

GENI

Global Environment for Network Innovations

GENI Quarterly Status Report

Document ID: GENI-QR-ERM-Jan10

January 01, 2010

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under Project Nr. 1631

“Embedding real-time measurements for cross-layer communications”

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	27 Dec 09	M.S. Wang	Initial draft
1.0	1 Jan 10	C.P. Lai	Revised update

Embedding real-time substrate measurements for cross-layer communications

GENI Quarterly Status Report

Project Nr.: 1631

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1. Major accomplishments

We are currently associated with three different projects in Cluster D. During the past quarter, our main accomplishments involved the completion of the first milestones for all three projects, and the continued work towards completing the next milestones.

For the ERM project, we completed milestone S2.a, which involves the design and prototype of a Unified Measurement Framework (UMF). Before this milestone, we had already decided to implement the UMF using a NetFPGA Cube. The NetFPGA Cube [netfpga_1] is an integrated system composed of a general purpose processor, in addition to the proprietary NetFPGA hardware [netfpga_2]. Upon achieving this milestone, we developed a more detailed architectural design of the UMF. It comprises of both a software component (run on the general purpose processor), as well as a hardware component (run on NetFPGA card). Each component has a defined role in facilitating the UMF to access the networking elements and its measurement data. After completing this milestone, we have been working towards milestone S2.b.

For the IMF project, we collaborated with RENCi and the University of Houston for the completion of milestone S2.a. This involved developing and documenting an initial architectural view of all the components required to realize cross-layer experiments. An initial set of figures were drawn to illustrate how the Integrated Measurement Framework (IMF) [imf_1], UMF, and SILO [silo_1] would fit into the ORCA framework. After completing this milestone, we have been working towards milestone S2.d due in February, which involves a more detailed architectural view. We are in the process of defining the interfaces between IMF, UMF, and SILO, and designing use-cases that can best showcase the advantages of these components. Further, we are also working towards milestone S2.e and S2.f due in March, which involves the prototype implementation and demo of the architectural view developed for milestone S2.d.

For the LEARN project, we collaborated with the University of Houston in the completion of milestone S2.h, which deals with the drafting of the data file format for the transfer of measurement data between the Infinera Digital Transport Node (DTN) [Infinera_1, Infinera_2] and the IMF. This data file format consists of the vendor-specific TL1 command and response formats supported by the Infinera DTN.

2. Milestones

The following section discusses the progress made on the agreed milestones for the three GENI projects that we are involved with.

ERM

Milestone S2.a: Prototype UMF Software (completed 12/3/2009)

Design and develop software for prototype implementation of the UMF by means of a NetFPGA, according to the evaluated GENI requirements for real-time measurements from year-1.

We decided to implement the UMF using a NetFPGA Cube. The UMF consists of a UMF SW component (implemented on the general purpose processor) and a UMF HW component (implemented on NetFPGA card). Each component has a defined role in facilitating the UMF to access the networking elements and its measurement data. Additional information, as well as a technical note, on milestone S2.a is available online [erm_1][erm_2].

Milestone S2.b: Demo software interface from UMF to embedded measurement subsystem (due 3/4/2010)

Establish and demonstrate 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. This experimental demonstration will use the interface specifications developed in year-1 (e.g. use the networking management protocol: SNMP).

Milestone S2.c: Demo UMF in an experimental use-case (due 6/3/2010)

Demonstrate the working prototype by implementing an experimental use-case, as delivered by Milestone 5 in year-1. This may consist of a proactive protection mechanism, whereby the UMF may monitor a physical layer signal (e.g. optical power). If the power undershoots a predefined threshold, the UMF will export this information such that external protection protocols can then reroute the impaired channel to avoid packet loss and uncorrectable bit errors. This work will be performed at the Lightwave Research Laboratory test-bed at Columbia University.

Milestone S2.d: Integrate UMF with BEN (due 8/31/2010)

Contribute to the Cluster D effort by integrating the UMF subsystem with the Cluster D network substrate. This will be done by physically migrating the developed hardware and software resources to the BEN infrastructure at RENCI.

Milestone S2.e: Design and demo XML data exchange software modules (due 8/31/2010)

Design the XML data exchange software modules for the UMF to interact with the researcher or an intermediate measurement software architecture (e.g. SILO, perfSONAR, etc.) Demonstrate the inter-operability of these software modules with BEN at RENCI.

Milestone S2.f: Plan to integrate UMF within another infrastructure (due 8/31/2010)

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 UMF within their infrastructures.

IMF

Milestone S2.a: Initial architecture (completed 11/16/09)

Develop and document an initial architectural view of all the components required in this project to realize cross-layer experiments using SILO, consistent with the Cluster D roadmap, identifying and defining at the data model level all new interfaces that will come to exist, identifying which of these will require new protocols to realize, and identifying what existing protocols (or planned to be developed in some other projects) will be leveraged, and review with other projects at GEC.

We collaborated with RENCI and the University of Houston for the completion of this milestone S2.a. An initial set of figures were drawn to illustrate how the Integrated Measurement Framework (IMF) [imf_1], UMF, and SILO [silo_1] would fit into the ORCA framework. Additional information is available online [imf_1].

Milestone S2.d: First component architecture (due 2/1/2010)

Develop and document a v1.0 architectural view of all the components required in this project to realize cross-layer experiments using SILO.

Milestone S2.e: Initial IMF software (due 3/1/2010)

Develop a skeleton version of the IMF software module that interfaces with the UMF to gather measurements from the optical substrate, based upon the UMF interfaces provided by the ERM project.

Milestone S2.f: Integrate IMF and UMF with BEN (due 3/16/2010)

Integrate the IMF and UMF (provided by the ERM project) with devices in BEN that include performance monitoring capabilities, and demonstrate gathering measurements from these devices.

Milestone S2.b: Initial ontology for measurement (due 6/1/2010)

Collaborate with the ORCA Augmentation project to develop and document an initial ontology for substrate measurement capabilities.

Milestone S2.g: Protocol between SILO and IMF (due 7/1/2010)

Define and document the protocol to communicate control/management/measurement data between SILO and IMF consistent with the v1.0 architectural view, implement the protocol in both the IMF and in SILO, and integrate.

Milestone S2.c: First GENI instrumentation and measurement architecture (due 7/20/2010)

Collaborate with other GENI projects and GPO to develop and document a v1.0 common GENI instrumentation and measurement architecture.

Milestone S2.h: Update the IMF software (due 7/20/2010)

Update the IMF software to v0.5, and integrate with both SILO and UMF in BEN, to demonstrate a 2-way flow of control/management/measurement data between SILO and IMF,

and conduct a simple cross layer experiment, e.g., where an optical layer measurement influences routing.

Milestone S2.i: First release of IMF and SILO software (due 9/30/2010)

Finish development and deliver a v1.0 version of the IMF and SILO software.

Milestone S2.j: Contribution to GENI outreach plan (due 9/30/2010)

Specific contribution to GENI outreach plan for Spiral 2.

LEARN

A subset of the LEARN project milestones involves collaboration with the ERM project. Only these milestones are described below.

Milestone S2.h: Draft measurement data file format (completed 11/16/2009)

Collaborate with the ERM project to draft data file format for transfer of measurement data between the Measurement Handler software and the Integrated Measurements Framework; complete specifications for the Measurement Handler software, which will utilize an existing interface (TL1 over SSH) into the Infinera Digital Transport Node (DTN) to make optical measurements.

We collaborated with the University of Houston in the completion of this milestone. This data file format consists of the vendor-specific TL1 command and response formats supported by the Infinera DTN. Additional information, as well as a technical note, on milestone S2.h is available online [learn_1], [learn_2].

Milestone S2.i: Implement and integrate measurement handler (due 3/16/2010)

Collaborate with the ERM project to complete specification of the data file format for transfer of measurement data between the Measurement Handler software and the Integrated Measurements Framework; implement the Measurement Handler software to make optical measurements using Infinera Digital Transport Nodes (DTNs); integrate the Measurement Handler software with the Integrated Measurements Framework provided by the ERM project; demonstrate the Measurement Handler using DTNs, and dark fiber resources from LEARN.

Milestone S2.j: Deliver release of measurement handler (due 5/1/2010)

Deliver release of Measurement Handler code for Infinera DTN and documentation to GPO.

Milestone S2.k: List of measurement handlers for GENI (due 7/20/2010)

Based upon results of Data Plane Measurements project, collaborate with GPO and other projects in Cluster D, to establish a list of measurement handlers that are needed for commercial transport and measurement equipment that will be used in GENI.

3. Deliverables made

- ERM Milestone S2.a (December 2009)
- IMF Milestone S2.a (November 2009)
- LEARN Milestone S2.h (November 2009)

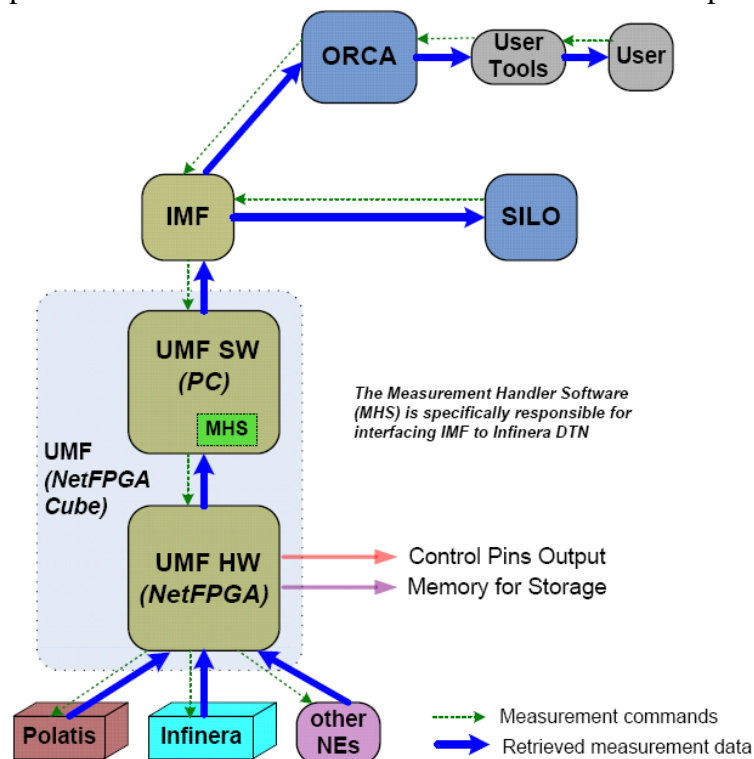
4. Description of work performed during last quarter

- Organizational work

Working with the GPO (specifically Harry Mussman), details regarding our ongoing work and our contributions to GENI Spiral 2 were released on the GENI ERM Wiki page; this includes quarterly reports and the Milestone S2.a technical note. An oral presentation, summarizing the work done in Spiral 1 and describing the plans ahead for Spiral 2 was presented at the 6th GENI Engineering Conference in November during the Cluster D meeting session. We have also participated in several Cluster D meetings through teleconference.

- NetFPGA Cube implementation of UMF

The main goal of the UMF is to present a uniform view and an abstraction of the measurement capabilities within a substrate and make them accessible/sliceable to a control framework. As such, the UMF is required to interface with both the GENI control framework, as well as to a set of network elements (NEs) within the GENI network substrate. The figure below shows an architectural flowchart of how the UMF interfaces specifically to the ORCA control framework and its NEs. The green dotted lines depict the flow of measurement commands, such as the signal monitoring commands, downstream from the ORCA control framework, through the IMF, down to the underlying NEs. The blue solid lines show the flow of retrieved measurement data from the NEs, up to the UMF and the ORCA control framework to be processed or stored.



- Infinera DTN measurement data file format

The Infinera DTN [infinera_1] receives and responds to commands via the TL1 format, which is a vendor-independent network management protocol. These commands are encoded in plain ASCII text, resulting in easy readability and greater interoperability. We plan on using the DTN to measure optical power and BER. The more detailed description of these commands is provided in the milestone S2.a technical report [learn_2].

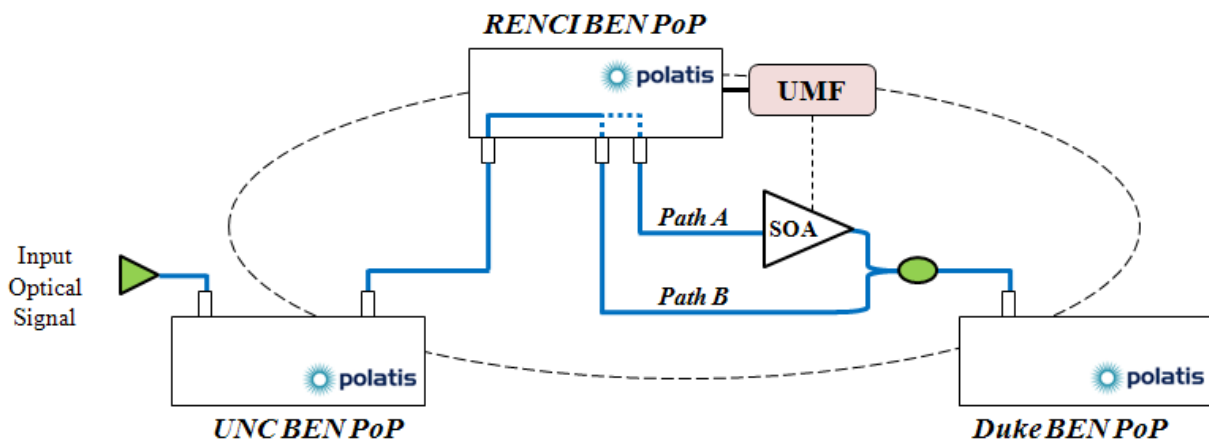
5. Activities and findings

5.1 IMF Use-Cases

Working towards the milestones S2.d (due February) and S2.f (due March), we have been working with RENCI and the University of Houston to design and implement use-cases that can best highlight the key points of the proposed architecture of IMF.

One particular use-case that we have designed highlights the fact that the UMF HW component has an assortment of I/O interfaces (GPIO pins, Ethernet ports, serial port, etc) that can control equipment that cannot be directly control via a general purpose computer. More specifically, we designed a use-case that uses GPIO pins of the UMF HW to control a semiconductor optical amplifier (SOA), as described below.

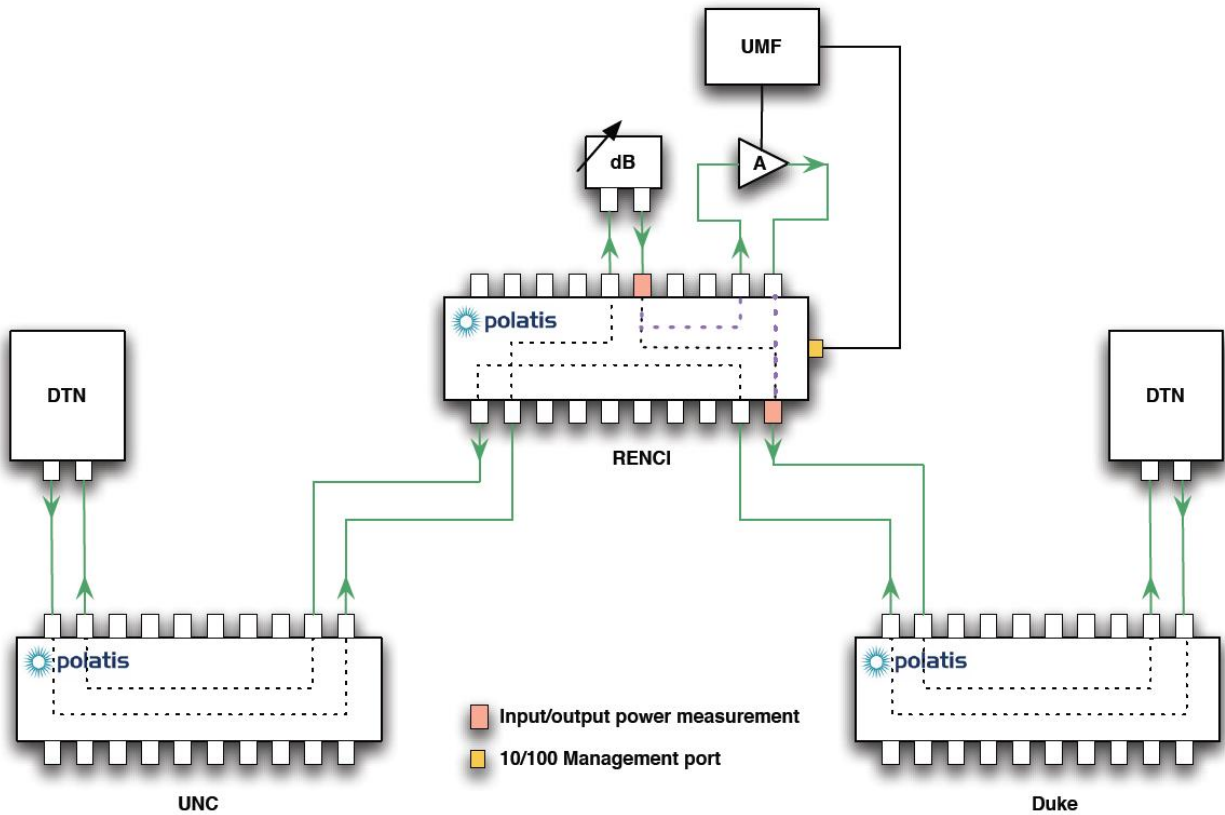
Optical layer view of the use-case on BEN:



SOA: semiconductor optical amplifier (active optical element)

Polatis: reconfigurable fiber switch

Physical layout/implementation view of the use-case on BEN:



Experimental use-case description:

- User wishes to send data from UNC to Duke, but lightpath traverses RENCi PoP
 - Assume that no other feasible path between UNC & Duke
- User also has constraint that data must reach Duke with x dB of optical power (x = to be determined)

At RENCi:

- The Polatis [polatis_1] fiber switch measures the power along the user's desired path
 - Measurement then forwarded to UMF, which has the measurement threshold level (Use-Case Function 4)
 - If the measurement is x dB or higher, UMF (SW) sets the Polatis to switch to path B.
 - If the measurement is less than x dB, then UMF (SW) sets the Polatis switch to path A and the UMF (HW) [NetFPGA] turns on the SOA to amplify the optical signal

Furthermore, we are currently in the process of developing another use-case that involves making use of SILO [silo09_1]. We are not aiming to implement this use-case for the February or March deadlines. More about this will be stated in the next quarterly report, as we develop it further.

5.2 Perl Scripts for UMF SW

The UMF SW component is responsible for sending and receiving the vendor-specific commands and responses from the various NEs within Cluster D [erm_1]. We have decided to use Perl script to develop this software. Since this script will be used at several physical locations (RENCI, Columbia, and University of Houston), we have decided from the beginning to agree on a common infrastructure to use. More specifically, we obtained the existing Perl scripts used at RENCI to control their NEs as a starting point.

6. Project participants

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Michael S. Wang, Columbia University New York, [msw2138@columbia.edu](mailto:mw2138@columbia.edu)

7. Publications (individual and organizational)

- C.P. Lai, M.S. Wang, K. Bergman, “Unified Measurement Framework: NetFPGA Cube Prototype (Project Nr. 1631, Milestone S2.a),” December 2009.
- M.S. Wang, D. Gurkan, C.P. Lai, K. Bergman, “Draft Measurement Data File Format,” (Project Nr. 1733, Milestone S2.h), November 2009.

8. Outreach activities

none

9. Collaborations

- **Cluster D:** Renaissance Computing Institute (RENCI) and North Carolina State University (NCSU), Ilia Baldin, Rudra Dutta, Anjing Wang
We work closely with Ilia Baldin of RENCI, and Rudra Dutta and Anjing Wang of NCSU to work on the IMF project. More specifically, we work with Ilia and Rudra on designing the interfaces between IMF and UMF, and we work with Anjing on designing the interfaces between SILO and UMF. We hold a phone meeting once every 1-2 weeks.
- **GENI LEARN Project:** University of Houston, Deniz Gurkan
We work closely with Deniz to collaborate on the LEARN project. We stayed in close contact during the release of milestone S2.h. We have continued to stay in close contact in developing the Perl scripts for the Infinera DTN.
- **GPO:** Harry Mussman
We closely cooperated with Harry Mussman to create an updated version of the GENI Wikipage and submitting milestone reports and quarterly status reports. Discussions via e-mail on the design and implementation issues for IMF were also conducted. More specifically, we communicated with Harry regarding on UMF is to interface with IMF, SILO, and LEARN.

10. Other Contributions

none

11. Bibliography

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- [10] [learn_2] M.S. Wang, D. Gurkan, C.P. Lai, K. Bergman, “Draft Measurement Data File Format,” (Project Nr. 1733, Milestone S2.h), November 2009, [Online]. Available: <http://groups.geni.net/geni/wiki/LEARN>