GENI Measurements

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Questions

- What needs to be measured? And, what can be measured?
- How can the measurements be accessed or shared as a resource?
- How can archiving of measurements work?
- How can we deliver health and status monitoring?

Measurements in GENI

- Any standalone measurement instrument is a component in GENI (needs to have O&M and slice coordination)
  - Programmable measurements of e.g. a spectrum analyzer on a link, a BERT on a link, an end-to-end spectrum utilization, etc.
- Embedded measurements in substrate components are resources: their slicing will depend on the component's resources
  - E.g. attenuation, power flatness among WDM channels, etc.

Measurement Challenges

1. Usually no interference between the measurement plane and the data plane is desired – or else use OMIS data.
2. Also, no interference between the IP infrastructure (that accesses and manages the components and resources) and the measurement plane is desired.
3. We need to figure out a way to make use of COTS instruments of today to emerge towards answering the future exotic measurement requests.
4. Programmability of measurements (using their Rspec as information on what they can do and how): access resources of measurements using the Rspec and then program an applicable configuration for a specific experiment.

Measurement Challenges cont.

5. Location of extensive measurement equipment will bias the experimenters towards research around those nodes leading to contention among resources.
6. GIMS architecture has to be hand-in-hand with measurement plane to prevent any GENI interface problems later.
   – Maybe, we should work on a measurement standardization scheme for optical layer at the same time? This would be similar to a sensor network architecture.

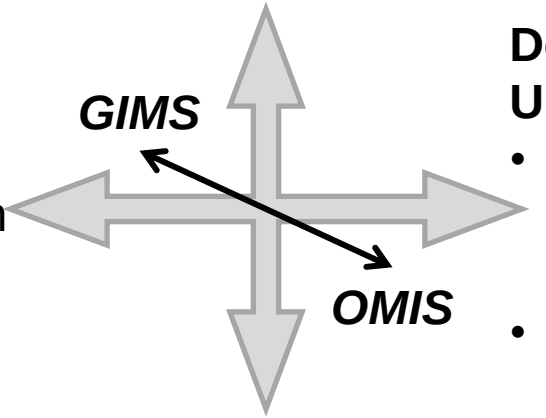
Measurement Architecture

Privacy of user opt-in

Rspecs for Instruments: Sensor → actuator

Slice Coordination Among Users:
- Component manager
- Resource management

Test and Measurement Instruments:
- Different interfaces
- Stream, parameter, alarm
- Multiple users
- Service ←→ hardware
- Designed for current IP
  - clean-slate research?

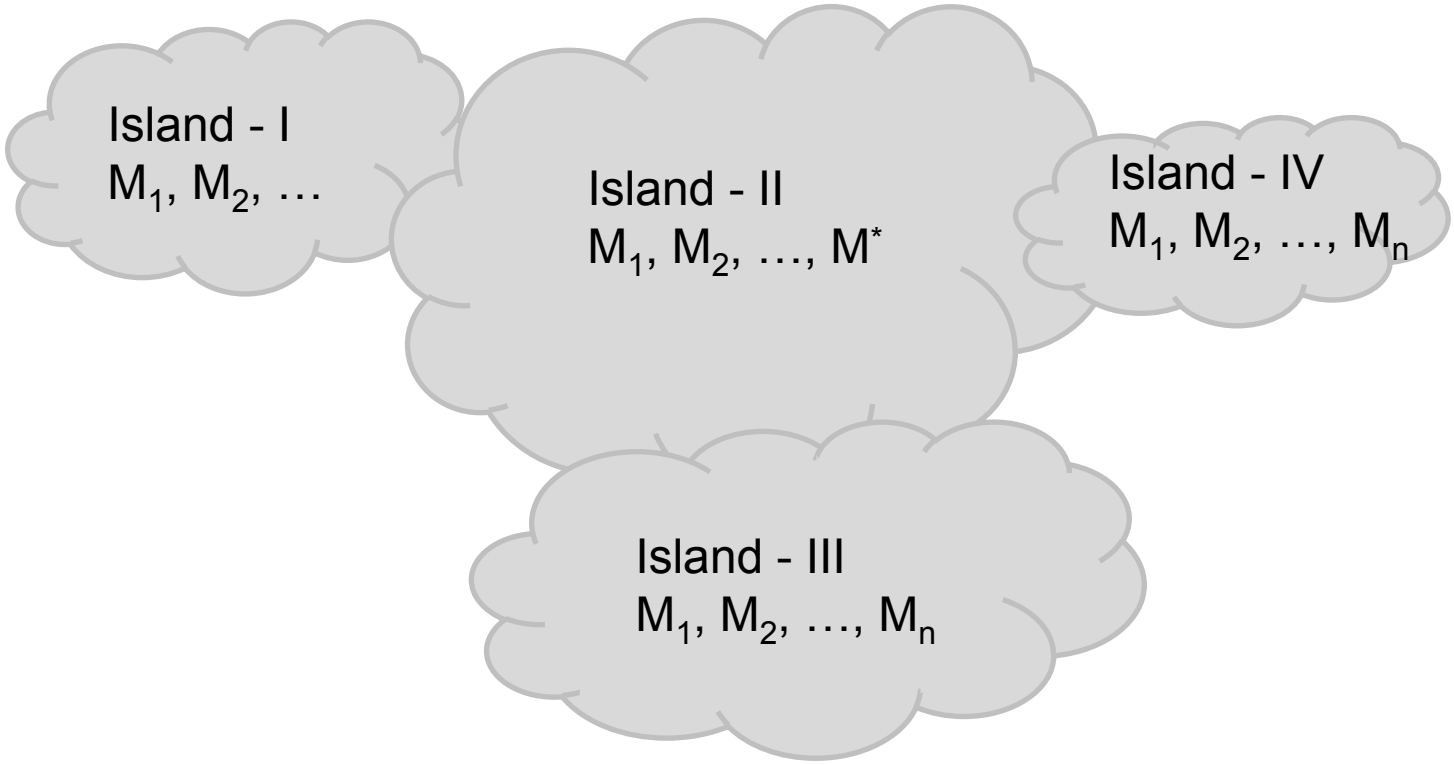


Devices (links, services) Under Test:
- End-to-end
  - processing intensive
  - intelligent output
- Link level measurements:
  - standalone or embedded
  - sensor output (raw)

Sensor Networks

Complex Flexible Connection Requirements:
- Data plane and measurement plane
- Data archiving
- Component manager connections

Measurements and GENI Islands



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Configuration of Measurements

- GENI has to have programmable (reconfigurable) measurement services:
  - Power attenuation and chromatic dispersion on a specific wavelength
  - BER of particular flows in wavelengths and in time
  - Spectral analysis of sources for varying transmission wavelengths
- Remote access of measurement configuration is key to the ease of use of GENI – since measurement plane is one of the key elements, it has to be easy to work with to be utilized by researchers: otherwise, it should die…

Measurement Instruments

Company	E/S	Remote	What is measured?
Aegis Lightwave	E, S	Depends	λ monitoring
Lightwaves 2020	E, S	RS-232	λ monitoring
Apex Technologies	S	Ethernet	OCSA
Tempo	S	IEEE 488, GPIB	OTDR
Photonic Solution Inc	E	?	power monitoring for ROADM
Axsun Technologies	E	RS-232, or other	spectrum monitoring for ROADM
Monitoring Division	S	various	in-band OSNR, impairments
Digital Lightwave	S	multi-user	Ethernet up to 40 Gbps
Capella	E	RS-232	power
JGR Services	E,	GPIB	insertion and return loss

OCSA: Optical Complex Spectrum Analyzer
E/S: embedded/standalone

Optical Layer Measurements and GENI

- Monitoring and all processing linked to the application
- Provide raw measurement reports
- Link by link measurements
  - BER
  - Wavelength channel quality
  - In-line hardware power penalty
  - Flow related
- End-to-end measurements
  - Packet loss rate
  - Hop count
  - Congestion
  - Buffering