NSRC

Network Startup Resource Center

The NSRC cultivates collaboration among a community of peers to build and improve a global Internet that benefits all parties. We facilitate the growth of sustainable Internet infrastructure via technical training and engineering assistance to enrich the network of networks.

Our goal is to connect people.

PacNOG 21 – Nuku'alofa, Tonga

December 4, 2017

Outline

- Who we are

- Overview of our work and impact

- Capacity, technology and abilities

- Lessons learned and challenges in the field

- Success stories

- How people can help

NSRC
Network Startup Resource Center

Building international R&E
connections...

Google

NSF

...in more than 120 countries
since 1992

Roots of the NSRC

- Started by Randy Bush and John Klensin in late 1980s and early 1990s
- First email systems (FidoNet and/or UUCP) in many countries
- First NSF grant formalized the NSRC in 1992 via MIT
- Operated from University of Oregon beginning in 1996
- Helped establish first Internet connections for
  - Peru, South Africa, Egypt, **Indonesia**, Kenya, Liberia, Morocco, Saudi Arabia, **Sri Lanka**, Tanzania, Togo, and assistance to many others
- Development of Internet Exchange Points
  - Panama, Uganda, Democratic Republic of Congo, Swaziland, Ghana, Angola, Kenya, Haiti, Côte d'Ivoire, Tanzania, Thailand (2), **Vanuatu** and others

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O | UNIVERSITY OF OREGON

Who is the NSRC
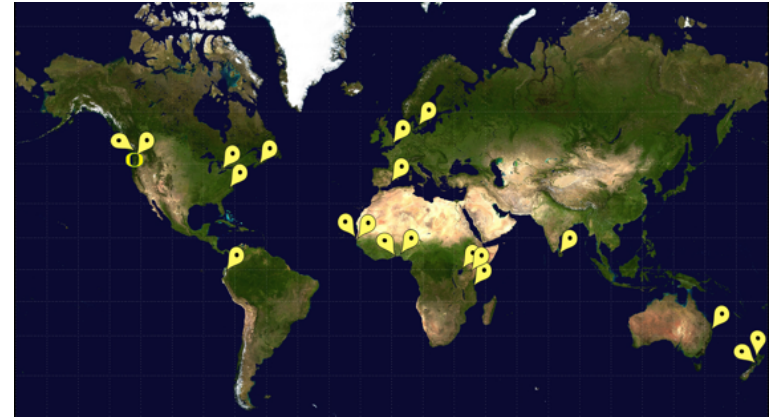
- Six University of Oregon personnel and several students based in Eugene, Oregon (Northwest United States)

- Twenty+ contractors based in: **Auckland**, Banjul, **Brisbane**, Colombo, Copenhagen, Dakar, Halifax, Ibadan, Kampala, Lomé, London, Quito, Seattle, Toronto, Vancouver, **Wellington**

- Dozens of long-time volunteers who work for various universities and industry

- Instructor-trainees in all regions of the world

- Core funding from NSF and Google with in-kind donations from Facebook, Cisco, ICANN, O'Reilly Media, DHL and others.

NSRC On the Ground 2011-2017…

…86 countries

American Samoa	Gambia	Malaysia	Saudi Arabia
Argentina	Ghana	Mali	Senegal
Armenia	Guam	Mexico	Singapore
Bangladesh	Guatemala	Micronesia	Solomon Islands
Benin	Haiti	Mongolia	Sri Lanka
Bhutan	Honduras	Morocco	South Africa
Bolivia	India	Mozambique	Swaziland
Botswana	Indonesia	Myanmar	Tanzania
Brazil	Ireland	Nauru	Tahiti & French Polynesia
Burkina Faso	Italy	Nepal	Thailand
Cambodia	Japan	Netherlands Antilles	Togo
Canada	Jordan	New Caledonia	Tonga
China	Kazakhstan	New Zealand	Trinidad & Tobago
Costa Rica	Kyrgyzstan	Nicaragua	Tunisia
Czech Republic	Kenya	Nigeria	Turkey
Denmark	Korea	Panama	UAE
Djibouti	Laos	Peru	Uganda
Ecuador	Lebanon	Philippines	USA
England	Lesotho	Portugal	Vanuatu
Fiji	Madagascar	Rwanda	Vietnam
Georgia	Malawi	Samoa	Zambia
Germany			Zimbabwe

During 2016 NSRC worked in 29 countries at 39 locations during 65 events training and assisting over 2,100 people:

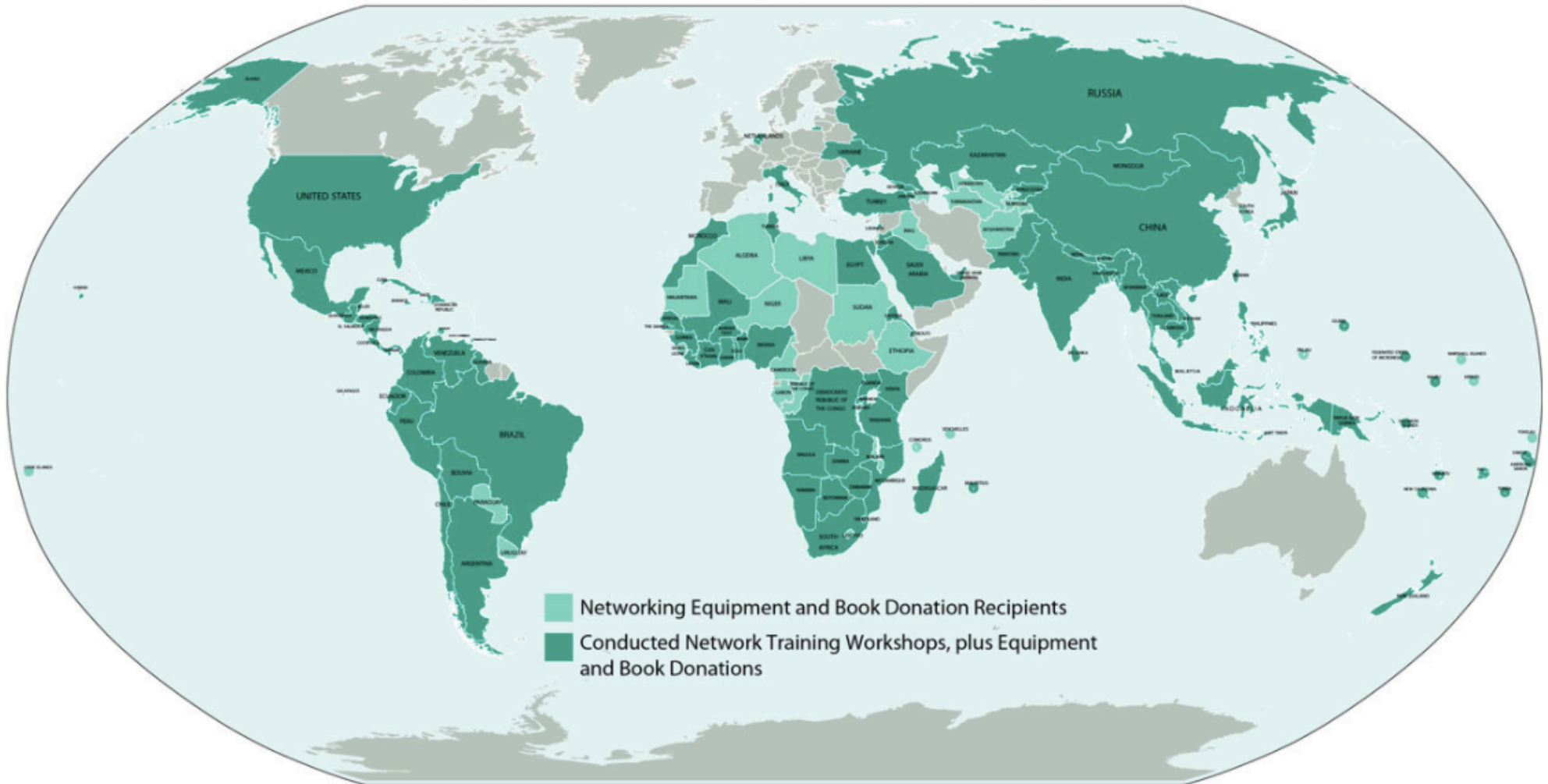|	Africa	AsiaPac	LA-Carib	NorthAm	Mid-East	Total
Men	371	1113	84	29	105	**1702**
Women	149	226	23	19	16	**433**

- Facilitated donations of over a ton of network equipment and books worth $280,000 to universities, research institutes, libraries and emerging NRENs
- 8 direct engineering assistance activities to improve campus network infrastructure, R&E networks and Internet Exchange Points in Africa and Asia-Pacific.
- Arranged for over $80,00 in fellowship funding to support over 40 network technicians from Africa, Asia/Pacific and Latin America to attend networking events and science meetings for collaboration with U.S and European counterparts

Worked with RENs to provide direct assistance and training:

APAN	BDREN	DOS-ASTI	LEARN	PREGINET	RwEdNet	UbuntuNet
APNIC	CamREN	DrukREN	LERNET	REANNZ	snRER	VinaREN
ASREN	CENIC	Erdemnet	mmREN	RENU	TEIN	WACREN
AfREN	CEPES	GÉANT	MyREN	RedCLARA	TERNET	
AfTLD	CERNET	Internet2	PERN	RedUniv	ThaiREN	

Network Startup Resource Center (NSRC)
University of Oregon
Internet Infrastructure Development and Technical Assistance

Networking Equipment and Book Donation Recipients

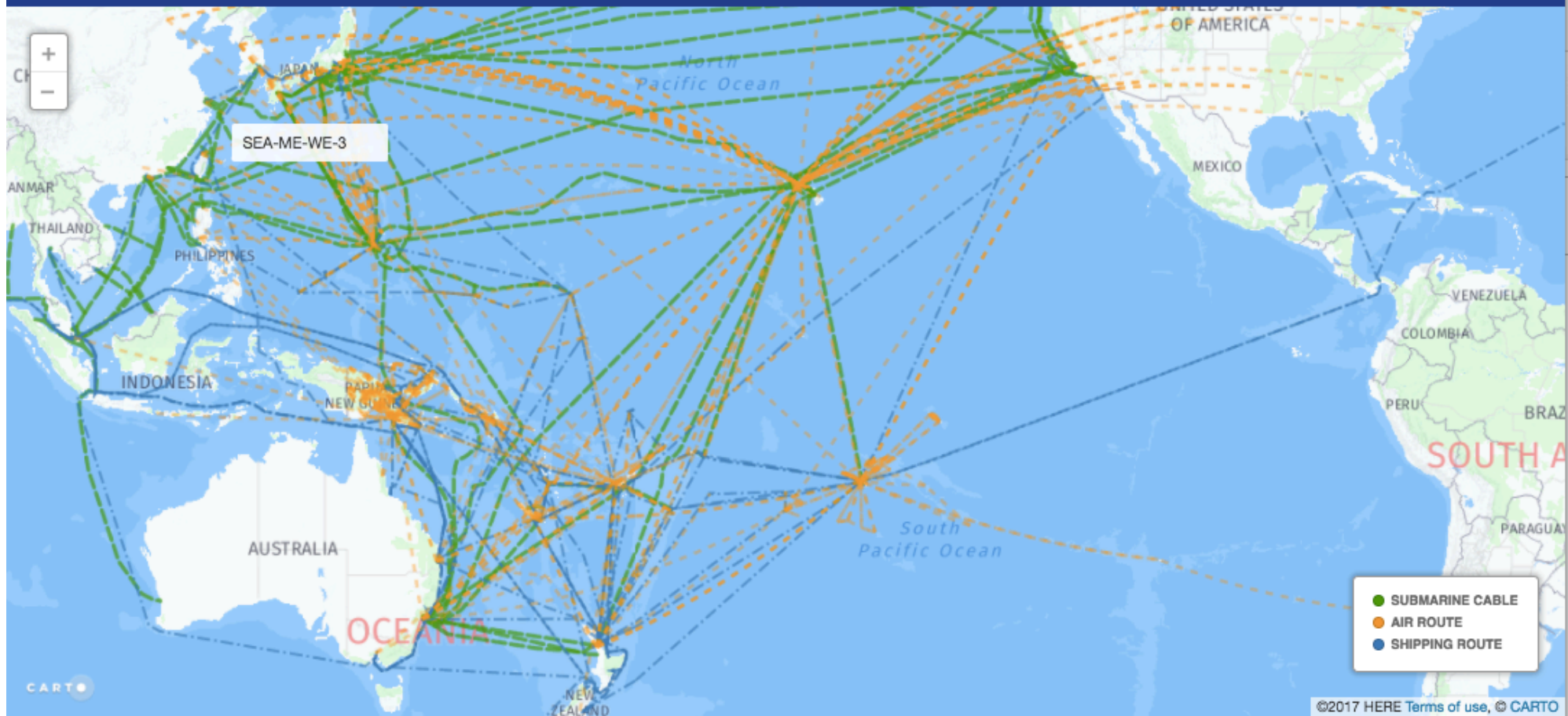Conducted Network Training Workshops, plus Equipment and Book Donations

*From 1992 to March 2017, the NSRC has facilitated the distribution of more than 650 tons of network equipment and technical reference books to engineering and computer science departments, university libraries, teaching hospitals, research facilities, non-governmental organizations (NGOs), and Internet training facilities in more than 120 countries around the world. Contributing sponsors and supporters are acknowledged at https://nsrc.org/supporters.

Recent / Upcoming Pacific Region Activities

- PacNOG 19, Fiji
- U of Guam / Mariana Islands Campus Network Design Workshop and Engineering Assistance, Mangilao, Guam
- Internet2 Tech Exchange Fellowships
- IDREN site visit
- BKNIX Peering Forum, Bangkok, Thailand
- 2nd DEA / DTN Setup, Univ. of Guam, Guam
- Wireless DEA, TakNET/AIT, Thailand
- Direct Engineering Assistance, USP, Suva, Fiji
- PacNOG 21, Tonga (UoG Co-Trainer)
- PTC planning meetings, Hawaii
- Co-Training with UoG Engineers, APRICOT 2018, Nepal
- Continued coordination with Pac-REN/PIREN and University of Hawaii, AARNET and others around Pacific R&E and Fiber optic cable projects.
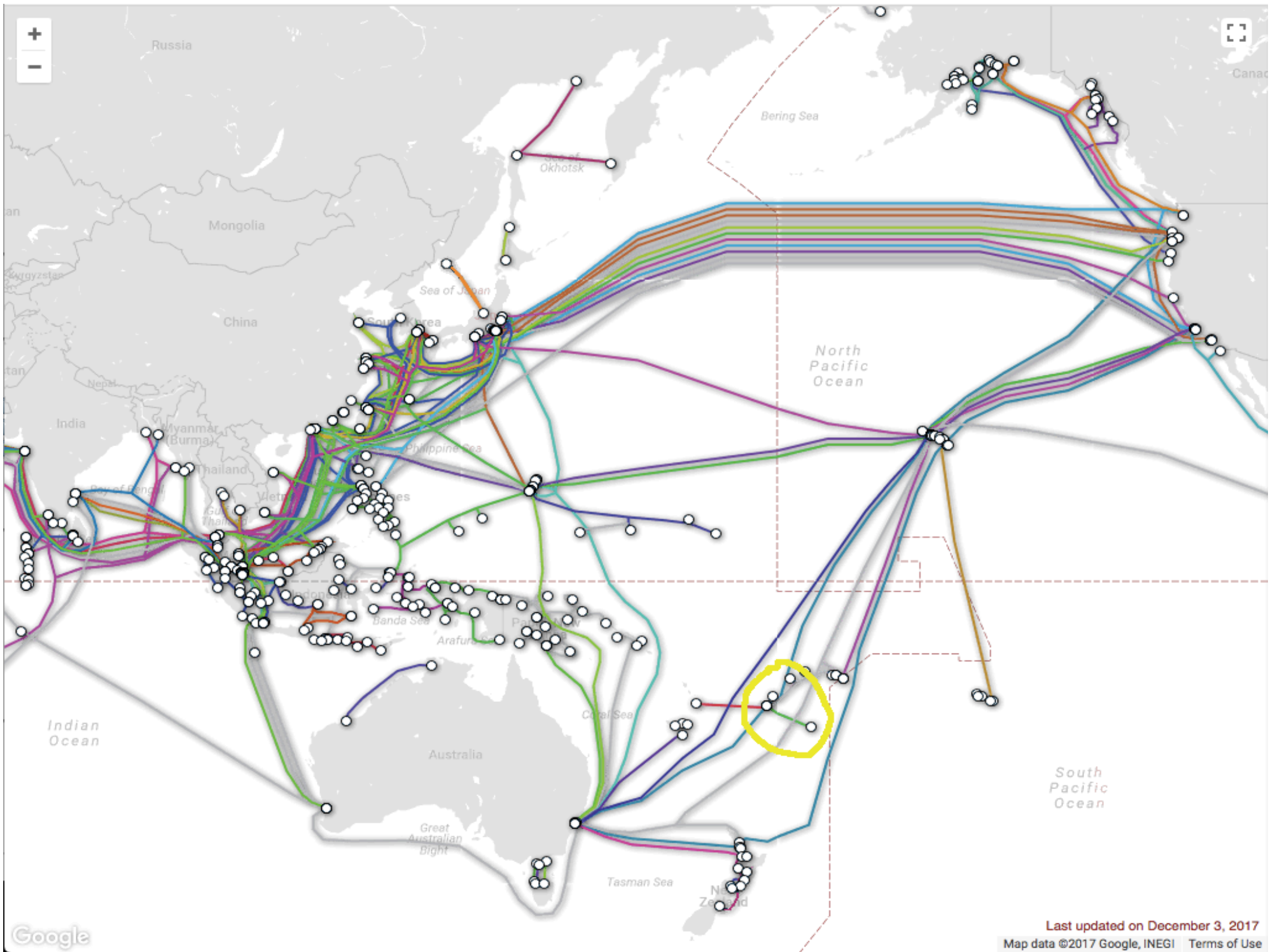
A Peering Strategy for the Pacific Islands

SEA-ME-WE-3

Legend:
- SUBMARINE CABLE
- AIR ROUTE
- SHIPPING ROUTE

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This site reviews the telecommunications environment of the Pacific Islands. It looks at each community's connectivity to the world: telecommunications, sea freight, air routes, and trade. It provides real-time statistics on provider market share. It considers the complexity of island telecommunications through the mythical nation of Avaiki. Over time it will be expanded to include data on carrier interconnections and performance to each market's major trading partners.

isif⚙asia (::) APNIC NSRC
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Tonga

Legend:
- SUBMARINE CABLE
- AIR ROUTE
- SHIPPING ROUTE

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Pacific Islands Research and Education Network

The University of Hawaii's Pacific Islands Research and Education Network is in place for the following:

Welcome

The Pacific Rim Application and Grid Middleware Assembly (PRAGMA) is a community of practice comprising individuals and institutions from around the Pacific Rim that actively collaborate with, and enable, small- to medium-sized groups to solve their problems with information technology. Key to PRAGMA's success is the active involvement of participants in scientific expeditions, technology development, student engagement, and outreach to new communities.

Attending our workshops is an ideal way to become familiar with what PRAGMA does, and how we interact as a community of trust. We invite you, your students and colleagues to explore this site, visit our partner sites, and attend future workshops (which do not carry a registration fee). We look forward to seeing you there!

Scientific Expeditions

PRAGMA forges collaborative, multidisciplinary teams to address scientific questions of high societal impact. These questions define and drive PRAGMA's technology development efforts. There are three current expeditions:

- Biodiversity: Understanding adaption in extreme environments.
- Limnology: Predicting impact of eutrophication on lake ecosystem services.
- ENT: Creating and utilizing an Experimental software-defined Network Testbed.

About

The Pacific Rim Application and Grid Middleware Assembly (PRAGMA) is **an international, distributed** community of practice for technology and approaches that supports the long tail of science, namely enabling small- to medium-sized international groups, to make rapid progress in conducting research and education by providing and developing international, experimental cyberinfrastructure.

Quick Links

» PRAGMA Overview
» Benefits
» Participants
» Leadership
» Sponsors
» Contacts
» Testbed Status

Upcoming Events

» PRAGMA 33
October 16-17, 2017
The University of Queensland, Brisbane, Australia

» eResearch 2017
October 16-20, 2017
The University of Queensland, Brisbane, Australia

» HPC Asia 2018
January 29-31, 2018
Tokyo, Japan

» PRAGMA 34
May 9-12, 2018
Akihabara, Tokyo, Japan

The NSRC Model

- Technical training and human resource development activities

- Direct engineering assistance (DEA)

- Participatory development (request-driven)

- Local hands cultivating local expertise (scaling)

Enabling International R&E Cooperation

- NSRC exemplifies the **NSF's stated strategic goal** of "encouraging collaborative research and education across organizations, disciplines, sectors, and international boundaries."

- Through **coordinated training programs**, NSRC builds institutional capacity to support the research community, and leverages U.S. research infrastructure to bring value to international researchers and educators.

- Through **hands-on, lab-based curricula and a train-the-trainers** approach, NSRC provides technical capacity development to thousands of network engineers working in hundreds of R&E institutions to augment networking expertise in regions of interest to NSF and the International Research Network Connections (IRNC) community.

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Enabling International R&E Cooperation

- Shared cyberinfrastructure enables scientific collaborations between U.S. scientists and international institutions
- Addresses and solves problems in the field with local partners
- Cultivates a culture of network operators helping each other
- Technical training with Universities, NRENs and regional NOGs
- Direct engineering assistance to physically improve networks
- Network security and performance monitoring
- Wireless infrastructure to improve both faculty and student access
- Assists with creation of Internet Exchange Points
- Leverages government, industry, and private investments
- Equipment donations improve core infrastructure and IP services

Challenges in the Field

Infrastructure and Regulatory Issues

- Lack of affordable bandwidth and competition for service providers
- Lack of stability/downtime on the local network
- Challenges with navigating Internet administrative processes
- Network security issues
- Reliable power and infrastructure issues
- Lack of terrestrial fiber
- High costs of telecommunications and networking equipment, exacerbated by high rates of importation duty, taxes and value-added tax (VAT) assessed to import hardware
- Difficult regulatory environments and regulatory barriers
- Poorly structured campus networks

Challenges in the Field

Human, Financial and Issues of Cooperation

- Lack of critical mass of well-trained network engineers

- *Staff retention once engineers are trained*

- Viable business models in rural areas

- Excessive dependence on external funding sources

- Lack of sustainable funding models for operational expenses and lack of well-structured R&E governance models

- Lack of national and/or regional cooperation

- Many countries need stronger national leadership to drive open access Internet policies and policies supporting R&E

Lessons

- Never, ever assume anything

- Prepare to be surprised

- What looks bad may just be miscommunication

- Don't do, but rather show and let someone local do to cultivate local hands for local expertise

- Respond to requests vs. acting alone

- Be respectful at all times
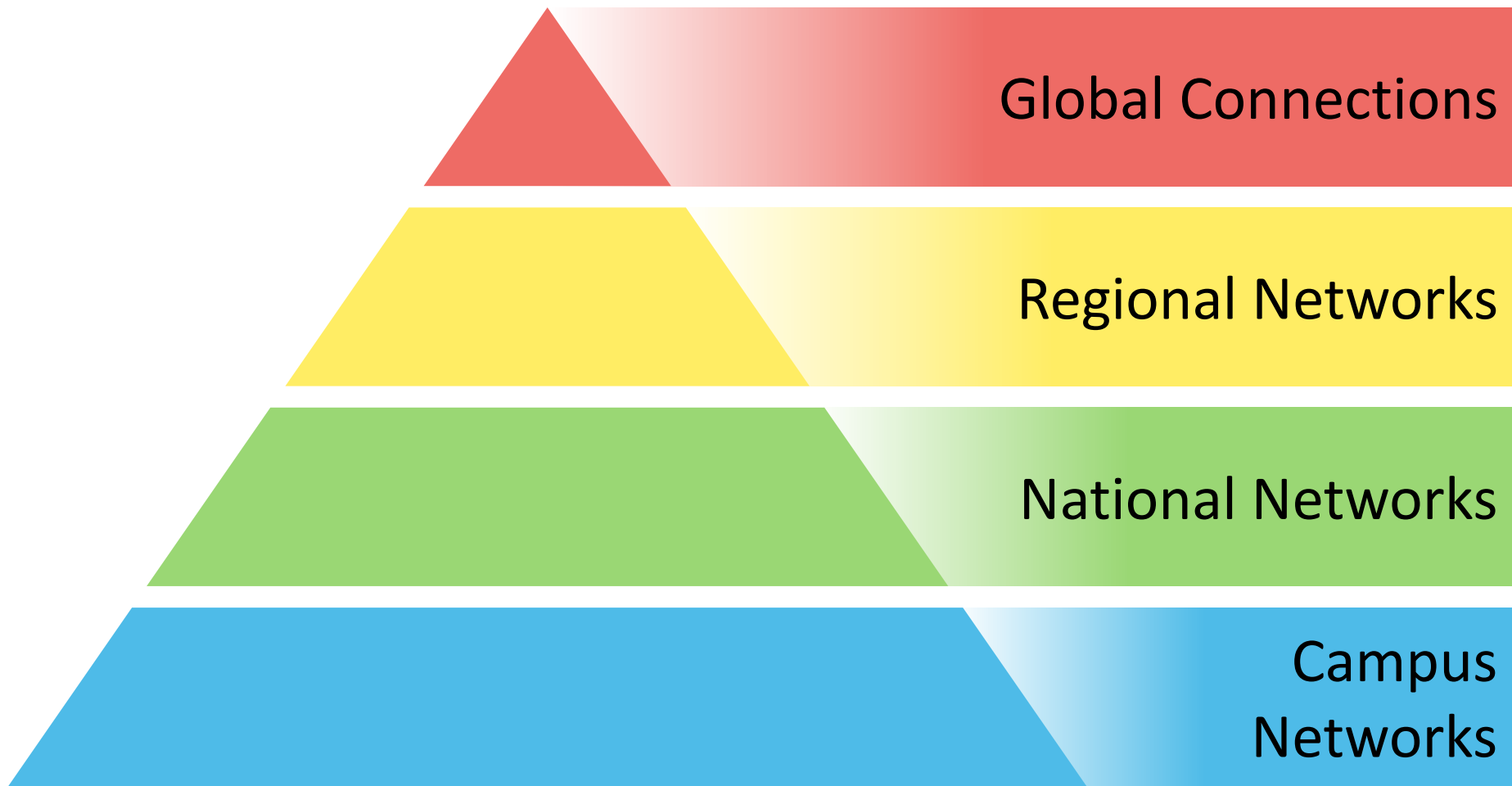
We Focus on RENs

- Network is the enabler for science
- The campus network is the foundation for research and education activities

- To optimally utilize network capacity, equipment and personnel
- No scientist is connected directly to a national R&E network. They are all connected to campus or enterprise networks for access.
- But, we work on all levels as well:
  - IXPs
  - Peering
  - Government regulations
  - NRENs and RRENs
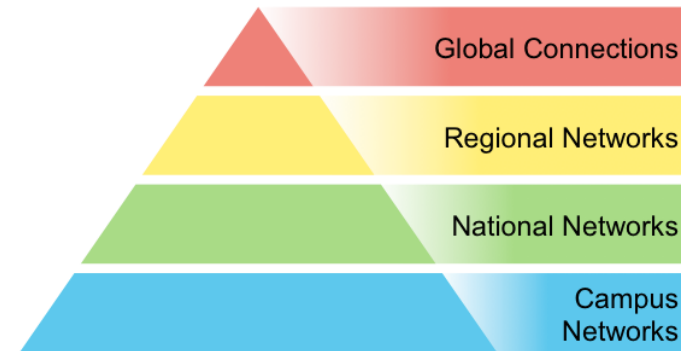
Why campus networks?

- Global connectivity options are changing and have changed dramatically.

- Connectivity is now within reach, but many campus networks are not ready.

- Until these networks are properly designed and implemented global collaboration, research and education can be hampered.
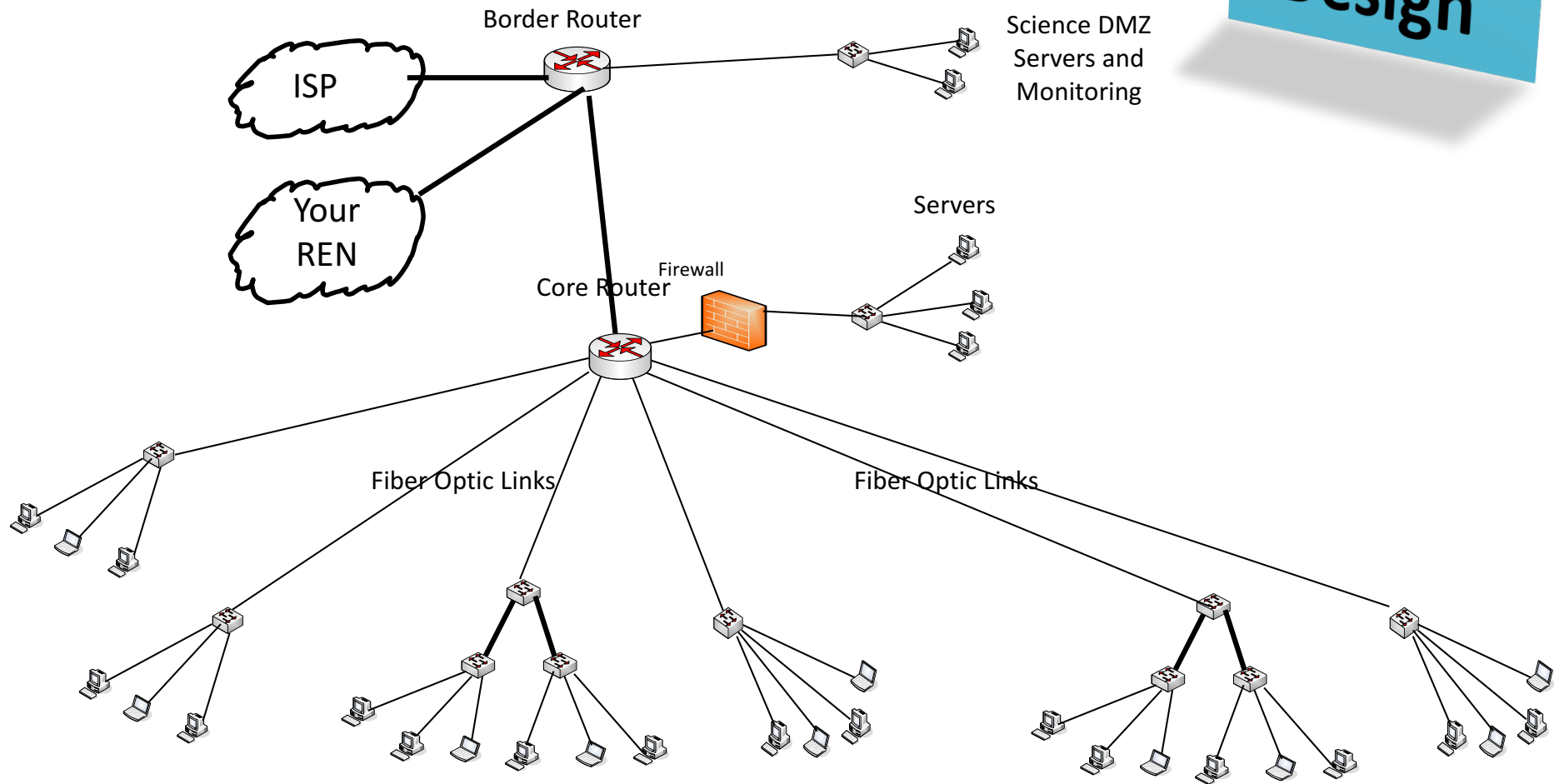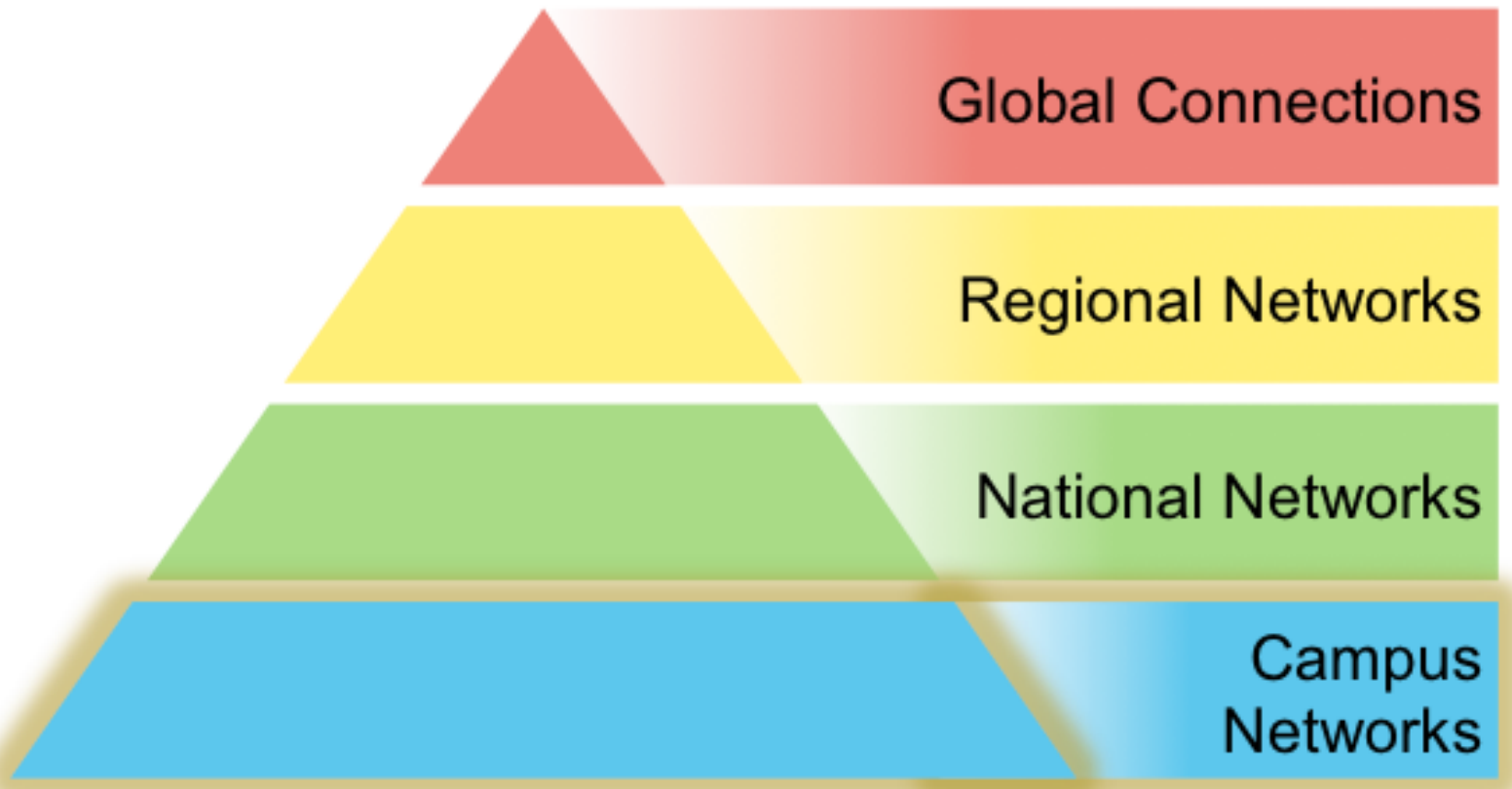
For example…

Poorly designed (campus) network…

Campus Network Design

router

REN
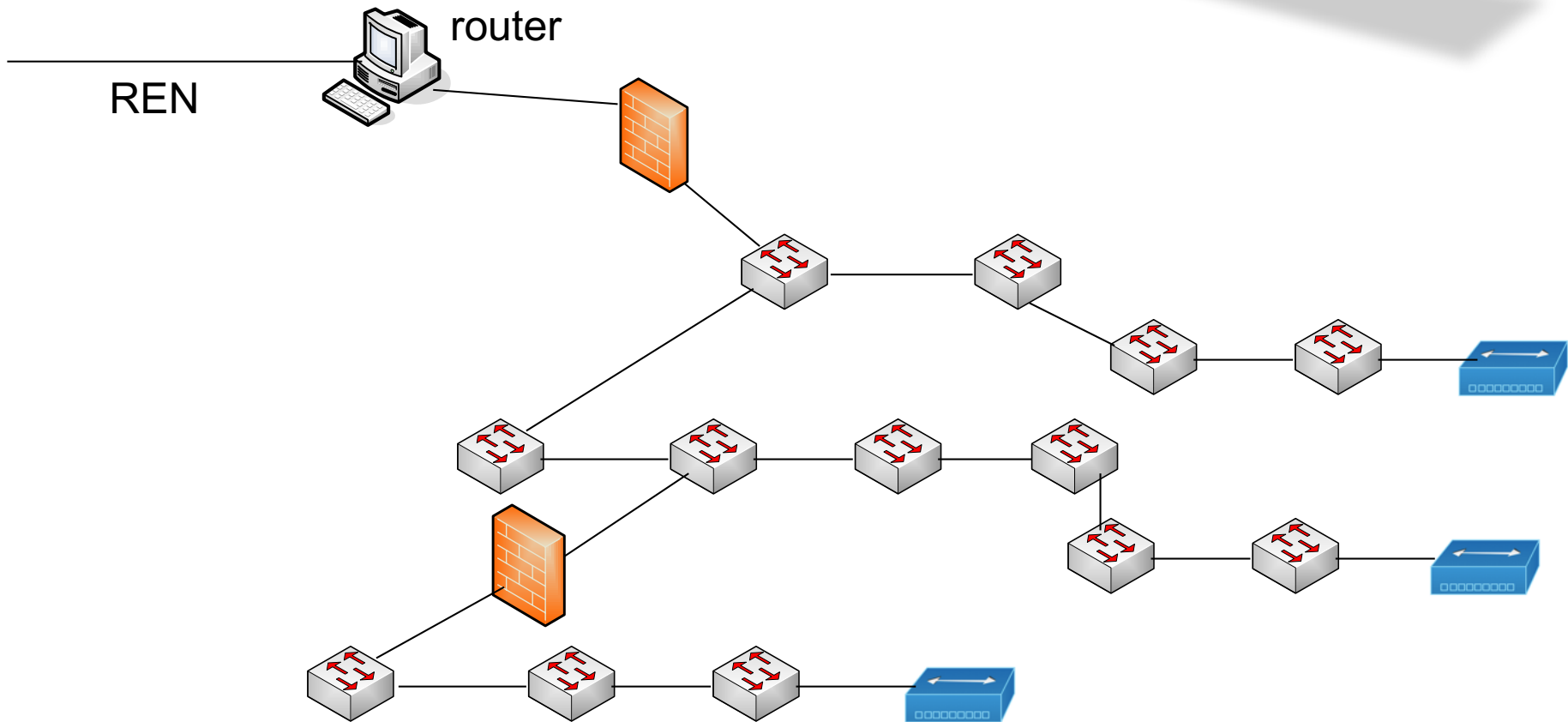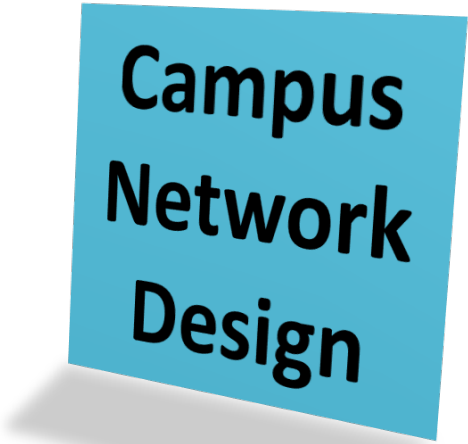
Reasonably designed (campus) network…

Campus Network Design

Border Router

ISP

Your REN

Science DMZ Servers and Monitoring

Servers

Firewall

Core Router

Fiber Optic Links

Fiber Optic Links

…with increased speeds comes increased necessity for properly designed networks

Evolving Technologies

…a few other areas we work with

- perfSONAR, data transfer nodes

  and

- Software Defined Networks (SDN)
- TV White Spaces (TVWS)
- Wireless Sensor Networks (WSN)
- Internet of Things (IoT)

NSRC has worked in all of these areas

Scaling our Effectiveness

- Virtual Training Platform (VTP)

- Materials Development Platform (MDP)

- Online training videos (learn.nsrc.org)

- train-the-trainer activities

- Partners (NRENs, industry, other orgs)

- Volunteers

VTP and MDP

VTP: Virtual Training Platform

- Single, portable computer to support entire workshops

- Leverage use of participant laptops to reduce cost

- Runs entire network, servers and back-end infrastructure (DHCP, DNS, WiFi, Web) in compact form using virtualization.

- Example: Intel NUC 32 GB RAM, 512 GB SSD (M.2 NVMe), i7 4 core CPU

MDP: Materials Development Platform

- Push-button deployment of workshop topics

- Presented as entire workshops, or topics grouped modularly

- Deploys in conjunction with VTP, or not. Back-end store is Git.

- https://mdp.nsrc.org/

- Shareable content https://nsrc.org/activities/outlines/

Train the Trainer and DEA

TtT: Train the Trainer

- Targeted training of local network engineers with backing of their organization to train others.

- NSRC provides pedagogical training and practice as well as Virtual Training Platforms.

- Local engineers can use NSRC tools to provide local, hands-on technical training to build capacity.

- This model has seen over 40 workshops completed in the past 3 years in Africa alone.

DEA: Direct Engineering Assistance

- Work with local engineers to improve, build and optimize networks (L1/L2/L3, monitoring, security, services)

- NSRC facilitates hardware donations as needed for DEA

- Follow-on activity to workshops with engineers in attendance

learn.nsrc.org
Esnet and NSRC Partnership

ESnet engineers and NSRC staff filmed and created 45+ informational and training videos on perfSONAR and Science DMZ concepts.

perfSONAR

- Each video is 3-5 minutes in length, includes copy/paste text of relevant commands and shows step-by-step details on perfSONAR configuration, or...

- ...overall conceptual ideas leading to step-by-step configuration of perfSONAR.

- Updated for perfSONAR version 4 release.

- perfSONAR nodes deployed by RENU using videos and email support

ScienceDMZ

- 3-5 minute videos describing in detail Science DMZ concepts.

- Diagrams and demonstrations are included.

Available at https://learn.nsrc.org/

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learn.nsrc.org
GÉANT, RedCLARA, REFEDS and Others

ESnet engineers and NSRC staff filmed and created 45+ informational and training videos on perfSONAR and Science DMZ concepts.

Federated Identity Management

- Value proposition of Federated Identity Management systems.
- Conceptual overview of EduROAM
- Available with Spanish subtitles
- Multiple planning documents are linked

Coming Soon – *BGP for All*

- Comprehensive video series centered around BGP for campuses and RENs
- Multiple related topis... Close to 100 videos.

Available at https://learn.nsrc.org/

learn.nsrc.org:

- ✓ **ScienceDMZ**
- ✓ **perfSONAR**
- ✓ **FedIDM**
- ✓ **BGP** (*coming soon*)

Science DMZ

The Science DMZ is a portion of the network, built at or near the campus or laboratory's local network perimeter that is designed such that the equipment, configuration, and security policies are optimized for high-performance scientific applications rather than for general-purpose business systems or "enterprise" computing.

Developed by ESnet engineers, the Science DMZ model addresses common network performance problems encountered at research institutions by creating an environment that is tailored to the needs of high performance science applications, including high-volume

Background and Structure

- ❱ Science DMZ Overview
- ❱ Science DMZ Examples
- ❱ Science DMZ Security

Specific Designs

- ❱ Minimal Science DMZ
- ❱ Multiple Science DMZs
- ❱ DMZ Multiple Data Transfer Nodes
- ❱ Science DMZ in a Supercomputer Center Network
- ❱ Science DMZ Big Data Site

Techniques and Technology

- ❱ Science DMZ TCP Performance
- ❱ perfSONAR in the Science DMZ
- ❱ Science DMZ Firewall Limits
- ❱ Science DMZ Backplane Limits
- ❱ Science DMZ for Software Defined Networks
- ❱ Science DMZ Data Transfer Nodes versus Enterprise Security
- ❱ Science DMZ as A Customer

ESnet
FASTERDATA KNOWLEDGEBASE

BERKELEY LAB

U.S. DEPARTMENT OF
ENERGY
Office of Science

perfS◉NAR

perfSONAR is a tool for end-to-end monitoring and troubleshooting of multi-domain network performance. perfSONAR provides network engineers with the ability to test and measure network performance, as well as to archive data in order to pinpoint and solve service problems that may span multiple networks and international boundaries. perfSONAR is currently deployed in over 1,700 locations around the world, and is extremely valuable when doing network troubleshooting. perfSONAR has been developed through an international collaboration led by ESnet, GÉANT, Indiana University, and Internet2. You can visit the perfSONAR website by clicking here.

To learn more about the capabilities of perfSONAR and its features,

Updated for Version 4

Intro & Installation

- ❯ What is perfSONAR?
- ❯ perfSONAR Deployment Plan
- ❯ How to Select Hardware for perfSONAR
- ❯ Install perfSONAR NEW
- ❯ How to Secure a perfSONAR node
- ❯ Interpreting Performance Behind Firewalls
- ❯ Understanding TCP Buffer-Size

Configuration

- ❯ How to Configure the Toolkit
- ❯ How to Configure Enabled Services
- ❯ How to Configure NTP Services NEW
- ❯ How to Configure Testing Policies
- ❯ How to Find Other perfSONAR Nodes NEW

Regular Testing

- ❯ Configure perfSONAR Tests NEW
- ❯ perfSONAR Graphing Tools NEW

Using Metrics

- ❯ Metrics Traceroute
- ❯ Metrics Delay
- ❯ Metrics Jitter
- ❯ Metrics Throughput

Network Measurements

- ❯ pScheduler NEW in pS4.0
- ❯ BWPing
- ❯ BWCTL
- ❯ TCP Buffer-Size
- ❯ BW Traceroute

Using MaDDash

- ❯ MaDDash Overview
- ❯ MaDDash Configuration File
- ❯ Install MaDDash
- ❯ Install MaDDash Mesh Configuration
- ❯ Configuring Test Hosts with MaDDash

Federated Identity Management

The process of establishing identity management systems, joining federations, and sharing resources presents many challenges and opportunities to institutions and organizations. From improving campus network security to offering resources on a global scale to students and faculty, the value of a well-designed identity management system is significant.

This series of video sessions will take you through the policies and technologies of identity management at a local level, with further discussion on how identity federations build on and are of value to campus identity systems, and how to manage the risks involved. These FedIdM materials

Campus Identity

- ❯ eduroam and Identity Services
- ❯ Introduction to Identity on Campus
- ❯ Identity and the Campus Network
- ❯ Identity and Cloud Services
- ❯ Defining Users

Federated Identity

- ❯ Introduction to Identity Federations
- ❯ Identity and Access Management for Researchers
- ❯ Identity Federation for Service Providers

Identity and Business Models

- ❯ Value Proposition and Business Models
- ❯ Risk Management and Identity

Federated Identity Management Training Partners

Some NSRC Partners

- Asi@Connect TEIN4
  - http://www.tein.asia/tein4/index.do
- GÉANT
  - https://www.geant.org/
- Pacific Network Operators Group
  - https://www.pacnog.org/
- UbuntuNet Alliance
  - https://www.ubuntunet.net/
- Workshop para América Latina y el Caribe (WALC)
  - http://eslared.net/
- West and Central African Research and Education Network
  - http://wacren.net/

… and Asian Institute of Technology, APAN, APIA, APNIC, ASREN, CAREN, Internet2, PRAGMA, RedCLARA… and …

Success Stories

Some from the past few years...

- Kenya Education Network (KENET)
- **University of Guam**
- Research and Education Network for Uganda and Infectious Diseases Institute, Makerere University
- **DrukREN (Bhutan)**
- Charles Darwin Research Station (Ecuador)

- Previously conducted network planning visit and provided campus network audit report (Dale Smith and Andy Linton)
- Coordinating all UOG assistance closely with University of Hawaii personnel
- Assisted UOG with applying to NSF for EPSCoR grant, which has been awarded
- Wireless course at PacNOG 18 hosted at University of Guam (Nov-Dec, 2015)
- Campus Network Design and Operations workshop, University of Hawaii link, and implemented BGP peering between commodity and R&E links with dramatically increased bandwidth (July, 2016)
- Second DEA (May 2017) working with CENIC
- Continuing to work with UoG, including joint trainings at PacNOG and APRICOT in 2017 and 2018.

University of Guam FIONette

Installed as part of a direct engineering assistance engagement between NSRC, CENIC and the University of Guam in May 2017.
(Thank you to Tom DeFanti, Larry Smarr and John Hess!)

DrukNet Network Training and Direct Engineering Assistance (DEA)
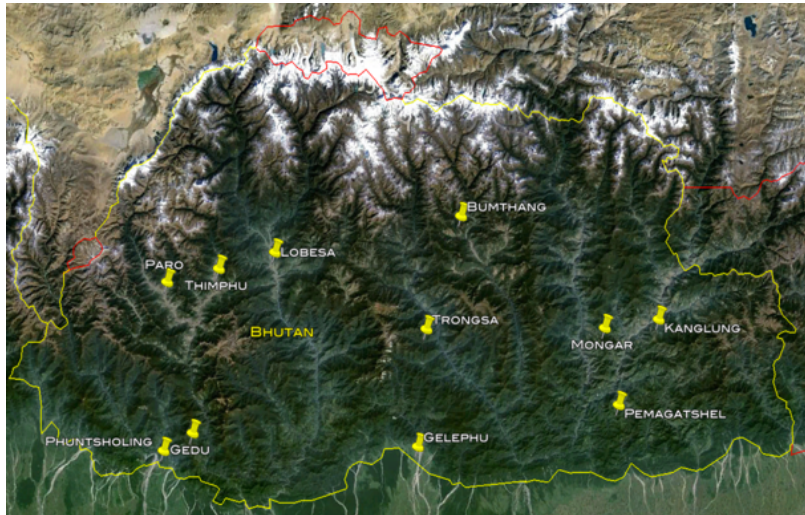
DrukREN DEA Locations

From September 12 to 21, 2015 NSRC personnel visited:

- Samtse College of Education (SCE) in Samtse
- College of Science and Technology (CST) in Phuentsholing
- Institute of Languages and Cultural Studies (ILCS) in Takse
- Sherubtse College of Kanglung
- Jigme Namgey Polytechnic (JNP) in Dewathang

In preparation for final international R&E connections from Bhutan to India, TEIN and the R&E fabric.
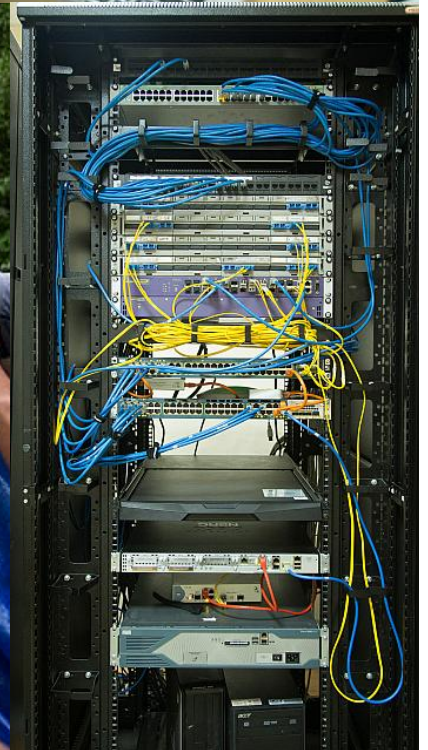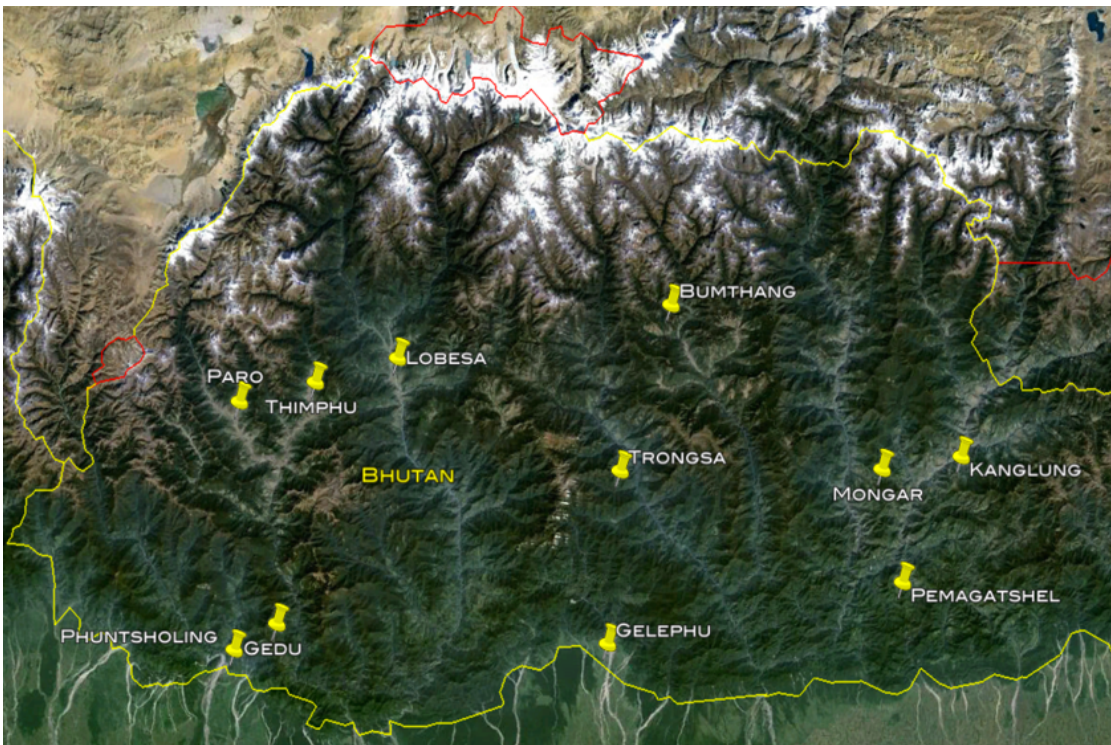
Helping the NSRC

- Keep us in mind for collaboration
  - If you have a researcher struggling with collaborations in emerging regions, engage us
- Sponsor a network engineer
  - Grace Hopper, Super Computing, Internet2, etc.
- Provide fellowships for participants
- Donate network equipment. We need
  - Edge and aggregation switches
  - Core routers with lots of fiber interfaces
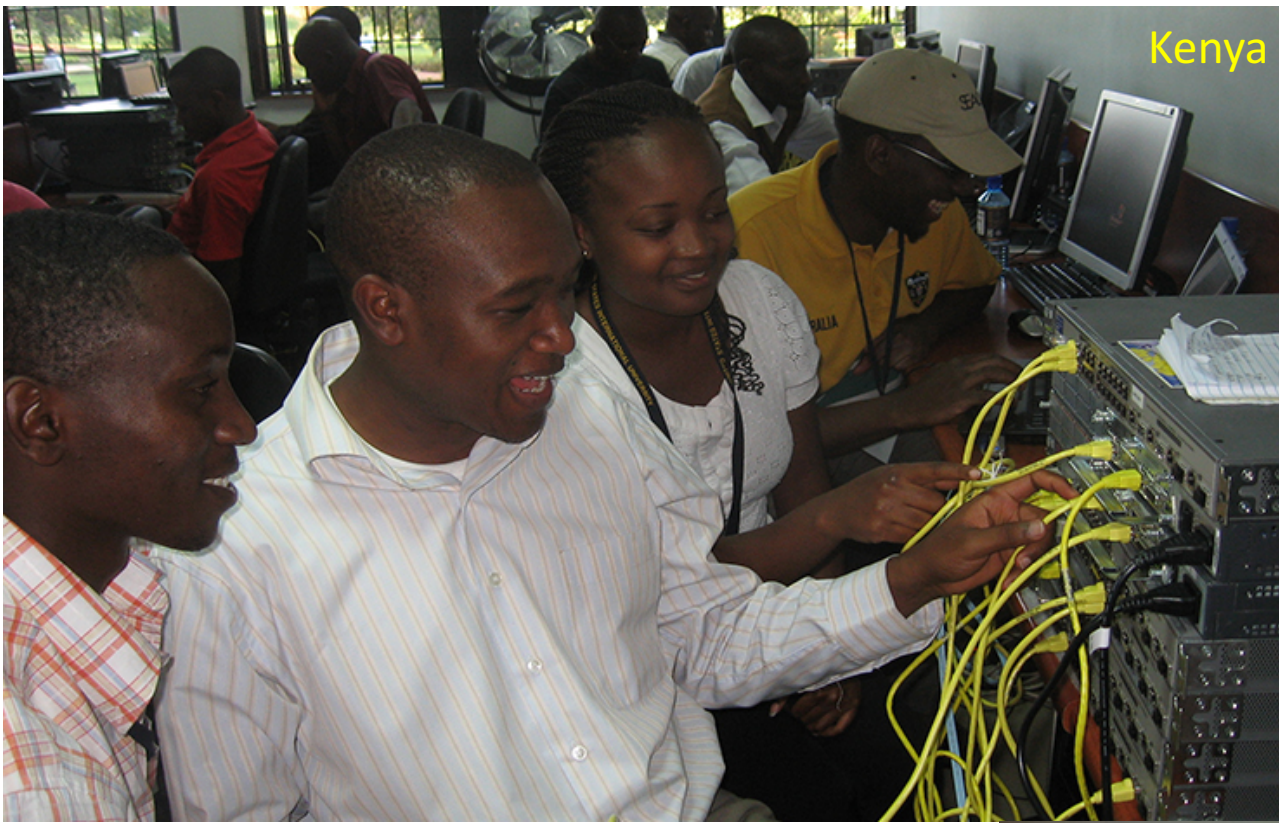 - Wireless hardware

Nicaragua (2010)

Nicaragua (2010)

Haiti (2014)

Panamá (2012)

Kenya
Cambodia
Bhutan
Japan

Myanmar

Senegal

Ghana

Rwanda

Malaysia

Thailand

Malaysia

Gambia

Cook Islands