Before the

FEDERAL COMMUNICATIONS COMMISSION

Washington, D.C. 20554

In the Matter of:	)	
	)	
Utilizing Rapidly Deployable Aerial	)	
Communications Architecture in Response to an	)	PS Docket No. 11-15
Emergency	)	

Comments of General Dynamics Command, Control, Computing, and Communicatons (C4) Systems

General Dynamics C4Systems, hereby submits comments in response to the questions raised in this Notice of Inquiry.

I. Background

General Dynamics C4 Systems (GDC4S) is a leading provider of tactical communications and command and control systems to the United States Military. We have a wide breadth of experience in the development, integration, test, and delivery of robust communications solutions into environments where little to no infrastructure exists. We also provide fixed infrastructure communications networks for the US Federal Government to include systems such as the US Coast Guard Rescue21 and US Department of Justice Integrated Wireless Network (IWN) systems. Moreover, with the recent acquisition of IP Wireless, GDC4S now combines this expertise with industry leading 3G and 4G Long Term Evolution (LTE) wireless broadband capabilities. IP Wireless (now a part of General Dynamics Broadband within GDC4S) is a leading provider of technology and solutions in support of the emerging nationwide interoperable broadband network for first responders, bringing high-speed access to vital information needed by law enforcement, emergency first responders, government agencies and other professionals responsible for the public's safety and the nation's security. Broadband technology also ensures that information, ranging from real-time video feeds to large image files and other mission-critical data will be available in cluttered urban environments, isolated rural areas, and everywhere in between. As the provider of the most advanced mobile broadband deployments in the government sector today, including New York City's Wireless Network (known as NYCWiN) and Adcom 911 (Adams County, CO's public safety LTE network) GDC4S is in a position to leverage the decade-long experience of

developing and deploying next-generation mobile broadband solutions while also incorporating lessons learned from a long history of providing tactical communications systems to the military.

To gain insight into potential technologies for the Deployable Airborne Communications Architecture, the Public Safety and Homeland Security Bureau (PSHSB) issued an FCC Public Notice (DA-175) on January 28, 2011, soliciting comment on the ability of DACA to provide communications when the terrestrial communications infrastructure is severely damaged or unavailable. PSHSB then subsequently published a white paper with the FCC entitled "The Role of DACA in Emergency Communications and Recommended Next Steps" (September 2011) detailing their vision of how DACA could be implemented and used. The DACA vision (as described in the white paper), involves an aerial capability, deployable within the first 12-18 hours after a catastrophic event, to temporarily restore critical communications, including broadband, for a period of 72 to 96 hours. The underlying assumption is that this capability could be deployed in scenarios where the power grid is inoperable, and backup power is depleted, resulting in an almost complete failure of landline, cellular, land mobile radio, and all Wi-Fi and Internet services in the affected area. In this scenario, certain capabilities, such as the temporary restoration of cellular services would be restricted to Wireless Priority Service and public safety communications, Government Emergency Telecommunications Services (GETS), and 911 calls. Other services, such as Wi-Fi and Internet access via Wi-Fi, could be publically available. A critical consideration in the DACA vision is the development of a spectrum interference control approach to protect surviving terrestrial communications from harmful interference from the DACA system as well as when they are restored via either temporary or permanent ground based systems by local carrier and providers.

Below summarizes available technologies within the context of the DACA solution shown in Figure 1

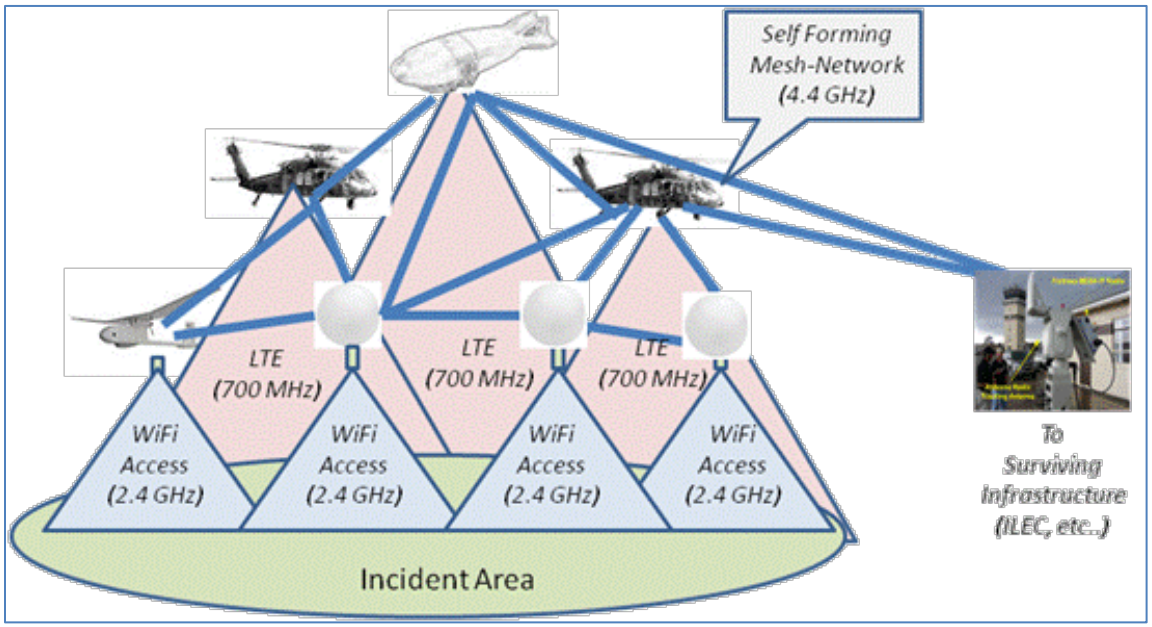


Figure 1

Our DACA vision (Figure 1), leverages our experience in the deployment of Government agency and DoD tactical networks, together with core products and technologies from General Dynamics Broadband to include:

- Wireless 3GPP LTE solutions tailored to a variety of custom environments to include both DoD as well as public safety applications (NYCWin and Adcom911). Spectrum-efficient implementations (N=1 frequency reuse) have been developed over a wide range of spectral solutions to include 450, 700, 800, 1900, 2010, 2053, and 2500 MHz .. The LTE solution can employ a distributed "flat" IP core network capability enabling small, rapidly deployable systems. This "network in a box" approach provides a complete LTE system (eNodeB and core) capability in a single package that can be deployed in a variety of fashions, and which, for example, be deployed in an airborne asset, such as a helicopter or aerostat, in the immediate aftermath of a disaster. Approaches have also been developed to separate RF transceiver functions from the processing functions in the eNodeB, allowing for tethering the RF functionality on small, easily transported, lightweight aerostat platforms. The application of IP wireless LTE technologies to the DACA is described in more detail in Section II, including the implications of supporting both a Band 14 Public Safety capability, as well a multi-band approach that would leverage band combinations that lend themselves to a shared architecture supporting commercial access for 911. For instance, with respect to LTE, Band Class 12, 13, 14, & 17 are all part of the 700MHz band, and span both commercial and public safety allocations. Though typically not deployed in this manner, it is technically feasible to implement a common radio for all four bands thereby enabling a cost effective multi-band DACA solution, as long as provided in conjunction with appropriate roaming agreements and spectrum usage allowances from local carriers in the DACA deployment.

- Fortress® MESH Internet Protocol (IP) radios. Capable of operating in unlicensed and licensed bands, these radios provide disaster relief workers self forming/self-healing 802.11 a/b/g/n access and network level connectivity in either the 2.4 or 5.8 GHz ISM bands, the 4.4GHz NATO C-Band, or the 4.9GHz Public Safety Band. This capability is available in small, lightweight ruggedized packages providing up to four channels and ranging in weight from 2lbs to 7lbs. As shown in Figure 1, below, one channel of the device could be utilized to provide low altitude 2.4 GHz Wi-Fi access to the ground (which can be secured for Public Safety use), and a second channel could be operated at 4.4 GHz to provide a self forming mesh to interconnect a variety of airborne assets in a flexible dynamic incident response system, and allowing for air assets to be taken on and off station without disruption in connectivity.

II. Comments on Public Notice

In the response below, GDC4s provides overall comments that address those issues raised by the Notice of Inquiry which are pertinent and relevant to our DACA vision and area of expertise. In each, the original paragraph has been provided in italics followed by GDC4S comments.

A. DACA Technologies

9. FCC Question: We seek comment on the ability of each of the various DACA technologies, either as standalone aerial platforms or add-on payloads, to deliver critical communications immediately after a catastrophic event. We also seek comment on each DACA technology's ability to support existing communication services and devices. Based on past experience, we believe that it is critical that the devices consumers and first responders use on a day-to-day basis be able to work with DACA systems. Are there other technological solutions similar to DACA that are ground based, such as drop-in suitcase architectures, that would be equally adept at restoring commercial and public safety communications to an area?

General Dynamics Broadband (formerly IP Wireless) is a pioneer in the development and commercialization of end-to-end 3GPP mobile broadband solutions, including multiple generations of chipsets, software, devices, and complete network solutions. Currently focused on 3GPP Release 9 solutions, General Dynamics Broadband has significant 3GPP design capabilities and has, for years, been a leader in developing 3GPP solutions for the special requirements of the Public Safety and broader Government markets. For LTE, General Dynamics Broadband provides a vertically integrated solution using its own eNodeB, User Equipment, Evolved Packet Core, and subscriber and network management servers. eNodeB and possibly Evolved Packet Core elements can be modified to suite a range of possible DACA platforms. By using existing bands and technology, such as LTE for Public Safety Band Class 14, DACA deployment can leverage deployed User Equipment without modification.

While GD Broadband's LTE products are originally intended for terrestrial deployments, the solutions can be adapted for use in a DACA deployment in order to provide rapidly deployable, airborne mobile broadband communications. General Dynamics Broadband has significant experience in modifying and testing our 3GPP mobile broadband technology for use in both ground-air and airborne aeronautical communication systems. Applicable for use in a DACA deployment, General Dynamic Broadband equipment has been adapted for use on various airborne platforms such as C130's and static high altitude tethered balloons to provide mobile broadband coverage. The on-board equipment can consist of simply the cellular basestation equipment or both basestation and core network equipment in a compact, rugged, and light weight form factor. With basestation-only systems, a backhaul link to a terrestrial datacenter housing the core network equipment is required, utilizing other GD products. With both basestation and core network onboard the aircraft, the DACA system can operate as a completely standalone network, providing disaster and major incident communications independent of existing terrestrial infrastructure.

Other alternatives and augmenting/complimentary capabilities are also commercially available in the same GD Broadband product line, to include Fortress® MESH Internet Protocol (IP) radios. Capable of operating in licensed and unlicensed bands, these radios provide disaster relief workers self-forming/self-healing Hastily Formed IP Networks (HFNs) with little effort compared to large "point-to-multipoint" fixed infrastructure systems.

Furthermore, to extend the ground network over large areas, or bridge widely-dispersed HFN's, Fortress® MESH IP radios can be installed on aerostats or winged aircraft. Communications through winged aircraft may require a tracking antenna depending on distance and relative movement.

Fortress® MESH IP radios provide high-capacity, wireless broadband network services to disaster relief personnel using consumer market devices.

Implementations relevant to DACA are shown in the below photos

Fortress MESH IP Radio
Deployment Kit

Fortress® MESH IP radio networks are used by the US DoD, National Guard, Department of Energy, and other government customers. To learn more, please refer to http://gdfortress.com/

10. FCC Question: The United States Armed Forces, particularly the National Guard, are recognized as emergency responders in the aftermath of major disasters across the United States. The record in response to the DACA PN showed that the U.S. Armed Forces have used DACA technologies successfully. What DACA technologies are the United States military currently using and in what situations are they used? Are they used domestically, internationally, or both? What has been the experience of the U.S. Armed Forces with such use? What lessons can we learn from the military's use of these technologies? Are there relevant differences between military use and civilian use that should be taken into account?

What are the costs and benefits associated with such use?

Regarding differences between military and civilian DACA applications, one relevant difference is that civilian use may need to support a range of frequencies for a given technology and possible multiple technologies. In contrast, military DACA deployments are likely intended for closed communication purposes where only a single frequency and technology is needed and likely preferred. While some DACA platforms will be able to support the equipment necessary for a mix of some of the available commercial technologies and bands, some platforms will not be able to support more than a single technology and band, and it is unlikely that any one solution will support the full range of public safety and commercial bands in use in a region.

With regard to DACA technologies currently in use by the US military, the US Army's Warfighter Information Network – Tactical (WIN-T) program has tested high capacity ground-to-air/air-to-ground communications among moving airborne and ground vehicles. The Army plans to have this capability fielded with WIN-T in 2015. Communications frequencies are in the C and Ku bands. The system uses electronically-switch antenna elements, to concentrate RF energy and achieve frequency re-use.

WIN-T Increment 3 Aerial Tier Test Aircraft (US Army C-23 Sherpa)

Furthermore, WIN-T ground-based stationary and mobile communications nodes can bridge the air-ground/ground-air network with commercial band, line-of-sight networks, thereby providing beyond-line-of-sight "internet-like" services to disaster relief personnel using consumer market devices.

The WIN-T System is used both domestically and internationally. As with all military communication systems, strict spectrum management is required.

To learn more, please refer to http://peoc3t.army.mil/wint/ or http://www.gdc4s.com/content/detail.cfm?item=538ca0ca-4675-4291-84e8-bf047859281f

General Dynamics C4S has also worked with Small Unmanned Aerial Vehicle (SUAV) manufacturer AeroVironment (http://www.avinc.com/) to deploy the Soldier Radio Waveform (SRW) onto the RAVEN, and other Small Unmanned Aerial Systems (SUAS). When equipped with this capability, a SUAS can be

used to quickly to re-establish communications within a local area without the need of additional infrastructure. This airborne radio capability enables simultaneous voice, video, and data networking via the secure JTRS Soldier Radio Waveform (SRW) currently used within the US Army.

13. FCC Question: AT&T and AeroVironment have stated that weight may be a limiting factor in how many communications payloads DACA technology can support at a time. We seek comment on this observation. Are certain technologies or communications payloads not appropriate for use in DACA because of weight? If so, what if any solutions are possible to mitigate weight limitations? What impact, if any, does weight have on the cost effectiveness of DACA deployments?

In examining the adaption of cellular technologies to a DACA solution, a significant driver of size, weight, and power ("SWAP") of a cellular basestation is the radio front end including the high power amplifier. Certain baseband processing may be performed on shared equipment, but this accounts for only a fraction of the SWAP of a communication payload. To implement multiple bands, typically separate radios are required resulting in a multiple to the SWAP of the communication payload. Certain band combinations lend themselves to a shared architecture. For instance, with respect to LTE, Band Class 12, 13, 14, & 17 are all part of the 700MHz band and span both commercial and public safety allocations. Though typically not deployed in this manner, it is technically feasible to implement a common radio for all four bands thereby enabling a cost and size effective multi-band DACA solution.

One possibility for reducing SWAP for DACA deployments is to reduce the size of the high power amplifier. For cellular technologies such as LTE, basestations are typically equipped with an output power of approximately 10-20W per antenna. However, with such output power levels the link budget is unbalanced between the downlink (basestation to user) and uplink (user to basestation). The uplink is the limiting link by at least 7dB. Therefore, it is possible to reduce the output power at the basestation up to a point without a corresponding reduction in coverage, though downlink capacity may be affected. Furthermore, the benign propagation environment associated with ground-to-air and air-to-ground communication could possibly tolerate still further reduced power and still achieve the coverage targets. However, this is dependent on multiple factors including desired coverage area and DACA platform altitude. This is discussed further in the section on coverage below.

B. System Performance

22. FCC Question: Adequate DACA coverage within the area affected by a disaster will be critical to the success of any DACA deployment. We seek comment on how to delineate the affected area for which a DACA solution is deployed. We seek comment on how to best achieve as much coverage of an affected area as possible. What are the factors that determine the extent of coverage by DACA platforms? How should coverage be measured? At the DACA Workshop Daniel Devasirvatham suggested deploying DACA platforms in stages, and at multiple altitudes, to quickly serve and restore communications. We seek comment on this approach. Could deployment of DACA solutions in stages provide maximum coverage to both emergency first responders and the public? How should coverage be measured? Should a staged deployment include various DACA platforms at different heights for specific communication services? What are the advantages and disadvantages of this type of deployment? What are the costs associated with deploying DACA solutions in stages? We also seek comment on the

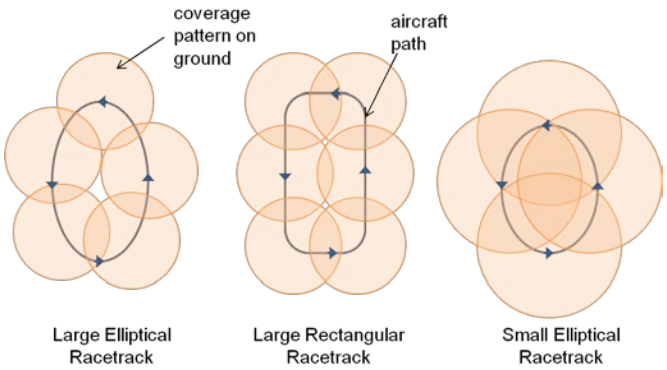
ability of DACA technologies to provide geographic coverage over all geographies and terrains. With the varied topography of the United States, can DACA technologies provide adequate service in areas with mountainous regions or in tall buildings? Are there geographical limits on the types of DACA solutions that can be deployed, including in densely populated metropolitan areas? Can DACA technologies provide in-building coverage or service in geographically complex areas? Are there other technologies that can complement DACA technologies that might be better suited to providing coverage in more complex environments? What are the costs and benefits associated with deployment and operation of these complementary technologies?

In addition to speed of deployment, an airborne communication platform brings the advantage of increased coverage relative to that from terrestrial sites. The general understanding is that a high altitude platform implies a higher maximum range. This comes from the fact that the altitude of the basestation is much greater than the clutter/obstacles on the ground, and in being so ensures a Line-of-Sight ("LOS") path, with benign propagation properties, between the basestation and the user. However, for a practical system, the effective range, that is the range when considering terrain information, is a function of several factors - one of which is the user elevation look angle to the aircraft. A high elevation angle generally implies a LOS propagation channel. As long as the link budget can be closed, coverage can be provided to the users on the ground. A low elevation angle generally implies that transmissions may be blocked or attenuated by the surrounding terrain. A high altitude aircraft does not guarantee LOS transmission or even network coverage if the user's elevation angle is low, but increases the likelihood of LOS.

Another factor when considering coverage from a DACA platform is aircraft mobility. Depending on the type of platform, the coverage footprint may be static, as with a tethered balloon, or highly dynamic, as with an orbiting UAV. With moving aircraft, the coverage footprint will move in relation to the aircraft's flight path. One possible scenario is an aircraft moving in a "racetrack" pattern over a region. Such a racetrack could be either elliptical or rectangular as shown in the figure below. The size of the racetrack relative to the aircraft's coverage footprint impacts the ability of a single aircraft to provide continuous coverage of a region.

For a large racetrack (relative to coverage footprint), multiple aircraft are required to provide continuous coverage. While such an option enables the possibility of extending the coverage area, and capacity over that achievable by a single aircraft, it also adds significant complexity to a DACA deployment.

For a small racetrack (relative to coverage footprint), a single aircraft can provide continuous coverage of a region as shown to the right in the figure below. As shown below, certain regions will remain constantly illuminated while other outlying regions will receive intermittent coverage as the aircraft follows the track.



23. FCC Question: The record demonstrates that frequency preplanning will be vital to successful deployment of DACA systems in order to avoid harmful interference and to enable terrestrial communications to be restored on an efficient and timely basis. Accordingly, we seek comment on the frequency bands that are most suitable for DACA use. Vincent "Tex" Boyer stated at the DACA Workshop that FEMA, through the use of CAP aircraft, has mounted and used very high frequency (VHF) spectrum, ultra high frequency (UHF) spectrum, and spectrum in the 700 MHz band to successfully provide communications services in disaster areas. Gerald Knoblach noted at the DACA Workshop that the forty narrowband VHF and UHF channels and forty 12.5 kHz channel pairs in the 900 MHz band that are licensed to Space Data could be used to support DACA solutions. AT&T stated that 2G, 3G, 4G, GSM, UMTS, LTE, and cdma2000 network services and technologies will need to be incorporated as well. On which frequency bands should DACA technologies be permitted to operate? Would use of DACA on certain bands interfere with public safety or other services? If so, in which bands and what solutions are available to minimize interference?

In alignment with current public safety communication efforts, a primary area of focus for frequency support by DACA solutions should be the public safety 700MHz allocation. In 700MHz, public safety has been allocated 10+10MHz of spectrum. For a public safety network, one means of deploying a DACA solution without the need for extensive frequency preplanning would be to establish a procedure whereby DACA operations are limited to only half the spectrum allocation or 5+5MHz. This would leave the remaining 5+5MHz of spectrum for reestablishing terrestrial communication services of the public safety broadband network. Such an approach would trade off the capacity of both the DACA system and terrestrial system against ease of coordination. Upon determination that terrestrial services are fully restored, the system would be reconfigured to full 10+10MHz operation. Both LTE basestations, eNodeB, and user equipment, UE, support the ability to operate in 5MHz and 10MHz bandwidths. Upon reconfiguration of the carrier bandwidth at the eNodeB, connected UE will automatically reattach to the network with minimal outage. Clearly, because of the reduction in terrestrial capacity when such a scheme is invoked, the decision would only be made by FirstNet and public safety agencies in situations where the benefits of aeronautical coverage override the need for full terrestrial capacity.

Similarly, often commercial carriers have multiple channels of a given frequency band in a region. Should a commercial band supported by a DACA solution be deployed, a similar plan for dividing up

channels between those for DACA support and those for restoration of terrestrial communication services may simplify coordination efforts.

24. FCC Question: AT&T has expressed concern over the interference potential of DACA deployment in commercial bands used by services premised on cellular architecture, for which highly coordinated reuse of frequencies is essential. AT&T suggests, however, that some of its interference concerns can be minimized if DACA technologies do not employ the commercial frequency bands and instead are limited to those bands used for unlicensed operations and other non-cellular-based technologies. We seek comment on this observation. What effect would limitations on the use of commercial frequency bands have on emergency response? Are there cost implications to limiting the use of DACA in certain bands? If DACA technologies cannot be deployed supporting commercial bands, how would consumers be affected? Would limiting the use of DACA in commercial bands affect the ability of consumers to reach 911 during a wide-scale disaster where terrestrial infrastructure may not be available?

In the context of mobile broadband technologies, limiting DACA deployments to public safety frequency allocations would restrict the ability for consumers to communicate during emergencies. First, consumer equipment would be required to support 3GPP band class 14, the public safety allocation, and in-bound roaming agreements would need to be in place in order for users to roam onto the DACA system. While the Middle Class Tax Relief and Job Creation Act does explore provisions for non-public safety user access via public private partnerships, the frame work for consumer roaming requires significant development. Furthermore, the ecosystem for consumer devices that support the public safety band will require time to develop. An additional consideration is the limited capacity supported by the public safety 700MHz allocation. While LTE does support both access control prioritization as well as traffic prioritization, it is unlikely that a DACA system utilizing only the PS allocation could fully support all traffic from both public safety and non-public safety users during an incident.

26. FCC Question: Several comments in response to the DACA PN raised the concern that use of certain DACA technologies may create harmful interference to commercial wireless services and other services. To ensure that frequency reuse does not cause interference, wireless providers must ensure that they coordinate the transmitters in their network and coordinate with providers operating in adjacent markets on the same frequencies. We seek comment on whether similar procedures should be adopted for DACA technologies and, if so, what they should include. What are the costs of implementing various interference mitigation techniques for DACA technologies? Do the costs of each justify relying on them? If so, identify the specific costs and benefits.

One advantage of DACA systems utilizing LTE is the ability of the technology to operate in a true N=1 frequency reuse manner whereby an entire network uses the same RF channel across a network. N=1 reuse requires extensive RF planning to ensure adequate, but not excessive, levels of overlap between neighboring cells, thereby minimizing the ability of terrestrial systems and DACA systems to employ the same RF channel. However, it does facilitate the possibility of a simplified frequency coordination plan between terrestrial and DACA systems since complex frequency reuse schemes do not need to be considered.

27. FCC Question: Comments on the DACA PN also raised the concern that the mobile nature of DACA technologies increases the difficulty of frequency coordination. Other than allocating dedicated spectrum for the use of DACA technologies, are there methods to ensure that frequency reuse does not cause interference or to minimize any such interference? Can DACA technologies use frequencies in areas where commercial base stations are out of service but have been coordinated with neighboring service markets? Once base stations that were out of service come back into service, can frequency reuse be coordinated with DACA technologies to limit interference? Could frequency reuse be managed by assigning unused base station frequencies that are not in service, within an existing system, essentially adding in a DACA system as if it were a planned base station? Are there other approaches to frequency coordination that the Commission should consider, such as existing cell selection mechanisms used in mobile handheld devices? What are the costs of allowing a DACA technology platform to serve as a base station? Do other frequency coordination approaches have costs? If so, what are they and will these other approaches provide the same benefits of frequency reuse as coordinating with neighboring service markets?

As above, in the context of LTE and recognizing the simplified frequency reuse plan, the simplest approach for coordinating would be to establish a dedicated allocation for use by DACA during emergencies. Whether public safety allocations only, or both public safety and commercial allocations, this presupposes multiple RF channels in each supported band in order to facilitate DACA-based communication alongside restoration of terrestrial services.

28. FCC Question: Several commenter's raised the concern that the use of DACA technologies during emergencies could overlap with the restoration of terrestrial services, potentially creating interference. We seek comment on ways to avoid this problem. Are there procedures available that will enable DACA solutions to operate in an affected area and limit harmful interference to terrestrial network services as they are restored, and have these procedures been used? Does the military have such an approach in place? If so, has it been successful? Are there costs to avoiding the overlap and interference between DACA solutions and terrestrial network services, as services are restored? If so, what are these costs and do the benefits of implementing any procedures justify the costs?

As discussed above, a straightforward method for providing DACA based communication without hindering restoration of terrestrial services would be to divide up the frequency resource between DACA and terrestrial services during an emergency. For 700MHz public safety broadband, this would take the form of splitting the 10+10MHz of public safety broadband spectrum into 5+5MHz allocations.

29. FCC Question: We also seek comment on DACA signal propagation. The radio frequency transmission from these systems through free space (usually air) provides almost ideal conditions for signal transmission. Also, the radio frequency propagation distance can be extensive and cover a considerably larger footprint than terrestrial operations and deployable systems close to the ground. The larger coverage area increases the potential for harmful interference. At what altitudes could DACA systems potentially operate (e.g., 250, 500, 1,000, 2,000, 10,000, 50,000 feet)? Is coverage dependent on which frequency is in use? What potential exists for interference with commercial network services that may remain operational during disasters or for cell sites and systems that are restored shortly after the

disaster? What are the methods to mitigate or reduce the impact of these interference scenarios? What are the costs of implementing such methods and techniques? Do the benefits of interference mitigation justify the costs of implementation? What are the appropriate levels of interference for commercial and land mobile radio (LMR) systems to accept, if any, such that during the worst disasters DACA technologies could be deployed to provide the required communications? Are there frequencies that aerial systems could use and altitudes at which such systems could operate to minimize interference? Are there any limited, practical scenarios in which aerial transmissions could be used without creating interference? If the uplink (mobile user to DACA platform) radio communication path is assumed to be the weaker path because of lower transmit power levels than the downlink (DACA platform to mobile user), what is the desired and acceptable altitude for a DACA platform based on currently available LMR and commercial mobile radios? Does the threat of interference from an aerial platform increase or decrease as its altitude changes? Is there an optimum altitude that would limit interference? Do certain technologies have improved interference parameters? If so, which ones and why? Are the costs directly proportional to the increase or decrease in altitude?

The target altitude for a DACA solution is dependent on both the type of DACA platform to be employed as well as the desired coverage area. In general, a higher platform altitude corresponds to a larger coverage footprint. This is due to the increase in elevation angle and therefore a larger probability of LOS conditions between DACA platform and users.

With respect to frequency, coverage range is linearly inversely proportional to frequency. As such, lower frequency bands will support larger coverage foot prints.

While LOS conditions may not be ensured for all users in a coverage area, the best means for predicting interference would be to model coverage based on LOS propagation since this provides the largest possible footprint.

It should also be noted that some technologies (such as WiMAX) have timing-related limits on maximum range, although this would only to be expected to be an issue with a high altitude platform towards the horizon.

30. FCC Question: Are there other methods available to mitigate the potential for harmful interference? For example, CTIA states that there needs to be advance coordination of the use of DACA technologies. Is advance coordination sufficient, and what would be required to complete coordination? Are automatic interference coordination features feasible with existing and evolving technologies such as Long Term Evolution (LTE)? Should parties coordinate among themselves or should there be a third party frequency coordinator? If there is a third party frequency coordinator, how should it be selected? What role should the FCC play, if any? What would be the relevant costs and benefits?

Ongoing work in 3GPP, via the LTE standards body, is focused on developing Inter-Cell Interference Coordination (ICIC) techniques for mitigating the impact of undesired interference. While current methods are limited to static or only semi-dynamic coordination akin to the higher order frequency reuse schemes, future capabilities should provide a fully dynamic means for coordinating the use of channel thereby mitigating interference concerns between DACA and terrestrial systems.

31. FCC Question: We also seek comment on directional antennas and any other products that can help to mitigate or reduce interference. Can directional antennas be used to focus aerial transmissions on the desired service area in a way that would limit interference? Are there currently available off the shelf products that can be used today to help mitigate interference for use by DACA systems, or do products need to be developed? What types of aerial systems, if any, make use of currently available products that would limit interference? What are the costs of such systems and what are the benefits?

The directionality of antennas on the DACA platform can be leveraged to focus on desired coverage footprint. An antenna with higher roll-off will provide more concentrated coverage in terms of look-angle from the aircraft. The actual ground coverage footprint would then be dependent on altitude of the aircraft.

While antennas with narrower pattern beam widths provide more focused coverage, a potential concern, when used on mobile DACA platforms, is aircraft banking. A narrower beamwidth is associated with increased roll-off of the beam pattern. With mobile DACA platforms following a race-track flight path, the aircraft will be required to bank continuously, for elliptical paths, or periodically, for rectangular paths. In either case, a tighter radius and higher velocities require larger bank angles. A DACA platform using a higher directional antenna with a narrow beamwidth is more likely to cause a large change in coverage conditions when banking than one employing a wider beamwidth. As such, a tradeoff must be considered between minimizing excessive coverage and achieving a tolerance to aircraft banking.

With regards to physical form factor of the airborne antenna, this will be dependent on the nature of the DACA platform in use. Mobile platforms, such as manned and unmanned aircraft, will require antennas in aerodynamic, “shark fin”, enclosures possibly requiring specialty development. Static platforms such as tethered balloons could potentially use standard directional antennas.

32. FCC Question: AT&T suggests that the use of tethered aerostats, i.e., aerostats tethered to the ground, would minimize interference concerns and propagate a more predictable signal, especially if equipped with stabilizers to minimize movement of the aerostat that accompanies the use of DACA technology. We seek comment on the suitability of tethered platforms. At what height could tethered systems operate to provide reliable service? Could tethered systems operate in the same frequency band as a commercial service provider? If tethered systems were deployed at only a few hundred feet, operating in the same frequency band as other base stations, could the height and service area of the platform be managed with proper frequency reuse? In such a scenario, could the system be considered an extension of the existing terrestrial network and coordinated in a proper manner to ensure that frequency reuse does not cause interference to existing base stations and adjacent systems? Should tethered systems be marked and illuminated, similar to fixed antenna structures, to avoid creating aviation hazards? What are the costs and benefits of such systems?

Tethered aerostats provide both benefits and limitations as a DACA platform. The primary benefit of a tethered DACA platform is static coverage which simplifies coordination of DACA coverage with operational terrestrial networks or with additional DACA platforms in the region. Additionally, a

tethered platform provides the possibility of providing wired power and an external data interface via the tether thereby mitigating power restrictions and backhaul limitations for the payload.

A potential limitation of a tethered DACA platform would be achievable altitude and therefore restricted coverage.

33. FCC Question: Interoperability is a central requirement of emergency response communications between multiple disciplines and agencies. If DACA technologies are used for emergency communications, it is critical to ensure that they preserve interoperability for emergency responders. How can existing public safety network services be accessed using DACA solutions while preserving interoperability? What are the technical and operational considerations for interoperability among existing communications network services and DACA technologies? What factors determine if DACA technologies can interoperate with existing communications network services? Are there or should there be any additional open technological standards that are considered to ensure interoperability? Could DACA solutions be interoperable with other base stations and systems operating in the same band and be considered an extension of the existing terrestrial network, coordinated in a proper manner for frequency reuse without any interference to existing base stations and adjacent systems? What are the costs of implementing interoperable DACA solutions, and do these outweigh the benefits?

Interoperability can be attained by using standards-compliant equipment. One such possibility is to use LTE standardized by 3GPP. In general, LTE will natively support airborne communication, though there are some considerations that may require adaption of the underlying technology. In particular, support for long range and high mobility must be considered. LTE inherently supports ranges of 100km. While this should be sufficient for many DACA-based scenarios, any uses requiring coverage footprints large than this would require specialty developments. Another consideration is Doppler. When DACA utilizes a mobile platform, it is possible for the relative velocity to between the basestation and user to be quite high. In general, LTE can support relative velocities up to 180 mph. Support for speeds in excess of this would require specialty consideration.

C. Prioritization of Service and Access

34 FCC Question:. DACA systems may have limitations in terms of the aggregate volume of traffic that can be supported by an aerial platform, due to factors such as the size, weight, and power of DACA technologies. Such limitations may create a need to examine priorities among the various communications services that DACA systems might help restore. We seek comment on the issue of prioritizing certain communications services immediately following a catastrophic event. How would prioritization be implemented with these technologies? What are the highest priority communication capabilities and services for a DACA solution to support in times of emergency? Would public safety responder communications have the highest priority and thus have to be available first, before other commercial services could be available?

A specific advantage of utilizing LTE for DACA-based communications is the inherent prioritization capabilities of the system. For initial access to a system, LTE supports Access Class Barring. Every user is assigned an Access Class either on a random or predefined basis. The network operator is then able to

bar, or block access, to the system for certain access classes. In this manner, access can be restricted to essential users only.

For control of finite traffic resources, LTE supports both Allocation and Retention Priorities ("ARP") and Quality of Service (QoS). ARP provides mechanisms for determining which users are able to preempt other users and which users are allowed to be preempted. Additionally every user is assigned one or more bearers which are individually assigned a QoS Class Identifier ("QCI"), which defines how individual packets are handled by this system. QCI defines whether a bearer has guaranteed or non-guaranteed bit rate, the relative priority, maximum tolerable latency, and maximum tolerable packet error rate. QCI enables different users and applications to receive the necessary prioritization on the network.

III. Conclusion

General Dynamics has a wide variety of products, solutions and extensive experience relevant to DACA. We have answered the above questions which have deemed pertinent in the context of our experience and technologies and we welcome further questions and/or dialogue with the Commission.

Respectfully submitted,

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