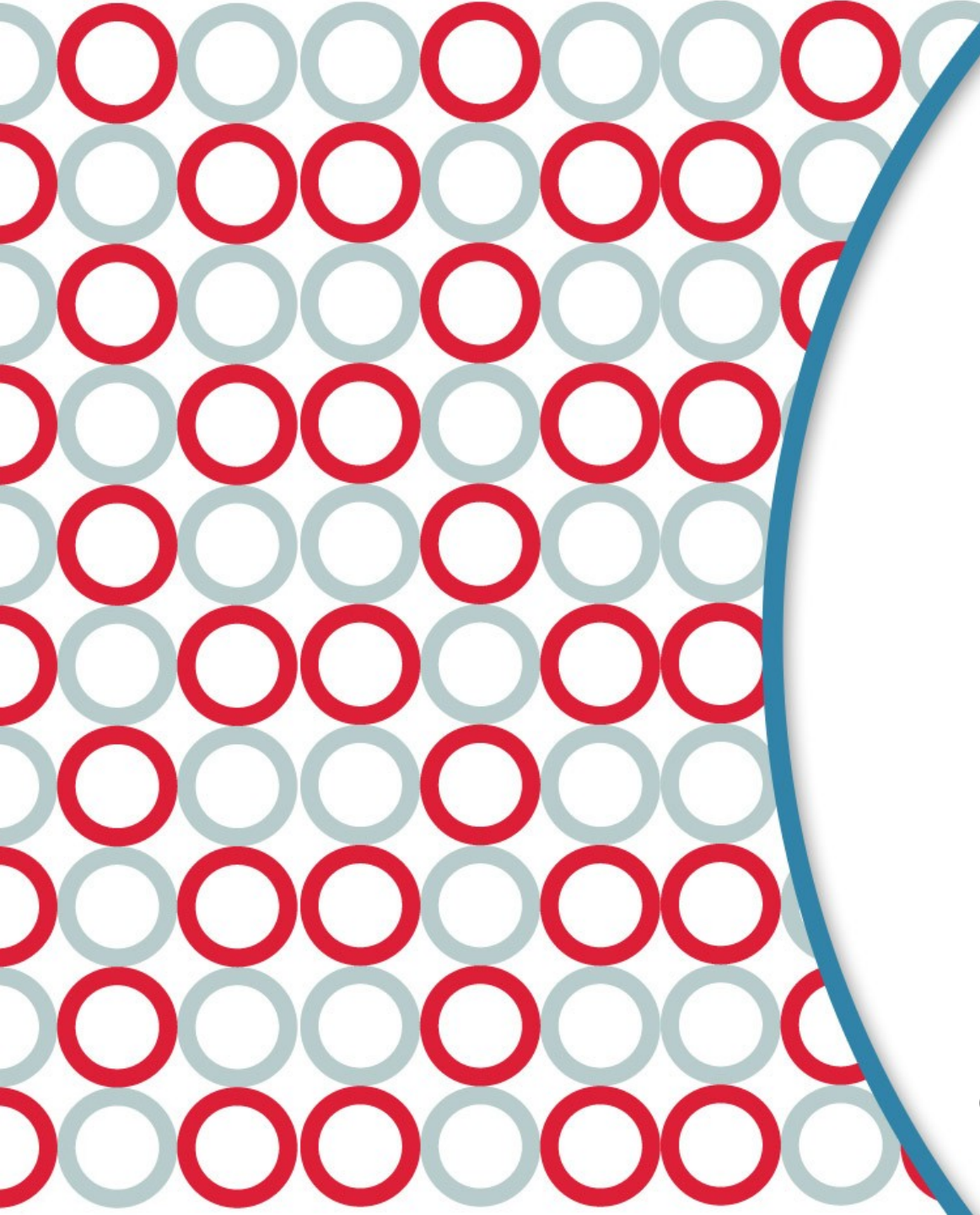

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Java & QA Automation

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http://iproduct.org

About me

Trayan Iliev

– CEO of IPT – Intellectual Products & Technologies

– Oracle® certified programmer 15+ Y

– end-to-end reactive fullstack apps with Java, ES6/7, TypeScript, Angular, React and Vue.js

– 12+ years IT trainer

– Voxxed Days, jPrime, jProfessionals, BGOUG, BGJUG, DEV.BG speaker

– Organizer RoboLearn hackathons and IoT enthusiast

What Will You Learn?

1. Java - 14h
2. Junit and TestNG 2x3h = 6h
3. Selenium WebDriver 2x3h = 6h
4. CI/CD DevOps best practices 2h
5. Testing Web APIs - 2h

Course Schedule

- Block 1: 17:30 – 19:15
- Pause: 19:15 – 19:30
- Block 2: 19:30 – 20:45

Where to Find the Code?

Java & QA Automation projects and examples are available @ GitHub:

https://github.com/iproduct/java-qa-automation

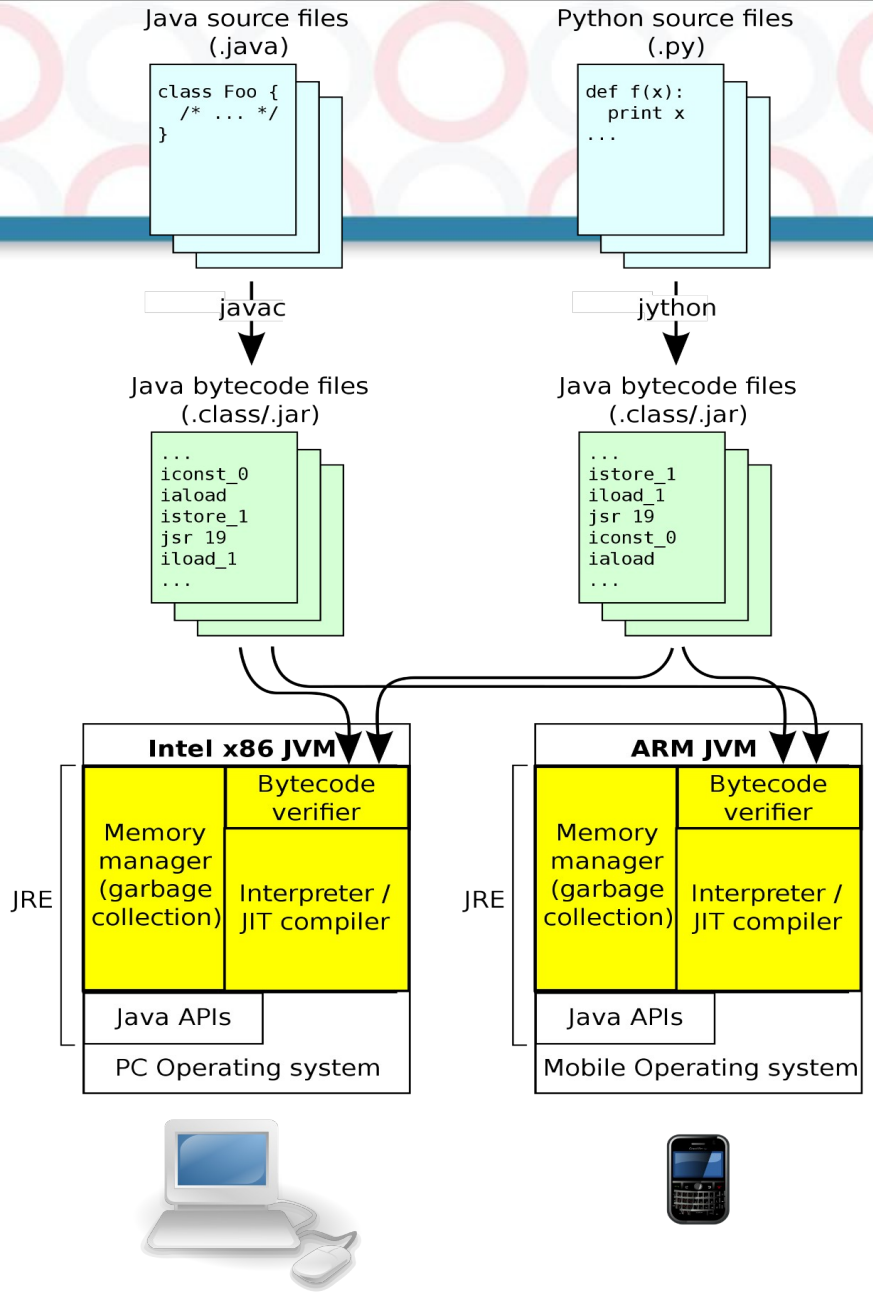
Key Features of Java Language

- Single base hierarchy - inheritance from only one parent class, with the possibility of implementation of multiple interfaces
- Garbage Collector – portability and platform independence, fewer errors
- Secure Code – separation of business logic from the error handling and exceptions
- Multithreading - easy realization of parallel processing
- Persistence – Java Database Connectivity (JDBC) and Java Persistence API (JPA)

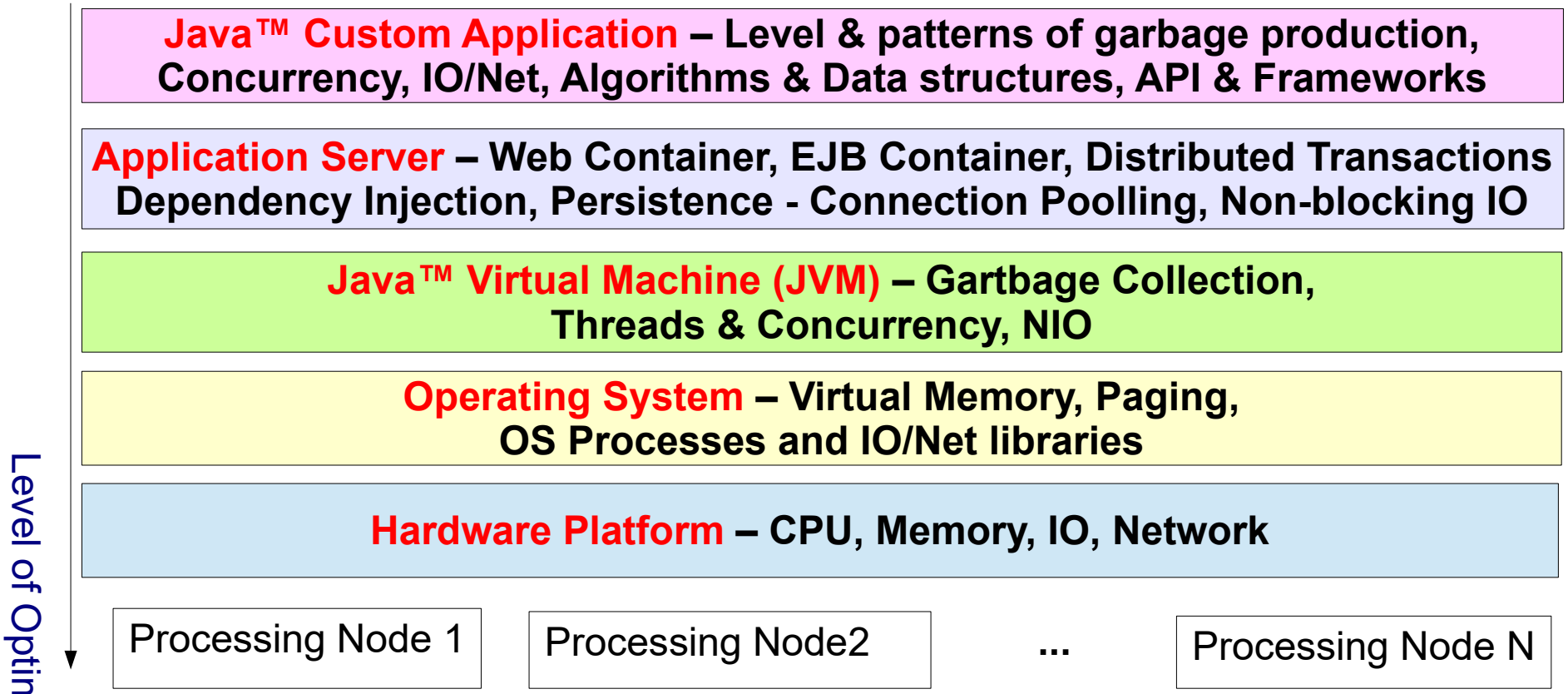
Integrated Development Environments for Java Applications

- Java™ development environment types:
- JavaSE, JavaEE, JavaME, JavaFX
- JavaSE: Java Development Kit (JDK) and Java Runtime Environment (JRE)
- Java™ compiler - javac
- Java Virtual Machine (JVM) - java
- Sourse code → Byte code
- Installing JDK 8+
- Compile and run programs from the command line
- IDEs: IntelliJ IDEA, Eclipse

Java Virtual Machine (JVM)



Java Application Stack



Classes, Objects and References

- Class - set of objects that share a common structure, behaviour and possible links to objects of other classes = objects type
  - ✓ structure = attributes, properties, member variables
  - ✓ behaviour = methods, operations, member functions, messages
  - ✓ relations between classes: association, inheritance, aggregation, composition – modeled as attributes (references to objects from the connected class)
- Objects are instances of the class, which is their addition:
  - ✓ own state
  - ✓ unique identifier = reference pointing towards object
-

Object (Reference) Data Types

- Creating a class (a new data type)

```
class MyClass { /* attributes and methods of the class */ }
```

- Create an object (instance) from the class MyClass :

```
MyClass myObject = new MyClass();
```

- Declaration and initialization of attributes:

```
class Person {
        String name = “Anonimous”;
        int age;
}
```

- Access to attribute: `Person p1 = new Person();`

```
p1.name = “Ivan Petrov”;        p1.age = 28;
```

Creating Objects

- Class String – modeling string of characters:

– declaration:

```
String s;
```

– initialization (on separate line):

```
s = new String("Hello Java World");
```

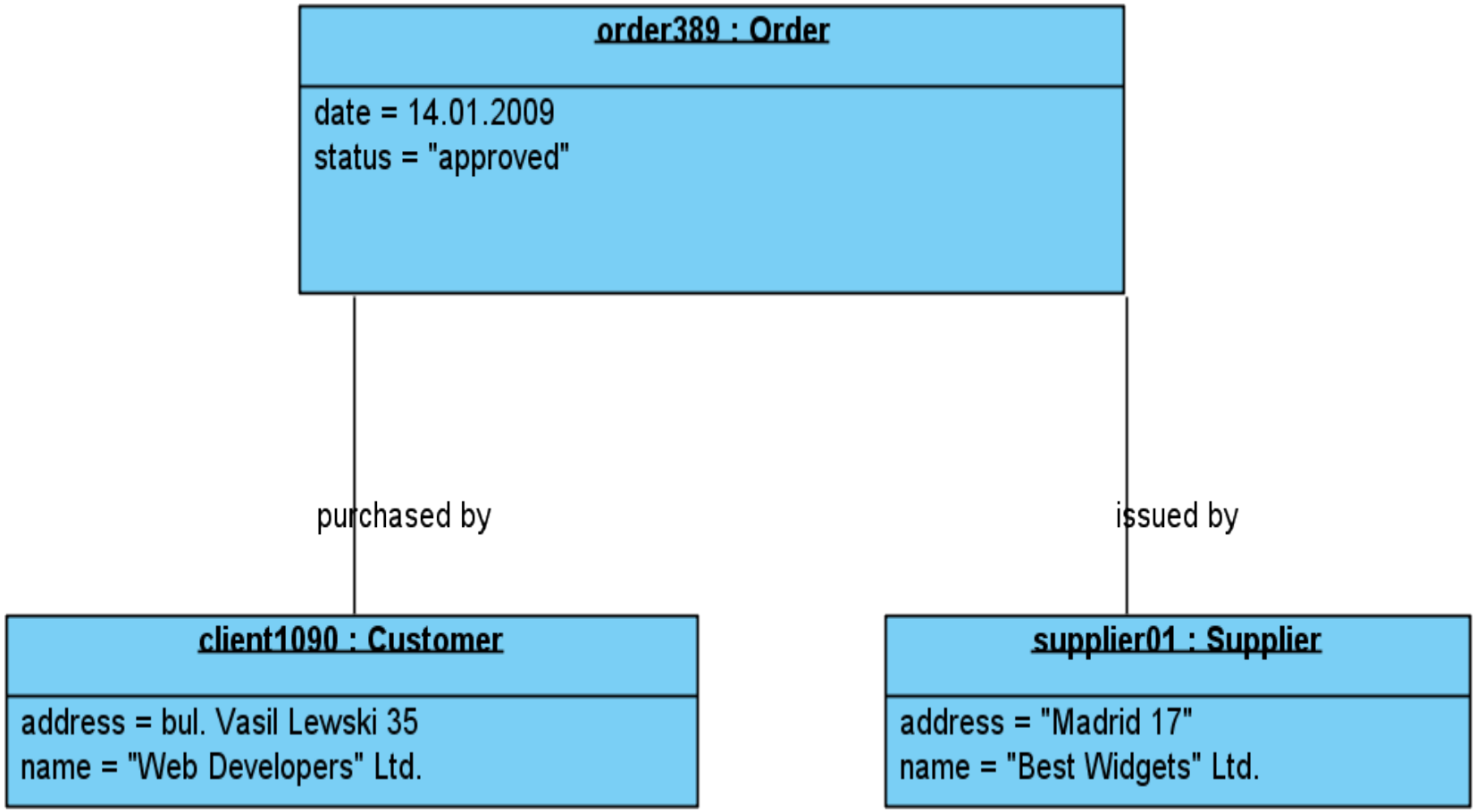
– declaration + initialization:

```
String s = new String("Hello Java World");
```

– declaration + initialization (shorter form, applies only to the class String):

```
String s = "Hello Java World";
```

Object Diagram



Packages and Access Specifiers

- Packages and directories
- Importing packages – import
- Access specifiers
  - **public**
  - **private**
  - **protected**
  - Friendly access – by default within the package

Primitive and Object Data Types

- Primitive data types, object wrapper types and default values for attributes of primitive type
  - boolean --> Boolean false
  - char --> Character '\u0000'
  - byte --> Byte (byte) 0
  - short --> Short (short) 0
  - int --> Integer 0
  - long --> Long 0L
  - float --> Float 0.0F
  - double --> Double 0.0D
  - void --> Void

❖ BigInteger and BigDecimal - higher-precision numbers

Primitive Type Literals

- in decimal notation:
  int: 145, 2147483647, -2147483648
  long: 145L, -1l, 92233720368547758O7L
  float: 145F, -1f, 42E-12F, 42e12f
  double: 145D, -1d, 42E-12D, 42e12d
- in hexadecimal notation: 0x7ff, 0x7FF, 0X7ff, 0X7FF
- in octal notation: 0177
- in binary notation: 0b11100101, 0B11100101

Object (Reference) Data Types

- Initialization with default values
- Value of uninitialized reference = null
- Declaring class methods

```
class Person {
    String name;
    int age;
    String changeNameAndAge (String aName, int anAge) {
        name = aName;
        age = anAge;
        return “Name: “ + name + “Age: “ + age;
    }
}
```

Method Name

Arguments

Return Type

Method Body

Returning Value

Object Constructors in Java

- Initialization of objects with constructors
- Overloading of constructors and other methods
- Default constructors
- Reference to the current object – **this**

Objects Initialization. Array initialization

- Initialization in declaration
- Initialization in constructor
- „Lazy“ initialization
- Initialization of static class members
- One-dimensional and multi-dimensional arrays
- Array initialization

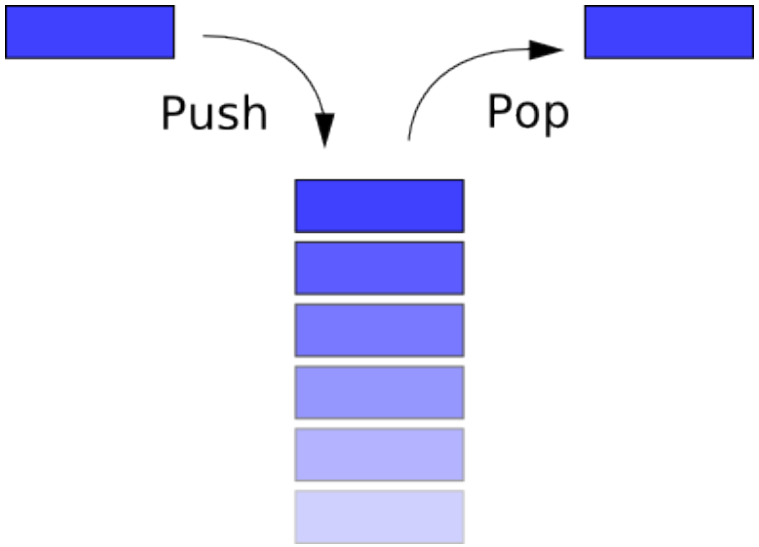
Memory Types

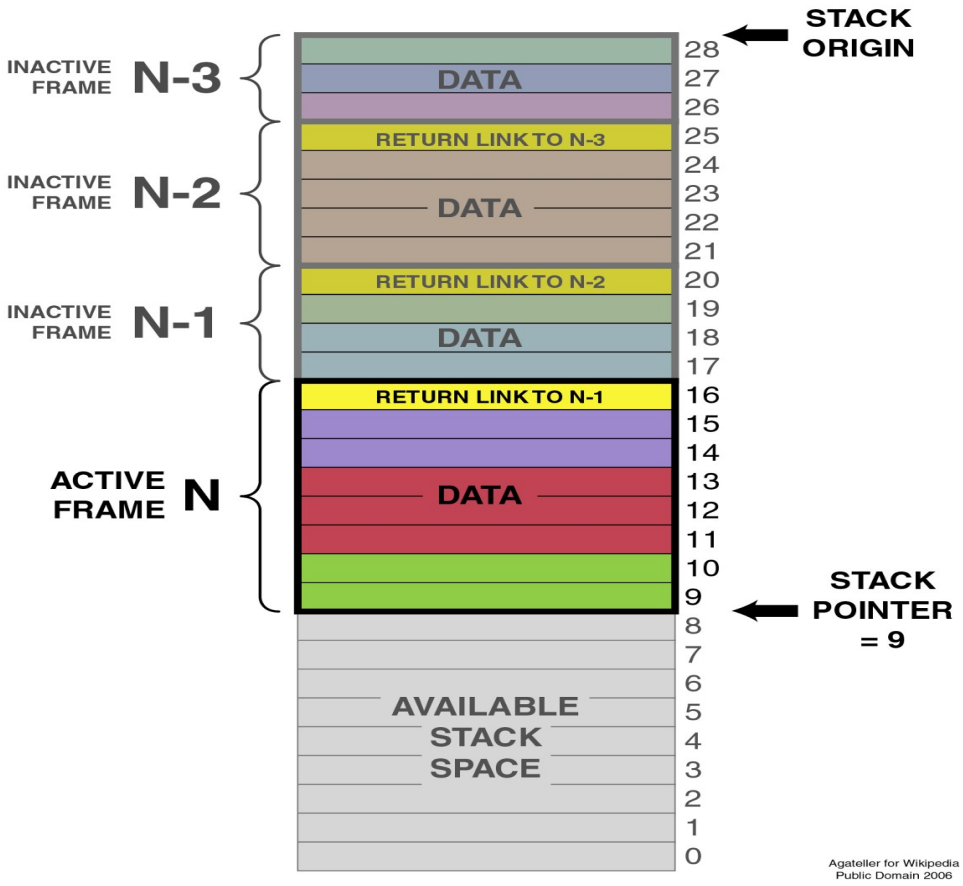
- Register memory - CPU registers, fast, small numbers stored operand instructions just before treatment
- Program Stack = Last In, First Out (LIFO) – Keep primitive data types and references to objects during program execution
- Dynamically allocated memory – Heap – can store different sized objects for different periods of time, can create new objects dynamically and to be released – Garbage Collector
  - Young generation – objects that exist for short period
  - Old generation – objects that exist longer
  - Permanent Generation = class definitions.

Java 8+ Metaspace

- Constant storage, non-RAM storage (external memory)

Program Stack





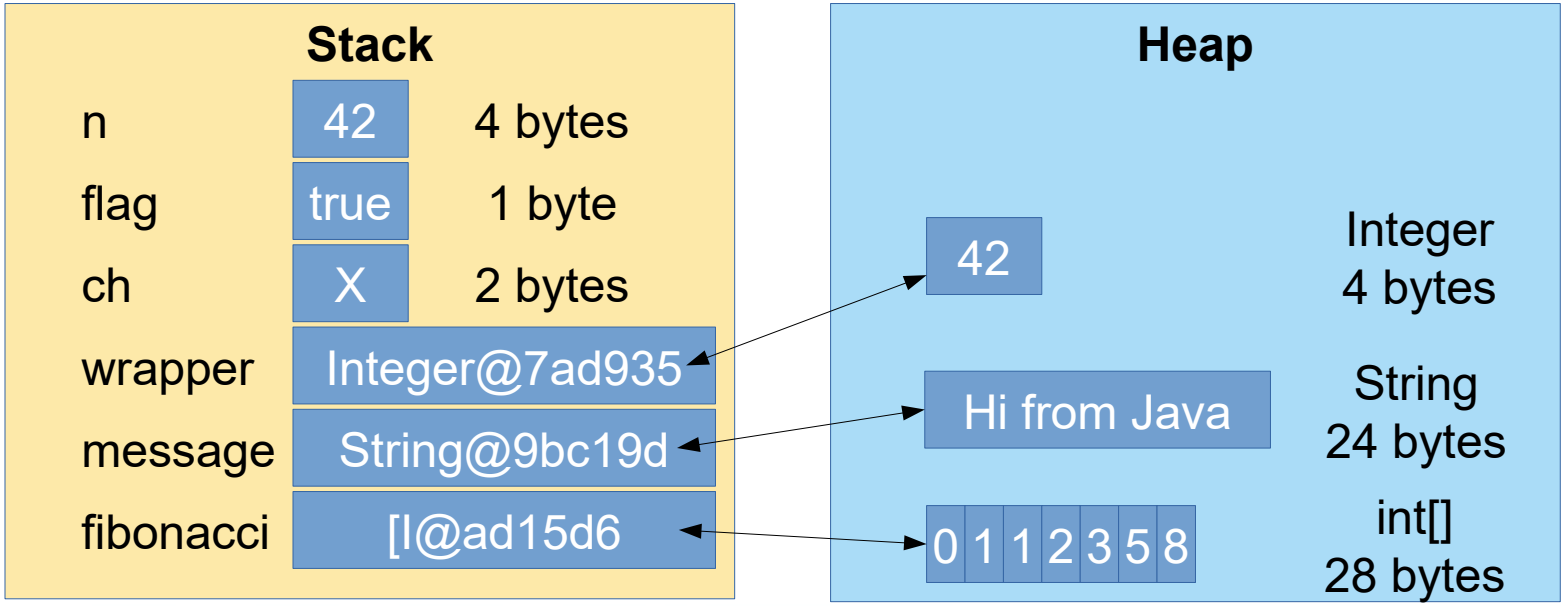
Source: http://en.wikipedia.org/wiki/File:ProgramCallStack2.png

C:\Windows\system32\cmd.exe

```
c:\CourseAdvancedJavaVerint\Temp>jstack 1612
2015-07-16 15:52:18
Full thread dump Java HotSpot(TM) 64-Bit Server VM (25.45-b02 mixed mode):

"DestroyJavaVM" #21 prio=5 os_prio=0 tid=0x00000000024b8000 nid=0x1f04 waiting on condition [0x0000000000000000]
   java.lang.Thread.State: RUNNABLE

"Thread-9" #20 prio=5 os_prio=0 tid=0x000000000bea7000 nid=0x2348 waiting for monitor entry [0x000000000d14f000]
   java.lang.Thread.State: BLOCKED (on object monitor)
        at simpletest.TwoThreadsSynchronizedCounter.lambda$0(TwoThreadsSynchronizedCounter.java:14)
        - waiting to lock <0x00000000d5e660a0> (a java.lang.Object)
        at simpletest.TwoThreadsSynchronizedCounter$$Lambda$1/424058530.run(Unknown Source)
        at java.lang.Thread.run(Thread.java:745)

"Thread-8" #19 prio=5 os_prio=0 tid=0x000000000bea5800 nid=0x6ac waiting for monitor entry [0x000000000ca2e000]
   java.lang.Thread.State: BLOCKED (on object monitor)
        at simpletest.TwoThreadsSynchronizedCounter.lambda$0(TwoThreadsSynchronizedCounter.java:14)
        - waiting to lock <0x00000000d5e660a0> (a java.lang.Object)
        at simpletest.TwoThreadsSynchronizedCounter$$Lambda$1/424058530.run(Unknown Source)
        at java.lang.Thread.run(Thread.java:745)

"Thread-7" #18 prio=5 os_prio=0 tid=0x000000000bea5000 nid=0x1ffc waiting for monitor entry [0x000000000cfcf000]
   java.lang.Thread.State: BLOCKED (on object monitor)
        at simpletest.TwoThreadsSynchronizedCounter.lambda$0(TwoThreadsSynchronizedCounter.java:14)
        - waiting to lock <0x00000000d5e660a0> (a java.lang.Object)
        at simpletest.TwoThreadsSynchronizedCounter$$Lambda$1/424058530.run(Unknown Source)
        at java.lang.Thread.run(Thread.java:745)

"Thread-6" #17 prio=5 os_prio=0 tid=0x000000000bea2000 nid=0x40c waiting for monitor entry [0x000000000cd5f000]
   java.lang.Thread.State: BLOCKED (on object monitor)
        at simpletest.TwoThreadsSynchronizedCounter.lambda$0(TwoThreadsSynchronizedCounter.java:14)
        - waiting to lock <0x00000000d5e660a0> (a java.lang.Object)
        at simpletest.TwoThreadsSynchronizedCounter$$Lambda$1/424058530.run(Unknown Source)
        at java.lang.Thread.run(Thread.java:745)

"Thread-5" #16 prio=5 os_prio=0 tid=0x000000000bea0800 nid=0x1708 waiting for monitor entry [0x000000000ceae000]
   java.lang.Thread.State: BLOCKED (on object monitor)
        at simpletest.TwoThreadsSynchronizedCounter.lambda$0(TwoThreadsSynchronizedCounter.java:14)
        - waiting to lock <0x00000000d5e660a0> (a java.lang.Object)
        at simpletest.TwoThreadsSynchronizedCounter$$Lambda$1/424058530.run(Unknown Source)
        at java.lang.Thread.run(Thread.java:745)

"Thread-4" #15 prio=5 os_prio=0 tid=0x000000000be9d000 nid=0xc0c waiting for monitor entry [0x000000000c7df000]
   java.lang.Thread.State: BLOCKED (on object monitor)
        at simpletest.TwoThreadsSynchronizedCounter.lambda$0(TwoThreadsSynchronizedCounter.java:14)
        - waiting to lock <0x00000000d5e660a0> (a java.lang.Object)
        at simpletest.TwoThreadsSynchronizedCounter$$Lambda$1/424058530.run(Unknown Source)
        at java.lang.Thread.run(Thread.java:745)

"Thread-3" #14 prio=5 os_prio=0 tid=0x000000000be9c800 nid=0x2394 waiting for monitor entry [0x000000000cc2f000]
   java.lang.Thread.State: BLOCKED (on object monitor)
```

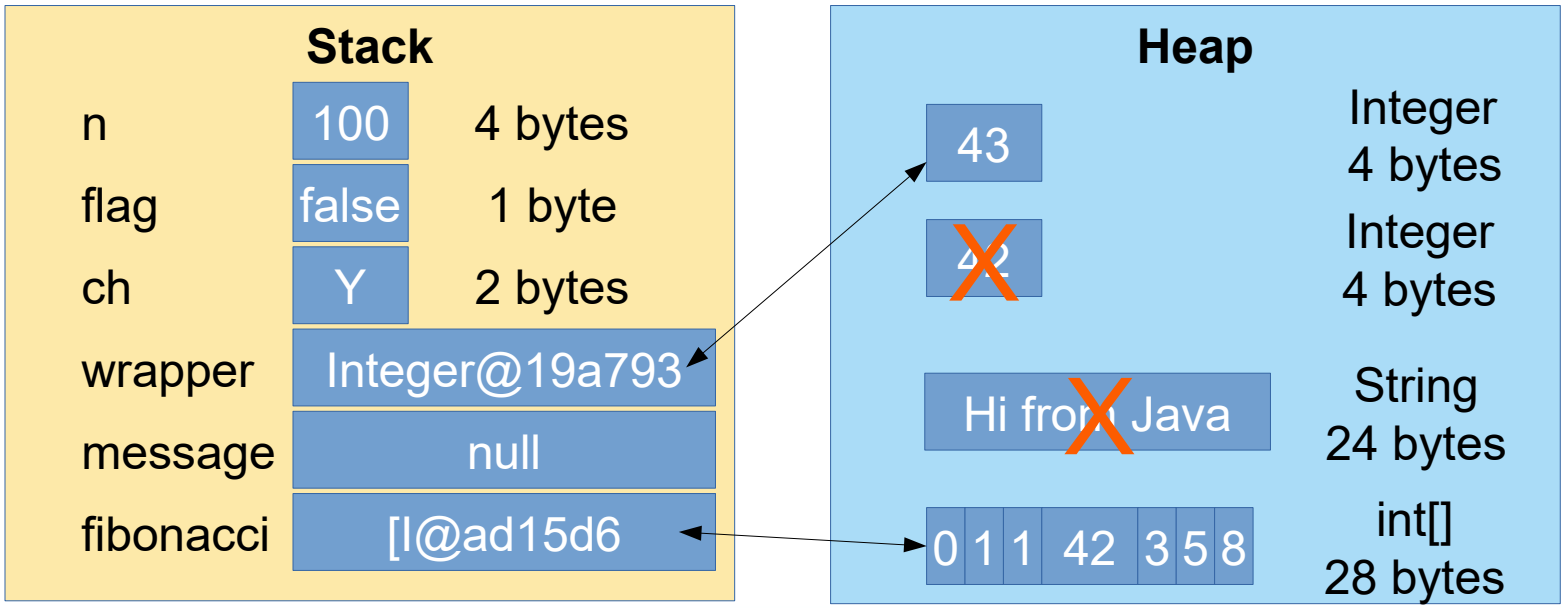
Stack and Heap (Quick Review)

```
int n = 42;
boolean flag = true;
char ch = 'X';
Integer wrapper = n;
String message = "Hi from Java!";
int[] fibonacci = { 0, 1, 1, 2, 3, 5, 8 };
```



Stack and Heap (Quick Review)

```
n = 100;
flag = !flag;
h = ++ch;
wrapper = ++wrapper;
message = null;
fibonacci[3] = 42;
```



Variable Scopes

```
public class VarScopes {
    static int s1 = 25;
    int i1 = 350;
    public static void main(String[] args) {
      if(s1 > 10){
          int a = 42;
          // Only a available
         {
             int b = 108;// Both a & b are available
         }
          // Only a available, b is out of scope
      }
      // a & b are out of scope
   }
}
```

Operators in Java - I

- Assignment operator
- Mathematical operators
- Relational operators
- Logical operators
- Bitwise operators
- String operators
- Operators for type conversion
- Priorities of operators

Operators in Java - II

- Each operator has priority and associativity - for example, + and – have a lower priority from * and /
- The priority can be set clearly using brackets (and) - for example (y – 1) / (2 + x)
- According associativity operators are left-associative, right-associative and non-associative: For example:
  x + y + z => (x + y) + z, because the operator + is left-associative
- if it was right associative, the result would be
  x + (y + z)

Operators in Java - III

- Assignment operator: **=**
  - is not symmetrical – i.e. **x = 42** is OK, **42 = x** is NOT
  - to the left always stands a variable of a certain type, and to the right an expression from the same type or type, which can be automatically converted to present

- Mathematical operators:
  - with one argument (unary): **-, ++, --**
  - with two arguments (binary): **+, -, *, /, %** (remainder)

- Combined: **+=, -=, *=, /=, %=**

For example: **a += 2** <=> **a = a + 2**

Send Arguments by Reference or by Value

- Formal and actual arguments - Example:

Static method - no **this**

Formal Argument
- copies the actual value

```
public static void incrementAgeBy10(Person p){
    p.age = p.age + 10;
}

Person p2 = new Person(23434345435L, "Petar Georgiev",
"Plovdiv", 39);
incrementAgeBy10(p2);
System.out.println(p2);
```

Actual Argument

Send Arguments by Reference and Value

- Case A: When the argument is a primitive type, the formal argument copies the actual value
- Case B: When the argument is a object type, the formal argument copies reference to the actual value
- Cases A & B: Changes in the copy (formal argument) does not reflect the actual argument
- However, if formal and actual argument point to the same object (Case B) – then **changes in properties (attribute values) of this object are available from the calling method** – i.e. we can return value from this argument

Operators in Java - IV

- Relational operators (comparison): **==, !=, <=, >=**
- Logical operators: **&&** (AND), **||** (OR) and **!** (NOT)

the expression is calculated from left to right only when it's necessary for determining the final outcome

- Bitwise operators: **&** (AND), **|** (OR) and **~** (NOT), **^** (XOR), **&=**, **|=**, **^=**
- Bitwise shift: **<<**, **>>** (preserves character), **>>>** (always inserts ziros left – does not preserve character), **<<=**, **>>=**, **>>>=**

Operators in Java - V

- Triple **if-then-else** operator:

<boolean-expr> ? <then-value> : <else-value>

- String concatenation operator: **+**

- Operators for type conversion (type casting):

(byte), **(short)**, **(char)**, **(int)**, **(long)**, **(float)** ...

- Priorities of operators:

unary > binary arithmetical > relational > logical > three-argumentative operator **if-then-else** > operators to assign a value

Controlling Program Flow - I

- Conditional operator - **if-else**
- Returning Value – **return**
- Operators organizing cycle - **while, do while, for, break, continue**
- Operator to select one from many options - **switch**

Controlling Program Flow - II

- Conditional operator **if-else**:

if(<boolean-expr>)

<then-statement>

or

if(<boolean-expr>)

<then-statement>

else

<else-statement>

Controlling Program Flow - III

- Returning value to exit the method: **return;** or
  return <value>;
- Operator to organize cycle **while**:

```
while(<boolean-expr>)
    <body-statement>
```

- Operator to organize cycle **do-while**:

```
do <body-statement>
while(<boolean-expr>);
```

Controlling Program Flow - IV

- Operator to organize cycle **for**:

```
for(<initialization>; <boolean-expr>; <step>)
<body-statement>
```

- Operator to organize cycle **foreach**:

```
for(<value-type> x : <collection-of-values>)
<body-statement-using-x>
```

Ex.:
```
for(Point p : pointsArray)
    System.out.println("(" +p.x + ", " + p.y + ")");
```

Controlling Program Flow - V

- Operators to exit block (cycle) **break** and to exit iteration cycle **continue**:

```
<loop-iteration> {
//do some work
continue;  // goes directly to next loop iteration
//do more work
    break;  // leaves the loop
    //do more work
}
```

Controlling Program Flow - VI

- Use of labels with **break** and **continue**:

```
outer_label:
<outer-loop> {
    <inner-loop> {
        //do some work
      continue; // continues inner-loop
        //do more work
        break outer_label; // breaks outer-loop
        //do more work
        continue outer_label;  // continues outer-loop
    }
}
```

Controlling Program Flow - VII

❖Selecting one of several options **switch**:

```
switch(<selector-expr>) {
  case <value1> : <statement1>; break;
  case <value2> : <statement2>; break;
  case <value3> : <statement3>; break;
  case <value4> : <statement4>; break;
  // more cases here ...
  default: <default-statement>;
}
```

Enumeration Types

```
public class MyEnumeration {
   public enum InvoiceType { SIMPLE, VAT }
   public static void main(String[] args) {
     for(InvoiceType it : InvoiceType.values())
         System.out.println(it);
     }
}
```

Резултат: SIMPLE
VAT

Garbage Collection – Main Concepts

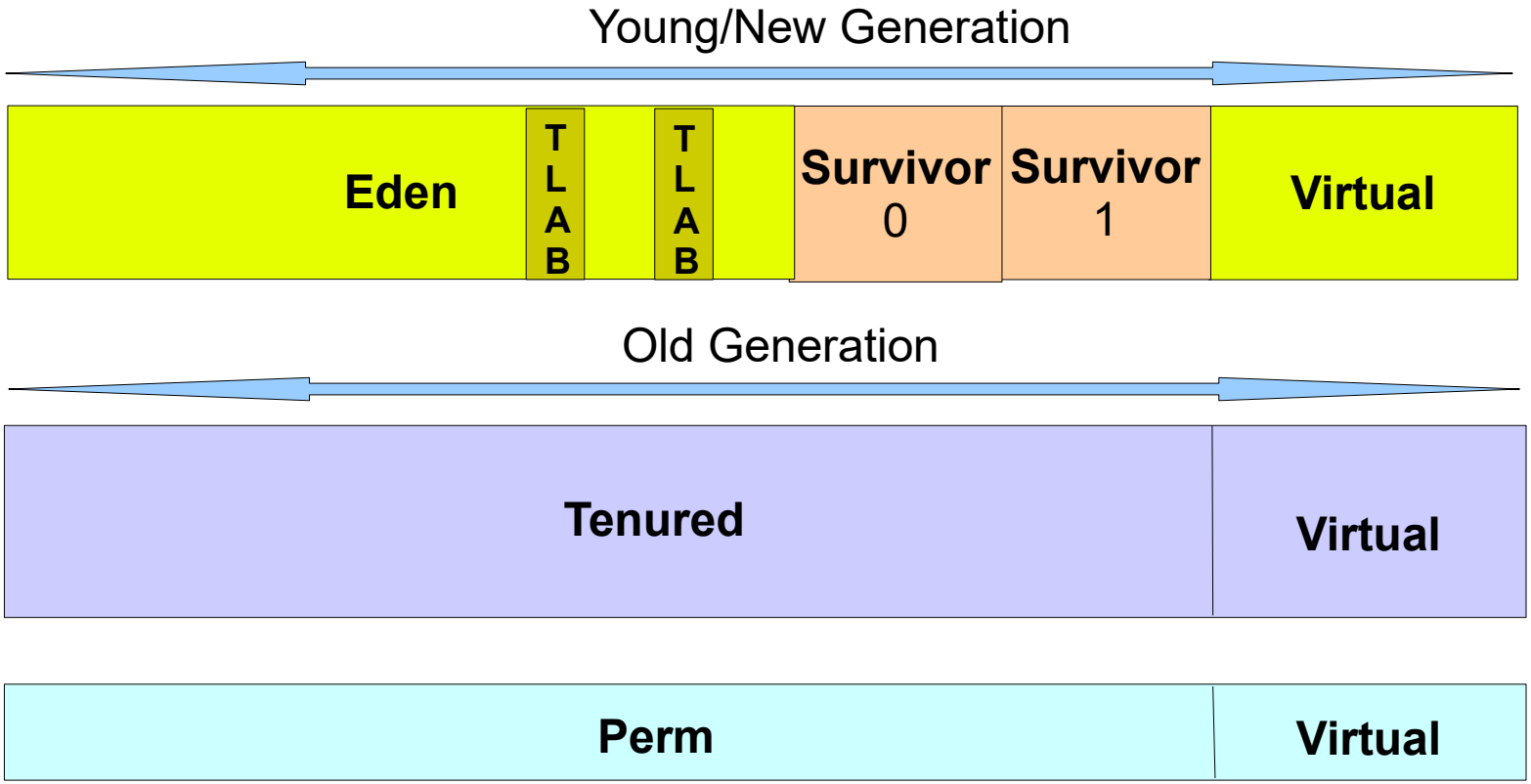
- Garbage collaction and finalization – method finalize()
- Client and Server VMs (≠ JIT Compiliers & Defaults), x86, x64
- Generational Garbage Collection – Young, Old & ~~Permanent~~ (in Java 8 → Metaspace) – Weak generational hypothesis:
  - Most of the objects become unreachable soon;
  - Small number of references exist from old to young objects.
- Tuning for Higher Throughput:

java -d64 -server -XX:+AggressiveOpts -XX:+UseLargePages -Xmn10g -Xms26g -Xmx26g

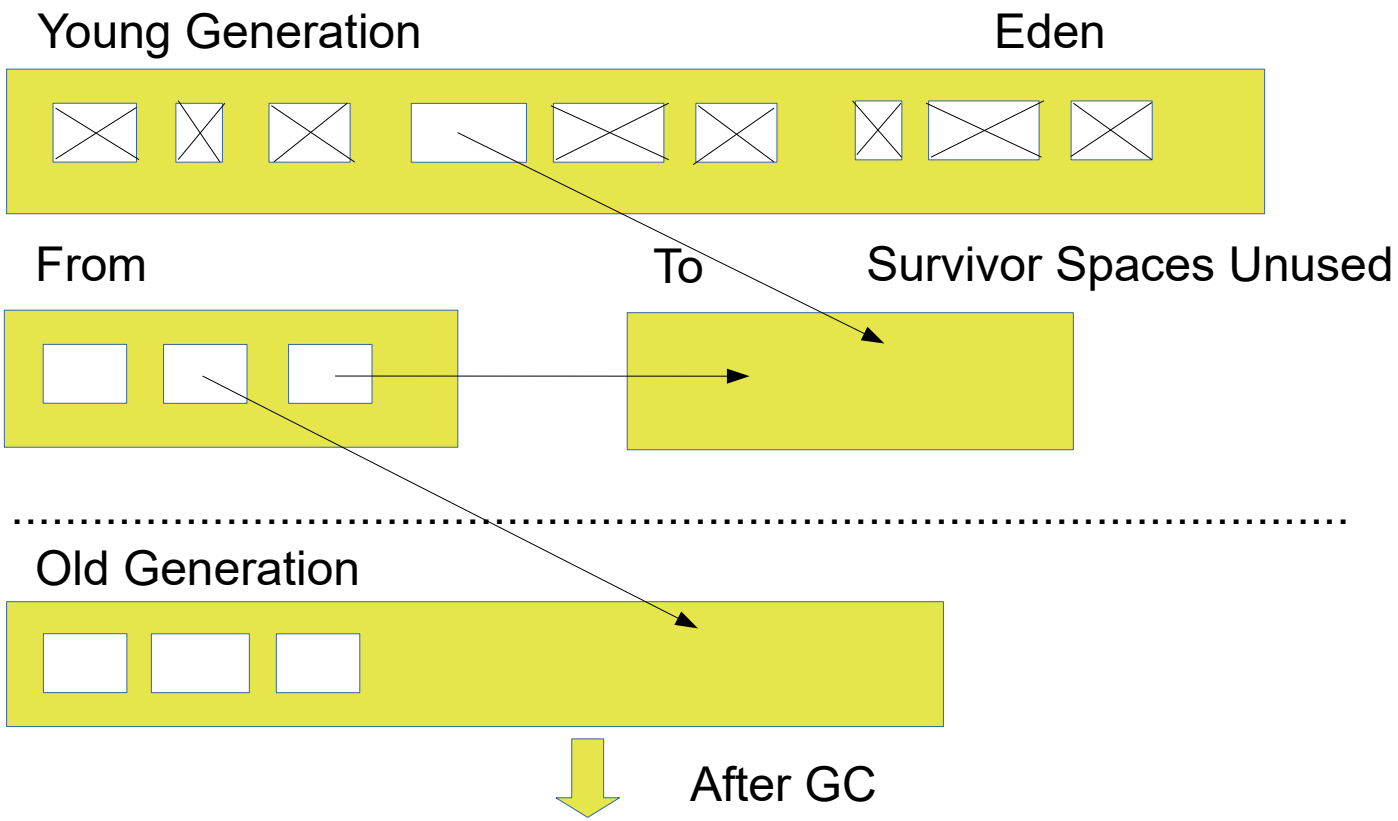
- Tuning for Lower Latency

java -d64 -XX:+UseG1GC -Xms26g Xmx26g -XX:MaxGCPauseMillis=500 -XX:+PrintGCTimeStamp

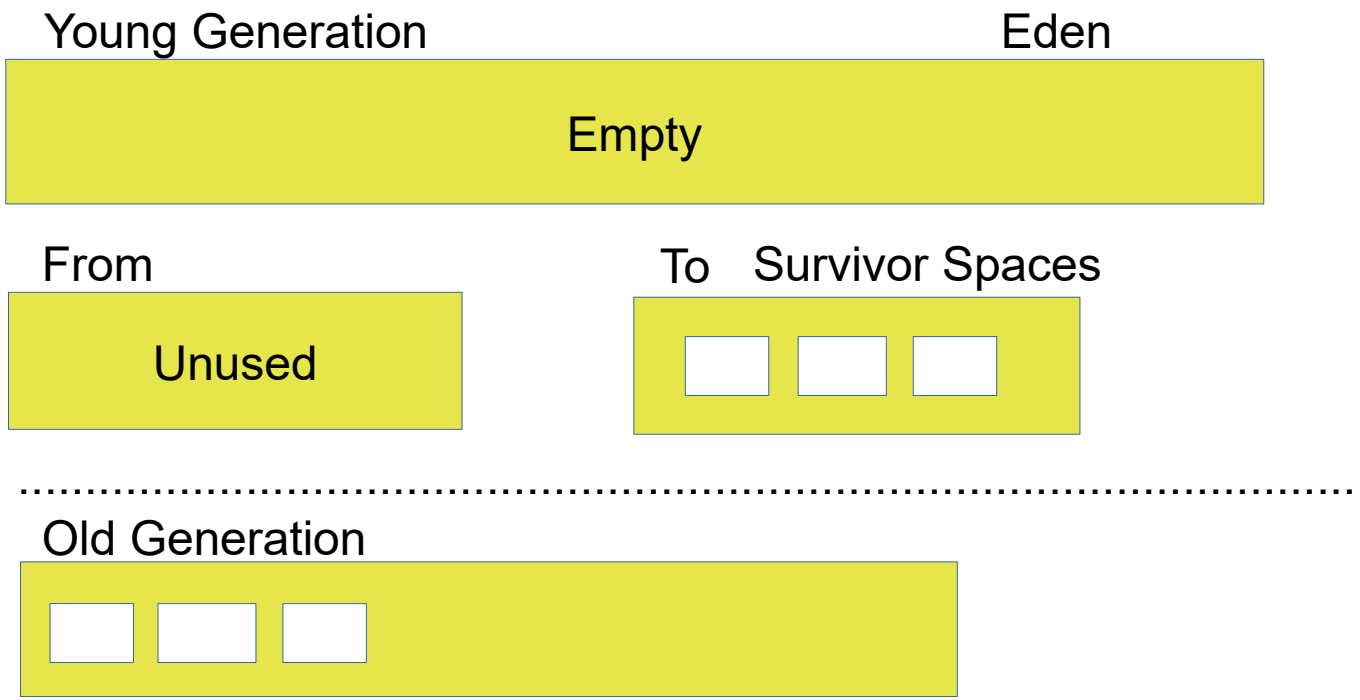
Garbage Collection – Main Concepts



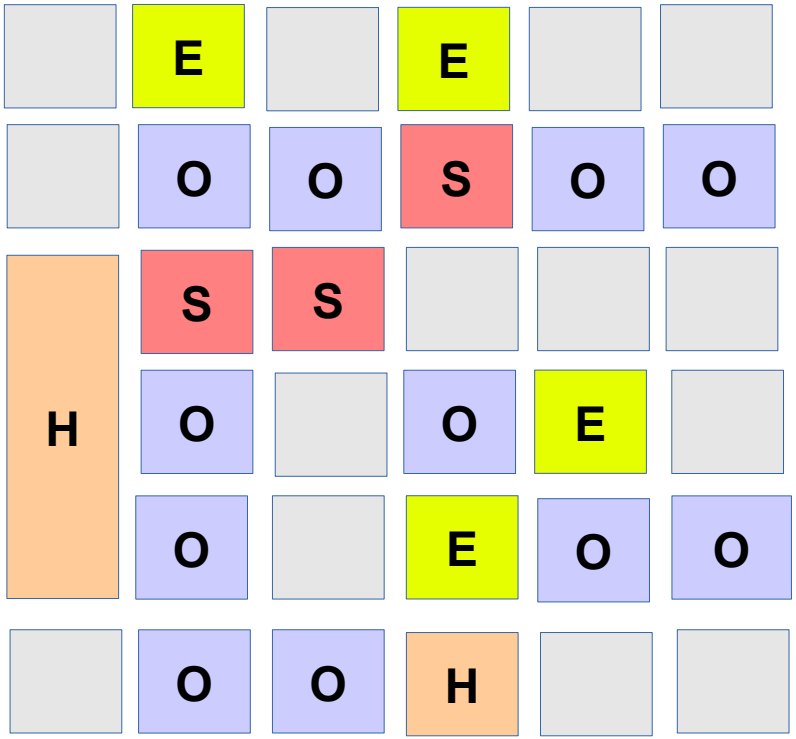
Before GC

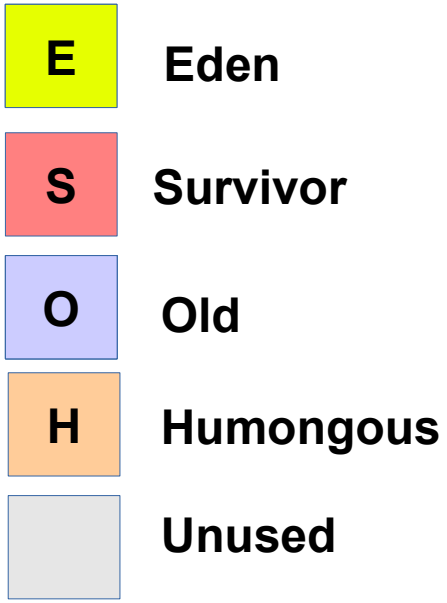


After GC



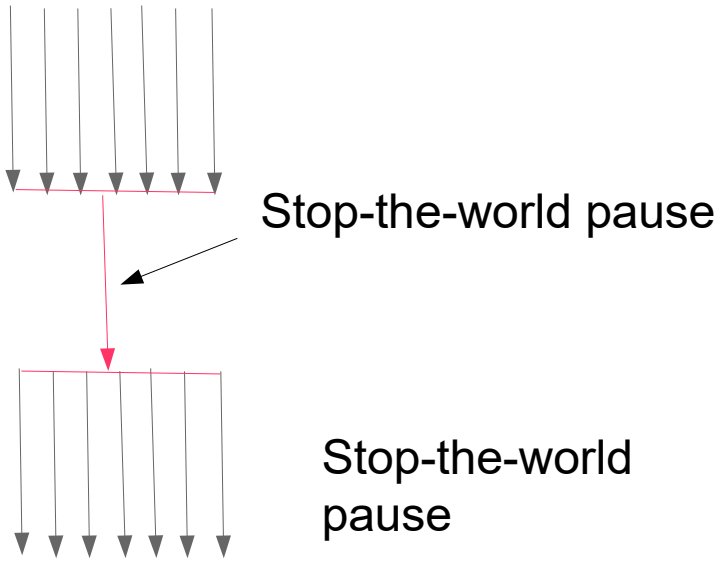
Garbage First G1 Partially Concurrent Collector



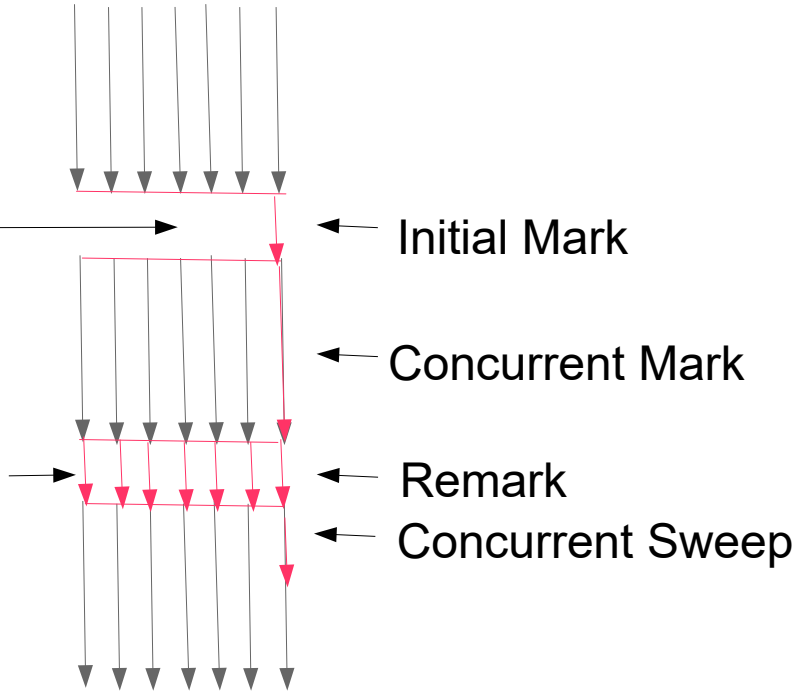


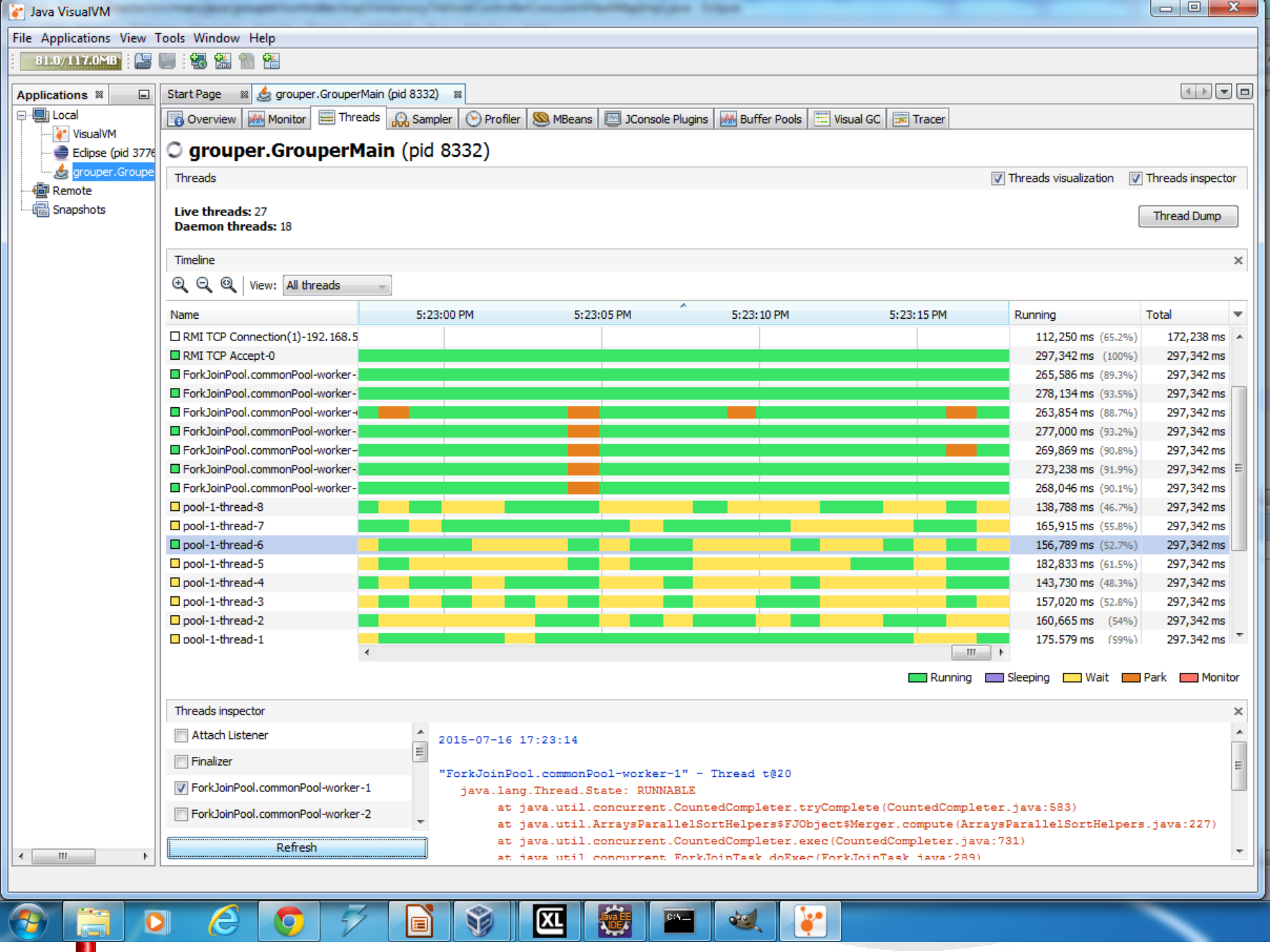
CMS GC (-XX:+UseConcMarkSweepGC)

Serial Mark-Sweep-Compact Collector



Concurrent Mark-Sweep Collector




Java VisualVM
File Applications View Tools Window Help
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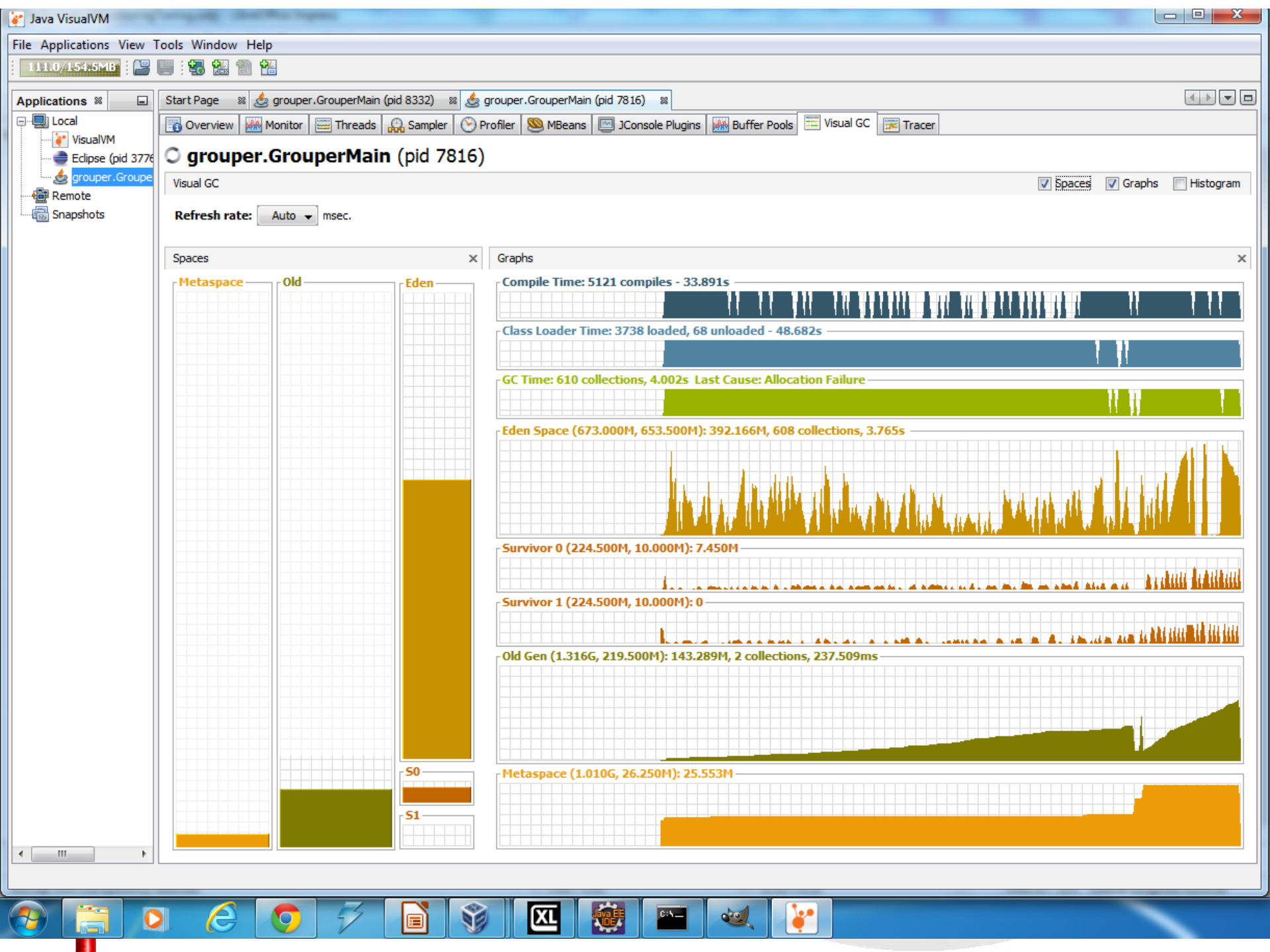
Applications
Local
VisualVM
Eclipse (pid 3776
grouper.Groupe
Remote
Snapshots
Start Page
grouper.GrouperMain (pid 8332)
Overview
Monitor
Threads
Sampler
Profiler
MBeans
JConsole Plugins
Buffer Pools
Visual GC
Tracer
grouper.GrouperMain (pid 8332)
Threads
Threads visualization
Threads inspector
Live threads: 27
Daemon threads: 18
Thread Dump
Timeline
View: All threads
Name
5:23:00 PM
5:23:05 PM
5:23:10 PM
5:23:15 PM
Running
Total
RMI TCP Connection(1)-192.168.5
RMI TCP Accept-0
ForkJoinPool.commonPool-worker-
ForkJoinPool.commonPool-worker-
ForkJoinPool.commonPool-worker-
ForkJoinPool.commonPool-worker-
ForkJoinPool.commonPool-worker-
ForkJoinPool.commonPool-worker-
ForkJoinPool.commonPool-worker-
pool-1-thread-8
pool-1-thread-7
pool-1-thread-6
pool-1-thread-5
pool-1-thread-4
pool-1-thread-3
pool-1-thread-2
pool-1-thread-1
112,250 ms (65.2%) 172,238 ms
297,342 ms (100%) 297,342 ms
265,586 ms (89.3%) 297,342 ms
278,134 ms (93.5%) 297,342 ms
263,854 ms (88.7%) 297,342 ms
277,000 ms (93.2%) 297,342 ms
269,869 ms (90.8%) 297,342 ms
273,238 ms (91.9%) 297,342 ms
268,046 ms (90.1%) 297,342 ms
138,788 ms (46.7%) 297,342 ms
165,915 ms (55.8%) 297,342 ms
156,789 ms (52.7%) 297,342 ms
182,833 ms (61.5%) 297,342 ms
143,730 ms (48.3%) 297,342 ms
157,020 ms (52.8%) 297,342 ms
160,665 ms (54%) 297,342 ms
175.579 ms (59%) 297.342 ms
Running
Sleeping
Wait
Park
Monitor
Threads inspector
Attach Listener
Finalizer
ForkJoinPool.commonPool-worker-1
ForkJoinPool.commonPool-worker-2
Refresh
2015-07-16 17:23:14
"ForkJoinPool.commonPool-worker-1" - Thread t@20
java.lang.Thread.State: RUNNABLE
at java.util.concurrent.CountedCompleter.tryComplete(CountedCompleter.java:583)
at java.util.ArraysParallelSortHelpers$FJObject$Merger.compute(ArraysParallelSortHelpers.java:227)
at java.util.concurrent.CountedCompleter.exec(CountedCompleter.java:731)


Java VisualVM
File Applications View Tools Window Help
111.0/154.5MB
Applications
Local
VisualVM
Eclipse (pid 3776
grouper.Groupe
Remote
Snapshots
Start Page
grouper.GrouperMain (pid 8332)
grouper.GrouperMain (pid 7816)
Overview
Monitor
Threads
Sampler
Profiler
MBeans
JConsole Plugins
Buffer Pools
Visual GC
Tracer
grouper.GrouperMain (pid 7816)
Visual GC
Spaces
Graphs
Histogram
Refresh rate:
Auto
msec.
Spaces
Metaspace
Old
Eden
S0
S1
Graphs
Compile Time: 5121 compiles - 33.891s
Class Loader Time: 3738 loaded, 68 unloaded - 48.682s
GC Time: 610 collections, 4.002s Last Cause: Allocation Failure
Eden Space (673.000M, 653.500M): 392.166M, 608 collections, 3.765s
Survivor 0 (224.500M, 10.000M): 7.450M
Survivor 1 (224.500M, 10.000M): 0
Old Gen (1.316G, 219.500M): 143.289M, 2 collections, 237.509ms
Metaspace (1.010G, 26.250M): 25.553M

Thank's for Your Attention!

Trayan Iliev

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