CDMA2000—A world view

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The world's first CDMA2000 networks were launched in Korea in October 2000, providing 144 kbit/s data rates to subscribing customers and delivering nearly twice the voice capacity that operators experienced with their cdmaOne (IS-95) systems. The success of the CDMA2000 1X system in Korea has encouraged many operators in the Americas and Asia to follow through with their plans to launch CDMA2000 this year.

The authors outline some of the products and describe product advantages that Ericsson CDMA customers will gain when rolling out Ericsson's CMS 11 R3 to provide third-generation services early next year. The authors also describe some of the key enablers in CMS 11 R3.

Updates in the evolution of CDMA2000

Since the spring of 2000, the evolution of third-generation CDMA systems has changed dramatically. Previously, the industry was focused on a widerband approach to high data rates—commonly referred to as CDMA2000 3X or 3XRTT. The 3X standard has now been superseded by a two-phase strategy called CDMA2000 1xEV, where 1xEV stands for 1X evolution, or evolution using 1.25 MHz. Today's CDMA2000 1X systems are based on a standard 1.25 MHz carrier for delivering high data rates and increased voice capacity (Figure 1).

Advances in the industry and engineering prowess contributed to new proposals for higher data throughput and more capacity while maintaining the 1.25 MHz bandwidth. Operators and manufactures soon realized that there were inherent cost, backward compatibility and timing advantages in keeping with the 1.25 MHz bandwidth for evolution. Thus, CDMA2000 3X has now been put on the wayside until market demands make it necessary to migrate to a widerband carrier (3.75 MHz).

1xEV-DO

The two phases of 1xEV are labeled 1xEV-DO and 1xEV-DV. *D0* stands for data only; *DV* stands for data and voice. CDMA2000 1xEV-DO was standardized by the Telecommunications Industry Association (TIA) in October 2000. 1xEV-DO was recently recognized by the ITU-R WP8F as an IMT-2000 standard. Formal approval is expected to be granted in November, when the standard is submitted to ITU-R SG-8. Ericsson has made significant contributions to the standard, including the provisions for handoff and interoperability with the CDMA2000 1X standard.

1xEV-DO can provide customers with peak data rates of 2.4 Mbit/s. To implement 1xEV-DO, operators will have to install a separate carrier that is dedicated to data-only use at each cell location where high-speed data services are demanded. However, customers will be able to handoff seamlessly from a 1X to a 1xEV-DO carrier (Figure 2).

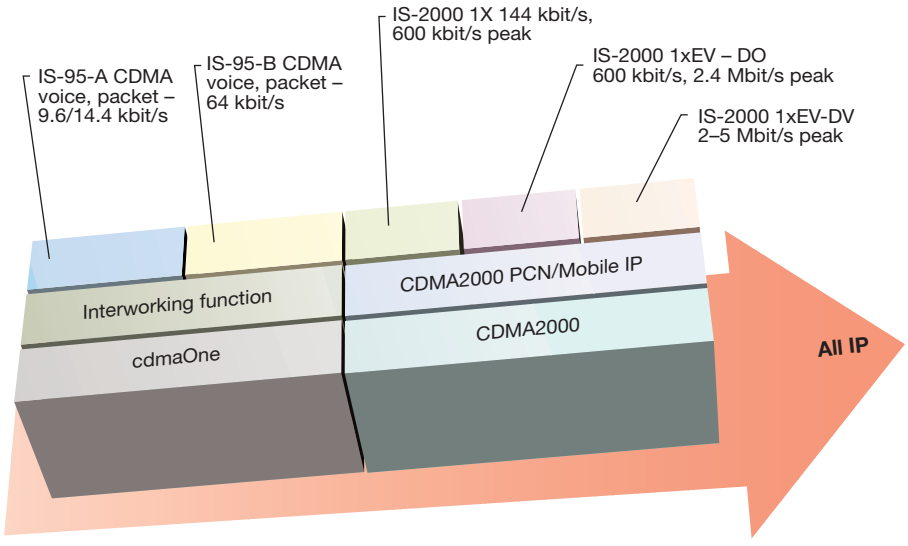


Figure 1
CDMA standards evolution.

The first 1xEV-DO systems will be launched in 2002, approximately 18 months after the launch of the first CDMA2000 1X system. Ericsson products are scheduled for delivery in late 2002 as part of CMS 11 R4.

1xEV-DV

The second phase of the 1xEV standardization is currently underway, and a goal has been set to complete the 1xEV-DV standard by the end of 2001. Several proposals are on the table for this phase of third-generation CDMA. Operator requirements, laid out with the help of the CDMA Development Group (CDG), focus on providing high-speed data and voice on one carrier—thereby eliminating the need for a separate carrier. Also, provisions should be made for delivering

- real-time packet-data services; and
- better mechanisms for guaranteeing a given quality of service.

Likewise, improved average throughput and peak rates are expected as well as greater capacity for voice. These are lofty goals for a standardization body that must deliver all this using the same 1.25 MHz carrier, but many people feel that the goals can be attained.

It is too early to confirm what the final standard for 1xEV-DV will offer CDMA operators and customers, but continued evolution with 1.25 MHz will speed up rollout, lower costs, and guarantee easily maintained backward compatibility with previous systems. 1xEV-DV systems are anticipated to be available in 2003 or 2004.

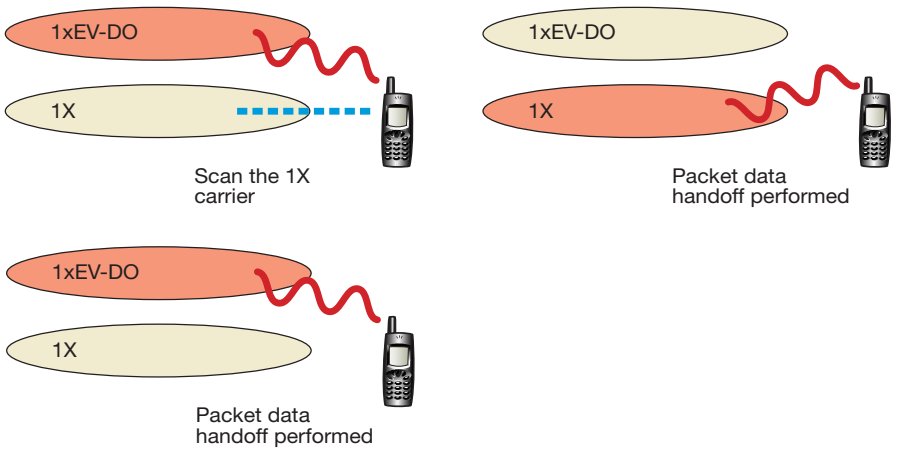


Figure 2
The CDMA2000 1X and CDMA2000 1xEV-DO interworking function provides faster end-user data connections.

Core network evolution

While the media focus seems to be primarily on the air-interface evolution of CDMA2000, other standards groups, namely the Third-generation Partnership Project Two (3GPP2) and TIA, are quietly and dili-

BOX A, TERMS AND ABBREVIATIONS

1X	From CDMA2000 1X (IS-2000), derived from 1XRTT, signifying 1 x 1.25 MHz carrier	DSSS	Direct-sequence spread spectrum	PCN	Packet core network
1xEV	1X evolution	GSM	Global system for mobile communication	PDA	Personal digital assistant
1xEV-DO	1xEV data only	HA	Home agent	PDSN	Packet data service node
1xEV-DV	1xEV data and voice	HLR	Home location register	QoS	Quality of service
3GPP/3GPP2	Third-generation Partnership Project/Two	IDAE	Integrated distributed application environment	RAN	Radio access network
3X	From CDMA2000 3X (IS-2000-A), derived from 3XRTT, signifing 3 x 1.25 MHz carriers	IEEE	Institute of Electrical and Electronics Engineers	RBS	Radio base station
AAA	Authentication, authorization and accounting	IETF	Internet Engineering Task Force	RNC	Radio network controller
AC	Authentication center	IOS	Interoperability standard	RNM	Radio network manager
ANSI	American National Standards Institute	IP	Internet protocol	SCP	Service control point
API	Application program interface	IRP	Integration reference point	SDK	Software development kit
ATM	Asynchronous transfer mode	ITU	International Telecommunication Union	SLA	Service level agreement
BSC	Base station controller	IWF	Interworking function	SMS	Short message service
BSS	Base station subsystem	LAN	Local area network	SMS-C	SMS center
CDG	CDMA Development Group	MCPA	Multicarrier power amplifier	TDMA	Time-division multiple access
CDMA	Code-division multiple access	MIP	Mobile IP	TIA	Telecommunications Industry Association
CPP	Cello packet platform	MSC	Mobile switching center	TMN	Telecommunications management network
		NMS	Network management system	WAP	Wireless application protocol
		OAM&P	Operation, administration, maintenance, and provisioning	WCDMA	Wideband CDMA
				WIN	Wireless intelligent network
				WLAN	Wireless LAN
				WML	WAP markup language
				WSN	WLAN serving node

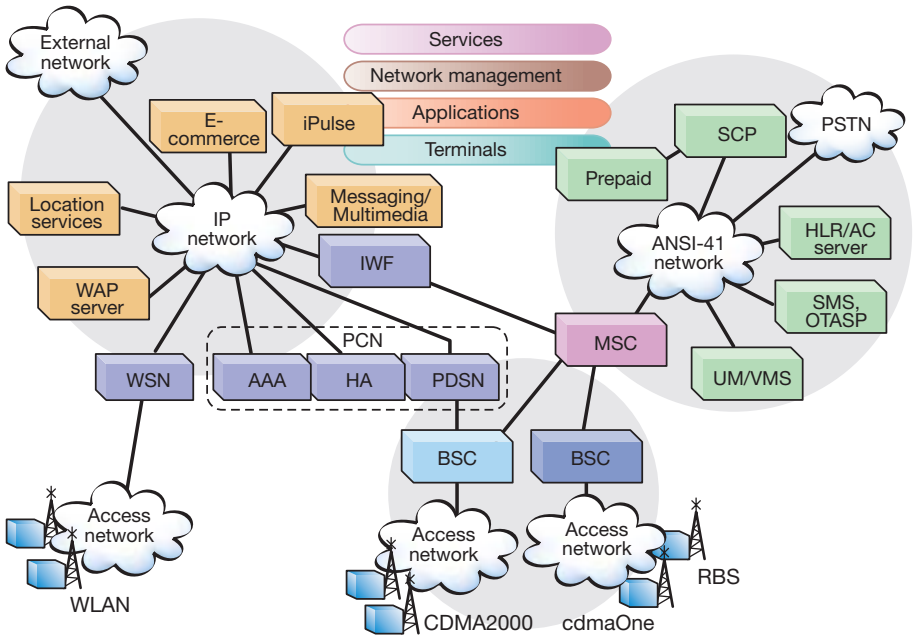


Figure 3
Total CDMA solution.

gently working on the core network evolution of CDMA2000, which starts with the introduction of a packet core network and evolves all the way to a system that can deliver services using IP protocols from end to end. Ericsson has been a key contributor to this work, primarily by bringing in expertise from the standardization of all-IP in 3GPP. The evolution to all-IP for CDMA2000 systems is based on existing Internet protocols and standards. The work in 3GPP2 is also closely tied to work in the Internet Engineering Task Force (IETF).

As core networks evolve, synergies between CDMA2000 and WCDMA networks will be beneficial to global operators and to the industry as a whole. Interoperability in the network between various air interfaces and other access media will become more and more important as wireless service providers expand the scope of their telecommunications businesses through partnerships and increased service offerings. Ericsson has already begun laying out product plans for future releases of CDMA2000 core network components.

Ericsson's CDMA2000 1X products

Ericsson's CDMA2000 1X products are part of the CMS 11 R3 product plans, which will be commercially available in 2002. Many of the products have been built from the ground up or have been taken from the global technology platform used for WCDMA. This gives Ericsson a lead over the competition. Also, the macro radio base station (RBS) designs in a micro package continue to lead the CDMA industry in many ways.

With CMS 11 R3 products, key changes will be made in the fundamentals of CDMA, including higher-speed data capabilities, always-on connectivity, and vastly improved voice capacity. A new system node, the packet core network (PCN), has been introduced for connection to the IP network (Figure 3). These fundamental product changes will benefit both cdmaOne and TDMA operators who migrate their networks to CDMA2000.

Radio access network

CMS 11 R3 is a commercial radio access network (RAN) product that implements the IS-2000-A standard for CDMA wireless communication. The CMS 11 is a third-generation mobile communications system that is capable of supporting the communication needs of mobile users in a third-generation environment. The Ericsson radio access network uses an IS-2000 air interface and the ANSI-41 core network. (Re-use of components in the ANSI-41 network are es-

pecially beneficial to TDMA operators who plan to implement CDMA2000 for third-generation services.) The RAN, which consists of the BSC 1120 (base station controller, BSC), the RBS 1127, and the radio network manager (RNM), is interoperable with switches from numerous vendors via the interoperability standard (IOS) interface. Ericsson's third-generation CDMA2000 radio access network (CDMA2000 RAN) makes it possible to offer advanced mobile multimedia applications between user equipment (mobile phones, terminals, personal digital assistants, and laptops) and a packet core network linked to Internet applications.

Radio base station

Ericsson is the world leader in the design of compact, large-capacity radio base stations for all CDMA standards. All of Ericsson's RBS products offer the most advanced technology available in attractive, compact models.

The RBS 1127, which is one of Ericsson's CDMA2000 radio base stations, is targeted for use in a broad range of small-to-large-capacity applications, supporting a maximum configuration of four radio frequency (RF) carriers with three sectors per carrier. Compared to IS-95 base stations, the RBS 1127 provides nearly twice the voice capacity per carrier. It also provides quick paging and higher data rates as defined by the IS-2000 (CDMA2000) standard. Being economical and scalable, the RBS 1127 provides multi-carrier capability in a low-profile and compact solution, and allows for low-cost growth through the deployment of additional remote units. What is more, the RBS 1127 has been designed to provide high reliability and to accommodate future CDMA2000 capabilities, such as 1xEV. Its design has been optimized for rapid installation and ease of maintenance, in order to limit capital and operating expenses. It supports both the 800 MHz and 1900 MHz frequency bands, and is IS-2000- and IS-95-compliant to, as well as backward compatible with, existing IS-95-based mobile stations.

The RBS 1127 Compact is an indoor/outdoor radio base station that consists of one main unit and up to six remote units. As shown in Figure 4, each remote unit can support one sector and up to two RF carriers. An additional remote unit can be deployed in each sector to support up to four RF carriers in a three-sector configuration. The main and remote units are small enough to be easily mounted to a pole, tower, wall or other suitable surfaces. Operators can first deploy a single carrier cell, and later, in a cost-effective manner, increase the capacity of the RBS 1127 as the capacity of the cell increases.

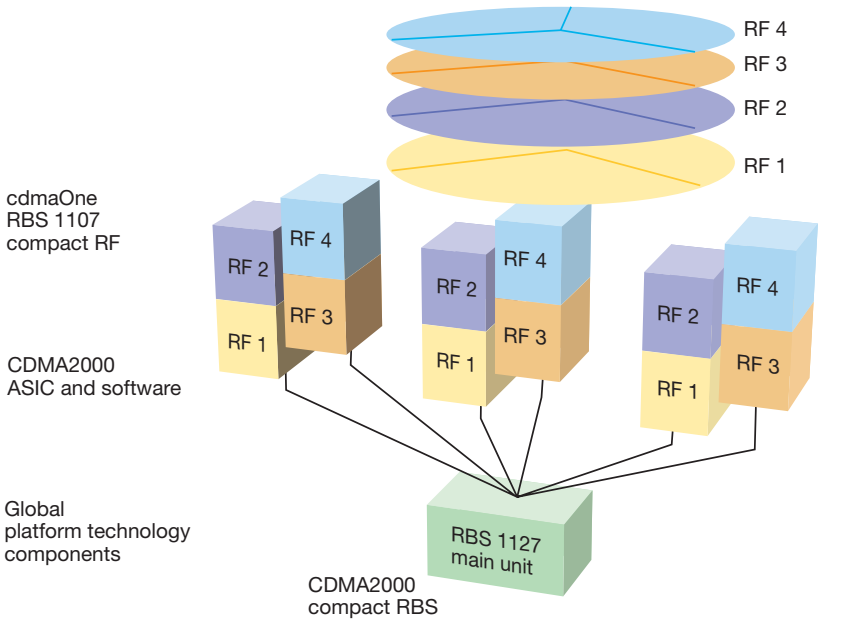


Figure 4
The highly scalable RBS 1127 Compact, whose performance-to size ratio is the best in the industry.

Base station controller

The BSC 1120 is the latest base station controller from Ericsson's new line of products built for the CDMA2000 network. The BSC 1120 is a modern, high-availability base station controller built on the Cello packet platform (CPP), which is Ericsson's asynchronous transfer mode (ATM) transport and control platform. The CPP is used in a wide range of products, such as the CDMA2000 RBS, WCDMA RNC, WCDMA RBS, media gateways, and IP routers.

When designing the BSC 1120, the developers wanted to make it modular and cost-effective both for small and large systems. The product's modular architecture supports growth in traffic channel capacity from as few as 96 channels to as many as 6,144, which makes the BSC 1120 extremely scalable.

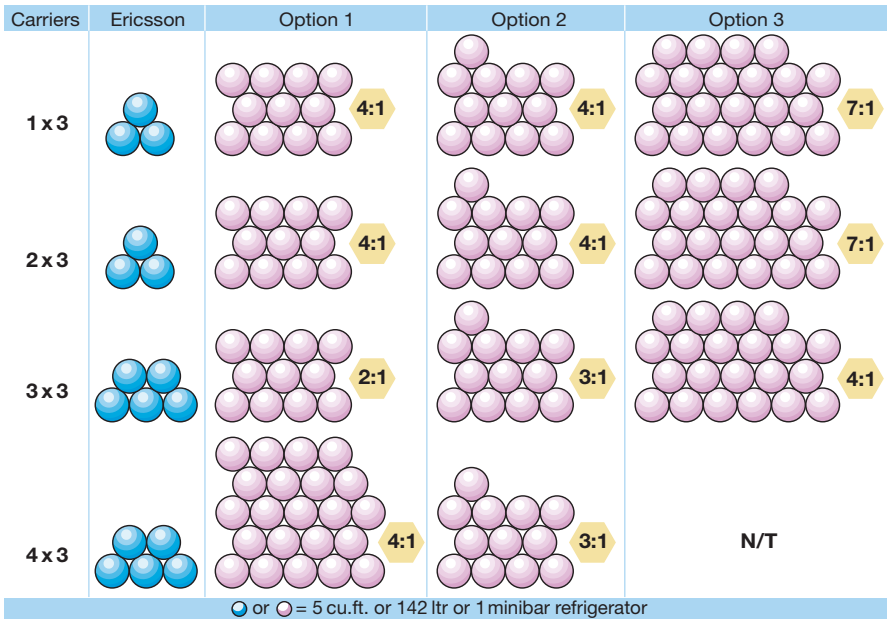


Figure 5
RBS performance-to-size comparison. The RBS 1127 Compact delivers three times as much performance (number of carriers) per unit of space.

The BSC 1120 has been designed with high availability as an integral part of the hardware and software architecture. There are no single points of failure in the hardware architecture. Each shelf in the unit supports the ability to hot-swap boards and power supplies. All software components are either distributed (*n+1* redundancy) or have hot-standby counterparts (*1+1* redundancy). The resulting product is 99.999 percent available with at least 50% of maximum capacity fully operational. Total system downtime is less than six minutes per year. Moreover, the BSC 1120 does not require any total system downtime during software upgrades.

The Ericsson BSC 1120 has been designed to be compliant with IOS 4.0. This gives service providers the freedom to build their networks using the best available products from other IOS-compliant equipment vendors. Ericsson's CDMA2000 RAN is uniquely positioned to provide a plug-and-play wireless system that can connect to a variety of switching platforms, including switches from Alcatel, Nortel and Lucent. Open systems allow operators to maximize the potential of their existing switch investments and create competition through the rapid evolution of equipment and technology. They also give operators the freedom to choose from among various suppliers for optimum system performance and price. By choosing a standardized open interface, operators can ensure interoperability now and in the future through a clear migration path to other IOS devices.

Differentiation from the competition

An analysis made of competitive offerings for CDMA2000 infrastructure showed that Ericsson is in the lead, especially when it comes to the footprint-to-capacity ratio of infrastructure. This ratio is a way of measuring the overall size of the offered infrastructure with the overall performance (capacity, number of carriers, and so on.) Ericsson's CDMA2000 offering thus leads the industry in terms of the RBS, BSC and mobile switching center (Figure 5).

The Ericsson 1120 BSC also leads the CDMA industry in terms of footprint-to-capacity: Ericsson can provide its customers with 7,500 erlangs of support in just three racks, thanks to a brand new platform for third-generation services. Most competitors are solely offering upgrades to existing, large second-generation BSCs. Ericsson is thus leap-frogging ahead of the competition with new performance-enhancing and space-saving products (Figure 6).

Mobile switching center

The CMS 11 R3 introduces CDMA2000 1X support in the mobile switching center (MSC) along with several other software features. The MSC Version 3 software for cdmaOne and CDMA2000 networks can be applied to both the CMX64 and CMX3G platforms.

Release 3.2 includes version 3 of the MSC software features. Enhanced capabilities include support for the CDG IOS version 4.0 for cdmaOne and CDMA2000 interoperability, and much more. Feature compatibility with ANSI-41 services is also a plus for TDMA operators who migrate to CDMA2000.

Internet services platform and mobile Internet enablers

Several new nodes or node enhancements will be available to Ericsson's CDMA customers, enabling them to offer advanced calling and mobile Internet services, and to build a multi-access Internet services net-

work. CMS 11 R1 and R2 introduced the AXC 700 interworking function (IWF), which is necessary for providing IS-9-A data services. This application functionality (provided in software) runs on the Tigris AccessOS; thus, the AXC 700 IWF provides smooth migration from second- to third-generation networks. The interworking function, for example, can be upgraded to support the packet data service node (PDSN) function in the packet core network. An added benefit of the AXC 700 IWF is the flexibility it affords operators in redeploying and reconfiguring the hardware platform to meet changing application requirements.

Ericsson's CDMA mobile Internet and data solutions give customers the opportunity to enhance their current service offering and to find new avenues for adding usage minutes, new subscriber services, and most importantly, new subscribers. Ericsson is also establishing partnerships with application and content providers to give customers end-to-end solutions for data services. All of Ericsson's service-network and data-enabling products are based on industry-standard open interfaces to ensure compatibility in multi-vendor environments.

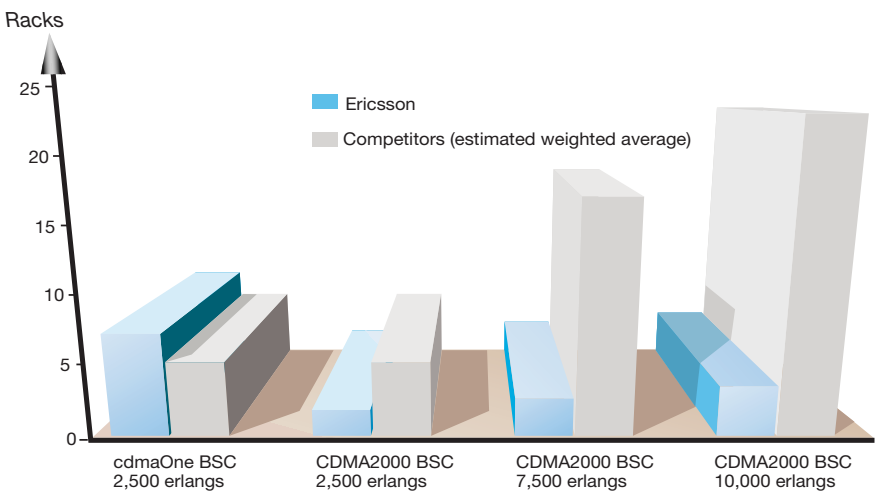


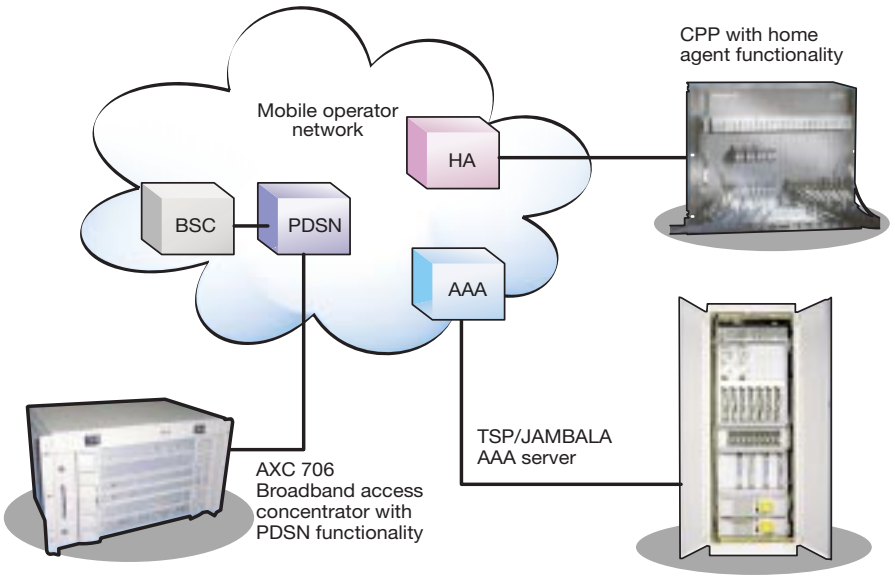
Figure 6
Ericsson's cdmaOne BSC and CDMA2000 BSC performance-to-size comparison relative to the industry average.

Packet core network

Ericsson's CDMA2000 packet core network is the cornerstone of end-to-end IP-based wireless services in a CDMA2000 network (Figure 7). The PCN product line enables operators to capture the full revenue streams from the CDMA2000 network as well as circuit mode fax and data services. The packet core network links the radio access network with rapidly evolving services using IP networks, such as the public Internet, a private operator IP service network, Internet service providers, corporate intranets, wireless local area networks (LAN), or any other IP network. PCN products—also referred to as nodes—are the PDSN, home agent (HA), and the authentication, authorization and accounting (AAA) policy framework. The PDSN and HA—which are the payload-handling nodes—have been developed on Ericsson's access routers. The IP policy management capability that resides in AAA provides operators with a flexible and efficient tool for launching new services in their networks. Service innovation and customer care are critical factors for success in capturing new revenues and retaining customers.

Ericsson's packet core network for CDMA2000 supports wireless mobility with Mobile IP (MIP) as a fundamental part of the architecture. The use of Mobile IP enables true Internet mobility. The open interface to the radio access network uses the IOS R-P interface.

Figure 7
The nodes of the packet core network (PCN):
· packet data service node (PDSN);
· home agent (HA); and
· authentication, authorization and accounting (AAA)..



Wireless LAN

The Ericsson set of direct-sequence spread spectrum (DSSS) wireless LAN (Figure 8) products will be introduced in CMS 11 R3. The use of Mobile IP protocols in CDMA2000 packet core networks has enabled quick integration of Ericsson's WLAN products.

The wireless LAN provides a bridging architecture between radio and wired networks. The products, which will operate in the license-free frequency band between 2.4 and 2.5 GHz, are based on the IEEE 802.11b standard. The product has been integrated into CDMA2000 through the new wireless LAN serving node (WSN). Wireless LAN provides complementary mobility to CDMA customers. In the future, when it is combined with Bluetooth, the complete circle of coverage (local, personal, and wide-area) can be obtained for all locations and services demanded by wireless users.

Internet services platform

Ericsson's Internet services platform will be made up of basic enabling nodes, applications, and consulting services. The primary service enablers will be wireless application protocol (WAP) gateways, mobile positioning centers, wireless intelligent networking/service control points (WIN/SCP), and short message service centers (SMS-C). Service network platform solutions will consist of messaging services, iPulse, mobile positioning services, mobile e-commerce, and service network management (including billing mediation, and service provisioning).

The TSP, which WCDMA, GSM, TDMA and wireline systems share, is another example of Ericsson's global platform strategy. This core technology platform, based on the TelORB operating system, provides a telecommunications operating environment for applications such as the home location register (HLR), authentication center (AC), and service control point (SCP), and will be used to deliver a host of other advanced applications. The HLR, AC, and SCP can be co-located on the same, shared-hardware TSP application platform, which increases its value as a cost-effective solution. Importantly, it has been developed on standard interfaces and is being deployed in networks based on several different digital wireless technologies as well as for wireline systems. One of its main benefits is scalability, a feature that allows operators to pay as they grow.

In CMS 11 R3, Ericsson also offers a unified messaging solution that handles any kind of message. It is based on an open, scalable and easy-to-use architecture with standard interfaces and protocols. With unified messaging, end-users are free to manage all messages, such as voice, text, fax and video, anywhere and anytime. All messages are stored in one mailbox. Subscribers access their mailboxes through a number of interfaces such as the Web, an e-mail client, a WAP browser or the device user interface. The messages are thus accessible from any type of device (mobile or fixed phone, PDA or PC). In Ericsson's unified messaging solution, every message is considered an e-mail message. Audio (including voice), fax, and video messages are stored as e-mail attachments. End-users can send, forward and store any type of message just as they would with regular e-mail. Unified messaging-over-IP has connectivity to GSM, TDMA, CDMA, WCDMA and GPRS. Likewise, it easily integrates into other mobile Internet services, such as portals, m-commerce, information, communication and customer-care systems.

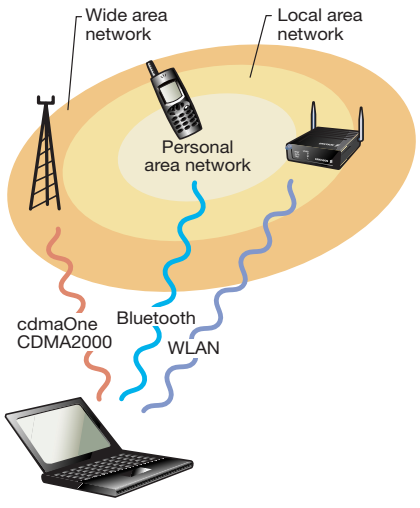
The WAP gateway bridges the gap between the Internet and wireless networks for handsets and terminals whose display and performance attributes differ from those of personal computers. It implements the WAP standard by optimizing data for wireless networks and by taking into consideration the form factor of wireless devices. The WAP gateway connects any WAP-compliant terminal to any Web server on the Internet or an intranet. It can access native WAP markup language (WML) content or convert hypertext markup language (HTML) into WML content for multiple types of bearers, such as circuit-switched data, packet data and short message service.

The WAP gateway will give operators the ability to offer a variety of wireless data services, which will add service differentiation through new and exciting applications. These services can be a significant asset in attracting additional clients and reducing customer churn.

OAM&P solutions for CDMA

Ericsson's operation, administration, maintenance, and provisioning (OAM&P) solution for CDMA allows customers to efficiently manage their network planning, service provisioning, service assurance, and billing and customer-care processes. The network-wide integrated OAM&P solution

Figure 8
Integration of wireless LAN and CDMA.



includes fault management, configuration management, performance management, security management, and access to external business- and service-management systems through the service provisioning and billing mediation gateways. The goal of Ericsson's OAM&P offering is

- to manage the operations in a cost-effective way;
- to proactively adapt to the changing business environment;
- to deploy services faster to the market; and
- to integrate into external systems through open standards.

The solution complies with the telecommunications management network (TMN) model, provides the necessary functions at the element-management and network-management layers, and interacts with the service- and business-management layers.

Being based on industry standards and open platforms, the solution provides the flexibility and scalability that is necessary to effectively manage future network expansion in terms of size, capacity, and services. What is more, the use of open standard interfaces and protocols ensures compatibility with current and future application systems supplied by Ericsson and other vendors. The CDMA2000 OAM&P solution uses different products from a range of internal research and development (R&D) resources (such as WCDMA and GSM) to provide common management functions across multi-standard networks. These products have been complemented by best-of-breed applications from strategic partners and joint ventures.

The main function of Ericsson's OAM&P solution is to provide element management, network management, and gateways to the service- and business-management layers of the TMN model (Figure 9). Ericsson also offers complementary solutions that specifically cover the service- and business-management layers. The product portfolio offering also provides support for the end-to-end management of business processes (service fulfillment, service assurance, service and network planning, customer care and billing) that cover all the management layers.

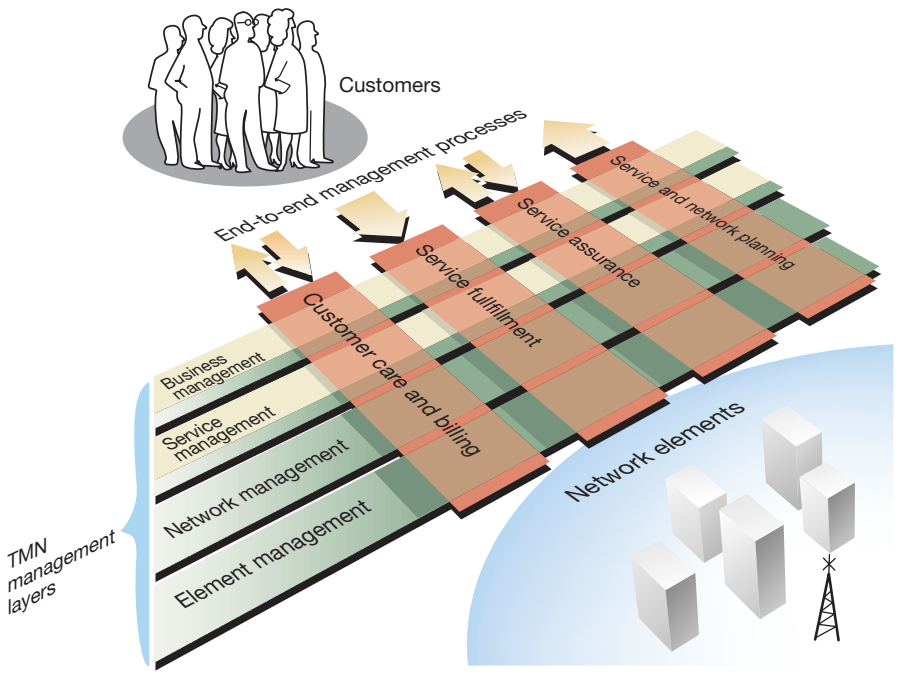


Figure 9
The OAM&P solution maps TMN layers to end-to-end management processes.

Coming CDMA2000 offerings

CMS 11 R4 will provide the necessary follow-on support for the evolution of CDMA2000 1X as well as support for CDMA2000 at 2 GHz—a requirement in Japan and Korea. All radio access network products introduced in R3 will support the evolution of CDMA2000 1X to 1xEV-DO. Also, a new macro RBS will be introduced for extremely dense urban areas. And more emphasis will be put on mobile Internet services and the Internet services platform. Follow-on releases will focus on multi-carrier power amplifiers (MCPA) and the separation of control and connectivity functions from the MSC.

CMS 11 R4

The main focus of CMS 11 R4 will be to provision CDMA2000 1xEV-DO capabilities in Ericsson's CDMA products. By adding new channel cards and software, all RBS 1127 products introduced in R3 can be upgraded to support 1xEV-DO. The BSC 1120 will solely require software upgrades. A new RBS—the RBS 1130—will also be introduced. It will be able to support eleven 1.25 MHz carriers, using 15 MHz of

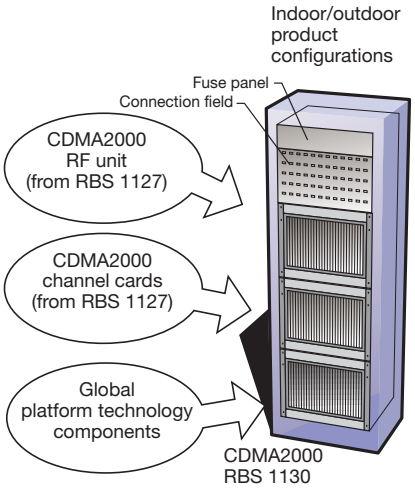


Figure 10
The Macro RBS 1130 supports eleven 1.25 MHz carriers or 15 MHz of spectrum.

spectrum in a three-sector configuration. The RBS 1130 will be built using elements of the RBS 1127 as well as from Ericsson's global platform for RAN products (Figure 10).

As part of CMS 11 R4, emphasis will be put on the Internet services platform, giving customers new ways of rapidly and cost-effectively deploying mobile Internet applications. Ericsson's CDMA Internet services platform uses a horizontally layered system architecture with shared components according to the principles of the integrated distributed application environment (IDAE). It is also based on an open system architecture that draws on the software development kit (SDK) and open application program interfaces (API).

Future releases

Future releases of CMS 11 will center around support of the evolution to all-IP, and the next phase of 1xEV—that is, of 1xEV-DV. The evolution to all-IP and the separation of the connectivity and control layers will begin with the splitting of MSC functions. Media gateway nodes will be introduced to provide an IP interface to the backbone transmission. The media gateway can provide synchronous transfer mode- (STM), ATM- and IP-based interfaces to the CDMA2000 radio network. Externally, the media gateway will provide STM/ATM connections to the PSTN/ISDN, and IP connections to Internet service providers, company intranets, and private or public voice-over-IP domains. In its new role, the MSC server will control the mobile system, including mobility management, call management and set-up, call feature delivery, and resource management in the network. In time, other new nodes, as specified by 3GPP2, will provide multimedia services with high quality of service (QoS), which is a prerequisite for end-to-end IP services.

On the air-interface side, 1xEV-DV will evolve. In all likelihood, the air interface will offer twice the current voice capacity, peak data rates beyond 2.4 Mbit/s, and average data rates in excess of 1 Mbit/s. Full multimedia/multiservice capability will be available on each 1xEV-DV carrier. As before, operators will be able to upgrade their RBS products simply by adding new channel cards and software; the BSC 1120 will solely require a software upgrade. Ericsson also has plans to introduce a pico RBS in conjunction with 1xEV-DV. This RBS will be a low-power, low-density base station designed for pico-cell applications. Indoor and outdoor installation will be supported.

Conclusion

IS-95-based CDMA systems will continue to be based on a standard 1.25 MHz carrier. 1X and 1xEV will satisfy CDMA operators' needs for data throughput and capacity over the next five years. Ericsson's CMS 11 solutions for each phase of CDMA2000 are well positioned to provide competitive offerings both locally and globally. By enabling the mobile Internet with a leading CDMA2000 solution, Ericsson is opening up new markets and revenue opportunities for its customers.

Ericsson has the means to support present-day and future third-generation services thanks to its leadership in packet networks and service network enablers. All Ericsson products are based on open interfaces. By combining these advantages with compact radio access products, Ericsson ensures its customers of always-online, always-connected functionality and direct access to all types of service network from IP and ATM to traditional circuit-switched networks.

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