Campus Network Basics

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Tuning up Campus Network – IT Center, University of Peradeniya

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Network Design Goals

- Performance
  - Bandwidth
  - Throughput
  - Latency
  - Jitter
  - Packet loss
- Reliability and Resiliency
  - Service outages
  - Highly reliable and available network that can survive during any network component failure without any operator intervention

Network Design Goals

- Security
  - Guarantee of confidentiality, integrity and authenticity
  - Traffic isolation between the traffic of guests and internal staff.
- Manageability
  - Manageable devices
  - Find problems
- Scalability
  - Needs to be able to grow as needs grow

Network Devices

Hub

Switch

Network Devices

Router

Firewall

Router vs Layer 3 Switch

Attribute	Router	Layer 3 Switch
Scope	WAN for Office, Data Center or Campus environment	LAN for Office, Data Center or Campus environment
Key Functionality	Routes across different networks across WAN are communicated and Routed by a Router	Routes across different subnets or VLANS on a campus LAN
MPLS and VPN Services	Router provides MPLS and VPN services like PPP etc.	Does not support MPLS and VPN services
Edge technologies support	NAT, firewalling, tunneling, IPSec	Not supported.
Size of routing table	Considerably bigger to support multiple Route entries.	Smaller Routing table compared to Router
Forwarding decision	Performed by Software	Forwarding is performed by specialized ASICs
Example of Routers	Cisco 3900 , 4000 Series ISR Routers	Cisco 3650, 3560 and 6500 Series are examples of Layer 3 Switches.
Interface Support	Support Ethernet ports (Fiber and Copper). Also support interfaces like SONT,OC-N, T1/T3 etc.	As general case L3 Switches support Ethernet ports (Copper and Fiber). Does not support SONET, OC-N, T-1/T-3
Throughout	Lower than Layer 3 Switches	High Throughput
Switching Capacity	Lower than Layer 3 Switches	High Switching Capacity
Cost	High cost	Low Cost
Port Density	Low	High

Source: medium.com

Layer 2 Switch vs Layer 3 Switch

Attribute	Layer 2 Switch	Layer 3 Switch
Basic function	Operate on layer 2 only (Switching only)	Operate on both layer 2 and layer 3 (Routing and Switching)
Switching speed	High speed switching	Lower than Layer 2 switch
Addressing used	Uses MAC addresses	Uses MAC and IP addresses

Source: medium.com

Twisted Pair Cables

Category	Cable construction	Bandwidth	Data rate	Max length	Application
Cat 3	UTP	16 MHz	10 Mbps	100m	Token Ring/ 10BASE-T Ethernet
Cat 4	UTP	20 MHz	16 Mbps	100m	Token Ring
Cat 5	UTP	100 MHz	100 Mbps	100m	100BASE-TX, 1000BASE-T
Cat 5e	UTP, F/UTP, U/FTP	100 MHz	100/1000 Mbps	100m	1000BASE-TX, 2.5GBASE-T

Twisted Pair Cables

Category	Cable construction	Bandwidth	Data rate	Max length	Application
Cat 6	UTP, F/UTP, U/FTP	250 MHz	10 Gbps	100m	5GBASE-T, 10GBASE-T
Cat 6A	UTP, F/UTP, U/FTP, S/FTP	500 MHz	10 Gbps	100m	5GBASE-T, 10GBASE-T
Cat 7	S/FTP, F/FTP	600 MHz	10 Gbps	100m	10BASE-T
Cat 7A	S/FTP, F/FTP	1 GHz	10 Gbps	100m	10BASE-T
Cat 8	U/FTP,F/UTP, S/FTP, F/FTP	2 GHz	25/40 Gbps	30m	25/40GBASE-T

Fiber Optic Cables

Designation	Cable Type	Core Diameter(um)	1Gb Ethernet Distance (m)	10Gb Ethernet Distance (m)	40Gb Ethernet Distance (m)	100Gb Ethernet Distance (m)
OM1	Multimode	62.5/125	275	33	Not supported	Not supported
OM2	Multimode	50/125	550	82	Not supported	Not supported
OM3	Multimode	50/125	550	300	100	100
OM4	Multimode	50/125	550	400	150	150
OM5	Multimode	50/125	550	400	150	150
OS1	Singlemode	9/125	2Km	2Km	Not recommended	Not recommended
OS2	Singlemode	9/125	10Km	10Km	40Km	40Km

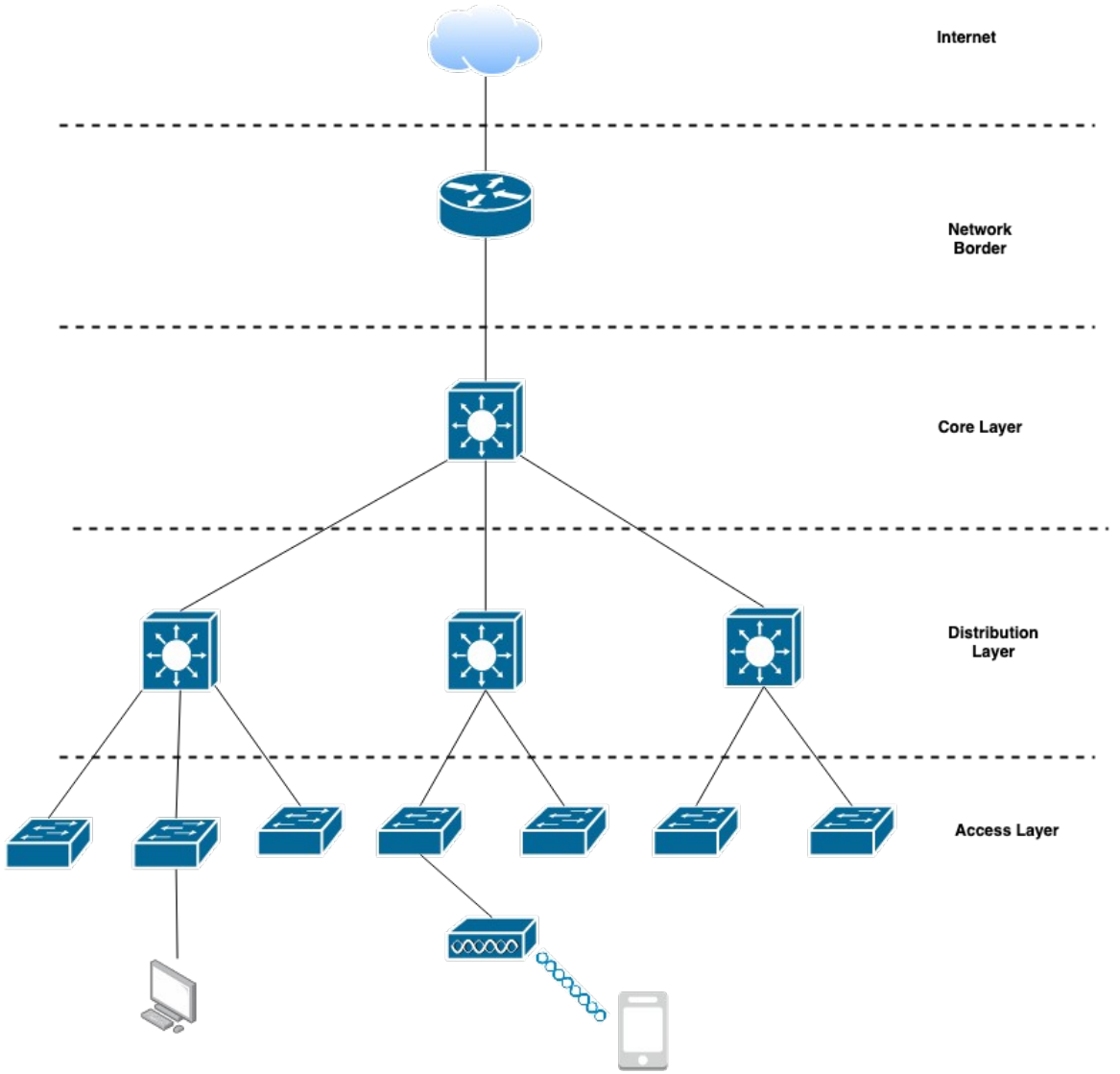
Campus Network Design rules

- Layered network design
- Minimize number of devices in any path
- Route near the Core, Switch at the Edges
- Provision central services near the Core
- Use DHCP centrally
- Separate DNS server duties

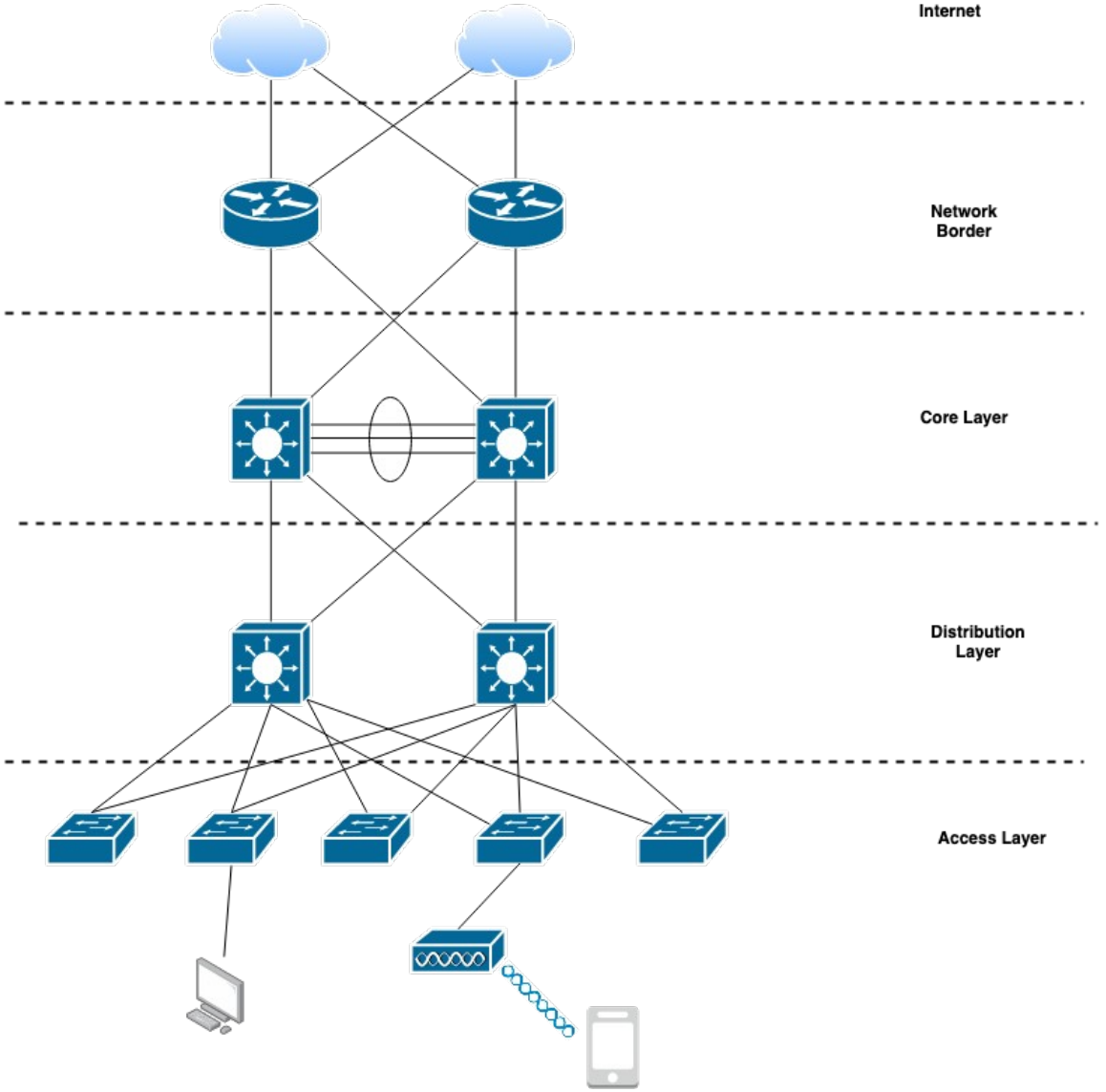
Layered Hierarchical Network Design

- A good network design is modular and hierarchical with a clear separation of functions
  - Core : resilient, few changes, few features, high link and high CPU capacity
  - Distribution: Aggregation, redundancy
  - Access: Port density, affordability, security features, many adds, moves and changes

Layered Network Design - Simple

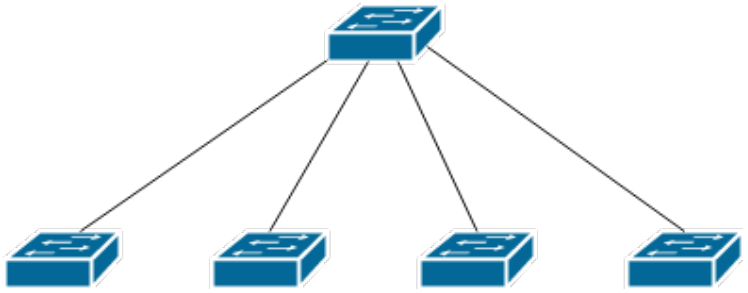


Layered Network Design - Redundant

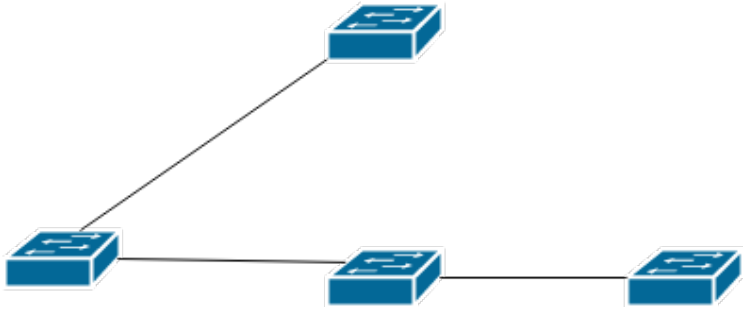


Minimize Number of Network Devices in the Path

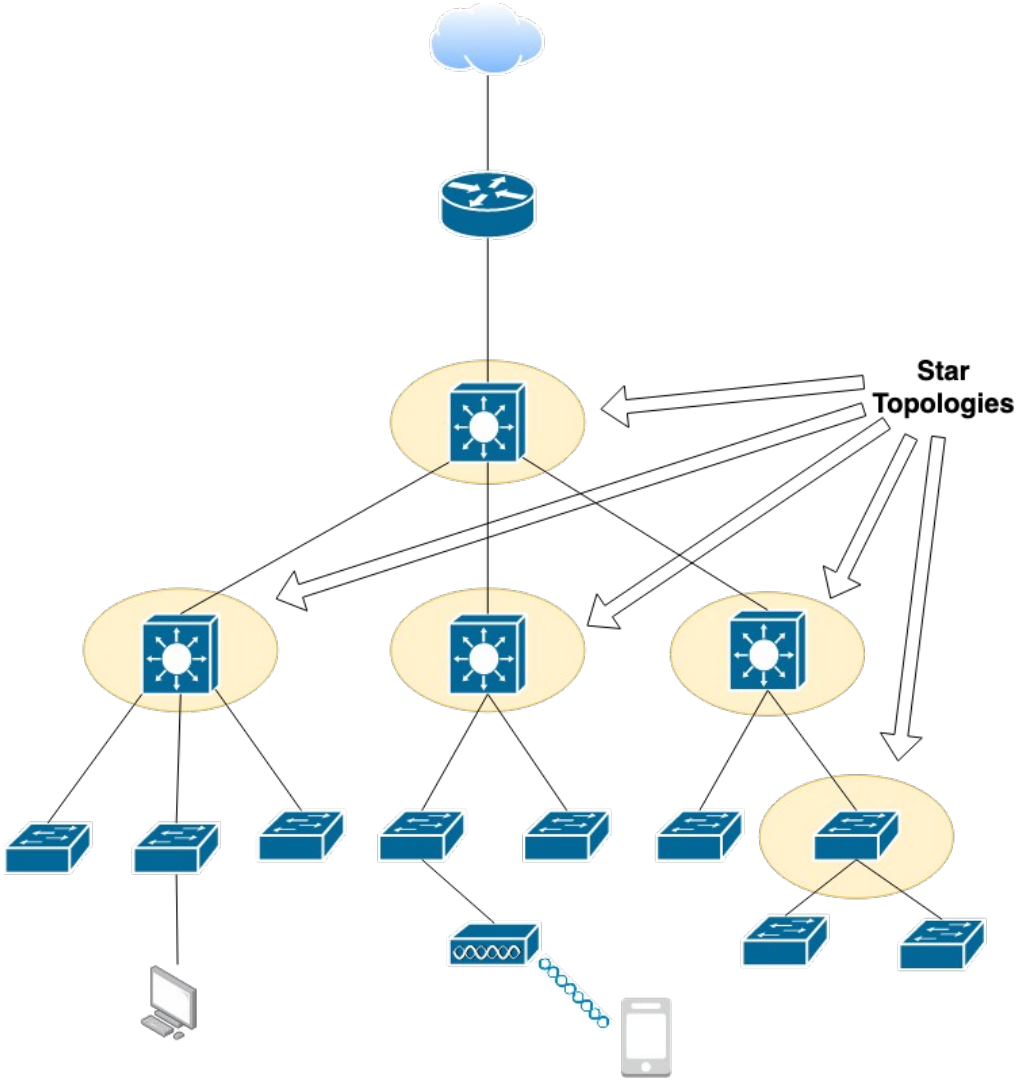
- Build start networks (Hub and spoke)



- Avoid daisy-chained networks (cascaded)



Star Topology

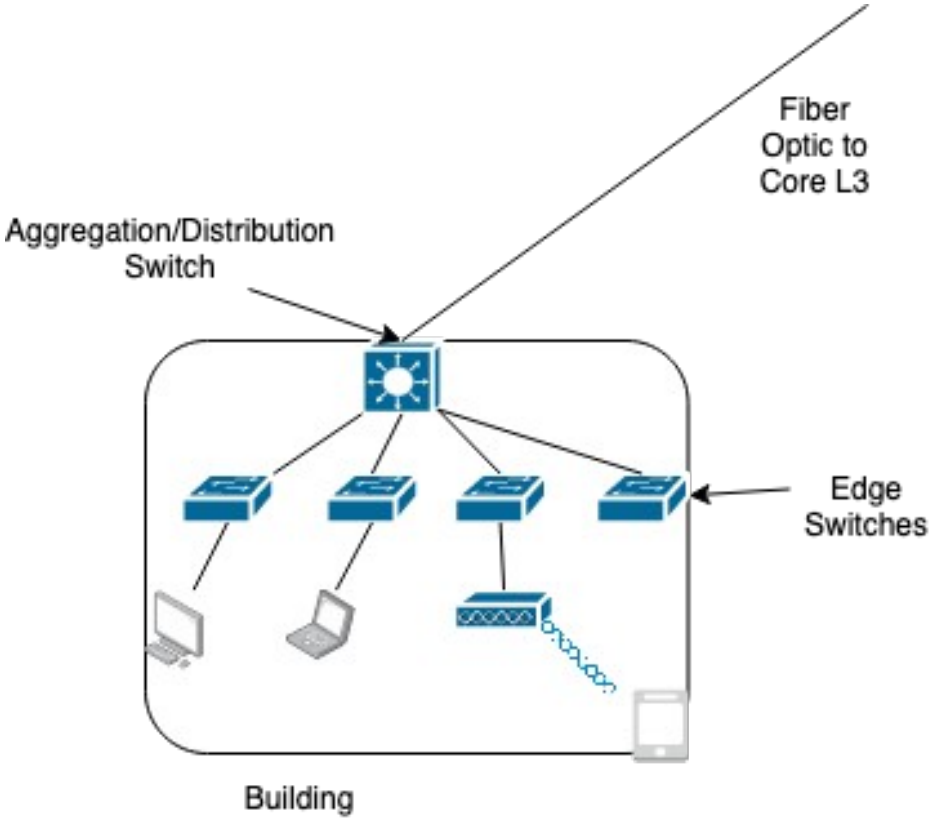


Route near the Core, Switch at the Edges

- The hub at the campus level (core network) is often a Layer 3 device.
- Best practices to route at the core
  - This segments network into independent subnets
  - Limits broadcasts

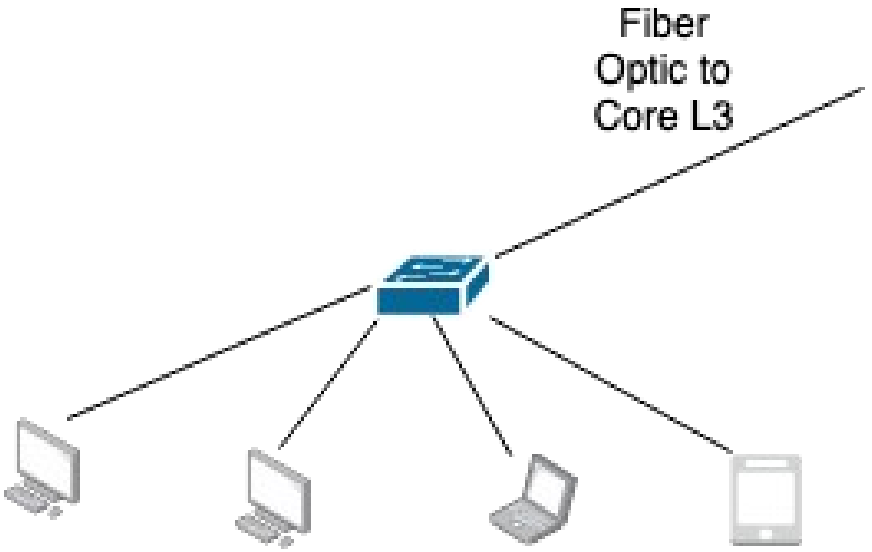
In-Building Edge Networks

- Make every building look like this



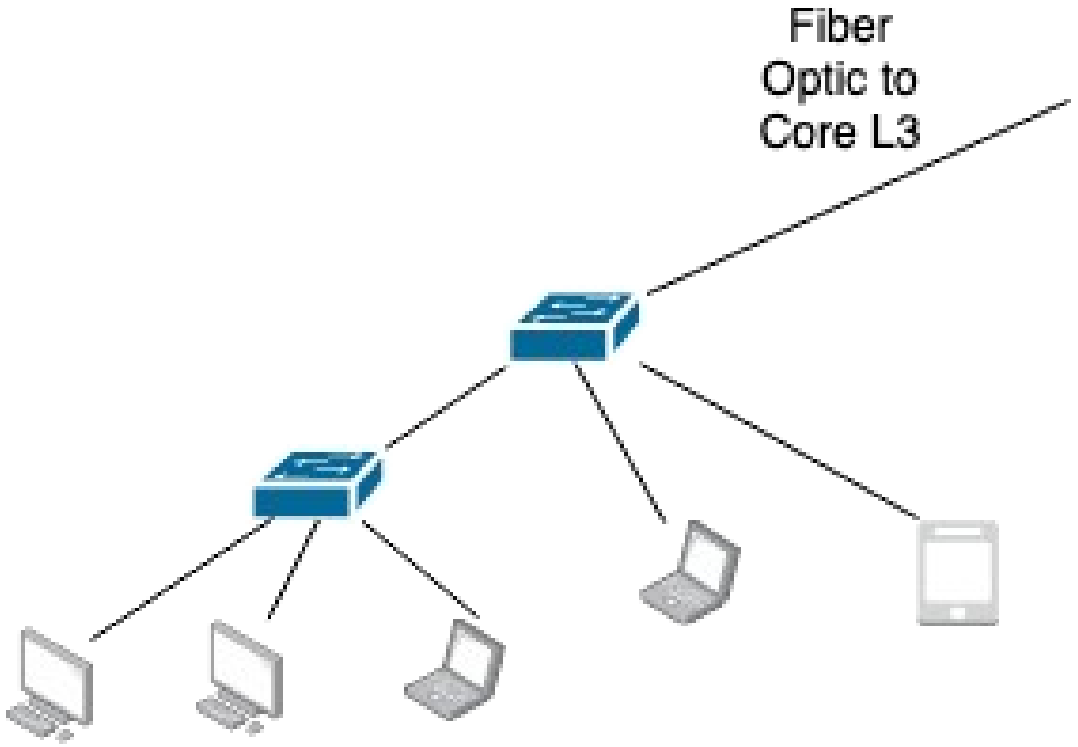
Edge Networks

- Start with small
- Build Edge network incrementally as you have demand and money



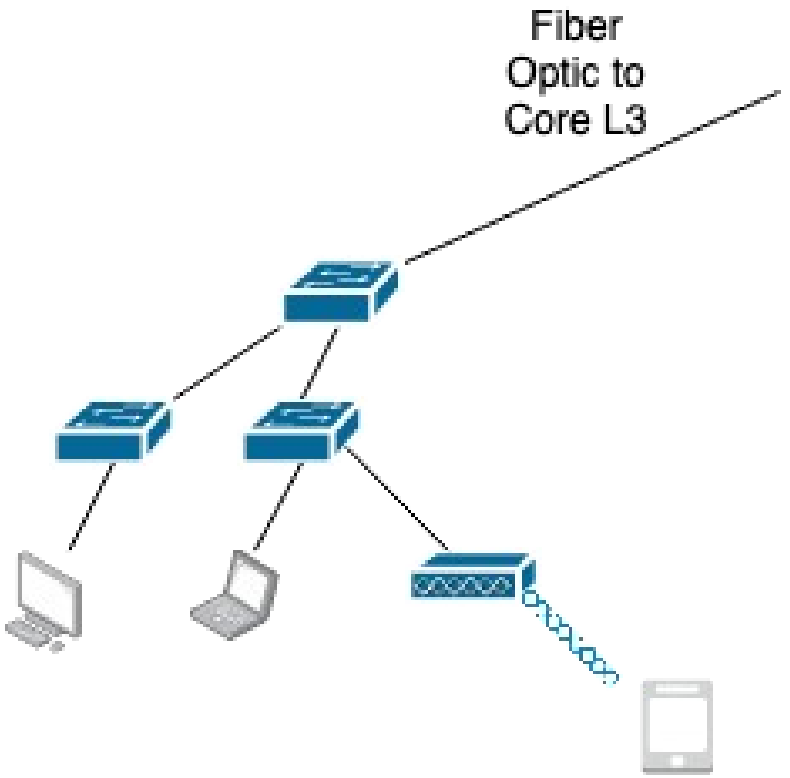
Edge networks

- Then as you need to add machines to the network, add a network rack and a switch



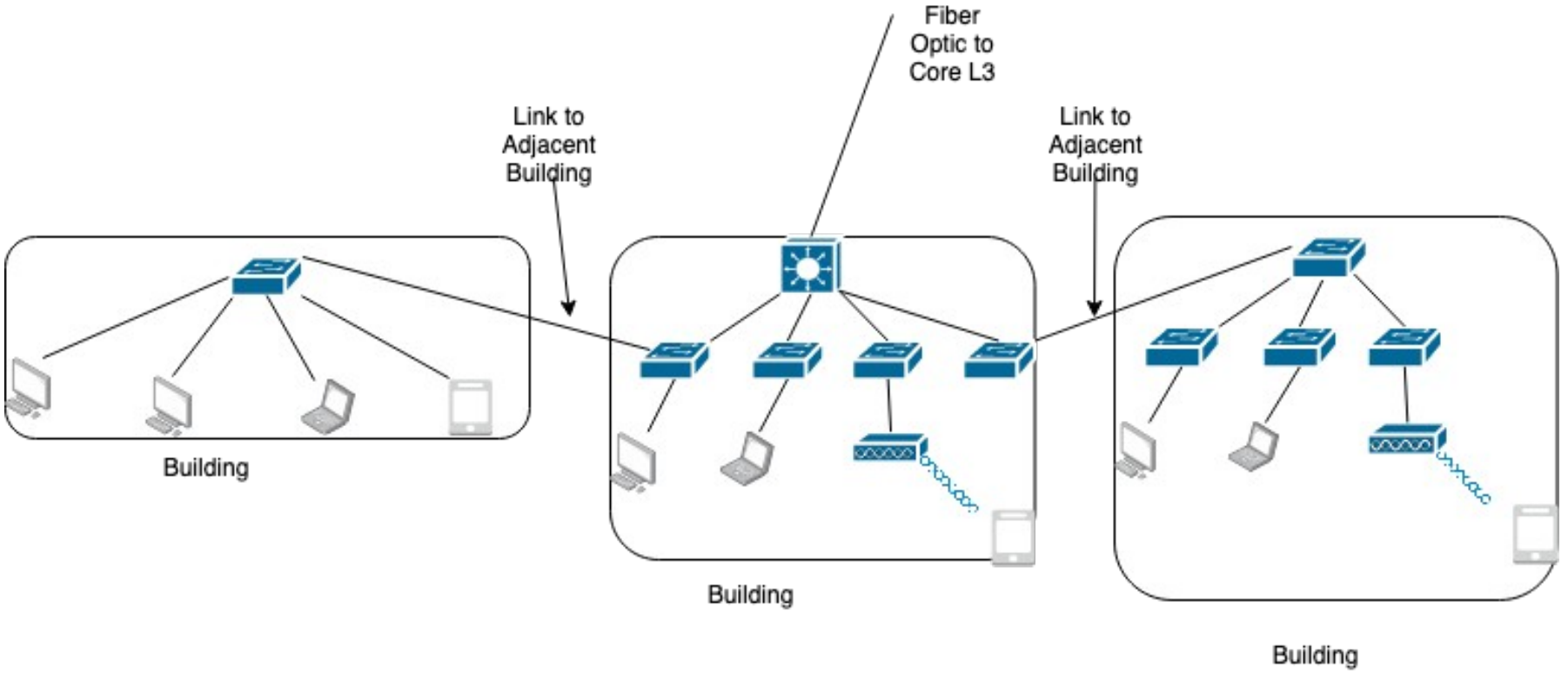
Edge Networks

- Keep adding racks and switches



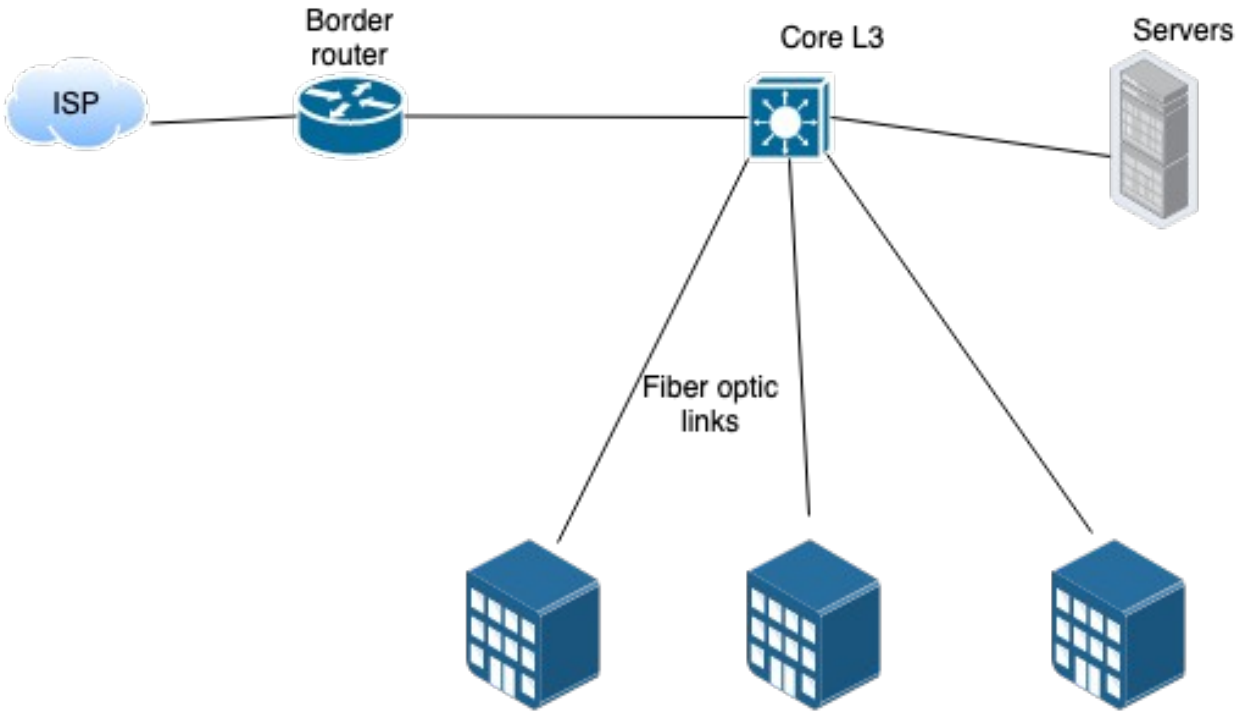
Edge Networks

- Avoid daisy-chaining and connecting building together



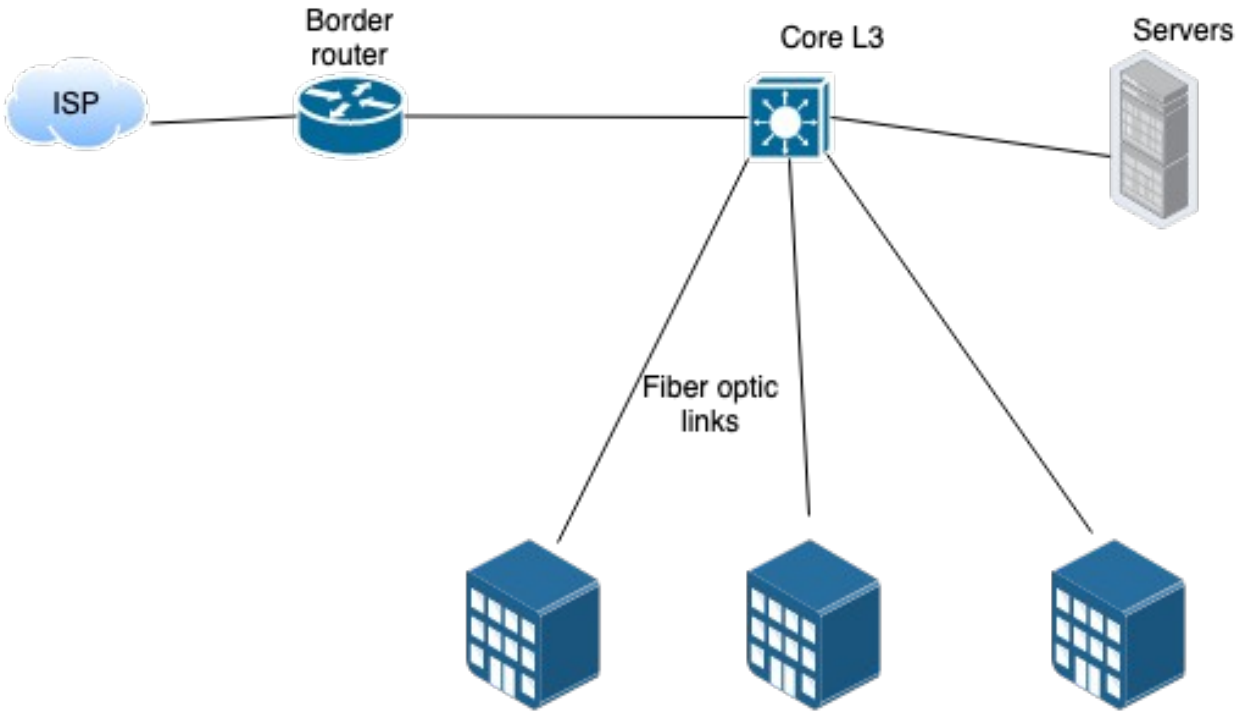
Core Network

- At the core network you must route not switch
- You may use a Router or Layer 3 switch
- Routers isolate networks



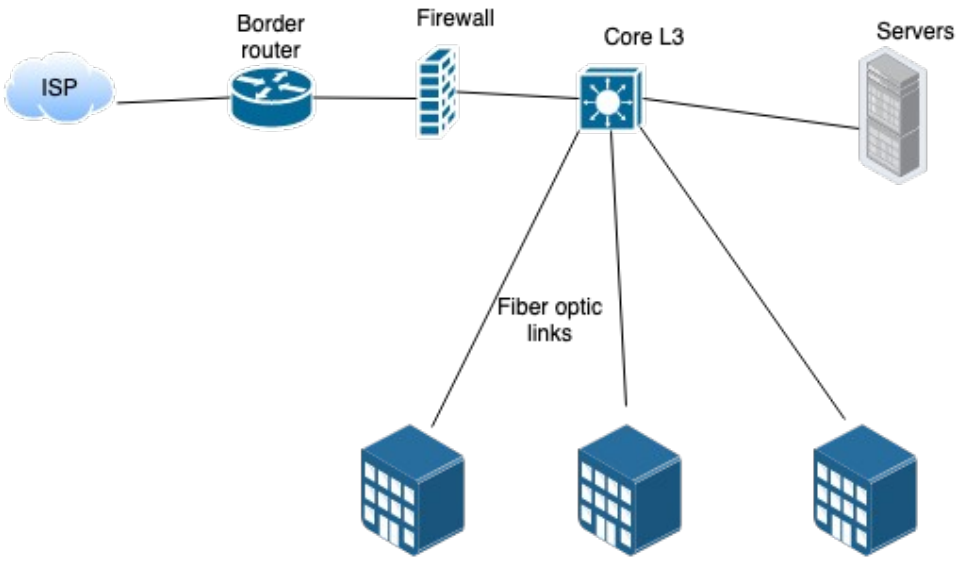
Where to put servers

- Should not be in the same subnet as users
- Should be near the core router/L3
- Should have good power and air conditioning



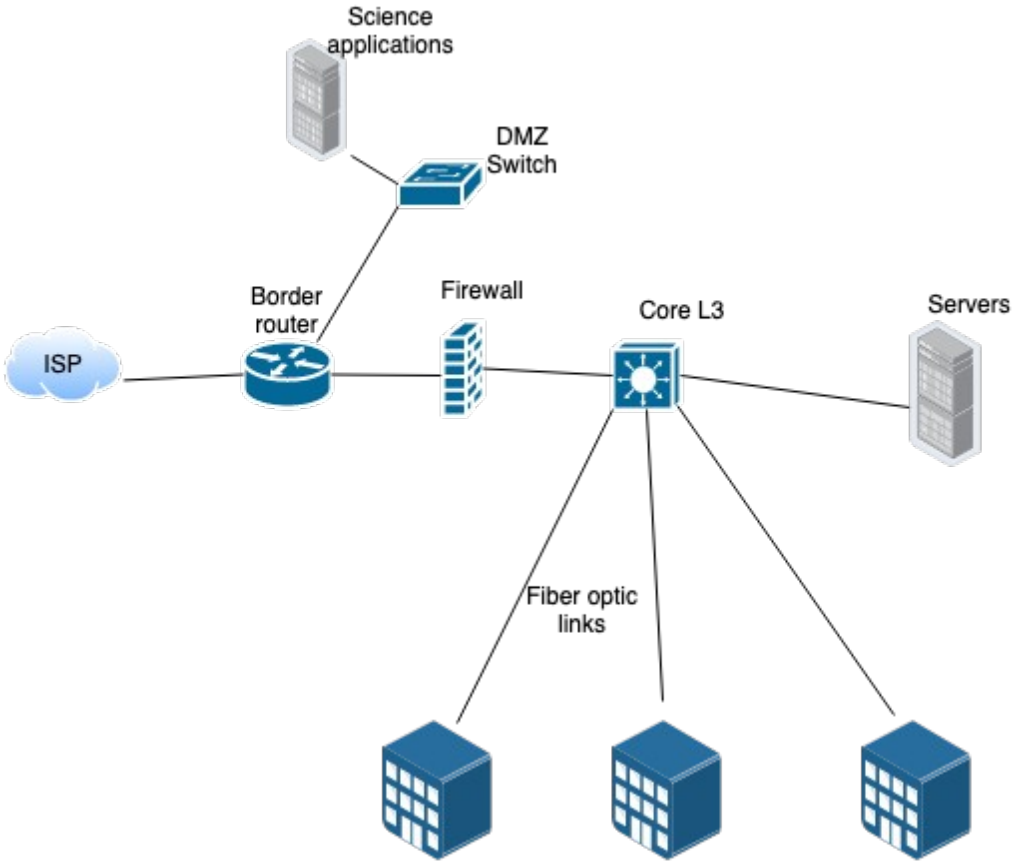
Where to put Firewalls

- Often placed in-line
- Typical design is below



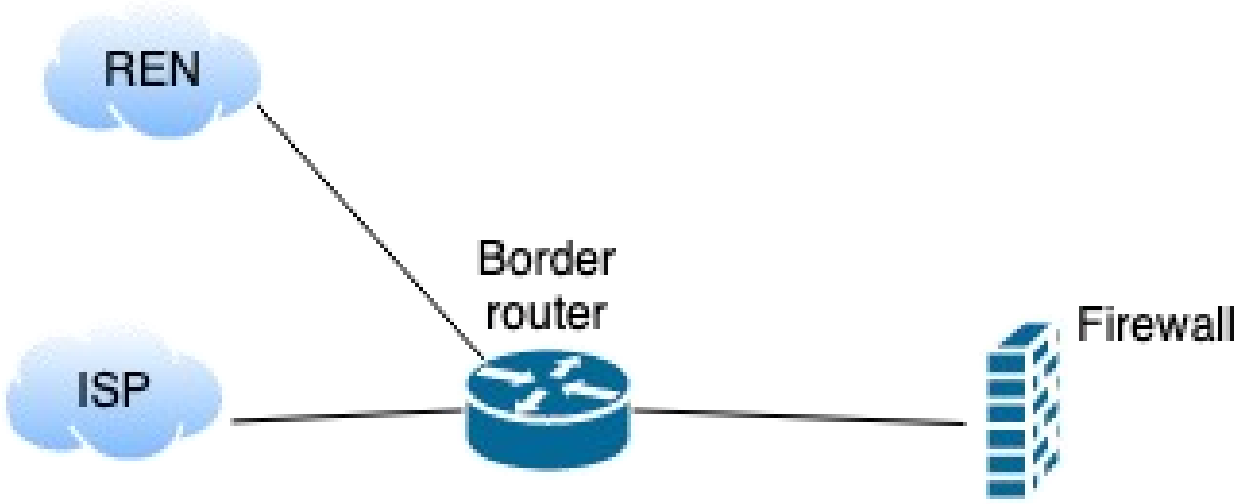
Science DMZ

- Optimized for high performance scientific applications
- Designed to hand high volume data transfers
- Going through stateful firewall would cause performance limit

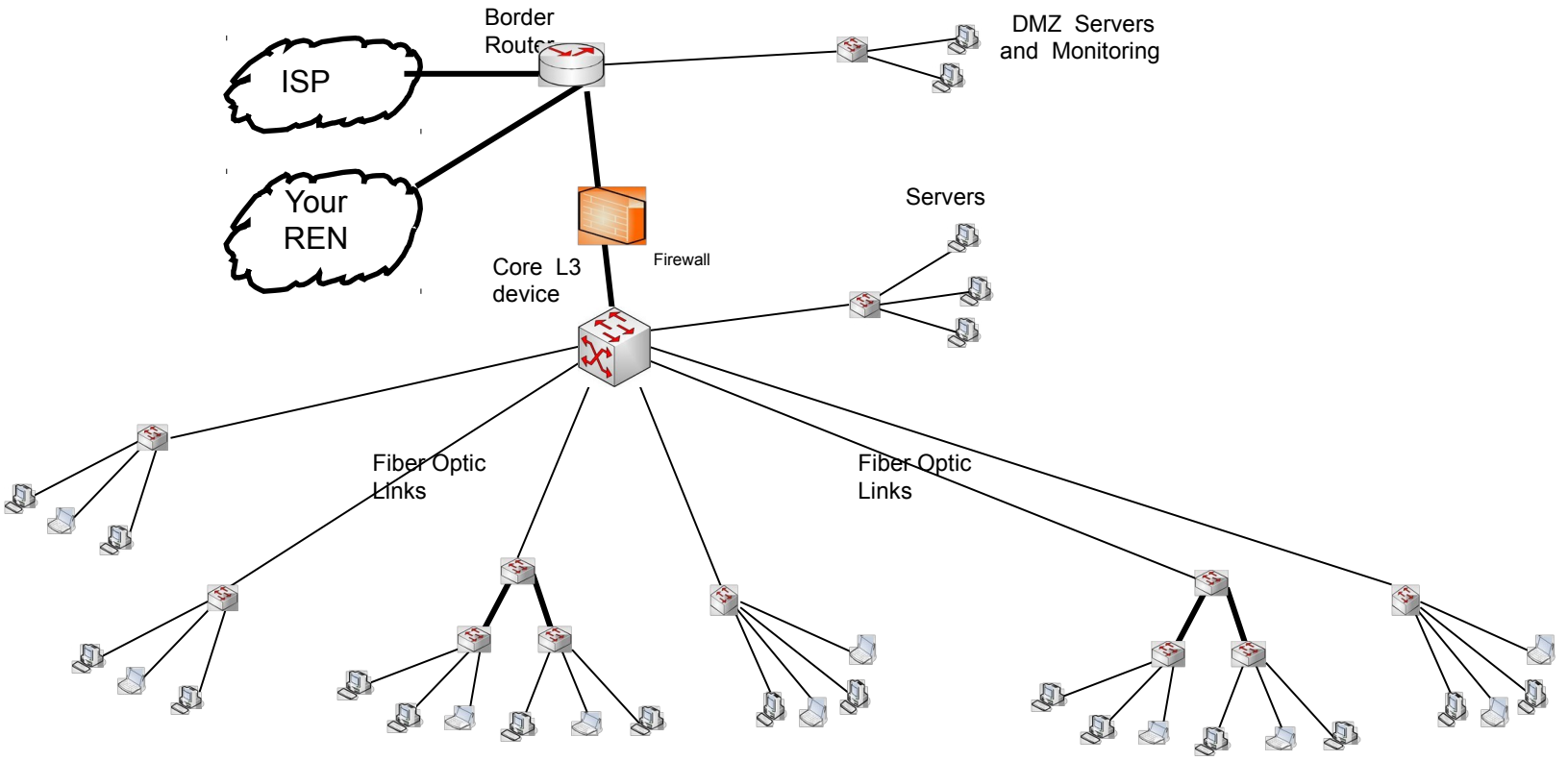


Border Router

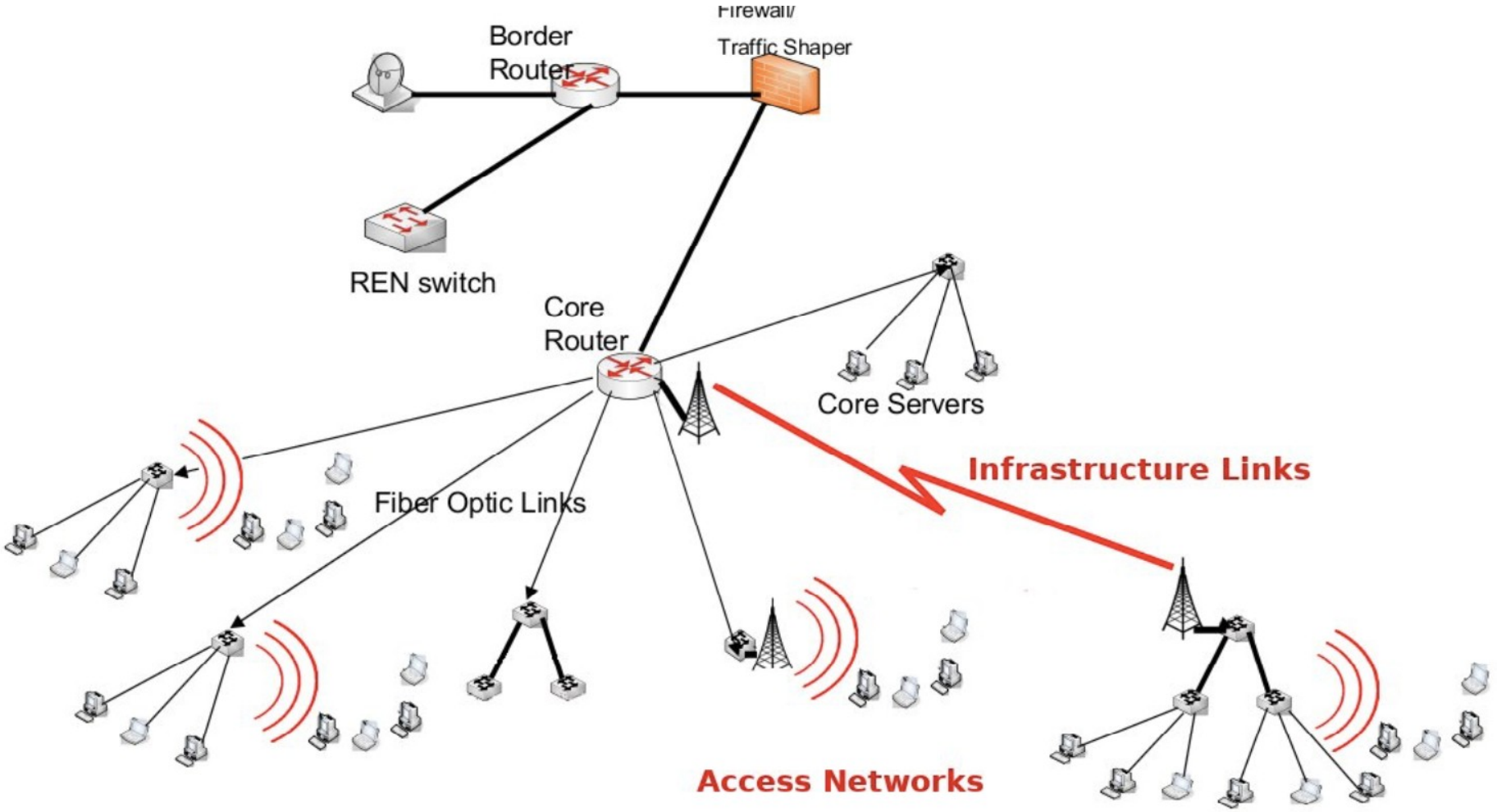
- Connect campus to outside world
- Connect to multiple ISPs, to your REN
- Some do firewalling, NAT here
  - Separate firewall is recommended for above



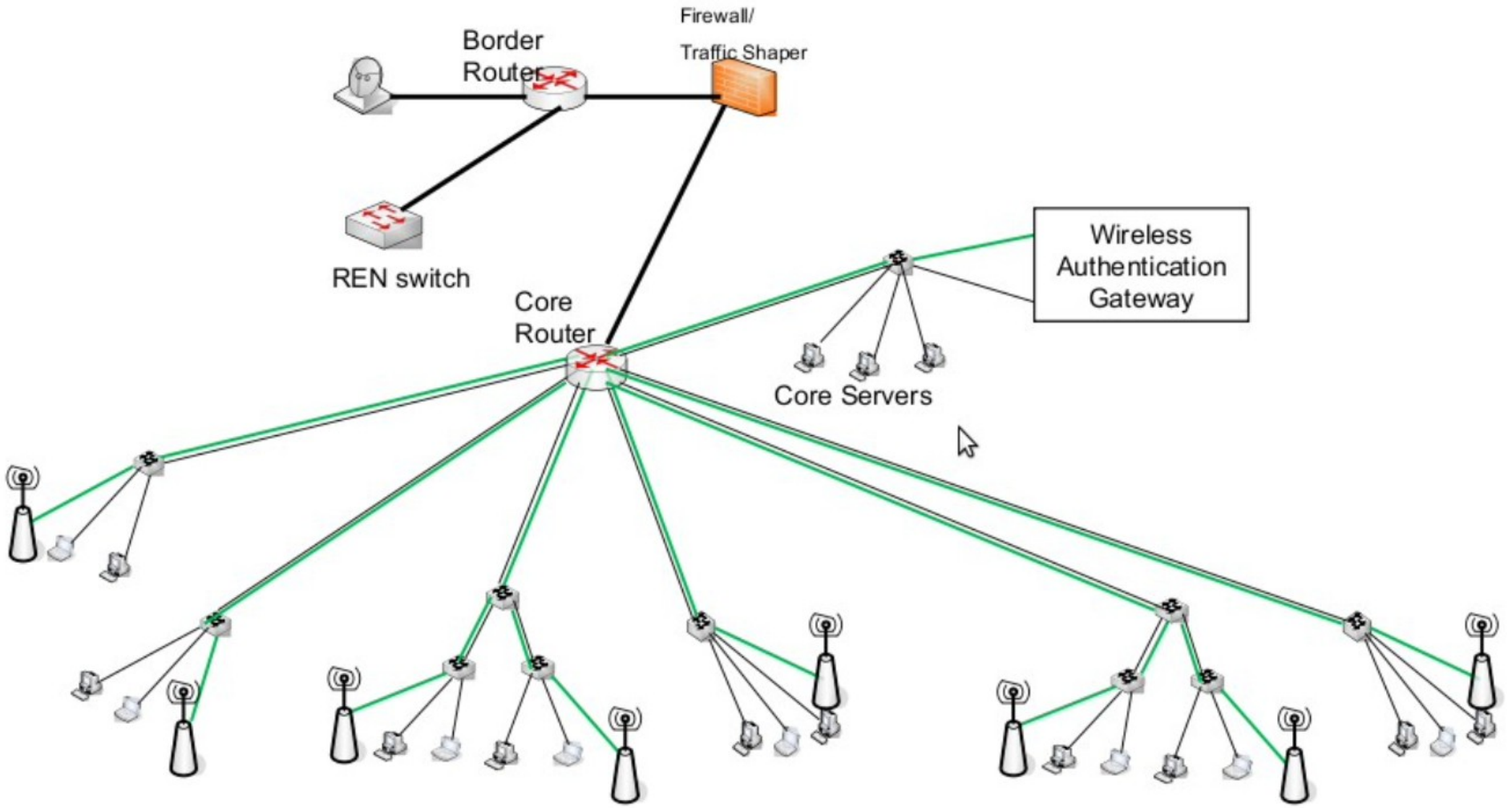
Putting it all Together



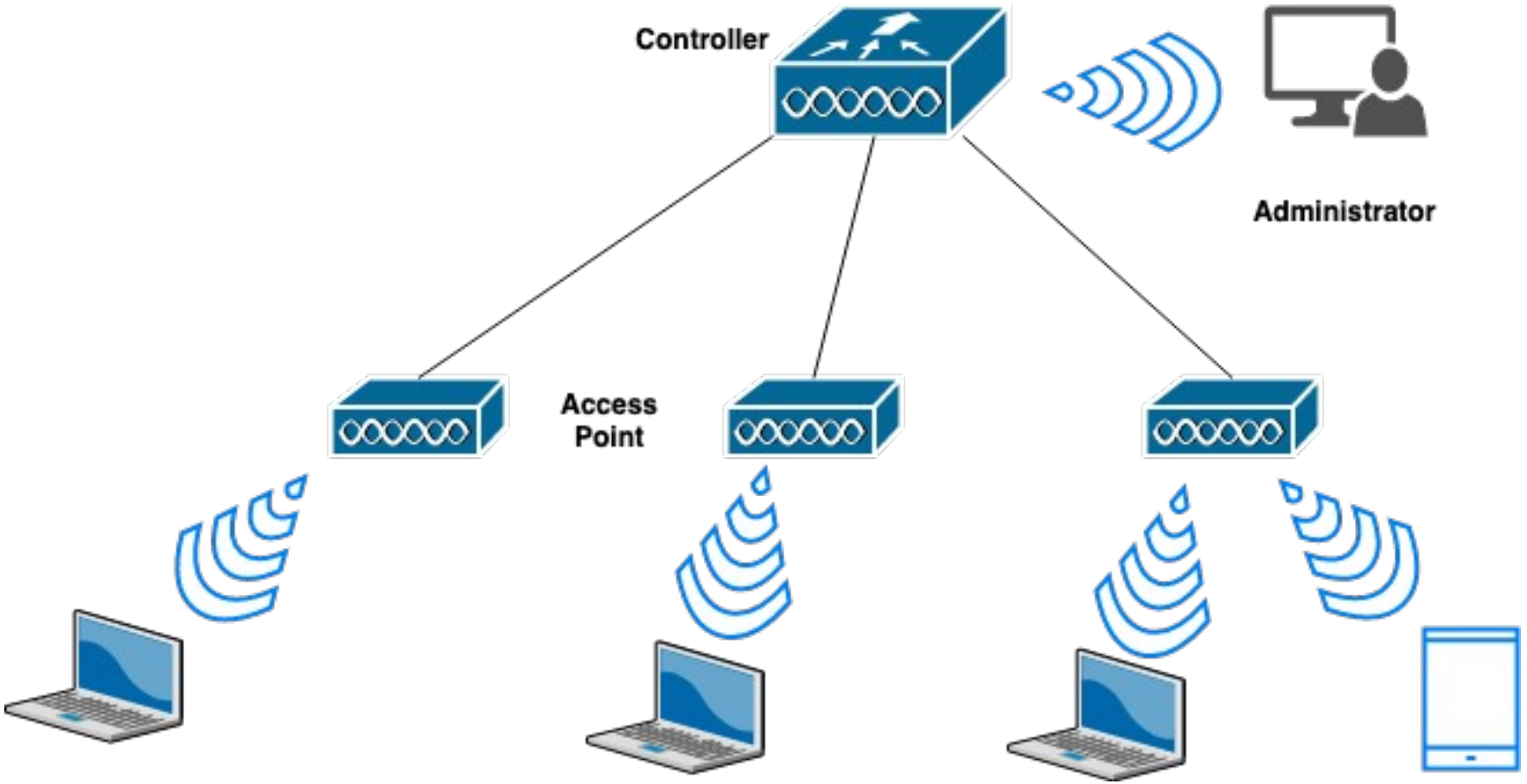
Wireless in Campus



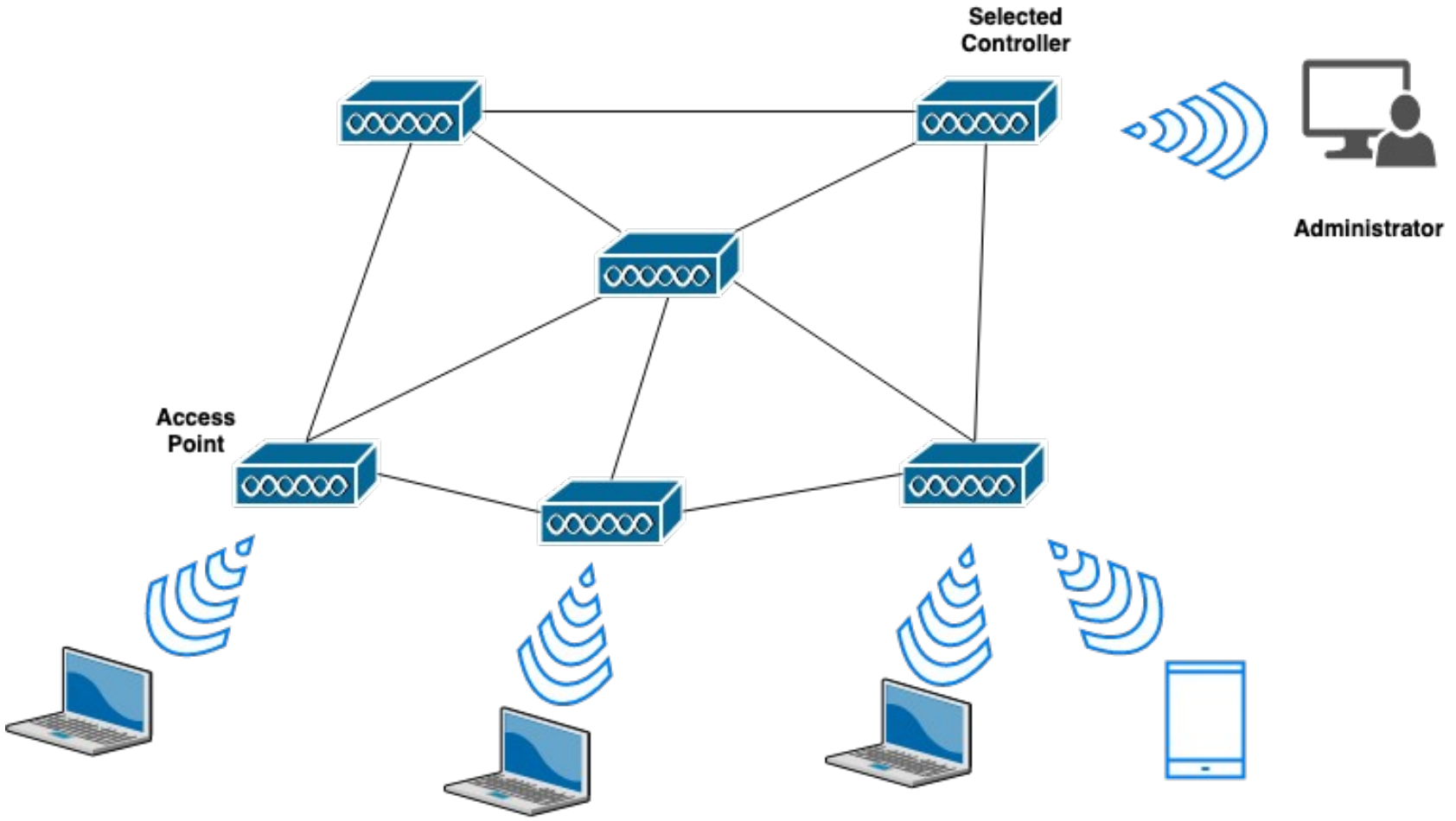
Authentication for Wireless Networks



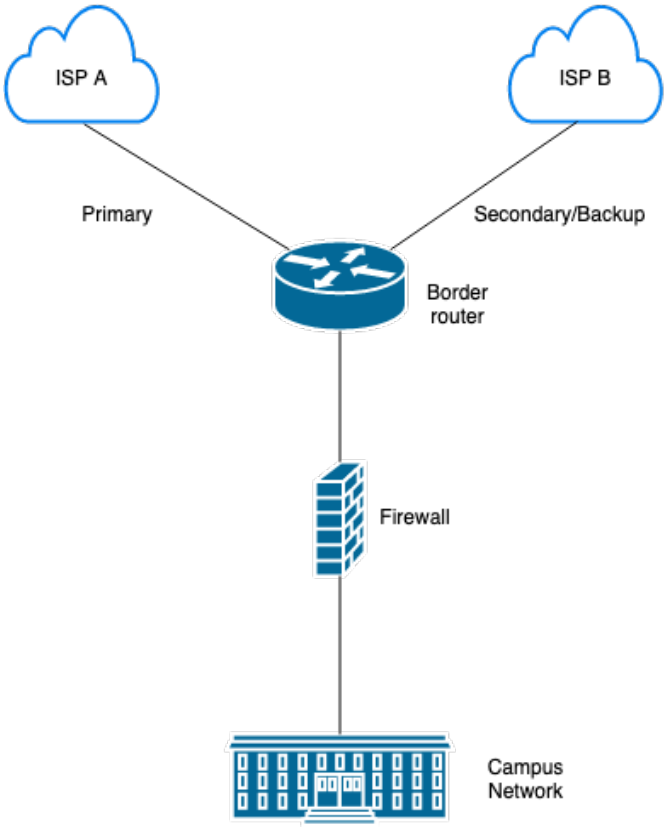
Wireless Network with Controller



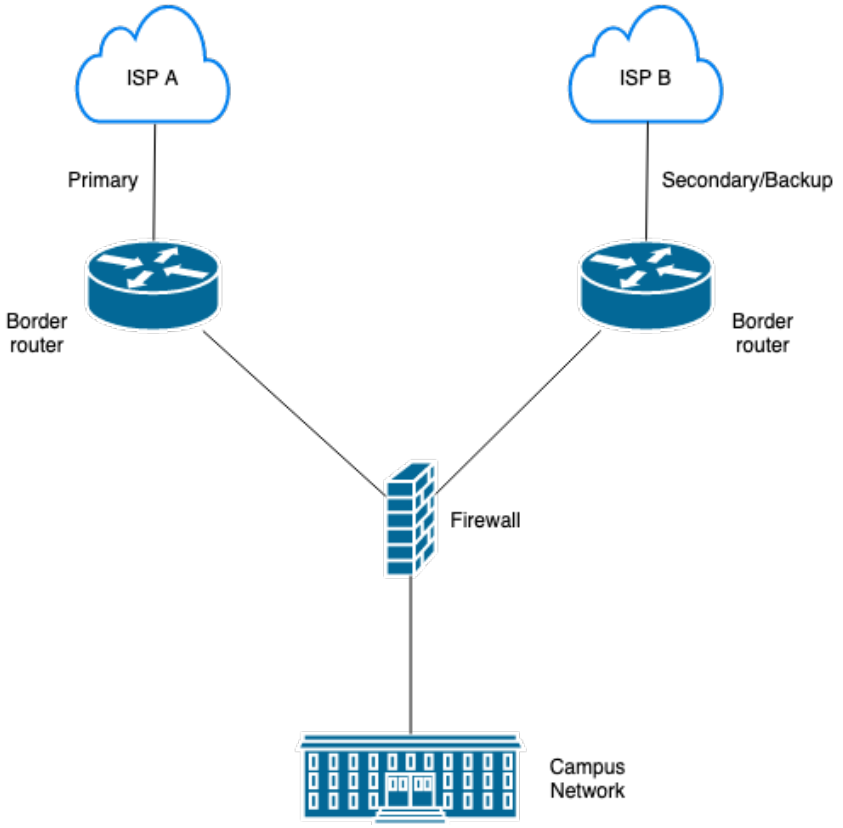
Wireless Network with Virtual Controller



Backup VPLS Link – Configuration 1



Backup VPLS Link – Configuration 2



DHCP server

- A central DHCP server
- Need DHCP relay form each subnet
- As you grow, add another server and run as a failover pair

DNS

- Must be reliable
  - No DNS = No Service
- A Central DNS server
- At least two servers for Authoritative and Recursive servers
- Authoritative vs Recursive

Server Function	Information	Target audience
Authoritative	Your domains	The Internet
Recursive	All other domains	Your users

Thank You

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