An Instrumentation Approach for ProtoGENI-based Edulabs

Jim Griffioen
Laboratory for Advanced Networking
University of Kentucky
Lexington, KY

Edulab Background

- Edulab is an Emulab-based emulation system used for research and teaching
- Emulab simplified experiment setup, but
- Emulab did not help observe a (running) experiment.
- Students do not typically have the system and network administration skills that are required to set up the instrumentation needed to observe an experiment.
- We needed a way to simplify the instrumentation process so students could observe the (runtime) behavior of their experiments.
- We added enhancements to the Emulab code to automatically set up instrumentation and make the results available via a web-based interface.

Edulab Features

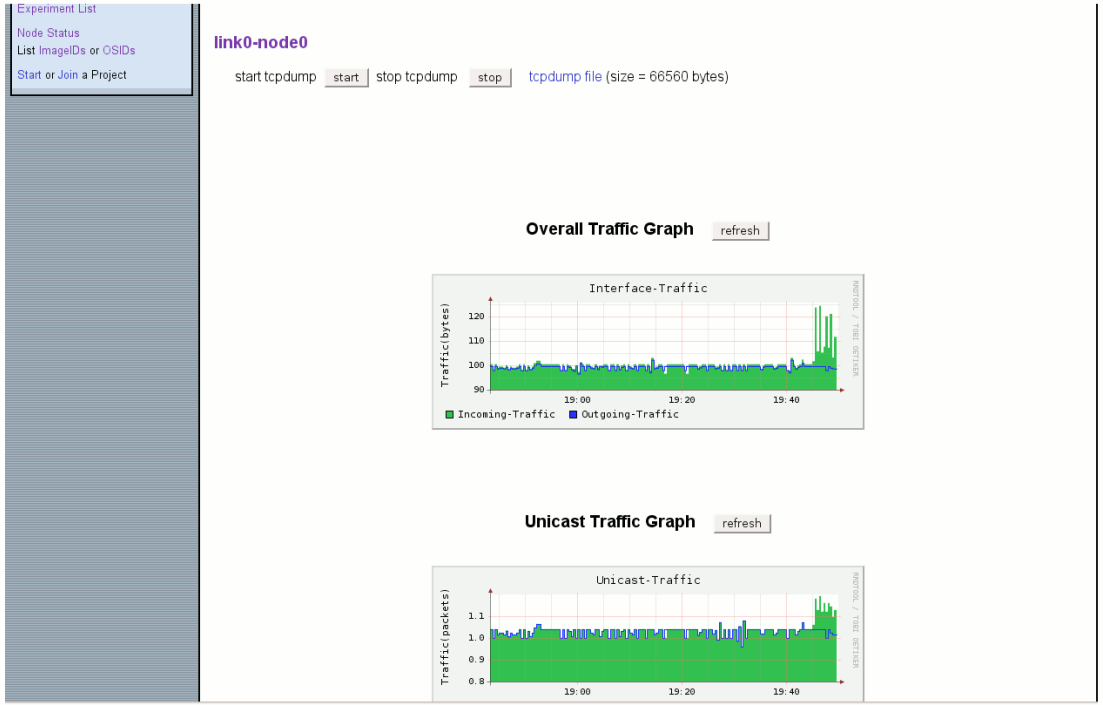
- Automatic instrumentation and monitoring capabilities to capture:
  - Packets
  - Network State
- Single web-based GUI monitors all resources
- Experiment snapshots
- Enhanced user management interfaces
- Protected (private) captured data
- Project scheduling
- Support for virtual nodes

Packets and Network State

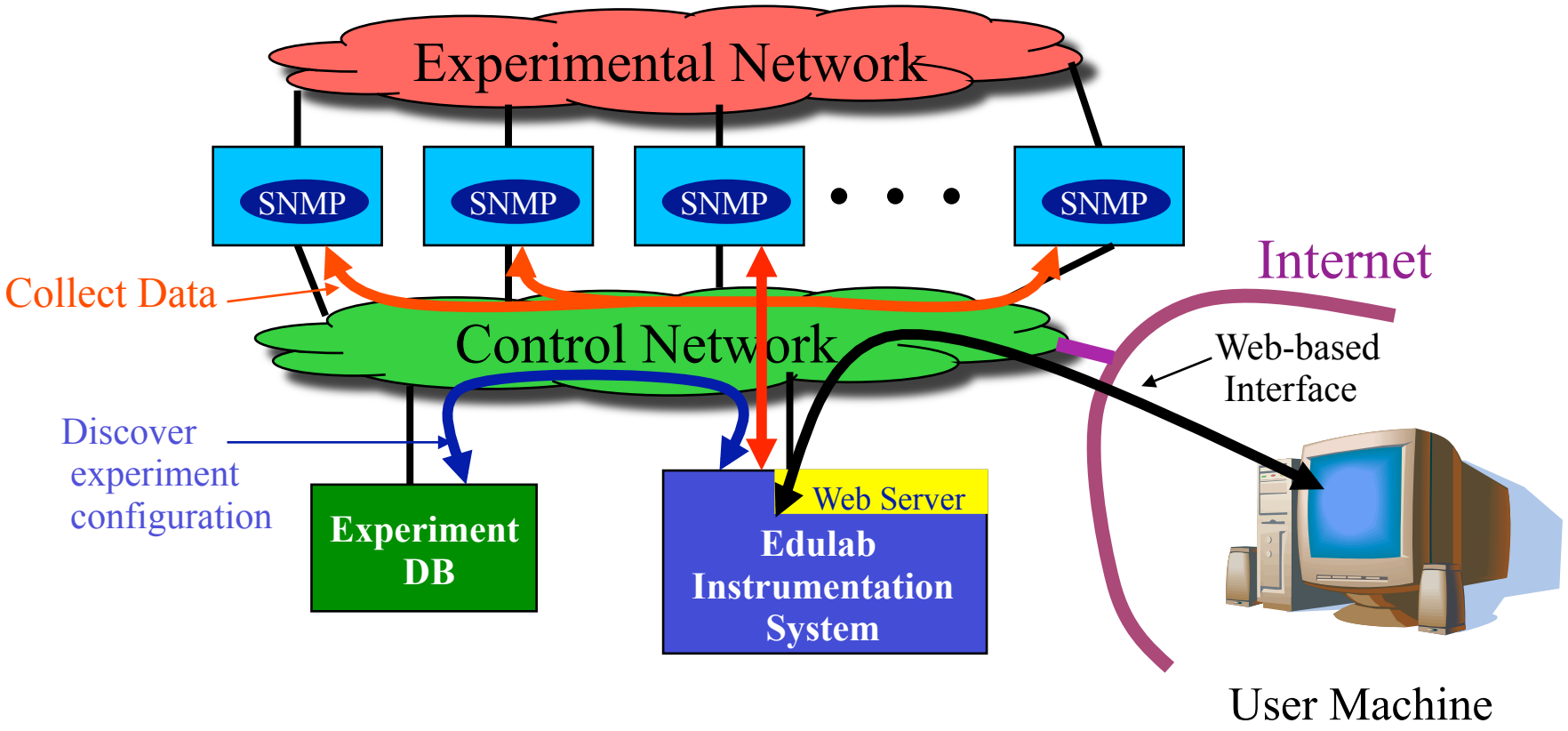
- While capturing and displaying packets is useful, it is equally important to capture the network state at switches and routers.
- Network state gives quick insights into how the network is handling/processing packets and is often more useful in student projects than packet capture.
- Network state included protocol-related state (e.g. routing table and ARP cache entries) and router-related state (e.g., processor load averages, memory usage statistics, process lists, etc). Other information that would have been useful included cached information (cached route advertisements, DNS cache entries, NAT cache entries, etc) as well as configuration and policy information (e.g., firewall rules, NAT rules, load balancing policies, etc).
- Ideally, the instrumentation system should support ways to specify and retrieve experiment-specific state or application -specific state using a common format and query method.

Edulab Web-based Interface

- Records and displays network state information
- Supports packet capture

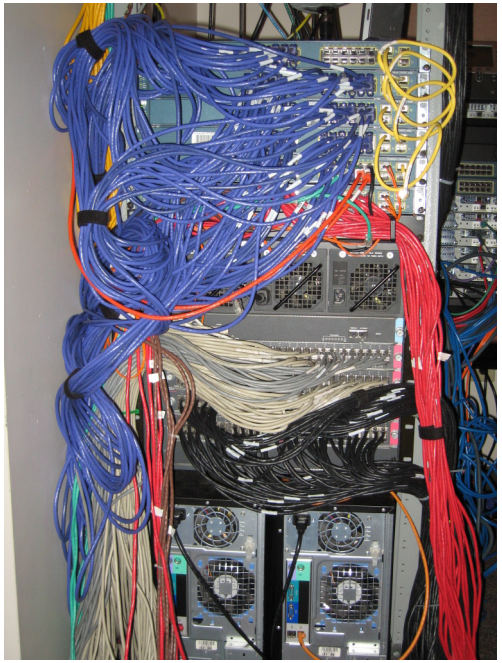


Edulab Architecture



Transitioning to a GENI World

The Kentucky ProtoGENI Aggregate



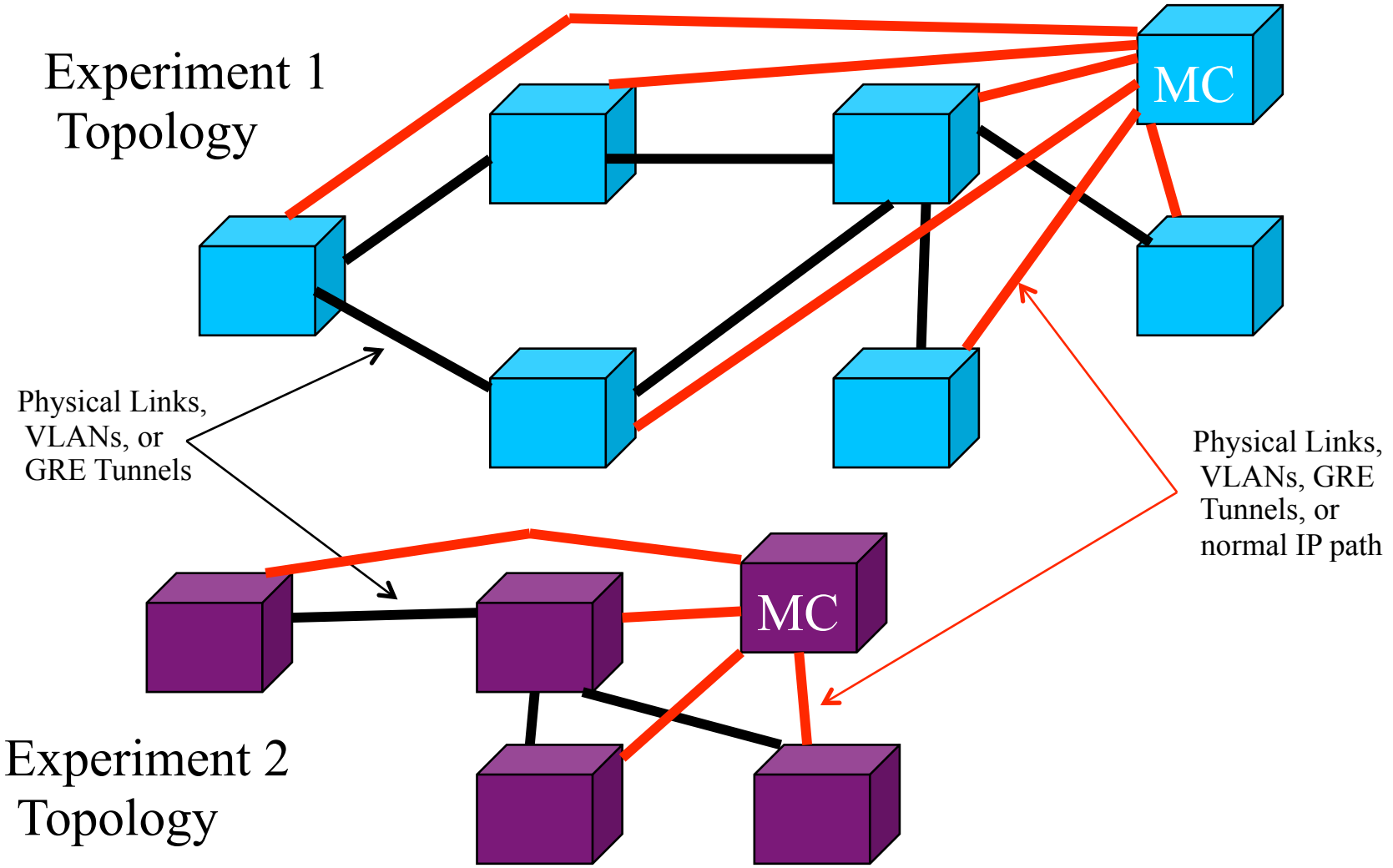
Converting to (Proto) GENI
(Differences)

- Experiments span multiple aggregates
  - No central database or global view of the topology
  - No central web server
- Resources are shared
  - Shared communication channels (with other experiments)
  - No dedicated "measurement channel"
- Being efficient is more important
- User management and authentication are quite different
- Instrumentation is considered a resource

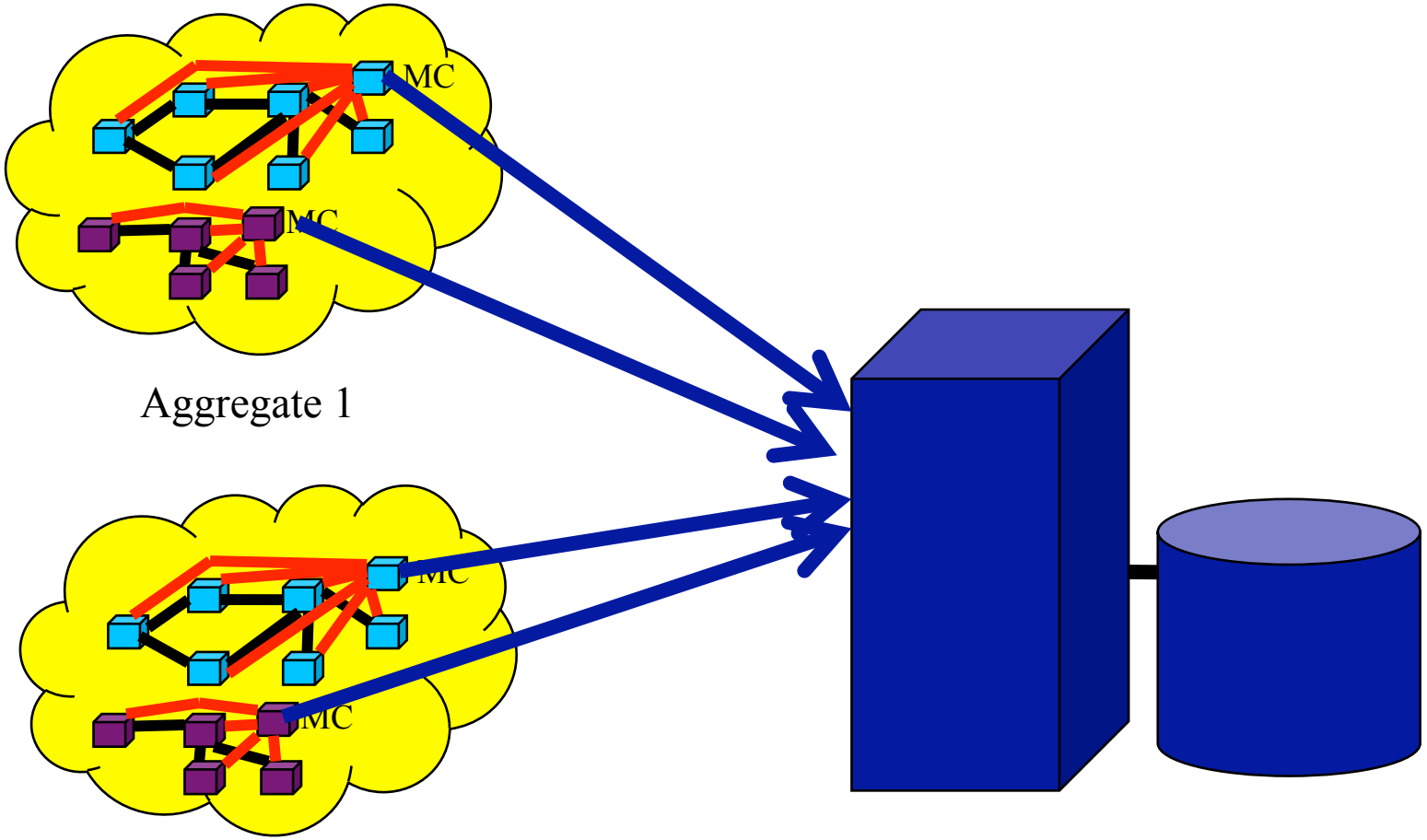
Measurement Controllers

- Each experiment has its own measurement controller (MC) that controls and collects packets and network state from measurement points in that experiment.
  - A measurement point (MP) is a packet sensor (link sensor in GIMS terminology) or a network state sensor.
- An experiment that spans aggregates will have (at least) one measurement controller per aggregate.
- Each MC is an extra sliver in the experiment (e.g., an additional node or virtual node).
- MCs are not dependent on the experimental network for connectivity to MPs.
- MCs obtain experiment topology information from the slice and component managers.
- Assume that MCs have significant amounts of storage.
- MCs offer a web-based interface to the data collected.
- Debating a global MC for each experiment.

Measurement Controller in ProtoGENI



Sharing and Archiving



Measurement-Capable ProtoGENI Nodes

- Working with Utah to develop a ProtoGENI node image that will be capable of capturing network state and packet state (i.e., an MP) .
- Packet capture software (tcpdump or custom code)
- SNMP daemon + extensions
- Node state daemon
- Control daemon to enable/disable monitoring
- Data processing on the MP should be avoided

Thank You!

Questions?

This material is based upon work supported in part by the National Science Foundation under grant numbers DUE-0511534 and CNS-0834243. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of GPO Technologies, Corp, the GENI Project Office, or the National Science Foundation.