- Benchmark White Paper -

Java – CICS TS V2.2 Application Performance Test on zSeries

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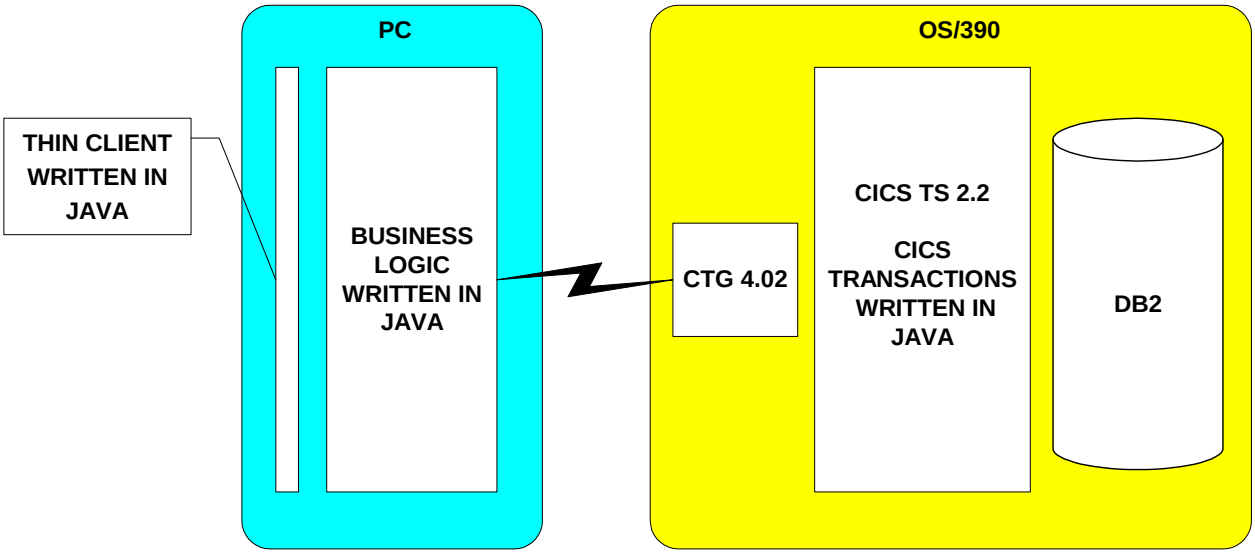
Contact

Jocelyn DENIS
EMEA ATS PSSC – Montpellier (France)
zSeries Benchmark Center
e-mail: jdenis@fr.ibm.com
PSSC intranet: http://w3.pssc.mop.ibm.com
eServer benchmark centers: http://w3.ibm.com/sales/systems/benchmarks

1. Requirements

1.1 Application architecture

The project consists of validating the application architecture in terms of functionalities, performance, scalability, stability, and reliability for a Banking Sector customer.
The customer application architecture is:



1.2 Project objectives

Demonstrate the performance, scalability, and reliability of Java programs executing in CICS:

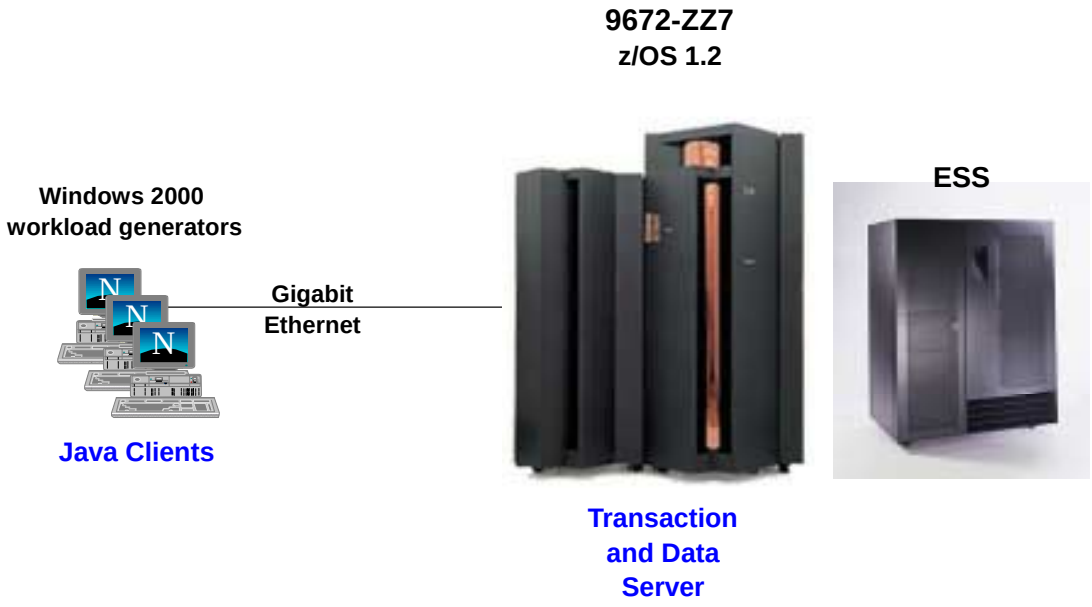
- Performance:
  Capability to reach a high performance level for 200 concurrent active users, executing 18 transactions/sec, with the average end-user response time < 1 sec.
  Measure the CPU utilization.

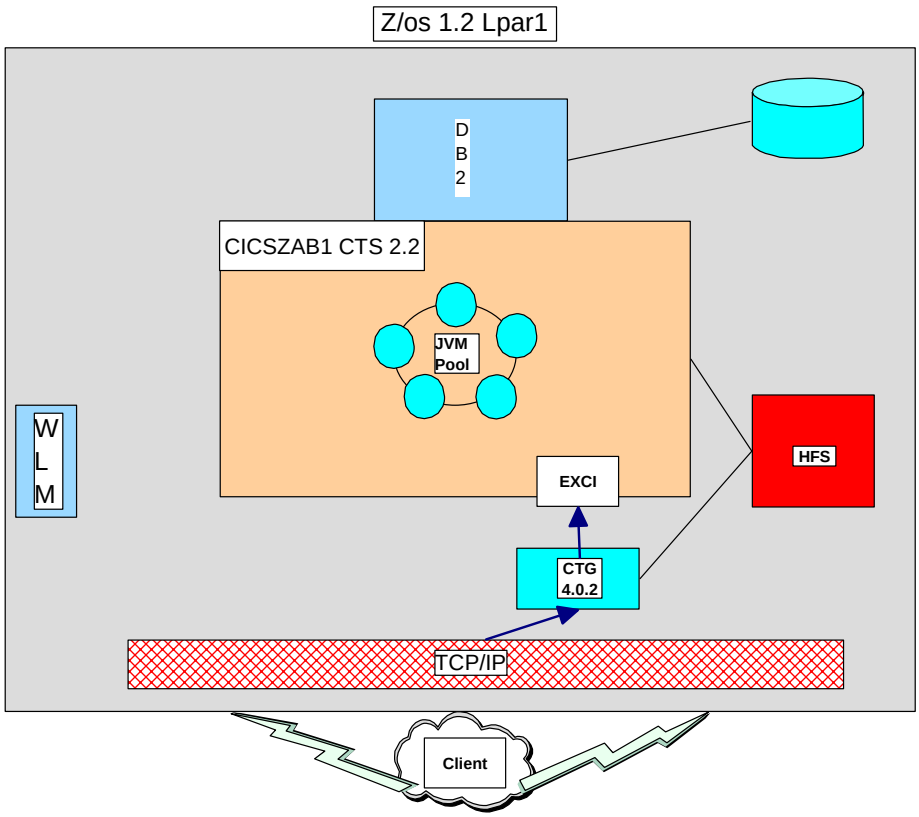
- Scalability:
  Capability to process a higher number of transactions (up to the maximum allowed by the configuration).
  Measure the achieved transaction rate and end-user response time.

- Stability and Reliability:
  Capability to run with 200 concurrent active users during 8 hours in a stable state (in terms of transaction rate and response time).
  Measure the CPU utilization.

1.3 Technical configuration

1.3.1 Hardware and logical configuration





1.3.2 Hardware infrastructure

1.3.2.1 Transaction and Database Server

- One @server zSeries 9672-ZZ7 computer, with a dedicated Logical Partition:
  - 6 dedicated CPs
  - 4 GB memory (2 GB central and 2 GB expanded)
  - 8 ESCON channels
  - One dedicated Gigabit Ethernet OSA card
- One Enterprise Storage Server (ESS) DASD sub-system, with 700 GB of storage (half capacity).

1.3.2.2 Network

- Dedicated Gigabit Ethernet connections.

1.3.3 Software infrastructure

1.3.3.1 Application and Enterprise Server

- z/OS V1R2.0
- z/OS V1R2.0 DFSMS
- z/OS V1R2.0 IBM Communication Server (TCP/IP)
- z/OS V1R2.0 SecureWay Security Server (RACF)
- z/OS V1R2.0 RMF
- CICS TS V2.2
- Java 1.3.1
- CTG 4.0.2
- DB2 7.1

1.3.3.2 Workload generation

- The PSSC team built, recorded, tested, and executed the workload generation scripts to simulate the thin Java client for the 200 concurrent users activity, each user running applicative banking transactions.

2. Results

2.1 Results summary

- Performance:
  - Transaction rate: **19 transactions/sec**
  - End-user average response time: **0.2 sec** (90% of the transactions < 0.26 sec)
  - Average CPU load: **165 MIPS** (approx. 9 MIPS per transaction/sec)
  - Average DASD activity: 120 I/O per sec, with an average response time of 2 msec
- Scalability:
  - Transaction rate: **71 transactions/sec**
  - End-user average response time: **0.5 sec** (90% of the transactions < 0.9 sec)
  - Average CPU load: **780 MIPS** (approx. 11 MIPS per transaction/sec)
  - Average DASD activity: 450 I/O per sec, with an average response time of 2 msec
  - Scalability demonstration:
    - For a transaction rate **x4**, the end-user average response time **x2.5** and the transaction/sec CPU cost **x1.2**.
- Stability and Reliability:
  - 19 transactions/sec during a **8 hours test**:
    - Very high stability in terms of transaction rate (**19 transactions/sec**) and end-users response time (**< 0.2 sec**).
    - Small CPU load increase to a **245 MIPS** average due to the DB2 database size increase and disorganization (approx. 12 MIPS per transaction/sec).

2.2 Scenario 1: performance test

2.2.1 Scenario description

This scenario simulated the activity of **200 concurrent active users**, running the **10 representative transactions**, with a transaction rate of **19 transactions/sec**, during 22 minutes (6 to 7 minutes of ramp-up, and 15 to 16 minutes of stabilized activity).

Based on previous tests, the optimum number of shareable JVMs was found to be **10** for the requested activity, with a JVM size of **56 MB**, and CICS MaxTasks setting of **60.**

2.2.2 Scenario results

This scenario (200 concurrent active users, running the 10 representative transactions, with an average transaction rate of **19 transactions/sec**) allowed us to:

- Demonstrate the performance level of the benchmark configuration (hardware and software) and the performance level of the Java transactions tested:
  - End-user average response time being lower than **0.2 sec** (the objective was to reach an end-user average response time lower than 1 sec).
    90% of the transactions had an end-user average response time lower than **0.26 sec.**
- Evaluate the required resources to execute the defined scenario:
  - Average CPU load of approx. 20%
    (approx. **165 MIPS** = **9 MIPS per transaction/sec**, based on the 6 CPs LPAR processing capacity of 822 MIPS)
  - Average DASD I/O rate of approx. **120 I/O per sec**
  - Average DASD I/O response time of approx. **2 msec**
- Demonstrate the stability of the performance level, and the stability of the resources consumed.

2.3 Scenario 2: scalability test

2.3.1 Scenario description

This scenario consists in simulating the activity of **200 concurrent active users**, running the **10 representative transactions**, with the **maximum transaction rate** allowed by the benchmark configuration, during 22 minutes (6 to 7 minutes of ramp-up, and 15 to 16 minutes of stabilized activity).

Based on previous tests, the optimum number of shareable JVMs was found to be **20** for the requested activity, with a JVM size of **56 MB**, and CICS MaxTasks setting of **100.**

2.3.2 Scenario results

This scenario (200 concurrent active users, running the 10 representative transactions, with an average transaction rate of more than **71 transactions/sec**) allowed us to:

- Demonstrate again the performance level of the benchmark configuration (hardware and software) and the performance level of the Java transactions tested:
  - End-user average response time being lower than **0.5 sec** (the objective was to reach an end users average response time lower than 1 sec for a transaction rate of 18 transactions/sec).
  - Except for the transactions G11C and G32C, which resulted in end-user average response time of approx. 2.7 sec (due to application business logic the 2 transactions were serialized).
  - 90% of the transactions had an end users average response time lower than **0.9 sec** (except for transactions G11C and G32C).
- Evaluate the required resources to execute the defined scenario:
  - Average CPU load of approx. 95%
    (approx. **780 MIPS** = **11 MIPS per transaction/sec**, based on the 6 CPs LPAR processing capacity of 822 MIPS)
  - Average DASD I/O rate of approx. **450 I/O per sec**
  - Average DASD I/O response time of approx. **2 msec**
- Demonstrate the **scalability** of the overall solution:
  - For a transaction rate multiplied by 4, the CPU load has been multiplied by 4.7, and the end users average response time has been multiplied by 2.5.

2.4 Scenario 2: stability and reliability test

2.4.1 Scenario description

This scenario consists in simulating the activity of **200 concurrent active users**, running the **10 representative transactions**, with a transaction rate of **19 transactions/sec**, during 8 hours (6 to 7 minutes of ramp-up, and 473 to 474 minutes of stabilized activity).

Based on previous tests, the optimum number of shareable JVMs was found to be **10** for the requested activity, with a JVM size of **56 MB**, and CICS MaxTasks setting of **60.**

2.4.2 Scenario results

This scenario (200 concurrent active users, running the 10 representative transactions, with an average transaction rate of **19 transactions/sec**, running during **8 hours**) allowed us to:

- Demonstrate again the performance level of the benchmark configuration (hardware and software) and the performance level of the Java transactions tested:
  - End-user average response time being lower than **0.2 sec** (the objective was to reach an end users average response time lower than 1 sec).
  - Except for the transaction G12C (DB2 CPU consumption increase due to table size increase during the test: Table Space Scan on DEPOSIT_BOX_CONT which was empty at start time of the run).
- Evaluate the required resources to execute the defined scenario:
  - Average CPU load of approx. 30%
    (approx. **245 MIPS = 12 MIPS per transaction/sec**, based on the 6 CPs LPAR processing capacity of 822 MIPS)
    Note: the CPU load increased slowly during the 8-hours run from 20% to 35% because of the DB2 tables increase and number of extends; this can be fixed by tuning the tables allocation parameters (not done during the benchmark due to lack of time).
  - Average DASD I/O rate of approx. **120 I/O per sec**
  - Average DASD I/O response time of approx. **2 msec**
- Demonstrate the stability of the performance level, and the stability of the resources consumed, in a typical online daily activity of 8 hours.

2.5 Conclusion

During the benchmark, we demonstrated that the major tuning effort areas were the JVM (number of shareable JVMs, JVM memory parameters…), and DB2 (application and database design, tables, tables indexes, locking reduction to improve databases access concurrency…).

The results of this benchmark have demonstrated that running Java programs in CICS TS V2.2 provides good performance, high scalability and a stable environment. The transaction rate and response time targets for the benchmark were passed and the results of additional tests, including an 8 hour stability run, left the customer feeling very confident about the use of Java in CICS.

We hope that this report will be of use to others who are considering the use of Java with CICS Transaction Server.