

Mobile Internet—An industry-wide paradigm shift?

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The Internet has had an overwhelming effect on the way we do business. It has simplified many of our daily tasks and engendered new lifestyles. As a marketing channel, it has displaced entire organizations and forced corporations to overhaul their operations. The Internet has also changed our way of viewing software, inspiring a new approach to application development. The question is, will the introduction of the mobile Internet give rise to a new paradigm?

Does the mobile Internet represent a true business opportunity? Today, data usage on mobile networks accounts for less than 1% of all traffic. Why, then, should we expect the majority of mobile users to subscribe to the mobile Internet? If the market for the mobile Internet is to take off in a big way, when will this occur, and how?

As with any new trend or innovation, the mobile Internet has a stable of stalwart evangelists. Notwithstanding, the initial reaction of most onlookers is “wait and see.” But after having witnessed the introduction and growth of the Internet, we have also learned not to pass hasty judgement on the unknown.

In this article, the authors share a vision, and point out numerous indicators that signal the imminent arrival, of the mobile Internet.

As with the Internet, the mobile Internet will consist of a wide variety of services and applications that run on top of the infrastructure. However, the reader should note that the mobile Internet will not be a slow copy of the Internet. Instead, applications for the mobile Internet will mainly capitalize on the fact that its users are mobile and continuously connected to the network (if they so desire). In time, today’s Internet will probably become a subset of these new services. The power of mobility is characterized by communication that is carried out as stipulated by the user.

I-mode and Mobitex

Even now, we see examples of how the mobile Internet is being successfully implemented. In February 1999, the Japanese mobile operator, DoCoMo, introduced I-mode, which is built on IP-over-packet PDC (P-PDC; that is, packet data for the Japanese standard). By September 1999, I-mode boasted 1.4 million subscribers, and the service continues to grow at an astonishing rate of 90,000 new subscribers per week—by March 2000, I-mode is expected to have over four million subscribers.

Today, I-mode supports some 230 applications and services. Examples include banking, ticket-reservation (concerts, movies and other events), travel-reservation services (flights, buses, hotels), and a variety of entertainment services. Several factors have contributed to the success of I-mode:

- it is simple;
- it supports only one size of phone screen and a subset of the hypertext transfer protocol (HTTP);
- traffic and subscription fees for the service are inexpensive; and
- it targets the Internet generation, which has the necessary technical savvy and purchasing power. Note: this marketing strategy represents a fundamental departure from traditional approaches, which have targeted traveling businessmen—in many circles, this group of consumers is considered to represent the early adopters of mobile communication technologies.

The Mobitex network in North America is another example of successful implementation of the mobile Internet. Initially, this network was solely used for vertical industry solutions, such as dispatch, utilities and field service. However, a little over a year ago, when the focus of the network shifted to messaging and two-way paging, the market began to surge. Palm Computing, Inc.,

The mobile internet

The infrastructure of the mobile Internet will be based on the Internet protocol (IP), which means we can reuse the hardware, software and competence we have devoted to building the Internet. The infrastructure will also be built around general packet radio services (GPRS) technology, which introduces packet data into GSM and TDMA (IS-136) systems. GPRS enables operators to use the same coverage for data and voice services, and establishes the IP network backbone that will be used in third-generation mobile systems. The key feature of GPRS technology is that it enables users to be connected and online at all times: “always connected, always online.”

BOX A, ABBREVIATIONS

EDGE	Enhanced data rates for GSM and TDMA/136 evolution	LAN	Local area network
GAA	GPRS Applications Alliance	MOA	Mobitex Operators Association
GATE	GPRS applications test environment	PDA	Personal digital assistant
GPRS	General packet radio services	P-PDC	Packet data over personal digital communication
GPS	Global positioning system	SMS	Short message service
GSM	Global system for mobile communication	UMTS	Universal mobile telecommunications system
HTTP	Hypertext transfer protocol	WAP	Wireless application protocol
IP	Internet protocol	WCDMA	Wideband code-division multiple access

a subsidiary of the 3Com Corporation, played a key role when it introduced the Palm VII—the Palm VII is a Palm computer with a Mobitex radio that supports Web clipping, a simple but effective way of utilizing the narrowband mobile Internet. The new success of Mobitex can be attributed to more mature products but also to a maturing market that understands and is ready to use the technology.

From these two examples we see that it is possible to create a substantial market using simple technology and low bandwidth. We also see that success comes from being user-oriented and taking a new marketing approach.

World market

However interesting these two examples might be, neither the I-mode nor the Mobitex market is substantial enough to make us believe in a large global market. To motivate investments for market sizes that exceed \$100 billion per annum, we must see more compelling evidence that points to a major worldwide market.

In January 1999, the Internet consisted of an estimated 43 million servers. This count did not include servers behind firewalls, in intranets, or behind dial-up connections. A server constitutes at least one content provider and one service, but more often than not each server hosts at least ten services. In other words, the Internet constitutes millions upon millions of services. In January 1999, the Internet had at least 150 million users, and experts feel certain this number will reach one billion by 2004. The Internet is an indisputable market of the masses, but as with nearly all markets, the early growth was slow.

Mobile telephony is another major market. Today, there are an estimated 250 million GSM subscribers worldwide, and the number of mobile subscribers (all standards) is expected to exceed one billion by 2004. Just think—two major markets with similar growth projections! What is more, recent market studies conducted in Europe indicate that more than 50% of all GSM subscribers also subscribe to the Internet (and visa versa). Thus, we see a huge potential market for mobile Internet. However, to create a market that attracts and retains these users, several conditions must be met:

- good coverage;
- mass-market pricing;
- endorsement by major players (who represent

end-users, financiers, and suppliers);

- pioneering users who lead the way in buying products and services, and who are willing to put up with the pitfalls of a nascent market.
- easy-to-use devices; and
- a plenitude of applications and services that meet the needs of individual mobile end-users.

Coverage

In GSM, the field strength of the radio signal for a standard call with acceptable voice quality must be at least 8 or 9 dBm. However, simulations of GPRS indicate that the signal strength only needs be 5 or 6 dBm to send packet data. The GPRS standard actually extends GSM coverage for data services, since data is less sensitive to signal strength than voice. Persons who use the short message service (SMS) might already have experienced this effect.

Mass-market pricing

The addition of GPRS functionality to GSM is essentially an upgrade. Depending on the supplier, the extent of the upgrade (in terms of hardware, software and labor) will vary. Assuming the upgrade is to a network supplied in full by Ericsson, we can draw a number of positive conclusions:

- A comparison of investments in an existing GSM network—either to accommodate additional voice subscribers or to add packet data capabilities—shows that operators stand to gain six times as many data subscribers as voice subscribers per

BOX B, MOBITEX

Work on the Mobitex specification began at Sweden's Televerket (now Telia), in the early 1980s. In 1987, the first Mobitex network was taken into commercial operation. In 1988, Ericsson, in cooperation with the Mobitex Operators Association (MOA), became responsible for further development of the Mobitex infrastructure. MOA is responsible for the Mobitex Interface Specification, which specifies the air interface and the protocol used by permanently connected terminals.

Mobitex is a network technology designed exclusively for two-way, wireless data communication. Mobitex has, since its commercial start in 1987, evolved into a system of very high qual-

ity and with numerous functions and applications. The bit rate, however, is only 8 kbit/s, which puts severe restraints on usage. Nonetheless, thanks to the huge success of the first basic information services, such as stock quotes and news, companies are now scrambling to introduce a host of new services. Two examples include the United Parcel Service, which gives subscribers up-to-date information on the location of parcels, and Merriam-Webster, which offers complete online versions of its dictionaries.

In the USA, the Palm VII personal digital assistant (PDA) uses the Mobitex radio interface to access packet data services.

invested dollar. Furthermore, the typical investment scenario will probably be carried out in two or more phases. The first phase is to offer full data coverage throughout the entire network. This done, the operator will increase network capacity as needed. In GSM networks, this can be accomplished while maintaining a positive cash flow.

- Data traffic in a GSM network can be offered on a best-effort basis; that is, data is transmitted in time slots that are not occupied by voice traffic.

Students of price-elasticity theory know that in an optimum market only 10% of the market is willing to buy a product or service at one price level and as much as 90% of the market will buy at another price level. Ordinarily, the initial price of a product or service is set somewhere between these two levels. For the mobile Internet market to take off in a big way, the subscription price must be set at a level that attracts approximately 50% of the market during the first few years after its introduction. During this period, however, operators must also be able to sustain a reasonable profit margin.

Investments and endorsements from major players

Are content providers and major user communities willing to invest in the mobile Internet? The automotive industry—in particular that of Europe—has begun to view drivers and passengers in a new light. Today, many millions of people spend over an hour a day commuting in their automobiles. Taken as a whole, this body of commuters constitutes a huge, but still relatively unharvested market. For instance, in Los Angeles, with a population of eleven million, approximately nine million people drive their cars everyday. Some products developed for this market by early entrepreneurs include navigational aids and safety systems. Many other products and services will soon follow. Examples include the automatic transfer of engine-related statistics prior to service, and up-to-the-minute information on traffic conditions—accidents, road construction, and alternate routes.

Many automobiles currently employ a computer to regulate engine power, fuel consumption and other operating attributes. Some automobile manufacturers are eyeing the possibility of downloading auto-performance upgrades to these on-car computers. Today, only luxury automobiles provide a phone as a standard accessory, but many of the auto manufacturers with whom we have spoken plan to make GPRS phones standard in all new cars.

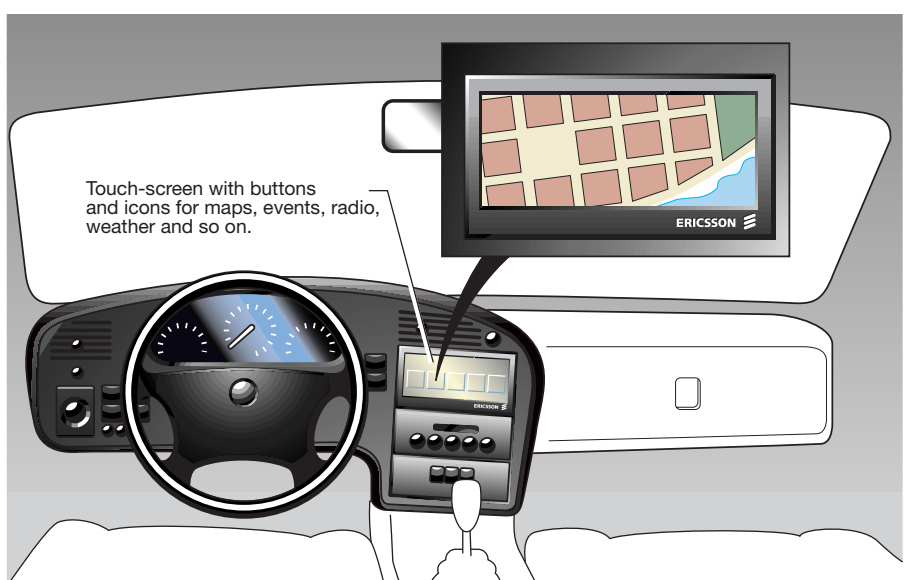
The trading industry also perceives the mobile Internet as a significant new business opportunity. For example, Charles Schwab, one of the largest brokerage firms in the USA, plans to offer mobile trading. Customers who subscribe to mobile, online trading services will not be bound by the constraints of time (office hours) or location to check on or update their portfolios. Instead, they will be able to access all necessary information and trade whenever they like.

The banking industry has also identified business opportunities in the mobile Internet, including

- automated banking services;
- clearing houses for electric commerce (e-commerce); and
- competing as service providers.

As Internet banking becomes more prevalent, banks are looking beyond the immediate horizon. They see mobile devices as being a tool from which users can manage their finances. Indeed, because it is easier to integrate secure transactions into a mobile

Figure 1
The user has easy access to online services via a touch-screen that is connected to a GPRS-enabled terminal. The touch of one icon brings up a map of the area; the touch of another icon calls up a report on current traffic conditions; the touch of still another icon fetches current events in the area (concerts, parades, and so on).



device, many banks actually prefer the mobile Internet to the fixed Internet.

To enable the commerce of goods and services over the Internet, a neutral, third party must clear the financial transactions and control the integrity of buyer and seller. No one is better set up to do this than banks and financial institutions. Likewise, e-commerce can further automate banking services and reduce costs, which makes it an attractive way of doing business. Some banks even envision the day when mobile e-commerce will relieve us of bills and other costly payment methods.

Recent mergers in the banking and insurance industries have created efficient and competitive service brokers. Banks are very competent at managing, marketing, billing and charging for any kind of professional service. Consequently, apart from selling banking and insurance services, many banks have also begun purveying telecommunications, travel, and utility-oriented services.

Other sectors that stand to benefit from the mobile Internet are utilities and safety and social services. For instance, via the mobile Internet, service technicians can obtain descriptions and instructions while they are in the field. In a like manner, fire brigades, police, and ambulance personnel can retrieve information on buildings (for example, blueprints), dangerous substances, criminal records, and medical conditions. Social services personnel can receive assignments and send and retrieve data on patient conditions.

The entertainment industry is espousing new opportunities to sell music, books, films, and games. For instance, the industry has plans to sell entertainment to travelers who are waiting at terminals and while they sit “captivated” en route to their destinations.

In Southeast Asia, mobile gambling is being seen as a major business opportunity. When combined with secure payment methods, the mobile Internet will enable users to bet on horses, lotto, cricket, or whatever they like wherever they are.

Yet another interesting use of the mobile Internet is machine-to-machine communication—also referred to as telemetry—of which there are two obvious applications:

- More efficient service and maintenance of field equipment—for example, Coca-Cola has begun to deploy machines that can communicate their current stock of goods, which makes maintaining the total field inventory much more cost-effective.

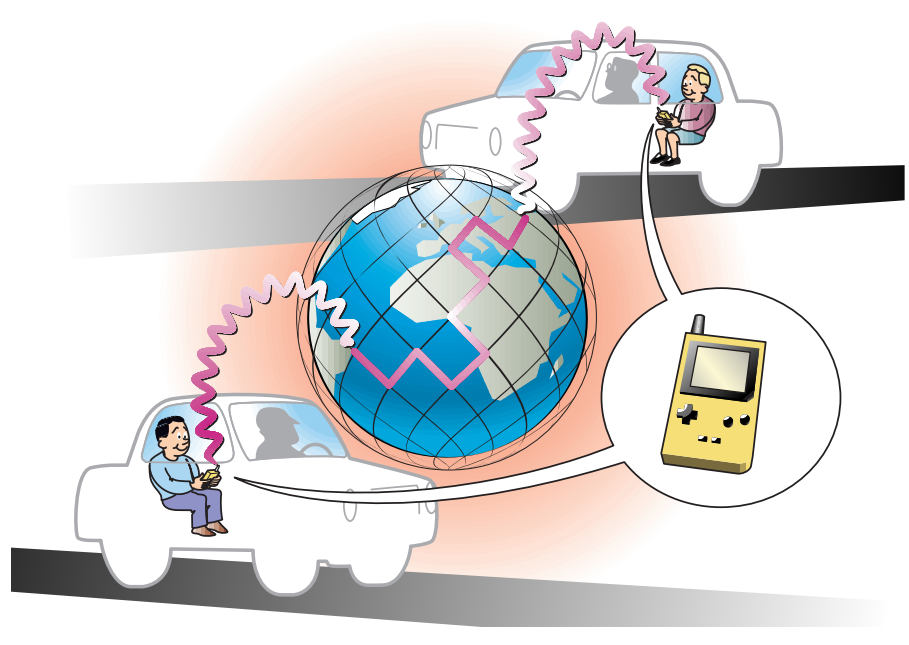


Figure 2
Two users in different parts of the world share a game. Could this mean that parents will finally see their children happily occupied and content during extended road trips or while on vacation?

- The ability to communicate with any device, anywhere and at any time:
 - The largest elevator service firm in Europe has plans to install GPRS terminals in all its elevators.
 - Weather stations and security systems are being outfitted for mobile service.
 - The combination of positioning systems (such as GPS) and GPRS makes it easier to track and maintain equipment, devices, and other valuable goods.¹

Availability of technology

Unless the devices and applications associated with the mobile Internet are simple, reliable, easy to use, and offer reasonable power consumption, then few people will be inclined to use them:

- Devices and applications must be intuitive and simple to use.
- Services must be easy to personalize; that is, users should only have to select the applications they want to have on their terminals—they should not have to download, unzip and install files if they do not want to.

BOX C, HANDSETS TO MATCH USERS' PERSONALITIES

Today, many users buy products that match their personalities. Many of them also buy accessories with which they can further personalize the exterior of their phones, PDAs, and so on. Taking this one step further, users will soon be able to pick and choose from among a variety of services—in essence, personalizing the content and behavior of their phones and PDAs.

For some, the mobile device will function like a phone or as a device for sending and retrieving e-mail. For others, it will be an instant messaging device as well as a terminal on which to play network games with friends.

- Mobile terminals must be as rugged and reliable as present-day mobile phones (which can be dropped on the floor and withstand a certain amount of moisture, and temperature extremes) but not more cumbersome to carry than keys, a wallet or a watch.

- Terminals must operate for at least 48 hours between charges.

Many device manufacturers claim to be well on the way to fulfilling these requirements, and numerous indicators confirm their claims (Box C):

- Soon the number of portable computers will exceed that of desktop computers.
- Palm Computing, the most successful manufacturer of portable handheld organizers, recently introduced the Palm VII, which features wireless access. The company also successfully breached the “leading-edge” segment and won the hearts of early adopters.
- Although it is heavy and cumbersome compared to most mobile phones, the Nokia Communicator is used by many workforces who need to communicate with the home office from a mobile work environment.
- At Telecom 99, Microsoft demonstrated that, using its Windows CE operating

system, it can connect to the Internet via a GSM phone.

- Bluetooth simplifies connections between terminals (communicating devices) and palmtop devices (computing devices).
- Many mobile phone manufacturers exhibiting at Telecom 99 demonstrated the potential of the wireless application protocol (WAP).

Pioneering end-users

Today, virtually every new GSM phone comes ready to handle packet data—SMS works right out of the box. Unfortunately, because the keypad on most terminals is not user-friendly for inputting text, the majority of users do not use SMS (Figure 3). Notwithstanding, Telia (Sweden) recently reported that it derives some 5% to 10% of its revenue from SMS.

Given the deep penetration of GSM in some countries, it is now more the rule than the exception for teenagers to own a mobile phone. Teenagers use SMS to communicate in the classroom, to communicate at night-clubs (where the music is too loud to permit normal conversation), for games, and to communicate with their partners.

The younger generation makes up a market

Figure 3
Ericsson's Chatboard.



segment that has the competence and savvy to use the mobile Internet. Moreover, this group is willing to put up with the initial pitfalls and shortcomings of mobile data, and it has buying power. Finally, this group of consumers is not bound to older paradigms that blind it from seeing new uses and solutions for making life simpler.

Applications

Today, most debates on wireless data center around the wireless application protocol, which is a suite of protocols that will aid applications in wireless environments, including new wireless technologies (GPRS, WCDMA, EDGE, cdma2000). Thanks to a superior, aided user interface and transmission over the air, the wireless application protocol successfully bridges the difficulties that arise when data services are used over wireless systems. However, WAP alone will not usher in the mobile Internet. Some applications simply cannot run over WAP, but require more of the client—more than a Web-based interface can provide. Similarly, some devices, such as laptop computers that run on Windows95/98, do not support WAP.

In all likelihood, many applications will be developed in a thin-client version (in WAP for small devices) and in a more advanced version that targets a specific environment (or perhaps in Java, to enable the application to run in a variety of systems).

Despite the wireless data success of I-mode and Mobitex, and a growing momentum for WAP applications, to date no GPRS-specific applications have been developed (although most IP applications run “okay” over GPRS). Several industry segments are monitoring this market closely, however, and some have already begun investing in it. In all likelihood, GPRS will be a significant enabler of WAP, by making it available to the masses.

The GPRS Applications Alliance

Ericsson has taken the initiative of driving the development of GPRS applications and services by setting up the GPRS Applications Alliance (GAA). As the leader in GPRS, with over 45 trials and deployment contracts, Ericsson is ideally positioned to drive the applications-development process forward.

The new applications and services needed to propel the GPRS market will be devel-

oped by new entrants on the mobile communication scene, such as software developers and content providers. The role of the GAA is to serve as a catalyst, by raising the awareness of opportunities offered by the introduction of GPRS.

Ericsson has established two GAA centers: one in Stockholm and one in Silicon Valley. Additional GPRS development centers—up to thirty in all—will be established at various sites around the world during the next few months. Some of these will be set up by Ericsson; others by partner companies who will provide local or regional support. Each center will offer the same training, development, and testing competencies as the centers in Stockholm and in Silicon Valley.

The GAA centers will support application developers at every step. Technical training will enable developers to assess the impact of GPRS on their current applications, the majority of which will have been developed for the Internet in the fixed environment. The centers will also help developers to create business strategies that address the world of GPRS. Technical support will provide the answers to questions such as “How will my desktop PC application work in a vehicle that is traveling at 100 kilometers per hour?”

One of the most important services provided by the GAA centers is application testing. After a developer has created an application, it must be thoroughly tested to ensure that it will operate effectively in GPRS environments. To this end, Ericsson has created the GPRS applications test environment (GATE). Running on a laptop computer, GATE simulates the impact that varying radio environments have on the IP stream, and thus on the application. Different scenarios can be simulated: for example, city centers with high levels of traffic, good coverage and competition for bandwidth as well as rural areas with poor coverage and little traffic but high bandwidth availability. The tests can be repeated as many times as necessary under identical conditions.

To further assist application developers, the GAA also offers a process for verifying products before their commercial introduction. If the GAA determines that an application meets all stipulated criteria, then the Alliance will work with the developer to market his or her product. The GAA is also setting up (at its first two centers) a radio test bed, which is essentially a live GPRS network that provides the final test of a new

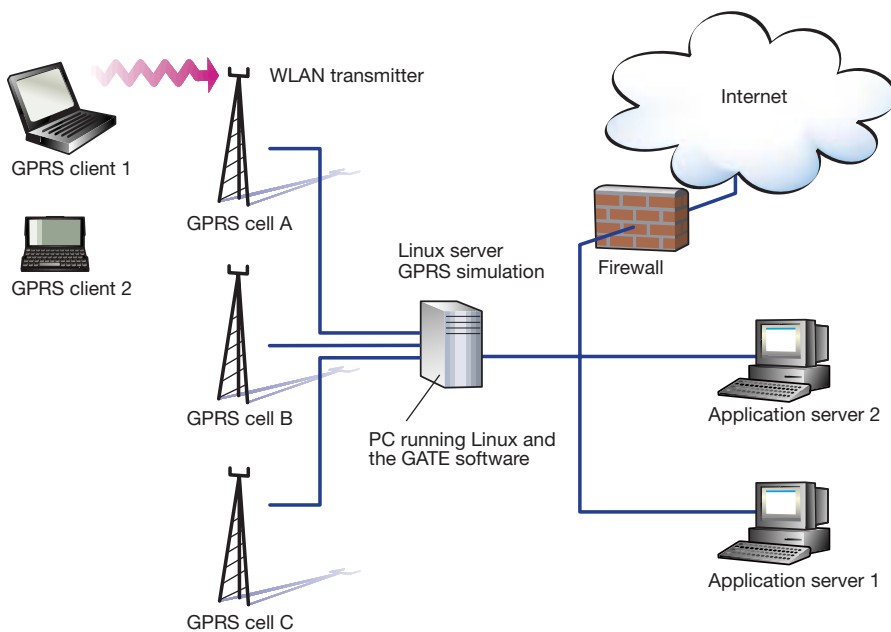


Figure 4
The GATE setup used for demonstrations.

TRADEMARKS

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application. After new applications have been tested and verified they are listed on the GAA website (www.gprsworld.com).

Since it was announced last November, the Alliance has attracted over 80 members (the charter members of the GPRS Applications Alliance are Ericsson, IBM, Lotus, Oracle, Palm Computing, and Symbian). The GAA has already begun working with several major software and application-development partners.

The creation of a successful applications environment for GPRS is an essential precursor to the evolution of UMTS. That is, the success of UMTS will be ensured through the introduction of GPRS applications and services. Ericsson's GPRS Applications Alliance initiative serves as a catalyst for creating a world of packet-switched applications and services.

The impact of technology

Experiences from GATE

The GPRS applications testing environment is a Linux-based simulator. Its name, however, is somewhat deceptive, since

GATE also aims to support EDGE and UMTS. GATE filters packets at the IP level and drops or delays packets according to the mobile network models that have been assigned to it. The objective is not to simulate every aspect of a full-fledged network, but to give a valid view of the mobile link, as perceived by the application. The GATE computer is connected to a local area network (and, optionally, to the Internet) that hosts various application servers. GATE's other network interface is connected to an emulated GPRS mobile terminal—a laptop computer or another IP-enabled device, such as the Ericsson MC218. This connection (Figure 4) can either be

- a wireless LAN—to demonstrate mobility and handover; or
- a wired Ethernet—if the intent is to test a specific application.

The testing procedure

When a company opts to join the GAA, the GAA technical team contacts the member technical team to discuss the applications to be tested and the technical details of the test. Early on, each party must understand what can and cannot be accomplished. Once all the details have been sorted out, the member team visits one of the GAA test labs. During phase-one testing (usually one day per application), the application is installed in the GAA lab and each party gets acquainted with the setup. When the application works as it was intended to do (most applications run out-of-the-box but with varying quality), some manual stress tests are applied through the GATE interface—for instance, simulated changes in network load, and out-of-coverage simulations. The technical teams then draft a suitable roadmap for future tests. The member usually submits a test specification for the application, which shows how the developer intended the application to work. The rigorous tests run the application through a series of repeatable scenarios. The resulting test protocol serves as the basis for improving the application. The intent is to make testing a cooperative effort between the member and the GAA: the GAA provides the testing facilities and wireless expertise, and the member provides expertise in software development (and specific knowledge of the application).

An often-heard comment at the end of the testing phase is: "This knowledge can be applied to all our products, not just GPRS or wireless products!" Indeed, all network or

Internet products should have efficient protocols that are fast and do not send excessive data. Accordingly, the process of optimizing a product and of making it more robust also prepares it for the conditions of bearers of greater bandwidth. This lowers the cost for users in systems that charge for bandwidth (which might be the case for WCDMA/EDGE/cdma2000) and gives better user experience.

Interruptions

Which of us has not had his or her e-mail software freeze up unexpectedly, for instance while downloading an attachment? Why does this happen? Are these incidents attributable to network failure, conflicts with the operating system, or a lack of system resources? Interruptions represent a complicated challenge, since—apart from the many ways radio conditions can affect an application—numerous other factors can prevent an application from reaching the server. Some technical solutions are available, however. And apart from these, much can be done to improve perceived performance by keeping the user informed and putting him in charge (Box D).

Interruptions become even more apparent in wireless environments, where varying delays and the temporary loss of connection occur more frequently than in fixed-wire environments. Smart, user-friendly software ensures that the end-user stays informed about what is happening and feels confident that he or she will not be forced to wait indefinitely or abort. A meter that indicates the progress of a download, or a dialog box that suggests options for troubleshooting a problem could make the difference between a satisfied end-user and one who ceases to use the software altogether.

Conclusion

Will the introduction of the mobile Internet give rise to a new paradigm—one in which the user is always connected, always online? We think so. Several indicators signal that the day of the mobile Internet is at the door:

- We are seeing simple but successful implementations of the mobile Internet—for instance, I-mode in Japan, and the Mobitex network in North America.
- We see a huge potential market where the subscriber to mobile telephony communications and the Internet subscriber are one and the same person.

BOX D, INTERRUPTION SCENARIO

Graham P. Richardson is a typical wireless data user. One sunny day in November, 2000, he and his wife depart on a well-deserved vacation from their home in Silicon Valley. Their destination is Las Vegas. Judy, Graham's wife, drives as Graham finishes up some work on his laptop computer. Graham's laptop is connected to the Pacific Bell GPRS network—consequently, he can connect wirelessly to the corporate LAN.

This morning, Graham needs to report the latest sales figures and synchronize his files with those on the server. But as the car approaches the Nevada desert, the coverage becomes very

weak and is finally non-existent. The GPRS modem loses the connection and the application freezes in wait for a response from the server. Frustrated, Graham cannot stop the task. When he comes back into range, the application does not understand that it can reconnect to the server. In the end, Graham has to reboot his computer and much of his input to the application is lost.

The events we have described in this scenario can and will happen unless developers have the properties of the wireless environment in mind when they design their applications.

- Mass-market pricing can be offered at cost levels optimized for GSM operators.
- Many user communities and content providers are already investing—"gearing up" for the mobile Internet.
- The younger generation, which already uses SMS and the Internet, constitutes a leading-edge segment that has the buying power to kick-start the mobile Internet.
- Mobile terminal and communicator manufacturers are fully ready to provide handsets for the mobile Internet.

The pieces of the puzzle are falling into place, opening the way for the mobile Internet. Being "always connected, always online," users will, simply by clicking or tapping, be able to manage their business and private affairs at any time and from any place.

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