A Performance Analysis of Distributed Algorithms in JavaSpaces, CORBA Services and Web Services

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A PERFORMANCE ANALYSIS OF DISTRIBUTED ALGORITHMS IN JAVASPACES, CORBA SERVICES AND WEB SERVICES

By

Suresh Sunku

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To my lovely wife Sulekha and my dearest children Nikhil and Nisha, without their continuous support and encouragement it would not have been possible to achieve graduation. I also wish to express my gratitude to my co-workers Laura Scholl-Smith, Dorothy Dean and Franco Venturi who have put up with me for more than 2 ½ years.
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ABSTRACT

Implementation of distributed parallel algorithms on networked computers has always been very difficult until the introduction of service-oriented architectures (SOA) like JavaSpaces service, CORBA services and Web Services. Algorithms of the type Master/Worker pattern are implemented with relative ease using the SOAs. This project analyzes the performance of such algorithms on three contemporary SOAs namely JavaSpaces service, CORBA services and Web Services. These architectures make the implementations of distributed algorithms reasonably fault tolerant and highly and dynamically scalable. Also, the systems built on these architectures are generally loosely coupled and operate asynchronously.

In this project we measure and analyze the latency, speed-up and efficiency metrics of an insertion sort of $O(n^2)$ complexity on all the three SOAs. We then draw conclusions of overall performance and scalability on all the three architectures.
Chapter 1

INTRODUCTION

1.1 Early beginnings

Today, with the advent of the Internet and the E-Commerce, many organizations have deployed some type of distributed computing solutions either to scale up or to integrate many disparate systems within and outside the organizations. With the increased adoption of distributed computing paradigm, came the increased number of protocols and technologies thus increasing the complexity of distributed computing.

The early solutions to the distributed computing involved low-level communication such as sockets programming where the messages between client and server were usually encoded in application-level protocols [RMISpec1.4]. So, the next genre of protocols such as RPC (Remote Procedure Call), MPI (Message Passing Interface) and PVM (Parallel Virtual Machine) have encapsulated the low-level communication, but the applications tended to be tightly coupled as with socket programming. In other words, the applications invoked procedures on each other to exchange data or messages and to do so they needed to know a lot about each other. The distributed system developed on these protocols tended to be very unstable and increased the number of points of failure. In other words, when one system or host in the distributed network application failed, then the whole application failed.

As the object-oriented languages provided the developers an ability to abstract away procedures into objects in which both the data and the functions that work on them are
bound together, they became very popular. This led to the adoption of object-oriented protocols such as DCOM, CORBA and RMI. Overall, these protocols have done an excellent job of providing distributed object communication but they are no more than RPC calls with the added ability to marshal the objects when the objects are used as parameters in the method calls. Hence, these protocols did not improve fault-tolerance of applications built using them nor they reduced the tight coupling needed between the components. However, as they were adopted with increasing popularity, there was also a need for object persistence across several invocations [JSSpec1.1].

These drawbacks have motivated the search for a better model and lead to the creation of service-oriented architectures such as JavaSpaces service, CORBA services and Web Services. These new service architectures introduced a new paradigm of developing distributed algorithms that are naturally scalable and reasonably fault tolerant. Also the applications built using these architectures tend to be loosely coupled and dynamically scalable [MKRM].

1.2 Master-Worker Pattern

We have chosen a parallel algorithm based on the Master-Worker pattern, a popular parallel algorithm, to measure the performance on all the three architectures. In a Master-Worker pattern, the master divides a task into several sub-tasks and then allocates each of the tasks to workers who are ready to execute and return the results. This pattern provides a natural scalability because each worker receives the number of sub-tasks based
its capacity to execute. The faster workers will get larger number of sub-tasks while the slower workers process less number of sub-tasks.
2.1 JavaSpaces

Sometime around 1998, Sun Micro Systems introduced new JAVA paradigm based on Linda Systems that is known as JavaSpaces. The JavaSpaces technology consists of a tuple space that provides mechanism for storing a group of related objects and retrieving them based on value-matching lookup for specified fields' [JSSpec1.1]. This ability to store and retrieve objects within JavaSpaces not only provides distributed object persistence but also aids in the design of distributed algorithms.

The figure 1 illustrates a distributed algorithm utilizing the space for parallel computing.

![Figure 1](image)

The distributed algorithms implemented using JavaSpace service are naturally scalable since one can start a new worker if there are more tasks written to the space than the number of tasks taken from the space for processing. Also, the applications are not only loosely coupled but they are anonymous too because the workers and the master/client are never aware of each other.
The JavaSpace service is a JINI service and hence can be combined with JINI transaction service to provide and maintain integrity of the space. A worker can start a transaction before taking a task from the space and end the transaction after the successful write of the result-task back to the space. This provides a degree of fault tolerance since the transaction manager will restore the original task back into space when a worker crashes or fails to complete and this allows another worker to take the task and process to completion.

The JavaSpaces API consists of 4 main method types:

- Write() - writes an entry to a space.
- Read() - reads an entry from a space.
- Take() - reads an entry and deletes it from a space.
- Notify() - registers interest in entries arriving at a space.

All objects must be serializable since Write() writes the serialized bytes to the space and the Read()/Take() reconstructs the object from the serialized bytes.

2.2 CORBA Services

Around 1997 the OMG group published various service specifications that run on top of CORBA specification. Although there is no single CORBA service that is comparable to JavaSpaces service, one can combine multiple services such as the Trader service and the Transaction service to build and implement distributed parallel algorithms. The CORBA's Trading Service is similar to the yellow pages; it allows objects that can
provide a service to register their abilities and it then allows clients to locate those services by describing the functionality they require. From then on, the client deals directly with the service provider object.

Since the Trader service is defined to be language neutral and designed to run on any architecture, it is not designed to store objects itself but to store CORBA remote references to the objects. Hence, the algorithms using the Trader service must interact with the service provider object to interchange the actual sub-tasks and the result. Typical steps involved using Trader service is shown in figure 2.

![Figure 2](image)

Like JavaSpaces, here too, the number of tasks performed by a worker depends on their capacity and the load on their respective computers. One can easily start a new worker to improve performance and when combined with CORBA transaction service, one can build very robust and fault-tolerant solutions. However, unlike in the JavaSpaces, the
master and the worker are not anonymous, as they need to know of each other to exchange the data.

2.3 Web Services

The Web Services (WS) architecture is modeled more like CORBA trader service in that it also employs a trader like service registry that can be queried to discover services and it is also designed to be language neutral. However, the WS APIs are designed to be operable across World Wide Web and firewalls. Typical steps involved in using Web Services are shown in figure 3.

![Diagram of Web Services architecture]

Figure 3

Unlike the above 2 architectures, here the Master can not create and register sub-tasks because there is no way for a Worker to remove a service from the registry once it is consumed. Hence, the Master registers the whole task as one service but divvy up a portion of array to each Worker as the Workers contact for sub-tasks.
The Web Services specifications consists of 3 sets of API namely UDDI (Universal description, discovery and integration), WSDL (Web Services Description Language) and SOAP (Simple Object Activation Protocol). The service providers register the service offerings using UDDI and/or WSDL. And the service consumers query the service registries to obtain protocol bindings to the end points, in other words the service providers. After the discovery the service provider and the consumer exchange data directly.

The web services specification is still a work-in-progress and many features such as objects as payloads, security and choreography (transactions across multiple messages) are still being worked on.
3.1 Overview

First, we developed a distributed algorithm to perform an insertion sort using JavaSpaces. The insertion sort was chosen because it has both average and worst case performance in $O(n^2)$ and can put significant execution demand on servers. We then developed a similar algorithm using CORBA services and Web Services while making every effort to keep the algorithms as similar as the architectures allowed us to be.

The goal of the study is to evaluate the performance of distributed algorithms using JavaSpaces, CORBA Services and Web Services by measuring latency, speed-up and efficiency. We then draw our conclusions on scalability of each of the three architectures. However, in this study, we do not attempt to make a straight comparison between JavaSpaces, CORBA Services and Web Services because there are many issues that can affect the performance other than the architectures itself. For one thing, our implementation in their respective architectures may not be optimal and may be contributing to the overhead. Also, the products that we used may not be the best of the breed in the market and hence adding to the overhead. However, we made every effort to implement our algorithm consistently across the architectures and followed the best practices of the respective architectures. One example is that in our implementation using CORBA services, the remote references are cleaned up as soon their need is over, causing an additional communication loop to the remote reference end-point. While in
JavaSpaces the objects are serialized and de-serialized at the site where they are used and hence there is no additional trip to destroy the objects. And in Web Services the objects are never exchanged and so the clean up never arises.

3.2 Hardware

The hardware for this study consists of a cluster of homogeneous workstations all running RedHat Linux v7.2. The machines are all Intel based PCs consisting of single 500 MHz processors connected by 100 megabit fast Ethernet.

3.3 Software

The software is Java (TM) 2 Runtime Environment, Standard Edition (build 1.3.1) [Orbacus] available free from Sun. In order to keep the variables in performance evaluation to low, the Java language environment is used. We have used GigaSpaces [Orbacus] an implementation of JavaSpaces, ORBACUS 4.0.5 [Giga] an implementation of CORBA services and Axis an implementation of SOAP to develop and evaluate the performance of distributed parallel algorithms. All of the software mentioned above is available for free from the GigaSpaces corp., Iona technology inc., and Apache foundation respectively for academic use.
Chapter 4

THE RESULTS

4.1 Testing

Although the initial goal was to measure the performance of SOAs only, but we have decided to include the performance metrics of a MPI (Message Passing Interface) implementation of Master/Worker pattern. Since MPI is more popular for parallel architectures, we thought it would be more meaningful to contrast the observations of SOAs against the MPI’s numbers.

We ran a series of executions for each version of the architectures using 8K, 16K, 32K & 64K integers and using 1, 2, 4, and 8 workers/servers. The data are distributed so that each server has the same amount of data. The servers do all the work while the client only distributes and receives data. All tests were executed under similar conditions for each of the SOAs during a time when the load on the dedicated network and servers was at a minimum.
Observed data: The table below summarizes the observed data.

<table>
<thead>
<tr>
<th>CORBA Services</th>
<th>( T_s ) (P=1)</th>
<th>( T_p ) (P=2)</th>
<th>( T_p ) (P=4)</th>
<th>( T_p ) (P=8)</th>
<th>JAVA Spaces Service</th>
<th>( T_s ) (P=1)</th>
<th>( T_p ) (P=2)</th>
<th>( T_p ) (P=4)</th>
<th>( T_p ) (P=8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Size</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8K</td>
<td>6060</td>
<td>4573</td>
<td>4368</td>
<td>4385</td>
<td>3892</td>
<td>2674</td>
<td>2534</td>
<td>2595</td>
<td></td>
</tr>
<tr>
<td>16K</td>
<td>11160</td>
<td>6087</td>
<td>5050</td>
<td>4545</td>
<td>9058</td>
<td>4093</td>
<td>2753</td>
<td>2961</td>
<td></td>
</tr>
<tr>
<td>32K</td>
<td>29598</td>
<td>11210</td>
<td>6454</td>
<td>5498</td>
<td>29962</td>
<td>9350</td>
<td>4735</td>
<td>3526</td>
<td></td>
</tr>
<tr>
<td>64K</td>
<td>110607</td>
<td>33292</td>
<td>15317</td>
<td>8720</td>
<td>111780</td>
<td>30272</td>
<td>11236</td>
<td>6713</td>
<td></td>
</tr>
</tbody>
</table>

| Web Services | MPI |                     |                     |                     |                     |                     |                     |                     |                     |
| Input Size   |     | \( T_s \) (P=1) | \( T_p \) (P=2) | \( T_p \) (P=4) | \( T_p \) (P=8) | \( T_s \) (P=1) | \( T_p \) (P=2) | \( T_p \) (P=4) | \( T_p \) (P=8) |
| 8K           |     | 197624           | 130936           | 89821            | 70893            | 2314            | 2107            | 1909            | 1593            |
| 16K          |     | 330012           | 259680           | 177830           | 136700           | 8128            | 2789            | 2234            | 2429            |
| 32K          |     | 689287           | 518070           | 352723           | 272821           | 31558           | 9496            | 3316            | 2646            |
| 64K          |     | 1488396          | 1056166          | 709469           | 538059           | 106362          | 29044           | 10120           | 4466            |

Figure 4

Note:

\( T_s \): Time taken for a sequential process, in other words time taken with 1 worker.

\( T_p \): Time taken for a parallel process with \( P \) processors.

4.2 Latency:

We measured latency as time taken for an integer to make a round trip. The figure 3 shows the latency for each implementation. We have observed higher latency in using CORBA services and Web Services over other architectures.
The following summarizes our assumptions for the increased latency:

A) CORBA: It takes 2 additional hops to complete the loop Master-Worker-Master than the other three architectures due to the CORBA’s use of remote references that requires additional steps to clean up the remote objects. While in JavaSpaces it takes only four hops because JavaSpaces architecture serializes the objects at source and de-serializes the objects at destination. Since the objects are instantiated locally at destination, there is no need for communication over the wire to destroy an object reference. Also in JavaSpaces the un-referenced objects are deleted asynchronously, the time to destroy an object is never included in the measured time. The following shows the six steps needed to complete a loop:

- The Master writes remote reference to a sub-task to the trader.
- The Worker extracts the reference.
- The Worker gets data using the remote reference.
- The Worker invokes remote delete on the Sub-task reference.
- The Worker then instantiates an Iterator for result set and pass the reference to Master.
• Master uses the remote iterator to get data and then invokes a remote delete of iterator.

B) Web Services: We think that the implementation of AXIS as a servelet running in TOMCAT servlet container is one of the major reasons for high latency in our Web Services architecture. Also our set-up and configuration (or lack of it) of TOMCAT could have contributed to latency. We think that our service was instantiated on the first call to service, which in turn caused for a new JVM (Java Virtual Machine) to come up and thus increasing the latency.

4.3 The Speed-up

Speed-up is defined as ratio of time taken to process sequentially to time taken to process in parallel. We measured sequential time as the time taken with one worker.

The table below shows the speed-up of observed data:

<table>
<thead>
<tr>
<th>CORBA Services</th>
<th>JAVA Spaces Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Size</td>
<td>Ts (P=1)</td>
</tr>
<tr>
<td>8K</td>
<td>1</td>
</tr>
<tr>
<td>16K</td>
<td>1</td>
</tr>
<tr>
<td>32K</td>
<td>1</td>
</tr>
<tr>
<td>64K</td>
<td>1</td>
</tr>
<tr>
<td>Web Services</td>
<td>Ts (P=1)</td>
</tr>
<tr>
<td>8K</td>
<td>1</td>
</tr>
<tr>
<td>16K</td>
<td>1</td>
</tr>
<tr>
<td>64K</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 6
Figure 7, 8, 9 and 10 display the speed-up achieved by all the three architectures. It is clear from the charts that all the systems had increasing speed-up as the processors and input size are increased. The SOAs have achieved a speed-up comparable to the speed-up observed with MPI.

![CORBA Services Speed-Up (Ts/Tp)](image)
JavaSpaces Service Speed-up (Ts/Tp)

Figure 8

Web Services Speed-up

Figure 9
4.4 Efficiency

The efficiency is defined as $Ts/P\times Tp$. The figure below charts the efficiency of all the four architectures. It uses the diagonal values from the table of observed data, in other words it uses the data in the cells where the input and the processors are doubled.

<table>
<thead>
<tr>
<th>Efficiency: $(Ts/P\times Tp)$</th>
<th>1</th>
<th>2</th>
<th>4</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>CORBA Services</td>
<td>1</td>
<td>0.9167</td>
<td>1.1465</td>
<td>1.5855</td>
</tr>
<tr>
<td>Java Spaces</td>
<td>1</td>
<td>1.1065</td>
<td>1.5819</td>
<td>2.0814</td>
</tr>
<tr>
<td>Web Service</td>
<td>1</td>
<td>0.6355</td>
<td>0.4886</td>
<td>0.3456</td>
</tr>
<tr>
<td>MPI</td>
<td>1</td>
<td>1.4572</td>
<td>2.3792</td>
<td>2.977</td>
</tr>
</tbody>
</table>
Figure 12

Efficiency

Processor/Worker/Server count

Efficiency

CORBA
JavaSpaces
Web Services
MPI
Chapter 5

SUMMARY AND CONCLUSIONS

Before we make any conclusion from the data, one must keep in mind that the performance metrics from MPI is for reference only. We can not expect any of the SOAs, as they are implemented by us, to out perform MPI implementation because the MPI code was written in “C”, which allowed us to run the executable. While all of the other implementations were done in JAVA, which uses byte code and runs in interpreter mode. However, the CORBA and the Web Service specifications are language neutral and that means that we could have implemented in “C++” for better performance but we wanted to be consistent across all the implementations of the SOAs.

Overall the From the observed data we can conclude that the distributed parallel algorithms of type Master-Worker pattern have performed very well on all of the SOAs except in Web Services architecture. The observed speed-up and efficiency for CORBA Service and JavaSpace service is comparable to that of MPI solution and indicates that these architectures really scale well. However, we can not say the same thing for implementation of the Web Services. Also all the three SOA implementations have higher latency but it seems to be constant irrespective of input size and processor count and that suggests that for large tasks the latency is negligible.

As it is shown above that these architectures provide tremendous benefits in terms of fault-tolerance and dynamic scalability that the performance hit we take is negligible over traditional parallel implementations such as MPI. Since the SOAs support object-oriented
languages, the benefits of Object Oriented programming can be and probably should be realized when doing parallel distributed processing. No study is complete without mentioning the ease of use and implementation of the three SOAs. The development and implementation of Java Spaces was the easiest of all since the specification only has five commands and the implementation is a lot cleaner. However, it is limited in that the JavaSpaces can only be implemented on Java platforms supporting JINI architecture. Relatively the use and implementation of Web Services is harder than JavaSpaces, it is not difficult to master. However, we can not say the same for CORBA specification but CORBA’s specification is language and platform independent and also provides very good scalability. Of the three SOAs, we find that debugging is lot easier in Web Services because the wire protocol is Unicode, which allowed us to read message payload with out any need of special tools.

Today there is a lot of work is being done in the field of Grid computing also known as On-Demand computing where the concept of cluster computing is expanded to embrace network of computers that are spread over wide area sometimes over different continents. The grid-computing platform appears to be a natural platform to implement distributed and parallel algorithms. A performance study should be conducted to see how well the grid platform scale up for distributed parallel algorithms.

Very recently the Grid-computing community has adopted service-oriented architecture to provide the users access to computing resources on-demand which only validates the benefits of using SOAs.
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Universal Description, Discovery and Integration standard organization:
http://www.uddi.org
APPENDIX A
JavaSpaces Code Listings

*******************************************************************************
*          JavaSpaces Client listing          *
*          JspaceClient.java               *
*******************************************************************************
package client;
import java.util.*;
import java.io.*;
import net.jini.space.*;
import net.jini.core.transaction.*;
import net.jini.core.transaction.server.*;
import net.jini.core.lease.Lease;
import com.j_spaces.core.IJSpace;
import java.rmi.RMISecurityManager;
import com.j_spaces.core.client.SpaceFinder;
import com.j_spaces.core.client.LookupFinder;
import utils.*;

/**
 * This class is responsible for splitting the task of sorting ints
 * into sub tasks, gathering the partial results and return
 * the final result.
 */
public class JSpaceClient
{
    private static Properties clientprop;
    private static utils.arrayHolder thearray = null;

    public static void main(String args[]) throws Exception
    {
        // check usage
        if (args.length != 2)
        {
            usage();

            long starttime=System.currentTimeMillis();

            // extract params
            String lookupHost = args[0];
            int taskcount = Integer.parseInt(args[1]);

            // set RMI Security Manager
            if ( System.getSecurityManager() == null )
            {
                System.setSecurityManager( new RMISecurityManager() );
            }

            // get references to space and transaction services
            JavaSpace space = (JavaSpace)SpaceFinder.find( lookupHost );

            System.out.println("Looking for Transaction Manager...");
        }
    }
}
TransactionManager trManager =
    (TransactionManager) LookupFinder.find(
        null, null, // service name, class name
        new Class[]{
            net.jini.core.transaction.server.TransactionManager.class
        }, // service attributes, lookup groups
        null, // unicast lookup host
        "localhost", // timeout 10 seconds
        10*1000 // timeout 10 seconds
    );

if (trManager == null) {
    System.out.println("Transaction Manager can not be found...");
    System.exit(1);
} else { System.out.println("Found: Transaction Manager.");

    clientprop = new Properties();
    try {
        FileInputStream pFIS = new FileInputStream("client.properties");
        clientprop.load(pFIS);
        pFIS.close();
    } catch (Exception e) {
        e.printStackTrace();
        System.exit(9);
    }

    System.out.println("Loading ints.........");
    try {
        thearray = new utils.arrayHolder(
            clientprop.getProperty("input", "testfile"),
            Integer.parseInt(clientprop.getProperty("maxsize", "0")));
        System.out.println("Done loading ints: " + thearray.getLength());
    } catch (Exception e) { e.printStackTrace(); System.exit(9); } // sort the ints.
    sortInts(space, trManager, taskcount); // finish
    long endtime = System.currentTimeMillis();

    System.err.println("=============JS Sort==========================");
    System.err.println(" Problem Size: " + thearray.getLength());
    System.err.println(" Processor count: " + taskcount);
    System.err.println(" Elapsed time: " + (endtime - startime));
    System.err.println("=============================================");

    -23-
public static void sortInts(JavaSpace space, TransactionManager trManager, int taskcount)
    throws Exception
{
    // create a new transaction
    Transaction.Created tCreated = TransactionFactory.create(
        trManager, 3600 * 1000);
    Transaction tr = tCreated.transaction;

    // break task into several tasks and write them to space in one transaction
    //int numOfTasks = (int) Math.sqrt((double) thearray.getLength());
    int numOfTasks = taskcount;
    int numbersPerTask = (thearray.getLength() / numOfTasks);
    System.out.println("Creating " + numOfTasks + " tasks, " +
        numbersPerTask + " numbers per task.");
    for (int i=0; i<numOfTasks; i++)
    {
        int start = i * numbersPerTask;
        if (i == numOfTasks - 1)
            numbersPerTask = thearray.getLength() - start;
        SortTask task = new SortTask(thearray.getArray(start, numbersPerTask));
        space.write(task, tr, Lease.FOREVER);
    }

    // commit transaction
    tr.commit();

    // wait for any result.
    // create a new transaction
    System.out.println("Waiting for results");
    tCreated = TransactionFactory.create(
        trManager, 3600 * 1000);
    tr = tCreated.transaction;
    int numOfResults = 0;
    int [][] resultsets = new int[numOfTasks][];
    while (numOfResults < numOfTasks)
    {
        ResultTask template = new ResultTask();
        template.sortedarray = null;
        ResultTask taskResult = (ResultTask)
            space.take(template, tr, Long.MAX_VALUE);
        resultsets[numOfResults] = taskResult.getResult();
        numOfResults++;
    }
    tr.commit();
    PrintUtils.printInts(resultsets, numOfResults);
    return;
}

static void
usage()
{
    System.err.println();
    System.err.println("Usage: java client.JSpaceClient [-h]
SpaceName TaskCount");
    System.err.println("also refer to client.properties file to
set " +
        "properties.");
    System.err.println();
    System.err.println("Options:");
    System.err.println();
    System.err.println(" -h Show this help message");
    System.exit(1);  
}

package worker;
import java.util.*;
import java.io.*;
import net.jini.space.*;
import net.jini.core.transaction.*;
import net.jini.core.transaction.server.*;
import net.jini.core.lease.Lease;
import com.jspaces.core.IJSpace;
import java.rmi.RMISecurityManager;
import com.j_spaces.core.client.SpaceFinder;
import com.j_spaces.core.client.LookupFinder;
import utils.*;

public class JSpaceWorker
{
    public static void
    main(String args[]) throws Exception
    {
        // check usage
        if (args.length != 1)
            usage();
        // extract params
        String lookupHost = args[0];
        // set RMI Security Manager
        if ( System.getSecurityManager() == null )
        {
            System.setSecurityManager( new RMISecurityManager() );
        }
    
}
get references to space and transaction services
JavaSpace space = (JavaSpace) SpaceFinder.find(lookupHost);

System.out.println("Looking for Transaction Manager...");
TransactionManager trManager =
(TransactionManager) LookupFinder.find(
   null, // service name
   new Class[] { net.jini.core.transaction.server.TransactionManager.class }, // service
class name
   null, // service attributes
   "localhost", // unicast lookup host
   null, // lookup groups
   10*1000 // timeout 10 seconds
);

if (trManager == null)
{
   System.out.println("Transaction Manager can not be found...");
   System.exit(1);
}
else
   System.out.println("Found: Transaction Manager.");

   // executing the task.
   executeSort(space, trManager);
   // finish
   System.exit(0);

public static void executeSort(JavaSpace space, TransactionManager trManager)
   throws Exception
{
   // create a new transaction
   // get task if any
   SortTask template = new SortTask();
   template.sortarray = null;
   while(true)
   {
      Transaction.Created tCreated = TransactionFactory.create(
         trManager, 3600 * 1000);
      Transaction tr = tCreated.transaction;
      System.out.println("Searching space for SortTask...");
      SortTask task = (SortTask) space.take(template, tr, Long.MAX_VALUE);
      if (task == null)
      {
         tr.commit();
         break;
      }
      System.out.println("Got the handle for SortTask!");
      ResultTask resulttask = new ResultTask(task.run());
space.write(resulttask, tr, Lease.FOREVER);
// commit transaction
tr.commit();
}
return ;
}
static void
usage()
{
    System.err.println();
    System.err.println("Usage: java client.JSpaceWorker [-h]
SpaceName ");
    System.err.println("Options:");
    System.err.println();
    System.err.println(" -h  Show this help message");
    System.exit(1);
}
********************************************************************************
*  JavaSpaces Utilities listings   *
********************************************************************************
package utils;
import java.io.*;
import java.util.*;
public class arrayHolder
{
    public int[] thearray= null;
    public arrayHolder(String infile, int maxsize)
        throws Exception
    {
        int arraysize=0;
        if (maxsize == 0)
            maxsize = 160000;
        int[] intarray = new int[maxsize];

        BufferedReader br = new BufferedReader(new
        FileReader(infile));

        String line = null;
        StringTokenizer stk = null;
        while((line=br.readLine()) !=null)
        {
            stk = new StringTokenizer(line);
            while(stk.hasMoreTokens())
                intarray[arraysize++] =
                Integer.parseInt(stk.nextToken());
        }
        thearray =new int[arraysize];
        for(; arraysize > 0 ; arraysize--)
            thearray[arraysize-1] = intarray[arraysize-1];
    }
    public int getLength() { return thearray.length;}
    public int[] getArray(int start, int size)
    {
        int[] retarray = new int[size];

    }-27-
for (int i = 0; i < size; i++)
{
    retarray[i] = thearray[i+start];
}
return retarray;

package utils;

import net.jini.core.entry.Entry;

/**
 * This object encapsulates a task entry in space. The performer of this task
 * simply executes the run method.
 */
public class ResultTask
    implements Entry
{
    public int[] sortedarray;
    public ResultTask()
    {
    }

    public ResultTask(int[] inarray)
    {
        sortedarray = inarray;
    }

    public int[] getResult()
    {
        return sortedarray;
    }
}

package utils;

import net.jini.core.entry.Entry;

/**
 * This object encapsulates a task entry in space. The performer of this task
 * simply executes the run method.
 */
public class SortTask
    implements Entry
{
    public int[] sortarray;
    public SortTask()
    {
    }

    public SortTask(int[] inarray)
    {
        sortarray = inarray;
    }

    public int[] run()
System.out.println("Length of the array to be processed is: "+sortarray.length);
    for (int i = sortarray.length; --i>=0;)
    {
        boolean flipped = false;
        for (int j = 0; j<i; j++)
        {
            if (sortarray[j] > sortarray[j+1])
            {
                int T = sortarray[j];
                sortarray[j] = sortarray[j+1];
                sortarray[j+1] = T;
                flipped = true;
            }
        }
        if (!flipped) { return sortarray; }
    }
    System.out.println("completed sort of: "+sortarray.length);
    return sortarray;
}
module worker
{
  typedef sequence<long> IntSet;
  exception EndOfSetReached{};

  //iterator to pass ints between clients
  interface IntIterator {
    boolean getNextSet(in long setsize, out IntSet subset)
    raises(EndOfSetReached);
    oneway void destroy();
  };

  //clients callback object for the server to return sorted ints
  interface ClientCallBack {
    oneway void getSortedInts(in long intcount, in IntIterator srvrItr);
  };

  //sort int server
  interface Sorter {
    oneway void sortInts(in long intcount, in IntIterator clientItr,
      in ClientCallBack ccb);
  };
}

package client;
import java.util.*;
import java.io.*;

public class TraderClient
{
  private static Properties clientprop;
  private static int psize;
  private static int pcount;

  private static int run(org.omg.COREA.ORE orb, String args[])
  {
    // Use argc to position us past the last option
    //
    int argc;

    // Check options
    //
    for(argc = 0 ; argc < args.length ; argc++)
if(args[argc].equals("-h"))
    usage();

String constraint, preference, policyFile;
    constraint = clientprop.getProperty("constraint");
    preference = clientprop.getProperty("preference");
    policyFile = clientprop.getProperty("policyfile");

    // Connect to Trading Service
    //
    org.omg.CosTrading.Lookup lookup =
    utils.SortUtils.connect(orb);

    if(lookup == null)
        usage();

    try
    {
        String type = utils.SortUtils.getServiceType();

        org.omg.CosTrading.Policy[] policies;
        if(policyFile != null)
            policies = getPolicies(orb, policyFile);
        else
            policies = new org.omg.CosTrading.Policy[0];

        desiredProps =
        desiredProps.__default(
            org.omg.CosTrading.LookupPackage.HowManyProps.all);

        org.omg.CosTrading.OfferSeqHolder offers =
        new org.omg.CosTrading.OfferSeqHolder();
        org.omg.CosTrading.OfferIteratorHolder iter =
        new org.omg.CosTrading.OfferIteratorHolder();
        org.omg.CosTrading.PolicyNameSeqHolder limits =
        new org.omg.CosTrading.PolicyNameSeqHolder();

        //
        // Perform the query
        //
        System.out.println("TraderClient querying Trader...");
        lookup.query(type, constraint, preference, policies,
        desiredProps, 20, offers, iter, limits);

        if(offers.value.length == 0 && iter.value == null)
        {
            System.out.println("No offers found.");
            return 0;
        }
        else
            System.out.println(offers.value.length + " offers found!!!!!!!!!!!!");
// Execute the offers

if (offers.value.length > 0)
    executeOffers(offers.value, orb);
else

    // If we received an iterator, then add all of its
    // offers to the vector
    //
    if(iter.value != null)
    {
        org.omg.CosTrading.OfferSeqHolder seq =
            new org.omg.CosTrading.OfferSeqHolder();
        iter.value.next_n(20, seq);
        executeOffers(seq.value, orb);
        iter.value.destroy();
    }
}

try{

    catch(org.omg.CosTrading.IllegalServiceType e)
    {
        System.err.println("Illegal service type");
    }
    catch(org.omg.CosTrading.UnknownServiceType e)
    {
        System.err.println("Unknown service type");
    }
    catch(org.omg.CosTrading.IllegalConstraint e)
    {
        System.err.println("Illegal constraint");
    }
    {
        System.err.println("Illegal preference");
    }
    catch(org.omg.CosTrading.LookupPackage.IllegalPolicyName e)
    {
        System.err.println("Illegal policy");
    }
    catch(org.omg.CosTrading.LookupPackage.PolicyTypeMismatch e)
    {
        System.err.println("Policy type mismatch for");
    }
    {
        System.err.println("Invalid policy value for");
    }
    catch(org.omg.CosTrading.IllegalPropertyName e)
    {
}
public static void main(String args[]) {
    long starttime=System.currentTimeMillis();
    clientprop = new Properties();
    try {
        FileInputStream pFIS = new
        FileInputStream("client.properties");
        clientprop.load(pFIS);
        pFIS.close();
    } catch(Exception e) {
        e.printStackTrace();
        System.exit(9);
    }

    java.util.Properties systemprops = System.getProperties();
    systemprops.put("org.omg.CORBA.ORBClass", "com.ooc.CORBA.ORB");
    systemprops.put("org.omg.CORBA.ORBSingletonClass", "com.ooc.CORBA.ORBSingleton");

    int status = 0;
    org.omg.CORBA.ORB orb = null;
    try {
        args = com.ooc.OBCORBA.ORB_impl.ParseArgs(args, systemprops, null);
        orb = org.omg.CORBA.ORB.init(args, systemprops);
        status = run(orb, args);
    } catch(RuntimeException ex) {
        System.err.println("Illegal property name '" + e.name + ")
    }
    catch(org.omg.CosTrading.DuplicatePropertye) {
        System.err.println("Duplicate property name '" + e.name + ")
    }
    catch(org.omg.CosTrading.DuplicatePolicyName e) {
        System.err.println("Duplicate policy name '" + e.name + ")
    }
    catch(org.omg.CORBA.SystemException e) {
        e.printStackTrace();
    }
    return 0;
}
ex.printStackTrace();
status = 1;
}

if(orb != null)
{
    try
    {
        ((com.ooc.CORBA.ORB)orb).destroy();
    }
    catch(Exception ex)
    {
        ex.printStackTrace();
        status = 1;
    }
}

long endtime = System.currentTimeMillis();
System.err.println("-------------CORBA Sort------------------
" + psize);
System.err.println(" Processor count: " + pcount);
System.err.println(" Elapsed time: " + (endtime - starttime));
System.err.println("============================================
System.exit(status);
}

static void executeOffers(org.omg.CosTrading.Offer[] offers, org.omg.CORBA.ORB orb)
{

    String servername = null;
    pcount = offers.length;
    utils.arrayHolder thearray = null;
    System.out.println("Loading ints.............");
    try
    {
        thearray = new utils.arrayHolder(
            clientprop.getProperty("input","testfile"),
            Integer.parseInt(clientprop.getProperty("maxsize","O")));
        psize = thearray.getLength();
        System.out.println("Done loading ints: " +
            thearray.getLength());
    }
    catch(Exception e) { e.printStackTrace(); System.exit(9); }

    //create clientcallback object for sorter to return result set
    try
    {
org.omg.PortableServer.POA root =
    org.omg.PortableServer.POAHelper.narrow(
        orb.resolve_initial_references("RootPOA"));
root.the_POAManager().activate();
worker.ClientCallback_impl ccbImpl =
    new worker.ClientCallback_impl(root, offers.length);
worker.ClientCallback ccb = ccbImpl._this(orb);
System.out.println("Created ClientCallback Object...")

//
// determine the length of each int sub-set
//
int subsetSize = thearray.getLength()/offers.length;

for(int i = 0, startindex = 0; i < offers.length; i++)
{
    try
    {
        worker.Sorter sorter = null;
        try
        {
            sorter =
                worker.SorterHelper.narrow(offers[i].reference);
        } catch(org.omg.CORBA.BAD_PARAM ex)
        {
            System.out.println(" Object is not a Sorter -
             skipping");
            continue;
        }

        // Extract the properties of this offer
        //
        org.omg.CosTrading.Property prop =
            offers[i].properties[0];

        if(prop.name.equals("servername"))
            servername = prop.value.extract_string();

        System.out.println();
        System.out.println("Executing Offer from:" +
            servername);

        //get sub-set of ints
        //
        if ((offers.length - i) == 1)
            subsetSize = thearray.getLength() - startindex;
        worker.IntIterator clientIttr =
            (new worker.IntIterator_impl(root,
                thearray.getArray(startIndex,
                subsetSize)))._this(orb);
        startIndex +=subsetSize;
sorter.sortInts(subsetSize, clientItr, ccb);
}
catch(org.omg.CORBA.SystemException ex)
{
    System.out.println(" Unable to contact "+
    servername);
    ex.printStackTrace();
    System.exit(2);
}

try
{  //wait until the call back receives sorted arrays from all servers.
    //while(!ccbImpl.isDone()){}
    catch(Exception e) {e.printStackTrace();System.exit(9);}
}

static org.omg.CosTrading.Policy[]
getPolicies(org.omg.CORBA.ORB orb, String file)
{
    org.omg.CosTrading.Policy[] result = null;
    java.io.File f = new java.io.File(file);
    if(f.exists())
    {
        System.out.println("Reading policies from "+ file + "...");
        java.io.FileReader fr = new java.io.FileReader(f);
        java.io.BufferedReader reader = new
        try
        {
            java.util.Vector vee = new java.util.Vector();
            java.io.FileReader fr = new java.io.FileReader(f);
            java.io.BufferedReader reader = new
            String line;
            while((line = reader.readLine()) != null)
            {
                String trimline = line.trim();
                if(trimline.length() == 0 ||
                trimline.startsWith("#"))
                    continue;

                int pos = trimline.indexOf('=');
                if(pos < 0 || trimline.length() == pos + 1)
                {
                    System.err.println("Error: Invalid line " +
                        line +
                        " in file " + f);
System.exit(1);

String name = trimline.substring(0, pos);
String value = trimline.substring(pos + 1);

org.omg.CosTrading.Policy policy = null;

if (name.equals("exact_type_match"))
    policy = getBooleanPolicy(orb, name, value);
else if (name.equals("use_modifiable_properties"))
    policy = getBooleanPolicy(orb, name, value);
else if (name.equals("use_dynamic_properties"))
    policy = getBooleanPolicy(orb, name, value);
else if (name.equals("use_proxy_offers"))
    policy = getBooleanPolicy(orb, name, value);
else if (name.equals("search_card"))
    policy = getULongPolicy(orb, name, value);
else if (name.equals("match_card"))
    policy = getULongPolicy(orb, name, value);
else if (name.equals("return_card"))
    policy = getULongPolicy(orb, name, value);
else if (name.equals("link_follow_rule"))
    policy = getFollowOptionPolicy(orb, name, value);
else if (name.equals("hop_count"))
    policy = getULongPolicy(orb, name, value);
else
    { System.err.println("Error: Unknown policy "+name+
        in file " + f);
        System.exit(1);
    }

vec.addElement(policy);

fr.close();

result = new org.omg.CosTrading.Policy[vec.size()];
vec.copyInto(result);
}
catch(java.io.FileNotFoundException ex)
{
    System.err.println("Error: Unable to open file "+f);
    System.exit(1);
}
catch(java.io.IOException ex)
{
    System.err.println("Error: Unable to read file "+f);
    System.exit(1);
}
else
    result = new org.omg.CosTrading.Policy[0];
return result;
}

{
  org.omg.CosTrading.Policy result = null;

  if(value.equalsIgnoreCase("true"))
  {
    org.omg.CORBA.Any any = orb.create_any();
    any.insert_boolean(true);
    result = new org.omg.CosTrading.Policy(name, any);
  }
  else if(value.equalsIgnoreCase("false"))
  {
    org.omg.CORBA.Any any = orb.create_any();
    any.insert_boolean(false);
    result = new org.omg.CosTrading.Policy(name, any);
  }
  else
  {
    System.err.println("Error: Invalid boolean value for policy "+name+"'");
    System.exit(1);
  }

  return result;
}

static org.omg.CosTrading.Policy getULongPolicy(org.omg.CORBA.ORB orb, String name, String value)
{
  org.omg.CosTrading.Policy result = null;

  try
  {
    int n = Integer.valueOf(value).intValue();
    org.omg.CORBA.Any any = orb.create_any();
    any.insert_ulong(n);
    result = new org.omg.CosTrading.Policy(name, any);
  }
  catch(NumberFormatException ex)
  {
    System.err.println("Error: Invalid numeric value for policy "+name+"'");
    System.exit(1);
  }

  return result;
}

static org.omg.CosTrading.Policy getFollowOptionPolicy(org.omg.CORBA.ORB orb, String name, String value)
org.omg.CosTrading.Policy result = null;

if(value.equals("local_only"))
{
    org.omg.CORBA.Any any = orb.create_any();
    org.omg.CosTrading.FollowOptionHelper.insert(any,
        org.omg.CosTrading.FollowOption.local_only);
    result = new org.omg.CosTrading.Policy(name, any);
}
else if(value.equals("if_no_local"))
{
    org.omg.CORBA.Any any = orb.create_any();
    org.omg.CosTrading.FollowOptionHelper.insert(any,
        org.omg.CosTrading.FollowOption.if_no_local);
    result = new org.omg.CosTrading.Policy(name, any);
}
else if(value.equals("always"))
{
    org.omg.CORBA.Any any = orb.create_any();
    org.omg.CosTrading.FollowOptionHelper.insert(any,
        org.omg.CosTrading.FollowOption.always);
    result = new org.omg.CosTrading.Policy(name, any);
}
else
{
    System.err.println("Error: Invalid FollowOption value for "+
            "policy " + name + ")");
    System.exit(1);
}
return result;
}

static void usage()
{
    System.err.println();
    System.err.println("Usage: java client.TraderClient [-h] ");
    System.err.println("refer to client.properties file to set "+
            "properties.");
    System.err.println();
    System.err.println("Options: ");
    System.err.println(" -h Show this help message");
    System.exit(1);
}

*******************************************************************************
* CORBA Trader Worker listings  *
*******************************************************************************
package worker;

public class SortServer
{
private static final String offerIdFile_ = "offers.dat";

// ---------------------------------------------
// main() and supporting methods
// ---------------------------------------------

private static int run(org.omg.CORBA.ORB orb, String args[])
throws org.omg.CORBA.UserException
{
    org.omg.PortableServer.POA root =
    org.omg.PortableServer.POAHelper.narrow(
        orb.resolve_initial_references("RootPOA"));

    boolean showHelp = false, withdrawOffers = false;
    String servername = null;

    // Check arguments
    //
    for(int i = 0 ; i < args.length ; i++)
    {
      if(args[i].equals("-w"))
        withdrawOffers = true;
      else if(args[i].equals("-h"))
        showHelp = true;
      else if(servername ==null) // assume it is the server name
        servername = args[i];
      else // unknown argument
        usage();
    }
    
    if (servername == null)
        servername = "testserver";
    if (showHelp)
        usage();

    // Start server event loop - this is necessary in case
    // the trader calls us back (i.e., _get_interface)
    //
    root.the_POAManager().activate();

    //
    // Connect to Trading Service
    //
    org.omg.CosTrading.Lookup trader =
    utils.SortUtils.connect(orb);

    if(trader == null)
        usage();

    //

    -40-
// Quit now if -w option was specified
//
if(withdrawOffers)
{
    utils.SortUtils.cleanOffers(trader, offerIdFile_);
    return 0;
}

// Instantiate our sorter implementation
//
Sorter_impl SorterImpl = new Sorter_impl(root, servername);
worker.Sorter sorter = SorterImpl._this(orb);

// Install the 'sortints' service type and export our service
// offers
//
utils.SortUtils.installServiceType(orb, trader);
exportOffers(orb, trader, servername, sorter);

System.out.println("Server for "+servername+" is ready...");
orb.run();
return 0;

public static void main(String args[])
{
    java.util.Properties props = System.getProperties();
    props.put("org.omg.CORBA.ORBClass", "com.ooc.CORBA.ORB");
    props.put("org.omg.CORBA.ORBSingletonClass", "com.ooc.CORBA.ORBSingleton");

    int status = 0;
    org.omg.CORBA.ORB orb = null;

    try
    {
        args = com.ooc.ORBORBA.ORB_impl.ParseArgs(args, props, null);
        orb = org.omg.CORBA.ORB_init(args, props);
        status = run(orb, args);
    }
    catch(Exception ex)
    {
        ex.printStackTrace();
        status = 1;
    }

    if(orb != null)
    {
        try
        {
            ((com.ooc.CORBA.ORB)orb).destroy();
        }
        catch(Exception ex)
        {
            ex.printStackTrace();
        }
    }
}
catch(Exception ex)
{
    ex.printStackTrace();
    status = 1;
}

System.exit(status);

static void
exportOffers(org.omg.CORBA.ORB orb,
org.omg.CosTrading.Lookup trader,
String servername,
worker.Sorter sorter)
{
    String result = null;
    System.out.println("Exporting service offers... ");
    try
    {
        // Write the ID of each offer we export to a file
        java.io.FileWriter fw = new java.io.FileWriter(offeridFile_);
        java.io.PrintWriter writer = new java.io.PrintWriter(fw);
        org.omg.CosTrading.Register reg = trader.register_if();
        if(reg == null)
        {
            System.err.println("Error: Trader does not support "+"the Register interface");
            System.exit(l);
        }
        org.omg.CosTrading.Property[] props =
        new org.omg.CosTrading.Property[1];
        props[0] = new org.omg.CosTrading.Property();
        props[0].name = "servername";
        props[0].value = orb.create_any();
        props[0].value.insert_string(servername);
        String id = reg.export(sorter,
        utils.SortUtils.getServiceType(),
        props);
        writer.println(id);
        writer.flush();
        fw.close();
    }
    catch(java.io.IOException ex)
{  System.err.println("Error: Unable to write file " + offerIdFile_);  System.exit(1);}
catch(org.omg.CosTrading.RegisterPackage.InvalidObjectRef e)  {
    System.err.println("Error: Invalid object reference");  System.exit(1);}
catch(org.omg.CosTrading.IllegalServiceType e)  {
    System.err.println("Error: Illegal service type " + e.type + ";");  System.exit(1);}
catch(org.omg.CosTrading.UnknownServiceType e)  {
    System.err.println("Error: Unknown service type " + e.type + ";");  System.exit(1);}
catch(org.omg.CosTrading.RegisterPackage.InterfaceTypeMismatch e)  {
    System.err.println("Error: Interface type mismatch for " + e.type + ";");  System.exit(1);}
catch(org.omg.CosTrading.IllegalPropertyName e)  {
    System.err.println("Error: Illegal property name " + e.name + ";");  System.exit(1);}
catch(org.omg.CosTrading.PropertyTypeMismatch e)  {
    System.err.println("Error: Property type mismatch for " + e.prop.name + ";");  System.exit(1);}
catch(org.omg.CosTrading.ReadonlyDynamicProperty e)  {
    System.err.println("Error: Readonly dynamic property " + e.name + ";");  System.exit(1);}
catch(org.omg.CosTrading.MissingMandatoryProperty e)  {
    System.err.println("Error: Missing mandatory property " + e.name + ";");  System.exit(1);}
catch(org.omg.CosTrading.DuplicatePropertyName e)  {
    System.exit(1);}
}
System.err.println("Error: Duplicate property ", e.name + ",");
System.exit(l);
}
catch(org.omg.CORBA.SystemException e)
{
e.printStackTrace();
System.exit(l);
}

static void
usage()
{
System.err.println();
"server-name");
System.err.println();
System.err.println("Options:");
System.err.println();
System.err.println(" -h Show this help message");
System.err.println(" -w Withdraws existing offers and 
exits");
System.exit(l);
}

//
// Generated by the ORBacus IDL to Java Translator
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//
//******************************************************************************

// Version: 4.1.2

package worker;

//
// IDL:worker/IntIterator:1.0
//
/**/

public class IntIterator_impl extends IntIteratorPOA
{
    private org.omg.PortableServer.POA poa_
    private int[] thearray;
    private int nextindex;

    public

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IntIterator_impl(org.omg.PortableServer.POA poa, int[] fullset)
{
    poa_ = poa;
    thearray = fullset;
    nextindex = 0;
}

public org.omg.PortableServer.POA
_default_POA()
{
    if(poa_ !=null)
        return poa_;
    else
        return super._default_POA();
}

//
// IDL:worker/IntIterator/getNextSet:1.0
//
public boolean
getNextSet(int setsize,
    IntSetHolder subset)
    throws EndOfSetReached
{
    if (nextindex >= thearray.length)
        throw new EndOfSetReached("Message from Iterator");
    boolean _r = true;
    int newarraysize = setsize;

    if ((thearray.length - nextindex) < setsize)
    {
        _r = false;
        newarraysize = thearray.length - nextindex;
    }

    subset.value = new int[newarraysize];
    int i = 0;
    for (; i < newarraysize; i++)
    {
        subset.value[i] = thearray[nextindex + i];
    }
    nextindex += i;
    return _r;
}

//
// IDL:worker/IntIterator/destroy:1.0
//
public void
destroy()
{
    try
    {
        _poa().deactivate_object(_object_id());
    }
    catch(Exception e)
    { e.printStackTrace();}
package worker;
import utils.*;

public class ClientCallBack_impl extends ClientCallBackPOA {
    private org.omg.PortableServer.POA poa_
    private int[][] resultsets;
    private int to_arrive_setcount;
    private int setcount;
    private boolean done = false;

    public ClientCallBack_impl(org.omg.PortableServer.POA poa, int cbcount) {
        poa_ = poa;
        resultsets = new int[cbcount][];
        to_arrive_setcount = cbcount;
        setcount = cbcount;
    }

    public org.omg.PortableServer.POA _default_POA() {
        if(poa_ != null)
            return poa_
        else
            return super._default_POA();
    }

    // // IDL:worker/ClientCallBack/getSortedInts:1.0
    // ***/
    public void getSortedInts(int intcount,}
}
IntIterator srvrItr)
{
    resultsets[to_arrive_setcount -1] =
        SortUtils.buildArray(intcount, srvrItr);
    to_arrive_setcount--;
    if (to_arrive_setcount == 0)
    {
        SortUtils.printInts(resultsets, setcount);
        done = true;
    }
}

public boolean isDone()
{
    return done;
}

// Generated by the ORBacus IDL to Java Translator

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//

package worker;
import utils.*;

//
// IDL:worker/Sorter:1.0
//
/***/

public class Sorter_impl extends SorterPOA
{
    private org.omg.PortableServer.POA poa_
    private String servername;

    public Sorter_impl(org.omg.PortableServer.POA poa, String name)
    {
        poa_ = poa;
        servername = name;
    }

    public org.omg.PortableServer.POA
default_POA()
    {
        if(poa_ != null)
return poa_; 
else
    return super._default_POA();
}

// IDL:worker/Sorter/sortInts:1.0
//
public void
sortInts(int intcount,
    IntIterator clientItr,
    ClientCallBack ccb)
{
    System.out.println(servername + " :begin to sort the array ....");
    int[] result =
        SortUtils.sort(SortUtils.buildArray(intcount, clientItr));
    System.out.println(servername + " :Finished sorting the array of size " +
        result.length);
    //SortUtils.printArray(result);
    try
    {
        IntIterator_impl serverItrImpl = new
            IntIterator_impl(poa_, result);
        //the following 2 lines are standard way of creating a incarnated corba
        //object.
        org.omg.CORBA.Object obj =
            poa_.servant_to_reference(serverItrImpl);
        IntIterator srvrItr = IntIteratorHelper.narrow(obj);
        // the following is ORBACUS way of creating an incarnated object
        //
        IntIterator srvrItr = serverItrImpl._this();
        ccb.getSortedInts(result.length, srvrItr);
    }
    catch(Exception e) { e.printStackTrace();}
}

******************************************************************************
*                   CORBA Trader Utilities listings                         *
******************************************************************************
package utils;

import java.io.*;
import java.util.*;
public class arrayHolder
{
    public int[] thearray= null;

    public arrayHolder(String infile, int maxsize)
        throws Exception
    {
        int arraysize=0;
   if (maxsize == 0)
               maxsize = 160000;
        ...
int[] intarray = new int[maxsize];

BufferedReader br = new BufferedReader(new
FileReader(infile));

String line = null;
StringTokenizer stk = null;
while((line=br.readLine()) !=null)
{
    stk = new StringTokenizer(line);
    while(stk.hasMoreTokens())
        intarray[arraysize++] =
    Integer.parseInt(stk.nextToken());
}

thearray = new int[arraysize];
for(; arraysize > 0 ; arraysize--)
    thearray[arraysize-1] = intarray[arraysize-1];

public int getLength() { return thearray.length;}

public int[] getArray(int start, int size)
{
    int[] retarray = new int[size];
    for (int i = 0; i < size; i++)
    {
        retarray[i] = thearray[i+start];
    }
    return retarray;
}

package utils;
import worker.*;
// Things are just too ugly without this
import org.omg.CosTradingRepos.ServiceTypeRepositoryPackage.*;

public abstract class SortUtils
{
    private static final String serviceType_ = "SortInts";

    public static int[] sort(int a[])
    {
        for (int i = a.length; --i>=0;)
        {
            boolean flipped = false;
            for (int j = 0; j<i; j++)
            {
                if (a[j] > a[j+1])
                {
                    int T = a[j];
                    a[j] = a[j+1];
                    a[j+1] = T;
                }
            }
        }
    }
}
a[j+1] = T;
flipped = true;
}
if (!flipped) { return a; }
return a;
}
public static int[] buildArray(int maxsize, Iterator itr) {
    int[] result = new int[maxsize];
    int nextindex = 0;
    IntSetHolder intsetholder = new IntSetHolder();
    int fetchcount = 65538;
    try {
        boolean morerows = itr.getNextSet(fetchcount,
intsetholder);
        do {
            int i = 0;
            for (; i < intsetholder.value.length; i++)
                result[nextindex+i] =
intsetholder.value[i];
            //System.out.println("From buildarray: " + result[nextindex+i]);
            nextindex += i;
            morerows = itr.getNextSet(fetchcount,
intsetholder);
        } while (morerows);
        itr.destroy();
    } catch (EndOfSetReached eosr) {
        itr.destroy();
    } catch (Exception e) {
        e.printStackTrace();
    } finally { return result; }
}

public static String
getServiceType() {
    return serviceType;
}

// Connect to Trading Service by resolving the ' TradingService'
// initial reference.
//
public static org.omg.CosTrading.Lookup
connect(org.omg.CORBA.ORB orb) {
    org.omg.CosTrading.Lookup result = null;
/\n/\n// Resolve the 'TradingService' initial reference
//
try{
    org.omg.CORBA.Object obj =
    orb.resolve_initial_references("TradingService");
    result = org.omg.CosTrading.LookupHelper.narrow(obj);
}
catch(org.omg.CORBA.ORBPackage.InvalidName ex)
{
    System.err.println("Error: Unable to resolve initial " +
                        "reference 'TradingService'");
}
return result;
}

public static void
installServiceType(org.omg.CORBA.ORB orb,
org.omg.CosTrading.Lookup trader)
{
    boolean typeExists = false;
    org.omg.CosTradingRepos.ServiceTypeRepository repos = null;

    // Verify that the type "SortInts" already exists in the
    // service type repository; if not, we need to install it
    try{
        org.omg.CORBA.Object obj = trader.type_repos();
                        narrow(obj);
        repos.describe_type(serviceType_);
        typeExists = true;
    }
catch(org.omg.CosTrading.IllegalServiceType ex)
    {
        // ignore
    }
catch(org.omg.CosTrading.UnknownServiceType ex)
    {
        // ignore
    }
catch(org.omg.CORBA.SystemException e)
    {
        System.err.println("System error occurred");
e.printStackTrace();
        System.exit(1);
    }

    if(!typeExists)
    {
        // installation code here
    }
System.out.println("Installing service type '" +  
    serviceType_ + "'...");

try
{
    String[] superTypes = new String[0];

    // Define the properties for this service type
    //

    PropStruct[] props = new PropStruct[1];
    props[0] = new PropStruct();
    props[0].name = "servername";
    props[0].value_type = orb.create_string_tc(O);
    props[0].mode = PropertyMode.PROP_NORMAL;

    repos.add_type(serviceType_,  
        worker.SorterHelper.id(),
        props, superTypes);
}
catch(org.omg.CosTrading.IllegalServiceType ex)
{
    System.err.println("Illegal service type: " +  
        ex.type);
    System.exit(1);
}
catch(org.omg.CosTrading.UnknownServiceType ex)
{
    System.err.println("Unknown service type: " +  
        ex.type);
    System.exit(1);
}
catch(org.omg.CosTradingRepos.ServiceTypeRepositoryPackage.  
    ServiceTypeExists ex)
{
    System.err.println("Service type '" + ex.name +  
        "' already exists");
    System.exit(1);
}
catch(org.omg.CosTradingRepos.ServiceTypeRepositoryPackage.  
    InterfaceTypeMismatch ex)
{
    System.err.println("Interface of service type '" +  
        ex.derived_service +  
        "' does not match super type '" +  
        ex.base_service + "'");
    System.exit(1);
}
catch(org.omg.CosTrading.IllegalPropertyName ex)
{
    System.err.println("Illegal property name '" +  
        ex.name + '"");
System.exit(1);

catch(org.omg.CosTrading.DuplicatePropertyName ex)
{
    System.err.println("Duplicate property name '" +
    ex.name + "'");
    System.exit(1);
}

catch(org.omg.CosTradingRepos.ServiceTypeRepositoryPackage.
    ValueTypeRedefinition ex)
{
    System.err.println("Property type for '" +
    ex.definition_2.name + "' is not compatible with the
    definition " +
    "in service type '" +
    ex.type_1 + "'");
}

catch(org.omg.CosTradingRepos.ServiceTypeRepositoryPackage.
    DuplicateServiceTypeName ex)
{
    System.err.println("Duplicate super type: " +
    ex.name);
    System.exit(1);
}

catch(org.omg.CORBA.SystemException e)
{
    System.err.println("System error occurred");
    e.printStackTrace();
    System.exit(1);
}

public static void
cleanOffers(org.omg.CosTrading.Lookup trader, String fileName)
{
    //
    // If the offer ID file exists, then read the offer IDs from
    // file and withdraw them
    //
    java.io.File f = new java.io.File(fileName);
    if(f.exists())
    {
        String[] offers = readOffers(f);
        System.out.println("Removing old offers...");
        try
        {
            org.omg.CosTrading.Register reg =
            trader.register_if();
        }
    }
if(reg == null)
{
    System.err.println("Error: Trader does not
    " +
                    "the Register interface");
    System.exit(1);
}

for(int i = 0 ; i < offers.length ; i++)
{
    try
    {
        reg.withdraw(offers[i]);
    }
    catch(org.omg.CORBA.UserException ex)
    {
        // ignore
    }
}

try
{
    java.io.FileReader fr =new java.io.FileReader(f);
    java.io.BufferedReader reader = new
    java.io.BufferedReader(fr);
    // Read all the offer IDs in the file, one ID per line
    //
    String id;
    while((id = reader.readLine()) != null)
    vec.addElement(id);

    fr.close();

    result = new String[vec.size()];
    vec.copyInto(result);

    //
public static void printInts(int[][] sortedarray, int arraycount) {
    int arrayptr = Integer.MIN_VALUE;
    int[] ptr = new int[arraycount];
    boolean numfound = true;
    while(numfound) {
        int lownum = Integer.MAX_VALUE, lowarray = Integer.MIN_VALUE;
        numfound = false;
        for (int i = 0; i < arraycount; i++) {
            if (sortedarray[i] != null) {
                arrayptr = ptr[i];
                if (sortedarray[i][arrayptr] <= lownum) {
                    lownum = sortedarray[i][arrayptr];
                    lowarray = i;
                    numfound = true;
                }
            }
        }
        if (!numfound) continue;
        ptr[lowarray]++;
        if (ptr[lowarray] >= sortedarray[lowarray].length) {
            sortedarray[lowarray] = null;
        }
        System.out.println(lownum);
    }
}

public static void printArray(int[] inarray) {
    for (int i = 0; i < inarray.length; i++)
System.out.println(i + " : " + inarray[i]);
import java.util.*;
import java.io.*;
public class multipleTester {
    static long starttime=0, endtime=0;
    public static void main(String[] args) throws Exception {
        Properties prop = new Properties();
        FileInputStream pFIS = new FileInputStream("client.properties");
        prop.load(pFIS);
        pFIS.close();

        System.out.println("Loading ints...........");
        arrayHolder thearray = new arrayHolder(
            prop.getProperty("input","testfile"),
            Integer.parseInt(prop.getProperty("maxsize","0")));
        System.out.println("Done loading ints: "+
        thearray.getLength());

        int servercount =
            Integer.parseInt(prop.getProperty("webServiceCount","1"));
        int startPtr = 0;
        int incr = thearray.getLength()/servercount;

        threadedTester[] testers = new threadedTester[servercount];
        int start = 0;
        for (int i=0,j=1; i < servercount; i++,j++) {
            if ((servercount - i) == 1)
                incr = thearray.getLength() - start;

            testers[i] = new threadedTester(
                thearray.getArray(start, incr),
                prop.getProperty("url"+j));
            start +=incr;
        }
    }
t[i].join();
System.out.println("Thread " + i + " ended.");
}

int[][] sortedarray = new int[servercount][];
for (int i = 0; i < servercount; i++)
{
    sortedarray[i] = testers[i].getSortedArray();
}

// printInts(sortedarray, servercount);
endtime = System.currentTimeMillis();
System.err.println("Time to sort and print " +
thearray.getLength() + " using " +
servercount + " servers: " + (endtime - starttime));

public static void printInts(int[][] sortedarray, int arraycount)
{
    int arrayptr = Integer.MIN_VALUE;
    int[] ptr = new int[arraycount];
    boolean numfound = true;
    while(numfound)
    {
        int lownum = Integer.MAX_VALUE, lowarray =
Integer.MIN_VALUE,
numfound = false;
        for (int i = 0; i < arraycount; i++)
        {
            if (sortedarray[i] != null)
            {
                arrayptr = ptr[i];
                if (sortedarray[i][arrayptr] <= lownum)
                {
                    lownum = sortedarray[i][arrayptr];
                    lowarray = i;
                    numfound = true;
                }
            }
        }
        if (!numfound) continue;
        ptr[lowarray]++;
        if (ptr[lowarray] >= sortedarray[lowarray].length)
        {
            sortedarray[lowarray] = null;
        }
    }
    System.out.println(lownum);
}

/**
 * SortIntSrvc.java
 *
 * This file was auto-generated from WSDL
 * by the Apache Axis Wsdl2java emitter.
 */

public interface SortIntSrvc extends java.rmi.Remote {
public int[] sortInts(int[] a) throws java.rmi.RemoteException;
/**
 * SortIntSrvcService.java
 * This file was auto-generated from WSDL
 * by the Apache Axis Wsdl2java emitter.
 */
public interface SortIntSrvcService extends javax.xml.rpc.Service {
    public String getSortIntSrvcAddress();
    public SortIntSrvc getSortIntSrvc() throws javax.xml.rpc.ServiceException;
    public SortIntSrvc getSortIntSrvc(String address) throws javax.xml.rpc.ServiceException;
    public SortIntSrvc getSortIntSrvc(java.net.URL portAddress) throws javax.xml.rpc.ServiceException;
}
/**
 * SortIntSrvcServiceLocator.java
 * This file was auto-generated from WSDL
 * by the Apache Axis Wsdl2java emitter.
 */
public class SortIntSrvcServiceLocator extends org.apache.axis.client.Service implements SortIntSrvcService {
    public String getSortIntSrvcAddress() {
        return SortIntSrvc_address;
    }
    public SortIntSrvc getSortIntSrvc() throws javax.xml.rpc.ServiceException {
        java.net.URL endpoint;
        try {
            endpoint = new java.net.URL(SortIntSrvc_address);
        }
        catch (java.net.MalformedURLException e) {
            return null; // unlikely as URL was validated in WSDL2Java
        }
        return getSortIntSrvc(endpoint);
    }
    public SortIntSrvc getSortIntSrvc(String address) throws javax.xml.rpc.ServiceException {
        java.net.URL endpoint;
        try {
            endpoint = new java.net.URL(address);
        }
catch (java.net.MalformedURLException e) {
    return null; // unlikely as URL was validated in WSDL2Java
}

return getSortIntSrvc(endpoint);

public SortIntSrvc getSortIntSrvc(java.net.URL portAddress) throws javax.xml.rpc.ServiceException {
    try {
        return new SortIntSrvcSoapBindingStub(portAddress, this);
    } catch (org.apache.axis.AxisFault e) {
        return null; // ???
    }
}

/**
 * For the given interface, get the stub implementation.
 * If this service has no port for the given interface,
 * then ServiceException is thrown.
 */

public java.rmi.Remote getPort(Class serviceEndpointInterface) throws javax.xml.rpc.ServiceException {
    try {
        if (SortIntSrvc.class.isAssignableFrom(serviceEndpointInterface)) {
            return new SortIntSrvcSoapBindingStub(new java.net.URL(SortIntSrvc_address), this);
        }
    } catch (Throwable t) {
        throw new javax.xml.rpc.ServiceException(t);
    }

    throw new javax.xml.rpc.ServiceException("There is no stub implementation for the interface: " + (serviceEndpointInterface == null ? "null" : serviceEndpointInterface.getName()));
}

/**
 * SortIntSrvcSoapBindingStub.java
 *
 * This file was auto-generated from WSDL
 * by the Apache Axis WSDL2Java emitter.
 */

public class SortIntSrvcSoapBindingStub extends org.apache.axis.client.Stub implements SortIntSrvc {
    private java.util.Vector cachedSerClasses = new java.util.Vector();
    private java.util.Vector cachedSerQNames = new java.util.Vector();
    private java.util.Vector cachedSerFactories = new java.util.Vector();
    private java.util.Vector cachedDeserFactories = new java.util.Vector();

    static org.apache.axis.description.OperationDesc [] _operations;
static {
    _operations = new org.apache.axis.description.OperationDesc[1];
    org.apache.axis.description.OperationDesc oper;
    oper = new org.apache.axis.description.OperationDesc();
    oper.setName("sortInts");
    oper.addParameter(new javax.xml.namespace.QName("", "inO"), new javax.xml.namespace.QName("http://DefaultNamespace", "ArrayOf_xsd_int"), int[].class,
            org.apache.axis.description.ParameterDesc.IN, false, false);
    oper.setReturnType(new javax.xml.namespace.QName("http://DefaultNamespace", "ArrayOf_xsd_int"));
    oper.setReturnClass(int[].class);
    oper.setReturnQName(new javax.xml.namespace.QName("", "sortIntsReturn"));
    oper.setStyle(org.apache.axis.enum.Style.RPC);
    oper.setUse(org.apache.axis.enum.Use.ENCODED);
    _operations[0] = oper;
}

public SortIntSrvcSoapBindingStub() throws org.apache.axis.AxisFault {
    this(null);
}

public SortIntSrvcSoapBindingStub(java.net.URL endpointURL, javax.xml.rpc.Service service) throws org.apache.axis.AxisFault {
    this(service);
    super.cachedEndpoint = endpointURL;
}

public SortIntSrvcSoapBindingStub(javax.xml.rpc.Service service) throws org.apache.axis.AxisFault {
    if (service == null) {
        super.service = new org.apache.axis.client.Service();
    } else {
        super.service = service;
    }
    java.lang.Class cls;
    javax.xml.namespace.QName qName;
    java.lang.Class beansf = org.apache.axis.encoding.ser.BeanSerializerFactory.class;
    java.lang.Class beandf = org.apache.axis.encoding.ser.BeanDeserializerFactory.class;
    java.lang.Class enumsf = org.apache.axis.encoding.ser.EnumSerializerFactory.class;
    java.lang.Class enumdf = org.apache.axis.encoding.ser.EnumDeserializerFactory.class;
    java.lang.Class arraysf = org.apache.axis.encoding.ser.ArraySerializerFactory.class;
    java.lang.Class arraydf = org.apache.axis.encoding.ser.ArrayDeserializerFactory.class;
    java.lang.Class simplesf = org.apache.axis.encoding.ser.SimpleSerializerFactory.class;
    java.lang.Class simplesdf = org.apache.axis.encoding.ser.SimpleDeserializerFactory.class;
}
qName = new javax.xml.namespace.QName("http://DefaultNamespace",
  "ArrayOf_xsd_int");
CachedSerQNames.add(qName);
cls = int[].class;
cachedSerClasses.add(cls);
cachedSerFactories.add(arraysf);
cachedDeserFactories.add(arraydf);

private org.apache.axis.client.Call createCall() throws java.rmi.RemoteException {
  try {
    org.apache.axis.client.Call _call = (org.apache.axis.client.Call)
      super.service.createCall();
    if (super.maintainSessionSet) {
      _call.setMaintainSession(super.maintainSession);
    }
    if (super.cachedUsername != null) {
      _call.setUsername(super.cachedUsername);
    }
    if (super.cachedPassword != null) {
      _call.setPassword(super.cachedPassword);
    }
    if (super.cachedEndpoint != null) {
      _call.setTargetEndpointAddress(super.cachedEndpoint);
    }
    if (super.cachedTimeout != null) {
      _call.setTimeout(super.cachedTimeout);
    }
    if (super.cachedPortName != null) {
      _call.setPortName(super.cachedPortName);
    }
    java.util.Enumeration keys = super.cachedProperties.keys();
    while (keys.hasMoreElements()) {
      java.lang.String key = (java.lang.String)
        keys.nextElement();
      _call.setProperty(key,
        super.cachedProperties.get(key));
    }
    // All the type mapping information is registered
    // when the first call is made.
    // The type mapping information is actually registered in
    // the TypeMappingRegistry of the service, which
    // is the reason why registration is only needed for the
    // first call.
    synchronized (this) {
      if (firstCall()) {
        // must set encoding style before registering
        serializers
        _call.setSOAPVersion(org.apache.axis.soap.SOAPConstants.SOAP11_CONSTANT
          S);
        _call.setEncodingStyle(org.apache.axis.Constants.URI_SOAP11_ENC);
      }
  }
}
for (int i = 0; i < cachedSerFactories.size(); ++i)
{
    java.lang.Class cls = (java.lang.Class) cachedSerClasses.get(i);
    javax.xml.namespace.QName qName =
        (javax.xml.namespace.QName) cachedSerQNames.get(i);
    java.lang.Class sf = (java.lang.Class) cachedSerFactories.get(i);
    java.lang.Class df = (java.lang.Class) cachedDeserFactories.get(i);
    _call.registerTypeMapping(cls, qName, sf, df,
false);
}

return _call;
}
}

public int[] sortInts(int[] inO) throws java.rmi.RemoteException {
    if (super.cachedEndpoint == null) {
        throw new org.apache.axis.NoEndPointException();
    }
    org.apache.axis.client.Call _call = createCall();
    _call.setOperation(_operations[0]);
    _call.setSoapAction(true);
    _call.setSoapActionURI("");
    _call.setSoapVersion(org.apache.axis.soap.SOAPConstants.SOAP11_CONSTANT s);
    _call.setOperationName(new
    javax.xml.namespace.QName("http://DefaultNamespace", "sortInts"));
    setRequestHeaders(_call);
    setAttachments(_call);
    java.lang.Object _resp _call.invoke(new java.lang.Object[]
{inO});

    if (_resp instanceof java.rmi.RemoteException) {
        throw (java.rmi.RemoteException)_resp;
    }
    else {
        getResponseHeaders(_call);
        extractAttachments(_call);
        try {
            return (int[]) _resp;
        } catch (java.lang.Exception _exception) {
            return (int[])
        org.apache.axis.utils.JavaUtils.convert(_resp, int[].class);
    }
}
}
import java.io.*;
import java.util.*;
public class arrayHolder{

  public int[] thearray= null;

  public arrayHolder(String infile, int maxsize) throws Exception {
    int arraysize=0;
    if (maxsize == 0)
      maxsize = 160000;
    int[] intarray = new int[maxsize];

    BufferedReader br = new BufferedReader(new FileReader(infile));

    String line = null;
    StringTokenizer stk = null;
    while((line=br.readLine()) !=null) {
      stk = new StringTokenizer(line);
      while(stk.hasMoreTokens())
        intarray[arraysize++] = Integer.parseInt(stk.nextToken());
    }

    thearray = new int[arraysize];
    for(; arraysize > 0 ; arraysize--)
      thearray[arraysize-1] = intarray[arraysize-1];
  }

  public int getLength() { return thearray.length; }

  public int[] getArray(int start, int size) {
    int[] retarray = new int[size];
    for (int i = 0; i < size; i++)
      retarray[i] = thearray[i+start];
    return retarray;
  }

}

******************************************************************************
* SOAP Service listings                                                   *
******************************************************************************
public class SortIntSrvc {

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public int[] sortInts(int a[])
{
    for (int i = a.length; --i>=0;)
    {
        boolean flipped = false;
        for (int j = 0; j<i; j++)
        {
            if (a[j] > a[j+1])
            {
                int T = a[j];
                a[j] = a[j+1];
                a[j+1] = T;
                flipped = true;
            }
        }
        if (!flipped) { return a; }
    }
    return a;
}

*******************************************************************************
* Service deploy and undeploy files *
*******************************************************************************
<!-- Use this file to deploy some handlers/chains and services -->
<!-- Two ways to do this: -->
<!-- java org.apache.axis.client.AdminClient deploy.wsdd -->
<!-- after the axis server is running -->
<!-- or -->
<!-- java org.apache.axis.utils.AdminClient deploy.wsdd -->
<!-- from the same directory that the Axis engine runs -->

<deployment
    xmlns="http://xml.apache.org/axis/wsdd/
    xmlns:java="http://xml.apache.org/axis/wsdd/providers/java">

    <!-- Services from SortIntSrvcService WSDL service -->
    <service name="SortIntSrvc" provider="java:RPC">
        <parameter name="className" value="SortIntSrvc"/>
        <operation name="sortInts" returnQName="return">
            <parameter name="a" type="tns:ArrayOf_xsd_int" xmlns:tns="http://DefaultNamespace"/>
        </operation>
        <typeMapping
            xmlns:ns="http://DefaultNamespace"
            qname="ns:ArrayOf_xsd_int"
            type="java:int[]"
            serializer="org.apache.axis.encoding.ser.ArraySerializerFactory"
            deserializer="org.apache.axis.encoding.ser.ArrayDeserializerFactory"
            encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"/>
    </service>

</deployment>
</deployment>
<undeployment xmlns="http://xml.apache.org/axis/wsdd/">
  <service name="SortIntSrvc"/>
</undeployment>
VITA

Suresh Sunku has a Bachelor of Engineering from Mysore University India, in Mechanical Engineering, 1983 and expects to receive a Master Of Science in Computer and Information Sciences from the University Of North Florida, April 2003. Dr. Roger Eggen of the University Of North Florida is serving as Suresh’s project director. Suresh is currently employed as a Database Administrator at Merrill Lynch for the past 5 years and has been employed at the company for the past 12 years. Prior to that, Suresh had worked as applications development manager at Merrill Lynch. Overall, Suresh has over 18 years of experience in the field of Information Sciences.

Suresh has on-going interest in the field of Grid/On-Demand computing and is working with University Of North Florida professors to develop services for the grid community. Suresh has extensive experience in C++, and Java programming languages and also worked with commercial database products such as IBM’s DB2 and Microsoft’s SQL Server. Suresh is married and has 2 children of age 10 and 9 years.