Alcatel·Lucent

TECHNOLOGY WHITE PAPER

Exploiting CDMA2000 1xEV-DO: Satisfying the Need-for-Speed

Multicarrier EV-DO (1xEV-DO Revision B) Extends 3G Data Performance

Wireless operators are looking to maximize investments in their networks by upgrading to improve capacity, performance and spectral efficiency. Multicarrier EV-DO (MC EV-DO), a software upgrade to cdmaOne™, CDMA2000® 1X voice and 1xEV-DO Rev A data networks, lets operators combine two or three 1.25 MHz EV-DO Rev A carriers into a 2.5 MHz or 3.75 MHz "super-carrier". MC EV-DO offers operators improved data-adoption rates and revenues, the potential for "premium" and "mass-market" segmentation, and investment protection while meeting end users' growing demand. While peak data rates may differ theoretically, the end-user experience of MC EV-DO and other 3G technologies is comparable given the real-world limitations of devices. EV-DO demonstrates a time-to-market advantage over other technologies, positioning networks for VoIP-enabled blended services.

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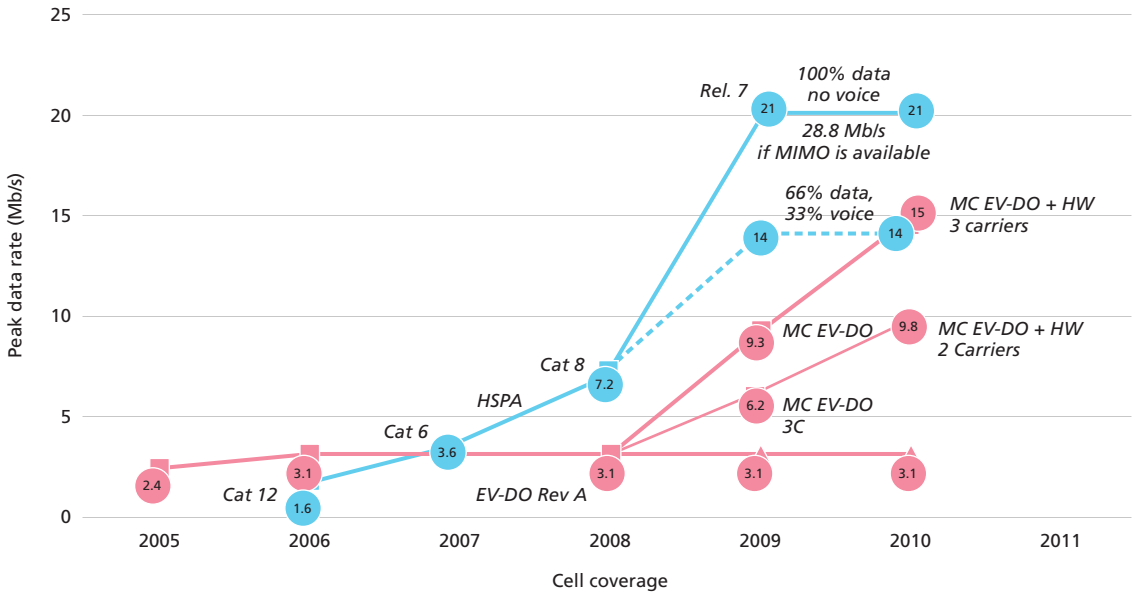
1. Introduction

In a 1965 paper, Intel® co-founder Gordon E. Moore observed a phenomenon that would stand the test of time and is expected to continue for years to come. In what is now known as Moore's Law, he predicted that the number of transistors placed in an integrated circuit (IC) would increase exponentially, doubling every two years. As noted in Wikipedia®, "Almost every measure of the capabilities of digital electronic devices is strongly linked to Moore's law: processing speed, memory capacity, sensors and even the number and size of pixels in digital cameras. All of these are improving at (roughly) exponential rates as well. This has dramatically increased the usefulness of digital electronics in nearly every segment of the world economy."

The world of mobile communications has benefited from these advances and has seen significant capacity and performance gains, especially in the area of wireless data. Leveraging the increased IC processing power, and aligned with improvements in antenna technology and data coding schemes, the peak data rates of wireless airlinks have grown from 14.4 kb/s in 2000, to 100 Mb/s in 2009, as shown in Figure 1:

- 2000: 14.4 kb/s circuit-switched data
- 2002: 2.4 Mb/s with 1x Evolution-Data Optimized (EV-DO)
- 2006: 3.1 Mb/s with 1xEV-DO Revision A
- 2006: 14.7 Mb/s with High Speed Packet Access (HSPA)[1]
- 2007: 21 Mb/s with Evolved HSPA (HSPA+)[1]
- 2009: 100 Mb/s with Long Term Evolution (LTE)[1]

Figure 1. Comparison of peak data rates: 1xEV-DO and UMTS



Theoretical standard peak rates e.g. 14.4/28.8 - Standards defined, no terminal available

[1] Theoretical maximum. Real-world peak rates are impacted by device limitations.

Despite the recent ups and downs of the overall economy, the one bright spot in the wireless industry remains wireless data. Industry analysts retain the upbeat vision they have espoused for mobile data since 2000, and with Third-Generation (3G) data subscribers reaching 255 million as of June 2009 (47 percent 1xEV-DO, 52 percent HSxPA, and 1 percent Worldwide Interoperability for Mobile Access [WiMAX]), their optimism seems well founded. While voice additions are slowing and voice average revenue per user (ARPU) is dropping, data is finally delivering its long-predicted positive impact on the bottom line: data users are being added at an increasing rate and ARPU is increasing significantly.

U.S. WIRELESS DATA MARKET UPDATE – Q1 2009

- U.S. wireless data-service revenues grew 5% Q/Q to $10B in Q109. Compared to Q108, data-services revenues grew 32%.
- This marks the first time any country has reported a $10B quarter (for mobile data services).
  - ¬ Verizon's data revenues grew the most: 18% QoQ and 46% YoY.
  - ¬ AT&T experienced a 39% lift.
  - ¬ T-Mobile reported a 24% increase in YoY data-revenue growth.
  - ¬ Sprint had a fourth consecutive quarter of data-revenue growth.
- AT&T and Verizon now account for 68% of market data-services revenues. The average industry percentage contribution of data to overall ARPU is now 26%. The U.S. market is likely to exceed the 30% mark in 2009.

FierceWireless – May 11, 2009

As users and applications drive more data through the networks, operators are looking for more cost-effective ways to provide capacity relief while continuing to satisfy users' increasing bandwidth demands. In the last year, two emerging technologies have garnered the most attention: HSPA+ and LTE. Some CDMA operators, such as those recently acquired by European corporations, are pursing the evolution of Universal Mobile Telecommunications System (UMTS)/HSPA. Other operators — typically those with 700 MHz spectrum or those who have not yet deployed 1xEV-DO — are pursuing the LTE path.

However, not all operators see these technologies as integral to their evolution plans: they are looking to maximize investments in their CDMA2000 networks by implementing upgrades to improve the capacity, performance and spectral efficiency of their existing spectrum and wireless infrastructure. Several planned upgrades could increase CDMA's voice and data capacity, but this paper will focus on a specific set of features known as Multicarrier EV-DO (MC EV-DO), a component part of the full 1xEV-DO Revision B Standards.

2. What is 1xEV-DO?

1xEV-DO (EV-DO) is a simple upgrade to cdmaOne and CDMA2000 1X voice networks. Commercially available in networks since 2002, EV-DO has proved its worth in over 100 diverse countries across Africa, Asia, Australasia, the Caribbean, Europe, the Middle East, and North and South America. As of Q109, the CDMA Development Group (www.cdg.org) reports over 120 million EV-DO subscribers worldwide. With another 75 networks launching or about to launch commercial services in 2009, EV DO is testament to the value that true 3G data services bring to mobile networking. EV-DO has evolved since 2002:

- 1xEV-DO Revision 0 allowed CDMA2000 voice operators to add high-speed packet data to their networks in increments of 1.25 MHz of free spectrum. 1xEV-DO Rev 0 led the industry with its ability to supply peak data rates of 2.4 Mb/s on the forward link (FL) (downlink) and

153 kb/s on the reverse link (RL) (uplink). Operators quickly deployed 1xEV DO Rev 0 in hundreds of networks, and subscribers grew in the millions each year.

- In 2006, 1xEV-DO Revision A upgraded data rates on the FL and RL paths to 3.1 Mb/s FL and 1.8 Mb/s RL, and improved latency while adding greater capacity per sector/carrier.
- Available in 2009, MC EV-DO is a set of software upgrades, with additional hardware options to come, that allow operators to combine two or three separate 1.25 MHz EV-DO Rev A carriers into a 2.5 MHz or 3.75 MHz "super-carrier". Combining Rev A carriers offers higher individual peak data rates, better performance across the cell footprint (especially at the edges), and more capacity than running two or three Rev A carriers individually.

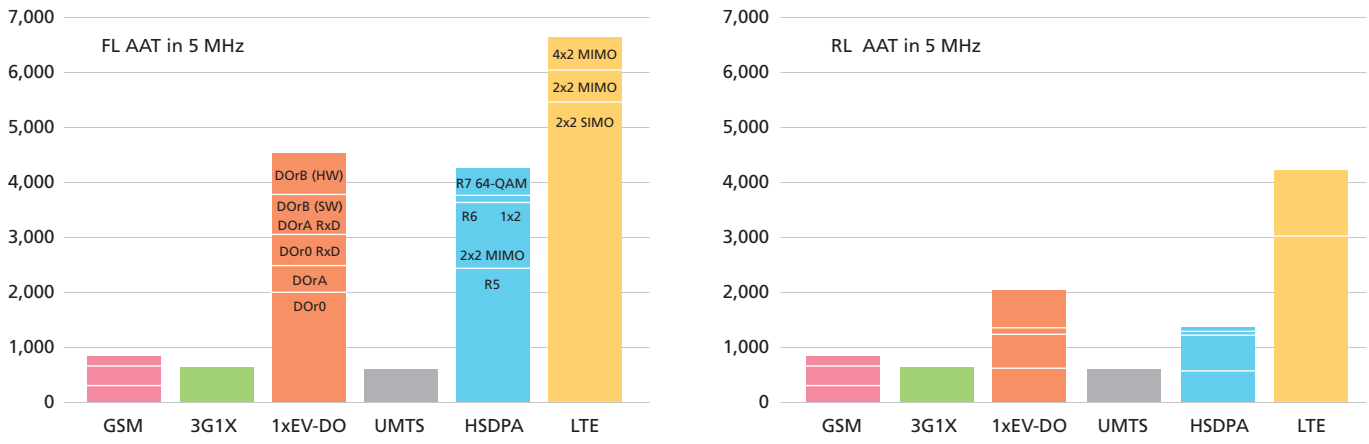
3. Why do operators need MC EV-DO?

EV-DO Rev 0 and Rev A addressed operators' business models to grow ARPU with new high-speed data services and applications. Competitors with wireless (HSPA, LTE, and WiFi/WiMAX) solutions are conducting aggressive marketing and sales campaigns to dislodge EV-DO from its leadership position. Other white papers have explained the state of maturity of the different technologies and how peak performance numbers differ from real-world user experiences. However, this does not deter competitors from positioning the theoretical peak capabilities of their technologies instead of the lesser numbers achievable in the real world.

For example, HSDPA commercial networks still position FL speeds as 14.7 Mb/s even though current handsets limit FL peak data rates to 7.2 Mb/s, and EV-DO Rev A is positioned as inferior because it only supports 3.1 Mb/s. To position EV-DO effectively, CDMA operators need to position the new speeds of MC EV-DO: 9.3 Mb/s to 14.7 Mb/s FL (see software, hardware and configuration options in this paper) and up to 5.4 Mb/s RL. Even though there is still a theoretical disparity between the FL peak speeds of MC EV-DO and other 3G technologies, the actual end-user experience is comparable given the real-world limitations of available devices.

Peak rates are only part of the story: user experience is more commonly determined by network capacity. The measure of capacity is average aggregate throughput (AAT), which indicates the total throughput per sector from all users sharing the link. The FL AAT and RL AAT graphs in Figure 2 and Figure 3 indicate throughput in 5 MHz and show that, overall, the technologies support comparable capabilities. This is a game of leapfrog: one technology may demonstrate an advantage for a short period, other technologies then implement improvements to gain advantage, and so on.

Figure 2. Comparison of FL AAT and RL AAT(5 MHz)



MC EV-DO implements new channel protocols that aggregate spectrum, allowing two or three EV DO Rev A carriers to be combined as one wider band CDMA super-carrier. A user with a suitably equipped mobile device can see two to three times the peak rate that they would experience with just one Rev A carrier under the same conditions. The link is faster, and the experience is more consistent across the entire footprint of the cell — closer to a cable-modem experience than to EV DO Rev A. Users at the edge of the cell are in the most challenging RF conditions, which typically result in lower throughputs. A two- to three-fold improvement in the peak rate benefits these users significantly.

Operators benefit because the aggregate throughputs from all users are balanced. For example, with two individual Rev A carriers, users are assigned time slots on each carrier, but one carrier may be heavily loaded and the second carrier may have relatively few users and many unused time slots. MC EV-DO assigns users to slots on both carriers, thereby utilizing resources that would otherwise go unused. These improvements will not only delight end users, but will lead to capital expenditure (CAPEX) and operating expenditure (OPEX) gains for operators.

3.1 Arguments for MC EV-DO

There are a number of persuasive reasons for persuasive reasons for CDMA and LTE operators, CDMA and LTE operators to consider incorporating MC EV-DO:

- Speeds time-to-market; meets the market need for CDMA multicarrier capabilities in 2009
- Allows operators to maximize their existing investments in EV-DO and to compete with HSPA+ and LTE
- Allows CDMA spectrum-constrained operators to maximize their networks' operational efficiencies
- Allows CDMA operators to obtain maximum capacity from their networks, deferring migration decisions until their business case warrants it
- Allows LTE operators to improve the capabilities of their EV-DO fallback networks, providing extended coverage for "LTE islands" for many more years
- Provides more ATT, push-to-talk (PTT) and Voice over IP (VoIP) capacity than with multiple individual Rev A carriers
- Leverages Rev A deployments
- Software-only option available
- Creates a more consistent user experience across the cell footprint
- Allows for tiered pricing programs, in which preferred users get premium services

4. How EV-DO works

In a CDMA network, the Base Transceiver Station (BTS) is the transmission and reception station that acts as the access point for the user to the network, handling network traffic from cdmaOne/CDMA2000 1x voice components and EV-DO simultaneously. An EV-DO Rev A card is installed in a free slot in the BTS alongside the CDMA voice cards. EV-DO shares common resources, such as linear amplifiers, filters, power supplies and antennas, with the voice carriers. EV-DO Rev A modem cards are single-board solutions — single-board 1xEV-DO Modem for Modcell 4.0 [SB-EVM] and EV-DO Rev 0 were dual-board solutions) — so they only need one slot in the following Alcatel-Lucent BTSs:

- Alcatel-Lucent 9216/9226 Base Station Compact
- Alcatel-Lucent 9218/9228 Base Station Macro
- Alcatel-Lucent 9222 Base Station Micro
- Alcatel-Lucent 9224 Base Station Sub Compact/Sub-Compact EN
- Alcatel-Lucent 9234 Base Station d2U Distributed
- Alcatel-Lucent 9222 Base Station Micro

EV-DO utilizes the advantages of the Spread Spectrum technologies of CDMA voice networks but differs from them by introducing TDM techniques to ensure the most efficient, fast delivery of packet-data traffic on the FL. This is a major innovation: TDM improves network performance by allowing multiple users to share the entire downlink channel, with each user assigned specific time slots and receiving data at the maximum speed capable in that slot. EV-DO employs a technique called dynamic rate control (DRC), in which the BTS takes data packets and schedules their transmission in the user's assigned time slots, honoring a user's DRC request by stating the maximum data rate the device can receive under current radio frequency (RF) conditions. If the user's RF condition improves or worsens, this exchange varies the data rate, ensuring that the user receives the highest throughput in the assigned time slots while connected.

4.1 EV-DO Revision A

EV-DO Rev A provides expanded retransmission mechanisms for faster error correction. In a Spread Spectrum network, the user device must both acknowledge receipt of the data and communicate key information about issues such as channel condition and power control back to the BTS. A BTS typically dispatches a data packet to a handset, and the BTS waits for an acknowledgement. If it does not receive one within a prescribed time, the BTS assumes that the data packet is lost and retransmits it. EV-DO Rev A implements a scheme that assumes that, because RF is such a harsh environment, more packets contain errors than not. EV-DO Rev A therefore anticipates errors and prepares to resend the packet. If in the interim the first packet is positively acknowledged, the BTS drops resending of the packet and sends the next one in the sequence. While it may sound counter-intuitive, this aggressive use of hybrid automatic repeat request (HARQ) results in more efficient use of the airlink scheme and provides higher throughput and lower latency. In short, the driver behind this upgrade is the provision of optimum bandwidth for all users, coupled with the best-possible channel conditions.

EV-DO Rev A retains all the attributes of Rev 0 while improving user data rates and, more significantly, latency. Latency is the length of time it takes to transmit data across the network to and from the BTS. Improving (decreasing) latency improves network response time and makes real-time interactive applications such as VoIP, PTT and interactive gaming viable. MC EV-DO supports higher VoIP and PTT capacity than the equivalent two or three individual Rev A carriers.

4.2 MC EV-DO

MC EV-DO retains all the attributes of Rev A, reusing BTS hardware to deliver these improved capabilities. When the initial Third Generation Partnership Project 2 (3GPP2) standards bodies met in the early 1990s, they elected to deliver cdmaOne in carrier increments of 1.25 MHz. This made sense at the time because spectrum was constrained to cellular bands only and was congested with analog voice-services support. Deploying cdmaOne in this narrow band allowed easier spectrum management as digital CDMA displaced analog cellular services. Deploying digital technologies eased some spectrum congestion, but real capacity relief arrived with the Personal Communications Service (PCS) spectrum auctions in the mid 1990s and the launch of 3G (CDMA2000) in 2000. With free spectrum available, 3GPP2 pursued standards to enable wider band CDMA solutions.

Now that spectrum constraints have been removed, the new standards exploit a technological reality that the "wider" a CDMA carrier is, the higher the data rates it can support. This is underscored by some technologies' marketing claims of rates of 100 Mb/s+. These speeds are achieved when the carrier is 20 MHz and are typically only stated in the fine print. Most UMTS and LTE deployments are deployed when the carrier is 5 MHz. MC EV-DO standards theoretically allow for a 20 MHz MC EV-DO carrier, but in practice devices will be limited to 5 MHz.

MC EV-DO will be phased in with several releases. The first release will be software upgrades to the BTS, combining two and then three existing EV-DO Rev A carriers to form a 2.5 MHz or 3.75 MHz carrier. Existing EV-DO Rev 0 and Rev A users will be unaffected; only users with new MC EV-DO devices will benefit from the new MC EV-DO features. Later releases will offer a new hardware

option to replace EV-DO Rev A cards (SB-EVMs) with a new Multicarrier EVM (MC-EVM) card. The releases supporting this card will improve FL peak data rates from 3.1 Mb/s to 4.9 Mb/s and will improve RL operational efficiencies. Again, existing EV-DO Rev 0 and Rev A users will be unaffected, and users with MC EV-DO B devices will benefit from enhanced Rev B features without requiring new devices.

4.3 Alcatel-Lucent 9271 EV-DO RNC

The Alcatel-Lucent 9271 EV-DO Radio Network Controller (9271 EV-DO RNC) has overall control of EV-DO resources in the BTSs and is also responsible for handoffs in the network. The packet control function (PCF) and packet data serving node (PDSN) handle and route packet-switched data traffic, equivalent to the mobile switching-center handling of circuit-switched traffic in a CDMA voice network. Using the 9271 EV-DO RNC for packet-data traffic minimizes transmission delays in the network by placing key processing at the BTS, closer to the air interface and the user. New hardware and software upgrades are available to allow for additional processing demands required to handle the higher volumes of data driven by MC EV-DO.

5. Upgrading to MC EV-DO

Only some of the vendors who claim their systems are "EV-DO-ready" are actually prepared for EV-DO. Several Alcatel-Lucent competitors rely on outside vendors for their EV-DO components. As a result their products are not as tightly integrated. In contrast, Alcatel-Lucent designs and develops EV-DO products to run in the company's own networks. Vendors may downplay the reality that RF optimization, network operations, administration, and maintenance and provisioning(OAM&P) are handled as separate entities, with no common elements or look-and-feel. The operational impact is the need for multiple training sessions often resulting in different maintenance staff supporting different network elements.

Alcatel-Lucent recognized the cost and efficiency benefits of EV-DO at an early stage. As a result, Alcatel-Lucent cdmaOne and CDMA2000 BTSs require only a software upgrade and new carrier cards in free slots to support new EV-DO carriers. Alternatively, EV-DO carrier cards can replace existing cdmaOne or CDMA2000 voice cards.

5.1 SB-EVM installation and software upgrades

Upgrading to MC EV-DO carrier is straightforward. The SB- EVM, installed in all Alcatel-Lucent BTSs since May 2006, contains the changes to support MC EV-DO carrier aggregation. Because the SB-EVM supports EV-DO Rev 0, Rev A and MC EV-DO, customers with the SB-EVM must simply update software in the BTS, Alcatel-Lucent 9271 EV-DO RNC, and PDSN to upgrade to MC EV-DO. Customers with the earlier EV-DO Rev 0 dual-board EVM (DB-EVM) solutions will need to replace the DB- EVM with the SB-EVM and follow the same previously mentioned software upgrade.

Two or three SB-EVMs are required to support two or three carrier MC EV-DO solutions. Of course, users need new MC EV-DO-capable devices, but Rev 0 and Rev A mobile devices will continue work on the MC EV-DO, though without the new MC EV-DO capabilities. Likewise, MC EV-DO devices will work on BTSs that do not have MC EV-DO software installed, falling back to Rev A or Rev 0 capabilities depending on the airlink the BTS supports.

5.2 MC EV-DO devices

Key to the release of any new technology is the maturity of the airlink and availability of end-user devices, which are critical to the launch of any new service. MC EV-DO leverages the earlier Rev 0 and Rev A technologies and capabilities; if history is any indictor, we should expect commercial-grade services to be available sooner and with fewer problems than with technologies based on

brand new airlinks. Three vendors plan to have MC EV-DO devices ready for launch in Q409, and others are expected to appear in multiple form factors as users adopt the technology. The MC EV-DO devices launched in 2009 will support initial MC EV-DO services and future EV DO Rev A+ and B+ improvements.

6. Benefits of MC EV-DO for operators

MC EV-DO allows operators to capitalize on their Rev A investments, providing competitive data services and driving new revenue in the near- to mid-term with minimal changes to their existing network. MC EV-DO offers operators a range of benefits:

- Improves data-adoption rates and revenues
  - ¬ Data service with a peak data rate comparable to HSPA and superior to Rev A
  - ¬ Building on existing Rev A carriers to substantially improve broadband data throughput, coverage and latency performance
  - ¬ Significant user-experience improvements over Rev A
  - ¬ Higher peak rates and improved latency, providing better support for applications such as gaming
- Offers the potential to divide the market into "premium" (MC EV-DO) and "mass-market" (Rev A) segments
  - ¬ Premium segment (MC EV-DO devices)
    - Willing to pay more to get higher data rates
    - Want assurance that they are getting the "best" data experience
    - High-end enterprise users and technology-savvy consumers typically generate the highest voice ARPU
    - More open to paying for additional services, such as blended Web 2.0 services
  - ¬ Mass-market segment (Rev A PC-card or handset)
    - Price-sensitive enterprises and consumers
    - Not willing to pay more for higher data rates
    - Willing to subscribe to a mobile data service or switch service providers if the price drops
- Allows improved positioning to both premium and mass-market segments
  - ¬ Generation of higher data revenue using more targeted marketing to both segments
  - ¬ Different plans (limited versus unlimited usage, peak speed, additional data-services bundling, price point)
  - ¬ Higher ARPU and margin with the premium segment
  - ¬ Higher subscriber volumes with the mass-market segment
- Protects investments with simple, smooth upgrades that meet end users' growing demand
  - ¬ Minimal impact on the existing network
  - ¬ No impact on existing EV-DO users
  - ¬ Backward compatibility to Rev 0/A
  - ¬ Seamless roaming across Rev 0/A/MC and future offerings
  - ¬ Software upgrades to the BTS and Alcatel-Lucent 9271 EV-DO RNC
  - ¬ New devices required for MC EV-DO capability

Note: Higher data rates are not guaranteed; limited by MC EV-DO coverage.

7. Future enhancements: MC-EVM and EV-DO Rev A+/Rev B+

CDMA2000 1X Radio Transmission Technology (1xRTT) was the critical first step in improving network performance with increased voice and data capacity. EV-DO Rev 0 took these networks to true 3G capabilities, and EV DO Rev A improved performance by supporting peak network speeds up to 130 percent faster than the standards specified. MC EV-DO now supports 9.3 Mb/s FL peak speeds when combining three EV-DO Rev A carriers. In 2010, new BTS hardware (MC-EVM Multi Carrier EVM) will be available to implement the full capabilities of 1xEV-DO Rev B, increasing FL peak speeds to 14.7 Mb/s. The Reverse link will support 5.4 Mb/s when combining three EV-DO Rev A carriers.

In addition to the MC EV-DO software aggregation previously described in this paper, the complete EV DO Rev B standards specify a new hardware option, Rev A+/B+. The "+" designation refers to the new MC-EVM that replaces the SB-EVM in the BTS. The MC-EVM has new EV-DO chips (MSM6850) that introduce 64-QAM coding schemes and improve the peak data rate of the Rev A carrier from 3.1 Mb/s to 4.9 Mb/s (Rev A+). The new MSM6850 chip also introduces advanced interference-cancellation routines on the RL, resulting in an estimated 50-percent improvement in AAT, a 40-percent in VoIP traffic, and improved device battery life over Rev A.

The MC-EVM supports four EV-DO three-sector carriers in one board slot. When used in conjunction with the MC EV-DO software (Rev B+), peak data rates are 9.8 Mb/s for two-carrier Rev B+ and 14.7 Mb/s for three-carrier Rev B+. The devices deployed to support the previously described MC EV-DO software will be capable of supporting Rev A+ and Rev B+ improvements.

8. Conclusion

Today's markets are hugely competitive. User expectations are formed by their experience with fixed, cable, local area network (LAN) and wireless networks. MC EV-DO, Rev A+, and Rev B+ extend the life of existing EV-DO investments, expanding network capabilities to support next-generation, Web 2.0 sophisticated mobile IP multimedia services.

The landscape is becoming increasingly crowded, and some operators are aggressively positioning HSPA+ and LTE upgrades of their networks against EV-DO. CDMA operators in the leadership role established with EV-DO need to upgrade so their customers (end users) can benefit from the operational efficiencies and improved user speeds that MC EV-DO Rev A+, and Rev B+ bring.

Historically, EV-DO has demonstrated a time-to-market advantage over other technologies. However, this advantage is transitory: soon the competition will catch up. The only way to maintain industry leadership is to forge ahead and deploy network performance that the competition cannot match. MC EV-DO delivers these capabilities while at the same time positioning networks to weather the trials of the next industry paradigm shift: VoIP-enabled blended services.

9. About Alcatel-Lucent

Alcatel-Lucent is a leading player in the wireless infrastructure market, having deployed 350 commercial wireless networks worldwide. The pioneering Alcatel-Lucent multistandard BTSs, with more than 665,000 units shipped since 1999, are designed to support IP transformation and are part of the company's unique converged radio access network (RAN) strategy, allowing operators to smoothly evolve toward future mobile broadband technologies. Alcatel-Lucent is the leading CDMA/EV-DO vendor, with global market share of more than 40 percent in 2008. In addition, the company has been the industry's leading optical vendor since 2001, is number two in the IP/Multiprotocol Label Switching (MPLS) service-provider edge routing market with 19 percent market share in 2008, and is a world leader in the design, deployment, management and integration of networks.

Alcatel-Lucent is a world-class supplier of mobility solutions. Innovation is at the heart of our business. Our Centers of Excellence and the global facilities of Alcatel-Lucent Bell Labs are shaping the way our world communicates. We offer unchallenged market leadership in Spread-Spectrum CDMA radio access, the underlying technology for 3G networks, ATM backbone networking technology, circuit and packet switching as well as the expertise to integrate and deploy complex networks.

Alcatel-Lucent is the trusted partner of service providers, enterprises and governments worldwide, providing solutions to deliver voice, data and video communication services to end users. A leader in fixed, mobile and converged broadband networking, IP technologies, applications and services, Alcatel-Lucent leverages the unrivalled technical and scientific expertise of Alcatel-Lucent Bell Labs, one of the largest innovation powerhouses in the communications industry.

With operations in more than 130 countries and the most experienced global services organization in the industry, Alcatel-Lucent is a local partner with a global reach. Alcatel-Lucent achieved revenues of Euro 16.98 billion in 2008 and is incorporated in France, with executive offices located in Paris. For more information, visit Alcatel-Lucent on the Internet: http://www.alcatel-lucent.com

10. Abbreviations

1xRTT	1X Radio Transmission Technology
2G, 3G	Second Generation, Third Generation
3GPP2	Third Generation Partnership Project 2
9271 EV-DO RNC	Alcatel-Lucent 9271 EV-DO Radio Network Controller
9500 MPR	Alcatel-Lucent 9500 Microwave Packet Radio
AAT	average aggregate throughput
ARPU	average revenue per user
BTS	Base Transceiver Station
CAPEX	capital expenditure
CDMA	Code Division Multiple Access
cdmaOne™	brand for TIA/EIA/IS-95B
CDMA2000®	brand for TIA/EIA/CDMA2000 Series
DB-EVM	dual-board EVM
DOrX	EV-DO Revision X
DRC	dynamic rate control
EV-DO	Evolution-Data Optimized
EVM	EV-DO Modem for Modcell 4.0
FL	forward link
GSM	Global System for Mobile Communications
HARQ	hybrid automatic repeat request
HSPA	High Speed Packet Access
HSPA+	Evolved HSPA
HSUPA	High-Speed Uplink Packet Access
HW	hardware
LAN	local area network
LTE	Long Term Evolution
MC EV-DO	Multicarrier EV-DO
MC-EVM	Multicarrier EVM
MIMO	multiple-input, multiple output
MPLS	Multiprotocol Label Switching
OAM&P	Operations, Administration, Maintenance and Provisioning
OPEX	operating expenditure
QAM	quadrature amplitude modulation
PCF	packet control function
PCS	Personal Communications Service
PDSN	packet data serving node
PTT	push-to-talk
QoQ	quarter-over-quarter
RAN	radio access network
Rev	Revision
RF	radio frequency
RL	reverse link
SB-EVM	single-board EVM
SIMO	single-input, multiple-output
SW	software
TDM	Time Division Multiplexing
TIA	Telecommunications Industry Association
UMTS	Universal Mobile Telecommunications System
VoIP	Voice over IP
WiFi	wireless fidelity
WiMAX	Worldwide Interoperability for Microwave Access
YoY	year-over-year

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