G E N I

Global Environment for Network Innovations

Milestone S2.f

Plan to integrate UMF within another infrastructures

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under Project Nr. 1631
“Embedding real-time measurements for cross-layer communications”

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1 Document Scope

This section describes this document's purpose, its context within the overall GENI project, the set of related documents, and this document's revision history.

1.1 Executive Summary

This technical note presents the outcome of the work package Milestone S2.f of Project Nr. 1631, "Embedding real-time substrate measurements for cross-layer communications." This milestone document comprises work with other GENI clusters (outside of Cluster D) and/or other networking communities, such as Wisconsin's Measurement System GENI project or Internet2's perfSONAR framework, to define mechanisms to integrate the unified measurement framework (UMF) within their infrastructures. We discuss our recent proposals to integrate UMF with other networking infrastructures.

In Section 2, we summarize our previous work in milestone S2.a, S2.b, S2.c, S2.d, and S2.e. In Section 3, we describe the proposals in detail. In Section 4, we explain the software and hardware component of the UMF that will be implemented on the network infrastructures. Section 6 gives a summary and conclusion.

1.2 Related Documents

The following documents are related to this document, and provide background information, requirements, etc., that are important for this document.

1.2.1 GENI Documents

Document ID	Document Title and Issue Date
ERM_S2a_Dec09	Spiral 2 Milestone 2.a Technical Note
ERM_S2b_Mar10	Spiral 2 Milestone 2.b Technical Note
ERM_S2c_Jun10	Spiral 2 Milestone 2.c Technical Note
ERM_S2d_Aug31	Spiral 2 Milestone 2.d Technical Note
ERM_S2e_Aug31	Spiral 2 Milestone 2.e Technical Note

1.3 Document Revision History

The following table provides the revision history for this document, summarizing the date at which it was revised, who revised it, and a brief summary of the changes. This list is maintained in chronological order so the earliest version comes first in the list.

Revision	Date	Revised By	Summary of Changes
1.0	30 August 10	B.G. Bathula	Initial draft
1.1	31 August 10	M.S. Wang	Revision
1.2	1 September 10	B.G. Bathula	Revision

2 Previous Work (Summary of Previous Spiral 2 Milestones)

The goal of milestone S2.a [erm_1] involved the design and development of UMF, which serves as a means for gathering physical-layer measurements and conveying the data to the GENI researcher in an aggregated, unified way. Design considerations were taken into account so that the UMF could be integrated within the ORCA cluster, initially, and then extended to other GENI control frameworks in the future. Further, we discussed an implementation of the UMF by means of a NetFPGA Cube [netfpga_1], which is an integrated system composed of a general purpose processor, in addition to the proprietary NetFPGA hardware [netfpga_2]. The UMF comprises of both a software component (implemented on the general purpose processor), as well as a hardware component (implemented on NetFPGA card). Each component has a defined role in facilitating the UMF to access the networking elements and its measurement data.

Further, the goal of milestone S2.b [erm_2] involved implementing and demonstrating a working software interface between the UMF and at least one subsystem that is capable of embedded physical layer measurements, such as bit-error rate (BER) measurement or optical power monitoring. The specific subsystem we chose is a set of four Polatis switches within the ORCA-BEN [orca_1] network, from which we retrieved the optical power. In doing so, we have merged our UMF design with the integrated measurement framework (IMF) [imf_1] project implementation. By realizing the measurement handler (MH) for the Polatis switch and testing the functionality of the XMPP server and pubsub module (PSM), we demonstrated the ability of IMF to obtain real-time optical power measurements from any of the four Polatis switches in the ORCA-BEN network [orca_1].

Then, the goal of milestone S2.c [erm_3] involved demonstrating a working UMF prototype by implementing an experimental use-case at the Lightwave Research Laboratory at Columbia University. We set up a protected lightpath where the input signal can be switched to containing a semiconductor optical amplifier (SOA) if the input optical power is below a predefined threshold, and bypassing the SOA otherwise. We compared the eye diagrams and BER curves for the unprotected and protected paths while changing the attenuation of the input signal using a variable optical attenuator (VOA). For the same attenuation, we examine a more open eye diagram and lower BER for the protected path versus the unprotected path.

The goal of milestone S2.d [erm_4] involved contributing to the cluster D effort by integrating the UMF subsystem with the Cluster D network substrate. More specifically, we integrated the developed hardware and software resources of UMF to the BEN infrastructure at the RENCI Point-Of-Presence (PoP).

The goal of milestone S2.e [erm_5] involved developing an XML-RPC-based software module within the UMF. This module enables SILO to communicate with UMF through a set of predefined API functions, thereby enabling cross-layer communication. We demonstrated the interoperability of SILO and UMF by demoing a cross-layer optimized digital media streaming application across the BEN network.

3 Proposals

We are planning to extend the unified measurement framework (UMF) to different networking infrastructures. In order to facilitate this, we are participating in the following proposals:

1. RENCI's GENI Racks
2. GENI Measurement and Instrumentation Infrastructure (GEMINI),
3. International Center for Advanced Internet Research (iCAIR)

3.1 RENCI's GENI Racks

Our proposal to deploy 'GENI Racks' for use by our university and a number of other sites aligns with our goals of supporting collaborative research on a national scale and will provide researchers at our university with a unique opportunity to benefit from becoming early adopters/users of this unique infrastructure. These racks will be housed at the 32 Avenue of the Americas facility in downtown Manhattan and will be connected to Columbia University networking equipment at that site. This equipment would be accessed by the Lightwave Research Laboratory located in Schapiro CEPSR to conduct experiments on cross-layer optical networking. This rack will be used in time-sharing with Cornell University.

These racks would be connected via multiple static VLANs to NLR (and potentially Internet2) to allow the creation of various topologies. The racks will be deployed over a period of 3 years as the solicitation requires. Each rack will be linked to other campuses through the ORCA control framework and national-footprint dynamic circuit networks (e.g., NLR and/or I2). In the standard configuration, the racks will be accessible locally through vendor interface, Eucalyptus and OpenFlow APIs, and from GENI through the ORCA control framework. Fig.3.1 shows the Columbia University IP/ Ethernet network physical layer. Columbia University is directly connected to NLR via a gateway at 32 Avenue of the Americas. The letter of support is attached in the Appendix section.

3.2 GENI Measurement and Instrumentation Infrastructure (GEMINI)

Our proposal to develop the GENI Measurement and Instrumentation Infrastructure (GEMINI) offers exciting collaboration opportunities for our ERM project. Our ERM efforts involve providing an abstraction of physical layer measurements (i.e. optical power and BER) through a unified interface, and utilizing these measurement capabilities to allow for cross-layer control and optimization. We understand that GEMINI aims to serve the dual roles of support for managing and monitoring the substrate for infrastructure providers and operations centers, but will also provide experimenters with the tools they need to analyze their experimental results or to adapt system behavior at runtime. The work being done in ERM to provide physical-layer measurement and cross-layer control can potentially extend the range of performance metrics supported by GEMINI and offers a nice counterpart to its existing goals.

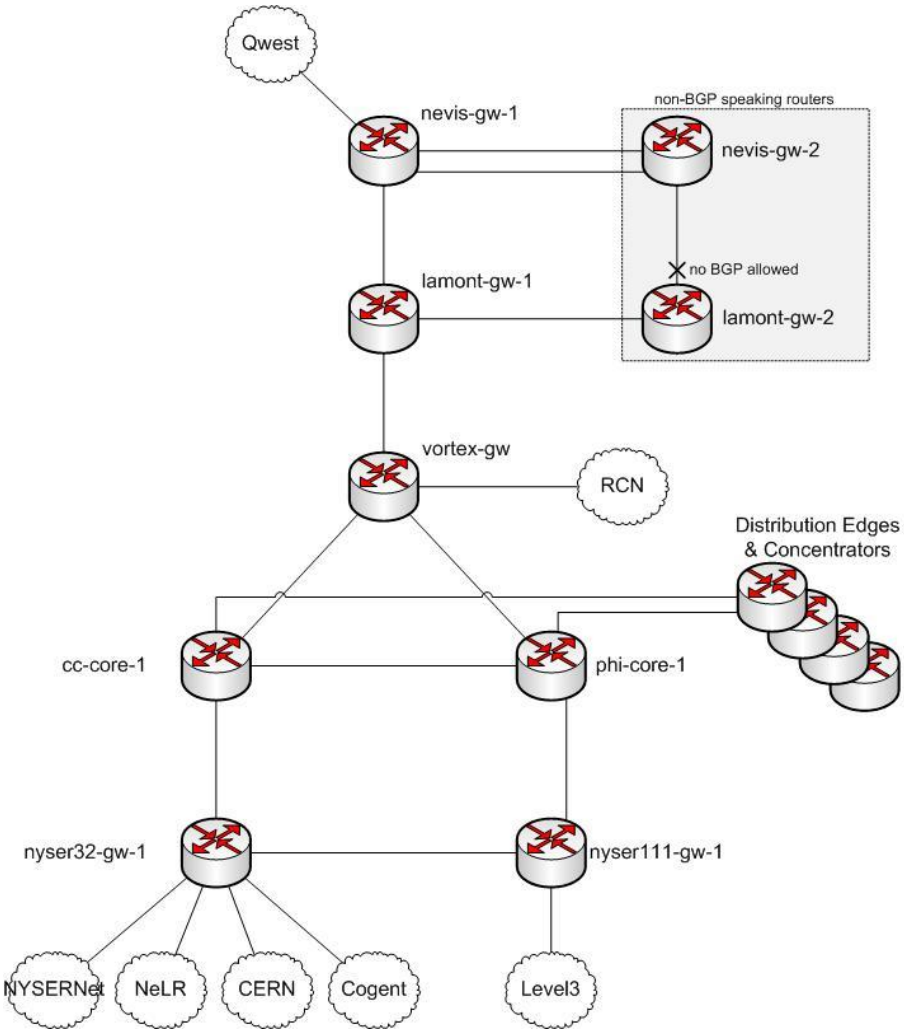

Fig 3.1 – Columbia University IP/Ethernet Network - Physical Layer

3.3 International Center for Advanced Internet Research (iCAIR)

Figure 3.2 shows the iGENI cloud connecting different sites of cluster-D. We are currently in the process of collaborating with iCAIR to bring the dynamic VLAN L1/L2 path to Columbia University.

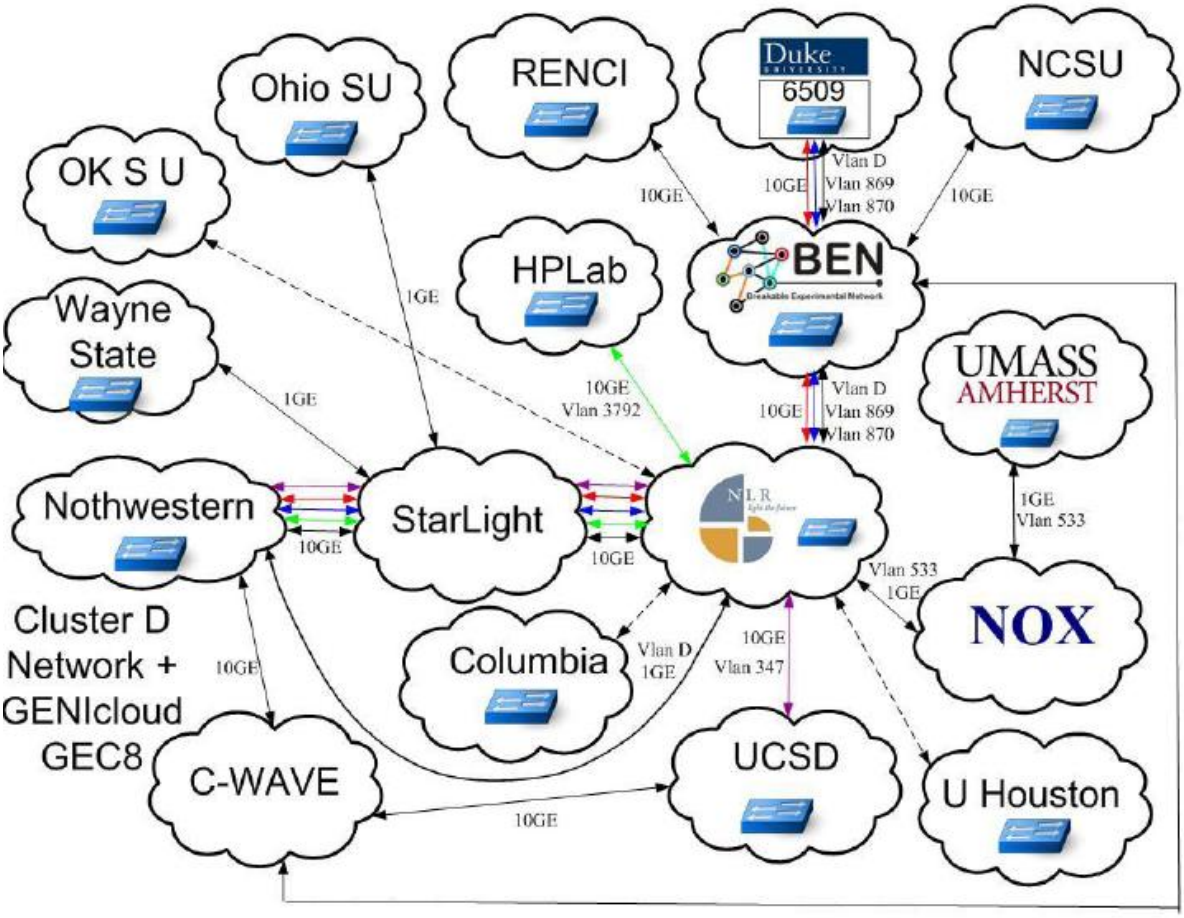

Fig 3.2– iGENI Network with L1/L2 paths to multiple Cluster-D sites. The dotted lines indicate the work in progress [iGENI]

We have discussed with Joe Mambretti of Northwestern University (PI for iGENI) with regards to:

1. Implementing at least a 1-Gb/s path from our lab (Schapiro CEPSR) to the campus data communications external gateway.
2. Implementing a path from the campus data communications external gateway to the MAN LAN exchange.

4 Summary and Conclusion

We plan to design and develop a more universally deployable version of UMF consisting of (a) a suite of software and a NetFPGA to expand optical-layer measurement capabilities; (b) a set of active optical components (SOAs, VOAs, etc) to enable cross-layer control. We then aim to deploy UMF within multiple infrastructures in other GENI clusters. Our vision is for the NetFPGA cube to act as an optical control plane that provides the programmability for the physical components and thus provides the cross-layer optimization.

5 Bibliography

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6 Appendix

6.1 Letter of Support for GENI RACK

COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

COLUMBIA UNIVERSITY INFORMATION TECHNOLOGY
CANDACE FLEMING

August 12, 2010

Ilia Baldine, Principal Investigator
RENCI, UNC Chapel Hill
100 Europa Dr., Ste 540
Chapel Hill, NC 27517

RE: "*Network-agile multi-provisioned infrastructure for GENI and ExoGENI*".

On behalf of Columbia University, I am pleased to support your proposal in response to GENI Solicitation 3 for GENI Development & Prototyping.

Your proposal to deploy 'GENI Racks' for use by our University and a number of other sites align with our goals of supporting collaborative research on a national scale and will provide researchers at our university with a unique opportunity to benefit from becoming early adopters/users of this unique infrastructure. These racks will be housed at the 32 Avenue of the Americas facility in downtown Manhattan and will be connected to Columbia University network equipment at that site. This equipment would be accessed by the Lightwave research laboratory located in Schapiro CEPSR to conduct experiments on cross-layer optical networking.

CUIT's network engineering staff will be able to provide coordination between the parties involved for this project for the setup and installation of this equipment, which will be in use by Columbia researchers for the duration of April 1, 2011 - March 31, 2014. These parties are: Professor Keren Bergman and her research staff, NYSERNET, RENCI and CUIT.

We anticipate that we will need to provide 10-20 hours of coordination activities by our network engineering staff, as well as some installation tasks which we estimate will require on the order of $1000 in engineering labor fees. We also anticipate a small amount of recurring fees for "out-of-band" management fees during the course of this three year project, which CUIT may be able to absorb.

We understand that our engineering labor fees and the other costs associated with this project, which have been estimated to be roughly $31,000 in one-time costs, and $37,000 in annual recurring costs, will be covered by Professor Keren Bergman or RENCI. These estimates were provided by CUIT's director of network engineering Joe Rini.

Sincerely,

Candace Fleming
Vice-President, Information Technology
Columbia University

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6.2 Letter of Support for GEMINI

COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

DEPARTMENT OF ELECTRICAL ENGINEERING

August 20, 2010

Martin Swany
University of Delaware
Department of Computer and Information Sciences
18 Amstel Avenue, Rm. 103
Newark, DE 19716

RE: "*GEMINI: a GENI Measurement and Instrumentation Infrastructure*".

Dear Prof. Swany,

On behalf of the Columbia University Lightwave Research Lab (LRL) I am pleased to support your proposal in response to GENI Solicitation 3 for GENI Development & Prototyping. As you are aware LRL is currently leading the GENI project on Embedded Real-Time Measurement (ERM) focused on providing physical layer measurement capabilities to GENI. Your proposal to develop the GENI Measurement and Instrumentation Infrastructure (GEMINI) therefore offers exciting collaboration opportunities with our ERM project.

Our efforts on ERM involve providing an abstraction of physical layer measurements (i.e. optical power and bit-error rate) through a unified interface, and utilizing these measurement capabilities to allow for cross-layer control and optimization. We understand that GEMINI aims to serve the dual roles of support for managing and monitoring the substrate for infrastructure providers and operations centers, but will also provide experimenters with the tools they need to analyze their experimental results or to adapt system behavior at runtime. The work being done in ERM to provide physical layer measurement and cross-layer control can potentially extend the range of performance metrics supported by GEMINI and offers a nice counterpart to its existing goals.

We are very enthusiastic about working with the GEMINI team, and we look forward to the great technical collaborations to come.

Sincerely,

Professor Keren Bergman
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