Police Radio History and Innovation: What Have We Learned?
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Abstract
The history of electronically-assisted police communications began with the telegraph and telephone, eventually evolving into wireless radio. Innovators recognized telegraph as a way to send information from one location to law enforcement officials in another venue. Telegraph and telephone development in the 19th century brought about the first dispatching from a base station to the field. Police officers no longer had to respond to the department to receive calls for service. The use of radio transmissions began as a way for officers to receive information, but soon transformed the policing world when two-way communications became available. Radio improved over the years with the advent of secure digital frequencies and portable units capable of switching between many different channels. With modern computer technology and truncated digital frequencies, police departments still suffer difficulties communicating with one another. After disasters such as Hurricane Katrina and the 9/11 attacks, established departmental policies hinder further progress in communications.

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Since the inception of policing, law enforcement agencies faced communication difficulties between officers, other agencies and the public. Communicating with the public and with officers was slow as word of mouth was the only means of relaying information. Innovations such as telegraph, telephone, and radio relayed information quicker. Further improvements in communications allowed for the mobility of radio transmissions, but also Internet, text, pictures, and video. With all of these modern innovations, police and other emergency service agencies still lack the ability to communicate with other agencies freely. Departments from neighboring jurisdictions often lack the ability share information with radios or computers. This research examines the history of police communications, modern innovations, and reasons for the inability to communicate between agencies, even after problems with interoperability became apparent during recent critical events such as Hurricane Katrina, Columbine, and 9/11.

The need for unified emergency response communication interoperability became apparent during events such as Hurricane Katrina, the bombings in New York and Oklahoma City, and the shooting at Columbine High School. Emergency responders from many different jurisdictions arrived at these scenes and found they had no way to communicate with one another. In each of those events, it was necessary to employ runners to carry communications between different command posts even though all responders were equipped with mobile radios (National task force on interoperability, 2005). The radios lacked the ability to transmit to the local jurisdiction’s dispatch center. Have radio communications for emergency responders improved since the last major incident? Unified digital radio standards defined by Project 25 provide interoperability technology to police agencies. In most areas, however, agencies still lack the ability to communicate with neighboring departments. To discover why, it is necessary to analyze the history of police communications.

History

Morse’s invention of the electronic telegraph in 1835, and the further development of Morse Code by Vail in 1838, allowed remote stations to communicate with one another (Connected Earth). In 1846, Scotland Yard installed the first telegraphs linking their main office to a central communications center. This center, privately owned by the Electric Telegraph Company, relayed messages to satellite district stations. Soon after this, telegraph technology came to American police departments. The New York Police further developed this technology when installing a dial system of telegraph which allowed officers to send messages without code (Leonard, 1938).

By the end of the 1800s, police agencies utilized a new technology, the telephone. The first known use of the telephone in police communications was in Albany, NY, in 1877. Telephones were installed allowing communication between the mayor’s office and the five police districts. Washington D.C. adopted the first call boxes equipped with telephones linked to a central dispatch in 1883. A signal box equipped with an illuminated signal was installed on the streets of Glasgow, Scotland in 1891. This box not only provided officers a way to communicate
with a central dispatch, but it allowed dispatch to alert officers of a pending call for service.  
(Stewart, 1994).

In the decades after Marconi’s first wireless communication patent in 1897, radio broadcasts by amateur radio enthusiasts became common. Some police agencies recognized the potential of wireless communications and began devising ways to send dispatches to patrol cars. Victoria, Australia police completed the first wireless communication by sending a Morse code transmission between a central dispatch and a patrol car in 1923 (My emergency services, 2013).  In 1924, the Detroit Police successfully transmitted voice dispatches from a central location, which were received by mobile radio installed in a patrol car (Institute of Electrical and Electronics Engineers, 1987).

In order to broadcast radio dispatches, the Detroit Police acquired a license from the Federal Radio Commission (FRC), predecessor to the Federal Communication Commission (FCC).  The FRC mandated that transmissions of entertainment value be included with police dispatches. In response, police agencies broadcasted the song “Yankee Doodle Dandy” before each radioed call for service. W.P. Rutledge, an early pioneer of police radio, commented on the unnecessary meddling by the federal government:

Before much progress can be made, we must receive full cooperation from those who control the destinies of police radio ... the Federal Radio Commission ... The progress achieved by the Detroit Police Radio Division... has been obtained in spite of the federal authorities, rather than with their cooperation. (Poli, 1942, p. 194)

This would not be the last time federal authorities interjected into police communications. Not all of the efforts by federal authorities were detrimental, as shown by the development of Project 25 and organization of the radio spectrum.

Two-way communications continued improving with the implementation of the hand-held radio and microwave transmissions. Worn on the belts of foot patrol officers in Atlantic City, NJ, the first hand-held radios allowed wireless talking communications by 1940 (Poli, 1942). Point-to-point communications between police stations became problematic in the 1950s due to the increase in demand for the radio frequency spectrum. Innovations in microwave technology allowed for higher frequency radio wave transmissions that generally do not interfere with other types of broadcasts such as television and public radio. Additionally, microwave radio links require no cable connections between stations, allow for fast movement of large amounts of data, and can be set up between any two points as long as there are no solid obstructions in the line of sight (Institute of Electrical and Electronics Engineers, 2014).

More demand for bandwidth from both the private and public sectors continued throughout the 1960s and 1970s. Reallocations of the radio spectrum by the FCC forced police and emergency responders into smaller ranges of the radio spectrum. This led to several key innovations such as digital transmitting, trunked radio systems, and interoperability standards accepted by radio manufacturers.

Digital radio transmissions technology allowed for computers to analyze communications data. Prior to digital radio, a fixed frequency allowed for one transmission at a time. All officers heard every transmission by each individual user on the fixed frequency. Larger departments needed more fixed frequencies. Digital radio transmissions were digitized into packets, allowing computers to sort many points of contact using fewer frequencies. Digital transmissions allowed for the further innovation of trunked radio systems.
Trunked radio systems allow a large number of users to communicate with a small number of different frequencies. Groups of users sharing a common purpose, such as patrol districts, SWAT, or other specialized units, are assigned a channel by a computer. The entire department shares a few frequencies, but trunking splits those frequencies into many distinct channels. Tuning to the desired channel filters in group communications to the user while blocking all others (Veeneman, 2005).

New problems surfaced as digital and trunked radio manufacturers developed these systems giving little consideration to interoperability with competitor’s systems. Concerns over interoperability between digital radio systems led to standardized protocols such as Terrestrial Trunked Radio (TETRA) in Europe and the Association of Public-Safety Communications Officials-International (APCO) Project 25 in the United States. Project 25, according to a Colorado research team, was a:

$2 Billion initiative… launched jointly by two national industry groups: 1) the APCO, and 2) the National Association of State Tele-communications Directors (NASTD), and four federal U.S. government agencies including: 1) the National Telecommunications and Information Administration (NTIA), 2) the National Communications System (NCS), 3) the National Security Agency (NSA), and 4) the US Department of Defense (DoD). (Merchant, p. 2)

The intent of Project 25 was to assure all emergency responders had the means to communicate with one another. However, Project 25 failed to address problems outside of the digital standardization of radio frequencies.

The Problems

Technological advances in communications allow emergency responders to communicate within their own groups with ease and clarity. The problem, however, lies not with technology, but with the absence of mitigation strategies, compatible radio frequencies and equipment, and adequate funding. As pointed out earlier in this research, Project 25 and TETRA provided interoperability standards to enable all emergency responders to talk to one another, but these unresolved issues still block communication.

The lack of mitigation concerning potential difficulties in emergency responder’s communications is nothing new. Two-way radio communications presented potential problems soon after it was introduced to law enforcement. As early as 1938, Leonard identified problems associated with law enforcement placing too much emphasis on current events and failing to mitigate for critical incidents:

Police departments are usually so busy administering current business that they give little thought to the planning of police procedure for times of disaster or catastrophe, such as great earthquakes, fires, floods, or tornadoes, or for times of social disturbance, such as race riots, strikes, and political upheavals. Furthermore, they may function for years without ever being faced by the pressing problems which a great earthquake, fire, or flood brings; and this tends to lull them into a false sense of security – false because no community can be certain that it will not be the scene of the next disaster. (1938, p. 320)

Leonard pointed out mitigating for a critical incident should include plans to incorporate alternate ways to keep communications operational. Over fifty years later, however, communications failures during key critical incidents proved the value of mitigation.
Problems associated with failing to mitigate alternate strategies for communications surfaced during events such as the Oklahoma City bombing (1995) and the Columbine High School shooting (1999). On April 19, 1995, Oklahoma City emergency personnel responded to a bombing at the Alfred P. Murrah Federal Building. The police department had four radio channels while the fire department had two. The fire department dedicated one channel to the scene while keeping the other open for all other fire dispatch traffic for the rest of the city. All police channels quickly became congested, as did the cellular phone network (Mayer-Schoenberger, 2002). Similar problems arose on April 20, 1999, at Columbine High School emergency responders from surrounding counties, cities, and state agencies arrived with radios unable to communicate with the local dispatch. Mayer-Schoenberger (2002) summed up the problem:

Within the first hour of the operation, the Jefferson County, Colorado, dispatch center lost access to the local command post because the radio links were jammed. Steve Davis, public information officer of the Jefferson County Sheriff’s Office, later commented that “Radios and cellular phones and everything else were absolutely useless, as they were so overwhelmed with the amount of traffic in the air.” The real miracle of Columbine High is that nobody else got killed because of the complete communications breakdown, either through friendly fire or uncoordinated agency activity. (p. 4)

The second challenge is finding a common radio frequency or compatible equipment capable of communicating over neighboring networks. Interoperable radios, like those manufactured to Project 25 and TETRA standards, are capable of communicating over modern digital networks of many kinds, but the radio spectrum is widespread over varying frequencies. Public safety frequencies occupy 10 different bands of the radio spectrum, ranging from 25 MHz to 4.9 GHz (McEwen), making it nearly impossible for multi-jurisdictional responders to maintain interoperability. Moore (2005), researching this topic for Congress, stated:

The immediate barrier to achieving radio communications interoperability is, simply put, that UHF and VHF frequencies cannot connect directly with each other, and that older, analog equipment widely used below 512 MHz cannot connect with newer digital equipment at 800 MHz. (p. 7)

The biggest obstacle to interoperability, however, is the absence of funding. The cost of outfitting a dispatch center and officers with Project 25-compatible radios is much higher than previous analog UHF and VHF networks. Hand-held radios can cost as much as $3000 (Moore, 2005). Cost estimates for replacing older radio networks nationwide exceeds $18 billion, over 80% of which will come from local and state funds (Mayer-Schoenberger, 2002). Additionally, agencies incur the costs of training and practicing to use the new system. Grants from the federal government, such as Community Oriented Policing Services–Making Officer Redeployment Effective Grants (COPS-MORE), the Urban Area Security initiative, and the Public Safety Interoperability Implementation Act, seek to fund, at least partially, state and local efforts to improve interoperability. However, grants provide only a fraction of the necessary funds to update out of date and incompatible systems.
Conclusion

From the beginning, problems with communications between emergency responders existed (e.g., Technology advanced communications from word of mouth to wired point-to-point conversations to wireless broadcasting). Modern radios are capable of using a small amount of bandwidth, while linking hundreds of users. The latest innovations in radio technology will allow all emergency responders to communicate with one another, regardless of venue. Critical incidents like the 9/11 terrorist attacks, the Columbine shooting, and the Oklahoma City bombing, showed the need for radio communications interoperability. Still, few departments have the ability to communicate with neighboring agencies due to technological incompatibilities.

Agency heads mitigate strategies for critical events, which will require response from multiple jurisdictions, as well as state and federal agencies. Not only do mitigation plans need to include considerations for logistics, finance, and recovery, but also for communications. Recent critical events shown public safety radio systems fail when overloaded with users. Responders from other agencies oftentimes cannot use the host agency’s frequency. Cellular phone communications also fail due to the high demand placed on networks by victims, responders, and the media.

To improve interoperability, departments nationwide should upgrade radios to use a common part of the new radio spectrum. The recently allocated 4.9 GHz frequency range, dedicated solely to public safety communications, is a good choice. This frequency range allows for digital truncation to maximize the number of users, while maintaining a narrow band. Neighboring agencies will use a similar system with compatible radios, insuring all responders to a critical incident will have interoperable communications.

Undoubtedly, the biggest hurdle to interoperability lies in funding. Agencies are already strapped by the growing costs of personnel and equipment. Few agencies can afford the high costs of upgrading radio systems to a digital network in an all-new radio frequency. Some agencies refuse to relinquish old UHF and VHF networks, which are not interoperable with modern radios. The federal government once favored the push for interoperability, but momentum has slowed in recent years. Funding for interoperability has diminished somewhat, but still exists in a few grant programs. Many of these grants go unrewarded, unfortunately, as they require matching funds from the requesting agencies up front (Mayer-Schoenberger, 2002).

With well over one hundred years of innovations and improvement to public safety radio communications, we still cannot talk to one another. The time has come to mitigate for communications during critical events, migrate to a common part of the radio spectrum, and to find funding to upgrade radios to allow for interoperability. Public safety depends on emergency responder’s ability to react quickly and safely in the face of danger. A lack of interoperability should not deter from that ability.
About the Author: Travis Brown is a police specialist at the Fort Mitchell, Kentucky Police Department. He received his BA in Police Administration at the University of Louisville. He is currently nearing completion of his Master’s Degree in Public Administration at Northern Kentucky University. During his twenty-one-year career as a police officer, Brown served with the Kentucky State Police as a trooper and a detective. In Fort Wright, Kentucky, Brown served as an office and a detective, becoming the evidence and property manager. Brown still serves as evidence and property manager with the Fort Mitchell Police Department where he currently serves as a police specialist. In the future, he plans to retire and look for new challenges in municipal governmental management. In addition to policing, Brown pens a wine blog named the T-Scale. He currently resides in Florence, Kentucky with his wife Christina, their dog Maggie, and his BMW motorcycle. He can be contacted at troopintj@gmail.com
References


