Network Design and Management

- Network Design, Needs Anaylsis, Technology Design, cost Assessment, Design for network performance, configuration management, performance and fault management, end user support.

- Introduction to Network Design
- Network design is a crucial process in the creation of a computer network. It involves planning, implementing, managing and maintaining the data communication infrastructure within in organization. A well design network enables efficient data exchange, resource sharing and seamless communication among devices, application and user

- **Network Architecture Components**
- **Introduction**
- **Definition:** Network architecture encompasses the design and layout of a computer network. It defines how computers, devices, and components within a network are organized and how information flows between them.
- **Overview:** Network designers consider seven distinct components when designing networks.
- **1. Local Area Network (LAN)**
- **Purpose:** Provides network access to users within a building or a specific area.
- **Technologies:** Includes network hubs, switches, and wireless access points.
- **Access Layer:** Often referred to as the access layer since it provides entry points to the network.

- **2. Building Backbone Network (Distribution Layer)**
- **Function:** Distributes network traffic between LANs within a building.
- **Technology:** Utilizes faster switches due to higher traffic volume compared to LANs.
- **Role:** Acts as the distribution layer in network design.
- **3. Campus Backbone (Core Layer)**
- **Purpose:** Connects all buildings within a campus.
- **Technology:** Employs high-speed routers or Layer 3 switches due to the significant amount of traffic.
- **Core Layer:** Serves as the core layer of the network, managing the flow of data between building backbones.

4. Data Center

- **Description:** Houses the organization’s critical servers (e.g., database, email).
- **Design:** Structured differently from user-access LANs, often located centrally on the enterprise campus.
- **Significance:** Many organizations have multiple data centers for redundancy and localized data storage.
- **5. Enterprise Edge**
- **Components:** Includes the WAN, Internet access, and e-commerce edge.
- **Location:** Positioned at the edge of the enterprise campus.

- **5a. Wide Area Network (WAN)**
- **Purpose:** Connects different campus locations via leased circuits from carriers.
- **Private Network:** Used exclusively for the organization’s internal traffic.
- **5b. Internet Access**
- **Function:** Enables the organization to connect to the global Internet.
- **Technology:** Uses similar technologies as WANs for large organizations.
- **5c. E-commerce Edge**
- **Description:** A specialized LAN that hosts servers for electronic data exchange with external entities.
- **Examples:** Web servers, customer/supplier communication.

- **The Traditional Network Design Process**
- **Introduction**
- **Definition:** The traditional network design process is a systematic approach used to create a computer network that meets the organization's requirements efficiently and securely.
- **Approach:** This process follows a structured systems analysis and design methodology similar to those used in developing applications.
- **Key Phases of Traditional Network Design**

1. Analysis Phase

1. **User Requirements:** Meeting with users to determine their needs, applications, and overall network expectations.
2. **Traffic Estimation:** Estimating data traffic across different parts of the network to design circuits that support this traffic.
3. **Cost Estimates:** Obtaining cost estimates for the equipment and services needed to support the designed network

- **Design Phase**
- **Logical Design:** Involves developing the network's structure, including topologies, protocols, and addressing schemes.
- **Physical Design:** Specifies hardware components (routers, switches, cables) and their physical layout in the network.
- **Scalability Considerations:** Ensures the network can expand and adapt to future needs.
- **Implementation Phase**
- **Deployment:** Involves the actual installation and configuration of network components.
- **Testing:** Pilot testing and fine-tuning based on real-time performance data.

- **Challenges of Traditional Network Design**
- **Technological Evolution:** Rapid advancements in networking technologies, such as cloud computing, IoT, edge computing, and SDN, demand more flexible and adaptable network designs.
- **Rising Network Traffic:** Traditional designs may struggle to keep up with the rapid growth in data traffic.
- **Cost Dynamics:** The balance of costs between network equipment, bandwidth, and management has shifted dramatically in the past decade.

- **Impact of Modern Business Needs**
- **Scalability:** Traditional designs may lack the elasticity needed to handle fluctuating resource demands efficiently.
- **Security Requirements:** Evolving cybersecurity threats require more robust intrusion detection, encryption, and threat analysis, which traditional designs may not adequately provide.
- **Remote Access:** The rise of remote work demands secure and reliable access solutions, which traditional designs, focused on on-premises infrastructure, may struggle to support.
- **Conclusion**
- **Adaptation Needs:** While traditional network design processes provide a solid foundation, the dynamic demands of modern businesses necessitate a shift towards more flexible, scalable, and secure network architectures.

- **Building-Block Network Design Process**

1.Overview

1. Focuses on creating a network architecture using modular components or "building blocks."
2. Emphasizes flexibility, scalability, and adaptability in network design.

2.Comparison with Traditional Network Design

1. Traditional designs often involve detailed predictions of user traffic and specific custom solutions.
2. Building-block design uses standard components across the network, aiming for simplicity and ease of management.

3.Key Concepts

1. **Simplicity of Design:** Uses a narrow range of technologies and devices, applied deeply across the network.
2. **Scalability:** Networks can easily grow by adding more standard components rather than re-engineering entire sections.
3. **Cost Efficiency:** Standardizing components reduces long-term costs and simplifies network management

- **Design Process**
- **Needs Analysis:**
  - Assess current and future network needs for users, departments, and applications.
  - Classify needs into categories such as typical or high-volume usage.
- **Technology Design:**
  - Evaluate available technologies to meet user needs.
  - Match network needs with appropriate technologies, focusing on flexibility for future growth.
- **Cost Assessment:**Analyze the costs of different technologies.
- Recycle through the needs analysis, technology design, and cost assessment to refine the design.

- **Process Cycle**
- **Iterative Process:** Continually refine needs, technology, and cost as the network evolves.
- **Growth-Oriented:** Build capacity ahead of demand and ensure the network can adapt to changing needs.
- **Benefits**
- **Ease of Management:** Fewer components lead to simpler maintenance.
- **Future-Proofing:** The design easily adapts to new technologies and changing business needs

- **Needs Analysis Phase of Network Design**

1.Understand Business Requirements

1. **Objective:** Determine the overall goals and objectives of the business that the network must support.
2. **Considerations:** Growth plans, application requirements, remote access needs, and overall business strategy.

2.Security Requirements

1. **Objective:** Identify the security needs to protect data and ensure network integrity.
2. **Considerations:** Data protection, access controls, threat management, and compliance with security policies.

3. Performance and Bandwidth Requirements

- **Objective:** Assess the performance needs and bandwidth requirements for efficient network operation.
- **Considerations:** Traffic patterns, peak usage times, application performance, and required bandwidth.

4. Network Infrastructure

- **Objective:** Evaluate the existing network infrastructure and identify any upgrades or additions needed.
- **Considerations:** Current hardware, network topology, and integration with existing systems.

5. Disaster Recovery and Redundancy

- **Objective:** Plan for network reliability and resilience in case of failures or disasters.
- **Considerations:** Backup solutions, failover mechanisms, and recovery plans.

6. Compliance and Regulation

- **Objective:** Ensure the network design adheres to relevant regulations and industry standards.
- **Considerations:** Data privacy laws, industry-specific regulations, and compliance requirements.

7. User Experience and Support

- **Objective:** Enhance user experience and provide adequate support for network issues.
- **Considerations:** User satisfaction, helpdesk support, ease of access, and training needs

8. Budget Constraints

- **Objective:** Align network design with budgetary constraints and cost-effectiveness.
- **Considerations:** Total cost of ownership, initial setup costs, and ongoing maintenance expenses.

- Network Architecture Component
- **Break Down the Network into Components**
- **Objective:** Segment the network into distinct architecture components for detailed analysis.
- **Components:**
  - **Building Backbones**
  - **Campus Backbone**
  - **WANs (Wide Area Networks)**
  - **Internet Access**
  - **E-commerce Edge**
  - **Data Center**

2. Assess Infrastructure Constraints

- **Objective:** Identify and document constraints imposed by existing infrastructure.
- **Example:** If a new building is added to an office complex using 1 Gbps Ethernet, use the same standard to ensure compatibility.

3. Develop High-Level Network Diagram

- **Objective:** Create a preliminary diagram showing major network connections.
- **Details:**
  - Focus on WANs and enterprise campuses.
  - Include logical network connections and basic layout.
  - Additional details like circuit types will be added later.

4.Create Individual Campus Diagrams

- **Objective:** Design detailed diagrams for each enterprise campus.
- **Approach:**
  - Use separate diagrams for complex networks.
  - Use a single diagram for simpler setups.

5.Gather General Information and Environmental Characteristics

- **Objective:** Understand the operational environment and external factors.
- **Considerations:**
  - Legal requirements (local, state, federal, international)
  - Regulations and building codes
  - Environmental conditions and constraints

- **Document Constraints and Requirements**
- **Objective:** Record any constraints or specific requirements affecting the design.
- **Examples:**
  - Existing technology standards
  - Compliance and regulatory needs

- Application System
- **Review of Current Applications:**
- Identify existing internal applications (e.g., payroll) and external applications (e.g., Web servers).
- Document the location of each application for network planning.
- **Baselining Process:**
- Add applications expected to use the network in the future.
- Ensure the baseline reflects current and upcoming network usage.
- **Long-term and Short-term Planning:**
- Assess the organization's strategic goals, development plans, and potential changes in product mix.
- Consider the impact of new offices or major expansions on network requirements.

- **Consideration of Security and Compliance:**
- Evaluate security issues and compliance with regulations.
- Plan for future commitments to technology, such as major electronic commerce initiatives.
- **Hardware and Software Requirements:**
- Identify the specific hardware and software needs of each application.
- Determine the protocols each application will use (e.g., HTTP over TCP/IP, Windows file access).
- **Impact on Network Design:**
- Use this information to shape network documentation and design.
- Ensure scalability to accommodate future growth and changes

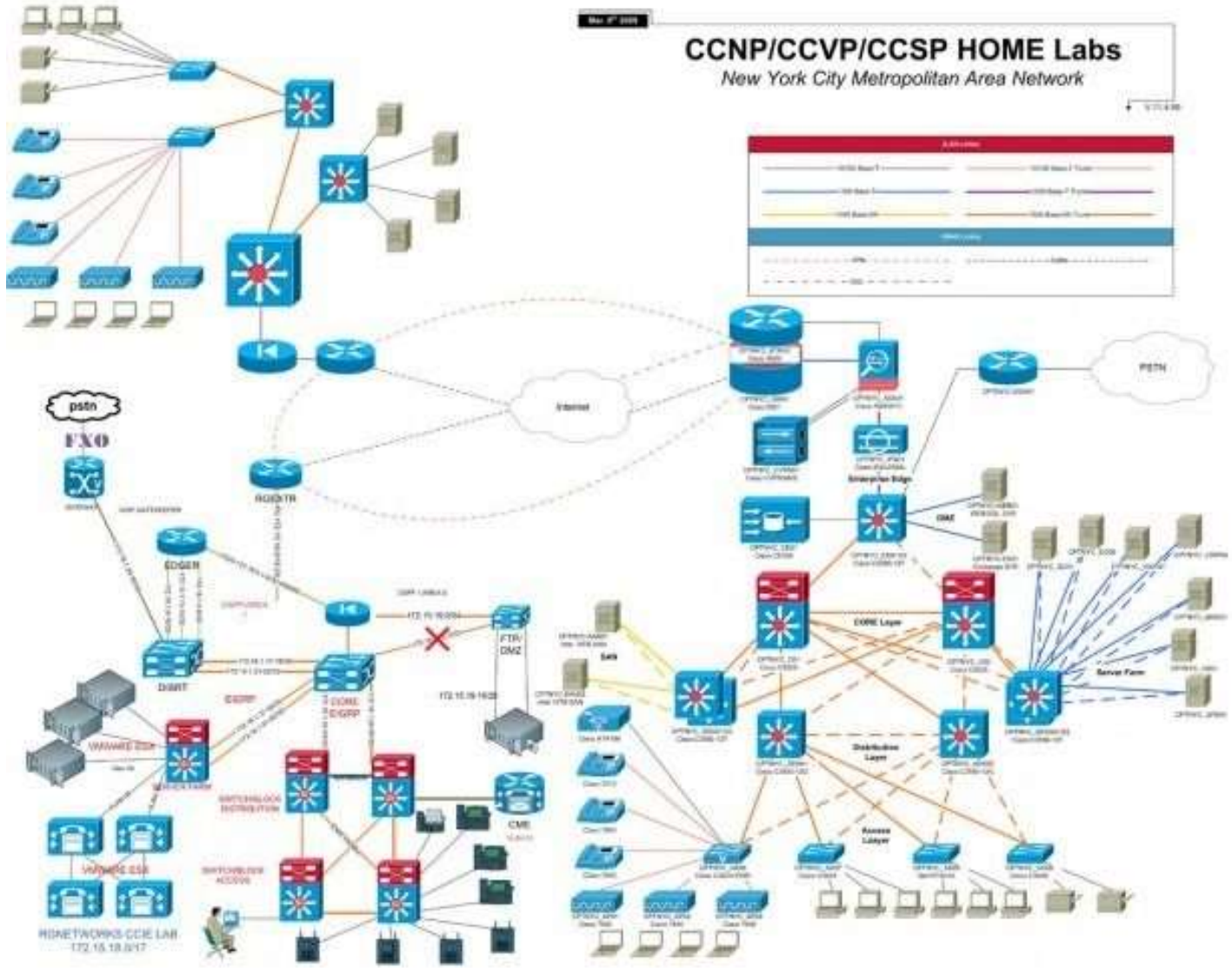
- Categorizing Network needs
- **Categorization**: Requirements are organized into specific categories to make analysis prioritization, and addressing each aspect more effective.
- **Network Design Overview**:
- The network is now designed in terms of **geographic scope**, **application systems**, and **users.**
- **Traffic Assessment**:
- The next step is to assess the relative amount of traffic generated in each part of the network.
- **Traditional Design Approach**: Involves detailed analysis of network traffic.
- **Building-Block Approach**: Focuses on providing a rough assessment of network needs.

- **Application System Traffic Analysis**:
- Evaluate the network traffic generated by each application system, both current and future.
- Compare the traffic impact across different applications.
- **User Traffic Categorization**:
- Classify users into two categories: **typical users** and **high-traffic users**.
- These assessments will be further refined in the next design stage.

- **Designing Clients and Servers**
- **1. Building-Block Approach:**
- Specify client and server needs using standard units.
- Allocate base-level client computers to typical users.
- Assign advanced computers to users and servers requiring higher performance.
- **2. Considerations for Typical and Advanced Users:**
- Typical users receive standard client computers.
- Advanced users or applications receive more powerful computers.
- **3. Adaptability Over Time:**
- Specifications improve and costs drop every 6 months.
- A typical user today may receive a computer initially designed for advanced users.
- Advanced users may receive the latest available computers at the time of implementation.

- Designing Circuit
- In the context of network design typically involves creating logical diagram that represents the flow of the data between different components. These diagram help visualize the connection and interaction between router, switches server and other. There are different tools to design some of them are.
- **Cisco Packet Tracer**: A network simulation tool that allows users to create, configure, and test network topologies virtually, making it ideal for learning and practicing networking concepts.
- **GNS3**: A network software emulator that enables the design and testing of complex networks with real network devices and virtual machines, useful for both learning and production environments.

- **SolarWinds Network Configuration Manager**: A comprehensive tool for managing network configurations, automating backups, and ensuring compliance with policies, helping to reduce downtime and manage changes effectively.
- **Wireshark**: A powerful network protocol analyzer used for capturing and examining data packets on a network, allowing detailed troubleshooting, analysis, and security auditing.
- **Microsoft Visio**: A diagramming tool that enables the creation of detailed network diagrams, flowcharts, and other visual representations, essential for documenting network architectures and workflows.
- **draw.io**: An online diagramming tool that allows for the creation of various types of diagrams, including network topologies, flowcharts, and process maps, offering a flexible and easy-to-use platform for visual documentation.


CCNP/CCVP/CCSP HOME Labs
New York City Metropolitan Area Network
pstn
FXO
Internet
PSTN
EDGER
DART
CME
Server Farm

- **Cost Assessment in Network Design**

1. **Purpose**: Evaluate the costs of physical network design alternatives, considering software, hardware, circuits, performance, and reliability.
2. **Key Cost Factors**:
    1. **Circuit Costs**:
        1. Includes leasing costs for WAN and Internet circuits from common carriers.
        2. Costs of purchasing and installing proprietary cables.
    2. **Network Devices**:
        1. Expenses related to switches, routers, and other networking hardware.
    3. **Hardware Costs: Includes** servers, printers, UPS systems, and backup solutions like tape drives
    4. **Software Costs: Network** operating systems, application software, and middleware.
    5. **Network Management Costs: Expenses** for network management tools, training, and ongoing support.
    6. **Test and Maintenance Costs: Costs** for monitoring equipment, software, and maintaining an inventory of spare parts
3. **Complexity**:
    1. Estimating costs involves various interconnected factors that may not be immediately obvious.

- Request of Proposal
- A Request for Proposal (RFP) is a formal document issued by an organization to solicit proposals from vendors or service providers for a specific project or service.
- **Purpose of an RFP**
- **Gather Information**: Collect detailed proposals from various vendors to compare and select the best option.
- **Ensure Transparency**: Provide a clear and fair process for evaluating potential vendors.
- **Define Requirements**: Clearly communicate what is needed and expected from the vendor.

- Selling the proposal to management

- Introduction to Network management
- **Network Management** refers to the processes, tools, and techniques used to ensure a computer network operates efficiently, securely, and reliably. It involves a range of activities aimed at monitoring, administering, and optimizing network operations to ensure that the network is available and performs well for its users. The primary goal of network management is to move data from one location to another in a timely and organized fashion, ensuring that the network provides value to its users.

- **Key Aspects of Network Management:**

1.Operation:

1. Day-to-day management of the network to ensure smooth functioning.
2. Involves monitoring network performance, managing user access, and ensuring data flow.

2.Monitoring:

1. Continuous observation of the network to detect and respond to issues.
2. Monitoring tools provide alerts on performance degradation, failures, or security threats

3. Administration:

- Managing the network's resources, including hardware, software, and network devices.
- Tasks include user management, device configuration, and network policy enforcement.

5. Proactive vs. Reactive Management:

- **Proactive Management:** Involves planning, predicting potential problems, and preventing issues before they occur. It requires adequate time spent on network design and organization.
- **Reactive Management:** Involves dealing with issues as they arise, often leading to a "firefighting" approach, where immediate problems overshadow long-term planning.

- Managed Network
- **Introduction to Managed Networks**
- Definition: A managed network is designed for optimal performance through careful planning, strategic decision-making, and ongoing maintenance.
- Managed by: Typically overseen by Managed Service Providers (MSPs) or internal IT teams.
- Key considerations: Efficiency, security, and scalability.

- **Importance of Managed Devices**
- **Managed Devices:** Standard network devices (e.g., switches, routers) with built-in computers to monitor traffic and device status.
- **Functions:**
  - Perform core networking tasks (routing, switching).
  - Record data on processed traffic.
  - Send alerts or reports to network management system
- **Benefits of Managed Devices**
- **Proactive Problem Detection:**
  - Detect and report issues (e.g., failing devices, traffic spikes) before they become critical.
  - Managed devices can disable faulty circuits and alert network managers.
- **Quick Issue Resolution:**
  - Problems can be identified and fixed in minutes rather than hours.

- **Hardware and Software for Managed Networks**
- **Managed Devices:** Include switches, routers, access points with built-in CPUs and software.
- **Network Management Software:** Essential for storing, organizing, and analyzing reports and alerts from managed devices.
- **Cost Considerations:**
  - Managed devices are more expensive due to additional features.
  - Some organizations use a mix of managed (backbone) and unmanaged (access layer) devices to reduce costs.

- **Types of Network Management Software**
- **Device Management Software:** Monitors and controls individual network devices.
- **System Management Software:** Manages the overall network infrastructure, including servers and storage systems.
- **Application Management Software:** Focuses on monitoring and managing applications running over the network
- **Conclusion**
- **Optimal Performance:** Achieved through the use of managed devices and comprehensive network management software.
- **Proactive Management:** Ensures network reliability, quick issue resolution, and long-term scalability.

- **Introduction to Network Traffic Management**
- **Network Traffic Management:** Involves controlling and optimizing data flow across a network to ensure efficient and reliable performance.
- **Key Techniques:** Load balancing and policy-based management.
- **Load Balancing**
- **Definition:** Distributes network traffic across multiple servers or paths to ensure no single device or connection is overwhelmed.
- **Benefits:**
  - **Improved Performance:** Prevents bottlenecks by evenly distributing traffic.
  - **High Availability:** Ensures service continuity even if one server or path fails.
  - **Scalability:** Allows the network to handle more traffic as demand increases.

- **Types of Load Balancing:**
- **DNS Load Balancing:** Distributes traffic based on DNS requests.
- **Server Load Balancing:** Balances traffic across multiple servers.
- **Link Load Balancing:** Distributes traffic across multiple internet connections.

- **Policy-Based Management**
- **Definition:** Uses predefined rules or policies to manage and prioritize network traffic.
- **Benefits:**
  - **Customized Control:** Tailors traffic management based on business needs.
  - **Enhanced Security:** Applies specific policies to control access and data flow.
  - **Efficient Resource Utilization:** Allocates bandwidth according to priority and application needs.

- **Examples of Policies: Quality of Service (QoS):** Prioritizes critical applications and limits bandwidth for less important traffic.
- **Access Control Policies:** Regulates which users or devices can access certain parts of the network.
- **Traffic Shaping:** Manages data flow to avoid congestion by delaying or prioritizing packets.

- **Introduction to Network Traffic Reduction**
- **Goal:** To minimize network congestion, enhance performance, and optimize bandwidth usage by effectively managing capacity, utilizing content caching, and employing content delivery strategies
- **Capacity Management**
- **Definition:** The process of planning, monitoring, and optimizing network resources to ensure they meet current and future demands.
- **Key Strategies:**
  - **Traffic Analysis:** Continuously monitor and analyze traffic patterns to identify peak usage times and bottlenecks.
  - **Resource Allocation:** Dynamically allocate network resources based on demand, prioritizing critical applications
  - **Scalability Planning:** Ensure the network can scale to handle increased traffic by upgrading infrastructure or adding more capacity when needed.
  - **Load Balancing:** Distribute traffic evenly across network resources to prevent overloading any single device or path.

- **Content Caching**
- **Definition:** Storing frequently accessed content closer to the user to reduce the need for repeated requests to the original source.
- **How It Works:**
  - **Local Caching:** Content is stored on a local server or device after the first request, reducing the need for further external requests.
  - **Edge Caching:** Caches content at locations closer to the end-user, such as regional data centers or edge servers.
- **Benefits:Reduced Latency:** Faster access to content as it’s delivered from a nearby cache rather than the origin server.
- **Lower Bandwidth Usage:** Reduces the amount of traffic sent across the network, conserving bandwidth.
- **Improved User Experience:** Provides quicker load times for frequently accessed content.

- **Content Delivery**
- **Definition:** The use of a distributed network of servers (Content Delivery Networks - CDNs) to deliver content more efficiently based on the user's geographic location.
- **Key Components:**
  - **Content Distribution:** Spreads content across multiple servers in different locations to ensure availability and quick access.
  - **Load Balancing:** Directs user requests to the closest or least busy server, reducing load on the origin server.
  - **Geographic Proximity:** Minimizes the distance data must travel, reducing latency and improving response times
- **Benefits: Traffic Offloading:** Reduces the load on central servers by distributing traffic across multiple locations.
- **Faster Content Delivery:** Speeds up the delivery of web pages, videos, and other content to users, especially during high traffic periods.
- **Scalability:** Allows the network to handle a large number of simultaneous users without degradation in performance.

- **Conclusion**
- **Key Takeaways:**
  - Effective capacity management ensures that network resources are used efficiently.
  - Content caching minimizes redundant data requests, saving bandwidth and reducing latency.
  - Content delivery networks distribute traffic and content efficiently, reducing the load on central servers and improving access speed

- **Configuration Management**
- **Definition:** The process of systematically managing, maintaining, and organizing the settings and configurations of a network and client computers to ensure consistency, reliability, and efficiency.
- **Importance:** Helps prevent configuration drift, enhances security, ensures compliance, and simplifies troubleshooting.
- **Configuring the Network**
- **Network Configuration:**
  - **Router and Switch Setup:** Define IP addresses, VLANs, routing protocols, and security settings.
  - **Firewall Configuration:** Set up rules to control incoming and outgoing traffic, protecting the network from unauthorized access.
  - **Access Control Lists (ACLs):** Implement ACLs to control user and device access based on predefined policies.
  - **Wireless Network Setup:** Configure SSIDs, encryption protocols, and network segmentation for secure wireless access.
  - **Network Services:** Configure DNS, DHCP, and other essential network services to ensure seamless communication.

- **Configuring Client Computers**
- **User Account Management**
- **Adding and Deleting Accounts:**
  - New users are categorized into groups based on their role (e.g., faculty, students, accounting).
  - **Access Privileges:** Define what servers, directories, and files each user group can access.
  - **Log-in Scripts:** Automated scripts run at log-in to set up user environments, connect to public disks, and launch required applications
- **Software Updates for Client Computers**
- **Software Deployment Challenges:**
  - Updating client computers when new applications or versions are released.
  - **Manual Installation:** Traditionally required network staff to manually install updates on each machine, a time-consuming process.
  - **Scalability Issues:** For large organizations, manual updates across hundreds or thousands of client computers are inefficient and prone to errors.
  - **Automation:** Highlight the need for automated deployment solutions like SCCM, Group Policy, or other management tools.

- **Documenting the Configuration**
- **Importance of Documentation:**
  - **Ensures Consistency:** Clear documentation helps maintain a standardized configuration across the network.
  - **Facilitates Troubleshooting:** Accurate documentation speeds up the identification and resolution of issues.
  - **Supports Compliance:** Provides necessary records for audits and regulatory compliance.
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- **Creating Network Configuration Diagrams**
- **Diagram Components:**
  - **Network Circuits:** Include details on organization-owned or leased circuits.
  - **Network Servers and Devices:** Document the type and placement of hubs, routers, and other network devices.
  - **Client Computers:** Provide an overview of client computers within each LAN, BN (Backbone Network), and WAN (Wide Area Network).
- **Tools for Diagramming:** Use tools like Microsoft Visio, draw.io, or Lucidchart to create and maintain these diagrams.

- **Performance and faulty management**
- **Objective:** Ensure network reliability by detecting, diagnosing, and resolving issues promptly.
- **Network Operations Center (NOC)**
- **Role:**
  - **Staff:** Skilled technicians using network management software.
  - **Functions:**
    - **Detect Issues:** Automated alerts for problems.
    - **Resolve Problems:** Remote fixes or dispatching technicians.
- **Failure Control Procedures**
- **Reporting:**
  - **Channels:** Issues reported through NOC or help desk.
  - **Authority:** NOC handles contacts with vendors and service providers.
  - **Contact:** Central phone number for reporting problems.

- **Best Practices**
- **Monitoring:** Real-time alerts for early detection.
- **Reporting:** Centralized and clear reporting procedures.
- **Authority:** Defined roles for handling issues.

- **Failure Statistics**
- **Objective:** Key failure metrics to enhance network reliability.
- **Availability**
- **Definition:** Percentage of time the network is operational.
- **Calculation:** (Available Hours / Total Hours) x 100
- **Target:** Aim for 99-99.5% availability.
- **Mean Time Between Failures (MTBF)**
- **Definition:** Average time before a component fails.
- **Importance:** Higher MTBF means more reliable devices.
- **Mean Time to Repair (MTTR) / MTTD: Mean time to diagonse**
- **Definition:** Average time to restore a failed component.
- **Components:**
  - **MTTR = MTTDiagnose + MTTRespond + MTTFix**

- End User Support
- Effective strategies to support end users and resolve their issues.

- **Help Desk:** Central point for handling support requests.
- **On-Site Support:** Technicians visit users for hands-on assistance.
- **Remote Support:** Troubleshooting issues via remote access tools.

- **Common Support Activities**
- **User Account Management:** Creating, modifying, and deleting user accounts.
- **Software Updates:** Installing and updating software across client computers.
- **Issue Resolution:** Diagnosing and fixing hardware and software problems.

- Cost Management
- Strategies to manage and reduce network costs effectively.
- **Sources of Network Costs**
- **Total Cost of Ownership (TCO):** Includes direct costs (repair, upgrades, support) and indirect costs (user downtime, learning new software).
- **Challenges:** Growing data traffic vs. limited budget; escalating equipment and staffing costs.

- Develop standard hardware and software configuration for client server
- Work with vendors to reduce installation costs.
- Implement desktop management tools to lower costs and ensure consistent setup.
- Consolidate help desk functions to improve efficiency and reduce costs.
- Automate as much of network mgmt. function as possible by deploying a solid set of
- network mgmt tool
- Move to thin-client or cloud based architecture