

America's Race for 3G

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America's Race for 3G

I. Introduction

America's race to achieve 3rd generation (3G) wireless capabilities will redefine the way telecommunications companies operate, and determine how Americans communicate with one another. Wireless communication is slowly moving away from the world of limited bandwidth 2nd generation (2G) wireless technology to the next generation of wireless infrastructure that enables significantly higher bandwidth. This higher bandwidth will lead to the convergence of devices. Consumers will begin to utilize devices that combine cell phones, PDAs, video cameras, pagers, and other various gadgets. Increases in bandwidth will also enable users to download rich multimedia and access up-to-the-minute data from the Internet.

3G is a global wireless communication technology that makes packet-based transmission of digitized voice, data, and video a possibility. Packet-based networks provide an "always on" capability, which is not available through circuit based 2G networks. This evolution in technology also makes networks more bandwidth efficient and lowers carrier's costs. With the emergence of 3G the traditional billing model of charging by airtime no longer applies. The "always on" concept of packet-switching means that charging for long distance and the duration of a call are not appropriate, because they don't accurately reflect the amount of resources being used. New pricing models will likely be based on a combination of the amount of data transmission and charges for various services and content. The bill received from a 3G service provider will likely resemble a credit card statement rather than a typical telephone bill. Third party applications and services, such as a subscription to a wireless based MP3 download site, will be billed through the service provider.

The United States has traditionally trailed the leading wireless networks in Europe and Asia (Japan in particular), but large investments and initiatives on the part of American telecommunications giants have started to narrow the gap. America's early testing and

deployments of scaled down 3G networks have typically trailed their European and Asian counterparts by about a year and a half. 3G is poised to make a significant breakthrough into the mainstream U.S. markets relatively soon. Exactly how long is the subject of much debate. This paper will take an in-depth look at the scheduled 3G deployments of U.S. carriers.

Most experts agree that 3G represents the future of telephony. However, what they don't agree upon is exactly what the future will be like or how quickly it will roll out. How will the mobile Internet be used? What kinds of services will be offered? Who will be the leading providers of 3G technologies? At this point 3G is all 'potential' and no 'promise'. This paper explores some likely answers to these questions.

II. The Current State of Wireless

Over 400 million mobile phones were sold worldwide in 2000. Improved service capabilities and the enhancement of phone capabilities should push total mobile phone sales to over one billion by 2002. There are a number of factors driving the evolution toward broadband wireless capabilities; including the following:

Societal trends

- The emergence of a computer literate society
- Increasing travel and mobility
- Desire for entertainment
- The need for increased productivity
- Telecommuting

Technology Enablers

- High speed, cost effective mobile systems
- Integrated multimedia applications
- Small, powerful application intensive devices

Market Trends

- Rapid growth in mobile
- Rapid growth in Internet usage
- Accelerating pace of eCommerce and mCommerce (mobile)
- Rapid growth in usage of laptops, PDAs

The large majority of mobile phones sold to date have lacked the data capabilities that will be apparent with the emergence of 2.5G and 3G wireless technologies. Today's 2nd

generation (2G) wireless technology, which currently makes up most of America's wireless market share, is based on circuit-switching technology. Second Generation circuit-switching is accomplished using GSM (Global System for Mobile Communications), CDMA (Code Division Multiple Access), or TDMA (Time Division Multiple Access). GSM was launched as a worldwide standard in 1992 and is still the basis for much of the wireless services offered today. CDMA is another widely used 2G wireless standard. TDMA on the other hand has begun to lose market share from companies that are now shifting their networks to GSM. 2G's low bandwidth is capable of an average 9.6 Kbps, which is well suited for voice transmission but inadequate for data transmission.

2G has only been able to handle simplistic data services, such as email and text messaging. These basic services have been slow to catch on in America, due in part to both the unattractiveness of the capabilities, and the awkward navigation and input requirements of the current wireless devices. Yet another obstacle seems to be the failure for WAP (Wireless Application Protocol) to receive the universal support it expected, in part due to its lack of an "always on" feature. American standards organizations were hoping WAP would be the savior in terms of wireless protocols, while other countries abandoned it for arguably more promising technology. Japan's NTT DoCoMo is a prime example. They have been successful in signing up 20 million subscribers for their second-generation "always on" i-mode service.

NTT DoCoMo's global success in developing and launching wireless services makes them perhaps the leader in the global race for 3G. They will be the first carrier to achieve widespread 3G services. However, an in-depth discussion of NTT DoCoMo's global presence and their services is beyond the scope of this paper. Their alliance with AT&T Wireless will be discussed.

Figure 2.1 shows the recent evolution of wireless networks. Figure 2.2 displays the projected amount of mobile data users in the United States.

Figure 2.1

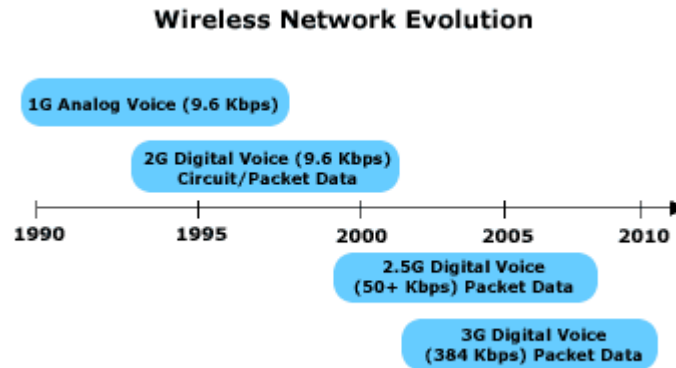
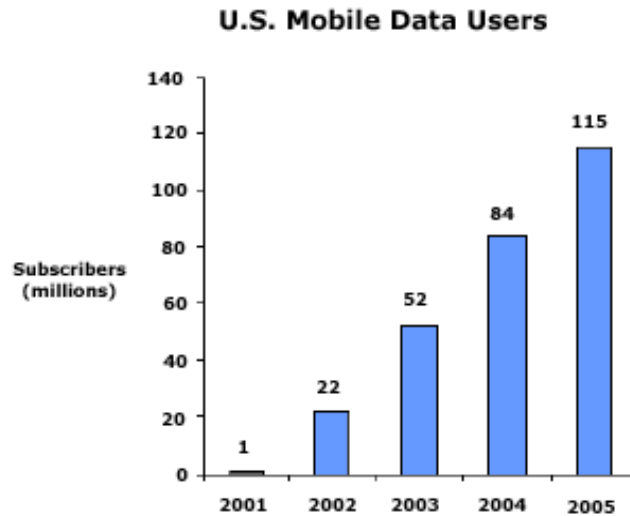


Figure 2.2



Source: Forrester Research, 2001

III. The Technology Behind the 3G Evolution

There are two dominant competing 3G options for American wireless carriers to follow; CDMA 2000 and W-CDMA (Wideband-CDMA). Carriers must roll the dice and choose which standard to follow, because both of these technologies cannot be implemented together within a network. W-CDMA is the natural progression for GSM and TDMA networks, while CDMA 2000 builds on platforms currently using CDMA technology.

There are major U.S. wireless providers that are backing each of these technologies. What this means is that the American 3G market will evolve having two widely used wireless standards. The transition from GSM and TDMA to W-CDMA, will not be a simple one. It will first be necessary to transition these networks to GPRS (General Packet Radio Service), then upgrade them to EDGE (Exchange Data Rates for Global Evolution) before it will be possible to make the transition to full 3G. GPRS speeds should reach up to 144 Kbps, with EDGE further enhancing data transfer speeds up to 384 Kbps. These two interim stages of technology represent what is referred to as “2.5G”.

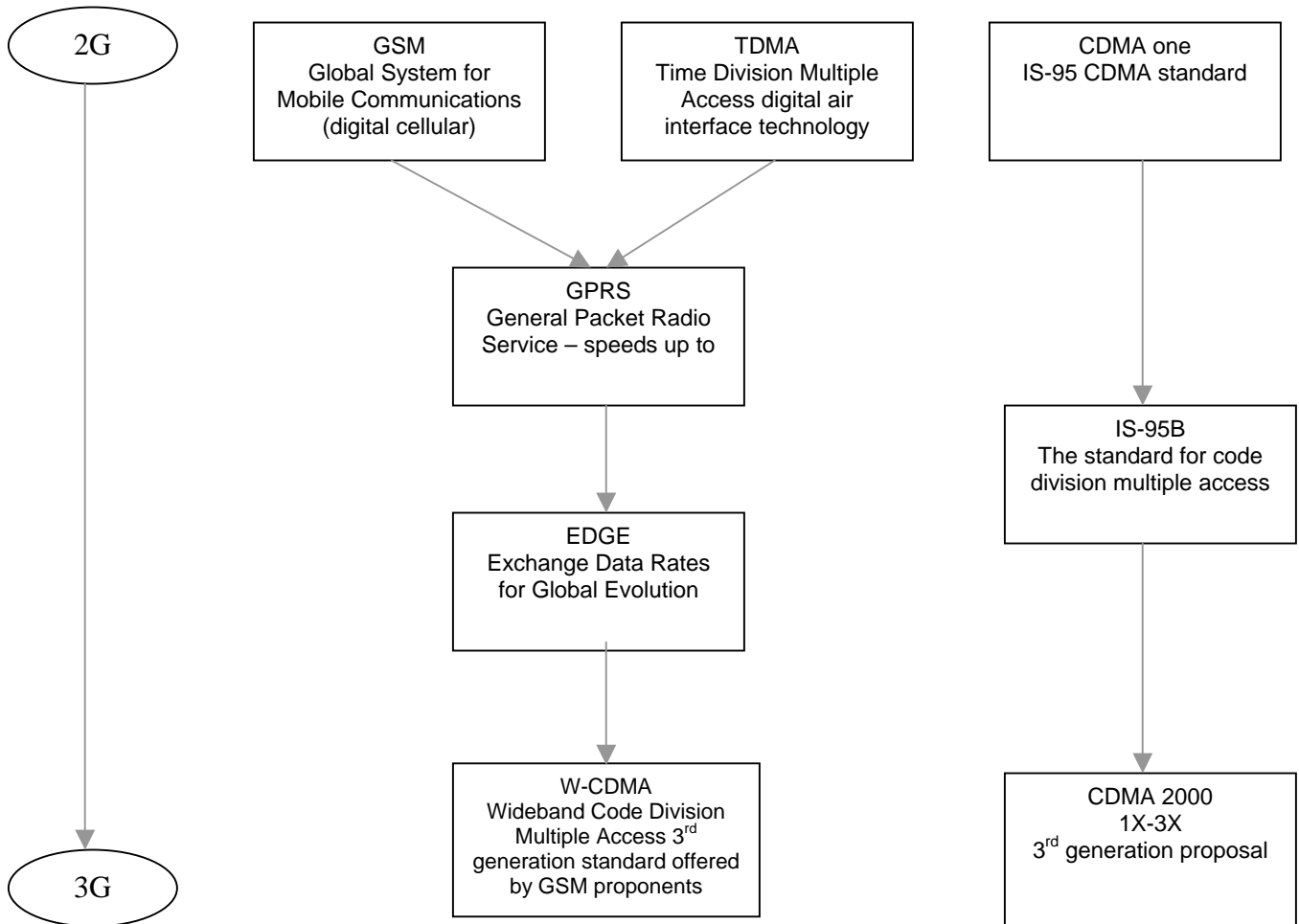
CDMA’s evolution to 3G will be a bit more straightforward. The migration to 3G for CDMA will move from its current 2G speeds of up to 14.4 Kbps, to a 2.5G standard called IS95B. This 2.5G technology utilizes the same spectrum, but offers speeds up to 64 Kbps. The next step will involve carriers moving to a realm known as CDMA 2000. CDMA 2000 will begin with a 1X version, then move to 2X, and reach full 3G capacity at 3X. The 1-3X represents the various steps that CDMA 2000 will take before reaching its full 3G capacity. *“Upgrading networks to 1X will facilitate data rates up to 144 Kbps. Once networks are upgraded to CDMA 2000 wireless transmission should be able to achieve speeds of up to 2 Mbps. To migrate through these steps, carriers will basically only have to change a channel card in their base stations, which will allow them to continue to utilize their infrastructures. The speed of this migration is a true economic incentive for carriers”* says Perry LaForge, executive director of the CDMA Development Group (CDG). LaForge contends that upgrading to 3G will be a much more cumbersome process for those currently using GSM and TDMA.

IMT-2000 (International Mobile Telephone Standard) is a framework developed by the International Telecommunications Union that is designed to set global standards and spectrum allocation for 3G. Under these guidelines 3G packet-based technology is capable of 144 kbps in a moving location, such as a car or train, and up to 2 Mbps in a fixed location. These guidelines also spell out the capability of global roaming, which is not possible using today’s wireless technology. IMT-2000 offers support for both W-

CDMA and CDMA 2000. Figure 3.1 shows the roadmap that must be followed by these competing technologies, in order to reach third generation wireless. Figure 3.2 illustrates the projected growth rates of the different technologies. Chart 3.3 provides reference definitions for each of the different technologies associated with 3G.

Figure 3.1

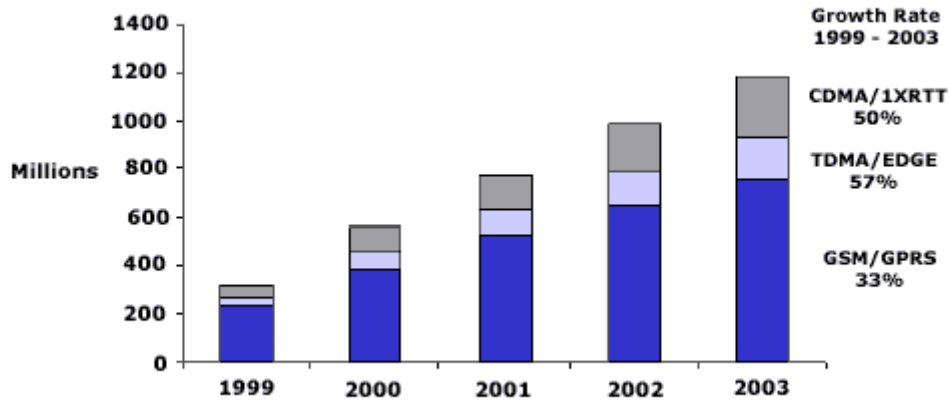
The U.S. Roadmap to Next-Generation Data Networks



Source: International Telecommunications Union

Figure 3.2

Global Subscriber Forecast, Growth by Technology



Source: Lehman Bros. Estimates

Chart 3.3

Wireless Technology Glossary (as defined by Upside Magazine, March 2001)

CDMA: Code division multiple access; air interface technology pioneered by Qualcomm, predominantly used in the United States.

CDMA 2000: Third-Generation form of CDMA; includes intermediary technologies 1X through 3X. Data rates range from 144 Kbps to 2 Mbps.

EDGE: Enhanced data rates for GSM and TDMA; 2.75-generation migration step for GSM and TDMA operates between GPRS and 3G technologies such as UMTS and W-CDMA. Data rates up to 384 Kbps.

GPRS: General packet radio services; 2.5-generation migration step for GSM and TDMA operators. Data rates of up to 115 Kbps.

GSM: Global system for mobile communication; air-interface technology currently used by most European cellular operators

TDMA: Time division multiple access; air-interface technology used mostly in the United States.

W-CDMA: Wideband code division multiple access; 3G technology for GSM and TDMA systems. Data rates of up to 2 Mbps.

IV. America’s Leaders in the 3G Service Provider Evolution

There are a wide variety of theories about how companies should go about transforming their networks from 2G to 3G. Some wireless providers seem inclined to take their time in evolving to 3G status. These companies, which include Cingular Wireless, Nextel Communications, and VoiceStream Wireless, will likely be deploying a set of so-called 2.5G services. Many feel that this conservative rout will benefit these companies by allowing them to get a better understanding of the emerging market's technology before making a more aggressive push towards 3G. It will provide them an opportunity to observe the market leaders to determine which of their paths to 3G seems the most promising, and follow that path. After all, the progression from 2G to 3G will be one of evolution rather than "big bang". For example, a service such as mobile banking may be released in 2G as a simple balance inquiry, and then extended in 2.5G to offer personalized portfolio management, and in 3G to include full transaction capabilities.

Wireless providers Sprint PCS, Verizon Wireless, and AT&T Wireless have emerged as the front-runners to first deliver a 3G network in North America. All three plan to begin offering introductory versions of 3G (3G Lite) by early 2002, and have already begun limited rollouts in selected cities. These companies are spending billions of dollars to establish the mobile infrastructure necessary to lay the foundation for 3G. Let's take a closer look at these leader's 3G implementation strategies.

Sprint PCS

Sprint PCS is hoping to be the first U.S. mobile provider to implement 3G. Their network is based on CDMA technology and will therefore be following the CDMA 2000 path to 3G. They are currently testing rollouts of CDMA 2000 1XRTT, and expect to complete their network upgrade to CDMA 2000 by the end of the first quarter of 2002.

"Sprint PCS has established a reputation as an innovator and industry leader. Our leadership advantage in the evolution to 3G is no exception. The clarity, coverage and reliability of a single-frequency, all-CDMA nationwide network, breadth of existing services and applications, and consistently sound business decisions puts us in an enviable position. Sprint PCS has the clearest, fastest, most economical path to more

robust applications, faster data speeds, a richer wireless experience and greater overall mobility for our customers." - Charles Levine, President, Sprint PCS

Verizon Wireless

Verizon's situation closely resembles that of Sprint PCS, in that their 2G network uses the CDMA protocol and they are currently in the process of conducting field trials of CDMA 2000 1XRTT. Their early deployments of 3G technology seem to be trailing Sprints by a few months.

In March 2001, Verizon entered into a \$5 billion contract with Lucent Technologies, which will substantially increase Verizon's network capacity, and speed deployment of 3G wireless services in the United States. This upgrade will double the voice capacity and increase data transmission speeds by 10 times. This deal makes Lucent the largest supplier of 3G infrastructure equipment to Verizon.

AT&T Wireless

AT&T's 2G network was originally based on TDMA, which distinguishes them from Verizon and Sprint and makes their transition to 3G a bit more complicated. In November 2000 NTT DoCoMo, arguably the world's largest mobile-phone carrier, announced that they would pay \$9.8 billion for a 16 percent stake in AT&T Wireless. NTT DoCoMo's minority stake in AT&T Wireless doesn't give them any management control, but does give them a foothold into the U.S. market. With AT&T's recently formed relationship with NTT DoCoMo they have begun to shift their network from TDMA to the global standard GSM. AT&T's current network foundation forces them to follow the GPRS – EDGE path to 3G. They must transition their network through the 2.5G stages of GPRS and EDGE before being able to rollout the full-3G W-CDMA (also known as UMTS).

AT&T recently rolled out 2.5G services for Seattle businesses. They say that this service will allow users to access information via wireless handsets, at speeds up to ten times faster than any other current U.S. wireless networks. The company's management claims

they will deploy a GSM/GPRS network to about 40% of their market by the end of 2001, and will cover 100% by the end of 2002. These deployments will lay the foundation for the company's eventual shift to a full 3G protocol. AT&T Wireless' upgrade in protocols will necessitate them changing their pricing structures. GPRS transmits data via packets, and therefore customers will be billed based on the amount of data sent and received, not on airtime incurred. Combined data and voice services begin at \$50, which includes one megabyte of data allocation and 400 voice minutes. Incremental use above a plans allocation will be billed at less than one cent per kilobyte.

The company's next step will involve the rollout of EDGE. This will likely begin to occur towards the end of 2002. After this AT&T will need to overlay W-DMA, which they hope to begin in 2003. Some experts argue that although the use of CDMA 2000 will likely dominate the U.S. market percentage wise, AT&T Wireless through their alliance with DoCoMo, will be able to deploy W-CDMA to reach the 3G plateau first.

Wireless service providers will succeed by taking an early lead in establishing a viable infrastructure, developing a powerful brand, building a loyal customer base, and partnering with handset and application providers to roll out a series of differentiated and revenue earning services. These application providers will be discussed in the next section. Figure 4.1 gives a snapshot of the major U.S. provider's march towards 3G.

Figure 4.1

The U.S. Carriers march towards 3G

Carrier	2G	2.5G	3G Lite	Full 3G
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AT&T Wireless	Uses TDMA and GSM	Launched GPRS service in Seattle in July 2001, expects to have the top 100 U.S. markets covered by 2004	Expects to deploy EDGE beginning in 2002	Expects to deploy WCDMA beginning in 2003
Cingular Wireless	Uses CDMA and GSM	Expects to launch GPRS in CA, WA, and NV in late 2001	Has no plans	Expects to deploy WCDMA but has no schedule date
Nextel Communications	Uses idem (a TDMA variant)	Deployed data version iDEN last year	Undecided	Undecided
Sprint PCS	Uses CDMA	Has no plans	Expects to begin deploying CDMA2000 1X by 2002	Undecided
Verizon Wireless	Uses CDMA	Has no plans	Expects to deploy CDMA2000 1X by end of 2001, testing now in NY/NJ	Undecided
VoiceStream Wireless	Uses GSM	Expects to launch GPRS winter 2001	Undecided	Undecided

V. What does it mean for the customer?

With all the unknowns surrounding 3G, why would companies rush to develop applications for a technology with competing standards and loads of implementation difficulties? The answer is in the possibilities presented by 3G. Potential applications range from streaming video, full-scale multimedia, and integrated voice and data services. 3G enabled devices, such as PDAs and mobile phones, will serve the functions of a video camera, computer, radio, pager, stereo, and telephone combined. Consumers will be able to combine voicemail and email messages in a single mailbox. They will be able to read or have their email read to them by their mobile device.

Mobile Internet services provide perhaps the biggest attraction for mobile customers. Applications such as web browsing, email, stock tracking, and airline reservations are just the tip of the iceberg. Mobile window-shopping, videoconferencing, and global roaming will be included in the next generation of applications. Mobile Commerce (m-Commerce or m-Business), the concept of carrying out financial transactions seamlessly

over mobile devices will help to spread the growth of 3G services. Wireless application providers are banking that the following services will become widely popular among mobile users.

- **m-shopping** – The ability to browse and make purchases on the Internet via a mobile device.
- **Audio and video downloads** – With the recent emergence of high quality compression protocols, such as MP3, music and video will be easily downloaded to a mobile device. The consumer will then be able to watch video or listen to music on their handheld.
- **Playing games/meeting others** – 3G will permit interactive, real time game playing. Users will be able to interact with others from across the globe. Mobile users will likely access game sites hosted by service providers.
- **Location aware alerts** – Third generation wireless devices will be “location aware”. This means that the devices will have the capacity to identify their exact physical location. This will be accomplished through either a built-in Global Positioning System (GPS) or through the process of “triangulation” between network base stations. Application and service providers will use this information to provide the user information that is relevant to their location. For example, an airline service might send a passenger directions from their hotel to the correct terminal.

Such service offer huge potential in the areas of mapping, driving instructions, parking locations, retail-outlet identification, localized advertising, traffic reporting, weather, and more. These services are also expected to one-day overlap with transactional capabilities. If someone can locate a parking spot, why not reserve and pay for it in advance? As a consumer walks through the mall they may receive sale notifications, matching their profile, from the stores they pass.

- **Virtual Ticketing** – Experts predict that 3G technology will eventually allow consumers to use their mobile device to gain entry to anything from airport check-in to a theatre or cinema. However, the events of September 11th, 2001 will hamper any quick advancement in this form of “virtual airline ticketing”. The

concept behind virtual ticketing works like this: The customer purchases a ticket over the mobile Internet and is issued a virtual pass. A compatible device at the gate or entrance reads the handheld's virtual pass.

- **Multimedia messaging** – 3G enabled phones and PDAs will be able to send and receive messages that incorporate text, video, photos, animation, sound, and video clips. Many expect that mobile devices will soon begin to incorporate the functions of a camera or video camera.

However, the current lack of availability of mobile devices that can handle such applications has slowed the implementation of 3G services. Currently some 3G enabled handsets cost around \$300, add to that a monthly service fee and it makes some consumers hesitant to rush out and get the newest devices. Equipment manufacturers aren't the only ones who need to speed up 3G development. Application developers must also get work in order to make up for the current lack of 3G applications available for handhelds. However, one can hardly blame these manufacturers for the delayed development and release of products. Demand drives supply, and until a sufficient 3G network is established in the U.S., there will be little demand.

VI. America's Leaders in 3G Equipment Manufacturing

Major equipment vendors are making mobile devices with both CDMA 2000 and W-CDMA in mind, as well as the interim steps (GPRS, EDGE) needed to get there. An equipment manufacturer that expects to fight for market share among all U.S. markets needs to consider all these angles when developing a product line for 3G. Some companies are beginning to align themselves with certain platforms through strategic partnerships. Motorola, Lucent, Nortel, Samsung, and Qualcomm have been developing equipment for U.S. CDMA 2000 beta rollouts. While at the same time Ericsson has partnered with Japan Telecom to test the worlds first voice over IP network using W-CDMA. Lets take a closer look at the 3G plans of three of America's leading mobile equipment manufacturers (see figure 5.1).

Nokia: This company's 3G implementation solution is based on an all IP (Internet Protocol) network consisting of an IP radio access network (IP-RAN) and IP Mobility Core network. These networks can support the GSM and W-CDMA platforms. The IP Mobile Core network utilizes IPv6, which provides an easy interface for the technologies of multiple vendors. Nokia has already announced they will select a service provider to provide "Club Nokia" which will deliver music, messaging, and other services wirelessly to Nokia handsets.

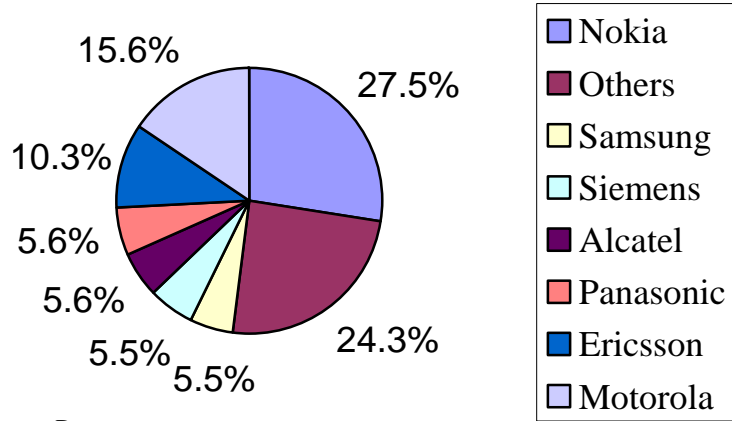
Ericsson: In addition to partnering with a Japanese company for intense testing of a W-CDMA network, Ericsson has been strangely involved in the development of a CDMA 2000 network. They recently announced the completion of a 3G CDMA 2000 Mobile Switching Center (MSC) that is set to be integrated into their wireless network.

Motorola: Motorola's Aspira technology is based on an all IP core network. Through a partnership with Cisco systems, this network devises separate paths for migration from CDMA and GSM platforms. They recently completed tests that delivered live video over their 3G product.

Motorola recently released their Timepoint 7382i GPRS enabled handheld to North America. The phone, which costs \$199.99 for AT&T Wireless customers, features voice activation, a voice note recorder, a WAP-enabled microbrowser, and data port for external connectivity. AT&T and Motorola are partnering to take one of the first steps towards delivering 2.5G technology to mainstream America.

Figure 5.1

Worldwide Mobile-Phone Market (Q4 2000)



Source: Dataquest

VII. Conclusion

3rd generation wireless will eventually deliver new and exciting services to mobile devices for both business and personal use. However, before this new technology becomes a reality to consumers, there is a lot of development that needs to be accomplished on the part of service providers and equipment manufacturers. Wireless service providers must take the necessary steps to upgrade their networks for 3G. Verizon Wireless, Sprint PCS, and AT&T Wireless are leading the development of 3G networks in the United States. Wireless providers are adopting two different 3G standards: W-CDMA and CDMA 2000. Meanwhile Nokia, Ericsson, and Motorola are the current leaders in developing the next generation of 3G mobile devices.

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