GROUP ASSIGNMENT

CMPE2000

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docs.google.com/document/d/1eogtSYsoFgHIfdqpDUetswb7AhUMlELx9Unwys5ynCo/edit?tab=t.0

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Project 1 – Group Reflection

Introduction
In this project, we used Cisco Packet Tracer to build and simulate three different network topologies: Star, Bus, and Ring. There are significant benefits and drawbacks to each topology in terms of performance, cost, and reliability.
Network Topologies

Star Topologies
A star topology is a network setup that has each device connected to a central node called a hub. The hub manages what data flows in and what flows out. The hub acts as the center point for communication between all devices. If one device wants to send data to another device, it must first send the information to the hub and then the hub transmits that data to the required device. The data is accepted once the hub has verified that the destination address matches; if not, the data is denied. It is widely used in homes, offices as it is easy to maintain and expand.
Advantages

A star topology is more reliable than the bus in the way that if one of the cable or devices fails then all others will still work.

Since LAN networks are less expensive and easier to install, they are the most often used.

It also has high performance, and no data collision can occur.

Adding or moving devices is very easy to do.

Disadvantages

- If the hub goes down, everything down, none of the devices can work without the hub.
- It require more cable then bus topology.

Bus Topologies
A bus topology is that all the end users are connected to one single cable , known as bus or backbone. This cable serves as a shared communication line allowing all connected devices to receive the same signal simultaneously.

Advantages

- It is easy to understand topology.
- It is the easiest topology to implement as it need minimal setup and, configuration with fewer devices.
- It requires less cable length than other topologies such as star.
- Bus topology is not complicated and works efferently, which makes it ideal for small networks.
- Very cost-effective compared to other topology such as mesh, star.
- Easy to connect or remove deceives in this network without affection any other devices.

Disadvantages

- Bus topology does not scale well, so it is not a wise decision to use it in large network.
- If any single cable fails, the entire network can come down due to its single point of failure.
- This network topology is very slow compared to other topologies.
- The entire network fails or divides in two if the main cable is broken.

Ring Topologies

A ring topology is a network configuration where devices create a circular path. Each device is connected to with its two neighboring devices.

Advantages

- Data only flows in one direction which reduces the chance of packet collision
- All device has the equal access to resources.

Disadvantages

- If one workstation stops working all of them stops working.
- The network may be disrupted if a device in the ring is added, moved, or has its settings changed.

Project 2 - Group Reflection

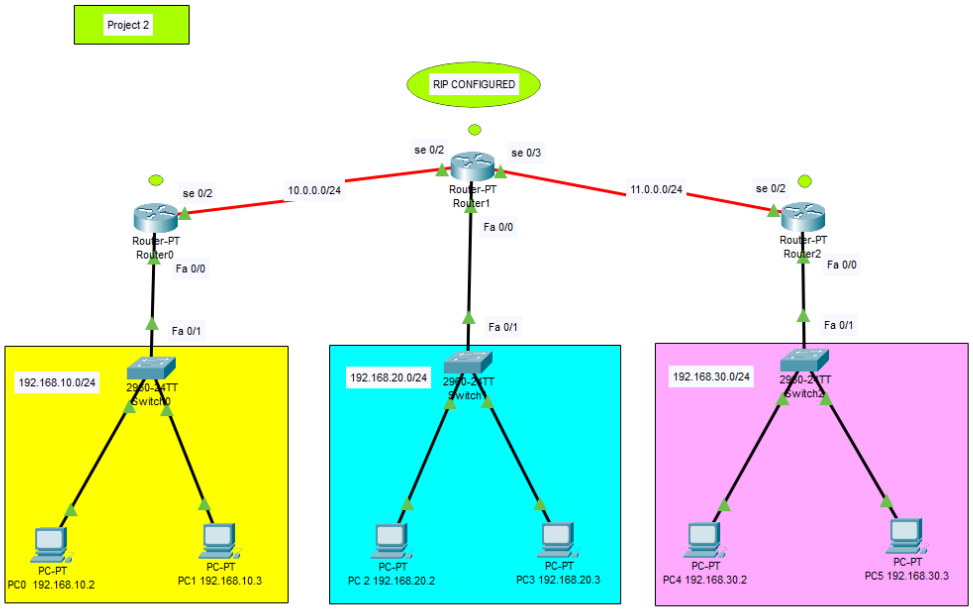
Introduction

In this project we used 3 Routers within the cisco packet tracer software to simulate Routing Information Protocol (RIP) which is a active routing protocol which utilises hop count at its primary routing metric to find the best suited route between a source and destination network

Structure

All networks within the LAN created that simulated RIP appear as follows:

Which is one cisco router connected to one cisco switch with 2 hosts (users) connected via copper straight through cables. Implementing this configuration on all 3 routers used left our final project file appearing as the following:



Each router switch has there own IP domain and all share a /24 subnet, the routers use serial cables between one another to form connection and all have there own IP domain respectively being 10.0.0.0 and 11.0.0.0 with a /24 subnet.

Advantages of RIP (Routing Information Protocol)

- Simple and easy to configure
- Favourable for small scale networks
- Has wide support not only on cisco devices but many branded network devices
- Minimal resource usage allowing it to run on many routers, including less powerful devices
- When changing topology of the network in most cases a network update isn't necessary unlike other routing protocols

Disadvantages of RIP (Routing Information Protocol)

- Has a strictly limited hop count
- Hogging bandwidth, as RIP runs on a periodic update of every 30 seconds regardless if any changes have been made in the network

In summary Project 2 was a great introduction to one of the more simple routing protocols being RIP and how it can be used in a LAN network type setting.

3. Project 3 Introduction - Shae

a. Objectives

The objective of this project is to create a LAN (Local Area Network) for the EECMS Building (314), through the use of various Cisco networking devices that we've been familiarised with throughout the CMPE2000 unit course work.

Objectively we desire every device to both be able to access the internet and communicate with all other required devices with the LAN. This LAN must be able to provide connection for up to and including 180 users, furthermore all users must have the ability to have wired access and or wireless access if their host device supports it.

To achieve this we will implement a hierarchical architecture through the use of VLANS to logically separate users into different groups and device types (PC, Printer, Switch, Router, Hub etc.). The use of Access Control Lists (ACLs) will also be prominent to block access to networks that some users are not permitted to access and vice versa (Student cannot access teacher network etc.). All routers will also be configured for either inter-VLAN routing via router on a stick topology or will be set up for trunking with 802.1q encapsulation.

Our design will prioritise Security and Performance while leaving scalability a possibility to in future be able to scale the network to possibly support more than its current max capacity of 180 users. [9]

In summary or key objectives are:

- **Create an Efficient IP addressing Scheme**
- **Configure Wireless and Wired Connections**
- **Configure Network Security Measures**
- **Design a well Structured LAN Topology**
- **Create ACLs to restrict unwanted access**
- **Provide Documentation of Network Specifices**

b. Scope

The project focuses on simulation of a local area network for the EECMS building (314). The scope encompasses the creation of a network with structure that is secure and provides seamless communication between devices and the internet and devices and each other, these devices include but are not limited to PC’s, Printers, Projectors and servers. [10]

This network must support up to 180 simultaneous users, this includes but is not limited to students, staff, lecturers and technicians spread across 4 departments.

The key components of Project 3 include:

- **An IP addressing scheme**: an implemented private IP addressing schema with valid subnetting with the use of VLSM (Variable Length Subnet Mask)

- **LAN Topology**: A hierarchical network design that allocates users to their respective departments which all have a respective VLAN (eg Teacher VLAN, Student VLAN, Technician VLAN etc.)

- **VLAN Setup**: The creation of VLANSs to separate staff, lecturers, and students along with any additional sub groups within the LAN

- **Router Configuration**: Configuring R1 and R2 with the necessary settings such as IP addresses, Static Routing etc.

- **Simulation Testing**: Running live play tests on Cisco Packet Tracer to simulate how the LAN would operate in real life, this additionally allows us to know if any problems are occurring with connectivity or IP address mismatching

c. Limitations

There will be some key limitations for the LAN network no matter how in depth and comprehensive our network design for EECMS Building 314 is. These limitations relate to the LAN being only a simulated version of Cisco Packet Tracer and not a real world LAN setup with hardware devices and therefore a lack of real world testing and error management. [11]

- **Simulation restrictions**: Cisco Packet Tracer simulations however the most advanced form of real world networking simulations it is still not identical to a hardware implementation of a network, for example hardware failures and environmental interference cannot be accurately represented in a digitally simulated network

- **Lack Of Real World Testing**: Furthering on from the above point, this network being digital and a simulation can and does not have any real world testing which would be essential if this network was going to be designed for building 314 in person

- **Lack of User Management**: Our LAN has not been directed to include but may be necessary in the future or be seen as “missing” when fully implemented these services are Guest Access and the following settings and segregation, Bandwidth Management preventing users from overloading the bandwidth or leading to other users experiencing slower speeds.

d. Assumptions

Our design of the LAN for the EECMS Building 314 will be based off some key assumptions:

- **User Count**: the network according to the guideline specification is currently set up to support a maximum of 180 simultaneous users which is built up of various numbers of Staff, Students and Technicians, If this 180 maximum is however not an accurate representation of the user amount in the real world scenario at building 314 the LAN will struggle to perform as intended.

- **User Types**: Our LAN currently intends to have 4 main user groups set up, being Students, Staff, Lecturers and Technicians. If the real world building 314 has additional user groups not accounted for in the previous 4 the network will not operate properly for those additional user groups.

- **IP addressing:** We assume the users in the LAN will be only using IPv4 addressing and not IPv6, along with all hosts assumed to be DHCP clients unless the brief states otherwise.

4. Network Devices 3 - Device Summary & Justification by Troyee

		Model	Role	Function	Justification
	Router	Cisco 2911	Inter-Vlan Router	Traffic is routed via subinterfaces between VLANs 20, 30, 40, and 50.	chosen because of its advanced routing capabilities for scalability and 802.1Q trunking.
	Switch	Cisco Catalyst 3650-24PS	Distribution switch	router-access switch trunk aggregation.	Perfect as a distribution layer switch in hierarchical design, it supports native VLAN setup, VLAN trunking, and high-speed switching.
		Cisco Catalyst 2960-24TT	Access Switch (4 pcs)	Set up VLAN segmentation and Layer 2 connectivity for every department.	Static VLAN assignments and trunk transmits to the distribution switch are supported by these trustworthy, low-cost switches.
End Device	**Generic PC** (PC-IT, PC-Support, PC-student, PC-Teacher)	PC-PT	User Workstation	Test IP connectivity, routing, and services by simulating users.	Verify service access from user endpoints, DHCP/static addressing, and VLAN segmentation.
	Web server	Server-PT	Web Host Server	HTTP content is hosted for cross-VLAN access testing purposes.	It simulates an internal web app that all departments share.
	Email Server	Server-PT	Mail Server	Inter-VLAN SMTP/POP3 email service is provided.	for testing protocol reachability and application-layer communication.
	FTP server	Server-PT	File Transfer Server	Provides access to a file repository using the FTP protocol (port 21) for document and resource upload/download.	In the IT VLAN, the FTP server was set up to act as a central location for departmental document exchange, logs, and internal software. It enables safe access to shared files for authorized users from other VLANs. This reflects real-world enterprise use, where IT handles controlled internal file transmission systems.

	Printer	Printer-PT	Departmental Printer	VLAN-based shared network printing	shows service accessibility and device segregation at the department level.

5. Network Design (Packet Tracer) - Aadhar

InterVlan Routing Network Design

The network design is tailored to a multi-department environment with four VLANs, Business(VLAN 20), IT (VLAN 30), Support (VLAN 40), and Student (VLAN 50). The technical requirements have been met by using Cisco's established best practices from

Cisco and guidance from Cybersecurity and Infrastructure Security Agency(CISA). Citations are provided where applicable.

Overview of the Network Design: The proposed network design follows Cisco's three-tier hierarchical model, incorporating Core, distribution, and access layers. The structure supports security, efficient traffic management, and scalability. Cisco 2911 router, Cisco 3650 switch, and multiple Cisco 2960 switches work together to facilitate communication between the departments while keeping the VLANs secure.

Design Details:

Core Layer: Routing Hub

The Cisco 2911 router serves as the backbone for inter-VLAN routing, utilizing a Router-on-a-stick configuration. Its physical interface (Gig0/0) connects to the network via a trunk link and has subinterfaces defined for each VLAN:

- VLAN 20 (Business Staffs): **IP 192.168.20.1**
- VLAN 30 (IT/Technician): **IP: 192.168.30.1**
- VLAN 40(Support Staff): **IP 192.168.40.1**
- VLAN 50 (Student/Teacher): **IP 192.168.50.1**

Each subinterfaces uses 802.1Q encapsulations to tag the traffic appropriately/ The setup centralised routing, supports future expansion, simplifies security enforcement by allowing new subinterfaces as needed (Cisco,2013,p.12).

Distribution Layer: Traffic Aggregation

A Cisco 3650 switch operates at the Distribution layer. It bridges the core and Access layers and it connects to the router and access switches by configured trunk ports.

- Gig1/0/1:Links to the router (allowing VLANs 10, 20, 30, 40, 50)
- Gig1/0/2: Links to the business switch, VLAN 20 only
- Gig1/0/3: Links to the IT switch, VLAN 30 only
- Gig1/0/4: Links to the Support switch, VLAN 40 only
- Gig1/0/5: Links to the Student/Teacher switch, VLAN 50 only

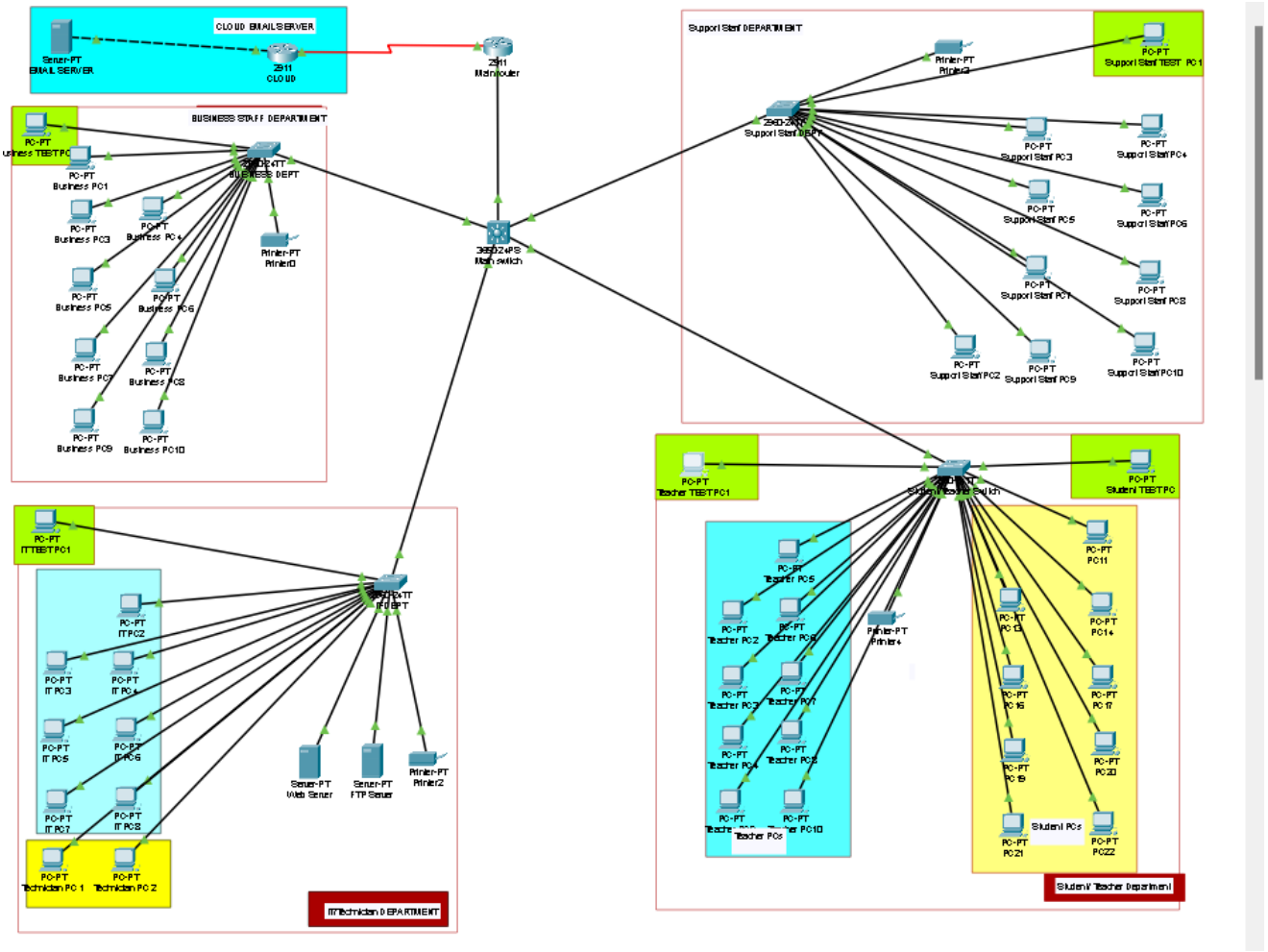
The native VLAN is set to an unused VLAN 999 for added security recommended by CISA(CISA,2024). This configuration aggregates traffic efficiently and also prepares the network for potential growth.

Access Layer: Department Connectivity

Cisco 2960-24TT Switches at the Access Layer connects to the end devices with access ports that is assigned to:

- Business Switch: VLAN 20
- IT/ Technician Switch: VLAN 30
- Support Switch: VLAN 40
- Student Switch: VLAN 50

  The Trunk ports to the Cisco 3650 carries only the respective VLAN to enhance the security and to reduce network congestion.



6. IP Addressing - Aadhar

Proposed IP Addressing Plan
VLAN Subnets and Gateways

Each VLAN is assigned a unique /24 subnet from the 192.168.0.0/16 private IP range, with the gateway set to the first usable IP address in each subnet

VLAN	Subnet	Gateway	Purpose
VLAN 20	192.168.20.10/24	192.168.20.1	Business Dept.
VLAN 30	192.168.30.10/24	192.168.30.1	IT/Technician Dept.
VLAN 40	192.168.40.10/24	192.168.40.1	Support Staff
VLAN 50	192.168.50.10/24 192.168.50.15/24	192.168.50.1	Students/Teachers

Router Configuration (Cisco 2911)

The Cisco 2911 router is configured for inter-VLAN routing using a Router-on-a-stick approach.

- **Physical Interface:** No ip address is assigned as it functions as a trunk port only.
- **SubInterfaces**
    - **Gig0/0.20: 192.168.20.1/24 (VLAN 20)**
    - **Gig0/0.30: 192.168.30.1/24 (VLAN 30)**
    - **Gig0/0.40: 192.168.40.1/24 (VLAN 40)**
    - **Gig0/0.50: 192.168.50.1/24 (VLAN 50)**

- **Encapsulations:** 802.1Q VLAN tagging is applied to each subinterfaces to segregate traffic.

Core Switch (Cisco 3650-24PS)

The core switch manages trunk lines to the router and access switches:

- **Gig1/0/1:** Trunk port allowing VLANs 20, 30, 40, and 50 and connects to the Router.
- **Gig1/0/2-5:**
    - Gig1/0/2: VLAN 20 (Business)
    - Gig1/0/3: VLAN 30 (IT)
    - Gig1/0/4: VLAN 40 (Support)
    - Gig1/0/5: VLAN 50 (Student)

Access Switches (Cisco 2960)

The access switches used operates at Layer 2:

- Access ports: Assigns end devices to their respective VLAN
- IP configuration: No IP addresses are assigned to switch interfaces, as they function only in Layer 2 devices.

End Devices (PCS)

- **Business PC: 192.168.20.10/24, Gateway 192.168.20.1**
- **IT PC: 192.168.30.10/24, Gateway 192.168.30.1**
- **Support PC: 192.168.40.10/24, Gateway 192.168.40.1**
- **Student PC: 192.168.50.10/24, Gateway 192.168.50.1**

- **Teacher PC:192.168.50.15/24, Gateway 192.168.50.1**

Justification and Evidences for the IP Addressing Plan

Uses Private IP Address: The proposed plan uses the 192.168.0.0/16 private IP range. It enhances the security as private IPs are not routable on the public internet, hence isolating internal traffic and reducing exposure to external threats. They conserve public IP address space, making them ideal for internal networks without direct internet access requirements.

Subnet size (/24): Each VLAN uses a /24 subnet, providing 254 usable IP addresses (192.168.20.1 - 192.168.20.254). SInce it supports up to 254 devices per VLAN it is sufficient for typical department needs. It can also be scaled for additional subnets and larger masks if needed.

Gateway Address Convention: Gateways are assigned as the first usable IP in each subnet. It adheres to the common practice of using the lowest IP for the gateway to enhance predictability. It also simplifies configuration and reduces the need for additional reference materials during setup or maintenance.

Router SubInterface Configuration: The CISCO 2911 uses subinterfaces for inter-VLAN routing. A single physical interface (Gig0/0) with subinterfaces handles all the VLAN traffic, streamlining routing management. It also meets the IEEE standards, as 802.1Q encapsulation is used for proper VLAN tagging (CISCO,2013). It also supports easy addition of new VLANs by configuring additional subinterfaces.

Trunk link Optimization: Restricting VLANs on trunks (e.g., Gig1/0/2 allows only VLAN 20) follows the principle of least privilege, reducing unauthorised access risks(CISA,2024). It also limits broadcast traffic optimizing the network efficiency. Cisco advises pruning unnecessary VLANS from trunks(Cisco,2013, p. 12)

Static Ip Assignment:: The end device uses the static IPs with DHCP as a future option. Static assignment ensures predictable addressing in a small, managed network. DHCP can be added per VLAN for dynamic allocation if the network scales.

Evidences of PC communication between different departments:

1. **PC of Business Staff Department:**

- **Active Connection between PCs of other Departments:**

```
C:\>ipconfig /all

FastEthernet0 Connection:(default port)

   Connection-specific DNS Suffix..:
   Physical Address.................: 00D0.FFB4.78B2
   Link-local IPv6 Address.........: FE80::2D0:FFFF:FEB4:78B2
   IPv6 Address....................: ::
   IPv4 Address....................: 192.168.20.10
   Subnet Mask.....................: 255.255.255.0
   Default Gateway.................: ::
                                     192.168.20.1
   DHCP Servers....................: 0.0.0.0
   DHCPv6 IAID.....................:
   DHCPv6 Client DUID..............: 00-01-00-01-1A-4C-59-0C-00-D0-FF-B4-78-B2
   DNS Servers.....................: ::
                                     0.0.0.0

Bluetooth Connection:

   Connection-specific DNS Suffix..:
   Physical Address.................: 00E0.F902.96C5
   Link-local IPv6 Address.........: ::
   IPv6 Address....................: ::
   IPv4 Address....................: 0.0.0.0
   Subnet Mask.....................: 0.0.0.0
   Default Gateway.................: ::
                                     0.0.0.0
   DHCP Servers....................: 0.0.0.0
   DHCPv6 IAID.....................:
   DHCPv6 Client DUID..............: 00-01-00-01-1A-4C-59-0C-00-D0-FF-B4-78-B2
   DNS Servers.....................: ::
                                     0.0.0.0
```

```
C:\>ping 192.168.30.10

Pinging 192.168.30.10 with 32 bytes of data:

Reply from 192.168.30.10: bytes=32 time<1ms TTL=127
Reply from 192.168.30.10: bytes=32 time<1ms TTL=127
Reply from 192.168.30.10: bytes=32 time<1ms TTL=127
Reply from 192.168.30.10: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.30.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

```
C:\>ping 192.168.40.10

Pinging 192.168.40.10 with 32 bytes of data:

Reply from 192.168.40.10: bytes=32 time=11ms TTL=127
Reply from 192.168.40.10: bytes=32 time<1ms TTL=127
Reply from 192.168.40.10: bytes=32 time<1ms TTL=127
Reply from 192.168.40.10: bytes=32 time=13ms TTL=127

Ping statistics for 192.168.40.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 13ms, Average = 6ms
```

```
Pinging 192.168.50.10 with 32 bytes of data:

Reply from 192.168.50.10: bytes=32 time=1ms TTL=127
Reply from 192.168.50.10: bytes=32 time<1ms TTL=127
Reply from 192.168.50.10: bytes=32 time<1ms TTL=127
Reply from 192.168.50.10: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.50.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms
```

2. PC of IT/ Technical Department:

```
C:\>ipconfig /all

FastEthernet0 Connection:(default port)

   Connection-specific DNS Suffix..:
   Physical Address................: 00E0.8F9E.62A3
   Link-local IPv6 Address.........: FE80::2E0:8FFF:FE9E:62A3
   IPv6 Address....................: ::
   IPv4 Address....................: 192.168.30.10
   Subnet Mask.....................: 255.255.255.0
   Default Gateway.................: ::
                                     192.168.30.1
   DHCP Servers....................: 0.0.0.0
   DHCPv6 IAID.....................:
   DHCPv6 Client DUID..............: 00-01-00-01-1A-4C-59-0C-00-E0-8F-9E-62-A3
   DNS Servers.....................: ::
                                     8.8.8.8

Bluetooth Connection:

   Connection-specific DNS Suffix..:
   Physical Address................: 0010.1155.D06A
   Link-local IPv6 Address.........: ::
   IPv6 Address....................: ::
   IPv4 Address....................: 0.0.0.0
   Subnet Mask.....................: 0.0.0.0
   Default Gateway.................: ::
                                     0.0.0.0
   DHCP Servers....................: 0.0.0.0
   DHCPv6 IAID.....................:
   DHCPv6 Client DUID..............: 00-01-00-01-1A-4C-59-0C-00-E0-8F-9E-62-A3
   DNS Servers.....................: ::
                                     8.8.8.8
```

- **Active Connection between PCs of other departments**

```
C:\>ping 192.168.20.10

Pinging 192.168.20.10 with 32 bytes of data:

Reply from 192.168.20.10: bytes=32 time<1ms TTL=127
Reply from 192.168.20.10: bytes=32 time<1ms TTL=127
Reply from 192.168.20.10: bytes=32 time<1ms TTL=127
Reply from 192.168.20.10: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.20.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

```
C:\>ping 192.168.40.10

Pinging 192.168.40.10 with 32 bytes of data:

Reply from 192.168.40.10: bytes=32 time<1ms TTL=127
Reply from 192.168.40.10: bytes=32 time<1ms TTL=127
Reply from 192.168.40.10: bytes=32 time<1ms TTL=127
Reply from 192.168.40.10: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.40.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

```
C:\>ping 192.168.50.10

Pinging 192.168.50.10 with 32 bytes of data:

Reply from 192.168.50.10: bytes=32 time<1ms TTL=127
Reply from 192.168.50.10: bytes=32 time<1ms TTL=127
Reply from 192.168.50.10: bytes=32 time<1ms TTL=127
Reply from 192.168.50.10: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.50.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

3. PC of Support Staff Department

```
C:\>ipconfig /all

FastEthernet0 Connection:(default port)

   Connection-specific DNS Suffix..:
   Physical Address.................: 0030.F2B5.23EE
   Link-local IPv6 Address.........: FE80::230:F2FF:FEB5:23EE
   IPv6 Address....................: ::
   IPv4 Address....................: 192.168.40.10
   Subnet Mask.....................: 255.255.255.0
   Default Gateway.................: ::
                                     192.168.40.1
   DHCP Servers....................: 0.0.0.0
   DHCPv6 IAID.....................:
   DHCPv6 Client DUID..............: 00-01-00-01-1A-4C-59-0C-00-30-F2-B5-23-EE
   DNS Servers.....................: ::
                                     0.0.0.0

Bluetooth Connection:

   Connection-specific DNS Suffix..:
   Physical Address.................: 0002.4A7B.7BC9
   Link-local IPv6 Address.........: ::
   IPv6 Address....................: ::
   IPv4 Address....................: 0.0.0.0
   Subnet Mask.....................: 0.0.0.0
   Default Gateway.................: ::
                                     0.0.0.0
   DHCP Servers....................: 0.0.0.0
   DHCPv6 IAID.....................:
   DHCPv6 Client DUID..............: 00-01-00-01-1A-4C-59-0C-00-30-F2-B5-23-EE
   DNS Servers.....................: ::
                                     0.0.0.0
```

- **Active Connection between PCs of other departments**

```
C:\>ping 192.168.20.10

Pinging 192.168.20.10 with 32 bytes of data:

Reply from 192.168.20.10: bytes=32 time<1ms TTL=127
Reply from 192.168.20.10: bytes=32 time<1ms TTL=127
Reply from 192.168.20.10: bytes=32 time<1ms TTL=127
Reply from 192.168.20.10: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.20.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
```

```
C:\>ping 192.168.30.10

Pinging 192.168.30.10 with 32 bytes of data:

Reply from 192.168.30.10: bytes=32 time<1ms TTL=127
Reply from 192.168.30.10: bytes=32 time<1ms TTL=127
Reply from 192.168.30.10: bytes=32 time<1ms TTL=127
Reply from 192.168.30.10: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.30.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

```
C:\>ping 192.168.50.10

Pinging 192.168.50.10 with 32 bytes of data:

Reply from 192.168.50.10: bytes=32 time<1ms TTL=127
Reply from 192.168.50.10: bytes=32 time<1ms TTL=127
Reply from 192.168.50.10: bytes=32 time<1ms TTL=127
Reply from 192.168.50.10: bytes=32 time=1ms TTL=127

Ping statistics for 192.168.50.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms
```

4. PC of Student / Teacher Department

a. Student PC

```
FastEthernet0 Connection:(default port)

   Connection-specific DNS Suffix..:
   Physical Address.................: 00D0.FF88.2615
   Link-local IPv6 Address.........: FE80::2D0:FFFF:FE88:2615
   IPv6 Address....................: ::
   IPv4 Address....................: 192.168.50.10
   Subnet Mask.....................: 255.255.255.0
   Default Gateway.................: ::
                                     192.168.50.1
   DHCP Servers....................: 0.0.0.0
   DHCPv6 IAID.....................:
   DHCPv6 Client DUID..............: 00-01-00-01-A2-52-9B-47-00-D0-FF-88-26-15
   DNS Servers.....................: ::
                                     0.0.0.0

Bluetooth Connection:

   Connection-specific DNS Suffix..:
   Physical Address.................: 0009.7C9A.2566
   Link-local IPv6 Address.........: ::
   IPv6 Address....................: ::
   IPv4 Address....................: 0.0.0.0
   Subnet Mask.....................: 0.0.0.0
   Default Gateway.................: ::
                                     0.0.0.0
   DHCP Servers....................: 0.0.0.0
   DHCPv6 IAID.....................:
   DHCPv6 Client DUID..............: 00-01-00-01-A2-52-9B-47-00-D0-FF-88-26-15
   DNS Servers.....................: ::
                                     0.0.0.0
```

b. Teacher PC

```
C:\>ipconfig /all

FastEthernet0 Connection:(default port)

   Connection-specific DNS Suffix..:
   Physical Address.................: 00D0.D314.4432
   Link-local IPv6 Address.........: FE80::2D0:D3FF:FE14:4432
   IPv6 Address....................: ::
   IPv4 Address....................: 192.168.50.15
   Subnet Mask.....................: 255.255.255.0
   Default Gateway.................: ::
                                     192.168.50.1
   DHCP Servers....................: 0.0.0.0
   DHCPv6 IAID.....................:
   DHCPv6 Client DUID..............: 00-01-00-01-61-C9-C1-7B-00-D0-D3-14-44-32
   DNS Servers.....................: ::
                                     0.0.0.0

Bluetooth Connection:

   Connection-specific DNS Suffix..:
   Physical Address.................: 0090.0C90.5B5D
   Link-local IPv6 Address.........: ::
   IPv6 Address....................: ::
   IPv4 Address....................: 0.0.0.0
   Subnet Mask.....................: 0.0.0.0
   Default Gateway.................: ::
                                     0.0.0.0
   DHCP Servers....................: 0.0.0.0
   DHCPv6 IAID.....................:
   DHCPv6 Client DUID..............: 00-01-00-01-61-C9-C1-7B-00-D0-D3-14-44-32
   DNS Servers.....................: ::
                                     0.0.0.0
```

- **Active Connection between PC of other Departments (Student PC)**

```
C:\>ping 192.168.20.10

Pinging 192.168.20.10 with 32 bytes of data:

Reply from 192.168.20.10: bytes=32 time<1ms TTL=127
Reply from 192.168.20.10: bytes=32 time<1ms TTL=127
Reply from 192.168.20.10: bytes=32 time<1ms TTL=127
Reply from 192.168.20.10: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.20.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

```
C:\>ping 192.168.30.10

Pinging 192.168.30.10 with 32 bytes of data:

Reply from 192.168.30.10: bytes=32 time<1ms TTL=127
Reply from 192.168.30.10: bytes=32 time=12ms TTL=127
Reply from 192.168.30.10: bytes=32 time<1ms TTL=127
Reply from 192.168.30.10: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.30.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 12ms, Average = 3ms
```

```
C:\>ping 192.168.40.10

Pinging 192.168.40.10 with 32 bytes of data:

Reply from 192.168.40.10: bytes=32 time<1ms TTL=127
Reply from 192.168.40.10: bytes=32 time<1ms TTL=127
Reply from 192.168.40.10: bytes=32 time<1ms TTL=127
Reply from 192.168.40.10: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.40.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ping 192.168.50.15

Pinging 192.168.50.15 with 32 bytes of data:

Reply from 192.168.50.15: bytes=32 time<1ms TTL=128
Reply from 192.168.50.15: bytes=32 time<1ms TTL=128
Reply from 192.168.50.15: bytes=32 time<1ms TTL=128
Reply from 192.168.50.15: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.50.15:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

- **Active Connection between PC of other Departments (Teacher PC)**

```
C:\>ping 192.168.20.10

Pinging 192.168.20.10 with 32 bytes of data:

Reply from 192.168.20.10: bytes=32 time<1ms TTL=127
Reply from 192.168.20.10: bytes=32 time<1ms TTL=127
Reply from 192.168.20.10: bytes=32 time<1ms TTL=127
Reply from 192.168.20.10: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.20.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

```
C:\>ping 192.168.30.10

Pinging 192.168.30.10 with 32 bytes of data:

Reply from 192.168.30.10: bytes=32 time=12ms TTL=127
Reply from 192.168.30.10: bytes=32 time<1ms TTL=127
Reply from 192.168.30.10: bytes=32 time<1ms TTL=127
Reply from 192.168.30.10: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.30.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 12ms, Average = 3ms
```

```
C:\>ping 192.168.40.10

Pinging 192.168.40.10 with 32 bytes of data:

Reply from 192.168.40.10: bytes=32 time=13ms TTL=127
Reply from 192.168.40.10: bytes=32 time<1ms TTL=127
Reply from 192.168.40.10: bytes=32 time<1ms TTL=127
Reply from 192.168.40.10: bytes=32 time=9ms TTL=127

Ping statistics for 192.168.40.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 13ms, Average = 5ms
```

```
C:\>ping 192.168.50.10

Pinging 192.168.50.10 with 32 bytes of data:

Reply from 192.168.50.10: bytes=32 time<1ms TTL=128
Reply from 192.168.50.10: bytes=32 time<1ms TTL=128
Reply from 192.168.50.10: bytes=32 time<1ms TTL=128
Reply from 192.168.50.10: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.50.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

7. Project 3 Reflection - Sabtain

In this project, we designed and deployed a hierarchical LAN for the EECMS Building (314), serving four departments (Business, Finance, IT, Student/Lab) with up to 180 concurrent users. The topology features:

- A central Core Switch linking all departmental switches and the Internet edge router
- Four 2960-24 access switches, one per department, each supporting PCs, printers, and servers
- An edge router providing Internet/cloud and email-server access

Challenges Faced

1. VLAN & IP Address Assignment

Having established a dependable and repeatable pattern for creating VLANs and assigning IPs to switches and PCs, we attempted the same on these client installations. We created the VLANs on all the access switches (vlan 10, vlan 20, etc.) and then used the interface-range command to specify the correct switch ports. On the PCs, static IP, subnet mask, and gateway were entered matching the VLAN's network. Verification for intra-VLAN connectivity came instantly; hosts within the very same VLAN pinged each other without trouble.

2. Inter-VLAN Routing

Allowing communication between VLANs involved configuring a device to route multiple networks. First, subinterfaces were defined on the router (e.g. interface Gig0/0.10, encapsulation dot1Q 10) and assigned each an IP address. Inter-VLAN pings were not being successful in the beginning due to incorrect mapping of the subinterfaces on the router to the VLAN IDs. Once the subinterfaces mapped to the switch SVIs and were verified that ip routing was enabled, inter-VLAN pings became successful.

3. Encapsulation & Trunking Setup

Carrying multiple VLANs over a single link meant conversion of an Ethernet port on the router and the main (distribution) switch to a trunk. The switch was configured with switchport mode trunk and switchport trunk allowed vlan 10,20,30,40 while on the router subinterfaces were configured with encapsulation dot1Q <VLAN_ID>. An incorrect VLAN tag or missing "allowed VLAN" clause made entire VLANs drop. Aligning the native VLAN settings and explicitly permitting

Through first lessons learned with VLAN creation, inter-VLAN routing, and trunk encapsulation, we gained a deeper view of router-on-a-stick architectures and trunk negotiation by working through the configuration steps. With planned checks of VLAN mappings and trunk settings, we managed to secure the full end-to-end connectivity for all departments—an impact that has set a potential basis for scalable segmented LAN deployments.

8. References

[1] Cisco Systems, Inc., "Cisco Best Practices," Cisco Systems, Inc., San Jose, CA, USA. https://www.cisco.com/c/dam/global/it_it/solutions/pdf/ipcom/cisco_best_practices.pdf

[2] Cybersecurity and Infrastructure Security Agency (CISA), "Best Practices for Cisco Device Configuration," CISA, Washington, DC, USA, Aug. 2024. https://www.cisa.gov/news-events/alerts/2024/08/08/best-practices-cisco-device-configuration

[3] GeeksforGeeks, “What is POP3 (Post Office Protocol Version 3)?,” *GeeksforGeeks*, Aug. 19, 2023. https://www.geeksforgeeks.org/what-is-pop3-post-office-protocol-version-3/

[4] gokhankosem, “FTP Ports | What is FTP? | FTP Modes | FTP Commands ⋆ IpCisco,” *IPCisco*, Jan. 10, 2021. https://ipcisco.com/ftp-and-ftp-ports/ (accessed May 09, 2025).

[5] “FTP Server Working and its Benefits,” *GeeksforGeeks*, Nov. 22, 2021. https://www.geeksforgeeks.org/ftp-server-working-and-its-benefits/

[6]Cisco Press, “Hierarchical Network Design Overview (1.1) > Cisco Networking Academy Connecting Networks Companion Guide: Hierarchical Network Design,” *www.ciscopress.com*, May 09, 2014. https://www.ciscopress.com/articles/article.asp?p=2202410&seqNum=4

[7]“Access, Distribution, and Core Layers Explained,” *ComputerNetworkingNotes*, May 04, 2021. https://www.computernetworkingnotes.com/ccna-study-guide/access-distribution-and-core-layers-explained.html

[8] E. R. S. Banger, “What is Router? Functions, Uses | Types of Routers with Examples,” *Computertechinfo.com*, Nov. 08, 2024. https://computertechinfo.com/what-is-router-definition-functions-uses-types-examples/

[9] https://www.facebook.com/legarski, “Cisco Routers: Overview and Key Features - SolveForce Communications,” *SolveForce*, Sep. 20, 2024. https://solveforce.com/cisco-routers-overview-and-key-features/ (accessed May 09, 2025).

[10] S. Liu, “What Is Distribution Switch and Why Do We Need It?,” *Medium*, Jul. 23, 2018. https://medium.com/@sylvieliu66/what-is-distribution-switch-and-why-do-we-need-it-c6978a8826b9

[11] Cloudfare, “What is a LAN (local area network)?”, 2025, https://www.cloudflare.com/learning/network-layer/what-is-a-lan/

[12] I. Yau, “Network Scope”, https://ireneyau.tripod.com/scope.htm

[13] D. Gallaghar, “Week 5 — Disadvantages of Packet Tracer”, Nov 27, 2018. https://medium.com/@danielgallagher707/week-5-disadvantages-of-packet-tracer-315eea8e6198

Peer Evaluation Form for Group Work:

Your name: Sabtain Afzal

Student ID: 232 69127

Write the name of each of your group members in a separate column. For each person, indicate the extent to which you agree with the statement on the left, using a scale of 1-4 (1=strongly disagree; 2=disagree; 3=agree; 4=strongly agree). Total the numbers in each column.

Evaluation Criteria	Student Name: Aadhar Karki	Student Name: Shae Sollivan	Student Name: ~~Tor~~ Troyee Troyee
Attends group meetings regularly on time.	4	~~4~~ 3	4
Contributes meaningful to the group discussions.	4	4	4
Prepares a quality of work and completes on time.	4	4	4
Demonstrates a cooperative and supportive attitude.	4	4	4
Contributes significantly to the success of the project.	4	4	4
TOTALS	20	~~20~~ 19	20

Peer Evaluation Form for Group Work:

Your name: Dhrubo Jouti Das Troyee

Student ID: 22663281

Write the name of each of your group members in a separate column. For each person, indicate the extent to which you agree with the statement on the left, using a scale of 1-4 (1=strongly disagree; 2=disagree; 3=agree; 4=strongly agree). Total the numbers in each column.

Evaluation Criteria	Student Name: Aadhar Karki	Student Name: Sabtain Afzal	Student Name: Shae Sullivan
Attends group meetings regularly on time.	**4**	**4**	3
Contributes meaningful to the group discussions.	**4**	**4**	**4**
Prepares a quality of work and completes on time.	**4**	**4**	**4**
Demonstrates a cooperative and supportive attitude.	**4**	**4**	**4**
Contributes significantly to the success of the project.	**4**	**4**	**4**
TOTALS	**20**	**20**	19

Peer Evaluation Form for Group Work:

Your name: **Aadhar Karki**

Student ID: **21519202**

Write the name of each of your group members in a separate column. For each person, indicate the extent to which you agree with the statement on the left, using a scale of 1-4 (1=strongly disagree; 2=disagree; 3=agree; 4=strongly agree). Total the numbers in each column.

Evaluation Criteria	Student Name: **Dhrubo Troyee**	Student Name: **Sabtain Afzal**	Student Name: **Shae Sullivan**
Attends group meetings regularly on time.	**4**	**4**	3
Contributes meaningful to the group discussions.	**4**	**4**	**4**
Prepares a quality of work and completes on time.	**4**	**4**	**4**
Demonstrates a cooperative and supportive attitude.	**4**	**4**	**4**
Contributes significantly to the success of the project.	**4**	**4**	**4**
TOTALS	**20**	**20**	19

Peer Evaluation Form for Group Work:

Your name: Shae Sullivan

Student ID: 20643731

Write the name of each of your group members in a separate column. For each person, indicate the extent to which you agree with the statement on the left, using a scale of 1-4 (1=strongly disagree; 2=disagree; 3=agree; 4=strongly agree). Total the numbers in each column.

Evaluation Criteria	Student Name: Aadhar Karki	Student Name: Sabtain Afzal	Student Name: Troyee Troyee
Attends group meetings regularly on time.	**4**	**4**	**4**
Contributes meaningful to the group discussions.	**4**	**4**	**4**
Prepares a quality of work and completes on time.	**4**	**4**	**4**
Demonstrates a cooperative and supportive attitude.	**4**	**4**	**4**
Contributes significantly to the success of the project.	**4**	**4**	**4**
TOTALS	**20**	**20**	**20**

9. Appendices