Switches in Networking: A Beginner's Toolkit

Augustin ROLET
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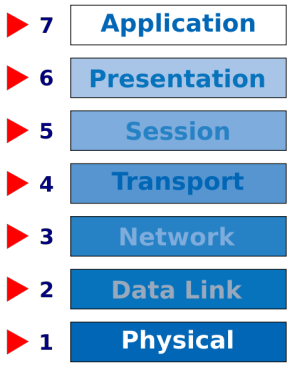
Overview

1 Introduction

This document serves as a beginner's toolkit for understanding and working with network switches. It provides essential commands and security setup instructions to help you get started with switches in networking.

2 Definition of a Switch

A network switch is a fundamental networking device that operates at the data link layer (Layer 2) of the OSI model. Its primary function is to forward data frames between devices within a LAN based on the destination MAC address. Switches make data forwarding decisions, enhancing network traffic efficiency compared to hubs.



OSI model, *freesvg.org*

3 Features of a Switch

Feature	Description
Firmware	A switch is running a firmware to perform hardware tasks
Connectivity	Switches connect devices within a LAN
Traffic Segmentation	Using VLANs, switches segment network traffic into isolated virtual networks
Port Forwarding	Switches reduce network broadcast traffic by forwarding data only to the specific port where the destination device resides
Security	Switches offer features like port security, access control lists (ACLs), and VLANs to enhance network security

Key Features of a Switch

4 Commands to setup a Switch

When working with a switch, remember that `running-config` is stored in RAM and is cleared at each reboot, whereas `startup-config` is stored in non-volatile memory and loaded upon every reboot.

4.1 Configuration

- `enable` - Enter privileged EXEC mode for configuring critical settings.
- `conf t` - Initiate configuration mode to configure various settings on the switch.

4.2 Security

- `enable password myPassword` - Set a plaintext password for privileged EXEC mode.
- `enable secret mySecretPassword` - Activate a secret password for privileged EXEC mode. (Encrypted by default)
- `banner motd "This is a custom banner"` - Set a Message of the Day (MOTD) banner displayed to users attempting to configure the switch.

4.3 Memory Management

- `copy running-config startup-config` - Save the running configuration to the startup configuration to retain changes after a reboot.
- `write-memory` ⇔ `copy running-config startup-config` ⇔ `cop r st`

5 Advanced Understanding of a Switch

5.1 MAC Address Table of a Switch

A MAC address table, also known as a CAM (Content Addressable Memory) table, is a fundamental component of a switch that facilitates efficient packet forwarding. MAC addresses are inherently unique and unchangeable as long as they are embedded in the network interface card of a device.

5.1.1 What is an ARP Request?

An ARP (Address Resolution Protocol) request is a broadcast message sent by a device to resolve an IP address into a MAC address. When a switch receives an ARP request, it forwards it to all connected devices. Upon receiving a response (or facing a timeout or failure), the switch updates its CAM table. This helps avoid repeating ARP requests for the same IP address in the future.

5.2 Important Networking Information

Switches operate based on MAC addresses, not IP addresses. Unlike IP addresses, which remain constant from source to destination, MAC addresses change each time a packet traverses a router. Switches add MAC addresses only for incoming requests.

As the world exhausts available IPv4 addresses, IPv6 is gaining prominence. IPv6 offers a vastly larger address space, accommodating the increasing number of devices on the internet.

Routers play a role in forwarding packets between networks. They store the MAC address of the next router in line, aiding switches in making forwarding decisions.

Network Address Translation (NAT) is a technique used for internet connectivity. NAT translates private IP addresses to public IP addresses via a router, ensuring requests reach the correct destination by adding the router's public IP to the packet.

5.3 OSI Model

The OSI (Open Systems Interconnection) model defines the layers involved in network communication. It's important to understand two key protocols:

- **TCP (Transmission Control Protocol)**: TCP ensures that packets are reliably delivered from the source to the destination, verifying that they arrive intact.
- **UDP (User Datagram Protocol)**: UDP, in contrast, sends packets without reliability checks. It's used for applications where speed is critical, and minor data loss is acceptable.

Did you know: Approximately 80% of network issues stem from the physical layer of the OSI model, emphasizing the importance of proper cabling and hardware maintenance in network management.

6 IP Addresses: An Overview

In networking, IP addresses are fundamental for identifying devices on a network. An IPv4 address combined with a prefix length is typically written in the form "192.168.1.1/24." Let's break down this notation:

- **IPv4 Address:** In the example "192.168.1.1/24" "192.168.1.1" is the IP address.
- **Prefix Length:** The number following the slash ("/") symbol, in this case, "24" is called the prefix. It represents the number of bits that are fixed and belong to the network portion of the IP address.

Using the prefix, we can derive various pieces of information about the IP address:

- **Hostpart:** The hostpart is calculated as the remaining bits in the IP address, which is equal to $32 - \text{prefix}$. It represents the free bits of the ip address
- **Key Functions:** Several key functions can be derived based on the prefix and IP address:
  1. **get_broadcast:** Calculates the broadcast address when the hostpart consists of all ones.
  2. **get_network:** Determines the network address when the hostpart consists of all zeros.
  3. **get_number_ip_available:** Calculates the number of available IP addresses within the subnet.
  4. **get_subnet_mask:** Computes the subnet mask for the given prefix.
  5. **is_valid:** Checks if the IP address is neither the network address nor the broadcast address.

For practical implementations of these functions, you can refer to the IPv4 class available in both C and Python. Visit my GitHub repository for the source code and more details:

`https://github.com/teloryfrozy/IPv4-Address-Calculator-Toolkit`

In summary, every IP address is considered valid unless it matches the network address or the broadcast address. Understanding these concepts is essential for network administrators and engineers to manage IP addressing effectively.