

The Smart Money Is On 3G

The accelerating migration to 3G technologies

August 2006

Prepared by: CDMA Development Group





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*Would you like to buy a car with windows that you have to manually roll-up yourself? Probably not.
How about a TV with an analog antenna and no remote control? Guess not.
What about a 2G technology for your wireless network equipment? Better think twice.*

When it comes to wireless network investments, the global market is in a major transition to next-generation services. It's not the first time we've experienced it; in the early- and mid-1990's new, second generation (2G) digital technologies such as GSM, TDMA and CDMA were being launched to deliver the benefits of better voice quality, higher network capacity, open architecture, and the more efficient use of scarce radio spectrum. However, this transition has taken more than 15 years. In fact, well into the mid-1990's, the most widespread technologies with the highest global subscriber numbers continued to be first generation (1G) analog AMPS and TACS. Meanwhile, new operators were becoming established in markets all over the world and they had to decide whether to start with analog and upgrade later, or to move right into one of the newer 2G digital technologies.

While manufacturers continued to offer their highly profitable analog equipment, forward-looking operators chose digital GSM, TDMA or CDMA to maximize their earnings. Once the digital technologies were widely proven and deployed, operators around the world knew that purchasing first generation equipment, even with its appealing low capital expense due to economies of scale, was a poor strategic and business decision when it came to their long-term cost of ownership, revenue opportunities and competitive position in the marketplace. It wasn't until 1997 that the number of digital 2G subscribers finally surpassed those for analog 1G subscribers.

Today, we see a similar trend with third generation (3G) cellular systems such as CDMA2000® and WCDMA (also called UMTS), but at a much quicker pace. For approximately five years now, manufacturers have indicated that the vast majority of their R&D investment has been allocated to their 3G product portfolio, with much of the funding coming from their 2G cash cows – GSM and CDMA. Yet availability of 3G equipment did not supplant the selling or the purchasing of 2G — until now.



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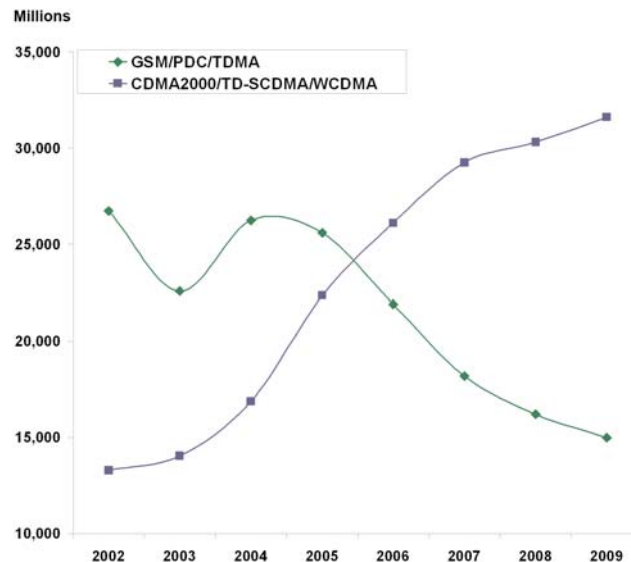
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3G MIGRATION

The majority of wireless infrastructure purchases today are for 3G systems. According to a Gartner Dataquest forecast for worldwide network infrastructure spending, 54% of all spending this year is going to CDMA2000 and WCDMA. By 2007, the spending jumps to 61% for 3G and continues to increase thereafter, while investment in 2G technologies like GSM continues to decline. Figure 1 illustrates the change in spending over time if we combine WCDMA with CDMA2000 and TD-SCDMA, and GSM/GPRS/EDGE with TDMA and PDC.

Figure 1
Worldwide Infrastructure Revenue by Technology



Source: Gartner Dataquest, Forecast: Mobile Network Infrastructure, Worldwide, 2002-2009, October 2005

Strategy Analytics (July 2006) also predicts that over half of the global spending for 3G wireless infrastructure will go to CDMA2000 and WCDMA during 2006 and indicates that 2G technologies will continue to decline thereafter.

It stands to reason that once operators make an investment in new infrastructure, the number of users on the network will grow proportionally. But what is most impressive is that the take-up of 3G services has outperformed any technology rollout in the wireless industry's history.

Figure 2 shows the subscriber take-up rates for the first 19 quarters after the commercial launch of CDMA, GSM, WCDMA and CDMA2000.

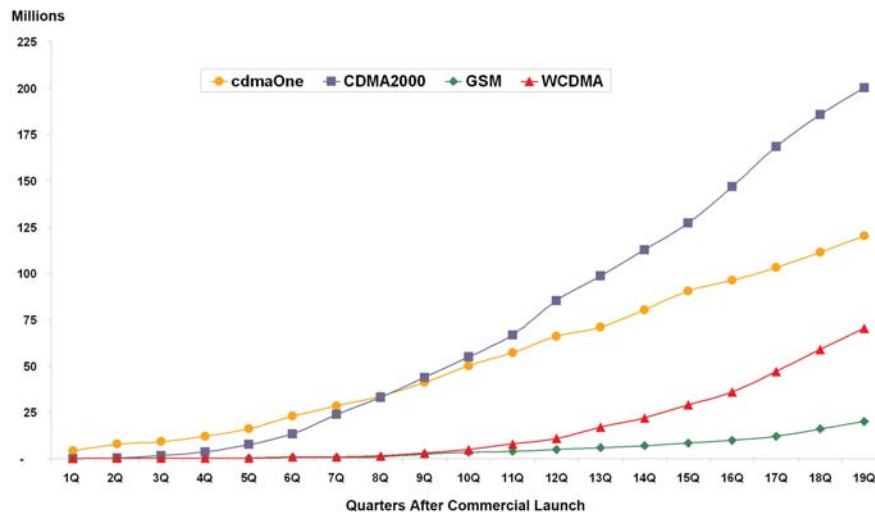


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Figure 2
Global Subscriber Growth by Technology in the First 19 Quarters of Commercial Service



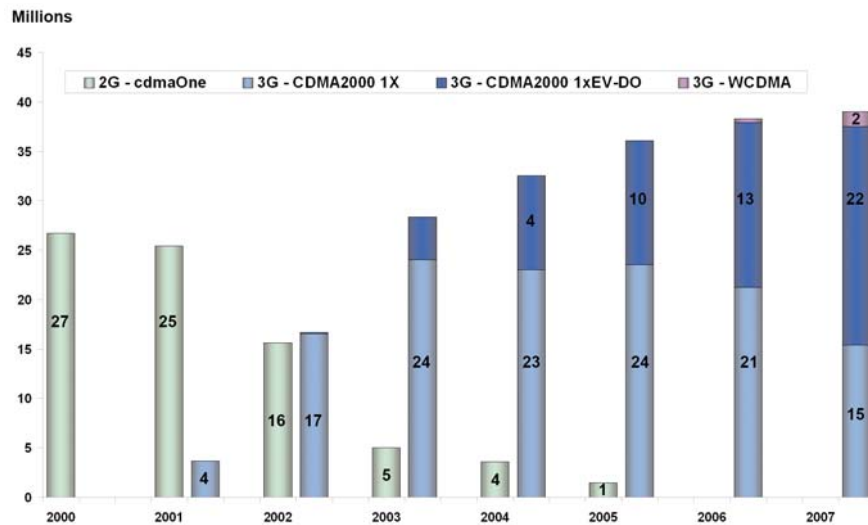
Source: CDMA Development Group and Strategy Analytics, June 2006

Migration to 3G started in developed and advanced markets, just as it did with 2G. Yet, the rapid adoption rate of 3G in markets such as Japan, Korea and the United States has been exceptional – much faster than that of 2G. In a matter of a few years, the number of 3G users in these countries surpassed that of 2G subscribers.

Korea

Korea proved to be a leader in 3G when its three operators began rolling out CDMA2000 starting in October 2000. Within two years, there were more 3G subscribers in Korea than 2G subscribers. Furthermore, today almost 40% of the country's CDMA2000 subscribers have upgraded their devices to take advantage of the more advanced 1xEV-DO mobile broadband services.

Figure 3
Korea Cumulative Subscribers



Source: Strategy Analytics, January 2006



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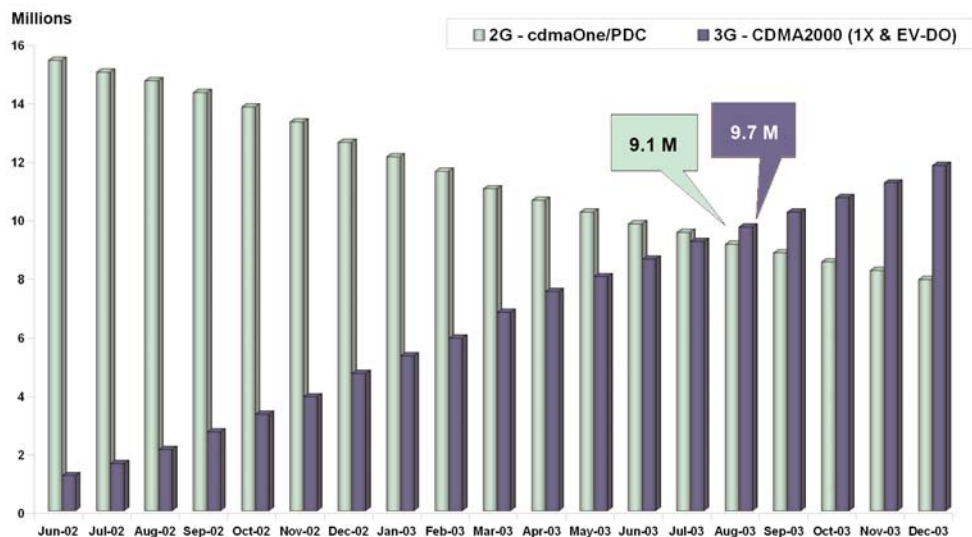
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Japan

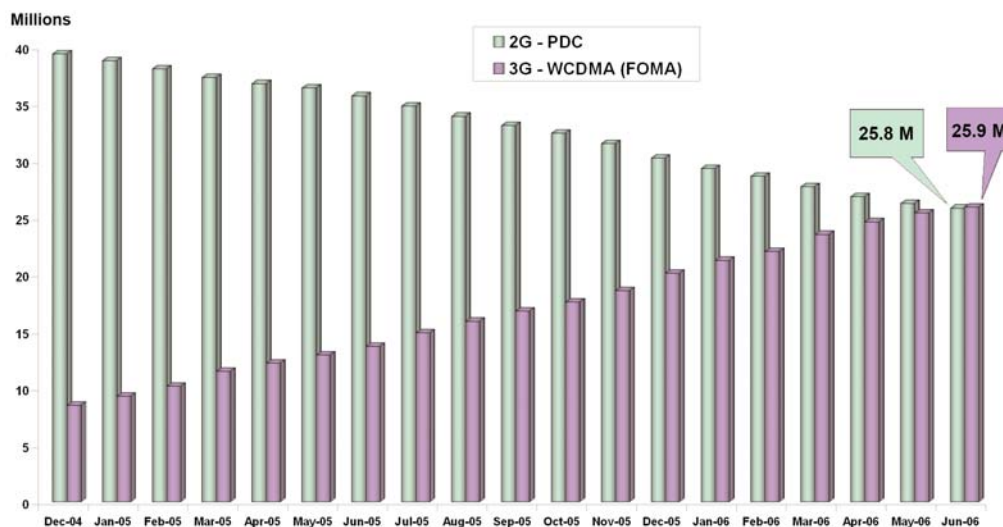
In Japan, the rapid growth in 3G subscriptions to the KDDI service (using CDMA2000) and the NTT DoCoMo FOMA service (now based on WCDMA) also tipped the scale in the country in favor of 3G users. In the case of KDDI, it took less than two years to migrate most of their 2G subscribers to 3G; it took NTT DoCoMo less than five years to do the same (see Figure 4). KDDI has remained in the lead when it comes to technology advancements; two years ago, they began offering 1xEV-DO broadband data services, branded WIN, on their network. In fact, as of June 2006, there were 9.46 million WIN users, which represents 40% of KDDI's subscriber base. NTT DoCoMo is now rolling out its High-Speed Packet Downlink Packet Access (HSDPA) mobile broadband data network and will introduce broadband services comparable to KDDI. Today, there are more than 54 million subscribers on all three 3G networks in Japan, which represents 60% of the entire subscriber base.

Figure 4
KDDI Cumulative Subscribers



Source: KDDI press releases and company information

NTT DoCoMo Cumulative Subscribers



Source: NTT DoCoMo press releases and company information



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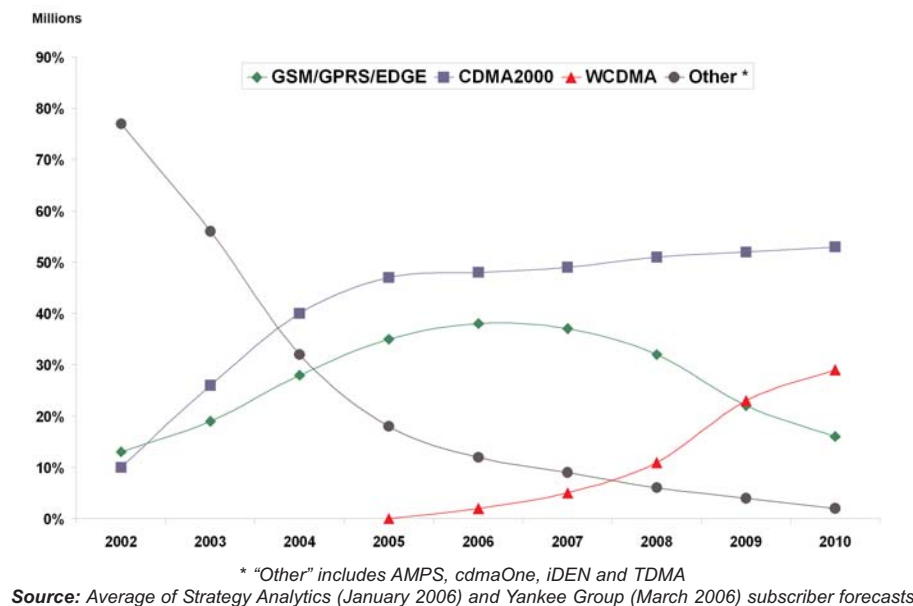
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North America

In North America, the same transition is occurring; by the end of 2006, there will be more 3G than 2G users in the region (see Figure 5.) Today, there are approximately 100 million CDMA2000 1X and 1xEV-DO subscribers, and WCDMA/HSDPA has started to gain users as Cingular Wireless expands its 3G coverage. As of 2006, the number of GSM subscribers begins its decline.

Figure 5
North America Cumulative Subscribers



Since 2004, CDMA2000 has been the dominant wireless technology within the United States. Subscribers to 3G services on Verizon Wireless, Sprint Nextel and 30 other CDMA2000 operators account for 49% of the total U.S. wireless market. These CDMA2000 1X and 1xEV-DO operators introduced new, popular services and their success accelerated the country's migration to 3G.

In fact, U.S. operator Cingular Wireless adopted an aggressive 3G deployment strategy as a result of the success of its CDMA2000 competitors. In its FCC public interest statement dated March, 2004 (regarding its acquisition of ATT Wireless services), the operator declared, "Consumer demand for new, high speed/bandwidth, advanced services is growing tremendously. Growth rates for data services dwarf the growth of wireless voice services. To compete with the new Verizon and Sprint offerings, Cingular and AWS (ATT Wireless Services) must deploy a technology that permits data transmission at comparable speeds. From a technology standpoint, the logical transition from EDGE is to the Universal Mobile Telecommunications System ("UMTS")."

The declaration included comments from analysts further stating, "Cingular and AWS face an impediment not faced by their national competitors: They are burdened with the need to support four different technologies. Over the next four or more years, they need to continue providing legacy analog and digital services that have no long-term future..."

After recently completing the deployment of its GSM/GPRS/EDGE network, Cingular is aggressively rolling out 3G and indicated that it will launch WCDMA and HSDPA in most major markets during 2006. The company stated that the new technologies would decrease network costs for both voice and data compared to its GSM network, while providing new data products to fuel growth (Cingular Wireless 4Q05 Report).



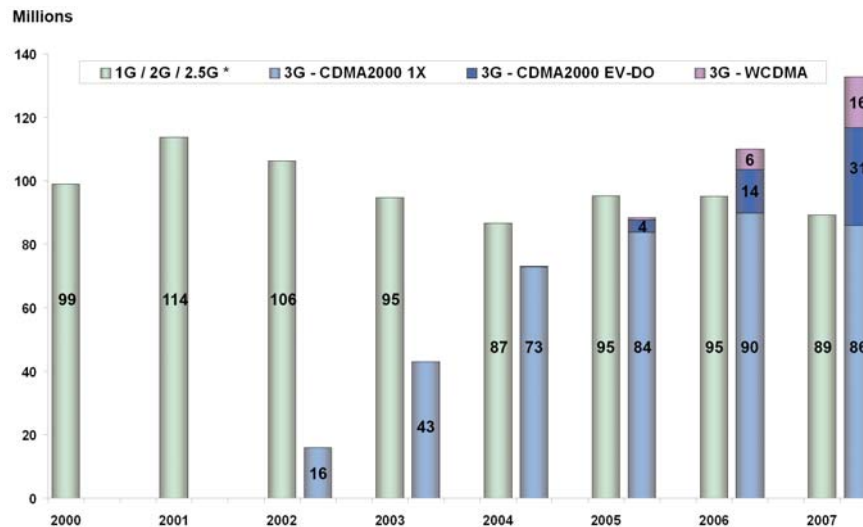
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By 2010, 3G subscribers are expected to make up 82% of all cellular subscribers in North America (Source: Average of Strategy Analytics, January 2006 and Yankee Group, March 2006, subscriber forecasts).

Figure 6
U.S. Cumulative Subscribers



Source: Average between Strategy Analytics, January 2006 and Yankee Group, March 2006

Western Europe

In Western Europe, the same trend is appearing. "We're seeing a profound change in dynamics between WCDMA and GSM in the net additions picture," notes UMTS Forum Chairman Jean-Pierre Bienaimé in a UMTS Forum press release dated 13 June 2006, (www.umts-forum.org). "During 2005, the contributions of GSM and WCDMA to total net subscriber additions in Europe were roughly equal. Today consumers don't need much encouragement to pick WCDMA over GSM: they're finding out for themselves that third generation is the only choice to meet their lifestyle needs." There are 34 million WCDMA subscribers in Western Europe today; more than 12 million subscribed within the first six months of this year. In addition to WCDMA, CDMA2000 technology has recently been launched at 450 MHz in Norway and is expected to make its debut in Denmark and Sweden later this year. In terms of total subscribers in the region, Strategy Analytics indicates that 3G subscribers are expected to surpass 2G subscribers by 2008 (Strategy Analytics, June 2006.)

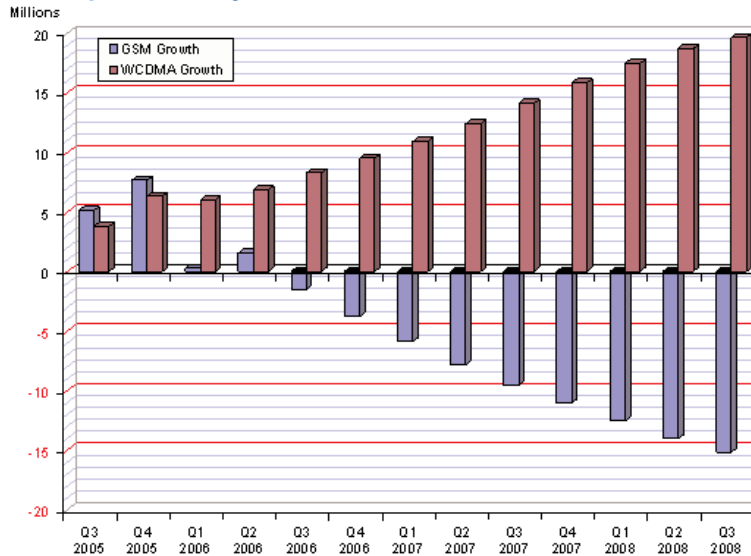


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Figure 7
Western Europe Quarterly Net Subscriber Additions GSM versus WCDMA

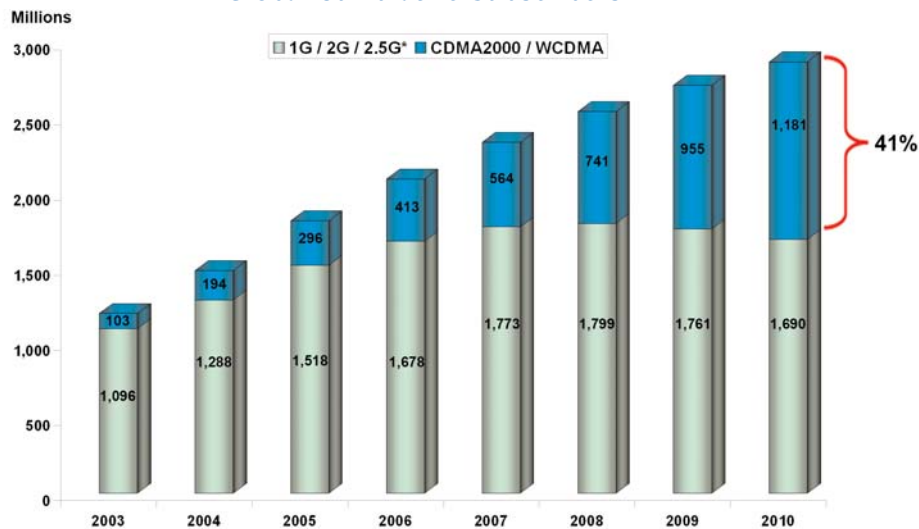


Source: Wireless Intelligence Database

Worldwide

Globally, analysts estimate that by 2009, the two dominant 3G technologies, CDMA2000 and WCDMA, will account for 41% of the market's subscribers and the world's once large GSM subscriber base will be on a steady decline. The number of 3G subscribers will surpass 2G subscribers in a matter of 10 years from 3G inception, which is 5 years fewer than it took 2G to take the lead over 1G.

Figure 8
Global Cumulative Subscribers



* Includes AMPS, cdmaOne, GSM/GPRS/EDGE, iDEN, PDC, PHS and TDMA

Source: Strategy Analytics, Worldwide Cellular User Forecasts, 2005-2010, January 2006



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3G APPEAL - THE ECONOMICS

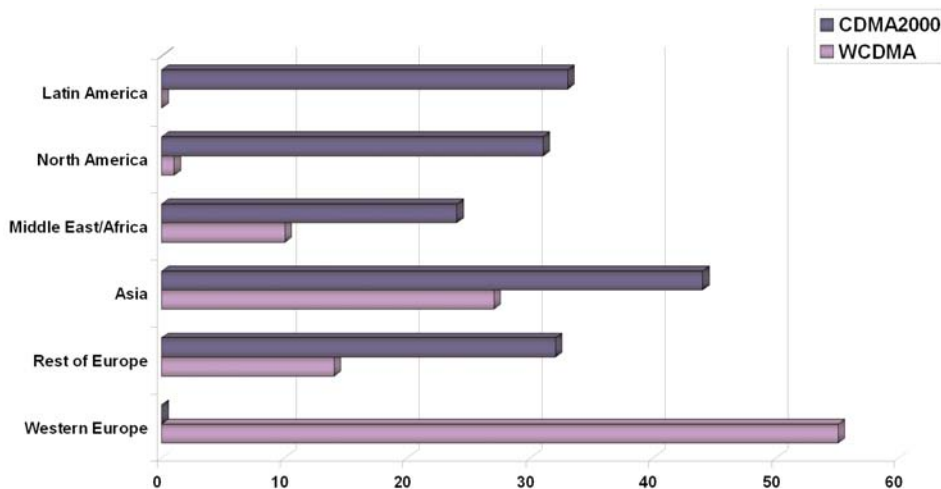
Network Operations

So what has the rationale been for those operators who tipped the scale and put 3G investment and new subscriber additions in the lead over those for 2G? Every operator has its own set of business, political, and market considerations, but for most operators, the key reasons for the migration to 3G have been improved economics, greater voice capacity to support increased minutes of use (MOU), more efficient use of valuable radio spectrum, and yes, the one we mostly hear about: new compelling data capabilities, which provide a variety of service revenue opportunities to compensate for declining voice revenue.

3G operators from the world's leading markets, in fact, reported fast take-up rates and increased revenue as a result of rolling out new data services on their next-generation networks. Most 3G operators around the world have reported average data revenue per user (ARPU) anywhere from 10 to 40 percent of total revenue per user on their 3G networks. In countries like the Czech Republic and the U.S., where CDMA2000 1xEV-DO services are readily available, operators with 2G GSM technology found it difficult to compete on price and performance, which forced them to consider aggressive plans to roll out WCDMA and HSDPA. The benefactors of this increased competition are consumers and enterprises who receive a better service for less money.

The movement to 3G is not limited to the world's developed nations, however. Emerging countries are also deploying 3G equipment for the same advantages. In these markets, inexpensive voice often takes precedence over broadband data and it is the economics of 3G, especially in lower frequency bands, that support the operators' business case for an in-band evolution to CDMA2000 and WCDMA. This is particularly the case in developing markets where landline services are not easily available and voice usage is moderately high.

Figure 9
3G Deployments Globally By Region



Source: 3G Americas and CDMA Development Group, July 2006

Network Total Cost of Ownership

A recent report by Signals Research on the total cost of ownership (TCO) of a 3G network provides a thorough evaluation of both capital and operating expenses for 2G and 3G networks over a ten year period. The report stated that if an operator intends to migrate to 3G at any point over that ten year period, it is more cost-effective to simply start with a 3G network. One of the key aspects of 3G that makes it more cost-effective is its ability to support greater voice and



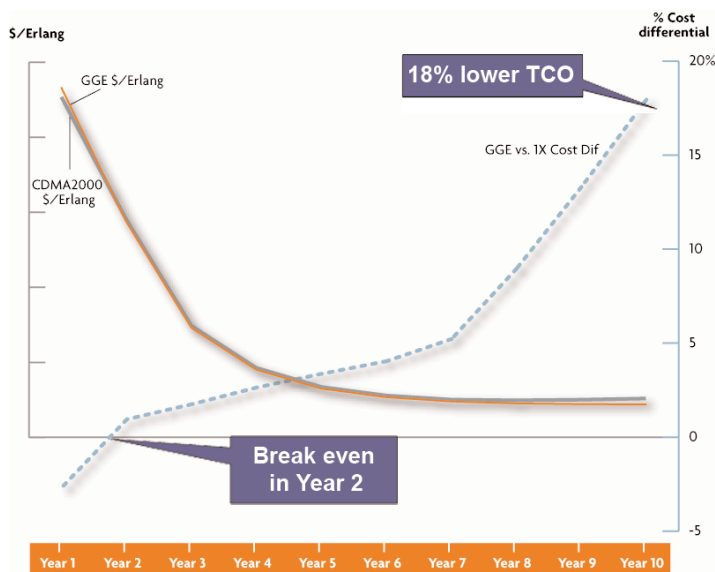
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data capacity within a given amount of radio spectrum, but there are also key advantages in operating costs. Even in cases where a GSM/GPRS/EDGE operator did not migrate to 3G during the ten year period, CDMA2000 can be up to 12% more cost-effective in a very moderate subscriber growth and MOU scenario. And, when the minutes of use and subscriber growth are increased, the total cost effectiveness of CDMA2000 becomes even more remarkable – an 18% to 23% cost savings. Figures 10 and 11 show the results for the scenario where voice and data traffic is higher.

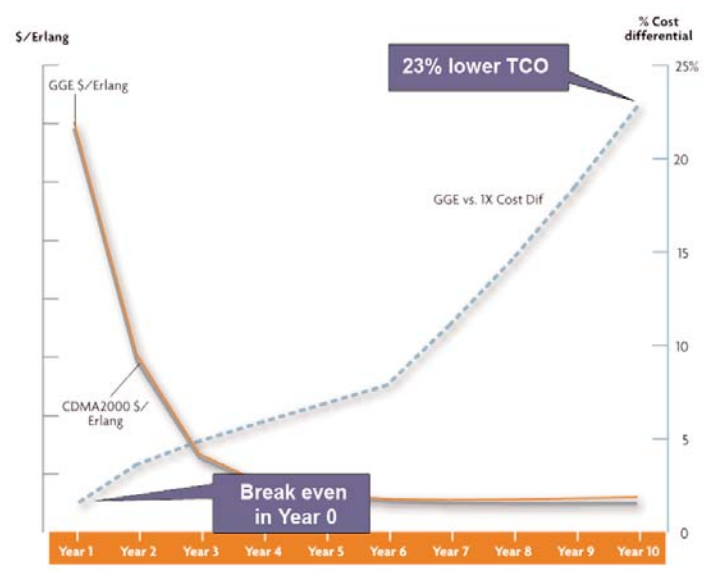
Figure 10
GSM/GPRS/EDGE vs. CDMA2000 Cost:
Higher Minutes of Use Scenario



Assumptions:
Year 1 Wtd Avg MOUs = 638
Year 10 Wtd Avg MOUs = 747

¹ Subscriber base growing from 750K in Year 1 to 9 million in Year 10
Source: Signals Research Group, LLC, May 2006

Figure 11
GSM/GPRS/EDGE vs. CDMA2000 Cost:
Higher Subscriber Growth Scenario



Assumptions:
Year 1 Wtd Avg MOUs = 5075

² Subscriber base growing from 900K in Year 1 to 15.3 million in Year 10
Source: Signals Research Group, LLC, May 2006

At lower frequencies (450 MHz and 850 MHz), 3G technologies are even more attractive when it comes to decreasing costs. At these frequencies, base stations can propagate the radio signal much farther and coverage is improved inside and outside of buildings. This means fewer base station sites are required to reach the desired population coverage area, and this translates into a lower capital investment for the operator – not only for the base station equipment, but also for the extensive site preparation, the number of high-bandwidth backhaul connections and the materials required for each. The difference can be substantial. As an example, 3G operator Belcel, in Belarus, covers 80% of the population with only 60 CDMA2000 base stations using the 450 MHz frequency band. Its GSM900/1800 competitor has a network with more than 500 base stations to cover the same area.

To avoid the debate over the value of 3G data services and capabilities, the Signals Research report does not evaluate revenue, but simply examines the cost aspects associated with building and operating the networks over time. If one adds in the potential for new revenue opportunities, the results could be even more convincing for the decision to deploy 3G networks. Lower non-hardware costs (e.g., site acquisition, preparation, operation, maintenance, etc.) also strengthen the 3G business case.



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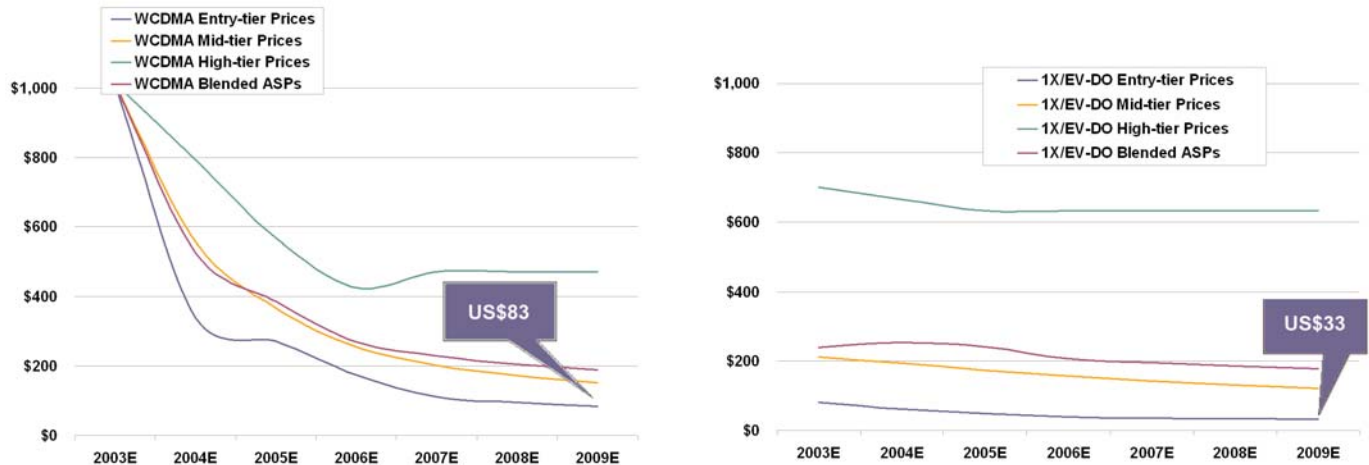
The Signals Research report also points out that with CDMA2000 1xEV-DO Rev. A, the latest version of the technology, an operator can begin offering packet-based Voice over Internet Protocol (VoIP) services and experience an increase in network capacity that can enable up to a 33% cost savings over traditional circuit-based networks. This is an extremely attractive proposition for developing, as well as developed, countries.

Device Pricing

Handset prices are also a key decision point for operators, especially in developing wireless markets. With 280 million subscribers, CDMA2000 already offers substantial economies of scale, resulting in a noteworthy impact on device pricing. In fact, due to widespread growth and use of CDMA2000, its entry-level handsets have already approached price parity with GSM handsets. In the future, WCDMA is expected to achieve high volumes and lower-priced handsets as well.

This aspect is also evaluated in the Signals Research report. The company estimates that by 2009, CDMA2000 handset sales will reach 278 million, up from 162 million in 2005 and WCDMA handset sales will reach 107.4 million, up from 45 million in 2005. The Signals Research study estimates that the average sales price (ASP) of 3G handsets will continue to fall, with entry-level WCDMA handsets reaching an average selling price (ASP) of \$83 USD by 2009 and CDMA2000 handsets dipping below the \$33 mark that same year in 2009 (see Figure 12).

Figure 12
3G Handset ASP Forecast (2003-2009)



Source: Signals Research Group, LLC, July 2006

Figure 13 provides a real example of a competitive market, India, where the price gap between 2G GSM low-end handsets and 3G CDMA2000 low-end handsets has narrowed to only \$4 USD. In fact, if one evaluates the entire product portfolio for both technologies offered, the 3G CDMA2000 devices have a notably lower ASP than the 2G GSM devices (see Figure 14). A lower lifetime cost of operation and the ability to offer affordable handset prices for end users are some of the economic reasons that no doubt serve as the logic behind developing countries' move to 3G today.

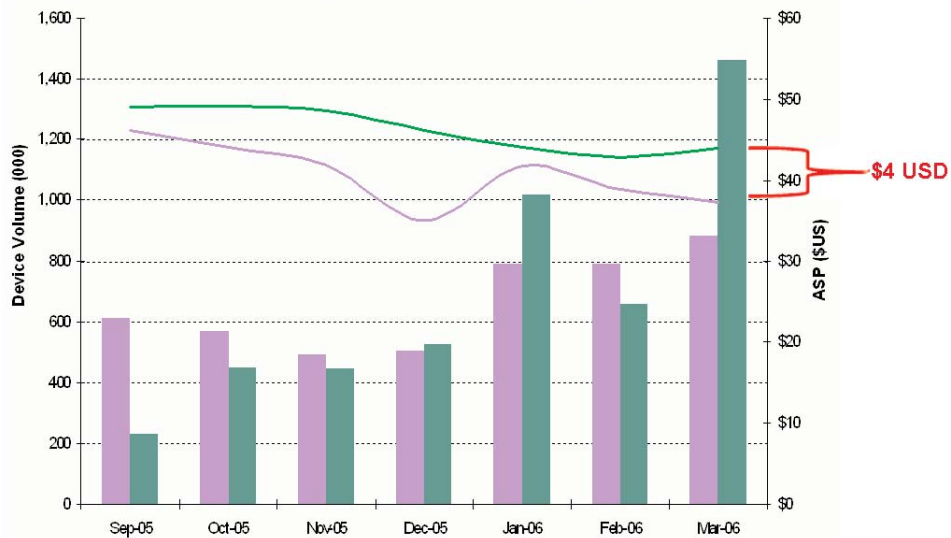


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Figure 13
Sub-\$50 USD Handset Shipments in India and Average Selling Price (Wholesale)



Source: The Yankee Group, June 2006

Figure 14
Total Handset Shipments in India and Average Selling Price (Wholesale)



Source: The Yankee Group, June 2006

3G STANDING

The two 3G technologies most widely offered today are CDMA2000 and WCDMA. Technologically, the two use the same fundamental techniques and offer similar capabilities. Both technologies offer robust, evolutionary roadmaps focusing on cost efficiencies as well as advancements that provide operators with a variety of new service offerings beyond voice and SMS.

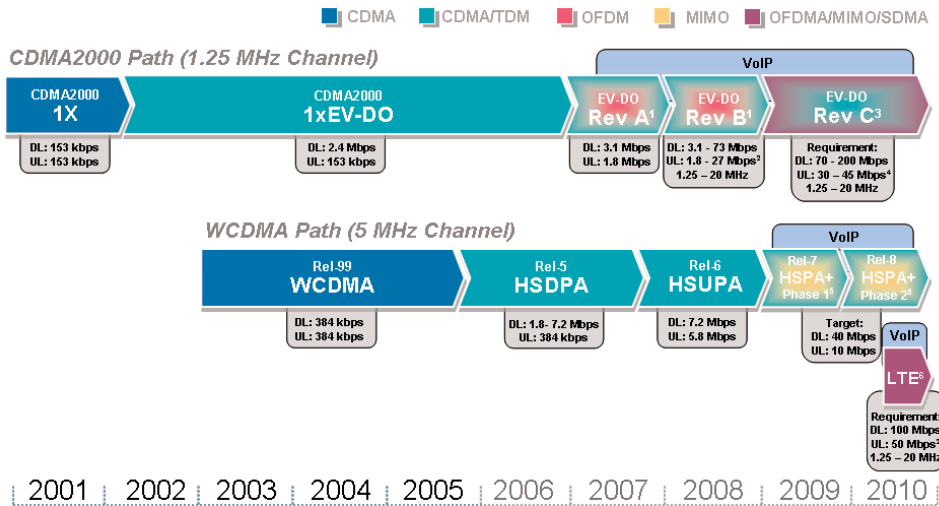


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Figure 15
CDMA: 3G Evolution Paths



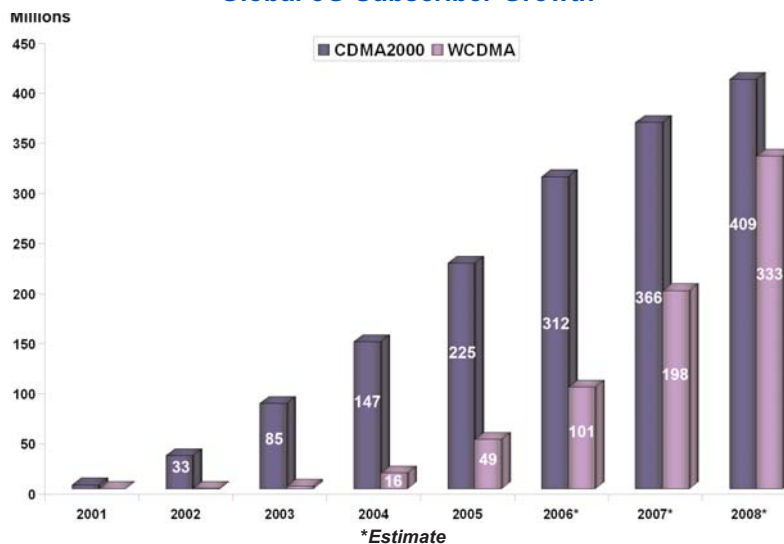
Note: timeline depicts initial commercial availability of each technology. Those introduced beyond 2008 are under standardization and are subject to variability

- 1 EV-DO Rev A and Rev B incorporate OFDM for multicasting
- 2 Data rates of 73 Mbps for the DL and 27 Mbps for the UL figures are based on a 2 x 20 MHz allocation
- 3 May have multiple modes, with at least one mode being backwards compatible with EV-DO (all versions); will likely utilize CDMA/OFDM or a combination of OFDMA and CDMA; MIMO/SDMA; leverages EV-DO protocol stack
- 4 Data rate dependant on level of mobility. Data rates of 73 Mbps for the DL and 27 Mbps for the UL figures are based on a 2 x 20 MHz allocation
- 5 Release 7 and Release 8 introduce enhancements such as MIMO and VoIP
- 6 Utilizes OFDMA on the DL and SC-FDMA on the UL; MIMO

CDMA2000

CDMA2000 has had a clear lead, since it was introduced much earlier, and today it maintains 80% global market share of all 3G subscribers (Figure 16). One reason for the rapid rollout of CDMA2000 is that it is backward and forward compatible with its 2G predecessor, IS-95 CDMA, known commercially as cdmaOne™. The cdmaOne handsets work on the next-generation CDMA2000 infrastructure and the CDMA2000 handsets have been supported on the widely deployed cdmaOne infrastructure. The upgrade cost was relatively inexpensive and it preserved previous network investments, since much of the installed base station equipment was capable of accommodating new, 3G software and channel cards. By design, the technology could be deployed in either existing or new radio spectrum. The time-to-market leadership of CDMA2000 has continued with the introduction of mobile broadband capabilities with 1xEV-DO in 2002 and the introduction of 1xEV-DO Rev. A, which is occurring in 2006.

Figure 16
Global 3G Subscriber Growth



Source: Strategy Analytics, January 2006



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There are now 164 CDMA2000 operators worldwide in 72 countries on all six continents of the world and 28 more are in deployment (see Table 1). About 8.5 million new users subscribe to CDMA2000 services every month. By the end of 2006, CDMA2000 will reach 350 million and analysts predict that the number will reach close to 500 million by 2010 (e.g. Strategy Analytics, January 2006).

Table 1
3G Deployments by Technology

	CDMA2000	1xEV-DO	WCDMA	HSDPA
Deployments	164	41	112	48
Countries	72	28	49	33
Subscribers (millions)	275 ¹	35 ¹	80	N/A
Handsets	1250	282	407	51

¹2Q 2006 Estimate

Source: CDMA Development Group and Global Mobile Suppliers Organization, July 2006

CDMA2000 has proven that 3G does live up to its promise, since the technology has already been successful in satisfying the wireless communications needs of densely populated urban markets such as Tokyo, as well as sparsely populated rural markets such as the Republic of Ghana. Operators of CDMA2000 networks have had the flexibility to offer a wide variety of voice and data services to consumers, small businesses and large enterprises worldwide, in fixed and mobile networks, across a broad range of frequency bands (see Table 2). CDMA2000 operators offer a broad range of applications such as multimedia messaging, entertainment, information and broadband Internet access. In countries such as Argentina, Egypt, Pakistan, Peru and Uganda, among others, the technology delivers affordable voice and Internet access to millions of users with limited purchasing power in cities as well as remote areas. With the introduction of 1,250 devices from more than 81 suppliers, CDMA2000 already offers a greater selection of terminals than any technology available today.

Table 2
3G Deployments and Handset Availability by Frequency Bands

	Deployments		Handsets	
	CDMA2000	WCDMA	CDMA2000	WCDMA
450 MHz	35	0	53	0
800 MHz ¹	84	1	953	18
900 MHz	0	0	0	0
1700 MHz	2	0	195	0
1900 MHz ¹	52	0	371	109
2100 MHz	1	111	N/A	166

¹NOTE: Includes 800/1900 MHz devices

Source: CDMA Development Group and 3G Today

While CDMA2000 was the logical evolution path for cdmaOne operators, at least 25 GSM operators have also deployed or are deploying it. (see Table 3). These operators offer both technologies, positioning each service in its unique way to meet their customer's needs.



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Table 3
GSM Operators That Deployed CDMA2000

Country	Operator	CDMA Network Status
Algerie	Algerie Telecom	Commercial
Algerie	Orascom/Telecom Egypt	Deployment
Aruba	Setar	Deployment
Aruba	Digicel	Deployment
Bahamas	Bahamas Telecommunications Company Ltd.	Deployment
Barbados	Digicel	Deployment
Bermuda	Digicel	Deployment
British Virgin Islands	CCT Global Communications	Deployment
Cambodia	Cambodia Shinawatra Co. Ltd.	Commercial
Cayman Islands	Digicel	Deployment
China	China Unicom	Commercial
Czech Republic	Eurotel Praha	Commercial
India	Bharat Sanchar Nigam Ltd. (BSNL)	Commercial
India	Mahangar Telephone Nigam Ltd. (MTNL)	Commercial
India	Reliance Infocomm*	Commercial
Indonesia	PT Indosat (StarOne)	Commercial
Jamaica	Digicel	Deployment
Laos	Lao Telecommunications	Commercial
Nepal	Nepal Telecom	Commercial
Pakistan	PTCL	Commercial
Saudi Arabia	Saudi Telecom Company	Deployment
Sri Lanka	Sri Lanka Telecom Limited	Commercial
Trinidad & Tobago	TSTT	Commercial
Uganda	MTN Uganda Ltd.	Commercial
Ukraine	Ukrainian Mobile Communications (UMC)	Deployment

*Reliance will continue to operate both GSM and CDMA2000 networks.

CDMA2000's broadband wireless offering, called 1xEV-DO, is deployed or being deployed by 81 operators in 49 countries and supports 35 million users today. There are more than 280 terminal devices now available for 1xEV-DO. A new version of this technology, 1xEV-DO Rev. A, is being deployed in 2006 and will offer even greater advantages on both the cost and revenue side of the operator's business. The technology provides much better support for a large selection of concurrent, symmetric and delay-sensitive applications, such as VoIP, push-to-talk, video telephony and online multiplayer gaming. This means that any operator rolling out an IP-enabled and low-latency 1xEV-DO Rev. A network with quality of service (QoS) for "conversational services" and VoIP would no longer need the more costly circuit-switched network equipment used in today's 2G and 3G networks to support voice communications. This upgrade will significantly increase network capacity and reduce costs.

The continued improvements and increases in data throughput speeds offered by 1xEV-DO Rev. A enables more affordable data services, better quality and an improved end user experience. Looking further ahead three years, 1xEV-DO Rev. C will support data speeds between 150 and 500 Mbps, depending on the level of mobility. This time-to-market advantage will continue to provide CDMA2000 operators with a significant competitive lead over other service providers in their markets.



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WCDMA

WCDMA is also growing rapidly and as many GSM operators migrate to WCDMA, the technology is likely to become the most widely deployed 3G technology by the end of the decade. Today, there are 112 commercial WCDMA networks in 49 countries supporting over 80 million subscribers. By 2008, analysts expect the technology to support 333 million subscribers. Device quantities and selection are ramping up, with 407 WCDMA devices now available from 44 suppliers.

The majority of current and future WCDMA deployments use the 2100 MHz frequency band. WCDMA is also offered at a lower frequency, 850 MHz, and it is expected to be offered in the future in the 900 MHz frequency bands, (see Tables 1 and 2). Currently, there are 18 devices on the market from 9 manufacturers that operate at 850 MHz (see Table 2).

The WCDMA broadband wireless offering, HSDPA, was introduced in November 2005 and is now commercial with 48 operators in 33 countries, with 21 others in deployment. There are 51 commercial devices on the market from 16 suppliers that support HSDPA. The next evolution of this wireless broadband technology, High-Speed Uplink Packet Access (HSUPA), is expected to be available in 2007 and will offer higher data throughput speeds in the uplink and other enhancements to improve the economics and performance of the 3G network. It is anticipated that once the HSUPA value proposition becomes prevalent in the marketplace, an even larger number of GSM subscribers will begin migrating to 3G.

3G ADDS UP

3G CDMA2000 and WCDMA networks are capable of delivering new, revenue-generating voice, multimedia and broadband data services while at the same time offering superior economics over the life of the network. One would certainly question any decision to start with 2G today. GSM technology, despite its substantial footprint globally, is a fifteen-year-old technology. In an industry of rapid change that is characterized with rapid technology advancement, GSM has seen little enhancement or technical improvement during the past five years. Over half of the world's investment in wireless infrastructure goes to 3G equipment today and with nearly 300 3G operators successfully offering high-quality voice and advanced data services already, the investment in 3G is no longer a risk — it is a priority for those manufacturers and operators that want to make money, and it is the inevitable direction of the industry. Today, the smart money is on 3G.