TELECOMMUNICATIONS

FCC Assisted in Hurricane Maria Network Restoration, but a Clarified Disaster Response Role and Enhanced Communication Are Needed

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Why GAO Did This Study

Hurricane Maria battered Puerto Rico and the U.S. Virgin Islands in 2017, causing great physical harm to residents and severely damaging the islands' critical infrastructure, including telecommunications networks (see photo). Federal agencies faced unprecedented challenges in the hurricane's aftermath that complicated efforts to address telecommunications outages. While DHS is the lead agency in federal disaster response, FCC has a supporting role related to telecommunications issues.

GAO was asked to review FCC's response to telecommunications outages after Hurricane Maria. This report examines (1) FCC's actions to support telecommunications restoration after Hurricane Maria and the extent to which FCC's disaster response role is clearly defined, and (2) FCC's efforts to identify lessons learned with public input and the extent to which FCC publicly communicated those efforts. GAO analyzed agency reports, assessed agency efforts against applicable criteria, and interviewed government officials and industry and advocacy representatives to obtain a range of non-generalizable viewpoints.

What GAO Recommends

GAO is making two recommendations including that DHS should update its emergency support function guidance to clearly define FCC's disaster response role, and that FCC should enhance the transparency of its operations by publicly reporting on its Hurricane Recovery Task Force. FCC and DHS concurred with the recommendations.

View GAO-21-297. For more information, contact Andrew Voh Ah at (202) 512-2834 or vonaha@gao.gov.

What GAO Found

The Federal Communications Commission (FCC) took several actions to support telecommunications restoration following Hurricane Maria. For example, FCC collected network outage information, provided staff assistance to Puerto Rico, created the Hurricane Recovery Task Force to support communications restoration in Puerto Rico and the U.S. Virgin Islands, and made funds available for network restoration. However, GAO found that FCC's disaster response role was unclear in guidance published by the Department of Homeland Security (DHS), even though the guidance states that all levels of government should understand their respective roles. In particular, DHS did not define specific actions for FCC in the emergency support function guidance related to restoring communications infrastructure; this lack of clarity could have contributed to confusion and delays in the hurricane's aftermath. By updating the emergency support guidance with FCC's role clearly defined, DHS could help to reduce confusion and leverage FCC's knowledge on new or evolving technologies that could assist in faster network recovery following disasters.

Aerial View of Downed Tower in Puerto Rico after Hurricane Maria, September 2017

Source: Telecommunications Regulatory Board of Puerto Rico. | GAO-21-297

FCC identified lessons learned to enhance its disaster response and recovery efforts following the 2017 Atlantic hurricane season and issued a report in August 2018 that included observations from four hurricanes, including Hurricane Maria. For example, FCC noted that it could enhance its role in training and improve its coordination with federal partners. However, specifically related to Hurricane Maria, GAO found that FCC obtained limited public input and that the Hurricane Recovery Task Force's efforts lacked transparency because FCC had not publicly communicated the task force's actions or findings. Lacking transparent communications on the task force's actions and findings, the public does not have a complete and accurate account of FCC's response efforts for Hurricane Maria; such an account could aid future disaster preparation. By publicly reporting the task force's efforts, FCC could help ensure territorial government officials and others understand what FCC has accomplished and what additional actions are needed to build telecommunications networks that are more resilient.

_____ **United States Government Accountability Office**

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Abbreviations

COVID-19	Coronavirus Disease 2019
DHS	Department of Homeland Security
DIRS	Disaster Information Reporting System
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
LTE	long-term evolution
PREPA	Puerto Rico Electric Power Authority
USAC	Universal Service Administrative Company
USF	Universal Service Fund
USVI	U.S. Virgin Islands

U.S. GOVERNMENT ACCOUNTABILITY OFFICE
A Century of Non-Partisan Fact-Based Work

441 G St. N.W.
Washington, DC 20548

April 29, 2021

The Honorable Frank Pallone, Jr.
Chairman
Committee on Energy and Commerce
House of Representatives

Dear Mr. Chairman:

In September 2017, Hurricane Maria battered the U.S. territories of Puerto Rico and the U.S. Virgin Islands (USVI), causing great physical harm to the islands' residents and severely damaging their critical infrastructure, including their telecommunications networks.[1] Hurricane Maria was one of the deadliest and costliest hurricanes to hit the U.S.[2] In particular, studies estimated that Puerto Rico lost more than 2,900 lives from September 2017 to February 2018,[3] and the hurricane caused over $100 billion in damages in Puerto Rico and $10 billion in USVI.[4] According to the Federal Communications Commission (FCC), Hurricane Maria caused significantly more damage to the telecommunications infrastructure in Puerto Rico and USVI than other 2017 hurricanes, such

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[1]For telecommunications networks, this report focuses primarily on wireless, broadband, and cable services.

[2]Hurricane Irma, a Category 5 storm, had struck the U.S. Virgin Islands and Puerto Rico 2 weeks before Hurricane Maria.

[3]Milken Institute School of Public Health, The George Washington University, *Ascertainment of the Estimated Excess Mortality From Hurricane Maria in Puerto Rico* (Washington, D.C.: Aug. 28, 2018). The George Washington University study commissioned by Puerto Rico estimated that from September 2017 through February 2018 there were 2,975 excess deaths (95 percent confidence interval: 2,658 to 3,290 deaths) in Puerto Rico as compared to the expected number of deaths had the hurricane not occurred. The researchers estimated the expected number of deaths using vital records data, population census data, and data on monthly net domestic migration. In August 2018, Puerto Rico revised its official death count to reflect the estimate from the George Washington University study. In addition, other publications have documented higher estimates of excess deaths over 4,645 deaths. *The New England Journal of Medicine*, "Mortality in Puerto Rico after Hurricane Maria," Special Article (Waltham, MA: July 14, 2018).

[4]According to FCC, the government of Puerto Rico estimated $1.5 billion in damage to communications networks.

as Hurricane Harvey in Texas and Hurricane Irma in Florida, resulting in much longer recovery times in the territories.

At the worst point following Hurricane Maria, 96 percent of telecommunications cell sites[5] were out of service in Puerto Rico and 77 percent were out in USVI, leaving residents without reliable and continuous access to voice and data communications.[6] Without telecommunication services, people were unable to call for help during a medical emergency, receive mobile weather alerts on floods and landslides, or apply online for federal assistance. Furthermore, citizens were unable to make credit- and debit-card transactions or ATM withdrawals to purchase necessary food, water, and supplies. As citizens and first responders are increasingly dependent on telecommunications, ensuring the resiliency and reliability of telecommunications networks in U.S. territories may prevent future loss of life. Further, telecommunications networks are especially important due to the enabling functions they provide across all critical infrastructure sectors. The loss of telecommunications in an emergency has cascading detrimental effects on other critical infrastructures due to interdependencies among sectors, including the transportation, medical, and financial sectors.

Although the private sector owns and operates the telecommunications infrastructure used to provide service to the public, federal agencies have significant roles in disaster response related to telecommunications infrastructure. The Department of Homeland Security (DHS) is responsible for protecting the nation's critical infrastructure, which includes the communications sector.[7] FCC, as the U.S. authority regulating telecommunications, supports and advises DHS with respect to

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[5]A cell site is defined as the entire set of equipment needed to receive and transmit radio signals for cellular voice and data transmission.

[6]FCC, *Communications Status Report for Areas Impacted by Hurricane Maria* (Sept. 21, 2017).

[7]Critical infrastructure sectors are systems and assets so vital to the United States that their incapacity or destruction would have a debilitating impact on security, national economic security, national public health or safety, or any combination of these matters. 42 U.S.C. § 5195c(e). Federal policy identifies 16 critical infrastructure sectors: chemical; commercial facilities; communications; critical manufacturing; dams; defense industrial base; emergency services; energy; financial services; food and agriculture; government facilities; health care and public health; information technology; nuclear reactors, materials, and waste; transportation systems; and water and wastewater systems.

telecommunications outages and restoration efforts during disasters.[8] Additionally, FCC can make funds available to support telecommunications network restoration and enhancement through the Universal Service Fund's high-cost program, which provides financial support to eligible telecommunications carriers to deploy voice and broadband services in areas that otherwise would not have service.[9]

You asked us to review FCC's response to the telecommunications outages in Puerto Rico and USVI in the aftermath of Hurricane Maria. This report examines:

- FCC's actions to support telecommunications restoration after Hurricane Maria and the extent to which FCC's disaster response role is clearly defined; and

- FCC's efforts to identify lessons learned with public input and the extent to which FCC publicly communicated those efforts.

Additionally, in appendix I we present information on FCC's funding for telecommunications restoration and enhancement in Puerto Rico and USVI.

To obtain information for this report, we reviewed relevant FCC orders and reports such as FCC's *2017 Atlantic Hurricane Season Report*, and other documents to understand its efforts and funding requirements to support telecommunications restoration and network resilience in Puerto Rico and USVI.[10] We also reviewed relevant information from our prior reports and others on network resilience and disaster response in Puerto

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[8]In addition to other responsibilities, FCC regulates nonfederal spectrum use.

[9]Through the multi-billion dollar Universal Service Fund, FCC has programs and policies to implement the universal service principle that all Americans should have access to communications services. For more information on FCC's high-cost program, see GAO, *Telecommunications: FCC Should Enhance Performance Goals and Measures for Its Program to Support Broadband Service in High-Cost Areas*, GAO-21-24 (Washington, D.C.: Oct. 1, 2020).

[10]*The Uniendo a Puerto Rico Fund and the Connect the U.S. Virgin Islands Fund*, Report and Order and Order on Reconsideration, FCC-CIR1909-01 (2019) and FCC, *2017 Atlantic Hurricane Season Impact on Communications* (Washington, D.C.: August 2018).

Rico and USVI on hurricane recovery.[11] Furthermore, we analyzed FCC's Disaster Information Reporting System (DIRS) data from September 2017 to March 2018 to understand the duration and cause of network outages after Hurricane Maria in Puerto Rico and USVI.[12] We took several steps to assess the reliability of DIRS data, such as reviewing FCC documentation and interviewing agency officials responsible for collecting and analyzing DIRS data, and found the data were sufficiently reliable to describe network outages after Hurricane Maria.

We interviewed officials from FCC and DHS who took part in the disaster response and recovery after Hurricane Maria to understand lessons learned and the status of those efforts. We also interviewed representatives from 30 stakeholders, including territorial government officials; telecommunications representatives (broadband, cable, and mobile); industry associations; government/industry committees; advocacy groups; and academics.[13] We selected the stakeholders to understand their perspectives on the information FCC communicated on network outages and government efforts to restore telecommunications; we obtained a range of non-generalizable viewpoints. We assessed lessons learned in FCC and DHS reports and the status of those efforts[14] against the *National Response Framework* and, in particular, Emergency

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[11]GAO, *Telecommunications: FCC Should Improve Monitoring of Industry Efforts to Strengthen Wireless Network Resiliency*, GAO-18-198 (Washington, D.C.: Dec. 12, 2017); GAO, *2017 Hurricanes and Wildfires: Initial Observations on the Federal Response and Key Recovery Challenges*, GAO-18-472 (Washington, D.C.: Sept. 4, 2018); GAO, *Puerto Rico Hurricanes: Status of FEMA Funding, Oversight, and Recovery Challenges*, GAO-19-256 (Washington, D.C.: Mar. 14, 2019); *U.S. Virgin Islands Hurricane Recovery and Resilience Task Force*, (2018); and Central Office of Recovery, Reconstruction, and Resiliency, *Transformation and Innovation in the Wake of Devastation: An Economic and Disaster Recovery Plan for Puerto Rico* (Aug. 8, 2018).

[12]DIRS is a web-based reporting system for telecommunications companies (wireless, wireline, broadcast, and cable companies) that wish to voluntarily report the operational status of their service and infrastructure during natural disasters such as hurricanes, wildfires, and earthquakes.

[13]We also interviewed two Puerto Rican residents who were identified for us by an advocacy organization.

[14]FCC, *2017 Atlantic Hurricane Season Impact on Communications* (Washington, D.C.: August 2018); DHS, *2017 Hurricane Season FEMA After-Action Report* (Washington, D.C.: July 12, 2018); DHS, *Puerto Rico Communications Information Technology Solutions Based Team (*Washington, D.C.: Jan. 17, 2019*); and* DHS, *Joint Operational Catastrophic Incident Plan of Puerto Rico* (Washington, D.C.: June 2019).

Support Function #2 of the framework, which covers communications,[15] as well as key practices for interagency collaboration.[16] Furthermore, we assessed FCC's efforts to publicly communicate information on its efforts to support telecommunications restoration against FCC's Strategic Plan,[17] past hurricane responses, OMB's *Open Government Directive*,[18] and federal internal control standards.[19] Appendix II describes our scope and methodology in greater detail.

We conducted this performance audit from February 2020 to April 2021 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

Telecommunications and Electric Power

Telecommunications networks depend on the availability of electric power. Following a hurricane, both sectors can be adversely affected by damaging winds and flooding, which could delay the restoration of telecommunications (see fig. 1). A report from the National Security Telecommunications Advisory Committee in 2006 highlighted the interdependencies between the telecommunications and electric power

[15]The *National Response Framework* is the part of the National Preparedness System established in Presidential Policy Directive 8 that is to be used to manage any type of disaster or emergency response, regardless of scale, scope, and complexity. The *National Response Framework* also identifies 14 Emergency Support Functions —such as communication, transportation, and energy—and designates a federal department or agency as the coordinating agency for each function.

[16]GAO, *Managing For Results*: *Key Considerations for Implementing Interagency Collaborative Mechanisms*, GAO-12-1022 (Washington, D.C.: Sept. 27, 2012). Specifically, we accessed efforts against the key practice of clarifying roles and responsibilities.

[17]FCC, *Strategic Plan 2018-2022* (Washington, D.C.).

[18]OMB, *Open Government Directive,* Memorandum M-10-06 (Dec. 8, 2009).

[19]GAO, *Standards for Internal Control in the Federal Government*, GAO-14-704G (Washington, D.C.: Sept. 10, 2014).

sectors as a critical component of the nation's security preparedness.[20] The report said that, in responding to hurricanes, the restoration of telecommunications and electric power must be given the highest priority after saving of life, and must include priority access to fuel, security, site access, and other logistical support such as staging areas for food and emergency response personnel.

Figure 1: Effects of Severe Storm Damage on Telecommunications and Electric Power Systems

Severe storms can damage telecommunications infrastructure and power grids. Telecommunications infrastructure depends on power grids to provide full service.

Damaged wireless towers

Offline network centers

Access to supplies

Blocked roadways

Repairing connections

Damaged wireless towers	Offline network centers	Access to supplies	Repairing connections	Blocked roadways
Storms can damage towers and antennas. Towers rely on the power grid to provide full service. Generators can supply temporary power, but must be refueled.	Network centers connect users. Storms can break the cables that link these centers to towers and antennas. Storms may also damage these facilities or cause them to lose power.	Without telecommunications, businesses may not be able to accept credit or debit card purchases and customers may not be able to withdraw cash from banks.	Optical fiber cables and power lines hung on utility poles may suffer damage. Repair crews depend on telecommunications to coordinate efforts to restore service.	Debris and damage may limit access to areas in need of repair or assistance. Isolated communities depend on telecommunications to reach aid.

Source: GAO. | GAO-21-297

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[20]National Security Telecommunications Advisory Committee, *Telecommunications and Electric Power Interdependency Task Force* (Jan. 31, 2006).

Key telecommunications network components—including switching centers, antennas at cell sites, and fiber cables—rely on power. Many devices—such as mobile phones, computers, and tablets—that emergency response personnel and the public depend on for information also rely on power. Telecommunications carriers can use battery backup and mobile generators as sources of short-term power during emergency situations. Some cell sites have extensive emergency backup capabilities and thus can support normal service for extended periods (weeks or months with appropriate refueling). Other sites have minimal emergency backup capabilities that might provide only a limited level of service, ranging from several hours to one day. Less centralized telecommunications assets, such as remote terminals and communications towers, typically have a battery backup for only a few hours. Portable generators must be deployed to these sites before the batteries discharge and service is interrupted. These generators are typically small and have fuel tanks that must be refueled frequently.

Prior to hurricanes Irma and Maria, the Puerto Rico Electric Power Authority (PREPA) and its electric power infrastructure was known to be in poor condition, largely due to underinvestment and poor maintenance practices.[21] Specifically, PREPA did not update or improve its electric generation and transmission systems, which hampered the systems' performance.[22] Hurricanes Irma and Maria left Puerto Rico's entire electricity grid inoperable, according to the economic and disaster recovery plan for Puerto Rico.[23] Some parts of Puerto Rico were without power for 11 months, and other parts did not regain electrical power until 18 months later. According to our analysis of FCC data, in September of 2017, 96 percent of cell sites were out of service in Puerto Rico—49 percent were not operational because of the power outage. However, by October 2017, the percentage of cell sites that were not operational due to power increased to 79 percent.

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[21]GAO, *Puerto Rico Electricity Grid Recovery: Better Information and Enhanced Coordination is Needed to Address Challenges,* GAO-20-141 (Washington, D.C.: Oct. 8, 2019).

[22]GAO-20-141.

[23]Central Office for Recovery, Reconstruction, and Resiliency, *Transformation and Innovation in the Wake of Devastation: An Economic and Disaster Recovery Plan for Puerto Rico* (Aug. 8, 2018).

Similarly, the Virgin Islands Water and Power Authority, which owns and operates most of USVI's energy infrastructure, also faced challenges before the hurricanes such as aging, inefficient, and oversized infrastructure and heavy reliance on imported fossil fuels. Hurricanes Irma and Maria damaged more than 90 percent of above-ground power lines and over 20 percent of the public utility's generation capacity, according to the *U.S. Virgin Islands Hurricane Recovery and Resilience Task Force* report.[24] Specifically, the hurricanes damaged more than 20,000 poles and 1,100 miles of transmission and distribution lines. The damaged poles affected telecommunications services because fiber cables were hung on these poles in both USVI and Puerto Rico (see fig. 2). For more information on the causes of the telecommunications outages in Puerto Rico and USVI see appendix III.

Figure 2: Examples of Damage Caused by Hurricanes Irma and Maria, September 2017

Sources: Viya and Telecommunications Regulatory Board of Puerto Rico. | GAO-21-297

Logistical and Other Challenges

Beyond restoring power, numerous other challenges affected response efforts in the aftermath of Hurricane Maria. Puerto Rico and USVI are located approximately 1,000 nautical miles from the U.S. mainland, and personnel, equipment, and other key resources to support disaster response and recovery had to be shipped or flown from the mainland to the territories. Given this distance, federal agencies faced challenges getting key personnel and resources from the U.S. mainland to Puerto

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[24]U.S. Virgin Islands Hurricane Task Force, *U.S. Virgin Islands Hurricane Recovery and Resilience Task Force*, (September 2018).

Rico and USVI in a timely manner before and after the hurricanes made landfall. For example, DHS officials told us it was not possible to pre-stage restoration supplies and equipment nearby prior to the hurricane, as would be the case for a hurricane headed toward the U.S. mainland. Furthermore, extensive storm damage to airports and seaports delayed and complicated response efforts. In the immediate aftermath of the hurricane, it was difficult to provide shelter for federal agency officials and telecommunications restoration crews. Moreover, as shown in figure 3, many roads and highways were unpassable because of damage and debris. According to telecommunications carriers we contacted, this hindered the ability of personnel or contractors to repair or replace equipment and deliver fuel for generators at cell sites. Additionally, they told us that fuel for the generators was also in short supply and that telecommunications equipment was often delayed at ports, subject to theft, or inadvertently damaged by debris removal crews.

Figure 3: Examples of Damaged Roads in Puerto Rico and the U.S. Virgin Islands, September 2017

Sources: Telecommunications Regulatory Board of Puerto Rico and Viya. | GAO-21-297

Disaster Response Roles and Responsibilities

Disaster response can involve many federal, state, local, territorial, tribal, private sector, and nongovernmental entities. The *National Response Framework* describes how these entities should respond to disasters and emergencies.[25] For example, state, local, tribal, and territorial governments are to play the lead roles in disaster response and recovery.

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[25]DHS, *The National Response Framework*. (Washington, D.C., Oct. 28, 2019).

Federal agencies can become involved in responding to a disaster when effective response and recovery are beyond the capabilities of the state and affected local governments. In such cases, the Robert T. Stafford Disaster Relief and Emergency Assistance Act permits the President to declare a major disaster in response to a request by the governor of a state or territory or by the chief executive of a tribal government.[26] Such a declaration is a key mechanism by which the federal government provides funding and coordinates response and recovery activities.[27] Under the *National Response Framework*, DHS is the principal federal agency for coordinating disaster response. Within DHS, the Administrator of the Federal Emergency Management Agency (FEMA) serves as the principal adviser to the President and the Secretary of Homeland Security regarding emergency management.[28]

In addition to DHS, at least 29 other federal agencies are part of the *National Response Framework's* Emergency Support Functions, which are key response-coordinating structures at the federal level.[29] In 2019, the *National Response Framework* identified 15 Emergency Support Functions—such as communication, transportation, and energy—and designated a federal department or agency as the coordinating agency for each function. For example, DHS designated FEMA and the Cybersecurity and Infrastructure Security Agency as primary agencies, and FCC is identified as a support agency for Emergency Support

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[26]42 U.S.C. § 5170.

[27]*Presidential Policy Directive-8 National Preparedness* (*PPD-8*) establishes a national preparedness system made of an integrated set of guidance, programs, and processes designed to strengthen the security and resilience of the United States through systematic preparation for the natural and human-caused threats that pose the greatest risk. This system breaks preparedness activities into five different lines of effort—prevention, protection, mitigation, response, and recovery—each of which requires a separate planning framework.

[28]6 U.S.C. § 313(c)(4).

[29]Emergency Support Functions are the federal government's primary coordinating structure for building, sustaining, and delivering response capabilities. There are 15 Emergency Support Functions, organized by specific functional areas for the most frequently needed capabilities during an emergency. Emergency Support Functions are designed to coordinate the provision of related assets and services by federal departments and agencies.

Function #2, dealing with communications.[30] DHS also supports 16 industry-led sector coordinating councils, including the Communications Sector Coordinating Council, that bring together representatives from private industry to collaborate with the government on critical infrastructure security and resilience activities.

In addition to supporting Emergency Support Function #2, FCC has other efforts and responsibilities related to disaster response. FCC's Strategic Plan 2018-2022 includes performance goals involving emergency public information and disaster management practices, and notes that FCC is committed to ensuring the public's safety at all times through the reliability of the nation's communications networks, and especially during natural and manmade disasters. FCC oversees a voluntary industry commitment by wireless providers to promote wireless communications and situational awareness during disasters, referred to as the Wireless Resiliency Cooperative Framework. FCC also collaborates with industry representatives through its federal advisory committees:

- the Communications Security, Reliability, and Interoperability Council, which has helped develop best practices for network resilience, and

- the Broadband Deployment Advisory Committee, which includes a Disaster Response and Recovery Working Group that issued a report with recommendations for improving disaster response by federal, local, and territorial government agencies and telecommunications carriers.

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[30]Following a disaster, Emergency Support Function #2 coordinates federal actions to help restore public communications infrastructure, facilitate communications restoration and response, and support response efforts. Emergency Support Function #2 also provides communications support to federal, state, local, tribal, and territorial governments and first responders when their systems have been affected.

FCC Took Several Actions to Support Telecommunications Recovery and Restoration, but FCC's Disaster Response Role Is Not Clearly Defined

FCC Supported Telecommunications Recovery Efforts by Collecting Outage Information and Other Efforts and Is Exploring Improvements to Its Data Collection System

After Hurricane Maria, FCC took several actions to support telecommunications recovery and restoration efforts in Puerto Rico and USVI, including collecting and reporting network outage information. According to FCC officials, FCC activated DIRS when Hurricane Maria made landfall in Puerto Rico on September 20, 2017, and collected information on network outages for 182 days, the longest period in FCC history. FCC shares these network outage data with DHS and releases limited outage data in public reports, called Communications Status Reports. FCC published and maintained a comprehensive webpage with the Communications Status Reports that it published daily between September 21 and November 17, 2017, and subsequently every 3 days until March 21, 2018. In total FCC published 107 reports in English and 79 reports in Spanish (the primary language spoken in Puerto Rico) during that time.

The Communication Status Reports included information on the number and percentage of cell sites that were out of service in each *municipio* in Puerto Rico or specific island in USVI, along with overall numbers for the territories.[31] FCC also provided information on the status of 911 call centers, cable systems, wireline telephone services, and broadcast radio and television stations. However, the effectiveness of this type of reporting was limited given that much of territories' populations did not have access to telecommunications services. FCC officials told us they did not know how many Puerto Rico or USVI residents were able to access the status reports. The officials noted that FCC is not subject to specific requirements with respect to communicating information to the

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[31]*Municipios* in Puerto Rico are similar to counties on the mainland.

public during a disaster. However, the officials said FCC endeavored to provide information that would be helpful to consumers. For example, in the October 22, 2017 status report, FCC noted that the "wireless companies had opened up roaming on the islands so that they, collectively, could serve the maximum population of the islands with the current coverage available."[32]

FCC reported that it received public comments and other feedback that both the publicly available, aggregated DIRS information and the non-public DIRS reports did not provide adequate information to reflect consumer communications experiences. FCC officials told us that DIRS does not capture data on the performance of network services—it captures information on whether particular network elements, such as switches or cell towers, are operational. Following Hurricane Maria, wireless telecommunications equipment came back online, operating at less than full capacity. FCC officials told us that measuring network performance would require a new data model. They added that this is a difficult problem because performance and service can vary over time for a myriad of reasons, particularly in the days following a disaster. For example, even when cell sites were restored, fluctuations in power levels and availability affected the performance of operational cell sites. Officials told us that incorporating network and service performance information in DIRS would require conversations with communications providers that participate in DIRS, which is a voluntary system. Officials told us they have not yet made any changes to the DIRS data model but added that changes are under consideration.

FCC also reported that it lacked an independent mechanism to verify information on the availability of wireless service submitted to DIRS by telecommunications carriers. At the time of our review, FCC officials told us that FCC was developing an app called "Speed Test" to enable consumers to test the performance of their mobile and in-home broadband networks and provide that data to FCC, which could help FCC to validate outage information reported in DIRS.[33] These officials also told

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[32]FCC. *Communications Status Report for Areas Impacted by Hurricane Maria* (Washington D.C.: Oct. 22, 2017).

[33]According to FCC, the network coverage and performance information gathered from the Speed Test data will help inform FCC's efforts to collect more accurate and granular broadband deployment data. FCC's Speed Test app was ready for consumers to download as of April 5, 2021, see https://www.fcc.gov/BroadbandData/consumers#speed-test.

us that they are working to further validate communications coverage by combining data from various sources, including FM, AM, digital television, and public safety broadcast information derived from on-site, over-the-air surveys using FCC's "Roll Call" sensors.[34]

At the time of our review, only DHS component agencies had direct access to all DIRS data, which according to DHS officials, they used to assess the telecommunications needs, identify trends over time, and coordinate the overall emergency response efforts with state and local first responders. DHS officials have noted issues with DIRS data, in terms of its timeliness, completeness, and accuracy. For example, DHS officials said there was a lag in the network outage data, which they addressed by coordinating with territorial agencies and telecommunications carriers to access detailed real-time data on the status of telecommunications services.

FCC has explored ways to improve access to network outage data for other government agencies to enable them to identify outage trends and enhance recovery and restoration efforts. In particular, in 2015, FCC requested comments on allowing federal, state, tribal, and territorial agencies direct access to network outage data.[35] Subsequently, FCC developed proposals and conducted meetings to collect viewpoints from industry, state public services commissions, trade associations, and other public safety stakeholders to understand the complexities of safeguarding network data. In February 2020, FCC proposed making improvements to DIRS because, according to FCC officials, the majority of comments supported sharing DIRS data directly with federal, state, tribal, and territorial agencies to help them prepare for or respond to an event that threatens public safety.[36] Specifically, FCC proposed a framework for granting these government agencies direct access to data that will assist

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[34]"Roll Call" allows FCC to identify disaster-related communications outages by analyzing radio signals before and after a disaster and comparing those results to the licensee database to determine which public safety or critical infrastructure systems are unexpectedly not in service.

[35]*In the Matter of Amendments to Part 4 of the Commission's Rules Concerning Disruptions to Communications*, Notice of Proposed Rulemaking, FCC 15-39, para. 51, 54 (2015).

[36]*In the Matter of Amendments to Part 4 of the Commission's Rules Concerning Disruptions to Communications,* Second Further Notice of Proposed Rulemaking, FCC 20-20, para. 15 (2020). The proposed rulemaking also included access to the Network Outage Reporting System, in addition to DIRS.

agencies in their efforts to keep the public safe while preserving confidentiality, ensuring appropriate access, and facilitating reasonable information sharing. In March 2021, FCC adopted the framework, which provides federal, state, local, and tribal entities read-only access to DIRS data.[37]

In addition to collecting and sharing network outage data, examples of other actions FCC took to support restoration, include:

- **Activating the Incident Management Team.** According to FCC, the Incident Management Team is a collaborative group of technical and policy experts that provided support to requests for information and requests for action from government entities, first responder agencies, and communications providers.

- **Providing staff assistance to Puerto Rico.** FCC officials told us in the immediate aftermath of the storm, FCC deployed staff in support of Emergency Support Function #2 to perform spectrum management activities and analysis to determine operational services. According to FCC officials, FCC staff traveled to Puerto Rico on a monthly basis to assist FEMA and local officials with network restoration issues until the Coronavirus Disease 2019 (COVID-19) caused the staff to halt travel in March 2020. FCC used these personnel, along with other remote monitoring systems, to analyze radio signals and determine the status of key broadcasters in affected areas.

- **Coordinating with carriers.** FCC officials and the carriers we interviewed told us FCC was in constant contact with the carriers to offer assistance. For example, one carrier told us that they had regular communication with FCC following Hurricane Maria and that FCC was very responsive and helpful. The carrier noted that FCC had granted it a special temporary authority license for temporary infrastructure assets to facilitate the carrier's ability to restore service. According to the FCC, it granted 879 special temporary authority licenses in connection with hurricanes Irma and Maria.

- **Creating the Hurricane Recovery Task Force.** FCC charged the task force with addressing the challenges facing Puerto Rico and USVI over the long-term recovery phase. During the course of its work, the task force made a number of recommendations to improve FCC's disaster response. For example, the task force recommended

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[37]*Amendments to Part 4 of the Commission's Rules Concerning Disruptions to Communications*, Second Report and Order, FCC 21-34 (2021).

that FCC should facilitate the addition of "backhaul providers" in the Wireless Resiliency Cooperative Framework.[38] To accomplish this, the task force recommended that backhaul providers and carriers cooperate to develop a process for sharing restoration information with one another and FCC, including a timeline of expected restoration efforts based on wireless providers' prioritized list of circuits or circuits designated for high traffic during emergencies.

- **Holding a public workshop.** In April 2018, FCC held a public workshop in Washington, D.C. to identify the communications needs of government and consumers to improve disaster preparedness and response with federal, Puerto Rican, and state government officials discussing hurricane and other natural disasters.[39]

- **Providing funding for network restoration.** FCC made funds available from the Universal Service Fund (USF) to help telecommunications carriers operating in Puerto Rico and USVI restore, expand, and upgrade their networks. Specifically, FCC awarded $601 million from the USF high-cost program to support carriers operating in the territories.[40] For additional information on the funds FCC made available, see appendix I.

FCC Lacks a Clear Role in the National Response Framework

Although FCC supported disaster response and recovery following Hurricane Maria, we found that FCC's role in responding to disasters is undefined in the *National Response Framework* and, more specifically, that the Emergency Support Function #2 guidance does not include any specific actions for FCC. This guidance coordinates federal actions to help restore communications infrastructure and service following disasters. DHS listed FCC as a support agency in the current edition of

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[38]"Backhaul" is the portion of a broadband network that links local access points and end users to the main internet network. In wireless telecommunications, backhaul providers connect cellular antenna networks and the main internet network. The Wireless Resiliency Cooperative Framework is a voluntary industry commitment to promote resilient wireless communications and situational awareness during disasters. *See Improving the Resiliency of Mobile Wireless Communications Networks, et al.,* Order, 31 FCC Rcd 13745 (2016).

[39]According to FCC, the purpose of the workshop was to ensure FCC was collecting the critical information necessary to best support the preparedness and response activities of stakeholders to facilitate the availability and reliability of communications during emergencies, disasters, and significant events.

[40]The high-cost program provides subsidies (referred to as "support") to carriers that provide voice and broadband services in areas the carriers would otherwise not serve and where there is no competition from other unsubsidized carriers. The program support is targeted to areas that are costly to serve because, for example, the customer base is relatively small and the cost of installing infrastructure is high. For more information on the high-cost program, see GAO-21-24.

the Emergency Support Function #2 guidance, published in 2016, along with other federal agencies, such as the departments of Commerce and Defense. However, at the time of our review, the Emergency Support Function #2 guidance did not list specific actions for FCC. In contrast, Emergency Support Function #2 lists multiple actions for other agencies. Further, we also found that the 2008 edition of Emergency Support Function #2 did include specific actions for FCC. For example, the 2008 guidance instructed FCC to collect, compile, and analyze communications infrastructure and service outage and restoration information as well as to assist with developing and conducting communications restoration training and exercises.

FEMA recommended in July 2018 that it work with its partners to revise the *National Response Framework* and, as required, the Response Federal Interagency Operational Plan to emphasize addressing the interdependencies and cascading effects among critical lifelines and cross-sector coordination.[41] FEMA stated that this updated framework should focus efforts on the rapid stabilization of critical lifelines, such as power, communications, health, food and water, and transportation. DHS updated the *National Response Framework* in October 2019 but has not updated its Emergency Support Function #2 guidance to reflect FCC's role in coordinating federal efforts with the telecommunications industry. DHS officials told us they have not updated their Emergency Support Function #2 guidance because the 2019 update occurred outside of the regular update cycle to create Emergency Support Function #14, which focuses on cross sector and business infrastructure.[42] DHS officials said that due to the size, degree of coordination required, and importance of speed in these updates all resources were focused on developing Emergency Support Function #14. Consequently, DHS did not perform a full review and revision of the *National Response Framework* and related guidance documents.

Participants in FCC's April 2018 public workshop noted that FCC could take a larger role in Emergency Support Function #2. In particular, they asked FCC to be more assertive in Emergency Support Function #2 exercises and training for regional and local emergency management

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[41]FEMA, *2017 Hurricane Season FEMA After-Action Report* (Washington, D.C.: July 12, 2018).

[42]Emergency Support Function #14 supports the coordination of cross-sector operations, including stabilization of key supply chains and community lifelines, among infrastructure owners and operators, businesses, and their government partners.

agencies. FCC officials told us that FCC participated in joint Emergency Support Function exercises in 2020 and is exploring memorandums of understanding with federal and state agencies to build stronger relationships and share information. Furthermore, FCC officials told us that FCC provided information to DHS in September 2019 regarding updates to Emergency Support Function #2. They added that this information included a recommendation to establish a communications section chief within DHS and update the Emergency Support Function #2 concept of operations to include FCC, in coordination with the Cybersecurity and Infrastructure Security Agency.

DHS's *National Response Framework* states that all levels of government (local, state, tribal, territorial, insular area, and federal) should understand their respective roles and responsibilities and how to complement each other in achieving shared goals. Further, key practices for interagency collaboration include clarifying roles and responsibilities.[43] It is imperative that each agency defines and agrees on its respective roles and responsibilities and understands the agency's role as a part of a larger effort. Interagency guidance that lacks an agency's role and responsibilities may create uncertainty during an emergency, potentially delaying disaster response efforts. For example, an official from the Puerto Rican government told us that there were a large number of federal agencies operating in Puerto Rico after Hurricane Maria and that it was not clear to the local government which one had what authority. Additionally, a telecommunications carrier representative told us that in the initial weeks following Hurricane Maria, there was chaos and no clear information on which federal agency was leading the restoration.

The absence of clear roles and responsibilities may also result in the underuse of FCC's technological expertise and hinder FCC from providing additional available support. We found opportunities exist for FCC to enhance future disaster preparation and response by identifying new and evolving technologies and participating in trainings and exercises on their appropriate use with other disaster-response agencies. FCC conducts engineering and technical studies, monitors emerging technologies, and issues experimental licenses to assist with the development of new communications technologies, among other functions. Through these efforts, FCC maintains expertise on new and emerging telecommunications technologies. For example, in Puerto Rico

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[43]GAO, *Managing for Results: Key Considerations for Implementing Interagency Collaborative Mechanisms*, GAO-12-1022 (Washington, D.C.: Sept. 27, 2012).

after Hurricane Maria, FCC used its authority to issue experimental licenses to allow new technologies to aid in providing telecommunications services, including wireless broadband provided by autonomous high-altitude balloons. However, one stakeholder told us that FCC did not coordinate with FEMA about this technology and that FEMA officials were unaware of how these experimental balloons functioned. This stakeholder added that FEMA officials were initially concerned that the signals from the balloons would interfere with FEMA's communications infrastructure. This stakeholder told us it took more than a week to brief FEMA officials about this technology and allay their concerns.

As the examples above illustrate, government organizations, both federal and local, may not be fully aware of all the capabilities FCC has, including available technologies or how they could use these technologies during disaster response. With clearer disaster response roles and responsibilities, FCC could better support training and provide information on new or evolving technologies that could assist with the rapid restoration of critical communications services following disasters.

FCC Identified Lessons Learned, but Its Efforts Were Informed by Limited Public Input and Not Fully Communicated

FCC Identified Lessons Learned with Limited Public Input

In August 2018, FCC reported lessons learned to enhance disaster response and recovery efforts in its 2017 Atlantic Hurricane Season Report.[44] FCC's report focused on hurricanes Harvey, Irma, Maria, and Nate and the resulting communications outages in various states and territories. FCC discussed lessons learned related to these hurricanes, such as improving DIRS data and enhancing FCC's role in training and exercises related to disaster response.

However, FCC did not have the benefit of substantial public input when developing its 2017 Atlantic Hurricane Season Report. FCC posted a

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[44]FCC, *2017 Atlantic Hurricane Season Impact on Communications Report and Recommendations Public Safety Docket No. 17-344* (Washington, D.C.: Aug. 24, 2018).

request for public comments on its response to the 2017 hurricane season to its website in December 2017; however, it is unclear the extent to which residents of Puerto Rico and U.S. Virgin Islands were able to respond. FCC gave the public until January 22, 2018, to submit comments either by uploading them to FCC's website or mailing them to FCC's Washington, D.C. office. However, many areas of Puerto Rico were still experiencing power outages, and some areas, such as the island of Vieques, still had a number of cell sites out of service during this comment period. For example, two Puerto Rican residents we interviewed told us they were without power and internet service for a period ranging from several months up to a year and were unfamiliar with FCC's efforts. We found some government entities from Puerto Rico and USVI, such as the Puerto Rico Telecommunications Regulatory Board, provided comments, but residents of the affected territories faced challenges providing comments to FCC due to the ongoing telecommunications outages.

In addition, FCC leadership held its first field hearing in Puerto Rico more than 2 years after Hurricane Maria, and 18 months after FCC issued its lessons learned report. In February 2020, FCC Commissioner Geoffrey Starks held a field hearing in Puerto Rico that addressed network resilience and the effects of Hurricanes Irma and Maria among other topics. FCC officials told us they did not hold a field hearing in the areas affected by Hurricane Maria earlier because they did not want to overburden Puerto Rico's restoration efforts. In 2017, then FCC Commissioner Jessica Rosenworcel commented that FCC's 2017 Atlantic Hurricane Season Report was not informed by field hearings, did not report solely on Hurricane Maria but rather combined four destructive hurricanes in one report, and failed to capture the gravity of Hurricane Maria.[45]

Following other disasters, FCC has reviewed telecommunications outages in a more transparent manner and included more input from the affected public. For example:

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[45]In addition to FCC's public hearing in Puerto Rico following Hurricane Maria, FCC leadership visited the territories. In November 2017 and again in March 2018, then FCC Chairman Ajit Pai visited Puerto Rico and USVI. According to FCC officials, the Chairman surveyed the damage and met with local officials and telecommunications carriers to better understand their needs during recovery. In March 2018, then FCC Commissioner Jessica Rosenworcel visited Puerto Rico to assess the hurricane's effect on telecommunications infrastructure and meet with residents.

- For Hurricane Katrina—which caused catastrophic damage in Louisiana, Mississippi, and Alabama in August 2005—FCC established an independent panel to review the effect of Hurricane Katrina on communications infrastructure. The panel held five public meetings at which interested parties could submit written comments and provide oral presentations. These meetings included a meeting in March of 2006 held in Jackson Mississippi, part of the area affected by Hurricane Katrina.

- Less than a month after Hurricane Sandy made landfall in New Jersey in October of 2012, then FCC Chairman Julius Genachowski announced that FCC would hold field hearings in New York in early 2013. FCC then held field hearings in New York and New Jersey on February 5, 2013, less than 4 months after the storm struck the area.

- In May 2019, FCC released a report following an investigation of communications outages caused by Hurricane Michael that included multiple recommendations for carriers 7 months after this storm struck the Florida panhandle.

FCC Did Not Clearly Communicate the Hurricane Recovery Task Force's Actions or Findings to the Public

Although FCC issued the 2017 Atlantic Hurricane Season Report, which described some actions and lessons learned from the Hurricane Recovery Task Force, FCC has not issued a report on the task force's actions or findings as a whole, or a full accounting of FCC's response to Hurricane Maria. According to FCC officials, the task force has continued to support recovery efforts in Puerto Rico and USVI since the task force's creation in 2017, but these efforts have not been made public. In particular, according to internal task force documentation (including weekly situation reports) that we obtained, the task force undertook a wide range of efforts to support recovery following Hurricane Maria that were not included in the 2017 Atlantic Hurricane Season Report. For example, we found that the task force:

- participated in coordination calls on a regular basis with government agencies and telecommunications carriers;

- conducted outreach to the power industry to stop recovery workers from cutting functional fiber cables; and

- worked with FCC's Public Safety and Homeland Security Bureau to develop a baseline map of telecommunications infrastructure in Puerto Rico and USVI prior to the 2017 Atlantic hurricane season.

Several public advocacy groups voiced concerns about FCC's efforts to examine the telecommunications outages caused by Hurricane Maria. In particular, public advocacy groups sent a letter to FCC in September 2018 criticizing FCC for not conducting a thorough review following

Hurricane Maria and requesting that FCC appoint an independent commission to develop recommendations to prevent catastrophic outages in the future. Additionally, a public advocacy organization filed a Freedom of Information Act request with FCC in November 2018 to gain access to documentation of the Hurricane Recovery Task Force's actions and recommendations. Representatives from this advocacy group told us they did not receive any documents related to the task force.

FCC's strategic plan states that FCC intends to improve the transparency of its operations and strengthen consumer access to emergency services and emergency public information sources by supporting improved preparedness, reliability of communications networks, and disaster management practices.[46] In 2018, FCC's then Chairman Ajit Pai said it is a priority to make FCC's work more transparent, open, and accountable to the American people. OMB's *Open Government Directive* explains that increasing transparency by expanding public access to information promotes accountability.[47] Further, federal internal control standards state that agency management should communicate quality information to external parties, including the public and other organizations to help the agency achieve its objectives.[48]

FCC officials told us they did not specifically issue a public report on the Hurricane Recovery Task Force, in part, because FCC had limited resources for preparing reports while managing the 2017 and 2018 disaster seasons. Nevertheless, FCC's lack of communication regarding actions taken by the Hurricane Recovery Task Force has left the public without a clear understanding of FCC's continued efforts to support recovery and improve network resilience in the territories. Further, the lack of full reporting to the public has contributed to the numerous concerns about FCC's response to Hurricane Maria expressed by the public advocacy groups we interviewed. Clear communication regarding the actions taken by the task force to support recovery efforts and identify lessons learned could help the public and stakeholders understand FCC's role in disaster response and actions needed to mitigate these kinds of telecommunications outages in future disasters.

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[46]FCC, *Strategic Plan 2018-2022* (Washington, D.C.).

[47]OMB, *Open Government Directive,* Memorandum M-10-06 (Dec. 8, 2009).

[48]GAO, *Standards for Internal Control in the Federal Government*, GAO-14-704G (Washington, D.C.: September 2014).

Conclusions

Puerto Rico and USVI experienced severe infrastructure damage in the aftermath of Hurricane Maria, damage that resulted in millions of people experiencing wireless, broadband, cable, and other telecommunications outages for months. As FCC continues to respond to emergencies, it is imperative that DHS define specific roles and responsibilities for FCC in its emergency support function guidance to avoid confusion during a disaster. Although FCC is the expert agency on telecommunications, DHS's guidance does not leverage FCC's knowledge on new or evolving technologies that could assist in faster network recovery following disasters. During a disaster, there is little time to learn about such technologies and their appropriate use when critical sectors require telecommunications services immediately. By articulating clear roles and responsibilities for FCC, especially related to new technologies or capabilities, DHS could reduce confusion and help ensure federal, state, local, and other partners understand available capabilities and can effectively employ them during an actual crisis.

Furthermore, although FCC established a Hurricane Recovery Task Force to focus on the telecommunications challenges facing Puerto Rico and USVI, a lack of transparent communications on the task force's actions and findings has left the public and territorial agencies without a complete and accurate account of FCC's response efforts that could aid future disaster preparation. By publicly reporting the task force's efforts, FCC could help ensure territorial government and telecommunications officials understand what FCC has accomplished and what additional actions are needed to build more resilient telecommunications networks.

Recommendations for Executive Action

We are making two recommendations, one directed to DHS in consultation with FCC, and one to FCC:

- The Secretary of Homeland Security, in consultation with FCC, should update Emergency Support Function #2 to list specific roles and responsibilities for FCC, including identifying new or evolving technologies that could assist disaster response efforts and supporting training or exercises on the appropriate use of such technologies prior to disasters. (Recommendation 1)

  The Chair of FCC should enhance the transparency and accountability of FCC's operations by publicly reporting on the actions and findings of its Hurricane Recovery Task Force and determine if any changes in policy are needed to ensure FCC has transparent operations for any future disaster-related task forces. (Recommendation 2)

Agency Comments

We provided a draft of this report to FCC and DHS for review and comment. FCC and DHS provided written comments, reprinted in appendixes IV and V, respectively, and concurred with our recommendations. Related to the first recommendation, DHS noted that it would continue to coordinate with its federal, state, local, and other partners to understand available capabilities and effectively employ them during disasters, as appropriate. FCC stated that it looked forward to further consultation with DHS on clarifying specific roles and responsibilities in the Emergency Support Function #2 guidance. Regarding the second recommendation, FCC stated it intends to explore options to implement it. Furthermore, FCC noted that under new leadership, it is taking urgent action to refresh its capabilities and procedures for disaster response. FCC also provided technical comments, which we incorporated as appropriate.

As agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies to the appropriate congressional committees, the Acting Chairwoman of FCC, and the Secretary of Homeland Security. In addition, the report is available at no charge on the GAO website at https://www.gao.gov.

If you or your staff have any questions about this report, please contact me at (202) 512-2834 or VonahA@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix VI.

Sincerely yours,

Andrew Von Ah
Director, Physical Infrastructure

Appendix I: Funding and Oversight of Telecommunications Carriers Serving Puerto Rico and the U.S. Virgin Islands

Funding for Telecommunications Restoration and Enhancement	The Federal Communications Commission (FCC) made funds available from the Universal Service Fund (USF) to help telecommunications carriers operating in Puerto Rico and the U.S. Virgin Islands (USVI) restore, expand, and upgrade their networks. Specifically, FCC awarded $601 million from the USF high-cost program to support carriers operating in the territories.[1] FCC provided this funding with a combination of advance high-cost program payments and new funds.[2] As a part of this process, FCC required telecommunications carriers to offer their best price proposal in terms of the financial support needed from FCC to restore and expand telecommunications networks in the territories. Consequently, not all funds that were made available were awarded and FCC considers these funds as a cost saving to the USF high-cost program.

The timing for FCC's funding efforts varied depending on the stage of the funding. For example, a few weeks after Hurricane Maria, in October 2017, FCC provided nearly $66 million in advance payments from the high-cost program to eight telecommunications carriers to assist with restoration efforts in the territories.[3] In March 2018, FCC established the Uniendo a Puerto Rico Fund and the Connect the U.S. Virgin Islands Fund and awarded funds to carriers through two distinct phases, referred to as stage one and stage two. For stage one, funding was disbursed in August 2018. Stage two funding will provide financial disbursements over periods ranging from 3 to 10 years to mobile and fixed broadband carriers, respectively. Funding awards and timing are shown in table 1.

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[1]The high-cost program provides subsidies (referred to as "support") to carriers that provide voice and broadband services in areas the carriers would otherwise not serve and where there is no competition from other unsubsidized carriers. The program support is targeted to areas that are costly to serve because, for example, the customer base is relatively small and the cost of installing infrastructure is high. For more information on the high-cost program, see GAO-21-24. "Advance payments" refer to payments that FCC made available to carriers to help with immediate needs and anticipated large repair costs.

[2]*The Uniendo a Puerto Rico Fund and the Connect the U.S. Virgin Islands Fund*, Order and Notice of Proposed Rulemaking, FCC 18-57 (2018).

[3]These telecommunications carriers were already participating in the high-cost program and included (1) Centennial Puerto Rico Operations Corporation; (2) Suncom Wireless Puerto Rico Operating Co. LLC; (3) Cingular Wireless, (4) PR Wireless Inc.; (5) Worldnet Telecommunications, Inc.; (6) Vitelco-Innovative Viya; (7) Choice Communications, LLC; and (8) the Puerto Rico Telephone Company. The Puerto Rico Telephone Company received three separate payments for its wireless and telephone/broadband services.

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Table 1: Universal Service Funds FCC Made Available and Awarded for Puerto Rico and the U.S. Virgin Islands after Hurricane Maria, as of January 2021

Stage	Available funding (in millions)	Description	Date awarded	Amount awarded (in millions)
Advance payments	$77	Advance payments from the high-cost program	October 2017	$66
Stage one	$64	Short-term funding for immediate restoration efforts	August 2018	$64
Stage two	$259	Medium-term funding for mobile technology restoration, expansion, and upgrades	June and October 2020	$259
	$691	Long-term funding for fixed voice and broadband	November 2020	$212
Total	**$1,091**			**$601**

Source: GAO analysis of the Federal Communications Commission's (FCC) data. | GAO-21-297

For stage one, FCC made funds available to cover immediate short-term costs of restoring and maintaining service for existing facilities for all 13 telecommunications carriers that applied and were eligible to receive USF support; this support was disbursed by October 2018.[4] Any facilities-based provider of voice and broadband internet service that was designated as an eligible telecommunications carrier was eligible to receive funding.[5] To receive USF support, carriers were required to provide the number of subscribers they had for their telecommunications services in Puerto Rico and USVI as of June 30, 2017.[6] For stage one, carriers providing service in Puerto Rico received $51.2 million, and carriers providing service in USVI received $13 million.

For stage two, FCC made funds available for mobile and fixed voice and broadband telecommunications carriers to promote the deployment of

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[4]The telecommunications carriers that received stage one funding were: PRTC, Worldnet, AT&T, Critical Hub, Data@ccess, Liberty Cablevision (also known as Liberty Communications of Puerto Rico), Neptuno, T-Mobile, VPNet, PR Wireless, ATN (VIYA, Choice Communications, and Viya Wireless), Broadband VI, and Lan Communications.

[5]FCC noted to be eligible for funding, the provider must be willing at the time of certification to be designated an eligible telecommunications carrier (ETC) by the relevant commission, must in fact become an ETC and submit that designation to the Universal Service Administrative Company before receiving any funding and must remain an ETC for at least one year after first receiving funding.

[6]FCC also required the carriers to file a copy of the certification and accompanying evidence through FCC's Electronic Comment Filing System as well as email a copy to ConnectAmerica@fcc.gov.

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advanced and resilient networks in the territories.[7] As a part of stage two, telecommunications carriers were required to provide a disaster response and preparedness plan to document their efforts to protect their networks before and after a disaster. According to the disaster response and preparedness plans we reviewed, several carriers had included best practices for protecting their networks, such as burying fiber cable because it is less susceptible to wind, falling trees, and flying debris.[8] Furthermore, carriers we interviewed said they have invested in permanent and temporary generators, stored thousands of gallons of fuel, and contracted with a local fuel supplier for additional fuel during an emergency as a way to ensure their networks remain operational in disaster situations.

FCC developed two separate application processes for stage two funding to evaluate the mobile and fixed voice and broadband carriers, as follows:

- **Mobile telecommunications funding.** In September 2019, FCC announced stage two funding of $258.8 million to be disbursed over 3 years for mobile carriers that offered services in these territories before the hurricanes (see table 2). The goal of this funding was to support carriers in restoring, expanding, and hardening their 4G long-term evolution (LTE) networks and deploying next-generation 5G networks in the territories. In June and October 2020, FCC had awarded funds to three carriers in Puerto Rico and three in USVI. Eligible mobile providers received a percentage of the budget equal to their share of mobile subscribers in each territory before the 2017 hurricanes.

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[7]Mobile carriers are providers of wireless telecommunications services outside of a fixed location, such as cellular phone service. Fixed carriers are providers of voice and broadband services with connections to fixed locations at customer premises, such as residences.

[8]The best practices came from one of FCC's federal advisory committees called the Communications Security, Reliability, and Interoperability Council.

Table 2: FCC Mobile Telecommunications Funding in Puerto Rico and the U.S. Virgin Islands, as of January 2021

	Amount available (in millions)	Amount awarded (in millions)
Puerto Rico	$254.4	$97.8 for AT&T
		$76.6 for Puerto Rico Telephone Company
		$80.0 for T-Mobile
U.S. Virgin Islands	$4.4	$4.0 for AT&T
		$0.3 for Choice Communications
		$0.1 for Vitelcom Cellular
Total	**$258.8**	**$258.8**

Source: GAO analysis of Federal Communications Commission's (FCC) data. | GAO-21-297

- **Fixed broadband funding.** In February 2020, FCC announced the stage two application process for fixed voice and broadband carriers in Puerto Rico and USVI for high-speed internet and voice communications. FCC announced funding of $691.2 million to be disbursed over a 10-year term in total, including $504.7 million for carriers operating in Puerto Rico and $186.5 million for carriers operating in USVI, as shown in table 3. The application process required that applicants provide the minimum amount of support they would accept for an area. According to FCC, they scored applications in three categories: price per location served; network performance (speed and latency); and network resilience and redundancy.[9] In November 2020, FCC awarded a total of $127.1 million to two carriers serving Puerto Rico, and $84.5 million to one carrier serving USVI, to be disbursed over a 10-year term.[10]

Although awards in Puerto Rico and USVI have been announced for fixed broadband carriers, FCC officials told us these carriers will need to

[9]Under this competitive process, FCC evaluated applications using a 270-point scale where lower scores were better. FCC assigned points in three categories: (1) price per location served: 0 to 100 points; (2) network performance (speed and latency): 0 to 90 points; and (3) network resilience and redundancy: 0 to 80 points. Within the network resilience and redundancy category, FCC assigned between 0 and 60 points based on the resilience of the proposed infrastructure.

[10]In December 2020, Viya petitioned FCC to reconsider its selection of Broadband VI in the Connect USVI Fund and issue a new notice announcing a winning applicant that "provides adequate transparency into the reasons and justifications underlying [FCC's] selection." Broadband VI filed an Opposition to Petition for Reconsideration on the bases that Viya's Petition was procedurally defective and that the Wireline Competition Bureau had adequately provided the explanation for selecting Broadband VI's winning bid, to which Viya replied in January 2021. At the time of our review, FCC had not granted, denied, or dismissed the Petition.

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complete the application process requirements prior to disbursement of support awards. In the event the announced winners fail to fulfill the application requirements, FCC would develop and implement procedures to select alternative winners for affected areas.

Table 3: FCC Fixed Broadband Funding in Puerto Rico and the U.S. Virgin Islands, as of January 2021

	Amount available (in millions)	Amount awarded (in millions)
Puerto Rico	$504.7	$55.56 for Puerto Rico Telephone Company for 35 *municipios*[a] $71.54 for Liberty Communications of Puerto Rico for 43 *municipios*[a]
U.S. Virgin Islands	$186.5	$84.5 for Broadband VI for St. Thomas, St. John and St. Croix
Total	**$691.2**	**$211.6**

Source: GAO analysis of Federal Communications Commission's (FCC) data. | GAO-21-297

[a]*Municipios* in Puerto Rico are similar to counties.

Carrier representatives we interviewed were generally positive about FCC's process for using USF funds to restore telecommunications and noted the funding was beneficial to rebuilding resilient networks in the aftermath of Hurricane Maria. For example, one carrier representative said the process incentivized applicants to make efficient use of USF funds since FCC prioritized price per location, and that FCC's scoring on resilience and redundancy favored buried fiber, which would result in more resilient networks, over aerial fiber on poles. In addition, another carrier said FCC's funding improved resilience in telecommunications networks because private insurance policies only paid for the replacement of damaged equipment.

However, a few carrier representatives voiced concerns about the process, funding amounts, and deployment milestones. For example, two carrier representatives said FCC took a long time to announce the filing requirements for stage two funding, and one noted the funding amounts were not enough to fully support restoration and the building of resilient networks. Other representatives took issue with FCC's scoring of applicants that prioritized price per location and network speed over resilience. In particular, they noted that building resilient networks is costly and to have a low, competitive price per location while building a new resilient network is not always feasible. Representatives from one carrier said they would not apply for stage two funding because the

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application process favored larger companies in terms of scoring for price per location. Moreover, representatives from one carrier expressed concerns about a potential gap in affordable broadband services in USVI because of the timing of network deployment milestones.[11]

FCC stated in its February 2020 notice and filing requirements that price per location was given the greatest weight because responsible spending was FCC's primary concern.[12] Regarding the amount of time it took FCC to issue the final filing requirements, in March 2018, FCC began publishing a variety of press releases, orders, and notices related to developing a process for stage two funding.[13] In May 2018, FCC requested public comments on various topics including the financial support necessary to rebuild, improve, and expand telecommunications services in the territories; requirements of the application process; factors to consider when evaluating bids; deployment milestones; and other items.[14] In September 2019, FCC discussed its evaluation of these comments and adopted a single-round competitive proposal process for stage two funding,[15] with the final notice being issued in February 2020.[16]

Oversight Procedures

FCC plans to use the USF's oversight procedures to oversee the Uniendo a Puerto Rico Fund and the Connect the U.S. Virgin Islands Fund. FCC officials told us that recipients of these funds are subject to the same network performance testing, reporting, and certification requirements as other recipients that participate in the high-cost program. For example,

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[11]As a part of the Connect the U.S. Virgin Islands Fund, the carrier awarded funds will have up to 10 years to deploy its network, while the current recipient of funds will no longer receive funds after 2023.

[12]FCC, *The Uniendo a Puerto Rico Fund and the Connect the U.S. Virgin Islands Fund*, *Notice and Filling Requirements and Other Procedures for Stage 2 Fixed Competitive Proposal Process*, DA 20-133, (Feb. 5, 2020).

[13]FCC Statement, *Chairman Pai Unveils $954 Million Plan to Restore and Expand Networks in Puerto Rico and U.S. Virgin Islands*, (2018).

[14]*The Uniendo a Puerto Rico Fund and the Connect the U.S. Virgin Islands Fund*, Order and Notice of Proposed Rulemaking, FCC 18-57 (2018).

[15]*FCC Fact Sheet, The Uniendo a Puerto Rico Fund and the Connect the U.S. Virgin Islands Fund*, Report and Order and Order on Reconsideration, WC Docket Nos. 18-143, 10-90, and 14-58 (September 2019).

[16]FCC, *The Uniendo a Puerto Rico Fund and the Connect the U.S. Virgin Islands Fund*, *Notice and Filling Requirements and Other Procedures for Stage 2 Fixed Competitive Proposal Process*, DA 20-133, (Feb. 5, 2020).

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network performance testing requires carriers to test network speed and latency.[17] Also, in 2016 FCC adopted reforms on annual-reporting requirements to incentivize efficient broadband deployment and ensure funds are used as intended.[18] Additionally, the Universal Service Administrative Company (USAC), the not-for-profit company that FCC designated to administer USF programs, is responsible for collecting, validating, and verifying carriers' broadband data and auditing USF payments. USAC officials we interviewed said they perform some audit site visits, but at the time of our review were unsure when they would visit Puerto Rico or USVI due to COVID-19. USAC officials told us that recipients of stage two funds will go into the same selection pool as recipients of other USF high-cost support and can be selected for audits in the future. Officials emphasized that they expect some number of stage two recipients to eventually be audited. As shown in table 4, the audit steps include carrier audits and carrier self-reporting.

Table 4: FCC Oversight Procedures for Telecommunications Restoration and Deployment in Puerto Rico and the U.S. Virgin Islands

Audit and oversight procedures	Description
Carrier self-certification	Carrier self-certification is the primary tool for ensuring that carriers use high-cost program support consistent with program rules. FCC's administrator of the program—the Universal Service Administrative Company (USAC)—uses cost and other data to qualify carriers for the high-cost program. Stage two recipients have annual reporting and certification obligations.
Carrier audits	Audits of carriers receiving high-cost program support are used to oversee carrier activities, and audits may be conducted by USAC, state regulators, or FCC's Office of Inspector General. USAC primarily relies on assessments that occur after disbursements have been made to detect improper payments, which may include fraud.

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[17]A speed test is a single measurement of download or upload speed of 10 to 15 seconds duration between a specific consumer location and specific remote server location that meets FCC's designated requirements. Speed requirements vary by fund. Carriers must conduct at least one download test and one upload test during each testing hour at each testing location. (*In the Matter of Connect America Fund*, Order on Reconsideration, FCC 19-104, paras. 24-26 (2019). A latency test is a single measurement of latency (delay) often performed using a single User Datagram Protocol (UDP) packet or a group of three Internet Control Message Protocol (ICMP) or UDP packets sent at essentially the same time. FCC 19-104, paras. 27-38 (2019).

[18]Since 2018, as a part of its high-cost universal broadband-carrier broadband-deployment verification process, FCC uses location-specific data as a metric to show the extent carriers have deployed broadband services, which are plotted on an interactive map to illustrate this information.

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Audit and oversight procedures	Description
Carrier data validation process	All cost data that the carriers submit to the National Exchange Carrier Association for purposes of high-cost support are subject to several electronic validations, which focus on ensuring that all required data are reported and that the data ranges are consistent with information reported in previous years.[a] In addition, the National Exchange Carrier Association compares the reported cost data with financial records supporting carriers' audited financial statements to identify any discrepancies and to require corrections when discrepancies are discovered.
Carriers' broadband deployment verification	Since 2018, USAC has performed carrier broadband deployment verifications by obtaining broadband location data to monitor whether a carrier's broadband deployment meets FCC requirements. For example, such data would document locations and speed for mobile or fixed broadband. Carriers receive verification reports from USAC that reflect the results of the verification process.

Source: GAO analysis of Federal Communications Commission's (FCC) information. | GAO-21-279

[a]47 C.F.R. § 54.1307 requires the National Exchange Carrier Association to submit Universal Service Fund cost and expense adjustment information annually.

To verify network deployment progress in Puerto Rico and USVI, telecommunications carriers will need to submit annual certifications and data to verify their services meet technological and speed standards. Also, carriers will need to show measures of progress toward resilience goals, such as burying fiber cable. Furthermore, FCC officials told us that mobile providers must certify 4G and 5G network performance at the end of the third year after receiving USF support. Carriers that fall short of their deployment and resilience goals are subject to having FCC withhold or reduce USF support. Carriers are required to update their disaster preparation and response plans when making any material changes to their operations. Also, carriers may choose to participate in a voluntary 5-year review process to reassess their deployment obligations. According to FCC, this process will allow the agency to determine whether to adjust any deployment requirements based on newly available data or changed circumstances such as disruptive disasters or significantly decreased revenue due to population shifts. During this process, the public will be allowed to review documentation, data, and evidence. Following the close of the public comment period, FCC could make an adjustment of deployment obligations or locations for any winning applicant.

At the time of our review, FCC was in the process of awarding funding from the Uniendo a Puerto Rico Fund and the Connect the U.S. Virgin Islands Fund so it was too soon to assess whether FCC's efforts would be successful in ensuring the appropriate use of funds. We previously recommended that FCC should follow leading practices from GAO's fraud risk framework to better ensure that it is addressing and strategically

**Appendix I: Funding and Oversight of
Telecommunications Carriers Serving Puerto
Rico and the U.S. Virgin Islands**

targeting the most significant fraud risks facing the high-cost program.[19]
As of December 2020, FCC officials stated that FCC was undertaking
further improvements to its fraud risk management program consistent
with our recommendations including conducting a fraud risk assessment
of the high-cost program, developing a fraud risk strategy, and other
efforts. FCC did not include a completion date for these efforts, and we
will continue to monitor FCC's progress related to these
recommendations. Given the continuing importance of deploying and
building resilient telecommunications services in Puerto Rico and USVI,
effective oversight of telecommunications carriers is an important
component for helping ensure that the high-cost program's funds are
used properly.

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[19]GAO, *Telecommunications: FCC Should Take Additional Action to Manage Fraud Risks
in Its Program to Support Broadband Service in High-Cost Areas,* GAO-20-27
(Washington, D.C.: Oct. 23, 2019).

Appendix II: Objectives, Scope, and Methodology

This report provides information on the Federal Communications Commission's (FCC) response to the telecommunications outages in Puerto Rico and the U.S. Virgin Islands (USVI) in the aftermath of Hurricane Maria. Specifically, this report examines: (1) FCC's actions to support telecommunications restoration after Hurricane Maria and the extent to which FCC's disaster response role is clearly defined, and (2) FCC's efforts to identify lessons learned with public input and the extent to which FCC publicly communicated those efforts.

To determine the actions FCC took to support telecommunications restoration, we reviewed numerous FCC documents, including the 2017 Hurricane Season Report,[1] internal situation reports from FCC's Disaster Information Reporting System (DIRS),[2] communication status reports for Hurricane Maria, and other internal documents. We also reviewed relevant information from our prior reports on network resilience as well as disaster response in Puerto Rico and the USVI.[3] To assess the extent that FCC's disaster response role is clearly defined in guidance, we interviewed federal officials and reviewed Emergency Support Function #2, which covers communications,[4] and compared the information with

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[1]FCC, *2017 Atlantic Hurricane Season Impact on Communications* (Washington, D.C.: August 2018).

[2]DIRS is a web-based reporting system for telecommunications companies (wireless, wireline, broadcast, and cable companies) that wish to voluntarily report the operational status of their service and infrastructure during natural disasters such as hurricanes, wildfires, and earthquakes.

[3]GAO, *Telecommunications: FCC Should Improve Monitoring of Industry Efforts to Strengthen Wireless Network Resiliency*, GAO-18-198 (Washington, D.C.: Dec. 12, 2017); GAO, *2017 Hurricanes and Wildfires: Initial Observations on the Federal Response and Key Recovery Challenges*, GAO-18-472 (Washington, D.C.: Sept. 4, 2018); GAO, *Puerto Rico Hurricanes: Status of FEMA Funding, Oversight, and Recovery Challenges*, GAO-19-256 (Washington, D.C.: Mar. 14, 2019); *U.S. Virgin Islands Hurricane Recovery and Resilience Task Force*, (2018); and Central Office of Recovery, Reconstruction, and Resiliency, *Transformation and Innovation in the Wake of Devastation: An Economic and Disaster Recovery Plan for Puerto Rico*, (Aug. 8, 2018).

[4]The *National Response Framework* is the part of the National Preparedness System established in Presidential Policy Directive 8 that is to be used to manage any type of disaster or emergency response, regardless of scale, scope, and complexity. The *National Response Framework* also identifies 14 Emergency Support Functions —such as communication, transportation, and energy—and designates a federal department or agency as the coordinating agency for each function.

the key practices for interagency collaboration[5] and the stated purpose of the *National Response Framework*.[6]

Additionally, we obtained DIRS data from September 2017 to March 2018, on network outage information submitted by telecommunications carriers. We analyzed the data to understand the extent and duration of network outages following Hurricane Maria in Puerto Rico and USVI. Specifically, we analyzed the causes of the telecommunications outages including power outages and damage to network connections and cell sites. We focused our analysis on cell site outages because according to Puerto Rican and USVI officials we interviewed, the territories' populations widely rely on cell service for emergency and other communications. We took several steps to assess the reliability of DIRS data, such as reviewing FCC documentation and the DIRS data dictionary, comparing outage percentages contained in the dataset to publicly available data in FCC's communications status reports for Hurricane Maria, and interviewing FCC officials responsible for collecting and analyzing DIRS data. We found the data were sufficiently reliable for describing the extent and cause of network outages after Hurricane Maria in Puerto Rico and USVI (see app. III for our analysis on network outages). We also interviewed officials at federal agencies with which FCC shares the DIRS data to obtain their perspectives on the data's usefulness. To understand FCC's proposed changes to DIRS, we interviewed FCC officials and reviewed the relevant notice of proposed rulemaking.[7]

To determine FCC's efforts to identify lessons learned with public input and the extent to which FCC publicly communicated those efforts, we analyzed various reports, including FCC's 2017 Hurricane Season Report and other internal documents. We determined that the information and communication component of internal control was significant to this objective, along with the underlying principle that management should externally communicate the necessary quality information to achieve the

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[5]GAO, *Managing for Results: Key Considerations for Implementing Interagency Collaborative Mechanisms*, GAO-12-1022 (Washington, D.C.: Sept. 27, 2012). Specifically, we accessed efforts against the key practice of clarifying roles and responsibilities.

[6]DHS, *The National Response Framework*. (Washington, D.C.: Oct. 28, 2019).

[7]*In the Matter of Amendments to Part 4 of the Commission's Rules Concerning Disruptions to Communications,* Second Further Notice of Proposed Rulemaking, FCC 20-20 (2020).

entity's objectives.[8] We assessed FCC's efforts to communicate
information on its telecommunications restoration efforts against this
internal control, as well as FCC's Strategic Plan,[9] involving transparency,
past hurricane responses, and the Office of Management and Budget's
(OMB) *Open Government Directive*.[10] We based our assessment on FCC
documentation and our interviews with public advocacy stakeholders. We
also reviewed reports prepared by the Department of Homeland Security
(DHS), such as the *2017 Hurricane Season Federal Emergency
Management Agency's After-Action Report*.[11] We interviewed officials
from FCC and DHS component agencies, including the Cybersecurity and
Infrastructure Security Agency and the Federal Emergency Management
Agency that took part in Hurricane Maria disaster response and recovery
and developed lessons learned based on their experiences.

Additionally, as described in app. I, we obtained information on the
funding FCC made available to restore and enhance telecommunications
networks in Puerto Rico and USVI. We reviewed various FCC orders and
other documents for funding requirements and amounts available for
restoration and network resilience.[12] We also interviewed FCC and
Universal Service Administrative Company officials and reviewed
Universal Service Fund audit steps and our prior work on this program.
We reviewed disaster response and preparedness plans submitted to
FCC by telecommunications carriers. These plans provided details of
equipment and tools to remain operational during disasters.

For all objectives, we interviewed stakeholders selected to ensure we
obtained a variety of perspectives (see table 5 for the list of stakeholders

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[8]GAO, *Standards for Internal Control in the Federal Government*, GAO-14-704G
(Washington, D.C.: Sept. 10, 2014).

[9]FCC, *Strategic Plan 2018-2022* (Washington, D.C.).

[10]OMB, *Open Government Directive,* Memorandum M-10-06 (Dec. 8, 2009).

[11]DHS, *2017 Hurricane Season FEMA After-Action Report*, (Washington, D.C.: July 12,
2018); DHS, *Puerto Rico Communications Information Technology Solutions Based
Team, (*Washington, D.C.: Jan. 17, 2019*); and* DHS, *Joint Operational Catastrophic
Incident Plan of Puerto Rico* (Washington, D.C.: June 2019).

[12]See *In the Matter of Connect America Fund*, Order, FCC 17-129 (2017); *The Uniendo a
Puerto Rico Fund and the Connect the U.S. Virgin Islands Fund*, FCC-CIR1909-01; *In the
Matter of The Uniendo a Puerto Rico Fund and the Connect USVI Fund*, Report and Order
and Order on Reconsideration, FCC 19-95 (2019); and Public Notice WC Docket NOS.18-
143, 10-90, DA 18-825.

we interviewed). We selected stakeholders based on our previous
reviews, a literature review, and recommendations from advocacy
organizations. While these interviews are not generalizable to the wider
population of stakeholders, they provided us with a variety of perspectives
on the federal government's response to telecommunications outages
following Hurricane Maria. In all, we interviewed representatives from 30
stakeholders:[13]

- telecommunications carriers providing service in Puerto Rico and
  USVI to understand their views on financial requirements and the
  federal government efforts to restore and build resilient networks. We
  selected the carriers based on initial FCC funding they received to
  rebuild their telecommunications networks and selected a mix of
  carriers that operate in the U.S. mainland and territories and
  exclusively in the territories;

- industry associations and government/industry committees to
  understand industry perspectives on working with the federal
  government during disaster response and recovery and developing
  lessons learned;

- academics who had published research on the telecommunications
  industry in Puerto Rico to understand community and industry
  perspectives on hurricane recovery efforts;

- advocacy groups to understand how information was communicated
  on network outages to local communities and what efforts were
  undertaken by the government to restore networks;

- territorial agencies to understand the perspectives of local officials
  involving telecommunication restoration efforts in Puerto Rico and
  USVI; and

  union representatives to understand the perspectives of
  telecommunications workers in responding to disaster recovery.

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[13]We interviewed two Puerto Rican residents who were adversely affected by the
telecommunications outages in the aftermath Hurricane Maria; these individuals were
identified for us by an advocacy organization.

Table 5: List of Interviewees

Telecommunications carriers
Puerto Rico
AT&T
Liberty Communications of Puerto Rico
Puerto Rico Telephone Company
T-Mobile
WorldNet Communications
U.S. Virgin Islands
AT&T
Broadband VI
LAN Communications
T-Mobile
Viya
Communications companies[a]
Hughes Network Systems
Loon LLC
Industry associations
Alliance for Telecommunications Industry Solutions
CTIA
Industry and government committees
Broadband Deployment Advisory Committee, Disaster Response and Recovery Working Group
Communications Sector Coordinating Council
Network Reliability Steering Committee
Academics
Dr. Federico Subervi, University of Wisconsin at Madison
Dr. Luis Rosario-Albert, University of Turabo, Puerto Rico
Advocacy organizations
Digital Equity Lab
Free Press
MediaJustice
National Hispanic Media Coalition
Public Knowledge
Territorial agencies
Telecommunications Regulatory Board of Puerto Rico
Puerto Rico Emergency Management Agency
Puerto Rico Electric Power Authority

Puerto Rico's Central Recovery and Reconstruction Office
Puerto Rico Emergency Operations Center Member
U.S. Virgin Islands Public Services Commission
U.S. Virgin Islands Water and Power Authority
Union
Communications Workers of America

Source: GAO. | GAO-21-297

[a]During our review, Hughes Network Systems (satellite) and Loon LLC (aerial broadband) companies contacted us to request an interview.

Appendix III: Causes of Prolonged Outages in Puerto Rico and the U.S. Virgin Islands in the Aftermath of Hurricane Maria

According to our analysis of Federal Communications Commission (FCC) data, power outages and extensive damage to cell sites or network connections were the two leading causes of prolonged cell site outages. Hurricane winds contributed to the collapse of transmission towers, destruction of antennas/radios on towers, failure of backup power systems, physical damage to communications shelters, and loss of equipment as a result of water damage. The hurricane winds also destroyed above ground infrastructure, including exposed aerial cables mounted to wooden poles and communications towers.

Puerto Rico. Our analysis of FCC data indicated that the extended power outage was the leading cause of prolonged cell site outages. Starting in September 2017, with Hurricanes Irma and Maria, some parts of Puerto Rico were without power for 11 months, and other parts did not regain electrical power until 18 months later, according to one carrier. In September of 2017, 96 percent of cell sites were out of service in Puerto Rico—49 percent were not operational because of the power outage. By October 2017, the percentage of cell sites that were not operational due to power increased to 79 percent (see fig. 4).

Figure 4: Causes of Cell Site Outages in Puerto Rico Following Hurricane Maria from September 2017 to March 2018

Number of cell sites out of service
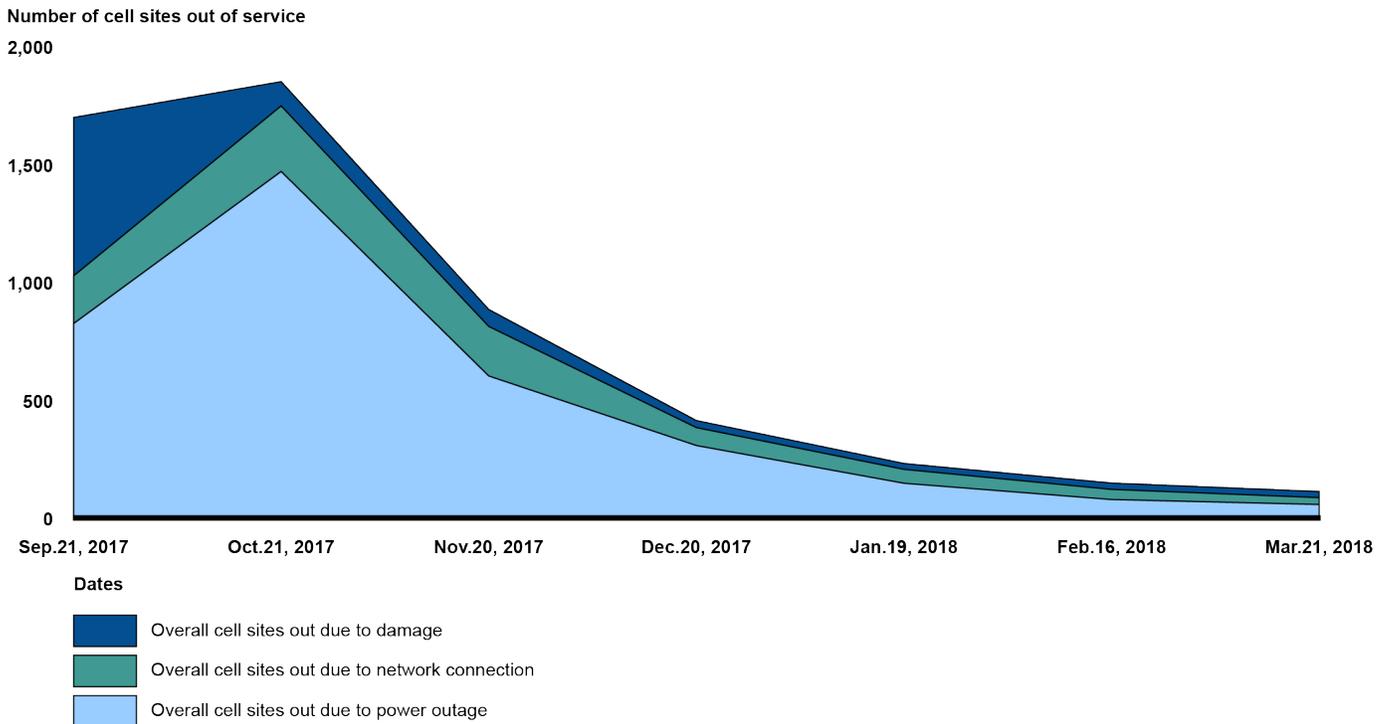
Source: GAO analysis of Federal Communications Commission data. | GAO-21-297

The Puerto Rican population is heavily dependent on wireless versus landline phones so the lack of wireless service substantially affected the population's ability to call for help or receive life-saving emergency alerts.[1] For example, Federal Emergency Management Agency (FEMA) officials said many people were unable to receive emergency alerts regarding flooding or landslides because of the wireless service outages.

Communications beyond wireless service were also negatively affected for weeks after Hurricane Maria. As a snapshot-in-time, on December 6, 2017, several weeks after Hurricane Maria made landfall:

[1]Central Office for Recovery, Reconstruction and Resiliency, *Transformation and Innovation in the Wake of Devastation: An Economic and Disaster Recovery Plan for Puerto Rico* (Aug. 8, 2018).

**Appendix III: Causes of Prolonged Outages in
Puerto Rico and the U.S. Virgin Islands in the
Aftermath of Hurricane Maria**

- five television stations in Puerto Rico were reported as operational, while 100 were not functioning;

- roughly one-third of AM and FM radio stations remained out of service; and

- cable system and wireline phone service remained out of service.[2]

In various communication status reports from September to December 2017, FCC noted that due to widespread power outages it received reports that large percentages of consumers were without either cable or internet services.

According to the telecommunications carriers providing service in Puerto Rico that we interviewed, the lack of electrical power was the most noteworthy challenge in restoring their networks. Department of Homeland Security (DHS) officials also said that telecommunications restoration crews did not have electricity to conduct accurate damage assessments of networks to report on available services and check signal reception. Furthermore, without power, the carriers relied on back-up generators to operate network equipment for months, 7 days a week. The necessary fuel for these generators and trucks for telecommunications crews was scarce, and theft of both fuel and generators further complicated the carriers' restoration efforts. Even after the carriers were able to restore their networks, many cell sites were not operational due to the lack of power. For example, a carrier representative told us the company was able to repair 93 percent of its cell sites and 88 percent of fiber cables within 100 days after Hurricane Maria, but only 50 percent of its cell sites were operational at that time because of the power outage.

According to government and telecommunications carrier representatives in Puerto Rico, the Puerto Rico Electric Power Authority did not prioritize areas the carriers identified as needing electricity and did not coordinate restoration efforts. The lack of prioritization and cooperation resulted in inefficiencies and delays in repair efforts. As a result, the carrier representative said they had to deploy resources reactively. That is, carriers would first learn an area had power and then would go to that area to repair the telecommunications equipment. The government and carrier representatives also told us that sometimes newly installed fiber-

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[2]FCC, *Communications Status Report for Areas Impacted by Hurricane Maria*. (Washington D.C.: Dec. 6, 2017). In December 2017, there were 107 television broadcasting stations, 74 AM, and 111 FM radio stations in Puerto Rico.

**Appendix III: Causes of Prolonged Outages in
Puerto Rico and the U.S. Virgin Islands in the
Aftermath of Hurricane Maria**

optic cables—used by mobile, landline, and internet services—were
inadvertently removed during debris cleanup by power restoration crews.

U.S. Virgin Islands (USVI). Our analysis of FCC data showed that
extensive damage to the cell site or to network connections was the
leading causes of cell site outages (see fig. 5). In September of 2017, 77
percent of cell sites were out of service— of those, 85 percent were not
operational because of damage to the network connection or to the cell
site.[3] USVI was without power for at least 5 months, which also
contributed to the delay in restoring communications.

Figure 5: Causes of Cell Site Outages in the U.S. Virgin Islands Following Hurricane Maria from September 2017 to March 2018

Number of cell sites out of service

Legend:
- Overall cell sites out due to damage
- Overall cell sites out due to network connection
- Overall cell sites out due to power outage
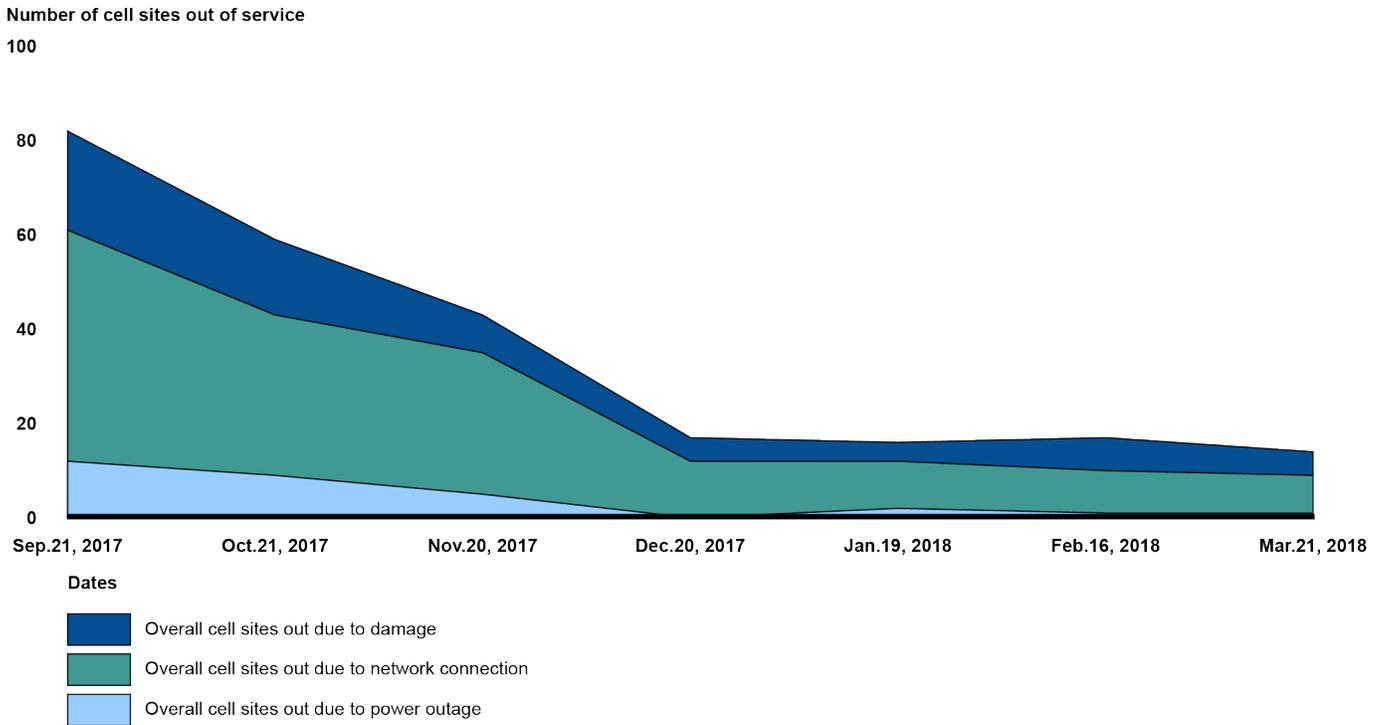
Source: GAO analysis of Federal Communications Commission data. | GAO-21-297

[3]According to the U.S. Virgin Islands Public Services Commission, currently an estimated
75 to 80 percent of the population uses cell phones. Fifteen years ago, there were more
than 80,000 landline customers, now it is below 50,000.

**Appendix III: Causes of Prolonged Outages in
Puerto Rico and the U.S. Virgin Islands in the
Aftermath of Hurricane Maria**

As a snapshot-in-time, on December 6, 2017, USVI still had:

- no operational television broadcasting, cable system, and wireline service, and

- only two AM and two FM radio stations were functioning.[4]

According to USVI Public Services Commission officials, the telecommunications carriers were able to establish Wi-Fi hotspots in airports and malls within a day or two since underground telecommunications infrastructure was not significantly damaged and was generally operational. A local government-engineering network had underground fiber-optic cable, which facilitated the establishment of Wi-Fi hotspots. Newspapers, radio stations, flyers, and word of mouth advertised the locations of Wi-Fi hotspots in the community. Also, telecommunications carriers allowed free roaming for everyone.

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[4]FCC, *Communications Status Report for Areas Impacted by Hurricane Maria*. (Washington D.C.: Dec. 6, 2017). In December 2017, there were 16 television broadcasting stations, 5 AM, and 23 FM radio stations in USVI.

Appendix IV: Comments from the Federal Communications Commission

Federal Communications Commission
Washington, D.C. 20554

April 12, 2021

Andrew Von Ah
Director, Physical Infrastructure Issues
Government Accountability Office
441 G Street, NW
Washington, DC 20548

Dear Director Von Ah:

Thank you for the opportunity to review the Government Accountability Office's (GAO) draft report, "FCC Assisted in Hurricane Maria Network Restoration but a Clarified Disaster Response Role and Enhanced Communications Are Needed." The Federal Communications Commission (FCC or Commission) is committed to ensuring that all Americans, especially citizens of the Commonwealth of Puerto Rico and the U.S. Virgin Islands impacted by Hurricane Maria in 2017, can secure and maintain reliable and resilient communications services. We appreciate the recommendations you provide in the draft report as the Commission continues to make measurable and significant progress towards achieving that goal.

As we noted in our report on the 2017 Atlantic Hurricane season, that year's season was notable for the devastation wrought to many types of infrastructure, not only communications. A larger-than-expected number of significant storms caused billions of dollars of damage and, more importantly, significant loss of life. All told, it was the most expensive hurricane season in United States history, almost doubling the cost of the 2005 hurricane season that included Katrina. According to initial estimates, the combined storms caused over $200 billion in damages in the United States and its territories.[1] The havoc wreaked by Hurricane Maria in Puerto Rico alone was projected to have caused at least $100 billion in damage and perhaps several thousand deaths.[2] The FCC took several actions to support telecommunications restoration in response to Hurricane Maria and throughout the hurricane season.

In the draft report, GAO makes two recommendations on how the Commission, working with its Federal partners, can more effectively address the communications-related ramifications of a disaster of the force and breadth of Hurricane Maria. *First*, GAO recommends that The Secretary of the Department of Homeland Security (DHS), in consultation with the FCC, should update Emergency Support Function

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[1] *See* "2017 Atlantic Hurricane Season Impact on Communications – Report and Recommendations," https://docs.fcc.gov/public/attachments/DOC-353805A1.pdf.

[2] Sheri Fink, New Data Sheds Light on Death Toll of Hurricane Maria in Puerto Rico (updated Jun. 8, 2018), https://www.nytimes.com/2018/06/02/us/puerto-rico-death-tolls.html; *see also* Frances Robles, Hurricane Killed 1,427, Not 64, Puerto Rico Admits in Funding Request, (updated Aug. 20, 2018), https://www.nytimes.com/2018/08/09/us/puerto-rico-death-toll-maria.html. *See also,* Nishant Kishore *et al.*, Mortality in Puerto Rico after Hurricane Maria, Special Article, New Eng. J. Med. (2018), available at https://www.nejm.org/doi/pdf/10.1056/NEJMsa1803972 (estimating over 5,000 deaths).

#2 (ESF#2) to list specific roles and responsibilities for FCC, including identifying new or evolving technologies that could assist disaster response efforts and supporting training or exercises on the appropriate use of such technologies prior to disasters. *Second*, based on its review of the FCC's response to Hurricane Maria, GAO recommends that the Chair of the FCC should enhance the transparency and accountability of the agency's operations by publicly reporting on the actions and findings of the Hurricane Recovery Task Force that the FCC established in response to that disaster and determine if any changes in policy are needed to ensure the FCC has transparent operations for any future disaster-related task forces.

We concur with GAO's Recommendation 1 regarding updating ESF#2 to more specifically delineate the roles and responsibilities of the FCC when that function is activated. We look forward to further consultation with DHS on clarifying specific roles and responsibilities for the FCC in ESF#2.

We concur also with Recommendation 2 regarding transparency and public information relating to the Hurricane Recovery Task Force and any future disaster-related task forces and intend to explore options for implementing this Recommendation.

Under new leadership, the FCC also is taking urgent action to refresh its capabilities and procedures for disaster response. For example, the Commission recently adopted new rules to provide state and federal agencies that are directly responsible for emergency management or first responder support functions with read-only access to communications outage data from the FCC's Network Outage Reporting System and Disaster Information Reporting System, while also preserving the confidentiality of the data. The Commission has also moved forward with proposing improvements to Wireless Emergency Alerts in a new proceeding that would create a class of non-optional National Alerts and a reporting system to encourage FEMA, State, Tribal, local, and territorial governments to report WEA false alerts to the FCC, as required by the National Defense Authorization Act for Fiscal Year 2021. Further, in response to Winter Storm Uri and in coordination with DHS, the Commission updated its internal procedures for analyzing and releasing information on the status of communications services during a disaster.

Thank you for the opportunity to review GAO's recommendations. We look forward to continuing to work with GAO in the future.

Sincerely,

Mark
Stephens
Digitally signed by Mark
Stephens
Date: 2021.04.14
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LISA FOWLKES
Digitally signed by LISA FOWLKES
DN: c=US, o=U.S. Government, ou=Federal
Communications Commission, cn=LISA
FOWLKES,
0.9.2342.19200300.100.1.1=27001000389622
Date: 2021.04.13 10:25:06 -04'00'

Mark Stephens
Managing Director
Office of Managing Director

Lisa M. Fowlkes
Chief
Public Safety and Homeland Security Bureau

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Appendix V: Comments from the Department of Homeland Security

Homeland Security

April 2, 2021

Andrew Von Ah
Director, Physical Infrastructure
U.S. Government Accountability Office
441 G Street, NW
Washington, DC 20548

Re: Management Response to Draft Report GAO 21-297,
     "TELECOMMUNICATIONS: FCC Assisted in Hurricane Maria Network
     Restoration but a Clarified Disaster Response Role and Enhanced
     Communication Are Needed"

Dear Mr. Von Ah:

Thank you for the opportunity to comment on this draft report. The U.S. Department of
Homeland Security (DHS or the Department) appreciates the U.S. Government
Accountability Office's (GAO) work in planning and conducting its review and issuing
this report.

The Department is pleased to note GAO's recognition of DHS' role and coordination
with the Federal Communications Commission (FCC) during the Hurricane Maria
response and recovery efforts in Puerto Rico and the U.S. Virgin Islands in 2017. While
DHS is the lead agency in federal disaster response, FCC, as the U.S. authority regulating
telecommunications, supports and advises DHS with respect to telecommunications
outages during disasters. Consequently, DHS and FCC coordinate on a number of
activities, such as FCC's engagement with public safety officials, management of data,
and efforts to reestablish communications.

DHS and its Components will continue to coordinate with their federal, state, local, and
other partners to understand available capabilities and effectively employ them during
disasters, as appropriate.

The draft report contained two recommendations, including one for DHS with which the
Department concurs. Attached find our detailed response to this recommendation. DHS

previously submitted technical comments under a separate cover for GAO's
consideration.

Again, thank you for the opportunity to review and comment on this draft report. Please
feel free to contact me if you have any questions. We look forward to working with you
again in the future.

Sincerely,

JIM H
CRUMPACKER

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CRUMPACKER
Date: 2021.04.02 13:38:25
-04'00'

JIM H. CRUMPACKER, CIA, CFE
Director
Departmental GAO-OIG Liaison Office

Attachment

2

**Attachment: Management Response to Recommendation
Contained in GAO 21-297**

GAO recommended that the Secretary of Homeland Security, in consultation with FCC:

Recommendation 1: Update Emergency Support Function [ESF] #2 to list specific roles and responsibilities for FCC, including identifying new or evolving technologies that could assist disaster response efforts and supporting training or exercises on the appropriate use of such technologies prior to disasters.

Response: Concur. In February 2021, the Cybersecurity and Infrastructure Security Agency Integrated Operations Division (IOD) initiated an update of the "ESF #2 - Communications Annex" to clarify roles and responsibilities of various federal, state, local, and other partners during disasters. More specifically, IOD is coordinating with the FCC to document its capabilities and working with representatives from the Federal Emergency Management Agency; the Departments of Agriculture, Commerce, Defense, Interior, the General Services Administration, others, as appropriate, to update the Annex as relates to each stakeholder. Estimated Completion Date: June 30, 2021.

3

Appendix VI: GAO Contact and Staff Acknowledgments

GAO Contact	Andrew Von Ah, (202) 512-2834 or VonAhA@gao.gov
Staff Acknowledgments	In addition to the contact named above, Sally Moino (Assistant Director); Nelsie Alcoser (Analyst in Charge); Joel Aldape; Janice Ceperich; Camilo Flores; Tina Paek; Malika Rice; Andrew Stavisky; Hai Tran; Sarah Veale; Michelle Weathers; Teresa Yost; Omar Williams; and Chris Zakroff made key contributions to this report.