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Java Virtual Machine Strategy

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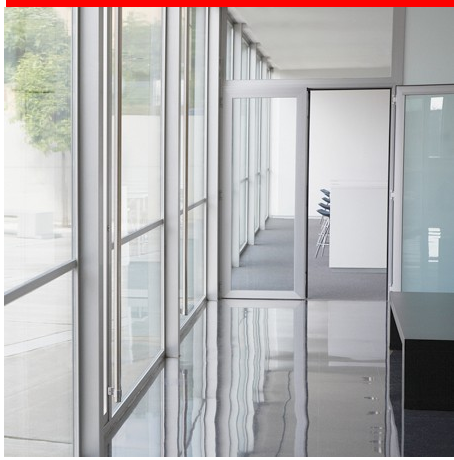
Agenda

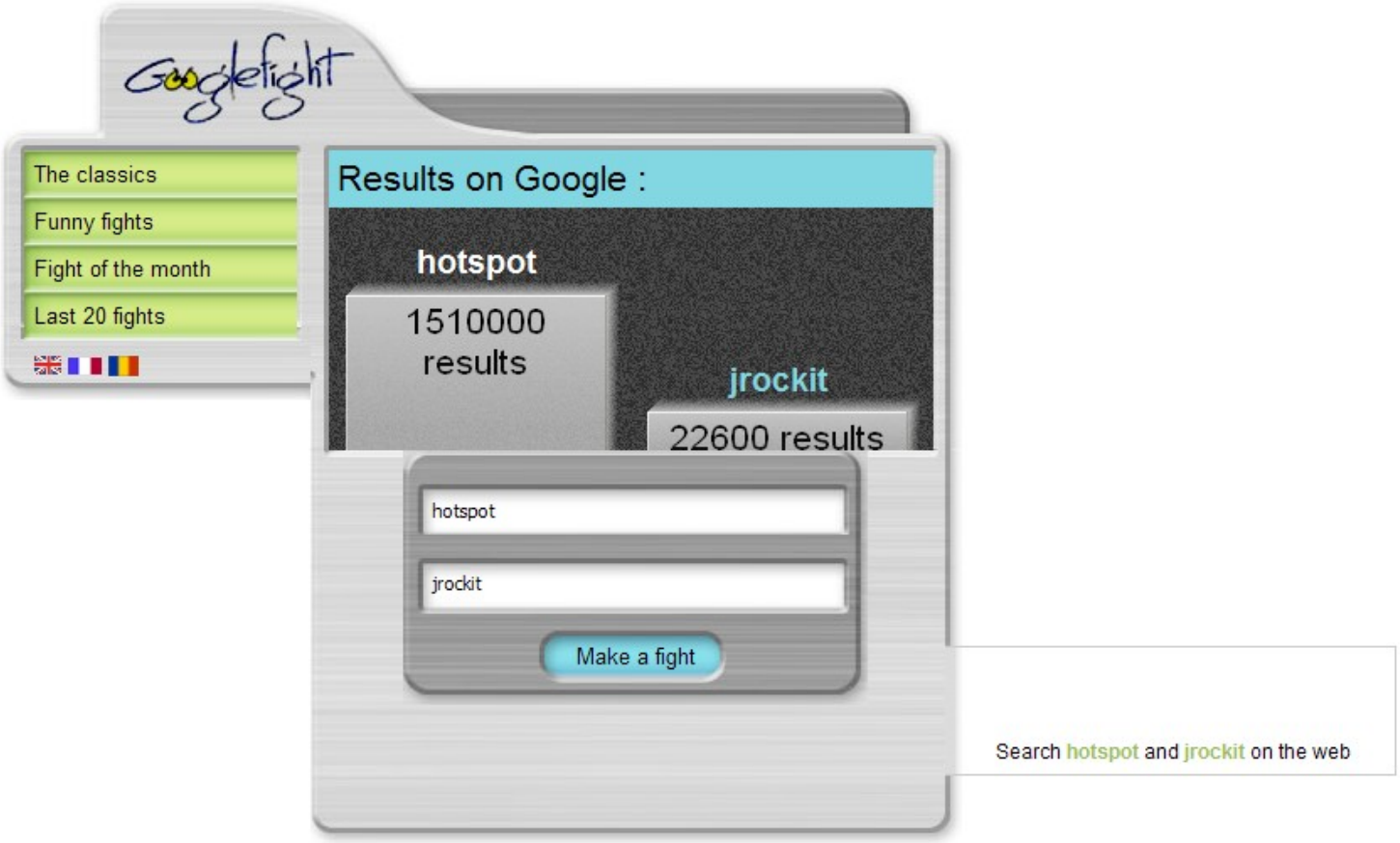


- Oracle's JVM Strategy
- Product Update
  - HotSpot
  - JRockit
- JVM Roadmap
  - Convergence Projects
  - Futures

Our Dilemma

- Two mainstream JVMs
- HotSpot
  - Versatile (client and server), market share leader, high quality and performance
- JRockit
  - Specialized for the Oracle server stack, basis of value-adds like Mission Control, Virtual Edition and Soft Real-Time
- Wasteful to continue development on both, so
- Goal: Single JVM incorporating best features
  - Pick one code base, port features from the other to make the result better than *both* parents everywhere it counts!
  - After much deliberation and business and technical due diligence over several months, it came down to ...

Hmm…



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Ok, let's be serious

- Technical due diligence did not point to a clear winner
- Way more engineers working on HotSpot, so
- Converged JVM based on HotSpot with all goodness from JRockit
- Open-sourced via OpenJDK
  - Some value-add such as Mission Control will remain proprietary
- Free binary download includes closed source goodies
  - Same use license as before
- Oracle committed to continued investment
  - JVM teams have been merged, working on feature transfer
  - And moving forward on new projects
- Will be a multi-year process

Shocking Discovery

- “Great minds think alike.”
- HotSpot and JRockit were already converging
- Similar market requirements lead to similar features
- E.g., escape analysis
  - Optimize use of objects allocated and used by only a single thread
- E.g., to get incremental GC, divide and conquer
  - Deterministic GC: power-of-2 number of heap regions
  - Garbage First: arbitrary number of heap regions

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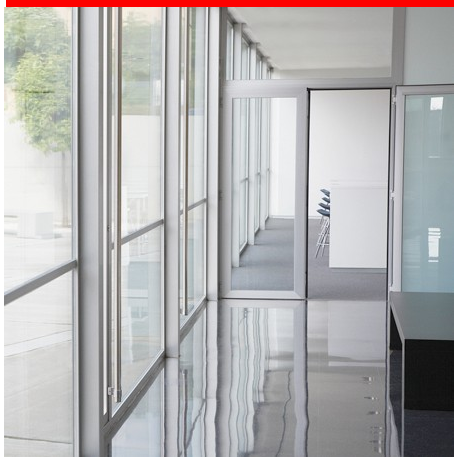

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JVM Enhancements YTD

- Java may have been moving slowly (we're fixing that) but the JVMs have not!
- JVM decoupled from JDK since 2005 (JRockit) and 2007 (HotSpot)
  - Will remain decoupled
- Aggressive, incremental enhancements to both JRockit and HotSpot over the past year

HotSpot Recent Goodies (1)

- Up to 32 GB heap compressed pointer JVM
  - Three variations, fastest first: < 4gb, up to ~26gb, up to 32gb
  - x64 JVM now as fast or faster than 32-bit x86 JVM
- NUMA garbage collector enhancements
  - Good parallel collector scaling beyond a single socket
  - -XX:+UseNUMA with parallel collector chunks the young generation on a per-socket basis: assumes transient data is local to a socket
  - Survivor space and old generation interleaved across sockets: assumes surviving data is shared across sockets
- Optimized String concatenation
  - Use a single char[] temporary for multiple concatenations

HotSpot Recent Goodies (2)

- Garbage First collector
  - Consistent low pause times with very large heaps
  - Stop-the-world, region based, incrementally compacting, prefer to collect regions that are mostly garbage
  - Eventual CMS replacement
  - Still experimental but getting there!
- Optimized and intrinsified array copy and fill
  - SSE4.2 support on x86/x64
- Compressed Strings
  - String object points to either a byte[] or a char[]
  - Starts out as byte[] unless locale requires char[]
  - Can drastically reduce heap footprint
- Escape analysis, on by default
- Many, many, many bugfixes and small enhancements

JRockit R28 (1)

- Next-generation JRockit, released early 2010
- Themes: Robustness, Serviceability, Performance
- Robustness
  - Cooperative Thread Suspension
  - More robust JIT compiler (no more native OOM)
  - White box testing APIs
  - Refactored codebase for maintainability
- Serviceability
  - JRockit Flight Recorder
  - HPROF heap dump support
  - Enhanced JMX agent
  - Native memory tracking
  - Fine granular compiler directives

JRockit R28 Goodies (2)

- Performance
  - Up to 64 GB compressed references (was 4 GB)
  - Up to 30% lower GC pause times overall
- Flight Recorder
  - Major serviceability effort integrated into Mission Control
  - New event mechanism integrated with logging
  - Java event API: integrated app and JVM events
  - Event ring buffer can be saved and inspected, captures info when problems happen
  - User-specified overhead, default low enough for production use

JVM Recommendation for Oracle Customers

- HotSpot
  - Oracle Apps and Middleware on Solaris
  - Client and non-Oracle Apps on Solaris/Windows/Linux
- JRockit
  - Oracle Apps and Middleware on Windows/Linux
- Recommendation only; use what works best for you

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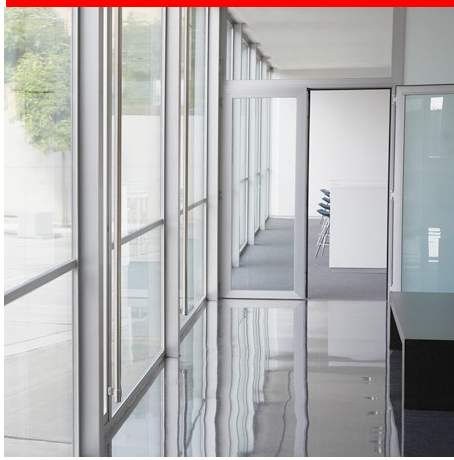

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Convergence Projects: JRockit Value-Add (1)

- Over roughly the next 2 years, incrementally deliver
- Mission Control and Flight Recorder Support
  - MC console UI and enhanced JMX agent support
  - Support for FR´s unified event and logging mechanisms
- No artificial class metadata size limit
  - App servers load or reload an unpredictable number of classes, often exceeding fixed size bounds
  - Eliminate the Permanent Generation, move metadata to native memory
  - Metadata size limited by virtual address space size
- Zero-copy I/O
  - JRockit can pin objects in place
  - Delaying GC until I/O is done may work too

Convergence Projects: JRockit Value-Add (2)

- Native memory tracking and its MBean
  - As JRockit R28
- GC and compiler control APIs
  - As JRockit R28
- Non-contiguous Java heap for 32-bit Windows
- Virtual Edition support
  - True Java virtual appliances!
- Soft real-time GC
  - Adopt the best from JRockit Deterministic GC
- 8-byte object headers for 64-bit JVMs
  - Adopt JRockit lock reservation and thin lock scheme

Futures: What's Next (1)

- Internal restructuring as necessary to improve reliability and maintainability
- The Practically Pauseless (and Scalable) VM
  - Garbage First as a large-heap CMS replacement
  - Garbage First concurrent evacuation
  - Plus super secret hush-hush project
- (Much) improved NUMA GC support
  - Vertical (multi-socket) scalability
- Pervasive ergonomics
  - Just say "java"
  - Internal and external ergonomics: "good citizen"
  - Per-app/user run history feedback, minimize time to optimized performance

Futures: What's Next (2)

- Improved support for dynamic languages
  - Particularly JavaScript
  - Hidden classes and fixnums
- Much faster startup, smaller footprint
  - MVM: multiple applications in a single JVM process
    - Share metadata and compiled code while preserving isolation
    - Per-task Java heaps and GC policies
  - Application class data sharing (saved class metadata)
  - Ahead-of-Time compilation
    - Of static initializers!
  - Tie-in to pervasive ergo and Java modules
- Faster native code interfaces: C <-> Java
  - JNI designed to be difficult to use: invent something else

Futures: What's Next (3)

- Improved inter-procedural analysis, more aggressive inlining, dependence-based vectorizer
  - Expands scope for escape analysis
  - Intel AVS SIMD and GPU support
  - JOCL (Java OpenCL wrapper) and a Java equivalent of Apple's Grand Central Dispatch
  - Resurrect Java Grande: HPC in Java
- G1-lite
  - Incremental GC for single-hardware-thread machines integrated into the Garbage First framework
- Platform support
  - ARM and PPC server compiler ports
  - MIPS support

Futures: What's Next (4)

- Resource Monitoring and Management APIs
  - Great for virtualization and cloud-awareness
  - Enables detailed chargeback
- Next-gen Java (?!) Mission Control
  - Continued enhancements in diagnostics, profiling, monitoring and management

Summary

- JRockit and HotSpot continue
  - Incremental feature enhancements as needed
  - Will be maintained for years to come
- *Current* R&D projects
  - Cross-pollination of QA and performance
  - Convergence
  - JDK 7 related – invokedynamic, etc.
  - Startup time – aiming to solve this once and for all!
  - Low pause GC
  - Performance – a Sisyphean task…
- First converged JVM based on HotSpot in CY2011
  - With JDK 7?
  - First batch of servicability and performance features
    - JRockit JMX agent, JRMC support and more!

Q & A

Related Sessions

- Monday
  - Oracle JRockit: Advances in Java Virtual Machine Technology (4 pm)
- Tuesday
  - How to Tune and Write Low-Latency Applications on the Java Virtual Machine (11:30 am)
  - JVM Analysis: Oracle JRockit Mission Control and Oracle JRockit Flight Recorder (1 pm)
  - Performance and Debugging Advancements in OpenJDK (6 pm)
- Wednesday
  - Experience Talk: Understanding Adaptive Runtimes (10 am)
  - Showdown at the Java Virtual Machine Corral (4:45 pm)


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