ADVANCED JAVA

Java Virtual Machine

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OUTLINE

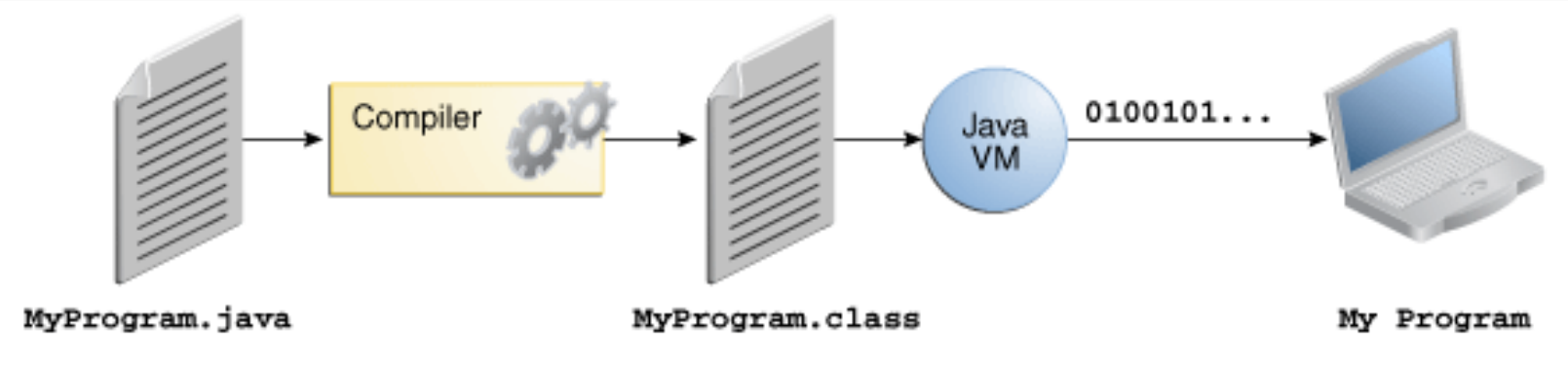
Java Technology Overview

JVM Tuning Options

Profiling and Other Utilities

JAVA TECHNOLOGY OVERVIEW

HOW JAVA PROGRAMS ARE EXECUTED?



Overview of Java Development Process (Oracle Docs)

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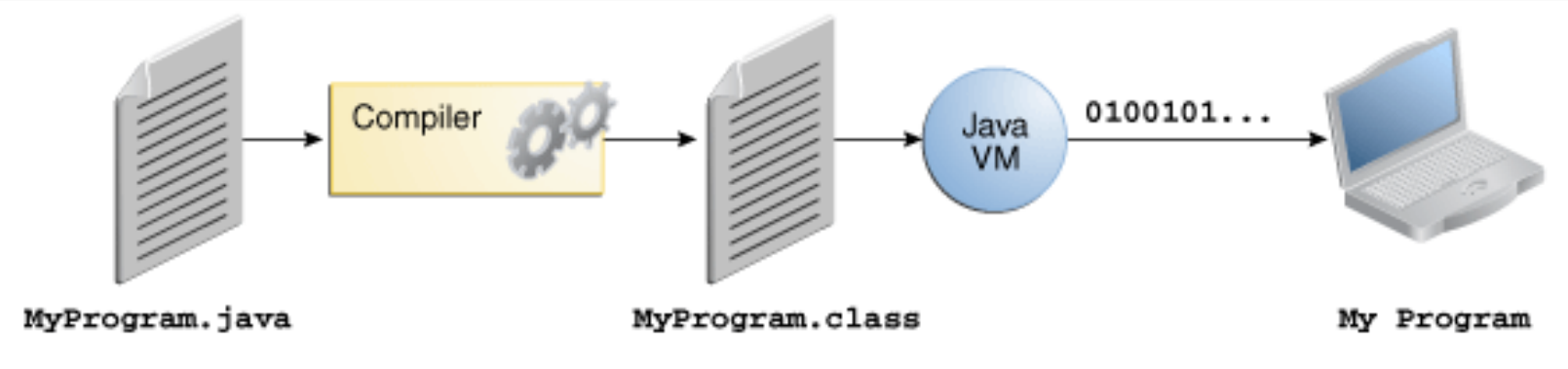

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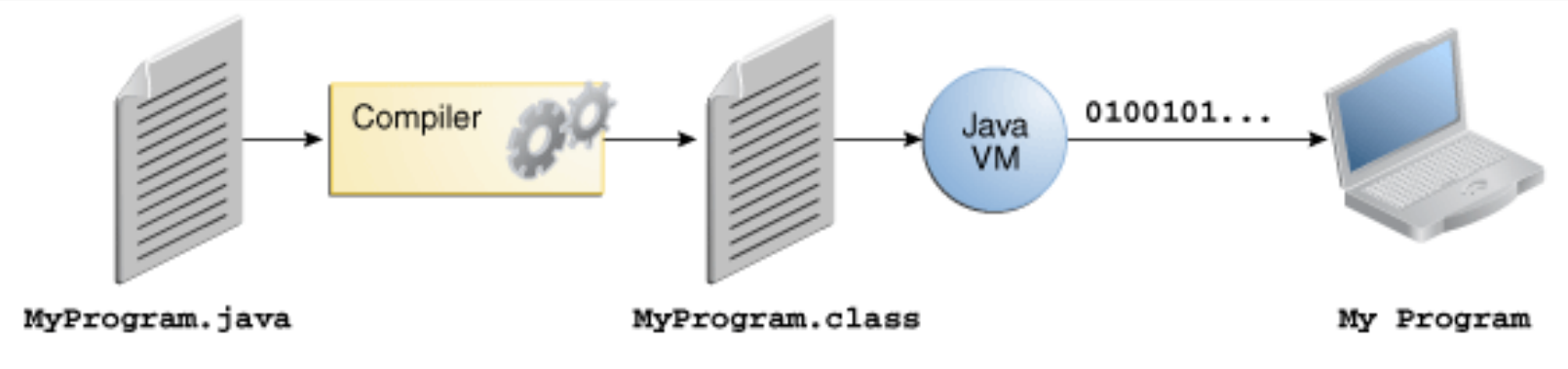

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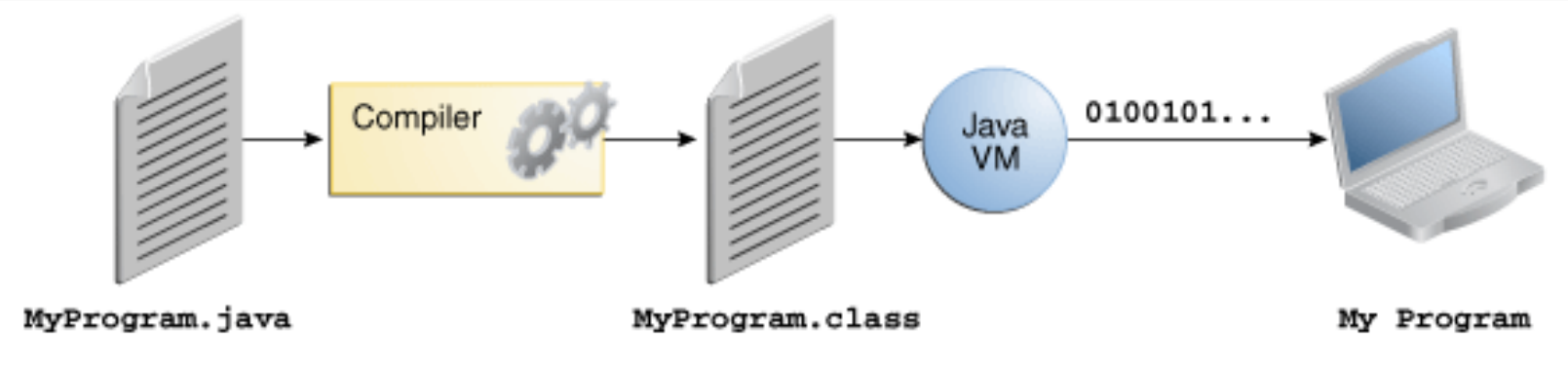

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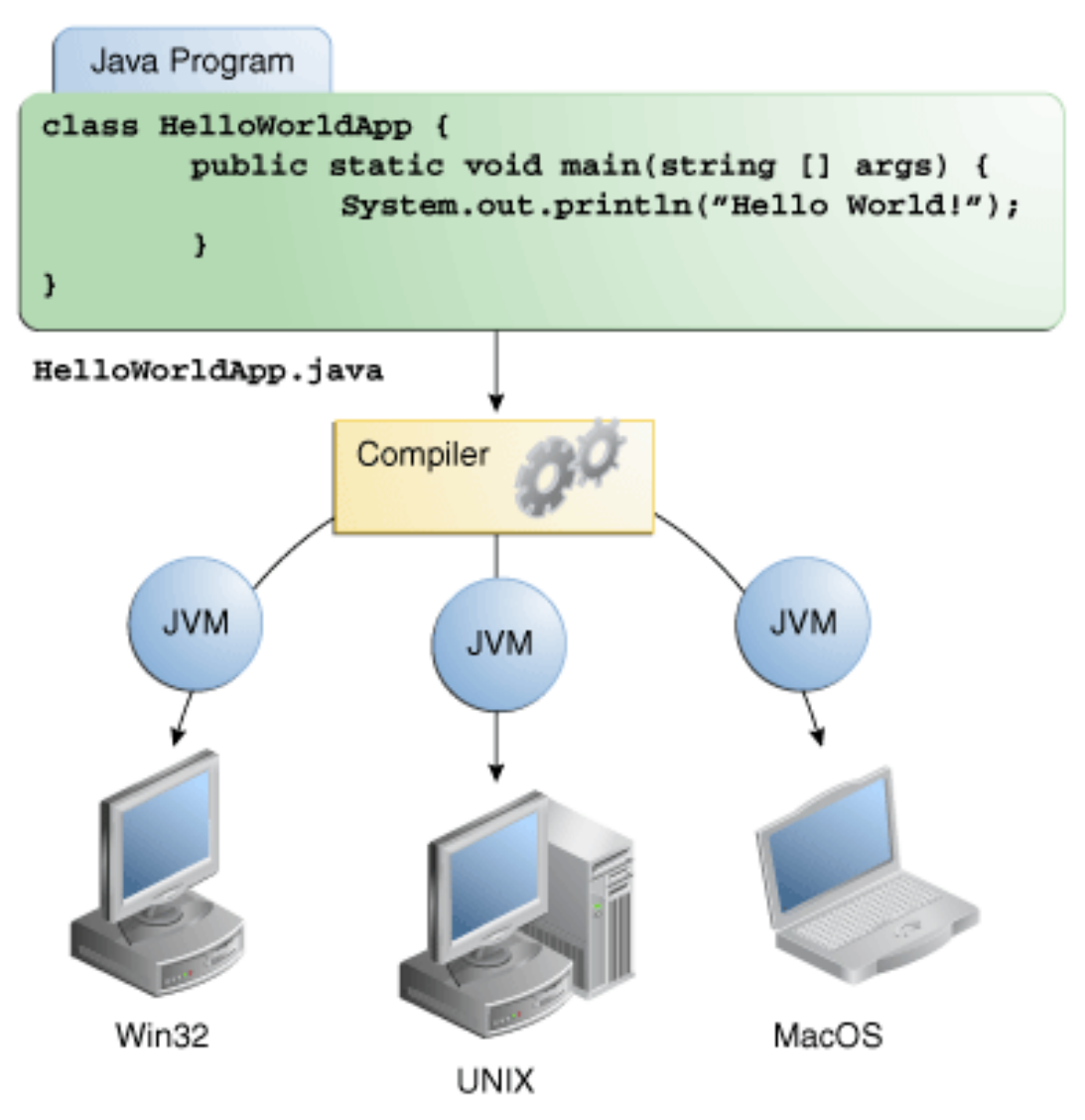
OVERVIEW OF JVM



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JVM and Bytecode

- Bytecodes
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- Java Virtual Machine
  - Abstract machine that can execute Java byte-code $\rightarrow$ Java software processor
  - JVM components
    1. Bytecode verifier
    2. Memory manager
    3. Execution engine (Interpreter/JIT compiler)

WHY USE A JVM?

Why do we need a JVM to `interpret` the `.class` file instead of compiling to machine code?

WHY USE A JVM?

1. Platform independence $\rightarrow$ Source and compiled code is independent of hardware and operating system platform
    - Compiled code is just dependent on the JVM platform
2. Allows distribution of binaries (`.class` files)
3. Compilation process is platform independent but compilers are not always
4. Compile once, run anywhere
5. Allows sand-boxing e.g., Applets
6. Allows instrumentation. Dynamic memory management.

Why use a JVM? (contd.)

7. Provides Extensibility
    - Any language that can compile down to bytecode can be interpreted (e.g., Scala, Kotlin)
8. Only JVM needs to be platform dependent. JVM writers can focus on efficient processing of bytecodes instead of the whole upper language stack
9. Has overheads. Various optimizations like JIT compilation, hardware processors supporting bytecodes

JVM TUNING OPTIONS

TUNING THE JVM

- JVM provides a tunable execution enviroment
- Various ways to affect performance of programs by tuning JVM
  1. Memory management (heap tuning and garbage collection)
  2. Code generation (e.g., control inlining of code)
  3. Configuration of enviroment variables using properties
  4. Usage of JVM hooks
- Use limited profiling support to understand program performance
- More than meets the eye (Use extreme care)

JVM TUNING OPTIONS

Meaning of the option prefix

- `-x` $\rightarrow$ non standard across different VM, subject to change without notice
- `-xx` $\rightarrow$ Non standard and not stable

For standard options see the reference pages for the platform

FEW COMMONLY USED GENERIC JVM TUNING OPTIONS

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`-Xint`	Turns off compilation to native code, only interpretation

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`-Xss`	Sets the stack size, `-Xss4096k` ← this value will be multiplied by the number of threads

GARBAGE COLLECTOR TUNING OPTIONS

- Tuning garbage collection is not only about setting parameters but understanding the process
- Generational garbage collection
- Can choose the type of garbage collector
- Blocking versus Incremental versus Concurrent

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`-XX:+UseParallelGC`	Enables the use of the parallel scavenge garbage collector (also known as the throughput collector)
`-XX:+UseParallelOldGC`	Enables the use of the parallel garbage collector for full GCs (heavy duty, long pauses)

Few garbage collector tuning options (contd.)

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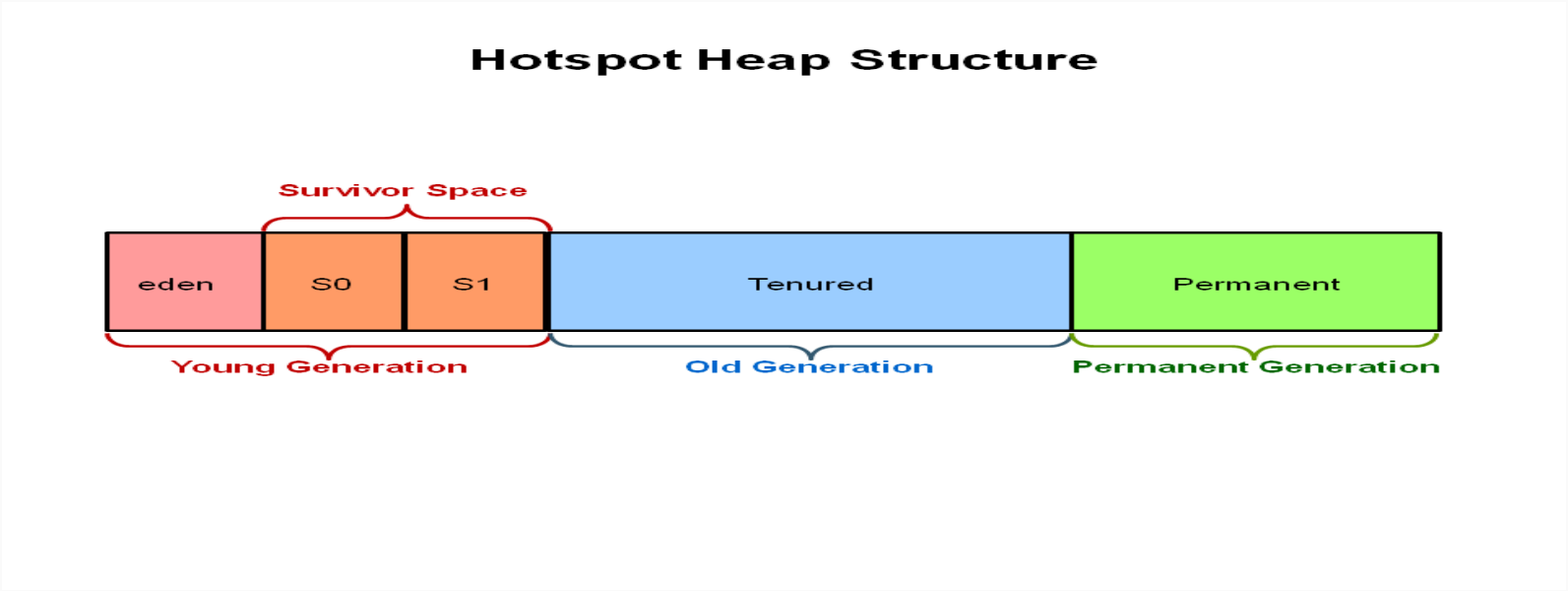
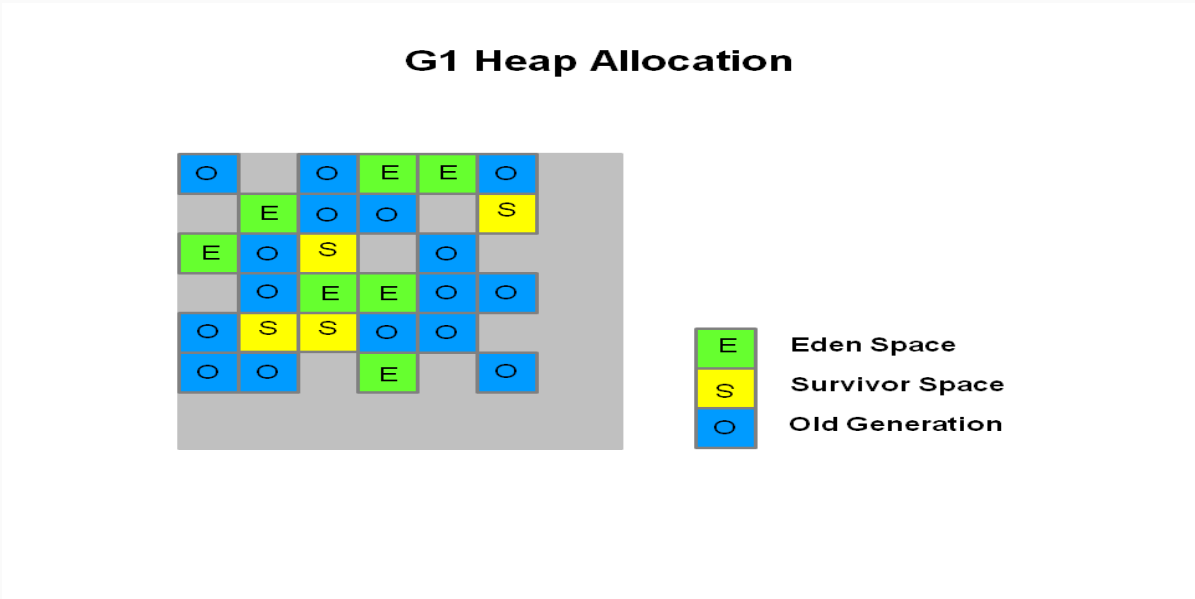
Use these options only if you understand the process and its impact

HEAP STRUCTURES FOR GARBAGE COLLECTION





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`-XX:NewRatio`	Ratio of old/new generations

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`-XX:SurviverRatio`	Ratio of eden/survivor space

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Lots more !! Use these options only if you understand them

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`-XX:LoopUnrollLimit=n`	Unrolls loops with a compiler internal representation node count of less than n

CONFIGURING PROPERTIES

- Properties passed using `-Dproperty=p`
- Retrieve the property value using `System.getProperty(p)`
- Some property keys are already predefined from which certain environment values can be retrieved
- Use `.properties` file instead of long list of properties in command line

PROFILING AND OTHER UTILITIES

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  - Use a profiler to understand your code better
- `-Xprof` $\rightarrow$ option for some basic profiling

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- JVM Monitor has nice integration with Eclipse
- Most full featured profilers are commercial

1. jdb - Java debugger
2. javap - Java disassembler
3. javadoc - Java document generator