G E N I

Global Environment for Network Innovations

Milestone S2.b
Demonstrating Embedded Real-Time Physical Measurement from ORCA-BEN Substrate

Document ID: ERM_S2b_Mar10

March 04, 2010

Prepared by:
M.S. Wang, C.P. Lai, and K. Bergman
Dept. of Electrical Engineering, Columbia University New York,
500 W. 120th Street,
New York City, NY 10027
under Project Nr. 1631
“Embedding real-time measurements for cross-layer communications”

TABLE OF CONTENTS

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.b of Project Nr. 1631, "Embedding real-time substrate measurements for cross-layer communications." This milestone document comprises the second deliverable of ERM in Spiral 2 and involves the implementation and demonstration of a working software interface between the unified measurement framework (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 choose to use is a set of four Polatis switches from the ORCA-BEN [orca_1] network, from which we will retrieve optical power measurements.

To achieve this milestone, we integrate the NetFPGA implementation of the UMF with the Integrated Measurement Framework (IMF) project [imf_1]. The IMF project is a joint-effort among research teams from North Carolina State University, Columbia University, University of North Carolina at Chapel Hill/RENCI, and University of Houston. At Columbia (GENI-ERM), our task is to program the unified interface that will communicate with the underlying substrates that has physical measurement capabilities. This interface is programmed as a set of Perl scripts running on the UMF SW, which is the PC component of the NetFPGA. In the future, ERM is also in charge of developing a substrate environment control functionality to allow users' tools/experiments to precisely control and manipulate the experiment environment. Examples of the environment may be varying certain levels of attenuation in optical links, or certain levels of interference in RF experiments. This may be implemented by using the UMF HW, which is the Virtex-II Pro FPGA embedded within the NetFPGA system.

In Section 2, we summarized the work of our previous work in milestone S2.a. In Section 3, we present an overview of IMF. In Section 4, we describe the IMF component architecture, and what parts for which ERM is responsible. In Section 5, we explain a working demonstration of using IMF to obtain real-time optical power measurements from any of the four Polatis switches [polatis_1] in the ORCA-BEN network. 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

GENI_S2H-part2-LEARN-Jan08	Milestone S2.h-part2, LEARN Project
IMF Architecture	Milestone S2.d, IMF Project

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	04 Mar 10	M. S. Wang	Initial draft
1.1	05 Mar 10	C. P. Lai	Revised update

2 Previous Work (Summary of Milestone S2.a)

The goal of the previous Spiral 2 milestone involved the design and development of a unified measurement framework (UMF), which serves as a means for gathering physical layer measurements and conveying the data to the GENI researchers 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 framework 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 (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.

3 IMF Overview

Figure 2-2 shows a schematic of the interactions between the substrates with programmable measurement devices, IMF, GENI control framework, user tools, and GENI experimenter.

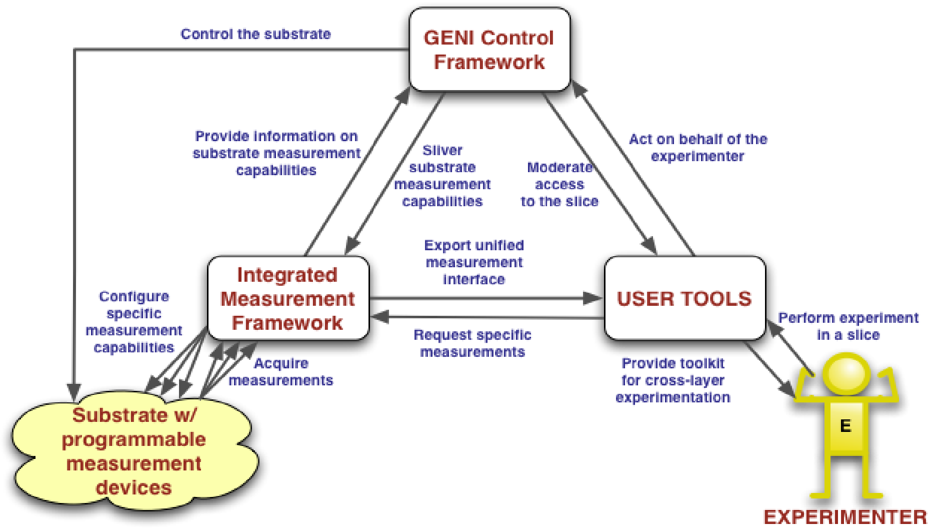

Figure 2-2: IMF Overview

For ERM, our task is to create a unified measurement interface that will obtain measurement data from a diverse set of substrates within the ORCA-BEN network. This interface is implemented as a set of Perl scripts, as described in Section 5, and can be run on any PC, including the NetFPGA SW component. In the future, ERM is also in charge of developing a substrate environment control functionality to allow users' tools/experiments to precisely control and manipulate the experiment environment. Examples of the environment may be certain levels of optical attenuation in optical links, or certain levels of interference in RF experiments. This may be implemented by using the NetFPGA HW component.

After a physical measurement is retrieved from a substrate, the data needs to be conveyed to the proper consumer. There are several types of consumers of measurement data:

- User/experimenter tools existing outside the slice (ET),
- In-slice functions that operate on the measurement data in order to provide closed feed-back loop (for example, SILO),
- Storage functions that collect and store the measurement data for later retrieval.

Since there are various substrates in multiple sites within the ORCA-BEN network, IMF will have to deal with how to correctly and efficiently convey measurement data to all these different consumers. In Section 4, we examine the component architecture of IMF that will address these challenges. A more detailed description of the IMF architecture is presented in [imf_2].

4 IMF Component Architecture

Figure 3-1 shows the components needed to implement the IMF. A more detailed version of the IMF architecture description is presented in [imf_2]. In this section, we describe the component architecture in the context of ERM's contribution.

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.

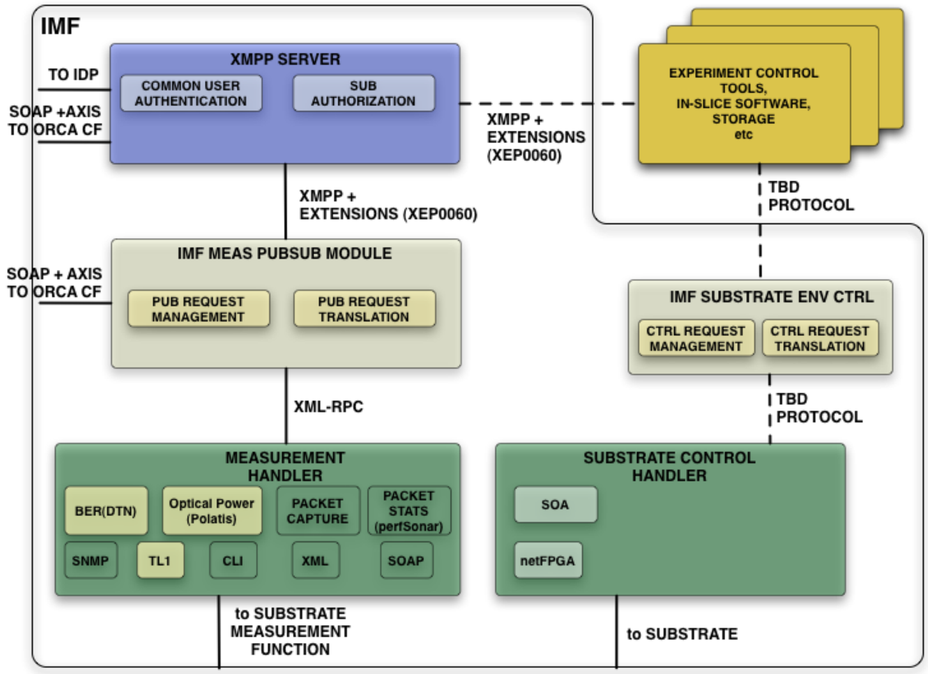

Figure 3-1: IMF Component Architecture

XMPP Server

- Track subscription requests from measurement data consumers.
- Receive publish events from the measurement PubSub Module, which contain measurement data or meta-data.
- ERM: we tested the correct functionality of this server within ORCA-BEN.

Measurement PubSub Module (PSM)

- Allows consumer to subscribe only to the measurement data one is interested in and receives the published data at the frequency that the data is generated, thus removing the need for explicit polling by data consumers.
- Translate information between physical topology of the substrate and virtual topology of the slice.
- ERM: we tested the correct functionality of this module as it receives subscribe requests of measurement data consumers and receives published results from the underlying substrate.

Measurement Handler (MH)

- Presents a uniform interface to configure and query substrate measurement capabilities.

- ERM: we developed MH for the Polatis switch to enable it to measure optical power.

Substrate Environment Control module (SEC)

- Same function as PSM module, but applied to substrate environment control, rather than measurement data collection.
- ERM: This is a newly defined functionality that will be implemented in the future.

Substrate Control Handler (SCH)

- Presents a uniform interface to functions and components within the substrate that can help control and manipulate the experiment environment.
- ERM: This is a newly defined functionality that will be implemented in the future.

5 Enabling Optical Power Measurement from Polatis Switch

Along with the rest of the IMF team, we have developed an initial working version of the IMF, consisting of an XMPP server, PSM module, and 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. 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.

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.

6 Summary and Conclusions

In this report, we discuss our latest Spiral 2 milestone of implementing and demonstrating a working software interface between the unified measurement framework (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 choose to use is a set of four Polatis switches from the ORCA-BEN [orca_1] network, from which we will retrieve 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 demonstrate the ability of IMF to obtain real-time optical power measurements from any of the four Polatis switches in the ORCA-BEN network.

7 Bibliography

[1] [netfpga_1] NetFPGA Cube main homepage. [Online]. Available: http://www.accenttechnologyinc.com/netfpga.php?category_id=0&item_id=1
[2] [netfpga_2] NetFPGA website. [Online]. Available: http://www.netfpga.org/
[3] [erm09_1] C. P. Lai, M. S. Wang, and K. Bergman, "Unified Measurement Framework: NetFPGA Prototype (Project Nr. 1631, Milestone S2.a)," (2009, Dec) [Online]. Available: http://groups.geni.net/geni/wiki/Embedded%20Real-Time%20Measurements
[4] [orca_1] ORCA main homepage. [Online]. Available: http://nicl.cod.cs.duke.edu/orca/
[5] [silo09_1] Net-Silos Team, "SILO Project – Services, Integration, controL and Optimization for the Future Internet," (2009, May) [Online]. Available: http://www.net-silos.net
[6] [imf_1] GENI IMF Wiki. [Online]. Available: http://groups.geni.net/geni/wiki/IMF
[7] [imf_2] I.Baldine, K.Bergman, R.Dutta, D.Gurkan, C.Lai, G.Rouskas, A. Wang, M.S. Wang, "IMF Architecture (Project Nr. 1718, Milestone S2.d)," (2010, Feb) [Online]. Available: https://geni-imf.renci.org/trac/wiki
[8] [polatis_1] Polatis main homepage. [Online]. Available: http://www.polatis.com/
[9] [learn_1] GENI LEARN Wiki. [Online]. Available: http://groups.geni.net/geni/wiki/LEARN
[10] [learn_2] M. Wang, D. Gurkan, C. P. Lai, K. Bergman, "Specification for Measurement Handler Software (Project Nr. 1733, Milestone S2.a Part II)," (2010 Dec) [Online]. Available: http://groups.geni.net/geni/wiki/LEARN
[11] [xmpp_1] RFC 3920: Extensible Messaging and Presence Protocol (XMPP): Core
[12] [xmpp_2] RFC 3921: Extensible Messaging and Presence Protocol (XMPP): Instant Messaging and Presence
[13] [xmpp_3] XEP-0060: Publish Subscribe (http://xmpp.org/extensions/xep-0060.html)
[14] [xmpp_4] OpenFire XMPP server (http://www.igniterealtime.org/projects/openfire/)