2 G Architecture– GSM, GPRS and Others

Lesson 04

GSM System Architecture

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Mobile communication using base station in cellular networks

- A mobile station, MS, communicates with a GSM public land mobile network (PLMN)
- In turn, may connect to a PSTN network
- The PSTN connects to a source–destination network which acts as an interface for the destination terminal, TE

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GSM NETWORK ARCHITECTURE

- Radio subsystem (RSS)
- Network subsystem (NSS)
- Operation subsystem (OSS)

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Mobile Station (MS)

- A mobile device or phone
- Connects to GSM network
- Radio transmission system used in mobile phones)

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Mobile Station (MS)

- Hardware and software to transmit and receive GSM data, and a user terminal (TE) through which the user receives and sends the data
- Transmits through the interface *Um* at a power of 1–2 W

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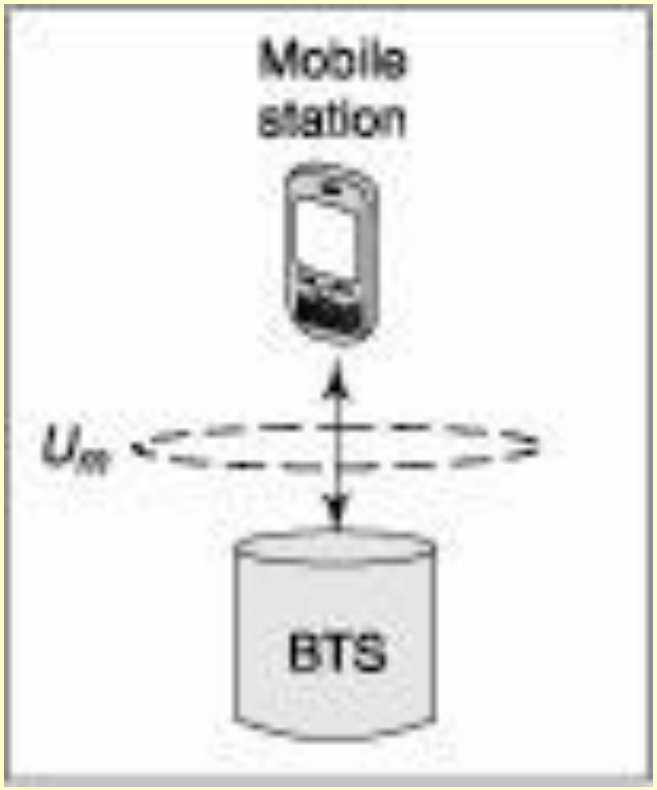
Mobile station to BTS interface in a GSM cell



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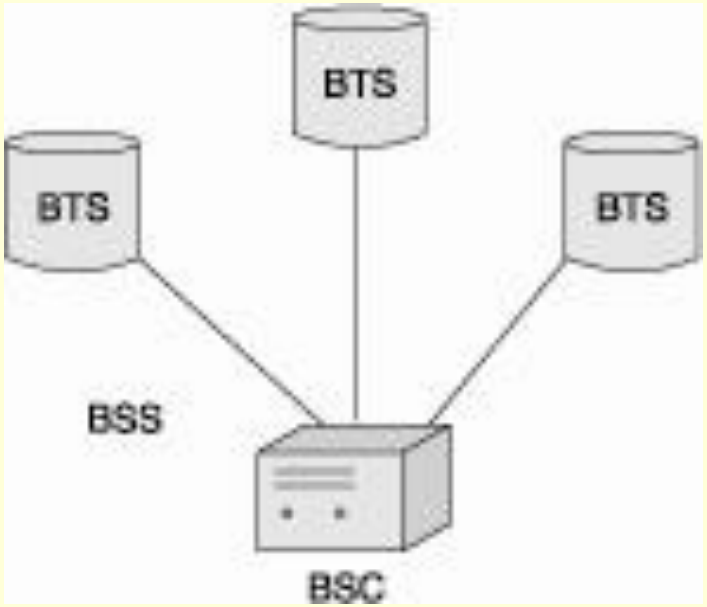
Base station system in a cellular GSM network



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RSS

- Consists of a number of base station controllers (BSC)
- Each BSC connects to a number of base transceiver stations (BTS) which, in turn, provide radio interfaces for mobile devices

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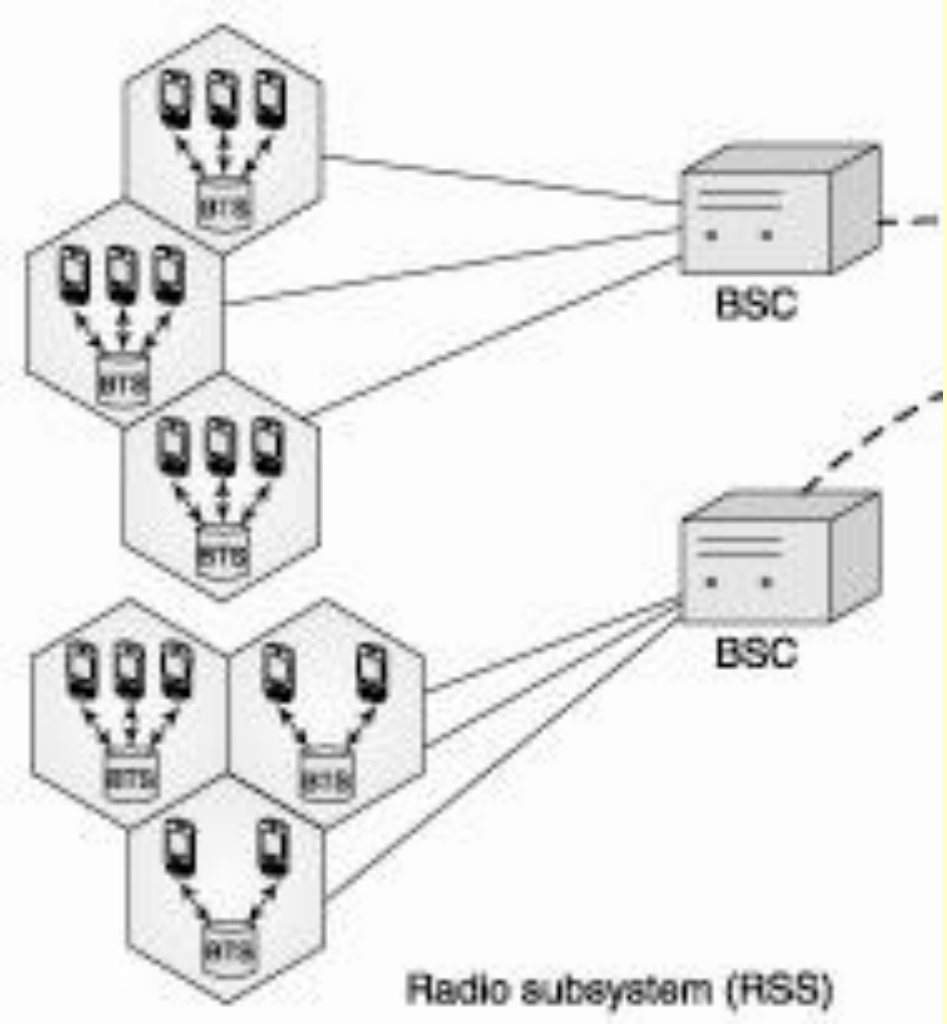
RSS



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NSS

- Consists of a number of mobile services switching centres (MSC)
- Each MSC of the NSS interfaces to a number of BSCs in the RSS
- Home location registers (HLR)
- Visitor location registers (VLR)

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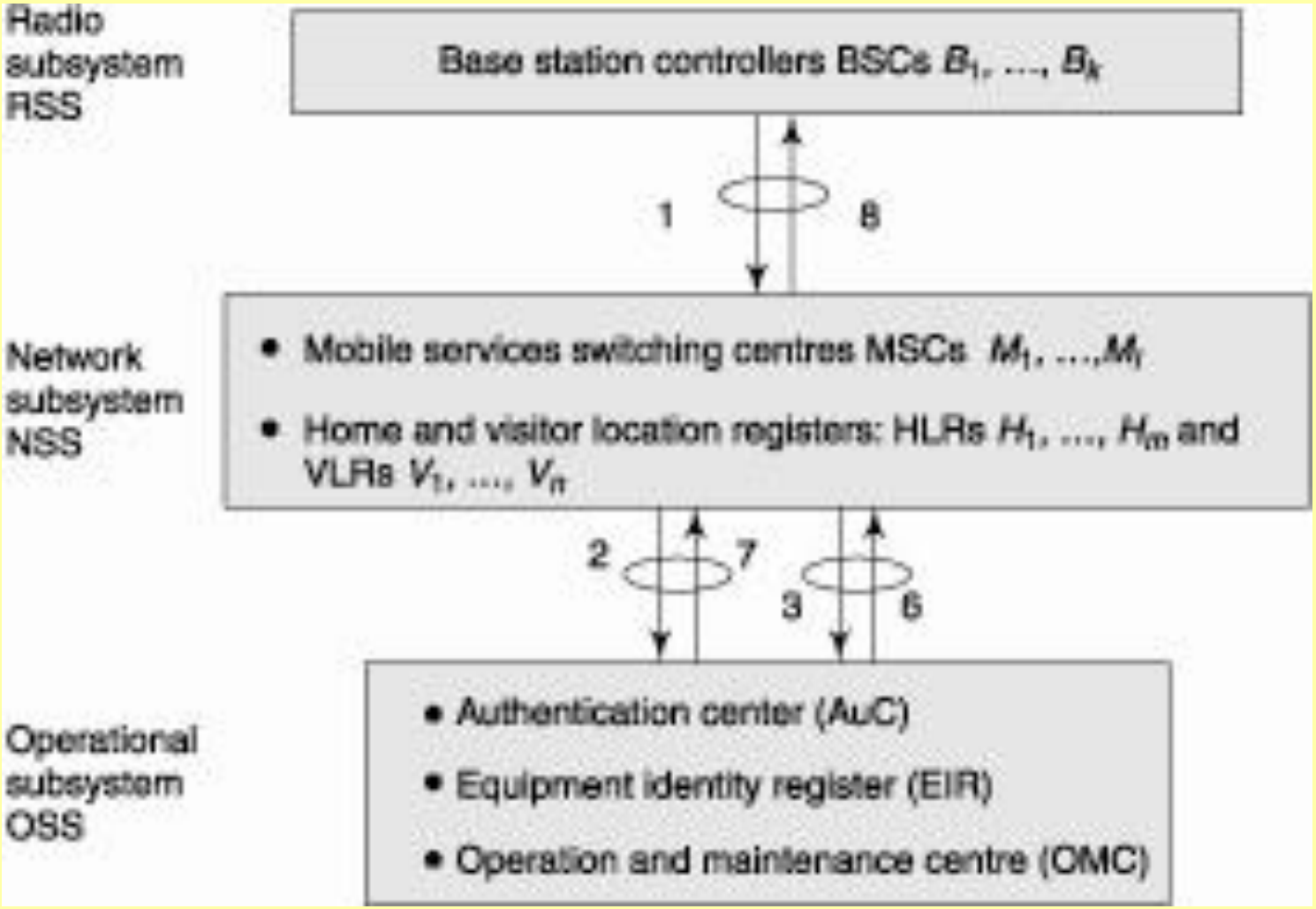
Interfacing between the three subsystems in a GSM network



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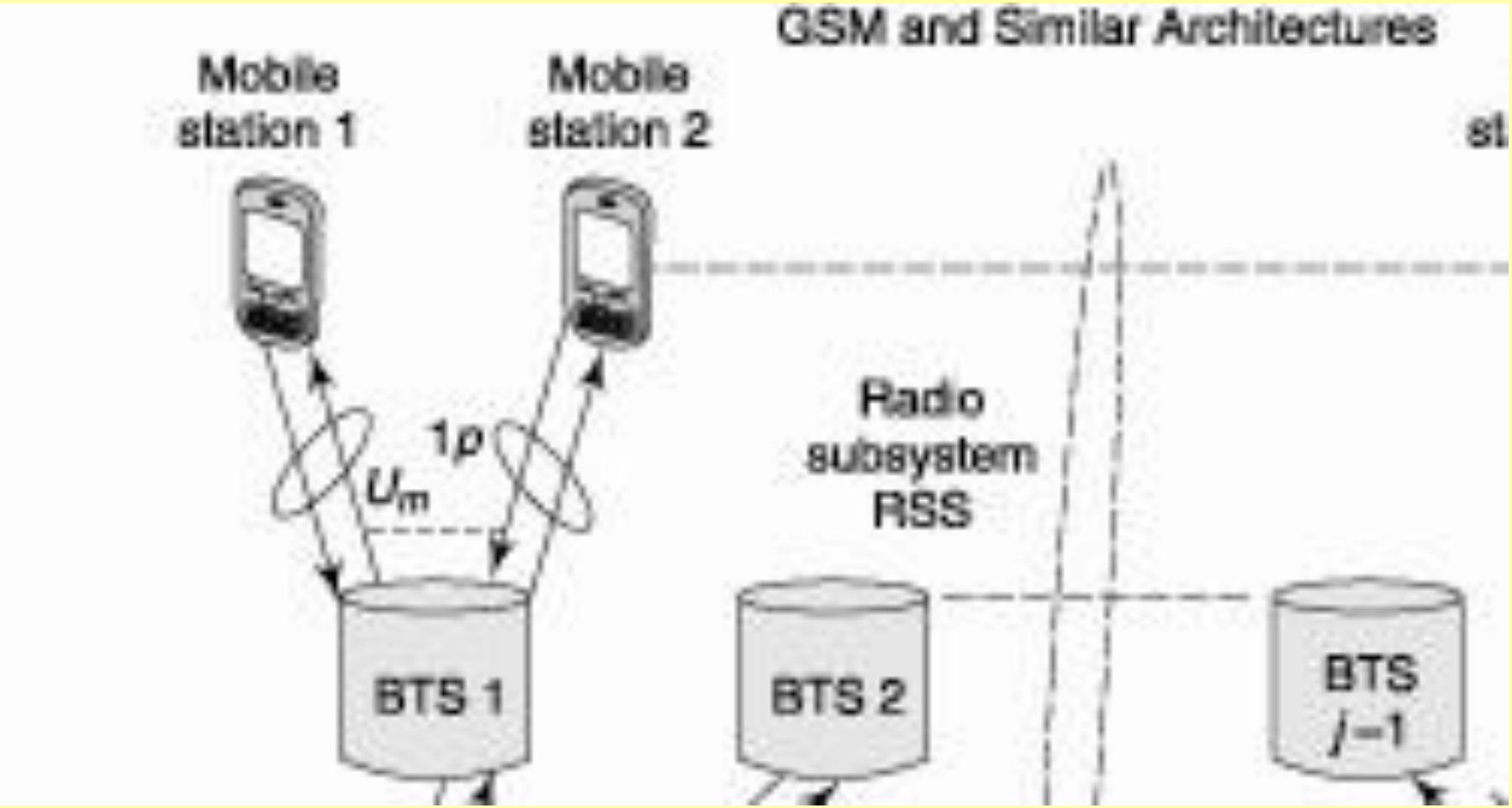
Connection interfaces in the RSS subsystem between BTS and the MSs



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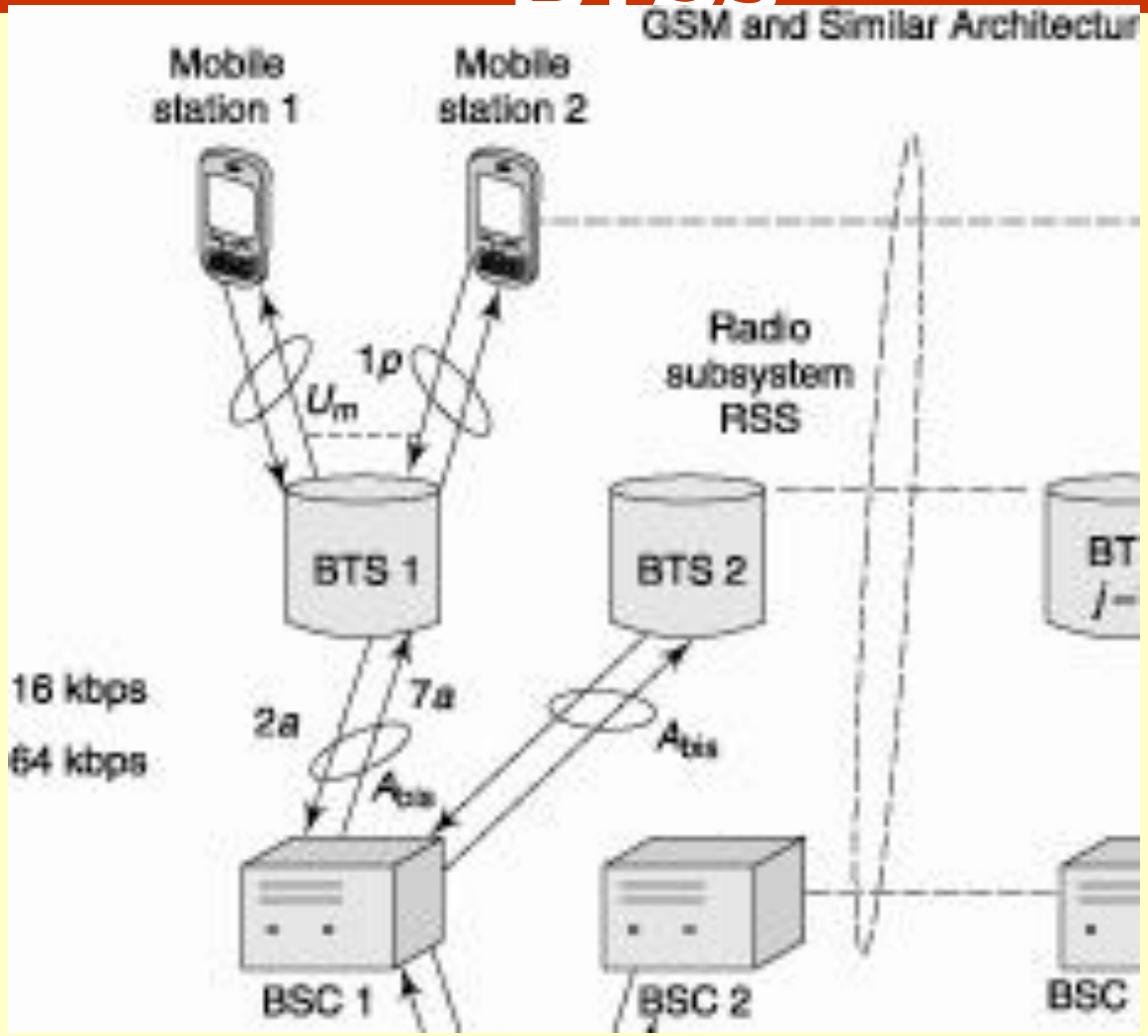
Connection interfaces in the RSS subsystem between BSC and the BTSs



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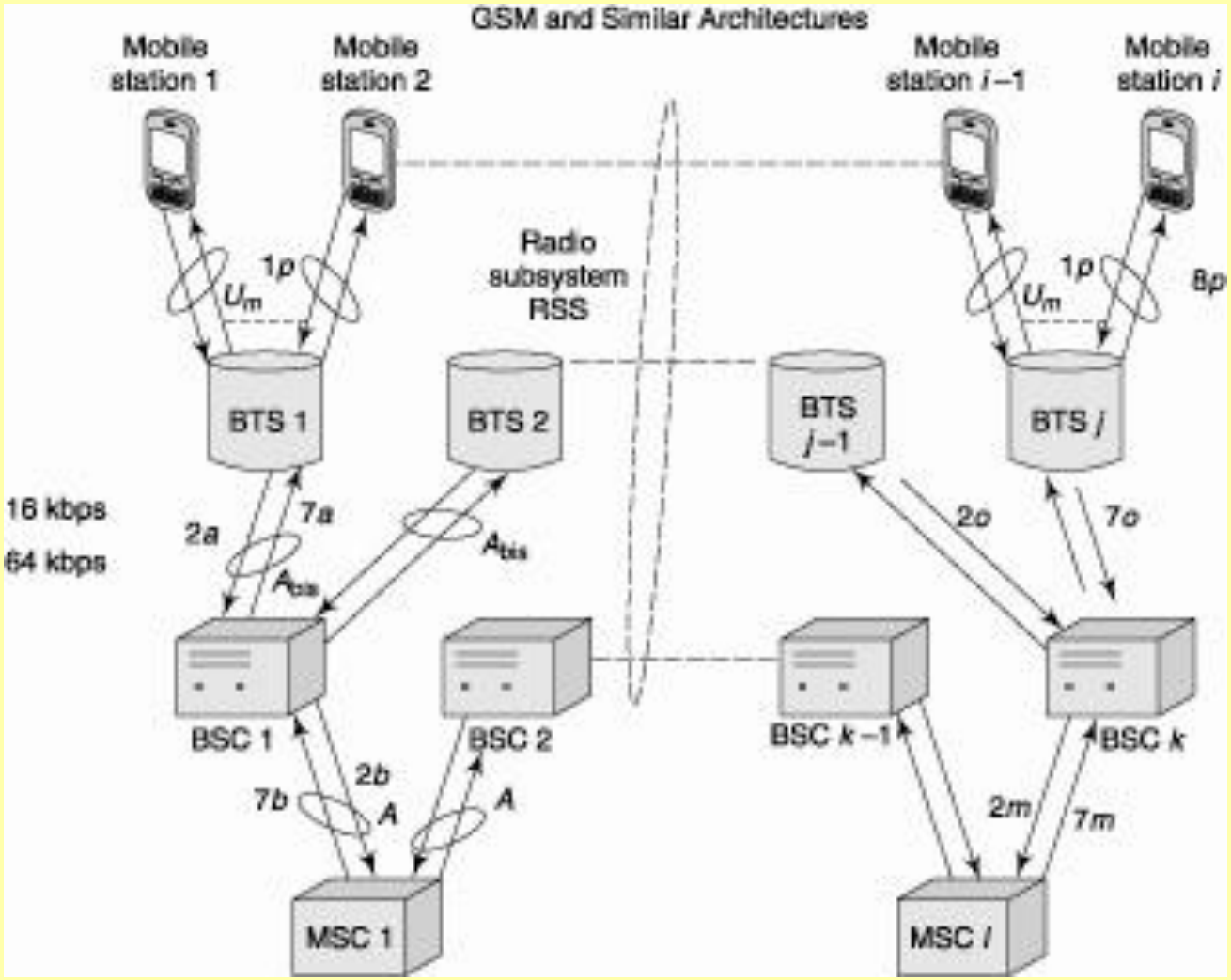
Interfaces in the RSS subsystem between MSC (in the NSS) and the BSCs



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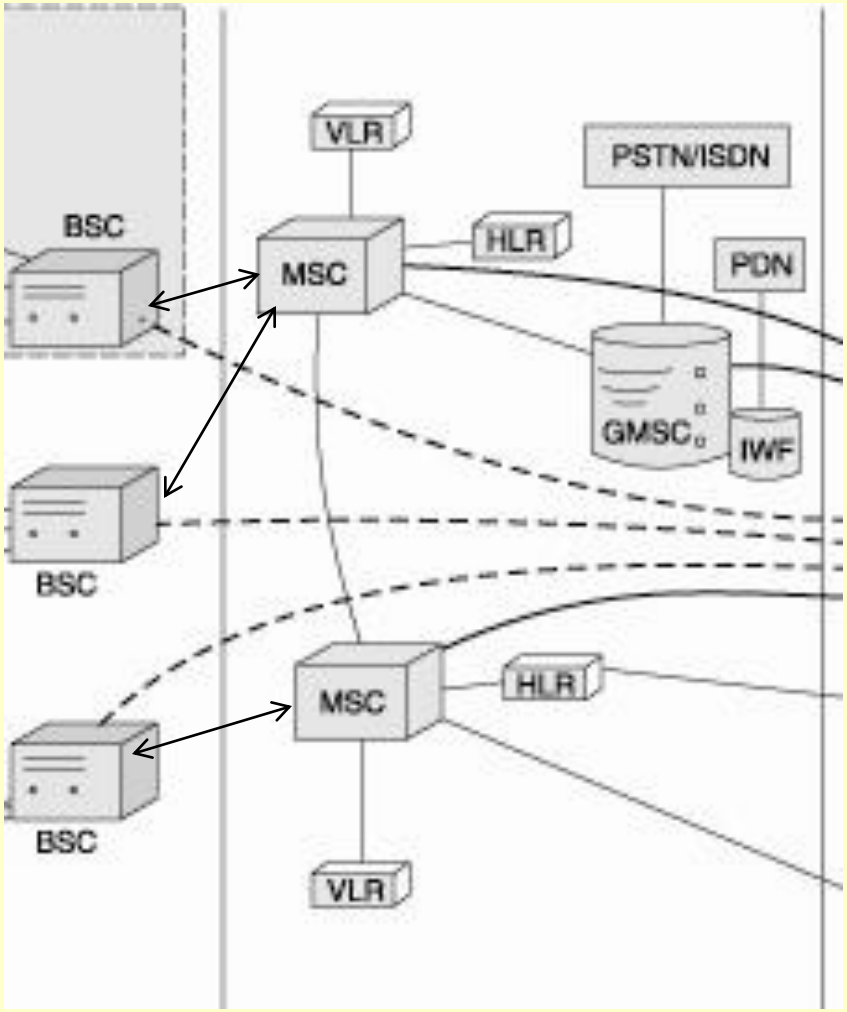
NSS



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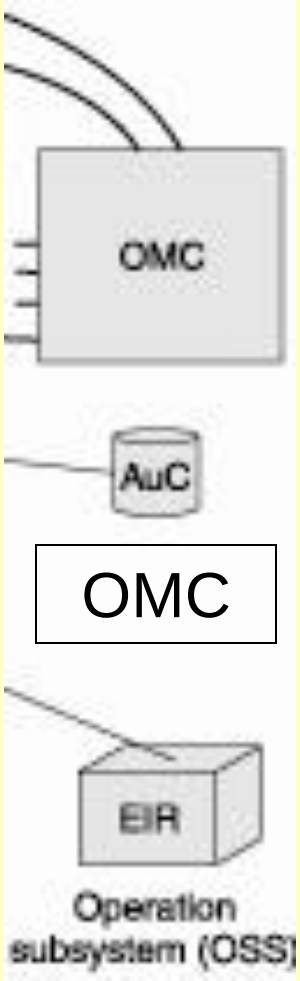
OSS



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Mobile Communication from the MS

- When a mobile station MS_x communicates to another mobile station MS_y, a switching center MSC_i establishes (switches) a connection (channel) between (i) MS_x interfaced to the BTS_p, then to the BSC_q, then to MSC_r and (ii) MS_y interfaced to the BTS_u, BSC_V, and MSC_w

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GSM System communication

- RSS and NSS for communication
- MSCs must have location registries to enable the NSS to discover a path (route or channel) between MS*x* and MS*y*
- The OSS facilitates the operations of MSCs

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Main functions performed by the BTS

- Formation of cells using appropriately directed antennae
- Processing of signals
- Amplification of signals to acceptable strength so that they can be transmitted without loss of data

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Main functions performed by the BTS

- Channel coding and decoding (for example, coding voice into bits so that it can be transmitted at 13 kbps and decoding received coded signals back to voice)

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Main functions performed by the BTS

- Frequency hopping so that multiple channels for various mobile stations can operate simultaneously using different channel band frequencies
- Encryption and decryption of data
- Paging

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Main functions performed by the BTS

- Adapting to the rate of data synchronous data transmission
- The receiver clock of the transceiver at one end of an interface adapts itself according to transmitter clock of the transceiver at the other end)

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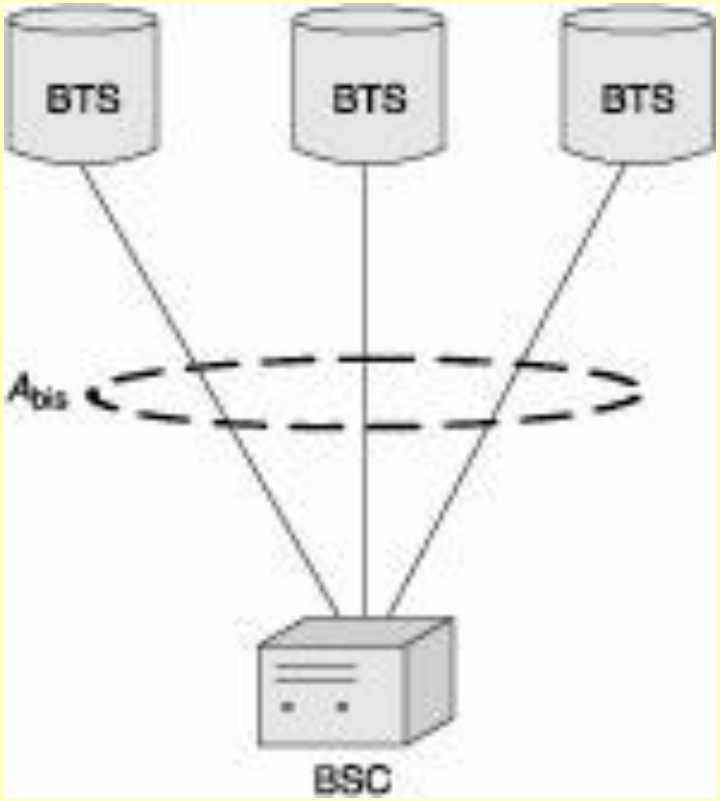
BTS to BSC interface in a GSM network



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A_{BIS} TRANSCEIVER

- Transmits and receives data with four multiplexed channels of 16 kbps or with a 64 kbps channel
- Usually a BTS is used to manage one cell in the GSM cellular network, but using a sectorized antenna, a single BTS can be used to manage many cells

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Base station controller (BSC)

- Manages a number of BTSs
- Uses the A_{bis} interface to connect to BTSs
- BSCs reserve radio frequencies for communication and manage handovers between BTSs

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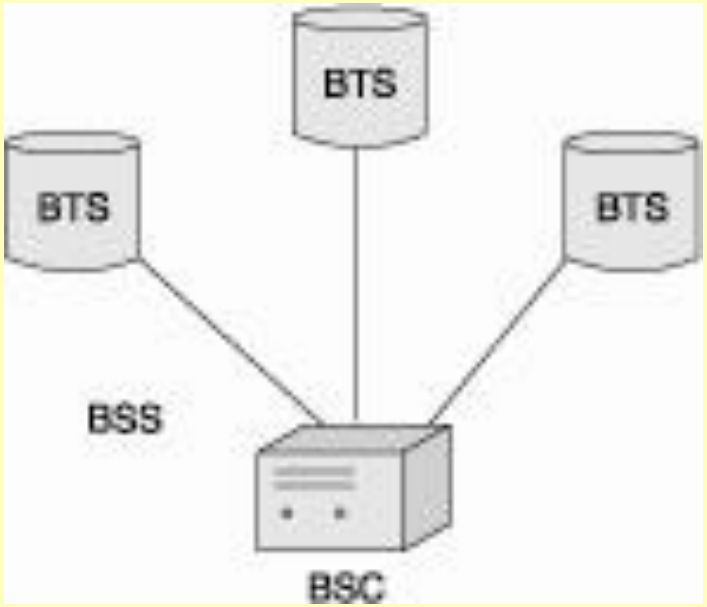
Base station system in a cellular GSM network



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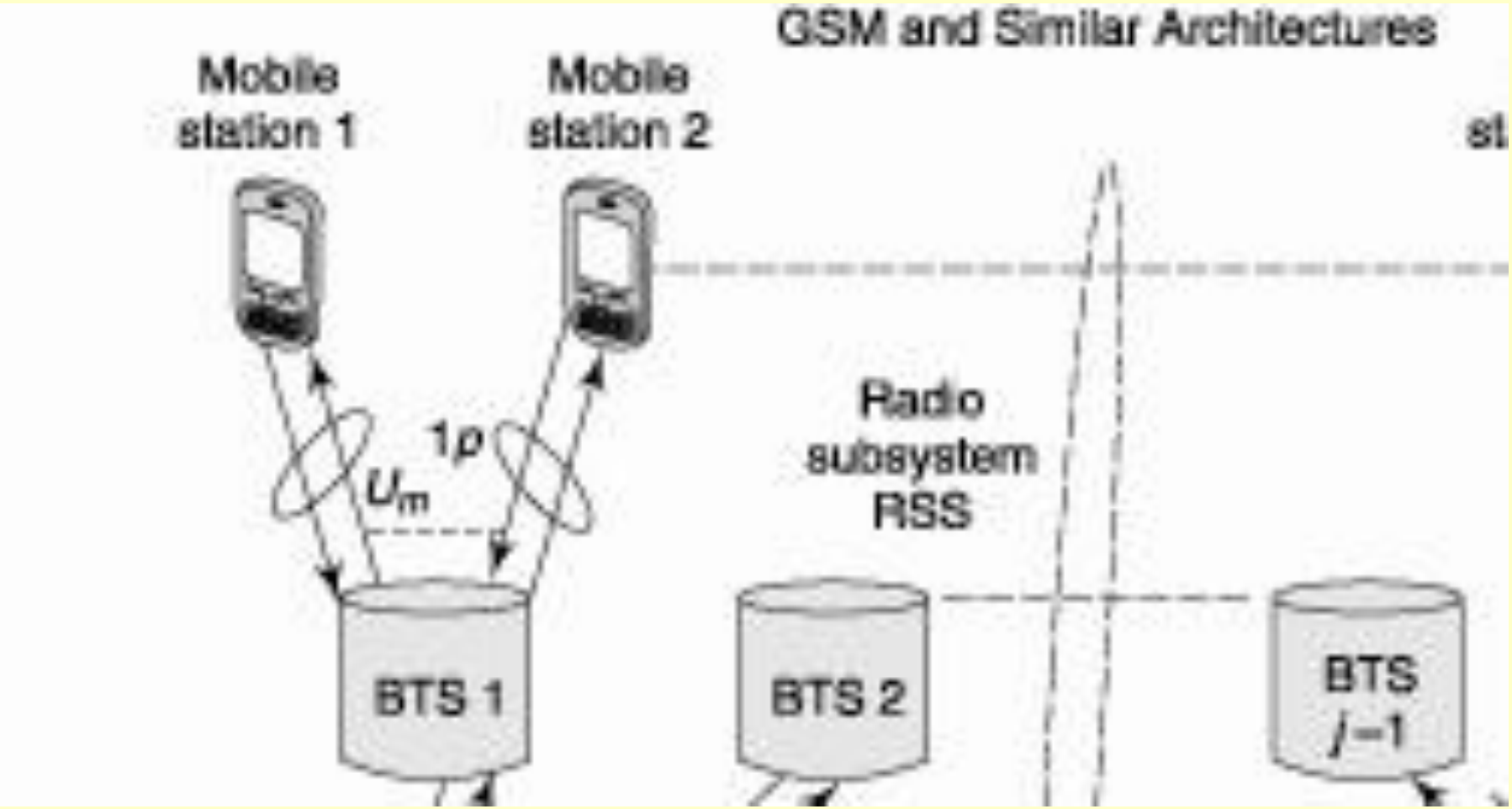
Connection interfaces in the RSS subsystem between BTS and the MSs



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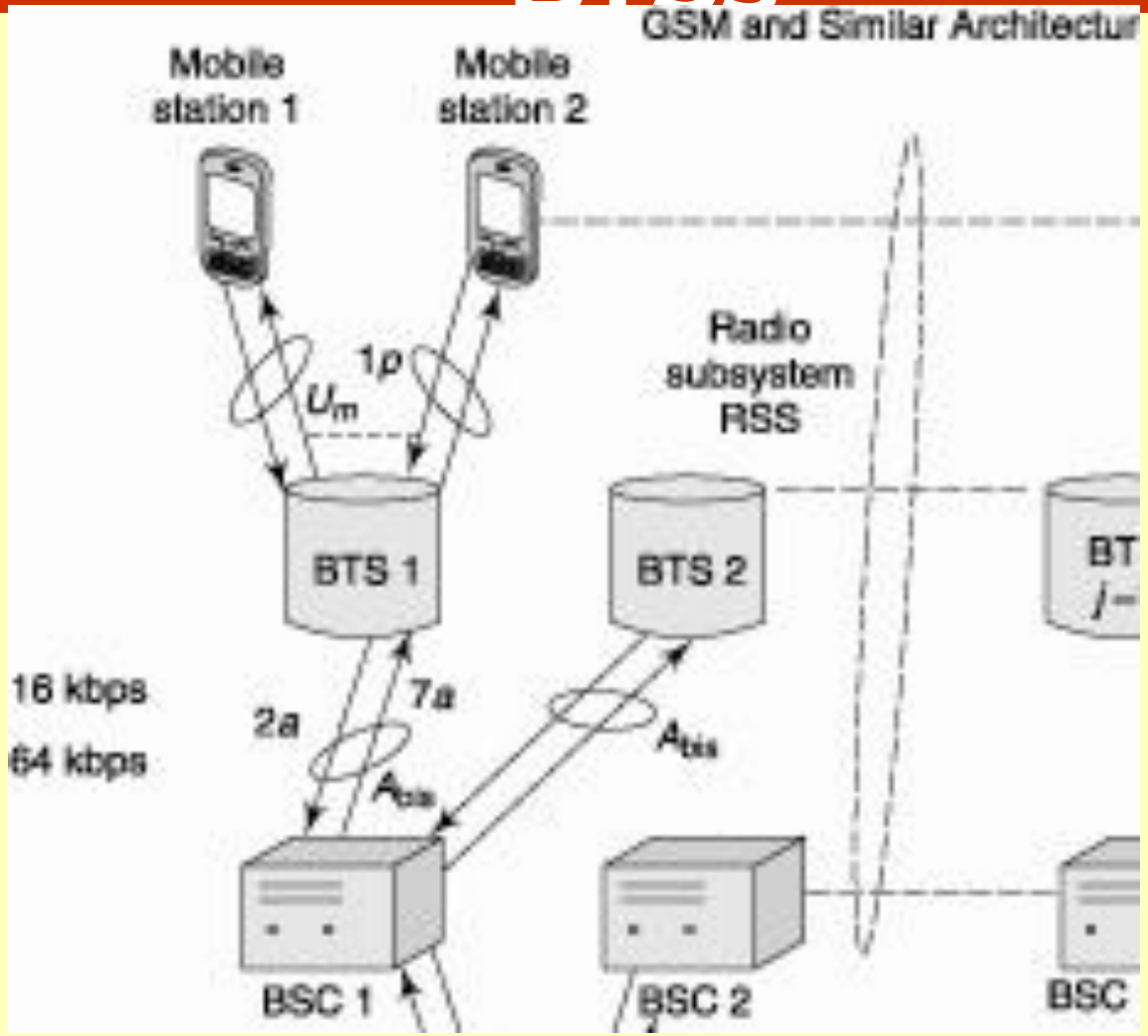

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Base station controller (BSC)

- A BSC along with the BTSs connected to it and the mobile stations managed through it forms a base station system (BSS)
- Also connected to an MSC in the networking and switching layer using an interface *A*

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Important functions performed by the BSC

- Processing of signals
- Controlling signals to the connected BTSs and control of handover of signals from one BTS to another within a BSS
- Control and handover of the signals from BSC to MSC

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Important functions performed by the BSC

- Mapping the signals of a channel– at given instant receives signals from a BTS at 16 kbps through A_{bis} and interfaces them to an MSC at 16 kbps
- Alternatively, may have to interface to a PSTN switching centre at 64 kbps through a fixed line network– mapped by assigning a 16 kbps channel for 64 kbps signals and vice versa

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Important functions performed by the BSC

- Reserving radio frequencies
- Frequency hopping (For example, multiple BTSs operate simultaneously by using the different frequencies at a given instant

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Important functions performed by the BSC

- Traffic control by continuous measurement of the frequency channel spectrum being used at a given instant
- Authentication, encryption, and decryption of data
- Updating location registry for the MSs
- Paging

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Network subsystem (NSS)

- Acts as an interface between wireless and fixed networks
- Mainly consists of switches and databases and manages functions such as handovers between BSS's, worldwide user localization, maintenance of user accounts and call charges, and management of roaming
- The interface between the NSS components and the AuC and the OMC in the OSS

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NSS

- Consists of *l* mobile services switching centres (MSC), *m* and *n* home and visitor location registers, gateway MSCs (GMSC), and inter-working functions (IWFs) with the mobile switching centres
- GMSCs and IWFs connect to the other networks (for example, PSTN, ISDN, or PSPDN)

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Basic connections and components in the NSS

- Each MSC in the NSS can manage several base station systems
- Every MSC has a home location register (HLR) and a visitor location register (VLR)
- An MSC can connect to another MSC, GMSC, and IWF

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Basic connections and components in the NSS

- An HLR connects to an AUC in the OSS.
- A GMSC can connect to an OMC in the OSS.
- GMSCs– also used to connect to a PSTN, ISDN, or PSPDN network

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Mobile services switching centre (MSC)

- Consists mainly of high-performance digital ISDN switches
- Connects to a number of BSCs over the *A* interface
- Connect to other MSCs and to fixed-line networks through GMSCs
- Used to manage BSCs in a geographical area

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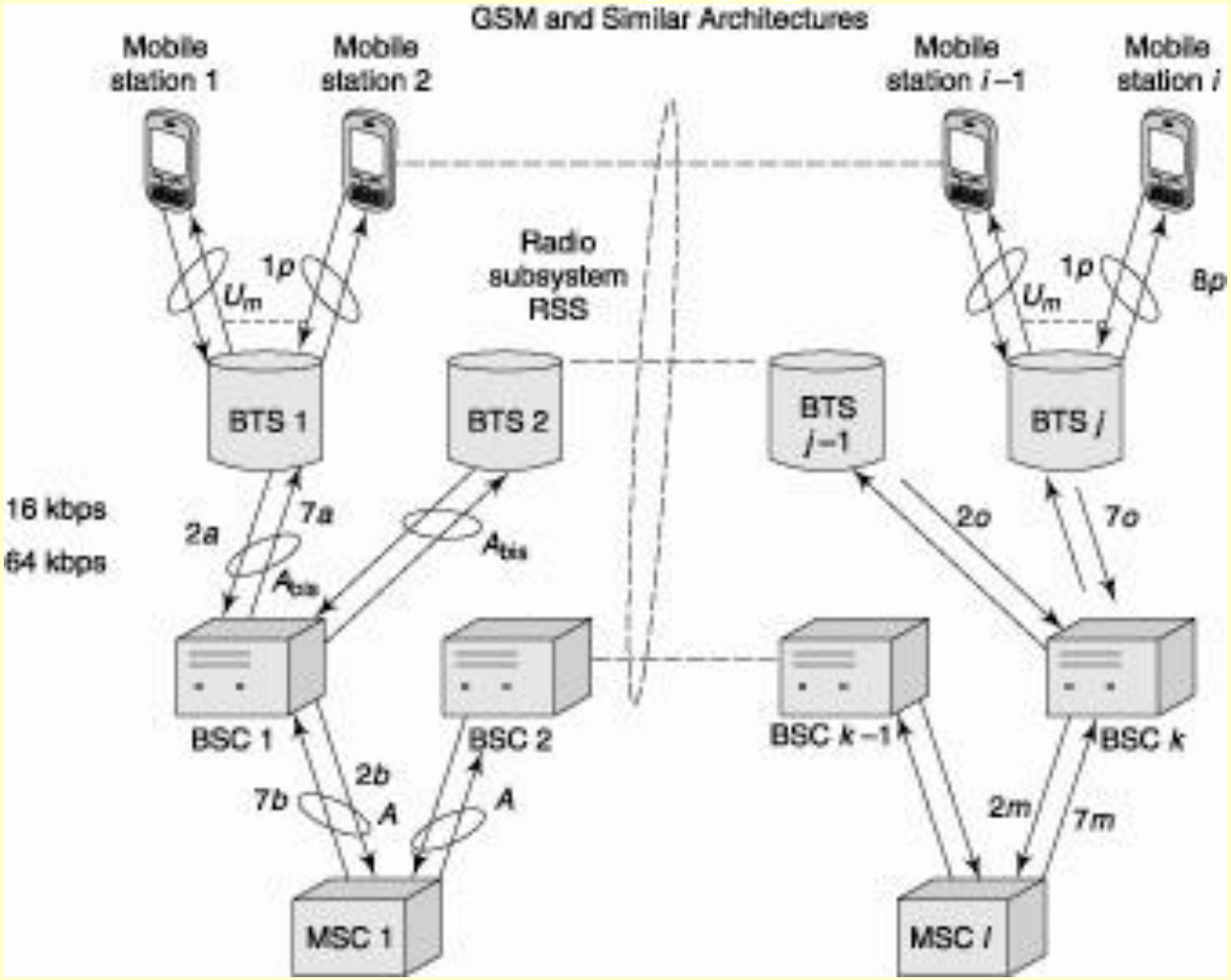
Interfaces in the RSS subsystem between MSC (in the NSS) and the BSCs



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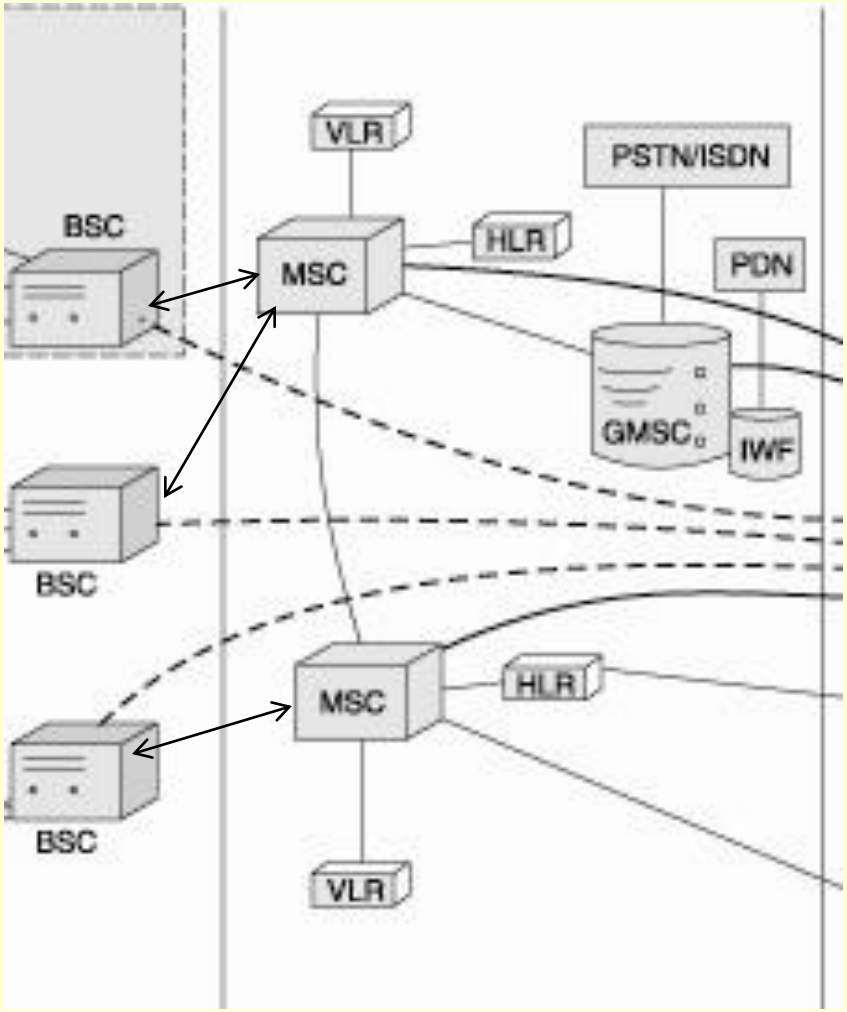
NSS



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NSS

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- Visitor location registers (VLR)

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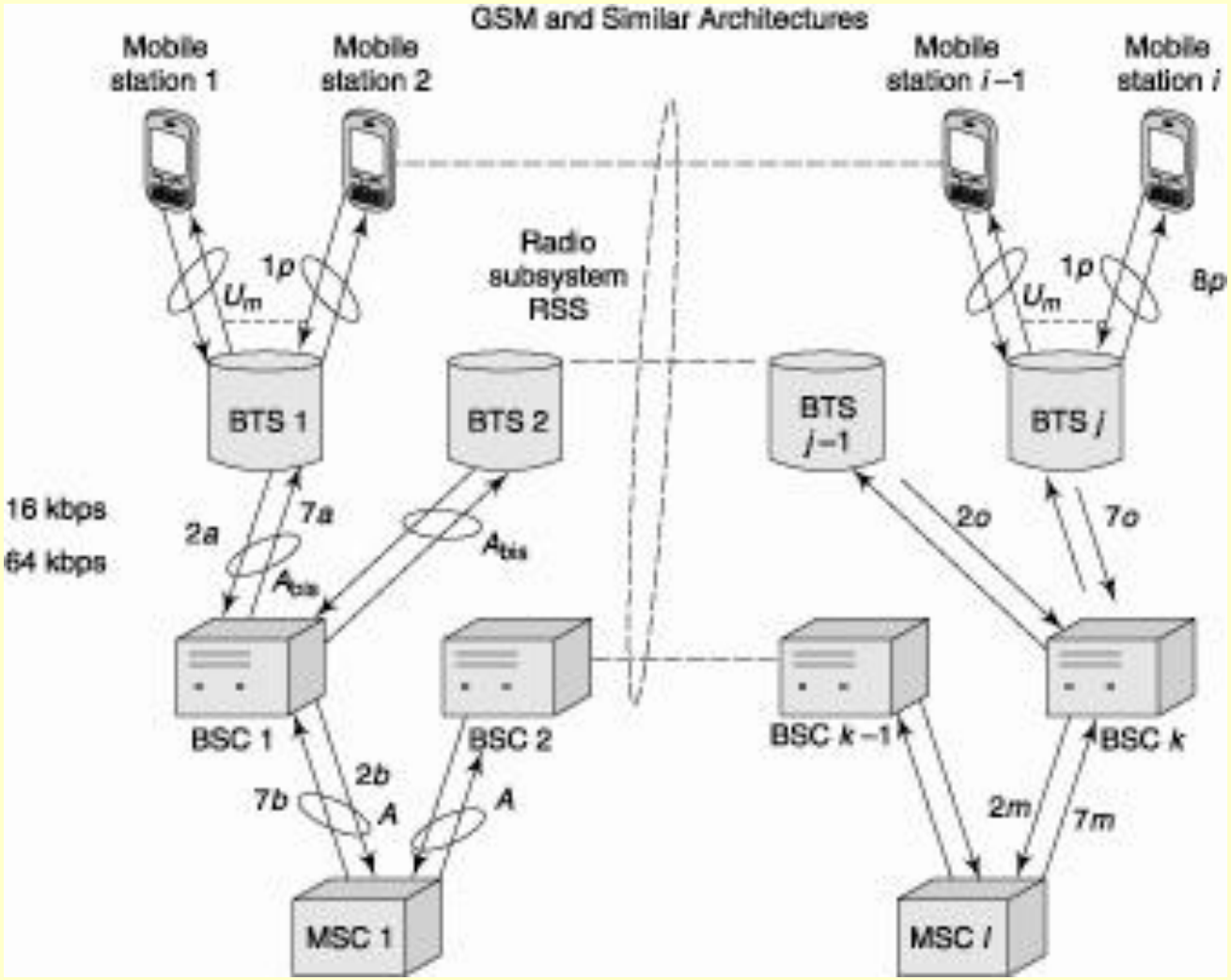
Interfaces between MSC and BSCs



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Functions performed by an MSC

- Processing of signals
- Establishing and terminating the connection between various mobile stations via BSCs
- The mobile stations to be connected may fall in a given MSCs own area or in the area assigned to another MSC, in which case the communication path has to be via the other MSC

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Functions performed by an MSC

- Establishing and terminating the connection between an MS and a fixed line phone via a GMSC or IWF
- Monitoring of calls made to and from an MS
- Call charging, multi-way calling, call forwarding, and other supplementary services

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Gateway Mobile Services Switching Centre

- A special node which handles connections to other fixed networks
- These other networks may be ISDN, PSTN, PSPDN, or other PLMN networks
- Special IWFs may be used by a GMSC to connect to public data networks such as the X.25

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Visitor Location Register at Each MSC

- A dynamic real-time database that stores both permanent and temporary subscriber data which is required for communication between the MSs in the coverage area of the MSC associated with that VLR. The VLR is an integral part of the MSC

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Home Location Register

- Has the MT databases
- Stores all the relevant subscriber data including mobile subscriber ISDN number (MSISDN), details of subscription permissions such as call forwarding, roaming, etc., subscriber's ISMI, user's location area, user's current VLR and MSC status

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HLR

- . Each mobile user has only one HLR record worldwide, which is updated constantly on a real-time basis
- Each MS must register at a specific HLR of a specific MSC
- The HLR contacts AuC in the OSS for authentication

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HLR

- Each HLR is associated to an MSC so that when an MS registered at a certain HLR moves to another location area (LA), serviced by another MSC, the user's home MSC update the user's current VLR

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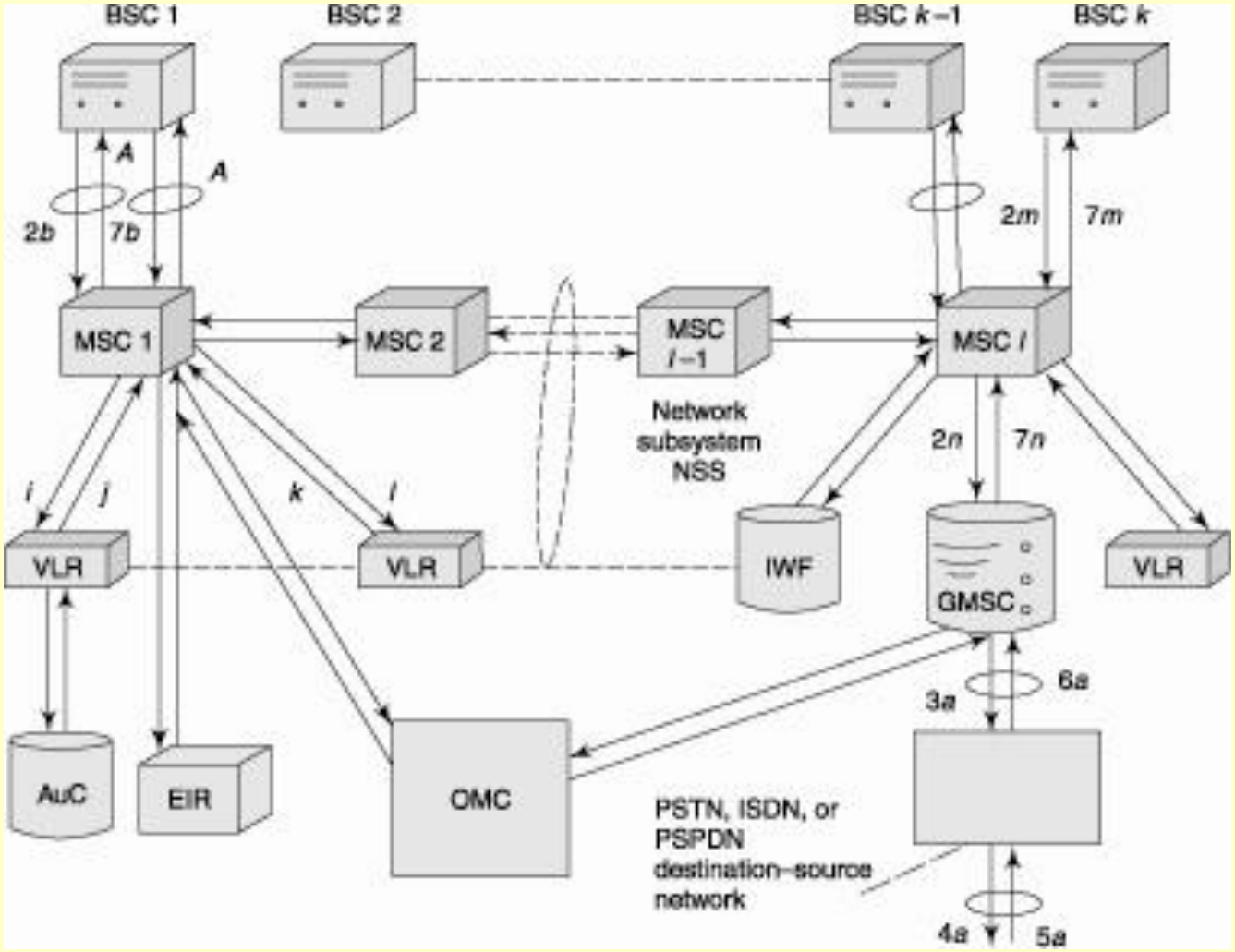
Interfaces in the NSS between MSC, BSCs, VLR, and OMC



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Operation subsystem (OSS)

- Administers the operation and maintenance of the entire network
- Each AuC associates with an HLR in the NSS and each EIR connects to an MSC
- An OMC at OSS can connect to an MSC or a GMSC in the NSS and to a BSC at RSS

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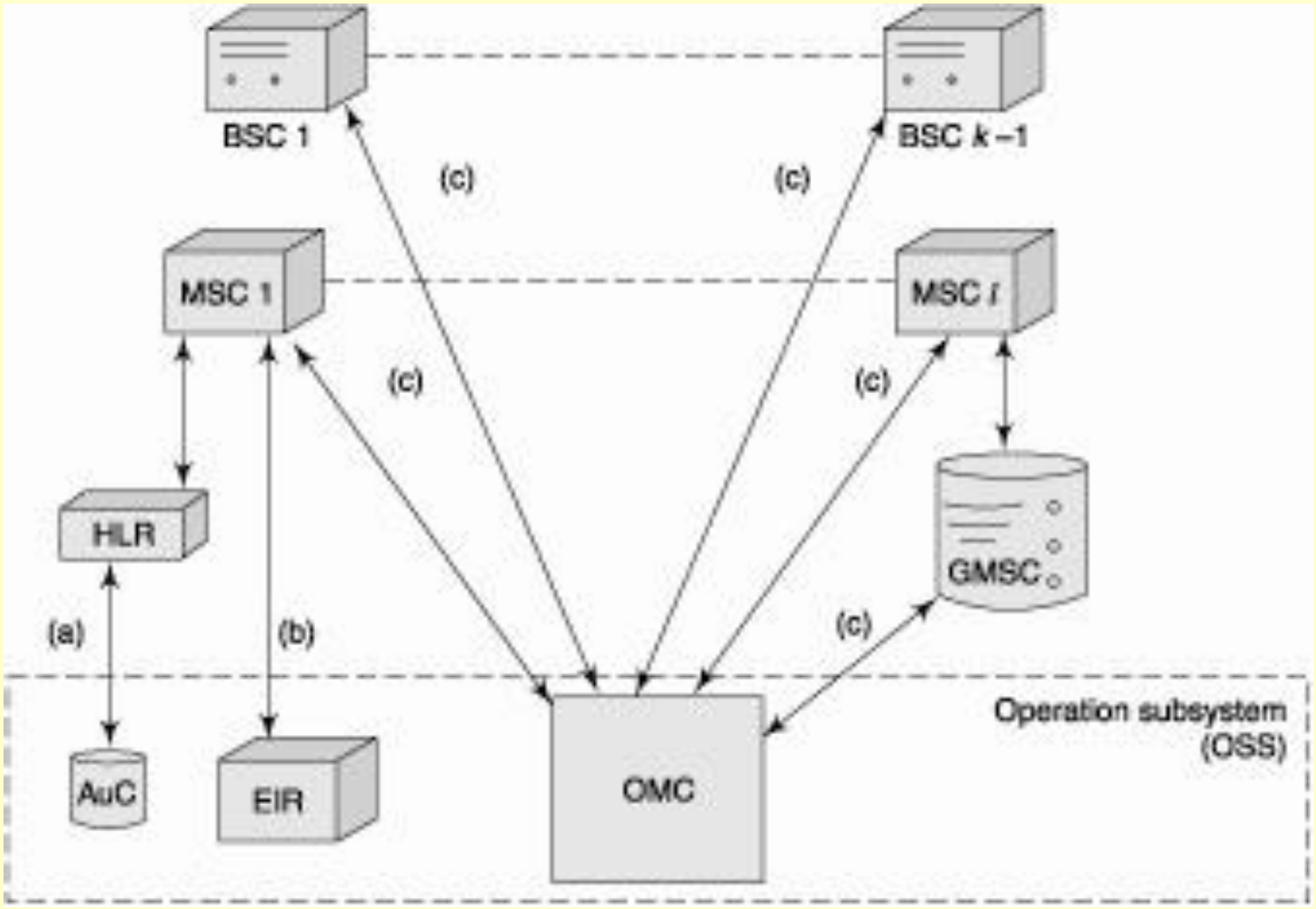
Interfaces between AuC, HLR, EIR and MSC, OMC, BSC, and GMSC



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Operation and Maintenance Centre

- Monitors and controls all other network entities through the *O* interface

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OMC FUNCTIONS

- Management of status reports
- Traffic monitoring
- Subscriber security management
- Accounting and billing

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Authentication Centre

- AuC calculation of authentication parameters and then conveying these to the HLR
- Used by the HLR to authenticate a user
- The AuC may also be a secured partitioned part of the HLR itself

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Authentication Centre

- Since mobile networks quite vulnerable to attacks, the GSM standard specifies that the algorithms for key generation should be separated out as an OSS network entity. This entity is the AuC

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AuC database

- Stores subscriber authentication keys

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The equipment identity register (EIR)

- Stores the international mobile equipment identity (IMEI) numbers for the entire network
- IMEI enables the MSC in identifying the type of terminal, mobile equipment manufacturer, and model and helps the network in locating the device in case it is stolen or misplaced

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EIR three lists

- A *black list* that includes mobile stations which have been reported stolen or are currently locked due to some reason.
- A *white list* which records all MSs that are valid and operating.
- A *grey list* including all those MSs that may not be functioning properly.

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Summary

- Data dissemination from server to mobile systems
- Data synchronization between one to one or one to many or many to many
- Radio subsystem (RSS)
- Network subsystem (NSS)
- Operation subsystem (OSS)
- Mobility Management

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End of Lesson 04

GSM System Architecture

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