COMPUTER AND DATA NETWORK

EC4060

NETWORK INFRASTRUCTURE DESIGN

FACULTY OF ENGINEERING NETWORK SYSTEM

(INDEPENDENT LEARNING AND IMPLEMENTATION ASSIGNMENT)

BY

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(2022/E/083)

FACULTY OF ENGINEERING

UNIVERSITY OF JAFFNA

Network Infrastructure Report Faculty of Engineering Network System

Project Description

The Faculty of Engineering requires a robust, scalable, and secure network infrastructure to support its five academic departments—Computer Engineering, Electrical & Electronic Engineering, Civil Engineering, Mechanical Engineering, and Interdisciplinary Studies (IDS)—along with the Administration section. The goal of this project is to design and implement a structured network system that ensures efficient communication, optimized traffic management, and high security while allowing future scalability.

The network is structured using Virtual Local Area Networks (VLANs) to segment traffic and ensure logical separation among different departments and device types. A Layer 3 core switch interconnects the departmental Layer 3 switches, providing inter-VLAN routing, while Layer 2 switches manage local connections within each department. Unique subnets are assigned to each section, considering a 30% expansion for future growth.

Critical devices such as computers, printers, and engineering-related equipment are connected within their respective VLANs, while a centralized CCTV subnet (VLAN 180) under the Administration switch enhances security monitoring across the campus. IP addressing is managed using a combination of static allocations and DHCP to ensure optimal utilization.

This project also includes a detailed simulation of the network using Cisco Packet Tracer, along with rigorous testing and validation procedures to ensure seamless connectivity, security, and scalability.

Design Task

The network design task involves the following key steps:

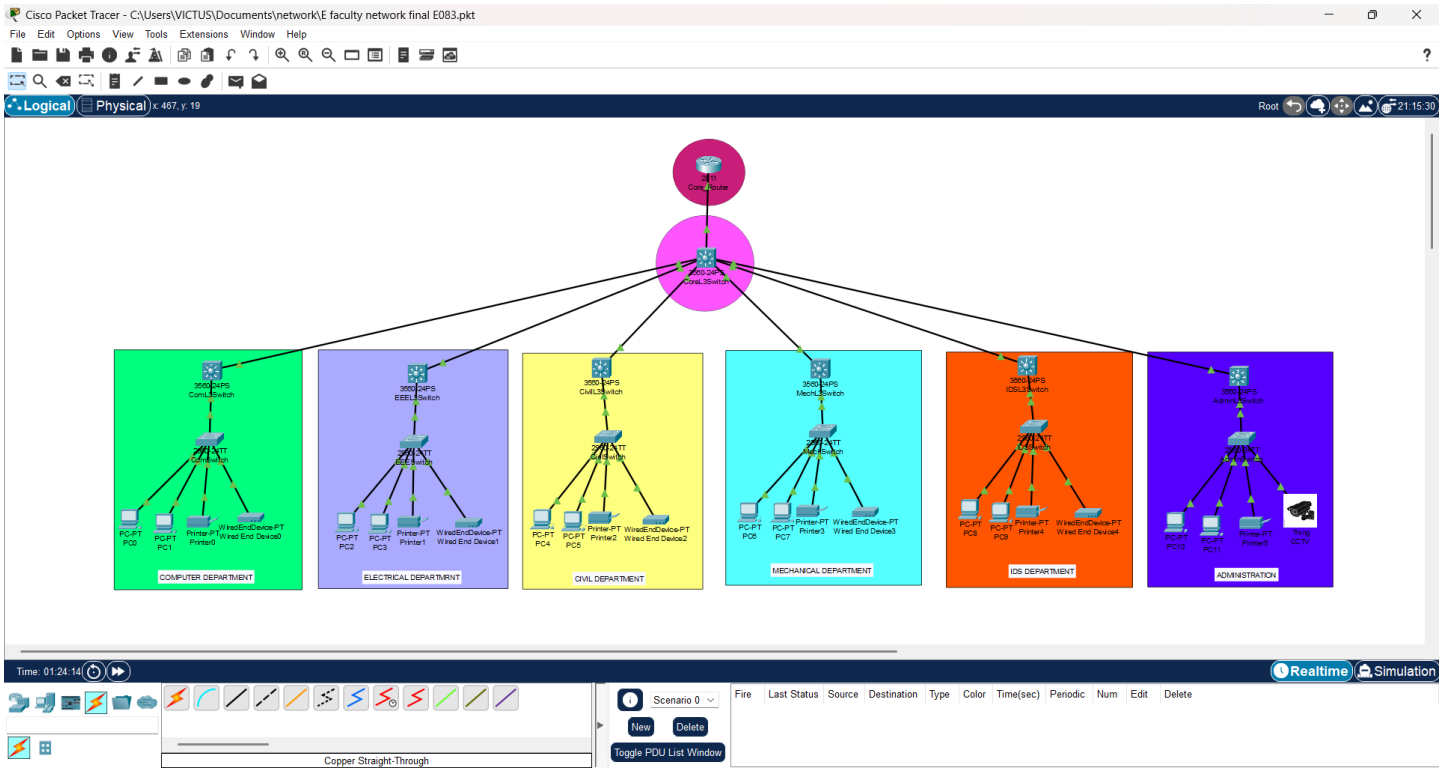
1. **Categorization of Subnets:**
    - Allocate unique subnets for each department and section.
    - Justify the need for each subnet.
2. **Virtual LAN (VLAN) Planning:**
    - Identify and categorize VLANs based on departments and device types.
    - Align VLAN assignments with subnets for logical separation and optimized routing.
3. **Subnet Calculation Table:**
    - Calculate subnet masks, network addresses, usable IP range, and broadcast addresses for each subnet.
4. **Topology Design:**
    - Define the network topology with routers and switches.
    - Assign IP addresses to virtual networks and physical devices.
5. **Simulation and Configuration:**
    - Build the network using Cisco Packet Tracer or GNS3.
    - Configure subnets, VLANs, and inter-VLAN routing on network devices.
    - Implement security policies such as ACLs.
6. **Testing and Validation:**
    - Perform connectivity tests (ping and traceroute) to verify:
        - Communication between staff devices and printers.
        - Communication between student devices within the same subnet.
        - Connectivity of CCTV cameras with administrative computers.

7. **Scalability Consideration:**
    - Add additional devices to validate network expansion capabilities.
8. **Final Report Preparation:**
    - Include subnet calculations, VLAN mapping, topology diagram, simulation results, and scalability assessment.

VLAN IP Allocation Table

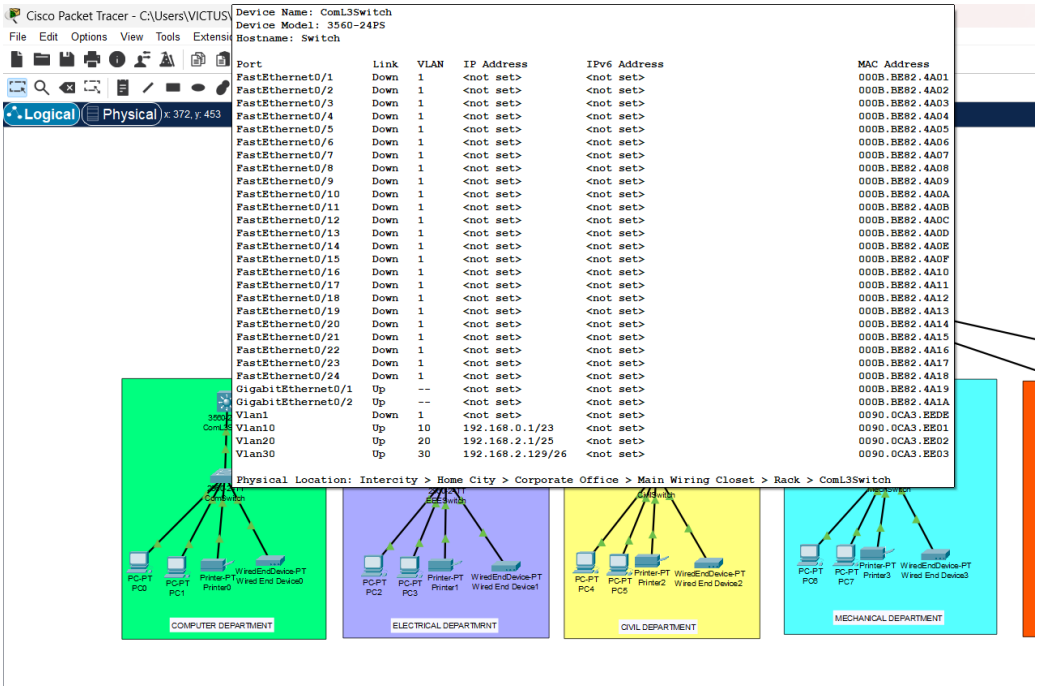
Department	VLAN ID	Device Type	Total Devices	Future Growth (30%)	Subnet Mask	Network Address	Usable IP Range
Computer Eng	10	Students	250	325	255.255.254.0 (/23)	192.168.0.0	192.168.0.1 - 192.168.1.254
Computer Eng	20	Staff	50	65	255.255.255.128 (/25)	192.168.2.0	192.168.2.1 - 192.168.2.126
EE Eng	40	Students	150	195	255.255.255.0 (/24)	192.168.3.0	192.168.3.1 - 192.168.3.254
EE Eng	50	Staff	50	65	255.255.255.128 (/25)	192.168.4.0	192.168.4.1 - 192.168.4.126
Civil Eng	70	Students	75	98	255.255.255.128 (/25)	192.168.5.0	192.168.5.1 - 192.168.5.126
Civil Eng	80	Staff	25	33	255.255.255.192 (/26)	192.168.5.128	192.168.5.129 - 192.168.5.190
Mech Eng	100	Students	75	98	255.255.255.128 (/25)	192.168.6.0	192.168.6.1 - 192.168.6.126
Mech Eng	110	Staff	25	33	255.255.255.192 (/26)	192.168.6.128	192.168.6.129 - 192.168.6.190
IDS	130	Students	15	20	255.255.255.224 (/27)	192.168.7.0	192.168.7.1 - 192.168.7.30
IDS	140	Staff	25	33	255.255.255.192 (/26)	192.168.7.32	192.168.7.33 - 192.168.7.94
Admin	160	Staff	25	33	255.255.255.192 (/26)	192.168.8.0	192.168.8.1 - 192.168.8.62
CCTV	180	Cameras	50	65	255.255.255.128 (/25)	192.168.9.0	192.168.9.1 - 192.168.9.126

Topology Diagram

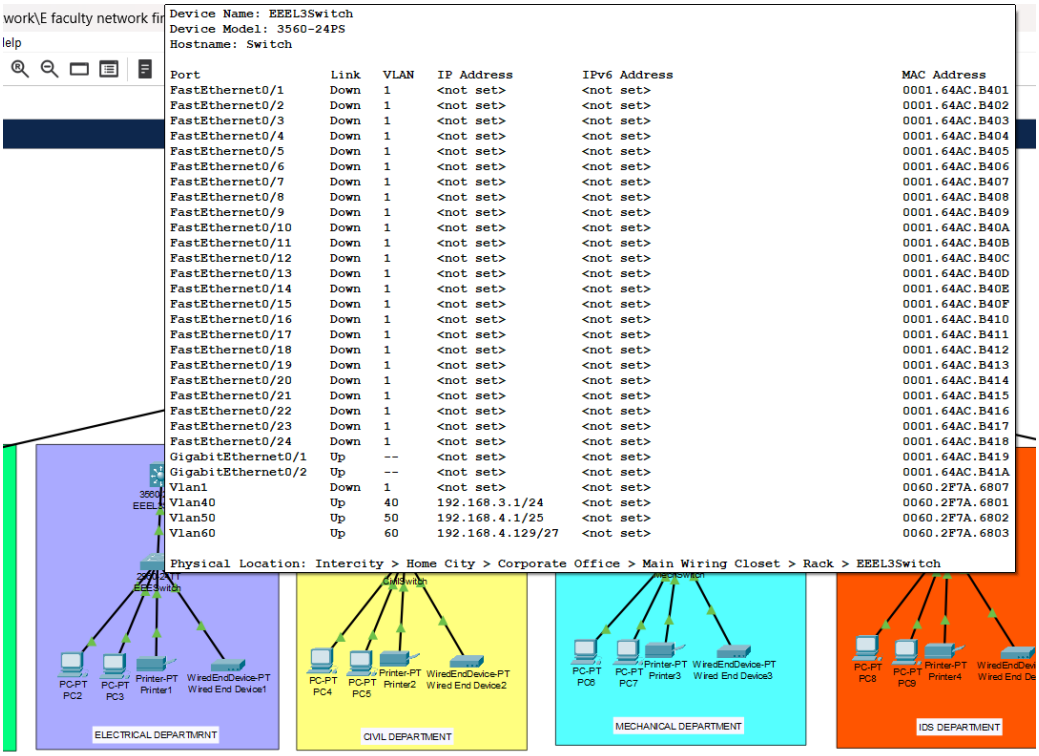


Simulation Results

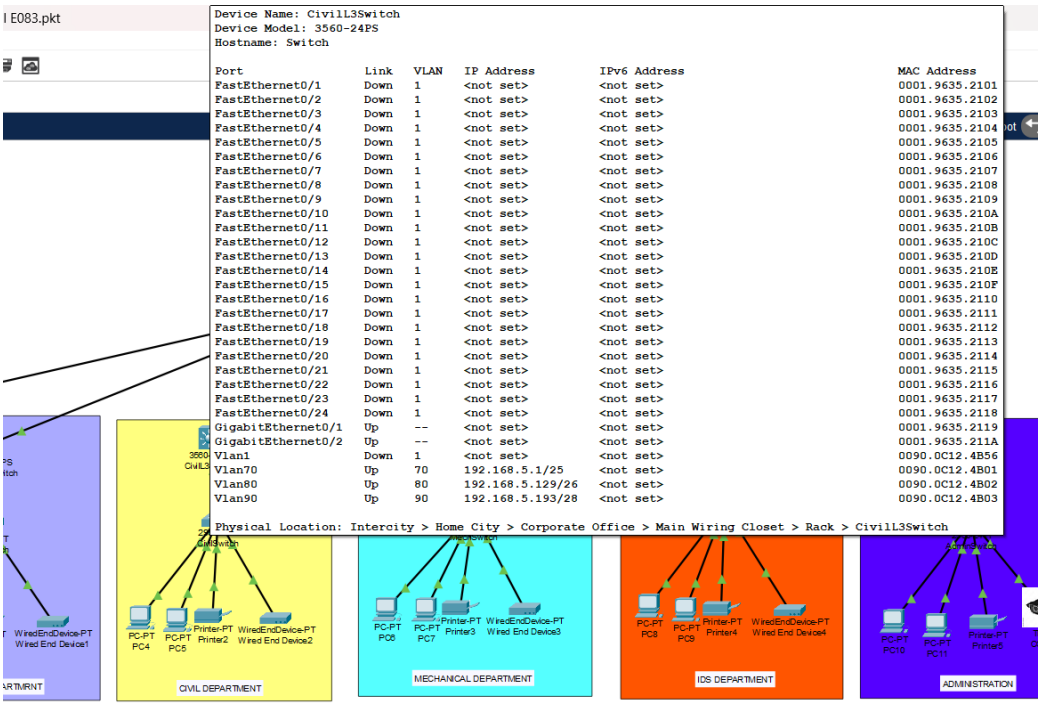
1. Computer Department



2. Electrical Department



3. Civil Department



```
Device Name: CivilL3Switch
Device Model: 3560-24PS
Hostname: Switch

Port              Link  VLAN  IP Address        IPv6 Address                MAC Address
FastEthernet0/1   Down  1     <not set>         <not set>                   0001.9635.2101
FastEthernet0/2   Down  1     <not set>         <not set>                   0001.9635.2102
FastEthernet0/3   Down  1     <not set>         <not set>                   0001.9635.2103
FastEthernet0/4   Down  1     <not set>         <not set>                   0001.9635.2104
FastEthernet0/5   Down  1     <not set>         <not set>                   0001.9635.2105
FastEthernet0/6   Down  1     <not set>         <not set>                   0001.9635.2106
FastEthernet0/7   Down  1     <not set>         <not set>                   0001.9635.2107
FastEthernet0/8   Down  1     <not set>         <not set>                   0001.9635.2108
FastEthernet0/9   Down  1     <not set>         <not set>                   0001.9635.2109
FastEthernet0/10  Down  1     <not set>         <not set>                   0001.9635.210A
FastEthernet0/11  Down  1     <not set>         <not set>                   0001.9635.210B
FastEthernet0/12  Down  1     <not set>         <not set>                   0001.9635.210C
FastEthernet0/13  Down  1     <not set>         <not set>                   0001.9635.210D
FastEthernet0/14  Down  1     <not set>         <not set>                   0001.9635.210E
FastEthernet0/15  Down  1     <not set>         <not set>                   0001.9635.210F
FastEthernet0/16  Down  1     <not set>         <not set>                   0001.9635.2110
FastEthernet0/17  Down  1     <not set>         <not set>                   0001.9635.2111
FastEthernet0/18  Down  1     <not set>         <not set>                   0001.9635.2112
FastEthernet0/19  Down  1     <not set>         <not set>                   0001.9635.2113
FastEthernet0/20  Down  1     <not set>         <not set>                   0001.9635.2114
FastEthernet0/21  Down  1     <not set>         <not set>                   0001.9635.2115
FastEthernet0/22  Down  1     <not set>         <not set>                   0001.9635.2116
FastEthernet0/23  Down  1     <not set>         <not set>                   0001.9635.2117
FastEthernet0/24  Down  1     <not set>         <not set>                   0001.9635.2118
GigabitEthernet0/1 Up   --    <not set>         <not set>                   0001.9635.2119
GigabitEthernet0/2 Up   --    <not set>         <not set>                   0001.9635.211A
Vlan1             Down  1     <not set>         <not set>                   0090.0C12.4B56
Vlan70            Up    70    192.168.5.1/25    <not set>                   0090.0C12.4B01
Vlan80            Up    80    192.168.5.129/26  <not set>                   0090.0C12.4B02
Vlan90            Up    90    192.168.5.193/28  <not set>                   0090.0C12.4B03

Physical Location: Intercity > Home City > Corporate Office > Main Wiring Closet > Rack > CivilL3Switch
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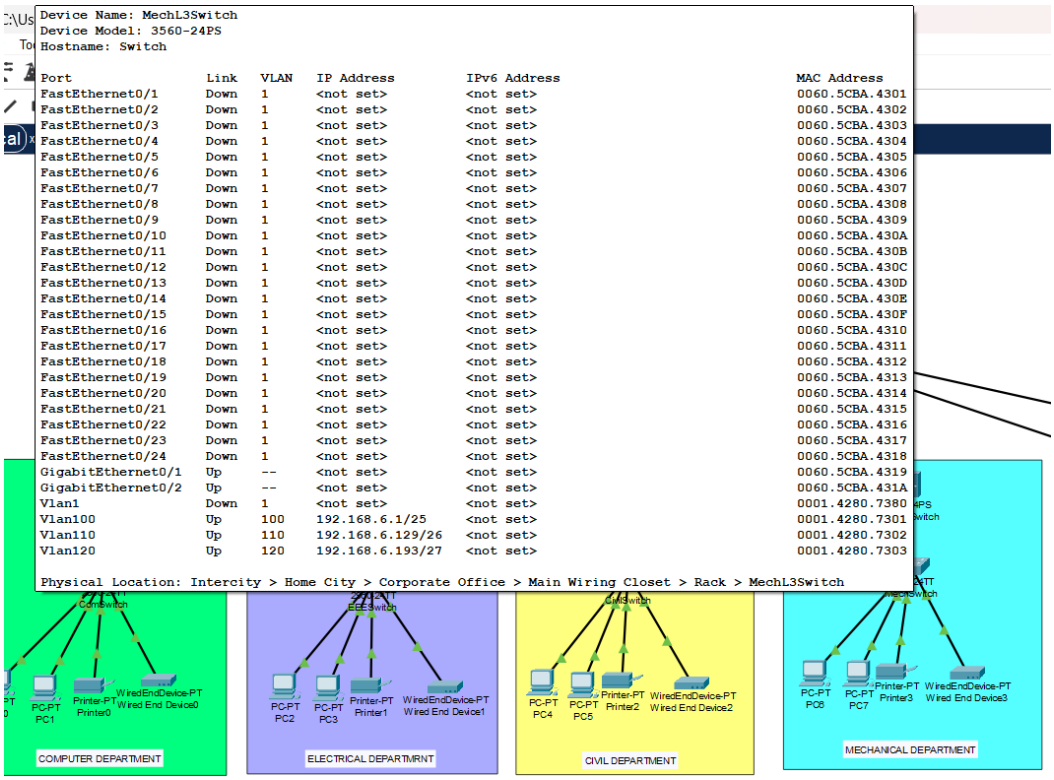
4. Mechanical Department

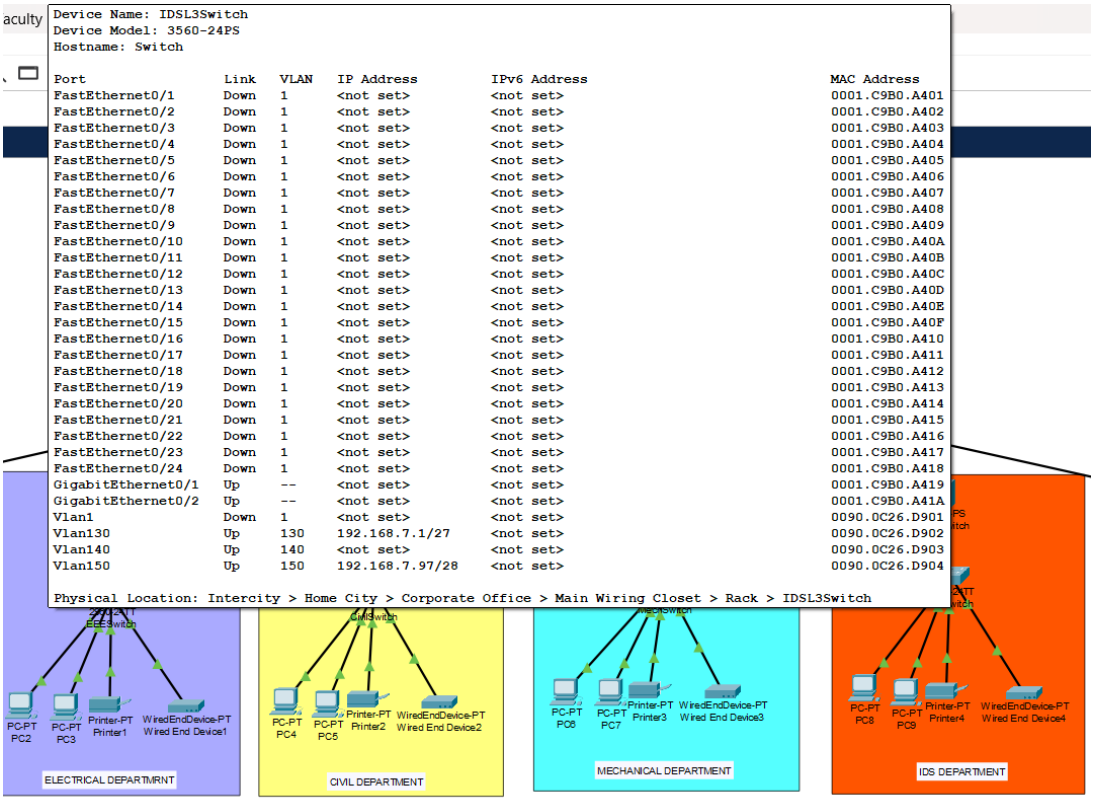


```
Device Name: MechL3Switch
Device Model: 3560-24PS
Hostname: Switch

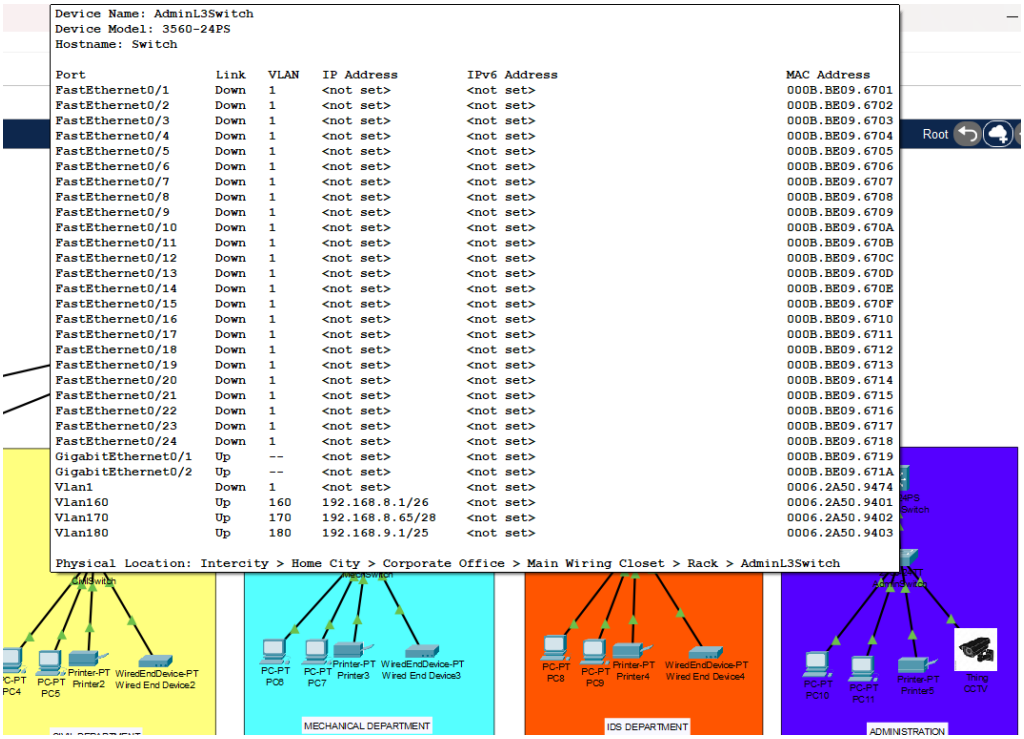
Port              Link  VLAN  IP Address        IPv6 Address                MAC Address
FastEthernet0/1   Down  1     <not set>         <not set>                   0060.5CBA.4301
FastEthernet0/2   Down  1     <not set>         <not set>                   0060.5CBA.4302
FastEthernet0/3   Down  1     <not set>         <not set>                   0060.5CBA.4303
FastEthernet0/4   Down  1     <not set>         <not set>                   0060.5CBA.4304
FastEthernet0/5   Down  1     <not set>         <not set>                   0060.5CBA.4305
FastEthernet0/6   Down  1     <not set>         <not set>                   0060.5CBA.4306
FastEthernet0/7   Down  1     <not set>         <not set>                   0060.5CBA.4307
FastEthernet0/8   Down  1     <not set>         <not set>                   0060.5CBA.4308
FastEthernet0/9   Down  1     <not set>         <not set>                   0060.5CBA.4309
FastEthernet0/10  Down  1     <not set>         <not set>                   0060.5CBA.430A
FastEthernet0/11  Down  1     <not set>         <not set>                   0060.5CBA.430B
FastEthernet0/12  Down  1     <not set>         <not set>                   0060.5CBA.430C
FastEthernet0/13  Down  1     <not set>         <not set>                   0060.5CBA.430D
FastEthernet0/14  Down  1     <not set>         <not set>                   0060.5CBA.430E
FastEthernet0/15  Down  1     <not set>         <not set>                   0060.5CBA.430F
FastEthernet0/16  Down  1     <not set>         <not set>                   0060.5CBA.4310
FastEthernet0/17  Down  1     <not set>         <not set>                   0060.5CBA.4311
FastEthernet0/18  Down  1     <not set>         <not set>                   0060.5CBA.4312
FastEthernet0/19  Down  1     <not set>         <not set>                   0060.5CBA.4313
FastEthernet0/20  Down  1     <not set>         <not set>                   0060.5CBA.4314
FastEthernet0/21  Down  1     <not set>         <not set>                   0060.5CBA.4315
FastEthernet0/22  Down  1     <not set>         <not set>                   0060.5CBA.4316
FastEthernet0/23  Down  1     <not set>         <not set>                   0060.5CBA.4317
FastEthernet0/24  Down  1     <not set>         <not set>                   0060.5CBA.4318
GigabitEthernet0/1 Up   --    <not set>         <not set>                   0060.5CBA.4319
GigabitEthernet0/2 Up   --    <not set>         <not set>                   0060.5CBA.431A
Vlan1             Down  1     <not set>         <not set>                   0001.4280.7380
Vlan100           Up    100   192.168.6.1/25    <not set>                   0001.4280.7301
Vlan110           Up    110   192.168.6.129/26  <not set>                   0001.4280.7302
Vlan120           Up    120   192.168.6.193/27  <not set>                   0001.4280.7303

Physical Location: Intercity > Home City > Corporate Office > Main Wiring Closet > Rack > MechL3Switch
```

5. IDS Department

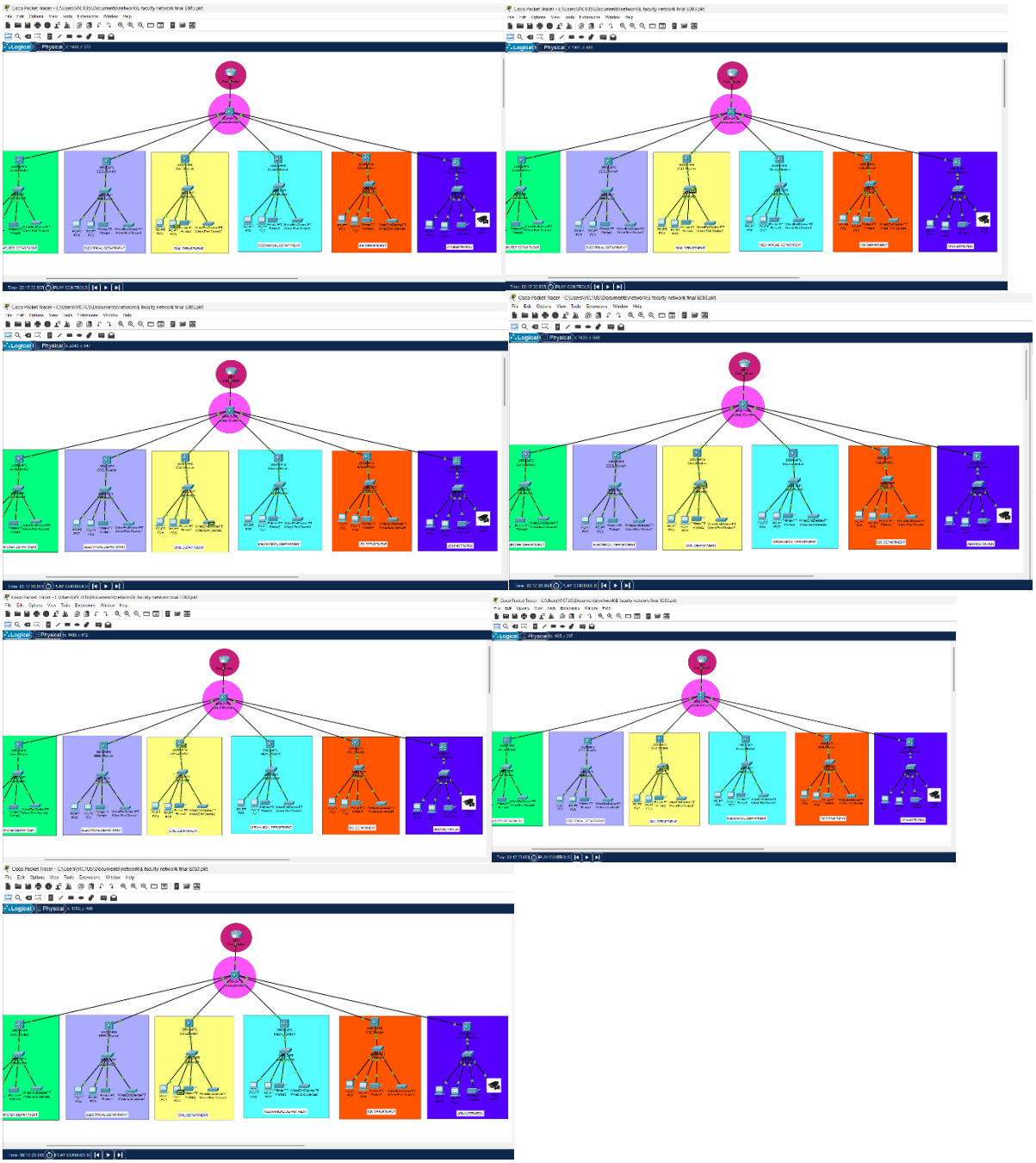


6. Administration

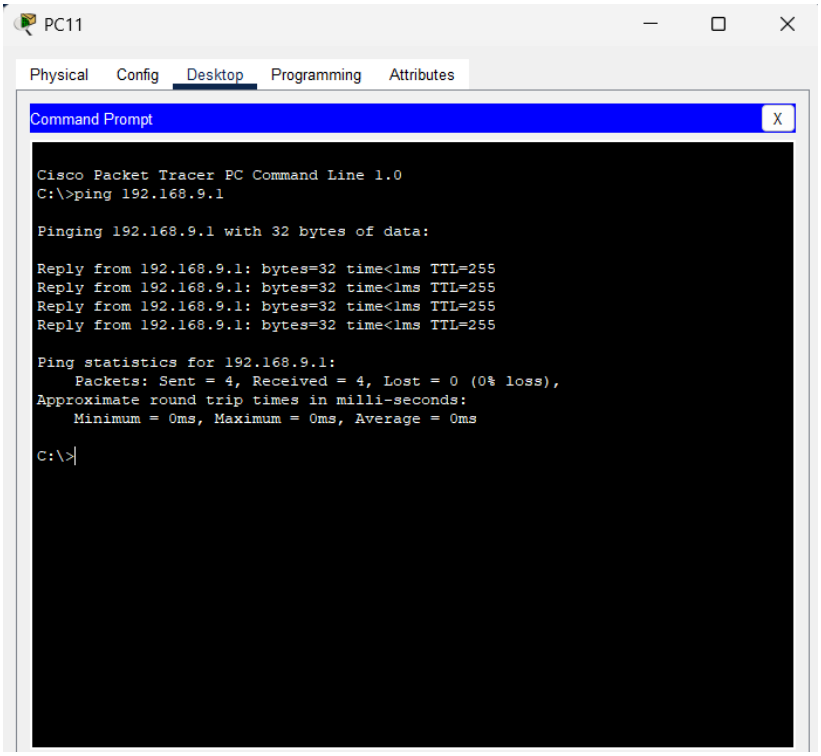


Testing & Validation

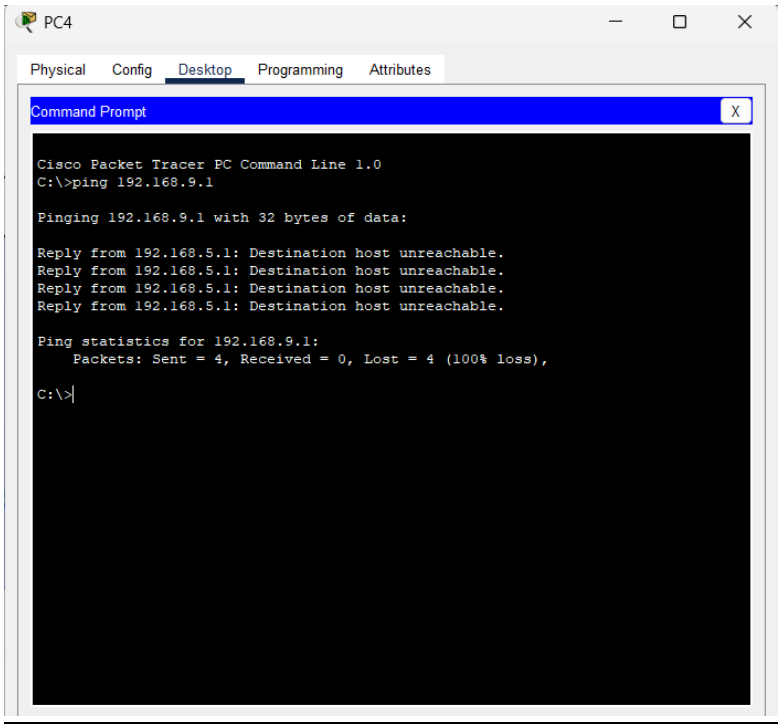
Here I sent a data packet from a staff device to an End device in Civil Department.



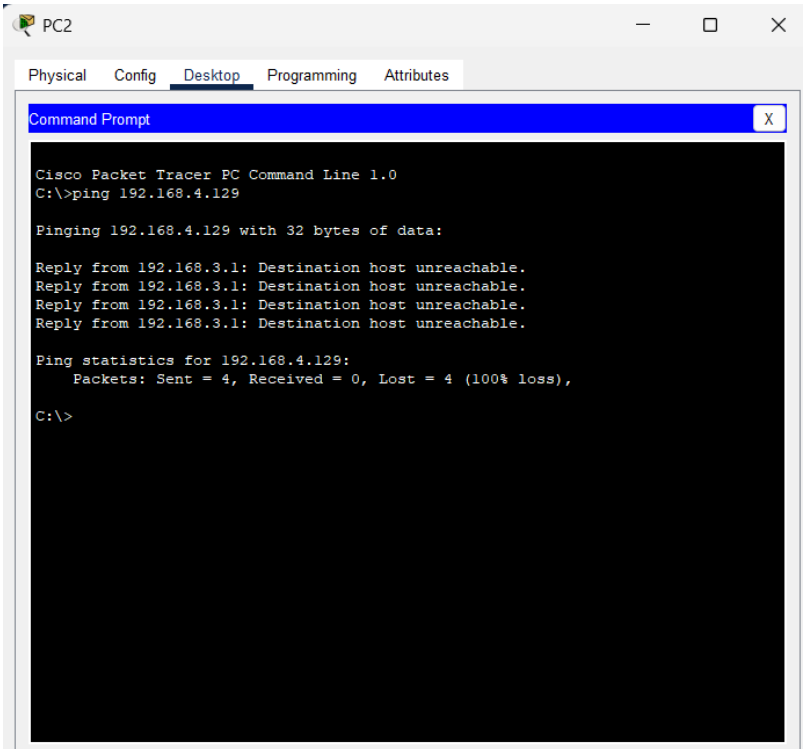
Here I ping Staff PC device to CCTV device in Administration. (0% loss)



Here I tried to ping from Student PC in Civil Dep to CCTV in Administration. (100% loss)



Here I tried to ping from Student PC in Elec Dep to Printer Device in it. (100% loss)



Summary

During the simulation and testing phase, most devices successfully communicated as expected. Connectivity was verified through ping tests, where the majority of packets reached their destinations, confirming proper VLAN segmentation and routing configurations. However, some data packets failed to reach their intended destinations, indicating possible misconfigurations in subnetting, VLAN assignment, or routing rules. Despite these minor issues, the overall network functioned effectively under the provided instructions and met most of the expected outcomes.

Further troubleshooting is required to resolve the remaining connectivity issues. Possible areas of improvement include verifying VLAN trunking, adjusting routing protocols, and ensuring proper device configurations. Overall, the project successfully demonstrated network segmentation,inter-departmental communication, and scalability while highlighting areas for optimization and refinement.