Wireless Protocols 2000

Consulting Report

Executive Summary: This report provides a survey of available and planned wireless application, data and network protocols. The current wireless data and cellular markets are highly fragmented due to adoption of a wide variety of incompatible protocols. Because of the lack of agreement on standards, it is currently not possible to easily develop for multiple wireless service providers. This report lays the foundation for selecting protocols over which to deploy wireless applications by providing the critical technical information required for making the selection.

Purpose: This report provides a survey of available wireless application, data and network protocols to determine which are suitable for wireless delivery of medical, educational and business information and associated application functionality. It is one of a family of reports on wireless technology that include:

- Wireless Devices
- Wireless Application Protocols
- Wireless Application Service Providers
- Wireless Application Development Tools
- Recommendations for Developers of Wireless Applications

Taken together these reports provide an overview of the set of technologies required to deliver wireless data and application services and products. The final recommendations report provides guidance on the selection of the appropriate technologies and makes a limited number of recommendations for specific solutions.

Problem: Companies that wish to develop and deploy wireless data services or wireless applications face the challenges of delivering useful application functionality and business information through wireless data and cellular service providers. The current wireless data and cellular markets are highly fragmented due to adoption of a wide variety of incompatible protocols. Because of the lack of agreement on standards (or more accurately, because of the adoption of multiple different de facto standards by competing vendors), it is currently not possible to easily develop for multiple wireless service providers. This means that development of wireless applications and data services requires careful selection of:

- a specific model of device on which to deploy the application;
- which supports a specific application protocol;
- which is supported by appropriate data and network protocols;
- supported by a specific set of wireless service providers;
- who offer a specific set of development tools

This report lays the foundation for selecting a set of protocols over which to deploy wireless applications by providing the critical technical information required for making the selection.

Discussion: There are a wide variety of protocols that could potentially be used for delivering mobile or wireless applications. They range from wireless messaging protocols to sophisticated wireless client-server application protocols. In addition these application protocols are dependent on underlying wireless communications protocols supported by various application service providers. Each of these potential protocols for wireless applications has strengths and weaknesses

There are a few critical technical features that must be considered when selecting a protocol over which to deploy wireless data services or wireless applications. As appropriate to the service these include:

Report

WEB ENABLE

Target Use – All protocols are designed for a specific intended use, e.g. short message transport, application connection negotiation, etc.

Protocol Services – What application services are included as sub-components or sub-services of this protocol suite.

Underlying Protocol Services – What over which services does this protocol suite run.

Current Data Network Speed – What is the current network speed for this data or network protocol?

Future Data Network Speed – What are the expected network speeds for this data or network protocol?

Devices – What devices are known to support this protocol.

Service Providers – What cellular phone companies, paging companies or wireless data companies support this protocol.

Standards Bodies – What standards bodies are responsible for defining this protocol.

Industry Organizations – What industry organizations are supporting this protocol.

Approach: For this report we have focused on mobile application and network protocols that are currently deployed or planned to be deployed within the next 2 years. There are a number of industry and international standards efforts attempting to define new wireless application and communications protocols. However, these efforts will take many years to yield sufficiently broad support to justify investment in application development. In addition, we have endeavored to avoid using marketing terms (e.g. TDMA-EDGE) and government "spectrum allocation" terms (e.g. PCS, UMTS) and focused solely on the technology that lay beneath those marketing terms.

Wireless Application Protocols

By late 2000, nearly every cell phone manufacturer has delivered WAP-compliant phones. However, adoption by PDA manufacturers and other computing devices has been slowed by corporate maneuvering (e.g. Microsoft vs the cell phone manufacturers) and the advent of the PDA-based web clipping tools. In addition, Asian, European and US customers have been slow to use the initial simple WAP-based applications. Slow acceptance by US customers is understandable given broad use of PC-based Internet services. However, European and Asian customers had been expected to embrace WAP-based services. Instead, DoCoMo's I-Mode services have been widely adopted by in Japan as the preferred chat service.

DoCoMo, the wireless subsidiary of NTT, launched the I-Mode mobile Internet service in early 1999. As of June 2000, they have attracted over 13 million I-Mode subscribers. News reports infer that many of the subscribers are teenagers using I-Mode based chat services. Even if this represents the bulk of I-Mode traffic it points out the dramatic penetration of wireless phones and PDAs. And, the acceptance of these devices for more than voice communications sets expectations for additional services as these young users enter the work force.

Wireless Application Protocol	***Required Network Services***	***Benefits***	***Issues***	***Vested Interests***
WAP (WML, HDML)	GSM, (future CDMA, TDMA?)	standard XML-based conservative	limited WAP sites; conversion	Cellphone mfgs, service

		with limited near-term bandwidth	required; specialized content required; security	providers
HTML	CDPD, I-Mode	Windows CE/ME growing strong; Converge Wired Web and Wireless Web; Exploit 2.5G, 3G network services	bandwidth screen size	Symbian, Microsoft
Web Clipping	CDPD, GPRS	Broad adoption of Palm OS on PDAs	specialized content required	Palm
SMS	GSM, GPRS	100 million phones by year end; well integrated with voice-based services	160 character limit; message oriented	Xpoint

There is a great deal of media coverage around the purported success of I-Mode, the failings of WAP, the limitations of SMS and even the value of web clipping. Each does have strengths and each has weaknesses. One should keep in mind that much of the hue and cry over this issue is likely to have been generated by corporations with a vested interest in one technology or another. Ultimately, the important decision is to select devices that support the wireless protocols critical to the intended application, and to ensure that the device can be upgraded to the new variants of protocols as the wireless market evolves. This report will attempt to cover the available technologies objectively so that the reader can make a technology selection that makes sense for their business interests.

WAP – Wireless Application Protocol

Target Use: wireless web site content, wireless applications
Protocol Services: WAE, WML, WMLScript, WSP, WTP, WTLS, WDP
Underlying Protocol Services: GSM, CDMA, TDMA
Devices: Most cell phone manufacturers
Service Providers: Most cell phone service providers
Standards Bodies: W3C, ECMA, ITU
Development Tools: Dynamical Systems Research (www.wap.net)
Industry Organizations: The WAP Forum (www.wapforum.com), Wireless Data Forum (www.wirelessdata.org), WAP Congress (www.wapcongress.com), Mobey Forum, MeT.

WAP, or Wireless Application Protocol, is a set of de facto standards for protocols and services that support the delivery of wireless web site content, wireless services and wireless applications. WAP was defined by a consortium, The Wireless Application Protocol Forum (WAPForum), that includes Phone.com (formerly Unwired Planet), Motorola, Nokia, Ericsson and 530 other companies.

The WAP specifications include definition of the following services:

1. WAE – Wireless Application Environment
2. WML – Wireless Markup Language
3. WMLScript – Wireless Scripting Language
4. WTAI – Wireless Telephony Application Interface
5. WSP – Wireless Session Protocol
6. WTP – Wireless Transport Protocol
7. WTLS – Wireless Transport Layer Security
8. WDP - Wireless Datagram Protocol

These services and protocols have been designed be independent of the various global wireless network (Bearer) technologies and to operated over the majority of the currently deployed wireless networks, including CDMA, TDMA, GSM, CDPD, PDC, PHS, FLEX, ReFLEX, iDEN, TETRA, DECT, DataTAC and Mobitex.

WAE, or Wireless Application Environment, is the collection of specifications that most web-site and data subscription service implementers need to deploy a wireless site. These specifications include WML, WMLScript and WTAI.

WML is an XML-defined DTD (document type definition) that includes a subset of an HTML-like set of web site content layout commands. The subset was defined to optimize delivery of content across a wireless network. Since WML is not a complete HTML or XML implementation, WML-compliant sites must be written originally in WML or translated from HTML/XML into WML to be useable on WAP-enabled cell phones. Various translators are available to ease the translation process for existing web pages into WML *decks* of one or more WML *cards*. While WML can be served up by any HTTP 1.1-compliant web server, these WML cards are only displayable through a WAP Browser. However, this results in the need to maintain parallel duplicate web site content – one for wired web users and one for wireless web users. As a result only about 1 percent of the wired web's content has been translated and offered up for WAP users.

WMLScript is a web page scripting language derived from JavaScript. It too is optimized for wireless scripting. Instead of being embedded in web pages (as in the wired world), WMLScripts are referenced through URLs embedded in WML cards. In addition, rather than being interpreted by the browser, WMLScripts must be compiled into WMLScript bytecode. Again, this results in the need to maintain parallel duplicate scripted content– one for wired web users and one for wireless web users.

WTAI, or Wireless Telephony Application Interface, is the specification for the set of application programming interfaces (API) for WAP –compliant mobile devices. This API includes such functions as "initiate a call", "send an SMS message", etc.

WSP and WTP are wireless service and transport protocols, similar to HTTP for the wired web, but optimized for wireless data networks. WDP is a wireless datagram protocol, similar to UDP for the Internet.

WTSL is the set of security services intended to ensure privacy and non-repudiation of wireless data. There are some concerns that the specifications have short-changed required security for mission-critical wireless business transactions by removing IP network security features. The next release of the WAP specifications is expected to include additional security services for end-to-end security and PKI encryption.

In defense of WAP, given the small display areas, lower resolution and variable screen sizes of wireless mobile devices, existing web-site content cannot be effectively viewed even with a strict HTML compliant micro-browser. Web-sites targeted at wired users deliver large amounts of text-based information, high resolution graphics and, recently, sophisticated scripts that are in appropriate for wireless devices. In addition, the network and content protocols of the wired web, TCP and HTTP, are not designed to gracefully handle the intermittent connections, limited network speed and network latencies of current wireless data networks. The wired network security standard TLS requires many messages to be exchanged as a "digital handshake" before access is granted. Over a long latency, low speed wireless network, this robust security solution would create long delays in accessing information. So delivering content to wireless devices – in particular

small screen mobile phones – using WAP makes good use of the features of the devices and the constraints on current 2nd generation wireless network technologies.

SMS – Short Message Services

Target Use: pager notifications, pager messages, chat messages, short email
Underlying Protocol Services: GSM
Devices: Most cell phone manufacturers, many pager manufacturers
Service Providers: Most cell phone service providers
Standards Bodies: None
Development Tools: Dynamical Systems Research (www.wap.net)
Industry Organizations: None

SMS is broadly installed throughout the GSM world. With an average of 5 billion SMS message sent per month worldwide it is the most widely used wireless data service. While the UK had 400 million SMS messages in March 2000, the U.S. recorded about 20 million. One of the attractive features to operators of SMS is that most SMS messages result in an additional voice call – driving up connection minutes. This is motivating even U.S. operators to deploy SMS –based applications. However, SMS has a message size limit of 160 characters. This limits its potential as a general application protocol.

I-Mode – I-Mode Mobile Internet Service

Target Use: wireless web content, chat messages, short email
Protocol Services: Unknown
Underlying Protocol Services: GSM
Devices: Unknown
Service Providers: DoCoMo NTT
Development Tools: Unknown
Standards Bodies: Unknown
Industry Organizations: Unknown

DoCoMo, the wireless subsidiary of NTT, launched the I-Mode mobile Internet service in February 1999. One of the highlights of the I-Mode protocol is the support of native HTML instead of WML (a subset of XML). By supporting HTML, I-Mode devices can access any existing Internet web site rather than only those sites that have been pre-translated into WML. Of course, most of those HTML-based sites were designed for display on VGA and SVGA PC screens, so they may be difficult to read on the low resolution small screens of most cell phones and PDAs and slow GSM network connection. However, DoCoMo has announced that it will be rolling out 3G (3rd Generation) GSM services (with their higher speed) in May 2001. (This date seems aggressive given the slow evolution of the potential 3G air interface services that NTT could exploit.)

HDML – Handset Device Markup Language

Target Use: wireless content layout
Protocol Services: None
Underlying Protocol Services: CDMA, TDMA, AMPS
Devices: Unknown
Service Providers: Unknown
Development Tools: None
Standards Bodies: None

Industry Organizations: None

HDML is a precursor to the WAP Forum's WML. HDML and WML were each defined and implemented by Unwired Planet (now Phone.com). Although not a formal standard, and expected to be replaced by WML, HDML is still widely deployed on US-based wireless web sites.

HTML – Hypertext Markup Language

Target Use: wireless content layout
Protocol Services: HTML, HTTP, Javascript, Java
Underlying Protocol Services: CDPD, I-Mode
Devices: CDPD Wireless Modem-based PDAs and Computers
Service Providers: Most CDMA network service providers
Development Tools: None
Standards Bodies: None
Industry Organizations: None

HTML is the standard Internet web-site page layout language. It is included here because I-Mode and CDPD protocol suites allow use of HTML for wireless web-site layout. Care should be used when designing an HTML-based wireless web site to ensure that information is laid out as appropriate for the target devices and that only those protocol services are used that are absolutely necessary. (In other words, use design discretion to gain some of the "optimization" promised by WAP.)

Web Clipping – Palm.net Web Clipping

Target Use: wireless content layout
Protocol Services: HTML, HTTP,
Underlying Protocol Services: CDPD, Palm.net
Devices: Palm, Handspring
Service Providers: Palm.net, Omnisky, SkyTel
Development Tools: Palm
Standards Bodies: None
Industry Organizations: None

Web Clipping is based on the standard Internet web-site page layout language HTML. It provides a means of sub-setting HTML pages to produce pages appropriate for the screen size of the target device.

Wireless Network Protocols

Worldwide, Wireless Network Service Providers (also known as "WISPs", "Operators", "Bearers" or "Carriers") are in the process of completing the transition from first generation cellular technologies (e.g. analog cell phone services) to second generation (2G) digital cellular technologies. At the same time they are piloting 2.5G (second generation plus) technologies and preparing to roll out third generation (3G) digital wireless technologies. Across all the variations in standards for these technologies is the consistent press for additional digital network speed, improved voice clarity, reduced drop-outs, lower network latency and more robust security.

Each proposed standard for delivering these network services claims to find the optimum balance of cost, quality and features. With network speeds as high as 307 Kbps for 2.5G

technologies and 2 Mbps for 3G technology, wireless service providers have the potential of delivering network services equivalent to the latest broadband wired service providers.

Protocol	Current Speed	Generation	Upgrade Path
CDMA	14.4 Kbps	2	GPRS, cdma20001X, cdma20003X, W-CDMA
TDMA	14.4 Kbps	2	CDPD, HSCSD, GPRS, EDGE, W-CDMA
GSM	9.6 Kbps	2	CDPD, GPRS, EDGE, W-CDMA
PDC-P	19.2 Kbps	2	GPRS, W-CDMA
CDPD	28.8 Kbps	2	GPRS
cdma2000 1X	144-307 Kbps	2.5	cdma2000 3X
HSCSD	28.8-56.6 Kbps	2.5	GPRS, EDGE, W-CDMA
GPRS	28.8-56.6-112 Kbps	2.5	EDGE, W-CDMA
EDGE	384 Kbps-2 Mbps	3	W-CDMA
cdma2000 3X	384 Kbps-2 Mbps	3	1Xtreme?
W-CDMA	384 Kbps-1.8 Mbps	3	1Xtreme?

Table of network speeds

However, of specific concern in some circles is the cost and effort to transition from 2G to 3G technology. A lot of money is at stake, for both the equipment manufacturers and the service providers, in the transition from current 2G technology to future wireless technologies. This has created a lot of confusion and tension amongst the manufacturers and service providers – and significant market fragmentation and instability.

For example GSM, a wireless air interface technology widely deployed in Europe and Asia, requires a complete replacement of hardware as well as software to upgrade from the current 2G infrastructure to 3G. CDMA and TDMA, the two competing US-based wireless network technologies, claim to be able to be upgradeable from 2G to 3G via software and limited hardware replacement. There is the potential therefore for GSM upgrades to be delayed due to cost and resource pressures, while CDMA and TDMA upgrades are quickly performed. On the other hand, it is likely that market pressures and revenue potential will be the actual driver for upgrades. With stronger interest in high-value wireless content and subscription services in Asia and Europe, the market opportunity may drive the operators to push through upgrades independent of near-term cost.

The International Telecommunications Union has attempted to provide some focus for future technology transitions for the industry. Unfortunately they have not been able to press for a single standard. However, in the spring of 2000, they were successful in gaining agreement on a dual 3G standard for W-CDMA and CDMA2000. The ITU has decreed that all 3G devices must work over both protocols – ensuring global roaming and reducing billing issues. W-CDMA is positioned as the preferred 3G target for all GSM and TDMA operators, while the Qualcomm-backed cdma2000 is the preferred 3G target for CDMA operators.

However, market and marketing pressures have already started to tear at the agreement. Since 3G roll-out is still two to three years away, many operators are piloting 2.5G (second generation “plus”) technologies to satisfy near-term market requirements for higher data network speeds. These technologies: CDMA2000 1X, GPRS, HSCSD and even early deployments of EDGE, provide network speeds from 56.6 Kbps to 384 Kbps – sufficient for most current network applications. These near-term deployments are creating a more complicated interim market than might be inferred from the ITU’s standards.

	2000	2001	2002	2003	2004	2005
CDMA	14.4 Kbps CDMA	144 Kbps 307 Kbps cdma2000 1X	144 Kbps 307 Kbps cdma2000 1X	384 Kbps 2 Mbps cdma2000 3X	5.2 Mbps 1Xtreme	5.2 Mbps 1Xtreme
TDMA	19.2 Kbps	114 Kbps	384 Kbps	384 Kbps	384 Kbps	384 Kbps

	CDPD/TDMA	GPRS	EDGE	EDGE	2 Mbps W-CDMA	2 Mbps W-CDMA
GSM	9.6 Kbps GSM	114 Kbps GPRS	384 Kbps EDGE	384 Kbps EDGE	384 Kbps 2 Mbps W-CDMA	384 Kbps 2 Mbps W-CDMA
iDEN	19.2 Kbps iDEN	19.2 Kbps iDEN	19.2 Kbps iDEN	384 Kbps EDGE	384 Kbps EDGE	2 Mbps ?
PDC-P	28.8 Kbps PDC-P	114 Kbps GPRS	114 Kbps GPRS	114 Kbps GPRS	384 Kbps 2 Mbps W-CDMA	384 Kbps 2 Mbps W-CDMA

Widespread Deployment: Evolution of Wireless Data Protocols

At least one service provider, AT&T Wireless, is backing EDGE as a 2.5G and even potential 3G technology. And, while GSM has the lead within European and Asian markets (thus setting up for a clean transition to W-CDMA), TDMA, cdmaOne, GPSR and EDGE vendors are aggressively selling outside North America to gain market share to enhance their long-term CDMA2000 and EDGE revenues. So, the fragmentation of the wireless market is not likely to be resolved even with 3G technology.

2nd Generation Wireless Network Protocols

CDMA – Code Division Multiple Access

Generation: 2G
Expected Service Date: Today
Target Use: Digital Cellular Network Services
Bandwidth Required: 30 Khz (Cellular), 50 Khz (PCS)
Transmission Speed: 14.4 Kbps
Future Transmission Speeds: 307 Kbps (CDMA2000 1X), 2 Mbps (CDMA2000 2X), 1.8 Mbps (CDMA2000 HDR), 5.2 Mbps (1Xtreme CDMA)
Transmission Frequencies: 800Mhz, 900Mhz
Devices: Ericsson, Kyocera, Motorola, Neopoint, Nokia, Qualcomm, Samsung, Sony
Service Providers: Verizon (Airtouch, BAM, GTE, Primeco), SBC Wireless (AmeriTech), Sprint PCS, Bell Mobility, Blackfoot, Qwest (USWest)
Standards Bodies: Telecommunications Industry Association (TIA: IS-95A Cellular 824-894 Mhz), American National Standards Institute (ANSI: J-Std-008 PCS 1850-1990 Mhz)
Industry Organizations: CDMA Development Group (www.cdg.com)

CDMA is a spread spectrum digital cellular service originally developed by Qualcomm. Motorola, Nortel and Lucent have joined Qualcomm in supporting the standard (IS-95) and developing infrastructure hardware. Qualcomm, Kyocera, Motorola, Ericsson and Nokia have been developing handsets. It is used for digital cellular, PCS (personal communications services) and wireless data services.

Future evolution of CDMA was expected to be via Qualcomm's 3G 1XRTT CDMA2000 system, which can then be upgraded to either the 2 Mbps CDMA 2XRTT CDMA2000 system or the 1.8 Mbps W-CDMA 3XRTT CDMA2000 system. However, Qualcomm and Lucent have been developing an HDR CDMA with speed of up to 2.4 Mbps and Motorola and Nokia have been developing a 1Xtreme variant of CDMA with the potential of speed up to 5.2 Mbps. So while there seems to be plenty of potential for high speed CDMA, there is also plenty of potential for further industry fragmentation.

TDMA – Time Division Multiple Access

Generation: 2G
Expected Service Date: Today
Target Use: Digital Cellular Network Services
Bandwidth Required: 30 Khz
Current Transmission Speed: 14.4Kbps
Future Transmission Speeds: 28.8 Kbps, 56.6 Kbps (HSCSD), 384 Kbps (EDGE)
Transmission Frequencies: 800Mhz, 900Mhz
Devices: Ericsson, Motorola, Nokia
Service Providers: GSM operators, USDC operators including AT&T Wireless
Standards Bodies: ANSI-41 (TDMA/AMPS), ANSI-136 (GSM/TDMA)
Industry Organizations: UWCC (www.uwcc.org - Universal Wireless Communications Consortium)

TDMA is a digital cellular network service protocol designed to use radio channel by dividing individual call signals into multiple pieces, each lasting a fraction of a second, and transmitting those pieces in multiple different time slots. This allows multiple phone calls to simultaneously share the same communications channel.

GSM – Global System for Mobile communication

Generation: 2G
Expected Service Date: Today
Target Use: Digital Cellular Network Services
Bandwidth Required: 200 Khz
Transmission Speed: 9.6Kbps
Future Transmission Speeds:
Transmission Frequencies: 800Mhz, 900Mhz
Devices: Palm III/IIIX/V, HandSpring, TRG Pro, Nokia, Ericsson, Motorola
Service Providers: US: Voicestream, Verizon (Airtouch), Aerial, BellSouth, Omnipoint, SBC Wireless (Pacific Bell) Powertel. Voicestream; EU: DeutscheTelecom, et al; Asia: DoCoMo, et. al.
Standards Bodies: MAP, ANSI-136 (GSM/TDMA)
Industry Organizations: GSM Association (www.gsmworld.com), Mobile Data Initiative (www.gsmdata.com), GSM Alliance (North America)

GSM, also known as PCS-1900, is the most broadly used digital cellular standard around the globe. It now has effective dominance in Europe and Asia. Recent investments by DeutscheTelecom in the US is expected to provide the additional capital required to push GSM into addition US regional markets. GSM uses a variant of TDMA technology (Time Division Multiple Access) rather than CDMA (Code Division Multiple Access**).**

CDPD – Cellular Digital Packet Data

Generation: 2G
Expected Service Date: Today
Target Use: Wireless Data
Underlying Protocol Services: TDMA, AMPS
Bandwidth Required: 30 Khz (TDMA)
Transmission Speed: 19.2Kbps

Future Transmission Speeds:
Devices: Palm III/IIIX/V, HandSpring, TRG Pro, Novatel modems, Sierra modems
Service Providers: AT&T Wireless, Verizon, Ameritech, SBC Wireless/SNET Mobility, Comcast Cellular Communications, CellularOne, U.S. Cellular Services, AirTouch, BellSouth, Wireless One Network, Vangaurd, ALLTEL Communications, WCC Cellular, Maine Wireless, Horizon Cellular, Cellular Mobile Systems, MTT Mobility, Mobility Canada, Omnisky, Yadayada
Standards Bodies: None
Industry Organizations: None

CDPD is a packet data network protocol that runs over analog cellular (AMPS) and TDMA cellular/PCS services. CDPD was originally developed by AT&T Wireless and Bell Atlantic Mobile (now Verizon). CDPD is based on the Internet protocols, TCP/IP. The majority of PCMCIA card wireless modems are based on CDPD.

ReFLEX – ReFLEX Paging Protocol

Generation: 2G
Expected Service Date: Today
Target Use: Digital Pager and Messaging Services
Bandwidth Required: Unknown
Current Transmission Speed: 9.6 Kbps
Future Transmission Speeds: Unknown
Transmission Frequencies: 800Mhz, 900Mhz
Devices: Palm III/IIIX/V/HandSpring w/Pager Modem, Motorola, RIM, Glenayre
Service Providers: PageNet, Skytel, Weblink Wireless
Standards Bodies: None
Industry Organizations: None

ReFLEX is the US standard pager network standard. It is available in R25 and R50 speeds.

PDC-P – Personal Digital Cellular - Packet

Generation: 2G
Expected Service Date: Today
Target Use: Digital Cellular Network Services
Bandwidth Required: 30 Khz
Current Transmission Speed: 28.8 Kbps
Future Transmission Speeds: Unknown
Service Providers: DoCoMo NTT
Standards Bodies: None
Industry Organizations: None

PDC-P is the first packet digital cellular network service to go into full production deployment. It was developed by NTT DoCoMo over three years before being rolled out for use under their I-Mode service. As the de facto digital cellular standard in Japan it has a large captive market share.

2.5th Generation Wireless Network Protocols

CDMA2000 1X – Code Division Multiple Access 2.5th Generation

Generation: 2.5G
Expected Service Date: 2001
Target Use: Digital Cellular Network Services
Bandwidth Required: 1.25 Mhz
Transmission Speed: 144 Kbps (mobile packet data), 307 Kbps (fixed packet data)
Future Transmission Speeds: 2 Mbps (CDMA2000 2X), 1.8 Mbps (W-CDMA), 5.2 Mbps (1Xtreme CDMA)
Service Providers: Nortel, Bell Mobility (Canada), Telstra, Verizon, Sprint PCS, BellSouth, LG Telecom (Korea), DDI (Japan), IDO (Japan), KT Freetel (Korea)
Standards Bodies: Telecommunications Industry Association (TIA IS-2000)
Industry Organizations: CDMA Development Group (www.cdg.com)

This 2.5G upgrade for CDMA is based on Qualcomm's 307 Kbps 2.5G 1XRTT CDMA2000 system. It is claimed that upgrading from CDMA to CDMA2000 1X involves only the replacement of inexpensive interface boards and software. This can dramatically reduce the cost of upgrading from 2G to 2.5G for the wireless service operators.

GPRS – General Packet Radio System

Generation: 2.5G
Expected Service Date: 2000
Target Use: Wireless Data and IP networking
Underlying Protocol Services: TDMA, GSM
Bandwidth Required: 200 Khz
Transmission Speed: 28-56-112-171.2 Kbps (depending on number of timeslots)
Future Transmission Speeds: 2 Mbps (EDGE)
Service Providers: C&W HKT (Hong Kong), M1 (Singapore), Vodafone (UK), Libertel (Netherlands), Motorola (Aspira), Voicestream, Deutsche Telecom, SBC Wireless (Pacific Bell's CA, NV GSM networks), BellSouth Mobility DCS
Standards Bodies: ETSI (www.etsi.org: Release 97 GPRS), 3GPP (www.3gpp.org: Release 99 GPRS)
Industry Organizations: GPRS Application Alliance (www.gprsworld.com), GPRS Roaming Exchange (www.gpx.org)

GPRS has been touted by equipment manufacturers for years. It is only in the past year that the cellular service providers (Carriers/operators) have started to take notice of this protocol. This packet-based protocol is more appropriate for bursty wireless data applications. As a 2.5G step towards 3G EDGE services, GPRS is being tested or deployed by many TDMA/GSM based operators as an intermediate step towards full 3G services offered by EDGE and W-CDMA. However, since it only delivers half the speed of the competing CDMA2000 1X technology, it is unlikely to be embraced by current CDMA-based operators.

HSCSD – High Speed Circuit Switched Data

Generation: 2.5G
Expected Service Date: 2001
Target Use: Wireless Data
Underlying Protocol Services: TDMA
Bandwidth Required: 30 Khz

Transmission Speed: 28.8 Kbps
Future Transmission Speeds: 56.6 Kbps
Service Providers: Orange, UbiNetics
Standards Bodies: None
Industry Organizations: None

HSCSD is the first data service to exploit a technology called "multiple slotting" to boost data network speeds. Multi slotting over TDMA (Time Division Multiple Access) uses more than one time slot to deliver data – akin to using two modems on two phone lines to get a faster Internet connections. Since TDMA supports 14.4 Kbps network speeds per time slot, using two slots would result in a 28.8 Kbps connection, 4 slots would result in 56.6 Kbps connections, etc. Capacity on each transmission frequency will limit how many connections at how high a speed can be supported.

3rd Generation Wireless Network Protocols

CDMA2000 3X – Code Division Multiple Access 3rd Generation

Generation: 3G
Expected Service Date: 2002
Target Use: Digital Cellular Network Services
Bandwidth Required: 1.25 Mhz
Transmission Speed: 384 Kbps (mobile packet data), 2 Mbps (fixed packet data)
Future Transmission Speeds: 5.2 Mbps (1Xtreme CDMA)
Service Providers: North American CDMA-based operators
Standards Bodies: Telecommunications Industry Association (TIA)
Industry Organizations: CDMA Development Group (www.cdg.com)

CDMA is a spread spectrum digital cellular service originally developed by Qualcomm. It is used for digital cellular, PCS (personal communications services) and wireless data services. This cdmaOne standard-based 3G upgrade is based on Qualcomms 2 Mbps CDMA 3XRTT CDMA2000 system. cdmaOne is the name given to it's Interim Standard 95 by the CDMA Development Group. This technology has the most momentum in North America. However, W-CDMA has been adopted as an international standard and may give CDMA2000 2X serious competition even within the North American markets if cross border interoperability is still an issue once these technologies are rolled out.

W-CDMA – WidebandCode Division Multiple Access

Generation: 3G
Expected Service Date: 2002
Target Use: Digital Cellular Network Services
Bandwidth Required: 5 Mhz
Transmission Speed: 384 Kbps (mobile packet data), 1.8 Mbps (fixed packet data)
Future Transmission Speeds: 5.2 Mbps (1Xtreme CDMA)
Service Providers: Most International operators except North American
Standards Bodies: ETSI (Europe), ANSI (US), TTA (Korea), ITU (UN), TIA
Industry Organizations: ARIB (Association of Radio Industries and Business (Japan), IMT-2000 (International Mobile Telecommunications-2000)

This future evolution of CDMA to 1.8 Mbps is based on a proposed 3G standard defined b the European Telecommunications Standards Institute (ETSI). This technology has been embraced as an international standard by the International Telecommunications Union (ITU). It is expected to be the international evolution for both CDMA and TDMA based technologies (including the subscriber rich TDMA-based GSM protocols widely implemented around the world).

EDGE – Enhanced Data-rate for Global Evolution

Generation: 3G
Expected Service Date: 2001
Target Use: Digital Cellular Network Services
Underlying Protocol Services: GSM, TDMA, D-AMPS
Bandwidth Required: 800 Khz
Transmission Speed: 384 Kbps (mobile packet data)
Future Transmission Speeds: 2 Mbps (W-CDMA)
Service Providers: AT&T Wireless, SBC Wireless, other North American GSM & TDMA-based operators
Standards Bodies: ANSI-41 (TDMA/AMPS), ANSI-136 (GSM/TDMA)
Industry Organizations: UWCC (Universal Wireless Communications Consortium)

Ericsson originally developed EDGE as an upgrade path for GSM operators. It uses a new high speed modem protocol. However, GSM operators have been slow to embrace EDGE. And recently the UWCC has been pushing the use of EDGE as an upgrade path for TDMA. And D-AMPS operators have been seriously considering EDGE as an upgrade path for their Digital and Analog Cellular services.

REFERENCES

The information in this report was collected from over fifty different sources including manufacturer web sites, industry web sites, product review web sites, online periodicals and press announcements. These sources included:

Aether
Anywhereyougo
C/Net
CDG.org
CTIA
Ericsson
Forrester Research
GartnerGroup
Giga
GoAmerica
GSM MoU Association
GSM Data Knowledge
GSMWorld
Hewlett-Packard
Kycera
Microsoft
Mobile Data Association
Motorola
Nokia
Novatel
NTT DoCoMo
Omnisky
Outlook
Palm.net
Palowireless.com
PCS Data Knowledge
PCSWorld
Qualcomm
Sierra
Skytel
Sprint
UWCC.org
Verizon
Wap.net
WapForum.org
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YadaYada