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Impact of Mobile Broadband Data Access on Police Operations:

An Exploratory Case Study of One Medium-Sized Municipal Police Department

Final Report

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Executive Summary

The present study has three primary objectives. First, this study seeks to explore the impact of dedicated mobile broadband technology on the operations of a medium-sized municipal police department in the northeast United States – Brookline, Massachusetts Police Department. As will be discussed, there is a lack of scientifically informed and independent knowledge with respect to how a large-bandwidth wireless capability may influence law enforcement's daily operations. Specifically, this capability may improve the police operations of information sharing, reduce time spent on administrative tasks, and improve police response time to calls for service, and the clearance of such calls. Second, this study seeks to provide guidance for implementation and practice within the field. As the movement towards law enforcement wireless networks gains momentum, the persons tasked with implementing this capability and developing policies to guide its use will be faced with challenges in an arena where little is known. This study seeks to inform their journey through best practices and evidence-based outcomes. Third, this study seeks to establish an empirical foundation for mobile broadband and large bandwidth digital communications research.

The ability of a law enforcement officer to perform certain functions such as completing a report, conducting training activities, or other authorized activities while away from his/her agency's home office, or while using a portable computing device, is becoming critical for many law enforcement agencies. This capability requires two things: an appropriate "mobile" end user computing device (e.g., computer, laptop, smartphone, tablet and associated software) and a suitable wireless communications channel. The quality and capacity of the communications

channel regulates, and often defines the underlying ability to remotely access and update data, wirelessly, as the user and associated computing devices physically move throughout his/her assigned duty area. Worth noting is that mobility refers to an inherent ability to move about, and "mobile computing" is a generic term referring to the functional capabilities made possible for end users, continuously, as they complete tasks from various physical locations. The process of an end user interacting with the computing device to access remote resources in real-time may be distinguished from the device automatically accessing remote resources, while performing essential background processing functions, e.g., to update locally stored data or to send data from the device to an agency processing center. These two inter-related, but independent processes, are both dependent upon the same wireless network resources. "How" these resources are leveraged is greatly dependent upon network and application software design choices. The term "broadband" refers to the (relatively wide) bandwidth characteristics of the wireless transmission medium and its corresponding ability to support multiple users and/or transport suitable quantities of data. For the purposes of this report, "mobile broadband" is used as a generic term to collectively refer to both terms in context of the aggregate capabilities made possible through their use, in comparison to other available mobile solutions and/or data.

In September 2012 the Government Accountability Office (GAO) issued a report to Congressional Committees calling for an improvement upon the quality of broadband data gathered – specifically noting "progress of the broadband projects is difficult to measure because of data limitations...struggles exist to demonstrate the progress and effectiveness of the broadband programs" (U.S. Government Accountability Office, 2012, p. i). To this point, the academic knowledgebase has been unable to maintain pace with emerging technologies within the field of policing. The literature is robust with respect to police information technology and mobile computing, yet there is a dramatic shortcoming with regard to digital data communications. Though this study is an explorative evaluation of mobile broadband and police operations, both the academic and professional communities are in dire need to be independently informed of this emerging capability.

The current study may have important policy implications. There are a number of critical decisions being made nationwide on spectrum, funding, technology, procedures and policies relating to wireless broadband data access; Brookline provides an opportunity to evaluate key operational issues related to such access. Brookline's deployment provides an opportunity to specifically consider the role 4.9 GHz technology and advanced technology in network bonding (since Brookline's deployment includes two logical broadband networks implemented over one physical network, as described below). This work aligns with the President's Spectrum Initiative; supports spectrum management and reallocation work currently underway within the Department of Commerce, and supports ongoing activity within the Federal Communications Commission to increase use of and perceived value of 4.9 GHz spectrum by public safety.

A variety of technological innovations are currently facing policing – ranging from automated license plate readers to mobile broadband access. In an effort to determine a baseline about police use of various technologies, a study conducted by the Police Executive Research Forum in 2012 surveyed law enforcement agencies and interviewed technology subject matter experts from a representative sample of law enforcement organizations about their current technologies. A consistent theme throughout this report was an acknowledged lack of public safety access to wireless broadband data given resource limitations and a lack of independent evidence by which justifications for such technologies can be made in order to secure procurement (Police Executive Research Forum, 2012). Though a knowledgebase does exist with respect to advancements in police information technology, as well as mobile computing, and the impacts such technology can have on police operations, there has yet to be an empirical exploration of the digital communication medium through which these hardware and software innovations are enhanced. Wireless mobile broadband serves as this desired medium.

Conducting an empirical evaluation of technological capabilities is often difficult and rarely employed from an operational perspective – that is, how does the technology impact the efficiency and effectiveness of police functions? There are truly very few public safety organizations in the U.S. that currently have an operational wireless broadband capability using dedicated, licensed frequencies. The agency selected for this operational evaluation was Brookline, Massachusetts Police Department. For purposes of conducting this unique operational evaluation, in addition to identifying a location that had the appropriate technical characteristics for such an evaluation, the researchers required an agency with a point of contact that could provide insight into the technical, operational, and business aspects of the network implementation. Moreover, this point of contact would need to act as an advocate and liaison for purposes of identifying and collecting data in order to see the scientific evaluation to the end. Brookline was selected as a result of their public-private partnership with a commercial carrier; a partnership that provided mutual fiscal incentives to deploy a shared infrastructure. Brookline was also one of the first municipalities to include an innovative licensed 4.9GHz public safety access network dedicated to support the town's emergency services wireless broadband communications needs. Moreover, the point of contact within the Brookline Police Department met, and exceeded, all of the components of the evaluation research criteria.

Through the application of a social science mixed methods case study approach, the purpose of the study was to describe the operation of one form of wireless broadband technology and determine the efficacy of this technology on police operations. Two primary research questions guided this research. First, was the wireless broadband technology implemented in accordance with initial expectations? Second, did the implementation have any effect on police operations related to information sharing, completion of job and administrative tasks, and response times to calls for service? Semi-structured interviews with select uniformed personnel, a web-based survey of all uniformed personnel, and a secondary analysis of computer-aided dispatch data were used to answer these questions.

Overall, the semi-structured interview results suggest that the wireless broadband technology was implemented with minimal difficulties and produced a number of perceived benefits for the department. The most direct benefit appeared to be the ease with which departmental technologies could be managed. Additional benefits were associated with increased access to timely information, increased information flow, and increased quality of reports. One of the main issues driving the procurement of a broadband wireless network were previous complications with information access, information exchange, and report writing due to unreliable commercial cellular provider wireless coverage. These results lend partial support to the notion that the network met anticipated expectations of improved information access and exchange.

Implementation and change, however slight, has the potential to create an assortment of problematic unintended consequences. This did not appear to be the case in Brookline. Semi-structured interviews revealed that a few weeks of training sessions and ongoing informal bulletin and email disseminations were needed to overcome skepticism about the transition to wireless broadband. The web-based survey results indicate most of the uniformed personnel noted they were aware of the change to wireless broadband and had received some form of training about the transition. Most of the uniform personnel did not oppose the implementation, nor did they perceive that the department was against the transition.

The other implementation challenge revealed during semi-structured interviews was the perceived increase in workload responsibilities associated with report writing. Two dimensions were particularly relevant. First, it was perceived that the transition to wireless broadband increased the amount of data entry fields required to submit reports. Similar to past research (Ioimo & Aronson, 2004), advancements in new technology which should increase line officer productivity may inadvertently *increase* workloads and *decrease* productivity. At the same time, additional fields can increase the quality of data entered and shared within the department and among public safety partners. There is a necessary trade-off between these two dynamics of increased data entry, which may affect operations. Second, and relatedly, these reports were perceived to be subjected to increased supervisory surveillance and accountability – perceptions confirmed by the web-based survey. The web-based survey findings indicated that information sharing was likely to be the most beneficial product related to wireless broadband implementation. Information was perceived to be easily accessible, internally shared, timely, and of better quality, which is consistent with the semi-structured interview findings. The benefits inherent to improved information sharing were thought to advance the completion of job tasks and responsibilities; especially those related to reporting. The results of the remaining operational outcomes – job and administrative tasks and response times – were inconclusive.

Secondary data analysis of computer-aided dispatch (CAD) data suggested that the implementation of wireless broadband had no influence on departmental response times to calls for service. Disaggregation of departmental data by patrol sector provided some evidence that the ability to affect response times may be more likely to be observed within patrol sectors than across the department as a whole. Sectors one and two appeared to benefit most from the implementation of wireless broadband. It is not clear why these sectors benefitted differentially from wireless broadband implementation. Sensitivity checks of CAD data within both sectors did not reveal any significant differences that would have contributed to the results.

Although the present research contributes to the case study literature on wireless broadband network technology, the findings should be considered with some limitations in mind that are further discussed within the report. First, traditional management information systems and monitoring capabilities limited the data that could be used to assess implementation and outcomes. Second, the network had already been implemented and operational for an extended period of time prior to the agreement of the research project. As such, the study was limited by its retrospective case study design. Third, measurement validity is limited with respect to the interview and survey data. Again, the research design had to rely upon retrospective respondent recall. Lastly, generalizing the Brookline model may be challenging to the rest of the United States given Brookline's unique community demographics (e.g., home income, professional and student populations seeking Wi-Fi access).

The present study provides a foundation to advance operational evaluations of mobile broadband in policing and identified recommendations for improving future research, which are further elaborated upon within the report. To begin, it will be highly beneficial for researchers to identify agencies who are seeking to implement mobile broadband in the future and to work with these agencies prior to procurement of the technology in an effort to establish reliable and valid pre/post measures.

Future research should incorporate clearance rates of crime. A consistent benefit of mobile broadband appears to be the speed and quality of information flow. As patrol officers, detectives, and analysts are accessing improved information more quickly, it seems logical to assume this will lead to improved clearance rates of crimes. Measures of community-oriented activities also should be considered. Mobile broadband is believed to enable patrol officers to engage more with the community. Future research should consider identifying measures of vehicle mileage to assess wear-and-tear and fuel costs related to in-field computing rather than officers making trips back and forth to the station, time spent sharing information during roll-call, and the amount of time officers spend engaged in administrative tasks that they handle via mobile computing. Lastly, measures should include both technical and operational indicators. A challenge of mobile broadband evaluations is to specifically target the technical capability it provides, rather than the operations it enables. For example, officers using mobile computing with a wireless broadband system who are asked questions on the wireless technology are likely to respond to question items from the perspective of the operational aspects of mobile computing – not the wireless technology. Although not independent, there is an inherent difference between the two.

Chapter 1 Introduction

Police departments are becoming increasingly more technologically sophisticated. A nationally representative sample of local police departments has suggested that most departments use computerized information systems to access and maintain records, dispatch fleets, assist with investigations, share information, and generate data for resource allocations (Reaves, 2010). Approximately 90 percent of officers use in-field computers or computer terminals. Field functions primarily support report writing and/or communications as well as provide access to vehicle, driving, calls-for-service, and criminal records. Six out of 10 police departments also electronically transmit field reports to headquartered information systems. From the year 2003 to 2007, the percent of departments using electronic transmissions increased by 58 percent (Reaves, 2010).

As technology continues to expand and advance, there are calls to integrate computerized information to improve intra- and inter-agency communications (Koper *et al.*, 2009). It is implicitly assumed that integration efforts will enhance the efficiency and effectiveness of a variety of police operations (see Koper *et al.*, 2009). To accomplish these objectives and realize the benefit potential, police departments must possess adequate communication system infrastructures. Recent momentum towards the development of wireless broadband networks for public safety is one approach to develop sustainable infrastructure. Though commonly accepted and implemented by private business, public safety organizations traditionally have been slow to keep pace with evolutions in digital communications. Resource limitations coupled with a lack of independent evaluation of such technologies contribute to this shortcoming.

Recently, a municipality in the New England region of the U.S. was able to use a public-private partnership to implement a wireless broadband capability for public safety while simultaneously bringing this digital communication to local business and citizens. The purpose of the following project is three-fold; 1) to describe and explore the public-private partnership that used to make this technology capability a reality for public safety, 2) to describe and explore the effect of this wireless broadband network, specifically a 4.9 GHz network, on the operations of one medium-sized municipal police department, and 3) to identify areas for informing future evaluation research on the emerging importance of wireless broadband technology for public safety.

1.1 Background and Context

In a 2009 study of 216 agencies across the U.S., the Police Executive Research Forum (PERF) assessed the technological needs of law enforcement that would improve police operations. While the study noted operational improvements are solely not the result of technological advancement (e.g. policy and structure implications still apply), key areas for improvement in operations by using technology were identified. The integration of information technology is paramount. Service and performance can be improved as a result of police using deployment strategies informed by information analytics that focus police resources on persons, places, times, and situations that account for large proportions of crime and disorder within jurisdictions (Koper *et al.*, 2009). As police patrol is a resource-intensive task (both personnel time and vehicle costs) and accounts for the majority of police time and responsibility, the allocation of these resources can be improved by integrating technology into calls for service and patrol functions (Kennedy *et al.*, 2011), which would allow agencies to devote additional resources to crime prevention strategies. Beyond improving resource expenditures, police also stand to benefit from collateral improvements of technology and patrol – such as improved citizen satisfaction of police (Brown & Brudney, 2003) and police officer job satisfaction (Manning, 1977; Robbins, 2000).

Contemporary policing strategies such as problem-orientated policing (POP), community-orientated policing (COP), and intelligence-led policing (ILP) now encourage police to make greater use of the data they routinely collect, and to be more analytic with regards to the data they use for tactical and strategic decision making (Carter & Carter, 2009; Goldstein, 2003; Manning, 2001; Nunn & Quinet, 2002). To fully embrace these problem-solving and preventative strategies, police are encouraged to collect data from a wide variety of sources of information, such as community members or organizations. Moreover, police are encouraged to disseminate this new information to external organizations as these external stakeholders will be increasingly responsible for assisting police in identifying problems and developing solutions for dealing with them (e.g., partnering with state and federal agencies as well as community and private sector organizations). Since these strategies move beyond the limited information police routinely collect, adjustments to information systems within departments will become necessary as police shift their focus from individual calls for service to community problems, concerns, and threats.

Data-driven police programs such as Comparative Statistics (CompStat) within the New York Police Department (McDonald, 2000) and the Strategic Approaches to Community Safety Initiative (SACSI) (Roehl *et al*., 2005) have illustrated the applicability of information collection and analysis to police operations. However, as Dunworth (2000, p.371) notes, "the present reality is that too few police departments are using that capability effectively." Arguably, the most challenging factor inhibiting police departments from using technology to enhance their information sharing capability is the lack of adequate bandwidth needed to accommodate large-scale wireless communication.

During an evaluation of Chicago Police Department's Citizen and Law Enforcement Analysis and Reporting (CLEAR) system, a member of the department explained the bandwidth issue facing Chicago and many police departments across the country, noting that "…home dial-up modems are 56K. What we're dealing with is only 9K, and the pipe is small" (Skogan *et al.*, 2003, p. 15). A similar obstacle faced the Rockford, Illinois Police Department (RPD) where officers were relegated to manual report writing in the field, which was then turned over to data entry personnel to input the reports into the records management system. It was found that the data entry system would only allow enough space for a summary report rather than the report in its entirety - leaving important details and information solely available from the original hard copy (Sprint, 2007). For RPD personnel, time was wasted as report writing was duplicated by multiple personnel, valuable information was not available to enhance the effectiveness of officer tasks, and records were subsequently incomplete.

1.1.1 *President of the United States: A Nationwide Wireless Network for Public Safety*

In his 2011 State of the Union address, President Barack Obama announced his *Wireless Innovation and Infrastructure Initiative* - specifically referencing the opportunity for a firefighter to use a handheld device to download the floor plans of a building before arriving at the scene of an emergency (Whitehouse, 2011a). While this example is an accurate demonstration of technological capabilities, a broadband network is arguably most beneficial to law enforcement as they are the first responders to crime, disturbances of social order, and emergencies. Through this initiative, first responders and public safety agencies are likely to be safer and more effective because they will be in a position to use new devices and applications that are currently unsupported by technology available to most public safety agencies throughout the country. From accessing video images of a crime in progress, downloading building plans to a handheld device, or connecting in real-time with personnel from other jurisdictions, a nationwide wireless broadband network for public safety is likely to have a dramatic impact on a day-to-day operations - not just during the most severe emergencies when the availability of an interoperable and operable network will be at its most important (Whitehouse, 2011b).

Wireless data network interoperability, data access and data interoperability are distinctly different but related terms. “Wireless data network interoperability” relates to the wireless technology, or “radio air interface” between end user equipment and/or the network infrastructure, and how this interface is managed. Data access relates to access to network resources; for instance what resources are accessible, and who is authorized, regardless of the wireless medium used, to obtain access. “Data interoperability” relates to common data formats or clearly defined data exchange formats so that otherwise non-interoperable data systems can converse, share and exchange information. This report focuses on “data access” interoperability—that is, the ability of officers of one jurisdiction to have authorized access to data provided by another jurisdiction. Examples include video provided to incident command in a multi-agency response; data relevant to specific incident response (e.g., building plans, annotated maps); and shared data such as incident and arrest reports. This report does not address “data use” interoperability—the challenge of whether data are in a format that can be shared among multiple agencies.

Recent federal legislation specifically supporting the establishment of a national public safety wireless broadband network, and dedication of spectrum to public safety, include the Public Safety Spectrum and Wireless Innovation Act (S. 28) and the Broadband for First Responders Act (H.R. 607) in January and February 2011, respectively. Federal support for the nationwide public safety broadband network became law by way of the Middle Class Tax Relief and Job Creation Act of 2012 (also known as the Middle Class Tax Act). This law was passed by both the House and Senate and became Public Law 112-96 with President Obama's signature on February 22, 2012.

Middle Class Tax Relief and Job Creation Act allocated 10 MHz of radio spectrum defined by the FCC as the "D" block to public safety, and also directed the FCC to reallocate the 470-512MHz Land mobile Radio (LMR) spectrum (currently used by Public Safety for land mobile radio voice communications in a number of large cities) for other non-public safety uses. The act also established of an independent network authority within NTIA (i.e., FirstNet) with a charter to, design, develop, and deploy a nationwide network using the D block spectrum and 10 MHz of previously allocated public safety broadband spectrum that is directly adjacent to the D block (e.g., 20 MHz total.) The law also directed the FCC to grant a single nationwide license to FirstNet for the entirety of 700MHz public safety broadband spectrum.

In addition, the law mandated that the FCC establish a Technical Advisory Board for First Responder Interoperability that must, within 90 days, provide minimum required levels of interoperability as guidance for the FirstNet authority. The act also outlined powers, duties and responsibilities of the FirstNet Authority and its advisory committees, outlined network coverage requirements, state-level opt-out procedures, and defined funding guidelines for the national network. While ongoing regulatory activities related to the national public safety broadband network were unfolding, the Public Safety community also was engaged in related activities to understand, and refine the needs and implications of evolving wireless technologies, and to describe the importance these evolving wireless technologies in the context of ongoing mission critical operations. Spectrum as a resource, as well as the technology used to exploit these wireless resources were the ongoing focus of consensus based activities with participation from all levels of government:

- In August 2009, NPSTC chartered the Assessment of Future Spectrum and Technology (AFST) Working Group to identify public safety communications requirements for a 10-year period, from 2012 to 2022, and to assess the impact on technology and radio spectrum. This was to be an update to the Public Safety Wireless Advisory Committee's (PSWAC) Final report, originally published in 1996. The National Public Safety Telecommunications Council (NPSTC) published the new report, Public Safety Communications Assessment 2012–2022 in June 2012.
- On June 8, 2011, Aneesh Chopra, the United States Chief Technology Officer (USCTO) requested that the Director of the National Institute of Standards and Technology (NIST) charge the Visiting Committee on Advanced Technology (VCAT) of the NIST with the task of developing a summary of desirable features that could be incorporated into the design of a nationwide public safety communication system. On January 24, 2012, after considering the responses to a NIST request for information and comment on "Desirable Features of a Nationwide Public Safety Broadband Network" and input from several public meetings, a VCAT report entitled "Desirable Properties of a Nationwide Public Safety Communication System" was published.
- In January 2006, the DHS SAFECOM program published a report entitled "Statement of Requirements for Public Safety Wireless Communications & Interoperability." This document captured practitioner-driven consensus requirements for a system of interoperable public safety communications needs, for use across all federal, state, local, and tribal "first responder" communications systems.

- In November 2007, a revision was published entitled "Public Safety 700MHz Broadband Statement of Requirements (SoR)" specifically capturing requirements associated with wireless broadband technology.
- In December 2012, another NPSTC report was published entitled "Public Safety Broadband High-Level Launch Requirements, Statement of Requirements for FirstNet Consideration." This consensus-based report was the result of a series of working meetings held in 2011 and 2012, through which consensus-driven requirements were derived, for near-term needs as the network is first launched. Meeting participants included public safety practitioners, technical experts and industry representatives. As of this writing, plans are underway to compile potential follow-on reports detailing public safety's longer-term vision and a more technical report intended to quantify these needs in a more concrete manner.

Though the benefits of this initiative are easily conveyed, a difficult challenge lies ahead for the implementation of such a capability – perhaps none so more challenging than cost. The formulation of spectrum policy and its associated costs generally diverges on whether to give priority to market economics or social goals – either to maximize economic gain and stability or further the welfare of society. The former is straightforward economics, calculating gains brought to the economy through innovative technology. The latter favors ensuring wireless access to support social objectives for which economic return is not easily quantified - such as improving education, health services, and public safety (Moore, 2012). Economics will be a salient factor in this wireless effort as the associated costs are likely to be significant. President Obama called for an investment of $10.7 billion to ensure public safety benefits from new technologies; $3.2 billion to reallocate the "D Block" - a band of spectrum that would be reserved and prioritized for public safety (Mays, 2010); $7 billion to support the deployment of this network; and $500 million from the Wireless Innovation Fund for research and development as well as technological development to tailor the network to meet public safety requirements (National Science Foundation, 2012).). Such an investment of resources is likely to yield criticism and demands for evidence-based support for expenditures. This type of criticism has already come to fruition regarding federal expenditures on law enforcement fusion centers to improve information sharing efforts (Taylor & Russell, 2012).

The Middle Class Tax Relief and Job Creation Act of 2012 established a Public Safety Trust fund to be managed by the U.S. Treasury. The Act also provided funding resources (i.e., funded via future TV spectrum auctions) to support of the design and implementation of a self-sustaining public safety broadband network;

- The Act provided $7 billion (reduced by the amount, up to $2 billion borrowed by NTIA, below) that will be deposited in a Network Construction Fund, following the auction of TV spectrum, for the build-out of the network.
- In the interim, as the FCC establishes and executes an auction process for TV spectrum, the NTIA may borrow from the Treasury as much as $2 billion for FirstNet to begin planning and implementing the broadband network. The NTIA then will reimburse the Treasury, without interest, from future funds deposited into the Public Safety Trust Fund via the pending TV spectrum auction.
- The Act established a $135 million state and local implementation fund (a planning fund).
- The Act established a $100 million fund for additional public safety research, to be made available from the Public Safety Trust Fund. The Director of NIST, in consultation with

> the Commission, the Secretary of Homeland Security, and the National Institute of Justice of the Department of Justice, as appropriate, shall conduct research and assist with the development of standards, technologies, and applications to advance wireless public safety communications.

Since the network is intended to be self-sustaining, the Act also authorized FirstNet to assess and collect user fees in support of ongoing network operations, maintenance, and evolution:

- Network user fees - A user or subscription fee from each entity, including any public safety entity or secondary user that seeks access to or use of the nationwide public safety broadband network.
- Lease fees related to network capacity.
- Lease fees related to network equipment and infrastructure: A fee from any entity that seeks access to or use of any equipment or infrastructure, including antennas or towers, constructed or otherwise owned by the First Responder Network Authority resulting from a public-private arrangement to construct, manage, and operate the nationwide public safety broadband network.

1.2 FirstNet Challenges

While the Middle Class Tax Act provided up to $7 billion to design and build a nationwide network, cost estimates to deploy such a nationwide public safety grade network is expected to exceed this amount significantly. As noted above, President Obama initially called for $10.7 billion to support this effort. In June 2010, the FCC issued a white paper entitled "The Public Safety Nationwide Interoperable Broadband Network: A New Model for Capacity, Performance and Cost" that hypothesized cost based on certain generic technical parameters for site density and coverage. The FCC report estimated the cost of a dedicated public safety network to be, at least, $15 billion and also offered an alternative, shared network, perspective reducing estimated costs to as little as $6.5 billion.

The funds estimated to build and deploy a national public safety network generally were limited to the cost of network infrastructure. It generally was assumed that this public safety network will be designed and built to be more robust than commercial networks of similar size and scope. The term "public safety grade" is often adopted to describe the perceived robustness characteristics, over and above those inherent in commercial infrastructure, required to provide public safety service reliability and coverage. One challenge is that even the public safety community has not quantified the term public safety grade in any consistent and useful way for network design; therefore, even public safety networks are hardened based on local design choices and "rules of thumb," not in a nationally consistent manner.

In addition to the core network, end user equipment must be available to access the network. As noted above, the costs for this end user equipment are not included in the estimates to fund and construct the network, and at the time of this report, the supply chain for such equipment was in its infancy. The public safety community and FirstNet are dependent on the marketplace to provide affordable end-user equipment, and because inter-carrier roaming for public safety and criminal justice users is assumed, multicarrier/multiband public safety devices also must provide access to commercial carrier networks.

Even if access to commercial networks is provided, data roaming will be a challenge for FirstNet. Data roaming between competing commercial carrier networks currently does not exist, and is subject to FCC proceeding Number 12-69 in which the FCC will decide if agency regulatory action is required to facilitate network roaming between regional and nationwide commercial network service providers. The results of this proceeding will have significant influence on how roaming between the public safety network and commercial networks will be implemented.

It is worth noting that the National Public Safety Broadband Network will, for the foreseeable future, be a data only network. This is because "mission critical" voice services (such as "one-to-many" dispatch or "direct mode") are not supported within the baseline 3rd Generation Partnership Project (3GPP) LTE standards defined by the FCC rules established for the public safety spectrum, or even within previous generations of 2G/3G cellular architectures. Commercial cellular carriers are just now devising standards and technology to enable roaming between LTE Internet Protocol (IP)-based networking technology and older generation 2G/3G circuit-switched voice technology. Native LTE core network support for IP-based voice services (as opposed to over-the-top voice services, for example, Skype) are expected to be added to commercial networks over the next few years. In the meantime cellular voice is supported in current generation end user equipment and handsets via separate, embedded, 2G/3G radios.

1.3 Purpose of the Study

The present study has three primary objectives. First, this study seeks to explore the impact of mobile broadband technology on the operations of a medium-sized municipal police department in the northeast United States – Brookline, Massachusetts Police Department. As will be discussed, there is a lack of scientifically informed and independent knowledge with respect to how a large-bandwidth wireless capability may influence law enforcement's daily operations. Specifically, this capability may improve the police operations of information sharing, reduce time spent on administrative tasks, and improve police response time to calls for service, and the clearance of such calls. Second, this study seeks to provide guidance for implementation and practice within the field. As the movement towards law enforcement wireless networks gains momentum, the persons tasked with implementing this capability and developing policies to guide its use will be faced with challenges for an arena in which little is known. This study seeks to inform their journey through best practices and evidence-based outcomes. Third, this study seeks to establish an empirical foundation for mobile broadband and large bandwidth digital communications research.

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Chapter 2 Literature Review

Integrating technology into law enforcement operations has become commonplace in the last two decades. Driven primarily by a scarcity of operational resources for police as well as more feasible costs for acquiring and maintaining technology have brought this movement to the forefront. Also not to be overlooked was the increase in post-September 11, 2001 federal grant programs for technology advancements in public safety that lacked any component of rigorous scientific evaluation following what technology was procured and how it was deployed to impact operations. While a variety of technological advances have been implemented by police, such as tasers, patrol cameras, and even lightweight body armor, perhaps no technological hardware has been more instrumental to daily police operations than mobile computers. The adoption of mobile computing technologies provides several benefits for law enforcement. In broad terms, the implementation of new technology has enhanced the productivity of law enforcement agencies by facilitating information sharing within and across departments, easing communication between law enforcement and the public for purposes of service and feedback, and enabling officers to identify and target crime problems more effectively (Colvin & Goh, 2005; Maguire & King, 2004).

Advances in computing have improved the ways law enforcement store, use, and disseminate data and information (Nunn, 2001). These advances have helped to translate conceptual policing philosophies such as problem-oriented policing and intelligence-led policing into practice - making law enforcement more efficient in the prevention and reduction of crimes, threats, and problems (Braga & Weisburd, 2006). Scholars have found mixed results with respect to technological advances and police operations; ranging from improved productivity and efficiency (Colvin & Goh, 2005) to less efficient (Manning, 2001) and no observed impacts on production (Nunn & Quinet, 2002). Furthermore, technological advances in policing also have served as a catalyst to restructure police forces (Maguire & King, 2004).

The presence of computer technology among U.S. police agencies is abundant. According to Roberts (2011), who examined the 2007 Law Enforcement Management and Administrative Survey (LEMAS), local police departments reported using computers for a variety of law enforcement functions, including records management (79 percent), crime investigation (60 percent), information sharing (50 percent), and dispatch (49 percent), while the vast majority of law enforcement agencies in the U.S. serving populations of more than 25,000 reported using computers for crime analysis and crime mapping. Furthermore, mobile computers allowed officers to access a variety of information sources including vehicle records (88 percent), driving records (81 percent), warrants (81 percent), protection orders (66 percent), interagency information sharing (60 percent), calls-for-service history (60 percent), and criminal history records (50 percent). The majority of all police departments (60 percent) indicated using electronic methods to transmit criminal incident reports (Roberts, 2011). A police patrol vehicle with a computer inside is not a technological advancement unless that computer is used as a tool to improve an aspect of police operations or functions. The presence of computers within police patrol cars has served as a means for a variety of ends, such as electronic reporting, improved information access and communication, and improved officer safety and job satisfaction. A universal demand for improved information technology is facilitated through computing – more specifically for police, mobile computing. The following review of literature focuses on the outcomes related to computers and policing while also identifying a significant shortcoming of research to date.

2.1 Information Technology

Policing is a function that requires pulling information from society and using this information to determine actions within society (Manning, 1992). The salient characteristic of police technology is the use, processing, and application of the information collected. Since the police are dependent on the information gathered from interaction and communication with the community, the methods by which the police collect, process, manage, and use information are critical to understanding their function within the societies they serve. Police collect diverse types of information and use it to different ends. They gather raw information that is used in support of policing for crime prevention, case clearance, and situational awareness. The overall implementation of information technology within a police department not only improves efficiency and effectiveness, but also dictates change across organizational culture and norms.

2.1.1 Technological Culture

Integrating information technology to impact operations has a ripple effect across organizations and alters structural, symbolic, and social organizations of policing (Manning, 1992a). Technology should not be seen solely as physical material. Rather, it should be considered as operations in a social context and its perceived meaning in different social and organizational positions. Impacts of technology are determined by factors beyond its technical capacity – such as psychological, social, political, or cultural. Technology may be constraining or enabling, but people have the ability to adapt, shape, develop, subvert, misuse, or manipulate technology for various purposes (Ackroyd *et al.*, 1992). Affects from technological advancements should be viewed as products of subjective human action within contexts and objective sets of rules and resources that mediate action and contribute to contexts. Technology can be viewed as both an antecedent and consequence of organizational action (Orlikowski &

Robey, 1991). Thus, it is critical to account for factors that influence technological change and the impact these factors can have on organizations.

Technological change can be viewed as the nature of technology itself and how technology has changed and how it is managed. When basic routines of police work are built into the system, officers literally are not able to work without using the technology (Ericson & Haggerty, 1997). For example, if a new aspect of reporting is integrated and this function relies on a mobile computer and has never been done on paper, the task becomes moot if the technology fails or is removed. Simply put, when tasks are implemented within an organization and personnel have only been trained to do it electronically, or the only manner possible to complete the task is electronically, this task (or operation) becomes impossible unless the technology is working correctly. If the technology fails, so do the tasks/operations/functions that rely on the technology as there is likely no contingency plan. When systems are less coercive or less effective, technology can be used to solve problems – such as creating automated data sharing, which was impossible prior to mobile computing. The cultural aspects of technology are concentrated on the assumptions inherent in the technology and extent these are congruent with those held by users within organizations. Structure of the organization and the experiences of its members can reduce organizational uncertainty about new technologies, but also inhibit creativity and reinforce established assumptions (Orlikowski & Gash, 1994).

An understanding of what technology is capable of, why technology was introduced into the organization, how technology will be routinely used, and anticipated consequences and benefits of such use can facilitate the ease of established preconceptions. These preconceptions are typically related to the perception officers have of the congruence or incongruence the technology poses for the perceived reality of policing. These perceptions will be rooted in officers' perception of conflict between traditional style policing (e.g. response time concerns) with problem-solving policing (e.g. proactive work, analyze call histories, make mature and responsible decisions). Political aspects of integrating new technology also must be considered. Technology can be seen to restrict discretion and autonomy of street level officers while enhancing the status of information technology specialists (Cope, 2004). Technology can be interpreted to alter the balance of power among organizational members. As such, resistance and sabotage can occur by those who feel threatened by the technology. Examples of such behavior by officers can include avoid being tracked by automatic vehicle locators and the refusal or resistance to report mandatory or non-mandatory offenses. For successful implementation to occur, executives need to develop a sense of the agency's policing mission and how the technology will help to facilitate that mission. New technology leads to a process of normalization, adjustment, reconstitution, and reintegration for organizational members (Manning, 1992b). This is achievable with proper planning as organizational change is emergent and continuous rather than rapid and discontinuous. It relies on a series of ongoing and situated accommodations, adaptations, and alterations designed to integrate an innovation rather than append it to the organization (Orlikowski, 1996).

2.1.2 Diffusion of Information Technology within Policing

There are three perceived imperatives advancing the movement for technology innovation. First is improved effectiveness and efficiency of operations driven by technology. Investments in improved hardware and software promise to improve crime control and enhance professional status and organizational legitimacy. Such an investment allows police departments to increase their capacity to store and process large volumes of data, improve information sharing and investigative capabilities, and provide real-time access to records and crime information. A remaining factor that inhibits the full potential of effectiveness and efficiency is the need for compatibility with other agencies. Effective real-time crime and offender information is reliant on multi-jurisdictional information sharing and the technical/functional ability for multiple agencies across multiple jurisdictions to share information with one another.

A second imperative of information technology is the ability of police departments to satisfy demands of external organizations for information requests driven by information and reporting needs. Municipal police departments are responsible for providing crime and accident data to external bodies for management and risk assessment needs – both internally and externally.[1] Lastly, advancements in information technology allow police to meet requirements of new forms of police management and accountability. Driven by policy, this catalyst of technology innovation allows agencies to effectively address external demands of accountability, cost-effectiveness, probity, and procedural regularity. Supervisors use data collected on arrests made and the number of citations issued to evaluate subordinates, and occasionally use crime analysis to direct the activity of their units (Dunworth, 2000). Police executives have come to embrace (or perhaps accept) this form of entrepreneurial revolution as a means to respond to external investigations and review boards as well as maximize internal accountability mechanisms through surveillance technology (e.g. patrol dash cameras of officer activity or automated vehicle locators).

Information technology is recognized as a tool not only for the policing of citizens, but also for policing the police. Such an approach has been found to affect how officers think, act and report (Ericson & Haggerty, 1997). Moreover, officer discretion appears to be circumscribed by rules, formats, and technologies of reporting systems while supervision is tightened

[1] A common form of such information requests is the FBI's National Incident-Based Reporting System (NIBRS) which is an incident-based reporting system in which agencies collect data on each crime occurrence.

prospectively as details of activities are embedded in required fields and retrospectively as supervisors take more scrutiny of field reports. The availability of such information creates new cultures and more transparency within police organizations (Ericson & Haggerty, 1997). At the patrol level, these new cultures have resulted in a refusal by officers to participate or more subtle aversions to the use of new technologies (Ericson & Haggerty, 1997). At the managerial level, despite perceived accountability improvement, supervisors have indicated these technologies to be burdensome and cumbersome systems (Walker, 2005). Furthermore, such innovations can lead to advancements in business plans and marketing strategies on behalf of police departments to improve customer service by making the department more accessible through social media or the Internet. These methods also enhance crime management and public perceptions of crime and disorder, which have then been found to improve community satisfaction with the police (Rosenbaum *et al*., 2005).

In the policing context, more information is assumed to be better than less - an assumption that justifies investments by police agencies in information technology (Manning, 1996). Any allocation of resources is likely to require an assessment of return on investment. Effects on the policing function have been the dominant focus of information technology research. Empirical evidence of these impacts has been mixed. Some scholars have found information technologies to be disappointing; noting that effects have been minimal when compared to the expectations of practitioners as a result of information technology being constrained by the traditional structure of policing and the traditional role of a police officer (Manning, 1992). Scholars also have found collateral shortcomings related to information technology and policing. Such unintended consequences have included an increase, rather than decrease, in paper files and work being more office-oriented rather than less (Ericson &

Haggerty, 1997). Furthermore, the use of technology may increase productivity without resulting in any gain in efficiency (Henman & Marston, 2008) as officers have been found to spend more time reporting when using an information technology system compared to hand-written field reports (Ioimo & Aronson, 2004).

Evidence also indicates that information technology systems have a positive impact on police operations. Early research on computer information management found detectives were able to access information easier and faster as they did not have to travel to different places to locate records while also having constant access to information at any time of day (Harper, 1991). In one of the most comprehensive studies of police time and information technology, Chan (2001) employed a representative non-random survey of 506 officers, completed 23 interviews with senior-level police and information technology specialists, conducted 11 focus groups with 106 participants including officers, detectives, intelligence officers, supervisors, and information management personnel, and documented more than 30 hours of ride along observations across eight shifts in an attempt to examine the impact information technology had on police operations. The results indicated that police officers spent, on average, three hours and thirty seven minutes per eight hour shift using computers for administrative tasks. Moreover, higher ranking personnel were more likely to be affected by the implementation of information technology given their responsibilities of supervising, reviewing reports, and planning. Similar in this regard, detectives and executives believed information technology hampered their routines in that it required police to follow unnecessary steps to get things done (Chan, 2001). There was a consistent comparison of time spent on similar functions pre- and post-implementation among respondents. Common examples of time allocation were remarked by respondents as "…it would take me this long to do it before, now it takes me this much longer."

Overall, respondents of the Chan (2001) study indicated information technology had the following impact on their time allocation:

- 41 percent agreed they spent more time satisfying accountability and reporting requirements
- 36 percent agreed they spent more time doing paperwork
- 30 percent agreed they spent more time planning, organizing, and analyzing information
- 26 percent agreed they spent more time supervising staff
- 39 percent agreed they spent less time patrolling the streets
- 30 percent agreed they spent less time interacting with members of the community in non-crime or non-emergency situations
- 25 percent agreed they spent less time informing citizens on progress of their case
- 20 percent agreed they spent less time responding to calls from citizens

With respect to respondents' perceptions of the effectiveness and efficiency of information technology, 72 percent thought it made a great difference to police work while 26 percent thought it made little difference. More specifically, respondents indicated that information technology allowed them to work more effectively (79 percent agreed versus 3 percent disagreed), made work easier (66 percent versus seven percent disagree), and helped them access information police needed to do work properly (59 percent versus 10 percent disagree). It was noted that these gains in efficiency were salient to those respondents who had experience with old technology prior to the implementation of new information technology (Chan, 2001) – perhaps suggesting the importance of technical ability and training. More to this point, further results indicated new information technology results in an enhancement of technology literacy among the majority (75 percent) of respondents.

In terms of improving communication, the majority of respondents indicated information technology improved information sharing among employees and that it helped people to work more cooperatively while also promoting a more positive work atmosphere (Chan, 2001). Factors associated with information technology that perhaps diminished the quality of the work environment included the majority of lower-level officers feeling this technology would limit their ability to exercise discretion (59 percent) and that information technology would require officers to report activities more frequently and be held more accountable for actions (66 percent). Furthermore, the majority of officers agreed information technology has led to closer scrutiny of work by supervisors (55 percent) and makes supervisors more aware of day to day activities of the officers (52 percent). Direct assessment of accountability indicated the majority of officers agree information technology improves accountability (50 percent), but this same percentage believe it also has led to an overemphasis on accountability. Moreover, 40 percent of respondents thought information technology led to less trust among officers and supervisors and a more paranoid organizational atmosphere. The major concerns among officers are whether technology is used to punish behavior, manage risk behavior, and create an inability to cut corners.

The impacts on policing style and practice appeared neutral in that just 52 percent of respondents indicated information technology led to more problem solving or more proactive policing (Chan, 2001). Although a separate study by Legosz and Brereton (2001) found checks on traffic warrants in car computer terminals was enthusiastically supported by officers as it allowed them to execute high numbers of checks and warrants. Such a reliance on this form of technology has drawbacks. As Chan (2001) noted, police no longer carry policing knowledge in their head, are removed from local knowledge, are not as directly involved with the community, and do not engage in as much hands-on traditional information gathering on the street. Lastly, it was noted that the transparency effects of information technology prove beneficial for practice. The majority of respondents agreed information technology led to improved service to the public (60 percent) and an improved response to crime (59 percent). As a result of having tracking numbers associated with information inquiries, there was an improvement in the time of feedback on case progress.

Perhaps no technological hardware advancement has impacted police information technology more than mobile computing. The police have always been excellent at collecting information – from field interview reports to contemporary examples of suspicious activity reporting. What have changed dramatically are the mechanisms by which police can now manage and best use this information. Where police were once sifting through piles of paper reports containing short-hand phrases and poor penmanship to locate information on an incident that occurred two weeks prior, officers are now able to query information electronically and not only retrieve the information more quickly, but with dramatic improvements in accuracy and comprehensiveness. Given the impact of mobile computing on police information technology, this has been the focus of much research to date.

2.2 Mobile Computing

Prior to the benefit of laptops in patrol cars, law enforcement had to first acclimate to using computers in their police stations to complete tasks traditionally done with pen and paper. Thanks largely in part to the efforts of the Law Enforcement Assistance Administration (LEAA) and the Omnibus Crime Control and Safe Streets Act of 1968, law enforcement and agencies were able to add computerized management science and information sciences to their crime fighting toolbox (Northrop, *et al.*, 1995). With the use of computerized information systems at police departments, it has been found that police reported increases in the number of search warrants issued and detectives' use of computer files in active investigations (Northrop, *et al.*, 1995). This same study found overall that police officers indicated that computers made it easier to retrieve desired information and saved them time in the process. The use of desktop computers certainly facilitated information management in police departments. However, officers using desktop computers inside police stations are officers that are not on the streets actively protecting and serving their communities. In addition to enabling officers to engage in more service-oriented functions, mobile computing reporting systems are designed to have collateral benefits that can improve the entire organization. For example, as noted by Skogan *et al.* (2003, p. 9), Chicago Police Department's Automated Incident Reporting Application (AIRA) was designed and implemented with the intent to "…simplify the reporting process; improve reporting accuracy, quality and completeness; free supervisory personnel from reviewing report minutiae; provide follow-up investigators with complete and timely information to improve case solvability; reduce the number of hours tied to report processing; and ensure compliance with federal NIBRS data standards."

2.2.1 Police Efficiency and Effectiveness

During the mid-1990s, the Office of Community Oriented Policing Services (COPS) initiated the Making Officer Redeployment Effective (MORE) program designed to increase officer presence on the streets of U.S. communities (U.S. Department of Justice, 2012). Critical to this end was the use of computers to allocate police resources to maximize this presence. The computing emphasis was focused within patrol cars using what has now been commonly referred to as mobile computing terminals[2] (MCTs). Following a framework of information systems research that considered mobile computers under the tool and proxy views of information

[2] Also, but less commonly, referred to as mobile data terminals (MDTs).

technology originally suggested by Orlikowski and Iacono (2001), Agrawal *et al*. (2003) developed a model to be employed in the policing context, using survey data of 153 patrol officers who used mobile computing to study the impacts of mobile computing terminals on police operations. Of primary interest was how mobile computing terminals have improved critical factors that affect the work environment of officers, particularly related to the deterrence of crime and disorder as well as impacts on officer job satisfaction.

The authors note in an example from the New York State Police that prior to the installation of the MCTs, officers communicated license plate numbers over the police radio for verification. The time-consuming scenario would play out as follows:

> At the control center, after verifying the number with the officer, transmitted the request through its computer to the state headquarters at Albany for in-state vehicles. The reply was transmitted back to the officer by radio. This process had many obvious limitations. Transfer of information over radio required repeated voice checks to confirm the information. This took up a lot of time from the busy staff at the control desk, and officers never made cold checks, to avoid annoying the control desk (Agrawal *et al*., 2003, p. 76).

It was noted that prior to the use of MCTs, information retrieval processes, such as the one illustrated above, were highly cumbersome and could take up to 20 minutes - thus delaying decision making and amount of time officers spent on a particular encounter with a citizen.

In their study of 153 police officers who used mobile computing terminals in their patrol cars to conduct license plate and driver's license checks, Agrawal, *et al*. (2003) found such requests were sent through the departmental server to the state headquarters and the details of the vehicle were retrieved in roughly 20 seconds without having to route requests through the control center. Perhaps the most impressive finding from this study was that time saved as a result of officers' use of MCTs in conducting plate checks, issuing summons, and executing warrants of arrest was equivalent to the work performed by approximately 68 officers, or approximately 10 percent of the patrol force of 649 total patrol officers. Moreover, the study showed that officers with MCTs felt safer in neighborhoods in which there was perceived danger because they were able to gather information quickly on dangerous elements in the area whereas before officers had to rely on their personal knowledge.

Using a random survey of 100 members of a medium-sized police agency in Arizona, Ioimo and Aronson (2004) measured how well mobile computing systems match the tasks field officers must perform throughout their daily routines. Ioimo and Aronson (2004) used Goodhue's (1998) task-technology fit data collection instrument. This instrument was designed specifically to assess user perception of how well a technology meets their needs and facilitates their tasks more efficiently. The validity of this instrument underwent extensive testing using a sample of 357 users in 10 companies (Goodhue, 1998). The instrument was found to have "excellent reliability and discriminate validity for 12 dimensions of task-technology fit and exhibits strong predictive validity" (Ioimo & Aronson, 2004, p. 410). To more directly measure the impact of MCTs within the context of police officers and field reporting, the authors employed specific field computing items gleaned from previous research on technology at the individual level. These items asked officers if MCTs allow them to complete their tasks with more speed, quality, ease, control, (Davis, 1989; Moore & Benbasat, 1992; Seddon & Kiew, 1995) and less error (Leonard-Barton & Deschamps, 1988), while also asking respondents to directly indicate how MCTs affected the effectiveness, performance, and productivity of their tasks (Davis, 1989; Moore & Benbasat, 1992; Seddon & Kiew, 1995).

Generally, the Ioimo & Aronson (2004) study found statistical support indicating that inquiries to local, state, and national criminal information databases increased with the implementation of mobile computing. The authors also found that field officers recognized the potential benefits mobile computing afforded them and that the amount of time required for completing reports increased with the implementation of field mobile computing. Findings also indicated that administrators, detectives, and records management personnel all experienced statistically significant improvements in the tasks they performed directly resulting from the implementation of mobile computing (Ioimo & Aronson, 2004).

More specifically, the authors found increases in the number of arrests and inquiries into criminal information systems. While there was a lack of statistical support for officer productivity directly as a result of mobile field computing, it appears officers generally are more engaged in tasks while out in the field on patrol. Officer satisfaction with new technology was positive overall in that officers indicated a belief in the potential benefits of mobile field computing. However, officers indicated an improvement in the software design, applicability of the information received, and training on the new technology would further enhance their ability to best use the technology. Patrol officer indicated the perception of an overall decrease in productivity as compared to their perception that other personnel in the department had improved their productivity as a result of the efforts on patrol officers using the new technology. Officers believed management and detectives were able to better access and manage information as a result of officers using field computing for reporting purposes.

This is perhaps one of the most intriguing findings of their study as patrol officers felt other personnel in the department reaped the benefits of patrol using mobile field computing. For example, officers believed detective’s clearance rates improved as a result of improved information management and access – even though patrol officers felt field computing was three times more time consuming than traditional methods due to increased number of items to report (Ioimo & Aronson, 2004). In contrast to previous research citing the benefits of mobile computing for law enforcement (Agrawal, *et al*., 2003; Northrop, *et al*., 1995), Ioimo and Aronson (2004) used task-technology fit theory to instead show disparity in the perceived usefulness of field computing between management and field officers. Two hypotheses tested by Ioimo and Aronson (2004) sought to examine the availability of the patrol officer to engage in community policing and found that instead of the predicted increase in availability for community policing, patrol officers did not demonstrate any change in community and business interactions. Noting the lack of support for more time available for community policing is important because an increase in community policing was an expected outcome for the time savings afforded by mobile computing. Overall, these findings suggest some limitations to actual time savings accrued for law enforcement officers when using mobile computing terminals in their patrol cars as noted by previously mentioned studies (Agrawal, *et al*., 2003; Northrop, *et al*., 1995).

2.2.2 Enhancing MCTs through Wireless Communications

Improved efficiency of processes while retaining or improving effective outcomes is at the heart of the mobile computing and information technology movement. However, though MCTs alone have shown a great deal of promise for improving police operations, their capabilities are magnified through the use of data sharing digital communications. The presence of a mobile computer (e.g. laptop computer) within a patrol vehicle allowed officers to streamline the reporting process by using an electronic format rather than pen and paper. Despite the patrol vehicle computing capability, officers would complete their reporting on the mobile computer and information would be saved to the hard drive until it was then uploaded onto a main records management system at the station. While this was an improvement for information management, it did not necessarily translate to an improvement in real-time reporting (Chan, 2001) or overall time savings (Ioimo & Aronson, 2004). The potential capability of MCTs has been dramatically enhanced by recent technological advancements in digital communications via inter- and intranets that allow for communicating and computing while on the move. Webb (2004) noted the data speeds offered by wireless broadband allow officers to complete all necessary tasks remotely from the patrol car: To replicate the office environment in the field requires broadband rates in excess of one megabyte per second. This speed allows an officer to access information quickly and do all paperwork in the patrol car. Broadband also enables voice and real-time video to be streamed to and from the patrol car. Officers can pull up feeds from fixed cameras and see real-time video while supervisors or dispatchers can see and hear what is happening in the vicinity of other units (p. 28).

The benefits to mobile computing via high-speed broadband access are not strictly limited to the police officers using it in patrol cars. Ioimo and Aronson (2004) claim in their six year-long study that non-patrol sections of the police department such as the records, investigative, and administrative personnel also experience increases in efficiency. Without mobile computing, the time for traditional paper reports from patrol officers to be entered into the system and be available to investigators can be several days, while mobile computing can instantaneously provide information to police personnel on a real-time basis - thus preventing a delay of critical information. Prior to digital communications, the processing time of reports was dependent upon different channels it had to go through before actually being entered into the information database. Sprint (2007) documented the archaic paper reporting system of the Rockford, Illinois Police Department (RPD) along with the complaints of incomplete records associated with traditional methods of reporting. Sprint provided RPD with wireless data cards for their patrol vehicles to allow for improved information sharing over a larger bandwidth; improved accuracy and increased time savings were reported to ensue.

The use of commercial, cellular-based, wireless communications technology is becoming more prevalent within police patrol vehicles (Argawal *et al*., 2003; Hampton & Langham, 2005). Many commercial cellular providers – such as Verizon, Sprint, and AT&T – partner with public safety departments to provide service at a price deemed reasonable for those agencies. Commercial services often present agencies with a convenient and affordable upgrade path from lower bandwidth resources. For example, commercial services can facilitate performance improvement over legacy (narrowband data channel) technologies and provide improved user access to information and sharing of large data files. Many agencies do not expect that commercial wireless data services can present a long-term solution to address many law enforcement agencies bandwidth needs but, due to the diverse needs of many agencies it is expected that commercial services will continue to be a primary source, or supplemental resource for the day-to-day business needs of many agencies.

The utility and effectiveness of commercial services for incident and disaster response are often hampered by a number of mitigating factors: limited cellular network coverage, available cellular network capacity, data roaming limitations, unpredictable quality of service through the network, no priority access to connect when the commercial network is congested, and network robustness has become a concern for most first response applications. Commercial cellular network coverage, network capacity, and infrastructure robustness often varies by location, limited by commercial market decisions (i.e., rate of return on investment). Commercial cellular network connection speeds and connection availability are both contingent upon the proximity of end users in relation to cellular towers.

Tower deployment determines network coverage (e.g., network density and/or extent) and network design choices often result in areas with no (or weak) coverage and lower net capacity near the edge of a given cell site coverage area. Devices operating in fringe locations often cannot reliably communicate with the network to support large bandwidth data (Sharma & Jain, 2010) or users experience dead spots where service coverage is unavailable. Within areas dominated by tall buildings, mountains, or other large physical obstacles that interfere with (i.e., block) radio communication waves, signal strength can be significantly reduced (Chandra *et al*., 2011; Lia *et al*., 2008). Difficulties associated with terrain and their impact on coverage and interoperability are not new to policing. Geographic terrain has always presented a constant challenge for radio communications (Taylor *et al*., 1998) and emergency response efforts (Chenoweth & Clarke, 2010).

One solution to resolve communication shortcomings experienced by commercial network users and include wireless network coverage limitations is through the implementation of alternative wireless technology. Wireless (Wi-Fi) broadband systems present one such alternative and networks based on Wi-Fi technology (to include Wi-Fi-based mesh networking technology) can be designed to fill jurisdiction-specific coverage gaps and provide stronger, more consistent signal strengths (Amaldi *et al*., 2008). These networks can often be designed to provide large bandwidth capabilities across diverse terrains (Marina *et al*., 2010). With respect to the contemporary demands of police personnel, such broadband systems and the bandwidths they provide have become critical to agency operations. In a case study of the 2007 bridge collapse in Minneapolis, Minnesota, a municipal Wi-Fi network enabled police to set up a command center in a parking lot near the site of the collapse. The study noted that "…this network had to be fast and robust enough to handle large, data-intensive geographical information services (GIS) maps…there is no way they could have downloaded or worked on all those heavy GIS maps, big bandwidth users, on a cellular network" (ENCOM Wireless, 2010, p. 35).

Wi-Fi technology presents a cost-effective, functional, alternative technology for agencies or local/regional governments to quickly fulfill incident and day-to-day broadband data communications needs. The challenges associated with implementing relatively dense Wi-Fi network technology on a large scale are multifaceted and particularly challenging for suburban and rural applications covering large areas of land. These challenges are analogous to many of the challenges associated with deployment of commercial network small-cell technology. This type of network is often most suitable for use in urban areas that can more readily accommodate and support a large number of low-power base stations. Network deployment cost considerations include network design, Wi-Fi equipment acquisition, infrastructure support/acquisition, site preparation, network backhaul, and ongoing maintenance/support. Each of these items is location and application specific; variations are almost infinite depending on agency and user needs, network environment, and commercial network infrastructure support agreements. While these types of costs are rarely a line-item within many traditional municipal budgets, some public safety organizations have been successful in establishing and leveraging commercial partnerships and cost-sharing arrangements to reduce the overall cost burden for tax payers. One of the most promising benefits of a municipal Wi-Fi system is the potential shared network-based services provided to a wide-range of government and private community users.

Lide (2008) offers a more broad view of municipal Wi-Fi use and makes note of the different benefits and concerns associated with municipal-wide broadband applications. These networks can be used by public government to fulfill a variety of tasks, from street traffic monitoring to providing remote file access for government employees. Due to the mobile nature of most municipal employees' daily routines, wireless broadband infrastructure enables them to perform their job more efficiently – such as firefighters that can leave the station faster because information on a call can be accessed on the way to the scene. With the ability to communicate effectively or get information across agencies via the wireless broadband, the response to larger emergency situations, such as natural disasters and terrorist attacks, can be improved with use of the existing communication structures to quickly move resources into place. Moreover, Lide (2008) identifies how wireless video camera systems, transmitting images over Wi-Fi broadband, in strategic areas also can assist disaster response to assess situations before arriving on the scene and enabling better preparedness. Such cameras use also has been found to deter crime in high crime areas (Caplan *et al*., 2011).

It must be mentioned that with all technological innovations, and most policing initiatives, collateral issues and costs exist. To maximize the performance of a Wi-Fi system – or even use it at all – many police departments will have to upgrade their hardware systems as well. Many police mobile computing terminals are either not compatible with wireless systems or do not have processors current enough to use data speeds provided by new networks. Though training may be needed by some department personnel, the implementation of a Wi-Fi network is not likely to require a significant investment in personnel time or agency resources for training as many of the applications provided through broadband access are already used by the majority of police personnel on desktop computers. Policies and operating procedures involving the use of communication networks must be updated or implemented. Departments must have policies to safeguard against privacy concerns with increased information sharing (Lide, 2008) as well as increased potential for officer abuse of the technology (e.g. using the broadband service on personal devices, such as a tablet, while on duty).

Furthermore, to protect the efficiency of the broadband system (and perhaps control for market competition), Gillett (2005) recommended the creation of additional safeguards for the protection of future entrants into the wireless broadband market that serves local governments who may be barred from entry. Additionally, a plan to promote interoperability needs to be proffered to truly improve communications between agencies and jurisdictions; this also should be considered when local agencies are given the flexibility of how to implement communications systems. Peha (2007) also suggested that one provider of communication services should not be relied upon singularly. A backup communications plan should be in place in case of system failures during emergencies.

2.2.3 Collateral Benefits

The implementation of a mobile broadband capability to enhance mobile computing promises to yield additional benefits to a police organization. As mentioned, some departments are likely to face costs associated with upgrading technology to use broadband technology. However, also resulting from such an upgrade is the potential to save resources related to a variety of aspects that result from a broadband capability. For example, United Parcel Service (UPS) spent $100 million to upgrade their wireless systems to manage the movement of goods. Though this is a significant up-front investment, UPS expects the investment to pay for itself within 16 months (Nelson, 2001) by reducing personnel time in tracking and management efforts. Chrysler Corporation also demonstrated a return on investment with improved information technology systems to manage parts from their suppliers and saved approximately $60 per vehicle by using electronic data interchange (Mukhopadhyay *et al.*, 1995). As Argawal *et al.* (2003) noted, departments are now able to streamline multiple processes and functions –

such as no longer relying on computers with slow hard drive processing as information is relayed through real-time servers. In many cases, a mobile computer with broadband access can serve as a multifunction machine, allowing officers to do real-time reporting, geographic positioning (GPS), computer-aided dispatch (CAD), and even vehicle maintenance procedures.

The COPS MORE program focused on the use of computers to augment and redeploy the resources of police departments across the country in an effort to effectively increase the number of officers available for police work on the streets. The greatest gains of redeployment occurred as a result of the use of laptop computers in patrol cars (Argawal *et al.*, 2003). The staffing challenges persist for police executives in the current fiscal environment. The management benefits behind mobile computing and the use of broadband is rather straightforward. Less time personnel spend on administrative tasks or tasks in general depending on their assignment, the more time is generated for personnel to complete more work. In short, personnel work time is gained within that individual's assigned shift. This philosophy extends beyond patrol officers, sergeants, and detectives and applies to information technology and records management personnel as well. An example of this approach is illustrated by Chicago Police Department's (CPD) struggle with maintaining personal data terminals (PDTs) within their patrol vehicles to maximize the CLEAR system. As Skogan *et al*. (2003, p. 12) points out:

> …at any given time CPD had 20 to 25 percent of each district's PDTs out of service…contributing to the problem neither was the fact that there was no formal procedure for documenting unit malfunctions nor was there one for tracking the status of units sent out for service...the new establishment of a "triage area" in each motor maintenance garage where technicians would diagnose the problem and either make repairs or send the units to the manufacturer.

Resource efficiency related to performance time savings of regular activities has been well documented (Davenport & Stoddard, 1994; Stalk & Hout, 1990, Thomas, 1990). With the implementation of a mobile broadband capability, software and system updates can be managed remotely – keeping terminals within the patrol vehicles at all times. Not only does this approach remove the physical effort of handling the hardware, but also the space and other hardware tools needed to work on the machines. Technicians are able to better maintain and address system issues by remotely managing the fleet of terminals. This same thought holds true for patrol officers that make fewer trips back and forth to the station to complete routine paperwork and handle many low priority calls by pulling up required information through mobile terminals. And while information technology has been found to increase the total number of calls attended by officers (Greene & Klockers, 1991), it also has reduced time spent on functions carried out during calls - such as filling out forms (Meyer, 1993). Such beneficial characteristics of technology are important in influencing its adoption and deployment (Sipior & Sanders, 1994).

Potential benefits from computing technologies discussed above are certainly most beneficial from an operational perspective, but not the sole benefit. Research on mobile computing technology to date has focused on how MCTs have improved the critical factors that affect the work environment of police officers, particularly related to the deterrence of crime and disorder as well as officer job satisfaction (Manning, 2008). From a technological and business perspective, such technology streamlines communication, computing, and information architectures to enable officers with disparate systems to communicate and perform tasks without interruption. From an organizational perspective, technology can change organizational structures and processes, increase the customization of information and products used by its members, and can allow for modification of traditional job descriptions. With improvements in personnel task operations, such as limited interruptions or delays when completing officer field reports, and customized products such as sector-specific crime information, officers are likely to perceive an improvement in their overall job satisfaction.

Studies exploring the influence of information technology on police work environment have focused on officer job satisfaction and the deterrence exercised over law violators. Mobile computing terminals have been found to reduce risk faced by officers on the job, thereby increasing self-initiated activities and making the officer's job easier (Manning, 1977). Moreover, most employees prefer to work in relatively modern environments with adequate tools and equipment (Robbins, 2000) – MCTs can increase the professionalism of officers. This notion was observed among police officers in a study by Singh and Hackney (2011, p. 8) when officers described how they felt bystanders perceived them to be "professional" because they were working on reports on agency-issued computing tablets. Officer satisfaction also is related to dimensions of challenging, work and supportive working conditions (Manning, 1977). Mobile computing terminals are viewed as "new tools" that increase the interest and challenge of officer's routine activities while improved information sharing and communication as a result of real-time computing makes officer's working environments safer and less uncertain. Lastly, officers are likely to perceive an improved credibility of their ability to deter crimes as information sharing and communication raise the probability of detection of certain offenses.

In summary, previous research suggests mobile computing and information technologies are likely to influence police operations. Though research has struggled with a lack of available adequate evaluation designs, the results generally are promising. Police operations believed to benefit most from mobile computing and information technology are access to information, sharing of information, time spent on administrative tasks, time to process calls for service, and the management of information by all levels of personnel within an agency. Moreover, dimensions related to job satisfaction with respect to task completion, information access, task efficiency and effectiveness, and quality of service delivered to citizens are believed to improve as a result of mobile computing and information technology.

2.3 Research Gaps

A variety of technological innovations are currently facing policing – ranging from automated license plate readers to mobile broadband access. In an effort to determine a baseline about police use of various technologies, a 2012 PERF report conducted a survey of law enforcement agencies and interviews with technology subject matter experts from a representative sample of law enforcement organizations about their current technologies. A consistent theme throughout this report is an acknowledged lack of public safety access to wireless broadband given resource limitations and a lack of independent evidence by which justifications for such technologies can be made to secure procurement (Police Executive Research Forum, 2012).

The knowledgebase pertaining to police information technology and mobile computing is strong – examining a host of constructs ranging from time savings, resource deployment, and officer work environment. However, the literature falls short of exploring the extent to which information technology and mobile computing can be enhanced through wireless mobile broadband – more specifically, large-bandwidth data sharing capabilities. In fact, at the time of this writing, the authors could not find an empirical assessment of any form related to mobile broadband use within policing. There does exist some rather anecdotal insights related to the use of cellular data communications – however this information must be viewed with caution as it is usually published by the commercial carriers who provide the data services. Further complicating this gap is the difficulty of operationalizing measures to directly assess effects resulting from large-bandwidth data sharing. As police departments currently use wireless data communications – usually thin-platforms with narrow bandwidths – it presents a challenge to parcel out effects of narrow- versus broad-bandwidth effects on police operations.

Such a gap in research can be attributed to two primary factors. First, scientific evaluations of technology are rarely in concert with the pace at which technologies are implemented into practice. This is a product of both the technology evolution curve as well as the fact that scientific research is time consuming and requires a construct of inquiry to be in place for a period of time in order for an evaluation to occur. In an ideal sense, an evaluation of broadband technology would identify metrics for data collection and be able to collect this information over a period of pre- and post-implementation of the technology. Such a research design is resource intensive and rarely found in technological research. Second, very few police departments within the U.S. have a dedicated, private mobile broadband capability. Current public safety mobile broadband data capabilities are implemented as users on a commercial cellular system, Wi-Fi "hotspots" (without general coverage over the jurisdiction), or private data systems. The Brookline network is unusual in that their system is a broadband network in which public safety has licensed, dedicated access[3] (via 4.9 GHz) to a broadband network built out over the majority of the jurisdiction (not just in "hotspots"). To implement this capability, local departments and their administrators must navigate through a complex set of political, financial, and operational hurdles. The present study provides a baseline exploration of the impacts wireless mobile broadband may have on police operations and helps to fill a gap in current police technology research.

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[3] Dedicated access means that public safety does not need to compete with other non-public safety users for access to the system as is the case when public safety is using commercial cellular networks. Thus data collected in Brookline is not compromised by issues of availability and reliability of a commercial network.

Chapter 3 Study Context: Brookline, Massachusetts Police Department

The agency selected for this operational evaluation was Brookline, MA Police Department. For purposes of conducting this unique operational evaluation, in addition to identifying a location with the appropriate technical characteristics for such an evaluation, the researchers needed an agency with a point of contact that could provide insight into both the technical and business aspects of the network implementation, could act as an advocate and liaison for purposes of identifying and collecting data, and understood the goals and objectives of scientific evaluation to properly see the project to the end. There are very few public safety organizations in the U.S. that currently have an operational wireless broadband capability. Brookline was selected as a result of their public-private partnership with Galaxy Communications. This partnership enabled the innovative use of a licensed 4.9 GHz public safety wireless broadband access network – a type of resource sharing arrangement that is not currently prevalent among public safety agencies in the United States. Moreover, the point of contact within the Brookline Police Department (the agency's Director of Technology) met, and exceeded, all of the components of the evaluation research criteria.

The Brookline Police Department's use of mobile data to support patrol officers in the field began in the late 1980s. As wireless technology progressed, the department upgraded equipment to take advantage of improved data speeds and network coverage. In the late 1990s, like many other police departments, Brookline contracted with a commercial cellular service provider to provide wireless data services. Although commercial services provided increased data rates, network coverage provided throughout the town was inconsistent. The holes in the carrier's network coverage impeded police operations, and the town indicated that network coverage was both spotty and unpredictable. Officers became frustrated as they were unable to perform basic data checks (e.g., retrieving license plate, warrant information). Over time, officers became reluctant to use the commercial mobile data system as they deemed the service unreliable.

In an effort to correct these problems and restore officer confidence in this wireless service, the town attempted to negotiate with the commercial cellular carrier to improve its network coverage within the town's jurisdictional footprint. The negotiations ended unsuccessfully because the commercial carriers' proposed solution required the construction of additional tower sites within the town, and required that the town bear the full burden of construction costs. This was unacceptable to the town because of the large costs but also, more importantly, because the town and its residents were adamantly opposed to any new tower construction within the town limits. The Police Department's need for a mobile data service led them to a search for an alternative solution. The Police Department identified an alternative approach based on a network leveraging spectrum in the licensed 4.9 GHz public safety band[4] that would provide police access to a mobile data network providing the broadband network speeds and network coverage required to support police department needs. The information and

[4] The 4.9 GHz band was allocated for licensed public safety use in 2002 and consists of 50MHz of contiguous spectrum space between 4.94 and 4.99 GHz. This allocation was intended to support fixed and mobile public safety wireless broadband applications, and recent FCC rule changes were made to accommodate fixed/point to point microwave radio backhaul applications on a primary basis. The FCC Part 90 rules define 1MHz and 5MHz channels within the 50MHz allocation, and aggregation of these channels is allowed, facilitating radio frequency carriers up to 20MHz wide. The 4.9 GHz band support broadband applications possible, in a licensed, secure and controlled environment, with application performance similar to that experienced via Wi-Fi technologies but with much higher power emissions. Personal, Incident and Jurisdictional area networks can be facilitated within this band, and the rules also allow its use for high-speed point-to-point microwave links. The FCC declined to specify the technology used in this band, so there are no mandated standards outside the emission constraints defined by the FCC Part 90 rules, but in general, IEEE 802.11 (Wi-Fi) based technology is predominant. FCC authorizations are granted to governmental entities for use of the entire band, with the assumption that local planning and coordination is a prerequisite to band use. The FCC believes that the band is underutilized, and on August 3, 2012 the Public Safety and Homeland Security Bureau announced comment and reply comment dates for the Fifth Further Notice of Proposed Rulemaking on the 4.9 GHz Band (WP Docket No. 07-100, PS Docket No. 06-229, WT Docket No. 06-150) intended to solicit ideas in regard to how the band could be used more efficiently. Comments were due in late October 2012, and the FCC proceeding was still open at the time this report was generated.

perspectives presented in this section were gained through a series of focus group interviews, personal interviews, and personal communications with Brookline Police Department personnel.

3.1 Profile of Brookline

The town of Brookline (Brookline) is located in Norfolk County, a suburb of the City of Boston, which surrounds the town on three sides. The town is approximately 6.8 square miles and, according to the 2010 US Census reports, has a population of 58,732 with a median household income of $92,451 as compared to a national average of $50,831 (U.S. Department of Commerce, 2010). Making Brookline even more unique is the town's close proximity to Boston University and Boston College. As a result, the town experiences a fluctuation in its population during the academic school year. The vast majority of commercial activity is concentrated in the northern part of the town, while the southern part of the town is more residential and has more open space (e.g., parks). The Brookline Police Department has 140 sworn officers (60 percent of whom have advanced degrees beyond a bachelor's degree), two information technology officers, one analyst, 16 full-time civilian dispatch, and 24 full-time civilian support staff. The majority of crime occurrences in Brookline are larceny, burglary, and assault, while the most frequent types of calls handled by Brookline police are building checks, medical emergencies/transportation, traffic, and alarms. Table 1 provides an illustration of Brookline as compared to areas of similar size in the United States.

Table 1. Brookline, MA crime compared to national averages in 2010

	Brookline	National Population 25,000 – 49,999	National Population 50,000 - 99,999
Property Crime			
Burglary	149	220	488
Larceny	656	758	1542
Motor Vehicle Theft	23	61	168
Arson	2	5	19
Total	828	1040	2198
Violent Crime			
Murder	0	1	3
Forcible Rape	3	9	19
Robbery	30	31	83
Aggravated Assault	128	70	165
Total	161	111	269

Source: 2010 Uniform Crime Report data (Federal Bureau of Investigation, 2010)

3.2 Wireless Broadband Baseline Functional Requirements

Brookline Police Department management indicated that they realized efficiency gains in operations when they deployed commercial cellular data technology. Unfortunately spotty coverage experienced when they deployed commercial cellular network services frustrated patrol officers. This limited perceived efficiency gains to levels below those the agency had hoped for from their mobile data investment. The department sought an alternative solution that would provide a more reliable network with ubiquitous coverage. The commercial carriers' approach to addressing the coverage issue was to construct another cell tower in the town, but no suitable location was identified that would meet zoning requirements. In considering alternative approaches, the department planning goals also included finding a solution that would reduce recurring costs (e.g., current commercial service costs were 40 units x ~ $50 per month totaling ~ $2000.00 per month).

To achieve these goals, the Police Department decided to pursue a broadband wireless network that used equipment operating in the licensed 4.9 GHz public safety frequency band.

The Brookline Police and Information Technologies Departments developed and published a request for proposals entitled “Municipal Wireless Broadband Initiative.” This request for proposals detailed the public safety broadband network requirements and introduced the concept of a public-private partnership, hoping to create an attractive business model based on a shared public pay-for-service network to offset public safety network construction and maintenance costs.

The requirements for the public safety and municipal department network included the following:

- Public Safety: provide secure, reliable, and ubiquitous wireless access to specified users and applications at no cost to the town
- Municipal Services: provide secure, reliable, and ubiquitous wireless access to specified users and applications at no cost to the town and public housing locations and public parks
- Community Hotspots: provide reliable wireless broadband access in designated public spaces with minimum restrictions (bandwidth, session length, etc.) at no cost to the town
- Commercial Districts: Coolidge Corner, Washington Square, Brookline Village
- Increased Competition: provide residents and businesses with another choice for commercial broadband services
- Assure continuity in the event of any vendor default or breach of contract and protect the network from obsolescence over time

The technology requirements specified within the RFP included:

- Open, non-proprietary technologies with industry standard interoperability preferred
- 2.4 GHz (802.11b and 802.11g) preferred for network access

- 4.9 GHz preferred for public safety connectivity and possible future public safety network access
- 5.8 GHz preferred for other public safety network and commercial network backhaul
- Mesh or other ad hoc networking functionality preferred to support network mobility and flexibility
- Dynamic interference detection and interference abatement functionality preferred
- Modular, accessible equipment designed to facilitate technology upgrades (software, firmware, hardware components) preferred

The Brookline Police Department representative stated that the driving force behind the shared wireless broadband initiative was deployment of a public safety 4.9 GHz wireless broadband network. The towns' offering of a public-private partnership to provide commercial paid Internet service and free public Wi-Fi access was intended to attract a vendor to design, construct and operate a combined network that would also provide public safety services. Through the public-private partnership, revenue is generated so the commercial partner can fund the construction and maintenance of the combined network.

Alternatives to commercial cellular data service were considered for wireless data services, but the Brookline Police Department determined that no other option than the wireless data service would meet their needs. Since they had recent experience with less than acceptable levels of coverage provided by a commercial cellular service provider, they evaluated network coverage provided by other area commercial cellular service providers and found little difference. The town determined that a private network, using spectrum in the licensed public safety 4.9 GHz band, was the towns' best option for several reasons:

- A wireless mesh networking technology would minimize cable installation costs

- New cell towers were not needed; wireless infrastructure equipment could be mounted to existing infrastructure such as light poles and traffic signals
- System coverage could be expanded and optimized by adding wireless nodes as needed
- A public-private partnership could provide a revenue source to pay for network construction and maintenance
- There was no monthly recurring cost to the town government for public safety wireless broadband service

Government officials recognized the need for broadband data services within the community and appointed a committee to study the issue. The committee was comprised of government employees and representatives from the community and their study resulted in the issue of a request for information (RFI) released to identify potential alternative broadband communication solutions that required less intrusive construction methods (e.g., street level infrastructure versus new towers). The Police Department, working with the Information Technology Department, subsequently published a request for proposal, titled Municipal Broadband Wireless Initiative – Brookline, MA. Galaxy Internet Services Inc. responded to the request for proposals and in 2006 was granted a license agreement by the town to construct and maintain the network using government owned infrastructure (e.g., a license to use light poles not to be confused with the 4.9 GHz FCC authorization issued by the FCC to the Town of Brookline). On October 3, 2006 Brookline granted a license to Galaxy Internet Services Inc., permitting them to deploy a municipal wireless broadband network to provide services. The license agreement allowed Galaxy Internet services Inc. to construct a shared network infrastructure within town limits. This network would contain components in both licensed (4.9

GHz) public safety and unlicensed[5] spectrum (both 2.4 GHz & 5 GHz Wi-Fi) and leverage town infrastructure, to provide:

- Commercial Internet services (paid commercial service), via unlicensed Wi-Fi, to town residents and businesses
- Free Internet access, via unlicensed Wi-Fi hotspots, for non-public safety municipal departments,
- Free public Internet access, via unlicensed Wi-Fi hotspots, at specified public locations, and;
- Secure mobile access to the network, via network access points & hot spots operating in the licensed 4.9 GHz band, for Brookline public safety users.

The Brookline network design consists of a mesh network backbone based on a commercial technology designed to simultaneously support several radios operating in multiple frequency bands (2.4 GHz, 4.9 GHz and 5.8 GHz). Galaxy designed and constructed the network as follows. Equipment operating in the 2.4 GHz Wi-Fi band provides commercial public Internet access, and support for (non-public safety) data communications for municipal departments such as the Department of Public Works. 4.9 GHz wireless access is used in conjunction with Virtual Private Network (VPN) technology to provide dedicated and secure access to town IT resources

[5] Public safety agencies are not precluded from deploying wireless networks in the unlicensed, Part-15, (Wi-Fi) bands. Unlicensed Part-15 commercial off the shelf (COTS) Wi-Fi networking technology is often used by public safety agencies to establish hot spots and/or municipal wireless broadband networks. Unlike licensed FCC Part-90 4.9 GHz technology, unlicensed FCC Part-15 Wi-Fi equipment is available for anyone to use, and this unlicensed spectrum also supports other technologies like microwave ovens and cordless phones, requiring agencies to exercise care when considering unlicensed bands for mission critical applications. Network security, network availability, and reliability within a congested RF environment are all important considerations when using unlicensed spectrum-based technologies. Public Safety users, just like any other Part-15 equipment user, must expect no exclusive rights to unlicensed frequencies and must accept interference; no legal recourse is available if interference is experienced. It is expected that many public safety agencies will continue to take advantage of unlicensed Wi-Fi technology, as a resource to augment and support mission critical applications residing in licensed bands, like the 4.9 GHz band, just as Brookline has done via its network sharing agreement.

for police officers and firefighters. Galaxy manages and operates the network, providing Internet Services to town users as the core of their commercial offering (Galaxy is a commercial Internet service provider; known as an ISP). Equipment operating in the unlicensed 5.8 GHz frequency band provides backhaul communications for the shared backbone network.

The Brookline wireless broadband network is designed to provide ubiquitous mobile coverage for public safety users within Brookline geographic boundaries; access to the public safety network resources beyond the town borders is limited. As a result, the police equip their patrol cars that travel outside of the broadband network coverage with commercial cellular air cards to supplement the broadband network. This includes patrol cars assigned to the North, bordering the City of Boston and West bordering Newton, where coverage is marginal or not existent. The use of the commercial cellular network in the areas adjacent or just outside Brookline allows officers to continue to access necessary data resources maintained by Brookline when they move outside of 4.9 GHz radio coverage. It is important to understand the fundamental limitations of RF coverage apply the same to data networks as public safety voice radio networks.

Once a Brookline officer travels outside "home coverage," the data resources are no longer accessible because of signal degradation and attenuation. None of the neighboring jurisdictions have deployed similar 4.9 GHz networks; therefore there are no interoperable alternatives for Brookline officers travelling into the neighboring jurisdictions. Patrol vehicles for users fitting this description are equipped with a commercial cellular data card. Conversely, officers from other jurisdictions travelling into Brookline's jurisdiction that may have compatible air-cards do not have access to the Brookline 4.9 GHz network because of governance and security issues. If users with compatible radio access equipment were to implement inter-agency agreements with Brookline, and management protocols were in place, interoperability likely could be established in an analogous fashion to voice interoperability agreements often used to provide land mobile radio system sharing and mutual aid support. The management issues with broadband data are much more complex and likely would extend to terms within the licensing agreement between the town and Galaxy communications.

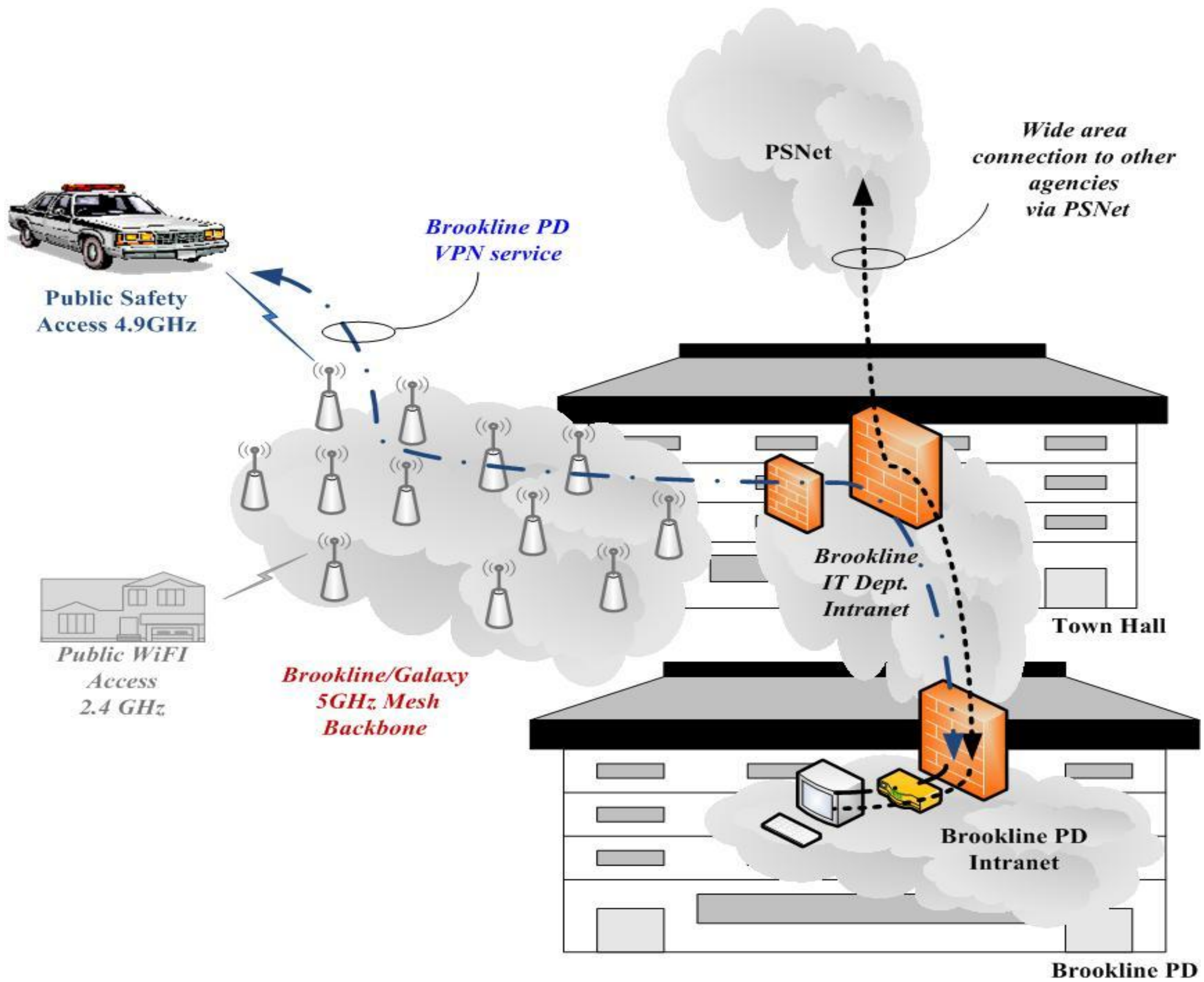
3.3 Description of the 4.9 GHz Implementation

The wireless broadband network as deployed in Brookline is designed to serve both the general public by providing both wireless commercial Internet services and mobile public safety access to municipal network resources. From a radio spectrum and FCC rule perspective, the municipal network consists of three components:

- A dual-channel unlicensed 5 GHz Wi-Fi network backbone based on a proprietary commercial "mesh" technology that is self-provisioning, self-healing, and uses algorithms to pick an optimal path for user data to traverse the network.
- Unlicensed 2.4 GHz Wi-Fi access points are used to provide connectivity (access) for paid subscribers, non-public safety municipal departments and free Internet access for locations designated as community "Hot Spots" such as public parks and other designated public areas.
- Public safety users (police and fire) access the network by way of FCC licensed 4.9 GHz spectrum to obtain secure mobile access to the town's IT network resources.

The vast majority of unlicensed 2.4 GHz Wi-Fi and licensed 4.9 GHz radios are collocated in the same light-pole mounted housings with the unlicensed 5 GHz Wi-Fi mesh radios & routers that form the mesh network backbone. Public safety connections through the shared backbone are segregated and secured from public traffic through the use of virtual private networking (VPN) technology operated/managed by the Brookline Police Department's Information Technology personnel. Figure 1 illustrates the stakeholders and structural components of the Brookline municipal wireless broadband network.

Figure 1. Components of the Brookline Municipal Network



Wireless networks constructed with mesh technology like that used in Brookline permit the nodes of the backbone network to automatically and continuously optimize network communications paths through the network, and provides mobility for first responder use, as users move and are handed off between pole mounted access-points, while maintaining session connectivity as they move through the police department's jurisdictional area. This architecture essentially presents the operator and users with a network containing a number of self-healing features: network nodes, as a collective, continuously communicate available routes and paths through the network, thus, as individual nodes are damaged or become inoperable, other functioning nodes can reconfigure to bypass a damaged/non-operating node if an alternate path is available. The use of traffic routing algorithms also allow nodes to continually monitor communications traffic loads within the network and intelligently re-route network and user data using the most optimal available path based on current traffic loads.

The backhaul communications are maintained using radios configured as a mesh network operating in the unlicensed 5 GHz Wi-Fi band. The interconnection between 5GHz nodes uses the IEEE 802.11a air interface standard. The network is divided into four geographical sectors, with a node density of approximately fifty nodes per square mile (e.g., approximately 350 nodes in 6.8 square miles). There are three aggregation points where the mesh network is connected to the Internet or town resources via dedicated microwave links or fiber optic cable. The main public safety service termination point is at the Brookline Town Hall, where the public network provides access to the Internet and 4.9 GHz connections interface with the Police Department's network via VPN connections and a firewall. To provide network access for users who operate at the fringe or beyond the limits of 4.9 GHz network coverage, Brookline Police use a limited number of cellular air cards to provide supplemental access to network services for users that travel beyond the municipal network coverage area.

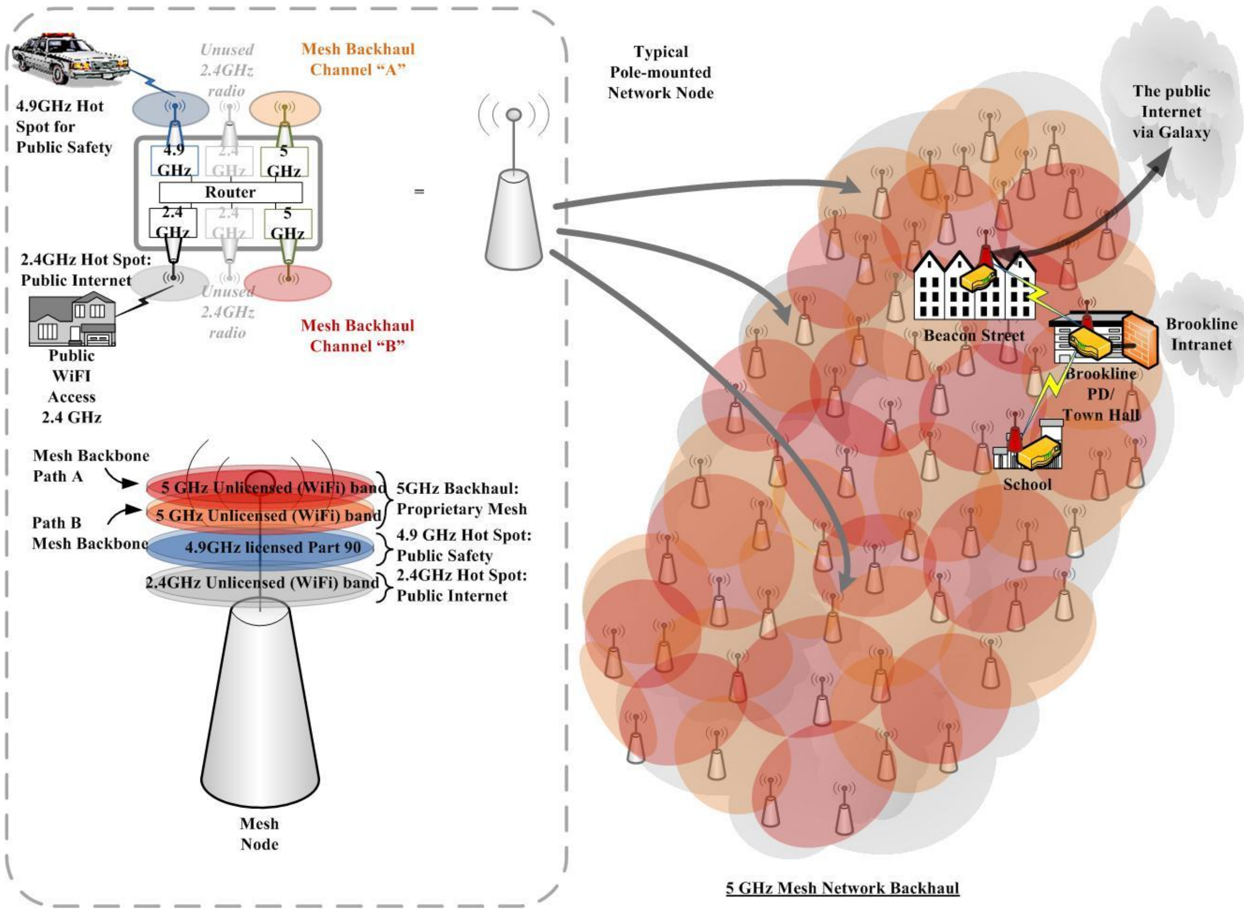
3.4 Technical Description of the Network

The wireless broadband network was built using network equipment manufactured by Strix Systems, Inc. The vast majority of 2.4GHz Wi-Fi (unlicensed FCC Part 15) and 4.9GHz (licensed FCC Part 90) access points, as well as IP routers that form the mesh network are collocated in the same physical housings as the 5GHz Wi-Fi (unlicensed FCC Part 15) mesh backbone radios. Each of the Strix Outdoor Wireless System (OWS Outdoor) wireless nodes typically contains a total of six radios: two 5 GHz radios, one 4.9 GHz radio and three 2.4 GHz radios. The total number of (active) radios in a node may vary depending on location.

Most of the wireless nodes are mounted to municipally-owned light poles and/or traffic signal poles. A smaller number of nodes are mounted to buildings (e.g., primarily at the three backhaul locations). Unless specific engineering issues require use of higher performance directional panel antennas, pole-mounted radio nodes use omni-directional antennas. As noted above, a few of the nodes use directional antennas for 5GHz backbone connections or to improve coverage at certain locations. However use of omni-directional antenna configuration is most prevalent for all types of connections. Over-all backhaul and self-healing efficiency in the self-configuring mesh backbone network is much greater using omni-directional antennas since each backbone node is visible to one or more neighboring backbone nodes, via 5GHz Wi-Fi connections. As noted above, public safety connections through the shared backbone are segregated and secured from public traffic through the use of virtual private networking (VPN) technology operated/managed by the Brookline Police IT Department.

Brookline police vehicles are equipped with Strix Mobile Wireless System radios. These units operate in the licensed 4.9 GHz frequency band that allows higher radio frequency (RF) power and higher gain antennas in comparison to unlicensed Wi-Fi technology. DC power to operate the Strix radio units is supplied by the vehicle, and the data radios are connected to a laptop computer using standard Ethernet cables. The laptop computer software includes NetMotion Wireless Mobility XE. This product supports mobile virtual private networking, network access and application session persistence and performance as the mobile unit moves between wireless access points. It is important to note that Brookline police equip vehicles assigned to patrol areas not supported by the 4.9 GHz network with commercial cellular air cards to provide network access.

Figure 2. Network Node Configuration



As described above, the backbone network consists of a proprietary wireless mesh technology operating at 5.8 GHz to provide network backhaul between end users and the three aggregation points. Each node of the mesh network dedicates two 5.8 GHz radio frequency pairs to support backhaul connectivity; one radio (and frequency pair) for uplink and a second radio (and frequency pair) for downlink. To avoid interference between neighboring nodes, backbone radios are programmed to use different frequencies in the unlicensed 5.1- 5.8 GHz UNII band.

Figure 3. Typical Utility-Pole-Mounted Network Node

Thus as officers send and receive data over the 4.9 GHz access network, data packets are routed via the 5.8 GHz mesh backbone to one of the three termination points. In Brookline data may traverse more than ten hops from access to termination point. This occurs because of the mesh topology of the network; the termination points are not necessarily centrally located, nor may the closest point be the path chosen because of network traffic/congestion. The primary path of each transmission is selected by signal strength, traffic congestion and delay. The use of multiple radios in the backbone tuned to multiple 5.8 GHz frequencies greatly improves the efficiency of network transport. It is important to remember that the 4.9 GHz access network shares 5.8 GHz backhaul resources with the commercial users accessing the shared backbone via the 2.4 GHz commercial / public access network. As a result, congestion on the backbone from either network may impact the other.

The shared network infrastructure provides benefits to public safety services that may not be obvious. The user density for commercial network customers operating at 2.4 GHz has dictated an increase in the number of nodes on the network, e.g., increased node density required to support high demand on the network for commercial Internet services. As noted above, in addition to capacity issues, when compared to licensed 4.9 GHz radios, relatively low power limitations for the unlicensed 2.4 GHz Wi-Fi radios require a higher density of unlicensed nodes to be deployed in support of the commercial network. The environment in Brookline adds further design complexities to support wireless coverage: signal attenuation because of the number of trees, dense buildings and the layout of town streets (e.g., multiple "T" and "Y" intersections and curves) all create engineering issues specific to Brookline in regard to providing reliable RF coverage.

The town employs management and security features in conjunction with the 4.9 GHz licensed access network and unlicensed 5.8 GHz mesh backbone. The town's information technology intranet is not managed by Galaxy. That is, Galaxy operates the RF aspects of the wireless network to ensure that wireless access services are operating, but secure, private, Internet protocol networking services are provided for public safety users by the town information technology department. No manipulation of public safety data traversing the network is performed by the vendor. Public safety traffic, originating via the 4.9 GHz access network, has priority over 2.4 GHz commercial/public network services when data packets are transmitted through the 5.8 GHz mesh backbone. Public Safety services provided to users via the 4.9 GHz access network are provided via a dedicated Virtual Local Area Network (VLAN). Data encryption for mobile clients is managed for the police by the information technology department, using the NetMotion Wireless Mobility XE product. Police user data are encrypted using Cisco virtual private network (VPN) software. The 4.9 GHz access network is secured via hidden and encrypted service set identifications (SSID).

3.5 Applications Used

The Brookline Police Department information technology officer reported that wireless broadband network services, made possible with 4.9 GHz access technology, allow officers to access all public safety databases from their vehicle mounted laptops. This is possible because the broadband network provides secure connectivity to the town's internal public safety wired network. This connectivity allows mobile public safety laptops to access the department's server, active directory service, anti-virus software and the public Internet via a network management access and filtering product called Websense. Mobile users are provided the same network access rights and restrictions they would experience if they were logged directly into the network via the towns wired network, to include network security and firewall rules. From a network management perspective services accessed via the wireless broadband network are an extension of those available via department's internal public safety network. Brookline Police Department personnel used a host of applications via the wireless broadband network. Perhaps the most relied upon applications are products from Larimore Associates, which allows officers to access systems such as:

- Computer Aided Dispatch (CAD)
- Records Management System (RMS)
- Arrest & Field Interview (FI) applications
- Training
- Scheduling applications

Officers that use services provided through the wireless broadband network have in-vehicle access to a number of applications listed above. For example, they can complete department reports (e.g., standard incident reports) while in the field. Officers and dispatchers also have the ability to use silent dispatching technology (e.g., text messages between CAD system and a patrol vehicle), they can access online arrest data and mug shot information and input field interview data to forms directly from the field; plus they have access to a number of other applications. According to the Brookline Police representative, this capability enables officers to complete reporting tasks while they remain in their patrol sector; enabling them to be much more efficient when answering calls and writing reports from their patrol vehicle.

Brookline personnel also rely upon a software application known as PocketCop to access a host of information systems. This application allows patrol officers to quickly and easily get the time-critical information desired without dispatcher involvement and waiting for a verbal response – thus making officers more efficient and effective while reducing support costs and radio traffic. Of the information systems available, PocketCop gives law enforcement secure mobile access to the National Crime Information Center (NCIC). This application was customized by BPD to best fit their department needs. Information imputed to various server connections is uploaded live and accessed through PocketCop, which allows for real-time information sharing. Detailed capabilities included (but are not limited to):

- Accessing criminal history servers
- Observe NCIC arrests and police encounters with individuals
- Query license plates and vehicle registrations
- Warrant information
- Intranet for downloading intelligence reports from the Boston Regional Intelligence Center (BRIC), criminal photos, videos, comparative statistics (CompStat) reports, and bulletins
- Public building floor plans (through BSafe program)
- BPD manual/policies/procedures, training documents, and emergency management information. Instant messaging capability

According to the interviews with BPD personnel, another significant benefit of the wireless broadband network is that officers can complete these tasks without the fear of losing their work, which they previously experienced when using commercial services. In the past, when using the commercial cellular air cards, officers were limited to accessing the department's records management system using a thin client application. This application crashed on a frequent basis because of coverage issues experienced with the cellular network. At times service was so bad that officers would not even attempt to write a report from the vehicle; they would opt to return to the station before entering reports. The wireless broadband network enables officers to access many more law enforcement and non-law enforcement data sources. Some of these include:

- Commonwealth of Massachusetts databases
    - Department of Motor Vehicle
    - Department of Criminal Justice Information Services
- Nlets – the international justice and public safety network[6]
- NCIC – National Crime Information Center[7]

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[6] See http://www.nlets.org/. Nlets, is a private not for profit corporation owned by the States that was created over 45 years ago by the 50 state law enforcement agencies. The user population is made up of all of the United States and its territories, all Federal agencies with a justice component, selected international agencies, and a variety of strategic partners that serve the law enforcement community-cooperatively exchanging data.

The types of data being exchanged (via Nlets) varies from motor vehicle and drivers' data, to Canadian and Interpol database located in Lyon France, to state criminal history records and driver license and corrections images. Operations consist of nearly 1.5 billion transactions a year to over 1 million PC, mobile and handheld devices in the U.S. and Canada at 45,000 user agencies and to 1.3 million individual users.

[7] For more general information about NCIC, see http://www.fas.org/irp/agency/doj/fbi/is/ncic.htm
NCIC is a computerized index of criminal justice information (i.e. criminal record history information, fugitives, stolen properties, missing persons). It is available to federal, state, and local law enforcement and other criminal justice agencies and is operational 24 hours a day, 365 days a year. The purpose for maintaining the NCIC system is

- Town of Brookline
  - E-mail
  - Documents to include general orders, policy documents, directives, special orders, crime bulletins, COM Stat reports, crime stats and mapping information and training materials (the agency is working toward broadcasting training video to the field)
  - Emergency management databases that contain the schematics and general information for Brookline schools (both public and private, including local colleges)
  - Global Information Systems (GIS) applications - a high bandwidth application (ArcGis) that could not run over the CDMA network
  - Camera feeds (two camera networks are available, one is a critical infrastructure camera monitoring system, and the second system is cameras deployed to high-crime areas, using the wireless broadband network. These cameras can be placed anywhere within the town borders and are configured to run through the unlicensed 2.4 GHz Wi-Fi access network.)

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to provide a computerized database for ready access by a criminal justice agency making an inquiry and for prompt disclosure of information in the system from other criminal justice agencies about crimes and criminals. This information assists authorized agencies in criminal justice and related law enforcement objectives, such as apprehending fugitives, locating missing persons, locating and returning stolen property, as well as in the protection of the law enforcement officers encountering the individuals described in the system.
Specifically in Massachusetts, NCIC access works as follows The criminal justice information systems agency (CSA) is designated by the FBI to provide management control of FBI criminal justice information systems within a state. The Department of Criminal Justice Information Systems (DCJIS) is the Massachusetts designee.

3.6 Brookline, MA Business Model for 4.9 Mobile Broadband Capability

Public safety, emergency services, and daily municipal operations communities are increasingly reliant on the use of broadband data communications. More specific to the current discussion, public safety personnel rely on Wi-Fi mesh network broadband capabilities for readily available, large bandwidth, connectivity to people, video surveillance cameras, strategic and tactical equipment, and databases for effective and efficient operations. The performance and benefits of Wi-Fi technology have resulted in a large number of devices/products utilizing the technology – whether it is 2.4GHz 802.11a/b/g or licensed 4.9 GHz spectrum specifically assigned for official public safety use. Device form factors range from laptops, tablets, and smartphones as well as specific devices used for public safety and emergency services (such as emerging portable radios which may utilize broadband for programming). Despite such operational benefits, municipalities that are able to procure and implement a wide-area wireless broadband network with coverage throughout an entire jurisdiction are the exception rather than the rule – largely in part due to a lack of resources to purchase and/or maintain the capability. The model to be discussed here presents a unique approach to bring this capability to a medium-sized municipality for both public safety and the greater community.

The town of Brookline has several unique characteristics that combined to create an opportune situation for the deployment of the first integrated unlicensed 2.4 GHz, 5 GHz & licensed 4.9GHz public safety, residential, and commercial mobile broadband network in the country. Surrounded by the city of Boston on three sides, geographically contiguous to Boston University (and thus student and employee residences), and home to roughly 58,000 residents of which the average home income is approximately $92,000 annually – Brookline is thriving with a population which relies on, and demands, access to broadband internet. Further enhancing Brookline's need for a mobile broadband capability is its barriers to other feasible options for this function. The town suffered from poor cellular coverage as a result of frequent tree-lined streets, large buildings on the edge of Boston, and a majority of the citizenry averse to the erection of cellular towers in or around their property. As a result, Brookline's public safety operations (i.e., police, fire, emergency medical, etc.), businesses, and constituents could not utilize a large bandwidth data communication capability that was both ubiquitous and reliable. Thus the need, and unique opportunity for, the establishment of a mobile broadband network in the town identified.

Brookline did not possess the capital funds to construct a mobile broadband network. As a result, the town offered an opportunity for a commercial vendor to construct and operate the network using existing town infrastructure resources. Franchise agreements with utilities and communications providers are common in many municipalities; however as noted, the use of government-owned resources to support a commercial venture is not as common. In December, 2005, the town of Brookline published a request for proposal (RFP) to construct and maintain a wireless broadband network. In their RFP, the town offered the use of the town's physical infrastructure as resources to host network equipment and they also offered a public-private partnership incentive for an internet service provider to operate and maintain the network.

Capping a two-year process, in October 2005 Brookline executed a license with Newton-based Galaxy Internet Services to build and operate a Wi-Fi network that will cover the entire community. This approach led to the current public-private partnership that exists between Galaxy Internet Services Inc. and the town of Brookline. Galaxy Internet Services Inc. constructed the wireless broadband network, at no cost to the town of Brookline. Galaxy serves as the prime contractor and local project manager for the Brookline network and provides retail ISP. NeoReach (owned and operated by MobilePro) was responsible for designing, deploying and operating the open wholesale wireless network while SkyPilot provided the mesh hardware used to build out the Brookline network infrastructure. In addition, the agreement provides Brookline with free user accounts for all town employees and a dedicated percentage of the provider's bandwidth for the town's non-public safety departments' use. Thus, the town of Brookline receives all the benefits of a commercial network without the recurring monthly costs for service or the capital investment to construct the network.

Revenues generated from service subscription fees associated with commercial Internet services covered Galaxy's construction costs associated with the shared network. Galaxy Internet Services, Inc. stated that the town of Brookline provided an attractive opportunity for them to develop this particular network. The primary incentive was a densely populated town with, at that time, limited resources to obtain wireless Internet access services. A consumer market study by Galaxy led them to believe that there was a significant demand for wireless services. Addition of the town's offer to provide access to physical infrastructure & and resources, in exchange for public safety services reduced network construction costs significantly since costly components such as tower sites and access to optical fiber links for backhaul were provided. The points below summarize the key aspects of the public-private partnership model:

The physical resources that the town offered to interested bidders to included access to:

- Street light and utility poles
- Municipal buildings
- Fiber cable between town hall and high school and conduit space where available.
- Network operations center (NOC) facilities
- Town equipment and staff to facilitate and assist with network construction tasks and;
- An expedited permitting process to facilitate network construction

Public private partnership incentives included:

- Business model should minimize network capital costs and operating expenses to town by utilizing a portion of commercial broadband service revenue to fund project;
- Preference toward a partnership with a single vendor with a Massachusetts State blanket contract with existing working relationships and/or subcontracts with other companies such as equipment manufacturers, software companies, professional IT service providers, contractors, and wireless Internet service providers;
- Preference toward an agreement to establish private ownership of network infrastructure that provides the town with specified rights of use and access;
- Preference toward an agreement that provides for maintenance (repairs) by the private partner to include technology refresh (upgrades) of network components;
- Contract duration, including terms for commercial services and network maintenance, were open to negotiation;
- Shared risks; and;
- Financial terms that may have included a performance bond and other appropriate protections.

Financial options for community members and businesses included the following:

- Multiple residential and commercial service offerings
    - Basic and full featured service options
    - Residential best effort 1Mbps upstream and downstream offerings
        - $20.00 per month
- Commercial offerings
    - High speed commercial solutions, $40 - $300 per month

- Community Hotspots
    - Commercial districts
        - Brookline Village, Coolidge Corner, Washington Square
    - Public parks
        - Larz Anderson, Downes Field, Warren Field, Amory Park, Cypress Playground
    - 1 Hour Free Access per Day
- Public Housing
    - Free Access to Town qualified public housing locations
        - Helping to “close the digital divide”

The network also supports traditional Internet services and voice over Internet protocol (VoIP) for municipal, commercial, and consumer applications. A free trial period allowed all Brookline residents and visitors to access the wireless network to explore its robust Internet access and ubiquitous coverage by selecting the city's 'BrooklineWireless' Wi-Fi SSID.

The town of Brookline receives several additional benefits from the public-private partnership. The following network use conditions were outlined in the License Agreement between the town of Brookline and Galaxy Internet Services, Inc., in exchange for use of town property and resources to support of the wireless broadband network:

- The town government receives free user accounts, and day-to-day use of network, but use is limited to 10% of the Wireless Broadband Network’s Overall Capacity, as measured by the commercial partner.
- The Town and Licensee agreed to meet annually, or as needed, to assess the Wireless Broadband Network’s performance, discuss engineering issues, assess technology

direction and to review and assess the Town's municipal, public safety, and technology needs. The town and its commercial partner will then take mutually agreed upon action as reasonably necessary to meet the town's ongoing needs.

- The provisions in the agreement do not limit network use by public safety users, on a first priority basis, if bandwidth exceeding 10% of overall network capacity is needed during a declared emergency.

Given that Brookline public safety communications operated on what is known as a Code Division Multiple Access (CDMA) network, which is limited in capacity and prone to interference from other sources (especially given the topography of the town's south side where it is rolling hills), the Brookline Police Department viewed the partnership as a significant benefit since the town did not possess the capital funds to construct and maintain the public safety network. The town's license agreement secured not only the construction of the 4.9 GHz public safety network but unlike most franchise agreements, Brookline has a dedicated a percentage of bandwidth to access the Wi-Fi network for non-public safety departments and free user accounts for all town employees. The citizens of Brookline benefit through free Wi-Fi Internet access at designated community locations and by having another option for paid Internet service. The Galaxy representative described the partnership as a win as they were provided free access to town infrastructure. This greatly reduced the network construction costs and increased the number and availability of sites for equipment installation. In addition, the license agreement allows Galaxy access to offer paid commercial Internet service in an area that their market studies indicated strong consumer interest and need. The economic considerations made by an agency in pursuing wireless broadband will depend heavily upon the budget and finance policies of the municipality. These policies often dictate whether the agency is likely to pursue a privately owned network with capital investment or a commercial carrier leased services solution.

The public safety network is also a cost saver for the town, which was paying Verizon (their cellular data provider) approximately $60 a month for each broadband data card – which was more than 40 wireless cards – which police and firefighters used to access the CDMA network. Once the network was installed, these costs were greatly mitigated. It should be noted that Brookline did not get rid of all their cellular data cards. The police department continues to subscribe to a few cards for certain users as a supplement to address coverage holes, and as a back-up in the event of hardware or service failure within the licensed 4.9 GHz access network. Other components of the Brookline town government has also experienced (or anticipated to experience) benefits from the network; such as enabling building inspectors, auditors, engineers, and other employees in the field to enter information directly into central town databases. Moreover, the network is designed to augment the Metro Boston Homeland Security Region's infrastructure with a secure, reliable, and interoperable wireless network infrastructure.

Establishing a wireless network for public safety communication is not a straightforward or simple process – and most agencies do not enjoy the successes experienced in Brookline. For example, an effort to increase its access to the bandwidth they have access to, for improved data sharing capability, the Chicago Police Department experimented with a system known as Greenhouse (Skogan et al., 2003). This technology, a Motorola product, promised to increase bandwidth from 9.6K bit/sec to 460K bit/sec, providing a wide-enough bandwidth for transmitting incident report data as well as larger data files such as mug shots, live audio and video, and driver's license photos. Such a system would allow officers to share information approximately 48 times faster than the current technology available to the department at the time

(Sparrow, n.d.). However, full implementation of the Greenhouse system was not easily achieved and Greenhouse was deployed for a short time but never took off. It was replaced by an Radio Data Link Access Protocol (RDLAP) system that is still in place - although it too is currently at the end of its life span. They have deployed commercial cellular to run the Citizen Law Enforcement Analysis and Reporting (CLEAR) web applications not supported by RDLAP. On a larger level, the Federal Communications Commission (FCC), which provides authorization for (i.e. licenses) non-federal radio spectrum use, would have had to issue a permanent license for long-term use of Greenhouse system frequencies in the city of Chicago.

In Brookline, coverage issues with the existing system motivated the police to search for an alternative. From a financial perspective, the town sought a solution that would reduce or eliminate monthly recurring costs. From the commercial provider's perspective, Galaxy indicated that they are only able to provide this type of solution to Brookline as the numbers of subscribers on the commercial pay service are significant and generate sufficient funds for the company to maintain the network and be profitable.

Chapter 4 Methods

A mixed methods approach was used to determine the effect of wireless broadband network implementation on police operations.[8] This design allows for the combination of several different methods to provide depth to observations. Given the exploratory nature of this case study, this approach helps to reduce inherent measurement and sampling biases. Three primary components were used: a semi-structured interview with select uniformed personnel, a web-based survey of all uniformed personnel, and secondary analysis of Computer-Aided Dispatch (CAD) data that were extrapolated from Brookline Police Department's management information system.

Two research questions guided the current research. First, was the broadband network implemented according to initial expectations? To determine the effect of implementation on operations in an evaluative framework, it is essential to capture information on the *process* of making the network functional. Ease or difficulty of implementation has the potential to shape outcome measures. Additionally, process information often identifies unintended benefits and problems that are important for procurement decisions. Semi-structured interview and web-based survey components of the research were designed to capture process information.

Second, did the implementation of the broadband network have any effect on police operations? Based on the review of literature, it is anticipated that wireless technology would most directly improve information sharing, efficiencies related to the completion of job and administrative tasks, and response times to calls for service. These dimensions of daily police operations were the primary outcomes of this research. Web-based survey and secondary data components of the research were designed to capture outcome information.

[8] The research protocol received Institutional Review Board approval (CIRB Pro00006751).

It is important to note that the research questions and design components were products of ongoing discussions and feedback from experts in the field of communication technology. All facets of the research were presented to and validated by the National Institute of Justice's Communication Technology Working Group.

4.1 Semi-Structured Interview with Select Uniformed Personnel

One site visit to the Brookline Police Department was made for the sole purpose of administering a semi-structured interview protocol with select uniformed personnel. A non-probability purposive sampling strategy was used. Critical to the formulation of a sample was expertise about or knowledge of the wireless broadband network and its functional capabilities. Members of the sample must have been employed by Brookline Police Department prior to the October 2006 wireless broadband network implementation. Additionally, representatives of a full range of department roles were selected in an effort to increase variability in responses. The research team worked with Brookline Police Department's Director of Technology to identify members of the sample. This process was completed one month before the site visit.

A total of five uniformed personnel were interviewed. Respondents included the Chief of Police, Director of Technology, one Sergeant of the Patrol Division, one Lieutenant of the Training Division, and one Analyst. All of the respondents possessed variable degrees of knowledge about the wireless broadband network, were employed with Brookline Police Department prior to network implementation, and served a variety of roles in Brookline Police Department. Respondents held supervisory and administrative positions central to operations of Brookline Police Department. Interviews were typically one and a half hours in length and took place in a meeting room at Brookline Police Department. Each interview was one-on-one with members of the research team.

Interview questions represented an outline of topics to be covered (see Appendix A for the interview protocol). The order of topics within each interview varied and was dictated by the conversation flow. Broad, open-ended questions were used to capture background information on the implementation of the wireless broadband network, benefits perceived, issues that were faced, and remedies to resolve problems. Probes were used as necessary for clarification and elaboration purposes. Additional broad, open-ended questions were created to capture information about how the implementation may have influenced specific roles in the department. These questions were designed to elicit discussions of whether the network was perceived to have any effect on job tasks associated with specific roles.

Short-hand notes were taken by four members of the research team. These notes were elaborated, compared, and discussed. This process of obtaining inter-subjective agreement allowed for the identification of the most salient themes manifested from the interviews and increased confidence in the reliability and validity of observations. This portion of the research specifically sought to capture information on the process of implementation. As such, the findings are limited to themes concerning implementation process, implementation benefits, and implementation challenges or drawbacks that emerged across interviews and interview questions.

4.2 Web-Based Survey of All Uniformed Personnel

A web-based survey was administered to all 140 uniformed Brookline Police Department personnel. A non-probability sampling strategy was preferred to capture variation in end-user knowledge about the wireless broadband network implementation as well as experiences working with the capabilities offered by the network. Whereas the semi-structured interview component of this research focused on expertise, there is no assumption that respondents would possess technical knowledge about the network.

The web-based survey link was distributed to all uniformed personnel through their departmental email address. Periodic email reminders were sent regardless of whether the survey had been completed. Announcements were made during in-service training sessions held in the first six months of 2012. Access to the survey was available at the station at desktop computer terminals. The survey also could be accessed through personal home computers during off hours. Uniformed personnel were unable to complete the survey on mobile computer terminals. The survey remained open for a period of four months, March 1, 2012 through June 30, 2012.

The final sample consisted of 76 respondents. The sample represents 62% of uniformed Brookline Police Department personnel who were active for duty across the four-month period (76/123 = 62%) and 54% of all uniformed personnel (76/140 = 54%). The rate of response is consistent for exploratory web-based survey (see Sheehan, 2001). Table 2 displays survey respondent demographics. On average, respondents had been employed by Brookline Police Department for almost 18 years, possessed a graduate degree, and were White males over the age of 38. Most of the respondents were assigned to patrol.

Table 2, Respondent Demographics (n=76)

	Mean	Frequency (Percent)
Staff Position*		
Command Staff		4 (5%)
Lieutenant		4 (5%)
Sergeant		7 (10%)
Patrol		45 (62%)
Detective		10 (14%)
Analyst		3 (4%)
Education		
Master's Degree		48 (66%)
Bachelor's Degree		18 (25%)
Associates Degree		3 (4%)
High School Degree		4 (5%)
Age		
53 or older		16 (22%)
48 – 52		15 (21%)
43 – 47		8 (11%)
38 – 42		15 (21%)
33 – 37		8 (11%)
28 – 32		5 (7%)
23 – 27		5 (7%)
Gender		
Male		65 (92%)
Female		6 (8%)
Race/Ethnicity		
White		63 (86%)
African American		3 (4%)
Asian		3 (4%)
Hispanic or Latino		3 (4%)
Native Hawaiian/Other Pacific Islander		1 (2%)

*Average years on force was 17.84 with a standard deviation of 10.20.

The survey instrument was designed to capture a variety of dimensions associated with wireless broadband implementation and police operations (see Appendix B for the survey instrument). Many of the dimensions and their underlying items were gleaned from previous research and found to possess adequate levels of measurement reliability and validity (Chan, 2001, Chan et al., 2001). Items consisted of statements intended to prompt perceptual and/or attitudinal responses. One of the challenges with trying to measure adoptions to new technology or changes in existing technology among a sample of end-user respondents who may not possess baseline technical knowledge about technology is the need to develop items that resonate with respondents. Brookline Police Department made use of mobile computer terminals prior to wireless broadband implementation. However, the implementation enabled the expanded use of mobile computer terminals and their inherent software programs and applications. In recognition of these correlated events, survey items are contextualized with reference to mobile computer terminals and software applications. The survey instrument was disseminated to the National Institute of Justice's Communication Technology Working Group who reviewed and provided feedback on survey items and structure. Results of this pre-test helped to shape the final instrument.

Implementation Dimensions. The ability to implement technology is reliant on three end-user factors: technology proficiency, training, and awareness of and involvement in the implementation process (Pollard & Cater-Steel, 2009). *Technology proficiency* consists of three closed-ended survey items that gauge respondent perceptions of skills, confidence, and familiarity working with computers and computer software and two close-ended items on preference for using computers. *Training* consists of four closed-ended survey items that capture perceptions of formal and informal training services respondents had received on mobile computer software and changes to the software and one closed-ended item about the need for more training. It is presumed that high levels of proficiency and training are an indirect indicator of successful adoption to new technology or changes in existing technology (Inan & Lowther, 2010). As such, these are important background factors to the current case study. *Implementation process* consists of two closed-ended survey items about awareness and involvement in the implementation of the wireless broadband network and two additional closed-ended items serve as measures of implementation challenges. This is a direct measure of respondent perceptions of wireless broadband implementation.

Dimensions of Police Operations. The implementation of wireless broadband is expected to improve police operations. Specific improvements should be observed in information sharing and efficiencies related to the completion of job and administrative tasks. This section attempts to capture respondents' perceptions of whether respondents perceive such benefits based on their experiences. In the development of relevant operations measures, the research team integrated an assortment of measures gleaned from Chan *et al*. (2001) and Nunn and Quniet (2002).

Within information sharing, two sub-components were identified and explored. First, *information flow* consists of 14 closed-ended items. Five of these items represent measures of ease of information access and receipt as well as the ability to share information. Four items capture information on perceptions of information overload. Four additional items are directly and indirectly related to the ability to create information that can be shared through reporting. Second, *information quality* consists of 12 closed-ended items. Five of these items serve as measures of preparation and safety, three items for speed of information, and three items for quality of information produced.

Within the completion of job and administrative tasks, four sub-components were used. First, *frequency and importance of applications* consisted of four closed-ended items. Two of these items captured how often respondents made use of primary software applications at Brookline Police Department. The remaining items measured the applications and types of information respondents perceived they needed most to do their job. An open-ended question was included for this sub-component to document technological needs that should be integrated into the wireless broadband network. In all, these measures form an important baseline for the remainder of the job and administrative task sub-components.

Second, *job effectiveness* consists of 11 closed-ended items that seek to capture information on perceived improvements in service and productivity (six items), internal and external communication (three items), and general professionalism (two items). Third, *time savings* consists of 12 closed-ended items. These items consist of an assortment of general measures of potential time savings (six items) as well as savings within specific functions related to answering calls for service (four items), initiating traffic stops (one item) and engaging with the community (one item). Fourth, *job satisfaction* is measured by three closed-ended items about job ease, enhanced ability to do job, and accountability.

The findings are presented as descriptives due to the exploratory nature of this case study. Closed-ended items included Likert style response sets in matrix format with no neutral category provided. Response sets ranged from "strongly agree" (one) to "strongly disagree" (six) or "many times per day" (one) to "very rarely" (seven). Higher scores therefore indicate higher levels of disagreement with an item or less frequent use of a specific item. The emphasis here is on individual items, rather than higher-order dimensions. Averages are presented. These averages consist of means and standard deviations by item. Additionally, the modal category of response is included for each item. Open-ended items were summarized by content by two members of the research team.

Preliminary survey data were reviewed with the Director of Information Technology during a secondary site visit to Brookline Police Department. The objective of this visit was to debrief, seek clarification, and gain context on preliminary findings. Valuable insights were gained from this session. Findings will be presented with integration of discussions gleaned from the debriefing session as well as observations made from the semi-structured interview with select uniformed personnel.

4.3 Secondary Analysis of Computer-Aided Dispatch Data

Computer-Aided Dispatch (CAD) data were extracted for the years 2004 through 2009 from Brookline Police Department's management information system for all 232,809 CAD calls received by the department. These data were provided to the research team in summary form with measures of total calls received and average response times in minutes. These data were restructured and transformed with stratifications by year, patrol sector, and CAD call code specification to form a series of abbreviated longitudinal panel datasets for analysis.

These data allowed for a test of whether wireless broadband implementation had any effect on response times to calls for service, which is a key component of police operations and a primary outcome measure for this report. To test this anticipated benefit, pre- and post-implementation comparisons of total calls and average response times were made for the department as a whole as well as within the patrol sectors. It was decided that an emphasis on patrol sectors was needed. One of the primary objectives of the wireless broadband procurement decision was to remedy coverage issues within sectors with significant terrain challenges and weak communication system signals. Moreover, analyses of patrol sectors would minimize aggregation problems that may influence departmental observations.

The wireless broadband network was deployed October 2006. As a precaution against unobserved implementation delays and to provide conservative estimates, the pre-implementation period was defined as the years 2004-2006. The post-implementation period was defined as the years 2007-2009.

Mean difference tests were used to compare pre- and post-implementation observations. The tests were adjusted for autocorrelated covariance structures inherent to panel data. The number of observations available for analysis ranged from six (for analysis of departmental average response times by year 2004-2009) to 54 (for analysis of average response times for nine patrol sectors by year 2004-2009). *Total calls* represents the average number of calls received in the pre- or post-implementation period. This measure is used to provide background information on response times. *Average response time* is the average response time in seconds for calls received in the pre- or post-implementation period. Seconds were used as the unit of measurement to maximize variability in average response times. This measure is a function of total calls received.

Chapter 5 Findings

5.1 Semi-Structured Interview with Select Uniformed Personnel

A variety of rich information about implementation resulted from these interviews. A number of themes became readily apparent during the process of observation. The following is a brief summary of these comments.

Implementation Process. Across the interviews, the respondents noted that the implementation process led to few challenges. Major themes included:

- Streamlined, ease of transitioning into the wireless broadband network.
- Negligible learning curve for personnel.
- Openness and willingness to use new technologies.

On a broad, departmental level, the ease of implementation was viewed as being a product of a town that integrates emerging technologies. Within the department, leadership and personnel also try to make use of technologies as they become available. This openness to technology is a critical factor that may have helped to streamline the implementation process. Equally important is the observation that the implementation of the wireless broadband network required very few changes that affected daily roles and tasks.

Implementation Benefits. Similarly, respondents generally agreed that implementation produced a number of benefits. These observations included the following:

- The ability to manage personnel access to network is much easier.
- Less time is used to update/maintain applications and computers.
- More information can be obtained and disseminated, including video and color images.
- Increased speed and efficiency of information flow.
- Makes training easy; simply disseminate training modules over the network.

- The quality of report submissions have increased.
- Data extractions to complete bulletins much easier to process.

Many of the observed themes addressed how the implementation of wireless broadband helped to simplify job responsibilities and tasks. Most of the realized benefits were associated with time savings. An increase in the amount of information available to personnel and the quality of such information was observed to be a key benefit. Simultaneous use of departmental applications could be used for every police-citizen encounter. Real-time updates provided timely and accurate information that could be circulated much wider than what could be achieved prior to the implementation of wireless broadband.

Implementation Challenges and Drawbacks. The interviews also produced observations about challenges. These issues can be thought of as falling into categories relevant to the initial implementation in 2006 and those remaining today.

Initial Implementation

- Two weeks needed to induce personnel "buy-ins" about the network.
- Increases in required data entry fields and supervisor oversight.

Initially, personnel were skeptical about the function and use of broadband network. The pessimism loomed large with patrol personnel who experienced many difficulties with report writing prior to the implementation of wireless broadband. At that time, data entered into report writing applications would often become lost if air-card access to the network was dropped due to a loss of signal. This resulted in duplication of efforts as partially completed reports would need to be regenerated. Access to applications also was limited with the loss of signal. To ameliorate these concerns, the Director of Technology attended training sessions to give briefings on the broadband network. Informal disseminations of training bulletins and departmental emails were used to keep personnel informed of the implementation process and anticipated benefits. Given the seamless implementation of the wireless broadband network, this challenge did not appear to have much, if any, negative impact that would influence operations.

A theme related to implementation that may have influenced operations was associated with increased responsibilities, particularly among patrol staff. It was observed that personnel are (a) responsible for more data entry and the completion of more data entry fields when finalizing reports, and (b) subjected to increased surveillance from supervisors when finalizing reports after implementation. These changes were viewed on a continuum. On the one hand, the entry of more data with more oversight was observed to be beneficial. This is the process needed to ensure accurate, complete, and timely information that can be consumed by personnel. Essentially, the implementation minimized the "garbage in, garbage out" aspect of reporting.

On the other hand, increases in job and task responsibilities were viewed negatively. Two trends were observed. First, increases in responsibilities were considered to add to one's existing workload. Electronic reports are often turned back to the reporting officer for modification after preliminary reviews by supervisory staff that must be completed and re-submitted before the end of the reporting officer's shift. Viewed as being more work, there was a variable degree of "kick-back" among personnel. Second, there were some idiosyncratic views concerning information overload. The sheer amount of information that is available, shared, and reviewed can be overwhelming and can lead to the partitioning of what information is consumed.

Pressing Present-Day Challenge

- Video use is limited.
- Continual integration of new applications as they become available.

Observations about implementation challenges the department still faces concerns the integration of new technology. These challenges are only indirectly related to the network. That is, the existing broadband wireless network would support the integration of new applications, modules, and technologies. However, there are difficulties in maximizing the use of emerging technologies. Real-time video use has been particularly problematic and it is anticipated that automated license plate readers will produce additional challenges that must be remedied. Working relationships with the town council, interest groups, and citizens have led to the creation of policies and procedures that allow truncated use of video feeds. This process is not unique to the study site; agencies will need to adapt the use of emerging technologies to levels of public support (see Lum *et al*., 2011; Welsh & Farrington, 2009).

5.2 Web-Based Survey of All Uniformed Personnel

Implementation Dimensions: Technology Proficiency. Critical to the success of implementing a broadband wireless capability is the extent to which personnel who will be using the technology are proficient with computer hardware and software that will be enhanced through broadband. As user proficiency with technology has been found to be an indicator of successful technology adoption (Inan & Lowther, 2010), it is necessary to account for the extent to which BPD personnel perceive their proficiency with computers and software programs. While proficiency with computers and software is expected, as the majority of respondents have advanced degrees and have used computers prior to the hardware becoming mobile, such an assumption must be confirmed. Table 3 illustrates respondents' proficiency with computer hardware and software.

Table 3, Respondent's Technology Proficiency (n=76)

	Mean (SD)	Modal Category
Possesses strong computer skills	2.54 (1.07)	Somewhat Agree
Confident working with internet	2.24 (.93)	Agree
Familiar with computer software programs	2.38 (1.03)	Agree
Rather complete tasks with computer than handwritten	2.13 (1.13)	Agree
Rather complete reporting using mobile system than at the station	3.70 (1.58)	Disagree

Note: Response sets range from "strongly agree" (1) to "strongly disagree" (6) with no neutral category. Higher scores indicate higher levels of disagreement with the item. Reliability (alpha) for this latent dimension is .75.

As anticipated, respondents indicated being proficient with computers, software programs, and the Internet. Respondents, on average, indicated they preferred to complete their reporting requirements at the police station as opposed to their patrol vehicles. Based on interviews with BPD personnel, this preference is likely the result of two factors. First, prior to wireless broadband there was a lack of reliable data coverage that resulted in lost reports or hardware errors in reporting. As a result, officers were losing reports they had already completed and submitted through the mobile computing process and were required to duplicate the work. Such losses and duplication of effort created a lack of confidence in the mobile reporting system and a preference by officers to complete reports at the station where they felt confident their reports would be submitted without problems. Second, it is believed that officers would rather complete their reports at the police station as this provides an opportunity to engage in informal social communications with fellow officers. While the desire to communicate with peers is understandable (and expected), it likely results in more time spent at the station rather than in the assigned patrol sectors.

Implementation Dimensions: Training. Proficiency with technology can result from formal training, peer influence, or self-taught skills on behalf of the user. Table 4 displays respondents' perceptions with respect to formal and informal training related to the effectiveness of mobile broadband. On average, respondents indicated they received formal training on the software programs used while mobile computing and they desired additional training on these programs. This is to be expected as the implementation of technology provides ever-increasing wireless access speeds[9] that enable end user applications, and other software enabled capabilities (for instance, forthcoming machine-to-machine communications technology) that previously were unavailable. Through personnel interviews it was apparent that while personnel were confident with the software programs on mobile computers, they were unaware of all the functions possible – many were surprised to learn what type of information could be accessed and what functions (e.g. real-time video) were available as a result of the broadband. Furthermore, to facilitate functionality of the capability, the BPD training division would create video tutorials and instructional procedures for officers to access while mobile in their vehicles. Respondents indicated they were able to access this information. Furthermore, respondents indicated they were willing to use informal methods of learning by asking fellow officers for assistance in learning about hardware/software capabilities as well as indicating a willingness to learn on their own. This is promising as many departments who are considering the implementation of broadband are likely to be concerned about training and managing individual needs. The learning curve for technology will vary across individuals and thus formal training programs may be sufficient for the majority of personnel, they may not be sufficient for each officer. These informal mechanisms for learning provide a method by which such variances can be addressed with minimal resource investment on behalf of the department.

[9] The FCC defines broadband as 4Mbps download speeds and 1Mbps upload speed (Federal Communication Commission, 2012). Until 2010, the commission defined broadband as 200Kbps in both directions, and then adopted the current 4Mbps/1Mbps definition for the last three broadband progress reports.

Table 4, Training (n=76)

	Mean (SD)	Modal Category
Received formal training on mobile software	2.66 (1.08)	Agree
Received formal training on technology changes	3.00 (1.97)	Agree
Desire more training on mobile software	2.89 (1.04)	Agree
Will ask fellow officer for help to use software	2.72 (.86)	Agree
Will learn on your own to use software	2.73 (1.07)	Agree

Note: Response sets range from "strongly agree" (1) to "strongly disagree" (6) with no neutral category. Higher scores indicate higher levels of disagreement with the item. Reliability (alpha) for this latent dimension is .50.

Implementation Dimensions: Implementation Process. Personnel involvement in the organizational change process has been demonstrated to significantly facilitate successful change in police agencies (Elias, 2007). The extent to which BPD personnel were aware of, and involved in, the implementation of a mobile broadband system are presented in Table 5. On average, respondents indicated they were aware of the changes being made to implement the broadband system in the year 2006 and that neither they, nor the department, were opposed to the implementation. However, respondents indicated they were not involved in the process of implementing the broadband technology. Upon speaking to BPD personnel regarding the involvement of personnel in the implementation process, it appears respondents interpreted the item in two ways – both of which have plausible explanations for their perceived lack of involvement.

First, officers felt they were not involved in the decision-making process to implement a broadband network. However, as was indicated by a BPD information technology officer, many respondents were unaware the technology was available and were "surprised" to learn of the initiative to implement the broadband network. The fact that respondents did not perceive individual or departmental opposition to implementation partially illustrates the favorableness of personnel to have the technology. Second, respondents may have interpreted the item as pertaining to involvement from an installation perspective (e.g. physically assisting the technology implementation). Respondents were not asked to be involved at this level as the commercial carrier provided hardware installation – as well as the fact that such efforts are largely out of the scope of many respondents' responsibilities.

Table 5, Implementation Process (n=76)

	Mode (SD)	Modal Category
Aware of broadband implementation made in 2006	3.00 (1.97)	Agree
Involved in implementation of broadband	4.00 (2.27)	Disagree
Respondent opposed implementation	4.00 (1.64)	Disagree
Department opposed implementation	4.00 (1.97)	Disagree

Note: Response sets range from "strongly agree" (1) to "strongly disagree" (6) with no neutral category. Higher scores indicate higher levels of disagreement with the item. Reliability (alpha) for this latent dimension is .78.

Dimensions of Police Operations: Information Flow. Improvement across multiple information-related metrics is the catalyst behind mobile broadband implementation. As noted above, the extent to which job effectiveness and time savings are influenced by mobile broadband is contingent upon the access to, and quality of, information. Table 6 displays respondents' perceptions of information flow resulting from wireless mobile broadband implementation in Brookline Police Department. Three primary trends are reflected in the responses. First, there is belief that information is more easily manageable. On average, respondents indicated information was easy to access, easy to share, and moved more quickly. Second, more information is desired. On average, respondents indicated they do not receive too much information, could do a better job with more information, and want information from agencies outside of their own.

Third, wireless mobile broadband is an improvement upon the use of commercial cellular air-cards. Respondents, on average, indicated they could observe differences in signal strength across optimal coverage sectors and reduced coverage sectors and that if assigned to a reduced coverage sector it would change how they complete their job tasks. This is an interesting trend in that BPD uses an application known as NetMotion, which continually monitors signal strength between the wireless broadband network and the commercial cellular air-card signal. At any given point when one signal is higher quality than the other, NetMotion is designed to "hop" back and forth to always maintain the best signal strength. However, given poor cellular coverage in parts of Brookline – primarily the southern patrol sectors due to a lack of towers – the difference of quality signals of air-cards versus mobile broadband is noticeable.

Table 6, Perceptions of Information Flow Resulting from Wireless Mobile Broadband (n=76)

	Mean (SD)	Modal Category
Easy to access information you need	2.53 (1.15)	Agree
Receive information more quickly	2.38 (1.03)	Agree
Share information easier	2.61 (1.16)	Agree
Able to share information with other PDs	3.02 (1.23)	Agree
Could do job better if had more information from other PDs	2.94 (1.02)	Agree
Responsible for reporting more information	2.85 (1.14)	Agree
Responsible for reading more information	2.57 (1.20)	Agree
Receive too much information	3.16 (1.18)	Disagree
Desire more information	2.87 (1.10)	Agree
Prefer mobile broadband over cellular air-cards	3.40 (1.42)	Agree
Differences in signal strength across patrol sectors is a problem	2.81 (1.21)	Agree
If assigned to sector with weak signal strength, it changes how you will complete your job	3.06 (1.29)	Agree
Reporting will be submitted without problems	3.13 (1.22)	Agree

Note: Response sets range from "strongly agree" (1) to "strongly disagree" (6) with no neutral category. Higher scores indicate higher levels of disagreement with the item. Reliability (alpha) for this latent dimension is .91.

Dimensions of Police Operations: Information Quality. Flow of information is mitigated by the quality of information being communicated. If the information being collected, accessed, and shared is of poor quality, it does not matter how accessible or fast the information is – it will not be beneficial to the operations of a police department. Table 7 illustrates respondents' perceptions of information quality resulting from the implementation of a wireless mobile broadband system.[10] Respondents' perceptions of information quality fall into two primary

[10] Real-time information access, up to date information, and the speed information is shared compared to respondents' first experiences at BPD are included in the "information quality" table rather than the "information

trends. First, the quality of information has improved since the information is now real-time. Brookline Police Department personnel can access information as soon as it is input into the system – there is no lag time where personnel across the organization are waiting for information.

Moreover, BPD personnel employed prior to the implementation of mobile broadband in 2006 indicated that information they had access to be of better quality and faster to access than before implementation. Second, mobile broadband improves how patrol officers perceive an upcoming encounter. Respondents indicated, on average, a belief that mobile broadband allowed them to be more confident and safe when approaching an encounter while also improving the judgment officers use during an encounter. Improved quality of information has been demonstrated to improve officer discretionary decision making (Guyot, 1991; Manning, 1992). If an officer is able to query a licenses plate and identify the likely driver (or vehicle passenger), he/she is able to gain immediate access to criminal history, police encounters, and warrant information prior to approaching the vehicle – rather than waiting until the officer has already encountered the vehicle driver and seeks this information after obtaining the person's driver's license. Such information positions an officer to be more prepared for an encounter with a potentially violent offender or wanted individual.

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flow" table as information that is real-time and, as a result, contemporary is considered to be a "quality" characteristic of police information. Real-time information is better than lagged information input into a records system each evening. As such, the authors decided these items were more appropriate to consider within the realm of quality rather than flow.

Table 7, Perceptions of Information Quality Resulting from Wireless Mobile Broadband (n=76)

	Mean (SD)	Modal Category
Information allows better preparation upon approach	2.59 (.98)	Agree
Access to pictures and criminal history increases confidence upon approach	2.40 (1.10)	Agree
Access to pictures and criminal history allows you to do job more effectively	2.41 (1.09)	Agree
Information makes you feel safer upon approach	2.90 (1.20)	Agree
Information allows for more accurate judgment upon approach	2.79 (1.07)	Agree
Information accessed is more up-to-date	2.54 (1.06)	Agree
Information accessed is real time	2.41 (.99)	Agree
Speed of information received is faster than when first started with BPD	3.00 (2.16)	Agree
Information in your reports is more accurate	2.96 (1.15)	Agree
Reports are of higher quality	3.08 (1.18)	Agree
Quality of information is better than when first started with BPD	3.00 (1.87)	Agree

Note: Response sets range from “strongly agree” (1) to “strongly disagree” (6) with no neutral category. Higher scores indicate higher levels of disagreement with the item. Reliability (alpha) for this latent dimension is .88.

Dimensions of Police Operations: Frequency and Importance of Applications. As guided by the review of literature, the implementation of a wireless broadband capability to enhance mobile computing is expected to improve police operations. Specifically with regard to Brookline Police Department (BPD), officers use two primary software applications on their mobile computers. These two programs – the Larimore Associates software and PocketCop – are the software interfaces that officers go through to complete reporting, query criminal information, and access police activity information. To explore the extent to which mobile broadband has influenced police operations, the frequency to which BPD personnel employ these software programs and their perceptions of wireless broadband impacts must be targeted.[11] Table 8 displays respondents’ perceptions of the frequency of use and importance of mobile applications as they apply to their job tasks.

[11] For purposes of the perception of the network among Brookline personnel it is important to note that Brookline Police Department does not incorporate any mobile broadband-related metrics into personnel evaluations – thus the organization is unlikely to have undue influence on the network’s perception among personnel.

Table 8, Frequency and Importance of Mobile Applications (n=76)

	Mean (SD)	Modal Category	Frequency (Percent)
How frequently use Larimore	1.17 (.51)	Many times a day	
How frequently use PocketCop	3.45 (2.91)	Many times a day	
Application most important to do job effectively			
Larimore			29 (51%)
PocketCop			21 (37%)
Other			7 (12%)
Information types most important to do job effectively			
Pictures of individuals			4 (7%)
Criminal history of individuals			29 (53%)
Encounter history			6 (11%)
Crime/Intelligence Reports			16 (29%)

Note: Response sets range from "many times per day" (1) to "very rarely" (7). Higher scores indicate less frequent use of a specific application.

On average, respondents indicated that they used both the Larimore and PocketCop applications many times a day. More specifically, there was less variance in the respondents' indication of the Larimore applications as compared to the PocketCop application. This is to be expected as the Larimore application (as discussed in the Brookline Context section of this report) is the main interface for all computer-aided dispatch and reporting for Brookline personnel. This application is more applicable to a greater number of personnel within BPD compared to PocketCop since the primary function of PocketCop is to access criminal information (e.g. history, photos). The Larimore application is accessed by patrol to respond to calls for service and complete reporting requirements, used by supervisors to read reports and query incident information, and used by the analyst to access information from reports. Closer analysis supports this assumption in that 70 percent of patrol officers indicated they used PocketCop "many times a day" as compared to just 15 percent of personnel in other positions within BPD. This difference is in contrast to the use of the Larimore application as 89 percent of both patrol officers and other BPD personnel indicated using this application "many times a day."

Respondents were provided an open-ended response option to indicate what technological needs they believed would benefit their everyday tasks. However, few respondents provided insights on other technological needs they would like to see integrated. Only 17 percent of the sample provided a response and common trends of the responses were focused on hardware and software needs as well as informational needs. With respect to hardware and software needs, respondents indicated they would benefit from access to live-feed video cameras, electronic finger print capture in the field, automatic license plate queries when approaching a vehicle, mobile, and internet access. The prospect of internet access within patrol vehicles was addressed by BPD's information technology personnel who viewed the feature as more of a problem than a benefit. Allowing officers to freely access the internet would likely increase officer misbehavior and decrease productivity (officers would surf the internet or watch videos rather than complete reporting or engage in community efforts beyond the minimum required). In terms of information needs, respondents indicated a desire to access driver histories for non-registered drivers, probation and parole information, reports from other police agencies, telephone numbers and addresses, and the integration of flags or indicators for recent arrests or violent criminal histories when querying individuals. These perceived needs have been communicated to Brookline Police Department and, at the time of writing this report, they are making a determination on the feasibility of such requests.

Dimensions of Police Operations: Job Effectiveness. The extent to which wireless mobile broadband impacts police operations is explored through overall job effectiveness, time savings, and job satisfaction. Table 9 illustrates respondents' perceptions of overall job effectiveness resulting from the implementation of mobile broadband. Respondent perceptions of the impact of mobile broadband on job effectiveness are mixed. On average, respondents do not perceive mobile broadband as allowing them to better serve the public, be more productive, self-initiate activities, be more professional, communicate better with the public, or communicate better with supervisors. Although, respondents, on average, also indicated they believed mobile broadband generally helped them do their jobs better, take unassigned pending calls for service, generate more arrests and license plate checks, and also communicate better with fellow officers. The trend that overall service to the public and lack of improved productivity is perplexing as respondents also indicated a trend that demonstrates the perception that mobile broadband allows them to do their jobs better and has increased arrests. Unfortunately, the lack of variability in the data does not allow for these oddities to be explored further.

Table 9. Perceptions of Job Effectiveness Resulting from Wireless Broadband Implementation (n=76)

	Mean (SD)	Modal Category
Allows better service to the public	3.13 (1.21)	Disagree
More productivity	2.90 (1.20)	Disagree
Self-initiated activities increased	3.14 (1.23)	Disagree
Took unassigned pending call viewed on CAD	2.96 (1.12)	Agree
Arrests have increased	2.91 (1.14)	Agree
Plate checks made more frequently	2.50 (1.22)	Agree
Allows better communication with public	3.51 (1.13)	Disagree
Allows better communication with supervisors	3.28 (1.12)	Disagree
Allows better communication with officers	2.92 (1.04)	Agree
Professionalism increased	3.40 (1.32)	Disagree
Generally helps to do a better job	2.73 (1.30)	Agree

Note: Response sets range from "strongly agree" (1) to "strongly disagree" (6) with no neutral category. Higher scores indicate higher levels of disagreement with the item. Reliability (alpha) for this latent dimension is .93.

Dimensions of Police Operations: Time Savings. Table 10 illustrates respondents' perceptions of time savings resulting from the implementation of mobile broadband. On average, respondents agree that mobile broadband has resulted in fewer trips to the station, and allows them to complete their reporting requirements more quickly.

Table 10, Perceptions of Time Savings Resulting from Wireless Broadband Implementation (n=76)

	Mean (SD)	Modal Category
Fewer trips to station	2.88 (1.30)	Agree
Reduces overall time pressures of job	3.12 (1.41)	Agree
Allows more free time	3.62 (1.30)	Disagree
Roll call takes less time	3.45 (1.19)	Disagree
Less time on administrative tasks in the station	3.36 (1.27)	Disagree
Complete reporting quicker	3.23 (1.43)	Agree
Allows more time to make service calls	3.42 (1.13)	Disagree
Reduces time dealing with high priority calls	3.59 (1.14)	Disagree
Reduces time dealing with medium calls	3.46 (1.13)	Disagree
Reduces time dealing with low calls	3.44 (1.13)	Disagree
Allows more time to engage in community	3.36 (1.27)	Disagree
Allows more time to make traffic stops	3.19 (1.33)	Disagree

Note: Response sets range from "strongly agree" (1) to "strongly disagree" (6) with no neutral category. Higher scores indicate higher levels of disagreement with the item. Reliability (alpha) for this latent dimension is .93.

Moreover, respondents indicated that, on average, they believed mobile broadband reduced the overall time pressures of their job. Though this appears promising, the overarching trend depicted by respondents' perceptions is that mobile broadband does not reduce time spent on the vast majority of the tasks for which they are responsible. On average, respondents did not believe that mobile broadband reduced the time is takes to deal with calls for service, did not allow them more time to engage in other services or tasks, did not allow for more free time, and did not reduce the perceived time spent on administrative tasks at the station.

Further analysis helps to clarify these perceptions. Only 58 percent of patrol officers perceived mobile broadband to reduce the overall time pressures of their job. This is in contrast to the 72 percent of other personnel within BPD who had similar beliefs. Such findings are consistent with previous research on police mobile computing in which patrol officers felt other personnel within the department would benefit from their increased efforts in mobile computing (Ioimo & Aronson, 2004). As an example, patrol officers may feel detectives and analysts are able to more efficiently query information they need, which in turn makes their jobs easier. This ability to query specific information quickly would not be possible without officers imputing the information from the field via mobile computing.

Dimensions of Police Operations: Job Satisfaction. Without perceived benefits resulting from the mobile broadband, it seems logical to assume job satisfaction would not be perceived by respondents to improve from the new technology. As illustrated in Table 11, this assumption appears to be incorrect.

Table 11,Perceptions of Job Satisfaction Resulting from Wireless Mobile Broadband (n=76)

	Mean (SD)	Modal Category
Makes job easier	2.74 (1.17)	Agree
Enhanced ability to do job	3.00 (2.21)	Agree
More accountable for work	3.05 (1.30)	Agree

Note: Response sets range from "strongly agree" (1) to "strongly disagree" (6) with no neutral category. Higher scores indicate higher levels of disagreement with the item. Reliability (alpha) for this latent dimension is .40.

On average, respondents indicated they believed mobile broadband made their job easier and enhanced their ability to do their job. Moreover, respondents indicated they perceived an increased level of accountability for their work as a result of mobile broadband. Net all of the previous dimensions, perceptions of job satisfaction resulting from a transition to wireless broadband take on special importance. Generally speaking, respondents believed that the implementation of wireless broadband positively contributed to how their own work and tasks are accomplished. Even though respondents perceived being held more accountable for their work, these perceptions did not seem to effect overall perceptions related to job satisfaction.

When comparing patrol officers to non-patrol personnel, a larger percentage of non-patrol personnel (74%) indicated the technology enhanced their ability to do their job as compared to patrol officers (64%). Furthermore, non-patrol personnel indicated they perceived the accountability of their work to increase (70%) more so than patrol officers (63%). Based on previous research (Ioimo & Aronson, 2004; Northrup *et al*., 1995), these contrasts in perceived job enhancement and accountability are related to detectives' and analysts' ability to query more real-time and better quality information. With an improvement in accessible information, non-patrol personnel whose tasks revolve around this information to complete their tasks are likely to feel increased accountability. In short, increased quality input should translate to increased quality output.

5.3 Secondary Analysis of Computer-Aided Dispatch Data

Overall Departmental Responses and Response Times. The objective was to determine if there was any variability in the average number of calls fielded by BPD and if there was any variability in the average response times. Once determined, it is possible to observe whether the variability is associated with the implementation of wireless broadband technology. It is anticipated that the implementation would decrease response times. Table 12 provides departmental averages pre- and post- implementation.

Table 12,Departmental Call Responses and Time Averages by Implementation Period (n=6)

	Mean	Standard Deviation	Percent Change	T-test	P value
Total Calls					
Pre-Implementation (2004-2006)	39750	2749.65	-4.8%	0.59	.61
Post-Implementation (2007-2009)	37853	3141.27			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	213	22.55	+9.9%	-2.83	.10
Post-Implementation (2007-2009)	234	11.27			

Note: T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

The results identify a few trends. The number of calls received by the department was slightly lower after wireless broadband implementation. Average response times were 21 seconds longer in the post-implementation period. The mean differences for both of these estimates were not statistically dependable at the conventional threshold of testing ($p < .05$).

Patrol Sector Responses and Response Times. To further examine the average number of calls fielded and response times, departmental trends were disaggregated by patrol sectors. This allowed for the observation of overall trends within patrol sectors and the determination of whether the variability of the trends is associated with wireless broadband implementation. Once again it was anticipated that response times would decrease after implementation. Table 13 presents a summary table of the patrol sector analyses (see Appendix C for estimated means and test statistics).

Overall, the results indicate that average response times within sectors decreased in the period of time following the implementation of wireless broadband. This trend is observed despite increases in the number of calls received in sectors two, six, and seven. The only exception to the general trend is Sector four, where increases in average response times were observed. Sector four experienced significant decreases in the number of calls fielded after implementation. This finding suggests there were unique differences between the pre- and post-implementation periods in Sector four call volume. It is also important to note that decreases in average response times were often associated with decreases in calls fielded (see Sectors one, three, five, eight, and nine). It is possible that the observed decreases in response times are artifacts of reduced call volumes within these sectors.

Table 13,Summary Table of Patrol Sector Call Responses and Time Averages (n=54)

	Total Calls	Calls T-test	Average Response Time	Time T-test
Sector 1	-	NS	-	S
Sector 2	+	NS	-	S
Sector 3	-	NS	-	NS
Sector 4	-	S	+	NS
Sector 5	-	NS	-	NS
Sector 6	+	NS	-	NS
Sector 7	+	NS	-	NS
Sector 8	-	NS	-	NS
Sector 9	-	NS	-	NS

Note: T-test adjusted for autocorrelated or dependent samples. Negative signs (-) indicate post-implementation reductions, while positive signs (+) signal increases. NS refers to non-significant statistical test and S refers to statistically significant statistical tests. Source: BPD Computer Aided Dispatch Data 2004-2009

While the trends indicate decreases in average response times, the mean differences between pre- and post-implementation estimates were not statistically dependable. It is likely that these observed differences were due to the large variability of calls received and response times. Overall, the implementation of wireless broadband technology did not appear to influence the observed reductions. However, two patrol sectors appeared to benefit from significantly reduced response times after implementation.

Average response times in Sector one decreased by 19%, saving an estimated 58 seconds per call. In Sector two, a 14% decrease in average response times were observed, which translates to 40 seconds per call. Both of these reductions were partially associated with the implementation of wireless broadband.

Behind Sector five, which is the location of BPD headquarters, Sectors 1 and 2 process the second and third highest proportion of calls for the department. Both sectors are located in the northeast and northwest corners of the jurisdiction and border Boston. Beyond these observations, no additional data are available to determine why these two sectors uniquely benefitted from wireless broadband implementation. To increase confidence in this finding, it is critical to examine additional sources of data to rule out alternative explanations that may have produced a similar effect. Sensitivity CAD data checks on these results reinforced the reported findings (see Appendix D and E for these analyses). In short, there were no observable changes in response times within sectors that could have influenced the observed reductions in Sectors one and two.

A secondary focus was to determine if the trends were differentially affected by patrol sectors that had experienced less than optimal air-card network coverage in the past. Response times may be lower in these patrol sectors with broadband wireless implementation. Table 14 illustrates the results. The results confirm previous analyses. Reductions in average response times were found, but these reductions are likely due to unobservable changes within the two groups of coverage sectors than wireless broadband implementation. These fluctuations are to be expected from yearly trends. The results also indicate that there were no differential time savings benefits for patrol sectors that had difficulties with network connections prior to wireless broadband implementation. Additionally, patrol sectors that possessed optimal connections prior to implementation did not experience enhanced time-savings. Decreases were observed, but failed to achieve statistical significance.

Table 14, Call Responses and Time Averages by Coverage Sector and Implementation Period (n=54)

	Mean	Standard Deviation	Percent Change	T-test	P value
REDUCED COVERAGE SECTORS					
Total Calls					
Pre-Implementation (2004-2006)	3074	319.81	-4.1%	.55	.64
Post-Implementation (2007-2009)	2947	207.44			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	311	17.06	-19.6	2.47	.13
Post-Implementation (2007-2009)	250	26.68			
OPTIMAL COVERAGE SECTORS					
Total Calls					
Pre-Implementation (2004-2006)	4862	266.13	-4.2%	.80	.51
Post-Implementation (2007-2009)	4657	351.47			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	277	22.27	-14.4%	2.15	.17
Post-Implementation (2007-2009)	237	14.11			

Note: Reduced coverage was observed in Sectors 1, 7, 8, and 9. Optimal coverage was observed in Sectors 2 through 6. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

For a final sensitivity check on the overall findings, a random effect pooled time series multivariate analysis was conducted (see Appendix F). This technique controls for variation that exists within and between patrol sectors and years of observation. The findings generally reinforce the mean difference tests. Net of available predictors, multivariate models indicate that broadband implementation was related to reductions in response times. A 33 to 41 second decrease in average response times between patrol sectors over time was observed[12]. There is no evidence to suggest differential benefits of lowered response times for reduced coverage sectors after broadband implementation.

[12] Standardized z-scores were transformed back to raw scores. Response time had an original mean of 265.80 seconds and standard deviation of 53.08. From Model 1 a 40.87 second reduction was observed [(-.77)(53.08)+265.80]=224.93. Model 2 estimated a 33.44 second reduction [(-.63)(53.08)+265.80=232.36.

Chapter 6 Discussion and Conclusion

Through the use of a mixed methods case study approach, the purpose of the study was to describe the operation of one form of wireless broadband technology and determine the efficacy of this technology on police operations. Two primary research questions guided this research. First, was the wireless broadband technology implemented in accordance with initial expectations? Second, did the implementation have any effect on police operations related to information sharing, completion of job and administrative tasks, and response times to calls for service? Semi-structured interviews with select uniformed personnel, a web-based survey of all uniformed personnel, and a secondary analysis of computer-aided dispatch data were used to answer these questions.

Overall, the semi-structured interview results suggest that the wireless broadband technology was implemented with minimal difficulties and produced a number of perceived benefits for the department. The most direct benefit appeared to be the ease with which departmental technologies could be managed. Additional benefits were associated with increased access to timely information, increased information flow, and increased quality of reports. One of the main issues driving the procurement of a broadband wireless network were previous complications with information access, information exchange, and report writing due to unreliable commercial cellular provider wireless coverage. These results lend partial support to the notion that the network met anticipated expectations of improved information access and exchange.

Implementation and change, however slight, has the potential to create an assortment of problematic unintended consequences. This did not appear to be the case in Brookline. Semi-structured interviews revealed that a few weeks of training sessions and ongoing informal bulletin and email disseminations were needed to overcome skepticism about the transition to wireless broadband. The web-based survey results indicate most of the uniformed personnel noted they were aware of the change to wireless broadband and had received some form of training about the transition. Most of the uniform personnel did not oppose the implementation, nor did they perceive that the department was against the transition. It is unclear if the formal training and informal exchanges contributed to perceptions of opposition. The results provide some degree of suggestion that despite perceptions of uniformed personnel skepticism gleaned from semi-structured interviews, personnel survey responses provide little indication of perceived opposition.

The other implementation challenge revealed during semi-structured interviews was the perceived increase in workload responsibilities associated with report writing. Two dimensions were particularly relevant. First, it was perceived that the transition to wireless broadband increased the amount of data entry fields required to submit reports. Second, and relatedly, these reports were perceived to be subjected to increased supervisory surveillance and accountability. The web-based survey appeared to provide confirmation of these perceptions. Uniformed personnel perceived they were responsible for reporting more information. Additionally, most perceived that they are more accountable for their work. At the same time, survey results suggested that personnel perceived they were able to complete reports faster and submit without problems. Moreover, personnel largely agreed that information captured in the reports is more accurate and of higher quality. These perceptions cautiously lend some support to notions of improved report writing, but also suggest that perceptions may be related to other extraneous factors distantly related to network implementation.

Web-based survey findings provide indication that information sharing was likely to be the most beneficial product related to wireless broadband implementation. Information was perceived to be easily accessible, shared, timely, and of better quality, which is consistent with semi-structured interview findings. The benefits inherent to improved information sharing were thought to advance the completion of job tasks and responsibilities; especially those related to reporting. The results of the remaining operational outcomes – job and administrative tasks and response times – were inconclusive.

With respect to job and administrative tasks, there were mixed findings. On the one hand, wireless broadband technology was perceived to enhance the ability of personnel to do their job. Improvements in information flow and quality were central to these perceptions. Uniformed personnel expressed perceptions of being more confident and safe during encounters. Report writing was perceived to be completed more efficiently with wireless broadband. On the other hand, wireless broadband was not perceived to allow for better service delivery or generate much time savings. Personnel noted some alleviation of time pressures, but did not perceive these reductions to be associated with daily activities such as attending roll call, responding to calls, and completing administrative tasks.

Secondary data analysis of computer-aided dispatch (CAD) data suggested that the implementation of wireless broadband was related to reductions in response times to calls for service. Findings were largely driven by disaggregation of data from annual departmental observations to observations of patrol sectors by year. Using a pooled time series approach, broadband implementation was associated with a 33 to 41 second decrease in average response times between patrol sectors over time. Mean difference tests within patrol sectors provided substantive trends to support post-implementation reductions. Eight out of nine of Brookline

Police Department's patrol sectors experienced reduced response times. However, most of these within sector reductions were statistically non-significant. Only Sectors one and two achieved statistically dependable reductions between pre- and post-implementation periods. At face value, this finding suggests that Sectors one and two benefitted the most from wireless broadband implementation.[13] In combination, these secondary analysis findings present evidence that wireless broadband implementation can influence police operations (measured by response times to call for service), but this effect will be small in magnitude and somewhat narrow. Concentrated effects should be anticipated among specific patrol sectors rather than a consistent, department-wide benefit.

Relatedly, CAD data analysis also showed no differential benefits in terms of improved response times for patrol sectors that experienced reduced communication coverage relative to patrol sectors that did not experience such challenges prior to wireless broadband implementation. As one component of BPD's procurement decision, wireless broadband was thought to improve communication coverage within problematic patrol sectors. In turn, it was anticipated that police operations within these sectors would be enhanced. This did not appear to be the case. Reduced and optimal coverage sectors produced trends consistent with reduced

[13] It is not clear why these two patrol sectors achieved statistically dependable reductions via mean difference testing whereas the remaining patrol sectors did not. Both sectors are similar in that they both boarder Boston and manage high proportions of calls for service each year and across the study period. They diverge in terms of their past communication system coverage. Sector one was deemed to possess unreliable coverage, whereas Sector two retained optimal coverage. A variety of sensitivity checks of CAD data within both sectors did not reveal any systematic changes in fielded calls or response times for most frequent call types, most time consuming call types, and common criminal activity call types that would have contributed to the observed results (see Appendix E). This is especially apparent in Sector two. It is possible that reductions in average response times in Sector one were influenced by post-implementation responses to calls for malicious damage (see Appendix E, Table E19). Given the fluctuation of calls used in the sensitivity checks for Sector one this effect would likely be small and would not negate the overall findings. As previously discussed, both patrol sectors boarder Boston and manage high proportions of calls for service.

response times, but there were no discernible differences between pre- and post-implementation periods or coverage sector classifications.

It is important to be mindful that technology is inherently neither good nor bad. It is simply a tool to meet goals and objectives. The results of this research suggest that wireless broadband technology did appear to meet initial expectations and may have minimally influenced some of the difficulties that led to network procurement and deployment. Uniformed personnel believed that the change to broadband helped to ease job tasks and enhanced their ability to do their job. However, the extent to which the network subsequently influenced traditional police operations remains far from clear despite some promise from this study. Mechanisms connecting anticipated technology benefits with user experiences need to be elaborated to determine how this technology-user interaction can shape relevant law enforcement and public safety outcomes (see Salvendy, 2012). Information sharing appeared to be the most promising component of police operations, based upon uniformed personnel perceptions. Future research would benefit from exploring the dynamics of information sharing before and after the implementation of a variety of new technologies with innovative measures and rigorous research designs.

6.1 Study Limitations

Although the present research contributes to the case study literature on wireless broadband network technology, the findings should be considered with some limitations in mind. First, traditional management information systems and monitoring capabilities limited data that could be used to assess implementation and outcomes. This is a common issue with research on technology (see Nunn & Quniet, 2002). Many of the concepts and correlates deemed important from extant research and literature could not be extracted or produced (see Appendix G for the preliminary data request). As a result, it is not possible to examine additional factors that could have influenced the results.

Second, the network had already been implemented and operational for an extended period of time prior to the agreement of the research project. As such, the study was limited by its retrospective case study design. Due to the lack of a pre-determined baseline measures relating to the technology, there is limited means for determining the extent to which change occurred as a result of the technology. Semi-structured interviews and the web-based survey were inherently cross-sectional and could only use pre-implementation prompts to elicit responses. Although the study was largely unable to use pre-test measures, the computer-aided dispatch data provided by Brookline Police Department (BPD) was purposively requested to form abbreviated longitudinal panel datasets that would allow for a pre- (2004-2006) and post-implementation (2007-2009) design. These data were consistently collected by BPD in the designated years. In discussions with BPD administrators, there were no policies or procedural changes across project years that influenced how uniformed personnel responded to calls for service.

Third, measurement validity is limited with respect to the interview and survey data. Again, the research design had to rely upon retrospective respondent recall. It is plausible that the perceptions offered were a function of hindsight, misattribution, or unobserved higher order factors. Additionally, the survey data required respondent interpretation of more than 100 survey items. Based on debriefing interviews with BPD personnel, respondents had difficulty discerning between mobile computing pre- and post-implementation of the mobile broadband. Furthermore, subjective interpretation of specific technology criterion has consistently plagued police technology evaluations (Colvin & Goh, 2005). Survey items were framed with the use of cues that directed respondents to consider the end-user hardware and software applications supported by wireless broadband. This approach was necessary since few within the department possessed operational knowledge of network specifications, but may have captured a mixture of perspectives indirectly related to wireless broadband. Valid technology criterion to produce quality data was the focus of a recent report from the Government Accountability Office, specifically noting "Data limitations make it difficult to fully measure the effect of expanding access to and adoption of broadband" (U.S. Government Accountability Office, 2012, p. 12). The ability to determine the effectiveness of technological innovations continues to be extremely difficult (Colton, 1977).

Finally, generalizing the Brookline model may be challenging to rest of the United States. Given Brookline's high socioeconomic standing, highly educated population, and minimal violent crime, wireless broadband was a tangible reality. The business model that made the implementation possible relies on a population (client) base that can both demand and afford a wireless capability. A commercial carrier is less likely to enter into such a partnership if they believe the population of an area will not allow them to generate positive earnings. Further complicating these efforts across the U.S. is the still-to-be-determined status of public safety spectrum for large bandwidth communications. Since wireless networks require an investment in hardware infrastructure conducive to a specific sector of spectrum (i.e., 700 MHz versus 4.9 GHz) and the system must be approved by the Federal Communications Commission, municipalities are likely to be hesitant to commit to such technology without the assistance of a public-private partnership. The ability to form such partnerships may be especially problematic for suburban rural jurisdictions.

6.2 Recommendations for Future Research

The present study has provided a foundation to advance operational evaluations of mobile broadband in policing and identified recommendations for improving future research. To begin, it will be highly beneficial for researchers to identify agencies seeking to implement mobile broadband in the future and to work with these agencies prior to procurement of the technology. Such a partnership will position the agency and researchers for optimal success. Researchers will be able to provide independent knowledge (non-commercial informer) during the procurement decision-making process. This will allow the agency to best determine the technology specifications to fit their demands and also will help researchers to develop an understanding of how other business models develop. More importantly, from a research design perspective, this approach will allow for the use of quasi-experimental designs with baseline comparison groups and the development of robust measures that can be observed before and after implementation. These measures should be unique to the technology being evaluated, but also identified in a manner that allows for them to be directly observed and easy to record – a difficulty that presents itself with some police management information systems. Such steps will improve reliability and validity of observations and increase confidence in the determination of technological effectiveness.

Future research should incorporate clearance rates of crime. A consistent benefit of mobile broadband appears to be the speed and quality of information flow. As patrol officers, detectives, and analysts are accessing improved information more quickly, it seems logical to assume this will lead to improved clearance rates of crimes. The present study was unable to account for clearance rates as this information was unavailable from BPD during the research time frame. Measures of community-oriented activities should also be considered. Mobile broadband is believed to enable patrol officers to engage more with the community. Survey data challenged this assumption; most respondents did not perceive that they gained more time to participate in such activities. This measure is difficult to conceptualize and will vary across agencies in terms of how they define community activities. Personnel time spent on activities related to mobile broadband should also be measured. One of the most significant benefits of mobile broadband is the improvement of software and hardware management (e.g., remote software updates, time spent updating computers). Activity time of information technology officers is likely to be most affected. Future research should consider identifying measures of vehicle mileage to assess wear-and-tear and fuel costs related to in-field computing rather than officers making trips back and forth to the station, time spent sharing information during roll-call, and the amount of time officers spend engaged in administrative tasks they handle via mobile computing (e.g., personnel files, break time, time-off requests).

Lastly, measures should include both technical and operational indicators. A challenge of mobile broadband evaluations is to specifically target the technical capability it provides, rather than the operations it enables. For example, officers using mobile computing with a wireless broadband system who are asked questions on the wireless technology are likely to respond to question items from the perspective of the operational aspects of mobile computing – not the wireless technology. There is an inherent difference between the two. An officer using mobile computing without wireless broadband would not be able to access and stream videos from the training lieutenant. Conversely, an officer using mobile computing without wireless broadband would still be able to fill in an automated field report.

Chapter 7 References

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Appendix A. Implementation Semi-Structured Interview Protocol

Name: ____________________________________ Date: __________________

General

What is your current position within Brookline Police Department (BPD)?

Given your position within BPD, please describe your role in BPD operations.

Did you work for BPD prior to the broadband network being implemented?

If Yes:

In what ways, if any, has the broadband network improved your role/responsibilities?

In what ways, if any, has the broadband network negatively impacted your role/responsibilities?

What are the main objectives of the broadband communication system used by BPD?

How does the broadband communication system impact BPD operations? What operations are impacted the most? What operations are impacted the least?

What was the single most important accomplishment of the broadband communication system? What are some additional accomplishments?

What was the single most important key to the successful implementation of the broadband communication system? What are some additional keys to successful implementation?

What was the largest problem encountered in the establishment of the broadband communication system? What steps were taken to overcome this problem? What are some additional problems? What steps were taken to overcome these problems?

What was one aspect of the broadband communication system that did not work like you thought/expected? Were there any other aspects of the system that did not work like you thought/expected?

What have you learned about broadband communication that you did not expect?

What advice would you give to interested stakeholders looking to create a broadband communication system similar to BPD?

What was one aspect of the broadband communication system you would like to see replicated in future police communication systems? Were there any other aspects of the broadband communication system you would like to see replicated in the future?

What was one aspect of the broadband communication system you would like to see removed in future police communication systems? Were there any other aspects of the broadband communication system you would like to see removed in the future?

What is the most important aspect that needs to be considered in establishing a broadband communication system to assist police operations?

Does the broadband network allow you to enhance your connectivity with the community (e.g. social networks/communications to inform of emergency situations)?

Patrol

How has the implementation of the broadband network (BN) impacted how you complete the required field reporting?

Has the amount of information you are required to report increased since the BN was implemented?

How do you think the BN has impacted the amount of time it takes you to complete the required field reporting?

How do you think the BN has impacted your engagement with the community?

Since the BN was free of charge to be implemented by BPD, do you believe the BN would be a worthwhile investment if the BPD had to fund the network from the BPD budget?

Does your ability to carry out your tasks change if you are in an area that requires the use of the Verizon air cards versus access to the BN?

Detectives

Has the implementation of the BN impacted clearance rates? If so, how?

As a result of the BN, how has your ability to query information been effected?

-Are you able to access information more quickly?

-Is the information you have access to more current than before the BN was implemented?

-Do you feel as if the expectations for solving crimes have increased with the implementation of the BN? If so, how/why?

Analysts

How has the implementation of the BN impacted your ability to produce analytic products?

How has the implementation of the BN impacted your access to information?

Is the information you receive since the BN was implemented more current?

Do you think the implementation of the BN has effected expectations for your roles/responsibilities? If so, how?

Chief

Can you explain how the BN implementation partnership was initiated, agreed upon, and executed?

What were the approximate costs BPD encountered to implement the BN?

Did BPD have to purchase additional hardware or software to use the BN?
If so, what were the approximate costs?

How do you feel the implementation of the BN has impacted the overall operations of BPD?

Can you provide any specific examples of how the BN has improved operational performance?

Can you provide any specific examples of how the BN negatively impacted operational performance?

Records management

How has the implementation of the BN impacted your day-today operations?

Do you feel as if your tasks have become more streamlined/efficient as a result of the BN being implemented?

Appendix B. Web-Based Survey Protocol

Instructions:

You are invited to participate in a research study from the Communications Technology Center of Excellence (CToE). CToE is sponsored by the National Institute of Justice (NIJ), which is the research, development, and evaluation section of the U.S. Department of Justice. The purpose of this research is to document and explore the benefits associated with the mobile broadband network currently utilized by Brookline Police Department (BPD). We are particularly interested in your opinions related to the usefulness, efficiency, and effectiveness of the mobile broadband network.

The study involves one survey, which will begin today and take approximately 25 minutes to complete. We know your time is valuable, but believe the information you provide will improve the implementation of mobile broadband networks within police departments across the United States. You have been selected as a possible participant in this study as a result of your unique operational knowledge of the mobile broadband network and role within BPD.

There are no foreseeable risks or discomforts from participating in this research study. Your answers will provide us with valuable insights into the benefits of a mobile broadband network as well as potential problem areas. We believe the results will help to identify critical procurement, implementation, and training gaps and assist in the development of best practices in law enforcement mobile broadband use.

Your responses are confidential and are protected to the extent allowable by federal, state, and local laws. The U.S. Department of Justice regulations (28 CFR 22) and Federal Statute (42 USC 3789(g)) prohibits disclosure of your information for any purpose other than research or in any judicial or administrative proceedings without your consent.

Your participation in this survey is entirely voluntary. You do not have to participate and no one will know or be informed of your choice not to participate. You may refrain from providing responses to any questions you would not like to answer and may discontinue participation at any time. Your decision to limit responses or discontinue participation will not result in any penalty or loss of benefits to which you or your agency are otherwise entitled. All of the information you provide is strictly confidential. The information will be used for research purposes in the aggregate and individual identifiers will not be captured.

Please contact the principal researchers, Dr. Eric Grommon or Dr. Jeremy Carter , if you have any questions about the survey, how to complete the survey, or want to know the results of the research.

Consent: I have read this form and understand its contents. By continuing to the next page, you agree to participate in the study.

Instructions

Please complete the following survey to the best of your ability. The majority of items on this survey are in the form of a statement. To respond to these statements you will indicate the extent to which you either agree or disagree to the statement provided.

All responses will remain anonymous and your participation in this survey is completely voluntary. All information gathered as a result of this survey will only be used in the aggregate and will have no impact on your duties with Brookline Police Department.

We greatly appreciate your time and effort.

Demographics

The items in this section are to gain insight into the demographics of the department. This information will only be used in the aggregate.

In what year were you hired by Brookline Police Department (Format: 2002 for example)?

Which of the following best describes your role in the Brookline Police Department?

Command Staff (i.e., Chief, Superintendent, Captain)
Lieutenant
Sergeant
Patrol
Detective
Analyst

What is your highest level of education completed?

High School Diploma
Associates Degree
Bachelor's Degree
Master's Degree
Doctoral Degree

Which patrol sector are you currently assigned to or predominately supervise/manage?

Sector 1
Sector 2
Sector 3
Sector 4
Sector 5
Sector 6
Sector 7
Sector 8
Sector 9
Station
Not Applicable

Which of the following age ranges do you fit into?

- 18 – 22
- 23 – 27
- 28 – 32
- 33 – 37
- 38 – 42
- 43 – 47
- 48 – 52
- 53 or older

Gender?

- Female
- Male

Race/Ethnicity

- American Indian or Alaskan Native
- African American
- Asian
- Hispanic or Latino
- Native Hawaiian or Other Pacific Islander
- White

Implementation

In 2006, BPD integrated a wireless broadband network to support information technology and mobile computing needs. The intent of this section is to gain insight into changes that occurred before and after the implementation of the network.

You were aware of the changes made in 2006.

- Strongly Agree
- Somewhat Agree
- Agree
- Disagree
- Somewhat Disagree
- Strongly Disagree
- Hired after 2006
- Not Applicable

You received formal training on the changes made in 2006.

You were involved in the implementation of the changes in 2006.

You initially opposed the changes in 2006.

The department initially opposed the changes in 2006.

The changes made in 2006 have enhanced your ability to do your job

The amount of information available to you now through your mobile computer is greater than that was available when you first started with BPD

The quality of information available to you now through your mobile computer is worse than that was available when you first started with BPD

The speed with which you receive information through your mobile computer now is faster than that was available when you first started with BPD

General Computer and Internet Proficiency

The questions in this section are intended to gain insight on knowledge of computers and the Internet among staff in the department. All information will only be used in the aggregate.

You have strong computer skills.

- Strongly Agree
- Somewhat Agree
- Agree
- Disagree
- Somewhat Disagree
- Strongly Disagree

In general, you are confident working with the Internet.

In general, you are confident in the Internet as a reliable system.

In general, you are familiar with computer software programs (such as Microsoft, Adobe, etc.).

In general, you would rather complete tasks using a computer versus pen and paper.

You prefer to complete your reporting requirements using the mobile broadband computing system rather than at the police station.

Time

The questions in this section are intended to gain insight on how time allocations may be influenced by computing technology supported by the wireless broadband network. All information will only be used in the aggregate.

Per shift, how long (in minutes) do you spend resolving incidents and clearing CAD calls?

Per shift, how long (in minutes) do you spend filing reports?

Per shift, how long (in minutes) do you spend on patrol?

Per shift, how long (in minutes) do you spend waiting at the holding cell, at the county jail, or at the hospital?

Per shift, how long (in minutes) do you spend waiting for a detective or supervisor to arrive on scene?

Per shift, how long (in minutes) do you spend searching databases?

Per shift, how long (in minutes) do you spend reading/sending departmental email?

Per shift, how long (in minutes) do you spend reviewing bulletins?

Per shift, how many times do you leave your assignment and return to the police station to complete reporting requirements?

How often do you use Larimore?

- Many times per day
- Few times per day
- Several times a week
- Once or twice a week
- Several times a month
- Once or twice a month
- Vary rarely
- Never

How often do you use PocketCop?

How often do you use CopLink?

You make fewer trips to the police station during a shift since you began using wireless mobile computing.

- Strongly Agree
- Somewhat Agree
- Agree
- Disagree
- Somewhat Disagree
- Strongly Disagree

Wireless computing helps reduce some of the time pressures of your job.

Roll call takes less time due to sharing information using wireless broadband mobile computing.

Wireless mobile computing reduces your time in dealing with high priority calls.

Wireless mobile computing reduces your time in dealing with medium priority calls.

Wireless mobile computing reduces your time in dealing with low priority calls.

You are able to complete your reporting requirements more quickly due to wireless mobile computing.

Wireless mobile computing allows you more time to engage with the community.

Wireless mobile computing allows you to make more traffic stops.

Wireless mobile computing allows you to make more calls for service.

Wireless mobile computing allows you to have more free time.

You spend less time on administrative tasks in the police station now that you have wireless mobile computing.

Wireless mobile computing hinders performance because it takes too much time to read unnecessary messages.

Communication

The questions in this section are intended to gain insight on the influence of wireless broadband technology on the department's communication channels. All information will be used in the aggregate.

Wireless mobile computer allows you to communicate better with the public.

Strongly Agree
Somewhat Agree
Agree
Disagree
Somewhat Disagree
Strongly Disagree

Wireless mobile computing allows you to communicate better with your supervisors.

Wireless mobile computing allows you to communicate with other police officers.

Job Satisfaction

The questions in this section are intended to gain insight on the influence of mobile broadband technology on job tasks. All information will be used in the aggregate.

Your job would be more difficult without wireless mobile computing.

Strongly Agree
Somewhat Agree
Agree
Disagree
Somewhat Disagree
Strongly Disagree

Wireless mobile computing makes your work more difficult.

Wireless mobile computing makes your job easier.

You feel that your job satisfaction has decreased since you started using wireless mobile computing.

You are responsible for reporting more information due to using wireless mobile computing.

You feel that you are more accountable for your work as a result of the wireless mobile broadband computing system.

Effectiveness

The questions in this section are intended to gain insight into whether or not wireless broadband technologies influence job task effectiveness. All information will be used in the aggregate.

Wireless mobile broadband computing allows you to provide better service to the public.

Strongly Agree
Somewhat Agree
Agree
Disagree
Somewhat Disagree
Strongly Disagree

You work more productively since using wireless mobile broadband computing.

Your self-initiated activities have increased due to wireless mobile broadband computing.

The degree of professionalism in the department has increased due to wireless mobile broadband computing.

In general, wireless mobile broadband computing helps you do your job better.

You have volunteered to take a pending call not assigned to you because you saw it on the wireless mobile broadband computing system.

You think arrests have increased since the department began using mobile broadband computing.
You run a series of plate checks more frequently since you began using the wireless mobile broadband computing.

Information Flow

The questions asked in this section are intended to gain insight into whether or not wireless broadband technology influences the flow of information to officers. Information gathered will only be used in the aggregate.

You receive information more quickly due to using wireless mobile broadband computing.

Strongly Agree
Somewhat Agree
Agree
Disagree
Somewhat Disagree
Strongly Disagree

You are able to share information more easily with other people in your department due to using wireless mobile broadband computing.

You are able to share information with other police departments.

Accessing information is easier using the wireless mobile broadband computing as compared to the Verizon air-cards.

You are responsible for reading more information due to wireless mobile broadband computing.

You receive too much information as a result of wireless mobile broadband computing.

You want access to more information through your wireless mobile computers.

You get "information overload' as a result of the wireless mobile broadband computing system.

You are confident that your reporting will be submitted without a problem using the wireless mobile broadband computing system.

You could do your job better if you had more information from other police departments that was related to your jurisdiction.

Brookline Police Department provides enough information for you to do your job effectively.

Information Quality

The questions in this section are intended to gain insight into whether or not the quality of information the department has access to is influenced by wireless broadband technology. All information will be used in the aggregate.

The information you have access to through your wireless mobile broadband computing system is more up-to-date as compared to information prior to the wireless mobile broadband computing system.

Strongly Agree
Somewhat Agree
Agree
Disagree
Somewhat Disagree
Strongly Disagree

The information you have access to as a result of the wireless mobile broadband computing system is “real time”.

The information you have access to as a result of the wireless mobile broadband computing system allows you to approach individuals or situations more prepared.

Being able to access information such as pictures and criminal history from the wireless mobile broadband network makes you feel more confident when you approach an individual or situation.

Being able to access information such as pictures and criminal histories from the wireless mobile broadband network allows you to do your job more effectively.

The information you have access to as a result of the wireless mobile broadband computing system is poor.

The information you have access to as a result of the wireless mobile broadband computing system is not relevant to your job.

Information you access through the wireless mobile broadband computing system makes you feel safer when you approach an individual or situation.

Information you access through the wireless mobile broadband computing system allows you to make a more accurate judgment about an individual or situation you encounter.

The information you include in your reports is more accurate as a result of the wireless mobile broadband computing system.

Your reports are of higher quality as a result of the wireless mobile broadband computing system.

Information Access

The questions in this section are intended to gain insight into whether access to information was influenced by wireless broadband technology. All information gathered will be used in the aggregate.

In general, you can easily access the information you need.

Strongly Agree
Somewhat Agree
Agree
Disagree
Somewhat Disagree
Strongly Disagree

You are comfortable using the Larimore application.

The Larimore application allows you to do your job effectively.

You could do your job effectively without the Larimore application.

In general, the programs within the Larimore application are easy to use.

You are comfortable using the PocketCop application.

The PocketCop application allows you to do your job effectively.

You could do your job effectively without the PocketCop application.

In general, the programs within the PocketCop application are easy to use.

You are comfortable using the CopLink application.

The CopLink application allows you to do your job effectively.

You could do your job effectively without the CopLink application.

In general, the programs within the CopLink application are easy to use.

You are able to access the same amount of information using the wireless mobile broadband computing system regardless of the patrol sector you are working in.

You prefer to use the wireless mobile broadband computing system over the Verizon air-cards.

You believe the differences in signal strength of the wireless mobile broadband computing system across patrol sectors is a problem.

If you are assigned to work a patrol sector that has weak signal strength it changes how you will complete your job that day.

Which of the following applications is MOST important for you to do your job effectively?

- Larimore
- PocketCop/Interact
- CopLink
- Internal E-mail

Which of the following applications is LEAST important for you to do your job effectively?

Which of the following types of information is MOST important for you to do your job effectively?

- Pictures of individuals
- Criminal history of individuals
- Agency interaction with individuals or physical address (home/business)
- Crime / Intelligence Reports

Which of the following types of information is LEAST important for you to do your job effectively?

What type of information do you wish you had access to that you currently do not?

Training

The questions in this section are intended to gain insight into whether or not training was received (or should be received) for the wireless broadband technology. All information will be used in the aggregate.

You received formal training on the software applications you use in the patrol vehicles.

- Strongly Agree
- Somewhat Agree
- Agree
- Disagree
- Somewhat Disagree
- Strongly Disagree

You received formal training on software applications you use in the station on a desktop.

You would like to receive formal training on the software applications available in the patrol vehicles.

The training division is able to get training/education information to you easily using the wireless mobile broadband computing system.

If you do not know how to use a feature of the wireless mobile computing system you will go to a fellow officer to learn how.

If you do not know how to use a feature of the wireless mobile computing system you will go to the training division to learn how.

If you do not know how to use a feature of the wireless mobile computing system you will learn how to use it on your own.

If you do not know how to use a technology you go directly to the technology division.

Appendix C. Patrol Sector Responses and Response Time Estimates

Table C1. Call Responses and Time Averages by Sector and Implementation Period (n=54)

	Mean	Standard Deviation	Percent Change	T-test	P value
SECTOR 1					
Total Calls					
Pre-Implementation (2004-2006)	6268	528.80	-6.8%	.82	.50
Post-Implementation (2007-2009)	5839	462.41			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	312	12.65	**-18.6%**	**6.60**	**.02**
Post-Implementation (2007-2009)	254	4.12			
SECTOR 2					
Total Calls					
Pre-Implementation (2004-2006)	5032	801.86	+7.8%	-1.29	.33
Post-Implementation (2007-2009)	5425	609.34			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	289	8.54	**-13.8%**	**7.70**	**.02**
Post-Implementation (2007-2009)	249	14.14			
SECTOR 3					
Total Calls					
Pre-Implementation (2004-2006)	4399	421.21	-13.1%	1.35	.31
Post-Implementation (2007-2009)	3824	380.56			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	333	23.43	-17.7%	2.55	.13
Post-Implementation (2007-2009)	274	16.85			
SECTOR 4					
Total Calls					
Pre-Implementation (2004-2006)	8883	275.58	**-6.8%**	**8.44**	**.01**
Post-Implementation (2007-2009)	8281	328.36			
Average Time (in Seconds)					
Pre-Implementation (2004-2006)	203	32.14	+4.9%	-.32	.78
Post-Implementation (2007-2009)	213	23.11			
SECTOR 5					
Total Calls					
Pre-Implementation (2004-2006)	4884	494.16	-7.8%	.97	.43
Post-Implementation (2007-2009)	4502	234.96			

Mean Standard Percent T-test P

		Deviation	Change		value
SECTOR 5 (continued)					
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	276	41.33	-15.6%	1.65	.24
Post-Implementation (2007-2009)	233	29.02			
SECTOR 6					
Total Calls					
Pre-Implementation (2004-2006)	1112	280.24	+12.6%	-.51	.66
Post-Implementation (2007-2009)	1252	211.62			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	286	110.25	-24.8%	.99	.43
Post-Implementation (2007-2009)	215	18.71			
SECTOR 7					
Total Calls					
Pre-Implementation (2004-2006)	1723	168.44	+3.9%	-1.08	.39
Post-Implementation (2007-2009)	1790	237.43			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	297	31.08	-23.6%	2.78	.11
Post-Implementation (2007-2009)	227	22.67			
SECTOR 8					
Total Calls					
Pre-Implementation (2004-2006)	1979	165.05	-5.3%	2.78	.11
Post-Implementation (2007-2009)	1874	148.09			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	257	16.33	-4.3%	.33	.77
Post-Implementation (2007-2009)	246	37.89			
SECTOR 9					
Total Calls					
Pre-Implementation (2004-2006)	2327	454.99	-1.8%	.12	.91
Post-Implementation (2007-2009)	2284	209.36			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	379	31.19	-28.2%	2.50	.13
Post-Implementation (2007-2009)	272	44.09			

Note: T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Appendix D. Supportive Tables for Departmental Sensitivity Checks of Most Frequent, Most Time Consuming and Common Criminal Activity Call Types

Additional pre- and post-implementation sensitivity checks were conducted on the *most frequent* CAD call types fielded, the *most time consuming* CAD call types fielded, and common higher priority CAD call types for *criminal activity*.[14] Examination of these calls can contextualize the current results. Variation in these calls may have contributed to the lack of dependable differences between pre- and post-broadband wireless implementation periods. Most frequent CAD call types fielded corresponded to the top four CAD call designations that had reached at least five percent of all calls within the patrol sector across 2004-2009. Most time consuming CAD call types fielded followed a similar identification process. These call types represented the top four most time consuming proportion of calls within the patrol sector across any given year. Common higher priority CAD call types for criminal activity focused on priority two calls that were observed to represent a high volume of calls received and also consumed a large proportion of average call times at the departmental level and across patrol sectors. These calls consisted of: suspicious activity, suspicious person, suspicious vehicle, larceny, and malicious damage. Table D1 provides a summary table of the sensitivity analyses for the department.

[14] In recognition of the regression to the mean likelihood of a focus on common calls types that were the most frequent and time consuming, these sensitivity checks used alternative statistical modeling techniques (i.e., generalized linear regression with autocorrelated covariance matrices). These models did not differ from the mean tests.

Table D1. Summary Table of Departmental Sensitivity Checks

	Total Calls	Calls T-test	Average Response Time	Time T-test
MOST FREQUENT (n=216)				
Residential Alarm	-	NS	+	NS
Medical Emergency	+	NS	+	NS
Traffic	-	NS	+	NS
Building Check	+	NS	-	NS
MOST TIME CONSUMING (n=216)				
Loud Party	-	NS	-	NS
Traffic Hazard	+	S	-	NS
Lost Property	-	NS	-	NS
Assist Other Agency	-	NS	+	S
CRIMINAL ACTIVITY (n=270)				
Suspicious Activity	-	S	+	NS
Suspicious Person	-	S	+	NS
Suspicious Vehicle	-	S	-	NS
Larceny	+	NS	+	NS
Malicious Damage	-	NS	-	NS

Note: T-test adjusted for autocorrelated or dependent samples. Negative signs (-) indicate post-implementation reductions, while positive signs (+) signal increases. NS refers to non-significant statistical test and S refers to statistically significant statistical tests. Source: BPD Computer Aided Dispatch Data 2004-2009

The sensitivity checks identify a few significant differences that occurred between the pre- and post-implementation periods. Many of these differences concerned call volume. The department experienced substantial increases in calls for traffic hazards and decreases in calls for suspicious activities, persons, and vehicles. These changes did not affect average response times. The only dependable difference between pre- and post-implementation periods with respect to response time was observed with calls to assist other agencies. On average, the response time associated with these calls increased by one minute after wireless broadband implementation. It is possible that this significant increase in response time contributed to departmental findings. However, given the relative infrequency of calls to assist other agencies the effect of this increase is likely to be minimal.

There are a few noteworthy trends associated with average response times. Frequent call types appeared to experience an increase in response times irrespective of changes in call volume. The only exception observed was for building checks. Average response times largely decreased for calls that tend to take up an inordinate amount of time. Among common criminal activity calls, suspicious activity, suspicious person, and larceny calls all appeared to experience increased response times. These increases were observed despite the trend of decreased call volume of suspicious activity and person calls.

Table D2. Call Responses and Time Averages by Most Frequent Call Types (N=216)

	Mean	Standard Deviation	Percent Change	T-test	P value
RESIDENTIAL ALARM					
Total Calls					
Pre-Implementation (2004-2006)	1687	195.43	-13.2%	2.93	.10
Post-Implementation (2007-2009)	1464	134.40			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	172	86.52	+51.7%	-1.55	.26
Post-Implementation (2007-2009)	261	29.39			
MEDICAL EMERGENCY					
Total Calls					
Pre-Implementation (2004-2006)	3654	79.77	**+6.5%**	**-15.75**	**.01**
Post-Implementation (2007-2009)	3891	54.08			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	202	117.91	+54.5%	-1.69	.23
Post-Implementation (2007-2009)	312	17.20			
TRAFFIC					
Total Calls					
Pre-Implementation (2004-2006)	3861	128.41	-3.0%	.78	.52
Post-Implementation (2007-2009)	3747	153.52			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	166	66.96	+43.4%	-1.89	.20
Post-Implementation (2007-2009)	238	91.13			
BUILDING CHECK					
Total Calls					
Pre-Implementation (2004-2006)	3283	2372.15	+16.8	-.31	.79
Post-Implementation (2007-2009)	3835	1438.16			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	3	4.90	-66.7%	.98	.43
Post-Implementation (2007-2009)	1	.57			

Note: Top fielded call types represent CAD calls that have reached at least 5% of all calls received 2004-2009. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table D3. Call Responses and Time Averages by Top Time Consuming Call Types (N=216)

	Mean	Standard Deviation	Percent Change	T-test	P value
LOUD PARTY					
Total Calls					
Pre-Implementation (2004-2006)	455	45.78	-16.0%	1.78	.22
Post-Implementation (2007-2009)	382	116.92			
Average Time (in Seconds)					
Pre-Implementation (2004-2006)	1040	842.41	-76.7%	1.83	.21
Post-Implementation (2007-2009)	242	200.38			
TRAFFIC HAZARD					
Total Calls					
Pre-Implementation (2004-2006)	67	9.64	**+173.1%**	**-6.81**	**.02**
Post-Implementation (2007-2009)	183	24.02			
Average Time (in Seconds)					
Pre-Implementation (2004-2006)	996	617.94	-61.7%	1.61	.25
Post-Implementation (2007-2009)	381	42.39			
LOST PROPERTY					
Total Calls					
Pre-Implementation (2004-2006)	214	119.62	-66.4%	2.26	.15
Post-Implementation (2007-2009)	72	11.53			
Average Time (in Seconds)					
Pre-Implementation (2004-2006)	791	935.46	-46.0%	.54	.64
Post-Implementation (2007-2009)	427	341.03			
ASSIST OTHER AGENCY					
Total Calls					
Pre-Implementation (2004-2006)	103	17.46	-37.9%	2.56	.12
Post-Implementation (2007-2009)	64	9.06			
Average Time (in Seconds)					
Pre-Implementation (2004-2006)	217	67.62	**+29.0%**	**-6.58**	**.02**
Post-Implementation (2007-2009)	280	82.50			

Note: Top time consuming call types represent CAD calls whose aggregate time 2004-2009 was observed to be the highest among all other calls. Since these aggregates may be influenced by yearly outliers, the percentage of change will be artificially inflated. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table D4. Call Responses and Time Averages by Common Criminal Activity Calls (N=270)

	Mean	Standard Deviation	Percent Change	T-test	P value
SUSPICIOUS ACTIVITY					
Total Calls					
Pre-Implementation (2004-2006)	466	18.03	**-7.5%**	**4.21**	**.05**
Post-Implementation (2007-2009)	431	5.48			
Average Time (in Seconds)					
Pre-Implementation (2004-2006)	201	92.09	+20.4%	-.39	.73
Post-Implementation (2007-2009)	242	151.99			
SUSPICIOUS PERSON					
Total Calls					
Pre-Implementation (2004-2006)	432	77.05	**-46.1%**	**7.21**	**.02**
Post-Implementation (2007-2009)	233	30.53			
Average Time (in Seconds)					
Pre-Implementation (2004-2006)	129	36.59	+54.3%	-2.61	.12
Post-Implementation (2007-2009)	199	25.92			
SUSPICIOUS VEHICLE					
Total Calls					
Pre-Implementation (2004-2006)	233	18.33	**-25.8%**	**10.32**	**.01**
Post-Implementation (2007-2009)	173	8.96			
Average Time (in Seconds)					
Pre-Implementation (2004-2006)	341	208.77	-19.6%	.55	.63
Post-Implementation (2007-2009)	274	45.53			
LARCENY					
Total Calls					
Pre-Implementation (2004-2006)	230	12.29	+64.8%	-.67	.57
Post-Implementation (2007-2009)	379	390.78			
Average Time (in Seconds)					
Pre-Implementation (2004-2006)	753	163.44	+11.6%	-.91	.46
Post-Implementation (2007-2009)	840	34.22			
MALICIOUS DAMAGE					
Total Calls					
Pre-Implementation (2004-2006)	273	37.99	-26.7%	6.75	.02
Post-Implementation (2007-2009)	200	46.23			
Average Time (in Seconds)					
Pre-Implementation (2004-2006)	626	80.39	-4.2%	.26	.82
Post-Implementation (2007-2009)	600	93.05			

Note: Common criminal activity calls are Priority 2 calls and were within the top third of calls fielded 2004-2009. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Appendix E. Supportive Tables for Patrol Sector Sensitivity Checks of Most Frequent, Most Time Consuming and Common Criminal Activity Call Types

Departmental data were disaggregated by patrol sector to replicate sensitivity checks performed in Appendix D. The same criteria were applied to identify the *most frequent* CAD call types fielded and the *most time consuming* CAD call types fielded. The call types produced varied by patrol sector. Common higher priority CAD call types for *criminal activity* were not allowed to vary; the call types used were the same as the departmental analyses to allow for comparison across precincts. Summaries of the average response time findings are presented below.

Most Frequent. Only one dependable difference was observed pre- and post-wireless broadband implementation. In sector three, the average response time for traffic calls decreased by 45 seconds. This observation needs to be cautioned. The number of traffic calls fielded within the sector also significantly differed between implementation periods. Moreover, the trends within sector three indicate that the remaining most frequent calls increased over time. Beyond this single observation, there were no significant differences in response times for the most frequently occurring calls received within each patrol sector by implementation period. Overall trends suggest increases in average response times among a majority of the most frequent call types in sectors one through six and mixed trends in sectors seven through nine after implementation.

Most Time Consuming. There were no discernible differences between pre- and post-implementation response time averages within each patrol sector by implementation period. Overall post-implementation trends suggest decreases in average response times among the top consuming time call types in sectors four, five, and nine, among the majority of most time consuming call types in sectors one, two, three, and seven and mixed trends in sectors six and eight.

Criminal Activity. Significant pre- and post-implementation differences were observed in sectors five and seven. The average response time for malicious damage calls were 38% lower after broadband wireless implementation in sector five. The rate of time savings was observed despite a slight increase in malicious damage calls received within the sector. Among the remaining criminal activity calls in sector five, the trends also indicate decreases in average response times. In sector seven, the average response times for suspicious person calls increased by over a minute following wireless broadband implementation. Suspicious activity and vehicle trends were also observed to experience increases in average response times, while response times associated with larceny and malicious damage calls within the sector appeared to be slightly lower after implementation. Overall trends for the remaining sectors suggest reductions in average response times among criminal activity calls in sector five, increases in sector two, and mixed trends in sectors one, three, four, six, seven, eight, and nine.

Table E1. Sector 1 Call Responses and Time Averages by Most Frequent Call Types (n=24)

	Mean	Standard Deviation	Percent Change	T-test	P value
MEDICAL EMERGENCY					
Total Calls					
Pre-Implementation (2004-2006)	607	38.42	+9.4%	-2.62	.12
Post-Implementation (2007-2009)	664	27.78			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	210	187.46	+19.0%	-.29	.80
Post-Implementation (2007-2009)	250	88.39			
NOISE COMPLAINT					
Total Calls					
Pre-Implementation (2004-2006)	246	36.72	<1.0%	.02	.99
Post-Implementation (2007-2009)	245	26.10			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	793	268.86	-63.3%	2.30	.15
Post-Implementation (2007-2009)	291	173.44			
TRAFFIC					
Total Calls					
Pre-Implementation (2004-2006)	914	125.35	-28.4%	3.66	.07
Post-Implementation (2007-2009)	654	17.46			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	306	105.99	-47.1%	1.57	.26
Post-Implementation (2007-2009)	162	77.83			
BUILDING CHECK					
Total Calls					
Pre-Implementation (2004-2006)	444	297.00	-2.7%	.04	.97
Post-Implementation (2007-2009)	432	292.18			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	4	6.63	-91.8%	1.00	.42
Post-Implementation (2007-2009)	<1	.57			

Note: Top fielded call types represent CAD calls that have reached at least 5% of all calls received 2004-2009 within the sector. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E2. Sector 2 Call Responses and Time Averages by Most Frequent Call Types (n=24)

	Mean	Standard Deviation	Percent Change	T-test	P value
MEDICAL EMERGENCY					
Total Calls					
Pre-Implementation (2004-2006)	624	12.65	-3.0%	.42	.71
Post-Implementation (2007-2009)	605	70.04			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	250	60.06	+14.0%	-.99	.43
Post-Implementation (2007-2009)	285	4.00			
PARKING COMPLAINT					
Total Calls					
Pre-Implementation (2004-2006)	269	38.03	-13.0%	.68	.56
Post-Implementation (2007-2009)	234	80.43			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	472	26.65	+20.8%	-1.88	.20
Post-Implementation (2007-2009)	570	82.64			
TRAFFIC					
Total Calls					
Pre-Implementation (2004-2006)	801	117.19	-5.0%	.34	.76
Post-Implementation (2007-2009)	761	85.42			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	274	76.42	-10.6%	1.16	.37
Post-Implementation (2007-2009)	245	112.74			
BUILDING CHECK					
Total Calls					
Pre-Implementation (2004-2006)	429	344.62	+15.4%	-.26	.82
Post-Implementation (2007-2009)	495	202.66			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	6	10.95	-100.0%		
Post-Implementation (2007-2009)	0	0			

Note: Top fielded call types represent CAD calls that have reached at least 5% of all calls received 2004-2009 within the sector. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E3. Sector 3 Call Responses and Time Averages by Most Frequent Call Types (n=24)

	Mean	Standard Deviation	Percent Change	T-test	P value
MEDICAL EMERGENCY					
Total Calls					
Pre-Implementation (2004-2006)	688	70.55	+4.5%	-1.62	.25
Post-Implementation (2007-2009)	719	45.18			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	250	102.00	+30.4%	-1.19	.36
Post-Implementation (2007-2009)	326	29.05			
PARKING COMPLAINT					
Total Calls					
Pre-Implementation (2004-2006)	167	33.53	+9.0%	-.47	.68
Post-Implementation (2007-2009)	182	25.81			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	588	45.08	+13.4%	-1.48	.28
Post-Implementation (2007-2009)	667	76.00			
TRAFFIC					
Total Calls					
Pre-Implementation (2004-2006)	290	9.27	**-61.4%**	**7.05**	**.02**
Post-Implementation (2007-2009)	112	36.29			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	137	74.48	**-32.8%**	**7.72**	**.02**
Post-Implementation (2007-2009)	92	64.48			
BUILDING CHECK					
Total Calls					
Pre-Implementation (2004-2006)	263	169.00	+49.4%	-.94	.45
Post-Implementation (2007-2009)	393	177.53			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	<1	0			
Post-Implementation (2007-2009)	<1	0			

Note: Top fielded call types represent CAD calls that have reached at least 5% of all calls received 2004-2009 within the sector. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E4. Sector 4 Call Responses and Time Averages by Most Frequent Call Types (n=24)

	Mean	Standard Deviation	Percent Change	T-test	P value
MEDICAL EMERGENCY					
Total Calls					
Pre-Implementation (2004-2006)	725	48.99	+9.1%	-1.04	.41
Post-Implementation (2007-2009)	791	60.06			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	182	119.07	+62.6%	-1.42	.29
Post-Implementation (2007-2009)	296	20.74			
TRAFFIC					
Total Calls					
Pre-Implementation (2004-2006)	372	214.38	+12.1%	-.33	.77
Post-Implementation (2007-2009)	417	23.69			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	56	16.49	+132.1%	-1.64	.24
Post-Implementation (2007-2009)	130	85.85			
BUILDING CHECK					
Total Calls					
Pre-Implementation (2004-2006)	434	363.56	-53.5%	.87	.48
Post-Implementation (2007-2009)	202	129.10			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	12	20.20	-91.7%	.83	.49
Post-Implementation (2007-2009)	1	2.27			
PRISONER TRANSPORT					
Total Calls					
Pre-Implementation (2004-2006)	610	25.88	-9.7%	.74	.54
Post-Implementation (2007-2009)	551	112.08			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	8	3.46	+238.0%	-4.06	.06
Post-Implementation (2007-2009)	27	11.70			

Note: Top fielded call types represent CAD calls that have reached at least 5% of all calls received 2004-2009 within the sector. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E5. Sector 5 Call Responses and Time Averages by Most Frequent Call Types (n=24)

	Mean	Standard Deviation	Percent Change	T-test	P value
RESIDENTIAL ALARM					
Total Calls					
Pre-Implementation (2004-2006)	298	38.82	-17.8%	2.51	.09
Post-Implementation (2007-2009)	245	37.76			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	184	100.33	+24.5%	-.79	.49
Post-Implementation (2007-2009)	229	17.06			
MEDICAL EMERGENCY					
Total Calls					
Pre-Implementation (2004-2006)	725	48.99	+9.1%	-1.04	.41
Post-Implementation (2007-2009)	791	60.06			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	182	119.07	+62.6%	-1.42	.29
Post-Implementation (2007-2009)	296	20.74			
TRAFFIC					
Total Calls					
Pre-Implementation (2004-2006)	1102	36.14	**-11.9%**	**8.62**	**.01**
Post-Implementation (2007-2009)	971	50.48			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	72	20.83	+119.4%	-2.81	.11
Post-Implementation (2007-2009)	158	70.77			
BUILDING CHECK					
Total Calls					
Pre-Implementation (2004-2006)	449	307.94	+10.2%	-.20	.86
Post-Implementation (2007-2009)	495	168.14			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	3	3.00	-66.7%	1.73	.23
Post-Implementation (2007-2009)	1	2.24			

Note: Top fielded call types represent CAD calls that have reached at least 5% of all calls received 2004-2009 within the sector. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E6. Sector 6 Call Responses and Time Averages by Most Frequent Call Types (n=24)

	Mean	Standard Deviation	Percent Change	T-test	P value
RESIDENTIAL ALARM					
Total Calls					
Pre-Implementation (2004-2006)	121	3.16	-14.0%	2.12	.17
Post-Implementation (2007-2009)	104	12.33			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	254	18.73	+58.3%	-.99	.43
Post-Implementation (2007-2009)	402	243.48			
MEDICAL EMERGENCY					
Total Calls					
Pre-Implementation (2004-2006)	76	13.11	-11.8%	1.14	.37
Post-Implementation (2007-2009)	67	10.20			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	279	11.79	+32.6%	-2.91	.10
Post-Implementation (2007-2009)	370	59.36			
PARKING COMPLAINT					
Total Calls					
Pre-Implementation (2004-2006)	51	16.28	-13.7%	.56	.63
Post-Implementation (2007-2009)	44	6.48			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	711	410.21	+11.0%	-.46	.69
Post-Implementation (2007-2009)	789	288.36			
BUILDING CHECK					
Total Calls					
Pre-Implementation (2004-2006)	319	261.40	+27.6%	-.42	.71
Post-Implementation (2007-2009)	407	137.99			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	1	1	-67.0%	1	.42
Post-Implementation (2007-2009)	<1	.57			

Note: Top fielded call types represent CAD calls that have reached at least 5% of all calls received 2004-2009 within the sector. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E7. Sector 7 Call Responses and Time Averages by Most Frequent Call Types (n=24)

	Mean	Standard Deviation	Percent Change	T-test	P value
RESIDENTIAL ALARM					
Total Calls					
Pre-Implementation (2004-2006)	221	42.76	-22.6%	2.45	.13
Post-Implementation (2007-2009)	171	23.07			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	260	22.61	-2.7%	.38	.74
Post-Implementation (2007-2009)	253	13.00			
MEDICAL EMERGENCY					
Total Calls					
Pre-Implementation (2004-2006)	141	13.75	+1.0%	-.17	.88
Post-Implementation (2007-2009)	142	8.72			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	321	19.60	+19.3%	-1.56	.26
Post-Implementation (2007-2009)	383	50.27			
TRAFFIC					
Total Calls					
Pre-Implementation (2004-2006)	55	27.87	+100.0%	-.90	.46
Post-Implementation (2007-2009)	110	87.50			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	99	23.07	+24.2%	-.55	.64
Post-Implementation (2007-2009)	123	63.46			
BUILDING CHECK					
Total Calls					
Pre-Implementation (2004-2006)	227	160.60	+50.7%	-2.26	.15
Post-Implementation (2007-2009)	342	120.68			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	2	2.83	-59.9%	.48	.68
Post-Implementation (2007-2009)	1	1.15			

Note: Top fielded call types represent CAD calls that have reached at least 5% of all calls received 2004-2009 within the sector. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E8. Sector 8 Call Responses and Time Averages by Most Frequent Call Types (n=24)

	Mean	Standard Deviation	Percent Change	T-test	P value
RESIDENTIAL ALARM					
Total Calls					
Pre-Implementation (2004-2006)	245	30.82	-8.6%	1.74	.22
Post-Implementation (2007-2009)	224	13.75			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	310	84.18	-14.8%	.98	.43
Post-Implementation (2007-2009)	264	7.55			
BUSINESS ALARM					
Total Calls					
Pre-Implementation (2004-2006)	104	12.12	**-65.4%**	**7.65**	**.02**
Post-Implementation (2007-2009)	39	5.00			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	236	48.74	+8.9%	-.36	.75
Post-Implementation (2007-2009)	257	56.32			
MEDICAL EMERGENCY					
Total Calls					
Pre-Implementation (2004-2006)	184	8.72	**+41.3%**	**-5.39**	**.03**
Post-Implementation (2007-2009)	260	28.48			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	308	69.74	+27.6%	-1.65	.24
Post-Implementation (2007-2009)	393	25.10			
BUILDING CHECK					
Total Calls					
Pre-Implementation (2004-2006)	290	235.74	+55.2%	-1.35	.31
Post-Implementation (2007-2009)	450	185.17			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	3	3.05	-90.1%	1.96	.19
Post-Implementation (2007-2009)	<1	.57			

Note: Top fielded call types represent CAD calls that have reached at least 5% of all calls received 2004-2009 within the sector. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E9. Sector 9 Call Responses and Time Averages by Most Frequent Call Types (n=24)

	Mean	Standard Deviation	Percent Change	T-test	P value
RESIDENTIAL ALARM					
Total Calls					
Pre-Implementation (2004-2006)	256	8.19	-3.1%	.42	.71
Post-Implementation (2007-2009)	248	40.04			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	282	12.33	+1.4%	-.28	.80
Post-Implementation (2007-2009)	286	17.92			
MEDICAL EMERGENCY					
Total Calls					
Pre-Implementation (2004-2006)	215	68.44	+26.0%	-1.52	.27
Post-Implementation (2007-2009)	271	8.06			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	266	112.62	+39.8%	-1.34	.31
Post-Implementation (2007-2009)	372	24.43			
TRAFFIC					
Total Calls					
Pre-Implementation (2004-2006)	105	53.00	-32.3%	.87	.48
Post-Implementation (2007-2009)	71	23.71			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	131	68.77	-1.5%	.05	.96
Post-Implementation (2007-2009)	129	41.88			
BUILDING CHECK					
Total Calls					
Pre-Implementation (2004-2006)	405	297.00	-9.4%	.17	.88
Post-Implementation (2007-2009)	367	89.61			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	8	8.12	-95.7%	1.68	.24
Post-Implementation (2007-2009)	<1	.57			

Note: Top fielded call types represent CAD calls that have reached at least 5% of all calls received 2004-2009 within the sector. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E10. Sector 1 Call Responses and Time Averages by Top Time Consuming Call Types (n=24)

	Mean	Standard Deviation	Percent Change	T-test	P value
ALARM/SCHOOL					
Total Calls					
Pre-Implementation (2004-2006)	17	8.54	+17.6%	-1.32	.32
Post-Implementation (2007-2009)	20	8.06			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	254	118.28	-15.4%	.79	.46
Post-Implementation (2007-2009)	215	109.74			
ANIMAL COMPLAINT					
Total Calls					
Pre-Implementation (2004-2006)	45	7.94	-20.0%	-.60	.54
Post-Implementation (2007-2009)	36	14.46			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	697	409.54	-9.2%	.28	.81
Post-Implementation (2007-2009)	633	31.75			
MOTOR VEHICLE BLOCKING					
Total Calls					
Pre-Implementation (2004-2006)	49	11.00	-10.2%	.34	.77
Post-Implementation (2007-2009)	44	20.98			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	903	549.95	-30.9%	.92	.46
Post-Implementation (2007-2009)	624	152.40			
ASSIST OTHER AGENCY					
Total Calls					
Pre-Implementation (2004-2006)	13	10.82	-23.1%	.36	.75
Post-Implementation (2007-2009)	10	4.58			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	116	115.50	+349.1%	-1.12	.38
Post-Implementation (2007-2009)	521	524.87			

Note: Top time consuming call types represent CAD calls whose aggregate time 2004-2009 was observed to be the highest among all other calls within the sector. Since these aggregates may be influenced by yearly outliers, the percentage of change will be artificially inflated. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E11. Sector 2 Call Responses and Time Averages by Top Time Consuming Call Types (n=24)

	Mean	Standard Deviation	Percent Change	T-test	P value
ASSIST					
Total Calls					
Pre-Implementation (2004-2006)	30	8.31	**-46.7%**	**9.17**	**.01**
Post-Implementation (2007-2009)	16	5.66			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	116	21.54	+94.8%	-.85	.48
Post-Implementation (2007-2009)	226	202.69			
NOISE COMPLAINT					
Total Calls					
Pre-Implementation (2004-2006)	118	27.22	-19.5%	2.45	.13
Post-Implementation (2007-2009)	95	16.55			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	824	614.83	-64.9%	1.55	.26
Post-Implementation (2007-2009)	289	18.87			
LOUD PARTY					
Total Calls					
Pre-Implementation (2004-2006)	58	12.04	-31.0%	-1.00	.17
Post-Implementation (2007-2009)	40	2.45			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	1690	565.67	-78.2%	3.89	.06
Post-Implementation (2007-2009)	369	34.42			
VIOLATION TOWN LAW					
Total Calls					
Pre-Implementation (2004-2006)	38	2.00	**-18.4%**	**7.18**	**.02**
Post-Implementation (2007-2009)	31	3.46			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	871	914.70	-77.0%	1.27	.33
Post-Implementation (2007-2009)	200	21.73			

Note: Top time consuming call types represent CAD calls whose aggregate time 2004-2009 was observed to be the highest among all other calls within the sector. Since these aggregates may be influenced by yearly outliers, the percentage of change will be artificially inflated. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E12. Sector 3 Call Responses and Time Averages by Top Time Consuming Call Types (n=24)

	Mean	Standard Deviation	Percent Change	T-test	P value
AUDIBLE ALARM SOUNDING					
Total Calls					
Pre-Implementation (2004-2006)	18	6.63	+27.8%	-1.09	.39
Post-Implementation (2007-2009)	23	6.63			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	241	150.32	+20.7%	-.32	.78
Post-Implementation (2007-2009)	291	124.90			
YOUTH COMPLAINT					
Total Calls					
Pre-Implementation (2004-2006)	25	9.06	+8.0%	-.18	.87
Post-Implementation (2007-2009)	27	11.00			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	1165	1343.77	-78.3%	1.09	.39
Post-Implementation (2007-2009)	253	102.89			
LOUD PARTY					
Total Calls					
Pre-Implementation (2004-2006)	79	1.41	-17.7%	.79	.51
Post-Implementation (2007-2009)	65	32.00			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	827	900.75	-51.8%	.76	.53
Post-Implementation (2007-2009)	399	154.51			
MOTORIST LOCK OUT					
Total Calls					
Pre-Implementation (2004-2006)	67	6.24	**-28.4%**	**6.08**	**.02**
Post-Implementation (2007-2009)	48	6.63			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	647	353.62	-14.4%	.47	.68
Post-Implementation (2007-2009)	554	47.70			

Note: Top time consuming call types represent CAD calls whose aggregate time 2004-2009 was observed to be the highest among all other calls within the sector. Since these aggregates may be influenced by yearly outliers, the percentage of change will be artificially inflated. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E13. Sector 4 Call Responses and Time Averages by Top Time Consuming Call Types (n=24)

	Mean	Standard Deviation	Percent Change	T-test	P value
ODOR OF GAS					
Total Calls					
Pre-Implementation (2004-2006)	22	1.15	+31.8%	-3.19	.09
Post-Implementation (2007-2009)	29	4.62			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	1666	2435.29	-79.0%	.92	.45
Post-Implementation (2007-2009)	350	95.60			
LOUD PARTY					
Total Calls					
Pre-Implementation (2004-2006)	70	10.39	-11.4%	.89	.47
Post-Implementation (2007-2009)	62	25.36			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	1003	235.32	-74.3%	3.99	.06
Post-Implementation (2007-2009)	258	131.58			
VIOLATION TOWN LAW					
Total Calls					
Pre-Implementation (2004-2006)	39	18.71	-38.5%	2.02	.18
Post-Implementation (2007-2009)	24	7.21			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	1303	1553.60	-62.5%	1.07	.40
Post-Implementation (2007-2009)	488	257.84			
LOST PROPERTY					
Total Calls					
Pre-Implementation (2004-2006)	42	23.17	-57.1%	2.10	.17
Post-Implementation (2007-2009)	18	4.36			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	2608	4038.38	-77.1%	.81	.50
Post-Implementation (2007-2009)	596	300.42			

Note: Top time consuming call types represent CAD calls whose aggregate time 2004-2009 was observed to be the highest among all other calls within the sector. Since these aggregates may be influenced by yearly outliers, the percentage of change will be artificially inflated. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E14. Sector 5 Call Responses and Time Averages by Top Time Consuming Call Types (n=24)

	Mean	Standard Deviation	Percent Change	T-test	P value
LOUD PARTY					
Total Calls					
Pre-Implementation (2004-2006)	40	3.21	0.0%	-.07	.95
Post-Implementation (2007-2009)	40	11.27			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	1387	1005.23	-72.0%	1.81	.21
Post-Implementation (2007-2009)	389	63.84			
MOTOR VEHICLE BLOCKING					
Total Calls					
Pre-Implementation (2004-2006)	48	17.78	-35.4%	1.32	.32
Post-Implementation (2007-2009)	31	6.11			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	461	67.63	-.01%	.02	.98
Post-Implementation (2007-2009)	458	119.54			
FOUND PROPERTY					
Total Calls					
Pre-Implementation (2004-2006)	17	3.05	+5.9%	-.50	.67
Post-Implementation (2007-2009)	18	3.46			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	491	30.51	-8.6%	.44	.70
Post-Implementation (2007-2009)	449	144.98			
REQUEST POLICE					
Total Calls					
Pre-Implementation (2004-2006)	42	8.08	-31.0%	2.86	.10
Post-Implementation (2007-2009)	29	6.00			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	902	538.42	-52.1%	1.49	.27
Post-Implementation (2007-2009)	431	202.61			

Note: Top time consuming call types represent CAD calls whose aggregate time 2004-2009 was observed to be the highest among all other calls within the sector. Since these aggregates may be influenced by yearly outliers, the percentage of change will be artificially inflated. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E15. Sector 6 Call Responses and Time Averages by Top Time Consuming Call Types (n=24)

	Mean	Standard Deviation	Percent Change	T-test	P value
NOISE COMPLAINT					
Total Calls					
Pre-Implementation (2004-2006)	9	3.16	-22.2%	.49	.67
Post-Implementation (2007-2009)	7	2.65			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	3054	4515.81	-83.4%	.94	.45
Post-Implementation (2007-2009)	506	247.26			
TRAFFIC CRASH					
Total Calls					
Pre-Implementation (2004-2006)	9	1.00	+11.1%	-.47	.69
Post-Implementation (2007-2009)	10	4.04			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	3409	5169.82	-91.6%	1.07	.40
Post-Implementation (2007-2009)	288	136.10			
MOTOR VEHICLE BLOCKING					
Total Calls					
Pre-Implementation (2004-2006)	5	1.53	+40.0%	-.55	.63
Post-Implementation (2007-2009)	7	5.03			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	688	176.99	+21.2%	-.69	.56
Post-Implementation (2007-2009)	834	505.67			
FOUND PROPERTY					
Total Calls					
Pre-Implementation (2004-2006)	5	2.00	+40.0%	-1.15	.37
Post-Implementation (2007-2009)	7	2.65			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	938	120.53	+17.0%	-.37	.75
Post-Implementation (2007-2009)	1097	657.41			

Note: Top time consuming call types represent CAD calls whose aggregate time 2004-2009 was observed to be the highest among all other calls within the sector. Since these aggregates may be influenced by yearly outliers, the percentage of change will be artificially inflated. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E16. Sector 7 Call Responses and Time Averages by Top Time Consuming Call Types (n=24)

	Mean	Standard Deviation	Percent Change	T-test	P value
ALARM SCHOOL					
Total Calls					
Pre-Implementation (2004-2006)	21	8.08	0.0%	.19	.87
Post-Implementation (2007-2009)	21	6.93			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	280	128.16	+42.1%	-.76	.53
Post-Implementation (2007-2009)	398	144.06			
NOISE COMPLAINT					
Total Calls					
Pre-Implementation (2004-2006)	23	13.00	-13.0%	.28	.81
Post-Implementation (2007-2009)	20	3.79			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	901	1123.19	-56.0%	.84	.49
Post-Implementation (2007-2009)	396	110.34			
LOUD PARTY					
Total Calls					
Pre-Implementation (2004-2006)	7	.57	+28.6%	-.90	.46
Post-Implementation (2007-2009)	9	5.00			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	5825	9661.33	-95.1%	.99	.43
Post-Implementation (2007-2009)	288	67.55			
TRAFFIC HAZARD					
Total Calls					
Pre-Implementation (2004-2006)	7	1.73	**+242.9%**	**-5.29**	**.03**
Post-Implementation (2007-2009)	24	4.36			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	4036	6696.38	-94.0%	.97	.43
Post-Implementation (2007-2009)	243	54.37			

Note: Top time consuming call types represent CAD calls whose aggregate time 2004-2009 was observed to be the highest among all other calls within the sector. Since these aggregates may be influenced by yearly outliers, the percentage of change will be artificially inflated. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E17. Sector 8 Call Responses and Time Averages by Top Time Consuming Call Types (n=24)

	Mean	Standard Deviation	Percent Change	T-test	P value
ASSIST					
Total Calls					
Pre-Implementation (2004-2006)	10	2.00	0.0%	-.16	.88
Post-Implementation (2007-2009)	10	2.88			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	323	238.94	+25.7%	-.26	.82
Post-Implementation (2007-2009)	406	431.23			
ANIMAL COMPLAINT					
Total Calls					
Pre-Implementation (2004-2006)	17	1.15	-17.6%	1.22	.35
Post-Implementation (2007-2009)	14	4.36			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	582	197.71	+27.7%	-.53	.65
Post-Implementation (2007-2009)	743	346.21			
ANIMAL LOOSE					
Total Calls					
Pre-Implementation (2004-2006)	14	4.58	-21.4%	.69	.56
Post-Implementation (2007-2009)	11	3.05			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	481	205.31	+24.3%	-.63	.59
Post-Implementation (2007-2009)	598	137.23			
TRAFFIC HAZARD					
Total Calls					
Pre-Implementation (2004-2006)	4	2.00	0.0%	-.20	.86
Post-Implementation (2007-2009)	4	1.53			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	987	988.17	-13.9%	.21	.85
Post-Implementation (2007-2009)	850	347.57			

Note: Top time consuming call types represent CAD calls whose aggregate time 2004-2009 was observed to be the highest among all other calls within the sector. Since these aggregates may be influenced by yearly outliers, the percentage of change will be artificially inflated. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E18. Sector 9 Call Responses and Time Averages by Top Time Consuming Call Types (n=24)

	Mean	Standard Deviation	Percent Change	T-test	P value
DISPUTE					
Total Calls					
Pre-Implementation (2004-2006)	10	3.51	**-50.0%**	**5.00**	**.04**
Post-Implementation (2007-2009)	5	3.78			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	3222	5119.95	-94.0%	1.02	.42
Post-Implementation (2007-2009)	193	46.87			
LOUD PARTY					
Total Calls					
Pre-Implementation (2004-2006)	8	3.51	-37.5%	.83	.49
Post-Implementation (2007-2009)	5	2.88			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	6659	10620.65	-95.2%	1.03	.41
Post-Implementation (2007-2009)	317	72.79			
TRAFFIC HAZARD					
Total Calls					
Pre-Implementation (2004-2006)	6	2.07	+166.7%	-2.87	.10
Post-Implementation (2007-2009)	16	5.51			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	4983	7712.25	-92.5%	1.05	.40
Post-Implementation (2007-2009)	375	156.60			
FOUND PROPERTY					
Total Calls					
Pre-Implementation (2004-2006)	12	2.65	0.0%	-.12	.91
Post-Implementation (2007-2009)	12	6.51			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	541	216.78	-2.4%	.04	.97
Post-Implementation (2007-2009)	528	418.25			

Note: Top time consuming call types represent CAD calls whose aggregate time 2004-2009 was observed to be the highest among all other calls within the sector. Since these aggregates may be influenced by yearly outliers, the percentage of change will be artificially inflated. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E19. Sector 1 Call Responses and Time Averages by Common Criminal Activity Calls (n=30)

	Mean	Standard Deviation	Percent Change	T-test	P value
SUSPICIOUS ACTIVITY					
Total Calls					
Pre-Implementation (2004-2006)	90	11.22	-20.0%	1.74	.22
Post-Implementation (2007-2009)	72	9.06			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	282	83.72	+8.9%	-.37	.75
Post-Implementation (2007-2009)	307	35.79			
SUSPICIOUS PERSON					
Total Calls					
Pre-Implementation (2004-2006)	88	6.24	**-44.3%**	**25.53**	**.001**
Post-Implementation (2007-2009)	49	8.72			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	119	13.56	+67.2%	-2.04	.18
Post-Implementation (2007-2009)	199	55.07			
SUSPICIOUS VEHICLE					
Total Calls					
Pre-Implementation (2004-2006)	35	10.39	-40.0%	2.83	.11
Post-Implementation (2007-2009)	21	2.24			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	276	105.31	-2.5%	.06	.96
Post-Implementation (2007-2009)	269	130.37			
LARCENY					
Total Calls					
Pre-Implementation (2004-2006)	41	12.00	-29.3%	1.80	.21
Post-Implementation (2007-2009)	29	3.61			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	699	130.85	+2.6%	-.23	.84
Post-Implementation (2007-2009)	717	260.97			
MALICIOUS DAMAGE					
Total Calls					
Pre-Implementation (2004-2006)	62	2.65	**-35.5%**	**4.78**	**.04**
Post-Implementation (2007-2009)	40	10.00			

	Mean	Standard Deviation	Percent Change	T-test	P value
MALICIOUS DAMAGE (continued)					
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	592	82.92	-0.1%	.02	.99
Post-Implementation (2007-2009)	589	142.12			

Note: Common criminal activity calls are Priority 2 calls and were within the top third of calls fielded 2004-2009 within the sector. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E20. Sector 2 Call Responses and Time Averages by Common Criminal Activity Calls (n=30)

	Mean	Standard Deviation	Percent Change	T-test	P value
SUSPICIOUS ACTIVITY					
Total Calls					
Pre-Implementation (2004-2006)	79	3.46	-16.5%	1.26	.34
Post-Implementation (2007-2009)	66	17.00			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	215	32.02	+41.9%	-.73	.54
Post-Implementation (2007-2009)	305	184.96			
SUSPICIOUS PERSON					
Total Calls					
Pre-Implementation (2004-2006)	94	22.47	**-56.3%**	**5.68**	**.03**
Post-Implementation (2007-2009)	41	6.24			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	98	42.14	+170.4%	-1.10	.39
Post-Implementation (2007-2009)	265	221.57			
SUSPICIOUS VEHICLE					
Total Calls					
Pre-Implementation (2004-2006)	33	9.43	-36.4%	1.69	.23
Post-Implementation (2007-2009)	21	2.83			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	124	22.61	+52.4%	-2.12	.17
Post-Implementation (2007-2009)	189	47.81			
LARCENY					
Total Calls					
Pre-Implementation (2004-2006)	55	9.64	**-43.6%**	**26.84**	**.001**
Post-Implementation (2007-2009)	31	9.70			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	647	299.89	+46.2%	-2.08	.17
Post-Implementation (2007-2009)	946	106.53			
MALICIOUS DAMAGE					
Total Calls					
Pre-Implementation (2004-2006)	37	2.83	-8.1%	.98	.43
Post-Implementation (2007-2009)	34	7.21			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	532	153.00	+3.9%	-.12	.92
Post-Implementation (2007-2009)	553	158.64			

Note: Common criminal activity calls are Priority 2 calls and were within the top third of calls fielded 2004-2009 within the sector. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E21. Sector 3 Call Responses and Time Averages by Common Criminal Activity Calls (n=30)

	Mean	Standard Deviation	Percent Change	T-test	P value
SUSPICIOUS ACTIVITY					
Total Calls					
Pre-Implementation (2004-2006)	56	5.48	-12.5%	3.51	.07
Post-Implementation (2007-2009)	49	4.00			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	608	559.79	-49.0%	1.17	.36
Post-Implementation (2007-2009)	310	124.54			
SUSPICIOUS PERSON					
Total Calls					
Pre-Implementation (2004-2006)	48	5.10	**-41.7%**	**18.19**	**.003**
Post-Implementation (2007-2009)	28	4.90			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	145	57.97	+35.9%	-2.64	.12
Post-Implementation (2007-2009)	197	29.56			
SUSPICIOUS VEHICLE					
Total Calls					
Pre-Implementation (2004-2006)	22	2.00	-22.7%	1.53	.27
Post-Implementation (2007-2009)	17	4.00			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	1484	2284.72	-78.0%	.85	.48
Post-Implementation (2007-2009)	326	82.66			
LARCENY					
Total Calls					
Pre-Implementation (2004-2006)	28	9.00	-35.7	3.67	.07
Post-Implementation (2007-2009)	18	4.12			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	926	167.39	-18.0%	.75	.53
Post-Implementation (2007-2009)	759	225.46			
MALICIOUS DAMAGE					
Total Calls					
Pre-Implementation (2004-2006)	40	6.63	-32.5%	3.65	.07
Post-Implementation (2007-2009)	27	6.78			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	589	96.89	+23.1%	-1.54	.26
Post-Implementation (2007-2009)	725	148.86			

Note: Common criminal activity calls are Priority 2 calls and were within the top third of calls fielded 2004-2009 within the sector. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E22. Sector 4 Call Responses and Time Averages by Common Criminal Activity Calls (n=30)

	Mean	Standard Deviation	Percent Change	T-test	P value
SUSPICIOUS ACTIVITY					
Total Calls					
Pre-Implementation (2004-2006)	72	16.49	+6.9%	-.38	.74
Post-Implementation (2007-2009)	77	11.00			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	253	83.14	+30.8%	-1.44	.29
Post-Implementation (2007-2009)	331	62.52			
SUSPICIOUS PERSON					
Total Calls					
Pre-Implementation (2004-2006)	77	23.07	**-51.9%**	**5.24**	**.03**
Post-Implementation (2007-2009)	37	9.85			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	136	59.14	+38.2%	-1.54	.26
Post-Implementation (2007-2009)	188	22.72			
SUSPICIOUS VEHICLE					
Total Calls					
Pre-Implementation (2004-2006)	27	3.05	-18.5%	1.63	.25
Post-Implementation (2007-2009)	22	5.03			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	182	15.37	+79.1%	-2.54	.13
Post-Implementation (2007-2009)	326	83.34			
LARCENY					
Total Calls					
Pre-Implementation (2004-2006)	43	11.66	-30.2%	3.21	.08
Post-Implementation (2007-2009)	30	7.35			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	847	200.15	-17.0%	.87	.48
Post-Implementation (2007-2009)	703	104.84			
MALICIOUS DAMAGE					
Total Calls					
Pre-Implementation (2004-2006)	47	6.78	-25.5%	3.42	.08
Post-Implementation (2007-2009)	35	10.05			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	591	7.75	+18.6%	-1.37	.30
Post-Implementation (2007-2009)	701	141.84			

Note: Common criminal activity calls are Priority 2 calls and were within the top third of calls fielded 2004-2009 within the sector. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E23. Sector 5 Call Responses and Time Averages by Common Criminal Activity Calls (n=30)

	Mean	Standard Deviation	Percent Change	T-test	P value
SUSPICIOUS ACTIVITY					
Total Calls					
Pre-Implementation (2004-2006)	52	7.81	-19.2%	.90	.46
Post-Implementation (2007-2009)	42	10.95			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	702	825.75	-31.3%	-.43	.75
Post-Implementation (2007-2009)	482	358.31			
SUSPICIOUS PERSON					
Total Calls					
Pre-Implementation (2004-2006)	39	4.90	**-38.5%**	**5.00**	**.04**
Post-Implementation (2007-2009)	24	.57			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	758	26.53	-71.8%	-2.57	.12
Post-Implementation (2007-2009)	214	15.10			
SUSPICIOUS VEHICLE					
Total Calls					
Pre-Implementation (2004-2006)	23	5.03	-8.7%	.66	.58
Post-Implementation (2007-2009)	21	2.00			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	1389	2059.79	-79.0%	.89	.47
Post-Implementation (2007-2009)	291	147.31			
LARCENY					
Total Calls					
Pre-Implementation (2004-2006)	31	4.12	-29.0%	1.32	.32
Post-Implementation (2007-2009)	22	8.37			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	715	163.12	-3.1%	.13	.91
Post-Implementation (2007-2009)	693	190.59			
MALICIOUS DAMAGE					
Total Calls					
Pre-Implementation (2004-2006)	26	6.63	+11.5%	-.64	.59
Post-Implementation (2007-2009)	29	13.89			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	767	94.00	**-37.9%**	**12.40**	**.01**
Post-Implementation (2007-2009)	476	95.02			

Note: Common criminal activity calls are Priority 2 calls and were within the top third of calls fielded 2004-2009 within the sector. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E24. Sector 6 Call Responses and Time Averages by Common Criminal Activity Calls (n=30)

	Mean	Standard Deviation	Percent Change	T-test	P value
SUSPICIOUS ACTIVITY					
Total Calls					
Pre-Implementation (2004-2006)	16	4.00	0.0%	-.09	.94
Post-Implementation (2007-2009)	16	2.89			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	317	104.01	+6.3%	-.26	.82
Post-Implementation (2007-2009)	337	43.51			
SUSPICIOUS PERSON					
Total Calls					
Pre-Implementation (2004-2006)	9	5.20	**-22.2%**	**.87**	**.48**
Post-Implementation (2007-2009)	7	2.65			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	197	109.18	-4.1%	.19	.87
Post-Implementation (2007-2009)	189	49.52			
SUSPICIOUS VEHICLE					
Total Calls					
Pre-Implementation (2004-2006)	10	3.61	0.0%	.28	.81
Post-Implementation (2007-2009)	10	3.05			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	386	106.15	-49.0%	1.60	.25
Post-Implementation (2007-2009)	197	101.66			
LARCENY					
Total Calls					
Pre-Implementation (2004-2006)	4	.57	-25.0%	1.00	.42
Post-Implementation (2007-2009)	3	2.08			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	904	118.65	+104.3%	-.87	.48
Post-Implementation (2007-2009)	1847	1754.86			
MALICIOUS DAMAGE					
Total Calls					
Pre-Implementation (2004-2006)	8	.57	-25.0%	.57	.63
Post-Implementation (2007-2009)	6	3.51			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	712	247.05	-11.2%	.29	.80
Post-Implementation (2007-2009)	632	512.48			

Note: Common criminal activity calls are Priority 2 calls and were within the top third of calls fielded 2004-2009 within the sector. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E25. Sector 7 Call Responses and Time Averages by Common Criminal Activity Calls (n=30)

	Mean	Standard Deviation	Percent Change	T-test	P value
SUSPICIOUS ACTIVITY					
Total Calls					
Pre-Implementation (2004-2006)	24	2.00	-8.3%	1.00	.42
Post-Implementation (2007-2009)	22	3.51			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	271	155.00	+27.3%	-.84	.49
Post-Implementation (2007-2009)	345	69.08			
SUSPICIOUS PERSON					
Total Calls					
Pre-Implementation (2004-2006)	15	3.61	-6.7%	.47	.69
Post-Implementation (2007-2009)	14	2.08			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	113	43.59	**+57.5%**	**-4.77**	**.04**
Post-Implementation (2007-2009)	178	25.53			
SUSPICIOUS VEHICLE					
Total Calls					
Pre-Implementation (2004-2006)	18	3.61	-22.2%	.79	.51
Post-Implementation (2007-2009)	14	4.73			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	182	35.64	+43.4%	-1.97	.19
Post-Implementation (2007-2009)	261	83.01			
LARCENY					
Total Calls					
Pre-Implementation (2004-2006)	5	1.73	-40.0%	1.15	.37
Post-Implementation (2007-2009)	3	2.08			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	1282	860.88	-52.2%	1.92	.19
Post-Implementation (2007-2009)	613	263.57			
MALICIOUS DAMAGE					
Total Calls					
Pre-Implementation (2004-2006)	12	5.66	-50.0%	2.00	.18
Post-Implementation (2007-2009)	6	4.16			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	739	213.57	-29.6%	1.29	.33
Post-Implementation (2007-2009)	520	269.88			

Note: Common criminal activity calls are Priority 2 calls and were within the top third of calls fielded 2004-2009 within the sector. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E26. Sector 8 Call Responses and Time Averages by Common Criminal Activity Calls (n=30)

	Mean	Standard Deviation	Percent Change	T-test	P value
SUSPICIOUS ACTIVITY					
Total Calls					
Pre-Implementation (2004-2006)	20	8.32	+10.0%	-.30	.79
Post-Implementation (2007-2009)	22	.57			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	349	54.22	+25.8%	-.60	.61
Post-Implementation (2007-2009)	439	224.56			
SUSPICIOUS PERSON					
Total Calls					
Pre-Implementation (2004-2006)	14	1.73	-35.7%	3.27	.08
Post-Implementation (2007-2009)	9	1.00			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	161	71.46	+68.3%	-3.08	.09
Post-Implementation (2007-2009)	271	122.76			
SUSPICIOUS VEHICLE					
Total Calls					
Pre-Implementation (2004-2006)	21	8.66	-33.3%	1.41	.29
Post-Implementation (2007-2009)	14	1.15			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	256	77.51	+28.1%	-2.17	.16
Post-Implementation (2007-2009)	328	130.15			
LARCENY					
Total Calls					
Pre-Implementation (2004-2006)	12	5.86	-41.7%	1.32	.32
Post-Implementation (2007-2009)	7	1.53			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	791	385.34	-19.8%	.71	.55
Post-Implementation (2007-2009)	634	70.89			
MALICIOUS DAMAGE					
Total Calls					
Pre-Implementation (2004-2006)	11	3.61	-45.5%	1.24	.34
Post-Implementation (2007-2009)	6	3.21			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	710	216.57	+31.3%	-2.28	.15
Post-Implementation (2007-2009)	932	254.43			

Note: Common criminal activity calls are Priority 2 calls and were within the top third of calls fielded 2004-2009 within the sector. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Table E27. Sector 9 Call Responses and Time Averages by Common Criminal Activity Calls (n=30)

	Mean	Standard Deviation	Percent Change	T-test	P value
SUSPICIOUS ACTIVITY					
Total Calls					
Pre-Implementation (2004-2006)	34	5.86	+14.7%	-.96	.44
Post-Implementation (2007-2009)	39	4.04			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	1488	1133.87	-46.4%	.61	.60
Post-Implementation (2007-2009)	797	844.90			
SUSPICIOUS PERSON					
Total Calls					
Pre-Implementation (2004-2006)	22	3.21	-31.8%	1.42	.29
Post-Implementation (2007-2009)	15	6.11			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	226	42.51	+1.8%	-.07	.95
Post-Implementation (2007-2009)	230	131.59			
SUSPICIOUS VEHICLE					
Total Calls					
Pre-Implementation (2004-2006)	31	6.81	-16.1%	1.19	.35
Post-Implementation (2007-2009)	26	3.61			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	314	45.31	-4.1%	.27	.82
Post-Implementation (2007-2009)	301	128.02			
LARCENY					
Total Calls					
Pre-Implementation (2004-2006)	7	4.36	0.0%	0.0	1.00
Post-Implementation (2007-2009)	7	2.65			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	722	154.15	+90.2%	-1.23	.34
Post-Implementation (2007-2009)	1373	764.76			
MALICIOUS DAMAGE					
Total Calls					
Pre-Implementation (2004-2006)	19	5.69	**-57.9%**	**7.11**	**.02**
Post-Implementation (2007-2009)	8	3.21			
Average Response Time (in Seconds)					
Pre-Implementation (2004-2006)	726	142.52	-55.0%	3.43	.07
Post-Implementation (2007-2009)	327	66.26			

Note: Common criminal activity calls are Priority 2 calls and were within the top third of calls fielded 2004-2009 within the sector. T-test adjusted for autocorrelated or dependent samples. Bolded p-values identify statistically dependable differences between groups. Source: BPD Computer Aided Dispatch Data 2004-2009

Appendix F. Random Effects Pooled Time Series Regression Models

To specify the regression models, two dummy variables were used. *Post-implementation* is defined as the years 2007 through 2009 and is compared against a reference category of years 2004 through 2006. *Reduced coverage* identifies patrol sectors 1, 7, 8, and 9 who had experienced past coverage issues prior to broadband implementation. These sectors are compared against patrol sectors 2, 3, 4, 5, and 6 who experienced optimal coverage prior to implementation. *Response times* and *total calls* were standardized into z-scores. Random effect models were specified following Hausman specification test results. Robust standard errors were estimated to minimize disturbances in variance structures. Model 1 does not include a set of dummy variables for yearly observations. Model 2 integrates five dummy variables (not shown) for each year of observation, with the year 2004 used as the reference category.

Table F1. Random Effects Pooled Time Series Regression of Standardized Response Times by Implementation with Robust Standard Errors (n = 54)

	Model 1	Model 2
	b (RSE)	b (RSE)
Post-Implementation	-.77 (.28)**	-.63 (.32)*
Total Calls (z)	-.03 (.16)	-.11 (.19)
Reduced Coverage	-.51 (.48)	-.45 (.46)
Post-Implementation*Reduced Coverage	.20 (.48)	.20 (.50)
Constant	.85 (.39)*	.51 (.39)
Multiplier Test	10.84***	21.67***
Model Chi-Square (Wald)	10.42	48.23
df	4	8
R-square	.25	.49
Sigma u	.48	.49
Sigma e	.59	.52
Theta	.55	.60
Rho	.39	.47

*p < .05, **p <.01, ***p < .001. Note: Model 2 includes a series of dummy variables (not shown) for years of observation in this research. Source: BPD Computer Aided Dispatch Data 2004-2009.

Appendix G. Quantitative Metrics Data Request

Brookline Mobile Broadband Evaluation
Data Needs and Request

The following data is requested for years 2003-2010 and will be used to provide background information on department and compare to national averages. Note variation in demographics by year.

Departmental demographics
- Number of officers
- Number of civilians
- Organizational rank structure
- Gender
- Race
- Educational background
- Military service
- Salaries (averages by rank at minimum).

Executive, departmental, and operational budgets

Number of Memorandums of Understanding (MOUs) created
- Associated with the creation, implementation, and continued use of broadband network.
- Associated with other networks that can be accessed by the BPD network.
- Associated with applications supported by network.

Copies of actual Memorandums of Understanding (MOUs) created
- Associated with the creation, implementation, and continued use of broadband network.
- Associated with other networks that can be accessed by the BPD network.
- Associated with applications supported by network.

The following data is requested for years 2003-2009 *total departmental and per patrol sector*:

CAD response times

Number of arrests

Number of citations

Daily activity time

Disciplinary infractions
Officer injuries

Reported crime

From the Interact/PocketCop Application….

Number of criminal history checks through NCIC and state of MA

Number of license plate and vehicle registration inquiries through NCIC and state of MA

Number of warrant checks through NCIC and state of MA

Number of Boston Regional Intelligence Center product disseminations

Number of CompStat report disseminations

Number of bulletin disseminations

Number of roll-call emails disseminated

Number of training emails disseminated

Number of emergency management emails disseminated

Use of mapping component

Use of instant messaging component

From the Larimore/CopLink Application…

Number of reports generated

Number of CAD calls generated

Number of field interrogation reports generated

Fleet maintenance and equipment

STAR reports

From the PSNet Application…

Number of mug shots shared/requested

Number of arrest histories shared/requested

Number of videos shared/requested

Number of finger/palm prints shared/requested