SCHOOL OF ENGINEERING AND TECHNOLOGY

ASSIGNMENT COVER SHEET

COURSE: NET1014 – Networking Principles

LEVEL: BCNS, BIT, BCS, BSE, BDS - Year 1

ACADEMIC SESSION: September 2024 Semester

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GROUP NO: 22

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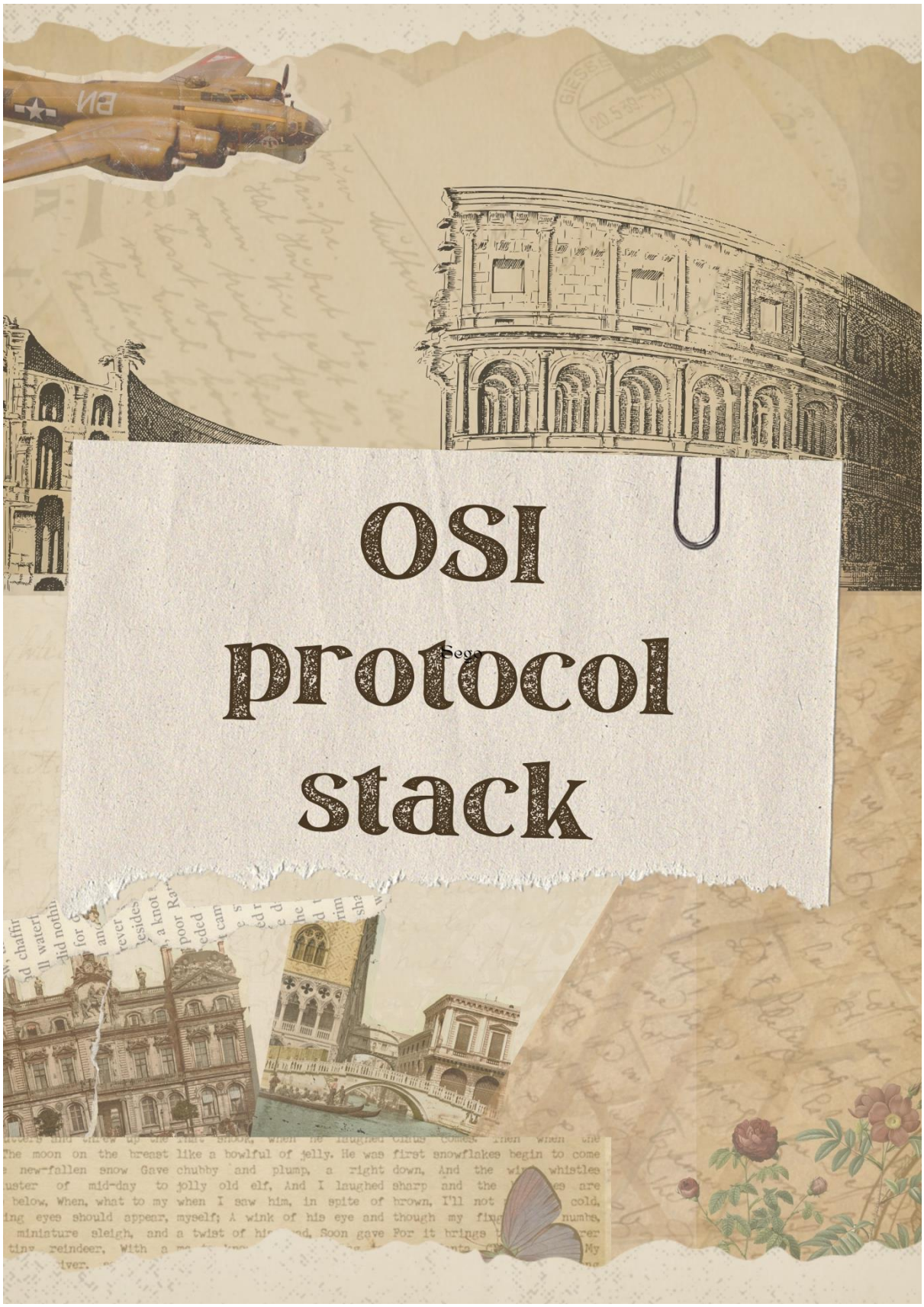
1. **Comprehensive Analysis of OSI Protocol Stack (20 marks)**



Introduction

OSI model:

OSI also know as "open system interconnection" is a conceptual framework created by **international organization for standardization (ISO)** that is used to to give accurate details about the function of networking systems. an **OSI** model also acts a universal language for computing networking allowing for different type of communication systems for standard protocol. In a **OSI** communication systems are split into **7** different abstract layers: **Physical Layer**, **Data Link Layer**, **Network Layer**, **Transport Layer**, **Session Layer**, **Presentation Layer**, and **Application Layer.**

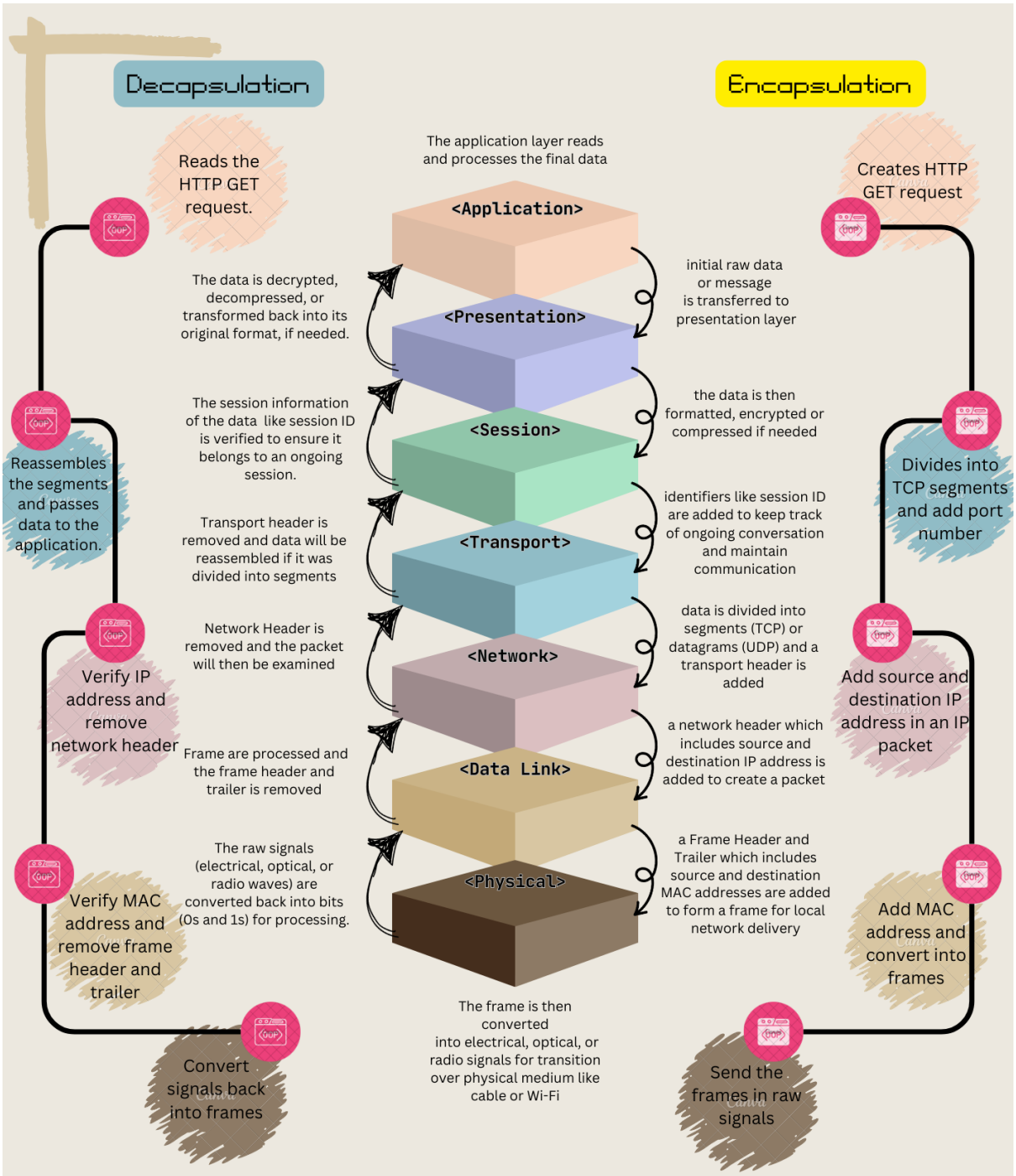
Advantages:

- Scalability: OSI provides a scalable framework for designing and expanding a network. It can also add new hardware and software components as organizations grow, allowing for networks to adapt to change without overhauls and network disruption.
- Common language: OSI models provide common languages that can be used to communicate with other network professionals from other groups or organizations. Common language also help prevent misunderstandings when discussing about network issues.
- Vendor_Neutral: OSI models are vendor neutral meaning that it is not tied to any manufacturer, which allows fair competition in the networking industry and it ensures for multiple networking solutions.

Challenges:

- Abstract and theoretical in nature, these models are seldom implemented precisely as defined. In practical applications, certain layers often overlap, as observed in the TCP/IP model.
- Highly conceptual, these models serve primarily as frameworks for understanding rather than strict blueprints. Real-world implementations often adapt or combine layers to suit specific requirements.

Layer	Purpose	Key Protocols	Example Applications
Application (7)	Offers the user services	HTTP, FTP, SMTP, DNS	Web browsing, file sharing
Presentation (6)	Encryption and data translation	SSL/TLS, JPEG, GIF	Secure websites, multimedia formats
Session (5)	Oversees data sharing and sessions.	NetBIOS, PPTP	Remote desktop, VPN
Transport (4)	Guarantees dependable data transmission	TCP, UDP	Streaming video (UDP), file downloads (TCP)
Network (3)	Handles logical addressing and routing	IP, ICMP	Internet communication, error reporting
Data Link (2)	Manages routing and logical addressing	Ethernet, PPP	Local networks (LANs), DSL
Physical (1)	Sends a raw bitstream over a tangible medium.	Ethernet cables, Wi-Fi	Wired and wireless connections



Writing the Evaluation
For the evaluation, consider:

Real-world scenarios (e.g., how OSI aids in troubleshooting).
Discuss modern trends and whether OSI is still fully relevant (hint: many systems follow the simpler TCP/IP model).

2. Design and Implementation of a Network (80 marks)

Part A: Design (30 marks)

1. List of Required Equipment

a) Cisco 2911 Routers (2):

- Justification: The routers allow communication between subnets. One of the routers is used in connecting the HUMAC Lab, and the other router is used for connecting the SET Labs. It also offers the network routing to external connectivity as and when required.

b) Cisco Catalyst 2950-24 Switches (5):

- Justification: Every lab has one switch to connect the wired devices such as PCs, servers, and printers in HUMAC, Communications, Advanced Wireless, and IoT Labs. One more core switch added to provide the fluent communication between the labs and routers.

c) Access Point-PT (4):

- Justification: One access point is installed in every lab to provide mobile devices like laptops, tablets, and smartphones with wireless access to ensure flexibility and mobility among wireless users.

d) Copper Straight-Through Cables (16):

- Justification: The cables that interlink these devices like PCs, servers, and printers with the network switches are actually used in providing dependable wired connectivity.

e) Copper Cross-Over Cables (3):

- Justification: The network devices directly connect using crossover cables, such as switch-to-switch and router-to-switch connections, which allow adequate intercommunication among devices.

f) Serial DTE Cable (1):

- Justification: A serial DTE cable links the Uni Router and SET Router for communication between the two buildings, the University and SET.

g) PC-PT (10):

- Justification: PC-PT uses computers as wired workstation setups. Four PCs each housed in HUMAC Lab and IoT Lab; two PCs allocated to Communications Lab.

h) Laptop-PT (8):
    - Justification: Laptops enable portability and flexibility by allowing wireless connectivity to access points. Each lab has two laptops, which support mobile use-case scenarios and wireless testing.

i) TabletPC-PT (3):
    - Justification: Tablets would facilitate the task of testing and monitoring wireless and IoT functionalities, as well as increased flexibility on the part of users.

j) Smartphone-PT (2):
    - Justification: Smartphones allow testing of mobile wireless connectivity and IoT network performance to cover strong wireless coverage.

k) Server-PT (2):
    - Justification: The servers have their hosts for important network services like DHCP, DNS, file sharing, and such. Both servers are designed for the IoT Lab.

l) Printer-PT (1):
    - Justification: A shared network printer available within the Communication Lab to print documents from different laboratories.

2. **Estimated Cost of the Equipment**

Category	Equipment	Quantity	Unit Cost (USD)	Total Cost (USD)	Details
Routers	Cisco 2911 Router	2	$3,550	$7,100	Uni Router and SET Router for intersubnet and interbuilding communication
Switches	Cisco Catalyst 2950-24 Switch	5	$3,550	$17,750	HUMAC Lab, Communication Lab, IoT Lab, Advanced Wireless Lab, and Main Switch
Access Points	Cisco Aironet 1830 Access Point	4	$373	$1,492	HUMAC Lab (1), Communication Lab (1), IoT Lab (1), Advanced Wireless Lab (1)
Servers	Generic Server	2	$1,758	$3,516	DNS Server and HTTP Server in IoT Lab
End Devices	PCs (PC-PT)	10	$800	$8,000	HUMAC Lab (4), IoT Lab (4), Communication Lab (2)
	Laptops (Laptop-PT)	8	$1,000	$8,000	HUMAC Lab (2), IoT Lab (2), Communication Lab (2), Advanced Wireless Lab (2)
	Tablets (Tablet-PT)	3	$600	$1,800	HUMAC Lab (1), Communication Lab (1), Advanced Wireless Lab (1)
	Smartphones (Smartphone-PT)	2	$400	$800	HUMAC Lab (1), Advanced Wireless Lab (1)
	Printer (Printer-PT)	1	$500	$500	Communication Lab (1)
Cables	Copper Straight-	16	$5	$80	To connect end devices and switches.

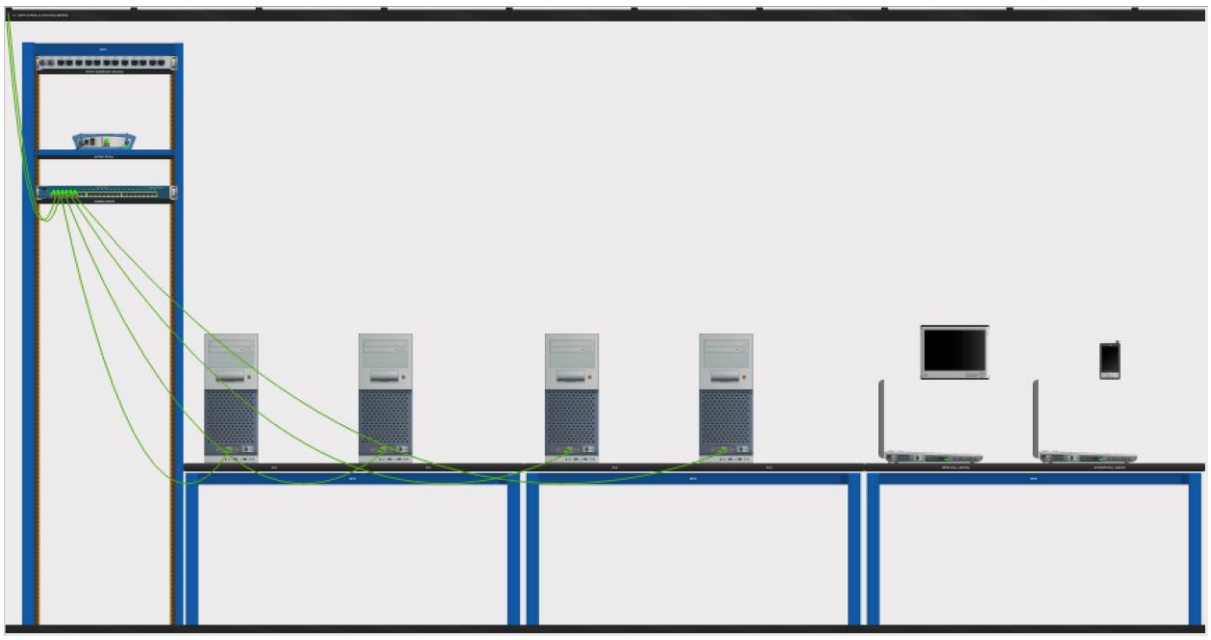
	Through Cable				
	Copper Crossover Cable	3	$10	$30	To connect switches to routers.
	Serial DTE Cable	1	$15	$15	To connect the Uni Router to the SET Router.
Grand Total				$49,083	

3. **Physical topology**

The physical topology underpins the connection locations of the switches, routers, access points, and end devices in each lab to meet the respective connectivity and accessibility requirements.

HUMAC Lab

In particular, the HUMAC Lab located at the 3rd floor of the University Building consists of a 2950-24 switch (HUMAC Switch), which serves as the main point of reference for wired and wireless connections within that location. Wired devices such as: PC0, PC1, PC2, and PC3 are hardwired to the switch, while wireless devices such as Laptop0, Laptop1, Tablet PC0, and Smartphone0 connect through Access Point0, which is connected to the switch. The HUMAC Switch is directly connected to the Uni Router for delivering traffic from and to other subnets.

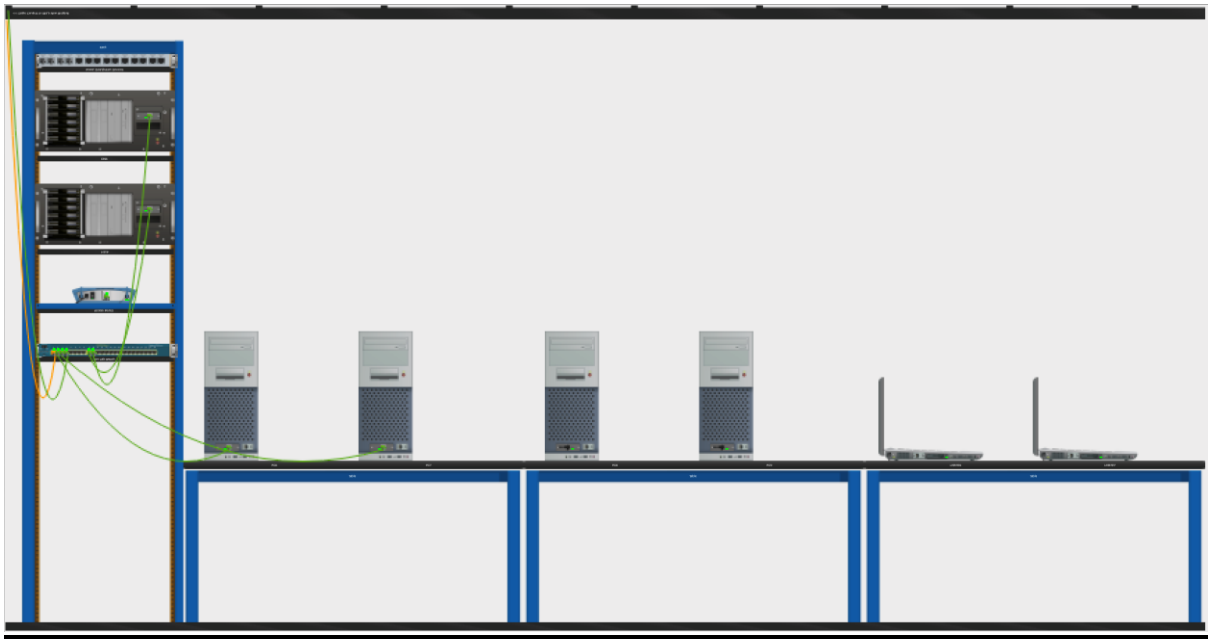


SET Building Labs

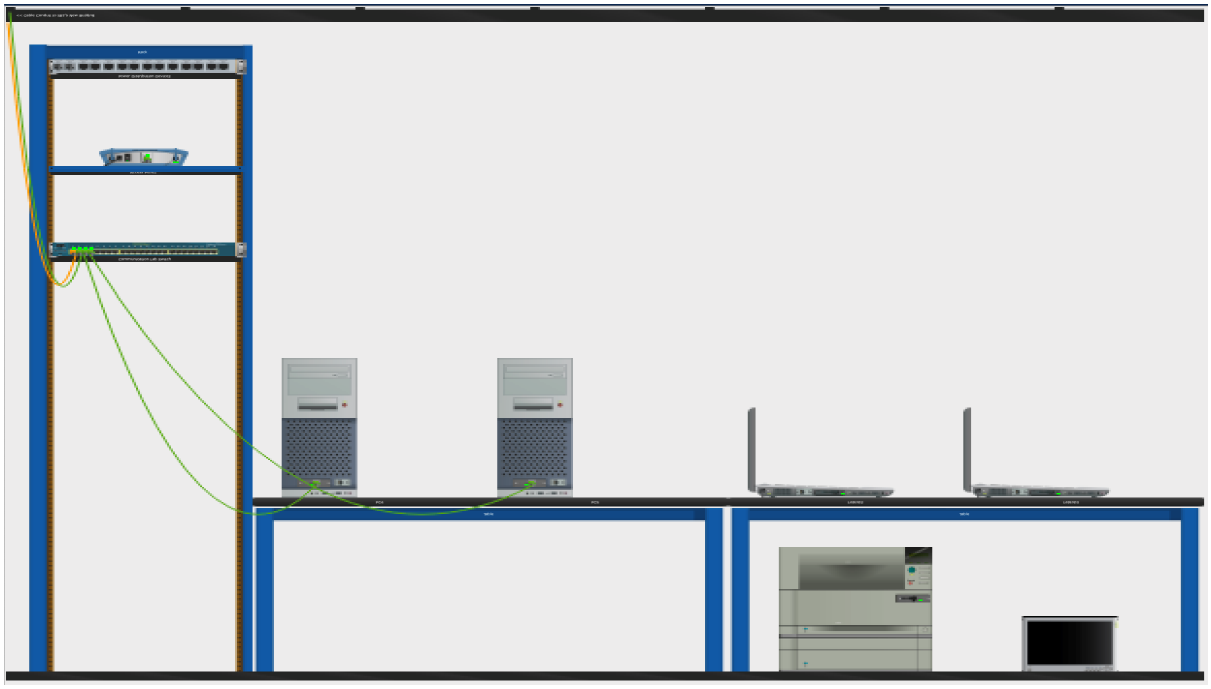
Within the SET Building, the Main Switch, which bears the IP address of 192.168.8.52, serves as the connecting point for the switches of the Communication Lab, the IoT Lab, and the Advanced Wireless Lab with an SET Router.

- **IoT Lab**: The connectivity of IoT Lab with the Main Switch is further established through the 2950-24 switch that is coined as the IoT Lab Switch. DNS Server and HTTP servers, along with wired PCs like PC6 and PC7 are connected directly to the IoT Lab Switch. Connection of wireless devices, like PC8, PC9, Laptop6, and Laptop7, occurs

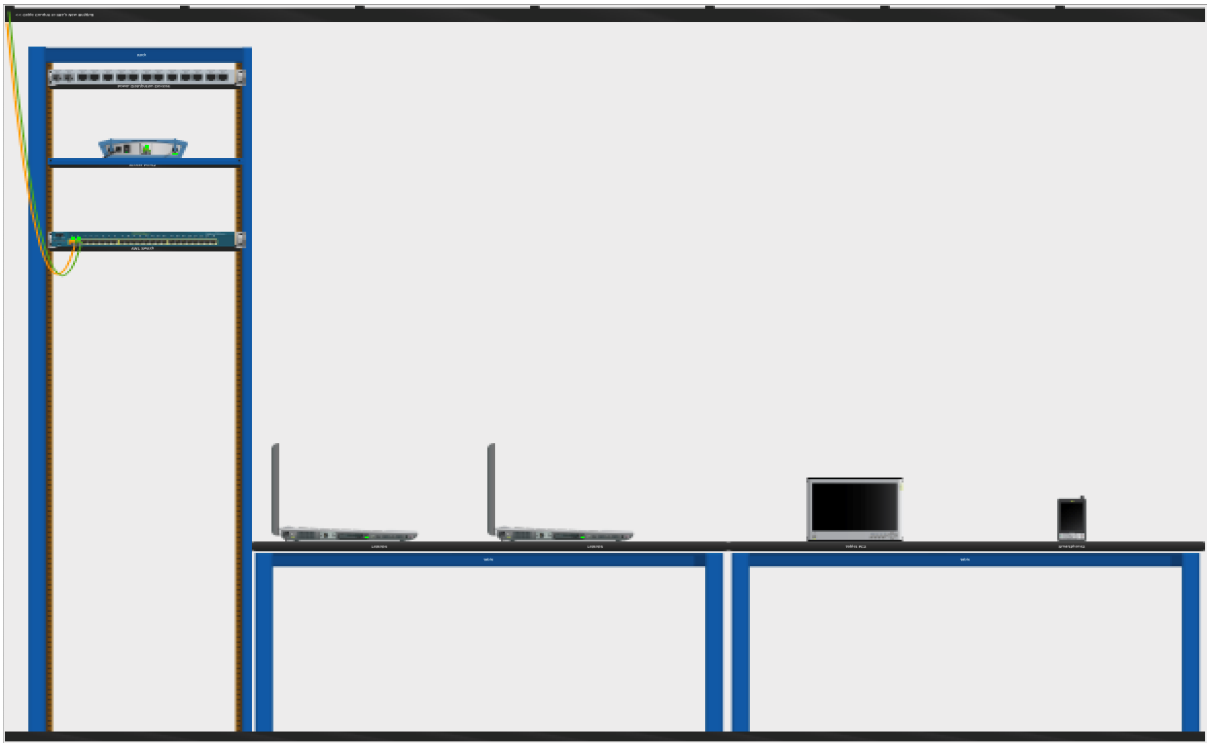
through an Access Point3 that is linked to the IoT Lab Switch. The IoT Lab Switch is forwarding all external traffic through the Main Switch.



- **Communication Lab**: A 2950-24 switch is used for local connection management by the Communication Lab. Wired devices like PC4 and PC5 are directly connected to the Communication Lab Switch, whereas the wireless devices, like Tablet PC1, Printer0, Laptop2, and Laptop3, are connected to Access Point1, which further links to the switch. Communication Lab Switch connects to the Main Switch for the communication with the rest of the labs and the router.



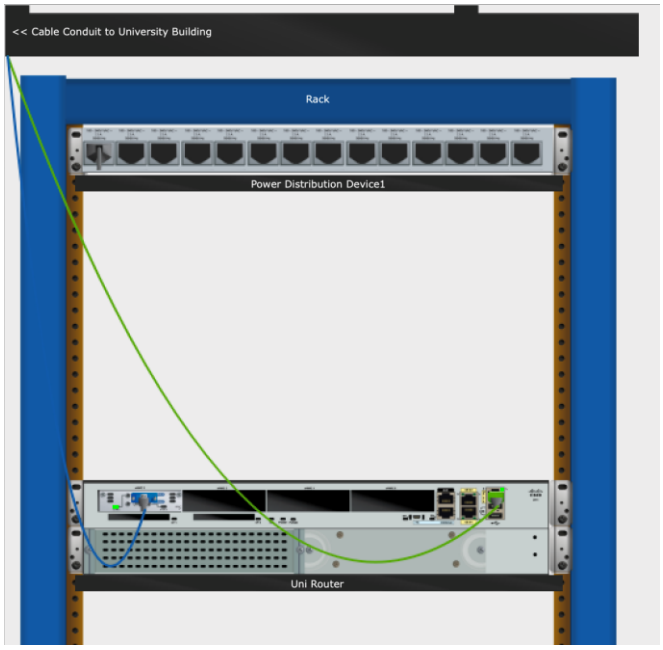
- **Advanced Wireless Lab**: Advanced Wireless Lab connects to the Main Switch via the 2950-24 AWL Switch. Wireless devices such as Laptop4, Laptop5, Smartphone2, and Tablet PC2, are connected via Access Point2, which is connected to the AWL Switch. The AWL Switch then relays to the Main Switch for routing either to other labs or out to the outside world.



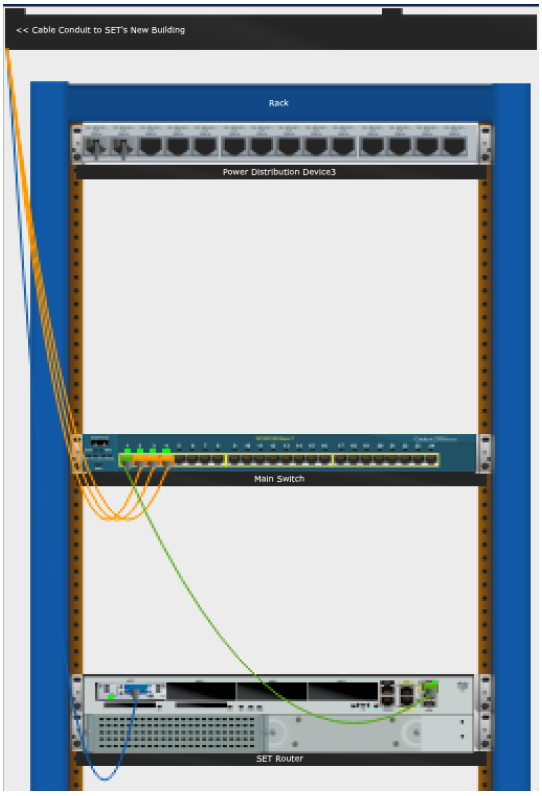
Interconnection Between Uni Router and SET Router

Uni Router, SET Router, and Main Switch are the main components of the backbone network housed in the SET Building. The Uni Router (12.12.0.1) is an interface with HUMAC Switch at University Building and has a point-to-point connection between it and the SET Router. In the SET Building, there is the SET Router, with its own interface (12.12.0.2) to link it to Uni Router, along with its collection to the Main Switch (192.168.8.52) that completes the distribution to lab switches of Communication Lab, IoT Lab, and Advanced Wireless Labs. Such a structured network incorporates a seamless setup usage between the buildings and within individual labs.

Uni Router



SET Router



4. **Logical Topology**

The network is divided into three segments of networks, that is, HUMAC lab, SET building Labs (which includes Communication Lab, IoT Lab, and Advanced Wireless Lab), and a small internal subnet of connection between Uni Router and SET Router.

HUMAC Lab

HUMAC Lab uses a subnet 192.168.8.0/27 that gives the total number of addresses equal to 32 (which are usable 30). It is connected with HUMAC Switch (192.168.8.9) and Access Point0. Physical devices in the HUMAC Lab are PC0 (192.168.8.1), PC1 (192.168.8.2), PC2 (192.168.8.3), and PC3 (192.168.8.4). Devices on the wireless connection are Laptop0 (192.168.8.6), Laptop1 (192.168.8.5), Tablet PC0 (192.168.8.7), and Smartphone0 (192.168.8.8). The default gateway for all devices in HUMAC Lab is 192.168.8.1.

SET Building Labs

The SET Building Labs have been placed in the 192.168.8.32/27 subnet, providing a total of 32 addresses (30 of which are usable). This subnet includes the IoT Lab, Communication Lab, and Advanced Wireless Lab.

- **IoT Lab**: The devices in the IoT Lab connect through the IoT Lab Switch (192.168.8.53) and an Access Point3 for the wireless connectivity. The lab contains a HTTP Server (192.168.8.34) and a DNS Server (192.168.8.35) in addition to wired PCs: PC6 (192.168.8.36) and PC7 (192.168.8.37). Wireless devices are PC8 (192.168.38), PC9 (192.168.8.39), Laptop6 (192.168.8.40) and Laptop7 (192.168.8.41).
- **Communication Lab**: These devices connect through the Communication Lab Switch (192.168.8.54) and Access Point1. Wireless devices are Tablet PC1 (192.168.8.42), Printer0 (192.168.8.43), Laptop3 (192.168.8.44), and Laptop2 (192.168.8.45). Wired devices include PC5 (192.168.8.46) and PC4 (192.168.8.47).
- **Advanced Wireless Lab**: Devices are connected through AWL Switch (192.168.8.55) and Access Point2. The wireless devices are Laptop4 (192.168.8.48), Laptop5 (192.168.8.49), Smartphone2 (192.168.8.50), Tablet PC2 (192.168.8.51).

All devices in the SET Building Labs use 192.168.8.33 as the default gateway.

Backbone Connectivity

The backbone connects the Uni Router, the SET Router, and the Main Switch. The Uni Router (192.168.8.10) in the University Building connects to the HUMAC Switch. It uses the 12.12.0.0/30 subnet over to SET Router (192.168.8.33). This SET Router then connects at Main Switch (192.168.8.52) because that is needed to distribute traffic to SET Building Labs and maintain communications with HUMAC Lab.

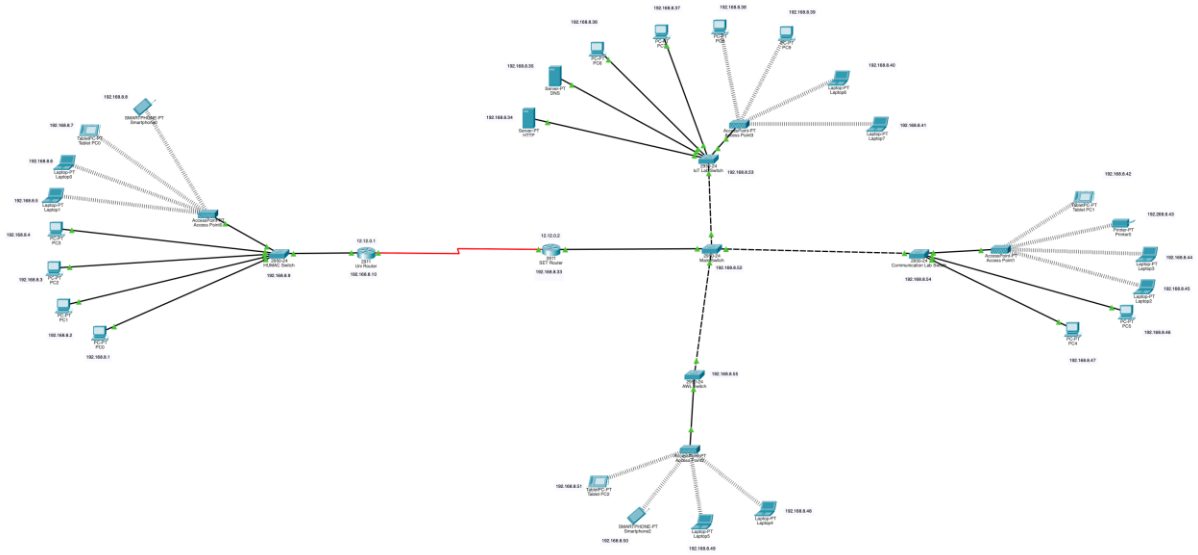
Interconnection Between Uni Router and SET Router

Subnetting 12.12.0.0/30 connects the Uni Router and SET Router via a subnet that offers only two usable addresses. The interface on the Uni Router connecting to the SET Router is given the IP address of 12.12.0.1, while the corresponding interface on the SET Router is using this 12.12.0.2 address. This subnet will be used for communication between the routers and in addition, thereby providing connectivity between the HUMAC Lab and the labs at the SET Building.

Routing Configuration

The two routers have been statically configured with a route to communicate between the subnets. A route to subnetwork within the SET Building Labs subnetwork (192.168.8.32/27) has been set on the Uni Router with its next hop being 12.12.0.2. Similarly, on the SET Router, the next hop has been defined as 12.12.0.1 for the HUMAC Lab subnet (192.168.8.0/27).

Subnet Description	**Number Of Hosts**	**Network Address/ CIDR**	**Host Address Range**	**First Usable Host Address**	**Last Usable Host Address**	**Broadcast Address**
HUMAC Lab	30	192.168.8.0/27	192.168.8.1 – 192.168.8.30	192.168.8.1	192.168.8.30	192.168.8.31
SET Labs (Communication, IoT, Advanced Wireless)	30	192.168.8.32/27	192.168.8.33 – 192.168.8.62	192.168.8.33	192.168.8.62	192.168.8.63
Interconnection (Uni Router – SET Router)	2	12.12.0.0/30	12.12.0.1 – 12.12.0.2	12.12.0.1	12.12.0.2	12.12.0.3



Part C: Lesson Learned (10 marks)

Teamwork Experience

Teamwork and communication are really great points of emphasis in this project. We used strengths individually while distributing tasks and held regular meetings to ensure both tracks were on the right paths, and everything was made visible to all involved in the project. We shared out documents to keep it organized. It not only simplified the whole process but also stresses on the importance of mutual support toward overcoming challenges.

Technical Challenges

We faced a host of technical problems such as creating an IP addressing scheme, debugging misrouted routing configurations, and setting up wired and wireless devices in the IoT Lab. Moreover, proper locations of switches and access points would also have required detailed planning to optimize connections within the place because of how it was laid out. All these challenges forced us to go back and rethink networking concepts as well as solvent procedures.

Issue Resolution

The systematic approach and teamwork helped in troubleshooting and resolving issues. Network misconfiguration was detected using ping and traceroute, and Packet Tracer simulated and tested the changes before the implementation. Moreover, calculating subnet masks and checking device configurations improved network reliability and efficiency. The assurance of the final setup was improved with the reference to best practices.

Overall Experience

This project has given real life exposure of designing and implementation of a working network. Skills learned from it include subnetting, configuring routers and switches, and troubleshooting connectivity issues. The experience has a lot more to offer the learner outside of technical knowledge. The significance of practical application was emphasized in all aspects of the building in networking concepts**.**