Performance Analysis and Projections

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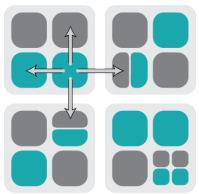

Charm++

"We must not allow the clock and the calendar to blind us to the fact that each moment of life is a miracle and mystery."

H.G. Wells

Each moment of life may be a mystery, but each moment of our programs shouldn't be.

Measuring Performance

In the serial world:

- `clock_gettime()`, `gettimeofday()`
- `gprof`
- `valgrind`

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Parallel

These techniques don't really work for distributed parallel programs.

Problems in Parallel Analysis

- Different processors may do radically different work
- Performance problems may be on the network
- Load may not be balanced between processors

Parallel Analysis Tools

In general, tools must be used to do parallel performance analysis:

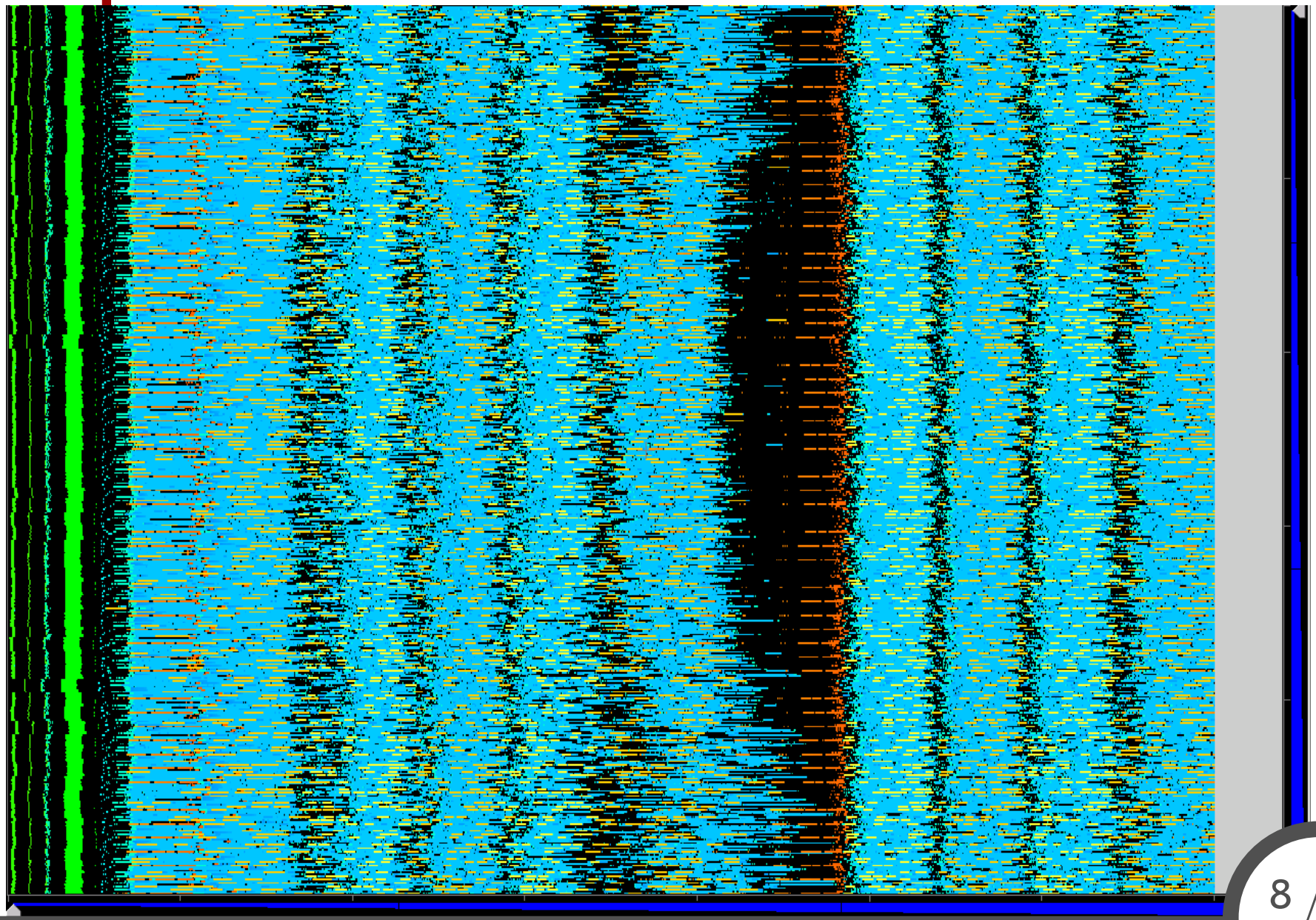
- mpiP
- Vampir
- HPCToolkit
- Projections

These tools provide details on communication, scaling, mapping, load imbalance, etc.

Projections

- Projections is a performance analysis tool for Charm++
- Provides tools for analyzing most of the discussed issues in parallel performance
- Runtime traces application executions, creates logs for local analysis

Projections Tools



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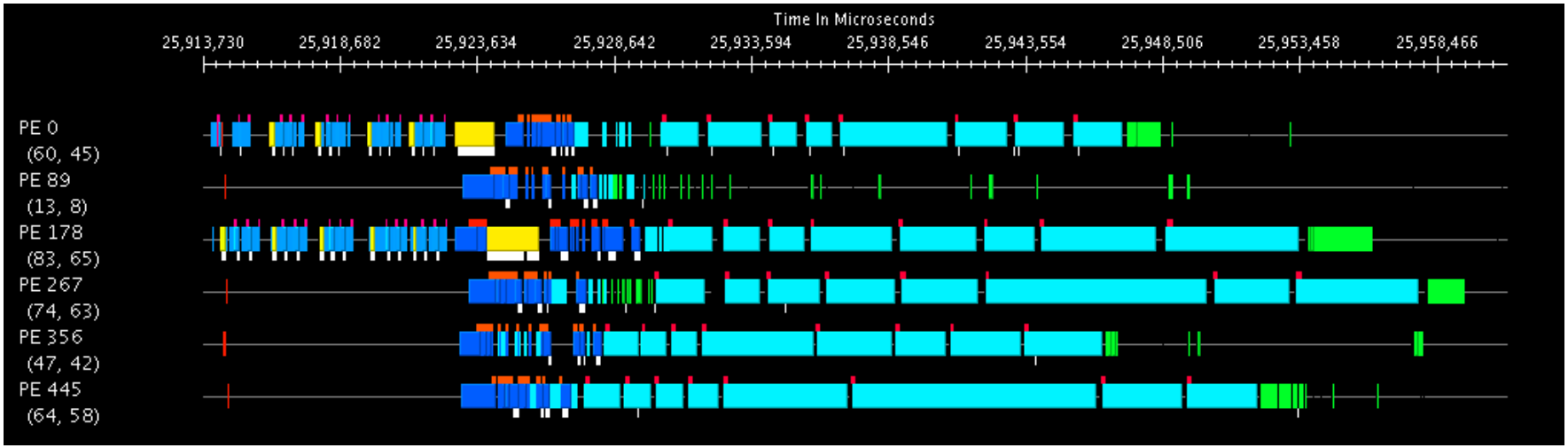

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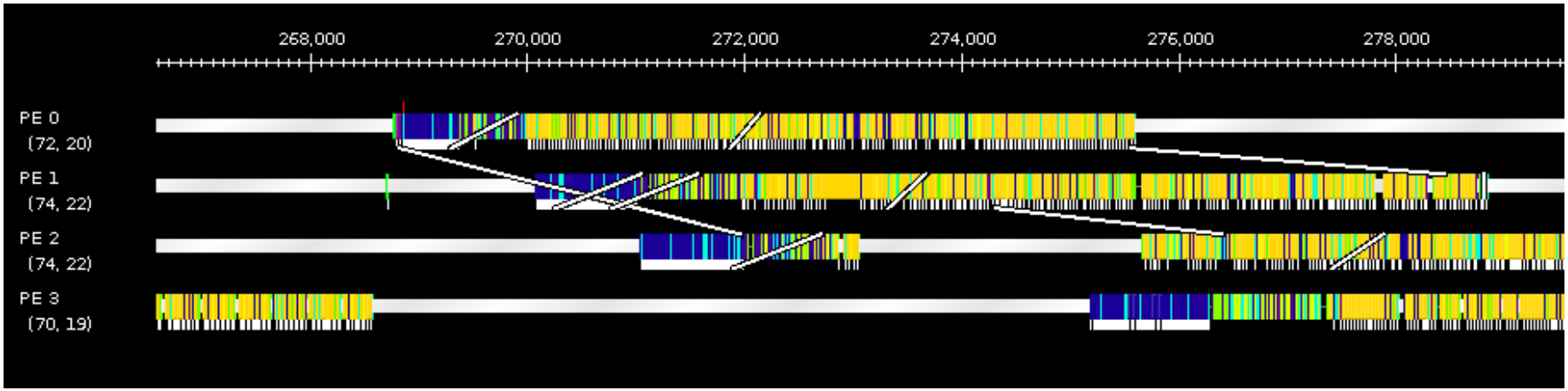

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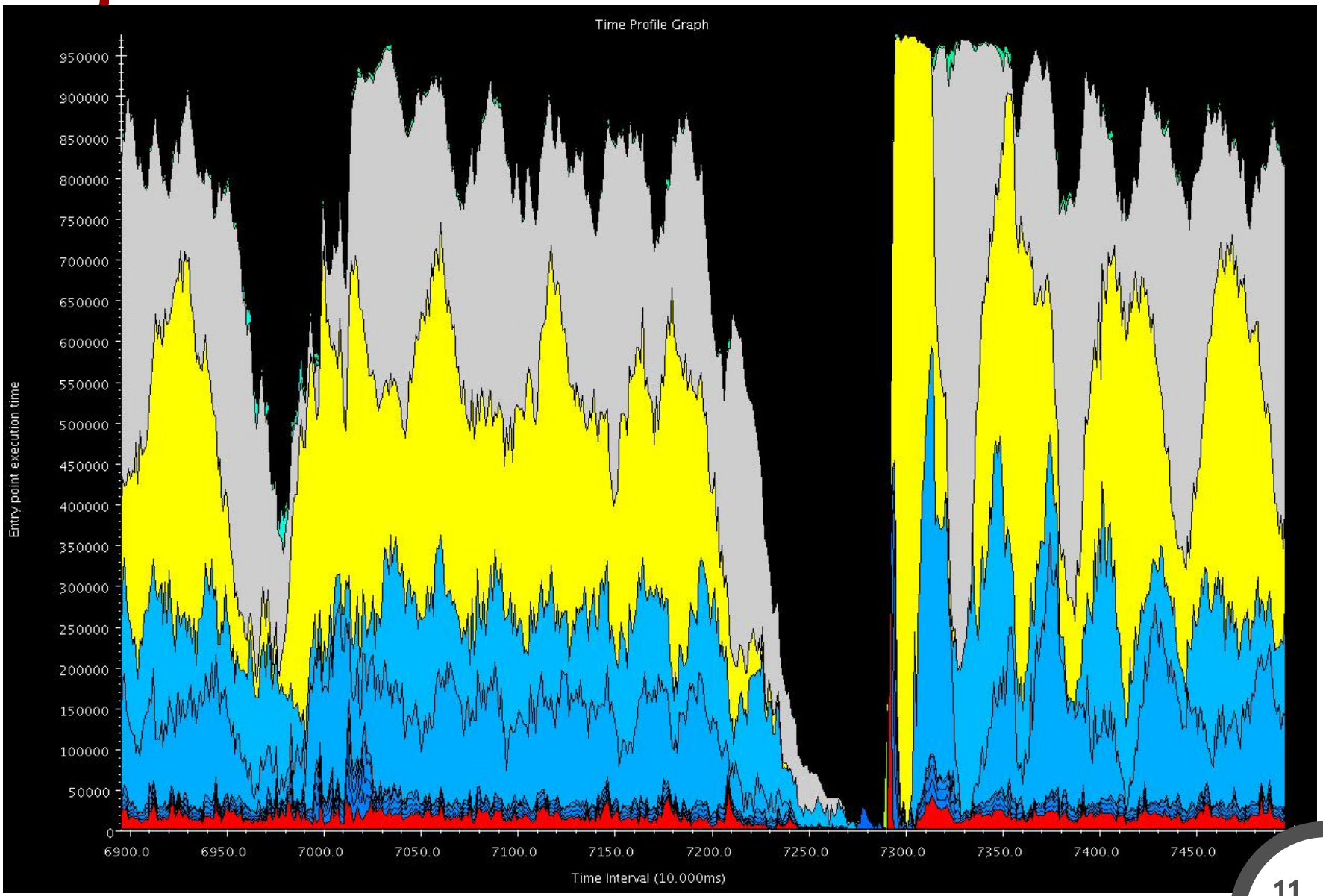

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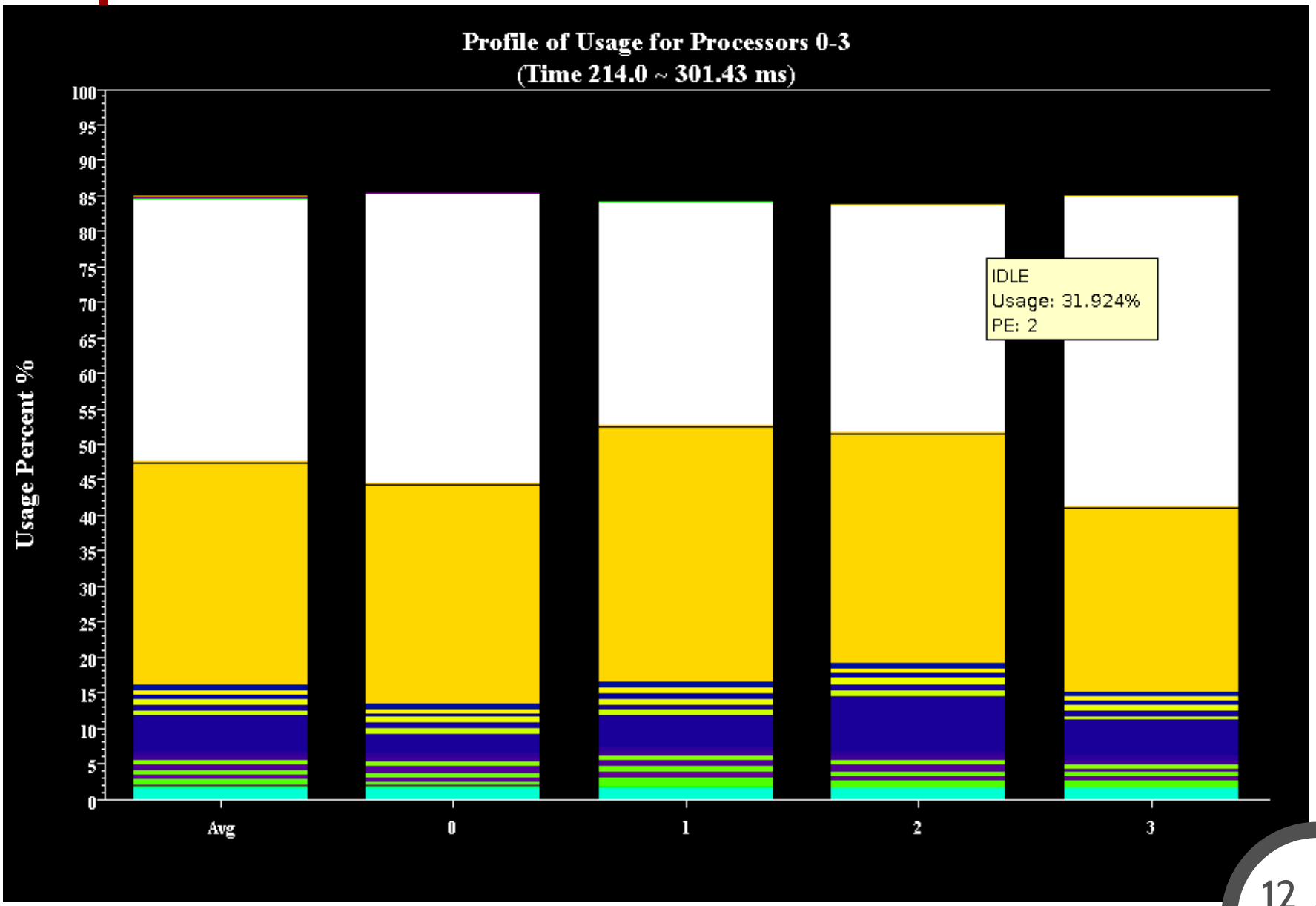

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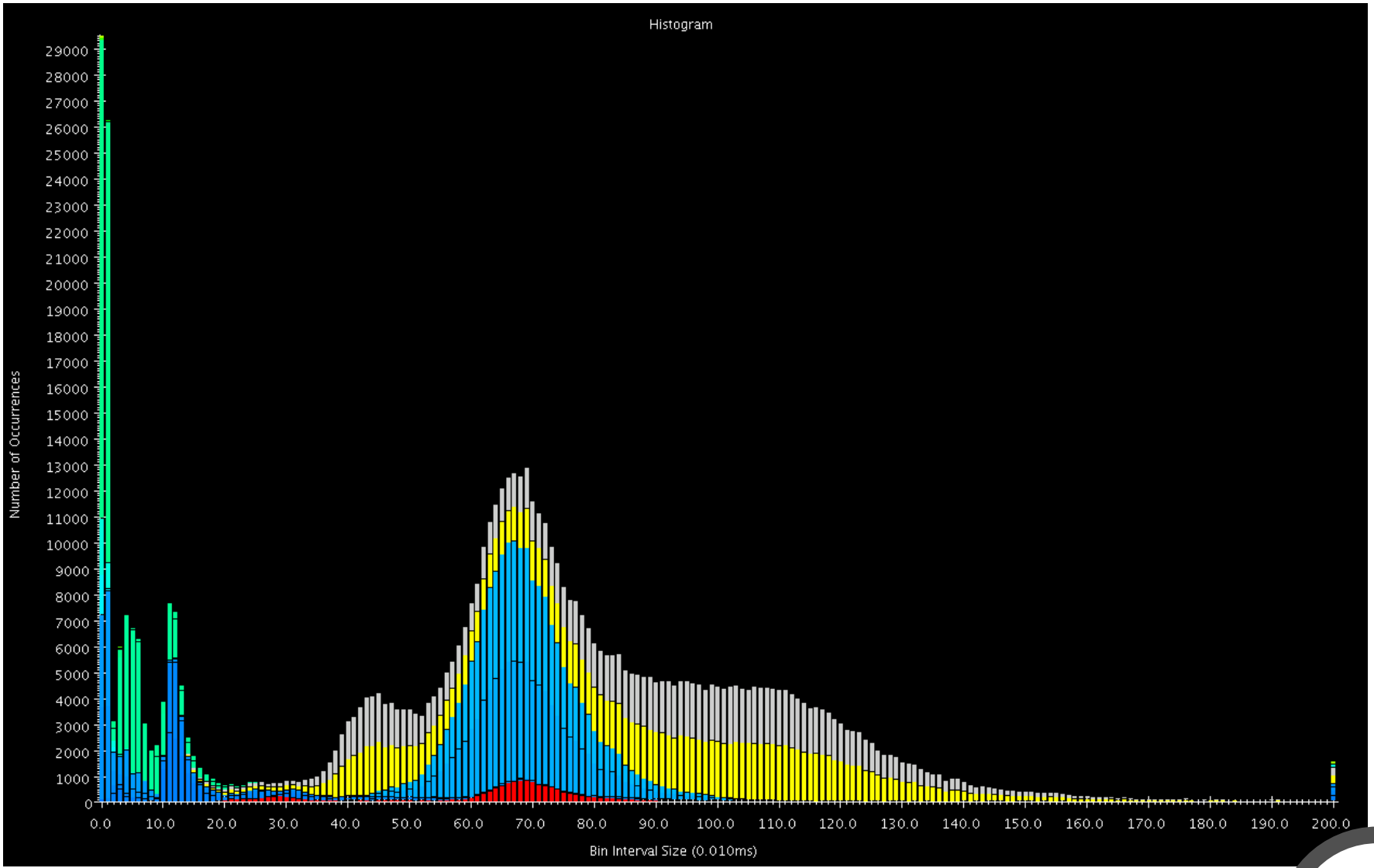

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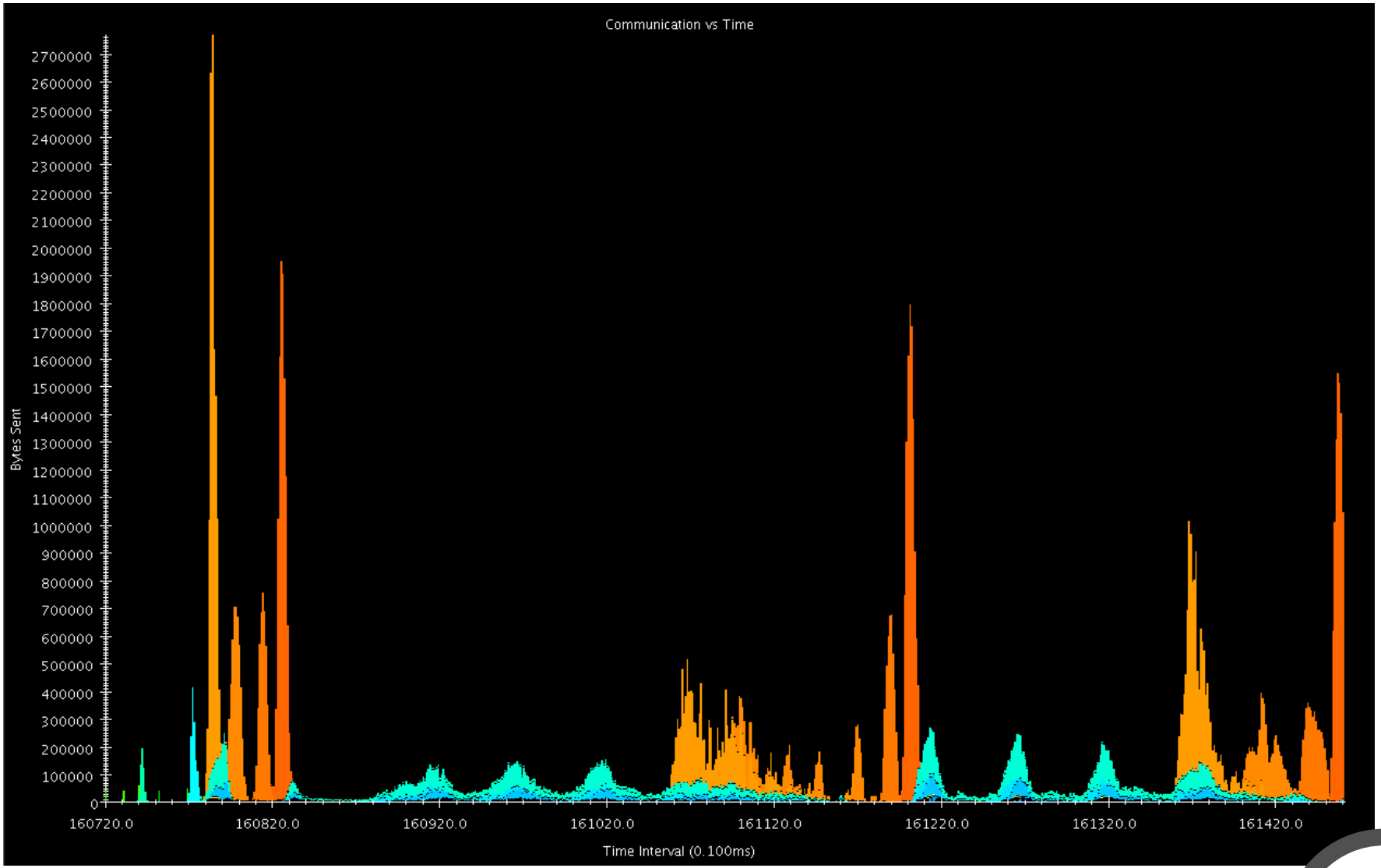


Recent Advancements in Projections

Recently, we have added some advanced analysis tools to Projections:

- Cache latency measurement
- Communication thread tracing

Cache Latency Measurement

Using sampling techniques, we have developed a method to trace cache accesses and attribute them to specific lines.

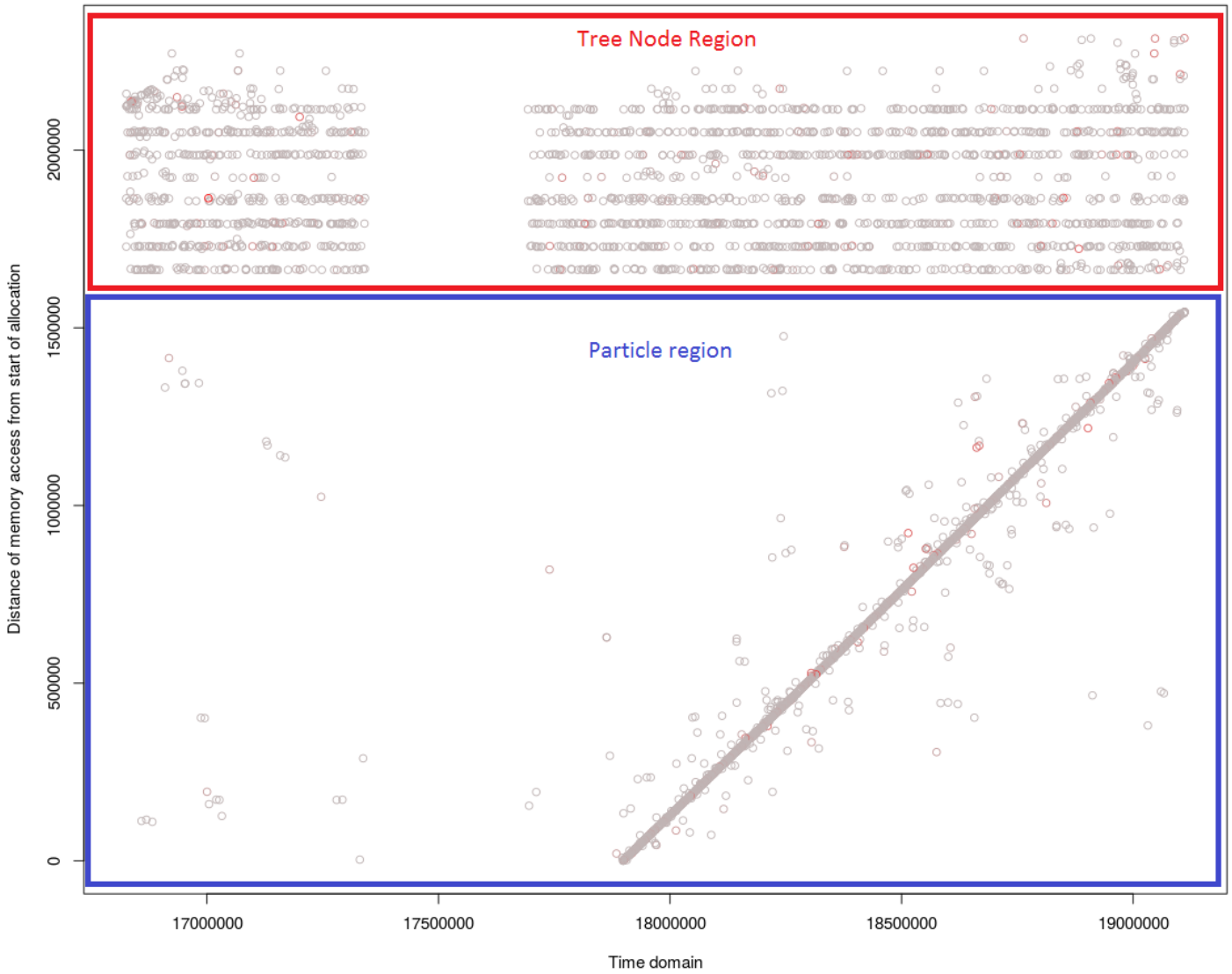
- Intel PEBS - Precise Event Based Sampling
- Provides instruction pointer with sample
- Provides latency of access, not mere hit/miss count

Cache Latency Measurement

Collected data allows us to analyze:

- Spatiotemporal memory access pattern and latency
- Cache miss rate over time
- Cache latency per source line

Cache Performance Tools



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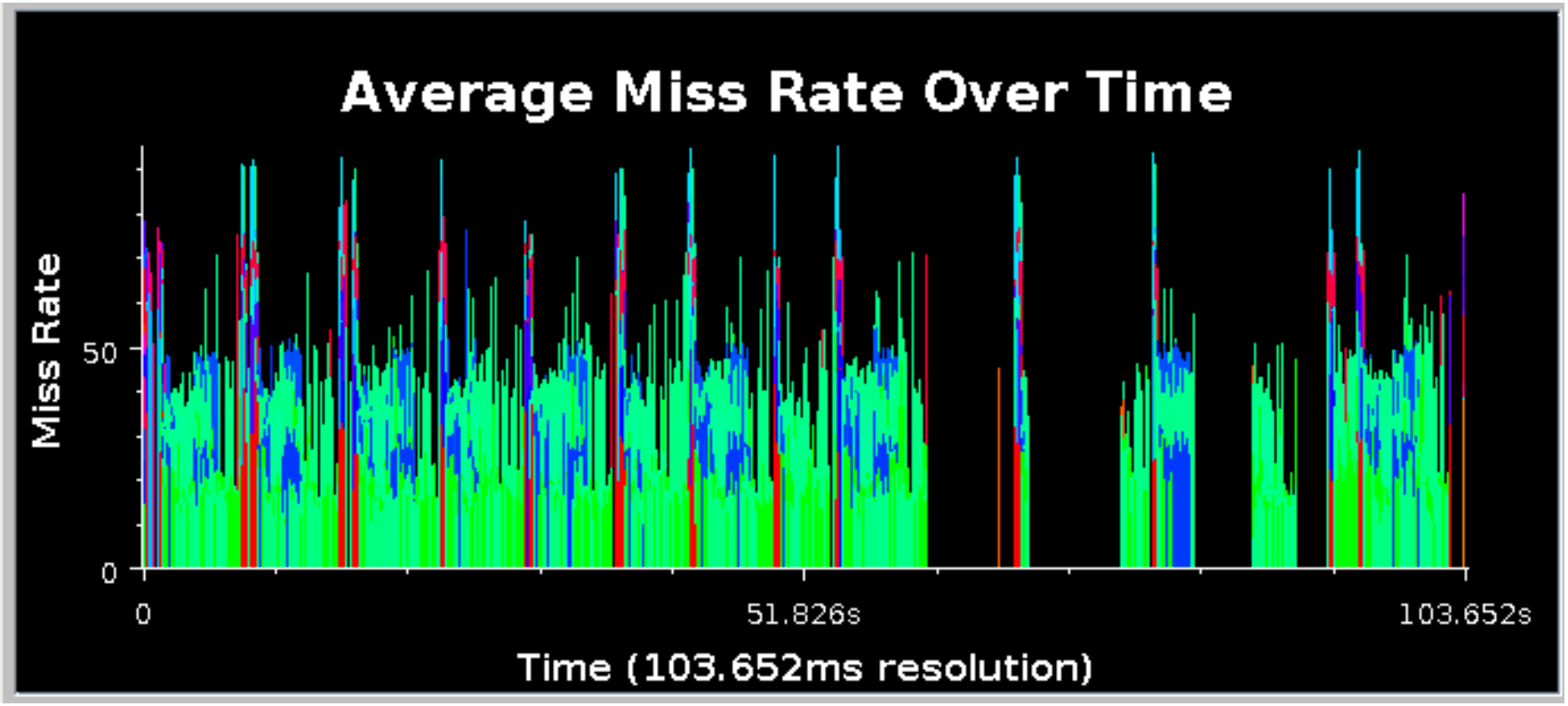

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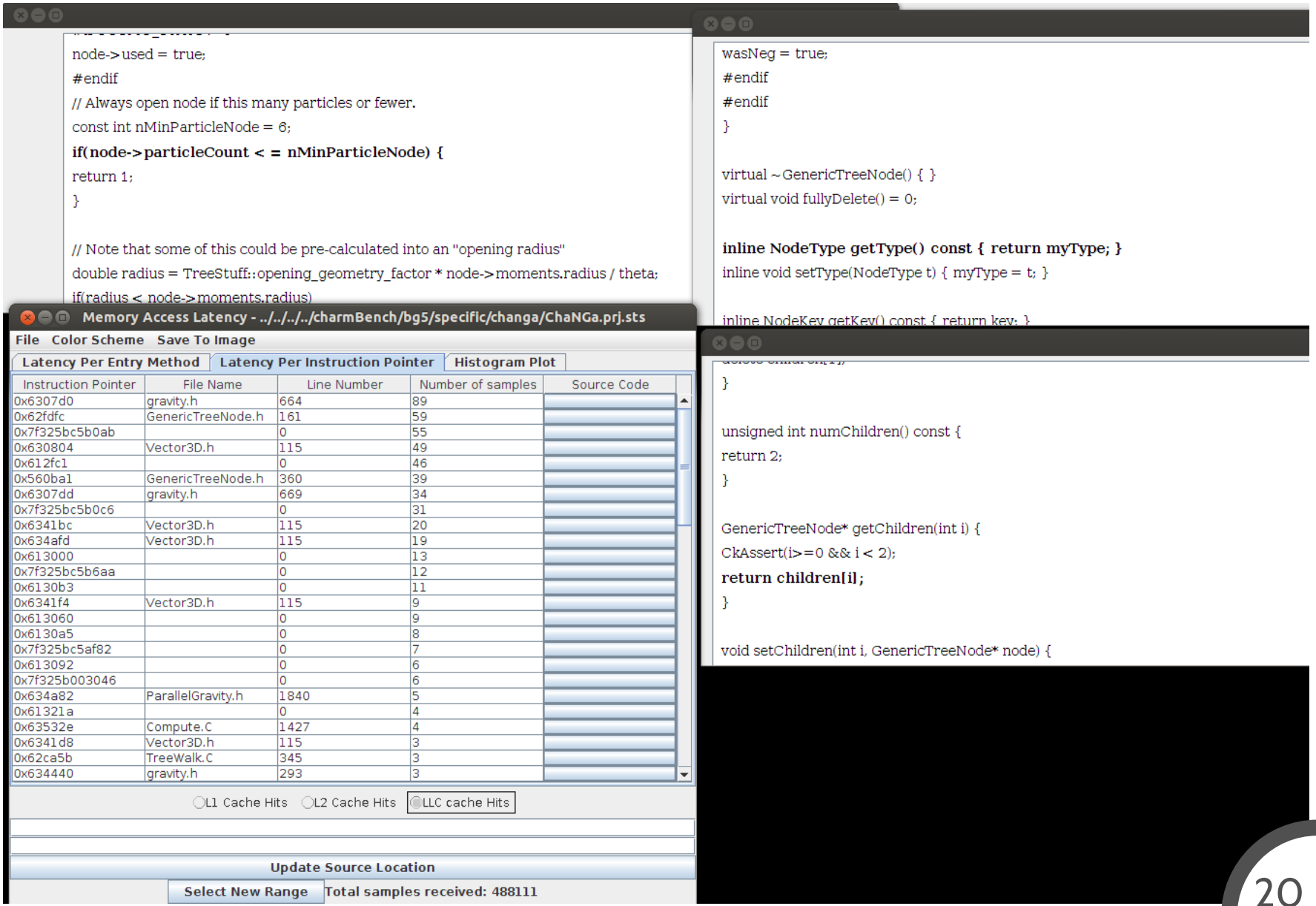
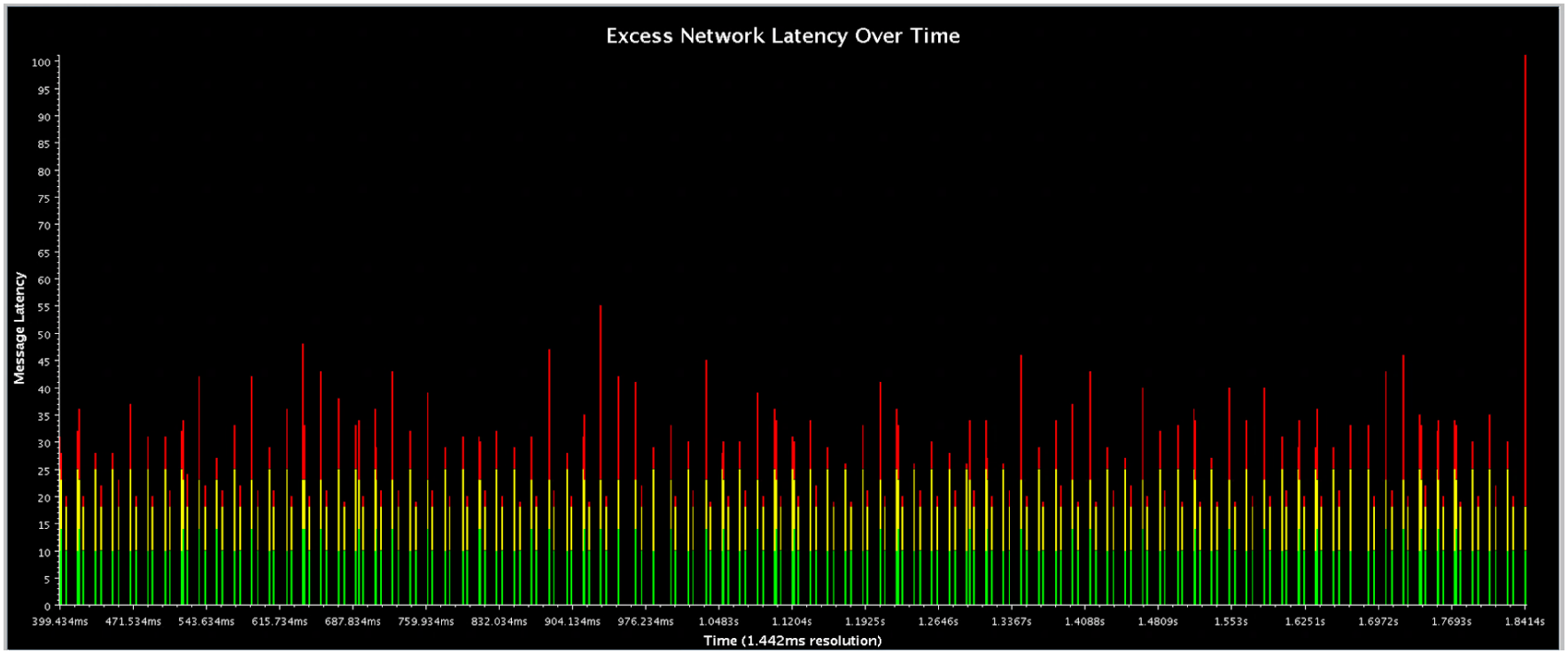


Communication Thread Tracing

When Charm++ is used in SMP mode, every process has a communication thread. When built with `--enable-tracing-commthread`, the runtime will specifically trace this thread.

Using these logs, we can analyze network performance in detail.

Communication Thread Tracing



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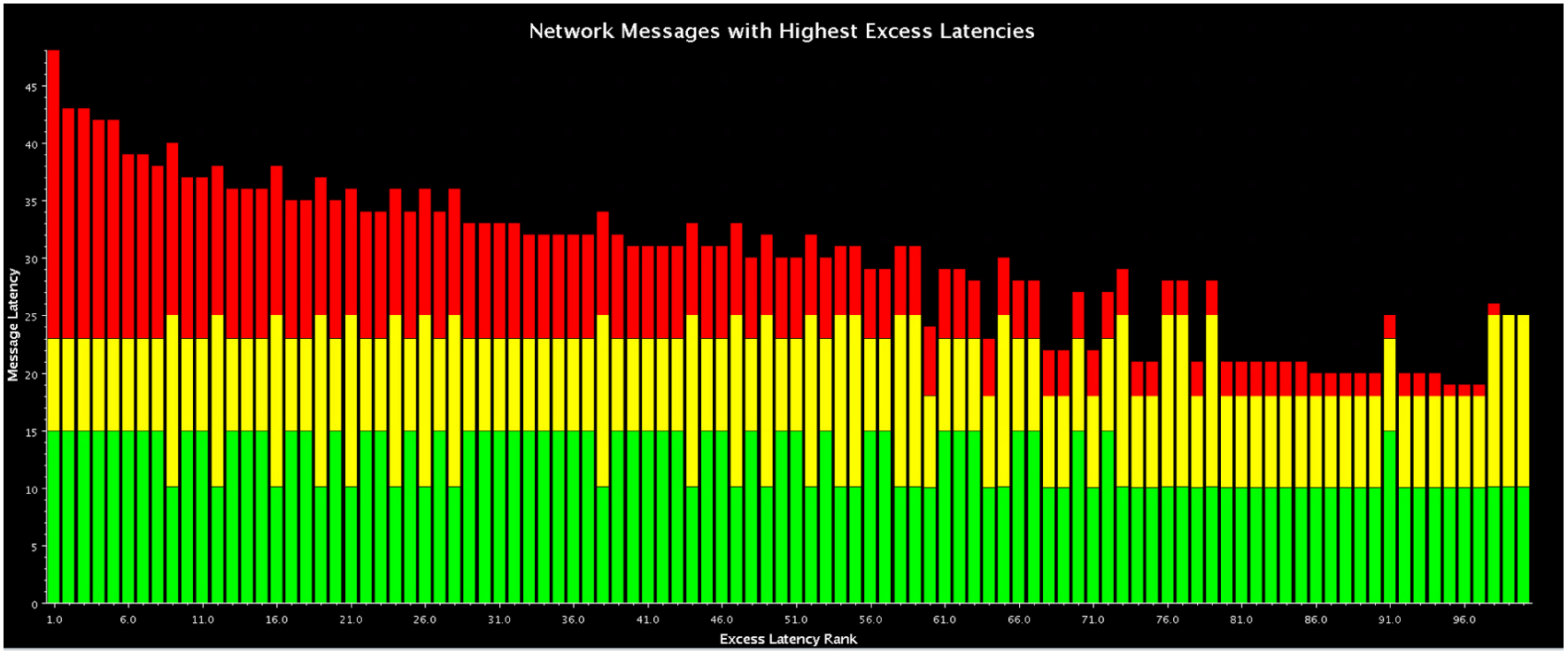

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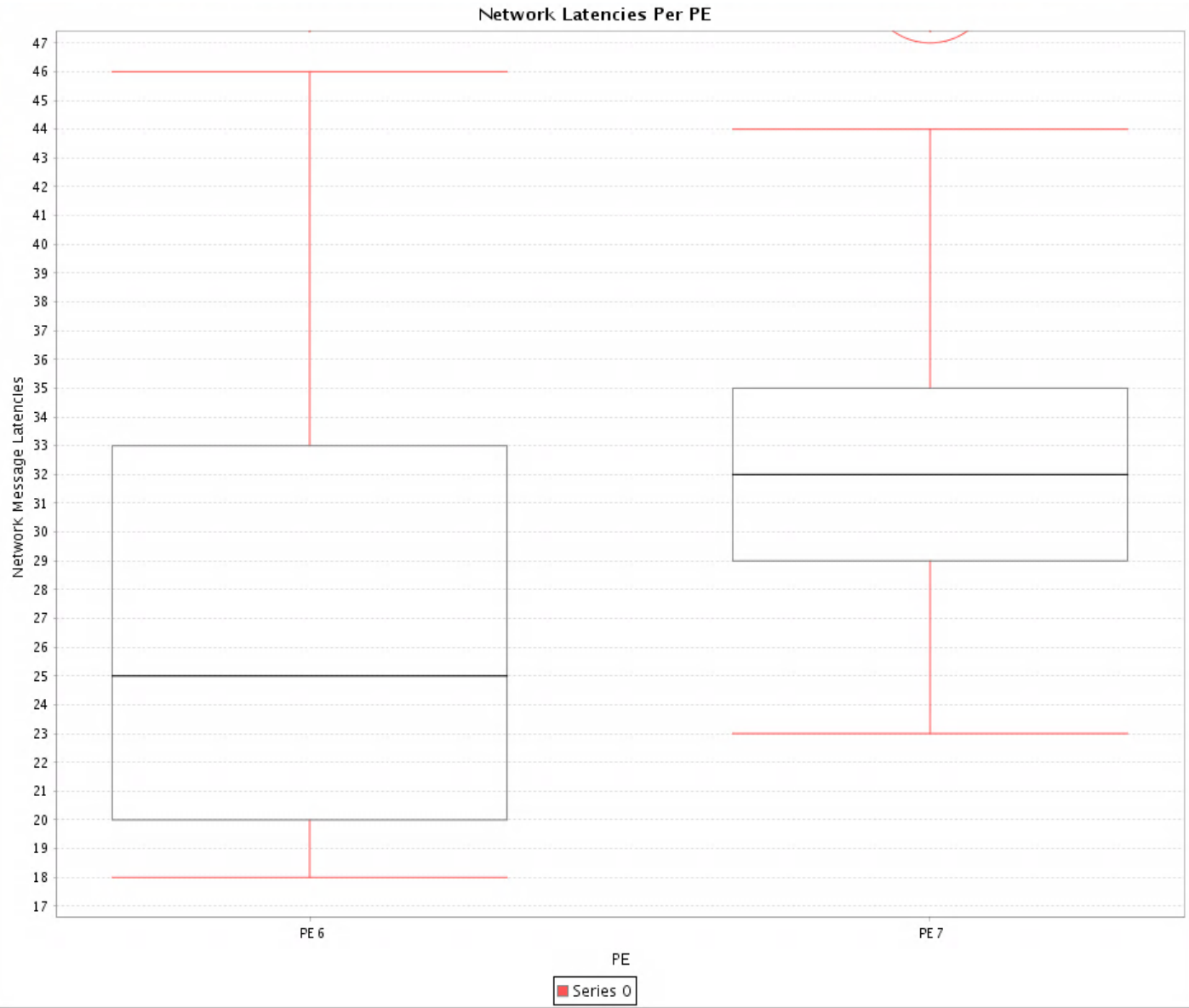

Communication Thread Tracing

Future work:

- Identify communication thread oversubscription
- Estimate runtime given ideal network
- Use topology and routing information to identify network hotspots

Conclusion

- Performance analysis tools are *critical* for optimizing HPC applications
- Detailed metrics (performance counters, network delay, etc) can provide insight
- Make performance problems as obvious as possible
- Make it possible for users to write *ad hoc* analysis tools

Thanks