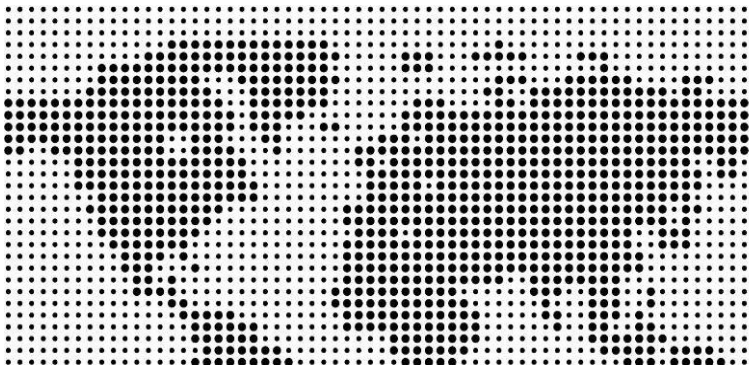
1X Advanced – Four-Fold Increase in Voice Capacity



Qualcomm Incorporated
May 2009

Table of Contents

[1] Executive Summary

Mobile services have witnessed a phenomenal growth in recent years. According to media reports, global mobile subscriptions crossed the 4 billion mark early this year (2009). Remarkably, the last billion came in less than 18 months. Both voice and broadband data service have seen rapid growth, with emerging markets driven primarily by voice services and developed markets registering record broadband data subscriptions. CDMA2000, a leading 3G technology, is at the center of this global proliferation.

CDMA2000 1X is a proven technology adopted by more than 265 operators worldwide and serving more than 400 million subscribers, as of early 2009. 1X with its best-in-class capacity allows operators to offer cost-effective voice services. To keep up with the ever-increasing demand, CDMA2000 1X is evolving to 1X Advanced, a natural next step that quadruples the capacity of today's 1X networks. The unprecedented voice capacity of 1X Advanced allows operators to free up spectrum to efficiently offer high revenue earning EV-DO based broadband data services, or to support more voice demand with the same spectrum.

Operators can transition to 1X Advanced gradually and economically. As a first step, they can easily get up to 50% higher capacity by employing devices with enhanced features (EVRC-B and QLIC), available in the market today. The next step would be to move to 1X Advanced, which is a simple channel card upgrade with new devices. Additionally, they can also pre-seed the market with devices supporting mobile receive diversity to realize up to 2.3x capacity improvement immediately after the channel card upgrade. 1X Advanced is expected to be commercial in second half of 2010.

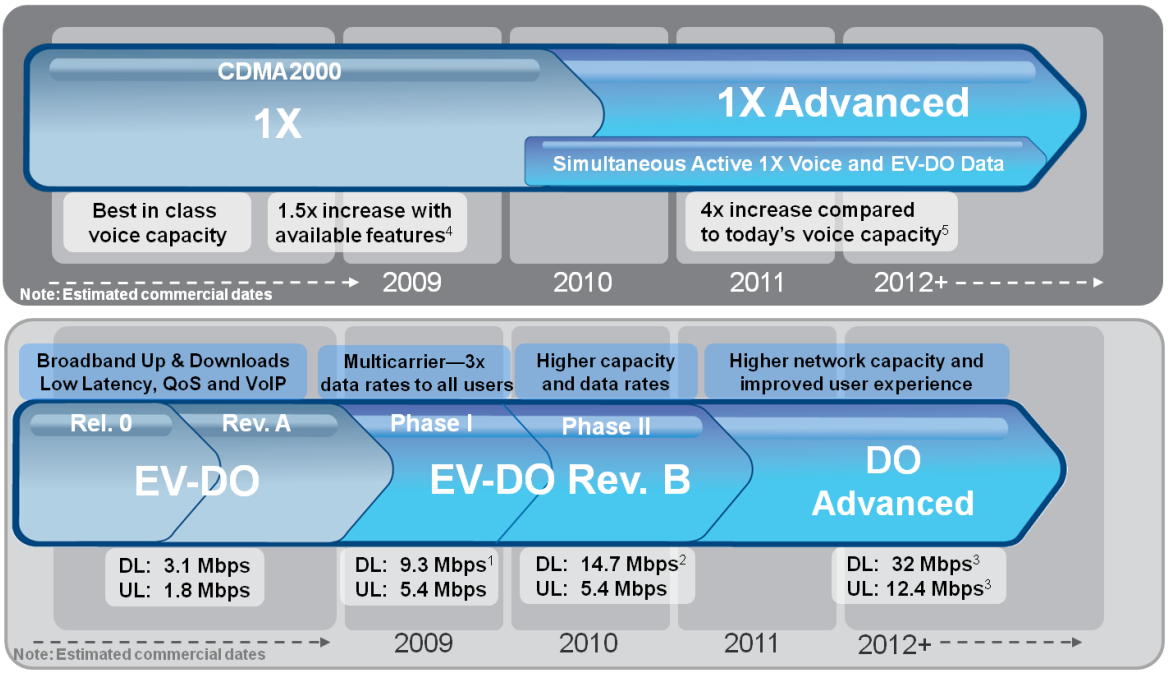
Simultaneous active 1X Voice and EV-DO Data (SVDO) is a complementary device enhancement that will significantly improve user experience without impacting standards or infrastructure. SVDO allows devices to access EV-DO data services while in an active 1X voice call.

[2] Strong CDMA2000 1X and EV-DO Evolution Paths

Ever since its commercialization in 1995, CDMA technology has been at the forefront of wireless innovation. It continues to set new standards in voice and data efficiency. Its 3G version, CDMA2000 is enabling operators to economically address the ever-increasing demand for voice and data services through 1X and EV-DO, respectively.

1X Advanced — Four-Fold Increase in Voice Capacity

As shown in *Figure 1*, both 1X and EV-DO have strong and well established evolution paths. Both of these evolution paths provide simple, cost-effective upgrades that are future-proof and fully backward compatible. This paper focuses on the evolution of CDMA2000 1X and its ability to significantly enhance voice capacity.



[1]Peak rate for 3 EV-DO carriers supported by initial implementation.
[2]Peak rate for 3 EV-DO carriers with 64QAM in the DL. Rev. B standard supports up to 15 aggregated Rev. A carriers.
[3]DO Advanced peak rate for 4 EV-DO carriers, assumes 2x2 MIMO and 64QAM in the DL and 16 QAM in the UL.
[4]Capacity increase possible with new codec (EVRC-B) and handset interference cancellation (QLIC).
[5]4x increase with receive diversity; 3x without

Figure 1: CDMA2000 1X and EV-DO both have strong evolution paths

CDMA2000 1X is the first and most widely deployed 3G technology in the world, as measured by the number of subscribers. It incorporates efficient vocoders, robust power control and soft hand off mechanisms to offer excellent voice quality with best-in-class capacity.

Moreover, CDMA2000 1X is supported by a large ecosystem of device vendors, providing the full range of devices with varying feature sets and price points. CDMA2000 1X's low total cost of ownership has made it a popular choice among both developed and emerging markets.

[3] 1X Advanced is a Natural Next Step for CDMA2000 1X

In the era of “unlimited voice” offerings and the emergence of voice-centric developing markets, operators are in search of efficient voice solutions. At the same time, the growing popularity of broadband data is compelling operators to dedicate increasingly larger quantities of spectrum to data services. The evolution of CDMA2000 1X, of which 1X Advanced is a cornerstone, is designed to fulfill such needs.

1X Advanced, by providing a significant capacity increase over today’s 1X networks and being a simple incremental upgrade, is a natural next step for CDMA2000 1X.

3.1 Device Enhancements Provide Up to 50% Improvement in Capacity

As a first step toward 1X Advanced, operators can easily get up to a 50% increase in capacity by utilizing new devices with a more efficient vocoder EVRC-B (4GV™-B) and device interference cancellation QLIC. The network side requires a software upgrade to support the new vocoder. Devices with these enhancements are commercially available today and are already deployed in the field.

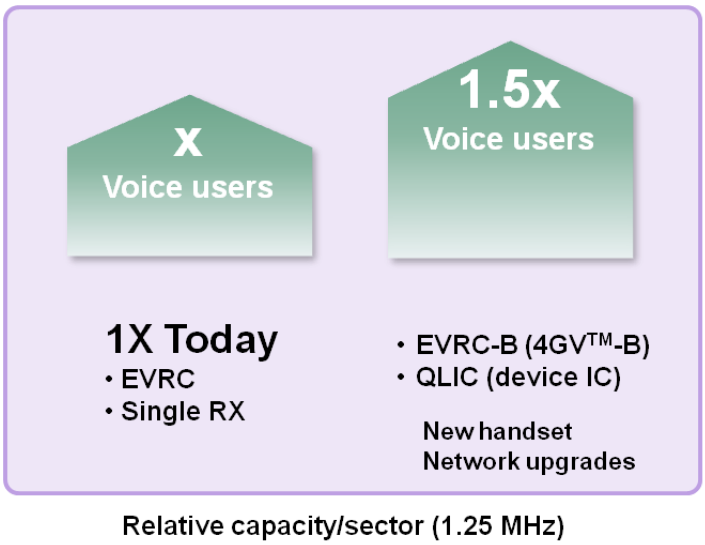


Figure 2: Up to 50% increase in capacity with available enhancements

EVRC-B, a mode of Qualcomm's 4GV™ suite of voice codec technologies, is a new, highly efficient vocoder. EVRC-B offers higher capacity than the EVRC vocoder used in most of today's CDMA devices, while providing the same voice quality.

QLIC is a forward link interference cancellation feature incorporated in the device. QLIC essentially removes intra and inter sector interference experienced by the device. This decrease in interference results in an increase in overall forward link capacity.

Both EVRC-B and QLIC are already supported in many commercial devices based on Qualcomm's MSMs. In fact, some operators have already deployed these devices, along with the upgrades to their networks.

3.2 1X Advanced Offers 4x Voice Capacity Increase

1X Advanced builds on the aforementioned enhancements and provides a four-fold increase in capacity by applying interference cancellation and other enhancements to proven 1X technology. *Figure 3* shows the evolution of voice capacity leading up to 1X Advanced. The unprecedented four-fold capacity increase includes the 50% increase achieved through available enhancements discussed in the previous section.

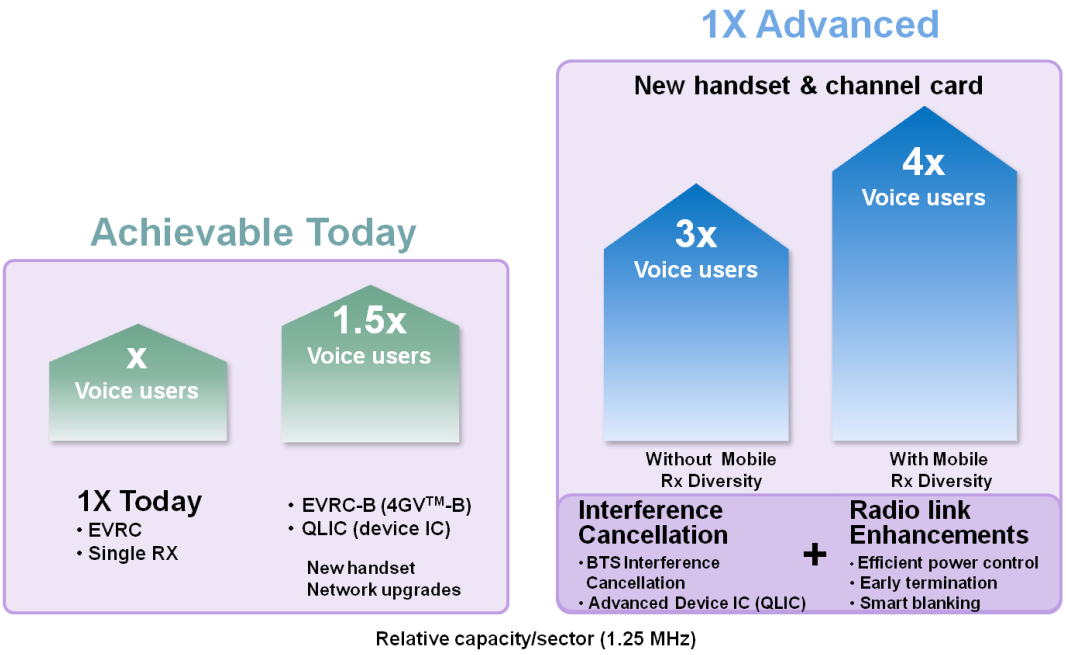


Figure 3: 1X Advanced offers up to 4x increase over today's 1X capacity

1X Advanced — Four-Fold Increase in Voice Capacity

1X Advanced is a simple incremental upgrade to the existing infrastructure with channel cards based on a new CSM (cell site modem), interoperating with 1X Advanced new devices.

As shown in Figure 4, 1X Advanced incorporates interference cancellation, radio link enhancements and mobile receive diversity to increase capacity.

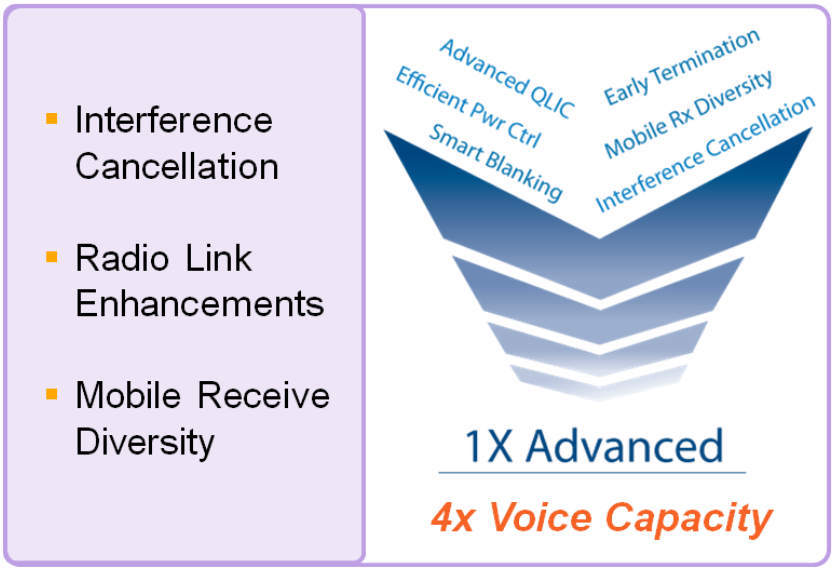


Figure 4: 1X Advanced applies IC and other enhancements to today's 1X

Interference Cancellation (IC): In any wireless system, particularly CDMA, the radio link capacity is dependent on the signal-to-interference ratio. Evidently, any reduction that can be achieved in interference improves this ratio, and hence the capacity.

The Interference Cancellation technique has been known in theory for some time. But until recently, it was not possible to commercially implement it in microcircuits (chips) because it required new levels of processing power and high-speed memory. Thanks to the latest semiconductor technology, the memory and processing capabilities of chips are at a stage now that makes IC a reality. Qualcomm was one of the first vendors to introduce commercial CSM and MSM platforms that support IC.

1X Advanced incorporates both uplink (reverse link) IC, performed at the BTS, and downlink (forward link) IC, performed at the device. Uplink IC, sometime referred to as BTS IC or RLIC, is supported in the new CSM. 1X Advanced devices will have Advanced QLIC – the enhanced version of QLIC that is already commercially available in many MSMs and devices.

Mobile Receive Diversity (MRD): Mobile receive diversity is a device enhancement that improves capacity without impacting infrastructure or requiring new standards. It uses two receiver chains with two antennas to improve capacity. MRD is already supported in many commercial EV-DO Rev. A and HSPA PC cards as well as USB dongles. Qualcomm's many commercial MSMs support receive diversity today.

Other radio enhancements: 1X Advanced incorporates many enhancements to improve voice efficiency, most of which are already proven with EV-DO VoIP technology. Following are details regarding these enhancements:

- Efficient Power Control – reduces the signaling overhead
- Smart Blanking of 1/8th rate frames – reduces resource utilization during quiet periods in speech
- Early Termination – exploits the times when the device is in good RF conditions
- QOF (Quasi Orthogonal Function) – increases the number of simultaneous calls supported.

The above enhancements complement each other and ensure that the capacity in both uplink and downlink is increased and balanced.

3.3 Early Time-to-Market by Leveraging Available MSMs with MRD

As mentioned in the previous section, BTS IC and MRD contribute substantially to the gains achieved with 1X Advanced. Qualcomm's many commercially available MSMs support MRD today, allowing operators to pre-seed the market with devices supporting MRD. This not only improves the capacity of existing networks, but also sets the stage for an immediate capacity boost when the network is upgraded with new channel card supporting BTS IC.

As illustrated in *Figure 5*, pre-seeding can provide up to 2.3 times increase immediately after the new channel card upgrade. Also, from a commercialization perspective, it is expected that the new channel card will support BTS IC in the first release, followed by support for other enhancements coming in the later releases.

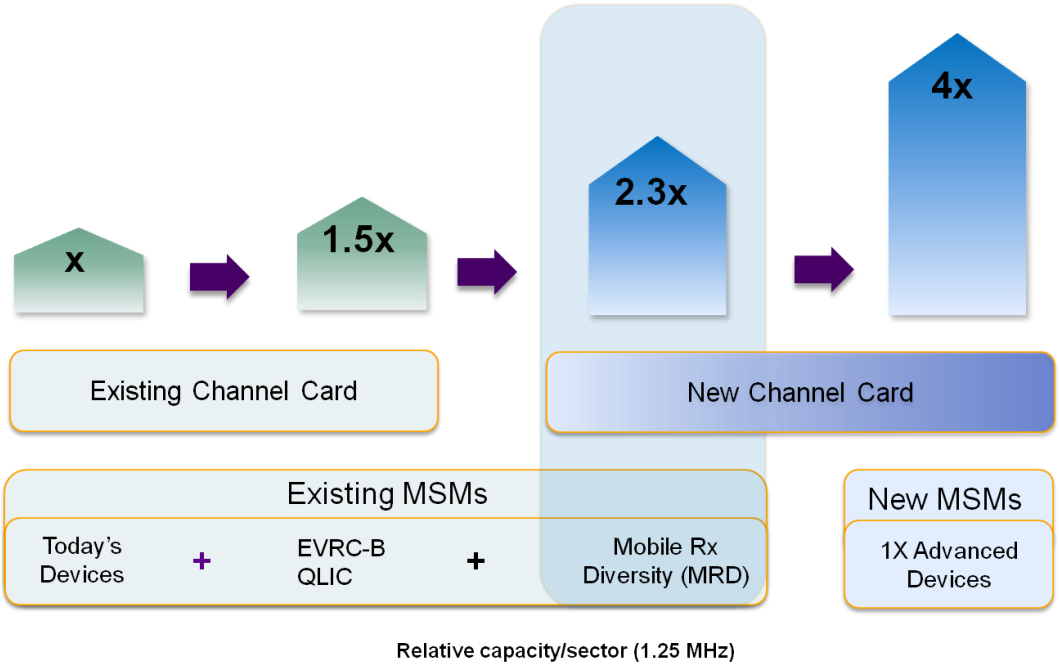


Figure 5: Immediate up to 2.3x capacity increase by pre-seeding the market with MRD devices

[4] 1X Advanced Frees Up Spectrum for EV-DO Data

1X Advanced uses only a quarter of the spectrum to support the same amount of voice traffic as 1X today, freeing up precious spectrum resources. The freed-up spectrum can be used efficiently to offer high revenue earning EV-DO broadband data services, as illustrated in *Figure 6.*

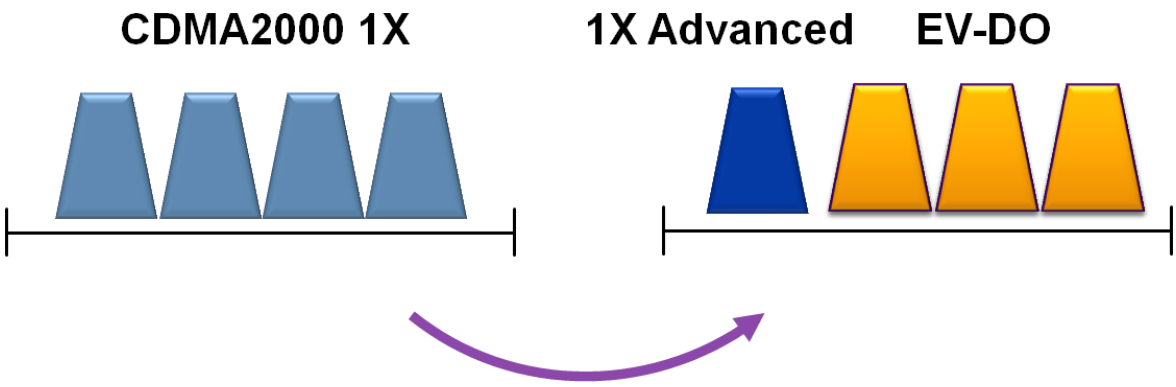


Figure 6: 1X Advanced frees up spectrum for EV-DO data

As noted earlier, voice traffic is still a major driver in some markets. 1X Advanced allows operators in such markets to easily support the increase in voice traffic without the need for additional spectrum. With unlimited voice plans gaining popularity, 1X Advanced helps operators to economically offer such plans.

In many markets, voice traffic is leveling off with broadband data traffic substantially ramping up. In such a scenario, 1X Advanced helps operators dedicate more spectrum to EV-DO for broadband data services while sustaining the same amount of voice traffic.

[5] Simultaneous Active 1X Voice and EV-DO Data Improves the User Experience

Simultaneous active 1X voice and EV-DO data, sometimes referred to as SVDO, is a new standard-independent device feature that significantly enhances the user experience without impacting the infrastructure side.

In today's networks, a device can be paged to receive 1X voice calls while in an EV-DO data session. However, no data connectivity is possible while in a voice call. SVDO establishes independent voice and data sessions using separate transmit and receive chains in the device, as shown in *Figure 7*.

The SVDO feature can be effectively utilized by many applications. For example, users will be able to send emails or access the Web while on voice calls; phones with GPS can update maps or download real-time traffic information while on voice calls, etc.

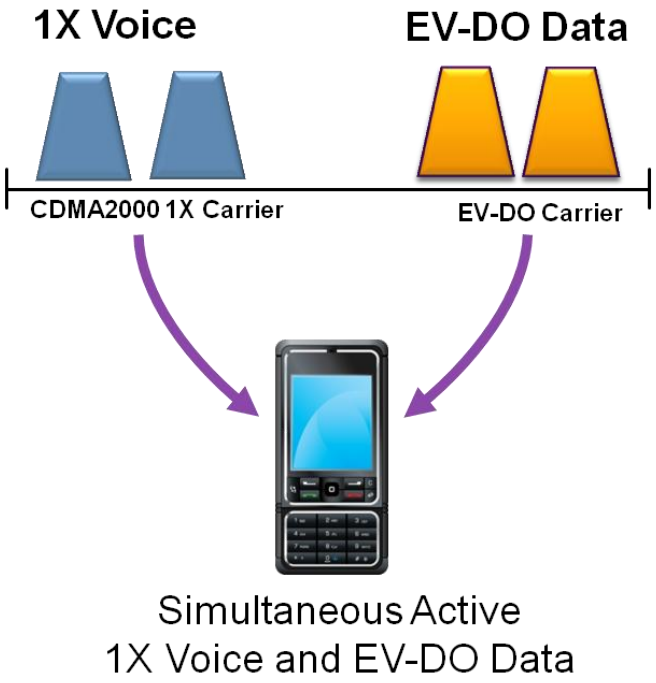


Figure 7: SVDO establishes independent 1X voice and EV-DO data sessions

The SVDO feature will be supported in new devices, and will work with 1X or 1X Advanced with EV-DO Rev. A or Rev. B. Qualcomm is planning to support the SVDO feature in all of its new EV-DO MSM chipsets.

[6] Conclusion

CDMA2000 1X has a strong evolution path, allowing operators to effectively support increasing voice demand. CDMA2000 1X provides best-in-class voice capacity and has been adopted by more than 265 operators around the world.

Operators can increase the capacity of today's 1X networks by up to 50% by employing commercially available device enhancements along with a software upgrade to the infrastructure.

1X Advanced provides a four-fold increase over today's 1X capacity by applying interference cancellation and other enhancements to proven 1X technology. 1X Advanced is a simple channel card upgrade based on a new CSM. The higher capacity of 1X Advanced frees up precious spectrum resources which can be used to offer more voice or EV-DO based broadband data services. SVDO is a new standard-independent

device feature that enhances the user experience without impacting the infrastructure.

In essence, 1X Advanced is a cost-effective natural next step for today's CDMA2000 1X networks, providing protection for operators' current investments.