Research and Education Networks

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Research and Education Networks

- Some Terminology
  - Research and Education = R&E
  - Research and Education Networks = REN
  - National REN = NREN
- Globally, the REN connectivity is very complex and very difficult to understand

REN Characteristics

- High bandwidth networks
  - 10G backbones with 40G and 100G coming
  - Research typically needs uncongested networks
    - Which means many RENs are lightly used with lots of unused capacity (we call it headroom)

- Low latency
  - Terrestrial fiber

- Open Networks with no filtering
  - Firewalls can make it hard for ad-hoc activities

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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

Why Are We Doing This?

- Our goal is to build networking capacity to support Research and Education
    - Remember: University = Research & Education
- Buying all service from you local ISP is a losing game – you will spend more money and not have control of the network
- The pattern around the world is to build regional, national, and larger Research and Education Networks (RENs)

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REN versus Campus Network

- 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
- The campus network is the foundation that the REN is built upon

Problems with 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

What are Our Goals?

- Network Design Goals
  - Reliability/Resiliency
  - Performance
  - Manageability
    - Must have this to find problems
  - Scalability
    - Need to be able to grow as needs grow
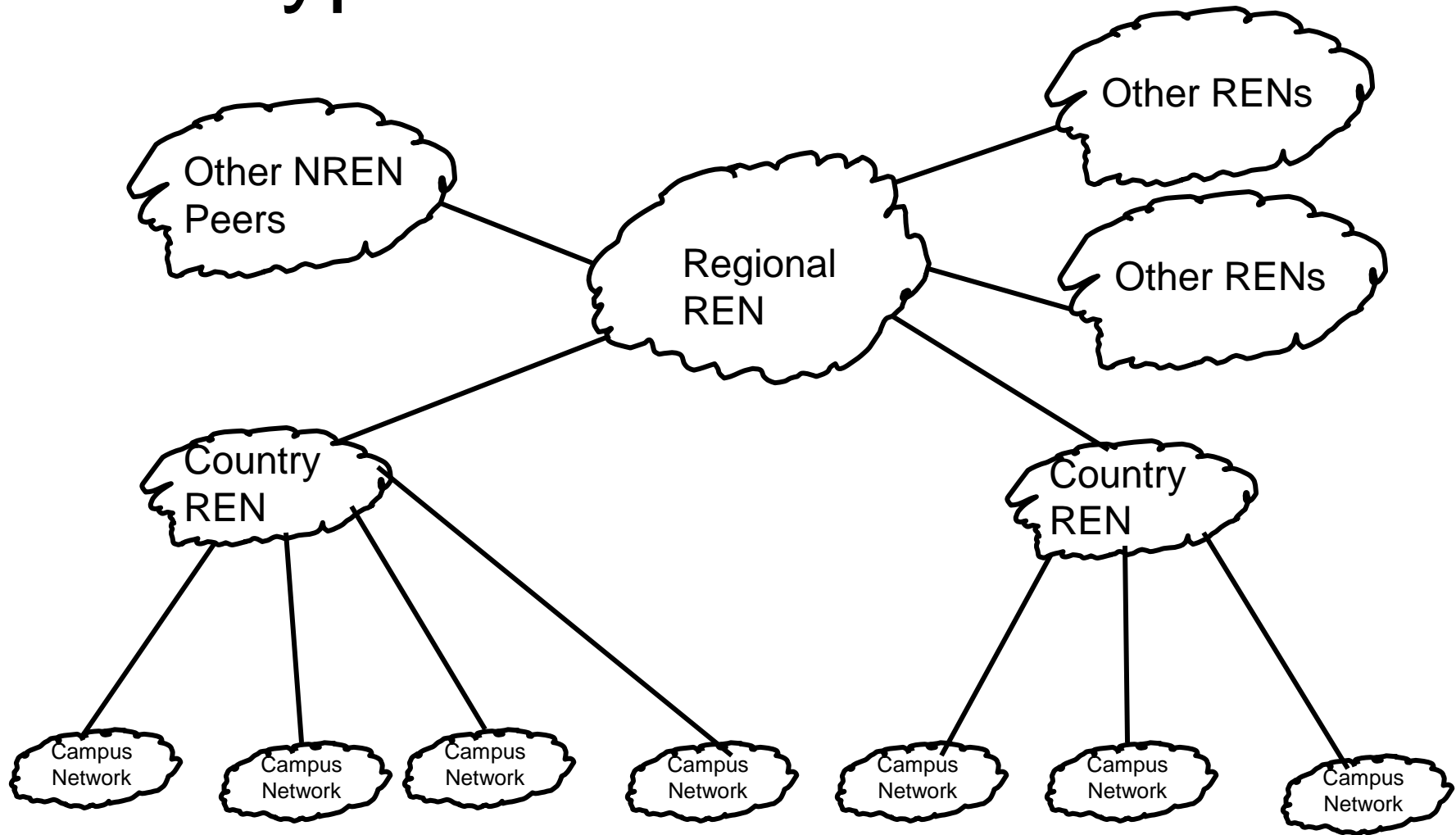- Need this in the campus and the REN

REN Ecosystem

- A layered model
  - Global Connectivity
  - Regional RENs
  - National Research and Education Networks
  - All users are connected at the campus network level
    - No scientist is connected directly to a National Network. They are all connected to campus or enterprise networks

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Typical REN Architecture

Diagram showing network connections between: Other NREN Peers, Other RENs, Other RENs, Regional REN, Country REN, Country REN, and multiple Campus Networks.

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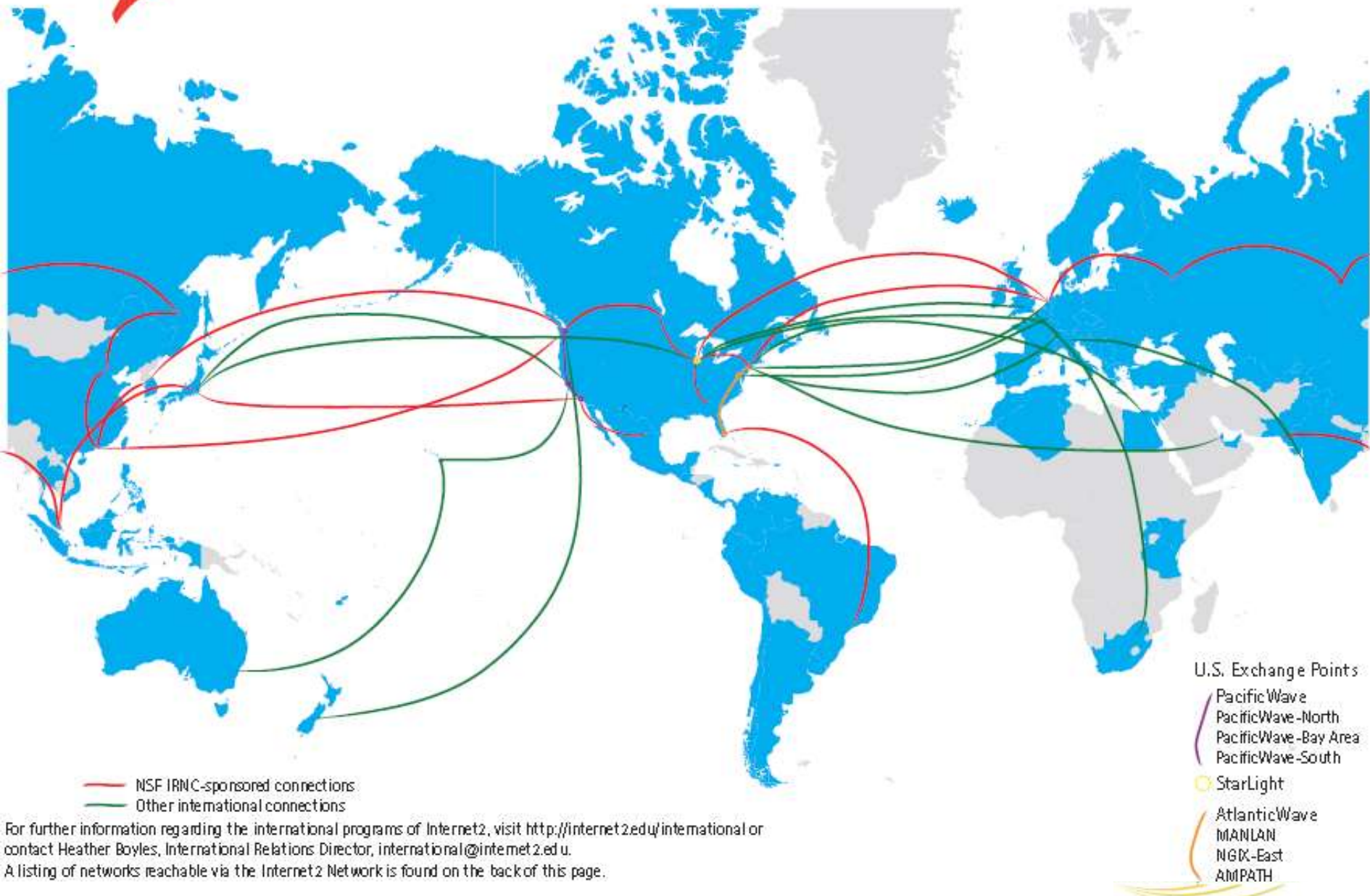
REN Topics

- A look at the Global and Regional REN environment

- A closer look at USA RENs

- How does this relate to South Asia

- NREN IP Transport Models

- Technical Requirements for campus networks and NRENs

Global REN Connections

- Connect Regional or National networks together
- Tend to be longer, more expensive circuits
- Not always well coordinated
- Routing policies often inconsistent
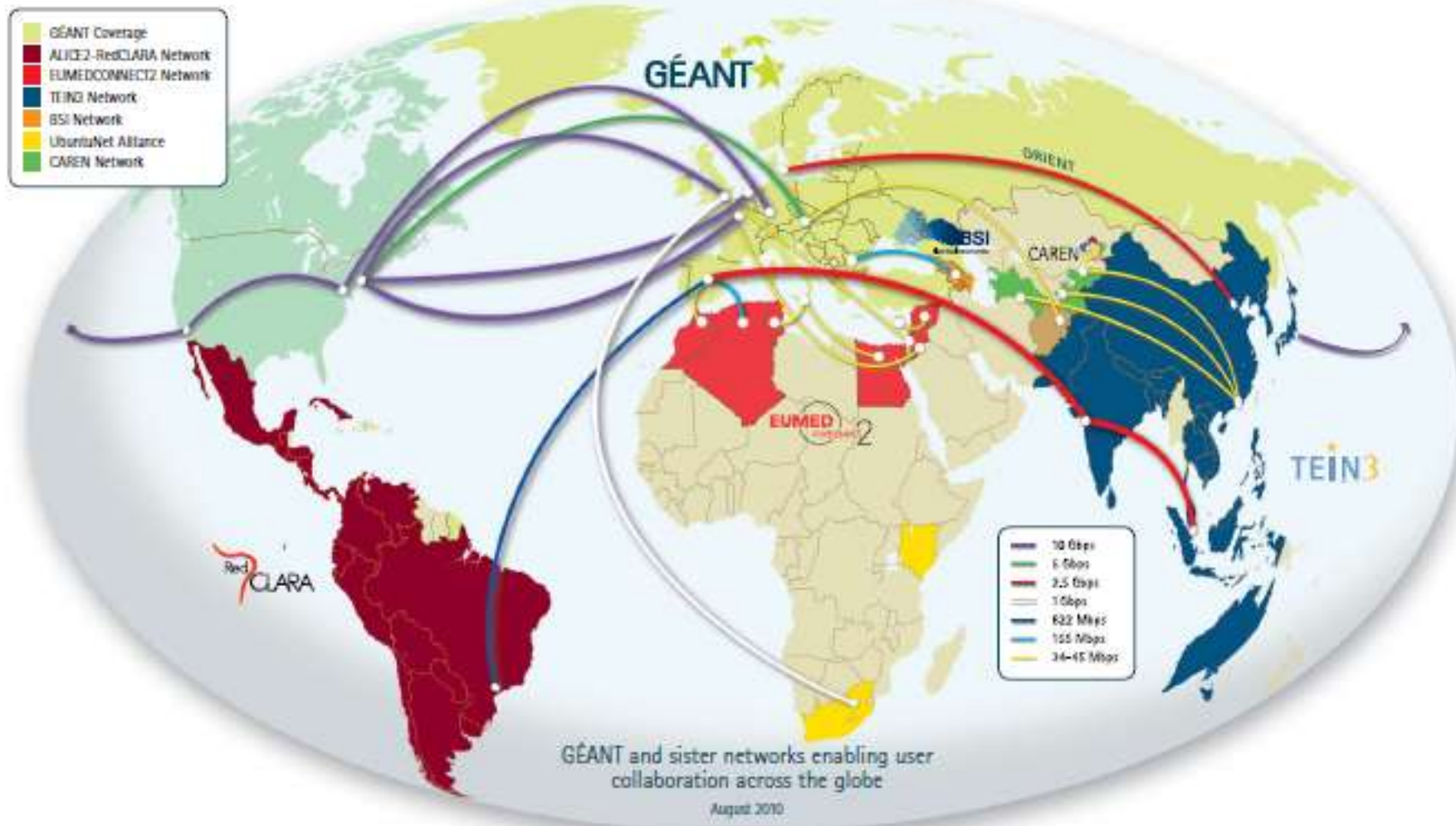- Always are peering networks

INTERNET2® www.internet.edu

U.S. Exchange Points

PacificWave
PacificWave-North
PacificWave-Bay Area
PacificWave-South

StarLight

AtlanticWave
MANLAN
NGIX-East
AMPATH

— NSF IRNC-sponsored connections
— Other international connections

For further information regarding the international programs of Internet2, visit http://internet2.edu/international or contact Heather Boyles, International Relations Director, international@internet2.edu.
A listing of networks reachable via the Internet2 Network is found on the back of this page.

Asia-Pacific Backbone Topology

APAN/TransPAC2(Affiliated)
GEANT2/TEIN3(Affiliated)
JGN2plus SINET3
AARNet GLORIAD(Affiliated)
Others

As of August 30th 2010

Regional REN Connections

- Connects RENs of individual countries within a geographic region
  - TEIN is a good example
- Some Regional RENs are also Global
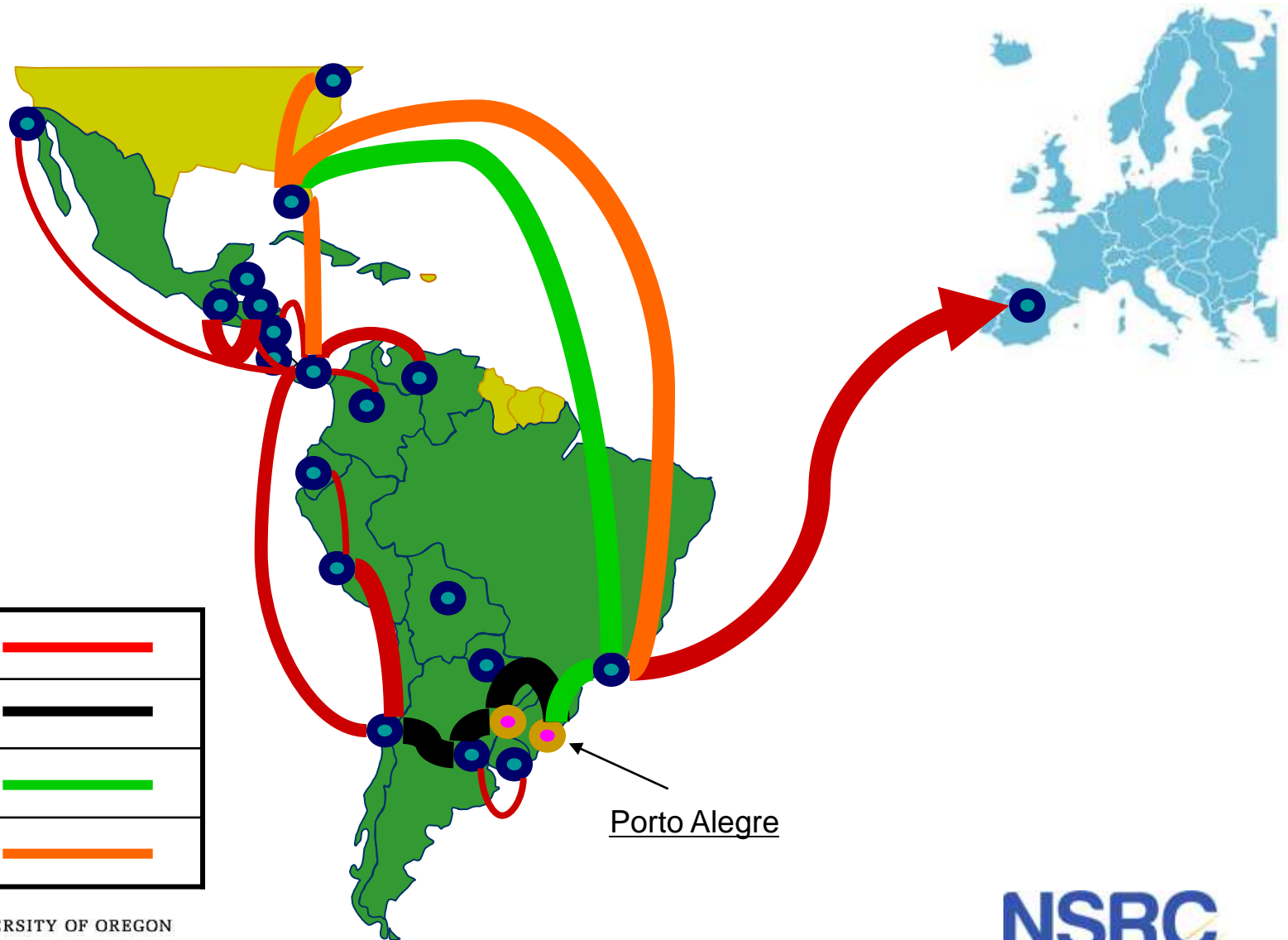 - APAN is a good example

Regional REN Connections

- Most regional networks have funding from European Union
  - EUMedConnect
  - TEIN/TEIN2/TEIN3
  - GEANT
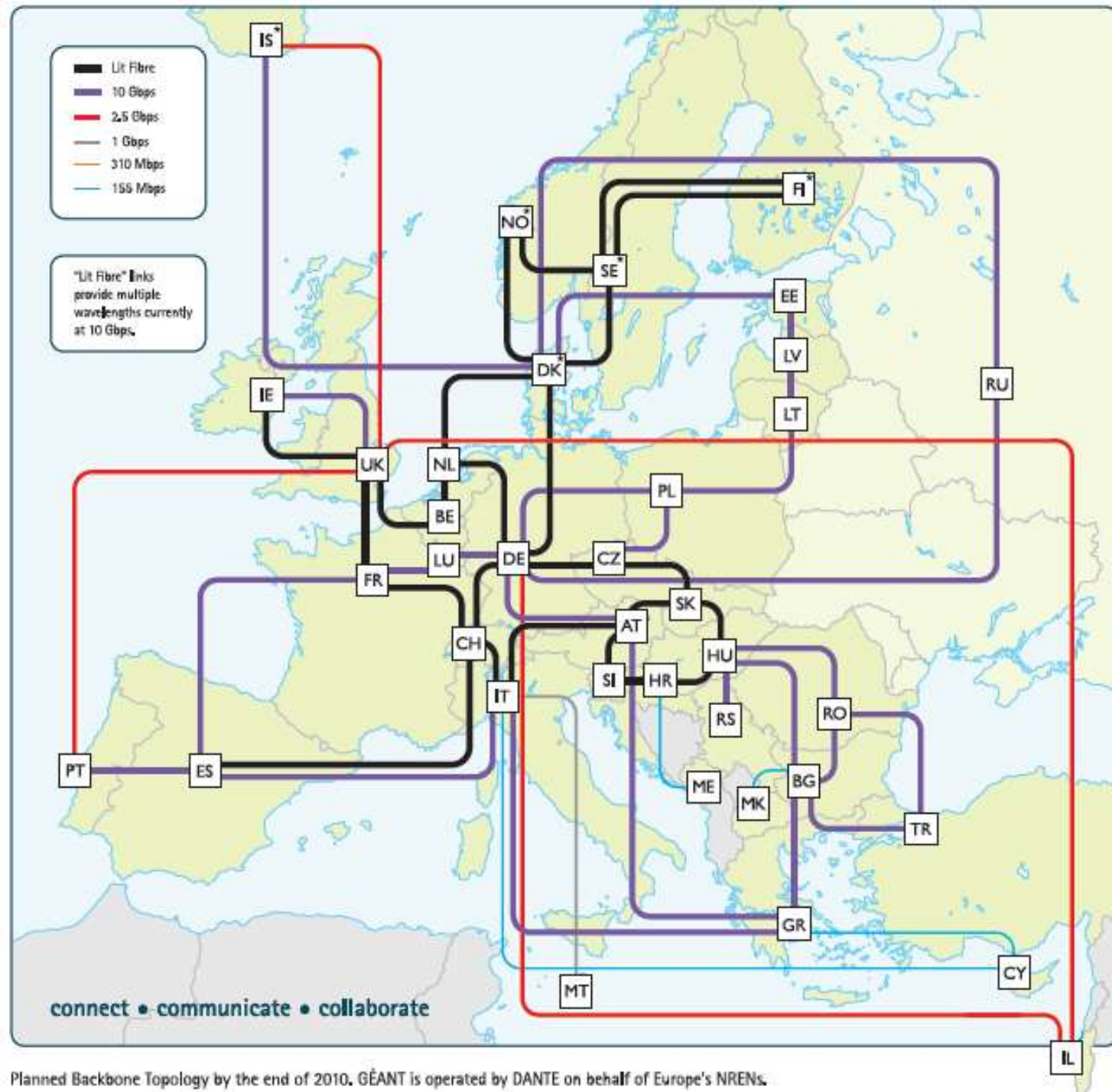 - ALICE/ALICE2 – RedCLARA
  - AfricaConnect/Ubuntunet

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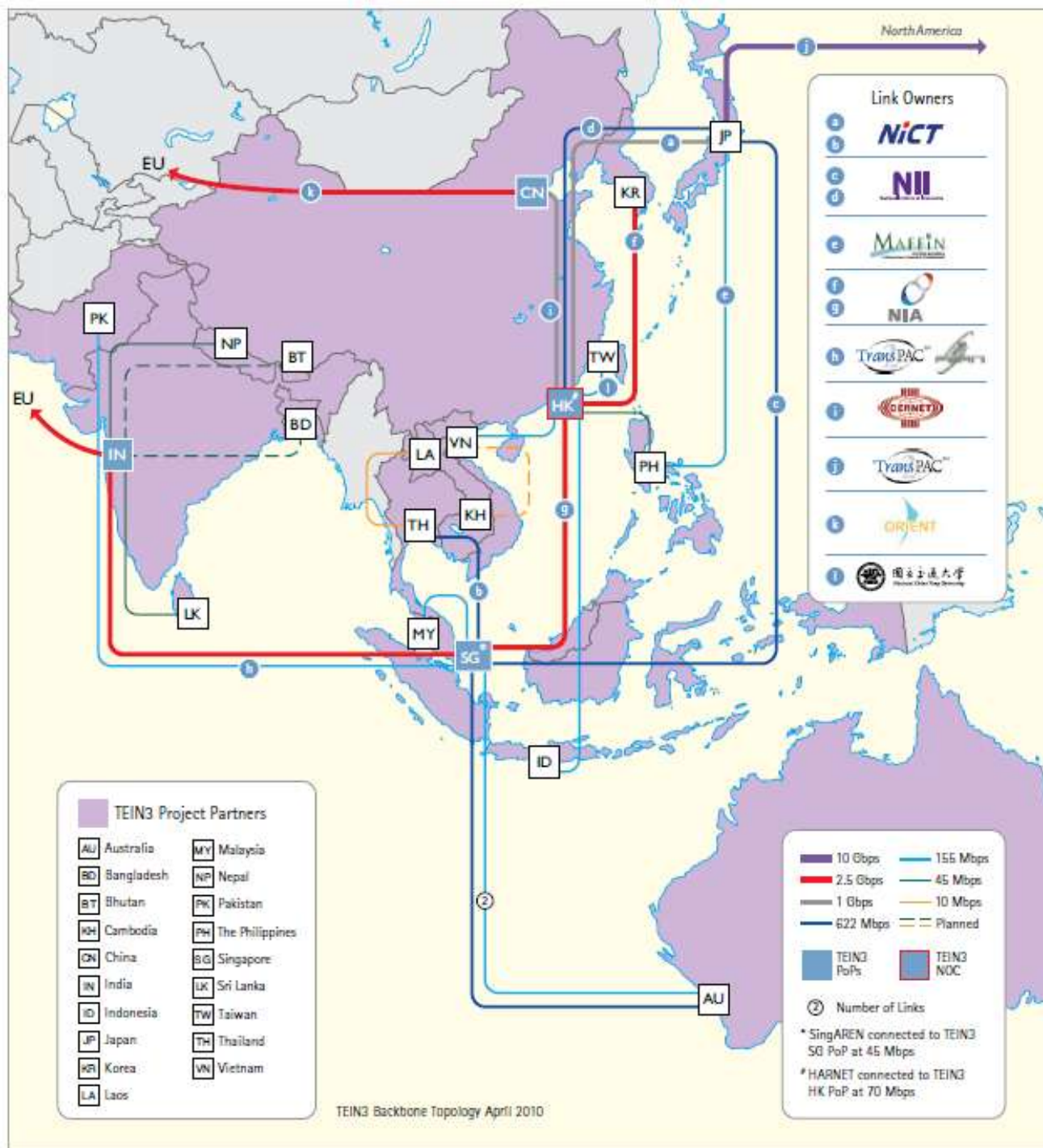
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RedCLARA March 2011

ALICE2	
CLARA	
RNP	
AmLight	

Porto Alegre

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Planned Backbone Topology by the end of 2010. GÉANT is operated by DANTE on behalf of Europe's NRENs.

TEIN3 Backbone Topology April 2010

USA NREN: Internet2

Internet2 Combined Infrastructure Topology
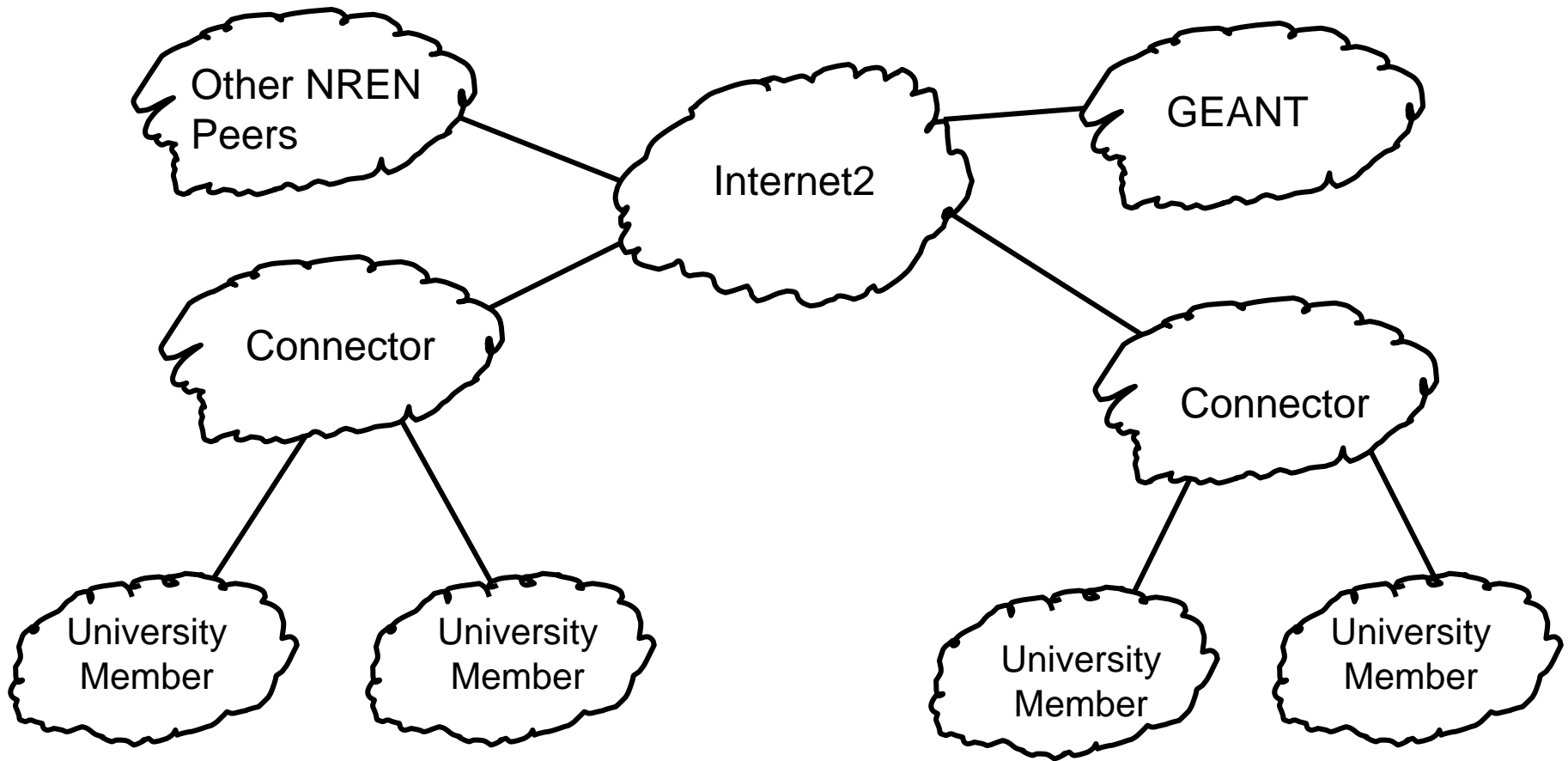Portfolio of network infrastructure and services across the Internet2 footprint

Internet2 Logical Network

The Key to Internet2 is the Connector

- Internet2 doesn't connect individual campus networks
- Internet2 connects to Connector Networks
  – These connector networks provide service typically in one state, some provide connections to multiple states
- The Regional Networks provide connections to campus networks

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USA Connector Networks

- Often they cover a single state
- Each Connector is similar, but different
  - Legal Status
    - Approx 50% are legal non profit
    - Approx 40% are housed at a University
  - Startup Funding
    - Most obtained funding from State Government

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USA Connector Networks

- Staffing
  - Range in size from 1 to 110 employees
  - RONs associated with Universities frequently used University back-office functions

- Network Operations
  - All provided 24x7 monitoring
  - Only half provided staffed 24x7 NOC
  - Over 40% outsource NOC functions
    - ¾ of those who outsourced used University member

USA Regional Networks

- Services
  - All provided IP transport to Internet2
  - Not all provide commodity Internet access
  - Many provide other services
    - Video Conferencing
    - VoIP
    - Business Continuity/disaster recovery services
    - Email hosting
    - Web hosting
    - Data center space

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USA Connector Networks

- Pricing/Cost Recovery
  - State Government funded
  - Member funded
    - Some split costs evenly among members
    - Others had tiered pricing
  - Most who provided "other" services charged specifically for that service
- Customer base
  - Most serve more than Universities

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The Africa Picture (incomplete)
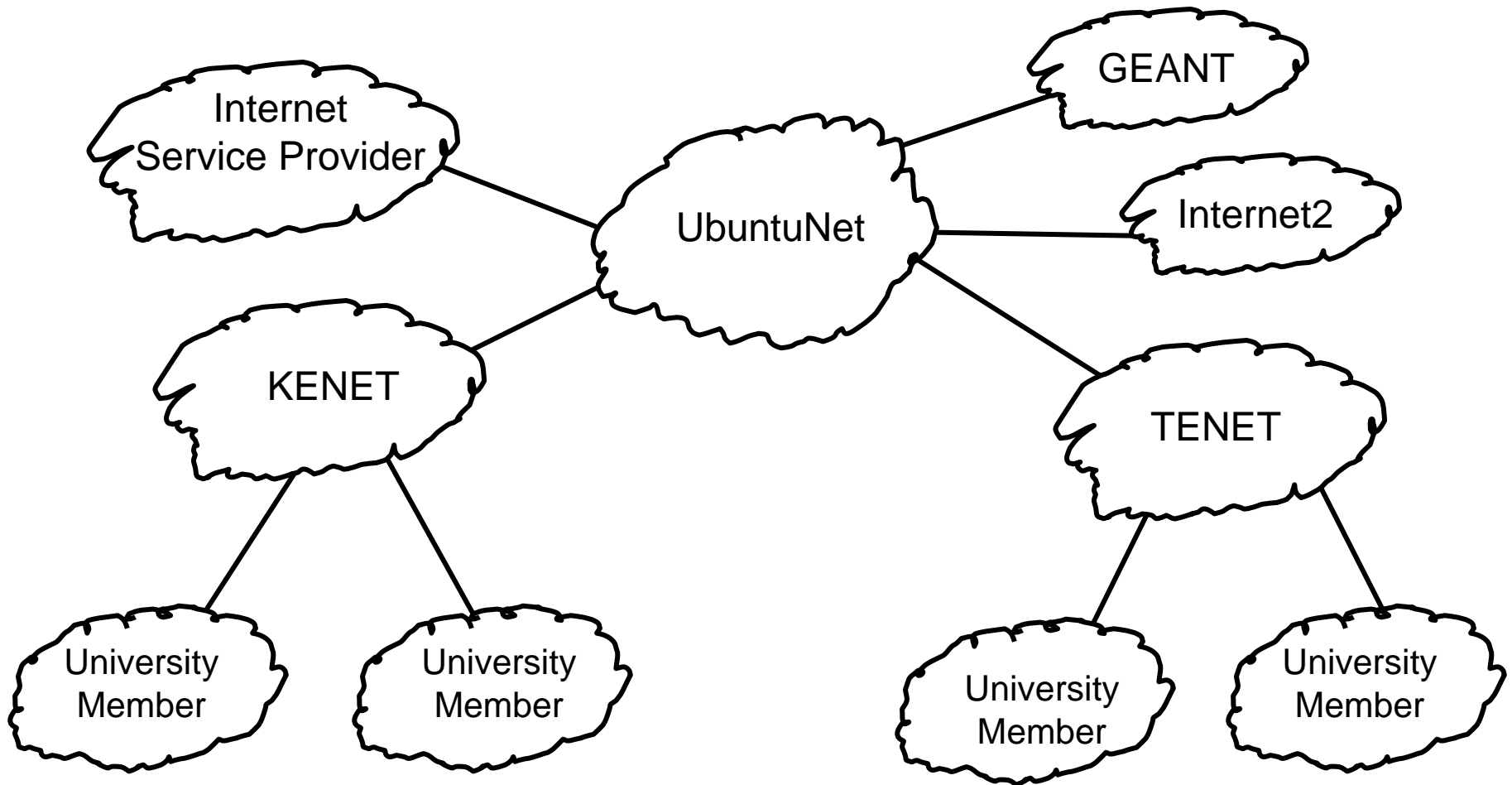
NREN Models of Service

- Two basic models:
  - Peering network
    - Exchange traffic between members
    - Provide international connections (GEANT, etc)
    - Can peer with a local commercial exchange (Google, local ISPs, etc)
  - REN provides all Internet connectivity
    - REN is the ISP
    - In this case, REN also provides peering network

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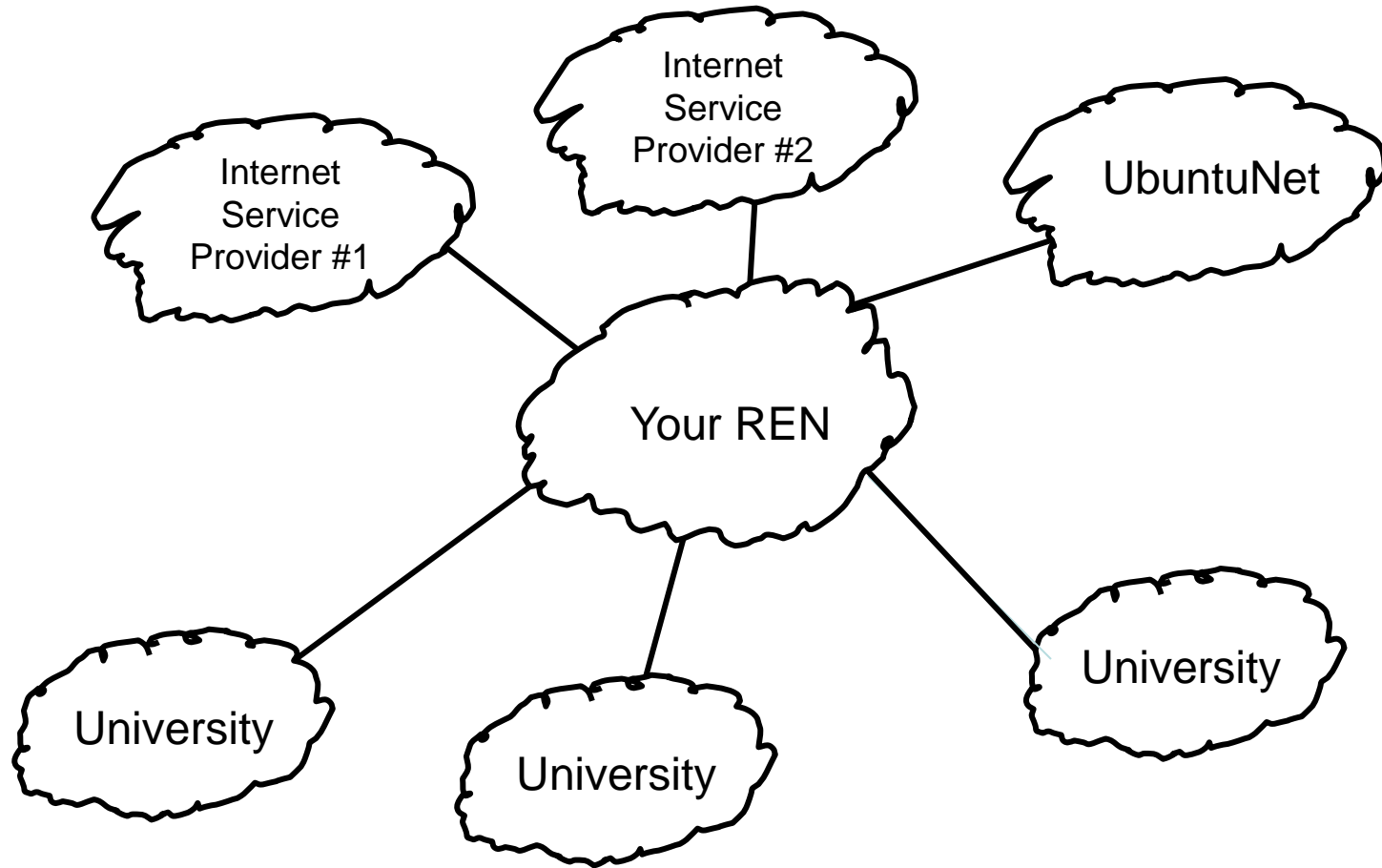Network Startup Resource Center

NREN as Peering Network
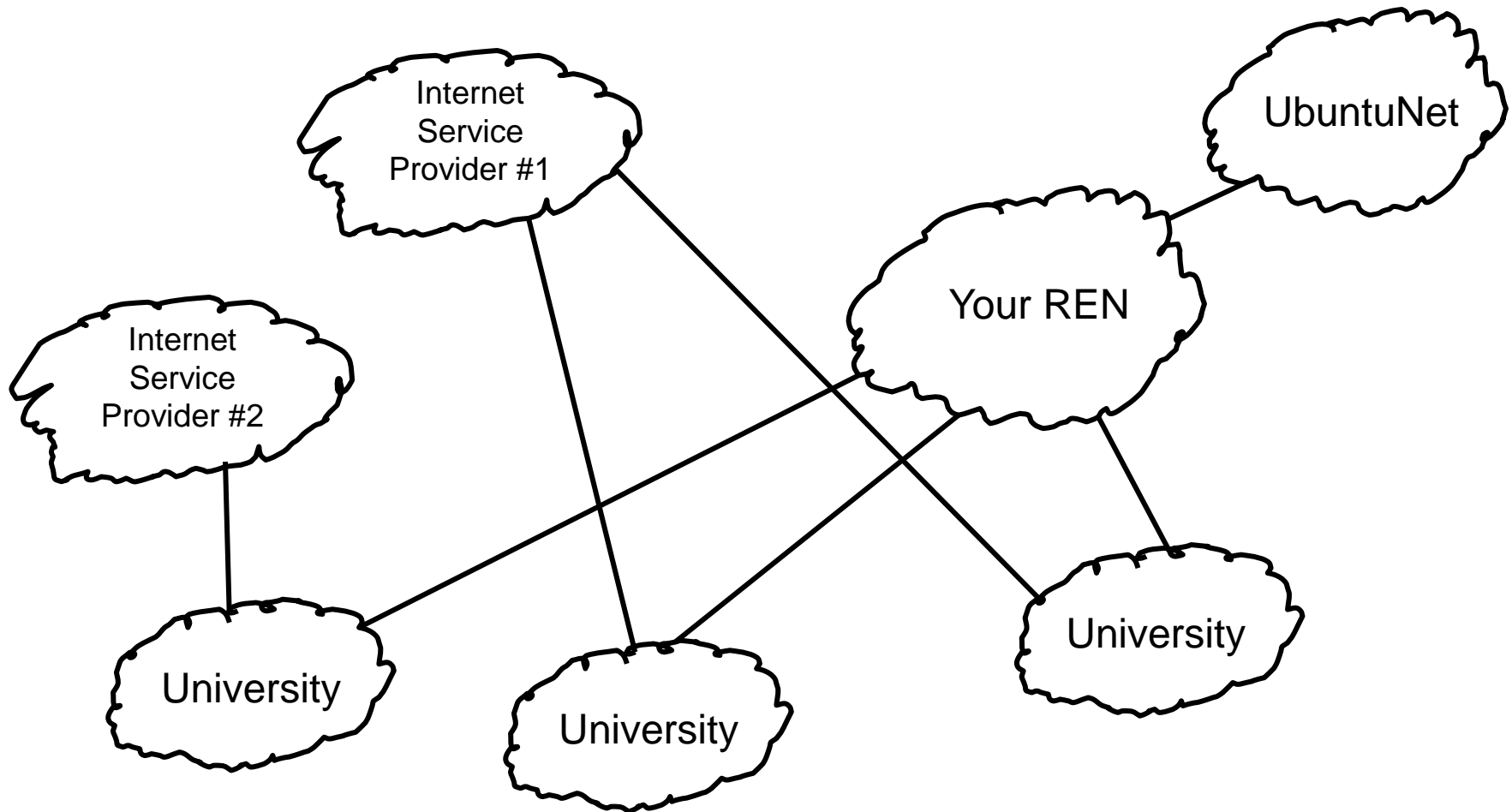
NREN as ISP

Implications for Universities

- If NREN is a Peering Network
  - Each University still has their own ISP
  - 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

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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?

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NRENs Around the World

- Most NRENs act as the Internet Service Provider
- For those that do 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?

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Your REN as Peering Only

- How will each campus manage two connections?

  – Split the campus network into two sections?

  – Get routes from the REN to your NAT box and use NAT translations?

  – Get Autonomous System Number (ASN), Provider Independent IP addresses, and run BGP?

Your REN as an ISP

- This is simple for campuses. The campus just has a default route to your REN.

- What the REN do about a backup connection to improve reliability?

  – If link to the ISP goes down, the campus will lose Internet – Maybe two ISPs?

- What are the politics of having your REN be an ISP?

Questions/Discussion?

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