Federal Communications Commission
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White Paper: The Role of Deployable Aerial Communications Architecture in Emergency Communications and Recommended Next Steps

Public Safety and Homeland Security Bureau
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Overview

A major goal of the Federal Communications Commission (FCC or Commission) is to ensure that reliable communications are available throughout the United States, including to first responders on both a day-to-day and emergency basis. However, communications capabilities are often limited during and immediately after disasters, when the terrestrial communications infrastructure may be severely damaged or unavailable for a period of time. To gain insight into potential technological solutions to this issue, the Public Safety and Homeland Security Bureau (PSHSB) issued in early 2011 a public notice soliciting comment on the ability of deployable aerial communications architecture (DACA) to provide communications when the terrestrial communications infrastructure is severely damaged or unavailable. This paper addresses the staff's vision for how DACA could be implemented and used, summarizes the comments we have received on this issue, and provides recommendations for next steps.[1]

Background

A critical lesson learned from every disaster, regardless of its size or the level of devastation, is the importance of communications for managing and coordinating the response, maintaining the rule of law, and keeping the public safe and fully informed.[2] Unfortunately, terrestrial communications services are often damaged during disasters. This complicates even the most prepared response effort. During the first 72 hours of a response, communications may be partially or completely disrupted due to damaged facilities, widespread power outages, and lack of access by restoration crews and equipment to the impacted area.[3]

In November 2010, the Federal Emergency Management Agency (FEMA) introduced the "Whole Community" concept for stabilizing a catastrophic event in the first 72 hours.[4] This new concept transitions from the mindset that the Federal government is always in the lead to a mindset that builds upon the strengths of local communities and their citizens. The Whole Community concept focuses on proactive engagement with neighborhood associations, businesses, schools, community groups, trade groups, fraternal organizations, and other civic-minded organizations that can mobilize their networks to build community resilience and support local needs in times of catastrophe. The key to the success of the Whole Community concept is the ability of these individuals and groups to communicate during the first critical 72 hours.

The geographic features of the United States make it susceptible to a varied range of potentially devastating natural phenomena, including the recent Mineral, Virginia, earthquake and Hurricane Irene, both of which affected much of the Eastern United States. As a result of Hurricane Irene, there were widespread power outages which directly impacted communications services in the affected areas.

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[2] See http://www.fcc.gov/guides/emergency-communications.

[3] Dourandish, Zumel and Manno, Command and Control during the First 72 Hours of a Joint Military-Civilian Disaster Response, 2007 Command and Control Research and Technology Symposium (June 19-21, 2007); www.72hours.org.

[4] http://www.fema.gov/pdf/about/odic/all_hands_719.pdf.

These are just two examples. The United States could also experience other disasters, including a catastrophic earthquake (with an estimated moment magnitude of 7.7) at any time along the New Madrid Seismic Zone (NMSZ), which covers eight states.[5] An earthquake of this magnitude would be estimated[6] to cause nearly 86,000 injuries and fatalities; require at least 42,000 search and rescue personnel; damage 130 hospitals, 715,000 buildings, and 3,500 bridges; and cause more than 425,000 breaks and leaks in both local and interstate pipelines. Approximately 2.6 million households would likely be without power after such an earthquake. Even at 72 hours after the earthquake, 7.2 million people could still be displaced, and an additional 2 million people could require temporary shelter. Except for those with satellite capability, widespread communications outages would be expected after the first 12 hours, at which point back-up batteries and generators at critical communications facilities would begin to fail. Cascading effects could result in a deterioration of communications systems outside of the disaster area.

In disasters this severe, it is all but certain that terrestrial communications facilities would be severely damaged and subject to significant communications outages. The inclusion of DACA capabilities in our communications arsenal could potentially improve emergency response dramatically in this and other disaster situations.

The DACA Vision

The DACA vision for disasters involves an aerial capability that is deployable within the first 12-18 hours after a catastrophic event to temporarily restore critical communications, including broadband, for a period of 72-96 hours. This capability would be useful in situations where the power grid may be inoperable for 5-7 days, depleting back-up power supplies and resulting in an almost complete failure of landline, cellular, land mobile radio, broadcast, and cable transmissions, as well as Wi-Fi and Internet services.[7] In such circumstances, access roads and bridges may be impassable, preventing communications repair crews and fuel suppliers for generators from entering the area. If DACA systems were available, users on the ground could continue to rely on their day-to-day communications devices in a transparent manner.[8]

The Federal government would provide and coordinate air operations for the aerial platform, which would allow authorized spectrum users to deploy a temporary capability that conforms to and is integrated into existing communications systems. Certain capabilities, such as the temporary restoration of cellular services, would be restricted to wireless priority service (WPS), Government Emergency Telecommunications Services (GETS), and 911 calls, while other

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[5] Illinois, Indiana, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, and Missouri.

[6] Mid-America Earthquake Center Report, "New Madrid Seismic Zone Catastrophic Earthquake Response Planning Project," October 2009.

[7] The Japanese government funded a project in which a DACA solution (in this case, a high altitude platform) would be used to provide terrestrial communications in the event of an earthquake. The system is still under development and was not yet available in March of 2011 when Japan experienced an earthquake of magnitude 9. See e.g., Baker, High Altitude Platforms for Military Communications, Strategic Defense Intelligence (April 14, 2011), available at http://www.strategicdefenceintelligence.com/article/fByndVw6XM/2011/04/14/insight_high_altitude_platforms_for_military_communications/. (Baker Article).

[8] We still need to explore issues such as roaming charges and network access. The Bureau recommends these issues be considered in a proceeding.

services, such as Wi-Fi and Internet services, could be open for public use. Other capabilities, such as public safety communications, could be supported by the DACA system. There would also need to be a spectrum interference coordination method in place, especially to protect terrestrial communications systems from harmful interference from the DACA system as they are restored. This type of coordination procedure could be implemented by the FCC and coordinated by the FCC in conjunction with FEMA and other federal, state, and local authorities responding to the emergency.

Military Use

While the commercial communications industry and the public safety community does not typically use deployable aerial communications architecture today, the U.S. military uses aerial platforms for signal transmission.[9] The range extension and additional coverage area provided by aerial platforms are appealing in a tactical and dynamic battle space. The military has employed aerial platforms using piloted aircraft, unmanned aerial vehicles (UAVs), and tethered or untethered balloons for localized communications and to provide enhanced coverage areas and extend the battle space.[10] Each DACA technology has its own particular characteristics and capabilities, but all capitalize on the unique propagation advantages that altitude provides and use coordinated frequency assignments to allow multiple users on the ground to access the aerial platform and enjoy the increase in coverage area.[11]

February 2011 DACA Public Notice

On January 28, 2011, the PSHSB issued a public notice (DA 11-175) (DACA PN) seeking comment on current and future technologies that could restore critical communications during the first few hours after a catastrophic event. The DACA PN sought information on several types of DACA, including unmanned aerial vehicles and balloon mounted or unmounted systems that could be rapidly deployed to an area within the first few hours after a disaster to provide an accessible, reliable, resilient, cost-effective, and secure capability for public safety and emergency response personnel to communicate during the critical restoration period. We sought comment on the use of DACA over a variety of communications platforms, such as UHF, VHF, 700/800 MHz, cellular, Internet, and satellite, which would enable users to continue to use their communications devices. Approximately twenty parties filed comments in response to the DACA PN.[12]

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[9] See e.g., Baker Article; Singer, Pentagon Eyes High Altitude Balloons for Emergency Communications Systems, Space News (July 18, 2007) available at http://www.space.com/4079-pentagon-eyes-high-altitude-balloons-emergency-communications-system.html.

[10] Id.

[11] In the application of these aerial platforms, the military has taken advantage of unique frequency coordination and use characteristics that are inherent to the military planning infrastructure, including dedicated frequencies. In this way, it is able to avoid many of the coordination issues that are faced by the commercial sector. For example, the use of airborne platforms for commercial cellular service would require extensive frequency coordination with the commercial license holders to avoid interference issues. These issues need to be addressed in the commercial context for these technologies to be successfully utilized. Accordingly, the Bureau recommends that the FCC initiate a proceeding to determine how to successfully address coordination and interference concerns.

[12] Appendix A contains a list of commenters.

Summary of the DACA PN Record

The DACA PN solicited information on current and future technologies for DACA and associated technical issues. The technology companies that filed comments identified rapidly deployable technologies used for military and commercial use, including unmanned aircraft, balloon-borne systems, and near space platforms.[13] The technology companies recognized that coordination, including frequency coordination to avoid harmful interference, could be addressed by the FCC and network operators to support DACA services.[14]

Communications service providers described the substantial investment they are making in portable equipment, such as cell towers or satellite equipment on wheels.[15] They raised concerns regarding how DACA could complicate the interference environment and suggested the need for a rulemaking to consider interference and related issues.[16]

Commenters also recognized the need for the use of DACA to be coordinated with other federal agencies, such as the Federal Aviation Administration (FAA), as well as state and local public safety officials.[17]

Promising Technological Solutions

The record compiled in response to the DACA PN demonstrates that there are a number of promising technologies that could be deployed during the first 72 hours after a disaster to help ensure communications capabilities but without requiring deployment of any new user devices.[18] Such technologies can support current communications services, such as cellular and public safety voice services. This would mean that commercial and emergency response services could be restored in the affected areas quickly using DACA technologies.[19]

The following are DACA technologies that are currently available that can support current communications services, such as cellular and emergency communications services. Each possible solution has advantages and disadvantages, which we recommend that the Commission explore in more detail through a notice of inquiry

- Small unmanned aerial vehicles (SUAV): Hand-launched, battery-powered vehicles that fly to about 500 feet above ground level (AGL).[20] SUAVs can generally support one communications service, such as a single frequency band for cellular services. This equipment can be pre-deployed, brought into a disaster area, or launched from a nearby

[13] Comments of Space Data Corporation; Comments of AeroViornment, Inc; and Comments of Arkansas Interoperable Communications Executive Committee.
[14] Comments of Space Data Corporation.
[15] See e.g., Comments of AT&T, Comments of Sprint Nextel, and Comments of CTIA.
[16] Id.
[17] Comments of APCO.
[18] See Comments of Aurora Flight Sciences Corporation at 1; Comments of Space Data Corporation at 2-11.
[19] See Comments of Space Data Corporation at 6-10; and Comments of AeroViornment at 1-3.
[20] See e.g., Comments of AeroViornment, Inc. at 1.

location. SUAVs can stay airborne for several hours at a time and can be used as repeaters or virtual cell towers.[21]

Launch of a SUAV

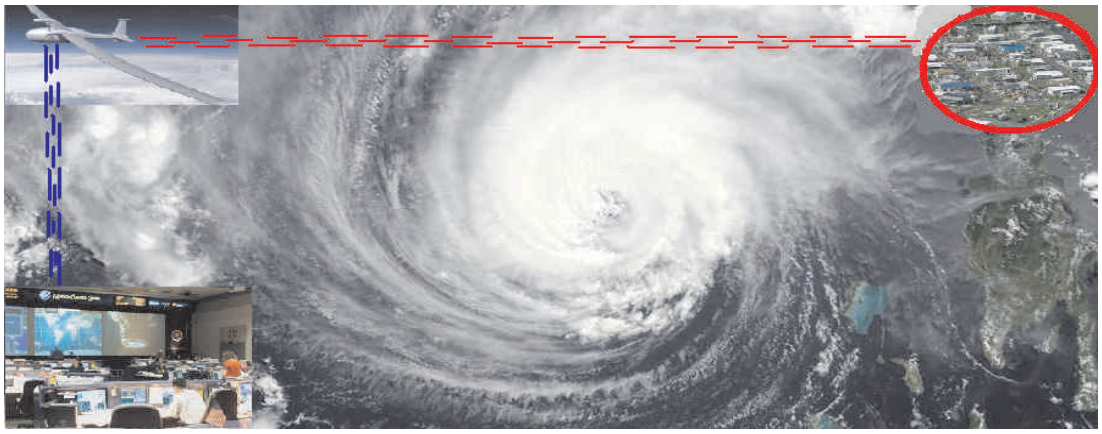
- Weather balloon technologies (Balloons): Balloon-borne technologies in a six-pound package that can act as repeaters.[22] These systems can bridge repeater technologies to allow use of more than one band of frequencies by the overall system. However, frequent re-launching may be required to ensure continued communications coverage because of the short time that balloons can remain aloft.

Weather balloon technology

- High altitude long distance unmanned vehicles (HALE): Allow for deployment at potentially higher operational altitudes, for longer durations, with greater payloads.[23] HALEs, because of their height and maneuverability, may allow for geographically-

[21] Id.
[22] See e.g., Comments of Space Data Corporation at 2-4.
[23] Comments of AeroViornment, Inc. at 1.

directed communications, which may decrease the potential for harmful interference, and may provide greater capacity than other available solutions.



High altitude long distance unmanned vehicle (HALE)

- Deployable suitcase systems: Deployable suitcase transceivers that can be placed on low flying aircraft to be used as repeaters.[24]

Deployable suitcase system

Other technologies, such as quick-mounted antennas, repeaters and transmitters on wheels, and satellite technologies, were also identified in the record as potential solutions for communications during emergencies where the terrestrial infrastructure is compromised.[25] In addition, satellite technologies were identified as a critical component of most DACA technologies for connectivity. PSHSB staff recommends that any future proceeding also consider the advantages and disadvantages of these potential solutions.

[24] Comments of Arkansas Interoperable Communications Executive Committee at 1-2.
[25] Comments of Sprint Nextel at 1-5; Comments of ComSite Hardware, Inc. at 1; Comments of ViaSat, Inc. at 1-2.

Regulatory and Other Issues

The record shows that cellular and public safety communications services can be restored in a disaster area using "mini cell sites" on DACA facilities capable of providing service just within the area. However, some commenters suggest that these systems should be authorized to operate in a manner that avoids interference with surviving and recovering terrestrial communications.[26] An airborne "mini cell site" could operate under the license of the carrier authorized to provide service on the frequencies it uses, or it could be separately authorized to a third party—*e.g.,* a public safety entity—pursuant to Special Temporary Authorization (STA). Alternatively, the Commission could adopt rules defining eligibility to operate such a site during an emergency, perhaps limiting eligibility to public safety entities or for very short term uses with accompanying pre-notification and other requirements. This is an issue that we recommend the FCC explore further.

From a technical perspective, our analysis demonstrates that an airborne mini cell would have to be equipped with a rudimentary switch to accomplish handoffs and to limit use to authorized public safety users. There would also need to be coordination with commercial operators to prevent harmful interference as commercial operations are restored. This is an issue that we recommend the FCC explore further.

Some cellular companies argue that airborne cellular facilities should be activated only with the permission of cellular operators in the affected area.[27] Others urge the FCC to adopt specific rules to limit potential interference from airborne facilities to area cellular systems.[28] Although it is clear that the use of airborne cellular facilities should be coordinated with nearby cellular systems, we believe the issue of whether to require permission prior to activation should be explored further.

Other commenters have argued that there is a potential for interference to terrestrial communications services from airborne communications facilities.[29] However, there are potential ways to address interference concerns. For example, the interference potential of mini cell sites can be controlled by limiting the altitude of the airborne platform and the power of the mini cell. Interference potential could be further reduced by coordinating use with the potentially affected carriers. We recommend that the Commission explore these and other possible solutions.

International Considerations

U.S. treaties and arrangements with Canada and Mexico are complex but generally seek to prevent interference by limiting the power flux density (signal strength) of stations operating near the borders. It is important to consider where further international arrangements are

[26] Comments of APCO at 1-2; Comments of NPSTC at 3-6.
[27] See Comments of CTIA at 4.
[28] Comments of CTIA at 5-6.
[29] Comments of APCO at 1-2; Comments of CTIA at 1-2; Comments of AT&T at 2-3; Comments of Sprint Nextel at 6.

necessary to enable deployment of DACA technologies in border areas. We recommend that the FCC explore this issue further in conjunction with the Department of State (State Department).

Coordination with Other Agencies

Since the FCC does not have sole authority among federal agencies for authorizing the operation of DACA-type devices for emergencies, interagency coordination is crucial. Agencies with an interest in DACA deployment include the FEMA, which is responsible for the nation's emergency response; the FAA, which controls the airspace; State Department, which is responsible for international relations; and the National Telecommunications and Information Administration, which manages government spectrum use. We recommend that the FCC coordinate with these and other relevant agencies.

Recommended Next Steps

- Initiate a notice of inquiry by the end of the year to address FCC-related issues, including the role of DACA solutions during disasters, radio interference, spectrum coordination, authorization requirements, costs, cost-effectiveness, and operational procedures.
- Host a workshop on deployable aerial communications architecture solutions and outstanding issues by the end of the year.
- Share findings with FEMA, the FAA, and other federal partners to initiate discussions regarding next steps for possible pilot programs and implementation.
- Determine which issues have international ramifications, working with the State Department and other appropriate federal agencies, and determine appropriate next steps.

Commenters on the DACA PN

AeroVironment, Inc.
Association of Public Safety Communications Officials (APCO)
Arkansas Interoperable Communications Executive Committee
AT&T
Aurora Flight Sciences Corporation
Cellular Telephone and Information Association (CTIA)
Cohen, Dippell and Everist, P.C.
Comsite Hardware, Inc.
Daniel Devasirvatham
Emilio Lopez
Layer 2 Connections, LLC
National Public Safety Telecommunications Council (NPSTC)
Rex Buddenberg
Satellite Industry Association
Space Data Corporation
Sprint Nextel Corporation
ViaSat, Inc.
WildBlue Communications, Inc.