Simulating OpenFlow Using Mininet

Aim: To simulate a Software Defined Networking (SDN) environment using Mininet and observe the working of the OpenFlow protocol between a switch and a controller.

Theory: Software Defined Networking (SDN) is a modern network architecture that separates the control plane (decision-making) from the data plane (packet forwarding). This is done using a central controller that communicates with network switches via a protocol like OpenFlow.

Mininet is a lightweight network emulator that creates a virtual network with hosts, switches, and controllers. It uses Open vSwitch (OVS) to simulate software-defined switches.

In an OpenFlow network:

Switches send unknown packet events to the controller.

The controller responds with flow rules that get installed into the switch's flow table.

Future packets matching those rules are forwarded directly by the switch without involving the controller again.

This practical demonstrates the basic operation of OpenFlow using a simple topology in Mininet.

Understanding Software Defined Networking (SDN)
Traditional networks are often rigid and hardware-driven, where each switch or router has its own control logic. In contrast, Software Defined Networking (SDN) is a modern approach where the control plane (decision-making) is separated from the data plane (packet forwarding). This architecture gives network administrators centralized control and greater flexibility.

In SDN, the controller is the brain of the network. It decides how traffic should flow and instructs the switches accordingly using a standardized protocol — typically OpenFlow.

What is OpenFlow?
OpenFlow is the first standard communications interface defined between the control and forwarding layers of an SDN architecture. It allows an external controller to interact with a switch's forwarding plane — inserting, modifying, and deleting flow rules dynamically.

Each OpenFlow-enabled switch contains:

A flow table with rules that match packets and specify actions (e.g., forward, drop, send to controller).

A secure channel to communicate with the SDN controller.

An OpenFlow protocol to manage flow table entries.

Mininet: A Lightweight SDN Testbed
Mininet is a network emulator that runs a collection of virtual hosts, switches, links, and controllers on a single Linux machine. It supports:

Rapid prototyping of SDN applications

Testing controller-switch interactions

Simulating various topologies using Python or CLI

Mininet uses Open vSwitch (OVS) as the virtual switch, which is OpenFlow-compatible and supports many SDN features.

How It All Works in Practice
When a host sends a packet:

The switch checks its flow table.

If no matching rule exists, it forwards the packet to the controller using OpenFlow.

The controller analyzes the packet and installs a flow rule in the switch.

The switch then forwards future packets directly, reducing latency and controller load.

This behavior mimics real-world programmable networks used in data centers, enterprise networks, and cloud infrastructure.

Educational Value
Simulating OpenFlow using Mininet gives students hands-on experience with SDN principles:

Dynamic network control

Traffic engineering

Protocol interaction between switches and controllers

Real-time flow table inspection

This prepares students to work with cutting-edge network technologies like SD-WAN, cloud networking, 5G, and network automation platforms.

Commands:

🔷 1. Start Mininet with 3 Hosts and 1 Switch
mn --topo single,3 --mac --switch ovsk --controller remote

🔷 2. Start the POX Controller (in a new terminal)
cd ~/pox
./pox.py forwarding.l2_learning
(Alternatively, use Mininet's default controller with --controller=default if POX is not installed)

🔷 3. Run Basic Connectivity Tests from Mininet CLI
mininet> pingall

🔷 4. Test Bandwidth Between Two Hosts
mininet> h1 iperf -s &
mininet> h2 iperf -c h1

🔷 5. View Flow Table Entries on the Switch
mininet> sh ovs-ofctl dump-flows s1

🔷 6. Exit Mininet
mininet> exit

Conclusion: In this practical, we successfully simulated an SDN network using Mininet. We observed how the OpenFlow protocol enables switches to communicate with a central controller to manage flow rules dynamically. This demonstrates the key SDN principle of separating the control and data planes, enabling more flexible and programmable network management.

For Video demonstration some part of the given practical click on the link or scan the QR-code

https://youtu.be/hSEN_YAbUZY?si=-yEWFWVT1m25wG28