**CCNA 1.0: Network Fundamentals Cheat Sheet**

**1.1 Network Components**

| Device | OSI Layer | Primary Function & Characteristics |
|---|---|---|
| **Router** | Layer 3 | Connects distinct networks. Forwards packets based on IP. Breaks broadcast domains. |
| **L2 Switch** | Layer 2 | Connects devices within the same network. Forwards frames based on MAC addresses. Breaks collision domains. |
| **L3 Switch** | Layers 2 & 3 | Performs hardware-based inter-VLAN routing (SVIs) at switching speeds. |
| **NGFW** | Layers 3–7 | Next-Gen Firewall. Inspects payload for application awareness (e.g., blocking specific web apps, not just ports). |
| **IPS** | Layers 4–7 | Intrusion Prevention System. Scans for malware/anomalies and *actively* drops malicious packets. |
| **AP** | Layer 1 & 2 | Access Point. Bridges 802.11 wireless RF to 802.3 wired Ethernet. Usually "Lightweight" (LAP). |
| **WLC** | Layer 7 | Wireless LAN Controller. Centralized management for LAPs (roaming, RF channels, authentication). |
| **Endpoint** | Layers 1–7 | End-user devices (PCs, phones, printers) that originate or terminate data flows. |

**1.2 Topology Architectures**

- **2-Tier (Collapsed Core):** Combines Core and Distribution layers into one. Standard for medium enterprises.
- **3-Tier:** Access (endpoints), Distribution (routing/policies), Core (high-speed backbone). Large campuses.
- **Spine-Leaf:** Datacenter topology. Leaves connect to all Spines. Consistent 1-hop latency for East-West traffic.
- **SOHO:** Small Office/Home Office. All-in-one appliance (router, switch, firewall, AP).
- **On-Premises:** Capital Expenditure (CapEx). Complete physical control and maintenance.
- **Cloud (IaaS/SaaS):** Operational Expenditure (OpEx). Scalable, pay-as-you-go, shared responsibility.

**1.3 Physical Interfaces & Cabling**

**Ethernet Copper Standards (Max Distance: 100m)**

| Speed | Standard | Informal Name | Wires Used |
|---|---|---|---|
| **10 Mbps** | 10BASE-T (802.3i) | Ethernet | 2 Pairs (4 wires) - TX/RX |
| **100 Mbps** | 100BASE-TX (802.3u) | Fast Ethernet (FE) | 2 Pairs (4 wires) - TX/RX |
| **1 Gbps** | 1000BASE-T (802.3ab) | Gigabit (GigE) | 4 Pairs (8 wires) - Bidirectional |
| **10 Gbps** | 10GBASE-T (802.3an) | 10 GigE | 4 Pairs (Cat6a = 100m, Cat6 = 55m) |

**T568B Pinout (Standard Straight-Through)**

1. **White/Orange** (TX+) | 2. **Orange** (TX-) | 3. **White/Green** (RX+) | 4. **Blue** | 5. **White/Blue** | 6. **Green** (RX-) | 7. **White/Brown** | 8. **Brown**

*(Note: Modern Cisco switches use Auto-MDIX to automatically cross TX/RX pins, eliminating the need for Crossover cables).*

**Fiber Optic Standards**

| Type | Speed | Standard | Distance | Core Size / Light |
|---|---|---|---|---|
| **MMF** (Multi-Mode) | 1 Gbps | 1000BASE-SX | Up to 550m | 50/62.5µm / LED |
| **MMF** | 10 Gbps | 10GBASE-SR | Up to 400m | 50/62.5µm / LED |
| **SMF** (Single-Mode) | 1 Gbps | 1000BASE-LX | Up to 5km | 9µm / Laser |
| **SMF** | 10 Gbps | 10GBASE-LR | Up to 10km | 9µm / Laser |

**1.4 Ethernet Frames & Layer 2 Switching**

**Anatomy of an Ethernet Frame (802.3)**

| Field | Size | Core Function |
|---|---|---|
| **Preamble** | 7 Bytes | Alternating 1s and 0s (10101010...) used to synchronize receiver/transmitter clocks. |
| **SFD** | 1 Byte | Start Frame Delimiter (10101011). Signals that the frame data begins immediately next. |
| **Dest MAC** | 6 Bytes | Physical address of the destination device. Used by the switch to route the frame. |
| **Source MAC** | 6 Bytes | Physical address of the transmitting device. Used by the switch to build its MAC table. |
| **Type / Length** | 2 Bytes | Identifies encapsulated Layer 3 protocol (e.g., 0x0800 = IPv4, 0x86DD = IPv6). |

| Field | Size | Core Function |
|---|---|---|
| **Payload** | 46–1500 B | The actual data layer (IP Packet). Padded to 46 bytes minimum if too small. |
| **FCS (CRC)** | 4 Bytes | Frame Check Sequence. Uses a Cyclic Redundancy Check mathematical formula to test for corruption. If receiver math doesn't match the FCS value, the frame is dropped. |

**The 48-Bit MAC Address**

- **OUI (Organizationally Unique Identifier):** First 24 bits (3 bytes). Assesses manufacturer identification (assigned by IEEE).
- **Vendor Serial Number:** Last 24 bits (3 bytes). Unique identification code assigned to the specific NIC.
- **Cisco Notation Format:** aabb.ccdd.eeff (Hexadecimal grouped into 4-character blocks separated by periods).

**Core Switch Operations (CAM Table Logic)**

1. **Learn:** Examine the **Source MAC** of incoming frames. If not present in the CAM table, map the MAC address to that physical incoming interface port with a default 300-second aging timer.
2. **Forward:** Examine the **Destination MAC** of incoming frames. If a matching entry exists in the CAM table, forward the frame cleanly out that exact port only (Unicast).
3. **Flood:** If the Destination MAC is a Broadcast (ffff.ffff.ffff), Multicast, or an **Unknown Unicast** (not yet learned in the CAM table), replicate and flood the frame out every single active port belonging to that VLAN *except* the ingress port it arrived on.

**1.5 TCP vs. UDP & Common Ports**

| Protocol | Characteristics | Primary Uses |
|---|---|---|
| **TCP** | Connection-oriented (3-way handshake), reliable, sequenced, flow control (windowing), high overhead. | HTTP, HTTPS, FTP, SSH, Email |
| **UDP** | Connectionless, unreliable (best effort), unsequenced, no flow control, low overhead, extremely fast. | VoIP, Video Streaming, DNS queries |

**Critical Layer 4 Ports**

| Port | Protocol | Service | | Port | Protocol | Service |
|---|---|---|---|---|---|---|
| **20/21** | TCP | FTP (Data / Control) | | **67/68** | UDP | DHCP (Server / Client) |
| **22** | TCP | SSH (Secure CLI) | | **80** | TCP | HTTP (Web) |
| **23** | TCP | Telnet (Insecure CLI) | | **110** | TCP | POP3 (Email Receive) |
| **25** | TCP | SMTP (Email Send) | | **161/162** | UDP | SNMP (Network Mgmt) |
| **53** | UDP/TCP | DNS (Resolution) | | **443** | TCP | HTTPS (Secure Web) |

**1.6 IPv4 Addressing & Subnetting**

**Subnetting Cheat Sheet (4th Octet)**

*Formula: Usable Hosts = Block Size - 2 (Network & Broadcast IPs)*

| CIDR | Subnet Mask | Block Size (Magic #) | Usable Hosts | Primary Use Case |
|---|---|---|---|---|
| **/24** | 255.255.255.0 | 256 | 254 | Standard Client Data LAN |
| **/25** | 255.255.255.128 | 128 | 126 | Mid-Sized Network Partition |
| **/26** | 255.255.255.192 | 64 | 62 | Isolated Server / Infrastructure Subnet |
| **/27** | 255.255.255.224 | 32 | 30 | Small Voice/VoIP/Management Subnet |
| **/28** | 255.255.255.240 | 16 | 14 | DMZ Public Facing Routing Blocks |
| **/29** | 255.255.255.248 | 8 | 6 | Edge Firewalls HA / ISP Hand-offs |
| **/30** | 255.255.255.252 | 4 | 2 | Point-to-Point Internal Serial/Router Links |
| **/32** | 255.255.255.255 | 1 | 1 | Router Loopbacks / Specific Host Routing |

**RFC 1918 (Private IP Space) & Special Addresses**

- **Class A:** 10.0.0.0 to 10.255.255.255 (/8)
- **Class B:** 172.16.0.0 to 172.31.255.255 (/12)
- **Class C:** 192.168.0.0 to 192.168.255.255 (/16)
- **APIPA (Link-Local):** 169.254.x.x /16 (DHCP assignment failure)

- **Loopback:** 127.0.0.0 /8 (Local protocol host processing verification)
- **Default Route:** 0.0.0.0 /0 (Gateway of Last Resort configuration target)

**1.7 IPv6 Addressing**

**Format:** 128-bits, Hexadecimal, 8 Hextets.

**Rules:** 1. Omit leading zeros. 2. Use double-colon :: to compress contiguous all-zero hextets (**ONLY ONCE** per address).

| Type | Prefix Identifier | IPv4 Equivalent | Notes |
|---|---|---|---|
| **Global Unicast (GUA)** | 2000::/3 | Public IP | Routable on the public internet. |
| **Unique Local (ULA)** | FC00::/7 or FD | Private IP | Internal site routing only. |
| **Link-Local** | FE80::/10 | APIPA | Required on all interfaces. Used for OSPFv3 routing. |
| **Multicast** | FF00::/8 | Broadcast | Replaces IPv4 broadcasts. |

- **SLAAC:** Stateless Address Autoconfiguration. Hosts generate IPs via Router Advertisements (RA).
- **EUI-64:** Takes a 48-bit MAC, inserts FFFE in the middle, flips 7th bit to create a 64-bit host ID.
- **NDP:** Neighbor Discovery Protocol. Uses ICMPv6 to replace ARP.

**1.8 Wireless Principles**

- **2.4 GHz Band:** Longer range, slower speeds, high interference. **Channels 1, 6, 11** are the only non-overlapping channels (22MHz wide, 5MHz separation).
- **5 GHz Band:** Shorter range, faster speeds, ~25 non-overlapping channels.
- **RF Interference:**

    - *Absorption:* Walls trap signal (turns to heat).
    - *Reflection:* Metal bounces signal (causes multipath distortion).
    - *Refraction:* Glass/Water bends signal (alters path).
    - *Scattering:* Foliage shatters signal.
- **SSID:** Network name. **BSSID:** AP's radio MAC address. **ESSID:** Multiple APs sharing the same SSID for roaming.

**1.9 Virtualization Fundamentals**

- **Type 1 Hypervisor (Bare-Metal):** Installed directly on hardware (ESXi, Proxmox). Highly efficient.
- **Type 2 Hypervisor (Hosted):** Installed on a Host OS (VirtualBox). Good for testing.
- **vSwitch:** Virtual switch inside the hypervisor connecting VMs internally and to physical NICs.
- **VMs vs Containers:** VMs virtualize hardware and require a full, heavy OS per instance. Containers (Docker) virtualize the OS, sharing the host kernel, making them lightweight and instant to boot.