Scalable Security Vulnerability Analysis via Sampling

Joseph Greathouse, Ilya Wagner, Valeria Bertacco, and Todd Austin, University of Michigan

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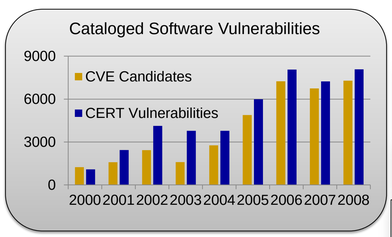
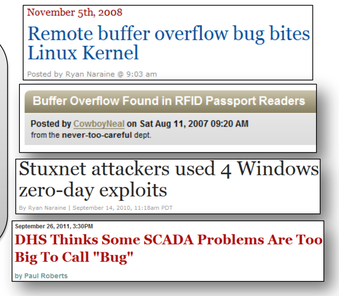
Motivation: Software Errors Abound

- NIST: SW errors cost US **~$60 billion/year** as of 2002
- FBI CCS: Security Issues **$67 billion/year** as of 2005
  - >⅓ from viruses, network intrusion, etc.





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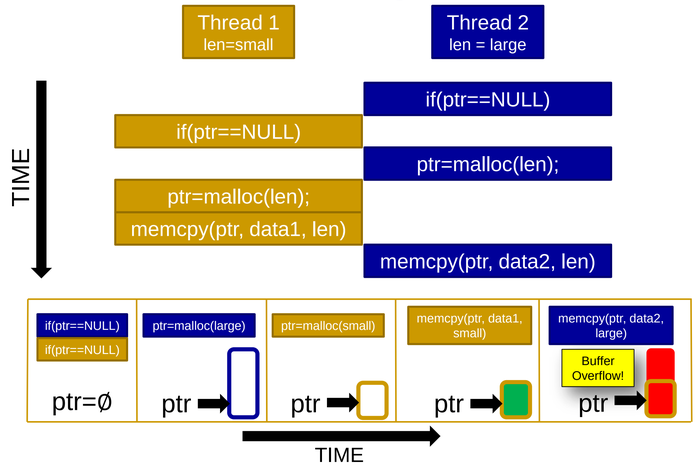
A Modern Security Bug



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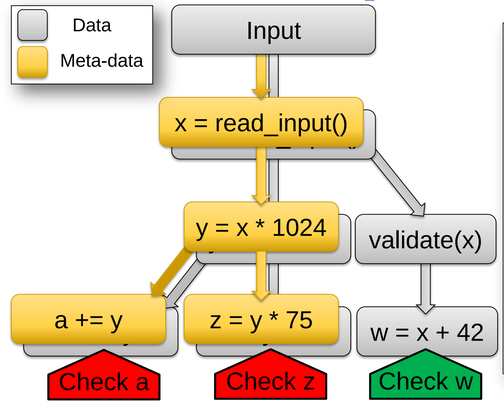
Dynamic Dataflow Analysis Techniques are Powerful but Expensive



Overheads

Memory Checking	5-50x
Taint Analysis	2-200x
Data Race Detection	2-300x
Symbolic Execution	10-200x

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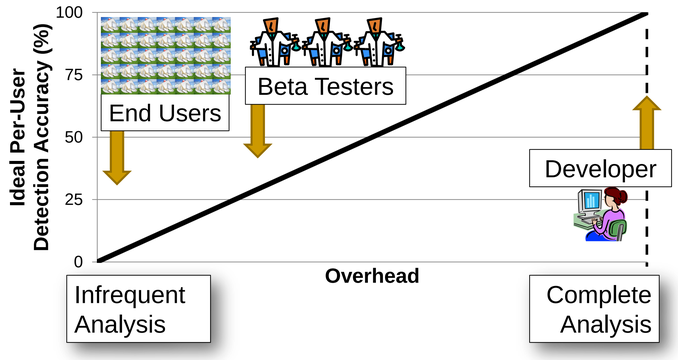
Our Solution: Dataflow Sampling

Lower overheads by skipping some analyses



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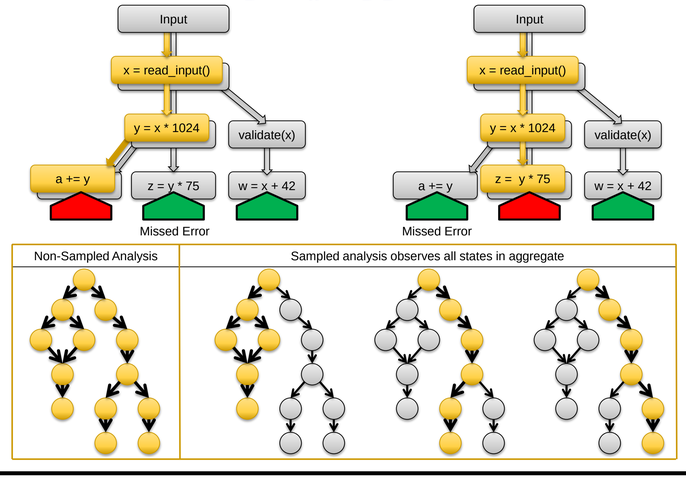
Dataflow Sampling Approach



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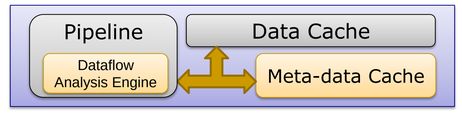
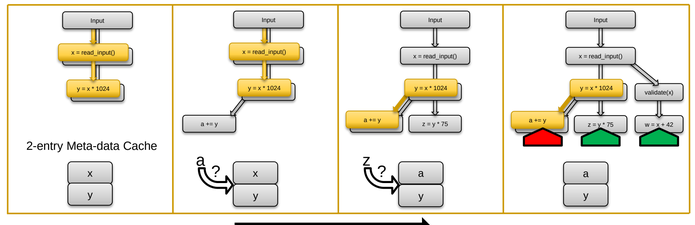
Testudo: Hardware Dataflow Sampling



- What happens when the cache overflows?
  - **Use sampling to randomly remove meta-data**
  - Reduces off-chip changes while facilitating meta-data sampling



Work presented at MICRO'08

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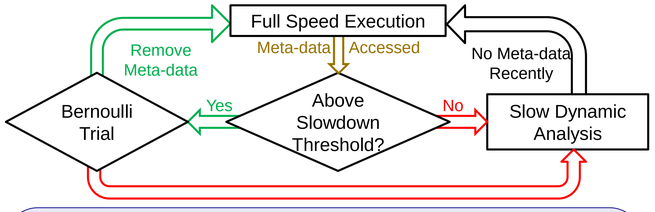
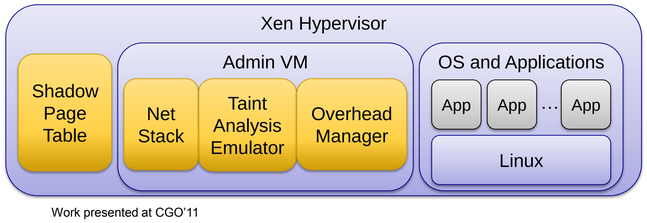
Software-Based Dataflow Sampling





Work presented at CGO'11

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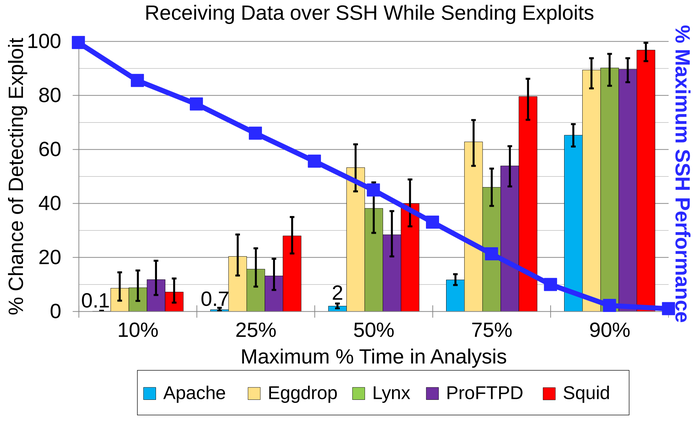
Accuracy and Performance



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Other Applications and Future Work

- Generalized hardware mechanism to find meta-data
  - Use hardware-supported watchpoints to speed up many analyses
  - To be presented at ASPLOS'12
- Simple hardware to accelerate data race detection
  - Performance counters enable SW race detector on-demand
  - Presented at ISCA'11
- Use dynamic sampling to improve static software analysis
  - Control paths near executed code are often exploited by hackers
  - Keep track of paths users don't execute across entire population
  - Focus on these paths in static analysis tool

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