

## Level 3: Advanced **Networking Practices**

This presentation outlines the key components of the Level 3 Advanced Networking Practices course, covering essential concepts, practical skills, and assessment methods.

#### **CONTENT OF THE SESSIONAL COURSE**

**MD. TARIQUL ISLAM** Lecturer, Department of CSE University of Global Village (UGV), Barishal

## **Course Learning Outcomes**

### **CLO1**

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Demonstrate understanding of fundamental networking concepts, including network types, devices, and topologies.

#### CLO2 2

Apply networking protocols, IP addressing (IPv4/IPv6), subnetting, and configure LAN, MAN, and WAN networks.

### 3

CLO3

### CLO4

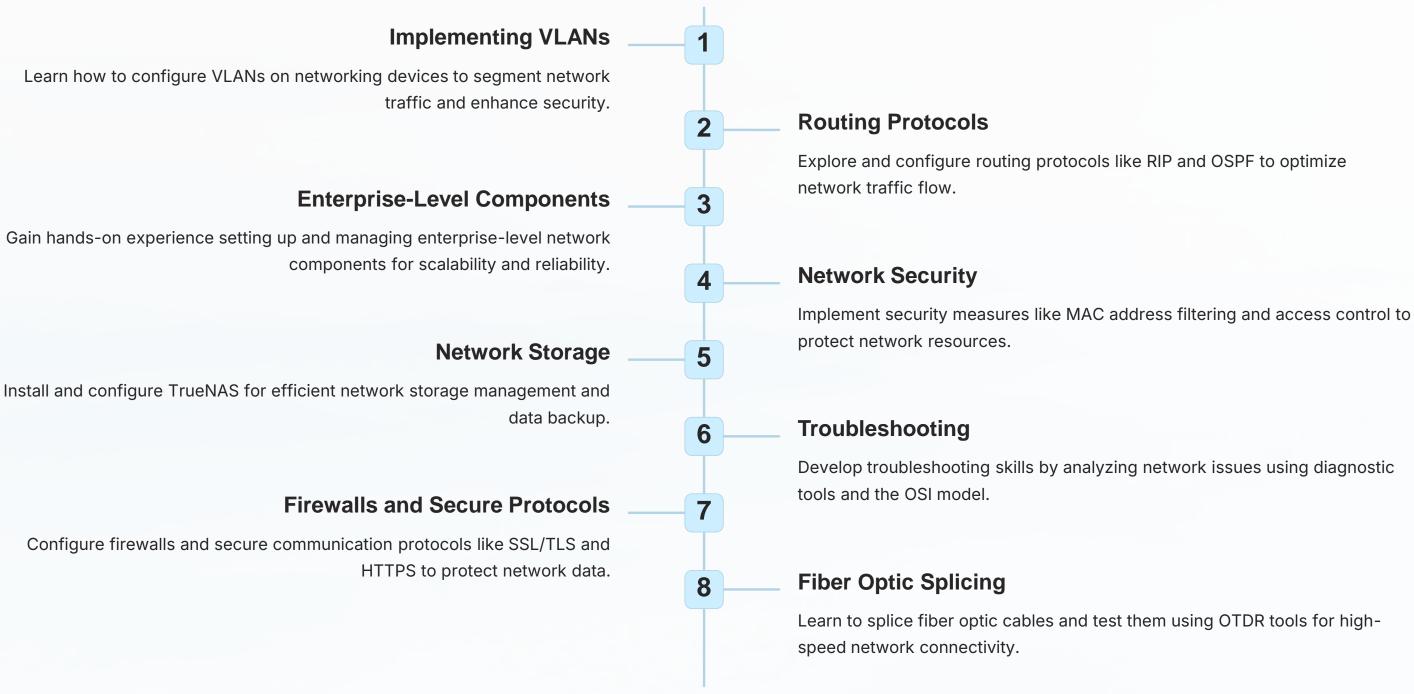
Troubleshoot and resolve network issues using diagnostic tools, network monitoring tools, and OSI model layers.



Integrate emerging technologies (SDN, IoT, Cloud Networking) and advanced network security practices into systems.

Design and implement secure and scalable enterprise-level networks using VLANs, VPNs, routing protocols, and NAS.

### **Course Content Overview**



### Course Plan

Wee k No.	Topics	Teaching-Learning Strategy(s)	Class Hour	Practice Hour	Assessment Strategy(s)	Alignment to CLO
1	Introduction to Network Security: Basic Concepts	Lecture, Demonstration, Group Discussions	5h	5h	Quiz, Homework	CLO1
2	Cryptography Basics: Symmetric vs Asymmetric Encryption	Lecture, Hands-on Lab	5h	5h	Lab Assignment, Quiz	CLO2
3	Digital Certificates and Digital Signatures	Lecture, Group Work, Case Study	5h	5h	Lab Report, Quiz	CLO3
4	Network Security Protocols: SSL/TLS, HTTPS	Hands-on Lab, Demonstration	5h	5h	Lab Report <i>,</i> Quiz	CLO3
5	Firewall Configuration and Management	Hands-on Lab, Group Work	5h	5h	Lab Assignment, Quiz	CLO4
6	Intrusion Detection and Prevention Systems (IDS/IPS)	Hands-on Lab, Group Work	5h	5h	Lab Report, Practical Test	CLO4
7	VPN Setup and Configuration for Secure Remote Access	Hands-on Lab, Group Work	5h	5h	Lab Assignment, Quiz	CLO5
8	Securing Wireless Networks: WPA, WPA2, and WPA3	Hands-on Lab, Demonstration	5h	5h	Lab Report, Quiz	CLO3
9	Implementing Two-Factor Authentication (2FA)	Hands-on Lab, Problem Solving	5h	5h	Quiz, Lab Assignment	CLO4
10	Network forensics and Packet Analysis with Wireshark	Hands-on Lab, Group Work	5h	5h	Lab Report, Practical Test	CLO4

### Course Plan

Week No.	Topics	Teaching-Learning Strategy(s)	Class Hour	Practice Hour	Assessment Strategy(s)	Alignment to CLO
11	Setting up DNSSEC for Securing DNS	Hands-on Lab <i>,</i> Group Work	5h	5h	Lab Report, Quiz	CLO5
12	Advanced Routing: OSPF, BGP Security Configurations	Hands-on Lab, Problem Solving	5h	5h	Lab Report, Quiz	CLO4
13	Implementing IPSec VPN for Secure Communication	Hands-on Lab <i>,</i> Group Work	5h	5h	Lab Assignment, Practical Test	CLO5
14	Advanced Network Monitoring and Troubleshooting	Lecture, Hands-on Lab, Demonstration	5h	5h	Lab Report, Final Project	CLO5
15	Cloud Networking and Security	Hands-on Lab, Case Study	5h	5h	Final Project, Presentation	CLO5
16	Network Automation and Orchestration	Hands-on Lab, Demonstration	5h	5h	Lab Assignment, Quiz	CLO5
17	Review of Advanced Networking and Security Topics	Group Discussion, Q&A Session	5h	5h	Final Exam, Project Submission	CLO5



## **Recommended Resources**

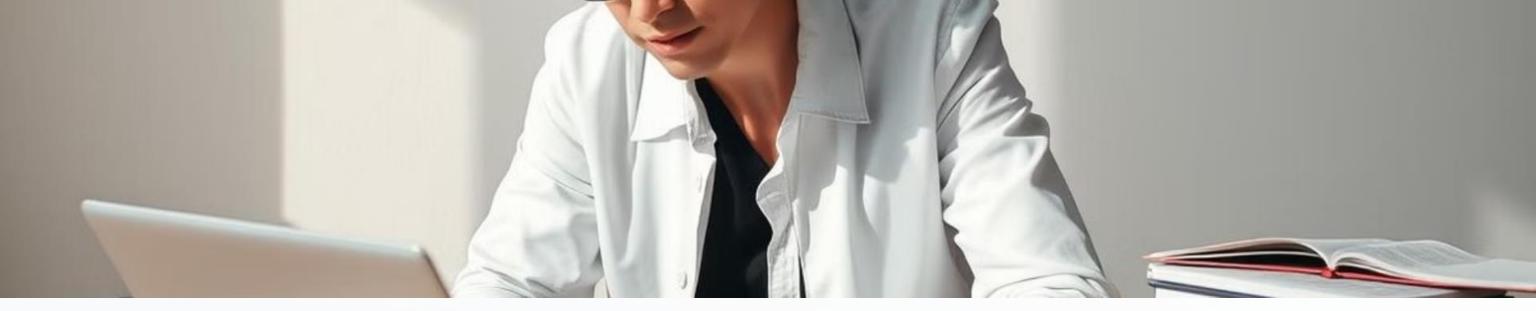
#### **Textbooks**

Computer Networking: A Top-Down Approach by James Kurose and Keith Ross, Computer Networks by Andrew S. Tanenbaum, Network Security Essentials by William Stallings.

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### **Online Tutorials**

Udemy, TutorialsPoint, YouTube channels like NetworkChuck, Professor



### **Assessment Pattern**



Assignments

10 marks

Lab Participation

10 marks

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Quizzes

10 marks

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20 marks

### **Final Project**



## Key Takeaways

This Level 3 Advanced Networking Practices course provides a comprehensive foundation in network security, troubleshooting, and emerging technologies. By mastering these skills, you will be well-equipped to design, implement, and manage secure and scalable enterprise-level networks.



## Week-01 Introduction to Network Security: Basic Concepts



### **Module Objectives**

**Understand Core Principles** 

Grasp fundamental network security principles, like confidentiality, integrity, and availability.

**Identify Common Threats** 

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Explore prevalent network security threats, such as malware, DDoS attacks, and data breaches.

### Master Security Best Practices

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- Learn essential best practices for
- securing networks, including
- access control and encryption.

## **Required Equipment**

#### Laptop

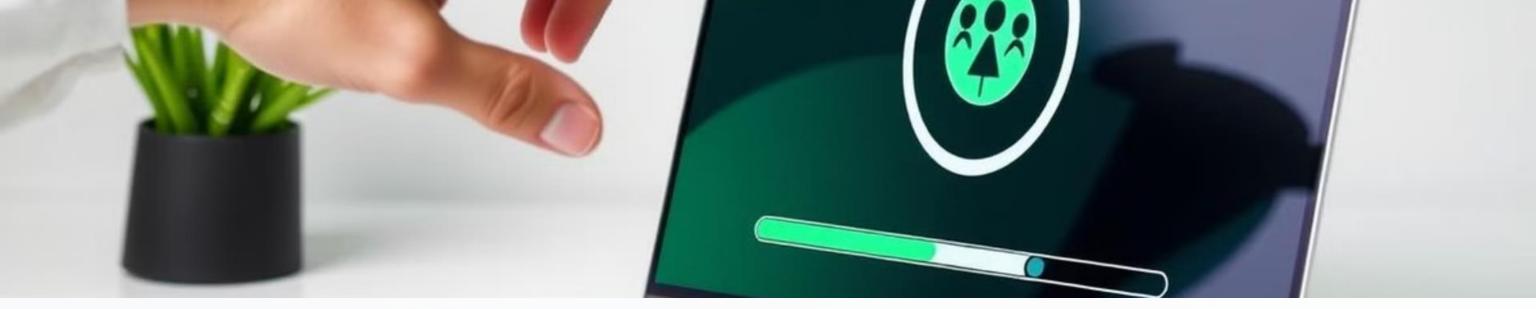
Use your personal laptop or one provided by the lab.

### **Network Simulation Software**

Install and utilize simulation software like Packet Tracer or GNS3 for handson exercises.

#### **Online Resources**

Access online resources like cybersecurity blogs, tutorials, and vendor documentation.



### **Preparation Steps**

#### **Install Network Simulation Software**

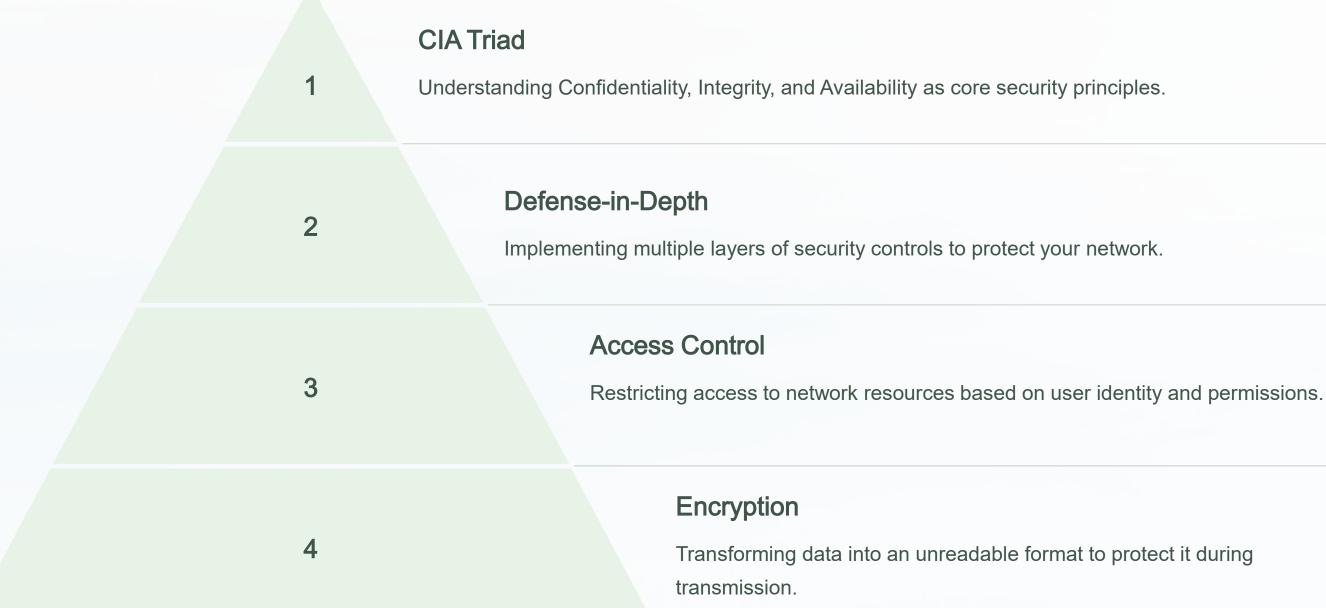
Download and install the chosen network simulation software on your laptop.

### **Review Networking Concepts**

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Refresh your knowledge of fundamental networking concepts such as IP addressing and network topologies.

### **Network Security Fundamentals**



# Understanding the Threat Landscape

#### Malware

Malicious software designed to harm computers, steal data, or disrupt operations.

#### **DDoS Attacks**

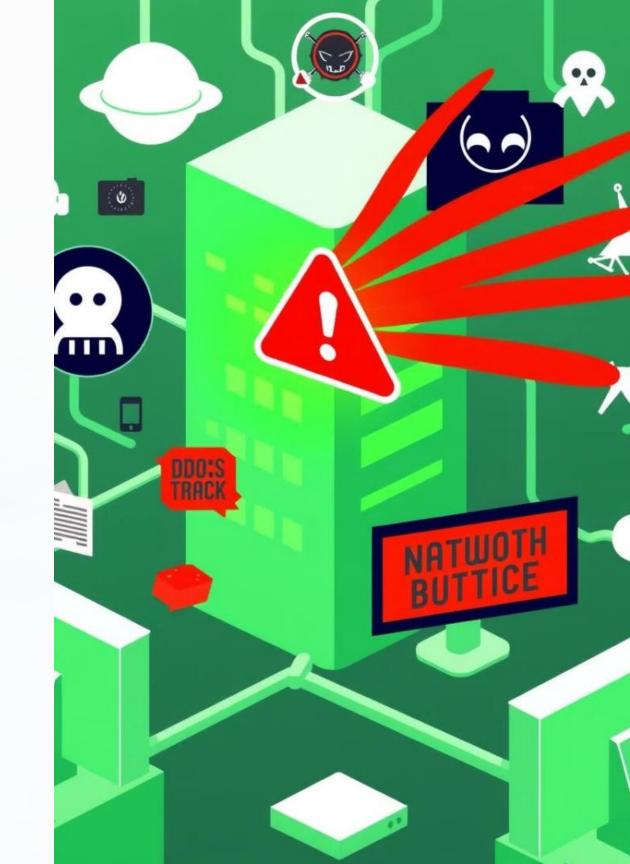
Overwhelming a network with traffic from multiple sources to disrupt its services.

#### **Unauthorized Access**

Gaining access to network resources without proper authorization.

#### **Data Breaches**

Unauthorized access to sensitive data, compromising confidentiality and integrity.



### Securing Your Network

#### **Firewalls**

Hardware or software that filters network traffic, blocking unauthorized access.

#### VPNs

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Create a secure connection over a public network, encrypting data for privacy and security.

#### Intrusion Detection/Prevention Systems

Identify and prevent malicious activity by analyzing network traffic for suspicious patterns.

#### **Endpoint Protection**

Secure individual devices like laptops and desktops with antivirus software and firewalls.

#### **Network Segmentation**

Dividing a network into smaller, isolated segments to limit the impact of security breaches.

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## **Conclusion and Key Takeaways**

#### Importance of Network Security

Protecting your network is crucial for safeguarding data, maintaining privacy, and ensuring business continuity.

#### **Continuous Learning**

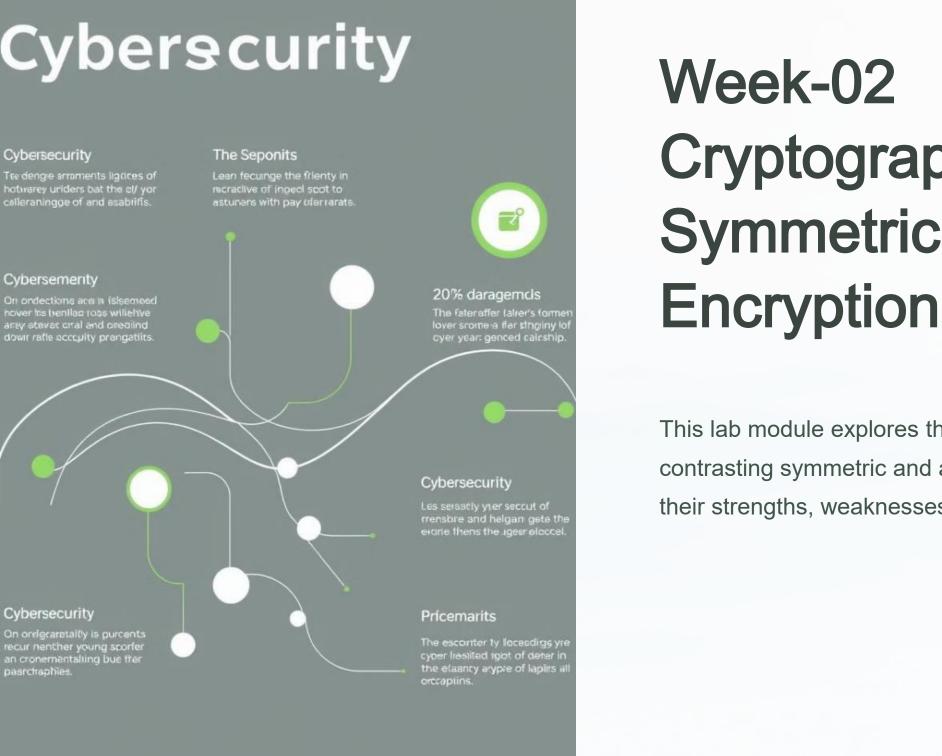
The threat landscape is constantly evolving, so continuous learning and staying updated on new threats is vital.

#### **Stay Ahead of Threats**

Proactively adapt security practices to address emerging threats and vulnerabilities.

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## Week-02 Cryptography Basics: Symmetric vs Asymmetric Encryption

This lab module explores the fundamentals of cryptography, comparing and contrasting symmetric and asymmetric encryption methods. We'll analyze their strengths, weaknesses, and real-world applications.

## Objectives

#### Symmetric Encryption

Understand the concept of shared secret keys.

Explore common symmetric algorithms like AES, DES, and Blowfish.

#### **Asymmetric Encryption**

Learn about public/private key pairs and their role.

Examine key algorithms like RSA, Diffie-Hellman, and Elliptic Curve.

## **Encryption Basics**

#### Symmetric Encryption

Uses a single secret key for both encryption and decryption.

The key must be shared securely between sender and receiver.

### Asymmetric Encryption

Employs a pair of keys: a public key for encryption and a private key for decryption.

The public key is widely shared, while the private key is kept secret.

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## Symmetric Encryption



Symmetric algorithms are generally faster than asymmetric algorithms.

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#### **Applications** 3

Widely used for data encryption at rest and in transit, like file encryption and secure communication protocols.

### Efficiency

Require less computational power for encryption and decryption.

## **Asymmetric Encryption**

#### Security

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Provides stronger security by keeping the private key secret.

### 2 Key Management

Simplifies key distribution and management, as only the public key needs to be shared.

### 3 Applications

Essential for digital signatures, secure communication, and public key infrastructure (PKI).

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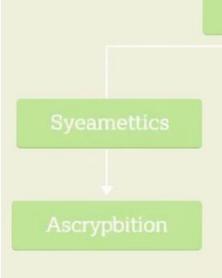
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## Comparison

Feature	Symmetric	Asymmetric
Key Management	Difficult key distribution	Simplified key distribution
Speed	Faster	Slower
Security	Vulnerable to key compromise	More secure
Use Cases	Data encryption at rest, secure communication	Digital signatures, secure communication



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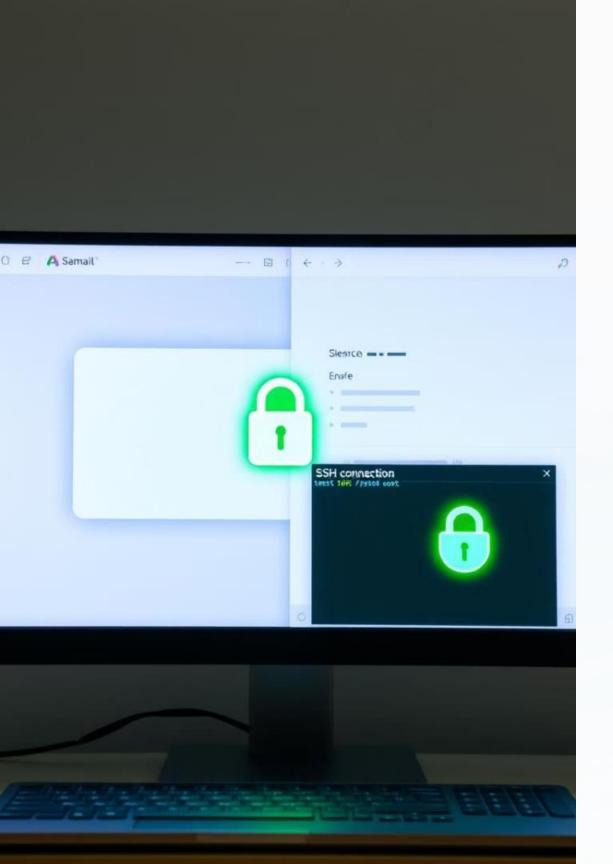


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## **Practical Examples**



### **Email Encryption**

Securely sending and receiving emails using PGP (Pretty Good Privacy).



### Web Transactions

Protecting online transactions through HTTPS (Hypertext Transfer Protocol Secure) using SSL/TLS certificates.

### SSH Key Management

Securing remote access to servers using SSH keys for authentication and encryption.



## Conclusion

Understanding the differences between symmetric and asymmetric encryption is crucial for implementing effective cryptography strategies. Choose the appropriate approach based on your security needs, key management requirements, and performance considerations.



## Week-03 Digital Certificates and Digital Signatures

This module will introduce you to the world of digital certificates and signatures, exploring their key concepts and practical applications.



## **Module Objectives**

#### 1. Purpose

Gain understanding of the importance and uses of digital certificates and signatures.

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### 2. Principles

Learn the fundamental principles and underlying technologies behind these concepts.

## **Required Equipment**

#### Hardware

A laptop or computer with internet access.

### **Software**

Software for digital certificate management (e.g., OpenSSL, Let's Encrypt, etc.).

#### Resources

generating your own).

#### Sample digital certificates (obtainable

#### from Certificate Authorities or by

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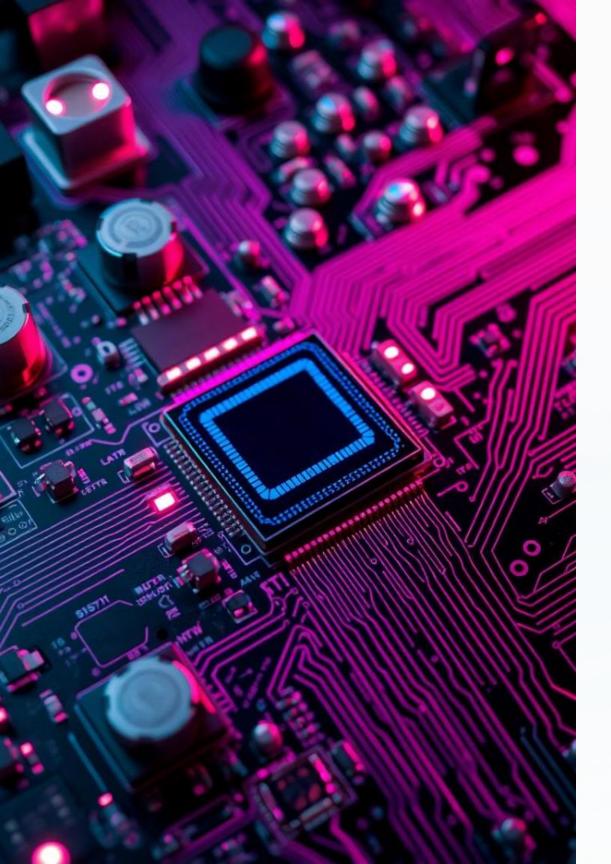
### **Preparation Steps**

#### **Software Installation**

Install the necessary digital certificate management software on your device.

#### **Certificate Acquisition**

- Acquire sample digital
- certificates from a trusted
- source or generate your own
- self-signed certificates.



### **Detailed Procedure**

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#### **Step 1: Generating a self-signed certificate**

Learn how to create a self-signed certificate using the installed software.

#### Step 2: Requesting a certificate from a CA

Understand the process of obtaining a certificate from a Certificate Authority (CA), including the required steps and documentation.

#### **Step 3: Configuring applications to use certificates**

Learn how to configure applications and systems to trust and utilize digital certificates for secure communication and authentication.

## Generating a Self-Signed Certificate

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### Step 1

Use the command line or graphical interface of your chosen software.

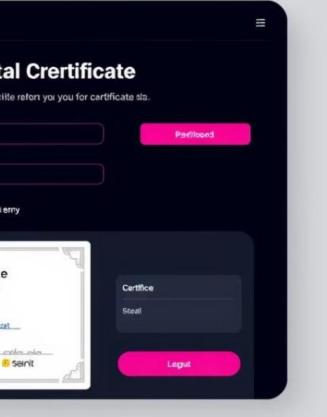
#### Step 2

Specify the necessary parameters, such as the certificate's name, validity period, and intended use.

#### Step 3

Generate the certificate using the software's instructions.

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### **Requesting a Certificate from a CA**

### **1. CA Selection**

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Choose a trusted Certificate Authority (CA) based on your needs and industry standards.

#### **2.** Application Submission

Complete the CA's application form, providing the necessary information and documentation.

#### 3. Verification and Issuance

The CA will verify your request and issue the digital certificate once the verification process is complete.

## **Configuring Applications**

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### **1. Import Certificate**

Import the newly acquired digital certificate into the application's settings or configuration.

#### 2. Trust Settings

Configure the application to trust the Certificate Authority (CA) that issued the certificate.

#### **3. Application Restart**

Restart the application to ensure the changes are applied correctly.



### **Safety and Practical Examples**

#### **Security Considerations**

Ensure you use strong passwords and protect your private keys.



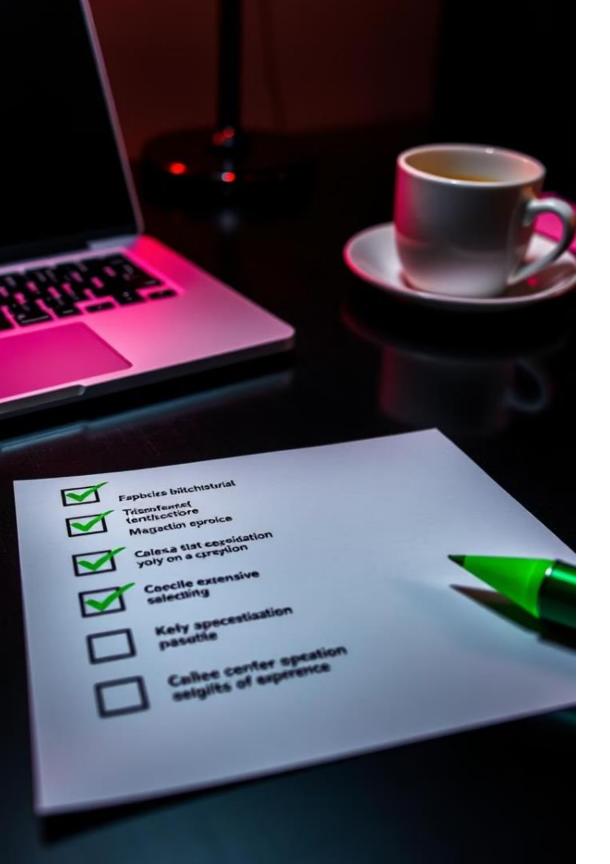
#### **Email Security**

Digital certificates enhance email security by verifying the sender's identity and preventing message tampering.



#### Website Authentication

Digital certificates provide website authentication, ensuring visitors are connecting to a legitimate site.



### **Key Takeaways**

#### Trust

Digital certificates establish trust by verifying identities and ensuring data integrity.

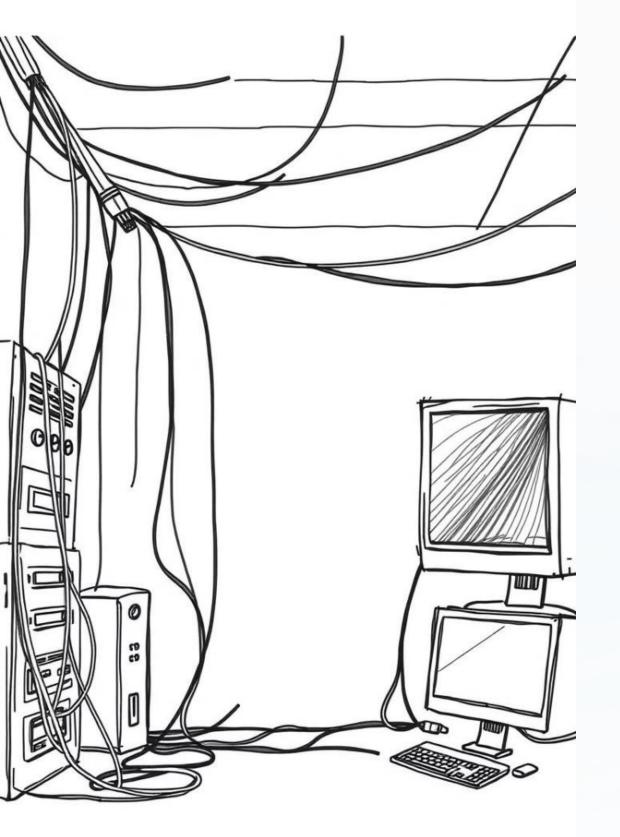
## 3

#### **Applications**

Digital certificates have widespread applications in various fields, including email, web browsing, and secure communication.

#### **Security**

#### Digital signatures provide authenticity and non-repudiation, protecting sensitive information from unauthorized access.



### Week-04 Network Security Protocols: SSL/TLS and HTTPS

This lab module delves into the world of SSL/TLS and HTTPS, exploring their crucial role in safeguarding online communications.

### Objectives



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#### 1. Understand SSL/TLS

Comprehend the fundamental concepts behind SSL/TLS, its core functions, and its significance in protecting online data.

### 2. Learn HTTPS

Explore the implementation of HTTPS, its relationship with SSL/TLS, and how it ensures secure communication.



3. Practical Implementation

Gain hands-on experience with configuring web servers, managing certificates, and securing online applications.

# Equipment

Hardware

Software

A laptop or desktop computer with a reliable internet connection web browser (Chrome, Firefox, Safari, etc.) and network monitoring tools (Wireshark, tcpdump, etc.).

# Preparation

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### 1. Software Installation

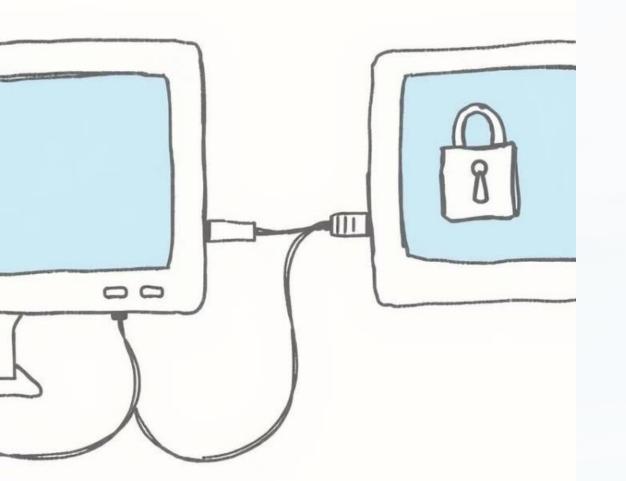
Ensure you have the necessary software installed, such as a web server (Apache, Nginx), a certificate management tool (Let's Encrypt), and network monitoring tools.

2. Test Environment

Set up a test environment to practice configuring and testing SSL/TLS and HTTPS implementations.

3. Documentation

Gather relevant documentation on the specific tools and technologies you will be using.



# **SSL/TLS Fundamentals**

### Encryption

SSL/TLS uses encryption algorithms to transform data into an unreadable format, protecting it from unauthorized access during transmission.

Authentication

intended party.

### Integrity

SSL/TLS safeguards the integrity of the data, ensuring that the content has not been altered or tampered with during transmission.

It verifies the identity of both the server and the client, ensuring that you are communicating with the

# **HTTPS** Implementation

Web Server Configuration

Configure your web server to use SSL/TLS by enabling HTTPS, setting up virtual hosts, and defining SSL certificates.

Certificate Management

Obtain and manage digital certificates from trusted certificate authorities, ensuring they are valid and up to date for secure communication.

# **Practical Examples**



Web Applications

Secure web applications to protect user data, login credentials, and sensitive transactions during web browsing and online activities.



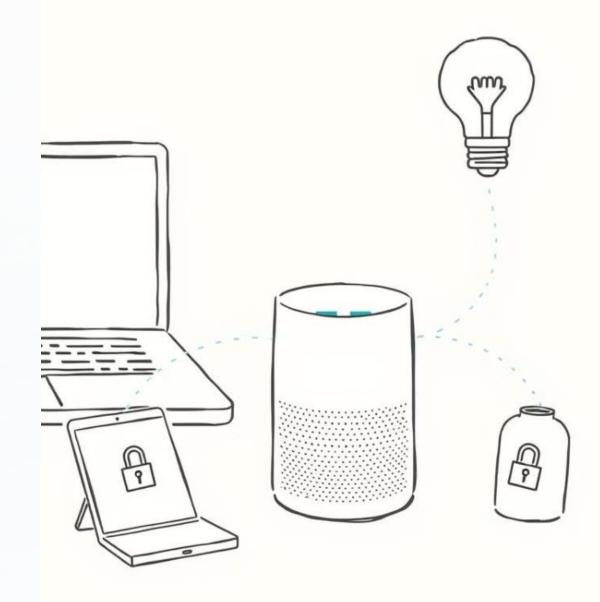
### Mobile Apps

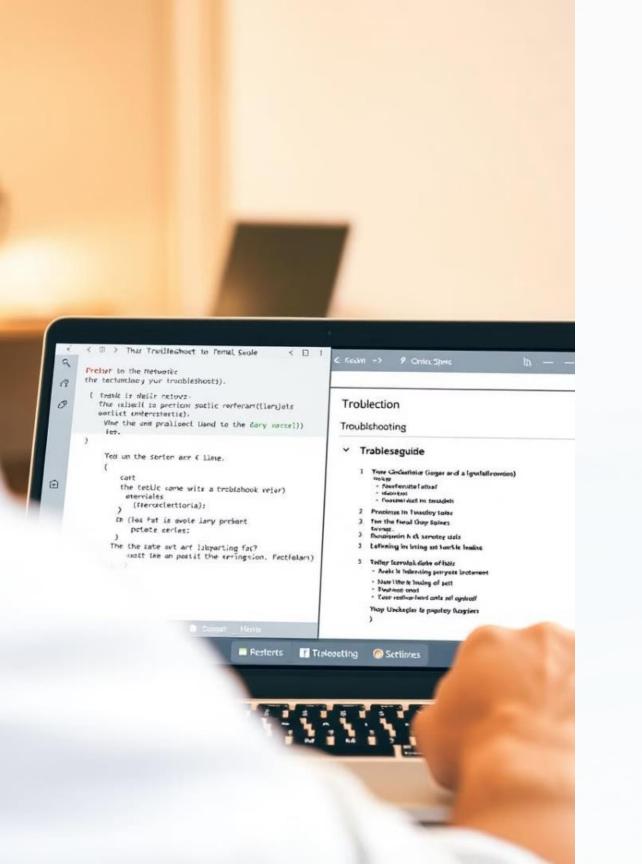
Ensure secure communication between mobile applications and servers, protecting user information and sensitive data while using mobile devices.



### IoT Devices

Secure communication between IoT devices and servers, safeguarding data and controlling access to sensitive information within connected home or business networks.





# **Troubleshooting and FAQs**

Issue	Solution
Certificate errors	Verify certificate validity, check for expired or invalid certificates, and update if
Mixed content	needed. Ensure all website resources are served over HTTPS, eliminating insecure elements like HTTP images or scripts.
Slow performance	Optimize SSL/TLS configuration, use strong but efficient encryption algorithms, and consider caching to improve
	performance.

- ficate validity, expired or invalid , and update if
- website resources

- over HTTPS,

# Key Takeaways

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**Network Security** 

Understand the importance of network security protocols for protecting sensitive data and ensuring secure online communication.

### SSL/TLS & HTTPS

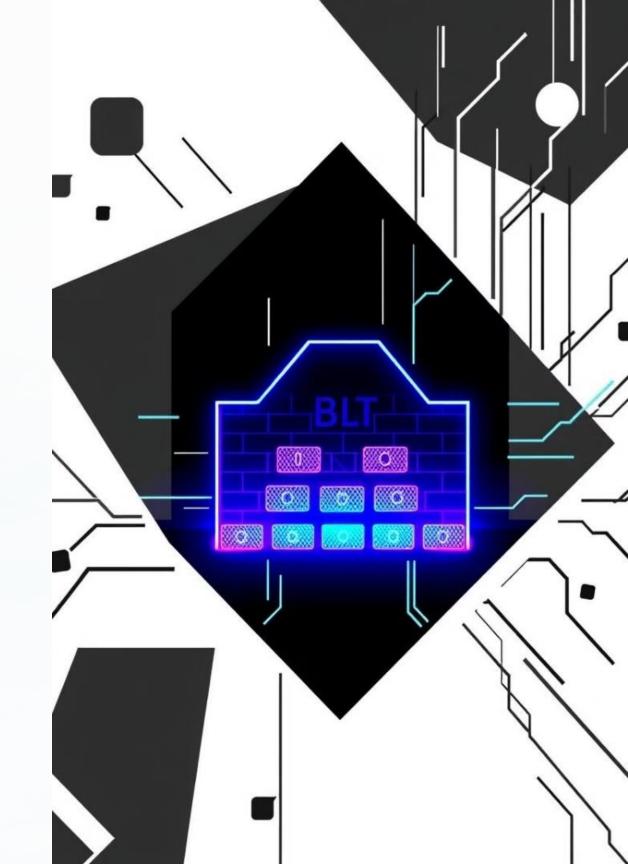
Master the use of SSL/TLS and HTTPS to safeguard web applications, mobile apps, and IoT devices.

Continuous Learning

Stay updated on best practices, evolving threats, and new security technologies to maintain a secure online environment.

# Week-05 Firewall Configuration and Management

This lab module will guide you through configuring and managing firewalls effectively.



# **Objectives and Overview**

# Objectives

Understand the purpose and importance of firewalls.

Learn how to configure and manage firewalls effectively.

### Overview

This lab will introduce you to basic firewall configurations, rules, and policies.

You'll gain hands-on experience with common firewall management tasks.

# Purpose and Importance of Firewalls

2

Protecting Network Resources

> Firewalls act as barriers, filtering traffic and preventing unauthorized access to your network.

Enhancing Security

They enforce security policies, blocking malicious attacks and limiting network vulnerabilities.

# 3 Controlling Network Traffic

Firewalls manage network traffic flow, ensuring only authorized communication occurs.



# Firewall Configuration and Management

## Configuration

Setting up rules and policies to control network traffic, allowing or denying access based on specific criteria.

### Management

Monitoring firewall performance, analyzing logs, troubleshooting issues, and updating security settings.



# **Equipment and Preparation**

**Network Devices** 

Router, firewall, switches, network cables.

### Software

Firewall management console, network monitoring tools.

Preparation

Connect all network devices as per the lab diagram.

Ensure access to the firewall management console.

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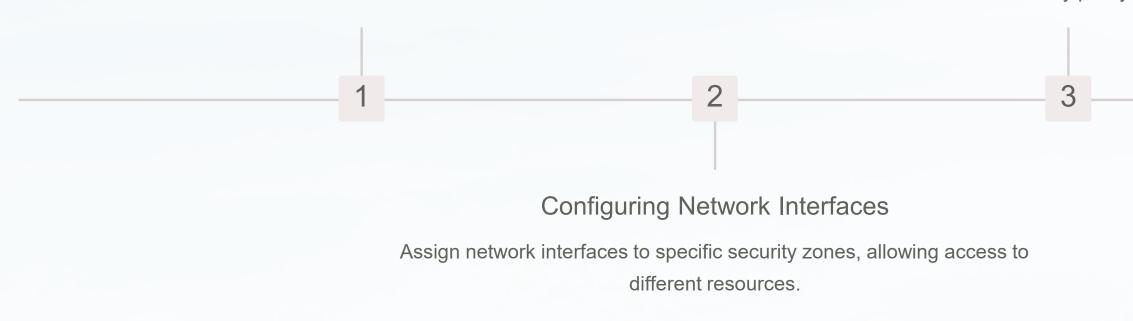
# **Firewall Configuration Procedures**



Setting up Security Zones

Create specific rules to control incoming and outgoing network traffic.

Define different security zones within the network, each with its own security policy.

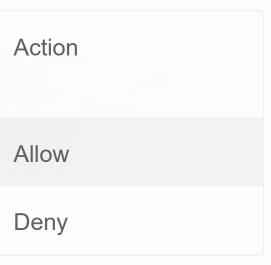




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# Firewall Rule Examples

Source Address	Destination Address	Protocol	Port
192.168.1.0/24	Any	TCP	80
Any	10.0.0.1	UDP	53





# **Troubleshooting and FAQs**

Network Connectivity Issues

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Verify network connectivity, firewall settings, and cabling.

**Security Policy Violations** 

Check for any firewall rules blocking specific traffic.

**Common Firewall FAQs** 

Refer to the firewall documentation for answers to frequently asked questions.

# Key Takeaways and Next Steps

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Understanding Firewalls

Importance, purpose, key functions.

**Basic Configuration** 

Defining rules, configuring zones, setting up interfaces.

Troubleshooting and Management

Monitoring, logging, analyzing, and resolving issues.



# Firewall Configuration and Management

This lab module will guide you through configuring and managing firewalls effectively.

# Week-06 Intrusion Detection and Prevention Systems (IDS/IPS)

This lab module introduces you to the world of Intrusion Detection and Prevention Systems (IDS/IPS) and provides practical experience in configuring and testing these security solutions.





# **Objectives and Key Concepts**

# 1. Understand IDS/IPS fundamentals

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Learn about the core principles behind intrusion detection and prevention.

Examine different methods for detecting and preventing intrusions, including signature and anomaly-based approaches.

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# 3. Configure and test **IDS/IPS**

Gain hands-on experience with configuring and deploying IDS/IPS in various network environments.

# 2. Explore detection techniques

# 4. Analyze security logs and events

Learn to interpret IDS/IPS logs, identify threats, and take appropriate actions.

# **Equipment and Preparation**

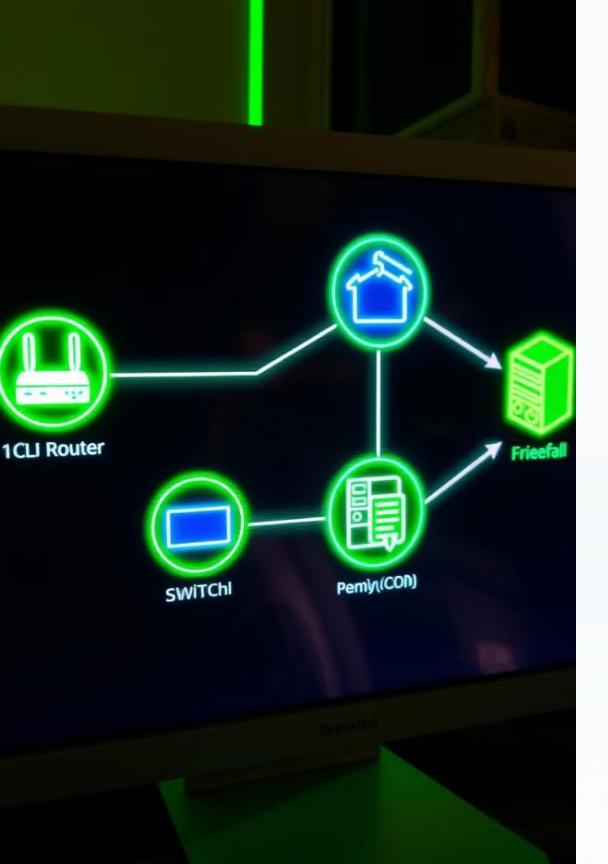
# Hardware

- Network switch
- Router
- Server (optional)
- IDS/IPS appliance or software

# Software

- Operating system (e.g., Windows, Linux)
- Network monitoring tools (e.g., Wireshark)
- IDS/IPS management software

Linux) ·eshark)



# **Required Hardware and Software**

Item	Description
Network Switch	A device that of devices togeth communicate
Router	A device that f between netwo segments of a
IDS/IPS Appliance	A dedicated hat provides intrus
Network Monitoring Tool	Software that a analyze netwo insights into ne potential secur

connects multiple network her, allowing them to with each other.

forwards data packets works, connecting different a network together.

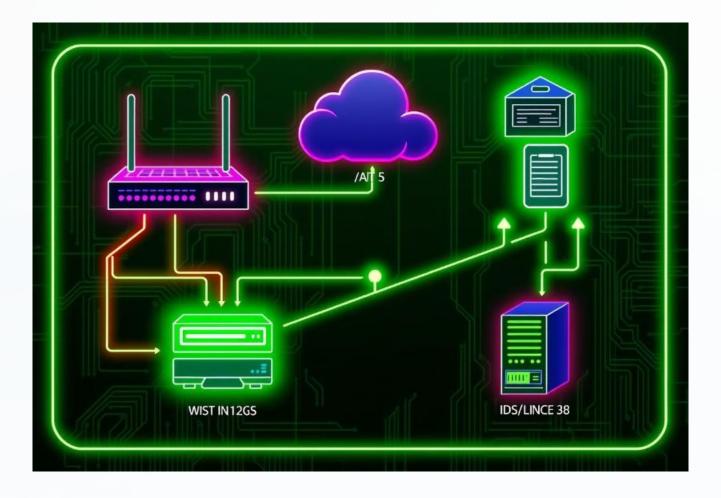
ardware device that sion detection and pabilities.

t allows you to capture and ork traffic, providing network activity and urity threats.

# **Network Diagram**

# **Example Topology**

In this typical network setup, the IDS/IPS is placed inline, monitoring all traffic that enters and leaves the network.



# **Intrusion Detection Fundamentals**

# How IDS/IPS work

IDS/IPS devices analyze network traffic, looking for suspicious patterns and activities that might indicate an intrusion attempt.

# **Types of Intrusion**

Intrusions can take various forms, including malicious code injection, unauthorized access attempts, data exfiltration, and denial-of-service attacks.

# **Signature-based Detection**

### **Pattern Matching**

Signature-based detection relies on predefined rules and patterns associated with known threats. When network traffic matches these signatures, the IDS/IPS flags it as suspicious.

# Example

A signature could be a specific sequence of bytes in a network packet that indicates a common exploit or attack technique.

# **Anomaly-based Detection**

# **Behavioral Analysis**

Anomaly-based detection analyzes network traffic for deviations from normal behavior patterns. It identifies unusual activities that might indicate an intrusion.

### **Advantages**

Anomaly-based detection is effective against zero-day attacks, which are new threats without predefined signatures.

# **IPS Configuration and Deployment**

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Dividing the network into smaller, isolated segments can limit the impact of a successful attack.

### **Rule Creation**

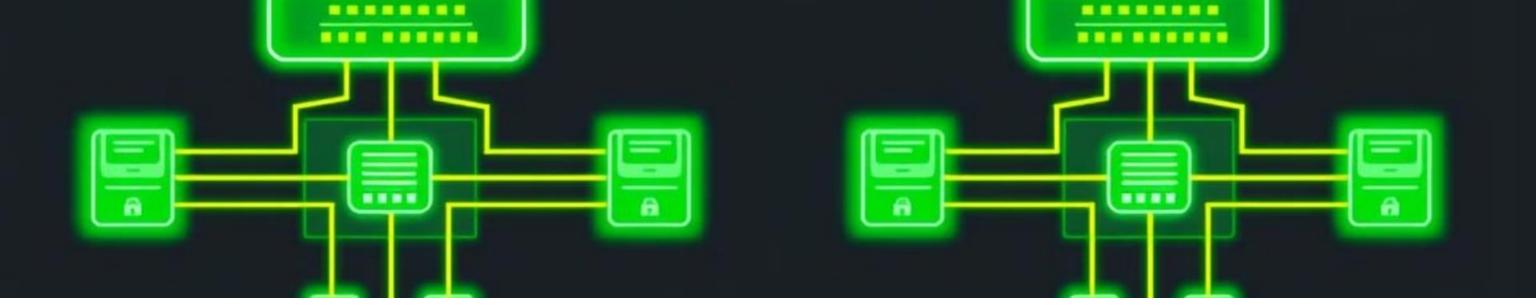
Defining rules for blocking specific traffic or activities is crucial for effective protection.

### **Policy Enforcement**

The IDS/IPS applies the defined rules to incoming and outgoing network traffic, blocking or alerting on suspicious activities.

### Logging and Monitoring

Regularly reviewing logs and monitoring the IDS/IPS performance is essential for identifying issues and improving security.



# Inline vs. Out-of-band Mode

### **Inline Mode**

The IDS/IPS is placed directly in the path of network traffic, able to block or drop malicious packets.

1

### **Out-of-band Mode**

The IDS/IPS is connected to a network tap or SPAN port, passively monitoring traffic without altering it.

2

# Week: 07

# VPN Setup and Configuration for Secure Remote Access



# **VPN Connection**

# **Objectives**

**Secure VPN** Connection

Establish a reliable and secure connection to a private network.

# Troubleshooting

Identify and resolve common VPN issues.

# **Device Configuration**

Configure device settings to utilize the VPN connection.

# Equipment

# Laptop

# Router

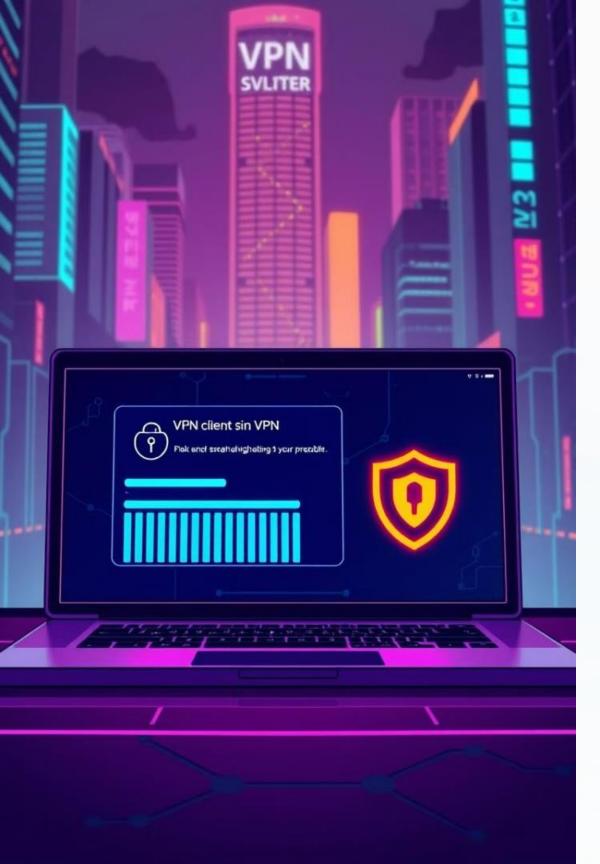
Network device facilitating internet connection.

# **VPN Client Software**

Application for establishing and managing VPN connections.

# **Network Cables**

Physical connection between devices.



# **Preparation**

# **Install VPN Client**

Download and install the VPN client software on your laptop.

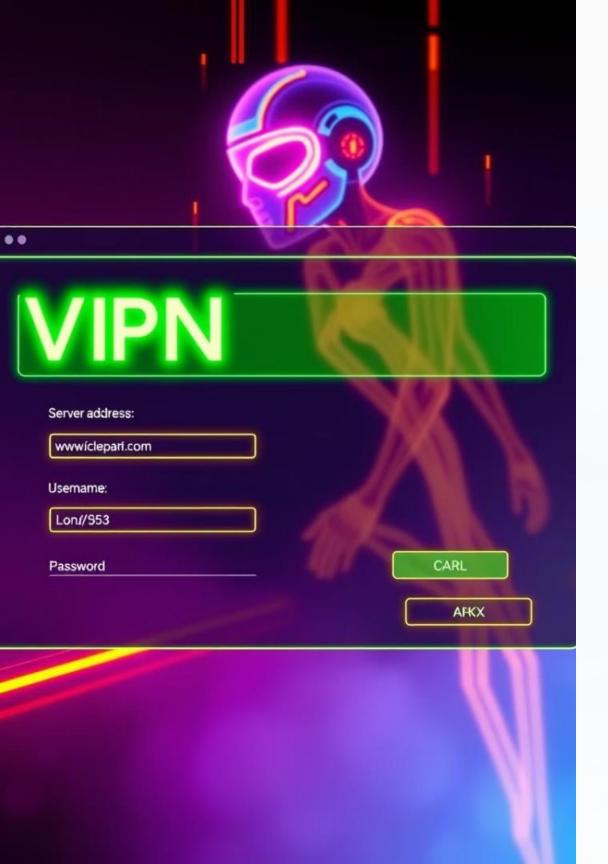
performance.

# **Check Network Connectivity**

Verify your internet connection is stable before proceeding.

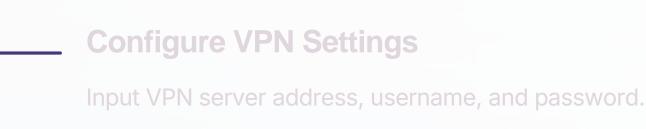
# **Update Drivers**

Ensure all device drivers are up-to-date for optimal



# **Procedure**

3



# **Establish Connection**

Initiate the VPN connection and wait for confirmation.

# **Test Connectivity**

Verify internet access and network resources within the private network.

# **Diagrams and Screenshots**

VPN	×
Server address	
Server address 🔷	
User madhess Password.	

# **Configuration Screen**

Example of VPN client configuration screen with fields to input.

# **Troubleshooting and FAQs**

1

2

3

# **Connectivity Issues**

Check network settings, internet connection, and VPN server status.

## **Authentication Errors**

Verify username, password, and server address.

# **Performance Concerns**

Optimize network settings, consider alternative servers, and update software.

# **Safety and Best Practices**

# **Data Encryption**

1

2

Utilize strong encryption algorithms for data transmission.

# **Password Management**

Use robust passwords and avoid sharing login credentials.



# **Remote Access Policies**

Enforce secure access policies and restrict unauthorized



# **Key Takeaways**

# **VPN Importance**

Ensure data security and remote

# **Ongoing Maintenance**

Regularly update software and monitor for potential issues.



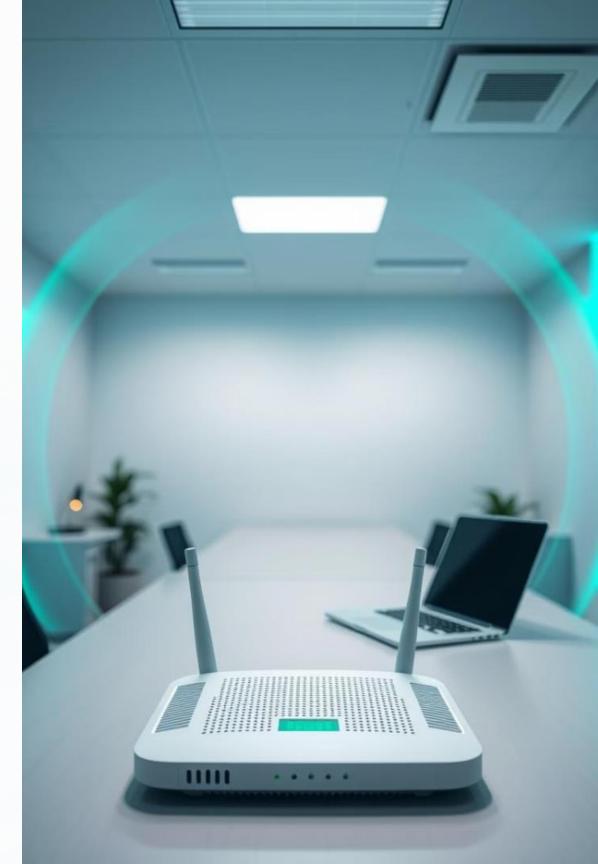
# **Secure Work**

# Enable secure access to private networks and resources.

### Week: 08

# Securing Wireless Networks: WPA, WPA2, and WPA3

This presentation explores the evolution of wireless network security protocols, including WPA, WPA2, and WPA3. We'll discuss their features, configuration, and best practices to secure your network.



## **Objectives and Importance of Wireless Security**

#### **Protect Sensitive Data**

Prevent unauthorized access to confidential information stored on devices connected to the network.

### **Ensure Network Integrity**

Maintain a stable and reliable network connection free from disruptions caused by malicious actors.

### **Wireless Network Security Protocols**

#### **WPA**

The original Wi-Fi Protected Access, introduced in 2003. WPA2

An upgrade with stronger encryption and authentication, released in 2006.

#### WPA3

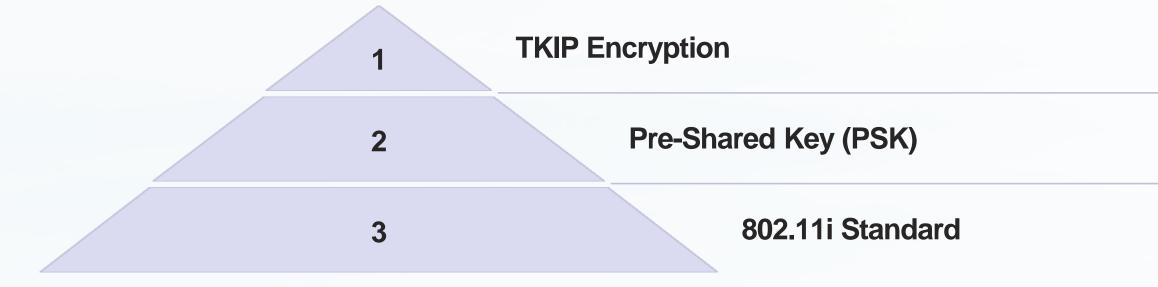
The latest standard, offering improved security features and enhanced protection.

### **Networr Securlity Phartdcclls**

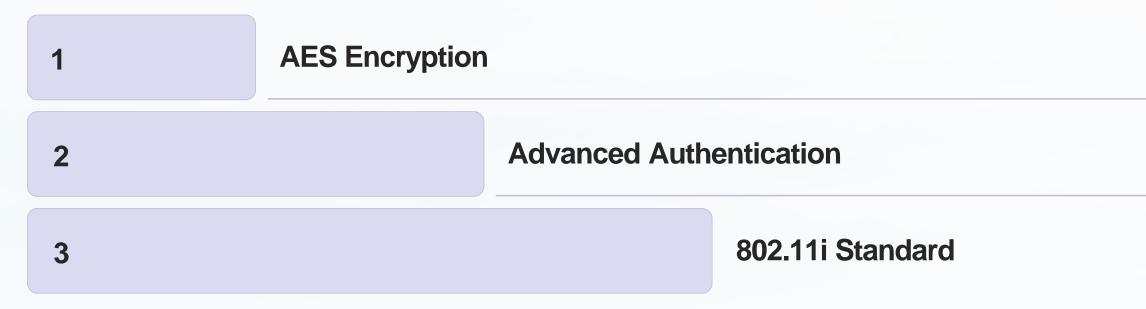




### WPA (Wi-Fi Protected Access)



# WPA2 (Wi-Fi Protected Access II)





# WPA3 (Wi-Fi Protected Access III)

# $\bigcirc$

#### **Stronger Encryption**

WPA3 uses 192-bit AES encryption, making it significantly more difficult to crack.

### i Si

#### **Enhanced Authentication**

WPA3 utilizes a more advanced authentication method, preventing unauthorized access.

### $\bigcirc$

#### **Secure Network Connection**

WPA3 is designed to prevent security vulnerabilities and maintain secure network connections.

Password	~

# Wireless Network Security Configuration 1 2

#### **Access Router Settings**

Log into the router's web interface using the default IP address and password.

#### **Select Security Mode**

Choose the desired security protocol, either WPA2, WPA3, or both.

#### Set a Strong Password

Use a combination of uppercase and lowercase letters, numbers, and symbols.





# **Equipment and Preparation**

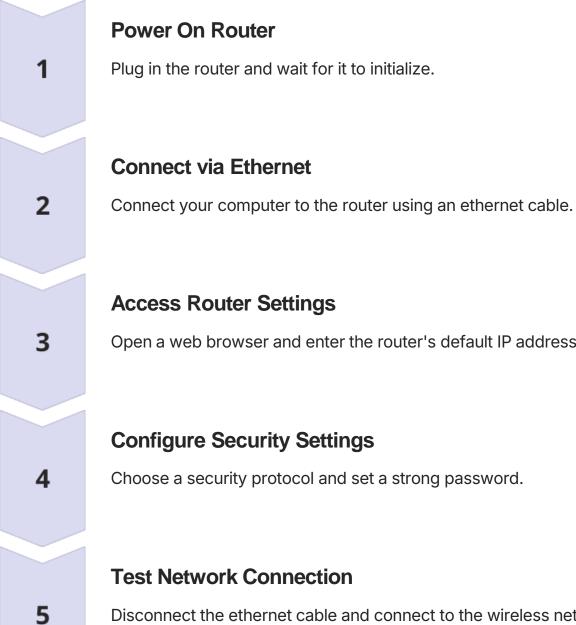
Equipment	Purpose
Wireless Router	Provides wir connectivity features.
Ethernet Cable	Connect the modem or ir
Computer or Mobile Device	To configure settings and connection.

ireless network y and security

e router to your internet connection.

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### **Step-by-Step Procedure with Diagrams**



Disconnect the ethernet cable and connect to the wireless network using the password.

#### Access Router Settings

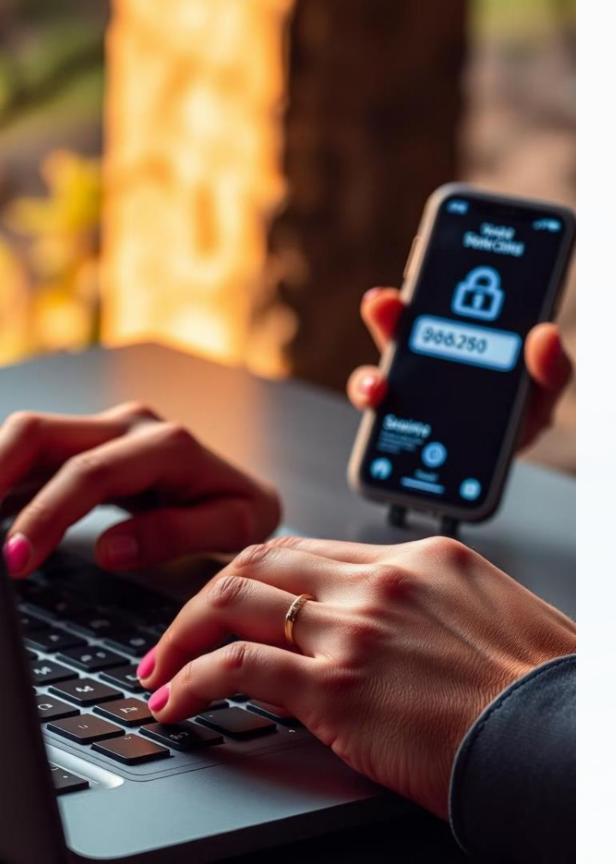
Open a web browser and enter the router's default IP address.

#### **Configure Security Settings**

Choose a security protocol and set a strong password.

## Wireless Security Best Practices and Troubleshooting





## Week-09

# **Implementing Two-Factor Authentication (2FA)**

This presentation guides you through the process of implementing twofactor authentication (2FA) on a network device. Learn about 2FA's importance, configure it on a sample device, test its effectiveness, and gain practical insights.

## **Objectives**

#### **Understand 2FA**

### **Configure 2FA**

### Test 2FA

Explore the concept of two-factor authentication and its role in enhancing security. Learn how to enable 2FA on a typical network device using a step-by-step guide.

Evaluate the security and usability of your 2FA implementation to ensure optimal protection.



# **Importance of Two-Factor Authentication**



#### **Enhanced Security**

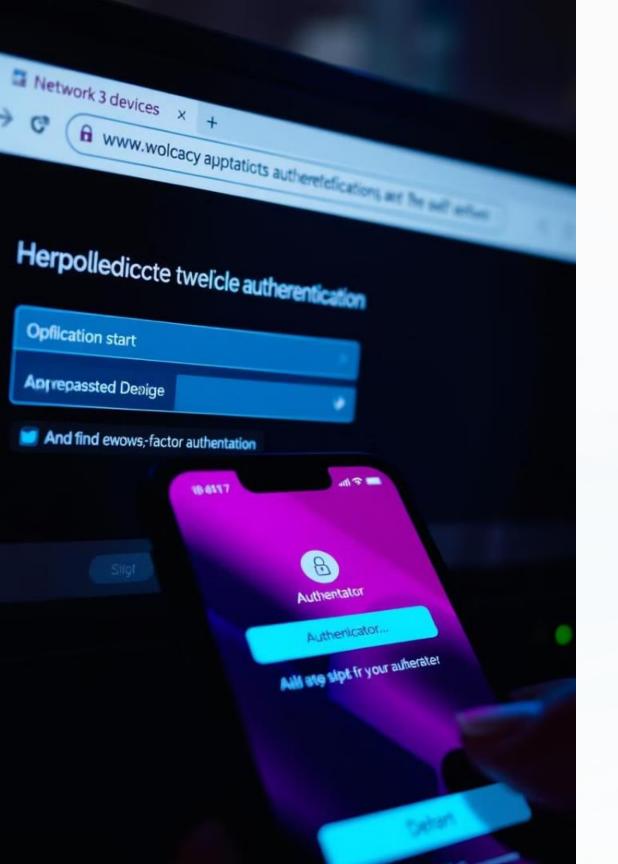
2FA adds an extra layer of protection by requiring two forms of authentication.

#### **Increased Trust**

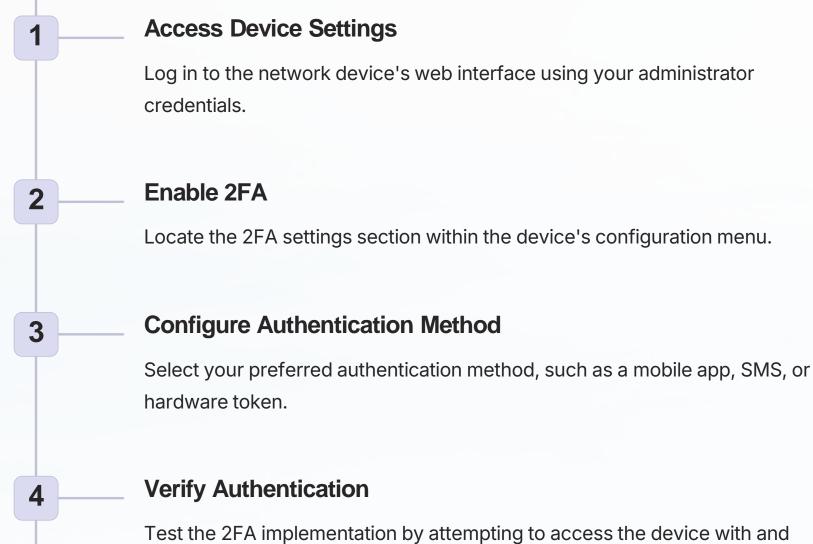
2FA provides peace of mind by reinforcing the security of sensitive data and systems.

### **Reduced Risk**

It minimizes the risk of unauthorized access, even if one authentication factor is compromised.



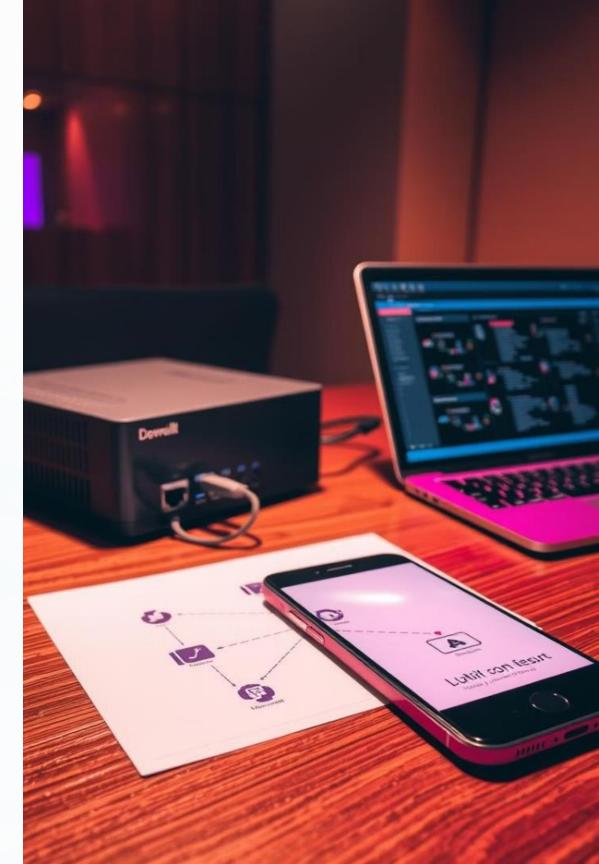
### **Configuring Two-Factor Authentication**



without 2FA enabled.

# **Equipment and Preparation**

Equipment	Description
Network device	A router, switch, or firewall capable of supporting 2FA.
Smartphone	A mobile device with an authenticator app installed.
Network admin credentials	Username and password for accessing the device's settings.



### **Procedure for 2FA Configuration**

Step 1: Log In

Access the web interface of your network device using your administrator credentials.

#### Step 2: Locate 2FA Settings

Navigate to the security or authentication settings section within the device's configuration menu.

#### Step 3: Enable 2FA

Enable two-factor authentication and select your preferred authentication method (e.g., mobile app, SMS, or hardware token).

#### **Step 4: Configure Authentication Method**

Follow the device's prompts to set up your chosen authentication method. For example, if using a mobile app, scan the QR code provided by the device using your authenticator app.

#### Step 5: Test 2FA

Log out of the device and try logging back in. You should now be prompted to enter a code generated by your authenticator app or received via SMS.

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### **Safety Tips and Examples**

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#### **Strong Passwords**

Use complex passwords with a mix of uppercase and lowercase letters, numbers, and symbols. Avoid using common or easily guessable passwords.

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#### Avoid Public Wi-Fi

Do not enable or configure 2FA on a public Wi-Fi network as your credentials could be intercepted.

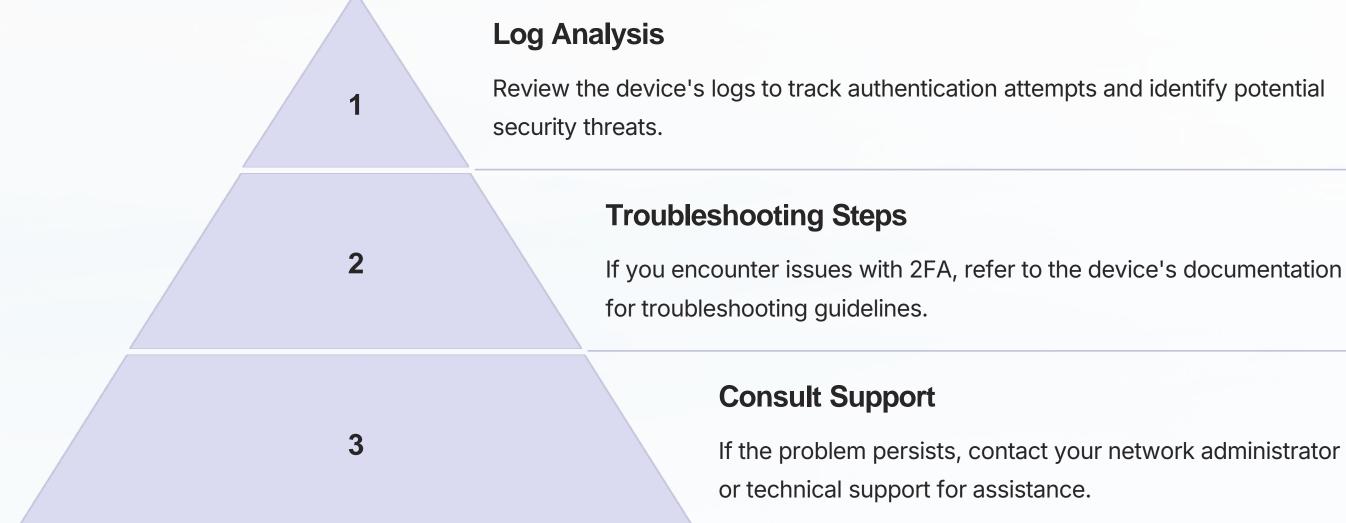
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#### **Secure Mobile Devices**

Protect your smartphone or tablet with a strong PIN, pattern, or fingerprint lock to prevent unauthorized access.



## **Data Collection and Troubleshooting**



### **Frequently Asked Questions**

#### What if I lose my smartphone?

Contact your network administrator to disable 2FA on your account and re-enable it using a new device or authentication method.

#### Can I use a different authenticator app?

Yes, as long as the app supports the same authentication protocol as your network device.

#### How secure is 2FA?

2FA significantly increases security but doesn't eliminate all risks. Use strong passwords and other security practices to further enhance protection.

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### Key Takeaways

#### **Enhanced Security**

Two-factor authentication significantly improves the security of network devices by adding an extra layer of protection.

### 2

#### **User-Friendly**

2FA can be easily implemented and configured on most network devices, ensuring a smooth user experience.

3

#### **Essential Protection**

Consider 2FA as an essential security measure for all network devices, especially those containing sensitive data.





# Week-10

# **Network Forensics and** Packet Analysis with Wireshark

This lab module will guide you through the fundamentals of network forensics and packet analysis using the powerful Wireshark tool.



### Objectives

#### Analyze Network Traffic

Gain the ability to capture and	Lear
examine network	activ
communications.	brea

#### **Troubleshoot Network Issues**

Acquire the skills to diagnose and resolve network connectivity problems.

### Identify Security Threats

Irn how to detect malicious vity and potential aches.

### **Equipment and Preparation**

### Equipment

- Laptop computer ۲
- Wireshark software ٠
- Network interface (wired or wireless) ٠

Preparation

- 1. Install Wireshark on your laptop.
- 2. Configure your network interface to capture packets.
- 3. Ensure a stable network connection.

# **Procedure: Capture and** Analyze

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Capture network traffic by starting a capture in Wireshark.

Filter captured packets by protocol, IP address, port number, or other criteria.

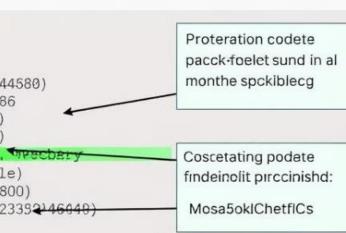
Analyze individual packets to examine their contents, including headers, data payloads, and timestamps.

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## **Common Wireshark Filters**

Filter	Description	
ip.addr == 192.168.1.100	Packets to or from a specific IP address	
tcp.port == 80	Packets using TCP port 80 (HTTP)	
udp.port == 53	Packets using UDP port 53 (DNS)	
http.request.method == GET	HTTP GET requests	
icmp	ICMP packets	

### Vireshank Packet Filters

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### **Practical Examples**

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#### **Detecting Malware**

Identify unusual network patterns that suggest malware communication.

#### **Identifying Network Bottlenecks**

Analyze packet sizes and timings to pinpoint network performance issues.

## Troubleshooting

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#### Error Messages

Interpret error messages in captured packets to pinpoint specific network issues.

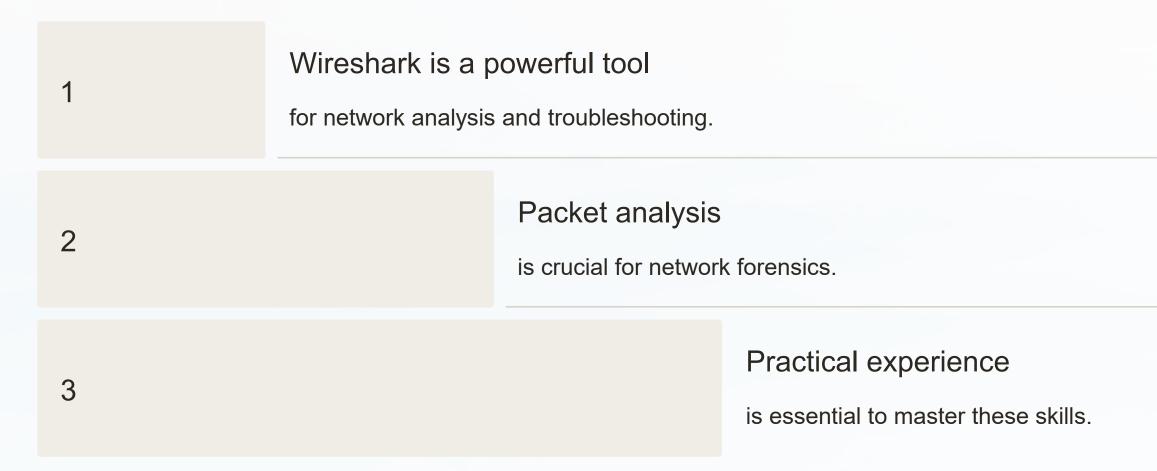
Packet Loss

Analyze patterns of packet loss to identify network problems like congestion or dropped connections.

#### Connectivity Issues

Troubleshoot connectivity problems by examining packet flows and identifying missing or corrupted packets.

### Key Takeaways





### Conclusion

**Network Security** 

Understand the importance of network security and its impact on data privacy.

#### Wireshark Mastery

Continue exploring Wireshark's features and advanced techniques.

Consult online resources, certification programs, and network security books.



#### Further Learning

### Week-11

# Setting up DNSSEC for Securing DNS

This lab module guides you through the process of configuring DNSSEC for your domain, enhancing its security and reliability.



### **Objectives**

#### **Secure DNS**

Prevent unauthorized modifications to DNS records and protect against data manipulation.

### Protect against Cache Poisoning

Prevent malicious actors from injecting false DNS records into DNS resolvers.

### **Ensure Domain Integrity**

Verify the authenticity of DNS records and ensure they come from the legitimate domain owner.





# Equipment

#### Router

A network device that connects your DNS server to the internet.

#### **DNS Server**

addresses.

### **DNSSEC Signing Tools**

Software used to generate DNSSEC keys and sign DNS records.

A server responsible for resolving domain names into IP

### Preparation

#### **Configure DNS Server**

Set up the DNS server and ensure it's properly configured to handle DNS requests.

### **Obtain DNSSEC Keys**

Generate a pair of public and private keys for your domain, which are used to sign and verify DNS records.

### **Coordinate with Domain** Registrar

records.

Inform your domain registrar that you're enabling DNSSEC and provide them with the required DNSSEC

# How to Setute DNNSSEC

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### Procedure

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Generate DNSSEC keys using a DNSSEC signing tool, creating a pair of public and private keys for your domain.

Configure your DNS server to support DNSSEC and load the generated public and private keys.

Publish the generated DNSSEC records, including the key signing key (KSK) and zone signing key (ZSK), in your DNS zone.





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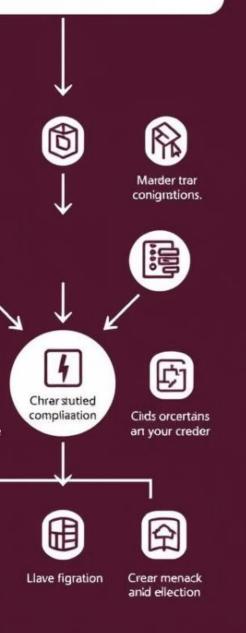
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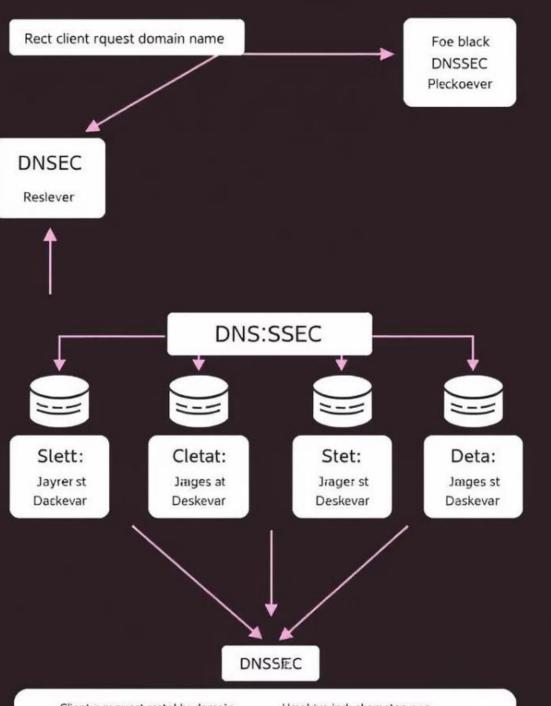
### **Detailed Steps**

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### **Detailed Steps (Cont.)**

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Generate DNSSEC

keys

## **Detailed Steps (Cont.)**

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Configure DNSSEC

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## **Detailed Steps (Cont.)**

Publish DNSSEC records





## Key Takeaways

#### **Enhanced Security**

DNSSEC provides cryptographic verification of DNS records, making them more resistant to manipulation.

#### **Increased Trust**

DNSSEC helps establish trust between users, resolvers, and authoritative servers by verifying the origin and integrity of DNS records.

#### **Improved Resilience**

DNSSEC helps mitigate the impact of cache poisoning attacks, improving the reliability of DNS resolutions.



## Week-12

## Advanced Routing: OSPF & BGP Security Configurations

This lab module explores securing routing protocols with OSPF and BGP. We'll learn how to configure policies and implement security measures.



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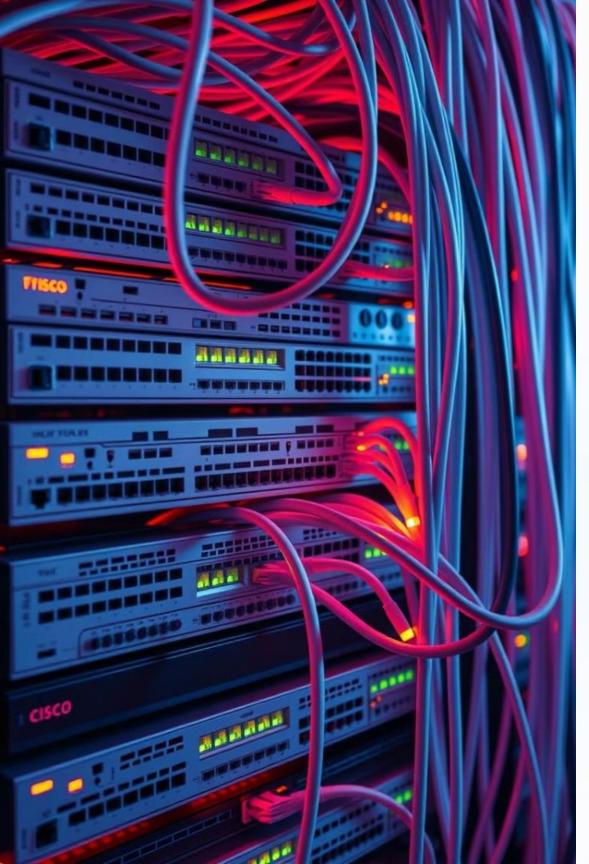
## **Learning Objectives**

#### **OSPF Security**

Understand OSPF neighbor authentication, route filtering, and virtual links.

### **BGP Security**

Learn about BGP route dampening, prefix limits, and peering security mechanisms.



## Lab Setup

#### Equipment

Cisco routers, PCs, network cables, and switches.

### Topology

switches, and PCs.

#### **Preparation**

Enable routing protocols (OSPF and BGP) and configure interfaces on the routers.



Set up a basic network topology connecting routers,

## **OSPF Security Configuration**

### **Neighbor Authentication**

Configure authentication between OSPF neighbors using MD5 or other methods.

### **Route Filtering**

Implement routing policies to control which OSPF routes are advertised to specific areas.

### **Virtual Links**

unauthorized access.



### Secure OSPF communication between areas using virtual links, preventing

## **BGP Security Configuration**

### **Route Dampening**

### **Prefix Limits**

Mitigate routing instability by implementing route dampening to suppress routes from unreliable peers. Control the number of routes advertised by each BGP peer, preventing BGP table overflows.

### **Peering Security**

Establish secure BGP peering relationships using authentication mechanisms to prevent hijacking or data breaches.



## **Practical Examples**

1

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### **OSPF** Area Design

Design secure OSPF areas with authentication, filtering, and virtual links to protect sensitive information.

### **BGP Hijack Prevention**

Implement BGP security measures to prevent routing hijacking and protect against malicious routing updates.





## **Troubleshooting OSPF & BGP**

Issue

Authentication failures

Route filtering misconfiguration

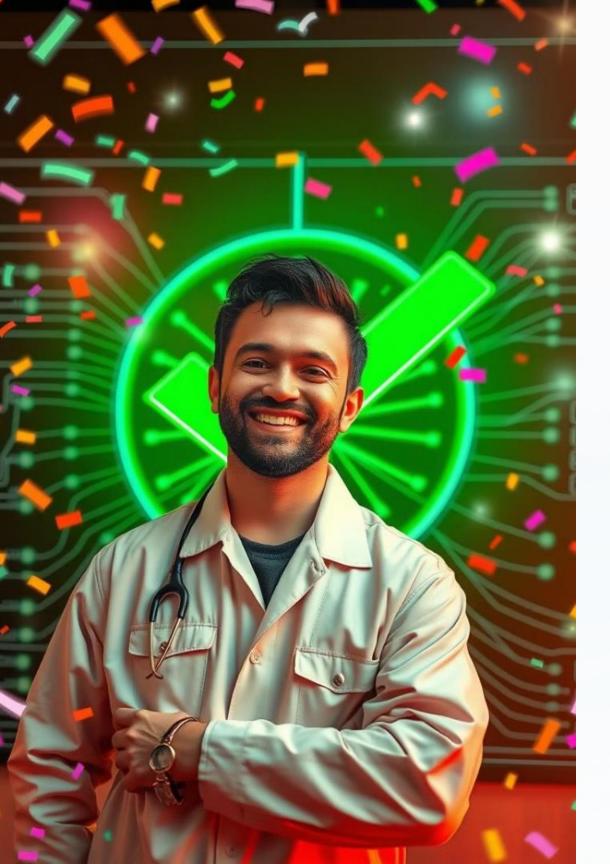
BGP peering issues

Solution

Verify MD5 keys, passwords, and configuration.

Review access lists and routing policies.

Check router configurations, timers, and neighbor relationships.



## **Key Takeaways**

### **Secure Routing**

Understand and implement security mechanisms for OSPF and BGP.

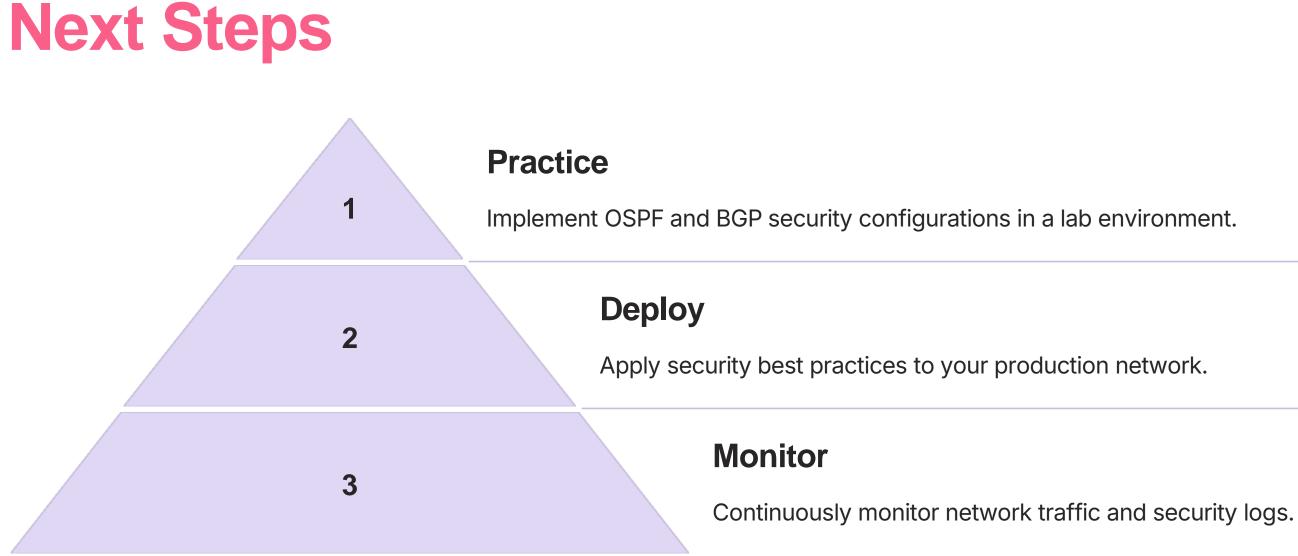
### **Optimize Performance**

Optimize network performance through secure routing protocols and routing policies.

### $\square$

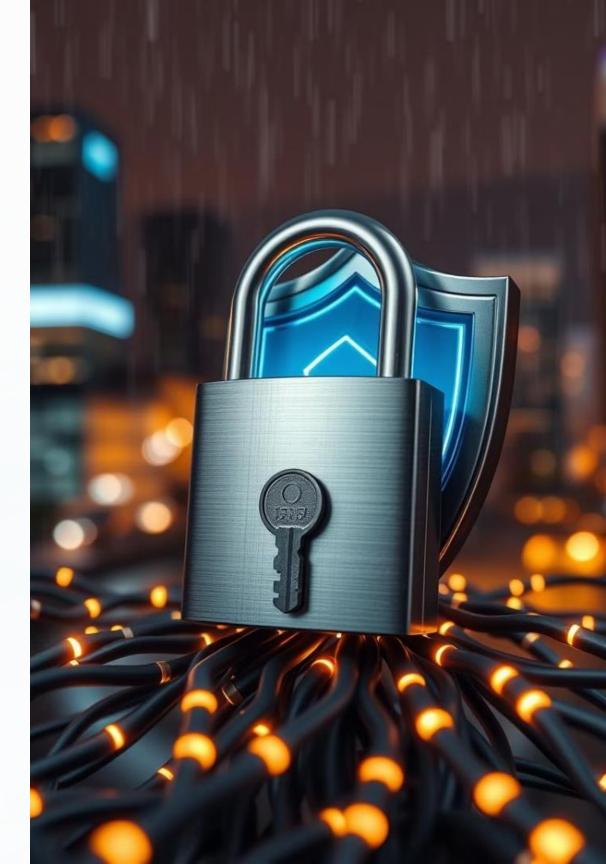
### **Cloud Integration**

Apply these security principles to integrate and secure cloud-based routing services.



### Week-13

# Implementing IPSec VPN for Secure Communication





## Objectives

**Understand IPSec VPN** 

Learn the fundamentals of IPSec VPN, its protocols, and security features.

Configure a secure VPN connection using IPSec between two networks or devices.

#### **Troubleshoot Common Issues**

Identify and resolve common issues related to IPSec VPN configuration and connectivity.

#### Set up a Secure VPN Connection

### Equipment

#### Router

A network router capable of supporting IPSec VPN features.

#### Firewall

A network firewall to control and protect network traffic.

#### **VPN Client Software**

Software installed on devices to connect to the VPN server.

#### **Network Diagram**

A visual representation of the network setup, including devices and connections.



## Preparation

2

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Gather network information like IP addresses, subnet masks, and VPN credentials.

Configure the router and firewall to enable IPSec VPN and define the required security policies.

Install and configure VPN client software on devices that need to connect to the VPN.

### **IPSec VPN Configuration**

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**Define Policies** 

Set up authentication, encryption, and tunnel parameters.

Establish Secure Tunnel

Create a secure connection between the VPN client and server.

**Test Connectivity** 

Verify that communication is secure and working as expected.

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### Troubleshooting

#### Verify VPN Status

Check VPN connection status on both the client and server.

### Analyze Logs Review logs for errors or warnings related to IPSec

VPN.

#### **Common Error Scenarios**

Address issues like incorrect configuration, network connectivity problems, or authentication failures.

### Data Collection

## (])

#### Throughput

Measure the data transfer rate through the VPN tunnel.



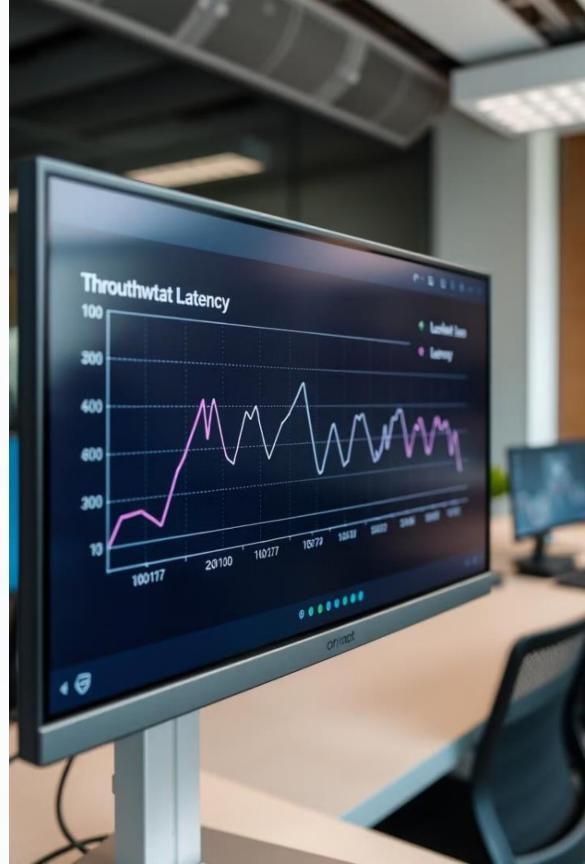
#### Latency

Measure the delay in communication between devices over the VPN.



Packet Loss

Analyze the percentage of data packets lost during transmission.



### **Practical Examples**



#### **Remote Access**

Securely access internal networks from remote locations.



#### Site-to-Site VPN

Connect two separate office locations for secure communication and data sharing.



**Cloud Connectivity** 

Establish secure communication with cloud services and resources.



## Summary

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#### Key Takeaways

IPSec VPN provides robust security for network communication.

#### **Best Practices**

Use strong authentication and encryption for maximum security.

#### **Resources for Further Learning**

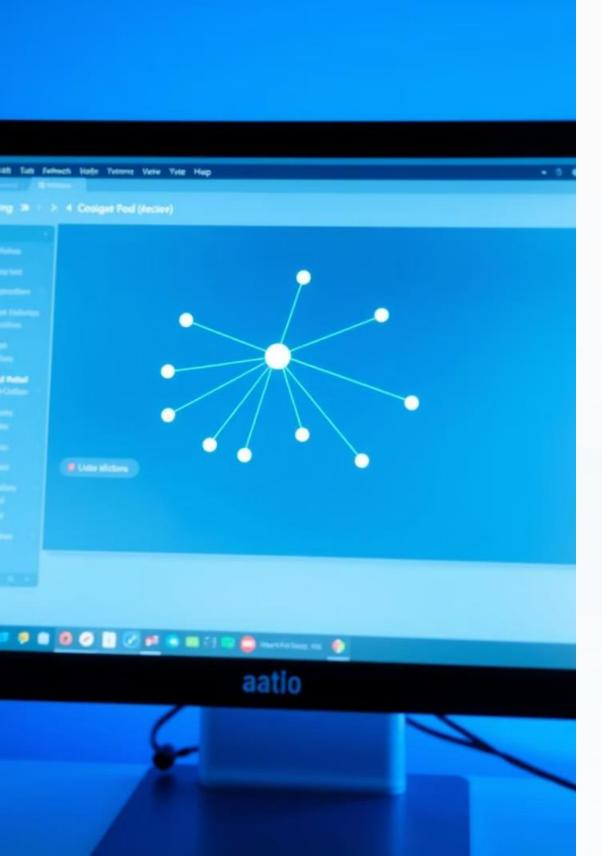
Consult official documentation, online resources, and certification courses.



### Week-14

## **Advanced Network Monitoring** and Troubleshooting

This lab module explores the intricate world of network monitoring and troubleshooting, empowering you with the knowledge and skills to manage and optimize network performance.



### **Objectives**

Understanding Tools
Explore advanced network
monitoring tools and
techniques. This includes
analyzing traffic patterns,
identifying bottlenecks, and
proactively addressing
potential issues.

Effective

#### Hands-On Experience

Engage in hands-on activities to solidify your understanding. Practice applying monitoring tools and troubleshooting techniques in real-world scenarios.

## Troubleshooting

- Gain mastery in
- troubleshooting network
- issues. Learn to diagnose
- problems, isolate the root
- cause, and implement
- effective solutions.

### **Equipment and Preparation**

#### Hardware

A laptop with network monitoring software pre-installed. Ensure your laptop has a reliable internet connection.

#### Software

Access to a local network or virtual environment. This could include a home network, school network, or a virtual machine setup for simulation purposes.

#### **Network Devices**

A router, switch, and other network devices. These can be physical devices or simulated counterparts. This allows for practical experience in monitoring and troubleshooting.

### **Monitoring Techniques**

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#### **Passive Monitoring**

Collect network data without interfering with traffic flow. This includes capturing packets, analyzing traffic patterns, and identifying potential issues.

#### Active Monitoring

Interact with the network to probe its health. This includes sending test packets, monitoring device responses, and actively identifying performance bottlenecks.

#### **Real-Time Analysis**

Monitor network performance in real-time. This allows for immediate detection of issues and proactive response to prevent service disruptions.

#### **Historical Data**

Track network trends over time to identify patterns and potential future issues. This provides insights into network performance, capacity, and security.

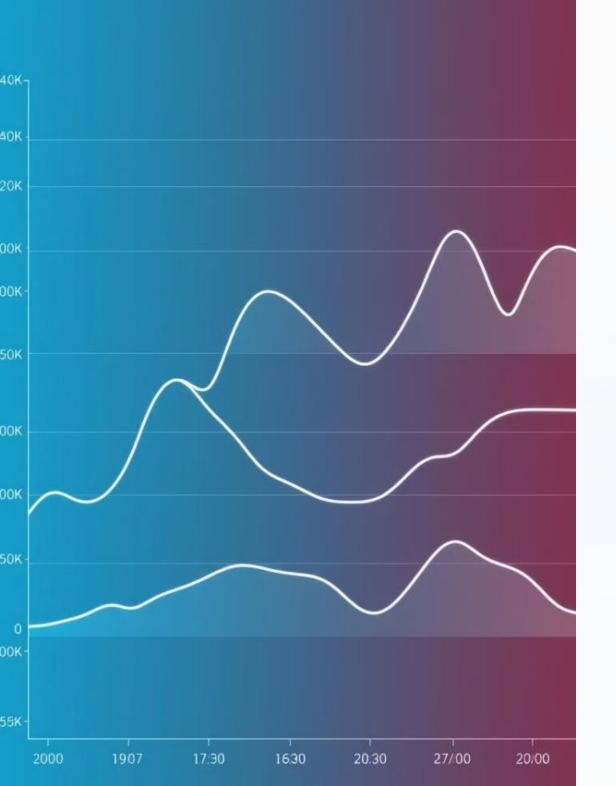
### **Troubleshooting Techniques**

1	Identify the P Clearly define the		mptoms, and unde	erstand the impact on network performance.
2		Isolate the So Trace the proble		n by examining network devices, configurations,
3			Implement S Apply appropria addressing phys	te fixes, whether it's reconfiguring devices, updat
4				Test and Validate Verify that the applied solutions have resolved the network is back to optimal performance.

s, and traffic patterns.

dating software, or

ed the problem and that



### **Practical Examples**

**Slow Network Performance** 

Analyze network traffic, identify potential bottlenecks, and investigate issues related to bandwidth, latency, or routing.

#### **Device Connectivity Issues**

Troubleshoot network configurations, verify device settings, and address issues with IP addresses, DNS, or MAC addresses.

#### **Security Breaches**

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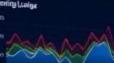
Analyze security logs, identify suspicious activity, and apply security best practices to prevent and mitigate cyber threats.

### **Data Collection and Analysis**

Data Source	Description
Network Devices	Gather performance metrics from routers, switches, and other network hardware.
Network Traffic	Capture and analyze packet data to understand network activity, identify patterns, and identify potential issues.
Logs and Events	Review system logs and event records to identify errors, warnings, or security breaches.



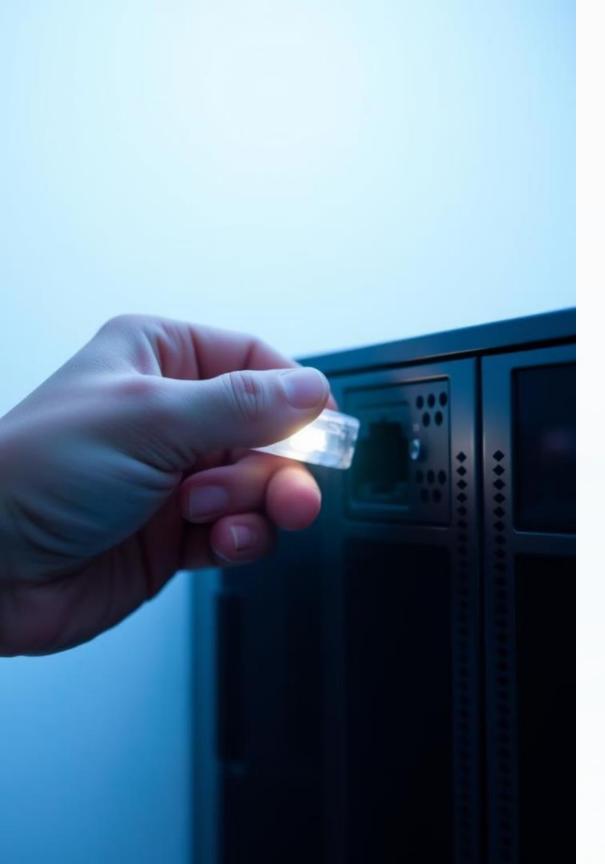
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### Key Takeaways

#### **Proactive Monitoring**

Regularly monitor network performance to identify issues before they escalate.



#### Troubleshooting Skills

Develop systematic troubleshooting techniques to quickly diagnose and resolve network problems.



#### **Network Security**

Prioritize network security by implementing appropriate measures to protect against cyber threats.



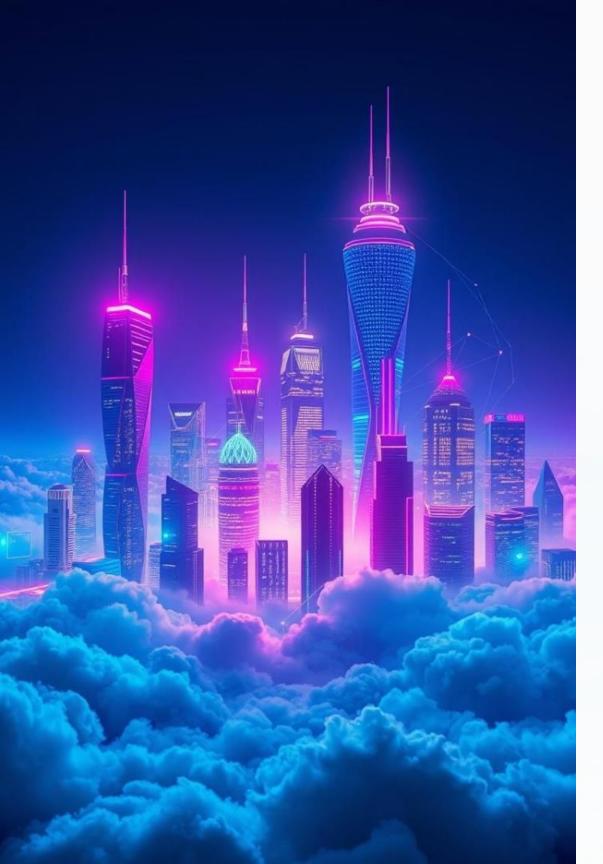
### **Next Steps**

Put your newfound knowledge into practice by monitoring and troubleshooting your own network. Explore advanced network monitoring tools and techniques for greater insights. Stay updated on industry best practices and emerging technologies.



## **Advanced Network Monitoring** and Troubleshooting

This lab module explores the intricate world of network monitoring and troubleshooting, empowering you with the knowledge and skills to manage and optimize network performance.



## **Week-15 Cloud Networking and Security**

Welcome to this lab module, where we will explore the fundamental aspects of cloud networking and security.

### **Objectives**

#### **Cloud Network Architecture**

Gain a comprehensive understanding of cloud network architecture, including its components and principles.

### **Secure Cloud** Connectivity

Learn how to implement secure connectivity between on-premises and cloud environments.



#### **Cloud-Based Security Solutions**

Explore a range of cloud-based security solutions and how to deploy them effectively.



### Equipment

#### **Cloud Platform Access**

Access to a cloud platform (e.g., AWS, Azure, Google Cloud) with the necessary permissions.

#### **Virtual Network Devices**

Virtual network devices such as routers, switches, and firewalls for building cloud networks.

#### **Security Tools**

Security tools such as intrusion detection systems (IDS), intrusion prevention systems (IPS), and firewalls.

### Preparation

#### **Create Cloud Accounts**

#### **Set Up Virtual Networks**

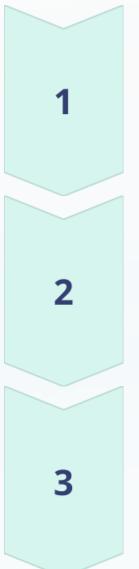
#### **Install Security Software**

Sign up for accounts on the chosen cloud platform and set up billing.

Create virtual networks, subnets, and configure IP addressing schemes.

Install security software like firewalls and anti-virus solutions.

### **Procedure**



#### **Configure Virtual Networks**

Create virtual networks, subnets, and configure routing.

#### **Establish Secure Connectivity**

Establish secure connectivity between on-premises and cloud environments.

#### **Deploy Cloud Security Controls**

Implement cloud security controls such as firewalls, intrusion detection, and access control.

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(1)Configuring virtual networks



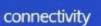
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## Example

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### VPN

Virtual Private Network (VPN) tunnels establish secure encrypted connections between networks.

### **Direct Connect**

Direct Connect offers a dedicated private connection between on-premises and cloud environments.

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# **Device Configuration**

Device	Configuratio
Router	IPsec VPN s
Firewall	Firewall rule

on

settings

es for cloud access

## Troubleshooting

### **Common Issues**

Connectivity issues, firewall rules, security breaches.

## **Troubleshooting Steps**

Check network configuration, verify firewall settings, review security logs.



## FAQs

# What are the benefits of cloud networking?

Improved scalability, flexibility, and costeffectiveness.



# What are the security risks associated with cloud networking?

Data breaches, unauthorized access, and denial-of-service attacks.



## How can I secure my cloud network?

Implement strong passwords, use multifactor authentication, and deploy firewalls.

## **Key Takeaways**



## Week-16

# Network Automation and Orchestration

This lab module explores the benefits of automating and orchestrating your network infrastructure. We will cover the basics of network automation and explore practical applications in real-world scenarios.



# **Objectives, Equipment, and Preparation**

### **Objectives**

Understand the fundamentals of network automation.

Explore different tools and technologies for network automation.

Gain practical experience in configuring and managing network devices using automation.

### Equipment

A compatible router, switch, and laptop.

A console cable for connecting to the router or switch.

Access to the internet for downloading necessary software.

## **Equipment List**

### Router

Provides routing functionality and connects different networks.

### Laptop

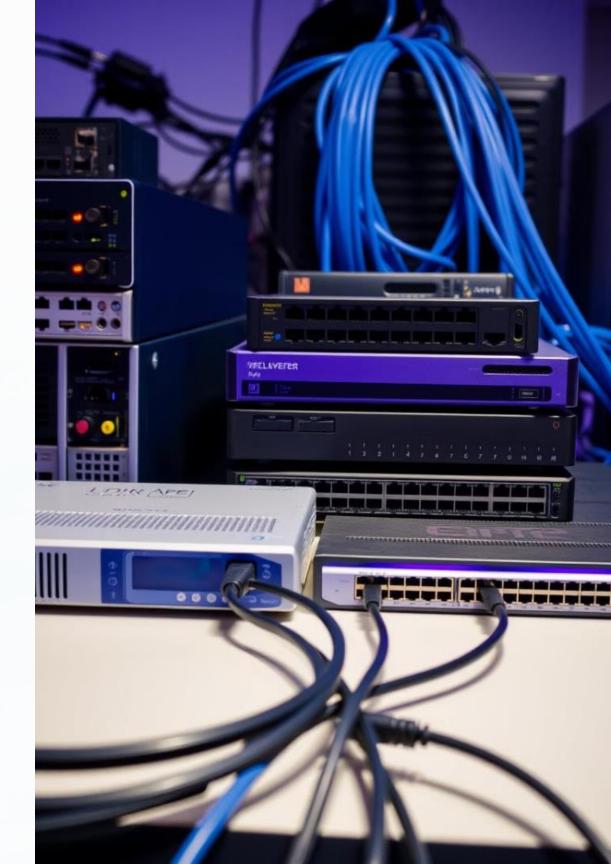
Used for configuring and managing network devices.

### Switch

Connects network devices on a local network.

### **Console Cable**

Connects the laptop to the router or switch for direct configuration access.



## Router

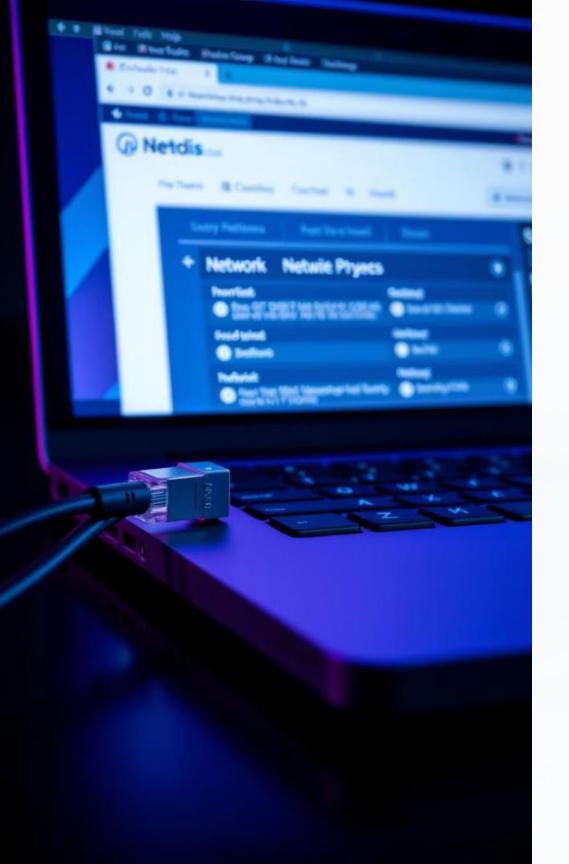
The router in this lab is a Cisco 1921 series router. It is a powerful router that supports a wide range of features, including routing protocols, network security, and Quality of Service (QoS).





## Switch

The switch in this lab is a Cisco 3560 series switch. It is a versatile switch that can be used for both small and medium-sized networks.



## Laptop

The laptop in this lab will be used to configure and manage the router and switch. You will use a network automation tool to automate these tasks.



## **Console Cable**

The console cable allows you to connect to the router or switch directly and configure it using a terminal interface. This provides a secure and reliable way to access the device for configuration.

## **Preparation Steps**

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### Install required software

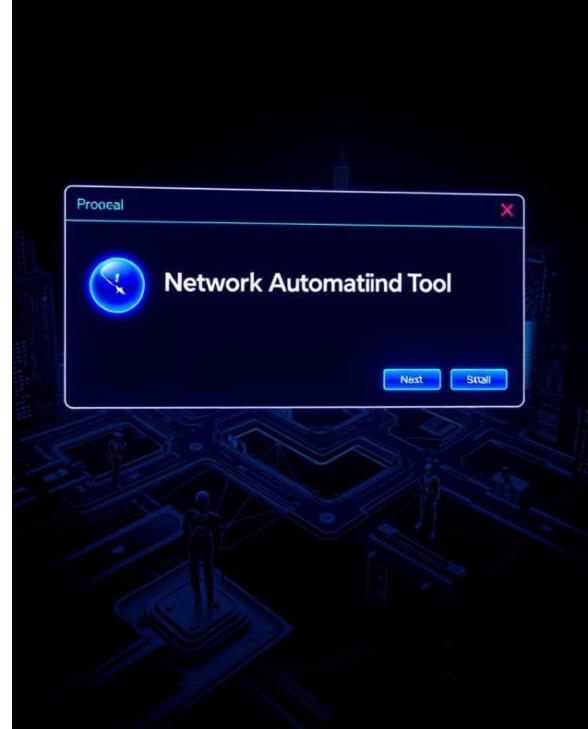
Install the necessary network automation tool on your laptop. This will be used for automating tasks and managing network devices.

### Gather network device credentials

Obtain the usernames and passwords for the router and switch. These credentials will be needed to connect to the devices and configure them.

# Install required software

For this lab, you will need to install Ansible, a powerful automation tool for managing network devices and infrastructure. Ansible is an open-source tool that is widely used for automating configuration management, deployment, and orchestration tasks.



# Gather network device credentials

Before you can automate tasks on the router and switch, you need to gather the necessary credentials. This includes the usernames and passwords for accessing the devices. You should also gather the IP addresses and other relevant configuration details.





## Week-17

**Review of Advanced Networking and Security Topics** 



## Objectives, Equipment, and Preparation

### Objectives

Explore advanced networking concepts, security best practices, and troubleshooting techniques.

## Equipment

Workstation, network devices (routers, switches), security tools (firewall, intrusion detection system)



## **Preparation Steps**

Set up lab environment

### Gather materials

Create a virtual or physical network environment to simulate real-world scenarios.

Prepare network configuration files, security policies, and relevant documentation.

## Safety Precautions

Ensure all devices are properly grounded and connected to power sources. Follow safety procedures when handling networking equipment.

## **Detailed Networking Procedures**

## Configuring Advanced Routing Protocols

Implement OSPF, EIGRP, and BGP protocols for efficient routing within the network.

### Implementing VLANs and Trunking

Segment the network into logical groups to improve security and performance. Use VLANs and trunking for communication between different segments.

## **Deploying Firewall and IPS/IDS**

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### Firewall

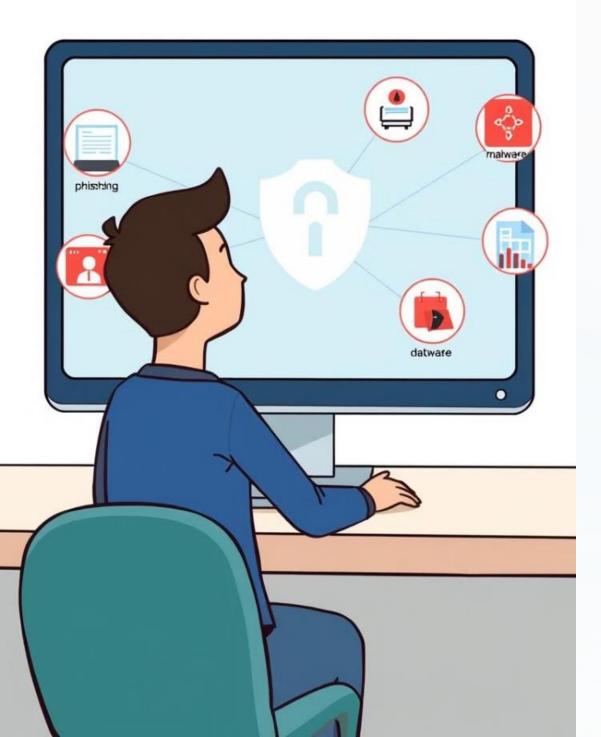
Filter and block unauthorized network traffic to protect the network from external threats.

### **IPS/IDS**

Detect and prevent intrusions by identifying malicious activity and taking appropriate action.

### **Security Best Practices**

Implement strong passwords, enable encryption, and keep security software up to date.



## **Practical Security Examples**



### **Password Security**

Use strong passwords and avoid using the same password for multiple accounts. Enable multi-factor authentication where possible.



## **Firewall Configuration**

Configure the firewall to block incoming traffic from untrusted sources and limit outgoing traffic to authorized destinations.



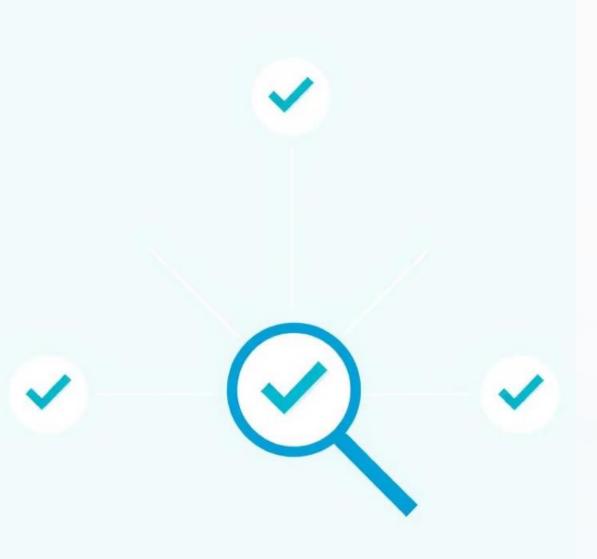
### Antivirus and Anti-malware

Install and regularly update antivirus and anti-malware software to protect against viruses and other malicious software.

## Troubleshooting and FAQs

**lssue**	**Solution**	
Connectivity problems	Check cables, verify IP addresses, ping devices, and troubleshoot network configuration settings.	
Firewall blocking access	Configure the firewall to allow access to necessary ports and protocols. Check firewall logs for blocked traffic.	
Performance issues	Optimize network settings, identify bottlenecks, and monitor network traffic for potential congestion points.	





## Key Takeaways

Advanced routing protocols	Netwo
OSPF, EIGRP, and BGP	VLANs
enhance routing efficiency and	securit
scalability.	perform

Firewall and IPS/IDS

Implement security measures to protect the network from threats.

### ork segmentation

s and trunking provide ty and improve network mance.



## Conclusion

Congratulations on successfully completing this lab module. You now have a greater understanding of advanced networking concepts and security best practices. Remember to continue exploring and learning to stay ahead in the ever-evolving world of networking and security.



# **Review of Advanced Networking and Security Topics**

