# WareLite Limited

## WareLite Business Operating Support System

*Performance and Scalability Benchmarks*

| | |
|---|---|
| **Benchmark** | **ROADMAP-A** |
| **Date** | 19 Apr 2006 |
| **Status** | Final |
| **Release** | 1 |
| **Site** | Milano |
| **Availability** | Public |

| Sponsors | |
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# 1. Summary

WareLite BOSS (Business Operating Support System) is an Event Driven Application Server – a grid-based platform for the execution of event-driven, real time business processes requiring extreme OLTP capabilities. The benchmarks reported in this paper measure WL BOSS performance and scalability.

WareLite BOSS architecture has four main components:

- Node Managers – Execute Processes in a Transactional Framework
- Global Lock Managers – Ensure Determinism to parallel processes generating contention (e.g. real time rating)
- Persistence Providers – Provide an abstraction layer between process execution and data storage/retrieval, implementing data partitioning and distribution across multiple RDBMSs
- Presentation Layer – Based on standard messaging (MSMQ), presents events to WL BOSS

The WL BOSS installation used to obtain these benchmarks was made of:

- Up to 4 computers hosting the Node Managers. In production implementations this number can be increased as needed to achieve the desired capacity;
- 1 computer hosting one Global Lock Manager. In production implementations the minimum number of GLM recommended is 2, to support high availability, and it can be increased as needed to achieve the desired capacity;
- Up to 2 computers hosting the Persistence Providers/RDBMS (SQL Server). In production implementations this number can be increased as needed to achieve the desired capacity;
- 1 computer hosting the Presentation Layer (MSMQ). In production implementations this number can be increased as needed to achieve the desired capacity;

The benchmarks shown in this document were obtained varying the number of Node Managers and Persistence Providers (RDBMS) within the WareLite BOSS Grid and monitoring the number of transactions per second at the RDBMS level.

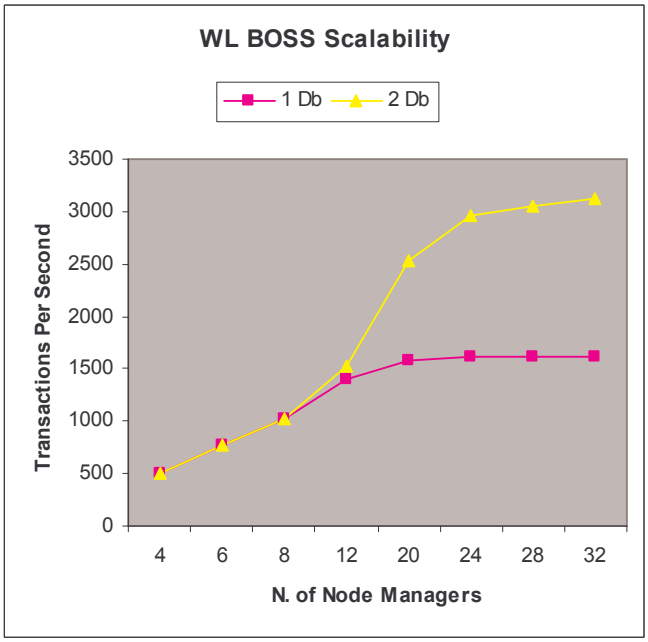
One of the benchmarks we executed is based on a simple real time rating process requiring contention resolution, provided by the Global Lock Manager. Each process generates 4 transactions ('read' and 'write' operations) against one or more databases, thus the number of business processes per second is calculated dividing by 4 the number of transactions per second measured by the RDBMS monitor. This benchmark has been selected for its closeness to commercial applications.

The benchmark shows that:

- **The capacity of WL BOSS is a linear function of the number of computers hosting the Node Managers (Horizontal Scalability).** In addition, multiple Node Managers can be hosted by the same computer, thus increasing the host capacity up to a limit dependent

upon the computer's characteristics (Vertical Scalability). In these benchmarks the capacity limit of a single computer is reached with 16 Node Managers.

- **The capacity of WL BOSS is a linear function of the number of Persistence Providers (i.e. Databases)**




The pink curve in the diagram shows that when using 1 single Db to support persistence, WL BOSS performance hits a plateau at around 1600 TPS, i.e. the addition of further nodes does not increase performance. This is because 1600 TPS is the capacity limit of a single database within our benchmark infrastructure. However, as shown in the yellow curve, horizontal scalability is restored by simply increasing the number of databases. The diagram shows that our WL BOSS benchmark infrastructure saturates the capacity of 2 databases.

**With a hardware infrastructure worth €19.302,00 (including networking and KVM equipment) and hosting Node Managers on 4 computers worth about €500 each, with 2,000,000 records partitioned over 2 Persistence Providers (Databases), we have achieved a sustainable rate of 3160 TPS (Transactions Per Second) against databases, i.e. 790 complete, deterministic Real Time Rating Processes Per Second, at a hardware cost per TPS of € 6.19[1]. The cost of the Transaction Per Minute is thus € 0.10.**

With the same hardware infrastructure we have achieved 3,800 TPS with 2,000,000 records for an intrinsically deterministic (i.e. with no Global Lock Manager) process. As this process comprises only one transaction, the number of Processes per Second (i.e. of events processed per second) equals the number of Transactions per Seconds. An intrinsically deterministic process might be a process providing transformation, implementing look-ups or appending records to a database. For instance most of the business processes needed to implement an RFID infrastructure are intrinsically deterministic processes.

Our benchmarks prove that WL BOSS provides extreme, scalable OLTP to event-driven business processes, thanks to the complete horizontal scalability of its four main components, Node Managers, Global Lock Managers, Persistence Providers and Presentation Layer:

[1] This figure is calculated taking into consideration the total cost of hardware, including network equipment, utilised to measure the benchmarks

- Performance can be increased by simply adding Node Managers to the infrastructure;
- Global Lock Managers ensure determinism but do not represent a performance bottleneck, as workload can be partitioned across any number of Global Lock Managers;
- The bottleneck typically exposed by databases does not limit overall WL BOSS scalability and performance: thanks to WL BOSS data partitioning and distribution services, performance can be increased by the addition of more physical databases to the infrastructure;
- Performance is not limited by the presentation layer, as multiple queues can be implemented to present events to the grid.

# 2. ROADMAP-A Description

The benchmark ROADMAP-A is based on the ROADMAP solution set. The ROADMAP solution set is distributed with the WL BOSS run-time and WL BOSS SDK licenses. The ROADMAP solution set comprises the following business processes:

- rdmp_create_product
- rdmp_create_customer
- rdmp_purchase_reseller
- rdmp_purchase
- drop

The ROADMAP-A benchmark utilises only the following business processes from the whole ROADMAP solution set:

- rdmp_create_product
- rdmp_create_customer
- rdmp_purchase

The benchmark ROADMAP-A is divided in two parts: customer creation performance and rating performance. The customer creation performance benchmark is based upon the business process rdmp_create_product whilst the rating benchmark is based upon the business process rdmp_purchase.

## 2.1. Customer Creation

During this phase of the benchmark, one or more client agents present events (WL EPL XML documents, each containing one instance of the class WL.examples.roadmap.customer) to a WL BOSS domain presentation component. One or more Node Managers drain the events and propagate the instances to one or more persistence providers. The benchmark is run based on different configurations, as shown in the detailed results.

The performance figures presented in the benchmark results are always obtained by monitoring the number of transactions per second at the RDBMS level.

The total number of transactions (fired against a RDBMS) generated by a single business process varies depending on the business process' scope. For example, the 'rdmp_create_customer' business process generates **two** insert operations against one or more RDBMS. The two insert operations belong to the same transactional unit, as any WL BOSS business process is executed

within a single transactional framework. Thus, a total of N insert operations per second measured on the target RDBMS means N/2 business processes per second executed by WL BOSS.

To obtain the RDBMS performance figure, a third party monitor facility has been used. In these benchmarks, the number of transactions per second has been obtained using the performance counters exposed by MicroSoft SQL Server. The results have also been cross-checked with other methods.

The word "transaction" is used with its technical meaning throughout this document – each transaction comprising one or more "begin transaction" instruction, a set of operations providing the content of the transaction and each transaction ending with one or more "commit" or "rollback" instruction. In this respect, the RDBMS deployed for the benchmarks are always accessed with AUTOCOMMIT OFF and with the isolation level (for each session accessing the databases) set to READ COMMITTED, unless otherwise specified.

## 2.2. Rating

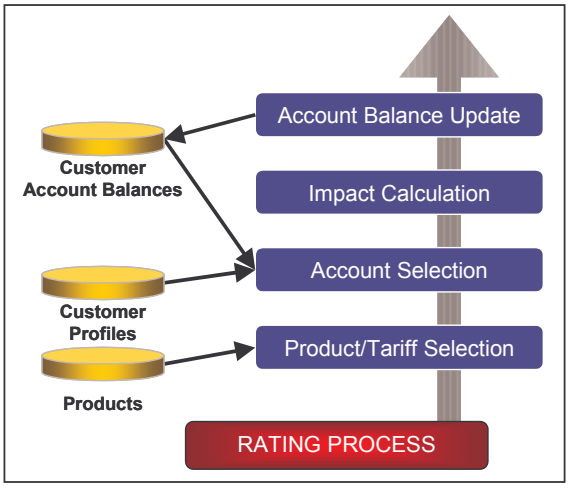
During this phase of the benchmark, a rating workload is presented to the WL BOSS domain. The workload is generated by one or more client agents presenting instances of the class WL.examples.roadmap.purchase to the domain presentation layer. In more detail, for each run a purchase event is presented for each customer object created during the customer creation phase, i.e. if N different customer objects have been created, then during the rating test phase N different purchase events will be presented to WL BOSS, simulating one purchase event for each single customer.

The business process (rdmp_purchase) triggered by each event will:

- load the customer object
- load the tariff of the product being purchased
- calculate the impact
- update the customer object (new balance)

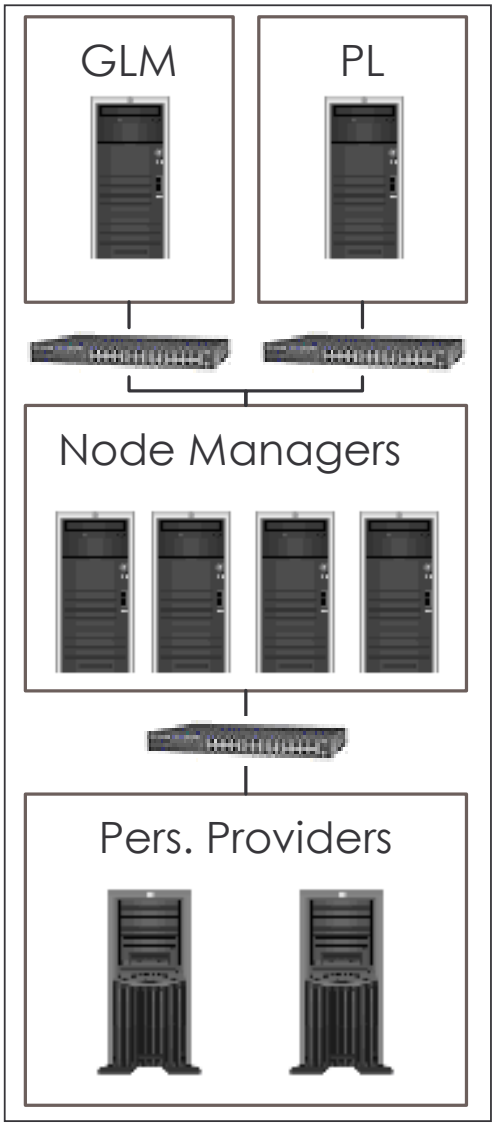
This business process generates 3 read operations against one or more RDBMS (the WL.examples.roadmap.customer class has been declared with inner partitioning) and 1 write operation against one or more RDBMS (in order to update the customer object with the newly calculated balance), for a total of 4 operations against one or more RDBMS (transactional mix: 75% Read, 25% Write).
The rating phase of the benchmark, differently from the customer creation phase, produces workload against the Global Lock manager component, ensuring determinism whenever the object 'customer' is updated.

The following picture shows the rdmp_purchase business process. The arrows with orientation toward a RDBMS represent write operations. The arrows with orientation toward the business rules represent read operations.



# 3. WL BOSS Domain Configuration (Hardware)

The picture below shows the hardware configuration used for the benchmarks described in this document. From top to bottom:




- **GLM** is the single Global Lock Manager used for the benchmark. The computer used for the benchmark is a HP ML110 with 512 megabytes RAM.
- **PL** is the single Presentation Layer component used for the benchmark. The computer used for the benchmark is a HP ML110 with two gigabyte RAM.
- The **GLM** is connected via a **Gigabit switch** to the Node Managers (**subnet A**). The Gigabit switch is a Netgear GS724T.
- The **PL** is connected to the **Node Managers** via a **Gigabit switch** (**subnet B**). The Gigabit Switch used for the benchmark is a Netgear GS724T.
- The **four** computers hosting the **Node Manager** processes used for this benchmark. The computers used for the benchmark are HP ML110 with 512 megabytes RAM.
- The **four Node Managers** are connected to the **persistence providers** via a **Gigabit switch**. The Gigabit switch used for the benchmark is a Netgear GS724T.
- The **two persistence providers**. The computers used for the benchmark are HP ML350.

The following tables provide details about network devices and computers (brand, configuration, etc.) used for the benchmark. The clients presenting events to the WL BOSS domain shown in the picture connect to the subnet B. We have used several different computers, typically laptops or desktops with a Pentium 4 2 Ghz or equivalent. The performance obtainable by the clients is not covered by this benchmark (the actual RDBMS being the limit for higher throughput).

| Computers | | | | |
|---|---|---|---|---|
| | **Node Manager** | **Presentation Layer** | **Persistence Provider** | **Global Lock Manager** |
| **Quantity** | **4** | **1** | **2** | **1** |
| **Model** | HP ML 110g3 | HP ML 110g3 | HP ML 350g4 | HP ML 110g3 |
| **CPU** | Intel Pentium 4 3.0 GHz, 800MHz FSB | Intel Pentium 4 3.0 GHz, 800MHz FSB | 2 x Intel Xeon Processor 3.2 GHz/800-2 MB L2 | Intel Pentium 4 3.0 GHz, 800MHz FSB |
| **Memory RAM** | 512MB | 2048MB | 2048MB | 512MB |
| **Disk Controllers** | 80 GB Ultra SATA Non Hot Plug | 80 GB Ultra SATA Non Hot Plug | 5 x 72 8 GB - ultra320 15k rpm SCSI | 80 GB Ultra SATA Non Hot Plug |

| Networking Devices & Other | | |
|---|---|---|
| **Switches** | | |
| **Quantity** | **Model** | **Specifications** |
| **3** | Netgear GS724T | 24x10/100/1000Base-T autosensing |
| **16** | Netgear GA311 | 10/100/1000Base-T Ethernet card |
| **KVM** | | |
| **Quantity** | **Model** | **Specifications** |
| **1** | Avocent AV 2000 | 2 users – 16 server control |
| **2** | Avocent AMX5120 | User Station |
| **8** | Avocent AMIQ-PS2 | Balun PS2 |
| **2** | HP PX850AT | L1906 TFT 19“ |

The following tables show the prices for the computers and networking devices utilised for these benchmarks.

| COMPUTERS | | | | |
|---|---|---|---|---|
| **Model** | **Description** | **Part No.** | **Qty** | **Unit Price in €** |
| HP ML 110 | ML 110 t g3 p4 30 2mb512mbRAM 80gb SATA | HP470063-787 | 6 | 468,00 |
| | 512MB ADV ECC PC2 4200 DDRII SDRAM | HP390825-B21 | 3 | 84,00 |
| HP ML 350 | pl ml350t g4p xeon 3 2 2mb cache 1gb ram raid sa641 | HP380196-421 | 2 | 1704,00 |
| | Intel 3.2 Ghz 2M-350 G4P Proc. Upgrade | HP382182-B21 | 2 | 470,0 |
| | NC7771 10/100/1000T 64/133MHZ PCI-X | HP290563-B21 | 4 | 156,00 |
| | HP 512 REG DDR2-3200 SGLDMM Memory | HP384163-B21 | 4 | 125,00 |
| | 72.8GB U320 15KRPM SCSI | HP286778-B22 | 10 | 415,00 |
| | | | **Subtotal A - €** | **12.682,00** |

| NETWORKING | | | | |
|---|---|---|---|---|
| **Brand** | **Description** | **Part No.** | **Qty** | **Unit Price in €** |
| Netgear | Netgear GS724T 24x10/100/100Base-T autosensing | GS724T | 3 | 474,00 |
| | Netgear GA311 10/100/1000Base-T | GA311 | 20 | 24,00 |
| HP | VIDEO LCD L1906 TFT 19“ | HP PX850AT | 2 | 409,00 |
| AVOCENT | 2 local users, 16 system switch, with GUI | AV2000-203 | 1 | 900,00 |
| | Avocent AMX5120 | AMX5120 | 2 | 900,00 |
| | Balun PS2 | AMIQ-PS2 | 8 | 150,00 |
| | | | **Subtotal B - €** | **6.620,00** |

| | |
|---|---|
| **Total (A+B) - €** | **19.302,00** |

# 4. WL BOSS Domain Configuration (Software)

| SOFTWARE CONFIGURATION | |
|---|---|
| **Node Manager** | **Windows 2000 Server** |
| **WLDC01** | **WL BOSS** |
| **Node Manager** | **Windows 2000 Professional with SP4** |
| **WLNM02,03,04** | **WL BOSS** |
| **Presentation Layer** | **Windows 2000 Professional with SP4** |
| **WLPL01** | |
| **Global Lock Manager** | **Windows 2000 Server** |
| **WLGLM01** | **WL BOSS** |
| **Persistence Providers** | **Windows 2000 Server** |
| **WLPP01,02** | **MicroSoft SQL Server 2000 with SP3** |

Notes:
WLDC01 is configured as a MicroSoft Windows domain controller.
All the benchmarks provided here utilise one single queue for the presentation layer.

# 5. How to read the benchmarks detailed results

The following chapter will provide all the results collected through several "runs". Please note that all runs described in this document use the same hardware configuration, as detailed in previous chapters.

For each run, this document provides three different tables:

1. **RUN Details**
2. **RUN results (Customer Creation)**
3. **RUN results (Rating)**

The first table (**RUN Details**) contains details about the run. In this table you will find all relevant information about the kind of partitioning that has been configured, which persistence providers have been used for the run, how many customer objects are being created, how many product objects are being created and how many Global Lock Managers are being used.

The second and third table (RUN Results, Customer Creation and Rating) contain 6 columns. The first 3 columns are representative of the configuration of the deployed domain of WareLite Node Managers, the other columns show the results obtained on such domain.

The first column (**NMHOST**) is the total number of computers used for the results shown on the same row. The second column (**NMPROC**) represents the number of Node Manager processes running on **each** computer (**NMHOST**) in the domain. The third column (**NMTHREAD**) shows the number of concurrent business processes running on **each** Node Manager process.
The following table provides an example of this representation.

| **RUN Results** | | | | | |
|---|---|---|---|---|---|
| **CUSTOMER CREATION** | | | | | |
| **NMHOST** | **NMPROC** | **NMTHREAD** | **P/S AVG** | **P/S MAX** | **DB T/S AVG** |
| 1 | 1 | 2 | 100 | 120 | 200 |
| 2 | 6 | 4 | 1037 | 1266 | 2074 |

This table shows two sets of results obtained on two slightly different domain configurations.

The first row describes a domain that includes 1 computer running 1 single instance of a Node Manager process which is configured to run 2 concurrent business process threads. In this configuration, the total number of computers is 1, the total number of Node manager processes is 1 and the total number of concurrent business process threads is 2.

The second row describes a domain that includes 2 computers. Each computer runs 6 instances of the Node Manager process. Each instance of the Node Manager process is configured to run 4 concurrent business process threads. Thus in this domain there are 12 Node Manager processes running and a total of 48 concurrent business process threads.

The fourth, fifth and sixth columns respectively show the sustainable number of business processes executed per second, the max number of business processes executed per second and the sustainable number of transactions committed per second against one or more RDBMS (the number of physical RDBMS – Persistence Providers - is shown in the RUN details table).

# 6. Benchmark detailed results

## 6.1. Benchmark RUN 1

| RUN details | |
|---|---|
| Persistence Providers | 1, WLPP01 |
| Partitioning | None |
| Number of Customer Objects | 5,000 |
| Number of Product Objects | 1,000 |
| Number of Global Lock Managers | 1 |

| RUN Results | | | | | |
|---|---|---|---|---|---|
| CUSTOMER CREATION | | | | | |
| NMHOST | NMPROC | NMTHREAD | P/S AVG | P/S MAX | DB T/S AVG |
| 1 | 1 | 1 | 55 | 68 | 110 |
| 1 | 1 | 2 | 100 | 120 | 200 |
| 1 | 1 | 4 | 144 | 212 | 288 |
| 1 | 1 | 6 | 170 | 283 | 340 |
| 1 | 2 | 1 | 92 | 123 | 184 |
| 1 | 2 | 2 | 144 | 188 | 288 |
| 1 | 2 | 4 | 250 | 308 | 500 |
| 1 | 4 | 4 | 440 | 500 | 880 |
| 1 | 6 | 4 | 550 | 677 | 1100 |
| 2 | 6 | 4 | 1037 | 1266 | 2074 |
| 4 | 6 | 4 | 1950 | 2337 | 3900 |

| RUN Results | | | | | |
|---|---|---|---|---|---|
| RATING | | | | | |
| NMHOST | NMPROC | NMTHREAD | P/S AVG | P/S MAX | DB T/S AVG |
| 1 | 1 | 1 | 31 | 32 | 124 |
| 1 | 1 | 2 | 31 | 32 | 124 |
| 1 | 1 | 4 | 32 | 32 | 128 |
| 1 | 1 | 6 | 32 | 32 | 128 |
| 1 | 2 | 1 | 63 | 64 | 252 |
| 1 | 2 | 2 | 63 | 64 | 252 |
| 1 | 2 | 4 | 64 | 64 | 256 |
| 1 | 4 | 4 | 127 | 129 | 508 |
| 1 | 6 | 4 | 191 | 194 | 764 |
| 2 | 6 | 4 | 377 | 389 | 1508 |
| 4 | 5 | 4 | 400 | 427 | 1600 |
| 4 | 6 | 4 | 417 | 460 (1) | 1668 |

(1)Notes: The performance limit of the RDBMS has been hit (the throughput upper limit is about 1600 transactions per second (based on the specific transactional mix of the rating business process).

## 6.2. Benchmark RUN 2.A

| RUN details | |
|---|---|
| Persistence Providers | 1, WLPP01 |
| Partitioning | None |
| Number of Customer Objects | 100,000 |
| Number of Product Objects | 1,000 |
| Number of Global Lock Managers | 1 |

| RUN Results | | | | | |
|---|---|---|---|---|---|
| CUSTOMER CREATION | | | | | |
| NMHOST | NMPROC | NMTHREAD | P/S AVG | P/S MAX | DB T/S AVG |
| 1 | 1 | 4 | 156 | 196 | 312 |
| 1 | 2 | 4 | 244 | 283 | 488 |
| 1 | 3 | 4 | 282 | 362 | 564 |
| 1 | 4 | 4 | 335 | 487 | 670 |
| 1 | 5 | 4 | 454 | 595 | 908 |
| 1 | 6 | 4 | 531 | 665 | 1062 |
| 2 | 6 | 4 | 964 | 1268 | 1928 |
| 4 | 6 | 4 | 1839 | 2183 | 3678 |
| 4 | 7 | 4 | 2072 | 2318 | 4144 |
| 4 | 8 | 4 | 2055 | 2417 | 4110 |

| RUN Results | | | | | |
|---|---|---|---|---|---|
| RATING | | | | | |
| NMHOST | NMPROC | NMTHREAD | P/S AVG | P/S MAX | DB T/S AVG |
| 1 | 1 | 4 | 31 | 32 | 124 |
| 1 | 2 | 4 | 64 | 64 | 256 |
| 1 | 3 | 4 | 96 | 97 | 384 |
| 1 | 4 | 4 | 127 | 128 | 508 |
| 1 | 5 | 4 | 160 | 161 | 640 |
| 1 | 6 | 4 | 191 | 192 | 764 |
| 1 | 7 | 4 | 223 | 225 | 892 |
| 1 | 8 | 4 | 254 | 257 | 1016 |
| 2 | 4 | 4 | 254 | 257 | 1016 |
| 2 | 6 | 4 | 378 | 384 | 1512 |
| 4 | 4 | 4 | 392 | 407 | 1568 |
| 4 | 5 | 4 | 395 | 413 | 1580 |
| 4 | 6 | 4 | 390 | 416 (1) | 1560 |

(1)Notes: The performance limit of the RDBMS has been hit (the throughput upper limit is about 1600 transactions per second (based on the specific transactional mix of the rating business process).

### 6.3. Benchmark RUN 2.B

| RUN details | |
|---|---|
| Persistence Providers | 1, WLPP01, WLPP02 |
| Partitioning | Horizontal Split |
| Number of Customer Objects | 100,000 |
| Number of Product Objects | 1,000 |
| Number of Global Lock Managers | 1 |

| RUN Results | | | | | |
|---|---|---|---|---|---|
| CUSTOMER CREATION | | | | | |
| NMHOST | NMPROC | NMTHREAD | P/S AVG | P/S MAX | DB T/S AVG |
| 1 | 1 | 4 | 166 | 214 | 332 |
| 1 | 2 | 4 | 288 | 342 | 576 |
| 1 | 3 | 4 | 392 | 464 | 784 |
| 1 | 4 | 4 | 467 | 543 | 934 |
| 1 | 5 | 4 | 552 | 639 | 1104 |
| 1 | 6 | 4 | 626 | 729 | 1252 |
| 1 | 7 | 4 | 709 | 817 | 1418 |
| 1 | 8 | 4 | 761 | 914 | 1522 |
| 2 | 1 | 4 | 299 | 363 | 598 |
| 2 | 2 | 4 | 514 | 611 | 1028 |
| 2 | 3 | 4 | 695 | 791 | 1390 |
| 2 | 4 | 4 | 872 | 1024 | 1744 |
| 2 | 5 | 4 | 1050 | 1196 | 2100 |
| 2 | 6 | 4 | 1136 | 1334 | 2272 |
| 2 | 7 | 4 | 1296 | 1583 | 2592 |
| 2 | 8 | 4 | 1369 | 1557 | 2738 |
| 3 | 1 | 4 | 405 | 513 | 810 |
| 3 | 2 | 4 | 723 | 893 | 1446 |
| 3 | 3 | 4 | 975 | 1136 | 1950 |
| 3 | 4 | 4 | 1238 | 1405 | 2476 |
| 3 | 5 | 4 | 1537 | 1831 | 3074 |
| 3 | 6 | 4 | 1692 | 1978 | 3384 |
| 3 | 7 | 4 | 1712 | 2013 | 3424 |
| 3 | 8 | 4 | 1822 | 2113 | 3644 |
| 4 | 1 | 4 | 553 | 713 | 1106 |
| 4 | 2 | 4 | 974 | 1105 | 1948 |
| 4 | 3 | 4 | 1231 | 1405 | 2462 |
| 4 | 4 | 4 | 1659 | 1926 | 3318 |
| 4 | 5 | 4 | 1862 | 2138 | 3724 |
| 4 | 6 | 4 | 2079 | 2429 | 4158 |
| 4 | 7 | 4 | 2110 | 2771 | 4220 |
| 4 | 8 | 4 | 2076 | 2943 | 4152 |

| RUN Results | | | | | |
|---|---|---|---|---|---|
| RATING | | | | | |
| NMHOST | NMPROC | NMTHREAD | P/S AVG | P/S MAX | DB T/S AVG |
| 1 | 1 | 4 | 31 | 32 | 124 |
| 1 | 2 | 4 | 63 | 63 | 252 |
| 1 | 3 | 4 | 95 | 96 | 380 |
| 1 | 4 | 4 | 128 | 128 | 512 |
| 1 | 5 | 4 | 159 | 160 | 636 |
| 1 | 6 | 4 | 191 | 192 | 764 |
| 1 | 7 | 4 | 223 | 224 | 892 |
| 1 | 8 | 4 | 255 | 257 | 1020 |
| 1 | 9 | 4 | 287 | 289 | 1148 |
| 1 | 10 | 4 | 319 | 321 | 1276 |
| 1 | 11 | 4 | 351 | 352 | 1404 |
| 1 | 12 | 4 | 383 | 384 | 1532 |
| 1 | 13 | 4 | 415 | 419 | 1660 |
| 1 | 14 | 4 | 445 | 450 | 1780 |
| 1 | 15 | 4 | 470 | 480 | 1880 |
| 1 | 16 | 4 | 495 | 504 | 1980 |
| 2 | 10 | 4 | 633 | 643 | 2532 |
| 3 | 7 | 4 | 660 | 671 | 2640 |
| 3 | 8 | 4 | 710 | 749 | 2840 |
| 3 | 9 | 4 | 745 | 787 | 2980 |
| 3 | 10 | 4 | 755 | 794 | 3020 |

This particular benchmark run shows the upper limit of the capacity offered by a single Node Manager host (the fingerprint is HP ML110 specific). This run is well suited to understand vertical scalability (increase of capacity on a single computer) obtainable with the Node Manager process. It is important to note that the capacity shown in the following runs (based on four Node Manager hosts) can be equalled by a domain with 2 node manager computers of the same type.

## 6.4. Benchmark RUN 3.A

| RUN details | |
|---|---|
| Persistence Providers | 1, WLPP01 |
| Partitioning | None |
| Number of Customer Objects | 200,000 |
| Number of Product Objects | 1,000 |
| Number of Global Lock Managers | 1 |

| RUN Results | | | | | |
|---|---|---|---|---|---|
| CUSTOMER CREATION | | | | | |
| NMHOST | NMPROC | NMTHREAD | P/S AVG | P/S MAX | DB T/S AVG |
| 1 | 4 | 4 | 415 | 516 | 830 |
| 1 | 6 | 4 | 574 | 714 | 1148 |
| 2 | 6 | 4 | 1043 | 1256 | 2086 |
| 4 | 6 | 4 | 1729 | 1960 | 3458 |

| RUN Results | | | | | |
|---|---|---|---|---|---|
| RATING | | | | | |
| NMHOST | NMPROC | NMTHREAD | P/S AVG | P/S MAX | DB T/S AVG |
| 1 | 1 | 4 | 32 | 32 | 128 |
| 1 | 2 | 4 | 63 | 64 | 252 |
| 1 | 3 | 4 | 95 | 96 | 380 |
| 1 | 4 | 4 | 127 | 128 | 508 |
| 1 | 6 | 4 | 191 | 192 | 764 |
| 2 | 4 | 4 | 254 | 257 | 1016 |
| 2 | 6 | 4 | 350 | 354 | 1400 |
| 4 | 5 | 4 | 397 | 412 | 1588 |
| 4 | 6 | 4 | 404 | 422 | 1616 |
| 4 | 7 | 4 | 405 | 419 | 1620 |
| 4 | 8 | 1 | 388 | 401 (1) | 1552 |
| 4 | 8 | 2 | 399 | 417 | 1596 |
| 4 | 8 | 4 | 405 | 427 | 1620 |

(1)Notes: The performance limit of the RDBMS has been hit (the throughput upper limit is about 1600 transactions per second (based on the specific transactional mix of the rating business process).

## 6.5. Benchmark RUN 3.B

| RUN details | |
|---|---|
| Persistence Providers | 2, WLPP01 & WLPP02 |
| Partitioning | Horizontal Split |
| Number of Customer Objects | 200,000 |
| Number of Product Objects | 1,000 |
| Number of Global Lock Managers | 1 |

| RUN Results | | | | | |
|---|---|---|---|---|---|
| CUSTOMER CREATION | | | | | |
| NMHOST | NMPROC | NMTHREAD | P/S AVG | P/S MAX | DB T/S AVG |
| 1 | 4 | 4 | 470 | 590 | 940 |
| 1 | 6 | 4 | 630 | 760 | 1260 |
| 2 | 6 | 4 | 1149 | 1360 | 2298 |
| 4 | 6 | 4 | 1940 | 2200 | 3880 |

| RUN Results | | | | | |
|---|---|---|---|---|---|
| RATING | | | | | |
| NMHOST | NMPROC | NMTHREAD | P/S AVG | P/S MAX | DB T/S AVG |
| 1 | 4 | 4 | 127 | 130 | 508 |
| 1 | 6 | 4 | 191 | 193 | 764 |
| 2 | 4 | 4 | 254 | 259 | 1016 |
| 2 | 6 | 4 | 382 | 392 | 1528 |
| 4 | 5 | 4 | 634 | 647 | 2536 |
| 4 | 6 | 4 | 740 | 766 | 2960 |
| 4 | 7 | 4 | 765 | 820 | 3060 |
| 4 | 8 | 1 | 585 | 615 | 2340 |
| 4 | 8 | 2 | 735 | 780 | 2940 |
| 4 | 8 | 4 | 780 | 831 (1) | 3120 |

(1)Notes: The performance limit of the RDBMS has been hit (the throughput upper limit is about 1600 transactions per second (based on the specific transactional mix of the rating business process) or 3200 transactions per second partitioned over two physical RDBMS.

### 6.6. Benchmark RUN 4

| RUN details | |
|---|---|
| Persistence Providers | 2, WLPP01 & WLPP02 |
| Partitioning | Horizontal Split |
| Number of Customer Objects | 2,000,000 |
| Number of Product Objects | 1,000 |
| Number of Global Lock Managers | 1 |

| RUN Results | | | | | |
|---|---|---|---|---|---|
| CUSTOMER CREATION | | | | | |
| NMHOST | NMPROC | NMTHREAD | P/S AVG | P/S MAX | DB T/S AVG |
| 2 | 6 | 4 | 585 | 678 | 1170 |
| 4 | 6 | 4 | 1010 | 1248 | 2020 |
| 4 | 8 | 4 | 1110 | 1445 | 2220 |

| RUN Results | | | | | |
|---|---|---|---|---|---|
| RATING | | | | | |
| NMHOST | NMPROC | NMTHREAD | P/S AVG | P/S MAX | DB T/S AVG |
| 2 | 4 | 4 | 255 | 257 | 1020 |
| 2 | 6 | 4 | 383 | 386 | 1532 |
| 4 | 5 | 4 | 634 | 645 | 2536 |
| 4 | 6 | 4 | 745 | 764 | 2980 |
| 4 | 7 | 4 | 770 | 805 | 3080 |
| 4 | 8 | 4 | 790 | 824 (1) | 3160 |

(1)Notes: The performance limit of the RDBMS has been hit (the throughput upper limit is about 1600 transactions per second (based on the specific transactional mix of the rating business process) or 3200 transactions per second partitioned over two physical RDBMS.

## 7. Glossary

| Glossary | |
|---|---|
| **NMHOST** | Number of computers running Node Manager processes |
| **NMPROC** | Number of Node Manager processes (Node Manager instances) for each computer (NMHOST) |
| **NMTHREAD** | Number of concurrent business processes for each Node Manager instance (NMPROC) |
| **P/S AVG** | Average number of business processes per second (sustainable) |
| **P/S MAX** | Maximum number of business processes per second (peak) |
| **DB T/S AVG** | Total Number of Transactions per Second committed on one or more RDBMS |