Department of Commerce

National Telecommunications and Information Administration

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Development of the Nationwide Interoperable Public Safety Broadband Network

Notice of Inquiry Response

Dated:

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Prepared for:

FirstNet Board of Directors

Prepared by:

Science Applications International Corporation

4015 Hancock Street

San Diego, CA 92110

SAIC is pleased to provide the following comments in response to the National Telecommunications and Information Administration (NTIA) Notice of Inquiry (NOI) (Docket No: 120928505-2505-01 RIN: 0660-XC002).

SAIC is a Fortune 500 scientific, engineering and technology applications company that possesses deep domain knowledge in the areas of Networking, Information Technology, Cybersecurity and Public Safety, held by our 40,000+ employees. Our comments are based on our experience as a management support contractor and systems/network integration company.

Our comments also incorporates our in depth understanding of the challenges of a Public Safety communications network based on a decade of work supporting Public Safety communications and interoperability. Some of the specific experiences that we are drawing from include:

- Interoperable Communications Technical Assistance Program (ICTAP) - DHS funded program to provide technical assistance to public safety agencies and First Responders relating to technology and operational aspects of voice and data interoperability. Our ICTAP support covered the following functional areas: Planning Exercises, Technical Assistance Tools, Engineering National Emergency Communications Plan (NECP), Technical Assistance, Configuration Management, and Quality Assurance. Work involved close liaison with Federal, State and Local First Responders.
- NPSBN Numbering Administrator - Developed Numbering Scheme for Nationwide Public Safety Broadband Network under FCC Directive. Worked closely with PSST

OAC, PSCR, and DHS OEC to finalize and obtain approval for a scheme that is directly applicable to FirstNet.

- **DISA Global Information Grid** - SAIC broke new ground in optical mesh technology and inserted a high-speed, high-capacity fiber backbone to provide a global, complex network solution for the U.S. Department of Defense (DoD) worldwide information network.
- **Enabling, Implementing and Maintaining Public Safety Communications Networks** - Enabling interoperable Public Safety communications and directing Public Safety network deployments for locations such as Oregon, Nevada, and Hawaii. Also responsible for maintenance of various networks. Deployed networks also served Public Safety functions at various DoD Range facilities.
- **Public Utilities** – Support provided to various public utility organizations in Hawaii, Arizona, Florida, California and companies such as Entergy in smart grid initiatives.

SAIC's response is in the form of various proposed concepts organized in accordance with the four criteria established in the NOI (Request for Comments) for Network and Applications.

A. FNN Conceptual Network Design Model

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

1.1. Technical Support to State Public Safety Organizations

The State and Local Implementation Grant Program (SLIGP) guidelines call for state governance structures to be expanded to include experts in broadband technology for consultation with FirstNet.[1] Allowing states to use grant funds to contract independently for this broadband consulting expertise incurs the risk that non-uniform, incomplete, or at best, uneven level of knowledge and corresponding quality of planning inputs are received from the states by FirstNet.

To mitigate this risk, SAIC recommends that NTIA establish a nationwide broadband technical support contract, similar to that provided by the PSIC, from which states can receive best in class broadband consulting expertise. Under the NTIA PSIC program, NTIA provided similar technical assistance to the grant holders to ensure common approaches to grant plans. NTIA could use this model to provide a cadre of broadband and Long Term Evolution (LTE) technology subject matter experts at the national level to assist states during the planning phase. They would share key implementation practices and standardize nationwide planning to ensure a common product for effective use by FirstNet. These technical resources would be uniformly trained and intimately familiar with the FirstNet planning process and proposed

[1] NTIA (2012, August 21). Development of Programmatic Requirements for the State and Local Implementation Grant Program to Assist in Planning for the Nationwide Public Safety Broadband Network (NPSBN). Retrieved from http://www.ntia.doc.gov/files/ntia/publications/fr_sligp_08212012.pdf

architecture, assuring states receive the technical support needed to provide a high quality and complete input to the FirstNet planning process.

States would immediately benefit from this common set of technical support experts to focus their staffs and contractors and prevent planning gaps. States often request this type of early assistance, as they work to bound their planning and ensure they address key areas while minimizing time spent on items that may later be left unused.

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;

2.1. Architecture Clarification

The FirstNet Nationwide Network (FNN) Proposal (Craig Farrill 9/25/2012) architecture charts are somewhat unclear in that the operator's core is shown as residing between the Band 14 RANs and the FirstNet Evolved Packet Core (EPC). This implies that the FirstNet traffic is sent into (perhaps a partitioned portion of) the operator's core and the connection then becomes an EPC-to-EPC trunk between the network provider and the FNN. However, the narration during the presentation implied that the FNN RANs would simply be backhauled to the FirstNet core; perhaps only being deployed in the same tower and backhaul infrastructure as the operators' own network.

The above context generates at least two options for FirstNet:

1. Network-of-Networks for both LTE and Public Safety (PS) networks.
2. Hybrid Network, where PS LTE RANs connect directly to the FirstNet EPC, and the Mobile Satellite (MS) and commercial networks are connected as core-to-core links.

Option 1 requires the network operators to handle two logical networks within their EPCs, or even implement a separate mini-EPC for the FirstNet part alone. This could also permit the use of a more distributed Home Subscriber Server (HSS) and Mobility Management Entities (MMEs). It permits easier local interconnects, where roaming between the commercial and FirstNet networks is handled locally by the commercial network provider unless the data has to travel outside the area. This could also enable a more locally robust network implementation.

Option 2 could exacerbate the backhaul problem where large amounts of data from every RAN are sent to the central FirstNet core to be perhaps sent back to the same network service provider for local roaming. While engaging border routers to contain the local traffic may be possible, it could result in a more fragile network that is susceptible to interruptions by backhaul failures to the FNN EPC.

2.2. Dual Band vs. Every Band Terminals

A key element of the FNN concept is working with standardized equipment both on the network side and the terminal side. The FNN Proposal (Multiple Network Diversity Increases Reliability, Slide 11) includes the capability to access the network via FNN (Primary Path) and multiple alternatives paths via Terrestrial Mobile Networks and

Mobile Satellite network) from a single terminal. The use of Band 14 already imposes additional costs in terms of available chipsets, etc. It appears that manufacturers and carriers are willing to consider incorporating the public safety Band 14 into their smart phones and terminals, in addition to their native LTE band and 2G and 3G technologies. However, the FNN appears to be calling for the capability to carry all the LTE bands of all the carriers as well. We believe that this is an impractical approach that could render the system infeasible.

Multiple LTE band FNN handsets will drive up cost. As an alternative, SAIC recommends a dual-band handset to support a primary band (FirstNet Band 14) and then a secondary LTE band (commercial carrier specific band).

Expecting FNN devices to have all the LTE bands is unrealistic. It will likely be opposed by commercial networks since it would make devices cost prohibitive and also remove the networks' market differentiators and branding. Dual LTE band terminals are a more reasonable approach. Further,

- Some networks are planning to implement commercial LTE outside the 700 MHz bands, in the AWS and PCS bands. So, there could be a wide variety of commercial bands covered by dual band terminals, some of which are supported primarily by rural providers.
- FirstNet should be able to evaluate the impact of dual band terminals on coverage and roaming across the country.
- As the FNN becomes more widely deployed, Band 14 could become the "glue" band that helps maintain user communications continuity during cross-over between these widely different commercial bands.

2.3. "Dual Track" (Urban and Rural) Network Architecture Approach

FirstNet has rightly emphasized the use of Multiple Wireless Network Operators (MNO) to build out the FNN. There is concern, however, that this could shortchange the rural and tribal areas, since these are not usually economical for MNOs to cover. This is true especially outside the urban and transportation corridors traditionally covered by the MNOs. Hence, for rural and tribal areas, it is recommend that FirstNet deploy its own FNN RAN built around the coverage agreements established with rural and tribal entities.

While FirstNet has outlined a plan to cover rural and wilderness areas using satellite communications (SATCOM) as a last resort, there are still a significant number of populated rural areas not too far from roads and highways; but where MNO penetration remains low. These could usefully benefit from operation on the FNN. Furthermore, some of the lands of smaller First Nations may not need many RAN structures to cover and still benefit significantly from access to the FNN. These isolated RAN clusters may even be more economically backhauled using the SATCOM network that will be part of the FNN. This offers a ready business for the SATCOM community to invest in which can only benefit the larger rural first responder community who may depend on the SATCOM part of the FNN.

Additionally, since the public safety traffic in these Rural and Tribal areas will most likely be low, the FNN could become a ready vehicle for commercial Internet Service Providers (ISP) to provide Internet access to these First Nations and rural areas with minimal infrastructure costs. This could be a source of revenue to the FNN to offset the cost of deploying to these sparsely populated geographies. Additionally, this could become an

economic engine to jump start or accelerate development of entrepreneurial activity in these information starved areas. While first responders have often expressed concern that commercial traffic could jeopardize First Responder use of the FNN, especially in emergencies, this becomes a non-issue for traffic supported by these isolated RANs, which would be directly backhauled to the EPC via SATCOM. Regardless, commercial traffic could always be throttled back or pre-empted if the First Responder demand truly becomes high during a major emergency, for example, in the case of a wild fire.

2.4. Rural Service

2.4.1. Rural Services with LTE

Some small rural telcos have broadband licenses that are not in Band 13 or Band 17. They do not have LTE devices available to operate within their bands because manufacturers have not built them due to the very small demand. These users will most likely depend on the large commercial LTE networks for the majority of their operations, or use SATCOM, as discussed below. However, not every large commercial carrier has Band 13 or Band 17 licenses. They may plan to use other bands, such as the PCS band at 1.9 GHz with 5+5 MHz configurations. In some cases, first responders may be forced to use only 3G for data and 2G voice services. FirstNet's network planning should include consideration of these bands and carriers, even if their terminals do not have Band 14 built in.

2.4.2. Rural Service with Mobile and Fixed Satellite Services

FirstNet has proposed that satellite services be incorporated into the FNN to cover deeply rural and wilderness areas. This is an innovative and realistic option to fully cover this vast country.

To accomplish this, there are some technical and operational issues that need to be resolved in the areas of:

- Mobile and Fixed Satellite Services
- Air Interface Standardization
- Satellite Specific Operations

Satellites can be geostationary or move in low or medium Earth orbits (i.e., GEOS, LEOS, or MEOS). Mobile satellite networks are often MEOS or LEOS since they require less powerful terminals and have reduced delay issues. GEOS are well suited to stationary operation using high bandwidth VSAT dishes on vehicles. The launch of new satellites such as the BGAN and ViaSat constellations are now making it possible to use GEOS for rapid use in the field using small terminals.

Satellites are bent pipes and broadcast via downlink of whatever is sent via the uplink. Each satellite service provider who uses these “birds” selects an air interface format based on the service they plan to provide. They operate using several frequency bands and offer differing data bandwidths. The question is whether a specific SATCOM band and air interface should be standardized for FNN use. While this may reduce the number of service providers, it would simplify ground equipment choices and reduce the cost.

However, the issue of different PS responders using different SATCOM service providers with different satellites and bands may not be quite as serious as it first appears. First Responders will all need to connect to their service providers' Network Operations Centers (NOC) through their satellites anyway before they can be interconnected, since there is no on-board switching. As long as the common element is the IP network, this should not be a problem. This will also leverage existing SATCOM links that First Responders may already own.

Rather than standardizing frequency bands or transmission protocols, FirstNet might make more progress by defining performance criteria for SATCOM and ensure that every service provider that is accepted to serve first responders meets those criteria. While this may result in higher terminal costs initially, the free market will, in due course, drive first responders to the most economical provider(s). This market-based approach would be greatly facilitated if FirstNet can negotiate contracts to enable terminal equipment to be leased rather than purchased, so that first responders are able to change providers when their lease contract is up after a reasonable period.

Backhaul Support: Satellites are suited to backhaul service from LTE towers that do not have economical access to microwave links.[2] This could significantly decrease the backhaul cost of LTE high sites in hard-to-reach, remote areas. SATCOM could also be used to support mobile repeaters in vehicles.

Multi-user Support: Where multiple users are being supported over SATCOM by using portable or vehicular terminals, it requires a multiple access air interface to share the

[2] An example is O3B Networks' approach for rural underserved equatorial regions: http://www.o3bnetworks.com/telcos/mobile-backhaul

bandwidth. FirstNet would need to select and specify a commercial air interface that can be obtained from more than one service provider to get the best competitive benefit. This is important since the choice of the air interface also affects the terminals that can be purchased to work over that interface, depending on the frequency band, protocol, etc. The mobile user air interface and bandwidth could be different from the backhaul links.

Push-to-talk over Satellite: First responders incorporate push-to-talk (PTT) voice communications into all their operations. PTT operation over a satellite link can be challenging due to channel acquisition and propagation delay constraints. This could result in key parts of the transmission being clipped off. Solutions to this problem exist, but have operational implications such as the need for "keep-alive" transmissions and nailed-up channels and the attendant cost.

When SATCOM solutions have been designed into emergency relief communications, the expenses for these have been often paid for by the federal government. It is a different matter when SATCOM is needed for daily operations by a rural jurisdiction, and paid for by their operating budget. Therefore, operating costs must be considered by FirstNet when selecting the architecture of the SATCOM portion of its national network.

2.4.3. Advanced Solutions

Multiband multimode Cognitive Radio technologies may be available in the future to manage the plethora of air interfaces and protocols. However, their use in rural

environments would be constrained by cost and the operating budgets of rural agencies.

FirstNet may need to consider options such as budgetary support for easing the cost of rural service and their more complex terminals.

3. Reaches operational capability as quickly as possible;

3.1. Implementation Manager

The network architecture set forth by the FirstNet Nationwide Network (FNN) Proposal consists of major integrated networks and systems. In order to properly manage and provide technical oversight to build out this architecture and to enable FirstNet to reach an operational capability as quickly as possible, SAIC suggests that FirstNet select an Implementation Manager (IM) to manage the deployment of the network. Figure 3.1 illustrates a recommended organizational structure which includes an Implementation Manager reporting to and supporting the FirstNet Program Office.

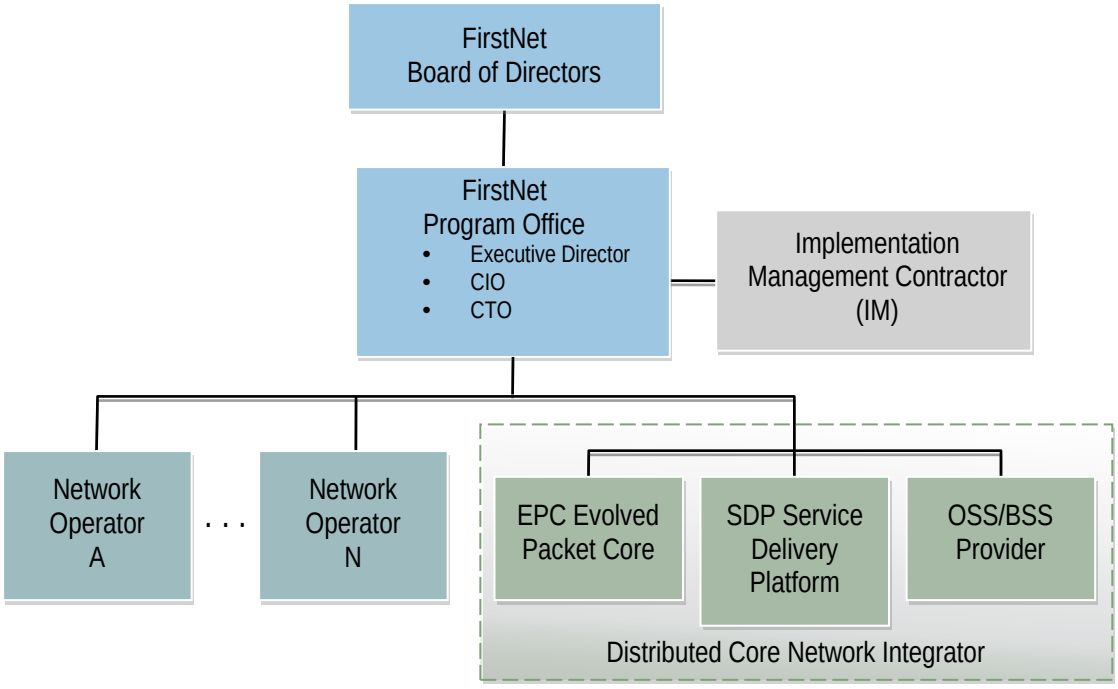

Figure3.1 FirstNet Organization

The FNN architecture consists of multiple numbers of integrated network operators, RANs and an integrated distributed core network each of which are major integration initiatives. At the FirstNet program level, the challenge is not only to perform the program and contractual management; but also carry out technical management of multiple connected large scale integrated systems. Such an endeavor requires both program management and technical management capabilities in addition to knowledge and understanding of working with the Public Safety stakeholders.

3.1.1. Role of Implementation Manager (IM)

SAIC proposes the role of the IM to be characterized as follows:

- IM performs management and technical oversight functions with strong technical analysis background to manage the deployment of the FNN.
- IM works for FirstNet, not for the network, equipment or service providers.

- IM is the top level manager and integrator of systems. It is the combination of performance of the management support functions for the FirstNet Program Management Office (PMO), technical oversight functions of the network integrators and liaison functions with Public Safety stakeholders at the state, territory and tribal levels.
- From a Program Management support perspective, the IM would support the FirstNet PMO in:
    - Developing and monitoring plans and schedules
    - Monitoring of the major integration contractors (i.e. Terrestrial Mobile Providers, FNN Core integrator, et. al.)
    - Performing risk and risk mitigation actions and management
- From a Technical perspective, the IM will provide
    - Technical analysis of various options and service provider impacts
    - Static and dynamic modeling of the network configuration, such as traffic capacity capability analysis of a given service provider or the combination of service providers
    - The impact of implemented priority levels on traffic of various classes, based on what a provider will support (not all service providers or network types will support all priority and QoS classes)
    - Failure analysis scenarios at the network level to study resilience when there is either a large natural or man-made incident
    - Evaluation of service provider network IS/IA standards where they connect to FNN
    - Evaluation of service provider RAN and Backhaul for the above criteria

- IM should be able to evaluate state proposals and local needs; e.g., examine Opt-Out states proposals to determine
    - If they meet FNN criteria
    - If they would put the rest of FNN at risk in some way, before the plan is authorized for funding and construction
    - If they meet the Information Security and Information Assurance (IS/IA) needs of FNN
    - The status of enterprise level controls of local networks, which would be needed to assure overall network security and integrity
    - Impact of local practices such as “bring your own device” (BYOD) on network operability and survivability

3.1.2. Required Qualifications

In order to perform the challenging management and technical oversight role, the IM needs to possess the following qualifications:

- Strong experience in managing the build-out of major networks
- Strong technical background in:
    - Wireless networking
    - Network and information security
    - Management of large, secure networks
    - Knowledge to perform technical functions such as modeling, test result evaluation, etc. to evaluate and validate network performance
- The IM should understand the:

    - Capabilities, limitations, and pitfalls of different types of networks which will make up the FNN, including LTE, LMR/P25 and various SATCOM based services
    - Interoperability issues between the various networks
    - Operational issues such as PTT delays when connecting through a satellite network
- Strong public safety background
- Ability to successfully work with network carriers, core integrators, and federal organizations (FCC, NTIA, DHS, CBP, PSCR, etc.)
- Experience to liaison with state, territory and tribal authorized contacts
    - Understand the cultural implications of tribal and territorial participants
    - Also understand the requirements of federal agencies, DOD, and other security sensitive agencies, such as the National Guard, CBP, and FBI
- Network operational experience and Operational Support Systems/Business Support Systems (OSS/BSS) expertise to define and implement the Operations and Maintenance (O&M) plan, provisioning, and billing
- Able to evaluate and explain complex issues and get buy-in from the different players

The Implementation Manager is much more than a Program Office support function. In addition to supporting program administrative support functions, it needs to be a capable technical force in the technical management and monitoring of the major network and system integrators.

3.1.3. Benefits of having a FirstNet Implementation Manager (IM)

An IM is a necessity for FirstNet, which encompasses multiple large integrated networks and systems. By providing strong management expertise and technical oversight, the IM will enable FirstNet to:

- Develop strong management plans and schedules and progress tracking
- Validate Terrestrial Mobile and SATCOM Network providers plans and design
- Impartially evaluate the operational impacts of different coverage densities
- Ensure that the integration of the FirstNet Core is properly progressing particularly with regards to integration with the Terrestrial Mobile Network providers
- Oversee interoperability and performance testing
- Identify risks and monitor mitigation actions
- Carry out the interactions and interfaces to rural and tribal organizations to gain consensus for FirstNet actions.

3.2. Provisioning, Billing, and OA&M Support

FirstNet in its presentation did not strongly address a major component of cellular telecommunications system operations, i.e., the Operational and Business Support Systems (OSS/BSS). OSS/BSS integration will be just as important for FNN operation as actual network deployment. OSS/BSS aspects include:

- Provisioning
- Billing

- Network Inventory
- Network Monitoring and Management
- Customer Care – Help Desk
- Trouble Management
- Finance
- Human Resources

The OSS/BSS functions for FirstNet are further complicated by the need to interoperate across multiple Terrestrial Mobile Networks and disparate operator support systems.

SAIC proposes that the FirstNet OSS/BSS be identified as a separate system that is integrated with the EPC and SDP to form the overall FirstNet Core. As it requires 12 to 24 months to stand up an initial operational OSS it is important for this procurement action start immediately to enable FirstNet to reach operational status as soon as possible. The initial OSS/BSS can then evolve to support future public/private collaboration models.

3.3. Other Existing Information and Structure

In addition to the use of commercial wireless infrastructure providing the beginning basis of the FNN RAN, there are other existing defined information sources and structures that should be considered for FirstNet use to reduce the time to reach initial operational status.

3.3.1. Public Safety Broadband Network Numbering Scheme – FCC Directive DA-12-25[2] directed the development a 3GPP LTE 700MHz Nationwide Public Safety Broadband Network numbering scheme for the PSST network. A Numbering

Scheme was developed by SAIC, and funded and managed by DHS OEC. The Numbering Scheme incorporated inputs from PSCR, PSST OAC and DHS OEC and was accepted by the OAC on February 8, 2012. It was subsequently accepted by FCC by its DA 12-423 Order of March 16, 2012. The Numbering Scheme is directly applicable to FNN. Representing significant time and effort invested by the Public Safety community under the FCC Directive, the Numbering Scheme can be used as a foundational starting point to speed FirstNet progress in this area.

3.3.2. The Interoperable Communications Technical Assistance Program (ICTAP) -

Funded by DHS and carried out by the U.S. Navy Space and Naval Warfare Systems Command (SPAWAR), ICTAP provides a set of Public Safety tools[3] and databases that can help in reducing data collection efforts for the Public Safety community. Relevant tools and databases include:

- Communication Assets Survey and Mapping Tool (CASM) and Database
- Frequency Mapping Tool (FMT)
- Response Level Communications Tool (RLCT)
- Statewide Interoperability Coordinator (SWIC) Tool
- Broadband Survey Tool (BBST)

Developed with public safety community input, the use and expansion of these tools for FirstNet activities will also speed the consultation process.

[3] www.publicsafetytools.info

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)

4.1. LMR – LTE Voice Interworking

During the period when both LMR and LTE public safety system are operating, LMR-to-LTE connections via an interworking gateway and handheld device app can provide Push-To-Talk (PTT) non-critical voice for secondary users. Non-standard solutions have been demonstrated by vendors. This could be a cost effective alternative for this user category and should be an area for further examination by FirstNet[4] for standardization.

[4] Harris Corporation's BeOn is an example of this technology: http://pspc.harris.com/Solution/BeOn/Overview.asp

B. Applications

1. **Testing and certification of local Packet Data Networks (PDNs) prior to interconnecting with the nationwide network.**

   The FNN will be only as secure as its weakest link. The sheer number of local public safety data networks across the nation represents a serious security concern as agency networks with varying security levels begin interconnecting with the FNN. SAIC recommends that FirstNet establish a centralized group to perform security audits and work with local network administrators to take corrective actions to secure their systems. The group would survey, audit, and test the existing network security, coordinate the implementation of remedial actions, and certify the local network is secure for interconnection to the national network.

   A common assessment group sets a uniform standard and ensures consistency of approach, increasing the public safety community's confidence in the nationwide network and encouraging use.

2. **Testing and certification of application servers and User Equipment applications ("apps")**

   Similar to PDNs, application servers and User Equipment (UE) based apps should also be tested to assure safe and secure operation prior to being deployed on the FNN.

   SAIC recommends the same or similar central group also be tasked to assess and certify application servers to assure hardening and readiness prior to connection with the

nationwide network. The process would be analogous to the Common Criteria Testing performed for products to be introduced into federal networks.[5]

Taken together, these precautionary activities will go far to maintaining the integrity of the public safety network, as it grows exponentially in coverage as well as use in the coming years.

3. Applications Deployment

SAIC has proposed that FirstNet leverage use of an Implementation Manager (IM) as it deploys FNN. The IM also plays an important role in the deployment of applications for FirstNet. The IM must understand, manage, and deploy the wide variety of apps that will be developed. It must make sure they interoperate in a way that enforces network and information segregation to maintain security and network integrity.

To accomplish this, SAIC recommends the use of existing data interchange models (such as the Justice XML Project) for FirstNet applications. FirstNet may also need to define and deliver other data interchange models where there are unmet needs beyond the capabilities of the above.

The likelihood of information theft increases as the number of applications increase. The opportunity for app-induced network instability and increased vulnerability rises as well. The interactions between the various apps also need to be evaluated and certified as being safe. Therefore, FirstNet should tightly control its applications deployment. The Apple Inc. approach to third party application development and release control

[5] http://ts.nist.gov/Standards/scopes/cct.htm

should be considered as a model for FirstNet SDP. FirstNet would not only publish standards, but also ensure that the apps are tested by FirstNet authorized entities to ensure that they meet both interoperability and safety criteria to prevent unauthorized data access and data theft, or rogue behavior. Apple is noted as an example since it has been able to both create and control an ecosystem that has produced an array of innovative applications, while at the same time keeping the applications space and supporting networks secure.

4. Applications for Mission Safety

The attention of the public safety community has been focused on broadband data applications. SAIC believes that it would also be useful to develop another class of applications that have very low bandwidth requirements but can usefully improve the safety of the first responder.

While delivering full motion video from a first responder inside a building to a control center is important, it also comes at a price, requiring costly dense deployment of small cell RANs to provide indoor coverage. Separately, FirstNet can also encourage the development of low bandwidth applications that could contribute to mission safety. For example, consider transmitting vital sign data of the heart-rate of the first responder or communicating alerts if the temperature within a structure is dangerously high, oxygen content is falling dangerously low, or when a room is reaching flashover point. The clothing and uniform the first responder wears may someday support very sophisticated sensors and communications working over a Body Area Network (BAN). Communicating exceeded-threshold alerts only would require a very low bandwidth link. The resulting network traffic load would be minimal. If an officer is shot inside a building and he is

down, or if his blood pressure is falling due to bleeding, that information can be sent outside to the on-scene command or remote control center using very few bytes. Many other such low bandwidth applications can be envisioned.

Summary

SAIC applauds FirstNet on its innovative and far-thinking approaches to radically upgrading public safety communications. SAIC has made suggestions based on its considerable experience that, it believes, will facilitate this mission by using best-of-breed approaches in concepts, solutions, and implementation methodologies. SAIC is available for further consultation and clarifications of these comments at FirstNet's convenience.

Please direct any questions regarding this response to:

Paul Chang or Kerry Allen

SAIC

4015 Hancock Street

San Diego, CA 92110

Paul.H.Chang@saic.com or Kerry.C.Allen@saic.com