Campus Network Design and Network Management

SANOG17 Workshop

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Instructors

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Daily Schedule

09:00 - 10:45	Morning Session 1
10:45 - 11:00	Tea Break
11:00 - 12:45	Morning Session 2
12:45 - 13:45	Lunch
13:45 - 15:15	Afternoon Session 1
15:15 - 15:30	Tea Break
15:30 - 17:15	Afternoon Session 2

Workshop Topics

- Campus Network Design Best Practices
  - Layer 2 Network Design + Lab
  - Layer 3 Network Design + Lab
- Security
  - Encryption + Authentication
- Network Management
  - Performance, Availability, Utilization
  - Documentation, Version Control, Ticketing

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Why Are We Doing This?

- Our goal is to build networking capacity to support Research and Education
  - Remember: University = Research & Education
- The end game is regional, national, and larger Research and Education Networks (RENs)
- All RENs start with campus networks

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 VSAT uplinks, but moving to high speed external links, they start to fail.

Justification

- Design Goals
  - Reliability/Resiliency
  - Performance
  - Manageability
  - Scalability

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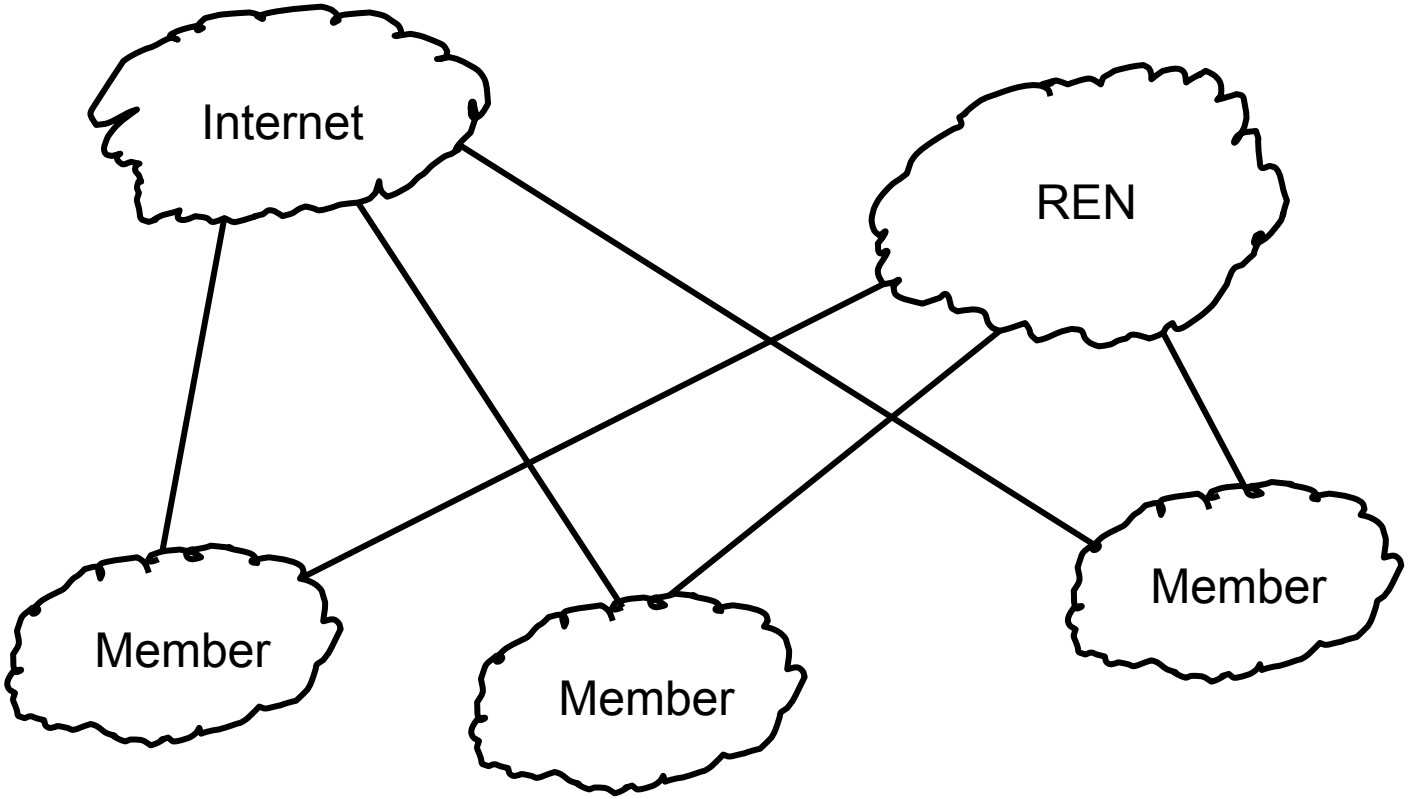
Why a REN?

- **Enable research or services that could not be accomplished otherwise**
- Cost Savings (buyers club)
  - Aggregate demand from multiple parties
- Vision of building alliances
- Successful RENs find that there are unanticipated benefits

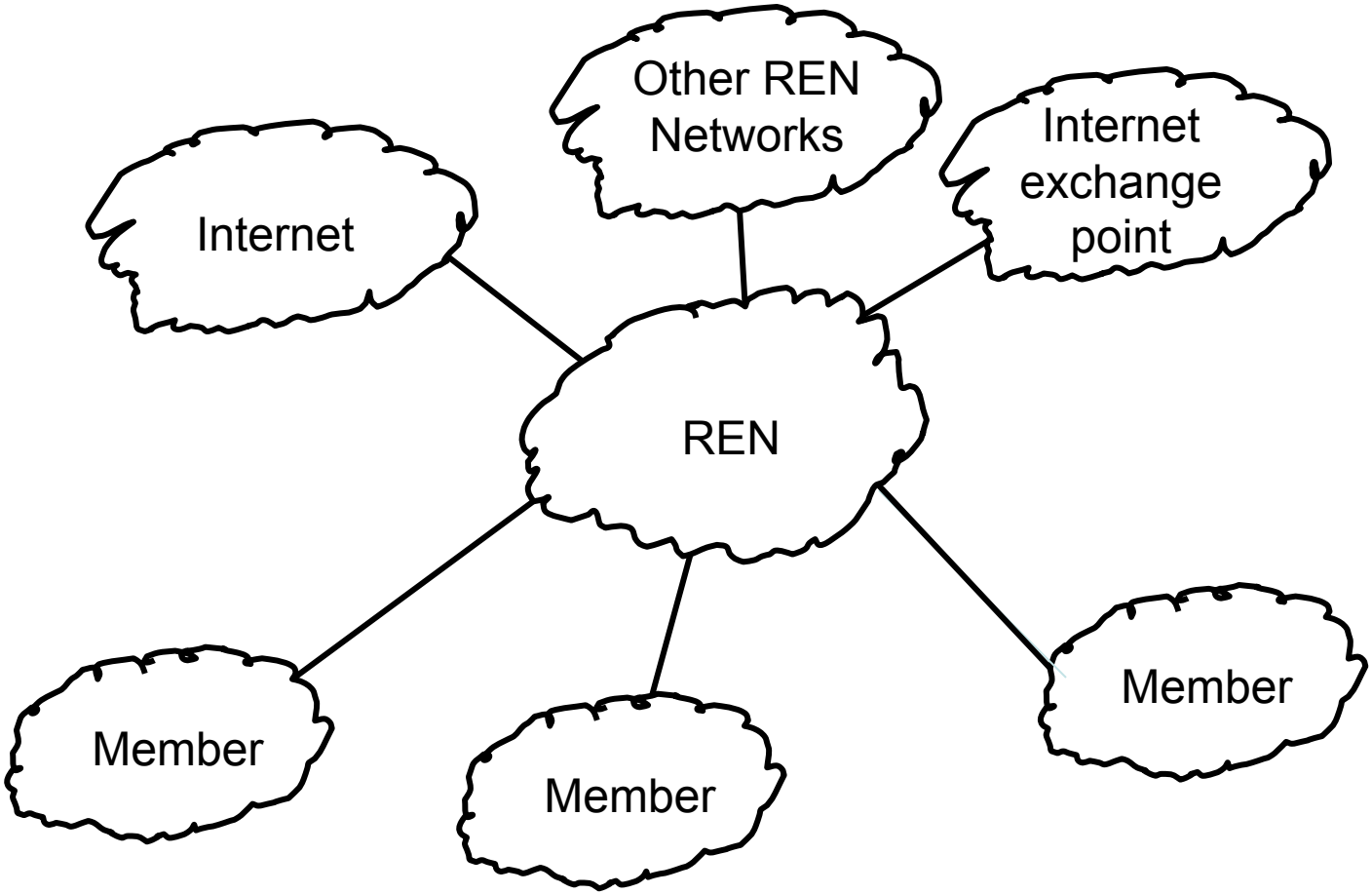
REN Services

- What services are provisioned? Various models:
  - REN provides all Internet connectivity
  - Peering network to exchange traffic between members
  - Advanced peering network that might
    - Develop or peer with a local commercial exchange
    - Provide international connections (GEANT, etc)
  - Other services (video conferencing)

REN as Peering Network



REN as Internet Service Provider



RENs Around the World

- United States – Two National RENs
  - Both provide peering, but have access to lots of commercial peering and other REN peering
- US Regional RENs (usually one per state)
  - Different models, but many act as ISP
- Europe – GEANT
  - Peering only. Much more restrictive on commercial traffic

REN Financial Models

- Some pay for bandwidth per Mb (typical for ISP model only)
- Some have membership fee with “eat as much as you want”
- Some pay on size of connection and can “eat up to the size of the connection”
- Some have combination
- REN needs staff and circuits

IP Addressing

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Who Needs Public IP Space?

- **Every campus must have Public IP address space – Where do you get it?**
- REN needs to get IP address space
- If REN becomes ISP, it must have address space for its “customers”
- Any University can get their own IP address space.

Provider Independent IP Addresses

- Public IP addresses that are not allocated to you by your Internet Service Provider.
  - Can move between service providers without changing IP addresses
  - Necessary for “multi-homing”
- If REN provides IP space, then addresses provided by REN are not provider independent

NAT is a reality

- NAT is common technique to reduce number of public IP addresses required
- NAT makes some things hard.
  - NAT breaks things like SIP (standard-based VoIP), which you have to work around
  - NAT translation device needs to know about applications. Stifles innovation.
  - Makes it harder to track down viruses and hackers

Who Needs Public IP and ASN?

- REN
  - Must have both ASN and Public IP
- Campus Network
  - All campuses must have Public IP
  - Only need ASN if campus is multi-homed
- How much IP address space?

General Notes on IP Addressing

- IP version 4 addresses are 32 bits long
- IP address blocks allocated in powers of 2
  - Blocks of addresses: 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096, etc.
- CIDR notation: Address blocks are described with a notation of /number. /32 = 1 address, /31 = 2, /30 = 4, …. /24 = 256

REN IP Addressing

- Every member connected with a point to point link
  - Every point to point link requires at least a /30 (4 addresses)
- REN will provide address space for
  - Network management equipment
  - Services such as web, video conferencing
- Build a spreadsheet that details all the above

Simple (Small) REN Example

Network	Hosts	CIDR block	Size	Qty	Total
Point to point links	2	/30	4	7	28
Server network for network Mgmt	40	/26	64	1	64
Server network for Services	40	/26	64	1	64
Future network for services	40	/26	64	1	64
Future customer links	2	/30	4	4	16
Total					236

You can't get a CIDR block of 236 addresses - rounding up, you get 256 or a /24

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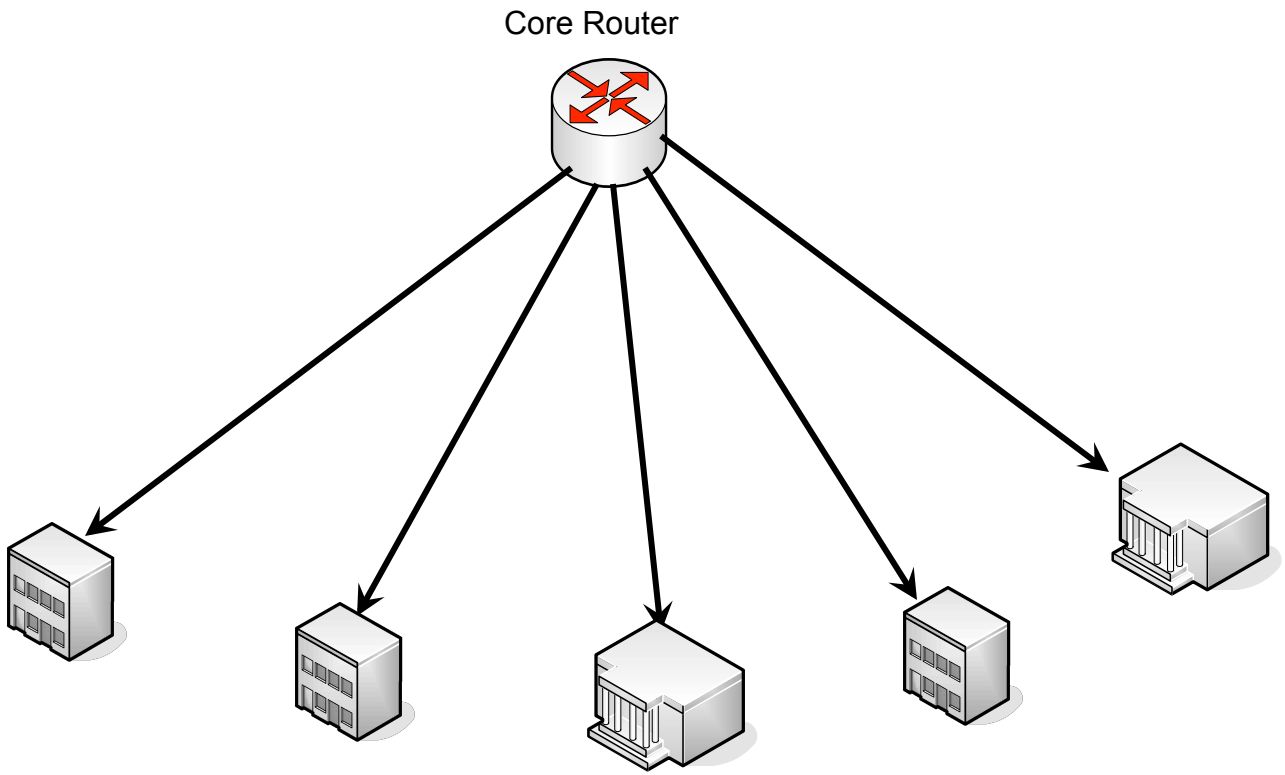
Campus Network IP Addressing

- Build a spreadsheet
  - One row for every building on your campus
  - Write down how many computers will be in each building
  - Round up to the nearest power of 2
  - Add a row for servers
  - Add a row for wireless

A Simple Campus Example



A Simple Campus Example

Building	Hosts	CIDR Block	Size	Qty	Total
Administration Building	68	/25	128	1	128
Physics Building	220	/24	256	1	256
Chemistry Building	120	/24	256	1	256
Computer Science	200	/24	256	1	256
Literature Building	44	/26	64	1	64
Server Network	20	/27	32	2	64
Additional Buildings Medium	100	/25	128	3	384
Additional Buildings Large	200	/24	256	2	512
Wireless Network	500	/23	512	1	512
Total					2432
Round 2432 up to the next CIDR block gives you 4096 or a /20					

Campus Network Personnel

- Every campus should have at least one person who does nothing but work on the network.
  - Not email systems. Not course management systems. Not helpdesk. Just networks.
- Larger campuses will need more
    - University of Oregon has 9 people just doing networking plus 3 doing security (26,000 network connections)
      - Started small 20 years ago with 2 people

Questions?

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