VMI-PL: A monitoring language for virtual platforms using virtual machine introspection

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August 5, 2014

Outline

Virtual Machine Introspection (VMI)

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- Semantic gap problem [Chen et al., 2001]

VMI Techniques

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Data-based techniques:

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- Monitor system and user defined interrupts

Stream-based techniques:

- Inspect network traffic
- Monitor keyboard input

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- Filters
- Reconfiguration instructions

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VMI-PL:

- Data probes
- Event probes
- Stream probes
- Filters
- Reconfiguration instructions
- Configuration

VMI-PL - Overview II

```
Configuration{
    <configuration-item>
}
<event-probe>(<parameters>){
    <data-probe>(<parameters>)
    <filter>(<parameters>){
        <data-probe>(<parameters>)
    }
}
<stream-probe>(<parameters>)
```

VMI-PL - Language Constructs I

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Data Probes:

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- `ProcessList(<field>, [<file-path> | <stream-id>])`

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- `Syscall([<syscall number> | -])`

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Stream Probes:

- CaptureNetwork(<mac address>, [<file-path> | <stream-id>])

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Data Probes:

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- WriteToMemoryAt(<register>, <offset>, <value>)
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Event Probes:

- CRWrite(<number>)
- Syscall([<syscall number> | -])

Stream Probes:

- CaptureNetwork(<mac address>, [<file-path> | <stream-id>])
- CaptureKeyboardInput([<file-path> | <stream-id>])

VMI-PL - Language Constructs II

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Filters:

- `RegisterHasValue(<register>, <value>)`

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Reconfiguration Instructions:

- `Pause`

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Filters:

- `RegisterHasValue(<register>, <value>)`

Reconfiguration Instructions:

- `Pause`
- `Reconfigure(<event probe id>)`

VMI-PL - Demo I

```
Configuration{
    ProcessListHead: 0xc17cdfe0
    TasksOffset: 440
    PIDOffset: 520
    ProcessNameOffset: 744
    MMStructOffset: 468
    ExeFileOffset: 444
    DEntryOffset: 12
    ParentOffset: 16
    DNameOffset: 28
    PGDOffset: 40
}
CRWrite(3){
    ReadRegister(CR3, #demo)
}
ExecuteAt(0xc104f060){
    ProcessList(PID, NAME, PATH, PGDP, #demo)
    ReadRegister(CR3, #demo)
}
CaptureNetwork(00:16:35:AF:94:4B, #demo)
```

VMI-PL - Demo II

Demo

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Evaluation - Measurement Scenarios

- Without monitoring support

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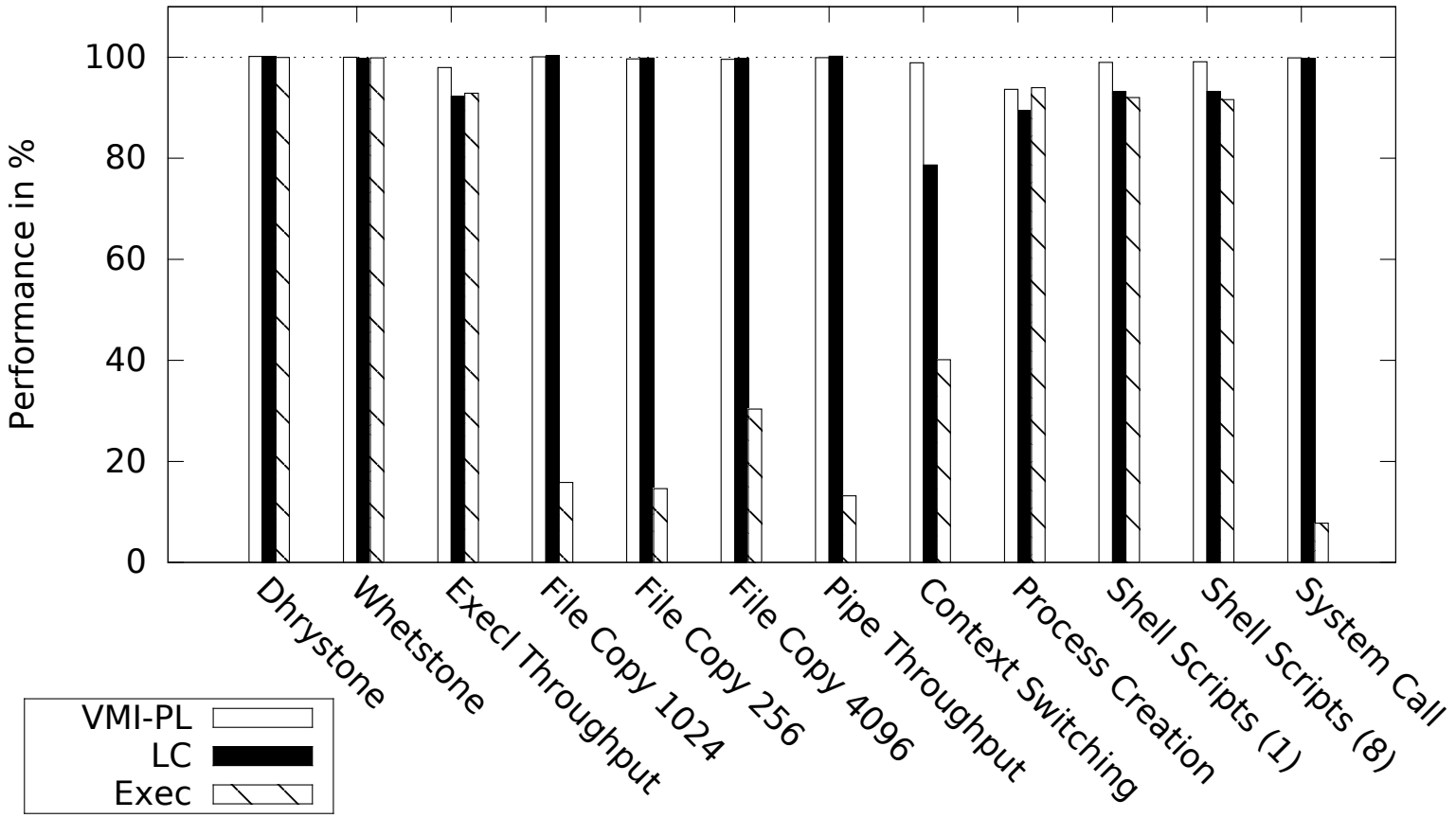
- Monitoring support enabled (*VMI-PL*, *VProbes*)
- Process life cycle monitoring (*LC*)
- Process execution monitoring (*Exec*)

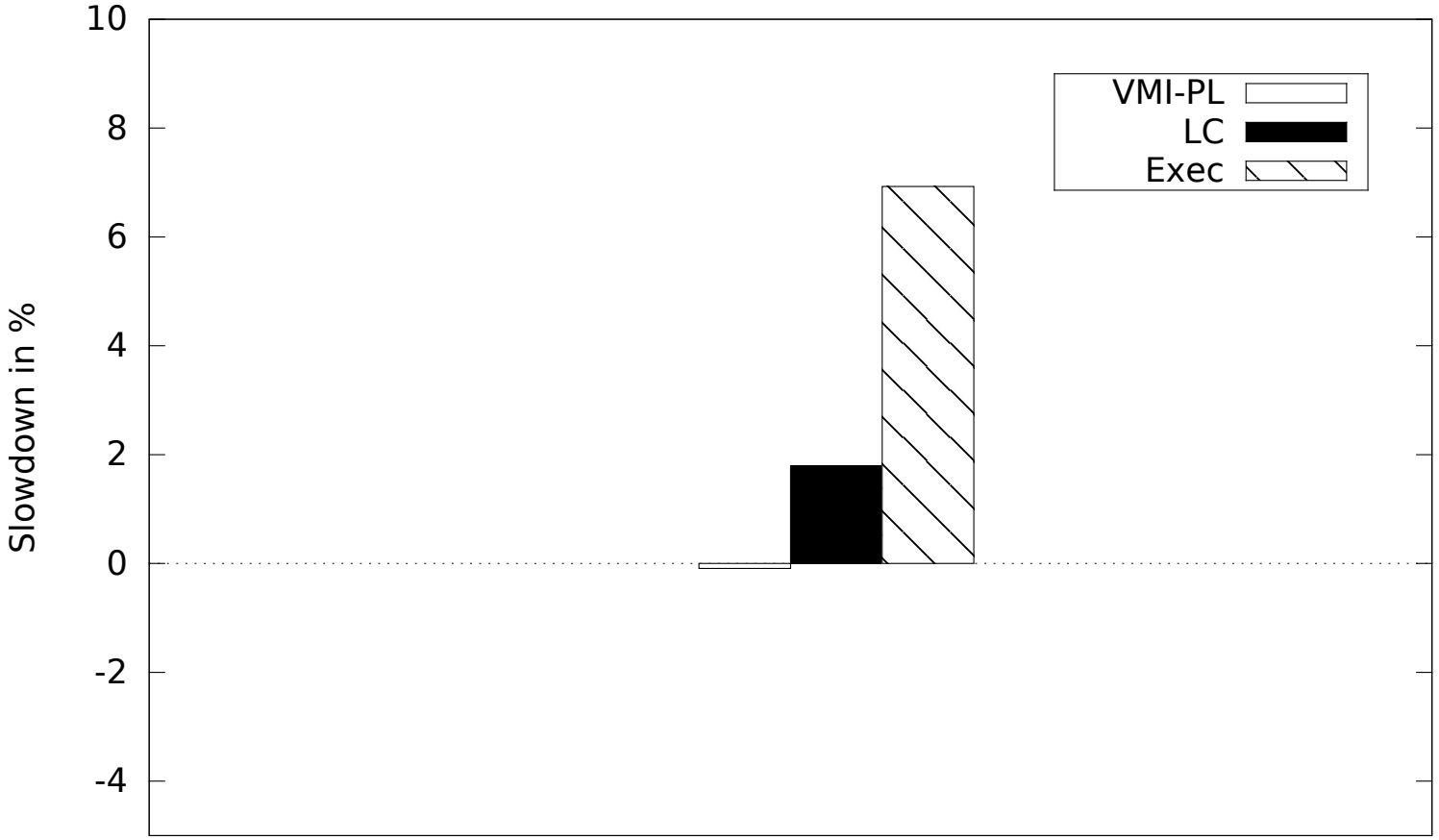
Evaluation - VMI-PL Performance I

UnixBench Benchmark



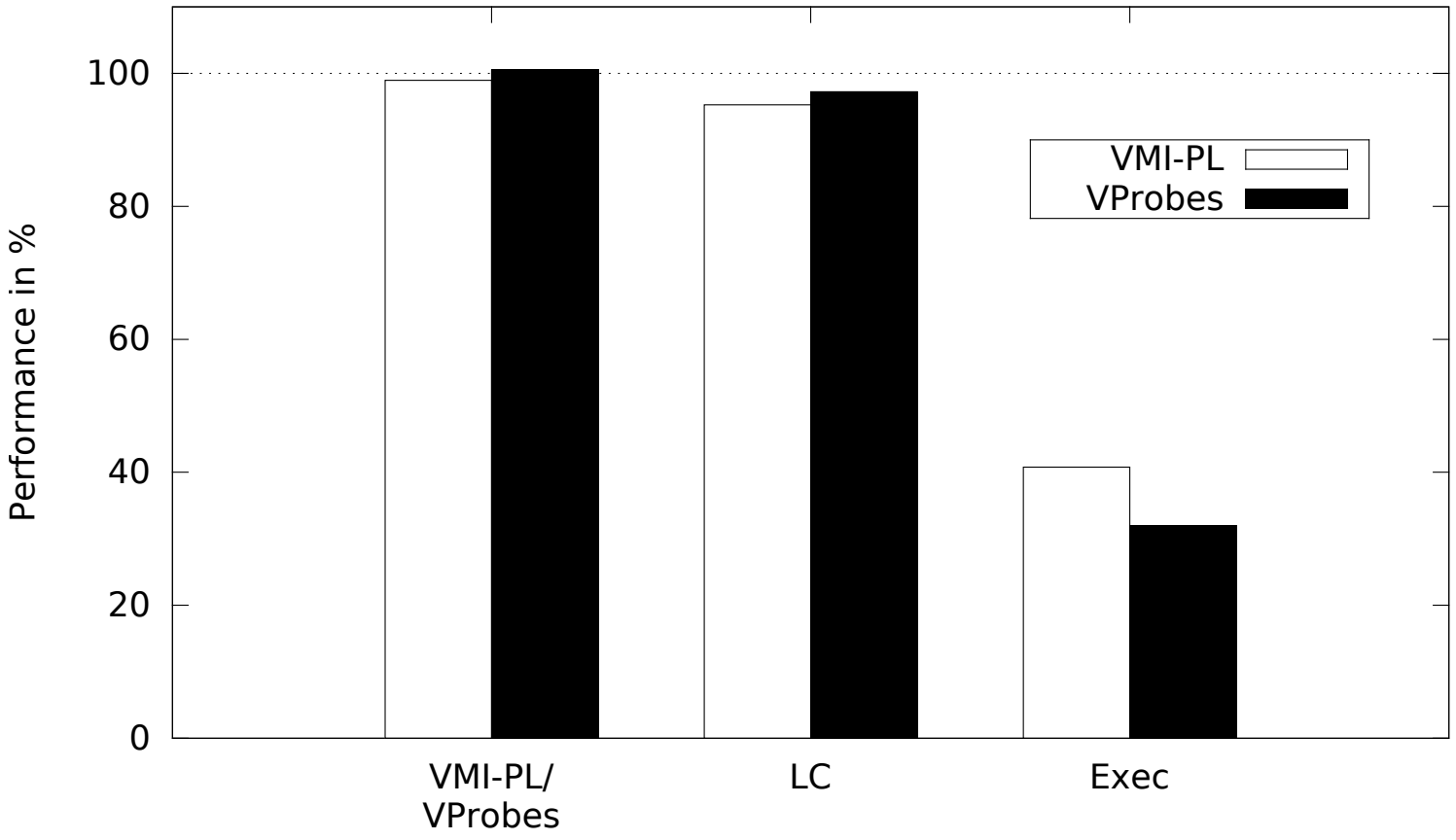
Evaluation - VMI-PL Performance II

VMI-PL Apache Build Slowdown



Evaluation - Comparison

UnixBench Benchmark



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- Classification scheme for VMI techniques
- Simple description language for VMI
  - Support for data, event, and stream-based techniques
  - Support for VM state manipulation
  - Support for retrieving operating system level information
- Prototype for KVM
  - Available at `https://github.com/FlorianWestphal/VMI-PL`

References

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