Virtual Execution Environments: Support and Tools

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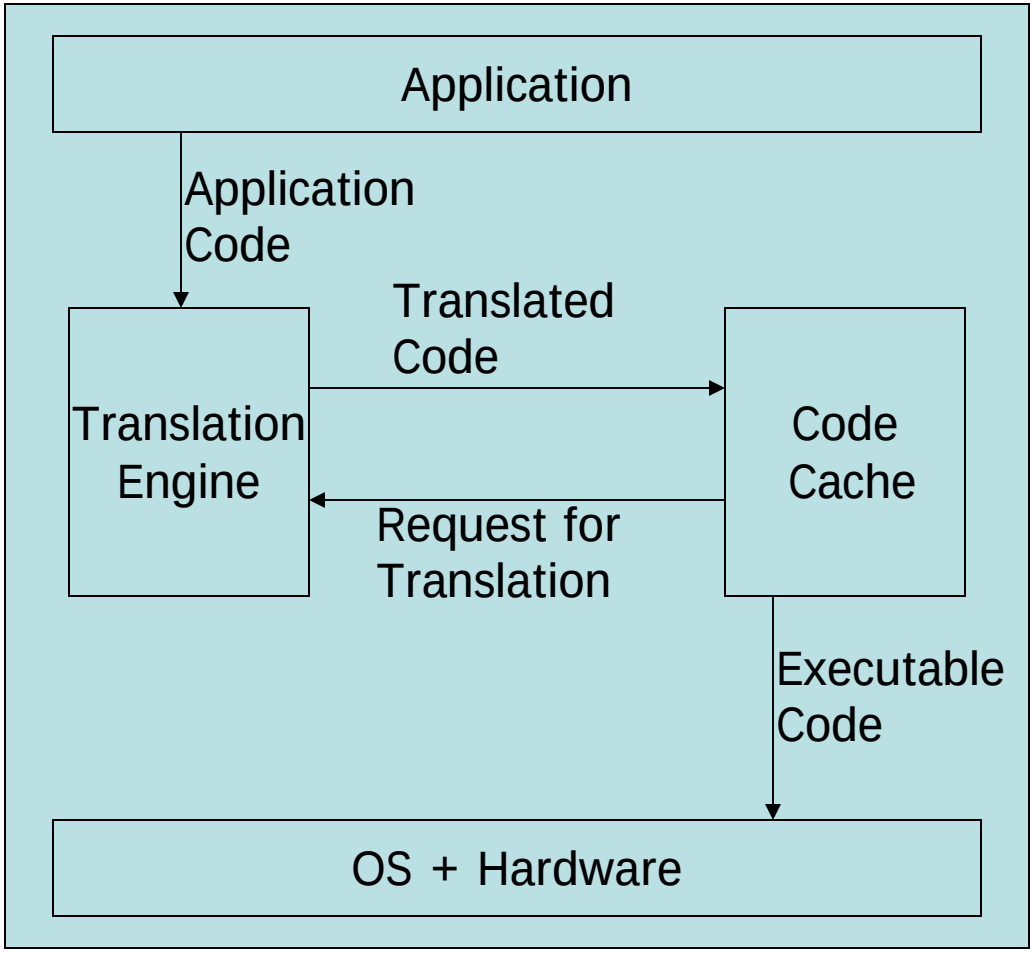
Virtual Execution Environments

- **Increasing interest in Virtual Execution Environments (VEEs)**
- **Research focus: Translation based VEE -** examines and translates a program's instructions
- **Our goals**
  - Improve performance and memory overhead
  - Develop tools to enable the widespread acceptance of VEEs

A Typical Translation-Based VEE



- Application layer
- OS + hardware layer
- VEE layer
  - Translation engine
  - Code cache

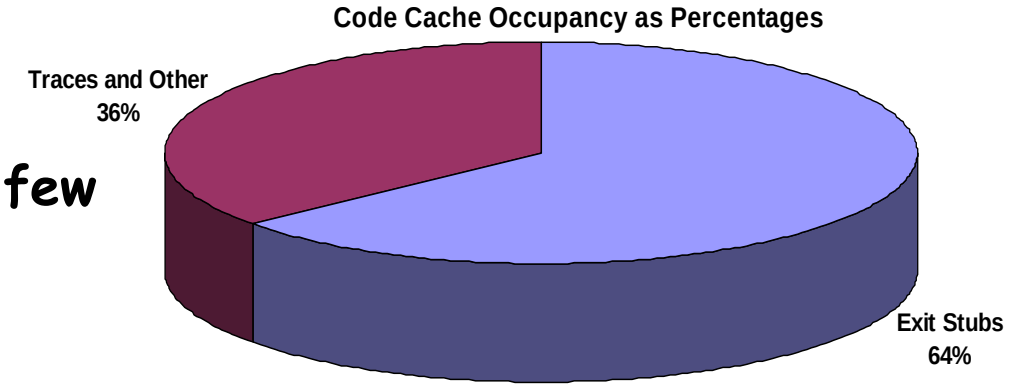
Techniques to improve performance

Performance

- Implemented VEE (Strata); explored overheads
  - Indirect branches expensive – context switch
- Indirect branches from conditionals
  - Indirect branch translation cache
  - Reduced overhead from 4.1X to 1.7X
- Indirect branches from returns
  - Reduced overhead from 1.7X to 1.3X

Reduce memory overhead

- Reduction in memory footprint of code caches
- Exit stubs
  - They are used very few times
  - They have standard functionality
  - They occupy a considerable percentage of code caches

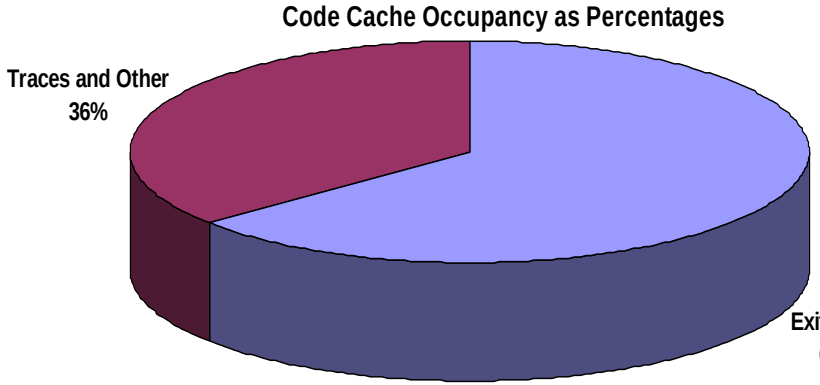


Our Approaches

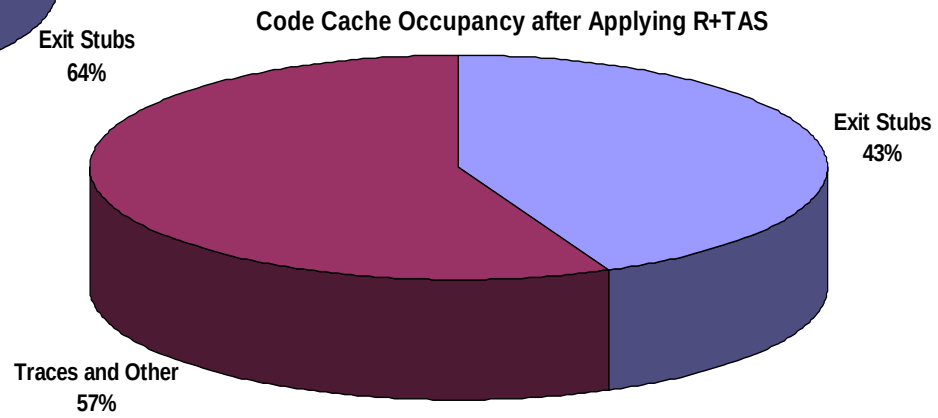
- Deleting exit stubs
- Avoiding generation of exit stubs
- Reducing the size of exit stubs
- Generating target address specific stubs

Evaluation – Stub Occupancy

Standard implementation



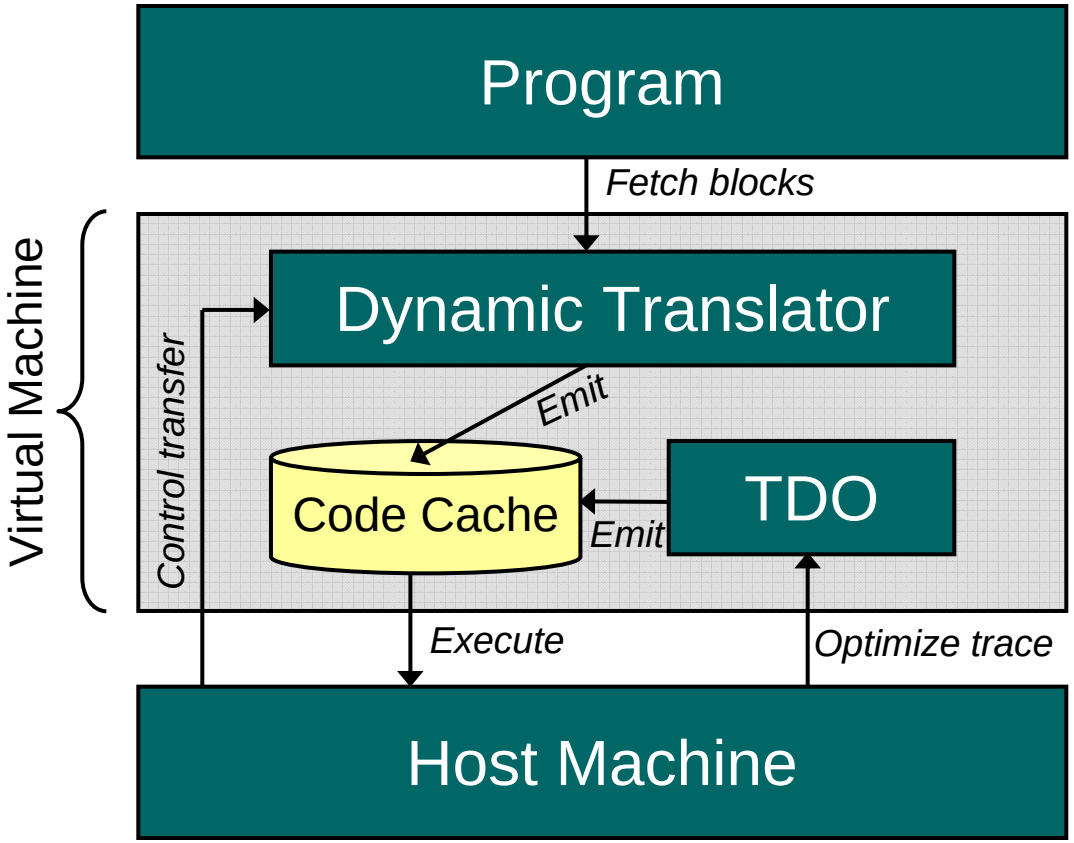
After Technique 4



Tools

- **Tools**
  - **Instrumentor for various VEEs**
  - **Dynamic Optimizer**
  - **Debugger for dynamically optimized code**

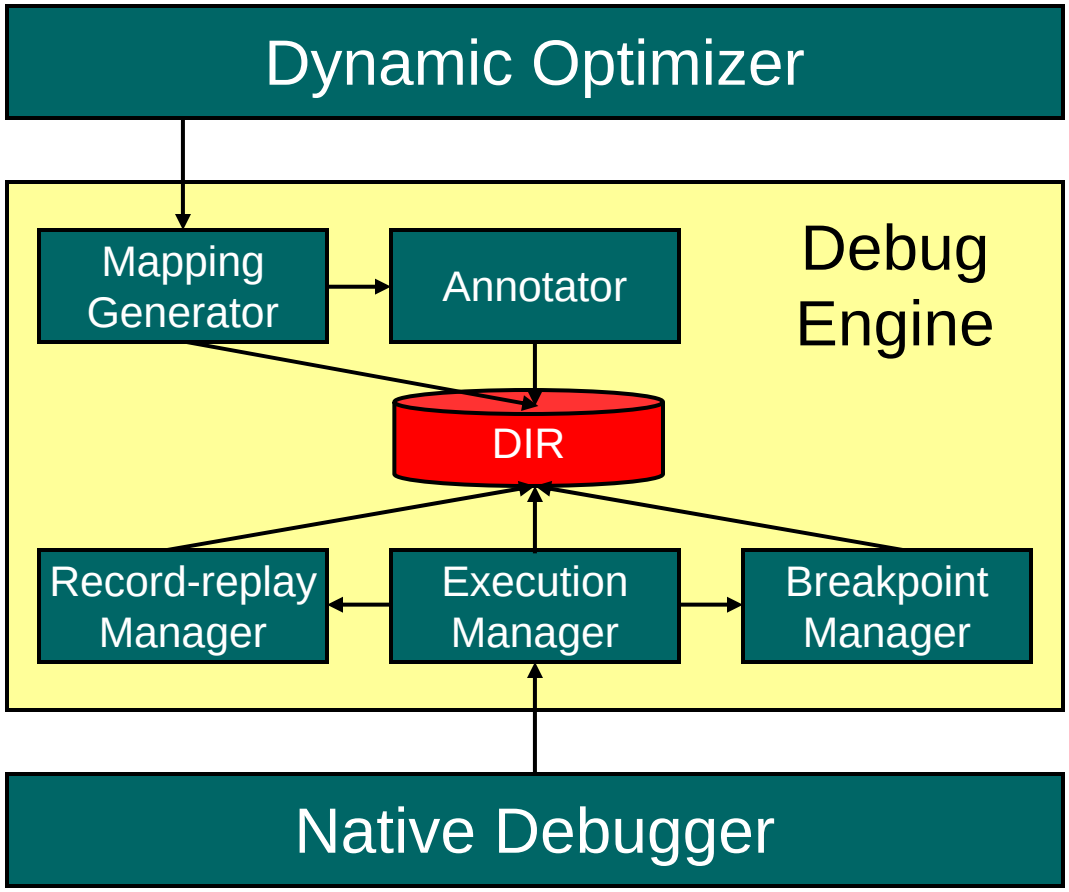
Trace-based Dynamic Optimizer



Challenges in Debugger

1. **Static debug information inconsistent**
   - Code is generated, modified, duplicated and deleted continuously during execution
   - Active debug environment needed
   - Code location problem – opt and duplication
2. **Re-optimization & trace combination**
   - Data-value problem – expected value
3. **Efficiency**
   - Frequent optimization of traces
   - Code duplication and code cache flushes

Debug Information Repository



Experimental Results

- Dynamic Optimizer: Strata-DO;
- Native Debugger: Gdb 5.3
- SPARC v9; Sun Blade 100; 500 MHz; 256 MB
- SPECint2000

- Can report all expected values except those deleted by optimizer
- Performance overhead - 2.6%
- Memory overhead average 685 KB

- Overheads are comparable to those debuggers for statically optimized code

Summary and future research

- Demonstrated that SDTs and tools can be efficient
- **Current and future research**
  - Limit study for dynamic optimizations to determine potential
  - Advanced execution system that automatically adapt application's execution to resource landscape originating from process variation

Questions?

Thank You

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http://www.cs.pitt.edu/coco