High Performance Java™ Software

Comparing a Common Design in Three Languages

Kevin Buesing
Field Applications Engineer
Objective Interface Systems
http://www.ois.com
Presentation Objectives

Compare the performance of a single middleware design implemented in Java, C++, and Ada 95.

Compare performance of using C sockets vs. Java sockets vs. JNI C sockets.

Compare multiple middleware designs implemented in various languages.
High Performance Java Software

Foundation Knowledge
Comparing Sockets
Comparing One Design Implemented in Multiple Languages
Comparing Different ORBs
Lessons Learned
Summary
High Performance Java Software

Foundation Knowledge
Comparing Sockets
Comparing One Design Implemented in Multiple Languages
Comparing Different ORBs
Lessons Learned
Summary
Objective Interface Perspective

• Vendor of communications software for:
  – Real-time and embedded systems
  – High-performance enterprise systems

• Common themes
  – Invest in long-term technologies
  – An extreme fixation on performance
  – High reliability requirements
  – Wide platform support (over 500 binary platforms)
  – Committed to standards (OMG, Open Group, JCP)
Technology Used for Comparison

- ORBexpress™: High Performance CORBA
- One design
  - Predictable and oriented for performance
  - Replaceable transports
  - Desktop, server, real-time and embedded systems
- Three ORBs implemented in their native languages
  - Ada ORB written in Ada
  - C++ ORB written in C++
  - Java ORB written in Java
  - Not language bindings
  - Common design and architecture
Transport Comparison

C++ Sockets vs. Java Sockets vs. JNI to C++

• With ORBexpress the transport itself is typically the bottleneck
  – Is using the JNI to access C sockets faster than the Java Socket class?
  – Pluggable transport API in ORBexpress makes this easy to test
  – JNI can require copies
    – Depends on JVM
    – JVM’s that force extra copies in either the socket class or JNI interface preclude high bandwidth utilization

• Objective Interface tests run on
  – 1.7 ghz Pentium 4
  – Microsoft Windows XP
Common Architecture ORB Comparison
ORBexpress: Java vs. Ada vs. C++

• Oneway
  – Data sent from the client to server
  – Time to write data to the socket

• Twoway
  – Data sent from the client to the server with reply.
  – Time to send data to and receive reply from server
Comparing Middleware Implementations

- **Scope of analysis**
  - Raw transport performance
    - Java Sockets
    - JNI C Sockets
    - C Sockets
  - ORBexpress performance
    - Ada 95
    - C++
    - Java
  - Comparisons to other ORBs
    - Sun JDK
    - TAO (C++)
    - ORBexpress for Java
    - ORBexpress for C++
Benchmarks Sources

• Independent Studies
  – Lockheed Martin, ATL - Guatam Thaker
  – Boeing Phantom Works - DII COE Study

• Objective Interface internal research
Hardware Used

• Lockheed Martin Advanced Technology Labs  
  – 933 MHz Dual Pentium III  
  – Linux

• Objective Interface  
  – 1.7 GHz Pentium M  
  – Windows XP
Software Used

- Linux kernel versions
  - Lockheed Martin tests
    - Version 2.4.20-13
- Microsoft Windows XP
  - Transport and common architecture comparisons
- ORBexpress versions used
  - Version 2.5.0 for Java
  - Version 2.5.1 for C++
  - Version 2.4.6 for Ada
- Objective Interface’s Bench and BenchTransport demos used in language and transport comparisons
Pitfalls of Benchmarks

• “In the computer industry there are three kinds of lies. Lies, damn lies, and benchmarks!”
  – “Lying” in benchmarks is frequently unintentional and the result of invalid comparisons
  – “What’s the difference between a used car salesman and a software salesman?”
    – “The used car salesman knows when he is lying.”

• Make sure to make a valid comparisons
  – Linux kernel revisions can have dramatic effects on network performance
  – The performance difference between Linux kernel versions was greater than the middleware!
Understanding the Graphs

• All data sources are listed at the bottom of the slide

• Two elements of understanding network performance
  – Latency (delay) of delivering first byte
  – Added latency for additional bytes
    – Extra copies
    – Extra system calls

• Important for comparing middleware
  – Relevant performance = time added to sockets
    (or whatever transport is used under middleware)
High Performance Java Software

Foundation Knowledge

Comparing Sockets
Comparing One Design Implemented in Multiple Languages
Comparing Different ORBs

Lessons Learned

Summary
Transport Comparison

C Sockets vs. Java Sockets vs. JNI to C Sockets

• With middleware and specifically ORBexpress the transport itself can be the primary bottleneck.
  — Is JNI faster than the standard Java sockets class?
  — Middleware with pluggable transports allows us to test this.
  — JVM’s that force extra copies in either the socket class or JNI interface will preclude high bandwidth applications

• Tests done by Objective Interface on a 1.7 ghz Pentium 4 running Microsoft Windows XP
Transport Comparison

C Sockets vs. Java Sockets vs. JNI to C Sockets

Source: Objective Interface internal research
High Performance Java Software

Foundation Knowledge
Comparing Sockets

Comparing One Design Implemented in Multiple Languages

Comparing Different ORBs
Lessons Learned
Summary
ORBexpress Performance (I)

Java vs. Ada vs. C++

• **Oneway**
  – Data is sent from the client to server without reply
  – Time measured = time to write the data to socket

• **Twoway**
  – Data sent from the client to the server with reply
  – Time measured = time for client to send the data to the server and the server responds with an reply

• **ORBexpress for Java transport**
  – ORB and transport are 100% Java
  – Used the Java standard socket class
  – Not JNI interface to C sockets
ORBexpress Performance (II)
ORBexpress for: Java vs. Ada vs. C++

Source: Objective Interface internal tests
High Performance Java Software

Foundation Knowledge
Comparing Sockets
Comparing One Design Implemented in Multiple Languages

Comparing Different ORBs
Lessons Learned
Summary
Comparing Different ORBs

Sun JDK vs. TAO (C++) vs. ORBexpress (C++ and Java)

Message Size (bytes) vs. Latency (usec) graph
Comparing ORB Added Latency

ORBexpress for C++ vs. ORBexpress for Java

• Important for comparing middleware: 
  Compare to transport (sockets)

• Relevant information: ORB added latency
  – ORB time minus socket time
  – Allows direct comparison of ORB overhead
  – ORB added latency
    – Relevant measure of the ORB code efficiency
    – Most relevant in comparing languages
    – Removes Java ORB’s penalty for using a slower socket library

• Tests Done
  – 1 byte Payload
  – 32,168 byte Payload
Delta ORB Comparison

ORBexpress for C++ vs. ORBexpress for Java

- Small (1 byte)
- Medium (16392 bytes)
- Large (32136 bytes)

Time (usec)

Source: Objective Interface internal tests
High Performance Java Software

Foundation Knowledge
Comparing Sockets
Comparing One Design Implemented in Multiple Languages
Comparing Different ORBs

Lessons Learned

Summary
Lessons Learned

• Java-specific optimizations
  – Well-written Java can beat compiled languages
  – Don’t create garbage!
  – Are final methods faster?
    – Depends on JVM
    – Sun’s latest Hot-Spot JVM doesn’t care
  – Encourage early class loading

• General optimizations
  – Minimization of data copies
  – Minimization of context switches
  – Minimization of system calls in the JVM
High Performance Java Software

Foundation Knowledge
Comparing Sockets
Comparing One Design Implemented in Multiple Languages
Comparing Different ORBs
Lessons Learned

Summary
In Summary

Java performance is competitive with compiled languages

• Java can beat compiled Ada 95
  – Typically because of integrity checks built into Ada language
  – Can suppress integrity checks, but this loses benefit of Ada

• Great Java implementations can beat good C++ implementations

• Fewer copies and system calls in JVM’s where possible will improve performance even further
Q&A

Kevin Buesing
Field Applications Engineer
Objective Interface Systems
http://www.ois.com
For More Information

• Lockheed Martin Advanced Technology Labs
  ─ Guatam Thaker

• Boeing Phantom Works - DII COE Study

• Objective Interface Systems, Inc.
  ─ [http://www.ois.com](http://www.ois.com)