GpENI: GREAT PLAINS ENVIRONMENT FOR NETWORK INNOVATION

I. OVERVIEW

• GpENI: The Great Plains Environment for Network Innovation – GpENI (pronounced [gpin]) will act on the middle syllable and rhyme with GENI) is an international programmable network testbed centered on a regional optical network between The University of Kansas (KU), Kansas State University (KSU), University of Nebraska – Lincoln (UNL), and University of Missouri – Kansas City within the Great Plains Network (GPN), supported with optical switches from Ciena interconnected by Qwest fiber infrastructure, in collaboration with the Kansas Research and Education Network (KanREN) and Missouri Research and Education Network (MOREnet). GpENI is funded in part by National Science Foundation GENI (Global Environment for Network Innovations) program as part of Cluster B. International expansion has begun anchored on Lancaster University in the UK and ETH Zürich in Switzerland.

• GpENI Topology and Network Infrastructure

GpENI is built upon a multi-wavelength fiber interconnection between four principal GpENI universities within the GPN, with direct connection to the Internet 2 backbone. Administration of Midwest GpENI infrastructure is assisted by GPN, KanREN and MOREnet. Each university has a GpENI node cluster interconnection to one-another and the rest of GENI by Ethernet VLAN. Additionally, each university is obtaining its own Ciena optical switch for layer-1 and -2 programmable interconnection among GpENI universities. GpENI is undergoing significant regional and international expansion, with institutions providing node clusters tunneled (L2TPv3 or IP) into the Midwest optical backbone. We are beginning to explore optical interconnection to some of the international nodes.

II. PROJECT GOALS

• Build a collaborative research infrastructure in the Great Plains region
• Provide programmable network infrastructure enabling GpENI member institutions to conduct experiments in future Internet architecture
• Provide flexible infrastructure to support the GENI program as part of control framework B
• Provide open environment on which the networking research community can run experiments

III. GpENI ARCHITECTURE AND INFRASTRUCTURE

• GpENI Node Clusters

38 node clusters are coming up in 17 nations, shown in Figure 1. Each GpENI node cluster consists of several components, physically interconnected by a Gigabit Ethernet switch to allow arbitrary and flexible experiments. GpENI uses KanREN /21 IP address space within the gpeni.net domain. The node cluster is designed to be as flexible as possible at every layer of the protocol stack, and consists of the following components, as shown in Figure 2:

- GpENI management and control processor: general-purpose Linux machine
- PlanetLab control framework consisting of aggregate managers: MyPLC with GENIwrapper SFA, myVINI, DCN
- PlanetLab programmable nodes
- VINI-based programmable routers, with Quagga and other extensions such as XORP and Click 2
- Site-specific experimental nodes, including software defined radios (such as the KUART), optical communication laboratories, and sensor testbeds
- Managed Gigabit Ethernet switch, providing L2 VLAN programmability and connectivity to the rest of GENI
- Ciena optical switch running DCN providing L1 interconnection among GpENI optical node clusters

The arrow overlaid on the Figure 2 shows a conceptual flow of an experiment in which the GENI experiment controls the configuration of the PlanetLab, which in turn configures a custom routing protocol, which in turn configures the optical switch configuration.

- GpENI Physical Topology and Infrastructure

The Midwest optical backbone physical topology consists of fiber interconnection between the four GpENI universities, and is currently being deployed, as shown in Figure 3 as white blocks. GpENI-specific infrastructure is deployed by grey blocks; deployment and operational status is described in a subsection below. Each of the four university node clusters will interface into the GpENI backbone via a Ciena CN4200 or CoreDirector switch. The rest of the GpENI node infrastructure for each site is labeled “GpENI node cluster.” The main fiber run between KU, KSU, and Kansas City is Qwest fiber IROU6 (leased) to KU, proceeding to the Internetc2 POP, which will provide access to GpENI from Internetc2. A chunk of C-band spectrum is planned providing multiple wavelengths between KU and KSU, and UMKC is connected to the GpENI nodes in the two campuses via Gigabit Ethernet 1 and 2. The selected two wavelengths are shown in Figure 3; note that this is constantly evolving as optical infrastructure is deployed.

• GENI Cluster B

GpENI is part of GENI control framework Cluster B. GpENI is one of two network infrastructure projects (along with Mid-Atlantic Crossroads) that will run the PlanetLab control framework and interface with other Cluster B participants, running GUSH experiment control and Raven code deployment.

IV. GpENI PRINCIPAL PARTICIPANTS

• Principal Universities

KU The University of Kansas
James P.G. Sterbenz (lead PI)

KSU Kansas State University: Caterina Scoglio (PI), Don Gruenbacher (co-PI), Richard Becker

UMKC Univ. of Missouri – Kansas City
Byrav Ramamurthy (PI)

• Research Networks

GPN Great Plains Network:
Greg Monaco (PI), Rick McMullen (Co-PI)

KanREN Kansas Research and Education Network
Cort Augustine (PI), Andrew Scott (Co-PI)

MOREnet Missouri Research and Education Network
Brad Fleming

G-Lab Kaiserslautern
Paul Müller (PI)

NorNet Simula Lab
Amund Kvalbein (PI)

V. RELATED PROJECTS

GpENI institutions participate in ten research projects that benefit from GpENI and GENI experimental capabilities:

• PoMo: Postmodern Internet Architecture (NSF FIND)
KU, University of Kentucky, University of Florida

• MAMMAs: Matrix, Models and Analysis of Network Security and Survivability (NSF CyberTrust)
UMKC, Duke University, University of Pittsburgh

• High Bandwidth Multimedia Applications (NSF CCF) UMD

• ResumeNet: (EU FP7 FIRE) Resilience and Survivability for Future Networking
KU, Lancaster U, ETH Zürich, Technische Universität München (TUM), Technische Universität Delft, Université de Lille (ULg), Universitat Passau, Uppsala Universitet (UU), NEC Labs Heidelberg, France Telecom – Orange Labs.

• G-Lab: German BMBF: TU-Kaiserslautern

• NorNet: Norway INFRASKUTUR: Simula Research Labs

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