More efficient and cost-effective use of precious bandwidth: CDMA2000® 1xEV-DO enables access to sophisticated mobile IP multimedia services.

This white paper addresses:

- The need for 1xEV-DO
- How 1xEV-DO works
- How to upgrade to 1xEV-DO revision A
- The future
Introduction

Increasing user demand for access to a broad range of new high-speed data applications and services is fuelling demand for more bandwidth in order to improve the user experience. Additionally, users expect access to these services when away from their desks and are looking to mobile networks for this access.

CDMA mobile network operators are satisfying this need by offering 1xEV-DO (1xEvolution Data Optimized) Revision 0 - a cost-efficient high-speed data upgrade to current CDMA (Code Division Multiple Access) mobile voice systems. 1xEV-DO delivers data speeds comparable to today’s wireless LAN services, but with the added benefit of mobility and ubiquitous coverage.

Improvements to 1xEV-DO, called Revision A, offers mobile operators even faster data speeds, improved latency and even greater capacity—providing a very real competitive benefit.

What is it?

1xEV-DO is an upgrade to current cdmaOne™ or CDMA2000® voice networks. 1xEV-DO has been deployed and commercially available in networks since 2002 and has already proven its worth in networks in countries as diverse as Korea, USA, Brazil, Chile, Czech Republic, Mongolia, Nepal, Guatemala, Israel and New Zealand. With nearly 40 operators launching (or about to launch) commercial services, 1xEV-DO is a testament to the value that true 3G data services bring to mobile networking.

1xEV-DO Rev 0 today:

• Full Compliance with the 3GPP2 standards
• Downlink data speeds between three and five times higher than those of existing mobile networks and equal to those promised in the next generations of service
• A return path equaling or bettering the data rates of existing mobile networks
• A three to five fold improvement in network capacity
• Sophisticated scheduling that allows favorable allocation of resources. 1xEV-DO’s improved spectral efficiency enables much faster downstream throughput than earlier technologies
• Interoperates with and is backwards compatible with cdmaOne™ and CDMA2000® networks

With planned availability in 2006, 1xEV-DO Revision A is the next evolution of this service and will drive the maximum data transfer speed from Rev 0’s 2.4 Mbps to 3.1 Mbps. When shared among users in an adequately covered area, this will provide each user with a 330K to 500K experience. Users in optimum conditions can experience up to 1.05 Mbps downlink, comparable to current wireless LANs and domestic fixed line broadband alternatives. The Uplink will be 1.8 Mbps – twelve times faster than the current 1xEV-DO Rev 0 rate. Additionally, advancements in the Rev A airlink provides for reduced latency to effectively support real time, inter-active applications such as gaming, streaming video, push-to-talk, Voice over IP.
Why do we need it?

Operators and the investment community know that for voice operators to grow ARPU (Average Revenue Per User) in the future, their business models must include viable plans for high-speed data services. 1xEV-DO will drive new mobile data subscription rates which will grow profitably exponentially. For example, the cost to deliver one Mbyte of data on today's mobile networks is estimated to vary from approx US$0.40 to US$0.70 depending on the network. 1xEV-DO can slash these costs for delivering data to US$0.22 per Mbyte according to assessments done by Qualcomm and Airvana.¹

CDMA operators must also ensure they can adequately support their new service portfolios with minimal capital expenditure. The main drivers for higher performance mobile networks include the need to address:

- Commercial pressure to replicate LAN experiences while mobile and support efficient access to office-based applications
- Demand from consumer services for alternative to fixed-line broadband that can support new applications – e.g., interactive gaming, streaming video, voice over IP and SIP-based multimedia
- Competing service offerings from alternative mobile and non-mobile wireless technologies
- Reduced cost of on-going network growth
- Lower cost per byte for data and VoIP services

There are many new and innovative applications that will emerge as 1xEV-DO gains mainstream acceptance and voice and data blend into seamless services offering capabilities. Examples include:

- Portable Travel Agent – whether at home or abroad this service keeps the user fully updated on leisure facilities and events and provides maps, guidance and help with translation and currency
- Home Security – connects directly to the user's home and monitors activity via bulletins and video links (which can also be preprogrammed at regular intervals). The system also enables the homeowner to turn lights on/off and control other integrated appliances
- Live Wire – intelligent on-demand multi-media service with access to unlimited music, short videos, TV, news or books. The service not only enables on-demand access it also remembers what you like and will make recommendations
- Activity Agent – program in your regular activities and the system will provide an optimum schedule taking into account traffic, roadwork, opening hours, retail information etc., and can even react to unexpected events such as an accident and reschedule your plan. The system can also be used for live on-line purchasing
- More Than Words – send handwritten messages, drawings, pictures and audio attachments in a fully customized multi-media message

• My Mobile Planet – enables the user to actively participate in both global and personal communication communities anytime, anywhere.

We asked a cross section of mobile phone users how often they thought they would use these services. The results are listed below.

![Graph showing frequency of use for various services]

Operators will need mobile networks that offer advanced quality of service capabilities and data speeds.

Such demands mean that in the very near future, operators will need mobile networks that offer advanced quality of service capabilities and data speeds that rival those delivered by wireline networks, such as DSL and Cable Modem services.

In addition, the emerging service environment will be one in which capacity can never be taken for granted. A major advantage of 1xEV-DO is that it enables operators to significantly increase voice capacity in a cost effective manner. Operators that adopt VoIP technology can benefit from more cost-effective networks and a chance to seize market share in the lucrative enterprise sector, as well as with low cost offerings to the Small/Medium Business and Mass Market Segments.

How does it work?

In a CDMA network, the base station is the transmission and reception station that acts as the access point for the user to the network and handles network traffic from cdmaOne™ or CDMA2000® 1X voice components and 1xEV-DO simultaneously. 1xEV-DO cards are installed in the base station alongside the CDMA voice cards.

1xEV-DO utilizes the advantages of spread spectrum technologies used in previous CDMA networks, but differs from them by introducing Time Division Multiplexing techniques to ensure the most efficient and fastest delivery of packet data traffic. This is a major innovation compared to earlier CDMA technologies, since TDM improves network performance by enabling multiple users to share the entire downlink channel with each one receiving data at an optimal speed. 1xEV-DO employs a technique called Dynamic Rate Control (DRC) where the base station takes data packets and schedules...
their transmission to a user by honoring a request from the user stating the maximum data rate the device can receive under the current RF conditions. As the user’s RF conditions improve, or worsen, this exchange will vary the data rate ensuring the user receives the optimal throughput while they are connected.

Finally, 1xEV-DO provides re-transmission mechanisms for faster error correction. In a spread spectrum network, it’s the role of the user device to both acknowledge the receipt of data and communicate key information relating to issues like channel condition and power control back to the base station. With 1xEV-DO, when a base station dispatches a data packet to a handset, the base station then waits for an acknowledgement. If it does not receive one within a prescribed time, it assumes that the data packet was lost and retransmits it. The drivers behind this upgrade are the provisioning of optimum bandwidth for all users, the best possible channel conditions and improved performance.

A Radio Network Controller (RNC) has overall control of the 1xEV-DO resources in the base stations and is also responsible for handoffs in the network; a Packet Control Function and a Packet Data Service Node handles and routes packet switched data traffic, and is equivalent to the mobile switching center handling circuit switched traffic in a CDMA voice network. Using an RNC for the packet data traffic minimizes transmission delays in the network by placing key processing at the base station and thus closer to the air interface and the user.

**How do you upgrade?**

While the majority of vendors claim their systems are “1xEV-DO-ready”, the reality is that some are considerably more ready than others. Lucent designed and developed our own 1xEV-DO product to run in our own networks. Many of our competitors rely on outside vendors for their 1xEV-DO components and as a result their products are not as tightly integrated. While other vendors may downplay this, the reality is that RF optimization, Network Provisioning and OA&M are handled as separate entities with no common elements or “look and feel”. The operational impact of this is an increase in OpEx expense and operational complexity as well as the need for multiple sets of training, often resulting in different maintenance staff supporting different elements of the network.

Lucent recognized the cost and efficiency benefits of a 1xEV-DO technology at an early stage. As a result, Lucent’s existing cdmaOne™ and CMA2000® Flexent® Modcells require only a software upgrade and new carrier cards in free slots to support a new 1xEV-DO Rev 0 or Rev A carrier. Alternatively, the 1xEV-DO carrier cards can replace existing cdmaOne™ or CDMA2000® voice cards.

**IMS and the value of end-to-end solutions**

Deploying high-speed data services involves more than just the airlink; it requires an end-to-end service architecture and a unified structure that supports the vast array of applications and services required by the mobile data user. Lucent’s IP Multimedia Subsystem (IMS)-based approach leverages the flexibility of Session Initiation Protocol (SIP). SIP enables multimedia applications such as combined video, voice, presence and content management. Lucent’s end-to-end approach addresses the three logical
functional layers (the Transport and Access Layer, the Call Session Control Layer and the Applications Layer) and supports applications that enable the blended service experience that provides the foundation for valued applications in high-speed 3G networks. IMS is designed to provide access independence, allowing entry by a variety of wireless and wireline IP technologies.

A service provider quickly profits from investment protection by ensuring an access-agnostic architecture. Implementation of 1xEV-DO on IMS components will enable cost savings and time-to-market improvements. Introducing new lifestyle services such as active phone book, broadband roaming and location-based services will create new revenue opportunities. Lucent’s IMS implementation includes a family of Bell Labs developed technologies that go beyond the IMS compliant components, enabling service providers to quickly and cost-effectively deploy new applications and blended services, and enhance the IMS architecture to make it a seamless, portable, personalized, simple and secure network.

The end-user will experience the value in 1xEV-DO-enabled IMS solutions through faster, seamless communications and the ability to maintain common contacts across multiple services. Applications will add multimedia functionality to enhance the experience and enrich data applications with voice capabilities. Users will also be able to share contact lists and stored data among various access devices.

**What about terminals?**

There is a perception that the lack of 3G terminals has acted as a constraint to the widespread adoption of new wireless technologies. This cannot be said of 1xEV-DO. Already many suppliers are offering a wide range of handsets, PDAs, fixed devices and PCMCIA or data only cards. Additionally, new suppliers continue to enter the market to offer new devices.

**Where and why?**

It seems certain that eventually every CDMA market will see 1xEV-DO deployments—the technology offers operators too much of an edge to be ignored. However, the circumstances of individual operators and the competitive environment in specific markets will determine the urgency of deployment.

Greenfield operators could see 1xEV-DO as a means of seizing market share from more established competitors, or even overlaying older 2G technologies with a data only network. 1xEV-DO could be the means through which established players hold their own in aggressively competitive markets.

Capacity gains are clearly important, along with the ability to offer a comprehensive suite of advanced data services. In increasingly aggressive markets, CDMA carriers can benefit in terms of network capacity and capability.

In the Asia/Pacific region, the increasing number of 1xEV-DO deployments is changing the face of the 3G landscape. Competing mobile high-speed data options from multiple service providers are increasing the choices available to end-users, spurring innovation that is driving user adoption.
As far as Europe is concerned, the emerging 450 MHz operators are already deploying 1xEV-DO networks and forcing the incumbent operators to clearly move up the agenda of deploying their own high-speed data solutions to remain competitive.

The future

CDMA2000® 1X was the critical first step in establishing the foundation for 3G mobile networks. It met the ITU’s data speed requirements for full mobility applications and also improved voice capacity. 1xEV-DO Rev 0 completed the ITU’s data speed requirements for pedestrian and fixed applications. 1xEV-DO Rev A takes the next step by exceeding the ITU’s 3G data speed requirements with data rates that are 50% higher than those specified in the standard.

However, there are already plans to push the technology even further. Discussions underway include improvements for 1xEV-DO Revision B that will likely combine multiple carriers to provide a multi-megabit downlink and potentially employ burst mode uplink improvements. Other improvements being considered include the addition of Orthogonal Frequency Division Multiplexing (OFDM) and Multiple-Input Multiple-Output (MIMO) or Intelligent Antenna (IA) capabilities, which will drive even greater throughput increases.

Conclusion

Lucent believes that 1xEV-DO is an extremely cost-effective path to higher data rates and provides the most efficient use of valuable spectrum. Blended with IMS, it enables operators to compete effectively in markets with increasing demands for IP-based converged applications and solutions, satisfy the need for enhanced bandwidth-hungry services, and effectively address latency critical VoIP in an efficient and cost-effective manner.

Today’s markets are hugely competitive. User expectations are formed by their increasing experience with fixed, cable, LAN and wireless networks. 1xEV-DO can meet these expectations and make access to sophisticated mobile IP multimedia services a reality for CDMA carriers and their customers.

With its peerless experience optimizing spread spectrum networks, its key role in the development of the relevant standards and the pioneering work of Bell Labs, Lucent is leading the way in bringing a significant competitive advantage to its operator partners.
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 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.

To learn more about our comprehensive portfolio, please contact your Lucent Technologies Sales Representative or call 1-888-426-2252. On the Continent contact us at +44 (0) 7000 582 368 or email: mobility@lucent.com. In Asia Pacific e-mail: wireless@lucent.com. Visit our web site at http://www.lucent.com

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