

# **Mastering Network Resilience and Scalability**

## Routing & Switching Foundations for Incident Management



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# Introduction to Routing and Switching

Routing and switching are fundamental elements in modern network infrastructures, serving as the foundation for the efficient transmission of data across both local area networks (LANs) and wide area networks (WANs).

Switching, which operates at Layer 2 of the OSI model (the Data Link Layer), is responsible for managing traffic within a LAN. It achieves this by utilizing Media Access Control (MAC) addresses to determine the destination of data packets, ensuring that data is delivered within the same network segment. Switches intelligently manage the flow of data between devices like computers, servers, and printers, reducing network congestion and optimizing the overall performance of the LAN. By ensuring that data is only sent to the intended recipient rather than broadcasting it to all devices on the network, switching enhances the efficiency and security of local communications.



# Layer 2 Switching Fundamentals

- Layer 2 switches use MAC addresses to forward frames within a LAN.
- **MAC Address Learning & Forwarding:** Switches maintain a MAC address table to direct traffic efficiently.
- **VLANs:** Virtual Local Area Networks improve performance by segmenting networks.
- **Trunking:** Allows traffic from multiple VLANs to travel over a single link.
- **Spanning Tree Protocol (STP):** Prevents loops in redundant topologies, ensuring network stability.



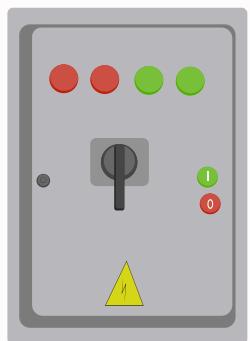
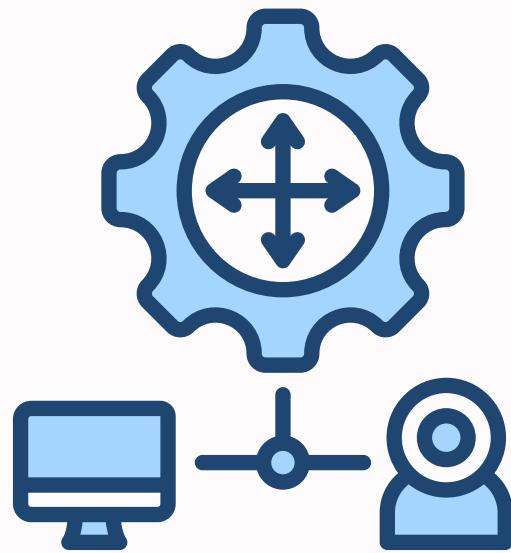
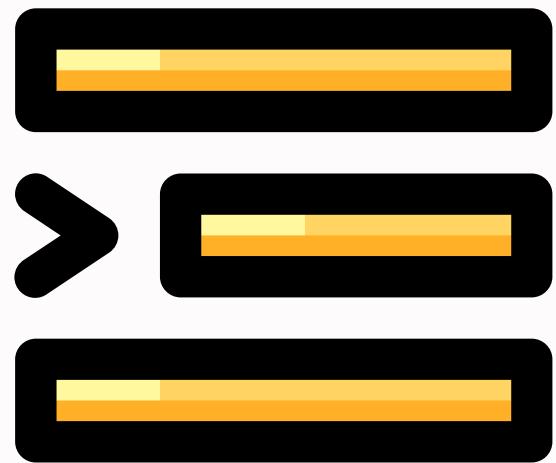
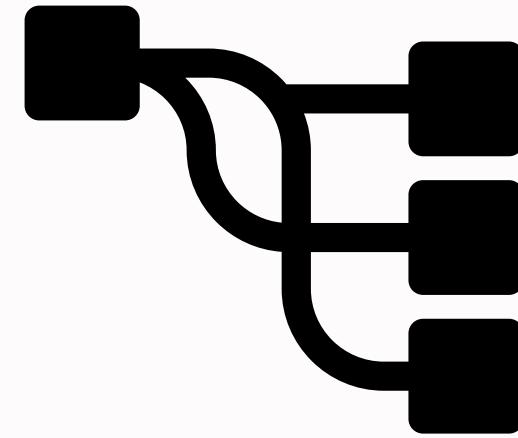
# Key Switching Technologies

VLANs: VLANs are a critical networking technology used to segment a larger network into smaller, more manageable logical networks. Each VLAN functions as an independent network within a single physical network, allowing network administrators to group devices based on function, department, or any other criteria. By creating VLANs, the broadcast domain—where devices can "hear" each other's network traffic—is reduced. This means that broadcasts, which can consume bandwidth and create unnecessary traffic, are limited to a specific VLAN, improving overall network performance and efficiency.

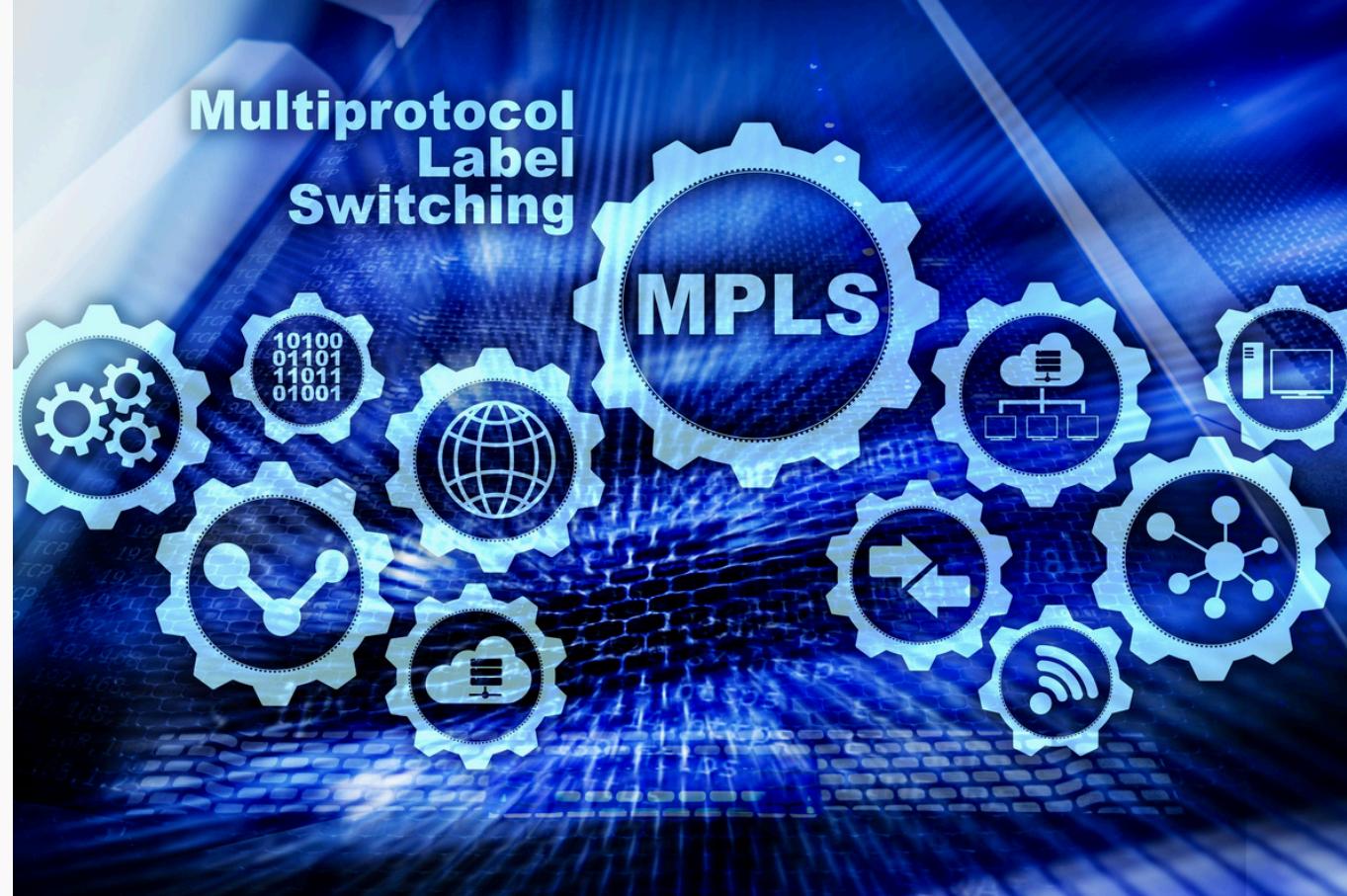
Trunking: Trunking is a technique that enables multiple VLANs to share a single physical network connection, thus reducing the need for additional cabling and increasing the efficiency of network resources. The IEEE 802.1Q standard defines how VLAN tagging is used in trunking, allowing a single link between network devices, such as switches, to carry traffic for multiple VLANs simultaneously.

# Routing Fundamentals and Core Protocols

- **Routing:** Operates at Layer 3 and directs data between different networks using IP addresses.
- **OSPF (Open Shortest Path First):** A link-state protocol that scales well for large networks.
- **EIGRP (Enhanced Interior Gateway Routing Protocol):** A Cisco-specific protocol known for quick convergence.
- **BGP (Border Gateway Protocol):** The protocol that powers the Internet, responsible for routing between autonomous systems.
- **MPLS (Multiprotocol Label Switching):** Not a routing protocol, but a forwarding mechanism for traffic engineering in service provider networks.



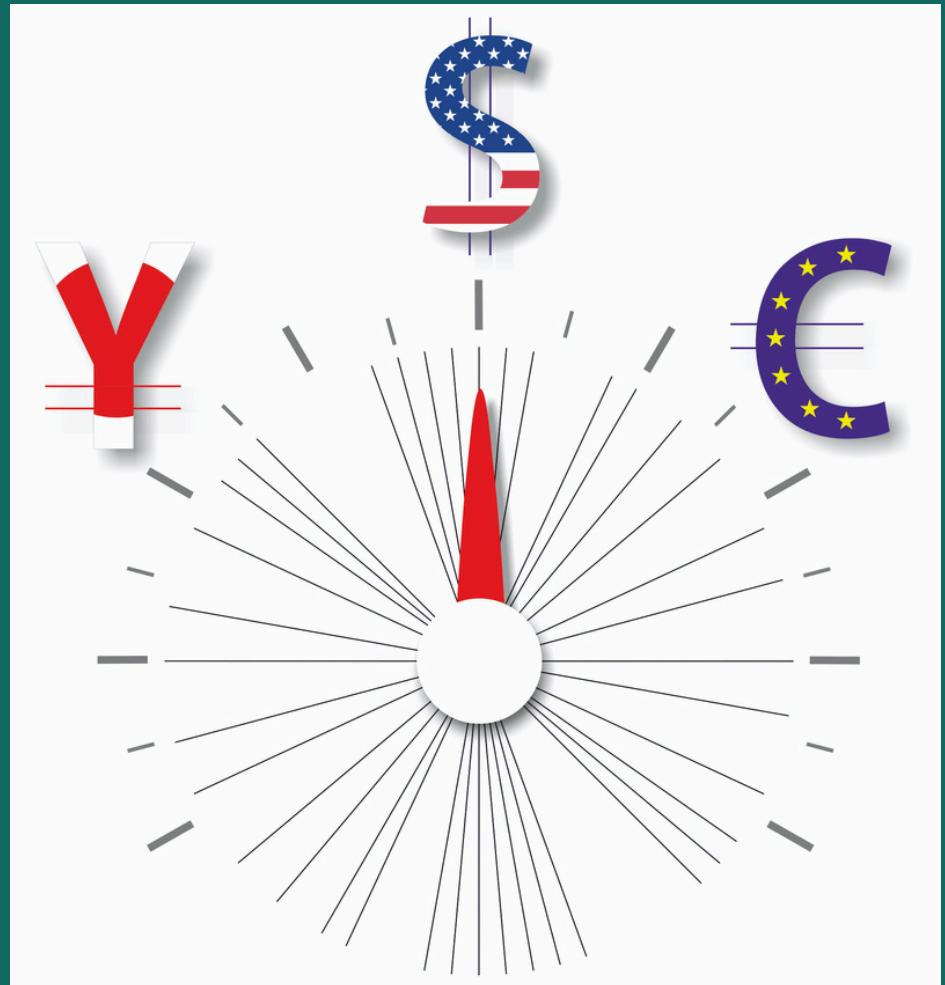
# Comparison of Routing Protocols



- **OSPF:** Ideal for large enterprise networks and service providers. Fast convergence and high scalability.
- **EIGRP:** Designed for Cisco networks. Fast convergence and efficient bandwidth usage.
- **BGP:** The backbone of Internet routing. Supports policy-based routing and inter-autonomous system routing.
- **MPLS:** Used in service provider environments to prioritize traffic and provide VPN services. Enhances routing efficiency.

# Synergy Between Routing and Switching

- Routing and switching are foundational to the way data is transmitted across networks, and they work in tandem to ensure that data flows smoothly and efficiently from one device to another, whether within a local area network (LAN) or across wider area networks (WAN). Switching operates at Layer 2 (the Data Link Layer of the OSI model) and manages data traffic within local networks. It uses MAC addresses to determine where to send data within a single network, ensuring that communication is localized and efficient. In contrast, routing operates at Layer 3 (the Network Layer) and is responsible for connecting different networks together, using IP addresses to direct data packets to their intended destinations, whether they are within the same LAN or across multiple remote networks.



# Advanced Network Design Concepts

- Route redistribution allows different routing protocols, such as OSPF, EIGRP, and BGP, to share information, ensuring seamless connectivity across diverse network environments. However, route redistribution requires careful planning to prevent routing loops and inefficiencies.
- Quality of Service (QoS) is another crucial element, enabling the prioritization of critical network traffic, such as voice, video, and mission-critical applications, over less time-sensitive traffic. This ensures that bandwidth is allocated where it is most needed, improving performance for essential services.
- IPsec (Internet Protocol Security) further enhances security by encrypting data at the network layer, creating secure tunnels for communication, particularly in Virtual Private Networks (VPNs). By integrating these advanced concepts, network professionals can design more resilient, efficient, and secure network infrastructures capable of meeting the demands of modern digital environments.

# Industry Applications

- **Enterprise Networks:** Routing and switching support low-latency, secure business operations (e.g., finance, retail, manufacturing).
- **Telecommunications:** Advanced routing and switching technologies ensure high-speed, reliable connections in 5G networks.
- **Cloud Computing:** Provides seamless connectivity between on-premises infrastructure and cloud services, critical for hybrid cloud models and SD-WANs.
- **IoT and Edge Computing:** Efficient routing and switching are essential for managing connected devices and reducing latency in edge computing environments.



# Conclusion

- Routing and switching remain foundational for modern networks, supporting scalability, security, and performance.
- Emerging technologies like 5G, IoT, and AI-driven networks will further enhance the role of routing and switching in future infrastructures.
- Future trends include Software-Defined Networking (SDN), Network Function Virtualization (NFV), and Intent-Based Networking (IBN), which promise greater automation and optimization.
- Network professionals must continuously adapt to these advancements to design, implement, and manage resilient, secure, and scalable networks.



THANK YOU