Glorifying the If-Statement

PHMon: A Programmable Hardware Monitor and Its Security Use Cases

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Royal Holloway, University of London


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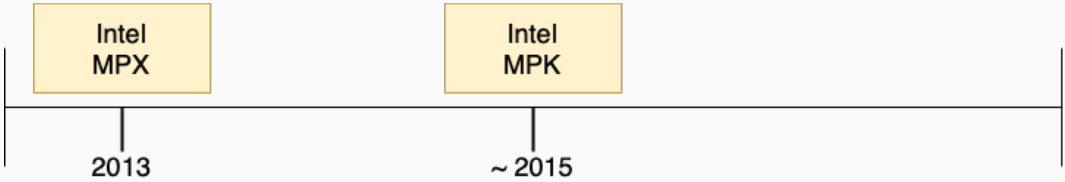
MPX
2013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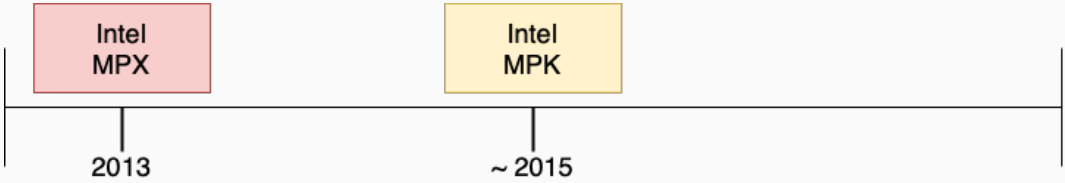
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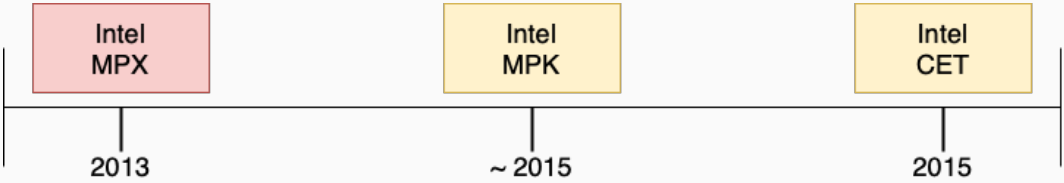
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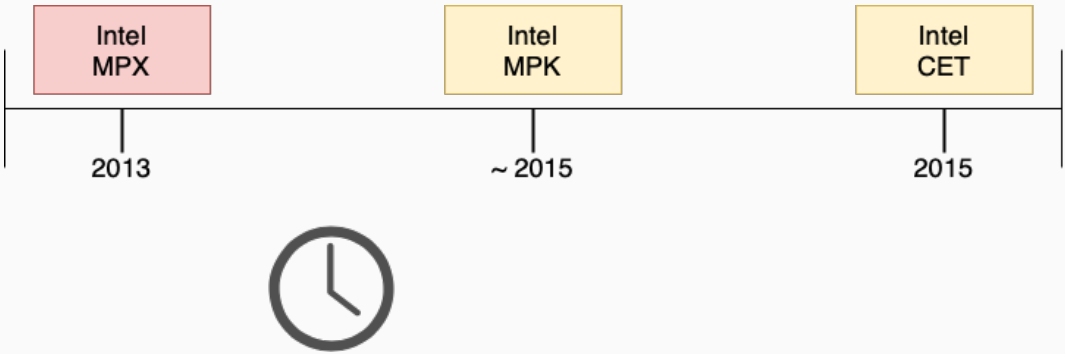
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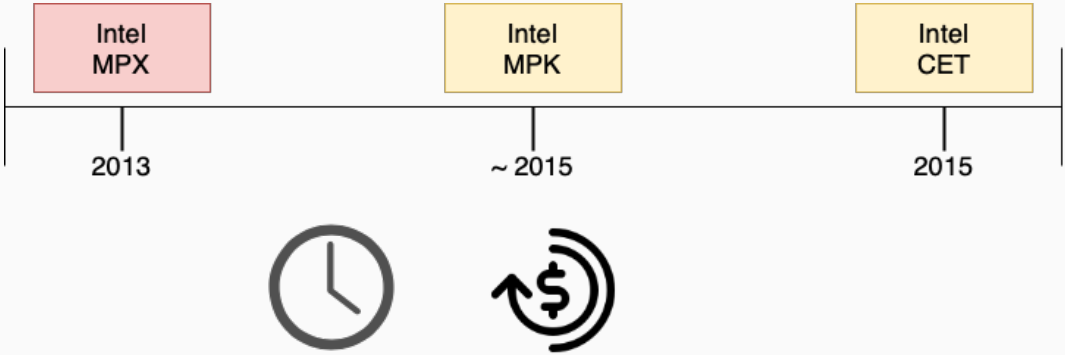
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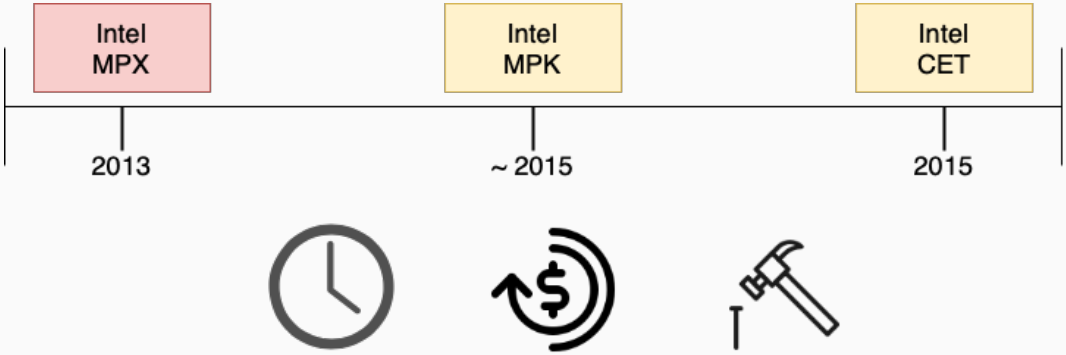
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Outline

PHMon

Overview

Programmable Hardware Monitor

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Event-Action Monitoring Model

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Event-Action Monitoring Model

Three Stage Pipeline:

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- Collect

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Event-Action Monitoring Model

Three Stage Pipeline:

- Collect
- Examine
- Action

Trace Unit (TU)

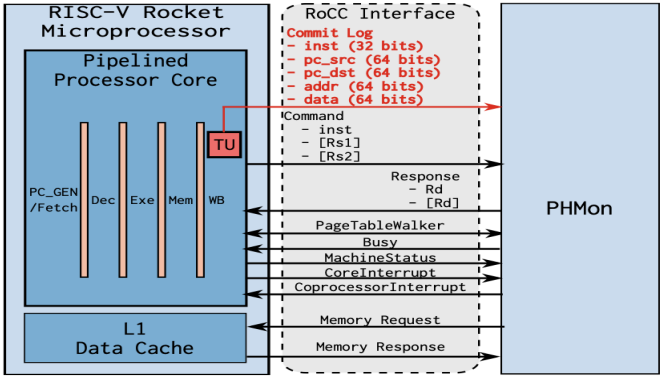

Figure 2: The RoCC interface extended with *commit log* execution trace.

Match and Action Units (MU & AU)

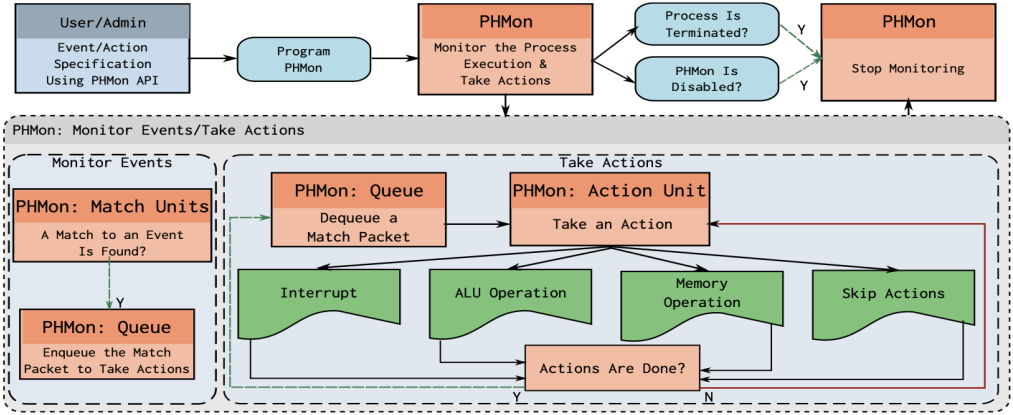

Figure 1: An overview of the *event-action* model provided in PHMon.

Use-cases

Potential Use-cases

Shadow Stack Protection

Potential Use-cases

Shadow Stack Protection

Hardware Accelerated Fuzzing

Potential Use-cases

Shadow Stack Protection

Hardware Accelerated Fuzzing

Prevention of Information Leakage

Potential Use-cases

Shadow Stack Protection

Hardware Accelerated Fuzzing

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Watchpoints and Accelerated Debugger

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Hardware Accelerated Fuzzing

Prevention of Information Leakage

Watchpoints and Accelerated Debugger

Hardware Accelerated Fuzzing

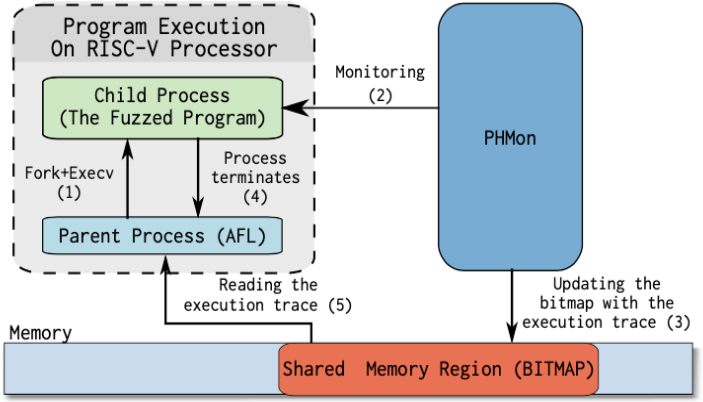

Figure 4: Integration of PHMon with AFL.

Evaluation

Overview

Evaluate performance of the aforementioned four use-cases

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RISC-V Rocket Chip with PHMon as RoCC

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Disclaimer:

No L2 Cache on set-up that may have impacted performance

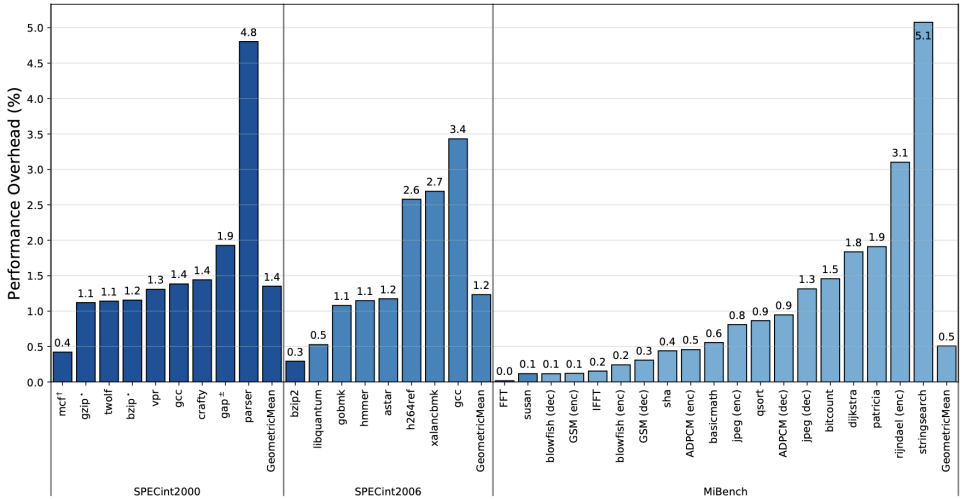

Figure 5: The performance overhead of PHMon as a shadow stack.

† We were not able to run mcf benchmark with `reference` input on our evaluation board; as a result, we used the `test` input for this benchmark.

* Due to the memory limitations of our evaluation board, we had to reduce the buffer size of the `reference` input to 3 MB for gzip and bzip2 benchmarks.

± We had to use `-O0` and an input buffer size of 96 MB to successfully run gap benchmark.

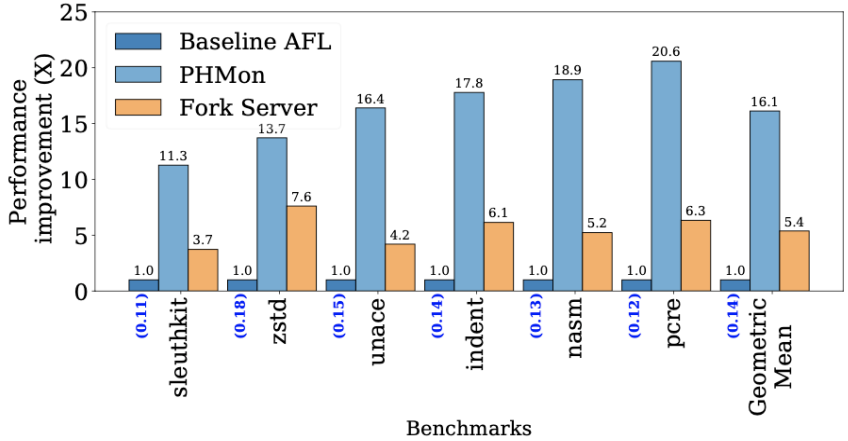

Figure 6: Performance improvement of PHMon over the baseline AFL compared to fork server AFL. The numbers below the "Baseline AFL" bars show the number of executions per second for the baseline AFL.

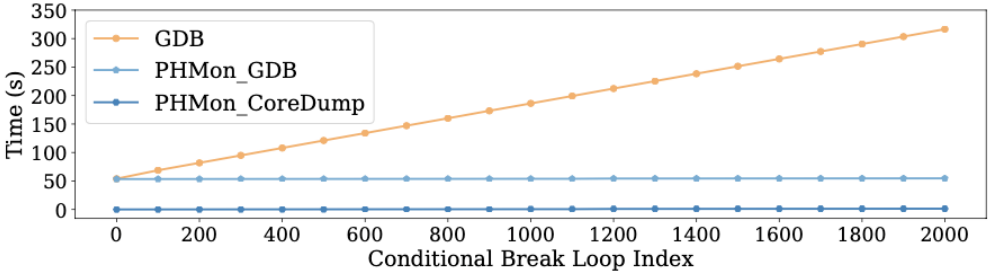

Figure 7: The performance overhead of PHMon compared to GDB for a loop conditional breakpoint.

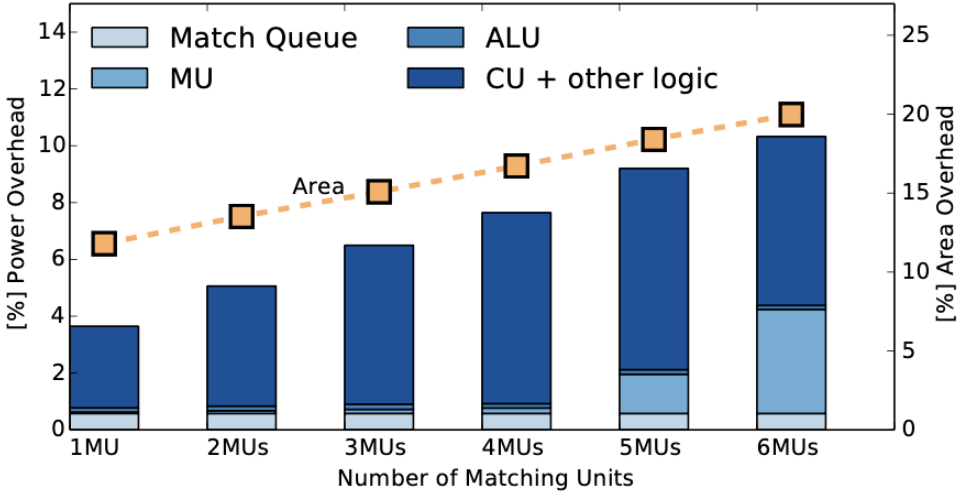

Figure 8: The power and area overheads of PHMon components compared to the baseline Rocket processor.

Conclusion

Discussion

Well motivated and reasonable approach

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Recontextualising of Match-Action Pipeline for security monitoring in an OS

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Fidelity and impact for research I would expect for USENIX

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Simplistic Threat Model

Summary

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Evaluation shows .9% overhead for shadow-stack protection

Improves performance of AFL by up to 16x, finding more bugs

Questions

1. Are there any caching opportunities for PHMon that could improve performance?
2. Does PHMon deal with branch prediction in monitoring?
3. Can monitoring rules be updated in real-time, or does it require PHMon to be offline?