

Broadband Connectivity Among Rural First Responders in Pennsylvania

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Abstract: This report details the experiences of rural first responders in Pennsylvania working with information communication technologies (ICTs) and digital networks. Through a series of focus groups and interviews with law enforcement officers, firefighters, emergency medical service providers, and 911 center representatives, along with county officials and other local stakeholders, we explore the challenges and opportunities brought by digital communication technologies for the work of rural first responders. In rural Pennsylvania, mobile communication and high-speed data networks (“broadband”) are not universal, leading to dropped calls and dead zones for first responders and the public alike. Even when they are available, networks have performed sub-optimally. This report demonstrates how current communication networks fail rural Pennsylvania first responders in three ways: (1) technology, including access to communication networks and infrastructure; (2) labor, such as the extent to which first responders have to work harder to ensure connectivity or in moments without connectivity; and (3) resources, such as the necessary funding to access standard technologies. To unpack these dynamics, we explain four themes that arose from our interviews and focus groups: (1) technology availability and use; (2) interoperability and interconnection; (3) ingenuity; and (4) funding. Gaps in communication networks, affordability, and devices mean delays in service, delays in response, and ultimately, the compromise of the safety of the public and our first responders. To improve this situation, this report concludes with key recommendations for policymakers and stakeholders in the Commonwealth of Pennsylvania to improve communication access for rural first responders.

Keywords: First Responders, Police, Fire, EMS, 911, Radio, Broadband, Mobile Phones FirstNet, NextGen 911

This project was sponsored by a grant from the Center for Rural Pennsylvania, a legislative agency of the Pennsylvania General Assembly. The Center for Rural Pennsylvania is a bipartisan, bicameral legislative agency that serves as a resource for rural policy within the Pennsylvania General Assembly. It was created in 1987 under Act 16, the Rural Revitalization Act, to promote and sustain the vitality of Pennsylvania’s rural and small communities. Information contained in this report does not necessarily reflect the views of individual board members or the Center for Rural Pennsylvania. For more information, contact the Center for Rural Pennsylvania, 625 Forster St., Room 902, Harrisburg, PA 17120, (717) 787-9555, www.rural.pa.gov.

Executive Summary

Introduction

First responders, including law enforcement, firefighters, and emergency medical services providers (EMS), along with 911 operators and dispatchers, rely on a host of digital communication technologies to do their jobs, and keep the public and themselves safe. Rural first responders, however, face unique challenges in both accessing and using devices such as radios, smartphones, tablets, computers, and applications. The reasons for these struggles are threefold: (1) the lack of ubiquitous broadband and mobile network signals, leading to dead zones and dropped calls; (2) the astronomical cost of contemporary devices; and (3) the overall lack of funding for rural first responder departments.

As a large, rural state, Pennsylvania struggles with universal digital connectivity. This struggle has immediate and impactful consequences for the work of first responders living and working in rural areas of the Commonwealth. Despite these circumstances, there has been little research—either in Pennsylvania or throughout the United States—on the experiences of rural first responders with digital communication technologies and how the lack of access impacts their work and public safety.

Given this dearth of knowledge, coupled with the crucial role played by rural first responders in assuring public safety, this report details the experiences of first responders working in rural areas of Pennsylvania with information communication technologies (ICTs) and the digital networks that support them. Through a series of focus groups and interviews with law enforcement officers, firefighters, emergency medical service providers, 911 center representatives, and county officials from eight rural counties in Pennsylvania, we learned about the challenges and opportunities brought about by digital communication technologies for the work of rural first responders. In so doing, we sought to address four key research questions:

- (1) What are the current policy discussions regarding rural first responders, connectivity and digital equity (access, affordability, training, hardware, support) in Pennsylvania?
- (2) For what purposes are ICTs needed by each set of rural first responders?
 - a. How are these purposes tied to the outcomes of their jobs?
- (3) What are the experiences of first responders in rural Pennsylvania regarding ICTs and connectivity?
 - a. What challenges do they encounter?
- (4) What can be done to improve connectivity, ICT usage, and availability for rural first responders in the Commonwealth of Pennsylvania?

Methods

We employed three qualitative methods of data collection to address the above research questions: (1) document analysis, (2) focus groups, and (3) interviews. First, we conducted document analyses of relevant laws, policies, and regulations from local,

state, and federal entities. Specifically, we examined the laws and policies governing emergency communication platforms like FirstNet and NextGen 911, using documents from the Federal Communications Commission, Congressional legislation, the Congressional Research Service, the National Telecommunications and Information Administration (NTIA), and the FirstNet Authority. From the federal level, we also examined the laws and regulations governing broadband funding programs, notably the ongoing Broadband Equity Access and Deployment (BEAD) program of the NTIA as a potential source of funding for Pennsylvania. At the state level, we examined the Pennsylvania-specific laws, policies, and regulations regarding telecommunications infrastructure, first responder operations, organization, and funding.

Next, we engaged in focus groups and interviews with rural first responders in eight counties. Focus groups consisted of a mix of law enforcement, firefighters, EMS, 911 center representatives, and county officials (such as supervisors, coroners, and directors). While interviews were originally planned to be with just 911 personnel, we experienced difficulty in recruiting for focus groups. This difficulty mandated a shift in strategy for certain counties, and interviews with law enforcement and EMS officials took place instead. Through 10 focus groups and eight interviews, we ultimately heard from 59 individuals representing eight counties.

Results

Over 700 pages of transcripts were generated from the interviews and focus groups. The qualitative data from both the documents and the focus groups were analyzed using thematic coding analysis. Our analysis revealed four key themes:

- 1) Technology, including both use and lack of access to technology
- 2) Interoperability/Interconnection, meaning the interconnection of communication networks, including inter-county communication and intra-county communication
- 3) Ingenuity, meaning the ways in which first responders coped with a lack of connectivity or technology, including increasing connectivity with the tools available, knowing your area and people, and using analog technologies
- 4) Funding, including affordable equipment, trade-offs, and feelings of de-prioritization

Conclusions

From these themes, we conclude that digital technologies and communication networks fail Pennsylvania's rural first responders in three distinct ways:

- 1) Technology, including access to communication networks and infrastructure
- 2) Labor, notably the extent to which first responders must work to ensure connectivity or improvise in moments without connectivity
- 3) Resources, in the inability to access necessary funds

Despite the dedication of these public servants, without the necessary corrections, their safety, and the public's safety, may be threatened. The crisis of connectivity in Pennsylvania, therefore, is a direct threat to the health and well-being of Pennsylvanians across the Commonwealth. Crucially, there is the will and the desire to do great things among our rural first responders even with these challenges.

Policy Considerations

Unused Federal Broadband Non-Deployment Funds

To rectify the failings of connectivity we outline in this report, we offer a series of policy recommendations for state-level elected officials and stakeholders. Funding is a major challenge with rural first responder departments, and much of what we suggest requires additional funds. As a potential source, we note that Pennsylvania's portion of the federal government's Broadband Equity Access and Deployment (BEAD) program has a surplus of over \$400 million. The federal government is in the process of deciding how these non-deployment funds can be used by states. Should the funds be released to Pennsylvania, we recommend that the Pennsylvania Broadband Development Authority (PBDA) allocate a portion to be used for first responder and public safety purposes.

Connectivity Assessment and Tower Construction

First responders experience a lack of ubiquitous mobile phone coverage leading to numerous dead zones, regardless of provider; this is clear in both theme 1 (technology) and theme 2 (inter-connectivity). This creates a safety hazard for both first responders and for the public. In theme 3 (ingenuity), we note how this has forced additional labor on first responders, such as going door-to-door to use a landline phone. On the public side, as noted in the background section, a lack of ubiquitous mobile connectivity across the Commonwealth means that some in rural areas cannot call for help through the NextGen 911 system. Based on what we have learned about towers, the PBDA could conduct a Commonwealth-wide assessment of mobile connectivity, including the FirstNet network. As part of this assessment, we recommend that the PBDA assess vertical assets (towers and other tall structures) in Pennsylvania to plan for greater mobile coverage in rural areas. Based on that assessment, any improvements suggested by the PBDA could be funded with the BEAD non-deployment funds to create an incentive program for mobile network deployment and tower construction.

Addressing the Multiplicity of Radio Frequencies in Use

Departments and counties use multiple radio frequencies which our focus group participants told us lead to interconnection and interoperability challenges. First responders noted that because different counties use different radio frequencies, and sometimes single counties make use of different frequencies, they often cannot connect with their counterparts. We note that the Commonwealth has adopted the P25 radio standard to ensure interoperability, but that this has been adopted sporadically across

counties, exacerbating interconnection issues [see the background section and discussion of theme 2 (inter-connectivity)]. We also found that while the Pennsylvania State Police (PSP) make use of the P25 network, they do so using encrypted channels, complicating how local first responders connect with the PSP. The need for inter-and intra-county interoperability and interconnection is essential, especially for neighboring counties and with the PSP. We recommend that the Pennsylvania Emergency Management Agency (PEMA) consider mandating the Commonwealth-wide adoption of P25 and ensure that the cost of the transition is not placed on local departments or counties. PEMA could also work with the PSP to ensure that its frequencies are accessible to rural first responder agencies.

Replacing Outdated Radio Technology

In themes 1 (technology), 2 (inter-connectivity), and 3 (ingenuity), we note the reliance of rural first responders on their portable and mobile radios. We also note the expense of those devices and how this expense falls to local departments (who cannot afford it) when counties undergo frequency changes or when equipment becomes outdated. In theme 4 (funding), moreover, we note that at least one county department is using radios almost two decades old. With this in mind, we recommend that PEMA, which oversees 911 infrastructure and the Commonwealth's transition to NextGen 911, and PSP, which oversees the P25 project, work together to negotiate jointly with radio manufacturers to secure a preferential rate for first responder organizations to make the purchase of equipment more affordable.

Funding Shortages

A key takeaway from this research is that rural first responder departments face extreme funding shortages that make digital improvements and other equipment purchases almost impossible. In themes 3 (ingenuity) and 4 (funding), we found that many departments lack adequate funds to ensure their digital equipment is up to date and up to the standards adopted by their counties and by the Commonwealth. The cost of digital devices, which can be upwards of \$10,000 for a radio, exacerbates the funding shortages. Departments are relying on fundraising efforts to fill the gaps in funding, but it is not enough. In the background section, we also found that local funding for first responders is capped for many municipalities through a set percentage of property taxes; this has prevented municipalities from funding first responder needs themselves. In 2024, PA Act 54 increased this limit for boroughs in three counties, while the proposed H.B. 393 (2025) promises to increase the limit for an additional 1,400 municipalities. We recommend that more funding be allocated to rural law enforcement, fire, EMS departments, and Public Safety Answering Points (PSAPs) from the General Government Operations (GGO) based on need and rurality. We also recommend that Governor Shapiro's \$30 million grant program for first responders be part of future Pennsylvania budgets and developed into an annual grant program. In terms of property assessments,

we recommend the General Assembly expand PA Act 54 to include all municipalities in the Commonwealth and that County Assessment Offices ensure that all property tax assessments are current.

Funding for the NextGen 911 System

Our background research taught us that while the NextGen 911 system is operational in all Pennsylvania PSAPs, it still requires monitoring and improvements. As noted in the background section, in summer 2025, the Commonwealth's 911 system, which had only just completed its transition to NextGen 911, experienced intermittent outages for several hours. In theme 2 (inter-connectivity), we also noted that while the NextGen 911 upgrades allow PSAPs to communicate with each other, first responders experience communication challenges when trying to reach PSAPs that use different frequencies. We recommend the General Assembly make the \$1.95 911 fee permanent rather than sunsetting it in 2029.

State Leadership Awareness

First responders in rural counties expressed the sense that leaders in Harrisburg do not understand the daily challenges of providing services. One possible solution is that the Center for Rural Pennsylvania should organize a rural first responder tour for elected leaders.

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Introduction

“If you lose signal, you can’t communicate, you better have God sitting on your shoulders because that’s the only person that’s gonna be able to help you.” - rural Pennsylvania first responder

Contemporary first responder work—police, fire, emergency medical services (EMS), along with 911 operations—is dependent on a host of information communication technologies (ICTs), from radio, to cellular, to data streams (Buchanan et al., 2023; Morrison et al., 2021).¹ Many of these technologies, like radios, mobile phones, laptop computers, and tablets are also used daily by the general public. In both cases, these devices require reliable and ubiquitous high-capacity connectivity, notably through wireless networks, but also wired networks or broadband. Ambulances, for instance, if properly equipped can communicate to hospitals to prepare for life saving procedures, while police officers and firefighters are able to review case files and report to dispatch via the internet, thus saving radio bandwidth. Crucially, they are also able to call for help in the cataclysmic moment of a first responder mayday.

Digital communication devices and networks are essential for first responder work, from extreme occurrences like natural disasters and mass casualty events, to large public gatherings like fairs and football games, to personal emergencies, like heart attacks, house fires, or break-ins. Communication networks keep our first responders and the public alike, safe. That is, if they work. Rural first responders face notable and unique challenges with accessing communication technologies and the digital networks necessary for their connectivity. As the epigraph that begins this introduction states, if signals fail, “you better have God sitting on your shoulders because that’s the only person that’s gonna be able to help you.” Rural areas are often less connected than their urban counterparts, both in terms of wired broadband infrastructure and in terms of mobile connectivity, leading to dead zones for mobile, radio, and data transmission (Ali, 2021; Klein, 2017).

In rural Pennsylvania, mobile communication and high-speed data networks (broadband) are not universal, leading to dropped calls and dead zones for first responders and the public alike. Even when they are available, networks have performed sub-optimally, such as in summer 2025, when Pennsylvania’s entire 911 system crashed only months after it had been upgraded to what is known as NextGen 911, an internet-based, rather than phone-based communication network (Chang, 2025). Radios and smartphones are also prohibitively expensive for rural first responders, who often rely on

¹ In Pennsylvania, 911 dispatchers are not considered emergency responders. However, a recently introduced bill (H.B. 453) passed the house on April 8, 2025, and now resides with the Senate. Should it pass, the bill would classify dispatchers as first responders (Defining Dispatchers as First Responders, 2025).

shoestring budgets and volunteers to make ends meet and perform their duties (notably the case for firefighters and EMS providers) (Michael, 2026).

Capturing these dynamics, this report assesses the state of digital communication networks and devices for rural first responders and 911 officials in the Commonwealth of Pennsylvania. In this report we address four research questions:

- 1) What are the current policy discussions regarding rural first responders, connectivity and digital equity (access, affordability, training, hardware, support) in Pennsylvania?
- 2) For what purposes are ICTs needed by each set of rural first responders?
 - a. How are these purposes tied to the outcomes of their jobs?
- 3) What are the experiences of first responders in rural Pennsylvania regarding ICTs and connectivity?
 - a. What challenges do they encounter?
- 4) What can be done to improve connectivity, ICT usage, and availability for rural first responders in the Commonwealth of Pennsylvania?

Following this introduction, this report offers a background on first responders in Pennsylvania, along with three crucial digital networks: FirstNet, NextGen 911, and P25. Following a brief review of the academic literature and an in-depth exploration of our methods of data collection and analysis, we turn to the four themes that comprise our findings. We conclude this report with a series of recommendations for county and state-level policymakers to ensure that our rural first responders and the public can access crucial, lifesaving, digital technologies.

Literature Review

Despite its importance to both first responder and public safety, the intersection between communication networks and rural first responders has not been well studied by academics and researchers (Buchanan et al., 2023).² Those studies that do exist focus more on technological design and user interface, than policy diagnosis and prescription.

While there is a paucity of studies regarding rural first responders and communication technologies, those that do exist are of the highest quality, most notably the *Voices of First Responders* project undertaken by the National Institute of Standards and Technology (NIST) in 2017-2018 (Choong et al., 2018). Through in-depth interviews and large scale surveys NIST documented “the experiences of first responders with communication technology, including their needs for, and problems with, communication technology” (Choong et al., 2018, title page). Like our present study, NIST reached out to the four segments of first response: 911, EMS, fire, and law enforcement, but with the goal of influencing design and developers (rather than policymakers). The NIST studies

² According to Buchanan et al. (2023, p. 181), “To date, little is known about what communication technology problems rural first responders most need addressed and what future technology they desire.”

remain the primary in-depth studies of first responders and communication technologies in the United States. In one of their reports (1.3), NIST specifically documented the experiences of rural first responders and communication technology (Greene et al., 2019). Within, they noted that rural and urban first responders often share many of the same technological needs and uses:

- **Interoperability** – The ability of a system or a product to exchange and make use of information with other systems or products without special effort on the part of the users—data integration and sharing from radios to radios, systems to systems, devices to devices, and departments to departments.
- **Reliability and connectivity** – 100-percent connectivity for radio, cellular, and wireless networks despite geography and topography—urban canyons, subways, basements, or other dead zones.
- **Accountability and location** – Development of technology that provides for accountability and location tracking of the crew, units, 911 callers, and building occupants.
- **Maintenance, technical support, and training** – Minimization of the burden and costs of the associated maintenance, technical support, and training of technology imposed on users and departments.
- **Organizational policies and administration** – Facilitation and promotion of technology adoption by first responders through policies, procedures, and administration to minimize barriers and hindrances to use while supporting first responders’ primary tasks. (Greene et al., 2019)

While hopeful, rural first responders face several unique challenges in their work. This includes the “lack of connectivity, interoperability, reliability, and the cost of communication technology” (Buchanan et al., 2023, p. 208). Notably,

Rural first responders often do not have department phones, emails, or websites – their communication infrastructure is often minimal...Rural first responder departments and agencies often have problems with communication and coverage, due to a lack of radio towers, and signal stations, and several spoke about how communication companies do not want to invest in rural areas leaving them without much needed coverage. (Greene et al., 2019, p. 25)

As a result of poor communication infrastructure (such as a lack of cell phone towers) rural first responders have a lack of coverage (i.e., “dead zones”) and subsequent “difficulties with communicating among disciplines across rural areas” (Buchanan et al., 2023, p. 193). From the wired side, “some updates require access to the latest technology or the use of broadband speeds to which many first responders do not yet have access” (Buchanan et al., 2023, p. 195). In addition to infrastructural issues, involving both access to technologies and a lack of connectivity, rural first responder organizations suffer from financial barriers:

many rural first responder departments and agencies do not have the financial resources to supply their staff with gear, tools, and/or education to meet state and federal requirements, potentially putting them in danger or disqualifying them from working. (Greene et al., 2019, p. 18)

Coupled with this, are personnel challenges, where recruitment and retention are major issues. “It is almost impossible,” NIST wrote, “to attract and keep personnel when the pay is low, and when the work is not what they expected, and departments often suffer from not having enough personnel to adequately staff their shifts” (Greene et al., 2019, p. 30). Of course, many rural fire departments rely on volunteers, which come with their own recruitment and retention challenges (Greene et al., 2019).

Related to all issues is the unique challenge of geography, whereby “rural first responder departments and agencies typically cover large distances, which often include remote areas” (p. 12). This impacts connectivity, because “in many cases, technology fails rural first responders, often as a result of the geographical characteristics that are part of their context of work. In addition to the physical size and space of rural areas, the topography is also different, which can also contribute to coverage and communication issues” (Greene et al., 2019, p. 13).

Ultimately, researchers at NIST concluded that what rural first responders want is not new technologies or gadgets, but rather technologies and networks that work consistently and reliably:

Overarchingly, rural first responders wanted greater reliability, functionality, and interoperability of their current devices. They emphasized that they need their current problems fixed and therefore wanted a strong focus on improving basic and current technology. Ultimately, rural first responders want to be able to trust the technology that they use, eliminating unnecessary burdens, disruptions, and stress they experience as a direct result of their current technology. (Buchanan et al. 2023; p. 204)

NIST provides a list of technology needs for rural first responders, which includes:

- Better coverage for radios, cell phones, computers, and other communication tools
- Better location capabilities to find people and “addresses”
- Tools for rural-based events to help with area-specific types of incidents (whether seasonal or topographic)
- Tools equipped for the rural expanse to help mitigate the size-distance issues
- Reasonably priced communication tools
- Access to basic equipment and gear before they can buy “newfangled” technology”
- IT support and help (Greene et al., 2019, p. 28)

To the issue of communication infrastructure in rural areas, Klein (2017) echoes many of the issues brought up by NIST, this time from a political economic critique of the lack of private investment in rural communication networks:

Because of sparse populations, rural safety workers are responsible for covering a larger area that has poorer infrastructure than urban centers, increasing the need for a reliable network to support them. A lack of resources combined with long transportation times to hospitals and long intervals between dispatch and arrival lead pose a greater challenge in rural areas...This more separated and sparser population has dissuaded many national broadband providers from being extensively involved in rural areas. The increased cost of entry and the lower return on investment has led to a broadband network that is unreliable for rural first responders. Additionally, the wide area of coverage and lack of interoperability between devices on different frequencies has increased the difficulty of responses to natural disasters, environmental risks and potential rescue situations. (Klein, 2017, p. 69)

Further afield from the particularities of rural first responders and communication technologies, critical scholars remind us that technology may not reduce existing inequalities and may reinforce them if deployed without deliberation and public input. Professor Elizabeth Ellcessor at the University of Virginia, for instance, notes that the media technologies used to address emergencies can “replicate... and entrench... differences of power and access, which nearly always disadvantage those already marginalized by race, disability, geography, poverty, gender or age” (Ellcessor, 2022, p. 3). Ellcessor is particularly concerned for how communication technologies mediate an already potentially fraught relationship between first responders and marginalized communities. What is more, she expresses strong concern over the adoption of proprietary technologies, notably by 911 centers and “often...with little public awareness as agencies contract with companies in closed-door negotiations that are covered through repurposed press releases” (p. 111).

This means that these companies now have a growing role in shaping how emergency reports are made and received; the close and procedural listening that has characterized the emergency media work of 911 professionals is being devalued and replaced by algorithmic representations of risk and reliability. (p. 111)

Ellcessor ultimately argues that we need to rethink or better put, re-imagine, our relationships with “emergency, mediation, responsibility, and aid,” something that can begin with greater public oversight (p. 147).

Law Professor Andrew Ferguson (2017) of George Washington University, writing specifically on the integration of big data into law enforcement practices, also worries about the uncritical adoption of technologies and algorithms by law enforcement, especially in terms of how it could impact marginalized communities. Ferguson worries that predictive policing—the use of big data to predict criminal activity—can replicate existing biases within law enforcement work, especially when “linked to commercially available big data systems ... [wherein] ... citizens might be inappropriately stereotyped

based on overbroad generalizations” (p. 93). In addition, there is the concern over surveillance and privacy violations that can accompany increased technological adoption. But, Ferguson, like Ellcessor, holds out hope for a better tomorrow, noting that “big data is not all dystopian” (p. 5). Instead, it can also help improve policy accountability, and “can be redirected to identify and target social, economic or environmental risk factors” something he calls “bright data” (p. 6). Ultimately, like Ellcessor, Ferguson recommends increased public oversight of the adoption of digital technologies by law enforcement.

From this brief literature review we see both the need for improved communication networks and access to digital technologies among first responders, along with the concern for the uncritical adoption of such technologies especially in the absence of public scrutiny and awareness. What is also clear is the need for further studies at the intersection of first responders and communication technologies, and the need to link these studies to extant policy issues and recommendations. The literature assisted us in formulating our research questions by offering both an empirical and methodological guide underscoring the importance of understanding experiences through ethnographic-based methodologies like interviews and focus groups. The NIST studies also gave us a point of comparison for our own research design and analysis in that we could go back and look for moments of agreement and disagreement (*i.e.* how much have things changed between then and now? How much is different when focusing specifically on Pennsylvania?). Having also used ethnographic-based methods, the NIST study validates our methodological decisions. The lack of both policy and Pennsylvania-specific studies in the literature further underscores the need and importance of this research.

Background

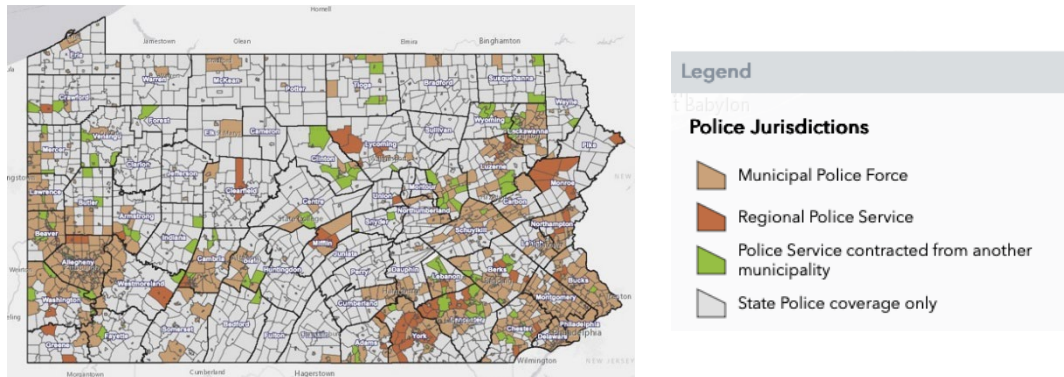
There are presently over 1,200 law enforcement agencies in Pennsylvania (municipal, regional, county detective, sheriff, and the Pennsylvania State Police), 1,205 EMS agencies, 2,400 fire departments, and 61 Public Safety Answering Points (PSAPs, more commonly known as 911 Centers). Many of these organizations and departments are located in rural counties (Center for Rural Pennsylvania, 2022).

Law Enforcement

Law enforcement in Pennsylvania is made up of municipal and regional police departments, sheriff departments (each county has its own sheriff’s office), and the Pennsylvania State Police (PSP), which is organized into 16 Troops across the Commonwealth (Commonwealth of Pennsylvania, 2026). The Commonwealth of Pennsylvania estimates that there are over 1,200 “municipal police departments, regional police departments and county detective agencies that service local communities by investigating crimes and filing criminal charges” (Commonwealth of Pennsylvania, 2026) (see Figure 1). If a municipality or region is unserved by a local department, it is served

by the PSP. In this regard, large swaths of rural and remote Pennsylvania are served exclusively by the State Police.

Figure 1: Police Departments in Pennsylvania



Source: Commonwealth of Pennsylvania (2026)

State police in Pennsylvania are funded mostly (80 percent) by contributions to the Motor License Fund and the General Fund (Keen, 2022). The Motor License Fund is controlled by the PA State Legislature and funded by transportation revenues like gas tax and vehicle registration fees (Motor License Fund, 1984). The General Fund is how the state finances most expenses, and is mostly collected via taxes (like Personal Income Tax and Corporate Net Income Tax) and through federal funds (PennWatch, 2025). The remainder of the budget typically comes from other state funds and federal funds. According to the Pennsylvania House Appropriations Committee, most federal funding for state police supports “homeland security, drug enforcement, and investigation of computer crimes” (Keen, 2022).

Regional and local police have more similar funding structures to each other than to state police. These regional and local departments do not exist in every locality and are often started using federal grant money. Their funding amount varies by department, especially due to the growing conglomeration of local departments into regional departments. Their funding comes mostly from vehicle offense fines, like speeding tickets. Precincts retain half of these funds and the other half are paid into the Motor License Fund (Legislative Budget and Finance Committee, 2014). In 2012, the restrictions on this funding shifted. To be released, the precincts must meet the following criteria: “population of not more than 3,000 or that provide at least 40 hours per week of local police services through its own local police department, participation in a regional police department, or contract with other municipal or regional police for police services” (Legislative Budget and Finance Committee, 2014, p. 17). Should these requirements not be met, the funds are released to support the next class of trainees for the State Police, under the assumption that the State Police will be serving said area. In counties with casinos, there may be special taxes implemented on gambling activities to support law enforcement.

Law enforcement at the state level is generally well-funded across Pennsylvania. State Police in particular have high budgets, with Governor Shapiro's budget proposal in 2025 allocating \$1.5 billion (Thompson, 2025). It is more difficult to track funding at the regional and local level. Since this funding tends to be dependent on patrol activities rather than a general fund, there is potential for a lack of budget stability. This lack of general budget may make it difficult for departments to enact long-term plans.

Fire and EMS

There are presently 2,400 fire departments across the Commonwealth of Pennsylvania. More than 90 percent of the state's firefighters are volunteer and many of them are based in rural communities (Nauman, 2026; Northup, 2026). Many rural volunteer fire companies are in jeopardy, however, leading to mergers with other departments or worse. The cause is largely one of staffing—there are fewer volunteers available with enough time to provide the services needed (Nauman, 2026). One estimate suggests that the total number of volunteer firefighters in Pennsylvania has decreased by 90 percent since 1970, with a 2024 total of around 38,000 (Gibson, 2024).

From the EMS side, there are presently 1,205 EMS agencies throughout the Commonwealth, "comprising 46,057 EMS-certified professionals" (Department of Health, 2024). The organizational structure of EMS agencies varies. According to a 2022 report from the Center for Rural Pennsylvania, a survey of 389 agencies (of 744 contacted) found that "45 percent are nonprofit organizations," "44 percent are part of a fire company," and "the remaining 11 percent are a mix of hospital-based, municipal, and other agencies" (Center for Rural Pennsylvania, 2022). The Center also noted that among rural agencies, 73 percent held a Basic Life Support license, while 42 percent held a Quick Response Services License (with overlap). The report concluded "that the majority of rural and urban/mixed agencies are being squeezed financially and are having difficulty recruiting and retaining providers," suggesting a similar experience among rural fire and EMS agencies (Center for Rural Pennsylvania, 2022, p. 6)

While the majority of Pennsylvania's firefighters are volunteer, employment is mixed in emergency medical services, varying vastly between rural and urban areas. In rural areas, over 80 percent of EMS provider stations are either volunteer or a mix of paid and volunteer compared to under 70 percent in urban areas (Center for Rural Pennsylvania, 2022).

Volunteer fire department and volunteer EMS budgets are typically funded by the general fund of their county, or in some cases their municipality. These funds are derived primarily from property taxes and any interest gained on existing county assets. Historically, the Commonwealth has had property tax caps which restrict counties to collect no more than \$3 million for fire services and \$0.5 million for emergency medical services. This does not restrict total property tax to that amount, instead restricting the amount that can be specifically earmarked for fire and EMS. In 2024 through PA Act No. 54, the General Assembly increased those limits to \$10 million for fire and \$5 million for

EMS for boroughs in three counties (Act No. 54 of 2024: Fiscal Code, 2024; PA State Association of Boroughs, 2024). In 2025, House Bill 393 promises to increase those limits in 1,400 municipalities following the reported success of the increase in available funds for these services (An Act Amending the Act of May 1, 1933 (P.L.103, No.69), Known as The Second Class Township Code, in Taxation and Finance, Further Providing for Township and Special Tax Levies., 2025). Not only does this increase the availability of funds for fire and EMS, it also creates a “lockbox mechanism” which serves a dual purpose: (1) it keeps the funding protected specifically for fire and EMS and (2) it informs the public on the specific use of their property tax for public service (Xian, 2025). This move has been widely praised by first responder communities.

The Commonwealth has historically capped a municipality or county’s ability to increase taxes specifically for fire or EMS. Given that the majority of local funding comes from tax revenue, this is a difficult issue to overcome. The biggest barrier remains that despite potential budget increases (to be clear: H.B. 393 will not increase the state budget but does permit municipalities and counties to do so), the costs of providing fire service and EMS care are astronomical, and they are rising.

EMS organizations have a second stream of funding via direct cost recovery. When EMS provides emergency transit to hospitals, those costs are meant to be reimbursed to EMS through the patient or their health insurance (Brook, 2025). Should EMS respond to a call where emergency transit is not required or is refused by the patient, their costs are not reimbursed. For un- or underinsured patients, it may be difficult to claim costs. Many insurers (including government insurers) have a fixed reimbursement rate for emergency transit, further complicating the ability to recoup costs and increasing EMS support on property tax funding (Brook, 2025).

There are other government funding resources available to first responders. In the 2025-2026 budget, Governor Shapiro proposed \$30 million in competitive grants for equipment for first responders (Sorensen, 2025). The grant, however, did not make the final state budget. Governor Shapiro has proposed it once again for the 2026-2027 budget (Finnerty, 2026). There are also existing grant and loan opportunities for fire and EMS through the Commonwealth’s Fire Company and Emergency Medical Services Grant, with current opportunities capping grants at \$20,000 for fire and \$15,000 for EMS. Loans can range from \$30-\$600K (Office of the State Fire Commissioner, 2026). There are also larger grants available for starting a new fire or EMS department, and grants for individual volunteers and their families for job-related injury, illness, or death.

911 Centers

The official designation of 911 call centers in the United States is Public Safety Answering Points (PSAPs). There are presently 61 PSAPs serving the Commonwealth, and Pennsylvania is “one of only 13 states that operates fewer primary PSAPs than there are counties” (Pennsylvania Emergency Management Agency, 2025a, p. 6). Pennsylvania has a consolidated approach to PSAPs, allowing counties to contract 911 services to another

county (such as what Cameron County does through Elk County) or to regionalize (such as “Snyder and Union Counties forming the Central Susquehanna Regional 911 PSAP” (Pennsylvania Emergency Management Agency, 2025a, p. 2). The Pennsylvania Emergency Management Agency (PEMA) is directly integrated into Pennsylvania’s 911 structure, “support[ing] counties with activities related to funding, planning, coordination, and oversight.” It also “administers the statewide Next Generation 911 services contract” (Pennsylvania Emergency Management Agency, 2025a, p. 7) (see below for more on NextGen 911).

In Pennsylvania, 911 systems are funded through a \$1.95 fee on monthly telephone bills. Originally \$1.65, the fee was increased to \$1.95 by Act 23 in December 2023 in part to keep up with rising demand of infrastructure for 911 systems to operate successfully with advanced technology (Pennsylvania Emergency Management Agency, 2025a).³ Specifically, the increase was partially to account for the increased costs associated with NextGen911 (also known as NG911), new 911 technology which allows more enhanced location tracking, video-to-911, text-to-911, and other improvements. The 911 fee increase was scheduled to be effective only through until January 31, 2026. The Pennsylvania 2025 budget, passed in November 2025, included a provision to extend the new 911 fee until February 2029 (PEMA, 2025). Early in 2026, some county commissioners asked the Governor to propose raising the fee to \$2.20 per month because the present amount covers only 80 percent of 911 costs (White, 2026).

Fees are collected by the Pennsylvania Emergency Management Agency (PEMA). Eighty-three percent of the funds are used to support PSAPs, while 15 percent are “used for statewide interconnectivity of 911 systems, which include costs for NG911 and 911 system consolidation or regionalization” (Pennsylvania Emergency Management Agency, 2025a, p. 4). The remaining 2 percent goes to PEMA “for costs related to administering the provisions of the legislation.” Of the 83 percent allocated towards PSAPs, 3 percent is directed towards each county. The remainder is based on the following:

- 65 percent over average quarterly formula payments from 2021 and 2022
- 2.5 percent population density
- 2.5 percent square miles (Pennsylvania Emergency Management Agency, 2025b, p. 6)

Any budgetary items exceeding the 911 fee come directly from the county “or other local revenue sources” (Pennsylvania Emergency Management Agency, 2025b, p. 5)

PEMA

The Pennsylvania Emergency Management Agency (PEMA) is the Commonwealth’s emergency response agency and has frequent contact with local first responders and 911 centers. With respect to the latter, it is the support agency for 911 centers, governs the

³ For text of the Act see: (Act No. 34 of 2023 Fiscal Code - Omnibus Amendments, 2023)

911 fee structure and the Commonwealth's transition to Next Generation 911, and maintains a 911 Advisory Board. With regards to funding, PEMA "reviews all costs funded by 911 fees to verify compliance with eligibility rules" (Pennsylvania Emergency Management Agency, 2025a, p. 4) It also reviews and maintains training standards for 911 personnel. From a larger first responder perspective, PEMA also administers several grant programs for local and county first responder organizations.

PEMA is primarily funded through multiple programs or sources, including General Government Operations (GGO). Its 2025 fiscal year budget included almost \$1 billion in appropriations (\$987,512,000) with the two largest income streams being the 911 fee (\$393 million of which almost all is distributed) and Federal Disaster Funding (\$339 million). It received almost \$22 million from Pennsylvania's general government operations (Padfield, 2025).

Communication Networks

There are three telecommunication networks operating as the backbone of first responder communications in Pennsylvania: NextGen 911, FirstNet, and P25.

Next Generation 911

Numerous advancements in communication infrastructure and technologies, notably the ubiquity of mobile phones, required a complete overhaul of the country's outdated 911 system. According to the Congressional Research Service (CRS) Congress has been encouraging the adoption of IP-based 911 centers since 2008 (Gallagher, 2018a). No longer are people making 911 calls from their landline home or office phones, but instead they rely on their mobile devices, and modalities other than voice, such as text/SMS and video. Indeed, 80 percent of all 911 calls are made from mobile devices (Gallagher, 2018a). The country's original 911 system, in place since the late 1960s, cannot keep up.⁴

Over almost 20 years, there has been a national discussion on the need to transition 911 centers from legacy copper networks to Internet Protocol (IP)-based systems, notably through the buildout of fiber optic networks. IP networks can do what legacy networks cannot: they can precisely locate the caller, rather than depend on location via an address attached to a landline phone record or indirectly through the nearest cell phone tower. Moreover, IP networks can accept text and video calls and allow greater communication output between the 911 dispatcher and first responders. This evolution has been named Next Generation 911, NextGen 911, or NG911. According to the CRS:

IP-based systems can: accept data communications (e.g., text, photos, videos) to allow those in danger to text 911 when they cannot call; leverage computer-

⁴ The first 911 call was made in 1968; however, 911 only became the national number in 1999 through the Wireless Communications and Public Safety Act (Gallagher, 2018a).

based geolocation applications to accurately locate callers; enable interconnections between PSAPs, allowing PSAPs to re-route calls during emergencies, building redundancies into the nation's 911 system; and interconnect with other public safety systems to enable information-sharing during response. (Gallagher, 2018a, p. ii)

NG911 also allows for greater usability for people with disabilities (Pennsylvania Emergency Management Agency, 2021). States begin the transition to NextGen 911 by deploying fiber optic connectivity to PSAPs on the hardware side, and on the network side incorporating "Emergency Services Internet Protocol Networks" (ESInets). This transition also requires the assistance of telecommunications providers (cell phone companies) who need to ensure that data from a phone call (such as exact GPS location) is transmitted to the PSAP.

For municipalities and regions, challenges in transitioning to NextGen 911 include cost and the accompanying lack of funding programs (Gallagher, 2018a). As the CRS explained, it would take at least \$2.68 billion to transition the country's PSAPs to broadband networks. This "does not include estimates of the cost of new PSAP equipment, dispatch software, security software, personnel, training" (Gallagher, 2018a, p. 7); full estimates suggested anywhere from \$9.5 to \$16.9 billion (Gallagher, 2018a).

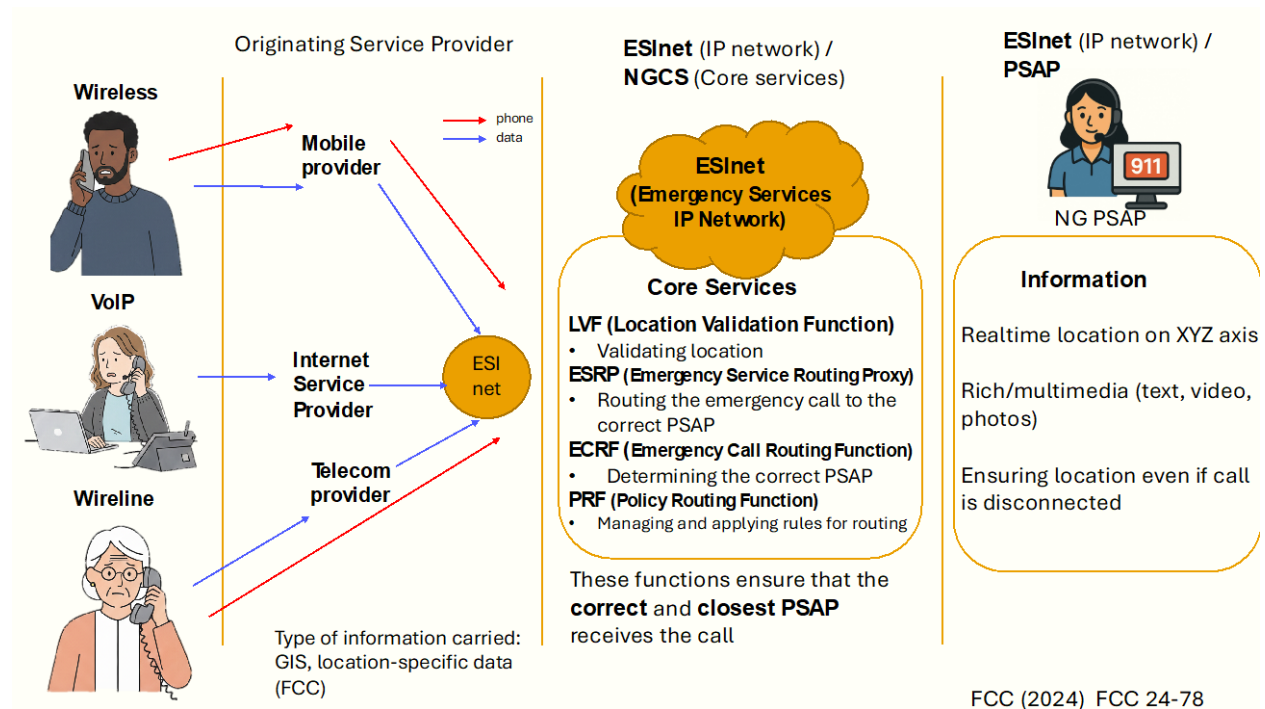
Pennsylvania began its transition to NextGen 911 in 2020 when the Commonwealth contracted ComTech Telecommunications Corp to build out the NG911 system (Pennsylvania Emergency Management Agency, 2023). This includes both the ESInets and the Next Generation Core Services (NGCS); NGCS is needed to process a 911 call on an ESInet. These includes functions such as routing calls to the correct PSAP, interfacing to PSAPs in different stages of transition, validating location, and allowing disaster recovery call routing according to PSAP specific backup plans" (Pennsylvania Emergency Management Agency, 2021, p. 4). In September 2022, Elk County became the first PSAP to migrate to NG911 and by year's end 2025, all 67 counties had upgraded their networks to NextGen 911. In the summer of 2025, Pennsylvania's 911 operating system experienced intermittent outages for several hours within the Next Gen 911 system (Fox-Sowell, 2025). A definitive report on the outage has yet to be released.

Making a 911 Call

From the user's side, calling 911 may feel no different on a legacy versus NextGen system (see Figure 2). All the changes happen internally. Let us say you are in a rural area of Pennsylvania and have been in a car accident. You call 911 for assistance. You are also able to video call or send texts or images. Your call is accompanied by data, including your precise location. Indeed, your location is delivered by your mobile phone provider first over their network, and then to the ESInet. The next thing that happens is that your call is directed to the nearest PSAP based on your exact location, rather than the closest cell phone tower as with the legacy network. This is crucial as previous networks would contact the closest PSAP to your nearest cell phone tower, which may

have led to talking to a PSAP in the wrong county, requiring the PSAP to reroute your phone call to the appropriate location.

Figure 2: How a NextGen911 Call Works



Source: Adapted from FCC 24-78 (FCC, 2024)

The dispatcher takes your information and sends it, along with other crucial data like any pictures you have shared – collectively known as “rich data” – to the appropriate first responder. On the PSAP end, NextGen 911 allows for stronger interoperability between PSAPs (such as during times of outage or emergency requiring multiple agencies) and between PSAPs and on the ground first responders (Pechtol, 2024). As PEMA explained, this interoperability between PSAPs is crucial as it,

provide[s] Pennsylvania’s PSAPs with the ability to have more flexible rerouting plans – for either times of heavy call volume, disaster recovery, or the need for balancing the load such as during pandemics or staffing shortages. While such decisions will remain a local responsibility, NG911 will give Pennsylvania’s PSAP directors additional options that do not exist today. For example, the legacy technology often limits PSAPs to automatically routing calls to an overflow or backup PSAP within their same 911 network during a disaster. These types of reroute arrangements require hard coding and, in some cases, costly dedicated circuits. With NG911, call re-routing can be controlled and managed by the PSAP and not by the carriers. (Pennsylvania Emergency Management Agency, 2021, p. 5)

There are some challenges remaining with NextGen 911 in Pennsylvania and most of these revolve around issues of network access. Cell phone coverage is not ubiquitous in the Commonwealth on any carrier. As a result, there are still “dead zones” by which neither a member of the public nor a first responder can get a cell phone signal. This is notably a challenge for rural and remote areas, which have poorer mobile connectivity than their urban counterparts. The Federal Communications Commission reports that while urban areas have almost ubiquitous access to 4G speeds, only 70 percent of rural areas have the same level of access (FCC, 2025). As a result, even though every county has upgraded to Next Gen 911, the public will not benefit without connectivity.

FirstNet

FirstNet is the country’s Nationwide Public Safety Broadband Network (NPSBN) operated by AT&T and overseen by the FirstNet Authority, a division of the National Telecommunications and Information Administration (NTIA). Like NextGen 911, FirstNet is an IP-enabled mobile network that is supposed to improve connectivity, interoperability, and interconnection for first responders and their departments across the country. Said differently FirstNet is:

“...a broadband network for public safety [that] provide[‘s] public safety users with high-speed access to data (e.g., video transfer, internet access) and specialized features and applications (e.g., prioritization of users, location-based services, device management) that are not available on current commercial networks or public safety radios.” (Gallagher, 2018b, p.3)

FirstNet was created as part of the 2012 Middle Class Tax Relief and Job Creation Act, but its origins come from the 9/11 Commission Report which documented a failure of interconnection between first responder agencies (National Commission of Terrorist Attacks upon the United States, 2004). Upon its creation, the FirstNet Authority was tasked to find a private industry partner willing to build and operate the network. In 2017, it was announced that AT&T would be that partner. It was given a large swath of spectrum (20 MHz in the 700 MHz range) and \$6.5 billion (Gallagher, 2018b). The next year (2018) all states and territories had agreed to participate in the FirstNet system (Gallagher, 2018b). FirstNet works by offering a dedicated mobile phone network to prioritize the phone calls and data requests made by first responders.

All wireless communication relies on information sent via radio waves, and all radio waves are part of the electromagnetic spectrum. The entire spectrum includes waves of varying energy and length and different frequency bands (for instance, radio waves for transmitting data vs. x-rays for medical procedures operate at different frequencies). Hertz is a measure of frequency and captures the number of waves per second; MHz is an abbreviation denoting one million per second (megahertz) (National Institute of Justice, 2005). Hertz can refer to specific frequencies (such as a local FM radio station at

101.9 FM – this means that the station broadcasts at 101.9 MHz). Hertz can also refer to bandwidth or capacity. For example, in May 2026 the FCC approved the sale of 30MHz of spectrum in the 3.45 GHz mid-band and approximately 20 MHz nationwide in the 600 MHz low-band for about \$23 billion from satellite company EchoStar (Weinschenk, 2026). Here 30MHz refers to the amount of spectrum, while 3.45 GHz refers to the location on the electromagnetic spectrum.

Different wavelengths and bands offer different wireless quality. Moreover, usable wireless spectrum is not unlimited, therefore chunks of spectrum (both location and bandwidth) are allocated to specific companies in the U.S. by the Federal Communications Commission (FCC) and the National Telecommunications and Information Administration (NTIA). This is one of the many reasons why telecommunications regulators play key roles in public safety.

For FirstNet to be successful, it requires individuals to subscribe to the service, much like a consumer would subscribe to a mobile service plan offered by AT&T, T-Mobile, or Verizon. Individual agencies are not required to use FirstNet by law, and therefore, there was early concern as to the take rate necessary for FirstNet to be self-sustaining. As of 2025, FirstNet had seven million customers out of a potential 14 million first responders in the country (AT&T, 2025). FirstNet has seen intense competition from both Verizon and T-Mobile, the former of which currently has 5.1 million subscribers on its first responder network (Hardesty, 2022).

AT&T is responsible for customer recruitment and retention, network operations, and, of course, network buildout. The network is based on 4G LTE technology, and FirstNet announced successful completion of its nationwide network in December 2023 (Wassel, 2023). This build-out, however, was not without critique, especially for the coverage of rural areas (Klein, 2017). In 2024, the Office of the Inspector General of the Department of Commerce criticized both the FirstNet Authority and AT&T for possibly exaggerating FirstNet’s footprint (OIG, 2024). Nevertheless, FirstNet promises “first responders with truly dedicated coverage and capacity when and where they need it” with Band 14 set aside for public safety and first responders alone, “enabling connectivity in challenging locations such as... rural areas” (FirstNet, *Frequently Asked Questions*).

P25

While mobile phones increasingly dominate the daily life of first responders, the land mobile radio (LMR) remains their primary mechanism of communication when on the job (Choong et al., 2018; Greene et al., 2019). Every first responder is issued a radio and each agency or department operates on a specific frequency or set of channels. Vehicle-based radios are known as “mobiles” while a radio on a person is a “portable.” The problem is that many times first responders from different agencies in the same county or from different counties are unable to use their radios to communicate with one another because they are incompatible. To mitigate these challenges, PA-STARNet, Pennsylvania’s Statewide Radio Network, adopted the P25 radio system in 2016. P25 is a

land mobile radio system that allows different radios programmed to different frequencies to speak with one another.

First responder radios work in three “bands:” VHF (100 MHz range), UHF (400 MHz range), and digital (800 MHz range). Basic radios, however, only operate on one band, meaning that different radios using different bands cannot communicate with one another. In an ideal world of first responders, all radios would be unified, with the ability for a firefighter to speak with a police officer in the same county, and for those two members of County A to speak to their counterparts in County B should the need arrive (such as a massive incident requiring mutual aid or everyday coordination between first responders in neighboring counties). The problem is that this is not the case for many rural Pennsylvania counties. For instance, if one county uses frequencies in the UHF range for fire and EMS (in the 400 MHz range) and a neighboring county uses digital frequencies in the 800 MHz range, then most radios would not be able to “talk” to their county counterparts as radios are only programmed for one set of frequencies. The Pennsylvania State Police (PSP) use the 800 MHz range; however, their radio frequencies are encrypted, prohibiting other local first responder agencies from access (see Table 1).

Some of the more expensive radios—upwards of \$10,000 each and known as tri band radios—allow the user to access different frequencies and different channels within those frequencies. The more basic radios, still in the thousands of dollars, however, only work within their designated frequencies. If different counties are on different frequencies, then only the most expensive radios will do. Or a first responder may have to carry multiple radios if they spend a lot of time crossing county lines.

In 2016, Pennsylvania adopted the P25 system through a contract with Motorola. This became known as the Pennsylvania Statewide Radio Network (PA-STARNet) and part of Pennsylvania’s Statewide Communication Interoperability Plan (Wrightstone, 2019). P25 is used by the Pennsylvania State Police, and many counties and 911 centers. The goal of the system is to unify all public safety and emergency response communications. The P25 system, through coordinated infrastructure, allows different radios and radio bands to speak with one another. As of 2024, 20 counties in Pennsylvania employ P25 as do eight Commonwealth agencies like PSP and PEMA, along with both houses of the General Assembly. While the Commonwealth rolled out the network for its agencies, local responsibility to adopt this system falls to counties, and its adoption is not mandatory (although many counties are in the process of adopting P25). As such, the Commonwealth is still left with multiple LMR systems. Moreover, the switch to P25 is tremendously expensive. In Cumberland County, for instance, P25 infrastructure is projected to cost \$34.8 million, while new radios (upwards of 3,000 mobile and portable radios) will cost approximately \$13.0 million, and the transition for computer-aided dispatch (CAD) system is estimated to cost \$3.7 million (Cress, 2024). A total of \$51.5 million for one county for complete P25 adoption.

Table 1: Counties in Our Study and Their Public Safety Frequencies

County	Frequencies	P25	Notes
Centre	UHF & 800	Yes	
McKean	VHF & UHF	Yes	
Greene	VHF	Yes	
Sullivan	VHF	Yes	
Monroe	UHF	No	
Mercer	UHF	Yes	ICORRS Member
Cambria	VHF & UHF & 800	Yes	ICORRS Member
Franklin	UHF	Yes	
Potter	VHF & UHF	Yes	
Huntingdon	VHF & UHF	Yes	
State Police	800	Yes	

Source: <https://www.radioreference.com/db/browse/ctid/2254>

Each of these communication networks – NextGen 911, FirstNet and P25 – require heavy coordination between states, counties, vendors, and providers. NextGen 911 and FirstNet also require federal leadership. This makes implementation difficult. NextGen 911 is meant to improve the responsiveness of 911 centers (PSAPs), FirstNet is to improve the data capacity and intercommunication of first responders nationwide through smartphones, while P25 is meant to improve inter-departmental communication through land mobile radios. The largest issue to adoption is that of funding (Gallagher, 2018b; Pechtol, 2024). With the exception of FirstNet, counties and departments are expected to pay for the upgrades to infrastructure (in the case of NextGen 911) and radios (in the case of P25). For FirstNet, it is still up to the county or the individual to pay the monthly subscription fees. Funding issues contribute to the piecemeal adoption of these networks.

Methods

To address the key research questions outlined above this research made use of several qualitative methodologies. Qualitative methods are best used when one wants to dive deeply into an issue and understand personal experiences and opinions. The goal is the thick description of a topic, event, or relationships based on individuals and their lived realities (Geertz, 1973). The primary mode of analysis in qualitative research is that of interpretation. Qualitative research is perfectly suited to this project which seeks to better understand how first responders use information and communication technologies because it seeks to understand experiences above all else.

There has been a recent push within public policy studies to amplify interpretative, qualitative methods and lived experiences (Dumas & Anderson, 2014; Fischer, 2000,

2009; McAleese & Kilty, 2019; Stone, 2012). Policy scholar Frank Fischer (2000) refers to this as “the argumentative turn” within a larger epistemological re-orientation in the field towards postpositivism (p. 69). The goal is to think about participants in qualitative research (such as interviewees and focus group participants) as local experts and to appreciate that people live policy decisions as part of their everyday lives (Ali, 2023; Dubois, 2015; Fischer, 2000; Kirkpatrick, 2013). As McAleese and Kilty (2019) argue, “qualitative methods allow us to draw out the complexities of social problems and the emphasis on storytelling in qualitative research is more conducive to findings that can be used to support transformative, political, and economic change” (McAleese and Kilty, 2019, p. 822). Rather than using the traditional quantitative evaluator of reliability, the goal of qualitative research is to develop trust through writing, transparency, logic, evidence, and argumentation (Corrigan, 2024; Kincheloe & McLaren, 1994).

Data Collection

We employed three qualitative methods of data collection to address our research questions: document analysis, focus groups, and interviews. First, we conducted document analyses of relevant laws, policies and regulations from the local, state and federal entities. Specifically, we examined the laws and policies governing emergency communication platforms like FirstNet and NextGen 911, using documents from the Federal Communications Commission, Congressional legislation, the Congressional Research Service, the National Telecommunications and Information Administration, and the FirstNet Authority. From the federal level, we also examined the laws and regulations governing broadband funding programs, notably the on-going Broadband Equity Access and Deployment (BEAD) program of the NTIA specifically as a potential source of funding for Pennsylvania. At the state level, we examined the Pennsylvania-specific laws, policies, and regulations regarding telecommunications infrastructure, first responder operation, organization, and funding.

Document analysis helped us address the first and fourth research questions by providing the necessary context and background of the current policy environment regarding first responders and telecommunications, and by assisting in the development of policy recommendations. Document analyses, as defined by Karppinen and Moe (2019) “help us gain an overview of policy issues and debates, the history and context of political and regulatory developments, the emergence of new concepts, policy-making options, as well as different stakeholders and their positions and views” (Karppinen & Moe, 2019, p. 250). It is the ideal jumping off point for a qualitative study of first responders, connectivity, ICTs, and public policy. A critical mindset in this analysis also reminds us that “all policy and industry documents – no matter how dry and neutral – frame issues in a certain light, and only present one possible construction of reality and one perspective into the issue and possible solutions” (Karppinen & Moe, 2019, p. 252). Within this research, it was crucial to focus not only on what is being said, but what is

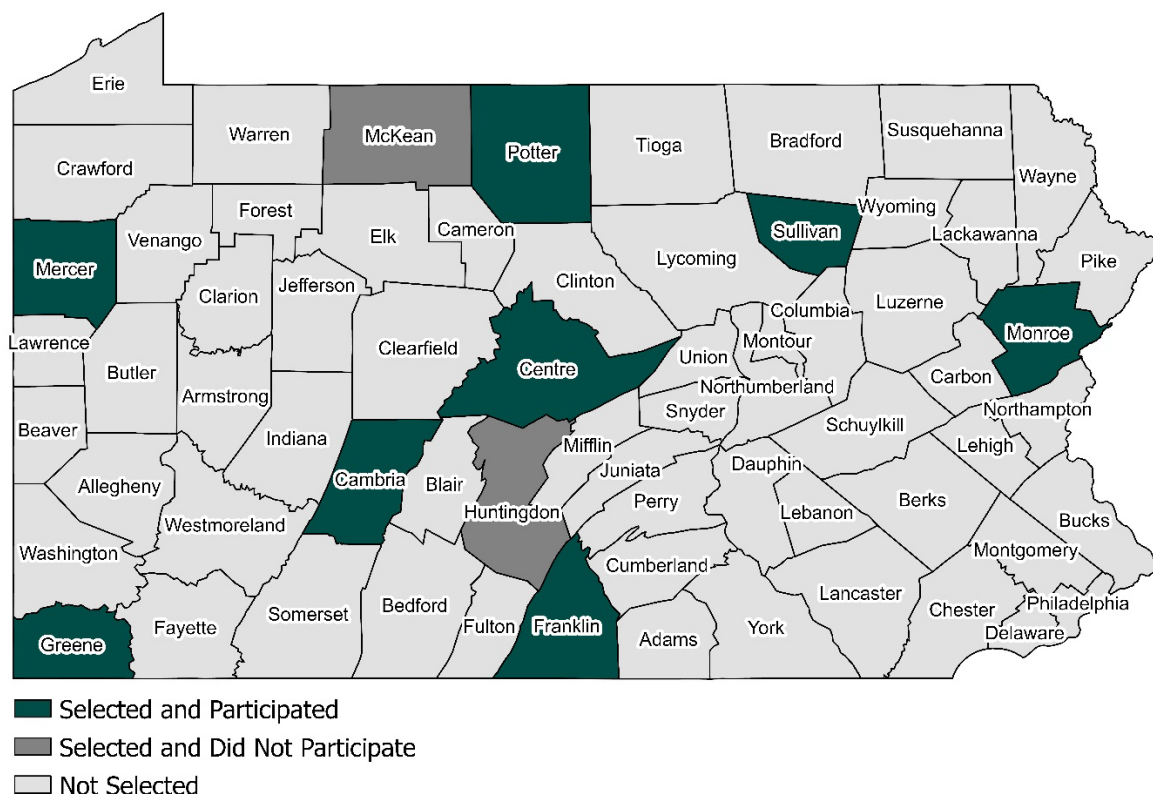
not being said. This helps us to locate gaps in policy and imagine alternatives that may not have been considered within policy documents or by policymakers.

As the document analysis proceeded, we engaged in our second and third methods of data collection: focus groups and interviews. These helped answer research questions two and three. Counties were considered the appropriate geographic unit of data gathering in this project for several reasons: 1) municipalities within counties host three divisions of first response: law enforcement, fire, and medical; 2) counties are responsible for 911 operations; 3) they were appropriately-sized geographic units to maximize Commonwealth coverage; 4) the research team was familiar with how to conduct county-level policy data collection and analysis when it comes to telecommunications (Ali et al., 2022).

We initially set out to conduct focus groups with active law enforcement, firefighters, and emergency medical services (EMS) providers in ten pre-selected counties (see Table 2 and Figure 3). According to the Center for Rural Pennsylvania, 48 counties are considered rural in the Commonwealth (Center for Rural Pennsylvania, n.d.). We selected our counties from these 48, with criteria being pre-existing relationships, levels of population density, and geographic distribution within the Commonwealth.

Table 2: County Selection

County	Pop. Density (square mile)	Location	Pre-existing Relationship?
Centre	139	Central	Yes
McKean	44	North Central	Yes
Greene	67	South West	Yes
Sullivan	14	Central East	Yes
Monroe	279	East	No
Mercer	173	West	No
Cambria	209	Central West	No
Franklin	194	South	No
Potter	16	North	No
Huntingdon	52	Central	No

Figure 3: Map of Selected Pennsylvania Counties

Map Data Source: PennDOT

To complement our focus groups, we also set out to interview 911 operators and managers to specifically understand how 911 factors into the first responder ecosystem of Pennsylvania and be able to fully explain how a NextGen 911call is made.

Ultimately, we conducted 10 focus groups in seven counties and eight interviews in four counties (see Tables 3 and 4). As planned, the focus groups consisted of a mix of law enforcement, firefighters, EMS providers, 911 representatives, and county officials (such as supervisors, coroners, directors, elected leaders). While interviews were originally planned to be with just 911 personnel, difficulty in recruiting for the focus groups mandated a shift in strategy in certain counties and interviews with law enforcement and EMS officials did take place. In total we heard from 59 individuals representing eight counties. The two pre-selected counties for which we could not obtain participation were Huntingdon and McKean.

Table 3: Total Focus Groups and Interviews by County

County	Focus Group (participants)	Interviews	Total
Centre	5	5	10
Cambria	6	0	6

County	Focus Group (participants)	Interviews	Total
Franklin	2+4*	0	6
Huntingdon	0	0	0
Greene	15	1	16
McKean	0	0	0
Mercer	0	1	1
Monroe	2+2+3*	1	8
Potter	5	0	5
Sullivan	7	0	7
Total	51	8	59

* Indicates that more than one focus group took place. In Franklin County, for instance, we conducted two focus groups, one with 2 participants and another with 4 participants.

Table 4: Focus Group Participants by County

County	Fire	EMS	911	Law Enforcement	Other/Administrative	Total
Centre	5	0	0	0	0	5
Cambria	4	1	1	0	0	6
Franklin	2	0	1	0	3	6
Greene	3	2	0	4	6	15
Monroe	4	1	1	0	1	7
Sullivan	0	1	2	2	2	7
Potter	1	3	0	0	1	5
Total	19	8	5	6	13	51

Focus groups are “carefully planned discussion(s) whose objective is to learn about the perceptions, feelings, attitudes, and ideas of the group participating in the discussion with respect to a defined area of interest” (Krueger & Casey, 2000, p. 5). According to Professor Peter Lunt of Leicester University, focus groups “share the commitment to providing an opportunity for participants to voice their interpretations, views, attitudes, beliefs and experiences through a moderated dialogue” (Lunt, 2019, p. 202). Focus groups have many advantages: they privilege group conversation and storytelling, they value the experiences of individuals while allowing participants to have some control over the process, and they allow participants to ask questions amongst themselves. They are also helpful when engaging with hard-to-reach communities by providing a sense of community (Hildebrandt, 1999).

In addition to the benefits noted above, both focus groups and interviews are appropriate for this project because they complement the interview-based structure of the first responder studies conducted by the National Institute of Standards and Technology (NIST) (e.g., Choong, S. T. Dawkins, et al., 2018). Echoing the human-

centered approach of NIST helps us compare our findings with those of the NIST studies conducted almost a decade ago (2017-2018).

Like focus groups, interviews “are chosen when studies deal with understanding someone’s experiences, perspectives, stories, accounts or explanations, the language forms used by those under study, inquiring about the past, or questions dealing with verifying, validating or connecting to other sources of data” (van Selm & Helberger, 2019, p. 162). We employed interviews in two ways. First, we conducted one-on-one interviews with 911 directors and officials to understand the operation of NextGen 911 (what van Selm and Helberger (2019, p. 164) might call “conceptual” use of interviews). Second, we conducted interviews when we could not schedule a full focus group either because of recruitment issues or scheduling issues.

Both our focus group and interview protocols were semi-structured and open-ended. The idea is to mimic a natural conversation (Hammersley & Atkinson, 2007). Open-ended, semi-structured interviews allow for respondents to tell their own stories, for unanticipated information and directions to arise, and give respondents a sense of ownership over the conversation (Hammersley & Atkinson, 2007; Lewis, 1991). As Cardiff University Professor Justin Lewis confirms, this type of interview “allows interviews to move in a direction of their own choosing, and to impose their own definitions and frameworks of interpretation upon the subject under discussion” (Lewis, 1991, p. 84)

As noted above, recruitment for the focus groups proved more difficult than anticipated. Initial recruitment began via email invitation to police chiefs, firefighter chiefs, EMS directors, and 911 directors. This strategy proved initially ineffective, although it did improve as the months went by. After receiving little reply, the next round of email invitations went out to county commissioners and emergency management directors. This strategy proved more successful, as the county-level personnel were able to connect us directly with relevant personnel. We also relied on the Center for Rural Pennsylvania to make several outreach efforts on our behalf. The principal investigator also invested time in attending county meetings, one-on-one meetings, and meals with first responders to answer questions and recruit respondents. To the best of our knowledge, no participant in the focus groups or interviews was ordered by a superior officer to attend. Instead, county officials and chiefs aided in recruitment by sending their officers our invitation. Unfortunately, some counties offered initial enthusiasm for the project and then failed to respond to multiple follow-up requests. As the project timeline continued and information saturation was assured, further outreach efforts for these counties were discontinued.

We are not alone in experiencing difficulties recruiting first responders. When it conducted a massive study of first responders and communication technology in 2017 and 2018, NIST also experienced significant recruitment issues. As NIST put it, “a major challenge was simply gaining access to first responders.” While NIST experienced difficulties with recruitment because of gatekeeping and permission, our recruitment

issues stemmed mostly from unrequited outreach. Both NIST and our team also experienced challenges identifying the correct people to contact (Choong et al., 2018).

When they were scheduled, focus groups took place both in person and over Zoom depending on the availability of respondents. For the focus group, when in person, the research team provided food and beverages; childcare and translation were also offered although no one opted for these provisions. Participants for both the focus group and interviews received a \$25 Visa Gift card for their time. Some participants refused the gift card as per their organization's ethics on gifts, while others donated the card to their organization. As per standard research ethics protocols, the Visa Gift card was theirs to keep even if they decided not to participate in the focus group once arriving. The focus group began with the principal investigator explaining the purpose of the group and explaining the information consent form. Crucially, participants were informed that they would remain anonymous in the final report, with only their position (fire, law enforcement, EMS, etc.) and county to identify them. Such anonymity is standard practice in focus groups as it allows participants to speak freely without fear of identification. Given the small communities in which we were present, identification was certainly possible. Upon review of the transcripts, we opted just to include their professional designation or county to further protect anonymity. Focus groups lasted between 46 and 85 minutes and consisted of between 2 and 15 participants. The majority lasted about one hour. In some counties, multiple focus groups were conducted to accommodate the schedules of participants.

On the interview side, three interviews were conducted with county 911 officials (out of a total of eight; see Table 3). These interviews generated enough information for saturation to occur. Additionally, one law enforcement officer, three EMS officials, and one emergency management official were interviewed to supplement the focus groups. Interviews lasted between 21 minutes and 2 hours and 30 minutes.

Analysis

Over 700 pages of transcripts were generated from the interviews and focus groups. The qualitative data from both the documents and the focus groups were analyzed using thematic coding analysis (Herzog et al., 2019). Thematic coding analysis (also known as thematic analysis or TA) is a standard interpretative method in qualitative research. As Herzog et al. remark, "TA is particularly suitable for analyzing experiences, perceptions and understandings" (Herzog et al., 2019, p. 385). Thematic analysis is predicated on the identification of patterns and themes within a corpus. It begins with the interpretive (inductive) coding of the data (in our case, documents and transcripts). Here "codes are labels applied to the segments of data which are likely to be relevant in the context of the research question(s)" (Herzog et al., 2019, p. 393). These codes are then grouped together as themes or patterns. These themes are then refined and grouped together to create larger, more abstract themes. Once the themes are complete, the argument is developed allowing for an inductive analytical process. Importantly, "themes do not

emerge passively” (Herzog et al., 2019, p. 395). Instead, “the researcher needs to take an active role in interpreting and reporting them” (Herzog et al., 2019, p. 395). As Herzog et al. continue, “TA is an interpretive method in qualitative data analysis: classifications and interpretations occur through complex and largely informal considerations that cannot be fully expressed in replicable terms such as a complete algorithm” (p. 396). That said, it is crucial that the research and the researcher “be consistent and transparent about the choices made” (p. 395).

To conduct the thematic coding analysis, each author inductively analyzed the transcripts for an initial identification of codes. The authors then came together over a series of meetings to discuss the codes and group them in patterns. Patterns were then assembled into themes by comparison – like patterns matched with like patterns. Agreement was ensured through deliberation and reflexivity. Initial codes and patterns were also saved so that they could be retrieved if necessary.

Our initial coding pass revealed 102 codes. These were then grouped together into patterns (for instance, individual apps were grouped together in a pattern called “apps.”). After several levels of abstraction, we ended up on six themes: technology and connectivity; lack of technology and connectivity; ingenuity; Interoperability/Interconnection; funding/budget; and recommendations. After one more level of abstraction, we settled on four themes: (1) Technology, including both use and absence; (2) Ingenuity, meaning the ways in which first responders coped with a lack of connectivity or technology; (3) Interoperability/Interconnection, meaning the interconnection of communication networks, especially at the county level, and; (4) Funding.

Results

Theme 1: Technology

Sub-Theme 1: Use of Technology

Across focus groups and interviews, first responders described using multiple communications devices and technologies, including radio, cell phone, tablet, computer-aided dispatch (CAD), FirstNet, and other applications in emergency response. However, technology use was not primarily a matter of preferences or innovation. Instead, it was shaped by affordability and departmental budgets. Technologies were used selectively, sometimes arbitrarily avoided or unevenly adopted due to cost constraints. As a result, technology use was influenced by affordability and financial limitations.

When we asked what kinds of devices they mainly use, most first responders said they rely on radios to communicate with each other. In terms of frequencies, some counties use VHF (e.g., Sullivan County), other counties use UHF (e.g., Franklin County), and some use both bands. In addition, even within UHF, counties such as Franklin County use 400 MHz (lower UHF) while an adjacent county uses 800 MHz (digital public safety band). Even within the same county, departments sometimes use different radio frequencies. For instance, in one county, while the fire and police departments deploy

UHF, the EMS department uses VHF. There are several reasons for heavy reliance on radio communication, but the central explanations were dead zones and coverage problems, as well as budget constraints.

With radio, first responders mainly communicate with other responders in the field, exchange information with the 911 center, and communicate with communication centers in other counties. Participants consistently explained that they rely on radio because other technologies are not reliable in the field. Due to insufficient cellular and broadband access, which will be discussed in the following section, radio becomes the only dependable communication option. As an EMS provider noted, “I always take a radio. And if I know, especially if the cell phone are not gonna to [*sic*] work, take the radio.” This aligns with other participants’ responses that only a few areas are fully covered by cellular service. Participants also distinguished between types of radio use and explained why they favor vehicle-mounted radios (mobile) over handheld devices (portables). One 911 representative provided detailed explanations:

Mobile radios are the ones that are mounted in vehicles. They're larger antennas, so you get a better performance out of them. ... We don't guarantee any portable coverage. Um, even though it's very good in areas, there's other areas that portable is a paper rock to you because just the terrain.

First responders thus rely heavily on radio for communication and dispatching, especially since cellular and broadband service are unreliable due to geographical limitations.

Using radio also involves several problems, including limited funding for replacement and competing bands that disrupt communication. Although radio is a primary tool for first responders, participants described not having the newest or upgraded radios. Many cannot afford to purchase or replace radios, and replacement costs are substantial: “We have some of the newest radios ... the chiefs do. We can't afford to purchase one for every radio.” One department said it would cost almost \$2 million to transition entirely to the proper radios.

We also found explanations of congestion in radio traffic that can interfere with dispatching. One county 911 official explained that a radio channel is shared across many departments, and traffic can be denied when the network is busy: “... sometimes they'll [police] get bonked off the network. If the network is busy, their radio traffic will be denied at that point in time, just because they're waiting for open air.” These statements show that first responders experience communication and dispatching constraints while relying on radio, limitations that would certainly be reduced with more reliable connectivity.

Participants also emphasized that the radio is not a mere communications tool, it also functions as a lifeline connecting personnel and command during emergencies. One noted that, “Radios are our lifeline when we are inside doing an interior attack.” Another stated:

We keyed in on the radios for ourselves, for the personnel, and for the apparatuses. And you understand why we need the radios. Because it's all about

life, safety, being efficient and effective on the communications ... within the communications at a fire ground, or doing search and rescue or something like that.

Through focus groups and interviews, we found that radio is important not just because of its technological features, but because it is often the most workable and efficient option among remaining alternatives. However, radio replacement costs, traffic congestion, and uneven signal coverage emerged as issues that needed to be addressed.

In addition to radio, first responders repeatedly emphasized personal cell phones as an important communication technology for both the public and first responders. In many parts of the county, personal phones are used as a primary tool for contacting emergency services, such as calling hospitals. An EMS provider mentioned: “We call the hospitals about 10 to 15 minutes before we get there and give their emergency department with our cell phones.”

However, cell phones were described as unreliable and constrained by coverage gaps, infrastructure, and affordability. Rather than replacing radio, personal cell phones function as a supplementary technology that is used only in certain locations and under specific conditions.

Cell phone use also encompasses several critical problems that disrupt first responders’ communication, especially in identifying the caller’s exact location. First, participants repeatedly pointed out that cellular coverage is uneven, or even nonexistent, across large portions of rural counties. “Half of our county has no cell phone coverage Some people, their only option is their phone lines. Landlines.” Even when the public and first responder uses cell phones, there are dead zones where they cannot communicate effectively (this issue will be discussed in the following section).

Some participants discussed FirstNet, a cellular network dedicated to first responders. While FirstNet is designed to provide more reliable connectivity for first responders, our focus groups and interviews reveal that uneven coverage becomes an issue. The satisfaction level varies by county and the experiences of first responders. As one EMS provider mentioned, “There’s mixed reviews as far as how well it works. Initially, they promised you the moon and delivered maybe an asteroid.”

To be sure, this was not presented as a FirstNet or AT&T-only problem. Participants also pointed out poor connectivity from Verizon. For some areas, those who use FirstNet had signal when Verizon users did not, and vice versa. A responder in one rural county noted that they use phones with dual SIM cards with AT&T and Verizon, saying:

I have a dual sim in my personal phone. I kind of know where I need to switch it over. Because location, for you go to ... Township, you better have AT&T. And you go to ... Township, [you better have] Verizon. ... You know where is [sic] service.

Beyond radio and cell phones, internet-based technologies were also used across counties. Computer-Aided Dispatch (CAD) is standard technology within PSAPs, and some agencies have outfitted their vehicles with CAD apps, such as CrewForce and IamResponding (IaR), allowing units to dispatch themselves or see where other units are

located. In this sense, CAD can provide more accurate information than radio technologies. However, CAD availability varies widely across counties and agencies, mainly due to a lack of funding and coverage. For instance, we learned that one county does not use mobile CAD and relies on radio for dispatching due to cost constraints. At the same time, they emphasized strong interest in mobile CAD and recognized its usefulness, saying, "...When we spec'ed [*sic*] our CAD five years ago, we had heavy interest in using mobile CAD. Unfortunately, when it came down to cost, um, it was something that was not obtainable by most departments." Another person in the county added:

We use radio communications. We don't use any MDTs [Mobile Data Terminals, laptops in vehicles]. ... a lot of that comes back to expense versus coverage issues. Again, everything there's a cost associated with it ... using a mobile CAD, or an MDT for police was just not financially capable.

In addition, responders pointed out the question of whether the benefits of CADs justify the heavy investment. Since adopting CAD encompasses costs for hardware, software, internet connection, training, and other related expenses, departments evaluate whether CAD is feasible and efficient under the local conditions. For instance, although one county we heard from operates a CAD system, it did not adopt in-car or mobile computer systems across departments, explaining:

... most of our municipal departments do not run a true in-car computer system because it's just troublesome for them to have connectivity to do the stuff that you invest all the money for a computer to do. ... I know certain places with the state police, they have a hard time with their in-car stuff and even using their GPS locations on the computer system because there's no connectivity.

Our focus groups revealed that first responders make use of a number of communication technologies, from land mobile radios, to smartphones, tablets, mobile data terminals, and computer-aided dispatch. These findings are consistent with the earlier NIST studies discussed in the literature. Also consistent with the NIST studies and as we discuss in the following section, rural first responders share the burden of a lack of consistent connectivity for these devices, making their use sometimes impossible. Between connectivity issues and cost issues, some communication technologies are inaccessible for rural first responder organizations.

Sub-Theme 2: Lack of Technology

While first responders use various types of technologies, they consistently shared that the lack of technology is a key problem. Notably, many first responders in rural Pennsylvania suffer from unreliable connectivity and dead zone issues, which significantly threaten their work and the public's safety.

The first and most critical issue is a lack of connectivity, which includes insufficient coverage, a lack of towers, and the loss of services. A great number of first responders

pointed out that neither radio, cellular, nor internet coverage is fully available in their areas.

In terms of cell service, for instance, first responders in Potter County responded that they have had cell service for only the last five or six years, and only half of the area is covered. Dead zones were reported not only in rural areas but also in metropolitan areas in Centre County, including lower floors of buildings or basements in downtown areas. First responders in Centre County stated that they lose connectivity when entering buildings in downtown areas or when passing the State College airport. The issue is not limited to a single technology. Responders across counties pointed out the lack of connectivity in radio, cellular, and broadband services. According to one responder, “We do have a lot of places in the county that don't have any cell service at all.” Another agreed:

...the county [is] getting more towers put in for us. Because we have these \$9,000 portable radios, even mobile radios, and there's certain areas in our [county] you get over the hill, and you can't [get signal,] it just bonks us out.

This is not a carrier-specific problem. In one county focus group, first responders described losing signal entirely when moving from hilltops into valleys. Similarly, responders in another county noted that even when multiple carriers were present, including AT&T and Verizon, neither worked consistently:

Myself and the two people behind me, none of us got out. None of us. And, [another responder] was one of them. She had AT&T. I had Verizon. And the other person had Cingular or something. Not one of us could get a message out.

This indicates that the lack of coverage is not driven by individual carriers but by largely infrastructural issues. First responders linked the lack of coverage, which stems from an insufficient number of towers, and the geographical characteristics of rural Pennsylvania, where mountains and valleys are common. First responders in one tree-heavy county, for instance, attributed the lack of connectivity to the county's geographical features:

A lot of the western side of the county is very rural. Very wooded. Uh, issues that we have there is [sic] ... it's tough to build more tower sites out there [be]cause there's a lack of infrastructure to run the phone, or. You know, we run off of phone lines to the direct tower sites. That's how we communicate from the 911 center to the radio sites.

As noted earlier, some counties do not use CAD due to the lack of coverage. Likewise, when first responders lose internet services, they are no longer able to use CAD, which makes them rely on analogue strategies, like paper maps.

The lack of cellular and internet service often leaves Pennsylvanians in life-threatening situations, forcing them to find locations where they can reach 911 even during severe emergencies.

We've had multiple fatalities because people have wrecked and they don't have cell phone service, and if they're trapped in the car or whatever, they can't reach

911. The person who finds them, the next day, has to drive five to six miles, somewhere to even get to a 911 or a landline to call 911.

One first responder shared with us an example of delayed dispatch for a heart attack patient. Similarly, an EMS provider explained that losing connectivity caused a delay of five to ten minutes, as the process had to be restarted once connectivity was restored, which in turn delayed dispatch. Across counties, first responders warned that travelers, especially those from urban areas such as Philadelphia, should be aware that they may not be able to reach 911 in rural Pennsylvania, due to the lack of cellular and internet connectivity. These examples suggest that the public can become victims of inadequate coverage. As a responder noted, even though they use NextGen 911, if the caller does not have connectivity, information cannot be received.

As a solution, first responders across counties consistently stated that more towers are needed to expand coverage:

If there's a number one priority, I think it should be getting those last miles built, whether it's microcells on telephone poles or if it's towers or whatever. You know, um, we have 11 tower sites in [our] county. A lot of ours are shared with cellular providers because they have the same coverage issues we do.

First responders acknowledged the difficulty of building more towers in rural areas due to limited infrastructure. Participants emphasized that the lack of connectivity is closely tied to the scarce infrastructure, particularly the absence of a fiber network and towers.

Across counties, responders also described the financial barriers to establishing more towers, particularly in mountain and valley areas:

[for areas with mountains and valleys] It's tower coverage in some of the mountain area. We have looked strategically at certain areas that may provide better coverage. Unfortunately, putting up a tower site for that type of coverage is anywhere from 1 million to 2 million per tower.

Given that cellular services require at least three connected towers, constructing additional towers remains a significant challenge. As one firefighter noted, "You need the towers not to support the population, but the distance and surface area to cover."

We also found that coverage was highly inconsistent across carriers. First responders repeatedly described situations in which AT&T and Verizon coverage varied by location, device positioning, or terrain. It is notable that these inconsistencies were not resolved by switching carriers. "If you don't have service, you don't have service regardless of its FirstNet or, or what." Another responder agreed:

Very few areas that it truly overlaps and is great 100 percent. There's enough areas that it's both services are, are nonexistent. But, um, like here in my office, I get a fairly good AT&T signal. And one of my other cell phones, it's Verizon.

There's times, depending [on] where it's sitting on my desk, I get no coverage.

The lack of ubiquitous network connectivity in rural areas reflects a broader structural problem that commercial providers have little financial incentive to invest in

infrastructure where population density is low and return on investment is limited (Ali, 2021). One responder mentioned:

Unfortunately, ... the issue has to do with the density ... the problem here that we have is that you can request companies put in more towers. ... if it's not commercially feasible, they are not going to do it.

Because tower companies require commitment from multiple carriers before construction begins, if the population is not enough, building towers is impossible even when the local township approves. As one responder directly pointed out, "You can approve all the towers you want. You can have this great plan, but you can't force a private entity to build." One responder pointed out that Pennsylvania's ban on municipal broadband prevents what may have first appeared to them as a viable solution. Designed to prioritize first responders' connectivity during emergencies, FirstNet depends on the same infrastructure and market logic that has failed in rural areas. Without enough towers having been built, prioritization does not offer an advantage. Due to weak coverage that stems from lack of towers, some responders do not use FirstNet, stating, "Our hotspot is Verizon. We get better service ... an emergency service facility is not using FirstNet because they went with AT&T, which was lesser of coverage." A lack of ubiquitous network connectivity undermines the effectiveness of FirstNet, forcing first responders to rely heavily on radio instead. This, in turn, could pose a direct threat to public safety.

Focus groups with rural first responders in Pennsylvania taught us that a lack of ubiquitous connectivity – so called "dead zones" – is prevalent across the Commonwealth and that these experiences are consistent regardless of mobile carrier. In the discussion section of this report, we reflect on the need for greater investment in telecommunications infrastructure.

Conclusions

Drawing on focus groups and interviews, we find that first responders' adoption of technology is constrained by the availability of technologies, including both infrastructure and funding. Although most first responders rely heavily on radio, this reliance does not reflect the superiority of radio over other technologies. Rather, radio represents the most viable option among those currently available. The use of technology thus indicates that first responders face significant affordability constraints. While many counties have adopted mobile CAD systems and first responders perceive them as useful, for instance, the use of more advanced technologies is limited by funding. In addition, first responders report a lack of reliable services, which significantly affects both their work and callers' safety. Overall, these findings suggest that constraints on first responders' tasks and public safety stem not only from funding limitations but also from insufficient infrastructure, notably a lack of ubiquitous network connectivity from mobile providers in rural areas.

Theme 2: Interoperability

We often assume that because we live in a digital age that all devices can interconnect. Interconnection, after all, is the basis of the Internet. While this may be the case for computers and smartphones, first responders across the country still rely on their radios (LMRs) as their primary modality of communication. Unfortunately, not all radios speak the same language.

In this section on interoperability and interconnection, we will discuss two sub-themes that arose from our thematic coding analysis: inter-county communication and intra-county communication.

Sub-Theme 1: Inter-County Communication

Responsibility for radio communication falls to the county and then often to individual agencies to purchase the necessary equipment. At the county level, the county decides on frequencies (VHF/UHF/800). This means that different counties, even neighboring counties, may use different radio frequencies and as a result communication between first responders from neighboring counties is a major challenge. This was expressed in statements from two study participants. The first explained, “And I think the crux of the problem is ... and I believe it’s statewide ... not all communication centers use the same form of communication. And not every fire company and ambulance uses the same radio.” The second pointed to another barrier: “But the thing of it is, being able to link everybody together, and we’ve all worked hard to do all these links, and nobody wants to play nice in the sandbox.”

Interconnection becomes especially challenging for those departments that serve multiple counties or have mutual aid agreements. Some first responders, for instance, serve multiple surrounding counties, which makes interconnection both crucial and frustrating. One town has a mutual aid agreement with a bordering county, but once the neighboring county switched radio bands communication between the counties became stressed:

But they went to the new 800 (MHz) before we did. They said they couldn’t dispatch us no more, but now we’re up to what they are, and they say they still can’t dispatch us.⁵

Interconnection issues cause significant delays in dispatching. In this situation, County A’s 911 center must contact County B’s 911 center and then have County B dispatch the necessary unit. As one respondent told us, “My department fought tooth and nail not to go to 800 [MHz] ... because everybody had money invested in 400 [MHz] and it wasn’t that old.”

Some counties have banded together to ensure interconnection. The Inter-County Regional Radio System (ICORRS), for instance, is a 10-county partnership between Allegheny, Armstrong, Butler, Cambria, Lawrence, Mercer, Fayette, Indiana, Somerset,

⁵ Because of the change to frequencies, the PSAP was no longer able to dispatch units from the neighboring county.

and Westmoreland, allowing first responders to freely speak with one another using authorized radios. It too has adopted the P25 system. In one county, ICORRS was praised, but frustration was also raised when trying to speak with non-participating counties:

The interconnection between counties is where the problem develops ... There's sometimes a connection failure. We had to buy special radios that have both capabilities for \$10,000 apiece so we could talk to ... County, and we'd go to ... [township] for a standby.

Some told us that they used multiple radios, so they could speak with other counties:

We actually used to have both of the bricks [radios], our own system that when we would go to ... [County], we would switch over and turn the repeater on the apparatus so we could talk. Anyhow, it was a ... [expletive] system. But it was the only system we had.

This was not the only county we encountered that used multiple radios. One firefighter in another focus group told us that they had a separate radio for a neighboring county.

One ambulance attendant told us that when they “get an ambulance call, which we run frequent to ... [town straddling two counties], they’ll set us a patch-up automatic.” By patch-up they meant that the 911 Center will connect speakers from one county to a neighboring county. When it comes to fire, however, “that becomes a problem where the officer ... unless they do set up a patch, which most times they do if we’re running a fire ... the officer would have to carry ... two radios.” This is a safety hazard for firefighters, this respondent continued, because “your firefighters weren’t privy to whatever’s going on.”

One focus group was particularly vocal about their displeasure with inter-county communication, noting that they had an easier time speaking with a bordering New York State County than neighboring Pennsylvania counties: “Now, I go towards ... [County] ... and we cover ... [County] sometimes and our radios are not compatible because they just went to a different system. We cannot talk to them.” As a result, we were told first responders in the field end up calling 911 dispatch to get their messages across to their neighboring county colleagues. The frustration was palpable: “I’m not messing with the radio. I’m calling the dispatch, and you’re going to talk to me because I can’t deal with all that nonsense.” Said another respondent, “So, if we were to get on the same page, being so close to different places that we go to, [it] would be so much more efficient.” Said another respondent, “When ... [expletive] hits a fan up here, we all work together because it’s the only way we can get anything done ‘cause we have nothing if we don’t.”

In contrast to what is not working, one EMS official told us that they had a radio that could access multiple neighboring counties. This was a tri-band radio: “So, basically, it’s one radio head. There are different zones and you just go to a different zone and scroll through it and find what-whatever frequency you want or whatever you need.” The official admitted, however, that “not a lot of companies have that” because of its cost. This county’s communication networks are so advanced that they are able to use the

app “I am Responding” (IAR) to see “our mutual aid companies and see what they have responding.” This type of interconnectivity makes inter-county coordination much easier.

Because counties elect what frequencies to use, the concern of inter-county communication can be viewed as a county issue but can also be addressed through guidance from the Commonwealth. Encouraging inter-county networks, such as ICORRS and Commonwealth adoption of P25 seems to be the logical conclusion from our conversations with first responders. At the county level, endorsing common frequencies, embracing P25, and coordinating with surrounding counties, are options, especially to avoid first responders having to go to the PSAP for a patch. That said, funding remains a crucial impediment to the implementation of these suggestions [see theme 4 (funding)].

Sub-Theme 2: Intra-County Communication

Sometimes interconnection challenges extend down into a specific county, when ambulance, fire, and law enforcement cannot speak with one another when on scene. Said differently, police, fire, and EMS in a given county may use different frequencies and may not have the devices capable of interconnection. This use of different frequencies means that a firefighter may not be able to speak with a law enforcement officer while both are on scene. This reality is a problem of interoperability. As a firefighter explained to us:

So they can talk to us on ... Fire 1. If I needed to talk to them, if I knew they were on scene we can talk on Fire 1. Fire 1 being a radio chat. Fire one is our dispatch frequency. That is not a communications frequency. That's not just for sitting there talking back and forth and you know, giving updates in there. You know, but in an emergent situation, they can use that. They can call on it ... But when it comes to in the field communications, it is limited. Like, I do have your VHF frequency in there. But like they said before, it depends on where you're at. So I may not be able to talk to them. Now there's other means, like we have a, a county-wide UHF frequency. [But] why am I gonna strap these guys with more radios just for that?"

Here, this firefighter both disliked the idea of having to burden his crews with secondary radios, and mentioned the inconvenience of having to go back and forth to the vehicle to use the mobile radio to speak with others on scene:

We have the VHF on our person. But even then, if we're far away from the vehicle and we have to try to talk to [another person] or get a hold of him, it's not gonna work. Not from our portable.

In contrast, mutual aid is facilitated by compatible communication networks and equipment:

There's a manpower shortage. So, that one fire call that used to take maybe two departments now takes five. So directions in being able to see a map and say, "Okay, here's where you go. Go this route, go that route." And our software will push it out. Depending upon what the fire department has, they'll actually show them a route of travel. It'll take in consideration speed limits. It'll take in

consideration construction. It'll take consideration if bridges are out, what the weight limits of those bridges are.

As more counties transition to P25 these interconnection challenges should hopefully be mitigated because even departments using different frequencies should be able to inter-connect.

Another problem relates specifically to the relationship between 911 dispatch and county borders. Some counties in Pennsylvania do not have their own 911 PSAP. Sullivan County is dispatched out of Lycoming County, for instance, while Potter County is dispatched out of Tioga County. The lack of interoperability means that there is the potential for delays between a call coming in and the first responders receiving the dispatch. For firefighters at the border of counties, for instance, a 911 call from County A would then have to get transferred to County B and then County B would dispatch the firefighters from neighboring County C. We were told this can create a lag of between 6 and 10 minutes. "If ... [County's] calling us for help, and we're already sitting at the station waiting to go. They have either a 6- or 10-minute delay of communication."

Thankfully, 911 Centers are all interconnected through the Commonwealth's NextGen 911 network and as such, neighboring centers can at least take calls. One 911 official said, "Our phone systems are pretty much all tied together." Another comment added, "They're all basically the same, [so] I can automatically transfer calls to other counties, you know, if I get over inundated, they'll start ringing over to a neighboring county."

Many focus group participants mentioned the difficulty of speaking with the Pennsylvania State Police. While the PSP uses the P25 network and protocols, their communication is encrypted, making it impossible for county police, fire, and EMS to speak with PSP officers while on scene. "PSP, the radio doesn't play nice with other radios" one focus group participant told us. Another participant was excited about finally getting the ability to patch different radios together, "but it still does not help with PSP because they're encrypted. We can't hear anything. We can't see anything of theirs."

When on scene with PSP, to avoid confusion and maintain safety, the best solution is to buddy up. As a law enforcement officer explained, "communica[ting] with PSPs also on scene is just a mess sometimes." Another explained:

We need to make sure you trade radios. So if you bring an extra radio for at least one person on their side ... or one person out ... or be buddied up with someone from them. So, we constantly have that. It's a challenge for us if we're serving a warrant or something. Or we're searching a house. Say, say we're searching a house and PSP's on a perimeter or vice versa, it can be a challenge 'cause there can be problems that arise that they need to communicate back and forth or let guys know what's going on. And it's, uh, really the only way to solve it is to always have ... always be buddied up. But it's just something we have to work around something [sic].

Consistency standards, such as the Commonwealth-wide adoption of P25, and the sharing of frequencies by the PSP could go a long way to address these issues.

Conclusions

While the P25 system will hopefully alleviate both inter- and intra-county communications challenges, its piecemeal rollout and expense remain a tremendous challenge. “There’s no guidelines. There’s no specifics that you have to follow” one EMS provider told us. “So, it’s agency specific.” On top of that, a critique we heard of P25 adoption is that it is up to the county to pay for the transition, and this means changing over both radios on towers along with portable and mobile radios. “But just to get it started right now would be like \$13 million [for one county]. It’s so expensive.” Many focus group respondents seemed resigned about communication in the near future. “I’m not holding my breath” a firefighter told us.

Theme 3: Ingenuity

Pennsylvania’s rural first responders have to endure several challenges due to lack of connectivity, coupled with a lack of funding and support. Nevertheless, they have created ingenious, jerry-rigged plans and fixes to continue to support their communities as best they can. In this section, we highlight their ingenuity under duress through three sub-themes: increasing connectivity with the tools we have; know your town and your people; and back to analog. While we describe the innovative practices of rural first responders, such a description should be taken both as praise for the first responders themselves and a critique of the fact that they have to go to such compensatory lengths. Having to go to such lengths makes their work harder and, in many cases, less safe.

Without constant ability to communicate, a first responder call can go downhill fast. A problem encountered by many of our first responders was ‘dead zones’ – areas of no coverage throughout their county. Even if there is coverage at the firehouse and the scene of the call, critical information comes through dispatch during transit. One EMS provider told us about how in a county with a high population of elderly folks, often they respond to calls where a person has fallen and cannot open a locked door for the responders. The caller will inform dispatch about a hide-a-key rock or a garage door code, and dispatch will attempt to inform responders. However, that message can be lost due to a bad connection, delaying response to the patient. Navigation to the scene also relies on consistent connection. If you lose connection en route to a scene, especially in such a rural area, and miss a turn or head up the wrong driveway, it can once again delay response.

Dead zones are not exclusive to data coverage. Radio dead zones also create issues, especially on the scene. One firefighter told us about being on a scene when the radio “literally bonked,” which means it began making bonking noises instead of transmitting or receiving messages. This can impede communication between different branches of responders (i.e., firefighters cannot talk to dispatch or police) and can also impact communication on the scene. If a firefighter in a house cannot communicate via radio with those operating the truck outside, it is a hazard not only to the callers but to the

responders as well. In this section, we highlight strategies used by first responders when they encounter dead zones of broadband or radio, or when their radios or ICTs fail.

Sub-Theme 1: Increasing Connectivity with the Tools We Have.

Personal device use is common for first responders across branches. Many use their personal phones for the communication tools we mentioned like first responder apps, to communicate with their team, and more. However, device use goes beyond that to battle dead zones of connectivity. Many first responders reported using personal phones as hotspots or having purchased (at their own expense) dual-SIM cards on different providers. One firefighter told us they “typically use the hotspots on our phone[s] as well as our, um, computers if we take our computers with us.” This works when the personal phone has network connectivity where the department’s devices, like iPads in firetrucks or ambulances, do not. As noted in an earlier theme, dual-SIM was mentioned by several of our responders. We learned that these responders were paying for dual-SIM on their own, even though they were volunteer responders. Dual-SIM cards allow one’s phone to access cell coverage on multiple networks; for example, AT&T and Verizon can both be accessed on one phone. This solves a commonly reported problem of coverage being provider specific. As a solution it is not without problems. One responder told us: “a solution would be to dual-SIM. But then you have to pay for it.” The same responder who did pay for dual-SIM explained that he could not get it reimbursed through the county, as they did not understand the need for it and, due to it being a personal phone, could not reimburse what they saw as personal expenses on the county’s budget. When dual-SIM could not be afforded, one strategy was to buddy up with another responder who had a different service. In one county, police officers patrol with a partner and discussed planning partners to who had opposing services—one partner Verizon and one AT&T—to ensure that a patrol unit had the highest potential for coverage throughout the shift. This is indicative of the impact of the lack of connectivity; pre-planning your partners based on the personal cell providers was a common topic of discussion among the local police officers. Personal device use was not exclusive to cell phones. One responder purchased his own radio at the cost of \$300, and had it programmed to work with the channels his response team used. He told us the device worked so well that “the guys took my radio because they could not get through [with the fire department’s].” This example also suggests that there are more affordable options for radios that work from carriers other than the major ones, such as Motorola.

A potential issue with personal device use raised by our responders is that when personal devices are used for response situations, particularly in the case of police officers, they can become subject to subpoena (see Choong et al., 2018). Not only for their contents related to the situation, but for any content on the device. This has responders worried about their privacy. In addition to privacy concerns, this is a risk to the responder’s personal life and finances. As a responder told us with regards to personal cell use: “if anything, whatever happened, that our phone would become

evidence or anything... then we're out of the phone for however long that takes, you know.”

While radios remain crucial to first responder operations, they have limitations. Radio frequencies, even when private, can be susceptible to outside listeners. Additionally, a radio requires that a responder speak out loud to communicate a message. When there is a safety concern for the responder, callers, or community, this affordance of radio can pose a problem. First responders must find different modalities of communication to convey messages that cannot go over the air or cannot be heard by anyone on scene. One Centre County focus group member told us about how they would utilize CrewForce, one of the first responder apps, in such a situation:

God forbid, I get on scene and I think this might be an arsonist and the arsonist might be on scene. Um, I would be able to type in the notes ‘possible arsonist on scene’ without going across the radio for [dispatch] to get the state police coming to me.

The notes section on CrewForce, from what our first responders have told us, is typically used to convey any extra information between responders and dispatch that does not fit into other boxes. Things like the hide-a-key situation would be included in the notes. Stating there is an arsonist nearby aloud could spook the subject into running—or worse—and put those on the scene in danger. By using the existing tools in innovative ways, our first responders continue to protect community safety.

First responders also took to using unconventional web services to support their communities in emergency situations, particularly in navigation. Lost hikers are a common problem in our counties, and navigation via connection is essential to locating and successfully rescuing folks lost in the woods. One such service was RapidSOS. This works from the side of the responder, no need to have the user download anything. It can deliver location information to the responders, as well as contacts, medical information, or other pertinent content that exists on the caller’s device. A 911 dispatcher told us that RapidSOS works faster than their existing CAD system, and the location is so accurate that they can guide them out of the situation by giving directions over the phone. Another app/website used was What3Words. What3Words divides the topography into a grid of 3 square meters, and each square is identified by a unique combination of three words. This makes it easier to locate individuals when rapid location tracking is not available. The caller can locate their three words and communicate that to responders. Firefighters told us they had seen it used in at least two land rescues. This use of unconventional apps compared to the traditional CAD deepened ability to quickly locate individuals in search and rescue situations.

A major problem with lack of connectivity is not only lack of coverage from specific providers, but also a complete lack of any coverage in some regions. Towers have either not been built due to low customer base (as determined by private ISPs), or due to problems with topography interfering with the ability of the towers to provide service, or a combination of both. First responders have used their personal devices to

communicate but also have made measures to meaningfully increase the scope of connectivity in their counties. Some mobile carriers have partnered with low-Earth orbital satellite companies, notably Starlink to improve coverage in hard-to-reach areas (O'Donnell, 2022).

Many counties with available funds have hotspots on ambulances and firetruck rigs to ensure on-scene connectivity. One EMS provider described to us: “the ambulance is sort of a rolling hotspot, um, to connect that doctor directly to the patient.” Having the hotspot on the ambulance itself ensures consistent communication with doctors at the hospital. The responders on the ambulance have the ability to provide care while patching in a doctor from a medical center, referred to by the responders as “the mothership” in Centre. This hospital has dedicated teams to communicate with responders, providing EMS teams with accurate information, especially due to the doctor’s ability to access all information necessary from their own knowledge, and from a computer. By connecting the responders on the ambulance to the doctors through hotspots, the hotspot enables the best possible care, so in tune with the hospital that “the paramedic acts as that doctor's hands.”

When hotspots are not available in public trucks or ambulances, first responders again made do with personal devices. One firefighter told us his personal truck had Wi-Fi hotspot capability, and he would connect to it to communicate with dispatch and other firefighters on remote scenes. The Wi-Fi capability from the truck was powered through OnStar, a geosynchronous satellite service, meaning it sometimes had further reach than the traditional providers. He described how it worked on the scene to us:

So I let my cell phone find my truck's network to make communications. And like when I'm on scene, and this has happened a couple of times, we get on scene, nobody has communications. State police included. I'll give them my password and they'll jump on my network off of my truck.

He used it to connect other first responders, including at a scene where state police requested his help connecting due to the lack of other broadband sources. Another firefighter described this type of hotspot connection as “a stopgap,” useful because the town does not have sufficient tower coverage. While the firefighters and responders are innovative in their use of hotspots, they know this is not a permanent solution to the lack of coverage in their counties. Most importantly, hotspots only work when there is connectivity to begin with. They depend on mobile network coverage just like a smartphone does.

Sub-Theme 2: Know Your Town and Your People

First responders emphasized to us that it was deeply important to be connected to their community, and to have a knowledge of the physical environment of the county they serve. By having this knowledge, first responders were able to increase their ability to connect, to respond quickly to calls, and to spread messages in case of emergencies.

One tactic mentioned by responders in a few cases was to use what they call “pull-over spots.” A firefighter told us:

We [firefighters] know where those spots ... the pull-over spots, like ... [location in the county]. You got to pull over and finish your conversation ... or going up a mountain, you know, like you're saying, the dead zones ...”

In response, an EMS provider in the focus group stated: “Or you ... speed up to get to the next ... the next tower.” This was not unique to one county. An EMS coordinator and a firefighter told us the same thing in separate focus groups, that they have to know when to end a call because they know a dead zone is coming.

Local knowledge extends beyond dead zones and into understanding the county.

Chief just lectured me pretty hard about knowing, knowing my streets, especially, you know, ‘do you know where ... [street name] Lane is?’ I'm like, ‘Well, it's, it's over there.’ Mostly, but, you know ... knowing, knowing your first due [*sic*], knowing your territory is, is important for that reason.

When the dead zones are too vast, or the situation is too dire to stop at pull-over spots, responders ensure that they know the territory well enough to navigate as best they can on their memories, quite a rarity in today’s day and age. Deep knowledge of the town is not just built through studying but also comes from the responder’s passion for their communities, often built on deep roots in the area. In one county, a responder told us about a recent call:

Two people recently said [to me], ‘you would never find where we had to go.’ Like, there's no cell phone coverage. And even maps aren't exactly right, you know, but we just happen to know. Because that's so and so's farm. That was my great-grandmother's aunt and whatever.

Given that many responders are local to their communities, or have lived there for many years, this type of personal knowledge is vital. First responders also told us that in terms of this local knowledge that “you kind of pass it down” to non-locals and to new first responders who may not have had to know the maps in such detail before.

First responders also rely on the community to connect. In one county, firefighters report going to nearby local businesses that they know have Wi-Fi connections or even knock door-to-door and ask if individuals have landlines that might be able to make a call where cell coverage is failing. This requires high levels of support and trust from the community. The firefighters reported to us that no one had ever denied them the call or the Wi-Fi access, stating “it's been the thing forever” out in their county.

Connecting with individuals and knowing the community is especially important in emergency situations, like natural disasters or evacuations. Many of our responders mentioned complicated relationships between responders and community members in “scannerland,” the term they used to describe community members who were interested in emergency response and closely monitored police radios using scanner devices. Some reported that this has caused problems with privacy or can lead to miscommunications between responders and the community. However, the knowledge of specific individuals

who engage in this practice was imperative in a particular emergency. Two emergency coordinators, one a dispatcher themselves, described to us a particular situation where emergency text (SMS) messages were not being sent due to provider-imposed anti-spam message protocols. Without reliable ways to get messages to the community in a desperate evacuation situation, first responders relied on knowledge of community members:

We don't typically put [information] out on the air that we're doing this, but we have enough people in scannerland in our county that we know will push it to social media, and we're hoping that they're listening ... which is a sketchy thing to do ... but it was the only option we had at the time to do it.

By knowing their community, first responders knew to push messages through the channels monitored by scanners in a time of desperate need, knowing those individuals would post on local social media groups that first responders might not have access to. Knowing and trusting community members can also be an asset in building out broadband networks. One respondent noted that Pennsylvania's lack of municipal broadband (where broadband networks are owned and operated by the municipality, much like a utility), was a detriment and that he would like to see communities build their own broadband networks.⁶ Two quotes from the same respondent illustrate this point:

That's, that's why I go back to the answer is we need ... to be able to do it ourselves. Because we have the technology and the capability. But not, you know, if they're telling us we ... we can't even ... like imagine being told, 'You can't even do it yourself.' Like ... if you own the land, if you owned 100 acres of your land, you cannot actually dig and make your own municipal line out there right there.

So, so if, if they would release something like that [funds for municipalities], right, then I could totally imagine, Hey, uh, we had a township. Township has a discussion. 'Hey, uh, you, you guys want to lay fiber?' 'Yeah, I don't know ... [expletive] about fiber, but sure. ... [expletive] it. Yeah.'

While this is the opinion of only one respondent, it is notable for its focus on community based solutions to infrastructure issues.

Sub-Theme 3: Back to Analog

Despite ingenuity with personal device use, hotspots, and even local knowledge, sometimes our first responders were forced to fall back on the tools of a pre-digital era. This required the knowledge and the foresight to know that connectivity may fail, and to plan ahead.

A very common fallback was having paper maps in ambulances and firetrucks. Centre, Greene, and Franklin County mentioned keeping paper maps or map books with them. Responders in other counties talked about pre-downloading a map of their route

⁶ Title 66, Section 3014 of Act 183 of 2004 inhibits municipalities from owning and operating broadband networks absent onerous restrictions and efforts.

to their device before leaving the station so that they could ensure a complete map before leaving an area with guaranteed service. This was particularly important in more remote calls or for fire calls, where maps can indicate locations of fire hydrants.

Physical materials extended beyond maps. While some counties were able to afford (and had enough service to support) apps with information on hazardous materials, others kept laminated binders in ambulances and fire trucks for reference. Often problems concerned fertilizers, especially in the most rural areas of our counties. Different materials require different actions to maintain community safety, and it is often essential to act quickly. When service was not available to access online information or to call in experts, these hazmat binders were essential to responders.

Another important tool of first response is awareness of surroundings. When communication technology completely fails—radios bonking, cell service out, broadband unreachable—first responders are still going to fight to get to the scene of emergency and protect their community. A firefighter described their strategy in the event of total tech failure. “At that point [when radios fail] ... if it's a fire, you just kinda, hopefully, you can see the smoke, and you follow the directions of the smoke.” When literally all else fails, first responders never stop supporting their communities. To the point of looking to the sky and locating the scene, there is no end to the dedication of our rural Pennsylvania responders.

Conclusions

A conversation from one particular focus group helps bring the issue home: “We make do.” A first responder told us. Another first responder replied: “Why should we have to make do?” Just a few moments later, stressing the importance to us, another responder said:

Unnecessary death has happened [emphasis added], you know. And ... potentially even the history of this county, I'm sure there'd be even public safety family members that have, you know, suffered one way or another because of that. So ... it's very unfortunate, and ... I think funding is important and it does need to be reallocated ... at a higher level. There's no question about it” [emphasis added].

First responders, especially rural ones, make their own solutions to best serve their communities in this connectivity crisis. But those solutions, innovative as they are, are not permanent fixes. They are clever workarounds developed by people who care deeply about their communities. But they are no substitute for real, tangible resources and increased broadband coverage. This sentiment was not unique; as a firefighter from a focus group offered:

I always say there's no fairy waiting at the station for me that's gonna like, boop, here we go. I wish. I wish it was. If we could get a fairy like that, I'd be quite happy ... You got to be your own fairy.

Making do is exactly what our first responders are doing, as best they can. The rural spirit is alive and well in the care and devotion in their solutions. A firefighter who had

relocated from a metropolitan area compared his experiences: “In more rural settings ... or maybe it's just the people up here, it's more of like, ‘Oh, that thing doesn't work. I'm tired of it. I'm going to do it myself.’”

While these solutions are innovative and demonstrate the great care of our first responders for their communities, they are not a substitute for proper support and funding for communication tools for first responders. The solutions demonstrate that our rural first responders are in such dire need of better broadband coverage and more affordable technology that they must rely on unconventional tools and tricks to provide as much for the community as possible.

Theme 4: Funding

A major concern among our first responders is the lack of funding. Proper gear and tools for first responders are expensive. A ladder truck (traditional fire truck) properly outfitted can cost upwards of \$2 million dollars; the town of Storm Lake, Iowa just committed \$2.8 million to replacing one truck (Laidlaw, 2025). Costs have increased significantly over the past few years, and only three manufacturers do a significant portion of fire truck sales across the nation.

Fire trucks themselves are not the only expensive pieces of equipment. Equipment from trucks to personal gear and more are all extraordinarily expensive. A recent report claimed that the costs of outfitting a firefighter with just turnout gear and a (shared) air tank would cost \$18,000 and \$10,000 respectively; this cost does not factor in any training costs for the individual firefighter (Bruening, 2023).

This section offers more detail on the financial challenges faced by our responders. In doing so, we honor the needs and challenges of our participants. One challenge is the high cost of gear; one problem that multiple responders expressed frustration with was the pervasiveness of misinformation about how much it costs to support first responders. Several called to attention the seemingly unlimited technological capabilities and budgets displayed on television programs depicting first responders. The general public, according to responders, struggled to understand that they genuinely did not have the available funding. Programs like *911*, *Rescue 911*, *Chicago Fire*, and *NCIS* were specifically mentioned. In fact, one dispatcher reported that a caller was confused the dispatcher could not locate her, stating “‘well, they do it on TV.’” First responders were so frustrated with this that, in advice to us, a firefighter said that in thinking about their financial situation, “do not go by *Chicago Fire*.”

This is one of the major barriers identified by our responders but did not stop them from attempting to educate their communities and community leaders. The need for funding is felt deeply. A firefighter told us:

And I just kept getting told by the, the elected officials, ‘well, you haven't given me anything. You haven't given me a number.’ And it's like it frustrates me. And I sort of lost it the one night at the ... and the one [other] firefighter asked me, ‘why do you take it personal?’ I say, ‘this is personal to me.’

Sub-Theme 1: Affording Equipment

The issue of affordability is perfectly summarized by a focus group respondent in a rural county: “The best technology in the country doesn't do us any good if we can't afford it.” Communication gear for first responders saves lives of the callers and the responders. Radios in particular were described to us as extremely vital pieces of gear. On the scene, they are the primary mode of communication. They are how a responder communicates “mayday” with their team when they or their team are in dire situations.

As noted in themes 1 (technology) and 2 (inter-connectivity), radios are the lifeblood of first responders. More reliable, better connected, and more resilient than smartphones, radios can reach almost everywhere. But, radios do not come cheaply. Moreover, they need to be replaced whenever there is a change in frequency, or when they are outdated or broken. Radios are priced at a flat amount, but any additional capabilities and programming are charged separately. Because of this, the costs can vary widely and get extremely high. Every county struggled to afford portable radios, particularly for firefighters. Counties are quoted different prices based on their needs, with many stating that the ideal portable radio to communicate with each other and with dispatch would be approximately \$10,000.

The variance is partially due to the different levels of programming capability based on the county's needs. It is important, therefore, to consider both the costs of programming and of the physical radios. We spoke with firefighters who recently were given funding by the county and told to use it to reprogram their existing radios to keep up with the updated systems of other first responder branches. This caused issues when their radios, some of which are twenty years old, were unable to function with the updates. “But because of the new reprogramming that the system has done or that the 911 has done, the county has done, um, the older radios are obsolete and can't take some of the new programming.” This firefighter was not the only one in the house with this concern. Another firefighter described fear over the reprogramming shutting down their current radios, and included further concern that they would not be supported by their county should that happen:

[The county] paid for the reprogramming, but they were not paying for new portables ... And that was the scare. The scare with this new programming was you have this age [sic] radio. There's a chance that when we go to do the upgrade, it's gonna fail. And if it does, ‘that's your problem, not ours.’

The county's investment caused further issues for the firehouse by rendering some of their radios non-functional. For their firehouse alone, not including the entire department or county, they were quoted \$1.8 million dollars to replace all radios and reprogram them to the new standard of the county. This is completely out of their funding capability in the current funding structure without a massive grant.

While new technologies and apps can be lifesavers, that can only be true if the responders can afford to allocate for them in their standard budget. As one firefighter

said directly: “Yeah. But the technology is making things better for us, but it's just too expensive. Too expensive. And we need the, the government to help us.”

The sentiment was shared across counties. As long as technology continues to advance, there will continue to be tools developed which assist first responders in protecting the safety of our communities. Extrapolating from this point, because of the rapid advancements in technology, no communication equipment costs are ever one time only. Radios need regular replacement, with one source suggesting that radios last only 5 to 7 years (Pujalt, 2021). Compare this with the firefighter who said their department was using the same radios “coming up on 20 years.” Funding is not increasing in tandem with the increased financial burdens of the new technology. When asked about a wish list for first responder communication, a firefighter told us, “keep the technology advancing at an affordable cost ... at some point, you can only afford so much.” With first responders being priced out of the important technology, there are direct impacts on local communities in terms of response time and quality of care.

One reason radio costs are so high for firefighters is that they must have extremely high heat ratings, as they are quite literally carried into the fire. As a firefighter described to us: “that radio will burn before your turnout gear.” The exterior must be capable of withstanding temperatures without melting, and the batteries must be heat resistant as well, otherwise they are liable to explode and cause injury or worse to the responders and any civilians nearby. It is important to state that while cell phones and first responder apps are in use, they are not a replacement for radio. Cell phone devices (and especially their batteries) are not fireproof and would present danger to first responders. Because of this, firefighters rely on fire-rated radios, mostly (but not exclusively) Motorola, purchased with specific fire certifications. The need is specific and the market is niche, causing high costs. One firefighter described this, stating, “But you can go from a \$6,000 radio or \$15,000 radio just by turning on the features you need ... [radio manufacturers] know they can charge whatever they want.” As another firefighter put it: “Anything with fire on [it], the price goes up.” This drives prices out of range for many rural firefighters. Yet another firefighter told us his fire house would need \$375,000 to get proper radios for each member.

Our participants informed us that on top of the high prices, there are no discounts given by the companies, despite the fact that first responders volunteer and many of the organizations being registered 501(c)3 non-profits. As a firefighter explained it, “and they [device manufacturers], they don't really cut us a break. Like, we're paying what, what normal people would pay ... So it's, it's a hefty bill.” The lack of available discounts and deals was a source of discontent for many of our first responders. They felt that, especially given their service to the community, private companies were taking advantage of the specific safety-related needs. A firefighter described the feeling:

I question that myself. Like can you cut us a break for a volunteer nonprofit? Something? But, I mean, I guess we're just an account number that's able to pay, pay the money ... We'd like to catch [a] break. Sure. Deals. Deals and discounts.

Sub-Theme 2: Tradeoffs

Because of the high costs of both traditional first responder equipment and communication equipment, many responders had to make tradeoffs in terms of what tools or improvements they would choose to fund within their standard budgets:

I mean, the amount that these things are costing us is, is to the point where we as a fire company can't say, 'I'm gonna spend, you know, \$50,000 on one tool ... for this rig.' And that's it. I mean, that, that would pretty much be it. Like, that would be what we would spend for the entire year. That one tool.

That \$50,000, based on the prices we saw, could potentially only provide five to ten radios for a department. Departments also require unique safety gear, such as turnouts, and specific equipment, like the jaws of life, which often need to be prioritized in the small budget.

This tradeoff also happens when first responders consider their monthly, fixed broadband bills. When asked about the potential of Starlink (a low-Earth orbiting satellite service theoretically available in many rural counties), first responders in one county told us that the monthly cost for only one location was \$225. In their view, Starlink did not offer the connections necessary to be a reliable primary broadband service, but they were interested in purchasing it to improve redundancy in cases of emergency. Due to the cost, this plan was tabled. Tradeoffs caused first responders to sacrifice redundancy, which is key to ensuring proper responses.

Sub-Theme 3: De-Prioritization

In concert with the challenges of conveying the cost of responding was a feeling of de-prioritization by both county and state officials. Referencing a conversation with a county official about attempting to get increased funding, a firefighter said, but the county did what they wanted. The county commissioners and those, those people did what they wanted. They didn't care about us." Other responders reported similar issues. Even in cases where money was available, they had a difficult time asserting their needs to the county and being prioritized for funds.

In response to budgetary crises, first responders worked both to raise funds to increase their budget, and in policy advocacy for increasing funding at the government level. Several fire departments in counties discussed fundraising as a potential revenue source. This added to the responsibilities of the firefighters and especially fire chiefs, who were generally responsible for maintaining the administrative aspects of the fundraisers. Common practices included raffle ticket sales, bingo nights, and having department members cook and sell dinners to the community. When equipment was replaced through regular funds or grants, some counties sold their old equipment to make up for deficits in their budget. While these efforts made some money for departments, in many cases the funds raised were minimal in comparison to the high financial needs. Put succinctly by a firefighter, "\$12 meals are only gonna get you so far."

Additionally, fundraising adds to the labor burden of responders. As told to us by a focus group respondent:

And when you're a volunteer service, now you're asking for people not only to do what they wanna do, respond to calls. Now you're asking them for fundraising activities. Taking them away from things that ... other things that they should be doing when they're already volunteering.

Grants were another source of innovation for first responders. Many sought grants for specific communication tools and had success in some cases and failure in others. Unfortunately, grant applications were described as both extremely competitive to win, and very cumbersome and time-consuming. When asked about grants, a responder told us, “you can be blessed if you can get a grant.” While they are occasionally available, it is not enough to completely cover the need, especially since the need is continuous and ongoing.

Among nearly all our responders, there was also a feeling of urban bias in existing funding programs for first responders and for counties. This was a point of frustration for our responders. One county official who attended a focus group to support first responders there told us:

Funding is based from the state level and the federal level on population within your community Well, rural communities are at a total disadvantage from the very beginning. And how are you supposed to look different? How are you supposed to grow differently ...?”

Because funding orders from the state can be based on population, less-populated counties are less likely to receive higher amounts of state funding and aid. As this county official is pointing out, though, more densely populated counties are more likely to have other sources of revenue, like increased funding from property taxes. Additionally, they are more likely to have existing infrastructures, like cell phone towers. One county specifically detailed many problems with cell phone coverage that would require millions of dollars to effectively remedy. But as they point out, their small population makes it unlikely they can raise that on their own, and unlikely that they will be awarded it by Pennsylvania.

Urban bias in funding led to disillusionment of first responders. They felt deprioritized and at times neglected by the state. From our responders, we heard that “you know, the more rural you get, the less money you get;” and, “our county doesn't have a very big budget ... we're north of [route] 80, we have no money.” These responders deeply felt the wounds of being underfunded, and seeing their communities suffer as a result.

Conclusions

First responders in rural Pennsylvania are working with budgets significantly below their needs. Extremely high equipment costs mean they must make trade-offs in order to determine what to purchase, meaning counties must go without certain equipment or

tools. This creates major need for first responder communities. A firefighter told us, everything, everything, every way that we communicate. We need more of everything.” Emphasizing further the words of our first responders, we close with a quote. At the closing of every focus group, we asked first responders if there was anything else we should know. The first responders were aware of our project, and the audience of legislators and lawmakers who would be soon hearing their words. A firefighter responded with this impassioned plea: “And that ... and somehow, the state House and Senate need to open up their eyes and understand that the volunteer fire companies need help.” Reforms to funding structures are desperately needed to support our first responders and protect the safety of Pennsylvanians.

Discussion

After spending hours with rural first responders and listening to them speak about their experiences with information communication technologies and digital networks, we came away with four key themes through our thematic analysis:

- 1) Technological availability and use
- 2) Interoperability and interconnection
- 3) Ingenuity
- 4) Funding

From these themes, we conclude that digital technologies and communication networks fail Pennsylvania’s rural first responders in three distinct ways:

- Technology, including access to communication networks and infrastructure
- Labor, notably the extent to which first responders must work to ensure connectivity or improvise in moments without connectivity
- Resources, in the inability to access necessary funds

Themes 1 and 2 address the lack of connectivity among rural first responders, be it in terms of signal dead zones, a lack of technological options, or a lack of interoperability and interconnectivity. These experiences suggest issues of incomplete telecommunications infrastructure in Pennsylvania. Despite upgrades to our 911 system through the NextGen system and the promise of universal connectivity by the FirstNet network, gaps exist in terms of signals, signal strength, data streams, and even radio communication. Recall that NextGen 911 only works if a caller has connectivity in the first place. Meanwhile, a lack of consistent mobile signals exacerbates difficulties of interconnection between agencies and between counties. Multiple systems and multiple frequencies have also resulted in a patchwork of localized networks, stymying the ability of first responders to make vital connections with their counterparts. While it was hoped that the P25 project would rectify this, it is not a panacea. The fact that the Pennsylvania State Police remain outside the communication abilities of local first responders is an excellent case in point. Coordination is needed across all agencies and the PSP.

As briefly touched upon in theme 1 (technology), respondents from several focus groups were quick to note that a reason for dead zones was a lack of cell towers in their areas. Some told us that their counties had been investing both in towers and tower upgrades (with one respondent telling us that a tower costs upwards of \$300,000 to build), while others focused on a lack of such vertical assets in combination with topography:

It's tower coverage in some of the mountain area. Um, we have looked strategically at certain areas that may provide better coverage. Um, unfortunately, putting up a tower site for that type of coverage is, you know, any ... from anywhere from 1 million to 2 million [dollars] per tower.

Another respondent complained about the three cell major cell carriers (Verizon, AT&T, and T-Mobile): “I complain about the spotty coverage, but I think the big three all have spotty coverage because the towers ... are few and far between.” As a last example, one respondent admitted that the way to achieve “more consistent coverage” was more towers: “And no one really wants to see more cell towers, but I do think that’s probably what the answer is.”

The political economy of telecommunications in the United States makes the construction of more towers in rural and remote areas challenging because with a sparse consumer base, providers and tower owners are uncertain about the return on investment (Ali, 2021; Simon, 2025). Still, to achieve ubiquitous connectivity, both for the commercial providers and for FirstNet, especially in the mountainous areas of Pennsylvania, more towers are needed. To improve mobile connectivity in rural areas, the Federal Communications Commission has proposed a \$9 billion 5G Fund for Rural America. The fund was approved in 2024, but a timeline has yet to be announced (Neenan, 2025). As also noted, some mobile providers have recently turned to partnerships with satellite companies to improve rural connectivity (Dano, 2025). Lastly, through the federal government’s Broadband Equity Access and Deployment (BEAD) program Pennsylvania is slated to spend over \$700 million on broadband infrastructure in rural and remote areas, the majority of which will go to fiber optic networks. These networks are essential not only for broadband connectivity, but more mobile networks as well since they connect wireless signals back to the larger internet (PBDA, 2025). To that end, one respondent made note of Pennsylvania’s lack of municipal broadband options. Exploring this option would mean changing Pennsylvania law, as Title 66, Section 3014 of Act 183 of 2004 discourages municipalities from owning and operating broadband networks, absent onerous restrictions and efforts.

When communication issues happen, first responders have to rely on their ingenuity (theme 3), and do so through buddying up with other responders, using commercially available apps like What3Words, knowing their pull over spots, memorizing streets, passing down vital information to junior colleagues, relying on members of the public to get the word out about public safety concerns and bringing back paper maps. Said

differently, they have to make do. This ingenuity in response to communication issues adds extra work for rural first responders, who, as we noted in the background section, are already stretched thin because of staffing issues. First responders should not have to work this hard to fill the gaps left by communication networks. First responders put their lives on the line to ensure public safety, and they are not equipped with the resources they need to do their jobs. Crucially, many of the first responders in our study, as in previous studies (i.e., NIST), are not asking for the latest and newest. Instead, they want communication technologies that work and that work everywhere (Buchanan et al., 2023; Greene et al., 2019).

Ultimately, solving these issues comes down to resources and funding (theme 4). First responder communication technologies are exceptionally expensive and most of the first responder organizations in our study are working on tight budgetary constraints. Millions of dollars in technology upgrades for radios for firefighters, for instance, are difficult to justify when a single firetruck is \$2 million. Nevertheless, the first responder organizations in our study are doing all they can to stay relevant and ready [theme 3 (ingenuity)]. This means being selective about equipment upgrades, conducting their own fundraising initiatives like community meals, and trying to drive awareness to their issues among policy makers. But they also feel neglected and isolated. Rural sociologists have labelled this a feeling of urban normativity, where the default policy perception is that of an urban environment (Thomas et al., 2013). Rural neglect was a sentiment that we heard repeatedly in our travels across the Commonwealth.

In closing, we celebrate the dedication, innovation, and care of our incredible first responder community. However, we also urge those reading this report to heed their words: they need help. Despite the dedication of these public servants, without the necessary corrections, their safety, and the public's safety, may be threatened. The crisis of connectivity in Pennsylvania, therefore, is a direct threat to the health and well-being of Pennsylvanians across the Commonwealth. Crucially, there is the will and the desire to do great things among our rural first responders even with these challenges.

Policy Considerations

Unused Federal Broadband Non-Deployment Funds

To rectify the failings of connectivity we outline in this report, we offer a series of policy recommendations for state-level elected officials and stakeholders. Funding is a major challenge with rural first responder departments, and much of what we suggest requires additional funds. As a potential source, we note that Pennsylvania's portion of the federal government's Broadband Equity Access and Deployment (BEAD) program has a surplus of over \$400 million. The federal government is in the process of deciding how these non-deployment funds can be used by states. Should the funds be released to Pennsylvania, we recommend that the Pennsylvania Broadband Development Authority (PBDA) allocate a portion to be used for first responder and public safety purposes.

Connectivity Assessment and Tower Construction

First responders experience a lack of ubiquitous mobile phone coverage leading to numerous dead zones, regardless of provider; this is clear in both theme 1 (technology) and theme 2 (inter-connectivity). This creates a safety hazard for both first responders and for the public. In theme 3 (ingenuity), we note how this has forced additional labor on first responders, such as going door-to-door to use a landline phone. On the public side, as noted in the background section, a lack of ubiquitous mobile connectivity across the Commonwealth means that some in rural areas cannot call for help through the NextGen 911 system. Based on what we have learned about towers, the PBDA could conduct a statewide assessment of mobile connectivity, including the FirstNet network. As part of this assessment, we recommend that the PBDA assess vertical assets (towers and other tall structures) in Pennsylvania to plan for greater mobile coverage in rural areas. Based on that assessment, any improvements suggested by the PBDA could be funded with the BEAD non-deployment funds to create an incentive program for mobile network deployment and tower construction.

Addressing the Multiplicity of Radio Frequencies

Departments and counties use multiple radio frequencies which our focus group participants told us lead to interconnection and interoperability challenges. First responders noted that because different counties use different radio frequencies, and sometimes single counties make use of different frequencies, they often cannot connect with their counterparts. We note that the Commonwealth of Pennsylvania has adopted the P25 radio standard as a way to ensure interoperability, but that this has been adopted sporadically across counties, exacerbating interconnection issues [see the background section and theme 2 (inter-connectivity)]. We also found that while the PSP make use of the P25 network, they do so using encrypted channels, complicating how local first responders connect with the PSP. The need for inter- and intra-county interoperability and interconnection is essential, especially for neighboring counties and with the Pennsylvania State Police. We recommend that PEMA consider mandating the adoption of P25 across the state, and ensure that the cost of the transition is not placed on local departments or counties. PEMA could also work with the PSP to ensure that its frequencies are accessible to rural first responder agencies.

Replacing Outdated Radio Technology

In themes 1 (technology), 2 (inter-connectivity), and 3 (ingenuity), we note the reliance of rural first responders on their portable and mobile radios. We also note the expense of those devices and how this expense falls to local departments (who cannot afford it) when counties undergo frequency changes or when equipment becomes outdated. In theme 4 (funding), moreover, we note that at least one county department is using radios almost two decades old. With this in mind, we recommend that PEMA,

which oversees 911 infrastructure and the Commonwealth's transition to NextGen 911, and PSP, which oversees the P25 project, work together to negotiate jointly with radio manufacturers to secure a preferential rate for first responder organizations to make the purchase of equipment more affordable.

Funding Shortages

A key takeaway from this research is that rural first responder departments face extreme funding shortages that make digital improvements and other equipment purchases almost impossible. In themes 3 (ingenuity) and 4 (funding), we found that many departments lack adequate funds to ensure their digital equipment is up to date and up to the standards adopted by their counties and by the Commonwealth of Pennsylvania. The cost of digital devices, which can be upward of \$10,000 for a radio, exacerbates the funding shortages. Departments are relying on fundraising efforts to fill the gaps, but it is not enough. In the background section, we also found that local funding for first responders is capped for many municipalities through a set percentage of property taxes; this has prevented municipalities from funding first responder needs themselves. In 2024, PA Act 54 increased this limit for boroughs in three counties, while the proposed H.B. 393 (2025) promises to increase the limit for an additional 1,400 municipalities. To address the issue of funds, we recommend that more funding be allocated to rural law enforcement, fire, EMS departments, and PSAPs from the General Government Operations (GGO) based on need and rurality. We also recommend that Governor Shapiro's \$30 million grant program for first responders be part of future Pennsylvania budgets and developed into an annual grant program. In terms of property assessments, we recommend the General Assembly expand PA Act 54 to include all municipalities in the Commonwealth and that County Assessment Offices ensure that all property tax assessments are current.

Funding for the NextGen 911 System

Our background research taught us that while the NextGen 911 system is operational in all Pennsylvania PSAPs, it still requires monitoring and improvements. As noted in the background section, in summer 2025, the Commonwealth's 911 system, which had only just completed its transition to NextGen 911, experienced intermittent outages for several hours. In theme 2 (inter-connectivity), we also noted that while the NextGen 911 upgrades allow PSAPs to communicate with each other, first responders experience communication challenges when trying to reach PSAPs that use different frequencies. To help address these issues, we recommend the General Assembly make the \$1.95 911 fee permanent rather than sunseting it in 2029.

State Leadership Awareness

First responders in rural counties expressed the sense that leaders in Harrisburg do not understand the daily challenges of providing services. One possible solution is that the Center for Rural Pennsylvania organize a rural first responder tour for elected leaders.

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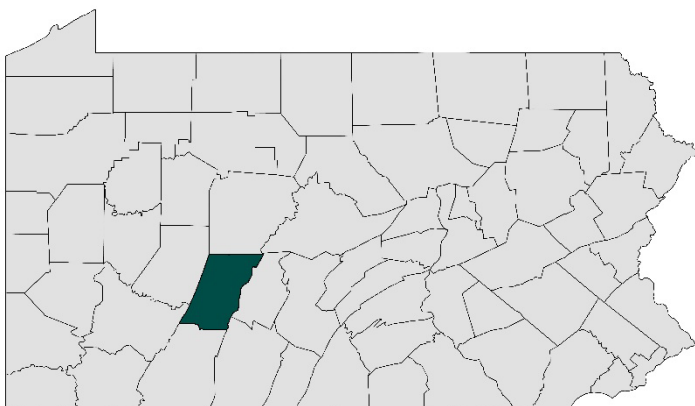
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Appendix 1: County Focus Group Descriptions

Cambria County, Pennsylvania



Source: PennDOT

Population: 130,108

Police Departments*: 30
(municipal) + 5 (regional
service) + 12 (contract) + PSP

Fire Departments: 47

EMS Services: 19

PSAP: 1

Fixed Broadband (at 100/20):
93.16%

Mobile Connectivity (at 4G):
97.26%

Pressing Issues Facing Cambria Co. First Responders:

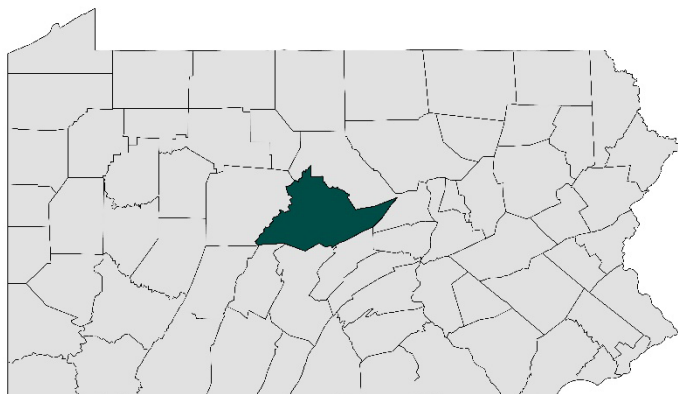
- First responders face interoperation challenges with adjacent counties that use 400 MHz or not included in ICORRS, implying that unified system is needed
- Due to communication issues with neighboring counties, there is a dispatch delay, especially when a call is from adjacent counties do not use 800MHz
- Cambria first responders are mandated to use Motorola's radio, but the price is high whereas some products offer nearly identical specifications at half the price
- FirstNet works well generally; however, there are several dead zones.
- More funding and grants are needed to cover equipment costs. First responders have to pay by themselves if funding grants do not cover costs

Data sources: Population data were obtained from the 2023 U.S. Census American Community Survey (ACS). Broadband and mobile connectivity data were retrieved by the author from the Federal Communications Commission (FCC). Fire and emergency medical services (EMS) data were obtained from the [Pennsylvania Firefighters Association](#). Police department data were obtained from the [Pennsylvania Department of Community and Economic Development \(DCED\) Municipal Statistics website](#).

Pressing Issues were derived by the authors from analyses of qualitative interviews or focus groups.

*Note: "Municipal" refers to the number of police departments operated by individual municipalities; "contract" refers to municipalities that receive police services through a contract with another municipality.

Centre County, Pennsylvania



Source: PennDOT

Population: 158,172

Police Departments*: 5
(municipal) + 2 (contract from
another county) + PSP

Fire Stations: 19

EMS Services: 14

PSAP: 1

Broadband Connectivity (at
100/20): 92.43%

Mobile Connectivity (at 4G):
91.89%

Pressing Issues Facing Centre Co. First Responders:

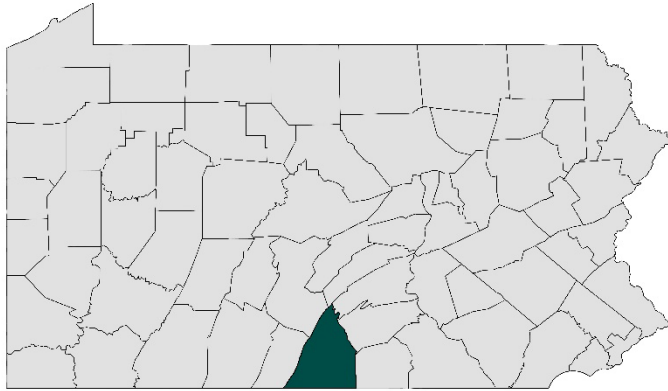
- Radios are essential for on-scene communication, but the cost to replace radios is far beyond the standard budget.
- New communication equipment, including updated radios, is the highest priority for Centre Co. first responders.
- Costs of firefighting continue to rise, and corporations are not partners in lowering costs.
- Budgets are set based on outdated data that no longer represents the area, further exacerbating existing budget issues.
- Communicating the needs of first responders to lawmakers is extremely difficult; they do not seem to understand how high the costs of fire equipment are.

Data sources: Population data were obtained from the 2023 U.S. Census American Community Survey (ACS). Broadband and mobile connectivity data were retrieved by the author from the Federal Communications Commission (FCC). Fire and emergency medical services (EMS) data were obtained from the [Centre County EMS Directory](#). Police department data were obtained from the [Pennsylvania Department of Community and Economic Development \(DCED\) Municipal Statistics website](#).

Pressing Issues were derived by the authors from analyses of qualitative interviews or focus groups.

*Note: "Municipal" refers to the number of police departments operated by individual municipalities; "contract" refers to municipalities that receive police services through a contract with another municipality.

Franklin County, Pennsylvania



Source: PennDOT

Population: 159,285

Police Departments*: 4
(municipal) + 1 (regional
service) + PSP

Fire Departments: 17

EMS Services: 16

PSAP: 1

Broadband Connectivity (at
100/20): 93.81%

Mobile Connectivity (at 4G):
94.11%

Pressing Issues Facing Franklin Co. First Responders:

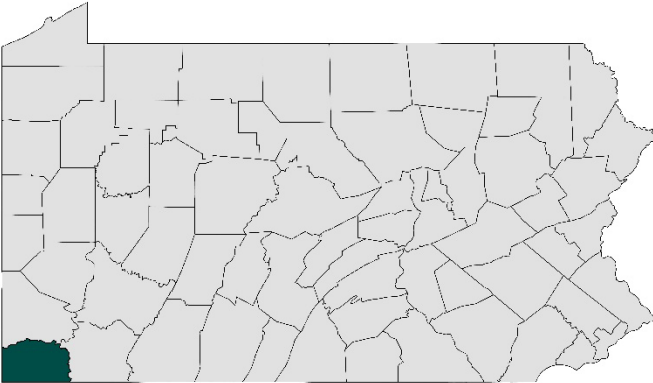
- First responders face lack of connectivity challenges, which lead to significant navigational issues in getting to scenes, and with callers alerting dispatch to their emergency
- In some areas, there is complete loss of cell coverage
- Geographical and environmental conditions (e.g., heavy snow)
- Due to tight budget and expense issues, first responders cannot use MDT/mobile CAD, which would help reduce radio traffic
- One channel is shared by more than 16 departments. This causes congestion of traffic, and, in turn, calls can be denied

Data sources: Population data were obtained from the 2023 U.S. Census American Community Survey (ACS). Broadband and mobile connectivity data were retrieved by the author from the Federal Communications Commission (FCC). Fire and emergency medical services (EMS) data were obtained from the [Pennsylvania Firefighters Association](#). Police department data were obtained from the [Pennsylvania Department of Community and Economic Development \(DCED\) Municipal Statistics website](#).

Pressing Issues were derived by the authors from analyses of qualitative interviews or focus groups.

*Note: "Municipal" refers to the number of police departments operated by individual municipalities.

Greene County, Pennsylvania



Source: PennDOT

Population: 33,960

Police Departments*: 2
(municipal) + 2 (regional
service) + 1 (contract) + PSP

Fire Stations: 16

EMS Services: 9

PSAP: 1

Broadband Connectivity (at
100/20): 80.3%

Mobile Connectivity (at 4G):
80.63%

Pressing Issues Facing Greene Co. First Responders:

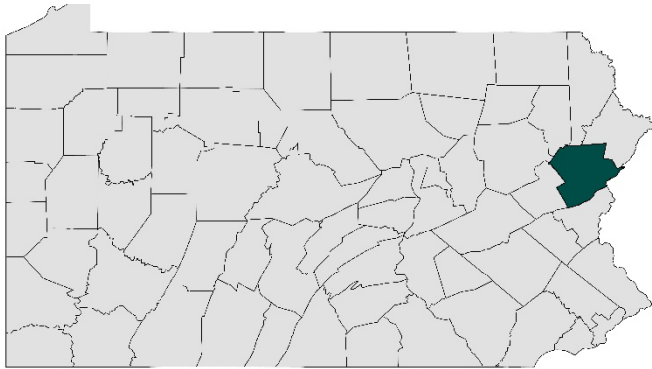
- Lack of connectivity is rampant in Greene Co. and surrounding areas.
- Without reliable connectivity there are issues creating redundancy, which is imperative for the safety of both responders and of those in emergency situations.
- Responders are having to spend their own funds to be properly equipped with communication tools.
- There is not enough funding to properly address connectivity needs.
- Grants and state funding favor higher populated urban areas, leaving behind areas of high need like Greene Co.

Data sources: Population data were obtained from the 2023 U.S. Census American Community Survey (ACS). Broadband and mobile connectivity data were retrieved by the author from the Federal Communications Commission (FCC). Fire and emergency medical services (EMS) data were obtained from the [Greene County Department Directory](#). Police department data were obtained from the [Pennsylvania Department of Community and Economic Development \(DCED\) Municipal Statistics website](#).

Pressing Issues were derived by the authors from analyses of qualitative interviews or focus groups.

*Note: “Municipal” refers to the number of police departments operated by individual municipalities; “contract” refers to municipalities that receive police services through a contract with another municipality.

Monroe County, Pennsylvania



Source: PennDOT

Population: 167,198

Police Departments*: 2
(municipal) + 8 (regional
service) + PSP

Fire Stations: 19

EMS Services: 8

PSAP: 1

Broadband Connectivity (at
100/20): 98.33%

Mobile Connectivity (at 4G):
98%

Pressing Issues Facing Monroe Co. First Responders:

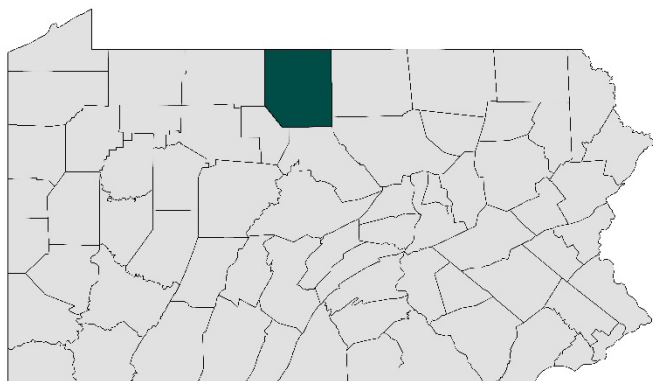
- Lack of connectivity impedes the ability to provide care.
- Technology developing faster than connectivity presents additional problems with standardizing communication.
- Lack of interoperability between providers is a huge setback in major emergencies.
- Funding is always a problem, and first responders feel de-prioritized.
- More providers in the region would increase ability to respond, connectivity, and redundancy.
- Profitability model of telecommunications causes problems in rural coverage that municipal broadband could solve.
- Latency of networks is a problem, even sometimes more than bandwidth

Data sources: Population data were obtained from the 2023 U.S. Census American Community Survey (ACS). Broadband and mobile connectivity data were retrieved by the author from the Federal Communications Commission (FCC). Fire and emergency medical services (EMS) data were obtained from the [Monroe County Municipality and EMS Contacts](#). Police department data were obtained from the [Pennsylvania Department of Community and Economic Development \(DCED\) Municipal Statistics website](#).

Pressing Issues were derived by the authors from analyses of qualitative interviews or focus groups.

*Note: "Municipal" refers to the number of police departments operated by individual municipalities.

Potter County, Pennsylvania



Source: PennDOT

Population: 15,993

Police Departments*: 3
(municipal) + PSP

Fire Departments: 9

EMS Services: 8

PSAP: 0 (dispatching through
Tioga County)

Broadband Connectivity (at
100/20): 96.34%

Mobile Connectivity (at 4G):
72.51%

Pressing Issues Facing Potter Co. First Responders:

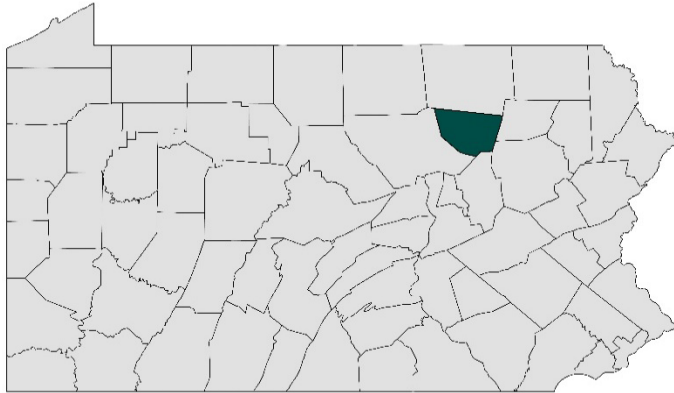
- First responders heavily rely on radio due to dead zones and coverage gaps
- Interoperability issue across counties and within centers caused a time lag (even up to 20 minutes) between the first call and dispatch
- Calling and classification procedures that rely on radio communication cause additional dispatching delays
- There are many areas that first responders cannot use either cell or internet service
- More funding is needed to update and unify communications systems and channels

Data sources: Population data were obtained from the 2023 U.S. Census American Community Survey (ACS). Broadband and mobile connectivity data were retrieved by the author from the Federal Communications Commission (FCC). Fire and emergency medical services (EMS) data were obtained from the [Pennsylvania Firefighters Association](#). Police department data were obtained from the [Pennsylvania Department of Community and Economic Development \(DCED\) Municipal Statistics website](#).

Pressing Issues were derived by the authors from analyses of qualitative interviews or focus groups.

*Note: "Municipal" refers to the number of police departments operated by individual municipalities.

Sullivan County, Pennsylvania



Source: PennDOT

Population: 5,927

Police Departments: Only PSP

Fire Departments: 9

EMS Services: 7

PSAP: 0 (dispatching through
Lycoming County)

Fixed Broadband (at 100/20):
48.36%

Mobile Connectivity (at 4G):
67.72%

Pressing Issues Facing Sullivan Co. First Responders:

- First responders face lack of cell and internet connectivity issues. They described that many areas in county that do not have cell or internet service at all
- In terms of field communications, while they mainly use radio, there are dead zones, particularly in valley area
- When responders operate in areas with weak or nonexistent cellular or internet coverage, they experience safety issues when they cannot request backup or mutual aid
- They face interoperation issues with other agencies, especially with state police systems
- First responders described that they are operating on extremely tight budget

Data sources: Population data were obtained from the 2023 U.S. Census American Community Survey (ACS). Broadband and mobile connectivity data were retrieved by the author from the Federal Communications Commission (FCC). Fire and emergency medical services (EMS) data were obtained from the [Pennsylvania Firefighters Association](#). Police department data were obtained from the [Pennsylvania Department of Community and Economic Development \(DCED\) Municipal Statistics website](#).

Pressing Issues were derived by the authors from analyses of qualitative interviews or focus groups.

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