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Building Reusable, Low-Overhead Tooling Support into a High-Performance Polyglot VM

MoreVMs 2017

Michael L. Van De Vanter
Oracle Labs
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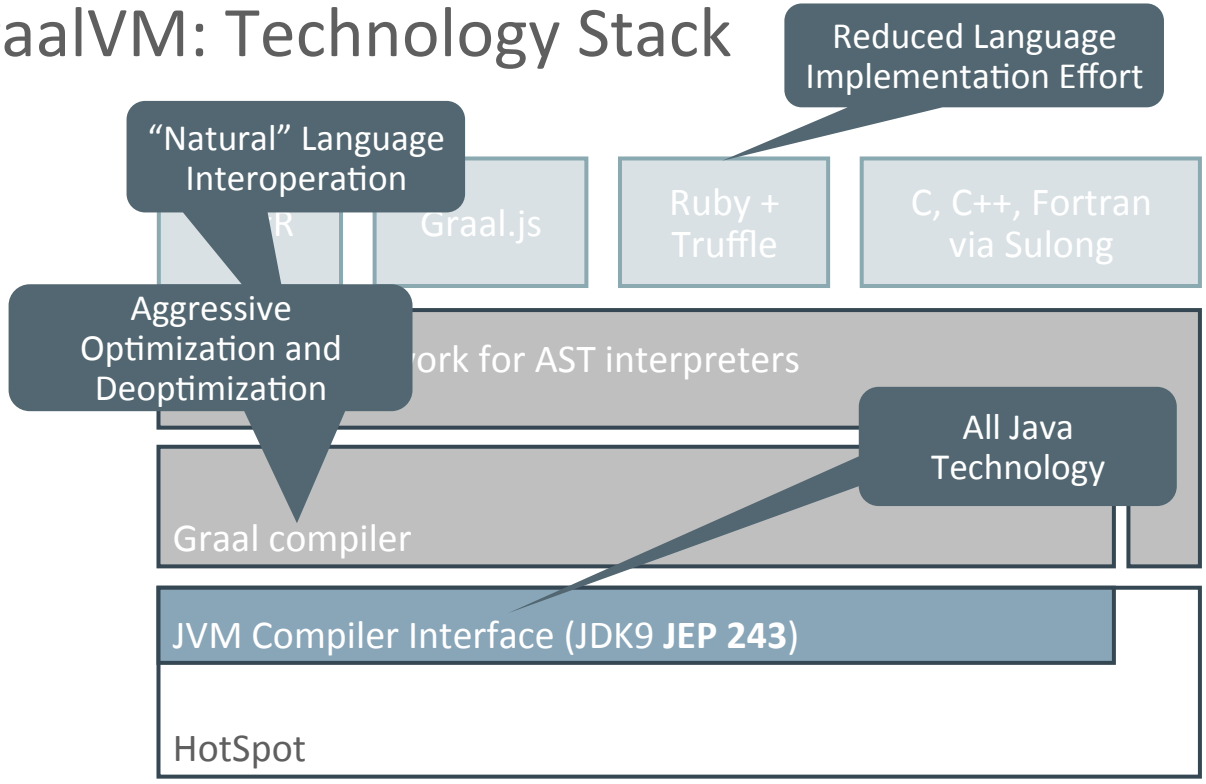
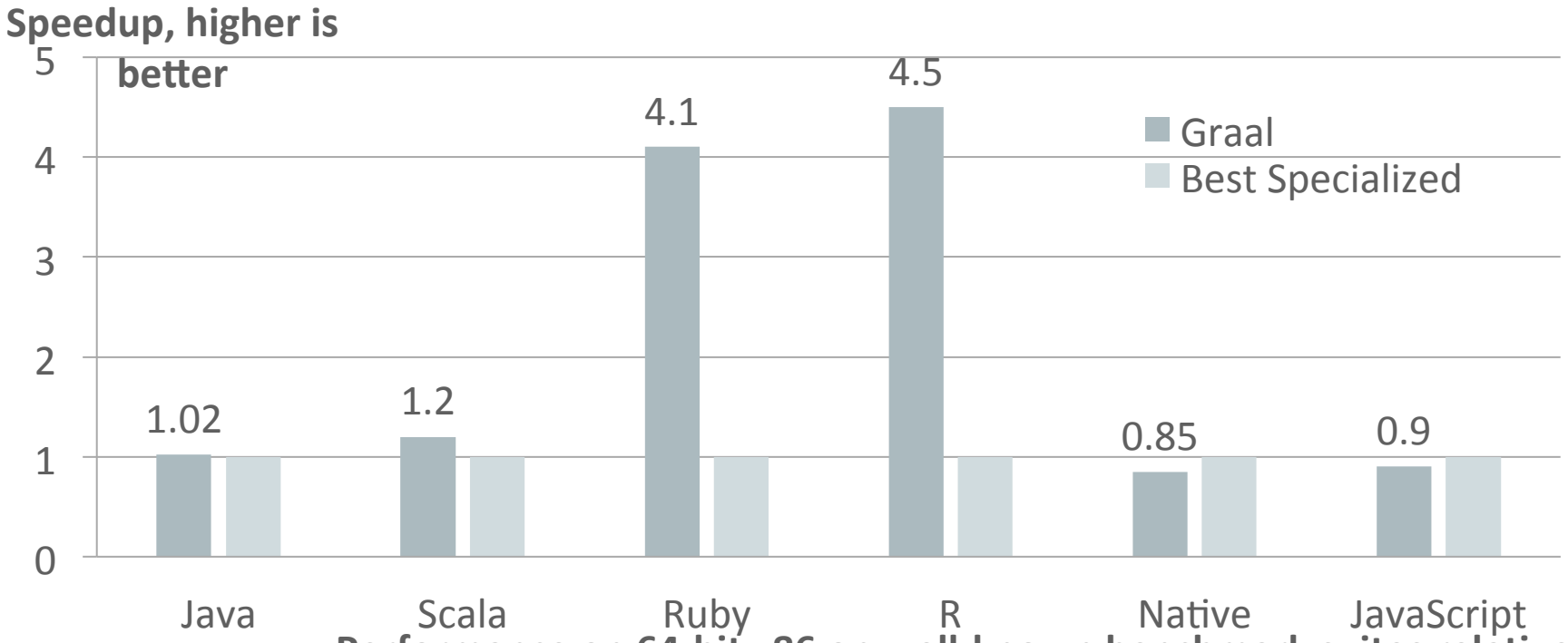
GraalVM: Technology Stack

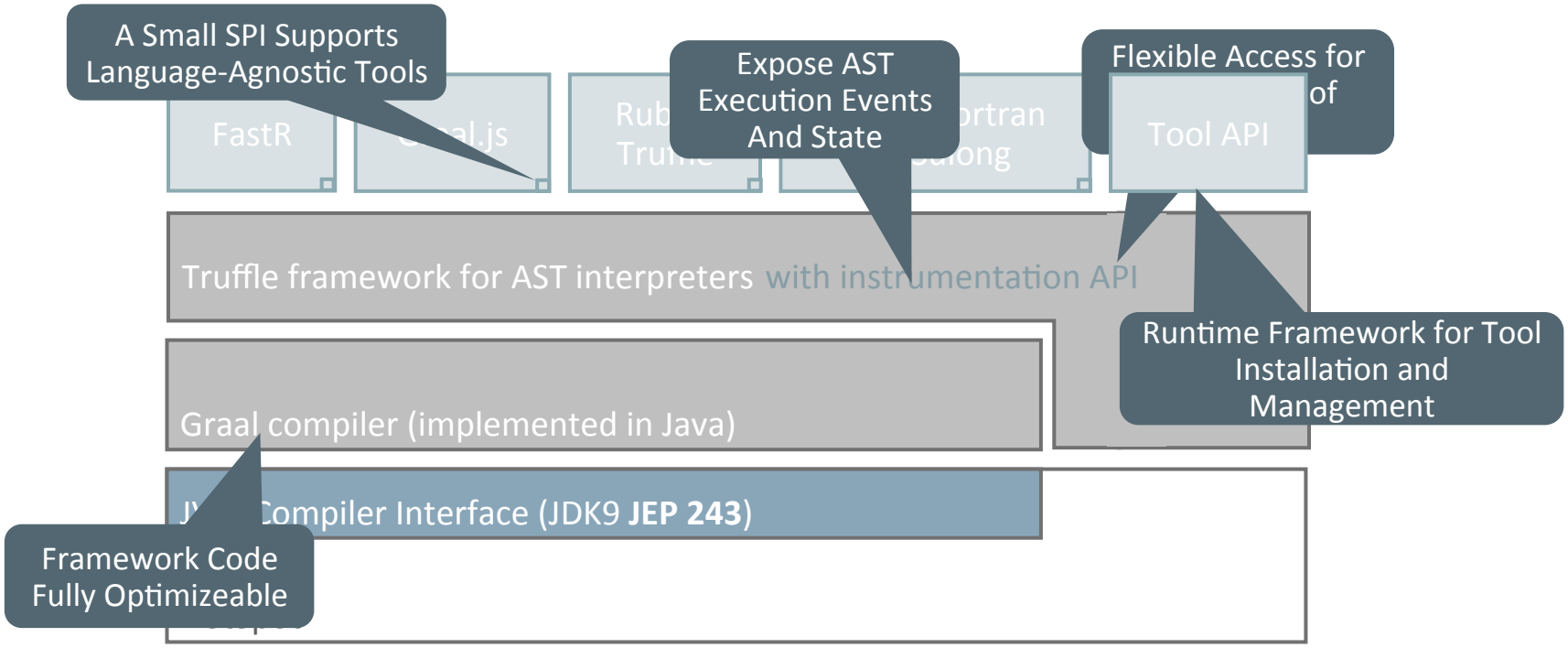


GraalVM: Peak Performance Results

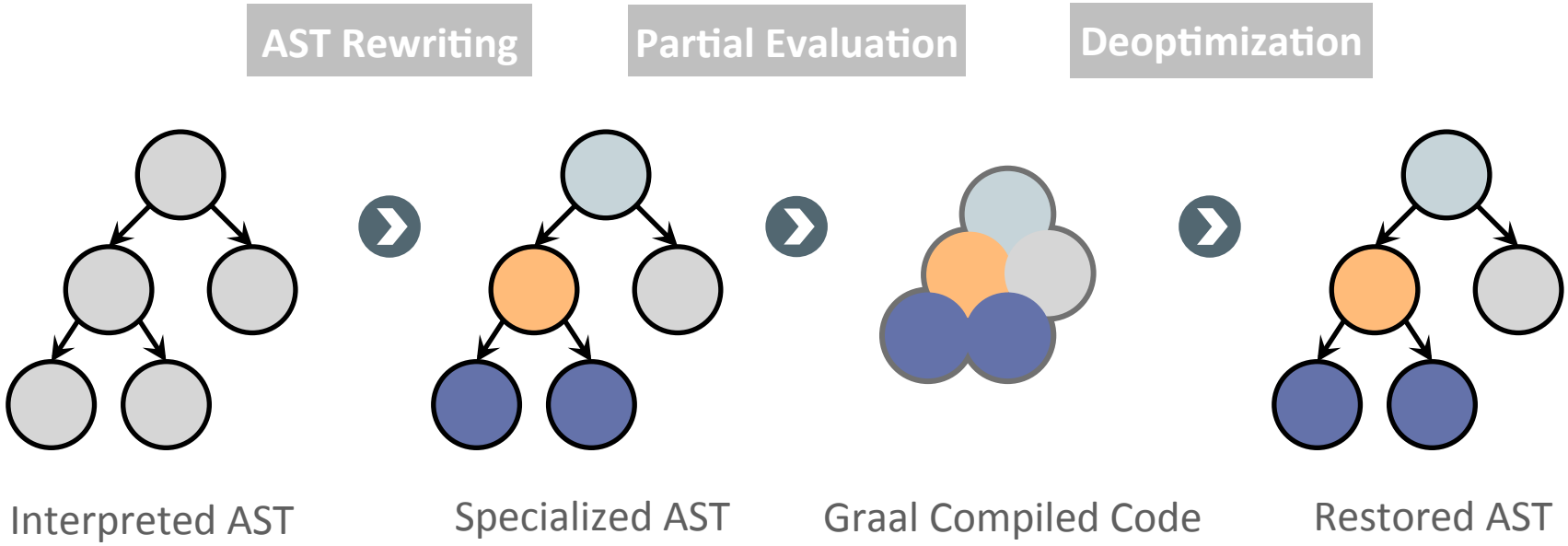


Performance on 64-bit x86 on well-known benchmark suites relative to: HotSpot/Server, JRuby, GNU R, LLVM AOT compiled, V8

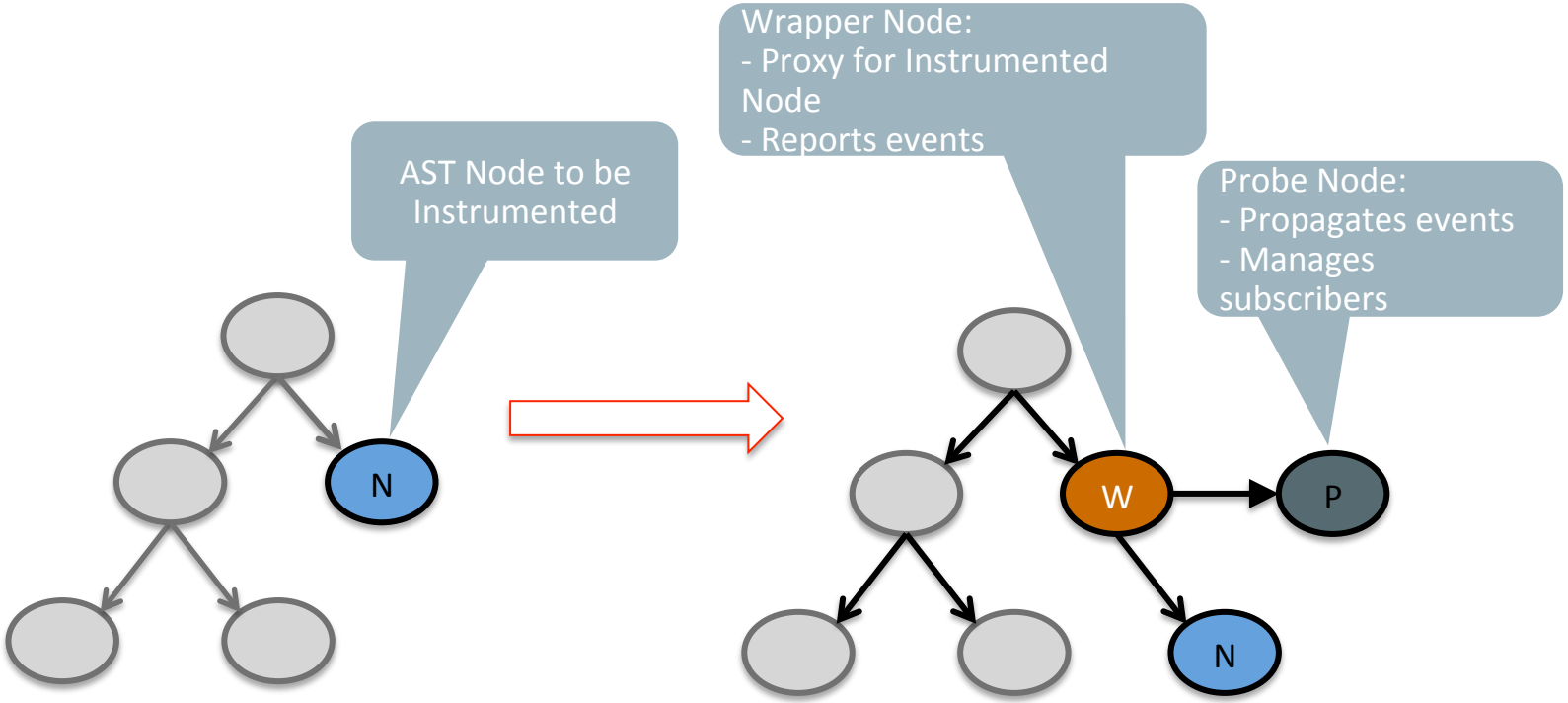
Instrumentation: Extended Truffle/Graal Technology



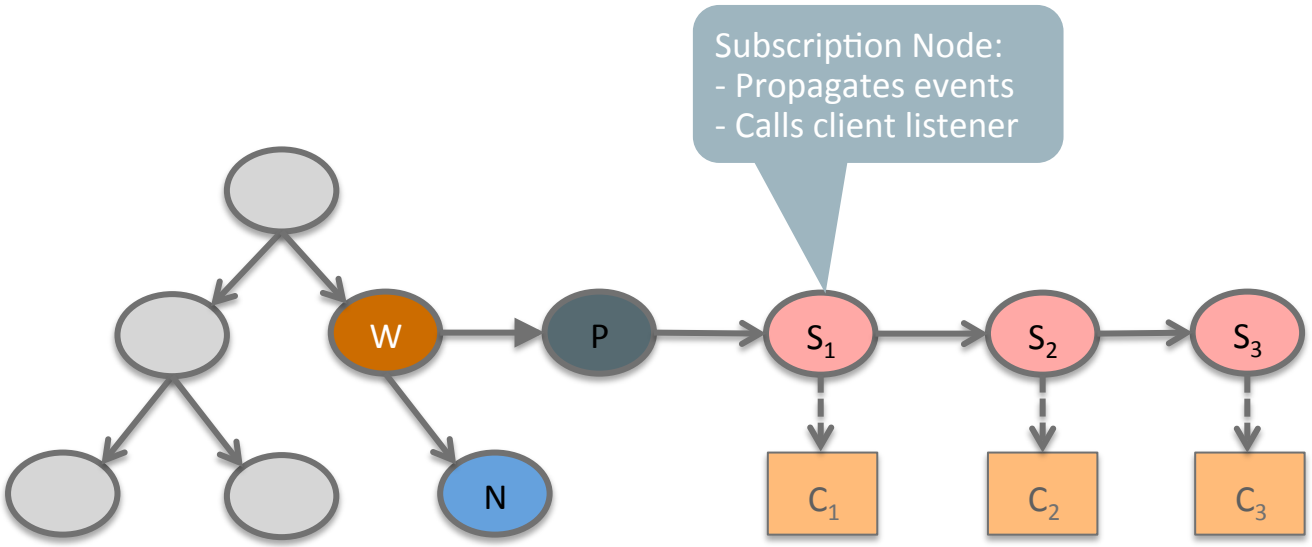
Graal Opt/Deopt: From interpreted AST to native & back



Probes: Event Capture by Node Insertion



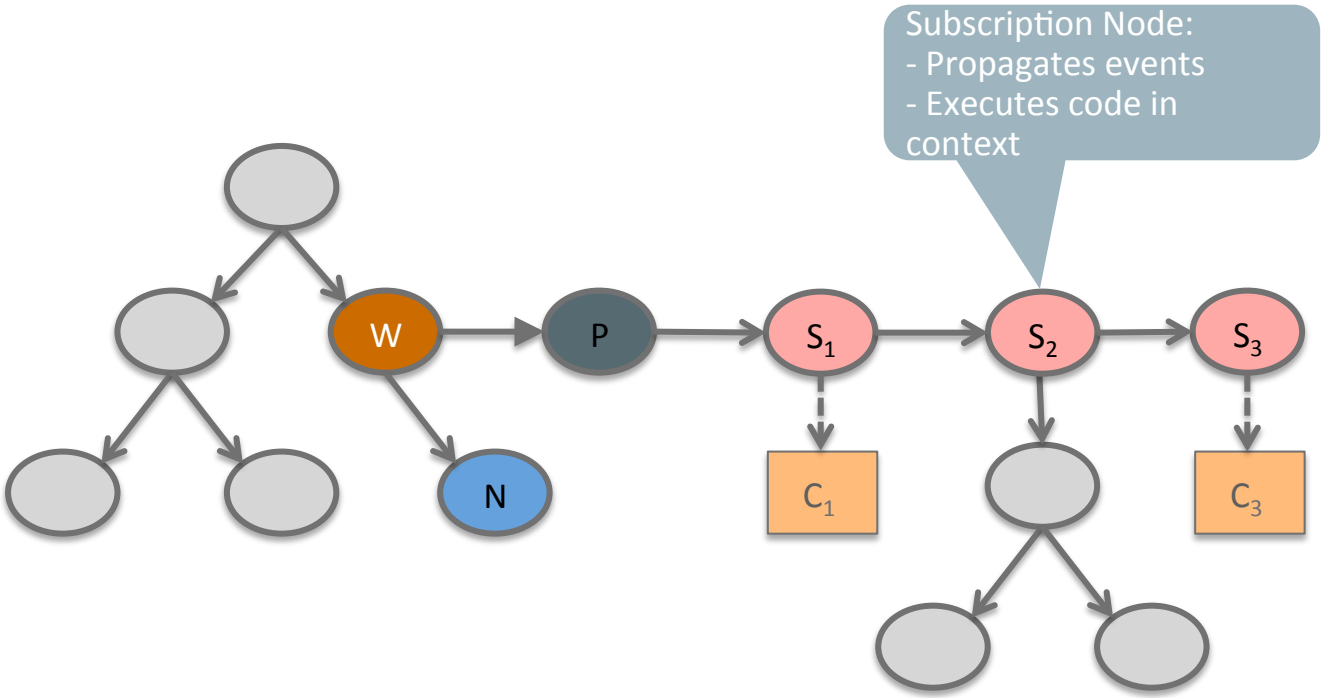
Subscriptions: Event Reporting to Clients



Subscriptions

- Locations specified by *query*:
  - For a breakpoint: “line 42 in mysource.js”
  - For stepping: “any STATEMENT” (nodes “tagged” by language implementation)
- Any number can be created/disposed dynamically
- Thread-safe
- *Deoptimizes* any affected fast-path code
  - But *lazily*, only when executed

Code Injection: Evaluation in Context



Language-Specific Support Requirements

- AST “markup”
  - Source attribution (detailed)
  - Node “tags”, e.g. *STATEMENT*, *EXPR*
- Visibility
  - Hide implementation artifacts (special frames, slot, sources, etc.)
- Presentation
  - How to display values, method names, etc.
- Dynamic eval in context of any stack frame
- Create a “patch” AST injection (e.g. for breakpoint conditions)

Performance Cost

Table 1 Performance times for `set_trace_func`, lower is better

	Disabled	Before	Empty	Increment	After
JRuby	0.555 ±0.004	15.928 ±0.062	125.371 ±0.0	338.526 ±0.0	16.707 ±0.047
TruffleRuby	0.044 ±0.001	0.044 ±0.001	0.085 ±0.001	2.096 ±0.006	0.044 ±0.0

Table 2 Performance times Ruby debugging, lower is better

	Disabled	Before	Not-taken	Conditional	After
JRuby	0.555 ±0.004	14.39 ±0.725	37.503 ±0.023	45.368 ±0.03	39.004 ±0.082
TruffleRuby	0.044 ±0.001	0.044 ±0.001	0.044 ±0.0	0.044 ±0.0	0.044 ±0.0

Applications (Known)

- Oracle Internal
  - Truffle Debugging API (clients: NetBeans, multi-language shell, web-based debugger)
  - Other APIs under develoment: Coverage, Profiling, …
  - Time boxing
  - Language features
    - Ruby set_trace_func
    - R stepping
- External
  - Event profiling, cross-language metrics (UC Irvine)
  - Code reloading (Univ. Tartu)
  - Specialized concurrency debugging, dynamic metrics (JKU Linz)

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Code

- OTN product page including download:
  - www.oracle.com/technetwork/oracle-labs/program-languages
- Graal projects on github:
  - Compiler: github.com/graalvm/graal-core
  - Truffle: github.com/graalvm/truffle
  - Ruby github.com/graalvm/truffleruby
  - FastR: github.com/graalvm/fastr
  - Sulong: github.com/graalvm/sulong
- Graal on OpenJDK:
  - openjdk.java.net/projects/graal

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