SniP: An Efficient Stack Tracing Framework for Multi-threaded Programs

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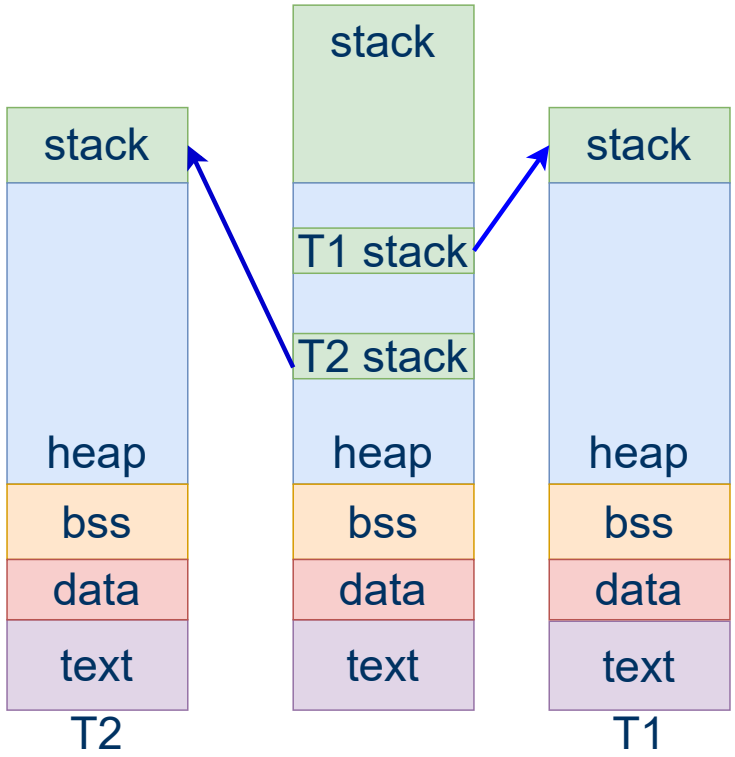
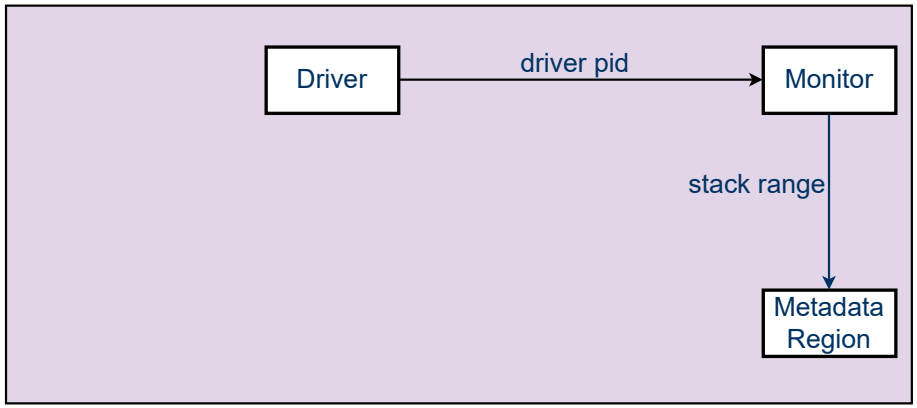


SniP Design

- OS extension (`Monitor`) captures thread's stack range information.



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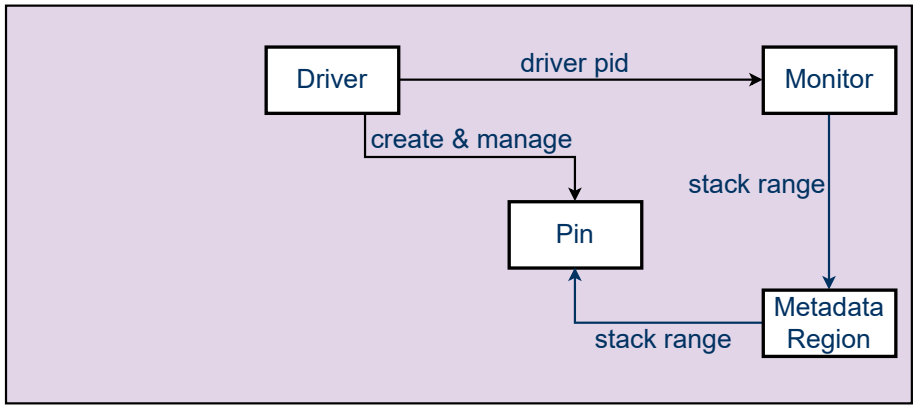

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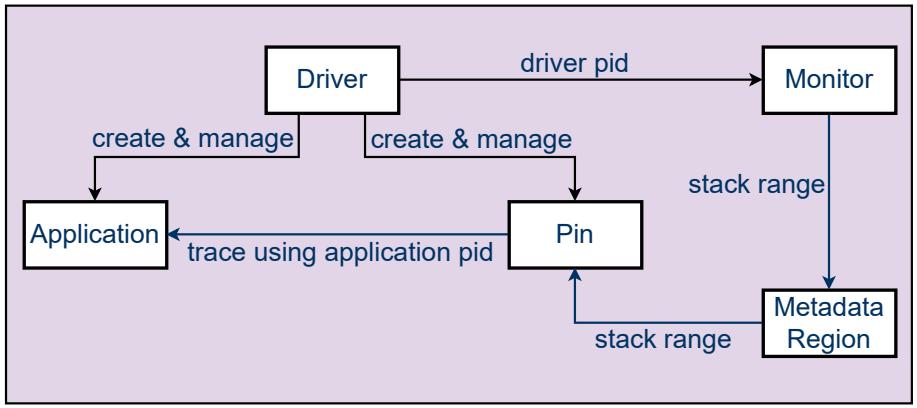
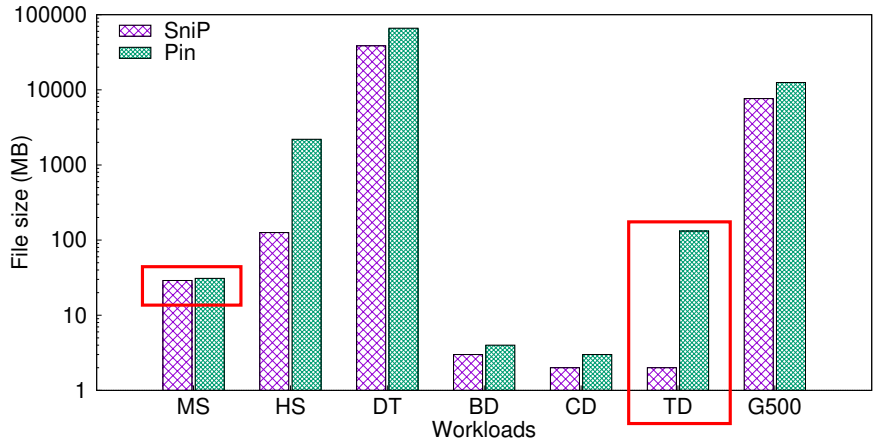
- `Pin` tool uses this stack range info and records only stack accesses in trace file.
- `Driver` program coordinates & manages tracing.



Benefits of SniP in Multi-threaded Program Stack Tracing

Trace File Size

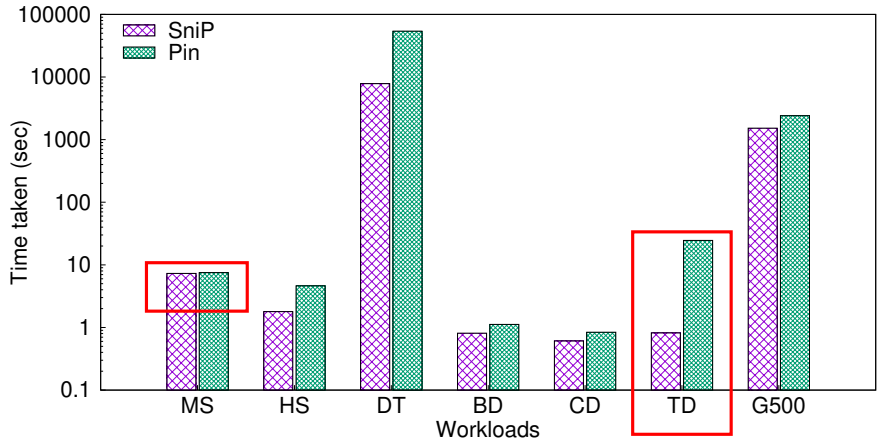
- Reduces file size for long running applications. — $\sim$ 98% reduction for TD.
- Marginal reduction ($\sim$ 6% for MS) in file size for short running, heavy stack usage applications.



[MS: Merge-Sort, HS: Python3 Http Server,
DT: Decision Tree Classifier, BD: BabyDBM,
CD: CacheDBM, TD: TinyDBM, G500: Graph500 BFS]
Y-axis is in log scale

Tracing Time

- SniP benefits long running applications. — $\sim$ 96% reduction in time for TD.
- Marginal benefit ($\sim$ 2% reduction for MS) for short running, heavy stack usage applications.



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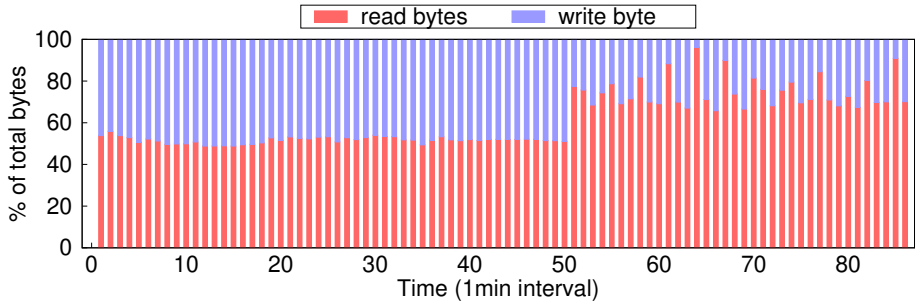
Example Use Cases of SniP

Tracing ML Classification Algorithms

- Studied stack read-write access pattern of popular ML algorithms.
- As an example, in Decision Tree Classifier, reads dominated writes.



% of read - write accesses to stack in Decision Tree Classifier

Detecting Uninitialized Memory in Stack

- Analysed program with uninitialized memory bug.
- Identified instances where read from stack happened before write.


```
{
    "0x7fffffffe2d8": [
        "0x7ffff7ac8a0c"
    ],
    "0x7fffffffe2f8": [
        "0x7ffff7ac8913"
    ],
    "0x7fffffffe308": [
        "0x7ffff7ac8927"
    ],
    "0x7fffffffe310": [
        "0x7ffff7ac8928"
    ],
    "0x7fffffffe318": [
        "0x7ffff7ac8929"
    ],
```


Parser output of uninitialized memory bug

Conclusion

- Program stack tracing is key in gaining insights, exposing security loopholes in applications.
- We introduced SniP, an efficient stack tracing framework for run-time tracing of multi-threaded application stack.
- SniP combines Intel's Pin with an intelligent OS extension, reducing trace file size and tracing time.
- SniP can be easily adapted for vast variety of use cases.

For more details contact:

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