Editorial Thoughtscapes
Words Impact Business Success
www.et-writer.com

B2B Enterprise Technology Story

Reading Time:
28 minutes

Reader Benefit:
♦ Gain insights on the validity of the mobile computing paradigm;
♦ Understanding the fundamental ideas about mobile computing;
♦ Some points to ponder about mobile computing.

Web Summary:

Mobile Computing

by Leon A. Enriquez

How is mobility transforming the modern corporation into a dynamic enterprise that is in-sync with a global market perspective? To prepare for the changing circumstances which will impact the increasingly mobile workforce, each organisation needs to understand the value that mobile computing brings.

Business people can no longer afford to operate in a vacuum without some sort of connectivity to the corporate network infrastructure. This is especially the case when their business journeys take them on-the-road away from the office LANs.

In order to be successful in meeting the customer's needs, today's mobile workforce needs mobile computing power, continuous access to information as well as computing resources.

In fact, the idea of mobile computing means connectivity wherever you are anytime, anyplace based on your choice of a mobile device. Yet, mobile computing means more than just hardware and software. It is really about the latest information that is updated on-the-fly to empower you to transact your business dynamically.

It appears that mobile computing may eventually emerge as the so-called "next-killer-application" because of a number of reasons. Chief among this is the TCP/IP connectivity enabled by the ubiquitous Internet and Web-based technologies built on open standards. Consider also the benefits that a software platform the Java language affords by supporting "thin-client" devices.

Mobile Computing

by Leon A. Enriquez

How is mobility transforming the modern corporation into a dynamic enterprise that is in-sync with a global market perspective? To prepare for the changing circumstances which will impact the increasingly mobile workforce, each organisation needs to understand the value that mobile computing brings.

Business people can no longer afford to operate in a vacuum without some sort of connectivity to the corporate network infrastructure. This is especially the case when their business journeys take them on-the-road away from the office LANs. In order to be successful in meeting the customer's needs, today's mobile workforce needs mobile computing power, continuous access to information as well as computing resources.

In fact, the idea of mobile computing means connectivity wherever you are anytime, anyplace based on your choice of a mobile device. Yet, mobile computing means more than just hardware and software. It is really about the latest information that is updated on-the-fly to empower you to transact your business dynamically.

It appears that mobile computing may eventually emerge as the so-called "next-killer-application" because of a number of reasons. Chief among this is the TCP/IP connectivity enabled by the ubiquitous Internet and Web-based technologies built on open standards.

Consider also the benefits that a software platform the Java language affords by supporting "thin-client" devices. Java works despite the limitations of low bandwidth situation of modem speeds and wireless connectivity afforded by mobile phone networks that support WAP (wireless application protocol) and WML (wireless markup language) which is a subset of XML (extensible markup language). Further benefits are emerging as XML allows connection between the latest IT applications as well as enabling back-end connectivity to legacy systems.

It is therefore not surprising that almost everyday, hardware and software vendors are announcing all sorts of strategic alliances to support mobile computing technologies such as WAP, GPRS (general packet radio service), and so on.

Access to Information

Previously, the idea of mobile computing conjured the image of a "road-warrior" travelling on-the-road away from the corporate office making business calls on existing customers and potential clients. Usually, the road-warrior was armed with a laptop computer and a modem connection through a telephone line to secure access to the information repository situated at the main office network.

Today, that image is somewhat different as there are a wide assortment of mobile devices – such as mobile phones, wireless consumer appliances, smart telephones, WAP devices and applications, and mobile electronic commerce (or m-commerce) – that are attracting a lot of attention. Even now, the potential of Bluetooth technology for the wireless LAN is going to make a significant contribution to this mobile revolution.

On the end-user side, IT managers are seriously investigating what such handheld devices and wireless data technologies can do for their organisations. Obviously, there are also some serious initiatives or solutions that will impact the mobile computing space. And people are naturally looking for more comprehensive information and updates on how to implement mobile computing projects.

As the frequency of business-related commuting increases, the demand for mobile access to corporate data grows exponentially. This unbounded access to data and applications promises to bring increased efficiency and effectiveness to organisations. Ease-of-use and portability seems to be the catch phrase. And here the mobile phone is the obvious handheld device that will increasingly gain favour with the masses in terms of sustainable use.

But the challenge facing upwardly mobile corporations – and in particular, the corporate IT department – is simply this: What is the best way to supply data to, and collect data from mobile professionals? This problem is expected to grow in complexity as more and more mobile devices are introduced. Like it or not, IT operations increasingly impact the virtual office. Put simply, the situation revolves around how information is made accessible to telecommuters.

Each mobile device introduces a variety of IT challenges. For instance, consider the problems caused by different operating systems, application tools, unique communication platforms, file systems, and so forth. In addition, each mobile device is particularly tailored to specific tasks such as contact management, field inspection, inventory review, etc. Undoubtedly, the most successful mobile solution for many organisations will involve a combination of mobile devices such as laptops, Palm Pilots and PocketPC-based devices – as well as a mix of different mobile communication choices – dial-up, RAS (remote access servers), VPN (virtual private networks), and wireless handphones.

The more mobile your organisation becomes, the more complex the technology burden that your corporate IT infrastructure and staff must manage. Add to that the WAP-and MMS/SMS-based mobile phone applications and the picture becomes even more interesting!

Mobile Computing Challenges

To fulfill the growing mobile needs of your business, your corporate IT team is left to research, evaluate and implement a myriad of technologies from a large number of vendors. Obviously, piecing together such solutions introduces incompatibilities and surprise limitations, as well as increased license and support costs.

Mobile workers at every level, look to the enterprise to provide the core services that they need like file distribution, data synchronisation and software distribution. At the same time, the enterprise needs to be able to offer these services in a way that is manageable, scalable, and secure.

With ever-increasing proliferation of mobile computers, handheld PDAs, and now a new breed of Web appliances and smart telephones, mobile computing has been glorified – as a hot new technology that will significantly change the way in which we conduct our work as well as non-work-related activities. It seems that the workplace and lifestyle scenarios have become meshed.

Consider the case that many vertical industries, such as financial services, public safety, health care and utilities have adopted mobile applications. Even now, horizontal applications (e.g., Internet e-mail access and field-service dispatch) have made significant gains recently.

Since the early '90s, the early adopters of mobile computing have demonstrated the potential of the technology. To cite a few early adopters, includes such organisations like IBM, UPS, Federal Express, Xerox, and so on.

However, the early adoption did not enhance the penetration rates of mobile computing significantly. For one, mobile computing as a mainstream technology in organisations did not match the forecasts of most of industry's market research companies.

But the scenario of the slow growth of mobile computing of the '90s is now changing drastically. Today, there is widespread consensus that the time for mobile computing has finally arrived. And the phenomenal impact will be contributed by the mobile phone which is an idea whose time has come.

There are several reasons for mobile computing gaining prominence. These are as follows:

♦*Business factors:* Substantial increase in remote workers, telecommuters, need for improved customer service. The economic justification of mobile computing solutions through productivity gains and competitive advantages gained by early implementers.

♦*Availability of inexpensive hardware:* Especially, hand-held computers and PDAs with pre-packaged vertical industry application solutions.

♦*Less expensive and faster wireless networks:* Especially 2.5G and 3G wireless networks. The emergence of "ready-to-implement" vertical applications, Internet-based wireless e-mail and industry solutions.

♦*Mobile projects:* More attention is given to mobile projects, which are getting higher priority in the eyes of IT business leaders as the post-Y2K non-crisis evaporated.

Size of Mobile Market

The actual size of the mobile computing market is a tough question to answer. There are perhaps as many answers to this question as the number of research firms who specialise in this marketplace. However, there are some estimates from analysts which give a fair idea of this ever-expanding sector.

There is no doubt that the mobile computing market is quite big. If we include in this market the broad spectrum – such as mobile devices used by the end-users, wireless LAN installations, public wireless data network services (e.g., private data wireless network infrastructure, etc.), application software products and systems integration services – the size of the market on a worldwide basis could be about US$280 billion by the year 2004 states a Yankee study. The largest segment, of course, is the cost of mobile computers used by the remote workers.

Some of the relevant statistics include the following:

♦A Yankee Group study (1999) noted that the total number of users who could benefit from wireless data is 48 million users (28 million professionals and 20 million other users) in USA alone. This is based on the premise that the industry achieves a penetration ratio of 10 to 25 percent among these users.

♦Handheld market share: PocketPC versus Palm OS space – The Palm OS continues to have over 65 percent market share in its class compared to PocketPC devices which garnered 25 percent during 2002.

♦Wireless LAN market projections: The wireless LAN segment of the mobile computing market is making significant progress. According to IDC's market study, this market is expected to grow from approximately 1,003,000 shipments today to 4,099,000 shipments in 2003, or by an average of more than 30 percent each year.

♦Narrowband mobile data market: According to a report by market research company Strategis, the mobile data market from narrow-band PCS (speeds of less than 28800 bps for now) will reach US$5.8 billion (Breakdown: US$3.2 billion in service revenue and US$2.6 billion in equipment revenue) by year 2004. Currently, mobile wireless data industry has 2.8 million subscribers with $860 million in services and equipment revenue. This does not include broadband market revenue.

♦Bluetooth market size: According to a recent Cahner Group market study, the number of Bluetooth-enabled devices is estimated at 200 million by 2003 and at 600 million units by 2004. Qualcomm and Ericsson have agreed to implement Bluetooth technology in CDMA handsets. One scenario for such a device will be to receive an e-mail,and then go to a printer equipped with Bluetooth and print the e-mail.

♦According to a study done by Yankee group published in July 1999, the wireless data market is expected to grow rapidly. Penetration rate as a percentage of wireless users, will grow from 4 percent to 25 percent by the year 2003. This forecast is reasonable if you take into account the growth of wireless cellular/PCS subscriber base for voice itself; and provided network subscribers keep the cost of usage lower and the assumption that wireless Internet applications growth continues.

♦In another study by the Gartner Group, the findings indicate that the number of mobile users is expected to grow from 50 million to 108 million over the next four years, by 2003.

As the number of mobile workers grow, so does the need for an enterprise-wide solution that will help administrators manage and support their growing mobile workforce. Corporations are looking for a solution that will help reduce the high cost of mobile computing.

At the same time, administrators want a solution that will enable them to quickly and easily manage mobile computer users in much the same way they have supported desktop users. Viable solutions must be able not only to optimise the low bandwidth of a mobile environment, but require minimal change to the corporation's existing communications infrastructure.

Support for Mobile Computing

In 1996, laptops represented more than 8 million – or three out of every ten new PCs – shipped to corporate America. According to IDC, laptop sales today are growing at almost two-and-a-half times the rate of desktop PC sales.

IDC estimates that in 1997, 6.3 million laptops were sold in North America and 15 million worldwide. Currently, approximately 40 percent of the installed laptops are in medium and large corporations. A 1997 report issued by FIND/SVP Research Publications estimated that the market for mobile computing products and services would reach US$119 billion by 2001. Present day figures place the figures at a conservative four times more.

Most industry analysts agree that the fully burdened cost of the average desktop PC is between US$8,000 and US$13,000 per year. The majority of this expense is not in hardware, but in service and support. However, while remote hardware technology is growing at a tremendous rate, very little is being done to make remote laptops more cost-effective and easier to support.

LAN-connected desktop PCs are already difficult and expensive to manage, but mobile PCs can present even greater support headaches. Gartner Group estimates that the annual cost of owning a laptop is US$11,745 compared with US$7,449 for a desktop PC.

Mobile workers, like desktop users, must have access to the most up-to-date corporate information as well as software updates and virus definitions in order to remain productive.

However, mobile computing environments are characterised by a number of unique computing problems, including limited modem/phone line bandwidth and unreliable connections. As a result, the total cost of ownership (TCO) for mobile workers increases.

In addition, IT professionals tasked with managing an enterprise-wide computing environment are faced with trying to deliver high quality support and service to mobile systems over unstable connections and without raising costs.

To be considered completely managed, mobile systems – like desktop systems – require updated software, correct system configuration, error-free installation, an information distribution mechanism, regular and on-demand access to service and support, and a reliable method for assessing mobile system status.

Support Observations

1. Mobile PC users who are not networked typically must choose from the following options if they intend to remain part of a well-managed computing enterprise:
2. They can send or take their laptops in for maintenance and support – an often costly solution that involves downtime, travel time, and travel costs.
3. They can use an 'On Loan' laptop while their own mobile PC is updated, repaired, etc. – at best an inconvenient solution that typically results in lower productivity.
4. They can ignore or postpone needed maintenance – escalating the probability of eventual system failure and prolonged downtime.
5. They can use dial-up lines and a modem as management tools – leading to worker and system downtime as large files move over slow lines with unreliable success.

For corporations with a large base of mobile workers, eliminating travel time and associated costs, results in significant savings. However, the bandwidth and reliability issues of providing mobile management remain. Administrators are left either to try to schedule management activities during unpredictable sessions and low speed connections, or to rely on the mail and telephone to resolve administrative issues.

Corporations, administrators, and users have discovered that LAN-based solutions are not suitable for remote users connecting to the network over dial-up links for several reasons:

- Existing products move all the data across the network, whether or not it is necessary. No check is performed to determine if the data is in fact needed at the target site. In addition, this unnecessary data is often moved across a slow link, which can frustrate a user and result in a hang-up.
- Existing products send the entire distribution job at one time, which may take several hours over a slow dial-up link. Some products perform a rudimentary check and disallow jobs if a slow link is detected, preventing the user from ever getting the distribution job.
- Remote distribution jobs are often interrupted and fail due to unreliable dial-up links. Most of today's LAN-based products make no consideration for partial installs, check-point restarts, or corrupt packages.
- Administrator intervention is usually required, which results in lower productivity for both administrator and user.

What's Needed?

We need to change the way administrators approach and manage their mobile users. Administrators should be able to install new software, modify system settings, maintain standard configurations, and even remotely diagnose problems without changing a corporation's communications infrastructure.

One of the most viable management solution should use a corporation's existing e-mail system – including Lotus Notes, Lotus cc:Mail, Microsoft Exchange, Microsoft Outlook, or any POP3-compliant Internet mail package – as its method of communication between server and client.

Because e-mail systems not only are the most closely managed communications tools used by corporations but also are considered a mission-critical application, using e-mail as a primary delivery mechanism facilitates mobile management functions.

For example, the organisation can design and create a profile of the correct configuration status (or "right state") for a specific mobile PC. This can then be used to compare a user's existing mobile PC configuration to that of a correct configuration, note the differences, and make changes to bring the mobile PC to the "right state."

This design also has the ability to segment the updated files into smaller packages, encrypt them, and send them to the mobile PC over a specified period of time. Then, when the mobile PC has received all the packages, the packages are decrypted, checked for integrity, and installed.

Bandwidth is optimised by sending small packages of files, and using an agent, works independently at the client level to implement changes, correct user errors, and communicate problems back to the server. Note that the agent is always active and transparent, even when the user is not connected.

A product incorporating this architecture could then diagnose and fix PC problems caused by user errors, user installations of non-standard software, Internet downloads that conflict with standard software, and user changes in system configuration. The solution could also distribute software such as upgrades and updates, new virus pattern files, and printer drivers. It could also manage remote PCs to a standard configuration set by corporate IT department.

The result of using such a solution to increase productivity, improve support, and add value to the corporate communications infrastructure by the decreased TCO of mobile PCs. With a dynamic enabling technology that provides the foundation for future software development, this solution becomes a strategic enterprise-wide management solution for the growing number of corporations with a multiplying mobile workforce.

As the mobile computing market grows at an unprecedented rate, the need for reliable and cost-effective management and support for mobile workers is increased. IT professionals require a solution that optimises available bandwidth over sometimes inconsistent connections, without changing the corporate communications infrastructure.

IT managers need a scalable management solution specifically developed for non-networked PCs. By utilising an existing corporate e-mail system, you can provide the smartest solution for managing laptop and mobile PCs, while giving administrators much the same full functionality currently found in desktop management systems.

In the past, mobile computing meant dragging around a laptop computer and a modem. Today, there is a whole spectrum of mobile computing devices and communications systems available. But they still operate as individual tools.

What is needed is the ability of mobile computing devices that can sync with the IT infrastructure. The focus would be to link hardware, software and systems needed to create a truly integrated range of mobile computing solutions that empower people to work wherever, whenever, and however they choose.

Achieving this goal will require a skilled talent pool. These IT-savvy people will possess a wide range of skills, from hardware and systems engineers to applications developers and leveraging the unique skill-sets in technology, connectivity, and mobile computing.

Mobile Agents

An agent is defined as an independent software program which runs on behalf of a network user. An agent may run when the user is disconnected from the network, even if the user is disconnected involuntarily. Some agents run on specialised servers, others run on standard platforms.

A mobile agent is specialised, and in addition to being an independent program executing on behalf of a network user, it can travel to multiple locations in the network. As it travels, it performs work on behalf of the user, such as collecting information or delivering requests. This mobility greatly enhances the productivity of each computing element in the network and creates a uniquely powerful computing environment well suited to a number of tasks.

For instance, a mobile agent may be written in the Java language, resulting in a new class of simple, easy-to-write and easy-to-run programs being enabled. Common examples are user GUIs, databases, and other agents. Administrators control which services are available to which agents and users, and full management features are provided.

A good example of a mobile agent application is a database search. Let's imagine a user with access to a corporate database is at some remote location – say a sales person is at a customer site. The sales person needs a price quotation and availability information for a product. Being at a remote location, there is no direct access to the corporate database, and the communications links are problematic. Security is another concern for the organisation.

How can agents create the solution to this problem? The corporation first deploys the agent server. This is a straightforward operation which requires selecting a platform within the corporate Intranet. Perhaps this platform already exists, if not then many systems can provide it, such as a Unix or Windows NT system. It can be co-located on an existing server machine, such as the database server, which in fact provides advantages of performance and management.

For instance, using the Java virtual machine (JVM) for a mobile agent's runtime environment makes installation particularly simple. Once the agent server is installed, the sales people need portable computing platforms suitable for agents. In many cases, this platform will be a laptop or Palm-based machine with either dial-up or wireless communications devices. The software environment will comprise a suitable operating system combined with an agent runtime environment.

The next step is to define security credentials and permissions – which can be used to identify agents and their users to the existing database service or whatever services are chosen for export by the corporation. An administrative process is then undertaken to manage and map these permissions, and the credentials are assigned to the users.

Finally, the corporation needs to create the agents which will actually perform the requests. In any case, the agent application is much easier to create. Based on an agent framework which transparently provides security, communications, and distribution, the IT department can focus on the job-at-hand. Sales people then go to work productively, using the power of agents to perform their remote queries.

Mobile Agent Advantages

The following are the primary advantages of mobile agents:

♦ *Facilitate high quality, high performance, economical mobile applications:*

Applications employing mobile agents transparently use the network to accomplish their tasks, while taking full advantage of resources local to the many machines in the network.

They process data at the data source, rather than fetching it remotely, allowing higher performance operation. They use the full spectrum of services available at each point in the network, such as GUI's at the user and database interface on servers. They make best use of the network as they travel.

♦ *Enable use of portable, low-cost, personal communications devices:*

Network support, including security, is contained in a lightweight server which manages the movement of agents in the network.

Coupled with the sophisticated, self-contained programming model afforded by agents, this permits a small footprint to be achieved on user devices, without sacrificing functionality for the application.

♦ *Permit secure intranet-style communications on public networks:*
Security is an integral part of a mobile agent framework, and it provides for secure communications even over public networks.

Agents carry user credentials with them as they travel, and these credentials are authenticated during execution at every point in the network. Agents and their data are fully encrypted as they traverse the network. All this occurs without requiring any intervention from the IT department.

♦ *Efficient and economical use low bandwidth, high latency, error prone communications channels:*
The agent network employs a store-and-forward mechanism to transfer agents between nodes. This is well-suited to the problematic nature of many communications channels, especially in the mobile arena.

Queuing and persistent checkpoints enhance this further, to the point that agents can use such channels with no degradation in reliability or response. Because the agent data processing takes place locally to the source, the network has no effect on the agent as it executes.

Client/Server Barrier
Historically, distributed applications were created with "client/server" programming. In this model, an operation is split into two parts across a network, with the client making requests from a user machine to a server which services the requests on a large, centralised system. A protocol is agreed upon and both the client and server are programmed to implement it. A network connection is established between them and the protocol is carried out.

The client/server model has the advantage of enabling the removal of the client to smaller, remote machines, and it works well for certain applications. However it breaks down under other situations, including highly distributed systems, slow and/or poor quality network connections, and especially in the face of changing applications.

In a system with a single central server and numerous clients, there is only a problem of simple scaling. When multiple servers become involved, the scaling problems multiply rapidly, as each client must manage and maintain connections with the multiple servers. The use of two-tier systems or proxies only moves this problem to the network. It does not eliminate the basic problem.

With client/server comes a need for good quality network connections. First, the client needs to connect reliably to its server, because only by setting up and maintaining the connection may it be authenticated and secure. Second, the client needs to be assured of a predictable response, since its many requests of the server require full round trips to be completed. Third, it needs good bandwidth, since due to its very nature, client/server must copy data across the network. Finally, the protocol which a client and server agree upon, is by its very nature specialised and static.

Often, specific procedures on the server are codified in the protocol and become a part of the interface. Certain classes of data types are bound to these procedures and the end-result is a special network version of an application programming interface. This interface is extensible, but only at the high cost of recoding the application, providing for protocol version compatibility, software upgrade, etc. As the applications grow and the needs increase, client/server programming rapidly becomes an obstacle to change.

Mobile Agents Work

Mobile agents overcome the inherent limitations in client/server model as follows:

- With mobile agents, the flow of control actually moves across the network, instead of using the request/response architecture of the client/server. In effect, every node is a server in the agent network, and the agent (or program) moves to the location where it may find the services it needs to run at each point in its execution. For example, the same agent interacts with the user via a GUI to obtain request keys, then travels to a database server to make its request.
- The scaling of servers and connections then becomes a straightforward capacity issue, without the complicated exponential scaling required between multiple servers. The relationship between users and servers is coded into each agent instead of being pieced out across clients and servers. It is the agent itself that creates the system, rather than the network or the system administrators. Server administration becomes a matter simply of managing systems and monitoring local load.
- The problem of robust networks is greatly diminished, for several reasons. The hold time for connections is reduced to only the time required to move the agent in or out of the machine. Because the agent carries its own credentials, the connection is simply a conduit, not tied to user authentication or spoofing. No requests flow across the connection, the agent itself moves only once, in effect carrying a greater “payload” for each traversal. This allows for efficiency and optimisation at several levels.
- No application-level protocol is created by the use of agents. Therefore, compatibility is provided for any agent-based application. Complete upward compatibility becomes the norm rather than a problem to be tackled, and upgrading or reconfiguring an application may be done without regard to client deployment. Servers can be upgraded, services moved, load balancing interposed, security policy enforced, without interruptions or revisions to the network and clients.

Hardware Diversity

To date, it has been very difficult, if not impossible, to provide user interfaces to systems from inexpensive, small, handheld user devices, nor in fact from mobile devices at all. Two things can change all that – the Java language and mobile agents.

We have noted how mobile agents can be used to create new, lightweight applications which move about the network to accomplish their jobs. Now consider what it means to deploy them on a range of devices from traditional desktop PCs to handheld devices.

The Java language has created many new opportunities in the software world to create truly portable applications. The "thin-client" envisioned by the Java community consists of little more than the Java runtime, a GUI, and a communications path to a server. What better platform than this on which to consider agents?

However, with so few local resources, how do we build powerful and useful applications which do not depend on expensive and local communications hardware?

Consider the following hardware diversity which mobile agent can be deployed effectively:

♦ *The desktop system:* On the desktop, the Web Browser is fast becoming the user interface of choice for many applications. Mobile agents are perfectly suited to this environment. With the powerful GUI tools, the integrated Java support, the security credentials and the rich communications across the LAN, all the pieces are in place for the mobile agent.

♦ *The portable PC:* The laptop or portable PC is basically identical to the desktop system, with the possible reduction in memory and disk resources, and of course the frequent disconnection from the LAN. This environment is where the advantages of mobile agents become apparent. While the machine may be able to function in a traditional client/server environment when docked in the office, it becomes much less useful as a remote client when used remotely. However, except for the network, all the software infrastructure is still available. Mobile agents can easily bridge this gap.

♦ *The personal communicator:* The Personal Digital Assistant (PDA) is not a new phenomenon, but the power of the hardware and software available on handheld device is a recent innovation. The Palm Pilot communicator, and PocketPC palmtop are excellent examples of powerful, portable user computing platforms.

♦ *The server:* Finally, agents run on servers, such as databases, groupware servers, and virtually any other system of interest. The Java virtual machine (JVM) is ubiquitous on such systems and in many cases is already supporting local access to such services. To such a server, mobile agents are simply another standard client. When coupled to the power of the mobile agent network, an entirely different, but more powerful system is created without impacting the server at all.

♦ *The Software Infrastructure:* Creating a software infrastructure for the agents is the next step. Apart from the mechanisms of getting the agents to the various platforms in the network, verifying their identity and permissions, reconstituting their state and running them, there is then the problem of making useful services available to them.

A number of possibilities exist:

1. *Use an existing legacy system:* This requires exporting the legacy system's programming interface to the agent runtime. Layer an existing legacy system under a standard agent API. This is similar to the first option, but more portable and possibly already provided by the software. A good example is JDBC, Java Database Connectivity, which is an open programming layer available for many databases.
2. *Code a new service as an agent:* This is not so far-fetched as it may seem, given the power of agent programming. Agents are well-suited for many dynamic tasks and can be the framework of choice for a wide variety of operations such as searching, directories, etc.
3. *Use a hybrid of the above options:* When used as a 'wrapper' for legacy systems, mobile agents can serve to provide numerous advantages not previously available. Mobile agents can provide new clients for a fraction of the development cost; and they can provide mobility to systems that were never designed with mobility in mind. Additionally, they can provide management and security in systems over public networks, and a host of other.

Advantages of Java

The Java language has a number of advantages that make it particularly appropriate for mobile agent technology. While Java is by no means the only language being employed by mobile agents, it is arguably the best choice.

The reasons for this are many and include the following:

- Java's main appeal for agents is its portability: Java's use of bytecodes and its interpreted execution environment mean that any system with sufficient resources can host Java programs. There are even machines being built today that execute Java natively. For mobile agents, this is a tremendous opportunity. The more platforms capable of executing the agents' code, the better.
- The ubiquitous nature of Java on the Internet: Because Java is embedded in many Web browsers, as well as application servers, there are many platforms deployed already. Application Programming Interfaces (API) such as AWT, the Advanced Windowing Toolkit, the Java Foundation Classes (JFC), and Java Database Connectivity (JDBC) are leading toward even more deployment of Java.
- Widespread deployment exactly targets the sort of services that agents can best use: Another major advantage is the proliferation of tools that support Java programmers. Many programmers are already familiar with C++, which Java resembles in many ways. Added to that is the migration of existing tools to Java and the creation of many more. The net result is an abundance of high quality, easy-to-use tools for both development and debugging.
- Movement of major segments of the software industry to Java: Not only will Java be here for many years to come, it will be employed in ever-increasing applications.

Mobile Agent System
We now know the characteristics systems that utilise mobile agents. Starting with a legacy system, or simply the existence of a database, order entry, groupware, or any other system, we add software interfaces to these existing services.

The language bindings are in Java, e.g., to existing Java definitions such as JDBC. To these straightforward API extensions, we write agents, prototyping them in only a few lines of Java code, and these agents navigate the network transparently to perform the programmer's requests. Users are entered into a security database and under control of a central policy, are allowed to launch these agents. With truly a minimum of work, a secure, distributed, mobile system is up and running.

Mobile Phone Frenzy?
Undoubtedly, the significant trend emerging in business is the need for mobility. And in particular, it is information mobility. In the business space of a company, it involves customers, partners and employees who need to be able to access the information resources and services from anywhere at any time.

There is fuelling a demand for access to more information and services using mobile phones. For example, in a study done in 1998, 60 percent of the mobile data users in the U.S. said they wanted to use a mobile phone for the mobile data instead of a computer or some other device.

Presently, mobile data users currently use mostly SMS applications, which can provide only limited functionality compared to Internet services. This trend is changing. It is estimated that by 2005, there will be about one billion mobile phone subscribers, and that a substantial portion of the phones sold that year will have multimedia capabilities.

There will be a surge in the number of services that can be provided to a mobile phone. Because markets, brands and customer loyalties are changing, constant availability and connectivity assures a competitive advantage in a dynamic marketplace.

The mobile phone represents a huge market potential for companies regardless of your business model. Using this new mobile channel – apart from offering existing services – there are unlimited possibilities to create new services and products for customers. Each mobile phone user can be offered personalised services that suit individual needs. Consider the scenario that in the future, it may well be just a media phone that enables you to do a lot transaction e.g., make calls, pay bills, buy tickets, check e-mail and manage your agenda, and so forth.

WAP Platform

The hype surrounding WAP (wireless application protocol) has fizzled out for many reasons beyond technology. In reality, WAP is still a promising platform that can make a positive contribution to mitigate the mobile computing problems. WAP represents an open universal standard for bringing together Internet content and advanced value-added services not just for mobile phones but for other wireless devices.

WAP technology, products and services have been much touted by the leading telecommunications companies based on the experience gained from the Web-based infrastructure. Specifically designed WAP tools take into account the critical constraints of the wireless world, namely:

- Limited bandwidth;
- Challenging conditions of use;
- Specific user interface; and
- Processing characteristics of mobile phones.

Fundamentally, WAP enables a wide range of wireless services that are independent of the underlying digital wireless network technology. WAP-based services are global, easy-to-use and offer improved security. The additional advantage is the similarity of WAP and Web tools. This makes it relatively straightforward to adapt existing applications and IT systems to the mobile environment.

Breaking New Ground

In order to understand the business potential of WAP, let's take a closer look at the characteristics of a mobile phone. A mobile phone, as an access device, has four important attributes: Personal, Mobile, Usable, and Trusted.

1. *Personal:* Firstly, a mobile phone tells a story about the owner simply because it a very personal device, and where the user has absolute control. A mobile phone user can choose where, when, and how he uses the device. A mobile phone enables the service provider to offer truly personalised and customisable services on a one-to-one basis.
2. *Mobile:* Secondly, by definition mobility is empowered by the mobile phone, because it enables the user to communicate at anytime regardless of physical location. The device is within easy reach round-the-clock.
3. *Usable:* Thirdly, the mobile phone is a highly usable device. The device is handy, in a ready-to-use mode without requiring boot-up time, and readily connected. For instance, there are no hassles with modem configurations and messy wires. In fact, the rapid penetration of mobile phones in all age, social and professional segments clearly illustrates the usability factor. Recent research statistics indicate that the total number of mobile phone users worldwide is over 300 million which is double the number of Internet users. By 2005, there will be about 1 billion mobile phone subscribers.
4. *Trusted:* Finally, a mobile phone is unmistakably a trusted device because it is a personal device, and thus, a natural platform for secure applications and payment transactions.

A mobile phone is fast becoming the preferred method of communication and an essential device to connect to the world of everyday reality.

Business Applications

WAP represents significant business potential for corporations across multiple industries. First, WAP provides an open technology platform for offering new and innovative services to the consumer market and a wireless channel for existing services. Second, it increases employee productivity and improves business performance through continuous mobile access to corporate networks.

The gap between work and free time is blurring. Note that the time spent away from work and from home is increasing. And there is also a growing number of time periods when an individual is neither working nor at home. A good example would be waiting time before an airplane flight. Obviously, many of us would like to use such idle moments as effectively and enjoyably as possible.

The mobile phone is a bi-directional channel enabling development of services that allow users to react only when notified by the mobile phone. For example, investors do not have to constantly watch the stock rates on their own, as a mobile phone can alert the user when the threshold limit of a stock rate is passed. The unique advantage is that the person can react immediately from wherever he or she is.

WAP applications may help the consumer to reduce the hassles related to many routine activities, thus freeing up time other meaningful activities. Banking is probably the one most often cited application area that will benefit from WAP. Being able to check your bank account and carry out transactions with a mobile phone is a very timely offering.

Online ticketing is another area where mobility offers interesting opportunities. Consider the business traveller who realises that a meeting will extend over the planned duration can use his mobile terminal to change his flight to the next available connection. To the business traveller, the real value is obvious.

Besides the business potential, being able to receive simple – yet in many cases – vital pieces of information such as weather, news and sports, traffic information, white and yellow pages, as well as public transportation schedules on a mobile terminal will make life easier for most of us. WAP is an entertainment medium as well.

Recent developments in the retail industry clearly underline the opportunities of Internet-based retailing. Mobility increases the business potential even further. It is important to note that it may be that only one part of the purchasing cycle is completed via a mobile terminal.

For example, it is likely that one would not define or configure a weekly shopping list with the limited user interface and a small keyboard of a mobile phone. However, it is easy to envisage modifying the list, glancing through available delivery times, and triggering the delivery through a WAP-enabled phone.

Real-Time Corporate Networks

In most companies there is a daily need to access corporate information. Sales people are meeting potential customers all over the world. Customer service representatives are working at customer sites. Management has to be able to track the development of business operations. Remote customers and suppliers want to know the status of their particular order.

Mobile access to corporate networks enable employees and business partners to access data in a cost and time efficient manner while on the move. This is true both in terms of generic applications, such as e-mail, calendar and directories, as well as access to tailored industry-specific applications.

More specifically, the following applications lend themselves especially well to being WAP-enabled:

- *Sales force and field service automation:* A WAP-application for sales force and field service automation includes mobile access to contact management, order entry, product and spare parts availability and deal tracking. Advanced push-notifications can bring additional benefits through distributing business-critical data when the timing of the information delivery is crucial.
- *Operations and maintenance:* Industrial machinery or even individual components can be equipped with "GSM chips." This then makes it possible to provide the operating and maintenance personnel with access to information about the component's performance and need for maintenance. This mission-critical information can be aggregated into a few high-level indicators, which can then be further investigated by "drilling down" into the specific data elements.
- *Management information:* In practically all companies there exists a vast amount of information that has significant managerial value. This information resides in various corporate databases, enterprise applications, and numerous departmental systems. It is essential for effective managerial decision making.

Moreover, in most cases, this information is simple textual information with low bandwidth requirements, thus ideal for WAP. Mobile access to corporate networks will enable companies to move one step closer to real time operations. In today's fast-paced competitive environment, this means operational excellence, faster and better decision-making, and optimal business performance.

Elements of a Global Standard

WAP enables Internet access to mobile devices. The fact that the access will be over a mobile network has some important implications as follows:

1. Firstly, saving bandwidth will always be relevant. The coming broadband networks, such as HSCSD, GPRS and UMTS, will indeed offer increased bandwidth.
2. However, their coverage will be, at least in the initial phases, limited to major metropolitan areas. In addition, even the peak bandwidth, that is 2 Mbps for stationery terminals and some 384 Kbps for mobile terminals, will be significantly less than wireline networks today. Moreover, the massive use of WAP devices will constrain the use of bandwidth. Hence, the bandwidth in the mobile network will be a scarce resource for the foreseeable future. Considering all this, it is important that WAP is designed with this limitation in mind.

3. Mobile access means that the access device will have to be small enough to comfortably fit in a pocket. From the technical aspect, this implies that the device will have a limited display and restricted man-machine interface capabilities.
4. Looking at the issue of usability, WAP applications and utilisation environments will be fundamentally different from that in the wireline Internet. People on the move typically use mobile phones with one hand. In such environment, the time for 'surfing-and-browsing' is very limited. Quick access to the information is the mode of use. The Wireless Markup Language (WML), which is part of WAP, is specifically designed for this kind of use.
5. Security is especially important in many corporate solutions. WAP includes a specification which implements options for authentication and encryption and is optimised for use in the mobile environment. It provides end-to-end security for messages. Corporations can be sure that the information travels securely all the way to the end-user.
6. Voice will remain an important application in the wireless world in the next few years. This is demonstrated by the success of already existing applications, e.g., phone banking. WAP is an application protocol for devices inherently geared towards voice communication and it accommodates for the integration between voice and data applications.

The WAP Standard

The WAP standard defines two things:

1. An application environment; and
2. An application protocol.

An application environment:

The application environment consists of two things: a markup language, WML, that allows programmers to define the application's user interface in a device-independent way; and a programming language, WMLScript, that allows programmers to embed executable logic in their applications.

In practice, these are realised in the microbrowser environment in a mobile terminal. Conceptually, the microbrowser is very similar to a Web browser. Because the WAP applications can be downloaded on demand and discarded when no longer needed, the application environment also allows for dynamic extension of the terminal's user interface.

An application protocol:

The actual application protocol is a layered communication stack that consists of a session protocol, a transaction protocol, a security protocol, and a datagram protocol.

The protocol stack isolates the applications from the bearer so that one application can be run regardless of the actual transport service being used.

Naturally the amount of data being transferred and the nature of user interaction affect the selection of the optimal bearer. For example, you would not implement an image database or a multi-user reaction time competition over SMS.

In addition to the application environment and the application protocol, the WAP standard also defines a technology known as WTA. It is a telecom-oriented technology that allows WAP to be integrated with the advanced services in the telecom network, such as "Intelligent Networks." Combined with the browser-based user interface of WAP, the WTA would allow, for instance, new Intelligent Networks based services to be introduced to users without modifying the terminals in any way.

The Wireless Application Protocol has all the elements of a successful global platform standard. It defines the key ingredients of interoperability at an appropriate level of abstraction. Interoperability is fundamentally defined by protocols, programming interfaces and content formats.

Moreover, recent years have brought to the attention of the public a new kind of content format: mobile code. It is an executable content format that can be dynamically downloaded and extended, as well as safely executed in its target environment.

Java is the most famous example of mobile code technologies. The trend of utilising mobile code in application development will strengthen continuously in the near future. WAP will provide the content developers with a mobile code technology that is especially designed keeping the limitations of mobile terminals in mind.

Box Story 1:

WAP Benefits

At a glance WAP (Wireless Application Protocol) offers the following benefits:

- Growing demand for mobility: Rapid changes in the business environment means that mobility is a legitimate demand. Customers, partners and employees need mobile access to the information resources and services of a company regardless of wherever they are, and whenever they want immediate access. Consider the millions of cellular phone users who know what they want, and they expect to get information now. The momentum is exploding, and WAP-based solutions and offerings are becoming a necessity.
- According to recent studies, the total number of mobile phone users worldwide is over 300 million. This figure is double the number of Internet users at 150 million. By 2005, the analysts' estimates indicate that there will be about one billion mobile phone subscribers. Of these, a substantial portion of the mobile phones (sold in 2005) will have multimedia capabilities.

- WAP provides a universal standard for bringing Internet content and advanced value-added services to mobile phones and other wireless devices. The compelling case for WAP is further enhanced because WAP supports all major standards like GSM, TDMA, CDMA, etc. WAP will also play an important role in the future when emerging broadband standards and technologies like GPRS and UMTS become available. WAP enables the organisation to be a part of the wireless future which is even now being created to support mobile computing.
- WAP is truly an open technology platform. This enables you to offer new and innovative services to the consumer market, as well as a wireless channel for your existing services. Additionally, WAP increases individual productivity and improves business performance through continuous mobile access to your corporate networks such as intranet and extranets.
- Consumers, companies, application developers and service providers will all derive benefit from the WAP standard. Mobile Web business is an opportunity that you can cash-in upon, e.g., stock prices, news, flight schedules, hotel bookings, corporate directories, buying tickets and wireless banking, and a whole range of possibilities. Early adopters will stand to gain from the competitive advantage by taking action now. For a business decision-maker, you may be interested in tapping this opportunity.
- Consider the situation that today, the WAP Forum members represent over 90 percent of the global handset market, carriers with more than 100 million subscribers, leading infrastructure providers, software developers and other organisations providing solutions to the wireless industry. This points to the obvious conclusion that WAP will empower the business process with wireless capability.

Box Story 2:

Mobile Computing FAQ

Here are some of the common questions that professionals ask while investigating or planning mobile projects. These questions are categorised in the logical sequence of the life of a project:

What are the attributes of a "mobile-worthy" application?
Certain business applications are more suitable for mobile computing implementation than others. The term "mobile-worthy" is used to describe any application that has characteristics which make it particularly suitable for use with remote mobile computers connected to central information resources.

These characteristics are:

- A significant percentage of work is performed away from a fixed place of work e.g. users are moving around a campus, metropolitan area, region or country – thus spend a lot of time away from the home office.
- Remote users are not permanently connected to an organisation's information servers. The application requires a small, portable and light-weight carry-on computer device.

- There is a significant economic value, public safety consideration or mission-critical nature in the information captured in the field or made available while the user is away from the office: extra travel is eliminated, selling cycles are reduced, patients' lives are saved, information is keyed correctly at source thereby making for shorter billing cycles, etc.
- Only minimal amounts of data from a central information server need be accessed at the mobile site – unlike the Web applications. Based on the current speed and cost of wireless networks, Web-browsing is not an economical or even a convenient application and cannot be called mobile-worthy. Some form of wireless or wireline connection is required either constantly or on-demand.

I have an application on my LAN or on my mainframe. Why can't I port it to a wireless WAN?
You can use and port a wireline LAN, e.g., Ethernet, application on a wireless LAN without any change. Of course, the speed of current suite of wireless LANs is about 2 Mbps. So you should not have as many users on a wireless LAN as you would on a regular 10 Mbps or 100 Mbps LAN.

LAN applications can be provided to remote users through remote access techniques, such as remote control through dial-up, frame-relay and VPNs without any change.

While LAN database applications send enormous amount on the LAN, legacy mainframe applications are typically designed to send smaller amounts of data. These legacy applications are not as bad on wireless wide area networks as LAN applications.

There are a number of reasons why it is not a good idea to port a LAN application on to a wireless wide area network. The most important factor is the speed and cost of wireless wide area networks. Secondly TCP/IP is particularly inefficient protocol for wireless networks. So you should consider some kind of middleware approach. With this approach, you need not change the application.

Therefore, you should consider these factors while porting or making these applications on a mobile network – whether it is a wireless LAN, PSTN, or a wireless WAN.

How can I build a business case for my mobile project?
You should review the business processes now and after implementing mobile computing solution. Estimate productivity improvements, workforce reduction, increased deliveries, fewer trips, additional service calls per service representative per shift and finally superior customer service and competitive advantage that this may give you. We are living in a fast-moving business environment.

What type of ROI or payback period should I expect in my mobile computing project?
Several research companies, such as Gartner, Giga and others, have quoted payback period of two to three years for most "mobile-worthy" applications. In the utility industry, it is two-and-a-half to three years. In field service, it is about three years.

But ROI/payback period based on tangible benefits gives you only a part of the story. Do not ignore customer service, increased market share and competitive advantage benefits that are hard to quantify.

Should we base our mobile solution on existing business processes or should we try to change the business processes as we build a mobile solution?
Business Process Reengineering (BPR) is strongly recommended inclusion of as part of the mobile solution. Business processes will and must change with this technology.

Having said that, we are not suggesting that BPR must be implemented in phase one of the project because change should be controlled and gradual – based on the sophistication of the end-users. Training is one of the most important parts of a mobile project – yet is not given enough attention.

Will BPR (Business Process Reengineering) make my project complex and should I avoid it?
BPR will make your project more complex because it takes a lot of time to redesign new processes and a number of cross-functional issues come up. Yet, you should not avoid it. Obviously, it should be staged properly.

A clear benefit is that BPR gives you the opportunity to get your users involved in process redesign - this fosters buy-in into new way of doing work.

Please explain to me how a mobile solution using a wireless network works. Explain the components.
A mobile computing solution is based on the following components:

Hardware:
1. An end-user computer device – a notebook, a handheld computer or a PDA.
2. Client application that represents user interface and dialogue with the user. This application also contains data validation rules and certain amount of business logic. This application may be based on a modern browser or traditional Windows98/2000 interface.
3. A wireless or switched wireline network which transports the data between this remote device and information server on a LAN or legacy mainframe. In case of the Internet-based solution, you have ISP's specialised router with wireless network support or a shared MCSS in front of ISP's router.
4. A Mobile Communications Server Switch (MCSS) or a Remote Access Server (RAS).
5. A Web-server, an application server on the LAN.
6. A traditional or Internet gateway to the legacy application super-server, e.g., a mainframe.
7. Other database servers that provide the most current information about products, prices, inventory, order status, account balances, etc.

Software:
Similarly, the following software components are involved in a mobile computing system:

1. Client operating software – this may be browser-based or device OS-based, e.g., Windows 95/2000, PalmOS, PocketPC, etc.
2. An application user interface that determines dialogue to get a business function accomplished.
3. Application logic and business rules – these may reside in the end-user device such as the PC, or in the Web server ("thin client" approach).
4. MCSS software – provides functions such as wireline and/or wireless network interface, process multi-threading, fault-tolerance, protocol conversion, transport processing, etc.
5. Wireless middleware that typically resides in MCSS.
6. Web server operating and systems software – typically purchased from vendors, such as Netscape, Microsoft, IBM, Oracle, etc.
7. Business application processing software – purchased as a package or custom-designed for the organisation

In a hardware-software system like this, browser and user interface portion of the client application interacts with the human user. When required, the data entered or collected in the field, is transmitted over the wireless network to an RF network base station. This base station is typically connected through a wireline connection to a communications controller – typically provided by a RF network vendor. The modern controllers support TCP/IP – whereas the older ones had proprietary RF protocols.

While client and server applications written by a customer may write to TCP/IP transport protocol, there may be and should be a wireless middleware that interfaces with multiple radio networks and optimises transport over expensive RF bandwidth.

Once the data is delivered to a server, it traverses its path just like any other application.

How do I select the most appropriate mobile device for my application?
You should take into account the following considerations in selecting the most appropriate device for an application:

1. Analyse the suite of applications that you are going to use on the device. Since no single device may satisfy the needs of all applications, emphasise the core applications – the ones most often used by the end-user – "some pain for most gain is not such a bad idea."
2. Determine what kind of data input interface should the application have – keyboard, pen, touch or speech (voice recognition).
3. Determine how big a screen does the application require. Sometimes, you can break the data in smaller bites.
4. If it is going to be used outdoors, appearance of the screen in sunlight is an important factor to consider.
5. Find out how the business application will be used most often, i.e., for most of the time – in the car, in a customer's home, office, or while walking about.

6. If you must carry it in your pocket (big or small), consider a PDA or Palm Pilot or a PocketPC-compatible organiser.
7. Determine whether it is going to be exposed to rough and tough environment – do you need an ordinary, semi-rugged or highly rugged environment. Remember the latter variety are expensive and more expensive to repair and replace – sometimes you can buy an ordinary notebook, replace it every two to three years and still come out ahead economically.
8. Size and weight requirements are important also.
9. Debate between a notebook, pen computer, handheld computer and a PDA is a tough decision. If the application is routine and repetitive, do not give the user a general purpose mobile device – for example, notebook to a FedEx driver is not appropriate.
10. Finally, let the users make the final selection – with some guidance from you – the mobile computing experts, of course. They are the ones who are going to live and breathe with it.

Which input method should I use – keyboard, pen, touch or speech?
This is a tough question and there is no universal answer. It depends on the application. On one end, the keyboard has been the main method of input for long and many of us are used to it. Now we are used to keyboard and mouse combination. On the other end, speech recognition is the most desirable and easiest human interface, if computers were smart enough. Speech-based input is getting better every day.

These are two primary methods of input – pen and touch are secondary or supplemental methods of input except for simple applications that may lend themselves to pen or touch.

Pen as a replacement of mouse is fine in mobile application but then, we are perhaps talking about pen plus keyboard combination. Pen-only input is suitable only for those applications that are structured and limited menu choices. Handwriting recognition is still not acceptable enough except for a limited set of applications.

Touch is useful in certain outdoor applications with simple menu and dialogue and no descriptive data input is required. Like pen, it could be a supplement to the keyboard.

So, what is the answer? Obviously, you should let the application needs and users' preference decide.

What is so unique about wireless networks that makes mobile computing complex?
The following factors make mobile computing systems integration more complex than traditional non-mobile application integration:

1. Mobile workers have different needs on-the-road – they work differently, they are always in a hurry, they work in non-dedicated mode (flipping from one task to another), and they are on their own without too much help. Mobile users need only relevant filtered data and they may be dealing in truly mission-critical applications – fire, ambulance and public safety. Application design must reflect these mobile needs of the user.
2. Lack of standards have caused too many interface problems. The industry has made a lot of progress made during the last three years.
3. There are only a few mobile-aware application solutions in utility, public safety, field force dispatch and sales force automation.
4. You can not simply port legacy or LAN applications onto mobile devices without change or agent software that insulates them from the traditional desktop interface.
5. Wireless networks are slower, more unreliable and more expensive than wireline networks. You cannot flood a wireless network with the data that travels on a LAN at 10Mbps or 100 Mbps speed. Hence you need an optimising transport middleware – not just compression.
6. There are many different varieties of wireless networks – each with proprietary radio protocol. There is no standards-based communications software (or MCSS) that deals with this. Some vendors (such as IBM) provide support multiple networks through their e-business wireless gateway.
7. Wireless support of the Internet is still in very early stages of development. Current implementations of browsers is too rich for the comfort of wireless networks. You need rather frugal methods of using that scarce bandwidth.
8. Application vendors do not understand peculiarities of radio networks and radio network service providers do not understand application development. You need specialised niche developers and systems integrators.
9. Not too many cookie-cutter mobile solutions are available in the marketplace. Some progress has been made in a number of vertical industries.

Should I go wireless or just use remote network access by PSTN?
True mobility can be achieved only with wireless networks which allow you to do your application anywhere and anytime. However, you can start with a PSTN or wireline solution but your target environment should be one based on wireless networks if you want the highest productivity gains.

If your business process does not require real-time data access or input, you can opt for switched wireline implementation only. This would be the case where construction crew in large projects sends in daily progress reports only at the end of the day.

What are the benefits of using a wireless network? What are the costs?
Only a wireless network gives you true mobility and anytime, anywhere communication with the office or headquarters. You can achieve maximum productivity gains with wireless networks.

On the cost side, we have rather expensive wireless network services, expensive wireless modems and application integration complexity.

When should I implement wireless LAN for my application versus a wide area network?
If the mobile users roam around a campus area only most of the time, then you should implement a wireless LAN solution. You do not need to change any of the applications. It is just a question of doing a detailed site survey, setting up access points and fitting wireless LAN adapters in the notebooks.

Remember, coverage of wireless LAN is in 60 to 240 metres range, though this can be increased by careful design.

You may need a metropolitan wireless solution if your workers go beyond a building but still within a limited distance.

If your workers visit all over the region or nation, then you need a true wireless WAN solution. This solution requires a lot of application and systems integration work.

In reality, you may need both a wireless LAN and wireless WAN for different users.

How do I integrate wireless networks in my enterprise?
You can implement a specialised MCSS (Mobile Communications Server Switch) for your mobile users. This MCSS can be connected to application server on the enterprise LAN. You will need client-agent-architecture to deal with mobile users who may interact with same set of business applications but expect an agent process to hide this difference.

How much will it cost to go wireless?
You can expect to pay in the range of 20 to 50 percent of your regular per user infrastructure costs for wireless network usage. This is in 5 to 10 percent range for traditional applications.

As a rough rule of thumb, it is not uncommon to allocate US$100 to US$200 per month per user for wireless network usage costs.

How does the Internet impact my mobile computing solution?
The Internet will impact mobile computing to a large extent in future. Here are some possible scenarios:

1. All remote users may use a subset of the standard Web-based interface as current implementations of a custom mobile interface.
2. Our dependence on the Internet e-mail is becoming so acute that we would be willing to pay for wireless support of these and a few other time-critical applications. This is especially true for high-priced professional staff.
3. Once the cost of wireless network usage comes down and speed increases, then Net-based thin-client architecture is more suitable for mobile applications. Right now, it is the reverse because you tend to keep as much functionality on the client side.
4. Wireless IP is gaining ground and more vendors are building support in their hardware and software.

When can I expect wireless networks to become faster? Will they ever match the speed of wireline networks?
You will see regular improvements in the speed of wireless networks, especially on the wireless LAN side. On the wireless WAN side, you will see significant increases in speed with third generation wireless networks but do not expect this to happen overnight. Widespread availability of third generation broadband PCS networks is estimated to take at least four to five years hence.

Please explain to me the various pieces of software I shall need to implement my mobile applications?
The following software components are required in a mobile computing system:

1. Client operating software – this may be browser-based or device OS-based, e.g. Windows 98/2000, PalmOS, PocketPC, etc.
2. An application user interface that determines dialogue to get a business function accomplished.
3. Application logic and business rules – these may reside in the end-user device (PC) or in the Web server (thin-client approach).
4. MCSS software – provides functions such as wireline and/or wireless network interface, process multi-threading, fault-tolerance, protocol conversion, transport processing, etc.
5. Wireless middleware that typically resides in MCSS.
6. Web server operating and systems software – typically purchased from vendors, such as Netscape, Microsoft. IBM, Oracle, etc.
7. Business application processing software – purchased as a package or custom-designed for the organisation

Please explain the role of wireless middleware?
Wireless middleware is required to provide the following key functions:

1. Interface with a variety of proprietary radio protocols from Nokia, Motorola, Ericsson, Qualcomm and others.
2. Provide a common API that uses standards-based TCP/IP calls.
3. Provide an optimised radio protocol to conserve the use of radio bandwidth – replace the chatty TCP/IP protocol with one that is more efficient.
4. Support concepts like Smart IP and Mobile IP that allows IP-based applications to be run in a radio environment without paying a performance penalty.

I have heard TCP/IP is not the best protocol for wireless. Yet it is a universal transport protocol. What do I do?
Use products that pretend to the application that they are dealing with TCP/IP network but actually use an optimised UDP or UDP-like protocol.

How do I keep my data on my PDA, PC and server in-sync?
There are a number of data synchronisation software products that allow you to do this.

Should I develop my applications in Java or Windows 98/2000?
Mobile applications are no different in this respect than traditional applications. If your organisation has taken the Java standardisation decision, go with Java. Note that some of the specialised tools may not support Java but major products do. However for the time being, use browser-based interface (which are actually optimised for the PC platform) carefully because it is not optimised for wireless networks.

About the Author
Leon A. Enriquez is managing editor and business manager of Editorial Thoughtscapes – a professional writing firm. Leon can be reached at leonenriquez@et-writer.com.

<ENDS>