COMPUTER ENGINEERING DEPARTMENT

CMPE451 NETWORK ENGINEERING-I

SKILL-BASED EXPERIMENT DESIGN PROJECT REPORT

Submitted by

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1 INTRODUCTION

The project aims to simulate and configurate two separate networks on Cisco Packet Tracer desktop application and establish a WAN (Wide Area Network) connection between them. The following report documents the design, configuration and testing the company network integration where each member of the group was responsible for one company's network. Inter VLAN routing was implemented after assigning the proper IP subnetting using Variable Length Subnet Masking (VLSM) that provided the proper number of subnets and usable hosts to each company (local network). The final network achieved full end to end IP connectivity between all devices in both company networks.

2 METHODOLOGY

2.1 VLSM Subnetting Plan:

To prepare the suitable VLSM subnetting plan for the companies, IP Network's address was calculated based on the last two digits of the university entrance of each member in the group:

Samet Tok: 20

Mohamed Ayham: 21

Therefore, the IP address block was set to be: 10.41.0.0

Next step was to determine the number of subnets that should be available on each network separately which was calculated based on the last digit of each member's student ID:

Samet Tok: 4, which means Samet's network should have 4 subnets

Mohamed Ayham: 0, since the subnet count is less than 10, Ayham's network had to have 10 subnets

In total, we have 15 subnets: 4 available in Samet's network, 10 available in Ayham's network and 1 used in the WAN connection between the two companies. Therefore, the last 4 bits in the IP address was reserved for hosts as: $2^4 = 16 \cong 15$ and /28 was used for Classless Inter-Domain Routing (CIDR) as shown below in *Table (1)*:

Subnet Name	Purpose	Network Address	Subnet Mask	CIDR	First Usable IP	Last Usable IP	Broadcast
Subnet 01	Ayham's LAN 1	10.41.0.0	255.255.255.240	/28	10.41.0.1	10.41.0.14	10.41.0.15
Subnet 02	Ayham's LAN 2	10.41.0.16	255.255.255.240	/28	10.41.0.17	10.41.0.30	10.41.0.31
Subnet 03	Ayham's LAN 3	10.41.0.32	255.255.255.240	/28	10.41.0.33	10.41.0.46	10.41.0.47
Subnet 04	Ayham's LAN 4	10.41.0.48	255.255.255.240	/28	10.41.0.49	10.41.0.62	10.41.0.63
Subnet 05	Ayham's LAN 5	10.41.0.64	255.255.255.240	/28	10.41.0.65	10.41.0.78	10.41.0.79
Subnet 06	Ayham's LAN 6	10.41.0.80	255.255.255.240	/28	10.41.0.81	10.41.0.94	10.41.0.95
Subnet 07	Ayham's LAN 7	10.41.0.96	255.255.255.240	/28	10.41.0.97	10.41.0.110	10.41.0.111
Subnet 08	Ayham's LAN 8	10.41.0.112	255.255.255.240	/28	10.41.0.113	10.41.0.126	10.41.0.127
Subnet 09	Ayham's LAN 9	10.41.0.128	255.255.255.240	/28	10.41.0.129	10.41.0.142	10.41.0.143
Subnet 10	Ayham's LAN 10	10.41.0.144	255.255.255.240	/28	10.41.0.145	10.41.0.158	10.41.0.159
Subnet 11	Samet LAN 1	10.41.0.160	255.255.255.240	/28	10.41.0.161	10.41.0.174	10.41.0.175
Subnet 12	Samet LAN 2	10.41.0.176	255.255.255.240	/28	10.41.0.177	10.41.0.190	10.41.0.191
Subnet 13	Samet LAN 3	10.41.0.192	255.255.255.240	/28	10.41.0.193	10.41.0.206	10.41.0.207
Subnet 14	Samet LAN 4	10.41.0.208	255.255.255.240	/28	10.41.0.209	10.41.0.222	10.41.0.223
Subnet 15	WAN Link	10.41.0.224	255.255.255.252	/30	10.41.0.225	10.41.0.226	10.41.0.227

Table (1): Network Subnet Design

2.2 Networks Topologies Designs:

2.2.1 Ayham's network:

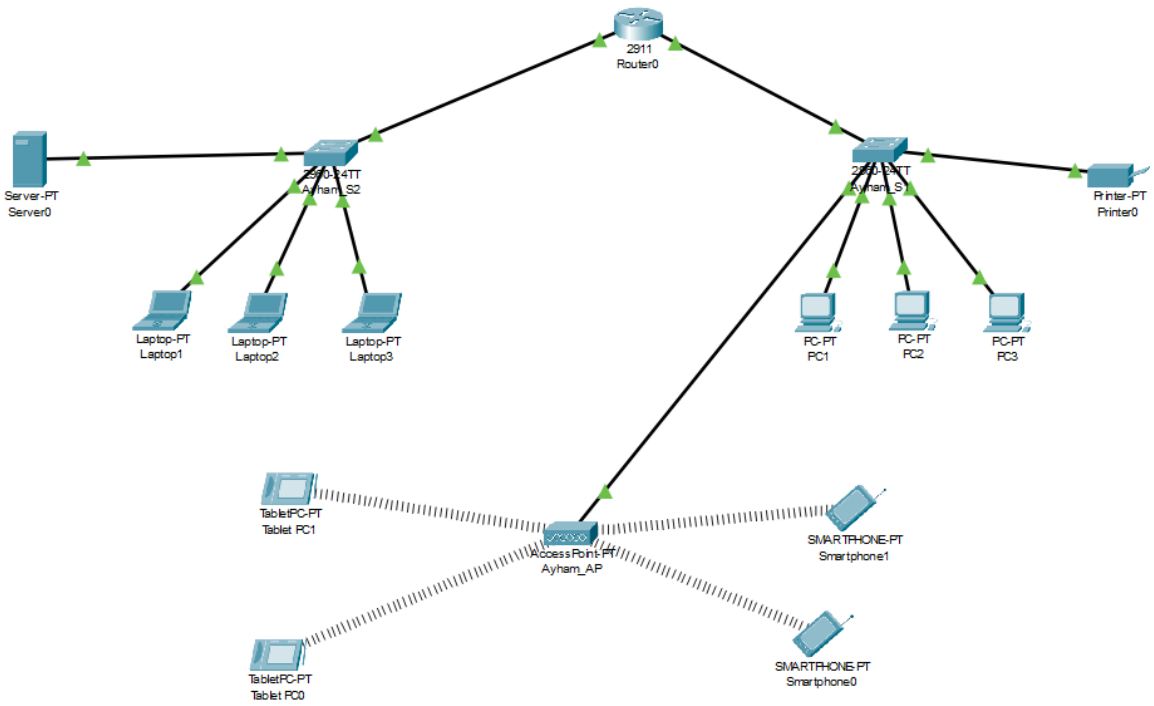

Image (1): Ayham's network topology

Ayham's company network consists of:

- 1 2911 Router (connecting to all internal subnets and the WAN)
- 2 2960 Switches (distributing connections within the office)
- 10 LAN subnets (as calculated earlier, however only 3 are being used)
- 1 Wireless Access Point_¨PT
- Multiple end devices (computers, laptops, tablets, phones, printers)

Detailed Subnet Usage:

- Switch 1 (Connected to Router with a Straight-Through Copper cable): Subnet 01 (10.41.0.2/28): Main office area
  - Desktop computers
  - 1 Printer
  - Router connection
  - Switch management interface

- Switch 2 (Connected to Router a Straight-Through Copper cable): Subnet 02 (10.41.0.18/28): Secondary office area

    - Laptop computers
    - 1 Server
    - Router connection
    - Switch management interface

- Wireless Network (Access Point connected to Switch 1 a Straight-Through Copper cable): Subnet 03 (10.41.0.34/28):

    - 1 Access Point
    - Smartphones
    - 2 Tablets
    - 1 Wireless printer

- Additional Subnets (for future expansion):
    - Subnet 04 (10.41.0.48/28): Department A
    - Subnet 05 (10.41.0.64/28): Department B
    - Subnet 06 (10.41.0.80/28): Department C
    - Subnet 07 (10.41.0.96/28): Department D
    - Subnet 08 (10.41.0.112/28): Department E
    - Subnet 09 (10.41.0.128/28): IT Management
    - Subnet 10 (10.41.0.144/28): Guest Network

- WAN Connection: Subnet 15 (10.41.0.224/30): Connection to partner's company

    - Ayham’s router's WAN interface: 10.41.0.225/30
    - Samet’s router's WAN interface: 10.41.0.226/30

In addition, Ayham’s company addressing table was set as show in *Table (2)*:

Device Name	Interface	IP Address	Subnet Mask	Default Gateway	Password
Ayham_R	G0/0	10.41.0.1	255.255.255.240	N/A	Ayham
	G0/1	10.41.0.17	255.255.255.240	N/A	Ayham
	G0/2	10.41.0.225	255.255.255.252	N/A	Ayham
	G0/3	10.41.0.33	255.255.255.240	N/A	Ayham
Ayham_S1	VLAN 1	10.41.0.2	255.255.255.240	10.41.0.1	Ayham
Ayham _S2	VLAN 1	10.41.0.18	255.255.255.240	10.41.0.17	Ayham
Ayham _AP	Ethernet	10.41.0.34	255.255.255.240	10.41.0.33	Ayham
Ayham _PC1	NIC	10.41.0.3	255.255.255.240	10.41.0.1	N/A
Ayham _PC2	NIC	10.41.0.4	255.255.255.240	10.41.0.1	N/A
Ayham _PC3	NIC	10.41.0.5	255.255.255.240	10.41.0.1	N/A
Ayham _Printer1	NIC	10.41.0.6	255.255.255.240	10.41.0.1	N/A
Ayham _Laptop1	NIC	10.41.0.19	255.255.255.240	10.41.0.17	N/A
Ayham _Laptop2	NIC	10.41.0.20	255.255.255.240	10.41.0.17	N/A
Ayham _Laptop3	NIC	10.41.0.21	255.255.255.240	10.41.0.17	N/A
Ayham _Server	NIC	10.41.0.22	255.255.255.240	10.41.0.17	N/A
Ayham _Phone1	WiFi	10.41.0.35	255.255.255.240	10.41.0.33	N/A
Ayham _Phone2	WiFi	10.41.0.36	255.255.255.240	10.41.0.33	N/A
Ayham _Tablet1	WiFi	10.41.0.37	255.255.255.240	10.41.0.33	N/A
Ayham _Tablet2	WiFi	10.41.0.38	255.255.255.240	10.41.0.33	N/A

Table (2): Ayham's Company Adress table

- The router has interfaces connecting to Switch 1 (G0/0), Switch 2 (G0/1) and the WAN (G0/2).
- Each subnet has a different network address from our VLSM plan.
- All end devices have their respective subnet's router interface as the default gateway.

IP Interfaces Configuration for Ayham's Network:

```
Ayham_R>enable
Password:
Ayham_R#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
GigabitEthernet0/0     10.41.0.1       YES NVRAM  up                    up
GigabitEthernet0/1     10.41.0.17      YES NVRAM  up                    up
GigabitEthernet0/2     10.41.0.225     YES NVRAM  up                    up
Loopback3              unassigned      YES NVRAM  up                    up
Loopback4              10.41.0.49      YES NVRAM  up                    up
Loopback5              10.41.0.65      YES NVRAM  up                    up
Loopback6              10.41.0.81      YES NVRAM  up                    up
Loopback7              10.41.0.97      YES NVRAM  up                    up
Loopback8              10.41.0.113     YES NVRAM  up                    up
Loopback9              10.41.0.129     YES NVRAM  up                    up
Loopback10             10.41.0.145     YES NVRAM  up                    up
Vlan1                  unassigned      YES NVRAM  administratively down down
Ayham_R#
```

```
Ayham_R#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, 24 subnets, 3 masks
C       10.41.0.0/28 is directly connected, GigabitEthernet0/0
L       10.41.0.1/32 is directly connected, GigabitEthernet0/0
C       10.41.0.16/28 is directly connected, GigabitEthernet0/1
L       10.41.0.17/32 is directly connected, GigabitEthernet0/1
C       10.41.0.48/28 is directly connected, Loopback4
L       10.41.0.49/32 is directly connected, Loopback4
C       10.41.0.64/28 is directly connected, Loopback5
L       10.41.0.65/32 is directly connected, Loopback5
C       10.41.0.80/28 is directly connected, Loopback6
L       10.41.0.81/32 is directly connected, Loopback6
C       10.41.0.96/28 is directly connected, Loopback7
L       10.41.0.97/32 is directly connected, Loopback7
C       10.41.0.112/28 is directly connected, Loopback8
L       10.41.0.113/32 is directly connected, Loopback8
C       10.41.0.128/28 is directly connected, Loopback9
L       10.41.0.129/32 is directly connected, Loopback9
C       10.41.0.144/28 is directly connected, Loopback10
L       10.41.0.145/32 is directly connected, Loopback10
R       10.41.0.160/28 [120/1] via 10.41.0.226, 00:00:02, GigabitEthernet0/2
R       10.41.0.176/28 [120/1] via 10.41.0.226, 00:00:02, GigabitEthernet0/2
R       10.41.0.192/28 [120/1] via 10.41.0.226, 00:00:02, GigabitEthernet0/2
R       10.41.0.208/28 [120/1] via 10.41.0.226, 00:00:02, GigabitEthernet0/2
C       10.41.0.224/30 is directly connected, GigabitEthernet0/2
L       10.41.0.225/32 is directly connected, GigabitEthernet0/2
```

Image (2): Ayham's Router Interfaces

Loopbacks were used to assigning IPv4 addresses for all subnets without being connected to physical devices.

2.2.2 Samet's network:

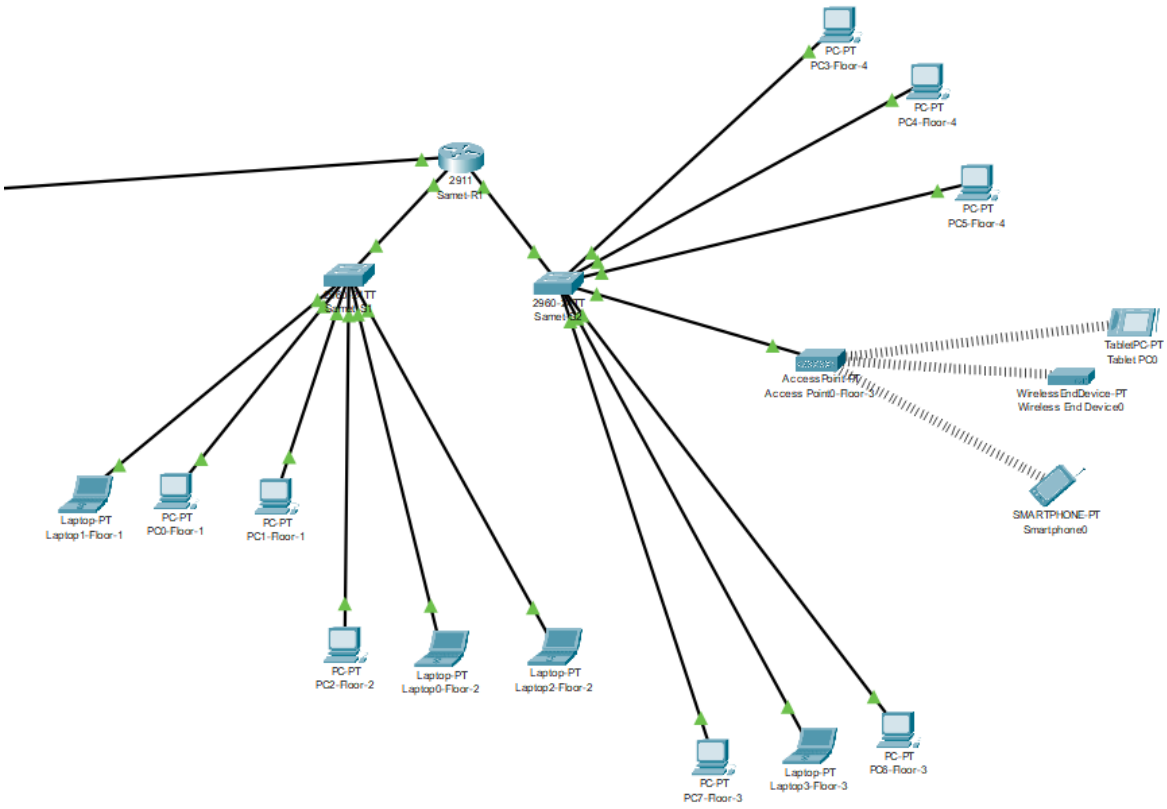

Image (3): Samet's network topology

Samet's company network consists of:

- 1 2911 Router (connecting to all internal subnets and the WAN)
- 2 2960 Switches (distributing connections within the office)
- 10 LAN subnets (as calculated earlier, however only 3 are being used)
- 1 Wireless Access Point_¨PT
- Multiple end devices (computers, laptops, tablets, phones, printers)

Detailed Subnet Usage:

- Switch 1 (Connected to Router): Subnet 01 (10.41.0.165/28): Main office area
  - Desktop computers
  - 1 Printer
  - Router connection
  - Switch management interface

- Switch 2 (Connected to Router): Subnet 02 (10.41.0.195/28): Secondary office area

  - Laptop computers
  - 1 Server
  - Router connection
  - Switch management interface

- Wireless Network (Access Point connected to Switch 1): Subnet 03 (10.41.0.178/28):

  - 1 Access Point
  - Smartphones
  - 2 Tablets
  - 1 Wireless printer

Device Name	Interface	IP Address	Subnet Mask	Default Gateway	Password
Samet-R1 (Router)	G0/0.11 (VLAN 11)	10.41.0.161	255.255.255.240 (/28)	N/A	Samet
Samet-R1	G0/0.12 (VLAN 12)	10.41.0.177	255.255.255.240 (/28)	N/A	Samet
Samet-R1	G0/1.13 (VLAN 13)	10.41.0.193	255.255.255.240 (/28)	N/A	Samet
Samet-R1	G0/1.14 (VLAN 14)	10.41.0.209	255.255.255.240 (/28)	N/A	Samet
Samet-R1	G0/2 (WAN)	10.41.0.226	255.255.255.252 (/30)	N/A	Samet
Samet-S1 (Switch)	VLAN 11 SVI	10.41.0.165	255.255.255.240 (/28)	10.41.0.161	Samet
Samet-S2	VLAN 13 SVI	10.41.0.197	255.255.255.240 (/28)	10.41.0.193	Samet
Samet_AP	WLAN Interface	10.41.0.178	255.255.255.240 (/28)	10.41.0.177	Samet

PC1-Floor1 (Samet)	Ethernet	10.41.0.162	255.255.255.240 (/28)	10.41.0.161	N/A
PC2-Floor1 (Samet)	Ethernet	10.41.0.163	255.255.255.240 (/28)	10.41.0.161	N/A
PC3-Floor1 (Samet)	Ethernet	10.41.0.164	255.255.255.240 (/28)	10.41.0.161	N/A
Laptop1-Floor2 (Samet)	Wireless NIC	10.41.0.179	255.255.255.240 (/28)	10.41.0.177	N/A
Tablet1-Floor2 (Samet)	Wireless NIC	10.41.0.180	255.255.255.240 (/28)	10.41.0.177	N/A
Phone1-Floor2 (Samet)	Wireless NIC	10.41.0.181	255.255.255.240 (/28)	10.41.0.177	N/A
PC1-Floor3 (Samet)	Ethernet	10.41.0.194	255.255.255.240 (/28)	10.41.0.193	N/A
PC2-Floor3 (Samet)	Ethernet	10.41.0.195	255.255.255.240 (/28)	10.41.0.193	N/A
PC3-Floor3 (Samet)	Ethernet	10.41.0.196	255.255.255.240 (/28)	10.41.0.193	N/A
PC1-Floor4 (Samet)	Ethernet	10.41.0.210	255.255.255.240 (/28)	10.41.0.209	N/A
PC2-Floor4 (Samet)	Ethernet	10.41.0.211	255.255.255.240 (/28)	10.41.0.209	N/A
PC3-Floor4 (Samet)	Ethernet	10.41.0.212	255.255.255.240 (/28)	10.41.0.209	N/A

Tabke (3): Samet's Company Adress table

In our implementation, Samet's network utilized trunking and router-on-a-stick architecture to enable inter-VLAN routing. Multiple VLANs (each mapped to a different floor) were assigned

distinct /28 subnets through Variable Length Subnet Masking (VLSM), optimizing address space while ensuring each VLAN had enough host capacity. Two physical interfaces on the router (G0/0 and G0/1) were configured as 802.1Q trunk links to two separate switches. Each VLAN was mapped to a dedicated router subinterface (e.g., G0/0.11, G0/1.13), allowing the router to serve as the default gateway for each VLAN. This design enabled full inter-VLAN communication within Samet's network. Ayhem's network was configured differently and does not use trunking; his methodology will be described separately.

```
Samet-S1#show interfaces trunk
Port        Mode         Encapsulation  Status        Native vlan
Fa0/1       on           802.1q         trunking      1

Port        Vlans allowed on trunk
Fa0/1       11-12

Port        Vlans allowed and active in management domain
Fa0/1       11,12

Port        Vlans in spanning tree forwarding state and not pruned
Fa0/1       11,12

Samet-S1#
```

Image (4): Trunking information at S1

```
Samet-S2#show interfaces trunk
Port        Mode         Encapsulation  Status        Native vlan
Fa0/1       on           802.1q         trunking      1

Port        Vlans allowed on trunk
Fa0/1       13-14

Port        Vlans allowed and active in management domain
Fa0/1       13,14

Port        Vlans in spanning tree forwarding state and not pruned
Fa0/1       13,14

Samet-S2#
```

Image (5): Trunking information at S2

IP Interfaces Configuration for Samet's Network:

```
Samet-R1>enable
Password:
Samet-R1#show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
GigabitEthernet0/0     unassigned      YES manual up                    up
GigabitEthernet0/0.11  10.41.0.161     YES manual up                    up
GigabitEthernet0/0.12  10.41.0.177     YES manual up                    up
GigabitEthernet0/1     unassigned      YES manual up                    up
GigabitEthernet0/1.13  10.41.0.193     YES manual up                    up
GigabitEthernet0/1.14  10.41.0.209     YES manual up                    up
GigabitEthernet0/2     10.41.0.226     YES manual up                    up
Vlan1                  unassigned      YES unset  administratively down down
Samet-R1#

Samet-R1#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, 19 subnets, 3 masks
R       10.41.0.0/28 [120/1] via 10.41.0.225, 00:00:12, GigabitEthernet0/2
R       10.41.0.16/28 [120/1] via 10.41.0.225, 00:00:12, GigabitEthernet0/2
R       10.41.0.48/28 [120/1] via 10.41.0.225, 00:00:12, GigabitEthernet0/2
R       10.41.0.64/28 [120/1] via 10.41.0.225, 00:00:12, GigabitEthernet0/2
R       10.41.0.80/28 [120/1] via 10.41.0.225, 00:00:12, GigabitEthernet0/2
R       10.41.0.96/28 [120/1] via 10.41.0.225, 00:00:12, GigabitEthernet0/2
R       10.41.0.112/28 [120/1] via 10.41.0.225, 00:00:12, GigabitEthernet0/2
R       10.41.0.128/28 [120/1] via 10.41.0.225, 00:00:12, GigabitEthernet0/2
R       10.41.0.144/28 [120/1] via 10.41.0.225, 00:00:12, GigabitEthernet0/2
C       10.41.0.160/28 is directly connected, GigabitEthernet0/0.11
L       10.41.0.161/32 is directly connected, GigabitEthernet0/0.11
C       10.41.0.176/28 is directly connected, GigabitEthernet0/0.12
L       10.41.0.177/32 is directly connected, GigabitEthernet0/0.12
C       10.41.0.192/28 is directly connected, GigabitEthernet0/1.13
L       10.41.0.193/32 is directly connected, GigabitEthernet0/1.13
C       10.41.0.208/28 is directly connected, GigabitEthernet0/1.14
L       10.41.0.209/32 is directly connected, GigabitEthernet0/1.14
C       10.41.0.224/30 is directly connected, GigabitEthernet0/2
L       10.41.0.226/32 is directly connected, GigabitEthernet0/2
```

Image (6): Samet's Router Interfaces

3 MAIN FINDINGS

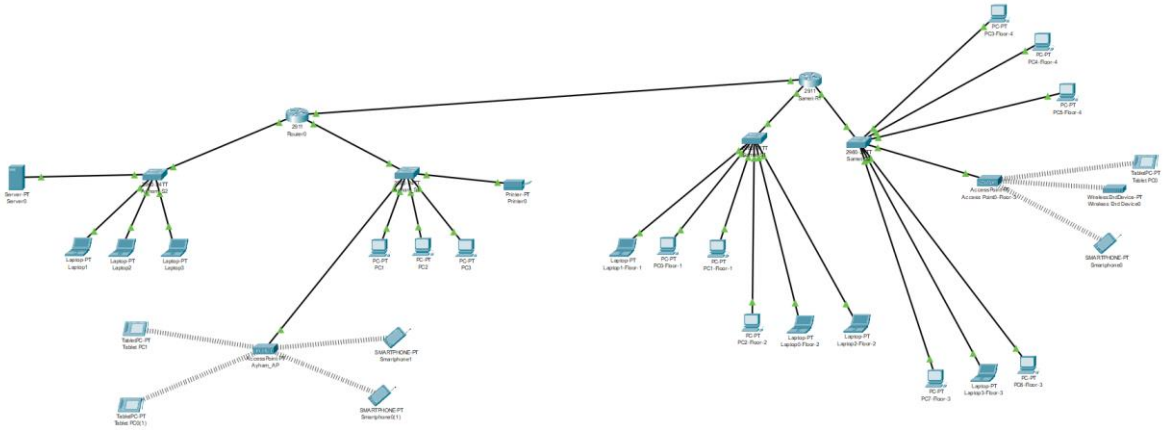

Image (7): Companies WAN Connection

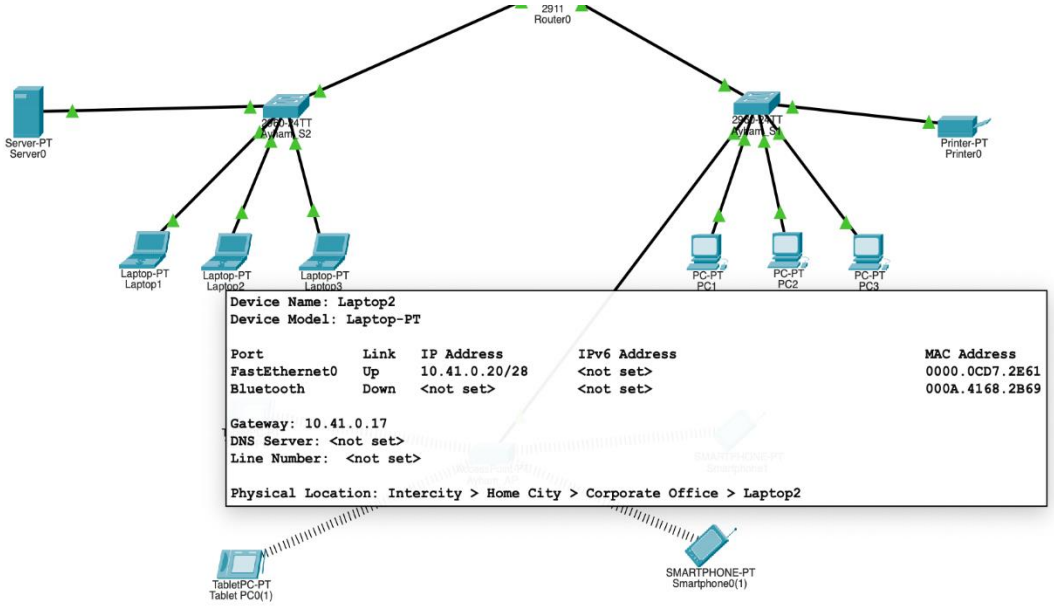

Image (8): Source device network information summary

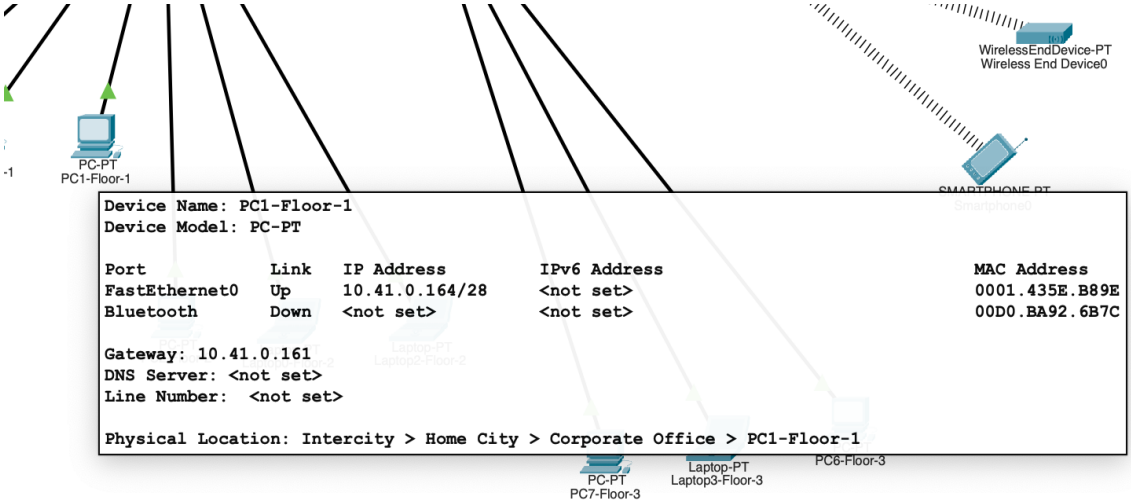

Image (9): Destination device network information summary

Image 8 shows the configuration details of Laptop2, which is connected to the network via interface FastEthernet0 with IP address 10.41.0.20/28 and default gateway 10.41.0.17. This device is part of the VLAN 12 subnet in Samet's network.

Image 9 displays the settings of PC1-Floor-1, which is assigned IP address 10.41.0.164/28 with default gateway 10.41.0.161. It belongs to VLAN 11 in Samet's network. Both devices were used in connectivity tests to verify inter-VLAN communication.

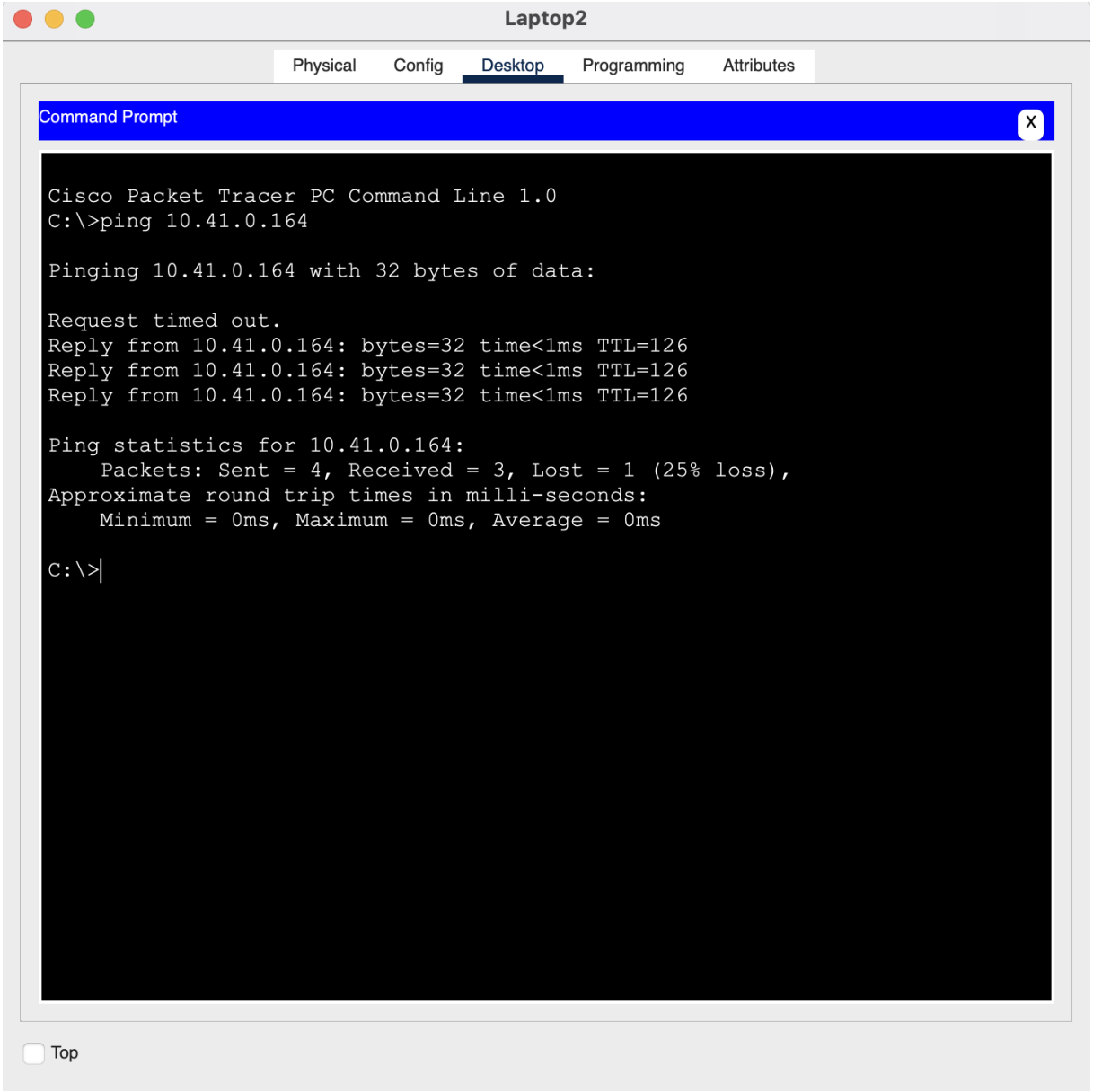

Image (10): Pinging Samet's PC1-Floor-1 from Ayham's Laptop2 device

A ping test from Laptop2 to 10.41.0.164 showed 3 out of 4 successful replies, with 1 initial timeout likely due to ARP resolution. The response time for all received packets was under 1 ms, indicating a fast and direct local connection. This result confirms basic connectivity and proper IP configuration between the two hosts.

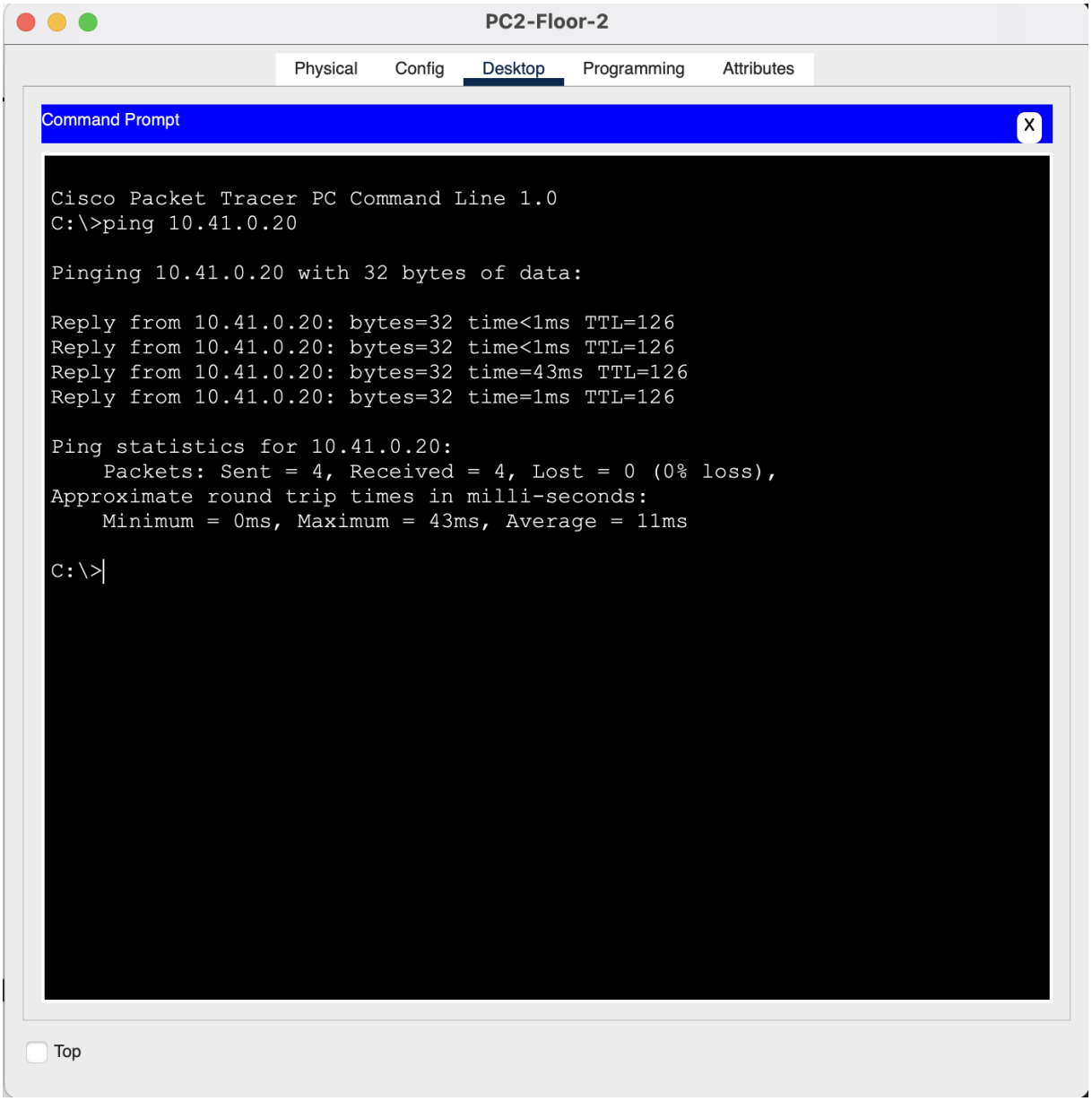

Image (11): Pinging Ayham's Laptop from Samet's PC1-Floor-1 2 device

A ping test was conducted from PC2-Floor-2 to 10.41.0.20, resulting in 4/4 successful replies with 0% packet loss. Response times ranged from 0 to 43 ms, indicating stable and direct communication within the local network or across routed VLANs. This confirms that IP configuration, inter-VLAN routing (if applicable), and switch connectivity are functioning correctly.

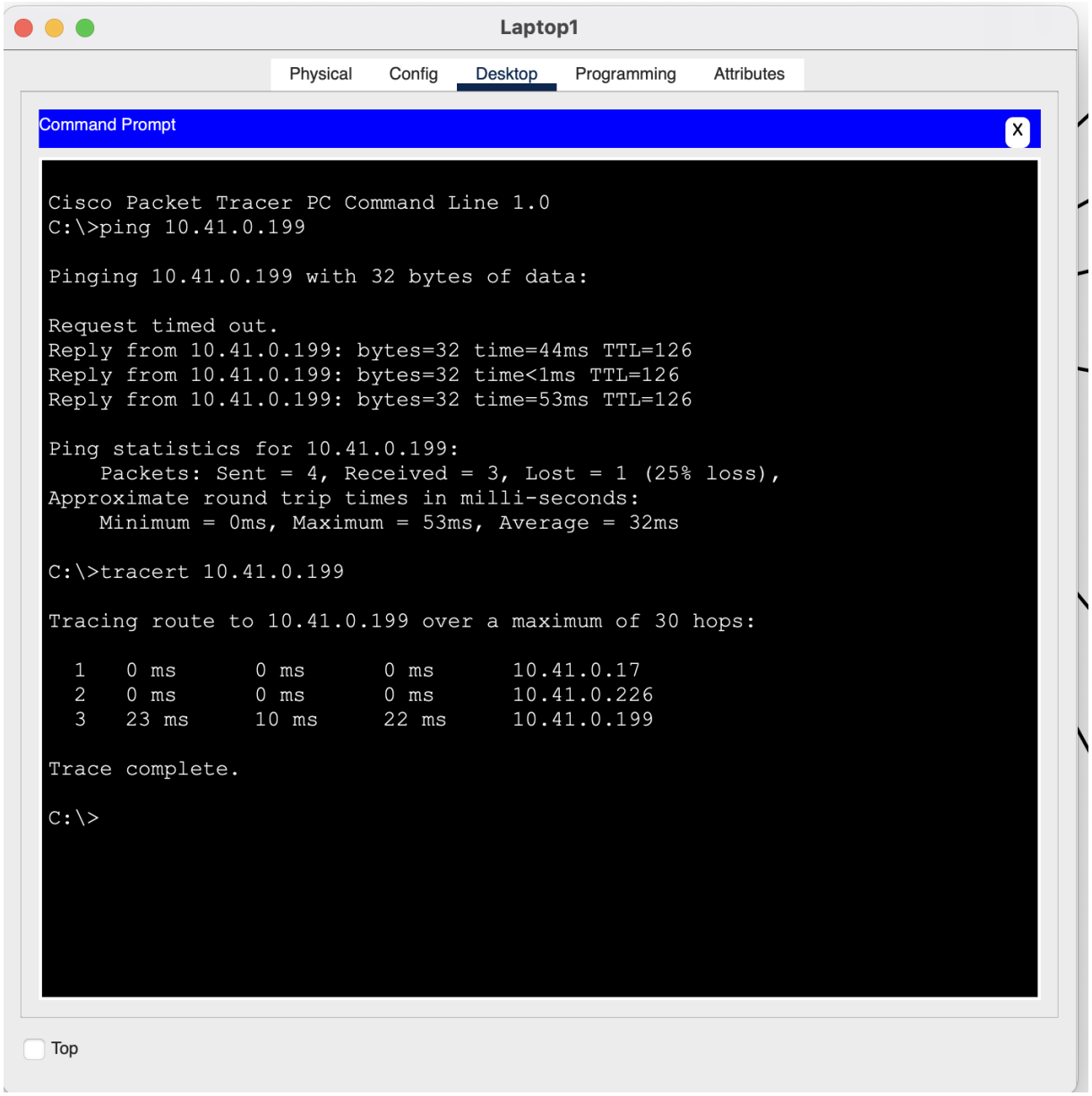

Image (12): Using tracert command in Laptop1 and tracing route to 10.41.0.199

We tested end-to-end connectivity from Laptop1 to IP 10.41.0.199 using ping and tracert. The ping was mostly successful (3/4 replies), with the first packet likely timing out due to ARP resolution. The traceroute showed three hops: the local gateway (10.41.0.17), Samet's router WAN interface (10.41.0.226), and the destination. This confirms that inter-VLAN routing, the WAN link, and RIP route propagation are all functioning correctly.

4 DISCUSSION

The design and implementation of the network topology for both companies demonstrated the practical application of several core networking concepts. By using VLSM, we were able to minimize IP address waste and ensure scalability for future expansion. Implementing inter-VLAN routing on Layer 3 switches allowed for efficient internal communication while maintaining logical separation between departments. Connecting the two companies via a WAN link using static routing provided a simple yet effective method for inter-company communication.

During the simulation, we encountered several challenges such as configuring trunk links correctly, assigning appropriate VLANs, and ensuring routing consistency across both networks. These issues highlighted the importance of careful planning and step-by-step verification during network configuration. Moreover, the project emphasized the necessity of good documentation, as consistent IP addressing and VLAN planning were crucial for troubleshooting and future maintenance.

Overall, the project provided valuable hands-on experience in designing a realistic enterprise network. It reinforced theoretical knowledge gained in class and helped us develop practical skills that are directly applicable to real-world network engineering tasks.

5 CONCLUSION

In this project, we designed and implemented a realistic network that connects two separate company LANs using Cisco Packet Tracer. Each company's network was divided into four VLANs—one for each floor—allowing for clear organizational structure and traffic management. We used a router-on-a-stick setup to enable inter-VLAN communication and connected the two companies through a point-to-point WAN link. To handle routing between the companies, we used RIPv2, which also allows the network to adapt to changes or future expansions.

We planned IP addressing carefully using VLSM, making sure to assign IPs from the 10.41.0.0/16 block efficiently. This helped us meet all host requirements while minimizing address waste. Every important configuration element—hostnames, passwords, VLANs, IP addresses, and routing—was implemented following both academic guidelines and best practices used in the industry.

As a result, we built a stable and secure network where each company retains its internal structure while being able to communicate seamlessly with the other. Testing showed that all parts of the network are working as intended: devices communicate properly across VLANs and over the WAN link. RIPv2 helps by automatically advertising routes, which is useful if new subnets are added later. We also took basic steps to improve security, such as setting passwords and login banners—an important practice in real-world deployments.

Overall, this project gave us valuable hands-on experience with designing and configuring a multi-site enterprise network. We put into practice key networking concepts like subnetting, VLANs, inter-VLAN routing, and dynamic routing. The final Packet Tracer file includes all configurations and can be used as a base for future improvements, such as adding redundancy or trying out different routing protocols. Through this work, we deepened our understanding of how real-world networks are planned and built.

REFERENCES

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