Squawk Java Virtual Machine Compiler Architecture

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Presentation Outline

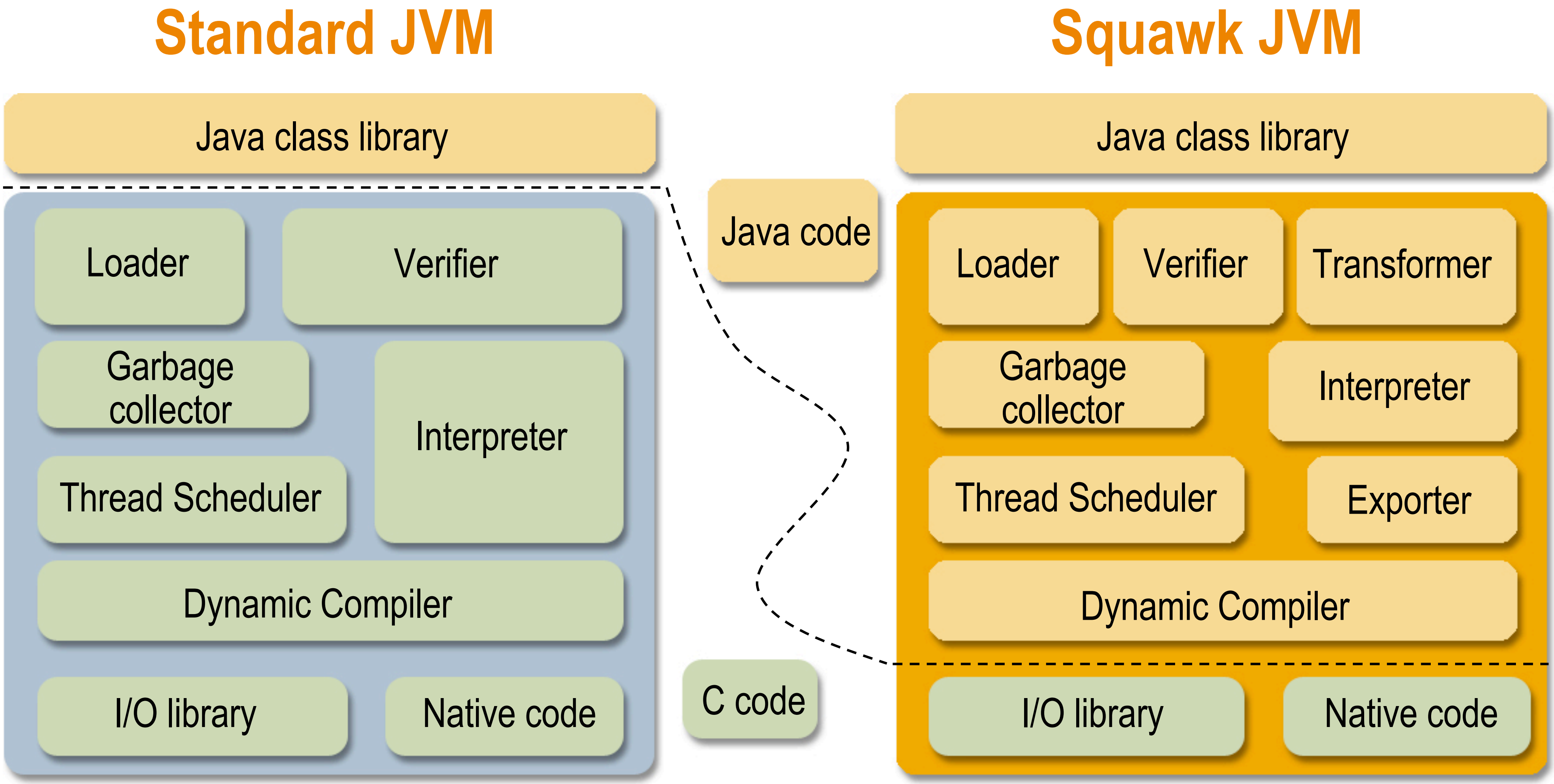
- What is Squawk?
- Standard JVM vs Squawk JVM
- Squawk architecture
- Compiler interface
- Multiple compilers - simple vs optimizing
- Execution of Squawk code
- Future work

What is Squawk?

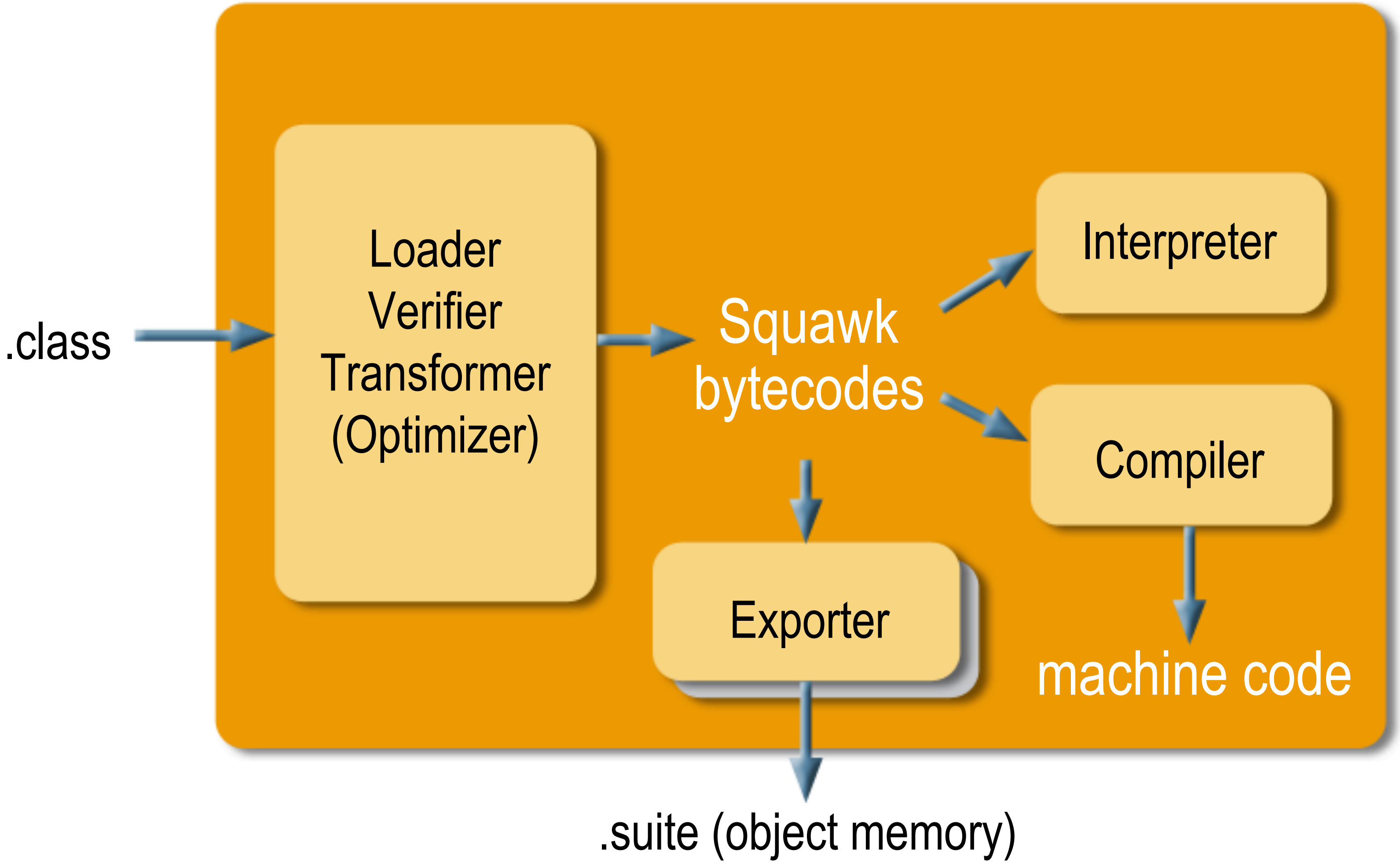
- Small, execute-in-place JVM
- Written in Java, not C
- Optimized for small devices
- Squawk architecture has an interpreter, compiler and jitter
- Current use: Sun Spot sensors platform
- Why write a JVM in Java?
  - Portability

- What performance can the Squawk JVM achieve?

Standard JVM vs Squawk JVM



The Squawk Architecture



Compiler Interface

- Stack-based, machine-independent instruction interface
- Allows multiple compiler implementations for Squawk
- Two types of compilers will be used by Squawk - simple and optimizing (collaborative research)

Squawk bytecode	Bytecode deconstructor	Compiler interface

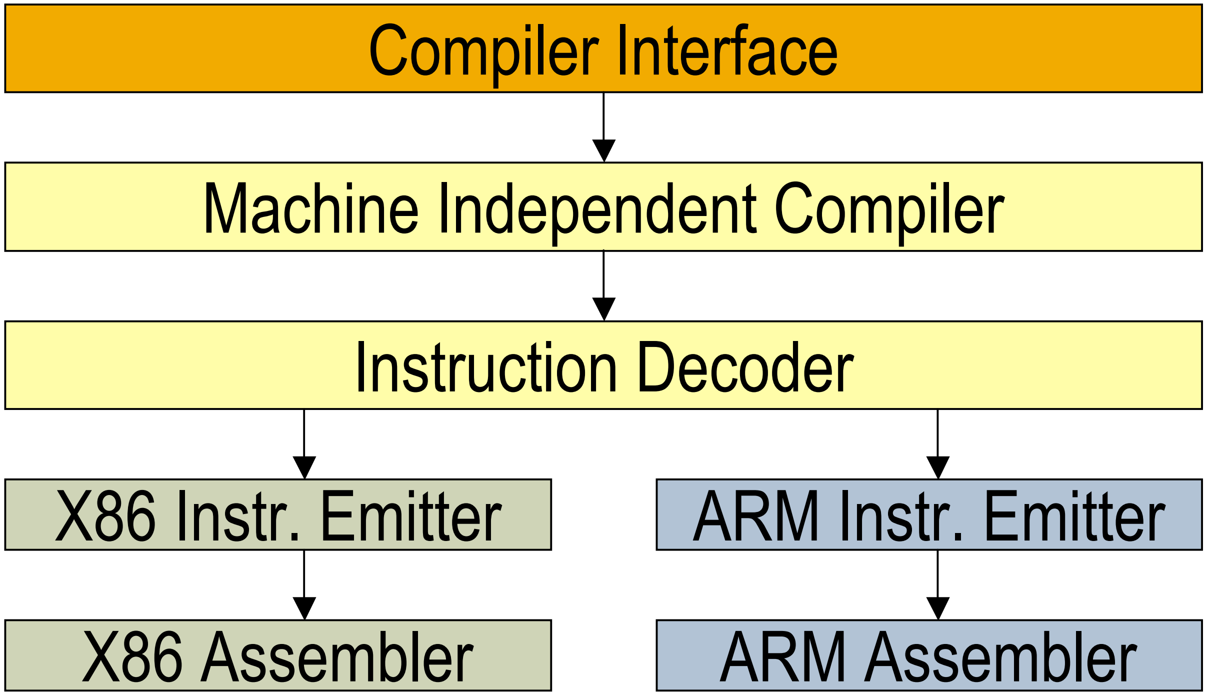
const_char 1004	→	c.literal(1004);
		c.push();

const_byte 32	→	c.literal(32);
		c.push();

ushr_i	→	c.pop(INT);
		c.pop(INT);
		c.ushr();
		c.push();

Simple Compiler

- Light-weight, single pass, non-optimizing compiler
- Designed for fast code compilation
- Currently supported back-ends - x86, ARM
- Will be used for jitting classes loaded at run time



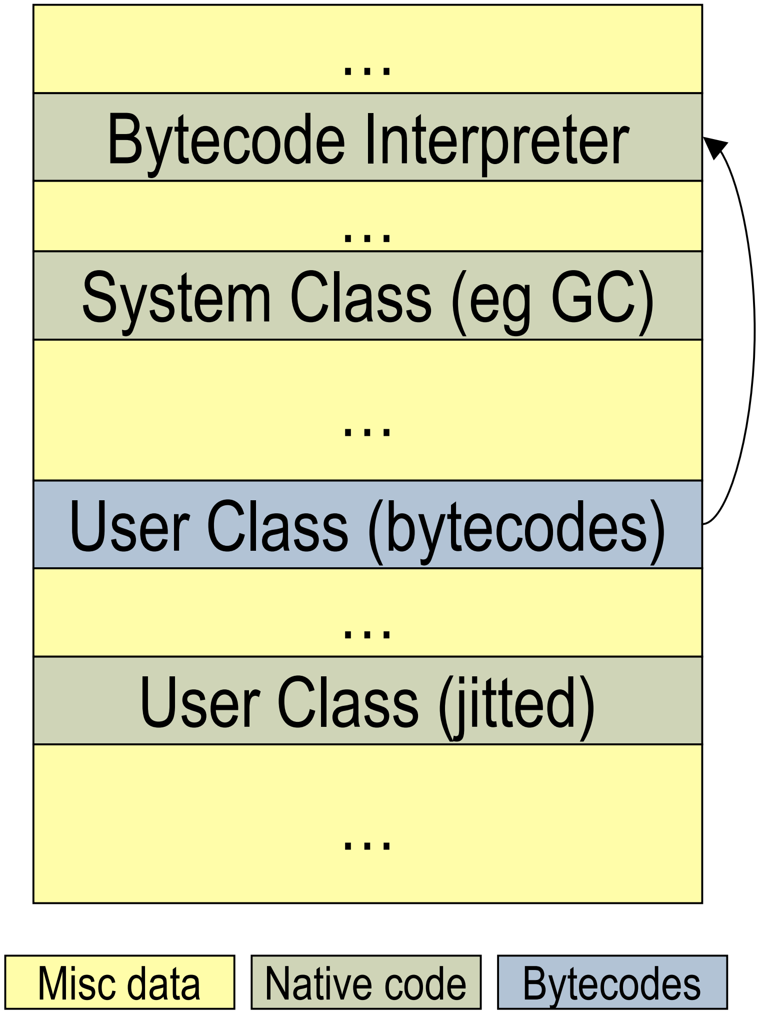
Optimizing Compiler

- Collaborative research with Usyd - Dr Bernhard Scholz
- Aim to test a new instruction selection technique - Partitioned Boolean Quadratic Programming as applied to general purpose machines
- Will be an optimizing compiler:
  - Constant folding
  - Dead code elimination
  - Partial Redundancy Elimination
  - Etc
- Will be used for:
  - Ahead-of-time compilation of system code (interpreter, libraries)
  - Potential jitting of frequently executed code for better performance

Squawk Bytecode Execution

- Currently using a Java interpreter macro-expanded and converted to C
- Future interpreter will be generated through the compiler interface
- Future bytecode execution modes:
  - > Interpreted
  - > Ahead-of-time compiled
  - > Just-in-time compiled
- Mix of bytecodes and compiled code in system memory

System Memory Layout



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Bytecode Interpreter

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System Class (eg GC)

...

User Class (bytecodes)

...

User Class (jitted)

...

Misc data | Native code | Bytecodes

Future Work

- Completion of Squawk compiler integration
  - Testing and debugging the interpreter
  - Compiling classes ahead-of-time
- Other compiler back-end implementations as needed
- Integration with Scholz's optimizing compiler framework
- Runtime profiling for better jitting
- Running benchmarks with standard JVMs vs Squawk using an optimizing compiler

Summary

- Squawk is a small, execute-in-place CLDC 1.0 compliant Java Virtual Machine
- Written in Java, not C
- Compiler interface for multiple compiler support
- Simple compiler for jitting classes at run time
- Optimizing compiler for ahead-of-time compilation
- Squawk code executed using mix of interpretation, ahead-of-time and just-in-time compilation
- Future work - compiler integration, benchmarking