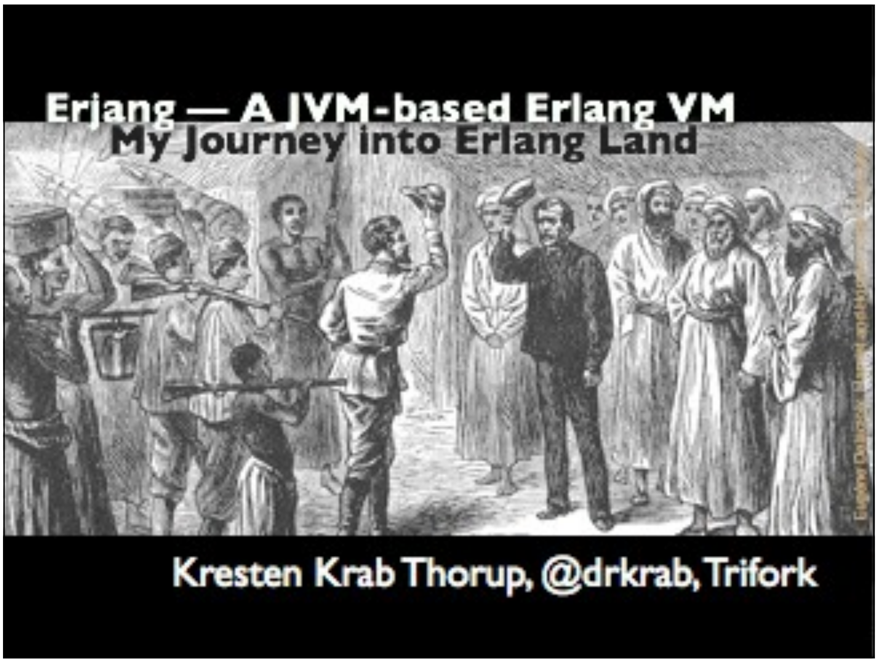


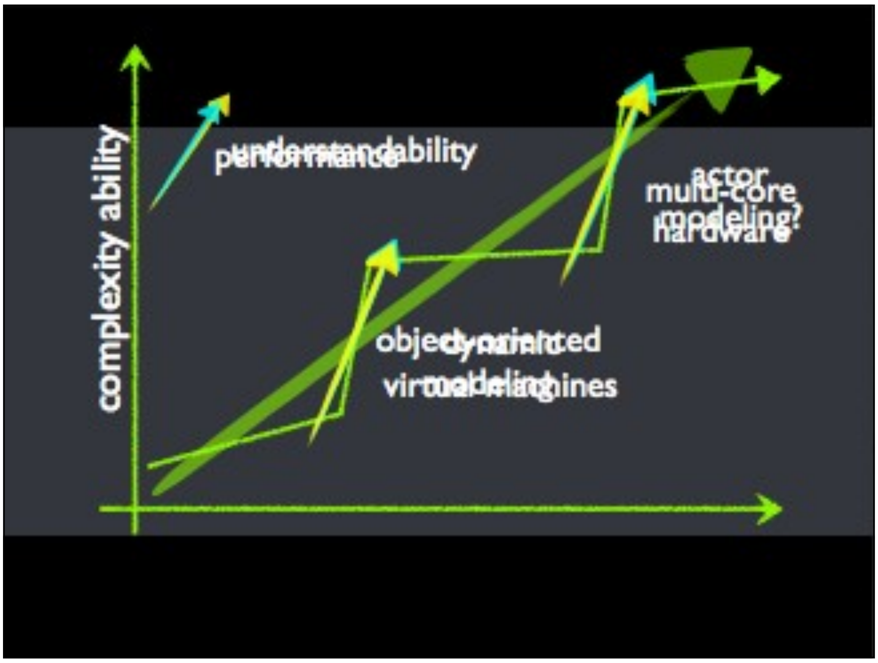
Erjang — A JVM-based Erlang VM

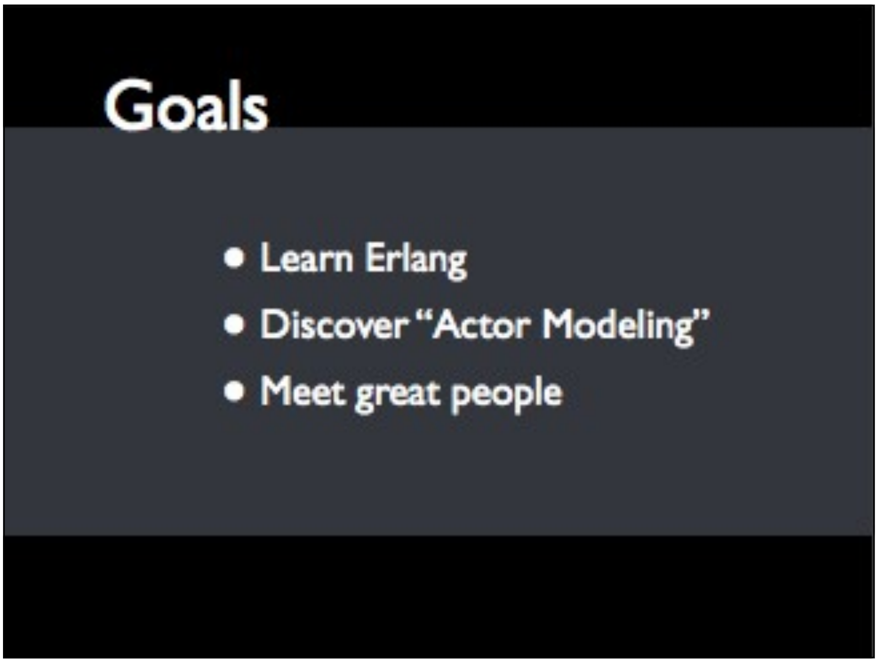
My Journey into Erlang Land

Kresten Krab Thorup, @drkrab, Trifork

The Desert of Java

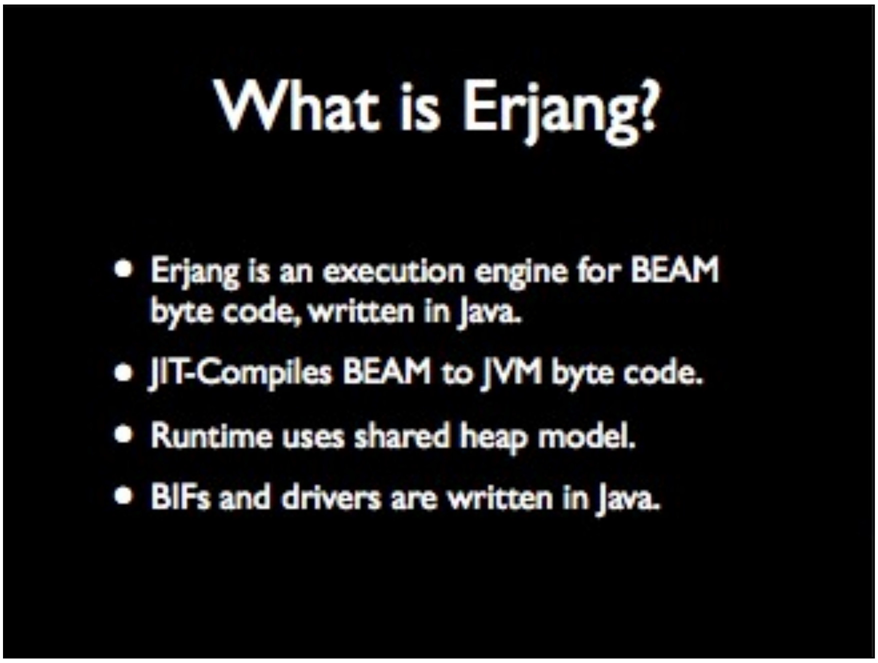
Java Threads
Brian Goetz
JAVA CONCURRENCY IN PRACTICE
Doug Lea
Concurrent Programming in Java Second Edition
THREADS & LOCKS AHEAD





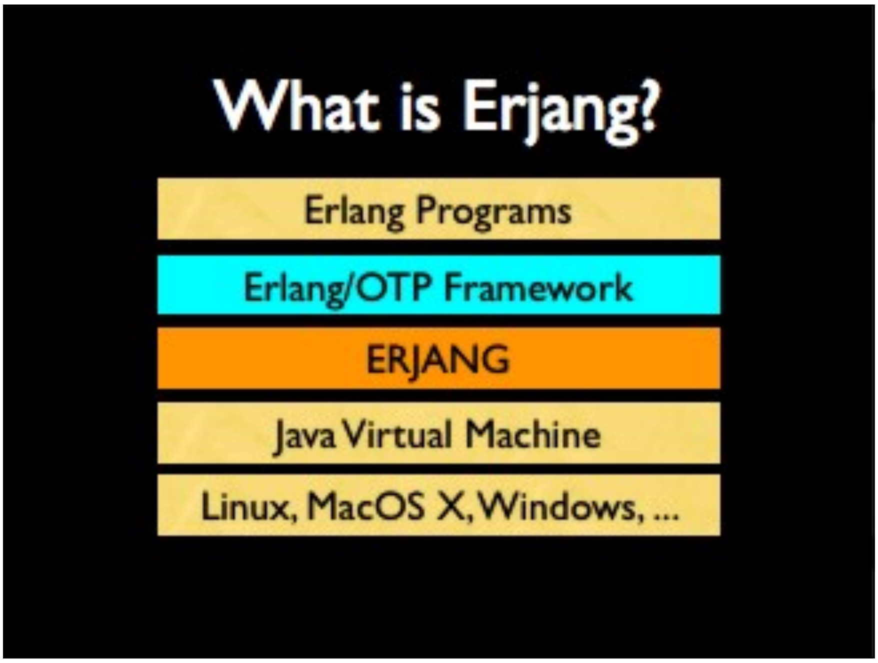
Goals

- Learn Erlang
- Discover "Actor Modeling"
- Meet great people



What is Erjang?

- Erjang is an execution engine for BEAM byte code, written in Java.
- JIT-Compiles BEAM to JVM byte code.
- Runtime uses shared heap model.
- BIFs and drivers are written in Java.



What is Erjang?

Erlang Programs

Erlang/OTP Framework

ERJANG

Java Virtual Machine

Linux, MacOS X, Windows, ...

DEMO

- Launching erjang
- basic shell

Erlang ≠ Erjang

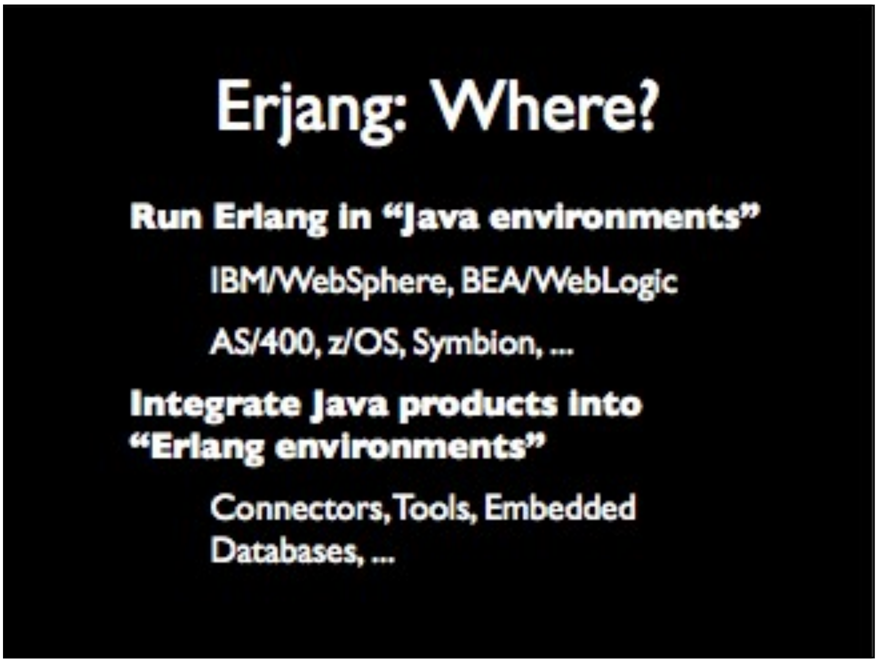
Shared heap

¬ Native drivers

¬ NIF

Why Java?

- JVM is everywhere (from mobile to AS/400)
- JVM has many libraries / integrations.
- JVM has 500+ man-years of engineering
- JVM is fast (for Java-ish programs).
- ... and I know JVM pretty well, ...



Erjang: Where?

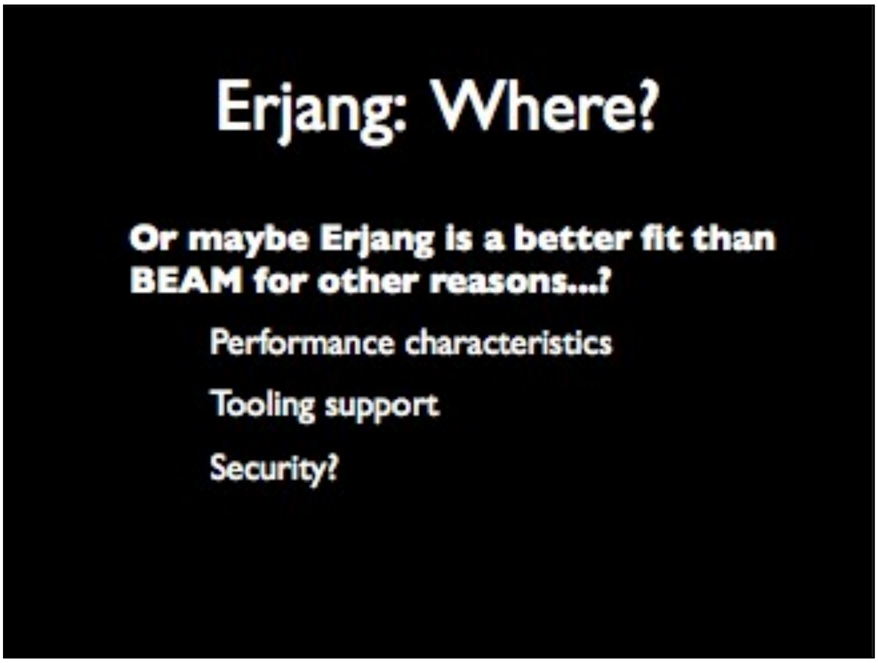
Run Erlang in "Java environments"

IBM/WebSphere, BEA/WebLogic

AS/400, z/OS, Symbion, ...

Integrate Java products into "Erlang environments"

Connectors, Tools, Embedded Databases, ...



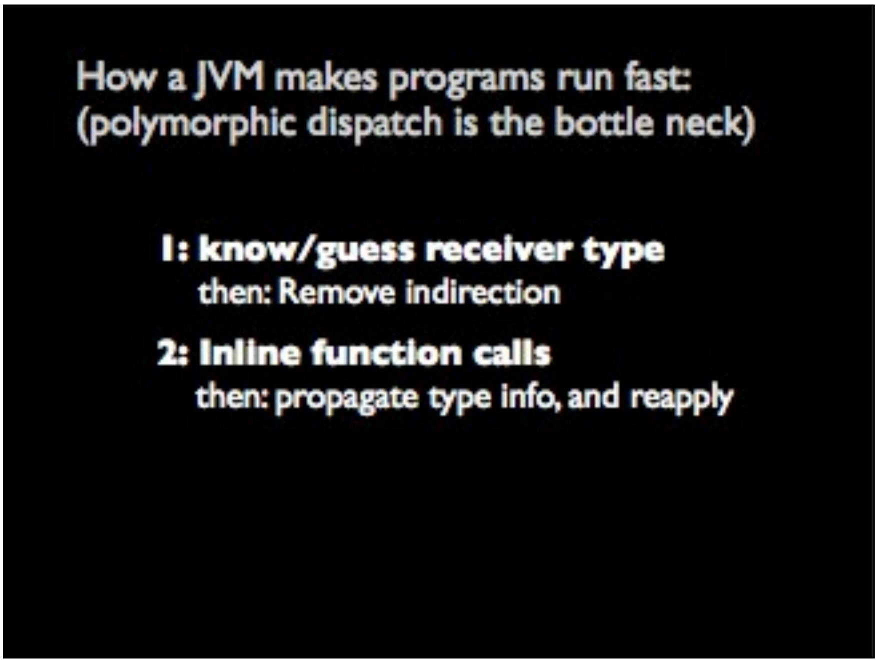
Erjang: Where?

Or maybe Erjang is a better fit than BEAM for other reasons...?

Performance characteristics

Tooling support

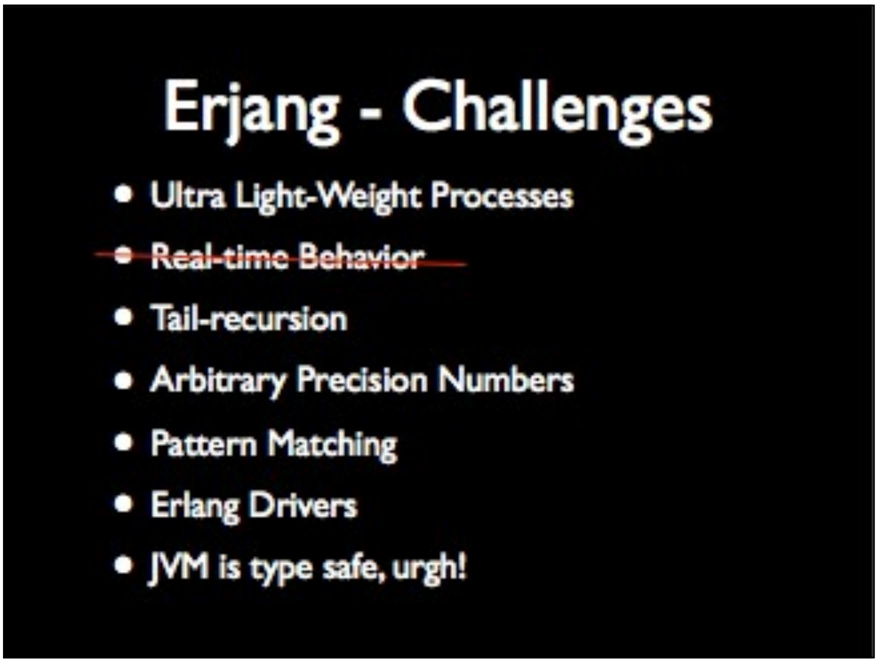
Security?



How a JVM makes programs run fast:
(polymorphic dispatch is the bottle neck)

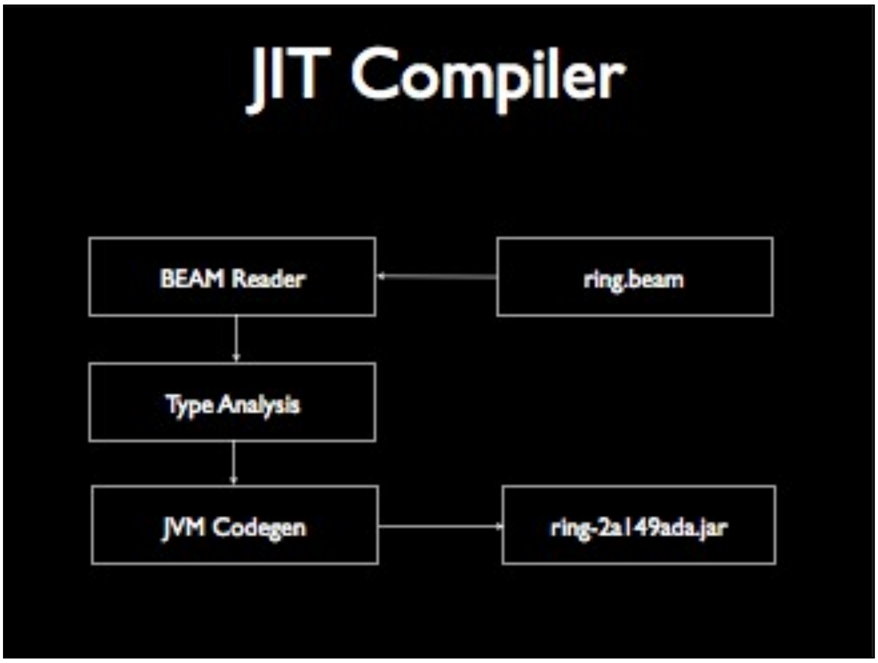
1: know/guess receiver type
then: Remove indirection

2: Inline function calls
then: propagate type info, and reapply

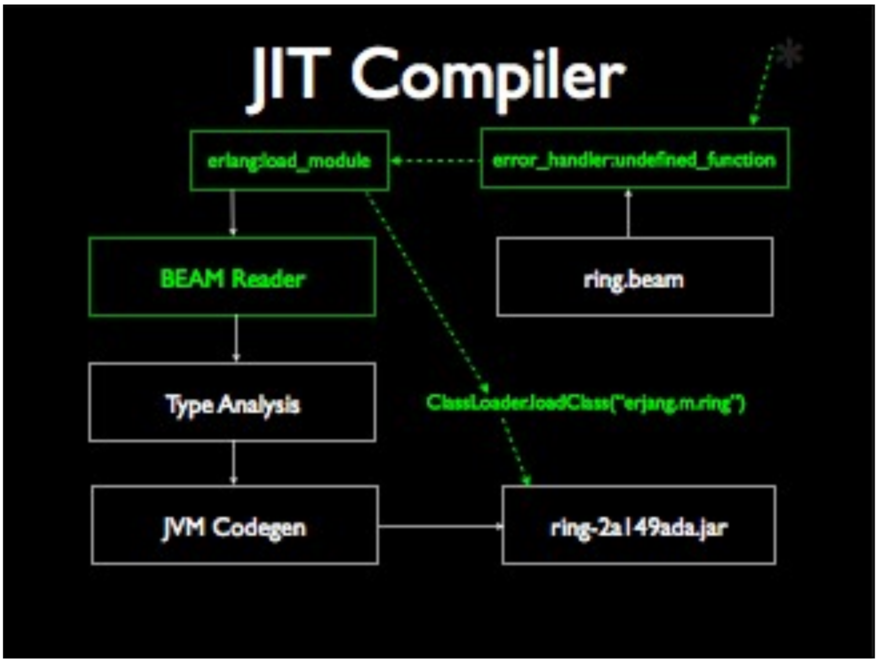


Erjang - Challenges

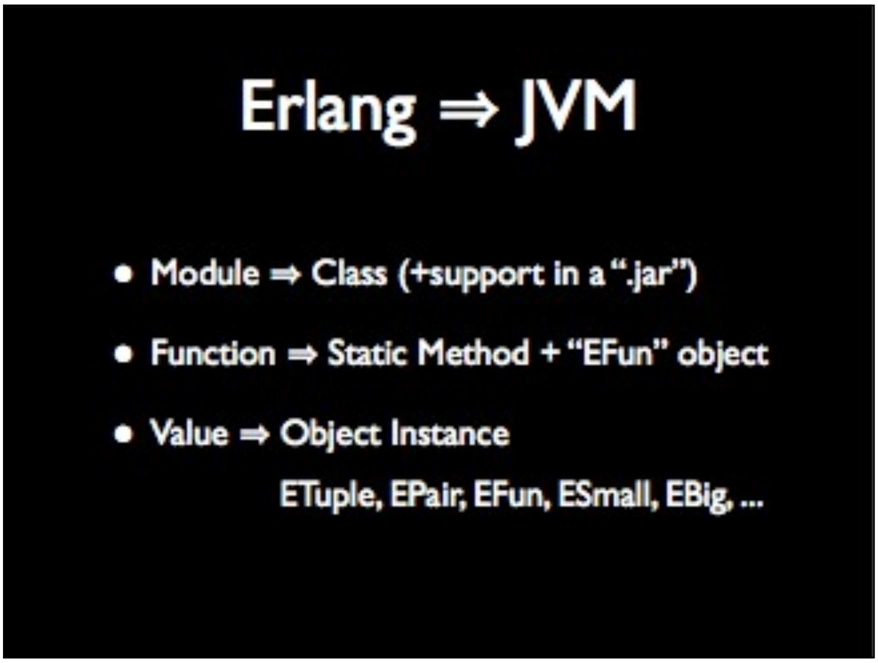
- Ultra Light-Weight Processes
- ~~Real-time Behavior~~
- Tail-recursion
- Arbitrary Precision Numbers
- Pattern Matching
- Erlang Drivers
- JVM is type safe, urgh!



JIT Compiler



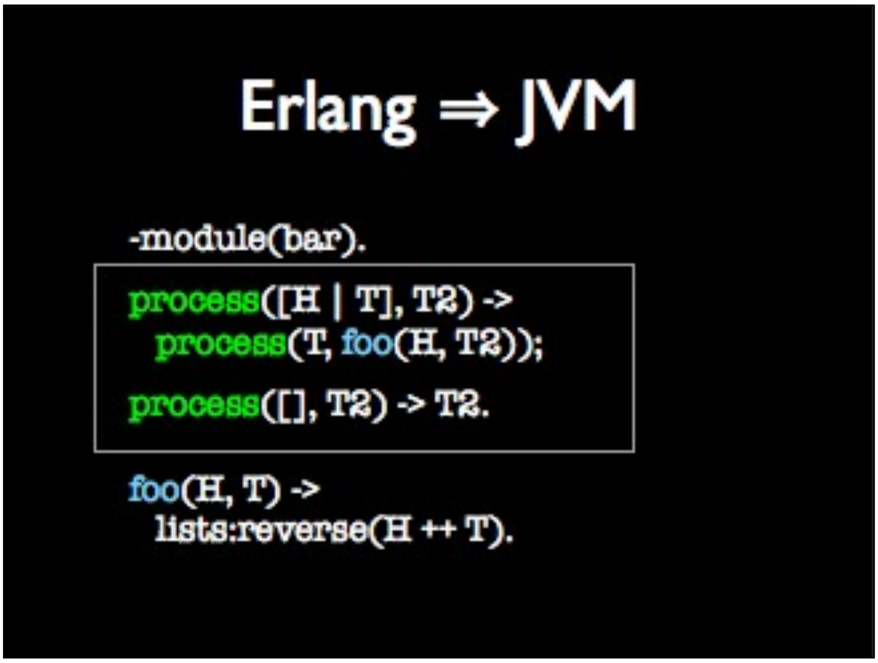
JIT Compiler



Erlang ⇒ JVM

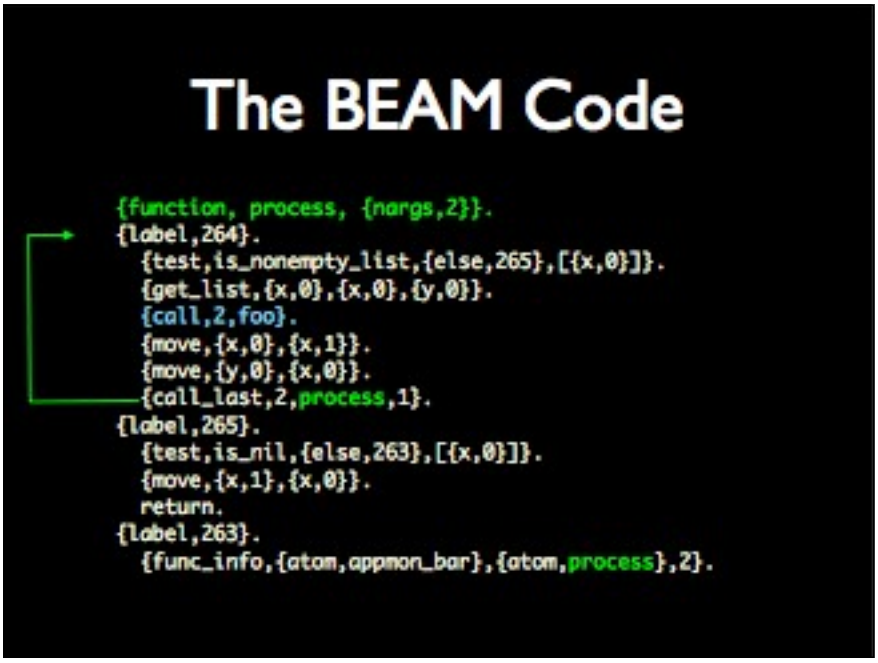
- Module ⇒ Class (+support in a ".jar")
- Function ⇒ Static Method + "EFun" object
- Value ⇒ Object Instance

  ETuple, EPair, EFun, ESmall, EBig, ...



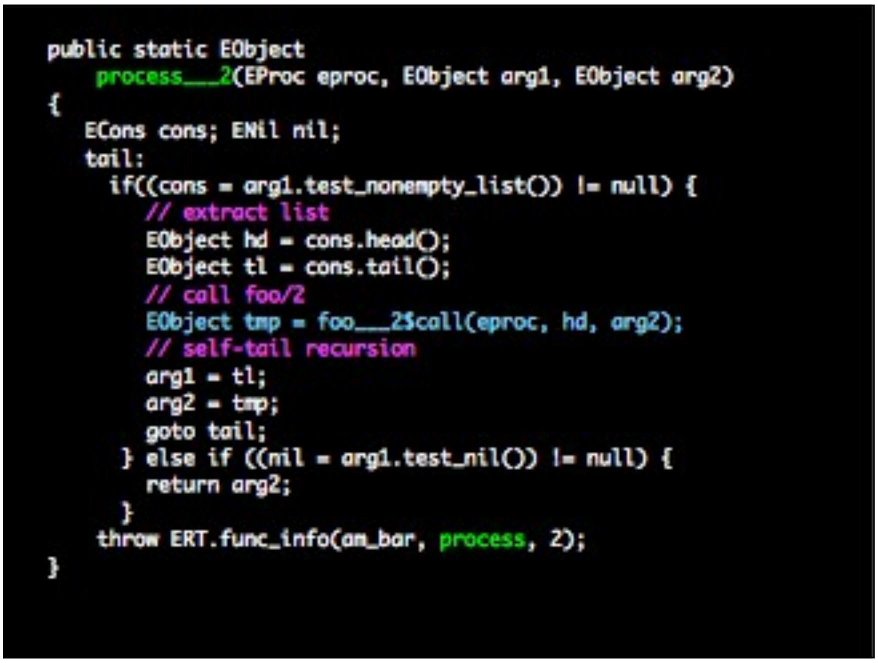
Erlang ⇒ JVM

```
-module(bar).

process([H | T], T2) ->
  process(T, foo(H, T2));

process([], T2) -> T2.

foo(H, T) ->
  lists:reverse(H ++ T).
```



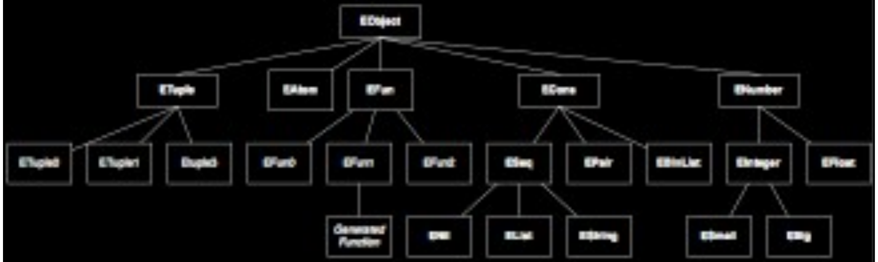
The BEAM Code

```
{function, process, {nargs,2}}.
{label,264}.
  {test,is_nonempty_list,{else,265},[{x,0}]}.
  {get_list,{x,0},{x,0},{y,0}}.
  {call,2,foo}.
  {move,{x,0},{x,1}}.
  {move,{y,0},{x,0}}.
  {call_last,2,process,1}.
{label,265}.
  {test,is_nil,{else,263},[{x,0}]}.
  {move,{x,1},{x,0}}.
  return.
{label,263}.
  {func_info,{atom,appmon_bar},{atom,process},2}.
```

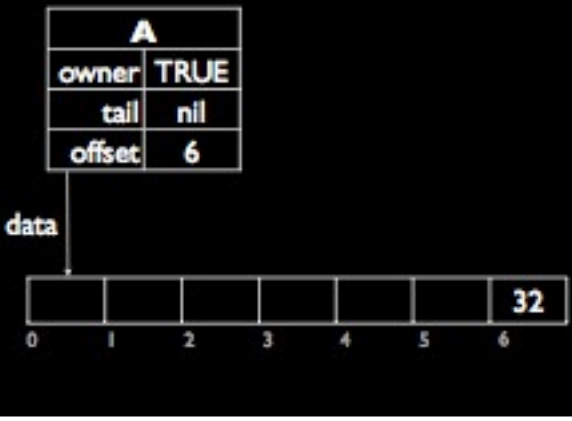


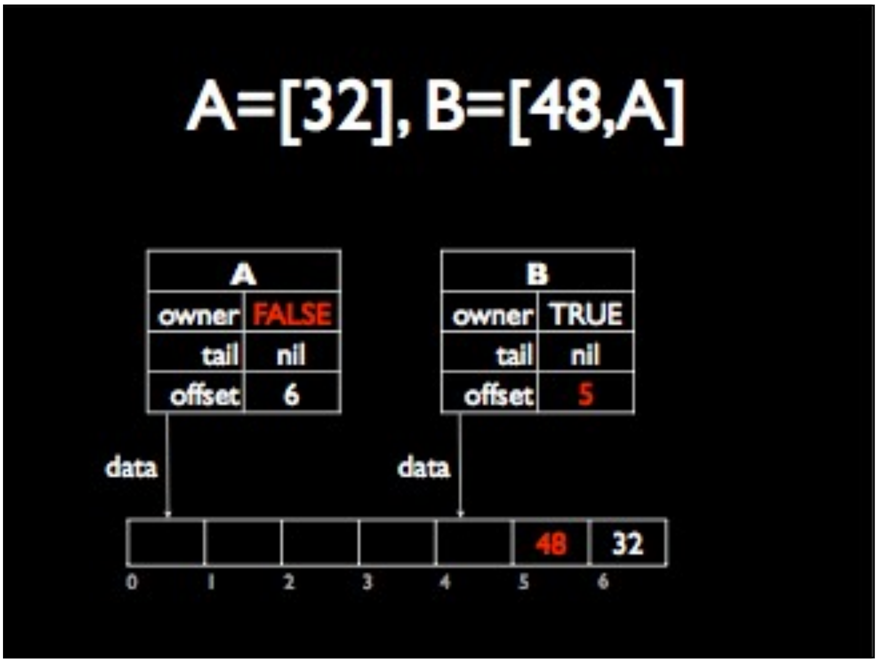
```
public static EObject
    process___2(EProc eproc, EObject arg1, EObject arg2)
{
   ECons cons; ENil nil;
   tail:
     if((cons = arg1.test_nonempty_list()) != null) {
        // extract list
        EObject hd = cons.head();
        EObject tl = cons.tail();
        // call foo/2
        EObject tmp = foo___2$call(eproc, hd, arg2);
        // self-tail recursion
        arg1 = tl;
        arg2 = tmp;
        goto tail;
      } else if ((nil = arg1.test_nil()) != null) {
        return arg2;
      }
    throw ERT.func_info(am_bar, process, 2);
}
```

Core Erjang Types



A=[32]



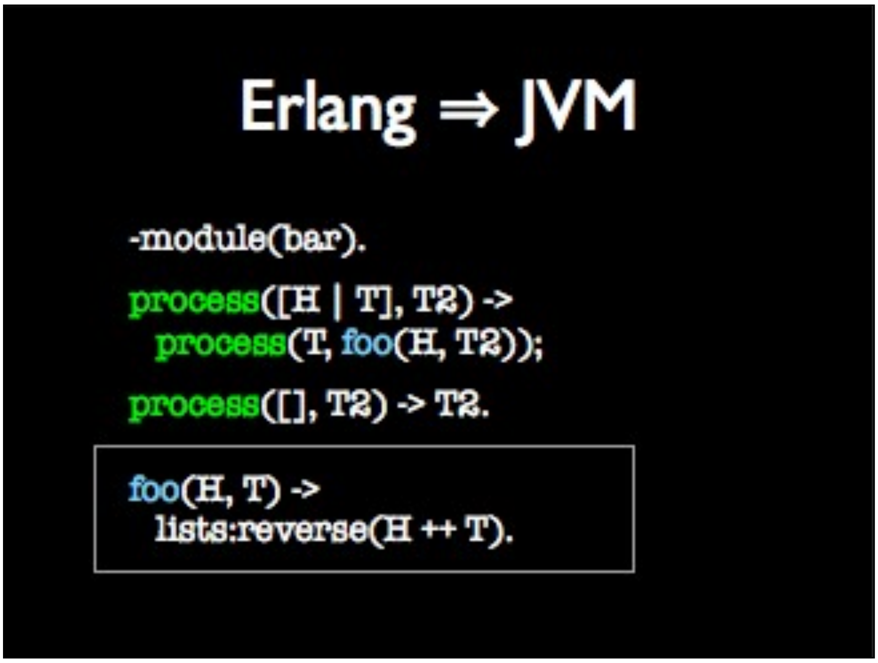


A=[32], B=[48,A]

A	
owner	FALSE
tail	nil
offset	6

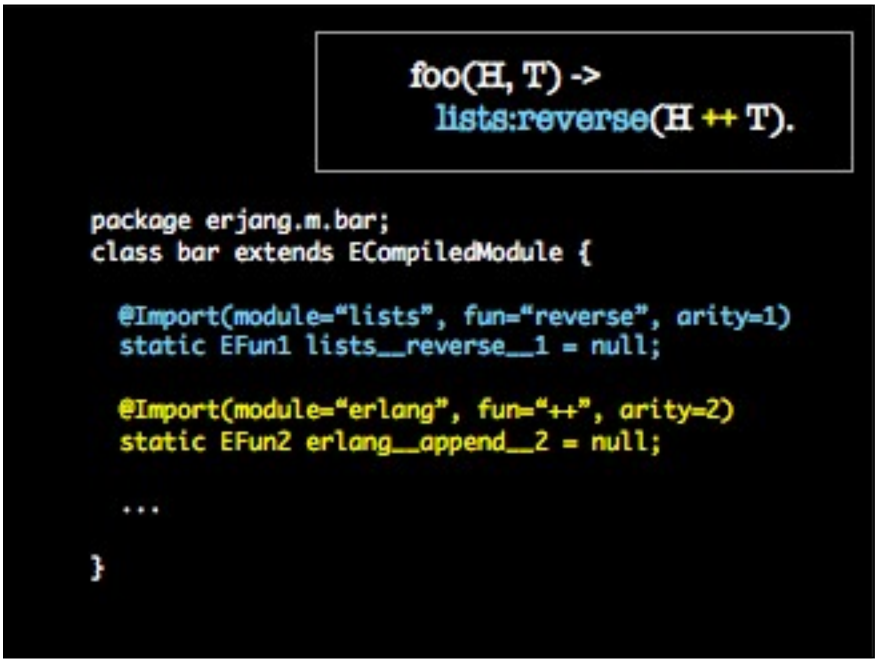
B	
owner	TRUE
tail	nil
offset	5

0	1	2	3	4	5	6
					48	32



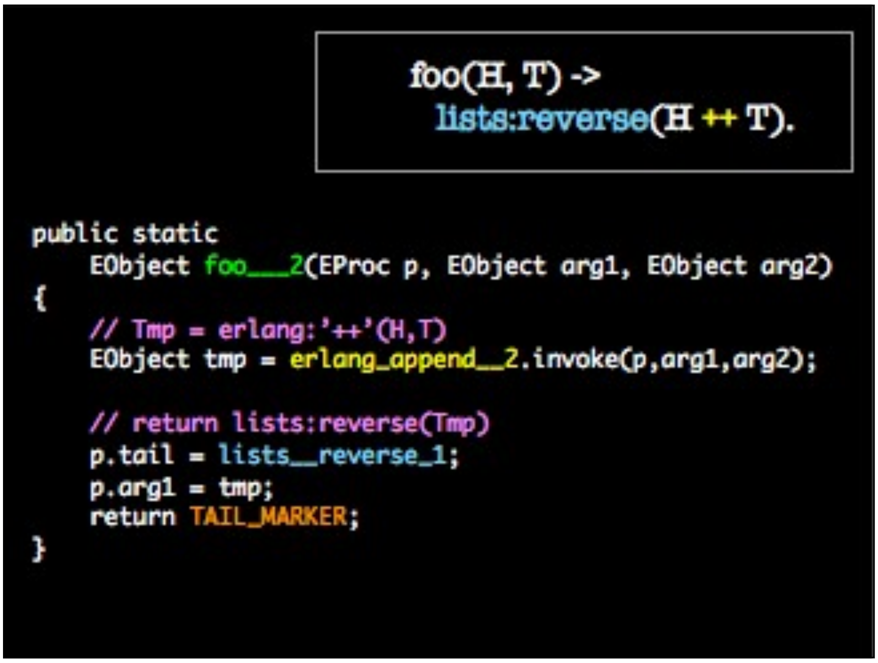
Erlang ⇒ JVM

```
-module(bar).

process([H | T], T2) ->
  process(T, foo(H, T2));

process([], T2) -> T2.

foo(H, T) ->
  lists:reverse(H ++ T).
```



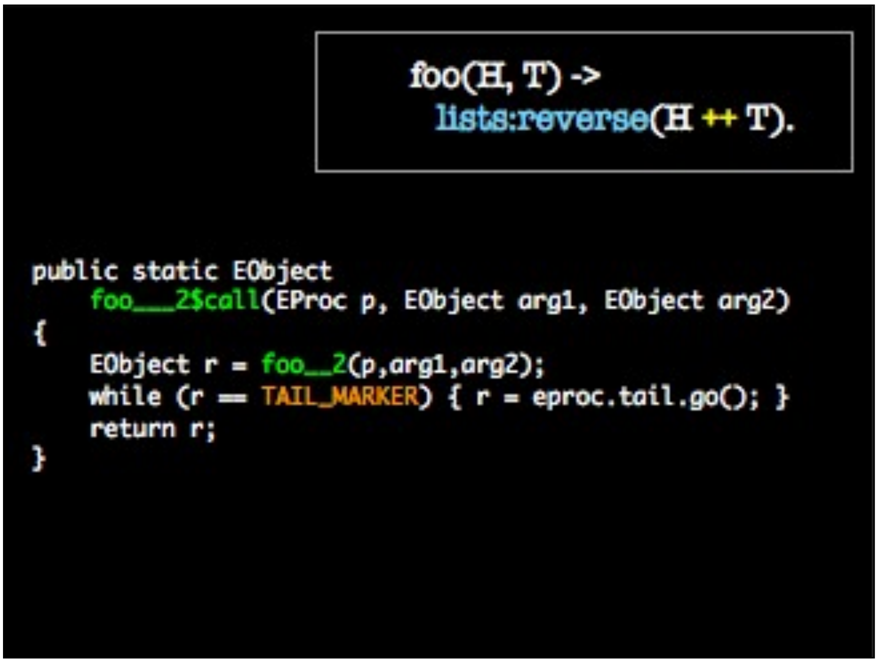
```
foo(H, T) ->
  lists:reverse(H ++ T).
```

```
package erjang.m.bar;
class bar extends ECompiledModule {

  @Import(module="lists", fun="reverse", arity=1)
  static EFun1 lists__reverse__1 = null;

  @Import(module="erlang", fun="++", arity=2)
  static EFun2 erlang__append__2 = null;

  ...

}
```



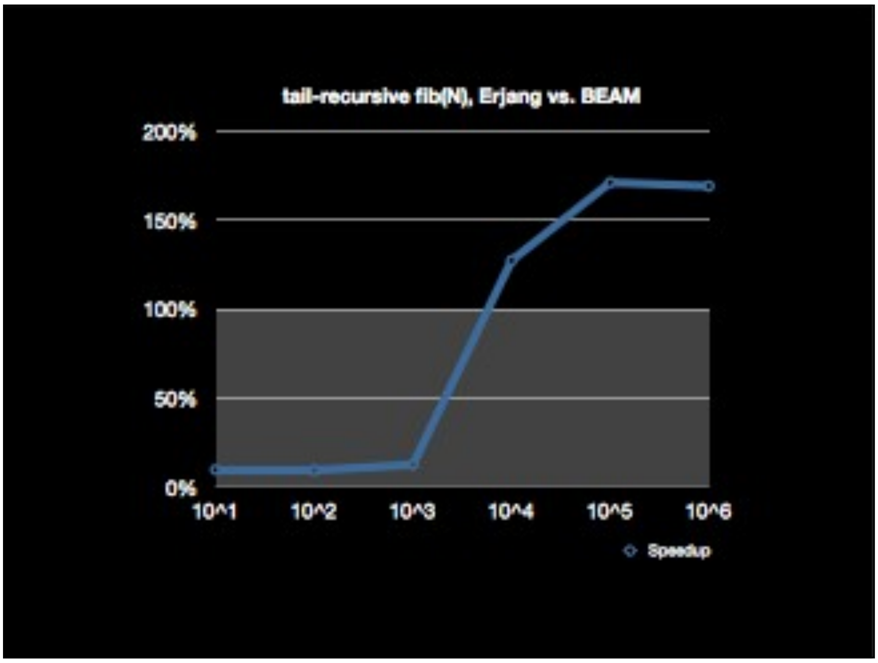
```
foo(H, T) ->
   lists:reverse(H ++ T).
```

```
public static
    EObject foo__2(EProc p, EObject arg1, EObject arg2)
{
    // Tmp = erlang:'++'(H,T)
    EObject tmp = erlang_append__2.invoke(p,arg1,arg2);

    // return lists:reverse(Tmp)
    p.tail = lists__reverse_1;
    p.arg1 = tmp;
    return TAIL_MARKER;
}
```



```
foo(H, T) ->
   lists:reverse(H ++ T).
```

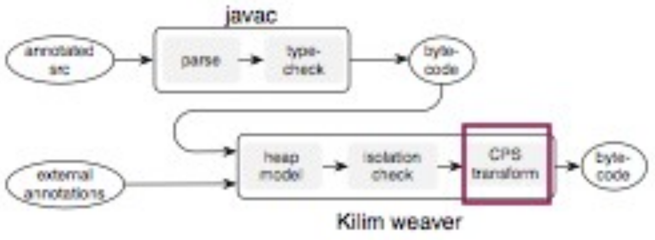
```
public static EObject
    foo__2$call(EProc p, EObject arg1, EObject arg2)
{
    EObject r = foo__2(p,arg1,arg2);
    while (r == TAIL_MARKER) { r = eproc.tail.go(); }
    return r;
}
```



Light-Weight Processes

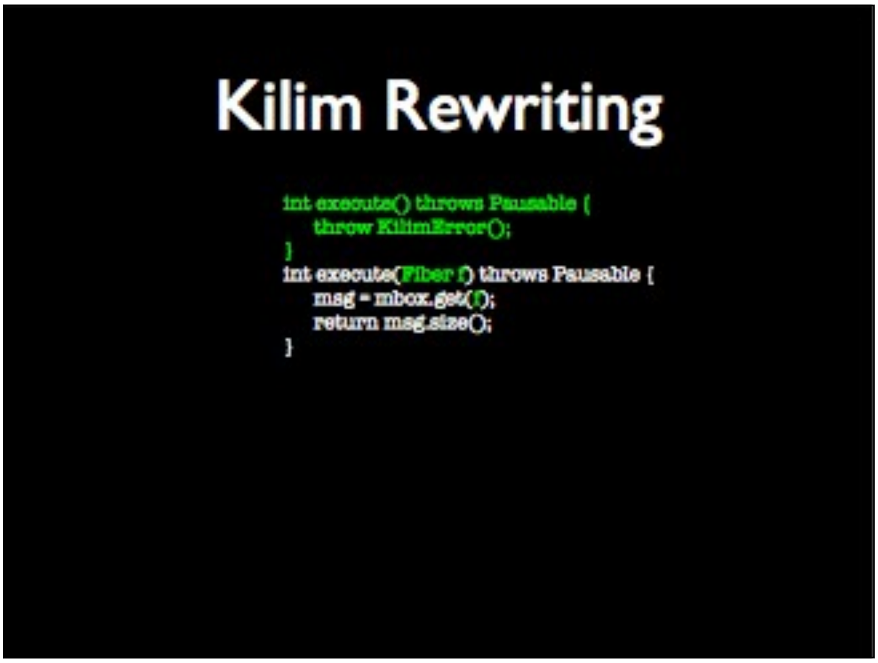
- Threads don't cut it;
  - Typical JVMs are limited to ~1000 threads
  - Context switch for threads is very expensive
- Erjang uses *Kilim*, a separate project
- Use one thread per CPU

Kilim



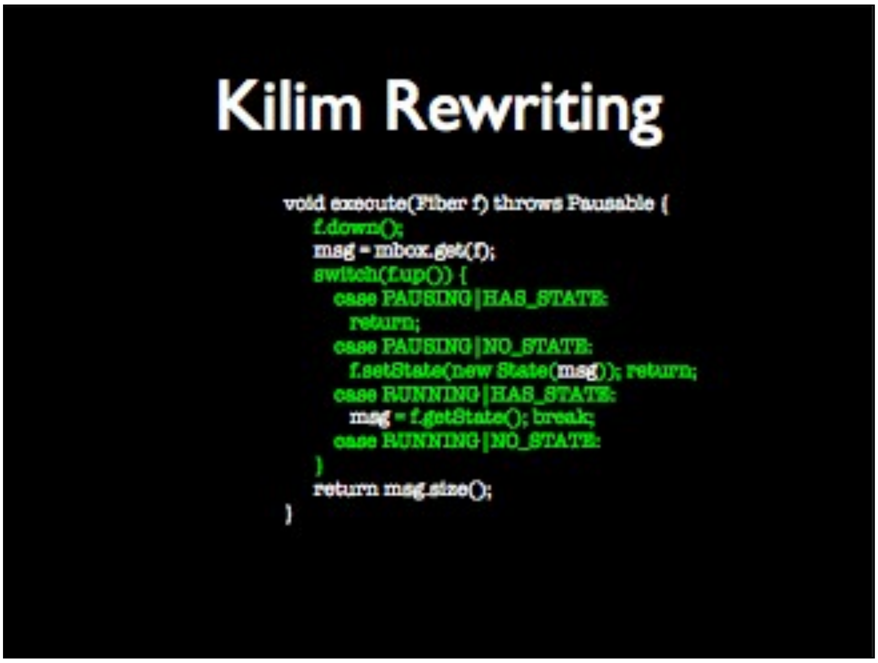
Kilim Rewriting

```
int execute() throws Pausable {
    msg = mbox.get();
    return msg.size();
}
```



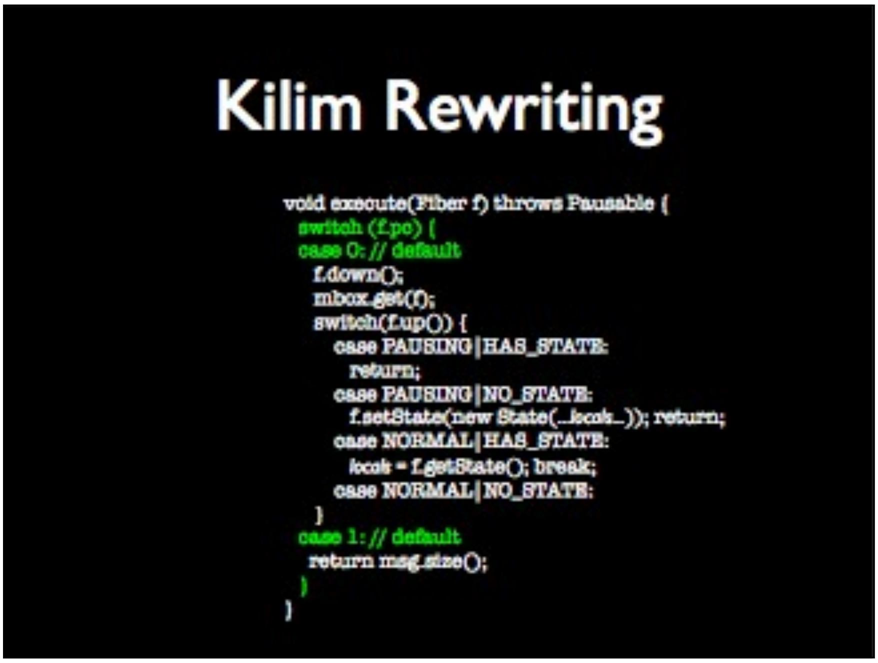
Kilim Rewriting

```
int execute() throws Pausable {
    throw KilimError();
}
int execute(Fiber f) throws Pausable {
    msg = mbox.get(f);
    return msg.size();
}
```



Kilim Rewriting

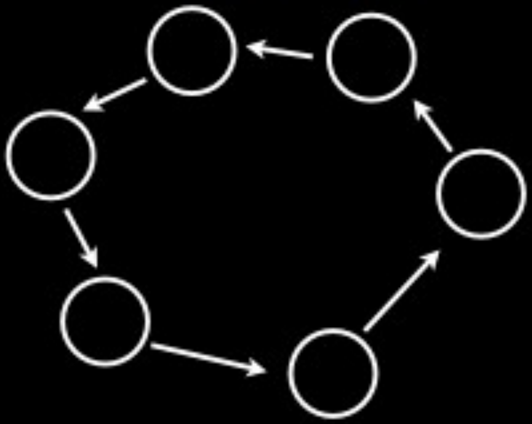
```
void execute(Fiber f) throws Pausable {
    f.down();
    msg = mbox.get(f);
    switch(f.up()) {
      case PAUSING|HAS_STATE:
        return;
      case PAUSING|NO_STATE:
        f.setState(new State(msg)); return;
      case RUNNING|HAS_STATE:
        msg = f.getState(); break;
      case RUNNING|NO_STATE:
    }
    return msg.size();
}
```

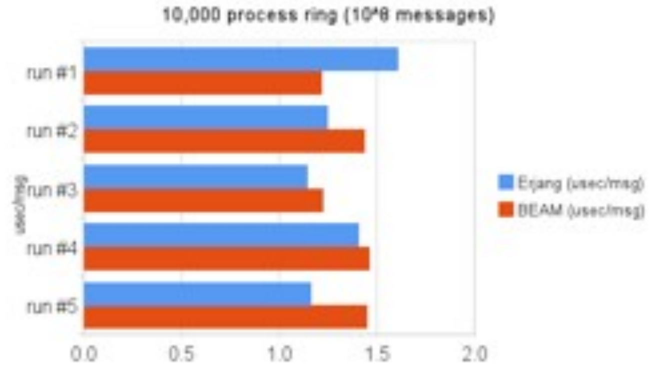


Kilim Rewriting

```
void execute(Fiber f) throws Pausable {
  switch (f.pc) {
  case 0: // default
    f.down();
    mbox.get(f);
    switch(f.up()) {
      case PAUSING|HAS_STATE:
        return;
      case PAUSING|NO_STATE:
        f.setState(new State(...locals...)); return;
      case NORMAL|HAS_STATE:
        locals = f.getState(); break;
      case NORMAL|NO_STATE:
    }
  case 1: // default
   return msg.size();
  }
}
```

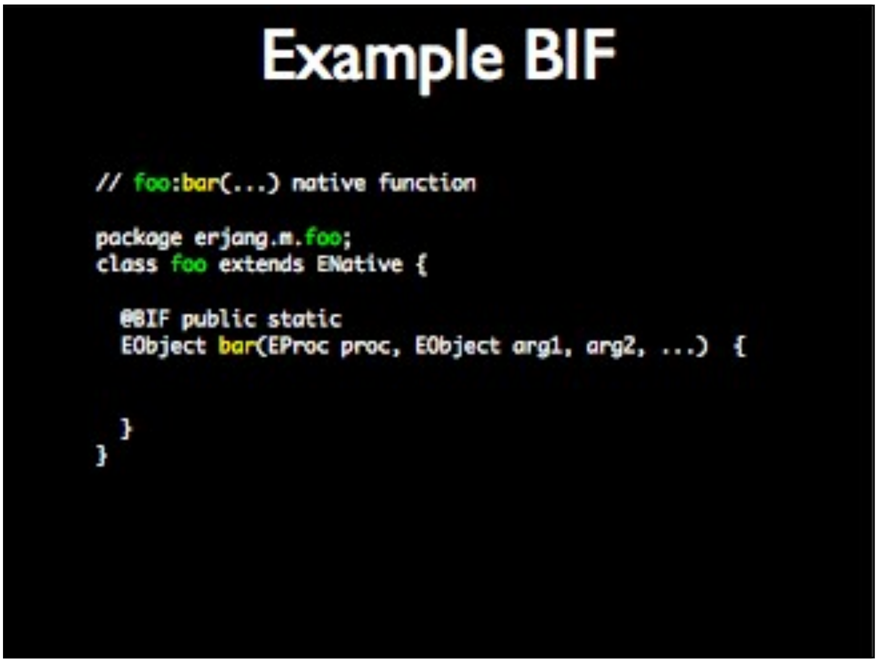
The ring!





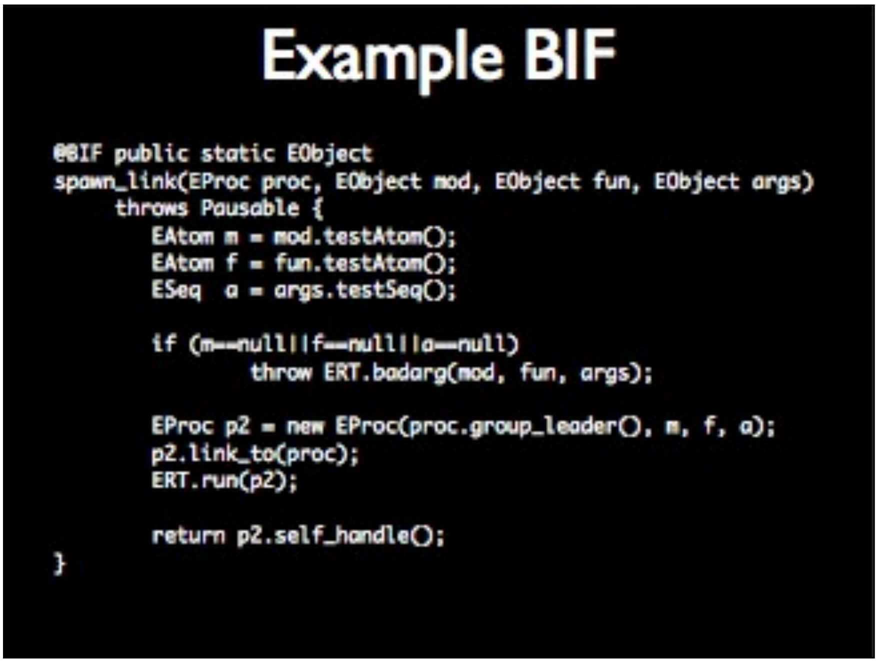
Interfacing to Java

- Erlang's primitive operations "BIFs" are implemented in Java
- @BIF annotation makes a static-public method available from Erlang.
- Erlang port concept for "drivers"



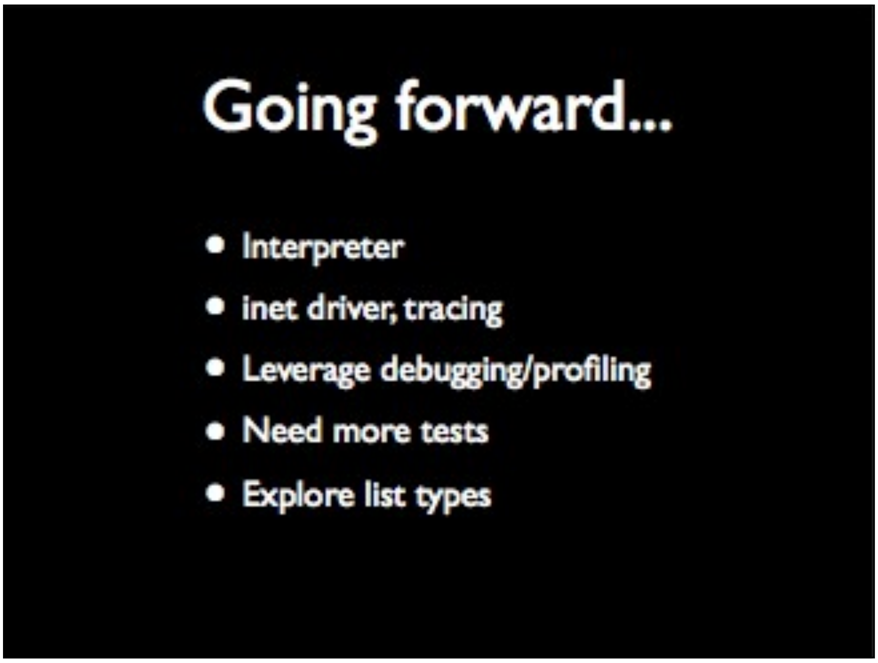
Example BIF

```
// foo:bar(...) native function

package erjang.m.foo;
class foo extends ENative {

  @BIF public static
  EObject bar(EProc proc, EObject arg1, arg2, ...)  {


  }
}
```



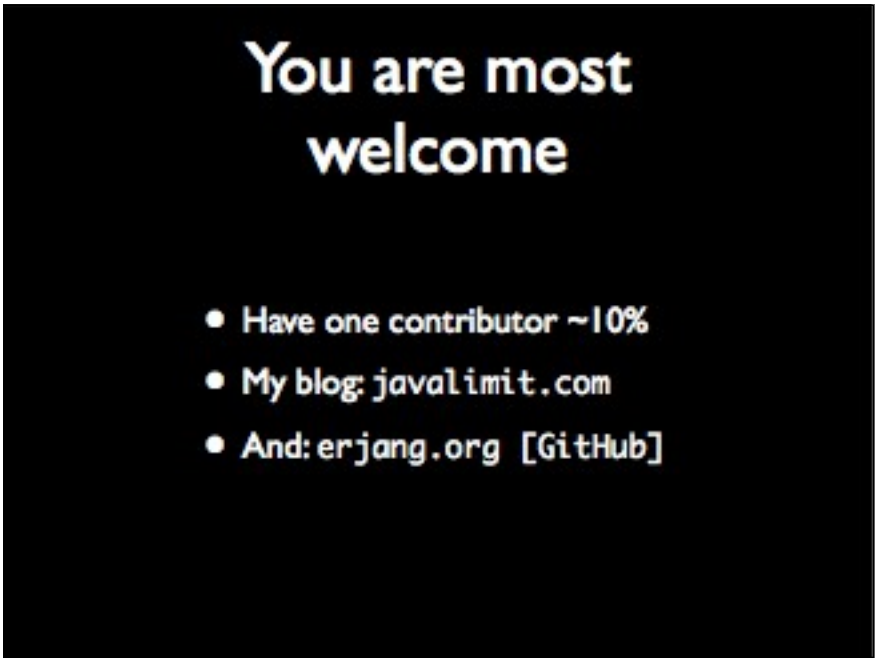
Example BIF

```
@BIF public static EObject
spawn_link(EProc proc, EObject mod, EObject fun, EObject args)
     throws Pausable {
        EAtom m = mod.testAtom();
        EAtom f = fun.testAtom();
        ESeq  a = args.testSeq();

        if (m==null||f==null||a==null)
                throw ERT.badarg(mod, fun, args);

        EProc p2 = new EProc(proc.group_leader(), m, f, a);
        p2.link_to(proc);
        ERT.run(p2);

        return p2.self_handle();
}
```



Going forward...

- Interpreter
- inet driver, tracing
- Leverage debugging/profiling
- Need more tests
- Explore list types



You are most welcome

- Have one contributor ~10%
- My blog: `javalimit.com`
- And: `erjang.org [GitHub]`

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Conference: March 10-12

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Aditya Agarwal - *"Facebook: Science and the Social Graph"*