
 Marmara University, 2021

Wireless and Mobile Networks


Subject 5
Wireless Local Area Networks

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Associate Professor


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- IEEE 802.11n
- QoS in WiFi Networks
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 INTRODUCTION


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 Introduction




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 Introduction



*Challenge in wireless networks
lies in their design and mobility options*

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 WIRELESS LAN

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Wireless Local Area Network (WLANs)



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Wireless Local Area Network (WLANs)



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The Wi-Fi Alliance



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The Wi-Fi Alliance



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The Wi-Fi Alliance



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The Wi-Fi Alliance

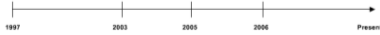


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Evolution of Wi-Fi



Wi-Fi

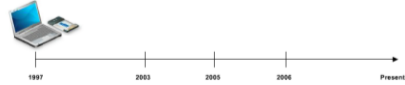


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Evolution of Wi-Fi



Wi-Fi

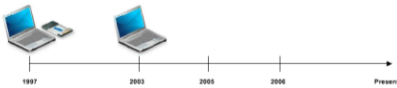


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Evolution of Wi-Fi



Wi-Fi



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Evolution of Wi-Fi



Wi-Fi



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Evolution of Wi-Fi



Wi-Fi



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Evolution of Wi-Fi



Wi-Fi



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Evolution of Wi-Fi



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WLAN NETWORK IMPLEMENTATION

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Service Set Identifier (SSID)



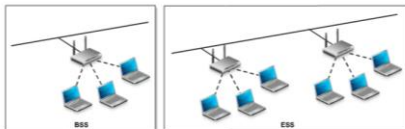
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Service Set Identifier (SSID)



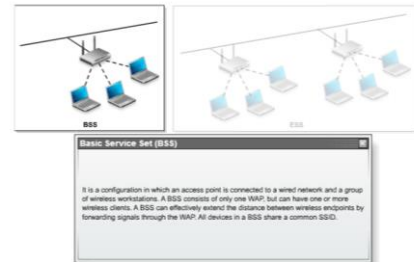
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Service Set



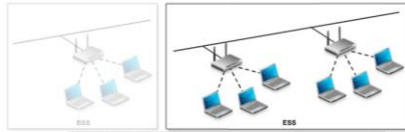
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Service Set



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Service Set



Extended Service Set (ESS)

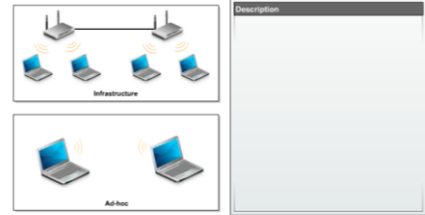
An ESS is a configuration of multiple BSSs used to handle mobility on a wireless local area network. It adds two new features to the WLAN.

It enables users to move their mobile devices, such as laptop computers, outside of their home BSS while keeping their connection. It also enables data to be forwarded from one BSS to another through the network backbone.

An ESS consists of at least two WAPs, and all the devices in an ESS do not require the same SSID.

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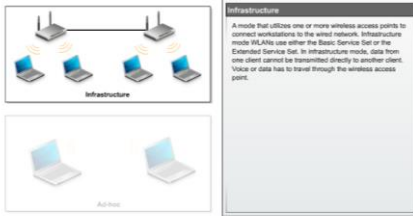
Wi-Fi Network Types



Description

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Wi-Fi Network Types



Infrastructure

A mode that utilizes one or more wireless access points to connect workstations to the wired network. Infrastructure mode WLANs use either the Basic Service Set or the Extended Service Set. In infrastructure mode, data from one client cannot be transmitted directly to another client. Voice or data has to travel through the wireless access point.

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Wi-Fi Network Types



Ad-hoc

A mode that utilizes a peer-to-peer configuration in which each wireless client talks directly to other workstations.

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802.11 Access Methods

802.11 Access Method	Description
DCF	
PCF	

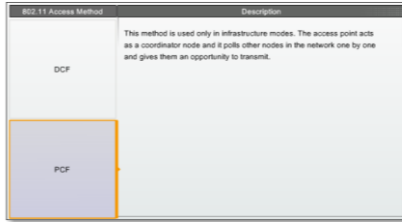
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802.11 Access Methods

802.11 Access Method	Description
DCF	It is a contention-based access method. In this method, the node that needs to transmit will sense the wireless medium. If the medium is free, the node waits for a random period of time and again checks the medium. If the medium is still free, the node transmits the information.
PCF	

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802.11 Access Methods



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Wi-Fi Deployment



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Wi-Fi Deployment



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Wi-Fi Deployment



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Wi-Fi Deployment



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Wi-Fi Deployment



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802.11 Wireless Standards



Standard	Description
802.11	
802.11a	
802.11b	
802.11e	
802.11g	

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802.11 Wireless Standards



Standard	Description
802.11	802.11 is the original IEEE wireless working group and standard. It specifies wireless data transfer rates of up to 2 megabits per second (Mbps) in the 2.4 gigahertz (GHz) frequency band.
802.11a	
802.11b	
802.11e	
802.11g	

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802.11 Wireless Standards



Standard	Description
802.11	
802.11a	802.11a is an approved specification for a fast and secure but relatively expensive wireless protocol. 802.11a supports speeds up to 54 Mbps in the 5 GHz frequency band. Unfortunately, that speed has a limited range of only 60 feet, which, depending on how you arrange your access points, could severely limit user mobility.
802.11b	
802.11e	
802.11g	

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802.11 Wireless Standards



Standard	Description
802.11	
802.11a	
802.11b	802.11b (also called Wi-Fi, short for "wireless fidelity") is probably the most common and certainly the least expensive WLAN protocol. 802.11b provides an 11 Mbps transfer rate in the 2.4 GHz frequency. Some vendors have increased the rate on their devices.
802.11e	
802.11g	

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802.11 Wireless Standards



Standard	Description
802.11	
802.11a	
802.11b	
802.11e	802.11e is a draft wireless standard for both home and business implementations. It provides multimedia support to 802.11a and 802.11b and is compatible with those standards.
802.11g	

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802.11 Wireless Standards

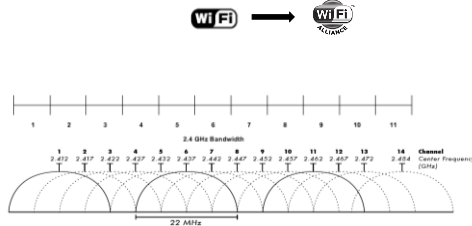


Standard	Description
802.11	
802.11a	
802.11b	
802.11e	
802.11g	802.11g is a specification for wireless data throughput at the rate of up to 54 Mbps in the 2.4 GHz band. It is compatible with 802.11b, which may be replaced by 802.11g due to faster speeds.

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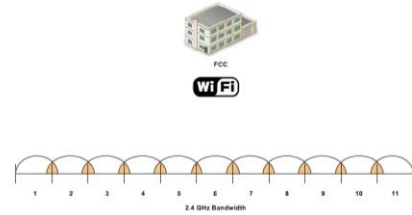
Wi-Fi Channelization

- In Europe;
- European Telecommunications Standards Institute (ETSI)
 - 13 channels



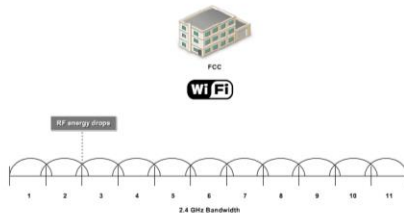
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Wi-Fi Channelization



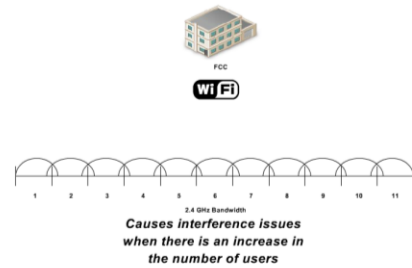
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Wi-Fi Channelization



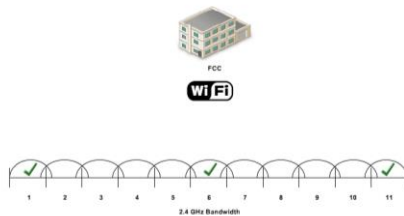
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Wi-Fi Channelization



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Wi-Fi Channelization



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IEEE 802.11N

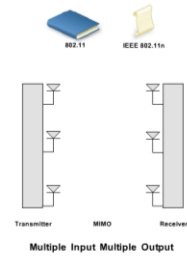
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The IEEE 802.11n Standard



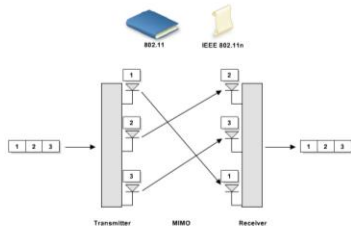
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The IEEE 802.11n Standard



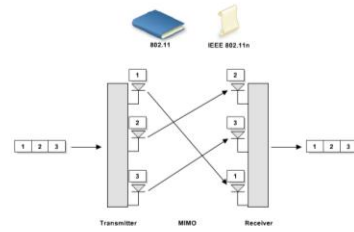
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The IEEE 802.11n Standard



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The IEEE 802.11n Standard



**802.11n devices work better even
when the distance between them increases**

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The IEEE 802.11n Standard

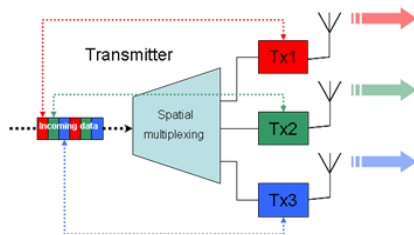


Figure Source: <http://www.air-stream.org.au/mimo>

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The IEEE 802.11n Standard

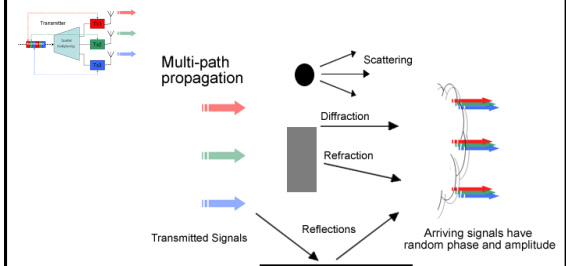
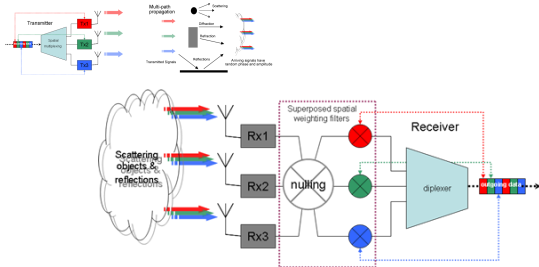


Figure Source: <http://www.air-stream.org.au/mimo>

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The IEEE 802.11n Standard



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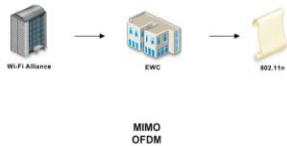
The IEEE 802.11n Standard



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The IEEE 802.11n Standard



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Advantages of IEEE 802.11n

Advantage	Description
More bandwidth for users	
Increased data rate	
Longer range	
Uniform reception of signals	
Lower infrastructure costs	

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Advantages of IEEE 802.11n

Advantage	Description
More bandwidth for users	Each user in a cell will have more bandwidth that will enable them to use applications such as video streaming over the WLAN. The earlier 802.11 standards also support video streaming, but it might affect the performance of other systems in the WLAN.
Increased data rate	
Longer range	
Uniform reception of signals	
Lower infrastructure costs	

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Advantages of IEEE 802.11n

Advantage	Description
More bandwidth for users	802.11n offers data rates of about 600 Mbps per BSS.
Increased data rate	
Longer range	
Uniform reception of signals	
Lower infrastructure costs	

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Advantages of IEEE 802.11n



Advantage	Description
More bandwidth for users	802.11n networks are based on the MIMO technology, which facilitates seamless transmission of wireless signals, even when obstructions are present in the path. This feature improves the range of 802.11n devices to about 450 feet.
Increased data rate	
Longer range	
Uniform reception of signals	
Lower infrastructure costs	

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Advantages of IEEE 802.11n



Advantage	Description
More bandwidth for users	Generally, in 802.11n networks, an obstruction in the path or placement of other devices in the room affects the signal strength. The signal strength varies throughout the room, ranging from being very high at few places to almost nil at other locations. 802.11n overcomes this disadvantage and offers uniform signal coverage. This is also achieved due to the usage of MIMO.
Increased data rate	
Longer range	
Uniform reception of signals	
Lower infrastructure costs	

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Advantages of IEEE 802.11n



Advantage	Description
More bandwidth for users	Because 802.11n offers a longer range, fewer access points will be needed in a network. This in turn reduces the network infrastructure costs.
Increased data rate	
Longer range	
Uniform reception of signals	
Lower infrastructure costs	

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Challenges in IEEE 802.11n Deployment



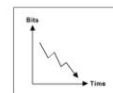
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Challenges in IEEE 802.11n Deployment



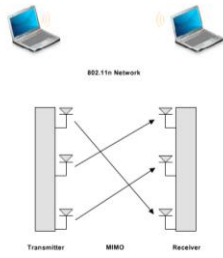
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Challenges in IEEE 802.11n Deployment



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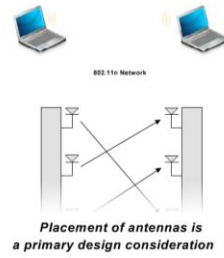
802.11n Network Design



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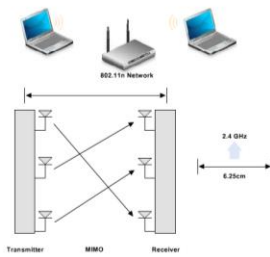
802.11n Network Design



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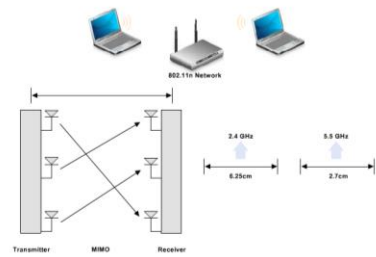
802.11n Network Design



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802.11n Network Design



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802.11n Physical Layer Technologies



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802.11n Physical Layer Technologies

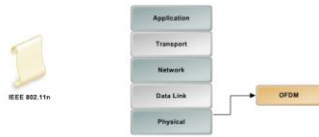


Orthogonal Frequency Division Multiplexing

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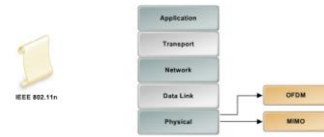
802.11n Physical Layer Technologies



OFDM supports higher data rates

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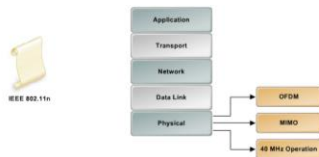
802.11n Physical Layer Technologies



Longer range
Uniform signal coverage

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802.11n Physical Layer Technologies



*Supports approximately
twice the data rate*

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802.11n MAC Layer Features



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802.11n MAC Layer Features



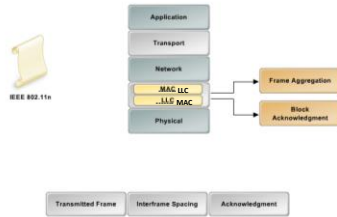
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802.11n MAC Layer Features



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802.11n MAC Layer Features



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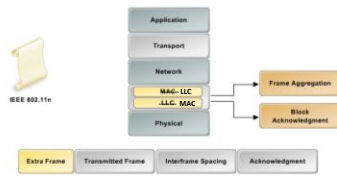
802.11n MAC Layer Features



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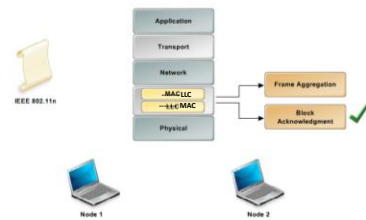
802.11n MAC Layer Features



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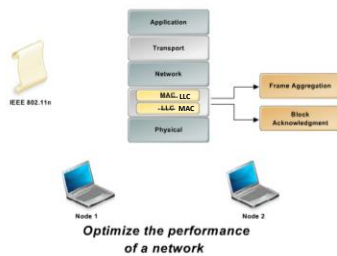
802.11n MAC Layer Features



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802.11n MAC Layer Features



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QoS in WiFi NETWORKS

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Quality of Service



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Quality of Service



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Quality of Service

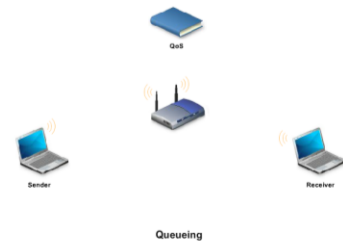


QoS parameters include:

- Maximum amount of delay
- Signal loss
- Noise
- Bandwidth priority
- CPU usage for a specific stream of data

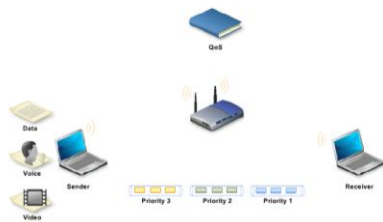
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Quality of Service



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Quality of Service



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Need for QoS



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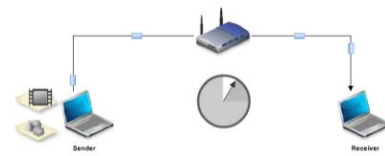
Need for QoS



Sensitive to packet loss

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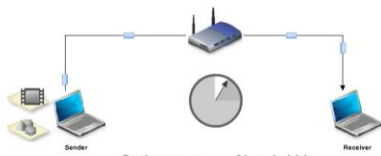
Need for QoS



Sensitive toward delays

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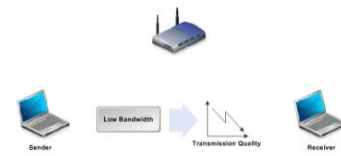
Need for QoS



*Optimum usage of bandwidth
is critical while dealing with
multimedia applications*

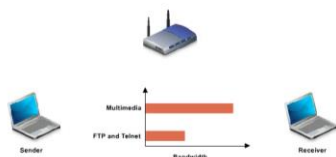
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Need for QoS



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Need for QoS



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Parameters Influencing QoS



Parameter	Description
Bandwidth	
Latency	
Jitter	
Packet loss	

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Parameters Influencing QoS



Parameter	Description
Bandwidth	The average number of bits that can be transmitted from a source to a destination over the network in one second.
Latency	
Jitter	
Packet loss	

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Parameters Influencing QoS



Parameter	Description
Bandwidth	
Latency	The time taken for a packet to travel from a source to a destination. It is also known as end-to-end delay. Delay sensitive applications will discard the packet if it is received with a delay that is more than a tolerable limit.
Jitter	
Packet loss	

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Parameters Influencing QoS



Parameter	Description
Bandwidth	
Latency	
Jitter	The variation in latency between sequentially transmitted data packets. Jitter affects the quality of streaming.
Packet loss	

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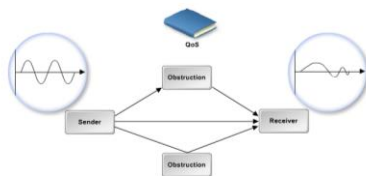
Parameters Influencing QoS



Parameter	Description
Bandwidth	
Latency	
Jitter	
Packet loss	The percentage of packets that do not reach the destination. Packets are lost when the buffers that store these packets are full.

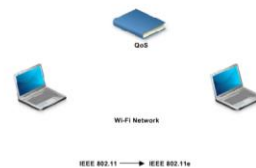
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Challenges of Wireless QoS



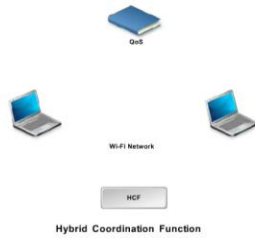
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The 802.11e Standard



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The 802.11e Standard



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The 802.11e Standard



Enhanced Distributed Coordination Access (EDCA)
HCF Controlled Channel Access (HCCA)

HCF Method	Description
EDCA	
HCCA	

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The 802.11e Standard



HCF Method	Description
EDCA	802.11e has proposed this method, in which the node with high priority traffic will wait for a shorter period of time before transmitting compared to nodes with low priority traffic.
HCCA	

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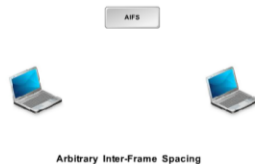
The 802.11e Standard



HCF Method	Description
EDCA	
HCCA	In this method, the access point acts as a Hybrid Coordinator (HC). The HC sends Contention-Free Poll (CFP) packets to nodes based on their priority. The node with a higher priority is chosen to transmit a packet first.

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Arbitrary Inter-frame Spacing



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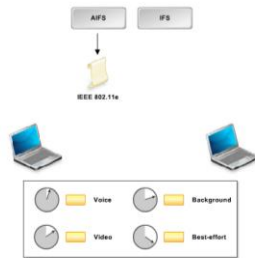
Arbitrary Inter-frame Spacing



Value of IFS varies depending upon type of packet present in the queue

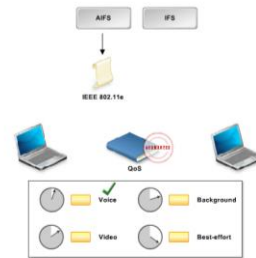
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Arbitrary Inter-frame Spacing



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Arbitrary Inter-frame Spacing



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EVOLUTION OF SECURITY in WiFi NETWORKS



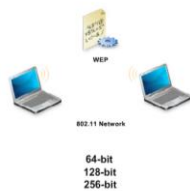
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Wired Equivalent Privacy



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Wired Equivalent Privacy



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Wired Equivalent Privacy



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Wired Equivalent Privacy



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Wired Equivalent Privacy



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Wi-Fi Protected Access



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Wi-Fi Protected Access



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Wi-Fi Protected Access



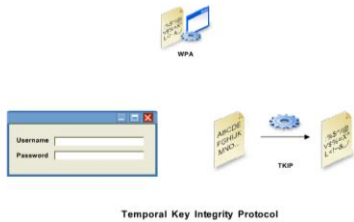
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Wi-Fi Protected Access



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Wi-Fi Protected Access



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Wi-Fi Protected Access



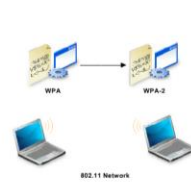
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Wi-Fi Protected Access



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WPA-2



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WPA-2



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WPA-2



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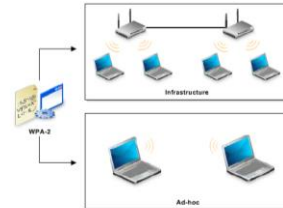
WPA-2



802.11i is referred to as WPA-2

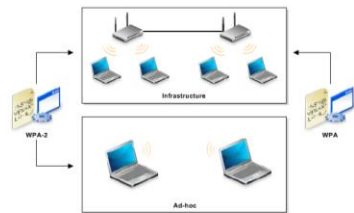
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WPA-2



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WPA-2



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WPA-2



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FUTURE TRENDS in Wifi



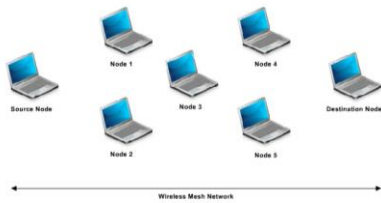
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Wireless Mesh Networks



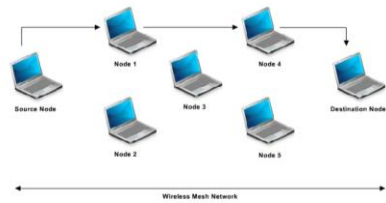
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Wireless Mesh Networks



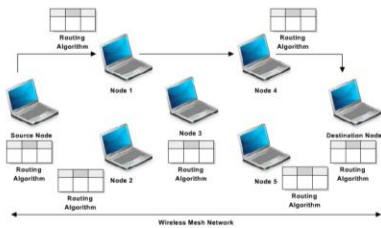
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Wireless Mesh Networks



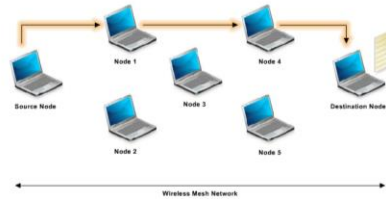
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Wireless Mesh Networks



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Wireless Mesh Networks



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Wireless Mesh Networks



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Wireless Mesh Networks



*802.11s extends the reach
of an 802.11
ad-hoc network*

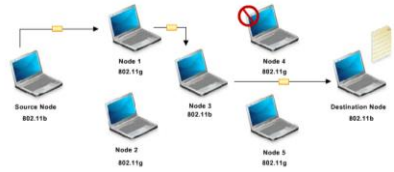
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Wireless Mesh Networks



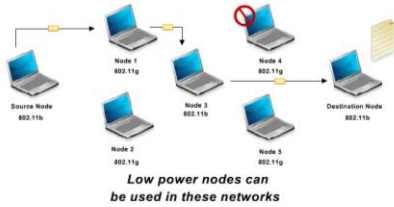
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Wireless Mesh Networks



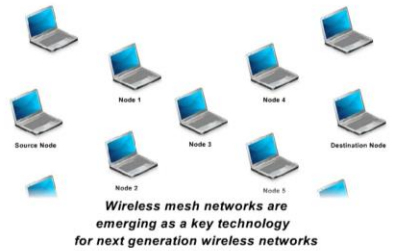
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Wireless Mesh Networks



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Wireless Mesh Networks



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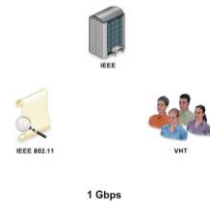
Very High Throughput



Very High Throughput

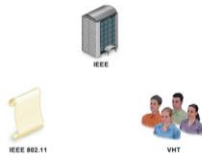
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Very High Throughput



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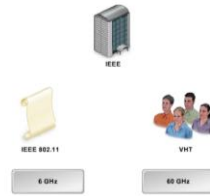
Very High Throughput



Uncompressed high quality video

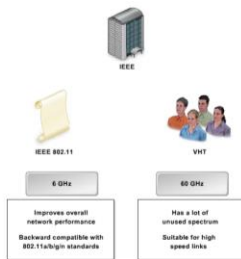
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Very High Throughput



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Very High Throughput



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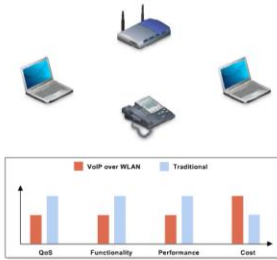
Very High Throughput



- 802.11ad in 2012
- 802.11ac has been released in 2014.
 - Operates at 5GHz only.
 - Upto 7 Gbps.
 - MU-MIMO

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VoIP over WLAN



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VoIP over WLAN



Key requirements to be met include:

- QoS
- Security
- Mobility
- Available state
- Fail-over strategies

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