Fast Prediction of Network Performance: k-packet Simulation

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Prediction of communication performance on supercomputer networks is useful for a variety of what-if analyses:

- How does performance change with task-mappings?
- Identify bottlenecks and explore solution space.
- Study the performance of future networks and algorithms.

Flit-level and packet-level simulators:

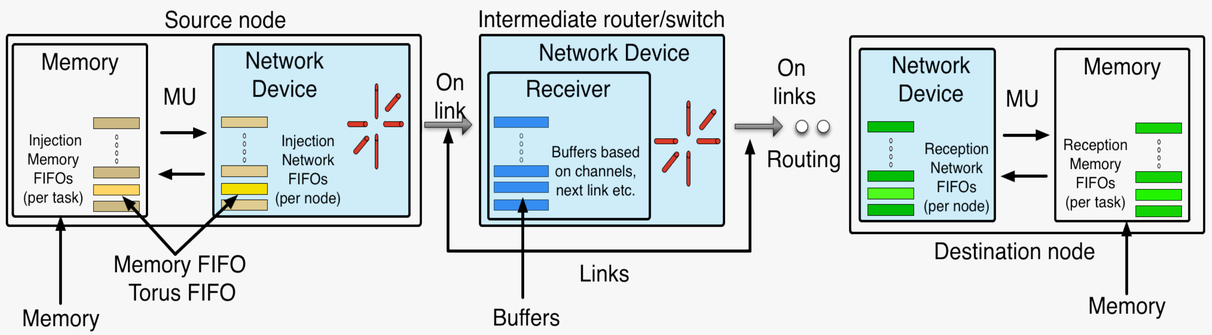
- Useful for accurate prediction of performance on small systems.
- Inefficient and very slow even for moderate-sized networks.

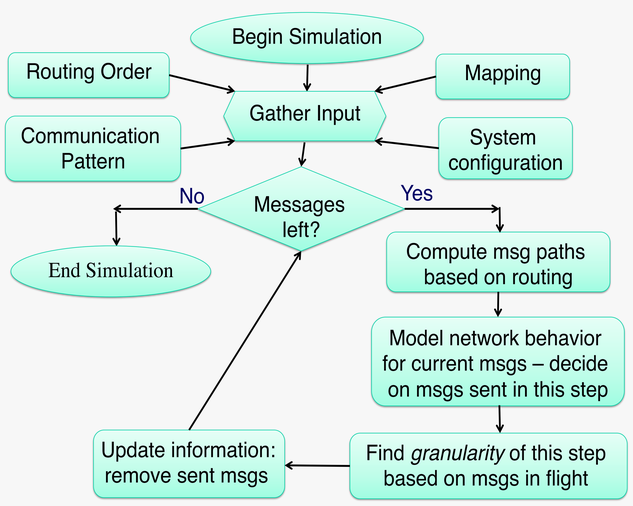
Explore a new simulation methodology that:

- **Decreases the granularity to message level events (k-packets where *k* is dynamic)**
- **Simulates different components at different resolutions**
- **Uses heuristics to estimate the stable state of the network**

Preliminary results show that the proposed approach can model the network behavior accurately, and is orders of magnitude faster than the previous methods.

Proposed Approach





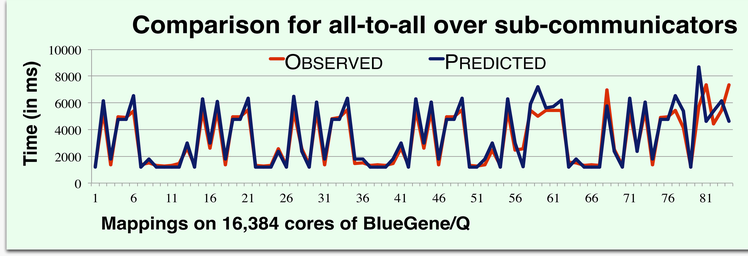
Base Principles

- Use analysis at message level events for approximating state in the intermediate period.
- Estimate aspects that affect network behavior using simple mechanisms - *memory, injection and reception mechanism, link bandwidth, buffer size and schemes, and routing.*

Future Enhancements

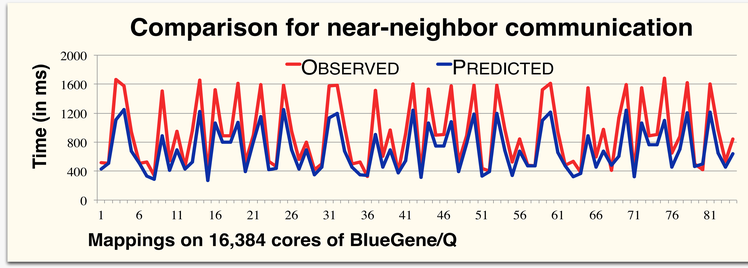
- Trace-driven simulation.
- Compute state of the network at intermediate time steps.

Preliminary Results



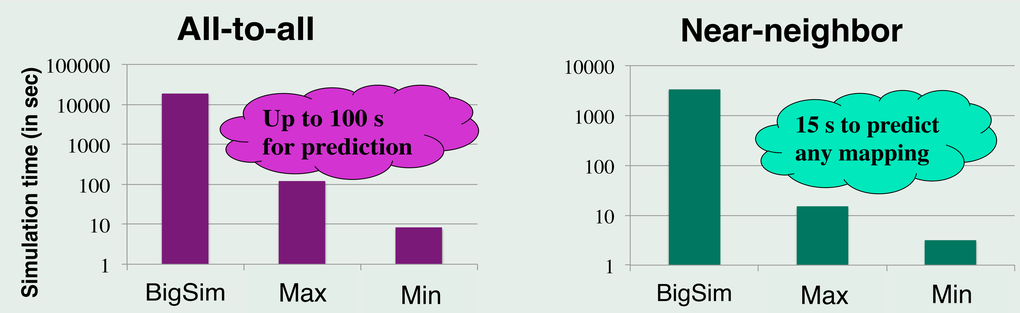
Benchmark 1: simultaneous all-to-all in MPI sub communicators of size 64 each

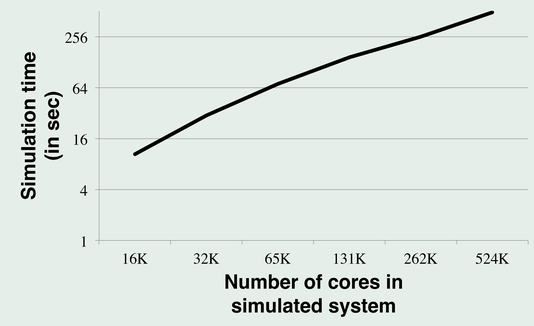
Highly Accurate



Benchmark 2: 14 point stencil, near neighbor communication

Accurate trend prediction



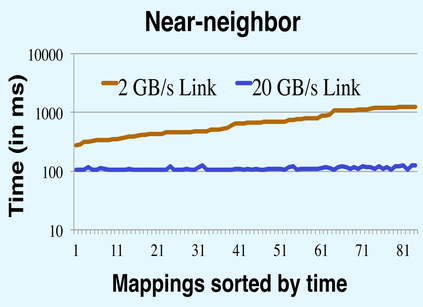


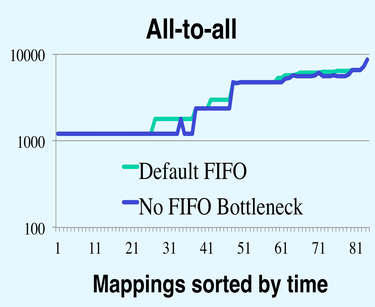
For the given benchmarks:

✓Performance for any mapping predicted within 100s (min - max are for time variation in prediction for various mappings)

✓Linear growth in time to predict with system size

What-if Analysis





✓**What if the link bandwidth on BG/Q was not 2 GB, but 20 GB? For near-neighbor, *this may make mapping irrelevant.***

✓**What if the bottleneck caused by injection FIFO is removed? For all-to-all, *such a change may not be useful.***