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ABSTRACT

This paper explores how different mobile communications technologies combined together have the potential to significantly change the way we work. Mobile telephony combining satellite and terrestrial cellular systems already has transformed the way people work by allowing "anytime, anywhere" telephone calling and text messaging. However, wireless data has not met the "anytime, anywhere" criteria due to problems with cost, power consumption, compatibility, and bit rate. Not all information should be available anytime, anywhere. The key is to provide information conveniently as quickly and easily as possible when needed and where needed. The evolution of different mobile technologies that consider different needs for time- and space-related information is providing a new capability, personal area networks (PANs), with the potential to change the way we work.

Keywords
Personal area network (PAN, wireless personal area network (WPAN), wireless local area network (WLAN), wireless interconnection; Bluetooth; wireless communication technologies, Wi-Fi (wireless fidelity), wireless application protocol (WAP), IT management, pervasive computing.

INTRODUCTION

The evolution of different wireless technologies to provide for a new capability, referred to as personal area networks (PANs), has the potential to change the way we work. Mobile and remote employees need to have seamless access to timely information as well as be able to stay in touch with customers, suppliers, and fellow workers. Mobile technologies have already transformed the way we work. Mobile telephony combines satellite and terrestrial cellular systems and has become a critical IT technology for mobile employees. Mobile phones were the first devices that employees could take with them away from the office. Work has been transformed to allow and expect that people will work using "anytime, anywhere" telephone calling and text messaging.

Wireless access to data and the Internet was the next step. A variety of mobile wireless standards allowed employees access to their email and other timely information and gave them the ability to make and accept transactions away from the traditional workplace at any time. However, wireless data has not met the "anytime, anywhere" requirement due to problems with cost, power consumption, compatibility, and bit rate. Today, IT managers plan and implement a variety of different mobile technologies from multiple service providers, which result in a number of issues. The goal to resolving these issues is the seamless access to information and services, which will result in the redefinition of both personal and organizational productivity (Chincholle, Eriksson, and Burden, 2002; Varshney and Vetter, 2002).

The distinction among wireless, wireline, and Internet service providers is blurring as data technologies evolve into third generation (3G) systems. Wireless Application Protocol (WAP) is one set of specifications, based on existing Internet standards, that is standardizing the way mobile telephones access the Internet. On the other hand, WAP content is different than traditional Web content, so Web site owners must have two types of Web sites, one for wired and one for wireless. Creating WAP content just for mobile devices or converting existing Web pages for wireless access are both expensive processes.

As WAP and 3G technologies evolve into market products, they may have only partial success in radically changing how we work due to their technical limitations. These limitations are not the topic of this paper, however, a new type of wireless

technology may overcome the limitations and create limitless opportunities for future business applications. Goodman (2000) described a new wireless communications paradigm that would:

> *Create <u>ad hoc</u> networks operating in <u>unlicensed</u> frequency bands. These networks will use signals <u>that adapt themselves</u> to the changing operating environment, thereby achieving <u>location-dependent</u> quality of service and <u>asymmetric</u> information flow between network nodes. (p. 38)*

Wireless access to the Internet and Intranets does not mean that all information should be available anywhere. The key is to provide the data conveniently as quickly and easily as possible when needed and where *needed*. Location-based information applications consider the differences in time- and space-related information. Users should have the seamless access to the specific services and information on a selected or location-based need (Miskell 1998). Information Technology (IT) planners need to understand when and where employees use information in order to deploy the right combination of technologies. A new mobile technology, personal area networks (PANs) considers different needs for time- and space-related information. We are only just beginning to envision how PANs will change the way we work.

Varshney and Vetter (2002) identified a series of mobile commerce research that will impact how IT managers plan and deploy new wireless technologies. Two items on their list address the topic of this research paper:

- *Identify novel applications and services made possible due to the wireless networks and mobile devices,*
- *Understand how context and location-awareness are unique to mobile commerce as many of the applications are sensitive to the context and the location of the user (p. 197.)*

The purpose of this research is to define how the evolution of PAN technologies will impact the way we work and to identify potential new and innovative business applications. The remainder of this paper discusses the various wireless technologies used by IT managers to meet the mobile communication needs of corporate employees. It also discusses the potential benefits and issues of PANs. Finally, this paper discusses some of the IT implications for planning and deploying PANs.

BACKGROUND

Changing Nature of Work

Work has been traditionally tied to a specific place or location and time. Table 1 shows different types of work functions depending on where and when a person works. Work was primarily defined by where you worked until the early 1990s when flextime was first introduced in corporate America. Once managers understood that work could be performed away from the "supervisor's watchful eye," employees were able to begin to do work other than at the traditional or fixed work location. Because of new technology capabilities, corporate managers should begin to think of work as more of an activity rather than a specific place or time (Miskell, 1998).

<div align="center">THE WORK PLACE</div>

		FIXED	REMOTE	AGILE
THE WORK TIME	FIXED	Factory Office Store	Telecommuting Outsourced "backroom"	Sales Onsite service / technical support Delivery drivers
	AGILE	Flextime Job sharing Desk sharing Hoteling	Global work teams Global outsourcing	Total Agility (time and location independent)

<div align="center">**Table 1: Types of Work Functions**</div>

The concept of the traveling sales representative has been around since the late 1800s. However, until the mid 1980s, sales reps had only a telephone to assist them. The advent of mobile computers and personal digital assistants (PDAs) allowed them to take their information with them (Adams, 2000). However, sales reps are more successful with immediate access to real-time data. Hayes-Roth and Amor (2003) conducted a case study comparing two sales reps using mobile computing applications with PDA devices to the traditional sales force. The study identified different techniques that saved time and improved productivity for the sales reps. Both sales reps downloaded specific customer data prior to customer meetings.

They placed orders directly from the customer's location. They were able to attend meetings remotely. They worked in a virtual workplace using local area networks, managed networks, and the Internet.

Mobile Computing

Mobile computing allows mobile access to corporate Intranets and databases through the public Internet.
Agrawal and Famolari (1999) predicted that the next generation of wireless communications would offer unprecedented level of connectivity and transmission capabilities. However, this next generation needed to solve the problems of early mobile data. These include limited access speed (bandwidth), power consumption, and limited graphics capability. Varshney and Vetter (2000, 2002) identified potential benefits of mobile commerce including providing better customer service by enabling orders in real time, checking inventory levels, and preparing quotes and proposals. To obtain these benefits, employees need to have the right IT products and services. This lead to the wireless paradox employees want to be "unattached" yet "connected" (Goodman, 2000).

Personal Area Network Technology

A personal area network (PAN) is a set of information technology devices that have the capability to interconnect each other within the range of an individual person. Employees with PAN technology carry or wear devices that have the capability to interconnect their own devices and other employees' devices within the range of approximately ten meters of an individual person allowing the exchange of various kinds of information. The interconnection of a personal area network allows access to the Internet or other networks without wires. This is synonymous with the concept of a wireless personal area network (WPAN). The close proximity of two WPAN-equipped devices (within several meters of each other) or within a few kilometers of a central server could maintain communication and provide information technology as if connected by a cable. The main difference between a PAN and a WLAN is that the PAN is directly channeled to a person while local area network (LAN) is connected also without wires and serves multiple users.

A WPAN, is a low-cost networking that wirelessly enables to communicate with each other over short distances. Unlike with wireless LAN's, only devices within this limited area typically participate in the service area, and without devices involved for online connection. These technologies can perform its function in public places, in the home, in the office, and in a car. A WPAN has the ability of serve and interconnect all ordinary computing and communicating devices that many people carry with them – or it could assist the surgeons and other team members to communicate during the surgery. An individual who has an access to WPAN devices will have effective delivery and response towards digital information.

Standards-based Wireless Systems

Existing wireless networks provide connectivity within specific environments limited by bandwidth availability, cost, and coverage area. Nikolaou, Vaxevanakis, Maniatis, Venieris, and Zervos (2002) discussed how the next generation of wireless technologies would finally be able to provide a "virtual" world for employees and consumers. They used a concentric ring analogy to identify the scope of the technologies. The rings include an in-building to an on-campus environment, a wide-area (outdoors), and a global area using satellite communications.

Wide-area Wireless Technologies

Cellular radio telephony systems were first deployed in 1986 in the United States using two different transmission schemes: time division multiple access (TDMA) and code division multiple access (CDMA). Global System for Mobile (GSM) communications is the predominant global cellular standard today. These second generation cellular systems were designed for voice telephony transmitting data at 14.4 kbps for circuit –switched transmission and up to 19.2 kbps for packet data (Johansson, Kazantzidas, Kapoor, and Gerla (2001); Nikolaou, et. al., 2002; Adams 2000). U. S. service providers using TDMA converted to General Packet Radio Service (GPRS), a modified version of GSM considered to be the 2.5 generation (2.5G), to achieve packet data transmission at 144 kbps. Third generation (3G) mobile networks are rapidly being developed. Referred to as Mobile Telecommunications System (UMTS), these 3G systems will provide access to the Internet through mobile phone devices. This would allow higher data rates in the hundreds of kilobits. 3G wireless technologies are designed for high-speed transmission of voice and data, including mobile audio and video.

Wireless application protocol (WAP) is a set of specifications based on existing Internet Protocol (IP) standards. WAP specifications standardize how wireless devices including cell phones and personal digital assistants (PDAs) access the

Internet with secure access to text-based information such as email and Web pages and for banking, stock trading, and customer care services (Gray; Adams 2000; Goodman 2000). Because of the limited screen-size and slower bit rate of wireless devices, WAP content is different than the Web. The potential opportunities for use by employees have led some companies to create basic WAP applications to access existing Intranet information such as customer contact or billing information. Enterprise resource planning (ERP) and customer relationship management (CRM) providers have also begun to build WAP technology into their systems. Third generation technology and WAB-enabled devices address the concerns about transmission speeds. The users must still content with the power consumption and cost issues (Goodman 2000).

In-building and Campus-wide Wireless Technologies

Initially, wireless LAN technology was deployed in traditional office environments where it was impractical to deploy wired networks, i.e., concrete floors, closely-spaced buildings with major highways between them. The WLAN was more expensive to deploy, but more than made up for its cost in the savings for ongoing moves and rearrangements. The technology evolved as the benefits of mobile computing spread to a diverse set of applications. Handheld hardware, such as barcode scanners, laptops, and stock checking devices, provided new ways of doing business while saving the costs of paperwork and operating expenses. Employees in remote locations including warehouses and manufacturing plants had the same access to the various information systems used to manage the business.

Personal Wireless Technologies

Wireless fidelity (Wi-Fi) standards provide wireless LAN (WLAN) capabilities to interconnect to the Internet or Intranets. These are used for in-building or on-campus settings. IEEE 802.11b is a direct-sequencing technique transmitting data at 11 Mbps. IEEE 802.11g provides greater speeds, up to 22 Mbps allowing greater bandwidth and more graphic-intensive information. Higher speeds tradeoff in shorter range, requiring more access points. Besides companies installing WLANs on their premises, wireless service providers also install "hot spots" in public areas such as hotels, airports, coffee shops (Berman and Drucker 2003). Unfortunately, these networks of hot spots need "roaming" agreements similar to early cellular service provider agreements. Otherwise, individual users would need to subscribe to all location-based service providers.

Bluetooth is a wireless technology developed by Ericsson, Intel, Nokia, and Toshiba that specifies how mobile phones, computers, and PDA's interconnect with each other, with computers, and with office or home phones. It replaces cable or infrared connections for such device. The network will connect and manage all the computing devices, services, and applications. Bluetooth uses frequency-hopping scheme in the unlicensed industrial, scientific, and medical (ISM) band at 2.4 GHz. An individual with Bluetooth PAN can then access the Internet two difference ways: 1. wireless local area networks (WLANs) access points; or 2. GPRS (2.5G) or 3G UMTS cellular networks. PANs can also interconnect with other PANs, thus creating ad hoc networks (Johansson, et. al., (2002).

Location-based services (LBS) are a new set of business applications that deliver geographic information between mobile and/or fixed users via a wireless network connected to the Internet. The key is to provide a user personalized information depending on the user's current position. This means the user gets only the information needed at that particular time in that particular place – the ultimate goal of moving information to employees and customers (Thorat 2002, Chincholle, et. al., 2002). Examples of LBS include user-solicited information including the news, weather, and stocks; mapping and routing information to reach a destination, and digital or e-coupons, which offer the limited –time special discounts to near-by business establishments (Chincholle, et. al., 2002).

FUTURE WORK FOR IT MANAGERS

Identifying employee core business needs before deploying new technology innovations. This includes understanding how the devices will be used in real work situations and how to make the interfaces simple and easy to understand (Chincholle, et al., 2002). Therefore, the work context and task must be considered. Otherwise, users need to do additional work to align their mobile devices with the work task. Kristoffersen and Ljungberg call this "making place." A new research area, mobile computer-supported cooperative work (mobile CSCW) research is addressing the business needs concerning the context, task, and content of work and how best to develop work-related applications.

The key is to consider both the tasks and the usability of the devices. Chincholle, et. al., (2002) recommended design considerations for WAP-enabled wireless service providers:

- Keep the service as simple as possible,
- Make the service easy to navigate,
- Give the user speed,
- Provide drill-down selection list to save inputting, and
- Test and redesign the service continuously.

IT managers will want to evaluate new wireless and PAN services using the above criteria. The bottom line is to enable the development of innovative applications for employees that are *"unattached yet connected*" (Goodman 2000).

CONCLUSIONS

IDC recently surveyed 700 U.S. households concerning emerging technologies. The number one consumer wireless applications was for location-based services (LBS). Although IDC predicts that 40 million consumers will be using LBS by yearend 2005, to key issues will affect that count: 1. whether service providers will deploy the necessary infrastructure, and 2. how will the service providers address user privacy issues (Thorat 2002).

New communications technologies may not necessarily change what people do at work. However, technologies may change how work is performed and create new ways to do the same old things. Therefore, deploying new technologies for work requires that IT managers understand what is changing and what is not changing as well as understanding the significance of new technological innovations. It will also be critical for the IT managers to build PAN services that exploit the mobility benefits of the integration of the various wireless technologies
 (Chincholle, et. al., 2002). New technological innovations must meet the core business needs of employees first, and the company second. Anderson, et. al., (2002) provide questions, which require and understanding of the changing means of work:

- *"...does the technology enable a broader population of less skilled or less wealthy employees (I substituted employees for the quoted customers) to do things for themselves that previously only experts or wealthy individuals could do?*

- *"...does this product or service help customers get done more easily and effectively what they are already trying to get done?" (Anderson, et al., 2002, p. 27.)*

These are the questions that future work will focus on.

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