December 2003

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ENTERPRISE MOBILE SERVICES: FRAMEWORK AND INDUSTRY-SPECIFIC ANALYSIS

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Abstract

In this paper we provide industry-specific analysis of mobile services. Before we describe each industry in detail we provide a framework for mobile services that is used to categorize various mobile services in three categories namely enterprise mobile services, consumer mobile services, and enterprise-advantage mobile services. We then describe the needs of each industry in terms of mobile services and the discussion of various issues that are responsible for the successful deployment of such mobile services.

Keywords: Enterprise mobile services, consumer mobile services, mobile services framework

Introduction

In the first wave of mobile services, few farsighted tech-savvy early adopters (such as FedEx, UPS, Avis, and Hertz) integrated wireless technologies into their mission-critical applications. They incorporated the wireless capability into the hearts of their basic businesses and operations. The second wave, in the mid- to late 1990s, enabled the companies to provide consumer content wirelessly (e.g., CNET, Yahoo, Charles Schwab, and Fidelity). The third and latest wireless wave is characterized by the development of focused end-to-end enterprise solutions that facilitate critical applications, and have attractive cost-benefit economics. In US alone, the subscribers to such mobile enterprise services are expected to number 26 million by 2005 (Junqueira et al., 2001).

Wireless Information Systems (WIS) can be defined as the systems that utilize wireless technologies for communication between mobile clients and other system components (Mendoza and Pérez, 2002). Services provided by such WIS are mobile services. *Mobile services* are defined as the mobile/wireless computing applications and services that can be either pushed to user's handheld wireless devices or downloaded and installed, over the air, on handheld wireless devices (Mouhmoud, 2003). Based on the objectives of wireless information systems, we believe that there exist three dimensions of the mobile services namely efficiency/productivity, time immediacy/urgency, and customer orientation. To describe the mobile services based on these three dimensions, we use a three-dimensional space as depicted in Figure 1. The efficiency/productivity dimension refers to whether the use of mobile services improves the efficiency of the members of organization. The time immediacy/urgency dimension refers to whether the content provided by the mobile services is extremely time sensitive and potentially needs the immediate attention of its user. Whereas the third dimension, customer orientation, refers to whether the use of such mobile services is geared towards increasing retention, satisfaction, and loyalty of the customers by means of such value added services. Based on the degree of membership to each of these dimensions, there exist at least three categories of mobile services.[1]

1. *Enterprise Mobile Services (EMS):* Services in this category are likely to be motivated by the need to reduce latency, increase speed of response, enhance efficiency of its current operations & workforce, improve productivity, boost revenues, and increase the competitive advantage. Giving the workers access from wherever they are will allow them to access mission-critical enterprise applications in a timelier manner rather than having to wait until they are back at the desktop. EMS enables the capture of the complete and accurate data at the point-of-origin, which replaces the inefficient paper data entry processes,

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[1]It is not necessary that there exist only these three categories. There may exist other categories with equal membership in all the three dimensions.
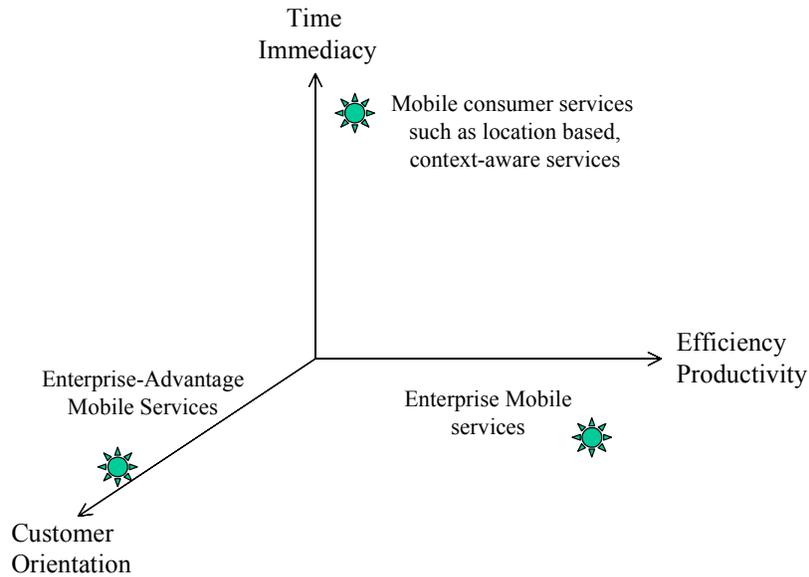
Time
Immediacy

Mobile consumer services
such as location based,
context-aware services

Efficiency
Productivity

Enterprise-Advantage
Mobile Services

Enterprise Mobile
services

Customer
Orientation

Figure 1. The Three Dimensions of Mobile Services

thus reducing errors. These EMS need to be tailored to the enterprise's specific needs. Enterprise mobile services are likely to have a much wider acceptance and stronger potential than the other two categories of mobile services. This category is also known as B2E or Business-to-Employee category.

2. *Enterprise-Advantage Mobile Services (EAMS):* Mobile services implemented in this category for an organization are used primarily to attract and retain the customers to use the services provided. Main objective of such services is to help organizations to improve customer satisfaction rate and to strengthen the customer relationships. They can be implemented as a competitive weapon or to defend an existing market position (Dekleva, 2002). Examples include the wireless check-ins for travelers, mobile banking services, provision of premium service packages for wireless phone subscribers with capabilities such as email, calendar, and musical ring tones etc. Organizations developing WIS in this category need to answer questions such as "Is the customer service critical (Dekleva, 2002)?"

3. *Consumer Mobile Services (CMS):* Mobile services implemented in this category are primarily for mobile B2C and C2C purposes. Examples inlcude mobile advertising, auctioning, gaming, and shopping, etc. Applications such as *Symbiotic Networking,[2] Personalized Devices,[3] Location based Services*[4] are soon to become mainstream reality (BusinessWeek, 2002). Unlike first category, services available in this category are primarily motivated by the need of immediacy, urgency, time-sensitivity, and high personalization of the information. Such services include driving directions, traffic report, tracking misplaced or stolen phones and locating stores or restaurants. Large body of research has emerged in an effort to realize this category of mobile services especially focusing on the location-based services. Examples include C-MAP (Sumi, et al., 1998), CyberGuide (Abowd, et al., 1997), Metronaut (Smailagic and Martin, 1997), CityGuide (Kreller, et al., 1998), comMotion (Marmasse and Schmandt, 2000).

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[2]Devices that have the ability to set up the network automatically will corporate and self-organize. For example Cybiko, a small gaming device aimed at the teenage market searches for a similar device within 300-foot range. If it finds one, two lucky owners can immediately start playing game.

[3]Device running contextual middleware with the knowledge of user's location and personal preferences. The device's search technology filters information based on its relevance to the user's interests, which is derived from a personal profile built up over time.

[4]These capabilities, inherent in 3G wireless networks, allow devices to be precisely located.

The primary focus of this paper is on the analysis of the enterprise mobile services, those that enable smoother and efficient operations of the employees in an organizational setting. Although consumer applications have generated the most wireless buzz and interest among the researchers, we believe that more sustainable opportunities exist for enterprise wireless and mobile services. There has not been much work done in analyzing the role of mobile services in the organizational settings specific to various industries. In the next section we analyze the role played by mobile services in different organizational settings.

Enterprise Mobile Services

Based upon the degree of mobility we further classify various industries in three groups. Further mobility can be thought in two ways: the mobility characteristics of the users and the mobility characteristics of the assets.

1. *Industries with high critical mobility:* This group involves the organizational settings where users as well as the assets are moving at all the times. Examples of such settings include shipping industry, trucking industry, home building industry, and the law enforcement agencies. Although in agricultural and utility industries assets are fixed, these assets are spread over a wide geographic region and the most work is accomplished in the field, thus making the mobility a critical factor. For this industry group, enterprise mobile services are crucial as they liberate mobile employees from wired connections and enable them to fulfill their data needs while on the go, thus eliminating need for them to travel back to office to fill out the forms ("dead-spots"). Mobile services are likely to boost the productivity of this group by serving the mobile worker's basic needs while eliminating the inefficiencies.

2. *Industries with medium mobility:* This group involves the settings where users are highly mobile but they do need to come back their offices to perform other functions. Examples of such settings include health-care and university settings.

3. *Industries with low mobility:* Users belonging to this category are occasionally mobile and hardly rely on mobile computing to accomplish their daily operations. Examples include settings such as offices, remote network troubleshooting.

With this classification scheme, in the next section we provide a detailed discussion of various organizational settings and/or industries where wireless infrastructures for deploying mobile services can be implemented. In Table 1, we provide a summary on the benefits that can be achieved by the implementation of various enterprise mobile services.

Table 1. Benefits Offered by the Implementation of Enterprise Mobile Services

Performance Criteria	Comments
Decision Making and Responsiveness	Access to real-time business intelligence speeds up and improves accuracy in decision-making process (Symbol Technologies, 2002)
Improvements in Supply Chain Management and flexibility	Reduction in "dead-spot" times, input errors, delivery times and better inventory management (Songini, 2001).
Efficiency and Effectiveness, Productivity	Access to accurate, timely data at point-of-need (Symbol Technologies, 2000)
Collaboration and communication with other members of the organization.	Facilitates collaboration among the members of organization (Farooq, et al., 2002)

Industry Specific Analysis of Mobile Services

Panis et al (2002) identify various key factors that influence the evolution of mobile services pertaining mostly to the consumer mobile services. From this list we chose those factors that are highly relevant to the enterprise mobile services. These factors address issues related to the security, the standards and regulations, the availability of wireless networks, and the suitability of the service to the mobile device in terms of the design and the functionality.[5] Table 2 presents a summarized discussion of these issues that influence the evolution of mobile services without regard to any specific industry. In the next subsections we present the detailed discussion of such issues with respect to various industries having different degrees of mobility needs. (See Table 3).

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[5]It includes selection interface, bandwidth, and memory issues.

Table 2. Issues in the Evolution of Enterprise Mobile Services

Issues	Comments
Security	Major concern. Can be potentially addressed by the combination of the integrated biometric based or the smart card based authentication and by adding the strong security mechanisms at various steps during the life of a transaction Griazina et al (2002).
Standards and Regulations	Can be important in industries such as health-care where HIPAA act plays a major role.
The Availability of Wireless Networks	Can be addressed by the various different combinations of the wireless network technologies. Available set of options includes Cellular, Personal Communications Service (PCS), Mobile Satellite Service (MSS), Specialized Mobile Radio (SMR), Wireless Wide Area Networks (WWAN), Wireless Local Area Network for data and voice (WLAN), Wireless Private Branch Exchange (PBX), Wireless Local Loop (WLL), and Paging.
Suitability of the Service to the Mobile Device in terms of the Design and the Functionality	Variety of different hardware and software platforms will co-exist, as different industries will have different working conditions. Device considerations such as physical size, processor type, method of data access, memory, and battery life need to be addressed.

Table 3. Examples of Industries with Different Mobility Needs

Degrees of Mobility	Example of Industry Sector Discussed
High	Agriculture, Utilities, Home building
Medium	Health-care
Low	Remote troubleshooting

Home-Building Industry

One booming application of the mobile computing is in the home-building industry. Although traditionally this industry has not been tech-savvy, with the right deployment mobile services can bring in the considerable cost-savings and improve the work-site efficiency. For home-building sector, one of the major concerns is efficiency of supply chain and mistakes made due to the miscommunication along with the tackling of the schedule changes and the notifications. This results into the right information never getting into the right hands at the right time, resulting into the loss of the operational efficiency (McGarvey, 2002). For the home-building sector examples of mobile services include project management tools such as scheduler, estimator, and tracker services for the various purchase orders (McGarvey, 2002). The contractors can coordinate the scheduling of the subcontractors and communicate with the suppliers to ensure the timely arrival of the building materials. Subcontractors can update their progress on the fly, so the next scheduled contractor can come in when the first has finished, reducing the downtime. These mobile services can also help to reduce the number of mistakes committed by delivering the wrong material at the wrong time at the wrong housing site, which can translate into huge savings per house built (Hamblen, 2002). Further efficiencies can be achieved by integrating such services with other back-end applications such as the payment and accounting applications. Such mobile services should be capable of detecting a schedule change, further determining the effect of the change on the other contractors and finally be able to notify them through cell phone, e-mail or fax without having on-site supervisor to make thousands of calls for rescheduling change purposes. Such capabilities demand for further research in mobile workflow management systems.

In order to implement the wireless infrastructure for home-building industry, one has to keep in mind the degree of familiarity the users will have had with the wireless technology (given that traditionally this sector has been tech-laggard!) Good user-friendly and intuitive interfaces are an important key. Another issue might include the inadequate wireless coverage as usually most of the home-building activities take place on the outskirts of cities where the wireless carriers have somewhat spotty coverage (McGarvey, 2002). Wireless technologies such as IEEE 802.11 or Bluetooth might not be as suitable since the mobile clients are outdoor most of the time. Thus one may have to resort to cellular/satellite wireless coverage. Hence it is necessary that these devices be able to access multiple different types of network in order to achieve mission-critical real-time updates. There has been some work done on how interoperability among the various different types of the wireless networks can be achieved (Jain and Varshney, 2002; Varshney and Jain, 2001). Use of satellite networks may affect the cost, which in turn translates into the development of the applications that send small bursts of information only when needed. It is also possible to build the

applications in such a way so as to allow users to input data while they are offline and then synchronizing with the enterprise databases when users have better wireless coverage.

Health-Care Industry

In a survey conducted by Medical Records Institute in 2002, many hospital administrators indicated that they are planning to deploy the mobile health care services for order entry, e-prescriptions, to capture the clinical information (such as dictation for transcription, direct input with stylus) and to retrieve the clinical information at the point-of-care (such as the lab results, drug reference information, clinical guidelines and protocols, administrative policies and practices), emergency admissions/ registration along with the charge capture and/or the coding information. Doctors and nurses can benefit tremendously from the mobility and the speed of wireless LAN-based mobile computing technologies. It enables them to make decisions and to take actions with the increased accuracy and efficiency without having to return to the fixed station to input the data in the clinical decision support systems or to check the information such as real-time automatic adverse drug event monitoring, the latest laboratory test results, and current care plan (Symbol Technologies, 2000). This can help improve the quality of the patient care, while realizing the reduction in the patient care cost and the documentation errors. Another benefit of having instantaneous access to the medical information is that it can significantly reduce the claims for malpractice, as doctors can now immediately check for the drug interactions online. It can improve the hospital's position in the event of litigation in addition to improving the audit results by the various health care organizations (Symbol Technologies, 2000).

Health care organizations such as the hospitals with open culture and very dynamic environment of health care present different set of challenges for creating and administering a secure and efficient wireless communications infrastructure. Hospitals support multiple business units, operating on multi-levels, possibly across many buildings on a campus. These units are usually affiliated with the remote clinics and doctors' offices. Additioanlly they are also linked to business partners such as payers, labs and supply companies. One of the major concerns includes the security of devices from unauthorized users and security of confidential protected health information (PHI) while sending/receiving messages and of in order to prevent health care fraud and abuse as demanded by HIPAA (Health Insurance Portability & Accountability Act) and other regulations. Doctors may need on-demand access to X-ray images or CT-scans on-the-go OR they may use it to perform clinical documentation, to access patient information, clinical protocols, or drug references. Such diverse need for the data will significantly impact the choice of wireless network technology for implementation. Doctors need to access crucial information easily and quickly making user friendliness of the interface an important issue. Attention to various details and needs of doctors and their context of use becomes important. Crucial concern for the hospital environment also includes the interference caused by the radio waves to other frequency-sensitive equipments such as pacemakers and respirators. Additionally Goldberg and Wickramasinghe (2003) describe challenges faced by 21st century health care and propose a mobile e-Health model to accelerate healthcare delivery improvements.

Agricultural Industry

Agricultural sector is a booming sector for deploying the wireless information systems. Treiblmaier et al. (2002) conducted a survey among the agriculturists to determine the nature of agricultural applications appealing to them. Agriculturists wanted the applications that could help them record a fertilizer plan, store a field master data plan, and record a crop-growing plan. In addition agriculturists also showed interest in the applications that aid them to keep track of the general working time, use of machinery, Global Positioning System (GPS) field maps, stock farming, and forestry. Since a lot of the actual work takes place outdoors, it seems natural that the data should be recorded and processed at the location where it occurs, in the fields, forests or the stables. Scanner can be used to read the stored data and make such data available immediately. More sophisticated applications can be used for the navigation of tractors and the operation of machinery thereby supporting agriculturists in their daily work routine. These applications can not only save the time and money but also help the agriculturists to use the natural resources more efficiently (Treiblmaier, et al., 2002).

Applications developed for such agricultural purposes need to have very user-friendly interface and should be easy-to use as the agriculturist may not be acquainted to using/carrying such devices. Agriculturist should be capable of mastering the use of these applications & devices on their own without much external training. Additionally this industry sector faces the same problem as the home-building industry namely the availability of various wireless networking technologies. It may also need to adopt one or more mixed network solutions similar to that of the home-building industry.

Utilities Industry

Another fascinating application of wireless is in the utilities sector. Firms in this sector can arm their mobile field-workers with the mobile devices for entering the results of their power and production meter readings. This can result into the significant timesaving and reduction in the data input errors. By automating meter-monitoring system (applications as the automated control and supervision of technical and industrial plant), utilities firm can collect the information remotely. This can not only reduce the number of errors but also can aid in the proactive monitoring, fast repair, and the timely maintenance of the equipment, thus further reducing the maintenance cost by eliminating the need for outside contractors to do the maintenance checks. Additionally, firms in the utilities industry can benefit by streamlining their work processes, thus reducing the number of outage minutes per year and possibly qualifying for the federal government incentives (Kuchinskas, 2002). Critical set of issues for this industry includes secure communication in addition to other issues such as friendly intuitive user interfaces, regulations and network technology availability.

Remote Troubleshooting Industry

While all the mobile services described above are an example of one-way data collection, remote troubleshooting such as wireless remote network administration is an example of interactive services. Firms that own or are responsible for large and mission-critical networks round-the-clock can arm their network administrators with such wireless remote network administration tools. Most of the problems that network administrators face bring the portions of the network to a halt and require human intervention even though they have simple known solutions. These problems include changing the password, unjamming the email queues, restarting the frozen server processes, and rebooting the servers (Yokomizo, 2002). Network administrators can use such mobile administration applications running on handheld devices or cellular phones to solve these problems while they are away from the office and have no access to a desktop.

While developing user interfaces for such applications, developers can take advantage of the fact that there are not many unpredictable sets of operations that an administrator will need to perform. Designers can design the menu-driven applications for the most commonly used operations while also providing the capability to enter the text-based commands/instructions for not so frequently utilized operations (Yokomizo, 2002). Since the network administrators need to be informed of the network problems immediately, these devices demand the use of always-on networking technology. The server should be capable of reporting the problems as well as carrying out the commands ordered remotely by the network administrators. Network administrators can preload the trouble-fixing scripts into a server that monitors the network, so when something breaks the server sends the alert messages to the administrator who then in turn can run these scripts remotely. Having these devices operate outside the corporate firewall and access the basic crucial resources pose a major security threat (Yokomizo, 2002).

Services Industry

While all the above discussion is targeted towards the enterprise mobile services, this subsection provides a brief discussion on the emerging mobile services in the enterprise-advantage mobile services category. Mobility is about entering or using the information without being tied to a desktop, while wireless is about immediacy. The difference is in the timeliness or immediacy of the information. Good wireless services must be urgent and relevant to what the customers are doing now.

If the users need to access and/or retrieve data frequently and securely, as is the case for stock trading, data integrity, constant connectivity (immediacy), and security become important issues. If the network cannot provide the continuous access then applications should be designed in a way to accommodate this deficiency or the alternative solutions need to be explored. Being mobile and being wireless is not exactly the same. Unlike stock trading, traditional banking services may not present issue of immediacy. To take advantage of the wireless on the go, the banking industries need to come up with services that provide the information to its users that they can act upon immediately. Examples of such services include "intelligent alerting" that informs users when their balance falls below a particular preset threshold and remind them to transfer the funds between the accounts in order to avoid any finance charges (Fox, 2002).

Conclusion and Future Research

Ensuring adequate levels of training, data integrity, and the device interoperability is critical for the successful deployment of the wireless infrastructure in the enterprises. IT managers need to realize that committing too many resources to the initial wireless

project is risky and they need to conduct the pilot projects before starting with the full-blown infrastructure to avoid the costly system failures. Federal Wireless User's Forum FWUF (2002) suggests that pilot projects can help managers to

• Determine whether a particular wireless technology or service can be used to support existing functions or provide additional capabilities,

• Explore quality of service issues such as reliability, interoperability, scalability, capacity, latency, coverage, convenience, operational impact, cost,

• Establish the business case for wireless communications versus other solutions,

• And importantly to clarify their needs and wants.

Furthermore enterprises may wish to integrate their voice and data applications. Network design issues in such instances include bandwidth sharing between the data and voice applications, higher usage of wireless telephones than data devices, higher mobility of wireless telephone users than data users.

In this paper we presented the framework using which industries can be differentiated by the three dimensions of WIS objectives. We then provided an in-depth discussion of several industries with the membership in these different categories. Enterprises need to ensure that the architecture of these new mobile services is flexible enough for the future growth and can integrate easily with their existing infrastructure. It is clear that the enterprises can benefit if they put the information at the employee's fingertips. It should be noted that the technology implementations alone would not succeed unless they are backed by the real need of the business processes. Hence when implementing the enterprise mobile services for moving the information faster, reducing the decision-making time, and improving the efficiency and competitiveness of the organization demand for the new enterprise practices to be followed by its employees. Future research includes field studies in one or more such industrial settings with the focus on identifying these new enterprise practices. Role of the mobile workflow management systems to enable these services is an emerging open area for the further research.

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