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Enterprise Solutions Division

Compaq Computer Corporation

Contents

World-Record Microsoft Exchange Server Scalability on Compaq ProLiant 7000 Pentium II Xeon Servers

Abstract: *Compaq Computer Corporation has set World-Record Exchange Server performance numbers on the Compaq ProLiant 7000 server with both 400 Megahertz and 450 Megahertz Intel Pentium II Xeon processors and on both two-processor and four-processor platforms.*

Ever since Microsoft introduced Exchange Server, Compaq has delivered the best performing platforms and the broadest range of servers. Close collaboration between Microsoft and Compaq provides a vehicle for continuous improvement in record-breaking scalability.

Compaq has recently out-performed previous Exchange Server scalability records by achieving the highest-ever MAPI Messaging Benchmark (MMB) on any two-processor or four-processor platform:

- *The highest MMB using four 400 MHz Intel Pentium II Xeon processors (19,000 MMB)*
- *The highest MMB using four 450 MHz Intel Pentium II Xeon processors (21,500 MMB)*
- *The highest MMB using two 450 MHz Intel Pentium II Xeon processors (14,600 MMB)*

The recent performance record of 19,000 simultaneous MAPI users, achieved on a ProLiant 7000 with four 400 MHz Intel Pentium Xeon processors, surpassed HP's previous record by 19%. The performance record of 21,500 MMB, achieved on a Compaq ProLiant 7000 with four 450 MHz Intel Pentium II Xeon processors, demonstrated the highest numbers of MMB for any vendor, ever.

Compaq enables a confident deployment and management of Microsoft Exchange Server on their products by conducting extensive integration engineering and capacity planning. Microsoft Exchange Server has been the focal point for extensive development and testing by both Microsoft and Compaq. Throughout this activity, Compaq and Microsoft have worked to optimize Microsoft Exchange Server performance on Compaq server products in order to provide an optimal balance between performance, availability, manageability, and cost. Compaq not only provides world-class server platforms, but also the experience necessary for successful deployments of messaging and collaborative applications.

Notice

World-Record Microsoft Exchange Server Scalability on Compaq ProLiant 7000 Pentium II Xeon Servers Solutions Guide prepared by Messaging and Collaboration Business Unit

Enterprise Solutions Division

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Introduction

Compaq ProLiant 7000

The Compaq ProLiant 7000 is the ultimate standards-based server delivering the most scalable performance and the highest levels of availability. The ProLiant 7000 supports up to four 400 Megahertz or 450 Megahertz Intel Pentium II Xeon processors and 8 GB of system memory. Its architecture supports Enhanced Peripheral Component Interconnect (PCI) Hot-Plug and a Triple-Peer PCI bus design (five 64-bit PCI, four 32-bit PCI, and one ISA slot). Standard equipment shipped with the Compaq ProLiant 7000 is the 64-bit PCI Compaq SMART 3100ES Array Controller that supports three Wide-Ultra Small Computer System Interface (SCSI-3) channels and 64 MB of cache. Leveraging Fibre Channel, the Compaq ProLiant 7000 can support nearly 7 TB of external storage. Combined with the latest high-availability features and processor technology, as itemized below, the Compaq ProLiant 7000 is designed for the most demanding and mission-critical applications:

- Up to four 400 MHz or 450 MHz Intel Pentium II Xeon Processors
- Ten (10) expansion slots: five (5) 64-bit PCI Hot Plug slots, four (4) 32-bit PCI Hot Plug slots, and one (1) ISA modem slot. All support new push-button mechanisms.
- Compaq Smart Array 3100ES Controller provides three-channel RAID support for internal hot-plug drive cages
- Support for SmartStart and Compaq Insight Manager
- Up to 218.4 GB storage with three internal hot-plug-drive cages, using 12 -x- 18.2 GB drives
- Up to 18 -x- 1" or 12 -x- 1.6" hot-pluggable-drive bays; mixing 1" and 1.6" permitted
- 24X CD ROM drive and floppy drive
- Compaq auto-sensing dual-port 10/100 TX base controller shipped as standard equipment
- Dual Channel Wide-Ultra SCSI-3 controllers delivering 2 -x- 40 MB/s
- Design enables easy servicing in a rack or as a tower.
- Board release levers throughout for quick access to modular, removable, components that slide out easily
- Color-coded hot plug features for quick and easy identification
- Pre-installed internal cabling providing improved reliability and manageability
- Redundant Network Interface Card (NIC) fail-over supported in PCI Hot-Plug slots
- Integrated Remote Console and Integrated Management Display
- Online Recovery Server
- Clustering Options
- Compaq Pre-Failure Warranty extended to support Pentium II Xeon processors

Test Methodology

The tests were conducted using Microsoft Messaging Application Program Interface (MAPI) Messaging Benchmark (MMB). The MAPI Messaging Benchmark (MMB) measures throughput in terms of a specific profile of user actions, executed over an 8-hour working day. This benchmark utilizes the 'Medium User' setting of the Load Simulator (LoadSim) MAPI tool. Results should be interpreted as a benchmark for comparing messaging throughput of various servers and configurations and should not be confused with deployment recommendations. Factors such as backup/restore, topology and other issues should be considered when planning a deployment.

Exchange Server Performance Test Results

Test Result Highlights

Table 1: Performance Highlights (Compaq ProLiant 7000)

Processor Type	400 MHz	400 MHz	450 MHz	450 MHz
System Configuration	In-box (See Note)	Out-of-box (See Note)	2-processor	4-processor
MAPI Messaging Benchmark (MMB)	15,000	19,000	14,600	21,500
Response Time (milliseconds)	343	288	396	326
Messages Submitted (4-hr steady-state)	106,510	133,405	103,683	151,477
Message Recipients Delivered (4-hr steady-state)	589,553	737,376	572,326	836,328
Messages Sent (4-hr steady-state)	28,657	35,884	28,367	40,571

Note: No external storage was provided for the "In-Box" configuration of the 400 MHz model. This constraint was removed for the "Out-of-Box" configuration of the 400 MHz model, where additional, external storage was permitted and a Compaq SMART 3200 Array Controller was provided. Further details are provided in Table 2.

Note: Complete disclosure of test results can be found in Appendix A of this document.

Table 2: Tested Configurations

COMPAQ PROLIANT 7000 TESTED CONFIGURATIONS				
MMB	15,000	19,000	14,600	21,500
Processors	Four (4) Pentium II Xeon 400-MHz Processors – 1 MB L2 cache per processor	Four (4) Pentium II Xeon 400-MHz Processors – 1 MB L2 cache per processor	Two (2) Pentium II Xeon 450-MHz Processors – 2 MB L2 cache per processor	Four (4) Pentium II Xeon 450-MHz Processors – 2 MB L2 cache per processor
Memory	4 GB RAM	4 GB RAM	4 GB RAM	4 GB RAM
Disk Subsystem				
Controllers:	One (1) Compaq SMART 3100ES Array Controller with 64 MB Cache	One (1) Compaq SMART 3100ES Array Controller with 64 MB Cache; One (1) Compaq SMART 3200 Array Controller	One (1) Compaq SMART 3100ES Array Controller with 64 MB Cache; One (1) Compaq SMART 3200 Array Controller	One (1) Compaq SMART 3100ES Array Controller with 64 MB Cache; One (1) Compaq SMART 3200 Array Controller
OS/Exchange DS/MTA Files	Two (2) 4.3-GB Drive – RAID1	One (1) 4.3-GB Drive	One (1) 4.3-GB Drive	One (1) 4.3-GB Drive
Pagefile	On above disk	One (1) 4.3-GB Drive	One (1) 4.3-GB Drive	One (1) 4.3-GB Drive
Exchange Log Files	On above disk	Two (2) 4.3-GB Drives– RAID0	Two (2) 4.3-GB Drives– RAID0	Three (3) 4.3-GB Drives– RAID0
Exchange Information Store Files	Sixteen (16) 4.3-GB Drives – RAID0	Twenty-four (24) 4.3-GB Drives – RAID0	Twenty-six (26) 4.3-GB Drives – RAID0	Twenty-eight (28) 4.3-GB Drives – RAID0
Network	Compaq Netelligent (100BaseTX) network interface card (NIC)	Two (2) Compaq Netelligent (100BaseTX) network interface cards (NIC)	Two (2) Compaq Netelligent (100BaseTX) network interface cards (NIC)	Two (2) Compaq Netelligent (100BaseTX) network interface cards (NIC)
Mail Software	Exchange Server Version 5.5 – Enterprise Edition	Exchange Server Version 5.5 – Enterprise Edition with Service Pack 2	Exchange Server Version 5.5 – Enterprise Edition with Service Pack 2	Exchange Server Version 5.5 – Enterprise Edition with Service Pack 2
OS Software	Windows NT Server Version 4.0 Enterprise Edition (using /3GB BOOT.INI switch)	Windows NT Server Version 4.0 Enterprise Edition (using /3GB BOOT.INI switch) with Service Pack 4	Windows NT Server Version 4.0 Enterprise Edition (using /3GB BOOT.INI switch) with Service Pack 4	Windows NT Server Version 4.0 Enterprise Edition (using /3GB BOOT.INI switch) with Service Pack 4

Note: Complete disclosure of test results can be found in Appendix A of this document.

What the Benchmarks Don't Tell You

It is important to understand that benchmarks such as these are designed to give planners of Exchange Server implementations baseline references for understanding and comparing the relative capabilities of hardware platforms from a single vendor such as Compaq or among competing hardware vendors. When interpreting these benchmarks, two things should be kept in mind.

First, consider whether benchmark tests are performed on what can be referred to as *customer-deployable configurations.* A hardware vendor may publish a result that is based on a platform or configuration that should not be deployed in a "real world" Exchange Server deployment. For example, many vendors (including Compaq) publish results using disk subsystems configured with RAID0. While RAID0 does provide the highest levels of disk subsystem performance, it fails to provide any protection against data loss. Compaq recommends deploying an Exchange Server with disk fault tolerance such as RAID1 or RAID5 for the highest levels of data protection.

Second, most vendors, including Compaq, conduct benchmark tests for Exchange Server that are *single-server* in nature. Also keep in mind that benchmarks do not account for issues such as backup and disaster recovery or information-store-maintenance sizing. Whatever the issue, care must be taken when interpreting benchmarks to ensure that they represent useful information for your Exchange Server deployment and are based on valid simulation methodologies.

While it is significant that the Compaq ProLiant 7000 server can successfully scale up to 21,500 MMB in a single-server benchmark exercise, Compaq recommends careful evaluation of all issues involved in real-world Exchange Server deployments – issues such as management, administration, and disaster recovery.

MAPI Messaging Benchmark (MMB) – LoadSim Medium User Redefined

To distinguish clearly between throughput benchmarks and capacity planning information for Microsoft Exchange Server, Microsoft has established the MAPI Messaging Benchmark (MMB) based on the workload from LoadSim Medium User profile. The MAPI Messaging Benchmark representative workload focuses on the resulting throughput and clearly communicates the profile under test.

The workload profile has not changed from the LoadSim Medium User profile formerly used, but is now expressed in clearer fashion. The intent is to make sure that customers can understand the MAPI Messaging Benchmark workload and can compare the MMB for one platform to the MMB for other platforms. In addition, the renaming of the benchmark reinforces the fact that the test is a measurement of messaging throughput and that additional considerations are required in capacity planning.

MMB Transaction Load

The transaction load created by the benchmark is equivalent to the user actions outlined in Table 3 over an eight-hour day.

Table 3: MMB Transaction Load

User Action	Actions Per Day
Check Inbox	12
Send Message	14.18
Avg. Recipients per Message	4.7
Messages Received	66.3
Read Message	81.3
Move Message	16.3
Delete Message	32.5
Update Calendar	5

Thirty percent of all mail messages have one distribution-list recipient. The average size of the distribution list (DL) is ten recipients. (Recipients created by distribution lists are included in the summary transaction load outlined in Table 3). All users are logged on prior to the benchmark measurement as the users are assumed to be using mail in a corporate setting. Mail is not cleared from the deleted-items folder during the test as this is assumed to occur when the user logs off.

Message Mix Description

The weights used when the Load Simulator randomly selects which message to send are listed in the following Table 4.

Table 4: Weights Given to Different Types of Messages in LoadSim Random Selection

Message Files	Body	Attachment	Content Description	Weight
Ups1k.msg	1K		Body as RTF	60
Ups2k.msg	2K		Body as RTF	16
Ups4k.msg	4K		Body as RTF	4
Ups10kat.msg	1K	10K	Body as RTF	6
			Notepad attachment	
Upsxlatt.msg	1K	15K	Body as RTF Microsoft Excel spreadsheet attached	4
Upswdatt.msg	1K	16K	Body as RTF	4
			Microsoft Word document attached	
Upsbmobj.msg	0.5K	43K	Body as RTF	2
			Bitmap attachment	
Upsxlobj.msg	1K	17K	Body as RTF	4
			Excel spreadsheet attachment	

Load Simulator

The tool used in generating the workload for the MMB benchmark was Microsoft Load Simulator (LoadSim). Load Simulator is a tool for simulating a client-user load on a server running Microsoft Exchange. Its purpose is to enable a single Windows NT server, called a LoadSim client, to simulate multiple Microsoft Exchange client users.

The operation of Load Simulator users is governed by a Load Simulator profile. This profile controls factors such as how long a Load Simulator "day" is, how many e-mail messages to send in a day's time, how many times to open and read e-mail, whether to use distribution lists, whether to use public folders, etc.

Load Simulator creates a highly accurate simulation of reality. It mimics the full Microsoft Exchange Client in many respects. First, it uses .MSG files, the same format used by the Exchange Client. This guarantees that messages generated by Load Simulator have the same properties as those sent by actual users of the Exchange Client. Second, Load Simulator uses the same MAPI remote-procedure-call (RPC) semantics as those used by the Client. Third, Load Simulator registers MAPI change notifications in the same manner as they are registered by the Client. Finally, Load Simulator even emulates the Microsoft Exchange Client list-box cache, which the Client uses for folder and message panes in the viewer when a user browses and selects messages on the server. For more information on LoadSim Medium canonical profiles, refer to the LoadSim documentation at www.microsoft.com/exchange/library/loadsim55x86.exe.

Appendix A

LoadSim Client

Tables A-1 through A-4 detail the configurations of the LoadSim clients used to simulate multiple Microsoft Exchange users generating the MMB workload for the MMB measurement.

Table A-1: Configuration of LoadSim Client for ProLiant 7000 (4) 400 MHz 15,000 MMB

LoadSim Clients	Configuration
Client CPU type and speed	2P/133-MHz Pentium processors or better
Number of clients	≤ 40 clients with 128MB RAM (≤ 400 users each)
Network Topology (100Base T, Token Ring, etc.)	100 Base-TX
Network Controller	Compaq Netelligent 10/100
Client network software name and version	Microsoft Windows NT Workstation 4.0 with SP3
LoadSim version	5.5 (Build 2187)

Table A-2: Configuration of LoadSim Client for ProLiant 7000 (4) 400 MHz 19,000 MMB

LoadSim Clients	Configuration
Model	Digital PC 3000
Client CPU type and speed	1P/300-MHz Pentium II processor
Number of clients	28 clients with 256MB RAM (750 users for 20; 500 users for 8)
Network Topology (100Base T, Token Ring, etc.)	100 Base-TX
Network Controller	DE500
Client network software name and version	Microsoft Windows NT Server 4.0 with SP3
LoadSim version	5.5 (Build 2187)

Table A-3: Configuration of LoadSim Client for ProLiant 7000 (2) 450 MHz 14,600 MMB

LoadSim Clients	Configuration
Model	Digital PC 3000
Client CPU type and speed	1P/300-MHz Pentium II processor
Number of clients	22 clients with 256MB RAM (750 users for 16; 500 users for 5; 100 users for one)
Network Topology (100Base T, Token Ring, etc.)	100 Base-TX
Network Controller	DE500
Client network software name and version	Microsoft Windows NT Server 4.0 with SP3
LoadSim version	5.5 (Build 2187)

Table A-4: Configuration of LoadSim Client for ProLiant 7000 (4) 450 MHz 21,500 MMB

LoadSim Clients	Configuration
Model	Digital PC 3000
Client CPU type and speed	1P/300-MHz Pentium II processor
Number of clients	34 clients with 256MB RAM (750 users for 24; 500 users for 4; 250 users for six)
Network Topology (100Base T, Token Ring, etc.)	100 Base-TX
Network Controller	DE500
Client network software name and version	Microsoft Windows NT Server 4.0 with SP3
LoadSim version	5.5 (Build 2187)

Performance Data

Performance data for the MMB measurement are detailed in Table A-5

Table A-5: (Measured During Test Run at Steady State)

Summary	400 MHz (4-processor in-box)	400 MHz (4-processor out-of-box)	450 MHz (2-processor)	450 MHz (4-processor)
Supported Benchmark Load	15,000 MMB	19,000 MMB	14,600 MMB	21,500 MMB
Benchmark Profile	MAPI Messaging Benchmark	MAPI Messaging Benchmark	MAPI Messaging Benchmark	MAPI Messaging Benchmark
Protocol	Exchange MAPI	Exchange MAPI	Exchange MAPI	Exchange MAPI
Length of Steady State	4 hours	4 hours	4 hours	4 hours
Length of Test	8 hours	8 hours	8 hours	8 hours
Unless otherwise noted, values listed are averages over entire steady state period.				
Transaction Load (hourly)				
Messages Submitted	26,627.69	33,351	25,920	37,869.25
Message Recipients Delivered	147,388.46	184,344	143,081	209,082
Messages Sent	7,164.49	8,971	7,091	10,142.75
Transaction Load (per Second)				
Message Opens/Sec	53.75	59.46	51.6	74.79
Folder Opens/Sec	14.05	16.7	13.5	19.7
RPC Read Bytes/Sec	47,250.31	60,473	46,456	68,043
RPC Write Bytes/Sec	383,111.15	378,054	293,149	422,938
Transaction Queues				
IS Send Queue Average Length	5.50	6.4	3.8	14.25
MTA Work Queue Average Length	8.04	2.22	3.06	3.9
Processor Utilization				
System Processor Utilization (%)	83.74%	71.1%	84.9%	80.8%
System Processor Queue Length	4.29	5.5	7.5	6.7
System Context Switches/Sec	5438	6911.4	4504.3	9003.9

Summary	400 MHz (4-processor in-box)	400 MHz (4-processor out-of-box)	450 MHz (2-processor)	450 MHz (4-processor)
Process % CPU Time - Store	272.33%	229.5%	135.1%	279.6%
Process % CPU Time - DS	25.38%	20.96%	12.15%	21.89%
Process % CPU Time - MTA	15.91%	15.0%	10.3%	15.08%
Memory Utilization				
Available Bytes	1.83GB	2.08GB	2.02GB	2.09GB
Pages/Sec	0.015	0.025	0.031	0.037
Process Working Set Bytes - Store	1.99GB	1.77GB	1.84GB	1.76GB
Process Virtual Bytes - Store	2.78GB	2.52GB	2.34GB	2.54GB
Logical Drive Utilization				
IS Database Disk Reads/Sec	409.40	578.5	384.5	719.0
IS Database Disk Writes/Sec	244.01	309.4	231.9	356.3
IS Database Average Disk Queue Length	11.36	10.83	7.18	15.9
IS Log Disk Reads/Sec	0.93	0.0	0.0	0.0
IS Log Disk Writes/Sec	159.82	137.99	111.66	136.6
IS Log Average Disk Queue Length	0.34	0.05	0.034	0.046

Note: Performance Results were measured using Microsoft NT Performance Monitor. Measurements and were obtained by measuring averages for the period of steady-state activity (i.e. after the users were successfully logged on). Tests measure the messaging throughput of a single-server, single-site topology.

For deployment-specific information contact a Microsoft or Compaq representative. More information can be found at**:**
www.microsoft.com/exchange/support/deployment/planning/deploy.asp?A=5&B=1

User Response Times

Table A-6 details response times for various user actions during benchmark testing.

Table A-6: User Response Times (Latencies) from Load Simulator

Client Actions **95th-Percentile Response Time**	400 MHz (4-processor in-box)	400 MHz (4-processor out-of-box)	450 MHz (2-processor)	450 MHz (4-processor)
MMB	15,000	19,000	14,600	21,500
Read	260 ms	180 ms	231 ms	200 ms
Send	531 ms	741 ms	1003 ms	821 ms
Delete	421 ms	300 ms	440 ms	351 ms
Move	550 ms	361 ms	541 ms	420 ms
Submit	441 ms	321 ms	461 ms	390 ms

Descriptive Terms

Messages Submitted

Submit calls made by clients. This equates to total message sends by users.

Messages Sent

Messages that the Information Store sends to the MTA (not messages sent by clients). Normally all messages submitted by the clients are sent to the MTA, except in the case where all recipients are local mailboxes. In that case, since all the deliveries can be performed locally, no message is sent to the MTA.

Message Recipients Delivered

Separate mailboxes that messages have been delivered to. Think of this as the number of Reads that are ‘caused’ by sending a message (one per recipient).

Message Opens/Sec

Messages accessed for reading per second.

Folder Opens/Sec

Folders opened for browsing per second.

RPC Read Bytes/Sec

RPC Bytes read from clients (i.e., submit calls).

RPC Write Bytes/Sec

RPC Bytes written to clients (i.e., message opens).

IS Send Queue Average Length

Send Queue Size is the number of messages in the private information store's send queue.

MTA Work Queue Average Length

Work Queue Length is the number of outstanding messages in the Work Queue, which indicates the number of messages not yet processed to completion by the MTA.

Appendix B: Related Documents

The following documents are available on the Compaq website.

Compaq and Microsoft Demonstrate Enterprise Scalability with Exchange Server 5.5,

www.compaq.com/support/techpubs/whitepapers/ECG00961197.html

Microsoft Exchange Server 5.5 on the Compaq ProLiant 850R,

www.compaq.com/support/techpubs/whitepapers/ECG0710698.html

Microsoft Exchange Server 5.5 on the Compaq ProLiant 3000,

www.compaq.com/support/techpubs/whitepapers/ECG0720698.html

Microsoft Exchange Server 5.5 on the Compaq ProLiant 6000 Class Servers,

www.compaq.com/support/techpubs/whitepapers/ECG0730698.html

Compaq Deployment and Configuration Guide: Microsoft Exchange Server on Compaq ProLiant Servers,

http://vcmproapp02.compaq.com/

Performance of Exchange Server 4.0 on Compaq ProLiant Servers,

www.compaq.com/support/techpubs/whitepapers/444A0696.html

"Deschutes" Family Processor Technology,

www.compaq.com/support/techpubs/whitepapers/ecg0500698.html

Disk Subsystem Performance and Scalability,

www.compaq.com/support/techpubs/whitepapers/ECG0250997.html

Configuring Compaq RAID Technology for Database Servers,

www.compaq.com/support/techpubs/technotes/184206-1html

Compaq SMART Array Controller Technology,

www.compaq.com/support/techpubs/whitepapers/667A0697.html

Hardware vs. Software Fault Tolerance,

www.compaq.com/support/techpubs/whitepapers/ECG0660298.html

Compaq Pentium Pro Processor-based Servers,

www.compaq.com/support/techpubs/whitepapers/308A0496.html

Configuring the Compaq ProLiant 5000 Server for Peak Performance,

www.compaq.com/support/techpubs/whitepapers/679A0697.html

Compaq White Paper Index,

www.compaq.com/support/techpubs/whitepapers