Marmara University, **2021**

Wireless and Mobile Networks

Subject 11

Cellular Network Technologies and Architectures

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Associate Professor

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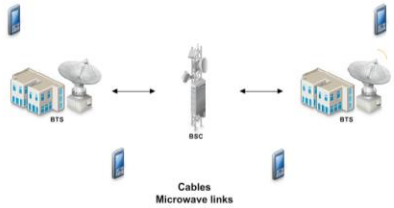

Cables
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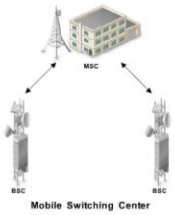
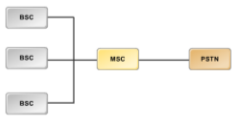
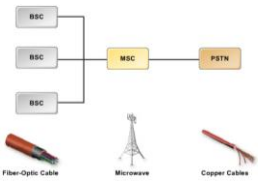


Mobile Switching Center

The 2G Cellular Network Architecture



The 2G Cellular Network Architecture



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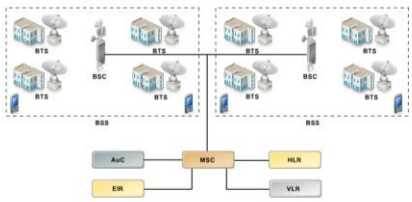

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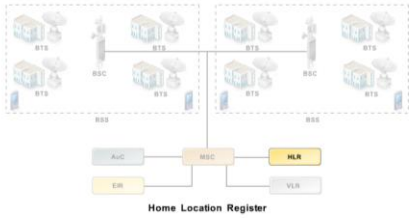
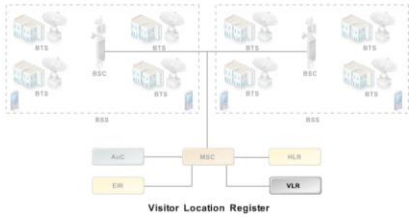


Home Location Register

The 2G Cellular Network Architecture



Visitor Location Register

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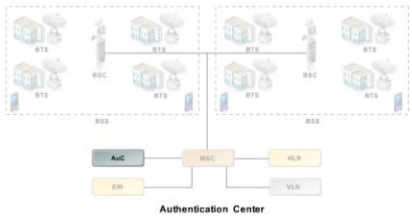
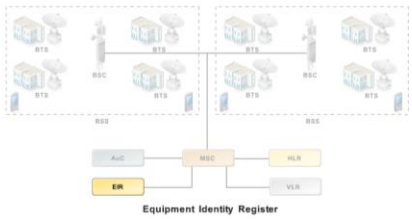


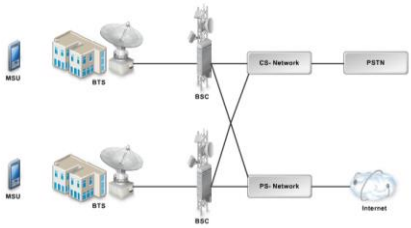
Authentication Center

The 2G Cellular Network Architecture



Equipment Identity Register

The 2.5G Cellular Network Architecture



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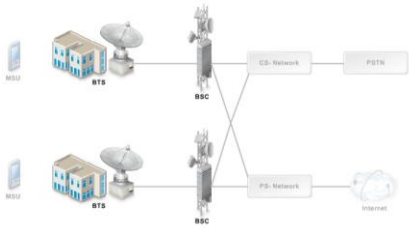

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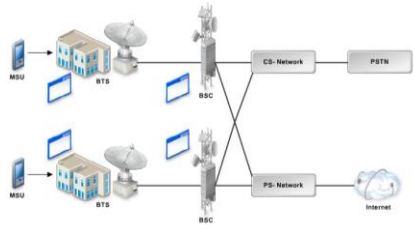

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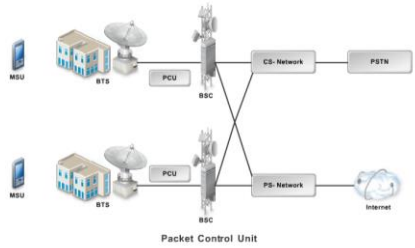

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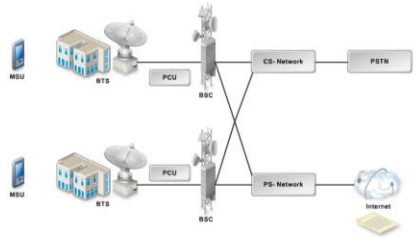

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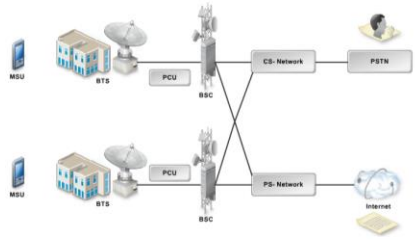
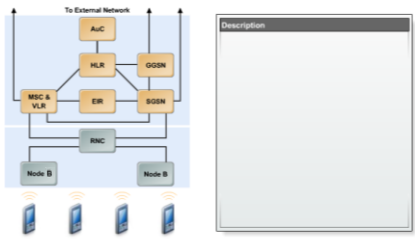


The 3G Cellular Network Architecture



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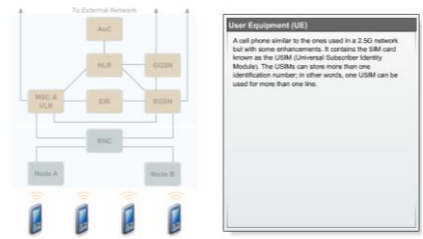

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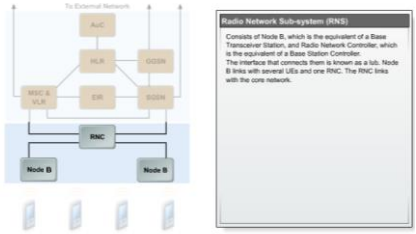

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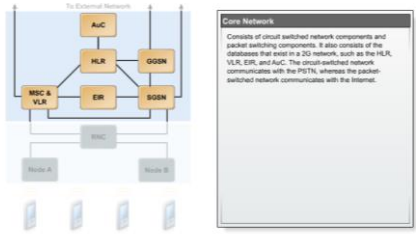

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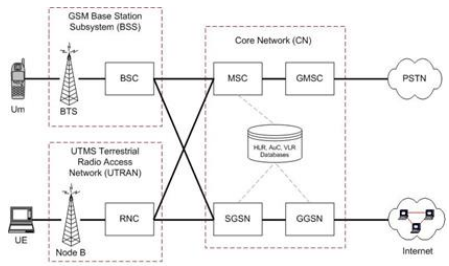

Figure from http://www.embedded.com/print/4016195

The 3G Cellular Network Architecture

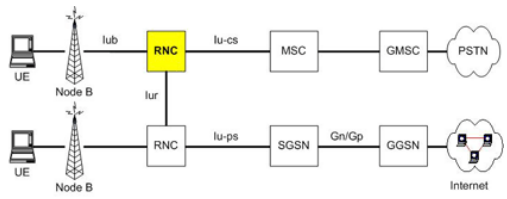

Figure from http://www.embedded.com/print/4016195

The 4G Cellular Network Architecture

The 4G Cellular Network Architecture

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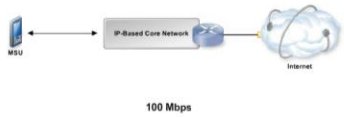
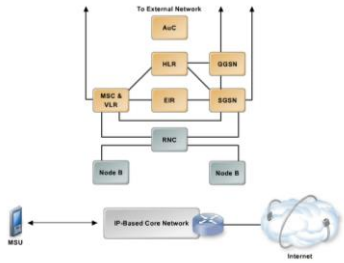
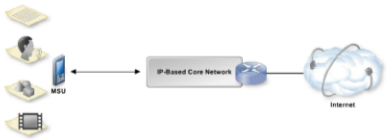


100 Mbps

The 4G Cellular Network Architecture



The 4G Cellular Network Architecture



The 4G Cellular Network Architecture

IP core supports:

- Mobility
- Call control
- Handover
- Security
- Billing

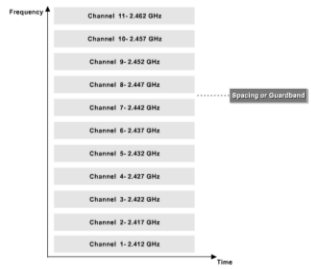
RADIO TECHNOLOGIES OF NEXT GENERATION CELLULAR SYSTEMS

Frequency Division Multiplexing

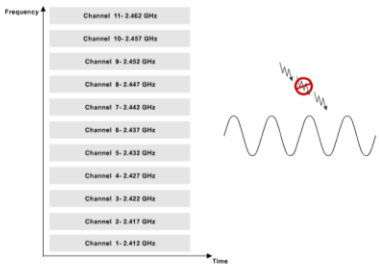
Frequency Division Multiplexing

Frequency Division Multiplexing

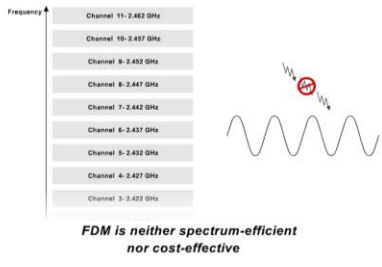
Frequency Division Multiplexing



Frequency Division Multiplexing



Frequency Division Multiplexing

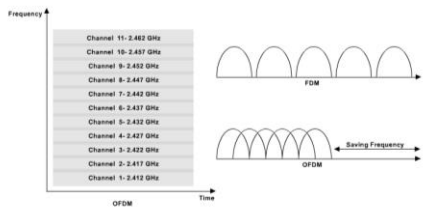


FDM is neither spectrum-efficient nor cost-effective

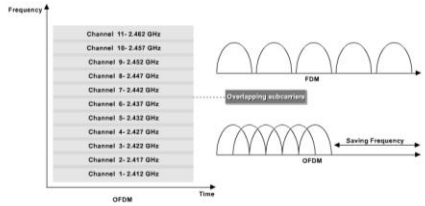
Orthogonal Frequency Division Multiplexing

Orthogonal Frequency Division Multiplexing

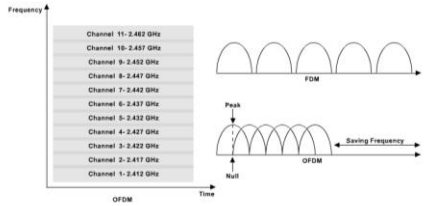
Orthogonal Frequency Division Multiplexing



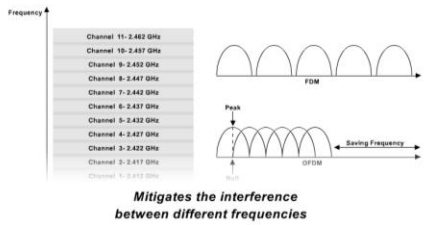
Orthogonal Frequency Division Multiplexing



Orthogonal Frequency Division Multiplexing

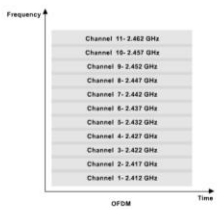


Orthogonal Frequency Division Multiplexing



Mitigates the interference between different frequencies

Orthogonal Frequency Division Multiplexing

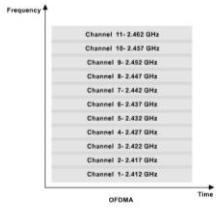


Orthogonal Frequency Division Multiplexing

Orthogonal Frequency Division Multiplexing

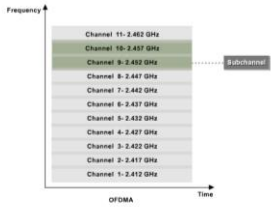
OFDM offers resistance to interference and degradation

Orthogonal Frequency Division Multiple Access

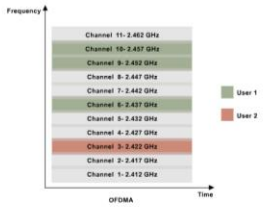


Orthogonal Frequency Division Multiple Access

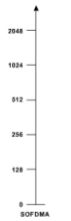
Orthogonal Frequency Division Multiple Access



Orthogonal Frequency Division Multiple Access

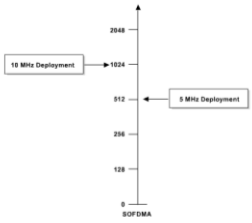


Orthogonal Frequency Division Multiple Access

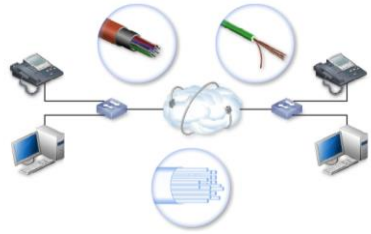


Scalable OFDMA

Orthogonal Frequency Division Multiple Access



Spatial Diversity



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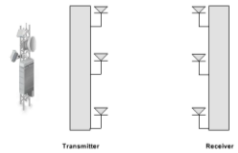

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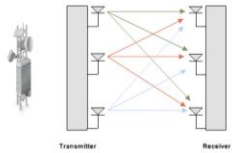

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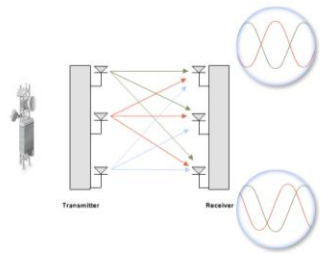
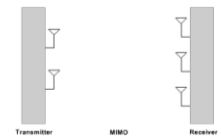


Spatial Multiplexing



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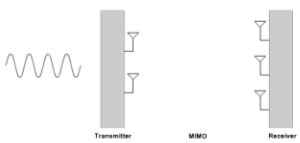

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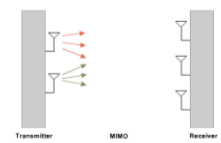

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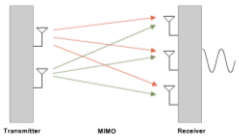

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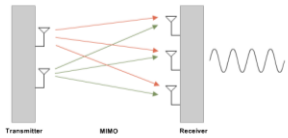

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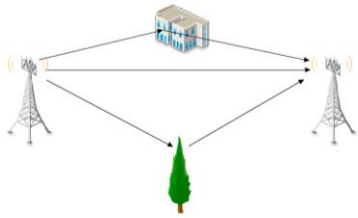
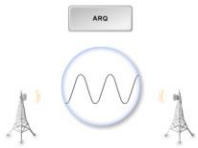
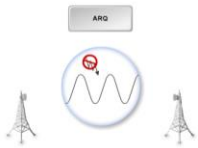


Spatial Multiplexing

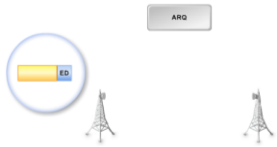
Radio Layer Error Recovery Techniques



Radio Layer Error Recovery Techniques



Radio Layer Error Recovery Techniques



Radio Layer Error Recovery Techniques

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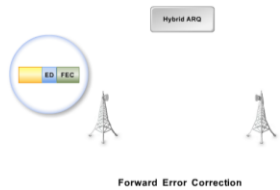
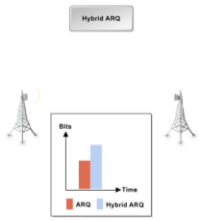
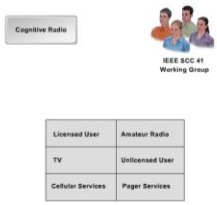


Radio Layer Error Recovery Techniques



Cognitive Radio

Cognitive Radio



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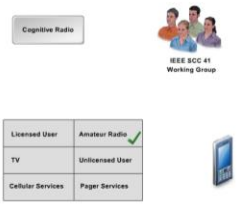
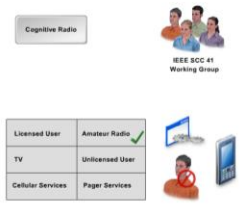
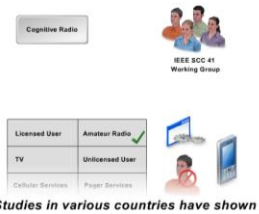


Cognitive Radio

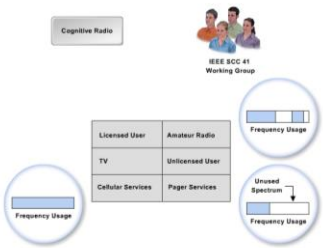


Cognitive Radio

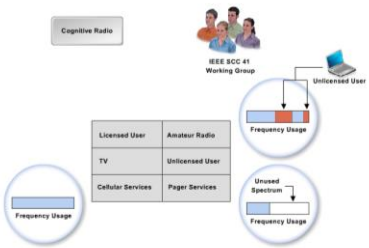


Studies in various countries have shown that radio frequency spectrum is not being utilized efficiently

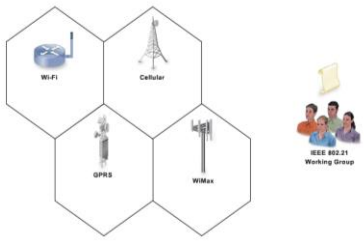
Cognitive Radio



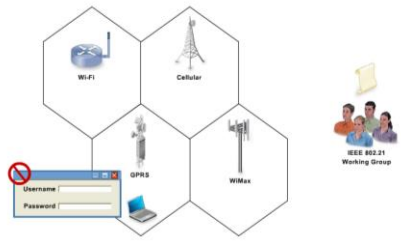
Cognitive Radio



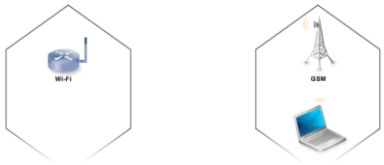
Inter-Technology Handover



Inter-Technology Handover

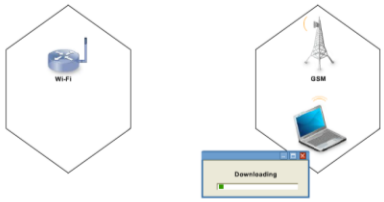


Inter-Technology Handover

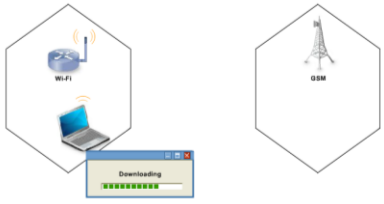


Inter-technology handover provides data session continuity for video streaming applications

Inter-Technology Handover



Inter-Technology Handover



Inter-Technology Handover

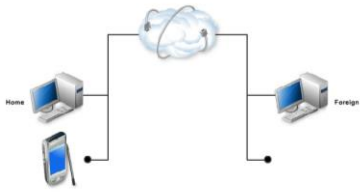
CORE NETWORKS OF NEXT GENERATION CELLULAR SYSTEMS

- Mobile IP
- IP Multimedia Subsystem
- Fixed Mobile Convergence
- Femtocells

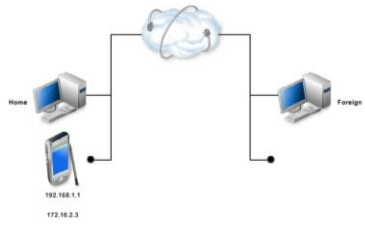
Mobile IP

Mobile IP

Mobile IP



Mobile IP



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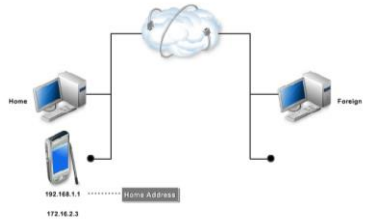

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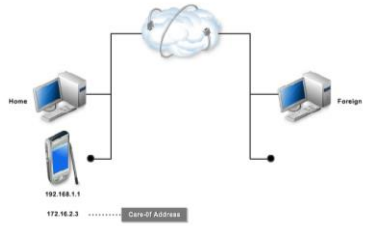

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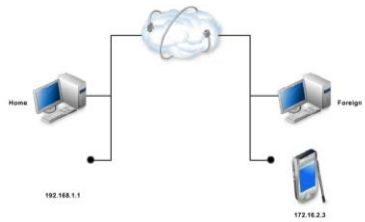

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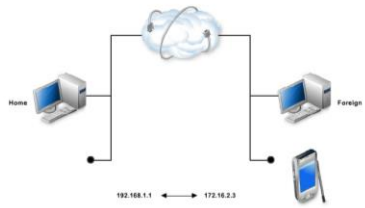

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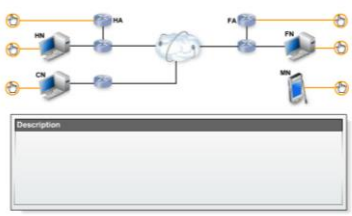

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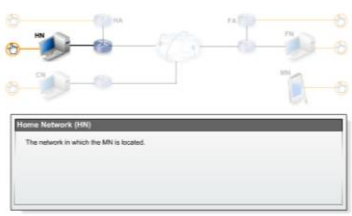

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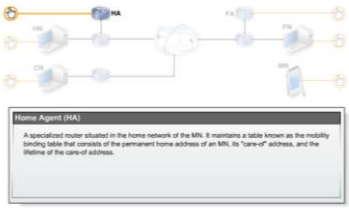

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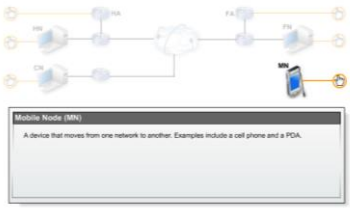

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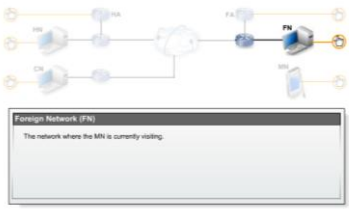
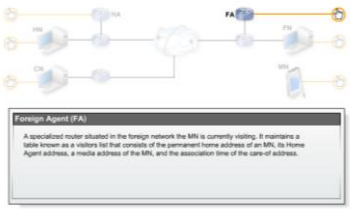
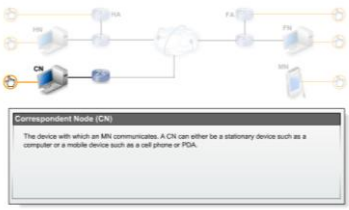


Mobile IP



Mobile IP



IP Multimedia Subsystem

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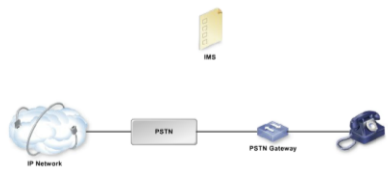
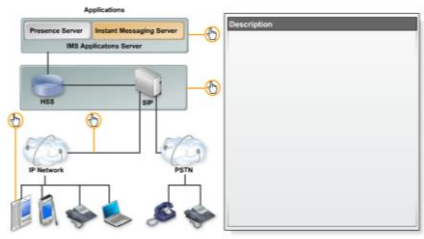
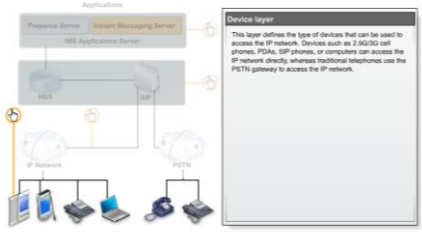


IP Multimedia Subsystem

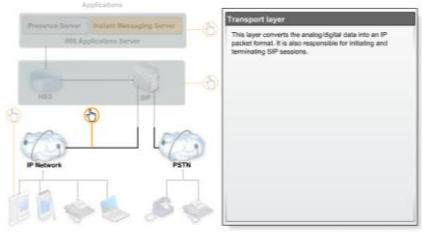
IP Multimedia Subsystem



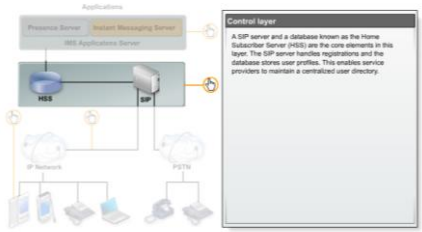
IP Multimedia Subsystem



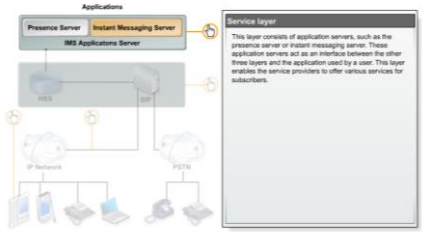
IP Multimedia Subsystem



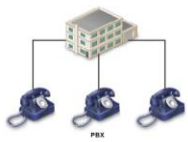
IP Multimedia Subsystem



IP Multimedia Subsystem



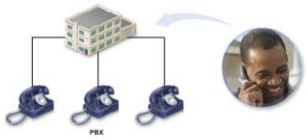
Fixed Mobile Convergence



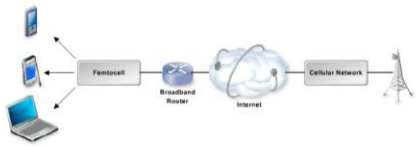
Fixed Mobile Convergence

Features supported by FMC:

- Three- or four-digit extension dialing
- Access to corporate voice mail
- Call transfer to a mobile device



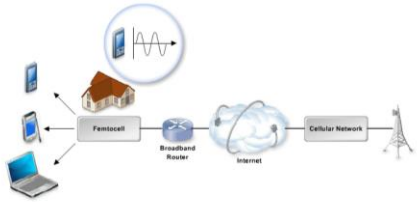
Femtocells



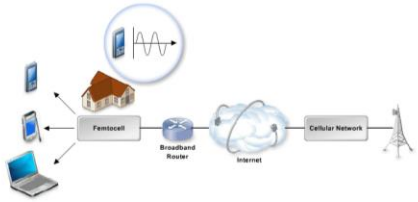
Femtocells

Femtocells

Femtocells



Femtocells



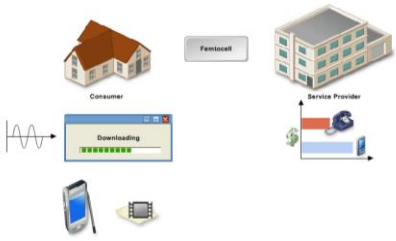
Femtocells use a licensed spectrum, reducing the risk of interference

Femtocells

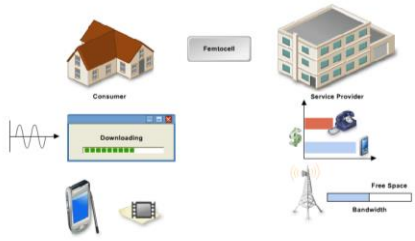
Femtocells

Femtocells

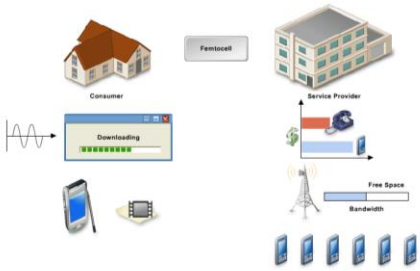
Femtocells



Femtocells

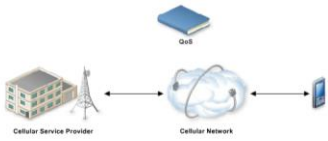


Femtocells

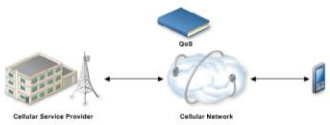


QoS IN CELLULAR NETWORKS

Cellular Network QoS



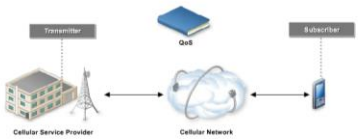
Cellular Network QoS



QoS parameters for voice calls include:

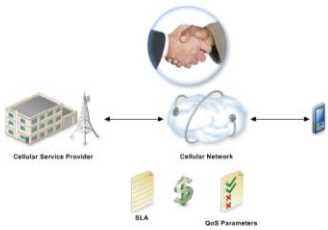
- Voice quality
- Signal strength
- Service availability
- Frequency of call drops
- Break in signal transmission

Cellular Network QoS

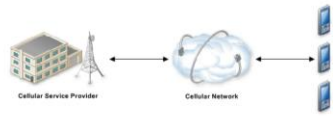


Cellular Network QoS

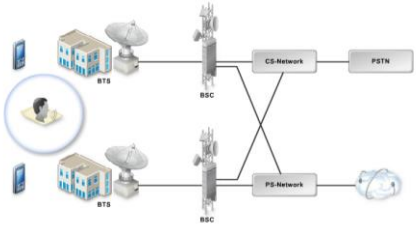
Cellular Network QoS



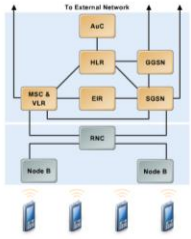
Need for QoS in Cellular Networks



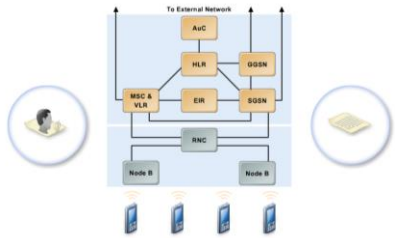
Need for QoS in Cellular Networks



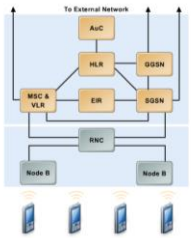
Need for QoS in Cellular Networks



Need for QoS in Cellular Networks



Need for QoS in Cellular Networks



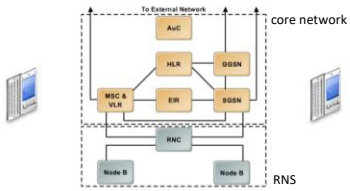
Primary concern for all subscribers is to enjoy:

- Good transmission quality
- Service availability
- Minimal delay

QoS Principles

Bandwidth
Fault tolerance level
Call handoff support

QoS Principles



QoS Principles

QoS Principle	Description
Packet classification	
Policing	
Appropriate resource allocation	
Call admission	

QoS Principles

QoS Principle	Description
Packet classification	Each packet coming to a network element is classified based on its QoS requirements. This classification enables the network element to process the packet based on its resource requirement. For example, a packet classified as data will need less bandwidth than a packet classified as voice.
Policing	
Appropriate resource allocation	
Call admission	

QoS Principles

QoS Principle	Description
Packet classification	An application requests the required amount of network resources, and it must always adhere to this request. An application must not send packets at a rate more than what was requested. In order to make sure the application is adhering to the parameters, policing of packets is implemented in the network.
Policing	
Appropriate resource allocation	
Call admission	

QoS Principles

QoS Principle	Description
Packet classification	A network may receive both data and voice packets simultaneously. It is the network device's responsibility to appropriately allocate resources, such as channels to communicate to both these types of data.
Policing	
Appropriate resource allocation	
Call admission	

QoS Principles

QoS Principle	Description
Packet classification	Once a network receives a QoS request, it verifies the available network resources to see if it can provide the required quality. In case of unavailability of network resources, the network can deny the request.
Policing	
Appropriate resource allocation	
Call admission	

QoS Classes

QoS Class	Description
Conversational	
Streaming	
Interactive	
Background	

QoS Classes

QoS Class	Description
Conversational	Applications that are most delay sensitive are part of this class. These include real-time voice applications, such as voice calls, VoIP, or video conferencing. QoS levels in this class are mostly defined by user-perceived data—that is, how much delay a person can tolerate for audio or video signals.
Streaming	
Interactive	
Background	

QoS Classes

QoS Class	Description
Conversational	Applications, such as audio and video streaming, are part of this class. The delay between subsequent packets should be maintained below an acceptable limit. If the time variation between two subsequent packets is large, the quality of streaming applications go down.
Streaming	
Interactive	
Background	

QoS Classes

QoS Class	Description
Conversational	Web browsing applications are part of this class. They are not very delay sensitive, but are sensitive to data loss.
Streaming	
Interactive	
Background	

QoS Classes

QoS Class	Description
Conversational	SMS applications are part of this class. These applications become active only on the arrival of an SMS; otherwise, they run in the background. These applications are not very delay sensitive, but are sensitive to data loss.
Streaming	
Interactive	
Background	

QoS Attributes

QoS Attribute	Description
Maximum bit rate (kbps)	
Guaranteed bit rate (kbps)	
Delivery order (y/n)	
Transfer delay (ms)	
Traffic handling priority	

QoS Attributes

QoS Attribute	Description
Maximum bit rate (kbps)	Maximum number of bits delivered within a period of time.
Guaranteed bit rate (kbps)	
Delivery order (y/n)	
Transfer delay (ms)	
Traffic handling priority	

QoS Attributes

QoS Attribute	Description
Maximum bit rate (kbps)	Guaranteed number of bits delivered within a period of time by the cellular network.
Guaranteed bit rate (kbps)	
Delivery order (y/n)	
Transfer delay (ms)	
Traffic handling priority	

QoS Attributes

QoS Attribute	Description
Maximum bit rate (kbps)	The order in which the data units are delivered. Indicates whether the delivery is sequential or not.
Guaranteed bit rate (kbps)	
Delivery order (y/n)	
Transfer delay (ms)	
Traffic handling priority	

QoS Attributes

QoS Attribute	Description
Maximum bit rate (kbps)	Defines the maximum amount of delay.
Guaranteed bit rate (kbps)	
Delivery order (y/n)	
Transfer delay (ms)	
Traffic handling priority	

QoS Attributes

QoS Attribute	Description
Maximum bit rate (kbps)	Indicates the priority level of packets.
Guaranteed bit rate (kbps)	
Delivery order (y/n)	
Transfer delay (ms)	
Traffic handling priority	

QoS Schemes

QoS Scheme	Description
Dynamic channel allocation	
Call Admission Control (CAC)	
Mobility prediction	
Individual QoS (iQoS)	

QoS Schemes

QoS Scheme	Description
Dynamic channel allocation	In this scheme, channels are allocated to subscribers dynamically, either using a central controller or a Mobile Service Station (MSS). In the central dynamic channel allocation scheme, requests for channels are sent to a central controller. In a distributed channel allocation scheme, requests are sent to MSSs, which are present in each cell. These MSS take care of channel allocations in their cell. Better channel allotment means better utilization of resources, which in turn provides better QoS.
Call Admission Control (CAC)	
Mobility prediction	
Individual QoS (iQoS)	

QoS Schemes

QoS Scheme	Description
Dynamic channel allocation	*Call Admission Control (CAC)* is a set of actions taken by a network during the call setup or call re-negotiation phase to determine whether a connection request can be accepted or rejected before the source information is admitted to the cellular network.
Call Admission Control (CAC)	When a connection is requested by an application, the application indicates to the network: the type of service required, a set of parameters describing the source traffic characteristics, and the quality of service parameters requested in each direction. CAC uses this information to assess the required quality of service for the connection and determines whether it has sufficient resources and channels to accept the requested connection based on the current network status.
Mobility prediction	
Individual QoS (iQoS)	

QoS Schemes

QoS Scheme	Description
Dynamic channel allocation	The path a mobile takes is studied over a period of time and stored in a database. Using this data, resources are blocked or prioritized so as to facilitate a proper handoff.
Call Admission Control (CAC)	
Mobility prediction	
Individual QoS (iQoS)	

QoS Schemes

QoS Scheme	Description
Dynamic channel allocation	It is the user-perceived QoS level. iQoS is the satisfaction level of each subscriber for the full duration of a call. There maybe times when the overall QoS in a network is good, but subscribers having lesser coverage may experience drop in calls. Therefore, it is necessary to measure the QoS at user terminals.
Call Admission Control (CAC)	
Mobility prediction	
Individual QoS (iQoS)	