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# What Language Would You Like to Run?

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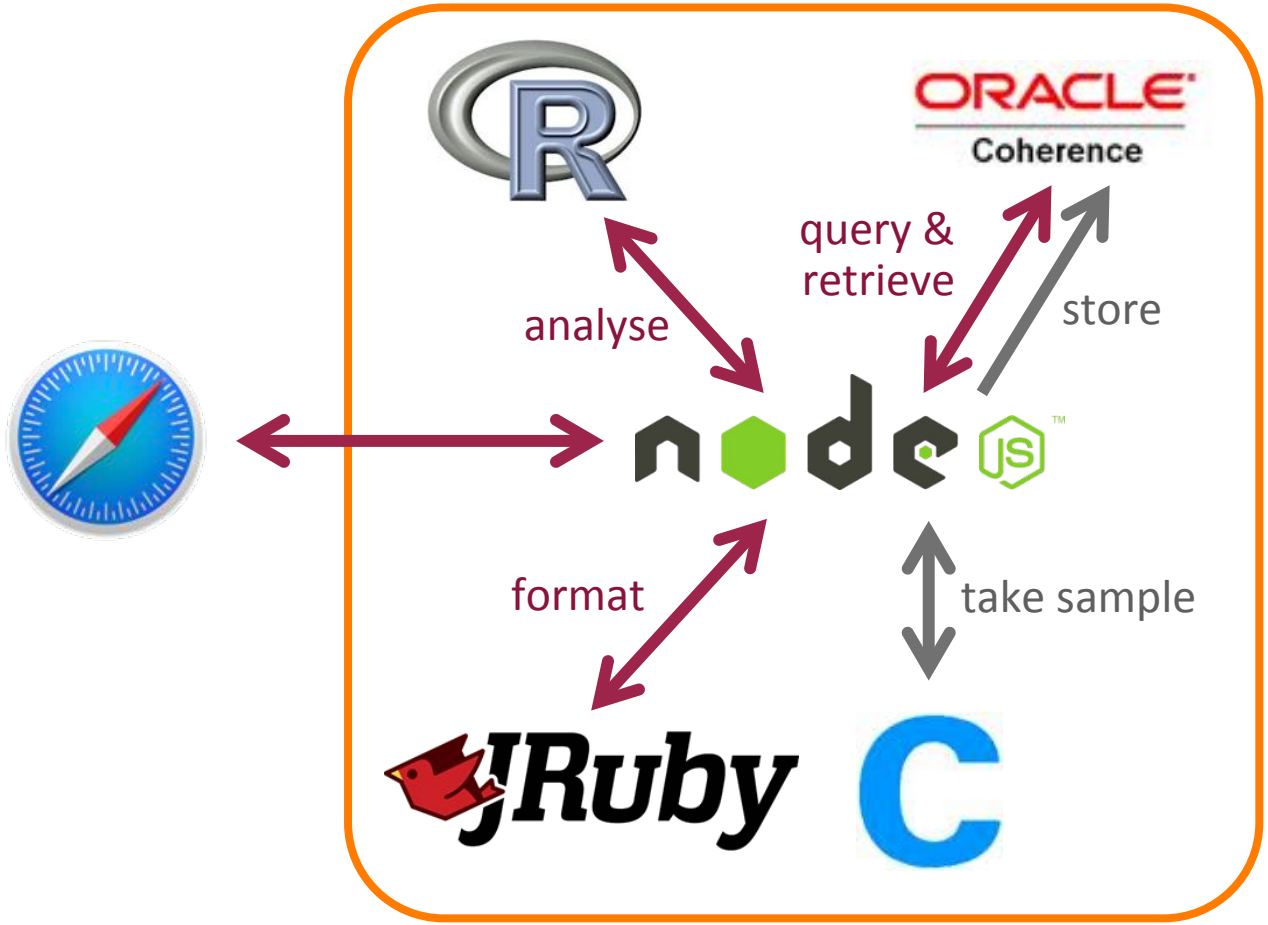
# Demo!

# What We Have Seen ...




**... all in one runtime engine.**

# Spot the Glue

**Lines of code (not counting comments): JavaScript: ~100, C: ~40, R: ~10, Ruby: ~30**

```
// set up Coherence
var CoherenceCacheFactory = Java.type('com.tangosol.net.CacheFactory')
CoherenceCacheFactory.ensureCluster()

var coherenceCache = CoherenceCacheFactory.getCache('javaland-demo'),
    Q = Java.type('com.tangosol.util.QueryHelper')

// query
var query = Q.createFilter("..."),
    result = coherenceCache.entrySet(query)
```

# JavaScript / C Interoperability

```
// C code
struct _sample {
    int vm_size;
    int resident_set_size;
    ...
};

struct _sample* take_sample(...) {
    struct _sample *sample = (struct _sample*) malloc(sizeof(struct _sample));
    ...
    return sample;
}
```

```
// take sample and store in cluster
var sample = take_sample()
coherenceCache.put(..., sample.vm_size)
```

# JavaScript / R / Ruby Interoperability

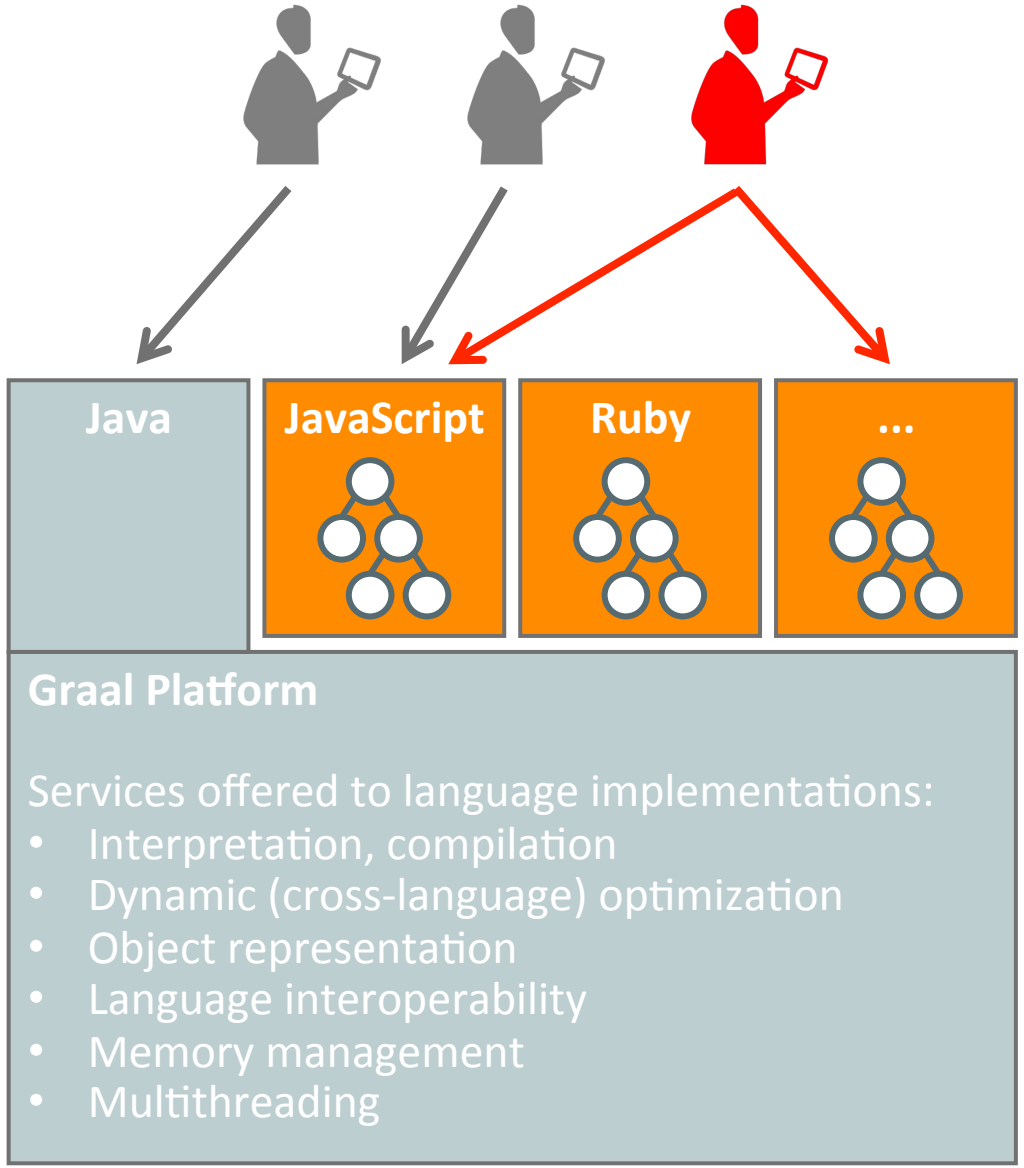
```
// Ruby code
DATA_TEMPLATE = ERB.new %{
  Summary for <%= data.n %> samples:
  <ul>
    <li>Range [<%= data.min %>..<%= data.max %>]</li>
    ...
  </ul>
}

def formatData(data)
    DATA_TEMPLATE.result(binding)
end
```

```
// R code
sample_stats <- function(receiver, data) {
    dn <- length(data)
    dmin <- min(data)
    dmax <- max(data)
    dmean <- mean(data)
    dsd <- sd(data)
    return(c(n=dn, min=dmin, max=dmax,
        mean=dmean, sd=dsd))
}
```

```
// JavaScript code
var vms = sample_stats(query("..."))
return formatData(vms)
```

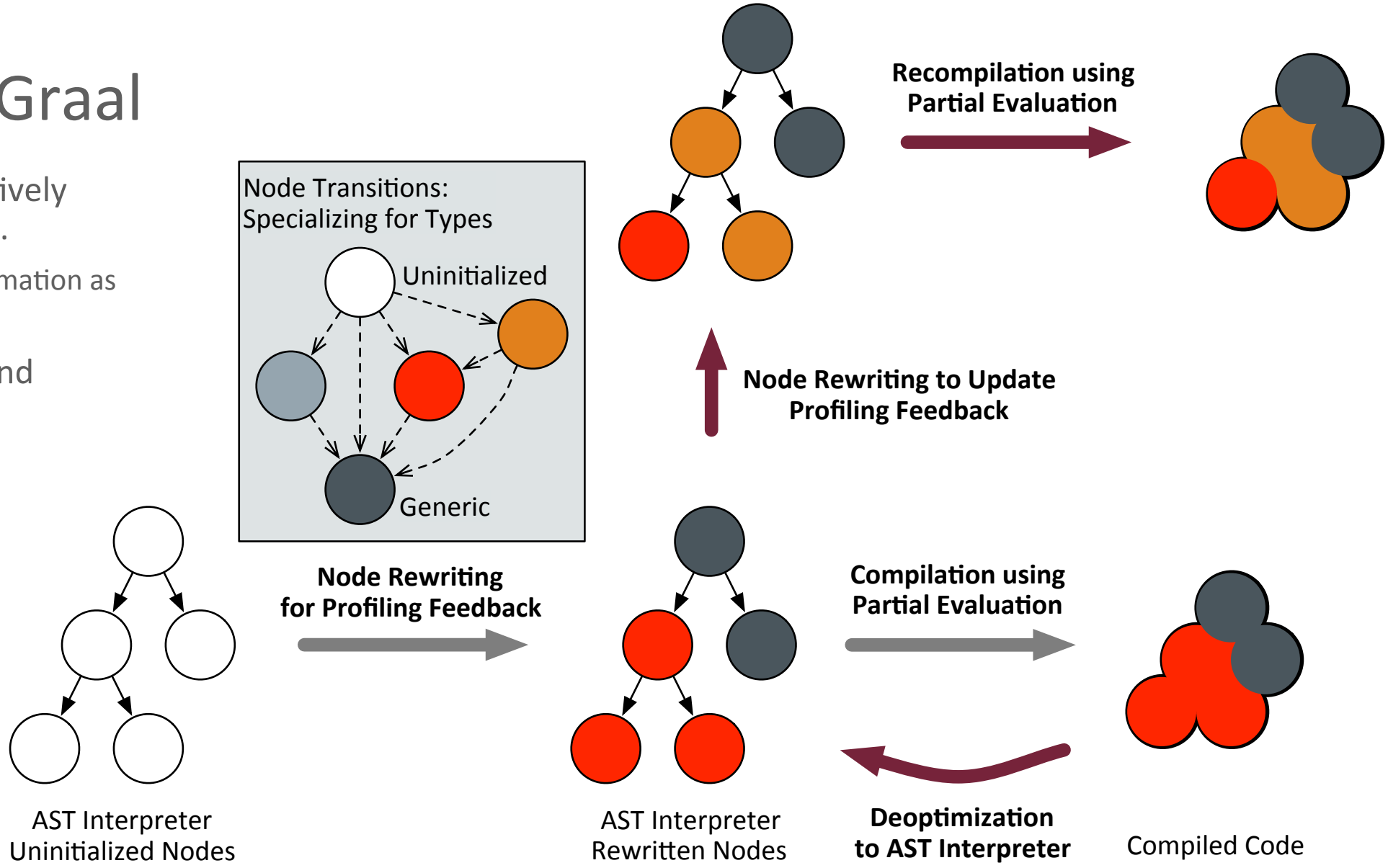
# The Graal Platform

- All languages are treated as equal
  - The bird's eye view is as on a runtime environment for the language(s) at hand
  - Java is implicitly part of the platform, but invisible unless required
- Language interoperability
  - Java interoperability comes for free
  - All optimization works transparently across language boundaries



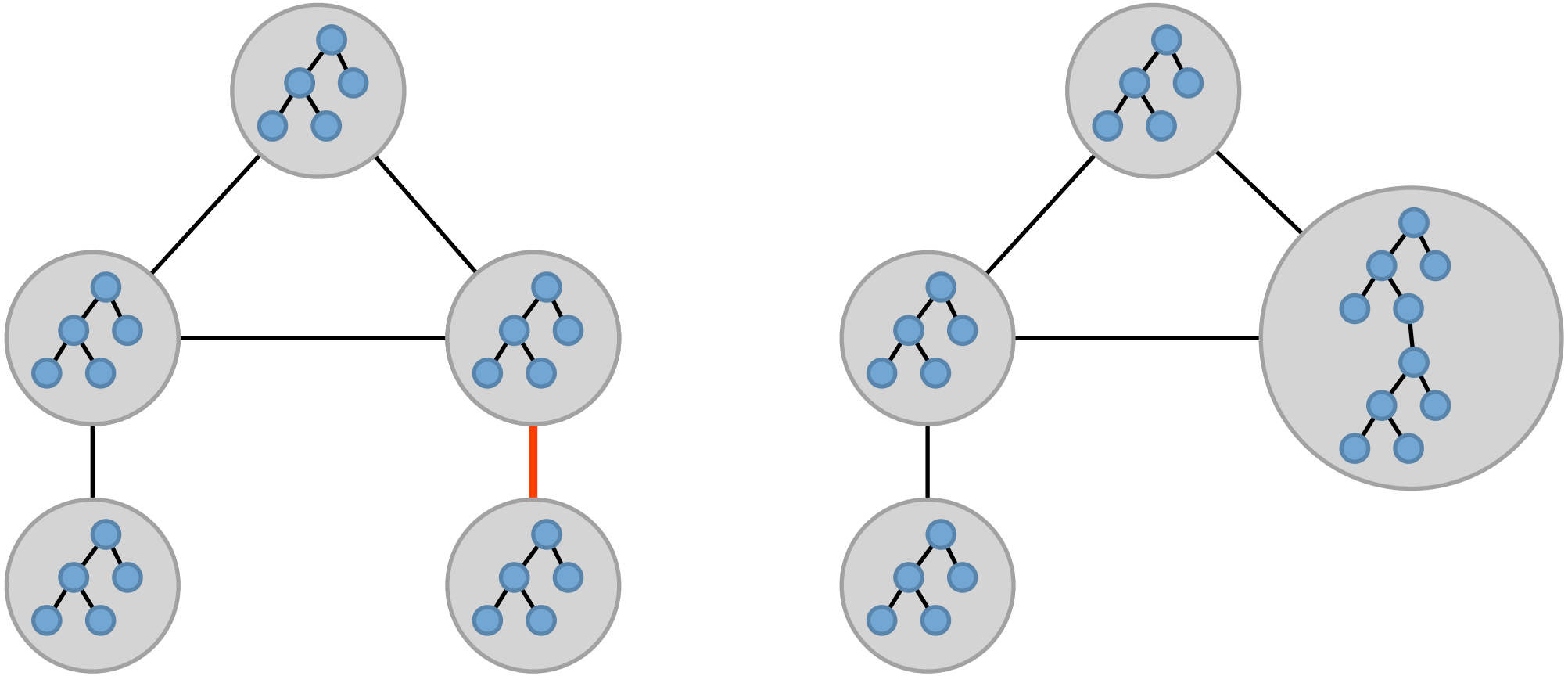
# Truffle and Graal

- Profile and speculatively optimize the code ...
  - Learn the type information as the program runs
- ... and deoptimize and reoptimize!
- Compiler has no dependencies on language type system



# Cross-Language Optimisation at the AST Level

## Inlining Across Language Boundaries

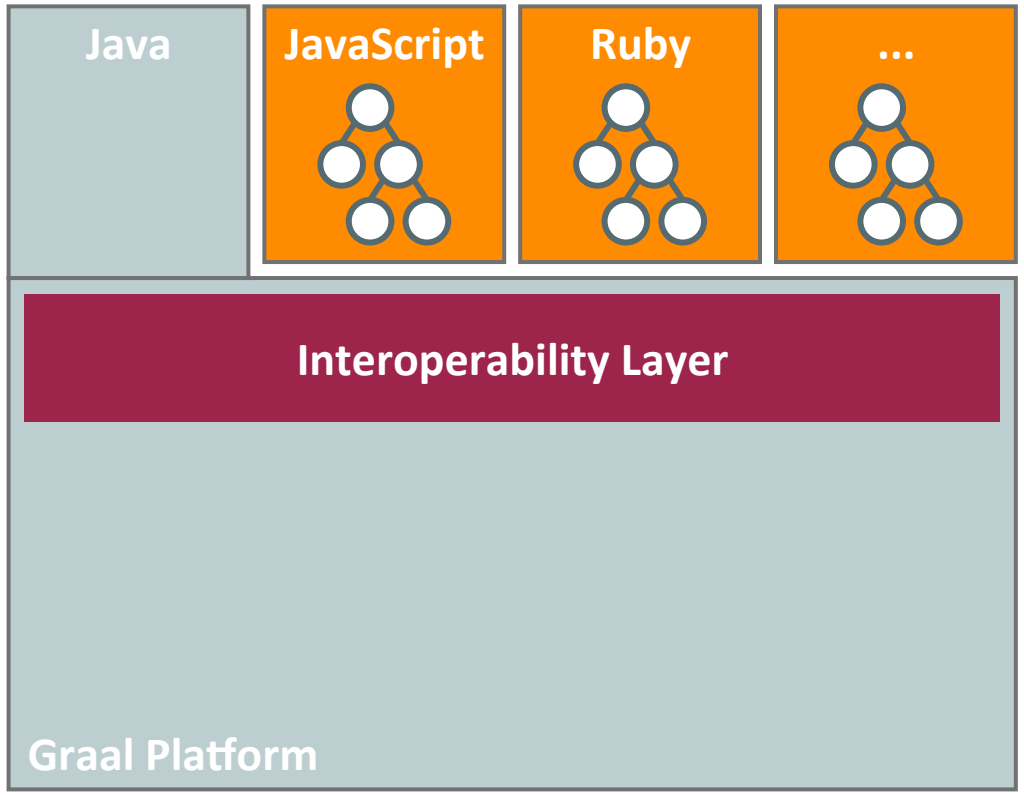


# Graal Compiler and Language Creation APIs

- Graal is a dynamic compiler written in Java that compiles Java
- Graal APIs allow you to write an interpreter for your language, and Graal will specialize it into a compiler for you
  - Learns types an application uses by executing the interpreter
  - Normally compilers are 100's of man-years to achieve quality
- Graal can compile itself
  - This makes it easy to add efficient optimizations at the simpler interpreter level
  - Supports classes of specializations or "fast paths" through code
- Speculates on data structures and specialized code paths
  - On exceptions, will deoptimize to interpreter and reoptimize

# Language Interoperability Architecture

- Graal platform provisions
  - Common abstractions
  - ASTs: abstraction for execution logic
- Shared interface for interoperability
  - Execution (calls)
  - Access (objects, fields, variables)
- Guest language implementations implement the interop interface



# Supported Languages and Performance Characteristics

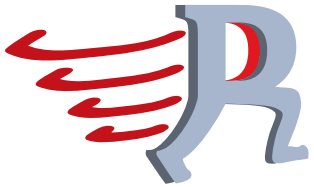
- Java
  - About as fast as HotSpot™ server compiler (SPECjvm2008, SPECjbb2013)
- JavaScript (ECMAScript 5.1)
  - About as fast as V8 (Octane, Node.js)
- Ruby
  - 13x MRI (synthetic and image processing benchmarks)
- R
  - 10x GNU R (shootout)
- C
  - Ca. 2x gcc -O0, within 10 % of best gcc/ clang performance (shootout)
  - Ruby+C: 3x MRI+C, 32x MRI
- Not maintained by Oracle
  - Python (ZipPy, UCI)
  - Smalltalk (SOM, Stefan Marr)

# A Word About Debugging

- Usual approach: debugging as an afterthought
- Graal platform has language-agnostic debugging capabilities


```
(JavaScript) break ../eg/demo.js:6
==> breakpoint set at demo.js:6
(JavaScript) loadr
    1  function demo(x, n) {
    2      result = x;
    3      for(var i = 0; i < n; ++i) {
    4              result = result + i;
    5      }
-->  6      return result;
    7  }
    8
    9  b = demo(2, 4);
   10  print("result=" + b);
(<1> demo.js:6) eval result
==> 8
(<1> demo.rb:6)
...
```


```
(Ruby 2.1.0) break ../eg/demo.rb:6
==> breakpoint set at demo.rb:6
(Ruby 2.1.0) loadr
    1  def demo(x, n)
    2    result = x
    3    n.times do |i|
    4      result = result + i
    5    end
-->  6    result
    7  end
    8
    9  b = demo(2, 4)
   10  puts "result=#{b}"
(<1> demo.rb:6) eval result
==> 8
(<1> demo.rb:6)
...
```



```
(Fastr) break ../eg/demo.r:6
==> breakpoint set at demo.r:6
(Fastr) loadr
    1  demo <- function(x, n) {
    2    result <- x
    3    for (i in 1:n-1) {
    4      result <- result + i
    5    }
-->    6   result
    7  }
    8
    9  b <- demo(2, 4)
   10  cat("result=", b, "\n")
(<1> demo.r:6) eval result
==> 8
(<1> demo.r:6)
...
```

# Available Language Implementations

- Java and JavaScript
  http://www.oracle.com/technetwork/oracle-labs/program-languages/overview/index.html
- JRuby+Truffle
  https://github.com/jruby/jruby/wiki/Truffle
- FastR
  https://bitbucket.org/allr/fastr
- Not maintained by Oracle:
  - ZipPy (Python)
    https://bitbucket.org/ssllab/zippy
  - TruffleSOM (Smalltalk)
    https://github.com/smarr/TruffleSOM

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