Practical Steps to Building an NREN

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Research and Education Networks

• Some Terminology
  – Research and Education = R&E
  – Research and Education Networks = REN
  – National REN = NREN

• Almost every developed country around the world has built a National Research and Education Network (NREN)

• Why?
For further information regarding the international programs of Internet2, visit http://internet2.edu/international or contact Heather Boyes, International Relations Director, international@internet2.edu.

A listing of networks reachable via the Internet2 Network is found on the back of this page.
Why an NREN?

• Develop networking capacity to support Research and Education

• Build a community that is a forum for collaboration

• Successful RENs find that there are unanticipated benefits

• Most NRENs are operated by Universities, not by an Internet Service Provider
Why not Internet Service Provider

• High bandwidth networks
  – Advanced R&E networks have 10Gbs backbones with some doing 40Gbs and 100Gbs
  – Research needs uncongested networks

• Open Networks with no filtering

• Commercial Providers can do this, but
  – Very few NRENs are operated by Providers
  – The barrier is cost. Most successful NRENs are operated by Universities, not Providers
NREN Challenges

• NSRC works throughout the world with many emerging NRENs
• Very difficult to get started with an NREN
• After getting started, NRENs frequently have two challenges:
  – Campus Networks are not adequate
  – Some NRENs don’t provide general Internet access
Inadequate Campus Networks

- Many are not structured properly and can’t effectively utilize high bandwidth REN 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
- Many don’t have sufficiently trained staff
NREN Not Providing Internet

• Two basic NREN models:
  1. NREN is Peering network
     • No access to the Commercial Internet
     • Exchange traffic between members
     • Provide international connections to other RENs
  2. NREN provides all Internet connectivity
     • Provides access to the Commercial Internet
     • Also exchanges traffic between members
     • Provides international connections to other RENs
     • The REN is the Internet Service Provider
NREN as Peering Network

ISP

University

University

University

Regional REN

REN
NREN as ISP

ISP
Regional
REN
University
University
University
Implications for Universities

• If NREN is a Peering Network
  – Each University still has an ISP connection
  – Each University connects to NREN
  – The two connections are hard to manage

• If NREN provides all Internet connectivity
  – Simplest for campus members
  – Treats NREN as Internet Service Provider
  – Only one connection to manage
NREN as a Peering Network

• Easiest to implement from a political perspective.
  – The Internet Service Providers like this approach because they keep many customers
  – Often the legal and regulatory environment allows this use without licensing and/or the license is easier to get

• However, there are problems with this approach
NREN as a Peering Network

• Universities now have two connections
  – How do they decide which one to use?

• Three approaches:
  1. Get provider independent IP address, autonomous system number, and run BGP
  2. Get routes from NREN and run special software and configuration on a NAT box
  3. Split campus network into NREN and Internet

• What do we find around the world?
NRENs Around the World

• Most NRENs act as the Internet Service Provider

• There are two classes of Peering Only
  – Advanced regions: they do the right thing and have Provider Independent IP addresses, ASN, and run BGP. This works fine.
  – Less advanced regions: they split their campus and the NREN becomes a video conferencing network.

• What kind of network will you build here?
But how do you build an NREN

• Many Universities get Internet access from an Internet Service Provider
• We will need to change the model for how the Universities get access
• Build a network connecting the Universities
• Then connect that network to the global Research and Education network and to several Internet Service Providers
A typical NREN

- Internet Service Provider
- Regional REN
- University
- University
- University
What is inside of the NREN?

- What components do you have inside of Your REN?
But what is inside of the NREN?

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

• Routers
  – Traditional routers, but maybe more powerful with more memory so you can run BGP

• Connections (many types)
  – Traditional SONET point-to-point (E1, STM1)
  – Dark fiber
  – Wireless point-to-point
  – Hybrid networks
NREN Components

• Switches
  – To connect between routers and to servers

• Servers
  – To provide services to NREN members
    • Web sites, information portal
    • Domain Name System or other network services
  – Monitor the NREN network to make sure it is working properly
Hybrid Networks

• Provider uses network 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

Provider Network (Probably MPLS)

University

University

University

University
Assembling the Components

• We have a region to build a network
Assembling the Components

• We have some Universities in this region

Portland State University (PSU)
Oregon State University (OSU)
University of Oregon (UO)
SOU
OIT
EOU
WOU

[Map showing locations of Universities]
A Straw Man Network

Provider MPLS Network

WOU
PSU
OSU
UO
EOU
PSU
SOU
OIT
Connections to the Outside

Provider MPLS Network

Internet Service Provider #1
Internet Service Provider #2
Internet Exchange

Internet2

PSU
OSU
UO

WOU
EOU
SOU
OIT
What is a POP?

• POP = Point of Presence
• Location where the REN has equipment that it operates to serve multiple customers
• Often, a POP will be at a customer site, but can also be co-located at an ISP POP
• 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
Typical NREN Decisions

• Where will your POPs be?
  – Will need POPs in all major cities to serve Universities. Need to start with one city.
  – Which POPs will get connection to ISPs?
  – Which POP will get International connection?
• Will the NREN need an operating license?
• How will we improve the internal campus networks at each University?