NEXT GENERATION FIRST RESPONDER
CASE STUDY
Location Services

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Homeland Security
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EXECUTIVE SUMMARY

The Department of Homeland Security (DHS) Science and Technology Directorate (S&T) launched the Next Generation First Responder (NGFR) Apex program in January 2015 as a strategic initiative to develop and integrate next-generation technologies with the goal of expanding first responder mission effectiveness and safety. The NGFR Apex program seeks to help tomorrow's first responder be better protected, connected and fully aware.

NGFR has conducted three integration demonstrations to assess how prototype technologies integrate to support the NGFR Apex program. The first demonstration in January 2016 was primarily a tabletop demonstration, and the second in May 2016 was a combined tabletop and field demonstration in a large urban area. For the third NGFR integration demonstration, the NGFR Apex program wanted to collaborate with a more rural community where cutting-edge technologies face a unique set of deployment challenges.

NGFR partnered with first responders in Grant County, Washington, to assess the capabilities of numerous NGFR technologies to support their public safety operations. This effort, known as the *Grant County – DHS Science and Technology Directorate Next Generation First Responder Apex Program Technology Experiment* (TechEx), involved deploying a suite of technologies. This study identifies and explains the technologies that were used in the TechEx, and presents a case study that can be used by public safety agencies as an example of how agencies can implement location services to track units and responders across their jurisdictions.

Initial discussions with Grant County identified the following five areas as priority needs for the Grant County first responders:

- Geo-location of first responder vehicles and personnel on map displays at the Grant County Multi-Agency Communications Center (MACC), command posts and on smartphones.
- Wireless data service at the Gorge Amphitheatre concert venue, campgrounds and along the Columbia River valley using various broadband technologies, including cellular broadband [Long Term Evolution (LTE)], Wi-Fi and digital television datacasting.
- Ability to view real-time video at the MACC, command posts, emergency management centers and other destinations when captured and streamed from small Unmanned Aircraft Systems (sUAS) or first responder smartphones.
- Capability to monitor first responders' physiological condition and send the data wirelessly to the MACC and command post(s) for viewing using a visual "dashboard" on a monitor.
- Support for communications and information dissemination using a combination of County-owned land mobile radios (800 MHz P25), commercial mobile networks and a deployable government-band public safety broadband network (Band 14 LTE, FirstNet) for data communications.

After further discussions, extensive planning, site visits, an integration and testing event, and a dry run of the experiment, NGFR and Grant County conducted the TechEx on June 6 and 7, 2017. The TechEx involved the deployment of more than 50 first responders from multiple Grant County first responder agencies, as well as 15 NGFR staff and support contractors.

The scenario-based event used three operational scenario vignettes, illustrated in Figure 1:

- **Vignette A** functioned as a systems check of the new technologies. Each technology was tested for the corresponding responders and vehicles (as applicable).
- **Vignette B** involved tracking down two (notional) lost hikers who wandered down into the Columbia River gorge. One hiker fell off a cliff and broke a leg. Sheriff's deputies were sent down into the gorge to find the victims with an sUAS used to assist in finding the hikers. Once the hikers were located, the fire district responders were dispatched to perform a ropes rescue to transport the victim up the cliff to be treated by responders.
- **Vignette C** involved the report of a brush fire, which was located by the sUAS. Fire Districts 3 and 5 personnel were dispatched to fight the fire. Soon after, an altercation occurred at the nearby campground, and deputies pursued the perpetrator.

Figure 1: Grant County responders during the NGFR TechEx

The TechEx scenario provided sufficient realistic opportunities to assess the various technologies' utility and integration with existing systems (technical and human). The scenario also provided opportunities for participating first responders to identify gaps and required enhancements for future NGFR events. The evaluation team was able to verify the NGFR system architecture implemented and configured in Grant County was easy to install, easy to use and provided capabilities that were valued by the first responders.

The NGFR Apex program and their partners provided location tracking solutions to support the TechEx that incorporated both unit and responder tracking, using a variety of software and hardware solutions. The location data from the NGFR solutions was displayed on multiple situational awarenes applications, providing location information to responders, incident commanders and county leadership, enabling better-informed resourcing decisions.

INTRODUCTION

Next Generation First Responder Apex Program

The Department of Homeland Security (DHS) Science and Technology Directorate (S&T) launched the Next Generation First Responder (NGFR) Apex program in January 2015 as a strategic initiative to develop and integrate next-generation technologies with the goal of expanding first responder mission effectiveness and safety. The NGFR Apex program seeks to help tomorrow's first responder be better protected, connected and fully aware. When firefighters, law enforcement officers and emergency medical services have enhanced protection, resilient communications and advanced situational awareness, they are better able to protect our communities and make it home safely. The NGFR Apex program develops, adapts and integrates cutting-edge technologies using open standards, increasing competition in the first responder technology marketplace and giving responders more options to build the systems they need for their mission and budget.

NGFR Integration Demonstrations

NGFR has conducted three integration demonstrations to assess how prototype technologies integrate to support the NGFR Apex program. The first demonstration in January 2016 was primarily a tabletop demonstration, and the second in May 2016 was a combined tabletop and field demonstration in a large urban area. For the third NGFR integration demonstration, the NGFR Apex program wanted to reach out to a more rural community where cutting-edge technologies face a unique set of deployment challenges.

One key component of the NGFR Apex program is that it is both modular—meaning responders can select diferent components that will easily integrate via open standards and interfaces—and scalable—meaning responders can build a large and complex system or a small and streamlined system, depending on their mission needs and budget. Throughout the course of the NGFR Apex program, it is essential to test both the modularity and scalability of the system with first responders, so that by the end of the program, responders will be able to build their own Next Generation First Responder system from tested, integrated and demonstrated components that have already been proven in real-world environments.

NGFR Technology Experiment in Grant County

The DHS S&T Next Generation First Responder (NGFR) Apex program partnered with the Grant County, Washington, Sheriff's Office to assess how NGFR technologies could improve the mission capabilities of Grant County public safety. The county, comprised of more than 2,700 square miles of river valleys, rolling hills and agricultural farmland, is decidedly rural, and Grant County responders have frequently struggled with poor communications coverage when supporting major events, managing wildland fires and coordinating multi-agency responses to large incidents.

The overarching objective for the event was to conduct a Technology Experiment (TechEx) in Grant County, Washington, in collaboration with Grant County public safety officials and first responders. The TechEx integrated several NGFR technologies to support an operationally-relevant, mission-based scenario centered on law enforcement and emergency response operations. The goal of this TechEx was to demonstrate the various technologies and assist Grant County in incorporating them into their daily operations, and to gather responder feedback to help improve both individual NGFR technologies and the program as a whole.

Purpose of This Case Study

This case study describes NGFR's recent efforts to provide a method of tracking the location of first responders and first responder vehicles, and displaying those locations on maps to expand situational awareness. This study identifies and explains the technologies that were used in the TechEx, and presents a case study for public safety agencies as an example of how agencies can implement location services to track units and responders across their jurisdictions.

TECHEX OVERVIEW

Background

The NGFR Apex program and Grant County partnership resulted in the *Grant County – DHS S&T NGFR Technology Experiment*. The two-day experiment was held in and around Grant County's Gorge Amphitheatre, a popular music venue and campsite surrounded by open farmland and canyons. The venue draws crowds that increase the county's population by 30,000—a 30 percent increase from Grant County's regular 93,000 residents—on weekends during summer events, and poses a strain on existing responder communications capabilities. This particular venue provided the optimal environment to test various NGFR technologies during the TechEx.

Objectives

The overarching objective for the event was to conduct a TechEx in Grant County in collaboration with Grant County public safety officials and first responders. The TechEx was based upon the integration of identified NGFR technologies to support an operationally-relevant mission-based scenario centered on law enforcement and emergency response operations. The goal of this TechEx was to demonstrate the various technologies and assist Grant County in incorporating them into their daily operations and existing systems. By gathering feedback from first responders on the technologies and how they did or did not augment Grant County emergency response capabilities, the NGFR Apex program will seek to better align the program to better meet rural as well as urban responder needs.

Figure 2: Grant County Command Center monitors TechEx activities

Requirements

Initial discussions with Grant County in December 2016 resulted in the identification of the following technology requirements for the TechEx:

- **Extended and Increased Communications:** Provide a broadband ([Long Term Evolution (LTE)] communications infrastructure that both works with existing commercial LTE providers and with a temporary public safety Band 14 LTE system to provide connectivity for the various technologies being demonstrated.

- **Video Capture, Storage and Distribution:** Capture video from responders' smartphones, small unmmanned aerial systems (sUAS) also known as drones and other devices to forward to a centralized video storage service; distribute captured video from a centralized service to responders, incident commanders and the Grant County Multi-Agency Communications Center (MACC).

- **Location Tracking:** Track location of first responder vehicles and smartphone-equipped first responders on map displays at the MACC, command posts and on smartphones.

- **Responder Physiological Monitoring:** Monitor first responders' heart rate and respiration rate data to send to the MACC and/or command post.

- **Situational Awareness:** Share first responder location, physiological data and captured video to the MACC, command posts, emergency management and other destinations for display on dashboards and maps.

TechEx Activities

Site Survey

NGFR and their primary support partners, Johns Hopkins University Applied Physics Lab (JHU APL) and the U.S. Department of Commerce National Institute of Standards and Technology's (NIST) Public Safety Communications Research (PSCR) division, performed a site survey of Grant County in February 2017, which specifically focused on the technology currently in use by the Sheriff's Office, the Fire Districts and at the Gorge concert venue. This survey enabled the NGFR team to identify the types of technologies that would fulfill the requirements and objectives of the TechEx. As part of the survey, the NGFR TechEx team developed an "as-is" configuration of Grant County's communications infrastructure and capabilities for use as a baseline.

Integration Testing

Once the technologies were identified and preliminary development and integration was complete, NGFR and their partners met at PSCR in Boulder, Colorado, in April 2017 to perform further integration testing. This three-day session enabled the technical participants to connect all technologies in both laboratory and radio transmitter test-range field locations to test the integration of the components as a system of systems.

Dry Run

Soon after the Boulder integration testing, the team reassembled at the Gorge concert venue in Grant County to install antennas, test coverage and perform a dry run of the scenario vignettes. This testing assisted the participants in finalizing the systems, testing the new capabilities in the actual event setting and preparing for the actual TechEx.

Technical Experiment

The TechEx was conducted June 6-7, 2017. It was conducted using an operational scenario with three vignettes:

- **Vignette A** functioned as a systems check of the new technologies. Each technology was tested for each of the corresponding responders and vehicles (as applicable).
- **Vignette B** involved tracking down two notional lost hikers who wandered down into the Columbia River gorge. One hiker fell off a cliff and broke a leg. Sheriff's deputies were sent down into the gorge to find the victims with an sUAS used to assist in finding the hikers. Once the hikers were located, the Fire District responders were dispatched to perform a ropes rescue to transport the victim up the cliff to be treated by responders.
- **Vignette C** involved the report of a brush fire, which was located by the sUAS. Fire Districts 3 and 5 personnel were dispatched to fight the fire. Soon after, an altercation occurred at the nearby campground, and deputies pursued the perpetrator.

The TechEx scenario provided sufficient realistic opportunities to assess the various technologies' utility and integration with existing systems (technical and human). The scenario also provided opportunities for the first responders to identify gaps and required enhancements to be addressed in future NGFR events and technical development. The evaluation team was able to verify the architecture implemented and configured in Grant County was easy to install, easy to use and provided capabilities that were valued by the first responders.

Communications Architecture

Based upon the site visits, the baseline assessment and ongoing collaboration with Grant County, a notional architecture was developed to establish the foundation for the architecture for the TechEx, as well as to ensure consistency with Grant County first responders' expectations and needs as shown in Figure 3.

Figure 3: TechEx Notional Data Architecture
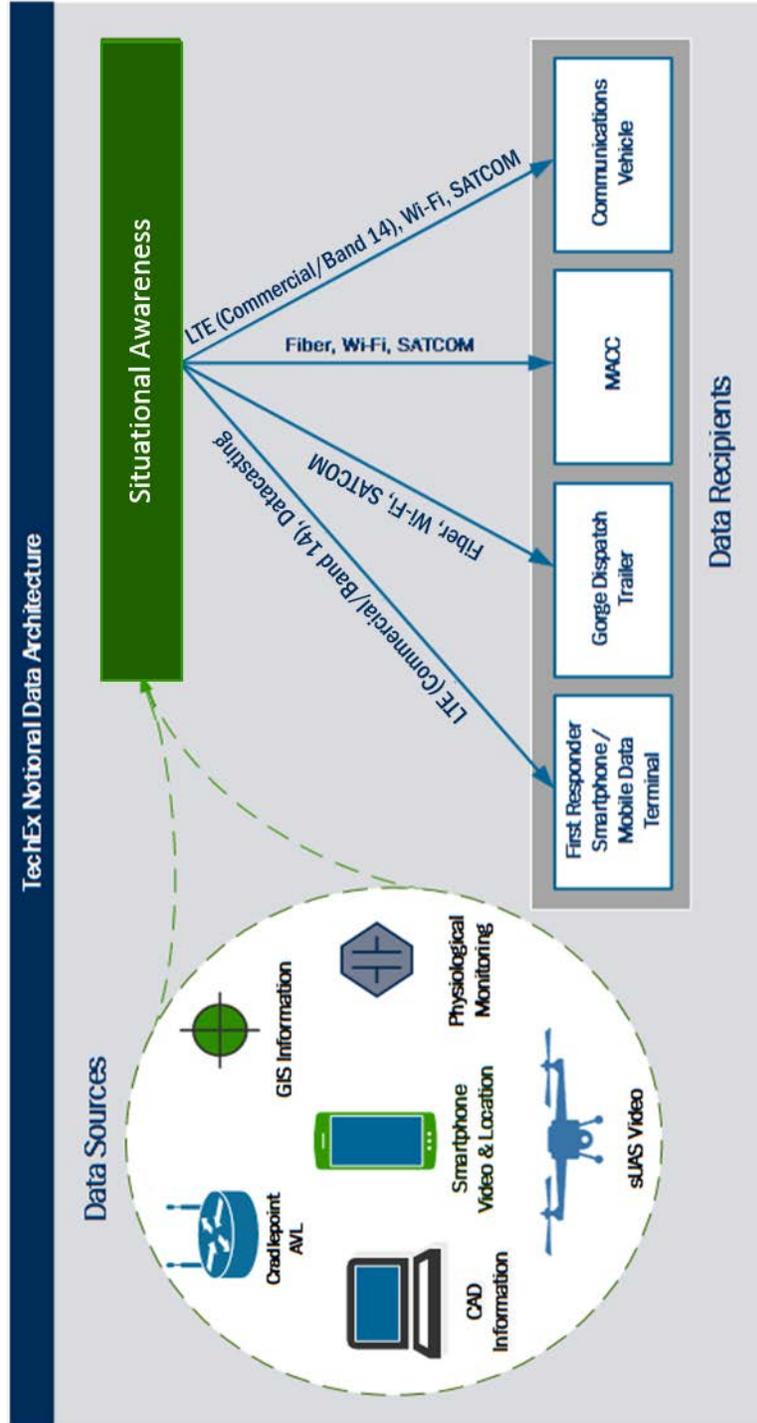
After the integration testing and the dry run, additional refinement occurred before the design was finalized as depicted in Figure 4.

Figure 4: Overall TechEx Architecture

Constraints and Limitations

The identified constraints and limitations for the TechEx event include:

- **Cost:** The NGFR Apex program had a limited budget for the TechEx. This precluded the use of the Band 14 LTE Cell-on-Wheels, and instead the manportable "backpack" Band 14 LTE solution was selected.

- **Schedule:** The Special Temporary Authority (STA) to transmit in the Band 14 LTE spectrum was only granted for three weeks, so Band 14 LTE could not be tested as part of the dry run that occurred four weeks prior to the event.

- **Staffing:** The number of NGFR and partner support staff was limited due to both staff availability and the cost of travel. This resulted in a limited ability to support any elaborate communications systems and required support from some of the technology developers who assisted in the configuration and training of their systems prior and during the TechEx.

- **Technology Maturity:** Some of the communications-based technologies were still in the prototype phase, but were chosen for this event as the technology, when complete, had the potential of addressing Grant County's needs.

- **LTE vs. LMR:** Because of the agreed-upon requirements (as identified above), the solutions that NGFR provided did not rely on or affect Grant County's existing Land Mobile Radio (LMR) infrastructure or system. LMR was only used during the TechEx for standard responder-responder and dispatch-responder communications.

Location Solutions Implemented

Figure 5. Dispatch monitors display situational awareness tools

It is crucial for public safety agencies to maintain effective real-time situational awareness in the execution of their various law enforcement, emergency care and fire safety missions. One major component of situational awareness is for the incident commanders, dispatchers and agency leadership to be able to track the locations of first responder vehicles and personnel as they travel through their jurisdictions on patrol or when dispatched to incidents. Knowing where personnel and resources are is key to ensuring officer safety and efficient deployment of resources. For example, if law enforcement officers are injured while on patrol, and no one can reach them through radio or cellular communications methods, having the capability to know where they are makes it easy for the commander to send backup, saving precious time and increasing the likelihood the officer will make it home safely.

Grant County Location Tracking Requirements

In order to effectively develop and implement a first responder and unit tracking system, NGFR and Grant County assessed their requirements for tracking responders and vehicles, and assessed the existing capabilities of Grant County's internal and commercial infrastructure to support collection, transmission and display of the location information.

Grant County determined they wanted to track individual first responders, especially firefighters, throughout the entire county. They noted they needed to track firefighters using their personal smartphones, because fire vehicles had no equipment installed to allow the vehicles to be monitored. Providing this smartphone tracking capability also allowed Grant County to track Sheriff's Deputies using their department-issued iPhones when they were away from their vehicles. In addition to tracking individual first responders, Grant County determined they wanted to track all their Sheriff's vehicles and as many fire vehicles as possible. Tracking Sheriff's units, all of which were equipped with LTE modems and laptops, was easier than tracking fire vehicles, which had neither LTE modems nor laptops installed.

Baseline Grant County Location Tracking Environment

Once Grant County determined their tracking requirements, NGFR and Grant County personnel evaluated the existing location tracking environment, including the communications infrastructure, vehicle equipment and any constraints or limitations caused by geographic features hindering tracking of first responder vehicles and personnel.

Existing Communications Infrastructure: The commercial LTE coverage in Grant County was determined to be adequate for tracking first responders and vehicles during the TechEx. NGFR installed a micro-cell Band 14 LTE site at the Gorge venue to provide broadband service for scenario operations – especially the transfer of video – which was also used for first responder tracking via their smartphones, but was not considered essential for tracking purposes. Although Grant County has an 800 MHz P25 LMR system, it was determined LMR would not be used as the data transfer medium for location data.

Existing Unit and First Responder Technology: For first responder equipment, Grant County had three versions of personal communications technologies that could be used for tracking individual responders, including:

- Firefighters and Sheriff's deputies using their personal smartphones' location capabilities;
- Sheriff's deputies using agency-issued iPhones' location capabilities; and
- Firefighters and Sheriff's deputies using an independent purpose-built device to determine and transmit location messages.

For first responder vehicle equipment, Grant County had three versions of vehicle communications technologies incorporated into the unit tracking solution for the TechEx, including:

- Deputy vehicles equipped with laptops and CradlePoint LTE/Wi-Fi routers;
- Deputy vehicles equipped with laptops and Verizon LTE/Wi-Fi routers; and
- Fire vehicles equipped with only LMR equipment.

Grant County Contstraints and Issues

There were several constraints and issues influencing the first responder and unit tracking solutions for Grant County, including:

- Grant County's Computer Aided Dispatch (CAD) system was not configured to receive and display unit and first responder locations.
- Grant County lacked the capability to receive, process and transmit location messages. As a result, ArdentMC provided a message switch – named "Vortex" – to receive unit and first responder identification and location information and pass that data on to the situational awareness application.
- Grant County's geographical information system (GIS) was not capable of receiving and displaying location messages in its original configuration. ArdentMC provided a GIS-enabled situational awareness tool using the Esri Ops Dashboard application for the County to use to display the location and identification information on a map.

## Location Services Tested During the TechEx

One solution used for tracking first responders used the location and communication capabilities already incorporated into smartphones. For the TechEx, ArdentMC developed their "Watchtower" application that was then installed on both the Sheriff's Office-issued iPhones and personal smartphones, using the phone's GPS receiver and broadband connectivity to determine the phone's location and transmit the location to the situational awareness environment for display. The Watchtower application also enabled the first responders to view their own location and other similarly-equipped first responders' locations on a map, thereby providing both location and situational awareness capabilities to the first responders.

A second solution used for tracking first responders was a purpose-built device called the Communications Hub, built by the Integrated Solutions for Systems (IS4S) company. This Comms Hub merged a Global Positioning System (GPS) receiver with a Raspberry Pi computer and either a smartphone or an LMR radio (on a non-Grant County frequency) or both. The Raspberry Pi computer received the location data from the GPS receiver and transmitted it out via either the LMR radio or the smartphone, depending upon which had connectivity at the time. The smartphone fed the data via the LTE network to

an IS4S "dashboard" for display of the location information on a map. The LMR radio transmitted the data to a second LMR radio, which then passed the data on to a laptop that sent the data via LTE to the IS4S dashboard. The location services data architecture used during the TechEx is illustrated in Figure 6.

Figure 6. TechEx Location Services Data Architecture
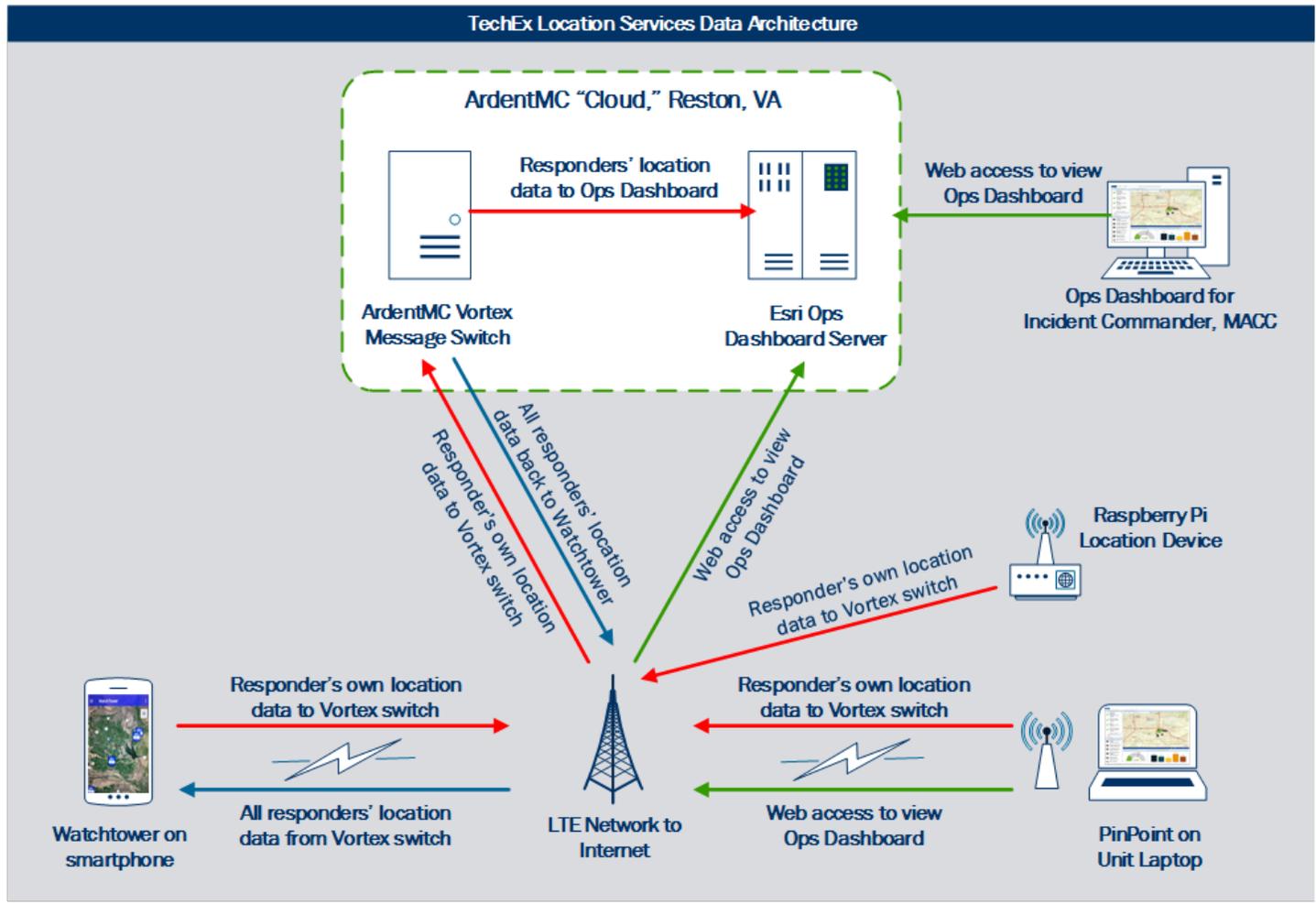
For tracking responder vehicles, NGFR worked with Grant County to implement three solutions during the TechEx:

- **Sheriff's deputy vehicles with CradlePoint LTE/Wi-Fi routers:** The CradlePoint routers already had GPS receivers built into the devices, so they required only the addition of a GPS antenna and a configuration change in the router to update the destination URL of the location data. The data was then transmitted to the Ops Dashboard via the Vortex switch. Deputies were then able to access the Ops Dashboard to view the location of the CradlePoint-equipped vehicles.
- **Sheriff's deputy vehicles with Verizon LTE/Wi-Fi routers:** Deputy vehicles with Verizon routers required the addition of GPS receivers/antennas connected to the vehicle laptops (via the USB port) and the addition of the ArdentMC "PinPoint" software to the laptop. PinPoint received the location of the unit from the GPS and transmitted it via the LTE router to the destination URL. Deputies then viewed unit and first responder locations via the Ops Dashboard.
- **Fire vehicles:** A limited number of fire vehicles – those participating in the TechEx – were equipped with GPS receivers connected to Raspberry Pi computers, which then connected via Wi-Fi to smartphones or Wi-Fi/LTE modems to transmit the location data. Fire vehicles were not able to view unit or first responder locations using vehicle equipment, but could view the information by using Watchtower on their smartphones.

Implementation Limitations to Consider

Variable Location Reporting Rate

Transmitting a first responder or vehicle location requires a specific amount of bandwidth. If the public safety agency would like to conserve bandwidth for any reason, a location tracking system should have the capability to vary the transmission rate of location data based on first responder or unit activities. For example, a law enforcement vehicle in pursuit of a stolen vehicle would need to transmit its location more frequently (e.g., every 2 seconds) in order to provide real-time situational awareness of a developing incident. However, a firetruck parked at the scene of an incident would need to transmit less frequently (e.g., every two minutes) and would still provide adequate situational awareness to dispatchers and decision-makers. In this example, varying the reporting rate based upon the detected speed of the vehicle or first responder would help optimize bandwidth use to save the agency money. For the TechEx, the location transmission applications that NGFR tested in Grant County did not have the capability to vary the reporting rate.

Responder and Unit Identification

Transmitting the location of a first responder or unit location is of limited value unless the identity of the first responder or unit is provided along with the location data. Any first responder or unit location solution must allow a unit ID to be programmed and transmitted along with the location data. Additional features, such as identifying the unit type (e.g., law enforcement, fire, emergency medical, aviation) and the agency (for a system serving miltiple agencies or jurisdictions) are also valuable. The solutions that NGFR tested in Grant County allowed first responders to indicate their unit, type of unit and agency as part of the location message. This information was then displayed on the situational awareness system.

System Survivability and Portability

Any electronic device first responders use must be compact and lightweight enough so as to not impede normal movement, but have enough battery power to remain operational through an entire shift or a prolonged event. It must also be ruggedized to continue to function in harsh environments and survive exposure to water or heat, especially those conditions experienced by firefighters in their operations. For more information on requirements for equipment used by fire services, please reference the National Fire Protection Association's codes and standards.

Centralized Location Data Message Server

For all of the solutions outlined above, the location data message must be forwarded to a centralized location data server for distribution to various situational awareness applications for display. Many public safety agencies use situational awareness systems provided by their CAD system vendor, in which case the CAD server may provide this "message switch" capability.

Providing standard LTE bandwidth capability to a first responder or unit location tracking device is expensive. In the event the first responder or unit only requires the data link to transmit location messages from the device, it may be possible to arrange for a lower-cost service that provides a low-data rate at a less expensive price by negotiating with the LTE provider. This lower rate plan would reduce the operational cost for implementing location tracking devices and would allow agencies to have automatic location tracking and the accompanying situational awareness at a minimal cost.

Location Tracking Policy Issues

Prior to implementing first responder or unit location tracking, an agency will need to develop policies for handling the tracking data. These policies will need to include the requirements for when first responders activate location tracking, how long the agency retains location data and who has access to the location data. The agency may need to negotiate these policies with public safety unions to ensure they are acceptable to all parties.

RESULTS

The TechEx proved to be successful in demonstrating both the advantages of the systems and their shortfalls as currently implemented. All of the requirements were fulfilled with the delivered capabilities, but with varying degrees of success. The input from Grant County first responders was overwhelmingly favorable. The first responders were very pleased to be able to view the location of other first responders and vehicles on their smartphones. In addition, the deputy who provided dispatcher duties for the event was able to see the location of all the first responders across the event response area, and direct their movements in searching for/rescuing the downed hiker and fighting the brush fire. A complete TechEx After Action Report is available upon request from NGFR at NGFR@hq.dhs.gov.

Additional sources are found in the References and Recommended Reading section.

Case Study Scenario

This scenario is provided as an example of how an agency can implement and use vehicle and first responder location services. The setting is a smaller agency in a rural area, currently lacking any capability to track agency units or first responders. The area has experienced several major events where tracking units and first responders would have been valuable, and anticipates that this trend will continue.

Determine Location Requirements

The first step for the agency is to assess their location service requirements. These would include:

1. **Who:** Does the agency need to track just units and, if so, which units (e.g., fire, law enforcement or both)? Does the agency need to track individual first responders and, if so, which ones (e.g., firefighters, law enforcement or both)?
2. **What:** What units does the agency want to track, just public safety units or does the agency or the local government have the need to track other vehicles besides public safety units (e.g., snowplows, buses, trash trucks, maintenance vehicles, etc.)?
3. **Where:** Does the agency need location tracking throughout their entire jurisdiction, or only in certain high-risk or high-activity locations?
4. **When:** Does the agency need to track units and / or first responders at all times, or just when on duty?

Identify Current Location Capabilities

The second step is for the agency is to determine their current location service capabilities. These would include:

1. **Telecommunications Infrastructure:** Does the agency have reliable broadband (LTE) coverage of the desired location tracking area, or will they have to depend upon their LMR system for the transmission of location data?
2. **LMR Capabilities:** Can the agency's LMR system provide location services – do the radios have GPS receivers, can the location data be transported by the LMR data network, or can the LMR system interface with the agency's CAD or GIS to display the location data?
3. **Vehicle Equipment:** Are the agency vehicles (and the non-public safety vehicles, if desired) equipped with laptop computers, GPS receivers and LTE modems/routers that could host and transport location tracking applications and data?
4. **First Responder Equipment:** Does the agency issue smartphones to first responders, or would they have to use their personal smartphones for hosting location tracking services?
5. **Agency CAD:** Does the agency's current CAD system have the capability to provide location tracking from CAD-equipped vehicles and display those locations on the CAD map system? Does the agency's current CAD system provide for the receipt of location data from non-CAD equipped vehicles using other solutions?
6. **Agency GIS:** Does the agency have a GIS capability that could be used for receiving and displaying location data? Does the GIS capability do this natively, or will an external message "switch" be required to route location data to/from vehicles, smartphones and the GIS?

Identify Solutions

Once the agency has determined their location requirements and current capabilities, they need to identify the solutions to fulfill those requirements. The agency would have to evaluate the costs of and functionality provided by each solution to dermine which one(s) to select. Alternatives could include one or a combination of the following:

1. Upgrade the current LMR system, including radios, to provide location data to CAD or GIS for display on a map.
2. Upgrade the current CAD system to incorporate location tracking services in the vehicles and display it on the CAD map. This may, however, not provide a method of tracking non-CAD equipped vehicles, unless the CAD had the capability to receive location data from sources other than CAD clients. This would involve:
   a. Installing GPS receivers in vehicles.
   b. Installing CAD software in vehicles that provides location tracking data to CAD.
   c. Upgrading CAD (as necessary) to receive that location data and display it on the CAD map.
3. Upgrade the current GIS system to receive location data and display it on the map. This would involve:
   a. Upgrading GIS to receive and display location data, including a "message switch" if necessary.
   b. Installing GPS receivers in vehicles.
   c. Installing location tracking software on vehicle laptops (where equipped) to provide location data to the GIS.
   d. Installing location tracking devices (e.g., Raspberry Pi "controllers" with location tracking software) on vehicles without laptops to provide location tracking services.

Implement Solutions

Once the agency has selected the solution(s), they develop an implementation plan for the system(s). The plan would include processes for:

1. Procurement of the software and hardware;
2. Installation of the components;
3. Configuration of the devices and associated applications;
4. Training support personnel on the maintenance of the devices and applications; and
5. Training the first responders in the use of the systems.

Summary

After implementation and testing of the location capabilities, the agency will then be able to track the vehicles and first responders as desired. Dispatchers, incident commanders and first responders would be able to view locations of vehicles and first responders across the agency's jurisdiction and maintain a higher level of situational awareness for events.

IMPLEMENTATION FOR YOUR AGENCY

The NGFR TechEx deployed responder and vehicle tracking devices and situational awareness platforms to provide augmented capabilities at the incident site. How can your agency apply this case study and best practices to improve your capabilities? The NGFR Apex program has developed the following checklists to assist your agency with planning how to implement location tracking for vehicles and first responders.

Location Services Implementation Checklist

- ☐ Identify Agency Location Tracking Needs
    - ☐ Who to track:
        - ☐ All first responders?
        - ☐ Selected first responders?
            - ☐ Only firefighters?
            - ☐ Only law enforcement personnel?
            - ☐ Only EMTs?
    - ☐ What to track:
        - ☐ All public safety vehicles?
        - ☐ Selected public safety vehicles?
            - ☐ Fire vehicles?
            - ☐ Law enforcement vehicles?
            - ☐ EMT vehicles?
        - ☐ Other local government vehicles?
    - ☐ Where to provide tracking coverage:
        - ☐ Track vehicles throughout entire jurisdication?
        - ☐ Track vehicles in only certain locations?
    - ☐ When to track vehicles and first responders:
        - ☐ All times?
        - ☐ Only when on duty / dispatched?
        - ☐ Only when activated by first responders?
- ☐ Identify Current Agency Location Capabilities
    - ☐ Telecommunications infrastructure:
        - ☐ Adequate LTE coverage?
        - ☐ Adequate LMR coverage?
    - ☐ Vehicle equipment:
        - ☐ Vehicles have laptops?
        - ☐ Vehicles have LTE routers?
        - ☐ Vehicles have GPS receivers?
        - ☐ Vehicles have LMR radios?
    - ☐ First responder equipment:
        - ☐ First responders issued smartphones?
        - ☐ First responders use personal smartphones?
        - ☐ First responders have no access to smartphones?
        - ☐ First responders have LMRs?

- □ Agency CAD:
  - □ Current CAD can receive/process/display location data from CAD clients?
  - □ Current CAD can receive/process/display location data from external sources?
  - □ Current CAD requires upgrade to receive/process/display location data?
  - □ Current CAD clients (on vehicles) require upgrade to provide location data?
- □ Agency GIS:
  - □ Agency GIS capable of receiving/process/displaying location data?
  - □ Agency GIS requires upgrade to receive/process/display location data?
- □ Identify Solutions
  - □ Location tracking display:
    - □ Use agency CAD for location tracking?
    - □ Use agency GIS for location tracking?
  - □ Location tracking data transport:
    - □ Use LMR
    - □ Use LTE
  - □ First responder location tracking:
    - □ Use LMR?
    - □ Use smartphones?
  - □ Vehicle location tracking:
    - □ Use LMR?
    - □ Upgrade existing modems?
    - □ Use application on laptop?
    - □ Use Raspberry Pi location device?
- □ Determine Necessary Changes
  - □ Upgrade first responder equipment:
    - □ Upgrade first responder LMR to transmit GPS data?
    - □ Issue smartphones to first responders?
    - □ Implement location tracking service on smartphones?
  - □ Upgrade equipment on vehicles:
    - □ Install GPS antennas / receivers?
    - □ Upgrade LMR to transmit GPS data?
    - □ Install Wi-Fi/LTE modems?
    - □ Install Raspberry Pi location devices?
    - □ Implement location tracking service on vehicle laptops?
  - □ Upgrade CAD:
    - □ Upgrade CAD software on CAD server?
    - □ Upgrade CAD software on vehicles?
  - □ Upgrade GIS:
    - □ Upgrade GIS?
  - □ Message switch :
    - □ Implement message switch to provide location data interface?

SUMMARY

This NGFR case study provided an overview of the NGFR TechEx in Grant County, with a focus on the implementation of location tracking capabilities to improve situational awareness and officer safety. In addition, this case study reviewed best practices for planning and implementing location services for public safety agencies.

If your agency finds this NGFR case study useful for improving your responder and vehicle location tracking, the NGFR Apex program would greatly appreciate your feedback. Please contact the NGFR team with stories from the field, questions or comments by emailing NGFR@hq.dhs.gov.

Figure 7: Grant County Emergency Medical Services during the TechEx

REFERENCES & RECOMMENDED READING

DHS Science & Technology Directorate

Next Generation First Responder Apex Program (https://dhs.gov/ngfr)
This website provides NGFR Apex program descriptions, updates and knowledge products.

NGFR TechEx After Action Report, November 2017 (available upon request from NGFR@hq.dhs.gov)
This document thoroughly describes the planning, execution and results of the NGFR TechEx.

NGFR TechEx Playbook, June 2017 (available upon request from NGFR@hq.dhs.gov)
This document was used to conduct the NGFR TechEx in Grant County.

GPS Blue Force Tracking Systems Application Note, April 2014
(https://www.dhs.gov/sites/default/files/publications/GPS-Blue-Force-AppN_0414-508_0.pdf)

Blue Force Tracking in GPS-Denied Environments TechNote, April 2014
(https://www.dhs.gov/sites/default/files/publications/GPS-Blue-Force-TN_0414-508.pdf)

Firefighter Accountability and Proximity (FFAP) System Fact Sheet, September 2016
(https://www.dhs.gov/sites/default/files/publications/Firefighter-Accountability-Proximity-System-Fact-Sheet_v2-508.pdf)

Firefighter Accountability and Proximity (FFAP) System Operational Field Assessment Report, February 2017
(https://www.dhs.gov/sites/default/files/publications/FFAP-OFA-Report-Feb2017-508C.pdf)

Precision Outdoor and Indoor Navigation and Tracking for Emergency Responders (POINTER), July 2017,
(https://www.dhs.gov/sites/default/files/publications/R-Tech_POINTER-FactSheet_170720-508.pdf)

NIST PSCR References

2015 Location-Based Services R&D Summit Report, April 2016
(http://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.1914.pdf)

Location-Based Services R&D Roadmap, May 2015
(http://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.1883.pdf)