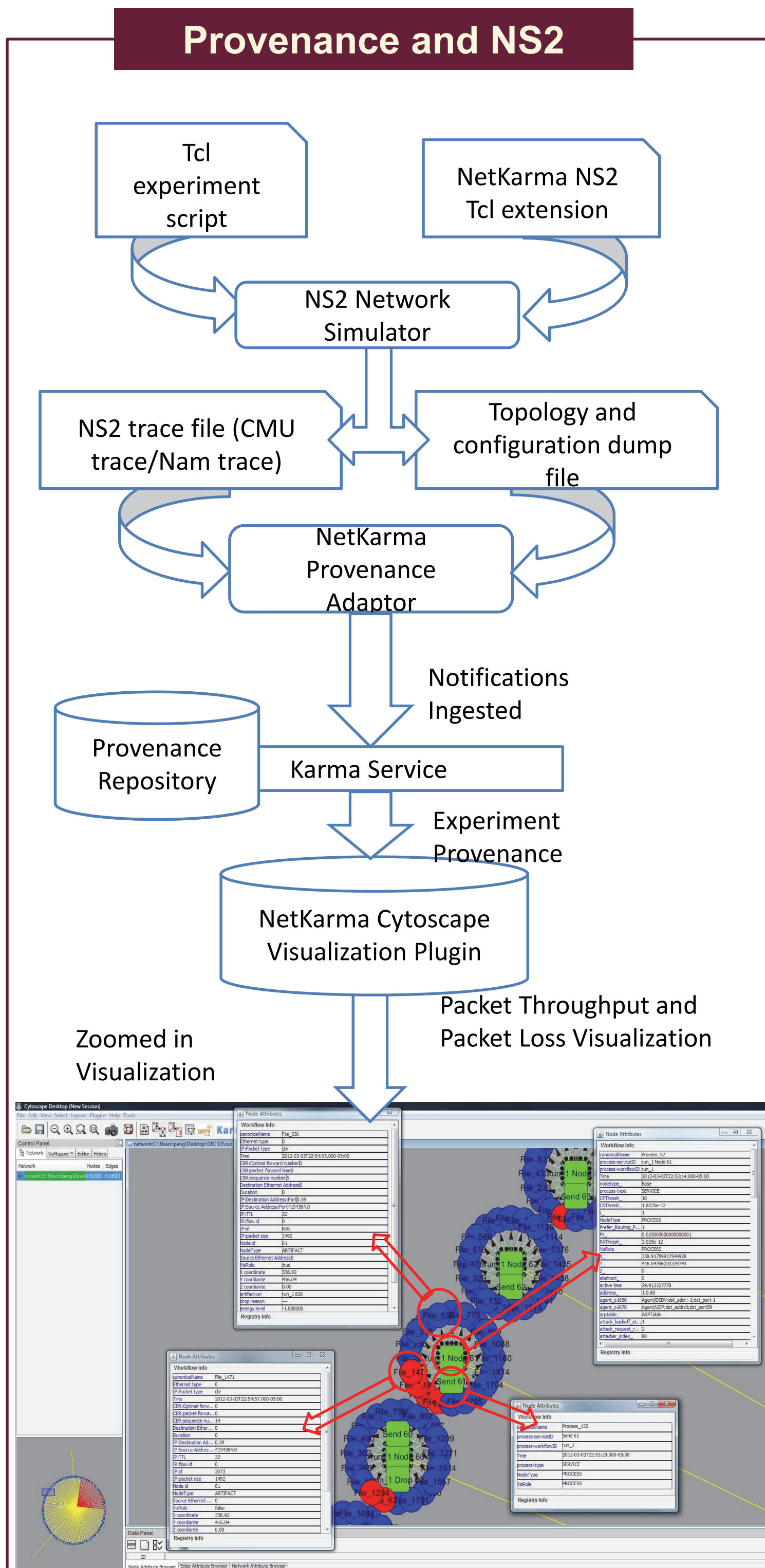


Role of Provenance in Visualizing Packet Throughput and Packet Loss



- NetKarma Adaptor interface accepts NS2 experiment trace file and topology (configuration) dump file and derives provenance that is ingested into the Karma repository.
- Netkarma's Cytoscape [1] Visualization Plugin retrieves and visualizes experiment provenance.

Experiment: WIMAX DDoS

- We capture provenance based on "DoS Attacks Exploiting WiMAX System Parameters" [2] by researchers at Clemson. The experiment uses 100 subscribers with varied configurations of 6 parameters running on NS2.

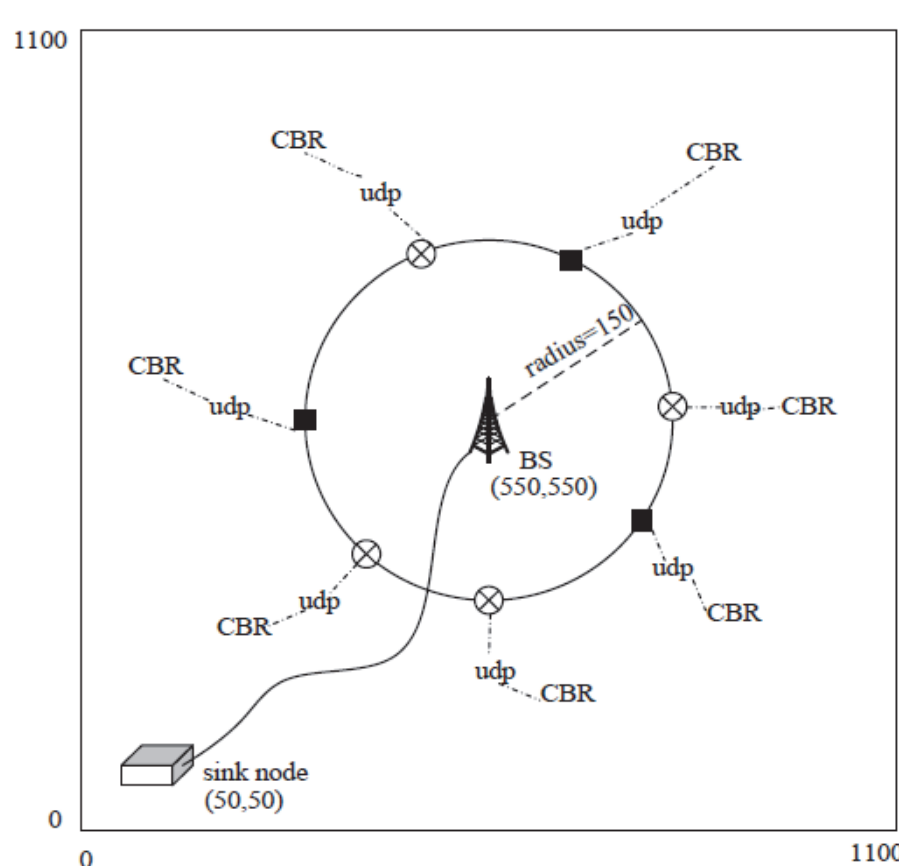


Fig.1: Network Topology

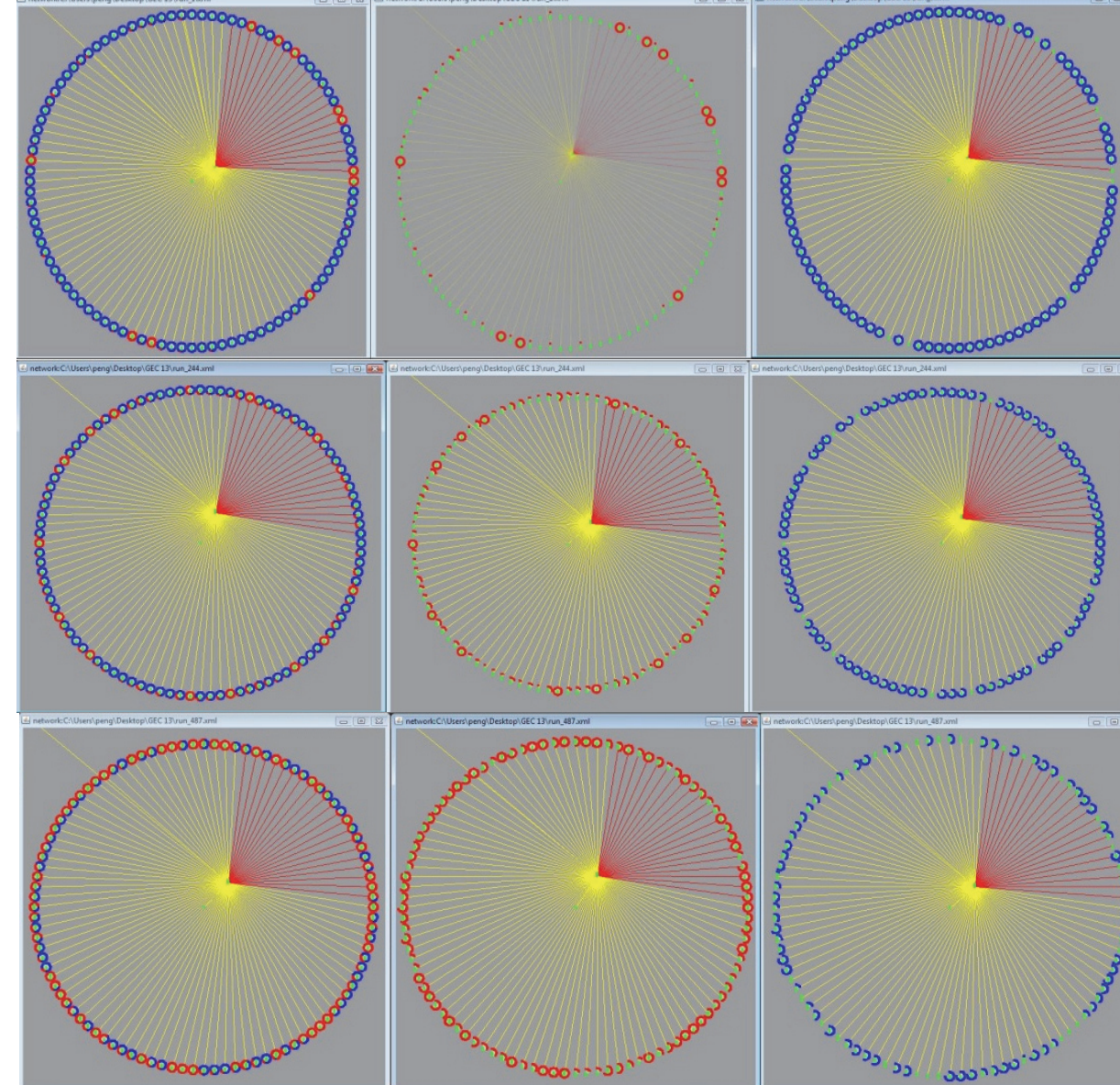
Table 1. Parameter Values

| Parameter | Values | | |
|--------------------------|-------------|-------------|-------------|
| | Treatment 1 | Treatment 2 | Treatment 3 |
| frame duration | 0.004 | 0.01 | 0.02 |
| number of attackers/user | 20/80 | 50/50 | 80/20 |
| dos backoff start | 1 | 3 | 5 |
| dos request retry | 2 | 6 | 10 |
| bw backoff start | 1 | 3 | 5 |
| bw request retry | 2 | 6 | 10 |

Provenance of WiMAX DDoS Experiment on NS2

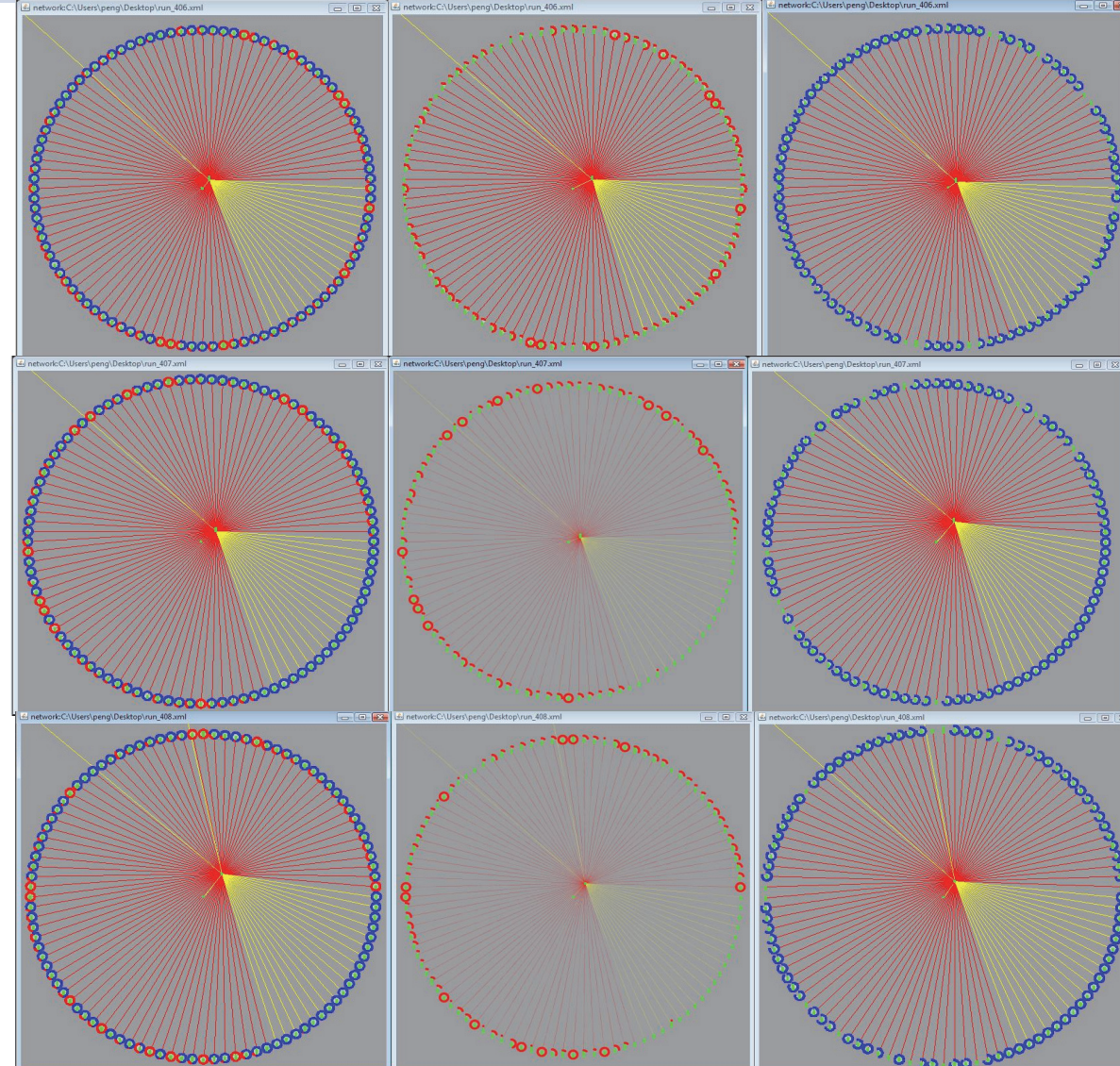
- Provenance capture with NetKarma, and visualization through NetKarma extensions to Cytoscape, allows GENI experimenters to capture detailed provenance of the events in their experiment and also exposes key performance information about those experiments.
- NetKarma captures not only provenance of packet movement, but also infers critical provenance regarding packets that were dropped, and by doing so is able to convey information about DDoS attacks through visualization that was done earlier through ANOVA.
- NetKarma's provenance filters and visualization extensions for Cytoscape enable side-by-side performance comparison of different experiment configurations. These visualizations below show both packets dropped and received, adjusting the visualization automatically for the provenance data volume based total number of packets sent.

| Run id | Frame duration | number of attackers | attack backoff start | attack request retry | bw backoff start | bw request retry |
|--------|----------------|---------------------|----------------------|----------------------|------------------|------------------|
| 1 | 0.004 | 20/80 | 1 | 2 | 1 | 2 |
| 244 | 0.01 | 20/80 | 1 | 2 | 1 | 2 |
| 487 | 0.02 | 20/80 | 1 | 2 | 1 | 2 |



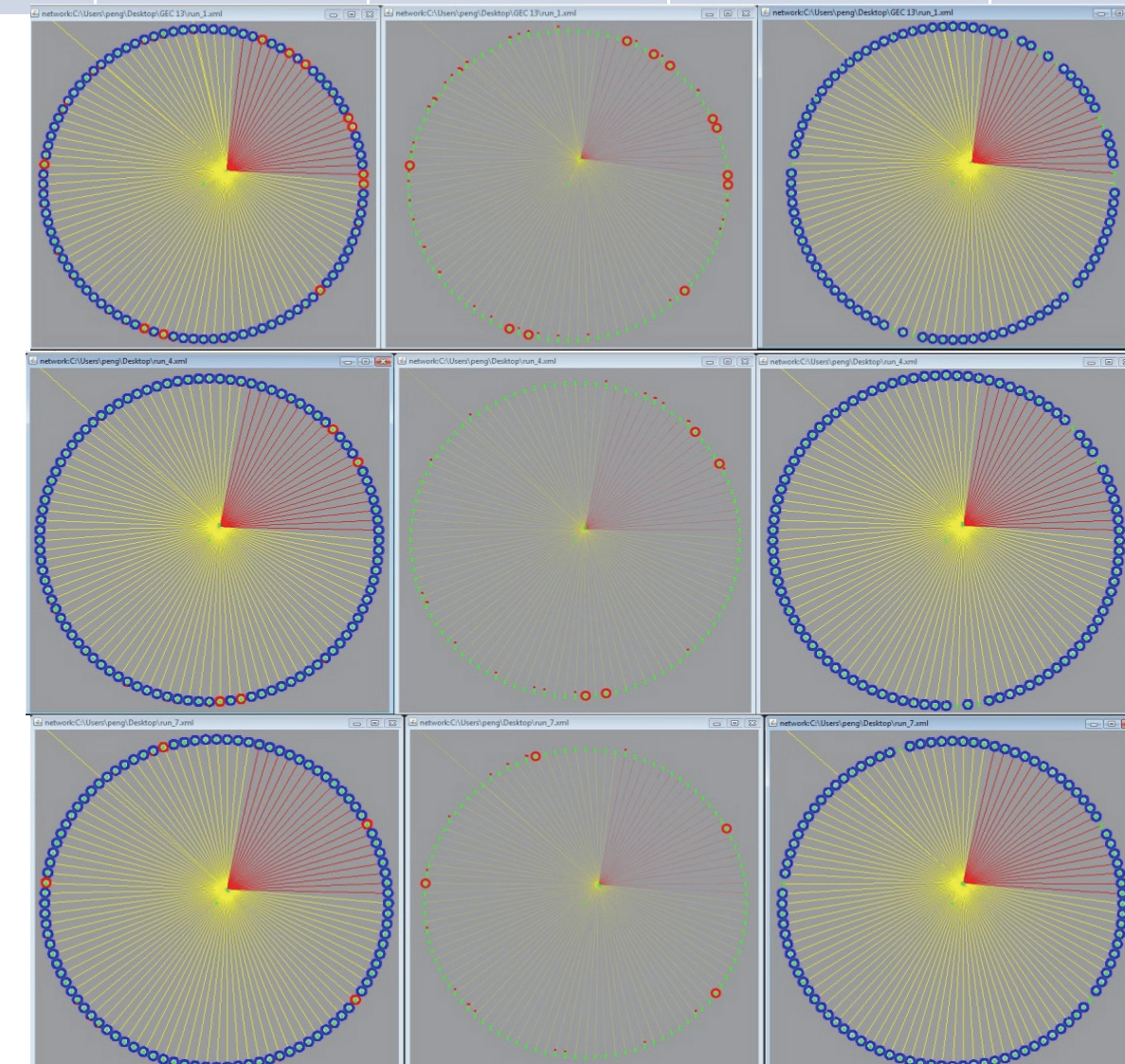
(a) packets dropped increases as frame_duration increases from 0.01s to 0.02s.

| Run id | Frame duration | number of attackers | attack backoff start | attack request retry | bw backoff start | bw request retry |
|--------|----------------|---------------------|----------------------|----------------------|------------------|------------------|
| 406 | 0.01 | 80/20 | 1 | 2 | 1 | 2 |
| 407 | 0.01 | 80/20 | 1 | 2 | 1 | 6 |
| 408 | 0.01 | 80/20 | 1 | 2 | 1 | 10 |



(b) packets dropped decreases as bw_request_retry increases from 2 to 6.

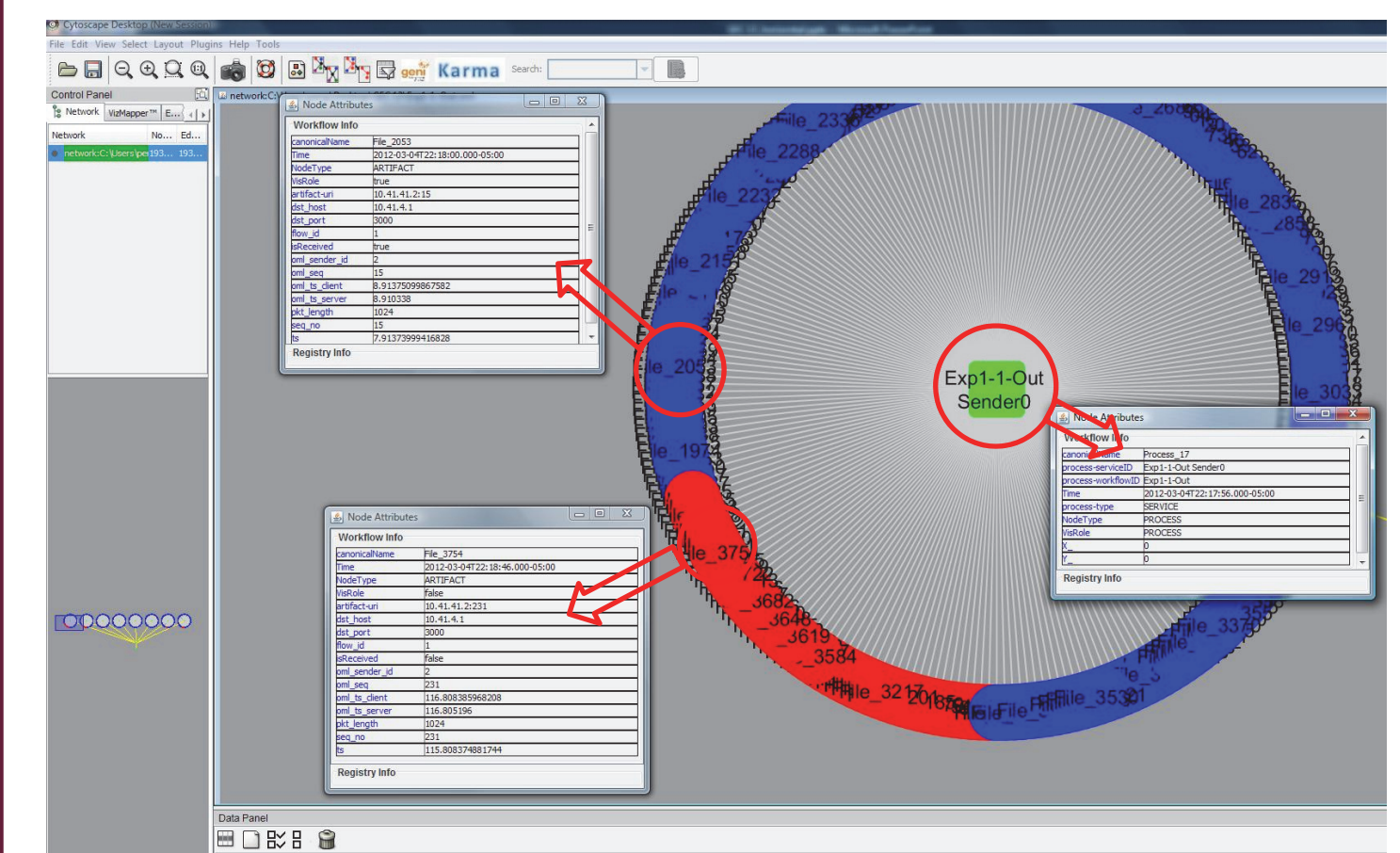
| Run id | Frame duration | number of attackers | attack backoff start | attack request retry | bw backoff start | bw request retry |
|--------|----------------|---------------------|----------------------|----------------------|------------------|------------------|
| 1 | 0.004 | 20/80 | 1 | 2 | 1 | 2 |
| 4 | 0.004 | 20/80 | 1 | 2 | 3 | 2 |
| 7 | 0.004 | 20/80 | 1 | 2 | 5 | 2 |



(c) packets dropped decreases as bw_backoff_start increases from 1 to 3.

Ongoing Work: Provenance of WiMAX Experiments on ORBIT

- In this application of NetKarma, provenance is captured for WiMAX DDoS experiments run on ORBIT.
- NetKarma harvests provenance from the measurements made by the Orbit Measurement Library (OML), and infers critical provenance regarding packets that were dropped.

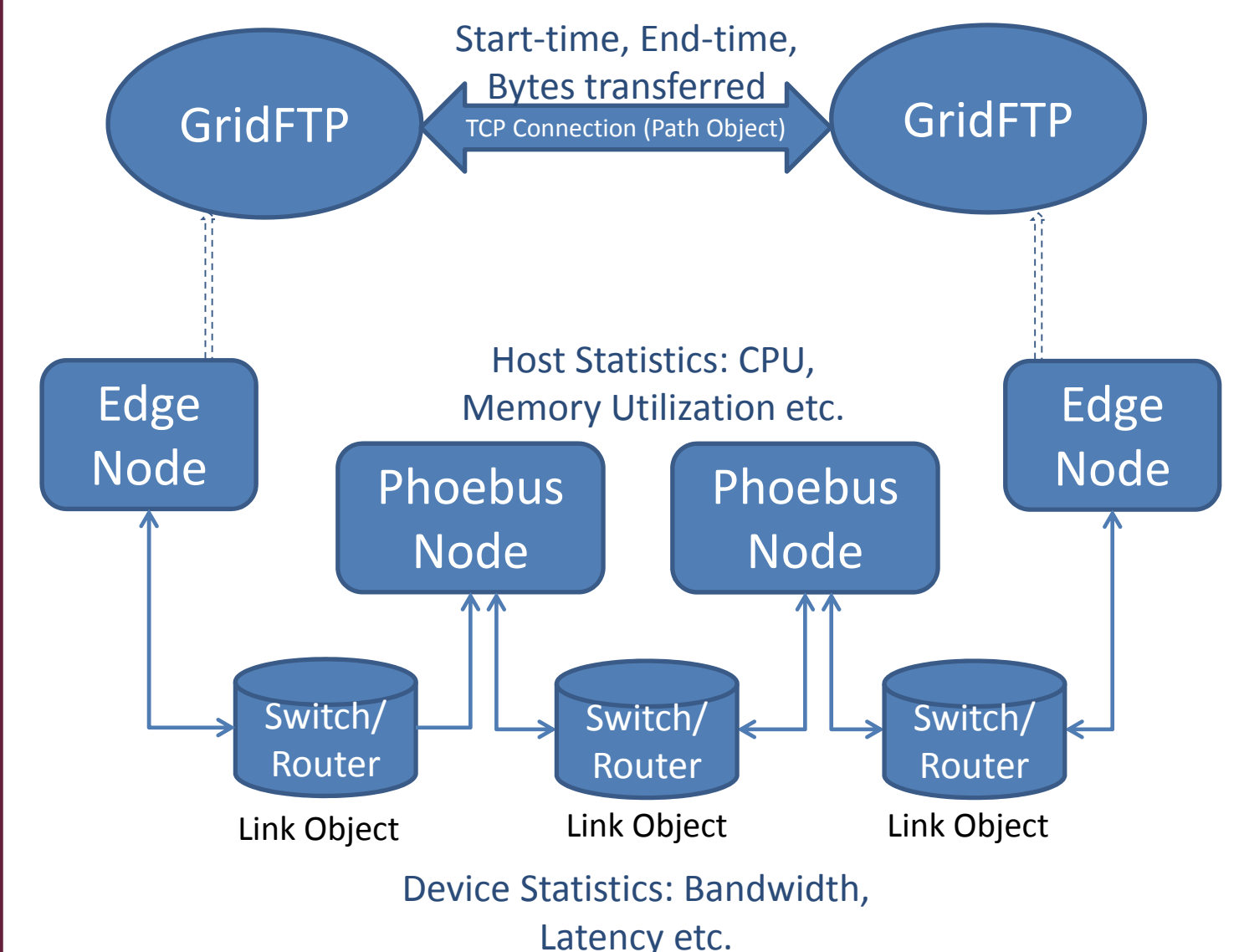


Zoomed in Visualization

- Researchers at Clemson are investigating the impact of "backoff_start" and "backoff_end" in WiMAX DDoS experiment on ORBIT, and our research looks at using provenance to compare the performance of different parameter configurations.

Ongoing Work: Capturing Provenance of eXtensible Session Protocol (XSP)

- Phoebus**: A new network framework and protocol designed to improve throughput for long distance data transfers.
- XSP**: Maintains session state between gateways and negotiates path specific parameters in Phoebus.
- Provenance** for XSP experiments includes the following information:
 - Logical view of the XSP experiment's execution and data associated with the experiment including topology of the nodes, commands, outputs, etc.
 - Metadata associated with the experiment such as start-time, end-time, and bytes or packets transferred.
 - Passive measurements, including: CPU, memory utilization and network interface stats.
 - Active measurements from LAMP measurement archive.



References

- <http://www.cytoscape.org/>
- J. Deng, R. Brooks, J. Martin, "Assessing the Effect of WiMAX System Parameter Settings on MAC-level Local DoS Vulnerability", *International Journal of Performance Engineering*, (2012).