

General Dynamics C4 Systems
Response To The National
Telecommunications And Information
Administration Notice Of Inquiry On
Behalf Of The First Responder Network
Authority (Docket 120928505-2505-01)

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1. Executive Summary.

General Dynamics C4 Systems (GDC4S), a market leader in communications networks, appreciates the First Responder Network Authority (FirstNet) Board's (the Board) seeking public comment¹ on the FirstNet Nationwide Network (FNN) Proposal (the Proposed FNN)² to establish the nationwide, interoperable public safety broadband network (NPSBN). This is our response to the Proposed FNN via the National Telecommunications and Information Administration (NTIA) Notice of Inquiry (NOI) on behalf of FirstNet (Docket 120928505-2505-01).

While the Proposed FNN is a valuable starting point for the NPSBN, additional architectural and acquisition attributes are needed to reduce enumerated risks to the NPSBN. Considering the three options presented by Mr. Farrill³, we judge the scenario most likely to succeed is a blend of Option 3 ("Create a Diverse Nationwide Network with Multiple Wireless Networks and Systems"), now the Proposed FNN of record, and Option 1 ("Build-out a Standalone Network"). We term this scenario GDC4S Alternate Concept (GDAC).

Specific GDAC attributes to improve on the Proposed FNN are distribution; open competition; transparency; vendor neutrality; primacy of Band Class 14; maximal leveraging of assets; opt-out neutrality; user-level interoperability; demonstrations, pilots and BTOP/700 MHz⁴ continuance; and security. We further propose a robust acquisition strategy that centralizes management and decentralizes execution. We discuss GDAC's benefits to FirstNet in Section 4.2.

The organizing principle of GDAC is a Band Class 14-centric dedicated public safety wireless network developed regionally and in parallel, leveraging to the maximum extent possible state and local assets by adopting a policy of opt-out neutrality, applying favorable in-kind terms for these assets in the NPSBN, and resuming the paused BTOP/700 MHz public safety communications activity funded by NTIA. Innovation and user acceptance are maintained through an ongoing program of public safety user-centric demonstrations and pilots based on real-world use cases. The system integrators of this network manage interoperability and security by leveraging standards and

applying accreditation. FirstNet decreases cost through transparent acquisition processes that mandate ongoing vendor-neutral competition for all aspects of the network build, operation, and maintenance. GDAC reduces the perceived risks (enumerated in Section 2.1) attendant to the building, operating, and maintaining of the NPSBN in a manner that responds to public safety user needs.

2. Reducing NPSBN Risk.

2.1 Risks to FirstNet.

Many observers judge NPSBN to be a once-per-generation opportunity to revolutionize public safety communications, albeit one weighted with substantial attendant risks. Discussion of the relative merits of competing proposals for the NPSBN must address the retirement of its systemic risks. Enumerated risks to the NPSBN, and by extension to FirstNet, include Acceptance Risk, Infrastructure Risk, Technology Risk, Acquisition Risk, Political Risk, and Regulatory Risk.

Acceptance Risk stems from two sources. First is the ability of FirstNet and the States, through their representatives⁵, to form an effective working partnership to carry out the national mandate for the NPSBN. Second is the acceptance by the millions of U.S. public safety practitioners and their agencies of the improved communications capability that is the intent of the Act. In the Proposed FNN presentation, Acceptance Risk was addressed by acknowledgement of the influence of the draft National Public Safety Telecommunications Council's (NPSTC) Statement of Requirements (SOR)⁶, encapsulated in six key requirements: ubiquitous, reliable, redundant, interoperable, lowers cost, and accelerates availability.

Infrastructure Risk arises from the uncertainty surrounding the cost, availability, and suitability of existing radio access and backhaul infrastructure for use in the NPSBN, and the schedule and cost to fill remaining gaps. Among the factors contributing to this risk are: (1) the uncertainty regarding the States' opt-out decisions allowed under the Act⁷; (2) the incompleteness of the States' inventories of assets that could be repurposed for the NPSBN; (3) the dependence of the

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relevance of these assets to NPSBN upon future financial, schedule, and technical decisions of FirstNet⁸; and (4) the aggregate risk associated with site acquisition, construction, and commissioning of new assets required to complete public-safety grade coverage for the NPSBN as part of each phase of the construction and deployment of the network, including rural areas as required by the Act⁹. In the Proposed FNN, Infrastructure Risk was addressed by co-use of existing commercial assets at many existing cell sites, and long-term, large-scale investments by private industry¹⁰. The Proposed FNN also plans co-use of assets belonging to rural telecom, rural electric, mobile satellite, and State and local networks. The Proposed FNN at the outset does not use Band Class 14, which will be added at some indeterminate future time¹¹.

Technology Risk originates in the economic fundamentals of the public safety wireless communications market. Investment decisions in the highly competitive wireless communications industry often hinge on miniscule cost-per-unit advantages that are realized over production runs of tens of millions of units. For very large manufacturing companies and their carrier partners, the technology research and development investment to provide the special features required by public safety cannot be amortized over a large enough demand base to justify the business case. The U.S. public safety population is less than two per cent of the total U.S. wireless subscriber base, and less than one-tenth per cent of the worldwide market that drives globalized technology development. Therefore it will likely fall to more innovative smaller manufacturing companies to drive the technology progress needed specifically for public safety applications in Band Class 14. In the introduction to the Proposed FNN presentation, Technology Risk was rated low¹², perhaps because Band Class 14 technology was not included at the outset.

Acquisition Risk derives from FirstNet's nascence and unique status as an independent authority within NTIA¹³. One respected telecommunications policy analyst has described some of the uncertainties related to FirstNet's business charter and its relationship with NTIA. The analyst cites

“many observers” view of extant Regulatory Risk created by ambiguities in the Act¹⁴. This Regulatory Risk would in turn cause delays in FirstNet’s acquisition plan until legal questions are resolved. Additionally, some in the U.S. industrial base are unsure how to interpret the FirstNet’s Administrative Procedures Act exemption¹⁵ in the context of offering products and services within the competitive, fair, and open Federal acquisition process to which they are accustomed. The broad powers granted to FirstNet include the power to issue Requests for Proposal governing acquisition with value up to \$7 billion, instantly generating wide commercial interest in this massive new addressable market. Yet no acquisition organization has been identified so far. In the Proposed FNN presentation, Acquisition Risk was not addressed, however the Board did adopt a resolution to negotiate and execute an agreement between FirstNet and NTIA for administrative, technical staffing and various other resources ... while [FirstNet is] considering its own staffing plan.¹⁶

Political Risk and *Regulatory Risk* are described in a recent Congressional Research Service paper.¹⁷ In summary, Political Risk develops from the erosion of political will to continue the FirstNet/NPSBN program. Regulatory Risk is a result of ambiguities in the Act regarding FirstNet’s ability to perform business functions and its legal position relative to NTIA.

2.2 The Proposed FNN: An Instant NPSBN Foundation, but with Community Critiques.

The FNN Presentation is self-documenting as to its benefits for the Proposed FNN.¹⁸ Before continuing our analysis, we note our very limited access to the internal deliberations, thought processes, and expertise of FirstNet that contributed to the Proposed FNN. Our evaluation is based solely on the FNN Presentation and Mr. Farrill’s narration. Although this is an unsatisfactorily narrow basis for substantive engineering dialogue, we nonetheless respond to NTIA’s request for comment with an alternative proposal that addresses enumerated risks and community critiques.

Critiques of the Proposed FNN fall into three major objection categories: (1) *Status Quo Dependency*. Public safety will depend on status quo commercial carrier arrangements for an

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indeterminate time until Band Class 14 supplants commercial LTE (Long Term Evolution) bands; (2) *Public Safety Community Involvement*. Public safety practitioners and community advocates want more involvement in the planning and operations for the NPSBN; and (3) *Acquisition Plan*. To support informed decision-making, more details are needed about the acquisition plan for the NPSBN. We present supporting detail on these categorized concerns in terms of five aforementioned risks: Acceptance, Infrastructure, Technology, Acquisition, and Political.

(1) *Status Quo Dependency*. The apparent initial dependency on technical solutions outside of Band Class 14 provides an opening for critics who recall the arduous struggle to secure those frequencies for public safety use and the acquiescence of the Congress in allocating, rather than auctioning, this valuable asset. Delay in advancing from existing commercial bands to Band Class 14 engenders Acceptance Risk and Political Risk.

Public safety has urgent unmet communications needs today. The chief operational concern with the Proposed FNN is that demanding public safety needs will continue to be unmet by continuing commercial service as the foundation of the NPSBN. FirstNet through the NPSBN must provide a higher level of service to meet public safety's mission-critical Quality of Service (QoS) demands during emergencies. As the 2008 D Block auction demonstrated, carriers are concerned that these demands will pre-empt existing commercial clients and consumers on their networks. The Proposed FNN relies for its immediacy on use of the existing national commercial wireless networks. Therefore some now question whether the Proposed FNN is merely the continuation of the status quo in which public safety rents service minutes from the commercial infrastructure, like any other customer. As the manifest inability of this status quo to meet the needs of public safety in the ten years since 9/11 is what led to the creation of FirstNet and the NPSBN in the first place, the question then arises: How does perpetuating the existing solution resolve existing unsolved problems in public safety communications? Acceptance Risk is escalated by community concerns that a carrier-centric

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approach will fall short across a range of Public Safety requirements that include coverage of rural under-populated areas from a lack of Mobile Network Operator (MNO) build-out and investment driven by population centers; control of priority, preemption, and QoS; reliability and availability for radio access, transport, and core network; interoperability across bands and technology; centralized user management; and physical security. These concerns increase user Acceptance Risk.

Another concern about the Proposed FNN is related to Technology Risk. Dependence in the initial phases of the NPSBN on existing carrier capability, particularly the first single carrier (“Carrier A” in the Presentation¹⁹) is sometimes viewed as a perpetuation of the technological status quo. This view discourages or dissuades innovators (for example, implementers of emerging Third Generation Partnership Project (3GPP) community standards that can enable mission critical voice over LTE) from investing resources in new products for the NPSBN. If the NPSBN is viewed as a protected market for a cartel of existing carriers, network suppliers, and handset makers that comprise today’s supply chain, then outside innovation, and thus competition, would be suppressed because of a perceived high barrier to entry. A manufacturer of advanced, distributed, modular, scalable Enhanced Packet Cores (EPCs) that we interviewed cited its expectation that the initial deployment of EPCs will be within Carrier A’s existing data centers, and that time-to-market advantage will perpetuate this arrangement even after the indeterminate time when new Band Class 14 based Radio Access Networks (RANs) are populated into the NPSBN. The disadvantage of this status quo to the public safety community, this manufacturer stated, is loss of flexibility, *e.g.* for smaller, scalable deployments that would serve sparse rural populations. Large carriers currently underserve some of these areas, and may continue to do so.

(2) *Public Safety Involvement.* There is a desire for increasing the role of public safety users in the planning and operations phases of the NPSBN. Although by statute public safety is well-represented on the FirstNet Board, and the Board meeting proceedings did invoke²⁰ the contributions

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of public safety and NPSTC, unanswered questions remain about the evenness of the emerging partnership between the FirstNet (a Federal entity) and its counterparts in the States²¹ regarding governance of public safety communications in the NPSBN.

The BTOP/700 MHz waiver issue has energized State public safety user community leaders²². Even though two waiver recipients, Charlotte, NC and Harris County, TX, were allowed by the NTIA and FCC after six months' hiatus to resume for six months some activities originally undertaken under BTOP/700 MHz waiver, there is a halt to the remainder of activities there, and to all the activities in the other five waiver-holding jurisdictions with BTOP grants, the additional 14 waiver holders without BTOP grants, and approximately 30 more "second wave" jurisdictions that applied for waivers in 2011. A continuing controversy centers on the propriety of continuing these projects in light of the emergence of the FirstNet NPSBN. Supporters of the halt contend that stoppage prevents wasting resources on "stranded investment" projects that may not be interoperable with the eventual NPSBN. Opponents of the halt counter with four reasons for continuing: (1) that the "Recommended Minimum Technical Requirements" document submitted to the FCC by the Technical Advisory Board for First Responder Interoperability as required by the Act²³ and binding on the NPSBN makes adequate provision for interoperability; (2) that lessons learned from exemplar waiver projects like Adams County, Colorado's ADCOM911 and the State of Mississippi will help NPSBN's deployment, and therefore should be allowed to continue, reducing Technology and Infrastructure Risk; (3) that the interval until NPSBN deployment should be used effectively for demonstrations and pilots to reduce NPSBN risks of Acceptance, Technology, and Infrastructure; and (4) that to avoid an unnecessary increase in Acceptance and Political Risk, States expending valuable resources formulating grant and waiver applications should be treated as equal partners in the critical national public safety communications enterprise, with adequate federal consideration given before abrupt reversals in established federal programs. In the Proposed FNN, there was no

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position taken on this issue. However, the transcript of the FirstNet Board meeting does reflect that FirstNet will provide input to NTIA on how to proceed with the BTOP projects²⁴.

Some perceive aspects of the Proposed FNN as contravening commonly held constructions of the intent of the Act regarding services and infrastructure. Perpetuating the carrier service model in the NPSBN contradicts views of the Act's intent that a new physical network be created using a combination of new and existing assets, not by re-leasing existing capacity in a pure services play. New physical assets are especially needed in underserved rural areas. Further, "existing assets" is construed as not exclusive to carrier-owned assets, as the Proposed FNN appears to intend, but to include other infrastructure owned by jurisdictions, tower companies, utilities, and the like. Finally, the Proposed FNN provisions that continue carrier services on a leased basis leaves unsatisfied the need of some States to enter into secondary leases as a source of revenue and service provision for other public uses (*e.g.* education and utility grids) as permitted by the Act.²⁵ These secondary leases are needed to provide a user base adequate to sustain an operating expense model with affordable per-user pricing.

These considerations have a cumulative negative impact on Acceptance Risk and Political Risk vis-à-vis the States, because of uncertainties they create at the State level as to whether FirstNet is acting *with* the States, or *for* them.

(3) *Acquisition Plan*. The Proposed FNN selects "diverse nationwide network with multiple wireless networks and systems" as its preferred option. The key to successfully delivering this option, thereby mitigating Acquisition Risk, is in selecting the acquisition strategy. Based on centralized management and decentralized execution, the acquisition strategy must provide the appropriate level of standardization to facilitate interoperability and efficiencies, while still allowing sufficient flexibility to respond to the unique state and local needs. The strategy must have sufficient flexibility to respond to diverse network design requirements, it should not be so rigid that the

strategy constricts or predetermines technology options by region. Additionally, the strategy should include regular infusions of competition to help ensure the best value.

2.3 GDAC as Risk Reduction for the NPSBN.

GDAC reduces the enumerated risks to NPSBN by offering alternatives in all three objection categories. We advocate immediate deployment of Band Class 14 as the dominant technology in the NPSBN to address Acceptance, Technology, Infrastructure, Acquisition, and Political Risks. To further reduce Acceptance and Acquisition Risk, we meet the demand for local autonomy within a nationally managed framework by advocating regional acquisition and developments, with maximum leverage of all available assets (not just carrier assets), a Federal policy that is opt-out neutral, and resumption of the paused activity in 700 MHz public safety communications funded by NTIA. In this context, innovation and user acceptance are maintained through an ongoing program of public safety user-centric demonstrations and pilots based on real-world use cases, with interoperability managed by regional system integrators. We select an achievable and balanced acquisition strategy so that deployments can proceed rapidly in parallel, implementing transparent FirstNet acquisition processes through ongoing standards-based vendor-neutral competition for all aspects of the network build, operation, and maintenance. Our GDAC is described further in Sections 3 and 4 of this paper.

3. Required Topics I.

This section documents GDAC as a response to issues facing FirstNet's provision of the NPSBN.

3.1 Meets public safety's requirements for priority, quality of service, and preemption features.

The 3GPP LTE standards required by the Act for the NPSBN support priority, preemption and QoS inherently, with these features implemented in the networks and governance to allocate priority levels to competing user groups. By inclusion in the FCC's Interoperability Board's "Recommended Minimum Technical Requirements"²⁶ these features must be included in the NPSBN, including those

commercial networks forming part of the NPSBN. These standard features are not usually required in the consumer cellular market, so commercial operators probably will not provide them. Public safety-grade service on the NPSBN would decrease to the degree it uses commercial networks, unless costly special provisions are made.

Granting top priority and preemption rights to public safety users on commercial networks reduces the service to the carriers' consumer and business users, which carries financial costs, as well as impairing consumers' ability to communicate during emergency. The commercial operators would be justified in seeking recompense for this, and the additional cost of public safety priority across the multiple commercial networks as proposed will fall on FirstNet. The experience of the D Block in FCC Auction 73 provides illustrative precedent. Among the factors contributing to the withdrawal of the spectrum from auction was commercial network operators' analysis that the cost of providing priority service to public safety and hardening of infrastructure did not justify their investment.

In contrast, dedicated Band Class 14 networks built for public safety will be dedicated to giving first responders priority, and the required priority, quality of service and preemption features can be built in from day 1. Further, FirstNet should exert direct control over its resources, probably through a FirstNet Network Operations Center.

On this basis, we recommend that FirstNet reconsider its all-or-none selection of Option 3 in the Proposed FNN, and consider some self-managed capability with less control ceded to the carriers. Rationale for this reconsideration continues in the next section.

3.2 Uses, to the extent possible, existing radio access network and core network infrastructure installed by commercial mobile operators in order to maximize the coverage and performance delivered to public safety while minimizing the capital expenditures.

Large scale use of services on commercial mobile networks MNOs is redundant with the status quo, may be inconsistent with the intent of other provisions of the Act which gives FirstNet a

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primary responsibility to build, deploy, and operate a nationwide public safety broadband network²⁷, and is inconsistent with the expectations of many in the public safety community.

Considering the existing infrastructure, MNO cell sites are not usually hardened to public safety standards and are often shared. Therefore, redundancy gains to meet network availability needed by public safety are not realized. Requiring site upgrades on multiple commercial networks to achieve this redundancy level would be a significant cost to FirstNet.

Under GDAC, a total greenfield build is not required, because it uses assets besides those owned by the MNOs. Tower companies independent of MNOs are a key resource, and nothing in the Act specifically requires FirstNet to leverage exclusively commercial mobile operator infrastructure. The definition of “commercial infrastructure” includes the tens of thousands of towers / cell sites owned by specialist companies such as Crown Castle and American Tower, from whom the mobile operators lease. For example, of the top five U.S. tower providers, MNOs comprise less than one-quarter of the ownership²⁸. The Act equally requires FirstNet to leverage existing Federal, state, tribal, or local infrastructure²⁹, which would include assets such as towers and operating centers owned by public safety jurisdictions, and utilities’ infrastructure, as examples. This should include the partially completed BTOP-funded public safety LTE networks. The Band Class 14 NPBSN RAN component can be built using these commercial assets, diversifying the benefit FirstNet’s expenditure to multiple commercial companies, and providing more state and local benefit. In cases where MNOs are using commercial tower company sites, they typically have to revise their leases for additional equipment, which may be cost-equivalent to a new RAN build. Depending on what bands are used by the MNO on a site, or their position in the 700 MHz band, sharing existing antennas and related infrastructure may not be easily achieved. Band Class 14 RANs can be implemented quickly by systems integrators experienced in large scale mission-critical network deployments on existing tower infrastructure owned by tower companies, public safety jurisdictions, utilities, and others.

As mentioned, the history of D Block in Auction 73 highlights the unfavorable precedent of reliance on the commercial carriers. There is no assurance that the commercial carriers will want to provide service to FirstNet once the terms and implications are known, even if they pledge support now. FirstNet should be cognizant of this risk, and the delays it would cause. Our distributed, open, transparent, vendor-neutral GDAC is a viable alternative.

3.3 Reaches operational capability as soon as possible.

Technical and Infrastructure. Clearly the Proposed FNN is optimized for deployment speed. While we appreciate the need for speed – to reduce Political Risk by building early confidence in FirstNet and the NPSBN – the Proposed FNN also carries elevated Acceptance and Technology Risks that outweigh the benefit of rapid deployment. The operational capability that FirstNet must provide is held to a higher public safety standard than commercial service. Replicating today’s service offerings to public safety and branding it FirstNet, while expedient, will not meet the intent of the legislation for dedicated public safety resources or end-user needs. A further Acceptance Risk is precipitated by the lack of a business plan outlining in detail the cost of subscribing and roaming from a primary FirstNet network to secondary and tertiary commercial service providers. Without this plan, it will be difficult for users to evaluate the cost effectiveness of accepting FirstNet services in place of existing commercial services. Therefore, despite the rapid deployment of Option 3, the Preferred FNN would likely add Acceptance and Political Risk due to decision delays by users, especially in the absence of demonstrations and pilots with user participation. By advocating primacy for Band Class 14 with early demonstrations and pilots providing operational leave-behind capability, GDAC addresses these concerns.

Acquisition. Without an acquisition strategy, FirstNet will not achieve operational capability. Our recommended strategy is to award a series of Federally-originated contracts to deliver the network. This would include separate awards for the major system components: core network/service

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delivery platform, wireless service, regional build out, long term operation and maintenance, and aggregate purchasing for devices and services on behalf of the public safety agencies and other first responder users. This strategy optimizes centralized management and decentralized execution, providing the following advantages:

- Directly brings provider value to each aspect of FirstNet delivery – RAN, core network, local implementation, operations and maintenance, and device procurement – without the overhead of a tiered (subcontractor) approach.
- Enforces standardized implementation approach within a FirstNet architectural construct while allowing flexibility of local implementation, ensuring consistency with the system architecture but with tailoring to accommodate local designs.
- Provides the optimum level of centralization for standardization, interoperability, and efficiency, with acquiring agency-appropriate federal contracting controls, including acquisition constructs such as: multiple award by service type or geographic region; indefinite delivery/indefinite quantity (IDIQ) with local task orders competed among prequalified contractors; and General Services Administration (GSA) schedules for mass quantity devices and network services with local ordering (*e.g.* U.S. Department of Homeland Security disaster purchasing), leveraging buying power and enabling specialized just-in-time purchase.

We considered two alternate acquisition strategies: Financial Assistance to States and Large-Scale Integrator model (awarding a single Federal contract to a single national prime contract systems integrator. Financial Assistance is not favored because to ensure some level of interoperability it would likely need a cooperative agreement program rather than a grant, so it would have the expense of federal administrative infrastructure with minimal benefit. States would incur costs for contract award and administration. The delivery schedule would be slowed by state and local timelines. This approach adds cost and schedule risk. The Large-Scale Integrator approach

maximizes centralization, but has significant weaknesses including inability to specialize and customize according to local preference (elevated Acceptance Risk), less flexibility for alternatives and technology insertion (elevated Technology Risk), and difficulty obtaining buy-in of major stakeholders, introducing significant schedule delay while policy, regulatory, and political issues are resolved (elevated Political Risk).

The Board has a ready acquisition example to study as contrast to the carrier-centric acquisition approach implied in the FNN Presentation. As one example of a central, technologically capable Government entity working effectively to provide mission-critical communications service to a diverse distributed community based on integration of existing solutions with technology refresh, the Board should consider the Defense Information Service Agency's (DISA's) network provision for the U.S. military. DISA's functions include command and control of the network, operations, contracting and procurement for the network, application hosting, establishment and enforcement of technological standards, information assurance, enterprise service provision, integration, testing, and certification. It would be productive for the Board to examine some civilian/public safety version of DISA as a model of an implementing agency that mediates between the Board and the network, consistent with our recommended acquisition approach. At a minimum, DISA's experiences should be considered before beginning the NPSBN buildout.

3.4 Enables voice services (cellular telephony and push-to-talk (PTT)) both within the FirstNet network as well as to/from other commercial networks, including the public switched telephone network (PSTN).

A primary driver behind the NPSBN's creation was the need for nationwide interoperability for public safety Mission Critical Voice (MCV), and recognition that the P25/LMR (Land Mobile Radio) environment has not met this need. Full support of MCV on FirstNet is therefore essential and deserves significant attention at this early planning stage.

To be effective for public safety, MCV must include push-to-talk (PTT), group calling, direct mode communication between users without infrastructure, and relay capabilities. Although direct mode communication can potentially be achieved in-band on an LTE system, consideration should also be given to the use of LMR spectrum in the adjacent 700 MHz narrowband allocation³⁰ for direct mode, retaining narrowband channels for this application.

MCV for public safety requires standards work as well as technology development, so FirstNet needs to plan for this capability on the NPSBN. Systems integrators as well as LTE equipment suppliers are taking the lead in developing and implementing MCV standards over LTE. Although it may take several years for standards to be fully agreed (both in the standards bodies and by the public safety community), early implementations with graceful upgrade to the agreed standard solution are feasible. Systems deployed under BTOP/700 MHz funding, such as ADCOM911 given its proximity to the National Institute for Standards and Technology's (NIST's) Boulder lab, are ideal early test beds for MCV over LTE.

With respect to the carriers' role in the Proposed FNN, in the short term most commercial carriers are planning to leverage LTE not for voice, but rather for data. Voice over LTE (VoLTE) does not support MCV, which is essential for public safety. The NPSBN needs point-to-multipoint bearers to be efficient in carrying group calls in major incident situations where large numbers of member of a call group are on one sector of a cell site, requiring additional features in provider RANs and EPCs. In Section 4.4, we propose research to reduce the cost to FirstNet of providing this capability on multiple networks.

4. Required Topics II.

This section discusses required topics vis-à-vis GDAC as an alternative to the Proposed FNN.

4.1 Assumptions needed for the GDAC proposal to succeed.

The ten most critical assumptions and attributes needed for GDAC (a blend between the FirstNet Board's Option 1 and Option 3) to succeed are:

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- **Distribution.** FirstNet RFPs should be structured as a set of between 8 and 12 acquisitions corresponding to U.S. geographic regions.
- **Open Competition.** FirstNet RFPs should be structured to allow competition from carriers and others. For example, system integrators have qualifying experience in providing integrated, high reliability, mission-critical secure wireless networks and infrastructure companies have expertise in rural buildouts.
- **Transparency.** FirstNet acquisition processes should maintain a standard of transparency and governance equivalent to that of Federal acquisitions today. Our acquisition strategy, described in Section 3.3, meets this criterion.
- **Vendor neutrality.** FirstNet RFPs acquisitions should incentivize multi-vendor offerings to encourage permanent competition and innovation.
- **Primacy of Band Class 14.** FirstNet should consider the implications of the Proposed FNN because the initial dependence on commercial MNOs in spectrum outside Band Class 14 (a) seems to foreclose competition early in the program; (b) defers the utilization of a very valuable Federal asset, the 10+10 spectrum for Public Safety; and (c) discourages private investment in Band Class 14 technology that would fully utilize the spectrum asset.
- **Leveraging of Assets.** FirstNet RFPs should not pre-establish an over-reliance on commercial carriers as the way to satisfy the statutory requirement to leverage commercial assets. All commercial and public safety assets (such as towers), not just access to carrier networks, should be considered in evaluating in-kind contributions.
- **Opt-out neutrality.** FirstNet should consult with the FCC and NTIA to consider a regulatory opt-out regime that is consistent with the Statute but opt-out neutral. Today, conditions imposed on States wishing to opt-out seem disincentivizing. FirstNet should not discourage opt-out, because some

analysts sense that opt-out would actually reduce FirstNet spend in each State and encourage additional investment at the State level to increase NPSBN coverage, with no loss in interoperability.

- User-level interoperability. FirstNet should facilitate user acceptance by selecting initial activities that focus on interoperability at the user management Home Subscriber Server/Policy and Charging Rules Function (HSS/PCRF) level, and on roaming and interconnectivity infrastructure, allowing flexibility for a variety of funding and distributed EPC models at the State level. Application development should be a later concern, subordinate even to applications environment development.
- Demonstrations, pilots, and BTOP/700 MHz continuance. FirstNet should include in its acquisition roadmap a program of early demonstrations and pilots, leveraging existing investment in public safety wireless broadband networks. FirstNet should allow BTOP funded networks, for example ADCOM911 and State of Mississippi, to proceed to provide early service availability, establish multiple regional EPCs that can be utilized to expedite FirstNet RAN deployments with reduced initial capital needs, and encourage their expansion with using other funding sources.
- Security. FirstNet's development strategy should include security measures to protect the integrity of all mission-critical data in the network. These measures should include appropriate supply chain risk mitigation and accreditation standards for device connection to the NPSBN.

4.2 Specific opportunities or benefits the GDAC proposal provides in meeting the Act's objectives and the criteria enumerated above.

The specific benefits and advantages of our technical and acquisition approach are:

- Ensures that the hard-won Band Class 14 spectrum is fully utilized early in the process, avoiding questions on why commercial spectrum and service are being used by FirstNet on a larger scale, and potential risks to the spectrum.
- The Band Class 14 implementation specifically for public safety is more likely to fully implement the Interoperability Board requirements and the user requirements in the NPSTC SOR, and ensure

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higher availability for public safety than sharing of commercial networks. Importantly, it ensures that the priority and QoS required by public safety can be implemented, as required by Interoperability Board recommendations. A dedicated Band Class 14 network allows MCV implementation and interoperability to be a priority.

- Breaks earlier from the risky model in which the small public safety market is outcompeted for development resources for special features by the larger consumer market.
- Recognizes FirstNet's funding limits, and encourages the widest range of investment solutions, including investment at the State level; use of public safety, utility, and other assets; public-private partnerships (PPPs); and innovative technical and economic solutions from system integrators.
- Meets the Act's requirement for the NPSBN to leverage commercial assets, including the large number of towers / cells owned by specialist tower companies, as well as other government, public safety, and utility assets.
- Maximizes competition at multiple levels, encouraging innovation at both the technical level by LTE technology companies, innovative network architectures by system integrators and carriers, and innovative business models by PPP partners and others.
- Leverages the deployed BTOP/700 MHz systems, and encourages expansion of these with FirstNet investment, maximizing coverage and early service availability.
- Recognizes the importance of state and local stakeholders, encouraging their meaningful input for regional acquisitions and deployments for both development and operations.
- Encourages secondary leases to non-public safety users as a way to grow user base so that the financial model remains viable.
- Our acquisition risk mitigation approach and suggested acquisition strategy dispel uncertainty about how FirstNet will acquire the NPSBN, encouraging broad industry participation. The approach

provides speed and accuracy of delivery, leverages standardization and existing infrastructure, and enables acquisition flexibility to accommodate technology refresh or changing mission.

Simply, our GDAC enables FirstNet to fully achieve Congressional intent which was to acquire nationwide public safety broadband communications, with full interoperability, and superior high-availability capability in a manner acceptable to the States.

4.3 Discussion of any challenges or obstacles that must be overcome to write the GDAC proposal.

In Section 2 of this paper, we enumerated the Acceptance, Technology, Infrastructure, Acquisition, Political, and Regulatory Risks inherent in the Proposed FNN and cited specific examples of heightened risk engendered in architectural decisions embedded in the selection of Option 3. We also summarized three types of community attention areas regarding the FNN: the role of the commercial carriers at the outset, the degree of involvement of the user community, and the uncertainty surrounding the acquisition plan. To reduce risk to the NPSBN enterprise, FirstNet should take steps to ameliorate concerns in each of these attention areas by undertaking a transparent, open, and fair process of engagement with stakeholders in the public safety user community, the research community, the industrial community, and the interagency process. For example, carriers appeared to have an advantage in influencing the Proposed FNN through their historic ties to some of the FirstNet board. They observe the access that carrier senior executives enjoyed with FirstNet leaders in the period before the Board was sworn in and are concerned the carrier-centric nature of the Proposed FNN is the predictable result of that access. A transparent process of industry engagements is needed to dispel this apparent bias and encourage new entrants with innovative and alternative approaches. As a second example, rescission of most of the BTOP/700 MHz waiver program is irritating recipients and applicants alike and foreclosing early demonstration/learning opportunities on any meaningfully large and transparent scale. Terminating the BTOP/700 MHz

projects will deprive the enterprise of already allocated development funds. The result, some opine, will be a monolithic, centrally-planned, inflexible FirstNet implementation, which will add Acceptance Risk. The BTOP/700 MHz program should be restructured, restarted, and augmented with FirstNet resources, reopened to the 50 or so participants and applicants, and so begin to inform the NPSBN architecture before it is set in stone. In a last example, to address Regulatory Risk, FirstNet should begin a consultative interagency/industry process to evaluate which Federal agency is most competent to conduct large and fair federal communications systems acquisitions of the type that will be required for FirstNet to succeed as a quasi-Governmental body.

4.4 Areas in need of further research and development to ensure the success of the GDAC proposal.

We propose a research program centered on MCV over LTE, the statutory standard for the NPSBN³¹. The primary public safety communications mode, especially for emergencies, is MCV as distinguished from commercial grade cellular voice communications. The elements of MCV are Direct Mode or Talk Around, Push-to-Talk, Full Duplex Voice Systems, Group Call, Talker Identification, Emergency Alerting, and Audio Quality³². The NPSBN enterprise is in part the reaction of the U.S. Government and the public safety community to the inability of Land Mobile Radio systems to meet emerging long-term public safety communications needs. To hasten public safety acceptance of LTE, research should be focused on two key areas: Open Mobile Alliance's Push-to-Talk-over-Cellular (OMA-POC) and enhanced Multimedia Broadcast Multicast Services (eMBMS) for PTT over LTE, and P25-LTE bridging.

OMA-POC is already a leading candidate to provide a MCV level of PTT service over the NPSBN. Technology leaders, including General Dynamics C4 Systems, are focusing work in this area to bring these implement these standards. OMA-POC provides FirstNet with options as to whether MCV should be hosted centrally by FirstNet or separately by the public safety jurisdictions

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that use the NPSBN with close integration with existing LMR systems for interworking during the overlap period. If FirstNet were to host MCV, two subordinate issues are the logistics of managing user groups for thousands of jurisdictions, and interworking with legacy systems nationwide. Research between 3GPP and OMA to optimize joint operation will leverage existing standards work. Specifically, FirstNet OMA-POC client software should be developed to support Talker ID and Group Calls. The NPSBN should investigate the best way to configure to provide emergency alerts with priority access to the network. Finally FirstNet's research program should leverage the efficiency of LTE Point-to-Multipoint (PTM) bearers (a subset of the LTE eMBMS broadcast / multicast standard) in the network for efficiently carrying group calls in major incident situations where large numbers of member of a call group are on one sector of a cell site.

In its research to implement Group Call, FirstNet must consider the need for talk groups to be configured dynamically when public safety agencies react to major incidents. This will include applying advanced security concepts such as distributed management of role-based and attribute-based access controls. The requirement for MCV on the NPSBN to interwork with existing P25 and other public safety Land Mobile Radio (LMR) systems should stimulate research to optimize NPSBN-supported PTT voice with decentralized but standardized administration of OMA-POC servers/gateways and their interconnect with existing LMR/P25 systems. This research would be a valuable pathfinder for smaller-scale, inexpensive systems to achieve nationwide interoperability in which all devices and servers support predefined mutual aid talk groups, with the flexibility for the local jurisdictions to add roaming users into other talk groups to meet many operational scenarios.

For Direct Mode, FirstNet should sponsor research to mature, evaluate, and select among three current and promising options. In 3GPP, Proximity Services (ProSe) is being considered as a means of providing direct communication between LTE, in-band on LTE spectrum. ProSe is not yet the agreed LTE direct mode standard for public safety because commercial demand did not support

it. However, NIST in conjunction with LTE technology companies such as General Dynamics C4 Systems has inserted Direct Mode into the public safety requirements. A second Direct Mode alternative is to use LMR spectrum and waveforms for the air link between LTE user equipment. A third Direct Mode alternative derives from military networks. Mobile ad-hoc network (MANET) technology is used in U.S. military networks such as the Joint Tactical Radio System (JTRS) to provide a self-configuring infrastructure-less network of mobile devices connected by wireless links. Each device in a MANET is free to move independently in any direction, and frequently changes its links to other devices. Each acts as a router, forwarding traffic unrelated to its own use. JTRS uses MANET technology to ensure every war fighter stays connected without fiber optic, cellular towers, routers or line of sight. In summary, several promising research vectors are open to FirstNet to lower Acceptance and Technical Risks and accelerate public safety's widespread adoption of the NPSBN.

5. Conclusion

In this paper, General Dynamics C4 Systems proposes GDAC, an alternative concept for the NPSBN. Combining elements of FirstNet Options 1 and 3, GDAC was created to reduce enumerated acceptance, technology, infrastructure, acquisition, and political risks to FirstNet and the NPSBN and to ameliorate community concerns about NPSBN's use of public safety spectrum, user involvement, and acquisition plan. Through its ten-point technical and acquisition program (including distribution; open competition; transparency; vendor neutrality; primacy of Band Class 14; maximal leveraging of assets; opt-out neutrality; user-level interoperability; demonstrations, pilots and BTOP/700 MHz continuance; and security) GDAC will provide substantial benefit to FirstNet. Our recommended acquisition strategy responds to Federal and State needs by balancing governance to centralize management and decentralizing execution, providing opportunity to include local public safety user preferences in the NPSBN without compromising interoperability. We provide the outlines of a research program to facilitate the integration of mission-critical voice in the LTE framework.

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We thank the NTIA for the opportunity to comment on the matter of the Proposed FirstNet Nationwide Network. Should it be of assistance, General Dynamics C4 Systems would welcome further dialogue with Assistant Secretary Strickling and/or his staff regarding this paper. Please do not hesitate to contact us for further engagement.

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¹ http://www.ntia.doc.gov/files/ntia/publications/firstnet_noi_10042012.pdf

² http://www.ntia.doc.gov/files/ntia/publications/firstnet_fnn_presentation_09-25-2012_final.pdf (“FNN Presentation”) and accompanying transcript http://www.ntia.doc.gov/files/ntia/publications/firstnet_board_9-25-2012_transcript.pdf (“FNN Transcript”)

³ FNN Presentation, p. 8. Option 2 was “Work with Single Nationwide Wireless Operator”

⁴ In this paper, “BTOP/700 MHz” refers to the 2010-2012 era assemblage of activities approved and funded under NTIA’s Broadband Technology Opportunities Program (BTOP) and/or waiver applications to the Federal Communications Commission (FCC) for authority to operate in 700 MHz public safety spectrum, both to support public safety communications projects.

⁵ P.L. 112-96, §6302

⁶ Cited in FNN Transcript, pp. 8 and 40 and FNN Presentation, p. 12. NPSTC’s 15 member associations include law enforcement, fire, emergency, transportation, and natural resource groups, as well as public safety communications, state chief information officers, and state chief technology officers.

⁷ P.L. 112-96, §6302(d)

⁸ FNN Transcript, p. 20

⁹ P.L. 112-96, §6206(b)(3)

¹⁰ FNN Presentation, p. 10

¹¹ FNN Presentation, p. 15 (including animated build)

¹² FNN Transcript, p. 7

¹³ P.L. 112-96, §6204(a)

¹⁴ Congressional Research Service General Distribution Memorandum, Establishment of the First Responder Network Authority: Business Models and Congressional Oversight by Linda K. Moore, September 17, 2012, pp. 20-21

¹⁵ P.L. 112-96, §6206(d)(2)

¹⁶ FNN Transcript, p.25

¹⁷ Moore, *Congressional Research Service General Distribution Memorandum*, pp. 20-21.

¹⁸ FNN Presentation, pp. 10-12 and 20-21

¹⁹ FNN Presentation, chart 15.

²⁰ FNN Transcript, p. 28

²¹ In this paper, “State” and “States” are used to denote all U.S. non-Federal jurisdictions, including the governments of the fifty states, the six territories, and sovereign independent tribes, and all of their subordinate governmental organizations, acting individually or jointly to address public safety communications matters.

²² See e.g. the National Governors Association statement of August 20, 2012 http://www.nga.org/cms/home/news-room/news-releases/page_2012/col2-content/governors-firstnet-board-appoint.html; the Potomac Institute for Policy Studies report written by James Barnett, “What Should FirstNet Do First? State Integration into the National Public Safety Broadband”

<http://www.potomacinstitute.org/attachments/article/1294/FirstNet%20NPSBN%20Report.pdf>; State of Mississippi response to the NTIA State and Local Implementation Grant Planning request for information,

http://www.ntia.doc.gov/files/ntia/state_of_ms_response_to_ntia_rfi_final_6_15_12.pdf, and Harris County, Texas filing

http://transition.fcc.gov/Daily_Releases/Daily_Business/2012/db0831/DA-12-1432A1.pdf, note 8

²³ <http://www.fcc.gov/document/recommendations-interoperability-board>

²⁴ FNN Transcript, pp. 22-24

²⁵ P.L. 112-96, §6302(g)(2)

²⁶ <http://www.fcc.gov/document/recommendations-interoperability-board>

²⁷ P.L. 112-96, §§6205(b), 6206(b), 6206(c)(1), and 6302(e)

²⁸ http://www.wirelessestimator.com/t_content.cfm?pagename=US-Cell-Tower-Companies-Complete-List, surveyed 7/1/2012

²⁹ P.L. 112-96, §6206(c)

³⁰ P.L. 112-96, §6102

³¹ P.L. 112-96, §6203(c)(2)

³² Mission Critical Voice Communication Requirements for Public Safety, NPSTC Broadband Working Group, 8/30/2011