# Lecture (11)
# Wireless LAN

**By:**

**Dr. Ahmed ElShafee**

FACULTY OF ENGINEERING
AHRAM CANADIAN UNIVERSITY



## Introduction

- A *wireless network* is a network that uses radio signals rather than direct cable connections to exchange information.
- A wireless network is often referred to as a *WLAN,* for *wireless local area network.*
- The term *Wi-Fi* is often used to describe wireless networks, although it technically refers to just one form of wireless networks: the 802.11b/g/n standards.
- A wireless network has a name, known as a *SSID.*
- SSID stands for *service set identifier* Each of the computers that belong to a single wireless network must have the same SSID.



- Wireless networks can transmit over any of several channels.
- In order for computers to talk to each other, they must be configured to transmit on the same channel.
- The simplest type of wireless network consists of two or more computers with wireless network adapters.
- This type of network is called an *ad-hoc mode network.*
- A more complex type of network is an *infrastructure mode network.*
- All this really means is that a group of wireless computers can be connected not only to each other, but also to an existing cabled network via a device called a *wireless access point,* or AP.

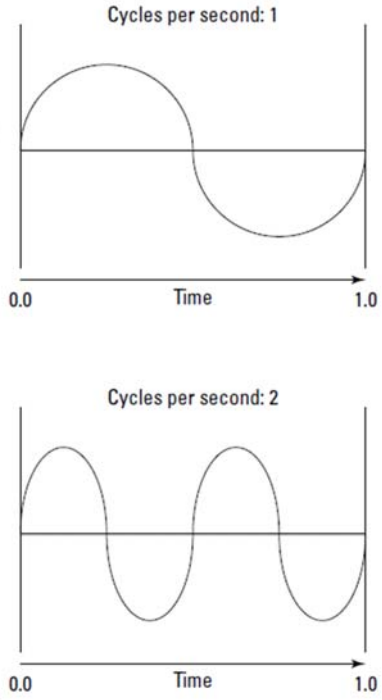


## Revision

**Waves and frequencies**

- *radio* consists of electromagnetic waves that are sent through the atmosphere.
- radio receivers can pick them up and convert them into sounds, images, or — in the case of wireless networks — data.
- Radio waves are actually cyclical waves of electronic energy (Electromagnetic) that repeat at a particular rate, called the *frequency*
- The measure of a frequency is *cycles per second,* which indicates how many complete cycles the wave makes in one second

- *cycles per second* is usually referred to as *Hertz,* abbreviated Hz.
- 1 Hz is one cycle per second. Incidentally, when the prefix *K* (for *kilo,* or 1,000), *M* (for *mega,* 1 million), or *G* (for *giga,* 1 billion) is added to the front of Hz.






- Transmitters can be tuned to broadcast radio waves at a certain frequency.
- Likewise, receivers can be tuned to receive radio waves at a certain frequency, ignoring waves at other frequencies.
- That's why you can tune the radio in your car to listen to dozens of different radio stations: Each station broadcasts at its own frequency.



- **Wavelength and antennas**
- A term related to frequency is *wavelength.*
- Radio waves travel at the speed of light.
- The term *wavelength* refers to how far the radio signal travels with each cycle.

$$F = C/\lambda$$

- the wavelength decreases as the frequency increases.
- The wavelength of a typical AM radio station broadcasting at 580 KHz is about 500 meters.
- For a TV station broadcasting at 100 MHz, it's about 3 meters.
- For a wireless network broadcasting at 2.4 GHz, the wavelength is about 12 centimeters.



- It turns out that the shorter the wavelength, the smaller the antenna needs to be in order to adequately receive the signal.
- higher frequency transmissions need smaller antennas.

# Spectrums, FCC, and ETSI

- The term *spectrum* refers to a continuous range of frequencies on which radio can operate.
- In the United States, the Federal Communications Commission (FCC) governs spectrum usage and allocation.
- In Europe and MENA, ETSI governs spectrum usage and allocation.
- radio spectrum is devised into dozens of small ranges called *bands* and restricted certain uses to certain bands.
- For example, AM radio operates in the band from 535 KHz to 1,700 KHz.



**Popular Bands of the Radio Spectrum**

| *Band* | *Use* |
|---|---|
| 535 KHz–1,700 KHz | AM radio |
| 5.9 MHz–26.1 MHz | Short wave radio |
| 26.96 MHz–27.41 MHz | Citizens Band (CB) radio |
| 54 MHz–88 MHz | Television (VHF channels 2 through 6) |
| 88 MHz–108 MHz | FM radio |
| 174 MHz–220 MHz | Television (VHF channels 7 through 13) |
| 470 MHz–806 MHz | Television (UHF channels) |
| 806 MHz–890 MHz | Cellular networks |
| 900 MHz | Cordless phones |
| 1850 MHz–1990 MHz | PCS cellular |
| 2.4 GHz–2.4835 GHz | Cordless phones and wireless networks (802.11b and 802.11g) |
| 4 GHz–5 GHz | Large dish satellite TV |
| 5 GHz | Wireless networks (802.11a) |
| 11.7 GHz–12.7 GHz | Small dish satellite TV |

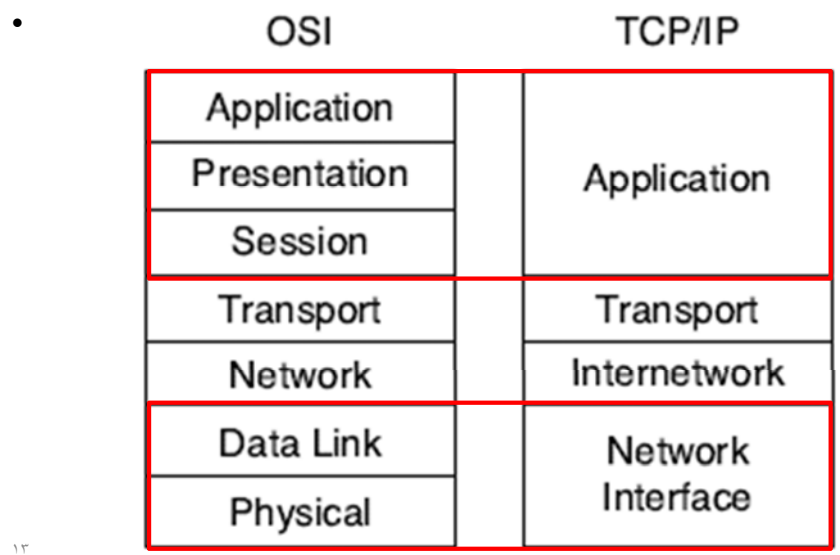


- Two of the bands in the spectrum are allocated for use by wireless networks: 2.4 GHz and 5 GHz.



# 802.11

- The most popular standards for wireless networks are the IEEE 802.11 standards.
- These standards are essential wireless Ethernet standards and use many of the same networking techniques that the cabled Ethernet standards (in other words, 802.3)
- The 802.11 standards address the bottom two layers of the IEEE seven-layer model: The Physical layer and the data link layer.
- Note that TCP/IP protocols apply to higher layers of the model.
- As a result, TCP/IP runs just fine on 802.11 networks.






- The original 802.11 standard was adopted in 1997.
- Two additions to the standard, 802.11a and 802.11b, were adopted in 1999.
- The latest and greatest versions are 802.11g and 802.11n.

**802.11 Variations**

| *Standard* | *Speeds* | *Frequency* |
|---|---|---|
| 802.11a | Up to 54 Mbps | 5 GHz |
| 802.11b | Up to 11 Mbps | 2.4 GHz |
| 802.11g | Up to 54 Mbps | 2.4 GHz |
| 802.11n | Up to 300Mbps (but most devices are in the 100Mbps range) | 2.4GHz |



# Ranges

- The maximum range of an 802.11g wireless device indoors is about 100 meters.
- Although the normal range for 802.11g is 100 meters , the range may be less in actual practice.
- Obstacles such as solid walls, bad weather, cordless phones, microwave ovens, nuclear reactors, all can conspire together to reduce the effective range of a wireless adapter.
- Also, wireless networks tend to slow down when the distance increases.
- 802.11g network devices claim to operate at 54 Mbps, but they usually achieve that speed only at ranges of 30 meters or less.



# Wireless Network Adapters

- The wireless network adapter is similar to the network interface card (NIC) that's used for a standard Ethernet connection.
- However, instead of having a cable connector on the back, a wireless network adapter has an antenna.

# Wireless Access Points

- *wireless access point,* also known as a *AP.*
- AP actually performs two functions:
  - First, it acts as a central connection point for all your computers that have wireless network adapters.
  - In effect, the AP performs essentially the same function as a hub or switch performs for a wired network.
  - Second, the AP links your wireless network to your existing wired network so that your wired computer and your wireless computers get along like one big happy family.



# Infrastructure mode

- When you set up a wireless network with an access point, you are creating an *infrastructure mode* network.
- It's called *infrastructure mode* because the access point provides a permanent infrastructure for the network.
- The access points are installed at fixed physical locations, so the network has relatively stable boundaries.
- Whenever a mobile computer comes into the range of one of the access points, it has come into the sphere of the network and can connect.



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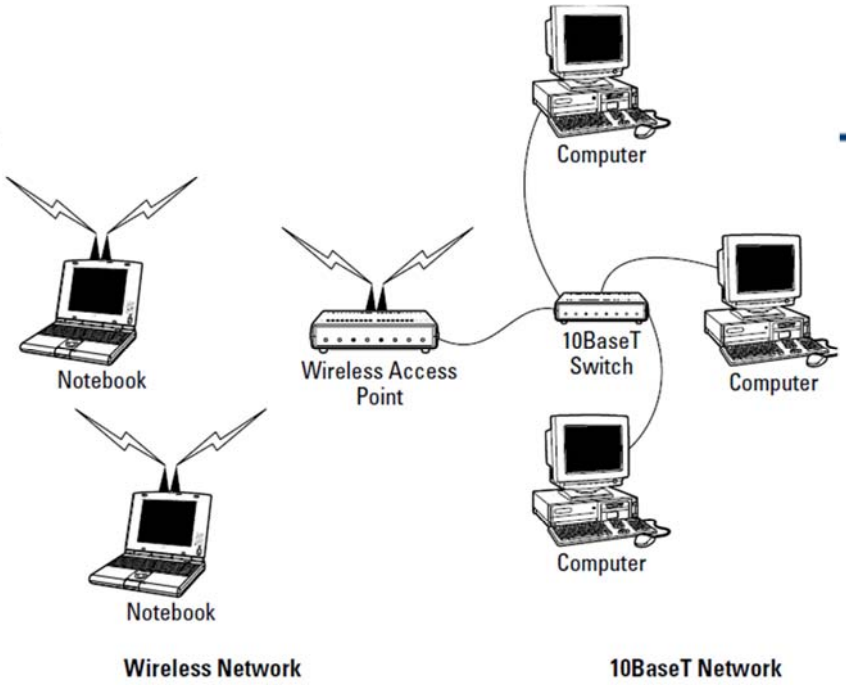




- An access point and all the wireless computers that are connected to it are referred to as a *Basic Service Set,* or *BSS.*
- Each BSS is identified by a *Service Set Identifier,* or *SSID.*
- When you configure an access point, you specify the SSID that you want to use.
- The SSID is often a generic name such as *wireless,* or it can be a name that you create.

**Multifunction WAPs**

- Wireless access points often include other built-in features.
- For example, some access points double as Ethernet hubs or switches, In that case, the access point will have more than one RJ-45 port.
- In addition, some access points include broadband cable or DSL firewall routers that enable you to connect to the Internet.



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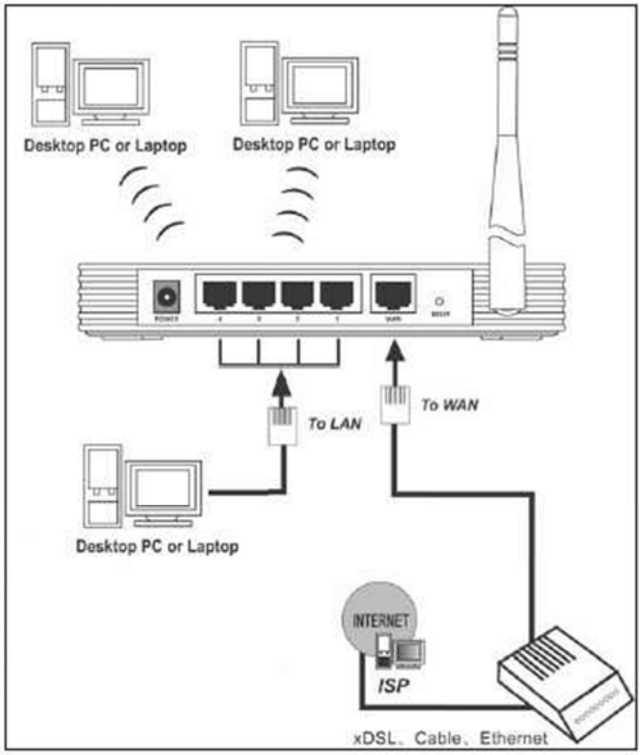





- A multifunction access point that's designed to serve as an Internet gateway for home networks .
  - 802.11b wireless access enables users to connect their PCs wireless
  - A four-port 10/100 MHz switch that I can connect up to four computers to via twisted-pair cable.
  - A DSL/cable router that connect user network to internet.
- This enables all the computers on the network (cabled and wireless) to access the Internet.

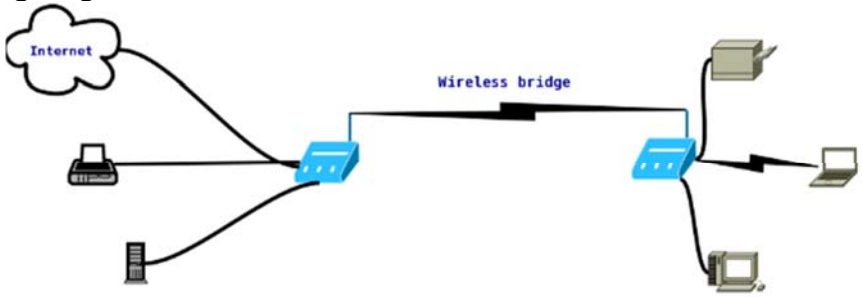


# Roaming

- You can use two or more wireless access points to create a large wireless network in which computer users can roam from area to area and still be connected to the wireless network.
- As the user moves out of the range of one access point, another access point automatically picks up the user and takes over without interrupting the user's network service.

# Wireless bridging

- Another use for wireless access points is to bridge separate subnets that can't easily be connected by cable.
- Connect one of the access points to the first, network and the other access point to the second network.
- Then, configure both access points to operate in bridge mode giving each AP the MAC of the other AP.






# Ad-hoc networks

- A wireless access point is not necessary to set up a wireless network.
- Any time two or more wireless devices come within range of each other, they can link up to form an *ad-hoc network.*
- All of the computers within range of each other in an ad-hoc network are called an *Independent Basic Service Set*, or *IBSS.*




# Configuring a Wireless Access Point

- **Enable/Disable:** Enables or disables the device's wireless access point functions.
- **SSID:** The Service Set Identifier used to identify the network.
- **Allow broadcast SSID to associate?** Disables the access point's periodic broadcast of the SSID.
- Normally, the access point regularly broadcasts its SSID so that wireless devices that come within range can detect the network and join in.
- For a more secure network, you can disable this function.
- Then, a wireless client must already know the network's SSID in order to join the network.



- **Channel:** Lets you select 1 of 11 channels on which to broadcast.
- All the access points and computers in the wireless network should use the same channel.
- **WEP (security):** Lets you use a security protocol called *wired equivalent privacy.*
- **DHCP configuration:** it's common for the access point to also be the DHCP server for the entire network.

# Securing a Wireless Network

- Wired networks are so secure that no one can gain access to the network if only he is physically connect to your network.
- on the other hand wireless networks are totally open, in which anyone within range of your wireless transmissions can log on.
- The goal of securing a wireless network is to find the happy medium between these two extremes that meets the access and risk-management needs of the organization.
- Wireless connections has important security issues to keep the intruders from accessing, reading and modifying the network traffic.
- We need an algorithm which provides the same level of security that physical wire does.



- usage
  - Protect wireless communication from eavesdropping.
  - Prevent unauthorized access to wireless network
- Goals and services
  - Access Control
    Ensure that your wireless infrastructure is not used.
  - Data Integrity
    Ensure that your data packets are not modified in transit.
  - Confidentiality
    Ensure that the contents of your wireless traffic is not learned



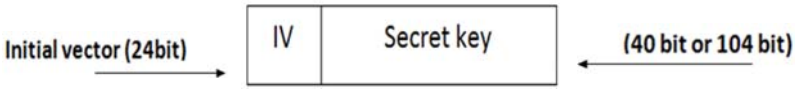
# WEP

- WEP –( Wired Equivalent Privacy)
  - part of the IEEE 802.11 specification
- Goal
  - make the Wi-Fi network at least as secure as a wired LAN.
  - Encrypt data transmitted to prevent the attackers from getting the information or change it.
- Services
  - access control to the network.
  - message confidentiality.
  - message integrity and authenticity.



**Operation**

- WEP uses encryption algorithm called RC4
- The key divided in two parts



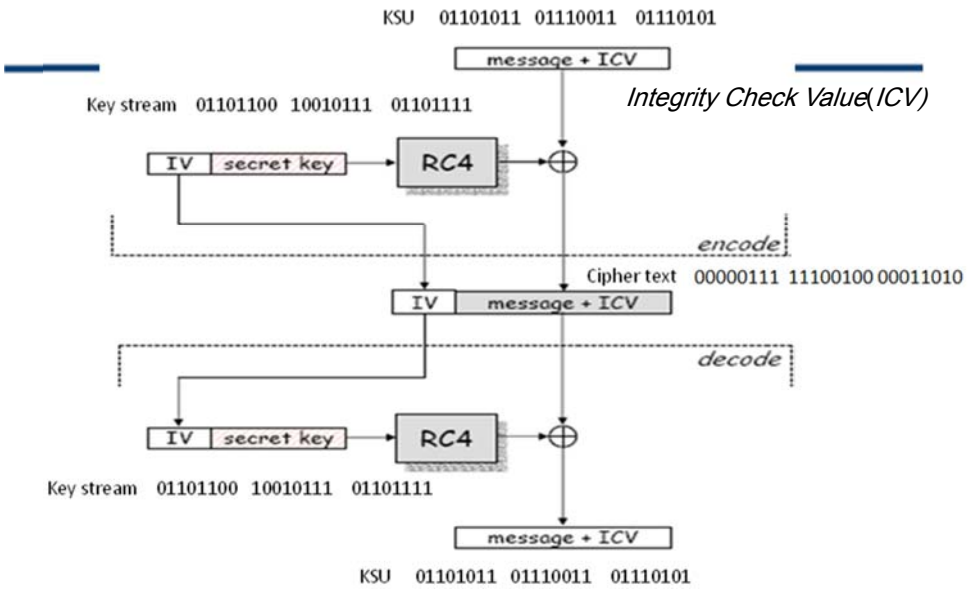

- There are two kinds of WEP
  1)WEP 64 (40 bit + 24 bit).
  2)WEP 128(104 bit + 24 bit).

**Example**

KSU K=6Bh, S=73h, U=75h

| | | | |
|---|---|---|---|
| Plaintext | 01101011 | 01110011 | 01110101 |
| key stream | 01101100 | 10010111 | 01101111 |
| Cipher text | 00000111 | 11100100 | 00011010 |








**The reason of Transition to WPA**

- The same IV can be used more than once.
- The secret key is common in WEP.
- The key that WEP uses is short .
- Most users usually do not change their keys.



# WPA

- WPA –(Wi-Fi Protected Access).
- WPA use the TKIP and depends on RC4.
- The key in WPA consist of 128 bit and 48 bit for initial victor.

**TKIP (*Temporal Key Integrity Protocol* )**

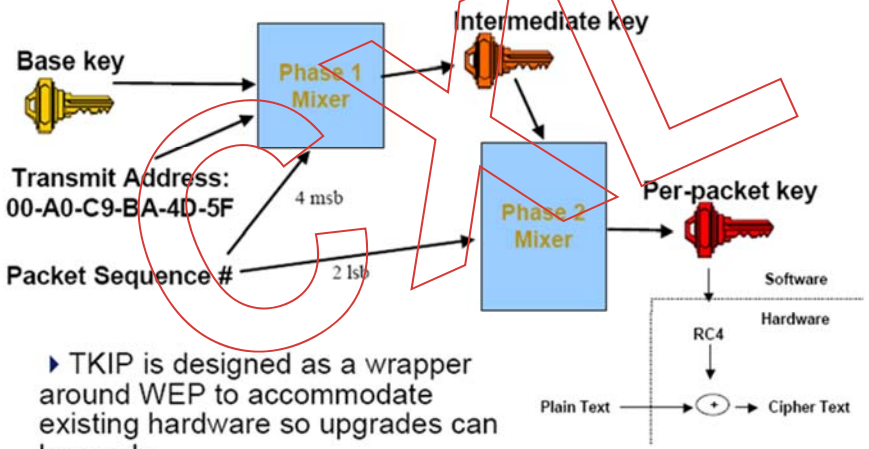
- TKIP is a security protocol used in the IEEE 802.11 wireless networking standard.
- TKIP was a solution to replace WEP without requiring the replacement of legacy hardware.
- TKIP implement three new security features



- First, TKIP implements a key mixing function.
- Second, WPA implements a sequence counter to protect against replay attacks.



**TKIP Design**




- TKIP is designed as a wrapper around WEP to accommodate existing hardware so upgrades can be made



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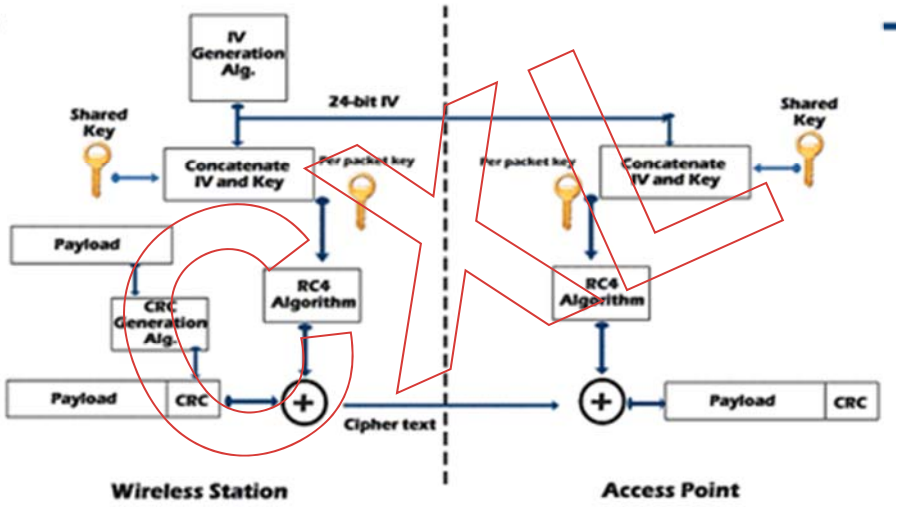

# 802.11i or WPA2

- WPA addressed problems with WEP, but still had room for improvement.
- Implements new encryption algorithm, No use of RC4.
- Uses Advanced Encryption Standard algorithm (AES)
  - Variable key sizes of 128, 192 and 256 bits.
  - Much harder to decrypt than WPA or WEP.
- Not compatible with old (WPA, & WEB)devices
  - Requires new chip sets.



- comparison between protocols

| | WEP | WPA | WPA2 |
|---|---|---|---|
| Encryption algorithm | RC4 | RC4 | AES |
| Key re-generation | None | Dynamic session keys | Dynamic session keys |
| Key distribution | Manually typed into each device | Automatic distribution available | Automatic distribution available |



**Summary**

- security has always been considered important for Wi-Fi.
- WEP is weak against security attacks.
- TKIP provides a quick way to upgrade firmware and fix many of the flaws => WPA
- WAP2 use AES encryption and message integrity check but requires new hardware.



# MAC address filtering

- MAC address filtering allows you to specify a list of MAC addresses for the devices that are allowed to access the network.
- If a computer with a different MAC address tries to join the network via the access point, the access point will deny access.

# Placing your access points outside the firewall

- The most effective security technique for wireless networking is to place all your wireless access points *outside* of your firewall.
- That way, all network traffic from wireless users will have to travel through the firewall to access the network.
- As you can imagine, doing this can significantly limit network access for wireless users.
- To get around those limitations, you can enable a virtual private network (VPN) connection for your wireless users.
- The VPN will allow full network access to authorized wireless users.