High Performance Java™ Software

Comparing a Common Design in Three Languages

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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

- ORB*express*™: 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 ORB*express* 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 ORB*express* 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

ORB*express*: 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
  - ORB*express* performance
    - Ada 95
    - C++
    - Java
  - Comparisons to other ORBs
    - Sun JDK
    - TAO (C++)
    - ORB*express* for Java
    - ORB*express* for C++

Benchmarks Sources

- Independent Studies
  - Lockheed Martin, ATL - Guatam Thaker
    - http://www.atl.external.lmco.com/projects/QoS/
  - Boeing Phantom Works - DII COE Study
    - http://www.ois.com/resources/corb-10-overview.asp
- 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
- ORB*express* 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)

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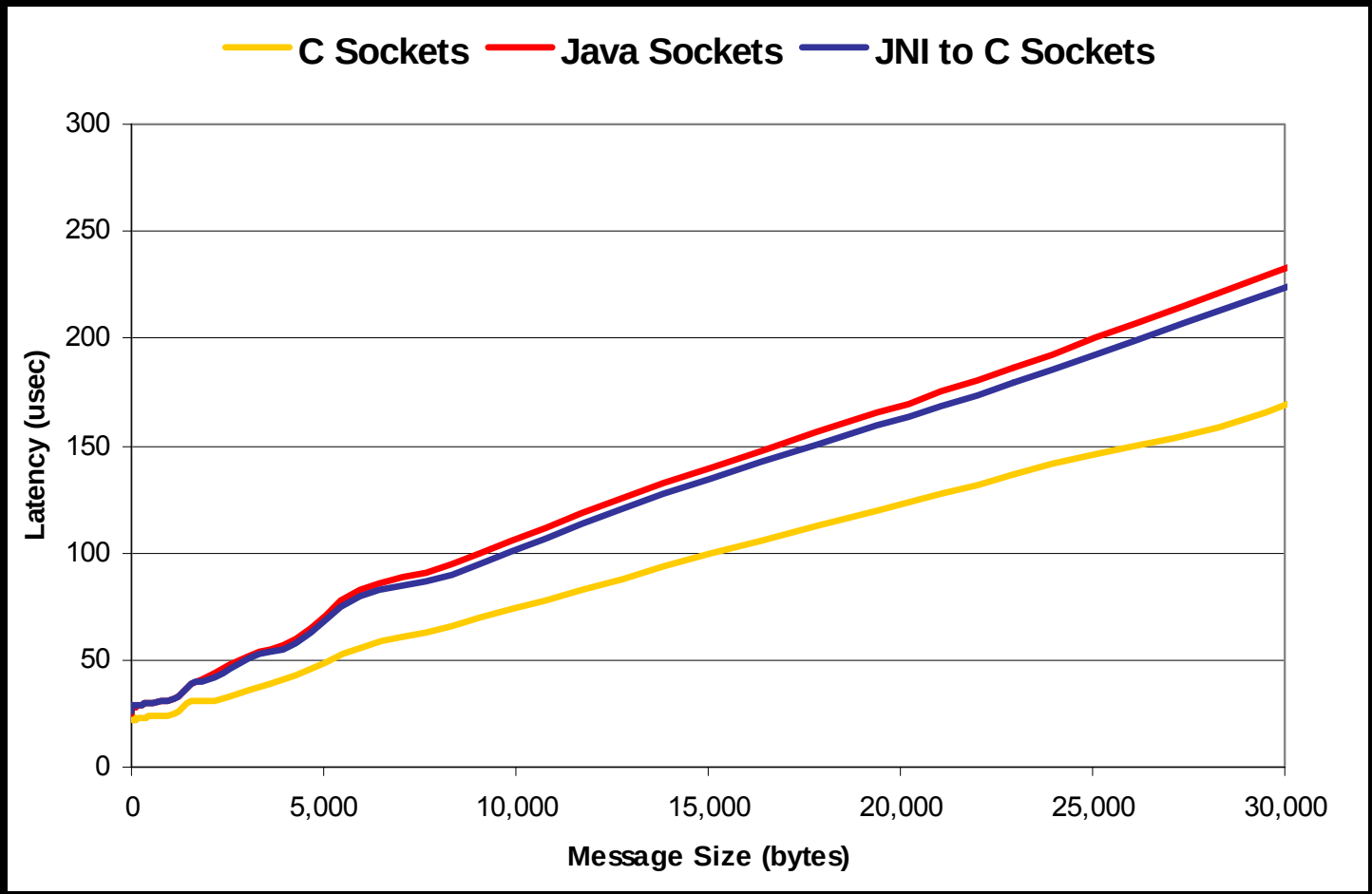
Transport Comparison

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

- With middleware and specifically ORB*express* 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



High Performance Java Software

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Summary

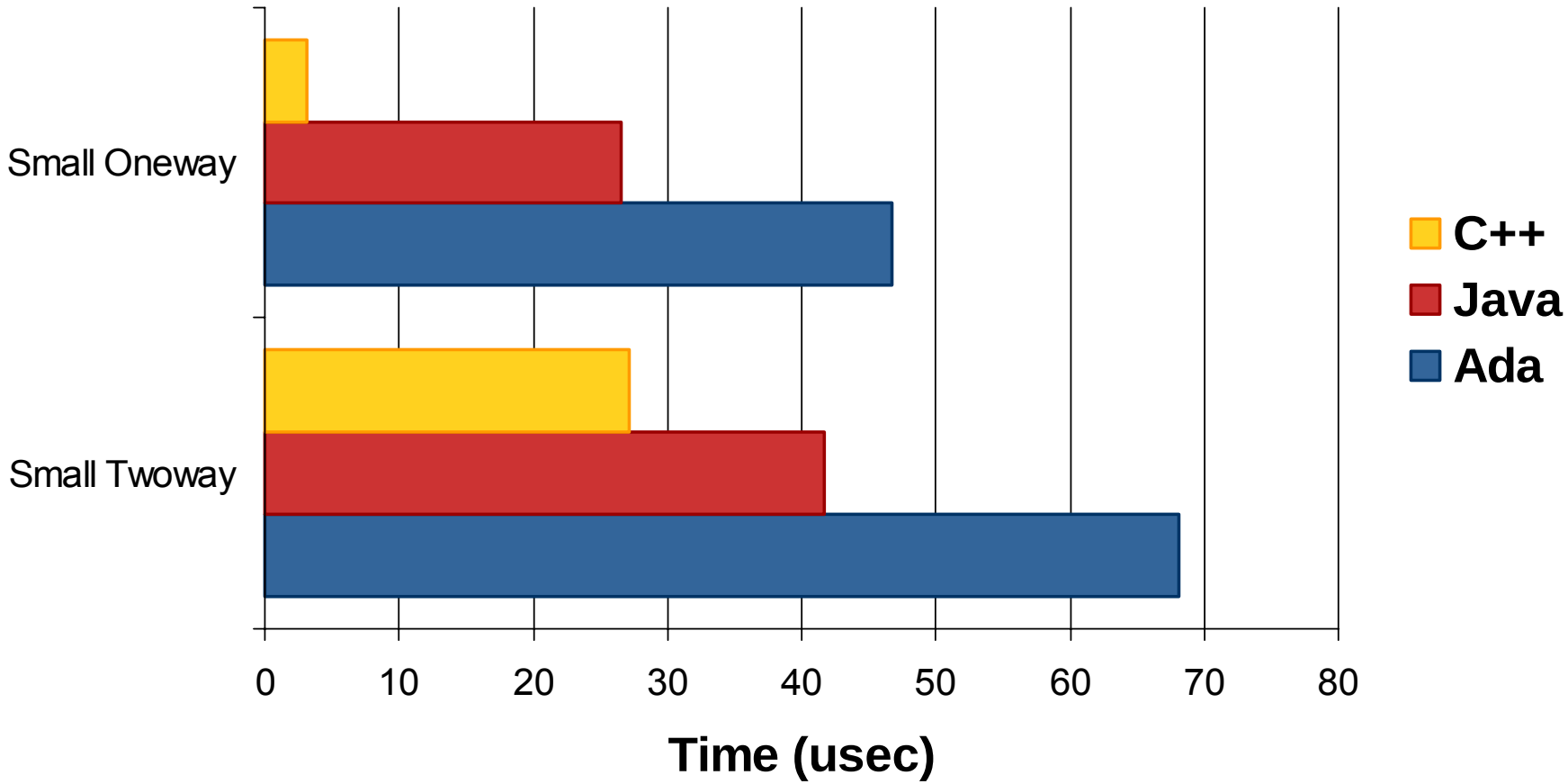
ORB*express* Performance (I)

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
- ORB*express* for Java transport
  - ORB and transport are 100% Java
  - Used the Java standard socket class
  - Not JNI interface to C sockets

ORB*express* Performance (II)

ORB*express* for: Java vs. Ada vs. C++



High Performance Java Software

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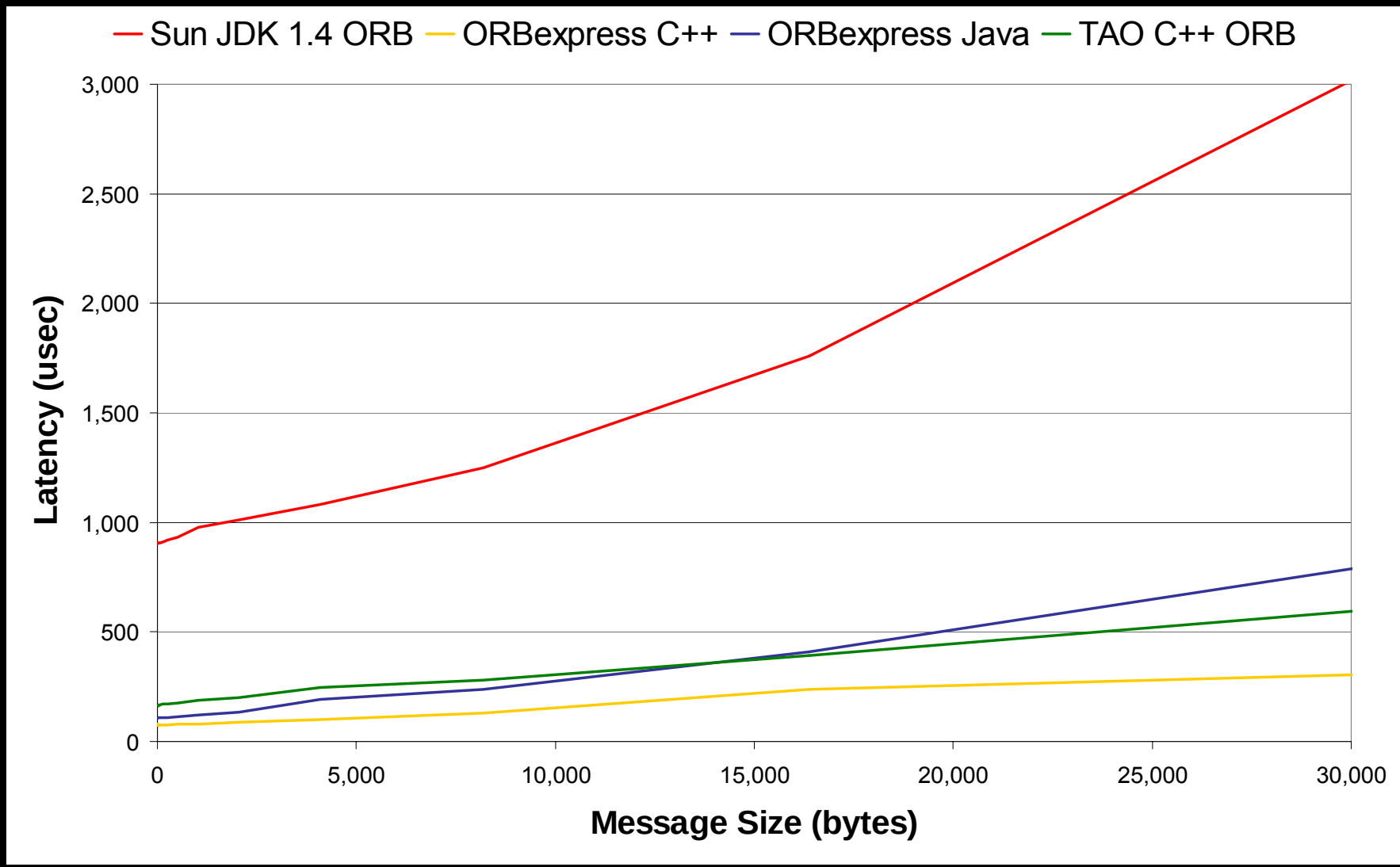
Comparing Different ORBs

Sun JDK vs. TAO (C++) vs. ORB*express* (C++ and Java)



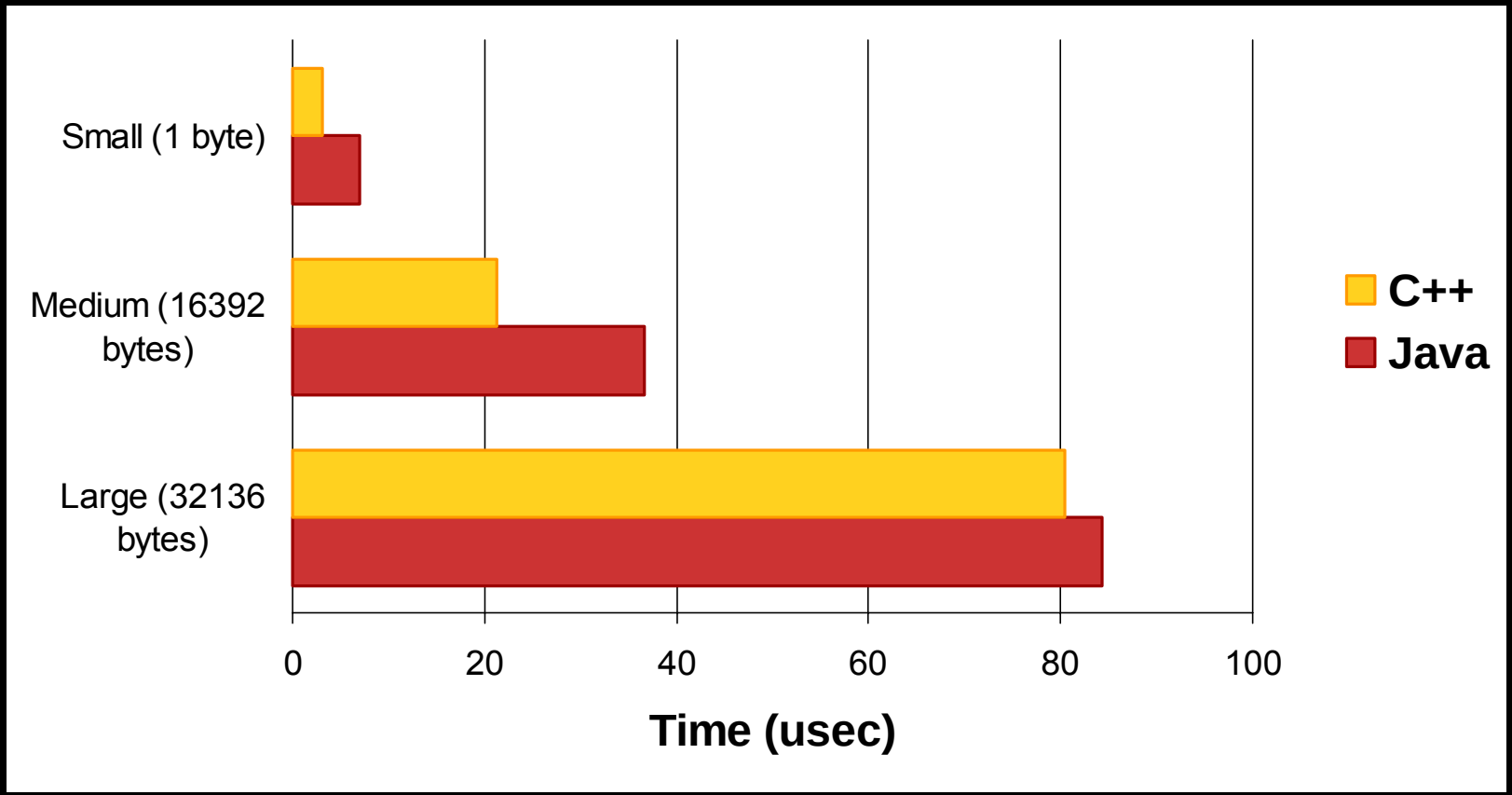
Comparing ORB Added Latency

ORB*express* for C++ vs. ORB*express* 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

ORB*express* for C++ vs. ORB*express* for Java



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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

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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

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For More Information

- Lockheed Martin Advanced Technology Labs
  - Guatam Thaker
  - http://www.atl.external.lmco.com/projects/QoS/
- Boeing Phantom Works - DII COE Study
  - http://www.ois.com/resources/corb-10-overview.asp
- Objective Interface Systems, Inc.
  - http://www.ois.com