The Wireless Future:

How to Get Connected and Stay Connected

White Paper

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Introduction

When speaking of wireless these days, it's helpful to qualify exactly what kind of wireless you mean – there are so many wireless initiatives. Wireless efforts include:

- **Phone services** – This area includes standard telephone features over a cellular network (people talking to people) as well as PCS features such as emailing to the phone and paging. Also included in this segment are unified messaging efforts that bring together voice mail, email, and wireless access.

- **Information services** – These range from traditional paging services, to interactive paging, Web browsing on PDAs and browser-equipped phones and pagers, and even information delivered via digital television. Access to Web pages and wireless portals is made possible by a variety of standards-based services.

- **Commerce services** – Commerce-enabled mobile phones are already a reality in Europe where you can buy a Coke from a vending machine using your phone. Including in this category are location-based services (Personal Area Networks, or PANs) that allow purchasing (and advertising) based on proximity to a vendor.

- **WAN and LAN services** – These services allow more-traditional computing devices to connect in an "always on" network. They include fixed wireless efforts that connect sites together, local wireless LANs, wireless (terrestrial and satellite) that provides high-speed Internet access, and wireless networking for mobile devices such as PDAs and laptops.

- **Voice services** – While not strictly a wireless initiative, the development of voice services from voice navigation on cell phones to Internet-driven information services such as TellMe and Quack to voice recognition will profoundly affect wireless services.

So it's a broad field, and one rife with both opportunity and pitfalls. This white paper examines existing and near-term wireless opportunities and how they are likely to affect current corporate computing practice. Of the categories mentioned above, we consider, at least briefly, all but the first, traditional phone services.

Overview

Since Sprint's introduction of PCS phone services in 1994, the US wireless industry has evolved from a niche player that offered expensive voice services on clunky equipment, to a nearly ubiquitous presence in corporate and consumer America. At the same time, non-voice-based information services on wireless phones have proliferated. Most cell phones purchased today have the ability to receive email and other short messages and to act as pagers. The newest models add limited Web browsing ability and even e-commerce capabilities. In fact, nearly half (48%) of all cell phones bought at retail in Q2 2000 were Net-ready – a tenfold jump from the same period a year ago, according to the NPD Group[1]. Mobile commerce, or m-commerce, is also developing rapidly. Today, for example, Sprint customers can buy books at Amazon using their phones and send gifts using the recipient's email address.

Overseas, wireless phone capabilities are even more advanced. In Europe, m-commerce enables users to purchase many goods and services using their wireless phones. Deutche Telekom, in fact, is even considering issuing its own electronic currency[2]. In Japan, 10 million NTT DoCoMo customers enjoy sophisticated services including news feeds, games and music on phones that include color screen models. Users pay for services through charges on their monthly bills. DoCoMo is piloting video services as well.

Cell Phone Momentum

With all this momentum, tremendous growth is projected for information services for cell phones:

- Gartner Group projects that by 2004, 95 percent of new mobile phones will be Wireless Application Protocol-enabled.
- A Cap Gemini and Corechange study projects wireless data applications to grow from 3 percent to 78 percent of the US Internet population by 2001. Today, a third of the US population uses cell phones for business purposes.
- A Strategis Group survey found 34 percent of wireless users were interested in a wireless portal service. The study predicted that the number of wireless portal users will grow to nearly 183.7 million worldwide in the next five years.
- Warburg Dillon Read predicts that wireless carriers will earn $1.5 billion in 2000 from wireless data products and services, and revenues should hit $31 billion by 2008.
- Cahners In-Stat Group forecasts that wireless data users in enterprise segments will multiply more than tenfold, from 784,000 in 1999 to nearly 9 million in 2003.
- The Yankee Group predicts that total wireless subscribers worldwide will hit 1.26 billion by 2005, up from 469 million at year-end 1999.
- International Data Corporation predicts that shipments of portable access devices will exceed the shipment of PCs by 2005.
- Forrester Research predicts that by 2005, non-PC devices will account for $23 billion in online sales, bringing the online total to $269 billion. Of the $378 billion in offline sales, non-PC devices will influence $128 billion.

[1] http://www.npd.com/corp/content/news/releases/press_000802.htm
[2] Silicon.com story: http://www.silicon.com/bin/bladerunner?REQUNIQ=970504724&REQSESS=2173639&4002REQEVENT=&REQINT1=38797&REQSTR1=News%20Search

- An AOL/Roper Starch Worldwide[3] study found "more than half of Internet users said they would be interested in using small, non-PC Internet devices to go online from anywhere."

Yet all is not rosy for mobile phone services. Concerns over privacy, security, and the usability limitations of current Web browsing phones may combine to limit the rapid adoption of these services, even overseas.

- Forrester Research found that 72 percent of US households have no interest in receiving data like news, weather, and sports scores on their wireless phones and nearly 75 percent of households saying they weren't comfortable with the concept of mobile e-commerce.

- Allied Business Intelligence (ABI)[4] found that less than 5 percent of a sample that included both cell phone users and non-users said the cell phone would be a good Internet access tool, while 40 percent thought it would not be.

- An ICM Research study found that only 22 per cent of UK mobile phone and Internet users will access the web via a handset.

- Rhetorik found that 42 per cent of UK businesses have no plans to implement m-commerce into their businesses.

- Broadband Communications found 52 per cent of people in the UK are concerned that buying goods and services over their mobile phones will put them at risk of security breaches.

PDAs Get Connected

But it's not all about phones, after all. There are wireless Personal Digital Assistants (PDAs) to consider as well. 3Com released the Palm VII Connected Organizer on a trial basis in May 1999. The Palm VII accesses Palm's wireless service, Palm.Net, which runs on BellSouth's network. Since then, Palm announced the Palm Mobile Internet Kit, which will enable Palm III, Palm V and m100 handheld users to access the Palm.Net service. Palm also showed at Fall Comdex 2000 a revamped Palm.net portal, called MyPalm, that will allow users to surf the Web, schedule meetings and access standard Pop3 email accounts. With a 72 share of the market, Palm plans to extend the dominance of its Palm OS by licensing it to manufacturers such as Handspring, Nokia, QUALCOMM, Symbol, Sony and TRG. None of the licensees, however, has yet offered a wireless-enabled product, although Handspring plans introduction of wireless modules (modems and phone) for its Visor PDA by the end of 2000.

Microsoft's PDA entries, based on the Pocket PC operating system, so far depend on connections to data-capable wireless phones for untethered access. However, Microsoft plans on making wireless a key part of their .Net initiative. And with the impending availability of Sierra Wireless' AirCard 400 for the Ricochet 128Kbps service, Pocket PC (and laptop) users can get very significant bandwidth in 11 major cities.

Third party hardware vendors such as OmniSky and Novatel have created wireless modems that attach to Palm handhelds and provide Internet connectivity. And server software vendors such as JP Systems, NetMorf, and portal vendor Corechange offer programs that allow businesses to support Web access for various types of PDAs, often with very little extra effort.

Other Devices

Other devices are also getting into the wireless act. Research In Motion (RIM) has released its Blackberry two-way interactive pager. Concentrating primarily on wireless' killer app, email, the Blackberry can also synch with your Personal Information Manager's (PIM) appointment, to do, and calendar capabilities. RIM

[3] http://www.ecommercetimes.com/news/articles2000/001024-5.shtml
[4] http://www.alliedworld.com/

has announced a Java initiative for the Blackberry, which means access to Web pages is definitely in the device's future.

IDC predicts a compound annual growth rate of 36 percent worldwide and 29 percent domestically for handheld/pocket-sized devices over the next few years.

Convergence

But what every mobile professional is really waiting for is the time when you can rely on a single device to connect you with all the mobile services you need. It is not uncommon today to see people with two, three, or more devices clipped to their belts. The device manufacturers are rushing to consolidate functions into a single device. Cell phone makers are morphing their phones into PDAs. PDA makers are morphing their devices into phones. In an example of the former, Motorola and Palm have announced a tri-band GSM wireless smart phone, expected to be available early in 2002[5]. The device will contain a larger color screen, General Packet Radio Service (GPRS – see more on this service below) compatibility and the Palm OS software. Already Motorola offers a Palm-compatible add-on for its StarTac phones. In an example from the PDA side of the issue, Handspring recently announced availability for its VisorPhone Springboard expansion module, which transforms the Visor PDA into a GSM phone[6].

Taking Advantage of the Opportunity

With all the hype, it's hard to determine exactly where and when the business opportunities represented by wireless devices will materialize. Equally hard is figuring out how these changes in commerce and information access will affect businesses processes and prospects. A good place to start is to determine the kinds of wireless devices you want to support and the functions you want to deliver.

Potential Wireless Applications

In the future, the scope of wireless applications is likely to include pretty much any kind of computing. Today, however, applications are limited by the restrictions imposed by the devices and networks currently available.

Today's phones present a challenging applications development environment. Developers of applications for phones must work within the following limitations:

- **Less powerful CPUs** – you can't count on lots of speed and graphics-processing capabilities
- **Limited memory (RAM and ROM)** – typically a few megabytes or less
- **Restricted power consumption** – any computation-intensive applications can quickly draw down the battery
- **Small displays** – most phones display less than a dozen lines of 20 to 30 characters
- **Difficult input devices** – it's difficult to type using only 12 keys
- **Limited bandwidth** – speeds are typically 9600bps
- **Latency** – often gateways and other translators stand between the Internet and the phone

Despite these limitations, there are many fertile areas for development. Below is a list of some potential application areas you can start exploiting today.

- **Sales Force Automation –** Sales people spend between 20 and 80 percent of their day away from a PC terminal or wired computing device. The wireless phone can provide instant, direct access to the latest pricing and competitive information, sales lead and contact information, the latest news from the office, and data-sheets or brochures.

[5] http://www.motorola.com/bluetooth/news/092500_pr_palm.html
[6] http://www.handspring.com/company/pr26.jhtml

- **Dispatch –** Delivery and service personnel can keep abreast of schedule changes, update order records, and order replacement parts

- **Real-time Delivery of Content –** Get current information about weather, traffic alerts, news and stocks

- **Banking –** Over time, banks will bring ATM features such as balance and funds transfer as well as bill payment to the display of a wireless handset

- **Electronic Commerce –** Known as m-commerce, electronic commerce over wireless may turn into one of the most lucrative uses of the new technology. Financial companies like Citigroup, Credit Suisse, Deutsche Bank AG, MasterCard and Visa are betting that it will be.

- **Email –** Email was the original killer app that drove connectivity on the early Internet. It remains the most ubiquitous network application on wireless networks.

- **Organizer –** The Holy Grail of mobile computing is the convergence of telephone, browser, and organizer. Despite the availability of a few expensive converged devices from Motorola, Qualcomm/Kyocera, Nokia and Visor, the goal of providing untethered access to phone lists, calendar, to do lists, and appointments remains elusive.

- **Interactive Chat –** Chat is one of the killer apps of the Internet, at least for teenagers around the world. The hassle of pecking out messages using the telephone keypad would seem to severely hamper the adoption of this technology, however. Predictive text services like those available on some Nokia phones[7] help make message composition less of a chore.

- **Auctions –** Another natural application for untethered devices is real-time auction notifications. Being informed when overbid or when a desired item comes up for auction is a real value added application that benefits from being set free of the PC. Equally valuable is the ability to interact with the auction and increase your bid.

- **Games –** Where computers have gone, games have quickly followed. It will be the same for wireless devices, many of which already feature built-in games. Networked wireless games will be limited for a time by the low bandwidth available, but by the end of the decade, expect to be able to play networked Quake on your phone.

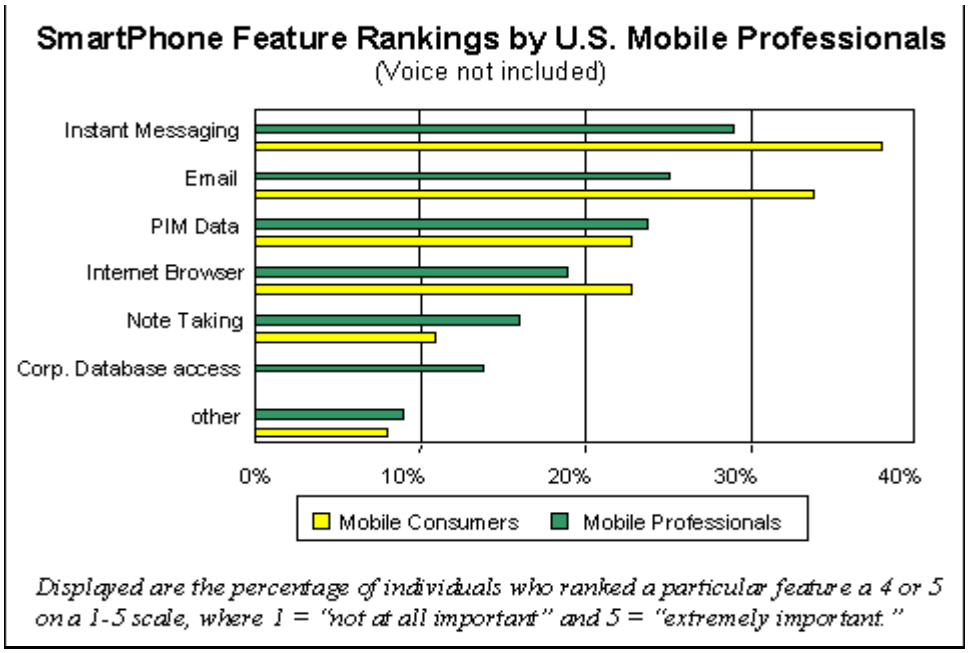
See Appendix D for lists of vertical and horizontal wireless applications for more ideas.

Deciding What Services to Support

Currently, there are a variety of access protocols and methodologies in use in wireless devices. We examine several of them in the section that follows, *Choosing A Standard*. Selecting the devices you want to support necessarily affects the standard you will end up dealing with. Also, the functions you want to deliver can determine which devices you support.

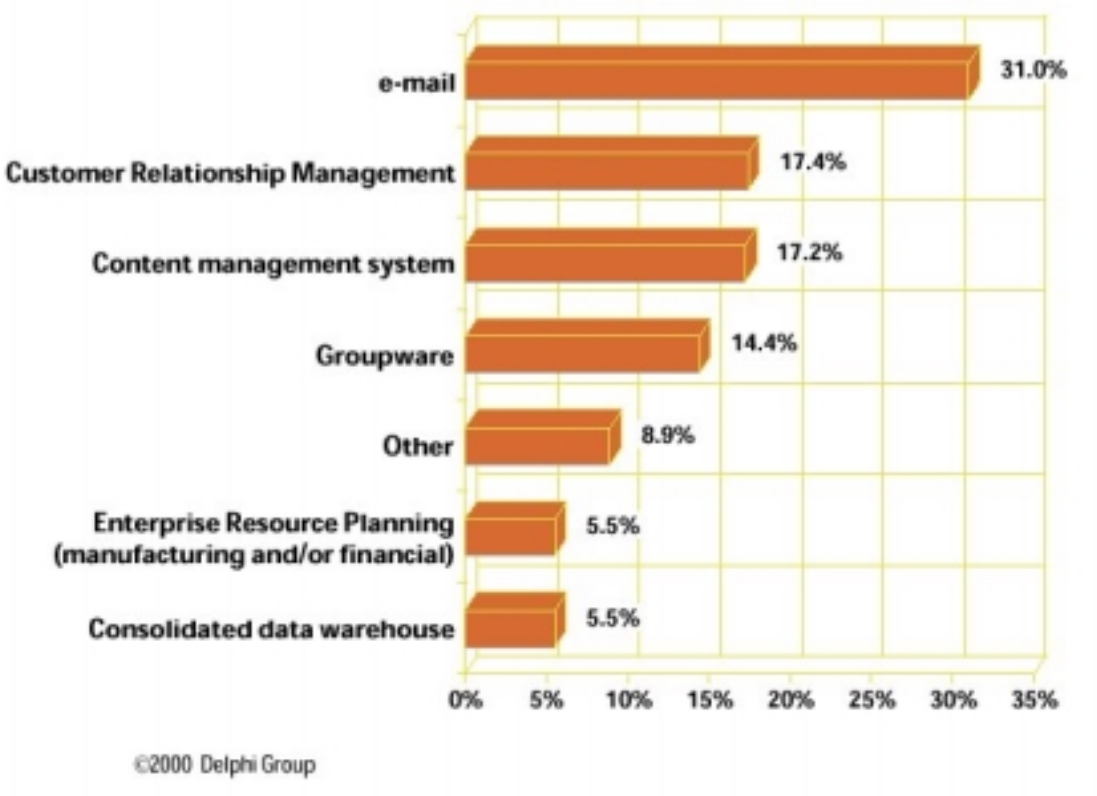
ResearchPortal did a survey of people who were planning on buying a cell phone. The asked what features these prospective customers considered to be most valuable. The sample included both consumers and mobile professionals and the answers are revealing.

[7] http://www.nokia.com/phones/7110/phone/new/predictive.html



Surprisingly, instant messaging (which we imagine includes paging functions) was the most desired feature by mobile professionals. Equally surprising was the fact that consumers rated both messaging and email more highly than did the professionals. Understandably, professionals ranked the ability to manage Personal Information Manager (PIM) data higher than did consumers.

A Delphi Group study found that wireless email was likely the first application to be employed in business. Interestingly, the next in line were Customer Relationship Management (CRM), which we assume includes PIM data access, and content management, which implies the ability to edit documents on wireless devices.



Match the Features and the Device

As you embark on developing your first wireless application, the myriad of options for functionality and devices makes it very important to choose a manageable feature set and a manageable device set. The table that follows lists wireless functions and which devices are most suitable for their delivery.

Wireless Function	**Target Device**
Email Access	
POP3 or MS Exchange (enterprise)	Blackberry, Palm with OmniSky, Novatel, Palm VII with third party software
Proprietary	Palm VII, most mobile phones
Instant Messaging	Mobile phones (particularly GSM-based), Blackberry (PDAs don't typically have "always on" wireless access
Synch PIM data	Blackberry, some phones (PDAs typically require wired synching via cradles)
Web Access	
Any Web Page	Palm with OmniSky, Novatel, Palm VII with third party software
Proprietary Access	Palm VII (web clipping), mobile phones
Corporate Database Access	Custom portal development
M-Commerce	Palm with third party software, some mobile phones, custom portal development

A key point to remember when selecting the devices to support revolves around the immediacy of access. Typically, PDA-based access is not instant because the devices are not "always on." This means the user must take steps to access wireless information. In the case of the Palm VII, the user must raise the antenna

and take one or more steps to select and activate an application to receive the information. The Blackberry (and similar pagers) and mobile phones, by contrast, can receive messages with little or no delay.

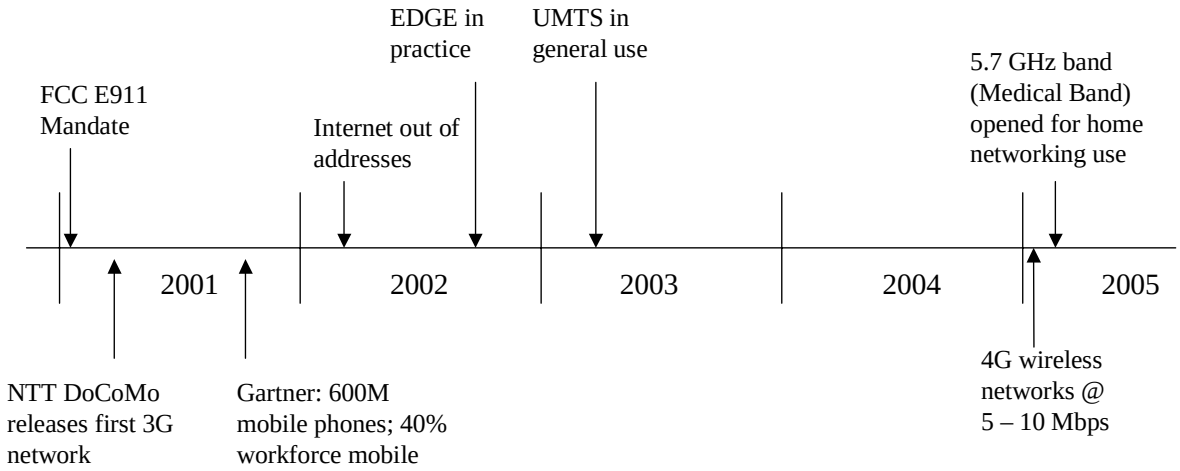
Another point to keep in mind is that with custom development, virtually any kind of informational or interactive application can be ported to almost any wireless device. The real key here is support. The number of devices you need to support could determine how difficult your support efforts become. This becomes especially apparent if you need to make copies of or modification to your existing Web content to support a device.

Future-Proofing Your Efforts

As we discuss in the next section, the wireless world is rapidly evolving, and there are many standards both proposed and in use. But even more important is the evolution of the hardware and networks that support untethered access. Current wireless networks are either 1G (analog) or 2G (digital, such as PCS). They support data access typically at 9600bps, with some supporting 19.2Kbps. With wired modem access averaging above 28.8Kbps, and Web sites becoming more and more graphics-intensive, it is obvious that some modification of content is necessary for wireless devices. Other modifications are necessary due to the small screen size featured in current offerings.

The next generation of wireless networks will offer increased bandwidth. It's just not completely clear exactly how fast they'll get and by when. Some network vendors are targeting so-called 2.5G technologies such as GPRS and Enhanced Data rates for GSM Evolution (EDGE), which increase maximum bandwidth to 384Kbps. Others are waiting for 3G, which promises speeds up to 2Mbps.

The following timeline lists some of the more significant events in the evolving wireless market.



A very significant near-term development will be the implementation of the FCC's E911, or Enhanced 911, mandate, which requires cell phone companies to be able to locate a cell phone within 30 to 50 meters. The E911 requirements are divided in two phases:

- In Phase I wireless carriers must be able to deliver to the emergency dispatcher the user's telephone number and the location of the cell site or base station receiving the 911 call
- In Phase II, carriers must deliver more specific latitude and longitude location information, known as Automatic Location Identification (ALI), to the dispatcher. Carriers must begin selling ALI capable phones by October 1, 2001, and 25 percent of phones sold must be ALI capable by December 31, 2001, 50 percent by mid-2002, and all by the end of 2002.

This initiative is significant for more than just 911 services, however. Once the network can locate your phone with accuracy, all sorts of commercial services become possible. Imagine you're driving in a large,

unfamiliar city around lunchtime. With the push of a button on your phone, you could receive discount offers and advertising from restaurants in your vicinity. These offers could even be tied to restaurant reviews to help entice you further.

Some vendors aren't waiting for the FCC mandate in 2001. Recently, Phone.com teamed with Vicinity to provide location-based services to wireless customers using Phone.com's Mobile Location Server. Another vendor, AirFlash, provides location-based services and e-commerce to Excite @home and the UK's Orange wireless services. The Orange trial includes developing location-based business listings, ATM finder, driving directions and hotel information.

Other uses of this capability include keeping track of mobile workers and basic navigational help – "Which way do I turn when leaving the subway station?"

Another emerging technology that will do even more to enable location-based services is called Bluetooth. This mobile device standard originated in Scandinavia and is named for Blue Tooth, the 10th century Danish king who unified Denmark (and, incidentally, conquered Norway as well). It is a wireless system that allows devices to communicate on a peer-to-peer basis. There's more on Bluetooth in a following section.

Using Bluetooth, you can set up a Personal Area Network (PAN). While the most commonly used PAN may end up being teenagers chatting during class, there are a myriad of possibilities for commercial services based on Bluetooth. For example, imagine visiting a mall, entering a search for khaki pants in your size on your cell phone, and have the various merchants respond with availability, pricing, and discount offers. Bluetooth could also become the means of choice of synching your data between your computer and your PDA or cell phone – no more cradles or cumbersome wire connectors. Ericsson has even demonstrated a scheme that uses Bluetooth to connect a headset with the phone. You could leave your phone in your briefcase and wander relatively unencumbered. Nokia and Fujifilm have created a prototype phone that can receive images taken on a Bluetooth equipped Fujifilm digital camera.

A key date on the timeline is the availability of EDGE technology. This technology delivers bandwidth of up to 384Kbps to wireless devices. That's enough bandwidth to do decent video services and enable Dick Tracy's two-way wrist TV. (Lest we get too excited, however, it is likely that the 384Kbps will be shared bandwidth, so each user typically will get only 20Kbps to 30Kbps throughput to a mobile device.) As previously mentioned, DoCoMo in Japan is preparing to offer similar video services over its i-mode phones. By the time 4G networks are widely available in 2005, the wireless device will have evolved into a very sophisticated phone/PDA/TV/Web browser combination.

The key to staying on top of wireless developments will, unfortunately, be flexibility. New services and standards are evolving almost daily, and the state of the art moves very rapidly. One thing is for certain: Devices will be a significant part of the future of computing. It is very likely that by the end of this decade, you will not longer sit down at a personal computer to do computing. Computing will have disappeared into the environment and you'll have access anywhere.

Choosing a Standard

While the future is all well and good, we live in the present, and today, there are a host of competing wireless standards to contend with. There's the battle of the device operating systems, with Palm OS as the reigning champ, Microsoft's revamped PocketPC as the contender, and a vast array of competitors in the TV set top OS arena. There's a battle over the transmission protocols used in cell phone telephony, with CDMA (Code Division Multiple Access), TDMA (Time Division Multiple Access), and GSM (Global System for Mobile Communications) duking it out in the US, and GSM predominating in the rest of the world. And there are all sorts of standards for fixed wireless networking contending for supremacy.

We'll take a look at three standards that are likely to be important in the near future for the mobile business device marketplace: Wireless Access Protocol (WAP), i-mode, and Bluetooth.

Wireless Access Protocol (WAP)

Wireless Access Protocol is on its way to becoming the dominant method of connecting wireless devices with the Internet. Strategy Analytics predicts that 525 million WAP handsets will be shipped in the U.S. and Western Europe between 1999 and 2003. Of course, WAP-enable phones are not the only way wireless users are accessing Internet services. Strategy Analytics estimates that there are over two million subscribers currently using a cellular or PCS device to access the Internet or email in some way.

The WAP protocol is maintained by an organization called the WAP Forum. The WAP Forum was formed after US network operator Omnipoint issued an RFP for mobile information services in early 1997. It received several responses from different suppliers, all proposing proprietary solutions. Omnipoint was not interested in a proprietary approach and suggested that various vendors work together to define a common, open standard. Thus was created the WAP Forum, and today, original founders Ericsson, Motorola, Nokia, and Unwired Planet (now called Phone.com), are joined by some 200 other members.

See Appendix A for a technical discussion of WAP.

WAP Problems

It has become fashionable to bash WAP just as it is starting to gain a foothold in the wireless industry. Critics point out its most glaring fault: In trying to turn the phone, and audio device, into a browser, a visual device, WAP goes against the very nature of the device, which is to deliver audio information such as phone calls. People aren't used to watching their phones, and thus using WAP requires a behavior change. Some critics have gone so far as to state that WAP solves a problem nobody cared about: how to turn an audio phone into a visual browser. Even Phone.com, one of the inventors of WAP, has said it expects to eventually move away from the technology.

A related problem is transforming rich, multimedia content designed for large PC screens to fit the small windows available on most wireless devices. Some critics call this the "Honey I Shrunk The Web" syndrome. It is a given that not all Web content is appropriate for delivery to wireless devices. Sites that rely heavily on Macromedia Flash presentations, for example, could be left out of the wireless revolution.

Of more concern is the growing tendency of vendors to tweak the WAP standard just enough to compromise interoperability.

Other concerns revolve around security. Gartner VP John Pescatore believes that as mobile phones become smarter, attacks through software updates and simple scripting will increase. He says that wireless vendors have taken shortcuts that leave systems vulnerable to attack. As single user devices, wireless phones and PDAs typically do not implement the type of file access security that other computing platforms do. In addition the limited computing resources available on wireless platforms make inclusion of tight security or antivirus measures difficult.

Of course, security involves more than just protection against viruses. It involves secure, private transactions. Baltimore Technologies sells a wireless device to gateway data transfer technology called Wireless Transport Security Layer (WTLS) that they say guarantees authentication, integrity and confidentiality of data.

Another problem with WAP is uneven support for the standard, which is itself ever-evolving. Some critics claim that phone manufacturers, who are releasing new models and microbrowsers on almost a monthly basis, don't even support WAP the same way in different iterations of the same phone. There are currently available several different versions of, for example, the Nokia 7110 microbrowser, and these different versions support WML code differently. Obviously, this inconsistency makes for a less than optimal user experience, and makes service developers' lives difficult as well.

It can also be a hassle to sign up for a new WAP service on a phone. There can be twenty or more parameters that must be set before you can access the service.

A final concern is that WAP, at least as implemented in Europe, is not "always on." European users need to endure a "dial-up" delay before obtaining WAP services. This is because WAP is a circuit-switched protocol, and thus an Internet session must be established. To add insult to injury, Europeans are charged connect charges when using WAP features. Leave the phone on all night by mistake, and that 16-hour mistake could cost you $250.

The WAP Future

Already WAP vendors are rolling out some pretty impressive capabilities. One UK vendor[8], for example, offers a package of services including email, corporate directory, calendar, Internet newsgroup access, chat, access to ERP data and applications, site search tools, and personalization.

The next major version of WAP will complete a migration to XHTML (eXtensible Hypertext Markup Language) and TCP (Transmission Control Protocol – what runs the Internet) as the foundation of the technology, which will make it easier for developers to write WAP applications

In addition to animation, streaming media, and music downloads, WAP will display color graphics, provide location-specific content, and allow users to synchronize information with personal information managers.

Along with the advances in bandwidth promised by adoption of the 3G and succeeding 4G wireless network standard, WAP will evolve to allow the delivery of services such as video to untethered devices. Nokia and others are already beginning to lay the groundwork for 3G networks and in Summer 2000, Samsung, Sprint, QUALCOMM, and 3COM demonstrated the first 3G network in the US.

WAP vendors are even starting to get into the location-based services business. Mviva, the WAP portal jointly owned by AOL Europe and retailer, Carphone Warehouse, has added a service called "m dealfinder." The service lets users search in real-time for best prices, best delivery times, and stock availability of over twenty categories of merchandise. The service also allows users to purchase securely via their WAP phone. As if this weren't enough, you can type in the barcode number of the particular item you're interested in and the service will find it.

On a negative note, a significant patent on technologies used in WAP is owned by Geoworks (creator of the GEOS operating system originally developed for the Commodore). Geoworks' patent, known as the Flex UI Patent[9], was awarded in 1994, and allows an application to be written once and run under a variety of user interfaces. As part of the WAP Forum charter, members can declare essential intellectual property rights, and Geoworks was the first to do so. Under the terms of the WAP Forum agreements, Geoworks will license their patent to any WAP Forum member.

Geoworks proposes a $20,000 licensing fee for WAP sites or developers, handset vendors, server vendors (plus 10 percent or $1 a seat royalty), and network providers. While this is not a tremendous sum of money, the existence of this patent, and other WAP Forum members' patents that have been asserted subsequently, could inhibit the free development of WAP, which was intended to be an open standard. Server vendors in particular may be reluctant to fork over a 10 percent royalty.

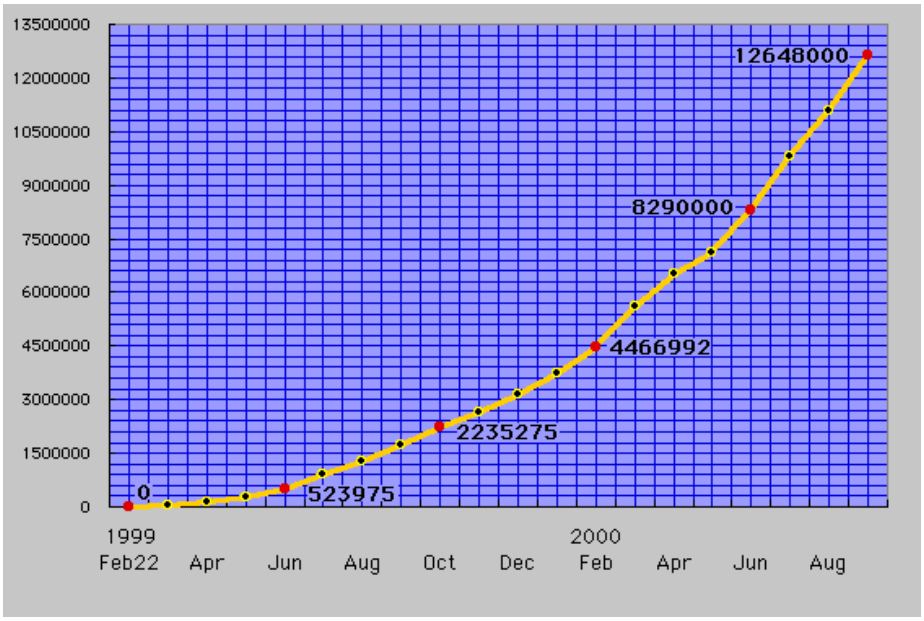
While the WAP Forum moves WAP toward XHTML and TCP, another wireless Internet technology, NTT DoCoMo's i-mode, is moving in the same direction. It remains to be seen if the two standards will converge.

i-mode

i-mode[10] is the brand used for a wireless Internet service developed by NTT DoCoMo, a unit of NTT, the Japanese telecom giant, in early 1999. Docomo means "anywhere" in Japanese.

[8] http://www.wapforum.org/new/20001012183UK-.htm
[9] http://www.geoworks.com/patent_licensing/GeoWIP.html
[10] In yet another example of the importance of domain names, i-mode.com does not belong to DoCoMo, but to an electronic publishing vendor.

With a 14 million subscriber base that is increasing by 50,000 a day, DoCoMo i-mode users represent more than half of wireless Internet users worldwide, according to Eurotechnology.com[11]. An additional 5 million Japanese users use WAP phones. In January 2000 DoCoMo introduced phones with color screens capable of 256-color graphics that can display animated GIF files just like Web browsers. Users of the service use the Net an average of 10 times a day according to the company, and the service has been so popular that DoCoMo had to stop shipping phones and promoting the service in early 2000 to catch up with the demand. The service had serious uptime problems as late as Fall 2000.



i-mode Subscriber Growth Since Inception
Source: DoCoMo.net

The i-mode service is primarily marketed as content; little mention is made of the Internet. DoCoMo has developed a sophisticated micropayment system, and charges users via their phone bill. i-mode charges for the amount of data not by the minute. Users pay a fixed charge of $3 per month and 30 cents per packet.

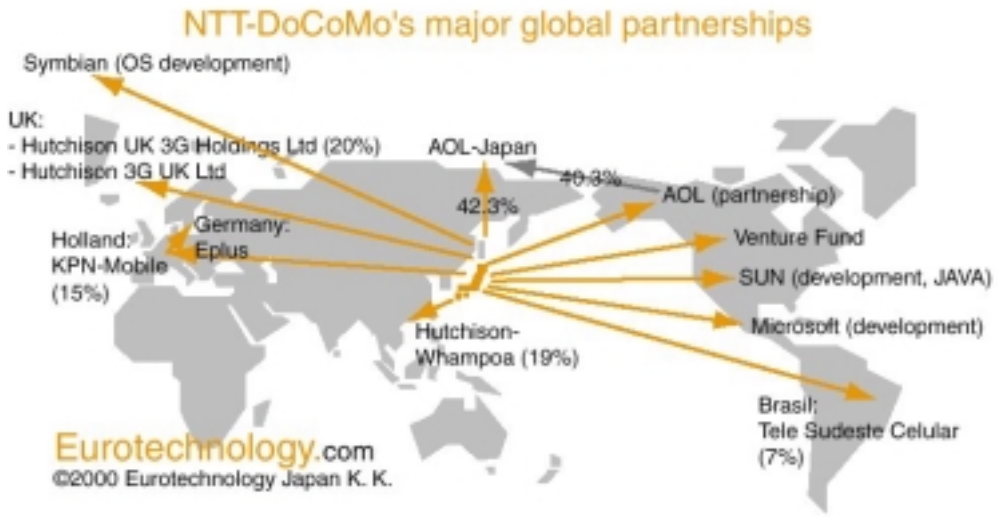
Although 95 percent of i-mode users purchase content or use premium sites, primarily for entertainment, with various cartoon or anime sites being especially popular, 43 percent of i-mode traffic is email and messages, despite a 250 characters per message limit, underscoring the importance of the traditional network killer app. System Lab is releasing its "NetMan p2i Server for i-mode" gateway software for access to corporate or Internet (POP) e-mail via i-mode.

A recent survey[12] by InfoCom Research found i-mode phone users spend 34.2 percent of their total usage time making and receiving calls (an average of 3.67 calls per day), 41.8 percent e-mail (an average of 9.08 email messages sent and received per day) and 24 percent surfing i-mode sites. Only 26.2 percent used i-mode at work or school.

DoCoMo recently allied with Sony to jointly develop PlayStation and i-mode technologies[13]. DoCoMo has also made many strategic overseas investments and alliances in North and South America, Europe and Asia, most notably with AOL, and this may be part of their strategy to take the i-mode technology outside of Japan. As evidence of this, DoCoMo will create a portal with Dutch wireless vendor KPN early next

[11] http://www.eurotechnology.com/i-mode/
[12] http://www.mobilemediajapan.com/stories/storyReader$1141
[13] http://more.abcnews.go.com/sections/tech/DailyNews/sony000801.html

year that will cater to i-mode phones. NTT is also rumored to be in talks with ATT Wireless about an equity investment. An NTT subsidiary, NTT Communications, recently acquired US network services provider Verio, who hosts more than 400,000 Web sites.



See Appendix B for a technical discussion of i-mode.

i-mode Problems

Symantec reported this summer that a feature of the i-mode phone, the ability to embed a phone number in a Web page and have the phone dial that number, has been used to place prank phone calls to emergency numbers in Japan. NTT DoCoMo has no plans to disable this feature and is likely to expand it in the future.

There has been some question about DoCoMo's ability to support the tremendous demand in Japan, and the system has experienced several outages since inception. These problems are more related to the capabilities of the vendor than to the scalability of the technology, however,

The i-mode Future

At a recent industry show in Japan, close to 40 new i-mode devices were shown[14], resembling everything from a traditional cell phone, to a cosmic egg, to a TV-like palm device. Sony is rolling out the I-jump camera and others are offering photo-printing services that work with i-mode phones. DoCoMo, Oki Electric, NTT Data, Mizuho Financial Group, Microsoft, and others are collaborating on the first secure payment system for i-mode.

The large number of NTT's overseas holdings and joint ventures, and especially the rumored investment in ATT Wireless, makes it a good bet that we'll see i-mode in the US at some point in the future. NTT also hopes to convince the WAP Forum to converge with the i-mode standard. Given the limitations and criticisms of WAP, some form of accommodation or convergence with the i-mode standard seems likely.

The short-term future in Europe and the US appears to be WAP. Hardly a day goes by without another WAP device being announced. But the cost of the service, combined with the inconvenience of enduring a dialup may lead consumers to demand sweeping changes in the service that could open the door for i-mode.

The Japanese market will have access to 3G data speeds in mid 2001, and then you're likely to see a real burgeoning of applications, both multimedia and e-commerce. NTT is under domestic pressure to expand

[14] http://www.mobilemediajapan.com/stories/storyReader$1143 For a listing of current handsets, see http://www.mobilemediajapan.com/hardware/i-mode-handsets

broadband access in Japan, which lags not only Europe and the United States, but also Korea and Taiwan[15]. It is conceivable that the telecom will aggressively push broadband wireless as a way to leapfrog itself into a broadband leadership spot. If this happens, we'll see a tremendous explosion of i-mode services in 2001.

A major factor that could limit i-mode's expansion is the proprietary nature of the technology. WAP is an open standard that can be adopted by any manufacturer. i-mode, on the other hand, is controlled by DoCoMo, at least so far. If the two standards don't converge, it might be tough sledding for the Japanese standard.

Bluetooth

Bluetooth is not a product, although it is a brand and a trademark. It is a standard set by the Bluetooth Special Interest Group (SIG), which was founded in May of 1998 by Intel, Nokia, Ericsson, Toshiba, and IBM. Currently there are 2,000+ Bluetooth SIG members and 1,300+ Bluetooth adopters.

Bluetooth uses common, unlicensed frequencies of radio spectrum typically used by high-speed wireless local area networks and bar-code scanning devices. The technology is available on a microchip, which incorporates tiny, integrated transceivers.

Bluetooth:

- uses the 2.4GHz radio band
- supports multipoint access (one to many) and not just point to point
- works in a small area – devices must be within 10 to 15 meters apart
- is able to support data transfer speeds between 720 Kbps and 1Mbps and will offer higher speeds in future
- has significant industry support with more than 1,800 members in the industry consortium

Think of Bluetooth as not only a way to eliminate wires, say from a headset to a phone, but also a way to assemble ad hoc networks between disparate devices. Using Bluetooth devices, people can electronically pay for vending machine items, parking meters, bus tickets, shopping, and movies. In addition, you'll be able to find the closest Starbucks for that latte fix simply by asking your phone.

Since Bluetooth's range is limited to 30 feet or so, most applications will likely involve networking peripherals or establishing Personal Area Networks (PAN) for users to chat with one another or find local goods and services for sale. Bluetooth may compete in the home wireless networking market despite its limited range (see Bluetooth Problems, below).

Bluetooth devices are starting to be released. Recently, Motorola unveiled its new Timeport 270 CDMA phone that has Bluetooth and WAP capability. Motorola's PC card has been out since June 2000.

Ericsson is releasing its GN 9000 Bluetooth wireless headset, which can communicate with any Bluetooth device within 30 feet. Using such a headset you could talk on your cell phone while it remains safely in your briefcase.

See Appendix C for a technical discussion of Bluetooth.

Bluetooth Problems

The main problem with Bluetooth is the fact that it uses bandwidth that is unlicensed in the US and much of the world. Although the UK and several other countries have begun to regulate the 2.4GHz band, in the US it is used for wireless LANs that follow the 802.11, or HomeRF, standard (a standard so nice, they named it thrice: 802.11, 802.11a, and 802.11b), and for other, unregulated uses. For example, the French military is uses part of the spectrum.

[15] http://www.nikkeibp.asiabiztech.com/wcs/leaf?CID=onair/asabt/fw/115775

This collision of bandwidth can spell major problems for the Bluetooth initiative. For example, Proxim plans to release of a building-to-building broadband access technology called Stratum MP, which link buildings that are up to 12 miles apart in a LAN-type structure at up to 10Mbps. It uses the 2.4GHz band, as do digital spread spectrum phones, home automation devices, and wireless home audio/video distribution networks. In fact, the major contributor of noise and interference in this band is probably your microwave oven, which operates at 2.4GHz.

So there may be interference problems on the 2.4GHz spectrum. However, compare this spectrum to the unlicensed 900 MHz band, which is narrower and more crowded than any other unlicensed band, with devices such as store security systems, paging systems, cordless and cellular phones, TV signal extenders, vehicle locating systems, and other spread-spectrum devices all using the range. Chances are good your cordless phone at home uses this band, and you still get decent reception, although voice is a low-bandwidth application. Bluetooth's frequency hopping and other measures may allow it to succeed when the 2.4GHz frequency gets crowded also.

Apparently, some testing facilities have observed problems with using Bluetooth devices near wireless products running on the 802.11 standard. Bluetooth devices have also been known to collapse networks running other standards. When more than one device tries to use frequency hopping in the same physical area, chances are good the most powerful device will prevail, crashing the connectivity of the other devices.

There are other problems with the 2.4GHz frequency, however. It is not only subject to interference by microwave ovens, it has difficulty penetrating many common objects, such as trees, buildings, snow, or anything that contains water. In fact, just like a microwave, water absorbs part of the radio energy and is heated as a result.

This brings up another concern, involving health. Plenty of people are already concerned about the effects of the radio frequencies that cell phones use. Bluetooth uses a much higher radio frequency, but, more importantly, Bluetooth devices will surround us, subjecting us to many more low power radio transmissions. So far, consumers' enthusiasm for going wirefree seems to be outweighing any concerns about radiation, but this could change.

The Bluetooth Future

It is estimated that, before year 2002, Bluetooth will be in more than 100 million mobile phones as well as in several million other communication devices, ranging from headsets and portable PCs to desktop computers and notebooks.

Despite its range limitations, Bluetooth may be one of the technologies competing for share in home networking market, which Frost & Sullivan[16] estimates will be a $282M industry by 2005.

Future Wireless Technologies

There are a number of wireless technologies on the horizon. The following are quick takes on some of the most promising. A major one on the immediate horizon which we'll take a closer look at is General Packet Radio Service (GPRS). GPRS is a transitional service that will give way to so-called 3G services starting in 2002. As we mentioned earlier, analog cellular phones represented the first wireless generation. PCS and other digital phones were the second generation. Transitional technologies such as GPRS and Enhanced Data rates for GSM Evolution (EDGE) form 2.5G. 3G aims to unify the various wireless standards (CDMA and TDMA in the Americas, GSM in the rest of the world) and deliver a dramatic increase in available bandwidth to mobile devices. Major worldwide standards bodies and wireless vendors are collaborating on the 3G standard, which is administered by the International Telecommunications Union (ITU) under the term IMT-2000 (for International Mobile Telephone).

[16] http://www.proxim.com/wireless/research/frost_sul_home.pdf

IMT-2000 is an open international standard for a high capacity, high data rate mobile telecommunications system that incorporates both terrestrial radio and satellite components. IMT-2000 sets several service objectives, but allows for different service standards and protocols to be used in reaching them. One that is receiving a lot of attention in Europe is called Universal Mobile Telephone System (UMTS). Following the section on GPRS, we'll take a quick look at 3G and UMTS.

General Packet Radio Service

General Packet Radio Service is a new service that has been rolling out in Europe since mid-2000, primarily on GSM networks. Since it can also be supported on the TDMA standard popular in the Americas, we can expect to see it here in the next year. The service basically allows any IP-based application to operate over a wireless link. This makes it very easy to consider wireless devices part of the greater Internet.

Unlike WAP, GPRS services are "always on," meaning there is no delay in connecting to the network. GPRS is packet-based rather than circuit-based like current wireless phone offerings. This allows the service to make efficient use of the bandwidth, since the user is not using any bandwidth unless he or she is transmitting or receiving data. Although the theoretical maximum speed is 171.2Kbps, this is achieved by using all eight timeslots at the same time. This will almost never happen, since other users will compete for the slots. For this and other reasons, the average end user bandwidth is likely to be 13.4Kbps in the uplink and twice that for the receipt of data. This is hardly a breathtaking revolution in speed, although it's better than some current implementations.

UK wireless provider BT Cellnet has recently launched the PocketNET Office suite, which allows corporate customers to access standard Microsoft products (Outlook, Calendar and Contacts) as well as optimized web content via Bluekite over GPRS. (Incidentally, BlueKite, which makes a technology that can increase throughput on wireless data links by a factor of five, has already signed up Connect Austria, Telecell and Swisscom Mobile in Europe and Sprint PCS in the US.) Currently BT has twelve corporate customers using the service, but adoption has been difficult due to customer concerns about security.

GPRS Problems

The GPRS standard hasn't stopped evolving yet, and that can cause problems for early adopters. BT's initial service, rolled out in June 2000, supported one standard (SMG29), but subsequent implementations will likely use a later standard (SMG31). The hardware currently in place both on the network and in the users' phones will have to be replaced to support the newer standard. Although BT has completed their network upgrade, phones in use for only a few months need to be replaced to take advantage of the new standard. Like all emerging technologies, GPRS will undergo this type of growing pain. This highlights one of the dangers of being on the leading edge of new technology. Since the current average global replacement rate for mobile phones is expected to remain stable at once every two years in the midst of all these new changes, designing services for the leading edge could definitely put you on the bleeding edge.

Despite being an "always on" packet-based service, currently GPRS devices are not directly connected to the Internet, primarily due to a fear of spamming and a lack of IP addresses. Instead, users must manually initiate a GPRS session using a WAP transaction. But a major problem of WAP is that it is not "always on" and incurs a delay before connecting. Thus, one of GPRS's real advantages over WAP is neutralized. This also makes application development difficult, since developers can't assume a connection is in place and thus must check for one.

Cost may also become a problem for the service. BT Cellnet's is pricing by usage tiers, ranging from Consumer WAP – 1MB of data (approximately 1000 WAP screens) – to Laptop Power User – bundles of 25MB to 100MB of data. For home and corporate users in the US accustomed to "all you can eat" services, this type of pricing might meet the same kind of resistance Palm has seen to its Palm.net pricing for the Palm VII.

Depending on how connections to the Internet are made, a possible worse case scenario is that mobile users would have to pay for receiving unsolicited junk content. Yet if direct connection to the Internet (known as mobile termination) is not supported, functionality is reduced.

The GPRS Future

Samsung and VoiceStream have announced an agreement to develop high-speed GPRS phones that will incorporate the Microsoft Smart Phone Platform (code-named Stinger) and Microsoft Mobile Explorer microbrowser technology in 2001. This alliance is notable as it is the first implementation of the Microsoft wireless platform. It will be interesting to see if this signals a change in Microsoft's desktop and server-centric strategy, or whether the software giant merely sees phones as new peripherals for these computers.

Through early 2002, typical single user GPRS throughput is likely to peak at 56Kbps. In 2002 throughput is likely to escalate to 112Kbps. By the end of 2002, GPRS Phase 2 and EDGE (Enhanced Data rates for GSM Evolution – see below) will begin to emerge.

Some of the applications we'll see include qualitative information like news and chat, connecting and publishing directly to Web sites, exchange of digital photos, document sharing, workgroup computing, audio delivery, remote LAN access, and home automation.

Enhanced Data Rates for GSM Evolution (EDGE)

Like GPRS, EDGE is a transitional standard that will help wireless networks transition to 3G. In fact, EDGE is also known as E-GPRS, for Enhanced GPRS. Boasting a nominal maximum rate of 384Kbps and a real world likely bandwidth of 48Kbps, EDGE was developed by Ericsson to help mobile network operators who were not able to win 3G Universal Mobile Telephone System (UMTS) spectrum licenses. It allows GSM network operators to provide higher bandwidth services while making some network changes that will ready them for 3G. A major advantage for these operators is the fact that EDGE works on their current wireless spectrum.

Because EDGE is a GSM technology, it is not likely to have a great impact in the US, since VoiceStream, the US GSM network, has the least coverage of the nationwide carriers.

3G

The Third Generation Partnership Project (3GPP) was created in December 1998 following an agreement between six standards setting bodies around the world including ETSI of Europe, ARIB and TIC of Japan, ANSI of the USA, and the TTA of Korea. While the final standards have yet to be hashed out in America, Japan and Europe have committed to an approach called wideband Code Division Multiple Access (W-CDMA). This technology, which is being promoted by NTT DoCoMo and others, promises dramatically improved bandwidth. DoCoMo has conducted high-speed transmission experiments demonstrating video transmission of up to 2Mbps. Once again, it is unlikely that individual users will obtain the highest speeds advertised. For example, this past summer, Samsung and Sprint tested the first North American 3G installation. The test results showed that data rates reached 144Kbps with 35 full-rate voice calls being conducted simultaneously. This is more likely to be typical throughput for wireless device users.

The selection of an enhanced version of CDMA instead of a Time Division Multiple Access (TDMA) technology for 3G means that evolution for most of the world will require completely new networking equipment. TDMA is dominant in the Americas, and GSM (Global System for Mobile Communications) is also based on TDMA technology. Partially as a result, Japanese network operators such as DoCoMo will be the first to implement 3G networks in 2001, and Japanese wireless phone manufacturers, who have not had much market share outside their home market, will be first with 3G handsets.

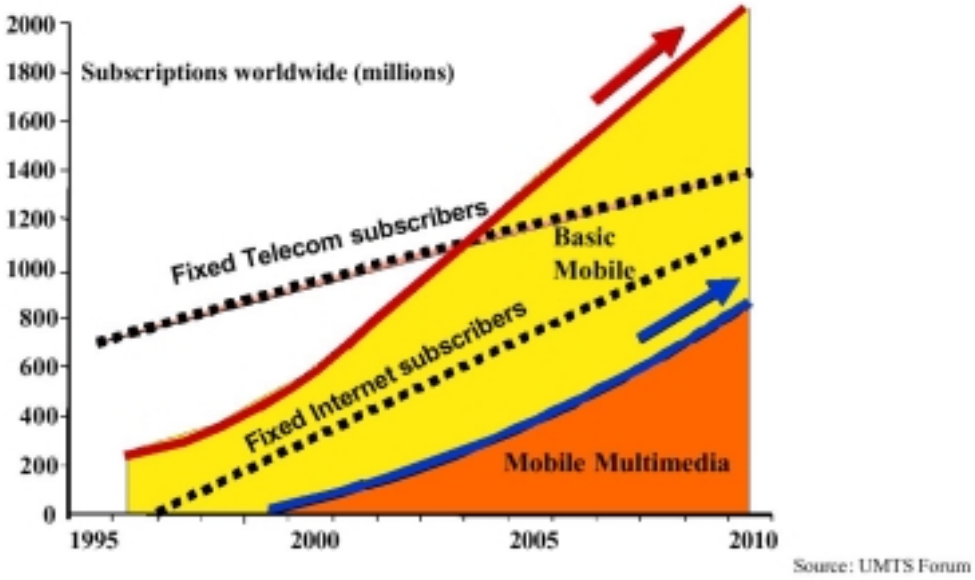
Third Generation mobile systems are being developed within the IMT-2000 framework defined by the International Telecommunications Union, which defines service objectives. One of the hottest IMT-2000 technologies is Universal Mobile Telephone System (UMTS).

Universal Mobile Telephone System (UMTS)

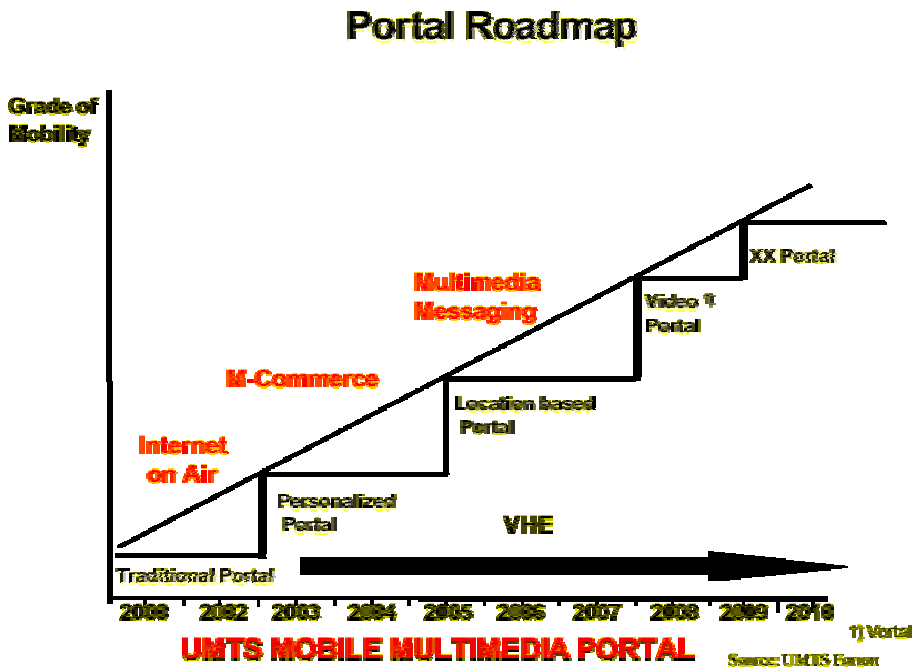
UMTS is a 3G technology that was developed via worldwide research and development efforts by major telecommunications operators and manufacturers throughout the past decade. UMTS is controlled the European Telecommunications Standards Institute (ETSI) in cooperation with other regional and national standards bodies around the world. The UMTS Forum is a consortium of interested parties who are helping hammer out the details of the standard. The Forum includes most of the major wireless networks and vendors worldwide, with the notable exception of those based in the US.

UMTS will require new network and handset components but intends to be an evolutionary step for the network operator to minimize the transition costs. The technology will deliver up to 2Mbps throughput and global roaming capabilities.

Right now, UMTS is primarily a European initiative. However, the UMTS Forum predicts rapid adoption of what they term the Mobile Multimedia Portal by the end of the decade.



In the UMTS design, the Mobile Multimedia Portal is not restricted to the Internet alone. It provides access to all IP-based services, including World Wide Web, audio and TV-media providers, application service providers (ASP), yellow pages, and advertising companies. A key to the user experience is a personalized home page, which aids in customer retention. In addition, the UMTS Forum has great plans to enable m-commerce. Projected mobile commerce services include m-brokering,
m-shopping, m-auctioning, m-banking, and m-cash. The Forum predicts the evolution of the portal over the next decade through personalization and location-based services, to video and beyond.



Basically, the UMTS Forum sketches out a very idealistic future that depends, in large part, on the various regulatory agencies worldwide getting together and getting along. Just the facts that UMTS is termed one of the 3G implementations covered under the ITU's IMT-2000 standard and the lack of significant participation by US network vendors in the forum indicate the likelihood that road to nirvana won't be easy.

Critical Success Factors

We've given you an overview of some of the most promising wireless technologies available today or in the near future. But good technology alone won't ensure success. As with any new technology, it's important to develop the business justification for wireless applications before committing to development. Below are some important factors to consider when planning your wireless effort.

Develop a Coherent Strategy and Goal

Wireless access is not appropriate for every business problem, so understanding current and future wireless capabilities and fitting them to your business strategy is a key first step. In order to do this, you'll need to do a competitive analysis to understand the marketplace, and investigate current and near-term technologies to determine their fitness to your problem. Since the wireless world is moving so fast, it is necessary to constantly track evolving specifications and emerging technologies and be willing to make adjustments during the development process.

A major objective of your strategy should be to match the proposed service with the target device. According to Forrester Research, many companies are rushing to deliver all possible content to all possible devices without regard to the fitness of the device and the technology to the business purpose. This strategy is not likely to succeed given the complexities of the technology and the marketplace.

While it may be important to ensure interoperability with multiple devices, it may be sufficient to deliver your application on a single device. Regardless of which way you decide, it is important to keep future devices and technology advancements in mind. In general, if it's easy to support multiple devices, it's probably a good idea to do so to protect yourself against obsolescence. On the other hand, it is important to

support devices your users already have. The user should not be forced to upgrade or buy a new device just to access a new site.

Look for Partner Synergy

The wireless world is so broad and so complex, it is not advisable to try to go it alone. Not only will you need development partners such as Geneer who can help you stay current throughout the development process, you also need to partner with content providers, device manufacturers, and wireless carriers. Not only can these collaborations reduce design and development costs, but they can also help you better understand user demands and build a better product.

Learn from Web Site Building Experience

If you've build Web applications, you'll be comforted to know that much of what you've learned can be transferred to your wireless efforts. Both environments place high premiums on usability, personalization, information architecture, and configuration options.

Create a Content Aggregation Plan

While today's environment is filled with incompatible devices and communications standards, in the future, these devices and standards are likely to converge to provide device independence. You'll need to deliver your content to desktops, mobile phones and PDAs, wired telephones, screenphones, televisions, pagers, watches, kiosks, airline seats, Web-enabled Playstation games, and on and on. Developing and maintaining separate content for each device will not be feasible. Consequently, a content model in which the same content is provided to different devices using templates will allow you to be more flexible as standards change.

Establish a Cycle of Prototypes and Trials

In a rapidly changing environment such as wireless, an iterative development method such as Geneer's Code Science® will be the most effective. Establishing cycles to design, develop, learn and iterate cannot only help you derive more immediate benefit from wireless technology, but can also help you keep your application abreast of technology changes.

Ensure Usability

Usability, which is important for any application, is even more critical for wireless devices with limited bandwidth, display, and input capabilities. Make sure your application is appropriate for the device, and your users can access what they need with a minimum of selections or parameters. Consider using user interface experts to help design your application.

Address Internationalization

If your application will cross borders, either initially or in the future, then you need to worry not only about the typically internationalization issues of language and currency, but also about the differing wireless standards in different parts of the world. It is much easier to handle these issues early in the design of your product than it will be to graft these capabilities on in a subsequent release.

Enable Personalization and Configuration

Wireless devices are users' most personal of devices. They likely keep them with them at all times and use them not only for work purposes, but also for entertainment and other leisure time activities. Personalization has proved to be a key to creating loyal customers on the Internet, and it will be even more important for wireless applications due to the limitations of the devices. For example, when navigation on the device is a limiting factor, providing a means for the user to immediately link with the information he or she accessed during the last session can be a tremendous value add. Also, because airtime costs money, it's imperative that content is targeted to user needs.

Provide Security and Privacy

Users will use wireless devices with the assumption that their transactions are absolutely secure. This can be a challenge depending on the platform you select. Because of the personal nature of wireless devices, breaches of security etiquette such as selling personal information to advertisers are likely to meet with ferocious resistance.

Establish Rational Pricing

There are many different billing models possible for wireless applications:

- Pay per transaction or use
- Pay per application/service/feature
- Pay for performance of a service
- Flat rate
- Pay by volume
- Monthly fee
- Pay for quality
- Free

Determining the proper pricing scenario can be critical to the success of your service. Service Level Agreements (SLAs) and Quality of Service (QoS) guarantees can also become part of your pricing strategy. In fact, for corporate customers especially, service levels can be more important than pricing, especially for mission-critical applications.

Commit to Renovate

It is important to recognize that, with technology as new and as fast moving as wireless, your first application is just the toe in the water. You need to commit to learn from the development effort and make changes in your application, or scrap it altogether if technology passes it by. In this type of environment it's important to fail early and often in order to hit the eventual home run.

Recommendations

As we hope you've seen, the wireless marketplace is dynamic, exciting, and poised for massive growth. It is also unsettled, highly competitive, and awash in current and emerging standards. If you're considering developing a wireless application, what should you do?

As we've noted in this paper, after developing the business case for the application you're proposing, it is important to match the functionality you want to deliver with the target wireless device. You need to make this decision early in your process as it is a choice that will dictate, to a large degree, your development path. A key part to selecting the target device is determining the target geography since both parameters are interdependent. If you are concentrating only on the US market, the decision is not that much simpler, due to the three major wireless network standards (TDMA, CDMA, and GSM).

At each step of the planning process, you will want to do a thorough competitive review. This is important in a marketplace that is evolving as quickly as wireless is. After selecting the target device(s), your competitive review should include an evaluation of wireless server and development tool vendors, as well as of potential strategic partners.

It is also extremely important to conduct an organizational assessment and determine how much of the development process your organization is able to undertake, and where you will need to outsource to development partners such as Geneer. Understand that, as with any hot technology, it will be difficult to add wireless expertise to your staff quickly.

Finally, consider establishing a rapid development methodology such as Geneer's Code Science® for your project. In such a dynamic market, projects with results more than 6 months out are very liable to become somewhat obsolete upon release. This may, of course, involve reducing the scope of each effort to enable quicker cycles. By rapidly developing and testing prototypes and incremental offerings, you will be better able to take advantage of key internal learnings and technology advances.

In addition to those general recommendations, we present below several more-specific, short-term recommendations for different types of participants. Since Bluetooth devices are only now being released in Europe, we feel they do not present short term opportunities for US developers Similarly, voice applications are not quite there yet as a development environment, although they are sure to be huge. Neither of these technologies are a safe bet for a first application, and thus the following short-term recommendations do not address these technologies, which concentrate primarily on phones and PDAs.

Recommendations for Independent Software Vendors

ISVs need to have a compelling product vision in order to survive in the wireless arena. There is already intense competition in many of the most obvious applications categories such as email access, news and weather information delivery, and instant messaging. Fertile areas for development will likely be access to corporate databases and intranets, sales force automation, including PIM synchronization and CRM, banking and games. A detailed competitive review and marketplace assessment is especially important for ISVs because of these factors.

If your target is wireless phones, WAP looks like the best bet as a development environment, at least in the short term. But beware standards creep: Already we've seen incompatibilities even within a single handset vendor's product lines. Thus you need to make sure your application can be continuously updated to support evolving standards.

If your target is PDAs, your choices are essentially Palm OS-based and Pocket PC-based, although you should consider the Blackberry as a possible alternative. Palm has the advantage of 75 percent share of the worldwide market, and a software developer community of more than 120,000. This means more existing competition, but also more existing knowledge and tools which you can leverage. Microsoft's Pocket PC has the advantage of a more robust hardware and OS environment, with the attendant application development complexity.

Pocket PCs are only now acquiring wireless capabilities. However, those capabilities, including the 128Kbps service provided by Ricochet, are impressive. By the same token, the rest of the Palm line now has wireless capabilities through add-ons, but the bandwidth is more limited than the Ricochet offering.

In the short term, Palm would seem to be the choice unless your application needs more bandwidth. But it will be important, once again, to closely track this market and build flexibility into your application.

Recommendations for Application Service Providers

One of the key themes wireless pundits emphasize about the future is that wireless portals will be a large growth area. The feeling is that users need a central place to go to access all the information and functionality they need. Given the limitations of the user interface, users won't want to jump from site to site to get what they need. A key implication of this idea for ASPs is: Users want one-stop shopping. So if you plan on offering wireless services, it behooves you to either develop a complete suite of services yourself, or to partner to provide them.

A key growth area of wireless ASPs will be corporate email access. Wireless can be a key factor motivating a corporation to outsource their whole email infrastructure. Access to high-value applications such as Enterprise Resource Planning (ERP) and corporate purchasing will also be fertile areas for ASP growth.

One possible pitfall involves the tendency for an ASP to decide to convert all their current offerings to wireless access. This is obviously easier to do if the ASP has created the applications itself. But regardless

of whether the applications are self-created or delivered through partners, it is very important to do a complete assessment of the user interface and especially the user data requirements before deciding to convert. The good news is that most ASP applications already use thin client interfaces, and so may be good candidates for conversion. The bad news is, many ASP apps require downloaded code or plug-ins to run, or have heavy interactivity or data requirements. Like all developers, it is very important for ASPs to understand the target user and carefully evaluate whether there is a demand for a wireless version of the application and whether all functionality needs to be delivered, or only a subset.

Recommendations for IT Consultants

There is tremendous opportunity for IT consultants and other developers of custom software. Unlocking corporate assets for wireless access will require lots of consulting services. A key for IT consultants is to quickly obtain wireless development expertise and develop a wireless consulting practice. The field has yet to be dominated by well-known players, and so aggressive wireless consulting brand development will be key.

There are two main development areas that should be profitable for these companies:

- Custom Feature Development – adding a new feature or function to existing software that extends its value and adapts it for wireless use. Key areas for development include existing intranet applications, roaming email access, and collaboration applications.
- Software Bridging – adapting functionality from an existing application for use with wireless devices. Key areas here are ERP, purchasing, and sales force automation/CRM.

Recommendations for Hosting Providers

Hosting providers should also profit from the wireless revolution. The major opportunity is in hosting wireless access points and wireless portals. It will be necessary for hosting providers to develop partnerships with wireless network providers. Indeed, it may be possible for hosters to assist wireless applications providers get a spot on the all-important default phone or PDA menu through their relationships with the providers.

Another opportunity is to provide wireless access points for corporate networks. This will require working closely with IT consultants and ISVs to coordinate application requirements.

Recommendations for Manufacturers

If you manufacture anything with wires, from networks to headphones, you should immediately prepare to adopt Bluetooth and/or one of the 802.11 standards. If you manufacture anything else, you should begin preparing for the time in the not-to-distant future when consumers can buy your products using wireless devices. The developing concepts of permission-based marketing and consumer privacy will be very important in this new world. Successful companies will begin immediately to learn about these new ways of selling to lay the groundwork for m-commerce.

Conclusion

Many pundits predict a gold rush mentality in the wireless marketplace over the next several years. If this is so, it is best to remember who really made money in the original gold rush: the merchants selling picks and shovels to the miners. It could be that the real wireless winners will be tool and infrastructure vendors.

The key traits of the wireless winners will be speed to market, flexibility and innovation. So it's never too early to dive into the wireless market and see how it can transform your business.

Appendix A

WAP – Technically

One of the first things to understand about WAP is that it is a protocol and not a page description language like HTML. However, part of the WAP definition specifies Wireless Markup Language (WML) as the page description language (PDL). Thus, people usually refer to WAP to mean both the protocol (means of transferring the data) and the PDL (means of controlling the format of pages and how they display.)

WML for Formatting Pages

WML is one of two wireless PDLs in widespread use, with a third dark horse PDL called CHTML being used in Asia. Handheld Display Markup Language (HDML) is the predecessor of WML and, although not as powerful as WML, it is more widely supported than the newer language. Japanese telecom DoCoMo uses the CHTML PDL for its i-mode phones. A main advantage of CHTML is it is closely based on HTML, the existing PDL used by virtually all pages on the Web. This means existing pages will need less modification to support i-mode devices than devices using WML or HDML. On the other hand, WML is based on XML (eXtensible Markup Language), an emerging data standard supported by a growing number of corporate applications.

Since WAP and WML are receiving all the hype, we'll take a closer look at these technologies.

WML is actually part of what is termed the Wireless Application Environment (WAE), which defines the phone's user interface. The WAE contains Wireless Markup Language (WML), WMLScript, and the Wireless Telephony Application (WTA).

WML includes four major functional areas:

1) **Text presentation and layout** – WML includes text and image support
2) **Deck/card organizational metaphor** – all information in WML is organized into a collection of cards and decks
3) **Inter-card navigation and linking**
4) **String parameterization and state management** – all WML decks can be parameterized, using a state model

What this means is WML is a rich environment for programming information delivery to devices. Most vendors who support WML use a microbrowser developed by Phone.com. You can find a list of phones supporting Phone.com's UP.Browser at http://developer.phone.com/dev/ts/. Supporting a standard browser makes a wireless effort much easier. In fact, if your application is XML-based, there are now available XSL (XML Style Sheets) that will easily transform your information for use with WML. However, any hope that we'd avoid a Web-style browser war has been dashed since Microsoft has weighed in with a version of Internet Explorer for devices.

WML was designed with the constraints of small narrowband devices in mind. It is smaller than HTML thus making transport over wireless networks much quicker.

WAP Transport for Delivering Information

As we mentioned, WAP is a transport protocol – a means of transferring information from one place to another. It is similar to the TCP/IP protocol now in use on the Internet, but with some key differences. WAP departs from TCP/IP mainly in the areas required to support high-latency, low-bandwidth wireless networks. One of the problems with TCP/IP involves supporting applications that require a dedicated connection. TCP/IP allows information (split into packets) to travel multiple routes from host to client. This can result in some packets arriving out of sequence. When this happens, the client must wait for the tardy packets and reassemble the data stream before displaying the results. If bandwidth is no problem, this

technique works fine, since the delay caused by out of sequence packets is small. In a bandwidth-constrained network like today's wireless networks, where bandwidth is as low as 9600 bps, any delay can severely affect system performance.

To solve this problem, WAP creates a unique link between server and client, thus eliminating the reassembly of out-of-order TCP packets. WAP permits only one packet stream order: the one formed as the packets generate. There's a downside to this technique, though: Network resources are used whether the user is transmitting or not.

WAP also enables "push" functions so that the server can send information, such as a stock quote or airline reservation change, to a client without the client initiating the request. The WAP Forum expects to approve Version 2.0 of WAP (Wireless Application Protocol) by mid-2001 and may complete specifications before that for features such as animation, streaming media, and downloading of music files,

WAP Services from Web Sites

Many WAP-enabled Web sites have sprung up, serving information for wireless devices. A good example is WiredCEO.com. This site offers access to business news, sports, weather, travel, finance, reference, entertainment and shopping all from a WAP-enable phone or PDA.

So far, in Europe, where the most WAP phones are, vendors have established per minute charges for WAP service use.

WAP Development

There are many development tools for creating WAP applications. A popular one, the Nokia Activ Server 2.0 Enterprise Edition, is intended for larger scale business use, operating on multiple servers with load balancing and fail-over support. This development environment is especially popular in mobile banking where it is used to manage accounts, assets and stock transactions in a secure environment.

Various corporate portal vendors, such as Corechange, are adding WAP support to their application development environments. Many are taking the XML approach, which allows them to create the applications using XML and then apply XSL style sheets to adapt the content for delivery in the WAP environment.

Still other vendors offer server solutions that transform existing Web site content for WAP access. JPSystems is a good example of this approach. Using their SureWave platform, you can maintain one code base for your Web site and, by inserting special tags, you can have the SureWave server extract the information and format it for WAP devices.

Appendix B

i-mode – Technically

DoCoMo's i-mode service accesses specially formatted Web pages, much like the Palm VII. A major difference is that the Page Description Language used, Compact HTML (CHTML) is not only a subset of HTML, but is endorsed by the W3C standards organization.

CHTML for Formatting Pages

The PDL used by i-mode is Compact HTML (CHTML[17]), a subset of the standard HTML that runs the Web. The use of this subset makes it much easier for content providers to repurpose their Web content for i-mode phones than using WAP or another PDL unrelated to HTML. There are more than 4,000 CHTML sites in Japan compared with around 100 WAP sites.

Unlike WAP, ordinary Web browsers can access CHTML pages, usually without problems. To test this yourself, go to www.eurotechnology.com/i/eurotechnologye.html and contrast that with the way www.wiredCEO.com works (or doesn't work) with your browser. Programs such as Adobe's homepage creation software for Windows and Mac, GoLive 5.0 will soon support page creation in CHTML as well as WML.

In partnership with Sun, DoCoMo has started to put a Java Virtual Machine running KJava on its phones, bringing real application power to the untethered user. Lest we get too enthusiastic, the application environment that will be available isn't the most robust: Java applets will be limited to 10k in size, with 5k of memory available as scratch, and they are single-threaded. Already some i-mode users can download small Java applets to run games online or offline or to act as information agents.

i-mode Transport Protocol

Unlike WAP, i-mode is a packet-switched IP system, very similar to the Internet's, running on top of a digital circuit switched cellular system using a transport that is a subset of the Web's http protocol. The current system transfers data at a poky 9600bps, but DoCoMo plans to introduce 3G services at 384Kbps download and 64Kbps upload by Spring 2001.

In theory, the i-mode service, based on CHTML, could run over the WAP transport. Some observers are predicting that i-mode and WAP will converge, but this is by no means certain. DoCoMo has made a proposal to the WAP Forum that a standard combining WAP and HTML be adopted for the 3G system. To discuss developing 3G services, DoCoMo started the Joint Initiative for Mobile Multimedia (JIMM) with wireless vendors Vodafone, British Telecom, France Telecom, AT&T Wireless, SK Telecom, and Singapore Telecom.

[17] http://www.w3.org/TR/1998/NOTE-compactHTML-19980209/

Appendix C

Bluetooth – Technically

Bluetooth is designed to be a short-haul networking protocol. It is based on the same radio spectrum as other wireless networking protocols, and unlicensed sector at 2.4Ghz. This unlicensed spectrum is very noisy, which dictates that Bluetooth use a frequency-hopping and spread spectrum approach, much like high-end cordless home phones. Bluetooth uses a fast acknowledgement and frequency-hopping scheme to avoid interference from other signals. A Bluetooth device hops to a new frequency after transmitting or receiving a packet. Short packages and fast hopping also limit the interference from domestic and professional microwave ovens, which create noise in the band Bluetooth uses. (An interesting little known fact: Hollywood actress Hedy Lamarr was co-inventor of frequency hopping technology in 1940[18].)

Bluetooth target applications involve any device that must be wired to another device. Bluetooth may be added on or integrated into any of the following:

- Cellular & PCS mobile phones
- Digital cordless phones
- Notebook & desktop PCs
- Handheld PCs & palmtop devices
- Digital still cameras
- Output equipment
- Accessories
- Automotive accessories
- Industrial & medical devices
- Home networking

Bluetooth Development

Although Bluetooth advertises megabit data speeds, in reality, applications aren't likely to get that kind of throughput. Bluetooth can support a data channel, up to three simultaneous voice channels, or a channel that simultaneously supports data and voice. The data channel is asynchronous meaning the device can either transmit or listen, but not both simultaneously, and can support 721Kbps in either direction while permitting 57.6Kbps in the return direction, or a 432.6Kbps symmetric link. Thus truly interactive applications are limited by the asynchronous connection and the reduced bandwidth. Nonetheless, 721Kbps is plenty fast for video and other data-intensive applications.

[18] http://wireless.oldcolo.com/course/hedy.htm

Appendix D

Vertical and Horizontal Wireless Applications

WirelessData.org's Wireless Applications List

WirelessData[19] compiled the following list of applications for wireless technology.

Vertical Applications

Field Service

- Dispatching
- Parts orders/confirmation
- Customer/equipment history
- Invoice generation
- Revenue generators
- Selling service contracts
- Preventive maintenance

Examples:

Otis Elevator

Focus is on preventive maintenance
2,000 technicians in the U.S.; 200 in Canada
Ardis saves each technician 45 minutes/day in parts ordering, inquiries, and time tickets

NCS (National Computer Systems)

-Repairs
scanners that read fill-in-the-dots forms common on school tests and employee tests
-98 service centers; testing Ram in Chicago, Los Angeles, Virginia, Carolinas

Public Safety

- Parking enforcement – New York, Chicago ticket collection/towing
- Vehicle checks (California Highway Patrol)
- Fingerprints
- Floor plans
- Database inquiries
- Hazardous materials
- Ambulance-hospital monitor links
- Vehicle tracking-Anti-theft

Distribution

- Toronto Sun uses Ram network for newspaper distributors who refill newsstand vending machines
- Distributors enter number of unsold papers

[19] http://www.wirelessdata.org/primer/primer.pdf

- Expert system software determines print run for following day based on number of unsold papers, weather, etc.

Financial

- Brokerage
- Dow Jones Telerate Access Service – Market data and pricing
- Davidge Data Systems – Wireless trading without using a leased line or calling a broker

Telemetry

- Energy industry (for remote areas)
- Meter monitors (reduces labor costs)
- Alarm systems (avoids cable-cuts)
- Health Care-Monitoring patient's vital signs (provides better care)
- Metriplex "LabAlert"
- Data Critical Vending: Amount of product left in vending machine, how much money is in the coin box, alerts for outages, coin and column jams and door openings

Identification

- Uses RF "tags" for inventory control, security, anti-theft – see MIT's Auto-ID project[20]

Horizontal Market Categories

- Field sales
- Messaging/Electronic mail
- Information services
- "Mobile professional"
- Vehicle location, mapping
- Facsimile

Luminant Worldwide's Wireless Applications List

Consulting firm Luminant Worldwide put together this list[21] of existing wireless applications using information from Mobile Communications International, WAP conferences, and company press releases:

Information services

- Portals (Yahoo!, MSN, Excite, Infospace, Lycos, Zingo, Phone.com, AT&T, European wireless carriers, Palm.net)
- News (CNN, Reuters, ABCNews, Altavista)
- Weather (Accuweather.com, Wunderground.com)
- Soap opera updates (SFR, Sonera)
- Sports scores (Sportspeed.com, ESPN, Statszone)
- Airline schedules (Thetrip.com)
- Traffic information (Webraska, Biztravel.com, Mapquest.com)
- Restaurants (Telecom Italia)

[20] http://auto-id.mit.edu/index2.html
[21] http://www.tradespeak.com/docdetails.asp?docid=1801

- Movie, TV schedules (Telecom Italia)
- Exchange rates (Oanda.com)

Personal organizers

- Access to names and phone numbers (Wirelessknowledge, Saraide, Lotus, Infinite Technologies)
- E-mail (Wirelessknowledge, Saraide, Lotus)
- Calendar (portals, Wirelessknowledge, Saraide, Lotus)

Transactional services

- Stock trading (Quote.com, Stocktips, Bloomberg Online, LesEchos, Schwab)
- Banking (CMG, BNP, CCF, Credit Mutuel, Handelsbanken, Harris Bank of Chicago, Infospace, MeritaNordbanken, The Woolwich, Radiolinja)
- Buying/selling lottery tickets (Telecom Italia)
- Insurance (Radiolinja)

E-commerce services

- Auctions (Ebay, Amazon.com, Yahoo!, BT Cellnet)
- Retail sales of books, jewelry and other consumer items (Amazon.com)

Entertainment

- Interactive games (Telecom Italia, Airtel, Sonera, NTT DoCoMo)
- Horoscopes, puzzles (SFR, Sonera, Cegitel, Telecom Italia)
- Chat (AOL, MSN)

Location-based services

- Yellow pages (Whowhere.com, Infospace.com)
- Information pull and push based on physical coordinates (Signalsoft, Loc8.net, Lucent, Motorola, Nokia, Qualcomm, US Wireless, Trueposition and major European, Japanese and U.S. carriers)

Corporate-centric applications

- Customer service (Lightbridge, Sprint, Comverse)

Enterprise applications

- Intranet applications (Cegetel, Sonera)
- Extranet applications

Vertical applications

- Dispatch and delivery (ServiceHub)
- Field service (e.g. utilities)
- Sales force automation

Appendix E

Wireless Resources

3GPP Initiative	Works with ETSI to establish technical specifications for 3G telecommunication standards	www.3gpp.org
Bluetooth SIG	Information about Bluetoon initiatives	www.bluetooth.com
DNA - Data Networking Association	A UK Government initiative to foster the cross-industry training of data professional staff	www.datanetworking.co.uk
Ericsson's Developers' Zone	Information for developers about Ericsson's WAP efforts	www.ericsson.com/developerszone/
ETSI - European Telecommunications Standards Institute	European wireless standards body	www.etsi.org
Futurefonezone.com	White papers and other research on wireless	www.futurefonezone.com/
GAA - GPRS Applications Alliance	(see MAI - Mobile Applications Initiative)	www.gprsworld.com
General Magic	MagicTalk voice services	www.genmagic.com
GMCF - Global Mobile Commerce Forum	A initiative launched by Logica to help resolve some of the problematic issues facing m-commerce	www.globalmobilecommerce.com
GSM Association	Previously known as the GSM MoU.	www.gsmworld.com
GSM North American Alliance	Information about GSM in North America	www.gsm-pcs.org
Hewlett-Packard e-Services	WAP servers and other mobile solutions	e-services.hp.com/mobile/index.html
IETF - Internet Engineering Task Force	De facto Internet technical standards organization	www.ietf.org
IrDA - Infrared Data Association	International industry association	www.irda.org
MAI - Mobile Applications Initiative	An Ericsson initiative replacing the GAA	www.gprsworld.org
MDA - Mobile Data Association	An industry-specific group formed to promote and develop the market	www.mda-mobiledata.org
MDI - Mobile Data Initiative ng	The MDI Next Generation is the second attempt by Intel to promote the mobile data market – primarily through Intel-based products	www.gsmdata.com www.mdi-ng.org
MeT - Mobile Electronic Transaction	An initiative formed by Ericsson, Motorola and Nokia to establish industry standards for secure m-commerce transactions.	www.mobiletransaction.org
Microsoft Wireless	Information about Microsoft's wireless efforts	www.microsoft.com/wireless

MWIF - Mobile Wireless Internet Forum	International non-profit industry organization	www.mwif.org
Nokia	Information on Nokia's WAP efforts	www.nokia.com/corporate/wap/
Phone.com	Maker of the most commonly used microbrowser for WAP phones	www.phone.com
Radicchio Forum	An organization to develop secure wireless e-commerce transactions. Founded by EDS, Gemplus, Mastercard, NTT, Sonera SmartTrust, Virgin Mobile, Visa, and Vodafone AirTouch.	www.radicchio.org
Strategic News Service	Newsletter offers information on wireless solutions	www.tapsns.com
UMTS Forum	Industry association supporting UMTS	www.umts-forum.org
VXML Forum	Sponsors of Voice eXtensible Markup Language for voice applications	www.vxmlforum.com
WAP Forum	The standards body for WAP	www.wapforum.org
Wap.net	Information for developers about WAP	www.wap.net/
WDF - Wireless Data Forum	Information for marketers and developers	www.wirelessdata.org
Wireless Developer Network	News, discussions, software, and training for wireless developers	www.wirelessdevnet.com/
WirelessData.org	Information about wireless	www.wirelessdata.org
WirelessOutpost	Wireless Outpost lists the rate and service plans for all of the US PCS carriers	www.wirelessoutpost.com