Campus Network Best Practices: Campus Network Design Principles

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Why Focus on Campus Networks?

• The Campus Network is the foundation for all Research and Education activity

• Without a good campus network, the Research and Education Network can’t work as well as it should

• Ad-hoc campus networks work OK with low speed Internet Connectivity, but moving to high speed external links, they start to fail.
Why Focus on Campus Networks?

• Your campus network is the foundation that all services are provisioned on.
• Ad hoc networks just don’t work well. They are unreliable and hard to maintain.
• If you don’t have a plan, how will you know where are going?
What are Our Goals?

• Network Design Goals
  – Reliability/Resiliency
  – Performance
  – Manageability
    • Must have this to find problems and viruses
  – Scalability
    • Need to be able to grow as needs grow

• Need this in the campus and the REN
Campus Network Rules

- Minimize number of network devices in any path
- Use standard solutions for common situations
- Build Separate Core and Edge Networks
- Provide services near the core
- Separate border routers from core
- Provide opportunities to firewall and shape network traffic
- Only buy managed network equipment
Core versus Edge

• Core network is the “core” of your network
  – Needs to have reliable power and air conditioning
  – May have multiple cores
  – Always route in the core

• Edge is toward the edges of your network
  – Provide service inside of individual buildings to individual computers
  – Always switch at the edge
Minimize Number of Network Devices in the Path

- Build star networks
- Not daisy chained networks
Edge Networks (Layer 2 LANs)

- Provides Service to end users
- Each of these networks will be an IP subnet
- Plan for no more than 250 Computers at maximum
- Should be one of these for every reasonable sized building
- This network should only be switched
- **Always buy switches that are managed – no unmanaged switches!**
Edge Networks

• Make every network look like this:

Fiber link to core router
Edge Networks Continued

- Build Edge network incrementally as you have demand and money
- Start Small:

![Diagram of network with fiber link to core router]
Edge Networks Continued

• Then as you need to add machines to the network, add a switch to get this:

![Diagram of network with fiber link to core router]
Edge Networks Continued

- And keep adding switches to get to the final configuration
Edge Networks Continued

• And keep adding switches to get to the final configuration
Edge Networks Continued

• Resist the urge to save money by breaking this model and daisy chaining networks or buildings together

• Try hard not to do this:
Edge Networks Continued

- There are cases where you can serve multiple small buildings with one subnet.
- Do it carefully.
- Two basic models:
Core Network
Routing versus Switching
Layer 2 versus Layer 3

• Routers provide more isolation between devices (they stop broadcasts)
• Routing is more complicated, but also more sophisticated and can make more efficient use of the network, particularly if there are redundancy elements such as loops
Switching versus Routing

These links must be routed, not switched
Core Network

• Reliability is the key
  – remember many users and possibly your whole network relies on the core
• May have one or more network core locations
• Core location must have reliable power
  – UPS battery backup (redundant UPS as your network evolves)
  – Generator
• Core location must have reliable air conditioning
• As your network evolves, core equipment should be equipped with dual power supplies, each powered from separate UPS
• Border routers separate from Core
• Firewalls and Traffic Shaping Devices
• Intrusion Detection
• Intrusion Prevention
• Network Address Translation
Core Network

• At the core of your network should be routers – you must route, not switch.
• Routers give isolation between subnets
• A simple core:

REN

Border Router

Core Router

All router interfaces on a separate subnet

Fiber optic links to remote buildings

Central Servers for campus

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Where to put Firewalls or NAT

- Firewalls or NAT devices must be placed “in line”
- This means that the speed of this device affects access to the outside world
- This is a typical design, but think about alternatives
Where to put Firewalls

- Try to have parts of your network non-firewalled, non NATed
- This will allow full bandwidth, un-filtered access to the Internet
- Simple configuration:
Where to put Servers?

- Servers should be on a high speed interface off of your core router.
- Servers should be at your core location where there is good power and air conditioning.
Border Router

- Connects to outside world
- RENs and Peering are the reason you need them
- Must get Provider Independent IP address space and Autonomous System Number and run BGP to really make this work right
Putting it all Together

Border Router

Firewall/
Traffic Shaper

Core Router

ISP

REN

Core Servers

Fiber Optic Links

Fiber Optic Links
Alternative Core Designs

• One Armed Router for Core

VLAN Trunk carrying all subnets

Fiber Optic Links

Core Router

Core Server

Core Switch

Fiber Optic Links

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Alternative Core Designs

- Wireless Links versus Fiber
Complex Core Designs

• Multiple Core Routers
Layer 2 and 3 Summary

• Route in the core
• Switch at the edge
• Build star networks – don’t daisy chain
• Buy only managed switches – re-purpose your old unmanaged switches for labs
Questions?

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Symbols to use for diagrams