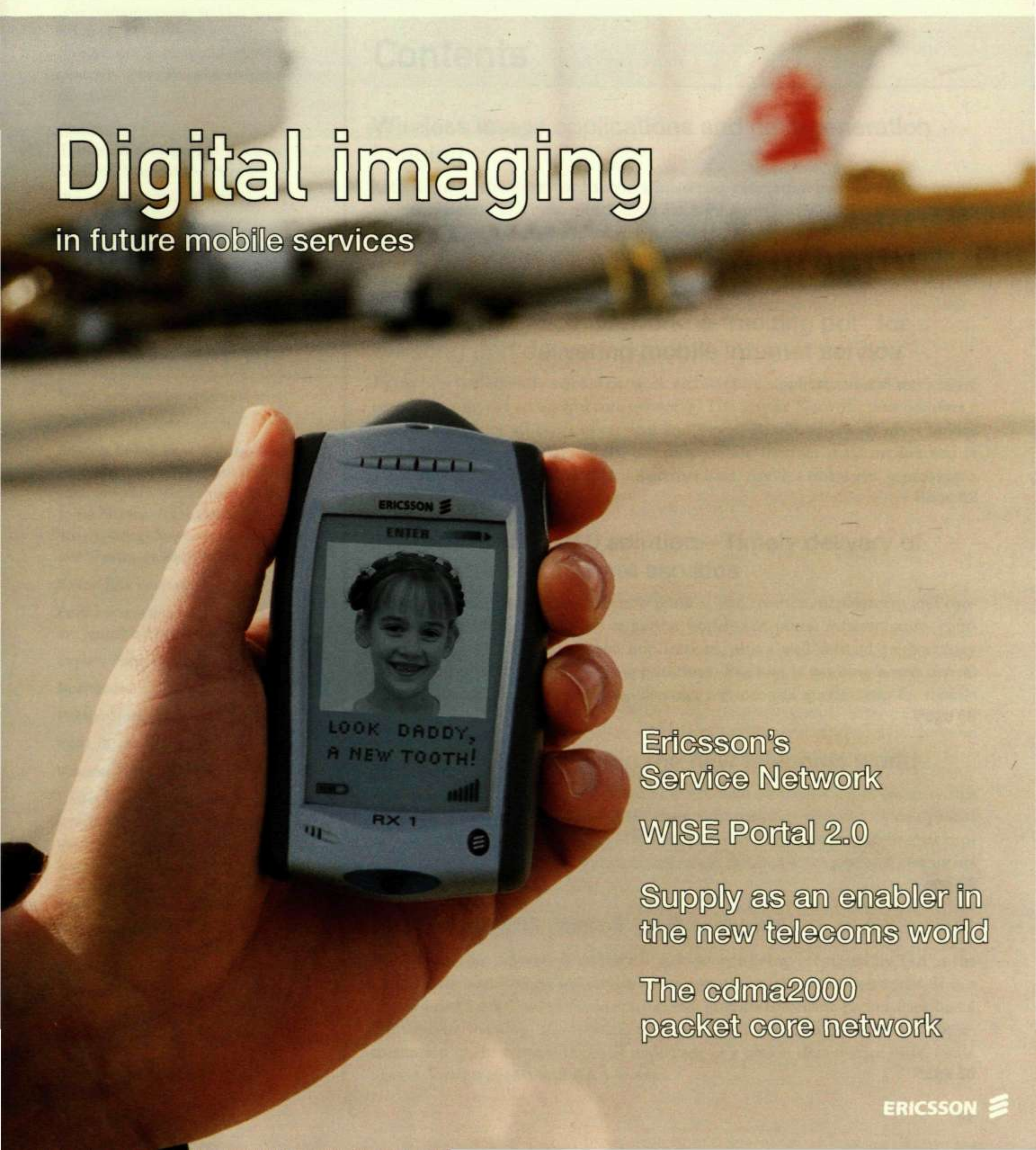
Ericsson

REVIEW

2/2001

THE TELECOMMUNICATIONS TECHNOLOGY JOURNAL



Digital imaging

in future mobile services

Ericsson's Service Network

WISE Portal 2.0

Supply as an enabler in the new telecoms world

The cdma2000 packet core network

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REVIEW

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Cover: With multimedia messaging service (MMS), users can compose, exchange and display/play back images, audio and text in the same message. Ease of use will allow users to create MMS messages nearly the same way they as they create SMS today. The message content will solely be limited by content developers' imaginations. In this example, for instance, a young girl is excited to share the news of her first permanent tooth with her father.

Contents

Contributors

In this issue

Joel Askelöf

Lars Boman

Charilaos Christopoulos

Andreas Grundsell

Karin Mallmin

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Wireless image applications and next-generation imaging

Joel Askelöf, Charilaos Christopoulos, Mathias Larsson Carlander and Fredrik Öijer

Ericsson constantly conducts worldwide consumer research to find out what kinds of application consumers want and how they want to use them. Besides making phone calls, imaging and messaging are on the tops of consumers' wish lists for future mobile applications.

Until now, imaging has mostly consisted of images and graphics that are displayed on Web pages. But because imaging will become a natural part of mobile services, image flow and digital-imaging requirements will change.

This article briefly discusses third-generation-imaging services, including multimedia messaging services, which is perhaps one of the most important services. It also discusses some requirements being put on new imaging applications and formats, and describes JPEG2000—the newly finalized ISO/IEC standard.

Imaging in third-generation messaging systems

Imaging is not an application, but it will be an integrated part of Ericsson's product offerings and solutions. Messaging is one of the most important applications that use images. For example—using a terminal, such as the one in Figure 1—envision taking photos of a hotel room when you are on a business trip, and sending them to your family, along with messages that say "miss you." Or how about taking photos of family members as they lie on a sunny beach, attaching a message, such as "don't want to come home," and sending the text and photos to your neighbors?

From consumers' perspectives, these applications will symbolize the third-generation regardless of underlying technology. The roadmap toward imaging in the third-generation starts with MMS in generation 2.5.

When we talk about imaging as a very important part of future mobile applications, we have to acknowledge that mobile phone users must somehow capture images. A natural way of doing this is to integrate a digital still-image camera into mobile phones, which would enable them to capture and send images and messages from the same phone. But not all mobile phones will have integrated cameras. To accommodate many different consumers and provide them with the most flexible solution, mobile phones must be able to transfer images from external cameras. In most cases, image transfer will occur via Bluetooth, which has the still-imaging profile—a dedicated profile that is standardized for this purpose.

Ericsson is actively participating in standards initiatives and thus ensuring that its phones will be compatible with external cameras. Ericsson also works with Canon Inc., to ensure that complete imaging systems will be available for mobile consumers. The Ericsson-Canon cooperation basically deals with

- Internet-based imaging services;
- image transfer from the camera to the mobile phone; and
- the development and promotion of world-

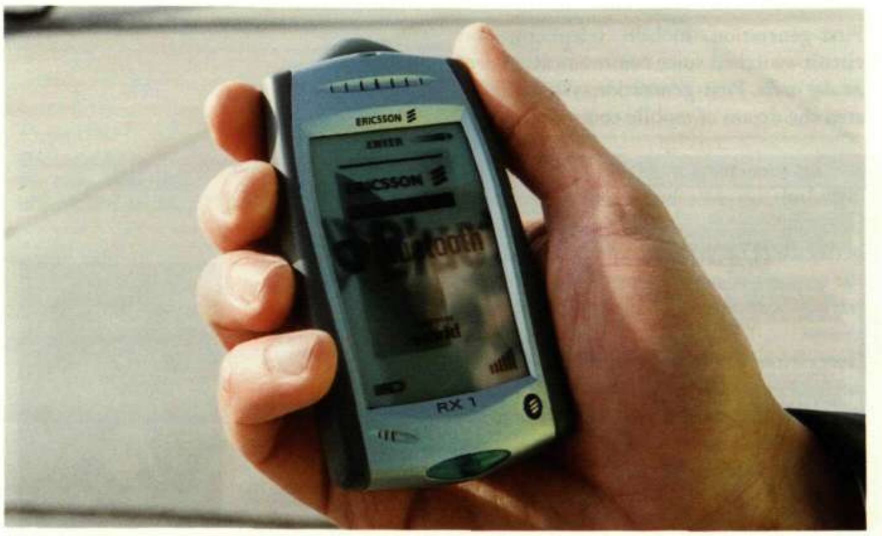


Figure 1
This future, pocket-sized, mobile multimedia concept device features voice, imaging, and video. A wireless, hands-free earphone connects via a Bluetooth connection.

wide standards for imaging and image communication.

Multimedia messaging service—the next generation of SMS

Short message service (SMS) is one of the most-used services in second-generation mobile telecommunications systems—more than 15 billion messages are sent monthly. Multimedia messaging service (MMS) is currently being defined and specified for generation 2.5 and third-generation implementation. MMS takes the mobile messaging evolution (which began with SMS) a giant step forward by giving users the power to become content developers and content consumers. It will be the first mobile application that can handle several different kinds of media (text, images, animation, video, audio, or any combination thereof) in the same message. The message content will solely be limited by content developers' imaginations.

Regular mobile phone users will create MMS messages nearly the same way as they currently create SMS messages. The big difference will be opportunities to include different kinds of media—besides text. As mentioned above, mobile phones will be able to import digital images from digital still-image cameras. Some phones might even have built-in cameras, or cameras as accessories, that facilitate image capture. If video cameras are used, then video clips can be recorded and inserted into messages. Users then add text and send messages using recipients' phone numbers as addresses. Simple and straightforward! This type of messaging will probably be the most common use for MMS.

Another interesting use occurs when content providers send teasers to consumers, for example, excerpts from new music CDs. The messages can contain images of a new CD and a short video clip or sound sample that enables users to listen to parts of the CD and then buy the complete album via their mobile phones.

MMS will be launched on the market at the end of 2001 and will spread widely in 2002. This service, which has been standardized within the Third-generation Partnership Project (3GPP), has strong, broad industry support. Among the companies participating in the standardization, we find the biggest operators and terminal manufacturers in the world. We all recognize the importance of MMS, and we are jointly developing and enhancing MMS specifications.

Figure 2
A typical MMS message might consist of text, an image, and a 20-second music excerpt.

Imaging using Bluetooth

Bluetooth connectivity will also be an important part of the mobile future. The ability to transmit images, video, and audio wirelessly between cameras, MP3 players, phones and smartphones will allow users to extend their communications with friends and family members. Within the Bluetooth special interest group (SIG), a working party was established to create the Bluetooth still-imaging profile.

Bluetooth connectivity will enable friends to exchange images and graphics, which can then be sent to other friends—using MMS. Mobile phones can also be used for other tasks, such as browsing images stored in digital cameras. For example, after a day of sightseeing, users can browse their digital cameras, select the images they like, and send them to their private, online photo albums. They can also use their mobile phones as remote controls for camera shutters. At the press of a phone key, an image is captured and sent to the phone's display. When the user arrives at home, the image can automatically be transferred from the camera to a PC—as soon as the camera is within range of the PC.

BOX A, TERMS AND ABBREVIATIONS

3GPP	Third-generation Partnership Project
Bluetooth SIG	Bluetooth special interest group
DCT	Discrete cosine transform
GIF	Graphics interchange format
GSM	Global system for mobile communication
IEC	International Electrotechnical Commission
ISO	International Standardization Organization
ITU-T	International Telecommunication Union – Telecommunications Standardization Sector
JPEG	Joint Photographic Experts Group
JTC1	Joint Technical Committee 1
MMS	Multimedia messaging service
MP3	MPEG, 1 and 2, layer 3
PNG	"Ping", portable network graphics
SC29	Subcommittee 29
SMS	Short message service
UMTS	Universal mobile telecommunications system
WAP	Wireless application protocol
WG1	Working Group 1 of ISO/IEC JTC1/SC29

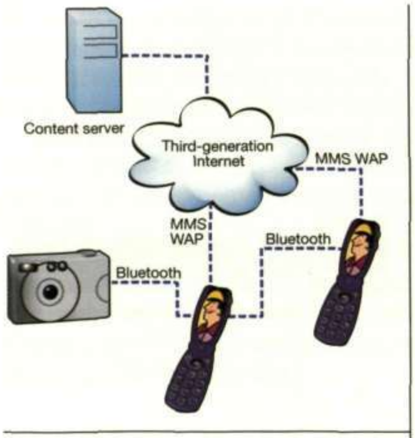


Figure 3
The new image flow.

New requirements

As image flow (Figure 3) changes, and the scope of mobile communication begins to embrace multimedia functions, new requirements will appear. Images will be exchanged between digital still-image cameras, phones and printers. As discussed above, images will also be uploaded to private photo servers or to online photo albums on the Internet, using Bluetooth, MMS, or WAP. Images and graphics will also be sent to and exchanged between family members and friends.

As new multiservice networks evolve, many different clients (phones and smartphones, high-power home PCs, game consoles and TVs) will access content on the Internet and mobile Internet (Figure 4). The convergence of services and networks has changed requirements for forthcoming imaging formats.

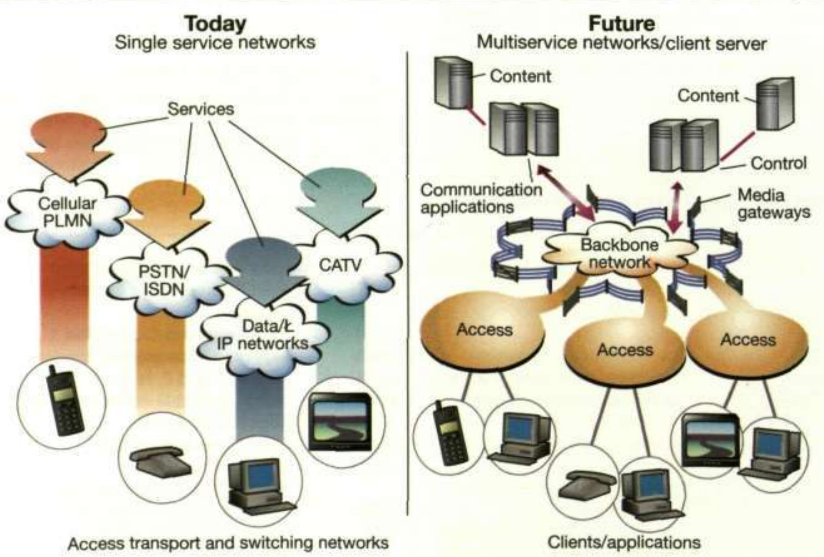
To enable image communication, the imaging formats must be widely used—that is, most applications and users must accept them. New requirements will be put on multimedia services and applications, because many different clients with different capabilities will access the same content. This creates a need to adapt content to the client. Traditionally, the adaptation of images to clients' capabilities has not been an important issue, because most clients that access content on the Internet have similar capabilities. The trend among new imaging formats is that they are designed to ease transcoding and adaptation to client capabilities.

To illustrate the need for adaptation, let us consider an online photo album service. Imagine that you take a photo of your favorite car with your digital camera and then upload the photo to your online photo album. At the website for the online service, the image can be accessed in the following formats:

- low resolution (thumbnail images, typically 160-by-120 pixels)—to be viewed, say, on your mobile device;
- medium resolution—for display on a PC or TV screen; and
- high resolution—to be used for high-quality printouts. Many of today's photo album services allow you to order high-quality printouts from the nearest print shop (so far, mainly in the US).

This scenario requires that content providers can deliver three different versions of the same image. A simple solution is to store three separate images with different resolution, but this increases the need for storage space. Another solution is to store one, high-quality version and then adapt the image to the client's requirements using media gateways in the network. However, operations at the gateways could be computationally complex if the imaging format is not properly designed for this type of application.

Figure 4
Evolution of network architecture.



Imaging formats

The adoption of digital imaging on the Internet depends on factors such as bandwidth, processing capacity and the number of users connected to the Internet. In the context of the mobile Internet, imaging is still in its infancy. As the number of services and users increases, the adoption rates and demand for imaging applications will grow—compared to the evolution of imaging applications on the fixed Internet. Several different imaging formats currently exist:

- GIF87a and GIF89a are among the most widely used formats for graphics compression and computer-generated images.
- JPEG (ITU-T Rec. T.81 | ISO/IEC 10918-1) is used for the compression of photographic images.

Some new formats (such as PNG, mainly for graphics) are becoming increasingly popular. Traditionally, imaging formats were designed for specific types of image, such as graphic or photographic images. So far, no format has been able to cover different types of image using the same compression engine. However, a new standard, JPEG2000 (ITU-T Rec. T.800|ISO/IEC 15444-1) leads the way in the new, imaging-formats area. The standard

- enables a unified system solution for as many imaging applications and image types as possible;
- introduces a way of compressing graphic and photographic images with the same compression engine;
- provides functions, such as random access, for the image code-stream and thus enables client-server applications to take advantage of the fact that users have limited viewing areas but want access to the full resolution of the stored image via commands such as image zoom and pan. This way, information that is solely required on the client side can be sent directly from the server; and
- provides different progression modes, superior compression efficiency, and region-of-interest capabilities. It will also offer easy transcoding with low computational complexity, which makes adaptation to client capabilities simple compared to other existing formats.

JPEG2000

Since 1997, Ericsson has been actively involved in JPEG2000 standardization (Table 1, see also Box B). As part of this initiative, Ericsson Research personnel held several positions, such as co-editors of JPEG2000—parts I, II, and V; editor of the JPEG2000 verification model, and chairman of the region-of-interest subgroup.

Ericsson Research also developed one of two official reference software applications for JPEG2000 together with Canon Research Centre France S.A and École Polytechnique Fédérale de Lausanne.[1] Ericsson will also host the JPEG meeting in July 2001, in Stockholm.

Requirements

When work on JPEG2000 first began, the goals for the new standard were high. Working Group 1 (WG1) wanted to design and create a flexible image-coding system that would last for many years. One important issue was that JPEG2000 was intended as a complement to the JPEG standard, not as a replacement. The aim of the new standard

TABLE 1, THE SEVEN PARTS OF JPEG2000

Part	Description
I	JPEG2000 image-coding system. The core coding system was finalized in December 2000. JPEG2000 part I was designed to contain a limited set of technologies, covering as wide a range as possible for the targeted applications of the standard.
II	JPEG2000 image coding system. Extensions to the coding system will be finalized in July 2001. Part II contains additional tools that are tailored to specific imaging applications.
III	Motion-JPEG2000 (to be finalized in November 2001). This part will be a standard for creating compressed video sequences, each video frame of which is compressed as a still image.
IV	Conformance testing (to be finalized in November 2001). This part describes what is required by a compliant implementation of a JPEG2000 decoder.
V	References software (to be finalized in July 2001). There are two reference implementations of JPEG2000 part I: the first implementation is written in C; the other is written in Java.
VI	Compound image file format (to be finalized in March 2002). In compound imagery, different parts of the image can be encoded separately using different encoding algorithms.
VII	Technical report (to be finalized in October 2001). Guideline of minimum functionality support of part I.

BOX B, BRIEF HISTORY OF THE JPEG2000 STANDARDIZATION INITIATIVE

Mid-1980s	The lack of an international standard for compression of continuous-tone still images becomes an issue.
1986	A working group is formed; the current name of this group (2001) is ISO/IEC JTC1/SC29/WG1, or the Joint Photographic Experts Group (JPEG).
1992	Work with the continuous-tone still-image standard results in the publication of ITU-T Rec. T.81 | ISO/IEC 10918-1—the JPEG standard.
1996	Extensions to JPEG ITU-T Rec. T.84 | ISO/IEC 10918-3 are published. During this work, it becomes evident that a new standard is needed that offers greater flexibility and functionality than JPEG.
1996	The original proposal for the new standard is submitted to ISO.
1997	WG1 issues a call for proposals for JPEG2000; Ericsson submits two proposals (the second is refined and subsequently included in parts I and II of the JPEG2000 standard): 1. An embedded DCT-based still-image-coding algorithm, which is based on the discrete cosine transform (DCT) algorithm, is used in the JPEG standard (called embedded DCT). 2. Efficient methods of encoding regions of interest in the upcoming JPEG2000 still-image standard, for a wavelet-based encoding of regions of interests.
1997	During an evaluation of the proposed algorithms, WG1 selects a scheme that is based on the Wavelet Transform—as a starting point for the development of JPEG2000. Ericsson's embedded DCT proposal is judged to be the best DCT-based proposal.

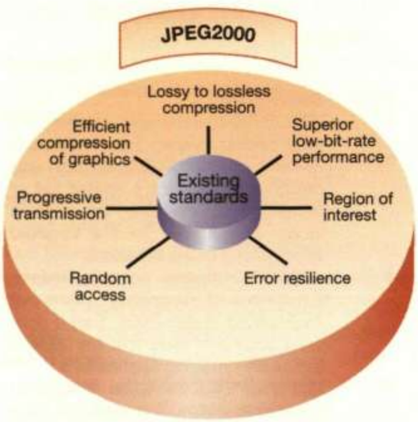


Figure 5
Requirements for JPEG2000 compared to existing standards.

was thus to provide (preferably within one unified system) an image-coding scheme for different image types (for example, bi-level, gray scale, color) with different characteristics, such as natural, medical, remote sensing, and rendered graphics.

The goals for JPEG2000 were to create a standard that was comparable to existing standards and that included all functions in one coding system (Figure 5). Moreover, the standard would

- allow for different imaging models, so the standard could work, for example, in client-server applications, real-time transmission, image archiving, and in situations with limited buffer and bandwidth resources;
- offer numerous functions—to suit it to a wide range of applications and markets;
- provide capabilities to markets that currently do not use compression;
- enable superior, low-bit-rate performance, because no existing imaging format provided good visual quality at high compression ratios;
- create a system that allows lossy and lossless compression. JPEG provides lossy and lossless compression, but uses different technology. It is impossible to decompress a lossy image with JPEG's lossless mode. Image formats (such as GIF and PNG) support only lossless compression;
- enable good compression of photographic and computer-generated images and other types of image, such as medical and remote sensing;
- create a flexible, image-coding system for the wireless environment that is robust against noisy channels; and
- enable random access to the image file and different types of progressive transmission (important requirements and tools)—this enables an image format to be used in as many applications as possible.

Important markets and imaging applications identified during the requirements work were the Internet, mobile communication, digital photography, e-commerce, digital library, printing, scanning (consumer and prepress), medical, and facsimile.

Features and functions

After drafting the requirements, the standardization group has worked to include as many features and functions as possible,

Figure 6
Comparison of JPEG and JPEG2000, at a compression ratio of 1:96.

without sacrificing too much in compression performance and without increasing the complexity of the algorithm.

The resultant compression algorithm offers very competitive compression performance for a wide range of image types, while still offering a large set of features and functions. The standard only addresses decoders, which means that all JPEG2000 decoders will be able to use those features and functions, whereas encoders can choose to implement only those features and functions that are necessary for a particular application. The main JPEG2000 features and functions of the JPEG2000 standard are

- compression efficiency;
- lossy to lossless;
- progressive transmission;
- error resilience;
- region-of-interest coding; and
- random access.

Compression efficiency

Arguably the most important feature of a still-image compression system is its compression efficiency. The more an image can be compressed while retaining acceptable image quality, the faster it can be transmitted and the easier it can be stored. One of the goals of JPEG 2000 was that it should perform better than JPEG at high compression rates. The comparison in Figure 6 illustrates that this goal has been achieved to a very large degree. Although it would probably be possible to design a compression system that is superior to JPEG2000 for some types of image, JPEG2000 currently performs well on more image types than any other standard.

Lossy to lossless

JPEG2000 can be used to compress images with and without loss of information. The lossless capability is very important for the compression of, say, medical and satellite images. But when a digital camera is used to take vacation photos, it might be sufficient to store them with acceptable quality—greater compression permits users to store more images in their cameras.

Progressive transmission

Another important feature of JPEG 2000 is the embedded nature of the compressed file. The most important information pertaining to the image is placed first in the compressed file. Thus, when the image is being transmitted, the recipient receives this information first.

The degree of importance of information in the image is determined when the image is encoded. Three progression modes are available:

- Progressive by resolution (Figure 7)—the image is encoded so that the recipient first receives a low-resolution version of the image followed by the information needed to increase the resolution (step by step).

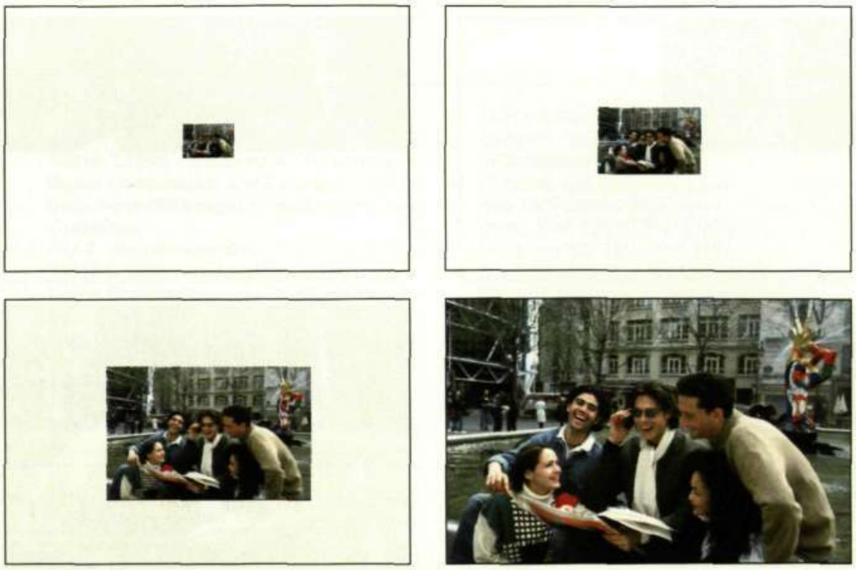


Figure 7
Progressive by resolution. The image is encoded so that the recipient first receives a low-resolution version of the image followed by the information needed to increase the resolution.

Figure 8
Progressive by quality. The image is encoded so that the recipient first gets a low-quality version of the image at full resolution and then receives information needed to improve the image quality.

- Progressive by quality (Figure 8)—the image is encoded so that the recipient first gets a low-quality version of the image at full resolution and then receives information needed to improve the image quality (step by step).
- Progressive by position (Figure 9)—the image is encoded in scan-line order so that the recipient first gets the top-left region of the image at full quality and resolution; the recipient then receives the remaining parts of the image from left to right and from top to bottom.

At any point, the recipient can choose to stop receiving the image and to decompress the information received thus far. For example, a device with a small display that receives an image that has been compressed according to the progressive-by-resolution mode can choose to stop receiving information when the desired resolution has been received.

Error resilience

In JPEG2000 files, there are several ways of increasing resilience against bit errors that occur in the file. Similarly, there are several ways of restarting the decoder at certain intervals, to prevent errors that occur in one part of the image from propagating into other parts of the image when the image is decoded. It is also possible to collect the most important information, such as header data, in one part of the file. This information can then be protected during transmission.

Region-of-interest coding

One requirement for JPEG2000 was the ability to encode different parts of the image at different qualities. Another requirement was earlier placement of information in the compressed file for regions of the image with

Figure 9
Progressive by position. The image is encoded in scan-line order so that the recipient first gets the top-left region of the image at full quality and resolution; the recipient then receives the remaining parts of the image from left to right and from top to bottom.

higher quality (regions of interest). Both of these functions have been implemented in the JPEG2000 algorithm. So when a JPEG2000 image is being received that contains region-of-interest information, the important parts of the image will be received before the background (Figure 10).

Random access

When a JPEG2000 image is compressed, it is divided into several levels of subdivisions. Each subdivision is encoded separately and can easily be found within the file. It is thus very easy to extract and decode only a desired region of the image.

A standard for the future

As described above, the JPEG2000 standard is intended to be a standard for the future. It will probably not replace existing standards, but it can serve to complement them with a wide range of features and functions. The flexibility and performance of JPEG2000 could make it a good candidate for future use in wireless image applications and next-generation imaging.

Figure 10
Region of interest.

Conclusion

Imaging will be a regular part of future mobile services. MMS will probably be one of the most important services in third-generation systems. The use of digital imaging will change as multiservice networks evolve—thus putting new requirements on future imaging formats. Because many different clients will access images, the new format must be flexible, so that it can easily adapt to different clients' capabilities. One such format is JPEG2000, recently finalized by ISO/IEC. JPEG2000—which is one of the first formats that can deal with different types of image and imaging application—is a good candidate for future wireless image applications.

REFERENCES

1 JJ2000 Project, http://jj2000.epfl.ch
2 ITU-T Recommendation T.81 | ISO/IEC 10918-1:1992, Information Technology—Digital Compression and Coding of Continuous-Tone Still Images—Requirements and Guidelines.
3 ITU-T Recommendation T.84 | ISO/IEC 10918-3:1996, Information Technology—Digital Compression and Coding of Continuous-Tone Still Images: Extensions
4 Portable Network Graphics, PNG (Portable Network Graphics) Specification, Version 1.2, http://www.libpng.org/pub/png/spec/
5 ITU-T Recommendation T.800 | ISO/IEC 15444-1:2000, JPEG2000 Image Coding System: Core Coding System
6 ITU-T Recommendation T.801 | ISO/IEC CD 15444-2:2000, JPEG2000 Image Coding System: Extensions, ISO/IEC JTC1/SC29/WG1 N851
7 ITU-T Recommendation T.xxx | ISO/IEC CD 15444-5:2000, JPEG2000 Image Coding System: Reference Software, ISO/IEC JTC1/SC29/WG1 N1851
8 D. Nistér and C. Christopoulos, An Embedded DCT-based Still Image Coding Algorithm, IEEE Signal Processing Lett., vol. 5, No. 6, pp.135-137, June 1998.
9 C. Christopoulos, J. Askelöf and M. Larsson, Efficient Methods for Encoding Regions of Interest in the Upcoming JPEG2000 Still Image Standard, IEEE Signal Processing Lett., vol. 7, No. 9, pp.247-249, September 2000.
10 C, Christopoulos, A. Skodras and T. Ebrahimi, The JPEG2000 Still Image Coding System, IEEE Trans. on Consumer Electronics, Vol. 46, No. 4, pp. 1103-1127, November 2000.
11 WAP Forum, Wireless Application Environment Specification, March 29, 2000, http://www.wapforum.org/

Ericsson's Service Network: a "melting pot" for creating and delivering mobile Internet service

Lars Boman

The Ericsson Service Network, a new solution for creating and delivering mobile Internet service, is based on the new horizontally layered concept—one that separates applications and services from the access and core networks. In this way, the mobile Internet and other communications services, which are accessed by users from any device and any network, converge at the application level. The Service Network becomes a "melting pot" for all types of services and service combinations. It gives service providers a way of managing the complex mobile Internet mass market and of maintaining "ownership" of their subscriber base. For end-users, it provides a personalized service environment, independent of access type.

In this article, the author outlines the need for the Service Network and describes how it will work.

The mobile Internet combines the power of the Internet with the convenience of mobility. Instead of connecting a personal computer or finding an Internet café, anyone with a mobile phone can access the Internet or other online information anytime, anywhere. But the mobile Internet means more than giving mobile access to the Internet. It is more personal. It provides access to services that are based on personal preferences, location, and current circumstances—content context action.

The difference between the Internet and the mobile Internet is akin to the difference between the cinema and television. A whole new genre of services is being opened up by the mobile Internet, in much the same way as TV delivered an enhanced viewing experience to a mass audience in their own homes. The mobile Internet is different from the Internet as we know it because it offers services that

- are relevant in a mobile environment;
- can be efficiently and neatly presented and used in this environment;
- have critical factors that are location-based;
- provide immediacy of reach and response; and
- offer the same basic service set and profile data in all access environments, even if they are presented and sometimes executed differently.

What makes the mobile Internet unique is the fact that the mobile terminal is closely tied to the individual user: terminals are normally switched on and carried by individuals wherever they go. Users can send and receive e-mail instantly. Important news can be "pushed" to users as it occurs. Localized Yellow Pages or street maps are immediately available. The mobile terminal provides secure transactions for online payments, banking and stock trading.

But for mobile Internet services to attract a mass market, certain critical success factors must be in place. First, a variety of suppliers must quickly and easily be able to develop new and attractive services. Similarly, users must quickly and easily be able to tailor services to suit their own individual requirements. Obviously, the services must be very easy to use. And user integrity must be secured at all levels, especially for location-based services. It is not enough that services are safe, they must also be perceived as being safe, particularly for mobile commerce.

BOX A, TERMS AND ABBREVIATIONS

3GPP	Third-generation Partnership Project	MExE	Mobile execution environment
AAA	Authentication, authorization and accounting	MPS	Mobile positioning system
API	Application program interface	MVNO	Mobile virtual network operator
ASP	Application service provider	O&M	Operation and maintenance
ASUS	Application support server	OSA	Open service architecture
CAMEL	Customized applications for mobile network-enhanced logic	OTA	Over-the-air
CRM	Customer relationship management	PKI	Public key infrastructure
E-commerce	Electronic commerce	PSEM	Personal service environment management
GSM	Global system for mobile communication	SAG	Service accounting gateway
HLR	Home location register	SCS	Service capability server
IDAE	Integrated distributed application environment	SDK	Service development kit
IP	Internet protocol	SIM	Subscriber identity module
ISP	Internet service provider	SMS-C	Short message service center
M-commerce	Mobile electronic commerce	SNOS	Service Network operation system
		USC	User service center
		VHE	Virtual home environment
		WAP	Wireless application protocol
		WISE	Wireless Internet solution
		WTA	Wireless telephony application

An increasingly complex picture

Ericsson predicts that once a mass market starts to develop, the number of mobile Internet users will grow exponentially and each user will demand more and new services. While mobile Internet services will have a role to play in simplifying everyday life, they will also become increasingly complex to deliver. Increased personalization will add complexity; billing will also be more complex; and each application will have to be able to use many different technology platforms (for example, positioning, messaging, and e-commerce systems) in an integrated way.

To be successful, operators and service providers will need to meet increasing user demand with a constant stream of sophisticated—and complex—new services. They must quickly be able to implement new services and make them available to the mass-market. Operators will increasingly become service brokers, and being first to market with new attractive services will be vital to success. The ability to personalize information by building up individual user profiles and then target information to specific individuals will also be key.

In the long term, there will most likely not be a separate mobile Internet: the mobile terminal will be just one means of accessing the Internet—the home of applications for fixed and mobile users. New and existing players (operators, service providers, content providers and application service providers) have ample opportunities to establish partnerships and gain first-mover advantage. The major players in the mobile Internet market are likely to be

- existing mobile operators—this group of players is already starting to offer mobile Internet services over second-generation networks, thereby gaining vital experience in preparation for third-generation systems;
- greenfield operators of third-generation systems—these players can start the business with a "clean sheet"; that is, without any pre-existing service obligations. They can implement third-generation systems and services at once, although a lack of operator experience might be a disadvantage;
- mobile virtual network operators (MVNO) are new players who do not need to make heavy investments in infrastructure. Instead, they can concentrate on services—the most important part of third-generation networks. A disadvantage is they do not control the network and, by implication, the quality of their services; and
- Internet service providers/application service providers (ISP/ASP)—these players are already well experienced in offering Internet-based services. One problem might be that they will have to charge for services that are currently offered for "free" on the fixed Internet.

In the mobile Internet, new streams of revenue are being created from content provision, advertising, e-commerce transactions, and so on. These revenues will be split between the different players (for example, network operators, content providers, portals and banks).

Shift from vertical integration to horizontal layers

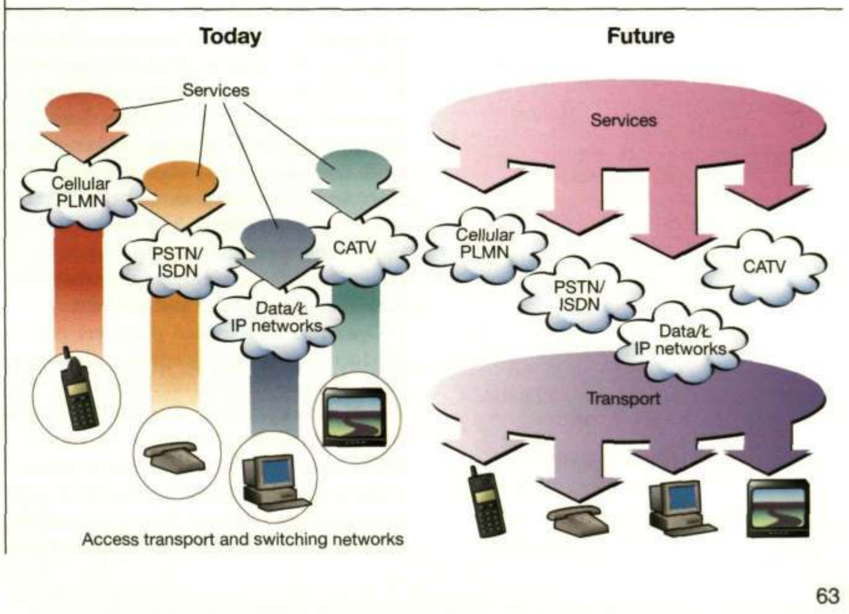
Traditionally, the telecommunications market has been vertically integrated, with applications and services closely tied to the delivery channel—whether the channel was GSM or the fixed circuit-switched network—which resulted in strong vertical segmentation of the supplier market and the associated value chains.

Unfortunately for end-users, Internet services are not uniformly managed or standardized, which makes global access to a set of Internet-based services difficult to achieve.

Perhaps paradoxically, the effect of the mobile Internet and third-generation systems is to improve this situation, by decoupling applications from the underlying infrastructure and by forcing the development of open standards.

The traditional vertical business and technology segmentation is beginning to tilt, so that the value chain is segmented horizontally, where virtually any application or service can be provided over any underlying network technology (Figure 1). Consequently, the mobile Internet business will be driven from the operator or service provider toward the enterprise or content provider.

Figure 1
The shift from a vertically integrated to a horizontally layered service environment.



supports the WAP gateway, WebOnAir filter proxy, SIM application toolkit, OTA SIM management, and a messaging solution, it does not support all enablers. It will thus be further developed to host the WISE Portal 2.1, together with some applications and additional enablers.[2] The user service center will migrate toward an open and flexible architecture based on the open-standard architecture specified by the 3GPP.

Benefits for operators and service providers

The Service Network gives operators, service providers and third-party developers an attractive and easy-to-use interface for developing applications. It has been designed to help operators and service providers to build successful mobile Internet services by offering

- a range of new applications and services, for example, through the Developers' Zone alliance program;
- efficient operation and maintenance with a common database and uniform subscription interfaces;
- end-user monitoring and satisfaction through customer relationship management (CRM) tools;
- a wide range of reliable service enablers; and
- expert consulting services to support strategic decisions, including advice, systems integration and facility management for operators, service providers and enterprises.

The Ericsson Service Network is designed to help operators and service providers to bring interesting and advanced services to market in the fastest, most convenient way, and to keep integration costs as low as possible. For example, the Service Network SDK will use standardized APIs, such as Parlay, Jain and other open-industry interfaces. The application developer can thus concentrate on the creative part—features—and leave the database integration, site management, user interface and access to the right core network functions to the Service Network.

The cost of introducing large quantities of new services rapidly needs to be low.

The Service Network will become a plug-and-play environment, helping operators to achieve short time-to-market and to establish a reputation for being the first to offer advanced services.

It will also be important to keep track of which services are successful, and which are not. Some services will be long-runners, while others might be an enormous but short-lived hit. One way that operators and service providers will be able to keep track of the success and usage of services is through the Service Network's CRM system, which helps identify users' personal preferences, thereby improving service targeting and enabling bundling and niche marketing campaigns. It will also show how successful individual services are and indicate when they should be removed to make way for new services.

How the Service Network works: an example

Ericsson has produced many different scenarios to illustrate the Service Network. What we believe will be one of the most important issues for success is how new services can be developed, operated and launched.

Imagine a third-party application developer who works in close partnership with a mobile operator. The developer can enter the Developers' Zone solution of the operator, hosted within the Service Network, and log on to his own Developers' Zone page.

Once logged on, the developer can see how existing services are doing—for example, how many people are using them, revenue earned, and so on—and create new applications.

To create an application, the developer uses a service development kit—made available by the operator—which can be likened to a toolbox for application development. The developer downloads the open APIs he needs to create the application, for example, for positioning, WAP, mobile e-commerce

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and video streaming. When he has finished developing the application, he can test it on a simulator or test site provided by the operator. Once the developer is satisfied with the application, he can upload it to an application server.

Finally, the application developer "signs" the new application to confirm that it is ready, perhaps also sending some information to the operator to indicate how he wants it to be marketed or how the operator should charge for its use.

When this is done, a message is automatically sent to the operator's O&M system. The operator then tests the application to ensure that it meets standards for, say, quality and decency. The operator can then make the application available to his customers.

The application can be categorized according to the operator's own model—for example, according to application type (sports, movie, or news) and functionality (positioning, messaging, or m-commerce).

Finally, the application is put on a publicly available application server. The new application can be marketed in a highly targeted way, by automatically sending a message to the website or mobile phone of customers whose profiles match the application categories.

The operator could also use the Service Network capabilities to send messages to members of the Developers' Zone, launching a competition for, say, the best sports application.

The Service Network enables the operators to have close or loose partnerships with application developers, perhaps giving certain developers special opportunities to test applications live and to stipulate how use of the applications is to be charged.

Conclusion

A highly flexible and open architecture is needed to deliver the mobile Internet's promise of "personalized services for the masses." Moreover, service providers must be able to create and offer personalized services quickly and easily, which is the role of the Ericsson Service Network.

Mobile Internet subscribers will demand—and get—a service environment that is tailored to their own personal requirements. They will want to access it using whichever device or method is most convenient at the time. The Ericsson Service Network fulfills this criterion, providing a vital layer between connectivity networks and the end-user.

Because its open architecture is standards-based, the Service Network enables operators to easily integrate new service and application ideas from third parties, whenever these ideas come along.

The Service Network is the IP-based "glue" that binds together the many different access media, core networks, content and service providers and user devices for seamless service delivery. It handles virtually any type of service and convergence of telecommunications, data communications, Internet and multimedia services. This convergence will enable new service combinations across numerous kinds of access network and across traditional service domains.

Using the Service Network as a platform, Ericsson can provide

- open, standardized interfaces;
- partnerships with content and service providers;
- support for third-party developers and application centers; and
- integration and consulting expertise.

Ericsson's goal is to enable mobile operators to add value to their services on their own terms, in a highly manageable way.

The Service Network approach is designed to provide performance, reliability and low cost of ownership. The open, scalable architecture of the Service Network is designed to provide economies of scale, while reducing development time and enabling easy integration of new technology as it becomes available. It offers mobile operators a low time and cost threshold for testing and introducing new applications, thereby reducing the business risk.

REFERENCES

1 Johnston, A., Papanikolaou, T. and Sissingar, M.: The WISE Portal 2.0 solution—Timely delivery of tailored mobile Internet services. Ericsson Review, Vol. 78(2001):2, pp. 68-79.

2 Swedberg, G.: Ericsson's mobile location solution. Ericsson Review, Vol. 76(1999):4, pp. 214-221.

The WISE Portal 2.0 solution—Timely delivery of tailored mobile Internet services

Andy Johnston, Thomas Papanikolaou and Mike Slssingar

Two of the hottest issues in mobile communications today are the growth of the mobile Internet and the evolution of new portals. Both are interdependent. Mobile Internet growth requires new portals. The creation, deployment and continued enhancement of new portals require a world-class portal infrastructure, combined with attractive and creative applications. And there must be a well-defined methodology for delivering the portal and the applications in order to capture a viable share of the market.

Ericsson is working across several industry sectors to develop mobile Internet services and applications for mobile operators around the world. The authors describe the WISE Portal 2.0 solution, which is a cornerstone of this work.

Today's mobile communications users have high expectations at a time when deregulation and open systems have made the competitive landscape more aggressive. The mobile Internet offers a golden opportunity for creating new services and new revenue streams. The key to unlocking these opportunities is the ability to deliver services and applications that work, are available at the right time, and offer personalization.

The tool that enables mobile operators and service providers to deliver personalization is the portal. Over the past decade or so, the development and operation of portals over the fixed-access Internet have taught us many lessons, and these have been brought to bear on the development of Ericsson's WISE Portal solution.

In the mobile environment, the portal enables its owner—the network operator or service provider—to tailor mobile Internet offerings to match the market requirements. For the user, the mobile portal provides a familiar, personalized service interface to employ the mobile Internet as a valuable yet simple tool that makes everyday life easier and more fun. An effective mobile portal helps ensure rapid end-user acceptance of mobile Internet services.

Ericsson's WISE Portal 2.0 is designed for the creation and delivery of targeted mobile Internet services that are user-friendly and closely tailored to individual users' needs. The solution has a crucial role to play in helping mobile users to access the services and information they want quickly and with a minimum number of clicks. Moreover, users can personalize the portal to suit their own preferences and needs.

The WISE Portal 2.0 seamlessly integrates the Internet and wireless application protocol-based (WAP) services so that they can be accessed from any personal computer, WAP phone or other mobile device.

Satisfying market expectations

The market has high expectations of portal solutions. First, the solutions must be usable. The WISE Portal 2.0 solution provides a unified user interface, called *bricks*, for WAP and Web access.

The solutions should also be scalable. The WISE Portal 2.0 solution can be scaled, for example, across processors and nodes, and in terms of the number of registered users, concurrent users, and content feeds that it can handle. The solution is available in several standard configurations.

The portals should offer high reliability and availability. The WISE Portal 2.0 solution can be supplied with "four-nines" (99.99%) or better availability.

Flexibility is also important. The WISE Portal 2.0 solution has a component-based architecture that enables flexible configurations as well as integration into portal operators' enterprise systems.

The portals must be global. The WISE Portal 2.0 solution can be deployed internationally and supports wide (16-bit) character standards, such as the universal transform format no. 8 (UTF-8) and unicode character set no. 2 (UCS-2).

BOX A, TERMS AND ABBREVIATIONS

3GPP	Third-generation Partnership Project	OSA	Open service architecture
API	Application program interface	PDA	Personal digital assistant
DNS	Domain name server	RADIUS	Remote authorization dial-in user service
DTD	Document type definition	RDBMS	Relational database management system
EJB	Enterprise JavaBeans	SDK	Software development kit
GPRS	General packet radio system	SMS	Short message service
GSM	Global system for mobile communication	SMS-C	SMS center
GW	Gateway	SSL	Secure socket layer
HDML	Handheld device markup language	UCS	Unicode character set
HTML	Hypertext markup language	UMTS	Universal mobile telecommunications system
HTTP	Hypertext transfer protocol	USC	User service center
ISP	Internet service provider	UTF	Universal transform format
IT	Information technology	WAP	Wireless application protocol
J2EE	Java 2 Enterprise Edition	WCDMA	Wideband code-division multiple access
JS	JavaScript of Java Servlet	WML	Wireless markup language
LDAP	Lightweight directory access protocol	XML	Extensible markup language
MAI	Mobile application initiative	XSL	Extensible stylesheet language
MSC	Mobile switching center		
O&M	Operation and maintenance		

The mobile environment puts additional demands on portal solutions. For example, mobile network operators generally have more stringent quality requirements than traditional portal operators. In all likelihood, mobile portals will have much greater numbers of simultaneous users than fixed portals. They will also have special integration requirements, for example, for charging and pre-payment systems. Similarly, strict conformance testing will be required during network integration. These demands for system quality have an impact on scalability, reliability, availability, security and interoperability—the task of managing the design, implementation and delivery of the portal is thus vital.

Therefore, a key element of Ericsson's WISE Portal 2.0 solution is the delivery methodology, which covers all aspects of the development of mobile Internet services and associated platforms, including the Service Network[1], positioning, transactions, integrated billing, portal core technology, an observational database, and personalization.

Ericsson has a mature solution-development methodology called *Framework*, which focuses on the business implications, design, and development, as well as the implementation and operation of the applications and platform on which the services run. Framework supports the development of customers' business and continues throughout delivery to maintain the momentum of each complex and concurrent element. It also includes management consulting, a project office, a systems design team, and applications development.

BOX B, THE WISE PORTAL 2.0 SOLUTION AT A GLANCE

WISE Portal 2.0 is a complete, end-to-end solution for the creation and development of mobile portals (Figure 1). With it, portal operators can choose to install and manage the portal in-house, or opt for an Ericsson-hosted portal, which comes complete with a generic set of applications and services.

The WISE Portal 2.0 meets the challenges presented by the mobile market by combining a number of key components:

- Ericsson WISE 2.0 Portal presentation layer and presentation layer bricks;
- BroadVision One-To-One enterprise application server;
- J2EE application server;
- Ericsson USC 1.2E; and
- Ericsson mobile Internet enablers.

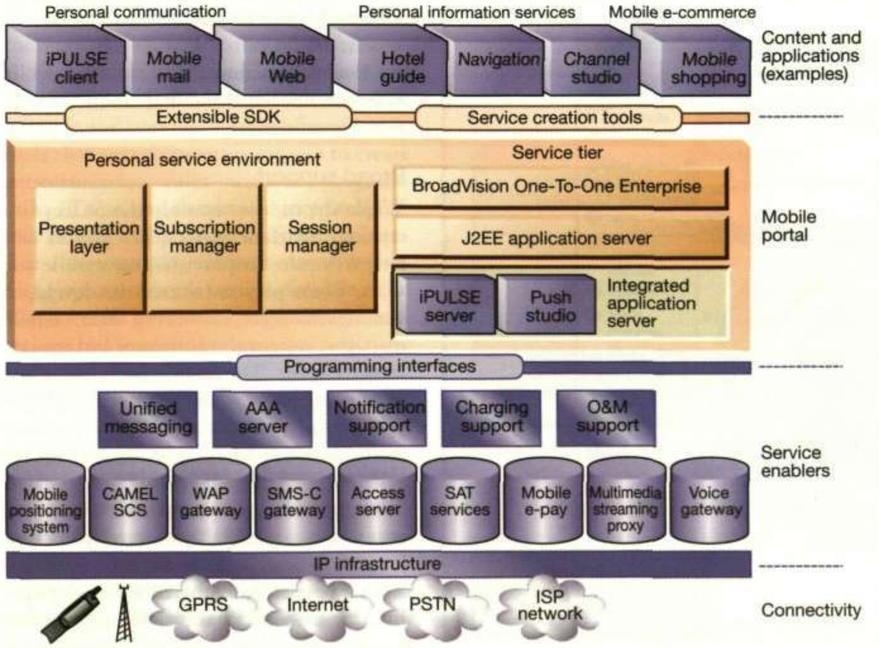


Figure 1
Overview of the WISE Portal 2.0 solution.

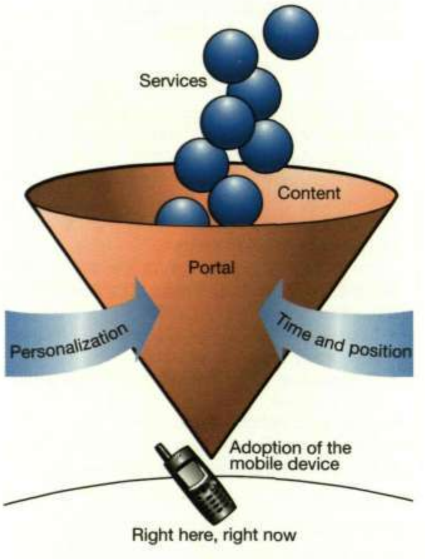


Figure 2
The "anywhere-Internet" concept.

The power of mobility

A solution that supports several important service attributes is needed to realize the "anywhere Internet" concept (Figure 2). These attributes are

- personalization;
- time and position;
- device support;
- services; and
- local content.

Personalization is key to mobile Internet services. Advanced personalization features help users to access information quickly and easily. Personalization and profiling features enable operators to serve their customers better—enhancing the "stickiness" of their offerings, encouraging customer loyalty, reducing churn, and growing the user base.

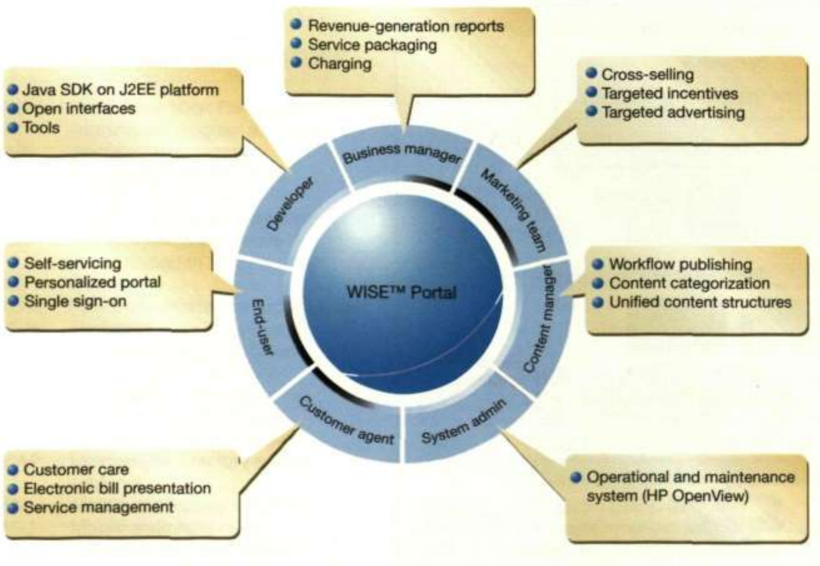
Intelligence in the network gives information on user whereabouts. When combined with time-of-day awareness, this information can be used to deliver highly targeted and relevant services.

The ability to support multiple devices for the delivery of mobile portal services is also a critical factor for success.

Compelling mobile Internet services are key to widespread take-up.

In mobile contexts, local content is of much greater importance than in the fixed Internet. Content must be filtered and delivered in a format that can be understood by the user.

Figure 3
Some ways in which players interact with the portal.



Market requirements

Ericsson has been driving the mobile Internet since its inception, and this has helped the company identify the key success factors for mobile portal-based services. In addition to meeting the market expectations outlined above, the mobile portal requires

- broad support among industry players;
- best-of-breed components;
- personalization;
- content management;
- service development; and
- universal delivery.

Broad support

While the user is certainly the focus of attention, there are many other players who have key roles in provisioning mobile services. These players include the developer, business manager, marketing team, content manager, system administrator and the customer's agent. The mobile portal solutions must support these different players (Figure 3).

Best-of-breed components

Industry-wide open interfaces enable components to be mixed and matched. Excellence in design, performance, and availability is essential, as is choice, because monolithic or proprietary solutions are generally unacceptable today.

The guiding principle in selecting components for the WISE Portal solution has been to choose the best-of-breed components from third-party suppliers in each major product area (directory server, application server, firewall, and so on). This requires evaluating the components against a rigorous set of criteria to ensure that they are feature-rich and of high quality. The components need to be proven market leaders. And the vendor must be reputable and have relevant expertise.

Ericsson then contributes its own business and technical know-how and experience, adding value to *de facto* standard architectures and developing third-party components for use in the mobile environment. The reuse of tried and tested technologies and components cuts time to market and enhances quality.

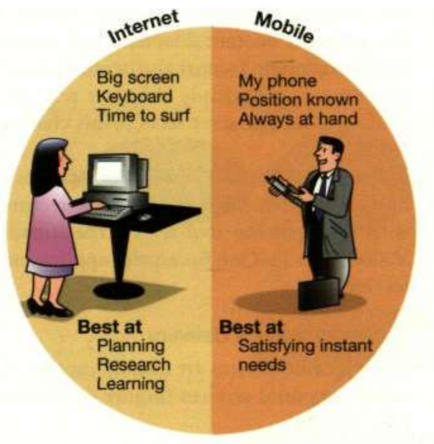


Figure 4
Personalization means a service that immediately satisfies needs regardless of user location.

Personalization

Personalization is a proven way of creating customer loyalty and generating repeat visits to mobile portals. Advanced forms of personalization can be created through new mobile network features, such as positioning (Figure 4).

The WISE Portal allows users to personalize their services in terms of presentation, service and service category selection, service delivery mechanisms, and content, and can provide automatic personalization based on an analysis of user behavior.

A portal solution that offers multidimensional personalization must provide concepts as well as features and tools that allow operators to immediately deliver and benefit from personalized services. The WISE Portal provides a range of easy-to-use tools that portal operators can use to create personalization rules without programming. These tools enable editors and content creators to produce and manage content—for example, while an extensive profiling system records user preferences. The WISE Portal solution can also observe user actions and learn from them.

Content management

Content management is key to offering compelling portal services. Portal solutions must provide comprehensive and efficient support for content management, especially when large numbers (100 or more) of content providers are involved.

The main content-management functions are creation, editing, removal, classification, integration, scheduling and staging. Other functions include managing adapter connections and controlling the quality of content feeds (Figure 5).

Several qualitative characteristics are also important. These include the ability to manage and process both static and dynamic feeds, and to process real-time feeds. The portal should be able to accommodate pop-

Figure 5
Content management using uncomplicated procedures.

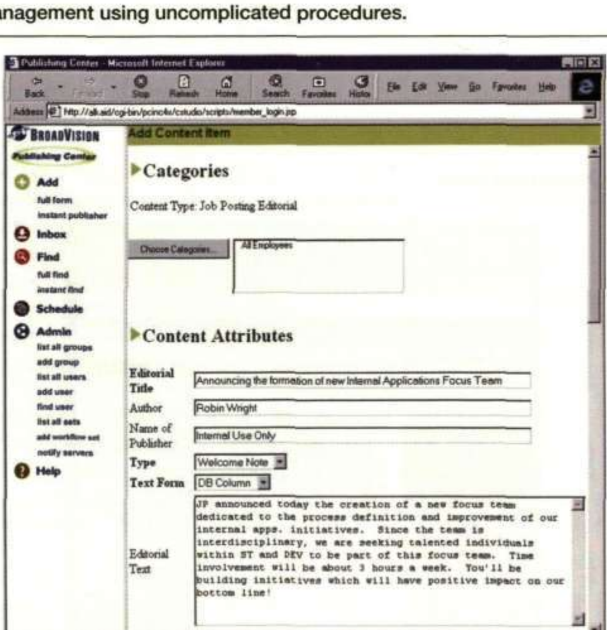


Figure 6
Mobile portals need to be independent of the devices that access them.

ular data feeds (such as newswire services) via packaged content adapters, and secure access to content. It must also be able to handle content in multiple character sets, including wide character sets (16-bit characters).

The WISE Portal 2.0 solution includes a unified content-management architecture with a supporting tool set via the BroadVision One-To-One Enterprise application service.

Universal service delivery

Many mobile devices are already capable of accessing portal services (Figure 6). Examples include

- devices that can handle short message service (SMS) notification;
- WAP-enabled phones;
- smart phones and personal digital assistants (PDA) that can handle WAP, handheld device markup language (HDML) or hypertext markup language (HTML);
- voice-browsing systems; and
- interactive television.

Mobile portals need to be independent of the devices that access them. They must also provide a universal delivery service.

Service development

Portal platforms must offer the rapid development and deployment of compelling services. Portal developers must be able to create simple services without complex programming—for example, through rule-based programming and profile- and content-driven service behavior. They must also be able to create complex services using standard programming languages and environments, such as the Java 2 Platform, Enterprise Edition (J2EE) server-side Java standards. Similarly, mobile portal operators or their subcontractors need a well-documented set of service-development concepts and interfaces with which to create services.

The WISE Portal uses the BroadVision One-To-One enterprise application server to support the creation of release-based profile- and content-driven services. Likewise, it uses the BEA WebLogic J2EE application server as a deployment platform (and any of the myriad Java development tools available on the open market as development environment) to support programmatic service creation.

A Java-based software development kit (SDK) provides additional programmatic service support through key system interfaces to

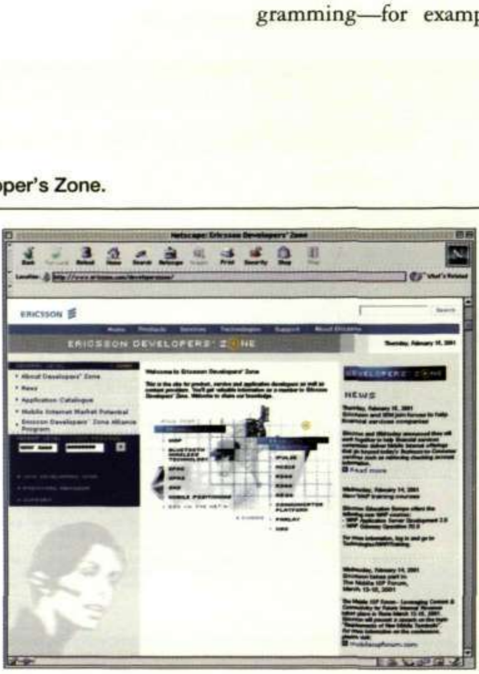
- subscriber directory access;
- charging and billing services;
- SMS notification services;
- presentation layer rendering services;
- operation and maintenance (O&M) and logging facilities; and
- session-management facilities.

Mobile portal solutions must extend service development to areas that add value in a specifically mobile context, for example, through interfaces to the mobile positioning system[2] and terminal characteristics database. In addition, mobile portal solutions must accommodate the interfaces currently being specified by the Third-generation Partnership Project (3GPP) and Parlay for the third-generation open service architecture (OSA).

Ericsson is also encouraging third parties to develop applications and services. The Ericsson Developers' Zone has been created to offer third-party application developers access to a wide range of Ericsson mobile application technologies and product (Figure 7). After registering with the Ericsson Developers' Zone, developers gain access to information and tools that enable them to build and test applications. The Ericsson Developers' Zone also includes an Alliance Program for companies who work closely with Ericsson on the development of mobile Internet applications and content.

Ericsson's Mobile Applications Initiative (MAI) program is designed to drive the

Figure 7
The Ericsson Developer's Zone.



GPRS and WCDMA/UMTS applications industry and to expand knowledge, experience and opportunities in these technology sectors. The aim is to stimulate market interest and to ensure that high-quality applications become available.

WISE Portal feature round-up

The WISE Portal 2.0 contains four key components that combine to create a complete solution for delivering personalized, easy-to-use, portal-based services to mobile users:

- the WISE Portal presentation layer;
- BroadVision One-To-One;
- the J2EE application server; and
- the user service center (USC).

WISE Portal presentation layer

The presentation layer, which is the user interface to mobile portal services, provides a scalable and robust extensible markup language-based (XML) publishing framework for portals and is capable of presenting services on multiple devices using multiple markup languages.

Using XML, the presentation layer clearly separates presentation from business logic. It also provides a specification that allows users to develop new or to integrate existing services into the presentation layer architecture. Services delivering plain HTML or plain wireless markup language (WML) can also be integrated.

The presentation layer provides extensive capabilities for branding, and for specifying the "look and feel" and behavior of the portal (the personality). It can support multiple "personalities" and comes with a default personality (bricks).

Presentation layer components

The connection manager is responsible for receiving a user request, transforming it into the standardized internal format of the presentation layer (Figure 8), and establishing the connection between the end-user and an application. Establishment of the connection usually includes the creation of a user session and additional security checks. This is checked by the user manager. To provide scalability, the connection manager is implemented using Java Servlet technology.

The request broker is responsible for retrieving the data requested from the user, by accessing the application's communication protocol. All information that is relevant to the application (such as the communication protocol) is stored in the application manager.

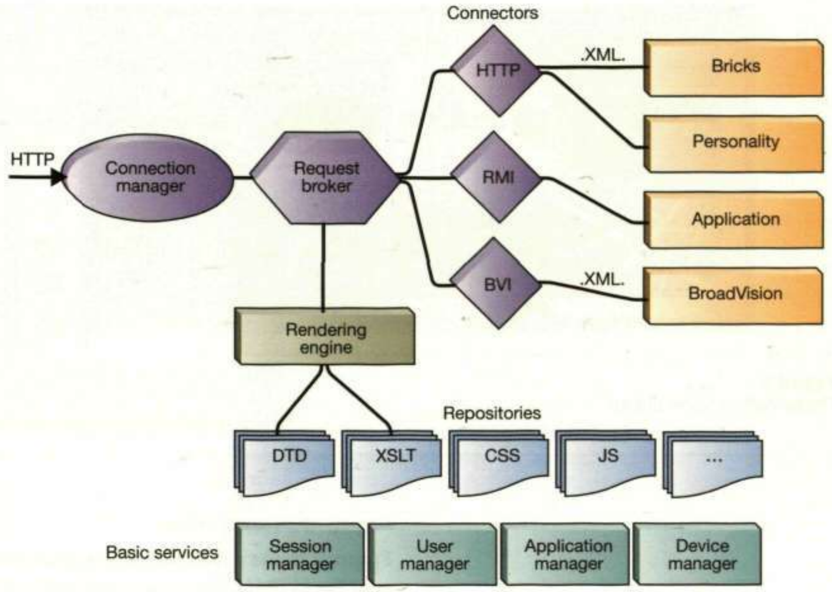


Figure 8
The architecture of the WISE Portal presentation layer.

XML data returned by applications is forwarded to the rendering engine, which parses, validates, and transforms the data appropriately for the user's device, using device information retrieved from the device manager and extensible stylesheet language (XSL) transformations.

Presentation layer repositories store all resources required for validating XML data sent by applications (document type definitions, DTD), transforming XML into a language understood by the end-user's device, and so on. The repositories enable resources to be associated with applications, and provide versioning facilities for the publishing framework.

The basic services are a minimal set of interfaces on which the presentation layer is implemented. The presentation layer can function with any component that provides sufficient functionality for implementing the basic services. In the current implementation, the basic services are implemented using Ericsson's USC user and application manager and the WISE Portal 2.0 session and device manager.

Figure 9
Presentation layer bricks.

Presentation layer bricks

Figure 9 shows a typical bricks portal entry page for HTML. The portal user is presented with a set of bricks, grouped into six categories (shown as tabs above the bricks grid. In this example, the tabs are Favorites, Finance, David, Travel, Messaging and Leisure).

Figure 10 shows the WAP variant of the interface described above. The tabs are shown on the WAP deck as a set of links. Selecting the Favorites link calls up the presentation of a second WAP deck with a set of links for each brick under Favorites.

Figure 11 shows how the user can personalize the bricks interface by dragging service bricks from the pane on the right to the bricks grid on the left.

Figure 10
WAP screenshot of presentation layer bricks.

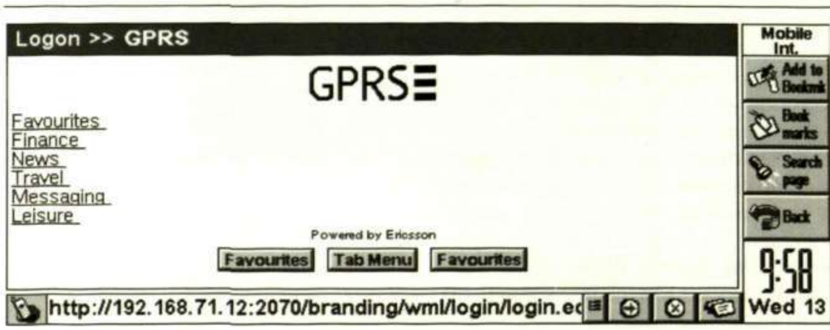


Figure 12 shows a single mobile trading brick ant its associated set of controls (*max*, *config*, *help* and *info*).

BroadVision One-To-One

BroadVision One-To-One provides content management, personalization, and rule-based service-development functions within the WISE Portal 2.0 solution (Figure 13). BroadVision and Ericsson have cooperated to design and develop a set of components that bring key BroadVision One-To-One functionality closer to the mobile network. These include interfaces to SMS gateways, charging systems and subscriber databases.

BroadVision One-To-One enables the development of portals that treat users as unique individuals, thereby increasing the level and regularity of user activity. It remembers and tracks data and transactions from visit to visit, stimulates transactions and feedback, and supports continuous improvement in the level and scope of personalized services.

Content management

The BroadVision One-To-One content-management features are the heart of the WISE Portal unified content-management architecture, providing authoring, workflow, scheduling, classification, tagging, persistence, audit trails of uploads and downloads, and previews. There are six types of pre-defined content, each with extensive semantics:

- templates;
- product catalogs;
- editorials;
- discussion groups;
- incentives; and
- advertisements.

A unique feature of BroadVision One-To-One is that it allows content creators to categorize the content in hierarchical folders. Matching attributes can be attached to content to enable powerful personalization. For example, a content creator can attach language, product, job title and level of technicality to each item which is then matched with the user's profile to show only the relevant content.

BroadVision also includes a publishing center (Box B). This is a configurable, Web-based tool designed for all participants in the content-management lifecycle, from full-time content professionals (who create, maintain, schedule, and manage content) to casual content contributors (who occasionally author and submit content.

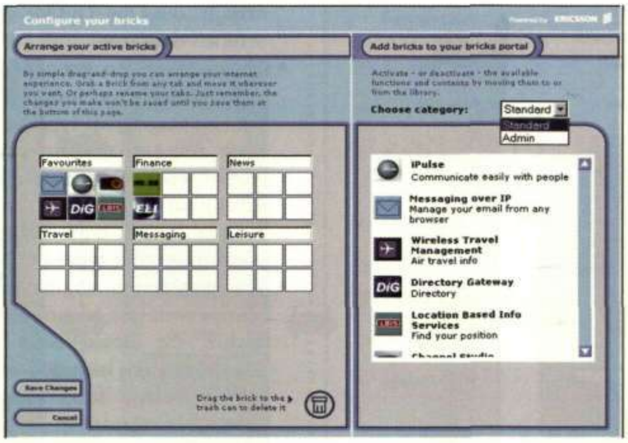


Figure 11
The bricks interface.

BroadVision One-To-One has a comprehensive user-profile concept and architecture, which forms a sizeable proportion of the WISE Portal approach to user profiling. This concept includes an extensive, persistent user profile that can be used by all parts of the BroadVision system as well as externally. There are two main sources of information on user profiles:

- the WISE Portal user information component, which is based on the USC subscription manager and is used to store relevant, general, cross-application information on the user profile; and
- the BroadVision One-To-One profile manager, which is used to store BroadVision application-specific profile data.

User profiling

BroadVision One-To-One tracks users as either members or guests of the site. Members have registered, retrievable profiles; guest profiles are typically limited to the current session. User profiles are stored in database tables (internal or external relational database management system, RDBMS). The contents of a user's profile can be extended and changed by the portal operator.

Session profiling

The BroadVision One-To-One command center can be used to create session rule sets that contain references to session and user-profiles attributes. By creating multiple session rules, it is possible to have a set that assigns different values to the same session profile variable for different visitors.

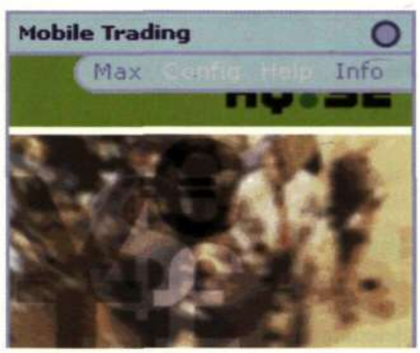
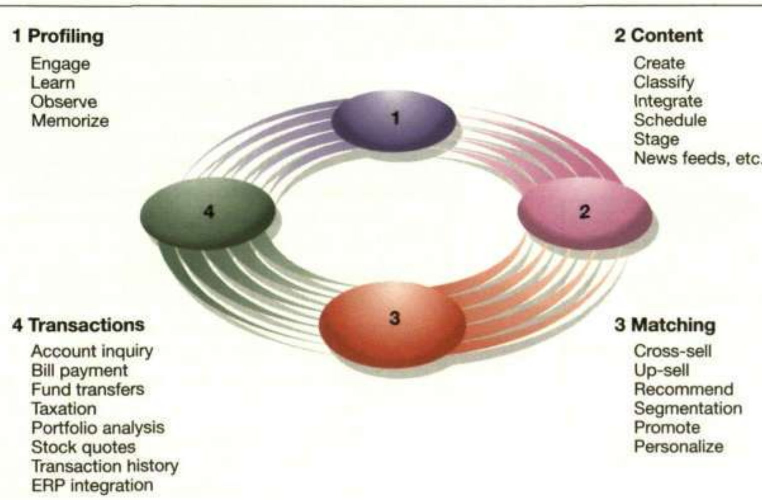


Figure 12
Mobile trading example.

Figure 13
BroadVision One-To-One functionality.



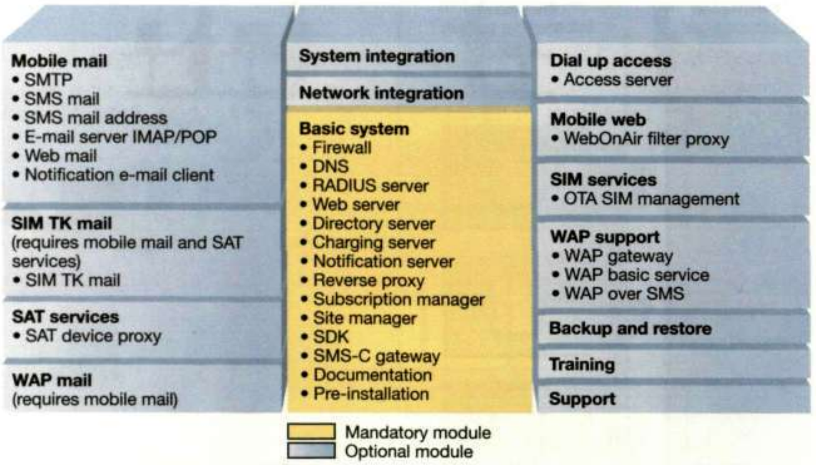


Figure 17
An overview of the USC.

The USC can be scaled in terms of performance, availability characteristics, and number of users. It consists of modules (Figure 17) for

- basic IP infrastructure support;
- application support functions;
- operation and maintenance support;
- service capability servers; and
- application and service development support.

The USC is built from standard hardware components, taking advantage of the latest developments in the information technology (IT) industry. This approach ensures that the USC always offers the best performance and provides world-class availability characteristics with trouble-free operator experience at a very competitive price.

In terms of software, the USC consists of a mix of industry-standard software and components developed by Ericsson. This mix gives the right balance between short time to market and suitability for the operator market. In July 2000, USC 1.2 went into commercial operation with operators in Europe and Asia.

Security

Because the USC is connected to external systems, such as the Internet, its services must be protected against unauthorized use. The USC thus provides firewalls, switches, reverse proxies, and remote authorization dial-in user service (RADIUS) servers. Support for the secure socket layer (SSL) protocol and other security features are also provided.

Directory server

Central to the USC architecture is a directory server that maintains all information on subscribers and the services to which they subscribe. The directory server is based on the lightweight directory access protocol (LDAP), to help ensure high performance and conformance to standards. The implementation is currently based on the Netscape Directory Server, which runs on Sun Solaris.

Web server

Many applications require the use of a Web server to host HTML and WML documents and applications. A highly scalable and reliable Web server is tightly integrated into the security architecture of the USC. The Web server can also be used for third-party and operator-specific applications.

BOX C, KEY FEATURES OF THE BROADVISION PUBLISHING CENTER

Increased publishing process control—content publishers can control the publishing process by

- granting and restricting publishing rights to individual users;
- subjecting content to a workflow process in order of appearance; and
- previewing content before it appears live on the site.

Increased publishing participation—content contributors can submit and edit content using Instant Publisher forms, which are tailored and personalized to each user's access and skill level.

The open solution leverages existing content in the enterprise (for example, in Documentum, Lotus Notes, Microsoft Office) and works with existing authoring tools, such as Macromedia, and versioning tools, such as Interwoven.

Flexible, rule-based interface—Instant Publisher provides personalized and customized forms for casual content contributors and sophisticated content-management tools for content editors.

Content profiling allows authors to profile content, which in turn, enables BroadVision matching agents to deliver personalized content by matching content and user profiles.

Browser compatibility—the Java-based solution supports Web-based publishing access and administration using a Java-compliant browser.

Open content support for content created from any tool, including HTML editors, Microsoft Office products, and Lotus Domino; ability to pull content from external content and document repositories including Documentum and Lotus Notes.

Publishing access control makes it possible to create and populate customizable access-control groups that grant rights (read, edit and approve publishing) to individual publishers.

Publishing workflow (customizable workflow states to support any publishing process) supports multiple start states, state branching, and "pass-back." Each portal can use multiple workflows.

Content scheduling makes it possible to manage a content programming calendar and to schedule content to go online and offline automatically.

Content preview before a presentation is put online.

Instant Publisher forms (simple, personalized, and easy-to-use publishing forms), which are tailored to each user's publishing tasks and skill level, make use of the powerful One-To-One Publishing Center functions, but solely expose what is needed to casual contributors.

The BroadVision One-To-One Publishing Center seamlessly integrates info InterWoven's TeamSite for content versioning and roll-back. Other versioning vendors' products can also be integrated.

Charging service

For services managed by the USC, a built-in charging service offers a variety of charging events. All services can generate charging records by calling the charging API. The subscription manager automatically generates a charging record when an end-user subscribes to or unsubscribes from a service. The charging service software (developed by Ericsson) runs on Sun Solaris.

Site manager

All components within the USC system, as well as the applications it manages, are supervised and managed by the site manager. Operators can thus

- manage complex multi-vendor information systems; and
- control resources, such as network components, computers, operating system, databases, and file stores.

The site manager is based on HP OpenView building blocks and a database whose management console runs on Sun Solaris.

Service capability servers

In current (GSM) mobile networks, an SMS center (SMS-C) is responsible for sending, receiving, storing and forwarding short messages between mobile terminals and servers that use proprietary protocols for communicating with applications.

The USC includes an SMS-C gateway that shields applications from the specific details of each vendor's SMS center. The gateway is based on the Across Wireless Transport Server, which runs on Sun Solaris and supports the major brands of SMS centers.

Application and service development support

The USC is an open system, which—thanks to the service development kit—can serve as a platform for components delivered with the USC, third-party equipment and existing operator equipment. The SDK gives interfaces to charging, subscription-management and notification functions.

Conclusion

More than anything else, the mobile Internet is set to be the most dynamic of markets the industry has ever addressed. Competition encourages users to shop around for services, and fashions change almost overnight. Keeping ahead of the market is one of the secrets of success. This has been a key consideration in the development of the WISE Portal solution.

The open architecture of the WISE Portal enables new services to be created and new technologies to be introduced easily and quickly. *Framework* (the design, implementation and delivery) includes market monitoring and feedback procedures which ensure that changes in taste and demands are identified and responded to immediately.

The WISE Portal 2.0 solution provides a highly adaptable gateway between service providers and users where mobile Internet services can be adapted to meet the changing needs of the market and individual users.

REFERENCES

1 Boman, L.: Ericsson's Service network: a "melting pot" for creating and delivering mobile Internet service. Ericsson Review, Vol. 78(2001):2, pp. 62-67.

2 Swedberg, G.: Ericsson's mobile location solution. Ericsson Review, Vol. 76(1999):4, pp. 214-221.

TRADEMARKS

Supply as an enabler in the new telecoms world

Andreas Grundsell and Karin Mallmin

Building the third-generation network infrastructures needed for mobile Internet services will require the production and delivery of base stations and network nodes in very large volumes.

At the same time, the demand for infrastructure equipment for GSM and other second-generation networks will continue to grow as existing networks expand to cope with the twin pressures of subscriber growth and traffic growth.

The supply processes that have brought the mobile communications industry this far will not be adequate to cope with the extreme market demand for equipment for second- and third-generation infrastructure. This is why Ericsson is developing supply concepts that have a lot in common with the techniques used in large-volume businesses, such as the automotive and consumer-electronic-goods sectors.

In this article, the authors focus on the likely impact of market growth on the supply flow, and profile the supply management initiatives being taken by Ericsson to meet the expected demand from mobile network operators.

Introduction

With more than 650 million mobile phone users in the world today—a number that is expected to reach one billion in the next two years—the mobile phone has clearly become a mass-market commodity (Figure 1). It has become as much a part of people's lives as televisions, cars, radios and washing machines. In fact, if you compare the mobile phone with any other consumer electronic product, the fact that its customer base grew from zero to 600 million in 15 years puts it in a league of its own.

Yet it is interesting to look back to the late 1980s and remind ourselves that the mobile phone was then regarded as an accessory that could only be afforded and justified by business people. In 1988, the industry was forecasting that by the year 2000, the number of mobile phone users might reach 20 million in western Europe.

Every couple of years since then, the industry raised the forecasts in light of growing market demand. Each time this happened, the manufacturers of infrastructure equipment (radio base stations, mobile switching centers, and so on) had to gear up for greater volumes.

As the main supplier of mobile infrastructures, with a global market share of around 40%, Ericsson had a bigger challenge than most companies each time the market growth exceeded expectations, since it also had to increase the production of necessary infrastructure equipment.

The fact that the company managed to maintain its global market share at a fairly constant level throughout this decade of rapid growth says much about the effectiveness of the supply strategies that have been developed. But as the world prepares for the build-out of third-generation mobile network infrastructures, it is clear that even more aggressive supply strategies will be re-

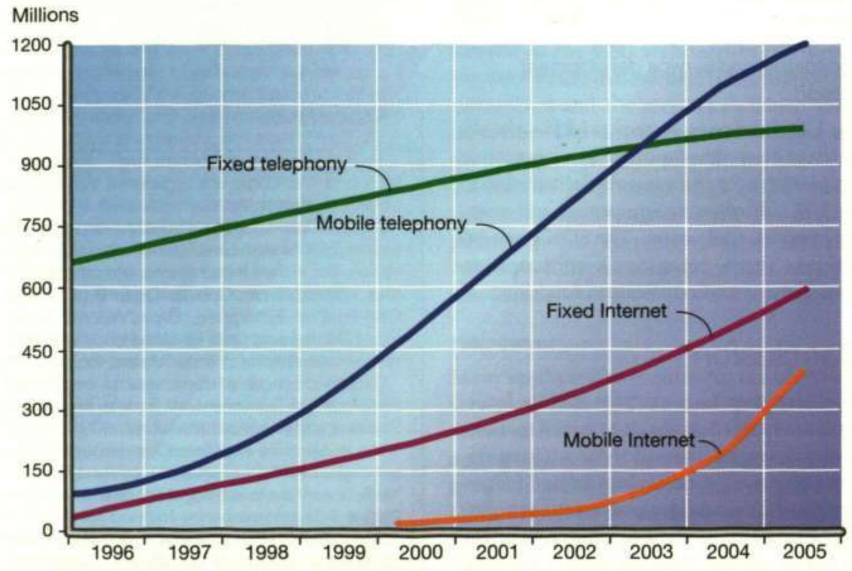


Figure 1
Subscriber growth.

quired (Figure 2). Mobile network operators are planning for

- rapid migration to third-generation resources; and
- rapid increases in traffic in the networks.

One scenario portrays an explosive growth of traffic in mobile networks, due to swift migration from fixed to mobile telephony and rapid growth in data traffic. This scenario represents the consequences of an operator's change in focus from subscriber growth to increased use of services by the subscriber base.

The industry is poised on the brink of another massive expansion phase, but this time there is greater pressure on shorter time to revenue than ever before. And when time and cost are essential, supply flow is critical.

BOX A, TERMS AND ABBREVIATIONS

BSC	Base station controller
FC	Flow control center
GPRS	General packet radio service
GSM	Global system for mobile communication
MSC	Mobile services switching center
OSS	Operations support system
TTC	Time to customer
TTS	Time to service
UMTS	Universal mobile telecommunications system
WCDMA	Wideband code-division multiple access

The pressure for change

Although mobile phones have become standardized mass-market products, the network infrastructures that support mobile phone users are generally still built up on the traditional telecommunications infrastructure supply model. According to this model, network operators specify in detail at the node level what they require, and a supplier, such as Ericsson, makes custom adaptations. This process has delivered what the industry wanted. At least, so far. But special orders mean special handling and special manufacturing and testing. Special orders also promote multiple variants. This is a costly and time-consuming approach that also creates capacity problems right through to the supply chain.

For the future, the emphasis is on achieving large volumes and rapid roll-out, with high quality and at low cost. The stakes are high for network operators, with the costs of licenses and of building out new and en-

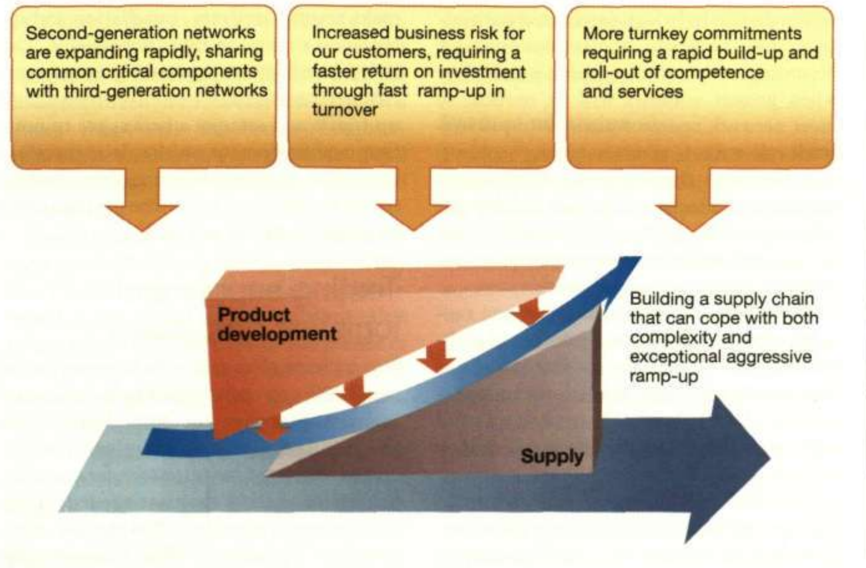


Figure 2
The supply challenge.

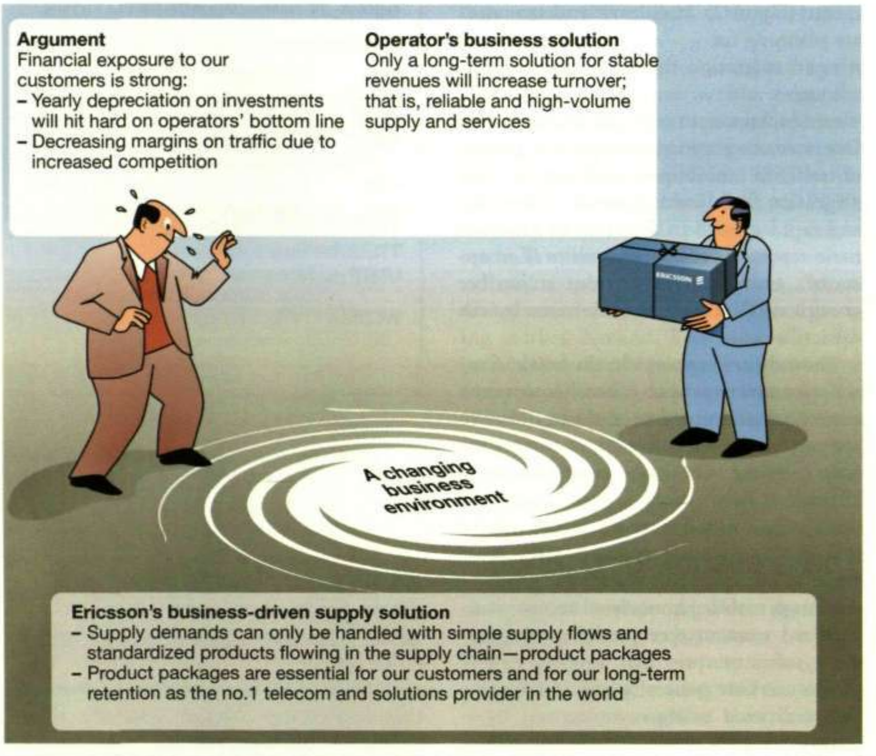


Figure 3
Changing business environments.

hanced network capabilities (Figure 3). Anything that adds unnecessary costs is unacceptable. This focuses attention on certain key areas of the supply chain. Special designs, multiple variants, and inventory all have heavy cost penalties.

Technology, of course, continues to be a vital ingredient. In fact, as we move to third-generation networks, the technologies are becoming even more complex—at a time when greater volumes will be needed, to meet network operator plans for rapid network roll-out.

A further challenge is that third-generation infrastructures will involve the integration of a greater proportion of products from multiple vendors than was the case with second-generation networks.

The process of consolidation among mobile operators has created a number of global operators—another factor that is shaping the supply strategies. Global operators expect standardized and consistent supply and support deals in every market in which they operate.

The challenge for manufacturers is to fit increasingly complex technologies into simpler, faster and less costly supply processes that deliver better quality. The only way to do this is through new supply chain strategies based on greater standardization that enables flexibility.

Large volumes of standard configurations allow a manufacturer to maintain good quality consistently. Standard products also make testing, delivery, installation and integration easier and more dependable. Delivery precision is particularly important. An operator might have to close streets, hold up traffic and arrange a helicopter to position new equipment on site. It is therefore vital that planned delivery commitments can be honored, not just to the day, but often to the precise hour and minute.

Testing supply and logistics processes

Several initiatives taken by Ericsson in the late 1990s, to transform supply chain and logistics processes for second-generation systems, had already highlighted the potential benefits. One initiative, for example, focused on cutting the time needed to fulfill customer orders for GSM mobile infrastructure equipment. This initiative has evolved into the wider TTC Global (time-to-customer) program initiative that operates across the entire Ericsson organization. The focus is on time to service (TTS), since the truly important requirement among network operators is to get equipment quickly installed, integrated and into service, in order to earn revenues.

The primary focus was on taking time and cost out of every stage of the supply chain—from the customer ordering stage through to delivery to the customer site and customer acceptance. This was tackled by introducing significant changes in the ordering process and the supply processes.

One result was that the time needed to build GSM base stations and ship them to the customer site was cut from around 60 to less than 14 days. Cutting the time needed to deliver built-to-order products is only one benefit. Quality and delivery accuracy also improved significantly. Likewise, the whole ordering process has become much easier for customers, thanks to simplified product packages and new e-business processes. This had the important spin-off benefit that customer personnel and Ericsson sales and support personnel spent less time engaged in completing and checking orders.

Greater standardization in the configuration of equipment, such as base stations, meant that there was less scope for errors in ordering, and reduced the number of variants that had to be manufactured. This led directly to better quality and greater production efficiencies.

Ericsson has introduced a logistics concept based on regional flow control centers (FC). Orders flow to the center directly from the customer via Web tools. Completed equipment is then shipped directly from the flow control center to the customer site. This allows traditional warehousing requirements to be reduced or even eliminated, and greatly improves delivery precision (Figure 4).

These supply processes offer clear commercial benefits to network operators. They also represent some big changes in established practices and ways of thinking. One of the main challenges is the acceptance of standard product packages, rather than fully customized products. As Ericsson introduces these supply processes, network operators recognize that a reduction in the "uniqueness" of the equipment they order is a small price to pay for significant improvements in time scales, cost, quality and simplicity.

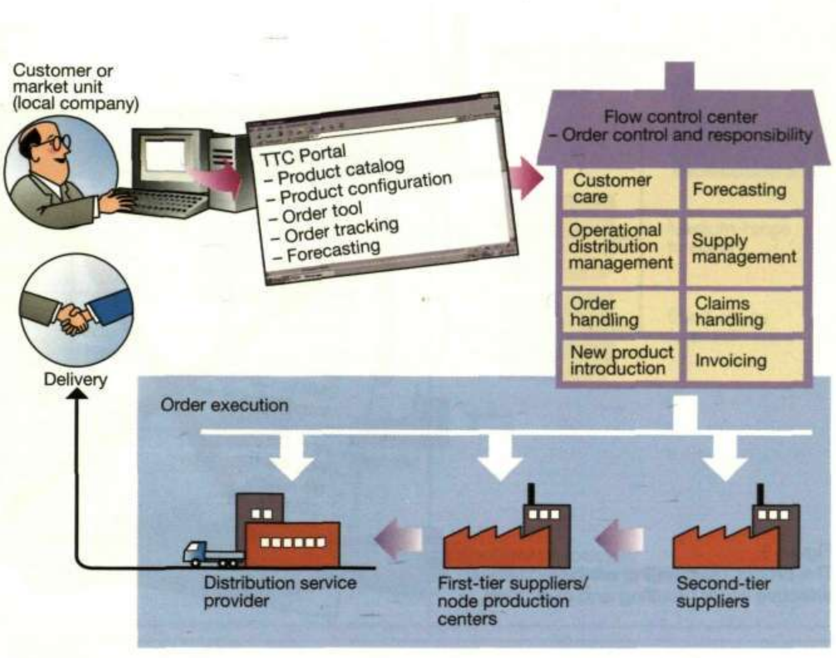


Figure 4
The flow control center concept.

Guiding principles for the supply of equipment

Drawing on experiences of the initial phase of the TTC Global program and other related initiatives, Ericsson has developed a supply and logistics framework that will cope with the combined need to deliver even greater volumes of second- and third-generation products.

Product packages

Product management is about considering the infinite variety of possibilities, and turning them into the actual products that can enter the supply flow. The enabler of this in Ericsson's supply strategies is strict adherence to standard product packages. Ericsson has looked to other industries to see what lessons could be learned, drawing ideas from strategies used in the automotive, personal computing, and consumer goods sectors.

In essence, the idea of product packages is that a customer should only be required to specify a few properties and options in order to get the node that will meet the network and service needs (Figure 5). This represents a major shift away from traditional ordering

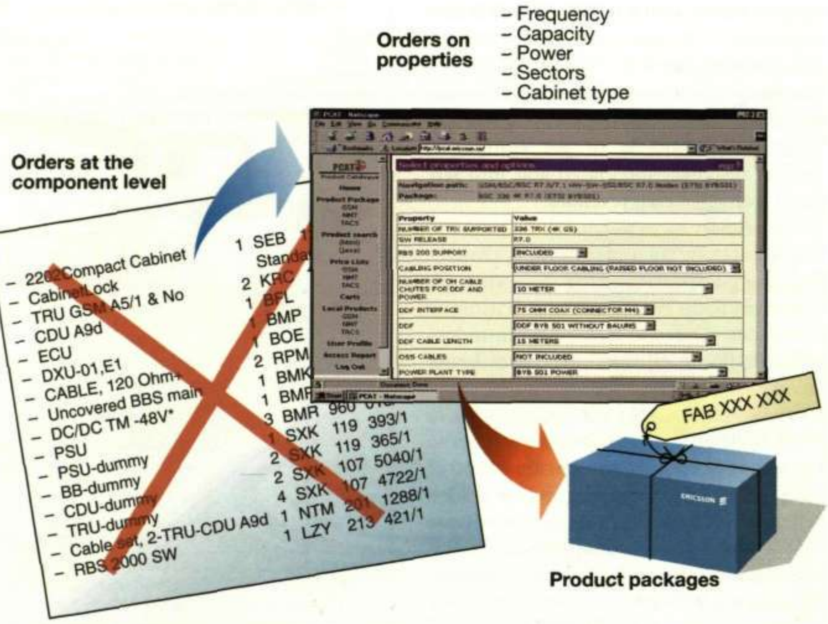


Figure 5
The product packaging enables cost-effective order handling and execution.

practices in the telecommunications infrastructure business, and reduces the operator's scope to specify unique market adaptations. The benefits, however, are considerable:

- because software is the main bearer of functionality, hardware platforms can now be standardized for a mobile network;
- the attraction of standardized product packages is that they promote or facilitate repetitive production, short and fixed lead times, and reduce problems during on-site installation and network integration;
- product packages enable better cost control throughout the chain of value-added activities, which yields configuration flexibility;
- standardized products or modules also enable the supply chain to provide the customer with better and more consistent product quality at lower cost; and
- the ordering procedures are simplified and more resistant to errors.

All new Ericsson product development for mobile network infrastructures is currently managed within this product package concept. Proposed designs are evaluated as much for their impact on supply processes as for price and functions.

The product-package approach has moved the ordering process to a higher level. The emphasis is on the functionality and value of the node in meeting the operator's business plan, rather than on a detailed technical appraisal of what is inside the equipment cabinets.

The product-package approach has strong parallels with, say, ordering an automobile: the product package is the model. Customer choices are simplified (color, engine size, seating, and so on). Additional items that can be specified might include aluminum rims or a stereo.

The product packaging model consists of core product packages—these represent the range of packages that suits all market requirements. On top of the core product packages are the options. There might also be additional materials (special needs to meet, for example, mandatory requirements for a certain market), and finally the installation materials.

Ericsson's goal is that standard product packages should cover over 90% of the market needs. Market adaptations can still be considered, but these will always incur higher cost and longer lead times.

In the case of an Ericsson base station controller, for example, there are now only a few core sizes from which to choose—each size supports a different number of speech channels. There are also a few options, such as interfaces to different generations of base station, choice of overhead or underfloor cabling, choice of 75-ohm or twisted pair connections, and inverter voltage level. Similarly, there are standardized expansion steps and upgrade packages from previous releases.

Site solution

The scope of the product-packaging idea is being broadened. The next step takes the ordering process even higher up in the value chain, to encompass complete site solutions. A site solution contains several node products together with all necessary cables, fixings, power, cooling, services and other items.

The completeness of a site solution can be extremely important in the timely completion of a network project. A missing two-dollar cable, for example, might not be a problem for a base station installation in a city—the installation staff can probably obtain a suitable replacement from a local computer shop. But if the installation is in a very remote location, it could result in several days' delay in getting the network into service. The missing cable could thus result in lost operator revenues running to thousands of dollars.

Forecasting

Forecasting is always a mission-critical activity in planning supply processes. As supply chains get leaner and faster, the role of forecasting will become even more important. Disturbances are more critical when lead times are shorter.

Good forecasting input results in good supply performance. Ericsson is thus developing ways of ensuring the accuracy of the forecasting process. In part, it is a question of education, so that everyone involved in the forecasting process, on the customer side and on Ericsson's side, understands the new context for forecasting. In part, it is an issue of trust on both sides: trust that the figures being presented are accurate, and that the requirements will be met.

Traditionally, forecasting has been more of an art than a science, subject to "adjustments" by people at various stages in the information flow. Part of the supply flow is a Web-based forecasting tool that authorized persons in the local markets use to update forecasts directly. In addition, some customers can currently update their own forecasts in the system. By means of the planning part in the tool, suppliers can immediately get access to updated plans for the products they supply.

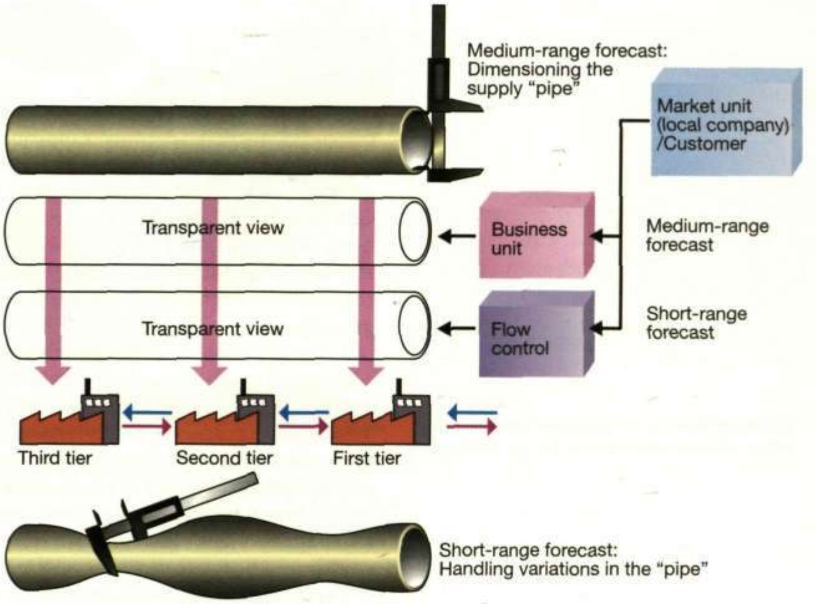


Figure 6
Forecasting information is critical to manage the supply chain.

The aim is to give everyone in the supply chain the required information at the same time, so that the necessary capacity can be accurately planned. The Internet is a good enabler of this objective (Figure 6).

Ericsson is also investigating a way of bringing greater precision to the process by means of a new software tool which, based on the figures of actual and desired network performance, will automatically calculate a forecast.

Direct distribution

Inventory costs money, and as the value of the inventory rises, so do the cost implications. At the same time, product lifecycles are becoming shorter, so there is a need to keep inventory as low as possible to avoid losses through obsolescence.

An important change to supply management is direct distribution. Beginning in 1999, Ericsson started to introduce a technique called *merge in transit*, which can be defined as the coordinated distribution of material from multiple suppliers in order to provide a single, complete, on-time delivery without using any inventory.

Software perspectives

Software delivers the functionality of a mobile communications network. Consequently, because traffic in mobile networks is growing, new types of node element for GPRS and WCDMA/UMTS services are being deployed. Similarly, as the number of services and applications expands, the need to install new software in the network is also growing.

A complication is that many software adaptations have been made to suit the needs of different operators in different countries. This legacy situation is being redressed as the market recognizes that, just as with the product-package concept in hardware, there are enormous benefits in accepting a more standardized, less customized, software strategy.

The traditional approach to a software upgrade is for the network operator to implement the upgrade node by node, with engineers spending time at each site. For an operator with many nodes in the network, this is a heavy, ongoing workload as well as a financial burden. It takes skilled people who might quickly tire of living out of a suitcase and working through the night in order to execute the upgrades.

In 1994, Ericsson began remotely loading software in GSM networks. Today, operators can manage upgrades automatically from a central maintenance center by means of electronic links (as well as satellite links) to the switches in the network. Increasingly, operators are allowing Ericsson to handle these upgrades.

In one case that has been studied, remote upgrading cut the number of man-hours needed by 90% compared to traditional methods. Remote upgrading also lays the foundation for new upgrade strategies. For example, in the past, the emphasis was put on big annual releases of new software, with monthly packages and corrections. With remote software loading, it is possible to install smaller packages at shorter intervals and with less disturbance to the network. Additional benefits are

- fewer human errors;
- operators can more easily retain the expertise of software specialists who no longer have to travel extensively to install software in individual nodes; and
- operators can tap into Ericsson's resources, if necessary, by giving Ericsson online access to individual nodes in the network.

A similar approach has also been adopted to the flow of software updates to customer networks. The automated update-deployment concept—which is based on the operations support system (OSS), Ericsson's network management system in use by the majority of Ericsson's mobile operator customers—facilitates a very aggressive roll-out of updates. The first mobile operator to apply this approach has reported that it could reduce its manpower resources for update handling by more than 80%.

As part of these new software supply processes, Ericsson is moving toward the licensing of software on a right-to-use basis. This business logic for mobile infrastructures fits well in an environment in which operators need to remain flexible and move quickly with their services. It also plays to the strengths of an industry that is moving toward high-functionality software running on non-proprietary hardware platforms.

E-business

Web-enabled ways of working are another integral part of the supply chain management program. The Internet is the main carrier of information along the supply chain, giving everyone the same information at the same time. It is also used as the central communication channel between Ericsson and customers, not only for product ordering, but also as a shared platform for information that can be used by Ericsson and customer personnel.

When customers use the "fast-track" supply processes based on standard product packages, they can place orders via a Web portal directly to the flow control center. Customers can check the status of the order, tracking it all the way to site via a global tracking system that is used by all main global distribution service providers.

Ericsson's first customer to switch to direct ordering of standard product packages over a Web portal did so in 1999.

The prime advantage of putting the product catalog on the Web is that it eliminates any handovers of paperwork or information between the customer and the flow control center. It also prevents customers from ordering non-standard product packages, since only standard packages are included on the Web portal.

For operators with a global business, Web ordering is useful for reinforcing a consistent ordering strategy across the entire organization.

Once the standard product information is on the Web, customers can easily look up relevant technical information on products and related subjects, such as training.

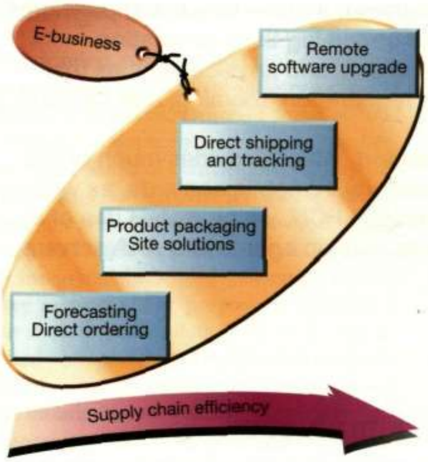


Figure 7
Enhancing business competitiveness by increasing efficiency in the supply chain.

Conclusion

The supply and logistics concepts presented in this article are part of a larger trend toward new ways of working between suppliers—in this case, Ericsson—and their customers.

Many operators are struggling to cope with shortages of skilled and experienced people. Consequently, many of them are reevaluating the role of their procurement functions. As a result, the language of procurement is changing. Instead of discussing bits and pieces, the participants

- want to discuss more strategic business issues, such as coverage, capacity and consultancy; and
- are seeking solutions that support their business objectives.

Operators are increasingly willing to give the technology supplier access to the network. That way, for key activities, such as software upgrades, updates, and planning for the expansion of infrastructure, the operator can benefit from the supplier's know-how and resources.

Obviously, these changes in the supply flow must be planned and implemented jointly by the operator and the supplier, because there are many related implications to be considered. In some cases, the supply processes will also require operators to change their own internal processes—for example, how should an e-procurement process be integrated into the operator's procurement and computer-support systems? However, the overall trend is clear: with the advent of third-generation products, the supplier-customer relationship is moving into new territory, putting new demands on the supply chain as a business-critical function.

The cdma2000 packet core network

Tim Murphy

The packet core network, which is a network architecture being promoted by TIA as the packet-data standard for upcoming third-generation cdma2000 networks, is a collection of logical and physical entities that provide IP-centric packet-data-based registration, roaming, and forwarding services for mobile nodes.

The author describes IP mobility support, which provides much of the basic functionality for proper IP connectivity in mobile contexts, as well as Ericsson's implementation in the cdma2000 PCN, which makes use of a packet data service node, home agents, foreign agents and AAA servers (datacom AAA and telecom AAA).

Introduction

The first commercial wireline telephone switchboard, an ungainly manual contraption, began operation in New Haven, Connecticut on January 28, 1878. It served twenty-one phones on eight separate lines, so the majority of users had to make do with what was referred to as a "party line." By 1903, the estimated number of independent (consumer/household) telephones in place in the US had risen to approximately two million.

Personal transmission of analog audio data was rapidly becoming a ubiquitous and indispensable feature of the technology landscape. Jumping ahead to the 1970s, the number of telephones installed, both household and business, had risen to well over 100 million plus all the commensurate infrastructure. With tongue in cheek, one might say that our reliance on access to a dial tone is now only slightly less than that on access to oxygen.

The first North American trial deployment of a wireless cellular phone system took place in Chicago, Illinois, in July 1978. Illinois Bell and AT&T rolled out a ten-cell advanced mobile phone service (AMPS) system that covered 21,000 square miles. A market trial with paying customers began on December 20, 1978. The first truly commercial service, after the dust of the Bell breakup had settled, was once again fielded in Chicago by Ameritech on October 12, 1983. By 1985, there were approximately 204,000 cellular subscribers. Within three years, this base had grown to 1,600,000 (incidentally, 1988 also saw the publication of TIA's IS-41 specification). In 1990, driven by capacity concerns, the US cellular network headed down the digital path with the introduction of IS-54B, or digital AMPS (D-AMPS), a TDMA-based dual-mode cellular standard. Three years later, the subscriber count had swelled to more than 13 million. By 1999, the combined North

BOX A, TERMS AND ABBREVIATIONS

3GPP/3GPP2	Third-generation Partnership Project	GRE	Generic routing encapsulation	PCF	Packet control function
AAA	Authorization, authentication and accounting	GSM	Global system for mobile communication	PCI	Peripheral component interconnect
ABR	Available bit rate	HA	Home agent	PCN	Packet core network
ADSL	Asymmetrical digital subscriber line	HDLC	High-level data link communication	PDSN	Packet data service node
AMPS	Advanced mobile phone service	HLR	Home location register	PPP	Point-to-point protocol
ANSI	American National Standards Institute	HTTP	Hypertext transfer protocol	RADIUS	Remote authentication dial-in user server/service
ATM	Asynchronous transfer mode	IANA	Internet Assigned Numbers Authority	RBS	Radio base station
BSC	Base station controller	ICQ	"I seek you"	RFC	Request for comments
BSD	Berkeley Software Distribution (UNIX)	IETF	Internet Engineering Task Force	RP	Radio packet
CBR	Constant bit rate	IP	Internet protocol	RRC	Radio resource control
CDMA	Code-division multiple access	ISP	Internet service provider	RTT	Radio transmission technology
CHAP	Challenge-handshake authentication protocol	LCP	Link control protocol	SDRAM	Synchronous dynamic random access memory
COA	Care-of address	LDAP	Lightweight directory access protocol	TCP	Transmission control protocol
CORBA	Common object request broker architecture	MAAE	Mobility agent advertisement extension	TIA	Telecommunications Industry Association
CPE	Customer premises equipment	MAP	Mobile application part	TPS	Transactions per second
CTIA	Cellular Telecommunications Industry Association	MIP	Mobile IP	TSP	The server platform
D-AMPS	Digital AMPS	MIPS	Million instructions per second	UBR	Unspecified bit rate
FA	Foreign agent	MN	Mobile node	UDR	Usage data record
		NEBS	Network equipment building standards	UTP	Unshielded twisted pair
		OA&M	Operation, administration and maintenance	VBR	Variable bit rate
				VPN	Virtual private network
				WWW	World Wide Web

American subscriber base of the remaining analog AMPS systems and digital TDMA/CDMA systems was (according to figures released by CTIA in April 2000) in the neighborhood of 86 million. Indisputably the phone, either fixed or mobile, and its services have become a necessary fixture in everyday life.

Roughly contemporaneous with the development of wireless phone service, the growth of the "capital-I" Internet proceeded apace. In 1983, 4.2 BSD UNIX with IP support appeared as the conceptual ancestor to the PC—the workstation. By 1987, there are approximately 10,000 interconnected hosts. This number jumped to 100,000 by 1989. The years 1991-1993 were also very big:

- Tim Berners-Lee "created" the World Wide Web (WWW) by introducing the hypertext transfer protocol (HTTP) for simple, atomic, client-server data requests;
- Mosaic offered an integrated "window" into the Internet (the distinction between the Internet and the WWW began to blur, at least in the popular mind) and overall data traffic grew by 341,634% (!) due to Mosaic-fueled browsing.

As of July 2000, there were over 93 million hosts and over 1 billion indexed Web pages, offering search, commerce, specialty communications, such as ICQ ("I seek you"), and purely informational services. Daily reliance on these services and multimedia data communication features made possible by connection to the Internet, now arguably rivals that on fixed/mobile phone services. However, packet-data network access, as exemplified by the Internet, is still "land-locked." Most end-users still connect their home systems to the Internet over analog phone lines via modem, or (increasingly) via newer, higher-speed purely digital technologies, such as ADSL or a cable modem. Access to mobile packet-data networks still suffers from two limitations:

- low data rates, which make accessing multimedia content and services an exercise in patience; and
- no support for true mobile packet-data service.

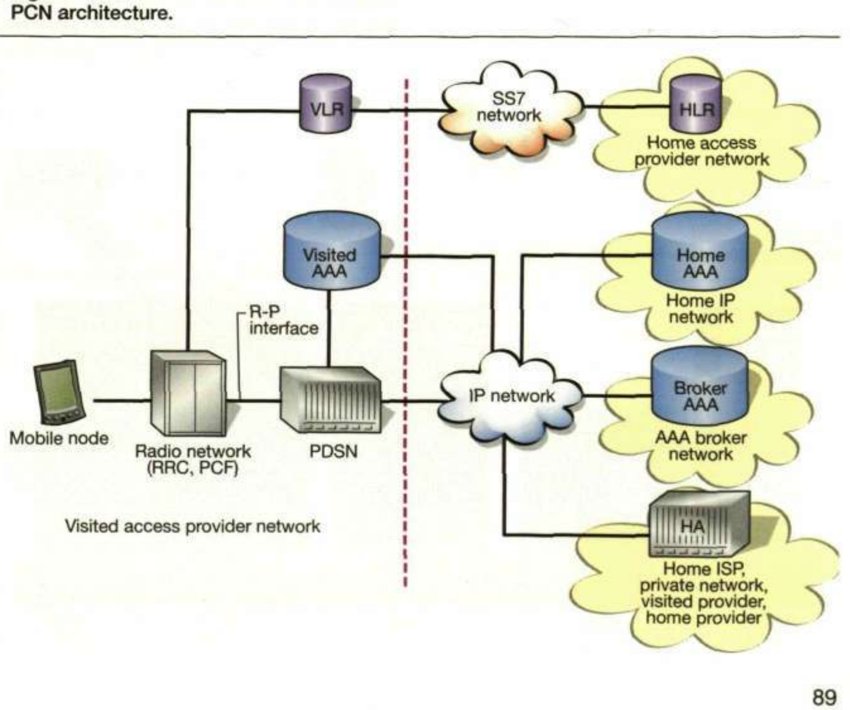
Ericsson's packet core network (PCN) solution, coupled with the higher data rates provided by their cdma2000 radio base station, heralds the convergence of the mobile circuit-switched and existing packet-switched worlds, to provide seamless voice and data service.

Background

The wireless evolution to third-generation technologies and services reflects a convergence of the circuit-switched world of "traditional" telephony and the packet-switched world of contemporary computer networks. Hardware and software which belong to packet-data networks and which support IP-centric protocols must be cleanly integrated into third-generation mobile core networks. The proposed architectures for mobile packet-data services are predicated on existing IP-related standards, which—in light of the unique requirements of mobile nodes (which constantly and sometimes rapidly) change their point of connection to a packet-data network—must be extended or completely developed "from scratch" to permit proper IP connectivity and operations.

As implied by its appellation, the packet core network is a collection of logical and physical entities that provide IP-centric packet-data-based registration, roaming, and forwarding services for mobile nodes. At a high level, the packet core network is analogous in operations and entities to an ANSI-41 or GSM mobile application part-based (MAP) mobile core network. The PCN is a network architecture being pro-

Figure 1
PCN architecture.



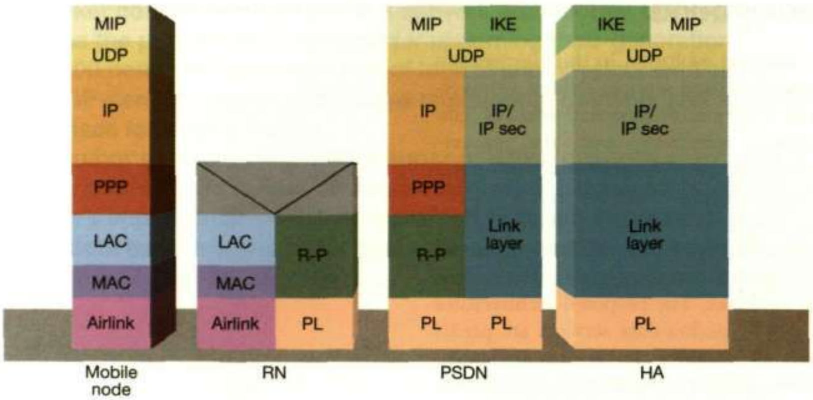
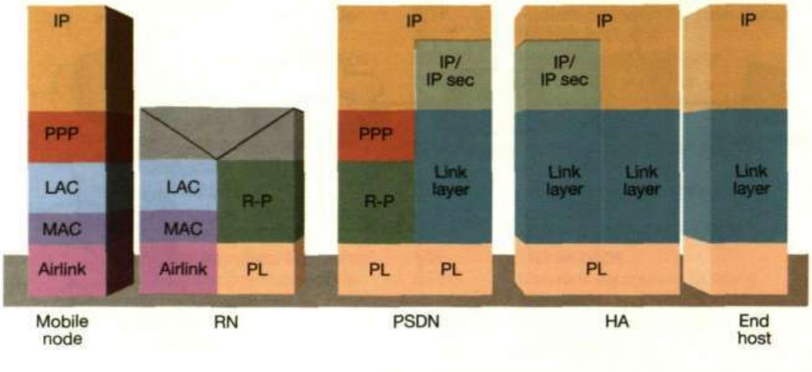


Figure 2
Protocol reference model for mobile IP control and IKE.

moted by group TR45 of the Telecommunications Industry Association as the packet-data standard for upcoming third-generation cdma2000 networks. The higher bit rates available from the 1xRTT CDMA air interface (up to 144 kbit/s of user data when radio configuration 3 rate sets are available) will permit the use of new wireless multimedia, voice and data applications that were formerly impractical with AMPS or cdmaOne IS-95A technology. In an effort to avoid reinventing the wheel, TIA relied on several existing IETF RFCs in crafting IS-835, the wireless IP network standard. The key RFC, from which was derived most of the basic functionality of the nodes described in IS-835, is RFC 2002, *IP mobility support*.

Figure 3
Protocol reference model for mobile IP user data.



IP mobility

IP mobility support describes the framework of procedures, messages, and message formats that enables a node to change its point of attachment to a network without requiring alteration to its IP address, which would otherwise disrupt layer 3 and higher operations. Peer nodes can respond to the sending node indicated by the IP source address of incoming packets regardless of the IP prefix of the network through which the sending node obtained connectivity. To do this, RFC 2002

- introduces a key distinction between the home address and the care-of address (COA);
- defines three entities—the mobile node (MN), foreign agent (FA), and home agent (HA); and
- delineates the exchanges between the MN, FA and HA that facilitate seamless roaming in layers 3 and above. RFC 2002 also augments the functionality of an existing standard, RFC 1256 ICMP, *router discovery messages*, and extends it to define a mobility agent advertisement extension (MAAE) that enables nodes to advertise their availability to provide foreign agent services in a manner similar to RFC 1256 provisions for the advertisement of routers.

The home address, which is the IP address assigned to a mobile node by its controlling provider, is assigned in much the same way as some Internet service providers (ISP) give a subscriber a fixed Class C address. This address, which can be assigned dynamically, is the source address value in the IP header of outgoing packets. Because the network prefix is the same as that of the network assigned to the controlling provider, this address will probably be topologically incorrect when the mobile node roams into a new network. The care-of address functions as an indirect pointer to the mobile node. It represents the topologically correct and reachable IP address that corresponds to the mobile node's current network attachment, so that the home agent can tunnel packets to it. The care-of address can be located

- in the foreign agent—this is more efficient, since only one address is required to support multiple mobile nodes; or
- in the mobile node itself—this obviates

the need for a foreign agent. In this case, the care-of address is referred to as a co-located COA.

A mobile node is basically any user device which features a TCP/IP stack and supports the added functionality that allows it to register its new location as it roams from network to network. The foreign agent is the critical entity in a (visited) network, making mobility services available to a roaming mobile node. It is also one endpoint of the HA-FA tunnel that is created when a mobile node successfully registers with its home agent for mobile IP (MIP) services. This might be an IP-IP, generic routing encapsulation (GRE), or minimal encapsulation tunnel. The foreign agent advertises its availability for service when a mobile node roams into its network and accepts, processes and forwards a mobile node's registration request to the home agent. The foreign agent also accepts, processes and forwards registration replies from the home agent. The home agent, which is the other endpoint of the FA-HA tunnel, is responsible for attracting traffic destined for the mobile node (based on network prefix) and for tunneling it to the care-of address associated with a given mobile node (presumably an interface on a foreign agent) for further delivery to the mobile node.

The position of the home agent in attracting and tunneling traffic to the mobile node gives rise to inefficiencies in the routing of traffic. If the roaming mobile node and a peer node are geographically very close to each other (in terms of router hops), possibly even on different subnets homed on the same node, packets from the peer to the mobile node must still travel through the mobile node, which may be many additional hops away. Referred to as triangle routing, this is one of the issues in the MIP standard being addressed by a number of IETF drafts collected under the umbrella term of route optimization (Box B and Figure 4).

IOS 4.0 and TIA IS-835

IS-835—TIA's wireless IP network standard—lays out the detailed architecture and procedures of the packet core network entities. The standard, which is intended as an implementation document, clearly specifies distinct nodes and their relative areas of responsibility for handling packet data service delivery and mobility management. The interoperability standard (IOS) 4.0 defines

- the radio packet (RP) interface, which is an open interface between the base station controller (BSC) and packet control function (PCF). A logical division was made, separating the BSC into the radio resource control (RRC) and packet control function (PCF, the "interface" to the PCN); and
- the packet data service node (PDSN), which is a key feature of Ericsson's PCN solution.

As stated above, IS-835 uses existing RFCs as a starting point, so I will focus on four important additions to the general MIP framework described in the document:

- the authorization, authentication and accounting (AAA) server;
- the packet-data service node;
- packet-data-related RADIUS attributes; and
- node-specific mobility-management procedures.

The radio packet interface defines two logical channels: *A11* for signaling, and *A10* for data. Signaling is based on MIP messages (*registration request* and *registration reply*) with two additions: *registration update* and *registration acknowledge*. Data from the mobile node is encapsulated in generic routing encapsulation and tunneled from the packet control function within the base station controller to the PDSN, where it is decapsulated and further processed.

The AAA server, which is based on remote authorization dial-in service (RADIUS), is analogous to the home location register (HLR) of the voice core network. It contains subscriber packet-data-provisioning information and is used to authenticate and de-

BOX B, TRIANGLE ROUTING

- The mobile node sends data to its peer node through normal means, using the foreign agent as its default router.
- The peer node sends data to the mobile node indirectly—the home agent intercepts packets destined for the mobile node.
- The home agent encapsulates and tunnels packets to the mobile node via the foreign agent's care-of address. This is inefficient, however, because in theory, a peer node adjacent to the mobile node, either geographically or by network segment, will still have its packets directed through the home agent, which might be located many hops away (see Figure 4).

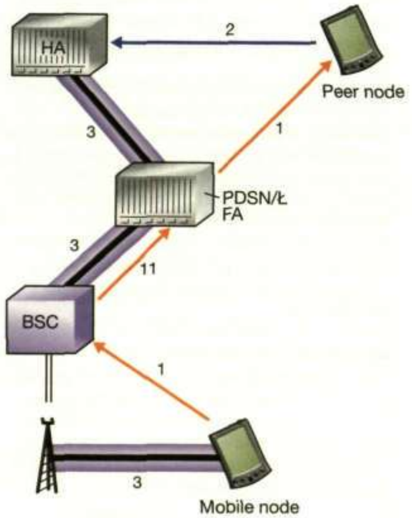


Figure 4
Triangle routing

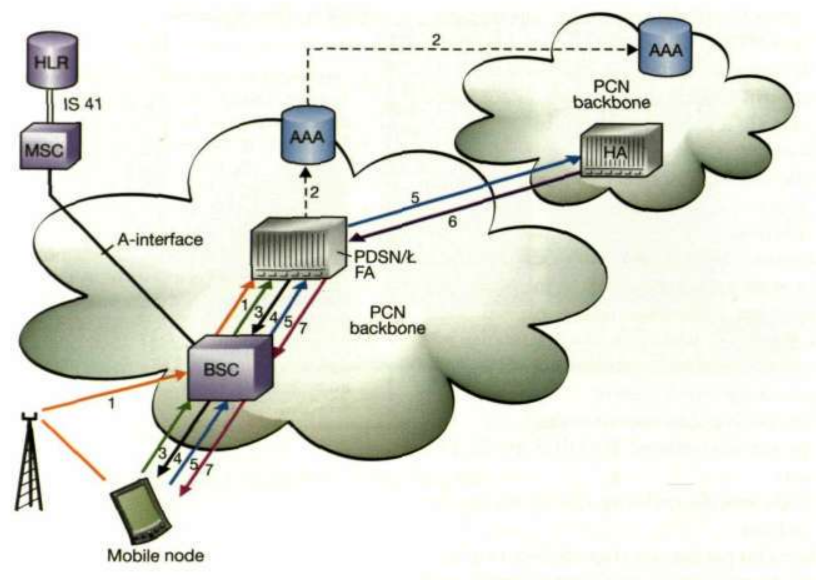


Figure 5
Mobile IP registration.

termine the parameters of a subscriber's packet-data session. It is also a store-and-forward point for accounting data in the form of usage data records (UDR) generated by the PDSN.

The PDSN is the mobility anchor point between the mobile node and PCN. The mobile node point-to-point protocol (PPP) data link terminates at the PDSN, and the FA logical entity resides in this same node. The PDSN

- operates as a RADIUS client toward an AAA server;
- is responsible for aggregating accounting information from the radio resource domain via updates sent from the PCF and for combining this data with its own packet traffic information to form complete accounting records; and
- vets subscriber credentials during PPP CHAP activity where the subscriber's information is verified to allow completion of PPP link establishment.

RADIUS attribute extensions have been defined by TIA in IS-835 to enable information on cdma2000 packet data operations to be exchanged within the RADIUS protocol framework. The extensions are of type "26"—that is, they are vendor-specific (3GPP2). The 3GPP2 vendor ID used with them is 5535, as defined by the Internet Assigned Numbers Authority (IANA). The attributes can be broken down further into accounting and service-related attributes, such as session status, session activity, security status, and differentiated services class option. These attributes are exchanged between the PDSN and AAA in, for example, access request, access accept, and accounting request RADIUS messages.

Mobility management defines two roaming scenarios and the procedures to accommodate them. In the PCF-to-PCF handoff scenario (intra-PDSN), the mobile node moves from one base station controller to another, and both BSCs are connected to the same PDSN. This type of handoff might not require the renegotiation of the PPP session between the mobile node and PDSN, since the PDSN can re-associate the PPP state of the mobile node with the new base station controller. In the PDSN-to-PDSN handoff scenario (inter-PDSN), the mobile node (presumably) roams into a new network with a different PDSN. In this case, the mobile node is required to establish a new PPP link to the new PDSN and then perform MIP registration again.

BOX C, DETAILED MIP REGISTRATION IN ERICSSON'S PCN

- The mobile node (MN) roams into a new (visited) network and sends an origination request to the base station, specifying packet-data service option 33.
- The packet control function (PCF) determines that there is no A10 connection associated with the mobile node and initiates A11 signaling to the packet data service node (PDSN) to set up A10 data connection.
- The mobile node negotiates PPP LCP with the PDSN to establish the data link.
- LCP link parameter negotiation concludes; the CHAP phase begins.
- The mobile node sends CHAP data (CHAP ID, CHAP secret, etc.) to the PDSN, which
  - creates a RADIUS access request, assigning CHAP data to appropriate RADIUS attributes; and
  - sends the attributes to the local AAA server, which proxies the request to the mobile node's home AAA.
- The home AAA returns a positive access accept message through the visited AAA to the PDSN.
- The PPP link is established.
- The mobile node sends agent solicitation to the PDSN/FA looking for an available foreign agent (FA).
- A foreign agent responds with a mobility agent advertisement, listing available foreign agents.
- The mobile node creates a MIP registration request, specifying a willing foreign agent as its care-of address (COA) and forwards the request through the foreign agent to the home agent (HA).
- The foreign agent processes the request and forwards it to the home agent.
- The home agent processes the request and responds with a positive registration reply. It also updates its binding tables with the mobile node's new care-of address association and its remaining lifetime.
- The foreign agent processes the reply, updates its visitor list with a new entry for the mobile node, and forwards the reply to the mobile node.
- A tunnel is established between the foreign agent and the home agent.
- The mobile node can now send packet data using the foreign agent as its default router.
- The home agent can now tunnel traffic sent to the mobile node's home address to the foreign agent, which decapsulates the traffic and transfers it to the mobile node.

An addendum to IS-835, IS-835-A-1, which is currently under review, attempts to clarify "gray areas" in the initial document, such as handoff optimization, security indications for optimized key exchanges, and the removal of data entities (these have been underutilized in emerging implementations of the standard).

Ericsson's packet core network

Ericsson has capitalized on decades of telecom and datacom expertise to deliver a fully open standards-compliant third-generation packet network architecture that incorporates the most recent advances in mobile packet-data transmission technology. The PCN product roadmap includes PDSN, HA and AAA offerings that span the range of subscriber or traffic loads, from equipment that handles from 5,000 to 7,000 simultaneous sessions to platforms that handle up to 400,000 simultaneous sessions typically deployed in a central office.

All Ericsson solutions offer carrier-class network equipment building standards (NEBS) level 3-compliant access platforms for the PDSN/foreign agent and home agent nodes. The AAA server is also NEBS-compliant for use in a carrier operations center.

PDSN

The first router in the Ericsson PCN family to implement PDSN functionality is the AXC, which has been optimized for small-scale deployment. In PDSN trim, up to 50,000 simultaneous PPP sessions are supported. The AXC provides a PCI-derived 1 Gbit/s packet bus coupled with a MIPS CPU and up to 512 MB of SDRAM, split between packet memory (for packet forwarding) and local memory. Up to 64 MB of flash memory is used for operating system activity, such as maintaining IP routing tables, physical interface tables, and so on. Dual control cards provide support for redundant failover, so that the failure of one control card will result in the backup card taking over—a necessary configuration in high-availability carrier environments. This configuration features 10/10BaseT unshielded twisted pair (UTP) redundant ports for network connectivity and uses asynchronous transfer mode (ATM) interface cards to the base station controller. These high-performance interface boards, which are based on the IDT R4700 processor, support OC-3 and STM-1 155 Mbit/s over single- or multi-mode fiber or CAT-5 STP. Standard ATM service class configurations, such as constant bit rate (CBR), variable bit rate (VBR), available bit rate (ABR) and unspecified bit rate (UBR) and their associated metrics are supported, as well as support for RFC 1483, to enable multiprotocol encapsulation over ATM.

The medium- to high-capacity PDSN platform is the AXI, in seven- or fifteen-slot configurations, supporting up to 200,000 simultaneous PPP sessions.

To the base station controller, each OC-3/STM-1 ATM interface card features four single- or multi-mode physical 155 Mbit/s fiber interfaces. The ATM forwarding engine supports both PPP (RFC 1619, *PPP over SONET*) and HDLC (RFC 1662, *PPP in HDLC-like framing*) encapsulation. All major components (the route processor module, switch fabric modules, fans, power supplies, and so on) are one-to-one (1:1) redundant and hot-swappable for zero-downtime operation.

Home agent

The home agent is based on the same hardware platforms as the PDSN. It is also pro-

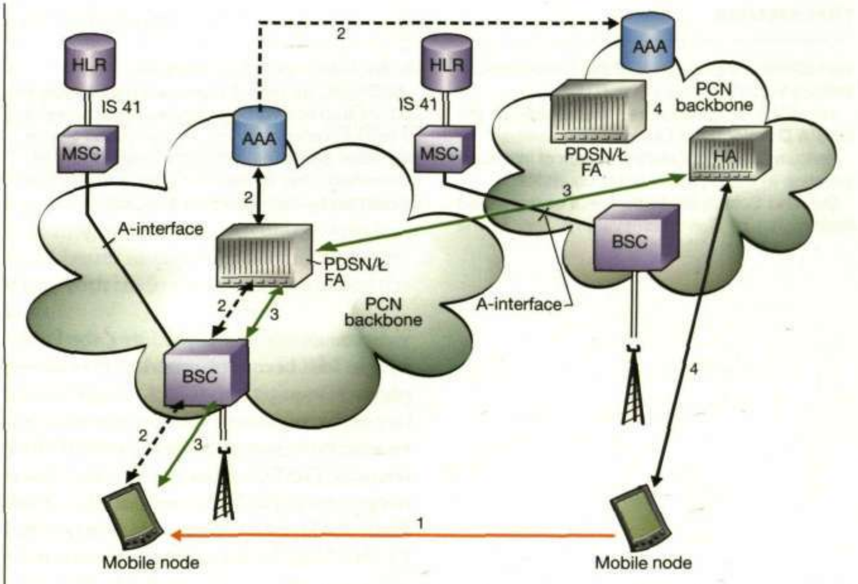


Figure 6
Mobile IP handoff.

BOX D, MOBILE IP HANDOFF

- The mobile node roams into a new access provider.
- The mobile node engages in new PPP negotiation with a new PDSN. As before, the PDSN determines the subscriber attributes during the CHAP authentication phase of PPP via an AAA server.
- The mobile node obtains the care-of address (COA) from the foreign agent and registers with the home agent, updating its mobility binding with the new COA (in Figure 6, the mobile node is shown roaming away from its home network). The foreign agent updates its visitor list.
- The previous PPP link is torn down and the foreign agent visitor list entry is deleted after registration lifetime expires.

TRADEMARKS

cdma2000 is a trademark of the Telecommunications Industry Association (TIA).

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vided on an additional platform, the Fraser, which has been optimized for customer premises equipment (CPE) solutions that target the corporate level (that is, virtual private networks) and supports up to 7,000 PPP sessions. The Fraser features two fast Ethernet ports, an IDT R4700 central CPU, 8 MB Flash RAM for configuration storage, and 16 MB DRAM dedicated packet memory.

AAA server

A unique design innovation in the Ericsson PCN places all node configuration information in the AAA server. Thus only the AAA server is provisioned—subscriber and node data is accessed by the PDSN or HA on an as-needed basis. This avoids the redundancy of duplicate provisioning, a situation which arises because IS-835 specifies the data that is required by the nodes for MIP operations but not how the data is to be disseminated. An additional benefit of this approach is the short deployment time for nodes in an Ericsson PCN. If a node currently operating as a PDSN must be rotated out or switched to home agent duty, a reload of the operating system (incorporating appropriate node-specific PCN features) is the only operator activity needed to completely re-provision the node. The remaining provisioning data is retrieved from the AAA server.

Datacom AAA

The AAA applications feature full RADIUS support with cdma2000-specific attributes (RFC 2138, 2139) as well as AAA extensions for MIP authorization and accounting support. The underlying database systems, which support widely accepted open data

BOX E, STANDARDS AND RFC'S

TIA standards

TSB115	Wireless IP Network Architecture
IS-707-A-1.10	Data Service Options for Spread Spectrum Systems: Radio Link Protocol Type 3
IS-707-A-1.11	Data Service Options for Spread Spectrum Systems: cdma2000 High Speed Packet Data Service Option 34
IS-707-A-1.12	Data Service Options for Spread Spectrum Systems: cdma2000 High Speed Packet Data Service Option 33
IS-835	Wireless IP Network Standard
IS-2000-1	Introduction to cdma2000 Standards for Spread Spectrum Systems
IS-2000-2	Physical Layer Standard for cdma2000 Spread Spectrum Systems
IS-2000-3	Medium Access Control Standard for cdma2000 Spread Spectrum Systems
IS-2000-4	Link Access Control Standard for cdma2000 Spread Spectrum Systems
IS-2000-5	Upper Layer (Layer 3) Standard for cdma2000 Spread Spectrum Systems
IS-2000-6	Analog Standard for cdma2000 Spread Spectrum Systems
IS-2001	Interoperability Specification for cdma2000

RFCs

RFC 1256	ICMP router discover
RFC 1661	PPP
RFC 1662	PPP HDLC framing
RFC 1701	Generic routing encapsulation (GRE)
RFC 1702	GRE in IP
RFC 2002	Mobile IP
RFC 2003	IP in IP encapsulation
RFC 2004	Minimum encapsulation
RFC 2138	Remote authentication dial-in user service (RADIUS)
RFC 2139	RADIUS accounting
RFC 2344	Reverse tunneling
RFC 2401	IPSec security architecture
RFC 2402	Authentication aeader (AH)
RFC 2406	Encapsulating security payload (ESP)
RFC 2661	Layer 2 tunneling protocol (L2TP)

processing standards, such as the lightweight directory access protocol (LDAP), are fully distributed and replicated (logically, and if so configured, geographically) for zero downtime, should a particular node or office fail. Very high transactions-per-second (TPS) levels can be sustained, which reflects the large subscriber base and high activity rate currently seen in the circuit-switched world.

Telecom AAA

The telecom AAA node is based on Ericsson's TSP, a multi-CPU and scalable applications platform. The distributed real-time operating system, runs on Pentium boards, each with 512 MB dedicated RAM, and supports open data transfer standards, such as the common object request broker architecture (CORBA). Dual, dedicated UltraSparc boards run operation, administration and maintenance (OA&M) applications, providing access to external databases. The AAA and HLR platforms are derived from the same architecture, providing a single point for packet and telephony subscriber provisioning.

Conclusion

Two forces have driven the development of the packet core network: the evolving consumer demand for convenient access to multimedia data services, as exemplified by the World Wide Web, and the approaching technological convergence of circuit-switching and packet-switching—a packet-based bearer medium supporting and coexisting with traditional circuit-switched services.

Ericsson's PCN solution introduces three nodes—the home agent, PDSN/foreign agent, and AAA—which support high-speed wireless packet-data operations and provide zero-downtime operational characteristics for demanding telecommunications environments. The nodes are evolved from mature hardware architectures with proven track records, such as the AXC, AXI and TSP platforms. With Ericsson's full support of the open standards radio-packet interface, the PCN can be rapidly and smoothly integrated into any cdma2000 core network.

REFERENCES

1 Perkins, Charles: Mobile IP Design Principles and Practices. Addison Wesley 1998
2 Harte, Lawrence: CDMA IS-95 for Cellular and PCS. McGraw-Hill 1999
3 Nilsson, M.: Third-generation radio access standards. Ericsson Review Vol. 76(1999):3, pp 110-112
4 Farley, Tom: Private Line's Telephone History. Independent 2000

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