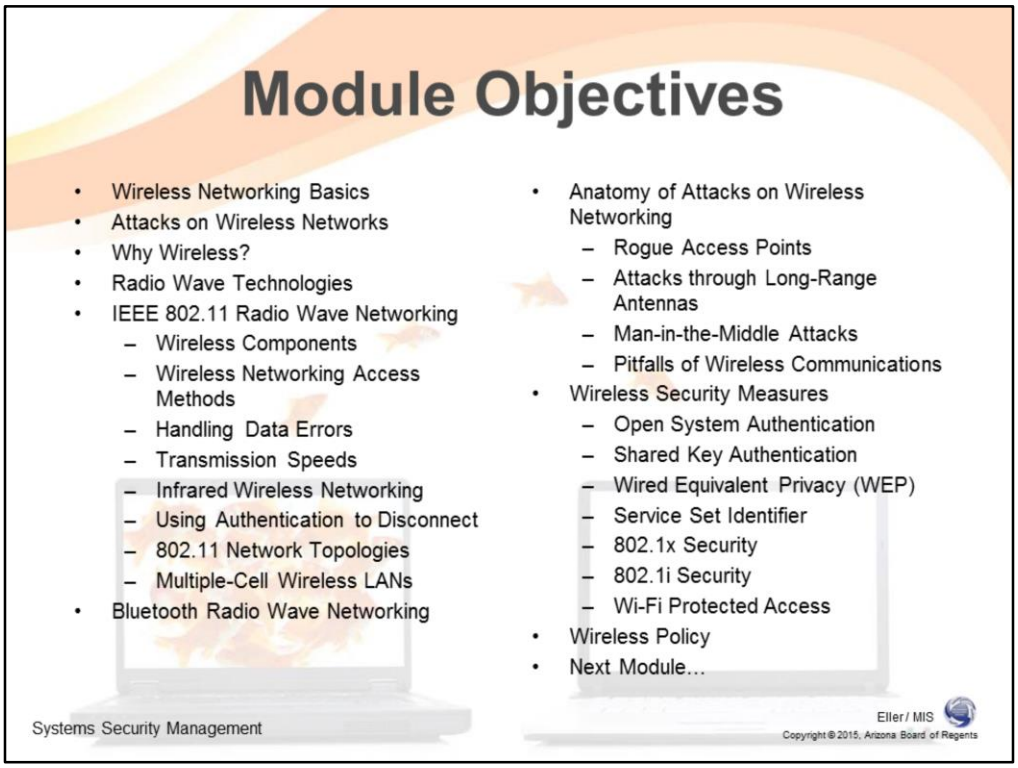
Wireless Security

Module 14

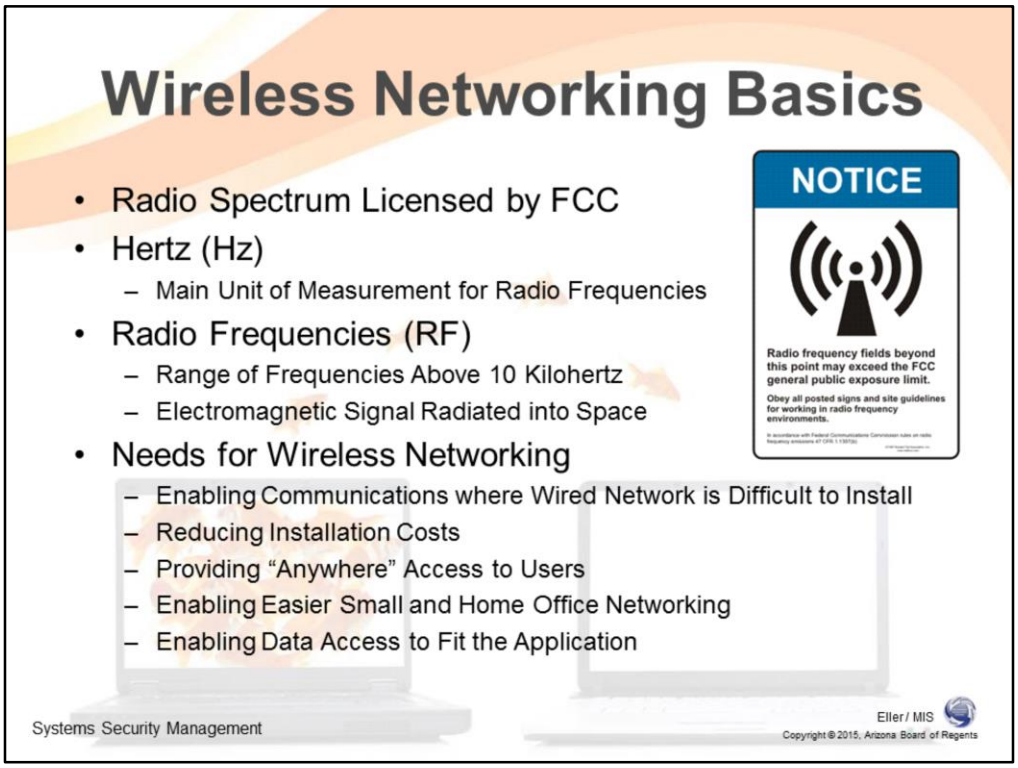
Systems Security Management

Eller / MIS



At the end of the module, you should be able to:

- Understand the basics regarding wireless networking.
- Understand what kind of attacks are possible on wireless networks.
- Describe why wireless is used in organizations.
- Describe the different radio wave technologies in use today.
- Understand the various IEEE 802.11 radio wave networking technologies and how they work.
- Understand the Bluetooth radio wave technology and what it is used for.
- Describe the different methods for attacking wireless networks.
- Describe the different security options available for wireless networks.
- Understand the need for a wireless policy.

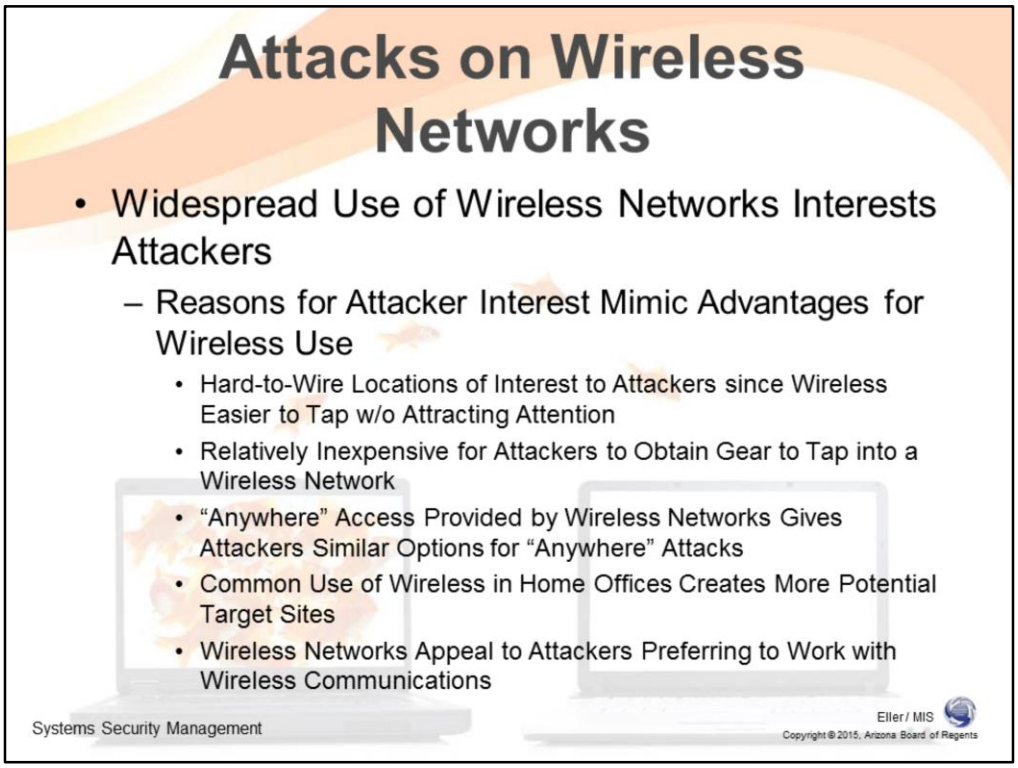


Wireless Networking Basics

In the United States, wireless networks make use of a radio wave spectrum that is licensed by the Federal Communications Commission, or FCC. Radio wave spectrums are measured in hertz (Hz), with radio frequencies, or RF, using the range of frequencies above 10 Kilohertz. Radio frequencies are electromagnetic signals that are radiated throughout a given area and even out into space.

In general there are several reasons why a wireless network might be necessary. These needs include:

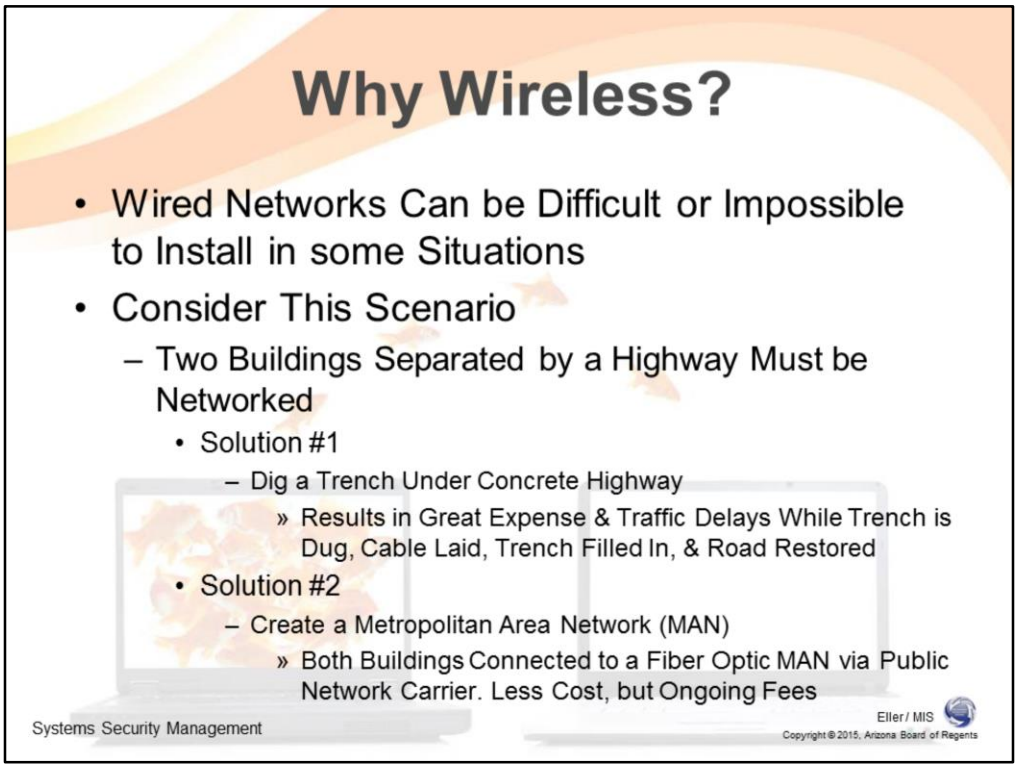
- Enabling Communications where Wired Network is Difficult to Install
- Reducing Installation Costs
- Providing "Anywhere" Access to Users
- Enabling Easier Small and Home Office Networking
- Enabling Data Access to Fit the Application



Attacks on Wireless Networks

The widespread deployment and use of wireless networks is a great interest to attackers, and the reasons these networks interest attackers directly mimic the advantages a wireless network provides for those who need them. Some of these reasons include:

- Hard-to-Wire Locations of Interest to Attackers since Wireless Easier to Tap w/o Attracting Attention.
- Relatively Inexpensive for Attackers to Obtain Gear to Tap into a Wireless Network.
- "Anywhere" Access Provided by Wireless Networks Gives Attackers Similar Options for "Anywhere" Attacks.
- Common Use of Wireless in Home Offices Creates More Potential Target Sites.
- Wireless Networks Appeal to Attackers Preferring to Work with Wireless Communications.



Why Wireless?

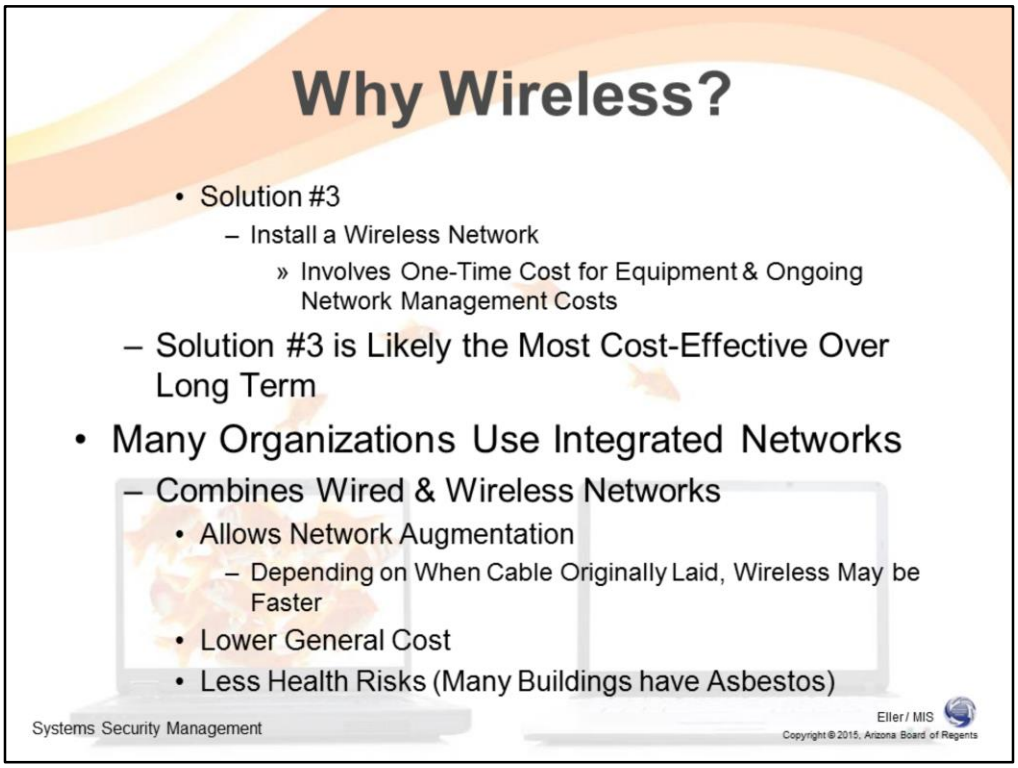
So why install a wireless network? One reason is in some instances it may be too difficult or impossible to install a wired network. Consider the following scenario: an organization is housed in two buildings, and both buildings are separated by a highway that runs between them. Both buildings must have a computer network, and both buildings must be on the same network. How might you accomplish this?

Solution #1

One solution might be to dig a trench under the concrete highway in order to lay fiber optic cable connecting the two buildings. This solution would result in great expense and traffic delays while the trench is dug, cable laid, trench filled in, and finally restoring the roadway.

Solution #2

A second solution might be to create a Metropolitan Area Network, or MAN. This would be accomplished by contracting with an Internet Service Provider, or ISP, for service to each building separately. This solution would allow both buildings to be connected to a fiber optic MAN via the ISP, which would incur less initial cost than solution #1; however, it would have ongoing fees to the ISP for the duration of the contract.

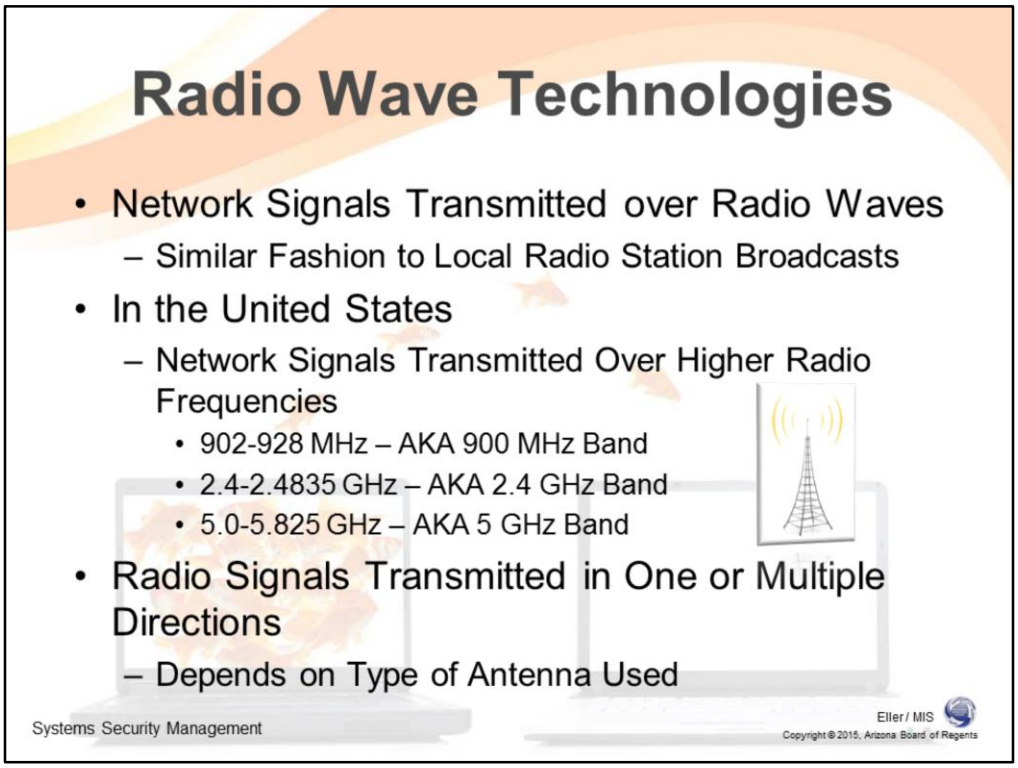


Why Wireless? (continued)

Solution #3

A third solution would be to install a wireless network in both buildings. This solution would involve a one-time cost for equipment and ongoing network management costs. Over the long-term, it is likely this solution would be the most cost-effective.

Many organizations make use of integrated networks, or a network that combines both wired and wireless networks. This allows network augmentation, and depending on when a building's cable was originally laid, wireless networks may be faster. In general, wireless networks provide a lower overall cost to the organization for deployment, and there are less health risks associated with deploying wireless networks since many buildings still have asbestos in the walls.

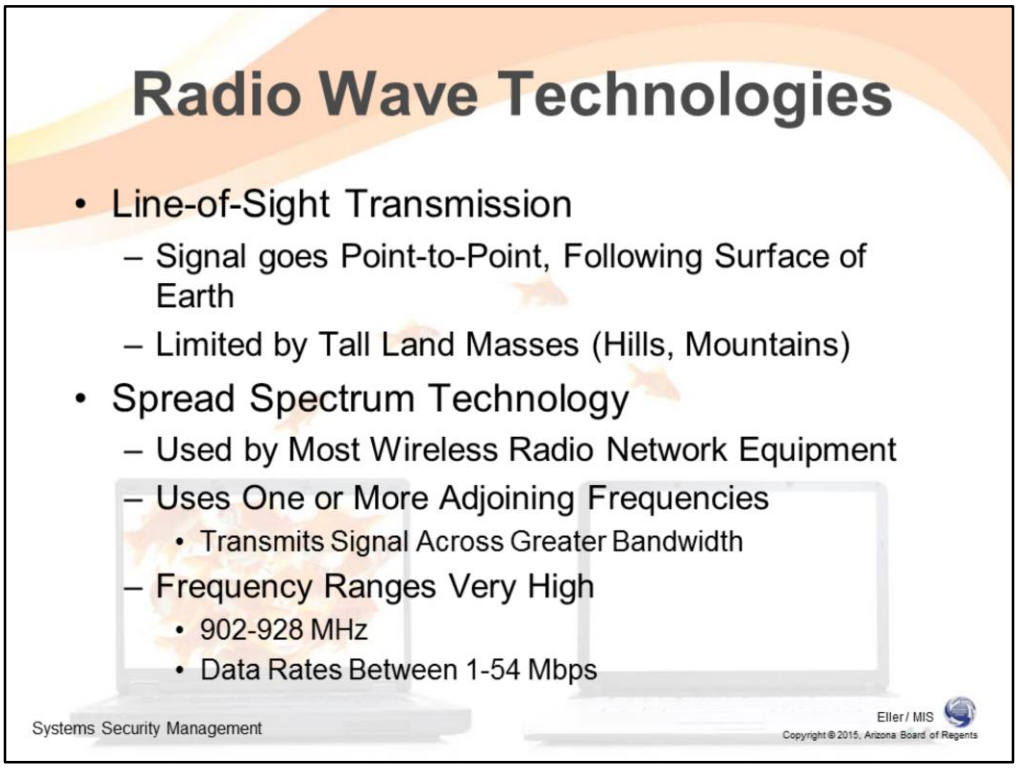


Radio Wave Technologies

Radio wave technologies transmit network signals over radio waves in a fashion similar to local radio station broadcasts. In the United States, network signals are transmitted over higher radio frequencies. The common radio frequency bands include:

- 902-928 MHz (900 MHz Band)
- 2.4-2.4835 GHz (2.4 GHz Band)
- 5.0-5.825 GHz (5 GHz Band)

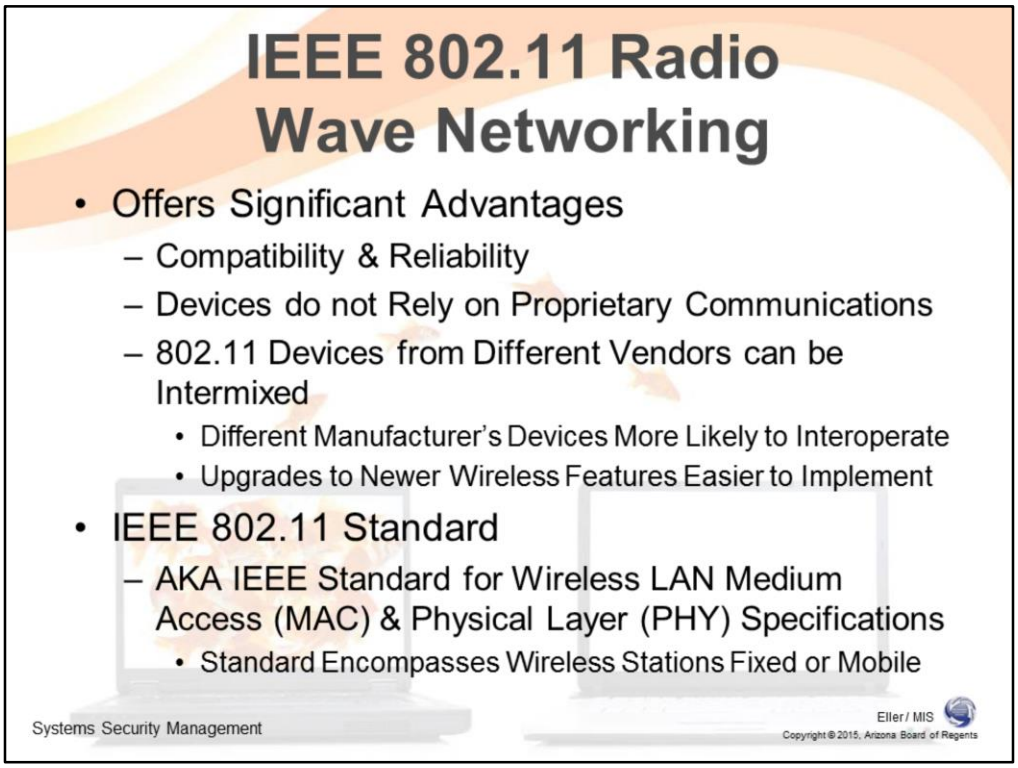
Also, radio signals can be transmitted either in a single direction or multiple directions at the same time, depending on the type of antenna used.



Radio Wave Technologies (continued)

Line-of-sight transmission involves a radio signal being transmitted in a point-to-point manner over the surface of the Earth. This type of transmission is limited by tall land masses, such as hills or mountains.

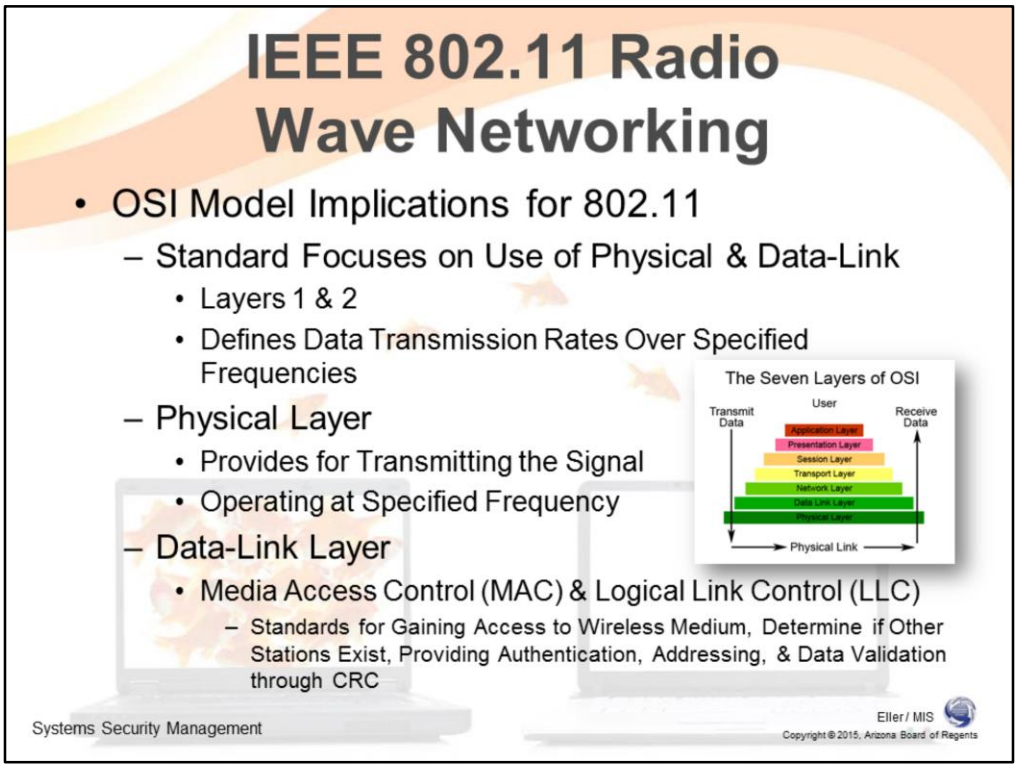
Spread spectrum technology is used by most wireless radio network equipment. Spread spectrum uses one or more adjoining frequencies in order to transmit a signal across a greater bandwidth. The frequency ranges are typically very high, usually operating in the 900 MHz band, from 902-928 MHz, providing data rates between 1-54 megabits per second.



IEEE 802.11 Radio Wave Networking

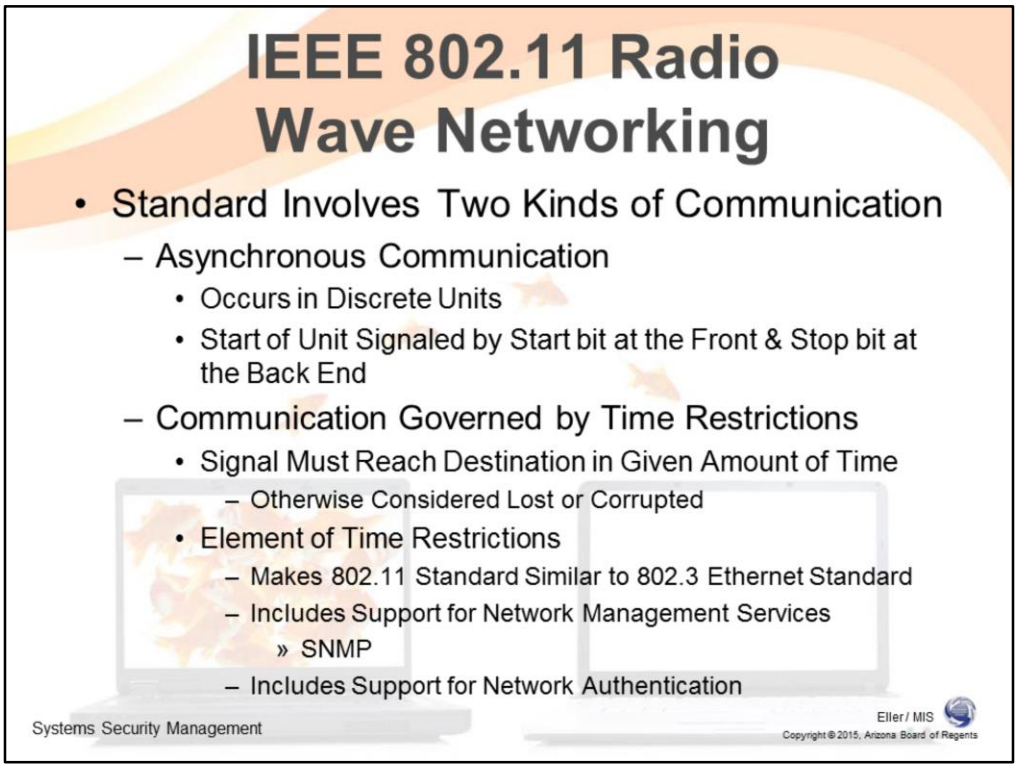
The IEEE 802.11 radio wave networking standards offer significant advantages with compatibility and reliability. These devices do not rely on proprietary communications, making it possible for 802.11 devices from different vendors to be intermixed. This standard allows for different manufacturer's devices to be able to interoperate, and any upgrades to newer wireless features will be easier to implement.

The IEEE 802.11 standard is also referred to as the IEEE standard for wireless LAN medium access and physical layer specifications. The standard encompasses both fixed or mobile wireless stations.



IEEE 802.11 Radio Wave Networking (continued)

There are some OSI Model implications where it relates to 802.11 radio wave networking. The standard focuses on the use of the Physical and Data-Link layers, or layers one and two, defining data transmission rates over specified frequencies. The physical layer provides for transmitting signals, operating at a specified frequency. The data-link layer uses Media Access Control, or MAC, and Logical Link Control, or LLC, which are standards for gaining access to wireless mediums, to determine if other stations exist, and to provide authentication, addressing, and data validation through cyclic redundancy checks, or CRCs.



IEEE 802.11 Radio Wave Networking (continued)

The IEEE 802.11 standard involves two kinds of communication: asynchronous communication and communication governed by time restrictions. Asynchronous communication occurs in discrete units, where the start of a unit is signaled by a start bit at the front and a stop bit at the back end.

Communications that are governed by time restrictions means a signal must reach its destination in a given amount of time, otherwise it is considered lost or corrupted. The element of time restrictions makes the 802.11 standard similar to the 802.3 Ethernet standard. Time restrictions also include support for network management services, such as SNMP, and support for network authentication.

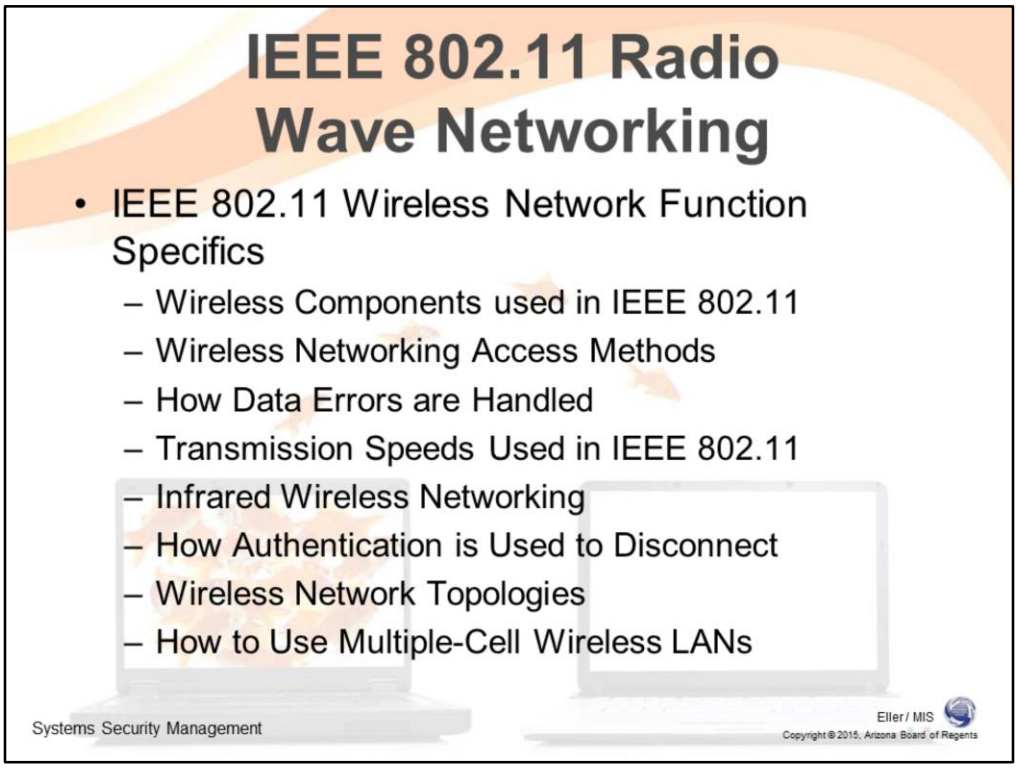
IEEE 802.11 Radio Wave Networking (continued)

IEEE 802.11 standard recognizes both indoor and outdoor uses. Indoor environments the standard supports include:

- Office Buildings
- Manufacturing Floors
- Retail Stores
- Private Homes
- Where Communications Occur Inside a Single Building

Outdoor environments the standard supports include:

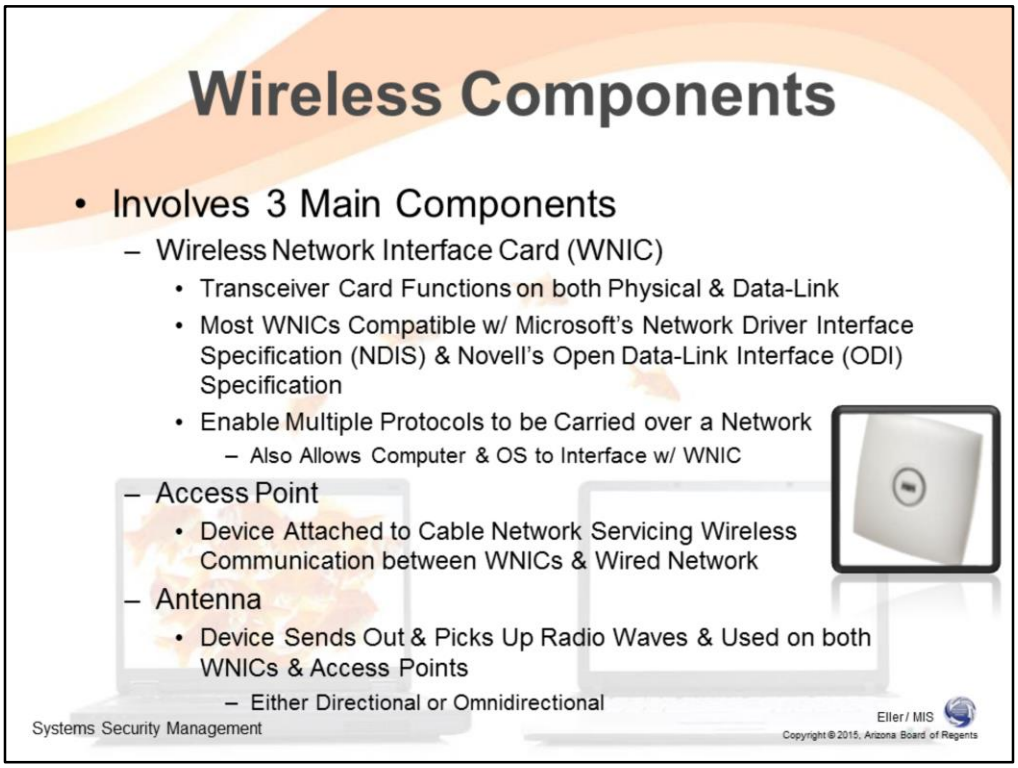
- University Campuses
- Sports Fields
- Parking Areas
- Where Communications are Required Between Buildings



IEEE 802.11 Radio Wave Networking (continued)

Finally, the IEEE 802.11 standard defines several wireless network function specifics, including:

- Wireless Components used in IEEE 802.11
- Wireless Networking Access Methods
- How Data Errors are Handled
- Transmission Speeds Used in IEEE 802.11
- Infrared Wireless Networking
- How Authentication is Used to Disconnect
- Wireless Network Topologies
- How to Use Multiple-Cell Wireless LANs



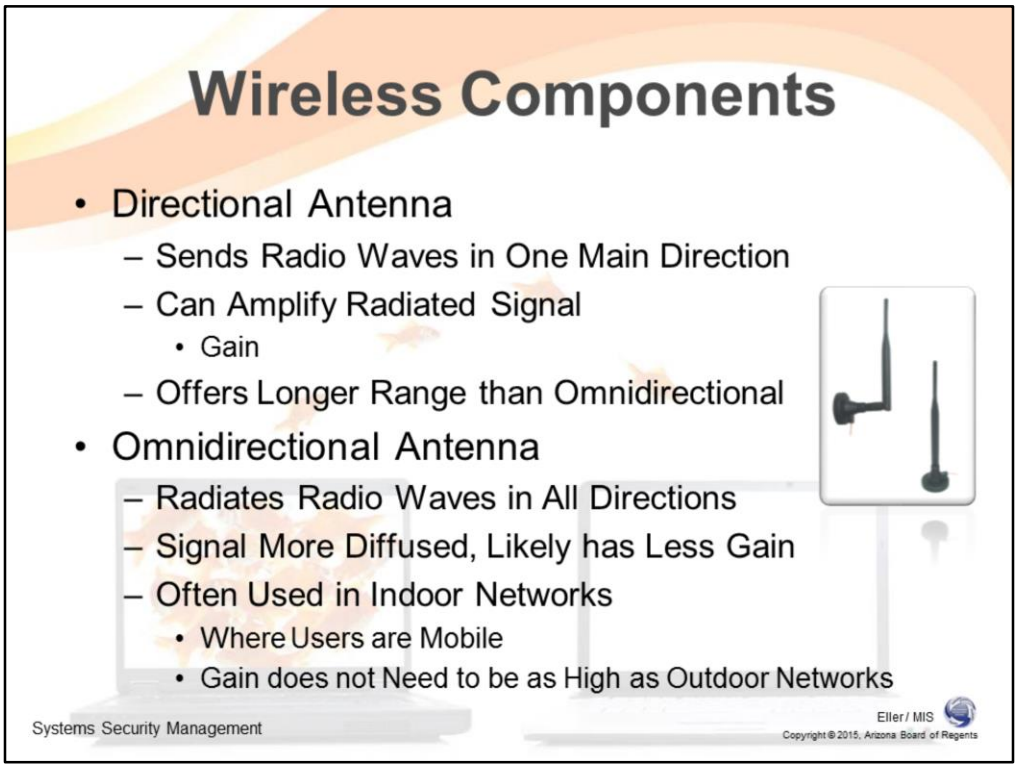
Wireless Components

Deploying a wireless network involves three main components: wireless network interface cards, access points, and antennas.

Wireless network interface cards, or WNICs, are a transceiver card that plugs into your computer (or is provided on the chipset in laptops) and operates on both the Physical and Data-Link layers of the OSI model. Most WNICs are compatible with Microsoft's network driver interface specification, or NDIS, and Novell's open data-link interface, or ODI, specification. Both of these specifications enable multiple protocols to be carried over a network, and allow the computer and operating system to interface with the WNIC.

Access points are devices which are physically attached to a wired network via cable and are designed to service wireless communication between WNICs and the wired network.

Antennas are devices which send out and pick up radio waves. Antennas are used on both WNICs and access points for communication, and they can be either directional or omnidirectional.



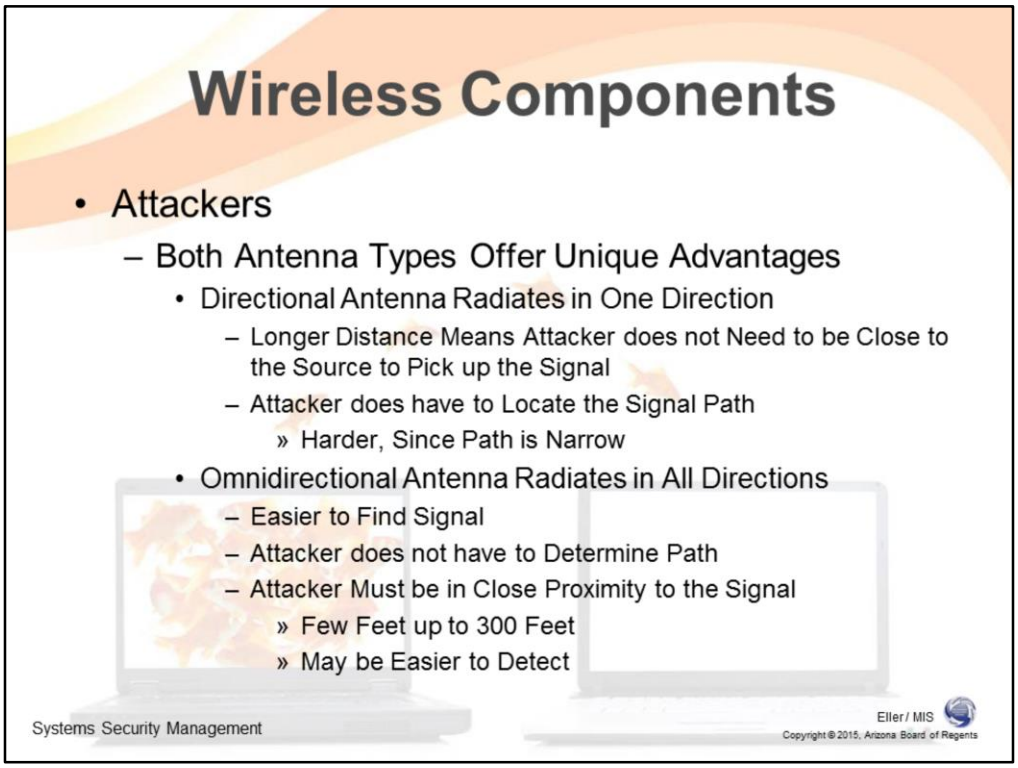
Wireless Components (continued)

Directional Antennas

Directional antennas are designed to send radio waves in one main direction. This allows the antenna to amplify the radiated signal, or gain, in order to offer a longer range than omnidirectional antennas.

Omnidirectional Antennas

Omnidirectional antennas, on the other hand, radiate radio waves in all directions. This means the signal is more diffused; however, it will generally have a lower gain. Omnidirectional antennas are often used in indoor networks where users are mobile. Using them in indoor spaces means the gain does not need to be as high as is necessary for outdoor networks.

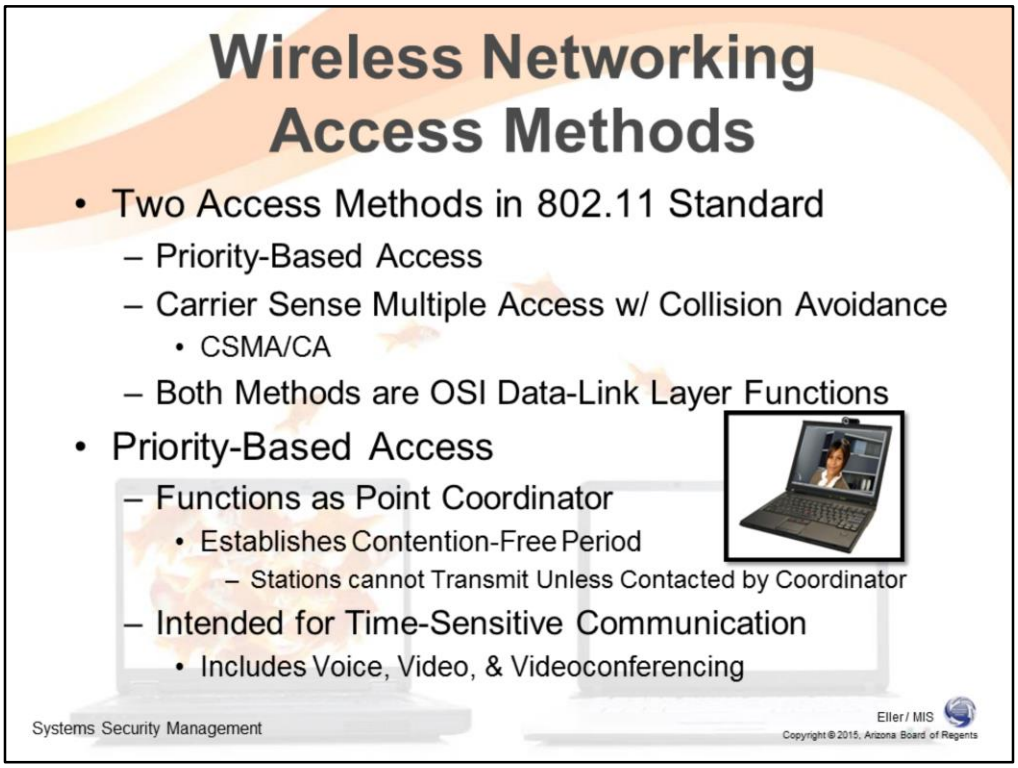


Wireless Components (continued)

When it comes to wireless networks, both types of antennas offer unique advantages with regard to protecting the network against attackers.

Directional antennas radiate in a single direction. For longer distances, this means the attacker does not need to be close to the source in order to pick up the signal; however, the attacker will need to locate the signal path, which is much more difficult since the radio signal path is narrow.

Omnidirectional antennas radiate in all directions, making it much easier for an attacker to find the radio signal since the attacker will not need to determine the signal path. Despite this, the attacker will need to be in close proximity to the signal in order to breach it. This range can be a few feet up to 300 feet, which makes the attacker much easier to detect.

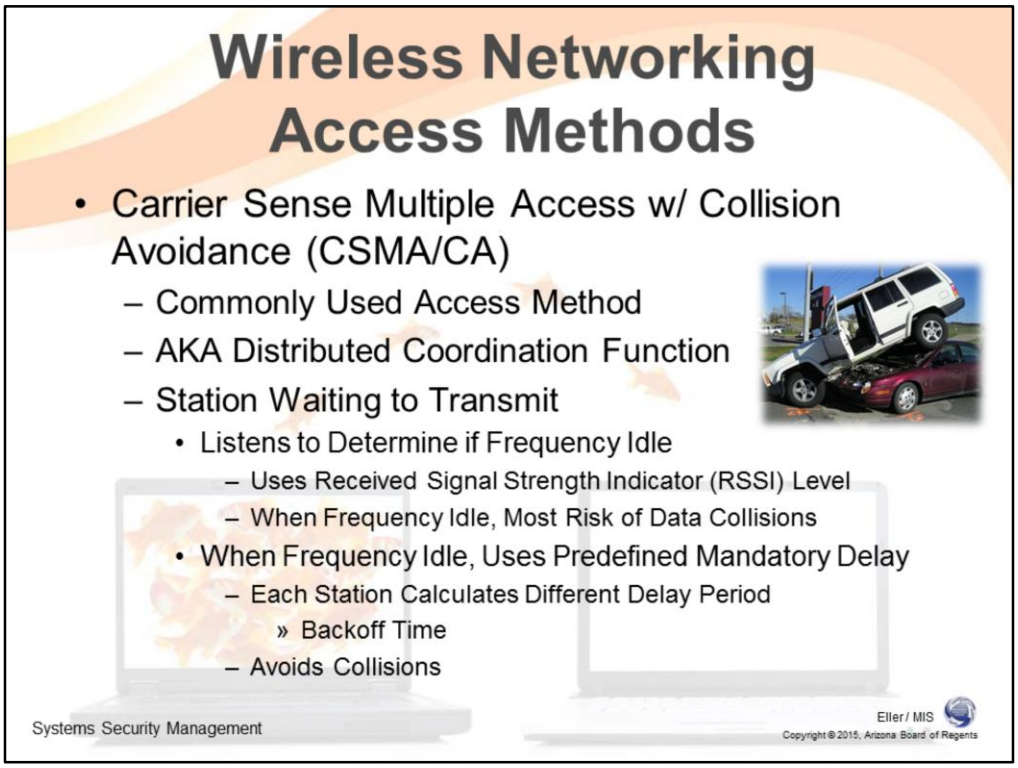


Wireless Networking Access Methods

There are two primary access methods for connecting to 802.11 standard networks: priority-based access and carrier sense multiple access with collision avoidance, or CSMA/CA. Both of these methods are OSI Data-Link layer functions.

Priority-based Access

Priority-based access functions as a point coordinator in order to establish a contention-free period. In other words, when using this access method, stations cannot transmit data unless they are first contacted by a coordinator. This type of access is intended for time-sensitive communications, such as voice, video, and videoconferencing.

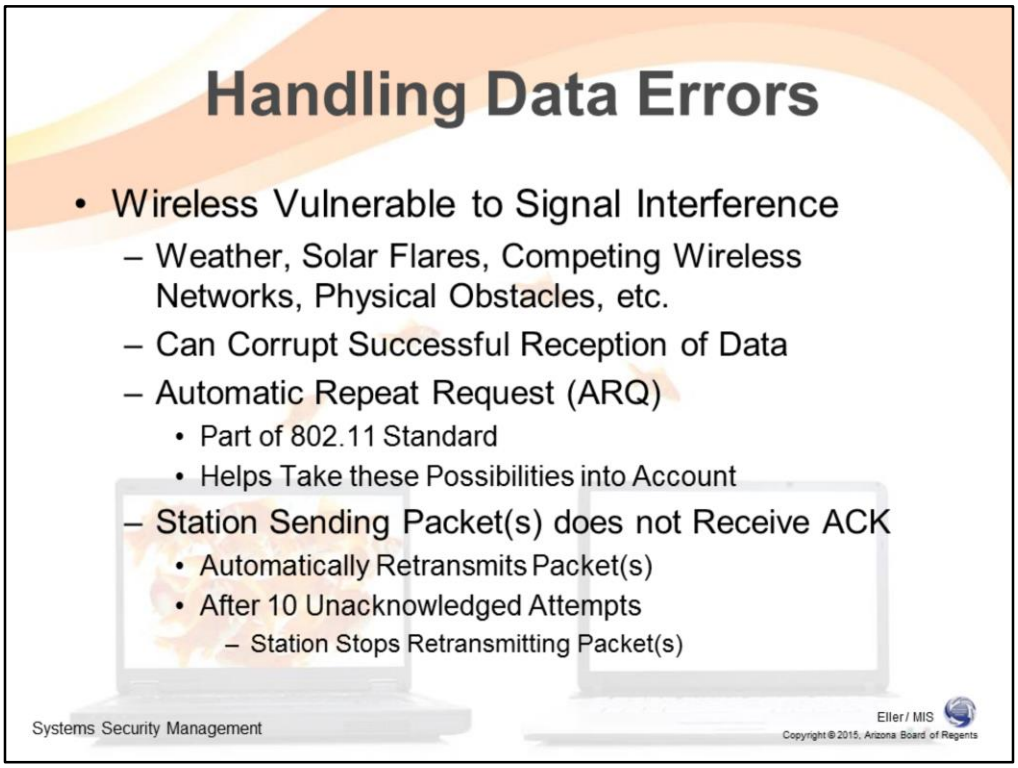


Wireless Networking Access Methods (continued)

Carrier Sense Multiple Access w/ Collision Avoidance

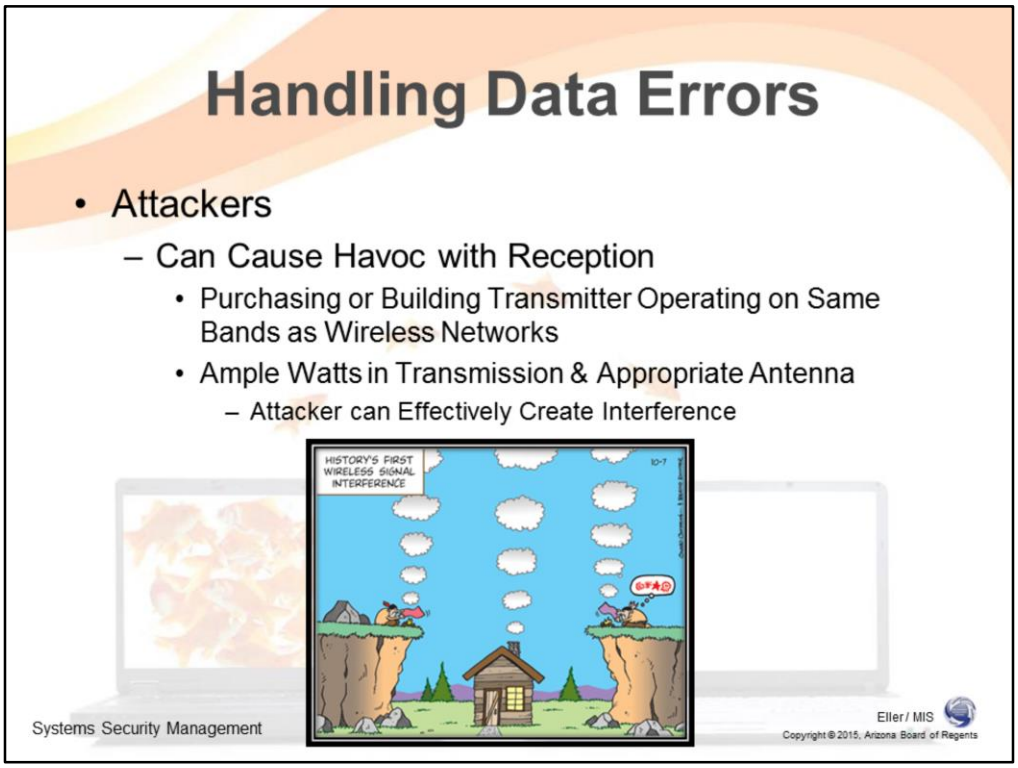
CSMA with collision avoidance is the most commonly used access method for wireless networking. Also known as a distributed coordination function, this access method involves communicating with stations that are waiting to transmit. The station will listen to determine if the radio frequency is idle, using a Received Signal Strength Indicator, or RSSI. This is used because the greatest risk for data collisions over a wireless network occurs when the radio frequency is idle.

When idle, the station will then use a predefined, mandatory delay before attempting to transmit data in an effort to avoid collisions. Each station will calculate a different delay period, and a backoff timer, used to provide an additional random length of time to wait before transmitting. All of this combined allows CSMA/CA to successfully avoid data collisions.



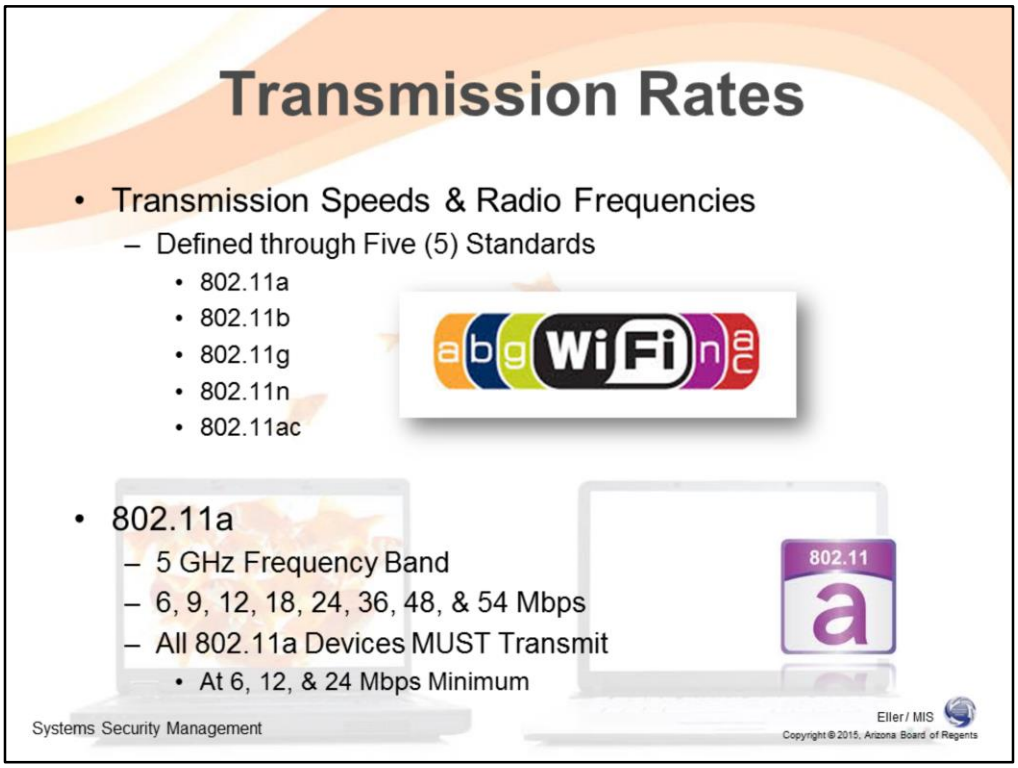
Handling Data Errors

Data errors on wireless networks can wreak all sorts of havok on the network. Wireless networks, by their very nature, are vulnerable to signal interference by the weather, solar flares, competing wireless networks, physical obstacles, and even microwave ovens, among others. This interference can easily corrupt successful reception of data. In order to help handle data errors, 802.11 wireless networking standards include the automatic repeat request, or ARQ. For example, if a station that is sending packets over wireless does not receive an ACK from the access point, the station will automatically retransmit the packets. After 10 unacknowledged attempts at transmitting packets, the station will stop transmitting.



Handling Data Errors (continued)

Attackers can also cause problems with wireless reception. For example, an attacker can purchase or build a radio wave transmitter that operates on the same radio signal bands as those used by wireless networks. By ensuring the transmitter has ample wattage and an appropriate antenna, the attacker can easily create effective interference.

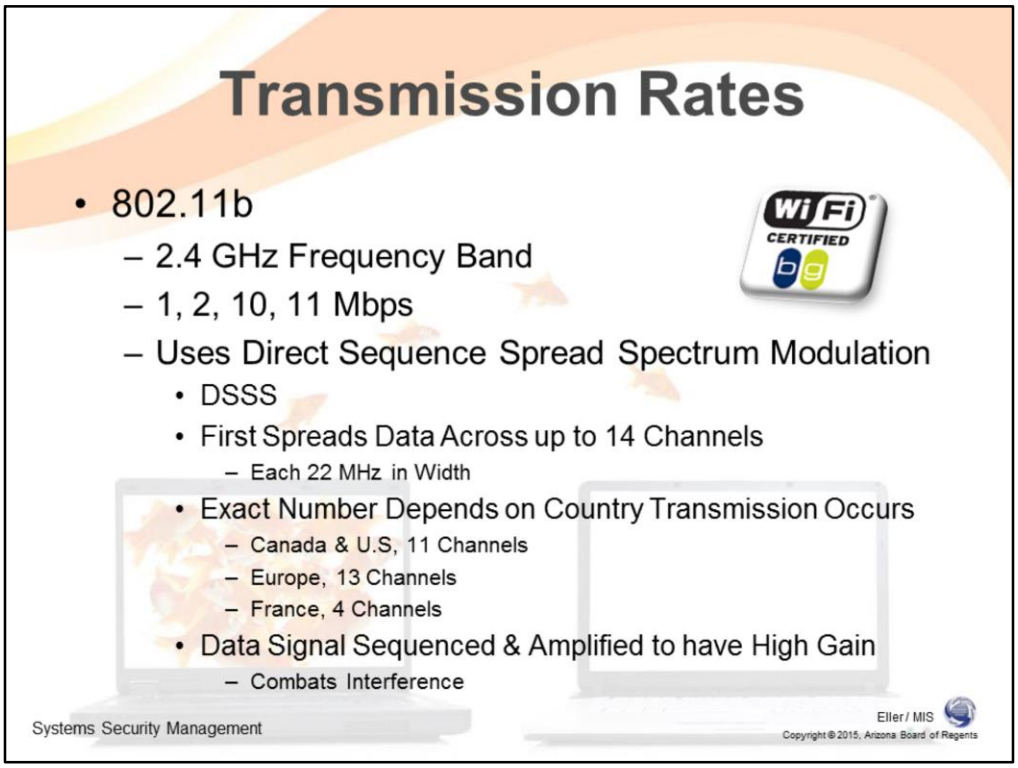


Transmission Rates

With 802.11 wireless networks, transmission speeds and radio frequencies are defined through five (5) different standards: 802.11a, 802.11b, 802.11g, 802.11n and 802.11ac.

802.11a

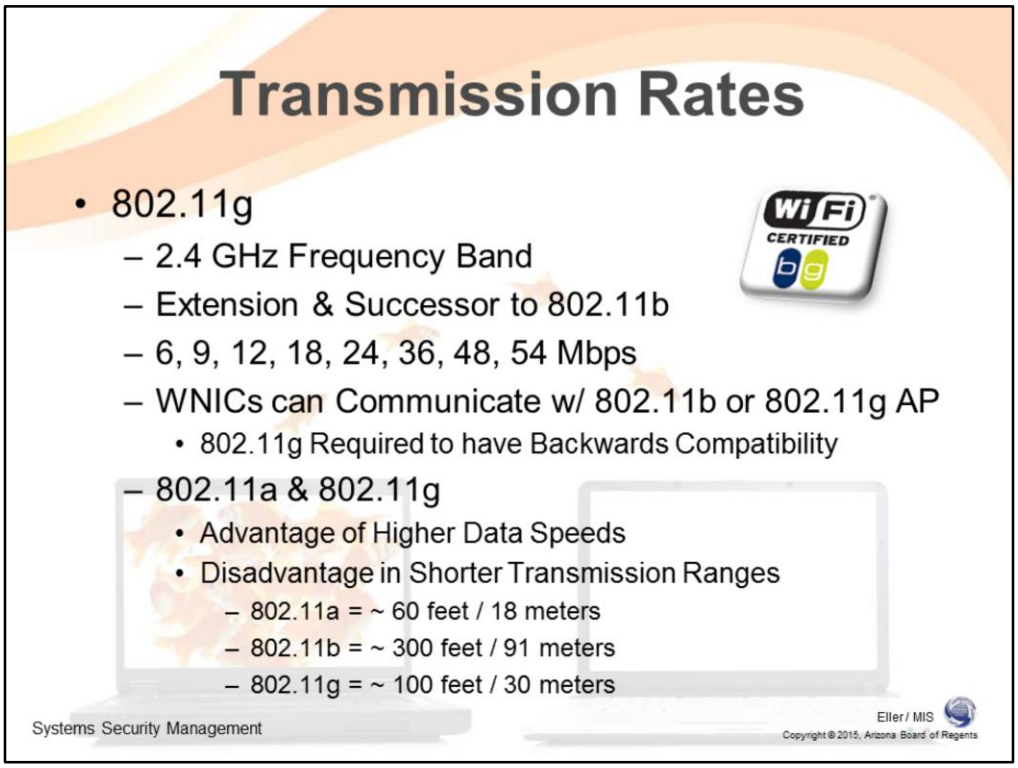
The 802.11a wireless network standard operates on the 5 gigahertz frequency band. This allows communications to operate at a variety of data rates, ranging from 6 megabits per second up to a maximum of 54 megabits per second. At a bare minimum, all 802.11a devices are required to transmit at 6, 12, and 24 megabits per second.



Transmission Rates (continued)

802.11b

The 802.11b wireless networking standard operates on the 2.4 gigahertz frequency band and guarantees data transmission rates between 1 and 11 megabits per second. 802.11b uses direct sequence spread spectrum modulation, or DSSS, in order to spread data across up to fourteen (14) different channels, each channel is 22 megahertz in width. The exact number of channels in this standard will vary depending on the country in which data transmission occurs. For example, in Canada and the U.S, 11 channels are used. In Europe up to 13 channels are used, and in France only 4 channels are used. By using different channels, this allows data signals to be sequenced and amplified in order to have a high gain, which helps to combat interference.

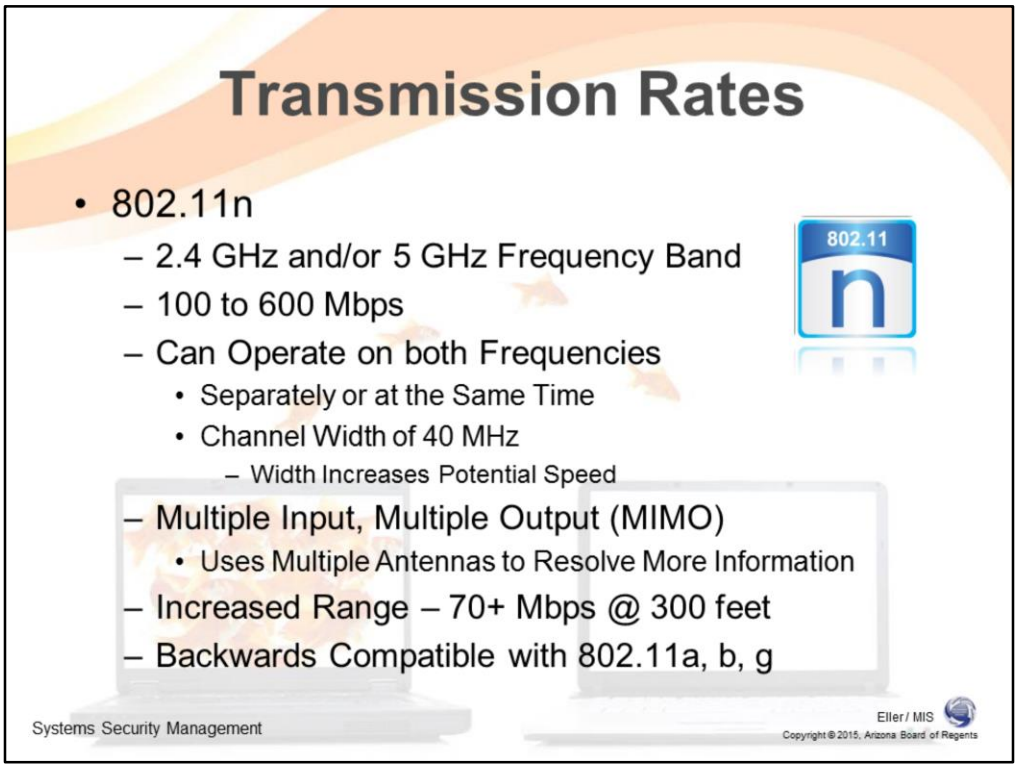


Transmission Rates (continued)

802.11g

Similar to 802.11b, the 802.11g standard also uses the 2.4 gigahertz frequency band for data transmissions. 802.11g is the official successor and extension to 802.11b. This is why you will often see wireless access points and wireless routers for sale that support both the 802.11b and 802.11g standards. This standard defines data rates between 6 and 54 megabits per second, so it operates at the same speeds as 802.11a, albeit at a much lower radio frequency. Wireless NICs that are designed for 802.11g are able to communicate with both 802.11b and 802.11g access points, since 802.11g is required to maintain backwards compatibility.

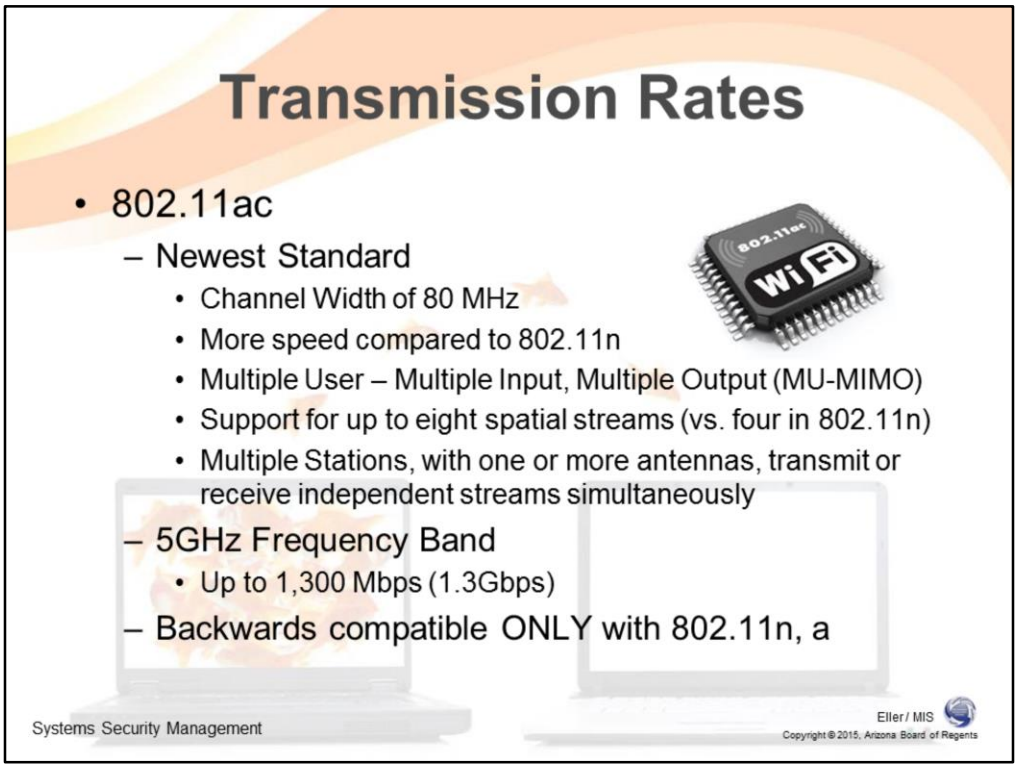
Both the 802.11a and 802.11g standards have the advantage of higher data speeds; however, the higher the data speed, the shorter the transmission range. With 802.11a, the transmission range is approximately 60 feet, with 802.11b, the range is approximately 300 feet, and with 802.11g, the range is approximately 100 feet.



Transmission Rates (continued)

802.11n

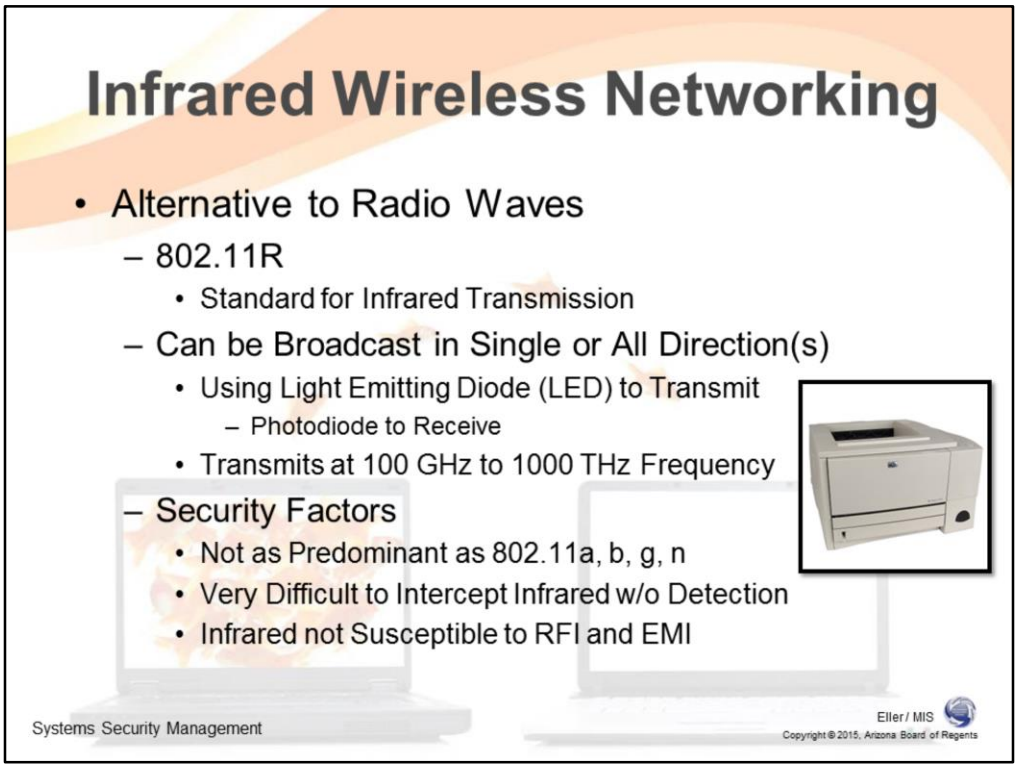
The newest wireless networking standard, 802.11n, was designed to operate at both the 2.4 gigahertz and 5 gigahertz frequency bands, achieving transmission rates between 100 and 600 megabits per second. 802.11n can operate on both frequencies either separately or at the same time. In addition, each channel has a width of 40 megahertz, which increases the potential speed for transmission. 802.11n uses multiple antennas in order to resolve more information through the use of multiple input, multiple output, or MIMO. This standard also increases the radio transmission range, allowing for 70 megabits per second at a distance of 300 feet. Finally, since this standard uses both frequency bands, it is backwards compatible with 802.11a, b, and g standard equipment.



Transmission Rates (continued)

802.11ac

The newest wireless networking standard, 802.11ac, was designed with increased wireless needs in mind. With the typical corporate user in possession of, on average, 2.7 devices, the need for greater throughput and speed is getting more apparent. The new technologies provided by 802.11ac include: extended channel binding (80MHz instead of 802.11n's 40MHz channels), more MIMO spatial streams (up to eight, compared to the four offered in 802.11n), downlink Multi-user MIMO that allows up to four simultaneous downlink MU-MIMO clients, and speeds of up to 1.3Gbps. Because it only transmits in the 5GHz range, it is only backwards compatible with 802.11n and 802.11a devices. Older devices with 802.11g or b WNICs will not even be able to connect to access points offering 802.11ac streams. In practice, however, most newer access points will contain two radios to ensure backwards compatibility with older technology.

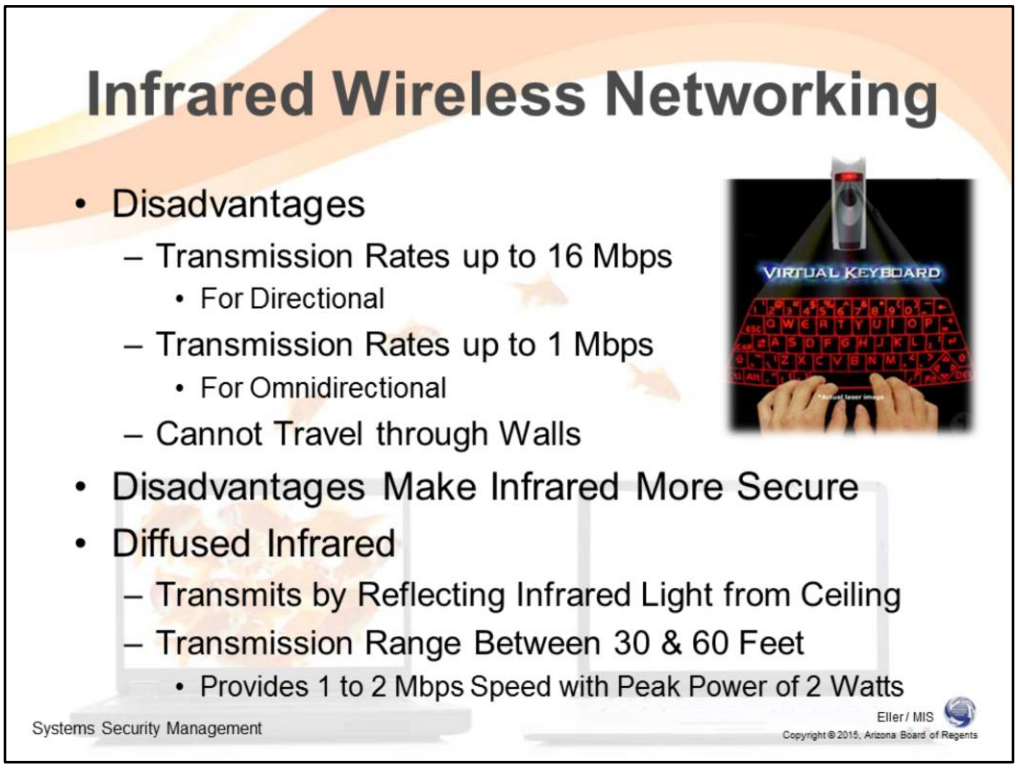


Infrared Wireless Networking

Another form of wireless networking uses infrared light technology. Infrared is an alternative to radios waves, and the standard for infrared transmission is 802.11R. One benefit to infrared is it can be broadcast in either a single direction or all directions using light emitting diodes, or LEDs. Photodiodes are used by infrared equipment for receiving data transmissions. Infrared technology transmits data between the 100 gigahertz and 1000 terahertz frequencies.

Security Factors

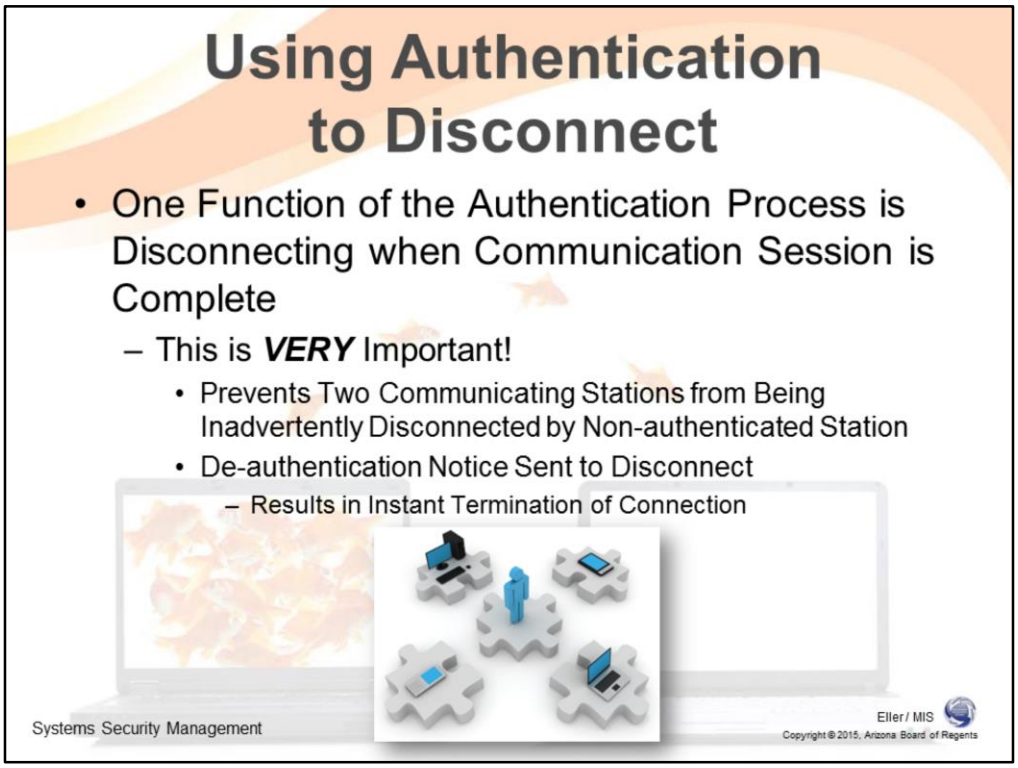
Some security factors for infrared networking include the fact it is not nearly as predominant as 802.11a, b, g, and n for data transmissions. It is also very difficult to intercept infrared transmissions without detection, and infrared is not susceptible to either radio frequency or electromagnetic interference, making this a more secure, albeit limited, wireless networking standard.



Infrared Wireless Networking (continued)

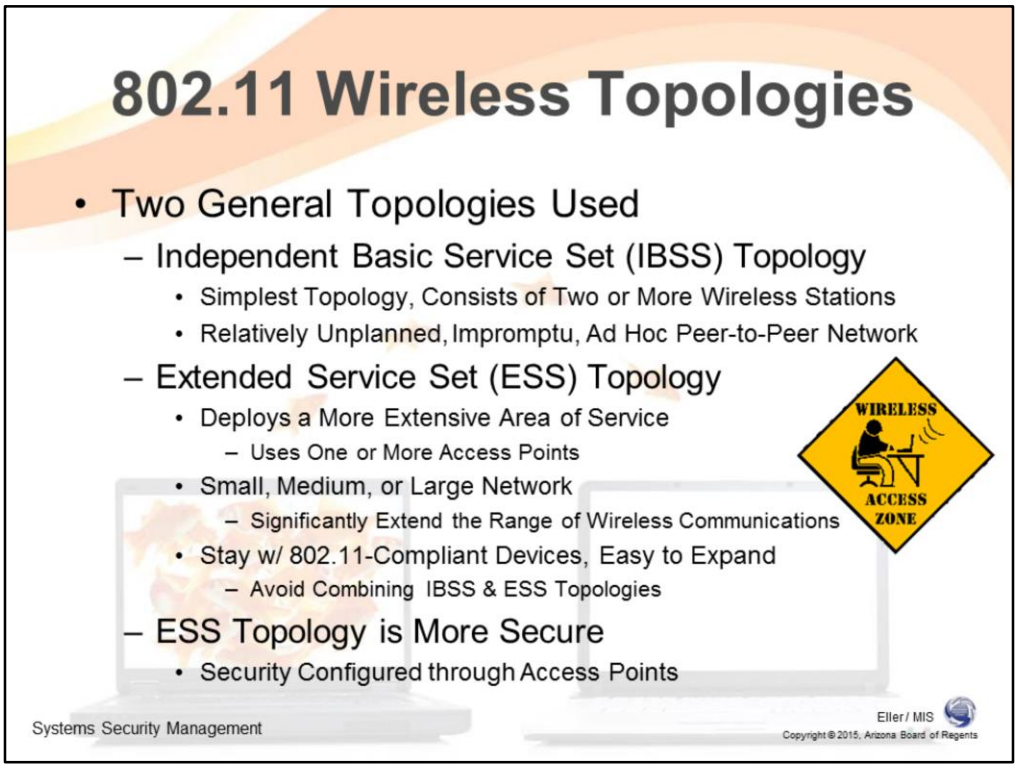
With infrared wireless networks, there are some disadvantages, specifically related to data transmission rates. When using directional infrared, transmission rates can be up to 16 megabits per second; however, when using omnidirectional infrared, transmission rates can only be as high as one megabit per second. Infrared also cannot travel through walls, making it more difficult to use in a multi-room scenario. The interesting thing about these disadvantages is they actually work to make infrared wireless networking more secure.

Another method for using infrared involves adopting diffused infrared, which works by transmitting infrared light by reflecting it off a ceiling. This helps to increase the transmission range to between 30 and 60 feet, providing 1 to 2 megabits per second speed with a peak power requirement of 2 watts.



Using Authentication to Disconnect

When using wireless networks, one major security function of the authentication process involves disconnecting securely when the communications session is complete. This is very important as it prevents two communicating stations from being inadvertently disconnected by a station that has not been authenticated. This process occurs after communications when a de-authentication notice is sent to the client system, which results in instant termination of the wireless connection.

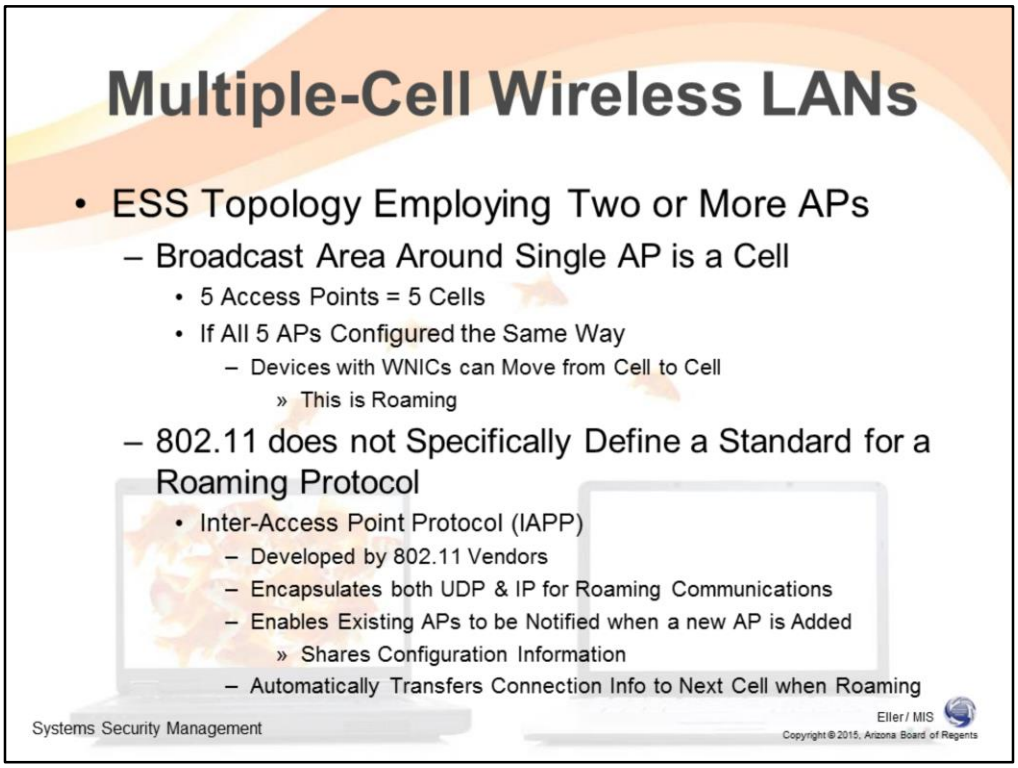


802.11 Wireless Topologies

With 802.11 wireless network standards, there are two general topologies used: the independent basic service set (IBSS) topology and the extended service set (ESS) topology.

IBSS is the simplest topology for wireless networks, consisting of two or more wireless stations. This topology is used by wireless networks that are relatively unplanned, impromptu, and used by ad hoc peer-to-peer networks.

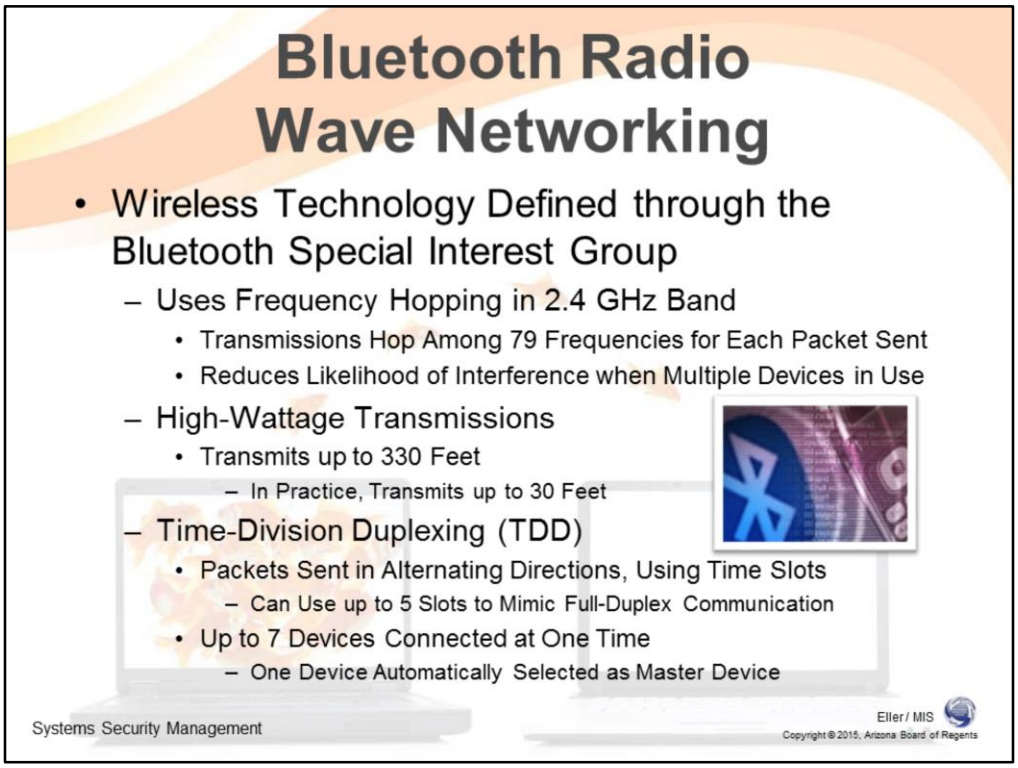
ESS topologies are used when deploying a more extensive area of service, using one or more access points. This is your typical wireless network that you will access in small, medium, or large organizations, or even just your local coffee shop. This topology allows network operators to significantly extend the range of wireless communications. It will be important for a network administrator to use 802.11-compliant devices, so the network will be easy to expand. It is also important to note that one should avoid combining both IBSS and ESS topologies as this can cause radio frequency interference on the network. ESS is also a more secure topology, as all security is configured and achieved through the use of access points.



Multiple Cell Wireless LANs

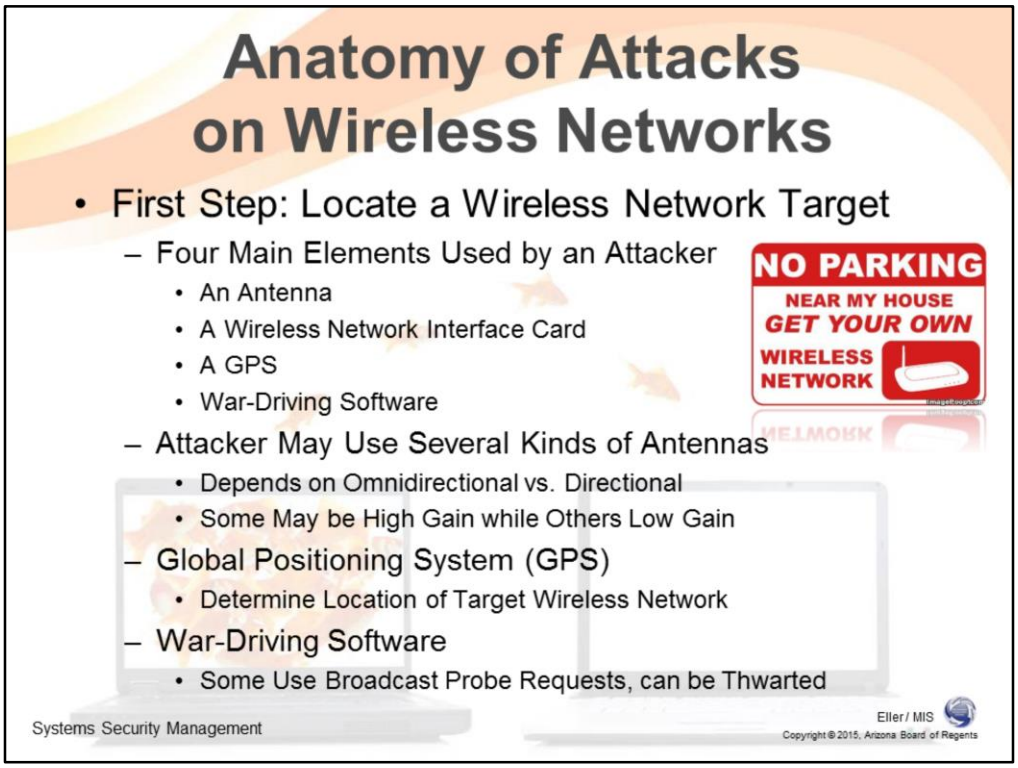
Deploying the ESS topology typically involves employing two or more access points. The radio broadcast area that surrounds each access point is referred to as a “cell.” So, if you deploy an ESS network using five access points, your network will have five cells. Assuming all of the access points are configured in the same manner, any devices with wireless NICs can move from one cell to another without disconnecting from the network. This is known as roaming.

The 802.11 standards do not specifically define any standard for a roaming protocol; however, the Inter-Access Point Protocol, or IAPP, was developed by 802.11 hardware vendors to achieve this goal. This protocol encapsulates both UDP and IP for roaming communications, enabling existing access points to be notified when a new access point is added to the network. The protocol then shares the access point configuration from existing APs to the new AP. The access points then automatically transfer connection information from one cell to the next when a user is roaming.



Bluetooth Radio Wave Networking

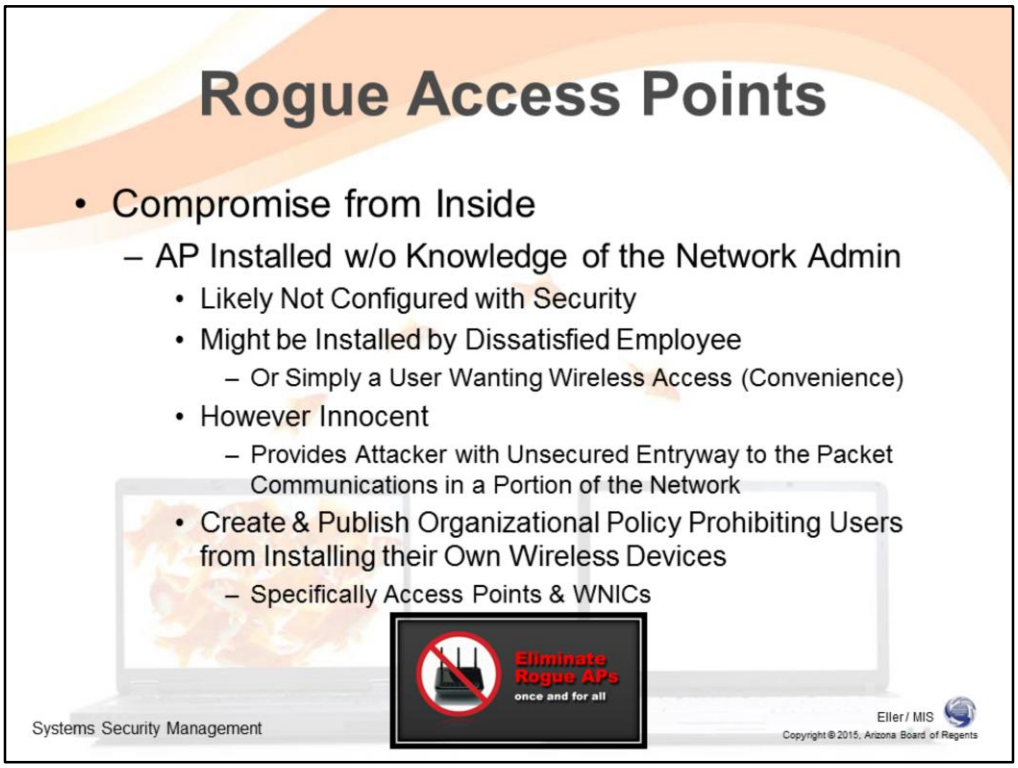
Bluetooth radio wave networking is a wireless technology defined through the Bluetooth Special Interest Group and is used in a wide variety of devices, from wireless keyboards to wireless earpieces for hands-free cell phone communication. Bluetooth technologies use frequency hopping in the 2.4 gigahertz band, allowing transmissions to hop among 79 different frequencies for every packet sent. This reduces the likelihood of interference when multiple Bluetooth devices are in use. The Bluetooth standard allows for high-wattage transmissions, enabling devices to transmit data up to 330 feet; however, in practice, Bluetooth devices typically transmit up to 30 feet. In addition, Bluetooth uses time-division duplexing, or TDD, allowing data packets to be sent in alternating directions using pre-determined time slots. Devices can use up to 5 slots, allowing Bluetooth data transmission to mimic full-duplex communication. Finally, Bluetooth allows up to 7 devices to be connected at any one time, which is only possible because one of the devices will automatically be selected as the master device.



Anatomy of Attacks on Wireless Networks

When an attacker is looking to find a wireless network to breach, this requires the attacker to first locate the wireless network target. Four main elements are used by an attacker: an antenna, a wireless network interface card, a GPS, and war-driving software.

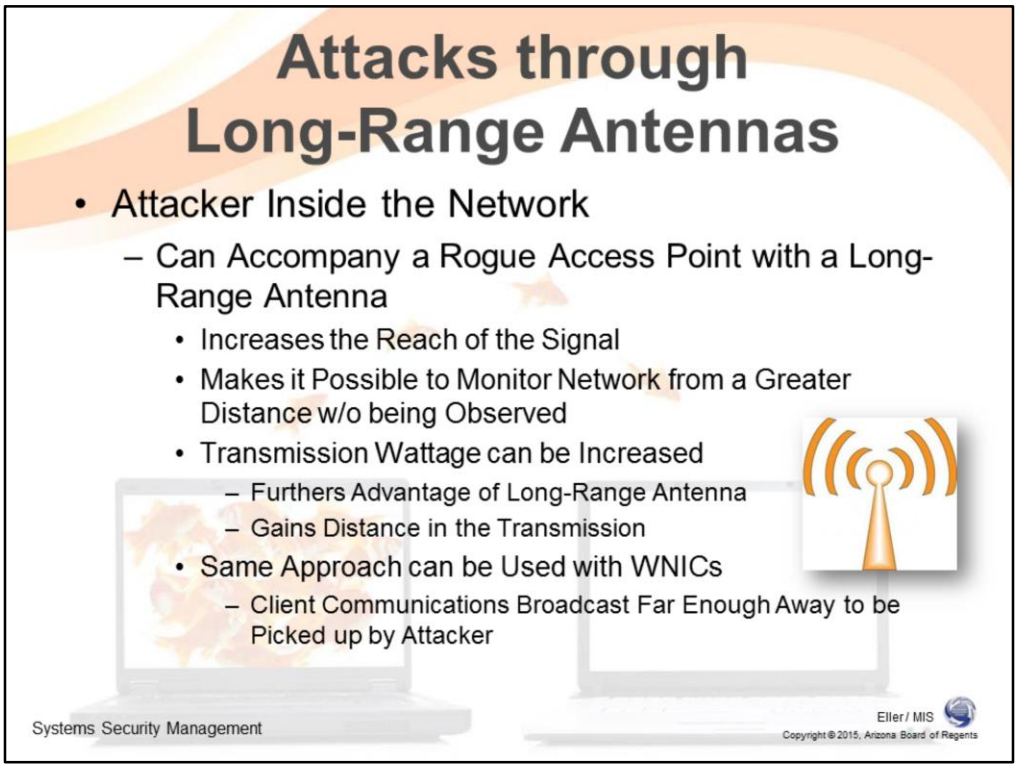
The attacker may choose to use different antennas in an attempt to breach the network. Depending on whether or not the antenna is directional or omnidirectional will determine the type of network, and some antennas may be high gain while others are low, determining the distance at which the attacker can operate. Using a global positioning system, the attacker can identify the location of the target wireless network within a few yards, and by using war-driving software, the attacker can also locate networks while on the move. It is important to note that some war-driving software uses broadcast probe requests, which can be easily thwarted.



Rogue Access Points

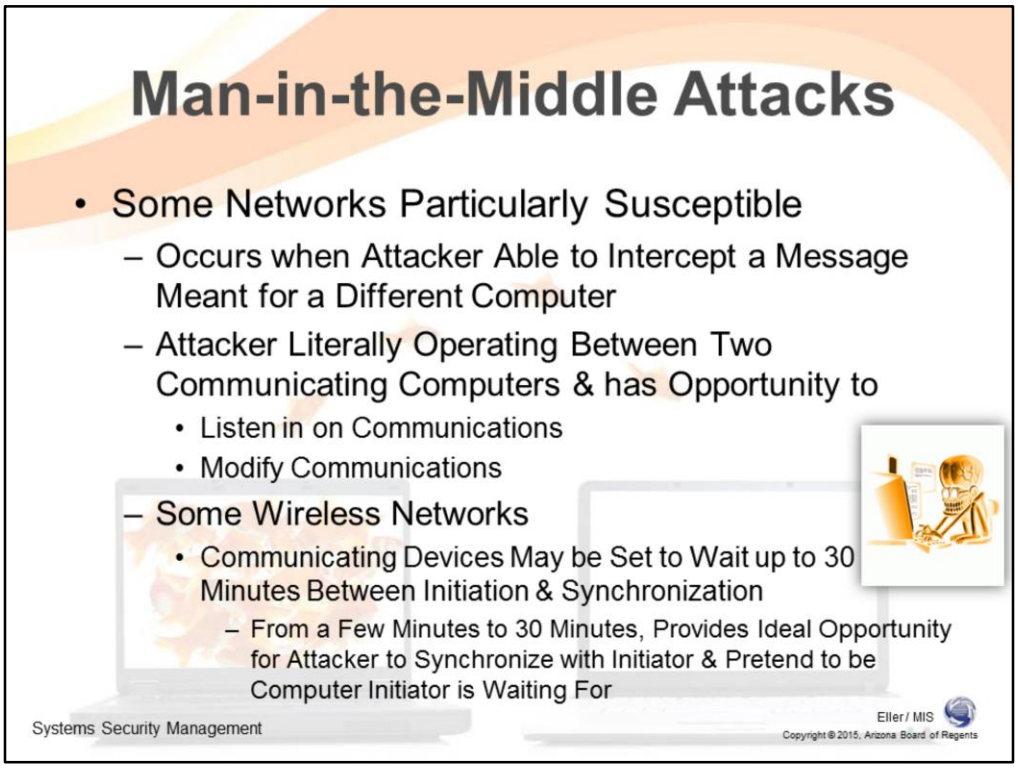
A rogue access point is an access point that is installed on a wireless network without the knowledge of the network administrator, so in effect, it is a compromise from within the organization. These rogue access points are not likely to have any security configured so it is much easier to breach a network. Rogues can be installed by a dissatisfied employee, or just simply a user wanting wireless access for their own convenience. However innocent the reason for installing a rogue access point, they provide attackers with an unsecured entryway to packet communications in a portion of the network.

To combat rogue access points, organizations need to create and publish organizational policy that prohibits users from installing their own wireless devices, specifically access points and wireless NICs.



Attacks through Long-Range Antennas

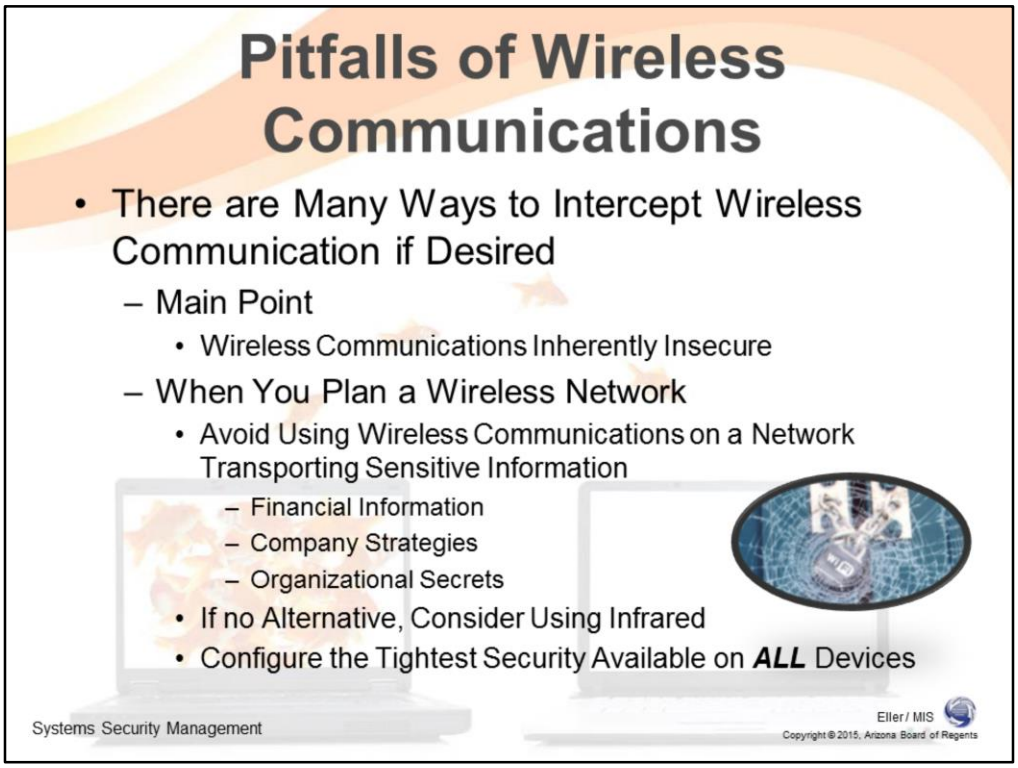
In some cases, if the attacker is actually inside the network, they can attach a long-range antenna to a rogue access point in order to extend the reach of the signal, making it possible to monitor the network from a greater distance without being observed. In addition, the attacker can increase the transmission wattage, which furthers the advantage of using a long range antenna in order to gain even more distance in the transmission. The same approach can be used with wireless NICs because client communications will be broadcast far enough away to be picked up by the attacker.



Man-in-the-Middle Attacks

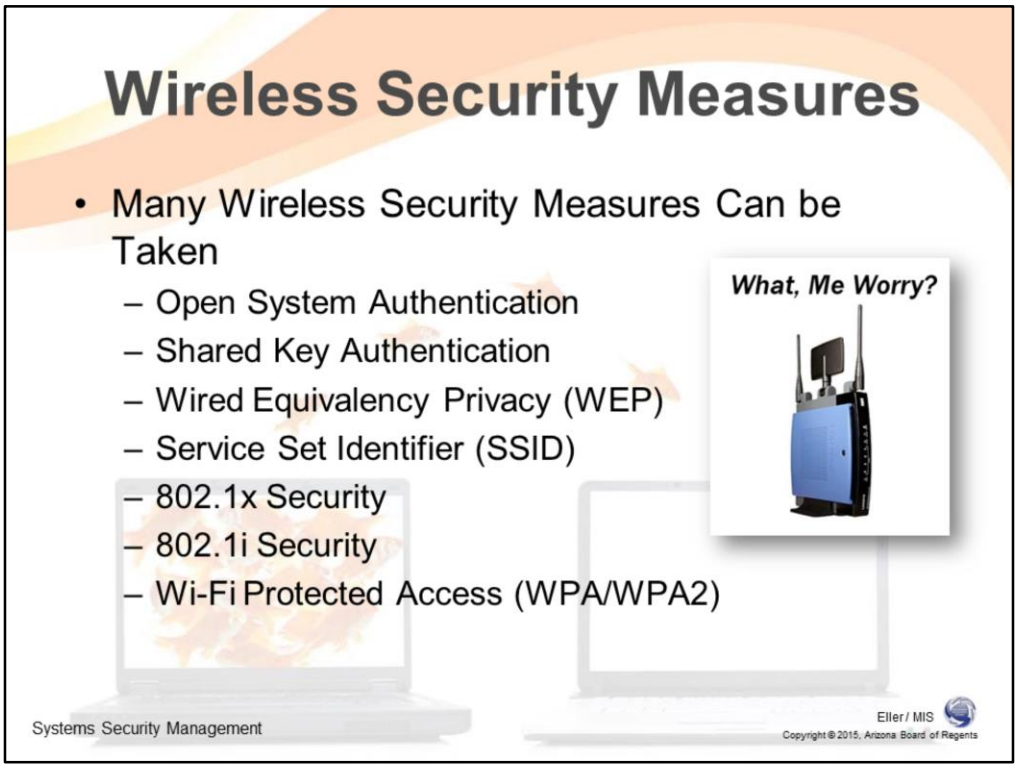
Some networks are particularly susceptible to a man-in-the-middle attack, where an attacker is able to intercept a message meant for a different computer. The attacker is literally operating between two communicating computers and has the opportunity to both listen in and modify the communication session.

On some wireless networks, communicating devices may be configured to wait up to 30 minutes between initiation of the connection and synchronization. Any timeframe from a few minutes to 30 minutes will provide an ideal opportunity for an attacker to synchronize with the initiator and pretend to be the computer the initiator is waiting to communicate with.



Pitfalls of Wireless Communications

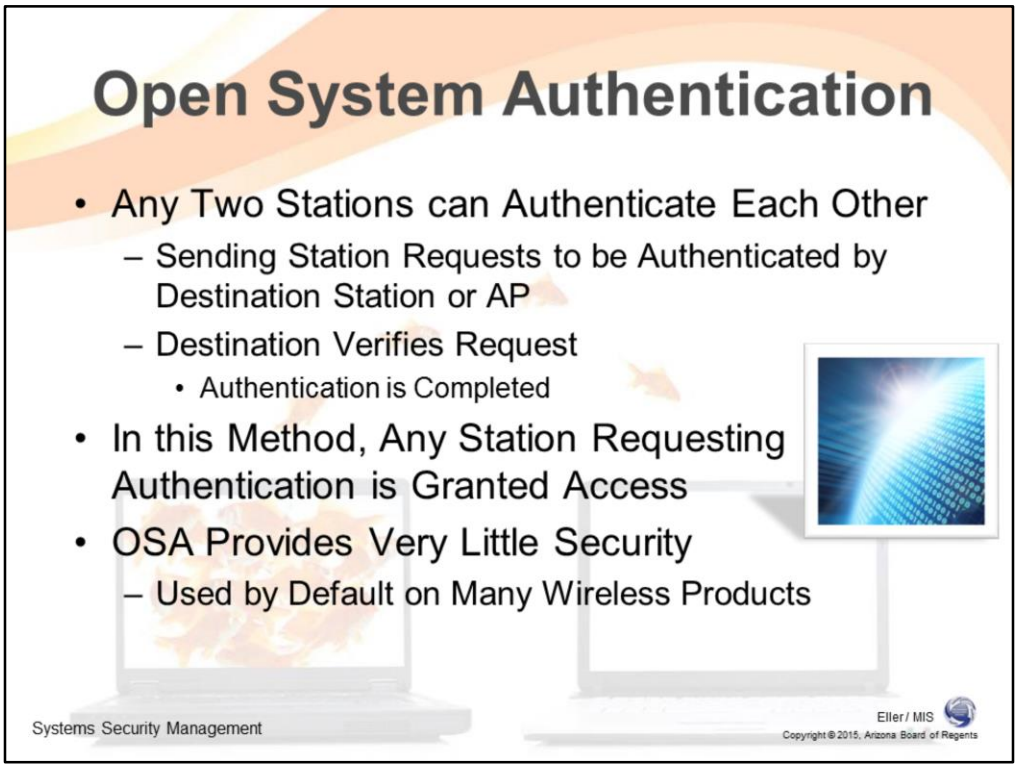
There are many ways to intercept wireless communication if an attacker desires. The main point with this is that wireless communications are inherently insecure. When you are planning a wireless network, avoid using wireless communications on a network where it is common to transport sensitive information, such as financial information, company strategies, or organizational secrets. If there is no alternative, and wireless access is required, consider using infrared technologies. Also, make certain you configure the wireless network to use the tightest possible security on ALL devices.



Wireless Security Measures

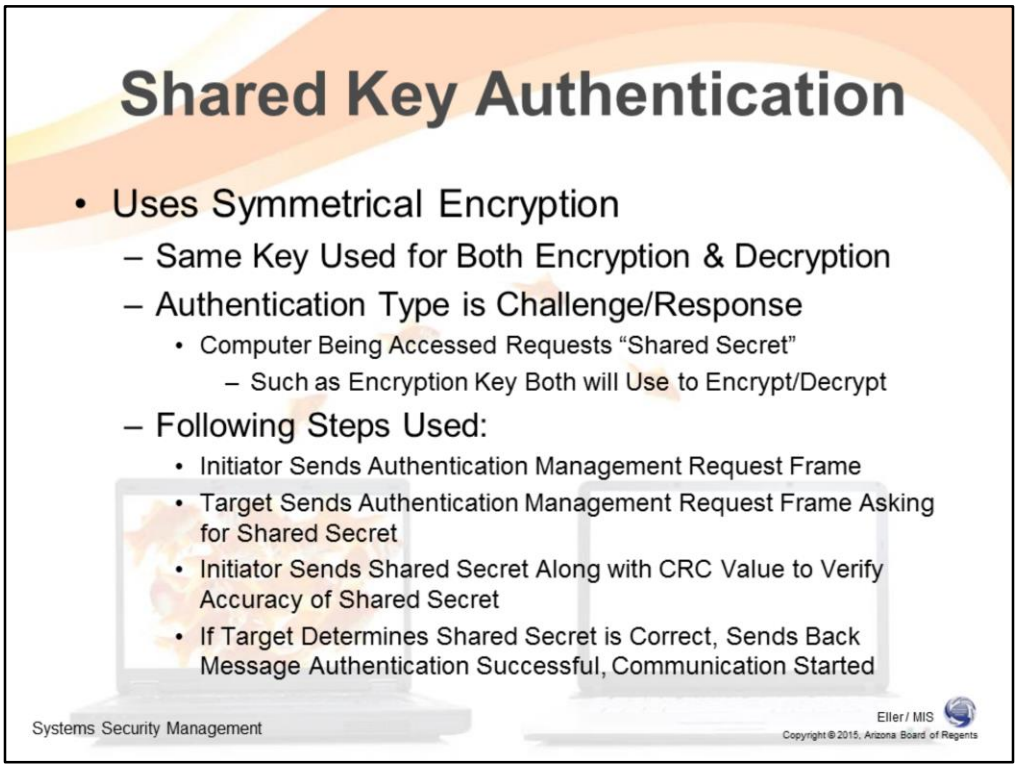
Having stated that wireless networking is inherently insecure, what security measure can be taken? The primary security measures for wireless networks include:

- Open System Authentication
- Shared Key Authentication
- Wired Equivalency Privacy (WEP)
- Service Set Identifier (SSID)
- 802.1x Security
- 802.1i Security
- Wi-Fi Protected Access (WPA/WPA2)



Open System Authentication

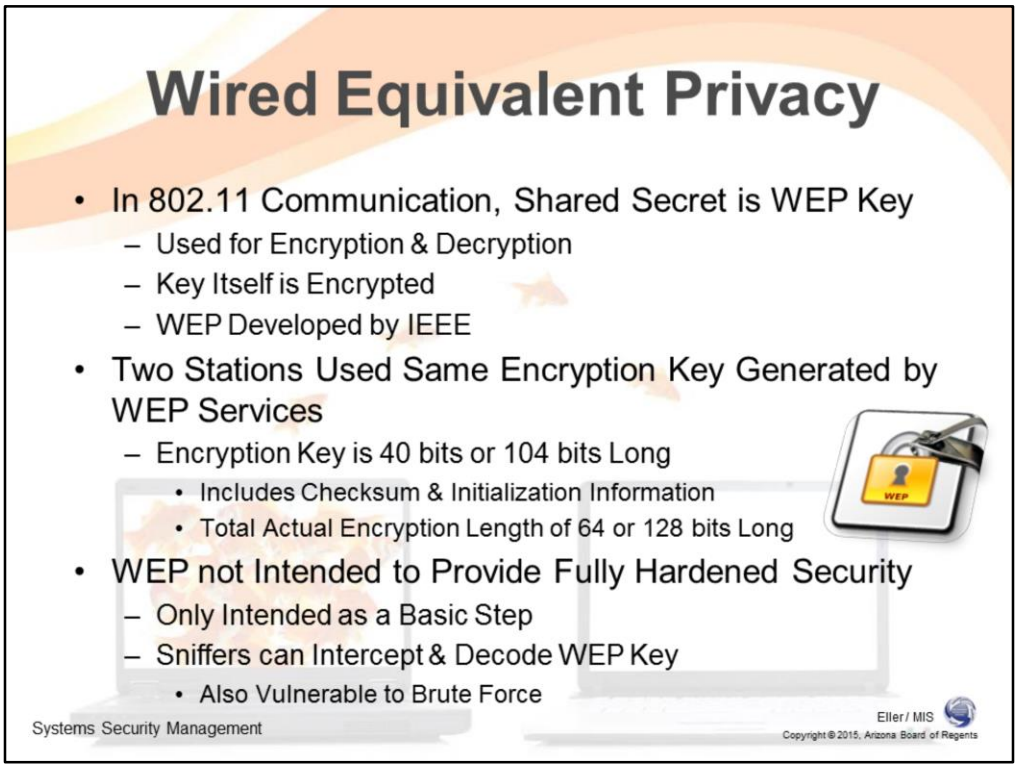
Open system authentication, or OSA, allows any two wireless stations to authenticate each other on the network. The sending station will request to be authenticated by the destination station or access point. The destination will then verify the request and authentication is completed. Using this method, any station requesting authentication is granted access, making OSA very insecure. Despite this, OSA is the default security setting used on many wireless products.



Shared Key Authentication

Shared key authentication uses symmetrical encryption, so the same key is used for both encryption and decryption. When authenticating to a wireless network using the shared key, the user is presented with a challenge/response authentication. The computer being accessed will request the "shared secret," which is the encryption key both will use to encrypt and decrypt. By selecting shared key authentication, the following steps will be used by systems on the network:

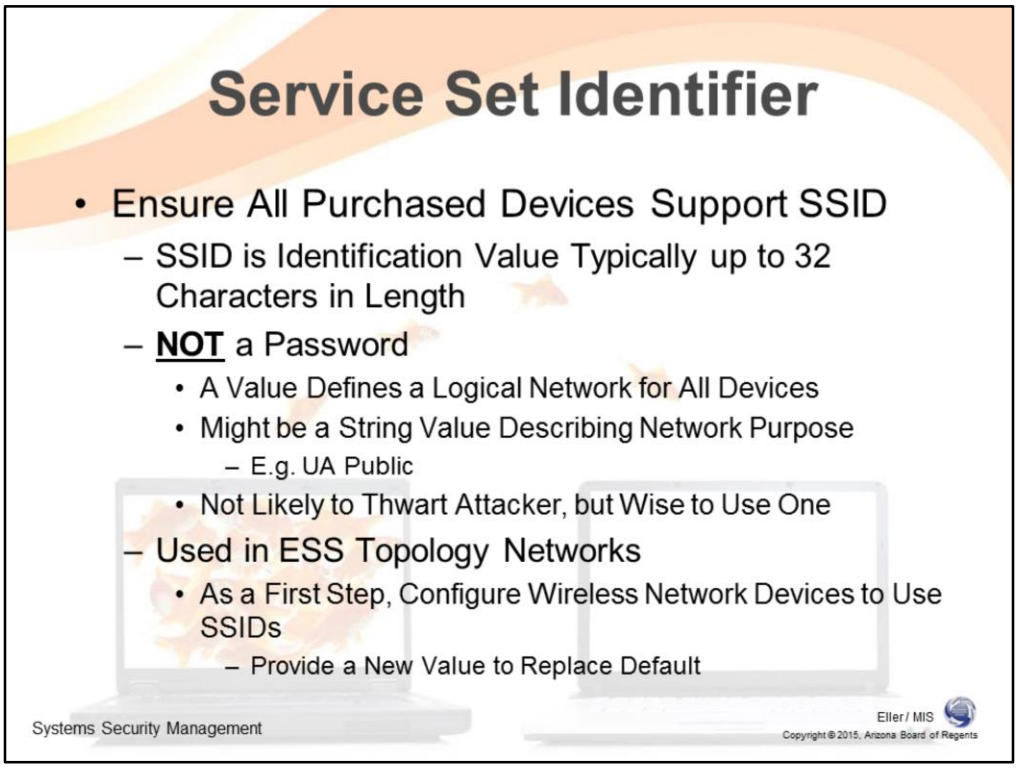
- Initiator Sends Authentication Management Request Frame
- Target Sends Authentication Management Request Frame Asking for Shared Secret
- Initiator Sends Shared Secret Along with CRC Value to Verify Accuracy of Shared Secret
- If Target Determines Shared Secret is Correct, Sends Back Message Authentication Successful, Communication Started



Wired Equivalent Privacy

In 802.11 wireless network communication, the wired equivalent privacy, or WEP, uses a shared secret as a WEP encryption key. This key is then used to encrypt and decrypt data during transmission, and the key itself will be encrypted to better protect it during transmission. WEP was developed by the IEEE standards organization for securing 802.11 wireless networks.

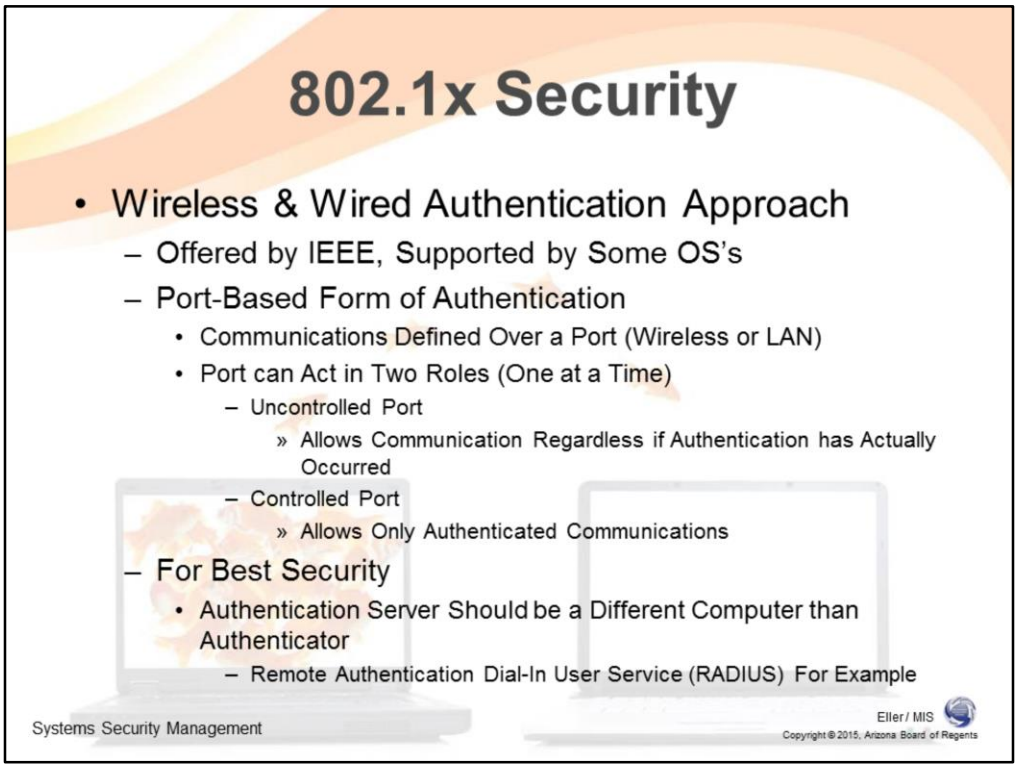
When using WEP, two stations will use the same encryption key that is generated by WEP services. The encryption key is either 40-bits or 104-bits long, and when the key includes a checksum and initialization information, the total actual encryption length will be 64-bit or 128-bits long. WEP was not designed to provide fully hardened security for wireless communications, it was intended to be a basic step into wireless security. Modern sniffers can intercept and decode WEP keys easily, and the standard is also vulnerable to brute force attacks.



Service Set Identifier

Network Administrators need to ensure that all purchased wireless devices support the Service Set Identifier, or SSID. An SSID is an identification value, typically up to 32 characters in length, that defines a logical network for all connected devices. Remember, this is NOT a password! The SSID may be a string value that describes the network's purpose, for example: UA Public provides a wireless network with no security for public use. The SSID is not likely to thwart an attacker, but it is wise to use one. In fact, it is also recommended that wireless devices are configured to not broadcast the SSID, making it more difficult to detect the wireless network.

SSIDs are used specifically in wireless networks using the ESS topology. As a first step, network admins should configure wireless devices to use SSIDs, providing a new value to replace the default.

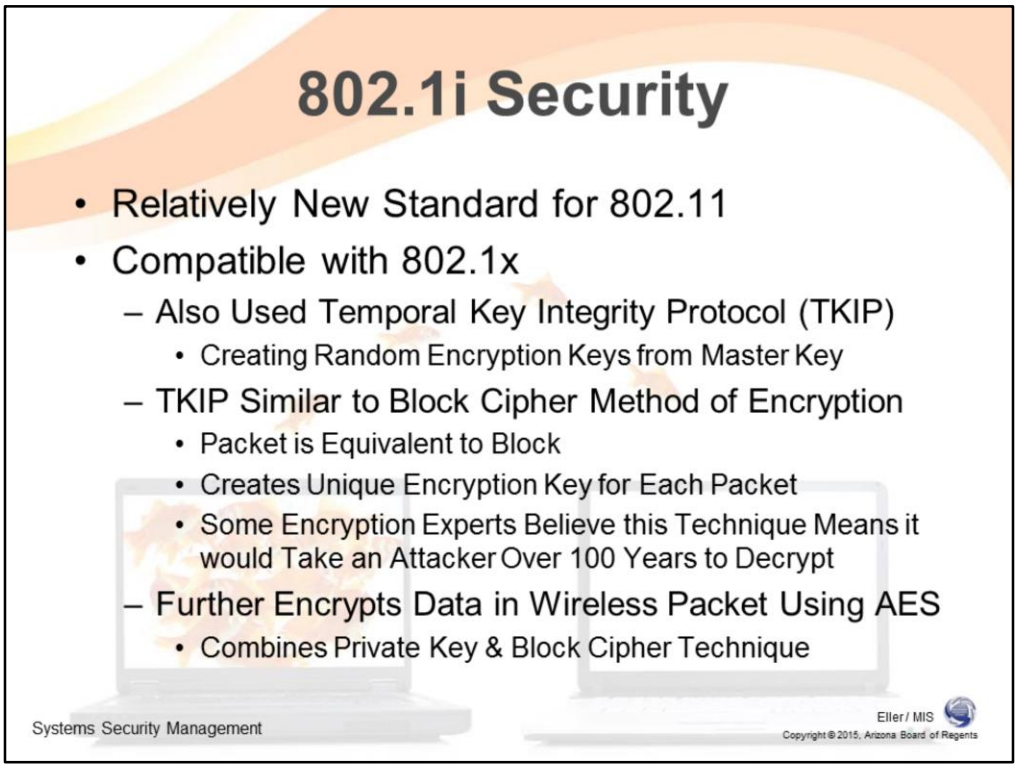


802.1x Security

802.1x security is both a wireless and a wired authentication approach offered by the IEEE and supported by some operating systems. 802.1x security is a port-based form of authentication. Communications are defined over a specific port, either wireless or wired and the port can act in two different roles, although only one at a time. Uncontrolled ports will allow communication regardless of whether or not authentication has actually occurred. Controlled ports allow for only that communication which has been authenticated. For the best security, the authentication server should be a different system than the authenticator, for example: using the Remote Authentication Dial-In User Service, or RADIUS.

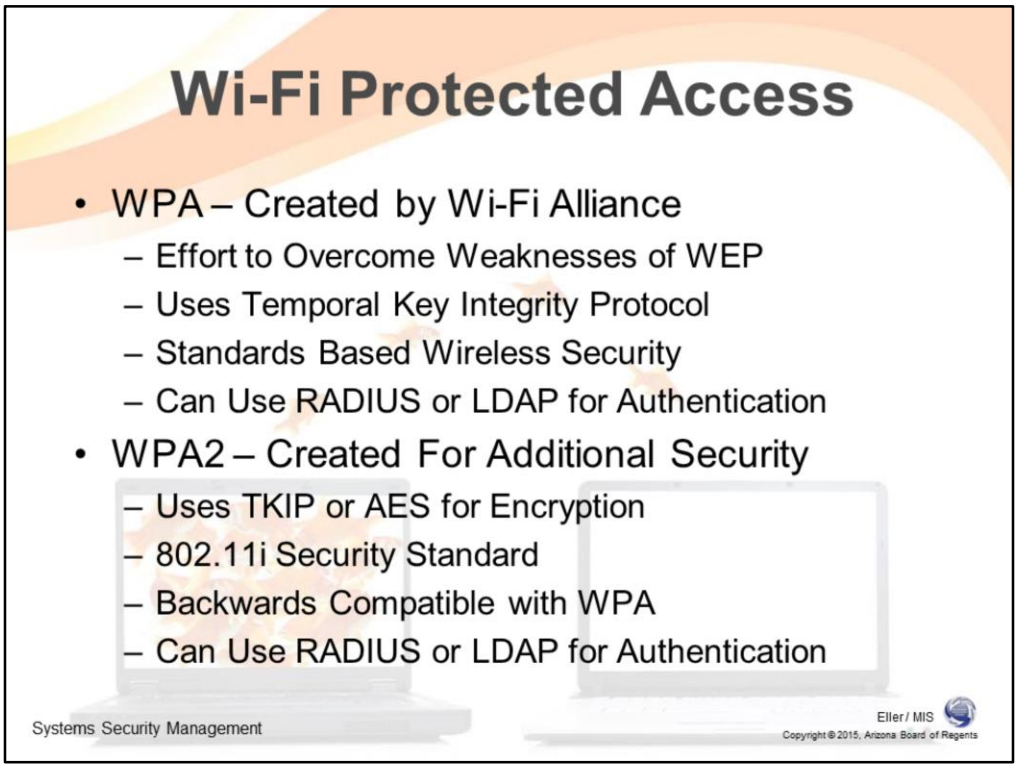
802.1x Security (continued)

Another important item to note is 802.1x security does not include encryption; however, it can be configured to work with the Extensible Authentication Protocol, or EAP. EAP can employ many encryption methods, such as smart cards, DES/3DES, and certificates. Evolving versions of EAP, such as EAP with Tunneled Transport Layer Security, or EAP-TTLS, is designed to provide more secure connections or controlled ports for the entire authentication process. By protecting all steps in the authentication process will open ways to use additional authentication and encryption methods. EAP-TTLS requires the use of digital certificates. Another EAP variant: Protected EAP, or PEAP was developed as an alternative to reduce the complexity of EAP and does not require the use of digital certificates.



802.1i Security

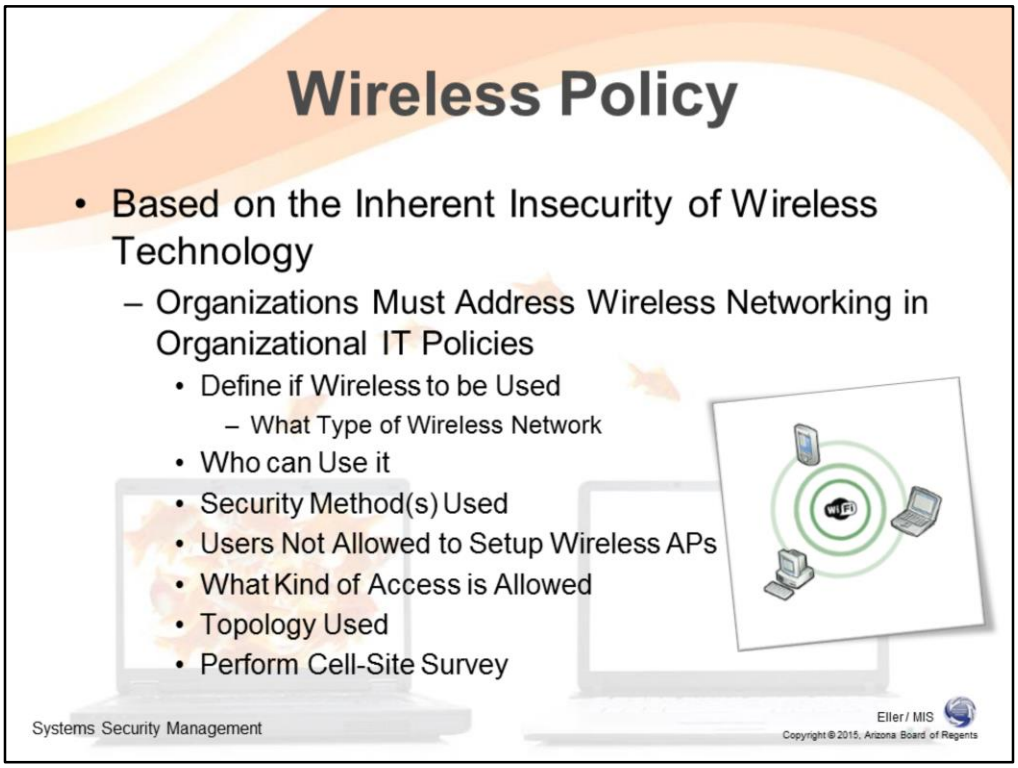
802.1i security is a relatively new standard for 802.11 networks. It is compatible with 802.1x security; however, it also adopts the use of the temporal key integrity protocol, or TKIP, allowing for the creation of random encryption keys from a master key. TKIP is similar to the block cipher method of encryption. Each data packet is the equivalent of a block of data. TKIP will then create a unique encryption key for each packet. Because of this encryption method, some experts believe this technique means it would take an attacker over 100 years to decrypt a communications session. In addition, 802.1i security further encrypts the data in wireless packets using the Advanced Encryption Standard, or AES, combining a private key encryption with a block cipher technique for increased security.



Wi-Fi Protected Access

Wi-Fi Protected Access, or WPA, was created by the Wi-Fi Alliance in an effort to overcome the weaknesses of WEP. WPA uses TKIP for encryption and is a standards-based wireless security method. In addition, WPA can use a RADIUS or LDAP server for authentication purposes.

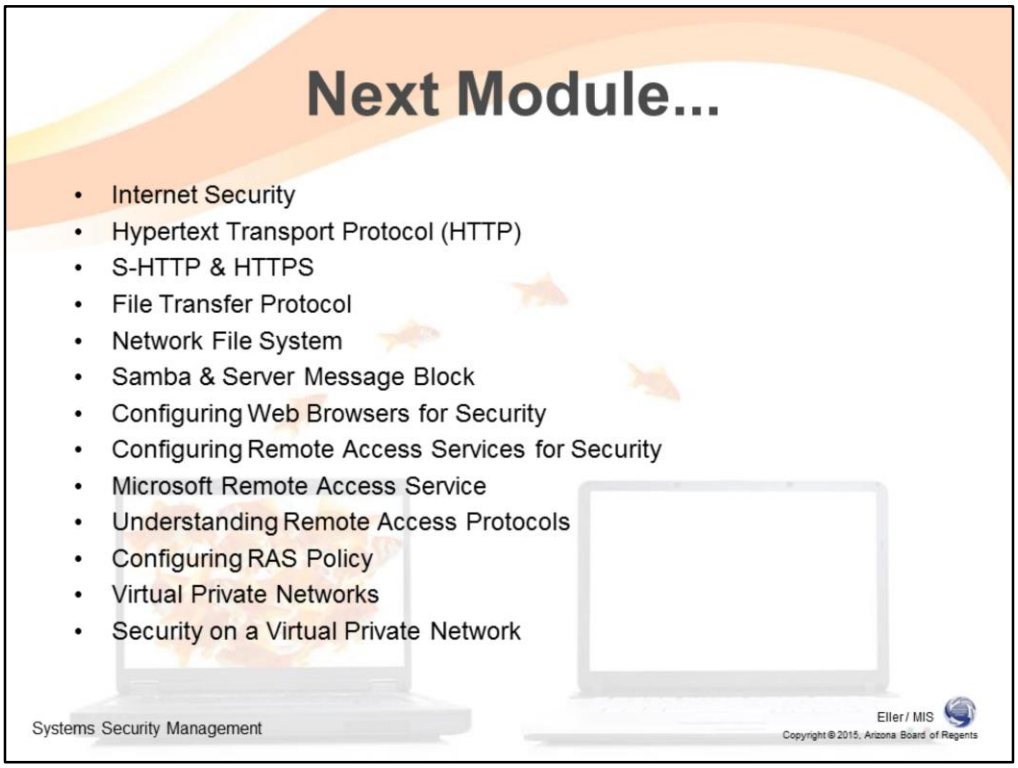
In order to improve the security of WPA, the Wi-Fi Alliance created its successor: WPA2. WPA2 uses either TKIP or AES for encryption and is considered to be an 802.1i security standard. WPA2 remains backwards compatible with WPA and can use RADIUS or LDAP for authentication.



Wireless Policy

Based on the inherent insecurity of wireless network technology, organizations must address wireless networking in organizational IT policy. Policies should include the following information:

- Define if Wireless to be Used, and What Type of Wireless Network to Adopt
- Who can Use it
- Security Method(s) Used
- Users Not Allowed to Setup Wireless APs
- What Kind of Access is Allowed
- Topology Used
- Perform Cell-Site Survey



In the next module we will discuss Web, Remote Access, and VPN Security, including:

- Internet Security
- Hypertext Transport Protocol (HTTP)
- S-HTTP & HTTPS
- File Transfer Protocol
- Network File System
- Samba & Server Message Block
- Configuring Web Browsers for Security
- Configuring Remote Access Services for Security
- Microsoft Remote Access Service
- Understanding Remote Access Protocols
- Configuring RAS Policy
- Virtual Private Networks
- Security on a Virtual Private Network

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