

GENI

Global Environment for Network Innovations

GENI Quarterly Status Report

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“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	01 Oct 09	M. Wang	Initial draft
2.0	28 Oct 09	C. P. Lai	Updated draft with current capabilities

Embedding real-time substrate measurements for cross-layer communications
GENI Quarterly Status Report
Project Nr.: 1631

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1. Major accomplishments

During this past quarter, our main accomplishments involved the completion of milestones 5 and 6, and the submission of the corresponding technical notes. Further, we are in the process of drafting ERM's year 2 milestones, and have started working on the NetFPGA implementation of the Unified Measurement Framework (UMF).

As our previous work and the following document show, we have supported the GPO in developing experimental designs for use-cases based on our work on a measurement-driven cross-layer communication system. We provide an experimental use-case that has been designed and explored, describing simulation and network test-bed experiments that show the advantages of our cross-layer schemes, as can be seen specifically in the Milestone 5 technical notes.

Also of significant note: our ongoing interactions with the GENI teams involved in Cluster D (ORCA), primarily Renaissance Computing Institute (RENCI) and Duke University, have resulted in our project ERM officially joining Cluster D in May. Recently, we have obtained funding for two new projects that will further our collaboration efforts with other GENI teams. The first project involves further collaboration with RENCi to develop an Integrated Measurement Framework (IMF) based in our developed measurement framework. The second project involves continued collaboration with the University of Houston in order to further develop real-time measurement capabilities on the Lonestar Education and Research Network (LEARN) network.

2. Milestones

The following section outlines the progress made on the pre-defined milestones as given in [erm09_1].

Milestone 1: GENI requirements for real-time measurements (completed 03/01/2009)

For this milestone, we evaluated the capabilities of GENI's infrastructure with respect to embedded real-time measurements and assessed the GENI requirements for real-time user access to data measurements across a diverse set of heterogeneous technologies. Additional information, as well as a technical note, on milestone 1 is available online [erm09_1], [fidler09_1].

Milestone 2: Develop specifications and networking protocols (completed 03/01/2009)

A set of specifications for supporting real-time measurements within the network substrate, as well as a set of specifications for networking protocols based on the GENI requirements for real-time user-accessed cross-layer measurements, were developed. We identified a set of technical specifications for the implementation of a unified, integrated measurement framework, with the ultimate goal of limiting the hardware and software overhead and complexity associated with

accessing the measurement data. Additional information, as well as a technical note, on milestone 2 is available online [erm09_1], [lai09_1].

Milestone 3: Perform discrete-event network simulations (completed 03/01/2009)

In order to enable and perform discrete-event network simulations and quantitatively evaluate the performance impact of several scenarios of cross-layer information exchange based on real-time measurements, we have developed new simulation modules for the ns-2 open source network modeling environment. The newly developed ns-2 ERM software modules, as well as the technical note, on milestone 3 are available online [erm09_1], [fidler09_2]. (*The software modules were developed in cooperation with Alcatel-Lucent, Bell Labs.*)

Milestone 4: Develop a software architecture (completed 06/01/2009)

Within the scope of this milestone, we have further developed our vision of the unified measurement framework (UMF) based on GENI real-time measurement requirements and other recent activities, developments, hardware/software resources, and products within other GENI prototyping efforts. We have interacted with other GENI prototyping groups, including existing software measurement architectures (e.g. SILO [silo09_1], perfSONAR [perfsonar09_1], OMF [rutgers09_1], etc.) and determined the potential of implementing a real-time measurement infrastructure within each of these architectures. Additional information, as well as a technical note, on milestone 4 is available online [erm09_1], [fidler09_3].

Milestone 5: Support GPO in developing an experimental use-case (completed 09/01/2009)

The goal of this milestone was to support the GPO in developing experimental designs for use-cases based on our work on a measurement-driven cross-layer communication system. Building on the successful simulation work with the modules developed in [erm09_1], we validate our cross-layer communication schemes in developing an experimental use-case based on proactive packet protection. We show network simulations, as well as an experimental demonstration, of our packet protection scheme. Additional information, as well as a technical note, on milestone 5 is available online [erm09_1], [erm09_2].

Milestone 6: Identify a candidate control framework (completed 09/01/2009)

The goal of this milestone was to interact with the GPO to identify a candidate control framework and cluster for the integration of our real-time measurement system. To this end, we recently joined the ORCA/BEN Cluster D [orcaben08_1]. This move was based on our continuing discussions with other GENI teams, particularly RENCi, Duke University, and North Carolina State University. We also have ongoing interactions with other GENI working groups and teams, such as the University of Houston [gurkan08_1] and the University of Wisconsin [barford06_1].

3. Deliverables made

- Oral Presentation: K. Bergman, ERM's integration Efforts with ORCA/BEN at 5th GENI Engineering Conference, Seattle, WA (July 2009)
- Technical Note Milestone 5 (September 2009)
- Technical Note Milestone 6 (September 2009)

- C. P. Lai et al., “Experimental Demonstration of QoS-Aware Cross-Layer Packet Protection Switching”, presentation at European Conference on Optical Communications (ECOC), Vienna, Austria (September 2009)
- F. Fidler et al., “Cross-Layer Simulations of Fast Packet Protection Mechanisms”, presentation at European Conference on Optical Communications (ECOC), Vienna, Austria (September 2009)
- F. Fidler et al., “Impairment-Aware Traffic Engineering Using Cross-Layer Protocols”, presentation at European Conference on Optical Communications (ECOC), Vienna, Austria (September 2009)

4. Description of work performed during last quarter

- Organizational work

Working with the GPO (specifically Vic Thomas and Harry Mussman), details regarding our ongoing work and our contributions to GENI Spiral 1 were released on the GENI ERM Wikipage; this includes quarterly reports and the Milestone 5 and 6 technical notes. An oral presentation, describing the integration effort with ORCA/BEN was presented at the 5th GENI Engineering Conference in July in the Cluster D meeting session. We have participated in several Cluster D meetings though teleconference. Further, we have drafted a set of milestones for the next year, and we are currently in the process of finalizing these milestones with the GPO.

- Collaboration efforts

We are currently engaging in collaboration efforts with several other GENI teams and groups, specifically RENCI, Duke University, and the University of Houston, with the overall endeavor of realizing real-time measurements in the future GENI network infrastructure. Our ongoing communications and discussions have led us to recently (May 2009) join Cluster D (ORCA/BEN), as described in Milestone 6 [erm09_3]. The Cluster D control framework recognizes the importance of enabling real-time measurements within BEN and test-beds, and will facilitate the integration of our work within their architecture and infrastructure. Recently, we have obtained funding for two new projects. The first project involves further collaboration with RENCI to develop an Integrated Measurement Framework (GENI IMF). The second project involves collaboration with the University of Houston using the LEARN test-bed.

- Real-time measurements - experimental use-case

Within milestone 5, we first discuss the details of the protection scheme and the feasibility of implementing this cross-layer signaling system within GENI. Building on previously designed modules, we then show simulation results in the open source simulation environment ns-2 that show that the proactive protection yields lower packet loss rates than existing FEC-based fast-rerouting schemes. Finally, we provide an experimental demonstration of the experimental use-case on our in-house network test-bed.

- Unified Measurement Framework – NetFPGA

One implementation of the real-time measurement software architecture is to use NetFPGA cards [netfpga09_1] hosted in a server as recommended in [lai09_1]. The NetFPGA can pre-process the measurement information in order for the corresponding measurement data to be stored in databases (e.g. SQL), then accessed and exported to other services/software frameworks (e.g.

SILO, perfSONAR, etc.) via XML based protocols. Furthermore, from the UMF, information about the resources, measurement capabilities, and network topology can be sent to the GENI control frameworks by means of XML encoded resource description languages such as NDL or RSpecs.

- **Year 2 Milestones**

We have drafted the set of milestones for the next year. We are currently in the process of finalizing these milestones with the GPO. One of the major goals of the next year is to develop a prototype implementation of the proposed UMF by means of a NetFPGA. During this last quarter, we have begun initial steps in this direction.

5. Activities and findings

5.1 Real-time measurements – experimental use-case

Our endeavors for milestone 5, as documented in [erm09_2], provide the GPO with an experimental use-case that can be implemented in the GENI infrastructure given the availability of a measurement framework (i.e. the UMF) in combination with an appropriate software framework which allows for cross-layer information exchange. Current collaborations with the ORCA cluster provide a potential means for implementing this experimental use-case within the BEN substrate.

5.2 Unified measurement framework - NetFPGA

During the last quarter, we have begun the first steps in developing our vision of the UMF through a realization of a NetFPGA system. Much of this design and development is slated to be completed by the first milestones of ERM's year-2.

6. Current Capabilities

Currently, ERM is at the end of year 1, during which we assessed and proposed the required measurement framework (the UMF). Within our year 2 milestones, we plan to develop the hardware and software prototype of the UMF using a NetFPGA and integrate the subsystem within Cluster D.

7. Project participants

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8. Publications (individual and organizational)

- C. P. Lai, F. Fidler, K. Bergman, “Experimental Demonstration of QoS-Aware Cross-Layer Packet Protection Switching” accepted at European Conference on Optical Communications (ECOC), Vienna, Austria (September 2009)
- F. Fidler, P. Winzer, C. P. Lai, M. K. Thottan, K. Bergman, “Cross-Layer Simulations of Fast Packet Protection Mechanisms” accepted at European Conference on Optical Communications (ECOC), Vienna, Austria (September 2009)

- F. Fidler, P. Winzer, M. K. Thottan, K. Bergman, “Impairment-Aware Traffic Engineering Using Cross-Layer Protocols” accepted at European Conference on Optical Communications (ECOC), Vienna, Austria (September 2009)
- C.P. Lai, F.Fidler, M. Wang, and K. Bergman, “Milestone 5: GENI Real-Time Measurements: Experimental Use-Case”, Technical Note, September 2009
- C.P. Lai, F.Fidler, M. Wang, and K. Bergman, “Milestone 6: Candidate Control Framework for GENI Real-Time Measurements”, Technical Note, September 2009

9. Outreach activities

none

10. Collaborations

- **Cluster D:** Renaissance Computing Institute (RENCI) and Duke University, Ilia Baldin
Our collaborations with Cluster D involves integrating the envisioned UMF with the Cluster D infrastructure, as well as participating in the Cluster D meeting at GEC5. Furthermore, we are starting a newly funded project with RENCi to develop an Integrated Measurement Framework (IMF) based in our developed measurement framework.

- **GENI Substrate Working Group:** University of Houston, Deniz Gurkan
We continued our collaboration with the University of Houston in order to further develop real-time measurement capabilities on the LEARN test-bed.

- **GPO:** Vic Thomas and Harry Mussman
We have engaged in e-mail discussions with Vic Thomas and Harry Mussman of the GPO regarding our latest milestone technical note releases, drafting of the set of milestones for next year, as well as our collaboration efforts with Cluster D.

- **Vendor:** Polatis, Jim Dertzbaugh, Rich Jensen, Bob Naftal
We obtained a 10x24 Polatis switch at the end of September. With the help of Bob Naftal and Rich Jensen, we have successfully set up this switch in our lab, and learned its basic functionalities. This fiber switch is capable of outputting its power monitoring measurements via the network protocol language SNMP. Since the 24-port version of the switch is currently deployed in BEN, the Polatis switch will comprise a valuable hardware resource in our lab and will help us test and experiment potential future hardware implementations of the UMF.

11. Other Contributions

none

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