NOVEMBER 26, 2025

FINAL PROJECT

SMART EDU SYSTEM

Contents

Final Project Report SmartEdu Multi Campus Network Infrastructure Design & Simulation

1.Project Title

SmartEdu Multi-Campus Network Infrastructure Design & Simulation

2. Group Members & Assigned

- **Abdullah Akif** – Group Leader, WAN Design , OSPF Routing &DHCP configuration
- **M. Zaka** – Topology & Design
- **Raja Ali Shahid** – IP Address Schema
- **Faseeh Ahmed Zahoor** – Documentation
- **Ammar Akhtar Butt** – GitHub Repository Management

3. Introduction

This project simulates a complete **enterprise-grade multi-campus network** for the fictional *SmartEdu Institute*. The design connects two campuses (Main Campus and City Campus) through a WAN connection supported by OSPF dynamic routing. The network uses a hierarchical design with VLAN segmentation, DHCP-based dynamic addressing, ACL-based security, and controlled Inter-VLAN communication. All configuration, documentation, and version control are managed through a dedicated GitHub repository.

4. Network Topology

The final topology includes:

- **2 interconnected campuses** (Main & City) using a WAN serial link.
- **Core routers** functioning as the backbone of routing and WAN connectivity.
- **Layer-2** for departmental distribution.
- **Multiple departmental LANs**, each represented with color-coded groups.
- **Centralized DHCP Server** at Main Campus.
- **Multiple VLANs**, each representing a separate department.
- **ACLs applied on router interfaces** to control inter-department communication.

Interpreted from the provided topology image:

- The **Main Campus** contains multiple clusters of PCs grouped logically (Admin, IT, Labs, Faculty).
- The **City Campus** hosts Student Affairs, Library, and Support departments.
- A large campus LAN is visible at the bottom with multiple switches and department blocks.
- Core routers interconnect all zones and provide WAN routing.

5. Detailed Task Responsibilities

Below is the filled-in content for each team member based on the project proposal and topology.

5.1 Abdullah Akif – WAN Design ,OSPF Routing &DHCP ROUTING

5.1.1 WAN Design

- The two campuses are connected using a **serial WAN link** between their respective routers.
- The WAN acts as the backbone for inter-campus communication.
- A **hierarchical model** is used:
    - Core Layer: WAN Routers
    - Access Layer: Multiple switches per department

5.1.2 OSPF Routing Configuration

- OSPF is implemented for **dynamic routing across both campuses**.
- Each department subnet is advertised into the OSPF process.
- Multi-area OSPF design is used for future scalability.
- Routing ensures full end-to-end reachability within and across campuses.

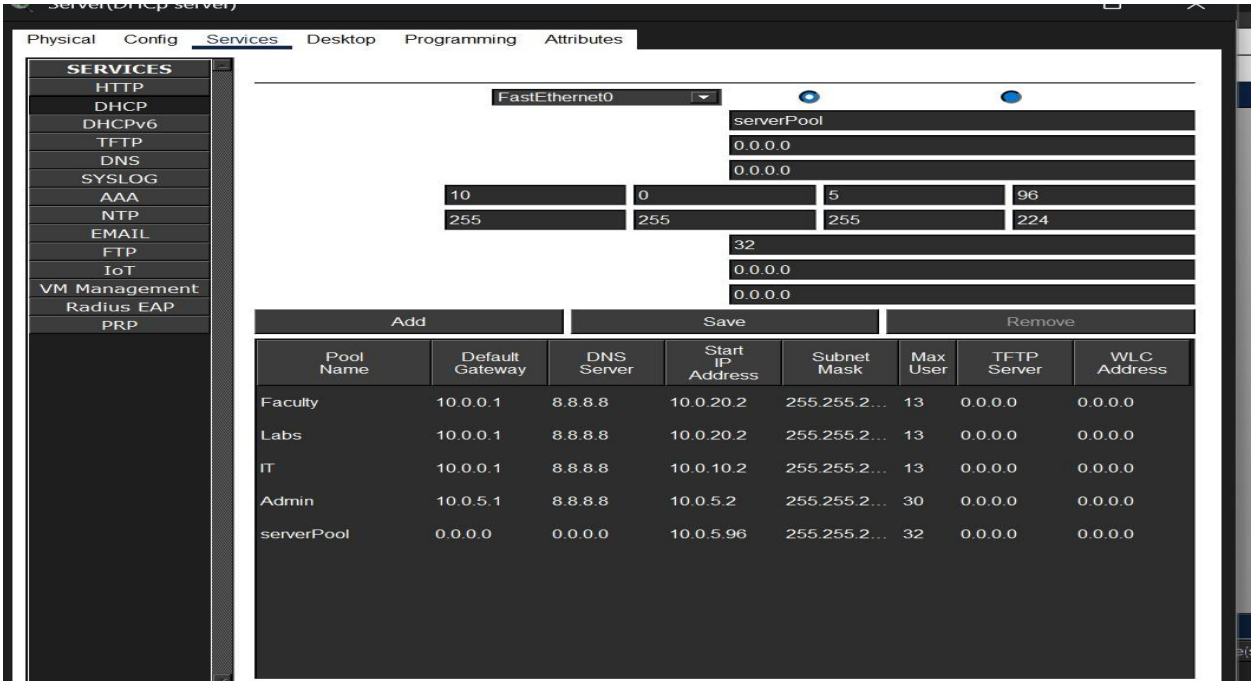
```
RouterA_DHCP>show ip ospf
 Routing Process "ospf 1" with ID 10.0.100.2
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 SPF schedule delay 5 secs, Hold time between two SPFs 10 secs
 Minimum LSA interval 5 secs. Minimum LSA arrival 1 secs
 Number of external LSA 0. Checksum Sum 0x000000
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
 External flood list length 0
    Area BACKBONE(0)
        Number of interfaces in this area is 7
        Area has no authentication
        SPF algorithm executed 3 times
        Area ranges are
        Number of LSA 2. Checksum Sum 0x010b5d
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0

RouterA_DHCP>
RouterA_DHCP>show ip route ospf
O    192.168.40.0 [110/65] via 10.0.100.1, 00:38:48, Serial0/3/0
O    192.168.50.0 [110/65] via 10.0.100.1, 00:38:48, Serial0/3/0
O    192.168.60.0 [110/65] via 10.0.100.1, 00:38:48, Serial0/3/0

RouterA_DHCP>show ip ospf neighbor


Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.60.1      0   FULL/  -        00:00:32    10.0.100.1      Serial0/3/0
RouterA_DHCP>
```

5.1.3 DHCP Configuration



5.1.4 Verification

- Successful ping tests were performed between:
  - Main → City Campus

```
C:\>ping 192.168.50.12

Pinging 192.168.50.12 with 32 bytes of data:

Reply from 192.168.50.12: bytes=32 time=1ms TTL=126
Reply from 192.168.50.12: bytes=32 time=2ms TTL=126
Reply from 192.168.50.12: bytes=32 time=11ms TTL=126
Reply from 192.168.50.12: bytes=32 time=12ms TTL=126

Ping statistics for 192.168.50.12:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 12ms, Average = 6ms

C:\>
```

  - Admin → IT

```
C:\>ping 10.0.10.5

Pinging 10.0.10.5 with 32 bytes of data:

Reply from 10.0.10.5: bytes=32 time<1ms TTL=127
Reply from 10.0.10.5: bytes=32 time=13ms TTL=127
Reply from 10.0.10.5: bytes=32 time=12ms TTL=127
Reply from 10.0.10.5: bytes=32 time=1ms TTL=127

Ping statistics for 10.0.10.5:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 13ms, Average = 6ms

C:\>
```

  - Labs → Faculty

```
C:\>ping 10.0.30.3

Pinging 10.0.30.3 with 32 bytes of data:

Reply from 10.0.30.3: bytes=32 time<1ms TTL=127
Reply from 10.0.30.3: bytes=32 time=10ms TTL=127
Reply from 10.0.30.3: bytes=32 time<1ms TTL=127
Reply from 10.0.30.3: bytes=32 time=12ms TTL=127

Ping statistics for 10.0.30.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 12ms, Average = 5ms

C:\>
```

- `show ip route` and OSPF neighbor verification confirm correct adjacency.

```
RouterA_DHCP>show ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/8 is variably subnetted, 14 subnets, 3 masks
C       10.0.1.0/30 is directly connected, GigabitEthernet0/0
L       10.0.1.1/32 is directly connected, GigabitEthernet0/0
C       10.0.5.0/24 is directly connected, GigabitEthernet0/1.5
L       10.0.5.1/32 is directly connected, GigabitEthernet0/1.5
C       10.0.10.0/24 is directly connected, GigabitEthernet0/0.10
L       10.0.10.1/32 is directly connected, GigabitEthernet0/0.10
C       10.0.20.0/24 is directly connected, GigabitEthernet0/0.20
L       10.0.20.1/32 is directly connected, GigabitEthernet0/0.20
C       10.0.30.0/24 is directly connected, GigabitEthernet0/0.30
L       10.0.30.1/32 is directly connected, GigabitEthernet0/0.30
C       10.0.50.0/24 is directly connected, GigabitEthernet0/2
L       10.0.50.1/32 is directly connected, GigabitEthernet0/2
C       10.0.100.0/30 is directly connected, Serial0/3/0
L       10.0.100.2/32 is directly connected, Serial0/3/0
O    192.168.40.0/24 [110/65] via 10.0.100.1, 03:35:00, Serial0/3/0
O    192.168.50.0/24 [110/65] via 10.0.100.1, 03:35:00, Serial0/3/0
O    192.168.60.0/24 [110/65] via 10.0.100.1, 03:35:00, Serial0/3/0

RouterA_DHCP>
```

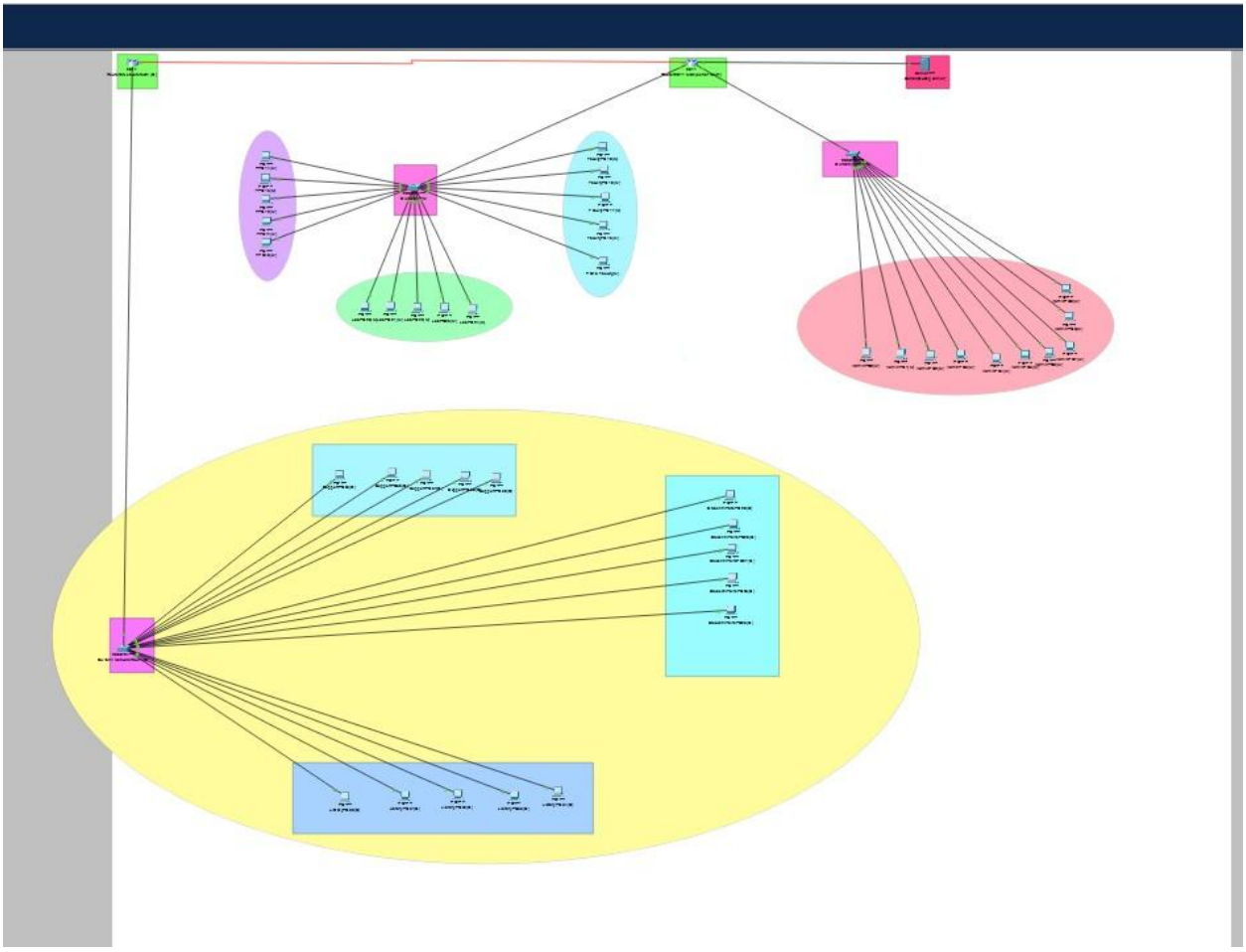
M.Zaka Topology (Physical & Logical) & Design

5.2.1 VLAN Design

Based on the proposal:

- **VLAN 5 – Admin**
- **VLAN 10 – IT**
- **VLAN 20 – Computer Labs**
- **VLAN 30 – Faculty**
- **VLAN 40 – Student Affairs** (City)
- **VLAN 50 – Library & Support** (City)

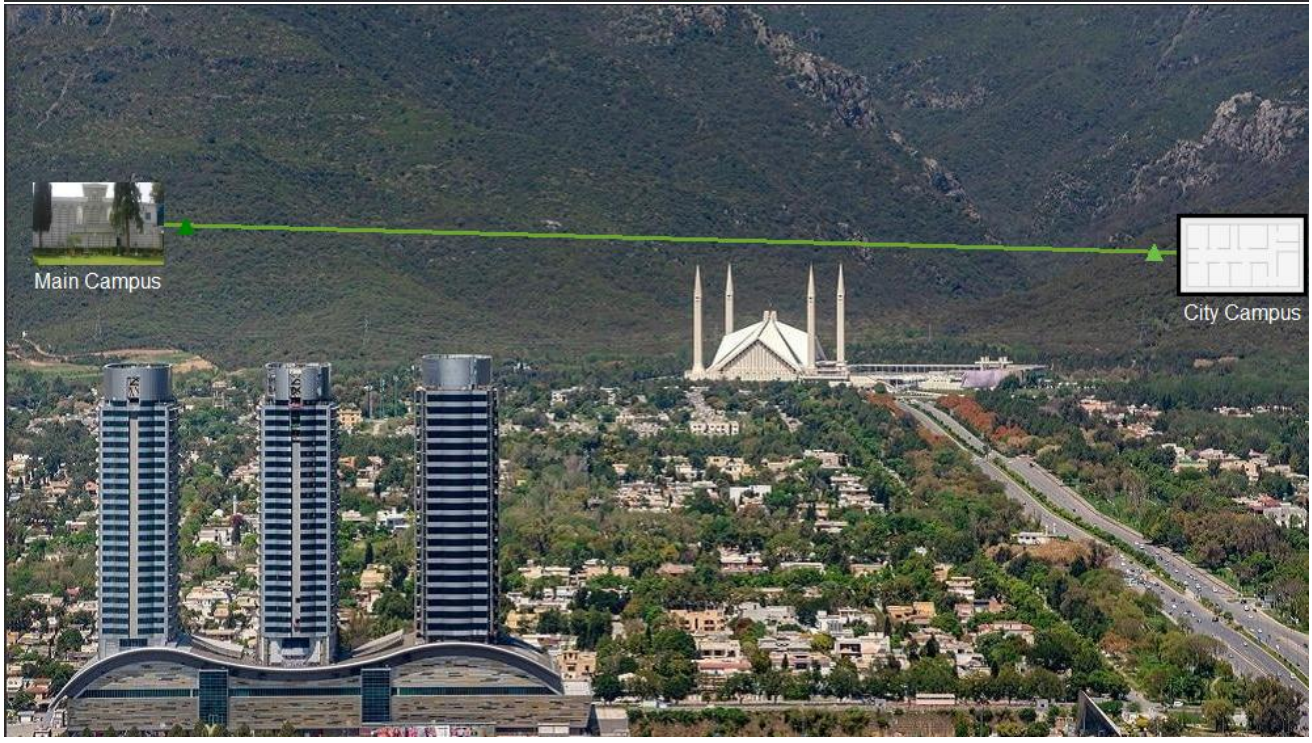
Each department has an isolated broadcast domain.

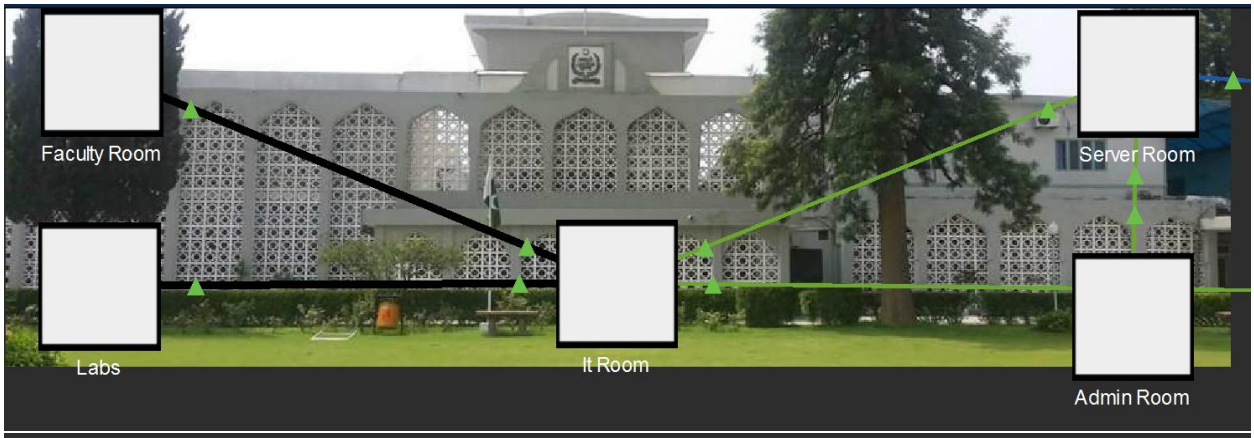


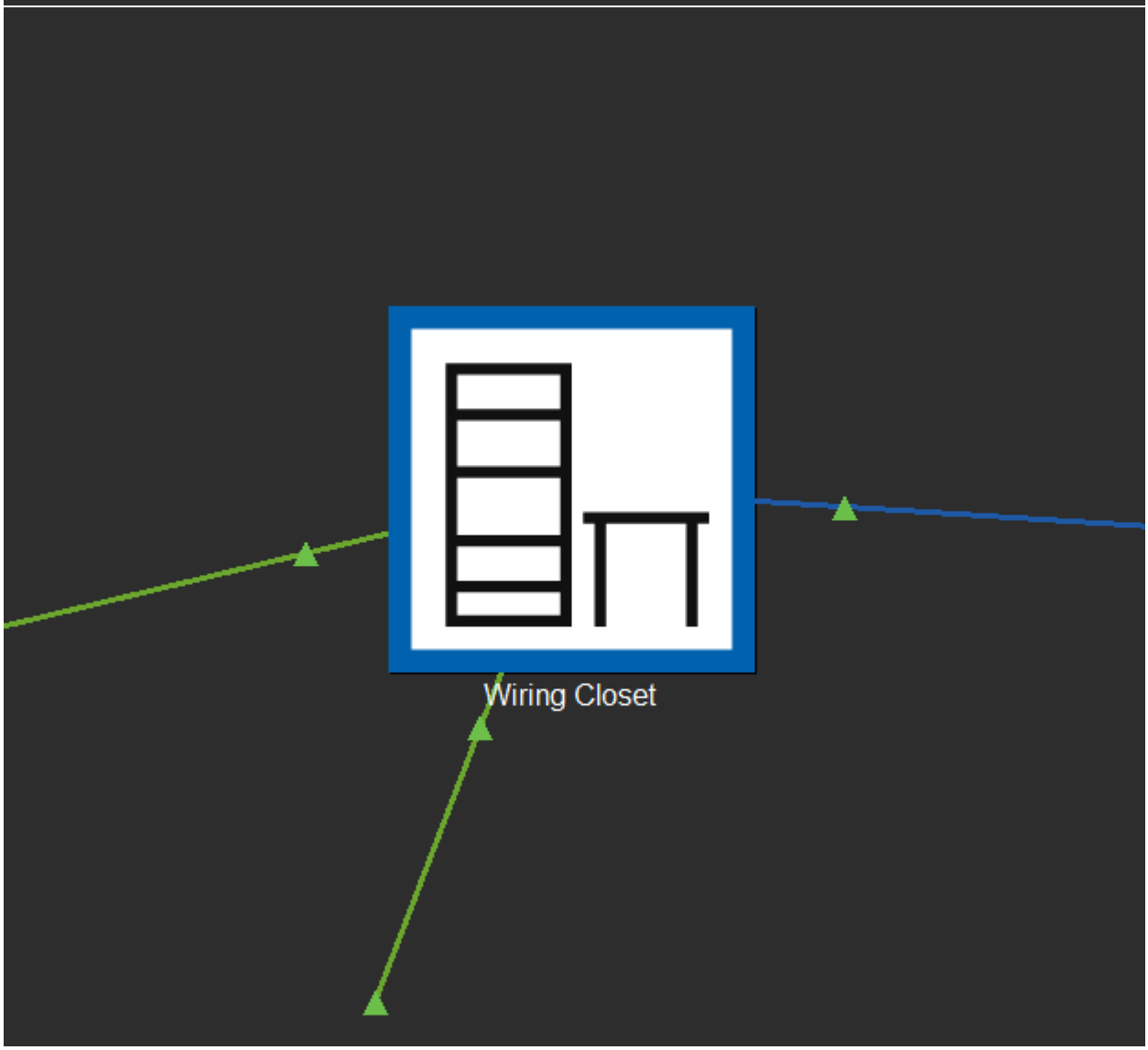
5.2.2 Switch Configuration Tasks

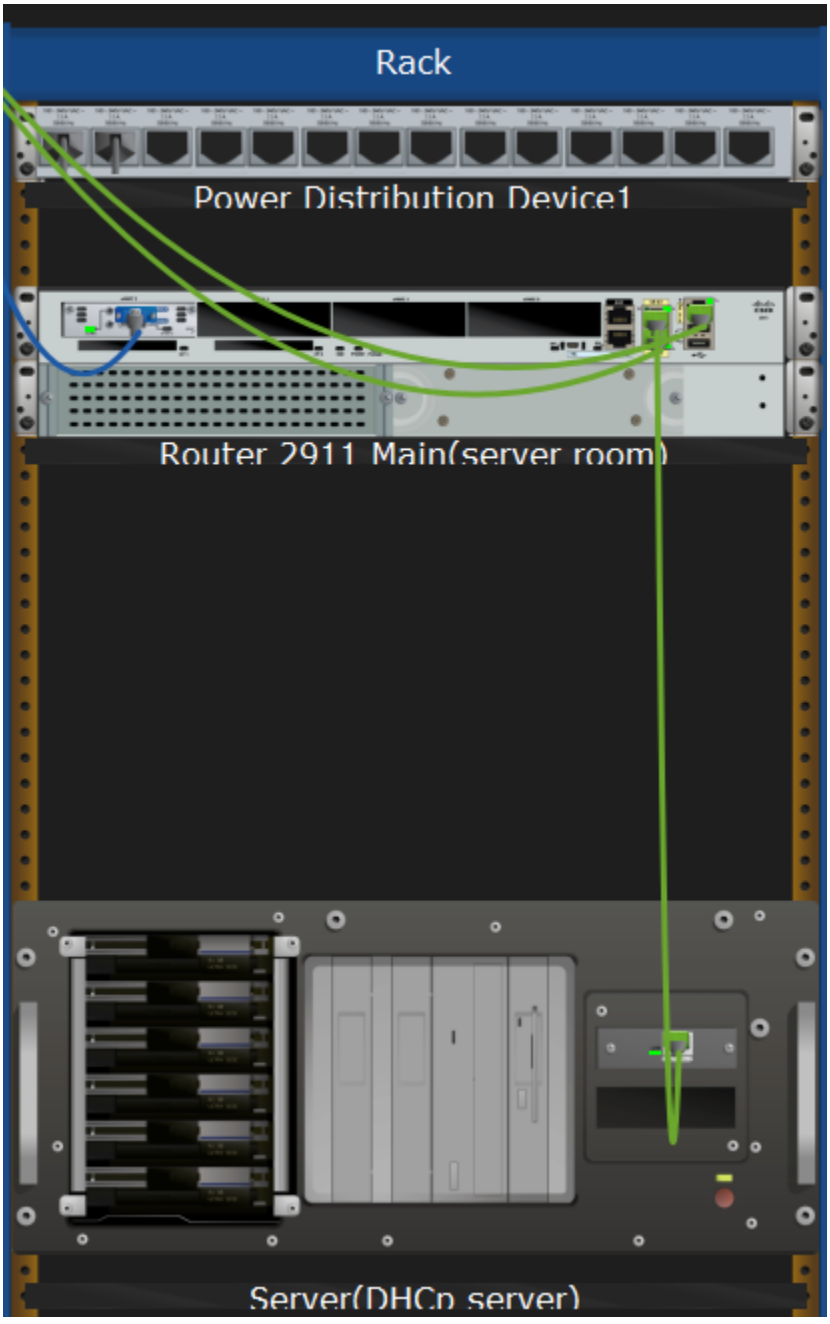
- All PCs connected to access ports mapped to their respective VLANs.
- Inter-switch links configured as **802.1Q trunk ports**.
- Switch spanning tree operates in default mode for loop prevention.


City


Main Campus
City Campus


Faculty Room
Server Room
Labs
It Room
Admin Room

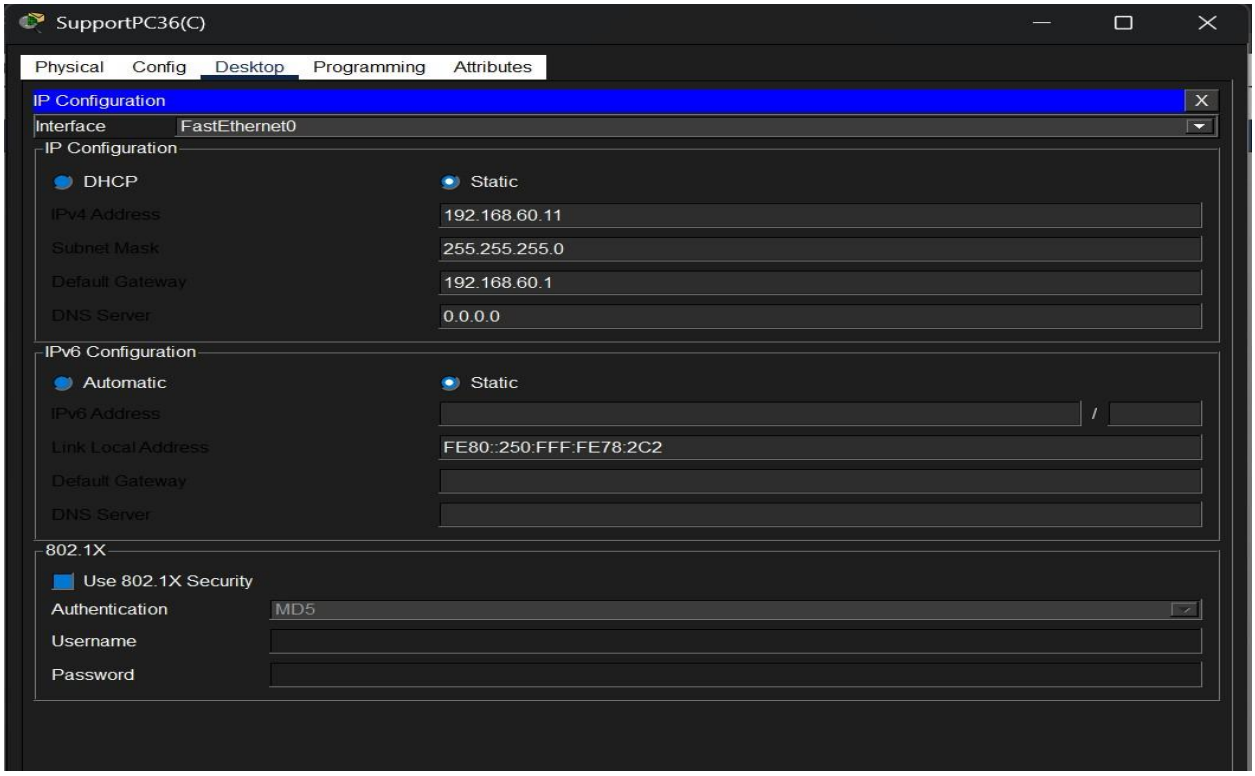

Wiring Closet


Rack
Power Distribution Device1
Router 2911 Main(server room)
Server(DHCp server)

5.3 Raja Ali Shahid – Static IP Address Schema

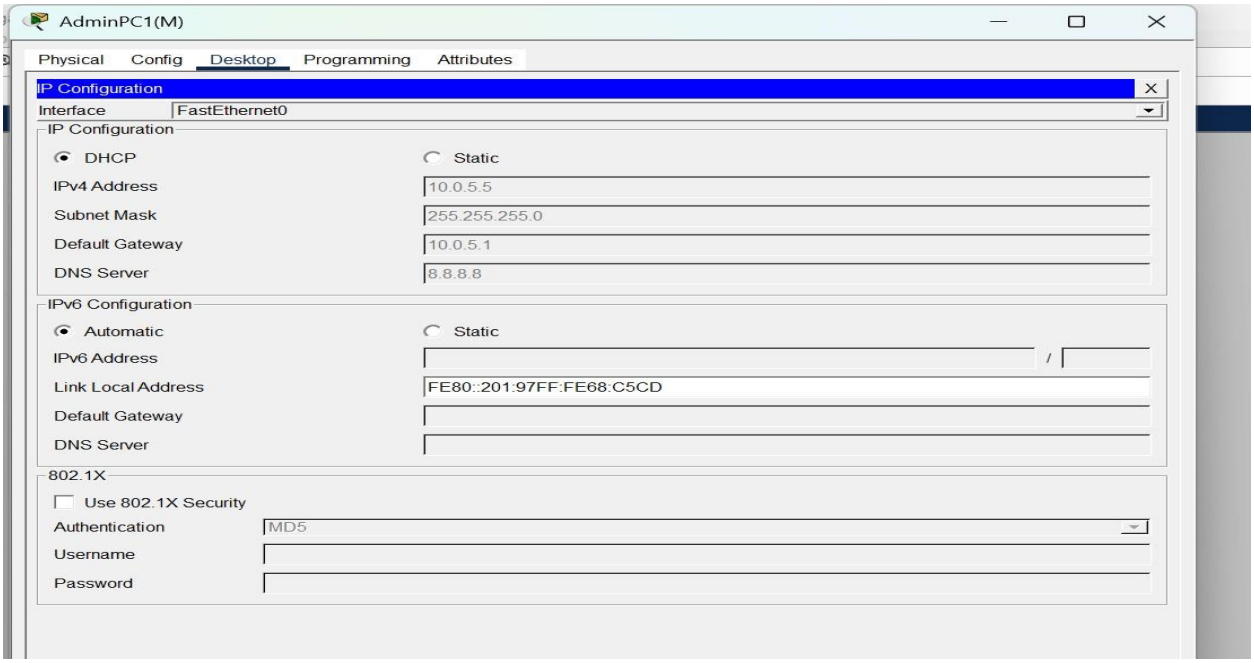
5.3.1 IP Addressing Schema

- A private IP addressing scheme designed using **VLSM**.
- Each VLAN receives its own subnet.
- Scalability ensured by assigning future-proof subnet sizes.
- DHCP Server located at **Main Campus** for centralized management.
- **DHCP Relay** configured on City Campus routers.



5.3.2 Testing

- All PCs successfully obtained IP addresses statically
- `ipconfig` on end devices verifies correct addressing.



5.4 Faseeh Ahmed Zahoor – Documentation

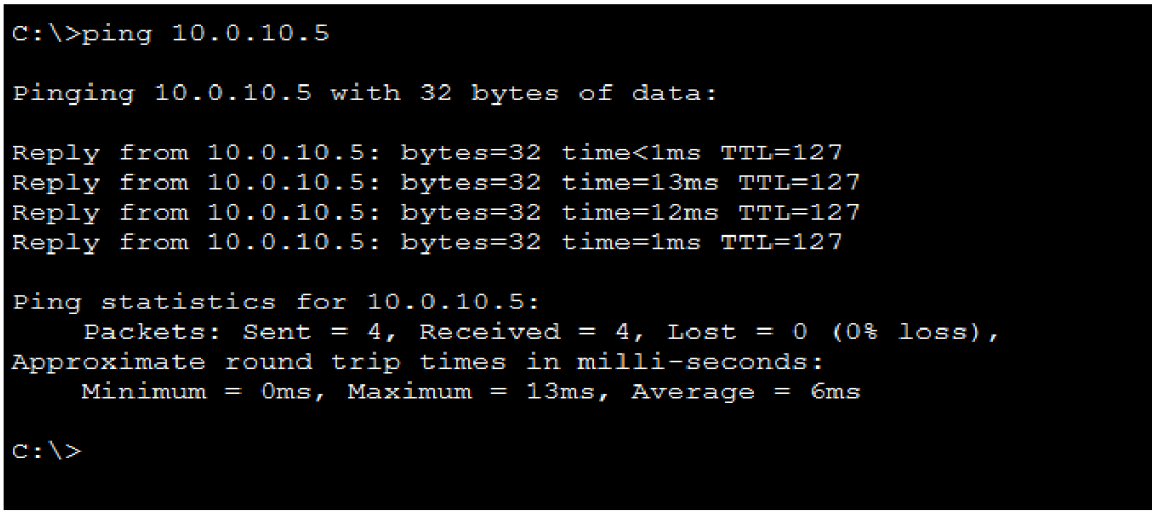
Collecting details

As explained before in the starting I collected details from all members and cross checked and verify everything

Screenshots & testing artifacts

Take screenshots for every important test. Save in `/screenshots` with descriptive filenames:

- **ping_admin_to_it_main-campus**



- **traceroute_main_to_city**

```
C:\>ping 192.168.50.12

Pinging 192.168.50.12 with 32 bytes of data:

Reply from 192.168.50.12: bytes=32 time=1ms TTL=126
Reply from 192.168.50.12: bytes=32 time=2ms TTL=126
Reply from 192.168.50.12: bytes=32 time=11ms TTL=126
Reply from 192.168.50.12: bytes=32 time=12ms TTL=126

Ping statistics for 192.168.50.12:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
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C:\>
```

- **ospf_neighbor**

```
RouterA_DHCP>show ip ospf neighbor

Neighbor ID     Pri   State           Dead Time   Address         Interface
192.168.60.1      0   FULL/  -        00:00:33    10.0.100.1      Serial0/3/0
RouterA_DHCP>
```

- **dhcp_ipallocation_admin**

```
RouterA_DHCP>show ip dhcp binding
IP address       Client-ID/              Lease expiration        Type
                 Hardware address
10.0.5.2         0060.70EC.62CE           --                     Automatic
10.0.5.3         0060.70C0.ACA6           --                     Automatic
10.0.5.4         0005.5E13.2672           --                     Automatic
10.0.5.6         0040.0B41.5522           --                     Automatic
10.0.5.5         00E0.A363.2BA6           --                     Automatic
10.0.5.7         0005.5ED1.B82C           --                     Automatic
10.0.5.8         0001.9633.C16A           --                     Automatic
10.0.5.10        0001.9768.C5CD           --                     Automatic
10.0.5.9         0001.422E.2AD2           --                     Automatic
10.0.5.11        0090.2B02.1C80           --                     Automatic
```

Copy Paste

Final Network Testing Summary

Network validation was performed through:

- End-to-end connectivity testing across campuses

- Inter-VLAN reachability where allowed
- DHCP automatic allocation for all devices
- Successful OSPF routing between all routers

All test results confirm that the network is **fully functional, scalable.**

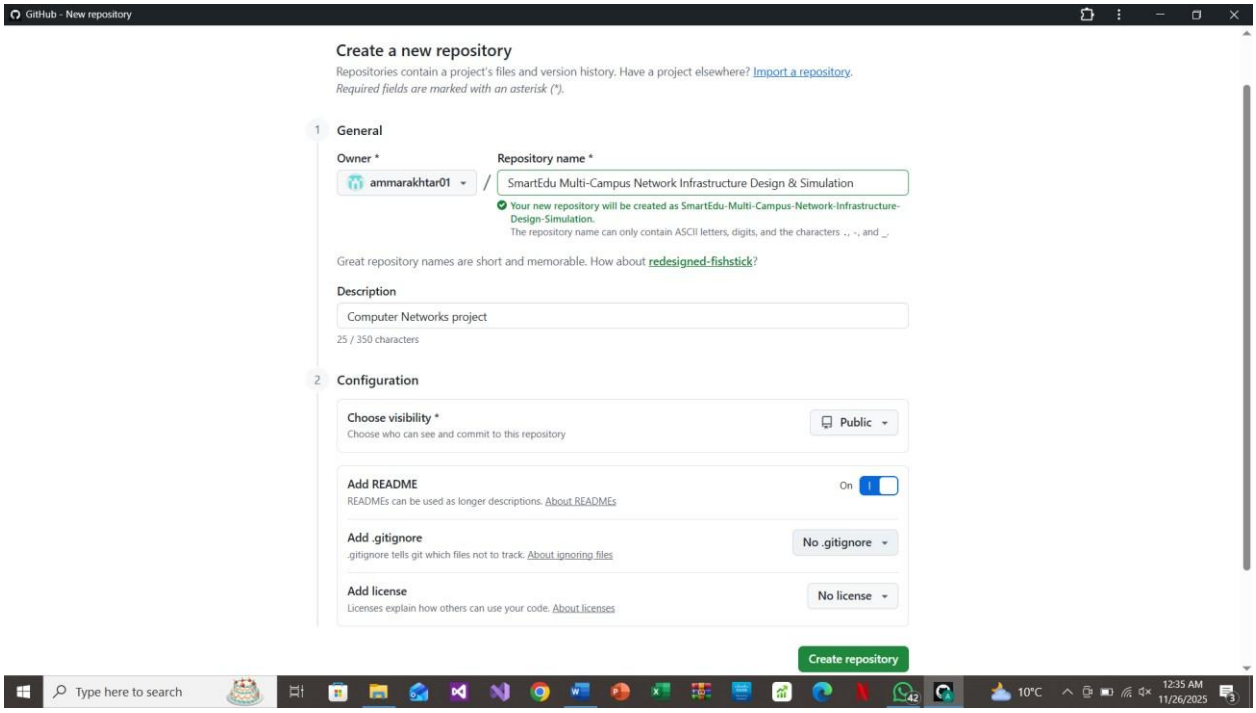
Contribution matrix & commit log

Create `docs/CONTRIBUTION_MATRIX.md` with a table:

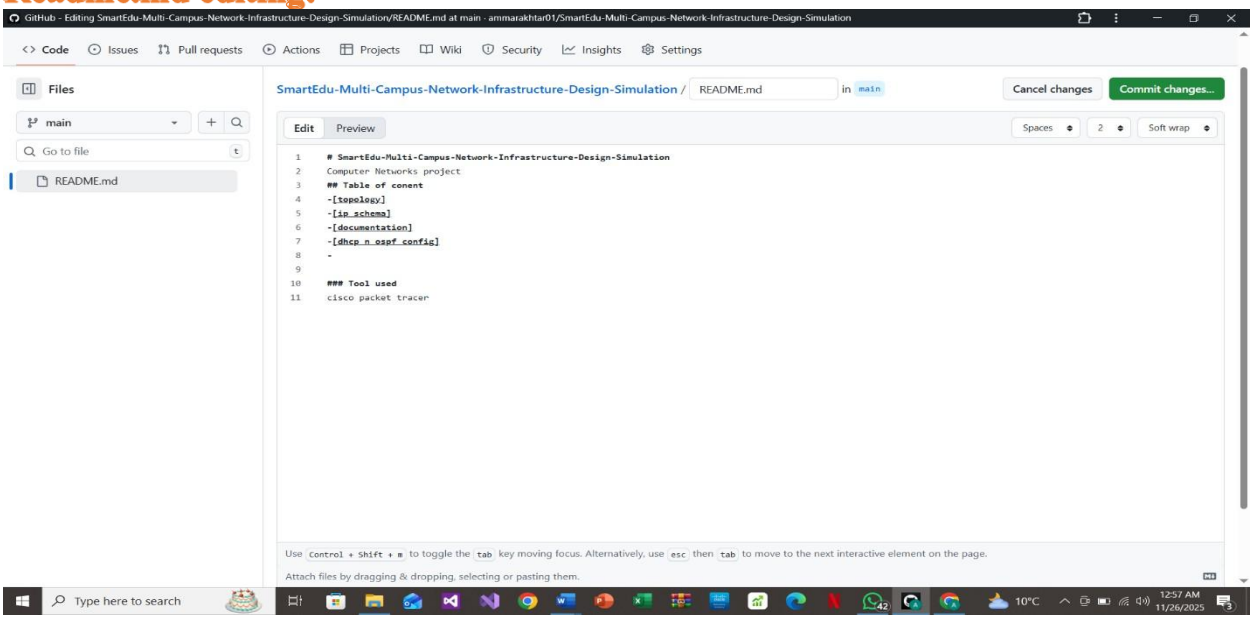
Member	Role	Files/Configs contributed	% contribution
Abdullah Akif	WAN & DHCP & OSPF	`configs/MainRouter...`	20%
M. Zaka	VLANs	`configs/switch...`	20%
Raja Ali Shahid	IP plan	`docs/addressing`	20%
Faseeh Ahmed	Docs	`documentation`	20%
Ammar Akhtar	Repo	`README.md`	20%

5.5 Ammar Akhtar Butt – GitHub Repository

Repository setup (assigning name and description)



Readme.md editing:



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6. Final Network Testing Summary

Network validation was performed through:

- End-to-end connectivity testing across campuses
- Inter-VLAN reachability where allowed
- DHCP automatic allocation for all devices
- Successful OSPF routing between all routers

All test results confirm that the network is **fully functional, scalable, and secure**.

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7. Conclusion

The SmartEdu Multi-Campus network successfully fulfills all technical, administrative, and security requirements. The project demonstrates:

- Robust hierarchical network design
- Efficient VLAN segmentation
- Dynamic routing across multiple campuses
- Strong access control policies for inter-department security
- Centralized and scalable IP management using DHCP
- Professional documentation and repository management

This network is ready for deployment simulation and meets all academic project standards.

THE END