# Communication Networks 2

## Mobile Identifiers and Scenarios

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# Permanent Identifiers in GSM

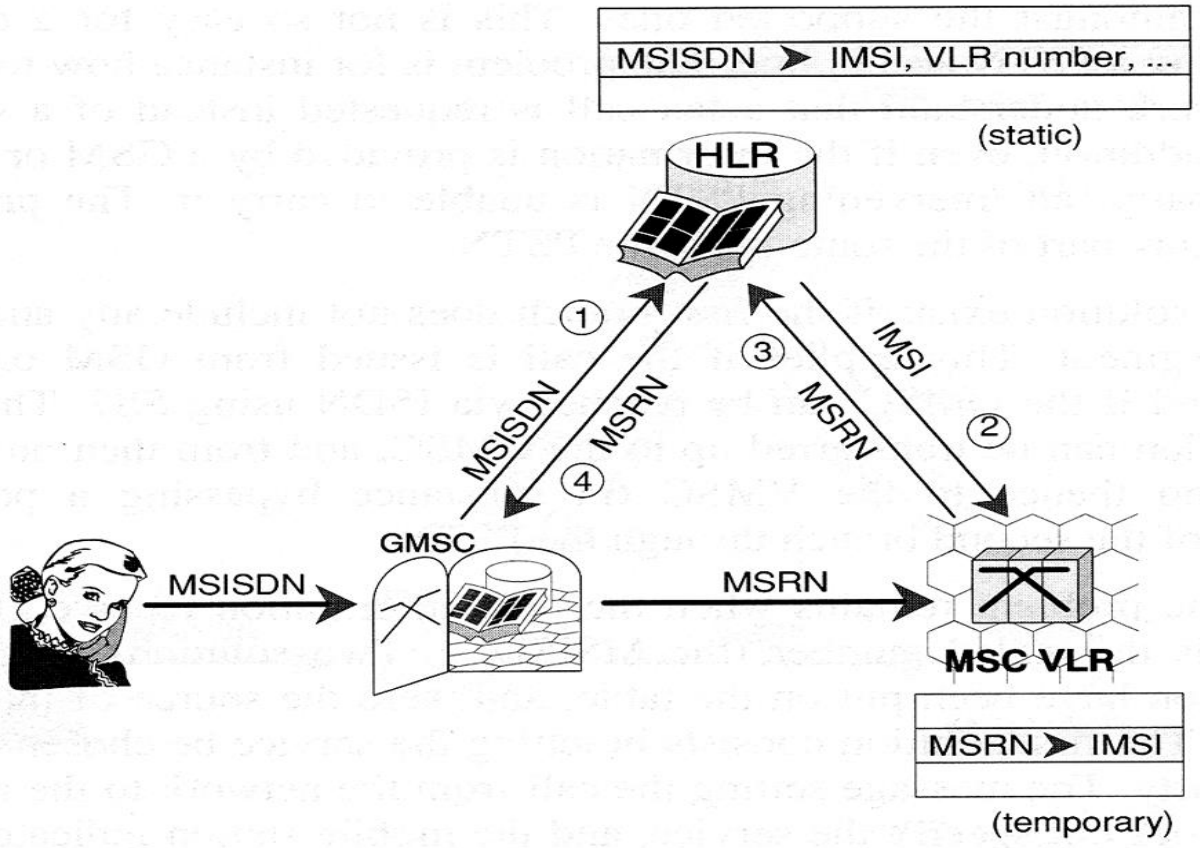
- **IMSI**: International Mobile Subscriber Identity
  - in GSM network this identifies the subscribers
    - in data bases (HLR, VLR - index)
  - assigned to SIM cards
  - unique worldwide
  - IMSI = Mobile Country Code (Hungary: 216) + Mobile Network Code (Hungary:01/30/70) + Mobile Subscriber Identifier (10 digits)
  - at operator change: MSISDN may be kept (number portability) but SIM card and therefore the IMSI must be changed
- **MSISDN**: Mobile Station ISDN Number
  - telephony number
  - unique worldwide
  - MSISDN = Country Code (Hungary: 36) + Network Identifier („area code”) (Hungary:20/30/70) + Subscriber Number

# Permanent Identifiers in GSM

- IMEI: International Mobile Equipment Identity
  - identifier of the mobile equipment
  - unique worldwide
  - IMEI = <equipment type+producer id> (8 digits) + <serial number> (6 digits) + <control digit> (1 digit) (+<software version id> (1 digit))
  - To query: *#06#
    - works on every GSM terminal
    - written under the battery, too
    - if they are different (or the latter is not present): the mobile is probably stolen!
      - exception: the SW version number is not always displayed by *#06# or it is not written under the battery

# Temporary Identifiers in GSM

- **MSRN**: Mobile Station Roaming Number
  - used when a MS is called
  - assigned to MSC(VLR)



# Temporary Identifiers in GSM

- **TMSI**: Temporary Mobile Subscriber Identity
  - used to hide IMSI on radio interface
- **LAI**: Location Area Identity
  - MCC+MNC+LAC
    (Location Area Code)
- **GCI**: Global Cell Identity
  - LAI + CI (Cell Id)

  - See User confidentiality chapter

# User Confidentiality

- Authentication
  - Verification of the identity of the subscriber
- Ciphering
  - Encryption of user voice/data transmission and signal transmission in the Radio interface
    - To prevent interception
- IMEI check
  - Verification of the Mobile Equipment by checking the validity of the International Mobile Equipment Identity (IMEI)
- User Confidentiality
  - Tariff structure
    - - called: right to hide location, not to be discovered even implicitly
    - - caller: to know in advance how expensive the call will be
  - Avoidance of the broadcast of user's IMSI on the Radio interface – TMSI

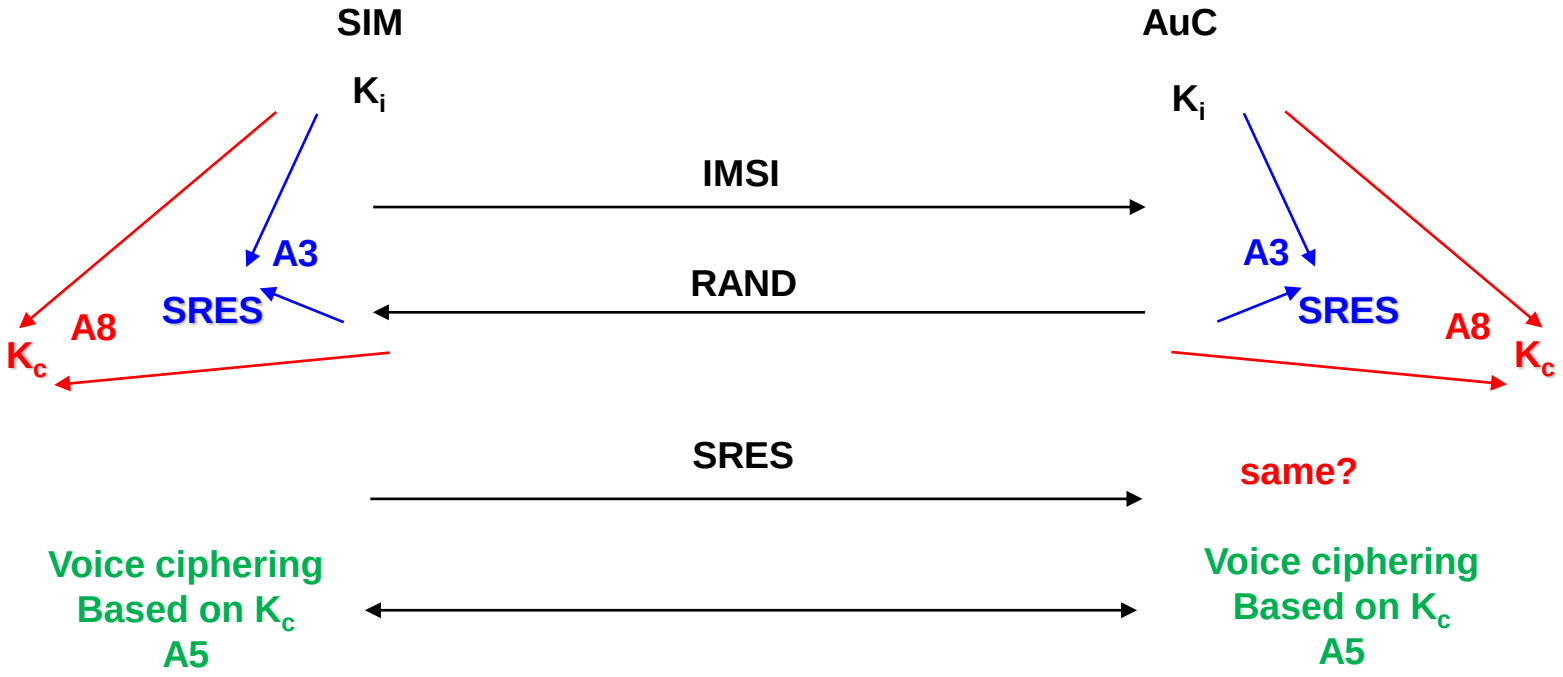
# Authentication

- Problem: On the Radio Interface anyone can call in the name of anyone else by using a public identifier (IMSI, MSRN)
  - And the cheated pays…
- Therefore the network must check the identity of caller - authentication
- Private identifier needed
- But this must NEVER be transmitted through the radio interface
- But, then how ????

# Authentication

- SIM card producer: Generates a 128 (from UMTS: 256) bit long private key (long enough) to each SIM card
  - $K_i$ – Individual Subscriber Key
  - Off-line presents (paper, CD, …) to the service provider buying the SIM
  - Stored in Authentication Centre (AuC):
    - IMSI – $K_i$ assignment

# Authentication – theory

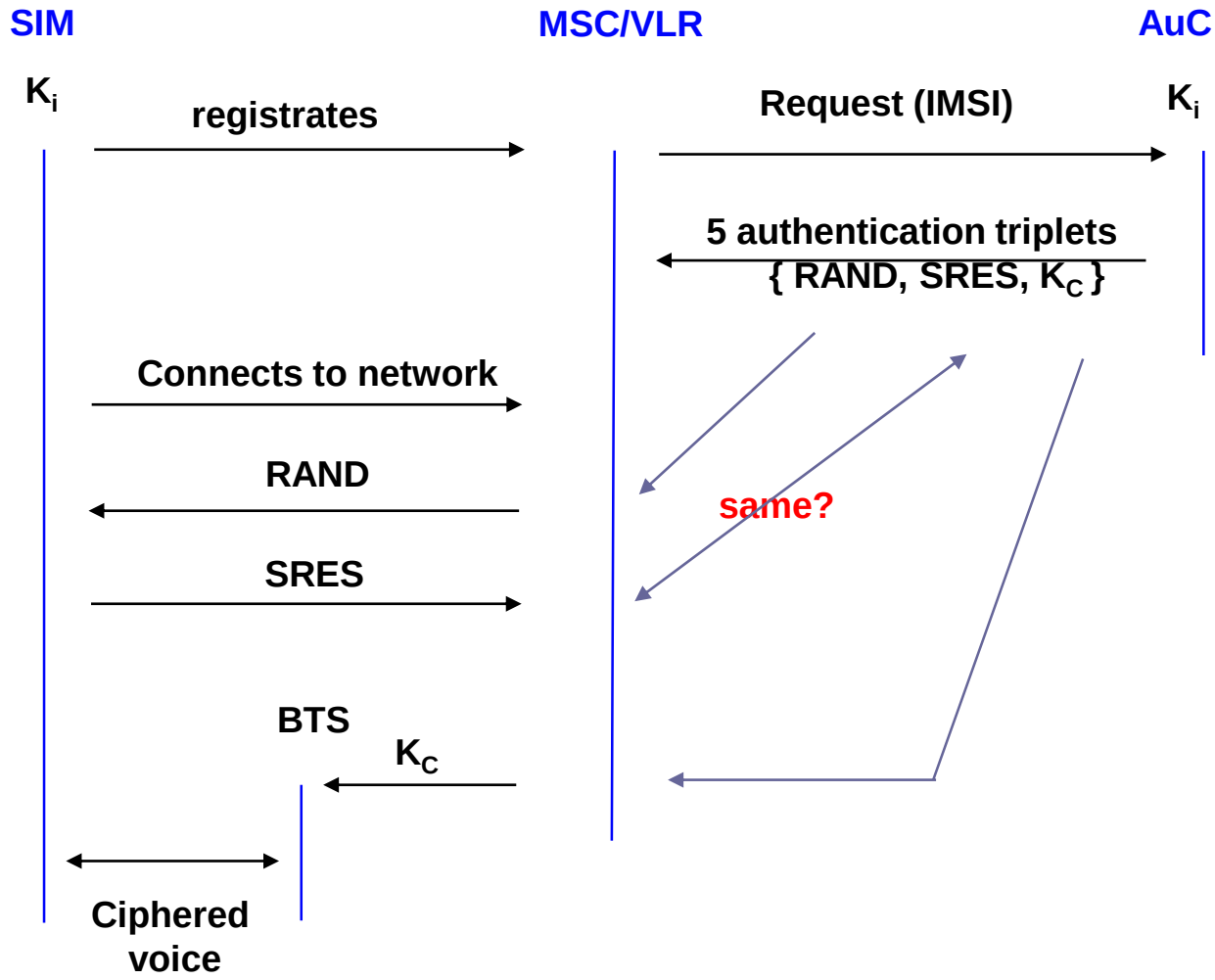



RAND: Random Number
SRES: Signed Result
Kc: Ciphering Key

**REQUIRES TOO LARGE Signaling TRAFFIC**

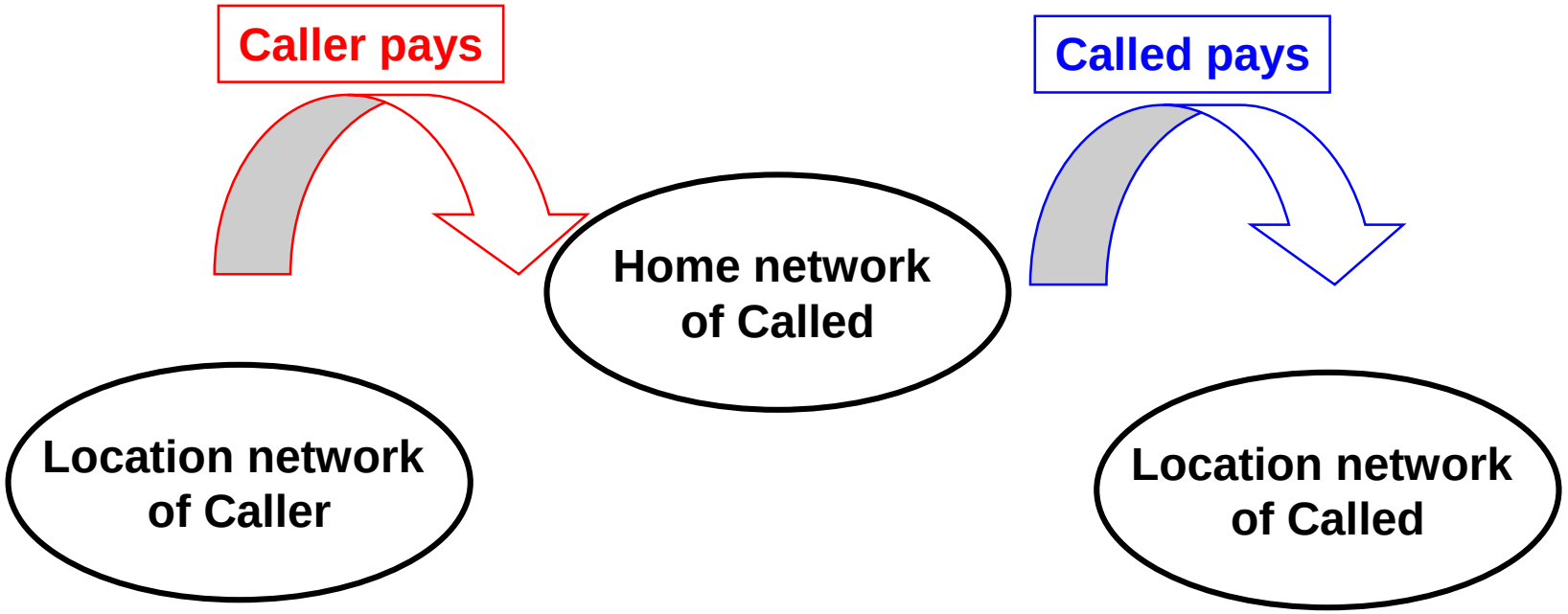
**LET US INVOLVE THE SERVING MSC!**

# Authentication – practical implementation



# User Confidentiality – Tariff

- Tariff structure
  - - called: right to hide location, not to be discovered even implicitly (through price of the call)
  - - caller: to know in advance how expensive the call will be



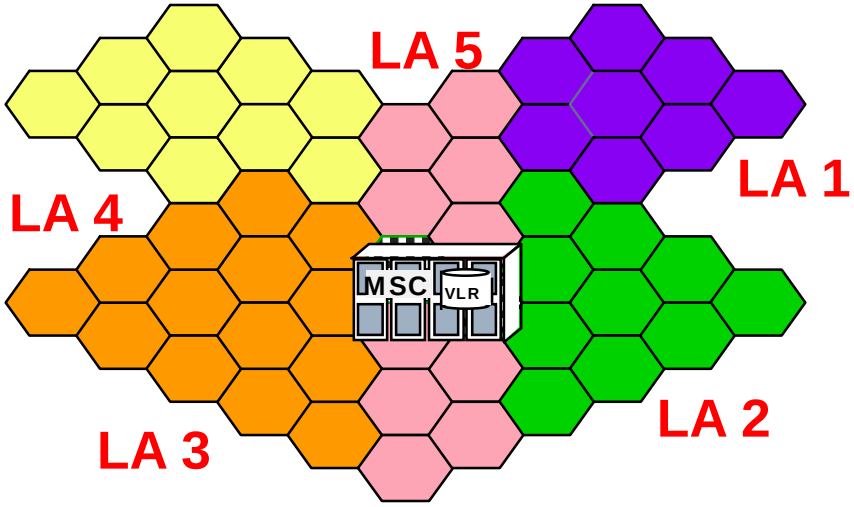
# Usage of TMSI instead of IMSI

- Do not send „sensitive” identifiers through radio IF
- At very first connection: IMSI
- MSC assigns a „random” identifier (this is the TMSI) to the mobile
- At next connection – mobile uses TMSI instead of IMSI
- But how can the MSC know, if the TMSI was assigned by itself or by another MSC?
- MS sends not only the TMSI, but the LAI where it received the TMSI
  - MSC querries the „old” MSC
  - See: Location Update

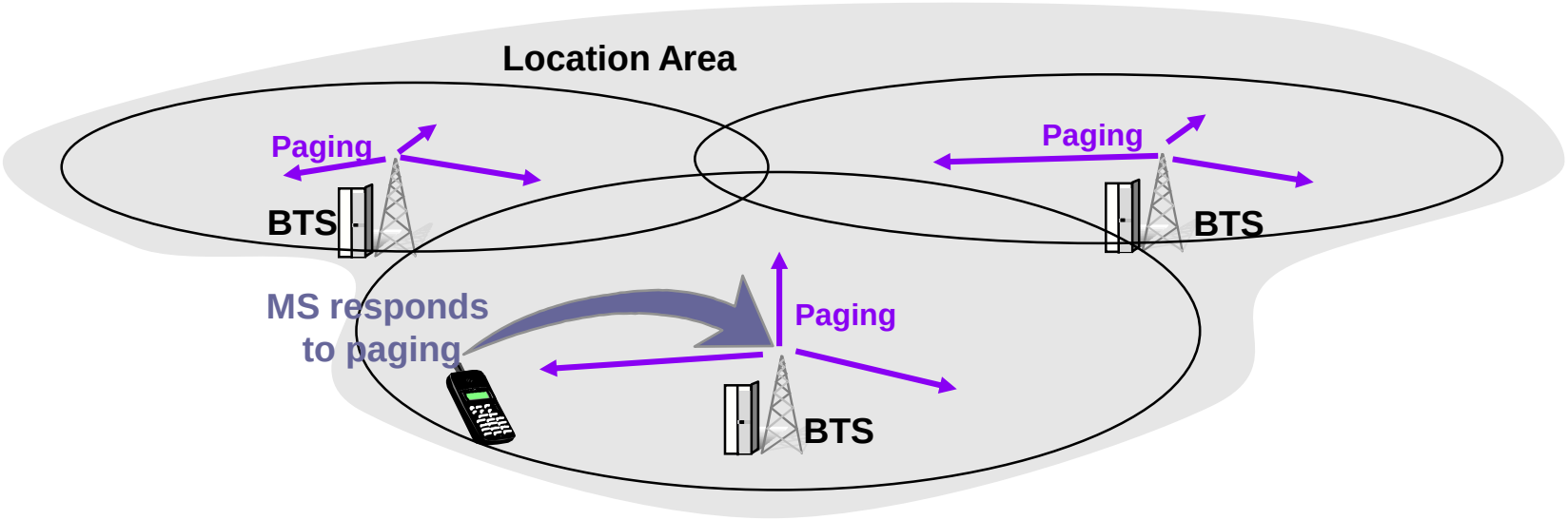
# Mobility Management (MM)

- The network must know the location of a MS to be able to connect a call, or deliver an SMS to it
  - If the world were just one area
    - No need for location management
    - But Paging in every cell of the world ☹
  - Divide the world to smaller areas – to Page an MS only in a limited part of the world
    - Location Area – LA
    - Often LA = Area served by an MSC, but at heavy traffic areas it is divided logically into more LAs
  - But then the network must keep track the movement of MSs
    - Additional signaling need
    - Additional network elements, processes
    - Still worth

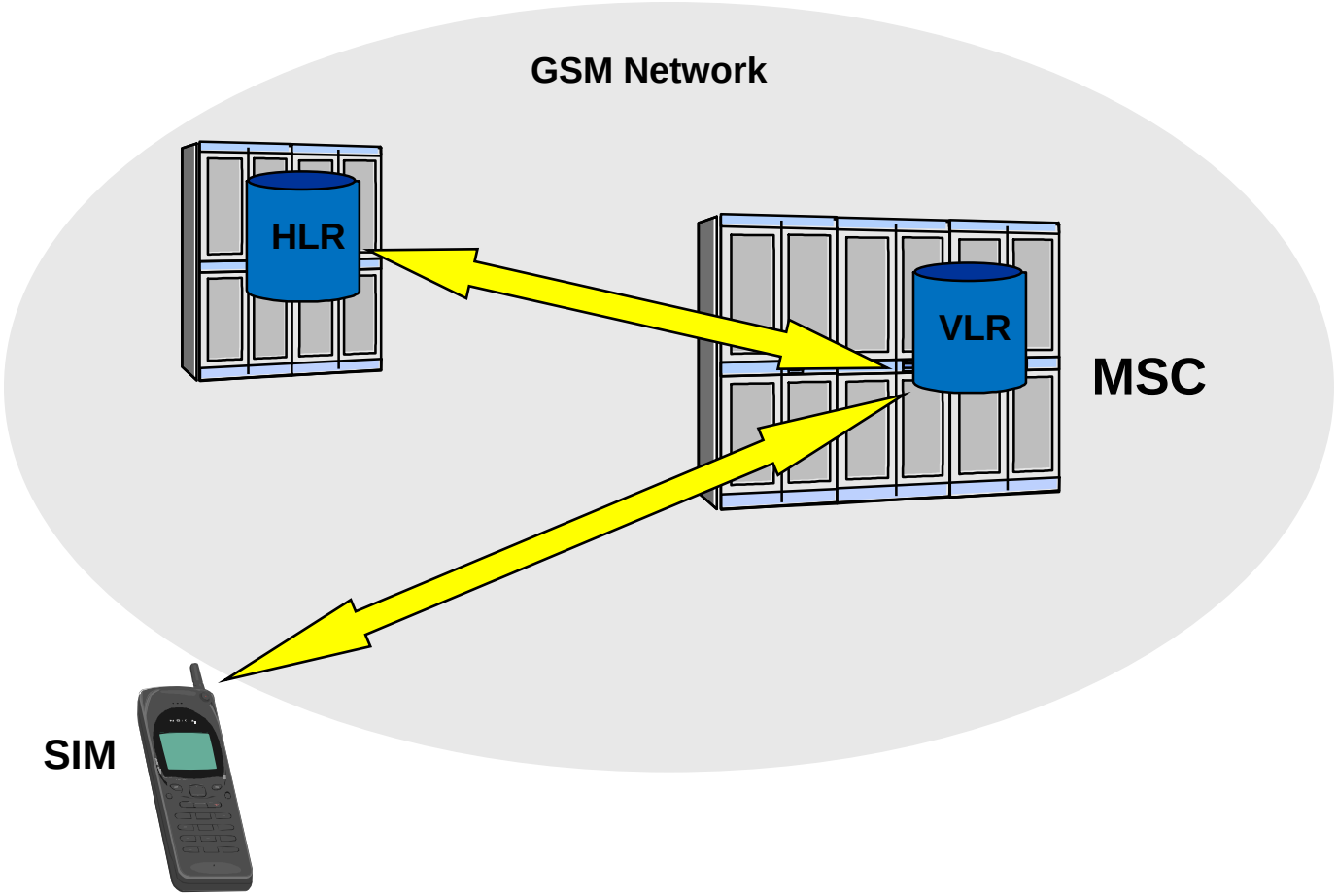
# Location Areas




- Area served by an MSC/VLR can be divided into smaller units: **Location Area**
- The maximum size of LA can be one MSC area and the minimum size is one cell
- A subscriber can move within this area without having to make a normal location update
- Paging is done in all cells of the LA where the subscriber is currently located



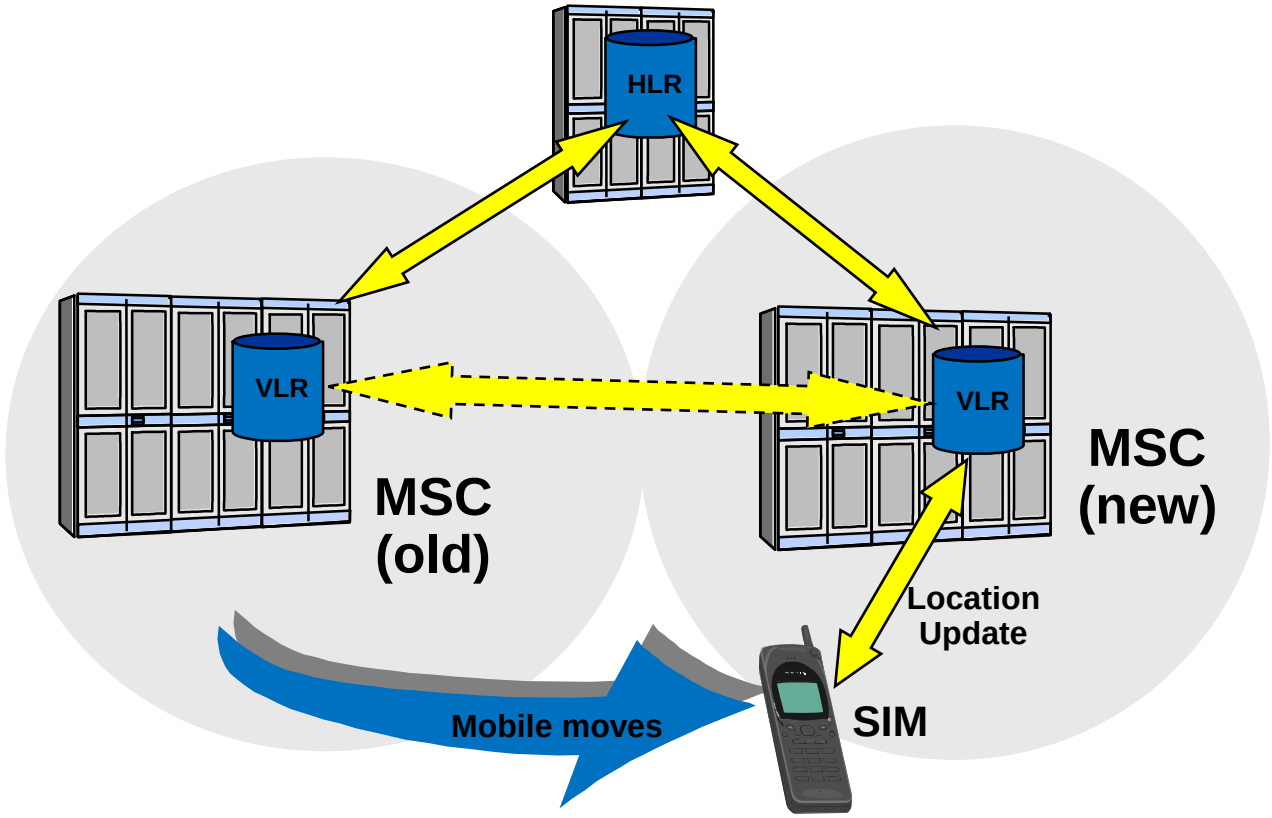
# Databases involved in MM in a GSM Network



# Location update

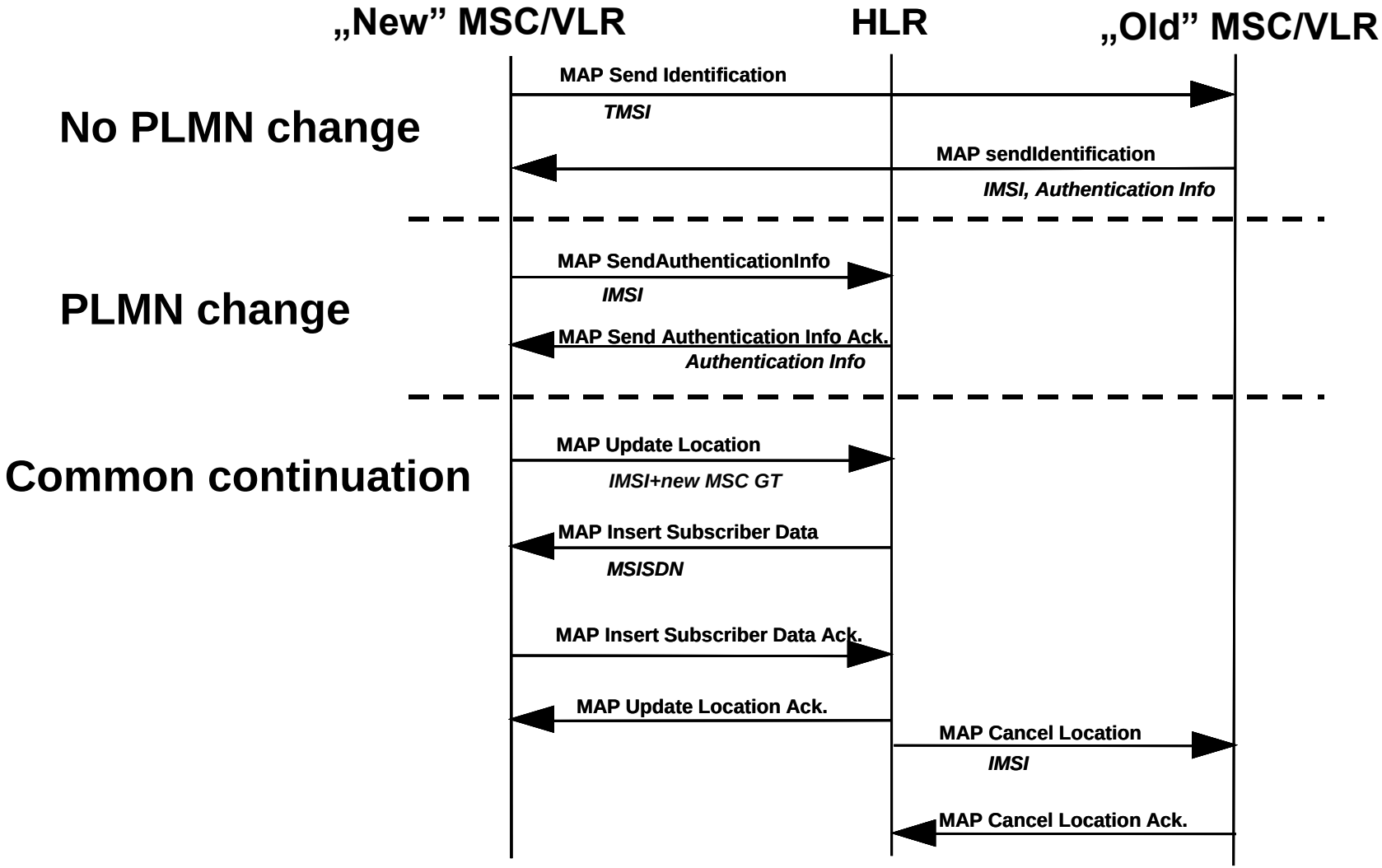
- The Mobile Station monitors the information broadcast by the network (BTS)
- The Mobile Station stores the current Location Area Identity (LAI) on the SIM card
- The Mobile Station continues to monitor the broadcast information
- If the Location Area Identity being broadcast by the network is other than the one stored in SIM, the Mobile Station starts the location update (LU) procedure

# Elements Involved in a Location Update




1. „New" MSC/VLR acquires:
   - IMSI,
   - User Profile (MSISDN),
   - Authentication triplets
2. Inform HLR about new MSC area
3. Inform „Old" MSC/VLR that MS has moved – can clear

# Location Update

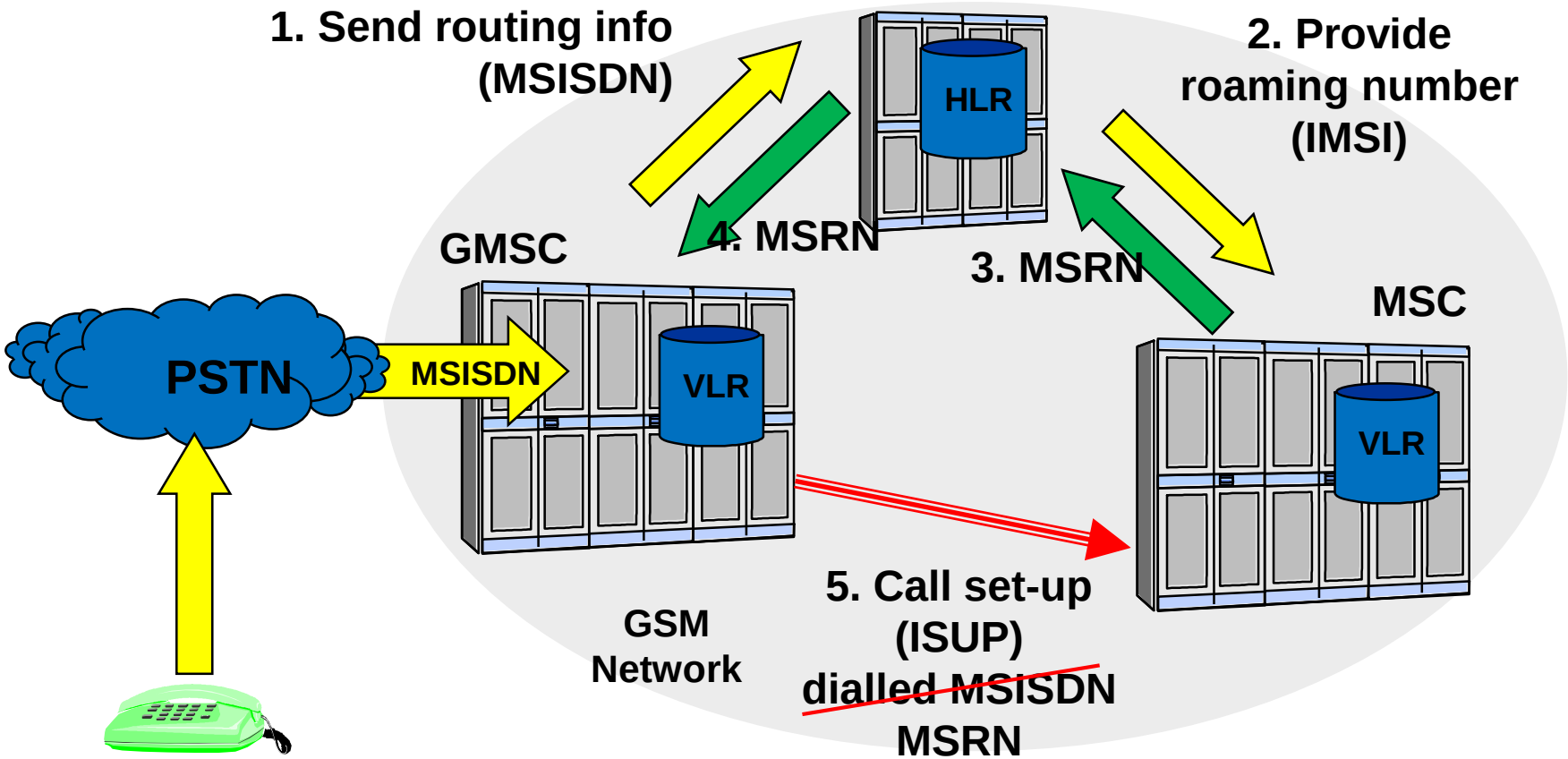


# LU variants

- „Normal” (Generic LU)
- Periodic

- Switch on (IMSI Attach)
- Switch off (IMSI Detach)

# Routing the call inside the GSM network



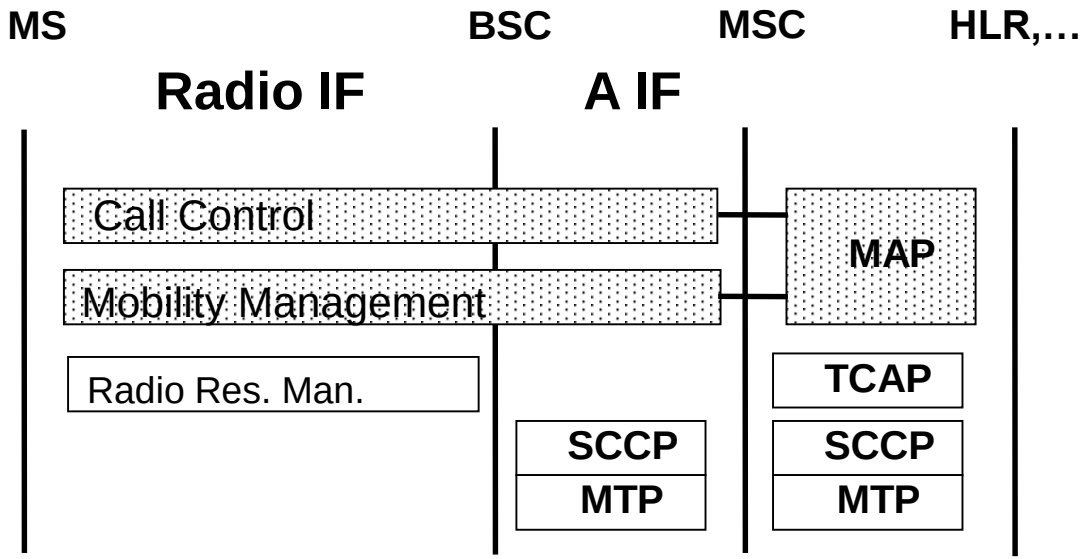

HLR and serving MSC (VMSC – Visited MSC) may be in different networks – SCCP Global Title

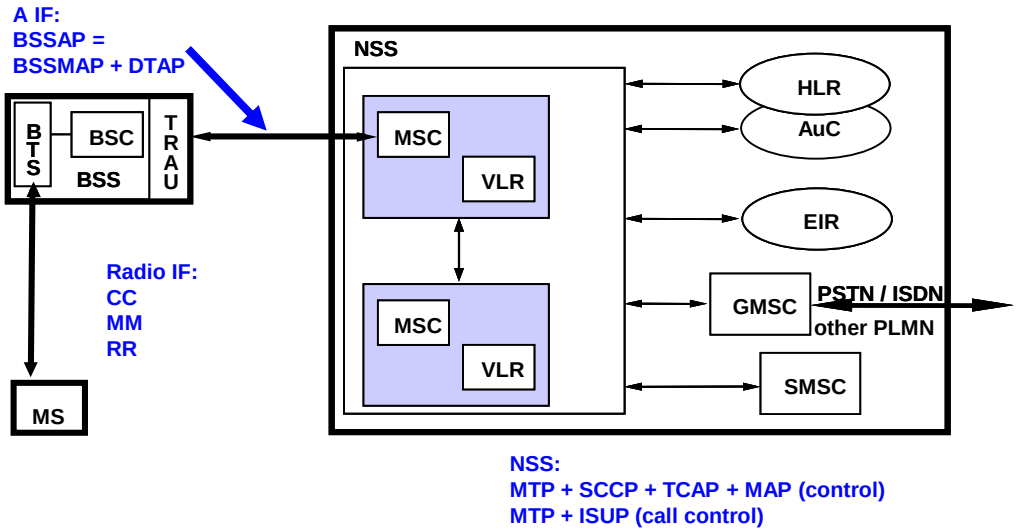
GMSC and serving MSC (VMSC – Visited MSC) may be in different networks – (international) transit switches

# GSM protocols

- Previously discussed: Protocos among MSC, VLR, HLR, EIR (C, D, E, F, G interfaces): SCCP/TCAP/MAP
- Let us have a look at the protocols between the MSC and MS (A, Abis, Um (radio) interfaces) -- simplified
  - Lower layers:
    - A interface: MTP + SCCP
    - Radio (Um) interface: LAPDm: modified LAPD (optimized for radio channels – e.g. shorter messages, etc.)
  - Two special protocols above them:
    - MM – Mobility Management
    - CC – Call Control (~DSS1)

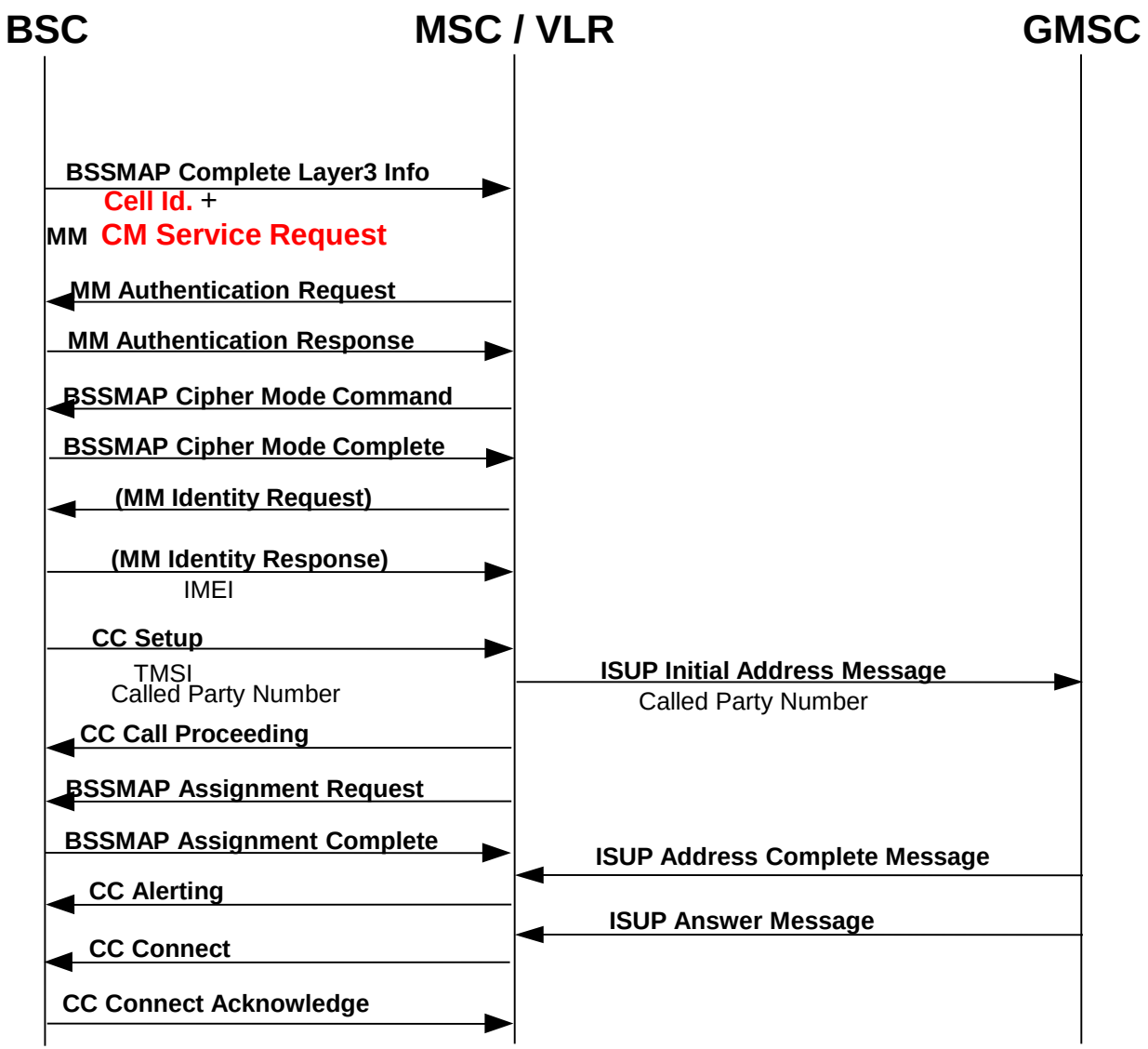
# GSM protocols



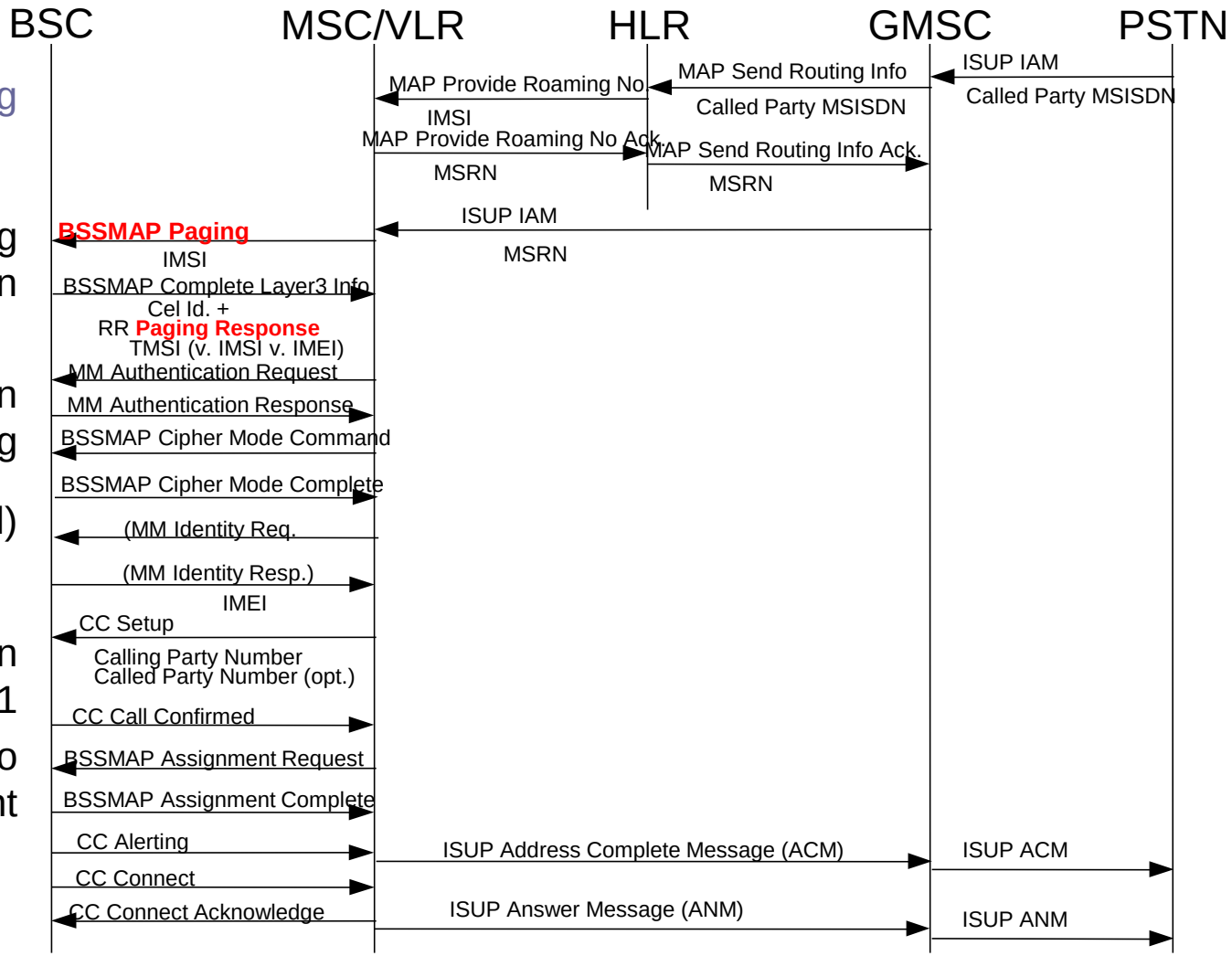
# Mobile Originated (MO) Call

- Connection indication
- Authentication
- Ciphering
- IMEI check (optional)
- Call setup – as in DSS1
- The exception: radio channel assignment



# Mobile Terminated (MT) Call

- MSRN acquiring
- Paging
- Conn. indication
- Authentication
- Ciphering
- IMEI check (optional)
- Call setup – as in DSS1
- The exception: radio channel assignment



# Short Message Service

- Signaling service, no voice lines involved
- Datagram service
  - Not requiring the end-to-end establishment of a traffic path between sender and receiver
  - Sender sends SM to SMSC of its home PLMN
  - SMSC delivers it to receiver
- Not guaranteed service
- Asymmetric: Mobile Originating Short Message transmission is considered as a different service from Mobile Terminating Short Message transmission

# Successful SMS transmission

**A: sender**
**B: receiver**