


 Marmara University, 2021

Wireless and Mobile Networks


Subject 8
Basics of GSM

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Associate Professor


 Contents

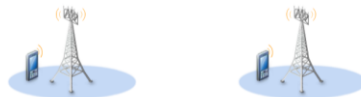
- GSM Systems
- GSM Architecture
- GSM Channels
- Call Processing in a GSM System
- GSM Security

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 INTRODUCTION

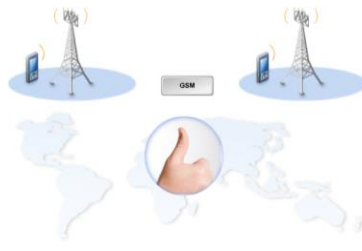
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 Introduction




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 Introduction



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 GSM SYSTEMS

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Global System for Mobile Communication (GSM)



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Global System for Mobile Communication (GSM)



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Global System for Mobile Communication (GSM)



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Global System for Mobile Communication (GSM)



Global roaming is a reality because of GSM

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Global System for Mobile Communication (GSM)



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Global System for Mobile Communication (GSM)



Services offered by GSM networks:

- SMS
- Call waiting
- Calling number identification

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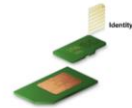
The Subscriber Identity Module (SIM) Card



Subscriber Identity Module

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The Subscriber Identity Module (SIM) Card



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The Subscriber Identity Module (SIM) Card



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The Subscriber Identity Module (SIM) Card



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The Subscriber Identity Module (SIM) Card



Re - Usable Identification Module

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International Mobile Equipment Identity (IMEI) Key



International Mobile Equipment Identity

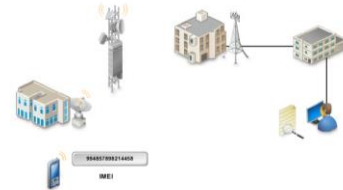
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International Mobile Equipment Identity (IMEI) Key



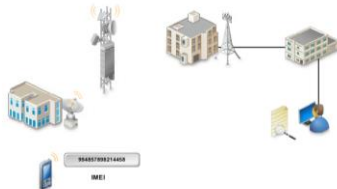
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International Mobile Equipment Identity (IMEI) Key



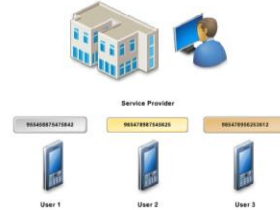
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International Mobile Equipment Identity (IMEI) Key



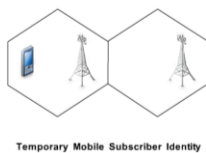
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International Mobile Subscriber Identity (IMSI) Key



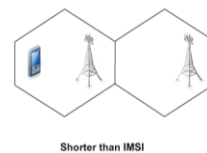
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Temporary Mobile Subscriber Identity (TMSI) Key



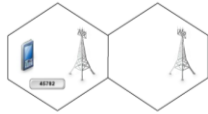
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Temporary Mobile Subscriber Identity (TMSI) Key



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Temporary Mobile Subscriber Identity (TMSI) Key



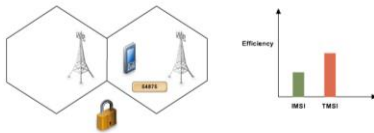
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Temporary Mobile Subscriber Identity (TMSI) Key



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Temporary Mobile Subscriber Identity (TMSI) Key

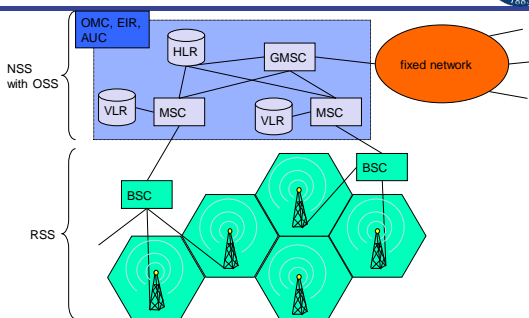


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GSM ARCHITECTURE

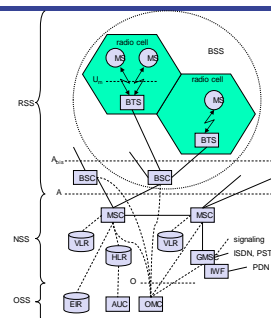
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GSM Architecture



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GSM Architecture



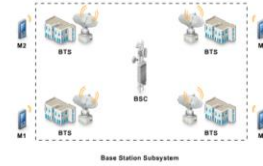
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Base Station Subsystem (BSS)



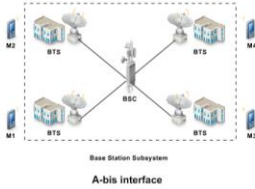
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Base Station Subsystem (BSS)



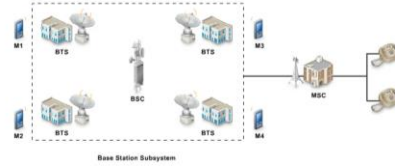
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Base Station Subsystem (BSS)



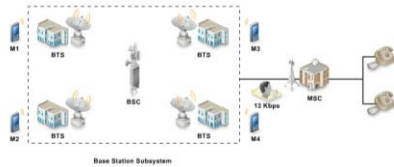
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Base Station Subsystem (BSS)



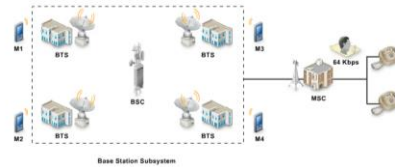
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Base Station Subsystem (BSS)



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Base Station Subsystem (BSS)



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Home Location Register (HLR)



Home Location Register

permanent data

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Home Location Register (HLR)



Special services such as:

- Call forwarding
- Caller identification

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Visitor Location Register (VLR)



Visitor Location Register

temporary data

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Visitor Location Register (VLR)



V L R

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Visitor Location Register (VLR)



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Visitor Location Register (VLR)



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Authentication Center (AuC)



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Authentication Center (AuC)



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Authentication Center (AuC)



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Authentication Center (AuC)



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Authentication Center (AuC)



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Equipment Identity Register (EIR)



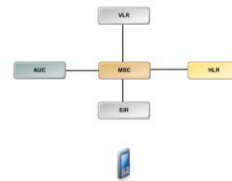
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Equipment Identity Register (EIR)



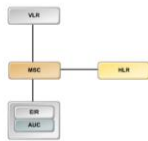
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Equipment Identity Register (EIR)



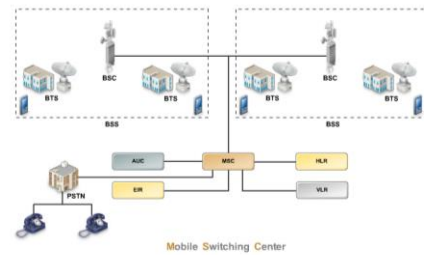
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Equipment Identity Register (EIR)



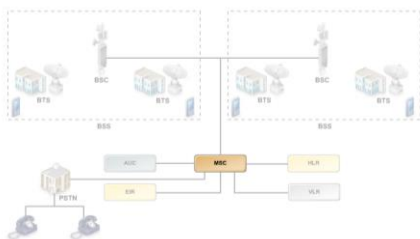
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GSM Mobile Switching Center (MSC)



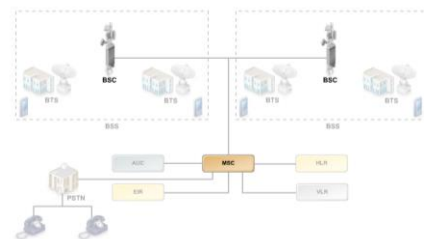
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GSM Mobile Switching Center (MSC)



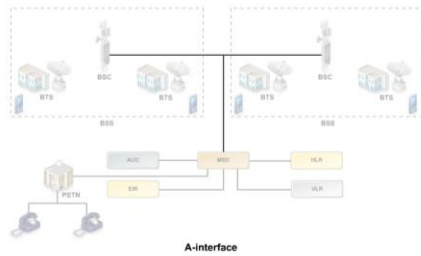
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GSM Mobile Switching Center (MSC)



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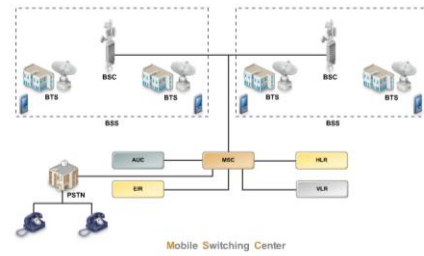
GSM Mobile Switching Center (MSC)



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GSM Mobile Switching Center (MSC)



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GSM CHANNELS

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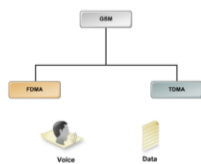
GSM Access Scheme and Channel Structure



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GSM Access Scheme and Channel Structure



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GSM Access Scheme and Channel Structure



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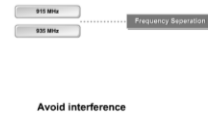
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GSM Access Scheme and Channel Structure



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GSM Access Scheme and Channel Structure



Avoid interference

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GSM Access Scheme and Channel Structure



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GSM Access Scheme and Channel Structure



Setup and manage calls

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GSM Access Scheme and Channel Structure



Voice traffic

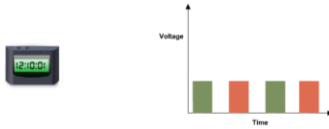
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GSM Access Scheme and Channel Structure



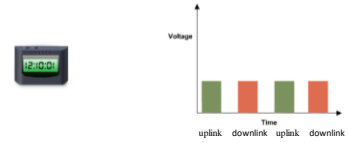
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GSM Access Scheme and Channel Structure



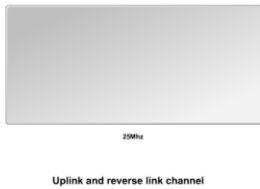
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GSM Access Scheme and Channel Structure



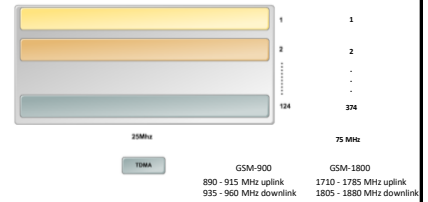
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GSM Access Scheme and Channel Structure



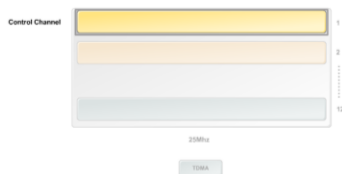
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GSM Access Scheme and Channel Structure



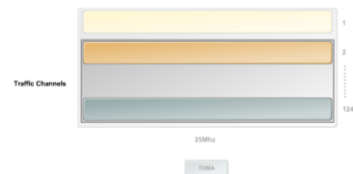
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GSM Access Scheme and Channel Structure



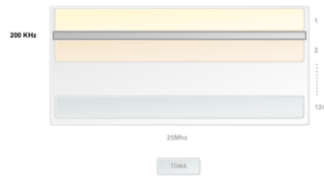
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GSM Access Scheme and Channel Structure



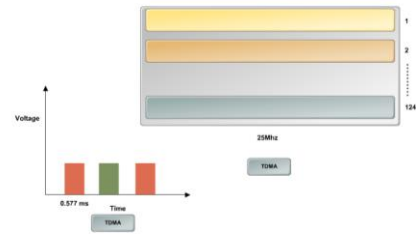
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GSM Access Scheme and Channel Structure



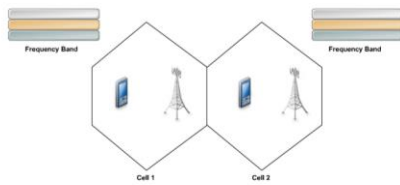
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GSM Access Scheme and Channel Structure



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GSM Control Channel



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GSM Control Channel



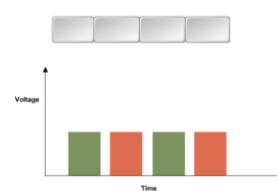
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GSM Control Channel



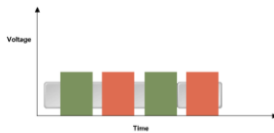
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GSM Control Channel



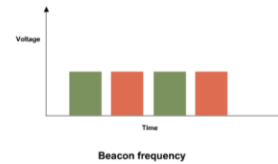
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GSM Control Channel



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GSM Control Channel



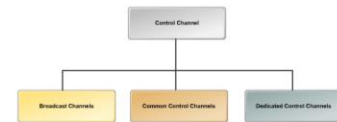
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GSM Control Channel



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GSM Control Channel



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Broadcast Channels

used for initial synchronization between the BTS and cell phone

Broadcast Channel	Description
Frequency Correction Channel (FCCH)	
Synchronization Channel (SCH)	
Broadcast Control Channel (BCCH)	

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Broadcast Channels

Broadcast Channel	Description
Frequency Correction Channel (FCCH)	The first logical part of the control channel. A series of 148 zeros are transmitted from the BTS in this channel. Once modulated, this sequence is equivalent to approximately 67 KHz. A cell phone scans for this frequency and adjusts its own frequency to that of the network. This tone is used to synchronize the local clock of the mobile receiver with the base station. This is needed to correctly extract the data.
Synchronization Channel (SCH)	[142 consecutive zeros], resulting in constant frequency signal being transmitted for 577 microseconds and enabling Mobile Stations to use it in order to correct their frequency offset during this period.
Broadcast Control Channel (BCCH)	<ul style="list-style-type: none"> 3 tail bits allowing the transmitter to power up. 57 coded data bits 1 bit framing flag 26 bits training sequence for synchronization and training of the adaptive equalizer 1 bit framing flag 57 coded data bits 3 tail bits

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Broadcast Channels



Broadcast Channel	Description
Frequency Correction Channel (FCCH)	Contains the BTS identification and location information. The SCH follows the FCCH and is transmitted by the BTS in the downlink channel.
Synchronization Channel (SCH)	The SCH carries the information to enable the MS to synchronize to the TDMA frame structure and know the timing of the individual timeslots. The following parameters are sent: <ul style="list-style-type: none"> • Frame number. • Base Site Identity Code (BSIC). The MS will monitor BCCH information from surrounding cells and store the information from the best six cells. The SCH information on these cells is also stored so that the MS may quickly resynchronize when it enters a new cell.
Broadcast Control Channel (BCCH)	

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Broadcast Channels



Broadcast Channel	Description
Frequency Correction Channel (FCCH)	Contains the frequency allocation information required by the cell phones to set up and receive calls. The BCCH is continuously broadcast by the BTS on the downlink channel.
Synchronization Channel (SCH)	<ul style="list-style-type: none"> • Location Area Identity (LAI). • List of neighboring cells that should be monitored by the MS. • List of frequencies used in the cell. • Cell identity. • Power control indicator. • DTX permitted. • Access control (i.e., emergency calls, call barring ... etc.). • CBCH description
Broadcast Control Channel (BCCH)	BCCH is transmitted at constant power at all times, and all MS that may seek to use it to measure its signal strength

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Common Control Channels



used by the BTS and the cell phone for call initiation

Common Control Channel	Description
Paging Channel (PCH)	
Random Access Channel (RACH)	
Access Grant Channel (AGCH)	

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Common Control Channels



used by the BTS and the cell phone for call initiation

Common Control Channel	Description
Paging Channel (PCH)	Used when there is an incoming call for a cell phone. The BTS uses this channel to inform the cell phone about the incoming call. The PCH channel is monitored by the cell phones periodically.
Random Access Channel (RACH)	
Access Grant Channel (AGCH)	

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Common Control Channels



used by the BTS and the cell phone for call initiation

Common Control Channel	Description
Paging Channel (PCH)	Located within the uplink channel and used when a cell phone initiates a call. The cell phone uses the channel as and when required.
Random Access Channel (RACH)	There is a possibility that two cell phones initiating a call at the same time try to access the RACH at the same time, thus causing interference. In such a situation, both the cell phones wait for a random period of time before re-accessing the network. Once the cell phone correctly accesses the network, the BTS sends an acknowledgment message.
Access Grant Channel (AGCH)	

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Common Control Channels



used by the BTS and the cell phone for call initiation

Common Control Channel	Description
Paging Channel (PCH)	Channel used to set up a call. Once the cell phone has used the PCH or the RACH to receive or initiate a call, the cell phone uses the AGCH to communicate with the BTS.
Random Access Channel (RACH)	Used by the BTS to assign a dedicated control channel to a MS in response to an access message received on the Random Access Channel. The MS will move to the dedicated channel in order to proceed with either a call setup, response to a paging message, Location Area Update or Short Message Service
Access Grant Channel (AGCH)	

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Dedicated Control Channels



used to manage calls

Dedicated Control Channel	Description
Standalone Dedicated Control Channel (SDCCH)	
Slow Associated Control Channel (SACCH)	
Fast Associated Control Channel (FACCH)	

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Dedicated Control Channels



used to manage calls

Dedicated Control Channel	Description
Standalone Dedicated Control Channel (SDCCH)	Used along with the SACCH to send and receive messages. They also relay signaling information.
Slow Associated Control Channel (SACCH)	
Fast Associated Control Channel (FACCH)	

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Dedicated Control Channels



used to manage calls

Dedicated Control Channel	Description
Standalone Dedicated Control Channel (SDCCH)	Used for both uplink and downlink transmissions. On the downlink, the BTS broadcasts messages of the beacon frequencies of neighboring cells to the cell phones. On the uplink, the BTS receives acknowledgement messages from the cell phone.
Slow Associated Control Channel (SACCH)	
Fast Associated Control Channel (FACCH)	

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Dedicated Control Channels

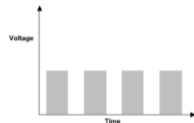


used to manage calls

Dedicated Control Channel	Description
Standalone Dedicated Control Channel (SDCCH)	Used to transmit unscheduled urgent messages. FACCH is faster than the SDCCH as it can carry up to 50 messages per second, whereas the SDCCH can carry only 4 messages per second.
Slow Associated Control Channel (SACCH)	
Fast Associated Control Channel (FACCH)	

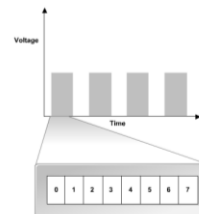
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Traffic Channel



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Traffic Channel



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Traffic Channel

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Traffic Channel

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Traffic Channel

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Traffic Channel

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Traffic Channel

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CALL PROCESSING in a GSM SYSTEM

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Process of Initializing a Call in a GSM Network



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Process of Initializing a Call in a GSM Network



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Process of Initializing a Call in a GSM Network



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Process of Initializing a Call in a GSM Network



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Process of Initializing a Call in a GSM Network



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Process of Initializing a Call in a GSM Network



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Process of Initializing a Call in a GSM Network



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Process of Initializing a Call in a GSM Network



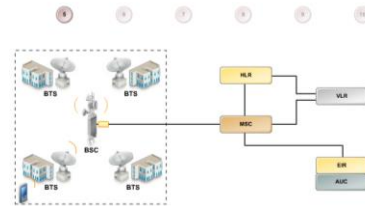
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Process of Initializing a Call in a GSM Network



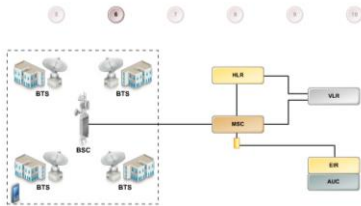
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Process of Initializing a Call in a GSM Network



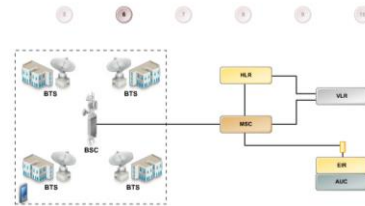
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Process of Initializing a Call in a GSM Network



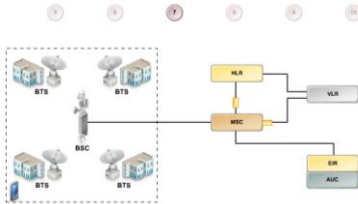
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Process of Initializing a Call in a GSM Network



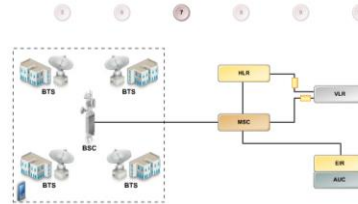
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Process of Initializing a Call in a GSM Network



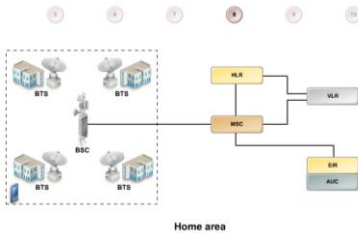
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Process of Initializing a Call in a GSM Network



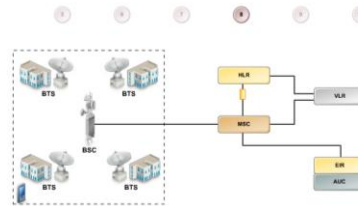
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Process of Initializing a Call in a GSM Network



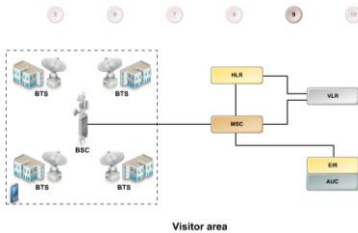
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Process of Initializing a Call in a GSM Network



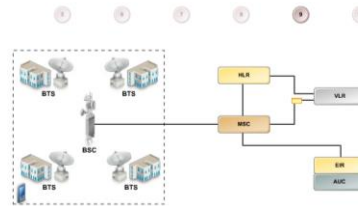
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Process of Initializing a Call in a GSM Network



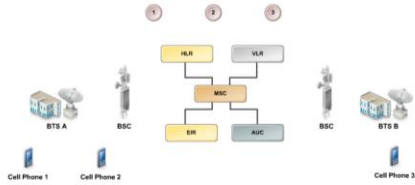
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Process of Initializing a Call in a GSM Network



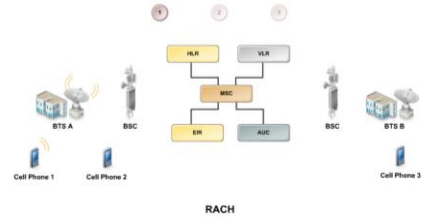
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Process of Making a Call in a GSM Network



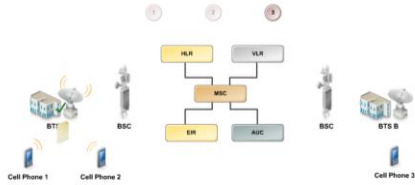
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Process of Making a Call in a GSM Network



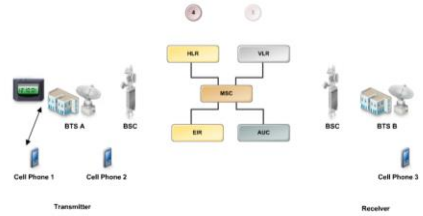
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Process of Making a Call in a GSM Network



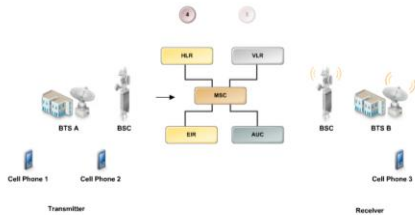
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Process of Making a Call in a GSM Network



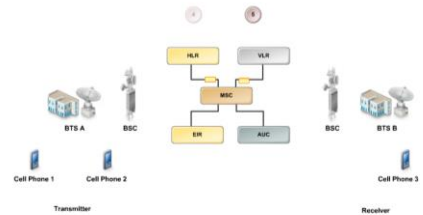
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Process of Making a Call in a GSM Network



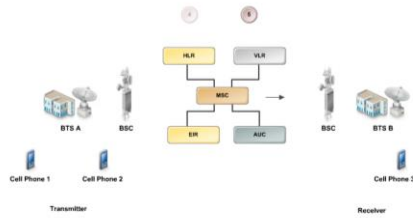
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Process of Making a Call in a GSM Network



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Process of Making a Call in a GSM Network



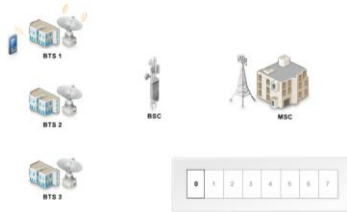
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Mobile-Assisted Handover (MAHO)



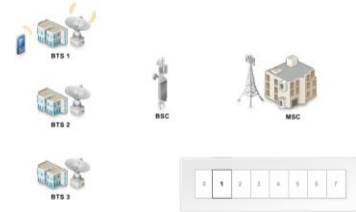
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Mobile-Assisted Handover (MAHO)



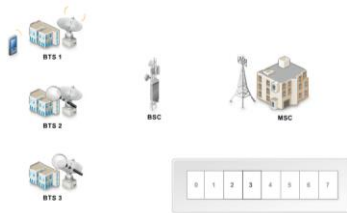
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Mobile-Assisted Handover (MAHO)



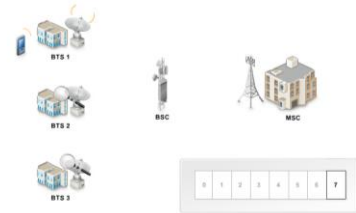
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Mobile-Assisted Handover (MAHO)



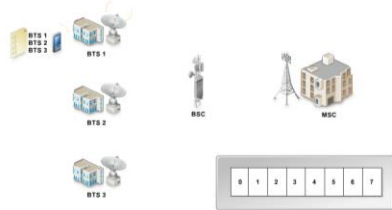
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Mobile-Assisted Handover (MAHO)



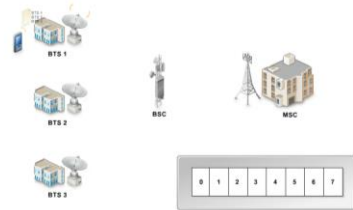
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Mobile-Assisted Handover (MAHO)



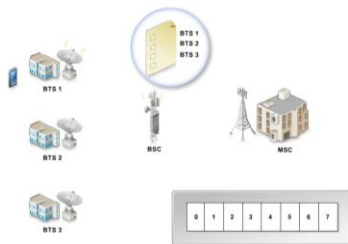
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Mobile-Assisted Handover (MAHO)



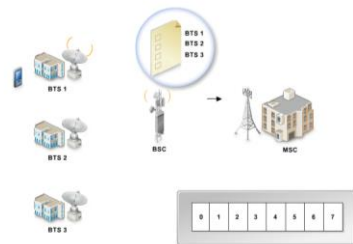
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Mobile-Assisted Handover (MAHO)



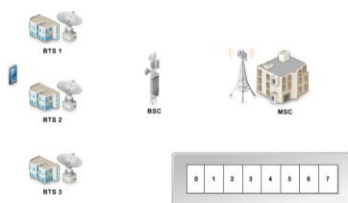
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Mobile-Assisted Handover (MAHO)



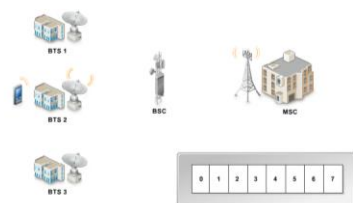
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Mobile-Assisted Handover (MAHO)



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Mobile-Assisted Handover (MAHO)



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GSM SECURITY

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Security in GSM

- Security services
 - access control/authentication
 - user \leftrightarrow SIM (Subscriber Identity Module): secret PIN (personal identification number)
 - SIM \leftrightarrow network: challenge response method
 - confidentiality
 - voice and signaling encrypted on the wireless link (after successful authentication)
 - anonymity
 - temporary identity TMSI (Temporary Mobile Subscriber Identity)
 - newly assigned at each new location update (LUP)
 - encrypted transmission
- 3 algorithms specified in GSM
 - A3 for authentication ("secret", open interface)
 - A5 for encryption (standardized)
 - A8 for key generation ("secret", open interface)

"secret":
• A3 and A8 available via the Internet
• network providers can use stronger mechanisms

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Personal Identification Number (PIN)



Personal Identification Number

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Personal Identification Number (PIN)



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Personal Identification Number (PIN)



Personal Unblocking Key

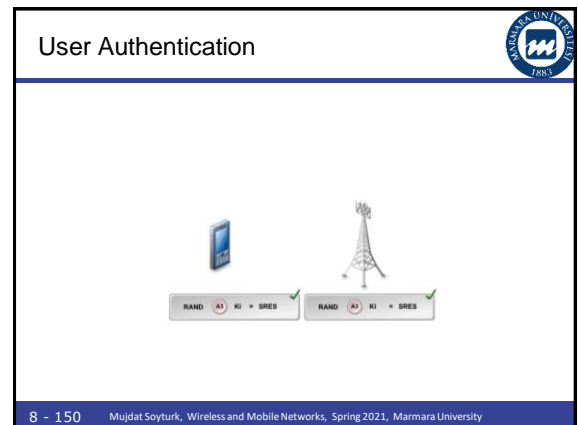
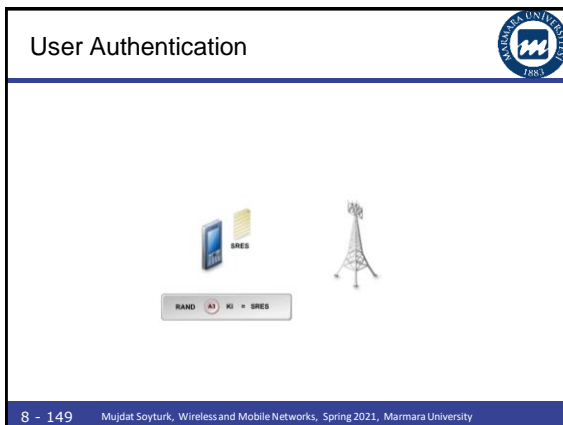
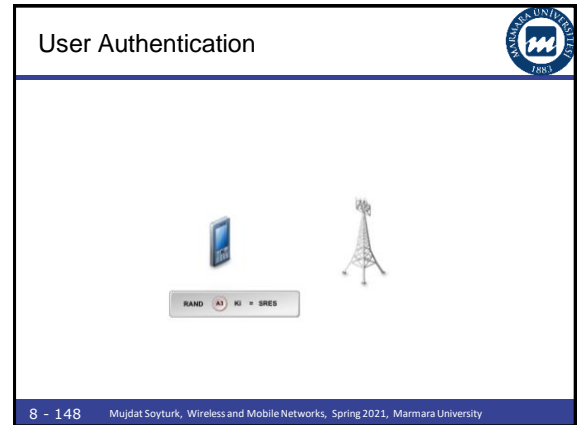
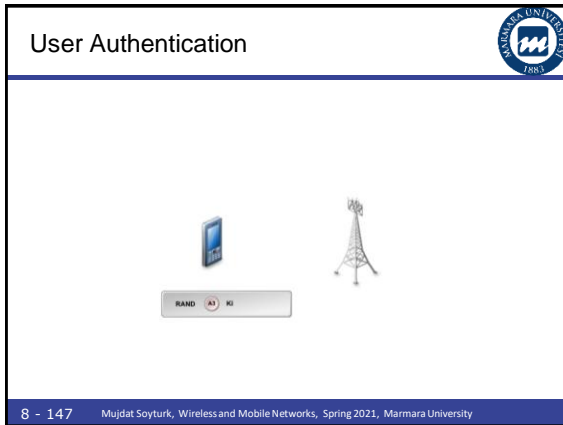
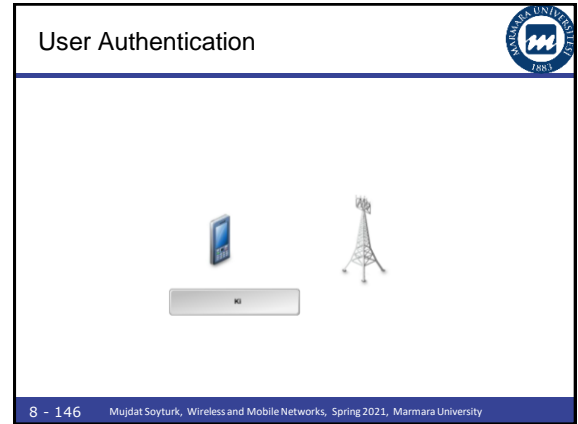
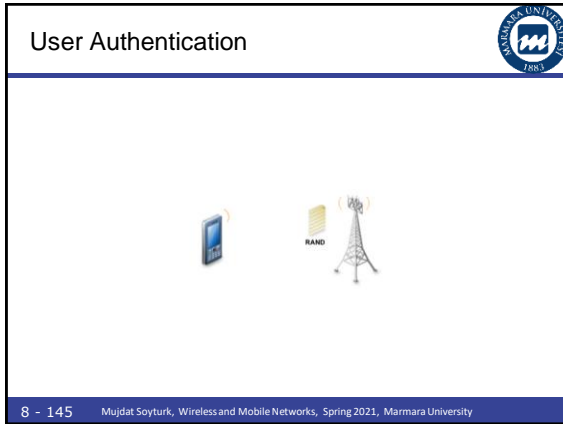
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Personal Identification Number (PIN)

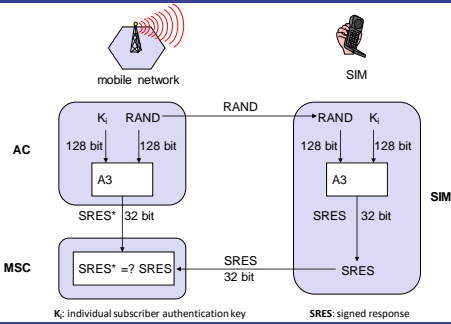


Security measure
is in the cell phone

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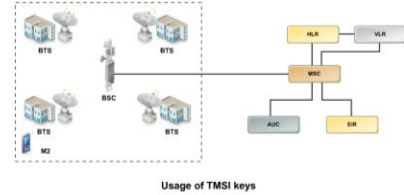


GSM - authentication



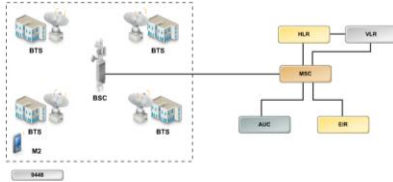
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TMSI-Based Security



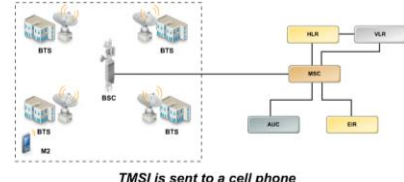
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TMSI-Based Security



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TMSI-Based Security



*TMSI is sent to a cell phone
after the authentication process*

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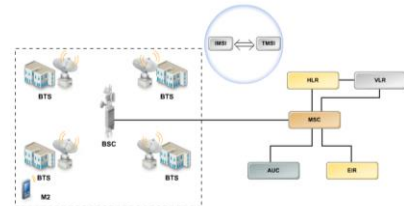
TMSI-Based Security



- TMSI key:**
- Keeps changing according to the location of the cell phone
 - Prevents unauthorized access of channel
 - Prevents intruder from tracing location
 - Enhances security of GSM network

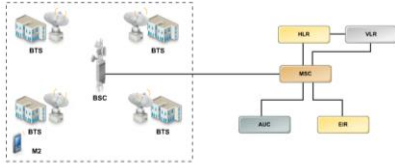
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TMSI-Based Security



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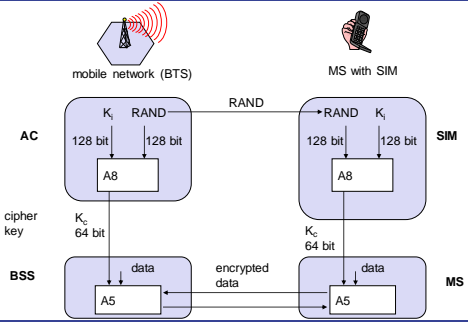
TMSI-Based Security



*IMSI key used only when
SIM is used for the first time*

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GSM - key generation and encryption



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