NOVEMBER 26, 2025

FINAL PROJECT

SMART EDU SYSTEM

Final Project Report – SmartEdu Multi-Campus Network Infrastructure Design & Simulation

1. Project Title

SmartEdu Multi-Campus Network Infrastructure Design & Simulation

2. Group Members & Assigned Roles

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

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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.

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4. Network Topology Overview

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.

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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>
```
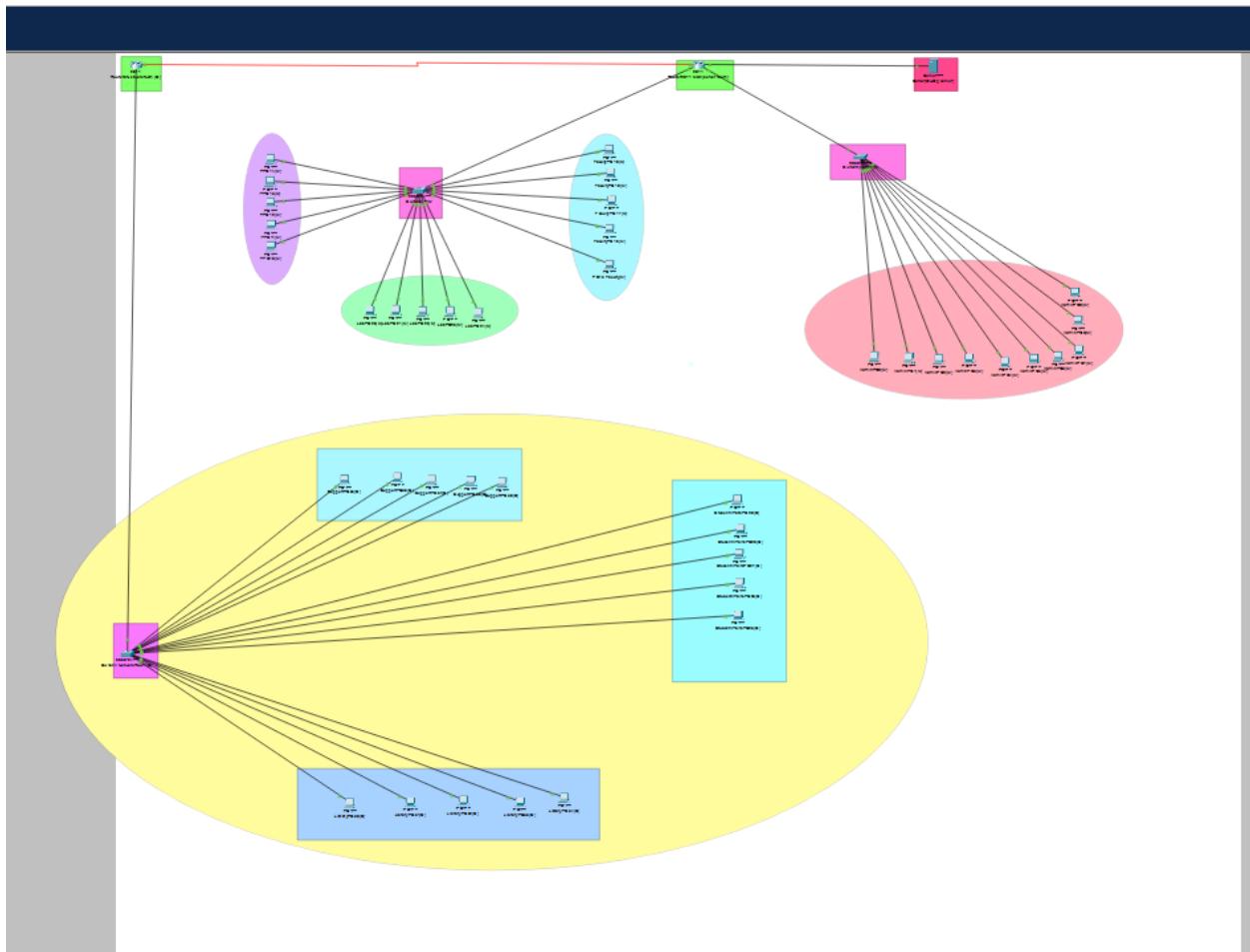
5.2 M. Zaka – LAN Switching + VLAN Deployment

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.

VLAN Name [   ]

[Add]   [Remove]

VLAN No	VLAN Name
1	default
5	Admin
10	IT
20	Labs
30	Faculty

5.2.3 Testing

- PCs within the same VLAN successfully communicate.
- Trunks verified using `show interfaces trunk`.
- VLAN table validated using `show vlan brief`.
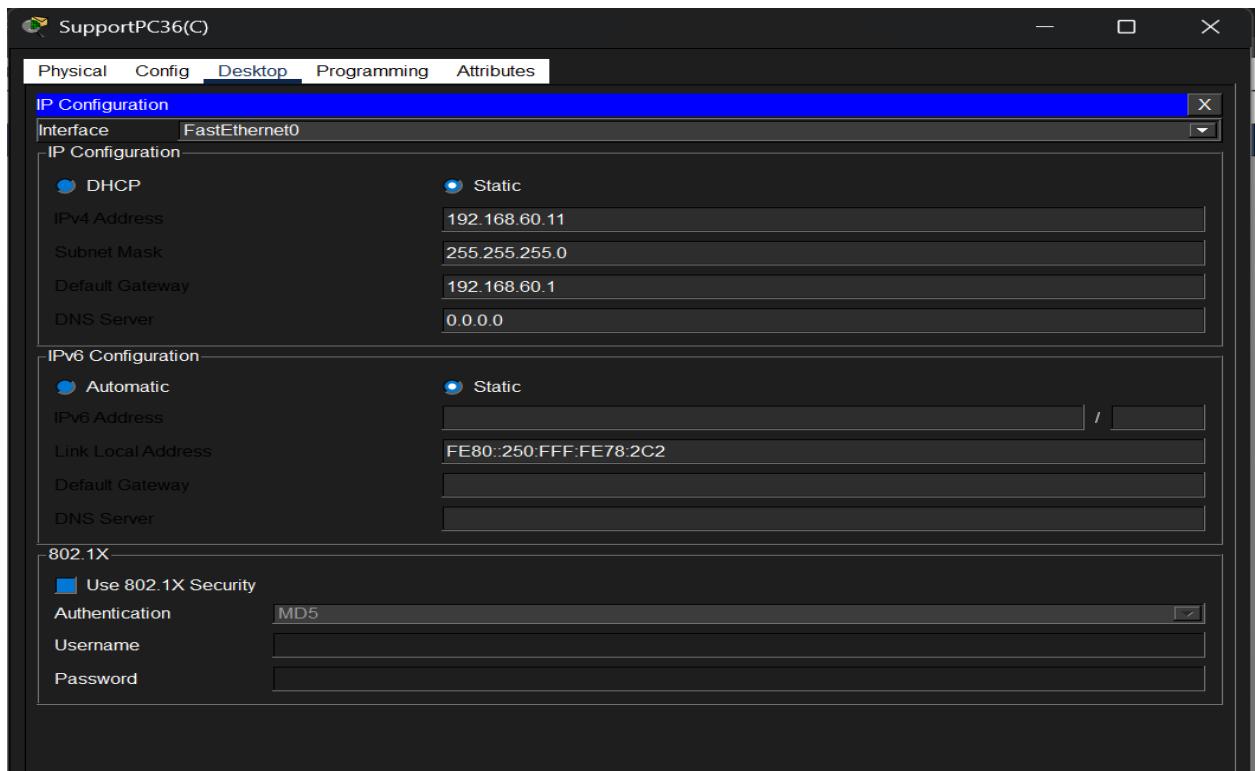
```
Switch>show vlan brief

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa0/16, Fa0/17, Fa0/18, Fa0/19
                                                Fa0/20, Fa0/21, Fa0/22, Fa0/23
                                                Fa0/24, Gig0/2
40   Student_Affairs                  active    Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                                Fa0/5
50   Library                          active    Fa0/6, Fa0/7, Fa0/8, Fa0/9
                                                Fa0/10
60   Support                          active    Fa0/11, Fa0/12, Fa0/13, Fa0/14
                                                Fa0/15
```

# 5.3 Raja Ali Shahid – Static IP Address Schema
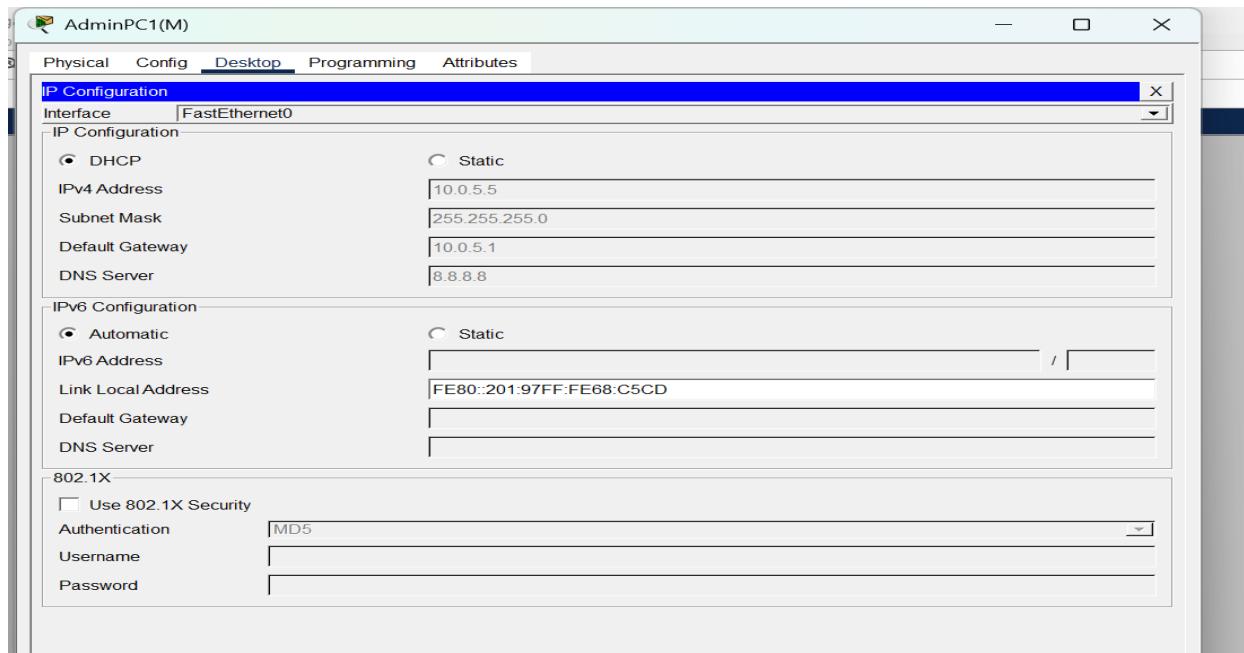
5.3.1 IP Addressing Schema

- 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**

```
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:\>
```

- **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:
    Minimum = 1ms, Maximum = 12ms, Average = 6ms

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.**
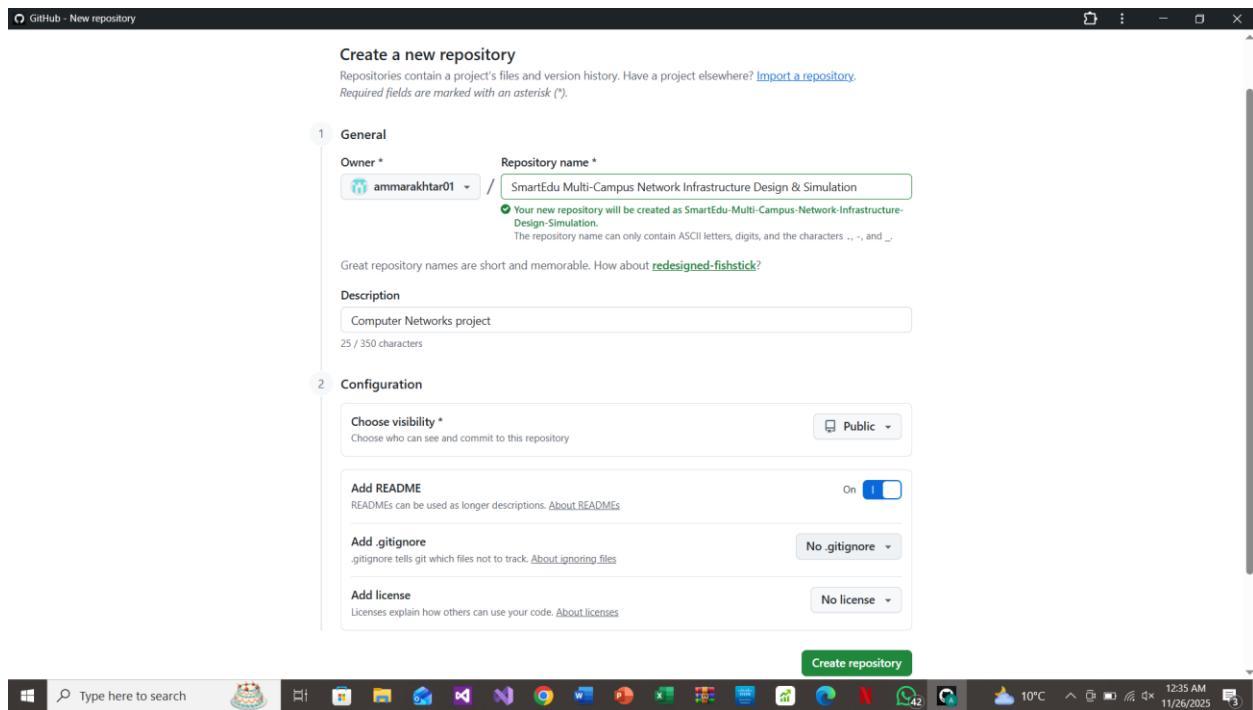
Contribution matrix & commit log

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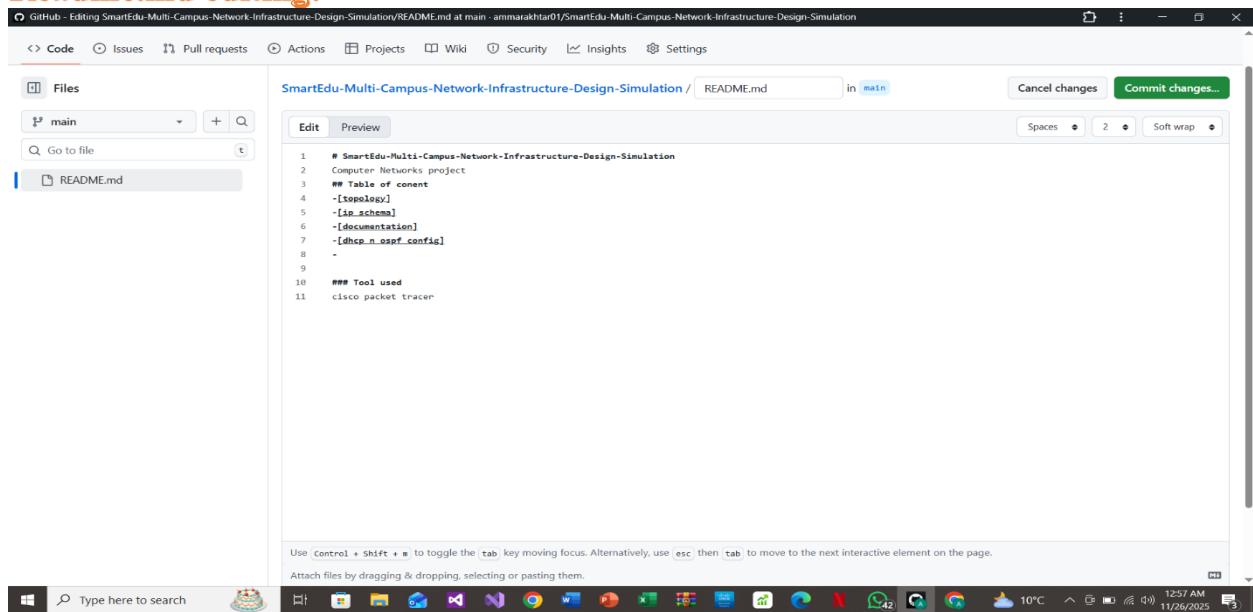
Member	Role	Files/Configs contributed	% contribution
Abdullah Akif	WAN & DHCP & OSPF	`configs/MainRouter...`	20%
M. Zaka	VLANs	`configs/switch...`	20%
Raja Ali Shahid	IP plan	`docs/addressing`	20%
Faseeh Ahmed	Docs	`documentation`	20%
Ammar Akhtar	Repo	`README.md`	20%

5.5 Ammar Akhtar Butt – GitHub Repository

Repository setup (assigning name and description)

Readme.md editing:


```
1    # SmartEdu-Multi-Campus-Network-Infrastructure-Design-Simulation
2    Computer Networks project
3    ## Table of conent
4    -[topology]
5    -[ip schema]
6    -[documentation]
7    -[dhcp n ospf config]
8    -
9
10   ### Tool used
11   cisco packet tracer
```

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