NOVEMBER 2004

From E-Government to M-Government? Emerging Practices in the Use of Mobile Technology by State Governments

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With the assistance of graduate students
of the Bush School M-Government Capstone
Project Teams

IBM Center for
The Business of Government

E-Government Series

E-GOVERNMENT SERIES

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November 2004

IBM Center for
The Business of Government

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FOREWORD

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On behalf of the IBM Center for The Business of Government, we are pleased to present this report, "From E-Government to M-Government? Emerging Practices in the Use of Mobile Technology by State Governments," by M. Jae Moon.

This report marks the Center's 25th report in its E-Government series (a full listing of previous reports is available in the back of this report). Over the last six years, the Center has examined government's swift movement to using technology to better deliver services to citizens, businesses, and government employees. Previous Center studies have examined such topics as federal intranet sites, leveraging technology at the Department of State, Internet voting, e-procurement, e-commerce, e-learning, digitally integrating the government's supply chain, using technology to increase citizen participation, e-reporting, the challenge of electronic signatures, measuring the performance of e-government, and privacy strategies for electronic government.

This report by Professor Moon adds to our expanding knowledge base and understanding of e-government by focusing on the potential of m-government (the use of mobile technology) to improve and enhance government services. Professor Moon broadly defines m-government as "government's efforts to provide information and services to public employees, citizens, businesses, and nonprofit organizations through wireless communication networks and mobile devices such as pagers, PDAs, cellular phones, and their supporting systems."

Through case studies of best practices in m-government and two surveys, Professor Moon demonstrates the potential of m-government to change the way the public sector delivers services. Professor Moon and his team of researchers at Texas A&M University find that mobile technologies can dramatically improve the delivery of emergency and public safety services, such as combating fires and natural disasters and enhancing public safety and homeland security.

We trust that this report will be both informative and useful to all public managers as they continue to explore the use of wireless and mobile technologies to deliver services to the American public.

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EXECUTIVE SUMMARY

This report explores the prospects of mobile government (m-government), an extension of the growing movement toward electronic government (e-government). Specifically, we look at the current status of mobile-technology applications at the state level, reviewing the relevant literature on m-government and some best-practice examples, particularly in the area of emergency management related to natural disasters and public safety.

This report also analyzes the data collected from two m-government surveys conducted to identify the current status of mobile-technology utilization among states as well as among Texas state agencies. The data analysis seeks to understand the extent to which state governments and state agencies use mobile technology to enhance communication within and between government agencies and the public, expand services to constituents, and increase overall efficiency in government performance.

This research is composed of four major parts: (1) Background Information and Issues, (2) Best Practices of M-Government, (3) The State of State M-Government, and (4) Conclusions. The background information reviews some basic literature on both e-government and m-government—information on the evolution of e-government and the emergence of m-government following the rapid development and diffusion of mobile technology. This section also addresses major concerns and challenges that governments face as they pursue m-government initiatives, including security and interoperability.

The case studies of best practices illustrate various applications of mobile technology in the area of emergency management. The selected cases suggest that mobile technology has been particularly useful and widely adopted in emergency management, fostering faster, more dynamic, and more collaborative communications within and among various agencies. In particular, mobile technology has become a critical part of emergency communication systems in the post-9/11 era. The case studies also review how three states (California, Virginia, and New York) have initiated and pursued m-government. After a brief survey of the structure of each state government's information and communication technology (ICT) agencies, m-government initiatives, and related issues, this research outlines a potential strategic plan for future m-government initiatives at the state level and identifies current limitations on their implementation.

The third part analyzes data from two m-government surveys on current m-government at the state and state-agency levels. The first survey was sent to the governments of the 50 states and the District of Columbia to assess their progress in developing enterprise architectures and integrating the use of mobile technology into their daily and emergency operations. Although a low response rate (27.5 percent) limits the generalizability of the conclusions derived from the data, there are still notable findings concerning enterprise architecture, mobile technology, and emergency management. The survey results suggest that enterprise architecture has not been widely adopted and that, unfortunately, existing enterprise architecture does not effectively address mobile technology. However, many states

perceive the benefits of mobile technology—improved efficiency, quality of services, communication, and accessibility—but they also perceive various barriers to its utilization—high costs, a lack of standardization and interoperability, and security concerns. The results also confirm that law enforcement and emergency management are the primary areas where mobile technology is used.

The second survey shows the status of mobile technology in Texas state agencies. The survey instrument, distributed to ICT officials at 186 Texas state agencies, was designed to provide an overview of mobile-technology plans, the utilization of mobile-technology devices, and the agency-wide effects of mobile-technology applications. With a response rate of 50 percent, the survey showed that 72 percent of agencies surveyed currently operate with some type of wireless network, but that 74 percent of them do not have a mobile-technology plan and roughly half do not have plans to develop one. Unfortunately, 51 percent have not seen an increase in their ICT budget in three years. Among Texas state agencies, security concerns were the most frequently cited barrier to mobile-technology adoption. Though state agencies are working toward greater efficiency and increased access for their constituents, they are just beginning to exploit the full capabilities of the available mobile technology.

Based on the best practices of m-government and the analyses of the two survey data, this report presents five conclusions regarding facilitating and improving the implementation of m-government initiatives:

- State governments should develop strategic m-government plans, which include enterprise architecture.
- The strategic m-government plans should include a strong business case.
- Adequate financial resources will be required to implement m-government in the states.
- Strong, sustained political leadership will also be required to implement m-government in the states.
- Implementation of m-government in the states will require intergovernmental, interagency, and intersectoral collaboration.

Mobile Technology: Background Information and Issues

Introduction

With the development of information communication technology (ICT) and the demand for better, more efficient, and more effective government, governments have pursued e-government initiatives to offer more information and online services to citizens, government agencies, businesses, and others.

Scholars and practitioners have recently begun to pay attention to mobile-technology applications in the public sector as a manifestation of e-government. The use of wireless-network technologies and mobile devices (personal digital assistants [PDAs], cell phones, wireless Internet connections, other wireless network systems, and other mobile devices) has spread rapidly. Government agencies use this technology to promote rapid information exchange intra- and inter-governmentally as well as between government and non-governmental entities (citizens, nonprofit organizations, and private businesses). Governments have actively integrated mobile technologies into the delivery of public services, particularly in the area of emergency management. For example, California, Virginia, and New York have launched some m-government initiatives, though their continued prospects remain questionable.

Despite the positive expectations for mobile-technology-driven public services (m-government), some issues, risks, and concerns are causing governments to proceed with caution. The major concerns about e-government—security, interoperability, privacy, and lack of resources—noted by many government agencies and citizens are expressed even more strongly in their attitudes toward adopting mobile technologies in the public sector, if only because wireless networks are more vulnerable and unstable than wired communication systems. The interoperability of these devices across agencies is a particular concern. Also, implementing mobile technologies in any agency is costly, and this financial strain can prove an insuperable obstacle.

This report on the prospects and challenges of m-government at the state level comprises four main parts. The first reviews some relevant literature, explores the scope and nature of mobile technologies, and then examines how the technologies can be applied in the public sector. The second section provides cases that demonstrate advances in m-government. Following this is an examination of how state governments and state agencies view the prospects of m-government. The analysis in this part uses data collected via Internet-based surveys of various states and Texas state agencies. The report

Acknowledgments

This report is written based on two Bush School Capstone Projects that the author worked on with 13 graduate students of the George Bush School of Government and Public Service, Texas A&M University. The following graduate students participated in different parts of the report including survey design, data collection, data analyses, case studies, and writing:

Jeff Benson, Melissa Bradley, Amy Brimer, Todd Bryson, River Burton, Miguel Fernandez, Michelle Garcia, Margarita Hernandez, Kelly Kennedy, Jake Norland, David Olvera, Nicholas Sisonian, and Megan Tapper.

concludes with policy suggestions for the effective implementation of m-government at the state level.

Many governments, realizing the prospects of ICT applications for better governance (Kraemer and Dedrick, 1994; 1997; Moon and Bretschneider, 2002; Peled, 2001), have pursued e-government as one of their primary strategic policy priorities. Beginning in the 1990s, as Internet technology became readily available and its protocols were standardized, governments began to explore the possibilities of disseminating public information, offering public services, and promoting policy and political participation via the World Wide Web. In fact, governments have been interested in ICT applications since the introduction of computer technology, and this interest has increased with the continued development of technologies such as mainframes and personal computers, geographic information systems (GIS), and web technologies. E-government initiatives in the 1990s were distinguishable from earlier applications and management of ICT in the public sector. Previously, governments adopted various types of ICT (such as software, mainframes, and PCs) primarily to enhance managerial efficiency, both intra- and interagency, through the storage, processing, analysis, and retrieval of data and through work automation. After the advent of Internet technology, governments started paying more attention to external applications of ICT: providing information and public services to other public agencies, businesses, and citizens via the web.

Under the Clinton administration's reinventing-government initiative, governments paid more attention to e-government. As Fletcher (2003) pointed out, there was a "symbiotic relationship" between the movements for reinvention and e-government. Other federal initiatives soon followed the National Performance Review in advancing e-government, such as the Electronic Freedom of Information Act (EFIA) of 1996, the Clinger-Cohen Act of 1996, Executive Order 13011, the Government Paperwork Elimination Act of 1998, Presidential Memorandum on Electronic Government of 1999, Electronic Signatures in Global and National Commerce Act of 2000, and the E-Government Act of 2002.

Following the strong lead of the federal government and the continued improvement of ICT, many state and local governments began to implement various e-government initiatives. Legislation in this area has addressed electronic, or digital, signatures; the development of statewide ICT departments, authorities, strategies, task forces, and policy boards; and the legal foundation of e-government (O'Looney, 2002). Despite staffing, technical, and financial limitations, many state (Gant, Gant, and Johnson, 2002) and municipal governments (Moon, 2002; Ho, 2002; Norris and Moon, forthcoming) have continued to pursue e-government initiatives, making significant progress in basic e-government functions since 1999.

For example, the majority of municipal governments currently have their own websites, which they use to provide public information to citizens, and more than half of municipal governments have established intranet systems. Less widespread are efforts to offer online financial and service transactions and to provide more opportunities for online political and policy participation (Norris and Moon, forthcoming). As Ho (2002) noted, e-government has shifted the paradigm of public-service delivery even at the local level, thereby changing the relationship between governments and the public. This reflects a close association between e-government initiatives and various managerial innovations in the private sector.

E-government enjoys great public support. According to a Council for Excellence in Government study (2001), 70 percent of citizens believe that e-government will make government more accountable and will improve government's ability to respond to public emergencies. Recent studies (Moon, 2004; Welch, Hinnant, and Moon, forthcoming) also suggest that e-government enhances public trust in government, probably because it enhances public perceptions of the transparency, accessibility, innovativeness, interactivity, and convenience of public services.

The Diffusion of Mobile Technology and the Emergence of M-Government

Governments, working with active, often-aggressive private partners, have devoted increasing amounts of resources to e-government (online public services, e-procurement, e-budgeting, e-politics, among

others). They perceive e-government to be a compelling mechanism for improving the quality of public services and enhancing the effectiveness of public management. During the early years of e-government adoption, much of the academic research and many of the practical initiatives in this area focused on desktop PCs, web technologies, and network systems. These measures, however, do not effectively address emerging mobile technologies and their potential applications to e-government, the scope and utility of which have become wider and more critical thanks to the unique mobile characteristics of communication and networking devices such as pagers, cellular phones, remote-access laptops, wireless Internet hook-ups, and telematics.

Broadly, m-government is defined as government's efforts to provide information and services to public employees, citizens, businesses, and nonprofit organizations through wireless communication networks and mobile devices such as pagers, PDAs, cellular phones, and their supporting systems. M-government will revolutionize citizen access to digital services and alter the ways that government employees have traditionally performed essential tasks. For example, agency inspectors can use PDAs to submit data to home offices while still in the field. Law enforcement officials can quickly relay information over radio waves to laptops in squad vehicles. Citizens with cell phones can give first responders instant information about traffic accidents. Governments can also provide emergency-related information (about natural disasters, wildfires, homeland security) to citizens.

The increase in the use of mobile technologies is projected to be dramatic. Based on the information from Computer Industry Almanac, Greenspan (2002) projected that about 53 million Americans use wireless access to the Internet through cell phones or PDAs in 2004. In the United States, wireless Internet use is projected to increase from 4.5 percent of Internet users in 2001 to 46.3 percent in 2007, an adoption rate nearly in step with a projected global increase of 40.8 percent during the same period (Greenspan, 2002). Table 1 on page 10 summarizes Internet use in the United States and the world.

At the 2003 Wireless Security Forum for Texas Government, Philip Ruth (2003) commented on the results of a national corporate survey that showed rapid growth in the adoption of mobile technology. Sixty-six percent of corporate respondents stated that they had adopted mobile technology within their businesses and departments, and 57 percent of these respondents had done so in the last two years. As wireless appliances and technologies become more pervasive and as citizens come to demand m-government services via wireless media, government should consider harnessing these technologies to the better delivery of public services.

Some governments have begun exploring the potential utility and feasibility of m-government. Virginia has made its homepage and other public-information dissemination services accessible via mobile devices, including cellular phones, PalmPilots, and pocket PCs having Internet access. Private companies have supported m-government by developing technologies (wireless networks and mobile devices) and technical solutions for various governmental operations.

Because of the unique properties of mobile technologies, governments have considered them a powerful tool for responding to situations that require immediate, coordinated communication and action; examples include street-level functions such as emergency management and law enforcement. After the September 11 tragedy in particular,

Wireless vs. Mobile Technology

Regarding technology, the terms "wireless" and "mobile" are often used interchangeably, but the two are distinguishable in the following way.

Wireless technology: "Wireless technology" is a broader term than "mobile technology" because most wireless devices are mobile, but mobile devices are not necessarily wireless. For example, a desktop PC is not a mobile device, but it can be wirelessly connected to a cable modem or a local area network (LAN) for Internet access.

Mobile technology: Mobile devices are the portable ones that people can carry and use for communication purposes. They include mobile phones, laptop computers, PDAs, pocket personal computers, pagers, wearable computers, and so on. (Chang and Kannan, 2002).

Table 1: Wireless Internet Usage and Projections

	Year-End	2001	2004	2007
USA	Internet users (millions)	149	193	236
	Wireless Internet user share	4.5%	27.9%	46.3%
Worldwide	Internet users (millions)	533	945	1,460
	Wireless Internet user share	16.0%	41.5%	56.8%

Source: Greenspan (2002). Originally adapted from Computer Industry Almanac

governments have paid closer attention to the ways that mobile technologies can help identify and assess high-risk activities, provide remote access to criminal databases and GIS data, and secure wireless communication channels between emergency or law enforcement officers in the field and their supporting officers. Many believe that mobile technologies can enhance the efficiency, effectiveness, responsiveness, and accountability of emergency management (natural disaster management, public safety management) and law enforcement (including homeland security) at the state and local levels. M-government initiatives for emergency management and law enforcement will require a great deal of coordination and communication among interested public actors and citizens. The most common platforms adopted so far provide information and alerts to citizens and public employees, mobile communications, and access to databases; other applications include those that assist workforces in the field. The number of applications will grow as other sectors shift to mobile technologies and as mobile products become more functional and affordable.

Concerns and Issues in M-Government

Citizens are using mobile technologies to communicate with one another and to access information. Therefore, it is critical that government learn from private-sector experiences to better capitalize on the strengths—and minimize the limitations—of mobile technology. Like many innovations, wireless services may present as many challenges as potential solutions. In an analysis titled "M-government: The Convergence of Wireless Technologies and E-government" (NECCC, 2000), the National Electronic Commerce Coordinating Council found three critical issues regarding m-government applications: security and privacy, accessibility, and impacts on public accommodation (for example, decreasing use of public pay phones).

Security and Privacy Issues in M-Government

A Hart/Teeter survey from August 2000 showed that because of security and privacy concerns, Americans favored, by a 2-to-1 margin, the slow implementation of e-government (The Council for Excellence in Government, 2001). Compared to public officials, citizens had more concerns about security and privacy issues and preferred the slower and cautious implementation of e-government (Moon and Welch, forthcoming).

How can governments ensure the security of sensitive data stored in laptop computers and wireless devices? How can governments make wireless communications secure during emergency, law enforcement, or homeland security operations? How can governments promote effective wireless communication between emergency or law enforcement officers in the field and their supporting officers? Wireless communications are very vulnerable to hacking activities and unauthorized access because their signals are transferred over the public airwaves. To cope with these security challenges, governments promoting m-government should formulate a thorough policy for mobile authentication. Following the lead of the federal government, state and local governments continue to take advantage of available public key infrastructure (PKI) and encryption technologies to secure the sensitive information stored in government laptops. As m-government advances, state governments should also address privacy-related issues and promote managerial and technical coordination among various interested actors in emergency management and law enforcement operations.

Because of the enormous size of many agencies and their differing emphases on accessibility, governments have found it difficult to adopt common standards for ICT and information management (Heiman, 2002). A number of states lack security-confidentiality laws or security risk assessments, and this creates holes in the system.

One facet of developing a security policy is to pay attention to the most vulnerable ICT components. Because of its heightened susceptibility to security breaches, mobile technology presents a unique challenge to policy makers and agency directors. There are three areas of security concerns in mobile technology: network infrastructure, software applications, and device problems (Chang and Kannan, 2002). Mobile technologies are more susceptible to security threats because they can be easily stolen and because they currently have weak built-in security measures. Protecting data stored on cellular phones, PDAs, and other handheld devices is a primary concern for government agencies: It is estimated that 85 percent of security breaches are at the device level. These security breaches involve lost devices, password hacking, and weak access control (Change and Kannan, 2002).

Tsai (2003) also addressed various security concerns about mobile technology and wireless networks, particularly regarding the wireless transmission of information. He highlighted three major ways to help ensure a secure mobile-technology network:

- Prevent data stealing during transfers between the network and the mobile device.
- Prevent unauthorized parties from accessing information in the mobile device.
- Ensure that viruses cannot be inflicted on unsecured mobile devices.

Security concerns associated with mobile technology are heightened because of the lack of embedded security controls in the devices themselves. Still, there are ways that agencies can protect themselves from security breaches. Much of the protection must come from responsible behavior by the employee using the technology. Currently, the use of memory cards in mobile technologies shows promise as a potential answer to security concerns. The memory card stores information in the mobile device and blocks interference by holes in the signal security. Data cannot be pulled up on the device without the memory card.

In a report for the National Institute of Standards and Technology (NIST), Karygiannis and Owens (2002) compiled a comprehensive security checklist for wireless network systems. Measures included developing a security policy, ensuring that users of the technology are trained in computer security awareness, performing risk assessments, and developing a physical security-access barrier (such as identification badges and sign-ins).

Interoperability Issues in M-Government

Mobile technologies must not only be secure, but they must be compatible across many platforms. Interoperability, which allows an agency to share information with others, is paramount. The benefits of interoperability include increased effectiveness, efficiency, and responsiveness. The ability of agencies to work together technologically could mean a reduction of redundancy in government. Reducing redundancy, in turn, leads to lower transaction costs (paperwork) and increased participation (Karygiannis and Owens, 2002). There are two types of interoperability (Karygiannis and Owens, 2002):

- Operational—formal and informal networks that collect, develop, and disseminate information. Through this process, agencies can recognize potential problems and choose how to delegate responsibilities.
- Technical—software and hardware compatibility in purchasing, standards, and research.

However, this information sharing creates a new obstacle for e-government: An infrastructure to support effective information sharing has to exist (Lansbergen and Walken, 2001). Other barriers to interoperability include privacy, ambiguity about statutory authority, openness to public scrutiny, trust, lack of experience, hardware/software incompatibility, data-sharing standards, and unawareness of opportunities for sharing (Lansbergen and Walken, 2001). These barriers can be overcome when agencies establish healthy working relationships prior to instituting information sharing, when both parties have common executive leadership, and when both parties agree that adopting information sharing is in their best interest (Lansbergen and Walken, 2001).

Interoperability problems are a by-product of the technological revolution. Agencies will resist change because of the difficulty in harmonizing hardware and software systems across organizational boundaries. However, collaboration is possible, and creating technological programs that can be used across agencies will foster mutual cooperation and enhance the quality of services for constituents.

Summary

Thanks to the rapid development and diffusion of mobile technologies, e-government now includes m-government. Mobile-technology devices like PDAs, mobile phones, and wireless networks have decreased response times for law enforcement and health services. New technology is being adopted in these areas with the aim of improving the quality of services and meeting emerging service needs. Although many government sectors use mobile technology, some major problems regarding security and interoperability remain. These problems can be overcome through technological solutions such as using firewalls and encryption and through tactics such as adopting systems that are more interoperable and collaborative.

The following section reviews some of the best practices of m-government at the local and state levels.

Best Practices of M-Government

Applications of Mobile Technology in the Public Sector

This section explores the wide range of actual or potential applications of mobile technologies in the public sector, particularly in the areas of emergency management, response, preparation, and prevention. As the following examples indicate, local and state governments and agencies around the country have begun to use mobile-technology applications to improve customer service, emergency response, and citizen awareness. The best-practice cases cover multiple mobile-technology applications in two major areas: (1) fire and natural disaster management, and (2) public safety and homeland security.

Emergency Management: Fires and Natural Disasters

As demonstrated during the September 11 tragedies in New York and Washington, D.C., mobile technologies can play a critical role in administering and coordinating complex emergency management and law enforcement efforts in which mobile actors must rely on fast, precise, and safe communication channels. As the examples under "Fire Management" indicate, there have been compelling uses of mobile technologies when many firefighters worked together to battle a large-scale wildfire. In this situation, communications between firefighters and emergency management officers were key to effective and safe operations. In fact, mobile equipment (e.g., iPAQs) combined with GIS and global positioning system (GPS) elements enabled emergency officers to identify the direction of the fire and the location of nearby structures, then transmit the critical information to firefighters on the front lines. The mobile technologies sped up data entry, retrieval, and analysis as well as communication.

In an emergency management system, mobile technology can be used to link field reporting, ambulance tracking, and other communication systems among emergency professionals, police officers, firefighters, and public works departments. For example, the Traffic Management Operations Center in Portland, Oregon, uses GPS and a network system to keep track of all emergency management vehicles.

During natural disasters such as earthquakes, hurricanes, and floods, mobile technologies have been widely used to send alerts to citizens and to strengthen the government's ability to link field officers to the headquarters of emergency agencies. (See examples under "Fire Management" and "Natural Disaster Emergency Management.")

Public Safety Management and Homeland Security

Law enforcement and 911 emergency management are other areas where mobile technologies have been widely used. A recent report on 50 ICT departments that support police, fire, and emergency medical services (EMS) units suggests that public safety departments increasingly use public wireless networks and mobile devices to "enhance productivity in the field, provide rapid connectivity and response in life-or-death situations, and to provide rapid access to information" (Jones, 2003).

M-Government Applications in the Public Sector

Fire Management

Wildfires at Prescott National Forest (Arizona) and Cleveland National Forest (California)
In May 2002, a forest fire began in the vicinity of Prescott's Indian Campground. Using state-of-the-art mapping and planning technologies, the Prescott fire department was able to effectively control the fire. These technologies, aided by a GIS system, enabled the department to have a better view of the affected area and to better assess the extent of damage. In addition, the advanced mapping equipment provided the department with higher-quality images of the affected areas. Officials with the city of Prescott felt that the image-based GIS operations enabled firefighters in the field to effectively handle the wildfire (Anderson, 2003).

In January 2002, California emergency personnel also used mobile technologies in their battle against a 10,000-acre blaze in the Cleveland National Forest. Specifically, the emergency personnel from various agencies (the National Park Service, the U.S. Forest Service, the Bureau of Land Management, and the California Department of Forestry) used mobile devices called iPAQs (Compaq's pocket PCs), which were loaded with communication and GIS software and which facilitated communication among emergency personnel and agency officials (Towns, 2003).

New York City Fire Department (FDNY)
In New York City, the fire department has installed a wireless system that allows, among other things, "mobile access to [the] e-mail system." The system also uses "BlackBerry technology and customized Mail Extension software." This software provides communication between FDNY headquarters and firefighters in the field. This infrastructure is powered by "end-to-end (Triple DES) encryption, FIPS 140-1 certification, and optional support for the S/MIME security standard" (Newcombe, 2003a).

Natural Disaster Emergency Management

Harris County, Texas—Flood-Plain Mapping
Harris County and City of Houston officials are in the process of implementing a system that will estimate flooding "by using light detection and ranging, or LIDAR, [which] is similar to the [radar] used in airplanes." This data could be transmitted over a mobile telecommunication device to emergency personnel in the event of flooding (Peterson, 2003).

Hurricane Data Centers
The monitoring and tracking of hurricanes requires advanced technological equipment and the simultaneous and coordinated efforts of multiple local, state, and federal emergency-response entities. According to the National Oceanic and Atmospheric Administration (NOAA), meteorologists are using geostationary satellites to measure and analyze "the location, size, and intensity of the storm." To effectively monitor and understand the paths of hurricanes, the U.S. Air Force Reserve also assists in the measurement of "wind, temperature, pressure, humidity, and location of the center of the hurricane." Additionally, NOAA reports that some regions are outfitted with radar that monitors the path of the hurricane as it approaches the coast, tracks the storm as it reaches land, and records its final stages after landfall. Research suggests that the primary way to improve this cooperative preparation-and-response effort is through the use in the field of mobile technologies that could upload pertinent data collected by the many entities described here (National Weather Service, 2001).

Fort Worth, Texas
Wireless technology played a major role in the implementation of Tarrant County's hazard plan during and after a tornado hit the area in May 2000. The main forms of communication used during the response to this disaster were pagers and cellular phones. The pagers were used to alert emergency-response personnel as well as government officials to the ongoing events, to provide updates, and to process city executive and staff requests. Cellular phones were used for communications between the Incident Command Post, the Emergency Operation Center, and the emergency responders. The primary limitation of this technology was the occasional loss of cellular service; the use of satellite technology could help alleviate this limitation in the future (Fort Worth, 2003).

Police officers have used wireless networks to access regional and national crime databases from the field. (See examples under "Public Safety Management.") Mobile technologies can also help identify the location of emergency calls and improve communication between the emergency crews of 911 agencies and the medical crews at hospitals.

In the Washington, D.C. area, for example, an intergovernmental partnership called the Capital Wireless Integrated Network (CapWIN) has been proposed to establish an integrated wireless network system for transportation and criminal justice information for Maryland, Virginia, and Washington, D.C. (Gluckman, 2003). This would be the first multistate integrated network for public safety and transportation. The strategic plan has already been developed, and a pilot project has been introduced to check the feasibility of the integrated wireless-network system that serves the Washington metropolitan area. In 2002, this project received a congressional appropriation of $20 million (Gluckman, 2003). As the system is put into place, federal agencies, state agencies, local governments, EMS vehicles, and service patrols will be able to communicate with one another wirelessly, regardless of their geographical or jurisdictional boundaries (Gluckman, 2003).

State and local governments have attempted to collaborate with private wireless-communication service providers, hospitals, police departments, and 911 emergency agencies on wireless communication networks to make public safety and emergency operations more effective. (See examples under "Homeland Security.") To promote effective information sharing and interagency or intergovernmental collaboration, governments have attempted to resolve the fundamental problems of interoperability and security.

Mobile technologies also have been used for homeland-security-related operations. Particularly after the September 11 attacks, governments have paid much more attention to reliable mobile communication and information sharing among agencies of interest. In addition, it has been found that the incompatibility of the walkie-talkies and other communication systems used by the different firehouses in Manhattan contributed to the needless deaths of firefighters in the World Trade Center collapse. The 9/11Commission (2004) found that there was a poor integration of command and communication among members of the Fire Department of New York (FDNY), New York Police Department (NYPD), and New York-New Jersey Port Authority Police Department (PAPD). In particular, communication was one of the major challenges. The commission indicated that cellular phone networks were overwhelmed and did not function well after the South Tower collapsed, but noted that pagers and BlackBerries functioned well, though not many people used them. The report (2004) also pointed out that the NYPD had more effective radio communication systems with robust protocol to secure separate frequencies for emergency communications while the FDNY and PAPD did not have effective wireless communications. The response to the events of 9/11 underlines the significance of secure and interoperable wireless communications among agencies in emergency situations.

Summary

These best-practice cases illustrate the use of a variety of mobile-technology applications in emergency management. In particular, m-government has improved emergency management by allowing faster, more dynamic, and more collaborative communication within and among agencies. Governments will be further pressed to adopt additional and more advanced forms of mobile technologies to improve their public services. The increased use of mobile technology will improve customer service and protection, improve emergency prevention and response efforts, and increase inter- and intra-agency communication.

State M-Government Initiatives

This section examines the efforts toward e-government and m-government at the state level in California, Virginia, and New York. For each case there is a brief review of ICT organization and management, m-government initiatives, and various m-government-related issues.

These three states are leaders in e-government and m-government and have been recognized for their efforts to use ICT in their operations, management, and public services (Gant, Gant, and Johnson, 2002; Emery, 2002; *Government Technology,* 2003).

M-Government Applications in the Public Sector

Public Safety Management

911 Emergency Services—Houston, Texas, and Silver Spring, Maryland

In Houston, Texas, a "911 Emergency Network" is being implemented to retrieve additional caller information during emergency calls. The service is being provided in conjunction with Cingular Wireless. Phase I of the project provides the phone number of the "wireless handset and the location of the cell tower that was carrying the call to the 911 operator." Currently Houston is implementing Phase II, which will provide dispatchers with additional details, including a more specific call location, as well as the nature and urgency of the particular emergency (Newcombe, 2003b).

A similar mobile communications system has been used in Silver Spring, Maryland, for emergency personnel and EMS. This system enables emergency personnel to coordinate efforts and communicate with other personnel in the area. The new mobile system provides "access to critical assessment, triage, and reporting data." This system has improved emergency response and made communications between hospital staffs and emergency responders more efficient and effective (Towns, 2002a).

Sheriff's Office, Harris County, Texas

The Harris County Sheriff's Office has been upgrading its existing mobile communication system, "Cellular Digital Packet Data (CDPD)," with "high-speed CDMA2000 1X." The CDPD system was used to check various types of information (domestic violence records, vehicle information) through laptop computers installed in police cars. With the new system, police officers will have faster connections to various criminal databases and "to the sheriff's network to file automated accident reports and issue citations in real time." "One example of the immediate benefits realized by this technology involves the ability to disseminate detailed AMBER alerts to every detective's laptop in real time, including photos." Overall, the mobile system supports faster communication, greater information dissemination, and more field time for officers (Jones, 2004).

Homeland Security

Radioactivity Detection

In the post-9/11 era, more attention is being paid to the prevention of terrorist attacks. Of particular importance is the ability of security personnel to identify possible terrorist threats. A new type of cell phone "will be able to tell the difference between a 'dirty bomb' and someone who has undergone radiation treatment." RadNet is designed to make phone calls, "surf the web, act as a Personal Digital Assistant, pinpoint locations with GPS technology, and sniff out radioactive materials." RadNet uses "low temperatures in order to detect gamma rays that are emitted by radioactive materials." RadNet is able to record the increase in "temperature when a single gamma ray hits the detector's super-conducting material." This type of information can be assessed and transmitted between RadNet devices in the event of an attack or in response to the identification of a potential threat (Locke, 2003).

Bioterrorism

To improve data collection, the Centers for Disease Control and Prevention (CDC) has set up new computer systems linked to additional means for quickly transmitting critical disease-related information. Essentially, the CDC's "emergency response teams will use computers with embedded GPS receivers" to gather additional information regarding potential health threats to the public. According to the CDC, "this technology automatically barcodes, uses time stamps, as well as uses GPS map coordinates" to comprehensively and quickly assess a situation before informing emergency personnel (Towns, 2002b).

U.S. Department of Health and Human Services

Handheld PDAs are being used by the U.S. Department of Health and Human Services (HHS) to assess potential biological threats. This allows HHS to "measure the best ways for federal officials to communicate effectively with frontline clinicians in the event of a bioterrorist attack." This project will help determine whether it is effective to transmit information to and from PDAs. The aim of this project is to measure the influence of technology on the treatment of patients and the prevention of future disasters (Newcombe, 2003c).

California

California, a pioneer in e-government and m-government, sets standards for other states to follow. California created a government web portal (State of California, 2003) that allows constituents to receive government services from various departments throughout the state. The state's efforts to deliver constituent services via the Internet and mobile devices have broken new ground in government technology. For example, the design of the state's web portal allows constituents to customize the site to meet their particular needs (Gant, Gant, and Johnson, 2002).

California does not have a centralized ICT department. Any allocated funding for new wireless or technological initiatives remains with a specific department or agency. No single mechanism monitors departmental efforts to utilize ICT, including mobile technology.

"My California On The Go" was introduced in July 2001 as a way for constituents to receive wirelessly immediate updates on energy warnings, traffic jams, state lottery results, press releases, and emergency information from the governor's office. Information can be disseminated to constituents who carry PDAs, pagers, and cell phones.

Former Governor Gray Davis stated, "By using the latest e-business technologies, we are able to provide real-time wireless notification of impending energy shortfalls. Armed with this information, provided through a timely e-mail or cell phone alert, Californians can take timely conservation action, deal with a potential power outage, and help prevent disruptive rolling blackouts" (Davis, 2001).

However, the state has struggled with a troubled economy that has affected technology funding; in fact, it announced the suspension of all wireless services because of a lack of funding. It is unclear what direction the new administration will take.

Virginia

Virginia has also been a leader among states implementing e-government. Some of its e-government services are the first of their kind: online, real-time customer-service assistance, online driver's license renewal, and a customizable homepage for citizens. Perhaps most impressive are the new mobile-technology services, including "My Mobile Virginia," the first wireless state portal in the nation that makes government services available via wireless and mobile devices (Emery, 2002).

This m-government offers various information and services regarding state government, online services, and emergency information. Services are primarily for citizens, though some were specifically developed for government employees. The m-government service offers a variety of downloadable information including emergency weather situations, terrorism threats, legislative information, lobbyist information, election information, tax-related information, and tourism information (Commonwealth of Virginia Government, 2003).

In an interview with Megan Tapper in 2003, Rodney Willett, general manager of Virginia Information Providers Network (VIPNet), discussed the mobile-technology capabilities of Virginia's state portal in an interview (Willett, 2003). He said that the top reason Virginia developed a mobile portal was for better customer service. According to Willett, the m-government initiatives in Virginia were sparked by consumer demand, and focus groups helped develop appropriate services for mobile devices. The first mobile services became operational in 2000. During the 2000 elections, many Virginians could look up their polling location, as well as receive up-to-date election returns, on their PDAs. Since the implementation of election services, VIPNet (Virginia Information Providers Network) has grown to include legislative tracking abilities, Department of Motor Vehicle services, customer complaint services, access to the calendar of public hearings, and emergency information and contacts. All these services were designed in response to consumer demand. M-government in Virginia has been so successful, according to Willett, because the current state portal structure supports new mobile services. As long as citizens continue to use the services and ask for more, Willett says, VIPNet will continue to provide those services.

Although the increased use of mobile technology seemed to be an overnight miracle in Virginia, in reality it was the result of hard work by legislators and governors dedicated to improving the lives of Virginians. Additionally, Virginia was the first state to make the secretary of technology a cabinet-level

position. Perhaps the most important governmental reform related to technological planning in Virginia was the development of the Virginia Information Technology Agency (VITA, 2003).

Under VITA, one centralized agency oversees the ICT plan for the entire state. The bill creating VITA, signed and enacted in April 2003, abolished the Department of Information Technology, the Department of Technology Planning, the Virginia Information Providers Network Authority, and the Chief Information Officer Advisory Board (Virginia General Assembly, 2003).[1]

Fortunately for Virginia, the security of the system has never been compromised, despite the increased use of mobile services. According to Willett (2003), encryption and subscription requirements prevent hackers from tampering with the portal. The mobile services are protected by the same security measures as the main Virginia government portal. Through the consolidation of government agencies and the provision of mobile services, Virginia has moved far ahead of other states in m-government implementation. Other states can learn much from Virginia's success in transforming government services to meet the demands of consumers on the go. As long as Virginia citizens request more mobile services and greater access to government agencies, ICT specialists in Virginia plan to deliver them.

New York

In New York, the Office for Technology (OFT), created in 1996 as part of Governor Pataki's initiative for government efficiency, has sought to satisfy the increasing need for coordination and management of technology within all areas of state government. OFT has made efforts to improve communication within the system so that government can function at its highest capacity (New York State Office for Technology, 2003). OFT develops a general strategic plan and also attempts to improve communication in the CIO Council, which is composed of the agencies' ICT officials, OFT, and the state's chief information officer (CIO). The council meets every month and deals with the impact of new ICT and mobile-technology programs on specific organizations. ICT representatives from state agencies, local governments, and public corporations work together on standing committees, which include leadership, fiscal and procurement, human resources, security, strategic planning, technology, and intergovernmental communications.

In the summer of 1996, OFT announced a new initiative, NYeNet, which was designed to unite the telecommunications systems within all state agencies and to provide a secure way for such agencies to communicate and share information. Despite substantial progress in consolidating some networks, such as the Empire Net, the Metropolitan Area Network, and the Long Distance Intercity Networks Communication Systems (LINCS), NYeNet is still anticipating further network consolidations in order to become the network used by all state agencies and local governments (The Business Review, 2003).

In January 2000, OFT also announced another groundbreaking statewide initiative—one of the largest in the state's history and the first comprehensive technology upgrade in over 30 years—the Statewide Wireless Network (SWN). The plan calls for the implementation of a statewide wireless radio network, which will increase the ability of intrastate agencies to communicate effectively. The motivation for this initiative stems from the lessons learned after September 11. According to an agency official, state administrators created SWN specifically to fill an apparent void in communication between vital organizations during times when emergency response is crucial. Although increasing inter- and intrastate agency communication is the primary objective of SWN, the proposal also fosters a better working relationship between state agencies and local government offices (New York State Office for Technology, 2003). Because of the high level of security maintained by all state and local agencies within New York, and because of the nature of this specific program, the status of SWN remains classified. However, officials state that implementation continues to progress on track.

New York State agencies have continued to introduce mobile technologies for public service applications. For example, the New York Division of Parole adopted an IBM-developed wireless solution. The IBM (2004) e-government solution team reports that the parole division has applied mobile technology to case management and is looking forward to cost savings and improved efficiency. According to the report, the parole division, the

largest paroling authority in the nation, implemented a system aimed at streamlining case management by improving communication between all parties in the parole process. Faced with the challenge of managing over 45,000 parolees and sharing information among over 1,200 parole officers, the division instituted a program that outfitted officers with handheld computers, called WorkPads, that are linked to a mainframe at the agency headquarters. While in the field, officers are able to input relevant data or request help, and the information is processed immediately. Parole officers armed with current, accurate information can moderate parolee behavior and enhance public safety. The use of this system eliminates the need for paper forms and time-consuming data entry, thus streamlining the maintenance of caseloads. It is also estimated that the system saves New York $1.5 million to $2 million annually (IBM, 2004).

Officials within OFT continually work to strengthen the existing system and maintain a secure statewide network. OFT also works with the Office of Cyber Security and Critical Infrastructure Coordination (OCSCIC) to ensure the "readiness, response and resilience" of New York's government websites and technology infrastructure in the case of another September 11–type disaster, hacker attacks, or cyber threats (New York State Office for Technology, 2003). New York introduced the Statewide Information Security Policy, the outcome of a joint effort between the Office of the CIO and OCSCIC (New York State Office for Technology, 2003).

Summary

The three selected states have demonstrated a strong interest in e-government and taken big steps toward m-government. As described in this section, there are some common characteristics as well as differences in the governments' mobile-technology initiatives. Centralizing ICT management, for example, Virginia and New York have developed and implemented innovative, strategic, specific m-government plans in a more proactive and effective way.

The State of State M-Government

Perceptions and Utilization of Mobile Technology at the State Level

This section surveys the current status of state-level m-government plans for the development of comprehensive enterprise architecture as well as the adoption and use of mobile technologies; it also examines major concerns about m-government among state governments. To collect the necessary information, we sent survey instruments to the CIOs of all 50 states and the District of Columbia via e-mail in the spring of 2003. The survey was designed to identify states' progress in developing enterprise architectures (including mobile technology) as well as to gauge their perceptions of mobile technology and related concerns and challenges.

Many states refused to answer some security-related questions and thereby opted out of the survey. Of the 51 population subjects, only 14 completed and returned the survey (Connecticut, the District of Columbia, Florida, Idaho, Louisiana, Minnesota, Mississippi, Missouri, Montana, New Mexico, Rhode Island, Texas, West Virginia, and Wisconsin), which produced a survey response rate of 27.5 percent. Despite the limited data, the information collected helps explain state governments' perceptions and concerns about m-government and their actual use of various mobile technologies.

This section examines state governments' perceptions about the benefits of mobile technologies and their actual use of such technologies in their daily operations. Responses to the survey were scored on a 7-point scale (1–7). Regarding the potential contributions of mobile technology, states appear to take a modestly positive view. Respondents indicated that mobile technology increases productivity (5.5), timeliness (5.29), monitoring and controlling capacity (5.0), internal communication (4.93), and information availability for decision making (4.92). (All figures are mean scores.) But they are less upbeat about the effect of mobile technology on changes in agency missions and activities (3.93), interagency communication (4.14), and the overall quality of decision making (4.36). This indicates that states perceive mobile technologies to be improving intra-agency communication, but not interagency communication; strengthening monitoring and controlling capacities, but not adaptability to changing missions; and increasing the information available for decision making, but not necessarily improving the quality of decision making.

Currently, the utilization of mobile technologies is fairly widespread, as Table 2 indicates. Respondents were asked to indicate the extent to which they used the various mobile technologies listed in Table 2. In scoring the responses, 2 indicated "used daily"; 1, "used in emergency situations only"; and 0, "not used at all." Nearly all of the mobile devices are used daily, which indicates that mobile devices are widely adopted and have become a critical part of communication systems. Tablet PCs, still considered very new devices, are not utilized much.

States utilize mobile technologies in numerous areas to improve their own performance or to provide better services to the public. The main areas we identified are law enforcement, emergency

Table 2: Current Utilization of Mobile Technology

	Mean
Two-way radios	2
Mobile phones	2
Pagers	2
Handheld devices (PDAs and pocket PCs)	2
Laptop computers	2
GIS (Geographic Information System)	2
GPS (Global Positioning System)	1.82
Text messenger/mobile e-mail	1.43
Wireless Internet to mobile technology	1.25
Smart phones	1.17
Tablet PCs	0.78

2 = used daily, 1= used for emergencies only, 0 = not used

response (including firefighting), parks and wildlife management, transportation, public works, healthcare, and social services. Respondents indicated the importance of mobile technology for each of these on a 7-point scale, where 1 indicated "not used at all" and 7 indicated "used very frequently." The rankings of the functional areas (with their mean score) is as follows:

1. Law enforcement (6.5)
2. Emergency response (including firefighting) (6.36)
3. Parks and wildlife management (5.21)
4. Transportation (5.00)
5. Public works (4.15)
6. Healthcare (3.86)
7. Social services (3.43)

Barriers and Challenges to the Use of Mobile Technologies

Currently, states view mobile technologies as being beneficial, and they utilize almost every form we identified in a number of functional areas. Most mobile technologies are relatively new, and they are evolving at incredible rates. Moreover, there are many issues associated with mobile technologies that may prevent their use, and we set out next to identify them. Our inquiries yielded some surprising results. We hypothesized that issues causing a reduction in the use of mobile technologies would include security; lack of technological knowledge about how to implement, use, and maintain the technologies; lack of infrastructure; privacy; and cost. To our surprise, most of these issues did not prove to be deterrents.

The following questions were asked about barriers to mobile-technology use in state governments. Almost all of the responses to the questions hovered around the neutral value of 4 on a 7-point scale, where 1 indicated "strongly disagree" and 7 indicated "strongly agree." As Table 3 on page 22 shows, two barriers stood out: security and financial cost.

Standardization and interoperability are also major concerns of state governments regarding ICT. The mean values for the perception of interoperability and standardization are, respectively, 4.36 and 4.71 on an 11-point scale from 0 to 10, where 0 indicated "not at all interoperable or standardized" and 10 indicated "completely interoperable or standardized." States perceive standardization and interoperability as imperative for providing faster and more convenient e-government or m-government public services. Many states also expect that enterprise architecture (comprehensive strategic plans for m-government) will improve the standardization and interoperability of mobile technologies. A question on this subject had a mean score of 5.57 on a 7-point scale, where 1 indicated that such plans would "slightly improve" m-government and 7 indicated that they would "greatly improve" it.

Poor infrastructure also appears to be a deterrent to the development of m-government. Mobile technologies require a network of some sort in which to operate; most technologies run off cellular towers or similar types of technology that use transmitters and receivers. We asked states to rate how

Table 3: Barriers to Utilizing Mobile Technology

	Mean
Issues regarding security	5.85
Financial costs associated with implementing systems	5.36
Lack of collaboration among departments	4.74
Issues regarding privacy	4.71
Lack of technology staff	4.50
Lack of technical expertise on the part of information services	4.23
Staff resistance to change	3.79
High volume of data communication	3.29

Scale of 1 to 7, where 1 = strongly disagree and 7 = strongly agree

sufficient their wireless networks were on a scale of 0 to 10, where 0 meant "not at all sufficient" and 10 meant "very sufficient." The mean response was 3.43, which indicates that many states consider their wireless networks insufficient.

The states identified cost as the last barrier to the use of mobile technology. New and rapidly improving technologies are expensive for a number of reasons, including costs associated with acquisition, maintenance, and contracting with third-party providers. As expected, states rated mobile technologies as cost ineffective. The mean value was 0.22, where 0 meant "not cost-effective" and 1 meant "cost-effective." Moreover, mobile technologies have increased states' operating costs for ICT management; the mean value for this variable was 0.64, where 0 meant that the technology "reduced costs" and 1 meant that it "increased costs."

For ICT budgeting in general, most states (9) allocate 0–5 percent of the state budget for the acquisition, utilization, and maintenance of ICT; West Virginia (11–15 percent) and Wisconsin (16–20 percent) are exceptions. Of this, very few ICT financial resources are allocated for mobile technology. Twelve states responded that they allocate less than 5 percent of their ICT budget for the acquisition, utilization, and maintenance of mobile technology (only Minnesota allocates more, with 6–10 percent of its ICT budget for mobile technology). However, budgets for mobile technology have increased for the last three years. Thirteen states (one did not respond) answered that they have increased their budget for mobile technology modestly (eight states by 0–10 percent, Connecticut by 21–30 percent, and the District of Columbia by 41–50 percent).

Mobile technologies are perceived as improving performance, efficiency, and quality. Only two states, Missouri and Connecticut, employed performance measures to evaluate the effect of mobile technologies on agency performance and the quality of services provided. On a 7-point scale, where 1 indicated that the technology "greatly diminished performance" and 7 indicated that it "greatly improved performance," both states rated mobile technologies a 5, indicating improvement in performance and the quality of services provided. Though a small proportion of states use performance measures, it appears that such measures make a positive impact on m-government performance.

Enterprise architecture is a new concept that is either not present or still being developed in most states (most states have been working on enterprise architecture for fewer than two years; six states for fewer than six months). Of particular importance to this study, mobile technology is not as prevalent in enterprise architecture as it needs to be. Overall, states do not believe that their current enterprise architecture addresses mobile technology effectively (a mean score of 3.3 on a 0-to-10 scale).

All of the respondents except Idaho said that their enterprise architecture does or will address the use of mobile technology. In particular, more-advanced and highly sophisticated mobile technologies (PDAs, GIS, GPS) are more likely to be incorporated into enterprise architecture than less-advanced and less-sophisticated mobile technologies (for example, pagers and two-way radios), although these, too, should be carefully incorporated into enterprise architecture because of their reliability, accessibility, and frequency of use.

Overall, states perceive the benefits of mobile technology for job performance and quality of services, and they have introduced various mobile technologies into their daily operations.

Mobile technology is utilized in most aspects of government; however, law enforcement and emergency management are the top two functional areas. Unfortunately, state governments do not seem to approach m-government systematically. Many state governments have not developed comprehensive enterprise architecture and do not have a strategic blueprint for mobile-technology applications. Moreover, as the state case studies indicate, state governments are not ready to provide many public services through wireless networks, though various online public services have been offered via e-government initiatives. Given this, mobile technologies need to be better integrated into enterprise architecture for improved effectiveness and efficiency of use. Better planning for the use of mobile technologies will reduce many of the barriers, including costs.

Mobile-Technology Applications at the State Agency Level

The data used for this section was collected by an Internet survey distributed to 186 Texas state agencies. The purpose of this survey was to identify the status of mobile technology in Texas state agencies and to address the following subjects: (1) the use of mobile devices, (2) wireless networks, (3) budgets, strategic plans, and issues, and (4) the effectiveness of mobile-technology applications.

Of the 186 agency contacts provided by the Texas Department of Information Resources (DIR), 93 respondents completed the survey, producing a survey response rate of 50 percent. We examined the data to find general trends and to identify similarities and differences among the agencies.

During the initial phases of this project, each agency was contacted and asked to participate in the study. At that time, the DIR provided contact information for each agency. On October 27, 2003, the survey instrument, an online interactive survey, was e-mailed to 186 agencies. The initial deadline for survey responses was November 1, 2003; however, this deadline was extended until November 8 to increase participation.

Based on the self-identification of the responding agencies and our own classification, the 93 responding agencies were categorized into 12 major functional areas (see Table 4).

Table 4: Survey Respondents by Functional Area

Agency by Functional Area	Frequency
Judicial/legal	11
Emergency response (including fire)	0
Parks and wildlife management	0
Healthcare	5
Social services	10
Public works	2
Transportation	1
Finance	3
Education	24
Licensing and regulatory	23
General government	9
Missing or did not respond	5
Total	**93**

Mobile Technology: Utilization, Strategy, Barriers, and Effects

Respondents were asked to list the types of mobile devices their agencies currently provide, plan to provide, or have no intention of providing. The most common mobile devices provided are mobile phones (71 percent). The majority of agencies (58 percent) use handheld devices such as PDAs and BlackBerries. The least common devices used are laptop computers with cellular connection cards (13 percent). Table 5 on page 24 provides a frequency breakdown of technology provision versus type of mobile technology.

Agencies were also asked to respond whether or not they have plans to acquire any of the listed devices in the near future. Twenty-two percent of the agencies said they intend to purchase and integrate laptop computers with wireless network connection cards in the next two years. According to the survey results, the least likely device to be utilized by the agencies is a global positioning device: 77 percent of the agencies said that they have no intention of purchasing this type of device.

Twenty-five percent of survey respondents said they use a wireless network in their agency. Of these

Table 5: Utilization of Mobile Devices in Texas State Agencies

	Two-way radios	Two-way pagers	Handheld devices	Mobile phones	Smart phones	Laptops w/WIFI	Laptops w/cellular	GPS
Is currently provided	34	34	54	66	16	35	12	15
Will be provided within 2 years	2	4	7	4	19	20	19	6
Will NOT be provided in the next 2 years	57	55	32	23	58	38	62	72

respondents, 40 percent (10 agencies total) claim that the reason for the implementation of this network is to "provide better citizen access to the network." Ironically, despite the claim that the network is for constituent access, only 14.8 percent of networks are accessible by the general public.

One explanation for this discrepancy may be that having a network of any kind helps agencies provide more services to their customers, regardless of whether the network is open or closed. But because survey respondents had the option of choosing "serving staff in the field" as the primary reason for the networks, yet only 27 percent chose that reason, there is no way to discern the true intentions of the respondents.

Of the 25 agencies that said they have a wireless network in place, 69 percent have a designated manager of the network. Almost half (45.5 percent) of the agencies that do not have wireless networks claimed that they lack sufficient resources to implant and maintain the network. It may be that the cost of employing a network manager is prohibitive or that those agencies do not have budget allocations for a wireless network.

There is a positive, statistically significant relationship between the percentage of an agency's 2004 budget allocated to ICT and whether or not the agency has implemented a wireless network. According to the output data, those agencies that allocate more money to mobile technology are more likely to have a wireless network. Eighty-two percent of the agencies allocate less than 5 percent of their budget for acquiring, utilizing, and maintaining mobile technology. As Table 6 shows, there is also a positive relationship between the number of full-time employees and the implementation of a wireless network. The cross tabulation suggests that there is a positive association between staff size and network implementation: The larger the agency, the more likely it is to have a wireless network.

As shown in Figure 1, almost half of the respondents stated that their budgets had increased over the past three years. Fifty-one percent responded that their budgets had not increased over the past three years, while 43 percent of the respondents had seen an increase in their ICT budgets.

Table 6: Utilization of Wireless Network in Texas State Agencies

How many full-time employees does your state agency have?	Has your agency implemented a wireless network?		Total
	No	Yes	
100 or less	32	3	**35**
101–600	15	11	**26**
601 or more	15	11	**26**
Total	**62**	**25**	**87**

Though mobile technology has begun to be widely adopted in the public sector, state agencies do not seem to be prepared for full-scale m-government, and most have not developed a strategic mobile-technology plan. As Figures 2 and 3 illustrate, 73.1 percent of responding Texas agencies said they do not have a comprehensive plan for mobile technology, and 43 percent are not currently considering such a plan.

Figure 1: Has your agency ICT budget increased in the past three years?

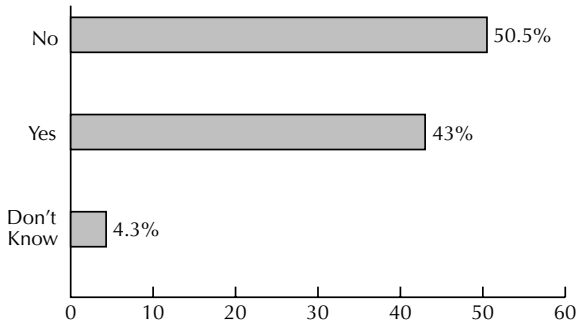


Figure 2: Do you currently have a mobile-technology plan or strategy?

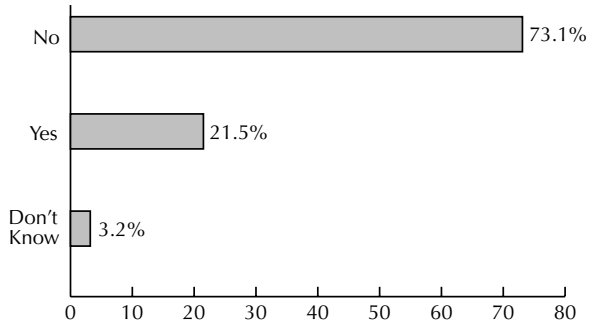
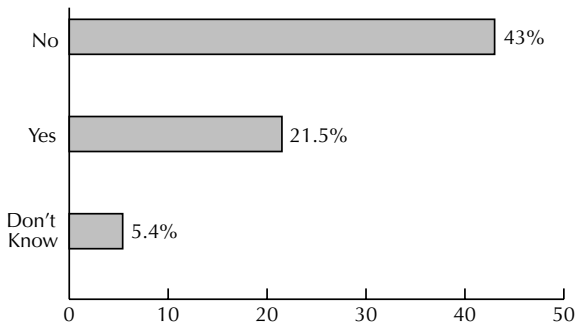


Figure 3: Are you currently considering any plan that addresses mobile-technology issues?



Barriers to the Adoption of Mobile Technology

Despite the great prospects of m-government and the rhetoric surrounding it, many challenges and issues remain unresolved. As Table 7 on page 26 indicates, the majority of respondents (over 62 percent) believe security concerns to be the most significant barrier to adopting mobile technology. Fifty-seven percent claimed that a lack of financial resources, the next highest frequency response, kept them from adopting mobile technology. Table 7 provides the overall frequencies and percentages for barriers to implementing mobile technology.

Other barriers cited by respondents included a lack of appropriate staff (38.7 percent), a lack of expertise (31.2 percent), privacy issues (25.8 percent), and a need to upgrade technology (21.5 percent).

Because of security concerns, 72 percent of the responding agencies do not transmit sensitive or confidential data through wireless and mobile-technology devices. Not surprisingly, 60.2 percent of the respondents listed the vulnerability of sensitive or confidential information as the security issue of greatest concern. Concerns about security also play a role in decisions not to implement a wireless network. The majority of respondents (56.1 percent) who do not have a wireless network cited security as a factor.

State agencies often use various technological means to make systems more secure. Of the responding agencies, 65.6 percent employ firewalls as the primary way to ensure the security and privacy of their mobile technology. Encryption (39.8 percent) and filters (36.6 percent) were two other frequently listed methods for ensuring the security and privacy of mobile technology.

The actual implementation of a wireless network seems to affect the number and type of security devices employed. Firewalls, filters, and encryption are more likely to be installed among the agencies that have wireless networks. The size of an organization or its budget does not seem to be a determining factor for the installation of firewalls or filters.

The Effectiveness of Mobile Technology in State Agencies

Table 8 on page 26 shows data on the effects of mobile-technology implementation; the responses were mixed indeed. Agencies listed a wide variety

Table 7: Barriers to Adoption of Mobile Technology

Rank	Barrier	Frequency	Percentage
1	Issues regarding security	58	62.4
2	Lack of financial resources	53	57.0
3	Lack of staff	36	38.7
4	Lack of expertise	29	31.2
5	Issues regarding privacy	24	25.8
6	Need to upgrade technology	20	21.5
7	Lack of information about applications	14	15.1
8	Issues relating to fees of online transactions	8	8.6
9	Lack of support from elected officials	6	6.5

of both positive and negative effects of mobile-technology implementation. Since adopting mobile technology, 29 percent had improved the efficiency of their business processes; 18 percent had experienced a change in the roles staff played in their agency; about 13 percent had experienced a reduction in time demands on their staffs; and the staffs of 11.8 percent had experienced decreased stress levels. Only 6.5 percent required a reengineering of their business practices after adopting mobile technology.

Not all of the effects of mobile-technology implementation were positive. Since adopting mobile technology, 20 percent of the respondents had experienced increased time demands on their staffs; the staffs of 15 percent had experienced increased stress levels; 12 percent had experienced increased administrative costs; 22 percent did not know what changes had occurred since adoption; and 25 percent had experienced results not listed in our survey.

Table 8: Effects of Mobile-Technology Implementation

		Frequency	Percentage
1	Improved the efficiency of business processes	27	29.0
2	Increased time demands on staff	19	20.4
3	Changed the role of staff	17	18.3
4	Increased staff stress levels	14	15.1
5	Reduced time demands on staff	12	12.9
6	Increased administrative costs	11	11.8
7	Decreased staff stress levels	11	11.8
8	Reduced administrative costs	10	10.8
9	Required a reengineering of business processes	6	6.5
10	Reduced the number of staff	2	2.2
11	Increased the number of staff	2	2.2
	Don't Know	20	21.5

Conclusions

Mobile technology has great potential to improve state government's capacity for communication and service provision. With the use of wireless networks and various mobile devices, governments are better able to share information within and between agencies as well as to provide citizens with efficient public services such as emergency management.

The selected case studies show that many local and state governments have begun to actively introduce mobile technologies, particularly for emergency management. At the state level, both Virginia and New York have articulated specific visions for mobile technology and made the development of a statewide wireless network and adoption of mobile technology a priority. In these states, a central agency seems to be responsible for planning and coordinating the development of m-government. The success of m-government initiatives appears to be the result of comprehensive plans and leadership.

Although the analysis of data from the state m-government survey indicated that state governments perceive the utility of mobile technology, have adopted various mobile devices, and have established wireless networks for their daily operations, state governments have not been able to develop comprehensive enterprise architecture that strategically incorporates mobile technologies into their e-government or m-government plan. Data from the survey of Texas state agencies also indicated a general lack of strategic plans. The agencies recognize the potential benefits of mobile technologies for enhancing the quality of communication and delivering services to the public—and, overall, mobile technology has improved agency operations, but its full capabilities are just beginning to be explored.

Together, the findings of the case studies and the analyses of the data collected from the two surveys suggest that the following are important factors for the successful implementation of mobile technology: (1) state governments should develop strategic m-government plans, which include enterprise architecture; (2) the strategic m-government plans should include a strong business case; (3) adequate financial resources will be required to implement m-government in the states; (4) strong, sustained political leadership will also be required to implement m-government in the states; and (5) implementation of m-government in the states will require intergovernmental, interagency, and intersectoral collaboration.

1. **State governments should develop strategic m-government plans, which include enterprise architecture.** Based on a comprehensive assessment of service needs and available mobile technologies, governments should develop a strategic m-government plan in order to offer a clear vision for m-government. The strategic plan should include the procurement, maintenance, and upgrading of various mobile devices and wireless networks. The strategic plan should also include guidelines for necessary financial and personnel capacities as well as institutional arrangements for intra- and intergovernmental collaborations. The plan should address training for public officials who will use the mobile devices. Without appropriate training programs, the technology will

not be used to its full capacity by employees. The strategic plan should also address various concerns, such as security and interoperability issues, that impede the effective implementation of m-government or prevent governments from obtaining the maximum use of technology. State ICT departments are particularly encouraged to incorporate mobile technology into the development of enterprise architectures. To achieve this goal, state ICT departments should use their current relationships with both federal and local governments and form additional intergovernmental and external affiliations to promote the statewide implementation of their enterprise architectures.

2. **The strategic m-government plans should include a strong business case.** State governments should carefully conduct cost-benefit analyses of m-government applications and assess their "business case." While many states answered that they are currently experiencing or expect positive outcomes (improvement in process improvement, coordination, information sharing, and communication), their positive experience with m-government and projected outcomes have not been practically reflected in their budget allocation. The business case is not always a primary driving force of m-government applications for emergency management due to its immediate and great societal demand. However, state governments should make a strong business case for m-government applications for other functional areas—such as education, health, and social services—because it helps to build strong political support from elected officials and citizens for state m-government efforts.

3. **Adequate financial resources will be required to implement m-government in the states.** The survey data suggests that state governments have not allocated enough resources to m-government, though mobile technology is becoming an increasingly important part of government operations, particularly in emergency management. Unless states provide the funding necessary for m-government initiatives, the benefits of new technology will become further out of reach. Since the September 11 attacks, standardized and interoperable communications have become a focus of national interest. State ICT departments should capitalize on this attention to seek out alternative sources of funding. Currently, the Department of Homeland Security rewards state and local efforts to enhance emergency preparedness and response practices, particularly the improvement of interoperable communications.

4. **Strong, sustained political leadership will also be required to implement m-government in the states.** Political leadership should envision the prospects of m-government and provide continuing support for m-government initiatives. Since m-government requires a strategic, long-term plan supported by substantial financial and personnel resources, a strong and sustainable political commitment is a primary factor for the successful implementation of m-government.

5. **Implementation of m-government in the states will require intergovernmental, interagency, and intersectoral collaboration.** Successful m-government also requires healthy and continuing collaboration among various governments, agencies, and sectors. Since communication via wireless networks is critical for m-government practices, constructive collaborative relationships among related actors are critical to the success of m-government. The development of interoperable systems among different levels of governments and agencies is highly desirable, as is intersectoral collaboration, since many m-government solutions have been developed by private service providers.

Mobile technologies will continue to have a positive impact on state governments. Although interoperability and security will remain major challenges to widespread adoption and effective implementation, the benefits of mobile-technology use appear to make it a worthwhile agency investment. Working with the federal government, other state governments, and local governments, state governments need to prepare for the future of m-government by observing the activities of other states and incorporating their best practices along with new technological solutions and devices.

Endnotes

1. SB 1247, a bill establishing VITA, does the following:

a. Establishes the Division of Project Management within VITA to assist the CIO in the development and implementation of a project management methodology to be used in the planning and development of IT projects.
b. Establishes a project planning, development, and approval process for major IT projects.
c. Authorizes the Virginia Public Building Authority to issue debt to finance major IT projects.
d. Provides for the consolidation of the procurement and operational functions of IT for state agencies.

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