

F R O S T  S U L L I V A N

A Global Growth Consulting Company

CDMA: Inroads to All-IP

Introduction

Mobile data revenues is playing an increasingly important role amid flagging voice revenues and the growing adoption of VoIP. While messaging services and basic content downloads have been popular mobile data applications, mobile operators are investing in bigger network pipes to deliver bandwidth-hungry data applications such as mobile TV/video, music and mobile broadband, in an effort to bolster higher average revenue per user (ARPU).

The deployment of IP Multimedia Subsystems (IMS) has also introduced high quality-of-service (QoS) blended services, which enables users to move seamlessly from one application to another and across communication devices over a single mobile operator. Aside from this, the drive for IP network transformation is also underscored by the growing dominance of All-IP CDMA in the mobile communications field. This paper provides the overview of the global CDMA infrastructure market. It examines the market opportunities for CDMA and its evolution plan to UMB; the drivers and restraints for the long term wireless evolution. It reviews the CDMA2000 1X and CDMA2000 1xEV-DO (EV-DO) market analysis and future prospects of UMB with emphasis on some of the vendors' activities and carrier choices.

Evolution of Wireless Technology

WCDMA Path

3GPP LTE (Long Term Evolution) was designed to improve the UMTS mobile phone standard to cope with future network requirements. Its objective is aimed at improving efficiency, lowering costs, improving services, making use of new spectrum opportunities, and better integration with other open standards.

The enhanced radio interface is expected to provide improved capacity in terms of the number of packet data users that can be connected simultaneously as well as improved state transition delays in order to shorten initial delays for service establishment or re-activation. The introduction of Multiple Input Multiple Output (MIMO) will further enhance mobile broadband offerings by taking theoretical peak rates well above today's 14 Mbps as well as improving the average cell throughput.

The long term evolution of the technology is expected to bring theoretical peak rates to above 100 Mbps for downlink and 50 Mbps for uplink, and at the same time, reduce latency to levels comparable with fixed broadband Internet.

CDMA Path

Widely used as both 2G and 3G networks, the CDMA air interface is the fastest growing wireless technology. CDMA was the foundation for 3G services: the two dominant IMT-2000 standards, namely CDMA2000 and WCDMA, are both based on the CDMA platform.

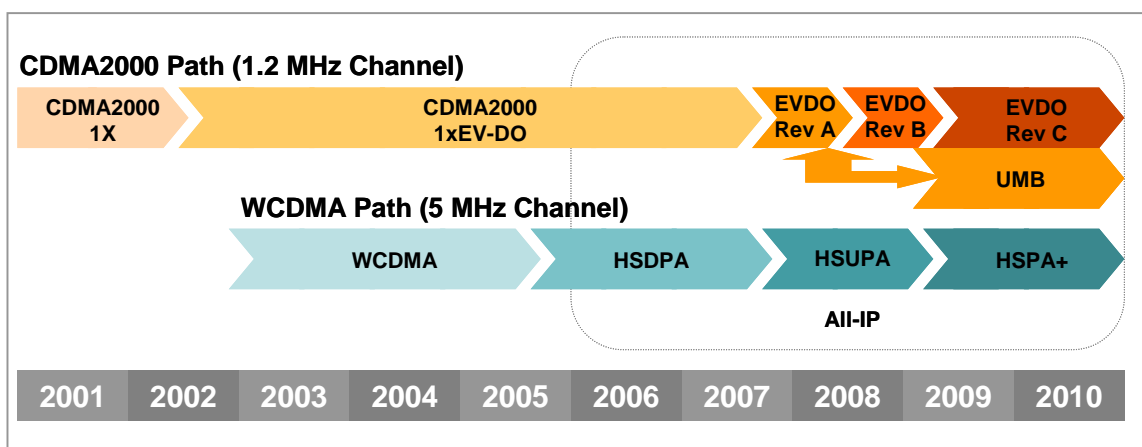
The evolution to an All-IP based network is designed to deliver increased network capacity to meet growing demand for wireless services and high-speed data services. All-IP is a development of 3GPP/3GPP2/IEEE, and encompasses end-to-end IP-based solutions including services, core network, operational and maintenance, transmission, access network and converged devices.

While CDMA2000 1X was the world's first 3G technology commercially deployed since October 2000, EV-DO (Evolution-Data Optimized) introduces new high-speed packet-switched transmission techniques that are specifically designed and optimized for a data-centric broadband network that can deliver peak data rates beyond 2 Mbps. CDMA200 1xEV-DO Release 0 (Rel 0) offers high-speed data access of up to 2.4 Mbps and was the first mobile broadband technology to be deployed in 2002 in South Korea.

Rev A is an evolution of EV-DO Rel 0 that further increased peak rates on both reverse and forward links to support a wide array of delay-sensitive and real-time applications, and concurrent voice and broadband data applications. OFDM has been incorporated in the technology to enable multicasting (one-to-many) multimedia content delivery. With its low network latency, service tiering with Quality of Service (QoS) and IP-based broadband architecture, Rev A has been designed to support time-sensitive applications, such as Voice over IP (VoIP), Push-to-Talk (PTT) and video telephony.

UMB (Ultra Mobile Broadband) is touted as the future evolution path for CDMA to support next generation applications and requirements. The system employs OFDMA technology along with advanced antenna techniques and is expected to provide peak rates of up to 280Mbps. UMB aims to significantly improve system capacity and greatly increases user data rates at lower costs. The UMB standardization is expected to be completed in mid 2007, with commercialization taking place around mid-2009.

Technology Evolution Path



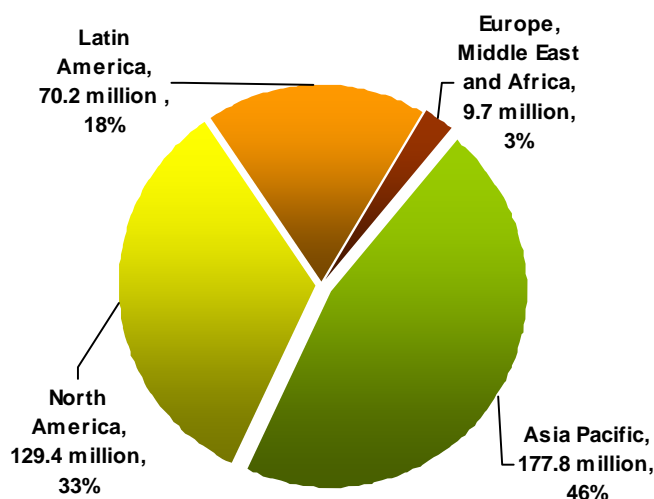
CDMA Market Overview

Worldwide CDMA subscribers reached 387.1 million as of 1Q 2007, spanning across more than 438 commercial networks in close to 100 countries. Asia Pacific and North America are the two largest continents of CDMA deployments, contributing 79.4% of total CDMA subscribers in 1Q 2007.

In Asia Pacific, CDMA is poised for future growth particularly in emerging markets such as Pakistan, China, Cambodia, India and Indonesia, where CDMA450 is a cost effective solution to drive up tele-density. In addition, Thailand's state-owned telecommunications company, CAT Telecom, has recently launched tele-health service using EV-DO network with Qualcomm as part of the Wireless Reach program to bridge the digital divide in remote islands of the country. This comes after previous failed attempts by government agencies to offer tele-health services as a result of the lack of infrastructure and the high cost of satellite leasing. Given the present lack of infrastructure in these markets, Frost & Sullivan expects Asia Pacific to continue to lead in terms of CDMA subscribers in the medium term.

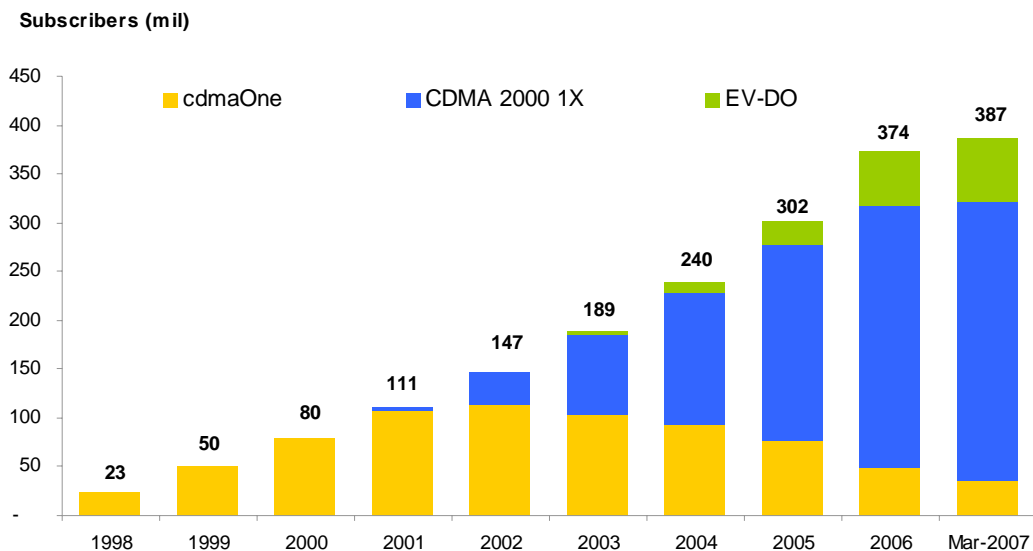
On the other hand, the dominance of CDMA in North America stems from its legacy infrastructure. This region is expected to remain a leader in terms of the adoption of CDMA technology advancements.

Breakdown of CDMA Global Subscribers by Region, 1Q 2007



Of the various types of CDMA technologies, CDMA2000 (CDMA2000 1X and EV-DO) subscribers represented more than 91.6 percent or 350.8 million subscribers of the total CDMA subscribers in 1Q 2007. A total of 224 operators have launched CDMA2000, out of which 84 are EV-DO commercial networks. The number of EV-DO deployments is expected to grow substantially over time, alongside the demand for greater bandwidth pipe. The figure below illustrates cumulative global CDMA subscribers by technology from 1998 to March 2007.

Cumulative Global CDMA Subscribers by Technology, 1998 to 1Q 2007



Trends towards an All-IP network

Driven by competitive pressures, service providers are compelled to invade each others' turfs, traditionally defined by circuit switching. As voice becomes just another application delivered across an All-IP network, there is an increasing need to embarking on the IP transformation journey to substitute lost revenues and defend falling voice revenues with new income streams. The evolution to an All-IP network is inevitable due to the economies of IP-networks and future-proof smooth transition towards IMS architecture.

The move towards IP transformation has spurred the emergence of mobile softswitch. More operators are demanding for mobile softswitch solution as a way to increase its competitiveness. It is believed that mobile softswitch is the first step towards next-generation network, capable of offering significant benefits in both capital expenditure (capex) and operational expenditure (opex) savings and also acts as the bridge towards fixed-mobile convergence.

Benefits

Some of the issues faced by service providers with the use of circuit switch based networks are as follows:

- High CAPEX and OPEX
- Expensive Transmission Network
- Slow provisioning of new services
- Complicated Network Architecture
- Lack of distributed systems for operations and management

All-IP networks can address the above issues and offer flexibility to the operators to distribute the network elements (BTS, BSC, MSC etc.) according to field requirements which helps, by using local gateways, in keeping the traffic restricted to local domains as opposed to carrying all the traffic to a centralized switch which is usually the case with circuit switching. The distributed architecture leads to reduced transmission and operational cost when compared to existing circuit switched networks, and furthermore, deploying IP based softswitch solutions relatively more appropriate and cost-effective to deliver telephony services to difficult-to-reach locations.

All-IP CDMA Networks

CDMA2000 technologies are compatible with IP and ready to support network convergence. All-IP CDMA2000 enables reduced network investment by providing enough flexibility for phased migration as per the service providers' existing network architecture and deployment requirements. Integration of an All-IP CDMA2000 network with other IP based wireless access technologies is comparatively smoother and easier compared to integration of legacy network.

A backward and forward compatible evolution path is one of CDMA2000's strongest differentiators, and enables operators to sustain a significant market advantage over competing technologies. By folding in larger bandwidth implementations, OFDM-based air link technologies, and advanced antenna techniques, the CDMA2000 roadmap will sustain this competitive advantage, while retaining existing economies of scale and minimizing capital and operating expenditures.

Evolution-Data Optimized or EV-DO which is classified as a broadband technology employs multiplexing techniques such as CDMA (Code division multiple access) as well as Frequency division duplex (FDD) to maximize the amount of data transmitted, compared to the EDGE networks employed by GSM networks, is significantly faster. There have been several revisions of the standard, named alphabetically starting with the first as Rev. A ("revision A") while the first standard is referred to simply as Rev. 0.

In the U.S., Sprint, Verizon Wireless, Leap Wireless International, Inc's (Leap) and Alltel have completed significant deployment of EV-DO since 2004. Sprint currently has the largest EV-DO

network, which covers a population over 209 million with plans to reach over 250 million by end of 2007. The operator also covers 190 million population with Rev. A as of 1Q 2007. Verizon Wireless EV-DO is available to more than 200 million people in 242 major metropolitan areas and while Alltel currently offers service in 40 major cities and plans to expand coverage to more than 40 cities. In 3Q 2006, Sprint signed a roaming agreement with Alltel for both voice and data roaming which will give customers of both operators free access to each others networks making Sprint and Alltel significantly the largest EV-DO network in the US. During this period, Leap has also announced its expansion of its EV-DO and foray into All-IP.

The emerging market such as India has also joined the bandwagon. Under the project, "Project WIN", Reliance has already made plans to roll out next generation, integrated wireless and wireline convergent voice, data and video digital network covering over 10,000 towns and 400,000 villages by 2010.

Late last year, KDDI, Japan's leading CDMA operator announced its plans of upgrading its CDMA2000 1xEV-DO network to Rev. A while evolving its core network to a totally IP-based platform.

Rev. A deployment will give KDDI a one-to-two year time-to-market advantage in continuing to offer more compelling and better performing voice, multimedia and broadband data services to its consumer and enterprise customers. KDDI has already announced the availability of two stylish Rev. A handsets from Toshiba, the W47T and DRAPE, to support the commercial launch of its advanced broadband technology services by December 2006. The Rev. A network upgrade also will provide KDDI with a smooth upgrade path to enable UMB services within the next few years.

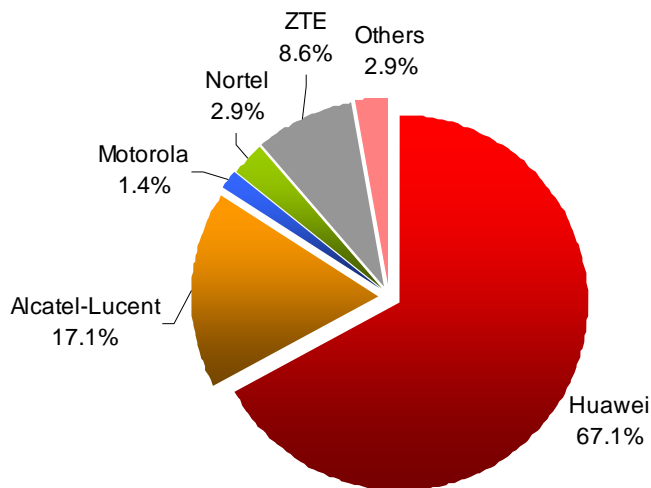
Ultra mobile broadband is the evolution path for CDMA to true high-capacity networks. Peak rates of 280 Mbps over a 20 MHz channel will be a significant improvement from the roughly 45 Mbps of capacity available over the same spectrum with EV-DO networks. Traditionally, the CDMA carriers have always been quick to adopt newer network technologies because of the 3GPP2's faster standards and development timelines. In the U.S. in particular, CDMA 1X and EV-DO launched long before their general packet radio services/enhanced data rates for GSM evolution and UMTS equivalents. For UMB, a similar approach from leading operators will be required to drive the market.

Market Share Analysis

CDMA2000

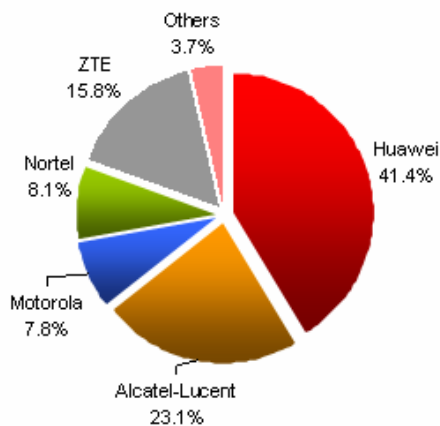
Number of service providers embarking to deploy EV-DO is on an increasing trend since 2004. Between 2006 and 1H 2007, the total number of contract wins for CDMA2000 1X topped the CDMA segment, with over 100 contracts being awarded globally. EV-DO followed closely behind, with most of the wins emanated from emerging markets. Huawei emerged as the market leader in terms of contract wins, accounting for over 67 percent of EV-DO wins between 2006 and 1H 2007.

Global EV-DO Contract Wins by Vendors, 2006-1H 2007

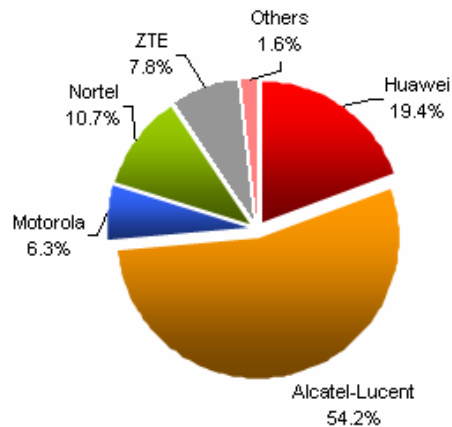


The market share breakdown by contract wins is in contrast with prior years where the former Lucent Technologies and Nortel dominate more than half of the global contracts awarded. Huawei, which emerged from third placing to be the leading mainstream CDMA vendor, has demonstrated significant achievements over the past three years. This is a result of its aggressive strategy in securing new clientele through rapid network expansion, while its more established peers undertook defensive play by participating in the network expansion and upgrades of existing operators.

**CDMA2000 1X Contract Value
 Awarded by Vendors (*Emerging Market)
 2006-1H2007**



**CDMA2000 1X Contract Value
 Awarded by Vendors (Global)
 2006-1H2007**



*Emerging market excludes NA, Japan and Korea

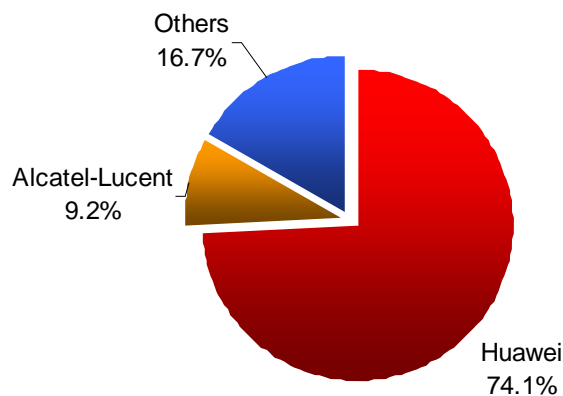
While there is a good mix of vendors competing for contract wins in other parts of the world, the North American telecommunications market is still largely protected and dominated by the three incumbent vendors; namely Alcatel-Lucent, Motorola and Nortel. This is because of the greater emphasis on customer satisfaction, which deters US-based network operators from seeking new entrants. However, 2006 marked a significant milestone especially for the Chinese vendors which have gained big strides in the North American market. ZTE's foray into this 'close market' began with its contract win in August 2006 with TELUS, the second largest Canadian telecommunications operator, to supply EV-DO data cards. Later in the year, ZTE won additional two All-IP CDMA2000 contracts to deliver 3G wireless voice, data, and multimedia services to subscribers within the United States. These achievements have clearly demonstrated ZTE's successful expansion plans, particularly when its core markets have typically been in Africa and Asia.

Huawei has also won a similar All-IP CDMA network contract in this region, which also marked its first entry into the North American market. While this is Huawei's first contract in the region, its force is to be reckoned with, particularly its aggressive play in recent years. This has paved the way for Huawei's entry into the North American market, not only in the CDMA field but also as a platform for other comprehensive product and service offerings. In spite of Huawei's impressive contract wins over the past 18 months, the largest CDMA contract ever awarded went to the

newly merged Alcatel-Lucent in March 2007. The US\$6 billion contract, the largest of its kind globally, was awarded by US network operator, Verizon Wireless, to increase the coverage and capacity of its wide-area broadband data network. The operator will also be introducing new A-IMS services, including VoIP, Push-to-Talk and mobile video telephony. This contract follows from a previous US\$5 billion project awarded by the same operator to the former Lucent Technologies.

CDMA450

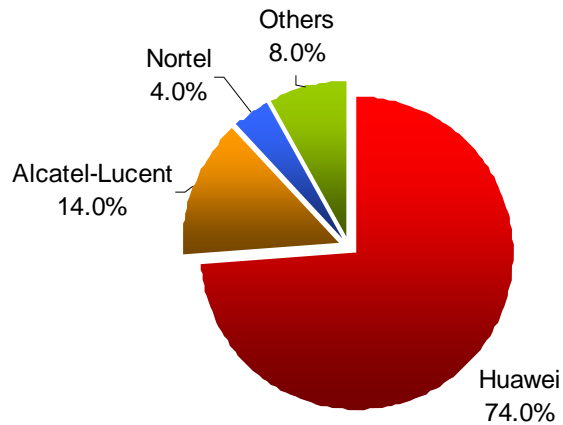
Global CDMA450 Contract Value Awarded by Vendors, 2006-1H 2007



One interesting area in the CDMA space is CDMA450. Although CDMA450 inhabits the spectrum formerly allocated to analogue Nordic Mobile Telephony systems which has limited functionality than its cousins in the 850 MHz, 1800/1900 MHz and 2100 MHz bands, its lower frequency and hence wide cell radius provides superior coverage, making it a cost effective and attractive solution to serve scattered rural communities. CDMA450 uses the same technology as CDMA2000 and has all the features and data speed of its parent technology. The low cost factor is one of the most compelling reasons for the adoption of this technology. This technology has scored some successes in emerging markets such as Eastern Europe, Asia and Russia. Huawei emerged as a leader in this space and is believed to use CDMA450 as a route to enter Europe as it seeks to establish its presence in the west.

Softswitch

Global CDMA Softswitch Contract Wins by Vendors, 2006-1H 2007



Softswitching plays a significant role in the transformation journey towards All-IP solutions. Many a time, softswitch is viewed as a first step moving towards next generation network (NGN). As an early adopter of distributed switching architecture, Huawei is leveraging its mobile softswitch as a competitive advantage in expanding its market share in the CDMA space. This is evident of its successes to win majority of softswitch contracts globally in the last 18 months.

Vendors' Strategy

Alcatel-Lucent

The world's largest CDMA vendor, Alcatel-Lucent, has invested significant resources in ensuring a UMB network deployment would be as prohibitive to CDMA carriers as the upgrade to EV-DO. It is preparing a CDMA base station that can be upgraded to ultra mobile broadband, filling in an important gap between the 3G and 4G equipment deployments. The aim is to try and overcome the biggest obstacle carriers will be facing during the transition: the need to deploy entirely new networks.

The company intends to reach a point where it will be able to allow the deployment of a Rev. A base station that will support UMB. In fact, according to the company, some of its evolution-data optimized deployments today already supported those capabilities.

Huawei

Huawei continues to focus on all wireless technologies such as CDMA, WiMAX, GSM/WCDMA and TD-SCDMA. The ultimate goal is for the vendor to have a unified platform, which can be leveraged across all technologies moving forward into an All-IP network. Despite being a new entrant in the mobile market, Huawei is a force to be reckoned with, having grown aggressively in the past three years. It has since surpassed the major vendors in terms of contract wins and gained entry into the North American market.

With years of research and development in mobile and IP technologies, Huawei is regarded as the leading vendor to take CDMA networks to the next level, evolving to an All-IP architecture. Huawei also announced the support of UMB as part of its overall roadmap for CDMA.

Motorola

Being a dominant player in the CDMA arena, Motorola had unveiled its all-IP CDMA2000 1xEV-DO Rev A in late 2005 and has a clear evolution path set for Rev B. It has also been a key vendor in upgrading Verizon Wireless's EV-DO network to Rev A.

However, in June 2007, the company announced its intention to bring long-term evolution, or LTE, out of the labs and commercializing it by 2010, citing increasing demand from traditional wireless carriers for LTE as the main driver. The decision to also pursue LTE in addition to its bet on WiMAX is an acknowledgement that more than one 4G technologies will co-exist in the market. In addition, Motorola is able to leverage a lot of its technology investment in WiMAX for LTE.

The same can not be true for UMB, according to the vendor, as the network architecture has not gathered the momentum of LTE or WiMAX. However, if it does in the near future, Motorola, with its strong presence in the CDMA arena, is likely to be able to put UMB on a commercialization track fairly easily.

Nortel Networks

Nortel Networks seems to be taking the most neutral approach to UMB and its competing technologies. The company has made significant investments in OFDM/MIMO and is currently pursuing all three OFDM/MIMO technologies, WiMAX, LTE and UMB. The company believes that, although the product paths for the technologies will eventually diverge, but much of the core radio access development can be shared between them. Taking into account that the early adopters of UMB won't be in network trials until 2009, the company wants to wait and see whether the market embraces the technology or not. If it does, the OFDM/MIMO work it has done for LTE and WiMAX can easily be applied to UMB. And if the market does not, UMB work can be redirected to a certain extent into LTE and WiMAX.

Qualcomm

The San Diego chipset-maker first developed CDMA, became the dominating force behind the 3GPP2 and eventually shepherded its technology into the 3GPP, which adopted wideband CDMA.

To a certain extent, Qualcomm has embraced OFDM by acquiring Flarion Technologies. According to the company, CDMA2000 1xEV-DO Revision C which is UMB will be released in the second quarter of 2007 and become commercially available in early 2009. In late 2007, Qualcomm plans to start testing its new UMB 4G technology that which would offer mobile data speeds up to 280 Mbps, using MIMO technology and scalable bandwidths up to 20 MHz.

Qualcomm has also recently launched its Wireless Reach program, selecting Thailand as its first project launch to introduce wireless broadband services over EV-DO network in the remote islands of the country. EV-DO is viewed to be a cost-effective solution, with high bandwidth for data transfer compared to satellite leasing. The program enables the offering of tele-health services effectively in remote islands, in view of its unique living conditions where poor voice and data communications have previously hampered medical assistance.

ZTE

Being a CDMA market player, ZTE had unveiled its CDMA2000 1xEV-DO Rev A solutions and has paved a clear evolution path towards Rev B, moving towards an IMS ready, All-IP architecture. As an active participant in the 3GPP2 standards process, ZTE has been heavily investing in UMB research and development. However, ZTE adopts a "wait and see" approach when it comes to commitment to develop a UMB product due to the required higher investment compared to developing the OFDM technology which can be leveraged across. In the meantime,

ZTE has conveyed its plans to exclude UMB as part of its product portfolio until it sees further demand for the technology. Eventually, how the market will play out will determine its strategic decision to place its bet.

Conclusion

The competitive landscape for CDMA has seen some major changes over the years. The incumbent CDMA vendors namely Alcatel-Lucent, Nortel and Motorola continue to milk their existing customer base, mainly in the North American market. Over the last 18 months, these vendors were involved in helping their customers migrating to higher speed EV-DO Rev A network. The biggest deal US\$6 billion was awarded to Alcatel-Lucent from Verizon Wireless in the US. Outside of US, there aren't many significant activities in terms of contract wins in the last 18 months.

The focus of the incumbent CDMA vendors in the North American market has provided Huawei a nice window of opportunity to spread its wing to capture many new wins globally. Through its end-to-end solutions, Huawei has managed to penetrate new markets with a suite of comprehensive offerings ranging from CDMA2000 1X, EV-DO, CDMA450 as well as softswitches. The inroads into one of the service provider in North America will perhaps see the Chinese vendor slowly gaining a foothold in this lucrative region.

As voice becomes just another application delivered across an All-IP network, there is an increasing need to embark on the IP transformation journey to substitute lost revenues and defend falling voice revenues with new income streams. CDMA2000, which is compatible with IP, enables reduced network investment with the flexibility of co-ordinating migration plans with service providers' existing network architecture and deployment requirements. Due to the economies of IP-networks and future-proof smooth transition towards IMS architecture, the evolution to an All-IP network is viewed to be inevitable. As such, the move towards an All-IP network is an ultimate goal of most vendors to have a unified platform.