December 2001

A Flak Jacket, a Weapon, and a Laptop: Going Wireless and Paperless Within a Major Metropolitan Police Department

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A FLAK JACKET, A WEAPON, AND A LAPTOP: GOING WIRELESS AND PAPERLESS WITHIN A MAJOR METROPOLITAN POLICE DEPARTMENT

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Abstract

In February 2001, a major metropolitan police department in the southeast began the rollout of a "mobile" information system that will eventually enable all information relating to incident reports, arrests, and investigations to be collected, distributed, and managed in a paperless, wireless environment. The system, dubbed Mobile Knowledge Policing System (MKPS), began as a "grass roots" project within the police department to reduce paperwork, increase data accuracy, share knowledge and information, and promote a problem solving analytical framework. The system has been under development for five years, from concept to initial implementation, and is now in the initial phase of implementation. The development strategies and approaches used to develop this system, the technologies employed, and, most importantly, the challenges faced in merging wireless, wired, database, and applications technologies while satisfying the user requirements of the police department are detailed in the following report. This case analysis illustrates a number of key issues that must be addressed within the development and implementation of a complex information system, particularly where immature technologies comprise an important piece of the application. As such, this case will be of considerable interest to practitioners and academicians alike. The lessons that can be learned are many and varied.

Keywords: Wireless, mobile computing, criminal justice

Introduction

The purpose of this paper is to report on "best practice" in the development and implementation of emerging mobile commerce applications. In particular, this paper describes the integration of wireless and traditional technologies into a major systems development project aimed at meeting the needs of a mobile workforce in the public law enforcement sector. This study is distinctly interpretive in nature, seeking to identify the processes through which a complex mobile commerce application was developed and implemented, rather than to test or build theory. A qualitative approach, based on interviews with key participants in a major metropolitan police department, is used to identify the major technical and organizational issues encountered in the process of developing and implementing a mobile policing system. Although the results of this single case study are not statistically generalizable, the richness of the contextual data gathered contributes to our understanding of the technological and organizational problems and challenges faced by IS managers and other practitioners as they attempt to roll out mobile commerce systems.

Previous Research

Wireless technologies are poised to revolutionize the business world in much the same way that the Internet and e-commerce have done over the last several years. A recent study by the Gartner Group estimates that the number of mobile devices in use globally will reach the 1 billion mark within the next few years (ClickServices.com, 2000). Industry analysts predict that devices utilizing the wireless application protocol (WAP) will account for as much as 40% of consumer-to-business e-commerce by 2004 (Haskin, 1999), with the mobile commerce market exploding to $230 billion/year by 2006 (Cellular Telecommunications and Internet

Association, January 01, 2001). By 2007, it is estimated that mobile data will have a U.S. penetration rate of nearly 60% (Cellular Telecommunications and Internet Association, January 29, 2001). While wireless and mobile networks are growing exponentially, the industry is still so new that business applications resulting from this growth have not been extensively reported in the literature. The current study addresses this gap by reporting on the development and early deployment of a complex wireless application and its integration with traditional IS technologies.

Varshney, Vetter and Kolakata (2000) proposed a theoretical model for mobile commerce research that can be used to guide this study. This two-dimensional framework identifies important issues from both the user and developer-provider perspective. The user plane includes four levels: (1) applications (which may be new or arise from modifications to existing e-commerce applications); (2) the user infrastructure (i.e., capabilities of the mobile devices); (3) the network infrastructure (i.e., network resources and capabilities); and (4) wireless middleware (important in providing a consistent and easy-to-use interface). Because our study focuses on the processes and practices involved in developing and implementing a mobile commerce application rather than on the user per se, the more important issues for this study are those that lie along the developer-provider plane of the framework. These are:

(1) ***network processing and storage requirements***, including an understanding of bandwidth and delay requirements, mobile device capabilities and limitations, support for disconnected operations, multicasting for group communications, and use of asymmetric processing and storage;

(2) ***application development***, including the use of existing software development tools, consideration for the maximum number of simultaneous users, restrictions on the size of application code, security issues, and user support;

(3) ***compatibility and interoperability***, including independence from underlying wireless access technologies and device functionalities, IP interoperability, and compatibility with WAP; and

(4) ***desirable features***, including support of intermittent connectivity, adaptivity to user and network environments, atomic transactions, ability to upgrade easily, and support for invocation of user-specified features.

In this paper, a qualitative, case study approach was used to "discover" the extent to which the key issues and problems identified in the above framework were encountered and dealt with in the development of a mobile commerce application. The qualitative approach is appropriate as a discovery methodology. It supports the development of an understanding of relationships and issues not previously considered (Eisenhardt, 1989; Orlikowski, 1993), and allows the researcher to delve deeply into issues that arise from the organizational context. Case studies can be used to build theory (Eisenhardt, 1989), or for theory testing (Lee, 1989), as well as to describe practice. While case studies have been used successfully in the broader IS and social sciences literature for all of these purposes [Irani and Love (2001), Macpherson et al. (2000), Williams and Wilson (1997), Burns et al. (1991), to mention just a few], we are not aware of published case studies that focus specifically on identifying and understanding the development processes and challenges associated with mobile commerce applications. To the extent that this study describes practice, it will certainly be of interest not only to law enforcement agencies but also for any organization that needs to exchange real-time information with a large mobile work force in the field. To the extent that it lays further groundwork for future theory development, it will also be of interest to IS researchers.

Methodology

Professional contacts provide researchers knowledge of organizations implementing advanced information systems. However, it is often difficult to gain access to such organizations or gain permission to share findings gleaned from analysis and review. Initial conversations with the chief information officer of a major metropolitan police department suggested a unique, leading edge environment worthy of careful investigation. Subsequent contact with the CIO provided access to the environment and facilitated data collection for this case. Though a single case, multiple units of analysis were employed including interviews, document collection, and observation. This is accepted case research practice (Yin, 1994) and provides a rich set of data for further analysis and synthesis.

Multiple visits were made to the organization to interview key project participants and observe initial systems rollout. Participants were purposively chosen to span diverse functional and technical areas of expertise. Semi-structured interviews of approximately one hour each were conducted with the following participants:

- chief information officer
- technical project manger
- functional project manager
- network manager
- wireless technical engineer
- applications developers
- database manager
- application support personnel
- systems users.

The interview protocol included questions drawn from the Varshney et al. (2000) mobile commerce research framework, the information systems implementation literature (Burns et al., 1991), discussions and interactions with professional colleagues, and professional work experiences of the authors. A combination of closed-ended and open-ended questions was employed to provide both objective and subjective input for analysis and interpretation. To improve reliability, all interviews were conducted with both researchers present, and both taking notes independently. These notes were later compared and synthesized to arrive at a clear and consistent interpretation of the verbal data. The remainder of this paper is devoted to describing the organizational context, identifying the major features of the application under study, and reporting relevant findings.

Case Background

The Major Metropolitan Police Department (MMPD) is the principal local law enforcement entity for a major city in the southeastern U.S. The MMPD employs approximately 2,200 people, including police officers and support staff. Of the 1,800+ police officers, most are assigned to the field in one of twelve police districts, the remaining are assigned to support and administrative positions at police headquarters or other offices. Support staff within the MMPD are assigned to a variety of clerical and administrative support functions related to but not directly involved in the practice of law enforcement activities. The MMPD is headquartered in a 4-year old, state-of-the-art building in the downtown area of the city. This facility was designed and constructed to support the computing and data communications needs of the MMPD. For local area network (LAN) connectivity, CAT5 is used within the building with fiber extending to district offices (up to 18 miles from the headquarters building via a SONET ring). Within the headquarters building and at district offices, CAT5 cable drops are available every ten feet each with quad jacks supporting two data connections and two voice connections. This wiring infrastructure provides maximum data connectivity and work area layout flexibility.

The information system requirements of the MMPD are many and varied. Major systems include those that support administrative and personnel functions, dispatching and 911 emergency services, and incident reporting/case management/arrest/investigative activities. Administrative and personnel functions (HR, payroll, etc.) are supported by an IBM mainframe that interfaces with other information systems managed by the city. This mainframe (an IBM 390) also hosts the dispatch and 911 emergency services system. The dispatch/911 application was developed internally by the MMPD 15+ years ago primarily in COBOL. The system is scheduled for replacement within the next 18 months. MMPD opted to evaluate and select a packaged solution for this requirement. The purchased system will provide a total hardware and software solution for dispatch and 911 services. The purchased system is a "best of breed" application that does not conform to current MMPD business processes. MMPD decision makers involved in the evaluation and purchase of this system (including the Chief of Police) have opted to change the MMPD business practices to fit the new software, rather than modify the package. MMPD recognizes the benefits of adopting best practices to improve not only their systems but also their processes.

The system of primary interest in this case analysis is the system that supports the information requirements encountered in the daily activity of law enforcement. This mission critical system includes, but is not limited, to incident reporting, case management, arrests, and investigation. A new system designed and developed to support these activities, dubbed Mobile Knowledge Policing System (MKPS), is currently being implemented within the MMPD. The remainder of this paper focuses on the issues faced in the development and implementation of the MKPS application.

The MKPS Application

MKPS supports police officers and investigators in creating and managing the police reports that document their work. When a police officer responds to an incident in the field, an incident report is filed. The portion of MKPS currently being implemented at the MMPD supports the electronic capture, storage, and retrieval of these incident reports and is referred to as the Incident Reporting System. Additional functionality within MKPS is being developed to support case management activities, arrests, and investigative activities. This additional functionality will be rolled out in phases over the next 18-24 months.

The Incident Reporting sub-system captures all essential information needed to complete and file an initial police report. This information is critical to subsequent arrest and investigative activities. Accurate, complete, timely information is key the successful resolution of an incident. An example of an Incident Report from the MKPS is available upon request. Context-sensitive, field level intelligence and workflow routing capabilities are built into this application. MKPS runs in a three-tiered client/server environment. The client runs on laptops issued to police officers in the field in what is essentially a browser window. Officers use the client software to create and/or supplement police reports ***while they are on the scene*** (rather than waiting until they return to their district office or police headquarters to complete their reports). The ability to capture the data at the source (without leaving the scene of the incident) is considered a significant contribution of the MKPS system. One of the systems

original goals was to push better investigation at the scene. Confidence in the benefits of this system is quite strong. So strong, in fact, that when an officer graduates from the police academy, he/she is now issued three items: a flak jacket, a weapon, and a laptop.

When an officer completes an incident report, the information is uploaded to servers at headquarters via a wireless link. Every vehicle (over 600) is equipped with a trunk-mounted mobile modem to facilitate electronic computing. At headquarters (HQ), the information is received and initially processed by message switching servers that handle the mobile to land interface, and then stored on Sun Solaris parallel servers in an Oracle database. This information is then immediately available to other authorized users of MKPS. Each time a report is filed, its contents cannot be modified. When changes/additions to an existing report are needed, a new report is appended and the previous version remains intact. Thus ensuring that MMPD never loses a version of the incident report – an important consideration for data integrity.

The phased rollout of the Incident Reporting system is being conducted in a six week period – two of the twelve police districts will "go live" each week. When the rollout is complete, there will be 150+ officers using this technology in the field concurrently. The implementation does not facilitate the conversion of prior incident data. The system will collect new data and older data will be maintained and processed by the prior (largely manual) system. Initially duplicate entry of new incident reports will be done to provide backup in the event of a major latent bug in the system.

The MMPD used a very proactive support strategy to assist officers during the implementation of MKPS. As of the go live date for the first district, a technical team of twelve full-time and six split-time people supported officers in the field. If an officer has questions that cannot be answered remotely or has problems with the system while at the scene, support personnel go to the field to assist. Some support personnel are stationed at HQ and others at district offices. Still other support personnel are mobile and thus able to respond quickly to an officer's questions at the incident site.

The MKPS Infrastructure

The infrastructure needed for MKPS was put in place prior to system roll out. This infrastructure included 1,500 laptops in the field, 100+ laptops at police headquarters for staff and support personnel, and some 500+ desktop computers. Currently, over 600 police vehicles are equipped with trunk-mounted modems that support wireless data communication to and from headquarters. Necessary servers and data switches were installed to support the implementation along with the required conventional wired connectivity. MMPD has worked with a local wireless data provider to achieve a 99.9% coverage rate in the community. Approximately 53 towers are used to enable communication via TCP-based cellular digital packet data (CDPD). Although these towers are shared with cellular phone service providers, the frequencies over which the MMPD transmits data do not compete with those used by cellular phone customers. The system provides multiple channels per tower and a 19.2 K shared (TDM) pipe. System requirements call for 4 to 8K packets, however, the average packet size for the MKPS application is 12K, with a maximum of about 20K.

Security was a major concern for the wireless implementation. For MMPD to operate in the mobile data environment the connections had to be reliable and secure. Almost two years were required to resolve security and authentication issues. The solution included user authentication with two levels of encryption. Two independent vendors ensure an end-to-end secure connection. The commercial wireless provider encrypts data across its channels, and an additional layer of priority encryption and compression is performed by a leading software-based security system running on MMPD servers. The system manages approximately one million inbound mobile requests per month, and supports 300+ simultaneous users. These numbers are expected to increase significantly as implementation continues with MKPS. The system has thus far proven to be highly reliable, experiencing fewer problems than the internal LAN within the MMPD.

The Development Process

The development process for MKPS has been lengthy – running five years from concept to initial implementation of the Incident Reporting sub-system. Initially, one year was spent determining the system requirements. System developers and consultants worked with a functional area expert from within the MMPD to map the required processes to a design specification. The functional area expert had more than 20 years of MMPD experience, most recently as a management analyst within the Research and Analysis group.

Despite early success in the requirements analysis and process mapping phases of development, the project soon suffered a variety of problems. These problems were primarily attributed to the creation of inadequate design specifications, failure to control project scope, and lack of a strong technical project leader. In addition, a number of organizational changes were taking place, including the retirement, in 1999, of the Chief of Police who initially supported MKPS. The new Chief's perspective and expectations for the MKPS were different from the original conceptualization. The original Chief had a broad, inclusive vision for the system. As development of the system progressed, the project experienced "scope creep." The new Chief had a more focused vision with clearly defined deliverables.

In 1998, a new Director of Information Technology was hired, and the project was "re-scoped" with clearly identified project phases. An experienced technical project manager was brought on board to work with and oversee the development team. A formal development plan was established with a heavy emphasis on system validation testing. The design specs were revised and new requirements defined. A great deal of progress on the MKPS application soon followed.

Design specifications were developed using Oracle Designer/Developer 2000. Designer was also used to generate web-based applications that run on the client. The Incident Reporting sub-system is comprised of approximately 250 tables. JavaScript and HTML were used for the majority of the client application on the laptops, with PL/SQL running on the Oracle server. MKPS is essentially an "open system" with all authorized users having query access to the database. Only limited role-based access is currently defined.

The total development team consisted of nine people – including applications developers, database administrators, systems administrators, project managers, and network/mobile communications experts. Initial coding for the Incident Reporting sub-system was finished in April 2000, and system validation testing was conducted in July and August. As a result of these tests, new functionality was added and a long test/fix cycle ensued. The technical project manager for the project identified the biggest development challenges as being those related to controlling scope changes, not enough up front documentation, and limitations imposed by the "newness" of the tools and "immature" technologies. The most notable restriction was the limited bandwidth available in the mobile environment (19K, effective 10K). Bandwidth issues led to changes in the systems architecture – moving JavaScript on the client and redesigning transaction confirmation screens (referred to as "Success" screens) to be brief. Other technical issues included assuring the servers would be Y2K compliant, configuring a fully redundant production environment, providing adequate security/authentication for wireless transmission of data, and dealing with bugs from the applications development vendor. Ongoing issues deal with configuration management, defect tracking, quality assurance, test planning, etc.

Future Enhancements

The next piece of MKPS will be the Case Management sub-system. This sub-system provides the capabilities to track a case from initial incident all the way through the arrest and investigation procedures. Enhancements are being planned to integrate into MKPS access to other local, state, and federal law enforcement systems. (Current access is provided to these resources but is independent of internal MMPD processes.) Through such links, police officers in the field will be able to tap into databases and obtain vital information. Software will also be developed to interface with the Universal Crime Reporting (UCR) system and the National Incident-Based Reporting System (NIBRS). The ability to generate these reports automatically from information within MKPS will be very beneficial. Other future enhancements may extend the system interfaces to include hospitals and other emergency services. Additionally, geographic information system (GIS) and global positioning system (GPS) components will be integrated into MKPS to provide street file overlays on the officer's laptop.

Conclusions and Implications

The Mobile Knowledge Policing System is designed as the wireless information platform of the future. The Major Metropolitan Police Department has invested significant time and resources to achieve a paperless, wireless environment. Key issues that were encountered and resolved in the implementation of this system include several items common to most information systems development projects, such as:

- overcoming initial project stagnation
- overcoming changes in leadership at all levels during the project
- managing project scope
- integrating multiple technologies, systems and applications.

More noteworthy, however, MMPD provides an illustration of leading edge wireless development of a mission critical application. Four key wireless issues were also encountered and resolved:

- developing an effective and seamless wireless to wired network interface
- ensuring a secure mobile data transmission environment supporting a highly sensitive data flow
- overcoming severe mobile bandwidth limitations in the development and delivery of a complex application
- integrating multiple technologies, including wireless, wired, database and web-delivery of applications.

Though not perfect, MMPD represents a current "best practice" case in complex, integrated, wireless systems development. Lessons learned from this experience have broad implications across a range of industry settings. Certainly, MKPS is a model for other law enforcement environments. The system is also applicable in commercial environments, i.e. logistics/distribution, insurance claims adjusting, dispatching of service/support personnel. Any organization with a mobile workforce that needs secure mobile connectivity could benefit from lessons learned at MMPD.

Development of the system continues. As additional functionality is added, network load increases. Load balancing and response time become critical concerns. There are additional challenges to be faced and resolved. Continuing study of the evolving development will provide additional insights into wireless applications development and delivery.

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NOTE: The authors would like to thank the anonymous reviewers of this paper for their insightful and helpful comments .