TECHNISCHE UNIVERSITÄT DRESDEN

Department of Computer Science, Software Technology Group

On Performance of Delegation in Java.

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Delegation

- One of the key mechanisms of object-orientation
- Heavily utilized in approaches for dynamic software upgrade
- Imposes performance penalties in terms of delayed execution
- But how big are these penalties ?

Experimental Setup

- Generation of classes, whose instances are connected to each other, forming a delegation chain

```
class C_i {
    private C_{i+1} next;
    public String call_i^1(t_1^1 p_1^1 ... t_j^1 p_j^1) {
        if(next != null) {
            double x = Math.sin(a) * ...
            return next.call_{i+1}^y (v_1^y, ..., v_k^y);
        } else return „end“;
    }
    ...
    public String call_i^k(t_1^k p_1^k ... t_q^k p_q^k) { ... }
    ...
}
```

workload

Experimental Setup

- Client, measuring the time **max** times (10.000) in order to take warm-up phase into consideration

```
class TestJIT {
   public static void main(String[] args) {
      //prepare
      for(int i = 0; i < max; i++) {
         long start = System.nanoTime();
         //invoke first method in chain
         long stop = System.nanoTime();
         //write result
      }
   }
}
```

Experimental Setup

- Generated client, measuring manually inlined methods

```
class TestManual {
   public void execute() {
      //insert all calculations
      long x_i = Math.sin(a_i) *
        Math.tan(b_i) + Math.hypot(c_i,d_i);
   }
   public static void main(String[] args) {
      TestManual test = new TestManual();
      for(int i = 0; i < max; i++) {
         long start = System.nanoTime();
         test.execute();
         long stop = System.nanoTime();
         //write results
      }
   }
}
```

Experimental Setup

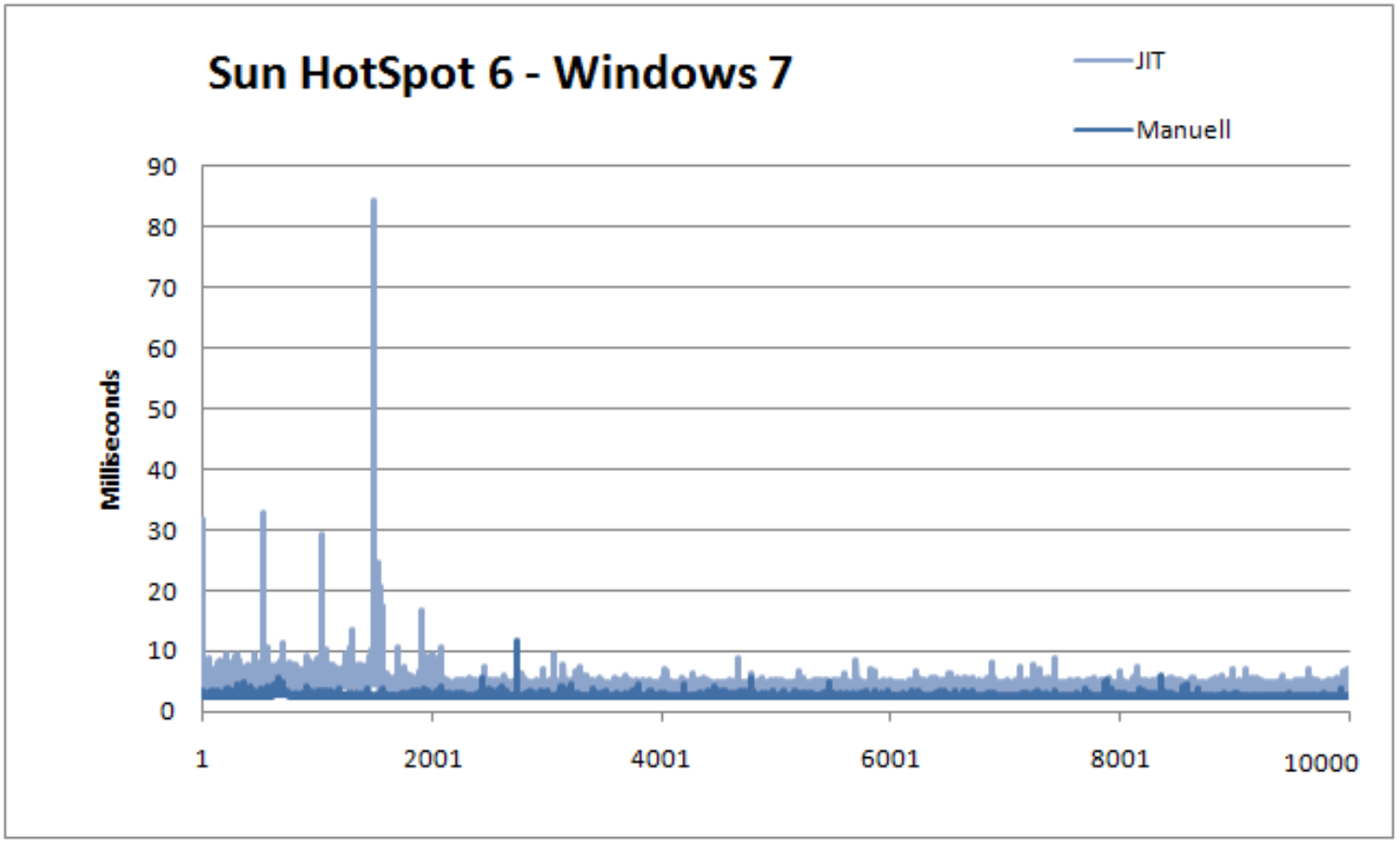
2 comparable **machines** used:

- Windows 7 and Linux (2.6.28) on
  - Intel Core 2 Duo T7700, 2.4GHz, 3GB RAM, 32bit
- Mac OS X on
  - MacBook Pro, Intel Core 2 Duo, 2.66GHz, 4GB RAM, 64bit

10 different **JVMs** observed:

- Sun HotSpot 5 + 6 for Windows 7 + Linux
- JRockit MC 3.1.0 for Java 5 + 6 for Windows 7 + Linux
- Apple HotSpot 5 + 6 for Mac OS X

Penalties are calculated using running average values.



Penalty

50%

But:

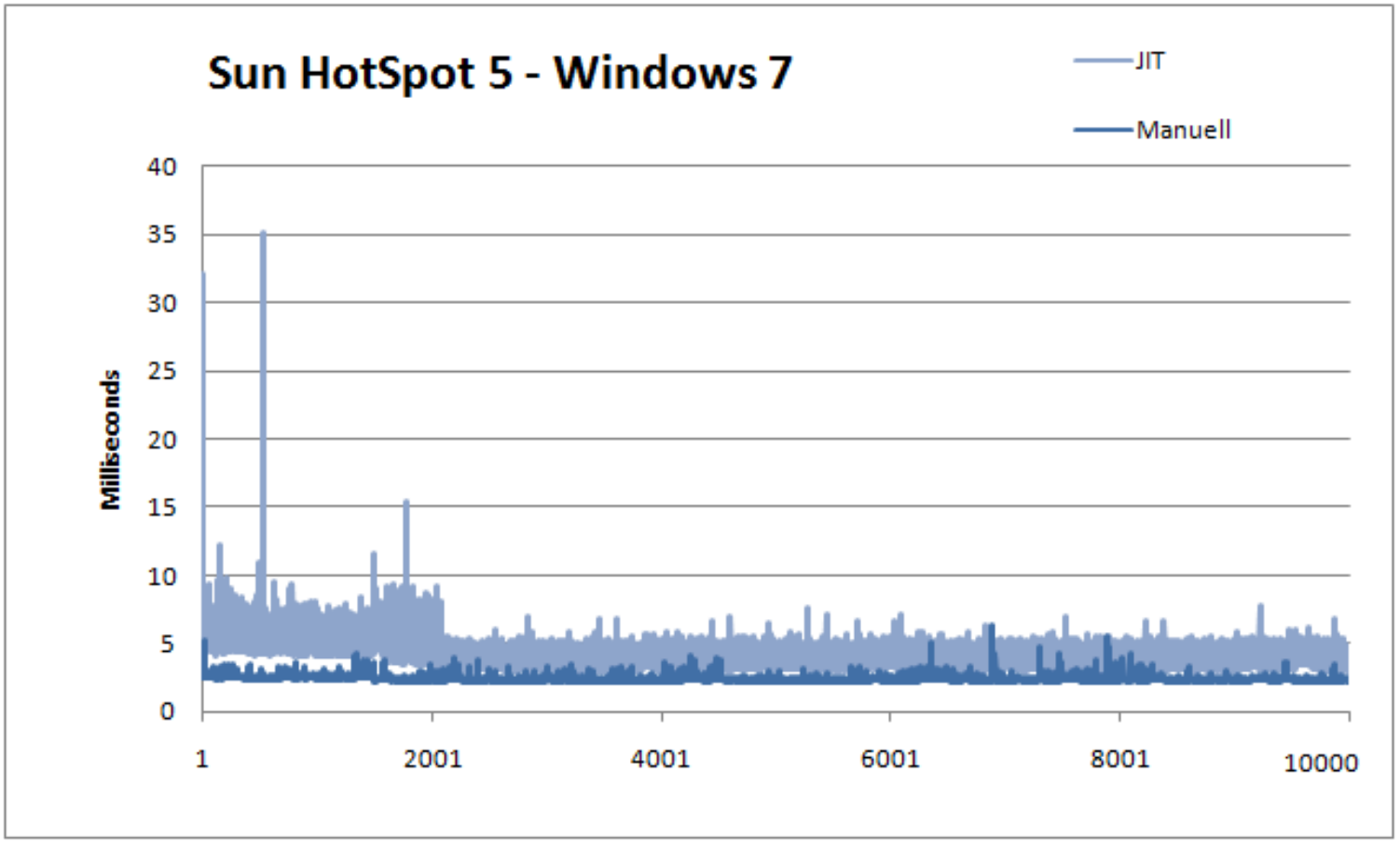
2x Workload:

32%

2,5x Workload:

12%

Windows 7



Penalty

46%

But:

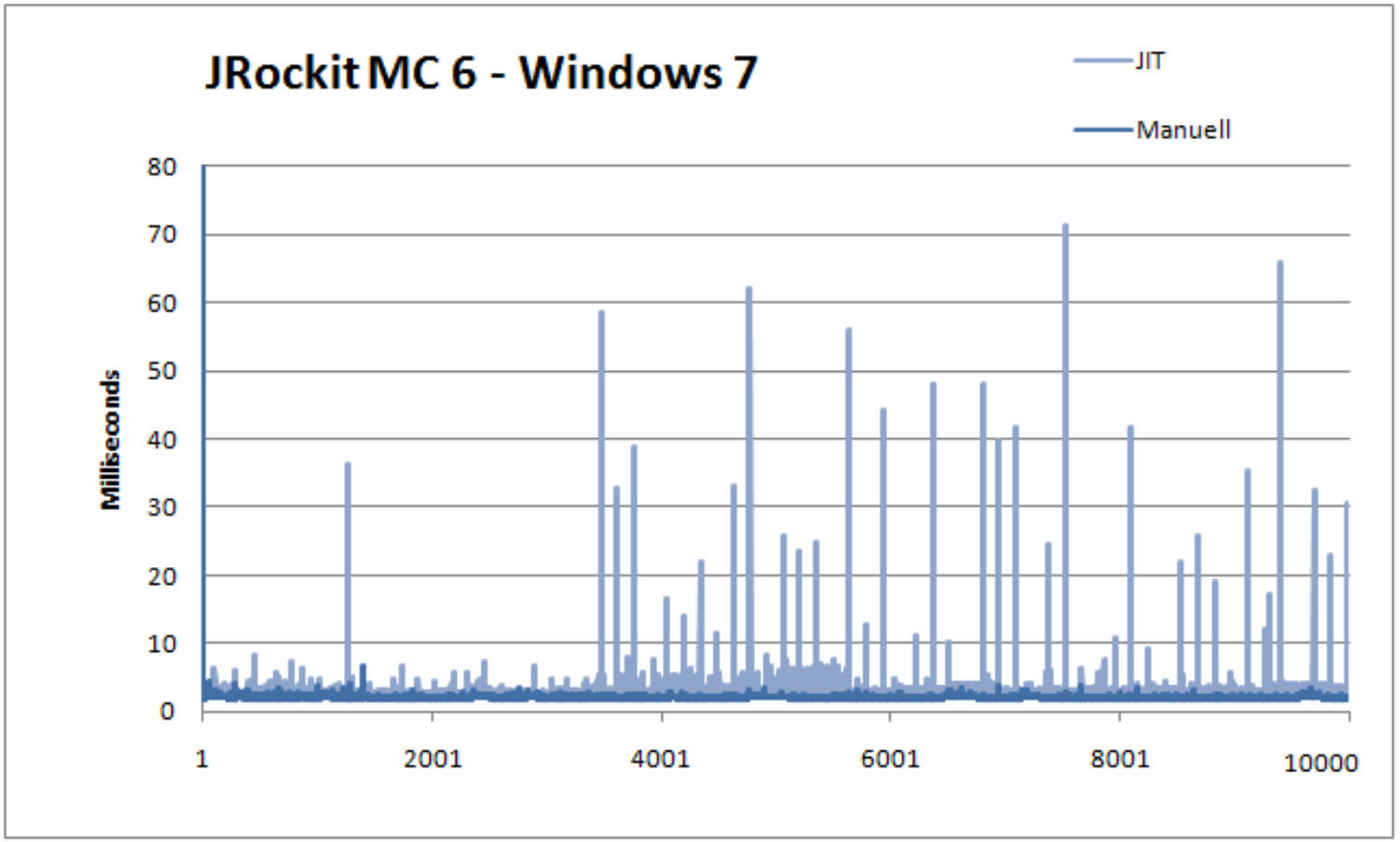
2x Workload:

14%

2,5x Workload:

14%

Windows 7



Penalty

43%

But:

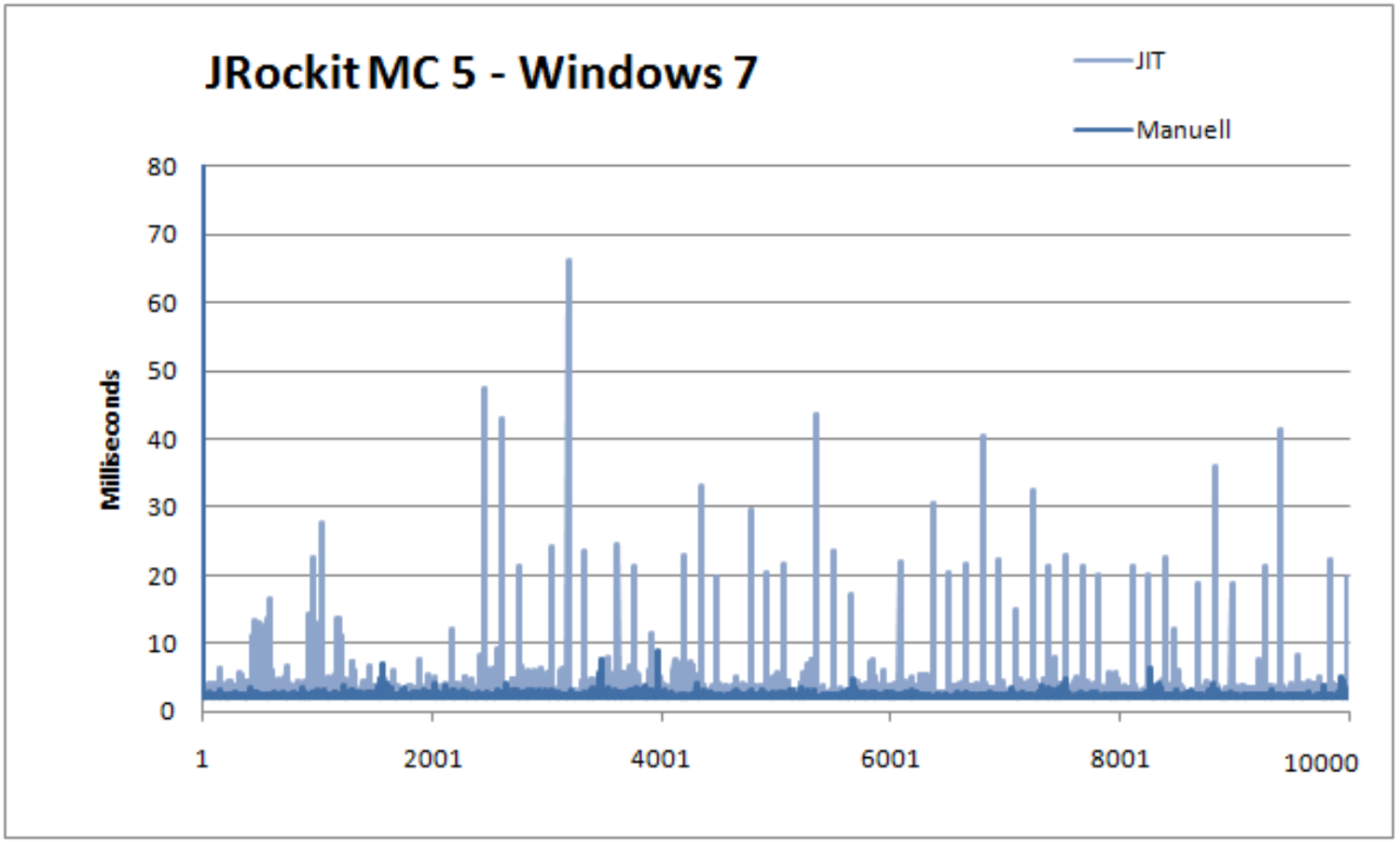
2x Workload:

31%

2,5x Workload:

2%

Windows 7



Penalty

39%

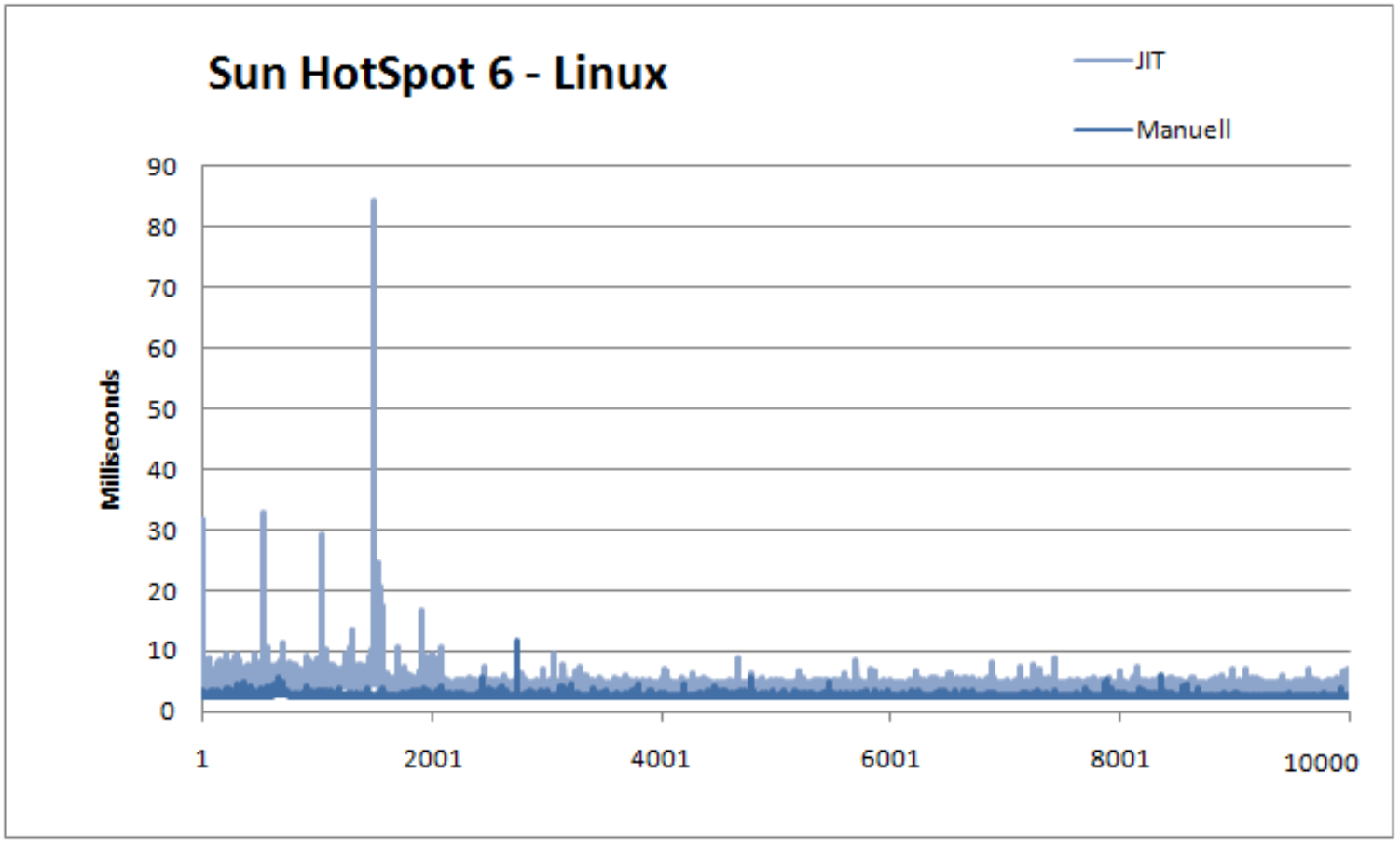
But:

2x Workload:

20%

2,5x Workload:

13%



Penalty

37%

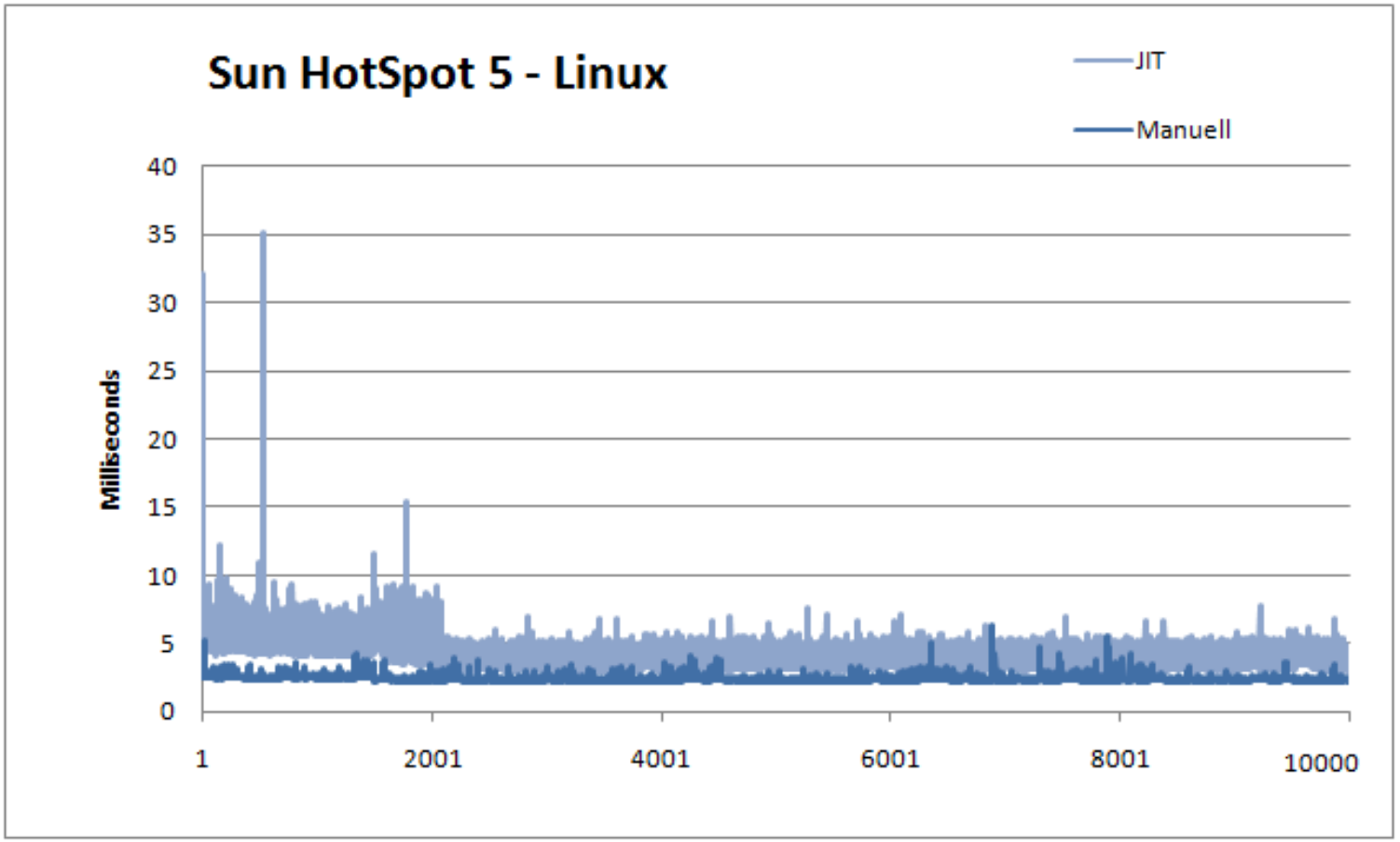
But:

2x Workload:

22%

2,5x Workload:

24%



Penalty

8%

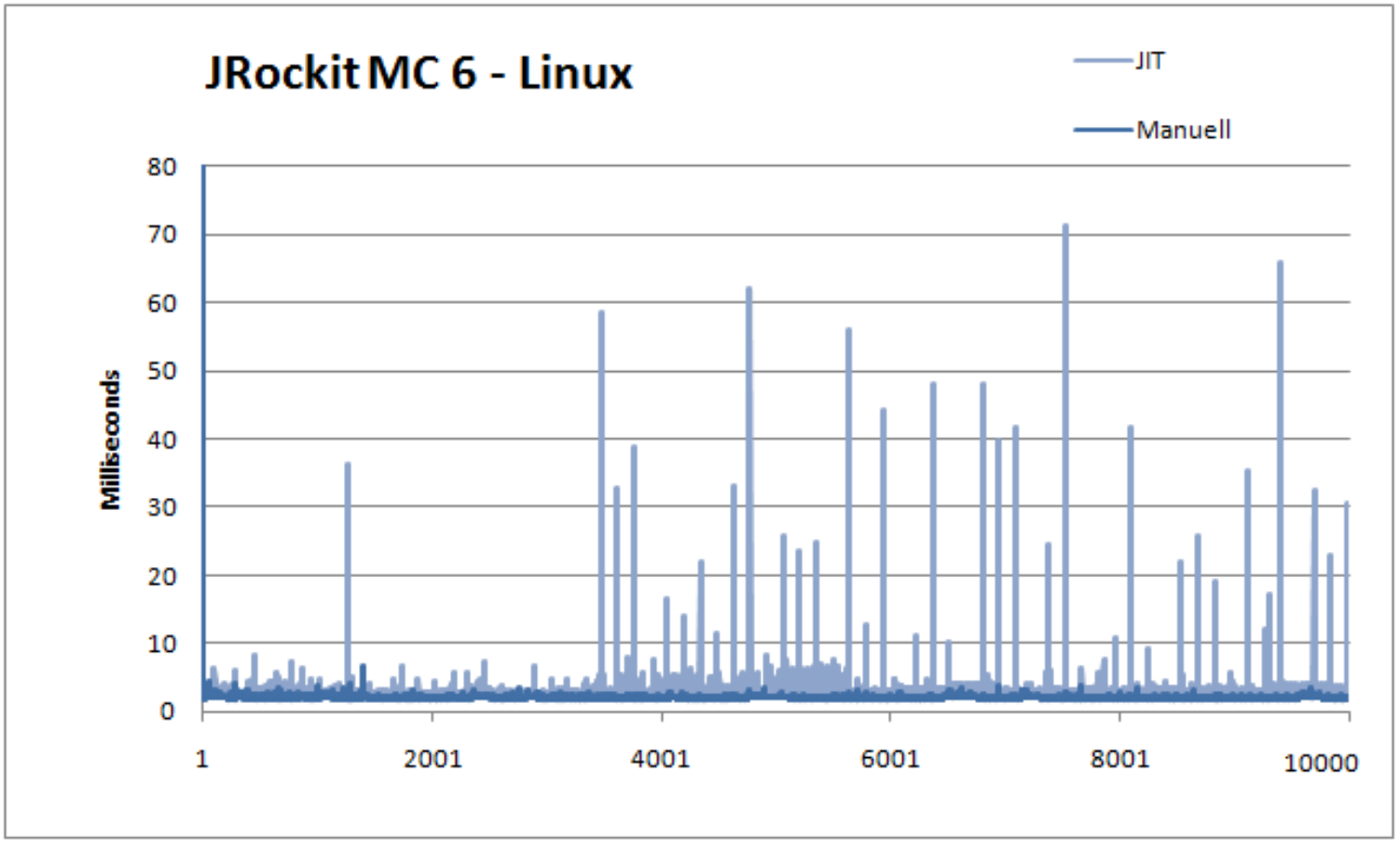
But:

2x Workload:

0%

2,5x Workload:

-8% !



Penalty

14%

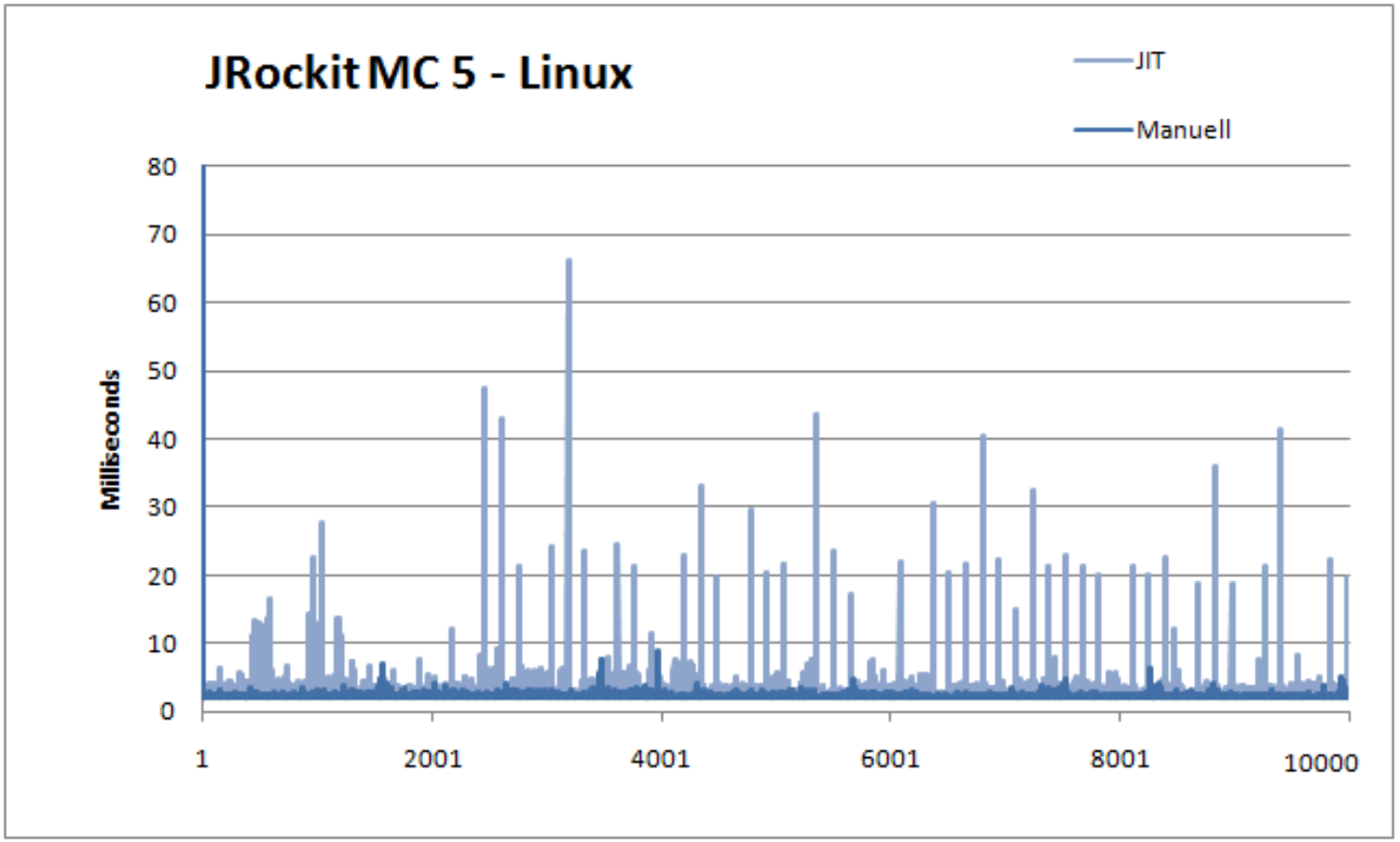
But:

2x Workload:

6%

2,5x Workload:

8%



Penalty

14%

But:

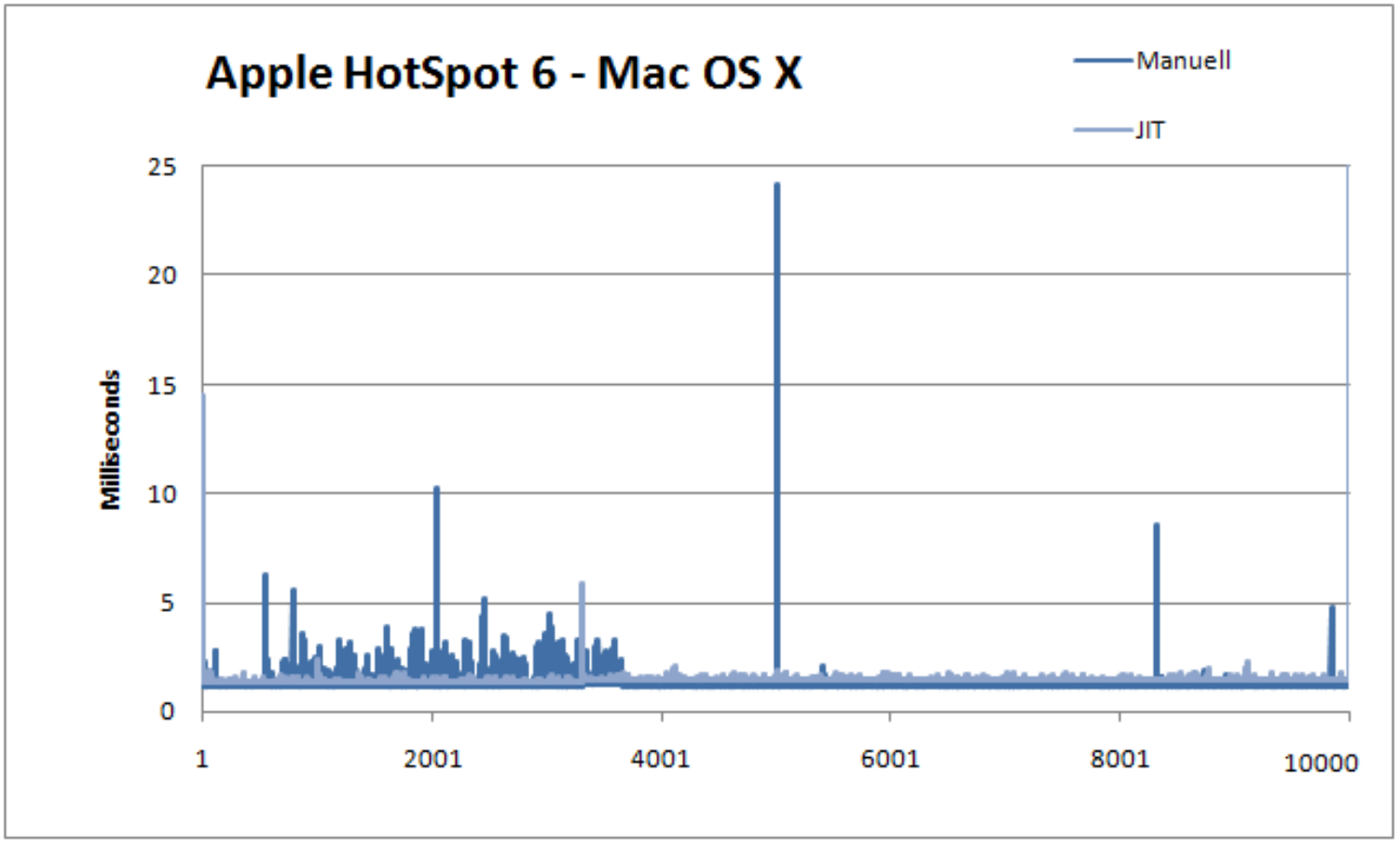
2x Workload:

13%

2,5x Workload:

7%

Mac OS X



Penalty

15%

But:

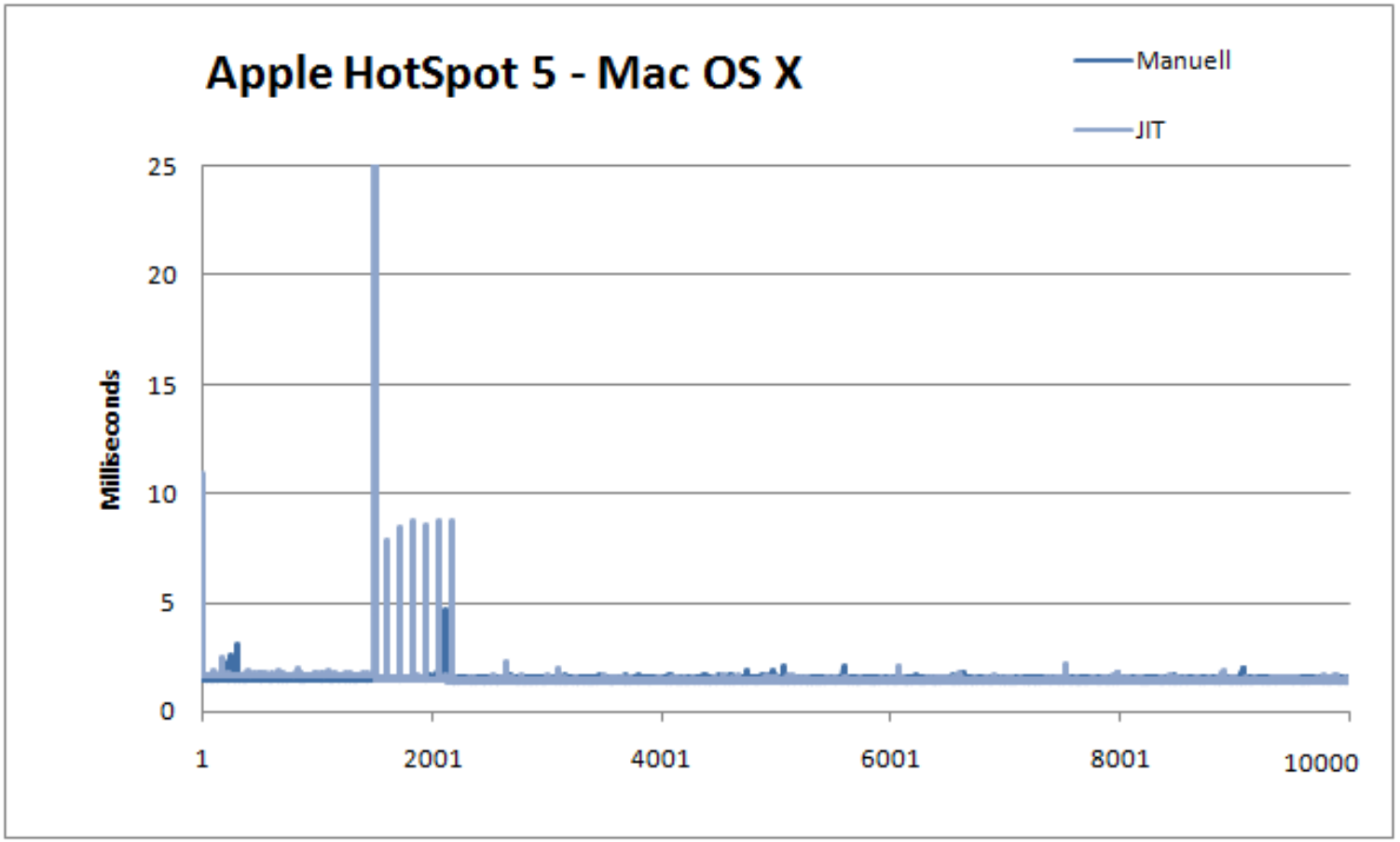
2x Workload:

7%

2,5x Workload:

6%

Mac OS X



Penalty

0%

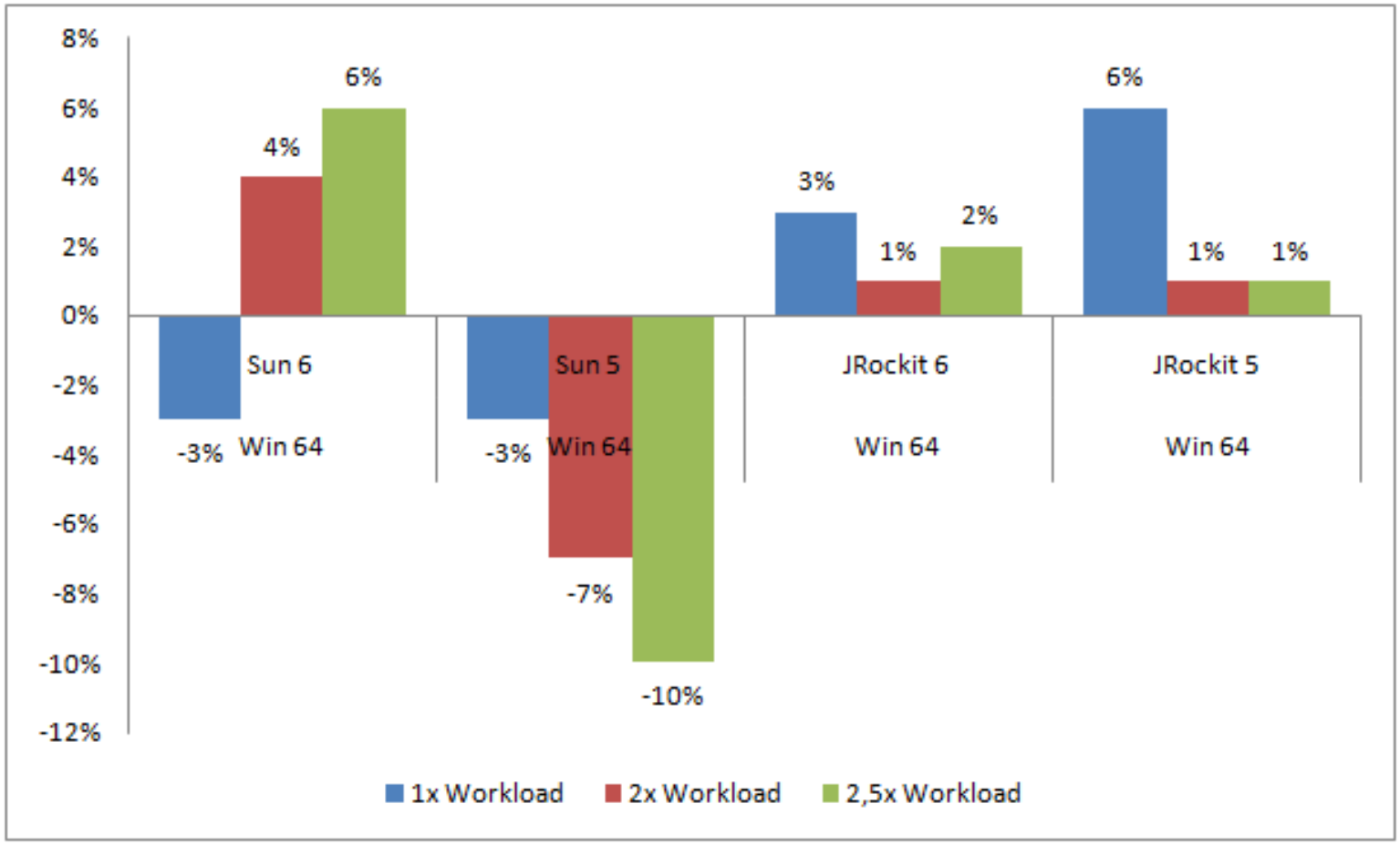
Possible Reason:
Highly optimized for architecture.

32bit vs. 64bit

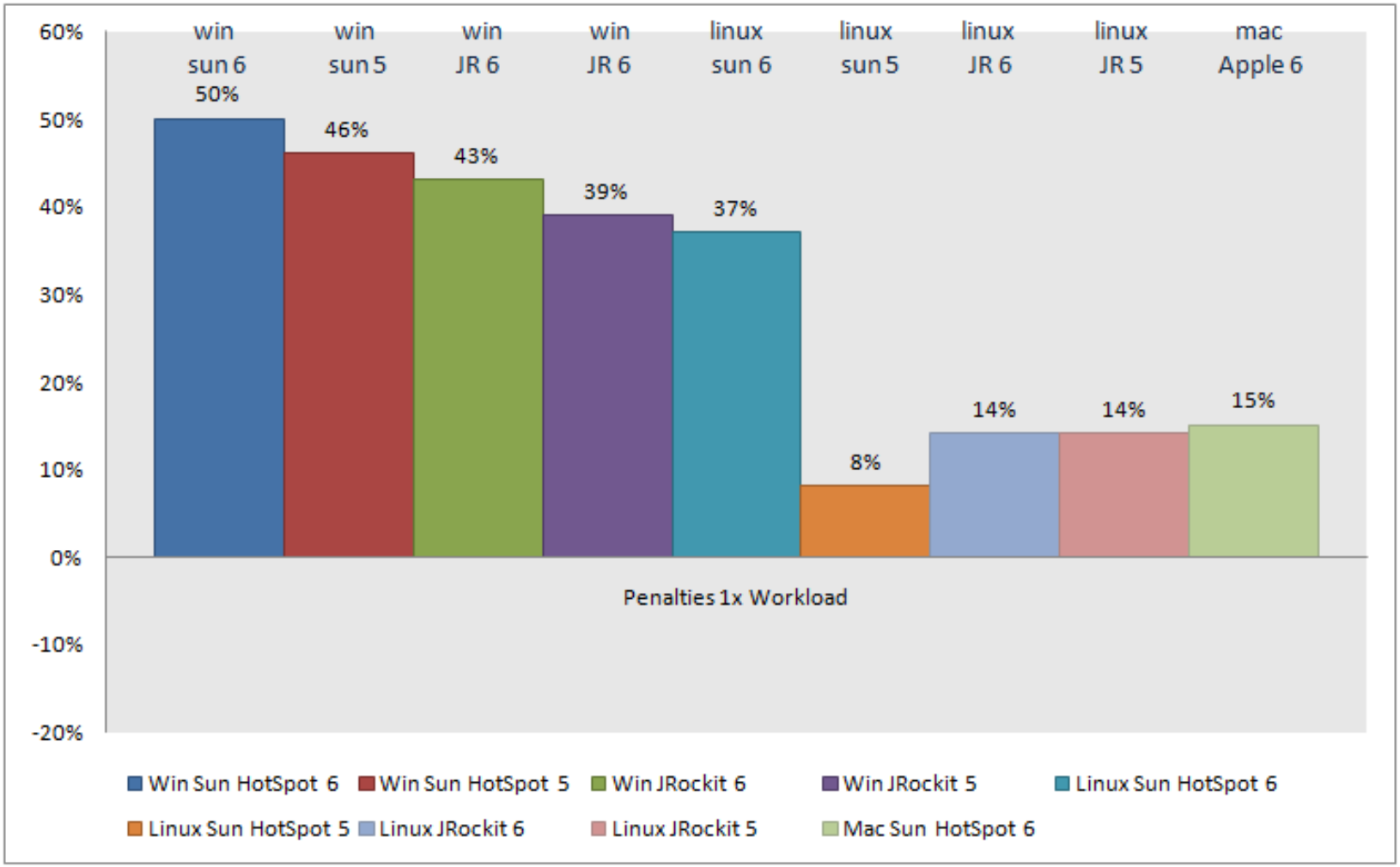
- Big difference between 32bit and **64bit** versions of the VMs
- Much better performance in 64bit VMs
- Sometimes Delegation is even faster, than manually inlined code

32bit vs. 64bit

64bit Results for Windows 7, varying workload



Conclusion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linux sun 6
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linux JR 5
mac Apple 6
50%
46%
43%
39%
37%
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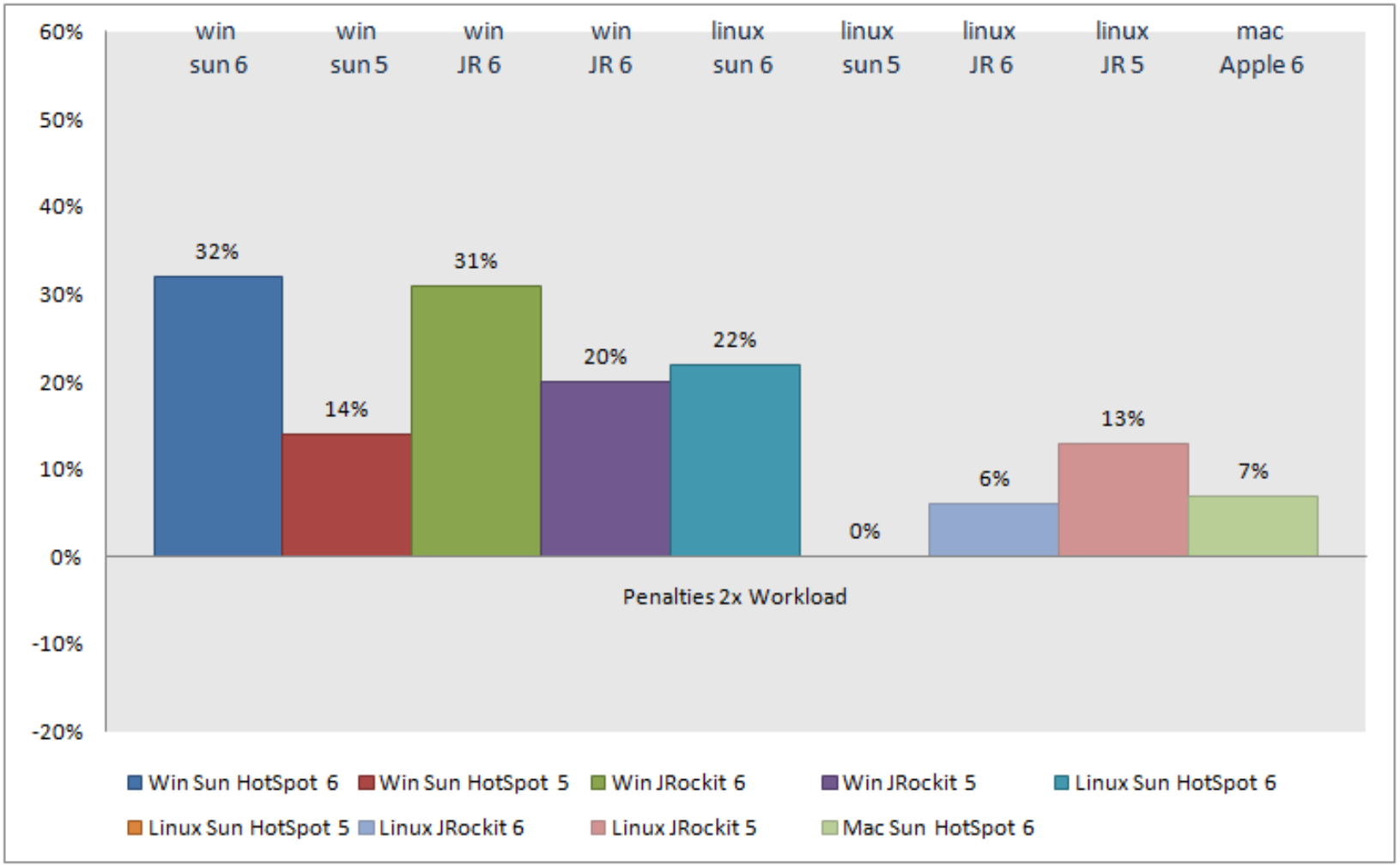
14%
15%
Penalties 1x Workload
Win Sun HotSpot 6
Win Sun HotSpot 5
Win JRockit 6
Win JRockit 5
Linux Sun HotSpot 6
Linux Sun HotSpot 5
Linux JRockit 6
Linux JRockit 5
Mac Sun HotSpot 6

Conclusion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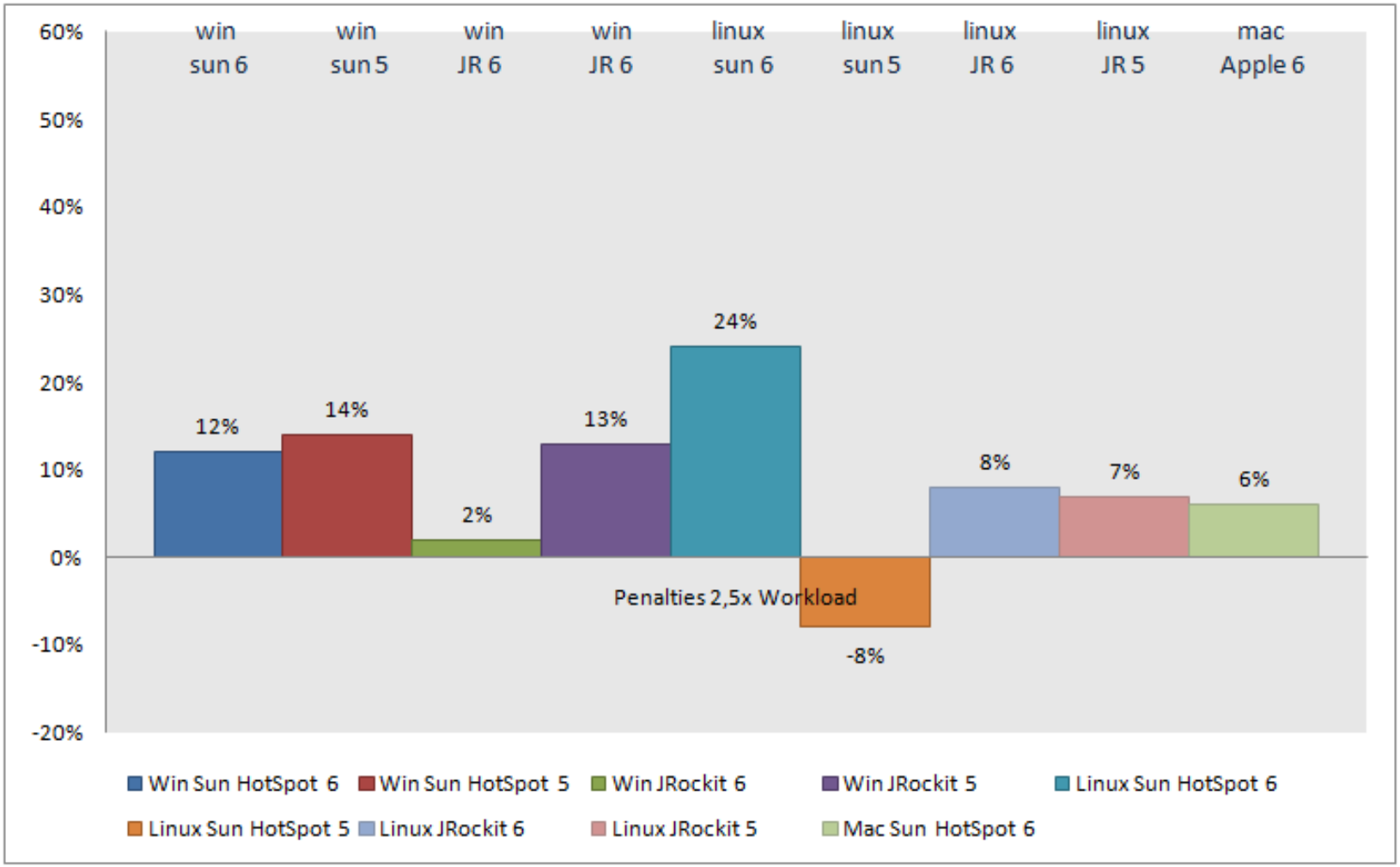
linux JR 6
linux JR 5
mac Apple 6
32%
14%
31%
20%
22%
0%
6%
13%
7%
Penalties 2x Workload
Win Sun HotSpot 6
Win Sun HotSpot 5
Win JRockit 6
Win JRockit 5
Linux Sun HotSpot 6
Linux Sun HotSpot 5
Linux JRockit 6
Linux JRockit 5
Mac Sun HotSpot 6

Conclusion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linux sun 6
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linux JR 6
linux JR 5
mac Apple 6
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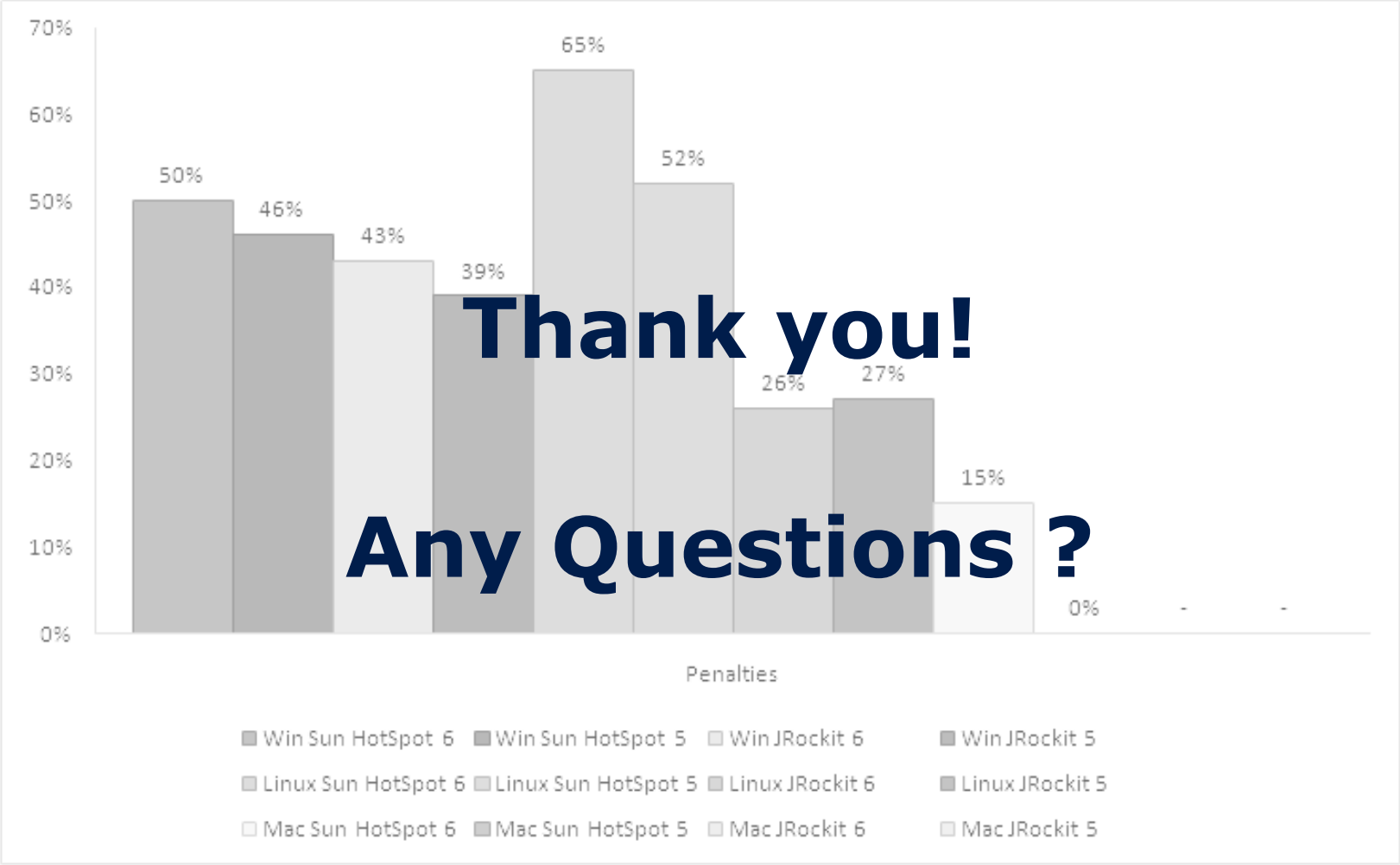
2%
13%
24%
-8%
8%
7%
6%
Penalties 2,5x Workload
Win Sun HotSpot 6
Win Sun HotSpot 5
Win JRockit 6
Win JRockit 5
Linux Sun HotSpot 6
Linux Sun HotSpot 5
Linux JRockit 6
Linux JRockit 5
Mac Sun HotSpot 6

Conclusion

- Valuable penalties (up to 50%)
- The more workload, the lower the penalty!
- 64bit JVMs give much better performance, than 32bit JVMs (at most **6%** penalty !)



Thank you!

Any Questions ?