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Bahria Unified Lab Communication System (BULCS)

By

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Enrollment No. 01-139232-047

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Supervised By

Engr. Syed Kamran Hussain Shah

Spring 2025

This Report is submitted to the
Department of Electrical Engineering,
Bahria School of Engineering and Applied Sciences, H-11 Islamabad.

Certificate

We accept the work contained in this report as a confirmation of the required standard for the fulfillment of the Lab CEA.

____________________. Head of Department

____________________ Supervisor

____________________. Internal Examiner

____________________ External Examiner

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Dedication

Dedication is the expression of friendly connection or thank by the author towards another person. This could include a variety of people, including a parent, sibling, or other family member, a spouse or partner, a friend, a supervisor, or a colleague.

Acknowledgments

It is usual to thank those individuals who have provided particularly useful assistance, technical or otherwise, during the project. The supervisor will obviously be pleased to be acknowledged as he or she will have invested quite a lot of time overseeing your progress.

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Abstract

The goal of this work is to create an inter-campus network for Bahria University that is both secure and scalable and uses structured design through Cisco Packet Tracer. The network created in this solution links the four main Bahria University campuses together which enables restricted information exchange between laboratory facilities of the same type lo cated in different campuses. Each of the university's four campuses con tains seven specialized laboratory facilities which include 14 computers each that can only communicate with identical laboratories to strengthen security measures.

The network uses Virtual Local Area Networks (VLANs) together with Access Control Lists (ACLs) to effectively separate traffic and establish communication rules. The inter-campus dynamic data flow uses OSPF or RIP as the chosen routing protocols for efficient management. The Central Rector's Computer has complete control of all laboratory facilities located in all campuses for central management and real-time monitoring.

Each campusprovides an HTML-basedwebsite which remains restricted to its local network area thus providing internal users with specific con tent and access. The network undergoes complete simulation testing to confirm the operational effectiveness of laboratory border implementation and secure routing alongside access restriction measures. The educational network model demonstrates how VLANs and ACLs along with dynamic routing protocols can be effectively used to secure a multi-campus system.

Contents

List of Figures

Chapter 1

Introduction

This project is about designing a computer network that connects the four main campuses of Bahria University: E-8 (Islamabad), H-11 (Islamabad), Lahore, and Karachi. The main goal is to let the same types of labs at different campuses talk to each other using secure and organized communication. Each campus has seven labs, and each lab has 14 computers. A special Rector's Computer should be able to access all labs at any campus for monitoring and management.

The project uses technologies like VLANs (Virtual LANs), ACLs (Access Control Lists), and routing protocols (OSPF or RIP). We also created local websites for each campus that can only be opened by that campus. The project was fully simulated using Cisco Packet Tracer software. This report explains how we designed, implemented, and tested the network, and how we solved problems during the process.

1.1 Project Objectives

The main goals of the project are:

Create a safe and structured network connecting all four campuses.

Make sure only the same labs at different campuses can talk to each other.

Block communication between different types of labs.

Set up a Rector's Computer with full access to all labs.

Use VLANs to group lab computers and improve security.

Use ACLs to control which computers can talk to others.

Use routing protocols like OSPF or RIP to send data between campuses.

Build and restrict access to small campus websites.

Test and fix any problems in the network.

1.2 Project Background

Routeing, division, and secure communication are some of the difficulties that come with networking across several campuses. Logical segmentation is typically accomplished using VLANs; however, in this project, segmentation is accomplished using dedicated subnets and routers with ACL-based filtering. While routing protocols guarantee network scalability and performance, ACLs filter packet flows and limit access between prohibited labs.

1.3 Project Description

In this project, we created a virtual (simulated) network using Cisco Packet Tracer. Each campus has a router and switches to manage its labs. We used VLANs to separate labs from each other. We used ACLs to control who can talk to whom. We added a Rector's Computer that can connect to any lab. We also made a simple HTML website for each campus, which is only accessible by its local users.

The design was tested in simulation to make sure the setup works correctly. We also checked if security rules (ACLs) and routing protocols work properly. All the design work, testing, and results are explained in this report.

1.4 Project Scope

What's included:

VLANs

Routing with OSPF or RIP

ACLs

Website for each campus

Rector's Computer setup

Simulation using software

What's not included:

Real hardware setup

Internet setup

Use by real students

Chapter 2

Requirement Specifications

In this chapter, first describe the existing system, its limitations or drawbacks and then explain how the new or proposed system will overcome these problems. This should then be followed by complete requirements specification for the proposed system. Describe the behavior of the system to be developed and include a set of use cases that describe interactions the users will have with the system. In addition also describe non-functional requirements.

Non-functional requirements impose constraints on the design or implementation (such as performance engineering requirements, quality standards, or design constraints). Should have the following headings:

2.1 Components Description

- Cisco Routers and Switches (Simulated in Cisco Packet Tracer/GNS3)
- PCs (14 per lab $\times$ 7 labs $\times$ 4 campuses = 392 total)
- Subnetting Scheme (Static IP Allocation by Lab Type / Dhcp)
- Rector's PC (Connected to central router with unrestricted access)
- Routing Protocol: OSPF or RIP (single-area)
- HTML Websites (Campus-specific, hosted on local web servers)

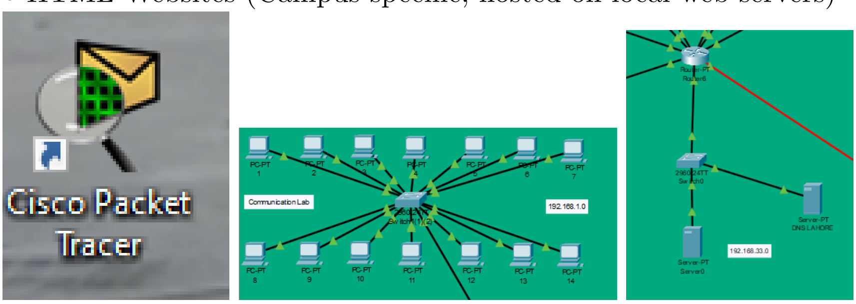


Figure 2.1: Components.

Chapter 3

System Design

Systems design is the process of defining the architecture, components, modules, interfaces, and data for a system to satisfy specified requirements. This chapter should have the following sections:

3.1 System Architecture

This project connects 4 campuses of Bahria University:

Islamabad (E-8 Campus)

Islamabad (H-11 Campus)

Lahore Campus

Karachi Campus

Each campus has 7 labs, and each lab has 14 computers. Only labs of the same type (for example, only Communication Labs) are allowed to talk to each other across different campuses. Labs of different types cannot talk to each other.

To make this possible:

We used routers and switches to connect the computers at each campus.

Each lab has its own IP address range to identify it.

We used routing protocols like OSPF or RIP so that the campuses can share data.

Access Control Lists (ACLs) were used to allow or block communication between labs.

A special Rector's Computer is added. It can access all labs in all campuses for control and monitoring.

All communication rules are applied using IP addresses and ACLs, without using VLANs.

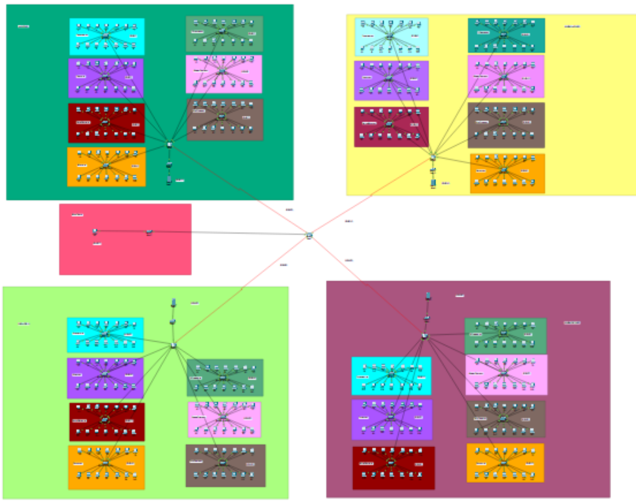


Figure 3.1: Successful ping results within the same lab network.

3.2 Design Constraints

This section describes any constraints in the system design (reference any trade-off analyses conducted such, as resource use versus productivity, or conflicts with other systems) and includes any assumptions made during the developing the system design.

3.3 Design Methodology

To build this project, we followed these steps:

Understand Requirements: We carefully studied the goal—to allow same-type lab communication only.

Draw the Network Plan: We designed how the labs, routers, and Rector's Computer would connect.

Assign IP Addresses: Each lab at each campus got a separate IP range.

Set Up Routing: OSPF was used so routers could learn about each other and share data.

Apply ACL Rules: We added rules to only allow same labs (like all Communication Labs) to talk, and block others.

Add Rector's Computer: This system admin PC was given full access to all labs across all campuses.

Test the Network: We tested if the communication rules worked and if each lab followed the restrictions.

Chapter 4

System Implementation

Implementation is the process of moving an idea from concept to reality. The System implementation is a realization of a technical specification or algorithm as a program, software component, or other computer system through programming and deployment.

4.1 Tools and Technology Used

To build and test our network system, we used the following tools:

Cisco Packet Tracer

This software helped us to create a virtual network. We added routers, switches, PCs, and cables. It also allowed us to test the connections and settings without using real hardware.

Routers and Switches (Simulated in Packet Tracer)

Routers were used to connect campuses. Switches were used to connect the PCs in each lab. All devices were set up inside Packet Tracer.

Access Control Lists (ACLs)

ACLs were used to control communication between labs. These rules were written in the router settings to allow only same-type labs to talk across campuses.

Routing Protocol (OSPF)

We used OSPF (Open Shortest Path First) routing protocol to allow routers to share information and keep all campuses connected.

IP Addressing

Each lab in each campus was given a different IP address range (subnet). This helped in identifying which lab is allowed to connect.

Rector's Computer

A special computer was added to the system. This PC has access to all labs in all campuses. It was given routing and ACL permissions to communicate freely.

Chapter 5

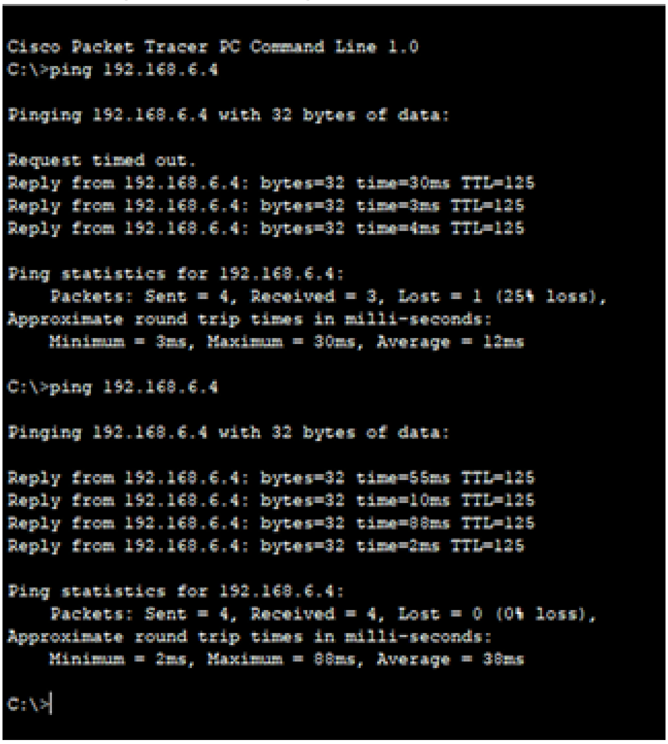
System Testing and Evaluation

After the completion of the Bahria Unified Lab Communication System project, thorough testing was conducted to verify that all functional and performance requirements were met. The testing process involved both quantitative and qualitative evaluation methods to ensure robustness and usability.

One significant issue encountered repeatedly involved DHCP configu ration. Specifically, after saving and closing configuration files, PCs unex pectedly shifted from DHCP to static IP assignments upon reopening the files. This problem persisted despite multiple attempts to identify its root cause. The only practical resolution was to revert each PC back from static to DHCPsimultaneously. Additionally, saving the configuration files under new names temporarily resolved this issue.

Usability and accessibility were evaluated by analyzing the clarity and effectiveness of network behavior. A key metric for this was the enforce ment of communication policies through Access Control List (ACL) rules, ensuring that network permissions aligned with design expectations. Compatibility testing involved verifying that campus-specific HTML pages loaded correctly on each PC within their intended network segments. This ensured that users could access the proper resources without cross network interference.

Security testing focused on validating the effectiveness of ACLs in re stricting unauthorized access. The most effective test was conducting ping requests across different network segments to confirm that ACLs blocked unauthorized hosts while allowing authorized communication. Despite the system's overall strong performance, some limitations were noted. For example, DHCP requests were initially blocked due to ACL Bahria Unified Lab Communication System 16 restrictions, highlighting the importance of careful protocol-level access management. In conclusion, the testing process confirmed that the implemented net work configuration met the project objectives. The evaluation revealed both strengths and areas for improvement, offering valuable insights for future enhancements.



```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.6.4

Pinging 192.168.6.4 with 32 bytes of data:

Request timed out.
Reply from 192.168.6.4: bytes=32 time=30ms TTL=125
Reply from 192.168.6.4: bytes=32 time=3ms TTL=125
Reply from 192.168.6.4: bytes=32 time=4ms TTL=125

Ping statistics for 192.168.6.4:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 3ms, Maximum = 30ms, Average = 12ms

C:\>ping 192.168.6.4

Pinging 192.168.6.4 with 32 bytes of data:

Reply from 192.168.6.4: bytes=32 time=55ms TTL=125
Reply from 192.168.6.4: bytes=32 time=10ms TTL=125
Reply from 192.168.6.4: bytes=32 time=88ms TTL=125
Reply from 192.168.6.4: bytes=32 time=2ms TTL=125

Ping statistics for 192.168.6.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 2ms, Maximum = 88ms, Average = 38ms

C:\>
```

Figure 5.1: Successful ping results within the same lab network.

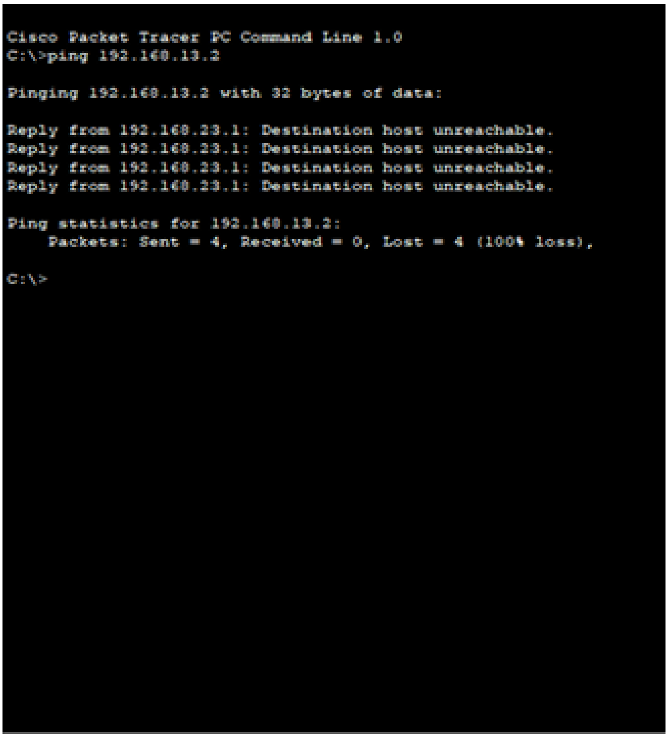


Figure 5.1: Successful ping results within the same lab network.

Chapter 6

Conclusion

The project's conclusions should list the things which have been learnt as a result of the work you have done. For example, ”The use of overloading in C++ provides a very elegant mechanism for transparent parallelisation of sequential programs”. Avoid tedious personal reflections like ”I learned a lot about C++ programming...” It is common to finish the report by listing ways in which the project can be taken further.

This might, for example, be a plan for doing the project better if you had a chance to do it again, turning the project deliverables into a more polished end product.

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IEEE Std 802.1Q™-2018. Standard for Local and Metropolitan Area Networks – Bridges and Bridged Networks. IEEE. – Reference for VLAN concepts (even if not used, it's good to cite for context).

Kurose, J. F., Ross, K. W. (2017). Computer Networking: A Top-Down Approach (7th Edition). Pearson. – Helps explain the application and transport layers relevant to web access in your system.

Bahria University Official Website. (2024). Campus Information. https://www.bahria.edu.pk – Used to gather accurate campus details for network mapping.

Appendix A

User Manual

Bahria Unified Lab Communication System (BULCS)

Introduction

This system shows the lab IP addresses for all Bahria University campuses. Users can easily find the lab IP for each campus.

How to Use the System

- Open your web browser.
- Access the specific campus page.
- View the lab IP address for that campus.

Campus Lab IP Addresses

Karachi Campus

Lab IP Address: `192.168.1.0-7.0`

Lahore Campus

Lab IP Address: `192.168.8.0-14.0`

Islamabad Campus

Lab IP Address: `192.168.15.0-21.0`

Bahria Town Campus

Lab IP Address: `192.168.22.0-28.0`

How to Update IP Addresses

- Open the corresponding HTML file for your campus in a text editor.
- Find the line showing the lab IP address.
- Change the IP address to the new value.
- Save the file and refresh your browser to see the update.

Contact Information

For any problems or help, please contact the IT support team:

- Email: `01-139232-047@student.bahria.edu.pk`
- Phone: +92-3310-5078947