
Mobile Stations

Chapter 8

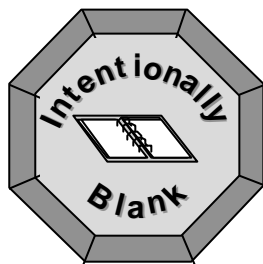
This chapter is designed to provide the student with an overview of the mobile station. It addresses mobile station components, their functions, features, required specifications.

There is also a short introduction to mobile stations for data communication and some accessories.

OBJECTIVES:

Upon completion of this chapter the student will be able to:

- List two important pieces of information stored on the SIM-card
- List one advantage of having a separation between telephony equipment (ME) and subscription (SIM-card)
- Describe the product categories of the Mobile Station (MS)




8 Mobile Stations

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INTRODUCTION

 Did you know?

In addition to being the largest supplier of mobile network infrastructure, Ericsson is one of the largest suppliers of mobile phones.

The MS is the equipment used to access the network. The MS consists of two independent parts:

- Subscriber Identity Module (SIM) card
- Mobile Equipment (ME)

A SIM card is an electronic smart card which stores information about the subscription. The ME is the actual telephone terminal.

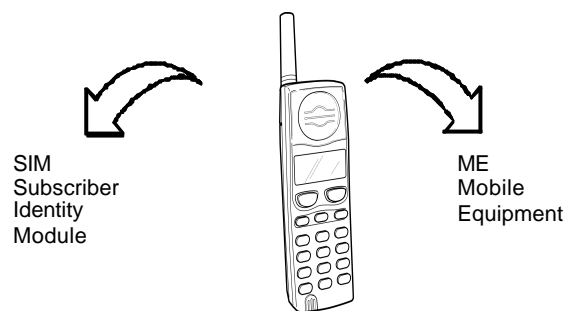


Figure 8-1 Mobile station

MOBILE STATION FUNCTIONS

TRANSMISSION AND RECEIPT

As described previously, the transmission and receipt process in an MS includes the steps shown in Figure 8-2.

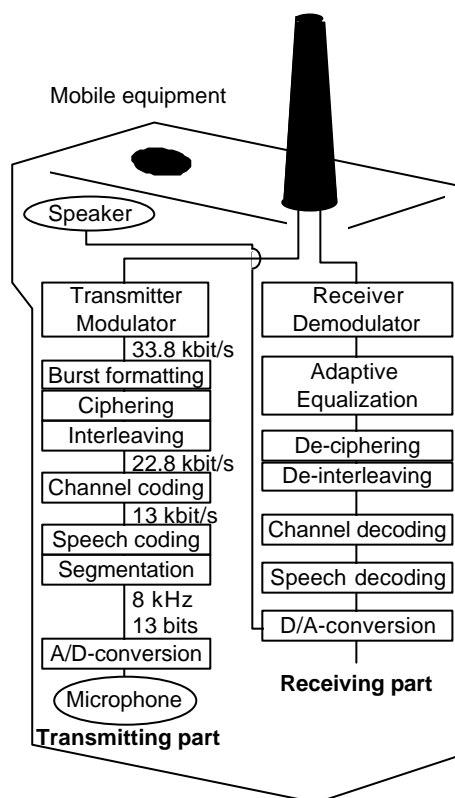


Figure 8-2 Transmission and receipt in an MS

MEASUREMENTS MADE BY THE MOBILE STATION

The measurements made by an MS are used in making decisions about signal strength and handovers. Measurements are taken in both idle and active mode.

Idle Mode

Cell selection is made at “power on” of the mobile:

1. The mobile scans all radio frequency channels in the GSM system and calculates average levels for each. The mobile tunes to the strongest carrier and determines if it is a BCCH carrier. If so, the mobile reads the BCCH information to find out if the cell is locked (e.g. chosen PLMN, barred cell, etc.). Otherwise the mobile tunes to the second strongest carrier, and so on until a valid BCCH carrier is found.
2. The mobile may optionally include a BCCH carrier memory of valid BCCH carriers in the home PLMN. In this case it only needs to search these carriers. If this ends unsuccessfully, the mobile performs as in 1.
3. If no valid BCCH carrier is found, but a BCCH carrier belonging to another GSM network operator is found, the mobile will display the message “Emergency calls only”. Every emergency call is permitted onto a GSM network, even if the subscriber has not subscribed to the network the MS chooses.

Alternatively, if no valid BCCH carrier is found, and no other network can be found, the MS will display the message “No network”. In this case no calls (including emergency calls) can be made.

Once it has tuned to a valid BCCH carrier, the mobile is informed which BCCH carriers it is to monitor for cell re-selection purposes. These are the BCCH carriers in neighboring cells. A list of the strongest carriers is updated regularly by the MS as a result of the measurements.

Active Mode

During a call, the mobile continuously reports (via SACCH) to the system how strong the received signal strength is from BTSs. Both signal strength and quality are measured on the MSs “own” BTS. These measurements are used by the BSC to make fast decisions about target cells when a handover is required.

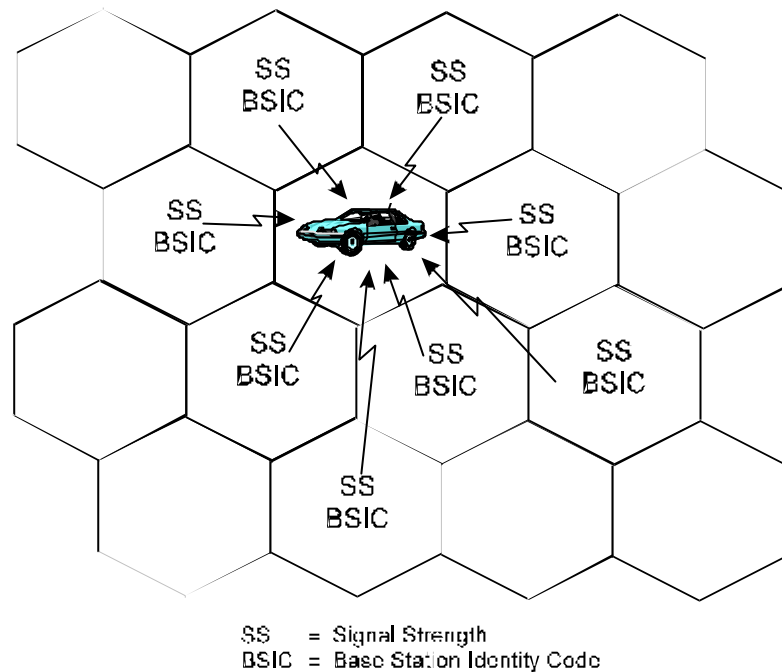


Figure 8-3 Monitoring BCCH carriers

Measurements on neighboring cells during a call takes place when the mobile is idle, i.e. when it is not transmitting or receiving.

POWER SAVING FUNCTIONS

Discontinuous Transmission (DTX)

Discontinuous Transmission (DTX) is a method of saving battery power for the MS. An MS with the DTX function detects the input "voice" and turns the transmitter ON only while "voice" is present. When there is no voice input, the transmitter is turned OFF.

When the MS detects that speech is absent during the conversation, it sends out a signal called "Post" to report a transmission output state OFF for the TCH. Conversely, when the MS detects that speech is present again, it sends out a signal called "Pre" to report the transmission output state ON for the TCH.

The Post signal incorporates background noise information from the MS, which enables the TRAU to generate background noise. This ensures that the other subscriber on the call hears something and does not think that the mobile subscriber has ended the call.

The MS transmits the Post signal periodically during a speech pause, to enable the BTS to update the background noise.

Discontinuous Reception (DRX)

Another method used to conserve power at the MS is Discontinuous Reception (DRX). The paging channel, used by the BTS to signal an incoming call, is structured into sub-channels. Each MS is assigned one of these sub-channels and needs to listen only to its own sub-channel. In the time between successive paging sub-channels, the mobile can go into "sleep mode", when almost no power is used.

MOBILE STATION CLASSES

Different types of MSs have different output power capabilities and therefore different ranges. Hand-held phones generally have a lower output power and consequently a shorter range than a vehicle-mounted phone. The output power varies according to the distance from the BTS. The further away from the source, the weaker the signal will be.

According to GSM specifications, MSs are categorized into five classes according to MS output power. These classes are listed in the following table:

Class	Type	Maximum output power		
		GSM 900	GSM 1800	GSM 1900
1	Vehicle & transportable	Undefined	1 Watt	1 Watt
2	Vehicle & transportable	8 Watts	0.25 Watts	0.25 Watts
3	Hand-held	5 Watts	Undefined	Undefined
4	Hand-held	2 Watts	Undefined	Undefined
5	Hand-held	0.8 Watts	Undefined	Undefined

Table 8-1 MS Power Classes

The location of the MS also affects the received power of the transmitted signal. An MS located at the top of a high building has a greater range than one that is located at or below ground level.

ERICSSON MOBILE PHONES

Ericsson offers a wide range of mobile phones for major cellular standards. For GSM alone, Ericsson has over thirty models.

GSM 900	GSM 1800	GSM 1900
GF 388	SH 888	CA 318
GA 318	T28s	CH 337
GO 118	T10s	CF 337
GH 337	T18s	CF 688
GF 337	R250PRO	I 888
GH 218	A1018s	T18z
TH 337		T28world
S 868		
SH 888		
I 888		
T28s		
T10s		
T18s		
R250PRO		
A1018s		
T28world		

Table 8-2 Ericssons range of GSM phones

EXAMPLE OF ERICSSONS GSM PHONES

T28s

Ericsson T28 is the smallest and most innovative mobile phone produced by Ericsson to date. Based on new technology and a unique design platform the phone's exterior features a new, arched design, which creates a series of finely balanced contours lending it all the clarity and sophistication traditionally associated with Scandinavian design. T28s houses the most up-to-date technology including a menu system that is easily navigated. T28s is for GSM



900 and GSM 1800.

Figure 8-4 Ericssons T28s

SUBSCRIBER IDENTITY MODULE (SIM)

A key feature of the GSM standard is the Subscriber Identity Module (SIM) card. A SIM card contains information about the subscriber and must be plugged into the ME to enable the subscriber to use the network. With the exception of emergency calls, MSs can only be operated if a valid SIM is present.

The SIM stores three types of subscriber related information:

- Fixed data stored before the subscription is sold: e.g. IMSI, authentication key and security algorithms
- Temporary network data: e.g. the location area of the subscriber and forbidden PLMNs
- Service data: e.g. language preference, advice of charge

GSM phase 1 SIMs contain all necessary network control information, while phase 2 SIMs include a large number of extra features such as a language identifier and a preferred language option.

TYPES OF SIM CARD

Two physical types of SIMs are specified. These are the "ID-1 SIM" and the "Plug-in SIM". The logical and electrical interfaces are identical for both types of SIM.

ID-1 SIM

The format and layout of the ID-1 SIM comply with ISO standards for Integrated Circuit (IC) cards (i.e. credit card size).

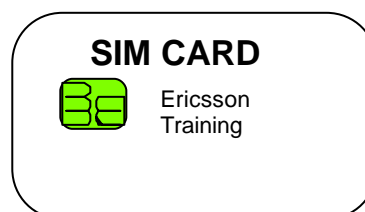


Figure 8-5 ID-1 SIM card

Plug-in SIM

The plug-in SIM is smaller than the ID-1 SIM. It is intended for semi-permanent installation in the ME.

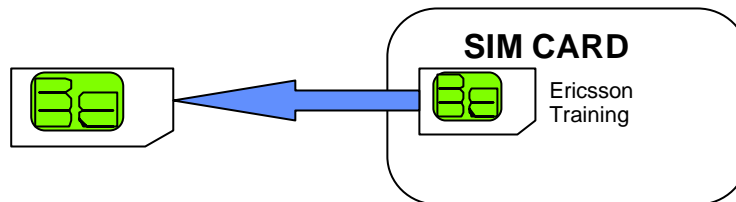


Figure 8-6 Plug-in SIM card

SECURITY FEATURES

GSM defines a number of security features to be supported by SIMs. These are:

- Authentication algorithm, A3
- Subscriber authentication key, Ki
- Ciphering key generation algorithm, A8
- Ciphering key, Kc
- Control of access to data stored and functions performed in SIM

SIM INFORMATION STORAGE REQUIREMENTS

A SIM contains information for GSM network operations. This information can be related to the mobile subscriber, GSM services or PLMN.

The data storage requirements of a SIM are divided into two categories: mandatory and optional.

Mandatory storage

A SIM must provide storage capability for the following:

- Administrative information: describes the SIMs mode of operation, e.g. normal or type approval
- IC card identification: unique information identifying the SIM and the card issuer
- SIM service table: indicates which optional services are provided by the SIM (e.g. last numbers dialled, call length indication, PLMN selection, etc.)
- International Mobile Subscriber Identity (IMSI): an identity-number used by the network to identify the subscription
- Location information: comprising LAI, current value of periodic location updating timer and location update status
- Ciphering key (Kc) and ciphering key sequence number
- List of carrier frequencies to be used for cell selection
- Forbidden PLMNs
- Language preference: subscribers preferred languages

The location information, Kc and the Kc sequence number may be updated at each call termination.

In addition the SIM must be able to manage and provide storage in accordance with the security requirements:

- Personal Identification Number (PIN)
- PIN enabled / disabled indicator
- PIN error counter
- PIN Unlock Key (PUK)
- PUK error counter
- Subscriber authentication key (Ki)

SUBSCRIBER DATA STORED IN THE MOBILE EQUIPMENT

All subscriber related information transferred to the ME during operation must be deleted after the removal of the SIM or deactivation of the MS. Examples of such information are the PIN and the PUK codes.

PIN MANAGEMENT

A SIM is required to have a PIN function even if it is deactivated by a user. The PIN consists of 4 to 8 digits.

An initial PIN is loaded by the network operator at subscription time. Afterwards the PIN, including the length, can be changed by the user. In addition, the user can decide whether to use the PIN function or not by activating an appropriate SIM-ME function called the PIN disabling function. The PIN is disabled until the user changes the status of the function. This PIN disabling function can be blocked at subscription time by a person authorized to do so.

If an incorrect PIN is entered, the user is informed. After three consecutive incorrect entries the SIM is blocked, even if between attempts the SIM has been removed or the MS has been switched off.

BLOCKING/UNBLOCKING OF SIM

When a SIM is blocked GSM network operations are forbidden. To unblock the SIM, the user must enter the PIN Unblocking Key, PUK.

The PUK is an 8 digit numerical code. If the PUK is entered incorrectly the user is informed. The user can make 10 attempts to enter the PUK before the system blocks entry, in which case the subscriber must contact their network operator.

MOBILE STATION FEATURES

A MS feature is defined as a piece of equipment or a function which relates directly to the operation of the MS.

TYPES OF MS FEATURES

MS features are defined as mandatory or optional. Mandatory features must be implemented as long as they pertain to the MS type. The choice of implementing optional features is left up to the manufacturers. Manufacturers are responsible for ensuring that the MS features neither conflict with the air interface nor interfere with the network, any other MS, or the MS itself.

Standardization of a minimum set of features is desirable to make a simple and uniform set of MS features independent of the MS manufacturer and type. This minimum set includes all the mandatory features.

There are three categories of MS features:

- **Basic:** Basic MS features are directly related to the operation of basic telecommunication services. Each feature is classed as being mandatory or optional.
- **Supplementary:** A supplementary MS feature is directly related to the operation of the supplementary service (e.g. display of calling line number). All supplementary MS features are optional.
- **Additional:** Additional features are neither basic nor supplementary. All additional MS features are optional.

BASIC MOBILE STATION FEATURES

Mandatory

Display of called number: This feature enables the caller to check that the selected number is correct before call set-up.

Dual Tone Multi Frequency function (DTMF): The MS must be able to send DTMF tones. There is special function in MSC to generate DTMF tones. MS just sends a digital signal to this function in MSC.

Indication of call progress signals: Indications are given such as tones, recorded messages or a visual display based on signaling information returned from the PLMN. On data calls, this information may be signaled to the Data Terminating Equipment (DTE).

Country/PLMN indication: The country/PLMN indicator shows in which GSM/PLMN the MS is currently registered. This indicator is necessary so that the user knows when roaming is taking place and that the choice of PLMN is correct. Both the country and PLMN are indicated. When more than one GSM/PLMN is available in a given area this information is indicated.

Country/PLMN selection: If more than one GSM/PLMN is available, the user must have the ability to select their preferred choice.

Service indicator: The user is informed that there is adequate signal strength (as far as can be judged from the received signal) to allow a call to be made and that the MS has successfully registered on the selected PLMN. This can be combined with the Country/PLMN Selection.

Subscription identity management: The IMSI is part of the SIM card and is physically secured and standardized in the GSM system. If the user can remove the SIM, its removal detaches the MS from the network causing a call in progress to be terminated, and preventing the initiation of further calls (except emergency calls).

International Mobile station Equipment Identity (IMEI): Each MS must have a unique identity and must transmit this if requested by the PLMN. The IMEI is incorporated into a module which is built into the MS and is physically secured. The implementation of each individual module is to be carried out by the manufacturer.

Support of A5/1 and A5/2: Provisions are made for support of up to seven algorithms as well as the support of 'no encryption'. It is mandatory for A5/1 and A5/2 and non encrypted mode to be implemented, but other algorithms are optional.

Short message indication and acknowledgment: This feature allows delivery of short messages to a MS from a service center. Such messages are submitted to the service center by a telecommunications network user who can also request information on the message status from the service center. The service center then transmits the message to the active MS user.

The MS must therefore provide an indication to the user that a message has been received from the service center and must also send an acknowledgment signal to the PLMN, to show that this indication has been activated. The PLMN then returns this acknowledgment to the service center.

Short message overflow indication: An MS user using the short message service will be informed when an incoming message cannot be received due to insufficient memory.

Emergency call capabilities: It must be possible to make an emergency call even without a valid SIM.

Optional

On/Off switch: The MS can be equipped with the means of switching its power supply on and off. Switch-off is generally “soft”, so that the MS completes housekeeping functions, such as deregistration, before actually switching off.

Keypad: A physical means of entering numbers, generally in accordance with the layout below:

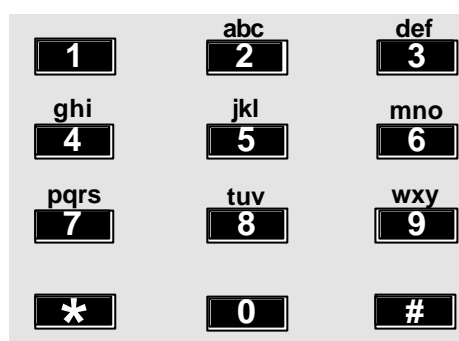


Figure 8-7 Keypad

DTE/DCE interface: This is a standard connector for attaching Data Terminating Equipment (DTE)/Data Communication Equipment (DCE) to an MS and is used with data services.

ISDN s' terminal interface: A standard connector for attaching equipment to ISDN.

International access function ('+' key): This enables a direct, standard method of gaining international access. For this purpose, the MS may have a key whose primary or secondary function is marked “+”. This has the effect of generating the International Access Code (IAC) in the network. This is useful because the IAC varies from country to country and may be unknown by a subscriber who is roaming internationally.

Short Message Service Cell Broadcast (SMSCB) screening: This feature enables the user of the MS to receive only those broadcast messages that are of interest to the user and in this way save on consumption of battery power. This may be useful in the future to ignore advertisements sent as short messages.

SUPPLEMENTARY MOBILE STATION FEATURES

Charge indication: This feature enables the display of charging information provided by the PLMN on a per call basis.

Control of Supplementary Services: It is mandatory that Supplementary Services can be controlled from the MS.

ADDITIONAL MOBILE STATION FEATURES

Abbreviated dialing: The feature stores a full directory number or part of a directory number in the MS with the abbreviated address. After retrieval, the directory number may appear on the display. An incomplete directory number must be supplemented by means of the keypad function or a second stored number. The full directory number is then transmitted on the radio path.

Fixed number dialing: Using this feature in conjunction with an electronic lock makes it possible to place a bar on calling any numbers other than those pre-programmed into the MS. There are two sub-categories to this service:

- All calls are made to only one predetermined number.
- Calls can be made to several predetermined numbers. The required number is selected by means of an abbreviated address code.

Sub-addresses may be added to the predetermined number.

In both cases, the actual directory number is transmitted on the radio path.

Barring of outgoing calls: This feature allows outgoing calls to be blocked with the exception of emergency calls. The barring condition may be activated/deactivated by using a key word.

The barring may be selective, that is, applied to individual services, individual call types (e.g. long distance, international calls) or supplementary services. No network signaling is involved.

DTMF control digits separator: This enables subscribers to enter DTMF digits with a telephone number. When the called party answers, the ME automatically sends the DTMF digits to the network after a delay of three seconds. This may be useful for accessing a voice mailbox, when the subscriber knows the actions which they wish to perform. For example, the sequence 087

5551234#31 may dial the mailbox (087 5551234) access menu 3 and delete message 1.

Call charge units meter: The MS may incorporate a call charge units indicator. This call charge indicator gives information about the actual call charge units consumed during the last conversation or information about accumulated call charge units for each PLMN.

Selection of directory number in short messages: The short message (point-to-point mobile-terminated or mobile-originated, or cell broadcast) can be used to convey a directory number which the receiver wishes to call. This can be indicated by enclosing the directory number in a pair of inverted commas (“ ”).

If the displayed message contains these characters enclosing a directory number then a call can be set up. The message can contain more than one directory number, in which case the receiver selects the desired one. This service is useful for giving someone a telephone number via SMS.

Last numbers dialed (LND): The MS can store the last ‘N’ numbers dialed in the SIM and/or the ME. ‘N’ can take the value up to 10 in the SIM but there is a greater number storage capacity in the ME.

THE EVOLUTION OF MOBILE STATIONS

The introduction of enabling technologies such as GPRS, WAP, EPOC, Positioning and Bluetooth, will set off a huge wave of wireless applications innovation. A convergence between industries is generating a new age of communication and distribution of information.

The driving force behind all the growth on all networks is the need for information exchange. In the coming years, with GPRS and UMTS available, the market will be even more segmented, with products tailor made for specific applications as well as multi-functional terminals.

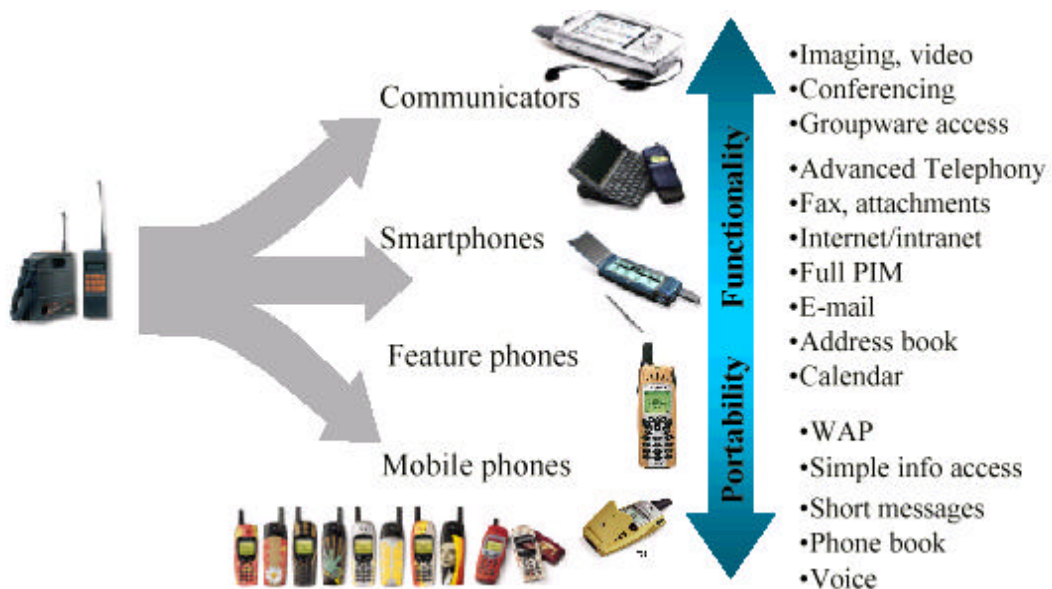


Figure 8-8 Driving Trends

FEATURE PHONE

In this category there are products that combine the good voice capability with text based messaging and data. Micro-service support by WAP is added as a non-voice application together with a built-in modem. This category is equipped with a slightly larger display to run messaging applications and possibly even images. WAP enables good usability even with a limited display.

For external interfacing it primarily utilizes Bluetooth. Now the T68, the world's first GSM/GPRS mobile phone with a true color display is available.



Figure 8-9 T68 Feature Phone

The T68 is a triple band mobile phone. It is packed with features including GPRS, Bluetooth™ and EMS(Enhanced Messaging Service). The T68 has advanced calendar and contacts and you can synchronize data in your phone with your PC.

SMARTPHONE

The Smartphone category of products, have a large display compared to the phones' actual size, in order to accommodate advanced services. It supports Internet applications such as limited web browsing, messaging, e-mail and support mobile terminated still image applications. It runs on the EPOC operating system. The Smartphone has PIM (Personal Information Manager) functionality and will provide synchronization with generic PC products. Ericsson is actively working with third party vendors to develop customer specific applications. Connectivity with peripheral devices will be accomplished primarily through Bluetooth.



Figure 8-10 The Smartphone R380 World

Camera devices are being utilized either as peripheral units or built-in. Even with the added message centric functionality, voice communication is still the primary function.

The Ericsson R380 world gives you access to all GSM services in Europe, Asia/Pacific, Africa and the Americas. This small-sized dual band "smartphone" combines the functions of a mobile phone with advanced communication features such as WAP services, SMS and e-mail.

It has a complete range of PDA-like tools including address book, calendar, notepad and support for synchronization with industry-leading PC applications.

COMMUNICATOR

At the functional high-end of the portfolio Ericsson will bring to market wireless devices that combine communications of voice, text and multimedia, and are open to 3rd party applications. The communicator is an advanced terminal designed for the mobile user. It is similar in size to a palm top with a large display. The product concept is distinct from PDAs and other hand-held computing products through the excellent and integrated communications capabilities, and from mobile phones and Smartphones by a further extended user interface suited for messaging and information access and exchange. Distinct “attributes” are user interface/ease of use and technology applied on real user needs. In figure 8-11, the Communicator has features such as GPS, camera, touch screen and Bluetooth enabled pen.



Figure 8-11 Communicator

MODULES

Modules are especially designed for machine-to-machine applications such as vending machines, parking meters, alarm and surveillance systems, vehicle communications for dispatch and location and so on. Ericsson firmly believes in the machine-to-machine market within the GPRS and UMTS time frame.

ERICSSON ACCESSORIES

Portable hands-free, headsets, cameras, displays, keyboards and so on. may either be connected via Bluetooth or as a plug-on.

BLUETOOTH

Bluetooth is a low power radio technology being developed with the objective of replacing the wires currently used to connect electronic devices such as personal computers, printers and a wide variety of handheld devices such as palm top computers and mobile phones.

Bluetooth operates in the 2.4 GHz band and devices equipped with Bluetooth should be capable of exchanging data at speed up to 720 kbit/s at ranges up to 10 meters. This is achieved using a transmission power of 1mW and the incorporation of frequency hopping to avoid interference. If the receiving device detects that the transmitting device is closer than 10 meters it will automatically modify its transmitting power to suit the range. The device should also shift to a low-power mode as soon as traffic volume becomes low or ceases altogether.



Figure 8-12 Ericssons first Bluetooth product, a Bluetooth(TM) Headset

The earpiece weighs in at just 30 grams, but provides excellent audio quality and unhindered movement within a range of 10 metres.

COMMUNICAM MCA-10



Figure 8-13 CommuniCam MCA-10

Instant imaging is growing in popularity. The mobile camera CommuniCam™ MCA-10 provides a quick and easy way to send pictures over the Internet. Its a snap-on camera that takes color snapshots and send them as e-mail via a mobile phone. The image resolution (352x288 pixels) is optimized for rapid transmission, which means a snapshot take no more than a minute to reach their destination..

MP3 HANDSFREE HPM-10

The MP3 Handsfree is a portable audio player that is attached to a mobile station. Incoming calls are channeled through both earpieces and the cord features a microphone to speak into and a button to answer calls with. If you listen to the music when you receive an incoming call, the sound from the player will automatically be muted and you may answer the call with the button on the cord. The high quality audio player is completely controlled and powered by the mobile phone- no extra batteries or space consuming buttons or display.

WAP-WIRELESS APPLICATIONS PROTOCOL

WAP is a technology designed to provide users of mobile terminals with rapid and efficient access to the Internet. WAP is a protocol optimized, not only for the use on the narrow band radio channels used by second generation digital wireless systems, but also for the limited display capabilities and functionality of the display systems used today's mobile terminals. WAP integrates telephony services with microbrowsing and enables easy-to-use interactive Internet access from the transactions, on line banking, information provisioning and messaging. WAP will enable operators to develop innovative services to provide differentiation in competitive market environments.

