ELECTRICAL ENGINEERING DEPARTMENT
COLLEGE OF ENGINEERING AND SCIENCES
FINAL YEAR PROJECT

SUPERVISOR:
Dr. Muhammad Imran Majid

PROJECT:
IMPLEMENTATION OF SOFTWARE-DEFINED NETWORK SERVICES USING MININET & RYU PROTOTYPE

GROUP MEMBERS:
Karrar Muhammad (20202-27137)
Kamlesh (20202-27132)

ABSTRACT

A private educational network is required for data privacy and improved network performance. Software defined network (SDN) prototype addresses this issue using scalability, latency, management and addresses resources limitations of traditional networks in educational context. To compute SDN performance, software simulations based on Mininet and hardware simulation based on RYU (as SDN controller) is proposed. Here, Raspberry Pi 3B is used as Open vSwitch and controlled by a workstation. The proposed design showcases 3 topologies in Mininet followed by RYU simulation to measure latency, throughput, round trip time and implement network function virtualization (NFV). The second stage includes real-time hardware based SDN, which decouples the data plane from the control plane and measures parameters through packet transfer and file exchanges between two Windows host PCs. This deployment scenario not only demonstrate the particular of SDN in educational environment but also provides a robust solution for secure campus communication. The novelty is the design of lab-based tests and extending this to hardware-based implementation focusing on real world parameters. Further deployment and troubleshooting steps are proposed. This project has applications for building infrastructure for lab-based curriculum design, distance learning, Agri-tech and robotic surgery, contributing to improved social status and economic growth.

INTRODUCTION

- The rapid evolution of network technologies has led to the rise of Software-Defined Networking (SDN), a paradigm shift designed to enhancing network management and performance through centralized control and programmability. SDN decouples the network control plane from the data plane, enabling more flexible and dynamic network configurations, improved resource management, and modernized network operations.
- Mininet is a powerful network emulator that allows the creation of a realistic virtual network, enabling researchers and network engineers to prototype and test network configurations and protocols in a controlled environment. Mininet facilitates the development and testing of new network concepts and solutions without the need for extensive physical infrastructure.
- The RYU controller is an open-source SDN framework that offers a set of software components designed to build and manage SDN environments. RYU provides APIs and libraries for developing SDN applications, making it easier to implement custom network logic and control devices. With OpenFlow protocol, RYU enables centralized management of network devices, allowing for more efficient and responsive network operations.
- This project aims to demonstrate the implementation of SDN services using Mininet and RYU, highlighting the advantages of SDN in terms of network flexibility, scalability, and programmability.

PROBLEM STATEMENT

Network interruptions frequently result in LAN or WAN with traffic disruptions, due to international disruptions local assess are restricted. Data integrity may be affected by this condition. Data security and latency is also compromised as data is routed through international nodes. In developing countries this results in a dependent architecture for which this will always lack human, intellectual and latency data assets.

PROJECT COMPONENTS AND TOOLS

❖ Hardware Components:

1. PC/Laptop as a Controller
2. Host PCs 2
3. Raspberry Pi 3b as Open vSwitch
4. USB to LAN Card 2
5. Ethernet Wires

❖Software Tool Used:

1. **Virtual Machine (VM):** A Virtual Machine (VM) is a software-based emulation of a physical computer that runs an operating system and applications just like a physical computer.
2. **Ubuntu**: Operating system used to connect the hardware part with software.
3. **Mininet:** A network emulator that creates a realistic virtual network, running real kernel, switch, and application code.
4. **RYU Controller:** A component-based software-defined networking (SDN) framework that provides software components for network management.
5. **Putty:** A free and open-source terminal emulator, serial console, and network file transfer application.
6. **Wireshark:** A network protocol analyzer used for network troubleshooting, analysis, and software development.

ARCHITECTURE DIAGRAM AND FLOWCHART

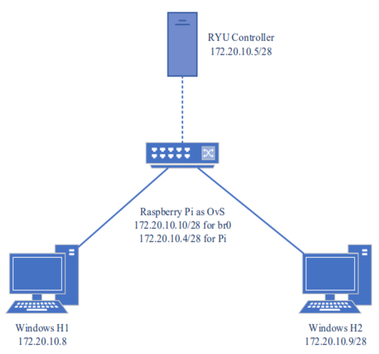

Fig 01: Architecture Diagram

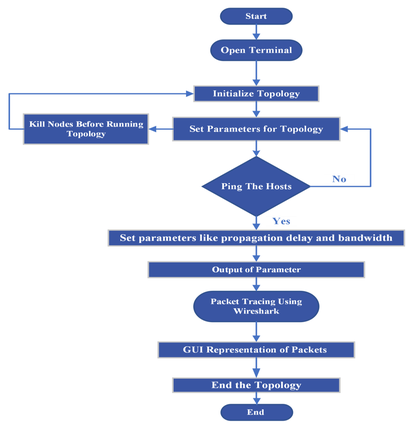

Fig 02: Mininet Flowchart

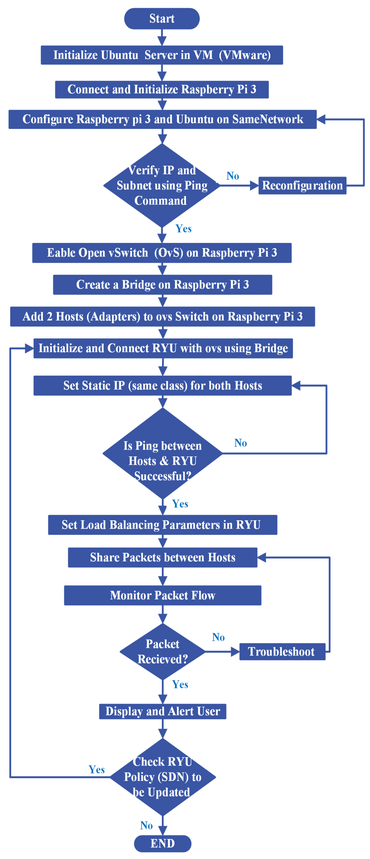

Fig 03: Hardware Flowchart

IMPACT & RESULTS (SDGS, CEPS)

- **Depth of Engineering Knowledge:** To understand the fundamentals of SDN and network virtualization, OpenFlow, Mininet, configuration of VM, Mininet topologies, Raspbian and SDN controllers. Comprehensive knowledge of networks, including TCP/IP, Ethernet, and QoS.
- **Range of Conflicting Requirements:** In SDN based network virtualization there is conflict between optimizing QoS fairness, QoS throughput and performing load balancing analysis.
- **Depth of analysis required:** Performing analysis through simulation, hybrid, lab-based hardware deployment, and creating hardware deployment scenario. Measurement of parameter like latency, RTT, throughput and packet flows.
- **Results:** Decoupling of data plane and control plane, hardware implementation of SDN services using Mininet and RYU, highlighting improved network flexibility, scalability, and control. Flow charts for simulation and hardware.

SDGS

- **SDG 09:** Industry, Innovation and Infrastructure.

Target 9.5: Enhance scientific research, upgrade the technological capabilities.

Indicator 9.5.1: Researchers (in full-time equivalent) per million inhabitants

- **SDG 11:** Sustainable Cities and Communities.

Target 11.3: By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated, and sustainable human settlement planning and management in all countries.

Indicator 11.3.1: Proportion of cities with a direct participation structure of civil society in urban planning and management that operate regularly and democratically.

INSTITUTE OF BUSINESS MANAGEMENT