

Does the Halting Necessary for Hardware Trace Collection Inordinately Perturb the Results?

BYU

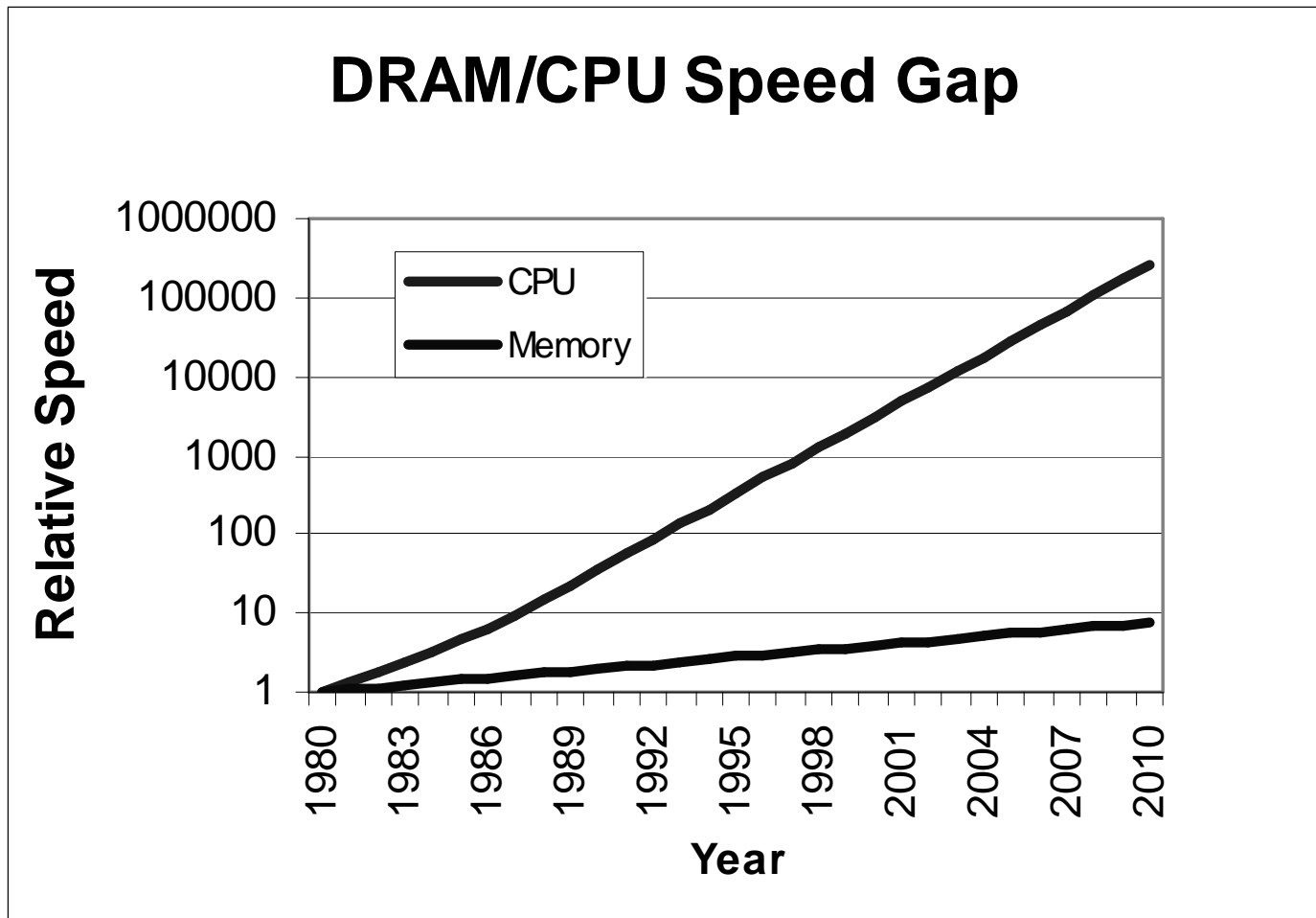
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Talk Outline

- Background
- Experiments
- Results
- Conclusion

DRAM/CPU Speed Gap



WWC-7 October 2004

Solution: Access DRAM Less Frequently

- Large solution space
- Example: memory hierarchy parameters
 - Number of levels
 - Size
 - Associativity
 - Line Size
 - Replacement Policy

Trace-Driven Simulation

- Uses memory access history
- Deterministic and repeatable
- Long traces are needed to avoid cold start effects

Trace Collection Continuum

- Flexibility vs. overhead tradeoff
- Varying completeness



Hardware Probes

Instrumentation

Simulation

BACH: BYU Address Collection Hardware

- Hardware trace collector
- Uses commercial logic analyzer
- Buffers 8 million references
- Halts SUT using device driver for long traces

Perturbation

- Resources used by device driver
 - Cache lines
 - TLB entries
- Reordering of interrupt handlers

Experiments

- Measure impact of halting
- SPEC CPU2000
 - All 12 integer benchmarks
 - three floating point

Experiments Contd.

- Vary halting frequency
 - Hold duration constant
(1/2 second and 2 second)
- Vary halting durations
 - Hold frequency constant
(every 1/8 second and 1/2 second)

Using Performance Counters to Detect Perturbation

- Performance counts characterize execution
- Perturbation should affect counts as well as execution

Hardware Performance Counters

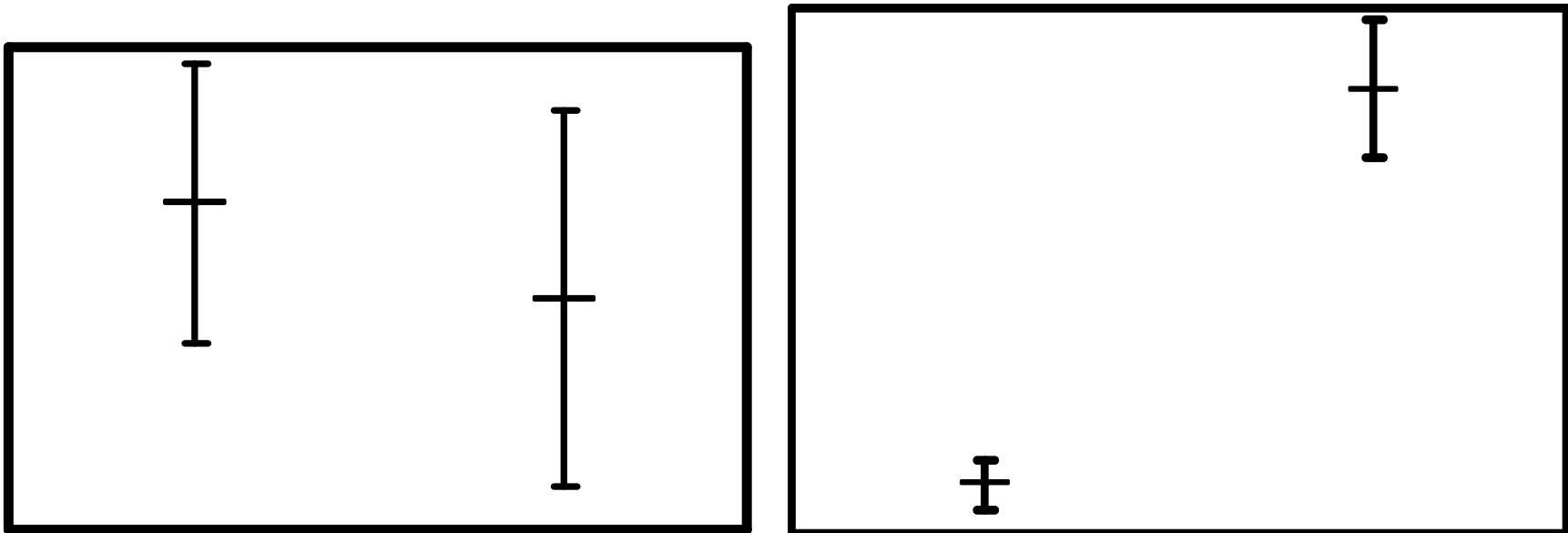
- Increment with microarchitectural events
 - Cache events
 - Opcode types
 - Bus cycles
- Low impact on the system
- Use total counts to minimize overhead
- Subtract obvious effects

Counter Selection

- Gomez et. al.
 - Used counters to compare benchmark reduction methodologies
- CPI, branch misprediction rate, cache miss rate
- We added a few others to fill counters
- We did not use L2 cache misses or bus statistics

Statistical Methods

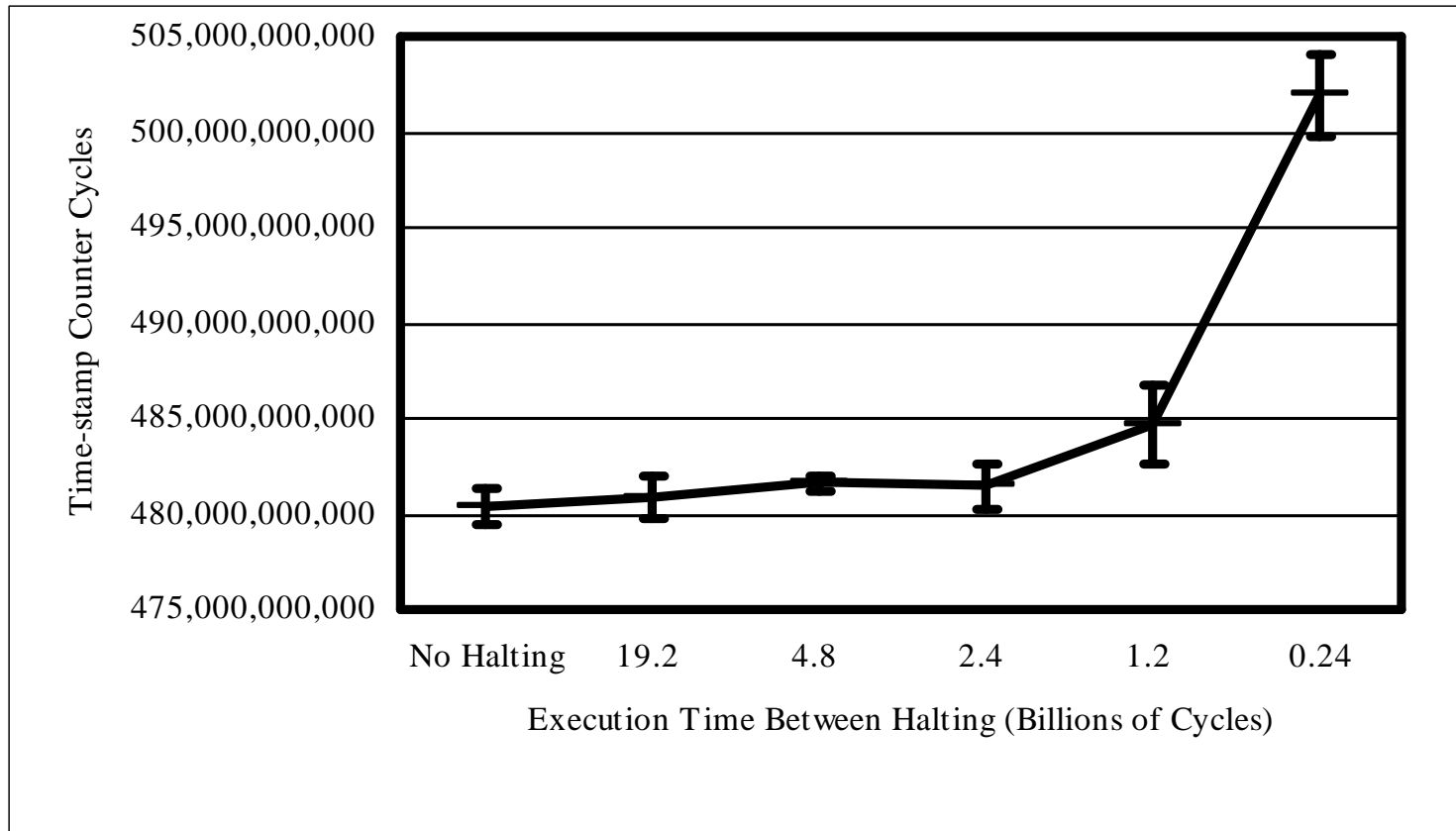
- Sample size estimation
- Confidence intervals around the mean



Disclaimer/Warning Slide

- Differences on the slides are larger than they appear
- Graphs are scaled to clearly present trends, not scale

A Significant Trend



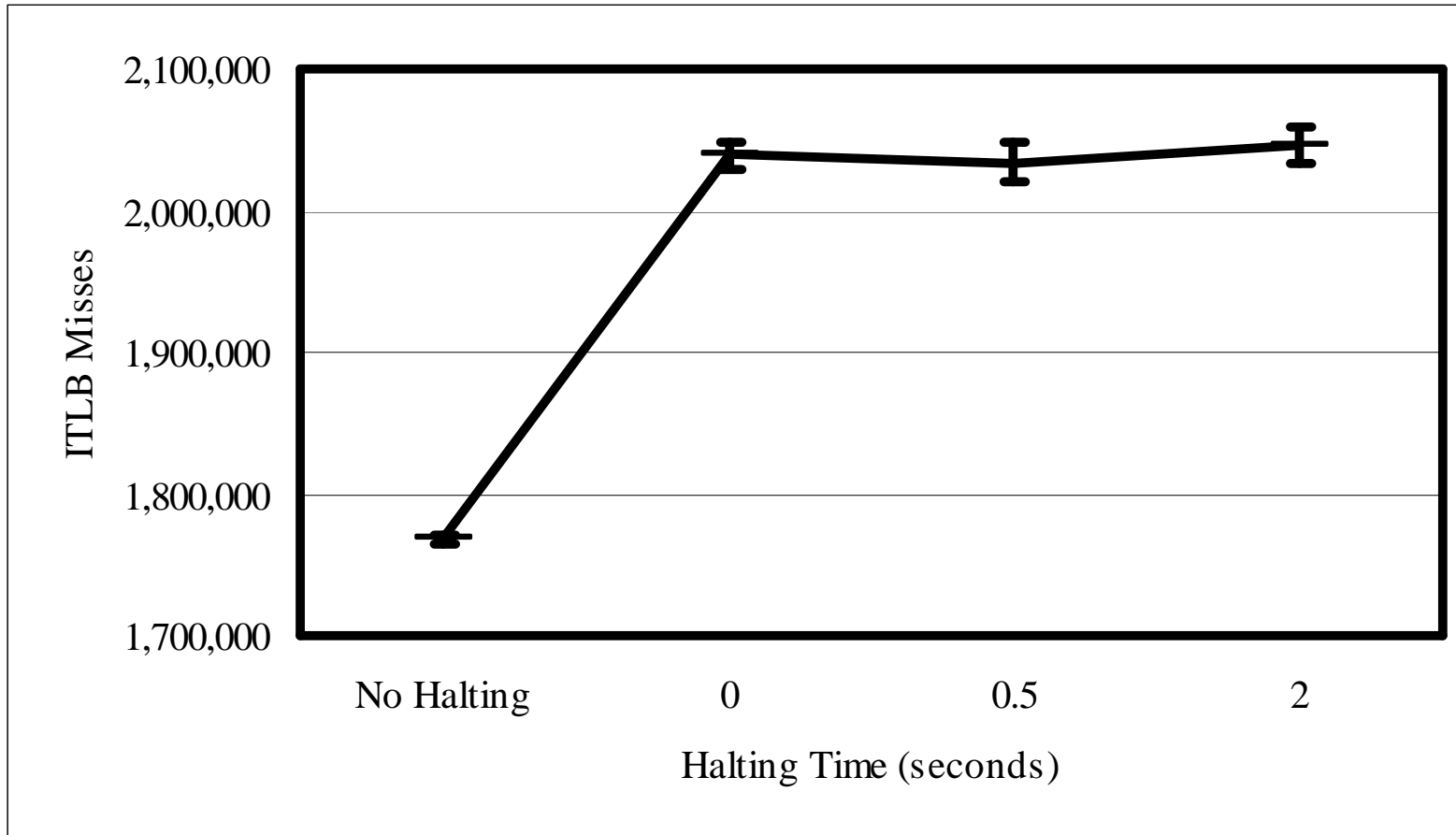
Not a Significant Trend



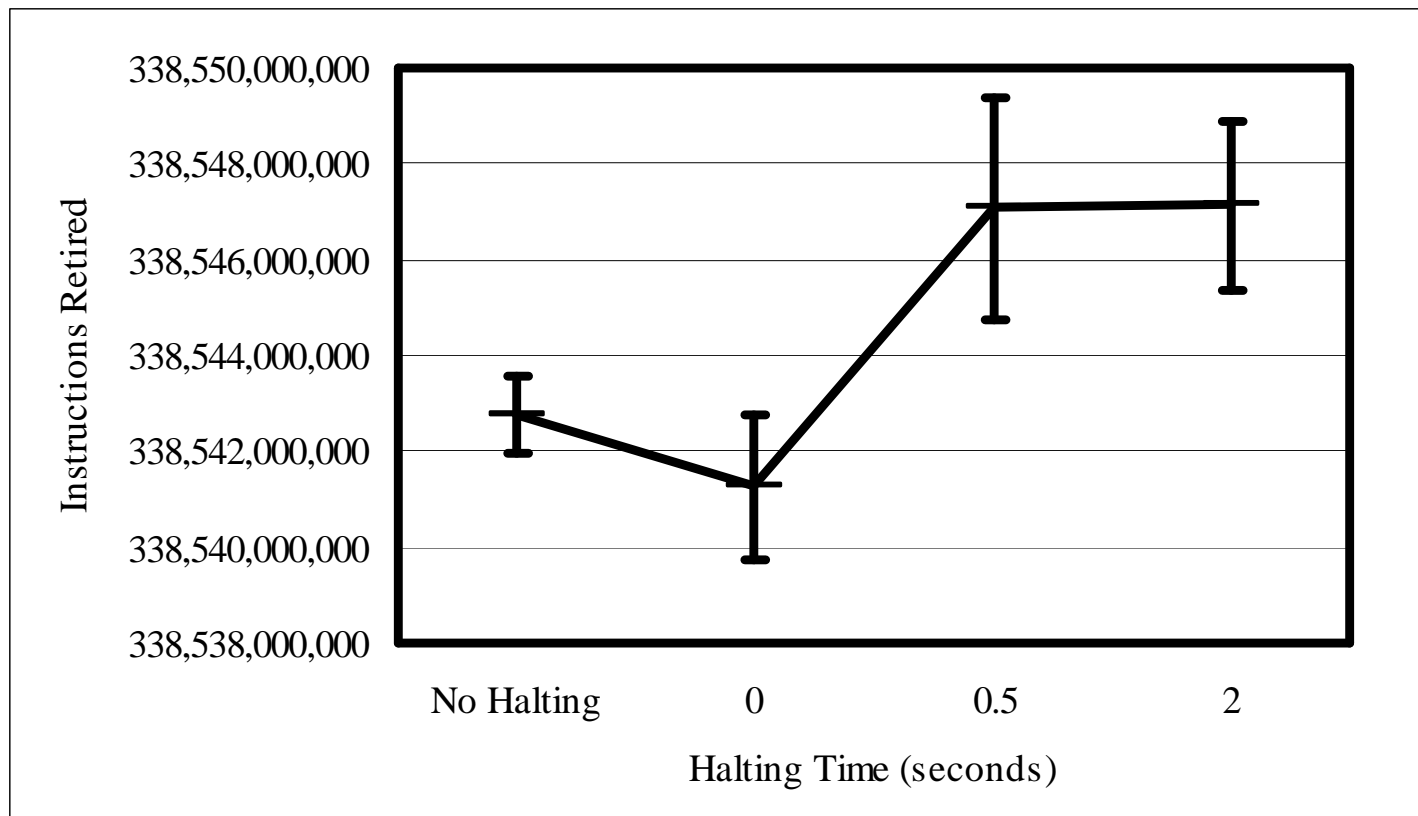
Effects of Increasing Halting Times

- No effect of increasing halting times
 - Step patterns
- Time spent in halting routine
 - Thermal throttling

Step Trend



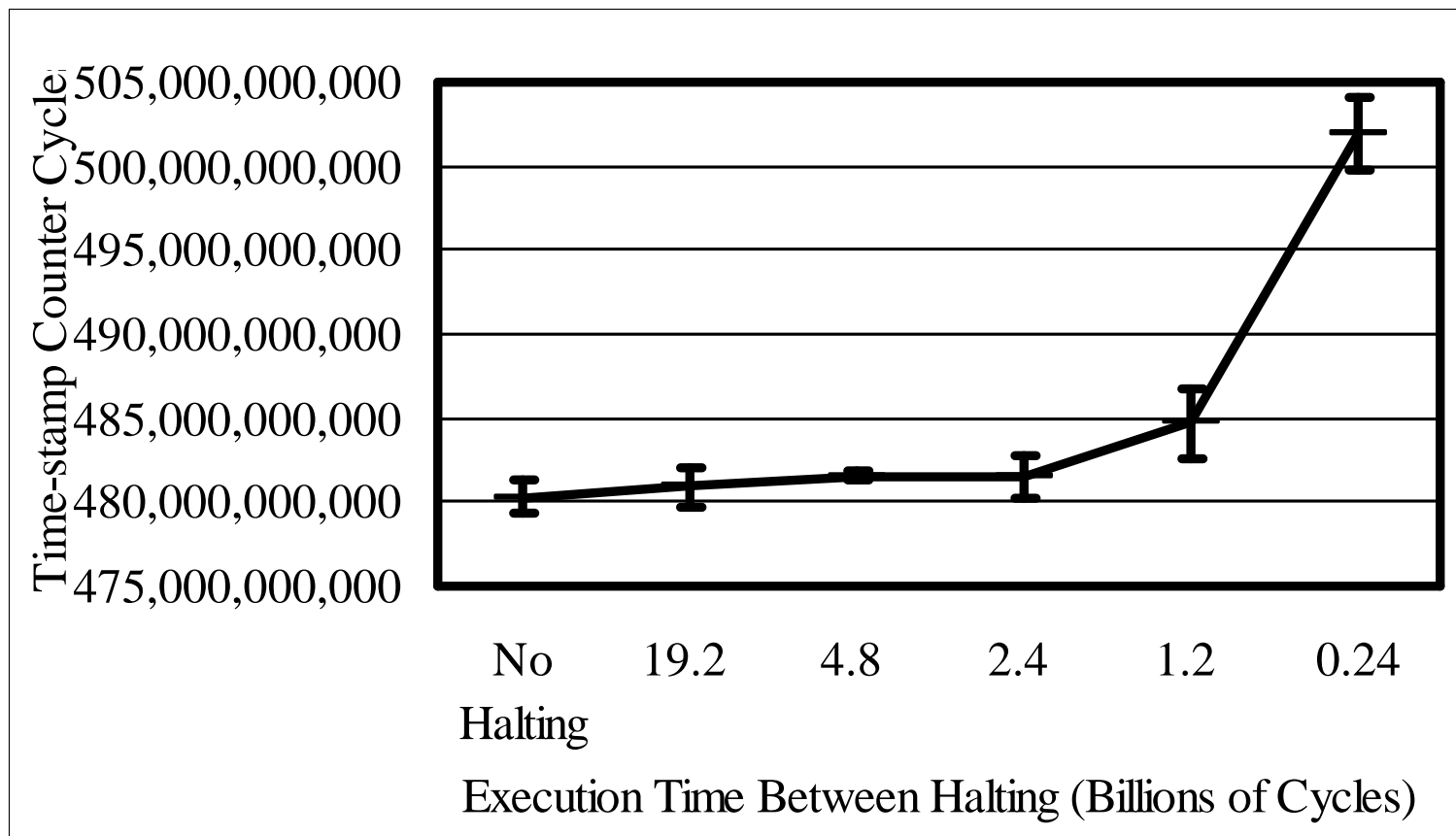
Another Step Trend



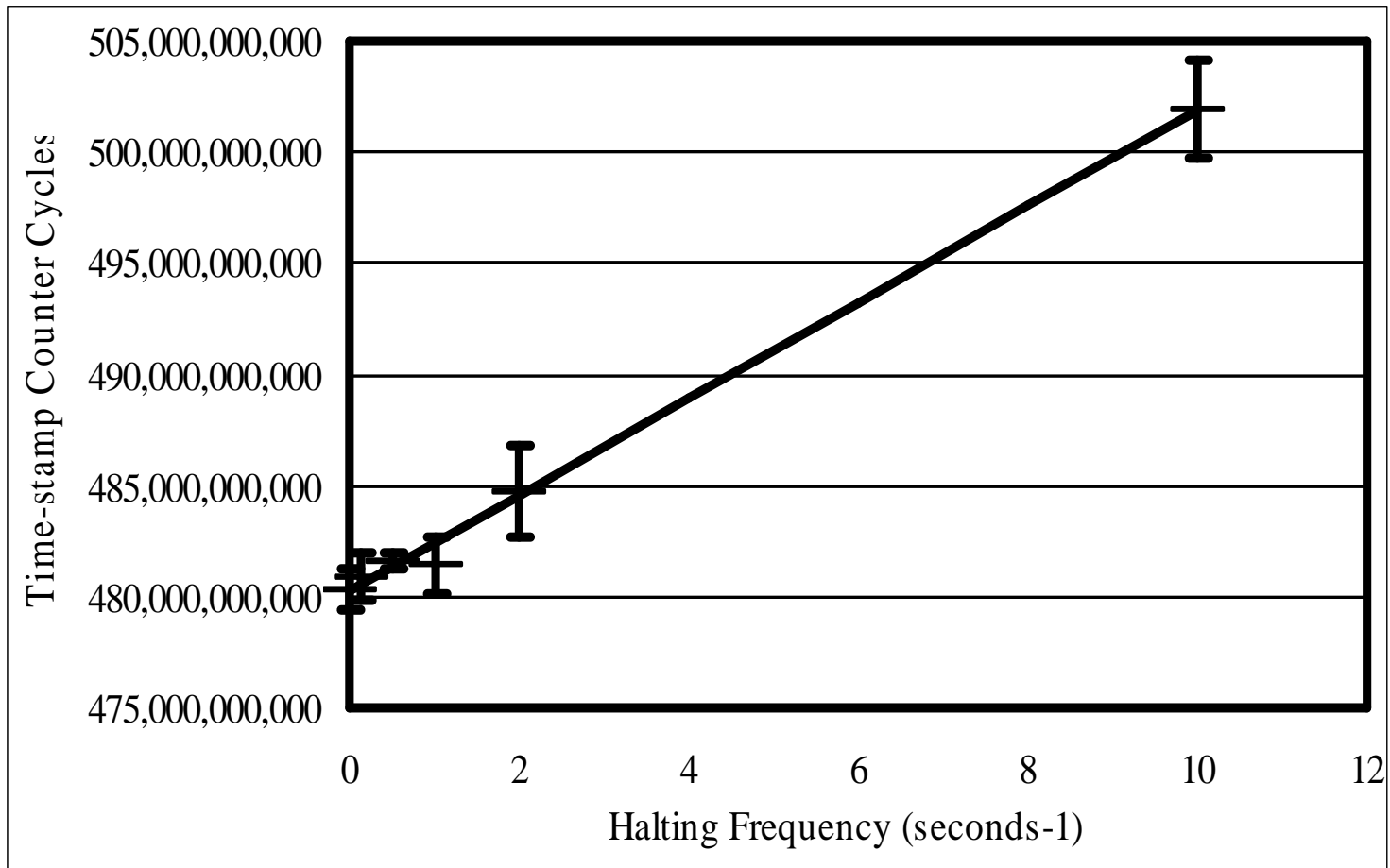
Effects of Increasing Halting Frequencies

- Counts increase with frequency
- Resource conflicts occur more frequently
- Benchmark dependent

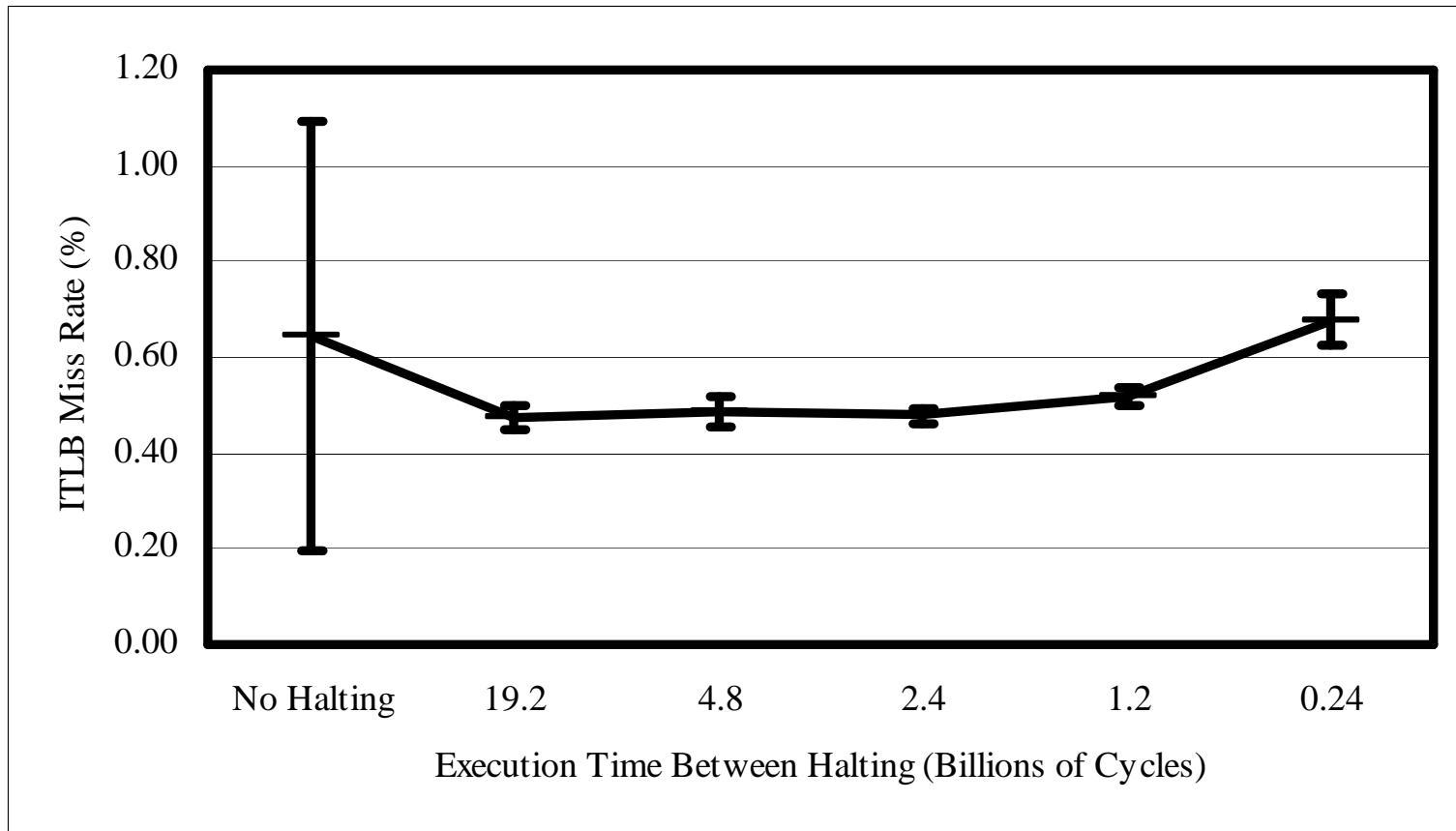
Linear Effect of Increasing Halting Frequency



Scatter Plot



Another Trend



Conclusions

- Halting for Hardware tracing is low overhead
- Perturbation is :
 - Benchmark dependent
 - Related to halting frequency
 - Unrelated to halting duration

Questions?