Choosing Switches and Routers for the Campus

Campus Network Design & Operations Workshop

UNIVERSITY OF OREGON

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NSRC
Network Startup Resource Center

Choices!

- Minimum requirements for L2 devices
- Edge Switch
- Distribution Switch
- Campus Core Router
- Campus Border Router

- In all cases examples of mainstream vendor models are given to *guide* campus network administrators

Selecting Switches

Selecting Switches

- Minimum features:
  - Standards compliance
  - Encrypted management (SSH/HTTPS)
  - VLAN trunking
  - Spanning Tree (RSTP at least)
  - SNMP
    - At least v2 (v3 has better security)
    - Traps
  - Remote management and configuration backup
    - CLI preferred, also serial console desirable

Selecting Switches

- Other recommended features:
  - DHCP Snooping
    - Prevent end-users from running a rogue DHCP server
      - Happens a lot with little wireless routers (Netgear, Linksys, etc) plugged in backwards
    - Uplink ports towards the legitimate DHCP server are defined as “trusted”. If DHCPOFFERs are seen coming from any untrusted port, they are dropped.
  - RA Guard
    - Prevent end-users from sending IPv6 Router Advertisements
      - Happens a lot with older Windows devices with IPv6 enabled, building automatic tunnels, and then announcing themselves as routers to the LAN

Selecting Switches

- Other recommended features:
  - Dynamic ARP inspection
    - A malicious host can perform a man-in-the-middle attack by sending gratuitous ARP responses, or responding to requests with bogus information
    - Switches can look inside ARP packets and discard gratuitous and invalid ARP packets.

Selecting Switches

- Other recommended features:
  - IGMP Snooping:
    - Switches normally flood multicast frames out every port
    - Snooping on IGMP traffic, the switch can learn which stations are members of a multicast group, thus forwarding multicast frames only out necessary ports
    - Very important when users run Norton Ghost, for example.

Selecting Edge Switches

- In addition to the previous general features:
  - L2 device only – connecting end users!
  - 24 or 48 10/100/1000 copper ports
    - Opt for some Power over Ethernet (POE) ports if requirement to connect wireless access points and/or IP phones
  - Two 1Gbps/10Gbps uplink ports (copper or fibre)
- Only connects to the building distribution switch
  - Copper at 1Gbps may well be enough
  - Fibre installation allows future growth to 10Gbps from edge to distribution by swapping SFP for SFP+

Example Low Cost Edge Switch

- Netgear “Smart Managed Pro” switches[1]
  - GS748 and GS752 have 48 10/100/1000 ports
    - PoE options if desired (TP and TPP)
    - 4x 1Gbps SFP
    - 24 port versions also available
  - GS110TP has 8 10/100/1000 ports
    - All PoE, plus 2x 1Gbps SFP
  - Full SNMP, management access (HTTP and telnet[2])
  - 802.1x, DHCP snooping, Dynamic ARP inspection
  - Shallow form factor – good for wall mount cabinets

[1] Avoid "Smart Managed Plus" – those are web-only, no SNMP

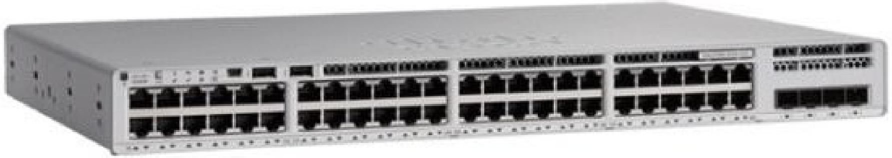
[2] But no HTTPS, SSH or serial console. More expensive M4100 has these.

Example Low Cost Edge Switch

- Dell EMC Switch N1524 & N1548
  - 24 port and 48 port respectively (10/100/1000)
  - 4x 10Gbps SFP+ uplink
  - N1524P and N1548P have PoE
  - CLI (Cisco like) and GUI, serial console port
  - SSH and HTTPS access
  - DHCP snooping, Dynamic ARP inspection, etc

Example Edge Switch

- Cisco Catalyst 2960X (older) or Catalyst 9200
  - 24 or 48 10/100/1000 ports
    - PoE options if desired
  - Uplink options
    - 4x 1Gbps SFP or 2x 10Gbps SFP+
    - Catalyst 9200 also offers modular uplink ports with 25Gbps and 40Gbps ethernet
  - Stackable (up to 8 units)



Selecting Distribution Switches

- In addition to the previous general features:
  - L2 device only – connecting edge switches!
  - 12 or 24 copper or fibre 1Gbps ports
  - 1 or 2 10Gbps fibre uplink ports
- Aggregates edge switches towards the core
  - May also connect end users
  - Copper ports for edge aggregation
  - Fibre ports for uplink

Example Distribution Switches

- Cisco Catalyst 2960X or Catalyst 9200
  - 24 10/100/1000 ports
  - Uplink with 2x 10Gbps SFP+ (2960X) or 4x 10Gbps SFP+ (9200)

- Cisco Catalyst 9300 (fibre)
  - 24 SFP fibre ports (C9300-24S)
  - 48 SFP fibre ports (C9300-48S)
  - Uplink modules include 4x 1G, 8x 10G, 2x 40G

Summary

- Edge Switch
  - Focus on access ports
  - Fibre to building distribution, or is copper enough?
  - Do NOT need any L3 capability
- Distribution Switch
  - Fibre ports to connect Edge Switches
  - 10Gbps fibre link to Campus Core Router
  - Do NOT need any L3 capability

Choosing a Core Router

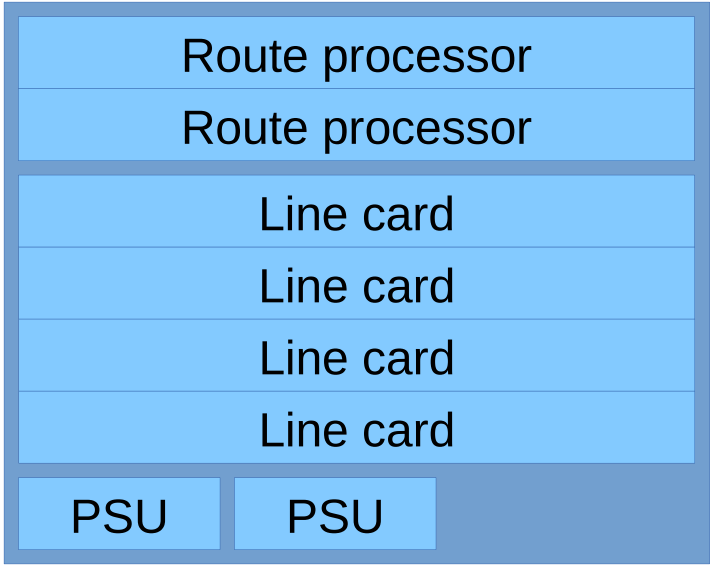
Core router: essential features

- Lots of fiber ports
  - SFP (1G) or SFP+ (10G)
- Robust, line-rate routing (layer 3 forwarding)
  - IPv4 and IPv6, static routes
- Sufficient ARP (IPv4) and NDP (IPv6) entries
- DHCP relay (DHCP helper)
- Management: SSH, SNMPv2/v3
- OSPF (v2 and v3) or IS-IS

Core router: optional features

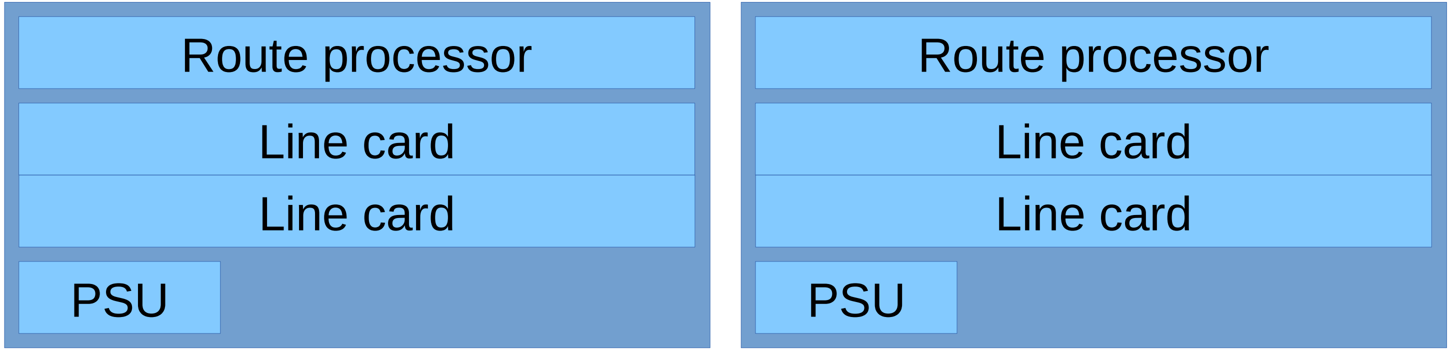
- HSRP/VRRP
- Mirror/span port
- Hardware redundancy (e.g. dual PSU)
  - But would you be better buying a whole second device?

One super-redundant device



- Chassis failures are not unknown ▮▮
- What would you do if that happened?

Two less-redundant devices



Route processor

Line card

Line card

PSU

Route processor

Line card

Line card

PSU

- Running “live-live” so everything is tested
- In emergency, can move key users to other side
- Key buildings can be dual-homed
  - This is where OSPF and HSRP/VRRP come in

Don’t spend too much!

- Many “edge” L3 switches make fine campus core routers
- You won’t be carrying a full routing table
  - So a limit of say 16K routes isn’t a problem
  - Check how many IP interfaces/VLANs it supports
- Whatever you buy today will be obsolete in 3-5 years anyway
- If it’s cheap you can afford two

Cisco Nexus C36180YC

- 48 SFP/SFP+ ports
  - Each port supports 1G/10G/25G ethernet
- 6x 40G/100G uplink ports
  - Will also operate as 4x25G or 4x10G with breakout cable
- Runs NX-OS
  - Very IOS like, but not the same
  - LAN Enterprise license needed for L3 routing protocols

Cisco Catalyst 9500-48Y4C

- 48 SFP/SFP+ ports
  - Each port supports 1G/10G/25G ethernet
- 4x 40G/100G uplink ports
  - Check transceiver/DAC/AOC support
- Needs “Network Advantage” license for BGP/OSPF/IS-IS
  - Beware: Cisco 3/5/7-year license for “DNA Advantage” for L3 feature set

Juniper EX4650

- 48 SFP/SFP+ ports
  - Each port supports 1G/10G/25G ethernet
- 8x 40G/100G uplink ports
  - Will also operate as 4x25G or 4x10G with breakout cable
- Premium Feature License needed for BGP and IS-IS support
  - Base Feature license has OSPF and RIPv2

Juniper QFX5120-48Y

- 48 SFP/SFP+ ports
  - Each port supports 1G/10G/25G ethernet
- 8x 40G/100G uplink ports
  - Will also operate as 4x25G or 4x10G with breakout cable
- Advanced 1 Feature License needed for OSPF/IS-IS/BGP support
  - Beware: 3/5-year license for Software Feature Licenses

Not big enough?!

- Above this you are looking at chassis switches
- Examples:
  - Cisco Catalyst 9600, Nexus 9000
  - Juniper EX9204/08/14, QFX10000

But do you need anything this big and power hungry??

Maybe you already have one!

- Check the features of your existing devices
  - And check on forums for experiences of people using the same device for routing
- May need to enable it: “ip routing” or similar
- May need to update to latest stable firmware
- Test with a spare device if you have one

Choosing a Border Router

Border router: essential features

- Robust, line-rate routing (layer 3 forwarding)
  - IPv4 and IPv6, static routes
- Strong CPU, Large Memory
- Management: SSH, SNMP, netflow/jflow/sflow/IPFIX
- OSPF (v2 and v3) or IS-IS
- NAT (if using internal private IPv4 address space)
- Hardware redundancy (e.g. dual PSU)
  - but would you be better buying a whole second device?

Border router: optional features

- If Multihoming:
  - Full support for BGP
  - Ability to carry full BGP table (if needed)
  - Support of all BGP Attributes, implementing BGP policies

Sizing a Border Router

- Consider connection to upstream provider
  - Allow for headroom far greater than link capacity
  - Bandwidth upgrades needed
  - Traffic growths larger than expectation
  - Dealing with Denial-of-Service Attacks from outside
- Physical chassis size is irrelevant
  - Smaller the better, reduced power and space requirements
- Border router needs:
  - Internal interface (to network core)
  - External interface(s) (to upstream provider(s))
  - 1 Rack Unit is usually enough

Typical Low-Cost Example

- MikroTik CCR1036-8G-2S+
  - 8 Gigabit Ethernet ports (copper)
  - 2 SFP/SFP+ ports
  - Real world throughput well in excess of 1Gbps
  - BGP only runs on one core – not suitable for full BGP table
  - IPv6 implementation not complete

Typical Examples

- Cisco ASR1001-X
  - 1 RU chassis
  - 2x10GE and 6x1GE interfaces
  - 2.5Gbps throughput default
  - License activates 10GE ports allowing up to 20Gbps

- Juniper MX150
  - 1 RU chassis
  - Throughput up to 40Gbps
  - 8 10/100/1000 copper ports, 2 100/1000 SFP ports, and 2 SFP+ ports

Typical Examples: High End

- Juniper MX204
  - Popular high-end border router
  - 4 built-in 100GE and 8 10GE interfaces
  - Throughput up to 400Gbps

- Cisco NCS540X-16Z4G8Q2C
  - 2 built-in 40/100GE, 8 10/25GE and 16 1/10GE interfaces
  - Throughput up to 300Mpps

Summary

- Core Router
  - Focus on scalability, sufficient CPU to ensure current and immediate future needs
  - Router or “L3 Switch” is often appropriate, as routing needs in the Core are not onerous
- Border Router
  - Physical size unimportant → small!
  - Needs v few interfaces
  - Needs big CPU to handle border functions
  - Consider future BGP needs

Questions?