Marmara University, 2021

Wireless and Mobile Networks

Subject 5

Wireless Local Area Networks

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Associate Professor

Contents

INTRODUCTION

Introduction

Introduction

Challenge in wireless networks lies in their design and mobility options

WIRELESS LAN

Wireless Local Area Network (WLANs)

Wireless Local Area Network (WLANs)

The Wi-Fi Alliance

The Wi-Fi Alliance

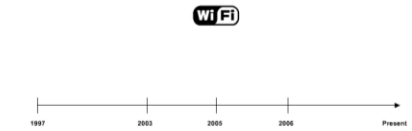
The Wi-Fi Alliance

About ~~300~~ 600 companies are part of the Wi-Fi Alliance

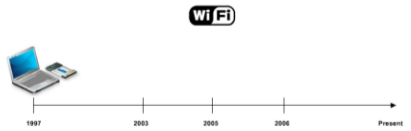
The Wi-Fi Alliance

certified over 45000 products

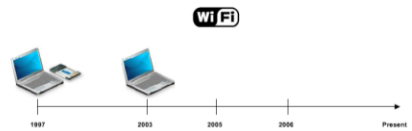
Evolution of Wi-Fi



Evolution of Wi-Fi



Evolution of Wi-Fi



Evolution of Wi-Fi

Evolution of Wi-Fi

Evolution of Wi-Fi

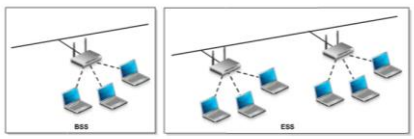
Evolution of Wi-Fi

WLAN NETWORK IMPLEMENTATION

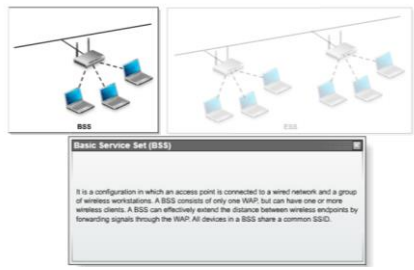
Service Set Identifier (SSID)

Service Set Identifier (SSID)

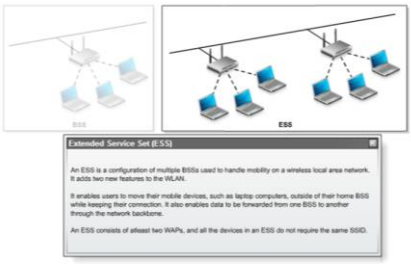
Service Set



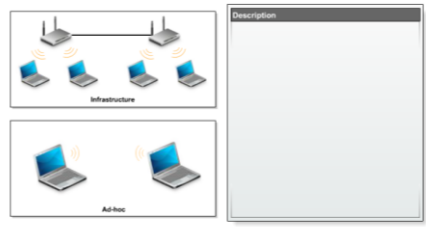
Service Set



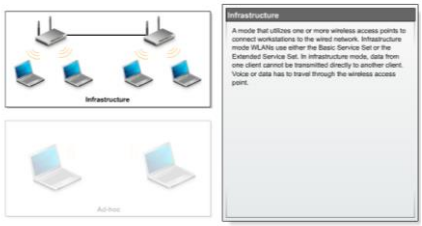
Service Set



Wi-Fi Network Types

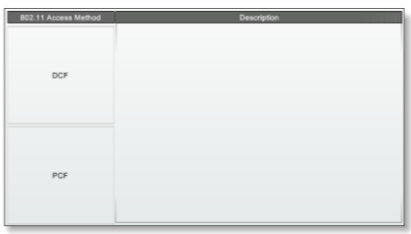


Wi-Fi Network Types

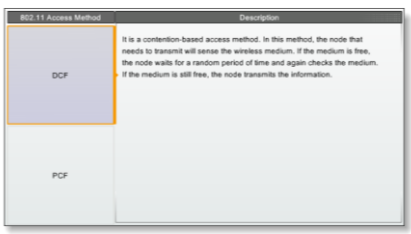


Wi-Fi Network Types

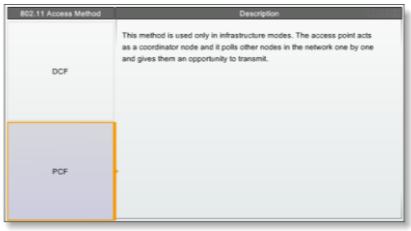
802.11 Access Methods



802.11 Access Methods



802.11 Access Methods



Wi-Fi Deployment

Wi-Fi Deployment

Wi-Fi Deployment

Wi-Fi Deployment

Wi-Fi Deployment

802.11 Wireless Standards

Standard	Description
802.11	
802.11a	
802.11b	
802.11e	
802.11g	

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	

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	

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. 802.11b has a range up to 1,000 feet in an open area, and a range of 200 to 400 feet in an enclosed space (where walls might hamper the signal). It is backward compatible with 802.11, but it is not interoperable with 802.11a.
802.11e	
802.11g	

802.11 Wireless Standards

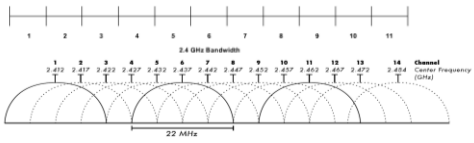
Standard	Description
802.11	
802.11a	
802.11b	
802.11e	802.11e is a draft wireless standard for both home and business implementations. It provides multimedia support to 802.11a and 802.11b and is compatible with those standards.
802.11g	

802.11 Wireless Standards

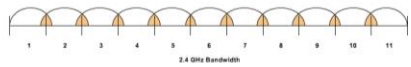
Standard	Description
802.11	
802.11a	
802.11b	
802.11e	
802.11g	802.11g is a specification for wireless data throughput at the rate of up to 54 Mbps in the 2.4 GHz band. It is compatible with 802.11b, which may be replaced by 802.11g due to faster speeds.

Wi-Fi Channelization

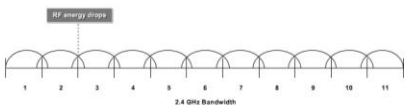
In Europe;
- European Telecommunications Standards Institute (ETSI)
- 13 channels



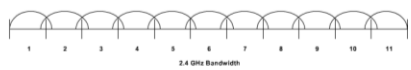
Wi-Fi Channelization



Wi-Fi Channelization

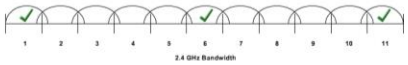


Wi-Fi Channelization



Causes interference issues when there is an increase in the number of users

Wi-Fi Channelization

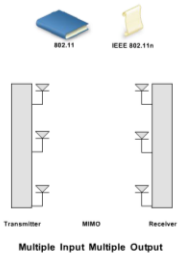


IEEE 802.11N

The IEEE 802.11n Standard

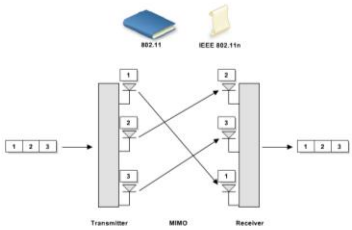
data rate of up to 600 Mbps

The IEEE 802.11n Standard

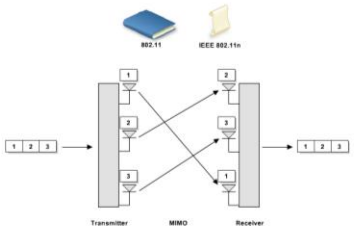


Multiple Input Multiple Output

The IEEE 802.11n Standard



The IEEE 802.11n Standard



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

The IEEE 802.11n Standard

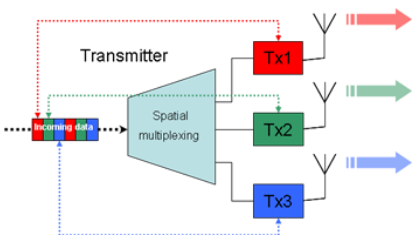
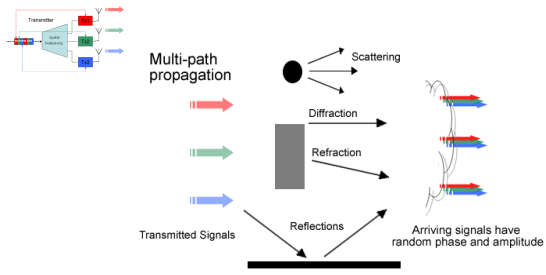


Figure Source: http://www.air-stream.org.au/mimo

The IEEE 802.11n Standard



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The IEEE 802.11n Standard

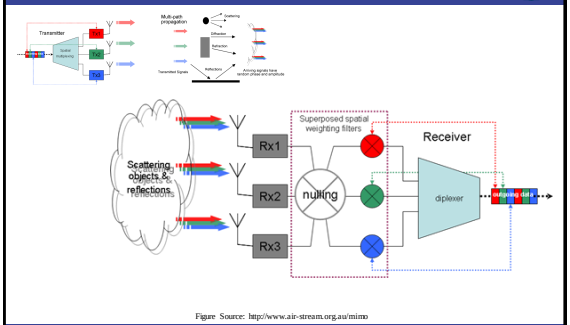


Figure Source: http://www.air-stream.org.au/mimo

The IEEE 802.11n Standard

Enhanced Wireless Consortium

The IEEE 802.11n Standard

MIMO
OFDM

Advantages of IEEE 802.11n

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

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	

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	

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	

Advantages of IEEE 802.11n

Advantage	Description
More bandwidth for users	Generally, in Wi-Fi 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	

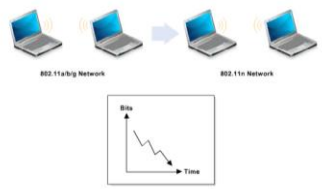
Advantages of IEEE 802.11n

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	

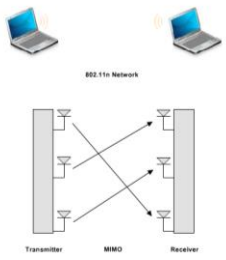
Challenges in IEEE 802.11n Deployment

Challenges in IEEE 802.11n Deployment

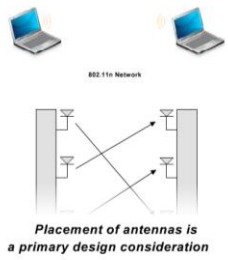
Challenges in IEEE 802.11n Deployment



802.11n Network Design

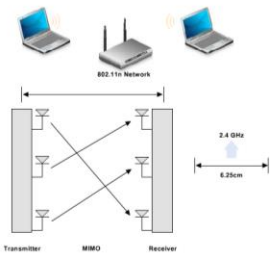


802.11n Network Design

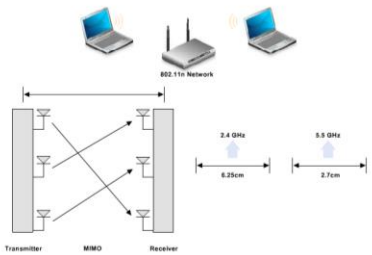


Placement of antennas is a primary design consideration

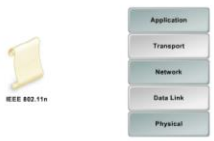
802.11n Network Design



802.11n Network Design



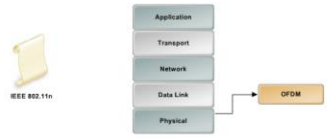
802.11n Physical Layer Technologies



802.11n Physical Layer Technologies

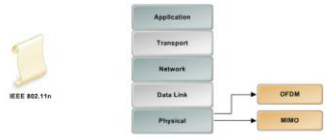
Orthogonal Frequency Division Multiplexing

802.11n Physical Layer Technologies



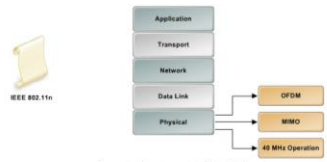
OFDM supports higher data rates

802.11n Physical Layer Technologies



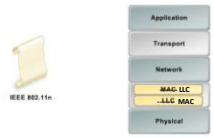
Longer range
Uniform signal coverage

802.11n Physical Layer Technologies



Supports approximately twice the data rate

802.11n MAC Layer Features



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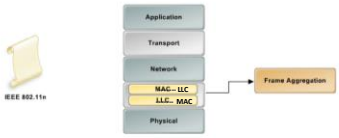

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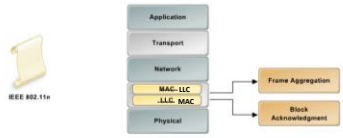
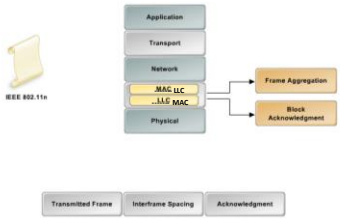


802.11n MAC Layer Features



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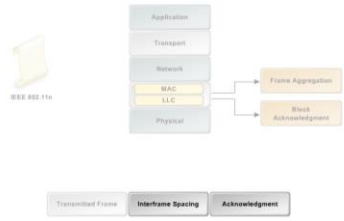
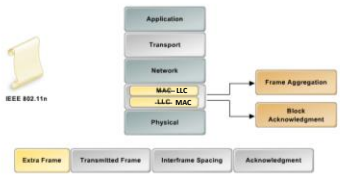


802.11n MAC Layer Features



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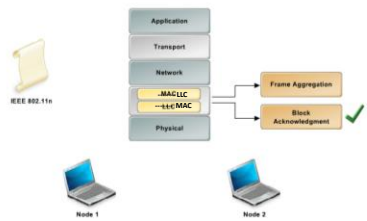

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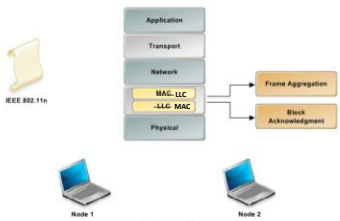


Optimize the performance of a network

QoS in WiFi NETWORKS

Quality of Service

Quality of Service

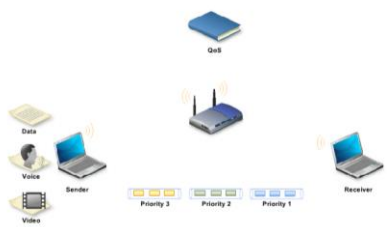
Quality of Service

QoS parameters include:

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

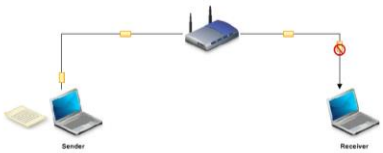
Quality of Service

Quality of Service



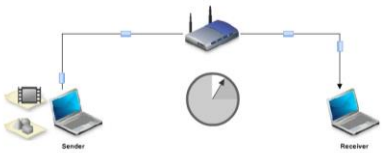
Need for QoS

Need for QoS



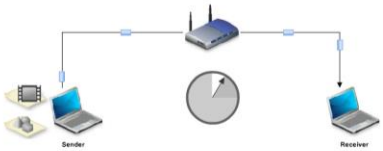
Sensitive to packet loss

Need for QoS



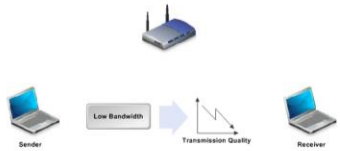
Sensitive toward delays

Need for QoS

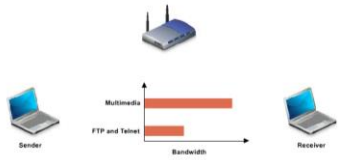


Optimum usage of bandwidth is critical while dealing with multimedia applications

Need for QoS



Need for QoS



Parameters Influencing QoS

Parameter	Description
Bandwidth	
Latency	
Jitter	
Packet loss	

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	

Parameters Influencing QoS

Parameter	Description
Bandwidth	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.
Latency	
Jitter	
Packet loss	

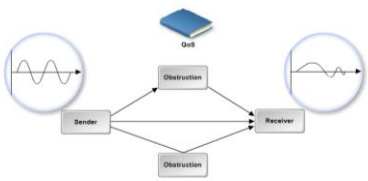
Parameters Influencing QoS

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

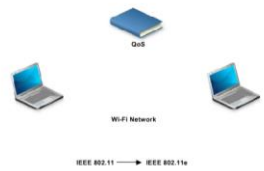
Parameters Influencing QoS

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

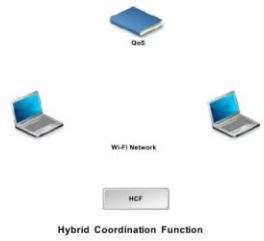
Challenges of Wireless QoS



The 802.11e Standard



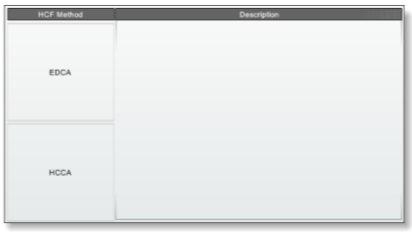
The 802.11e Standard



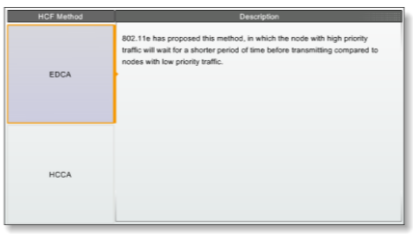
Hybrid Coordination Function

The 802.11e Standard

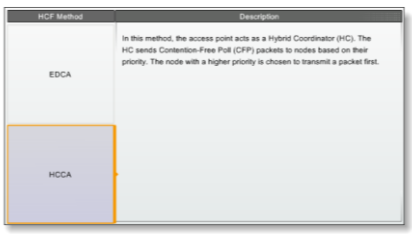
Enhanced Distributed Coordination Access (EDCA)
HCF Controlled Channel Access (HCCA)



The 802.11e Standard



The 802.11e Standard



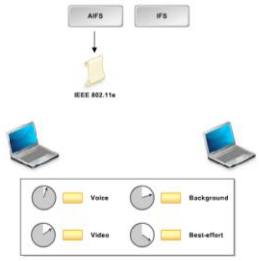
Arbitrary Inter-frame Spacing

Arbitrary Inter-Frame Spacing

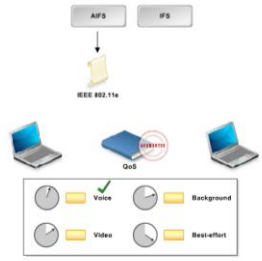
Arbitrary Inter-frame Spacing

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

Arbitrary Inter-frame Spacing



Arbitrary Inter-frame Spacing



EVOLUTION OF SECURITY in WiFi NETWORKS

Wired Equivalent Privacy

Wired Equivalent Privacy

Wired Equivalent Privacy

64-bit
128-bit
256-bit

Wired Equivalent Privacy

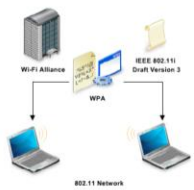
Wired Equivalent Privacy

Wired Equivalent Privacy

Wi-Fi Protected Access

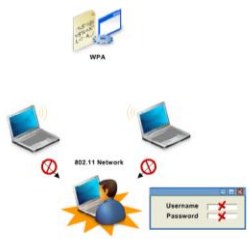
Wi-Fi Protected Access

Wi-Fi Protected Access



Wi-Fi Protected Access

Wi-Fi Protected Access



Wi-Fi Protected Access

Temporal Key Integrity Protocol

Wi-Fi Protected Access

802.1x

Wi-Fi Protected Access

Extensible Authentication Protocol

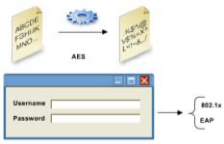
WPA-2

WPA-2

Advanced Encryption Standard

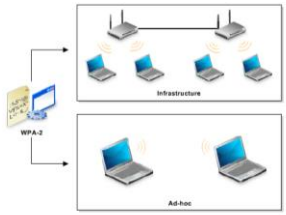
WPA-2

WPA-2

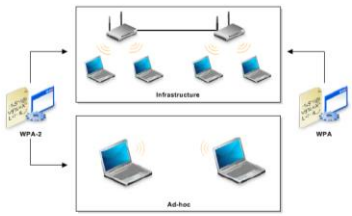


802.11i is referred to as WPA-2

WPA-2



WPA-2

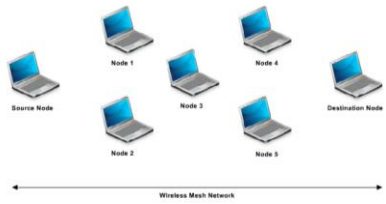


WPA-2

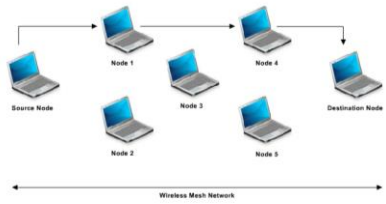
FUTURE TRENDS in Wifi

Wireless Mesh Networks

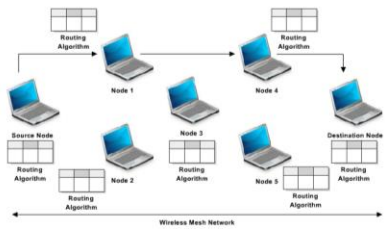
Wireless Mesh Networks



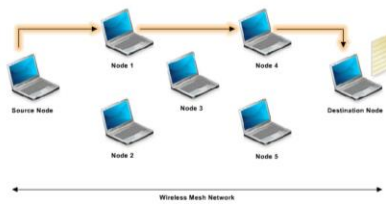
Wireless Mesh Networks



Wireless Mesh Networks



Wireless Mesh Networks



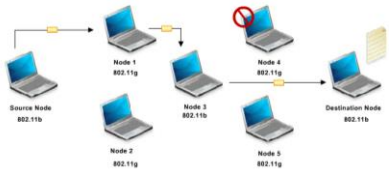
Wireless Mesh Networks

Wireless Mesh Networks

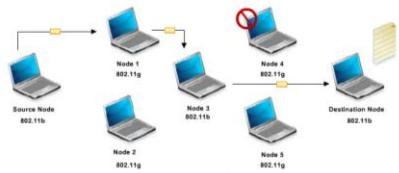
802.11s extends the reach of an 802.11 adhoc network

Wireless Mesh Networks

Wireless Mesh Networks



Wireless Mesh Networks



Low power nodes can be used in these networks

Wireless Mesh Networks

Wireless mesh networks are emerging as a key technology for next generation wireless networks

Very High Throughput

Very High Throughput

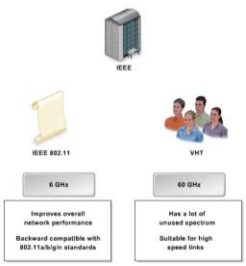
Very High Throughput

1 Gbps

Very High Throughput

Very High Throughput

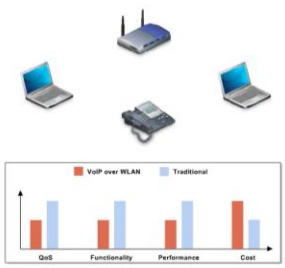
Very High Throughput



Very High Throughput

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

VoIP over WLAN



VoIP over WLAN