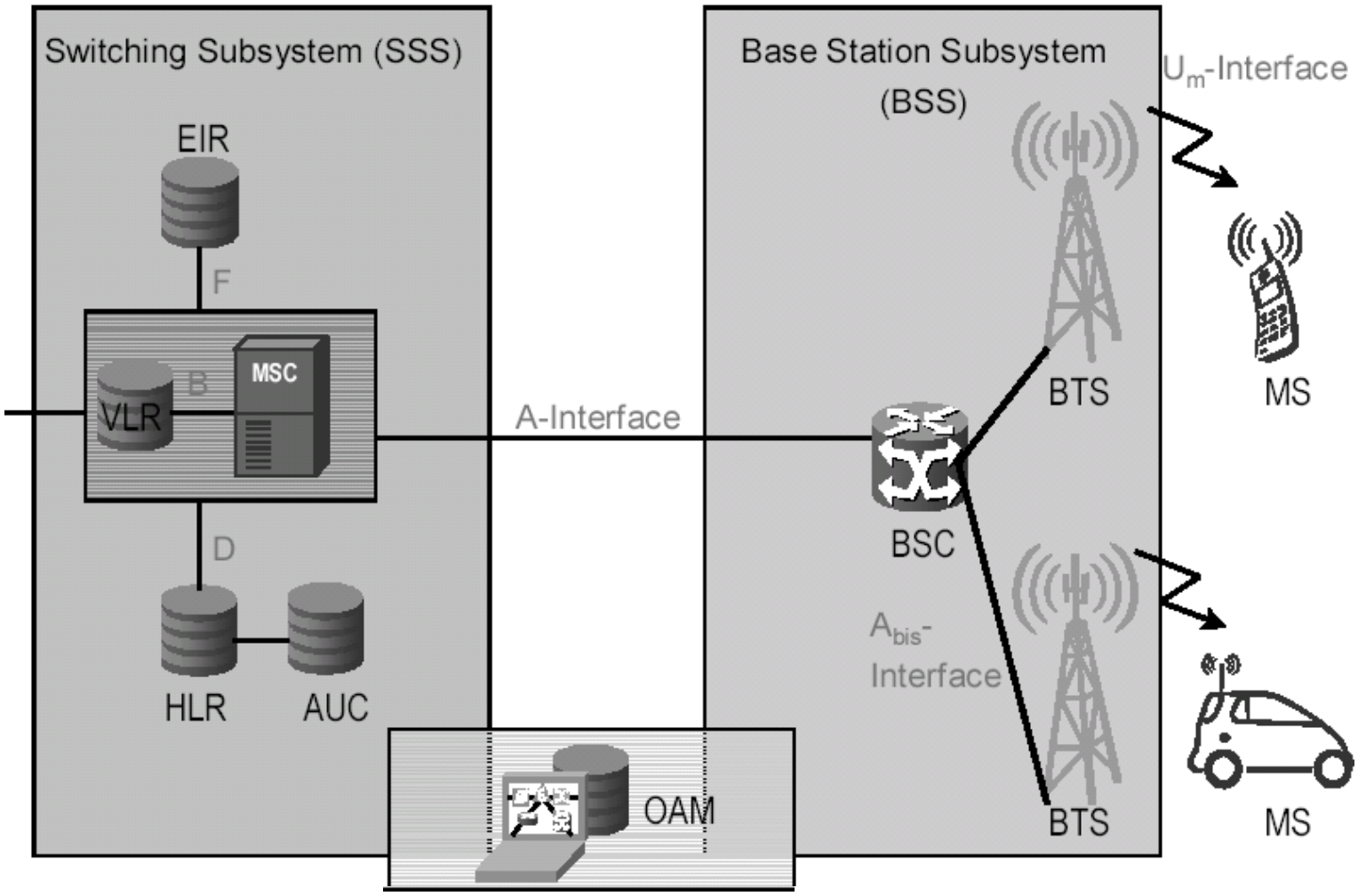
Cellular Mobile Networks - GSM
GSM System Architecture

Contents - GSM - GSM System Architecture

GSM System Components

- The GSM architecture is divided into four subsystems:
  - Mobile Station (MS)
  - Base Station Subsystem (BSS)
  - Switching Subsystem (SSS)
    - call processing
    - subscriber specific functions
  - Operation and Maintenance (OAM)
- Standardized interfaces (e.g. U_m, A, A_{bis})
  - enables the usage of network elements from different vendors
  - in particular important for the cooperation of mobile stations and base stations

GSM System Components - Overview



Remark:
- AuC, EIR and OAM are also known as **OSS** (Operation Subsystem)
- the SSS is also called **NSS** (Network Switching Subsystem)

Mobile Station (MS)

- The MS includes the Mobile Equipment (ME) and the Subscriber Identity Module (SIM)
- ME: handset - not subscriber specific
- SIM: smart card for subscriber specific data
  - contains information about authorization, encryption, ...
  - could be activated in different MEs with a PIN
  - required for the operation of the handset (except for emergency calls)
  - unique identification with IMSI (International Mobile Subscriber Identity) = 15 digit country, mobile network and subscriber code

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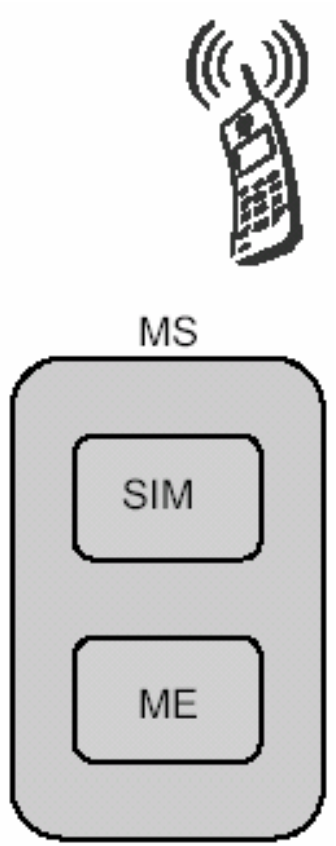
Subscriber Identification

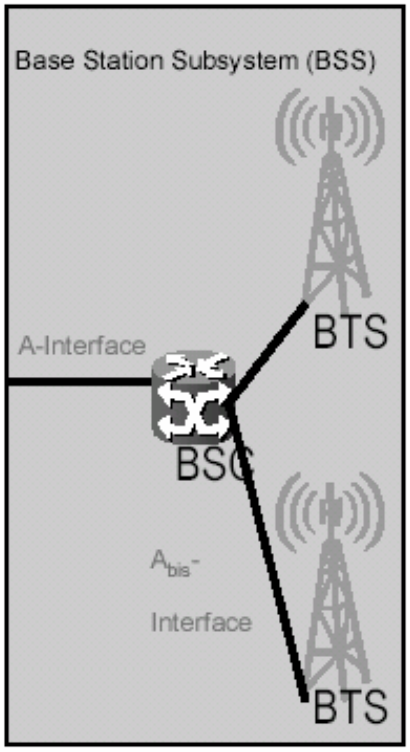
Mobile Network Code (MNC)

Mobile Country Code (MCC)



Base Station Subsystem (BSS)

- The BSS contains all functions regarding the radio interface; it comprises the BTS and BSC
- BTS/BS: Base (Transceiver) Station
  - transmitter/receiver at the radio interface towards the MS
- BSC: Base Station Controller
  - one BSC per BSS
  - works between BTS(s) and MSC
  - contains informations about the cell configuration
  - responsible for:
    - Radio Resource Management (e.g. channel assignment, frequency hoping)
    - Radio Link Control (e.g. handover management, power control)
  - sends error messages to the OAM

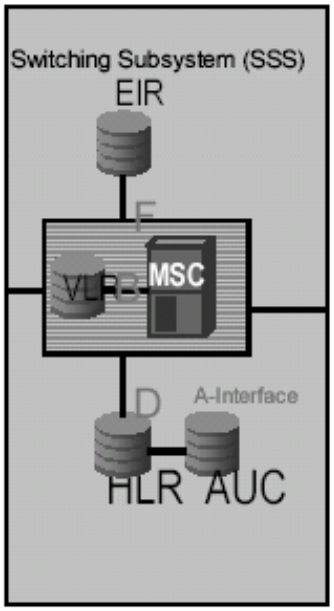


Base Station Subsystem - Functional Split of BTS/BSC

Functions	BTS	BSC
management of the radio channels		X
frequency hopping	X	X
management of the terrestrial transmission channels		X
mapping of the radio channels to the terrestrial channels		X
channel encoding/decoding	X	
rate adaption	X	
encryption / decryption	X	X
paging	X	X
measurements		
air interface (uplink)	X	
traffic		X
mobility management		
authentication		X
location registration, location update		X
handover management / execution		X

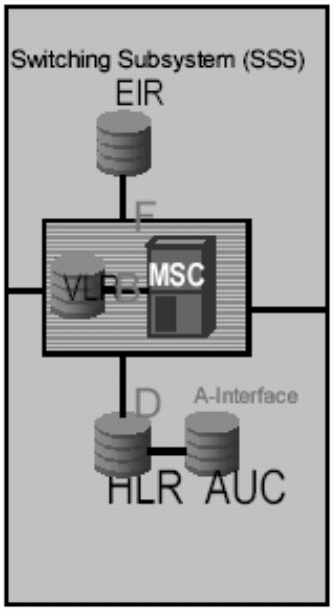
Switching Subsystem (SSS)

- The SSS allows switching of connections (intra-MSC, inter-MSC, to other networks e.g. ISDN) and therefore the communication between subscribers
- It includes the following components:
  - Home Location Register (HLR)
  - Mobile Switching Center (MSC)
  - Visitor Location Register (VLR)
  - Authentication Center (AuC)
  - Equipment Identity Register (EIR)
  - Operation and Maintenance Center (OAM)



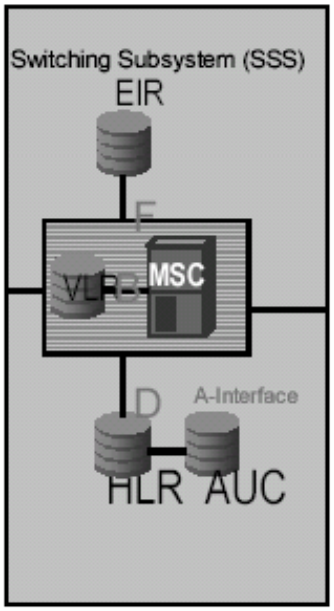
Switching Subsystem (SSS) - HLR

- **Home Location Register (HLR)**
  - most important data base of the mobile network
  - storage and administration of relevant data of the subscribers of the home network (i.e. one or more MSC regions)
    - IMSI
    - service profile of the subscriber (activated services)
    - current location, current roaming zone (VLR address)
  - the data of a new subscriber is put into the HLR of the network operator



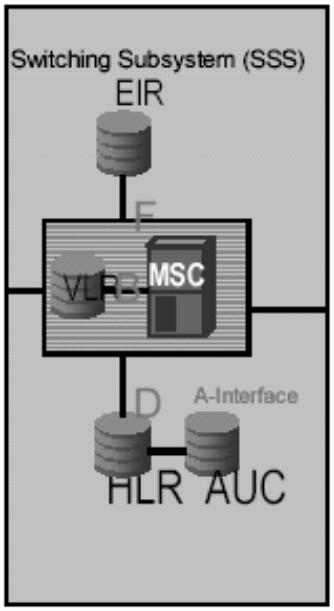
Switching Subsystem (SSS) - MSC

- **Mobile Switching Center (MSC)**
  - comprises also the Visitor Location Register (VLR) functionality
  - connects the SSS to the BSS
  - connects the SSS to the OAM
  - responsible for:
    - mobility management
    - connection setup within the own mobile network
    - connection setup to other networks
      - to other mobile networks
      - to public landline networks (PSTN/ISDN)



Switching Subsystem (SSS) - VLR und AuC

- **Visitor Location Register (VLR)**
  - data base with subscriber information (needed by the MSC); always implemented as integral part of the MSC (covers the same MSC service region)
  - if a subscriber moves into a new MSC service region, the HLR is interrogated once for subscriber data; this data then is stored temporarily in the VLR of the new MSC
- **Authentication Center (AUC)**
  - responsible for different security aspects: access security, encryption, interception and data protection
  - generation of subscriber specific authentication parameters (requested by HLR), which are forwarded to the VLR



Switching Subsystem (SSS) - EIR

- **EIR: Equipment Identity Register**
  - the EIR stores information about the MEs - in form of the "International Mobile Equipment Identity" (IMEI)
  - when the MS registers to the network the EIR is interrogated (authentication of the ME)
  - faulty, unauthorized or registered as stolen ME can be locked
  - IMEI structure:

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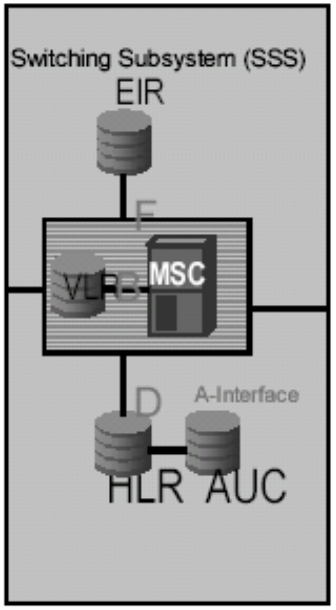
SVN: Software Version No.

CD: Check Digit

SNR: Serial Number

FAC: Final Assembly Code

TAC: Type Approval Code

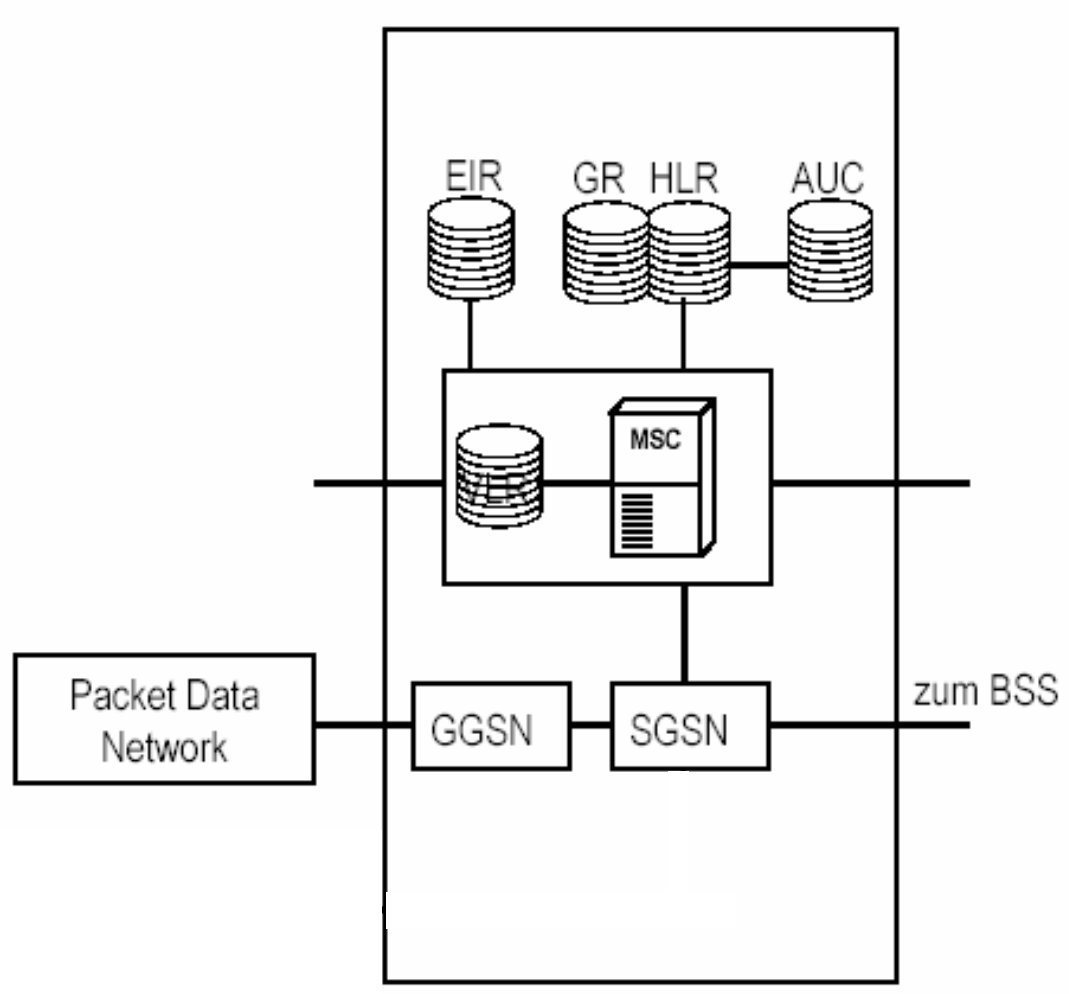


Operation and Maintenance Center (OAM/OMC)

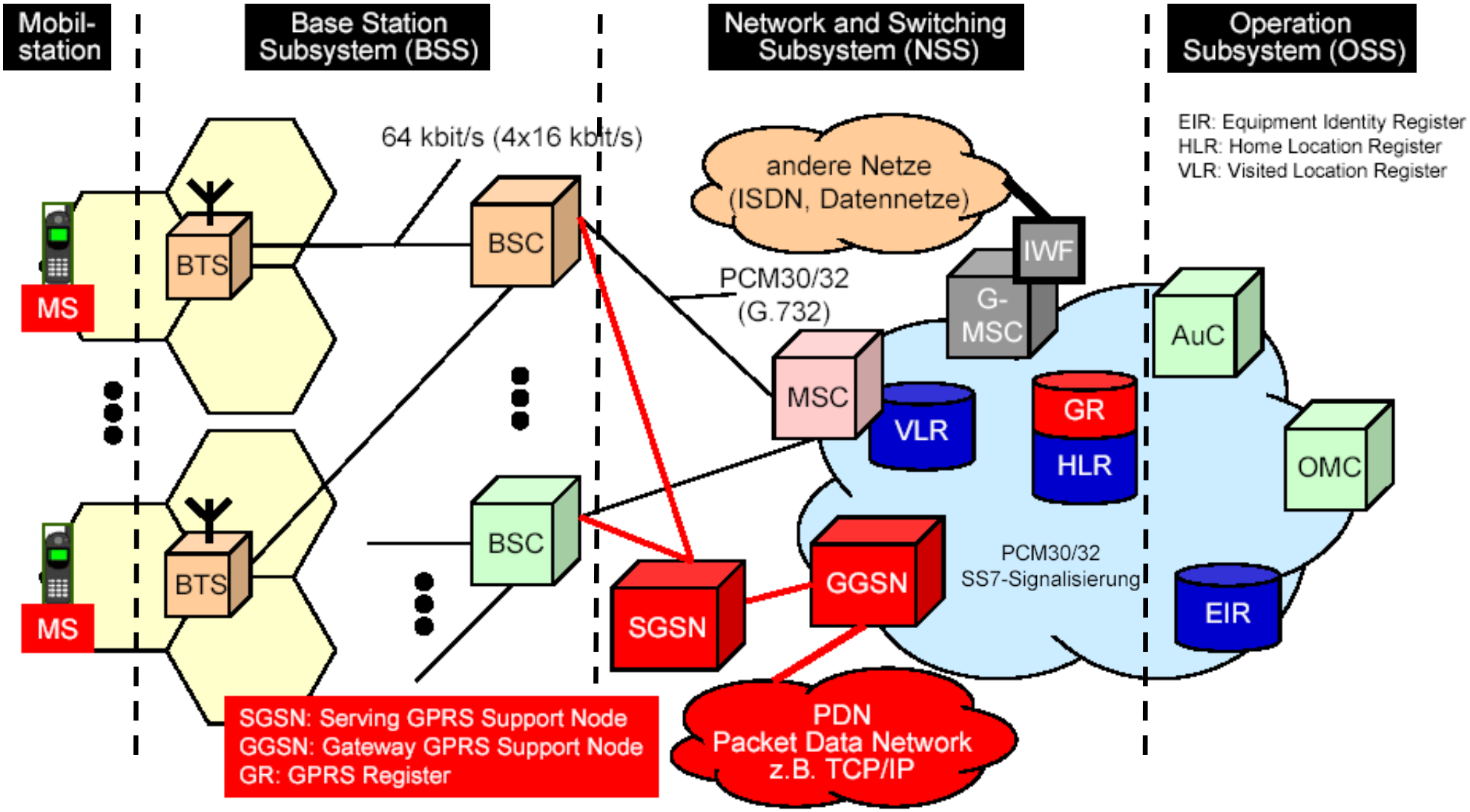
- **Operation & Maintenance Center (OAM/OMC)**
  - only used by the network operator
  - connection to all SSS elements and to the BSC
  - storage of the current network configuration
  - central control, monitoring and diagnosis of all network elements
  - administration/configuration of the network elements

Extensions for GPRS: SGSN and GGSN

- new system architecture parallel to SSS: GPRS Switching Subsystem
- **Gateway GPRS Support Node (GGSN):** allows access to external packet oriented networks
- **Serving GPRS Support Node (SGSN):** supports the GPRS functionalities similar to the MSC/VLR (e.g. mobility)
- **GPRS Register (GR)**

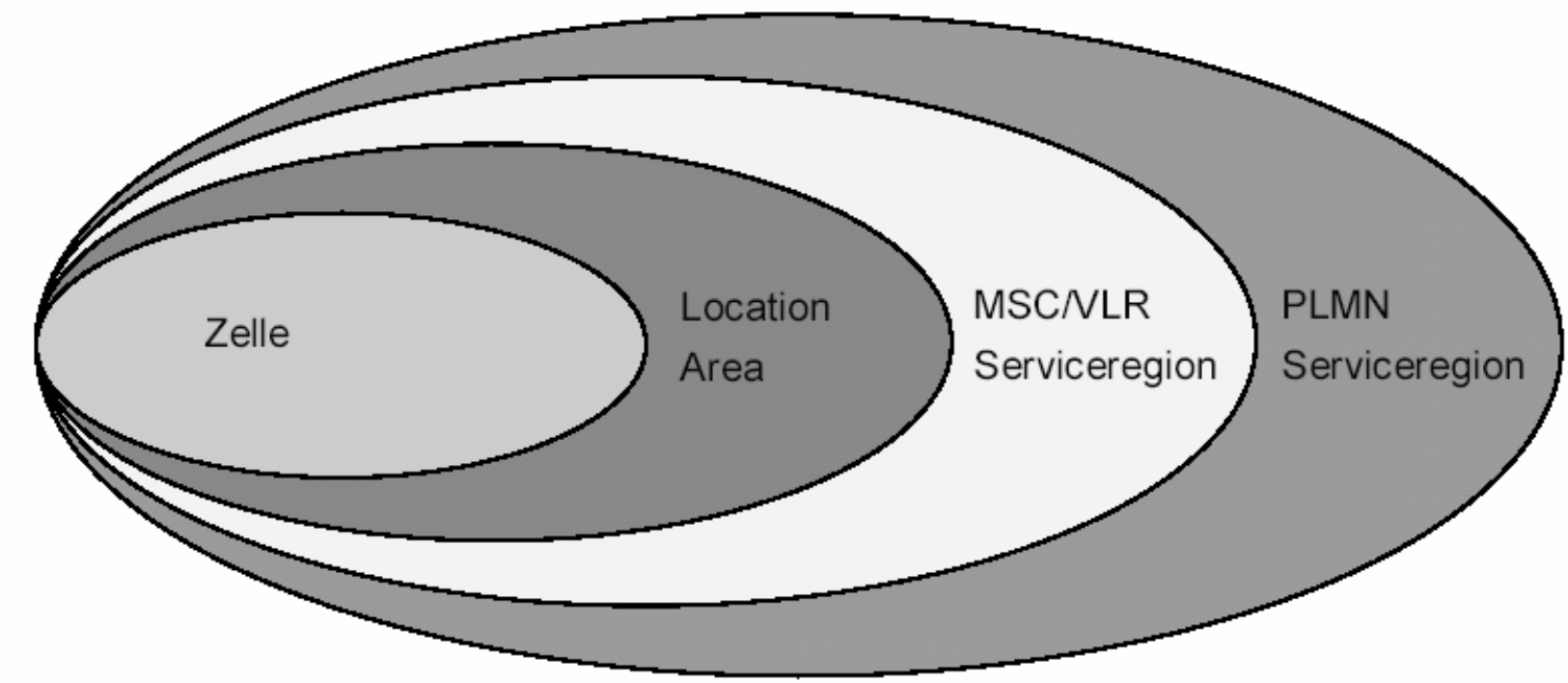


GSM/GPRS System Architecture - Summary

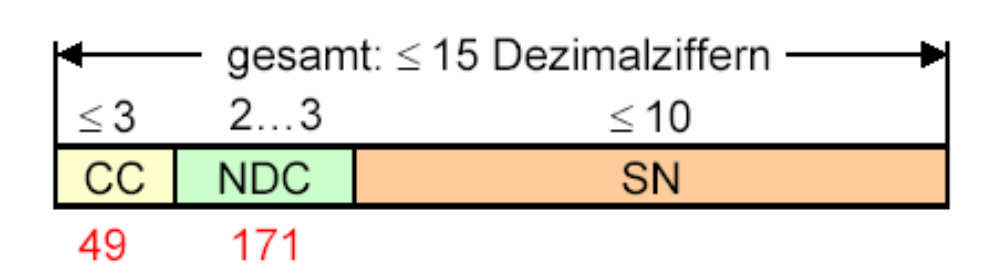


Administrative Regions

- Partitioning of the GSM network into (smaller) geographic regions
  - **Location Area:** denotes a group of cells
  - **MSC/VLR service region:** region, served by one MSC/VLR
  - **PLMN (Public Land Mobile Network) service region:** whole administrative domain of a mobile operator



GSM Addresses and Identifiers - MSISDN and MSRN

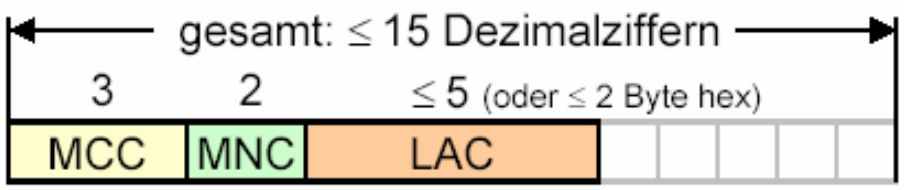


- **Mobile Subscriber ISDN Number (MSISDN)**
  - fixed (telephone) number of a subscriber (ITU-T E.164); known by the subscriber
  - CC: Country Code
  - SN: Subscriber Number
- **Mobile Station Roaming Number (MSRN)**
  - temporary, location dependent number of the subscriber
  - assigned by the local VLR of the visited network (out of its number pool); contains the identity of the responsible MSC
  - is used for the routing of incoming connections towards the MS

GSM Addresses and Identifiers - IMSI and TMSI

- **International Mobile Subscriber Identity (IMSI)**
  - unique identification of the subscriber; is unknown to the subscriber
  - MCC: Mobile Country Code
  - MNC: Mobile Network Code
  - MSIN: Mobile Subscriber Identification Number
  - is used during signaling procedures to identify a subscriber
  - is stored in the SIM, HLR and the visited VLR
- **Temporary Mobile Subscriber Identity (TMSI)**
  - temporary location dependent identification of the subscriber (max. 4 Byte)
  - is assigned locally by the responsible VLR; is only valid locally
  - is only stored in the SIM and in the visited VLR
  - is used to disguise the subscriber identity; might also be changed from time to time even if the subscriber stays within the VLR area ("ID Hopping")

GSM Addresses and Identifiers - LAI, CI and BSIC



- **Location Area Identity (LAI)**
  - unique identification of an Location Area (LA) (= group of cells)
  - MCC: Mobile Country Code
  - MNC: Mobile Network Code
  - LAC: Location Area Code
  - when changing the LA, the MS requests to update its location data (Location Update)
- **Cell Identifier (CI)**
  - identification of a cell within an LA (max. 2 Byte)
- **Base Transceiver Station Identity Code (BSIC)**
  - identification of a BTS (to distinguish neighboring BTSs)

GSM Addresses and Identifiers - Summary

- **IMSI (International Mobile Subscriber Identity):**
  worldwide unique number to identify a subscriber (≠ telephone number)
- **TMSI (Temporary Mobile Subscriber Identity):**
  for security reasons the IMSI isn't used any more after the authentication, instead the TMSI is used during the communication
- **MSISDN (Mobile Subscriber ISDN):**
  actual telephone number of a subscriber
- **MSRN (Mobile Station Roaming Number):**
  temporary subscriber number (in the visited network assigned by the MSC/VLR)
- **IMEI (International Mobile Station Equipment Identity):**
  number, which is allocated permanently to the mobile equipment (ME)
- **LAI (Location Area Identity) and CI (Cell Identifier):**
  numbers to identify a cell (remark: in case of sector antennas, one CI is assigned per sector cell)