Introduction to Scaling Networks

Routing and Switching: Scaling Networks – Chapter 1
Scaling Computer Networks

- Businesses can grow, along with their needs in terms of users, uptime, speed. Their network must be able to do the same.

- A computer network designed to accommodate the need for growth is called **scalable**.

- Enterprise networks need **enterprise hardware**, specifically designed to provide reliability through **redundancy** and **failover**. But nothing can replace a properly designed network.

- First need of a proper design: **the traffic must be organized so that it doesn't unnecessarily propagate** through the network at the cost of bandwidth.

- We achieve this through a **hierarchical design** composed of 3 layers, bottom-to-top: **Access, Distribution, Core**. Each layer has a specific function.
Hierarchical Network Design

- The **Access Layer** is in charge of **providing a connection to the final users** in a local network.

- The **Distribution Layer forwards traffic** from/to different local networks.

- The **Core Layer** is a high speed backbone between distribution blocks, that is networks that are geographically dispersed.

- Crucially, **user traffic starts at the access layer and it's not passed to the upper layer unless their functionality is required**.

- In smaller enterprise networks, **Distribution and Core Layers can be collapsed into a single one**, reducing cost and complexity.
Cisco Enterprise Architecture

- Cisco advises this network design principle that divides networks into modular components, maintaining the 3 layers.
- Its modules include: Enterprise Campus, Enterprise Edge, Service Provider Edge, Remote.
- The Enterprise Campus includes Access, Distribution and Core Layers. The entire enterprise infrastructure belongs to this module.
- In the Access Layer, L2/L3 switches provides port density and links/trunks to the distribution layer of the building.
- Distribution layer aggregates these links/trunks with L3 devices that provides routing, access control and QoS.
- The Core Layer provides very fast connectivity between distribution layer modules and the Enterprise Edge modules.
Cisco Enterprise Architecture

- **Enterprise Campus** can have additional **submodules**, such as Server Farm module, Data Center module, Service Module.

- **These submodules provided network monitoring and unified control** of services such as wireless controlling or telephony services.

- The **Enterprise Edge** includes modules that **connect the enterprise to remote resources** through the service provider network: Internet connectivity, VPN tunnels and WAN.

- The **Service Provider Edge** provides services through a **service provider** such as internet connection and phone lines.

- Each of these services has a corresponding **edge device** in the Enterprise Edge that examines all packet and decides whether it should be allowed on the enterprise network.
Failure Domains

- A failure domain is the area of the network that is impacted by a problem or failure.
- Much of the impact of a failure domain is determined by the functionality provided by the faulty device.
- When a problem occurs, smaller failure domains reduce the impact of the problem, simplify troubleshooting and thus decrease downtime.
- Reducing failure domains in the core layer is expensive, so designer concentrate on prevention. Making sure network errors affect a smaller area in the distribution layer is easier.
- Distribution device (L3 switches or routers) are usually deployed in pair, with access devices evenly distributed. This is called a switch block. Switch blocks act independently of the others.
Failure Domains
Tips for Scalability

- Use **modular devices** than can easily expands their capabilities. Some device are more **easily deployable in clusters** that simplify management and configuration.

- Use these modular devices in a **3-layer network design**.

- **Think about an IPv4 or IPv6 addressing strategy** that will accommodate future users. Re-addressing later could be a major disruption.

- Use **routers and L3 switches to limit broadcast** and filter traffic to the core.

- Use **redundant links** between network devices. **Link aggregation** (such as Cisco's **EtherChannel**) methods increase bandwidth without more expensive media channels.

- A **scalable routing protocol** that minimizes the size of the routing table.
Tips for Redundancy

- Redundancy is all about **minimizing the chance of a single point of failure**.

- One easy method to achieve redundancy is by **installing duplicate equipment**, at least for critical devices.

- Redundancy also means **redundant paths** that traverses the network.

- **Redundancy in switches could cause traffic loops at L2. Spanning Tree Protocol** (STP) is a mechanism that prevents them.

- **STP disables redundant paths until those paths are necessary**, for instance in case of failure.
EtherChannel

- Multiple traffic links between access and distribution switches will need to converge in a single outgoing link that could become a bottleneck.

- It is possible to tie multiple physical links together in a single logical one, increasing the available bandwidth. This is called link aggregation.

- EtherChannel is a Cisco protocol that use ports of the existing switches to create a logical EtherChannel interface.

- Every configuration is done on the EtherChannel interface, ensuring consistency between ports.

- EtherChannel can do load balancing between the links that are part of the EtherChannel interface, using several methods.
Wireless Connectivity

- **Wireless connectivity** is crucial in expanding a network, because it **increases flexibility without excessive costs**.
- Implementing wireless connectivity require at the very minimum:
  - A **wireless NIC** for end devices
  - An **access point (AP)** or wireless router
- Wireless connectivity needs careful planning. Several things must be considered, among them:
  - Types of devices
  - Coverage
  - Interference
  - Security
  - Speed and protocols
Tuning Routing Protocols

- OSPF supports a **two-layer hierarchical design**, or **multiarea OSPF**.
- All OSPF networks **begin with Area 0**, also called the **backbone area**.
- As the network is expanded, other, **non-backbone areas can be created**.
- All non-backbone areas must directly connect to **area 0**.
Switch Platforms

- Cisco has **5 categories** for enterprise switches: Campus LAN switches, Cloud-Managed switches, Data Center switches, Service Provider switches, and Virtual Networking switches.

- Enterprise switches comes in **several form factor**:
  - Fixed or Modular configuration
  - Stackable or Non-Stackable

- For switches that are mounted in racks, **thickness** is important. It is measured in **rack units** (U).

- These are the **most commons parameters** that need to be evaluated when choosing a switch solution: **cost, port density, power specifications, reliability, port speed, frame buffers, scalability.**
Port Density

- **Port density** is the number of port available on a **single** switch.

- **High-port density switches allow better use of space and power.** Consider a single 48-ports vs dual 24-ports switches, than scale the advantages to networks made of 1000+ end devices.

- **Modular switches can support extremely high port density through multiple expansion cards.** Catalyst 6500 switches can support more than 1000 ports.

- **Link aggregation reduces available ports**, something less of an impact with modular switches.
Forwarding Rates

- **Forwarding Rate** means how much data a switch is able to process per second.

- **Wire Speed** is the data rate a single port on the switch is able to attain. It can be 100Mb/s, 1Gb/s, 10Gb/s or even more.

- If forwarding rates are too low, switches cannot reach full wire speed on all of their ports at the same time.

- Access layer switches are limited by their uplink speed to the distribution layer anyway, so they don't need to have high forwarding rates, reducing costs.

- At the distribution and core layers an **high forwarding rates has a much greater impact** on overall network performance.
PoE – Power over Ethernet

- PoE can provide the power a device needs to operate on the same Ethernet cabling used for data transmission.
- PoE allows flexibility because it means a device can be installed any place reached by an Ethernet cable.
- PoE-capable switches are much more expensive, so it needs to be evaluated carefully if PoE is needed or not.
- Some Cisco switches also support PoE pass-through, which allows powering the devices in a cascading fashion starting for an upstream power source.
Multilayer Switching

- Multi-layer switches have the ability of **building a routing table**, support several routing protocol, and forward IP packets nearly at the same **L2 forwarding speed**.

- They are able to do that thanks to **specialized ASIC processors and routines**.

- The trend is clear: **the cost of supporting routing in switches is decreasing**. Soon all switches will support it.
Router Requirements

- Routing is an essential component of the distribution layer. **Without a routing process packets cannot leave the LAN.**

- Routers provide several functions:
  - Selection of the appropriate **path for the traffic**.
  - **Translation** between different media types/protocols.
  - Broadcast containment
  - Connect remote location
  - **Group users** logically
  - Provides **enhanced security**

- There are **3 categories of Cisco routers**:
  - **Branch Routers** (for local routing and WAN access),
  - **Network Edge Routers** (boundary routers designed for multi-WAN deployment),
  - **Service Provider Routers** (designed for Service providers who want to differentiate their services).
Router Hardware

- Routers can have many form factors, from small desktop router to rack or blade models.

- Routers can be:
  - **Fixed**: the desired router interfaces are built-in and not expandible.
  - **Modular**: the router has slots through which it's possible to change the interfaces or adding new ones.
Managing IOS Files and Licenses

- Cisco has a **single operating system, IOS**, for most of their products.
- IOS comes in many versions, and for a single version it has **many different images with different feature sets**.
- This feature sets are **customizable by the user** when a product is purchased.
- A new device is **shipped with an image preinstalled** that corresponds to the customer-specified packages, and with a **permanent license** for it.
In-Band vs Out-of-Band

• There are two methods for connecting to a Cisco IOS device for configuring it or monitoring it: **In-Band and Out-of-Band**.

• **Out-of-Band** is used for initial configuration and every time a network connection becomes unavailable.

• It requires direct connection to the console port as well as a terminal emulation client.

• **In-Band management** is used for normal maintenance and configuration, and it works over a working network connection.

• It requires at least one network interface active, connected and operational, as well as SSH, telnet or HTTP access to the device.
End of lesson