

GENI-IMF Demo at GEC8  
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(Project 1718)

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## 2. Overview

During GEC8, we were able to demonstrate a small but complete cross-layer reactive system, showing two-way communication between the SILO service operating in the networking stack in a slice, and both measurement and actuation capabilities in an optical substrate. We consider this to be a significant achievement, and a proof-of-concept of the basic vision of the IMF project, though the actual capabilities demonstrated are comparatively rudimentary. This document describes the details related to the demonstration of this capability.

### 2.1. Measurement Part

- Semiconductor Optical Amplifier (SOA) prototype board is ready to deploy;
- Variable Optical Attenuator (VOA) Control Script is finished;

### 2.2. SILO part

- SILO is deployed in BEN Eucalyptus Cloud both in the RENCI site and UNC site in form of virtual machines;
- SILO Application Gateway is developed to support video stream transportation;
- Measurement service is developed to communicate with the XMPP server for measurement data;
- The interfaces between SOA and netFPGA is defined and implemented through XML-RPC;
- Controller service is developed to control the SOA;
- Packet drop service is developed to simulate packet drop according to BER;
- Video stream has been successfully transmitted between silos across SOA/VOA controlled path;
- IMF demo setup described below was used at GEC 8.

### 3. IMF Demo Setup

#### 3.1. Optical Devices Connections

Figure 1: IMF Demo Physical Connections

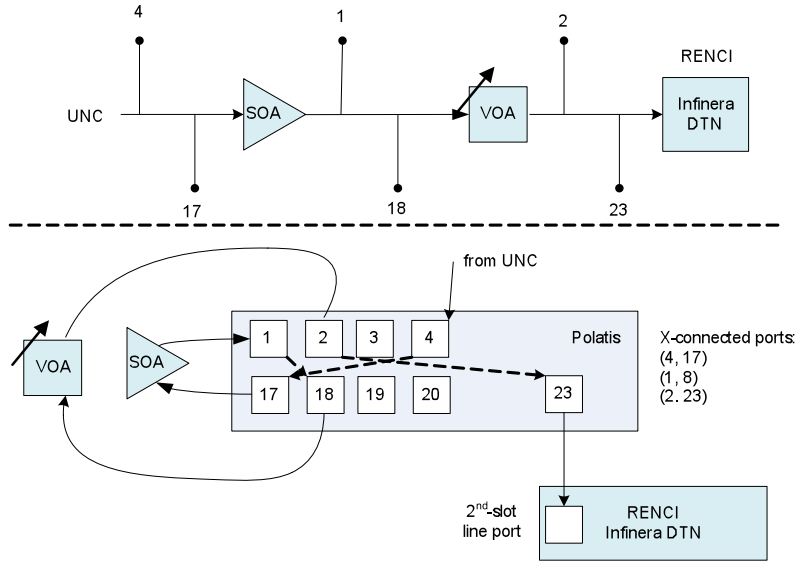


Fig. 1 shows the physical connections between optical devices in BEN at the RENCI site. The upper half shows the logical connections, and the lower half shows the physical connection and cross-connected in the Polatis Optical switch.

### 3.2. Virtual Machine Configuration

Figure 2: Virtual Machine Configuration

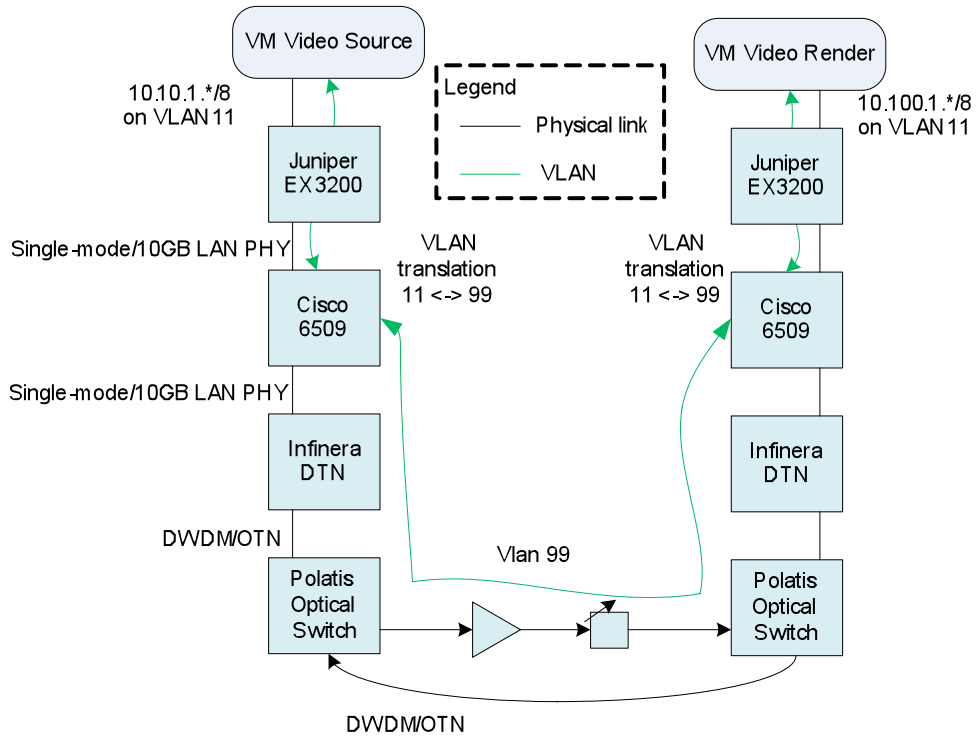
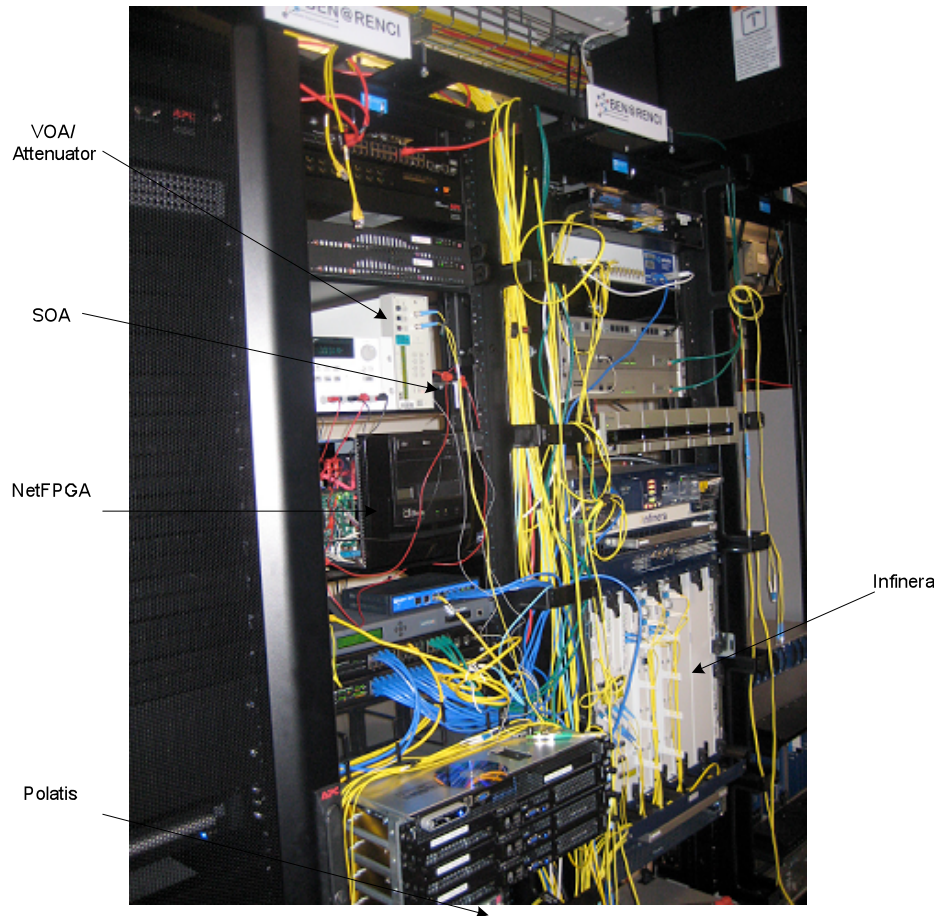


Fig. 2 shows the VM configuration in BEN at RENCi site. SILO is running in those virtual machines. VMs between RENCi and UNC are manually configured into a VLAN. VLAN translation technology is used to achieve this on the Cisco 6509 in the both sites.

### 3.3. IMF Infrastructure

Figure 3: IMF Infrastructure In RENCI



## 4. Cross-Service Control and Video Stream Demo

Fig.4 shows the details of the cross-service control and video stream demo. At least four SILO services are used in the each side.

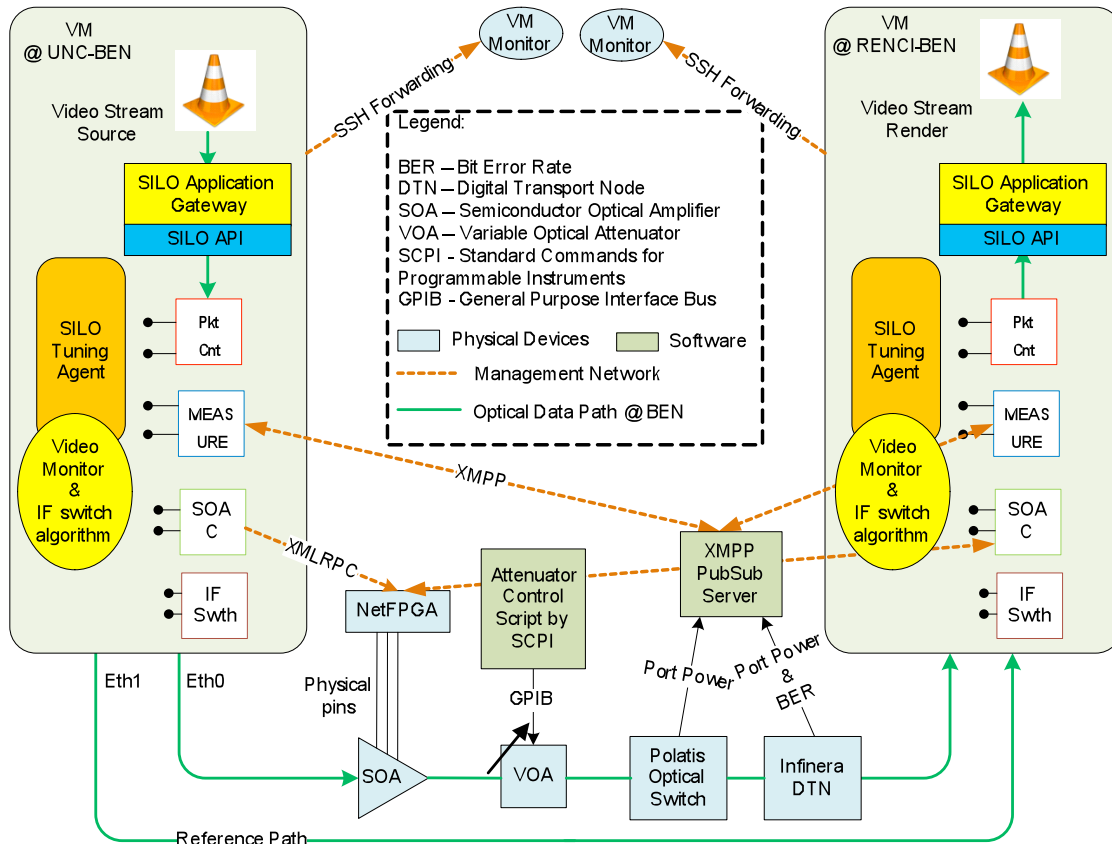
- *Packet Counter*: Counts the number of packets;
- *Measurement Collector*: Collects port power/BER from Polatis and Infinera, published by the XMPP server;
- *SOAC*: Controls the SOA through XML-RPC;
- *Interface Switch*: Switches video stream to the reference path when the SOA/VOA controlled path cannot be compensate anymore.

A SILO algorithm is loaded by the Silo Tuning Agent. Video monitor and Interface Switch algorithm oversees all four services, and tune the knobs, and try to reach three goals:

- 1) When the power decreases because of the attenuation (controlled by the Matlab script), pump up SOA to compensate the power loss;

- 2) Make sure the port power stay in the safe level, and turn down the SOA when necessary;
- 3) When the SOA/VOA controlled path cannot be compensated anymore, make decision to switch all traffic to the reference (backup) path. Since currently there is no available reference path in BEN, SILO switch traffic to management network.

Figure 4: the cross-service control and video stream demo



Note: Reference Path does not exist in the current experiment SILO switches traffic to the management network

## 5. Interface between the SILO SOA Controller and netFPGA

NetFGPA card is a PCI card. It is plugged into a PC running CentOS. XML-PRC server runs on this linux PC. The interfaces between the SILO SOA Controller service and XML-RPC server/netFPGA have been defined and implemented.

Originally, we tried to design functions like `set_gain( x dbm)`, `get_gain(x dbm)`. We found out it was not feasible because neither the SOA nor the netFPGA does retain any gain status. In light of this, we switch all logic to the SILO SOA Control service, and the following functions are designed.



- *soa\_up*: increases the SOA gain by the minimum granularity. This minimum granularity is not liner, and it changes between 0.3 dBm and 0.5 dBm.
- *soa\_down*: decreases the SOA gain by the minimum granularity. This minimum granularity is not liner, and it changes between 0.3 dBm and 0.7 dBm.
- *get\_soa\_gain\_threshold*: (optional) gets suggested value of the maximum gain a SOA is able to achieve, and does introduce risk to break down. This value is preset in the XML-RPC server. The SILO service should be able to use preset value in the tuning algorithm is this value is not provide by the XML-RPC server.

The SILO SOA Controller service uses the xmlrpc-c library [1].

## 6. Results

In the following experiments, we examine the port power on the Polatis port 23. This port power is controlled by SOA & VOA.

Figure 5: port power w/ attenuator 10 dBm

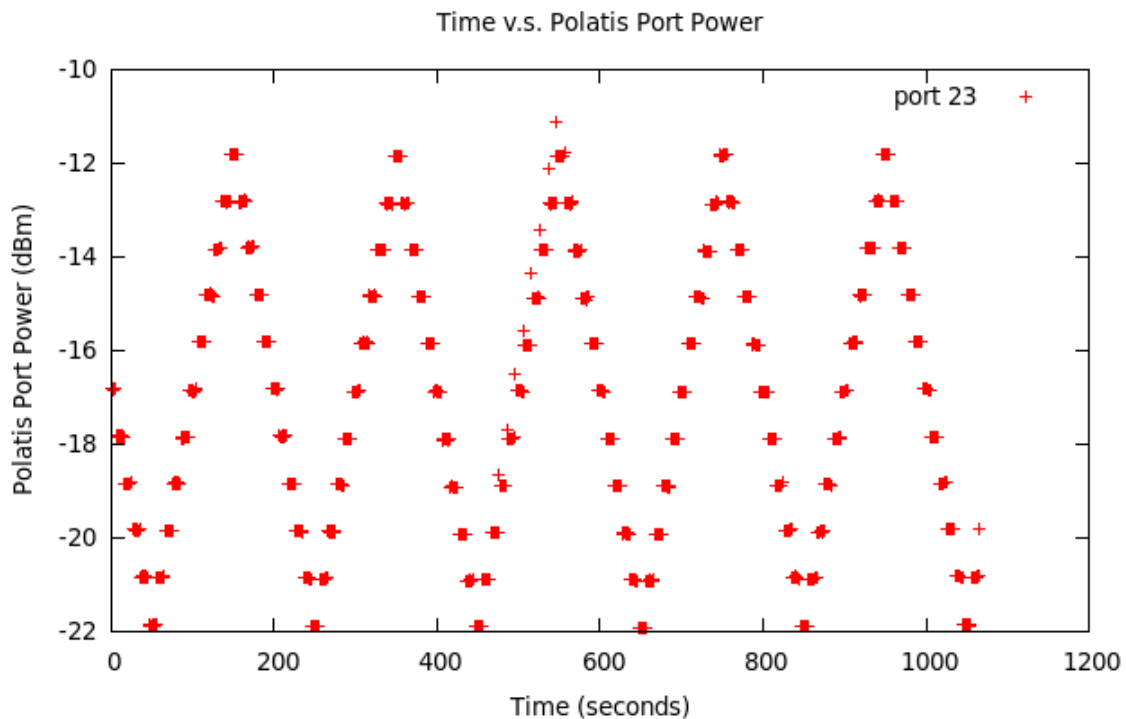


Fig. 5 shows the baseline of our experiments. Attenuator fluctuates from 0 dBm to 10 dBm in the manner of a step function. The output of the attenuator changes 1 dBm every 10 seconds.

Figure 6: port power w/ attenuator 10 dBm w/the SILO tuning

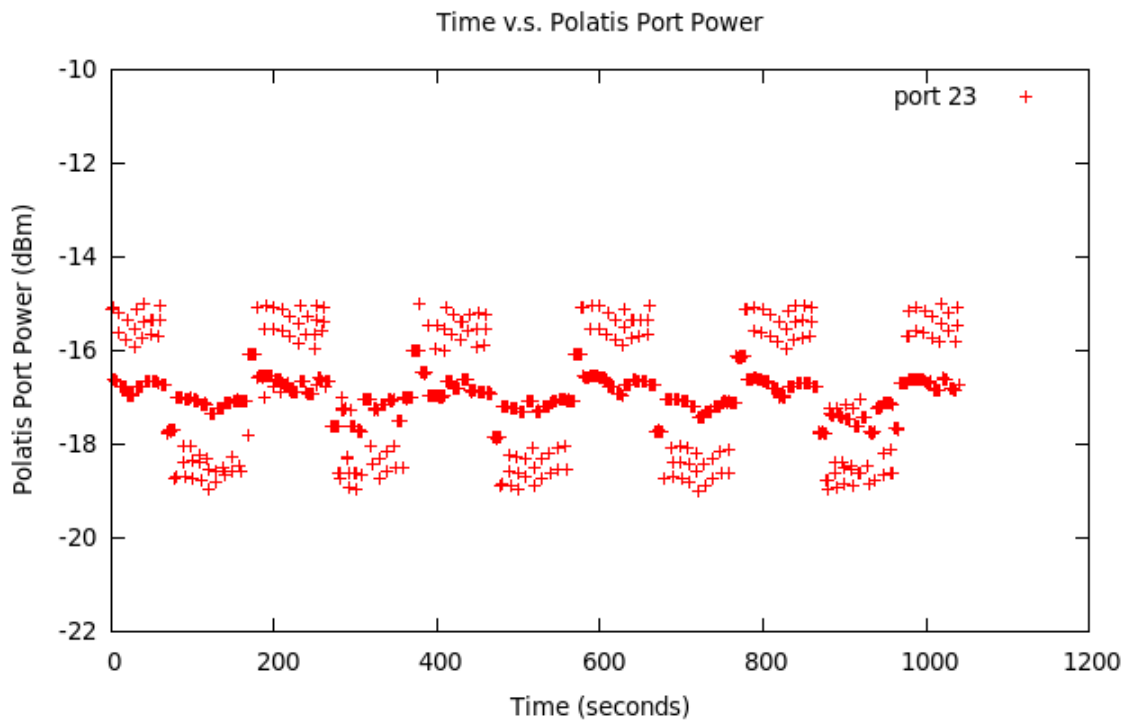
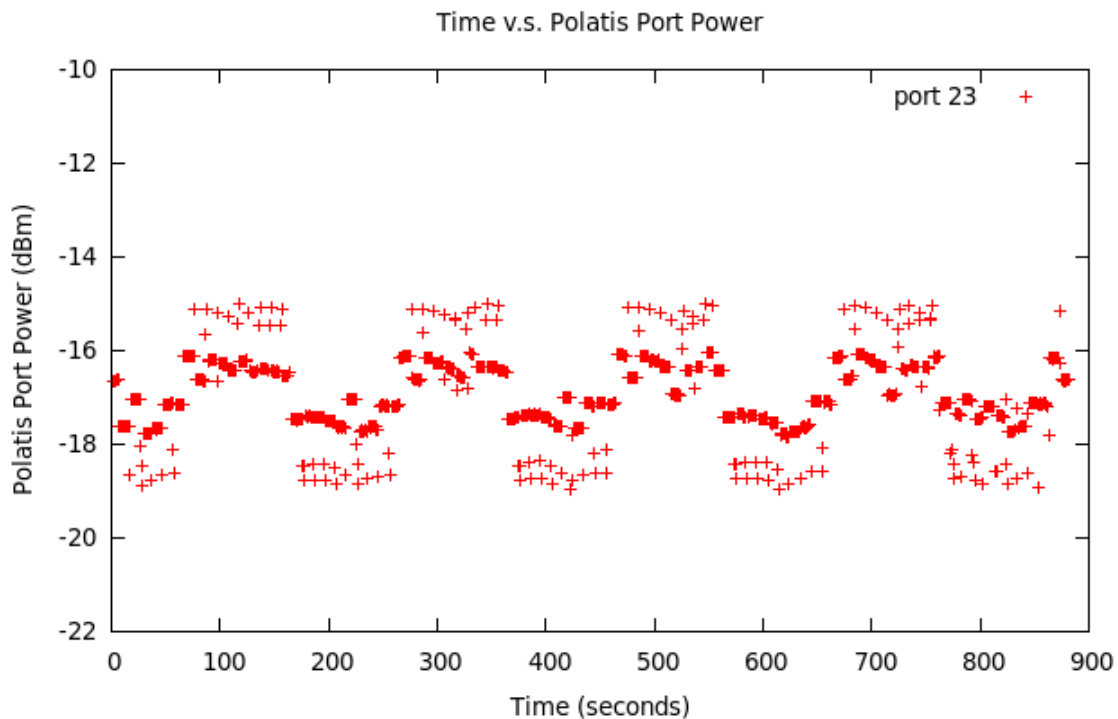


Fig. 6 shows the result when we introduce tuning algorithm to try to maintain the port power between -18 dBm and -16 dBm. Whenever the port power (monitored by the measurement service) is beyond this scope, the SOA Controller service increases or decreases the gain of the SOA by calling soa\_up or soa\_down one time. It shows most of the time, power is controlled between -16 and -18.

Figure 7: port power w/ attenuator 10 dBm w/the SILO tuning (slightly different tuning algorithm)



The algorithm used in Fig. 7 decreases or increases the SOA by calling `soa_up` or `soa_down` by  $x$  times ( $x = (\text{current port power} - 17) / 0.7$ ). This algorithm assumes that `soa_up` or `soa_down` changes the gain by 0.7 dBm. The control is slightly improved comparing to Fig. 6. This algorithm could be improved when we have the full SOA (power vs. gain) relation.

Note: Later on, we found there was some software bug from the XMPP publishing side, which affected the absolute value of port 23's power. The correct value should be around 8 dBm higher (might be non-linear). However, this does not affect our result, since we are observing the relative values. We are not going to adjust the current plots, and will generate new plots later on.

## 7. References

[1] The `xmlrpc-c` library (<http://xmlrpc-c.sourceforge.net/>)