RTALK -
SMALLTALK ON THE
JVM

Roos Instruments, Inc.

HARDWARE AND SOFTWARE FOR IC TEST

Smalltalk Basics

- Message Based
- Everything is an Object
- Simple syntax
- Fast
  - ODA (On Demand Assembler)
- Excellent FFI
- Supports extreme agile programming

Smalltalk Code Example

```
testHanoiMove: numberOfDisks from: source to: dest temp: temp
   "<modified:sys=GAKRE8CA,time=06/28/11 at 04:39:33 pm>   "
        numberOfDisks == 1 ifTrue: [^self].
        self
                testHanoiMove: numberOfDisks - 1 from: source to: temp temp: dest;
                testHanoiMove: numberOfDisks - 1 from: temp to: dest temp: source
```

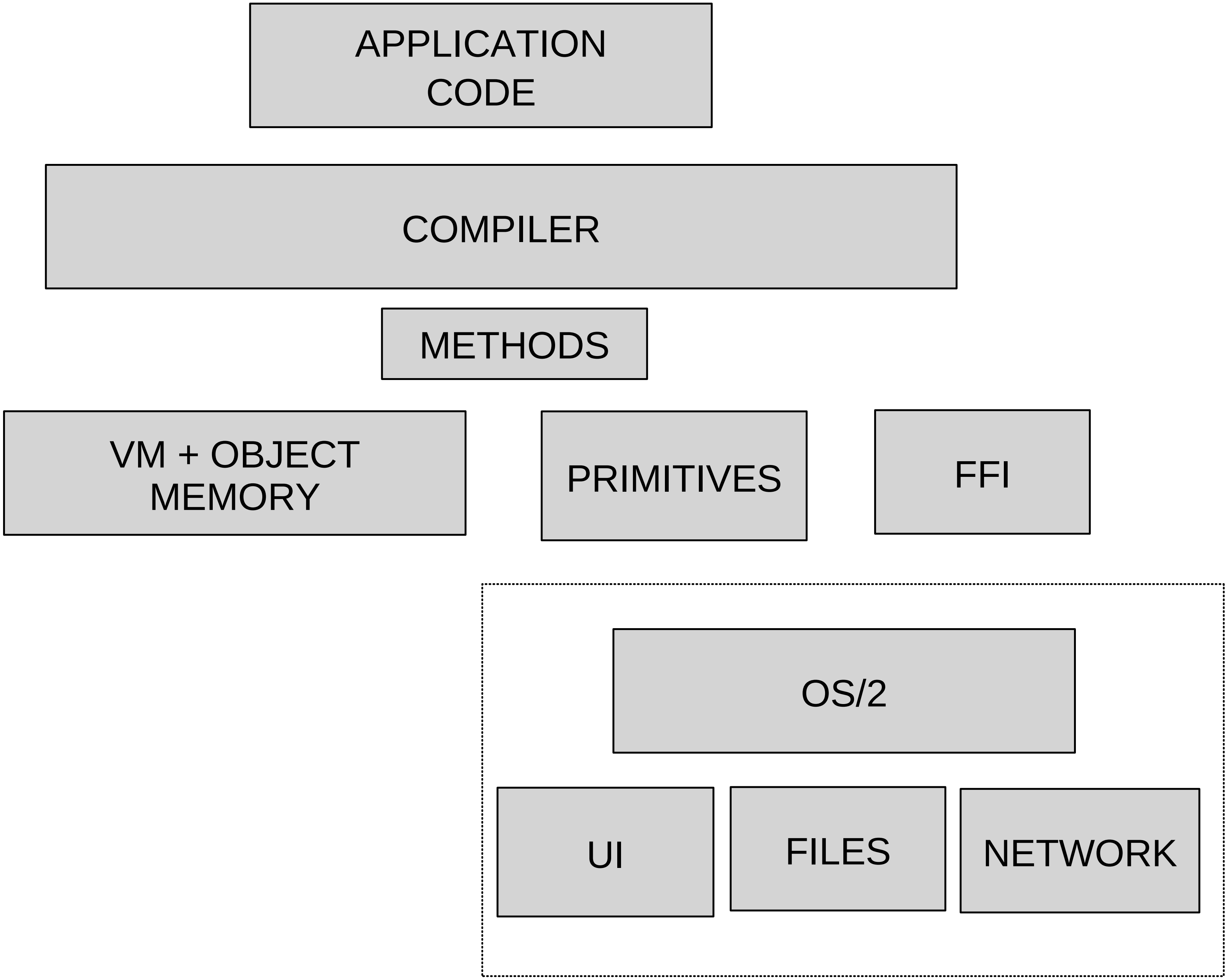
SMALLTALK AT RI

- Since 1989
- Efficiency - 3 to 9x Java
- Low errors - 1/3 Java
- 500K lines of code vs 2.5M
- But we now have Obsolete Platforms
  - OS/2
  - Digitalk
  - Heisenbug

Porting options

- Another Smalltalk
  - Same end game
- Another language
  - Will have to test 2.5M lines of code
- Port at the VM level
  - Difficult until JSR 292

Existing Architecture



APPLICATION CODE

COMPILER

METHODS

VM + OBJECT MEMORY

PRIMITIVES

FFI

OS/2

UI

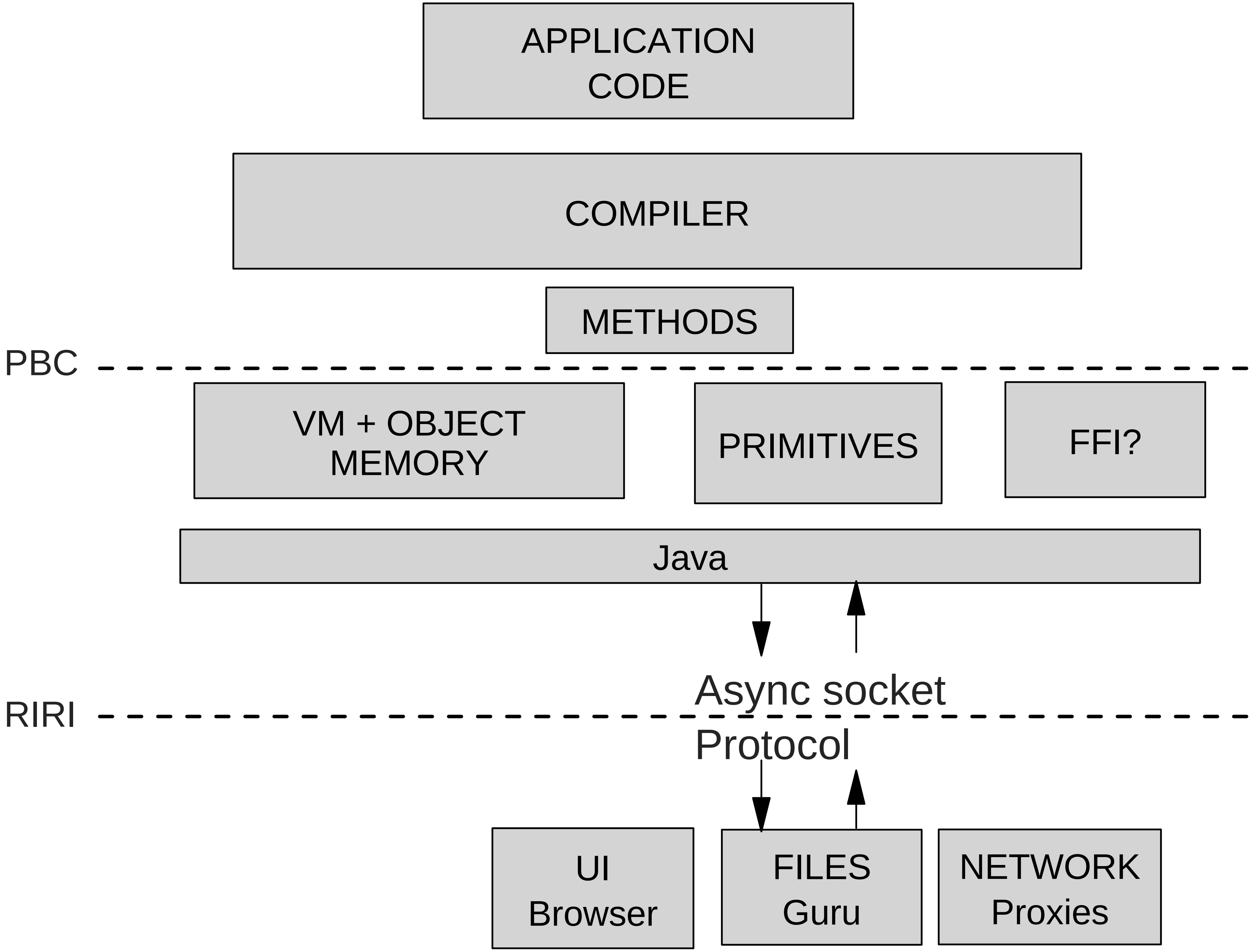
FILES

NETWORK

Process

- Analyze Existing code usage
- Build Tools
  - Byte Code inspectors
  - Reverse compilers
- Define a translation interface
- Port as is (don't try to improve it)
- Convert Op sys calls to async messages

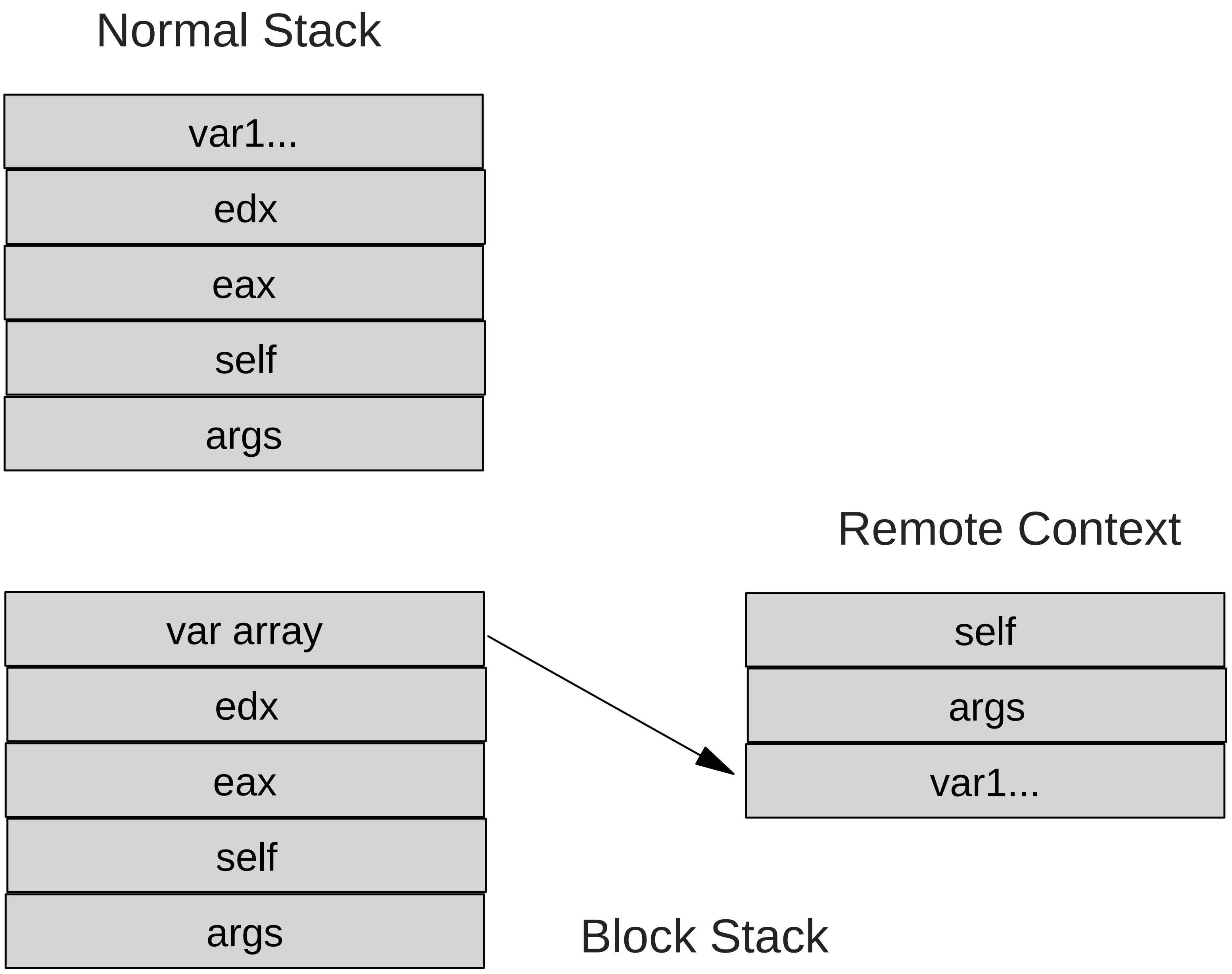
New Architecture



Architecture Mismatches

- Stack + 2 registers (eax edx)
- Stack space == variable space
- Object Memory (ints stored in pointer)
- Type artifacts

Stack Var Structure



Normal Stack

var1...

edx

eax

self

args

Remote Context

self

args

var1...

var array

edx

eax

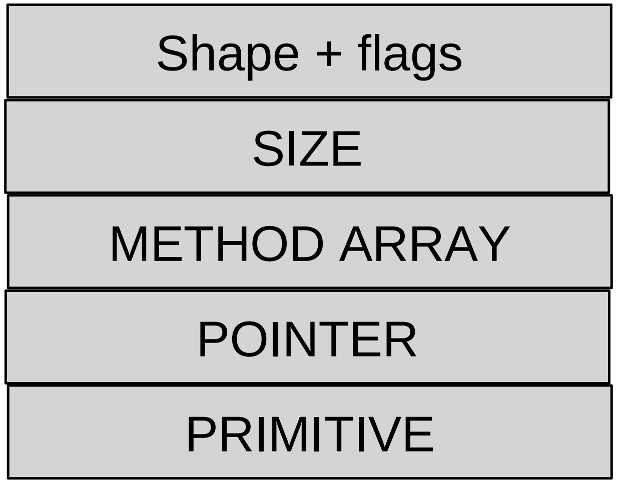
self

args

Block Stack

Object Structure

ri.RtObject

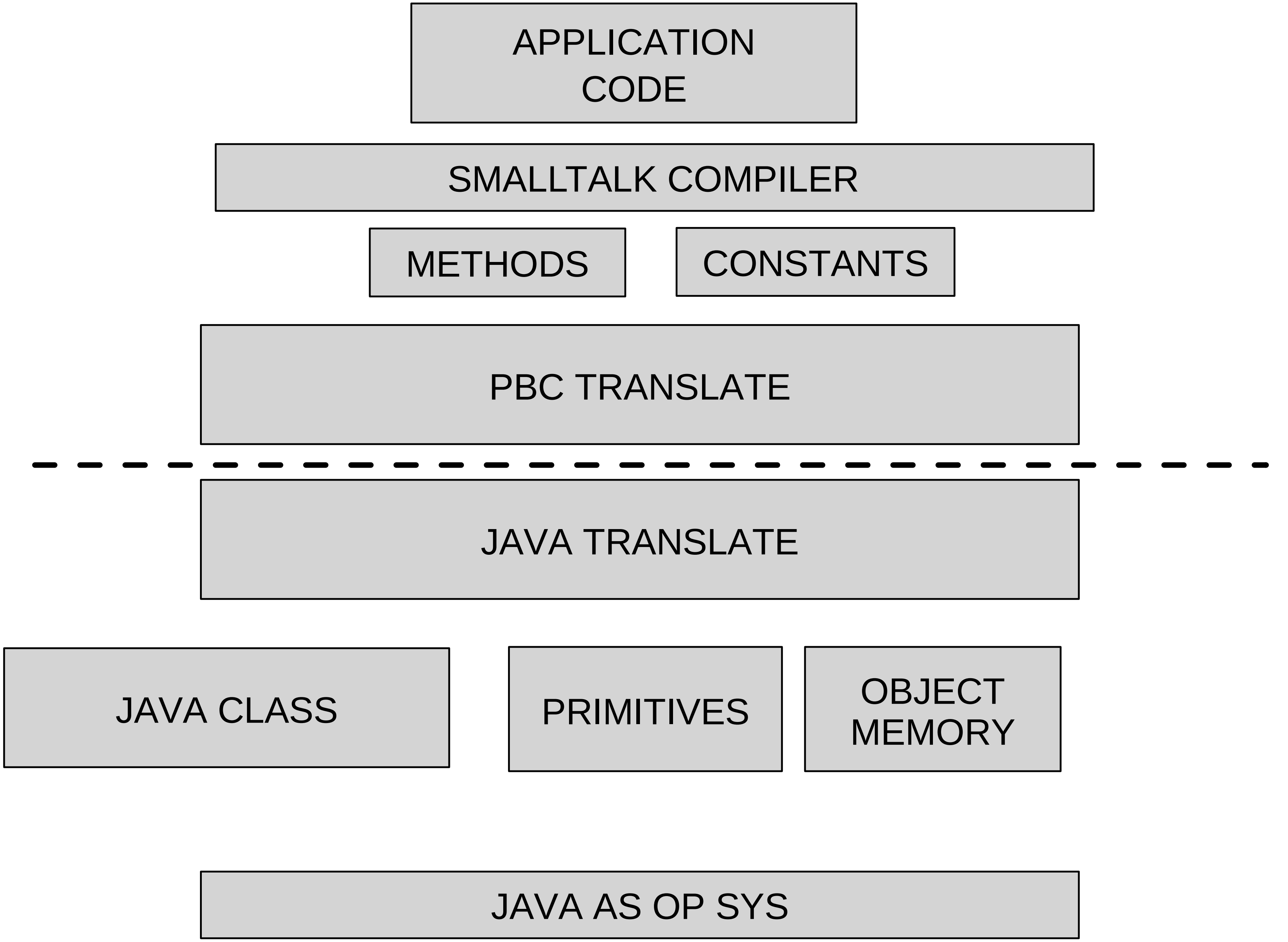


Shape + flags	
SIZE	
METHOD ARRAY	[[methods][methods][]...]
POINTER	byte[], double[], RtObject[], Object
PRIMITIVE	long, double

Methods from ST to Java

- Use supplied ST compiler
- Translate to PBC
  - constants serialization
  - byte code conversion
  - fixup dead code, order
- Translate from PBC to Java Class
  - Use ASM
- Build GWT inline cache on demand

JVM Architecture


APPLICATION CODE

SMALLTALK COMPILER

METHODS

CONSTANTS

PBC TRANSLATE

JAVA TRANSLATE

JAVA CLASS

PRIMITIVES

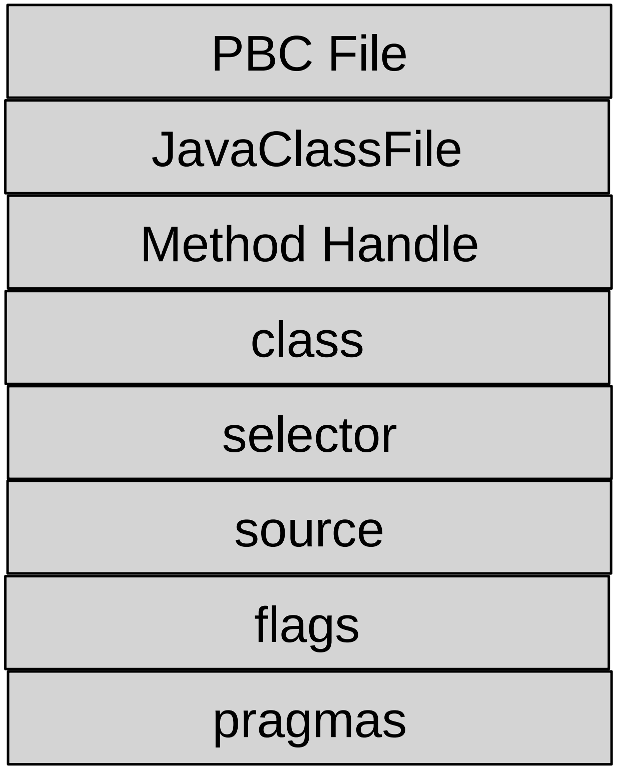
OBJECT MEMORY

JAVA AS OP SYS

Portable Code Example

```
:CODE,
type=classMethod,
class=RtDictionary,
selector=initialSize,
args=0,vars=0,blocks=0,
pbc=04000000230124022301240240023438240223021E
initialSize
        "Private - Answer the initial number of elements
         that a new instance of IdentityDictionary
         contains."
    ^8
```

Method Structure



PBC File

JavaClassFile

Method Handle

class

selector

source

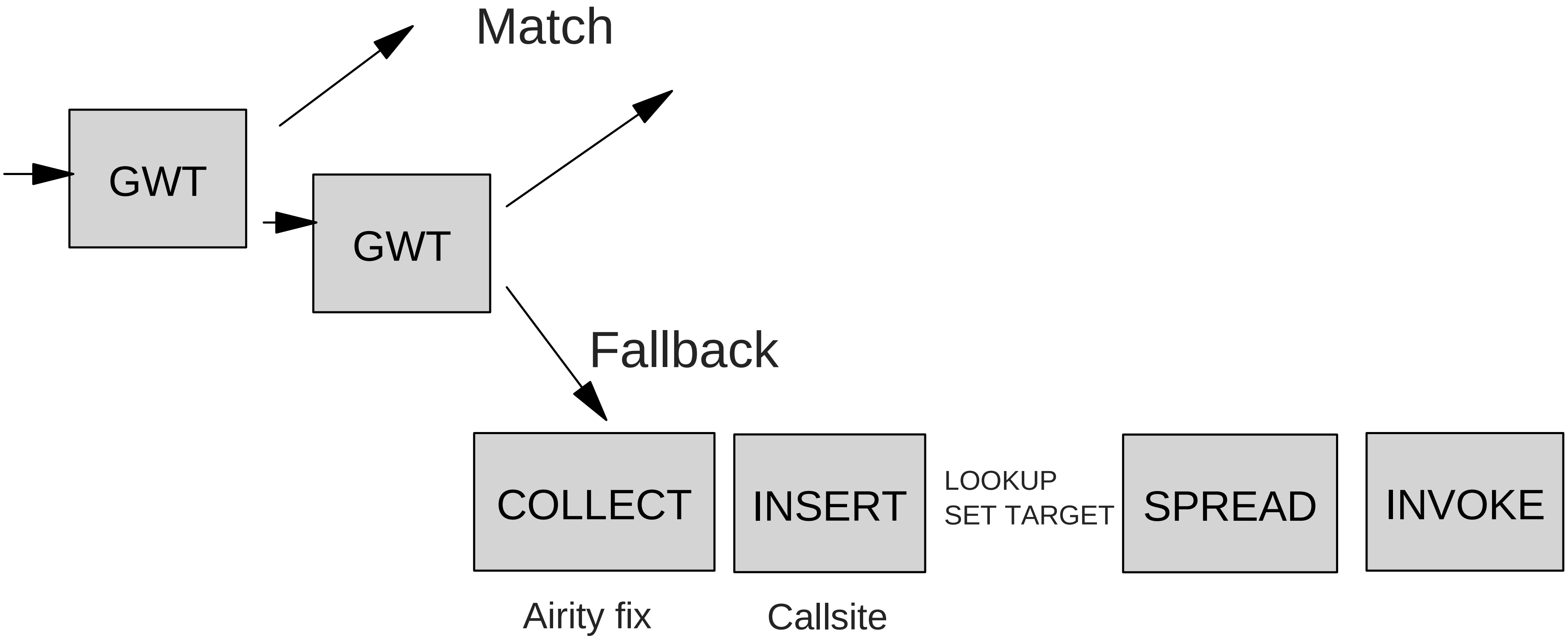
flags

pragmas

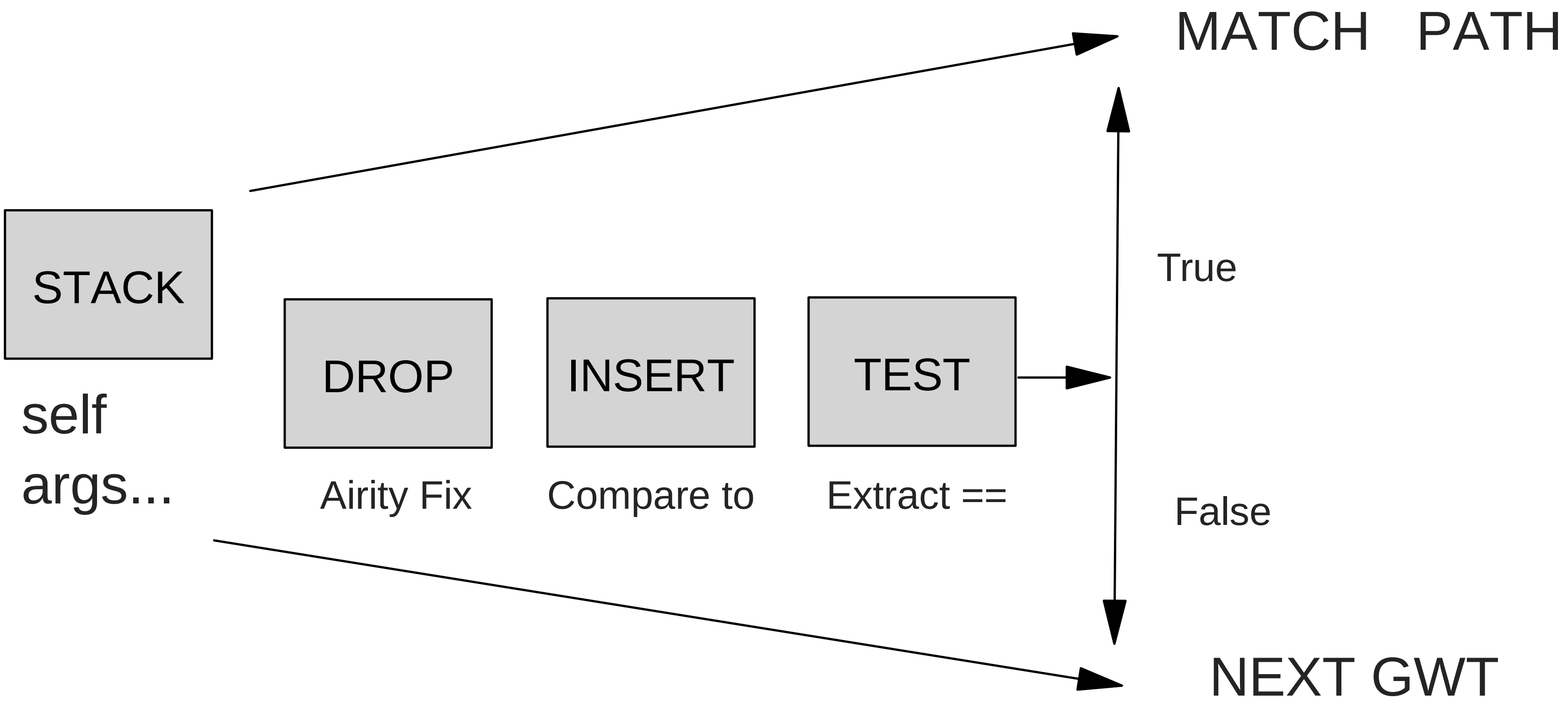
ByteCode Differences

- 25 PBC but only 4 real differences
- Method Invocation
- Primitives
- Blocks and returns
- Constants

GWT as inline cache



GWT


MATCH PATH
STACK
self
args...
DROP
Airity Fix
INSERT
Compare to
TEST
Extract ==
True
False
NEXT GWT

Blocks

- Code plus context
- Code is just another method
- Replaced stack vars with shared array
- Non local return
  - returns to caller of creator
  - use var array to locate return frame
  - throw exceptio

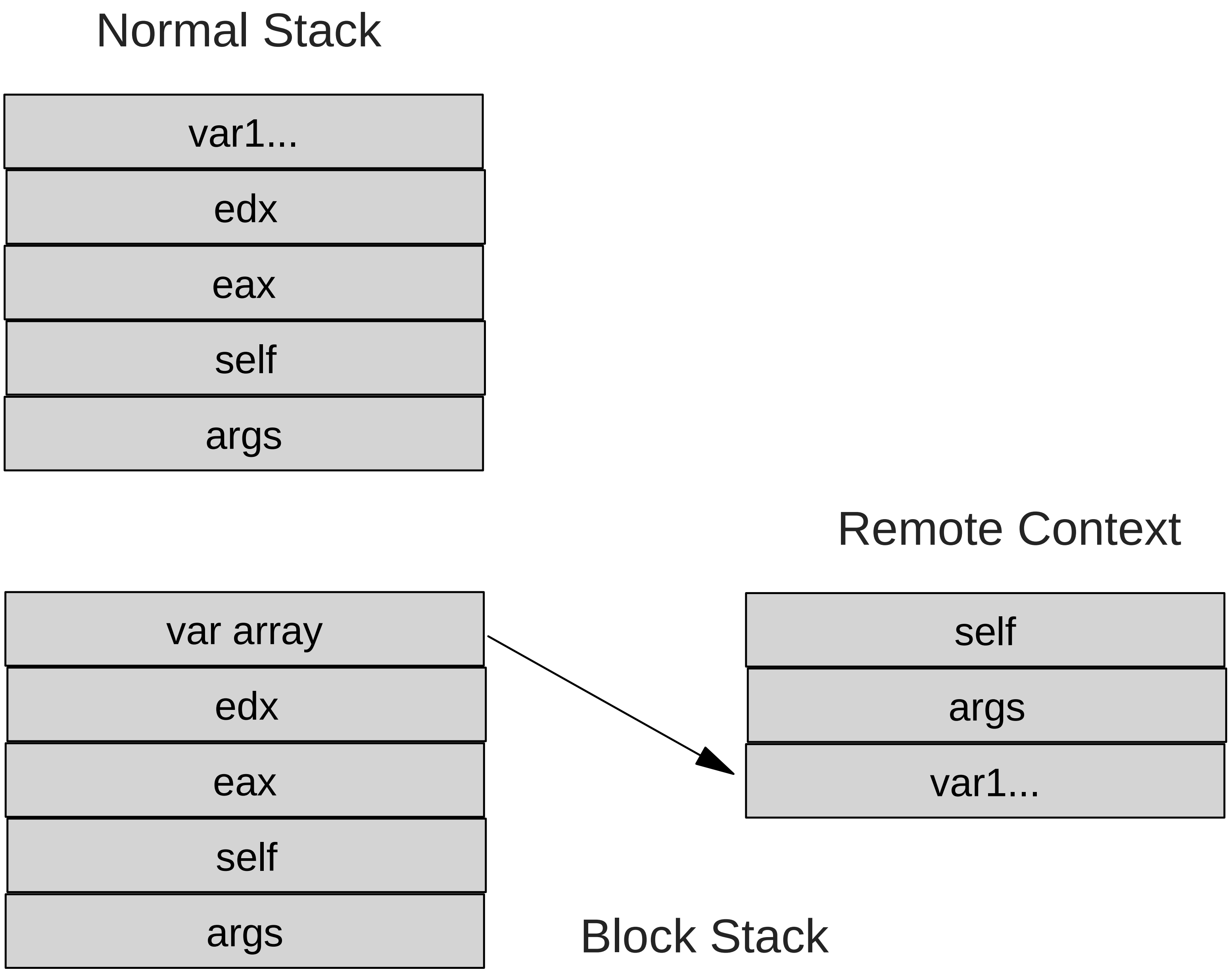
Block Code Example

```
handleMessage:aMessage
   "<modified:sys=GAKRE8CA,time=04/26/11 at 07:55:14 am>   "
        "Message is an RtSystemMessage"
    | dst hdlrs parameters channel|
    parameters := aMessage parameters.
    dst := aMessage destination.
    channel := (parameters at:1) asUpperCase.
    (dst isNil or:[dst = '00000000'])
        ifTrue:[" broadcasts look up by channel "
                " but drop if I am waiting for the response "
            hdlrs :=  handlers riDetectAll:[ :h | h key = channel].
            hdlrs isEmpty
              ifTrue:[
                Object allSubclasses do:[:c | c monitorsTopic:channel message:aMessage]].
            dst := ".
            handlers do:[ :a | a key = channel ifTrue:[(a value at:2)
                                              handleSystemMessage:aMessage]] ]
        ifFalse:[ " private so lookup by topic "
            handlers do:[ :a | a key = channel ifTrue:[(a value at:2)
                 handleSystemMessage:aMessage]]].
```

Return Code Example

```
includes: anObject
        "Answer true if the receiver contains an
         element equal to anObject, else answer false."
    self do: [ :element |
        anObject = element
            ifTrue: [^true]].
    ^false
```

Stack Var Structure



Normal Stack

var1...

edx

eax

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Remote Context

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var1...

var array

edx

eax

self

args

Block Stack

Primitives

- Along with bytecodes do all the work
- Written in Java with RtObject args
- Supports fallback to Smalltalk code
- Low level (math) and high level (string)
- Largest Java Code effort (1500 lines)

Primitive Code Example

```
at: anInteger
        "Answer the object in the receiver at index position
         anInteger.  If the receiver does not have indexed
         instance variables, or if anInteger is greater
         than the number of indexed instance variables,
         report an error."
    <primitive: 60>
    ^self primitiveFailed
```

```
  // prim 45
  static public RtObject primFLoatExp(RtObject rcvr) {
    // return exponential of the receiver
    double c=rcvr.getDoubleValue();
    return new RtObject(Math.exp(c));
  }
```

Constants/Literals

- In Smalltalk can be any object
- In Java are limited to primitives
- In reality are also limited in ST
  - primitives and arrays of primitives
  - Globals and Class Vars (use prim)
- Use Constant Methodhandle to create
  - name is serialized constant

Callsite management

- Need to invalidate on code changes
- Current approach is to drop all
- Also drop at 30K sites

FUTURE TOPICS

- Coroutines
- Debugger
- FFI
- Performance

FFI Code Example

```
allocSharedMem: pBaseAddress name: pszName size: ulSize flags: ulFlags
    <api: '#300' struct ulong ulong ulong ulong>
    ^self invalidArgument
```

Debugger

- Stack var inspection
- Hop step jump
- instances inspection
- Currently using JVMTI
  - slow
  - requires C code agent

Hanoi Code Example

```
testHanoiMove: numberOfDisks from: source to: dest temp: temp
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        numberOfDisks == 1 ifTrue: [^self].
        self
                testHanoiMove: numberOfDisks - 1 from: source to: temp temp: dest;
                testHanoiMove: numberOfDisks - 1 from: temp to: dest temp: source
```

```
public void testMoveLong(long numberOfDisks, long source, long  dest, long
temp) {
  if(numberOfDisks == 1L) return;
  testMoveLong(numberOfDisks-1L, source, temp, dest);
  testMoveLong(numberOfDisks-1L, temp, dest, source);
}
```

Performance for Hanoi 20

java prims	1.8 ms
smalltalk	3 ms
java boxed	4.7 ms
RtObjects	32 ms
Rtalk	65 ms