Frequency-based Overhead Compensation in HPC Application Traces

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Application tracing

- **Performance analysis**
- Logging of significant events
- Unique identifiers (timestamp)
- Chronological order
- **Parallel and distributed applications**

Overhead in traces?

Additional instructions!

- Direct perturbations
  - Logging overhead

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  - Compilier optimizations $\rightarrow$ binary instrumentation

Overhead in traces?

Additional instructions!

- Direct perturbations
  - Logging overhead → log less → **compensation**
- Indirect perturbations
  - Compilier optimizations → binary instrumentation
  - Cache, CPU optimizations

Compensation and overhead measurement

$$event_a^i = event_a^{i-1} + (event_m^i - event_m^{i-1}) - O$$

- Isolate the logging routine
- Take enough measurements
- Produce an estimator (e.g. mean)

Compensation and overhead measurement

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- Isolate the logging routine
- Take enough measurements
- Produce an estimator (e.g. mean)
- Very fast routines $\rightarrow$ high variability

Frequency

Logging overhead is a function of the logging **frequency**. The difference may be small, the error is **cumulative**. Also

- How high is the variability?
- What can be done about it?

Notes

- Mean frequency for the entire trace
- **Regular applications**
- MPI

Metrics

How to compare with previous methods?

- Total execution time
- Space/time view

Platform

- 2 NUMA nodes
- Intel Xeon E5-2630 (24 PU total)
- 32 GB RAM
- OpenMPI 1.6.5
- **Shared memory**
- Linux 3.16.0-51 (Ubuntu 14.04.1), GCC 4.8

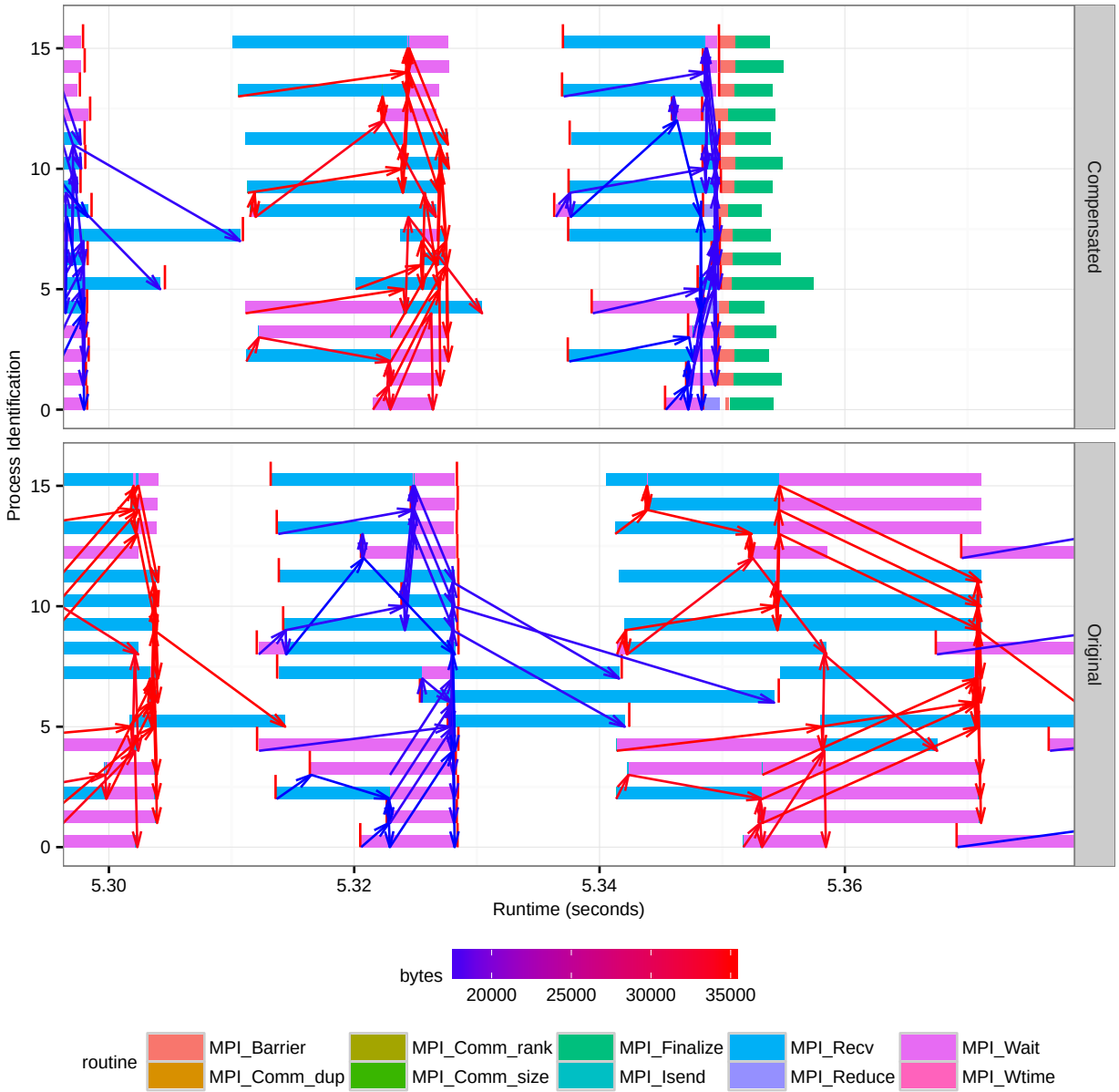
Applications

- OSU Microbenchmarks v5.2 (`osu_multi_lat`)
- Ondes3D v1.1

OSU Microbenchmarks

Execution	Mean	Standard error
UnInstrumented	12.9576502561	0.280464331573357
Instrumented	13.1024921894073	0.176561479255295
Traditional	13.0582891357813	0.176510576519728
Frequency	12.9450804535228	0.176508398007264

Ondes3D


Compensated
Original
Process Identification
0
5
10
15
5.30
5.32
5.34
5.36
Runtime (seconds)
bytes
20000
25000
30000
35000
routine
MPI_Barrier
MPI_Comm_dup
MPI_Comm_rank
MPI_Comm_size
MPI_Finalize
MPI_Isend
MPI_Recv
MPI_Reduce
MPI_Wait
MPI_Wtime

Conclusion

- Execution time is a function of the frequency
- Care should be taken with measurement variability
- Encouraging results using coarse metric
- Inconclusive results using fine grain metric

Future work

- Test traces with higher intrusion
- Tests in a networked environment
- Tests with tools with a higher intrusion
- Search for a fine grain metric
- Investigation with irregular applications

Thank you for the attention!

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