications services provided by the large incumbent price cap service providers. In addition, Iowa, Pennsylvania, New Jersey, and Rhode Island had reduced oversight in either all or part of the state after a formal commission examination and review proceeding.").

[21] *See Charter Advanced Services, LLC v. Lange,* 903 F.3d 715 (8th Cir. 2018); *MN PUC v. FCC,* 483 F.3d 570 (8th Cir. 2007).

demonstrate that discontinuing or impairing service to the community will not harm the public interest.[22] Streamlined discontinuance processes, however, allow discontinuances to be granted with little review. Interconnected VOIP and mobile voice providers are obligated to participate in the FCC outage reporting system.[23] As with all participants in the NORS and DIRS systems, these reports are kept confidential, preventing subscribers from making provider choices based on reliability.

Additional problems have emerged as providers of copper networks continue to discontinue these networks. In 2017 and 2018, the FCC relieved carriers of the bulk of their obligations to provide notice to customers when discontinuing networks. The FCC also eliminated the requirement to provide a comparable replacement network. Carriers may now discontinue all legacy copper service by asserting the presence of a broadband provider with sufficient capacity to support a VOIP product regardless of whether the broadband provider offers facilities-based VOIP.[24] The FCC also eliminated customers' ability to file complaints when carriers simply allow facilities to rot or fail to replace facilities after a disaster. As a consequence, customers currently served by legacy copper have no enforceable right to continued service, let alone reliable and resilient continued service.

Unfortunately, the FCC is not alone in deregulating even the legacy telephone network. The majority of the states have broadly deregulated their legacy telephone networks as well as IP-based networks. Those states that have investigated after deregulation have found that legacy networks have fallen into widespread disrepair -- particularly in rural areas.[25] Many of these rural areas lack cable systems or wireless networks; when the legacy copper stops working, communications in these regions simply *stops*. As a consequence of permitting legacy carriers to abandon, or constructively abandon, their networks, we now have communities in the United States that lack even basic 20th century communications infrastructure.

Finally, the FCC has taken affirmative steps to limit its own authority over communications networks. The FCC reclassified broadband service (fixed and mobile) as a Title I service in 2017, abandoning the agency's traditional authority to require network resilience and reliability. Given the 2017 Order's elimination of Section 706 (47 U.S.C. 1302) as an alternative source of authority over broadband, and general determination that it lacks significant ancillary

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[22] 47 U.S.C. § 214.

[23] *See* FCC Network Outage Reporting System (NORS) and Disaster Information Reporting System (DIRS).

[24] Accelerating Wireline Broadband Deployment by Removing Barriers to Infrastructure Investment, *Report and Order, Declaratory Ruling, and Further Notice of Rulemaking*, WC Docket. No. 17-84, 32 FCC Rcd 11128 (2017); Accelerating Wireline Broadband Deployment by Removing Barriers to Infrastructure Investment, *Second Report and Order*, WC Docket No. 17-84, 33 FCC Rcd 5660 (2018).

[25] In re Commission Inquiry into the Service Quality, Customer Service, and Billing Practices of Frontier Communications, P407, 405/CI-18-122 (2019); *see generally Telecommunications Service Carriers' Service Quality Report*.

authority over broadband, it is unclear whether the FCC could even require broadband networks to provide mandatory outage reports.

It is also uncertain to what extent the FCC will retain authority over interconnected VOIP providers or mobile providers. The FCC has declined to classify interconnected VOIP. In the Orders imposing outage reporting requirements on interconnected VOIP providers, the FCC has relied on both its Title II authority (in the event interconnected VOIP is Title II) and its "ancillary authority" as ancillary to Title II. When the legacy copper network is retired, however, any existing ancillary authority will disappear. In other words, if the Commission's efforts to sunset the PSTN in the next few years are successful, the Commission will have effectively terminated its authority over the landline communications network.

A similar fate awaits the FCC's authority over mobile networks. Section 332(d) defines Commercial Mobile Radio Networks (CMRS) as mobile networks that provide service to the public when interconnected with the "public switched network."[26] The 2017 "Restoring Internet Freedom Order" explicitly defined the "public switched network" as consisting of the traditional legacy phone network.[27] Once the existing legacy phone network is retired, CMRS will cease to exist as a legal category. All mobile services will be "Private Mobile Radio Service" (PMRS). While the Commission will arguably retain its Title III authority over mobile providers, it is unclear how much that authority allows it to regulate in the name of reliability and resilience. When the FCC attempted to impose a backup power obligation on licensees following Hurricane Katrina, the rule was challenged in the D.C. Circuit.[28] Because the case was rendered moot by the FCC withdrawing the relevant regulation,[29] the question of the FCC's Title III authority to impose reliability and resiliency regulations remains unresolved.

Finally, the Trump FCC consistently refused to acknowledge any authority to address issues of cybersecurity. The United States is thus the only developed nation whose telecommunications regulatory affirmatively avoids any consideration of cybersecurity as part of its deliberations. For the last four years, the FCC has assiduously avoided any hint of leadership or oversight in securing our critical communications infrastructure from cyber threats. This leaves, and will continue to leave until remedied, a giant and exploitable hole in our defenses. It is ironic indeed that the Federal Energy Regulatory Commission and Department of Energy have a mandate from Congress to consider cybersecurity threats to the electric grid and energy infrastructure, and meanwhile the Department of Transportation considers cybersecurity concerns to our transportation infrastructure, but the Federal Communications Commission is considered unsuited to protect the internet from cybersecurity threats. The humor of this

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[26] 47 U.S.C. §332(d).

[27] *Restoring Internet Freedom*, Declaratory Ruling, Order, Report and Order, WC Docket No. 17-108, 33 FCC Rcd 311, 355 para.75 (2017).

[28] RCR Wireless, Appeals Court Questions FCC Authority on Backup Power Rule, May 9, 2008.

[29] Matthew Lasar, FCC: Back to Square One on Cell Phone Tower Backup, Ars Technica (Dec. 8, 2008)

delightful irony will, alas, be of small comfort in the event our communications infrastructure is subverted by state-sponsored hackers or criminals seeking ransomware.

II.   Unregulated Markets Are Not Capable of Adequately Protecting Resiliency.

Carriers and proponents of deregulation have justified the risk to public safety by arguing that carrier's have sufficient financial incentive to invest in resilience and reliability.[30] There are several problems with this. First, empirical evidence clearly contradicts this hypothesis. As noted above, the number of outages and the length of outages have both *increased* with deregulation -- not decreased. Rural communities have seen legacy networks degrade and disappear without replacement by the promised advanced networks. Even setting this empirical evidence aside, classic economic theory demonstrates why public safety concerns such as network resiliency have traditionally been considered a case of market failure requiring regulatory intervention to achieve the desired result.

First, as noted above, networks have become far too complicated for carriers to assess what is required to maintain resiliency. This is why "sunny day" outages keep occurring. Fragility in the network from equipment failure or routing errors only becomes apparent after the fact. Nor can carriers force electric utilities to cooperate with them and agree to prioritize services. Carriers cannot prevent third parties from cutting fiber lines. While carriers can -- and should -- do more to improve their own networks, they cannot address the entire problem. Only the federal government can do that.

Second, while carriers have incentive to avoid outages, they also have substantial incentive to cut costs -- especially where investment does not yield back immediate short-term profit. This makes carriers especially subject to what is called the "optimism fallacy." Carriers believe that their preparations are sufficient because they take an optimistic view of likely outcomes (even when preparing for the worst). While economics likes to conceptualize corporations as rational actors immune to wishful thinking, corporations are managed by human beings. We should therefore expect that while those closest to the problem have valuable expertise, they may also have their own difficulty in remaining objective.

Third, even putting that aside, carriers that invest in reliability cannot expect to be rewarded for their efforts in the market. Because the FCC keeps reliability data confidential, customers cannot make purchasing choices based on reliability. Certainly carriers can (and do) claim to have the "most reliable network," but why should consumers believe these advertising claims? And even a network that is "most reliable" on average nationwide may not be particularly reliable in a specific county or recover quickly after a natural disaster.

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[30] *Technology Transitions; USTelecom Petition for Declaratory Ruling That Incumbent Local Exchange Carriers Are Non-Dominant in the Provision of Switched Access Services*, GN Docket No. 13-5, WC Docket No. 13-3, RM-11358, Declaratory Ruling, Second Report and Order and Order on Reconsideration, 31 FCC Rcd 8283 (2017).

By contrast, carriers will generally escape consumer backlash after a disaster-based outage because consumers blame the storm for the damage. Even when service is particularly bad by a specific carrier, outages are rare enough that consumer memory fades over time. Additionally, consumers face the uncertainty over whether the carrier they switch to will be a significant enough improvement in reliability to justify the cost and aggravation of switching. Finally, if mandatory network sharing agreements are in effect (which they should be), carriers that invest in more reliable networks face a free-rider problem. Other networks that chose to invest less in reliability will still remain operational by leveraging the responsible carrier's investments in resiliency. Because the public has no way of knowing that these networks are only operational as a consequence of the "prudent carrier's" investment, the prudent carrier will receive no recognition or marketplace reward for prioritizing network resiliency. Instead, the investment will reward the rival who failed to adequately prepare.

Finally, we must recognize that most of the costs we are concerned about do not fall directly on the carrier. Loss of business revenue, or even loss of life, from a communications outage is not charged to the carrier, whereas the cost of making reliability investments is. It is rational for carriers to discount the external costs. This is also why the federal and state governments should not only require carriers to meet standards of reliability, but also invest public money. While it is appropriate to have communications carriers serve the public interest as well as their private interests, it is equally appropriate for public money to be spent for broad societal benefits.

III.   RECOMMENDATIONS

Public Knowledge notes that Senators Markey and Wyden have introduced a bill that would address many of the problems of network resilience, and provide incentives to do so in an environmentally sustainable manner. Public Knowledge is pleased to support the Generating Resilient and Energy Efficient Network (GREEN) Communications Act as an important step forward. In addition, Public Knowledge endorsed the RESILIENT Act introduced last Congress in the House by Chairman Palone and Representative McNerny. These two bills are examples of Congressional action that would help to restore reliability to our critical communications infrastructure.

Public Knowledge makes the following recommendations for Congressional action. While some of these are reflected in the GREEN Communications Act, or were reflected in the RESILIENT Act, others were not. We hope you consider including these recommendations in any future legislation:

1.   *Provide the information necessary for proper planning and for the market to reward investment.* Direct the FCC to combine the National Outage Reporting System (NORS) NORS and the Disaster Information Reporting Service (DIRS) into a single, publicly available database that permits the public to identify carrier performance on a granular level. Direct the FCC to conduct a full report after every significant outage.

2.   *Provide clear authority to the FCC and the States.* Clearly empower the FCC and states to create necessary rules for network reliability, cybersecurity, and cooperation among relevant stakeholders. Congress should direct DHS to fully integrate the FCC into its disaster response in line with the GAO recommendations. Additionally, Congress should require the FCC and the Department of Energy to develop enforceable guidelines for cooperation between power companies and communications providers.

3.   *Create metrics necessary to set standards and promote accountability.* Require the FCC, National Telecommunications Information Administration (NTIA), National Institute of Standards (NIST), and the Department of Homeland Security (DHS) to develop suitable metrics to measure reliability and resiliency for wireline, fixed wireless, mobile terrestrial wireless, and satellite networks.

4.   *Promote sustainability and avoid environmental degradation.* Require further study to create recommendations for environmentally friendly and sustainable solutions, and to reduce existing practices that risk degrading the environment.

5.   *Make federal and state assets available in disaster recovery.* Permit and encourage the federal government and state governments to make available in an emergency communications resources such as fiber, spectrum, operating government networks, or other assets to communications providers to restore communications to the general public.

6.   *Fund network upgrades that promote reliability.* Provide federal money to pay for necessary upgrades to communications networks to enhance reliability. In particular, provide funding to replace aging copper networks with modern fiber networks built to modern resiliency standards. Where legacy carriers wish to retire their copper networks without replacement, create incentives to sell these networks to alternative providers (including state or local governments, community anchor institutions, and cooperatives) willing to provide wireline service. Additionally, federal grant programs that fund deployment should include mandatory reliability metrics.

7.   *FCC studies that address the specialized needs of specific communities.* Require the FCC to report to Congress on the special needs of island communities, geographically

isolated communities, Tribal lands, low-income and traditionally marginalized communities of color, and communities in environmentally sensitive areas. The report should include steps the FCC will take under its existing authority to address identified special needs, and recommendations to Congress for any other necessary action.

Thank you. I am pleased to answer any questions you may have.