SMARTBRIDGE PROJECT REPORT

on

WIRELESS NETWORKS SECURITY ASSESSMENT

Submitted by

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CONTENTS

3. WIRELESS NETWORKS SECURITY ASSESSMENT

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1. INTRODUCTION

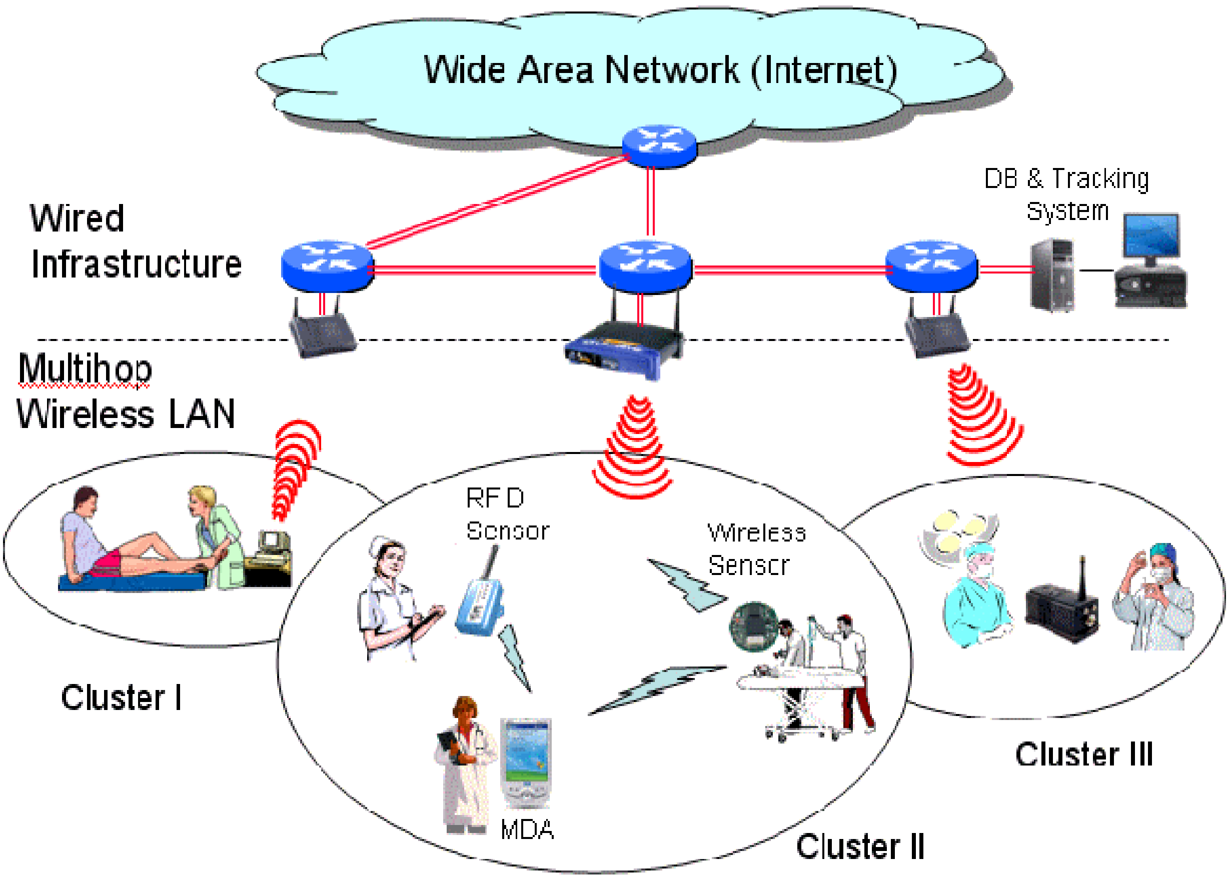
1.1 OVERVIEW

Wireless networks refer to computer networks that use wireless communication technology to connect devices and transfer data without the need for physical wired connections. Instead of relying on cables, wireless networks utilize radio waves or infrared signals to transmit data between devices. Wireless networks provide mobility and flexibility, allowing users to connect to the network and access resources from anywhere within the coverage area. Wireless networks have enabled advancements like mobile computing, IoT applications, and the proliferation of wireless communication in everyday life. Security considerations are crucial in wireless networks to protect against unauthorized access, data breaches, and network vulnerabilities. Encryption, authentication mechanisms, and secure configuration are employed to enhance network security. Wireless networks have revolutionized the way we connect and communicate, providing convenient and flexible connectivity in various environments. With the proliferation of wireless networks and devices, it is essential to safeguard data and protect against unauthorized access and also mobile devices and the popularity of public Wi-Fi hotspots, the potential for data breaches and other cybersecurity threats have increased exponentially. Wireless network security is vital because it helps protect your data from unauthorized access. Wi-Fi networks are particularly vulnerable to cyberattacks because they use radio waves to transmit data; this means that anyone within range of the Wi-Fi signal can potentially intercept and read the data being sent.

Security in wireless networks refers to the implementation of measures and protocols to protect the confidentiality, integrity, and availability of data transmitted over wireless communication channels. Wireless networks are susceptible to various security threats, including unauthorized access, data interception, and network breaches. Therefore, ensuring robust security is crucial to maintain the privacy of sensitive information and prevent unauthorized use or manipulation of network resources. The overview of security in wireless networks involves several key aspects: Authentication - Wireless networks employ authentication mechanisms to verify the identity of devices and users seeking access to the network. This ensures that only authorized entities can connect and utilize network resources. Encryption - Encryption techniques are employed to secure data transmitted over wireless networks. Encryption algorithms encode data into an unreadable format, which can only be decrypted by authorized recipients with the correct encryption keys. This protects the data from interception and unauthorized access. Access Control - Access control mechanisms are used to restrict network access to authorized users and devices. This involves setting up user accounts, passwords, and access privileges to ensure that only trusted individuals or devices can connect to the network. Network Segmentation - Wireless networks can be divided into separate segments or virtual LANs (VLANs) to isolate different types of traffic or user groups. This segmentation enhances security by limiting the impact of potential breaches and preventing unauthorized access to sensitive network resources. Intrusion Detection and Prevention - Intrusion detection and prevention systems (IDPS) are deployed to monitor network traffic and identify suspicious or malicious activities. These systems can detect potential security breaches and take proactive measures to prevent or mitigate them. Security Auditing and Monitoring - Regular security auditing and monitoring of wireless networks help identify vulnerabilities, detect security incidents, and ensure compliance with security policies and regulations. This involves reviewing logs, analysing network traffic, and conducting vulnerability assessments. Firmware and Software Updates - Keeping wireless network devices, such as routers and access points, up to date with the latest firmware and software patches is critical to address known security vulnerabilities and protect against emerging threats. Physical Security - Physical security measures, such as securing access points and network infrastructure, monitoring physical locations, and implementing video surveillance, are important to prevent unauthorized physical access to wireless network components. Security Policies and Education - Establishing comprehensive security policies, including acceptable use policies, password policies, and security awareness programs, is essential to educate users about security best practices and ensure compliance with security guidelines.

1.2 PURPOSE

The purpose of securing wireless networks is to protect the confidentiality, integrity, and availability of the network resources and data transmitted over the wireless medium. Some key reasons for securing wireless networks: Data Confidentiality - Wireless networks transmit data over the airwaves, making it more susceptible to eavesdropping and interception by unauthorized individuals. Protection against Unauthorized Access - Securing wireless networks helps prevent unauthorized access to the network infrastructure and resources. Network Integrity - Wireless networks are vulnerable to various attacks that can manipulate or modify network traffic, compromising the integrity of the data transmitted. Preventing Denial of Service (DoS) Attacks - Wireless networks can be targeted by DoS attacks, where attackers flood the network with a high volume of malicious traffic or exploit vulnerabilities to disrupt network connectivity. Mitigating Risk of Network Intrusion: Securing wireless networks helps protect against network intrusion attempts, such as unauthorized devices connecting to the network or rogue access points being introduced. Regulatory Compliance: Many industries and organizations are subject to regulatory requirements regarding the security and privacy of data. Securing wireless networks helps meet these compliance requirements and ensures that sensitive information is adequately protected. Preserving Reputation and Trust: Security breaches in wireless networks can have severe consequences for organizations, including reputational damage, financial losses, and loss of customer trust. By securing wireless networks, organizations demonstrate their commitment to protecting sensitive data and maintaining a secure environment for their stakeholders.



2. LITERATURE SURVEY

2.1 EXISTING PROBLEM

Wireless networks are vulnerable to various security threats and attacks. Here are some potential vulnerabilities in wireless networks:

Unauthorized Access: Attackers can attempt to gain unauthorized access to a wireless network by cracking weak passwords, exploiting default or easily guessable credentials, or bypassing weak authentication mechanisms. Once inside the network, they can eavesdrop on communications, steal sensitive data, or launch further attacks.

Rogue Access Points: Attackers can set up rogue access points that mimic legitimate networks. When users unknowingly connect to these malicious access points, attackers can intercept their traffic, capture sensitive information, or launch attacks such as man-in-the-middle attacks.

Encryption Weaknesses: Weak encryption protocols or misconfigured encryption settings can expose wireless networks to vulnerabilities. For example, using outdated encryption standards or not implementing encryption at all can make it easier for attackers to intercept and decrypt network traffic.

Denial-of-Service (DoS) Attacks: Wireless networks are susceptible to DoS attacks, where attackers flood the network with a high volume of traffic or exploit vulnerabilities to disrupt network connectivity. This can lead to service interruptions, rendering the network unusable for legitimate users.

Wi-Fi Eavesdropping: Wireless signals can be intercepted and eavesdropped upon by attackers within range of the network. This allows them to capture sensitive information transmitted over the wireless network, such as passwords, financial data, or personal information.

Lack of Security Updates: Failure to apply regular firmware updates and security patches leaves wireless devices and access points vulnerable to known exploits and vulnerabilities.

Weak or Misconfigured Security Settings: Inadequate security configurations, such as weak encryption protocols, open network configurations (without password protection), or disabled security features, make wireless networks more susceptible to unauthorized access and attacks.

Password Cracking: Weak or easily guessable passwords make wireless networks vulnerable to brute-force attacks. Attackers can use specialized tools to crack passwords and gain unauthorized access.

Insider Threats: Employees or individuals with authorized access to the wireless network may misuse their privileges, intentionally or unintentionally compromising network security.

Social Engineering Attacks: Attackers can manipulate individuals to disclose sensitive information or grant unauthorized access to the wireless network through techniques such as phishing or impersonation.

Physical Proximity Attacks: Wireless networks can be targeted by attackers who are physically close to the network's coverage area. They can attempt to exploit vulnerabilities in the network infrastructure, tamper with access points, or gain unauthorized physical access to network devices.

Device Misconfiguration and Vulnerabilities: Devices connected to wireless networks, such as laptops, smartphones, and IoT devices, can have misconfigurations or vulnerabilities that can be exploited by attackers to gain access to the network or compromise the device itself.

It's essential to implement robust security measures, such as strong encryption protocols, secure authentication mechanisms, regular security updates, and monitoring tools, to mitigate these vulnerabilities and protect wireless networks from potential threats.

2.2 PROPOSED SOLUTION

Security in wireless networks is essential to protect against unauthorized access, data breaches, and ensure the confidentiality, integrity, and availability of network resources. Here are some key aspects of security in wireless networks:

1. Authentication: Implement strong authentication mechanisms to verify the identity of devices and users connecting to the wireless network. This can include techniques like passwords, digital certificates, and multifactor authentication.

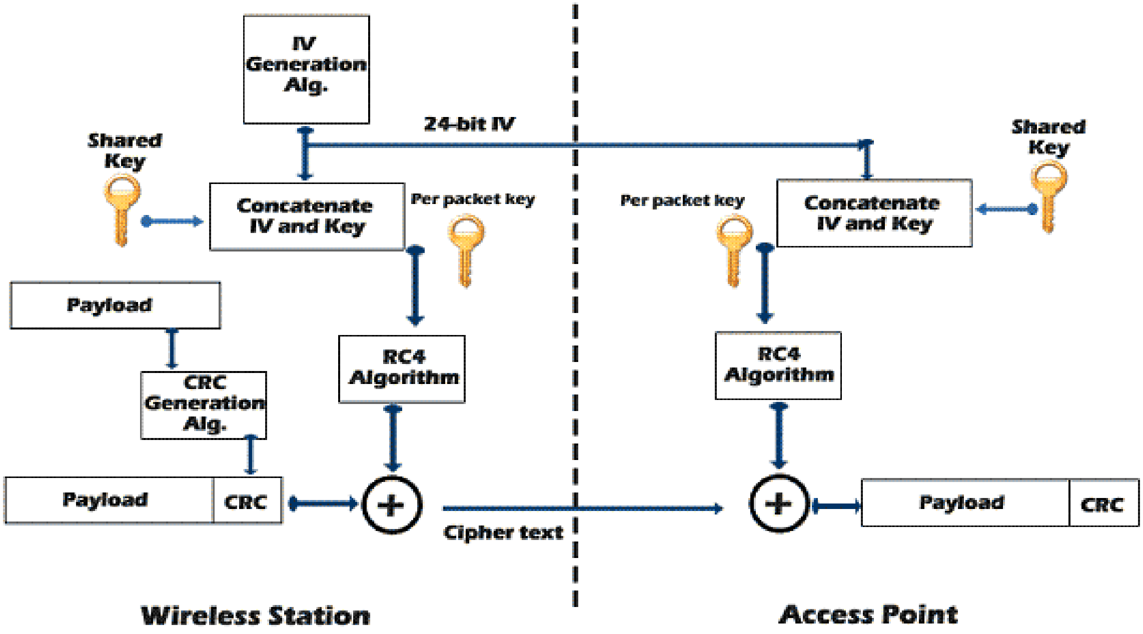
2. Encryption: Use robust encryption protocols, such as WPA2 (Wi-Fi Protected Access 2) or WPA3, to encrypt data transmitted over the wireless network. Encryption prevents unauthorized individuals from intercepting and deciphering the data.

3. Secure Configuration: Configure wireless network devices, such as access points and routers, with strong and unique passwords. Change default settings, disable unnecessary services or features, and implement security best practices recommended by the device manufacturers.

4. Network Segmentation: Separate wireless networks from critical internal networks through proper network segmentation. This prevents unauthorized access to sensitive resources and limits the potential impact of a security breach.

5. Wireless Intrusion Detection/Prevention Systems (WIDS/WIPS): Deploy WIDS/WIPS solutions that monitor wireless network traffic, detect and respond to suspicious activities, and prevent unauthorized access attempts.

6. Physical Security: Protect physical access to wireless network devices to prevent unauthorized individuals from tampering with or gaining direct access to the network infrastructure.



7. Regular Patching and Updates: Keep wireless network devices up to date with the latest firmware or software updates provided by manufacturers. These updates often include security patches to address vulnerabilities.

8. Rogue Access Point Detection: Implement measures to detect and prevent the deployment of unauthorized or rogue access points within the network. Unauthorized access points can create security risks and provide avenues for attackers to gain unauthorized access.

9. User Education: Educate users about security best practices, such as using strong passwords, avoiding public Wi-Fi networks, and being cautious when connecting to unknown networks or accessing sensitive information over wireless connections.

10. Monitoring and Logging: Implement monitoring and logging mechanisms to capture and analyse wireless network activities. This helps in detecting security incidents, investigating breaches, and maintaining an audit trail for forensic analysis.

Wireless network security requires a comprehensive and layered approach, incorporating technical controls, proper configuration, and user awareness. Regular security assessments, vulnerability scanning, and penetration testing can also help identify and address potential weaknesses in wireless network security.

3. THEORITICAL ANALYSIS

3.1 COMPONENTS OF WIRELESS NETWORKS

Wireless networks typically consist of the following components:

1. Wireless Access Points (WAPs): These devices act as hubs or routers that transmit and receive data between wireless devices and the network infrastructure. They provide wireless coverage within a specific area, known as a "hotspot" or coverage zone.

2. Wireless Network Interface Cards (NICs): These are hardware components or integrated circuits that enable devices to connect to a wireless network. They are found in devices such as laptops, smartphones, tablets, and IoT devices.

3. Wireless Routers: These devices combine the functionalities of a wireless access point and a traditional wired router. They connect the wireless network to the internet and allow multiple wireless devices to access the network simultaneously.

4. Wireless Protocols and Standards: Wireless networks use various protocols and standards to ensure interoperability and secure communication. Common wireless protocols include Wi-Fi (802.11 standards), Bluetooth, Zigbee, and cellular network standards (3G, 4G, and 5G).

3.2 BENEFITS OF WIRELESS NETWORKS

- Mobility: Wireless networks enable users to connect and access the internet or network resources from anywhere within the coverage area, without the limitation of physical cables.

- Flexibility: Devices can be easily added or moved within the network without the need for rewiring or reconfiguration.

- Convenience: Wireless networks eliminate the clutter and limitations of physical cables, allowing for a more organized and accessible workspace or living environment.

- Scalability: Wireless networks can be easily expanded or upgraded to accommodate additional devices or larger coverage areas.

Wireless networks have become an essential part of modern communication and connectivity, enabling wireless internet access, seamless device connectivity, and IoT applications in various settings such as homes, businesses, public spaces, and industries.

3.3 WHERE ARE WIRELESS NETWORKS USED?

Wireless networks are used in various settings and industries for different purposes. Here are some common examples:

Home Networks: Wireless networks are extensively used in homes for connecting devices such as smartphones, laptops, smart TVs, and smart home devices to the internet.

Businesses and Offices: Wireless networks are deployed in offices and businesses to provide network connectivity to employees and facilitate seamless communication and collaboration. They enable wireless access to resources like file servers, printers, and shared data.

Public Wi-Fi Hotspots: Wireless networks are available in public spaces like cafes, airports, hotels, libraries, and shopping centers to offer internet access to individuals who are on the go.

Education Institutions: Wireless networks are widely used in schools, colleges, and universities to provide internet connectivity to students, teachers, and staff. They support online learning, research, and other educational activities.

Healthcare Facilities: Wireless networks are utilized in hospitals, clinics, and healthcare facilities to enable wireless communication between medical devices, facilitate access to patient records, and support telemedicine applications.

Industrial Applications: Wireless networks are used in industrial environments to enable wireless monitoring, control systems, and data collection. They facilitate processes such as remote monitoring, asset tracking, and machine-to-machine communication.

Internet of Things (IoT): Wireless networks play a crucial role in connecting and managing IoT devices, such as smart sensors, smart appliances, and wearable devices, enabling them to communicate and exchange data.

Outdoor Environments: Wireless networks are deployed in outdoor environments for various purposes, including city-wide Wi-Fi coverage, public safety communications, and monitoring systems.

Wireless networks offer flexibility, convenience, and mobility, allowing users to connect and communicate without the constraints of wired connections. They have become an integral part of our modern digital lives and are continuously evolving to meet the increasing demand for wireless connectivity.

4. EXPERIMENTAL INVESTIGATIONS

4.1 CRYPTOGRAPHY IN WIRELESS NETWORKS

Cryptography plays a crucial role in ensuring the security of wireless networks. It provides several key security mechanisms that help protect the confidentiality, integrity, and authenticity of data transmitted over wireless channels. Here's how cryptography is used in the security of wireless networks:

Encryption: Cryptographic algorithms are used to encrypt wireless data transmissions, preventing unauthorized interception and eavesdropping. Encryption algorithms such as AES (Advanced Encryption Standard) are employed to encrypt the data packets, making them unreadable to unauthorized parties.

Authentication: Cryptographic techniques are used for user and device authentication in wireless networks. For example, the Extensible Authentication Protocol (EAP) is often used with the Transport Layer Security (TLS) protocol to establish secure authentication between wireless clients and access points.

Key Management: Cryptography helps manage the generation, distribution, and protection of cryptographic keys used for encryption and authentication. Key management protocols and techniques ensure secure key exchange and prevent unauthorized access to keys.

Secure Handshake: Cryptographic protocols, such as the Transport Layer Security (TLS) or its predecessor Secure Sockets Layer (SSL), are used for secure handshakes between wireless clients and access points. These protocols establish a secure and encrypted channel for communication.

Secure Protocols: Cryptography is utilized in various secure protocols used in wireless networks, such as Secure Shell (SSH) for secure remote access, IPsec (Internet Protocol Security) for securing IP communications, and SSL/TLS for securing web-based communications.

Digital Signatures: Cryptography enables the use of digital signatures in wireless networks, ensuring the integrity and authenticity of transmitted data. Digital signatures verify the identity of the sender and detect any unauthorized modifications to the data.

VPNs (Virtual Private Networks): Cryptographic techniques are employed in VPNs to create secure and encrypted tunnels over public networks. VPNs allow users to securely access private networks over wireless connections, providing confidentiality and integrity to the transmitted data.

Secure Key Exchange: Cryptographic protocols like Diffie-Hellman key exchange are used to securely exchange encryption keys between wireless devices and access points, ensuring that only authorized parties can decrypt the encrypted data.

Cryptography forms the foundation of secure communication in wireless networks, protecting against unauthorized access, eavesdropping, and data tampering. By implementing robust encryption, authentication, and key management mechanisms, wireless networks can ensure the confidentiality and integrity of data transmitted over wireless channels, enhancing overall network security.

4.2 ENCRYPTION ALGORITHMS IN WIRELESS NETWORKS

1. Wired Equivalent Privacy (WEP) Protocol

Wired Equivalent Privacy Protocol abbreviated as WEP, was initially originated in the 1999 and is considered the standard for wireless security encryption. It is less found in today’s modern world because of the risk of security it is associated with directly/ indirectly. WEP is not considered stable and Wi-Fi discontinued its use in 2004 because it is easy to exploit this level of security. Example: Security added in the LAN connections to protect from unauthenticated users trying to breach privacy.

2. Wi-Fi Protected Access (WPA) Protocol:

WEP was succeeded by Wi-Fi Protected Access Protocol abbreviated as WAP which offers more security and safety. WPA has a 128-bit dynamic key called Temporary Key Integrity Protocol (TKIP) that's hard to break and makes it unique. One noticeable disadvantage of WPA was that since it was made for WEP-enabled devices, so the core components were majorly the same for WPA and WEP.

3. Wi-Fi Protected Access 2 (WPA2) Protocol

Wi-Fi Protected Access 2 Protocol abbreviated as WPA2 came next and was better than the previous encryption types. Here, Temporary Key Integrity Protocol (TKIP) was replaced by Counter Mode Cipher Block Chaining Message (CCMP). It is one of the most used security encryption types. In 2006, WPA2 was declared to be used in all wi-fi devices for wireless security encryption. WPA2 offers Advanced Encryption Standards (AES). However, the major disadvantage of WPA2 is that if the security key reached the hands of a hacker, then the entire network is vulnerable to attack.

4. Wi-Fi Protected Access 3 (WPA3) Protocol:

WPA3 or Wi-Fi Protected Access 3 (WPA3) Protocol is the newest security encryption that's gaining popularity. WPA3 offers high protection and prevents unauthorized access. Unauthenticated and unauthorized individuals can't breach this level of security. WPA3 is the most desired for public networks as it performs automatic encryption.

4.3 POPULAR CRYPTOGRAPHY ALGORITHMS USED IN WIRELESS NETWORKS

In real-life wireless networks, several popular cryptography algorithms are commonly used to provide security and protect data transmitted over the wireless channels. Here are some widely used cryptography algorithms in wireless networks:

Advanced Encryption Standard (AES): AES is a symmetric encryption algorithm widely adopted as the standard for securing wireless networks. It provides strong encryption and is used in protocols like WPA2 and WPA3 to protect wireless data transmission.

RSA (Rivest-Shamir-Adleman): RSA is an asymmetric encryption algorithm used for key exchange, digital signatures, and authentication in wireless networks. It ensures secure communication and establishes trust between entities.

Elliptic Curve Cryptography (ECC): ECC is an asymmetric encryption algorithm that offers strong security with shorter key lengths compared to RSA. It is used for key exchange, digital signatures, and authentication in wireless protocols like EAP-TLS.

Diffie-Hellman Key Exchange (DHKE): DHKE is a key exchange algorithm that allows two parties to establish a shared secret key over an insecure network. It is used in wireless networks for secure key exchange, particularly in protocols like WPA2.

Hash Functions (e.g., SHA-256): Hash functions are used in wireless networks for message integrity checks and generating message digests. Secure Hash Algorithm (SHA) variants like SHA-256 are commonly employed to ensure data integrity and protect against tampering.

HMAC (Hash-based Message Authentication Code): HMAC is a cryptographic algorithm that combines a hash function with a secret key to provide integrity and authentication of data. It is used in wireless networks for verifying the authenticity of transmitted data.

EAP (Extensible Authentication Protocol): EAP is a framework for network authentication used in wireless networks. It supports various authentication methods, including TLS, which utilizes cryptographic algorithms like RSA and ECC for secure authentication.

TKIP (Temporal Key Integrity Protocol): TKIP is an encryption protocol used in older wireless security standards like WPA to enhance the security of data transmitted over wireless networks. It employs cryptographic algorithms like RC4 for encryption.

CCMP (Counter Mode with Cipher Block Chaining Message Authentication Code Protocol): CCMP is an encryption protocol used in the more secure WPA2 and WPA3 wireless security standards. It utilizes AES in the CCM mode for encryption and integrity protection.

5. FLOW OF PACKETS IN WIRELESS NETWORKS

In wireless networks, packets are encrypted during transmission to protect the confidentiality of the data being transmitted. The encryption process involves converting the original data into an encrypted form using cryptographic algorithms. Here's how packet encryption works in wireless networks:

1. Encryption Algorithm Selection: A suitable encryption algorithm, such as AES, is chosen based on the security requirements of the wireless network. AES is widely used for its strong encryption capabilities.

2. Encryption Key Generation: A unique encryption key is generated by either the wireless access point or the client device. This key is used to encrypt and decrypt the data packets.

3. Data Encryption: Before transmitting the data packets over the wireless network, they are encrypted using the selected encryption algorithm and the encryption key. The encryption process scrambles the data into an unreadable form.

4. Encrypted Packet Transmission: The encrypted data packets are transmitted wirelessly from the sender device to the receiver device using radio waves. These packets are indistinguishable from other wireless traffic and cannot be understood by unauthorized entities intercepting them.

5. Integrity Protection: To ensure data integrity, cryptographic mechanisms such as Message Integrity Check (MIC) or Message Authentication Code (MAC) are used. These mechanisms generate a checksum or hash value for the encrypted data, which is transmitted along with the packet. Upon receiving the packet, the recipient device can verify the integrity of the data by recalculating the checksum or hash value and comparing it with the received value.
6. Decryption at the Receiver: Upon receiving the encrypted packets, the receiver device uses the shared encryption key to decrypt the packets. This process reverses the encryption, converting the encrypted data back into its original form.

5.1 DIFFERENCES IN ENCRYPTION OF PACKETS IN WIRELESS NETWORKS

The main difference between packet encryption in wireless networks and wired transmission lies in the medium used for communication. In wired networks, data is transmitted over physical cables, which provide a more controlled and secured environment. In wireless networks, data is transmitted over the airwaves, which introduces additional security challenges due to the potential for interception and unauthorized access.

To address these challenges, wireless networks employ encryption to protect the data during transmission. Wired networks can also use encryption for added security, but they may rely more on physical security measures since the data transmission is limited to the physical connections between devices. Overall, the encryption process in wireless networks ensures that the data transmitted over the wireless medium remains confidential and secure, mitigating the risks associated with wireless communication.

5.2 ATTACKS ON WIRELESS NETWORKS

Wireless networks are susceptible to various types of attacks due to the inherent nature of wireless communication. Here are some common attacks on wireless networks:

Eavesdropping: Eavesdropping involves unauthorized interception and monitoring of wireless communications. Attackers can capture and analyze wireless packets to obtain sensitive information such as usernames, passwords, or confidential data.

Rogue Access Points: Attackers can set up rogue access points (APs) that mimic legitimate APs to deceive users into connecting to them. These rogue APs can be used to perform man-in-the-middle attacks, intercepting and manipulating data transmitted between users and legitimate APs.

Denial-of-Service (DoS) Attacks: DoS attacks aim to disrupt or disable wireless networks by overwhelming them with a high volume of traffic or by exploiting vulnerabilities in network protocols. These attacks can render the network inaccessible to legitimate users.

Man-in-the-Middle (MitM) Attacks: In a MitM attack, an attacker intercepts and relays communications between two parties without their knowledge. By positioning themselves between a user and an AP, the attacker can eavesdrop on or manipulate the communication.

Wireless Network Spoofing: Attackers can spoof wireless network credentials, such as the Service Set Identifier (SSID) or MAC addresses, to trick users into connecting to a malicious network. This enables attackers to capture sensitive information or launch further attacks.

Wi-Fi Jamming: Wi-Fi jamming involves the deliberate disruption of wireless signals by emitting interference on the same frequency band. It can disrupt or degrade the wireless network, causing connectivity issues for legitimate users.

Dictionary and Brute-Force Attacks: Attackers can attempt to crack the encryption keys of wireless networks by systematically trying all possible passwords or using a precomputed list of commonly used passwords (dictionary attack). These attacks are more successful against weak or easily guessable passwords.

Evil Twin Attacks: In an evil twin attack, attackers create a fraudulent AP with the same SSID as a legitimate network to trick users into connecting to it. Once connected, the attacker can intercept and manipulate data or launch further attacks.

Wireless Hacking Tools: Various tools and software are available to attackers, allowing them to exploit vulnerabilities in wireless networks. These tools can automate attacks, capture wireless packets, perform unauthorized actions, and exploit weaknesses in network security protocols.

To mitigate these attacks, it is essential to implement strong security measures such as encryption (e.g., WPA2/WPA3), strong passwords, authentication protocols (e.g., IEEE 802.1X), regular firmware updates, and network monitoring. Additionally, raising awareness among users about potential security risks and best practices for securing wireless networks can help prevent successful attacks.

5.3 RECENT ATTACKS ON WIRELESS NETWORKS

1. Kr00k (CVE-2019-15126): In 2019, the Kr00k vulnerability was discovered in Wi-Fi chips manufactured by Broadcom and Cypress. This vulnerability affected devices using Wi-Fi connections with WPA2 encryption. Attackers could exploit the vulnerability to decrypt wireless network packets, potentially exposing sensitive information.

2. WiFiDemon (CVE-2020-24588): WiFiDemon is a vulnerability that affects the Wi-Fi module found in certain MediaTek chipsets. It allows attackers within range of the wireless network to execute arbitrary code on vulnerable devices or cause a denial-of-service condition.

3. FragAttacks: FragAttacks (Fragmentation and Aggregation Attacks) are a collection of vulnerabilities discovered in 2020 that affect Wi-Fi devices. These vulnerabilities can be exploited to inject and intercept network traffic, potentially leading to data exfiltration or unauthorized access to devices.

It's important to stay updated with the latest security advisories, patches, and news to learn about the most recent wireless network attacks. Regularly updating devices, using strong encryption protocols, implementing secure configurations, and following best practices for wireless network security can help mitigate the risks associated with such attacks.

5.4 COMMON WIRELESS NETWORK THREATS AND HOW TO PROTECT AGAINST THEM

1. Configuration Problems (Misconfigurations or Incomplete Configurations)

Simple configuration problems are often the cause of many vulnerabilities because many consumer/SOHO-grade access points ship with no security configuration at all. Other potential issues with configuration include weak passphrases, feeble security deployments, and default SSID usage. A novice user can quickly set up one of these devices and gain access, or open up a network to external use without further configuration. These acts allow attackers to steal an SSID and connect without anyone being the wiser.

To mitigate the risk, use a centrally managed WLAN that features periodic audits and coordinated updates.

2. Denial of Service

For wireless networks it can be much easier, as the signal can be interfered with through a number of different techniques. When a wireless LAN is using the 2.4 GHz band, interference can be caused by something as simple as a microwave oven or a competing access point on the same channel. Because the 2.4 GHz band is limited to only three non-overlapping channels (in the U.S.), an attacker just needs to cause enough interference into these to cause service interruption.

A denial-of-service attack can also be used in conjunction with a rogue access point. For example, one could be set up in a channel not used by the legitimate access point. Then a denial-of-service attack could be launched at the channel currently being used, causing endpoint devices to try and re-associate onto a different channel that is used by the rogue access point.

3. Passive Capturing

Passive capturing (or eavesdropping) is performed simply by getting within range of a target wireless LAN, then ‘listening to’ and capturing data which can be used for breaking existing security settings and analysing non-secured traffic. Such information that can be “heard” include SSIDs, packet exchanges, and files (including confidential ones). When it comes down to it, passive capturing is possible nearly anywhere. There are also some go-arounds when an attacker can’t be within normal broadcast range, such as using a big antenna or a wireless repeater device to extend range by miles. An attacker can even use a packet sniffer application that captures all the outgoing packets, grabs and analyses them, then reveals its data payload. You can try a packet sniffer yourself to see the depth and breadth of classified information that is available to anyone who wants to hijack it.

It is almost impossible to totally prevent this type of attack because of the nature of a wireless network. What can be done involves implementing high security standards by using a firewall, and setting complex parameters.

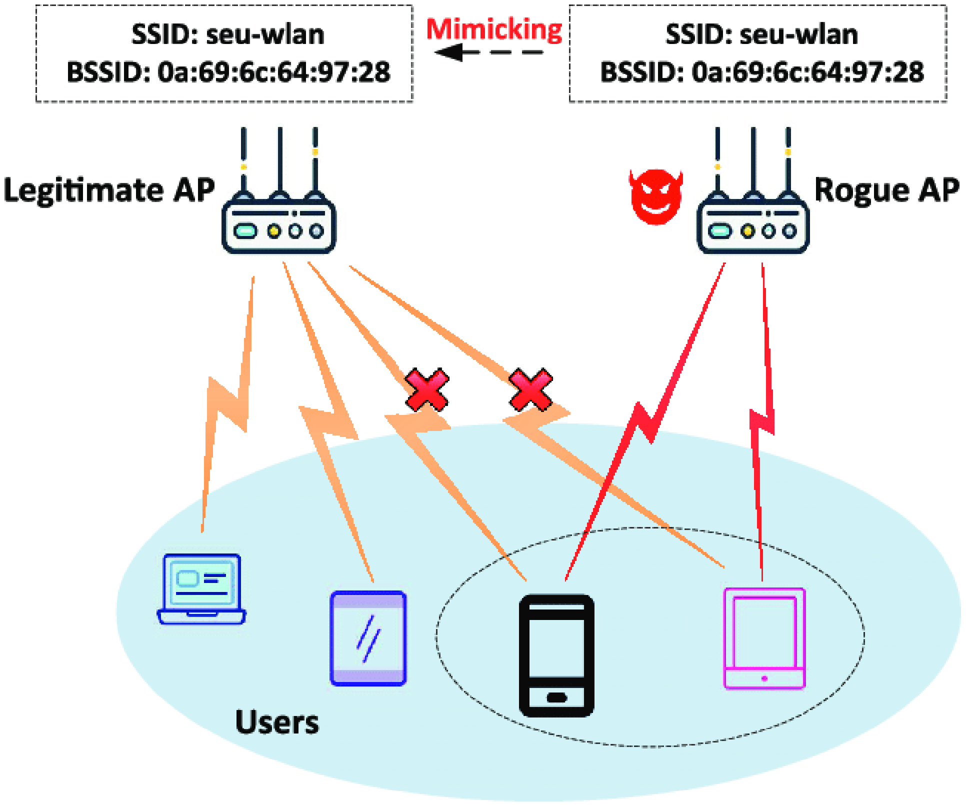
4. Rogue (or Unauthorized/Ad-Hoc) Access Points

To really be effective, this type of attack requires some amount of physical access. This is required because if a user associates with a rogue access point, then is unable to perform any of their normal duties, the vulnerability will be short-lived and not that effective. However, if an attacker is able to gain access to a physical port on a company network and then hook the access point into this port, it's possible to get devices to associate and capture data from them for an extended period of time.

The exception to this barrier is when the wireless LAN being targeted only provides internet access. A rogue access point can also offer simple internet access and leave the user unaware of their vulnerability for an extended amount of time.

Prevention

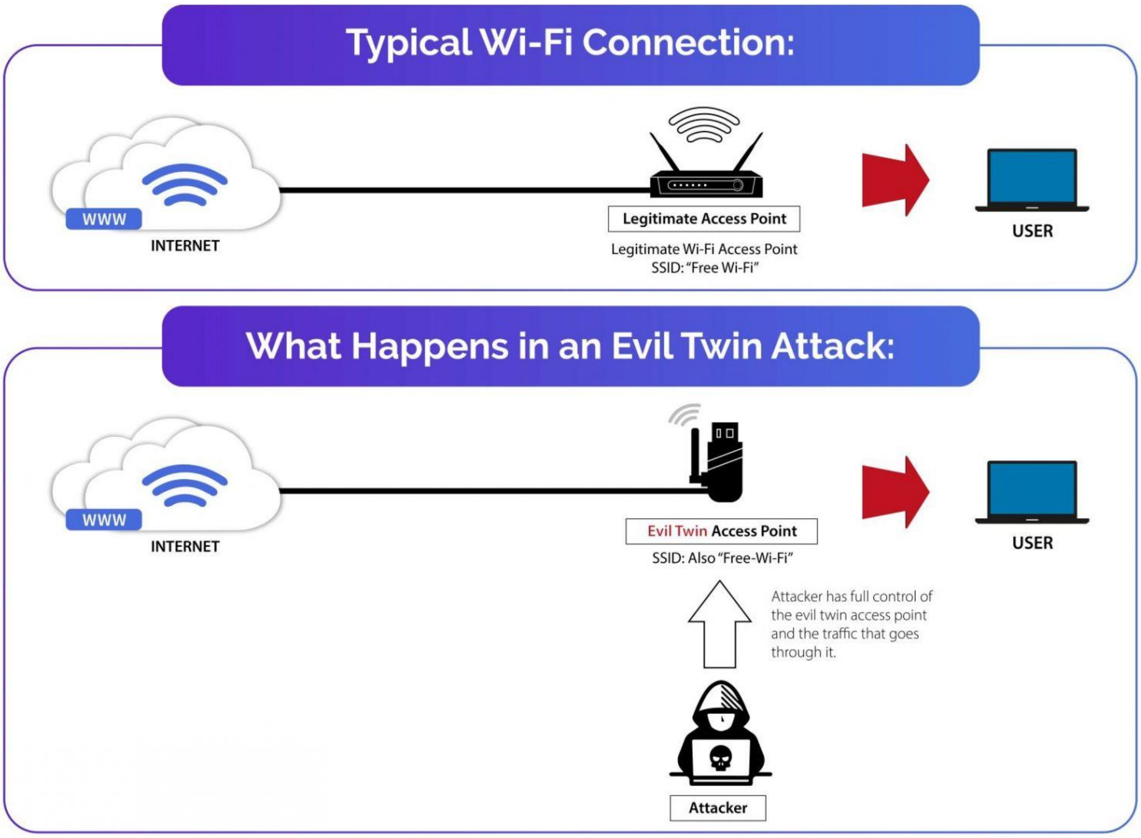
- Use proper WLAN authentication techniques and encryption methods.
- Install a WIPS (wireless intrusion prevention system) to scan radio spectrums, searching for access points with configuration errors.



5. Evil Twin Attacks

An evil twin attack is a type of wireless network attack where an attacker creates a rogue access point (AP) with the same network name (SSID) as a legitimate network to deceive users into connecting to it. The attack gets its name from the fact that the rogue AP appears as a malicious twin of the legitimate AP. An attacker can gather enough information about a wireless access point to impersonate it with their own, stronger broadcast signal. This fools unsuspecting users into connecting with the evil twin signal and allows data to be read or sent over the internet. To protect themselves from evil twin attacks, individuals should exercise caution when connecting to wireless networks, verify the legitimacy of networks before connecting, use encrypted connections whenever possible (such as HTTPS), and regularly update their devices with security patches.

Server authentication and penetration testing are the only tools that will aid in ending evil twin attacks. To mitigate the impact of evil twin attacks, it is crucial to implement strong security measures, such as using secure and encrypted wireless protocols, educating users about the risks, implementing network monitoring and intrusion detection systems, and regularly updating security patches and firmware to address any vulnerabilities.


Typical Wi-Fi Connection:
WWW
INTERNET
Legitimate Access Point
Legitimate Wi-Fi Access Point
SSID: "Free Wi-Fi"
USER
What Happens in an Evil Twin Attack:
WWW
INTERNET
Evil Twin Access Point
SSID: Also "Free-Wi-Fi"
USER
Attacker has full control of the evil twin access point and the traffic that goes through it.
Attacker

6. Hacking of Lost or Stolen Wireless Devices

Often ignored because it seems so innocent, but if an employee loses a smartphone, laptop, etc., that is authorized to be connected to your network, it's very easy for the finder or thief to gain full access. All that’s necessary is to get past the password, which is quite simple to do.

Make it a policy and practice to have employees immediately report a misplaced or stolen device so that it can be remotely locked, given a password change, or wiped clean.

7. Freeloading

Sometimes unauthorized users will piggyback on your wireless network to gain free access. Usually this is not done maliciously, but there are still security ramifications.

- Your internet service may slow down.
- Illegal content or spam can be downloaded via your mail server.
- “Innocent” snooping may take place.

Additionally, employees sharing files with unrecognized networks, or giving permission for a friend or family member to use their login credentials for computer access, both seriously disrupt security measures.

5.5 UNAUTHORIZED ACCESS POINTS IN WIRELESS NETWORKS

Unauthorized access points in wireless networks refer to access points that are not authorized or managed by the network administrator but are connected to the network infrastructure. These access points can be set up by unauthorized individuals or may be devices that have been compromised by attackers. Here are some key points about unauthorized access points:

1. Rogue Access Points: A rogue access point is an unauthorized access point that is intentionally deployed by an attacker. Rogue access points can mimic the SSID and characteristics of a legitimate network, tricking users into connecting to them instead. Attackers can then intercept network traffic, capture sensitive information, or launch further attacks.

2. Misconfigured or Unsecured Access Points: Sometimes, employees or users within an organization may set up their own wireless access points without proper authorization or configuration. These access points may have weak security settings, such as default or easily guessable passwords, or they may lack encryption, making them vulnerable to unauthorized access.

3. Evil Twin Access Points: An evil twin access point is a rogue access point that mimics a legitimate network, often by using the same SSID. When users unknowingly connect to the evil twin, the attacker can intercept their traffic, capture sensitive information, or perform other malicious activities.

4. Security Implications: Unauthorized access points pose several security risks. They can bypass the security measures implemented by the network administrator, making it easier for attackers to gain access to the network. Once connected, attackers can launch various attacks, such as eavesdropping, data interception, unauthorized data access, and even introduce malware or conduct further network reconnaissance.

5.6 PREVENTING UNAUTHORIZED ACCESS POINTS:

- Regularly monitor the wireless network for unauthorized access points using specialized tools that can detect and locate rogue devices.
- Implement strong access control measures, such as using strong passwords, implementing WPA2 or WPA3 encryption protocols, and enabling secure authentication methods like 802.1X.
- Educate employees or users about the risks of setting up unauthorized access points and enforce policies against such actions.
- Conduct regular network assessments to identify and address security vulnerabilities, including unauthorized access points.
- Use wireless intrusion detection and prevention systems (WIDS/WIPS) to detect and mitigate rogue access points.
- Perform regular security audits to identify and remove any unauthorized access points.
- By implementing these measures, organizations can minimize the risk of unauthorized access points and enhance the overall security of their wireless networks.

5.7 FOUNDATION OF WIRELESS NETWORKS

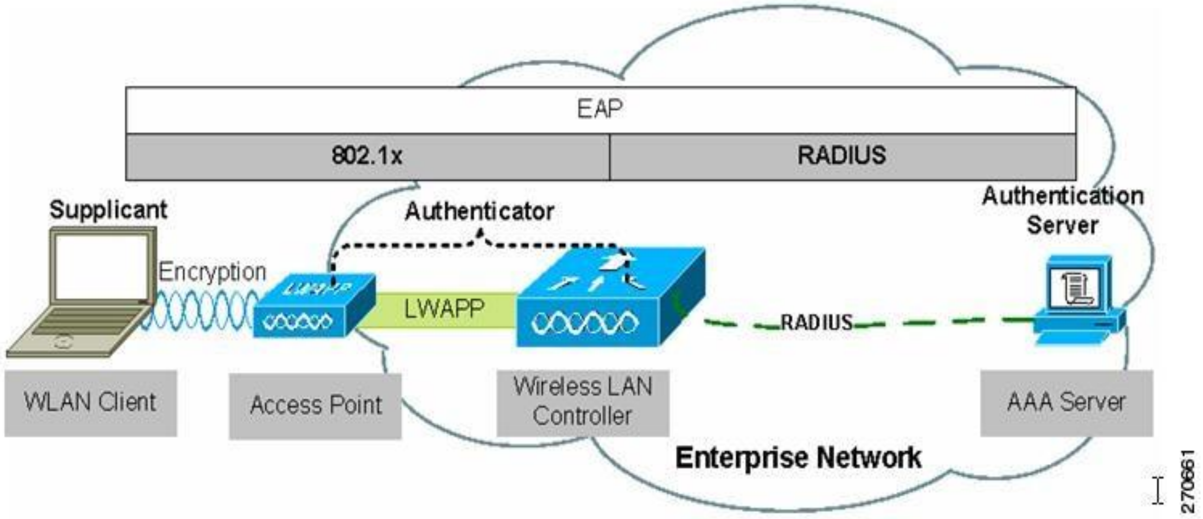


Image from Cisco

The fundamental concepts in wireless networks:

1. SSID (Service Set Identifier): SSID is a unique identifier for a wireless network. It is the name assigned to a Wi-Fi network, and it allows devices to identify and connect to a specific network. When connecting to a wireless network, users typically select the desired SSID from the available networks.

2. Access Point (AP): An access point is a device that acts as a central hub for wireless communication. It enables wireless devices to connect to a wired network or the internet. Access points broadcast the SSID of the network, authenticate and authorize devices, and facilitate the exchange of data between wireless clients and the network infrastructure.

3. Wi-Fi Security: Wi-Fi security refers to the measures taken to protect wireless networks from unauthorized access and data breaches. Common Wi-Fi security mechanisms include encryption protocols like WPA2 (Wi-Fi Protected Access 2) or WPA3, which provide confidentiality for wireless communications, and authentication methods such as Pre-Shared Key (PSK) or 802.1X for validating the identity of connecting devices.

4. Roaming: Roaming allows wireless devices to maintain network connectivity while moving between different wireless access points within the same network or across different networks. It enables seamless transition between access points without interrupting the user's connection. Roaming is especially important in larger wireless networks where multiple access points are deployed to provide coverage in a specific area.

5. Signal Strength: Signal strength refers to the power level of the wireless signal received by a device from an access point or another wireless device. It determines the quality of the wireless connection and affects the data transmission rate and reliability.

6. Data Rate: Data rate, also known as the transmission rate or link speed, represents the speed at which data can be transmitted over a wireless network. It is usually measured in megabits per second (Mbps) and depends on factors such as signal strength, distance, and interference.

7. Wireless Security: Wireless security involves implementing measures to protect the confidentiality, integrity, and availability of data transmitted over a wireless network. It includes encryption, authentication, access control, and other security mechanisms to prevent unauthorized access and protect against attacks.

8. Wireless LAN (WLAN): A wireless local area network (WLAN) is a network that allows wireless devices to connect to a local area network (LAN) without the need for physical cables. WLANs use wireless technologies, such as Wi-Fi, to enable wireless communication between devices.

9. Mesh Networking: Mesh networking is a decentralized network architecture where multiple devices, such as access points, collaborate to extend wireless coverage and improve network reliability. Mesh networks can dynamically route traffic and provide redundancy, enhancing overall network performance.

10. Mobile Ad hoc Network (MANET): A mobile ad hoc network is a type of wireless network where devices communicate directly with each other without relying on a fixed infrastructure, such as access points. MANETs are often used in scenarios where a traditional

network infrastructure is unavailable or impractical, such as in disaster areas or military operations.

These concepts form the foundation of wireless networking, enabling wireless communication, secure connections, and seamless mobility. Understanding these concepts is crucial for designing, deploying, and managing wireless networks effectively.

5.8 HOW WIRELESS NETWORKS WORKS

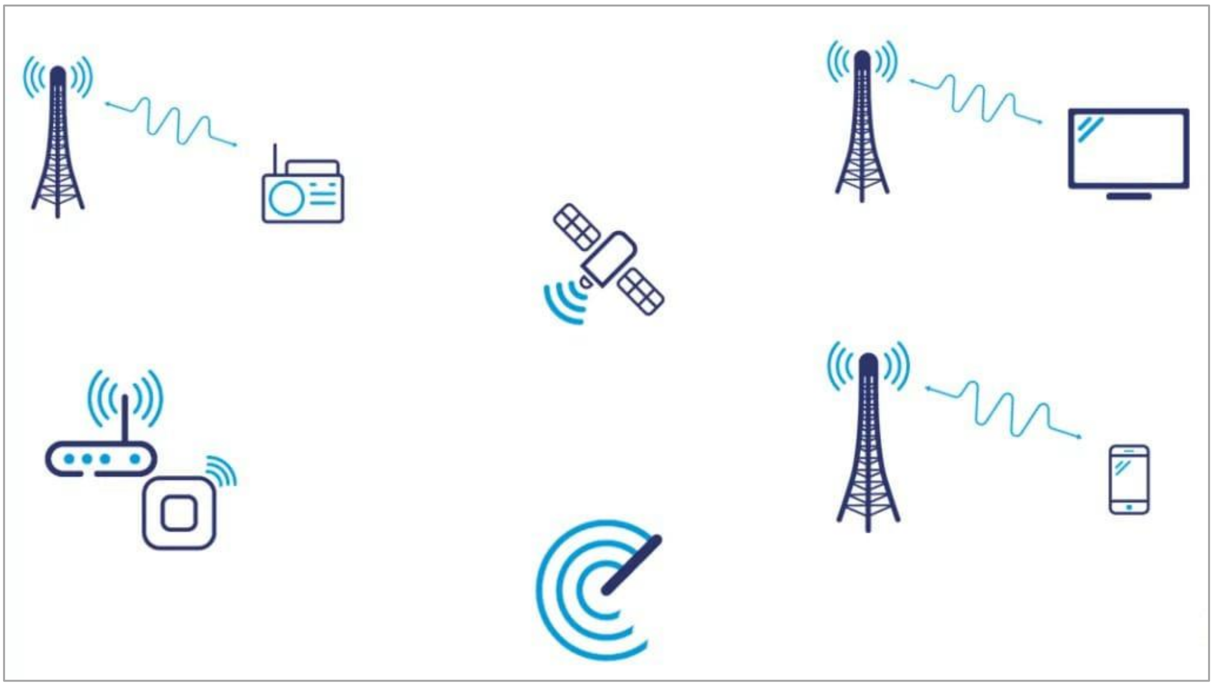
Radio waves are used in a wireless network just as they are used in televisions, mobile phones, and radios. Communication in a wireless network is very similar to two-way radio communication. Basically, first a computers wireless adapter changes the data into radio signals and then transmits these signals through the use of an antenna. Then a wireless router receives the signal and decodes it. It then sends the information through a wired Ethernet connection to the internet. This procedure also works backwards in which the router receives information from the internet and sends it to the computer.

Establishing a wireless connection

We can say that establishing a wireless connection is a technical and expensive task. However, this is not the case in reality. Establishing a wireless network does not involve many technical personnel and the machines. It is a simple network to establish as there are no wires involved. A person has to install software at large and he or she just has to buy a router. If we overall compare the cost of wireless network with that of wired network, wireless network is comparatively cheaper wireless network is a one-time expense. Whereas a wired network needs to be constantly updated and monitored. One more aspect involved in the network cost is the need for technical staff. This technical staff in some cases is the burden on the company, wireless network does not require any network assistant, and thus it eliminates the human resource cost at large. We can add more stations to wireless network as there is no hassle of wires. There is less destruction in case of electricity failure and natural disasters.

Wireless network used in

In most cases we use wireless communication to transmit data. It can be either in one direction, like radio or TV broadcasting or two-way data transfer where one entity acts as a transmitter and other as a receiver. In the second scenario we can use satellites, Wi-Fi Access points or mobile networks, like 3G, 4G or upcoming 5G as the intermediate points which help achieve such communication between the transmitter and receiver.



Wireless communication takes place

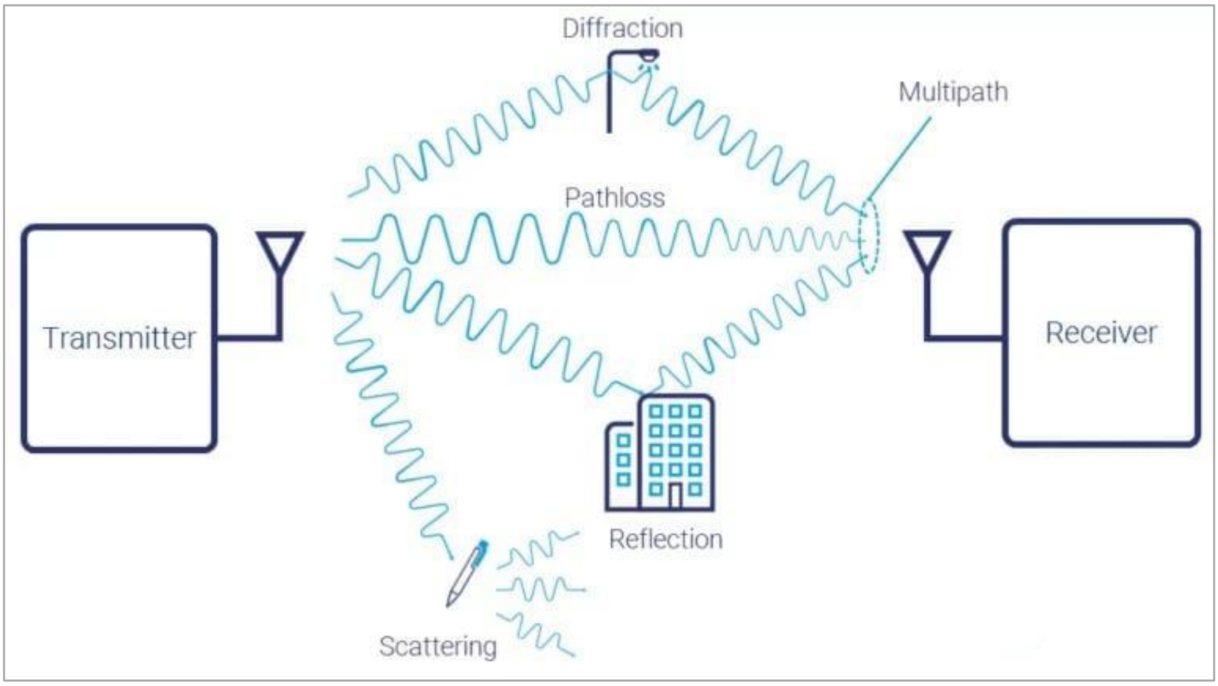
For wireless communication to take place we require data to be transported without wires. This data is transported using what we call signals (electromagnetic waves). Now the question comes how can we create signal to be sent over wireless? It all starts at the transmitter, where an oscillator generates periodic wave. This signal propagates through internal wires of the device up to the antenna. Since antenna is a conductor, electric current goes further towards the end of the antenna. The antenna then radiates the alternating current as an electromagnetic wave. This is where wireless starts i.e., antenna converts electric current into waves.

Frequency of the signal

Depending on how fast signal from the oscillator changes, output waves have different frequencies. These frequencies can be used for different purposes. We call range of different frequencies a spectrum. It is divided into areas of specific usage. Exemplary usages are: radio-navigation, radio-location, broadcasting, mobile communication, ISM band, satellite, space research and many others. Government authorities, like FCC, are responsible for assigning frequency ranges for specific purpose.

How signals travel

A signal usually does not go straight to the receiver after being transmitted. The antenna on the transmitter radiates the signal in many directions. Waves can reflect from buildings, diffract on sharp edges or scatter on small objects and still reach the receiver. On their way, waves suffer different attenuation and delay. Receiver captures all of them as a combined signal. When there is more than one route between transmitter and receiver, we call such channel a multipath channel.

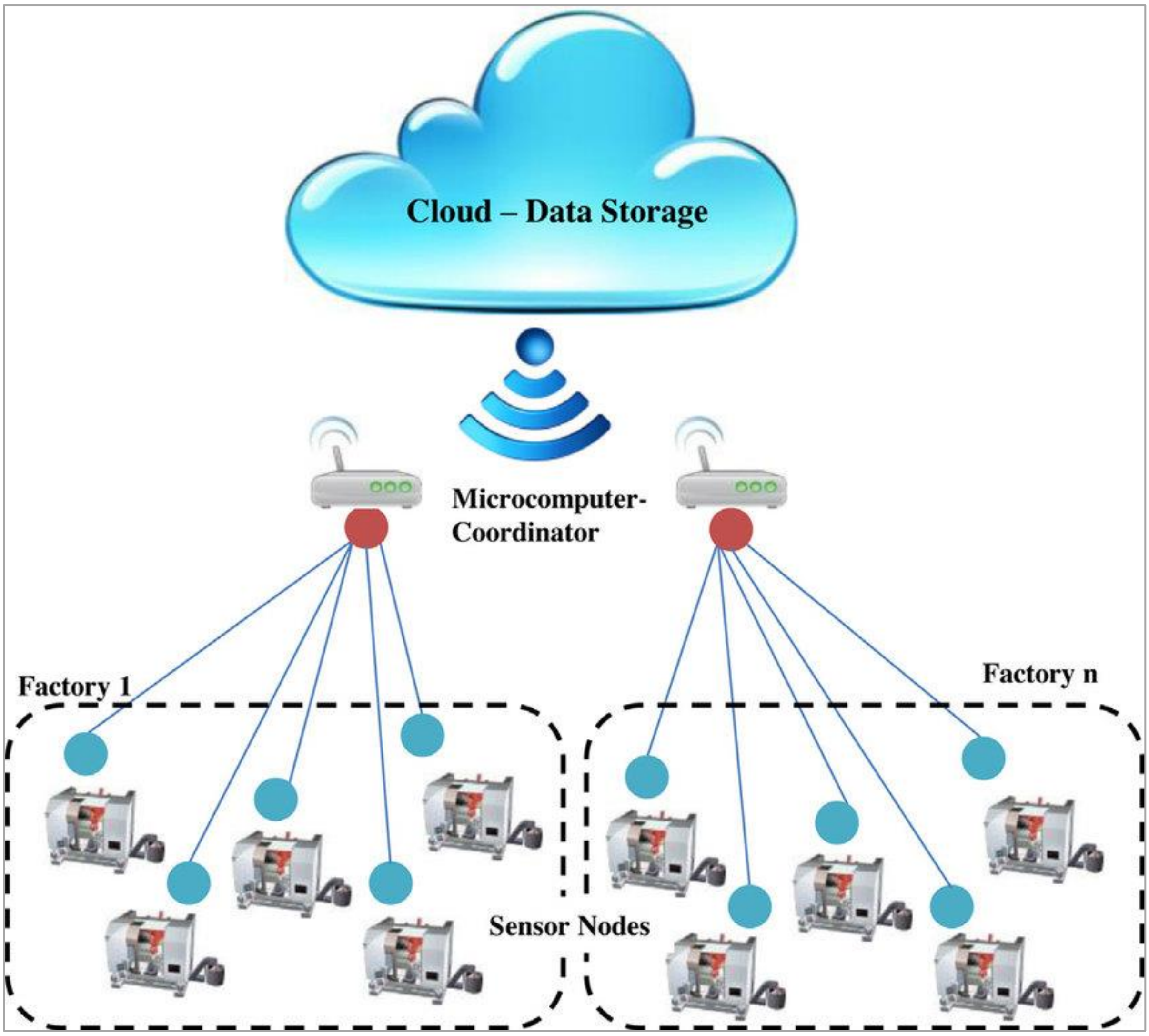


Inside transmitter

We know, that receiver must deal with the distorted and mixed signal to decode the data. This is not a trivial task since captured signal contains a huge amount of unwanted components. To make this task easier we take some additional steps in the transmitter. Before sending the user data, transmitter performs encoding. This operation appends additional bits to the message, which makes data recovery in receiver easier. After encoding bits are mapped onto symbols, modulated and passed to the antenna.

5.9 WIRELESS NETWORK MAPPING

Network mapping is the process of discovering and visually depicting the structure and connections of a computer network. It involves gathering information about the devices, systems, and services present on a network, as well as the relationships and interdependencies between them. The goal of network mapping is to create a comprehensive and accurate representation of the network's topology. Wireless network mapping is the process of discovering and visualizing the structure, coverage, and signal strength of wireless networks. It involves identifying and mapping wireless access points (APs), client devices, and their interconnections within a wireless network.



Here are the key aspects of wireless network mapping:

1. Access Point Discovery: The first step is to identify and locate all the wireless access points within the network. This can be done by performing wireless network scans using tools like Wi-Fi scanners or network monitoring software. These tools detect and list the available access points along with their SSIDs (network names) and signal strength.

2. Signal Strength Mapping: Once the access points are discovered, signal strength mapping is performed to visualize the coverage area and signal strength distribution. This is typically done by walking through the area and collecting signal strength measurements at different locations. The collected data is then used to create heatmaps or signal strength overlays on a map, showing areas with strong or weak signal coverage.

3. Client Device Mapping: In addition to mapping access points, client devices connected to the wireless network can also be mapped. This helps in understanding the distribution of devices, identifying potential coverage gaps or areas with high device density. Client device mapping can be done through network monitoring tools that track connected devices and their locations.

4. Interference Analysis: Wireless network mapping can also help in identifying sources of interference that can degrade network performance. By analysing the signal strength and quality at different locations, potential interference from neighbouring networks, other wireless devices, or physical obstructions can be identified.

5. Security Assessment: Wireless network mapping can aid in security assessments by identifying unauthorized access points or rogue devices. It helps network administrators detect any unauthorized or potentially malicious wireless devices that may have been introduced into the network.

Why network mapping?

Benefits of Wireless Network Mapping:

Visualization: Wireless network mapping provides a visual representation of the coverage area, signal strength, and device distribution, helping administrators understand the wireless network's characteristics.

Coverage Optimization: By analysing the signal strength maps, administrators can optimize access point placement, adjust transmit power, or add additional access points to ensure optimal coverage throughout the desired area.

Performance Enhancement: Identifying areas with weak signal strength or interference allows administrators to address coverage issues, improve performance, and enhance the user experience.

Security Enhancement: Wireless network mapping helps in detecting unauthorized access points, rogue devices, or potential security vulnerabilities within the network.

5.10 EXPLOIT TECHNIQUES ON WIRELESS NETWORKS

Wireless networks can be susceptible to various exploits and attacks due to their inherent vulnerabilities. Here are some common wireless exploits:

Man-in-the-Middle (MitM) Attacks: In a wireless network, attackers can position themselves between a client device and the legitimate access point to intercept and manipulate network traffic. By exploiting weaknesses in authentication or encryption protocols, attackers can capture sensitive information, inject malicious code, or modify data in transit.

Wi-Fi Eavesdropping: Attackers can use tools to capture and analyze wireless network traffic, allowing them to eavesdrop on sensitive information, such as usernames, passwords, or confidential data transmitted over the network. This can be done by sniffing wireless packets or leveraging vulnerabilities in encryption protocols.

Evil Twin Attacks: Attackers can set up rogue access points that mimic legitimate networks, often with the same SSID (network name). Unsuspecting users may connect to these fake access points, enabling attackers to intercept their traffic, steal credentials, or launch further attacks.

Wireless Denial-of-Service (DoS): Attackers can flood a wireless network with a large volume of malicious traffic or exploit vulnerabilities in the network infrastructure to disrupt network connectivity. This can result in denial of service for legitimate users, rendering the network unusable.

Wi-Fi Password Cracking: Weak or easily guessable Wi-Fi passwords can be cracked using brute-force attacks or dictionary-based attacks. Attackers can employ specialized tools to guess or crack the password, gaining unauthorized access to the network.

MAC Spoofing: Attackers can spoof the Media Access Control (MAC) address of their devices to impersonate authorized devices on the network. This allows them to bypass MAC filtering and gain access to the network.

WPS Vulnerabilities: The Wi-Fi Protected Setup (WPS) feature, designed to simplify the process of connecting devices to a network, can have vulnerabilities that allow attackers to guess or brute-force the WPS PIN and gain unauthorized access to the network.

KRACK Attack: Key Reinstallation Attack (KRACK) targets vulnerabilities in the WPA and WPA2 encryption protocols, allowing attackers to decrypt and intercept wireless network traffic. This attack can be used to steal sensitive information or inject malicious code.

It is important to consider wireless network security measures such as strong encryption, secure authentication protocols, regular security updates, and monitoring tools can help mitigate the risks associated with these wireless exploits. Implementing best practices, such as using strong passwords, disabling unnecessary network services, and staying updated with security patches, can significantly enhance wireless network security.

Techniques used to exploit the wireless exploits mentioned above:

Packet Sniffing: Attackers use packet sniffing tools to intercept and capture wireless network traffic. By analysing the captured packets, they can extract sensitive information, such as usernames, passwords, or other confidential data transmitted over the network.

Man-in-the-Middle (MitM) Attacks: Attackers position themselves between a client device and the legitimate access point to intercept and manipulate network traffic. They can achieve this by exploiting vulnerabilities in protocols like ARP (Address Resolution Protocol) or DNS (Domain Name System) to redirect traffic through their own devices.

Evil Twin Attacks: Attackers set up rogue access points with the same SSID (network name) as a legitimate network to deceive users. When users unknowingly connect to the rogue access point, the attacker can intercept and manipulate their traffic or capture sensitive information.

De-authentication and Disassociation Attacks: Attackers send forged de-authentication or disassociation frames to legitimate clients, forcing them to disconnect from the network. This can be used to launch denial-of-service attacks or facilitate other exploits by tricking clients into connecting to a rogue access point.

WPS PIN Cracking: Attackers exploit vulnerabilities in the WPS (Wi-Fi Protected Setup) feature, attempting to guess or brute-force the WPS PIN. Once they have the correct PIN, they can gain unauthorized access to the network.

Exploiting Encryption Weaknesses: Attackers target weaknesses in encryption protocols like WEP (Wired Equivalent Privacy) or vulnerabilities in implementations of WPA/WPA2 (Wi-Fi Protected Access). By exploiting these weaknesses, they can decrypt or intercept wireless network traffic.

MAC Address Spoofing: Attackers spoof the MAC (Media Access Control) address of their devices to impersonate authorized devices on the network. This allows them to bypass MAC filtering and gain unauthorized access.

Denial-of-Service (DoS) Attacks: Attackers flood the wireless network with a large volume of malicious traffic or exploit vulnerabilities in network infrastructure components to disrupt network connectivity. This can lead to denial of service for legitimate users. Understanding these techniques helps in implementing appropriate security measures to protect wireless networks and mitigate the associated risks.

6. RESULT

When security measures are applied to wireless networks, they can significantly enhance the overall security and protect against various threats and vulnerabilities. Here are some key results and benefits of implementing security measures in wireless networks:

Data Confidentiality: By using encryption protocols like WPA2 or WPA3, sensitive data transmitted over wireless networks is encrypted, ensuring that it remains confidential and cannot be easily intercepted or deciphered by unauthorized individuals. This helps protect the privacy of users' communications and prevents unauthorized access to sensitive information.

Authentication and Access Control: Implementing strong authentication mechanisms, such as passwords, digital certificates, or multi-factor authentication, helps ensure that only authorized users can access the wireless network. Access control policies can be enforced to restrict network access based on user roles, privileges, or other criteria, reducing the risk of unauthorized access.

Network Integrity: Security measures like integrity checks, digital signatures, or secure hash algorithms help ensure the integrity of data transmitted over wireless networks. These mechanisms detect any unauthorized modifications or tampering of data, providing assurance that the data remains unaltered during transmission.

Threat Prevention and Detection: Security measures include deploying firewalls, intrusion detection and prevention systems (IDPS), and other network security appliances to monitor and detect suspicious activities or potential threats in real-time. These measures help prevent unauthorized access attempts, detect malicious behaviour, and take proactive actions to mitigate risks.

Vulnerability Patching and Updates: Regularly applying security patches and updates to network devices, access points, and other components helps address known vulnerabilities. Keeping the network infrastructure up to date reduces the likelihood of successful attacks that exploit known weaknesses.

Security Auditing and Monitoring: Conducting regular security audits and monitoring the wireless network for any anomalies, unauthorized access points, or abnormal behaviour can help identify and address security gaps. Network administrators can proactively detect and respond to security incidents, ensuring a more secure environment.

User Awareness and Training: Educating users about best practices, security policies, and potential risks associated with wireless networks helps raise awareness and foster a security-conscious culture. Training users to recognize and report suspicious activities can significantly enhance the overall security of the network.

Compliance with Regulations: Implementing security measures in wireless networks helps organizations comply with industry-specific regulations and standards governing data security and privacy. Compliance with these requirements not only reduces legal and financial risks but also enhances the trust and credibility of the organization. Overall, applying security measures to wireless networks results in a more secure environment, reducing the risk of unauthorized access, data breaches, and other security incidents. It helps protect the confidentiality, integrity, and availability of data and resources, safeguard user privacy, and mitigate the impact of potential security threats.

7. ADVANTAGES & DISADVANTAGES

Advantages of Applying Security Measures in Wireless Networks

Enhanced Data Security: Applying security measures such as encryption and authentication protocols ensures the confidentiality and integrity of data transmitted over wireless networks, protecting it from unauthorized access and tampering.

Mitigation of Security Risks: Security measures help mitigate various security risks, including unauthorized access, data breaches, malware infections, and man-in-the-middle attacks. This reduces the potential impact of security incidents on individuals and organizations.

Protection of User Privacy: Security measures in wireless networks safeguard user privacy by preventing unauthorized monitoring or interception of their network communications. This helps build trust among users and ensures the privacy of their sensitive information.

Regulatory Compliance: Implementing security measures helps organizations comply with industry regulations and standards governing data protection and privacy. Compliance demonstrates a commitment to security and can help avoid legal and financial penalties.

Enhanced Network Performance: Security measures, when properly implemented, can improve the overall performance of wireless networks. By detecting and preventing unauthorized or malicious activities, network resources are optimized, leading to better network availability and performance.

Disadvantages of Applying Security Measures in Wireless Networks:

Complexity and Implementation Challenges: Implementing robust security measures in wireless networks can be complex and challenging. It requires expertise, time, and resources to properly configure and maintain security protocols, devices, and infrastructure.

Potential Compatibility Issues: Security measures may introduce compatibility issues, especially when integrating new security technologies or protocols with existing network infrastructure. This may require additional configuration and testing to ensure seamless compatibility.

Performance Overhead: Some security measures, such as encryption, may introduce a performance overhead on wireless networks. This can result in increased latency or reduced network throughput, particularly in resource-constrained environments or when using high levels of encryption.

User Experience Impact: Stringent security measures can sometimes inconvenience users, requiring them to go through additional steps for authentication or encryption setup. This can affect user experience and may lead to resistance or non-compliance with security protocols.

Cost: Implementing robust security measures in wireless networks may require investments in security hardware, software, and ongoing maintenance. This can add to the overall cost of network infrastructure deployment and operations.

False Positives and False Negatives: Security measures like intrusion detection systems may generate false positives (identifying benign activities as threats) or false negatives (failing to detect actual threats). This can impact the effectiveness of security monitoring and response. Despite these potential disadvantages, the benefits of applying security measures in wireless networks outweigh the challenges. It is essential to carefully plan and implement security measures, considering the specific needs, risks, and constraints of the network environment to strike a balance between security and usability.

8. APPLICATIONS

Applying security measures in wireless networks has numerous practical applications across various sectors and use cases. Here are some common applications of these security measures:

1. Home Networks: Security measures are essential for protecting personal data, securing internet connectivity, and preventing unauthorized access to home wireless networks. Encryption, strong passwords, and firmware updates help safeguard home networks from external threats.

2. Corporate Networks: Security measures are crucial for protecting sensitive business data, confidential communications, and intellectual property within corporate wireless networks. Authentication mechanisms, access controls, and network monitoring help defend against unauthorized access, data breaches, and insider threats.

3. Public Wi-Fi Networks: Security measures are necessary for securing public Wi-Fi networks found in coffee shops, airports, hotels, and other public places. Encryption, user authentication, and network segmentation help protect users' data and prevent unauthorized access to their devices.

4. Internet of Things (IoT): Security measures play a vital role in securing wireless networks used by IoT devices. Encryption, access controls, and device authentication prevent unauthorized access, data tampering, and the exploitation of IoT vulnerabilities.

5. Healthcare Networks: Security measures are critical in healthcare environments to protect patient privacy and secure sensitive medical data. Robust authentication, encryption, and intrusion detection systems help safeguard patient information and ensure compliance with healthcare regulations.

6. Financial Networks: Security measures are essential for securing wireless networks used in banking and financial institutions. Strong encryption, two-factor authentication, and secure protocols protect financial transactions, customer data, and prevent unauthorized access to sensitive financial information.

7. Government Networks: Security measures are vital for protecting classified information, government communications, and critical infrastructure. Robust encryption, secure authentication, and network segmentation help defend against cyber threats and ensure the integrity and confidentiality of government networks.

8. Educational Institutions: Security measures are crucial for securing wireless networks in schools, colleges, and universities. Access controls, content filtering, and user authentication help protect student and faculty data, enforce policy compliance, and prevent unauthorized access.

9. Industrial Control Systems: Security measures are vital for protecting wireless networks used in industrial control systems (ICS) and supervisory control and data acquisition (SCADA) systems. Strong authentication, encryption, and network segmentation help defend against cyber-attacks that could disrupt critical infrastructure.

10. Military and Defence Networks: Security measures are paramount in military and defence networks to protect classified information, secure communications, and ensure mission-

critical operations. Robust encryption, secure key management, and strict access controls are essential in these environments.

In general, implementing these measures is crucial in any scenario where the confidentiality, integrity, and availability of data and network resources need to be protected from unauthorized access, malicious activities, and potential security breaches.

9. CONCLUSION

In conclusion, security in wireless networks is of paramount importance due to the increasing reliance on wireless communication and the potential risks associated with it. Protecting the confidentiality, integrity, and availability of data transmitted over wireless networks is crucial to ensure the privacy of sensitive information and maintain the trust of users. The implementation of robust security measures, such as authentication, encryption, access control, network segmentation, and monitoring, helps mitigate security threats and vulnerabilities. By adopting a layered approach to wireless network security, organizations can create a strong defence against unauthorized access, data interception, and network breaches. The application of security measures in wireless networks is crucial for ensuring the protection, integrity, and privacy of data and resources. Wireless networks are susceptible to various threats and vulnerabilities, making it essential to implement robust security measures to mitigate risks and safeguard against unauthorized access, data breaches, and malicious activities. By applying encryption protocols, authentication mechanisms, access controls, and network monitoring, wireless networks can be fortified against potential attacks and unauthorized intrusion. These security measures provide numerous advantages, including enhanced data security, protection of user privacy, regulatory compliance, and improved network performance. While there may be some challenges and potential disadvantages associated with implementing security measures, such as complexity, compatibility issues, and performance overhead, the benefits outweigh these drawbacks. The importance of security measures in wireless networks is evident across various sectors, including home networks, corporate environments, public Wi-Fi networks, healthcare, finance, government, education, industrial control systems, and military networks.

Overall, the conclusion is that securing wireless networks through the application of appropriate security measures is essential in today's interconnected world. It helps protect sensitive information, maintain privacy, prevent unauthorized access, and ensure the reliable and secure operation of wireless network infrastructures. As technology evolves and cyber threats become more sophisticated, continuous efforts to improve and adapt security measures in wireless networks are crucial for maintaining a robust and resilient cybersecurity posture.

10. FUTURE SCOPE

It is important to note that wireless network security is an ongoing process. The landscape of threats is constantly evolving, and new vulnerabilities may emerge. Therefore, organizations need to stay vigilant, regularly update their security measures, and adapt to emerging security challenges. Additionally, user education and awareness play a crucial role in wireless network security. Users should be educated about the risks and best practices to ensure they understand their responsibilities in maintaining a secure wireless network environment. Ultimately, by prioritizing and investing in security measures, organizations can minimize the potential risks associated with wireless networks, protect sensitive information, and maintain the integrity and availability of their wireless communication infrastructure. The future scope of security measures in wireless networks is vast and continues to evolve as technology advances and new threats emerge. Here are some potential areas of future development and improvement:

Enhanced Encryption: Encryption algorithms and protocols will continue to evolve to provide stronger and more secure encryption mechanisms. This includes the development of post-quantum encryption algorithms that are resistant to attacks from quantum computers.

Machine Learning and AI-Based Security: Machine learning and artificial intelligence (AI) can be leveraged to enhance wireless network security. These technologies can help detect and prevent advanced threats, identify anomalies in network traffic, and automate security incident response.

Blockchain for Network Security: Blockchain technology has the potential to enhance network security by providing decentralized and tamper-resistant mechanisms for authentication, access control, and secure transactions. Its application in wireless networks can enhance trust and integrity.

Internet of Things (IoT) Security: As the number of IoT devices connected to wireless networks increases, securing these devices becomes critical. Future security measures will focus on IoT-specific protocols, authentication mechanisms, and secure firmware updates to protect against IoT-based attacks.

Cloud-Based Security Solutions: Cloud-based security solutions offer scalability, flexibility, and centralized management for wireless network security. Future developments may include cloud-based threat intelligence, real-time monitoring, and security analytics for wireless networks.

User Behaviour Analytics: Analysing user behaviour can provide valuable insights into potential security threats and anomalies. Future security measures may include advanced user behaviour analytics to detect unauthorized access, suspicious activities, or compromised devices.

Quantum Cryptography: With the advancement of quantum computing, quantum cryptography will play a significant role in the future of wireless network security. Quantum key distribution (QKD) and quantum-resistant encryption algorithms will be essential to protect against attacks from quantum computers.

Zero Trust Networking: The concept of Zero Trust Networking emphasizes a strict access control approach, assuming that no user or device should be inherently trusted. Future security measures will focus on implementing Zero Trust principles in wireless networks to minimize the risk of insider threats and unauthorized access.

Continuous Security Monitoring: Real-time monitoring and threat intelligence will be crucial in detecting and responding to security incidents promptly. Future security measures will involve automated monitoring, advanced threat detection techniques, and security orchestration for rapid incident response.

Privacy-Preserving Technologies: As privacy concerns continue to grow, future security measures will focus on privacy-preserving technologies, such as differential privacy, homomorphic encryption, and secure multi-party computation, to protect user data while maintaining network security.

As technology and threats evolve, it is crucial to continuously innovate and adapt security measures to address emerging challenges and ensure the resilience of wireless network security in the years to come.

ATTACK SIMULATION VIDEO LINKS:

1. Man in the Middle attack using Wireshark and Ettercap - https://youtu.be/AihxFLjkDKM

2. Packet Sniffing using Wireshark –

https://drive.google.com/file/d/1ty73lyn9SmTPrKP7w3t5MFjKJ1JgHSp5/view?usp=sharing

3. Accessing wireless network using Bettercap –

https://drive.google.com/file/d/16gLLGKERCVV1-k-VzAErFJ6PNZEquMO1/view?usp=sharing

4. Password cracking - https://youtu.be/yOcfiAjHxKY

11. REFERENCES

Images from Google Images