IBM Java Just-In-Time Compiler

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Objectives

- Understanding the IBM Just In Time Compiler (JIT)
- The Mixed Mode Interpreter (MMI)
- Hints and Tips for isolating JIT problems

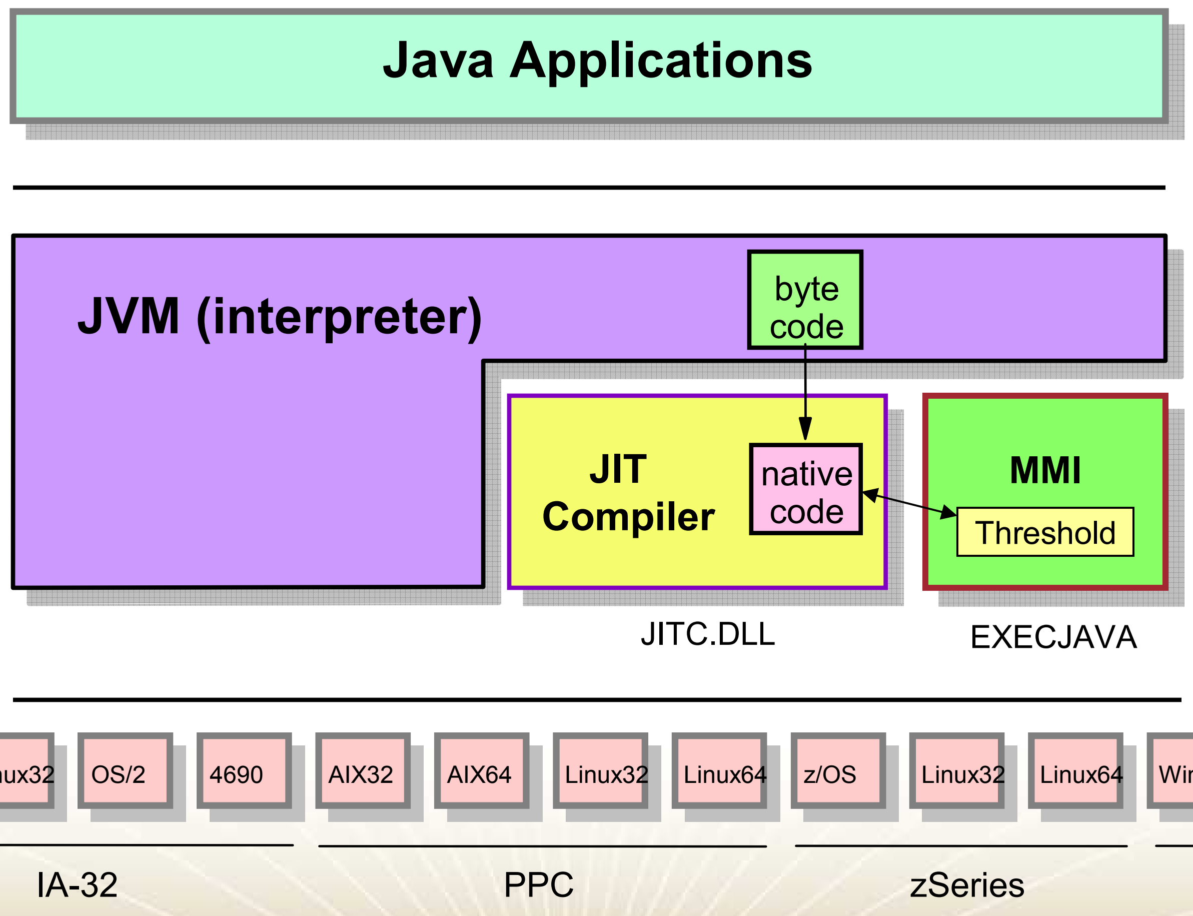
JIT Overview

- What does JIT compiler do?
  - It dynamically generates machine code for frequently used bytecode sequences in Java applications while they are running
- Purpose
  - To improve performance by optimizing machine code execution
- Value
  - Without JIT
    - JVM starts up rather quickly but runs slowly
  - With JIT
    - JVM starts up with slight delayed but improve overall performance
- IBM SDK includes the JIT component
- IBM JVM is running with JIT enabled by default
- A comprehensive set of runtime and debug options available

JIT Technology

- ❖ Problem Statement
  - The JVM interpreting bytecodes can’t match the performance of native applications with machine code
  - Need to improve the performance of JVM startup (interpreting/compiling) and Java applications over the life of JVM
- ❖ Solution
  - A compiler that will allow JVM to start reasonably quickly
  - JIT **code optimization** processes
  - Improve overall Java applications performance
- ❖ The Front-end
  - Method analysis and optimization is common to all platforms
- ❖ The Back-end
  - Machine code generation is z/OS specific
- ❖ The Other Half of JIT
  - The introduction of MMI (Mixed Mode Interpreter)

A Glance at JIT and MMI



Supported Platforms

Win32	Linux32	OS/2	4690	AIX32	AIX64	Linux32	Linux64	z/OS	Linux32	Linux64	Win64	Linux64
IA-32				PPC				zSeries			IA-64	

MMI Technology

- Purpose:
  - Designed to optimize the startup time and runtime performance of Java applications
  - Using a fast Assembler bytecode interpreter
- Value
  - MMI only JIT compile Java methods that are frequently used or execute over a long time
  - Infrequently used methods which may not be compiled at all
- Threshold value
  - Default threshold count 2000
  - When count = 0, the method is JIT compiled
  - MMI behavior can be changed by adjusting the threshold count value
  - Must evaluate and track results to achieve optimal performance level

The JIT & MMI Operating Modes

Operating Mode	JIT	MMI	Effects
Default	ON	ON	Interpret Method and JIT compile, JVM start reasonably quickly, improve overall application performance
Interpreter Disabled	ON	OFF	JIT compile all methods immediately, JVM starts slowly but performance is satisfactory
JIT Disabled	OFF	OFF	Always interpret methods, runs in interpretive mode only. The JVM starts up quickly, but runtime performance is poor

Note: When turning JIT off, the Interpreter does not invoke JIT translated code

Hints & Tips on Isolating JIT Problems

- Does it fail if JIT is disabled? export JAVA_COMPILER=
- Does it fail if MMI is disabled? java -Xcomp **...**
- Compilation Failures
  - Disable JIT and re-compile, if problem persist, not a JIT problem
  - Remember to re-enable JIT
  - Set IBM_MIXED_MODE_THRESHOLD=0 (Disabling MMI)
- Selectively Disabling JIT Based on Conditional Code Points
  - Investigate and carefully pick-n-choose JIT compile options
    - Narrowing down to a single option
  - Mitigate performance hit all at once
- Workarounds are far less intrusive than –Xint (no JIT)
- Skipping a method does not mean it doesn’t run – it just doesn’t get compiled
- Reducing opt level of a method has minimal impact
- Workarounds are designed to provide relief *while we work on a fix*

JIT Compile Option Groups

- JITC_COMPILEOPT=NMMI2JIT
  - MMI to JIT transfer process
- JITC_COMPILEOPT=NINLINING
  - Tells JIT not to inline code
- JITC_COMPILEOPT=NQOPTIMIZE
  - Disable all Quad optimizations
- JITC_COMPILEOPT=NALL
  - Generate native machine code without any of the optimizations (identify failing optimization by disabling all optimizations)
- JITC_COMPILEOPT=NOTHER
  - Uncategorized options
- JITC_COMPILEOPT=NGLOBAL
  - Not method-specific

Things You Want to Know About JIT

- ❖ You can not use non-IBM JIT with the IBM JVM
- ❖ JIT can not de-compile what is already JIT compiled code
- ❖ Do not replace the JIT that are packaged with the JVM
- ❖ You can set the JIT initial status only at JVM start-up time
- ❖ The JIT can be started up only at the same time as the JVM
- ❖ JIT is not part of JVM but it is loaded along with the JVM executables
- ❖ IBM continues to perfect the functions and features of JIT technology

Summary

- Tip: Avoid disabling JIT and/or MMI in a production environment unless it is absolutely necessary
- Tip: Follow “process of elimination” approach to isolate problems
- Tip: Use the JIT compile options, debug options
- Tip: Use the IBM JIT Diagnostic Guide for problem determination and rely on the IBM defect support staff for advice before turning off JIT
- Tip: If you require a quick startup for your applications and does not care much about runtime performance –
  Use the Xquickstart option

Note: http://www.ibm.com/developerworks/java/jdk/diagnosis/

- Verify JIT
  - java –version (either JIT enabled or JIT disabled)
- -Xint option disables the JIT Compiler
  - Java –Xint class
- Use binary reduction to narrow down to failing method (later methods are most suspect so start by skipping second half)
- Dynamic slip trap
  - JITC_DEBUGOPT=slip{class}{method(sig)}
- JIT can produce a limit file listing compilations:

```
java -Xjit:verbose,vlog=compiling.out MyClass my args
```