Campus Network
Best Practices:
Core and Edge Networks

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Campus Network Challenges

- Many are not structured properly and can't effectively utilize high bandwidth connections

- Many make heavy use of NAT and firewalls that limit performance

- Many are built with unmanaged network equipment that provide no ability for monitoring or tuning the network

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How to Best Support R & E

- Research and Education needs flexible and open networks

- Things to consider
  - NAT makes some things hard (H.323 video conferencing)
  - Filtering makes it hard for researchers, teachers, and students to do interesting things
  - Your campus network must not be the bottleneck

- Make a plan for improvement – without a plan, how will you get there.

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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
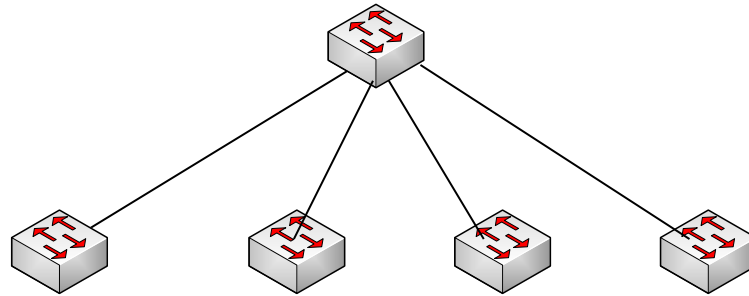
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Core versus Edge

- 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
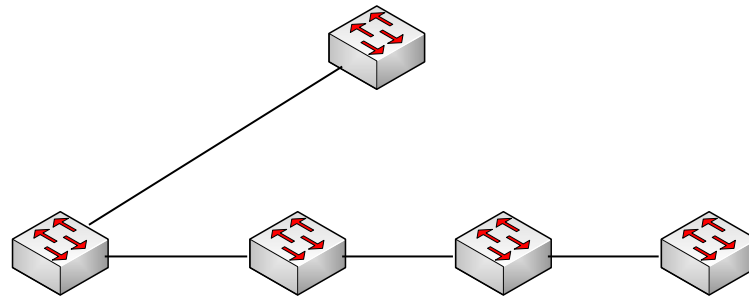 - Always switch at the edge

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!

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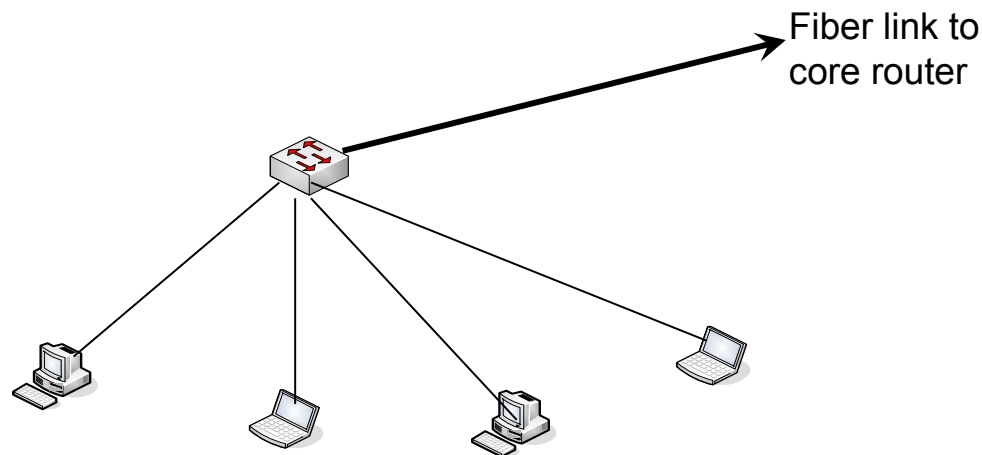# Edge Networks

- Make every network look like this:

Fiber link to core router
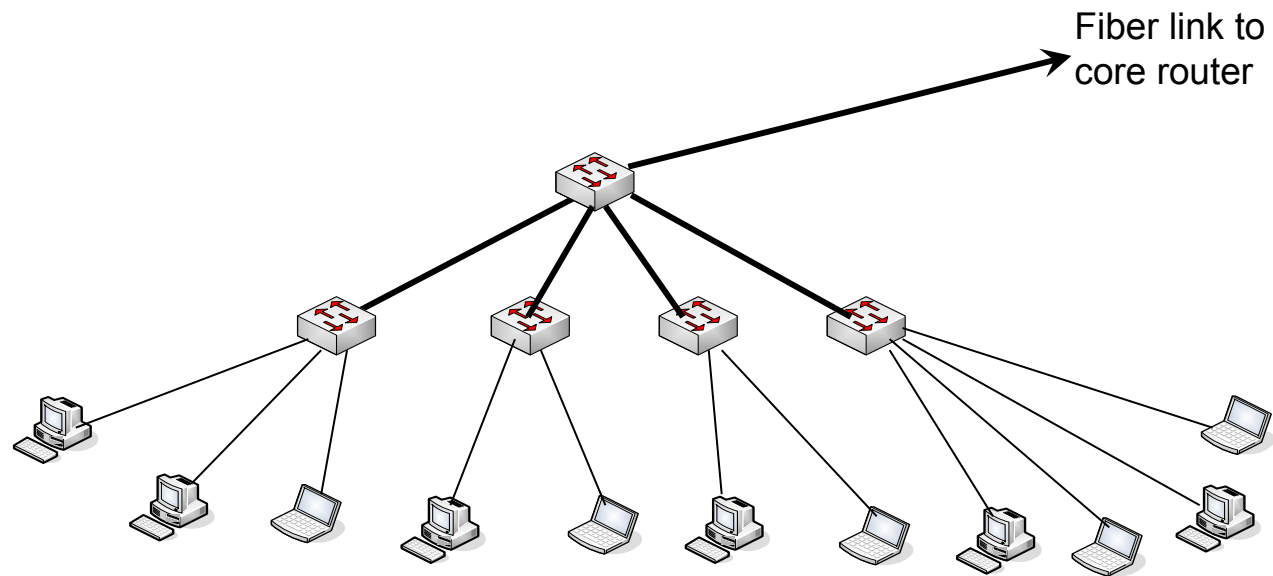
Edge Networks Continued

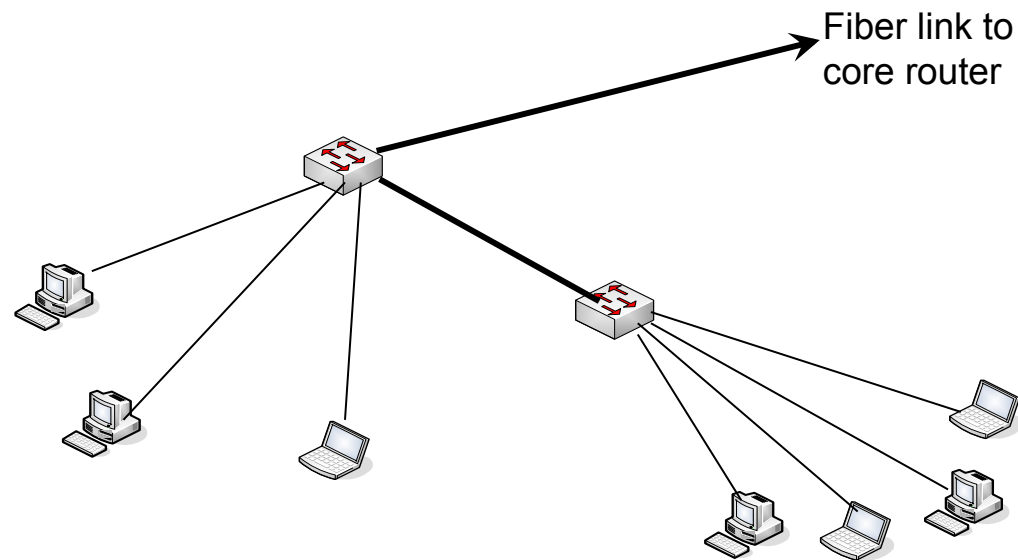- Build Edge network incrementally as you have demand and money
- Start Small:

Fiber link to
core router

Edge Networks Continued

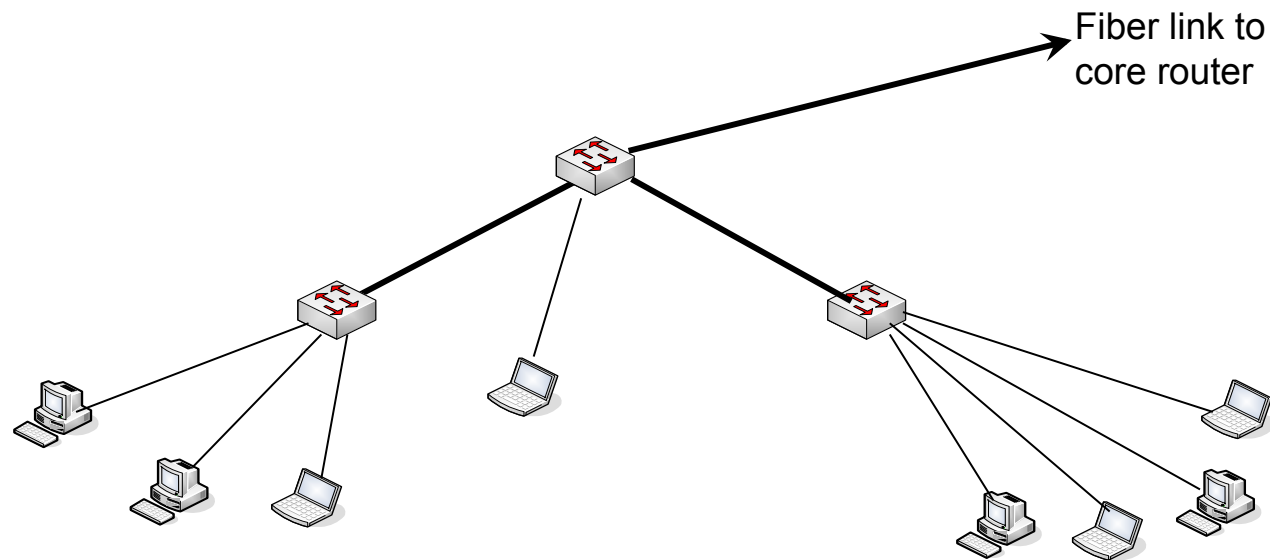- Then as you need to add machines to the network, add a switch to get this:

Fiber link to
core router

Edge Networks Continued

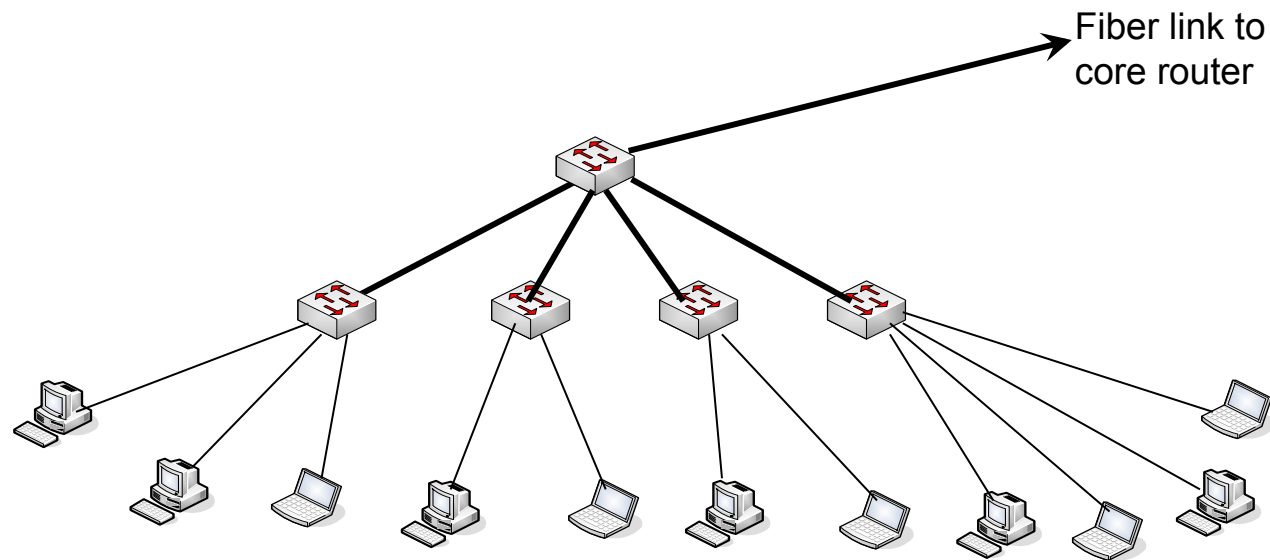- And keep adding switches to get to the final configuration

Fiber link to core router

Edge Networks Continued

- And keep adding switches to get to the final configuration

Fiber link to core router
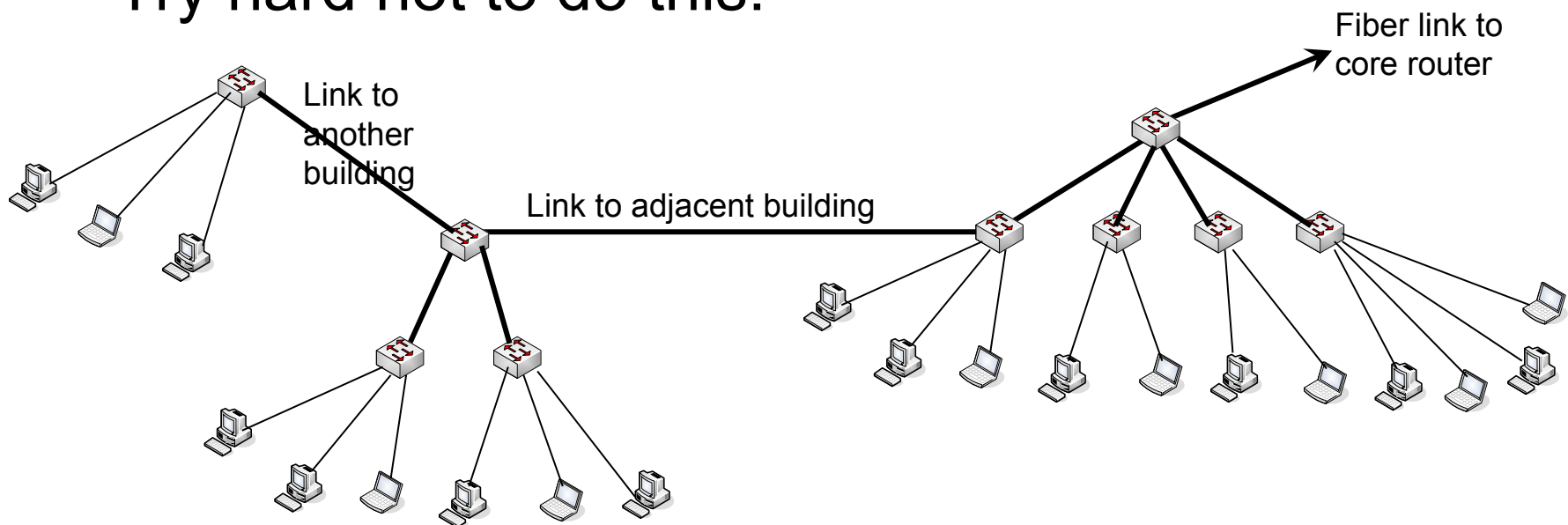
Edge Networks Continued

- Resist the urge to save money by breaking this model and daisy chaining networks or buildings together
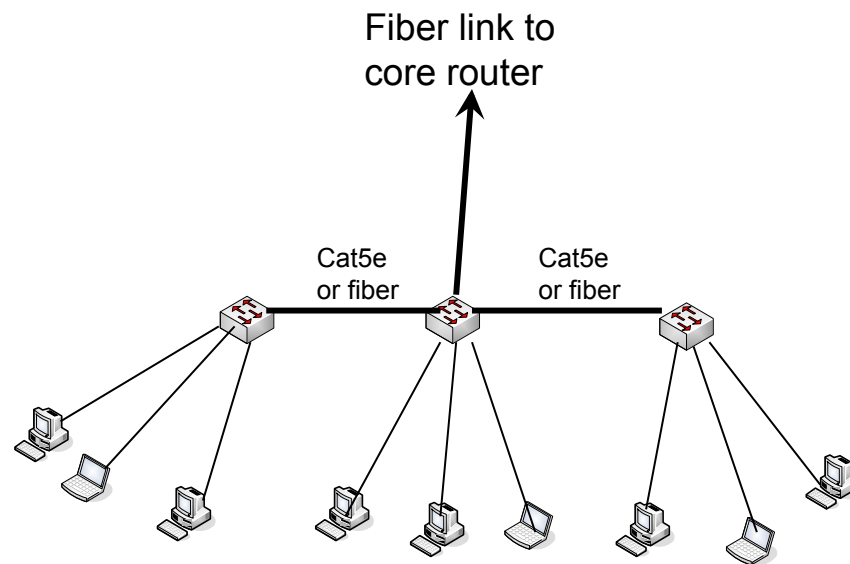
- Try hard not to do this:

Fiber link to core router

Link to another building

Link to adjacent building

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Edge Networks Continued

- There are cases where you can serve multiple small buildings with one subnet.
- Do it carefully.

Fiber link to core router

Cat5e or fiber   Cat5e or fiber

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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
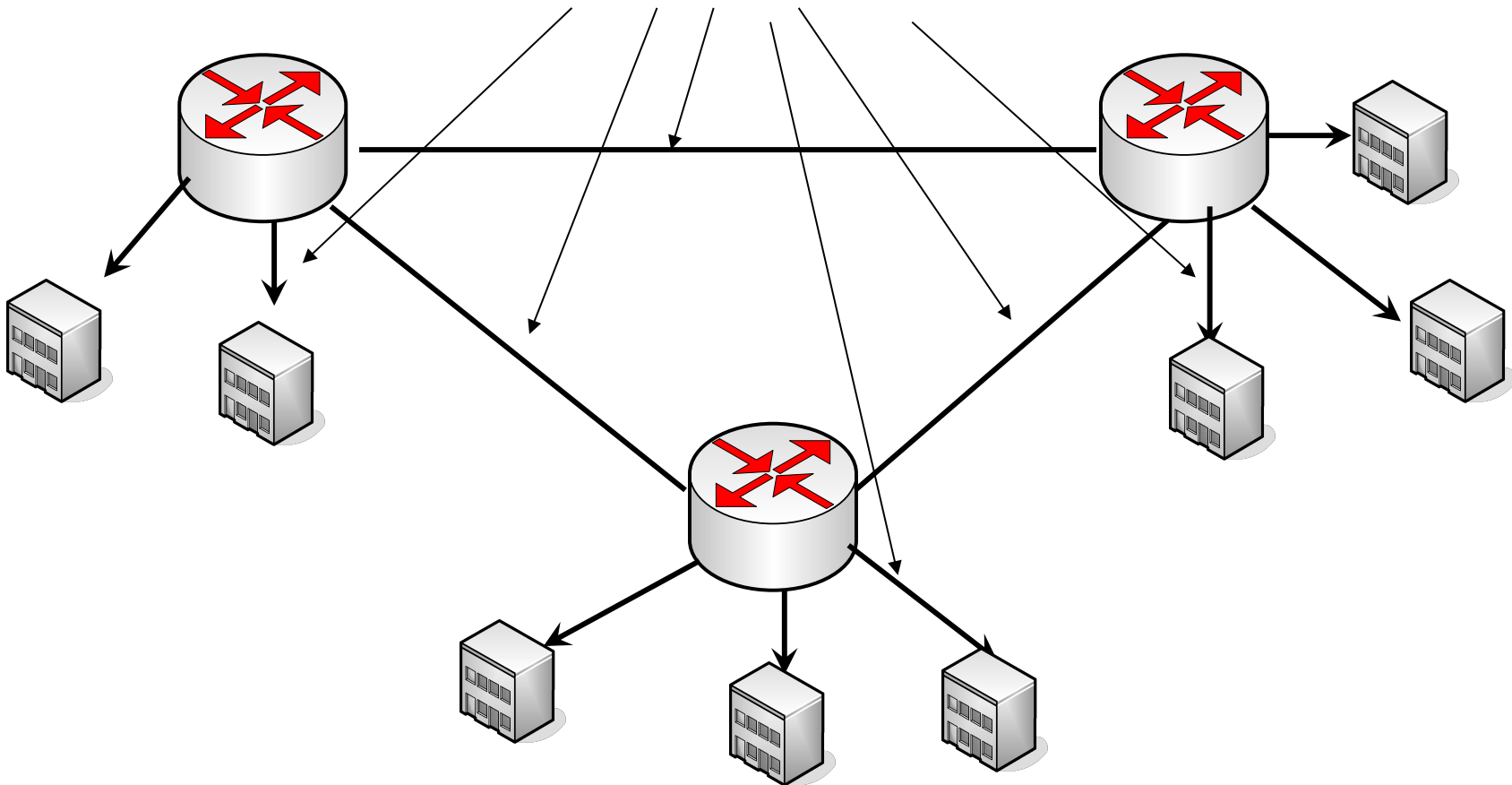
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Layer 3 Switches

- Many vendors use the term "Layer 3 Switch".

- These are contradictory terms
  - Layer 3 = Routing
  - Switch = Layer 2

- What vendors mean is that it is a device that can be configured as a router or a switch or possibly both at the same time.

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Switching versus Routing

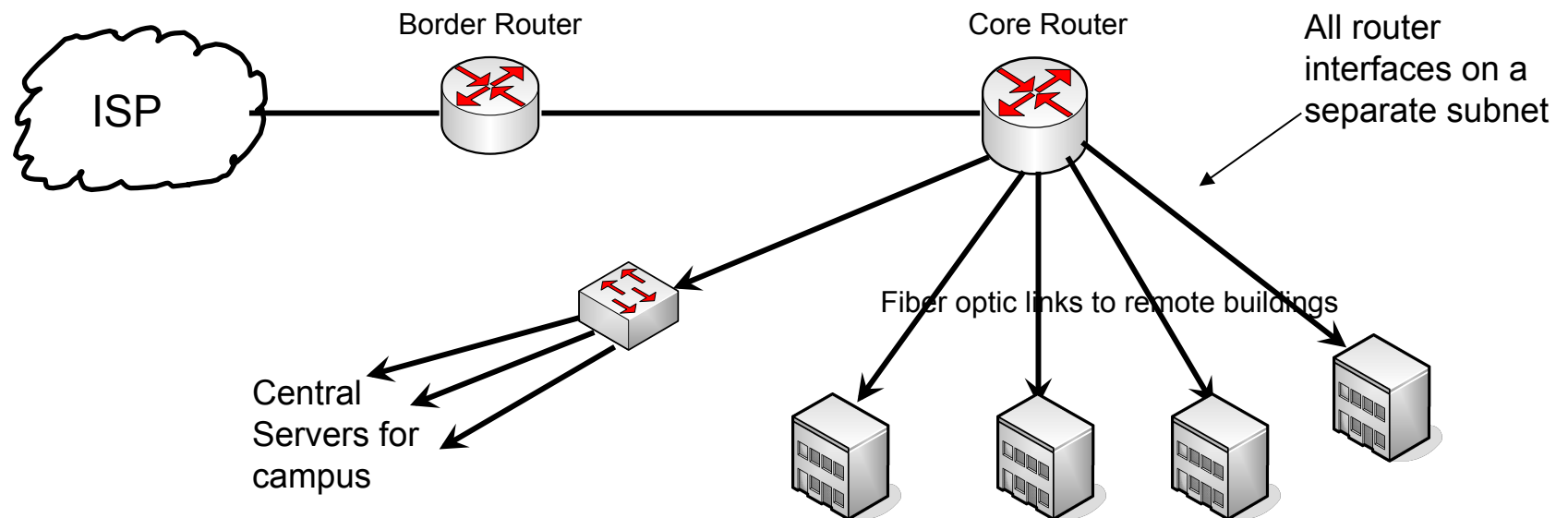These links must be routed, not switched

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
  - Grounding and bonding
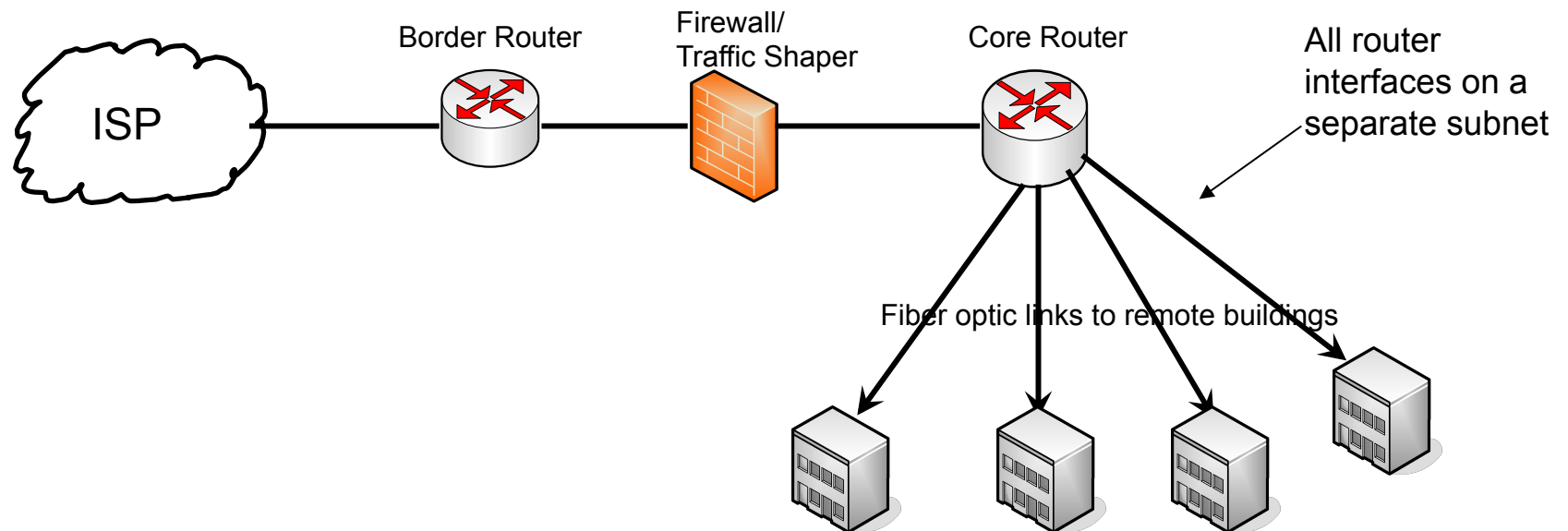- Core location must have reliable air conditioning

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Core Network

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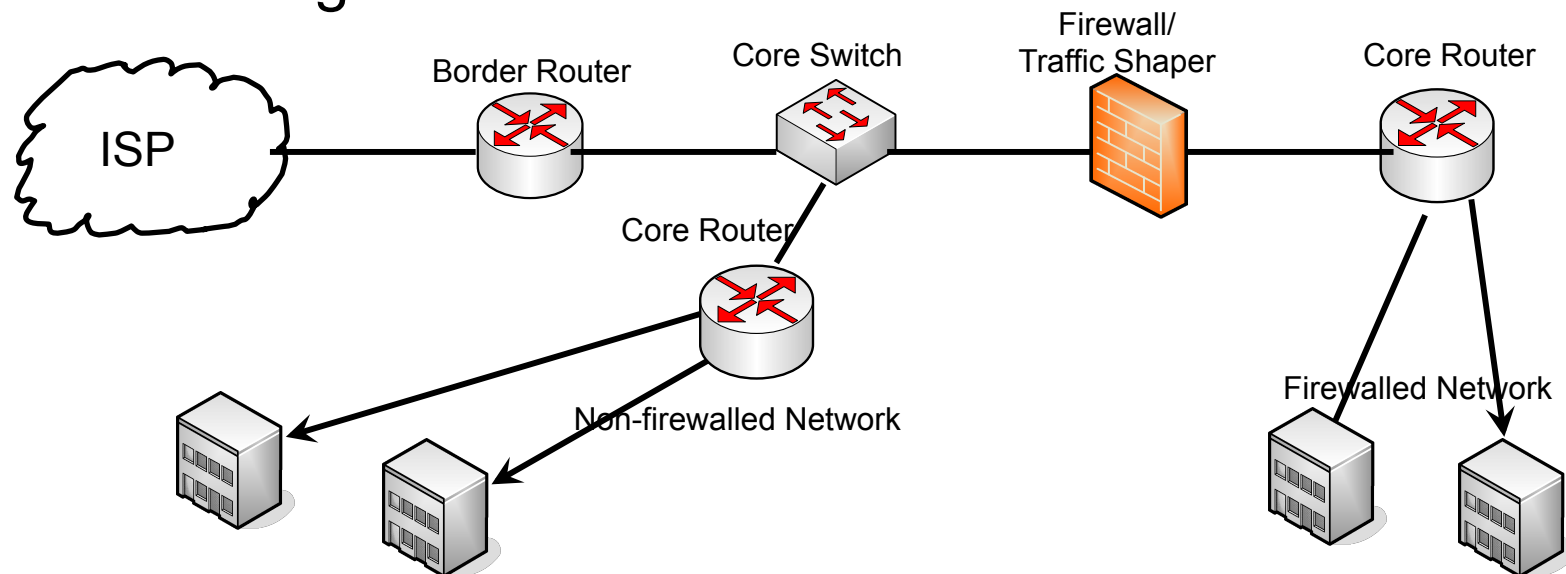- Routers give isolation between subnets
- A simple core:

Border Router

Core Router

All router interfaces on a separate subnet

ISP

Fiber optic links to remote buildings

Central Servers for campus

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Where to put Firewalls

- Security devices must be placed "in line"
- This means that the speed of the firewall affects access to the outside world
- This is a typical design:

Border Router

Firewall/
Traffic Shaper

Core Router

All router
interfaces on a
separate subnet

ISP

Fiber optic links to remote buildings

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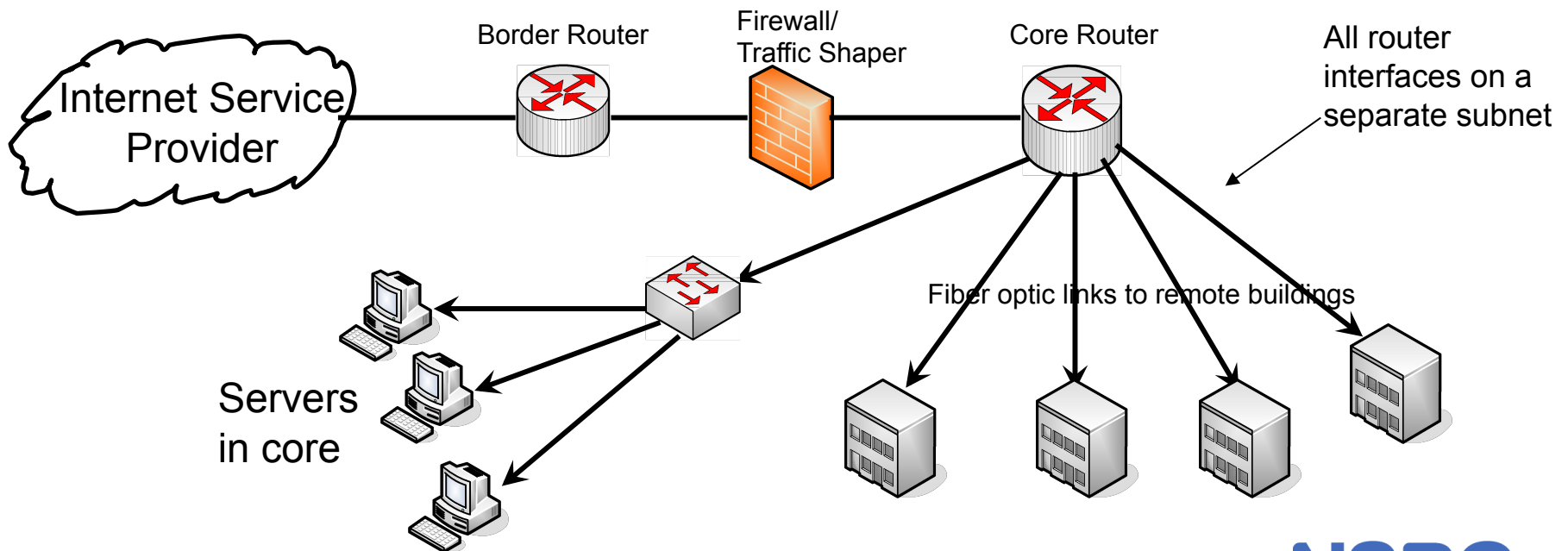Network Startup Resource Center

Where to put Firewalls

- As Campus Networks have gotten better bandwidth, the firewall becomes a bottlenect.
- Can move part of your network from behind the firewall to allow full bandwidth, un-filtered access to the Internet
- One configuration:

ISP

Border Router

Core Switch

Firewall/
Traffic Shaper

Core Router

Core Router

Non-firewalled Network

Firewalled Network

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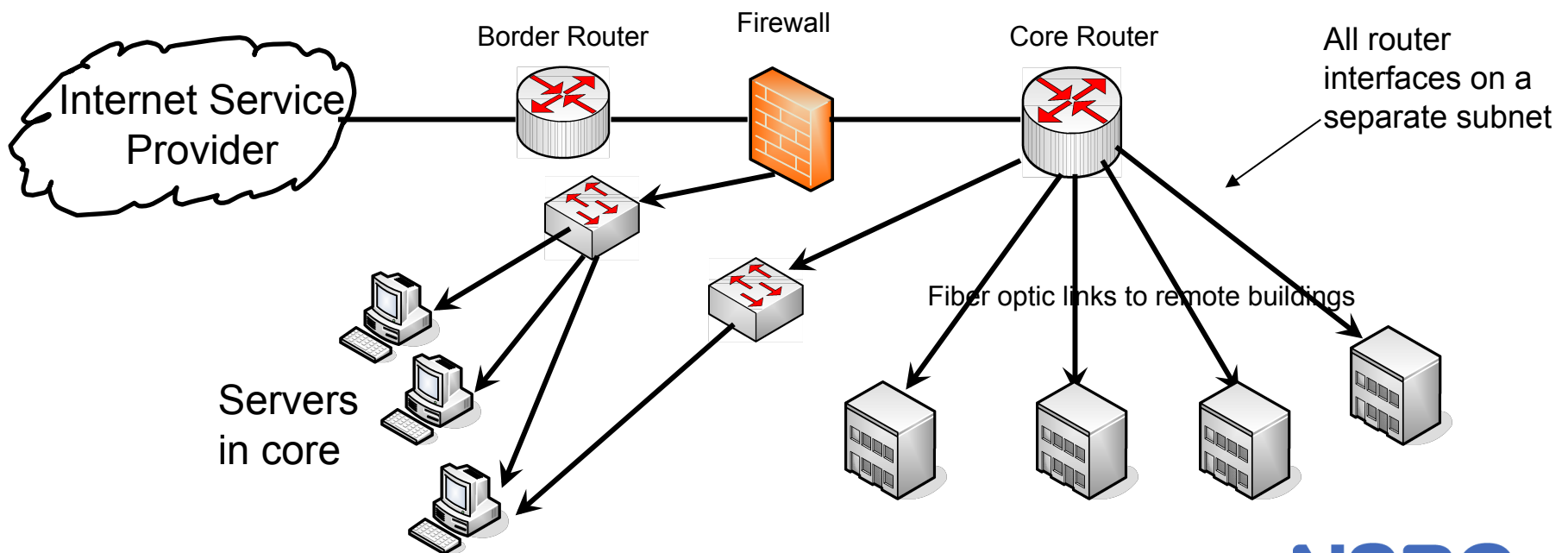Network Startup Resource Center

Where to put Servers?

- Servers should never be on the same subnet as users
- Should be on a separate subnet off of the core router
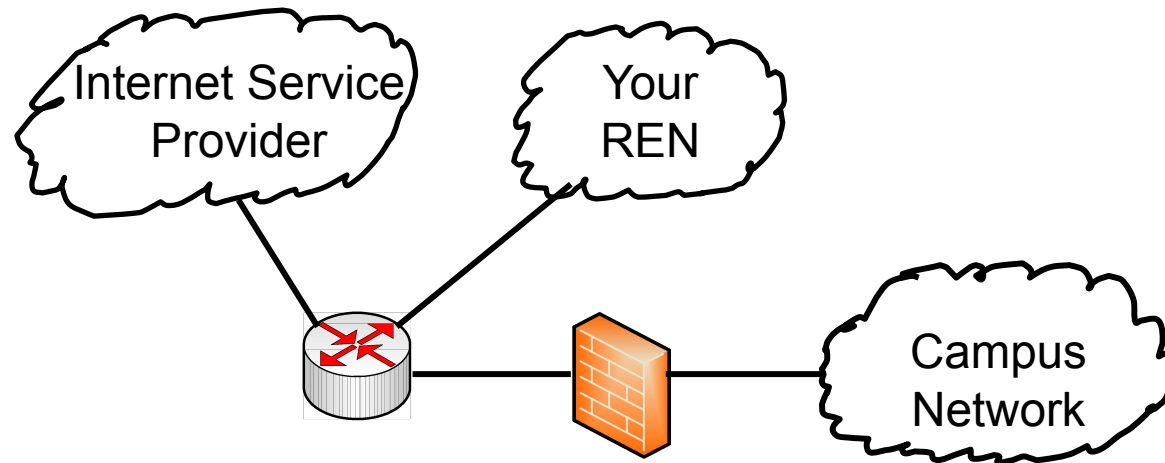- Servers should be at your core location where there is good power and air conditioning

Border Router

Firewall/
Traffic Shaper

Core Router

All router interfaces on a separate subnet

Internet Service Provider

Servers in core

Fiber optic links to remote buildings

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Where to put Servers?

- Sometimes you need servers that have public IP addresses
- Can put directly off of a firewall with no NAT
- Can have some servers with an interface on both the external network and an internal network
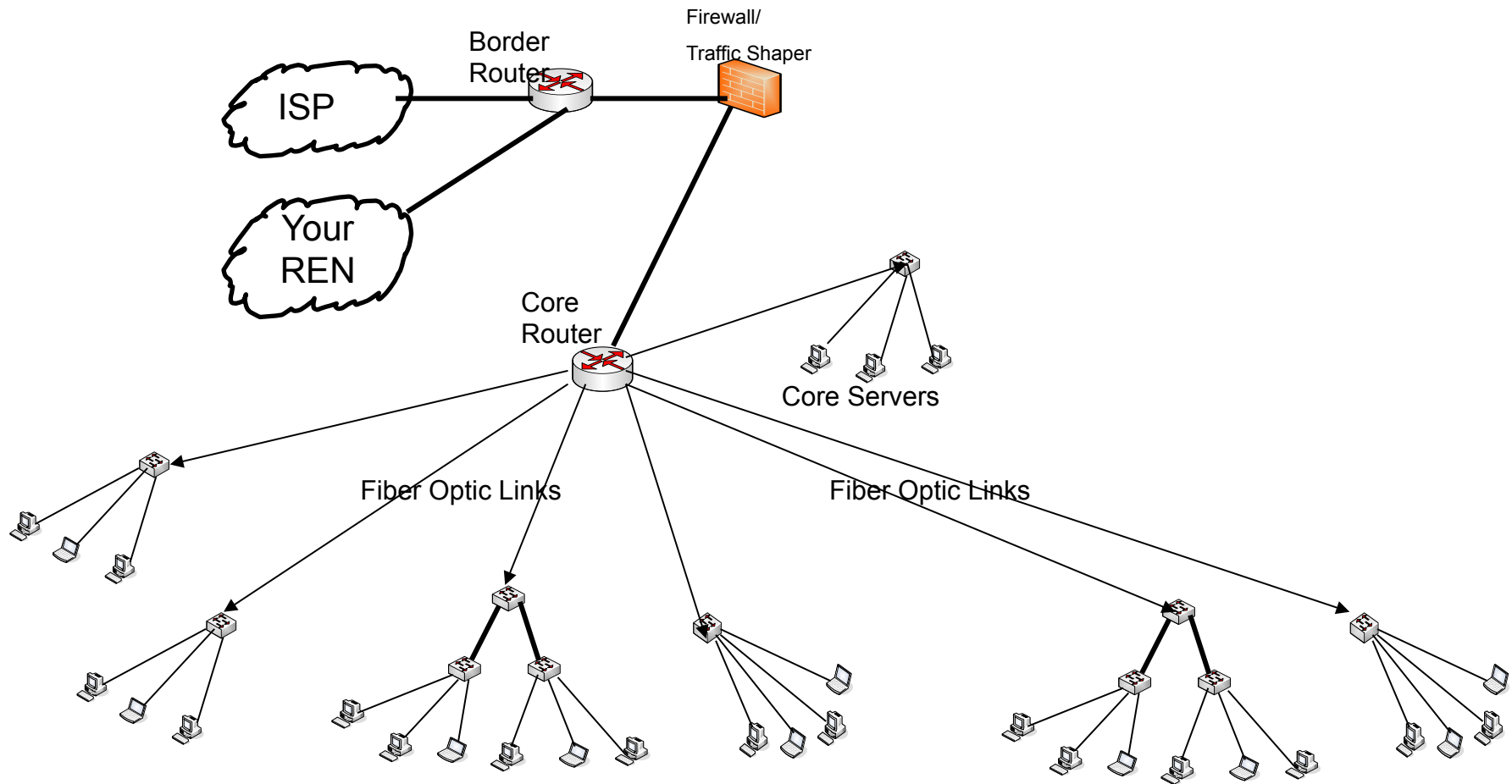
Border Router

Firewall

Core Router

All router interfaces on a separate subnet

Internet Service Provider

Fiber optic links to remote buildings

Servers in core

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Border Router

- Connects to outside world
- RENs and Peering are the reason you need them
- Must get Provider Independent IP address space to really make this work right

Internet Service Provider
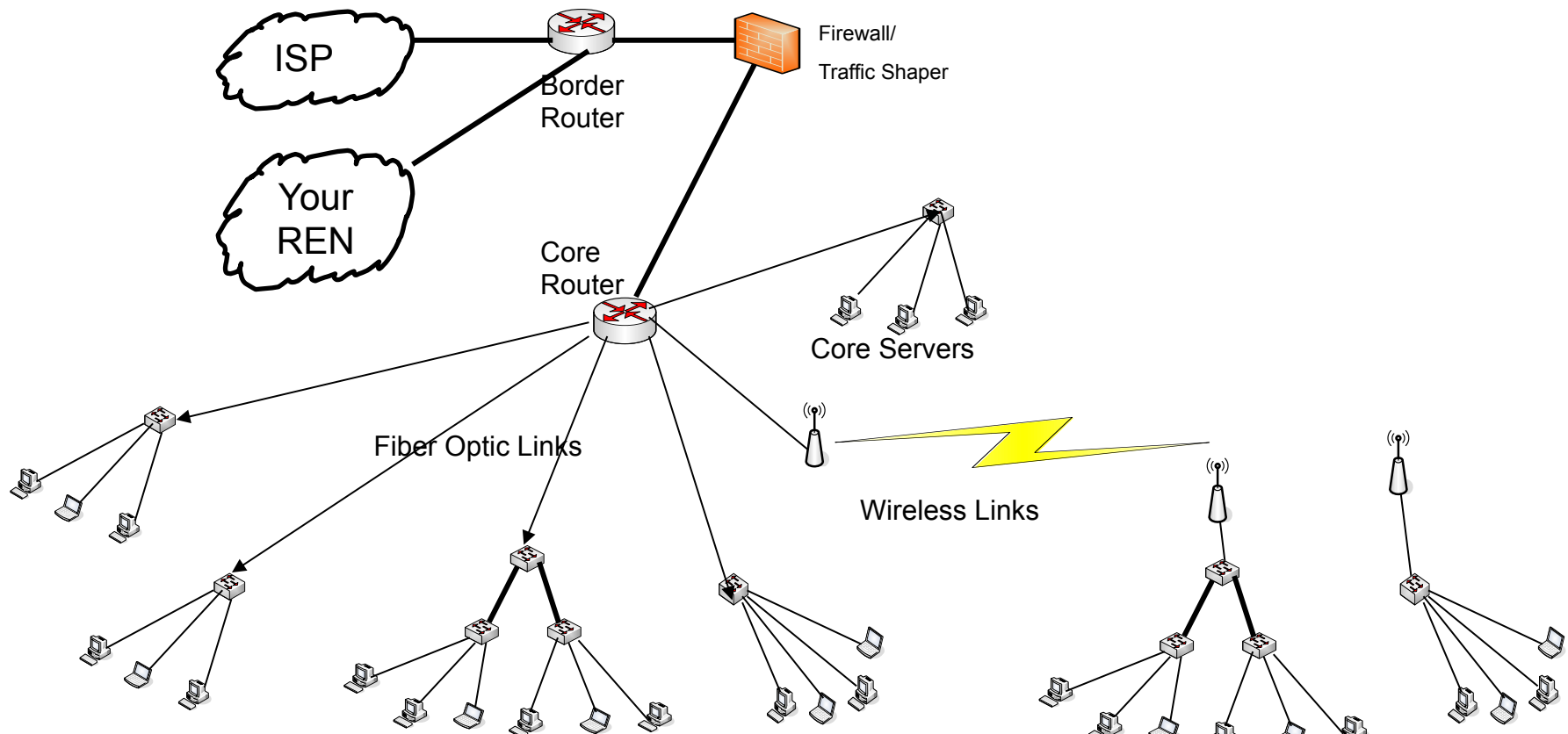
Your REN

Campus Network

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Putting it all Together

Firewall/
Traffic Shaper

Border
Router

ISP

Your
REN

Core
Router

Core Servers

Fiber Optic Links

Fiber Optic Links

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Alternative Core Designs

- ## Wireless Links versus Fiber

Layer 2 and 3 Summary

- Route in the core

- Switch at the edge

- Build star networks – don't daisy chain

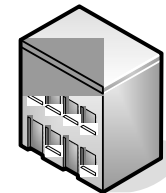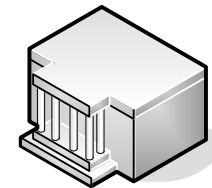- Buy only managed switches – re-purpose your old unmanaged switches for labs

Questions?

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Symbols to use for diagrams