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This Roadmap is a significant milestone for the First Responder Network Authority and the public safety community that we serve. It provides a view of public safety’s operational needs and technology trends for mobile broadband communications over the next five years. And it charts a course for ensuring the delivery of a dedicated and differentiated broadband communications experience.

The FirstNet Authority developed the Roadmap based on public safety’s feedback and input. We engaged with public safety representatives from urban, rural, island, and tribal areas throughout the country. We also conducted targeted industry engagements and market research to capture technology trends. Using their input, the FirstNet Authority built the Roadmap around six “domains” that reflect the most important communications capabilities for their mission.

The Roadmap is a living plan that will continue to guide the future of FirstNet. We will follow the priorities outlined in the Roadmap to ensure that our programs, activities, and investments deliver the communications tools that first responders need to save lives and protect communities. And we will continue our engagements with the public safety community on these priorities to develop a deep and shared understanding of their evolving operational needs.

Public safety has helped us make FirstNet a reality. Moving forward, we will continue to work together – following this Roadmap – to transform the future of public safety communications.
Committed to a Differentiated Public Safety Network Experience

The First Responder Network Authority (FirstNet Authority) was charged by the U.S. Congress to ensure the development, building, and maintenance of a nationwide mobile broadband network dedicated to meeting the needs of the public safety community. Over the past several years, the FirstNet Authority has made great strides toward fulfilling this purpose, including the establishment of a public-private partnership with AT&T, Inc. (AT&T) to deploy the nationwide public safety broadband network across the country and adoption of FirstNet service by hundreds of thousands of public safety professionals. As FirstNet matures and public safety reaps the benefits of a network dedicated to providing them with needed capabilities and features, the FirstNet Authority is focusing on the next stages of fulfilling its mission.

The FirstNet Authority is committed to a vision where a dedicated and differentiated broadband communications experience transforms public safety operations to save lives and protect communities. This vision encapsulates the entirety of the “FirstNet Experience” from AT&T’s deployment of the FirstNet network to the FirstNet Authority’s value-adding activities and investments, which make FirstNet different from any other public safety communications experience. Over time, the FirstNet Authority’s work will help enable public safety to communicate in new and ever more useful ways to help transform public safety operations.

The FirstNet Authority Roadmap Sets the Course

The FirstNet Authority Roadmap (Roadmap) is the centerpiece of all this activity. It reflects stakeholder input and expresses what the FirstNet Authority will do to evolve and advance the FirstNet Experience. It is the basis for continued collaboration with public safety whereby the FirstNet Authority enables agencies to reap the benefits of the FirstNet Experience; for the fostering of an industry ecosystem that applies itself to producing products and solutions for the public safety marketplace; for engagement across government to integrate the FirstNet Experience with other public safety- and broadband-related initiatives; and for support to AT&T for its deployment and maintenance of the FirstNet network.

The Roadmap guides efforts to advance the network by depicting a multiyear view of public safety operational needs and technology trends. It incorporates what the FirstNet Authority learned through its engagements with public safety agencies, industry players, other government agencies that share a public safety mission, and AT&T, and synthesizes that information into a set of actionable priorities.

Figure 1: The FirstNet Authority is setting the course for the next 5 years.
Roadmap Framework

The Roadmap is organized into a framework of six domains representing groupings of related technologies and capabilities that are essential to the public safety community’s mobile broadband communications experience. The two principal domains are the **Network Core**, which provides the essential intelligence for the functioning of the network, and **Coverage and Capacity**, which enables robust and ubiquitous access to that network. Two domains relate to specific public safety features: **Situational Awareness**, which envisions real-time access, collection, and distribution of critical information, and **Voice Communications**, which envisions high-quality, reliable voice communications nationwide working seamlessly across analog and digital platforms. The final two domains concern tailoring public safety users’ experience: **Secure Information Exchange** relates to the assurance that all access is secure, reliable, and easy-to-use, and **User Experience** concerns ensuring interfaces are designed for specific public safety users’ operational challenges.

The Roadmap establishes a vision for each of the domains, as depicted in Figure 2 below, and the domain overviews provide detailed information (e.g., key technology areas, public safety feedback, priorities) for Coverage & Capacity, Situational Awareness, Voice Communications, Secure Information Exchange, and User Experience. The Core domain serves as an enabler for the other five Roadmap domains and, as a result, the FirstNet Authority focused engagement on the other domains taking into consideration all inputs that may drive needed enhancements to the Core.

**Figure 2:** The Roadmap Framework comprises six domains, including foundational elements and those specific to the public safety community. The FirstNet Authority has established a vision for each.

Roadmap Priorities Are Driven by Public Safety’s Needs

Since undertaking nationwide consultation and data collection in 2013 to inform the requirements for the FirstNet Request for Proposal, the FirstNet Authority has expanded its collaboration with public safety. In 2018 alone, the FirstNet Authority participated in more than 1,000 engagements reaching 63,000 public safety stakeholders. During the first half of 2019, the FirstNet Authority specifically undertook an extensive series of engagements with public safety agencies and users across the country to inform them of the Roadmap development. Conferences, surveys, meetings, and research were used to identify public safety users’ operational priorities.

The FirstNet Authority also engaged with industry to understand what it regards as its marketplace challenges and opportunities, with government agencies to determine policy priorities, and with AT&T to understand how it will continue to deploy and service the FirstNet network. This information was synthesized and analyzed to develop one or more goals for each domain, and most importantly, a set of priorities to drive the FirstNet Authority’s future undertakings. Figure 3 summarizes the essential feedback gained from the FirstNet Authority’s public safety engagements and the resulting priorities.
Public Safety Feedback

| CORE | • Advocate for the development and use of devices that improve the performance and efficacy of priority services. |
| Coverage & Capacity | • Increase outdoor and indoor coverage, particularly Band 14, at locations deemed to be public safety priorities. |
| Situational Awareness | • Act as a catalyst in the industry for the creation and evolution of mapping and display technologies that allow easy consumption of geo-location information. |
| Voice Communications | • Work with public safety to assist in operationalizing FirstNet’s MCPTT solution by educating on relevant use cases and supporting efforts to establish relevant nationwide governance and policies. |
| Secure Info Exchange | • Collaborate across government for standardized governance and procedures to simplify and integrate access and exchange of information with select national-level data sets. |
| User Experience | • Improve the performance and efficacy of priority services through evaluation in real-world deployments, development of case studies, and analysis of performance with AT&T. |

Through engagement on the other five domains, public safety implied a dedicated core is necessary to ensure mission-critical levels of availability, reliability, priority, and security.

Public safety wants transparency on where coverage exists today and the ability to guide where it will expand in the future. Fixed, reliable wireless broadband coverage is preferred for public safety operations especially as it becomes foundational to public safety communications. Temporary coverage solutions must be readily available to an agency and their use must easily integrate into their operations.

Location services, including the z-axis, is the priority for public safety, and it must be easy to use. Agencies need assistance to understand and leverage best practices for implementing and integrating sensors, wearables, and camera technologies into their operations.

Broadband-based push-to-talk (PTT) solutions must be able to communicate with legacy systems (including dispatch consoles) and offer comparable features and performance. Responders will not consider FirstNet’s PTT solution to be “mission-critical capable” until it has been validated in real world scenarios. The public safety community foresees various governance, standards, and policy challenges with multi-agency use of mission-critical PTT (MCPTT) and expects the FirstNet Authority to assist in addressing them.

Data access, sharing, interoperability, and cybersecurity are both near- and long-term priorities for public safety. The need to share data transcends disciplines, jurisdictions, and solutions. Public safety needs standardized and consistent cybersecurity procedures to ensure the safe exchange of critical, sensitive information and the overall protection of the network.

Successful deployment of priority services on Band 14, as well as AT&T’s commercial bands, is one of the most important features of the FirstNet network. User interfaces and public safety interactions with these services must be tailored for, and evolve with, public safety’s needs. Development of new applications tailored to public safety needs brings valuable operational benefits.

Figure 3: Public safety feedback helped the FirstNet Authority develop specific Roadmap Priorities for each domain.
Domain Overview
Access to mobile broadband with reliable, dependable, and consistent coverage and sufficient capacity can fundamentally change how first responders work. A principal focus of the FirstNet Authority’s contract with AT&T is to build a robust nationwide broadband network for public safety’s use on Band 14 spectrum. Coupled with public safety’s access to all of AT&T’s commercial spectrum with the same public safety features, public safety agencies have access to the FirstNet network when and where they need it, enhancing their ability to access network services that can transform operations.

The Vision
The FirstNet Authority envisions the network will be available to public safety personnel when and where they need it.

Roadmap Priorities for Coverage and Capacity
The FirstNet Authority assessed multiple factors to determine its Roadmap Priorities for Coverage and Capacity.
These priorities will be developed into a series of initiatives that will direct the FirstNet Authority’s efforts and drive its investments.

- Increase outdoor and indoor coverage, particularly Band 14, at locations deemed to be public safety priorities.
- Advocate for changes in policies, codes, and standards to facilitate in-building coverage enhancements.
- Grow and enhance the deployables fleet considering varying operational needs, staging locations, and technology options.
Key Technology Areas that Comprise Coverage and Capacity

- **Macro Coverage**: A broad coverage footprint, typically enabled by fixed towers.
- **Capacity**: Availability of sufficient network resources to deliver mission-critical services at all times and under all conditions.
- **In-Building Solutions**: Persistent coverage in areas that may be hard to reach by the macro network (e.g., inside commercial buildings, underground public transit stations, crowded sports arenas).
- **Range Extension**: Ability for end users to maintain connectivity beyond the radio access network edge (e.g., vehicular network system, high powered user equipment, LTE relay).
- **Device-to-Device**: Capability for communications devices to link services (i.e., voice, video, and data) directly between or among other devices (“direct mode” or proximity services [ProSe]) without relying on central network infrastructure.
- **Temporary/On-Demand**: Temporary, on-demand, or as needed coverage (e.g., FirstNet deployables, customer owned and managed).
- **Air-to-Ground**: LTE operations and use of broadband applications while in the air (e.g., aircraft, LTE drones).
- **Maritime Operations**: LTE operations and use of broadband applications while operating in coastal and inland waterways.
- **Availability/Reliability/Resiliency/Hardening**: Survivability and recoverability in cases of extreme impairment.

Public Safety’s Take on Coverage and Capacity

- Public safety wants transparency on where coverage exists today and the ability to guide where it will expand in the future.
- Fixed, reliable wireless broadband coverage is preferred for public safety operations especially as it becomes foundational to public safety communications.
- Temporary coverage solutions must be readily available to an agency and their use must easily integrate into their operations.

Key Takeaways from the FirstNet Authority’s Analysis of Learnings from Stakeholders

- FirstNet has established a robust coverage network through its public private partnership.
- Coverage expansion investments will have a direct and meaningful impact when targeted at critical locations, both indoor and outdoor.
- Meaningful improvements to indoor coverage can be achieved by updating relevant policies to encourage cooperation from building developers and owners.
- Deployables have had a high impact when used, and enhancing the fleet with more and a wider variety of solutions will improve accessibility and effectiveness for public safety operations.
Domain Overview
Public safety agencies across the Nation have access to an unprecedented amount of information that is ever increasing as technologies evolve and sensors proliferate. Situational awareness refers to the ability to aggregate and synthesize that information in real-time from multiple sources (e.g., human, machine, sensors) and to derive and present actionable insights to public safety professionals. The FirstNet network should allow for and include capabilities that automatically collect and analyze data into actionable insights to be shared with public safety personnel in a manner that enables critical data to reach responders amid split-second decision-making conditions and other emergencies.

The Vision
The FirstNet Authority envisions real-time access, collection, and distribution of information concerning threats, hazards, and conditions in a manner tailored to public safety operations.

Roadmap Priorities for Situational Awareness
The FirstNet Authority assessed multiple factors to determine its Roadmap Priorities for Situational Awareness. These priorities will be developed into a series of initiatives that will direct the FirstNet Authority’s efforts and drive its investments.

Act as a catalyst in the industry for the creation and evolution of mapping and display technologies that allow easy consumption of geo-location information.

Collaborate with industry and advocate for the development of standards, devices, technologies, and systems that collect, synthesize, analyze, and share information regarding personnel, assets, threats, and hazards in a manner that improves public safety operations.
Key Takeaways from the FirstNet Authority’s Analysis of Learnings from Stakeholders

- The FirstNet Authority’s public private partnership with AT&T has and will significantly advance the development of z-axis location services.
- Indoor mapping technologies (including z-axis) is not widely available to meet the needs of public safety.
- There is a robust camera and sensors market serving public safety today, however these disparate products are not easily integrated.
- Public safety’s use of situational awareness tools is highly fragmented and there is limited sharing of best practices between agencies.

Key Technology Areas that Comprise Situational Awareness

- **Location Services**: Always and accurately locate people, vehicles, and assets on a day-to-day basis (including x, y, and z coordinates), both in- and outdoors, whether stationary or moving.
- **Mapping / GIS**: Access, integrate, and present geolocation information (including z-axis) from multiple sources (e.g., sensors, wearables, cameras) in an actionable manner, together with incident data, traffic and routing, hazard areas, and weather conditions.
- **Cameras / Video**: Gather and stream video in all situations (e.g., dash cameras, drones, body cameras, buildings).
- **Data Analytics / AI**: Analyze massive amounts of collected data to assist in decision-making and response in real-time conditions.
- **Wearables**: Monitor personnel health (e.g., vital signs) and safety (e.g., environmental conditions).
- **Sensors**: Collect, process, and transmit data from various sources (e.g., smart buildings, weather sensors, traffic sensors) to provide insight into existing conditions for all scenarios.

Public Safety’s Take on Situational Awareness

- Location services, including the z-axis, is the priority for public safety and it must be easy to use.
- Agencies need assistance to understand and leverage best practices for implementing and integrating sensors, wearables, and camera technologies into their operations.
Domain Overview

The FirstNet Authority recognizes that voice communications are the fundamental form of public safety communications, and as such, the FirstNet network provides priority and preemption for telephony voice services. AT&T will release a mission critical push-to-talk (MCPTT) service to FirstNet subscribers; however, the FirstNet network is built with the expectation that public safety will continue to rely on land mobile radio (LMR). The FirstNet Authority will ensure FirstNet voice capabilities are designed to interoperate with the thousands of LMR networks currently in use so that the promise of integrated voice, data, and video capabilities for public safety voice communications is realized.

The Vision

The FirstNet Authority envisions a nationwide network that provides high-quality, reliable voice communications, including push-to-talk, and leverages all available voice-related technologies to ensure the most advanced feature set is available.

Roadmap Priorities for Voice Communications

The FirstNet Authority assessed multiple factors to determine its Roadmap Priorities for Voice Communications.

These priorities will be developed into a series of initiatives that will direct the FirstNet Authority’s efforts and drive its investments.

- Work with public safety to assist in operationalizing FirstNet’s MCPTT solution by educating on relevant use cases and supporting efforts to establish relevant nationwide governance and policies.
- Continue an active role in 3GPP and other relevant LMR-LTE standards development focused on MCPTT and dispatch advancement.
- Advocate for continued implementation of critical MCPTT features such as device-to-device communications (ProSe), LMR-LTE interconnection, and dispatch capabilities.
Key Technology Areas that Comprise Voice Communications

• **Mission-critical Push-to-talk (MCPTT):** A standards-based, group-enabled PTT function that is designed for public safety’s use of mission-critical voice communications.

• **MCPTT to LMR Interworking:** Ability for interworking of LMR systems with the FirstNet MCPTT solution.

Public Safety’s Take on Voice Communications

• Broadband-based push-to-talk (PTT) solutions must be able to communicate with legacy systems (including dispatch consoles) and offer comparable features and performance.

• Responders will not consider FirstNet’s PTT solution to be “mission critical capable” until it has been validated in real world scenarios.

• The public safety community foresees various governance, standards, and policy challenges with multi-agency use of MCPTT and expects the FirstNet Authority to assist in addressing them.

Key Takeaways from the FirstNet Authority’s Analysis of Learnings from Stakeholders

• MCPTT advancements by FirstNet have contributed to a forthcoming product that public safety will begin to adopt.

• The introduction of MCPTT into existing public safety operations requires significant planning, training, and support to be successful.

• Key MCPTT features (i.e., direct mode, interconnection [including dispatch consoles]) will be monitored and continually refined to allow full adoption by public safety.
Domain Overview

Secure information exchange is essential to public safety’s mission. First responders require access to many data sources, and the information gathered, accessed, compiled, and stored by first responders must be secure from unauthorized access, adhere to security best practices, and comply with all relevant laws and regulations. Information exchange on the FirstNet network will address the secure management, access, and flow of data among users and applications within and across jurisdictions and public safety agencies.

The Vision

The FirstNet Authority envisions enabling secure, reliable, and easy-to-use access to and sharing of critical information across a variety of sources.

Roadmap Priorities for Secure Information Exchange

The FirstNet Authority assessed multiple factors to determine its Roadmap Priorities for Secure Information Exchange. These priorities will be developed into a series of initiatives that will direct the FirstNet Authority’s efforts and drive its investments.

- Collaborate across government for standardized governance and procedures to simplify and integrate access and exchange of information with select national-level data sets.
- Improve the performance and use of Identity, Credential & Access Management (ICAM) through evaluation of real-world experiences.
- Assess industry standards and procedures for end-to-end security of information at rest, in motion, and in use.
Key Technology Areas that Comprise Secure Information Exchange

- **Data Sharing/Interoperability**: Seamless sharing of data through common public safety applications, software, and records management systems, between and among agencies and jurisdictions.
- **Data Access**: Access to various internal and external data sources to improve incident response, such as Criminal Justice Information Services (CJIS), building floorplans, database queries, incident management plans, and fusion center intelligence data.
- **Cybersecurity**: A comprehensive management of data access and security throughout the FirstNet network to ensure that data at rest, in motion, and in use is accessible only to authorized personnel and is secure at all other times.
- **Identity, Credential, & Access Management (ICAM)**: A set of features and functions within the domain of cybersecurity that organize digital identities to facilitate information sharing, interoperability, and collaboration through an exchange of user or system attributes.

Public Safety’s Take on Secure Information Exchange

- Data access, sharing, interoperability, and cybersecurity are both near- and long-term priorities for public safety.
- The need to share data transcends disciplines, jurisdictions, and solutions.
- Public safety needs standardized and consistent cybersecurity procedures to ensure the safe exchange of critical, sensitive information and the overall protection of the network.

Key Takeaways from the FirstNet Authority’s Analysis of Learnings from Stakeholders

- The FirstNet Authority is uniquely positioned to support public safety’s access to national data sets through government coordination.
- Deployment of ICAM on the FirstNet network is a valuable technical advancement, and support to public safety is needed to operationalize the capability.
- Secure Information Exchange is a high priority for public safety and the FirstNet Authority should be an advocate for secure data interoperability.
- Network cybersecurity is an essential responsibility of the public private partnership but the overall cybersecurity of the data on the network is shared between the public private partnership and public safety.
The FirstNet network is specifically designed to meet the needs and requirements of public safety professionals. First responders need simple, easy-to-use devices and applications with the ability to communicate and access information during routine events and emergency response. All the various ways that public safety can and will interact with, or experience, the network must be considered.

The FirstNet Authority envisions a user experience driven by public safety operational needs that allows users to stay focused on their primary mission.

The FirstNet Authority assessed multiple factors to determine its Roadmap Priorities for User Experience. These priorities will be developed into a series of initiatives that will direct the FirstNet Authority’s efforts and drive its investments.
Key Takeaways from the FirstNet Authority's Analysis of Learnings from Stakeholders

- FirstNet has succeeded in providing public safety users with Priority and Quality of Service (QoS) through the FirstNet network.
- Data from real-world use will be invaluable to optimize the use of Priority and QoS, and they increase public safety’s confidence when using the network for mission critical needs.
- Public safety has a greater desire for a robust application ecosystem.
- The device market is competitive and responsive to the general needs of the consumer and enterprise markets, and the FirstNet Authority can create a similar dynamic and provide a strong centralized voice for public safety’s requirements.

Key Technology Areas that Comprise User Experience

- **Priority Services**: Priority services ensure a good voice, video, and data experience during times of extreme network congestion.
- **Applications**: Mobile applications relevant to and designed for public safety use cases.
- **Devices**: User equipment tailored to public safety operations and suitable for various environmental conditions.
- **Hands-Free Operations**: Ability for users to interact with technology through voice commands (e.g., virtual assistant, voice-to-text) in various situations (e.g., motorcycle, bicycle, in pursuit).
- **Accessories**: Device attachments or extensions developed for public safety use cases and suitable for various environmental conditions and operational scenarios where a basic device cannot perform.
- **Heads-Up Display**: Ability for users to view information within their field of vision whether in a vehicle or on the person.
- **Augmented or Virtual Reality**: Ability to leverage evolving augmented reality or virtual reality technologies for public safety use cases.

Public Safety’s Take on User Experience

- Successful deployment of priority services on Band 14, as well as AT&T’s commercial bands, is one of the most important features of the FirstNet network.
- User interfaces and public safety interaction with these services must be tailored for, and evolve with, public safety’s needs.
- Development of new applications tailored to public safety’s needs brings valuable operational benefits.

Public safety engagements that addressed User Experience (April 1 – June 30, 2019)

- **231 Engagements**
- **50 States**
- **9,304 Stakeholders**
Realizing the Roadmap Through Directed Investment & Collaboration

The public-private partnership model that the FirstNet Authority established with AT&T ensures that financial resources are available to advance the FirstNet network, and this investment capability is an essential means for enabling the organization to act and follow through on realizing many of the Roadmap Priorities. The Act that created FirstNet mandates that any reinvestment of funds may only be used for constructing, maintaining, operating, or improving the network. The FirstNet Authority has established an investment process to facilitate the evaluation of initiatives that derive from the Priorities, and selected projects will form the FirstNet Authority's investment portfolio each year. The FirstNet Authority's Investment Principles, adopted by the FirstNet Authority Board in March 2019, are the basis for the evaluation of investment projects. The principles dictate that investments must:

- Be derived from and benefit public safety;
- Maintain and advance the foundation of the FirstNet network;
- Consider a balanced approach and provide value to public safety; and
- Be fiscally responsible and reflect strong financial management.

The FirstNet Authority’s investment capacity is a strategic resource for advancing the FirstNet Experience, as is its public safety operational expertise and collaboration with various stakeholder groups. The FirstNet Authority’s stakeholder groups provide input to the Roadmap, and they are essential for realizing the Roadmap Priorities, as indicated in Figure 4.

Moving Forward

The Roadmap is central to the delivery of a dedicated and differentiated broadband communications experience for public safety. The Roadmap offers a clear path to the future of the nation’s public safety mobile broadband network, and the Roadmap Priorities are the basis for the work that will be undertaken by the FirstNet Authority to advance the FirstNet Experience. That work begins with developing a deep and shared understanding of public safety’s operational needs, developing and promoting the Roadmap to guide advancement of the experience, investing in the initiatives derived from the Roadmap Priorities, and finally, collaborating with public safety to realize the operational benefits of the FirstNet Experience.

This activity is constantly repeating. Future iterations of the Roadmap will be developed through collaboration among the public safety community, industry, government, AT&T, and the FirstNet Authority. The perspectives gained through this collaboration will be incorporated into the Roadmap as it is refreshed and released regularly. Therefore, the Roadmap will serve as a common reference point, focusing everyone’s attention on a coordinated approach to enhancing the public safety community’s mobile broadband communications capabilities.