G E N I

Global Environment for Network Innovations

Milestone 2
DMEAS: Document Embedded Measurement Capabilities
(DRAFT)

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"Data Plane Measurements"

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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 results obtained in work package "Milestone 2: Embedded measurements in substrate technologies" of Project Nr. 1653, "Data Plane Measurements". The purpose of this milestone is to document embedded measurements capabilities of all substrate technologies. In Section 2 we document the embedded measurements capabilities of all substrate technologies based on the current version (GENI-INF-PRO-S1-CAT-01.5) of GENI's "Spiral 1 substrate catalog" [geni09_1], as well as on information from equipment vendors and the internet. Embedded measurements are readily accessible measurements on network nodes. Remote connectivity and access capabilities of these measurements are very important for a GENI researcher.

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
GENI_QSR_D_MEAS-v5	4Q08 Status Report
GENI-INF-PRO-S1-CAT-01.5	GENI Spiral 1 Substrate Catalog

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	01 Mar 09	D. Gurkan	Initial draft
2.0	06 Mar 09	R. Krishnappa	Added details about FSP 3000 and Polatis fiber switch

2 Embedded measurements

2.1 Document Embedded Measurement Capabilities

Document the embedded measurements capabilities of all substrate technologies based on the current version (GENI-INF-PRO-S1-CAT-01.5) of GENI's "Spiral 1 substrate catalog" [geni09_1]. Some prototypes do not have this information posted yet.

2.1.1 Embedded measurement capabilities of several equipments in GENI infrastructure

Ciena CN 4200, Infinera DTN, ADVA FSP 3000

Ciena CN 4200[ciena09_1], Infinera DTN [inf09_1] and ADVA optical networking equipment FSP 3000 [adva09_1] are some of the instruments that are employed in some of the substrate technologies. Ciena CN 4200 is employed in GpENI substrate technology. Infinera DTN is employed in Proto-GENI and BEN substrate technologies. Adva optical networking layer 1 equipment, FSP 3000 is employed in mid-atlantic network substrate technology.

Table 1 gives the embedded measurement capabilities that are available on these instruments, the remote connectivity and programming tools that are available on these instruments. The information provided in the table is according to the vendor's webpages and datasheets. The remote connectivity can be leveraged using Ethernet based craft interface, RS-232, SNMP and TL1. Several remote programming tools are available with these instruments for local and remote node access.

Model	Measurement	Network management and Remote connectivity	Remote Programming Tool
Ciena - CN 4200	▪ Bit error rate. ▪ Optical power. ▪ Protocol specific performance monitoring like Remote Monitoring (RMON) for Ethernet connections. ▪ Performance monitoring on all client and network services.	▪ Remote programmability of both ports and connections. ▪ Two (2) 10/100BaseT ***Ethernet*** ports for remote connectivity, access to node level HTTP interface and access to SNMP agent SNMP v1 (RFCs 1155-1157), SNMP v2c, SNMP v3, CLI, Telnet, HTTP, FTP, ***RS-232*** serial port for local craft access ▪ Web-Based GUI, CLI, TL1, and Trilingual SNMP (v1, v2c, and v3). Transaction Language 1 (TL1) through a TCP/IP telnet connection using the MGMT (Management) interface port or by way of a Neighbor Discovery Protocol (NDP) optical connection to the NE. ▪ Command Line Interface (CLI) using the CONSOLE interface port, or by way of a telnet session using the MGMT (Management) interface port, or by way of an NDP-enabled optical connection to the NE. ▪ Simple Network Management Protocol (SNMP) using the MGMT interface port or by way of an NDP-enabled optical connection to the NE. ▪ Hypertext Transfer Protocol (HTTP) using the MGMT interface port or by way of an NDPenabled optical connection to the NE. Up to the following HTTP browser versions are supported: - FireFox 1.5.0 - Mozilla 2.0.0.3 - Internet Explorer 6.0 - Netscape 4.7	*ON-Center Network Control System* ▪ Manages services ▪ Network management capabilities such as monitoring performance and health of the network ▪ Automation

Infinera DTN	▪ Full digital access to the optical layer. ▪ Full digital performance monitoring. ▪ Fault management.	▪ SNMP ▪ TL1 interface ▪ Ethernet- based craft interface ▪ Remote connection via Data Communications Network (DCN) ▪ Remote connection via the in-band management channel carried by the Optical Supervisory Channel (OSC)	▪ Graphical Node Manager
FSP 3000	▪ Optical performance monitoring - Current records for SONET/SDH, physical layer, service availability - PM threshold setting - PM threshold crossing alerts ▪ FEC counters (only for 10G transponders) ▪ SNMP traps for alarm monitoring. ▪ Fault management	▪ SNMP ▪ Ethernet 10Mbit/s ▪ PPP/RS-232 ▪ Remote management via in-band channels	▪ FSP Element manager

Table 1: Measurement capabilities and remote connectivity of CN 4200, Infinera DTN, and FSP 3000 according to vendor's webpages and data sheets.

NEC WiMax Base Station Features

NEC WiMax Base is used in the WiMax substrate technologies. NEC WiMax Base station features are listed in the table 2. The Phy, MAC and networking layer information can be retrieved and the information might be useful for researchers.

PHY	**Access mode**	SOFDMA/TDD
	Frequency	2535 ~ 2605 MHz
	DL:UL ratio	35:12, 26:21, 29:18
	Channel BW	10 MHz , 8.75 MHz
	FFT size	1024, 512
	Frame duration	5ms
	TX output Power	35dBm (max)
	# of sectors	3
MAC	**Head compression**	PHS
	ARQ	HARQ/CC, ARQ
	MBS support	Single BS, multiple BS-MBS
	Resource management	Power control, mode control (idle, sleep etc.)

Networking	**IP protocols**	IPv4, IPv6
	Bridging/Routing	Transparent L2 switch, Bridging
	Packet handling	802.1Q VLAN, PHS**)

Table 2: NEC WiMax Base station features

Polatis 24 Port Fiber Switch

Polatis switch [polatis09_1] products combine switch, attenuation, and power meter functions into one product. The *Polatis switch* is employed within BEN and offers the possibility to remotely monitor the optical power on a per port basis. For remote power monitoring, the interfacing can be done via Ethernet, serial interface (RS232), or GPIB.

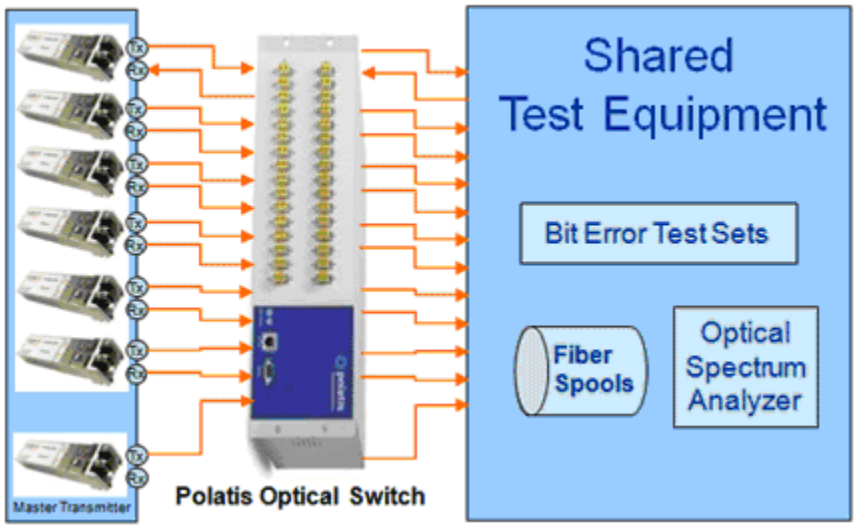

Figure 1: Polatis test and measurement solution [polatis09_1]

At the core on an automated test infrastructure, the Polatis solution provides connectivity with optical transparency.

Physical Layer Connectivity in Test Applications

Manufacturing Automation:

- Receiver and transmitter testing
- BER
- Jitter and protocol testing
- Burn-in and environmental testing

2.1.2 Embedded measurement capabilities in substrate technologies

The embedded measurement capabilities that are available in the substrate technologies are listed.

Cluster A

i) TIED

There is no information available as yet.

Cluster B

i) Mid Atlantic Network

Refer to Section 3.5 – Mid Atlantic Network: Measurement and Instrumentation of Spiral1 substrate catalog, document id GENI-INF-PRO-S1-CAT-01.5.

- Layer 1 equipment (Adva Optical Networking) provides access to optical performance monitoring data, FEC counters (only for 10 G transponders), and SNMP traps for alarm monitoring.
- Layer 2 Ethernet switches provide access to packet counters and error counters.
- The DRAGON network uses Nagios for monitoring general network health, round-trip time between nodes, etc.
- Cricket is used for graphing network performance (interface speeds) as well as graphing optical performance monitoring data (light levels, FEC counters, etc).
- The DRAGON network also has a Perfsonar active measurement point deployed at https://perfsonar.dragon.maxgigapop.net.

ii) GpENI

The measurements are not available for the GENI researcher's access according to the documentation received from GpENI.

- Real-time web-based monitoring interfaces will be made available on the GpENI wiki.
- Ciena CN 4200 is a box available on this network. The measurement capabilities of Ciena CN 4200 are listed below.
  - Bit error rate.
  - Optical power.
  - Protocol specific performance monitoring like Remote Monitoring (RMON) for Ethernet connections.
  - Performance monitoring on all client and network services.

iii) Enterprise GENI

Refer to Section 8.5 – Enterprise GENI: Measurement and Instrumentation of Spiral1 substrate catalog, document id GENI-INF-PRO-S1-CAT-01.5.

OpenFlow is used to gather statistics at a per flow entry granularity on the routers/switches directly. Users will need to operate an OpenFlow controller to control forwarding decisions in the network. This allows for complete control over L2/L3 forwarding decisions, including experimental protocols which are not IP based.

iv) SPP Overlay

Refer to Section 9.5 – SPP Overlay: Measurement and Instrumentation of Spiral1 substrate catalog, document id GENI-INF-PRO-S1-CAT-01.5.

- SPP Overlay will implement the standard PlanetLab mechanisms for auditing outgoing traffic. In addition, the core components provide a large number of low level traffic counters that will be accessible to users and can be used to generate real-time charts of traffic associated with a slice
- NetFPGA is a programmable hardware. Various measurements should be possible using NetFPGA. However, SPP Overlay group did not specify any specific measurements in their documentation.

v) Planet Lab

There is no information available as yet.

Cluster C

i) CMU Testbeds

Refer to Section 6.5 – CMU Testbeds: Measurement and Instrumentation of Spiral1 substrate catalog, document id GENI-INF-PRO-S1-CAT-01.5.

CMU testbeds have standard machine monitoring like interface monitoring, tcpdump/pcap, nagios-style monitoring of machine availability, etc.

ii) Proto-GENI

Refer to Section 10.5 – Proto-GENI: Measurement and Instrumentation of Spiral1 substrate catalog, document id GENI-INF-PRO-S1-CAT-01.5.

- Ethernet switches have basic packet counters, and can be configured to "mirror" traffic between ports for collection purposes. The PCs will be able to use standard measurement and capture tools, such as tcpdump.
- NetFPGA is a programmable hardware. Various measurements should be possible using NetFPGA. However, Proto-GENI group did not specify any specific measurements in their documentation.

iii) Programmable Edge Node

Refer to Section 11.5 – Programmable Edge Node: Measurement and Instrumentation of Spiral1 substrate catalog, document id GENI-INF-PRO-S1-CAT-01.5.

The measurement in PEN can be done on either x86 or network processor (NP). Measurement metrics that can be obtained on network processor are primarily flow statistics, including start-of-flow timestamp, current timestamp, packet count for each direction (host to NP and NP to host), byte count for each direction and the flow tuples. In addition physical NP ports statistics including number of octets, the number of unicast/multicast/broadcast packets, and the numbers of packets of different size intervals that have been sent and received by each physical port can also be measured.

iv) Measurement System

Refer to Section 12.5 – Measurement System: Measurement and Instrumentation of Spiral1 substrate catalog, document id GENI-INF-PRO-S1-CAT-01.5.

Measurement system enables the users to capture packets associated with their experiments. The measurement systems will also generate a set of system utilization measurements that will be available via SNMP and activity logs that will be available via syslog.

Cluster D

i) BEN

- *Polatis 32 fiber Reconfigurable Optical Switch:*

Refer to Section 5.5 – BEN: Measurement and Instrumentation of Spiral1 substrate catalog, document id GENI-INF-PRO-S1-CAT-01.5.

It supports optical power measurement. Renci is developing a graphical user interface with multiple views (based on credentials) to operate the Polatis optical switch.

Polatis - 20 directional optical power monitors (OPM) as specified in the table 3.

Fiber #	Input OPM?	Output OPM?	Fiber #	Input OPM?	Output OPM?
1	Yes	Yes	17	Yes	Yes
2	Yes	Yes	18	Yes	Yes
3	Yes		19		Yes
4	Yes		20		Yes
5	Yes		21		Yes
6	Yes		22		Yes
7	Yes		23		Yes

8	Yes		24		Yes
9			25		
10			26		
11			27		
12			28		
13			29		
14			30		
15			31		
16			32		

Table 3: Polatis 20 directional optical power monitors (OPM)

- Input optical power monitors measure light entering the switch
- Output optical power monitors measure light exiting the switch
- No optical power monitors on fibers 9-16 and 25-32
- Support for Ethernet interface, serial RS-232 interface, SNMP and TL1

- *Infinera Digital Transport Node (DTN) :*

  The measurement capabilities of Infinera DTN are listed below:

  - Full digital access to the optical layer.
  - Full digital performance monitoring.
  - Fault management.

Although these measurements are embedded into the nodes, they are not available to the GENI researcher's access through any software mechanism yet.

ii) DOME

Refer to Section 7.5 – DOME: Measurement and Instrumentation of Spiral1 substrate catalog, document id GENI-INF-PRO-S1-CAT-01.5.

When the computers come up they do a self-check of their health and log the results to UMass server. Once running, the computers on the buses continuously attempt to report their GPS coordinates so that we can determine a computer is running and track the bus's location.

The measurement metrics includes SSIDs discovered, whether a bus could communicate with the mesh or other buses, throughput information, etc. The control of the devices has now been ceded to the GENI experiments, and the GENI researchers are free to measure whatever they find useful. The information for 802.11 includes available SSIDs and BSSIDs, signal strength, noise level, and type of security that may be enabled. Since both the raw PCI device and root access is available, all traffic,

including beacons, can be recorded using standard tools such as tcpdump. With respect to the GPS device, both interpreted data and access to the raw sentences will be available.

iii) Vise

Refer to Section 13.5 – Vise: Measurement and Instrumentation of Spiral1 substrate catalog, document id GENI-INF-PRO-S1-CAT-01.5.

Each sensor measures attributes of its physical surroundings. The raw reflectivity and voltage data gathered by the radar is stored in NetCDF files.

Details of the NetCDF standard may be found at :
http://www.unidata.ucar.edu/software/netcdf/

http://en.wikipedia.org/wiki/NetCDF.

iv) Kansei Sensor Networks

Refer to Section 17.5 – Vise: Measurement and Instrumentation of Spiral1 substrate catalog, document id GENI-INF-PRO-S1-CAT-01.5.

The Kansei health management service, called 'Kansei Doctor', is an autonomous health service, periodically measures the number of available nodes, their health, radio link quality and other networking metrics relevant for sensor networks. Kansei also provides storage space for users to log their custom experimental data, and it has user interaction services such as data/command injection.

NetEye will use the Kansei health services/tools. NetEye provides storage space for users to log their experimental data, and user interaction services just as Kansei does.

Kansei and NetEye provide a web portal for local or remote users to easily access the testbed. Using the current web-interface an authorized user can create slices, schedule a job on the testbed to automatically program the sensor and wireless devices on a particular slice and store the experimental data on the server. Kansei supports scripted, real time data and event injection. The Kansei health monitoring service called the 'Kansei Doctor' is an autonomous self-contained health monitoring system which can be requested to run along with an experiment to monitor the job in real-time. Kansei and NetEye supports scripted, real time data and event injection.

Cluster E

i) WiMax

Refer to Section 14.5 – WiMax: Measurement and Instrumentation of Spiral1 substrate catalog, document id GENI-INF-PRO-S1-CAT-01.5.

WiMax plan to use features of the ORBIT measurement library for collecting real-time measurements for experiments. The library will run on the GBSN controller and record per flow or per packet measurements and maintain databases for each experiment, and make it available through the ORBIT experiment control portal. The

framework will handle both Layer 2 and 3 measurements. The collection library will aggregate the measurements and send them to a collection server running in the OMF management system.

NEC WiMax Base station features are listed in the table 2. The Phy, MAC and networking layer information can be retrieved and the information might be useful for researchers.

ii) Orbit

There is no information available as yet.

Disclaimer: The summary of substrate technologies available in GENI's substrate infrastructure given in this section does not raise the claim of completeness. GENI working group members are invited for further discussions. Any information about additionally, current or future, available at the substrate level should be sent to the authors (cf. contact information [geni08_1]) to be included in future revisions of this document.

3 Bibliography

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