

Dirty Hacks With Java Reflection (includes one or two useful hints)

Dr Heinz M. Kabutz

Last updated 2016-10-21

Heinz Kabutz

- **Created The Java Specialists' Newsletter**

- Advanced newsletter for gifted Java programmers
 - No “Hello World” tutorials, except maybe

```
System.out.println("Hello world!");  
    -> "Goodbye, cruel world!"
```

- **Special offer - sign up today and get an invite to join our new JavaSpecialists.slack.com team**

- Chat to over 1200 Java experts from around the world in real time
 - And listen to their conversations
- <http://tinyurl.com/geecon-slack>



Reflection is like Opium

- **A bit too strong for every day use**
 - But can relieve serious pain
- **Please do not become a reflection addict!**

Modifying/Reading Private/Final Fields

- **We can access private fields by making it accessible**
 - Requires security manager support
- **Note: value field is final and private!**

```
import java.lang.reflect.*;
```

```
public class PrivateFinalFieldTest {  
    public static void main(String... args)  
        throws NoSuchFieldException, IllegalAccessException {  
        Field value = String.class.getDeclaredField("value");  
        value.setAccessible(true);  
        value.set("hello!", "cheers".toCharArray());  
        System.out.println("hello!");  
    }  
}
```

cheers

Stack Interface

- **Yes, you can define classes in interfaces!**

```
public interface Stack<E> {  
    void push(E item);  
    E pop();  
  
    class Node<E> {  
        private final E item;  
        private final Node<E> next;  
  
        public Node(E item, Node<E> next) {  
            this.item = item;  
            this.next = next;  
        }  
        public E getItem() { return item; }  
        public Node<E> getNext() { return next; }  
    }  
}
```

Synchronized Stack

- Plain old synchronized locking

```
public class SynchronizedStack<E> implements Stack<E> {  
    private Node<E> top = null;  
  
    public synchronized void push(E item) {  
        top = new Node<>(item, top);  
    }  
  
    public synchronized E pop() {  
        if (top == null) return null;  
        E item = top.getItem();  
        top = top.getNext();  
        return item;  
    }  
}
```



```
public class ConcurrentStackAR<E> implements Stack<E> {
    private final AtomicReference<Node<E>> top = new AtomicReference<>();

    public void push(E item) {
        Node<E> oldHead, newHead;
        do {
            oldHead = top.get();
            newHead = new Node<>(item, oldHead);
        } while (!top.compareAndSet(oldHead, newHead));
    }

    public E pop() {
        Node<E> oldHead, newHead;
        do {
            oldHead = top.get();
            if (oldHead == null)
                return null;
            newHead = oldHead.getNext();
        } while (!top.compareAndSet(oldHead, newHead));
        return oldHead.getItem();
    }
}
```

AtomicReferenceFieldUpdater

- Used to be slow, but fast in later Java 8 versions

```
public class ConcurrentStackARFU<E> implements Stack<E> {
    private volatile Node<E> top = null;

    public void push(E item) {
        Node<E> oldHead, newHead;
        do {
            oldHead = top;
            newHead = new Node<>(item, oldHead);
        } while (!topUpdater.compareAndSet(this, oldHead, newHead));
    }

    public E pop() { ... }

    private final static
        AtomicReferenceFieldUpdater<ConcurrentStackARFU, Node>
        topUpdater = AtomicReferenceFieldUpdater.newUpdater(
            ConcurrentStackARFU.class, Node.class, "top");
}
```


sun.misc.Unsafe

- **Similar to atomics, but uses pointer arithmetic**

- **compareAndSwapObject()**

```
public class ConcurrentStackUnsafe<E> implements Stack<E> {  
    private volatile Node<E> top = null;
```

```
    public void push(E item) {  
        Node<E> oldHead, newHead;  
        do {  
            oldHead = top;  
            newHead = new Node<>(item, oldHead);  
        } while (!UNSAFE.compareAndSwapObject(  
            this, TOP_OFFSET, oldHead, newHead));  
    }
```

```
    public E pop() { ... }
```

sun.misc.Unsafe Plumbing

- Usually we hide gory details at end of class
 - Dangerous, don't use: sun.misc dependency, direct memory access

```
private final static Unsafe UNSAFE;  
private static final long TOP_OFFSET;  
  
static {  
    try {  
        Field theUnsafeField =  
            Unsafe.class.getDeclaredField("theUnsafe");  
        theUnsafeField.setAccessible(true);  
        UNSAFE = (Unsafe) theUnsafeField.get(null);  
        TOP_OFFSET = UNSAFE.objectFieldOffset(  
            ConcurrentStackUnsafe.class.getDeclaredField("top"));  
    } catch (ReflectiveOperationException e) {  
        throw new ExceptionInInitializerError(e);  
    }  
}
```


VarHandles in Java 9

- Replacement for Unsafe and AtomicXXXFieldUpdater

```
import java.lang.invoke.*;

public class ConcurrentStackVarHandles<E> implements Stack<E> {
    private final static VarHandle topHandle;

    static {
        try {
            topHandle = MethodHandles.lookup().findVarHandle(
                ConcurrentStackVarHandles.class,
                "top", Node.class
            );
        } catch (ReflectiveOperationException e) {
            throw new ExceptionInInitializerError(e);
        }
    }
}
```

VarHandles in Java 9

```
private volatile Node<E> top = null;

public void push(E item) {
    Node<E> oldHead, newHead;
    do {
        oldHead = top;
        newHead = new Node<>(item, oldHead);
    } while (!topHandle.compareAndSet(this, oldHead, newHead));
}

public E pop() { ... }
}
```


VarHandle compareAndExchange()

- Does a true compareAndSwap
 - Always returns the value that was found
 - Faster under moderate contention

```
public void push(E item) {
    Node<E> oldHead, newHead, swapResult = top;
    do {
        oldHead = swapResult;
        newHead = new Node<>(item, oldHead);
    } while ((swapResult = (Node<E>) topHandle.compareAndExchange(
        this, oldHead, newHead)) != oldHead);
}
```

Quick VarHandle Search

- **Where would we likely see this being used?**

Issues with VarHandles

- **Great, but**

- **Cannot use VarHandles on fields in foreign classes**
- **So how would you access the String.value field with VarHandles?**

```
import java.lang.invoke.*;
```

```
public class StringReader {  
    public static void main(String... args)  
        throws ReflectiveOperationException {  
        VarHandle valueHandle = MethodHandles.lookup().findVarHandle(  
            String.class, "value", byte[].class);  
        valueHandle.set("Hello there", valueHandle.get("Cheerio"));  
        System.out.println("Hello there");  
    }  
}
```

IllegalAccessException: member is private

Optimization methodology

- 1. Load test to identify bottlenecks**
 - Identify the easiest to fix
 - 2. Derive a hypothesis for the cause of the bottleneck**
 - Create a test to isolate the factor identified by the hypothesis
 - This is important, we have often been fooled by profilers!
 - 3. Alter the application or configuration**
 - 4. Test that the change improves the situation**
 - Also make sure the system still works correctly
- Repeat process until targets are met

Big Gains Quickly

- **Amdahl's law applies**

- **Consider an 4 layered application**

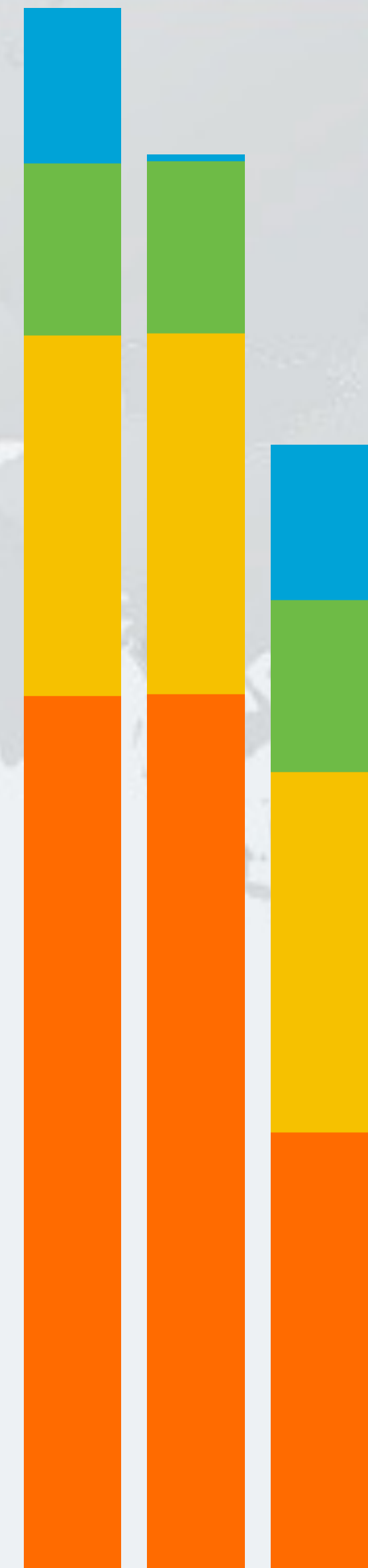
- **Servlet takes 10%**
- **Business component takes 11%**
- **EJB takes 23%**
- **SQL takes 56%**

- **Scenario 1, tuning Servlet gives 20x improvement**

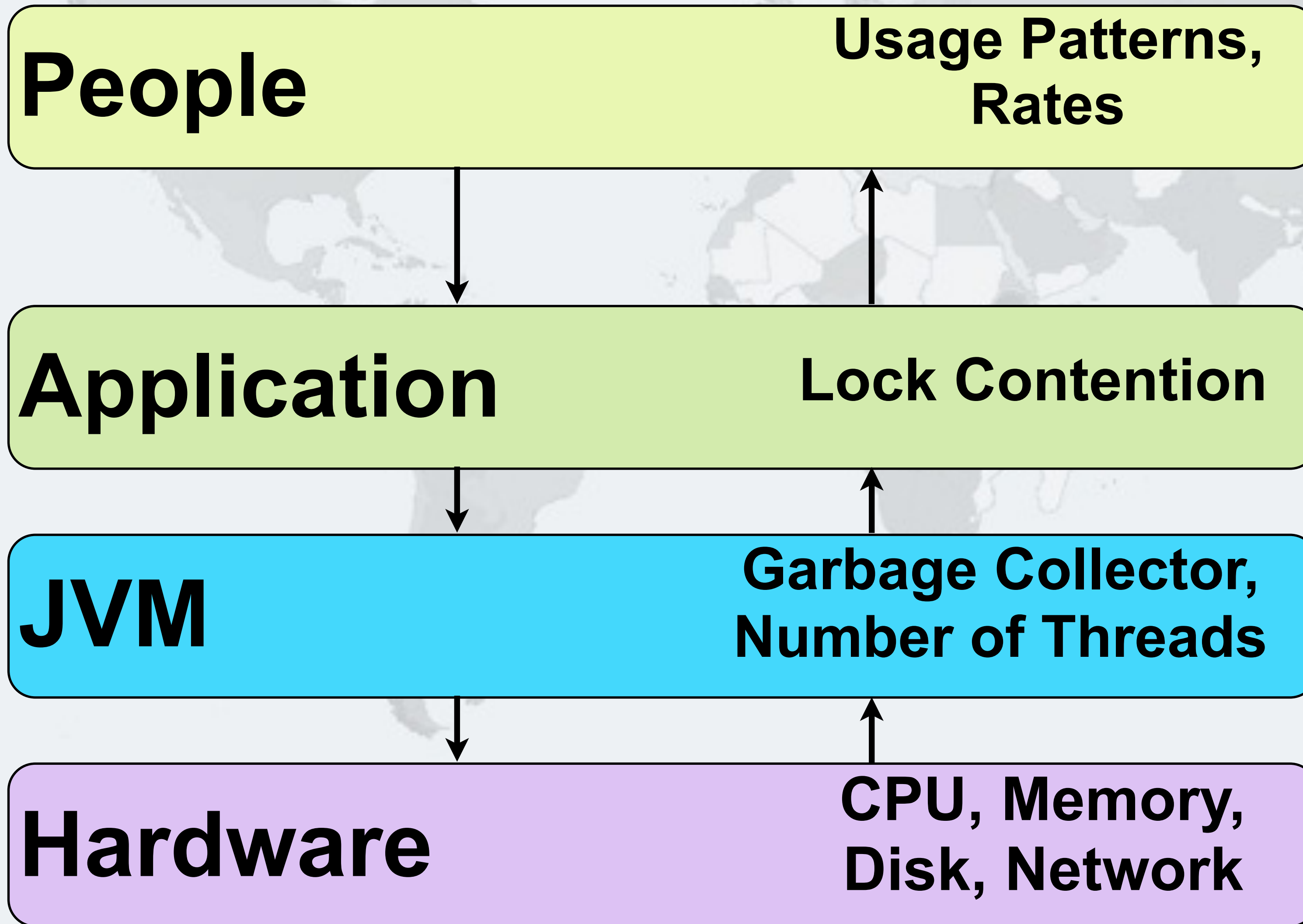
- **"Google" says that servlets are slow**
- **$0.10/20 + 0.11/1 + 0.23/1 + 0.56 /1 = 0.905$**

- **Scenario 2, tuning SQL give 2x improvement**

- **We *measure* and discover SQL is the bottleneck**
- **$0.10/1 + 0.11/1 + 0.23/1 + 0.56/2 = 0.72$**



System Overview - The Box



Remember:
tinyurl.com/geecon-slack

