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Moving Towards Mobile Third Generation Telecommunications Standards: The Good and Bad of the 'Anytime/Anywhere' Solutions

Jerry Fjermestad
New Jersey Institute of Technology, fjermestad@adm.njit.edu

Katia Passerini
New Jersey Institute of Technology

Karen Patten
New Jersey Institute of Technology

Michael Bartolacci
Penn State University - Berks

David Ullman
New Jersey Institute of Technology
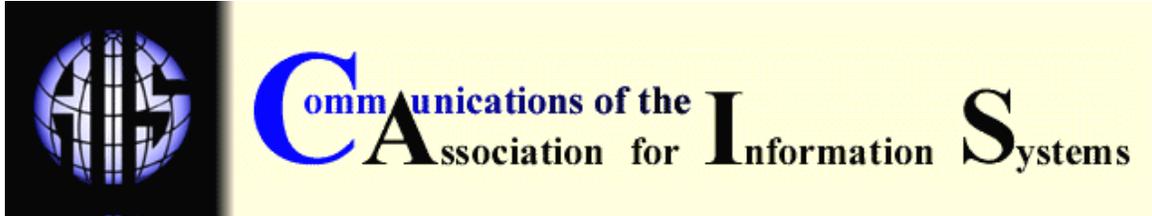
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MOVING TOWARDS MOBILE THIRD GENERATION TELECOMMUNICATIONS STANDARDS: THE GOOD AND BAD OF THE 'ANYTIME/ANYWHERE' SOLUTIONS

Jerry Fjermestad
Katia Passerini
New Jersey Institute of Technology
fjermestad@adm.njit.edu

Karen Patten
New Jersey Institute of Technology

Michael R. Bartolacci
Penn State University - Berks

David Ullman
New Jersey Institute of Technology

ABSTRACT

Mobile communication technologies are changing every aspect of the daily life, bringing new opportunities in many areas. Several converging mobile systems can potentially change organizations significantly by shifting the traditional boundaries of work-life and the workplace. Mobile telephony, combining satellite and terrestrial cellular systems, already transformed the way people work by allowing 'anytime/anywhere' telephone calling and text messaging. Broadband mobile telephony opens additional avenues to provide information conveniently as quickly and easily as possible, when needed and where needed. The evolution of wireless technologies (from Wireless Personal Area Networks to ubiquitous Third Generation/Universal Mobile Telecommunication System – UMTS) increased the number of services available to business organizations and mobile workers. Machine-to-machine, vertical applications, and mobile office applications are increasingly being deployed. Service providers and mobile operators are also changing the way they operate as a result of the increasing availability of mobile broadband communication services. IT departments need to change their systems, upgrade, and adapt their infrastructure and policies to support these mobile services. These changes are both positive and negative. With this progression, some fundamental questions related to privacy, security, and a new concept of work place and work space are raised. The implications for developing economies, such as China, and their potential for leapfrogging are future attention areas.

I. INTRODUCTION

This paper summarizes the discussion of the panel at AMCIS 2005 on the impacts of mobile applications and standards. The panelists discussed how mobile communication technologies are changing every aspect of daily life, bringing new opportunities in many areas. They addressed the impacts from three different perspectives:

- service providers,

- organizations, and

- users of mobile cellular services

and how each of these groups substantially changes the way they operate as a result of the increasing availability of mobile broadband communication services. These changes were analyzed as being positive, negative, or both. Specific topics included the evolution of wireless personal area network (wPANs) systems and the third generation (3G) mobile standards, such as Universal Mobile Telephone Services (UMTS), the evolving business models for mobile operators offering 3G services, the implications for organizations, and the implications for developing economies, with particular attention to China.

The panelists are the authors of this article.

II. OVERVIEW AND KEY QUESTIONS

Several converging mobile systems can potentially change organizations significantly by shifting the traditional boundaries of work-life and the workplace. Mobile telephony, combining satellite and terrestrial cellular systems, already transforms the way people work by allowing anytime/anywhere telephone calling and text messaging. Broadband mobile telephony is opening additional avenues to provide information conveniently as quickly and easily as possible, when needed and where needed. While wireless data does not meet the anytime/anywhere criterion because of cost, power consumption, compatibility, and bit rate issues, these problems and limitations are being resolved. In spite of the mobile data evolution, some fundamental questions remain concerning to what extent the anytime/anywhere paradigm should be driving the next investments in IT. Critical to these questions is the understanding that not all information should be available anytime, anywhere. The key is to focus on deploying different mobile technologies that consider varying needs for time- and space-related information.

General questions addressed by the panelists included:

- In the on-going blending of technological standards across industries and the emergence of network interconnectivity across wired and mobile platforms, what will be the social impact of unbounded mobility on the way people work?
- Which content and services should be created, managed, and delivered? What are the perceived key applications (if any) that will meet users' mobility needs?
- Considering the investments, risks, and efforts related to deploying the mobile broadband technologies, will mobile operators need to re-define their current operating models?
- What lessons can we learn from the implementation experiences of wireless campuses?
- Can 3G services open new opportunities for developing economies by guaranteeing access to information and communication technologies to a larger population?
- What are the implications of the Chinese telecommunications industry and its government's regulation on the rest of the wireless world with respect to 3G and possibly 4G?

III. WIRELESS CONNECTIVITY AND STANDARDS: FOCUS ON 3G

Wireless access, broadly defined as a means of distant connectivity to data and business applications through wireless devices by employees, clients, and partners, enables mobile workers to access resources remotely to complete their work-tasks, thereby extending their connectivity and reach. Business users are no longer limited by wired local area network connections to their workspaces, offices, and homes. They now can stay connected anywhere the business operates without being physically wired to a place or device.

Wireless telecommunication technologies rely on radio waves, microwaves, infrared, and visible light pulses to transport data between digital devices. Examples of communication networks span from terrestrial microwave, satellites, cellular, and Personal Communications Services lines (PCS) that utilize specific frequencies in the electromagnetic spectrum. A number of wireless standards that enable voice and data exchanges at different frequencies minimize interference and maximize communication efficiency [Intel Corporation, 2005]. These communication standards provide different connection mechanisms, throughputs and coverage ranges. Table 1 summarizes the emerging standards in the wireless communication environment and their key characteristics.

Table 1. Broadband Wireless Standards

	Ultra --Wide Band	Blue-tooth	Wi-FI	Wi-FI	Wi-FI	WiMAX
Standard	802.15.3a	802.15.1	802.11a	802.11b	802.11g	802.16a
Type	WPAN	WPAN	WLAN	WLAN	WLAN	WMAN
Throughput	110 to 480Mbps	Up to 720Kbps	Up to 54Mbps	Up to 11Mbps	Up to 54Mbps	Up to 70Mbps
Range – coverage	Up to 30 feet	Up to 30 feet	Up to 300 feet	Up to 300 feet	Up to 300 feet	Up to 31 miles
Frequency	7.5GHz	2.4GHz	5GHz	2.4GHz	2.4GHz	2GHz-11Ghz

	WiMAX	WiMAX	WiMAX	2.5G (GPRS)	3G	UMTS
Standard	802.16b	802.16d	802.16e	Edge	CDMA 2000 (1x-EV-DO)	WCDMA
Type	WMAN	WMAN fixed	WMAN mobile	WWAN	WWAN	WWAN
Throughput	11Mbps	Up to 75Mbps	Up to 30Mbps	Up to 384Kbps	Up to 2.4Mbps	Up to 2Mbps
Range – coverage	Up to 30 feet	4-6 miles	1-3 miles	1-5 miles	1-5 miles	1-5 miles
Frequency	2.4GHz	<11GHz	2-6GHz	1900Mhz	400,800,900, 1700, 1800, 1900, 2100MHz	1800, 1900, 2100MHz

Source: Adapted from Intel Corporation [2005]

Wireless Personal Area Networks (WPANs) are peer-to-peer networks that use Bluetooth radio frequencies and infrared connectivity in limited coverage areas. The use of Bluetooth technology avoids the line-of-site problem of infrared connectivity (as in TV remote controls, infrared connectivity requires direct pointing) and is easy to maintain and implement in local small offices settings. Ultra-wideband (UWB) is an upcoming higher speed form of personal area network with higher throughput in a short coverage range. Wireless LAN (WLAN) is supported by the 802.x family standards for local connectivity often used in medium size to large campuses [Boncella, 2002]. It is the preferred connectivity option for buildings and is deployed in many other locations (including cafés, airports and local libraries). WiMAX connectivity provides wider range and higher

speed than Wireless LAN and is based on the 802.16x wireless family. Wireless Wide-Area networks (WWANs) rely on geographically dispersed base antennas for cellular phone networks such as Global System for Mobile Communications (GSM), general packet radio service (GPRS) upgrades, and Code Division Multiple Access (CDMA) supported by the higher speeds of 3rd generation (3G) cellular wireless. The 3G mobile standards enable services and growth opportunities for mobile connectivity that are described in this paper. All these options better meet the needs of mobile workers.

A review of current 3G standards helps to understand the uncertainty surrounding their usefulness for business applications and personal productivity. Second generation (2G) standards such as CDMA, Time Division Multiple Access (TDMA), and GSM limit the applicability of mobile communications for data-intensive applications due to their relatively low data rate. The transition to 3G standards is necessary to make anywhere/anytime a reality. CDMA 2000, the standard that appears to have the most support in the U.S., was developed by Qualcomm and can be implemented in steps [Agrawal and Famolari, 1999]. This standard allows the 2G and 2.5G architecture to be upgraded over time as opposed to rebuilding the entire network at once. The ability to phase in this standard represents a significant financial advantage over other standards and is one reason why it is the choice of U.S. network providers. WCDMA (Wideband Code Division Multiple Access) is a standard requiring rebuilding of the existing network infrastructure. This standard has support in Japan and Europe [Zhang and Prybutok, 2005]. China, the largest mobile communications market in the world, is moving towards another proprietary and 'home-grown' standard, the TD-SCDMA (Time Division Synchronous Code Division Multiple Access).

IV. CHANGING THE WAY WE WORK

> *In the on-going blending of technology standards across industries and the emergence of network interconnectivity across wired and mobile platforms, what will be the social impact of unbounded mobility on the way people work?*

Traditionally, work was tied to a specific place or location and time. Table 2 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 1980s (Hiltz and Turoff, 1978; Johansen, 1984) when new forms of work, anytime/anyplace, were being investigated. Furthermore, Olmsted [1983] found that by 1981 more than one-fifth of the US workforce worked flexible, compressed or reduced schedules. Flextime, which allowed corporate employees to select their work hours within specific boundaries, was introduced into 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 the new technological capabilities of pervasive computing [Miskell, 1998], work begins to be disconnected from the traditional work place, and corporate managers begin to think of work as more of an activity rather than a specific place or time.

Table 2. Types of Work Functions (Source: Patten [2004])

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

Traveling sales representatives can be considered an example of mobile workers. However, these mobile workers had only technologies such as the telegraph and the telephone to assist them until the mid 1980s. Mobile laptop computers and personal digital assistants (PDAs) allowed mobile workers to take their information with them [Adams, 2000]. However, Hayes-Roth and Amor [2003] conducted a case study that showed sales representatives are more successful with immediate access to real-time data. They compared 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 representatives. In this regard, the sales representatives were able to downloaded specific customer data prior to customer meetings. They were able to place orders directly from the customer's location. They attended meetings remotely. They worked in a virtual workplace using local area networks, managed networks, and the Internet.

The distinction among wireless, wired, and internet service providers is blurring as data technologies evolve into 3G systems. Wireless access to the Internet and Intranets does not mean that all information should be available anywhere. The key is to provide 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. Information Technology (IT) planners need to understand when and where employees use information (point of need information delivery) in order to deploy the right combination of technologies [Egan, 2000; Rao and Minakakis, 2003].

The evolution of new mobile data technologies can help the techno-savvy employee become more productive. Theses employees are early adopters of new technology by experimenting with new uses for emerging technologies. They also are willing to spend their own money to experiment, especially if they perceive that they will receive any advantages [Wang et al., 2005]. These people are both a benefit and a disadvantage for the organization IT management. Experimentation saves expenses for the earliest implementations of new technology, but the technology is not integrated with the embedded infrastructure. The IT manager can learn from the early adopters' experiences as a trial, but must also deal with the issues of deploying the new emerging mobile technologies. End users are usually not concerned with system issues such as security and privacy, especially if the technology helps them. The IT manager must integrate the new technology into the organization's infrastructure, hopefully without taking away the benefits to the employees.

V. SERVICES FOR THE MOBILE WORKERS

> *Which content and services should be created, managed, and delivered to support mobile workers? What are the perceived key applications?*

A number of wireless broadband services can support the needs of the mobile workers, each requiring different levels of service personalization and integration with existing infrastructures. Some of these services may require a high level of integration with existing corporate networks and applications or they may require substantial application customization (to respond to pull requests from the mobile workers rather than pushing the same content to all employees). Each of these requirements provides challenges for IT departments.

Services that can support the needs for customization, information access, and communication efficiency are machine-to-machine services, vertical applications, mobile office applications, internet browsing services and mobile address. These services specifically help mobile workers [MacInnes et al., 2002; Sarker and Wells, 2003].

Machine-to-machine (M2M) services use wireless equipment sensors to improve equipment maintenance practices. Repair and maintenance small businesses operations can automatically be alerted of equipment malfunctioning by sensors which send cellular wireless signals to a

remote location or to the repair contractors' cellular phone. This approach automatically speeds up problem resolution and avoids the need for a call center to support the repair calls.

Vertical applications and service integration over personal digital assistants (PDAs), which is typical of extensive supply chains, can also benefit the small firms and contractor companies along the chain. For example, wireless services benefit car dealerships by providing customers at the dealership a real-time answer on inventory availability at related dealers and suppliers. DealerAdvance is an example of such integrations (www.strongholdtech.com) that enables queries to the inventory and wireless printing of car characteristics/alternative options in real time, which is fast enough to lock-in customers while at the dealership.   Systems similar to DealerAdvance are also particularly useful for real estate agencies with the additional option to integrate with location based services such as Geographic Positioning Systems (GPS) to identify nearby properties in the area. LogicBuilt Inc (www.logicbuilt.com) provides software that supports these services on cellular phones.

Mobile office provides wireless access to office applications, Internet Browsing, Adobe Reader-based documents, email, messaging, and advanced communication services on PDA interfaces. These services are particularly useful to mobile workers that need to access documents and files from multiple locations. Various companies are developing technologies to make these services available for delivery on compact interfaces. For example, Bitstream (www.bitstream.com/wireless/) launched a wireless Web browser (ThunderHawk) that can display sharp text and clear graphics of full Web pages and can reduce scrolling by compressing images, and using cache and text rendering (Figure 1).

Videoconferencing services are also slowly becoming accessible to provide remote conferencing capabilities while on travel. Samsung is launching push-to-all video streams on cellular phone devices and skype.com (www.skype.com) is experimenting with Voice-Over-Internet-Protocol (VoIP) real time 2-way video-conferencing on wireless.

The convergence of the '*mobile address*' as a single messaging center is a potential killer application for mobile workers. This service provides a single personal mailbox for voice, electronic mail, short-messaging system (SMS or text-messaging) and fax messages. E-mails and faxes can also use currently offered voice recognition and text-to-voice conversion options, such as Mailcall.com (www.mailcall.com). This service enables customers, clients, and related stakeholders to reach the mobile worker in multiple ways, while the mobile employee can retrieve any message in his/her preferred single delivery mode and device.

Source: http://www.bitstream.com/wireless/products/enterprise/corporations/screen_shot.html

Figure 1. ThunderHawk Wireless Web Browser

A number of applications both in the consumer and business market segment can drive increased revenues for mobile operators. They include, for example,

- information services (traffic information, GPS-Navigation);

- mobile-commerce services such as financial transactions and on-line trading [Varshney and Vetter, 2002; Rao and Minakakis, 2003; Lukkari et al., 2004];

- advanced communication services (E-mail on-the-go, Video-telephony, remote control and access to company data); and

- corporate solutions (mobile office suites).

As the technology matures and is further integrated in existing company infrastructures, these key services can, and will, move towards generalized adoption. The delayed boom of the key applications is mostly linked to higher complexity of their deployment because of the higher integration requirements. Figure 2 summarizes a relative positioning of these services based on the level of service personalization that can be provided to the mobile worker and the level of integration with existing company infrastructures that they require. The higher the level of integration coupled with a more complex the deployment of the service leads to a longer implementation timeline.
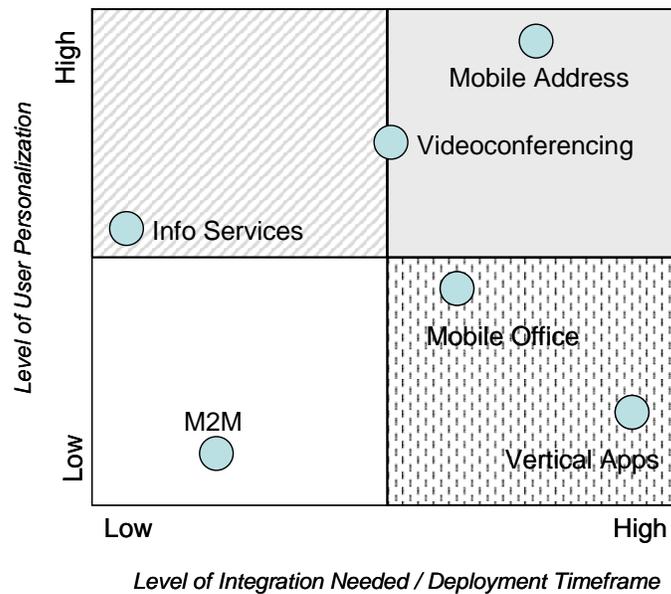
Figure 2. Wireless Broadband Services Characteristics

VI. THE CHANGING ROLE OF THE MOBILE OPERATORS

To service the mobile workers, will mobile operators need to re-define their current operating models?

To service the needs of an increasingly mobile workforce, mobile telephone operators are changing their traditional role as voice-communication backbone providers and are plunging into data and wideband services provisioning. They can now use the radio network infrastructure as the backbone infrastructure for ubiquitous e-commerce, e-banking, on-line information services,

video-on-demand, content-on-demand, and location-based services (such as traffic updates and real time driving directions). For example, Looney et al. [2004] discuss uses and emerging business models in financial services (mobile brokerage). If incumbent operators were mainly focused in developing the infrastructure for mobile voice service provisioning, attending to marketing and distribution of voice services, and setting up mechanisms for enhanced customer care, the emerging value chain appears more fragmented and opens a whole different set of prospects (Figure 3).

TRADITIONAL VALUE CHAIN OF MOBILE SERVICE DELIVERY
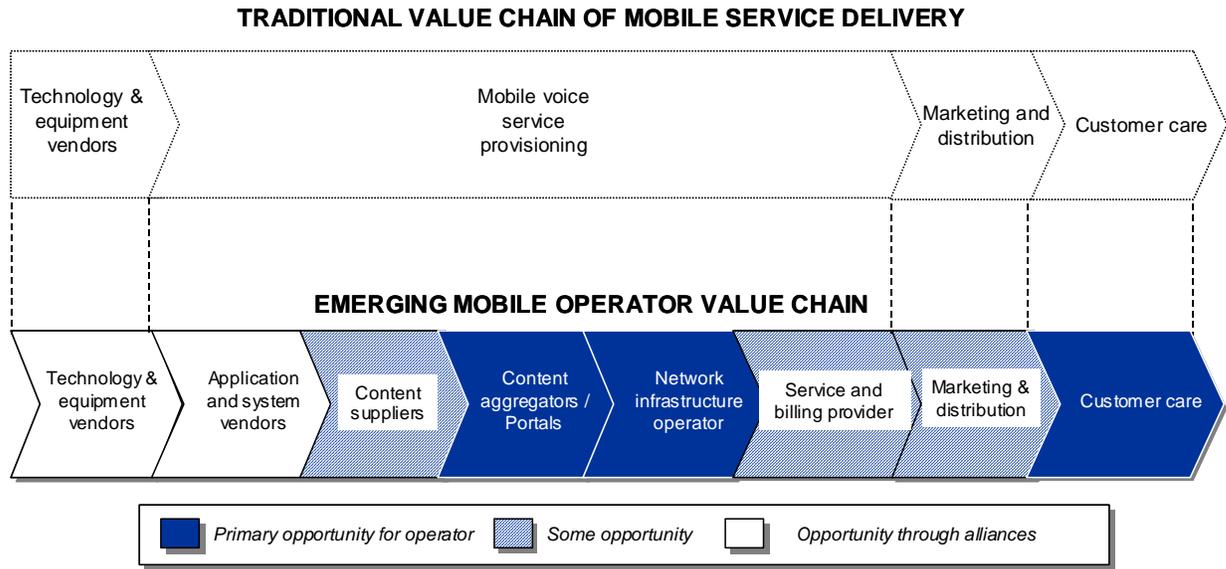
Source: Passerini et al. [2004]

Figure 3. Mobile Operators Value Chain

The fragmentation and re-intermediation of the traditional value chain is brought about by the development of the new 3G mobile technology such as the UMTS. In these digital cellular networks, besides voice continuing to be delivered at a high quality level, additional data services can be packaged with traditional voice connectivity options [Rupp and Smith, 2002]. To succeed in the emerging value chain, mobile operators must learn to leverage new technologies beyond their traditional assets such as the network infrastructure as in Figure 3. Their position as primary customer contacts gives them an advantage to learn from users' needs. By leveraging this information, and building a solid network of content, service, and technology providers, they can build innovative business models based on enhanced functionality, making end-user life easier, and opening entirely new doors and business channels for themselves and their partners. By leveraging both ends of the new mobile value chain (the emerging technologies and terminal equipments, and the customer needs knowledge-capture by sophisticated CRM systems), mobile operators should be able to expand their market shares against competitors. They can play multiple roles (Figure 4).
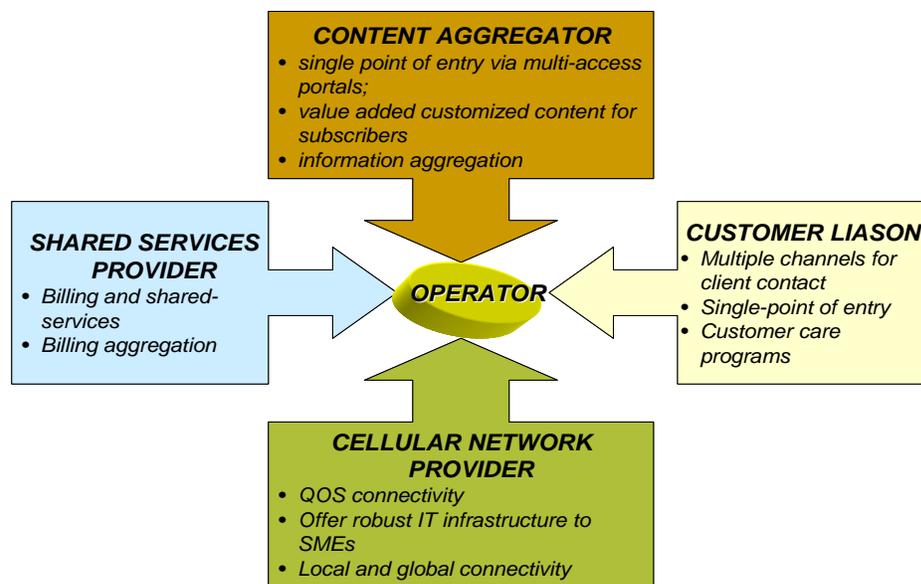
Figure 4. Mobile Operators Opportunities

CONTENT AGGREGATORS

- Guarantee a single point of entry trough multi-access portals;
- Provide value added customized content for subscribers
- Offer richer-media and information aggregation in a single device (a sophisticated cell phone or mobile PDA which uses the cells connectivity to route calls and access data services).

CELLULAR NETWORK PROVIDERS

- Provide network ubiquitous connectivity and quality of coverage;
- Implement a robust IT and network infrastructure also within traditional local campuses dominated by technologies;
- Provide local and global connectivity to achieve a true anywhere/anytime mobile connection to company data.

SHARED SERVICES PROVIDERS

- Offer billing and shared services based on earned competence in dynamic billing (using a business model such as pay-per-use, subscription, or pre-paid card).

CUSTOMER LIAISONS

- Leverage marketing channels through established distribution channels and new Web based channels;
- Offer different technology-based customer care programs not only for cell phone connectivity but also as the central customer care link for the new data services.
- Become (with a premium fee) the single point of entry, maintenance, and follow up for all the entities involved in the customers' transactions.

Mobile operators will gain higher advantages from business models that center on interacting with customers throughout all mobile services (connection and content access, billing, help desk and support) since the integrating role of customer liaison can lead to long term customer loyalty.

VII. IMPLEMENTING WIRELESS NETWORKS

> *What lessons can we learn from the implementation experiences of wireless campuses?*

As a technological research university, NJIT was an early adopter of wireless technologies, beginning deployment of wireless access points to classrooms and public meeting places in 2000. However, early adoption sometimes brings the lessons of bleeding edge that can serve to inform others as technologies evolve to mainstream. Gartner reports that enterprises outspent consumers for wireless LAN equipment for the first time last year [Gartner Inc., 2005]. Enterprise organizations planning for wireless network implementations can learn much from the experiences of higher education campuses. The lessons learned fall into a two broad categories: task technology fit and security.

TASK-TECHNOLOGY FIT

Wireless network implementations illustrate the importance of understanding Task-Technology Fit models in order to implement technologies that impact on individual performance positively [Goodhue and Thompson, 1995].

Executives and other senior managers in organizations were early adopters of PDA's because the devices keep them connected. Executives work at an unrelenting pace and activities are often characterized by brevity, variety, and discontinuity [Mintzberg, 1975]. PDA devices allow executives to multi-task, viewing and replying to messages with these characteristics that can be easily transmitted and viewed within the bandwidth and screen view limitations of PDA devices. Because of the nature of managerial work, PDA devices bring significant agility to the work time and place of executives. Likewise, separate studies of both students and teenagers show that both look to technology for convenience and communication [Kvavik and Caruso, 2005; Lenhart et al., 2005]. Instant Messaging and text messaging are preferred over e-mail as a communication technology among students and teenagers, users that are tech-smart, impatient, and expect results immediately [Oblinger, 2003]. These results explain their preference for synchronous chats and their demand for wireless networks across campuses to keep connected. However, when their attention turns to tasks beyond convenience and communication, tasks that require significantly more bandwidth, executives, faculty, staff, and students all turn to higher speed wired connections. The following examples illustrate that it is the nature of work, i.e. task characteristics and their natural fit to the current features and restraints of wireless mobile technology, that ultimately affect adoption, and the resulting agility of the worker.

- Faculty and students in the School of Architecture are seeking gigabit Ethernet connections for their computer-aided design workstations because of the need to share large files and manipulate complex design objects. When presented with investment options of expanding wireless connectivity in design studios vs. licensing advanced CAD software tools, the latter was their preferred investment option.

- Students gather individually and in small groups in between classes at NJIT's large student lounge in its Campus Center. Laptop computer users dominate the room. However, the casual observer may not notice the significant number of students gathered around the room's periphery and next to building columns where both power outlets and wired network connections are available. When asked about their use of a wired connection vs. using the wireless network, students explain that the wireless network is fine for IMs and browsing e-mail. However, if they need to download content-rich class notes or large documents from library databases, the wired connections are quicker and preferable.

- Perhaps wired connectivity is used the heaviest in student residence halls where there is a 1:1 port to pillow ratio with 100 Mbs switched Ethernet connections. This wired residence hall network supports the students' almost insatiable appetite for recreational

file swapping, downloading, and other peer-to peer applications. NJIT, like most colleges and universities supporting such residence hall networks, was forced to implement "traffic shaping" policies that prevent student residence hall network activity from dominating campus Internet connections. The traffic shaping policies allow students greater access to Internet connectivity after midnight, when other campus network activity subsides. Wireless network bandwidths cannot begin to support these applications.

- An early attempt at setting up a mobile wireless classroom for teaching an IT course resulted in less than desirable results. A single wireless access point served a class of approximately 25 students, each with a laptop computer. The class was designed with a significant number of activities where students were to interact frequently with files stored on a local server, and sometimes simultaneously. The results were less than desirable because the number of users and frequency of server access was greater than could be served by a single access point. Although the example illustrates poor instructional design by both the instructor and IT Staff, it highlights the importance of planning for the proper density of use in a given space served, and understanding what applications would be served. This infrastructure would have been more suitable for a class where students needed less than continuous Internet access and were not accessing the same site and or service simultaneously.

- In the retail world, "Cyber Monday" illustrates the importance of bandwidth for time-consuming task work. On "Cyber Monday," the term coined for the Monday after Thanksgiving, consumers return to work after the long Thanksgiving weekend and use their employers' high-speed Internet connections to make online purchases. It is now the biggest online holiday shopping day [Kawamoto, 2005]. Anecdotally one might infer that shoppers prefer the higher speed connections when making transactions that are more time consuming because of increased volume.

The moral of these stories is that wireless networks can not replace wired networks, at least not yet, and that careful planning is needed for implementing them successfully in enterprises and organizations. The lessons learned are to consider appropriate task- technology fit in designing where wireless networks will be deployed, recognizing they are best for applications requiring small amounts of bandwidth.

The density of wireless coverage must also be considered, recognizing that as the number of users in a given space increases, and as the task complexity and bandwidth requirements grow, the wireless infrastructure density must also evolve. Software tools are becoming available that help WLAN managers spread the load among access points and possibly restrict access to high-priority users.

As a practical consideration, older buildings with thick concrete walls require a higher density of access points than those with walls built out of sheet rock. Depending on the density of users and the tasks to be conducted, it may not be economically justifiable to deploy wireless coverage in such buildings if a wired infrastructure is in place. Conversely, organizations that did not yet invest heavily in a wired infrastructure may find installation of wireless networks significantly more economical as long as the task-technology fit is appropriate.

NEW SECURITY CONCERNS

The previous subsection discussed the use of PDA's by executives and the significant work time and place agility provided. However, the ease with which these devices can be lost or stolen raises serious security concerns. Password policies should be implemented for these devices that in essence, erase the contents of the PDA after a specified number of incorrect password attempts. The devices can then only by re-initialized when synchronized through a wired connection to the host device. Implementing wireless networks brings a whole new set of security concerns on top of those that are put in place to protect wired networks. Among the

greatest dangers is the techno-savvy employee who sets up an unauthorized wireless access point, i.e. one without the knowledge of the IT network manager. Instantly this employee may expose all the corporate resources that the network manager struggled to protect. Installing a rogue wireless access point in a corporate environment is almost as easy as installing a cordless telephone. As with cordless telephones, network signals can easily be picked up by unauthorized users. Unless the proper security is put in place, an unauthorized user can obtain access to the corporate network, piggybacking on the authentication and authorization of a corporate employee. Depending on the security requirements of an organization, rogue access points can be a significant security threat. Handheld devices can be used to check for rogue access points. In addition, sensors can be added to the wired network, constantly scanning for unauthorized access points.   These measures are expensive, but may be necessary depending on the organization's risk tolerance and need for security.

NJIT requires campus WLAN users to authenticate against an enterprise LDAP directory. A series of guest accounts are maintained for use by campus visitors and those attending special university events. The passwords for these accounts are changed regularly. When accessing university information systems, faculty, staff, and students are encouraged to encrypt data end-to-end by establishing a VPN connection during their WLAN session. However, in practice, network managers find this recommendation is often not followed.

Organizations requiring further protection might consider multi-tiered security measures allowing various degrees of access for employees, contractors, guests, and others. The requirement of strong 2-factor authentication measures may be the best consideration for those accessing the most sensitive corporate data.

VIII. MOBILE TECHNOLOGIES FOR DEVELOPMENT: THE CHINESE TELECOM INDUSTRY

What are the implications of the Chinese telecommunications industry and its government's regulation on the rest of the wireless world with respect to 3G and possibly 4G?

The rapid expansion of telecommunications in China is the result of a strategy that aims to leverage wireless telecommunications and 3G cellular technologies in particular, to expand the economy of the entire country. Before the 1990's, China did not have a comprehensive national information policy to govern wireless communications, other forms of telecommunications, and the Internet. China must still implement laws on telecommunications operations [Xue 2005; Chinese Ministry of Information Industry, 2005]. China initially started this process by upgrading its fixed line infrastructure. More recently it focused on wireless communications. The tele-density (% of the population with a fixed line telephone connection) in China in the late 1970's was a dismal 0.4% [Zhang, 2002] and as recently as 1995 of only 2.37% [Mueller and Tan, 1997]. Chinese government officials deliberately sought to expand their economy through the growth of the telecommunications infrastructure and, in particular, wireless technologies. "Government policymakers in China long acknowledged the importance of IT to the country's economic development, specifically identifying development of the IT industry as a top priority in the country's tenth five-year national economic plan …" [Quan et al., 2005, p. 70]. This overall plan led to a planned $151 billion investment in the national communications infrastructure during that 5-year period [Quan et al., 2005]. Since the majority of the required wireless infrastructure throughout the country would be new, the Chinese government has emphasized the implementation of the latest technologies and planning for the next generation. An example is the concerted effort by the government-controlled telecommunication providers to offer wireless 3G services as soon as possible including a rollout of services in the Shenzen area near Hong Kong in late 2005 [Chinese Ministry of Information Industry, 2005].

The strategy to build up the wireless infrastructure and corresponding wireless telecommunications business in China to support economic growth proved to be a wise one [Tan and Ouyang, 2002]. Using their own 3G standard, TD-SCDMA is being developed by the China Academy of Telecommunications Technology and a subsidiary of Datang Telecom Technology

Corporation, a mobile phone service provider, with support from Germany's Siemens Corporation. This standard is a cross between TDMA and adaptive, synchronous mode CDMA. The importance of wireless communications is supported by the growth in production of the supporting handsets as seen in Figure 5. [Chinese Ministry of Information Industry, April 2005]. Although these figures appear to be inflated by the Chinese government's regulating agency, they do point to the rapid growth in both cell phone production and use.
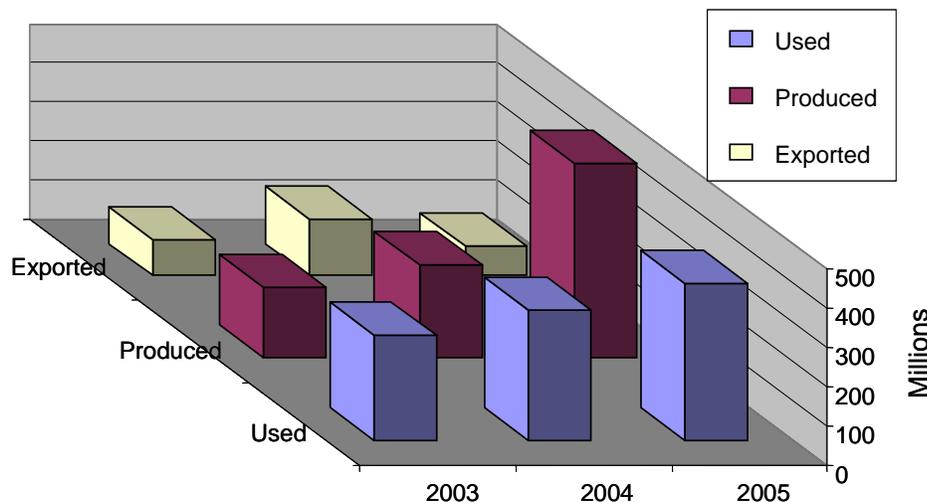
Figure 5. Chinese Cell Phone Production and Use

IX. THE GOOD, THE BAD, AND THE UGLY

Several authors discuss opportunities and challenges of mobile applications, particularly in the context of mobile commerce [Yang et al., 2004; Urbaczewski et al, 2003; Sarker and Wells, 2003; Rao and Minakakis, 2003]. For the mobile worker and the workplace, the evolution of 3G wireless technologies opened opportunities and challenges that can be summarized into "The Good," "The Bad," and "The Ugly."

THE GOOD

The goal of the totally agile workplace creates a completely new work model and requires a mobile technology infrastructure that enables employees to access critical data and post information. Because of new technology capabilities, work is more of an activity rather than a specific place or time. The technology should enable employee agility and flexibility. Universal access provided by 3G services open new opportunities for developing economies by guaranteeing access to information and communication technologies to a larger population.

THE BAD

Employees in an agile workplace can now work 24 / 7. Unfortunately, managers sometimes expect employees always to be available whenever they are needed. This approach can lead to abuse and overworked employees. Therefore, policies are needed to define the work times on an individual basis. Policies are also needed to control both security and privacy. Jupiter Research [Tsin, 2005] surveyed companies that deployed wireless LANs by March 2004. They found that while several companies were concerned about security and perceived the threat of possible network intrusions to be high, only 16% reported actual security breaches. The most common security fears include the use of rogue access points by employees and external users, the lack of hotspot security, and the careless use of passwords. Security, privacy and lack of uniform and manageable solutions are identified as critical problem areas.

Security

A key problem with security is that the issues are not merely technological. Security breaches can be caused by inappropriate policy implementations, by lack of common sense of the workforce when using passwords and securing access devices, and by lack of understanding of the implications of their actions.

Privacy

Employee privacy is more than just releasing personal or organizational information about the individual. It also includes the potential intrusion into personal time from an always connected access to and from the enterprise. An employee needs to expect accessibility expectations to be built into the job description. Is the position a 24/7 or a 40 hour per week job? Another privacy concern is the amount of location-aware information about individuals (employees and customers) that is collected automatically through wireless technologies [Passerini and Patten, 2005]. Information about location may be embedded, for example, in the protocols of PDAs or Bluetooth phones. Individuals may be also traced based on the wireless access points they are using.

THE UGLY

The IT department must deal with the increased (and sometimes 'uglier') issues of implementing an agile workplace and supporting mobile employees. These issues, which must be resolved, at least in a phased manner, include manageability, reliability, and integrating and supporting the embedded wired and wireless infrastructure.

X. SUMMARY AND RESEARCH AREAS

This panel discussion raised future research areas that impact the end users, the organization, and the service providers.

- How will the work space be redefined?

- How will the work place be redefined?

- What is the basic level of privacy that we need to protect?

- What are the tradeoffs between privacy and security?

- Including guaranteeing critical systems security?

- Which emerging economies will benefit most from the market penetration opportunities opened by pervasive connectivity?

As these areas are researched and new policies developed, the promises of the totally agile workplace will be met with the implementation of the new 3G technologies.

ACKNOWLEDGMENTS

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EDITOR'S NOTE: The following reference list contains the address of World Wide Web pages. Readers who have the ability to access the Web directly from their computer or are reading the paper on the Web can gain direct access to these references. Readers are warned, however, that

> 1. these links existed as of the date of publication but are not guaranteed to be working thereafter.
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> 2. the contents of Web pages may change over time. Where version information is provided in the References, different versions may not contain the information or the conclusions referenced.
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LIST OF ABBREVIATIONS

2G	Second Generation
3G	Third Generation
4G	Fourth Generation
AMCIS	Americas Conference on Information Systems
CAD	Computer Aided Design
CDMA	Code Division Multiple Access
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
IT	Information Technology
LAN	Local Area network
LDAP	Lightweight Directory Access Protocol
M2M	Machine-to-Machine
NJIT	New Jersey Institute of Technology
PCS	Personal Communications Services
PDAs	Personal Digital Assistants
SMS	Short-Messaging System or Text-Messaging
TD-SCDMA	Time Division Synchronous Code Division Multiple Access

UMTS	Universal Mobile Telecommunication System
UWB	Ultra-wideband
VoIP	Voice-Over-Internet-Protocol
WCDMA	Wideband Code Division Multiple Access
Wi-FI	*Wir*eless *Fi*delity
WiMAX	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network
WPANs	Wireless Personal Area Networks
WWANs	Wireless Wide-Area Networks

ABOUT THE AUTHORS

Jerry Fjermestad is Associate Professor in the School of Management at NJIT. His current research focuses on customer relationship management and on collaboration technology. He served as a special issue editor of *International Journal of Electronic Commerce*, *Journal of Organizational Computing and Electronic Commerce*, *Business Process Management Journal* and *Logistics Information Management*. His publications appear in *Decision Support Systems, Journal of Management Information Systems, Information Technology* and *Management, Information & Management*, and several other journals and conferences.

Katia Passerini is Assistant Professor of MIS at the New Jersey Institute of Technology. She conducts research on mobile telecommunication standards evolutions and their impact on business models. Prior to joining NJIT, she worked for a number of multinational mobile service providers in Europe in her capacity of information technology and strategy consultant for Booz Allen Hamilton. Katia received MBA and Ph.D. degrees from the George Washington University.

Karen Patten is a former IT manager at Bell Laboratories for emerging technology strategic and implementation management for internal use by Bell Labs engineers and scientists. She currently teaches telecommunications and information services management at NJIT. Her research interests include how emerging technologies change the way employees work and how IT organizations manage their technologies.

Michael R. Bartolacci is Associate Professor of Information Sciences and Technology at Penn State University, Berks College. His main areas of research are telecommunications modeling (with a focus on wireless telecommunications), electronic commerce, and customer relationship management systems. He received an M.B.A. and a Ph.D. in Industrial Engineering (Concentration: Information Systems) from Lehigh University.

David F. Ullman became Associate Provost and CIO at NJIT in 1999. Prior to that, he worked for twenty-five years in higher education information technology management. He holds an M.S. in Management and is pursuing a doctoral degree in information systems. He teaches information systems at both the undergraduate and graduate levels. His papers were presented at higher education information technology management conferences in both the United States and abroad.

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