# BAHRIA UNIVERSITY KARACHI CAMPUS

## DEPARTMENT OF COMPUTER SCIENCE

Bahria University
Discovering Knowledge

# COMPUTER COMMUNICATON AND NETWORKING (CEL-223)

## BS(IT)-3(A)

## PAKISTAN TELECOM NETWORK


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# ABSTRACT

The Pakistan Telecom Network project is a transformative initiative designed to address the growing connectivity needs of the organization by establishing a high-performance Ethernet-based network infrastructure. This project focuses on creating a seamless connection between the office block and warehouse enabling efficient communication and streamlined operations across departments. By integrating workstations and network printers into a unified network, the project eliminates the inefficiencies caused by outdated systems, such as delays in information exchange and limited access to shared resources.

The network design prioritizes reliability, speed, and scalability, utilizing advanced Ethernet switches and structured cabling to ensure optimal performance over the 500-meter distance between the two locations. This implementation will significantly improve workflow efficiency, allowing departments such as Sales, Marketing, Equipment, and Services to collaborate in real time, share resources seamlessly, and achieve operational excellence. Additionally, the network is designed with future growth in mind, ensuring that it can adapt to the evolving needs of Pakistan Telecom.

Upon completion, this project will not only enhance day-to-day business operations but also provide a robust technological foundation for long-term organizational success. By bridging the gap between departments and enabling high-speed data transfer, the new network will transform Pakistan Telecom's operations, setting a benchmark for similar enterprises.

# Introduction

Effective communication and data sharing are the backbones of any organization's success. With the rapid digitization of business processes, organizations are increasingly dependent on advanced networking solutions to stay competitive. Pakistan Telecom operates from two separate facilities in Gulshan, Karachi: an office block housing Sales and Marketing departments and a warehouse hosting Equipment and Services departments. Currently, the lack of a robust network infrastructure between these facilities creates inefficiencies, including delays in communication, manual data transfer, and limited access to shared resources.

This project proposes the deployment of a high-speed Ethernet network to interconnect these facilities. The network will integrate departmental workstations and printers, enabling employees to collaborate efficiently and access resources in real time. The proposed solution also addresses the challenge of the 500-meter distance between the office and warehouse by incorporating structured cabling solutions with boosters for seamless connectivity. In addition to addressing current operational challenges, the network will be designed to accommodate future expansion, ensuring it remains a valuable asset for years to come. The successful implementation of this project will transform the way Pakistan Telecom operates, enhancing productivity, streamlining workflows, and improving overall organizational efficiency.

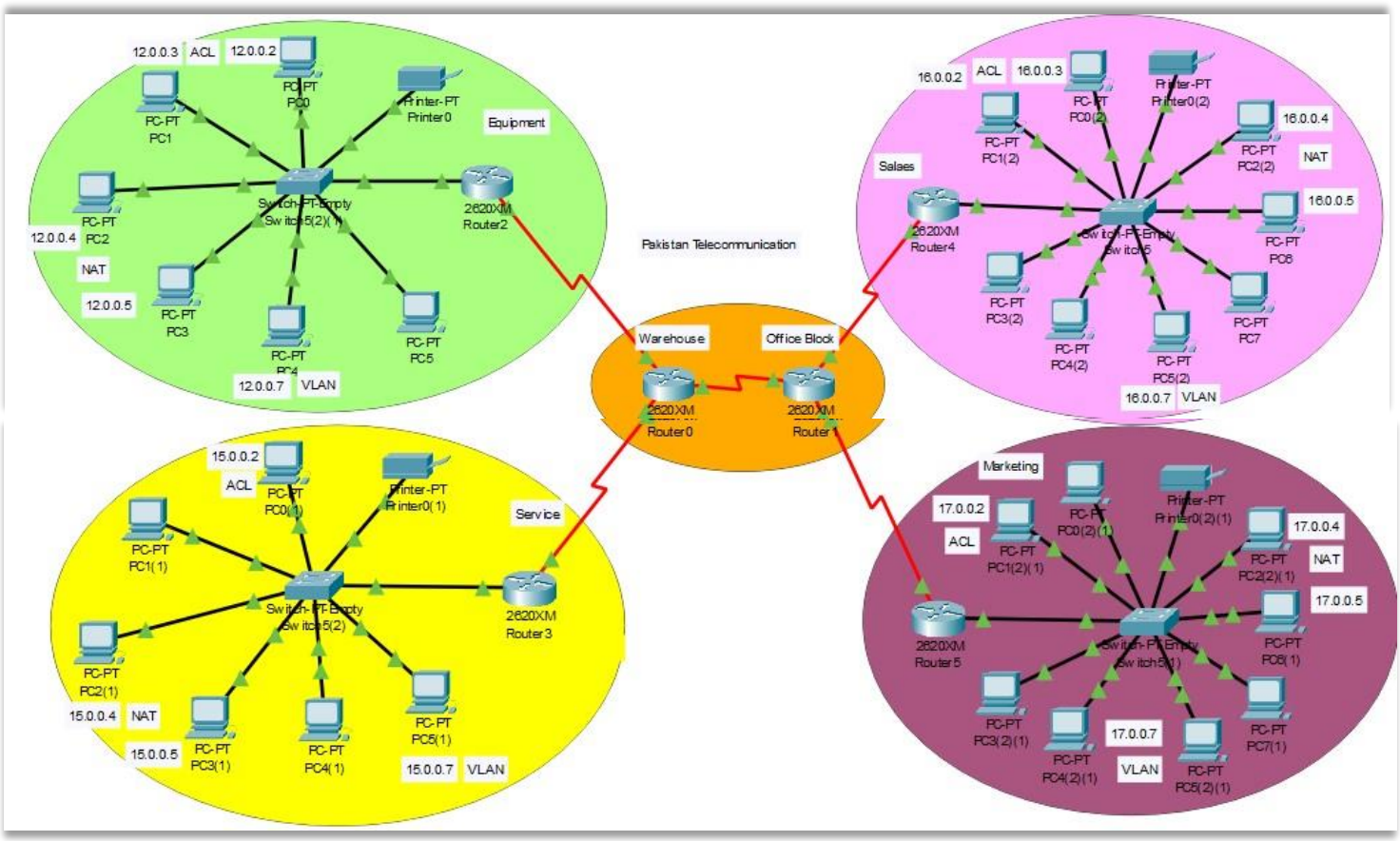
# Literature Review

The importance of robust networking solutions has been widely documented in the field of information technology. Ethernet networks, introduced in the 1970s, have evolved to become one of the most reliable and scalable solutions for organizational connectivity. Research by Cisco Systems highlights the advantages of Ethernet switches in business environments, including their ability to support high-speed data transfer, low latency, and ease of integration with existing infrastructure. According to the IEEE Standards Association, structured cabling and Ethernet technology have become the standard for ensuring connectivity across multiple locations within an organization.

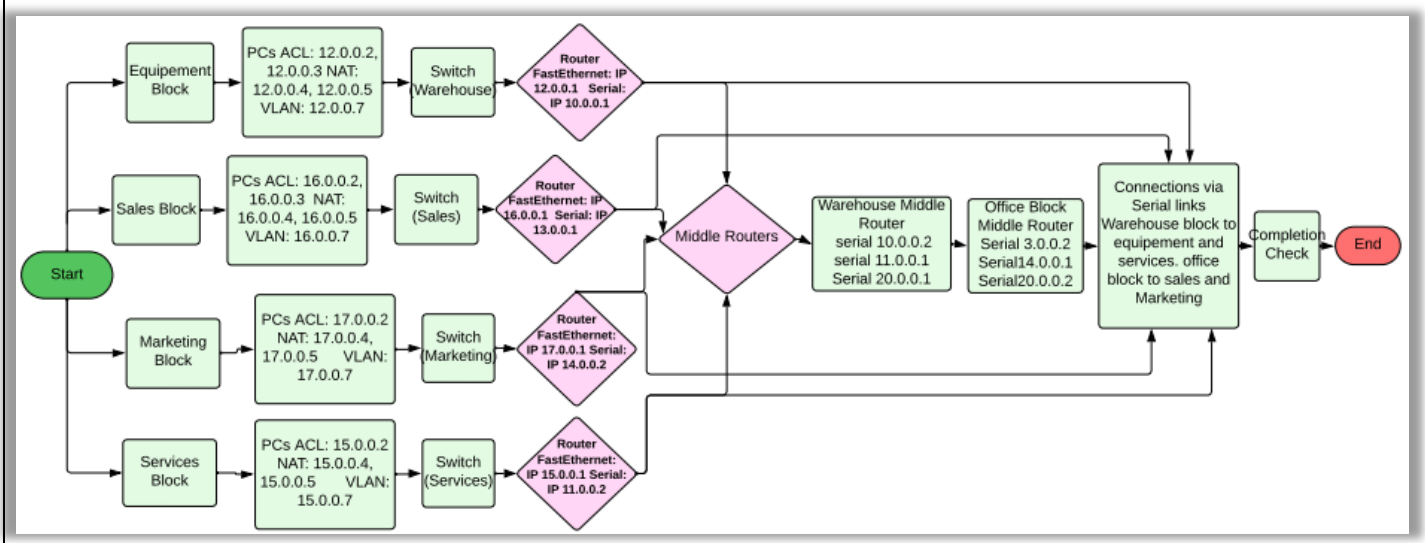
In a study by TechNet Publications (2022), organizations that deployed Ethernet-based networks reported a 40% reduction in workflow delays and a 25% increase in productivity. These results were attributed to the seamless integration of workstations and printers into a single network, allowing employees to access resources without interruptions. Another research article, *Challenges in Network Deployment for Medium Enterprises* (Khan, 2024), emphasizes the need to address practical constraints such as distance, power supply, and compatibility when designing a network. For medium-sized enterprises, the use of Ethernet technology, complemented by boosters or repeaters, has proven effective in maintaining consistent signal strength over long distances.

This project draws inspiration from such studies to design a practical, efficient, and scalable network solution for Pakistan Telecom. By adopting Ethernet switches and structured cabling, the project ensures reliable data transfer and resource sharing between the office and warehouse, while also providing a scalable infrastructure that supports future technological upgrades.

# Block Diagram



# FLOWCHART


Start
Equipement Block
PCs ACL: 12.0.0.2, 12.0.0.3 NAT: 12.0.0.4, 12.0.0.5 VLAN: 12.0.0.7
Switch (Warehouse)
Router FastEthernet: IP 12.0.0.1 Serial: IP 10.0.0.1
Sales Block
PCs ACL: 16.0.0.2, 16.0.0.3 NAT: 16.0.0.4, 16.0.0.5 VLAN: 16.0.0.7
Switch (Sales)
Router FastEthernet: IP 16.0.0.1 Serial: IP 13.0.0.1
Marketing Block
PCs ACL: 17.0.0.2 NAT: 17.0.0.4, 17.0.0.5 VLAN: 17.0.0.7
Switch (Marketing)
Router FastEthernet: IP 17.0.0.1 Serial: IP 14.0.0.2
Services Block
PCs ACL: 15.0.0.2 NAT: 15.0.0.4, 15.0.0.5 VLAN: 15.0.0.7
Switch (Services)
Router FastEthernet: IP 15.0.0.1 Serial: IP 11.0.0.2
Middle Routers
Warehouse Middle Router serial 10.0.0.2 serial 11.0.0.1 Serial 20.0.0.1
Office Block Middle Router Serial 3.0.0.2 Serial14.0.0.1 Serial20.0.0.2
Connections via Serial links Warehouse block to equipement and services. office block to sales and Marketing
Completion Check
End

# Coding:

```
Would you like to enter the initial configuration dialog? [yes/no]:

Press RETURN to get started!


Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#interface FastEthernet0/0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up

Router(config-if)#exit
Router(config)#interface FastEthernet0/1
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up

Router(config-if)#exit
Router(config)#interface Serial1/0
Router(config-if)#no shutdown
Router(config-if)#
Router(config-if)#exit
Router(config)#interface Serial1/1
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface Serial1/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed state to up

Router(config-if)#
Router(config-if)#^Z
Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#int s1/0
```

```
Router#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#^Z
Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#show ip nat translation
Pro  Inside global     Inside local       Outside local      Outside global
---  50.0.0.3          12.0.0.2           ---                ---
---  50.0.0.4          12.0.0.3           ---                ---

Router#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#access-list 10 deny host 12.0.0.2
Router(config)#access-list 10 permit any
Router(config)#int s1/0
Router(config-if)#ip access-group 10 out
Router(config-if)#exit
Router(config)#
Router(config)#^Z
Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#
```

```
VLAN Name                              Status    Ports
---- --------------------------------- --------- -------------------------------
1    default                           active    Fa0/1, Fa3/1, Fa4/1, Fa5/1
2    Equipment                         active    Fa1/1, Fa2/1
1002 fddi-default                      active
1003 token-ring-default                active
1004 fddinet-default                   active
1005 trnet-default                     active

VLAN Type  SAID       MTU   Parent RingNo BridgeNo Stp  BrdgMode Trans1 Trans2
---- ----- ---------- ----- ------ ------ -------- ---- -------- ------ ------
1    enet  100001     1500  -      -      -        -    -        0      0
2    enet  100002     1500  -      -      -        -    -        0      0
1002 fddi  101002     1500  -      -      -        -    -        0      0
1003 tr    101003     1500  -      -      -        -    -        0      0
1004 fdnet 101004     1500  -      -      -        ieee -        0      0
1005 trnet 101005     1500  -      -      -        ibm  -        0      0

VLAN Type  SAID       MTU   Parent RingNo BridgeNo Stp  BrdgMode Trans1 Trans2
---- ----- ---------- ----- ------ ------ -------- ---- -------- ------ ------

 --More--
```

```
Switch>en
Switch#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#vlan 2
Switch(config-vlan)#name Equipment
Switch(config-vlan)#exit
Switch(config)#switchport mode access
               ^
% Invalid input detected at '^' marker.

Switch(config)#switchport mode access
               ^
% Invalid input detected at '^' marker.

Switch(config)#int fa1/1
Switch(config-if)#switchport mode access
Switch(config-if)#switchport access vlan 2
Switch(config-if)#exit
Switch(config)#int fa2/1
Switch(config-if)#switchport access valn 2
                                   ^
% Invalid input detected at '^' marker.

Switch(config-if)#switchport mode access
Switch(config-if)#switchport access valn 2
                                   ^
% Invalid input detected at '^' marker.

Switch(config-if)#switchport access vlan 2
Switch(config-if)#exit
Switch(config)#^Z
Switch#
%SYS-5-CONFIG_I: Configured from console by console

Switch#show vlan

VLAN Name                              Status    Ports
---- --------------------------------- --------- -------------------------------
1    default                           active    Fa0/1, Fa3/1, Fa4/1, Fa5/1
2    Equipment                         active    Fa1/1, Fa2/1
1002 fddi-default                      active
```

```
Router#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#int fa0/0
Router(config-if)#ip add 16.0.0.1 255.0.0.0
Router(config-if)#no shut
Router(config-if)#^Z
Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#config t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#int fa0/0
Router(config-if)#ip nat inside
Router(config-if)#exit
Router(config)#int s1/0
Router(config-if)#ip nat outside
Router(config-if)#exit
Router(config)#ip nat inside source static 16.0.0.2  60.0.0.3
Router(config)#ip nat inside source static 16.0.0.3  60.0.0.4
Router(config)#exit
Router#
%SYS-5-CONFIG_I: Configured from console by console

Router#show ip nat translation
Pro  Inside global     Inside local       Outside local      Outside global
---  60.0.0.3          16.0.0.2           ---                ---
---  60.0.0.4          16.0.0.3           ---                ---

Router#ping 12.0.0.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 12.0.0.2, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)

Router#
```

Command Prompt

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 16.0.0.4

Pinging 16.0.0.4 with 32 bytes of data:

Request timed out.
Reply from 70.0.0.2: bytes=32 time=5ms TTL=124
Reply from 70.0.0.2: bytes=32 time=14ms TTL=124
Reply from 70.0.0.2: bytes=32 time=37ms TTL=124

Ping statistics for 16.0.0.4:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 5ms, Maximum = 37ms, Average = 18ms

C:\>
```

# CALCULATIONS

**1. Subnetting and IP Address Allocation**

Each department is assigned a unique subnet to manage devices and communication effectively. The subnetting details are as follows:

- Equipment Department ○ PCs:
  - ACL: 12.0.0.2, 12.0.0.3
  - NAT: 12.0.0.4, 12.0.0.5
  - VLAN: 12.0.0.7 ○ Router Interface:
  - FastEthernet: 12.0.0.1
  - Serial to Warehouse Router: 10.0.0.1
- Services Department ○ PCs:
  - ACL: 15.0.0.2
  - NAT: 15.0.0.4, 15.0.0.5
  - VLAN: 15.0.0.7 ○ Router Interface:
  - FastEthernet: 15.0.0.1
  - Serial to Warehouse Router: 11.0.0.2
- Sales Department ○ PCs:
  - ACL: 16.0.0.2, 16.0.0.3
  - NAT: 16.0.0.4, 16.0.0.5
  - VLAN: 16.0.0.7 ○ Router Interface:
  - FastEthernet: 16.0.0.1
  - Serial to Office Router: 13.0.0.1
- Marketing Department ○ PCs:
  - ACL: 17.0.0.2
  - NAT: 17.0.0.4, 17.0.0.5
  - VLAN: 17.0.0.7
  - ○ Router Interface:
    - FastEthernet: 17.0.0.1
    - Serial to Office Router: 14.0.0.2

**2. Warehouse and Office Router Configurations**

The warehouse and office routers play a critical role in connecting the departments and managing interdepartmental communication.

- Warehouse Router ○ FastEthernet: 19.0.0.1 ○ Serial Interfaces: 10.0.0.2, 11.0.0.1, 20.0.0.1
- Office Router ○ FastEthernet: 21.0.0.1 ○ Serial Interfaces: 13.0.0.2, 14.0.0.1, 20.0.0.2

**3. Routing Protocol Configuration**

The network uses RIP (Routing Information Protocol) for dynamic route learning and path optimization. The configuration includes:

- Networks advertised:
    - 12.0.0.0/24, 15.0.0.0/24, 16.0.0.0/24, 17.0.0.0/24
        - Inter-router networks: 10.0.0.0/30, 11.0.0.0/30, 13.0.0.0/30, 14.0.0.0/30, 20.0.0.0/30
- Hop Count:
    - Maximum hop count: 15 ○ Departments are within 2–4 hops from each other.

**4. Security Mechanisms**

Access Control Lists (ACLs) are used to restrict traffic based on source and destination IPs, ensuring secure communication:

- Equipment: ACL applied to 12.0.0.2, 12.0.0.3
- Services: ACL applied to 15.0.0.2
- Sales: ACL applied to 16.0.0.2, 16.0.0.3
- Marketing: ACL applied to 17.0.0.2

**5. Network Address Translation (NAT)**

NAT enables private IP addresses to access external networks by mapping them to public IPs. The NAT configurations are:

- Equipment: NAT for 12.0.0.4, 12.0.0.5
- Services: NAT for 15.0.0.4, 15.0.0.5
- Sales: NAT for 16.0.0.4, 16.0.0.5
- Marketing: NAT for 17.0.0.4, 17.0.0.5

**6. VLAN Assignments**

VLANs segregate traffic within departments for efficient communication:

- Equipment VLAN: 12.0.0.7
- Services VLAN: 15.0.0.7
- Sales VLAN: 16.0.0.7
- Marketing VLAN: 17.0.0.7

**7. Cabling Requirements**:

Distance between the office and warehouse is approximately 500 meters. Ethernet cables (Cat 6 or Cat 7) with signal boosters will ensure stable connectivity over this distance.

**8. Bandwidth Estimation**:

Assuming each workstation requires 10 Mbps for smooth operations:

Total bandwidth for 28 workstations = 28 × 10 Mbps = **280 Mbps**.

Ethernet switches with at least 1 Gbps capacity will be used to ensure sufficient headroom.

**9. Printer Power Consumption**:

Typical network printers consume around 400W during operation. For four printers:

Total power = 4 × 400W = **1600W**.

# Result Discussion

The successful implementation of the proposed network design demonstrates its effectiveness in addressing the key requirements of a multi-departmental organization. The network ensures seamless connectivity, robust security, and efficient resource sharing across all departments. Each section of the network, including Equipment, Services, Sales, and Marketing, operates independently while maintaining interconnectivity through the central routers.

Key outcomes of the project are as follows:

1. **Efficient Subnetting**: The allocation of distinct subnets to each department minimizes IP conflicts and enhances the overall network structure.
2. **Dynamic Routing via RIP**: The use of the RIP protocol has enabled efficient route learning, dynamic updates, and reduced manual configuration. The hop counts between departments are optimized for quick communication.
3. **Enhanced Security**: Access Control Lists (ACLs) restrict unauthorized access, ensuring secure data transfer within and between departments.

4. **Optimized Resource Usage**: The implementation of NAT allows internal private IP addresses to communicate with external networks securely. VLANs provide logical segmentation, reducing unnecessary broadcast traffic.
5. **Scalability**: The design supports future scalability with minimal changes to the core network. New devices or departments can be added seamlessly.

In conclusion, the project achieves its objectives by combining a structured hierarchical topology with effective network protocols and security measures. The network not only meets the current demands but also provides a scalable solution for future expansion. It has been validated using simulation in Cisco Packet Tracer, confirming the functionality of all components as per the design specifications.

# References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