
 Marmara University, 2021

Wireless and Mobile Networks


Subject 7
Cellular Communication

Mujdat Soyuturk, Ph.D.
Associate Professor


 Contents


- Basic Cellular Concepts
- Cellular Network Components
- Call Processing in a Basic Cellular Network

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 INTRODUCTION


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 Introduction




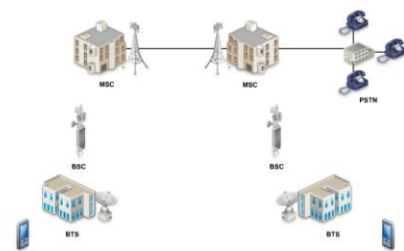
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 Introduction



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 Introduction



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EVOLUTION OF CELLULAR COMMUNICATION

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Evolution of Cellular Communication



Wireless Telegraph

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Evolution of Cellular Communication



Wireless Telegraph



Radio Technology



Transistor Technology

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Evolution of Cellular Communication



Cellular Technology

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Evolution of Cellular Communication



*US military first used
radio communication*

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Evolution of Cellular Communication

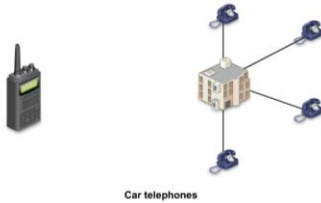


*AT&T introduced two-way radios
for commercial services*

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Evolution of Cellular Communication



Car telephones

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Evolution of Cellular Communication



First commercial CC system in 1979 by the Nordic Mobile Telephone (NMT)

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Evolution of Cellular Communication



Wireless Telegraph

Walkie Talkie

Cordless Phone

Cell Phone

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Cellular Network Generations



Cellular System Generation	Description
1G (first generation)	
2G (second generation)	
3G (third generation)	

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Cellular Network Generations



Cellular System Generation	Description
1G (first generation)	Voice-oriented systems based on analog technology. The Advanced Mobile Phone Service (AMPS) and cordless systems are considered first-generation systems.
2G (second generation)	
3G (third generation)	

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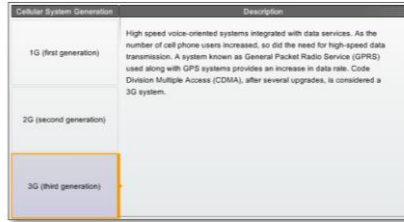
Cellular Network Generations



Cellular System Generation	Description
1G (first generation)	Voice-oriented systems based on digital technology. The Global System for Mobile (GSM) and US Time Division Multiple Access (US-TDMA) are considered second-generation systems. 2G systems were more efficient and used less spectrum as compared to 1G systems.
2G (second generation)	
3G (third generation)	

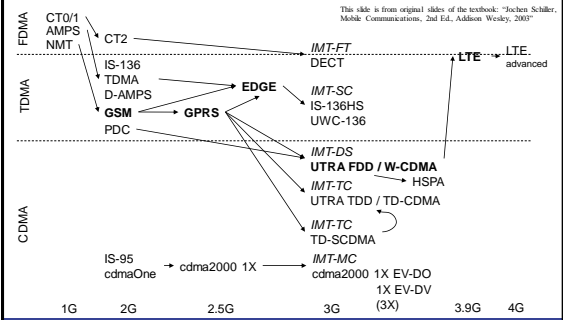
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Cellular Network Generations



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Cellular Network Generations



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BASIC CELLULAR CONCEPTS

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Frequency Reuse



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Frequency Reuse



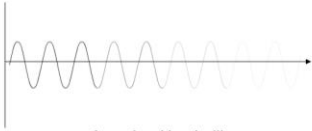
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Frequency Reuse



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Frequency Reuse



*Low signal level will
not cause interference*

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Frequency Reuse



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Frequency Reuse

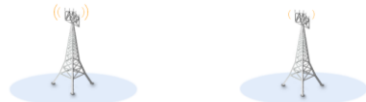


Specific frequency range

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Frequency Reuse



Same frequency range

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Cell



Basic geographical unit

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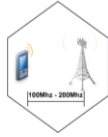
Cell



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Cell



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Cell



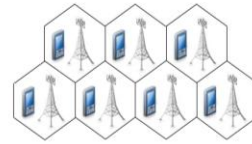
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Cell



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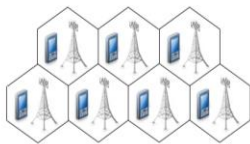
Cell Cluster



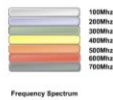
Cell Cluster

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Cell Cluster



Cell Cluster

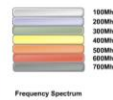


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Cell Cluster

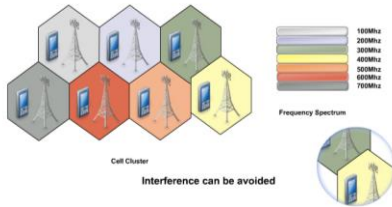


Cell Cluster



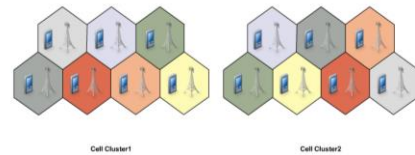
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Cell Cluster



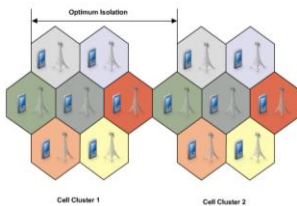
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Cell Cluster



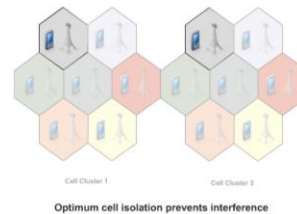
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Cell Cluster



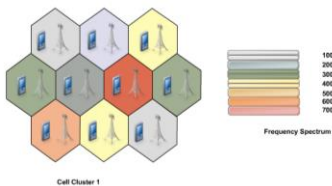
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Cell Cluster



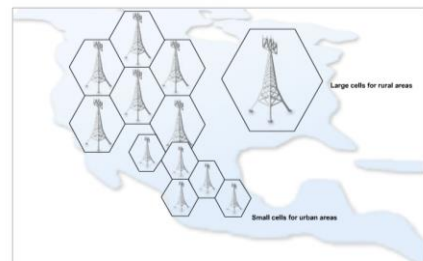
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Cell Cluster



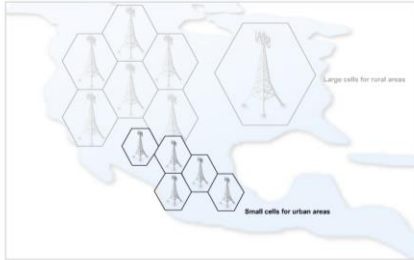
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Cell Splitting



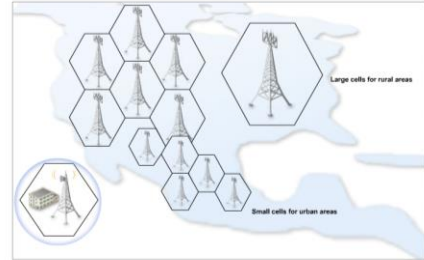
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Cell Splitting



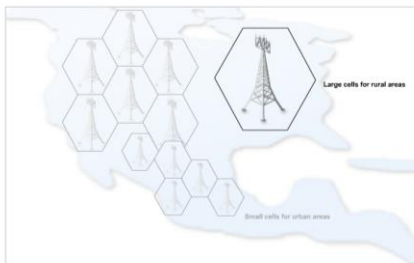
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Cell Splitting



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Cell Splitting



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Cell Types



Cell Type	Description
Macrocell	
Microcell	
Picocell	

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Cell Types



Cell Type	Description
Macrocell	Large cells used in remote areas. These cells are typically six miles in diameter and are located in sparsely populated areas. High-power transmitters and receivers are used in macrocells since their coverage area is large.
Microcell	
Picocell	

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Cell Types



Cell Type	Description
Macrocell	
Microcell	Small cells used in urban areas. These cells are typically half-a-mile in diameter and are located in densely populated areas. Low-power transmitters and receivers are used in microcells to avoid interference with signals from adjoining cell clusters.
Picocell	

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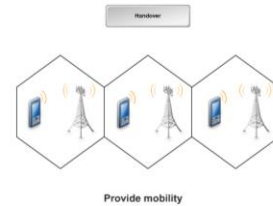
Cell Types



Cell Type	Description
Macrocell	Smaller cells as compared to microcells, used to cover areas such as a building or tunnel. As in microcells, very low-power transmitters are used, and the antennas are positioned in such a way as to not cover large areas.
Microcell	
Picocell	

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Handover



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Handover



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Handover



- The **cellular system** needs to **decide**:
- the exact **time** of the handover, and also
 - the **cell** to which the call has **to be transferred**

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Roaming



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Roaming



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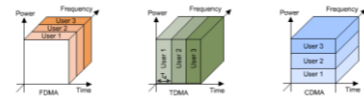
Roaming



Subscriber pays an extra charge to avail roaming facility

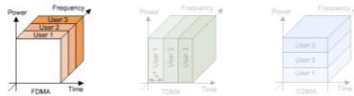
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Multiple Access Schemes



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Multiple Access Schemes

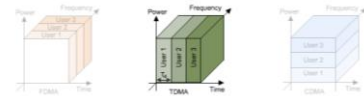


Frequency Division Multiple Access (FDMA)

In this scheme, when a subscriber enters the coverage area or moves from one cell to another, a frequency is allocated to the subscriber. Therefore, each subscriber is allocated a unique frequency, allowing him or her access to the network. This scheme was used in analog systems.

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Multiple Access Schemes

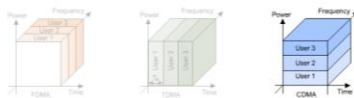


Time Division Multiple Access (TDMA)

This scheme is used in digital systems. In this scheme, digitized speech is sent in short bursts of data. Each subscriber is assigned a time slot to send or receive the data burst. Each subscriber will access the network only in the time slot assigned to him or her. Therefore, this system allows only a certain number of subscribers to use the system using a given frequency range. To use other frequency ranges as well, FDMA is also used along with TDMA.

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Multiple Access Schemes



Code Division Multiple Access (CDMA)

In this scheme, each subscriber gains access to the network based on code allocated to him or her. A code is assigned to the signal received from each subscriber. This code is multiplied with the signal received from the subscriber and transmitted. The same code is used at the receiver end to decode the signal. Therefore, at the receiver, signals using different codes are differentiated and ignored.

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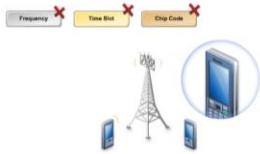
Control Channels



Control channel

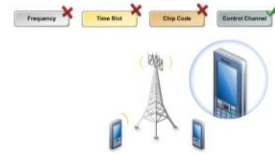
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Control Channels



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Control Channels



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Cellular Services



Various services offered

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Cellular Services



Short Messaging Service

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Cellular Services



Multimedia Messaging Service

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Cellular Services



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Cellular Services



Global Positioning System

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Cellular Services



Wireless Application Protocol

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CELLULAR NETWORK
COMPONENTS

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Base Transceiver Station (BTS)



Base Transceiver Station

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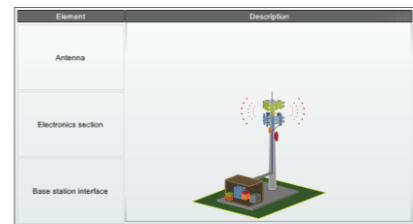
Base Transceiver Station (BTS)



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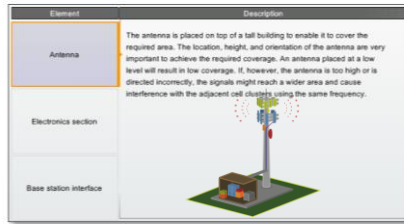
Base Transceiver Station (BTS)



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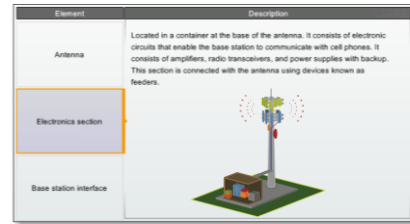
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Base Transceiver Station (BTS)



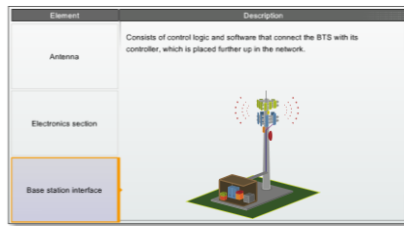
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Base Transceiver Station (BTS)



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Base Transceiver Station (BTS)



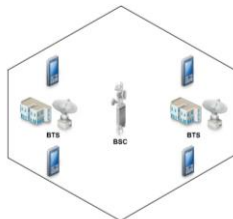
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Base Station Controller (BSC)



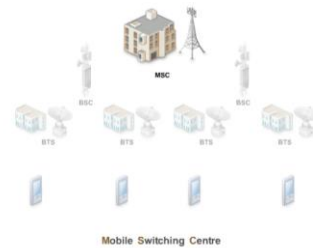
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Base Station Controller (BSC)



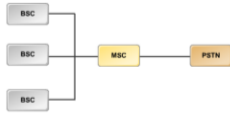
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Base Station Controller (BSC)



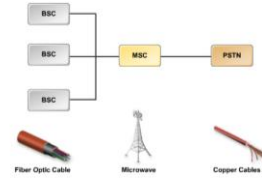
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Mobile Switching Center (MSC)



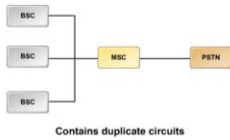
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Mobile Switching Center (MSC)



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Mobile Switching Center (MSC)



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Mobile Subscriber Unit (MSU)



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Mobile Subscriber Unit (MSU)



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Mobile Subscriber Unit (MSU)



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Mobile Subscriber Unit (MSU)



Control circuitry
Controls the transmitter and receiver. The control circuitry formats the data sent to and from the base station. It also aids in conserving battery power by putting various unused sections in the circuitry in sleep mode.

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Mobile Subscriber Unit (MSU)



Main-Machine Interface (MMI)
Consists of the keypad and display. MMI provides various functions such as the text message editor, phone book, games, and clock. The MMI is managed by the control circuitry.

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Mobile Subscriber Unit (MSU)



Subscriber Identity Module (SIM)
An integrated circuit card that stores the identity information of the subscriber.

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Mobile Subscriber Unit (MSU)



Battery
The power unit of a cellular phone. The power capacity of a battery decides the time duration a phone can operate. The most commonly used batteries are the Lithium ion (Li-ion) batteries, which provide a voltage of around 3 volts per cell.

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Cellular Link



Downlink or forward link

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Cellular Link



Uplink or reverse link

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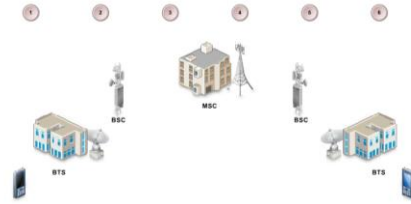


CALL PROCESSING IN A BASIC CELLULAR NETWORK

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The Process of Setting Up a Call



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The Process of Setting Up a Call



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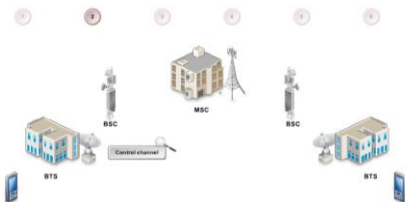
The Process of Setting Up a Call



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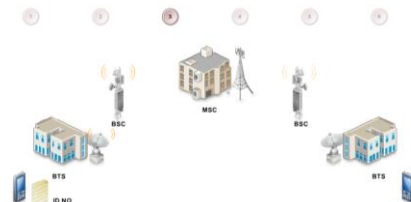
The Process of Setting Up a Call



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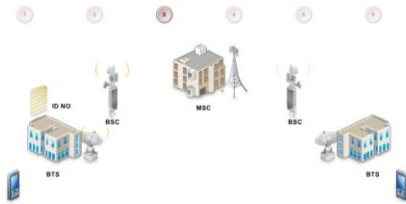


The Process of Setting Up a Call



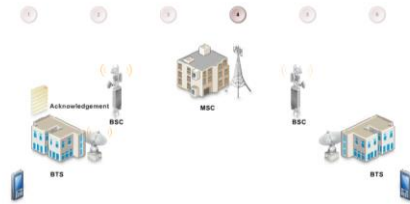
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The Process of Setting Up a Call



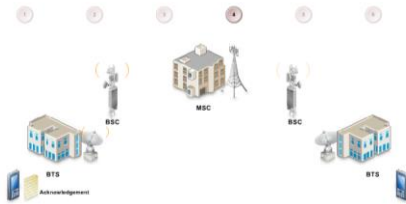
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The Process of Setting Up a Call



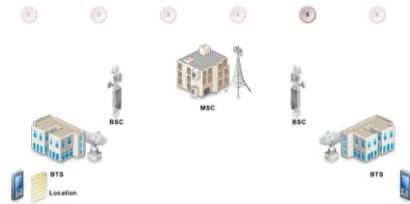
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The Process of Setting Up a Call



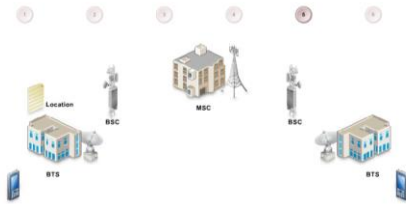
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The Process of Setting Up a Call



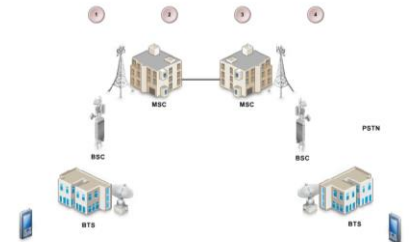
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The Process of Setting Up a Call



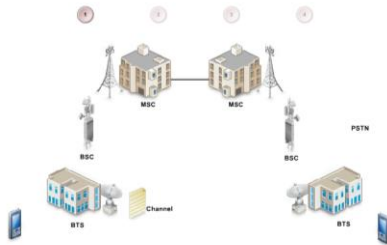
7 - 101 Mujdat Soyuturk, Wireless and Mobile Networks, Spring 2021, Marmara University

The Process of Making a Call



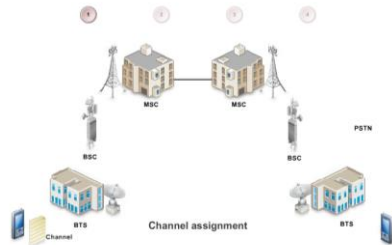
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The Process of Making a Call



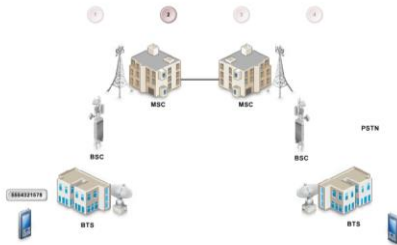
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The Process of Making a Call



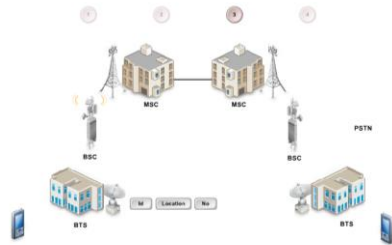
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The Process of Making a Call



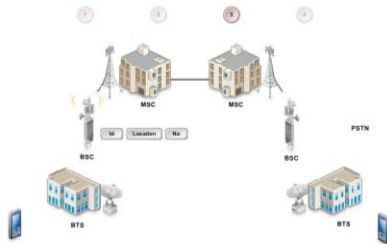
7 - 105 Mujdat Soyuturk, Wireless and Mobile Networks, Spring 2021, Marmara University

The Process of Making a Call



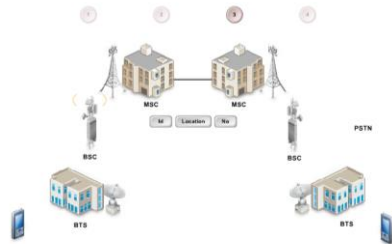
7 - 106 Mujdat Soyuturk, Wireless and Mobile Networks, Spring 2021, Marmara University

The Process of Making a Call



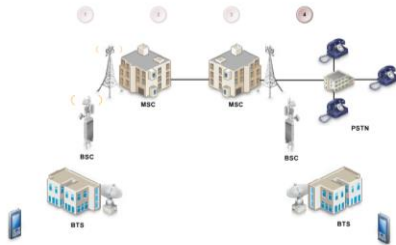
7 - 107 Mujdat Soyuturk, Wireless and Mobile Networks, Spring 2021, Marmara University

The Process of Making a Call



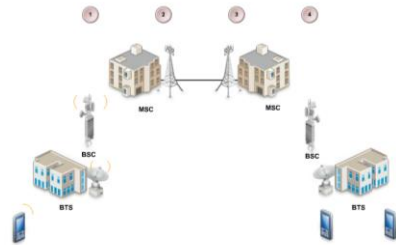
7 - 108 Mujdat Soyuturk, Wireless and Mobile Networks, Spring 2021, Marmara University

The Process of Making a Call



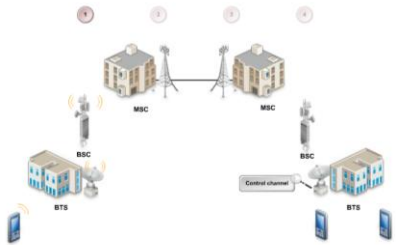
7 - 109 Mujdat Soyuturk, Wireless and Mobile Networks, Spring 2021, Marmara University

The Process of Receiving a Call



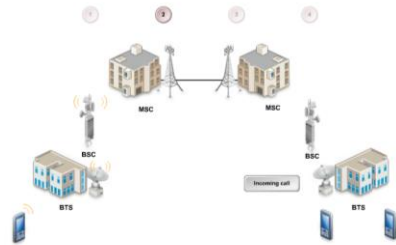
7 - 110 Mujdat Soyuturk, Wireless and Mobile Networks, Spring 2021, Marmara University

The Process of Receiving a Call



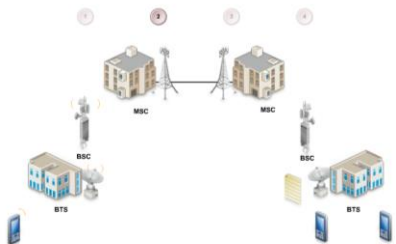
7 - 111 Mujdat Soyuturk, Wireless and Mobile Networks, Spring 2021, Marmara University

The Process of Receiving a Call



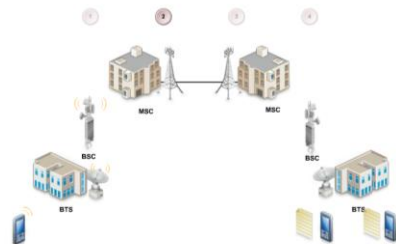
7 - 112 Mujdat Soyuturk, Wireless and Mobile Networks, Spring 2021, Marmara University

The Process of Receiving a Call



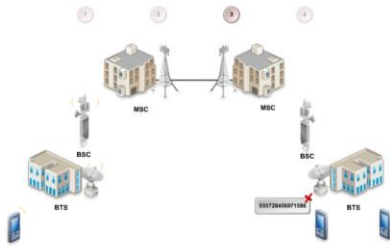
7 - 113 Mujdat Soyuturk, Wireless and Mobile Networks, Spring 2021, Marmara University

The Process of Receiving a Call



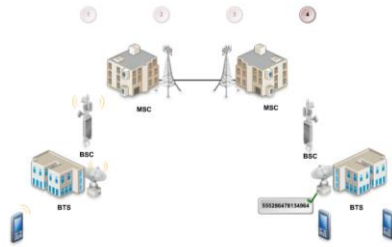
7 - 114 Mujdat Soyuturk, Wireless and Mobile Networks, Spring 2021, Marmara University

The Process of Receiving a Call



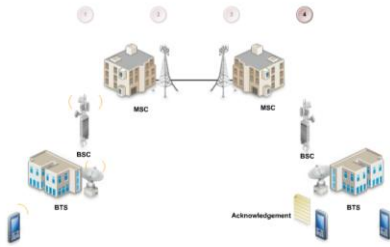
7 - 115 Mijdat Soyuturk, Wireless and Mobile Networks, Spring 2021, Marmara University

The Process of Receiving a Call



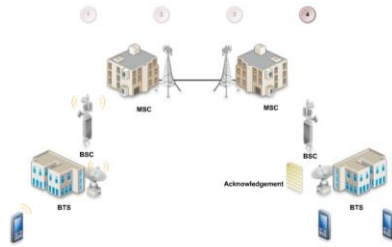
7 - 116 Mijdat Soyuturk, Wireless and Mobile Networks, Spring 2021, Marmara University

The Process of Receiving a Call



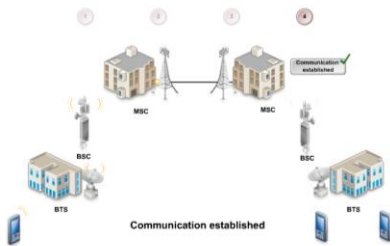
7 - 117 Mijdat Soyuturk, Wireless and Mobile Networks, Spring 2021, Marmara University

The Process of Receiving a Call



7 - 118 Mijdat Soyuturk, Wireless and Mobile Networks, Spring 2021, Marmara University

The Process of Receiving a Call



7 - 119 Mijdat Soyuturk, Wireless and Mobile Networks, Spring 2021, Marmara University