G E N I

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	31 March 10	M. S. Wang	Initial draft
1.1	31 March 10	C. P. Lai	Revised draft

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 milestone S2.b and the submission of the corresponding technical notes. To achieve this milestone, we integrate the NetFPGA [netfpga_1], [netfpga_2] implementation of the UMF with the Integrated Measurement Framework (IMF) project [imf_1]. We implemented and demonstrated a working software interface between 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 to use is a set of four Polatis switches [polatis_1] from the ORCA-BEN [orca_1] network, from which we measured the optical power. By realizing the Measurement Handler (MH) for the Polatis switch and testing the functionality of the XMPP server and Publish-Subscribe 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. We demonstrated this capability at the GEC7 demo session.

2. Milestones

The following section discusses the progress made on the milestones for the ERM project.

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 NetFGPA 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)
We implemented and demonstrated a working software interface between UMF and at least one subsystem that is capable of embedded physical layer measurements, such as bit-error rate measurement or optical power monitoring. The specific subsystem we chose to use is a set of four Polatis switches from the ORCA-BEN [orca_1] network, from which we retrieved the optical power. In doing so, we have merged our UMF design with the IMF project implementation. By realizing the MH for the Polatis switch and testing the functionality of the XMPP server and 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. Additional information, as well as a technical note, on milestone S2.b is available online [erm_2], [erm_3].

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.

3. Deliverables made

- ERM Milestone S2.b (March 2010)
- Poster Presentation at GEC7, "An Integrated Measurement Framework (IMF) for Enabling GENI Substrate Measurement and Control," joint work between ERM, IMF, and LEARN projects (March 2010)

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 Wikipage; this includes quarterly reports and the Milestone S2.b technical note. At the GEC7 demo session in March, we presented a poster and showcased a demo, which described the joint effort of ERM, IMF, and LEARN to obtain real-time BER and optical power measurements from the Polatis and Infinera switches located within ORCA-BEN. Further, an oral presentation, summarizing the completed work in Spiral 2 and describing the next steps ahead, was presented at GEC7 during the Cluster D meeting session. We have also participated in several Cluster D and GENI IMF meetings through teleconference.

- Defining IMF Component Architecture

In the milestone S2.a [erm_1] report, we described the design and development of the UMF by means of a NetFPGA Cube. Then, for milestone S2.b, we integrate the NetFPGA

implementation of the UMF with the IMF project [imf_1]. The IMF project is a joint-effort among the research teams from North Carolina State University, Columbia University, University of North Carolina at Chapel Hill/RENCI, and University of Houston. At ERM, we worked with the other research teams to design the IMF component architecture, as shown in Fig 4.1. IMF is implemented as a set of federated servers implementing Publish/Subscribe or *PubSub* functionality on an XMPP server [xmpp_1], [xmpp_2], [xmpp_3], [xmpp_4]. Using the PubSub module, consumers of measurement data would subscribe to a particular measurement data of interest and ignore the unwanted measurement data. Once the underlying substrate has obtained the result, the data is published and the only the subscribers of that data will receive the result. A more detailed version of the IMF architecture description is presented in [imf_2].

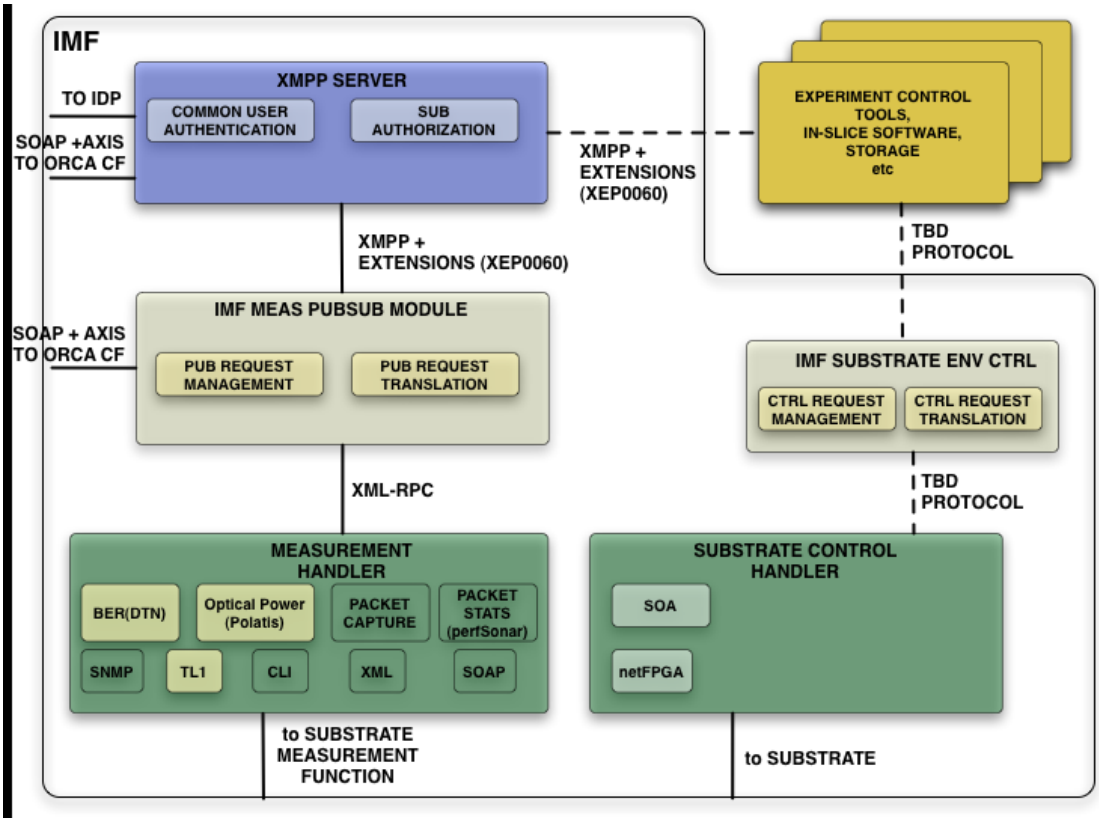

Fig 4.1: IMF Component Architecture

- Developing Perl Scripts for UMF SW

Along with the rest of the IMF team, we have developed an initial working version of the IMF, consisting of an XMPP server, PubSub Module, and Measurement Handler (MH). ERM has written the MH specifically for the Polatis switch. Currently, a GENI user can login to the ORCA-BEN network and obtain real-time optical power measurements from any of the four Polatis switches in ORCA-BEN. The MH software is implemented as 3 Perl scripts, and essentially satisfies the goals of the UMF SW.

The lowest level Perl script is a Perl module consisting of a set of general TL1 commands as provided by [sara_1]. Built on top of this Perl module is another Perl module that contains a set of TL1-based subroutines that is used to communicate with the Polatis switch. Some of these subroutines are:

- loginSwitch( ) – login to one of the four Polatis switches in BEN.
- find_power( ) – consists of the specific TL1 instruction to query for the optical power of a given port of the Polatis switch.
- retrieve_CRS( ) – retrieve the current cross-connect state of the Polatis. In other words, this commands returns which inputs are connects to which outputs for the given Polatis switch.
- logoutSwitch( ) – logout of one of the four Polatis switches in BEN.

Finally, the third Perl script is an application that will call the various Polatis-specific subroutines to login to a switch, obtain power measurement from a particular port, and logout.

5. Activities and findings

5.1 Obtaining Optical Power Measurements from Polatis Switch

At the GEC7 demo session, we demonstrated the ability to obtain optical power measurements from any of the four Polatis switches located in ORCA-BEN. As verification, we have obtained the following power measurements from the Polatis switch located at RENCI:

port	power (dBm)	port	power (dBm)
1	-46.27	17	-48.96
2	-47.19	18	-48.56
3	-20.83	19	-45.86
4	-47.83	20	-47.39
5	-46.1	21	-47.51
6	-44.38	22	-21.75
7	8.9	23	-48.6
8	-47.57	24	-48.89
9	Null	25	Null
10	Null	26	Null
11	Null	27	Null
12	Null	28	Null
13	Null	29	Null
14	Null	30	Null
15	Null	31	Null
16	Null	32	Null

The power readings confirm with the actual state of the RENCI Polatis switch. Not all the ports on the RENCI Polatis device have optical power monitoring (OPM) capability. Those non-OPM enabled ports have a NULL power reading.

5.2 Visit to RENCI to Begin Integration of Optical Components into ORCA-BEN

In January 2010, we visited RENCI in North Carolina to gain a deeper understanding of ORCA-BEN, and to begin integrating a set of optical components into ORCA-BEN [ben_1]. BEN consists of four point-of-presences (PoPs), located at RENCI, UNC, NCSU, and Duke. Initially, we wanted to connect a semiconductor optical amplifier (SOA) at the RENCI PoP of BEN. Specifically, we wanted to connect the SOA to the Polatis within RENCI-BEN. However, we were instructed by Infinera [infinera_1] to delay making this physical connection. The Polatis switch is connected to the Infinera DTN, and Infinera voiced concern that the additional amplification provided by the SOA may cause harm to their device. At this point, we have

received confirmation to continue with this connection, if we first add a programmable attenuator into the connection to limit the amplification.

While waiting for the confirmation from Infinera, we brainstormed other components that we can integrate into the BEN. We are planning another visit to RENCI to integrate a SOA, a programmable attenuator, and the implemented NetFPGA into the RENCI-BEN PoP.

6. Project participants

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7. Publications (individual and organizational)

- M. S. Wang, C. P. Lai, K. Bergman, "Demonstrating Embedded Real-Time Physical Measurement from ORCA-BEN Substrate (Project Nr. 1631, Milestone S2.b)," March 2010.
- C. P. Lai, M. S. Wang, A. S. Garg, K. Bergman, J.-Y. Yang, M. R. Chitgarha, A. E. Willner, "Demonstration of QoS-Aware Packet Protection via Cross-Layer OSNR Signaling," OFC 2010 OTuM2, March 2010.

8. Outreach activities

none

9. Collaborations

- **Cluster D IMF Project:** Renaissance Computing Insititute (RENCI), North Caroline State University (NCSU), and University of Houston: Ilia Baldine, Rudra Dutta, Deniz Gurkan Anjing Wang, and Debjyoti Majumder

We work closely with Ilia Baldine of RENCI, Rudra Dutta and Anjing Wang of NCSU, and Deniz Gurkan and Debjyoti Majumder of the University of Houston in the scope of the IMF project. More specifically, we worked as a team to design the component architecture for IMF. We worked with the Ilia and Debjyoti in testing the initial version of the IMF, which we demonstrated at the GEC7 demo session. We hold a phone meeting once every 1-2 weeks, and we communicate with email using an IMF mailing list.

- **GENI LEARN Project:** University of Houston: Deniz Gurkan, Debjyoti Majumder

We collaborated with Deniz and Debjyoti of the LEARN Project [learn_1] in implementing the measurement handler module. We wrote the module for the Polatis switch, while Deniz and Debjyoti wrote the module for the Infinera switch. We further collaborate by running each other's codes for testing.

- **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.

10. Other Contributions

none

11. Bibliography

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