System Overview

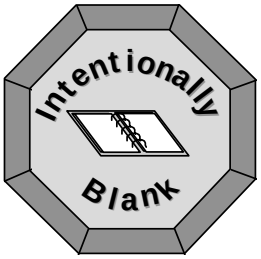
Chapter 1

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

OBJECTIVES:

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

- describe the network elements and their main functionality
- list the nodes realized in the AXE-10 technology
- describe some of the capabilities and features of OSS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1 System Overview

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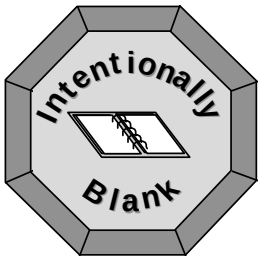
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SYSTEM ARCHITECTURE IN ERICSSON'S GSM SYSTEM

In Figure 1-1 the system model for Ericsson's GSM system is shown.

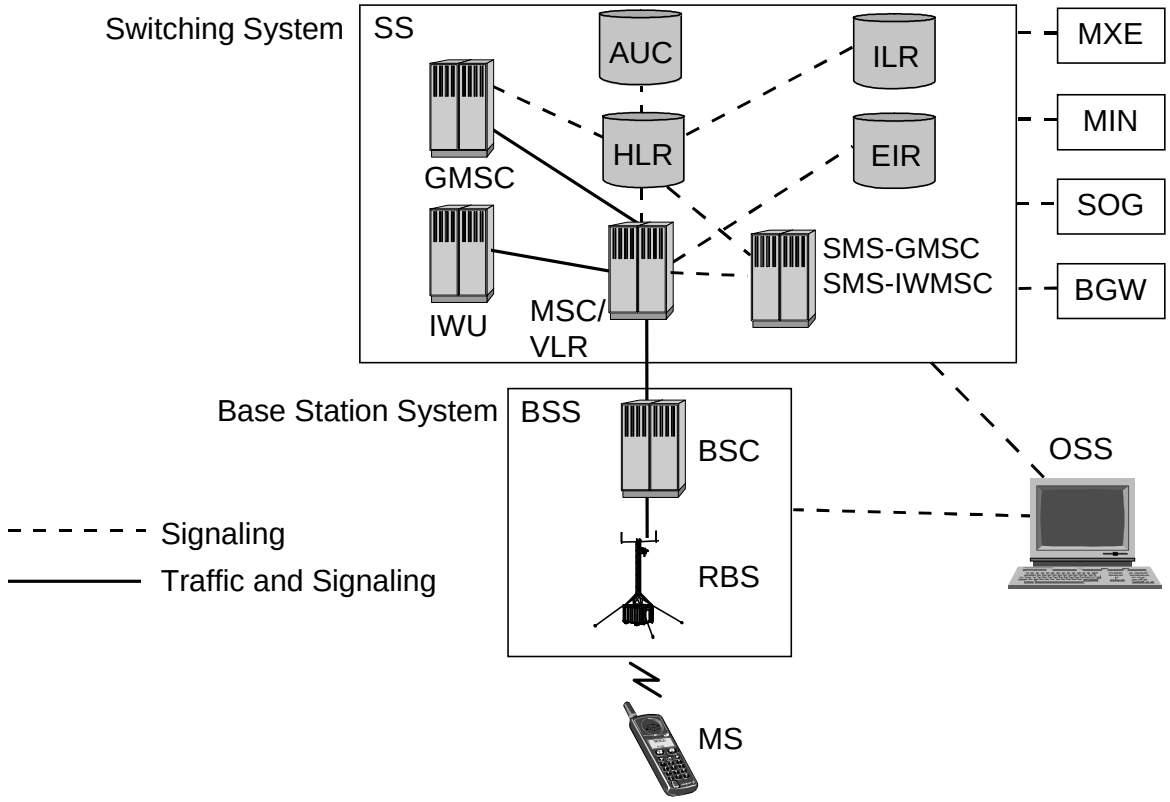


Figure 1-1 Architecture of Ericsson's GSM system.

Abbreviations:

AUC	AUthentication Center
BGW	Billing GateWay
BSC	Base Station Controller
EIR	Equipment Identity Register
GMSC	Gateway MSC
HLR	Home Location Register
ILR	Interworking Location Register
IWU	InterWorking Unit
MIN	Mobile Intelligent Node
MS	Mobile Station
MSC	Mobile services Switching Center

MXE	Message Center
OSS	Operation and Support System
RBS	Radio Base Station
SMS-GMSC	Short Message Service, Gateway MSC
SMS-IWMSC	Short Message Service InterWorking MSC
SOG	Service Order Gateway
VLR	Visitor Location Register

GENERAL

Ericsson’s GSM systems are cellular mobile telephony systems. They are implemented using Ericsson's latest AXE switching system technology. This means that all features and services implemented in AXE over the years are standard. In addition, Ericsson’s GSM systems will utilize future AXE developments.

Software development is carried out in stages, creating a platform where functionality improves with time. The fact that the AXE system is modular makes it possible to make modifications, additions and deletions without affecting existing system operations.

Hardware development keeps pace with increasing performance requirements and state-of-the-art technology. Using the open-ended structure of AXE architecture, new hardware (for example, processors and line terminals), are being introduced continuously.

The network is divided into three major systems:

- Switching System (SS)
- Base Station System (BSS)
- Operation and Support System (OSS)

Each of these contain a number of functional units which make up the entire system. The functional units are parts in the various hardware units.

SS is responsible for performing call processing and subscriber related functions. It includes the following functional units:

- Mobile services Switching Center (MSC)
- Home Location Register (HLR)
- Visitor Location Register (VLR)

- AUthentication Center (AUC)
- Equipment Identity Register (EIR)

Most radio related functions are performed in the Base Station System (BSS). BSS includes:

- Base Station Controller (BSC)
- Radio Base Station (RBS)

The Operation and Support System (OSS) handles error messages originating from the network. OSS has access to both the switching system (via MSC) and the base station system (via BSC).

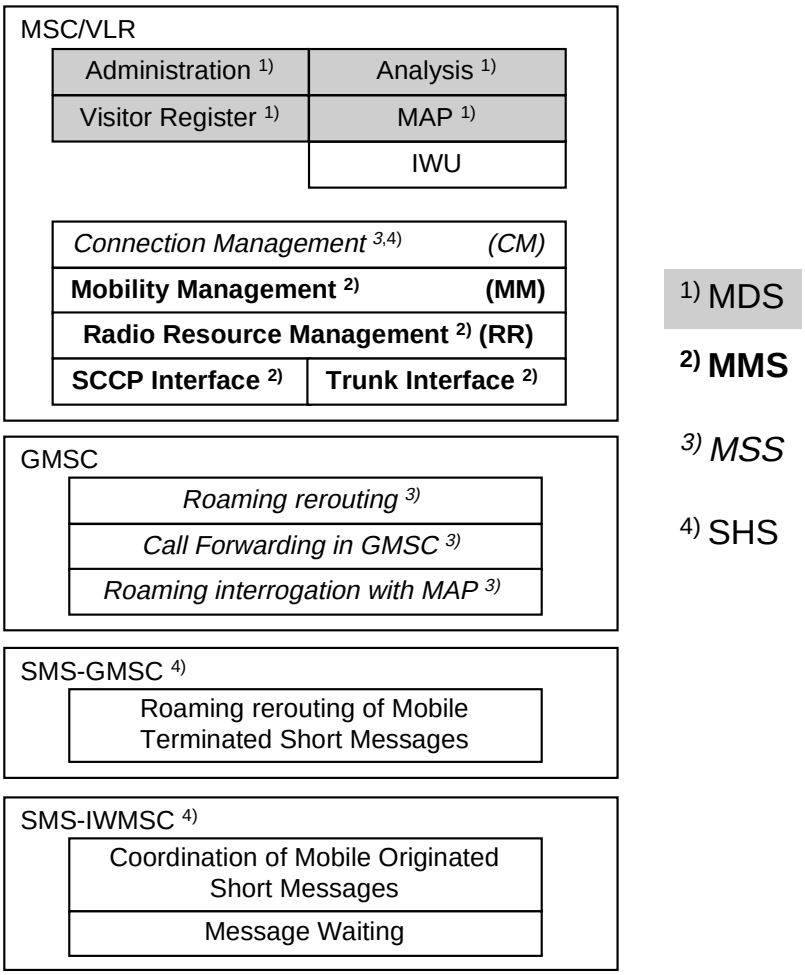
SWITCHING SYSTEM

MOBILE SERVICES SWITCHING CENTER

The Mobile services Switching Center (MSC) performs the system telephony switching functions. It also controls calls to and from other telephony and data systems, such as the Public Switched Telephone Network (PSTN) and Public Land Mobile Network (PLMN). In Ericsson's GSM system, the VLR (see next section) is always integrated with the MSC to form a MSC/VLR. The MSC/VLR is based on AXE technology. In Ericsson's GSM system the AXE in SS is structured in a new way according to a concept called Application Modularity (AM). For detailed information about this new concept, refer to AM course material.

The MSC/VLR functionalities are implemented in four AXE subsystems. They are (see also Figure 1-2):

- Mobile Switching Subsystem (MSS)
- Mobile Mobility and radio Subsystem (MMS)
- Mobile Data Subsystem (MDS)
- SHort message service Subsystem (SHS)



MDS = Mobile Data Subsystem
MMS = Mobile Mobility and radio Subsystem
MSS = Mobile Switching Subsystem
SHS = SHort message service Subsystem

Figure 1-2 Mobile functions in MSC/VLR, GMSC, SMS-GMSC and SMS-IWMSC.

The MSC/VLR is responsible for:

- functions for setting up and controlling calls, including supplementary services.
- functions for handling speech path continuity for moving subscribers (handover).
- functions for updating mobile subscribers' location (location updating and location canceling) in the different location registers.
- functions for updating mobile subscriber data.
- provision of functions for signaling to and from:
  - the BSCs and the MSs (using BSSAP, see chapter 10).

  - other GSM entities (using MAP, TUP or ISUP).
  - other networks such as PSTN or ISDN (using TUP or ISUP).
- administrative functions for defining data and handling of the mobile subscribers.
- security related functions which perform authentication or selective authentication, ciphering, (re)allocation and analysis of the TMSI.
- functions for IMEI check.
- functions for receiving and delivering short messages to and from the MS.
- charging and accounting.

VISITOR LOCATION REGISTER

The Visitor Location Register (VLR) is a database containing information about all MSs currently located in the MSC service area. The VLR contains temporary subscriber information needed by the MSC to provide service for visiting subscribers. The VLR can be seen as a distributed HLR. When a Mobile Station (MS) roams into a new MSC service area, the VLR connected to that MSC requests data about the MS from the HLR and stores it. When the MS makes a call, the VLR already has the information needed for call set-up. In Ericsson's GSM system, the VLR is always integrated with the MSC so that internal signaling can be used. This setup eliminates signaling between the two nodes over the network unnecessary thus decreasing the network signaling load.

GATEWAY MSC

The Gateway MSC (GMSC) is the point in the PLMN where calls to mobile subscribers enter the GSM network. Therefore each mobile terminating call must be routed via a GMSC in the home PLMN of the called MS.

The GMSC contains the interrogation facility. That is, the GMSC contains signaling functions for retrieving information from the concerned HLR which tells how to proceed with call set-up. Depending on the interrogation result, the call is either re-routed by GMSC to the MSC where the mobile subscriber is located or forwarded according to the forward-to number. Charging and accounting functions are also implemented in the GMSC.

The GMSC is constructed using the AXE technology and is normally integrated in the same node as MSC/VLR.

INTERWORKING UNIT

The Interworking Unit (IWU) provides an interface to various networks for data communication. At present, Ericsson implements this functionality in the Data Transmission Interworking unit (DTI) through which users can alternate between speech and data during the same call. Its main functions include modem and fax adapter pool plus the node has the ability to perform rate adaptation. This was earlier implemented as the GSM InterWorking Unit (GIWU). Both DTI and GIWU consist of software and hardware.

SHORT MESSAGE SERVICE - GATEWAY MSC

A Short Message Service Gateway MSC (SMS-GMSC) is capable of receiving a short message from a Service Center (SC), interrogating an HLR for routing information and message waiting data, and delivering the short message to the MSC of the receiving MS. In Ericsson's GSM system, the SMS-GMSC functionality is normally integrated in the MSC/VLR node.

SHORT MESSAGE SERVICE - INTERWORKING MSC

A Short Message Service InterWorking MSC (SMS-IWMSC) is capable of receiving a mobile originated short message from the MSC or an Alert message from the HLR and submitting the message to the sender's SC. The SMS-IWMSC functionality is normally integrated in the MSC/VLR node.

HOME LOCATION REGISTER

The Home Location Register (HLR) is a database that stores and manages subscriptions. In a PLMN there is one or several HLRs. For each "home" subscriber, the HLR contains permanent subscriber data such as:

- the associated numbers - MSISDN and IMSI (see Appendix).
- a list of services - tele services, bearer services and supplementary services, which the subscriber is authorized to use.

The HLR also stores and updates dynamic data about each "home" subscriber including subscriber location (VLR-address), services registered to/activated by the subscriber or the operator

such as call forwarded numbers and call barring for certain types of calls.

The HLR can be integrated in the same node as the MSC/VLR, or can be implemented as a separate node. The AXE technology is used.

The HLR provides functions defined in the GSM specifications. For example:

- Connection of mobile subscribers and definition of corresponding subscriber data.
- Maintenance of a database of mobile subscribers and corresponding subscriber data.
- Subscription to basic services.
- Registration/deletion of supplementary services.
- Activation/deactivation of supplementary services.
- Interrogation of supplementary services status.
- Functions for analysis of mobile subscriber numbers (MSISDN, IMSI, additional MSISDNs) and other types of addresses.
- Handling of authentication and ciphering data for mobile subscribers including communication with an authentication center.
- Functions for communication with GMSC and VLR using the No. 7 signaling system and MAP (see chapter 12).
- Statistical functions for collecting data about system performance.

AUTHENTICATION CENTER

The AUthentication Center (AUC) is a data base which stores the following data:

- a RANDom number (RAND)
- a Signed RESponse (SRES)
- a Ciphering Key (Kc)

These three pieces of data are called triplets. The AUC generates and provides one, or several triplets for a certain IMSI at each request from the HLR. The HLR forwards the provided triplets to the serving VLR. At any MS access attempt, the MSC may send RAND to the MS to authenticate the subscriber's SIM. The

SRES returned by the MS is then compared to the SRES provided by the AUC (via HLR) to the VLR. The MSC may also facilitate ciphering on the radio path by providing the TRX managing the traffic with the Kc. Successful ciphering is possible only if the Kc, which is calculated by the MS during the authentication procedure, is identical to the one provided to the TRX.

The AUC can be implemented as an Application Module in the MSC/VLR.

EQUIPMENT IDENTITY REGISTER

The Equipment Identity Register (EIR) is a data base which stores the International Mobile station Equipment Identity (IMEI) for each MS equipment. Each IMEI is unique. During any MS access (except in the case of IMSI-detach), the MSC/VLR may verify the IMEI. When necessary, the EIR is requested by the MSC/VLR to check the IMEI. The main objective is to ensure that the equipment is not stolen or faulty. Equipment can be classified as:

- white listed (permitted for use)
- gray listed (should be tracked for evaluation)
- black listed (barred)
- unknown equipment

The network rejects any access attempt if the equipment is classified as “black-listed” or “unknown”.

AUC and EIR are implemented either as stand-alone nodes or as a combined AUC/EIR node. AUC and EIR software are developed by Sema Group Telecom Division in Great Britain on a platform of standard hardware from Digital.

INTERWORKING LOCATION REGISTER

Interworking Location Register (ILR) is a product that exists in the CMS 40 network only. ILR makes inter-system roaming possible. This means that roaming between an AMPS network and a GSM 1900 network is possible. ILR consists of an AMPS HLR and parts of a GSM 1900 VLR.

BASE STATION SYSTEM

The Base Station System (BSS) consists of the BSC and the BTS.

The BSC in Ericsson's GSM system is based on AXE technology. It can be implemented as a stand-alone node or integrated with MSC/VLR.

Ericsson's BTS solution is the Radio Base Station (RBS). GSM 900/GSM 1800 has two basic series of base stations. They are RBS 200 and RBS 2000. CMS 40 uses RBS 2000 only.

Both series offer products for indoor and outdoor installations. Indoor installations include RBS 200 (GSM 900), RBS 205 (GSM 1800) and RBS 2202. Outdoor installations include RBS 203 and 204 (GSM 900), RBS 2101 and RBS 2102. The latter two are a mini and a compact version in the 2000 series.

BASE STATION CONTROLLER

The Base Station Controller (BSC) handles most radio related functions and is the BSS's center point. The BSC manages the entire radio network including:

- configuration of the network.
- administration and remote control of the RBSs.
- handling connections to MSs including handovers.

The large BSCs can handle up to 1020 transcievers (TRXs). The smaller combined MSC/BSC is designed for recently started mobile operating companies.

During call set up, a logical channel is allocated to the connection based on information about the available channels' characteristics. When the connection has been established, signal strength and speech quality are monitored by the MS and the TRX or TRU (Transciever Unit, appears instead of the TRX in RBS 2000) and reports are forwarded to the BSC. The decision to initiate a connection handover is then made by the BSC.

Strict Ericsson RBS transceiver orientation leads to a master-slave relationship between the BSC and the transceivers. That is, all major activities in the RBS are orchestrated by the BSC. The BSC sets TRX/TRU configurations and frequencies for each

cell. The BSC thus receives a set of logical channels that can be allocated to connections with MSs. The TRXs/TRUs are supervised by internal software tests and loop tests. A detected failure results in an automatic TRX/TRU reconfiguration, thereby keeping the logical channel set intact.

BASE TRANSCEIVER STATION/RADIO BASE STATION

The Base Transceiver Station (BTS), or as Ericsson calls it Radio Base Station (RBS) handles the radio interface to the MS. The BTS is the radio equipment (transceivers and antennas) needed to serve each cell in the network. One RBS includes all BTSs on a site. A group of BTSs are controlled by a BSC. Two types of RBS are available:

- the RBS 200 family
- the RBS 2000 family

The main RBS functions are:

- radio transmission, including frequency hopping.
- radio signal reception from MSs, including equalizing and diversity functions to compensate for fading effects.
- quality measurements: RBS measures signal strength and quality on the uplink. MS measures signal strength and quality on the downlink as well as signal strength on neighboring RBSs. The results are sent to the RBS. The RBS adds its measurements and reports to the BSC.
- time alignment measurements.
- transceiver and MS power control.
- multiplexing on the radio path, channel coding, interleaving, and ciphering.
- broadcasting system information and paging messages.
- receiving channel requests from MSs.

The RBS consists of a cluster of autonomous TRXs/TRUs. The software stored in TRX/TRU Random Access Memories (RAMs) is controlled, loaded, and upgraded from the BSC, thus reducing the need for on-site RBS visits. This remote control capability also includes automatic tuning of the combiners in case frequency planning is changed. Strict transceiver orientation means that faults are isolated per TRX/TRU and do not affect adjacent TRXs/TRUs in the same RBS.

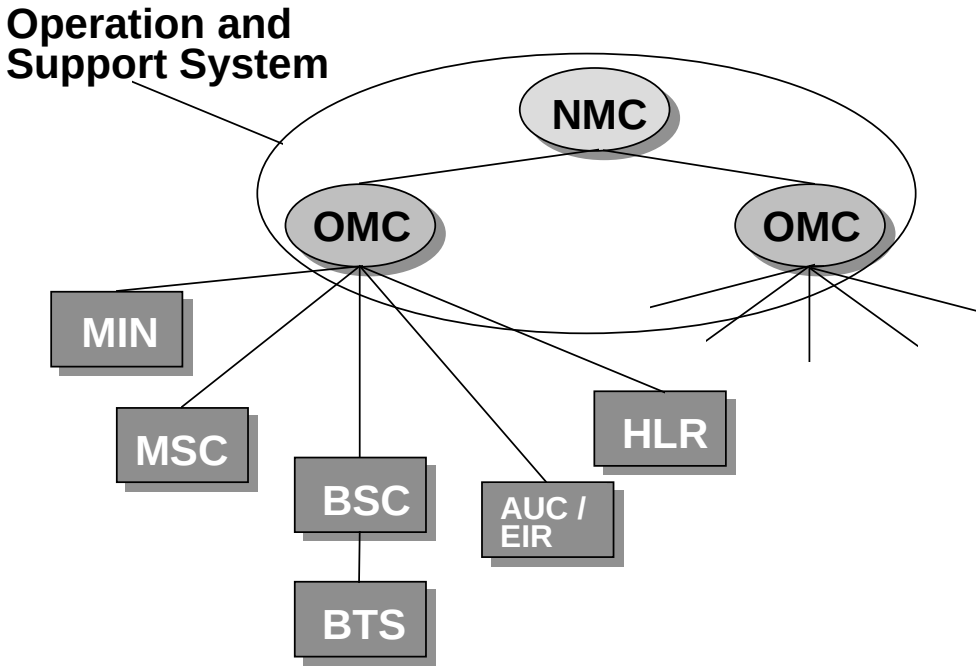
OPERATION AND SUPPORT SYSTEM

Operation and Support System (OSS) is Ericsson's implementation of OMC. OSS offers the customer cost effective support for centralized, regional and local operations and maintenance activities required by a cellular network. OSS is the functional entity from which the network operator monitors and controls the system.

OSS is based on an application in the product family Telecommunications Management and Operations Support (TMOS).

OSS is a two-level management function. For centralized control of a network, the installation of a Network Management Center (NMC) with subordinate Operation and Maintenance Centers (OMC) is advantageous. NMC staff can concentrate on system-wide issues, whereas local personnel at each OMC can concentrate on regional issues. The OMC and NMC functionality can be combined in the same physical installation or implemented at different locations.

The OSS is designed as a coherent management system used to support a number of other network elements. See Figure 1-3.



NMC = Network Management Center
OMC = Operation and Maintenance Center

Figure 1-3 OSS provides for central supervision of all network elements.

The BTSs are supported through the BSC. Other Ericsson nodes including Message Center (MXE) can be supported.

OSS management areas are based on Telecommunication Management Network (TMN), which is a model for telecommunication networks management. The most important parts are:

- Configuration management
- Fault management
- Performance management

ADDITIONAL NODES

MESSAGE CENTER

Message center (MXE) is the node used for handling Short Message Service (SMS), voice mail and fax mail. These services are optional, therefore the node is optional and does not belong to the basic system structure.

MOBILE INTELLIGENT NETWORK

Mobile Intelligent Network node (MIN) is the node used for handling the mobile IN services. MIN can be based on the AXE platform and therefore encompass the experience gained from intelligent network in fixed telephony. It can also be implemented as an Application Module in the MSC/VLR.

SERVICE ORDER GATEWAY

Operator's administrative systems, normally called Customer Administration Systems (CAS), are very complex. These administrative systems are often inflexible, and lead to high network adaptation costs.

The Service Order Gateway (SOG) is a product enabling CAS to exchange information with Ericsson's network elements that contain service information.

SOG provides a remote interface to network elements, see Figure 1-4. It combines functionality for subscription management in the HLR and the AUC with equipment administration in the EIR.

SOG receives message requests from CAS in the form of Customer Service Orders (CSO). SOG interprets the data content, manipulates the data and delivers appropriate information to the relevant network elements in the form of Network Service Orders (NSO).

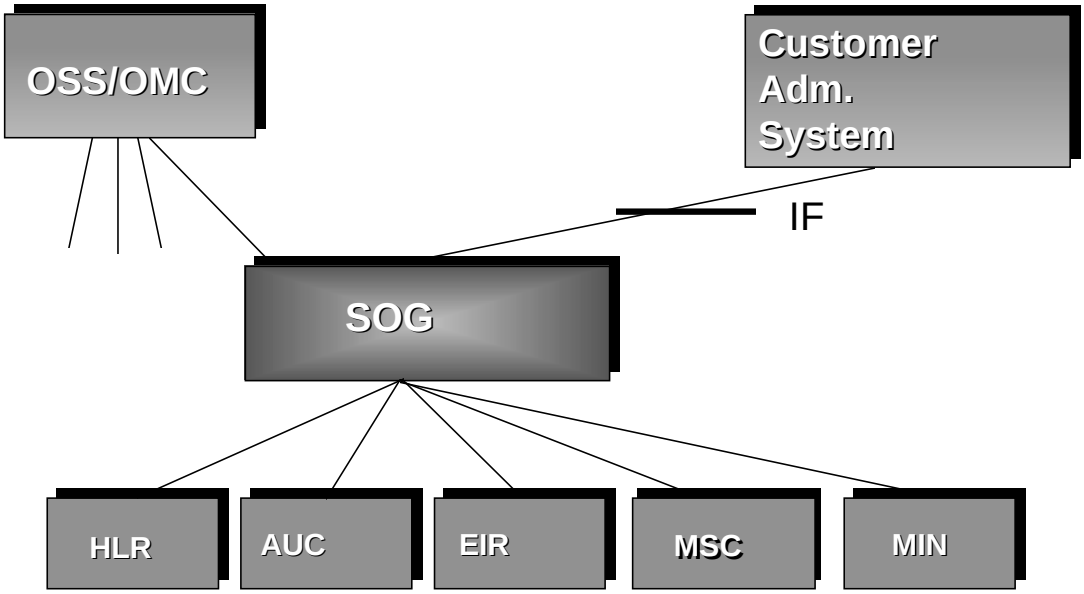


Figure 1-4 Service Order Gateway (SOG).

BILLING GATEWAY

The Billing GateWay (BGW) collects billing information, called Call Data Records (CDRs), from the network elements. CDR's are accumulated into files and immediately forwarded to post-processing systems that use the files as input. BGW acts as a billing interface to all network elements in an Ericsson network. The flexible BGW interface supports adaptation to new types of network elements as well.

Most often, the BGW resides near the customer administration and billing systems and is handled by the administrative organization.

To summarize, an operator uses the BGW to collect billing information from the network and the SOG to send service order information to different network elements, see Figure 1-5.

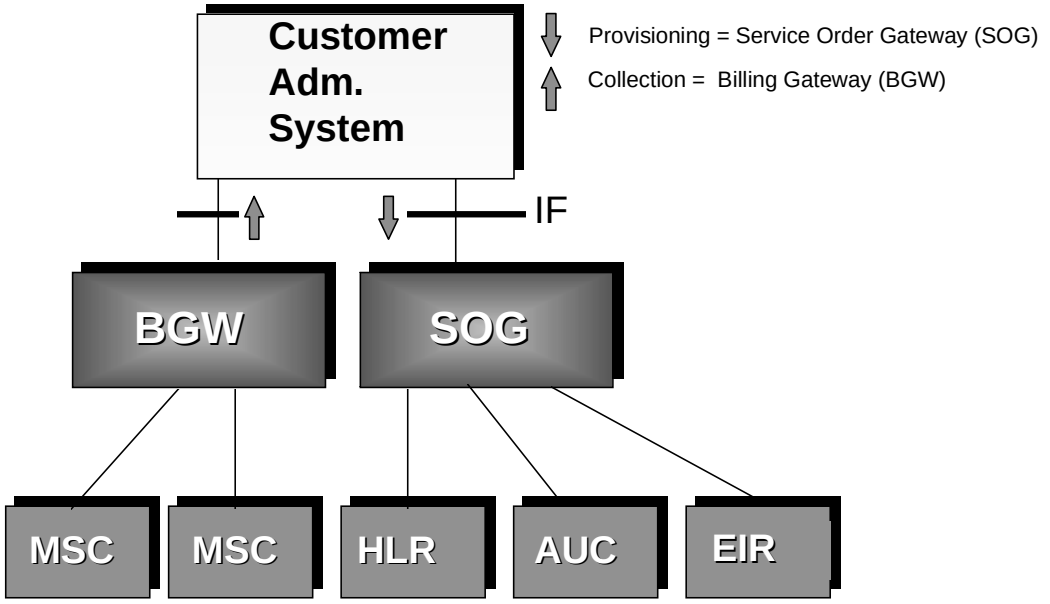


Figure 1-5 Gateway products for billing information and service