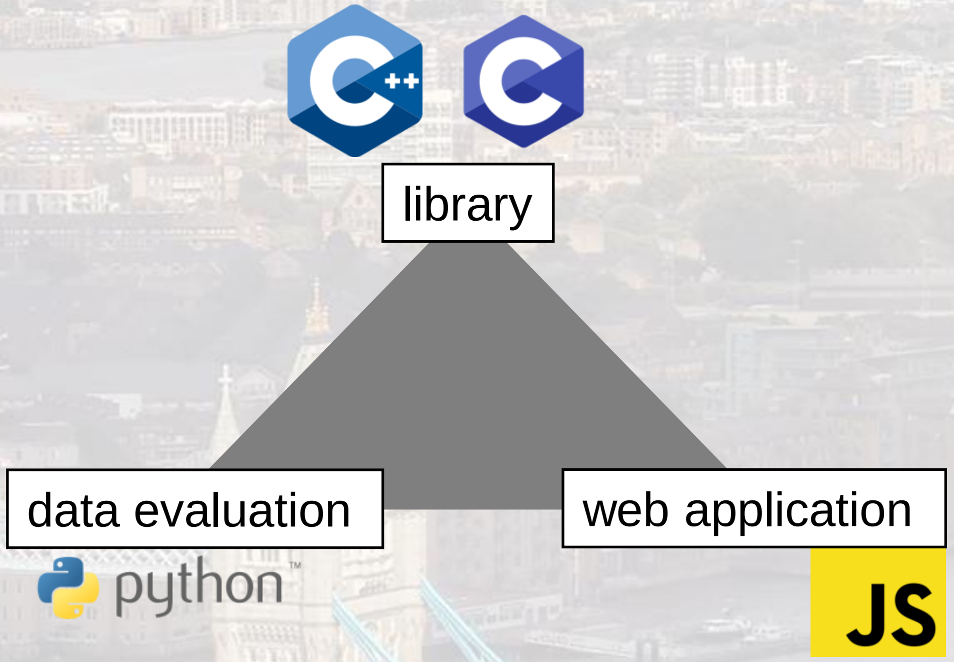
Engineering

→ combining best-suitable materials!

Software engineering?
→ cross-language interoperability!



JOHANNES KEPLER
UNIVERSITY LINZ

Extending Sulong for cross-language interoperability between C++/Swift and Java, JavaScript or Python

Christoph Pichler, Johannes Kepler University Linz (Austria)

Supervised by **Roland Schatz**

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Extending Sulong for object-oriented cross-language interoperability

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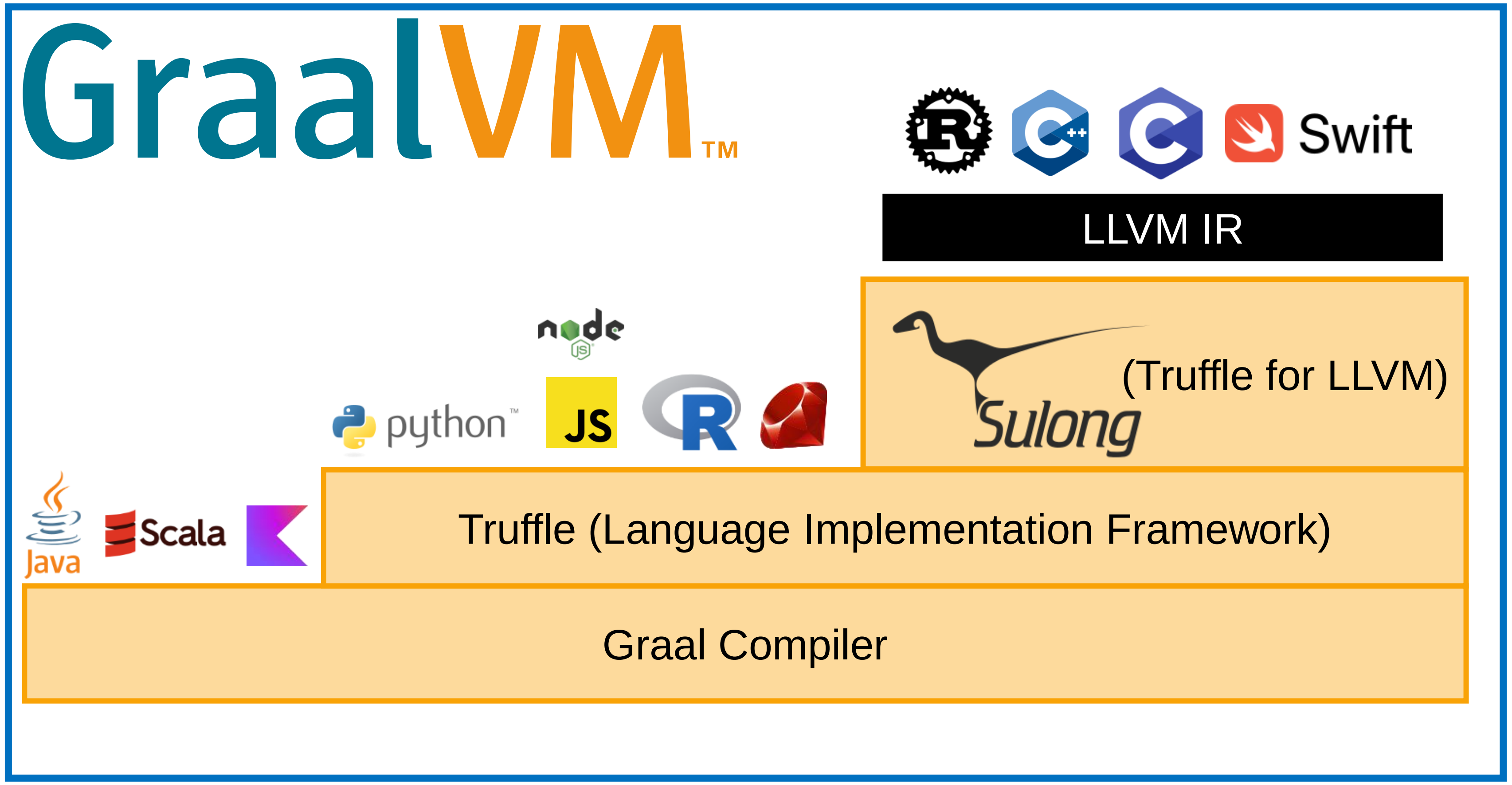
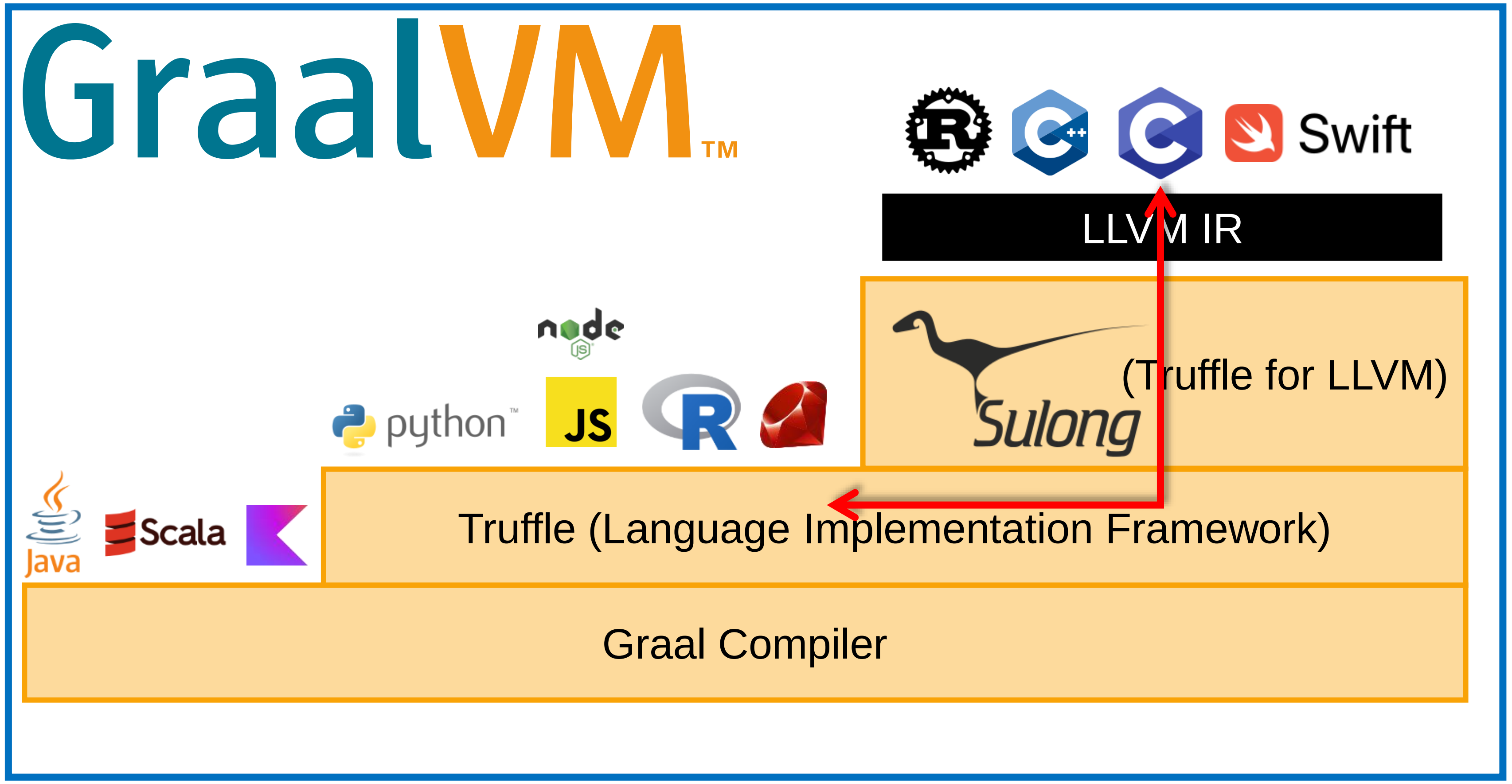
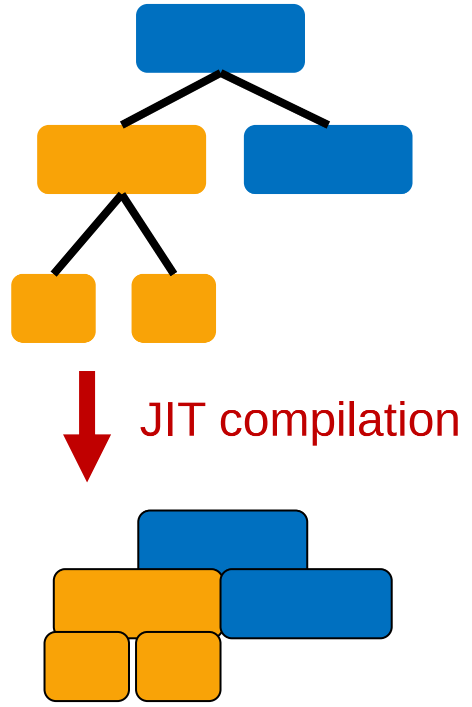
"lli of GraalVM"

GraalVM and Sulong

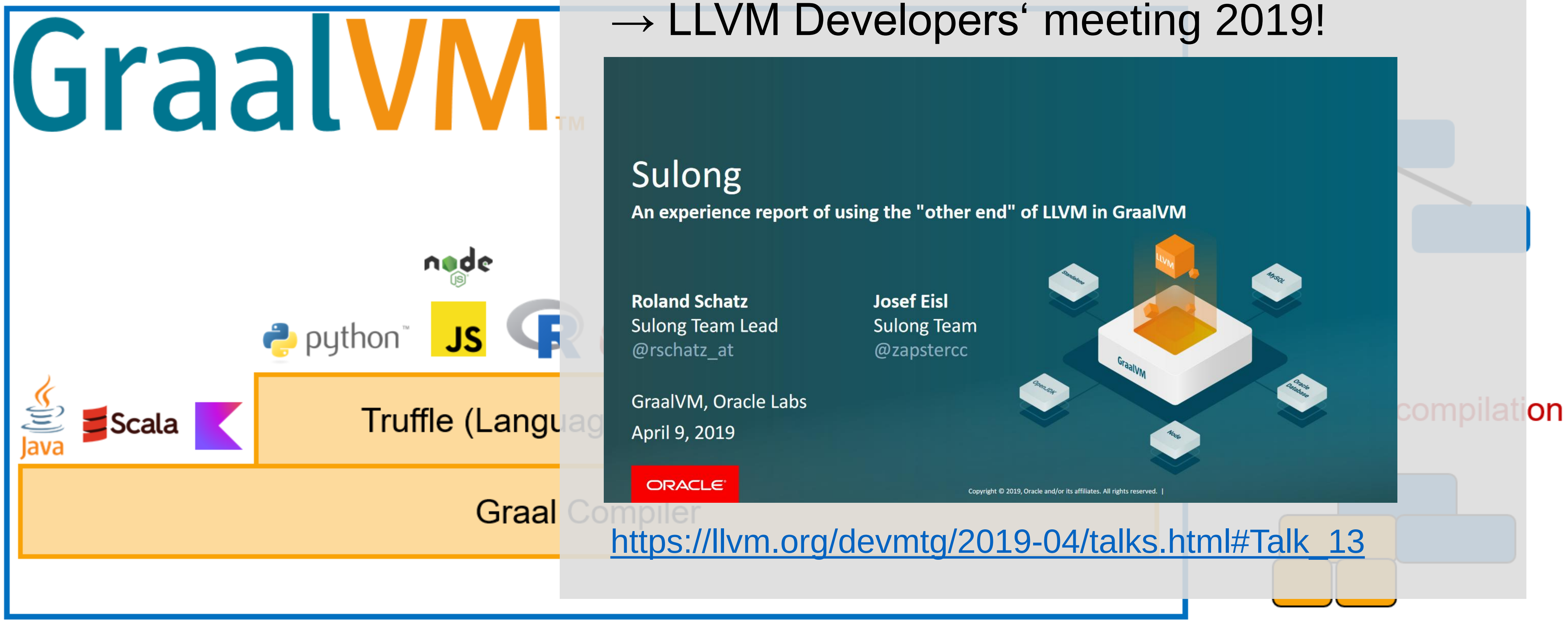


Existing interoperability

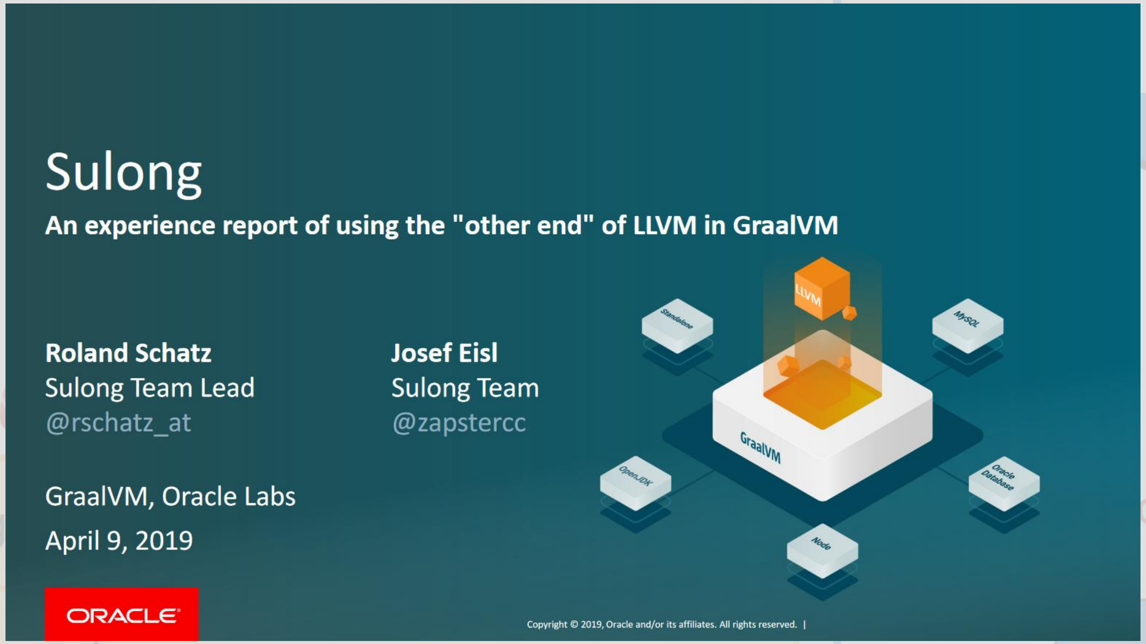




Existing interoperability



→ LLVM Developers‘ meeting 2019!


Sulong

An experience report of using the "other end" of LLVM in GraalVM

Roland Schatz
Sulong Team Lead
@rschatz_at

Josef Eisl
Sulong Team
@zapstercc

GraalVM, Oracle Labs
April 9, 2019

ORACLE

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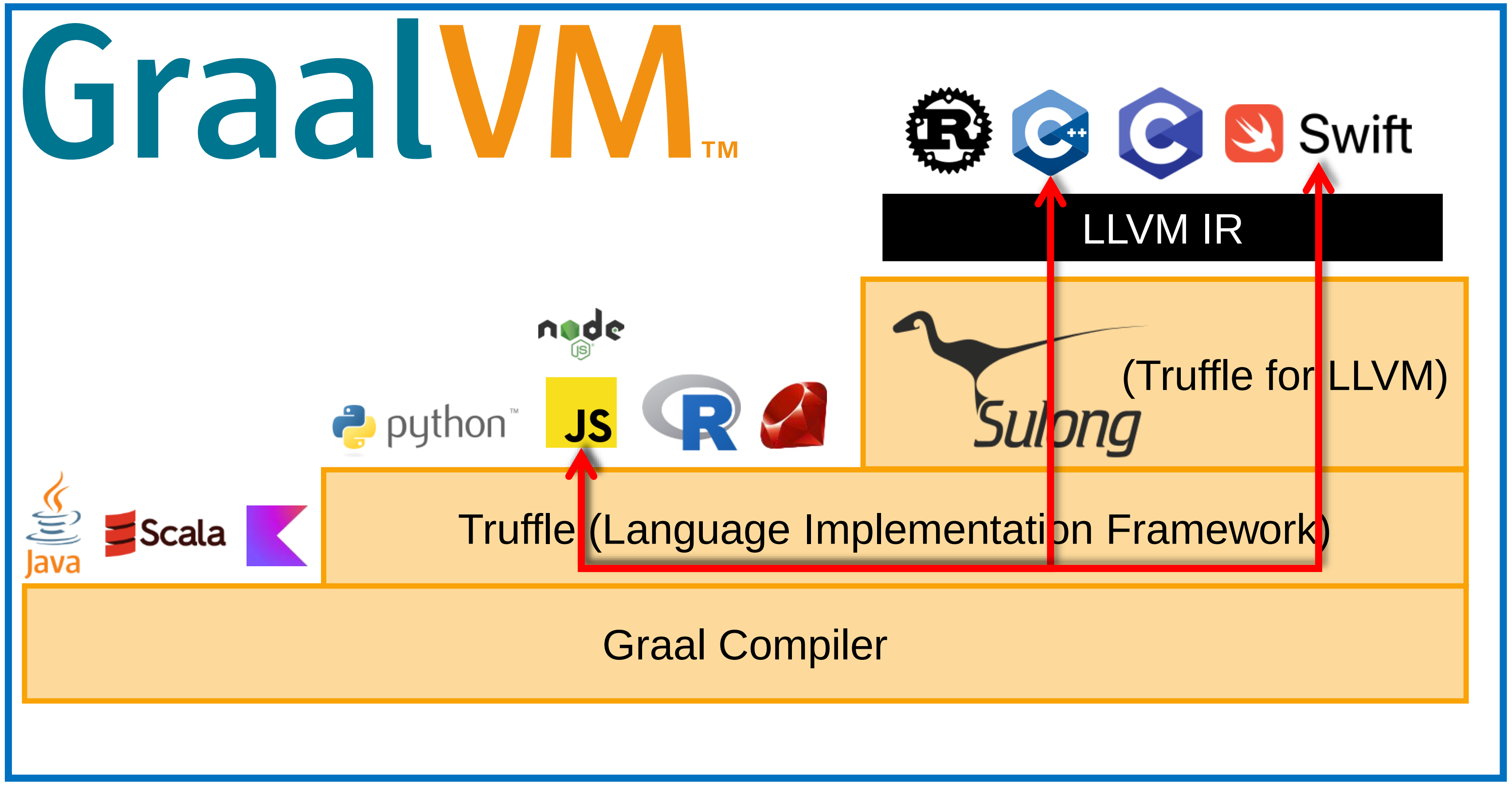
https://llvm.org/devmtg/2019-04/talks.html#Talk_13

Extending Sulong‘s interoperability for object-oriented languages



The following examples take place along the red axes!

Sample extension: Dynamic binding [1]

1 Example.js

```
llvmFile = eval("Example.swift")
p = llvmFile.createParent()

p.square()
```

2 **GraalVM JavaScript**

3 ***invoke***
Example.swift, p, "square"

Example.swift

```
class Parent {
  func
  square(n: Int) -> Int {…}
}
```

```
class Child: Parent {
  override func
  square(n: Int) -> Int {…}
}
```

LLVM IR

Example.so

```
%func $s6ParentC6squareSiyF {…}
%func $s5ChildC6squareSiyF {…}
```

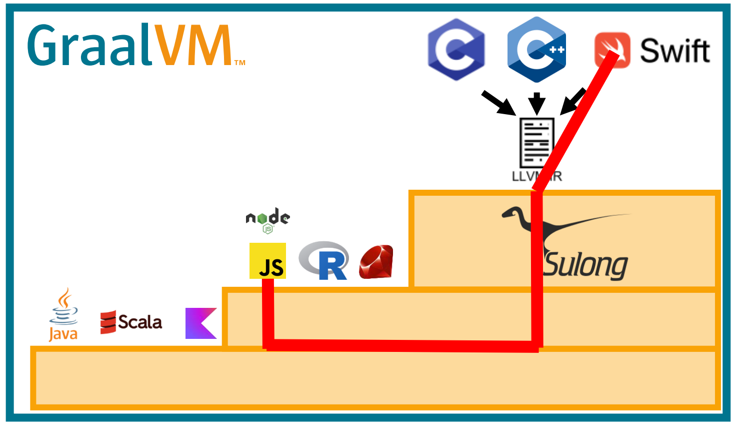
Sulong

*invoke Parent::square()**?***
*invoke Child:: square()**?***

5

4 ***invoke***
p, "square"

Truffle Framework



Sample extension: Dynamic binding [2]

LLVM IR

Example.so

```
%func $s6ParentC6squareSiyF {…}
%func $s5ChildC6squareSiyF {…}
```

DEBUG INFORMATION
!DISubprogram "square":
  …,
  virtualIndex: 0, …)

GLOBALS
$s7Inherit6ParentC6square1nS2i_tF
= getelementptr (baseObj, [0, 13])

Sulong

~~*invoke Parent::square()?*~~
~~*invoke Child:: square()?*~~

?

p->vtable[square_idx]()

invoke
p, "square"

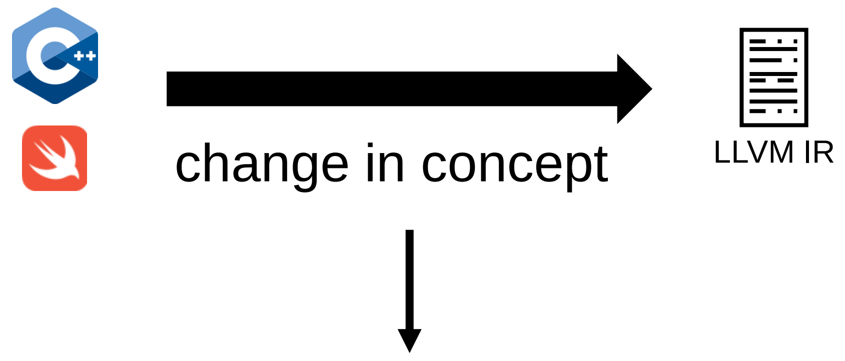
Truffle Framework

Live Demo

Files and step-by-step instructions can be found at
https://github.com/pichristoph/eurollvm2022

Higher-level semantics across languages!

- Name mangling
- **Dynamic binding**
- Field access
- Exception flow



Modifications necessary!

Open Source - ~~Do~~ *TRY* It Yourself!

GraalVM™

- graalvm.org
- github.com/oracle/graal

Concerning this talk:

- Slides, live demo files, step-by-step instructions, …:
  https://github.com/pichristoph/eurollvm2022

Related Talks at EuroLLVM 2019:

- Sulong and its interoperability for C-compiled LLVM (Roland Schatz, Josef Eisl):
  Sulong: An experience report of using the "other end" of LLVM in GraalVM.
- Sulong's debugging tools (Jacob Kreindl):
  LLVM IR in GraalVM: Multi-Level, Polyglot Debugging with Sulong