Name : Saurabh Khodke

Roll No: 33

Div : B

SRN : 202200497

**C2P2 Project-1 Problem Statement :**

**Create an efficient and scalable LAN for any real-time location like a university campus, office building, or similar environment.**

**1. Problem Definition:**

The goal of this project was to design a reliable, scalable, and cost-effective network infrastructure for a multi-building campus environment. The network needed to support inter-building communication, ensure ease of network management, and allow future scalability. Each building in the campus had a specific requirement for multiple end-user devices (PCs), and the architecture had to be designed in such a way that additional devices could be added without reconfiguring the entire network.

The primary challenges included:

1. Efficient distribution and management of IP addresses.
2. Ensuring communication between different buildings while maintaining isolated broadcast domains for security and efficiency.
3. Minimizing costs while ensuring the network’s performance, scalability, and ease of maintenance.
4. Establishing static routing between routers to manage traffic efficiently.
5. Implementing a robust configuration for both routers and switches to ensure smooth data transmission across the network.

Thus, the objective was to design a hierarchical network architecture that addresses these challenges, facilitates communication across all buildings, and is easy to manage, all while keeping within a tight budget.

**2. Methodology:**

To address the problem, a structured approach was employed:

**2.1 Site Survey and Physical Layout:**

A detailed site survey was conducted to understand the physical layout of the campus. Based on the survey:

* Five buildings (A1, A2, B1, B2, and C1) were identified, each requiring network connectivity.
* Each building was assigned a switch, and each switch connected three PCs as a base setup. This setup can scale to accommodate additional PCs as per the available IP range.
* Routers were placed in each building to manage inter-building communication.

**2.2 Network Design:**

A hierarchical network model was chosen as the most appropriate design, dividing the campus into subnets for each building and using routers for inter-subnet communication. Each building was assigned its own subnet, with switches connecting local devices (PCs) within that building. Routers were used to manage traffic between the subnets, enabling communication between different buildings.

**2.3 Subnetting and IP Address Assignment:**

**1. Given IP Address:**

* We can use any private Class C address range. For example, let's assume **192.168.1.0** as the starting address.

**2. Requirement:**

* You need 5 subnets.
* The number of subnets must be a power of 2, and the smallest power of 2 greater than or equal to 5 is **8** (2³ = 8).
* Therefore, you will need 3 additional bits from the host portion for subnetting.

**3. Subnet Mask Calculation:**

* Default subnet mask for Class C: **255.255.255.0** (which is /24 in CIDR notation).
* Add 3 bits for the subnet, making the new subnet mask: **/27**.
* **/27** means you have **27 bits** for the network and **32 - 27 = 5 bits** for the hosts.

**4. Calculating Number of Hosts Per Subnet:**

* With **5 host bits**, the number of usable host addresses per subnet will be 25−2=302^5 - 2 = 3025−2=30 (we subtract 2 because one address is reserved for the network address and one for the broadcast address).

**5. Subnet Mask in Decimal:**

* The subnet mask **/27** is written as **255.255.255.224** in decimal form.

**IP Address Range Calculation for 5 Buildings:**

Let’s assign the first subnet to **192.168.1.0/27**, and calculate the rest similarly by incrementing the network address by 32 (since each subnet supports 30 hosts):

* **Subnet I (A1 Building)**:
  + **Range of Addresses:** 192.168.1.0 to 192.168.1.31
  + **Network Address:** 192.168.1.0
  + **Broadcast Address:** 192.168.1.31
  + **Host Address Range:** 192.168.1.1 to 192.168.1.30
  + **Default Gateway:** 192.168.1.1 (Router A1)
* **Subnet II (A2 Building)**:
  + **Range of Addresses:** 192.168.1.32 to 192.168.1.63
  + **Network Address:** 192.168.1.32
  + **Broadcast Address:** 192.168.1.63
  + **Host Address Range:** 192.168.1.33 to 192.168.1.62
  + **Default Gateway:** 192.168.1.33 (Router A2)
* **Subnet III (B1 Building)**:
  + **Range of Addresses:** 192.168.1.64 to 192.168.1.95
  + **Network Address:** 192.168.1.64
  + **Broadcast Address:** 192.168.1.95
  + **Host Address Range:** 192.168.1.65 to 192.168.1.94
  + **Default Gateway:** 192.168.1.65 (Router B1)
* **Subnet IV (B2 Building)**:
  + **Range of Addresses:** 192.168.1.96 to 192.168.1.127
  + **Network Address:** 192.168.1.96
  + **Broadcast Address:** 192.168.1.127
  + **Host Address Range:** 192.168.1.97 to 192.168.1.126
  + **Default Gateway:** 192.168.1.97 (Router B2)
* **Subnet V (C1 Building)**:
  + **Range of Addresses:** 192.168.1.128 to 192.168.1.159
  + **Network Address:** 192.168.1.128
  + **Broadcast Address:** 192.168.1.159
  + **Host Address Range:** 192.168.1.129 to 192.168.1.158
  + **Default Gateway:** 192.168.1.129 (Router C1)

**Summary:**

* **Subnet Mask for all buildings:** 255.255.255.224 (/27)
* Each subnet has 30 usable IP addresses for hosts.
* Each building’s network has its own range of addresses, as shown in the breakdown above.

2.4 **Static Routing Configuration:**

* Routers were configured with static routes to ensure data transmission across buildings, enabling PCs in one building to communicate with those in another.
* Static routes were used because the network is relatively small, making it feasible to manually define routing paths. This method offers full control over how data is routed and reduces potential routing errors due to automatic misconfigurations.

**Router of Building A2**

A screen shot of a computer

Description automatically generated

2.5 **Switch Configuration:**

* Each switch in the building was connected to its respective router. Switches were configured to forward traffic to their default gateway, which was the router in each building.
* Simple VLAN configuration was also done to ensure that PCs connected to switches within the same building could communicate directly, while inter-building communication was routed through the routers.

**2.7 Implementation:**

* **Routers**: Five routers were configured with IP addresses on their interfaces connecting to other routers and their respective switches. Static routes were implemented on each router to ensure that data packets could be sent and received between the routers.
* **Switches**: Five switches were configured in each building, and their ports were connected to two PCs in each building. Each switch was connected to its respective router via a Gigabit Ethernet connection, ensuring fast communication between switches and routers.
* **End Devices (PCs)**: Two PCs were installed in each building, connected to the switches. The PCs were configured with static IP addresses within their assigned subnets. The default gateway on each PC was set to the IP address of the router in the same building.

2.8 **Testing and Validation:**

After implementing the network configuration, we tested the connections between different buildings to ensure proper routing and communication. Pings were sent from PCs in one building to another building to verify that data packets were reaching their destinations. ICMP echo requests between routers were used to confirm inter-router communication.

A screenshot of a computer

Description automatically generated

**Output:**

**A diagram of a computer network

Description automatically generated**

**Cost Estimation Report for Network Architecture**

1. Component List

* Routers: 5 units
* Switches: 5 units
* End Devices (PCs): Scalable, currently set to 3 per switch (total 10 PCs). Additional devices can be scaled as needed.
* Cabling and Accessories: Includes Ethernet cables, patch panels, and other essentials.
* Labor Costs: If any installation and configuration services are required.

2. Cost Breakdown

A. Routers

* Type: Cisco ISR 1841 Series (or equivalent)
* Estimated Cost per Unit: ₹40,000 - ₹80,000
* Total Cost for 5 Routers: ₹200,000 - ₹400,000

B. Switches

* Type: Cisco Catalyst 2960-X Series (or equivalent)
* Estimated Cost per Unit: ₹40,000 - ₹80,000
* Total Cost for 5 Switches: ₹200,000 - ₹400,000

C. Cabling and Accessories

* Ethernet cables (Cat6): Estimated cost ₹4,000 per building (5 buildings).
* Patch panels and accessories: ₹8,000 per building (5 buildings).
* Total Cabling and Accessories: ₹60,000

D. Labor Costs

* Network setup and configuration labor (if outsourced): Estimated at ₹40,000 - ₹80,000 per day. Assume 2 days for a team of technicians to complete the setup.
* Total Labor Costs: ₹80,000 - ₹160,000

3. Total Estimated Costs

* Routers: ₹200,000 - ₹400,000
* Switches: ₹200,000 - ₹400,000
* Cabling and Accessories: ₹60,000
* Labor Costs: ₹80,000 - ₹160,000
* Total Cost Range: ₹540,000 - ₹1,220,000

4. Scalability Consideration

* End Devices: As your network grows, adding more end devices will significantly increase costs, especially for hardware (PCs, printers, etc
* Infrastructure Upgrades: Depending on traffic and bandwidth requirements, routers and switches might need upgrading for enhanced performance in the future.