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ABSTRACT

Mobile Technology is a growing field converging mobile computing with telecommunications in a wireless environment that has become more robust in its own right. This convergence of mobile communications enables an organization and its individual workforce to become more flexible in communication as well as work structure. Mobile technology is enabling an organization to work together or separately on a global basis while maintaining its collaborative information sharing capabilities. This allows for a near-seamless work environment to maintain its operational tempo as a work force is dispersed temporarily or on a permanent basis globally. With the evolution of faster, more robust mobile technologies, organizations and the workforce are breaking out of the traditional work environment and moving into the global community allowing them to be continually tied into the virtual office. This thesis is intended to show how mobile technology has reshaped the strategic vision of an organization and has affected society on a global scale.
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CHAPTER ONE

“Not all who wander are lost.”
- J.R.R. Tolkien

DEFINING MOBILITY IN THE AGE OF WIRELESS TECHNOLOGY

INTRODUCTION

Mobile Technology is a technology that has been diffused throughout the globe at an incredible rate since the mid 1990’s. Like most technologies, large organization, government agencies and the military were instrumental in the development of such mobile technologies and this has seeped into mainstream private use as equipment has become more affordable and availability has grown. Converging mobile computing with telecommunications in a wireless environment has led to a more mobile society. This growth has and the way mobile technology is used in today’s society has forced organizations, large and small, to look at their strategic vision and goals and how to best leverage mobile communications. Part of this strategic vision encompasses the mobile workforce and the birth of the birth of the nomadic worker. Organizations have moved away from traditional brick and mortar workspace toward a roaming office environment that brings a great many advantages to the organization and society. This convergence of mobile communications enables an organization and its individual workforce to become more flexible in communication as well as work structure.

STATEMENT OF THE PROBLEM

This thesis is intended to show how mobile technology has reshaped the strategic vision of organizations and how it has affected society on a global scale.

NEED FOR THE STUDY

This study is intended to analyze the strategic impacts of mobile communications on organizations and its affects on society as a whole. Mobile communications is one of the fastest growing technologies in history. Mobile users require constant access to internet technologies such as email, telephonic voice communications, critical shared data, and the Internet. With these requirements driving mobile technology, organizations that drive the necessity for their personnel to stay connected spills over into society. This study looks at the strategic impact mobile technology has on organizations and how this drives the development of mobile technologies. This study also looks at the impact mobile technology has on society and the quality of life humans lead.
LIMITATIONS

Mobile communications is recent development when looking at communications across centuries. From the advent of wired communications to the birth of wireless communications, this study will only look at recent developments of mobile technologies while providing a brief historical background from the first uses of mobile technologies.
CHAPTER TWO
REVIEW OF THE LITERATURE

Introduction

Mobility and wireless are two terms that are interchangeable to the layman but have separate meanings to mobile technologist and developers or mobile and wireless communication technologies. They may be interchangeable depending on the situation. Kornak, Teutloff, and Welin-Berger define mobility in their book, *Enterprise guide to gaining business value from mobile technologies*, as “The application of mobile devices and wireless technology to enable communication, information access, and business transactions from any device, from anyone, from anywhere, at anytime.”

Mobility and wireless technologies and communications encompass a great many solutions that continue to evolve as the technology advances and requirements across all levels of humanity change and grow. Mobile technology allow individual users and organizations to access resources such as e-mail, files, and shared applications that make up what otherwise would be only accessible at a desktop computer in a traditional office environment. Wireless applications come in two flavors, public wireless solutions and private wireless solutions. Wireless public solutions enable a user to access a public wireless architecture to access more common resources readily available to the general population. Examples of these include web portals found on the Internet (Google, Yahoo) and Global Positioning Systems (GPS) (Kornak, Teutloff, and Welin-Berger, 2004).

Private wireless solutions utilize private networks to provide access to authorized mobile users. Business to Business (B2B) and supply chain processes are examples of private wireless solutions. Rental car companies such as Hertz normally found at airport locations are good examples of private wireless application of supply chain process as the attendants use wireless devices to check in cars as they are dropped off and then act as the point of sale to complete the sales transaction (Kornak, Teutloff, and Welin-Berger, 2004).

There exists a great many mobile and wireless devices available to support the user and the organization depending on needs and requirements. Many of these devices that are currently available to the general public (non-government/military) support the basic mobile and wireless requirements such as voice, data, email, Internet browsing and are able to operate in the typical GSM and UMTS architectures. The figure below, Figure 2-1, gives a high-level view of the different categories of devices and where they fit across the wire and mobile spectrum, from non-wireless and non-mobile devices to the completely wireless and completely mobile devices.
The convergence of mobile technology is intended to bring together e-mail, voice, text messaging, and calendars. Collaborative tools combine these functions to create mobile technology that enables the mobile work force the ability to work autonomously instead of working from a fixed location such as an office. Sean Ginevan, in his article “IT Survival Guide: Voice over IP Makes Convergence Possible”, discusses some of the new technology that drives a mobile work force. In his article, Ginevan refers to “Fixed-mobile convergence” or FMC and the ability to connect people through IP PBX technology. IP PBX allows users to have connectivity to VoIP phones as well as mobile devices. It also enables wireless calls and text messaging to be made through the IP PBX. Ginevan points out the significant cost savings and auditing control of utilizing this technology to connect mobile and fixed users. Ginevan also points out that buy-in across the entire organization is needed for successful deployment and integration throughout the organization. He notes that unified communications needs to be integrated in the business process to ensure the success of this technology to support a nomadic work force (Ginevan, 2007).

Converging voice, data, and video is a trend that many organizations are embracing to target the nomadic worker on a global scale. Recognizing the importance of this emerging technology, Sean Buckley discusses some of these solutions with the managing director of Fixed and Mobile in his article, “Fixed and Mobile connects the nomadic worker”. In this article, Buckley leads in with the relatively new market of providing access to nomadic users that are mobile on a global scale. Barbier points out that the real challenge is the transition from legacy telecommunications infrastructures to next-generation infrastructures to support the nomadic workforce that has increased by 50% to over 285 million new subscribers in 2006. Of course this statement is not backed up with hard statistical evidence which begs this point to be further researched.
The article goes on to highlight some solutions that Fixed and Mobile provide to the nomadic user. Three services that Fixed and Mobile provides to foreign workers, expatriates, and travelers include:

- Transfer To
- Call Me
- SMS Voucher

Transfer To enables the user to transfer credit from one mobile device to another via SMS. Barbier points out that Transfer To is “the first step towards mobile remittance and money transfers directly to mobile wallets”. Call Me is another solution that enables a nomadic worker the ability to have a second home country number and SMS Voucher is an international collect SMS service. The technology and features Fixed and Mobile deploys to enable a robust network includes:

- SS7 and SIGTRAN
- Roaming Agreement Management
- IREG Testing
- SMS filtering
- Real-time Reporting
- Customized Applications for Mobile network Enhanced Logic (CAMEL) charging

Fixed and Mobile continues to expand their coverage with over 500 networks in over 200 countries (Buckley, 2008).

The Nomadic Worker

One interesting article in the April 10th 2008 edition of The Economist focuses on some of the social aspects of the nomadic worker and the use of one such converged mobile device (Labour movement, 2008). The article looks at the pros and cons of nomadic work styles powered by mobile technology. As mobile technology advances and matures, the ability of employees to work anywhere has increased dramatically. Convergent technology such as the Blackberry enables employees to be tethered to work via email and cellular communications. This article compares telecommuting in the 1990’s with nomadic work styles today. Telecommuting in the 1990’s referred to employees working from home using an internet connection, fax-machine, and telephone. The employee wasn’t truly mobile but in a fixed location (home office) and not using mobile technology as a primary means of telecommunications; instead, employees were still tied to a central office. Nomadic work allows the employee to be anywhere such as a café, internet kiosk, library, vacation spots and anywhere else as long as the employee is outfitted with a converged, mobile device such as a Blackberry.
One of the pros to working anywhere and having access to constant email access with mobile devices such as the Blackberry is staying current with the constant stream of emails that seem to drive many organizations today. This gives the mobile employee the needed edge to remain responsive 24x7. This, of course, leads to one of the cons of being mobile which is increasing the amount of time a mobile employee will work. The common concern here is someone paying more attention to their Blackberry and less attention to families and social lives after normal business hours.

Mobile Communications and Diffusion

Diffusion is a recurring term that is found throughout the research of mobile technology and the social impacts it has on society. In a research report prepared for the International Workshop on Wireless Communications Policies and Prospects: A Global Perspective, held in 2004 at the Annenberg School for Communication, University of Southern California, a statistical overview of diffusion of wireless communications discussed. A significant amount of data is presented to back up this analytical overview of the social uses and effects mobile communications has across the globe with a focus on Europe, Asia and the United States. Castells, Fernandez-Ardevol, Qiu, and Sey prepared an in-depth report with supporting empirical data in 2004 focusing on the diffusion of wireless communications throughout different areas of the world. One purpose of the study was to address issues such as the type of social effects wireless communications have on society and to understand the type of conditions, whom it affects and what is actually affected. The report includes statistical data of the diffusion of wireless communications over the last decade in different regions across the globe. The report does use official and unofficial sources to provide the reader a view of the wireless landscape over the course of 10 years (1993 to 2003) by different regions. The report does state that while there is a robust amount of data for some countries, there is little data on wireless communication trends on others. The report goes on to admit that secondary sources of information are used such as newspaper reports to supplement scholarly and official sources of information (Castells, Fernandez-Ardevol, Qiu, and Sey, 2004).
CHAPTER THREE
CONVERGENCE AND THE MOBILE ROAD WARRIOR

The convergence of mobile technology has led the way for advances in the way people live and work. Mobile technology is shaping the way organizations operate in this new age of technology. This is seen in the advent of mobile nomads and the break away from brick and mortar office space. This is the development of from telecommuters to nomads who are not tied to an office or desk, whether this is at home or in an office building. As mobile technology advances and matures, the ability of employees to work anywhere has increased dramatically. Convergent technology such as the Blackberry enables employees to be tethered to work via email and cellular communications.

Telecommuting in the 1990’s was a growing trend to enable organizations to trim workspace costs as well as leverage the growing technological boom. Telecommuting in the 1990’s referred to employees working from home using an internet connection, fax-machine, and telephone. The employee wasn’t truly mobile but in a fixed location (home office) and not using mobile technology as a primary means of telecommunications; instead, employees were still tied to a central office. Nomadic work allows the employee to be anywhere such as a café, internet kiosk, library, vacation spots and anywhere else as long as the employee is outfitted with converged, mobile devices. Nomadic workers now find themselves equipped such as with two mainstay mobile devices, the wireless enabled laptop computer and an all-in-one mobile devices.

Organizations that depend heavily on a mobile workforce such as transportation (truckers), maintenance engineers, medical and protective services (ambulances and police), and military forces were the first to utilize mobile systems for communications. These types of mobile workers require constant communications with their fixed headquarters and access to critical information (Castells, Fernandez-Ardevol, Qiu, Sey, 2007). As mobile devices emerged and became more robust and affordable, other industries adopted mobile communications to increase their footprint and reach. These types of mobile workforce deployments are key to effective strategic planning and growth for profit industries.

The increasing amounts of Wi-Fi access points offering free or cheap wireless internet access are allowing people to work wherever they want or need, when they want. This not only enables large organization’s workforce, often found in the a sales force, but also has enables to renewed growth of start-ups that require low overhead and constant access to the internet to conduct business and spread their message through the World-wide web. One such company, Web Worker Daily, is a media company that has a small staff and a group of free lance writers whom all work from cafés, wireless kiosks, and anywhere else free or cheap wireless access is available (Fost, 2007).
The BlackBerry® 8707g and the Palm® Treo™ Pro are two market leaders of converged mobile smartphones. The BlackBerry 8707g, produced by Research In Motion Limited, is compact in size (4.93 ounces and 4.3”x2.7”x.08”), and includes the following features:

**Features**
- Wireless email
- Organizer
- Browser
- Phone
- Corporate data access
- Built-in GPS
- SMS/MMS
- Wireless Calendar
- 64MB Memory
- RIM® wireless modem

**Security**
- Password protection
- AES Supported/Triple DES Encryption
- FIPS 140-2 Validation

**Wireless Network**
- 2100 MHz UMTS networks
- North America: 850MHz GSM/GPRS networks
- North America: 1900MHz GSM/GPRS networks
- Europe/Asia Pacific: 1800MHz GSM/GPRS networks
- Europe/Asia Pacific: 900MHz GSM/GPRS networks

Figure 3-1: BlackBerry® 8707g (Research In Motion Limited, 2008)
The Palm Treo Pro, (www.palm.com) offers a plethora of mobile tools and features:

**Features**
- Wireless email
- Organizer
- Browser
- Phone
- Corporate data access
- SMS/MMS
- 256MB Memory
- Built-in GPS
- Wi-Fi: 802.11b/g

**Security**
- WPA/WPA2
- 801.1x authentication

**Wireless Network**
- HSDPA/UMTS/EDGE/GPRS/GSM
- Tri-band UMTS: 850MHz, 1900MHz, 2100MHz
- Quad-band GSM: 850MHz, 900MHz, 1800MHz, 1900MHz

Figure 3-2: Palm® Treo™ Pro (Palm®, 2008)
Telecommuting has evolved into the nomadic worker, cutting costs even more by doing away with the necessary home office and outfitting the roaming working force. One of the pros to working anywhere and having access to constant email access with mobile devices such as the Blackberry is staying current with the constant stream of emails that seem to drive many organizations today. This gives the mobile employee the needed edge to remain responsive 24x7. This, of course, leads to one of the cons of being mobile which is increasing the amount of time a mobile employee will work. The common concern here is someone paying more attention to their Blackberry and less attention to families and social lives after normal business hours.

Looking at the emergence of the technology-powered, mobile workforce, a comparison can be made between the new breed of nomadic workforce and the telecommuter of the 1990’s who works out of a home-office environment. The main reason for this new-breed of mobile workforce is money, or the need to save money on office space, whether this is in a corporate location or in a home/office. Outfitting the mobile workforce may be initially expensive, but with a well equipped salesperson, being totally mobile and un-tethered is more cost effective to a company (Johnson, 1994).

However, with this mobilization of an organization’s workforce come some social effects. Longer work hours are realized by the nomadic employee as well as the loss of worker interactions and camaraderie. Job loss is also a side-effect of a mobile workforce as the support staff previously required to support the frontline office workers (sales force, account representatives) are required to a lesser extent and more expendable. One example is Aetna Life & Casualty which cut a total of 12,000 jobs due to the deployment of a mobile sales force (Johnson, 1994). In a more recent report conducted between 2003 and 2007 in Australia, 10,000 jobs were lost due to increased use of mobile technology and the continuing technological advancements in mobile communications. The report found that the wide-spread use of mobile technology over this time period enabled organizations to be more productive and do more with a smaller work force when mobile technology was leveraged (Corner, 2008)
CHAPTER FOUR
THE STRATEGIC AND SOCIAL IMPACT OF MOBILE TECHNOLOGY

As society moves forward, mobile technology will continue to play a greater role in the strategic direction of organizations and on individual lives. People always strive for the perfect work/life balance based on an individual’s perceived notion of how that balance is defined. Mobile technology plays a significant role in today’s society increasing an organization’s productivity as it relates to its strategic goal, but also enhancing the lives of individuals outside of work. Organizations are realizing the benefits mobile communications bring and the results of successfully leveraging mobile technology. Each new generation of people grow up more mobile savvy and more comfortable with technology. This drives the ability of an organization to more successfully implement and use mobile technology to its advantage. The primary benefits of deploying mobile technologies in an organizational setting include:

- Revenue growth
- Reduction of operating costs
- Streamlined processes and procedures
- Competitive edge over other organizations
- Increased face time with customers
- Improved stakeholder relationships

These benefits are only realized when the mobile technology leveraged is customized to an organization’s unique strategic vision and direction driven by requirements. An organization must take a good internal look at its business model and outwardly at its strategic direction, its mission, and the overall goals it wishes to achieve. Whether an organization is a looking to add to its bottom line and increase profits, save lives and assist in disaster recovery or serve the public, or protect and defend a country’s way of life through military defense and action, the organization must clearly understand their strategic focus and direction and how mobile communications and technology can support this strategic vision (Kornak, Teutloff, and Welin-Berger, 2004).

Getting closer to the customer is the goal of most organizations today. No matter what type of organization, close interaction with the customer is what drives organizations to have a deployed workforce. Of course, a deployed workforce has a requirement to be tied into the organizational infrastructure to connect to critical resources. Increased diffusion of mobile networks and technologies enables geographically separated entities and nomadic workers to utilize mobile communications to be closer to their customer base while remaining constantly connected to the critical resources needed to support the customer. This pushes organizations to rely on mobile technology to drive their strategic direction and goals in today’s mobile environment.
There are three overarching steps that effectively define an organization’s leveraging of mobile technology to achieve maximum benefit and mission accomplishment. Kornak, Teutloff, and Welin-Berger outline these steps and break them down into three comprehensive phases:

1. Mobile/Wireless Strategy Formulation
   a. Vision Development –
      Vision development is high level planning of how mobile technology should best be implementation to attain an organization’s strategic vision and provide the desired benefits (Kornak, Teutloff, and Welin-Berger, 2004).
   b. Setting the Direction –
      Setting the direction allows the organization to define how mobile technologies benefit an organizations and the role mobile technology plays to point the organization in the desired direction (Kornak, Teutloff, and Welin-Berger, 2004).
   c. Portfolio Creation –
      Creating the portfolio of mobile solutions allows an organization to compare the functionalities of each mobile technology solution, perform a cost benefit analysis of each solution, study how each solution will impact the organization, roadmap development, risk mitigation, and end-user testing and validation (Kornak, Teutloff, and Welin-Berger, 2004).

2. Strategy Implementation
   Implementation takes the solution or solutions selected from phase one and deploying them throughout the organization (Kornak, Teutloff, and Welin-Berger, 2004).

3. Strategy Monitoring
   Tracking the implementation ensures that the mobile technologies implemented in an organization is having the desired affects and the strategic goals and benefits are realized. This is also the phase that identifies weaknesses not seen in phase one or two and adjusting the solution to better meet the set goals or just replacing the deployed solution with a better solution based on new requirements or enhanced mobile technologies that have emerged in the interim (Kornak, Teutloff, and Welin-Berger, 2004).

The development of converged technologies, from hardware to software and everything in between, is a continuing evolution of complex mobile systems and diffused networks that are enabling organizations and individuals to increase productivity and organizational effectiveness within their work environment and enhance their private life. This work/life balance, combined with the increased use of mobile technologies to enhance this balance, drives the mobile communications industry to create more powerful and useful mobile tools and technologies. Of course the ability to maintain the proper
work/life balance while affectively using mobile technology is one of the true challenges for current generations of mobile subscribers (Kornak, Teutloff, and Welin-Berger, 2004).

The boundary between work time and free time is and will continue to be a challenge as a mobile person differentiates these two in a mobile world. In a survey conducted between the March and April 2008 shows that 96% of 2,134 adults polled used e-mails, the internet or mobile phones. 80% of those 2049 people using one or all of those three types of technologies claimed that those technologies have improved their work effectiveness. 58% stated that these technologies empowered them with more control over their work. However, 46% complained that these same technologies have increased the pressure for them to work more, and 49% said that using these mobile technologies make it more difficult to unplug from work during their free time. 22% of the employed respondents claim they check work e-mail on the week, which is a 16% increase from a 2002 survey. Mobile devices such as the Blackberry and the Palm Treo are the leading cause for this 16% increase. Those polled who were employee claimed that they check work e-mails on the weekend and during vacation (The Associated Press, 2008).

This survey reflects what the National Computing Centre (NCC) 2006 report highlighting the “seven reflections on our future with mobile data”. The report outlines the terms “switching on” and switching off”. These terms would apply to the above survey findings. “Switching off” is defined as unplugging from one’s work life completely. This requires a certain level of discipline and this is creating a new type of worker that better understands mobile technology and work/life balance. This new generation of mobile employee better understands how to leverage mobile technology to maximize time allotted for work and without affecting their personal time needed (National Computing Centre, 2006).

This next generation of mobile worker may also have less human contact with the rise of mobile technology and nomadic work styles. Some organizations will (and have) eliminated the need for office space and the supported infrastructure. According to the National Computing Center Guidelines, “A company may be able to exist on a purely ‘virtual’ basis, with communications limited to the electronic transfer of data. Intelligence and information that used to be held in the centre of an organization is increasing distributed to maintenance and customer facing staff at the edge.” The lack of human contact with colleagues, more virtual meetings, and less face-to-face interaction will change the face of how organizations recruit their workforce, and create a leadership and management challenge. The concept of team and working toward one common organizational goal will be a challenge across all levels within organization. The sense of camaraderie may be lost unless organizational leadership takes proactive steps to recreate a virtual team environment (National Computing Centre, 2006).

On a societal level, mobile technology has forced society to relook the aspect of a person being tied to one place. Mobile technology will create a new sense of belonging. As a person moves from being tied to a land line phone to being un-tethered with a mobile device, the sense of home or office diminishes as a person is able to be reached anywhere and anytime. According to a 2004 background paper written by Lara Srivastava of the International Telecommunications Union, 2002 was a pivotal year for telecommunications as the amount of mobile users out-paced the number of fixed phones lines world-wide (Figure 4-1). This gaining dominance of mobile
technology in 2002 brought about a significant impact on social and economic development on a global basis. The rise of mobile access provides people and organizations with a powerful tool to enhance and better the way people live and work (Srivastava, 2004).

The ITU reports that by 2005, there were 19 countries where mobile phones outnumbered the entire population. Luxemburg was on the top of this list having 1.4 mobile phones per person. Norway, Denmark, Italy, Hong Kong, the UK, and Estonia were not far behind. Nepal and the Congo, on the opposite end of this mobile subscriber spectrum, had less than one mobile phone per 100 people. The United States fell in the middle with 67 mobile subscriptions per 100 people (Ling, 2008).

Looking at the different types of organizations and individuals whom leverage mobile technology to enhance productivity, there is a broad spectrum of uses for mobile communications that transcends the stereo-typical sales person on the road 100% of the time. Organizations such as FEMA, The Red Cross, and the U.S. Military put leading edge mobile communications to the challenge in support of their daily operations in a deployed environment.
CHAPTER FIVE
THE TECHNOLOGY OF MOBILE COMMUNICATIONS

The evolution of mobile technologies is driven by user requirements and the increased demands for converged mobility anywhere and at anytime. Users require access to voice, data, and multimedia applications while staying connected to an organization’s infrastructure, which is vital for the successful and fully equipped nomadic worker. As the technology that enables mobility is still growing, a significant change has been seen in the use of wireless systems. Between 1990 and 2005, Global System for Mobile Communication, or GSM, enabled the transition from first generation analog wireless systems with a very small user base, to a subscriber base of over 1.5 billion. This fifteen year span experienced the explosion of robust wireless and mobile architectures and the significant price reduction of mobile and wireless equipment (Sauter, 2006).

The underlying theme with mobility is low cost access. Though the equipment may vary in price, it is important to enable a large envelope of access and a standard rate, varying only when service is transitioned to a distant network, say in another country or region of the world. Universal Mobile Telecommunications System, or UMTS, is a third generation technology developed to bring together telecommunications and information technology into a converged, mobile solution for people on the go. As mobile multi-media applications and services become more accessible, the development and demand for new, more robust and better equipped mobile devices will grow along with it. Organizations requiring mobile workers to have access to all of the resources a wired desktop system has residing in the office space. This demand drives the telecommunications market to create more converged mobile technology such as smart phones and other personal digital assistant-like devices (Muratore, 2001).

The wireless architecture that enable mobile communications, such as the one represented in Figure 4-1, are becoming more robust and easily accessible to the mobile user. Convergence of applications and tools into mobile devices are easily supported by such architectures. As the amount of mobile devices is diffused throughout the globe, technology is accommodating these increased requirements through the constant evolution of infrastructure hardware and software. Mobile standards are being built upon and eventually replacing the previous generations wireless technology standard.
Wireless technology standards are the backbone of the mobile industry and shape the way mobile systems are developed and how they are supported. The cyclic effect of wireless standards development is a cause and effect relationship that is traced back to the first generation of wireless standards.

First Generation (1G)

First Generation, or 1G, mobile technology was developed in from the late 1970’s to the mid-1980s introducing analog mobile phone standards to the telecommunication’s industry. Examples of these analog standards include (ICT Regulation Toolkit, 2008):

- Advanced Mobile Phone System (AMPS) used in the United States
- Total Access Communications System (TACS) used in the United Kingdom
- Nordic Mobile Telephone (NMT) used in Norway, Sweden, Finland, Switzerland, and Russia
- C-450 was used in West Germany, Portugal, and South Africa
- Radiocom 2000 used in France
Second Generation (2G)

Second Generation, or 2G, mobile technology was developed to improve on the 1G technology and make mobile technology digital. The primary digital standards include (ICT Regulation Toolkit, 2008):

- GSM – Global System Mobile Communications, or GSM, is a Time Division Multiple Access (TDMA) based standard is used in most of the world
- IS-95 – This Code Division Multiple Access (CDMA) based standard was used mainly in North, Central and South America before most carriers moved to the GSM standard
- PDC – (TDMA-based) is used in Japan

2.5G, the extension of second generation mobile technology, offers connection rates of up to 384 Kbps. Enhanced Data for GSM Environment, or EDGE, is considered to be a 2.5G network technology that is based on the GSM cell phone standard and, with vendors such as Nokia Siemens, software upgrades doubling the download speeds of up 592 Kbps of these 2.5G networks extend the life of this already deployed technology (Reardon, 2008).

Third Generation, or 3G, mobile technology

Third Generation, or 3G, mobile technology was developed to improve on the 2.5G technology and make mobile technology digital. The 3G digital standards include (ICT Regulation Toolkit, 2008):

- W-CDMA – Wideband Code Division Multiple Access is the scheme defined by the ITU as the main platform for UMTS.
- CDMA2000 – Code Division Multiple Access 2000 is the family of technologies that included:
  - CDMA2000 1X – Doubles voice capacity of CDMAOne networks and delivers data speeds of 307 kbps in mobile environments.
  - CDMA2000 1xEV – This includes:
    - CDMA2000 1xEV-DO – delivering data speeds of 2.4Mpbs and supports applications such as MP3 transfers and video conferencing.
    - CDMA2000 1xEV-DV – provides integrated voice and simulations high-speed packet data multimedia services up to 3.09Mbps.
- TD-CDMA – Time Division – Code Division Multiple Access.
Fourth Generation, or 4G, mobile technology

Fourth Generation, or 4G, mobile technology is the next generation of wireless technology that is still being developed to fully replace 3G technology. 4G mobile technology brings data-transmissions speeds into the 100 Mbps and above range along with quality of service QoS and traffic prioritization. This combination of speed and traffic prioritization will enable the mobile worker to have the ability to join a video teleconference and other bandwidth-intensive applications from virtually anywhere using their 4G supported mobile devices, thus bringing yet another capability normally reserved for the desktop office workforce (Pappalardo, 2007).

The technology standards that will help shape 4G mobile technology include:

- OFDM – Orthogonal Frequency Division Multiplexing
- OFDMA – Orthogonal Frequency Division Multiple Access
- Mobile MiMAX – 802.16e IEEE specification designed to support up to 12Mbps transmission speeds using OFDMA
- UMB - Ultra Mobile Broadband (also known as CDMA2000 EV-DO)
- MIMO – Multiple-input multiple-output wireless LAN technology

4G will be designed as an IP-based, heterogeneous network (Figure 5-2) enabling mobile users to be connected and have access to any mobile device at anywhere and at anytime. 4G will provide mobile users with flexible, fast, sharp quality, global coverage. One of the big benefits of 4G is the support for resource intensive applications such as video teleconferencing (www.monet.postech.ac.kr, 2008).
Figure 5-2: 4G Network (monet.postech.ac.kr, 2008)
Table 5-1 below summarizes the past, present and future generations of mobile technology and their associated speeds and features.

<table>
<thead>
<tr>
<th>Services and speeds</th>
<th>Technology</th>
<th>Speeds</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1G AMPS n/a</td>
<td>Analog (voice only)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2G GSM CDMA iDen Less than 20Kbps</td>
<td>Voice; SMS; conference calls; caller ID; push to talk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5G GPRS 1xRTT EDGE 30Kbps to 90Kbps</td>
<td>MMS; images; Web browsing; short audio/video clips; games, applications, and ring tone downloads</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3G UMTS 1xEV-DO 144Kbps to 2Mbps</td>
<td>Full-motion video; streaming music; 3D gaming; faster Web browsing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5G HSDPA (upgrade for UMTS) 1xEV-DV 384Kbps to 14.4Mbps</td>
<td>On-demand video; videoconferencing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4G and beyond WiMax* 100Mbps to 1Gbps</td>
<td>High-quality streaming video; high-quality videoconferencing; Voice-over-IP telephony</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*WiMax has been mentioned as a possible 4G technology, but no standards have been set.

Figure 5-3: Rollup of the different generations of mobile technology (CNET, n.d.)
As the wireless technology becomes more popular and in demand, more and more hotspots emerge throughout common locations such as airports, café’s, hotels, and shopping malls to cater to both the mobile worker force as well as people on their free time. The Institute for Electrical and Electronics Engineers (IEEE) has led the drive to standardize the wireless LAN through the following standards:

**802.11b**
The 802.11b standard, ratified in 1999, is found in the 2.5G and 3G networks prior to the release of IEEE 802.11g in 2003. The 802.11b standard is used in hotels, airports, café’s, and in homes outfitted with a wireless network and are referred to as hotspots. The 802.11b operates in the 11Mbps bandwidth range (Kornak, Teutloff, and Welin-Berger, 2004).

**802.11a**
The 802.11a is the standard for wireless devices operating at 5GHz. Ratified in 1999, the 802.11a, designed prior to 802.11b but implemented after it, operates in the 6 – 54 Mbps bandwidth range and enables mobile devices to transmit between 40 mW and 200 mW, allowing applications to have greater frequency re-use. In order to support this standard, 50% more access points (hotspots) are required to keep pace with the 802.11b standard supporting the 2.4GHz transmission footprint (Kornak, Teutloff, and Welin-Berger, 2004).

**802.11g**
The 802.11g, released in 2003, is similar to the 802.11b standard for devices operating in the 2.5GHz bandwidth range but at much higher maximum operating speed of 54 Mbps for faster throughput (Kornak, Teutloff, and Welin-Berger, 2004).

**802.11n**
The draft 802.11n set for ratification in late 2008 or early 2009 and improves upon the 802.11g standard with faster speeds, enhanced security and greater range. It is backward compatible with 802.11b/g and 802.11n products are finding their way to the market place even though the standard is still in draft (Choney, 2008). Draft 802.11n operates in both the 2.4GHz and 5GHz bands and uses more efficient OFDM modulation delivering 65 Mbps data rate (Thryft, 2007).
CHAPTER SIX
SECURITY AND PRIVACY IN THE MOBILE WORLD

Security and privacy is always a concern with communications. Securing technology from the current threats that exist today has always been a challenge that starts with the developers of mobile and wireless devices, applications, and the networks that support mobile communications. Security and privacy have been mainstay issues for telecommunications and information technology even before the convergence of telecommunications and information technology. The advent of wireless technologies has added new threats and challenges. After September 11, 2001, the nature of security changed forever. New threats arose that took a multi-pronged approach to attacking an individual, a facility, an organization, and a government. Terrorists, hackers, and criminals as a whole begin taking new steps to gaining access to critical information that is stored electronically and passed over both wired and wireless mediums. Mobility and wireless technology has added a new dimension to an organization’s strategic and day-to-day security operations (Buckley, 2008).

Strategically, organizations must look to converged security operations to support the diverse technologies coming accessing their network and resources. The added dimension of wireless, multiplies security vulnerabilities. Different mediums with different types of data crossing over it opens up an organization to a whole host of threats. Mobile workers accessing an organization’s intranet resources utilizing wireless technologies and mobile equipment leave the door open to hackers, thieves and terrorists. Converging security allows total coverage of the multiple types of mediums and devices used by an organization (Berinato, et al, n.d).

Focusing on mobile systems and wireless networks, an organization must address these relatively new technologies and their associated threats and vulnerabilities. The Mobile Antivirus Researcher’s Association has identified the top most critical vulnerabilities that affect wireless and mobile communications:

**Default WiFi Routers**
Wireless routers start out in an unsecured state which may easily allow an attacker to connect and configure the router to meet their needs. The attacker may change the DNS server settings to a static IP that the attacker has control off. The attacker may also upload a hacked firmware version to a router giving the attacker complete control of data. Sniffing programs, wireless scanning drones, and attack scripts are just a few examples of malicious applications an attacker can install on a router and go completely undetected by the owner of that router (Mobile Antivirus Researcher’s Association, 2006).

**Rogue Access Points**
With the ease of setting up wireless access points, individuals within organizations could easily set an access point up within an organization's facility. If an attacker sets a rogue access point up and lures a user away from the organization’s network, the target computer is left vulnerable to the attacker as the attacker may have access to critical data and network configuration of the organizations network (Mobile Antivirus Researcher’s Association, 2006).

**Wireless Zero Configuration**
When computers connect to access points, a computer will normally retain the connection details locally. When a computer has retained these connection details, it will automatically try to reconnect to that access point without user interface. This reconnection is done by sending out a probe request into the airwaves with the SSID of the requested access point contained in the packet. The access point identifies the packet and sends back a probe response. However, since the SSID value is sent as plain text, anyone with a sniffer can see it. They can use this information and configure an access point with the requested SSID, which will then detect the requested SSID and respond as expected. Programs like Karma automate this process and can quickly establish a connection with a wireless user, thus taking over their web connection, and email (Mobile Antivirus Researcher’s Association, 2006).

**Bluetooth Exploits**
BlueSnarfing: OBEX protocol enabling the attacker to access a mobile phone’s calendar, pictures, videos, phone book, email, SMS, and MMS unbeknownst to the mobile phone’s owner. (Mobile Antivirus Researcher’s Association, 2006).

BlueBugging: Allows hackers to send SMS messages from a remote vulnerable phone spoofing the sender (Mobile Antivirus Researcher’s Association, 2006).

BlueJacking: Changing a mobile phone name, an attacker can trick victims into accepting bluetooth connections. A mobile phone’s assigned name is the make and model of the device. When an attacker alters this name to something that may lure a victim, such as “click this link to win $1M and a free car” the victim will may click the pop up, allowing the attacker to connect to the device and infect the victims mobile phone with malicious applications (Mobile Antivirus Researcher’s Association, 2006).

BlueTooth Denial of Service (DoS) attacks: Bluetooth is vulnerable to DoS attacks, therefore an attacker can send invalid Bluetooth requests to a mobile device taking up the entire channel rendering the device un-usable (Mobile Antivirus Researcher’s Association, 2006).

**WEP Weaknesses**
WEP encryption continues to be a common security feature but passwords can easily be cracked using Airsnort. It can take less than an hour to crack an access point’s password. The busier the access point, the greater the amount of packets captured, leading to a faster cracked password (Mobile Antivirus Researcher’s Association, 2006).
**Clear Text Encryption Passwords**
A mobile device is portable subject to easily being lost or stolen. Once a mobile device is out of the owner’s hands and into the hands of an attacker, most third-party encryption software programs do not properly secure sensitive information. Some even store passwords in plain text in the device’s registry (Mobile Antivirus Researcher’s Association, 2006).

**Lost and Stolen Devices**
Arguably, one of the biggest threats to enterprise data is a lost or stolen device. To avoid or minimize this threat, mobile databases should be encrypted. Layered security such as encrypted file systems, add to the securing a mobile device and the protection of critical data. Additionally, security policies and user training are key to avoiding and mitigating this threat. Mobile devices should all have a login copyright banner, along with return information (Mobile Antivirus Researcher’s Association, 2006).

As with most new technologies, the government and the defense industry lead the way in creating secure mobile devices and funding technological advances with regards to making systems more secure to mitigate some of the risks mentioned above. Due to the sheer cost of research, development, and fielding advance systems, these types of organizations are the ones that develop the initial technology. One such example of an advanced mobile system is the Talon® KOV developed for military and government use by L-3 Communications. The Talon (Figure 6-1) comes as part of a kit which includes the Talon Cryptographic Token PCMCIA Card and a Wi-Fi Adaptor (802.11b and g) enabling users with wireless access of up to Top Secret networked resources for anywhere and anytime (L-3 Communications, 2007).

![Figure 6-1: L-3 Communications Talon®](L-3 Communications, 2007)
L-3 Communications also develops the Guardian® Secure Mobile Environment Portable Electronic Device (SME PED) for the National Security Agency. Much like the Blackberry and the Palm Treo, this smart mobile devise merges wireless voice and data technology into a highly secure package with security as the prime goal. The Guardian enables the user the mobility that some government organizations, such as the military, while providing secure wireless voice and data access to mission critical resources world-wide over either a quad-band GSM or dual band CDMA network (L-3 Communications, 2007).

Some of the Guardian’s features include:

- Secure Voice
- Global Roaming over GSM and CDMA networks
- Secure E-mail
- Secure web browsing
- Secure wireless access to the SIPRNET and NIPRNET
- Personal Organizer

No matter what the threats to security are or some of the devices that promise security, the mobile technology provider and the mobile user need to remain proactive and vigilant. Kornak, Teutloff, and Welin-Berger outline four basic tenants that must be met to ensure security of a wireless network:

- Confidentiality
- Authentication
- Integrity
- Nonrepudiation
Confidentiality ensures that only the transmitting and receiving ends are privileged to the contents and details of a transmission. Cryptography is the method used to protect and guarantee confidentiality of a wireless transaction by a mobile device. Authentication ensures that both parties in a transaction are validated as to their true identity. Authentication is done through passwords, digital certificates, and tokens. Integrity is the process of analyzing a transmission to determine if the transmission and the contents being transmitted have been altered in some way. Finally, nonrepudiation ensures that any party in a wireless transaction cannot falsely claim that said party did not participate in that transaction. This is accomplished using digital signatures and certificates (Kornak, Teutloff, and Welin-Berger, 2004).
CHAPTER SEVEN

CONCLUSION

Organizations and individual users alike are reinventing communications and the way society interacts. The diffusion of mobile technology is changing the way people and organizations interact with each other. Organizations are realizing the benefits of mobility and mobile technology. Whether the organization is a not-for-profit organization, or a global company, mobility is changing the social fabric of society. The over-arching theme is touching as many parts of the globe and as many individual people as possible. The dramatic explosion of mobile technologies is forcing organizations to relook their strategic vision and to learn how to best leverage mobile communications. As the mobile workforce grows, an organization’s culture changes. Adapting to these cultural changes is the key to a successful and productive mobile workforce.

The use of mobile technologies by nomadic workers bleeds into mainstream society. Technology that is normally affordable only by organizations drives technology to make mobile communications in greater quantities. The flood of devices and mobile services drives prices down, making these devices and services more accessible to individuals. As society continues to evolve, technology will keep pace and continue to improve on advancements of mobile communications. Looking forward, the ability to shape the way organizations and individuals pattern their work and life will continue to advance and grow. The key to success for an organization is their ability to effectively leverage current technology and quickly adapt to new, emerging technologies. This will enable individuals and organizations continually improve upon the development of and advancement of society and enhance the quality of life on a global scale.
REFERENCES


