REN Design Issues
Internal Structure of a REN

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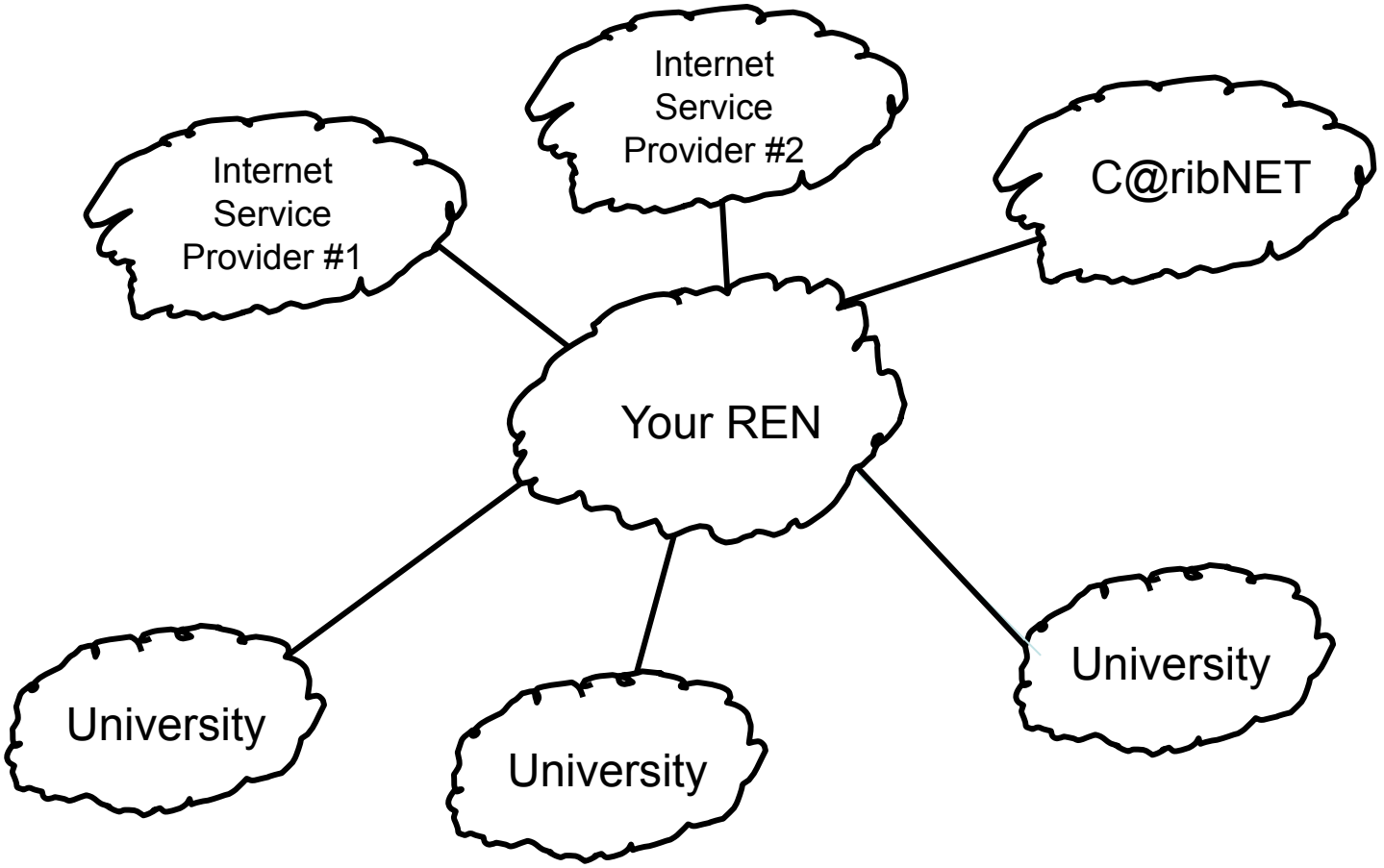
A typical NREN



But what is inside of the NREN?

- What components do you have inside of Your REN?

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- What components do you have inside of Your REN?
  - Routers
  - Connections between routers
  - Switches
  - Servers

A Basic REN Design

- Two basic components:
  - Points of Presence (POPs).
    - This is where you have routers, switches, servers, etc.
  - Connections between POPs
    - This is the way you move packets between your POPs

Points of Presence

- A POP will be place in strategic locations in your country that is used to serve nearby members.
- A POP consists of
  - Routers: traditional layer 3 routing, but maybe more powerful that typical with more memory so you can run BGP with both members and providers
  - Switches, servers, and other components to served the needs of your members

Connections

- This is how you connection POPs together
- Many different types of connections
  - Traditional SONET point-to-point
  - Dark fiber
  - Wireless point-to-point
  - Hybrid networks

Traditional SONET

- These are circuits based on traditional Telephone networks SONET Digital Hierarchy (SDH)
  - E1: 2Mbs
  - DS3: 45 Mbs
  - STM1/OC3: 155Mbs
  - STM4/OC12: 622Mbs
  - STM16/OC48: 2.5Gbs
  - STM64/OC192: 10Gbs
- Expensive to lease and expensive for interfaces in routers to connect to SDH circuits

Dark Fiber

- Look for opportunities to get access to fiber from one of your POPs to a REN member
  - Are campuses close?
  - Can you get right of passage to install fiber on poles or underground?
  - Does the government own fiber?
  - Is there fiber on the electrical power grid?
  - All advanced NRENs make use of dark fiber
  - Not an option for undersea connections

How to use Dark Fiber

- Can light this initially with very cheap optics – 1000BaseLX: 1Gbs service for a one time cost of $1000
  - We see this initially in countries that are just getting started
  - Bangladesh recently acquired fiber on the national power grid.
- As needs grow, use wave division multiplexing to make this many gigabits

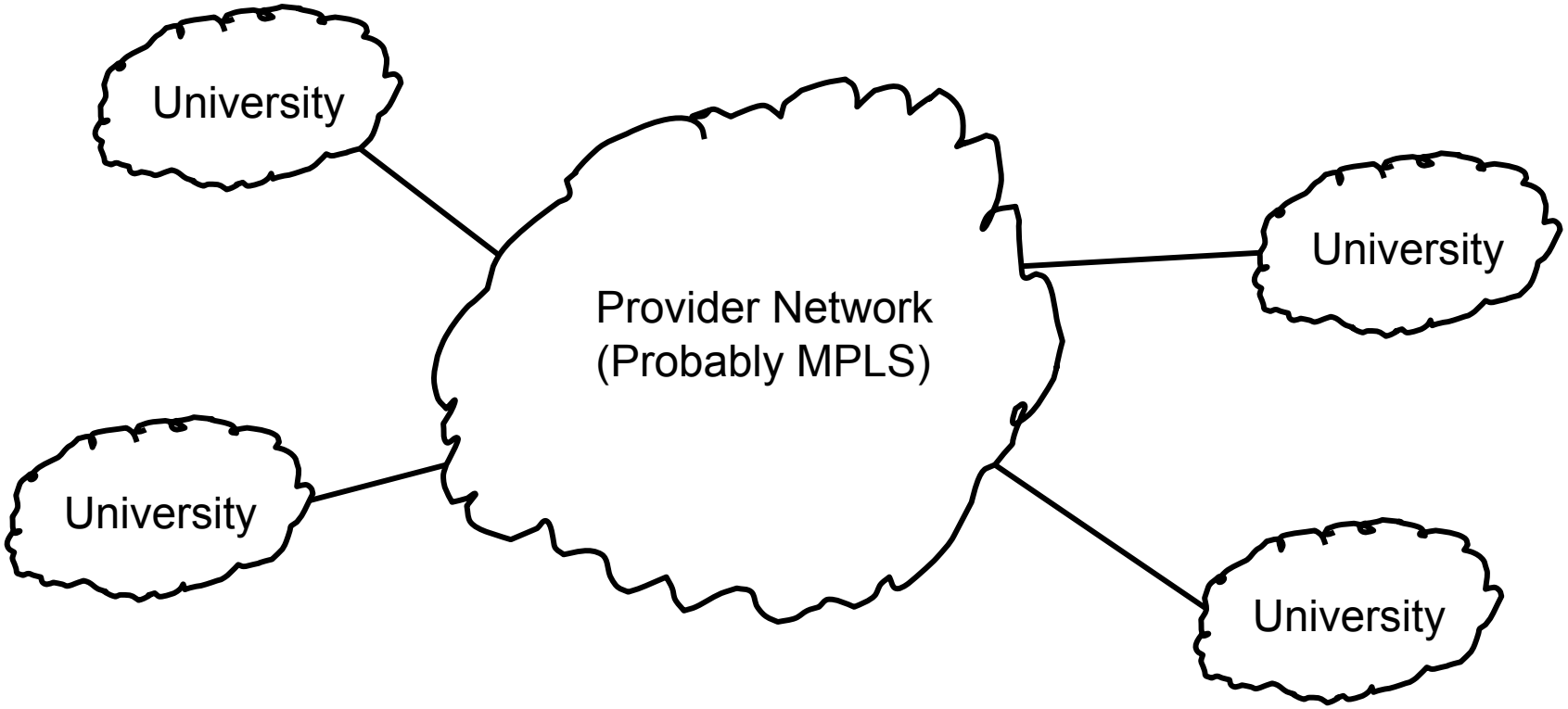
Wireless Point-to-Point

- Maybe a good way to get started
- Very inexpensive but good quality equipment is available today
  - Can do 100Mbs for 40km for < $1000USD
  - Can do 1Gbs for 12km for $3000USD
  - All require line of sight. Maybe you can rent space on a tower on a hilltop as a repeater site.
  - Possibly an option for some island to island connections

Hybrid Networks

- Provider uses basic components to simulate some type of private network
  - You as the customer sees the connection typically as an Ethernet connection
  - Carriers can use MPLS and/or VLANs and switches to simulate an Ethernet Local Area Network

Hybrid Networks

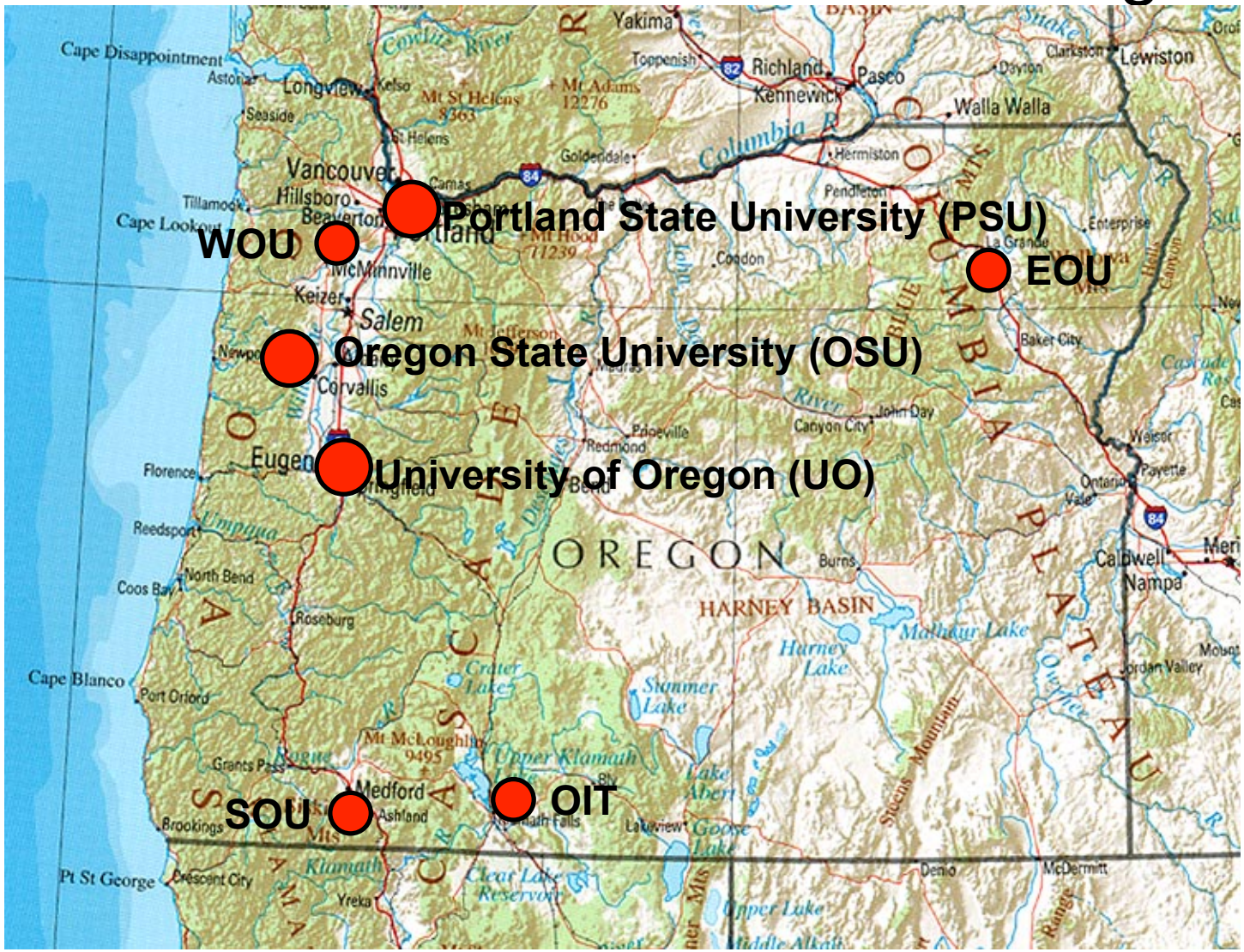


Assembling the Components

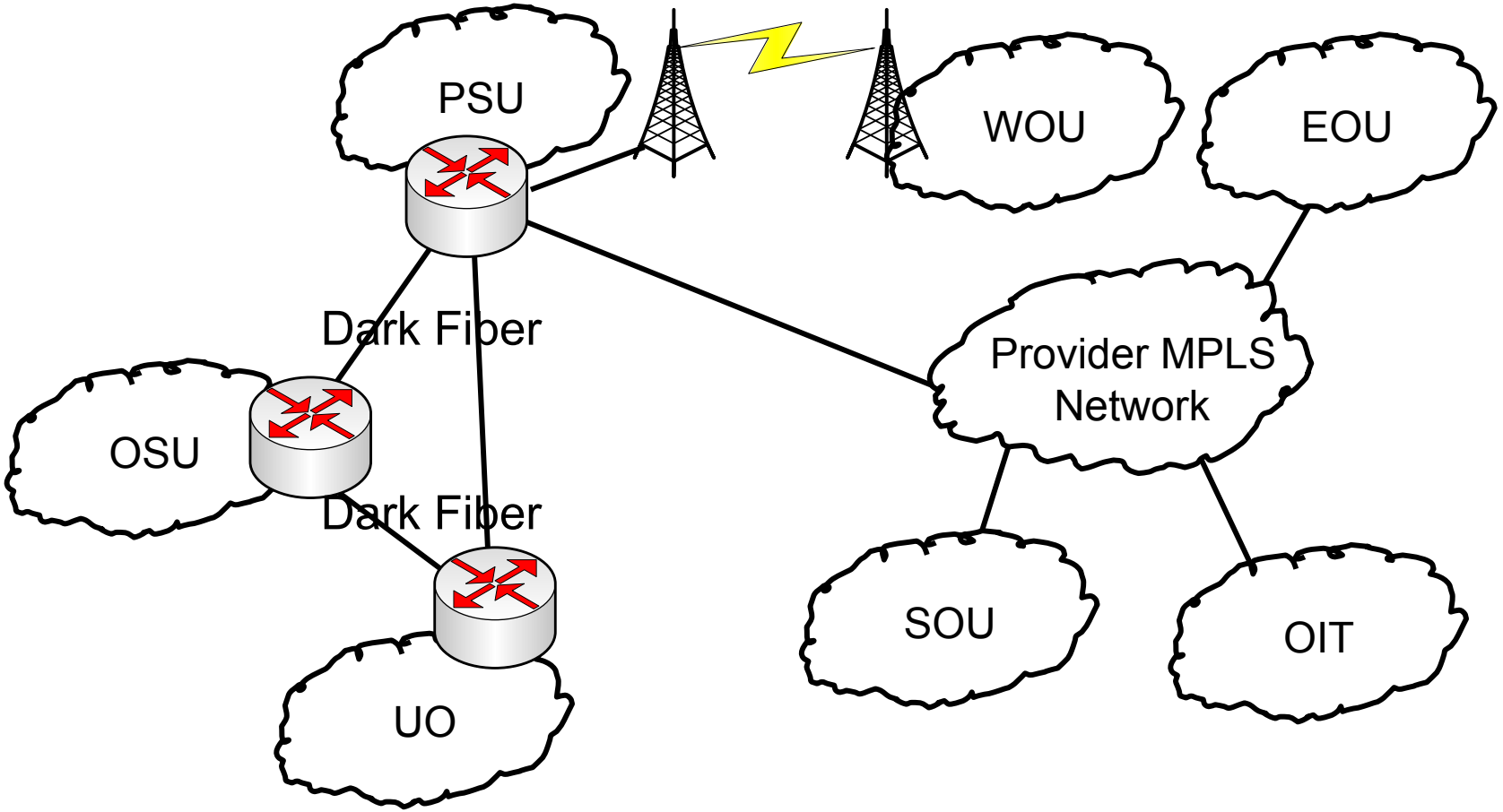
- We have a region to build a network

Assembling the Components

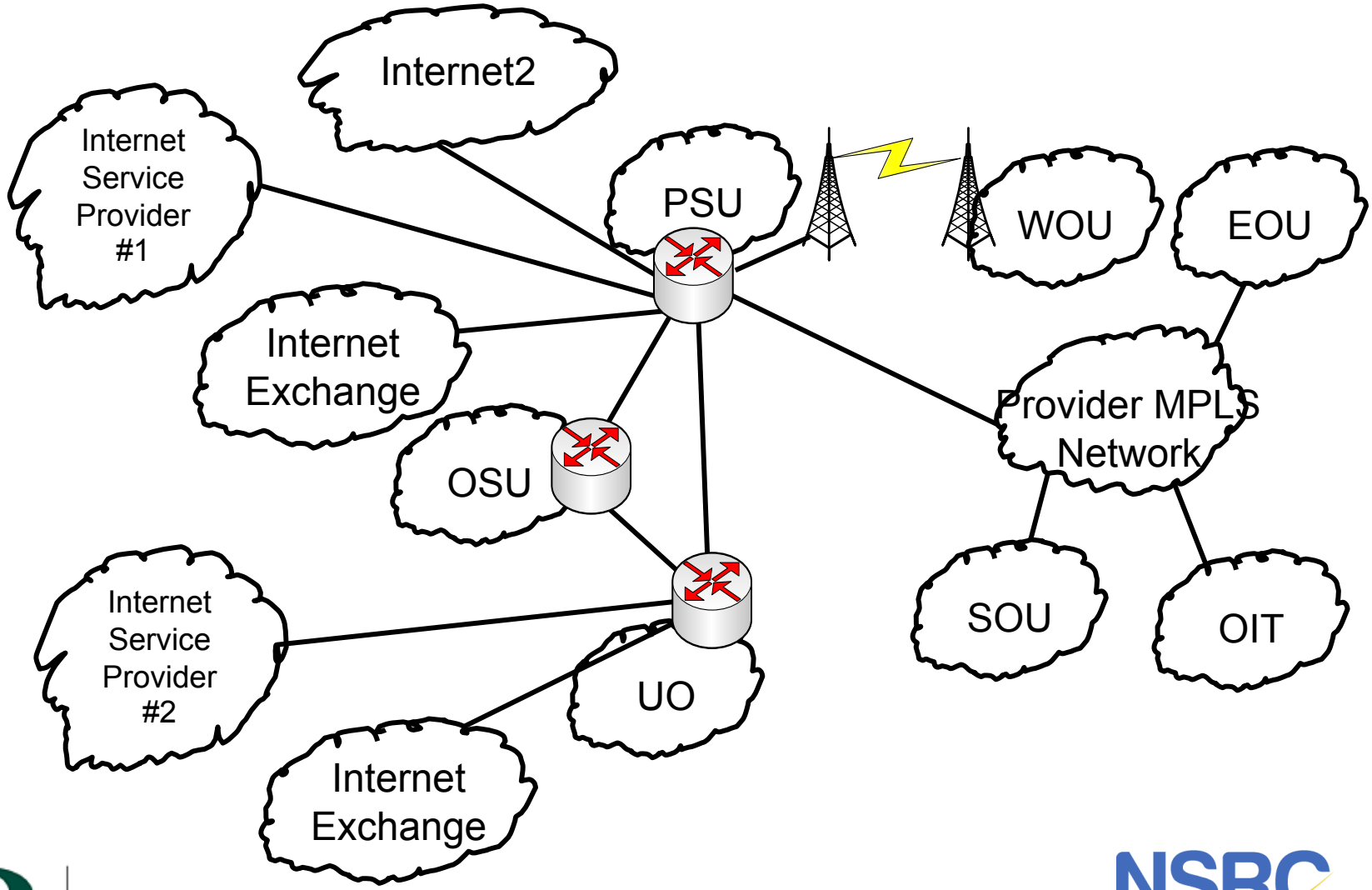
- We have some Customers in this region



A Straw Man Network



Connections to the Outside

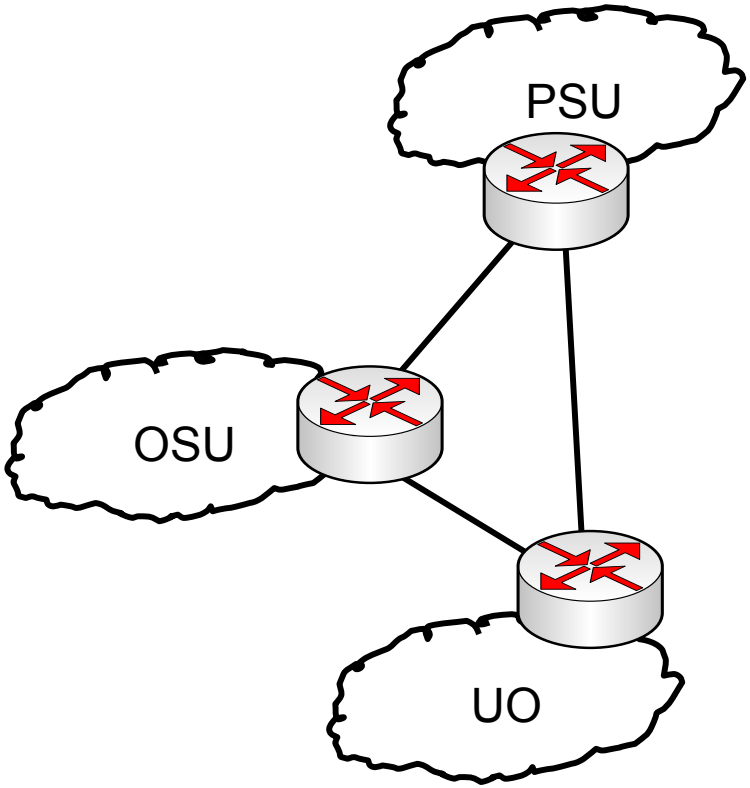


More about POPs

- Location where the REN has equipment that it operates to serve multiple members
- Often, a POP will be at a member site
  - Think about your more important and larger members
- A POP can have a lot of equipment, including DNS servers, Video Conferencing Multi Conference Units, mail servers, etc.
- A POP must have a router

POP design

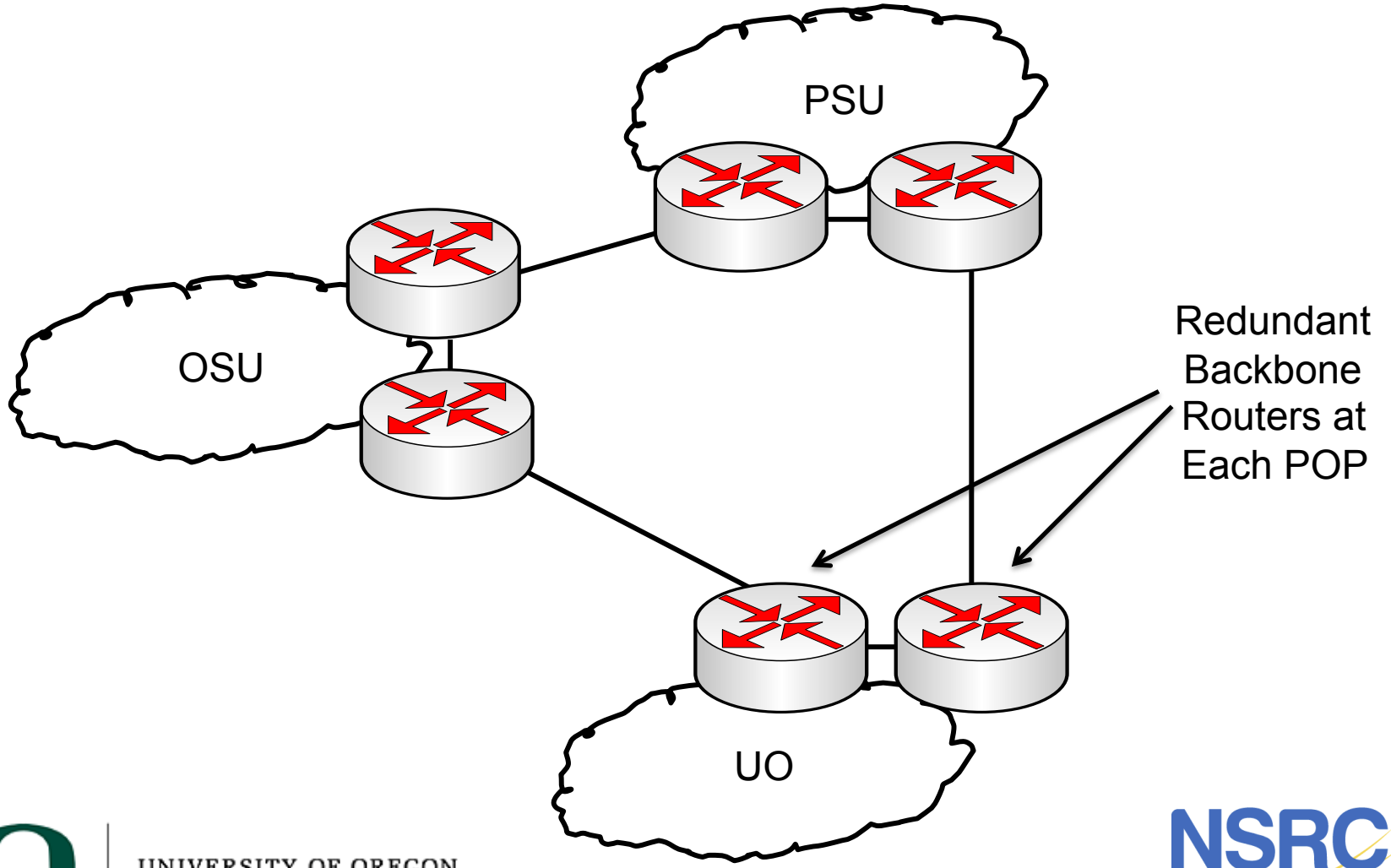
- The most simple POP is single router



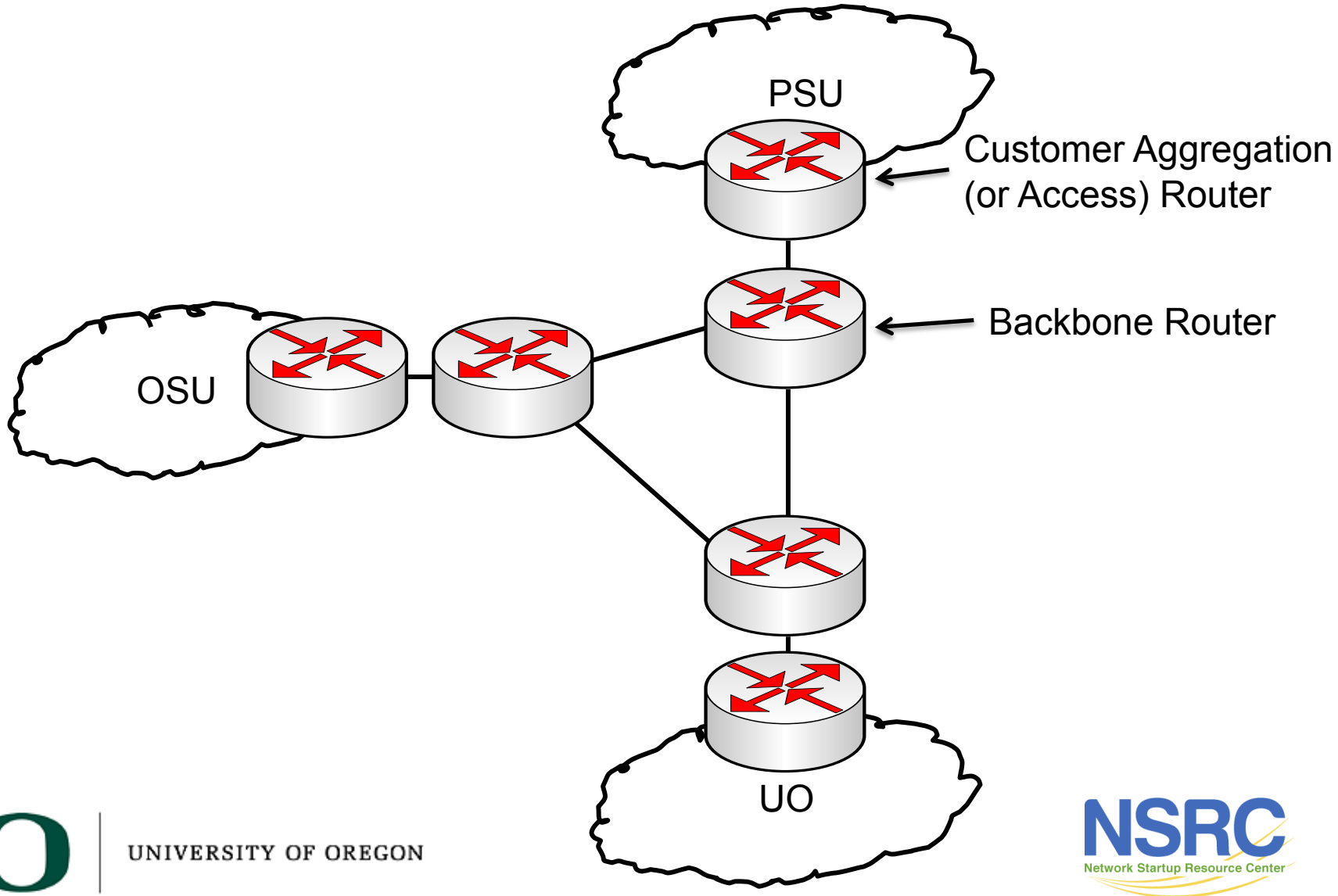
Single Router POP Issues

- Single router is simple and easy to understand and manage.
- Two problems
  - Single router is a single point of failure
  - Customers are connected to the same router as you are using to operate your backbone

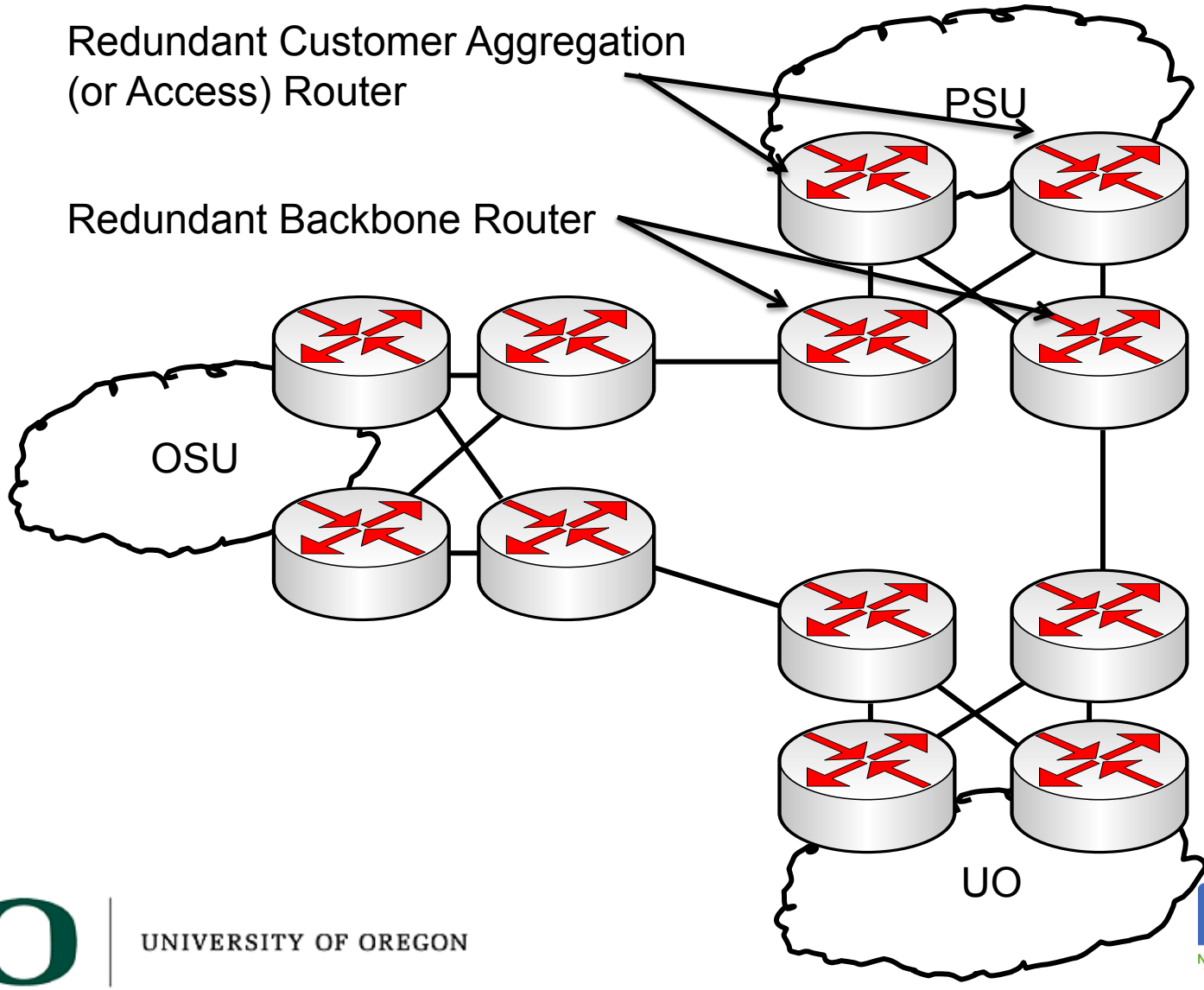
Eliminate Single Point of Failure



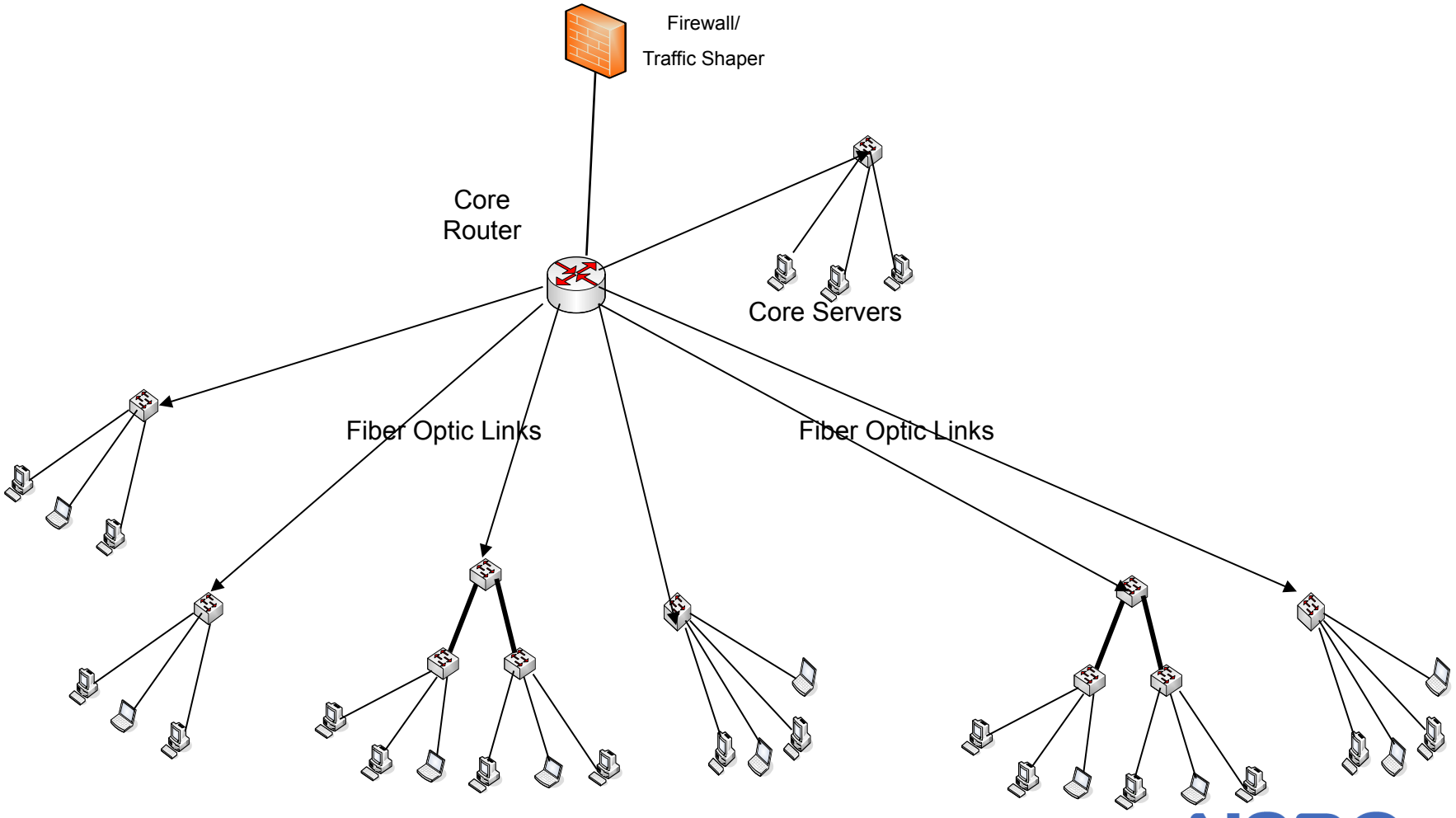
Separate Customer from Backbone



Combine Concepts



Relationship with Campus Net



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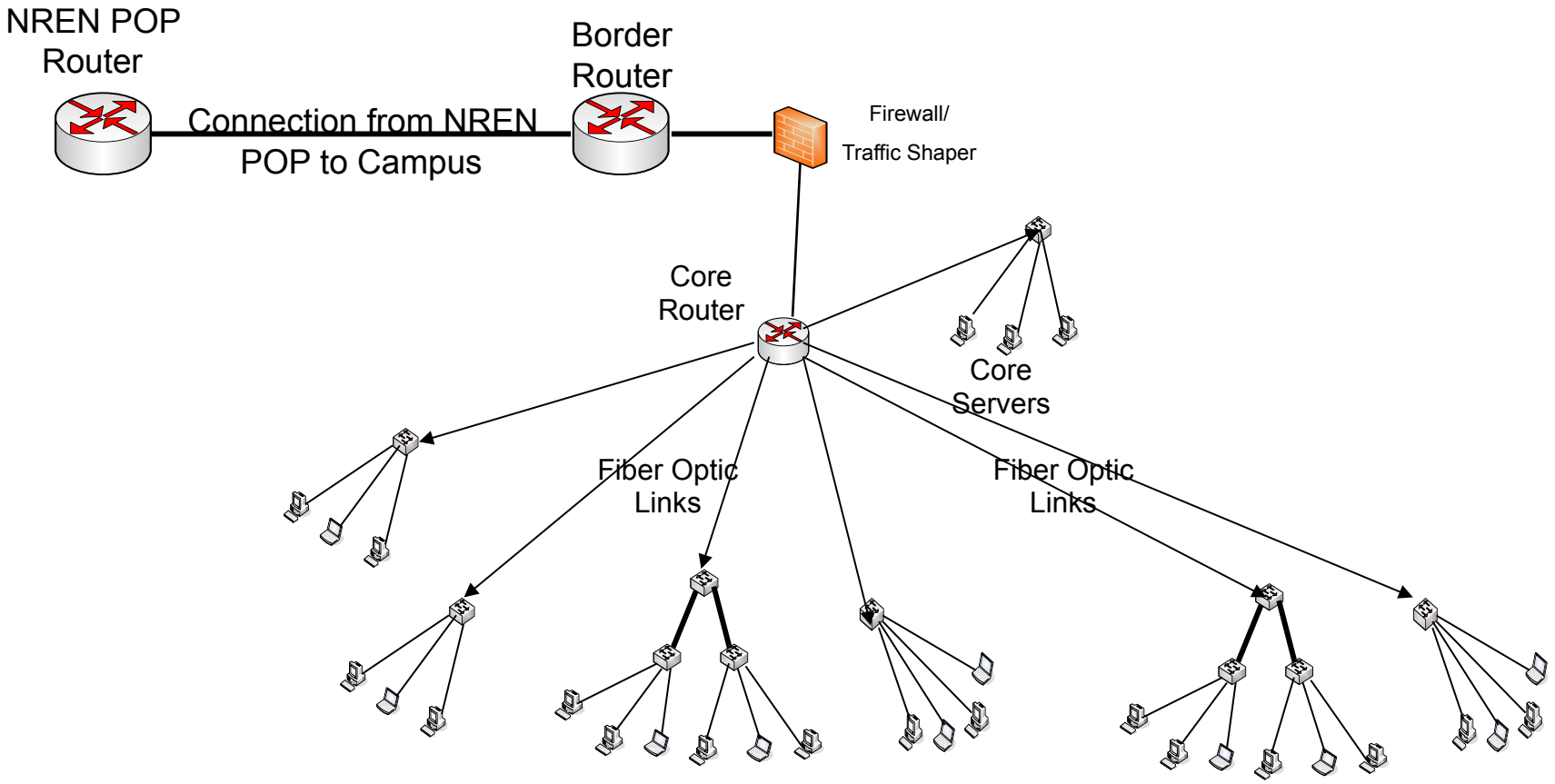

Who Owns the Router on Campus

- Is the router on the campus managed by the NREN or by the campus?
- What are advantages of each?
- NREN managed
  - Easier for NREN to guarantee services
  - Easier to monitor network
- Campus managed
  - Campus may have additional connections

Questions?

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Symbols to use for diagrams