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**Fundamentals of Computer Networks and Network Security**

**1. Introduction**

**Overview of the Course**

This course is designed to introduce you to the principles of computer networking and network security. These are crucial for building, maintaining, and securing modern digital systems.

* **Career Opportunities:** These skills are fundamental for roles in IT support, network administration, cybersecurity analysis, and more.
* **Relevance Across Industries:** Networking knowledge is essential for industries ranging from healthcare to e-commerce and finance.

**Importance of Computer Networks and Network Security**

* **Dependence on Networks:** Businesses use networks for data sharing, communication, and operational workflows.
* **Risks:** Networks are prime targets for cyber threats such as hacking, data breaches, and ransomware attacks.
* **Benefits of Security:** Network security prevents unauthorized access, protects sensitive data, and ensures business continuity.

**2. Fundamentals of Computer Networks**

**What is a Network?**

A computer network links devices (computers, servers, IoT devices) to share resources like data, printers, and the internet.

* **Types of Networks:**
  + **LAN (Local Area Network):** Limited to a small area, such as a building or office.
  + **WAN (Wide Area Network):** Covers large areas, often connecting multiple LANs (e.g., the internet).
  + **MAN (Metropolitan Area Network):** Larger than LAN, smaller than WAN, typically covers a city.
  + **PAN (Personal Area Network):** Connects personal devices like smartphones, laptops, and wearables.

**Reference Models: OSI Model and Its 7 Layers**

The **OSI Model** is a conceptual framework for understanding how data moves through a network:

1. **Physical Layer (L1):**
   * Handles raw data transmission over physical mediums like cables and radio signals.
   * Includes hardware like hubs, repeaters, and network interface cards (NICs).
2. **Data Link Layer (L2):**
   * Manages node-to-node data transfer and error detection.
   * Protocols: Ethernet, Wi-Fi.
3. **Network Layer (L3):**
   * Handles routing, IP addressing, and forwarding of data packets.
   * Protocols: IPv4, IPv6.
4. **Transport Layer (L4):**
   * Ensures reliable data delivery through error-checking and retransmission.
   * Protocols: TCP (reliable) and UDP (fast but less reliable).
5. **Session Layer (L5):**
   * Establishes and manages communication sessions between devices.
   * Example: Video conferencing apps.
6. **Presentation Layer (L6):**
   * Formats data for application-level processing (e.g., encryption, compression).
7. **Application Layer (L7):**
   * Interface for end-user applications to access network services (e.g., web browsers using HTTP).

**3. Core Networking Concepts**

**Routing and Switching Basics**

* **Routing:**
  + Determines the best path for data packets to travel between devices across different networks.
  + Routers operate at the Network Layer (L3) to connect LANs to WANs.
* **Switching:**
  + Connects devices within the same network, directing data to specific devices.
  + Switches operate at the Data Link Layer (L2).

**IP Addressing: IPv4 and IPv6**

* **IPv4:**
  + 32-bit addressing scheme with 4 billion unique addresses.
  + Example: 192.168.1.1.
* **IPv6:**
  + 128-bit addressing scheme with trillions of unique addresses to accommodate modern devices.
  + Example: 2001:0db8:85a3:0000:0000:8a2e:0370:7334.

**Introduction to TCP and UDP**

* **TCP (Transmission Control Protocol):**
  + Ensures reliable data transmission with error correction and acknowledgment.
  + Used for emails, file transfers, and web browsing.
* **UDP (User Datagram Protocol):**
  + Faster but does not guarantee delivery or order.
  + Ideal for real-time applications like streaming and gaming.

**4. Application Layer Protocols**

**Overview of Common Protocols**

* **HTTP (Hypertext Transfer Protocol):**
  + Used for accessing web pages.
  + Operates over port 80 or 443 (for HTTPS with security).
* **FTP (File Transfer Protocol):**
  + Transfers files between systems.
  + Operates over ports 20 and 21.
* **SMTP (Simple Mail Transfer Protocol):**
  + Sends emails from clients to servers.
  + Operates over port 25.
* **DNS (Domain Name System):**
  + Resolves human-readable domain names into machine-readable IP addresses.

**5. Overview of Network Security**

**Cybersecurity and Its Importance**

Cybersecurity protects digital systems and data from attacks, ensuring:

* **Confidentiality:** Only authorized users can access sensitive information.
* **Integrity:** Data is protected from unauthorized modification.
* **Availability:** Systems and data remain accessible when needed.

**What is Network Security?**

Network security involves tools and policies to protect data during transmission and storage, preventing unauthorized access.

**Types of Network Security**

* **Firewalls:** Block unauthorized traffic.
* **Intrusion Detection Systems (IDS):** Identify potential threats.
* **Encryption:** Converts data into unreadable formats without a key.

**6. Understanding Network Attacks**

**Types of Cyber Attacks**

* **Phishing:** Fraudulent attempts to steal sensitive information.
* **Malware:** Harmful software like viruses, worms, and trojans.
* **Denial-of-Service (DoS):** Overloads systems to make them unavailable.
* **Ransomware:** Encrypts files, demanding payment for decryption.

**Network Vulnerabilities**

Weaknesses that attackers exploit include:

* Poorly configured systems.
* Lack of security updates.
* Weak passwords.

**7. Ensuring Network Security**

**Tools and Techniques for Network Security**

* **Firewalls:** Block malicious traffic.
* **VPNs (Virtual Private Networks):** Provide secure remote access.
* **Antivirus Software:** Detects and removes malware.
* **Encryption:** Protects data integrity and confidentiality.

**Network Security Protocols**

* **SSL/TLS:** Secure communications for websites and apps.
* **IPsec:** Secures data during network transmission.

**Best Practices for Businesses**

* Regularly update systems and software.
* Educate employees on recognizing cyber threats.
* Use multi-factor authentication for secure access.

**8. Future Trends in Networking and Security**

**Mobile and Wireless Networks**

* Growth in 5G and Wi-Fi 6 offers faster speeds and better connectivity but raises security concerns.
* Ensuring secure connections for IoT and mobile devices is a top priority.

**Emerging Technologies in Cybersecurity**

* **AI and Machine Learning:** Enhance threat detection by analyzing patterns.
* **Quantum Cryptography:** Provides next-level encryption to counteract quantum computing threats.
* **Zero-Trust Architecture:** Assumes no device or user is inherently trusted.

**Certification of Completion**



