Ericsson seamless network

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The Ericsson seamless network is a concept that describes the path for GSM operators who are evolving their networks toward a third-generation environment in which GSM and WCDMA are regarded as one network. In this context—and throughout this article—GSM means all accesses deployed in the GSM band (GSM, GPRS and EDGE). The seamless network concept protects past and future investments in GSM by reusing network equipment: GSM is used for second- and third-generation services since it evolves with EDGE technology, and the existing core network evolves into a layered architecture that supports GSM and WCDMA.

Perhaps the most important driver of the seamless network concept is the fact that end-users will be able to have seamless third-generation services from GSM and WCDMA coverage. By allowing a balanced roll-out of WCDMA, the seamless network provides for flexible capital investment—after an initial WCDMA coverage phase, a parallel expansion of each technology enables operators to invest as needed. EDGE can be introduced rapidly, nationwide; capacity can be increased as needed through the addition of WCDMA.

When the seamless network has been fully implemented, it will make very efficient use of the combined GSM and WCDMA spectrum, treating the two as one.

Background

In 2000, to support the seamless GSM and WCDMA network, all subsequent standardization of GSM was transferred from ETSI to the 3GPP, to ensure a smooth harmonization of GSM and WCDMA. The outcome supports an evolved GSM core network with WCDMA and GSM/EDGE radio access.

There are currently more than 600 million GSM subscribers spread throughout 400 networks in 170 countries. Huge investments have been made to build these networks and it will be crucial for operators to continue to capitalize on them. Most operators in Europe have 20-30 MHz of GSM and 10-15 MHz of UMTS spectrum, and will need to find a way of optimizing the entire spectrum.

BOX A, TERMS AND ABBREVIATIONS

3GPP	Third-generation Partnership Project	HLR	Home location register
AAL1	ATM adaptation layer 1	HSCSD	High-speed circuit-switched data
ATC	Adaptive traffic control	HSS	Home subscriber server
ATM	Asynchronous transfer mode	IP	Internet protocol
BSC	Base station controller	OPEX	Operating expenditures
CAPEX	Capital expenditures	QoS	Quality of service
CAS	Customer administration system	RAB	Radio access bearer
CDMA	Code-division multiple access	RBS	Radio base station
EDGE	Enhanced data rates for global evolution	RNC	Radio network controller
ETSI	European Telecommunications Standards Institute	SCS	Self-configuring system
FTP	File transfer protocol	STM	Synchronous transfer mode
GERAN	GSM/EDGE radio access network	TSG	Technical specifications group
GPRS	General packet radio service	UMTS	Universal mobile telecommunications system
GSM	Global system for mobile communication	UTRAN	UMTS terrestrial radio access network
GSN	GPRS support node	WCDMA	Wideband CDMA

The seamless network

The Ericsson seamless network concept describes the path for GSM operators who are evolving their networks toward a third-generation environment in which GSM and WCDMA are regarded as one network. (Note: There is a similar evolution for CDMA, but that is outside the scope of this article.)

The transition from GSM to a third-generation environment entails adding more functionality and more value to the current GSM network and business model. This transition is not a series of revolutions but a smooth evolution whose parts add value to the whole (Figure 1).

The evolution begins with an upgrade of the GSM network with packet-data capabilities by adding GPRS, which introduces end-users to the "always-connected" experience.

The next step is to introduce third-generation services in existing and new spectrum. GPRS is enhanced with EDGE (Box B) to provide third-generation services in the GSM band; WCDMA gives third-generation services in new spectrum.

Network structure

To keep the discussion of a seamless network simple, we have divided the network into three areas (Figure 2):

- the GSM radio access network area;
- the WCDMA radio access network area; and
- a common area.

While GSM and WCDMA will not share a common radio access network any time in the near future, radio control features will allow them to work together as a common resource.

The common area in the seamless network consists of all the areas that are or will be shared between the GSM and WCDMA networks. This includes the core network with its GPRS packet backbone network, transmission, sites, handsets, the service network, customer administration system (CAS), and network management system.

Radio network integration

With the GSM/GPRS/EDGE and WCDMA network we have two third-

Figure 1
Evolution paths of second-generation standards.

generation-capable radio accesses in two different spectrums. To optimize efficiency and capacity in the combined spectrum, we must be able to manage the two resources as one, to create trunking efficiencies from inter-system handover, load sharing, and traffic diversion. Compared to separate operation of accesses, a combined network can yield trunking gains of up to 50%.

Table 1 shows a sample of the theoretical spectrum efficiency gains that can be achieved by combining GSM and WCDMA. (Note: Assuming 100% penetration of dual-mode handsets.)

In practice, the gains will be a result of the mixture of traffic (voice and data) and penetration of dual-mode handsets. Gains in efficiency will also increase with the requirement of high-bandwidth services.

To create adaptive traffic control (ATC), more intelligent communication is introduced between EDGE/GSM and WCDMA using an open interface between the base station controller (BSC) of GSM and the radio network controller (RNC) of WCDMA. In other words, Ericsson's solution for adaptive traffic control is a software function.

To take full advantage of each spectrum, the ATC functionality is complemented with self-configuring systems (SCS), which automate the settings of the most frequently changed cell and neighbor parameters for traffic control in the systems, using real-time performance monitoring and configuration data from the network.[1] This data includes real-time statistics and recordings from all active mobile terminals in the network on both the uplink and downlink.

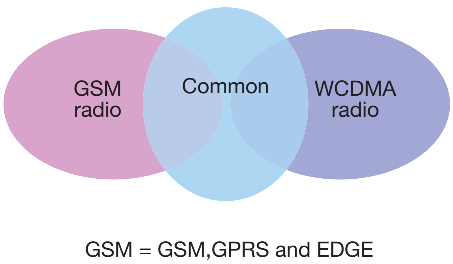


Figure 2
The Ericsson seamless network.

BOX B, EDGE

EDGE is a standardized set of improvements to the GSM radio interface that brings higher data rates and increased spectral efficiency for data services. With EDGE, the operator can serve three times as many subscribers than with GPRS, or provide triple the data rate for one end-user. EDGE provides the same type of third-generation services as WCDMA, but at lower data-transfer rates. Implementing EDGE is fast and cost-effective. EDGE uses the same channel structure, frequency planning, protocols and coverage as present-day GSM. Operators can thus derive more from the same physical resources.

Because the GSM frequency bands are a substantial part of an operator's total spectrum assets, it will become increasingly important to use GSM spectrum for third-generation services. The decision is not to choose between WCDMA and EDGE, but rather how to get the most from each.

Common infrastructure

Core network

The move to a third-generation environment in the core network results in a horizontally layered network that separates payload (voice and data), transport, session control, and applications or services into three distinct layers (networks) with open interfaces. This makes it possible to develop and expand the layers independently of one another. It also allows for the unification of transport technologies, such as IP, which brings telecommunications and data networks together. The common core network is actually an evolved GSM core network.

RBS sites

Since radio base station sites represent a substantial investment in the mobile network, operators have much to gain from sharing sites and site infrastructure.

For WCDMA, Ericsson has developed the RBS3000 series of base stations. An important input to the design of the RBS3000 was co-existence with RBS2000. WCDMA capability is introduced by adding new RBS3000 cabinets to existing sites and sharing transmission and antenna systems with GSM cabinets.

Ericsson has a track record of delivering superior RBS footprint. This also holds true for the two-cabinet solution for combined GSM and WCDMA sites. The built-in power supply and high power efficiency further reduce floor space requirements—that is, the installation does not require a separate power supply rack; similarly, it requires only a minimum of battery backup.

A common building practice is used for the GSM and WCDMA RBSs. This simplifies the installation and commissioning of WCDMA RBSs at existing GSM RBS sites. Therefore, the footprint is identical, as are fixing points and appearance. Furthermore, the same toolbox can be used for commissioning and integration, which reduces investments in equipment and the need for training personnel. Because the RBS cabinets can be mounted back-to-back or back-to-wall, operators can make the most of available space, especially in compact sites.

Transmission

Transmission in the radio access network will evolve as traffic grows and more bandwidth-hungry data services are introduced. The same transmission links can be shared between GSM and WCDMA RBSs, resulting in lower transmission costs.

To use available transmission resources in the most efficient way, Ericsson's RBS solutions support the use of fractional E1/T1, where fractions of the same physical E1/T1 can be used for STM, ATM and IP-based GSM and WCDMA base stations (Figure 3).

Another option is circuit emulation of GSM traffic using AAL1. This method of reducing transmission costs and enabling rapid network deployment is especially interesting for operators who can connect to an ATM network (Figure 4).

TABLE 1, GAIN IN SPECTRUM EFFICIENCY IN COMBINED GSM/WCDMA RADIO NETWORK (5 MHZ GSM/GPRS/EDGE AND 5 MHZ WCDMA).

	WCDMA capacity per cell (5 MHz)	GSM/GPRS/EDGE capacity per cell (8TRX) (5 MHz and 1/3 reuse)	WCDMA and GSM/GPRS/EDGE capacity separately	WCDMA and GSM/GPRS/EDGE capacity as one group	Spectrum efficiency (trunking) gains
Voice	49.7 Erl (60ch)	49.7 Erl (60 ch)	99.4 Erl	107.4 Erl	9%
UDI64	5.1 Erl (10 ch)	6.6 Erl (12 ch, ~4 slots per Erlang on average)	11.7	14.9 Erl	27%
64 kbit/s Web, e-mail	4.4 Erl (10 ch)	5.6 Erl (12 ch)	10.0 Erl	11.5 Erl	15%
UDI44	1.6 Erl (5 ch)	2.3 Erl (6 ch, ~8)	3.9 Erl	5.8 Erl	48%
144 kbit/s Web, e-mail	1.1 Erl (5 ch)	1.6 Erl (6 ch)	2.7 Erl	3.8 Erl	36%

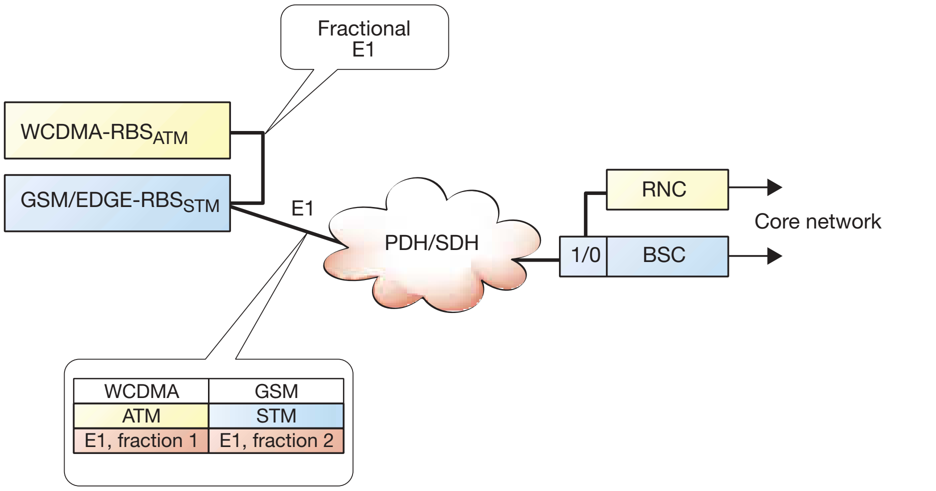


Figure 3
WCDMA on fractional E1.

Network management

Network management will evolve to support the "one network" evolution, and existing support systems will be integrated to give a unified environment for operation and maintenance. This will ease operation and is a prerequisite for optimizing adaptive traffic control.

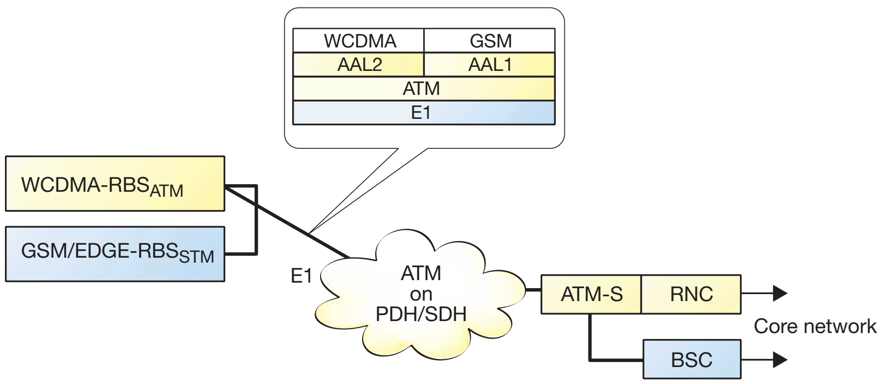
Handsets

Multimode GSM/GPRS/EDGE+WCDMA handsets are a prerequisite for the seamless network. Vendors have announced that they will begin supplying handsets in 2002—GSM/GPRS/WCDMA handsets for the European markets, and GSM/GPRS/EDGE handsets for the Americas. These two platforms, which are similar, feature color displays, cameras, joy sticks, enhanced keyboards, flash memory, and improved battery life. The next step, depending on market demand, will be to integrate the two platforms, creating a GSM/GPRS/EDGE+WCDMA platform.

Operator scenarios

Operators who already have a GSM network with nationwide coverage and who have already introduced GPRS want to use their investments in GSM when evolving it to the next generation of networks based on WCDMA. When rolling out WCDMA alongside GSM, operators face numerous challenges, such as regulatory requirements, cost optimization, and keeping the two access types aligned in terms of functionality. The seamless network must also be backward compatible and future-proof—that is, it must offer capacity and coverage fallback from GSM to WCDMA and vice versa. The load-sharing mechanism is thus dependent on how the operator builds and structures the common network.

Figure 4
GSM circuit emulation.



The path to a seamless network can be broken down into three steps (Figure 5). The arguments for providing a common network in each step may differ somewhat over time. Note: For some operators (mainly in the Americas), the steps will differ—they will deploy EDGE before WCDMA.

In many cases, the first implementation of WCDMA will be driven by regulatory requirements and mainly be concentrated to urban areas. Circuit-switched traffic will continue to dominate, which means that the load on the WCDMA radio network will generally be low.

While building coverage in their WCDMA networks, many operators will continue investing in GSM, to improve capacity and obtain coverage fallback for users who roam between the networks.

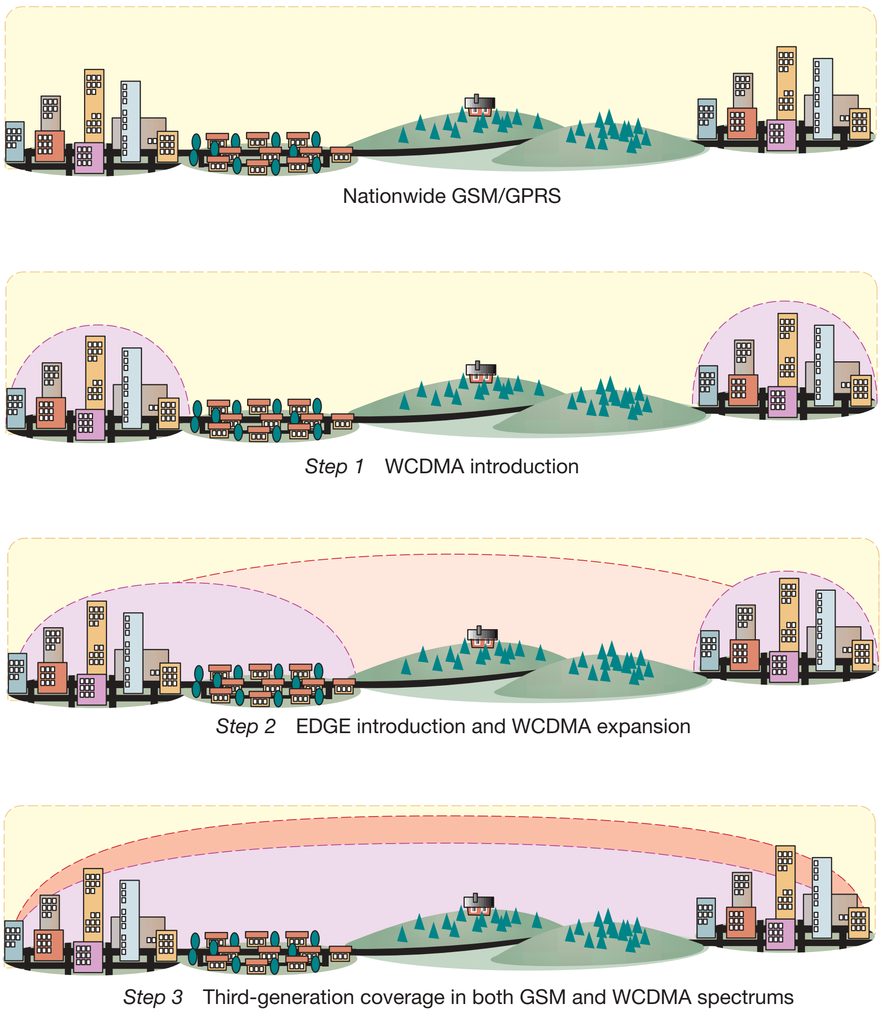
When numerous, attractive data services that require faster transfer rates have been introduced on a large scale, operators will be driven to increase capacity and extend their WCDMA networks to suburban areas. The operators can benefit from sharing traffic load between the GSM network and the WCDMA network. The main focus will be on quality assurance and transmission efficiency. Circuit-switched traffic will continue to dominate, while the load in some WCDMA cells (especially those in dense urban areas) will be heavy.

During the next phase of build-out, when WCDMA has become a mass-market technology, the focus will be on network optimization and beefing up capacity in all major areas. WCDMA coverage will also be extended into some rural areas.

Optimizing traffic between different access types and using all available spectrum in the most efficient way will be an essential aim of extending the network. The Ericsson seamless concept, with ATC and SCS, together with the combined network management system, will be supported in full.

Operators will derive great benefits from sharing sites and reusing power and transmission in the combined radio network. The majority of site hardware can be shared. While these benefits can be achieved earlier they are of prime importance when expanding capacity in urban areas and extending the WCDMA network outside urban areas.

Figure 5
Three phases of roll-out and expansion.



Load sharing and call cases

Load sharing

One of the main drivers for investing in the seamless network concept is the ability to steer traffic between the GSM and WCDMA radio networks. As mentioned above, this is handled by the ATC and SCS together with core network nodes, such as the HLR and GPRS support node (GSN). Basically, the operator has three ways of initiating load sharing:

- the sharing mechanism can be initiated by QoS requirements on services;
- it can be based on policy; or
- it can be triggered by type of subscription.

QoS-based service differentiation means that an application—for instance, streaming—moves to WCDMA when the GSM load is high. In the same way, an FTP file transfer on a background QoS is steered to GSM when the WCDMA load is moderately high. The capacity and coverage fallback is handled by the GSN.

With policy-based guidance, the operator defines parameters in the RNC and BSC, so that, for instance, all circuit-switched voice traffic and low-bandwidth data is managed in the GSM radio network and all high-bandwidth data is managed in the WCDMA radio network.

When load sharing is triggered by type of subscription, the operator assigns all "golden" customers (those with advanced third-generation services) to the best network—that is, the network that can provide the best service (lowest load, least congestion) at a certain point in time. This can be either the WCDMA or GSM network. The division of services between different types of subscription is set in the HLR and home subscriber server (HSS) nodes.

Call cases

The load-sharing function is also dependent on service type and QoS demands, handover possibilities, bandwidth, and the availability of GSM and WCDMA bearers. To steer traffic correctly between the GSM and WCDMA networks, each radio access bearer (RAB) must be aligned. For example, if a customer wants to run a Web-browsing service in the packet-switched domain while moving from one network to another, then each system must support an interactive or background bearer.

For a circuit-switched video telephony call, high-speed circuit-switched data (HSCSD) functionality is required in second-generation network environments, and a conversational bearer is required for circuit-switched multimedia in third-generation network environments. Likewise, for streaming applications on GPRS or EDGE, bearers that support streaming QoS are needed in second-generation environments; a streaming QoS bearer is required for packet data in WCDMA (Figure 6).

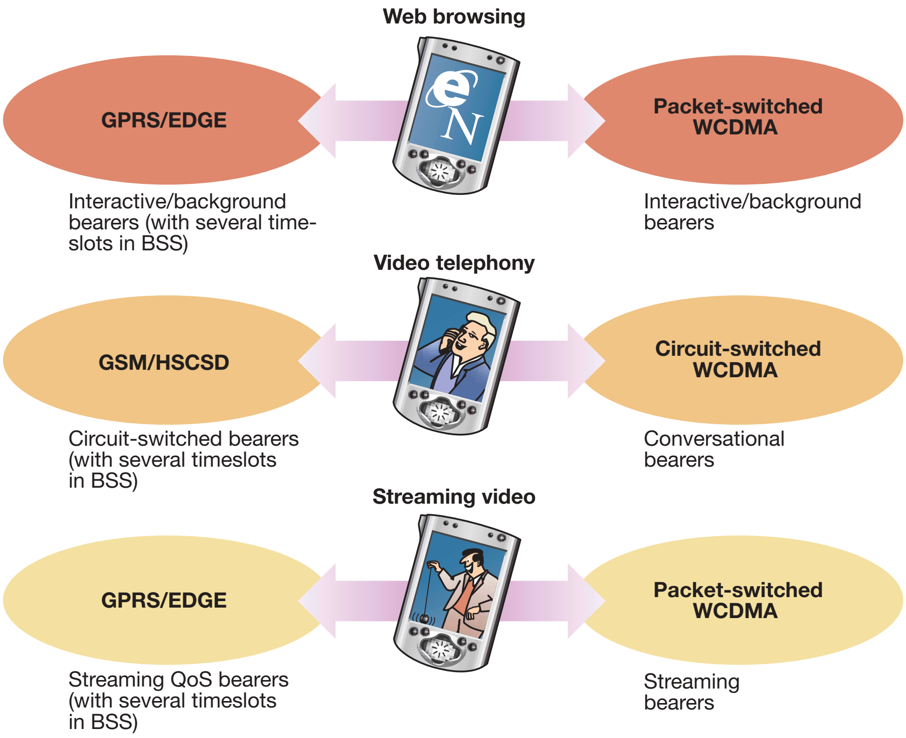


Figure 6
Examples of call cases and their relation to types of service, QoS class and bearers in GSM and WCDMA.

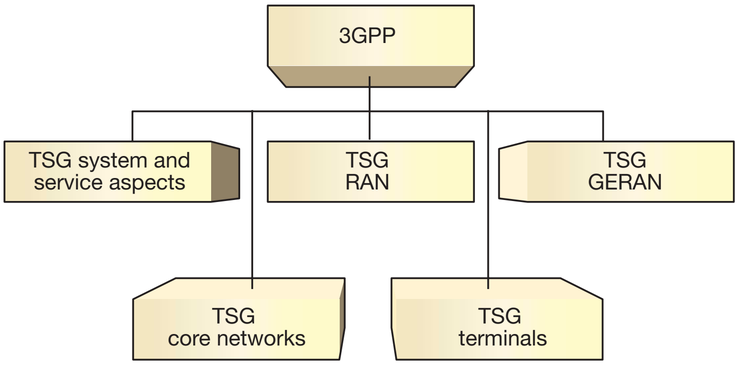


Figure 7
Standardization in 3GPP of GSM and WCDMA.

Evolution

At a high level, the seamless network concept relates to the evolution of the radio network, core network, and GSM and WCDMA network management. It also involves the handover mechanism between GSM and WCDMA, available radio access bearers, and multimode handset functionality.

Ericsson's WCDMA releases are coordinated with GSM releases to ensure that these areas are covered.

Standardization

In 2000, the standardization of GSM was moved from the European Telecommunications Standards Institute (ETSI) to the Third-generation Partnership Project (3GPP) to ensure the integrity of the GSM/WCDMA platform, thereby eliminating risks for incompatibility and inefficiency that might have occurred had the standardization been carried out by separate groups. A fifth technical specifications group (TSG) called the GSM/EDGE radio access network (GERAN) has been added to 3GPP to accommodate this work (Figure 7).

The main objective of the GERAN TSG is to align GSM/EDGE and WCDMA services, mainly as relates to providing conversational and streaming service classes. Best-effort and interactive service classes will also be supported.

These efforts will result in a GERAN system architecture that employs a common core network for UTRAN and GERAN.[2] To connect to the third-generation GSM/WCDMA network, Ericsson proposes to enhance the *Gb* interface to support a similar level of service as UTRAN. This mainly means support for the conversa-

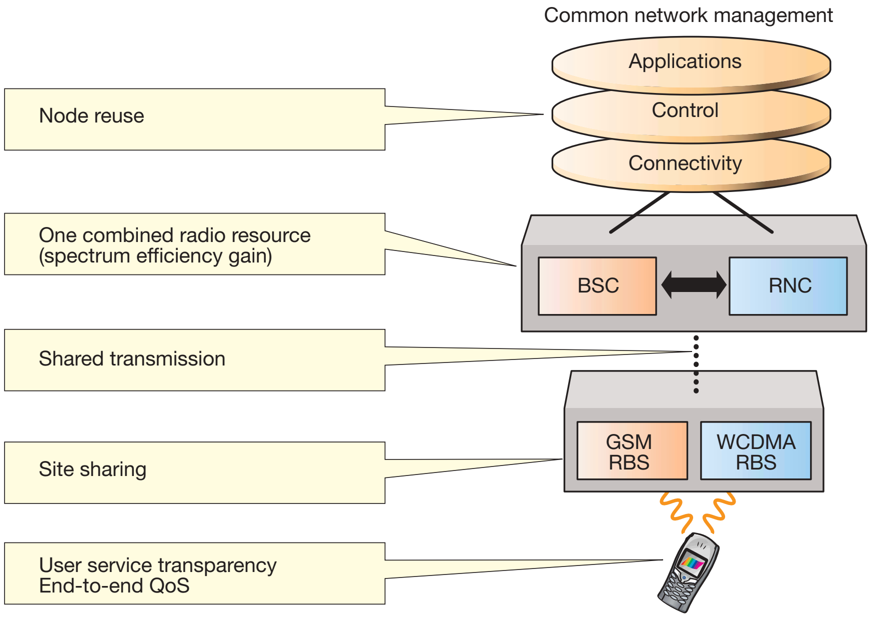


Figure 8
Benefits of the seamless network concept.

tional quality-of-service class, but with lower maximum bit rates.

Benefits

Many benefits can be derived from moving to a seamless network (Figure 8):

- The user receives the same services regardless of access technology—transparent user service. The focus is shifted from "technology coverage" to "applications coverage."
- Since the cost of base station sites is one of the operator's biggest, the ability to share sites between GSM and WCDMA will have great impact.
- Transmission can be shared between GSM and WCDMA from base stations to BSC and RNC.
- By regarding GSM and WCDMA radio accesses as a common radio resource, operators can obtain trunking gains.
- A common core network is used for GSM and WCDMA. Today's GSM and GPRS nodes can be reused to a large extent.
- A common network management system gives savings both in capital expenditures (CAPEX) and operating expenditures (OPEX).

Conclusion

The Ericsson seamless network concept supports the growth of today's services as well as the creation and growth of the Mobile Internet. Investments in GSM (past, present and future) are thus future-proof, and there is no conflict between investments in GSM and WCDMA since the two technologies evolve toward one network.

The seamless network adds flexibility in the deployment of third-generation services; it enhances system performance, and protects network investments by reusing resources.

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