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C++, Java and .NET:

Lessons learned from the Internet Age, and What it Means for the Cloud and Emerging Languages

Cameron Purdy
Vice President, Development

Overview

A retrospective of the trade-offs compared to C++ illustrated by Java, C# and other VM-based programming languages with Garbage-Collection, why scripting languages simultaneously thrived, and what this teaches us about the applicability of technology to emerging challenges and environments such as cloud computing.

About the Speaker: Cameron Purdy

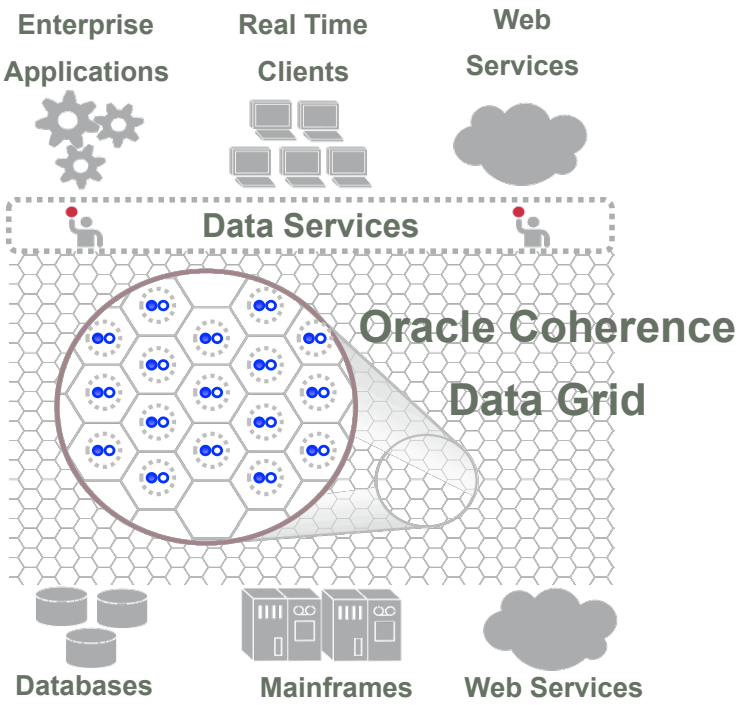
- Vice President of Development for Oracle Fusion Middleware, responsible for the Coherence Data Grid product, which has Java, C# and C++ versions
- Founder and CEO of Tangosol, acquired by Oracle in 2007
- Programming C++ since 1994, Java since 1996, Java EE since 1999, and C# since 2001

A word from our Sponsor

The Oracle Coherence In-Memory Data Grid is a data management system for application objects that are shared across multiple servers, require low response time, very high throughput, predictable scalability, continuous availability and information reliability.

Oracle Coherence Data Grid

Distributed in Memory Data Management

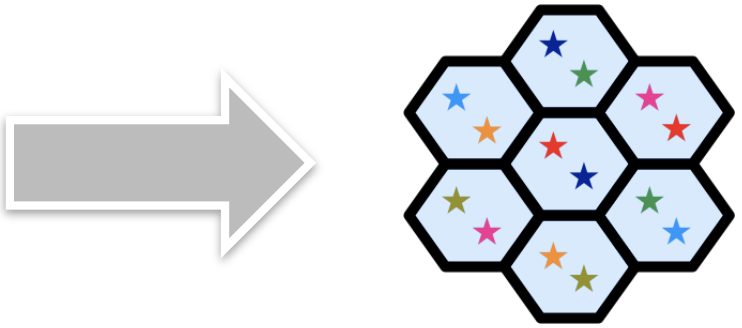


- Provides a **reliable data tier** with a single, consistent view of data
- Enables dynamic data capacity including **fault tolerance** and load balancing
- Ensures that **data capacity scales** with processing capacity

Oracle Coherence: How it Works

It's like RAID storage for Java Objects

Data is automatically partitioned and load-balanced across the Server Cluster

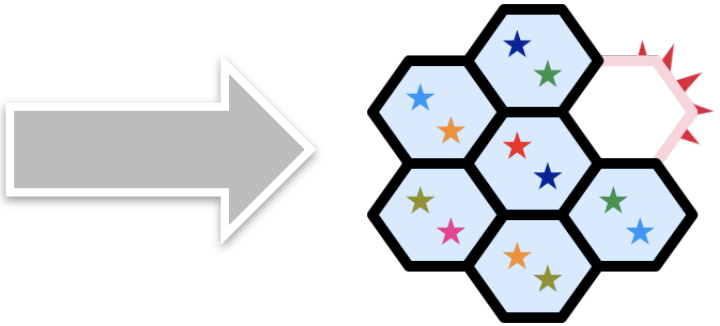


Data is synchronously replicated for continuous availability

Servers monitor the health of each other

When in doubt, servers work together to diagnose status

Healthy servers assume responsibility for failed server (in parallel)

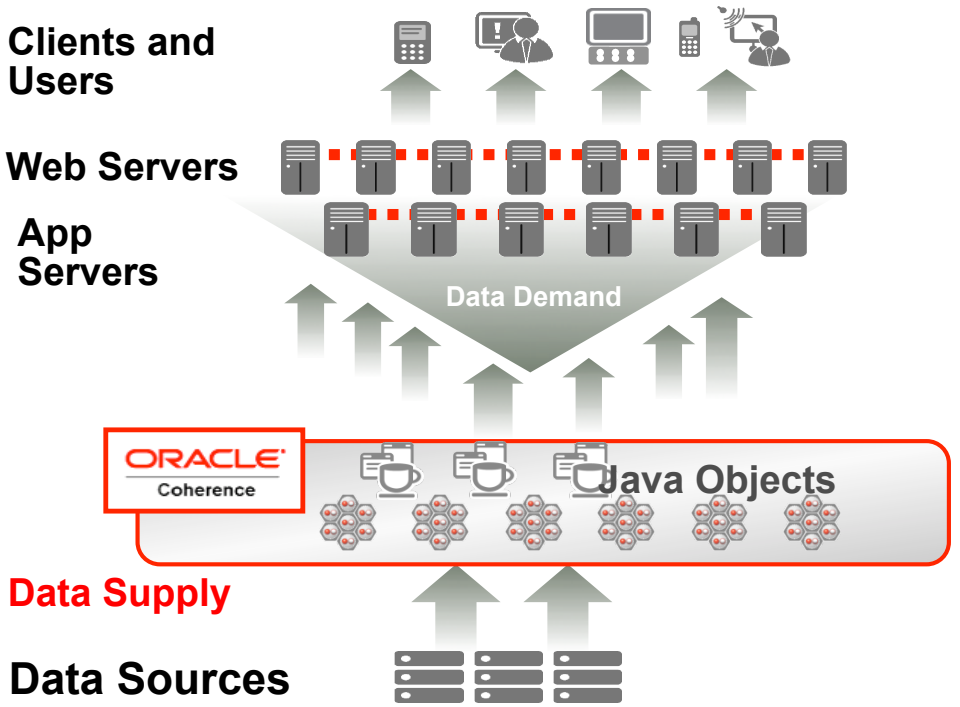


Continuous Operation: No interruption to service or data loss due to a server failure

Data Grid: Capability Summary

A Data Grid combines data management with data processing in a scale-out environment

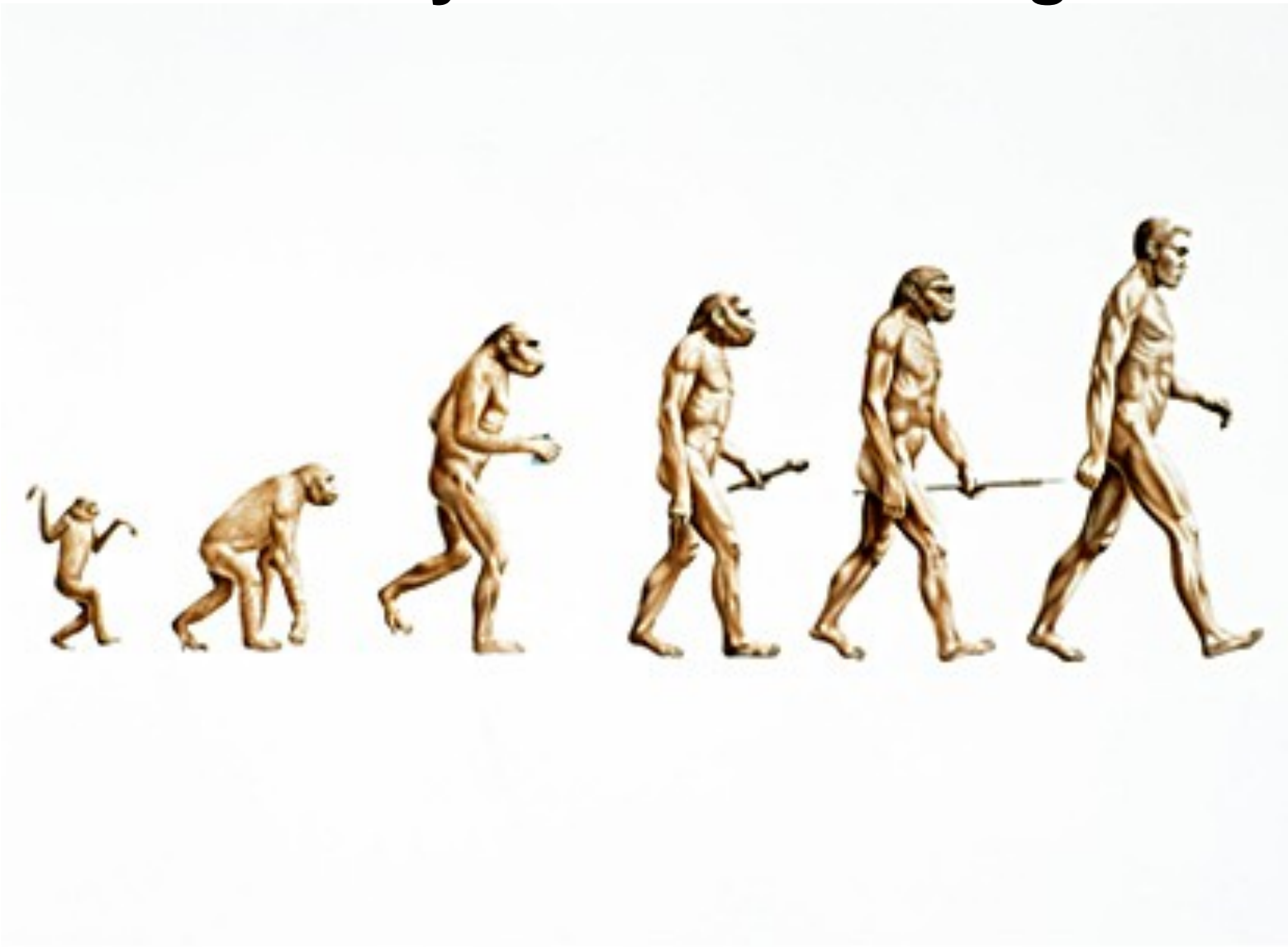
- Some or all of the servers in the grid are responsible for reliably managing live information
- Any or all of the servers in the grid are able to simultaneously access and manipulate a shared, consistent view of that information
- Processing power far exceeds aggregate network bandwidth, so data access and manipulation must be parallelized and localized within the grid
- Data locality is both dynamic and transparent



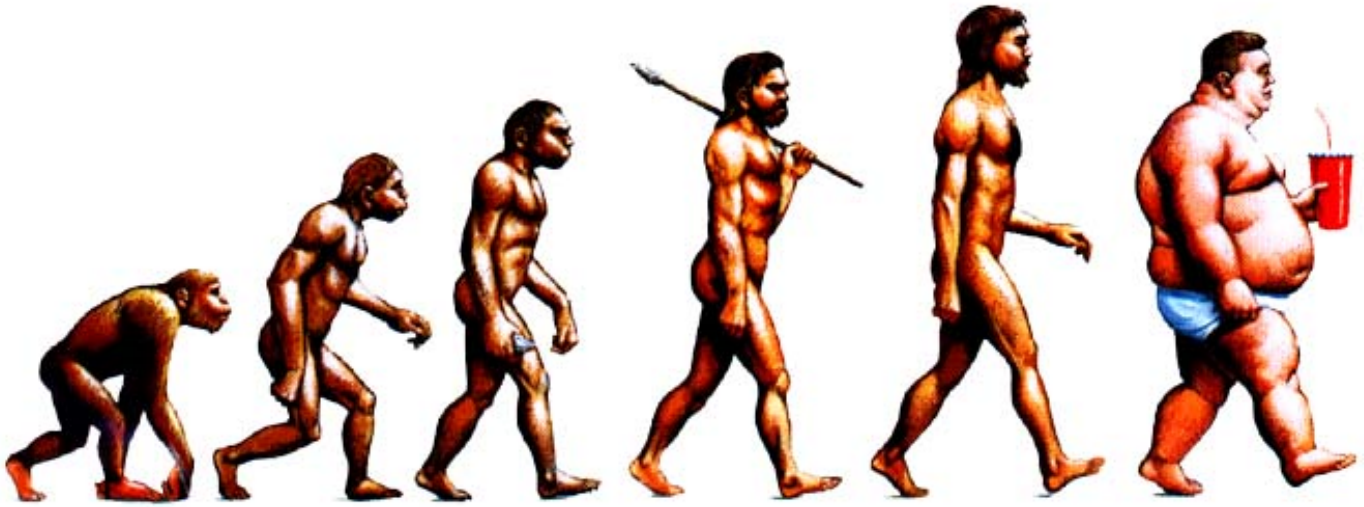
Disclaimer

The views expressed in this presentation are my own and do not necessarily reflect the views of my employer.

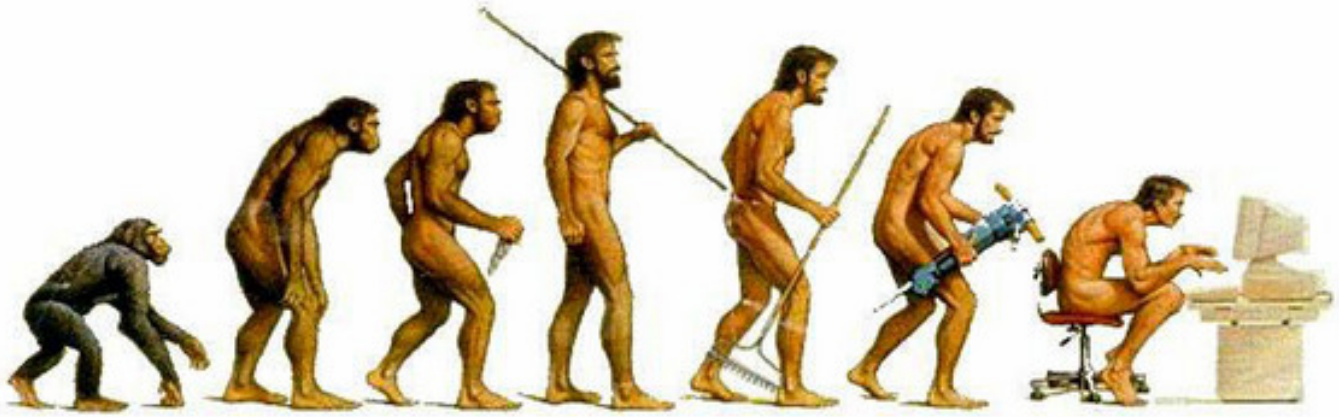
Java in the eyes of a Java Programmer



Java in the eyes of a C++ Programmer

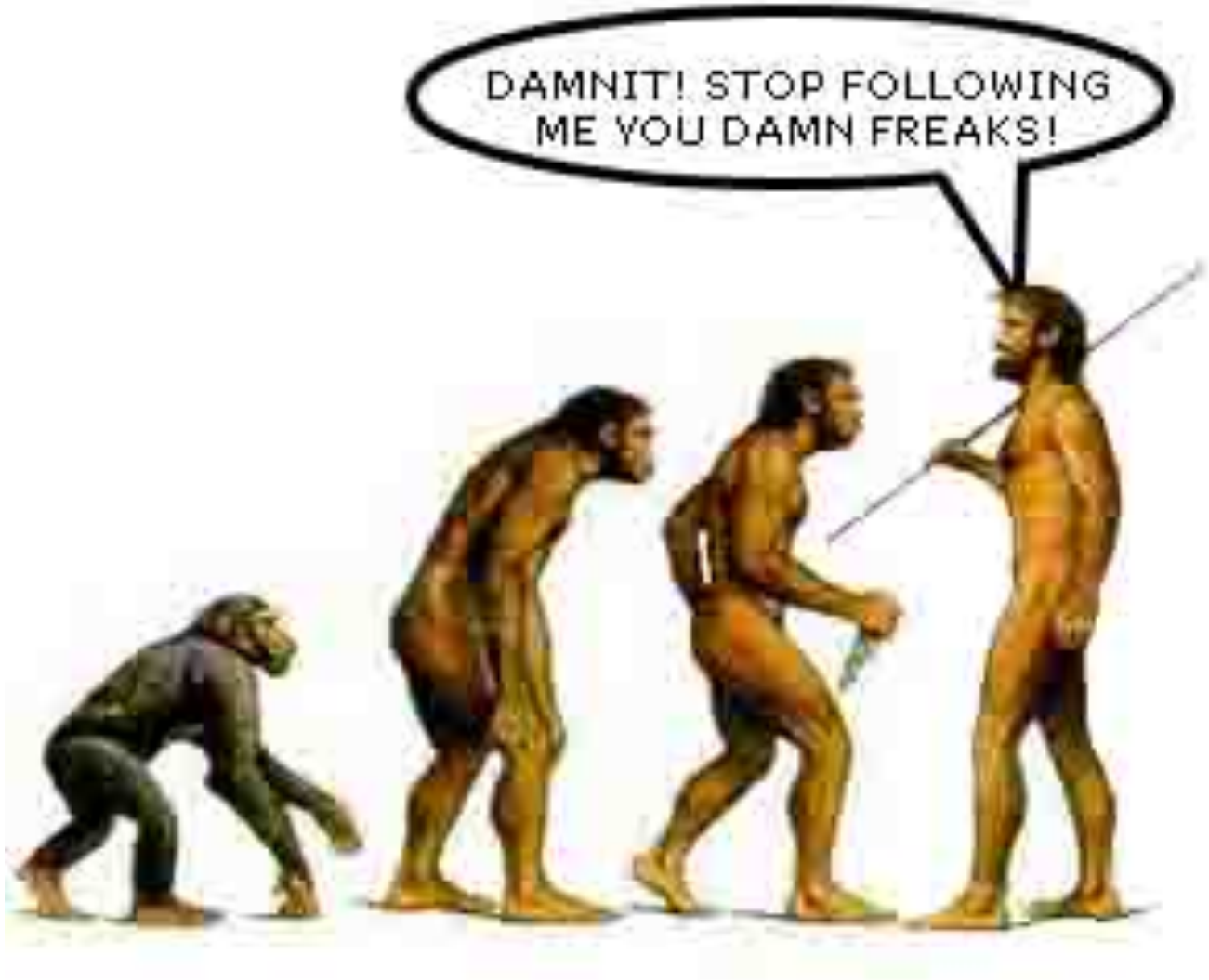


Java in the eyes of a Ruby Programmer



Java in the eyes of a Scala Programmer

Who needs the language when you have the JVM?


DAMNIT! STOP FOLLOWING
ME YOU DAMN FREAKS!

Top 10 Reasons Why Java *has* been able to supplant C++

Do not seek to follow in the footsteps of the men of old; seek what they sought.

- Matsuo Basho

Warning to Language Fanbois

Yes, I know that there are third party GC implementations for C++ and that you can get POSIX support on Windows from Cygwin, and ….

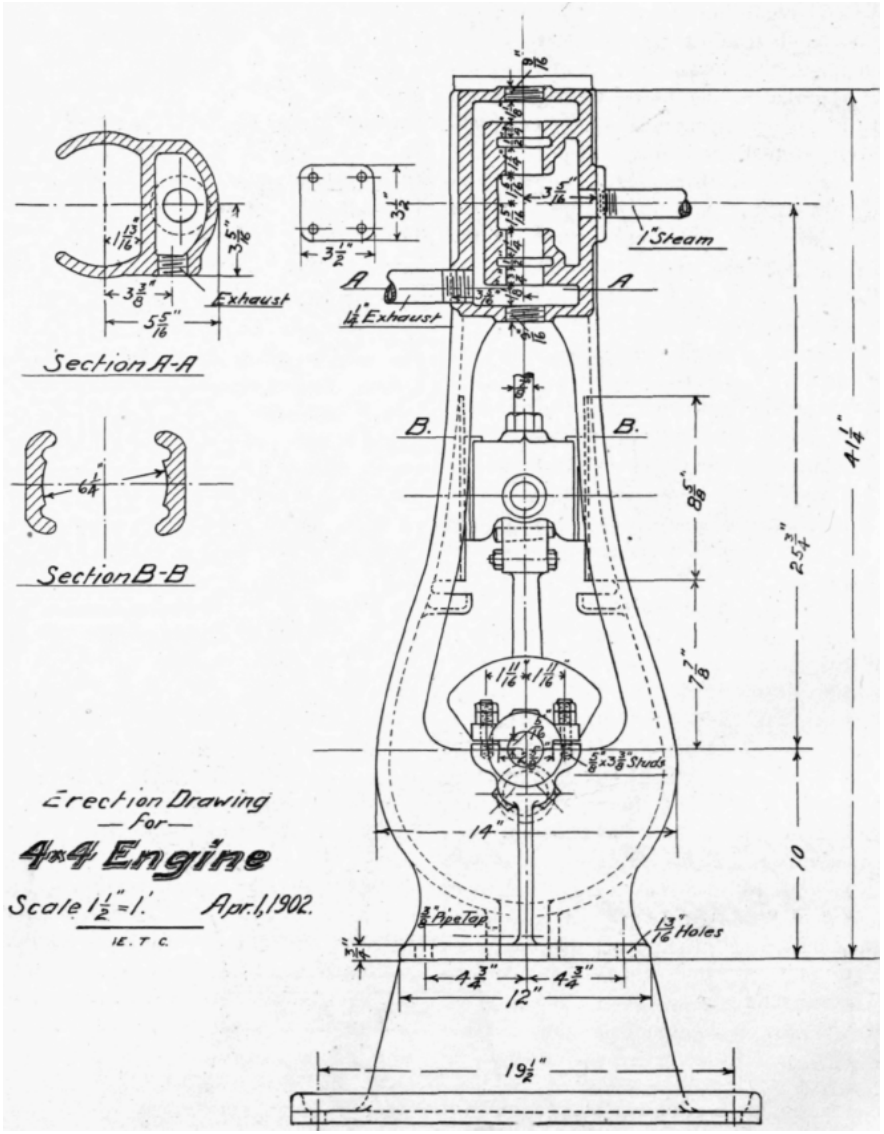
Don't go all Comicbook Guy on me. I'm describing reality as it *is*, not as how it *could* be.

10. Automated Garbage Collection

- A significant portion of C++ code is dedicated to memory management
- Cross-component memory management does not exist in C++
  - Libraries and components are harder to build and have less natural APIs
- Faster time to market, lower bug count

9. The Build Process

- C++ builds are slow and complicated
- Personal example: 20 hour full build in C++ compared to 7 minutes in Java
- Multiply that times two: For debugging C++, you need a second build
- Tools such as Ant & Maven are available in Java
  - *make*? *nmake*? Atrocious!



8. Simplicity of Source Code and Artifacts

- C++ splits source into header and implementation files
  - Header trawling
  - Require big monitor to see .hpp and .cpp at the same time
  - Code in multiple places: Some inlined in the header, some in the .cpp
- Artifacts are compiler-specific, but there are many of them
  - Java: Just one .java, one .class

7. Binary Standard

- In addition to being loadable as a class by a JVM, a Java Classfile can be used to compile against
  - C++ has no binary standard
  - Precompiled headers? Compiler and platform specific
  - C++ requires a large amount of source to be shipped in order to compile against it; brittle!
- Java defers platform-specific stuff to the runtime

6. Dynamic Linking

- No standard way to dynamically link to C++ classes
  - Compiler and platform specific
  - Messy at best
- Java allows arbitrary collections of classes to be packaged together and dynamically loaded and linked as needed
  - No DLL hell!

5. Portability

- Java is portable with very little effort; C++ is portable in theory, but in practice you have to build another language (#ifdef'd types, etc.) on top of it
- C++ has significant differences from vendor to vendor, e.g. standards support
  - Some *unnamed* major vendors have horrid support for the C++ standard, particularly templates
- "In theory, there's no difference between theory and practice"

4. Standard Type System

- Java has:
  - Specified, portable primitive types
  - Built in, specified, portable runtime library
  - Rich support for I/O, networking, XML/ HTML, database connectivity
- C++ has:
  - 16-bit? 32-bit? 64-bit? *80-bit!?!?*
  - Multi-threading? You must be joking
  - STL? Maybe some day
  - *Basically nothing is standard!*

3. Reflection

- Full runtime capability to look at the runtime
  - C++ has optional RTTI but no reflection
- Enables extremely powerful generic frameworks
  - Ability to learn about, access and manipulate any object

2. Performance

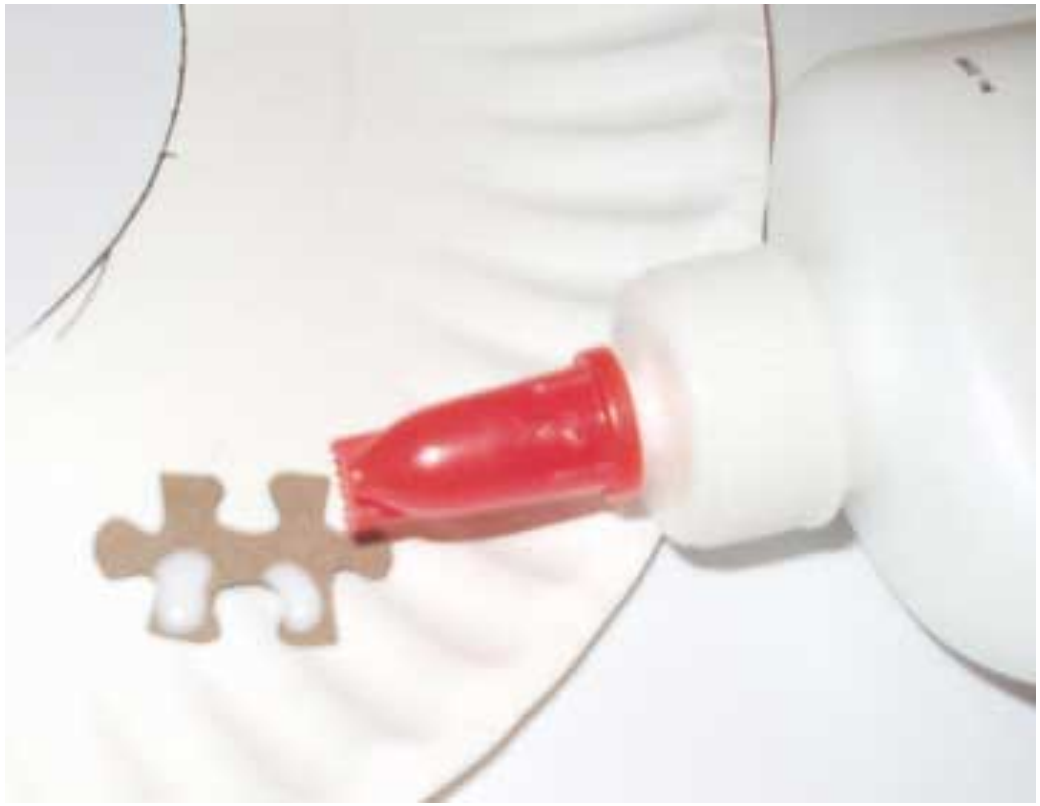
- GC can make memory management much more efficient
  - Slab allocators
  - Escape analysis
- Multi-threaded? No support in C++
- Thread safe smart pointers 3x slower than Java references
- Hotspot can do massive inlining
  - Very important for dealing with layers of virtual invocation

1. Safety

- Elimination of pointers
  - Arbitrary memory access
  - Ability to easily crash the process (core dump)
- No buffer overruns
  - Code and data cannot be accidentally mixed
- Bounds checked
  - All raw access via arrays and NIO buffers
  - Impossible to read/write outside of the bounds of either

Honorable Mention: C++ Templates

- Fugly
  - Atrocious syntax (IMHO)
  - Metaprogramming is near unreadable
  - Advanced features are not explainable to mortals
  - Only Bjarne understands
- Bloat
  - The compiler does the cut & paste for you
  - Personal example: 80MB binary



Top 10 Reasons Why Java has *not* been able to supplant C++

Old ideas give way slowly; for they are more than abstract logical forms and categories, they are habits, predispositions, deeply ingrained attitudes of diversion and preference.

- John Dewey

10. Startup Time

- The graph of initially loaded classes is pretty large
  - Loading
  - Validation
  - JITting
  - Initializer code
- The code is either getting JITted to native code each time the JVM starts, or it's initially being interpreted (Hotspot)
- Conclusion: Not good for "instant" and short-running processes

9. Memory Footprint

- Java uses significantly more memory than C++, particularly for “small” applications
  - Easily two orders of magnitude more at the extreme end of the scale
- Memory requirements limit Java adoption on some devices

8. Full GC Pauses

PRINCE FLORIMOND FINDS THE SLEEPING BEAUTY

- Sooner or later, there is a part of GC that can't be run in the background and can't be avoided
  - Results in a temporary halt
  - Makes real time impossible
- Havoc for distributed systems
  - Is the process dead? Locked up? Or in GC?
- Possible partial amelioration by increasing the memory footprint

7. No Deterministic Destruction

- No support for RAII
- Cannot count on finalizers
  - What if you own a socket? A thread? A mutex!?!?
- Not even a “using” construct in Java (there is one in C#)

6. Barriers to Native Integration

- Operating Systems are built in C/C ++
  - APIs are typically C
  - Native GUIs and other OS-level functionality often require C (e.g. cdecl or pascal) callbacks
- JNI allows Java to call … native code that was written explicitly to be called by JNI

So it wasn't a Top 10 list …

Top ~~10~~ 5 Reasons Why Java has *not* been able to supplant C++

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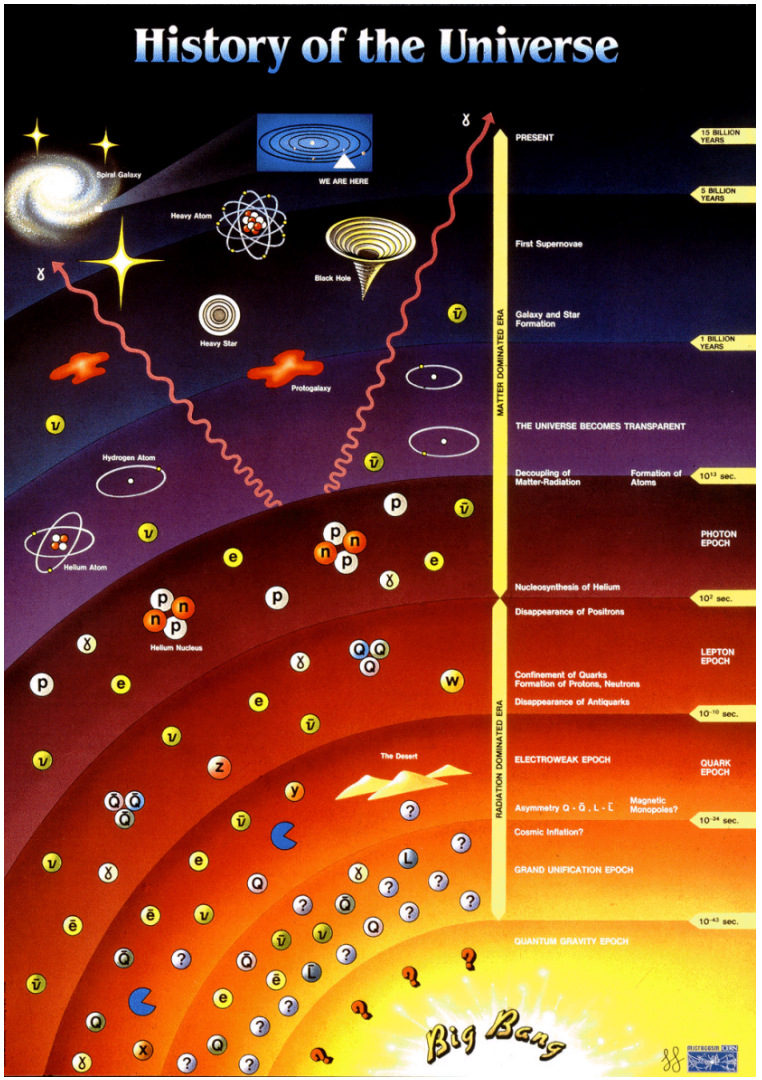
- John Dewey

Understanding the Shift to Java and C#

- Shift Happens
  - Internet & the World Wide Web
  - HTML Browser: No client-side software *per application*, no installation, no configuration
    - Eliminated startup time, memory footprint and native (e.g. GUI) integration benefits of C++
  - Required faster iterative development, better class libraries, modularity, long running capability (no memory leaks), multi-threading support and safety on the server



Scripting Languages

- Simplicity & Approachability
  - Hooks up to databases
  - Manages state on behalf of the user
  - Produces HTML
- Rapid Application Development
  - No OO Architectural Requirements
  - No compile step; save and refresh
- High Density
  - Designed for shared hosting
  - Much lower initial memory footprint
  - Stateless processes are easy to scale in the small, and easy to cycle

Cloud Computing

New roads; new ruts.

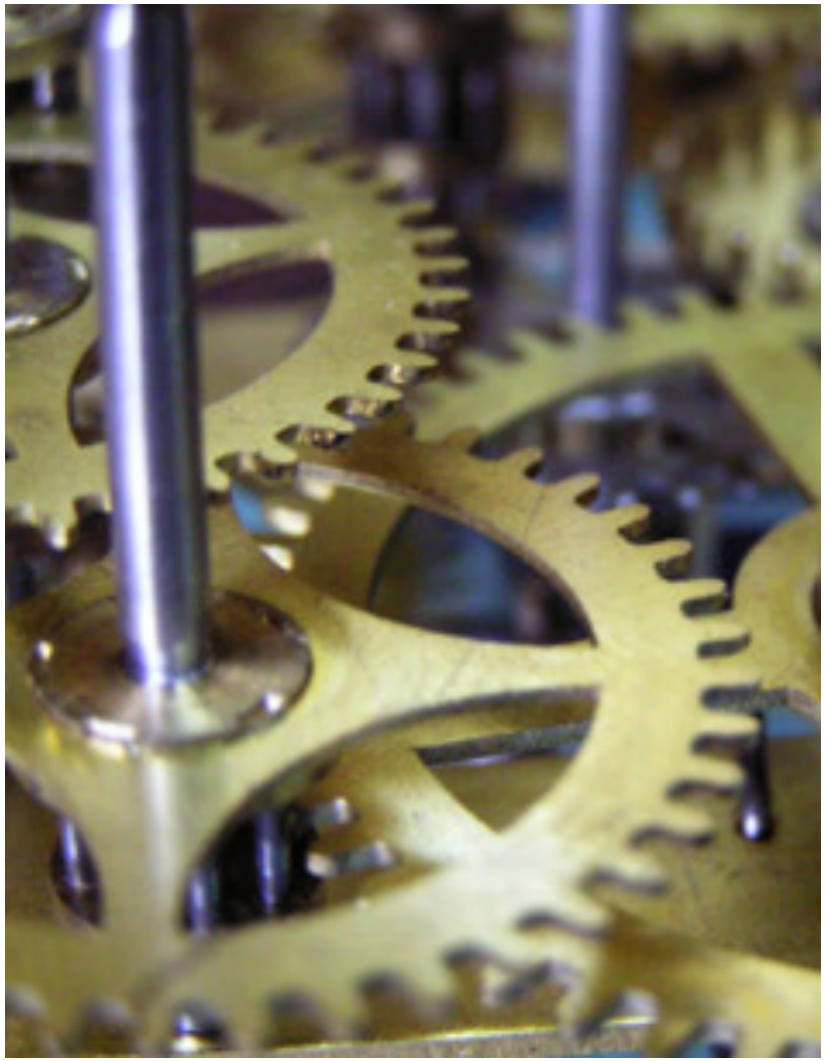
- G. K. Chesterton

What are we missing?

- Virtual Machine
  - Modularity, Lifecycle & Isolation
  - Lower memory footprint
  - Predictable GC pauses
- Platform
  - Distributed system as a system
  - Provisioning and Metering
  - Cloud Operating System APIs
  - Persistence (including key/value)
  - Map/Reduce-style processing
- Application Definition
  - Packaging, Resource Declaration
  - Security

Rethinking the Container for the Cloud

- What's changed in the world since Java was introduced?
  - Hardware Virtualization
  - Stateful Grid Infrastructure
  - Capacity On Demand ISPs (EC2)
- What's coming in Java?
  - Modularization
  - NIO pluggable file systems
  - JVM Bare Metal & Virtual Editions
- Conclusion: Java either steps up, or something else will



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