First Responders – Talking and Hearing Each Other

When you depend on the technology

State of Maryland – Department of Information Technology

Category: Information Communications Technology Initiatives

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Executive Summary

Following the horrific events of September 11, 2001, and other terrorist attacks on America, Maryland realized that law enforcement officers, emergency medical technicians ("EMTS"), and firefighters, as well as our federal agency partners could not clearly, quickly, efficiently and safely communicate with each other during emergencies or planned events. In response the State of Maryland ("State") has become a leader in building a state-of-the-art statewide first responder interoperable radio communications network for local, state and federal users now known as the Maryland First Responder Radio System Team (Maryland FiRST).

This comprehensive system, that integrates multiple technologies, is rare as only a small number of states have attempted to develop a statewide interoperable public safety radio system supporting its agencies and local governments as well as allied partners. Land mobile radio (LMR) trunked technology is complex and is typically found in a limited geographical area such as a city or county. In 2008, Maryland initiated a program to construct a statewide public safety LMR network utilizing the then newly created 700 MHz frequency band to provide communications interoperability. This system will be complete by the close of 2020. The extensive statewide network remains state-of-the-art through continual enhancements, upgrades, new technologies and investments. Since its inception, the depth and magnitude of incorporated technologies has evolved enormously and expanded far beyond the project's original scope.

When complete, every jurisdiction and person in Maryland will benefit from access to a standards-based interoperable network capable of operating at the local, regional, or statewide level. Already, approximately 70,000 communications devices owned by federal, State, and local agencies, are programed into the network including air-ground and marine communications. This number represents approximately 74% of all public safety communications devices in Maryland. The network expands into areas of our four bordering states to allow communication when an incident crosses over state borders. Allied technologies have been incorporated that permit others using nationwide interoperability frequencies programmed into their radios to be efficiently networked into the system. Maryland has addressed unique problems such as air-to-ground public safety communications by working with the Federal Communications Commission ("FCC") to create new radio frequencies dedicated for this purpose. Maryland is also working with the District of Columbia to explore use of the system to strengthen public

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safety communications in the nation's capital. With an original investment of $345,000,000, additional enhancements have been planned with a supplemental budget of $54,000,000 to upgrade technology, expand radio sites, and increase fiber optic redundancy for network connectivity to radio sites.

Concept and Operations

Maryland FiRST employs the United States Department of Homeland Security approved Project 25 Phase II 700 MHz trunked Land Mobile Radio ("LMR") standards with encryption capabilities for public safety. This system is designed to provide radio communication across the entire State using advanced automated trunked radio system management technology. The complexity of this technology introduces numerous challenges when it is employed over a statewide "real-time" network. Even before completion, a public safety official located at Deep Creek Lake, in the far Western mountains of the state, can instantly communicate with others in Ocean City in the far Eastern part of the state. Unlike a cellular phone, MD FiRST enables large numbers of responders to be in communication simultaneously. The system also provides air to ground and marine channels for public safety flight and water operations. Maryland has both mountainous terrain as well as 3,190 miles of shoreline.

One of the major findings of the United States Department of Homeland Security and the 9/11 Commission Report was to "Improve interoperable communications at all levels of government." Following the Report, Maryland adopted the need for public safety communications interoperability as a Homeland Security priority and committed over $345,000,000 to construct the statewide system. Governor Larry Hogan has continued to support Maryland FiRST and the services provided by the system to first responders strongly as evidenced by the addition of over $54,000,000 for enhanced technology improvements, new technologies, and additional radio sites across the state. Since 9/11, the State has vacated a world with extremely limited public safety communications interoperability to the present-day Maryland FiRST system which provides a robust statewide platform linking Federal, State, and local government first responders in Maryland and into our four bordering states and the District of Columbia. Additionally, special 700 MHz nationwide interoperability stations managed by the State Emergency Management Agency were added to Annapolis, Baltimore, and Lamb's Knoll Mountain and are capable of facilitating interoperability with resources coming from out of state areas.

Using Maryland FiRST, the State maximizes its fiscal communications resources while achieving interoperability by consolidating funding into the Department of Information Technology ("DoIT") to support a communications platform meeting the land mobile radio requirements of the major agencies; e.g., State Police, Natural Resources, Department of Transportation agencies, Emergency Medical Services, Maryland Department of Health, National Guard, DEA, Federal Air Marshals, United States Park Police, Maryland Dept of Public Safety and Correctional Services, Maryland Department of the Environment, Customs and Border Protection (Port of Baltimore), etc. Prior to Maryland FiRST, there were no consolidated radio systems on a statewide level resulting in disparate networks operating in

different frequency bands that hindered attempts at interoperability even when agencies desired improved communications

The State initiated a multi-phase program to construct communications towers and microwave systems throughout the State. These resources initially served to support the requirements of agencies and local governments seeking short-term fixes for communications. However, even though there were short-term benefits, users recognized that the ultimate need was for new technology and towers to develop a robust statewide system. Today, MD FiRST uses approximately 155 State, federal, local government, or privately owned communications towers throughout the State for first responder communication. By partnering and using existing towers, with Maryland FiRST technology communication spans across the entire state, while saving the tax payers millions of dollars and years of construction. As a result, only ten new towers had to be constructed to complete the initial phase of the statewide network.

DoIT (Maryland FiRST operations) has established a user input system that provides daily service assessments and allows technicians to provide just-in-time service and support for tens of thousands of first responders. Multiple formal assessments have been established to ensure the success of the program. These assessments include:

- Testing the radio coverage of the system in every county within Maryland. Testing was conducted with members of State agencies as well as participating local governments and representatives of the federal government using the network for daily operations and interoperability.
- State audit and review of all network components both pre-construction and post installation.
- Continuously monitoring the health of the network using automated tools.

The State's General Assembly established the Maryland Statewide Interoperability Radio Control Board ("Board") to provide for the shared governance of the Maryland FiRST. The Secretary of DoIT is the Chairman of the Board and the Governor appoints members of the Board from major State agencies and local governments who meet routinely to receive reports from system managers as well as users. The Board provides policy guidance as to the operation of the system. Any Operational issues from users can be reported the DoIT Chief of Public Safety Communications who acts as the Director of the Board. Through this system of governance, user reports are reviewed as system assessments on a continuous basis.

DoIT has complete oversight for the project and works with the Board to ensure that user issues are addressed promptly and appropriately. As examples; Talbot County identified a requirement for enhanced "in-building" coverage in a discrete portion of their jurisdiction. With the county agreeing to be the funding source, Maryland FiRST identified spectrum and performed all required licensing tasks as well as overseeing construction and operation of the site and coordinated connectivity with the statewide network. To allow for additional users Talbot also requested additional capacity for the simulcast cell. Maryland FiRST expanded the cell's capacity by requesting spectrum from the FCC's Regional Planning Committee for 700 MHz and obtained two additional frequency allotments which permitted four additional simultaneous conversations to occur within the local operating cell. With additional spectrum provided, Maryland FiRST applied for a new FCC license and the capacity of the cell was expanded.

In an effort to ensure accessibility while also maintaining information security, Maryland FiRST uses the standards based P25 Phase II architecture as well as State managed private networks for backhaul communications that link all radio and console sites. Again, the system employs other nationwide protocols such as the Advanced Encryption System ("AES") for security. AES is the only encryption protocol that has been approved by the United States Department of Homeland Security. The system also employs a software tool that authenticates a radio before permitting access to the system. This software also monitors radio identification numbers and alerts system managers to preclude the possibly illegal cloned radios attempting to surreptitiously gain access to Maryland FiRST.

Training is a significant piece of the success and the system's implementation. At the State level, almost all of the member agencies had limited experience with contemporary trunked radio technology as used with Maryland FiRST. Similarly, many users had little experience with interagency interoperability. These hurdles were overcome by developing the unique users committees which meet regionally to communicate and learn. These users instruct persons within agencies and local governments to re-train their teams in both the operation of trunked radios as well as interoperability communications throughout the system. Data are recorded within the system and by 2020, users were approaching 60,000 interoperability radio transmissions per month. Prior to Maryland FiRST, interoperability by State and local first responders was virtually zero.

Technology

Land mobile radio trunked technology is complex and is typically found in a limited geographical area such as a city or county. Trunked radio technology works through a consolidated database identifying specific user radios that have been programmed into the system. From the database, authorized users of the system are aggregated into "talkgroups" and the talkgroups are assigned a frequency to facilitate transmission. When a user's radio transmits, within microseconds, the system performs a number of critical tasks, some of which are identified below:

- Is the transmitting radio authorized to use the system?
- To what talkgroup is the user assigned?
- Which other radios are part of the talkgroup and where are they located?
- What radio sites should be selected to transmit and receive the authorized radio signal?
- Is there an available radio frequency?
- If the signal of any radio is weak, what are the optimal sites to use?
- Is a radio sending an emergency transmission so the system can pre-empt other radio calls and prioritize instantly the user's emergency information?

These are but a few of the elements in the decision matrix associated with a trunked radio system all occurring in real time with only microseconds of latency permitted. Most trunked systems, known as a "cell," have +/- 5-20 radio sites that are combined into a communications technology core. Maryland FiRST differs considerably in scope and the technological challenges are far more complex. Maryland FiRST also must assess, again in microseconds and instead of in a single city or county, search

approximately 145 different radio sites located throughout all twenty-four State jurisdictions stretching from the Atlantic Ocean to the western mountains near Pennsylvania and West Virginia. Unlike typical local systems, Maryland FiRST uses combinations of simulcast cells, where all transmitters operate at multiple locations simultaneously covering wide areas, as well as standalone repeaters addressing discrete radio requirements. The system must ascertain on a statewide basis and in real time without unacceptable latency of the elements identified below:

- Is the transmitting radio authorized to use the system?
- Is the transmission an emergency?
- To what talkgroup is the user assigned?
- What radio sites throughout Maryland should be selected to transmit and receive the authorized radio signal?
- Are frequencies available at every site to which a member of the talkgroup is affiliated?
- Do multiple system cores, the central processing unit, need to interoperate to link communications in multiple parts of Maryland?
- When multiple cores and cells are interrogated for transmission, does each cell or standalone site throughout the system have capacity to support the radio message?
- Are radios able to communicate to cores and cells redundantly as cores are geographically dispersed through the State to ensure continuity of operations?
- If the primary core is disabled or operating sub-optimally, are communications shifted to the redundant system core?
- Which other radios are part of the talkgroup and in which cores, cells, or standalone transmitter sites throughout the State are they located?
- If a backhaul link is disabled, what available alternative transmission paths are available?
- If the signal of any radio is weak, what is the optimal site to use?
- Does the radio transmission need to be linked to an external network like the nationwide FirstNet system?

To make the communication work as designed, Maryland FiRST uses a combination of fiber optic and digital microwave radios to operate reliably throughout the State. The system is designed to provide backhaul communications through combinations of technologies located in geographically diverse areas. As an example, fiber optic cable may be installed underground, under waterways, or attached to aerial poles. Microwave systems, which are used in rural areas without fiber, may operate in different modes as needed to optimize efficiency and reliability. All of the technologies are needed to ensure that first responders throughout the State can communicate efficiently and reliably.

Significance

The project's significance has been to address public safety communications interoperability for State agencies and local governments as well as federal law enforcement. Through this effort and as previously identified, all major State agencies requiring regional or statewide communications support are primary users of the system. To date eight counties in Maryland use the system exclusively and the remaining counties depend on this network for interoperability with neighboring counties, State agencies and federal

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agencies creating a true statewide interoperable first responder clear and efficient network. Maryland FiRST also provides a significant economic benefit for local governments and state agencies that would not otherwise have the financial ability to acquire such a modern comprehensive system. The counties that use Maryland FiRST exclusively do not have the expense of 24/7 maintenance, upgrades, repair and replacement of hardware on the network or the staffing costs to support the network. In consideration of the annual costs of radio maintenance as well as upgrades to maintain a contemporary network, each local government user saves well over $1,000,000 tax dollars annually by using Maryland FiRST as their primary public safety communications system.

Maryland FiRST is unique, it caused many former safety communication norms laden with failure to be transformed. As an example, the Maryland State Police were utilizing multi-channel simplex analog communications in the 39 MHz band; essentially, 1940 technology. The system suffered from interference generated by systems hundreds of miles away from Maryland. Maryland FiRST operates utilizing contemporary digital trunked radio systems which are state-of-the-art. To paraphrase Gordon Bethune, MSP communications went "from worst to first"[1] after joining MD FiRST. As a result, MSP continues to advance communications through interoperability with adjoining states and other agencies within Maryland.

Public safety communications are real time events critical to saving the lives of people and protection of property. Failures in communication systems are dramatic events that endanger citizens and first responders. Maryland FiRST users rarely experience or even perceive system failures. The system provides users access to our customized reporting system in which they report communications "dead spots" where radio coverage is weak or capacity constraints known as system "busies." Based on this data, Maryland FiRST maintains and updates a list of priorities for strengthening communications in these areas and engaging in formal projects to expand radio coverage. System "busies" are tracked, in a typical month with multi-million transmissions, capacity constraints and "busies," are typically reflected by a single digit number, which is well below the US industry standard.

Unique Challenges

One of the many challenges faced by Maryland FiRST was effective air-to-ground communications for the State Police and Emergency Medical Services ("EMS") agency. Maryland has a nationally recognized program for supporting emergency medical services through the Maryland State Police aviation unit that supports helicopters operating throughout the State. Maryland discovered that the FCC had not identified any radio frequencies in the traditional public safety radio bands for aviation use. While public safety frequencies could be used in aircraft with restrictions, the use was considered by the FCC as "secondary" which means aircraft radios could not cause any interference and if they encountered interference, it had to be accepted.

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[1] From Worst to First: Behind the Scenes of Continental's Remarkable Comeback by Gordon Bethune, John Wiley & Sons Inc., August 30, 1999.

To remedy this serious problem, Maryland worked with the National Public Safety Telecommunications Council ("NPSTC") to identify and understand the problem that affected all first responders in aircraft on a nationwide basis. NPSTC incorporated this requirement into other matters going to the FCC through a federal "Petition for Rule Making." After numerous meetings with Maryland First involving four years of work and research, the FCC established eight 700 MHz radio pairs that had been recommended by Maryland for air-to-ground communications. Not only does this benefit Maryland, many other states now use the air-ground communication channels for their air ambulances as well. The establishment of these frequencies on a nationwide basis is still being coordinated with Canada and Mexico in areas proximate to those countries.

Impact

The Maryland FiRST system has become a model for shared public safety communications infrastructure. It brings State and local governments closer together through common communications platforms and governance. Through the use of nationwide industry standards, federal users can easily migrate into the system for communications interoperability when necessary. With the implementation of Maryland FiRST, users went from old noisy analog technology to modern clear and reliable digital communications that consistently eliminates interference from almost all other sources. The State's first responders can now successfully and quickly communicate over wide areas including if necessary, statewide and into our bordering states.

Because of Maryland FiRST's unique operations and user group communication, the system provides flexibility to meet new challenges. COVID-19 has placed new demands on State agencies to respond to emergencies. Through a cache of emergency radios as well as vendor resources, Maryland FiRST was able to meet unanticipated demands for user radios quickly. Additionally, through system management and pre-planning, talkgroups supporting unique and/or interoperable communications were immediately made available and integrated into the statewide interoperable network to address the needs of agencies responding to the pandemic; e.g., the need for the rapid testing of large numbers of the general public.

Conclusion

Maryland FiRST is transforming public safety communications in the entire state from an uncoordinated combination of disparate systems where interoperability was at best complicated and with many failures, to a cohesive state-of-the-art reliable network supporting first responders at every level of government. The project has remained on budget while absorbing some unexpected infrastructure costs such as remediating or constructing a small number of new towers. Local governments joining the system have avoided the cost of common infrastructure, maintenance, staffing, and upgrades translating into millions of saved taxpayer dollars annually. With statewide radio coverage and configurations that permit all federal, State, and local governmental first responders to interoperate, Maryland FiRST provides a unique level of service through technology that can only be provided through a comprehensive, innovative, and robust statewide network. When an emergency occurs, lives are saved and property protected through Maryland FiRST's interoperable public safety communications avoiding the sad lesson learned by the New York City police and fire departments on 9/11 when 414 police officers and fire fighters were killed.