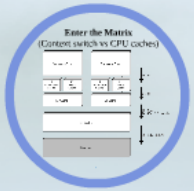
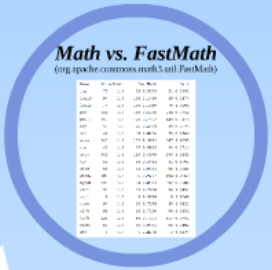
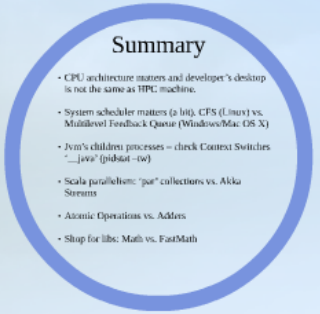
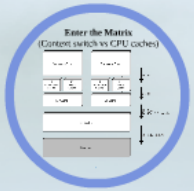


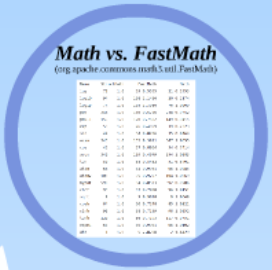


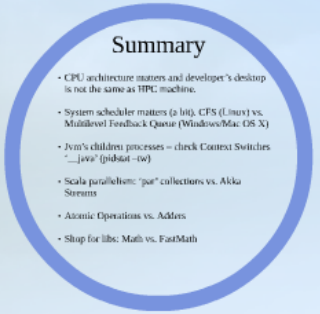


Scala on 40-core machine

Leszek Sliwko



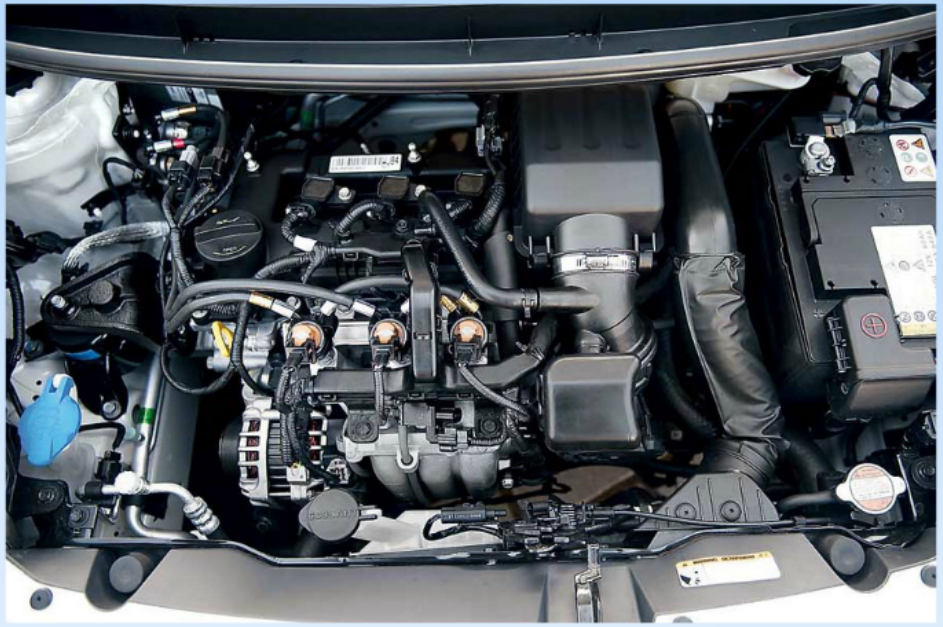




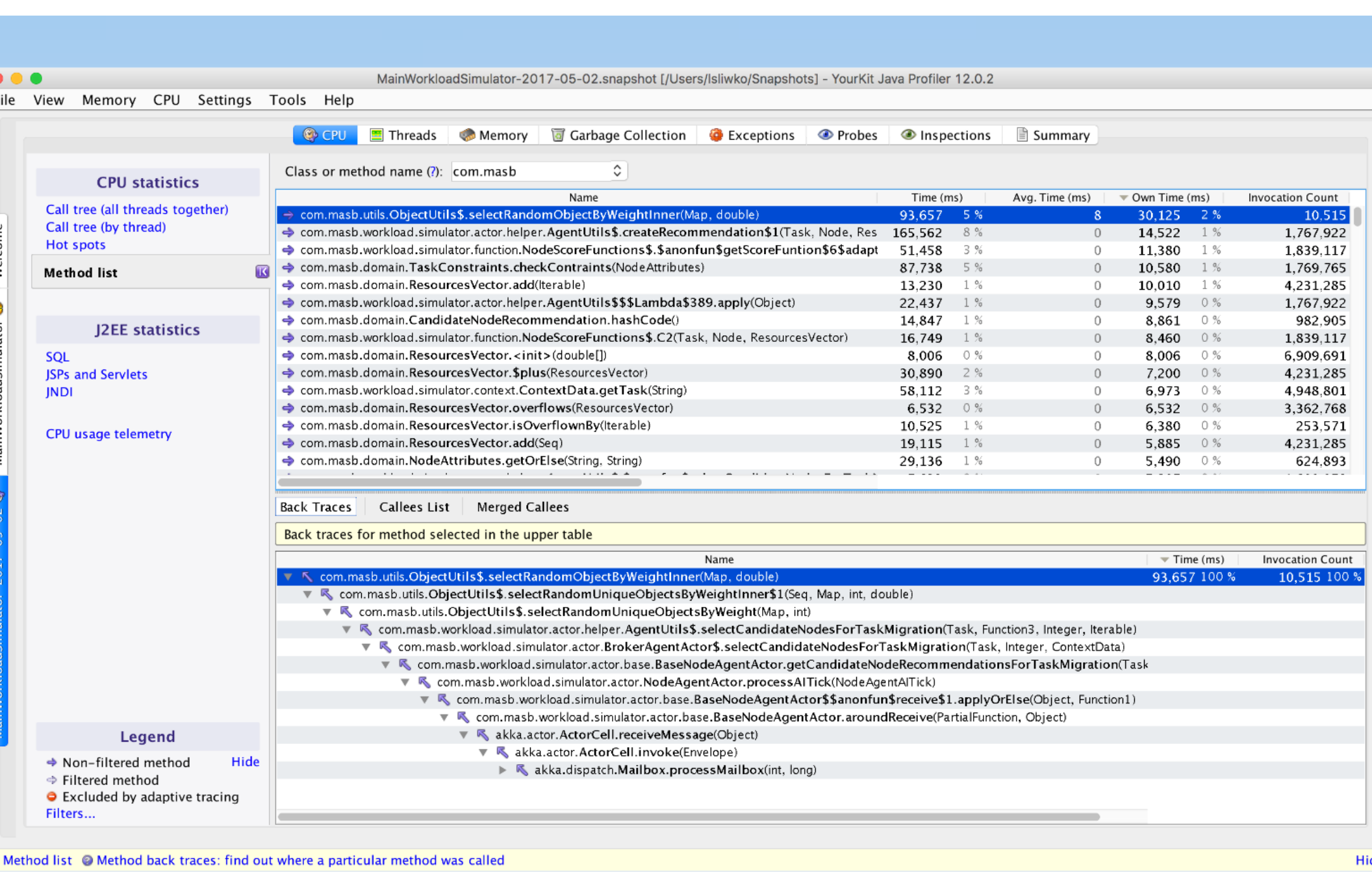
Scala on 40-core machine

Leszek Sliwko

JVM is complex!

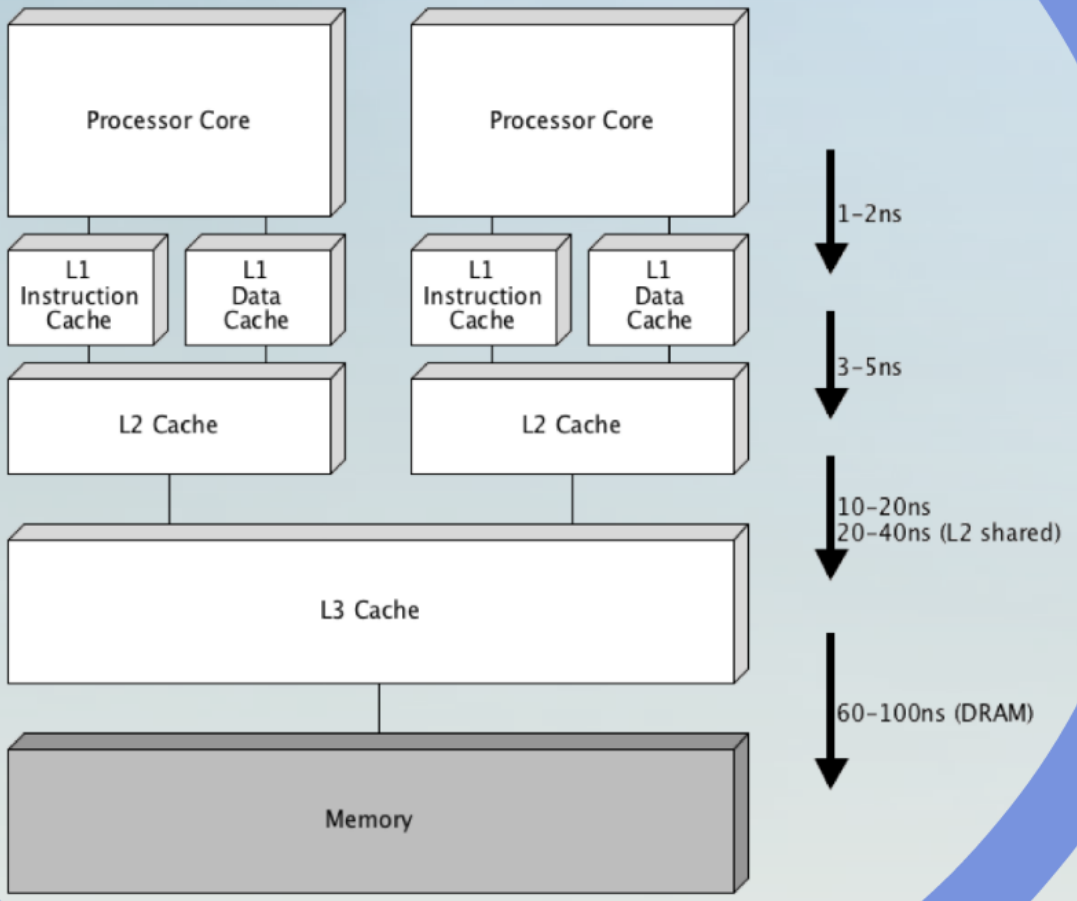


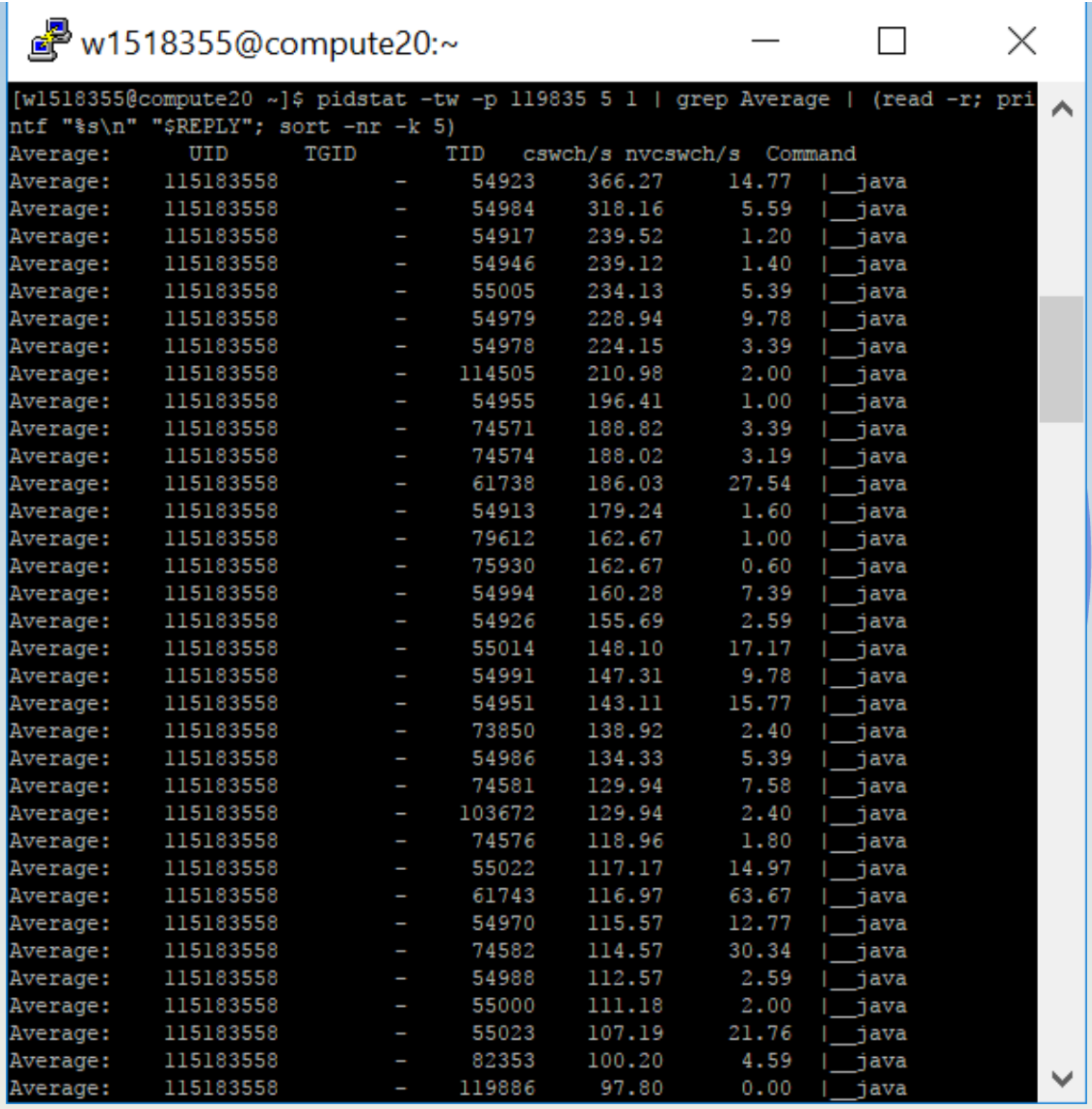
Java HotSpot, Compressed Oops, Branch Prediction, Null Check Elimination, Loop Unrolling, Inlining Methods, Thread fields and Thread Local Storage, Uncontended Synchronization, and so on.



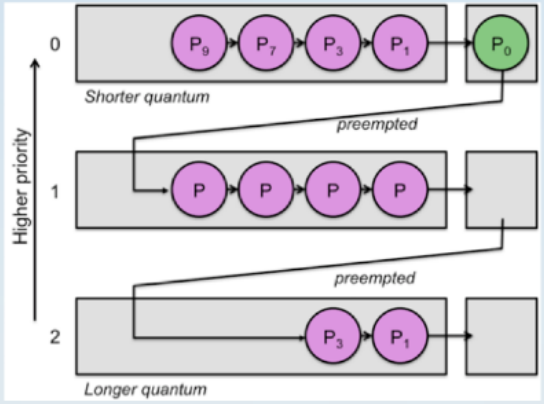
Profiler is your friend!

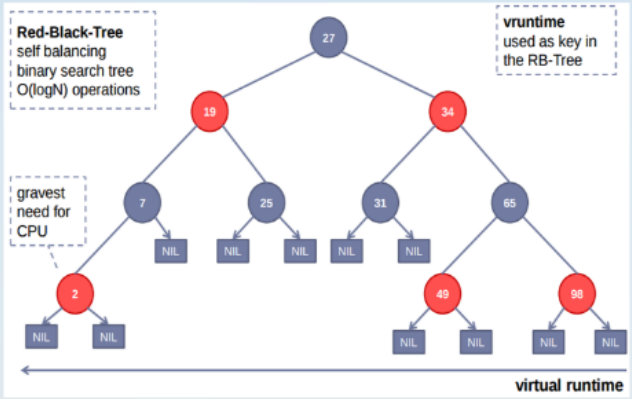
Enter the Matrix
(Context switch vs CPU caches)




w1518355@compute20:~
[w1518355@compute20 ~]$ pidstat -tw -p 119835 5 1 | grep Average | (read -r; pri
ntf "%s\n" "$REPLY"; sort -nr -k 5)
Average: UID   TGID   TID   cswch/s nvcswch/s Command
Average: 115183558   -   54923   366.27   14.77 |__java
Average: 115183558   -   54984   318.16   5.59 |__java
Average: 115183558   -   54917   239.52   1.20 |__java
Average: 115183558   -   54946   239.12   1.40 |__java
Average: 115183558   -   55005   234.13   5.39 |__java
Average: 115183558   -   54979   228.94   9.78 |__java
Average: 115183558   -   54978   224.15   3.39 |__java
Average: 115183558   -   114505   210.98   2.00 |__java
Average: 115183558   -   54955   196.41   1.00 |__java
Average: 115183558   -   74571   188.82   3.39 |__java
Average: 115183558   -   74574   188.02   3.19 |__java
Average: 115183558   -   61738   186.03   27.54 |__java
Average: 115183558   -   54913   179.24   1.60 |__java
Average: 115183558   -   79612   162.67   1.00 |__java
Average: 115183558   -   75930   162.67   0.60 |__java
Average: 115183558   -   54994   160.28   7.39 |__java
Average: 115183558   -   54926   155.69   2.59 |__java
Average: 115183558   -   55014   148.10   17.17 |__java
Average: 115183558   -   54991   147.31   9.78 |__java
Average: 115183558   -   54951   143.11   15.77 |__java
Average: 115183558   -   73850   138.92   2.40 |__java
Average: 115183558   -   54986   134.33   5.39 |__java
Average: 115183558   -   74581   129.94   7.58 |__java
Average: 115183558   -   103672   129.94   2.40 |__java
Average: 115183558   -   74576   118.96   1.80 |__java
Average: 115183558   -   55022   117.17   14.97 |__java
Average: 115183558   -   61743   116.97   63.67 |__java
Average: 115183558   -   54970   115.57   12.77 |__java
Average: 115183558   -   74582   114.57   30.34 |__java
Average: 115183558   -   54988   112.57   2.59 |__java
Average: 115183558   -   55000   111.18   2.00 |__java
Average: 115183558   -   55023   107.19   21.76 |__java
Average: 115183558   -   82353   100.20   4.59 |__java
Average: 115183558   -   119886   97.80   0.00 |__java

OS Scheduler matters too! (a bit)





Sources: https://www.cs.rutgers.edu/~pxk/416/notes/07-scheduling.html, https://stackoverflow.com/questions/34442691/linux-kernel-task-h-load

"Let's face it - the current scheduler has the same old basic structure that it did almost 10 years ago, and yes, it's not optimal, but there really aren't that many real-world loads where people really care. I'm sorry, but it's true." Linus. (http://tech-insider.org/linux/research/2001/1215.html)

(742 commits to fair.c since November 2011)

The Good, the Bad...

```
val numbers  = 1 to 10000

numbers.par.foreach{calculate(_)}

val futures = for (i <- numbers) yield Future {calculate(i)}
Await.ready(Future.sequence(futures), Duration.Inf)
```

...and the Ugly (Akka Streams)

```
Source(numbers)
    .groupBy(cpuCount, number => number.hashCode % cpuCount)
    .async
    .via(Flow[Int].map(calculate(_)))
    .async
    .mergeSubstreams
    .runWith(Sink.ignore)
```

Beware of auto-folding

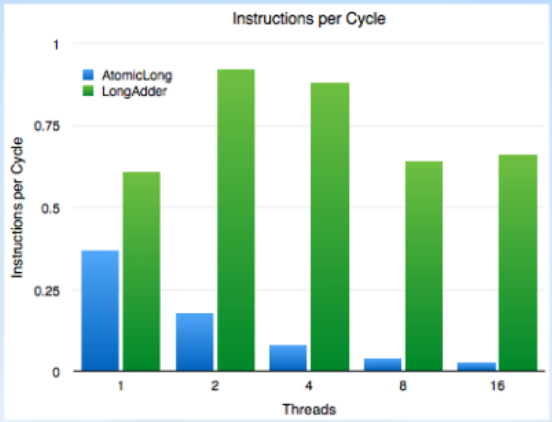
Complex configuration!

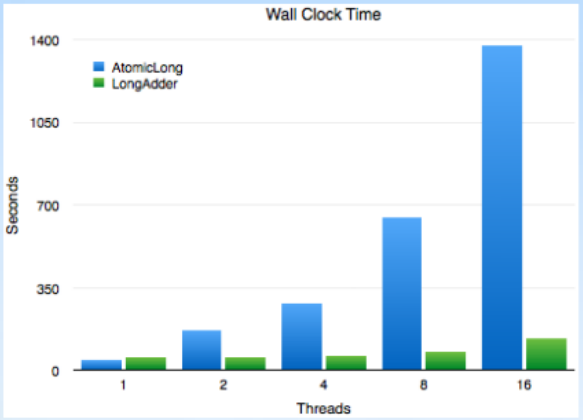
```
akka {
  scheduler {
    implementation = akka.actor.LightArrayRevolverScheduler
    ticks-per-wheel = 32
  }
  actor {
    serialize-messages = off
    default-dispatcher {
      executor = thread-pool-executor
```

Complex configuration!

```
akka {
   scheduler {
     implementation = akka.actor.LightArrayRevolverScheduler
     ticks-per-wheel = 32
   }
   actor {
     serialize-messages = off
     default-dispatcher {
       executor = thread-pool-executor
       thread-pool-executor.core-pool-size-factor = 2.0
       thread-pool-executor.core-pool-size-max = 1000
       throughput = 128
     }
   }
 ...
}
```

Doom Upon All The World
(AtomicXXX)





Source: http://blog.palominolabs.com/2014/02/10/java-8-performance-improvements-longadder-vs-atomiclong/

- AtomicLong - all L1/L2 caches have to synchronise
- LongAdder - synchronises only on get
- -XX:+UseBiasedLocking
- Random.nextInt uses AtomicLong (use ThreadLocalRandom)

Math vs. FastMath

(org.apache.commons.math3.util.FastMath)

Name	StrictMath		FastMath		Math	
log	71	1.0	39	0.5555	21	0.2953
log10	94	1.0	108	1.1466	20	0.2174
log1p	74	1.0	103	1.3986	76	1.0269
pow	244	1.0	140	0.5726	238	0.9752
powII	159	1.0	120	0.7582	149	0.9415
exp	53	1.0	26	0.4959	39	0.7323
sin	42	1.0	34	0.8286	35	0.8464
asin	345	1.0	135	0.3911	347	1.0055
cos	46	1.0	37	0.8064	34	0.7414
acos	340	1.0	139	0.4079	354	1.0383
tan	80	1.0	68	0.8462	51	0.6461
atan	64	1.0	64	0.9931	66	1.0285
atan2	103	1.0	95	0.9257	104	1.0069
hypot	598	1.0	34	0.0573	592	0.9906
cbrt	95	1.0	67	0.7088	96	1.0151
sqrt	9	1.0	9	0.9818	9	1.0069
cosh	84	1.0	60	0.7248	85	1.0221
sinh	95	1.0	68	0.7159	98	1.0352
tanh	120	1.0	86	0.7193	117	0.9751
expm1	66	1.0	66	0.9961	66	1.0102
abs	1	1.0	5	2.8708	2	1.4429

Summary

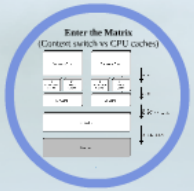
- CPU architecture matters and developer's desktop is not the same as HPC machine.
- System scheduler matters (a bit). CFS (Linux) vs. Multilevel Feedback Queue (Windows/Mac OS X)
- Jvm's children processes – check Context Switches '__java' (pidstat –tw)
- Scala parallelism: 'par' collections vs. Akka Streams
- Atomic Operations vs. Adders
- Shop for libs: Math vs. FastMath

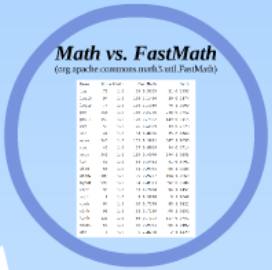
Other Notes

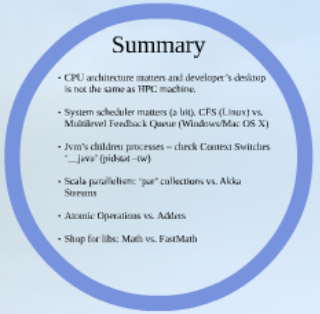
- YourKit Java Profiler: https://www.yourkit.com/java/profiler/features/
- Scala Boxing/Unboxing: https://stackoverflow.com/questions/6494860/how-to-spot-boxing-unboxing-in-scala
- Java HotSpot VM Options: http://www.oracle.com/technetwork/articles/java/vmoptions-jsp-140102.html
- 'for' vs. 'while' loop: https://stackoverflow.com/questions/16785826/why-are-scala-for-loop-comprehensions-so-very-slow-compared-to-for-loops
- Specialised arrays: https://www.scala-lang.org/old/node/10408.html
- Java's ConcurrentSkipListMap: https://docs.oracle.com/javase/7/docs/api/java/util/concurrent/ConcurrentSkipListMap.html

THANK YOU!

Questions?







Scala on 40-core machine

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