IN-BAND W–CDMA:

The Commercial Potential for 850, 900, 1800, and 1900 MHz Deployment

A Shosteck Group White Paper

Published March, 2005

The Shosteck Group

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The Shosteck Group
11160 Veirs Mill Road, Suite 709
Wheaton, Maryland 20902–2538 USA

Telephone: 1+(301) 589 2259 Fax: 1+(301) 588 3311
Email: jzweig@shosteck.com
Web: http://www.shosteck.com

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CHAPTER 2: CINGULAR AS A GLOBAL MODEL

Cingular is the first operator in the world to adopt in-band W–CDMA. It will serve as a model for others to follow.

Compared to GSM/GPRS/EDGE, W–CDMA and HSDPA provide greater capacity, higher data rates, and lower cost. Its higher data rate offers a competitive alternative to the rival technology, EV-DO. However, over the long term, capacity and cost will be more important.

This will stem from the continuing expansion of network traffic. Between 1997 and 2003, traffic in the U.S. increased by 13x. Between 2003 and 2004, it increased by 30 percent more. With more competition and lower tariffs, similar patterns will repeat themselves globally.

In-band W–CDMA enables operators to respond to market needs immediately. It likely precludes auction or other spectrum payments. When deployed at 850 or 900 MHz, it requires but one-half the infrastructure required of higher frequencies. It provides deeper in-building penetration than do higher frequencies. For these reasons, operators – and regulators – should consider it seriously.

However, there is a downside. This centers on managing interference in what may be very crowded 850 and 900 MHz frequencies. We examine this in our next chapter.

Chapter 3: The Need for Low-Cost Handsets

Low-cost handsets are essential for the widespread adoption of any radio technology. This includes W–CDMA 850/1900.

Data is increasing in importance. It will continue to do so. Nonetheless, voice will remain the most important mobile service into the foreseeable future. Given this – and questions of "strategic positioning" aside – low-priced W–CDMA handsets that facilitate low-cost voice as well as basic data are, and will continue to be, more important for operators. High-priced models that enable all advanced data service will have a role. They will become increasingly important as networks become more robust and attractive data applications more available. Nonetheless, voice services will remain primary.

Given the continued primacy of voice, this means that W–CDMA handsets must fall in price to approach that of low-cost GSM/GPRS. Without a closing of the price differential, GSM/GPRS models will continue to outsell W–CDMA.

Three factors will keep prices for North American W–CDMA 850/1900 handsets higher than the equivalents in Europe. First, the North American market is only 15 percent the size of that in Europe. This means smaller handset volumes and, with that, higher prices. Second, Cingular appears to be initiating a data-centric strategy to counter the competitive threat from Verizon and Sprint. As a consequence, it will focus more on higher tier W–CDMA models. Third, in Europe, Hutchison "3" appears to have adopted a strategy of providing low-cost voice. This means that it will continue to distribute lower priced W–CDMA models.

As a consequence, we estimate that the lowest priced W–CDMA handsets in North America will cost about $200 by year-end 2007, compared to $100 in Europe. This will be a difference of $100. More importantly, the lowest priced GSM/GPRS handsets will cost $50. This will be a difference of $150.

Given this latter difference, we foresee a relatively slow adoption of W–CDMA 850/1900 through 2007. In the years following, the price differences between W–CDMA and GSM/GPRS handsets will narrow. With that, North American adoption of in-band W–CDMA at 850/1900 MHz will accelerate.

Chapter 4: Adoption in Latin America

On the one hand, two out of three of the major Latin American operators will first focus on W–CDMA in Europe rather than Latin America. Most operators will be reluctant to spend on W–CDMA after their relatively recent investments in GSM/GPRS and GSM/GPRS/EDGE. This suggests little movement toward W–CDMA in the near future. In the years beyond, high infrastructure and handset costs will inhibit the transition.

On the other hand, competition from EV-DO and the potential of fixed wireless broadband as an alternative to DSL and cable TV may motivate GSM operators to consider W–CDMA and HSDPA sooner than otherwise would be the case. Fixed wireless as a broadband alternative may increase in importance, especially if EV-DO operators, such as Vesper, show rapid subscriber and revenue gains. If so, GSM operators will come under increasing pressure to confront how and when to deploy W–CDMA.

Given the lower infrastructure investment required for W–CDMA 850 compared to higher frequencies, in-band W–CDMA would offer an appealing evolution. Despite this, whether it becomes available will depend on regulatory decisions. Operators and vendors must petition the regulators to allow it. Time may be of the essence. The sooner operators deploy in-band W–CDMA, the less painful the likely problems of interference.

In approaching regulators to allow in-band W–CDMA, operators should remember the conflict between their needs to minimize capital expenditures versus the desires of governments to sell spectrum. An acceptable resolution may center on petitioning regulators to allow one 5 MHz channel of in-band W–CDMA, with subsequent channels assigned from what would be dedicated W–CDMA frequencies.

Most industry sources anticipate that Latin American operators will not launch W–CDMA 850 for five years. This would place initial deployment in late 2009. However, others hold that the success of EV-DO operators in serving fixed wireless broadband could cause GSM operators to deploy W–CDMA one to two years sooner. This would be late 2007 to 2008.

Chapter 5: Adoption in Europe

The standard for in-band 900/1800 W–CDMA will be set by the end of 2005, or near to it. European operators will likely prefer W–CDMA 900 to W–CDMA 1800 because of the favorable propagation characteristics of the former, in particular for rural and suburban areas.

Nonetheless, operators are now deploying W–CDMA 1900/2100 and GSM/GPRS networks, passed their investment peaks, are becoming increasingly profitable. These point to a long delay before the commercial launch of in-band W–CDMA 900/1800. Opinion varies on when this will begin, ranging from mid-2009 to late 2012.

European operators will not migrate to W–CDMA 900 until the business case warrants. However, two factors may draw that business case closer to 2009 than to 2012.

First, and well-recognized, W–CDMA delivers low-cost voice services. This stems from its greater capacity, low-cost infrastructure, and lower operating costs. Together, these may make earlier retirement of GSM equipment attractive – even if it is not fully depreciated.

Second, and little discussed, Cingular – soon to be followed by NTT DoCoMo – will have suffered the pain of launching "bleeding edge" in-band technology. By late 2007-2008, two to three years following in-band's commercial launch, Cingular's radio engineers, and those of its vendors, will be intimately familiar with the interference that arises from deploying W–CDMA in crowded bandwidth. More importantly, they will have learned how to resolve it. Not to be forgotten, the early cost premiums of W–CDMA compared to GSM/GPRS handsets will be greatly diminished, as ever more integrated and lower priced chips enter the market.

Even so, this means that in-band W–CDMA at 850/1900 MHz will remain a North American, Japanese at 800/2100 MHz – and possibly Latin American – story for the near to mid-term future. Plausibly, Chinese and/or Indian operators could adopt in band W–CDMA at 900/1800 MHz. However, as we discuss in our next chapter, we see little chance of this soon happening.

Chapter 6: Adoption in India and China

In sum, three factors preclude Indian operators from considering in-band W–CDMA into the foreseeable future. **First**, and unique to India, is the contention between CDMA and GSM operators over the 1900 MHz band. **Second**, and in common with Europe, is the absence of a standard. **Third** is the unavailability of equipment.

We surmise that efforts by MTNL will convince TRAI to allocate part of the 1900 MHz spectrum to W–CDMA. MTNL's build-out at 1900/2100 MHz will drive other GSM operators to deploy W–CDMA, as well. Given the cost of this deployment, and the capacity it will provide, we see no near- to mid-term impetus for India's GSM operators to deploy W–CDMA 900/1800.

In China, the MII is focused on three W–CDMA technologies – conventional W–CDMA 1900/2100, CDMA2000 (EV-DO), and TD-SCDMA, a Chinese standard. We believe that the focus of the Ministry and operators on these three options will preclude them from considering a fourth option, in-band W–CDMA. In addition, Chinese vendors, notably, Huawei, are succeeding in exporting W–CDMA 1900/2100 to Europe. This provides the incentive to accelerate development of W–CDMA 1900/2100. At the same time, it minimizes the motivation to divert resources to a so far untried in-band alternative.

Overall, developments in Indian and Chinese markets have raised considerable political and economic barriers to the introduction of in-band W–CDMA at 900/1800 MHz. We conclude that it is very unlikely to be deployed in those regions into the foreseeable future. This means that over the next five years, in-band W–CDMA will be a story of the Americas, primarily North America, and will be available only at 850/1900 MHz.

CHAPTER 1: AN OVERVIEW

INTRODUCTION

This study, *In-Band W–CDMA: The Commercial Potential for 850, 900, 1800, and 1900 MHz Deployment*, is the third in a series of W–CMDA white papers prepared by The Shosteck Group. Each analyzes and forecasts a different aspect of the commercial prospects for W–CDMA.

We have written them to balance the often-excessive hyperbole surrounding the technology – and stemming from that the unrealistic expectations for maturation and speed of commercial adoption. Almost always, these unrealistic expectations have been followed by just as unrealistic despair, when the new technology fails to perform adequately upon its first introduction. As we point out, this is always so for new technologies, and, in the case of W–CDMA, will certainly be overcome.

Our first study, *UMTS — When and Why It Will Happen: Timetables and Forecasts* (September 2003), observed that, in common with all new technologies, W–CDMA would require time to mature and for handsets to fall in price. Only then would it experience widespread adoption. We posited that this would begin during late 2004 and early 2005, as is now happening. With that, what had so far been the disappointing end-user acceptance of W–CDMA would rapidly accelerate. We also pointed out that, notwithstanding the press fascination with full-motion video in real-time, the **primary advantage of W–CDMA centers on its greater capacity and lower cost for delivering conventional voice services**. This, we noted, explained the strategy of "Hutchison 3" in entering the global market as a "pure" W–CDMA operator.

Our second study, *UMTS – The Data Story: Profit Opportunities for Operators* (January 2004), quantified the extent to which W–CDMA would reduce operator costs. It discussed the likely impact of reduced costs on tariffs, traffic, revenues, and profits and what types of data applications would prove most profitable. It concluded that notwithstanding the greater throughput and cost- efficiency that W–CDMA enabled, operators would still generate most data profits from lower bandwidth applications.[1]

This third study examines the potential for "in-band" W–CDMA. By this we mean W–CDMA deployed in frequencies already used for GSM,[2] rather than dedicated frequencies to which it is, or would be, allocated. In-band W–CDMA is being set in motion by the merger of AT&T Wireless into Cingular and the plans of Cingular to deploy W–CDMA within its currently assigned 1900 and 850 MHz spectrum.[3]

[1] These two earlier studies provide the foundation for the present analysis and support those statements of fact not specifically referenced.

[2] This includes GSM/GPRS and GSM/GPRS/EDGE. At 850 MHz, the same operator may deploy TDMA or CDMA and AMPS as well.

[3] AT&T Wireless contributed to this process by deploying W–CDMA 1900 in six cities prior to its acquisition by Cingular.

Greater Capacity and Higher Data Speeds

W–CDMA provides greater capacity for voice and data. This holds regardless of band. Adding voice capacity will be essential as network traffic continues to expand. Notwithstanding a fascination with high-speed data, voice remains the "killer" application in terms of both traffic and revenues. True, W–CDMA, together with its companion technology, High Speed Data Packet Access (HSDPA), will stimulate high-bandwidth data services. And, HSDPA is growing in importance as a competitive alternative to CDMA 1x EV-DO. In this regard, in-band W–CDMA/HSDPA is but part of the larger W–CDMA story.[4] Nonetheless, W–CDMA's greater capacity and lower cost remain key drivers.

GSM operators recognize that at some point, they will need the greater capacity and the greater functionality of high-speed data applications. To serve those needs, they will have to migrate to 3G. When they do, in-band W–CDMA, in particular at 850/900 MHz, may be a preferred choice. As we describe in our following chapters, it can cost less to deploy and offer greater coverage than can W–CDMA at higher frequencies.

European operators have spent more than 100 billion euros for 3G licenses at 1900/2100 MHz and tens of billions of euros more for W–CDMA 1900/2100 infrastructure and handset subsidies. For them, in-band W–CDMA is not a near-term option. They will deploy at 1900/2100 MHz to recover their earlier investment. For Cingular in the U.S., which has no dedicated spectrum for W–CDMA, in-band was, and remains, the only 3G alternative.

Cingular is not alone among GSM operators in having in-band W–CDMA as its only 3G alternative. As we describe below, operators in other regions of the world have, as yet, no dedicated 3G spectrum. However, Cingular is unique, in that it is the first operator to deploy in-band 3G. For this reason, it will serve as a global model for the in-band W–CDMA experience.

Cingular as a Global Model

So far, the mobile world has viewed in-band W–CDMA as a uniquely American story. Nonetheless, as we have already suggested, its adoption will extend beyond the U.S. While Cingular will lead, NTT DoCoMo will soon follow.

Cingular's plans will most affect the operators in Latin America who are making the transition from TDMA 850 (and in some cases CDMA 850) to GSM 850. Assuming Cingular's success, Latin American operators will learn from it. **Critically, they will enjoy the benefits of 850/1900 MHz infrastructure and handsets that will be developed and proven by Cingular's efforts.**[5]

[4] Technically, EDGE is also considered a Third Generation standard. However, in this analysis, when we use the terms "Third Generation" or "3G," we are referring to W–CDMA, unless otherwise stated.

[5] NTT DoCoMo's intention to close its PDC 800 network by 2010 and to deploy W–CDMA exclusively will also contribute to the availability of W–CDMA 850 infrastructure and handsets.

Not to be overlooked are the operators in India and China who have deployed GSM at the "conventional" 900 MHz frequencies. In concept, adopting W–CDMA to 900 MHz offers the advantage of more than doubling the signal propagation compared to 1900/2100 MHz.[6] This means that operators in these and similar countries would require less than half the investment in W–CDMA infrastructure to provide initial coverage than otherwise would be needed.[7]

Finally, and so far little recognized, W–CDMA 900 can provide a similar advantage for European operators, as well. True, European operators are in the process of deploying W–CDMA 1900/2100. However, because of its farther propagation, in-band W–CDMA at 900 MHz can enable more extensive and cost-efficient 3G coverage in rural areas, than is economically feasible using "conventional" W–CDMA 1900/2100.

To be fair, the above are conceptual advantages. The reality may prove different. Operators must consider how feasible in-band W–CDMA will be in terms of the technical, commercial, and regulatory issues that may affect its deployment. Three stand out.

First, will regulators authorize in-band W–CDMA? In parts of the world, notably Europe, spectrum is allocated in terms of technology. Operators at 900/1800 MHz can only deploy GSM/GPRS/EDGE. GSM operators are placing pressure on regulators to allow W–CDMA 900/1800. However, W–CDMA operators with only 1900/2100 spectrum, notably Hutchison 3, are opposing this. In the U.K., Hutchison would not bid on the original 1900/2100 MHz license until the regulator guarantied that GSM operators would not be allowed to deploy W–CDMA 900/1800. This means GSM operators, the regulator, and Hutchison must reach an accommodation for in-band W–CDMA to be allowed. A consensus is evolving that regulators will eventually approve in-band W–CDMA.[8] The questions remain of when and how.

Second, even if regulators allow in-band W–CDMA, will operators have the spectrum to deploy it? In core urban areas, GSM networks are at capacity. It will be difficult for operators to clear the 5 MHz of spectrum needed for deploying in-band W–CDMA.

Third, to what extent will EV-DO serve as a competitive driver? This will be especially relevant in Latin American. There, in common with Cingular, GSM operators use 850 MHz frequency assignments. However, it may also apply to India and China, as well, where GSM 900 operators may feel competitive pressures from those using CDMA 850.

In sum, this study assumes that GSM operators around the globe will, at some point, make the transition to W–CDMA. The study's purpose is to examine in-band W–CDMA, especially at 850/900 MHz, as an alternative, or complement, to dedicated 3G spectrum.

[6] These are the frequencies that European regulators have allocated for W–CDMA.
[7] This assumes that regulators in these countries would follow the European example and allocate W–CDMA to 1900/2100 MHz
[8] Personal communication, Geoff Varrall, Director, RTT Programmes, Twickenham, UK, January 21, 2005.

Many parties, we included, believe that in-band W–CDMA is inevitable. Notwithstanding likely contention with Hutchison, regulators could serve to stimulate it. As an important aside, NTT DoCoMo, as we describe later, will make substantial contributions in advancing the technology.

Organization of the Study

We have organized this study into five additional chapters. Chapter 2 examines the challenges that Cingular faces as the first operator in the world to deploy in-band W–CDMA and the role it shall play as a model for others. Chapter 3 analyzes the importance of low-cost handsets, when they will become available, and how higher prices will limit take-up until lower price models enter the market. Chapter 4 studies adoption in Latin America, the market that will almost certainly follow North America. It identifies the incentives and disincentives to adoption and estimates the likely time frame. Chapter 5 looks at Europe. It documents the already beginning evaluation of W–CDMA 900/1800 and estimates the time frame of plausible adoption. Chapter 6 turns to India and China. It points to the distractions from adoption in those areas. It ties adoption, if any, to what will likely be a lead from Europe, in particular with regard to setting and testing the in-band standard.

CHAPTER 2: CINGULAR AS A GLOBAL MODEL[9]

INTRODUCTION

Cingular Wireless will be the first operator in the world to adopt in-band W–CDMA. It will deploy in its currently assigned spectrum at 850 and 1900 MHz. With nearly 50 million subscribers, Cingular is the largest cellular operator in North America. This gives it the negotiating power to assure that vendors bring W–CDMA 850/1900 infrastructure and handsets to market. And, indeed, Cingular reports that vendors have made "commitments" at the CEO level.[10]

Cingular intends to deploy W–CDMA, including HSDPA, in 15 to 20 top markets by the fourth quarter of 2005 and in its "remaining markets" during 2006.[11] It will deploy first at 1900 MHz and subsequently at 850 MHz.[12] Deployment at 850 MHz will take place during 2006.[13]

We assume that its purpose is two-fold. On the one hand it is to take advantage of AT&T's experience from deploying 1900 MHz systems in six markets. On the other hand it is to use its least crowded spectrum, in order to minimize problems of interference. In this regard, Cingular has a spectrum advantage over other operators. It holds an average of 58 MHz in the top 100 U.S. Metropolitan Areas. This is half again or more that held by T-Mobile (24 MHz), Sprint prior to its pending acquisition of Nextel (26 MHz), and Verizon (38 MHz).[14]

Cingular will serve as the model for other operators. Assuming its success, Cingular's experience will assure the availability of the equipment that other operators will need to adopt in-band W–CDMA, should they choose to do so.[15] Conversely, in the unlikely event that Cingular would fail, other operators would be hesitant to follow. That would likely preclude further adoption of in-band W–CDMA for three to five years.

Four factors are driving Cingular to embrace W–CDMA. **First** is W–CDMA's greater capacity for transmitting voice and data.[16] **Second** is W–CDMA's higher data rate. This approximates 200-300 kbps, which is two to three times greater than that of EDGE, Cingular's fastest current option. **Third** is W–CDMA's lower costs compared to those of GSM and EDGE. We have calculated these at 3.5 to 5.4x **less** (71% to 81% less) than those of GSM.[17] Cingular places them

[9] Cingular declined to be interviewed for this study. In declining, its spokesperson pointed out that its press releases and conference call in late November and early December would provide the information that we requested.

[10] Ralph de la Vega, COO, *The New Cingular: Post-Acquisition Investor Update*, Analyst Teleconference, Cingular Wireless, Atlanta, Georgia, December 1, 2004.

[11] Vega, Slide 23, "UMTS Deployment," December 1, 2004.

[12] Personal communication, Paul Mankiewich, Chief Architect & Chief Technology Officer - Mobility Solutions, Lucent Technologies, Whippany, New Jersey, October 15, 2004.

[13] Personal communication, Chris Pearson, President, 3G Americas, Bellevue, Washington, December 7, 2004.

[14] Vega, Slide 7, "Industry-Leading Spectrum Depth," December 1, 2004.

[15] More precisely, it will assure the availability of in-band W–CDMA for 850/1900 MHz. We assume that the success of in-band W–CDMA at 850/1900 MHz will assure later development of equipment for 900/1800 MHz, as well.

[16] This is placed at 8-10 times that of conventional GSM.

[17] *UMTS - The Data Story.* These cost estimates assume fully loaded networks. They compare W–CDMA as of 2009 with GSM/EDGE as of 2004.

at 60 percent less.[18] **Fourth** is the emerging competition from CDMA2000 1x EV-DO. This is being deployed by Verizon, and soon Sprint, for high-speed data services.[19] There is also the potential competition from high-speed WLAN (802.11). This is not driving Cingular's adoption of W–CDMA. However, as WLANs become more common, they are likely to influence the W–CDMA decisions of other operators.[20]

Currently, the rivalry with EV-DO may be more salient. However, over the longer term, we believe that greater capacity, higher data rate, and lower cost will prove more important. The Global Mobile Suppliers Association points to these latter three, as well as "better radio propagation" at 850 MHz compared to 1900 MHz.[21] 3G Americas cites the latter three as well, along with global roaming and the "propagation characteristics." It mentions competition with EV-DO last in its comments.[22]

The Rivalry between W–CDMA and CDMA 1x EV-DO

Verizon and Sprint are launching CDMA2000 1x EV-DO, a rival technology to W–CDMA. EV-DO transmits at 300-500 kbps. This data rate, together with an IP format, enables EV-DO to deliver applications that are attractive to end-users and lucrative for operators. These include the highly publicized video streaming in real time, but more commonly ring tones, video clips, and digital photos. EV-DO is superseding CDMA 1x,[23] which delivers applications, albeit at the slower rate of 60-80kbps. Depending on country, operators are initially marketing EV-DO to consumers, or in the case of Verizon, to the enterprise.

SK Telecom and KTF in Korea, closely followed by KDDI in Japan, pioneered CDMA 1x and EV-DO in the consumer market. They launched the former between October 2000 and April 2002 and the latter between January 2002 and November 2003.[24]

Figure 2.1 documents the impact of CDMA 1x and EV-DO on operator income. Since introducing the technologies, SK Telecom, KTF, and KDDI have seen their data revenues increase from 4.9-10.4 percent during 2001 to 14.8-23.8 percent during 2004.[25] It is such gains that have motivated Verizon and Sprint to deploy EV-DO and Cingular to deploy W–CDMA.

[18] Vega, Slide 24, "Network Evolution," December 1, 2004. The differences in estimated cost savings, in part, center on different time frames. Our savings estimate is as of 2009. That of Cingular appears to be earlier.

[19] In its December 1 presentation, Cingular explicitly cited the value of high-speed data, the significance of low-cost voice/data, and the rivalry with EV-DO.

[20] For a full discussion see, *Wired and Wireless Networks: Two Worlds Coming Together*, The Shosteck Group, Wheaton, Maryland, June 2004.

[21] Personal communication, Alan Hadden, President, Global Mobile Suppliers Association, Sawbridgeworth, UK, December 8, 2004.

[22] Pearson, December 7, 2004.

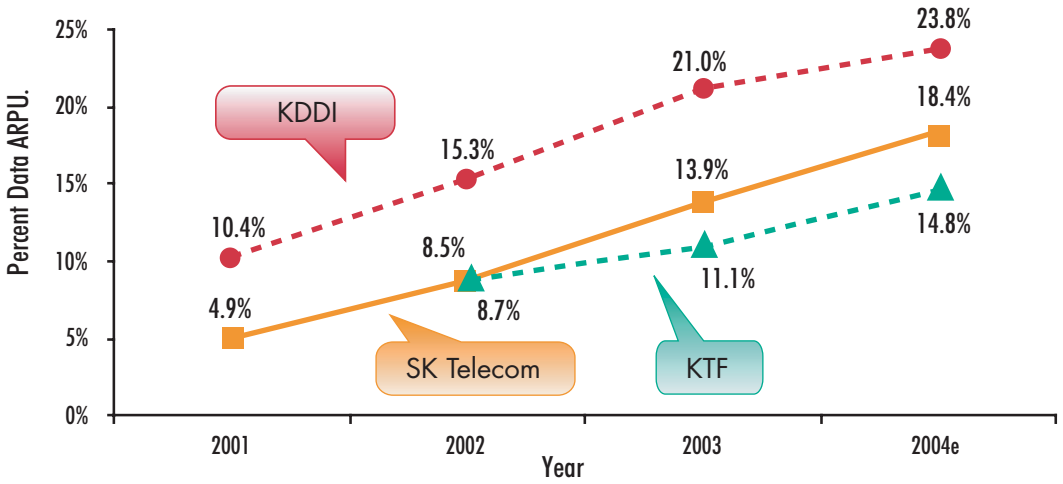
[23] The full designations for the two technologies are CDMA2000 1x and CDMA2000 1x EV-DO. For brevity, we have shortened the latter to "EV-DO" throughout this analysis.

[24] 3gtoday.com (www.3gtoday.com).

[25] KTF did not report separate data revenue until 2002. We infer that its data revenue during 2001 ranged from 4.0 to 6.0 percent. The differences in data revenues between the operators are due to (1) different conventions for reporting data revenues and (2) different tariffs. For example, KDDI has introduced a relatively high flat-rate pricing scheme for data services and relatively low pricing for voice. This tariff structure contributes to its higher percent of data revenues.

FIGURE 2.1

THE INCREASE IN PERCENT DATA ARPU, KDDI, SK TELECOM, AND KTF, 2001 - 2004



Sources: "Monthly Factsheet," Investor Relations Office, SK Telecom, Seoul, Korea, continuous, (www.sktelecom.com/english/investor/info/investor_packets/monthly/fact_sheet/index.html); "Monthly Factsheet," Investor Relations, KTF, Seoul, Korea, continuous, (www.ktf.com/eng/ir/invest/fact_sheet.jsp); Financial Results ..., "Trend for ARPU – Au Business," KDDI Corporation, Tokyo, Japan, continuous (http://www.kddi.com/english/corporate/ir/analysis/ fact/index.html) ; and derivations by The Shosteck Group.
Percent of total service revenues. Estimate for 2004 extrapolated from Q1-Q3.

Cingular's commitment to W–CDMA is due to the lower data rate of GPRS, and to a lesser extent of EDGE, when compared to EV-DO.

EV-DO commonly delivers 300-500 kbps, with recent claims of yet higher speeds. Lucent, for example, now indicates rates of 600-800 kbps.[26] Walter S. Mossberg, an independent commentator on personal technology, reports average speeds over the Verizon network of 585 kbps and for "much of the time ... [rates] at over 700 kbps."[27] Even the strongest advocates of GSM technologies do not claim rates as high. They credit GPRS, the basic data carrier of GSM, with 30-40 kbps (about 5-9% the rate of EV-DO). They hold that EDGE delivers 100-130 kbps (about 16-29% the rate of EV-DO). They maintain that W–CDMA delivers 200-300 kbps (about 36-64% the rate of EV-DO).[28]

Given such comparisons, Cingular plans to introduce HSPDA as early as Q4-2005. (Advocates hold that it will deliver data rates of 400-700 kbps.)[29]

[26] "Flexent® CEMA 450 Modcell ES," Lucent Technologies, Inc., Whippany, New Jersey, 2004.
[27] Walter S. Mossberg, "Verizon Is Crossing the U.S. with Speedy, True Wireless Access," *The Wall Street Journal*, April 8, 2004 (http://ptech.wsj.com/archive/ptech-20040408.html).
[28] *UMTS Capabilities, Technology, and Applications* (devCentral White Paper, Document Number 14046), AT&T Wireless Services, Redmond, Washington, April 21, 2004, pp. 17-18. These values refer to "down-link" rates, from the cell site to the device. However, independent field tests suggest that end-users may experience slower speeds. See: Brian T. Modoff and Jonathan L. Goldberg, "The Quick and the Dead (Zones)," *Signals to Noise* (SN2), Deutsche Bank, San Francisco, August 6, 2004, pp. 3-11. In its December 1 Teleconference, *The New Cingular*, Cingular referred to W–CDMA rates of 220-330 kbps (Slide #24).
[29] Vega, Slide 23, "UMTS Deployment" and Slide 24 "Network Evolution."

The Expansion in Network Traffic

Press releases and media reports often cite the rivalry between W–CDMA and EV-DO. However, over the long term, expanding network traffic – and the ensuing need for lower cost capacity – will be more significant. Stimulated by low-cost "tariff buckets," the U.S. has led the world in subscriber use and, in turn, expanding network traffic.

AT&T Wireless introduced tariff buckets in 1998. Tariff buckets refer to a specified number of monthly minutes – for example 400, 800, or 1500 – that an operator provides for a fixed charge – for example $39, $69, or $99. Subscribers pay the fixed charge regardless of use, up to the bucket limit. Should subscribers exceed the bucket limit, they pay a usually high "overage charge."

The advantages for subscribers are lower average per minute charges and predictable bills. The advantages for the operators are predictable revenues and gradually increasing "Average Revenue per User" (ARPU).[30]

Following AT&T Wireless, all major U.S. operators quickly adopted buckets. They have since introduced continuously lower-cost variations. These have centered on "free" long distance, expanded "home" calling areas, and larger buckets of minutes for relatively modest incremental increases in charges.

T-Mobile offers "Free Fridays," which allow subscribers to make free calls (calls not counted in a bucket) from midnight Thursday to midnight Sunday.[31] Sprint provides "Fair & Flexible," which automatically assigns subscribers who run over their bucket minutes to the next higher bucket plan, instead of levying more expensive overage charges.[32] Verizon offers unlimited national access to its EV-DO network for $79.99 a month.[33] Such plans have continuously reduced the effective per minute charges. With this, network traffic has soared.

Figure 2.2 documents the traffic gains. In 1997, prior to the introduction of buckets, U.S. cellular networks carried 63 billion minutes. By 2003, with the pervasive use of buckets, and the continuing reductions in effective per minute charges, traffic had expanded to 830 billion minutes, a 13-fold increase.[34] Between 2003 and 2004, we estimate that traffic expanded a further 250 billion minutes to 1,080 billion minutes, or by 30 percent.

[30] The U.S. is the world's best example. U.S. ARPU has increased from a low of $39.66 in 1998 to about $50.00 in 2004. "Average Local Monthly Bill," *Semi-Annual Wireless Industry Survey*, CTIA, Washington, DC, continuous and estimates by The Shosteck Group.

[31] "Ask T-Mobile" and "3-Day Weekends" (http://search.t-mobile.com/htmlgw/us.jsp?ui_mode=question &question_box=free +Fridays)

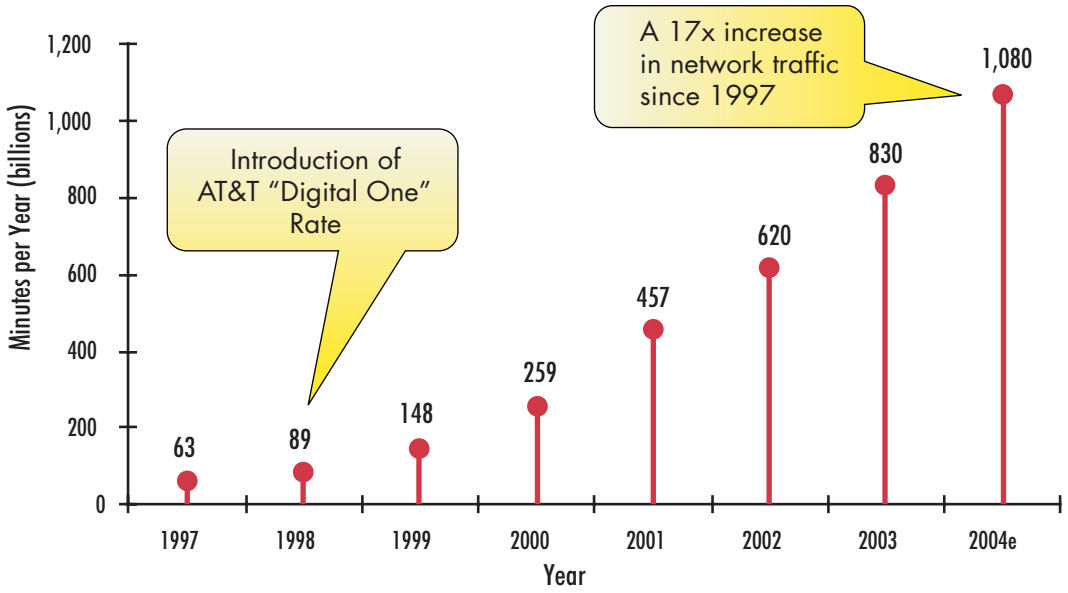
[32] "The Sprint PCS Fair & Flexible Plan," (http://www.sprintpcs.com/explore/ueContent.jsp?scTopic=promoFairFlexible&refurl=uh...)

[33] "Wireless Internet BroadbandAccess," (http://www.verizonwireless.com/b2c/mobileoptions/broadband/ index.jsp)

[34] "Calendar Year Annualized MoU Data," *Semi-Annual Wireless Industry Survey*, CTIA, Washington DC, continuous and estimates by The Shosteck Group.

FIGURE 2.2

TOTAL NETWORK MINUTES, US MARKET, 1997 – 2004 (BILLIONS)



Sources: "Calendar Year Annualized MoU Data," Semi-Annual Wireless Industry Survey, CTIA, Washington, DC, continuous and derivations and estimates by The Shosteck Group.

We foresee comparable traffic growth throughout the world. This is being driven/will be driven by the same factors that have driven it in the U.S. – relentless price, application, and coverage competition among operators.

Given such traffic gains, operators – whether CDMA or GSM – are experiencing continuing pressure to add capacity. For GSM operators neither GPRS nor EDGE can provide it. They must deploy W–CDMA.

The Advantages of In-Band W–CDMA

Depending on world region and the associated regulatory environment, **in-band** W–CDMA offers operators four advantages beyond the greater capacity, higher data rate, and lower cost of W–CDMA, in general.

First, where regulators have not yet assigned 3G spectrum, in-band W–CDMA enables operators to deploy W–CDMA in response to immediate market needs. They do not have to wait for regulators to assign dedicated spectrum.[35, 36]

[35] Spectrum "allocation" refers to the designation by the regulators of the frequencies at which operators can legally deploy 3G (or any other service and/or technology). Spectrum "assignment" refers to granting designated operators the rights to use specific portions of the allocated frequencies.

[36] For operators to do so, regulators must give permission for in-band. As of early 2005, those in the U.S. and Canada did. Those in Europe did not.

As suggested earlier, this means that, over the near- to mid-term, in-band 3G is potentially most attractive to operators in Latin America, India, and China, where regulators have not assigned dedicated W–CDMA spectrum. It is not now a European option. Virtually all major European operators have been assigned W–CDMA 1900/2100 and have begun to construct networks. Most have launched commercial service, or will do so by early 2005.

Second, and related to the above, regulatory permission to deploy in-band W–CDMA would rule out spectrum auctions or fees that regulators might otherwise impose. While regulators could charge for allowing in-band 3G, we believe it unlikely. On the one hand, operators that already have spectrum for 2G networks/services would likely challenge demands for additional payments. On the other hand, with the declining dollar, it is now easier than before for heavily indebted foreign governments to pay external debts.[37] This is reducing pressure on regulators to raise funds through spectrum sales.

Third, the majority of operators deploy GSM at 850 or 900 MHz. As we observed earlier, radio signals at these frequencies propagate for twice or more the distance as do those at 1700/2100 and 1900/2100 MHz.[38] This means that operators with 850 or 900 MHz assignments could deploy W–CDMA for roughly one-half the infrastructure cost required at the higher frequencies. **Thus, if regulators grant permission for in-band W–CDMA, such operators could extend coverage more rapidly, and serve more subscribers, than otherwise would be commercially feasible.**

Fourth, the lower 850/900 MHz frequencies provide deeper in-building penetration than do the higher 1700/1900/2100 MHz frequencies. This is inherent to lower frequencies regardless of air interface.

Operators and vendors alike recognize the importance of the latter. Cingular cites "in-building penetration" as one of the "integration objectives" stemming from its acquisition of AT&T.[39] **Rogers Communications** in Canada points to improved in-building coverage as part of its rationale for deploying W–CDMA at 850 MHz.[40] **Lucent** sees in-building coverage as a major challenge for operators, while Ericsson gives credence to its importance.[41, 42]

As operators deploy W–CDMA, outside coverage is/will be their first priority. However, as outside coverage increases, in-building coverage is becoming/will become a growing concern.

[37] Globally, most such external debts are denominated in dollars.

[38] These are the most likely spectrum allocations for 3G. Europe has long allocated and assigned W–CDMA spectrum at 1900/2100 MHz. The U.S., which generally serves as a guide for Latin America, is in the process of allocating 1700/2100 MHz.

[39] Vega, Slide 21 "Network Integration Objectives," December 1, 2004.

[40] Personal communication, David Neale, VP New Product Development, Rogers Communications, Toronto, December 6, 2004.

[41] Personal communication, Paul Mankiewich, Chief Architect & CTO - Mobility Solutions, Lucent Technologies, *3G Americas Analyst Forum*, Dallas, Texas, September 23, 2004.

[42] Personal communication, Carl-Henric Svanberg, President and CEO, L.M. Ericsson, "Industry Analyst Meeting," *3G World Congress and Exhibition*, Hong Kong, November 17, 2004.

The Challenges to Deploying in-Band W–CDMA

It is relatively easy to "down-band" W–CDMA from 1900/2100 MHz to 850 (or 900) MHz. Nonetheless, three factors may work against easily deploying it. These are (1) regulatory prohibitions, (2) interference, and (3) the availability of low—cost handsets. We discuss regulations and interference in the paragraphs below. We discuss availability and costs of handsets in our next chapter.

We can also add the cost of infrastructure. Even assuming that W–CDMA 850/1900 costs the same as W–CDMA 1900/2100, it may still be too expensive for some operators. Neither regulations nor cost will affect Cingular's infrastructure deployment. U.S. regulation allows it and Cingular has the funding. However, as we discuss in Chapter 4, they may affect deployment in Latin America.

REGULATORY PROHIBITIONS

Some countries, notably the U.S. and Canada, license radio frequencies for "services." A license may limit an operator to providing voice, broadband wireless, or fixed wireless services. However, the operator may choose which technology to use. Thus, in the U.S. and Canada, operators selected TDMA, CDMA, and later GSM.[43]

This is not the case in Europe. European regulators license radio frequencies as "networks." A license not only limits an operator to providing specific services, it also restricts the network technology that the operator may use. Thus, European operators that hold cellular licenses for 900 and/or 1800 MHz **must** deploy GSM.[44]

This technology requirement has simplified the inter-operability of European networks, services, and roaming. It has ensured massive economies of manufacturing scale, and with that the rapidly declining prices for GSM infrastructure and handsets. **However, it blocks introduction of alternative technologies. Today, these might provide benefits that were unrecognized when regulators adopted the original standard. In-band W–CDMA is a case in point.**

We anticipate that the commercial advantages of in-band W–CDMA will become increasingly apparent. However, in order to use it, operators and vendors will have to petition regulators to change current restrictions. We discuss this further in Chapter 5, where we analyze the adoption of in-band W–CDMA in Europe.

[43] In the case of original analog service, all operators selected AMPS, the only cellular technology then available in North America.
[44] They are also allowed to deploy GPRS and EDGE, which are considered evolutionary derivatives of GSM.

INTERFERENCE

While regulatory prohibitions can be cured with a stroke of the pen, radio interference cannot. In our experience, **every** cellular radio technology that has been introduced on shared spectrum (or, in some cases nearby spectrum) has generated "unexpected" interference. This has been the case with AMPS (in which AMPS signals interfered with each other). It has held with the transitions from AMPS to TDMA, AMPS to CDMA, TACS to GSM, and TDMA to GSM. There has also been interference of CDMA with TDMA, iDEN with public safety, and in Japan, PDC with W-CDMA.[45] In virtually all cases, radio engineers successfully overcame these interference problems.[46]

Given this history, we should assume that launching W–CDMA on 850 MHz spectrum that is already crowded with TDMA, GSM, CDMA, and in some cases AMPS, will generate interference as well. Such difficulties will be compounded by the need to clear, at least, 5 MHz to deploy the first W–CDMA channel.

Geoff Varrall, Principal of the UK consultancy, RTT Programmes, Ltd., foresees major challenges. In his words, deploying W–CDMA 850 "seems like a bad idea … [It] would … be a very major planning task to take out 5 MHz and sort out co-existence issues – not a great recipe for success."[47] Schema, an Israeli company that measures and optimizes network performance, likewise sees challenges. Roni Abiri, Schema's Chief Technical Officer, points to the difficulties of dealing with TDMA-based voice and EDGE-based data. He also observes that most of Cingular's GSM handsets do not yet have AMR, thus requiring more bandwidth.[48] Not to be overlooked, he notes that network traffic will continue to increase and with that, spectrum crowding. All will add to the complexity of W–CDMA deployment. Potentially, Cingular will get a marginal gain in capacity, perhaps up to ten percent, as it merges the AT&T network. However, this gain will not offset the increases in network traffic.[49]

Despite the preceding views, some do not see a challenge. When questioned about interference, Alan Hadden, President, Global Mobile Suppliers Association, replies, "No major barriers or restrictions are foreseen."[50] Chris Pearson, President, 3G Americas, answers, "none."[51]

Wherein lies the truth? We believe that W–CDMA will succeed, but with more difficulty than Cingular expects.

In common with all new radio deployments, Cingular will experience "unexpected" interference. Ironically, this may be more likely than otherwise would be the case because of Cingular's past success in integrating networks. Cingular intends to rely on that experience in merging AT&T into its current network and in deploying W–CDMA.[52]

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[45] AMPS was the original analog technology deployed in the Americas. TACS was one of several analog technologies originally deployed in Europe. PDC is the unique Japanese digital standard, closely related to TDMA.

[46] The interference of iDEN with public safety has been a partial exception.

[47] Personal communication, Geoff Varrall, Principal, RTT Programmes, Ltd., Twickenham, UK, November 3, 2004.

[48] AMR or "Adaptive Multirate" is an improved vocoder that increases the capacity of the GSM (and W–CDMA) air interface.

[49] Personal communication, Roni Abirir, CTO, Schema, Herzlia, Israel, November 8, 2004.

[50] Hadden, December 8, 2004.

[51] Pearson, December 7, 2004.

[52] Sigman and Vega, December 1, 2004.

Past experience will be valuable for integrating the AT&T and Cingular networks. It will not be relevant for dealing with the inevitable interference between W–CDMA, TDMA, GSM, GPRS, EDGE, and/or analog radio carriers – whether on Cingular's spectrum or the adjacent spectrum of other operators. None of Cingular's previous network integration involved a new RF technology.

The interference will be more challenging on the more crowded 850 MHz band than on the less crowded 1900 MHz band. For this reason, the difficulties may not become fully apparent until Cingular starts to deploy W–CDMA 850.

In common with the early experiences of NTT DoCoMo and Hutchison "3G," Cingular will undergo close press scrutiny over W–CDMA's initial interference tribulations.

However, difficulties will be the normal problems common to any new radio technology. It may take Cingular 12 to 24 months longer than it anticipates to deploy W–CDMA. Ericsson, one of Cingular's infrastructure suppliers, has acknowledged the challenges. But, as Ericsson adamantly affirms, "They will do it."[53]

Summary and Conclusions

Cingular is the first operator in the world to adopt in-band W–CDMA. It will serve as a model for others to follow.

Compared to GSM/GPRS/EDGE, W–CDMA and HSDPA provide greater capacity, higher data rates, and lower cost. Its higher data rate offers a competitive alternative to the rival technology, EV-DO. However, over the long term, capacity and cost will be more important.

This will stem from the continuing expansion of network traffic. Between 1997 and 2003, traffic in the U.S. increased by 13x. Between 2003 and 2004, it increased by 30 percent more. With more competition and lower tariffs, similar patterns will repeat themselves globally.

In-band W–CDMA enables operators to respond to market needs immediately. It likely precludes auction or other spectrum payments. When deployed at 850 or 900 MHz, it requires but one-half the infrastructure required of higher frequencies. It provides deeper in-building penetration than do higher frequencies. For these reasons, operators – and regulators – should consider it seriously.

However, there is a downside. This centers on managing interference in what may be very crowded 850 and 900 MHz frequencies. We examine this in our next chapter.

[53] Eric Oldmark, Vice President, Strategy, Marketing & Portfolio Management, L.M. Ericsson, "Industry Analyst Meeting," *3G World Congress and Exhibition*, Hong Kong, November 17, 2004.

CHAPTER 3: THE NEED FOR LOW–COST HANDSETS

INTRODUCTION

The lack of **well functioning** and **low-cost** handsets curses all new radio technologies. **Both functionality and low-cost are essential for widespread adoption of any innovation.**[54] One has only to recall the poor end-user acceptance of NTT DoCoMo and Hutchison "3" as they deployed W–CDMA. Both struggled with first and second-generation handsets that were cumbersome, poorly functioning, power hungry, and expensive.

Three years after DoCoMo's initial launch in October 2001, followed by Hutchison "3" in Europe in March 2003, conventional W–CDMA 1900/2100 handsets are working reasonably well. Their prices have declined. Such price declines have followed a historical pattern, which ranges from 20 to 35 percent per year.

Two factors drive such declines. On the one hand is the greater integration of chips and with that reduced chip costs. On the other hand is the economy of manufacturing scale. We anticipate that the annual declines of W–CDMA 1900/2100 handsets will be closer to 35 rather than 20 percent. This will be due to the far greater volumes of early W–CDMA production, compared to those of early GSM.

Price declines will also be affected by the rapid fall in non-recurring engineering costs. Networks are more stable than a year ago. Because of this, engineers require less time to test new handsets. Similarly, core applications and services are becoming more "standardized." This means more focused engineering development. Not to be overlooked, other operators, in addition to DoCoMo and Hutchison, are now buying in large volumes. This gives them price leverage to benefit from the economies of manufacturing scale.

Given the central importance of low-cost handsets, this chapter examines past price trends for conventional W–CDMA 1900/2100. Following, it forecasts prices of in-band W–CDMA 850/1900. Finally, it compares those forecasts to those of GSM/GPRS, the alternative technology for basic voice and data service.

In making this comparison, we reaffirm the importance of low-cost voice service. Real-time video attracts press attention. **Nonetheless, as we emphasized in Chapters 1 and 2, the majority of revenues and profits for operators will continue to come from voice. For this reason, the primary advantage of W–CDMA, particularly in the short- to mid-terms, will stem from its delivery of more voice capacity at lower cost.**

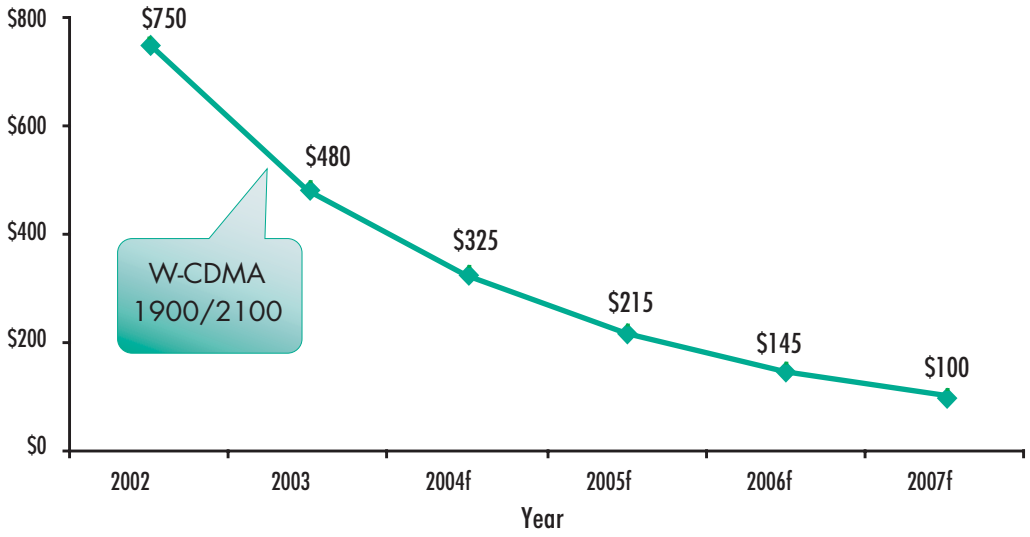
[54] These two points provide a central theme to the *Strategic Wireless Seminars*, which we present twice yearly, immediately following the CTIA conference in February or March in the U.S. and in June or July in Tuscany, Italy.

The Past Declines in Prices of W–CDMA Handsets

Figure 3.1 traces the year-end wholesale prices for the lowest-cost W–CDMA handsets since DoCoMo introduced its first fully commercial models during 2002. By the close of that year, trade sources estimate that DoCoMo was paying vendors $750. As more operators and vendors entered the market by year-end 2003, prices declined to $480. We surmise that as of December 2004, major operators were paying wholesale prices of about $325. This represented a decline of $425 from the original price of $750 or a compounded annual decline of 34 percent. Continuing declines of 33-34 percent will lead to prices of $215 by year-end 2005, $145 by year-end 2006 and $100 by year-end 2007.

FIGURE 3.1

THE WHOLESALE PRICES OF LOW-TIER W-CDMA 1900/2100 HANDSETS, 2002 - 2007



Sources: Trade press and industry sources and derivations-forecasts by The Shosteck Group.
Values represent low prices charged by first and second tier vendors to their largest customers.
Such prices may not be available in all markets. Prices as of year-end.

To be clear, these would be prices for "low-tier" products. Average wholesale prices could be considerably more.

One might question how, given the advanced data functionality of W–CDMA handsets, can there be "low-tier?" True, compared to "entry level" GSM or GSM/GPRS phones, the wholesale prices for all W–CDMA models are expensive. Nonetheless, price differences among models are significant and will continue to be so. Limited, if any, video capability, lower quality displays (less resolution, color differentiation, and color saturation), lower pixel cameras, less versatile zoom focusing, less sensitive sensors, less memory, and shorter "battery life" all help to reduce wholesale prices. In common with automobiles, such products may be satisfactory. But they do not deliver the end-user experience of a product that costs operators (or auto dealers) twice as much.

Western Europe is the major W-CDMA market. As of December 31, 2004, it supported 357 million cellular subscribers, all of whom will potentially migrate to W-CDMA 1900/2100.[55] In contrast, the new Cingular and the new Rogers[56] together served 55 million cellular subscribers. This is but 15-16 percent the size of the European market. At present, they are the only North American operators committed to W-CDMA 850/1900. This means that, unless and until T-Mobile makes such a commitment, there is virtually no chance of the potential North American market getting larger.

The 850/1900 MHz frequency bands require newly designed RF chips. Market size and vendor competition aside, only these new chips can enable W–CDMA 850/1900 handsets with the integration needed to follow the same downward price curve as that of W–CDMA 1900/2100. Thus, to understand future handset prices, we must understand the extent to which chip/platform suppliers will introduce W–CDMA 850/1900 products.

During 2004, both Ericsson Mobile Platforms (EMP) and Qualcomm delivered commercial products to support W-CDMA 1900.[57] In December Qualcomm sampled a chip that supports 850/1900 MHz (the Cingular frequencies) or 800/2100 MHz (the NTT DoCoMo frequencies).[58] We surmise that EMP will sample, at least, an 850/1900 chip/platform shortly. Based on the availability of these chips/platforms, "Cingular has received commitments from three major terminal vendors to deliver handsets by Q4 2005. Lack of [in-band W-CDMA 850/1900] terminals [for North America] is not expected to be a problem."[59]

The Delivery of W–CDMA 850/1900 Chips/Platforms

EMP, Qualcomm, and Texas Instruments are leading providers of chips/platforms to the mobile industry. For all three, 850/1900 chips/platforms are a high priority.[60] All see Cingular driving the market. EMP anticipates Latin America following, with the possibility of Japan deploying W–CDMA 800, as well.[61]

NTT DoCoMo, Japan's largest cellular operator, is committed to a rapid transition from its current PDC technology to W–CDMA. DoCoMo offers no specific timetable for deploying in-band W–CDMA 800, in that the transition "will be impacted by the Japanese Government's decision on 800 MHz spectrum allocation." That said, between April 2006 and March 2007, little more than two years from present, DoCoMo "anticipate[s] that the number of [W–CDMA] subscribers ... [will]

[55] "Western Europe - Cellular Telephone Subscriptions by Country, 3Q04," *Global Mobile*, November 17, 2004, p. 7.
[56] Rogers is acquiring Microcell.
[57] Personal communication, Michelle French, Director, Media and Industry Analyst Relations, Ericsson, New York, New York, December 1, 2004. Cyndi Black, CDMA Technologies - Public Relations, Qualcomm Inc., San Diego, California, December 8, 2004.
[58] Black, December 8, 2004.
[59] Pearson, December 7, 2004.
[60] Personal communications, French, Black, and Patty Arellano, Media Relations Program Manager, Wireless Terminal Business, Texas Instruments, Dallas, Texas, December 7, 2004.
[61] While unstated during our communication, we infer that Qualcomm shares the same view.

be almost equal to the number of PDC ... subscribers."[62] As of September 2004, DoCoMo reported 40.9 million PDC and 6.5 million W–CDMA subscribers, or 47.4 million in total.[63] This suggests that the company is planning for more than 20 million W–CDMA subscribers by March 2007. Assuming that regulatory permission is granted, some of those would be deployed primarily on 800 MHz spectrum.

None of the suppliers report technical barriers to developing the chips/platforms. However, they do see possible non-technical barriers. EMP cites the need "to have a demand for the terminals." TI observes that, "[s]ome platform and handset suppliers may not ... believe Cingular's aggressive rollout plans." Others, it continues, will be "concentrating on ... Japan and Europe which will drive larger volumes over the next few years."

All three suppliers plan W–CDMA 850/1900. EMP describes itself as "well into design and development." Qualcomm states that, "all future ... products ... will ... support 850/1900 W–CDMA." Its flagship product, the MSM 6275, will also support W–CDMA 1900/2100, as well as other frequencies.[64] Qualcomm intends to sample such commercial products in Q3 of 2005. EMP will follow in 2006. TI does not discuss shipment schedules for future products. That said, it "plans to include both 850 MHz and 1900 MHz W–CDMA support in its next generation of RF devices."

Separate from W–CDMA 850/1900, EMP is now shipping GSM/GPRS/EDGE 850/900/1800/1900 chips/platforms. All three companies will be shipping such products by 2006. Each will integrate that functionality into its W–CDMA 850/1900 offerings.

The time from chip/platform delivery to handset availability ranges from six to nine months. The shipping plans of these suppliers means that W–CDMA 850/1900 handsets will include integrated GSM/GPRS/EDGE – and therefore lower cost – chips/platforms by mid- to late-2006. That functionality will enable Cingular to serve W–CDMA subscribers on 850 as well as 1900 MHz. It will enable those subscribers to access Cingular's GSM 850/1900 network. It will allow them to roam onto GSM 900/1800 networks throughout the world and in the case of Qualcomm, if not others, onto the DoCoMo network as well.

In sum, integrated W–CDMA 850/1900 chips/platforms with advanced functionality are already entering the market. Qualcomm's 850/1900 – 800/2100 chip suggests accelerated production volumes. However, the question remains of whether suppliers will provide them at a low enough price to support wide adoption of the technology.

We asked the suppliers to indicate the "incremental price" of a W–CDMA 850/1900 + GSM/GPRS/EDGE 850/1900 chip/platform compared to the European equivalent (W–CDMA 1900/2100 + GSM/GPRS/EDGE 900/1800).

[62] Personal communication, Karen Lurker, Manager, Corporate Communications, NTT DoCoMo USA, Inc., New York, New York, December 8, 2004.
[63] "Asia-Pacific - Cellular Telephone Subscriptions by Network, 3Q04," *Global Mobile*, December 1, 2004, p. 9.
[64] "MSM6275(tm) Chipset Solution," Qualcomm CDMA Technologies, (http://www.cdmatech.com/enhancedplatform).

Apparently, prices will **not** be greater. No supplier provided specifics. However, EMP answered that, "the addition of the 2 GPRS/EDGE bands is not significant." TI replied that the "[a]bililty to support 900/1800 MHz in addition to the 850/1900 bands does not require a cost adder."

This does not mean that prices of W–CDMA 850/1900 handsets will follow the same downward cost curve, as have prices of W–CDMA 1900/2100 handsets. Chip/platform suppliers may not increase prices as they introduce W–CDMA 850/1900 products. However, the greater integration and versatility will enable them to maintain prices. In other words, prices for the W–CDMA 850/1900 chips/platforms may not fall as rapidly as have those for 1900/2100 MHz equivalents.

For this reason, we anticipate that price declines of North American W–CDMA 850/1900 handsets will lag the declines of European W–CDMA 1900/2100 models.

The Prices of W–CDMA 850/1900 Handsets

Unlike Cingular, Canada's Rogers Communications will launch W–CDMA 850, without first deploying W–CDMA 1900. Indeed, its plans for W–CDMA 1900 remain fluid. Rogers intends to launch pre-commercial W–CDMA 850 networks in Canada's three largest markets (Toronto, Montreal, and Vancouver) during late 2005 and move to fully commercial operations during 2006.[65]

Rogers views handset availability as its "major challenge." Nonetheless, it anticipates that handsets will be available "from the beginning." This is consistent with the product plans reported by the chip/platform suppliers.

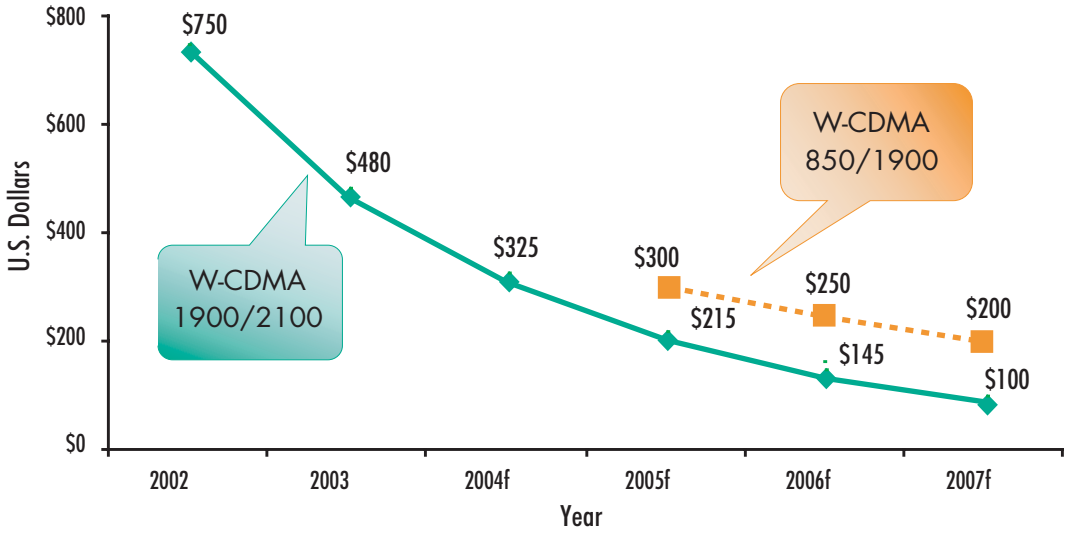
By year-end 2005, Rogers expects to be paying about US$300 wholesale for its "least expensive W–CDMA [850/1900] models." This price will fall to US$250 by year-end 2006, and US$200 by year-end 2007.[66]

Figure 3.2 compares Rogers' expectations of wholesale prices for North American W–CDMA 850/1900 handsets with our forecasts for the European equivalents. This shows an approximate one-year lag in initial North American prices compared to those in Europe. While handsets for the European market had declined to $325 by year-end 2004, prices for the North American market will be a roughly equivalent $300 by year-end 2005.

[65] Neale, December 6 and 8, 2004.
[66] Neale, December 6 and 8, 2004.

FIGURE 3.2

THE WHOLESALE PRICES OF LOW-TIER W-CDMA 1900/2100 AND 850/1900 HANDSETS, 2002 - 2007



Sources: Trade press and industry sources and derivations-forecasts by The Shosteck Group. Values represent low prices charged by first and second tier vendors to their largest customers. Such prices may not be available in all markets. Prices as of year-end.

Afterwards, prices for the two markets will fall at different rates. Low-tier W–CDMA models in Europe will fall to $100 by 2007. This will represent an annual decline of 33 to 34 percent. Over the same period, Rogers anticipates that low-tier models in North America will fall to $200. This will represent an annual decline of 17 to 20 percent. We surmise that price differences between Europe and North America will stem from three factors.

First, at 15 percent the size of Europe, the North American market is less significant. This means smaller handset volumes and, therefore, higher prices. The smaller volumes will be exacerbated by what we anticipate will be Cingular's difficulties in integrating the AT&T network into its own while trying to deploy W–CDMA at the same time. These difficulties will lead to slower adoption of W–CDMA – and yet lower handset volumes – than Cingular may expect.

Second, Cingular apparently will position W–CDMA as a data technology to compete against the EV-DO being deployed by Verizon and Sprint. If so, Cingular would place greater emphasis on fully-featured and expensive "pixel intense" W–CDMA handsets and PC cards, rather than the least expensive handsets, more suitable for disproportionate voice service.

Third, European operators, lead by Hutchison "3," will be more focused on using 3G to provide low-cost voice. True, Vodafone, Orange, T-Mobile and other operators have since launched W–CDMA. With that, data is becoming more important. However, as long as "3"continues to emphasize low-cost voice, other operators will have to respond. This will support the market for lower-priced handsets, with less data functionality rather than higher-priced handsets that provide maximum data functionality.

More important than the comparison of prices between North American and European W–CDMA is the comparison between North American W–CDMA and GSM/GPRS. (With the evolution of tri-band and now quad-band handsets, prices for GSM/GPRS models in Europe and North America are about the same and will continue to be so.) We use GSM/GPRS, rather than "pure" GSM, in that the former, with its basic data capability, is becoming the lowest tier "standard" for the more developed economies.

We compare North American W–CDMA with GSM/GPRS because of the continuing importance of voice. To repeat our perspective, voice will remain the primary service into the foreseeable future. Because of this, operators eventually will purchase most W–CDMA handsets not for their advanced data capabilities, but for their ability to provide low-cost voice. For this reason, the price differences between W–CDMA and conventional GSM/GPRS handsets become crucial.

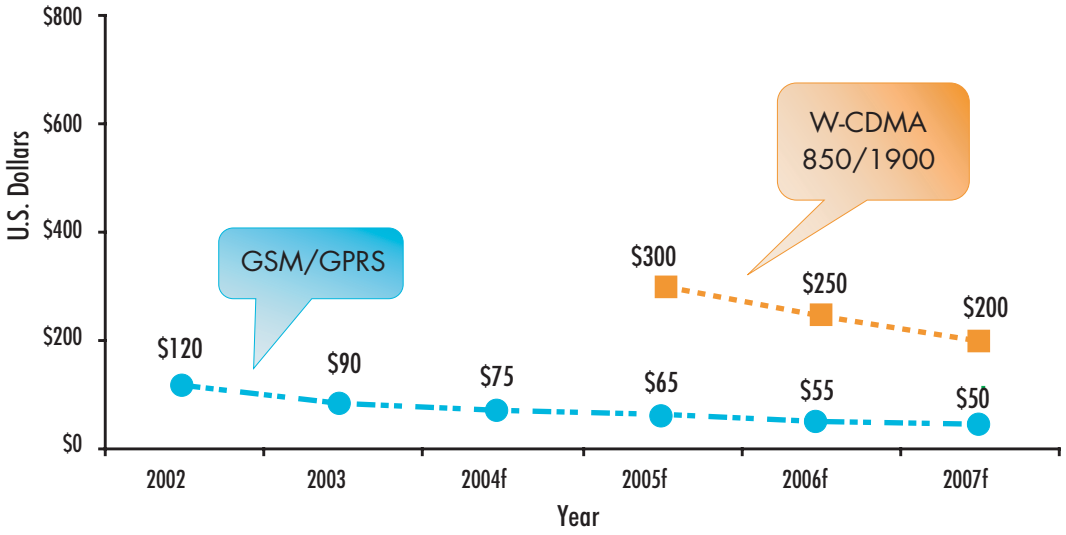
In making this statement, we are not diminishing the role of data. Data is increasing in importance and will continue to do so. To repeat the examples of Chapter 2, for leading Korean and Japanese operators, data as a percent of revenue increased from 4.9-10.4 percent during 2001 to 14.8-23.8 percent during 2004. This increase in data revenues will to be repeated as Verizon and Sprint deploy EV-DO and Cingular deploys HSDPA. Nonetheless, voice will continue to provide mobile operators with most of their revenues.

Figure 3.3 compares our forecasts for wholesale prices of low-cost W–CDMA 850/1900 and GSM/GPRS handsets. Between 2005 and 2007, W–CDMA 850/1900 handsets will fall from $300 to $200. GSM/GPRS handsets will fall from $65 to $50. By year-end 2007, the lowest-cost W–CDMA models will be four times as expensive as the lowest-cost GSM/GPRS models. Given this price differential, together with Cingular's relatively new (and, therefore, yet to be depreciated) GSM/GPRS/EDGE network, the long-term cost-advantages of W–CDMA will not yet be apparent.

However, the price of W–CDMA 850/1900 handsets will continue to fall. Their data capabilities will expand. GSM/GPRS networks will load. Data applications will proliferate. End-users will develop "fluency" with them. As a consequence, after 2007, W–CDMA will become more cost-efficient than GSM/GPRS for both data and voice. With that, W–CDMA 850/1900 will make up an increasing share of the handset purchases by North American operators.

FIGURE 3.3

THE WHOLESALE PRICES OF LOW-TIER W-CDMA 850/1900 AND GSM/GPRS HANDSETS, 2002 - 2007



Sources: Trade press and industry sources and derivations-forecasts by The Shosteck Group. Values represent low prices charged by first and second tier vendors to their largest customers. Such prices may not be available in all markets. Prices as of year-end.

Summary and Conclusions

Low-cost handsets are essential for the widespread adoption of any radio technology. This includes W–CDMA 850/1900.

Data is increasing in importance. It will continue to do so. Nonetheless, voice will remain the most important mobile service into the foreseeable future. Given this – and questions of "strategic positioning" aside – low-priced W–CDMA handsets that facilitate low-cost voice as well as basic data are, and will continue to be, more important for operators. High-priced models that enable all advanced data service will have a role. They will become increasingly important as networks become more robust and attractive data applications more available. Nonetheless, voice services will remain primary.

Given the continued primacy of voice, this means that W–CDMA handsets must fall in price to approach that of low-cost GSM/GPRS. Without a closing of the price differential, GSM/GPRS models will continue to outsell W–CDMA.

Three factors will keep prices for North American W–CDMA 850/1900 handsets higher than the equivalents in Europe. First, the North American market is only 15 percent the size of that in Europe. This means smaller handset volumes and, with that, higher prices. Second, Cingular appears to be initiating a data-centric strategy to counter the competitive threat from Verizon and Sprint. As a consequence, it will focus more on higher tier W–CDMA models. Third, in Europe, Hutchison "3" appears to have adopted a strategy of providing low-cost voice. This means that it will continue to distribute lower priced W–CDMA models.

As a consequence, we estimate that the lowest priced W–CDMA handsets in North America will cost about $200 by year-end 2007, compared to $100 in Europe. This will be a difference of $100. More importantly, the lowest priced GSM/GPRS handsets will cost $50. This will be a difference of $150.

Given this latter difference, we foresee a relatively slow adoption of W–CDMA 850/1900 through 2007. In the years following, the price differences between W–CDMA and GSM/GPRS handsets will narrow. With that, North American adoption of in-band W–CDMA at 850/1900 MHz will accelerate.

CHAPTER 4: ADOPTION IN LATIN AMERICA

INTRODUCTION

Commercially, Latin America is oriented toward both Europe and North America. It is and will remain a mixed-cellular region, with widespread deployment of both CDMA and GSM.

Telefonica (Spain), Telecom Italia Mobile/TIM (Italy),[67] and America Moviles (Mexico) form the region's "Big Three" operators. As such, they will likely drive the adoption of W–CDMA. Telefonica and TIM are deploying W–CDMA in their European home markets. They will use these technical and commercial experiences to develop their W–CDMA plans for Latin America.

Four major factors – (1) regulations, (2) costs, (3) rivalry from EV-DO, and (4) the potential for fixed broadband wireless – will determine the extent and the speed with which Latin American operators adopt W–CDMA, whether in new spectrum or their currently assigned frequencies.

As we document below, the potential for fixed broadband wireless is far greater in Latin America than in the U.S. This may serve as a stimulus to W–CDMA, which will bring it to market sooner than otherwise would be the case.

REGULATORY FACTORS

Brazil has announced a public inquiry into licensing W–CDMA. Unique to the region, it has allocated GSM to 1800 MHz. On this account, Brazil is the only major Latin American country that has 1900 MHz frequencies available.[68] Almost all others have followed the U.S. and allocated 1900 MHz to PCS cellular. As a consequence, most Latin American regulators are moving toward authorizing W–CDMA at 1700/2100 MHz, rather than at 1900/2100 MHz – the standard in Europe. Present regulatory sentiment favors auctions. Nonetheless, regulators have yet to announce how new frequencies will be assigned.

With a population of 180 million, Brazil is large enough to follow its own path. There, the regulator, ANATEL, has reserved 1900/2100 MHz for W–CDMA. However, it has yet to rule on whether it will also allow operators to deploy in-band W–CDMA at 850/1800MHz.

ANATEL, as well as other regional regulators, may be under government pressure to deny requests to authorize in-band W–CDMA. The Brazilian and other regional governments want operators to purchase new spectrum. All want the money to reduce external debts.

So far, the regulators have said little about W–CDMA in regional regulatory bodies. This suggests that they are unlikely to allocate and assign new W–CDMA spectrum in the immediate future.

[67] Telecom Italia, TIM's parent, is in the process of reabsorbing TIM.

[68] Personal communication, Erasmo Rojas, Director, Latin America and the Caribbean, 3G Americas, Plano, Texas, September 23, 2004.

When and how regulators decide will depend on petitions from the operators. **Such petitions may be up to the smaller operators rather than the leaders.** Given the European heritage of Telefonica and TIM, they may restrict their considerations of W–CDMA to the "conventionally" allocated 1900/2100 MHz bands. From their perspective, that would facilitate international roaming between, at least, Brazil and Europe.

Infrastructure and Handset Costs

Regulatory constraints aside, GSM operators are hesitant to move toward W–CDMA for cost reasons. Latin America is not as wealthy as is North America. ARPU is lower. Operators have spent heavily for 2G and 2.5G. Regardless of transition path, all are reluctant to spend more, at least, for now.

That said, by allowing lower-cost W–CDMA 850, regulators can encourage earlier and more extensive deployment of W–CDMA, than otherwise would be the case.

Handset costs may also discourage adoption of W–CDMA. As we discussed in Chapter 3, the wholesale prices of "conventional" 850/1900 GSM/GPRS/EDGE/W–CDMA handsets will fall to US$300 by year-end 2005, $250 by year-end 2006, and $200 by year-end 2007. These may be similar to the prices that will be paid by smaller European operators for 1900/2100 MHz models. However, even if prices fall somewhat lower, they will far exceed the prices of low-end GSM/GPRS handsets, which, as we showed will drop to about $50.[69]

This raises a major challenge for GSM operators, whether in Latin America or other developing regions, which are considering a transition to W–CDMA. Unless such operators insist that vendors provide very low-cost GSM/GPRS/W–CDMA handsets that would be intended primarily for voice services, high-cost handsets will inhibit adoption of W–CDMA.

Rivalry from EV-DO and the Potential of High Bandwidth Mobility

Regulatory constraints, a reluctance to invest, and high-cost handsets will inhibit the deployment and adoption of W–CDMA. Other factors, however, will encourage it. Two stand out – competition from EV-DO and the potential of fixed broadband wireless as an alternative to fixed DSL or cable TV.

In October 2004, VIVO, the largest operator in Brazil, launched commercial EV-DO service. Cantv in Venezuela announced that it would introduce EV-DO for its Movilnet subscribers.[70] By October, five Latin American/Caribbean operators had launched EV-DO. Eight others had announced launch plans.[71]

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[69] We discuss these pricing forecasts in "The Current World of Conventional Handsets and Forecasts for the Future," *Strategic Wireless Seminar*, The Shosteck Group, continuous.

[70] Press release, "CDMA2000 High-Speed Technologies Bring the Most Advanced Services and Broadband Internet Access to the Region," CDMA Development Group, Cost Mesa, California, June 21, 2004; and personal communication, Ewa Gawora, Director of Marketing, CDMA Development Group, Costa Mesa, California, December 16, 2004.

[71] Press release, "CDMA2000 Leads 3G Deployments in Latin America," CDG, Florianopolis, Brazil, October 26, 2004; and Gawora, December 16, 2004.

As EV-DO operators market high-bandwidth services, they will put increasing pressure on GSM 850/1900 operators to provide equivalent or near equivalent bandwidth. As this takes place, W–CDMA – including in-band – will become increasingly attractive.

The Potential for Fixed Wireless Broadband

Mobile broadband aside, Latin America may offer substantial opportunities for fixed wireless broadband as an alternative for landline. An examination of landline and cable TV penetrations explains why.

Brazil, Mexico, Columbia, and Argentina are the most populous Latin American nations. During 2002, the latest year for which readily available data exist, the four reported 14.7 to 22.3 main-line subscribers per 100 population. The U.S. reported 65.0 subscribers per 100 population – three to four times as many. Brazil, Mexico and Columbia reported 5.7 to 10.7 percent of TV homes with cable connections. The U.S. reported 68.9 percent – eight to nine times as many. Among the four, only Argentina approached the U.S. in terms of cable penetration, with 60.2 percent of TV households reporting cable connections.[72]

Without question, relative to the U.S., Latin America has limited landline infrastructure for delivering broadband data. This opens the opportunity for both CDMA and GSM operators to serve that need. To do so, they must deploy broadband, whether EV-DO or W–CDMA/HSDPA.

Brazil's Vesper is already seizing this opening. It provides voice through Wireless Local Loop (WLL) and broadband data through EV-DO. It launched the latter in April 2003, thereby becoming Latin America's first EV-DO operator.[73]

The interest in and opportunity for fixed broadband wireless is being heightened by the increasing attention that regulators are paying to CDMA at 450 MHz.[74] Given the greater propagation of the lower frequencies, 450 MHz promises to deliver low-cost broadband for underserved suburban and rural areas.

In June 2004, ANATEL announced successful CDMA 450 trials. It authorized these as part of its "Digital Inclusion and Universal Internet Access" program intended to overcome Brazil's "digital divide."[75] In December 2004, China's Huawei, in conjunction with Telecom Argentina, hosted a demonstration of CDMA 1x RTT and EV-DO 450 for Argentina's Ministry of Communications. Subsequently, the Ministry, addressing a meeting of the "Inter-America Telecommunication Commission" (CITEL), announced its support for the technology.[76, 77] The Secretary of Communication now appears committed to allocating 450 MHz throughout the region.[78] CITEL members discussed a draft document to explore in-band W–CDMA. They will discuss the issue further at the next meeting to be held in April 2005.[79]

[72] "Table 2 - Main Telephone Lines" and "Table 19 - MultiChannel TV," *World Telecommunication Development Report,* International Telecommunication Union, Geneva, December 2003, pp. A9-A11 and A77-A79.

[73] Gawora, December 16, 2004.

[74] CDMA is the only cellular technology that is produced for the 450 MHz frequencies.

[75] Press release, "Governments Around the World Are Choosing CDMA2000 in the 450 MHz Band to Provide Affordable Voice and Data Services," CDG, Costa Mesa, California, June 30, 2004.

As relevant as the Ministry's support of 450 MHz, is Huawei's encouragement of the Ministry. Huawei is the world's leading vendor of CDMA 450 infrastructure. Of 30 such contracts signed around the globe, Huawei has won two-thirds.[80]

These activities are heightening public awareness of fixed wireless broadband. This will benefit all such services – regardless of technology or band.

The Issue of Spectrum Crowding

Deploying in-band W–CDMA will face challenges. Into the immediate future, spectrum crowding will rank among the more important. In this regard, the experiences of Latin American operators will parallel those of Cingular.

As we discussed in Chapter 2, deploying a 5 MHz W–CDMA channel onto already crowded spectrum poses major radio engineering challenges. Crowded spectrum will be an issue for all GSM operators intending to deploy in-band W–CDMA. It will be especially so for those who cannot move subscribers from one frequency to another.

Cingular in the U.S. has the advantage of being able to clear 850 MHz spectrum by moving those subscribers to 1900 MHz. Many Latin American operators have this advantage, as well.[81] Others, however, are restricted to a single band at 850, 900, 1800, or 1900 MHz.

For these operators, especially, early launches of in-band W–CDMA will be necessary if they are to minimize the interference pain. By waiting until they need capacity, these operators may face a far more daunting task in launching in-band W–CDMA than if they do so early when they still have unencumbered spectrum.

This radio engineering reality argues for GSM 850/1900 operators – and regulatory bodies – to consider the strategic deployment of W–CDMA sooner, rather than later.

[76] "China Telecom to Resume CDMA-450 Mobile Services in Preparation of 3G," *Spectral Advantage*, December 9, 2004.

[77] The "Inter-America Telecommunication Commission" or the "Comision Interamericana de Telecomunicaciones" is a member of the Organization of American States (OAS). It works with governments and the private sector to facilitate and promote telecommunications within North and South America. Regulatory bodies throughout the regions are members, including those of the U.S. and Canada.

[78] Personal communication, Celedonio von Wuthenau, Director, Latin American Program, CDMA Development Group, Buenos Aires, Argentina, December 10, 2004.

[79] Personal communication, Erasmo Rojas, Director, Latin America and the Caribbean, 3G Americas, Plano, Texas, December 13, 2004. In common with similar bodies in Europe, CITEL makes recommendations, which may or may not be adopted by its national members.

[80] *Spectral Advantage*, December 9, 2004 and derivations by The Shosteck Group.

[81] Or in the case of Brazil, moving subscribers to 1800 MHz.

The Timing of Adoption

Cingular's adoption of W–CDMA 850 has already drawn the attention of Latin America. That said, operators within the region "will wait and see what happens with Cingular's ... launch during 2005 and 2006." Assuming the success of Cingular's deployment – and regulatory approval – Latin American operators will consider adopting in-band W–CDMA at some point afterward. Given the current availability of the "850, 1800 and 1900 [MHz bands] ... these would make the most sense for [W–CDMA] in the near future."[82]

Observers of Latin America are reluctant to offer more definitive opinions. They only agreed to discuss the matter in a "non-official" capacity or "off the record." All requested anonymity, citing "so many variables" or "too many factors to consider" in trying "to predict the exact future of [W–CDMA] 850 in Latin America."

These sources referred to voice as "still the main application for the next 5-10 years." They anticipate that this will be served by GSM. They anticipate EDGE serving what will be evolving data needs, at least, over the short term.

They see competition, spectrum availability, and the price of handsets as the most salient factors affecting W–CDMA deployment. The price of handsets will be most important – and operators will expect "little cost difference from European devices."

In light of these factors, these sources envision Latin American operators beginning to deploy W–CDMA 850 "in five years, and perhaps longer." This view points to late 2009 at the earliest.

However, one source commented, "we have seen technology capabilities accelerate at an increasing rate ... thus, deployments [of W–CDMA 850] could be sooner than later."[83]

We believe that this is possible. Given low-priced devices (either handsets or PC cards), sufficiently low tariffs, and aggressive advertising, operators of EV-DO networks may open the entire market for fixed wireless broadband.

Should this occur, GSM operators would almost certainly respond. In this case, and should regulation allow, the region could begin to adopt W–CDMA/ HSDPA within two to three years – or by late 2007-2008.

[82] Pearson, December 7, 2004.
[83] Personal communications, informed industry sources, December 20-21, 2004.

Summary and Conclusions

On the one hand, two out of three of the major Latin American operators will first focus on W–CDMA in Europe rather than Latin America. Most operators will be reluctant to spend on W–CDMA after their relatively recent investments in GSM/GPRS and GSM/GPRS/EDGE. This suggests little movement toward W–CDMA in the near future. In the years beyond, high infrastructure and handset costs will inhibit the transition.

On the other hand, competition from EV-DO and the potential of fixed wireless broadband as an alternative to DSL and cable TV may motivate GSM operators to consider W–CDMA and HSDPA sooner than otherwise would be the case. Fixed wireless as a broadband alternative may increase in importance, especially if EV-DO operators, such as Vesper, show rapid subscriber and revenue gains. If so, GSM operators will come under increasing pressure to confront how and when to deploy W–CDMA.

Given the lower infrastructure investment required for W–CDMA 850 compared to higher frequencies, in-band W–CDMA would offer an appealing evolution. Despite this, whether it becomes available will depend on regulatory decisions. Operators and vendors must petition the regulators to allow it. Time may be of the essence. The sooner operators deploy in-band W–CDMA, the less painful the likely problems of interference.

In approaching regulators to allow in-band W–CDMA, operators should remember the conflict between their needs to minimize capital expenditures versus the desires of governments to sell spectrum. An acceptable resolution may center on petitioning regulators to allow one 5 MHz channel of in-band W–CDMA, with subsequent channels assigned from what would be dedicated W–CDMA frequencies.

Most industry sources anticipate that Latin American operators will not launch W–CDMA 850 for five years. This would place initial deployment in late 2009. However, others hold that the success of EV-DO operators in serving fixed wireless broadband could cause GSM operators to deploy W–CDMA one to two years sooner. This would be late 2007 to 2008.

CHAPTER 5: ADOPTION IN EUROPE

INTRODUCTION

At first thought, European attention to in-band W–CDMA, in particular 900 MHz, would seem superfluous. In core urban areas, GSM channels, whether 900 or 1800 MHz, are at capacity. European operators have spent more than 100 billion euros on W–CDMA 1900/2100 licenses. They are spending tens of billions more on such infrastructure. European subscribers to W–CDMA 1900/2100 will exceed ten million by year-end 2005.

Yet, adhering to their tradition of long-range planning, the European standards bodies are already evaluating W–CDMA in the GSM 900/1800 frequencies.

This began in 2000 when the "World Radio Conference" (WRC2000) agreed to consider allocating W–CDMA to the 900/1800 bands "should there be a [future] requirement." In December 2004, the "European Telecommunications Standards Institute 3rd Generation Project Partnership" (ETSI/3GPP), which sets the 3G standards, began to study "the additional modifications to standards required to support W–CDMA at 900 MHz."[84] This study encompasses W–CDMA 1800, as well. ETSI/3GPP initiated its activity "with the support of a number of European operators and equipment manufacturers."[85]

THE ADVANTAGES OF W–CDMA 900

The "UMTS Forum" is a major world body dedicated to promoting UMTS systems and services.[86] It can be characterized as a trade association. It sees the 900 MHz (and 1800 MHz) band as enabling relatively low-cost deployment of W–CDMA by allowing operators to reuse GSM "[cell] sites and antennas in order to provide extended coverage for UMTS."[87, 88] In addition, W–CDMA 900 (and 1800) would share a common core network with established W–CDMA 1900/2100 systems – further reducing the cost of deployment.[89]

ETSI also points to the "better propagation" of the lower 900 MHz frequencies. This, it observes, would enable operators to provide 3G services to rural areas using fewer base stations than would be required at the higher frequencies.[90] Speaking in a personal capacity, Uwe Loewenstein, of O2 in Germany, likewise, points to the attractiveness of the 900 MHz band for rural propagation.[91] Mike Short, also of O2, cites the capacity gains provided by W–CDMA, together with the lower

[84] Personal communication, Klaus-Dieter Khort, PV, Portfolio Management, Network Infrastructure, Siemens, and Steering Group, UMTS Forum, London, December 10, 2004.

[85] Personal communication, Paul Reid, Promotion Team Manager, ETSI, Sophia Antipolis Cedex, France, December 13, 2004.

[86] UMTS refers to the entire GSM-based 3G standard. W–CDMA is a high speed/high capacity iteration of the UMTS air-interface.

[87] Khort, December 10, 2004.

[88] Notwithstanding the view held by the Forum, operators may not be able to reuse GSM antennas for W–CDMA service due to the different width of GSM and W–CDMA signals (200 KHz versus 5.0 MHz). However, the cost of new W–CDMA antennas (and, possibly, cabling) would be overshadowed by the savings inherent in reusing established cell sites.

[89] Reid, December 13, 2004.

[90] Reid, December 13, 2004.

[91] Personal communication, Uwe Loewenstein, Manager - Spectrum Technology Standards & Technical Policy, O2 Limited, Munich, November 15, 2004.

infrastructure cost. He adds that once W–CDMA has fully replaced GSM, it will assure lower operational expenses, as well.[92]

As a further point, Lucent observes the strong European sentiment against constructing new towers. Lucent notes that in-band W–CDMA could avoid new towers by co-sharing established GSM sites and, indeed, even base stations. Lucent is designing the latter for the European market.[93]

The Disadvantages of W–CDMA 900

The UMTS Forum speaks of few, if any, disadvantages to deploying W–CDMA in current 900/1800 GSM bands. It expects that multi-mode/multi-band handsets will enable roaming between networks and countries. It anticipates that European operators will maintain GSM channels "sufficiently long" to serve international roamers who may still use GSM, rather than W–CDMA.[94]

Mr. Short, however, differs. He foresees a "huge roaming disadvantage for many years," inferring that the required multi-mode/multi-band handsets may be unavailable or too expensive for many users.[95]

As a standards body, ETSI appears more sensitive than others to the technical challenges of deployment. It observes that the European 900 MHz bands are heavily loaded. As a consequence, "Interference issues need to be addressed with great care."[96] Mr. Loewenstein points to this as well, observing that operators that deploy in-band W–CDMA must resolve in-band as well as out-of-band interference.[97]

The Regulatory Perspective

ETSI/3GPP is a standards, not a regulatory, body. National regulators accept its standards (a pro forma step). Based on those standards, they allocate – or do not allocate – the required spectrum. The actions of national regulators may vary, depending on domestic needs.

The UMTS Forum notes that into late 2004, the "European Conference of Postal and Telecommunications Administrations" (CEPT), the association of European regulators, had yet to initiate a serious discussion of W–CDMA 900.[98]

However, that is now changing, with regulators beginning to pay more attention to in-band W–CDMA. "The Regulatory framework … is currently being developed in the CEPT Electronics Communications Committee" (CEPT/ECC). In September 2004, the CEPT/ECC began to discuss how GSM and W–CDMA might best share the 900 and 1800 MHz frequencies.[99]

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[92] Personal communication, Mike Short, V.P., European Public Policy, MMO2, Slough, UK, November 30, 2004.
[93] Mankiewich, October 15, 2004.
[94] Khort, December 10, 2004.
[95] Short, November 30, 2004. Such handsets would include W–CDMA 850/900/1800/1900 in addition to the W–CDMA 1900/2100 initially envisioned.
[96] Reid, December 13, 2004.
[97] Loewenstein, November 15, 2004.
[98] Khort, December 10, 2004.
[99] Reid, December 13, 2004.

With the exception of the UK, the major European countries license radio spectrum for a finite period. As their GSM licenses expire, the national regulators will be compelled to decide whether and how to reallocate the frequencies. GSM 900/1800 licenses in Germany, France, and Italy – which, with the UK, are the largest European countries – will expire between 2006 and 2016. **With the earliest of these dates approaching, in-band W–CDMA will be coming to the forefront of European discussions.**

The UMTS Forum observes that the French regulators have already "agreed [to] a periodic review process to change the technology [of the 900 MHz band] if there are compelling business and marketing needs."[100] ETSI also makes this observation.[101] In addition to France, the UK's "Office of Telecommunications" (OFTEL) is expected to favor in-band W–CDMA, as well.[102]

Figure 5.1 lists the GSM operators in each of the four countries, their frequency allocations, and the month and year in which their licenses will expire. The GSM 900/1800 licenses of SFR and Orange in France will expire in March 2006. These will be followed by the GSM 900/1800 licenses of Bouygues in France and T-Mobile and Vodafone in Germany. These will expire in December 2009.[103]

FIGURE 5.1

THE EXPIRATION OF GSM LICENSES, MAJOR EUROPEAN COUNTRIES

Country	Operator	Frequency	Expiration Date
France	SFR	900/1800	Mar 2006
France	Orange	900/1800	Mar 2006
France	Bouygues	900/1800	Dec 2009
Germany	T-Moblie	900/1800	Dec 2009
Germany	Vodafone	900/1800	Dec 2009
Germany	E-Plus	1800	Dec 2012
Germany	O2	1800	Dec 2016
Italy	Omnitel	900/1800	Feb 2010
Italy	TIM	900/1800	Feb 2010
Italy	Wind	900/1800	Jun 2013
Italy	Blu	1800	Aug 2014
UK	O2	900	None
UK	T-Mobile	1800	None
UK	Orange	1800	None
UK	Vodafone	900/1800	None

Source: *GSM Frequency Utilization Within Europe*, European Radiocommunications Office, March 2004 (www.ero.dk).

[100] Khort, December 10, 2004.
[101] Reid, December 13, 2004.
[102] Loewenstein, November 15, 2004.
[103] *GSM Frequency Utilization within Europe*, European Radiocommunications Office (ERO), March 2004 (www.ero.dk).

The approaching expiration of the SFR and Orange licenses explains why the French regulators are beginning to grapple with in-band W–CDMA. It also opens the possibility that France may provide a pivotal decision, which could determine whether Europe adopts in-band W–CDMA earlier or later.

The Timing of Adoption

ETSI estimates when adoption will occur in terms of the standards process. It believes that the CEPT/ECC will set the standard for in-band W–CDMA in "the near future." However, acceptance of the standards by national regulators is less certain.[104] ETSI also recognizes that after completing the specification, the industry will face "testing of equipment."[105] Given the potential of interference and the challenges of hand-off to W–CDMA 1900/2100, the time required for this testing may prove significant. Not to be forgotten, ETSI also cites the importance of "the availability of [commercial] network equipment and terminals."[106]

The UMTS Forum anticipates that GSM systems will "remain in use for many years to come."[107] It does not see operators deploying W–CDMA 900 until "GSM traffic will have decreased significantly."[108] This decrease will only occur in urban areas as operators move subscribers from GSM to W–CDMA 1900/2100 and possibly to the reserve W–CDMA bands at 2600 MHz. The Forum also observes that "European operators would be reluctant to replace their GSM [900] equipment … before the end of its economic life."[109]

That said, operators will still be motivated to load W–CDMA 1900/2100 networks both for the capacity gains and to see a return on their license and infrastructure investments. As operators deploy W–CDMA, end-users will adopt the high-speed applications that it enables. As they do so, they will demand such applications throughout the network, not restricted to the core urban areas. This demand may motivate operators to deploy W–CDMA 900 in rural areas, where they could easily do so without concerns over congestion.

The 3GPP will likely complete the W–CDMA 900 standard by the end of 2005. Nonetheless, there "has not yet been any serious discussion among European Regulators" concerning the timing of the transition from GSM to in-band W–CDMA.[110]

Assuming resolution of the regulatory questions and technology challenges, Mr. Loewenstein, again speaking in a personal capacity, views the business/commercial case for in-band W–CDMA as key to its deployment. As long as GSM-based revenue (which includes voice and GPRS-based data) remains high, operators have no commercial reasons for replacing GSM with in-band W–CDMA. Europe, he believes, would only migrate to in-band W–CDMA, when the business case is certain. This would be, at least, four to five years into the future[111] – or mid-2009 at the earliest.

[104] Reid, December 13, 2004.
[105] Reid, December 13, 2004.
[106] Reid, December 13, 2004.
[107] Khort, December 10, 2004.
[108] Khort, December 10, 2004.
[109] Khort, December 10, 2004.
[110] Khort, December 10, 2004.
[111] Loewenstein, November 15, 2004.

Mr. Short, likewise, sees the transition occurring only when operators depreciate their GSM investment and when that equipment "could easily be replaced." He emphasizes that "premature replacement is not an option." Mr. Short foresees Europe starting to adopt in-band W–CDMA in "eight years [or late 2012]... but [only] providing that a lot of detailed milestones ... [are] put in place first." Among such milestones will be "huge successes with current 3G deployments [during] 2005-2008."[112]

Mr. Short's perceptions are consistent with the industry's early history. In 1983, European regulators reserved the 900 MHz bands for GSM. In July 1991, GSM was officially launched in Helsinki. If W–CDMA 900/1800 follows this same eight-year developmental path, we should expect it to be initially deployed in about 2012.

Summary and Conclusions

The standard for in-band 900/1800 W–CDMA will be set by the end of 2005, or near to it. European operators will likely prefer W–CDMA 900 to W–CDMA 1800 because of the favorable propagation characteristics of the former, in particular for rural and suburban areas.

Nonetheless, operators are now deploying W–CDMA 1900/2100 and GSM/GPRS networks, passed their investment peaks, are becoming increasingly profitable. These point to a long delay before the commercial launch of in-band W–CDMA 900/1800. Opinion varies on when this will begin, ranging from mid-2009 to late 2012.

European operators will not migrate to W–CDMA 900 until the business case warrants. However, two factors may draw that business case closer to 2009 than to 2012.

First, and well-recognized, W–CDMA delivers low-cost voice services. This stems from its greater capacity, low-cost infrastructure, and lower operating costs. Together, these may make earlier retirement of GSM equipment attractive – even if it is not fully depreciated.

Second, and little discussed, Cingular – soon to be followed by NTT DoCoMo – will have suffered the pain of launching "bleeding edge" in-band technology. By late 2007-2008, two to three years following in-band's commercial launch, Cingular's radio engineers, and those of its vendors, will be intimately familiar with the interference that arises from deploying W–CDMA in crowded bandwidth. More importantly, they will have learned how to resolve it. Not to be forgotten, the early cost premiums of W–CDMA compared to GSM/GPRS handsets will be greatly diminished, as ever more integrated and lower priced chips enter the market.

Even so, this means that in-band W–CDMA at 850/1900 MHz will remain a North American, Japanese at 800/2100 MHz – and possibly Latin American – story for the near to mid-term future. Plausibly, Chinese and/or Indian operators could adopt in band W–CDMA at 900/1800 MHz. However, as we discuss in our next chapter, we see little chance of this soon happening.

[112] Short, November 30, 2004.

CHAPTER 6: ADOPTION IN INDIA AND CHINA

INTRODUCTION

Because of the relatively low incomes in India and China, one might discount the idea that operators in either country will soon deploy W–CDMA, especially in-band. Nonetheless, China is remarkably advanced in terms of telecom deployment and India is quickly becoming so. As such, both have the potential for entering the W–CDMA world.

We analyzed the emergence of India's telecom industry in late 2004.[113] We concluded that Indian telecom operators were entering a period of extraordinary growth. We attributed this to the introduction of the "Unified License." Under this license, the Telecommunications Regulatory Authority of India (TRAI), allows any operator to provide any access service using any technology.

With the Unified License, Indian operators entered into ferocious competition to provide mobile, fixed wireless, landline, broadband, long distance, international, and/or Internet services. As this competition intensified, mobile operators quickly went from minimum growth to adding tens of millions of subscribers per year. Between September 2003 and September 2004, Indian cellular subscribers increased by 24.9 million, from 18.3 million to 43.2 million.[114]

Much the same story can be told of China, albeit stimulated by government guidance rather than regulatory-encouraged competition – and leading India by ten years.

During the 1980s, the Chinese government sought to stimulate growth by encouraging open markets. It made infrastructure investment, including telecommunications, a core policy. As a consequence, by November 30, 2004, China had 330 million mobile subscribers, an increase of 60 million over the year,[115] and more than any other country in the world.

In common with Latin America, the factors that might drive in-band W–CDMA in India and China center on regulation, equipment costs, rivalry from EV-DO, the potential for fixed wireless broadband, and spectrum crowding.

But, there is a key difference. India and China deploy GSM at 900 (and in India, 1800) MHz, the frequencies of Europe, not at 850 (and 1900) MHz, the frequencies of the U.S. and most of Latin America. **This means that equipment developed for the 850/1900 frequencies of Cingular, in the U.S., and Rogers, in Canada, will not work in India and China. New 900/1800 MHz equipment must be first developed.**

As we concluded in our previous chapter, French regulators may grant permission for in-band W–CDMA 900 as early as 2006. However, European operators are unlikely to deploy it until 2009-2012.

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[113] *The Indian Telecommunications Experience: Its Relevance for the World*, The Shosteck Group, Wheaton, Maryland, USA, September 2004.

[114] "Asia-Pacific - Cellular Telephone Subscriptions by Country, 3Q04," *Global Mobile*, December 1, 2004, p. 7.

[115] "Mobile Subs Reach 329.92 mil. in China End-Nov," *Telecoms.com News*, December 21, 2004.

Because of this, Europe will provide little, if any, impetus for vendors to develop and produce W–CDMA 900 infrastructure and handsets prior to that time. Equipment for W–CDMA 900 could become available sooner. If so, it would have to come from Chinese vendors, such as Huawei and ZTE. Without a major market in Europe, we consider that unlikely.

Both India and China appear to be adopting W–CDMA at the conventional 1900/2100 frequencies. That would preclude near- to mid-term consideration of an in-band alternative.

The Indian Market

The Indian market is bedeviled by contention between the CDMA 850 operators, who are petitioning to use the 1900 MHz frequencies, and the GSM 900 operators, who want to reserve them for conventional 1900/2100 W–CDMA.[116] The CDMA operators claim to have only half the spectrum allocated to GSM operators and that reallocation of 1900 MHz for their use is necessary for "an equal playing field ... to introduce 3G services."[117] This spectrum fight is continuing into 2005. It will almost certainly distract attention from consideration of the in-band W–CDMA alternative, notwithstanding that CDMA advocates are pointing to the in-band W–CDMA option.

At the same time, state-owned Mahanagar Telephone Nigam Ltd. (MTNL) is intent on becoming India's first W–CDMA operator. It plans to deploy 4.0 million W–CDMA lines in Delhi and Mumbai beginning at year-end 2005. MTNL views its future as broadband and sees wireless as "its [broadband] lifeline," even while acknowledging, "broadband on fixed line will continue to be important." However, MTNL does not have a confirmed spectrum assignment. Rather, it is in "discussions with the Department of Telecommunications (DoT) on spectrum related issues."[118]

Nothing will move forward until this contention is resolved. Notwithstanding the announcement of MTNL, most Indian GSM operators are "waiting for the air to be cleared on spectrum allocation," prior to taking action on W–CDMA. Only when TRAI "comes out with its recommendations ... will any meaningful development take place."[119] Given the litigious nature of Indian mobile operators, the situation could be delayed by judicial appeals from any TRAI decision. We believe that in-band W–CDMA will be lost in the fray.

[116] Personal communication, Anup Jayaram, Assistant Editor, *Businessworld*, December 10, 2004; and "CDMA Industry Supports Allocation of 1900 MHz in India," 3G, October 26, 2004 (www.3g.co.uk).
[117] "CDMA Industry Supports Allocation of 1900 MHz in India," 3G, October 26, 2004 (www.3g.co.uk).
[118] Michael Newlands, "MTNL to Launch India's First 3G Service," *Total Telecom*, December 15, 2004.
[119] Jayaram, December 10, 2004.

The Chinese Market

Unlike the case in India, the Chinese government is more involved in the decision to deploy 3G. Likely, it will issue licenses for three types of 3G – conventional W–CDMA, CDMA2000 (in effect, EV-DO), and TD-SCDMA, the home-grown standard. Licenses have been expected for more than a year. However, the Ministry of Information Industries (MII) "is reluctant to issue them, as it fears … huge investment losses … if the services fail to take off."[120] At the same time, forces within the MII, in particular the "China Academy of Telecommunications Research," are supporting TD-SCDMA. They are urging the Ministry to delay licensing until TD-SCDMA is sufficiently "mature" to compete commercially against W–CDMA and CDMA2000.[121]

The anxiety of the MII is likely heightened by the weak financial showing of some of China's mobile operators. The trade press reports that China Unicom is delivering "distressing … results," notwithstanding a GSM network that is stretched to capacity.[122] In response, Unicom's management is restricting investment, spending only a third on capital expenditures compared to China Mobilcom.[123] Because of this, China Unicom has little money to spend on conventional W–CDMA at 1900/2100 MHz, let alone untried in-band W–CDMA at 900/1800 MHz.

On the vendor side, Huawei Technologies has met stunning success in exporting to Europe. It has just beaten Ericsson for a W–CDMA contract with Telefort BV of the Netherlands, valued at 200 million to 400 million euros.[124] This suggests that, through the mid-term, Huawei will continue to focus on developing W–CDMA at the conventional 1900/2100 frequencies. It will see little economic reason to direct resources into a W–CDMA variation for which the standard is not yet set and the market unsure. ZTE and UTStarcom will likely follow this lead.

Summary and Conclusions

In sum, three factors preclude Indian operators from considering in-band W–CDMA into the foreseeable future. **First**, and unique to India, is the contention between CDMA and GSM operators over the 1900 MHz band. **Second**, and in common with Europe, is the absence of a standard. **Third** is the unavailability of equipment.

We surmise that efforts by MTNL will convince TRAI to allocate part of the 1900 MHz spectrum to W–CDMA. MTNL's build-out at 1900/2100 MHz will drive other GSM operators to deploy W–CDMA, as well. Given the cost of this deployment, and the capacity it will provide, we see no near- to mid-term impetus for India's GSM operators to deploy W–CDMA 900/1800.

[120] "China Telecom to Resume CDMA450 Mobile Services in Preparation of 3G - Report," *AFX Asia via Factiva News and Business Information Service*, December 8, 2004.
[121] Rebecca Buckman, "China Keeps Telecoms Waiting on 3G," *The Wall Street Journal*, May 13, 2004.
[122] China Unicom has both GSM and CDMA networks. China Mobile, its major competition, has only GSM networks.
[123] Francis Cheung and Elinor Leung, "China Unicom Scrunched in 1H04," *Global Mobile*, September 8, 2004, p. 13.
[124] Stefan Simons, "Deal Worth E200m-E400m Expected To Be Announced Thursday," *Dow Jones Newswires*, December 8, 2004.

In China, the MII is focused on three W–CDMA technologies – conventional W–CDMA 1900/2100, CDMA2000 (EV-DO), and TD-SCDMA, a Chinese standard. We believe that the focus of the Ministry and operators on these three options will preclude them from considering a fourth option, in-band W–CDMA. In addition, Chinese vendors, notably, Huawei, are succeeding in exporting W–CDMA 1900/2100 to Europe. This provides the incentive to accelerate development of W–CDMA 1900/2100. At the same time, it minimizes the motivation to divert resources to a so far untried in-band alternative.

Overall, developments in Indian and Chinese markets have raised considerable political and economic barriers to the introduction of in-band W–CDMA at 900/1800 MHz. We conclude that it is very unlikely to be deployed in those regions into the foreseeable future. This means that over the next five years, in-band W–CDMA will be a story of the Americas, primarily North America, and will be available only at 850/1900 MHz.