Redes Definidas por Software
Implementing a L3 L4 Stateful Firewall with P4

Version: 2

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Assignment Overview

In this assignment, you will implement a Layer 3 (L3) and Layer 4 (L4) stateful firewall using P4 (Programming Protocol-independent Packet Processors). The scenario involves a company network with three LANs: Sales (LAN1), Research & Development (R&D) (LAN2), and Management (LAN3). Each LAN has its own set of servers and hosts connected to Open vSwitch (OVS) switches, and the OVS switches are connected to BMv2 (behavioral model v2) P4 routers.

Scenario

You are working for TechSecure Inc., a company with strict security requirements for its network. The company has three departments with specific security needs:

- **Sales (LAN1):**
  - Needs access to CRM systems (TCP port 443) and email servers (TCP port 25, 587).
  - Should have limited access to R&D (LAN2) and Management (LAN3) for specific services:
    - Access to Research Server 1 (10.0.2.10) on TCP port 80.
    - Access to Financial Data Server 1 (10.0.3.10) on TCP port 8080.
- **Research & Development (R&D) (LAN2):**
  - Requires access to dedicated research servers (IP range: 10.0.2.0/24).
  - Should have limited access to Sales (LAN1) and Management (LAN3) for specific services:
    - Access to Email Server (10.0.1.20) on TCP port 25.
    - Access to Financial Data Server 2 (10.0.3.20) on TCP port 443.
- **Management (LAN3):**
  - Needs secure access to financial data servers (TCP port 8080) and administrative systems (TCP port 22 for SSH).
  - Should have limited access to Sales (LAN1) and R&D (LAN2) for specific services:
    - Access to CRM System (10.0.1.10) on TCP port 443.
    - Access to Research Server 2 (10.0.2.20) on TCP port 22.

Tasks

Topology Setup

- Utilize Mininet with BMv2 for P4 device virtualization.
- Implement the following topology:

LAN1:

- svr11 (Server 1 in LAN1) - IP: 10.0.1.10
- svr12 (Server 2 in LAN1) - IP: 10.0.1.20
- h11 (Host 1 in LAN1) - IP: 10.0.1.100

Connections for LAN1:

- svr11 and svr12 are connected to an OVS (Open vSwitch) switch s1.
- h11 is also connected to s1.
- s1 is connected to r1 (BMv2 P4 Router 1).

LAN2:

- svr21 (Server 1 in LAN2) - IP: 10.0.2.10
- svr22 (Server 2 in LAN2) - IP: 10.0.2.20
- h21 (Host 1 in LAN2) - IP: 10.0.2.100

Connections for LAN2:

- svr21 and svr22 are connected to an OVS (Open vSwitch) switch s2.
- h21 is also connected to s2.
- s2 is connected to r2 (BMv2 P4 Router 2).

LAN3:

- svr31 (Server 1 in LAN3) - IP: 10.0.3.10
- svr32 (Server 2 in LAN3) - IP: 10.0.3.20
- h31 (Host 1 in LAN3) - IP: 10.0.3.100

Connections for LAN3:

- svr31 and svr32 are connected to an OVS (Open vSwitch) switch s3.
- h31 is also connected to s3.
- s3 is connected to r3 (BMv2 P4 Router 3).

Interconnections between Routers:

- r1 (BMv2 P4 Router 1) is connected to r2 (BMv2 P4 Router 2).
- r2 (BMv2 P4 Router 2) is connected to r3 (BMv2 P4 Router 3).
- r3 (BMv2 P4 Router 3) is connected back to r1 (BMv2 P4 Router 1).

Firewall Development

- Extend the P4 code for each router to implement a L3 L4 stateful firewall based on the provided security requirements.
- Implement rules for:
  - Accepting or rejecting packets based on TCP/UDP ports.
  - Allowing or denying traffic between specific IP addresses.
  - Tracking and maintaining session state for established connections.

Testing and Evaluation

- Develop test scenarios to validate the firewall's behavior in the company network setup.
- Run the tests and observe the firewall's actions.
- Document the test results, including:
  - Packet traces showing accepted/dropped packets.
  - Explanation of how the firewall rules were applied.
  - Observations on the firewall's effectiveness in enforcing the security policy.

Submission Guidelines

- Submit your extended P4 code for the routers with the L3 L4 stateful firewall implementation.
- Submit the mininet topology.
- Submit the rules made for the routers and firewalls.
- Include a Report file with:
  - Instructions to run your code on Mininet with the provided topology.
  - Description of the firewall rules implemented based on the company network requirements.
  - Explanation of the test scenarios and their outcomes in the company network context.
  - Any challenges faced and how they were overcome.
- The submission must be a .zip archive, **RDS-G"X"-TP1.zip**. Replace **"X"** with your group number. Your group number contains 2 digits.

Important Notes

- Use the resources from the tutorial and P4 documentation for reference.
- Collaboration with peers is allowed for discussions and problem-solving, but each submission must be as a group.
- The deadline for this assignment is 13 June 2024.
- If you have any questions or need clarification, please reach out to d12267@di.uminho.pt.