JADE PERFORMANCE TEST REPORT

IBM INNOVATION CENTRE PERFORMANCE TESTS - APRIL 2008

Contents

INTRODUCTION

In partnership with IBM, who provided hardware equipment and services at their Innovation Centre for Business Partners in Sydney Australia, the Jade Performance Test Lab (JPTL) conducted a number of performance tests using JADE 6.2, during a one-week on-site visit in April 2008.

Several of the JPTL's standard performance tests were used for this exercise.

- **TradeEm**: A high-volume Stock Exchange trading simulation
- **SkiDemo**: A large-scale financial services system
- **TPC-A**: An object-oriented implementation of the standard TPC-A test
- **Async Method Calls**: Used to test parallel prime number calculations

This report details the best-ever performance test results that were achieved.

This report reflects Jade's analysis of the performance tests and does not constitute an IBM endorsement of the results. Please refer to the attached IBM Fact Sheet.

SUMMARY

Excellent results were achieved, representing best-ever measurements across all tests. Highlights include:

- TradeEm (tcp sessions): **120,024 users** running at 4,110 TPS
- TradeEm (tcp sessions): **4,487 TPS** with 9,600 users
- TradeEm (thin clients): **6,000 users** running at 1,508 TPS
- TradeEm (thin clients): **2,642 TPS** with 1,200 users
- SkiDemo: **244 TPS** and 91 millisecond response time with 1,000 users
- TPC-A: **467,289 Read TPS** with 1,000 users
- Async Method Calls: Achieved a minimum **700% improvement** in response time in prime number calculation tests

TPS – Transactions per second

It is likely that with additional hardware for simulated users, the number of users and/or TPS rates could be increased even more. This applies particularly to TradeEm users (both tcp sessions and thin clients), SkiDemo users and SkiDemo TPS rates.

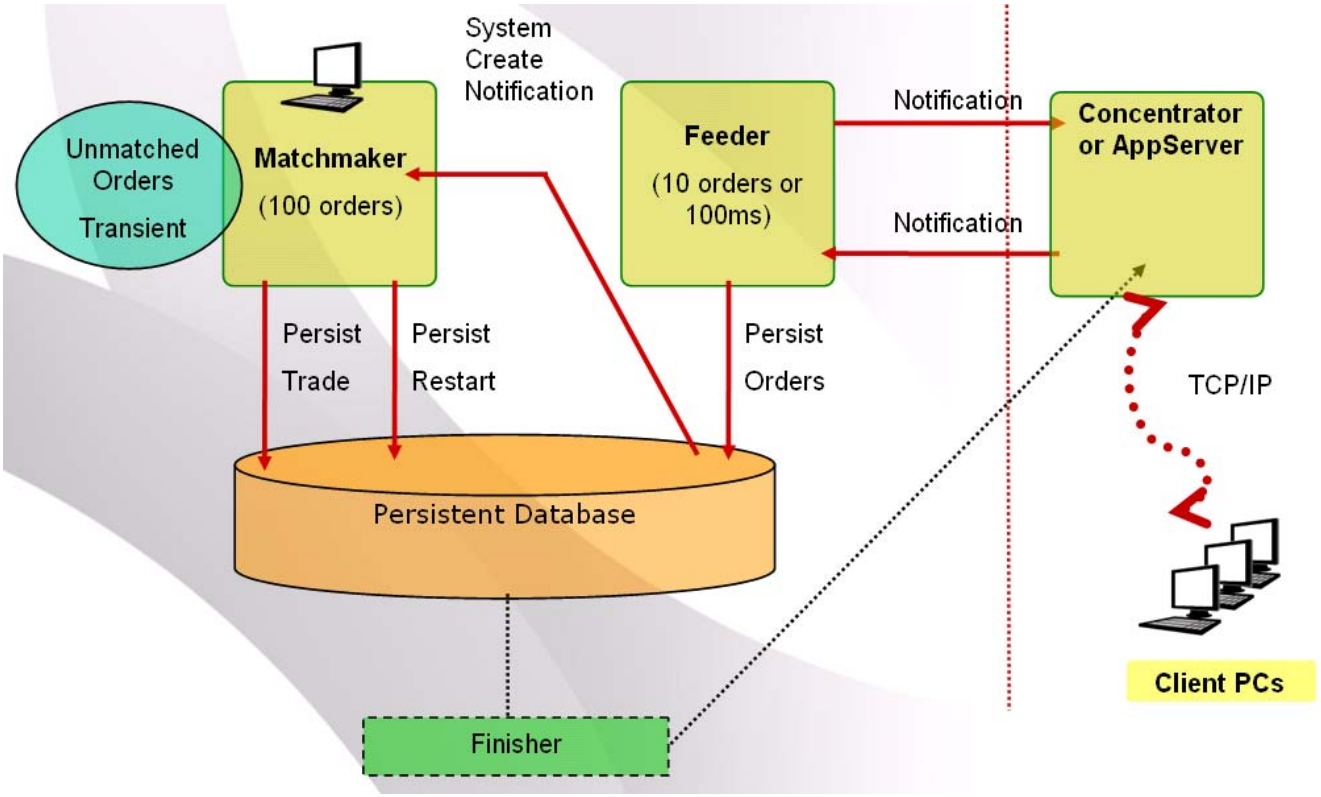
IBM HARDWARE

The following IBM Innovation Centre hardware was used for the performance tests and will be referred to throughout this report.

- **X105, X106, X111**: IBM x3650 Dual Quad-Core processor server running Windows 2003 Enterprise 64 Bit Edition. The server had PAE enabled with 18GB RAM installed.
- **X109, X110**: IBM x3650 Dual Quad-Core processor server running Windows 2003 Enterprise 64 Bit Edition. The server had PAE enabled with 6GB RAM.

TRADEEM TEST METHODOLOGY

For the TradeEm performance tests, the high-volume Stock Exchange trading simulation system was used. The following diagram shows the architecture of this system.



This proof-of-concept system represents an extreme design and was developed to verify that JADE 6.2 could meet the performance requirements of businesses similar to a high-volume Stock Exchange.

For the tcp session tests (except as noted):

- X105 was used for the database server, MatchMakers and Feeders
- X109 was used for the Concentrators
- X106 and X111 hosted the users (separate databases were installed on these machines to simulate the client infrastructure)

For the thin client tests:

- X105 was used for the database server
- X106 and X111 were used for application servers
- X109 and X110 hosted the users

The database was on a locally-attached RAID 0 array of six disks. The database logs were stored initially on another drive on a SAN, but were later moved to the database drive as the SAN proved to be a bottleneck. All machines were configured with a minimum 70GB pagefile, as the large number of tcp session users required a significant amount of virtual memory.

Note that in previous performance tests, the Feeders would commit 10 transactions at a time. However, with this hardware, more transactions can be accumulated into a single commit without significant delays being imposed on the users. Consequently, these tests were generally run with Feeders committing 100 transactions at a time.

JADE release 6.2.13.022 was used for these performance tests.

TRADEEM RESULTS

TCP SESSION USERS

The results of the TradeEm performance tests with tcp session users are as follows.

				Transactions Per Commit			
Users	TPS	Queues	Concentrators	Feeders	Match Makers	Logs	Collection Maintenance
9,600	4,487	4	12	4,000	2,000	DB	No
10,000	3,223	4	4	10	100	SAN	No
10,000	2,181	6	6	10	100	SAN	No
10,000	1,200	10	10	10	100	SAN	No
10,000	4,078	4	4	10	100	DB	No
40,000	4,086	4	4	10	100	DB	No
120,000	4,110	4	12	10	100	DB	No
120,000	1,615	4	12	10	100	DB	Yes

Queues *– The number of queues used in the test*
Concentrators *– The number of Concentrators used in the test*
Logs *– Whether the database logs were stored on a SAN or on the database drive*
Collection Maintenance *– 'Yes' if collection maintenance was enabled, otherwise 'No'*

To scale up the number of users, three machines were used to host users for the 120,000 user tests. There does not seem to be any correlation between the number of users and the throughput achieved. This is due to the Multi-Worker TCP Transport (MWTT) insulating the database from the user connections, as well as the Concentrators (which use the MWTT) running on a separate machine to the database server.

In previous performance tests, the most tcp session users ever connected to TradeEm was 16,000. Therefore 120,000 users represent a major increase. With 10,000 users per Concentrator and with the number of Concentrators able to be scaled up even more, we would expect a much larger number of users to be able to achieve similar throughput.

Most TradeEm performance tests are run with no collection maintenance other than object indexes, as we expect that a production implementation would be done this way to maximise online trading performance. A test was done **with** collection maintenance enabled to see the effect (this is the final row in the above table). Introducing collection maintenance significantly modifies the basic design of the test system. However, it is likely that higher throughput could be achieved with further tuning.

Because of the powerful hardware, we ran a test with increased transactions per commit in the Feeder (increased from 10 to 4000) and MatchMaker (increased from 100 to 2000) applications. This produced a 9% improvement over the previous best TPS rate. However, it is possible that blocking factors of this magnitude could introduce unacceptable delays for the users. In this mode, Feeders accumulate orders for approximately four seconds before committing them, so on average this would introduce an approximate two second delay.

THIN CLIENT USERS

The results of the TradeEm performance tests with thin client users are as follows.

Users	TPS
1,200	2,520
2,400	2,139
6,000	1,508

There were 30 application servers in total, distributed evenly across two machines. Users were distributed evenly across two machines and also evenly across the application servers.

There is a noticeable trend towards lower throughput when the number of thin client users is higher. This may be due to the larger number of JADE processes registered for notifications in the thin client user tests. In the tcp session configuration, each **Concentrator** registers for two notifications. In the thin client configuration, each **user** registers for two notifications. This means that the 120,000 tcp session user test registers for only 24 notifications, while the 6,000 thin client user test registers for 12,000 notifications. Clearly this is a significant difference.

SKIDEMO TEST METHODOLOGY

For the SkiDemo tests, the standard JPTL SkiDemo performance test system was used.

X105 was used for the database server and application servers. X106 and X109 hosted the users. There were 50 application servers.

The database was stored on a locally-attached RAID 0 array of six disks. The database logs were stored on another drive on a SAN. Warm cache was used, comparable to a normal production environment. A target throughput rate of 250 TPS was used. The actual throughput is a little less than the target, depending on the response times.

JADE release 6.2.13.022 was used for these performance tests.

SKIDEMO RESULTS

The results of the SkiDemo performance tests are as follows.

Users	Actual TPS	Response Time (ms)	Application Servers
1,000	233	281	Local
2,000	231	629	Local
1,000	244	91	Remote

Local *– The application servers were on the same machine as the database server*
Remote *– The application servers were on a different machine to the database server*

For the initial tests, all application servers were on the same machine as the database server. This pushed the memory limit on the machine. With 50 application servers and 2,000 users consuming memory, there was little left over for Windows file system cache. As a result, read I/O was increased and response times increased.

In addition to being memory-bound on the server, the large number of threads would have increased the cost of Windows context switches.

For the final test, we configured a distributed system. The 50 application servers were moved to the X111 machine. In addition to reducing the memory demand on the database server machine, this also reduced the number of threads this machine, which reduced the cost of context switches.

TPC-A TEST METHODOLOGY

TPC-A testing used a modified version of JPTL's object-oriented implementation of the standard TPC-A performance test. Essentially the performance test was to measure read-only transactions against the database. Each transaction simply referenced an account balance and the address details of a client.

X105 was used for the database server and application servers. X106 and X109 hosted the users. There were 50 application servers. The database was on a locally-attached RAID 0 array of six disks. The database logs were on another drive on a SAN. Warm cache was used, comparable to a normal production environment.

JADE release 6.2.13.022 was used for these performance tests.

TPC-A RESULTS

The results of the TPC-A performance tests are as follows.

Users	Actual Read TPS
1,000	467,289

ASYNC METHOD CALLS TEST METHODOLOGY

Async Method Calls testing used Jade Software Corporation's standard Async Method Calls example schema to calculate prime numbers. The calculate primes test used the following parameters:

- Number of Calls: 1
- Number of Workers: Ranging from 1 to 50, set with each test (see below)
- Parallel Task Parameter: 10,000
- Requests per Caller: 1
- Interval (milliseconds): 1
- Request Executions: 50

The X105 machine was used for all calculate primes performance testing. The database was on a locally-attached RAID 0 array of six disks. The database logs were on another drive on a SAN. Warm cache was used, comparable to a normal production environment. JADE release 6.2.13.022 was used.

ASYNC METHOD CALLS RESULTS

The prime number calculation test is CPU-bound. The results demonstrate that by increasing the number of workers, work is offloaded and distributed across all the CPUs in the server machine.

Workers	Max Worker Elapsed Time (Microseconds)
1	403,489,912
2	202,925,744
3	136,744,956
4	105,637,871
5	82,722,568
6	73,418,044
7	64,561,219
8	57,254,121
9	54,338,383
10	54,145,275
11	53,794,120
12	54,970,715
13	54,505,481
14	54,631,079
15	54,015,067
16	54,113,937
50	57,502,914

Jade Software achieves best ever performance figures on System x servers at IBM Innovation Centre

Jade Software Corporation Limited (Jade) is an information technology research and development organization with over 25-years experience in supplying innovative software solutions and services. Their core technology, JADE, is a high-performance, open software platform for delivering targeted solutions to complex business problems.

Jade has conducted regular in-house performance testing of their JADE platform for a number of years and has achieved excellent results. However, they needed to be able to significantly increase the capacity of these tests, for both internal R&D measurements and to have proof-points for customers and prospects.

Jade's Performance Testing Lab Manager, Matthew Williams, who is based in New Zealand, says the IBM Innovation Centre's range of hardware and ability to scale tests means they can easily push their platform far beyond what they would be able to achieve in-house.

"The great thing about the Innovation Centre is the range of equipment on offer and the flexible configurations they can provide. The staff there were always ready to help us reconfigure equipment if required, so we could get as much testing done as possible, to get the most value out of our visit," he said.

"We had an ambitious number of tests that we wanted to run in only one week. For example, in one test we exceeded 120,000 concurrent user sessions. In another we obtained an almost 10-fold increase in the transactions-per-second rate. We had a goal of beating all of our previous best results for the tests that we ran and I'm happy to say we achieved that."

Jade also find the ability to connect remotely to the IBM Innovation Centre highly valuable.

"Now that we're familiar with the Innovation Centre's equipment and we've met the people, if we want to perform additional testing we can arrange to do this remotely. It's a great service that gives us access to dedicated test equipment when required, that we wouldn't have access to in-house."

Williams says his team could not have reasonably scaled their performance tests to these levels without access to the specialised equipment and services offered by the Innovation Centre.

"While we can undertake most of our testing in-house, these very high-performance tests require equipment that it would be cost prohibitive for us to have in-house. The Innovation Centre gives us access to that equipment and allows us to produce far more valuable performance testing evidence for our customers."

JADE™

For further information:
Jade Software Corporation www.jadeworld.com
IBM Innovation Centre **ibm.com**/partnerworld/iic