

NotesBench Disclosure Report

Red Hat Linux Advanced Server 2.1
IBM eServer xSeries 342
Using Lotus Domino 5.0.10

Results Submitted July 18, 2002

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Sponsored by
Red Hat Corporation



Table of Contents

Section 1:	Executive Summary
Section 2:	Benchmarking Objectives
Section 3:	Test Methodologies
Section 4:	Data
Section 5:	Analysis
Section 6:	Conclusions
Section 7:	Statement by Auditor
Appendix A:	Overall Test Setup and Software Versions
Appendix B:	System Configuration
Appendix C:	Operating System Parameters Values
Appendix D:	Notes Parameters (NOTES.INI file)
Appendix E:	Network Configuration File(s)
Appendix F:	Guidelines for Information
Appendix G:	Pricing
Appendix H:	Optional (vendor-defined information)
Edition Notice	

Section 1: Executive Summary

The Red Hat Linux Advanced Server 2.1 and IBM eServer xSeries 342 server demonstrated leadership performance running Lotus Domino Server Release 5.0.10. The results detailed in this report were obtained using the NotesBench R5Mail-Only workload.

Test Script	Maximum Users	NotesMark (tpm)	Ave. Response Time (sec)	\$/User	\$/NotesMark
R5Mail-Only	7000	10321	.282	\$4.10/user	\$2.78/NotesMark

The IBM® eServer xSeries 342 server was configured with two 1.13 Ghz Intel Pentium III processors, 4 GB memory, and an IBM ServeRaid-4Mx Ultra160 SCSI Adapter controller managing 20 hard disk drives. Two Domino partitions, which were part of the same Domino domain, shared a directory containing 14,000 person documents. For complete configuration details, see *Appendix A: Overall Test Setup and Software Versions*.

The server under test supported an R5Mail-Only workload of 7000 active mail users (see price/performance results above), configured with two Domino partitions.

Innovative Computer Solutions, Inc. Performance and Capacity Testing Lab in Woburn, Massachusetts conducted the benchmark in June 2002, and KMDS Technical Assoc., Inc., audited the results in July 2002.

NotesBench provides an objective method for evaluating the performance of different platforms running Lotus Domino Server. NotesBench generates a transactions-per-minute (tpm) throughput metric, called a NotesMark, for each test, along with a value for the maximum capacity (number of users) supported, and the average response time.

Section 2: Benchmarking Objectives

The benchmark objective was to provide customers with information that Red Hat Linux Advanced Server 2.1 is a stable, secure, and high-performance Operating System on which to deploy Domino Server software. The benchmark also serves to provide customers with information on how to utilize the IBM xSeries 342 system as a Domino Server 5.0.10 mail server configured with the ServeRaid-4Mx Ultra160 SCSI Adapter for RAID-1E data redundancy.

Section 3: Test Methodologies

Hardware/Software Configuration

The Domino Server hardware used for the test was an IBM xSeries 342 server running Red Hat Linux 2.1 Advanced Server. The xSeries 342 system under test (SUT) was configured with two 1.13 Ghz Pentium III processors (512KB of ECC full-speed L2 write-back cache), 4 GB of memory, ten 18.2 GB 15K RPM hard disk drives, ten 36.4 GB hard disk drives. Two RAID-1E arrays each composed of ten hard drives, which contained the mail files, were connected to a ServeRAID-4Mx Ultra 160 SCSI Adapter. Three internal 8 GB non-RAID SCSI hard drives were in use, one used for storing and booting Red Hat Advanced Server 2.1, one for the swap file and one for the /tmp folder. The Domino server software was stored on the first hard drive in the /opt/lotus/bin folder. The network consisted of one segment connected to a 16-port 10/100 Mbit switch. The network interface consisted of one internal 10/100 Mbit NIC. The NIC was configured with two IP addresses, one for each partition.

The version of Domino tested was Domino Server 5.0.10.

The RAID controller configuration value for Strip Unit Size was set at 64KB. Write-back cache was enabled for all RAID-1 arrays.

The following NOTES.INI parameters were modified as recommended in the NotesBench operator's manual.

R5Mail-Only Workload
Server_Max_Concurrent_Trans=1000
NSF_DBCache_MaxEntries=10000
NSF_Buffer_Pool_size_MB=256
MAILLOGTOEVENTSONLY=1
Log_MailRouting=10
Log_Sessions=0
Server_Pool_Tasks=100
Max_Users=10000
Notes_PRIVATE_DPOOLSIZE=1000000
SHARED_DPOOLSIZE=41943040

In the Server-Configuration document for both partitions, five mail.boxes were used on each partition for mail routing.

The following parameters were added to suppress database activity logging after long runs and to capture server console output:

No_Force_Activity_Logging=1
Server_Show_Performance=1
Tcplp_TcplpAddress=0,192.168.1.XX:1352
Debug_Outfile=/tmp/serverYY.txt

In the last two lines above, XX is the net address and YY is the partition number for the corresponding partition.

All Notes server tasks were disabled except the Router task.

All Domino data files were located on the RAID-1E arrays. Each array was mounted as directories /notesdata1 and /notesdata2. The Domino executables were located on the internal 8GB SCSI disks. Partition 1 used the /notesdata1 array and Partition 2 used the /notesdata2.

Test Procedures

The test environment for the NotesBench R5Mail workload consisted of four discrete components:

- the *server under test (SUT)*,
- *child drivers systems* to generate load on the SUT by simulating the activity of Notes Mail users
- one or more *parent drivers* to control the progress of the test
- network through which the child drivers, parent drivers, and SUT communicate.

Preparation for the test included setting up the 342 xSeries server, the storage arrays, optimizing Red Hat Linux 2.1, initializing mail databases, starting the Domino partitions, and so on.

The NotesBench test began with starting the child drivers one by one over a ramp-up period of roughly over 3 hours. The 7000 users were distributed over 8 clients. Each client added 875 users to the SUT. The name and address book (NAB) contained 14,000 entries in a single mail domain. Once all the simulated users were active the peak load was maintained for 26 hours while the Domino partitions' console messages were monitored to ensure that all users remained connected.

To confirm steady state, we verified the number of users at the server and its logs. We confirmed steady state when the number of users on the SUT Domino Server console reached the intended number of users. We also used the *show stat mail* console command on the server to verify that at least 90 percent of the mail generated during the test period was delivered to the local mail databases during the test period.

NotesBench then shut down the child driver accounts one at a time over a ramp-down period of about 15 minutes. The Domino partitions were then shut down, and logs, configuration files and other products of the test were collected and archived.

System resource utilization was monitored using standard Linux tools such as *Iostat*, *VMstat*, *Free*, and *Top* while the test was active. The *show stat mail* command was monitored throughout the test. The output was examined to ensure that mail was routed promptly throughout the test.

Section 4: Data

Red Hat Linux Advanced Server 2.1 running on an IBM eserver xSeries 342 server demonstrated that it can support 7000 NotesBench R5Mail users, achieving a NotesMark rating of 10,321 transactions per minute with an average response time of .282 seconds per transaction. The test ran for a total of 26 hours at steady state with a ramp up time of a little over 3 hours. NotesBench reported no errors. At the end of the steady state period 99.9% of the generated mail had been delivered, more than satisfying the NotesBench requirement of at least 90% delivery.

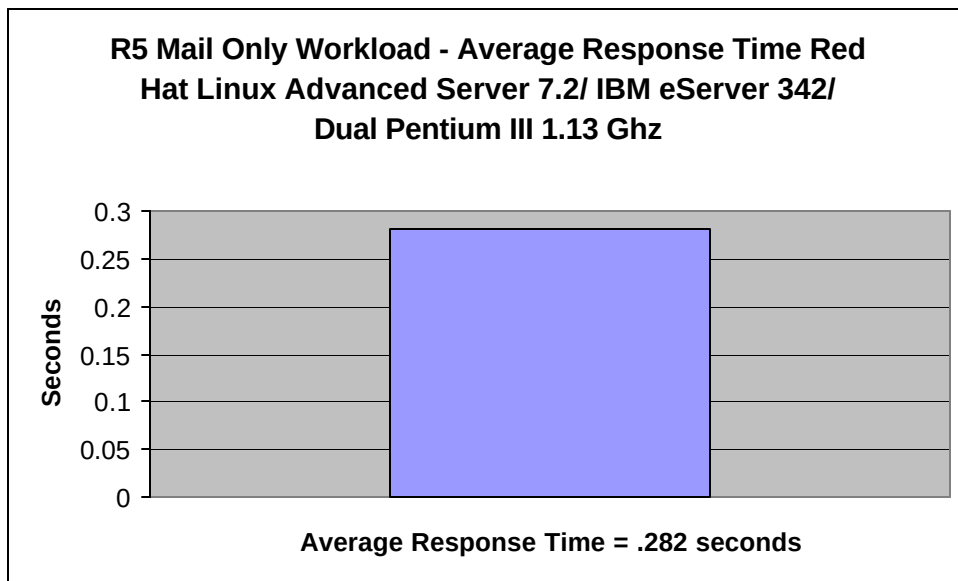
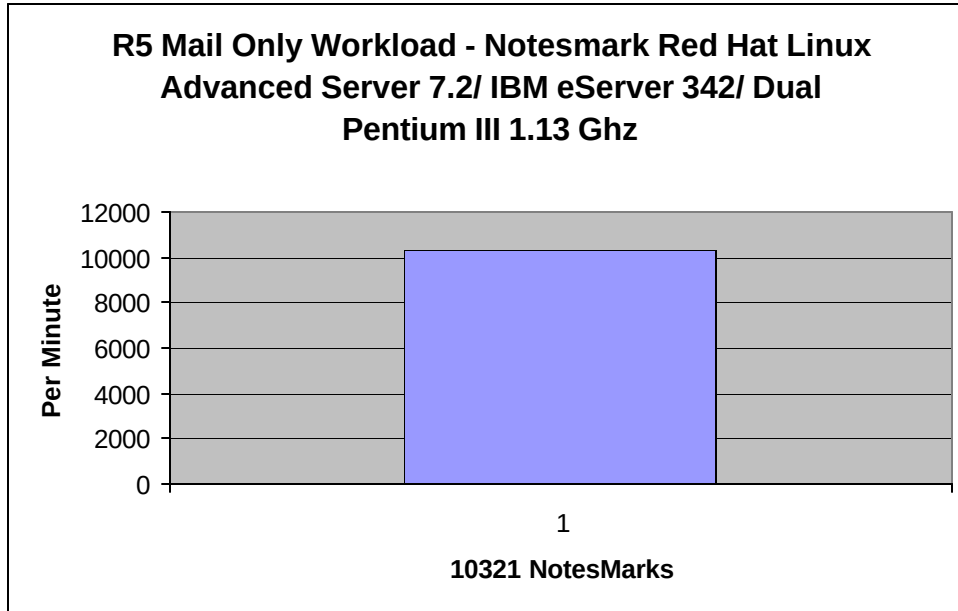
During the test, CPU utilization was measured by the *sar* utility program. Samples were taken at one-minute intervals during the ramp-up, steady state and ramp-down periods. As the following graph shows, the CPUs were fully utilized at peak load.

Red Hat Linux Advanced Server 2.1 running on an IBM 342 xSeries server demonstrated that it can support 7000 concurrent active users with this workload. The NotesMark throughput value was 10,321. Average response time was .282 seconds.

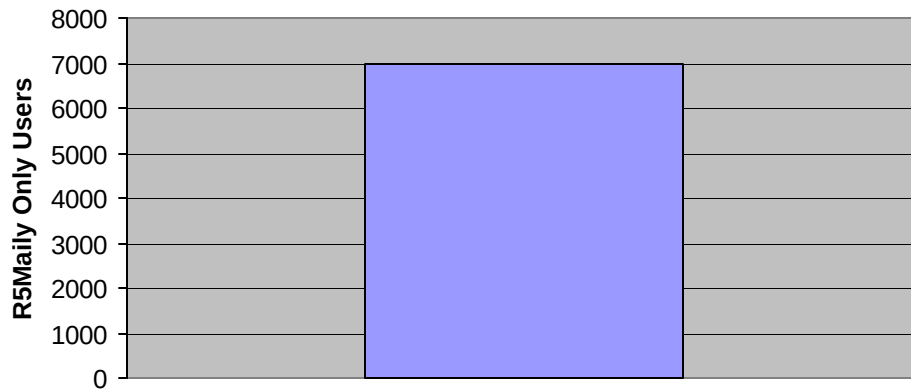
Mail-Only Users Test

The R5Mail test models an active user on a client reading and sending mail, scheduling an appointment, and sending a Calendar & Scheduling (C&S) invitation. An average user will execute this script four times per hour. For each iteration of the script, there are five documents read, two documents updated, two documents deleted, one view scrolling operation, one database opened and closed, one view opened and closed, three messages comprised of one memo to three recipients, three lookups against the Domino Directory (when NthIteration=6), one C&S appointment, and one C&S invitation are sent to the recipients approximately every 90 minutes.

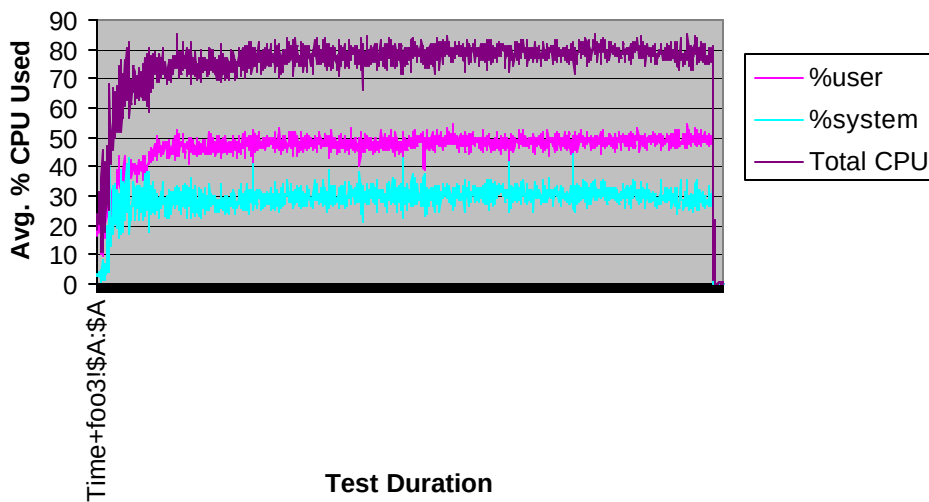
Below are the graphs depicting the NotesMark, number of users, response time, and CPU utilization.



**R5 Mail Only Workload - Users Red Hat Linux
Advanced Server 7.2/ IBM eServer 342/ Dual
Pentium III 1.13 Ghz**



**Average CPU Utilization
(sar output over entire test run)**



Section 5: Analysis

When configured as described in this report, Red Hat Linux Advanced Server 2.1 and the xSeries 342 server demonstrated that it can manage the intense resource usage during ramp-up to 7000 concurrent R5Mail users with no errors at the clients. During the steady-state period on one of the successful 7000-user runs, the average CPU utilization was 75.85%.

Since the test ran at steady state for 26 hours, this demonstrates the overall reliability and stability of the Red Hat Linux, Lotus Domino, and the IBM eServer platform.

The response time of .282 seconds also contributes to the overall performance and readiness of this platform as a viable solution for Domino mail services.

Section 6: Conclusions

The total hardware and software price for the server under test is \$28,709.00 (see Appendix G for details). This amounts to \$4.10/user, or \$2.78 per NotesMark. Red Hat Linux Advanced Server 2.1 running on an IBM 342 eServer represents an excellent platform for large system configurations and offers great reliability, stability and performance.

Mfr	Model	Description	Base	Quantity	Total
Server					
IBM	86692RX	eServer xSeries 342, Single PIII 1.13 Ghz, 256 MB Memory, Integrated 10/100 Nic	\$2,259.00	1	\$2259.00
IBM	24P3512	xSeries 1.13 GHz/133 MHz - 512 Cache Upgrade with Pentium III Processor	\$599.00	1	\$599.00
IBM	31P8300	1GB PC133 ECC SDRAM RDIMM	\$989.00	4	\$3956.00
IBM	06P5736	ServeRaid-4Mx Ultra160 SCSI Adapter	\$999.00	1	\$999.00
IBM	36L8772	9.1GB UW Hot swappable w/tray 80pin (internal drives)	\$275.00	3	\$825.00
IBM	35311RU	EXP 300 Drive Enclosure (FIRST STORAGE ARRAY)	\$3,179.00	1	\$3179.00
IBM	35301RU	EXP 200 Drive Enclosure (SECOND STORAGE ARRAY) (Note: using EXP 300 price, EXP 200 no longer available)	\$3,179.00	1	\$3179.00
IBM	06P5754	18.2 GB 10K-rpm Ultra 160 SCSI Hot-Swap SL HDD (FOR FIRST STORAGE ARRAY)	\$275.00	10	\$2750.00
IBM	06P5751	36.4 GB 10K-rpm Ultra 160 SCSI Hot-Swap SL HDD (second storage array)	\$499.00	10	\$4990.00
Princeton Graphics	EO14	15" Monitor	\$179.00	1	\$179.00
Red Hat	RHF0090US	Red Hat Advanced Server 2.1	\$799.00	1	\$799.00
IBM		IBM Domino Server	\$4995.00	1	\$4995.00
			Total Cost		\$ 28,709.00

Cost Per User: Total Cost/ Number of Users = \$28,709.00/7000 = \$4.10/User
Cost Per NotesMark: Total Cost/ NotesMark = \$28,709.00/10321 = \$2.78/NotesMark

Section 7: Statement by Auditor

August 5, 2002

Report Title: NotesBench Disclosure Report for Red Hat Linux Advanced Server 2.1 and IBM eServer xSeries 342 using Lotus Domino 5.0.10

Report Date: July 2002

Company: Innovative Computer Solutions

Auditor's Statement

This report's contents and the actual data files from the test runs have been audited for accuracy and completeness. The version of NotesBench used was compatible with the Notes Server code that was run on the server under test. The workloads were run correctly. The configuration of the test environment and system under test were verified. The NotesBench scaling rules were correctly applied. The tests did reach steady state. The capacity and performance information were direct outputs from the **notesnum.exe** program. All costs for the system under test were included in the price documented in this report. The driver systems were properly configured.

This report accurately reflects the test environment and results of the NotesBench benchmark tests described herein. This report **passes** the audit performed and its contents are approved for publication.

The certified report results are summarized below:

System Under Test Configuration	List Price	NotesBench Workload	Concurrent Users	Average Response Time (seconds)	NotesMark (transactions per minute)
IBM eServer xSeries 342 (2*Pentium III/ 1.13 GHz, 4GB RAM)	\$28,709.00	R5Mail	7,000	0.282	10,321

Signed,



Daryl K. Thompson
NotesBench Auditor
KMDS Technical Associates, Inc.

Appendix A: Overall Test Setup and Software Versions

Client Systems

For the test, ten driver systems were used. Eight of those systems were configured as child drivers (child 1 through child 8). Each driver simulated 875 R5Mail-Only users. Two parent systems were used to control the run.

The disk configuration used for the child systems is as follows:

- Child drivers 1-8
- C: Partition (4 GB - NTFS) - Windows 2000
- D: Partition (36GB - NTFS) - Notes 5.0.10 code and data

Parent Systems

The configuration of the two parent driver computers used to control the overall execution of the Notesbench test is as follows:

First Parent Driver:

- Pentium II 450 Mhz computer with 256 MB memory
- C: Partition (4GB – NTFS)- Windows 2000 and Notes 5.0.10 code and data
- Controlled child drivers 1-4 (configured to drive 875 users each)

Second Parent Driver:

- Pentium III 700 Mhz computer with 256 MB memory
 - C: Partition (4GB – NTFS)- Windows 2000 and Notes 5.0.10 code and data
- Controlled child drivers 5-8 (configured to drive 875 users each)

Server Platform

One server platform, the xSeries 342 with two 1.13 GHz Pentium III processors and 4 GB of memory, was benchmarked.

The disk configuration used for the system under test is as follows:

IBM EXP 300 STORAGE ARRAY	10 X 18.2 GB 10K disks. Mirrored to produce 90 GB useable data.	Mounted as /notesdata1 for first partition
IBM EXP 200 STORAGE ARRAY	10 X 36.4 GB 10K disks. Mirrored to produce 182 GB useable data.	Mounted as /notesdata2 for first partition
Internal SCSI 8GB Drive 1	Non-raid	Red Hat Linux Advanced Server installed. Lotus Domino also installed on this drive in /opt/lotus/bin
Internal SCSI 8GB Drive 2	Non-raid	Mount as /swap file
Internal SCSI 8GB Drive 3	Non-raid	Mount as /tmp file

Network

The network consisted of one CAT-5 LAN segment. All child drivers, parents and SUT were connected to one of 16 ports on a 10/100 Mbit/s switch.

Software Versions

Software versions used on the system under test were as follows:

- Red Hat Linux Advanced Server 2.1(no patches, fixes from Red Hat required)
- Lotus Domino Server Release 5.0.10 for Linux

Software versions used on the child and parent drivers were as follows:

- Microsoft Windows 2000 Advanced Server for child and parent drivers.
- Lotus Domino Client Release 5.0.10 for Windows 2000
- NotesBench Version 5.09a - R5.0.9 - July 17, 2001

Appendix B: System Configurations

	Server Under Test	Each Driver System
Model	IBM 342 eServer	
CPU's	2 Pentium III (512KB of ECC full-speed L2 write-back cache)	1 AMD Athlon each
CPU Clock Rate	1.13 Ghz	1 Ghz
Main Memory	4 GB	256 MB
Data Disks	IBM EXP 300 STORAGE ARRAY (10 X 18.2 GB 10K disks.) IBM EXP 200 STORAGE ARRAY (10 X 36.4 GB 10K disks.)	1 X 40 GB EIDE 7200 RPM (8 MB buffer)
Network Adapter	Intel EtherXpress 10/100	Intel EtherXpress 10/100
Operating System	Red Hat Linux Advanced Server 2.1	Windows 2000 Advanced Server
Benchmark Role	Server Under Test. Service database requests from child drivers	Parent: Overall benchmark control, Child: generate load for SUT.
Other Information	Partition 1 on the SUT to child drivers 1,2,3,4 and parent 1. Partition 2 on the SUT to child drivers 5,6,7,8 and parent 2. Single Domino Directory contained 14000 person documents	

The SUT's twenty data disks resided in two 10-disk IBM EXP storage arrays (the EXP 200 and EXP 300).. Each array was connected to the ServeRaid-4Mx Ultra160 SCSI Adapter and configured for RAID -1E data redundancy.

Each of the two Domino partitions was placed on a separate RAID volume to store names.nsf, notes.ini, and other server data files, and to store its share of the 14,000 database files. Each Domino partition successfully served 3500 users.

Appendix C: Operating System Parameters

The SUT ran Red Hat Linux Advanced Server 2.1 available at <http://www.redhat.com>.

The following non-default parameter settings were added:

/etc/sysctl.conf	
fs.file-max=49152	# increase maximum number of open files
kernel.shmmni=8192	# increase maximum number of shared memory segments
kernel.sem=250 18432 32 1024	# increase maximum number of system-wide semaphores

/etc/security/limits.conf	
soft nofile 1024	# default user limit for open files
Hard nofile 49152	# maximum user limit for open files

/etc/fstab	
Set the noatime attribute flag to disable the file access timestamp on all domino partitions	

/etc/pam.d/login	
session required /lib/security/pam_limits.so	# set user limits using limits.conf

/home/notes_user/.bash_profile	
ulimit -n 49152	# increase notes open files limit
Ulimit -s 512	Reduce the per process stack size to 512K
export Notes_PRIVATE_DPOOLSIZE=1000000	

The following glibc source file was modified and rebuilt as follows:

/usr/src/redhat/SOURCES/glibc-2.2.4/linuxthreads/internals.h,

Change the size of the thread stack reserve from 2 MB down to 256 kilobytes (with a page size of 4,096 bytes):

Original line:

```
#ifndef STACK_SIZE #define STACK_SIZE (2 * 1024 * 1024) #endif
```

New line:

```
#ifndef STACK_SIZE #define STACK_SIZE (64 * PAGE_SIZE) #endif
```

The second file is in sysdeps/unix/sysv/linux/bits/local_lim.h under the directory:

/usr/src/redhat/SOURCES/glibc-2.2.4/linuxthreads, you need to change the Posix thread implementation limit from 1,024 per process to 8,192 per process:

/usr/src/redhat/SOURCES/glibc-2.2.4/linuxthreads/sysdeps/unix/sysv/linux/bits/local_lim.h:

Original line:

```
#define PTHREADS_THREADS_MAX 1024
```

New line:

```
#define PTHREADS_THREADS_MAX 8192
```

Admin=CN=mail1/O=Test

TemplateSetup=67
Setup=62
ServerSetup=55
CleanSetup=1
MTEnabled=0
;=====NotesBench's Parameters=====

Max_Users=10000
NSF_DBcache_Maxentries=10000
Log_Sessions=0
Log_View_Events=0
LOG_DISABLE_SESSION_INFO=1
Server_Pool_Tasks=100
NSF_BUFFER_POOL_SIZE_MB=256
Server_Max_Concurrent_Trans=1000
MAILLOGTOEVENTSONLY=1
LOG_MAILROUTING=10
SERVER_SHOW_PERFORMANCE=1
MAILUSEPROCESSES=1
No_Force_Activity_Logging=1
Notes_SHARED_DPOOLSIZE=41943040
SHARED_DPOOLSIZE=41943040
Notes_PRIVATE_DPOOLSIZE=2097152
PRIVATE_DPOOLSIZE=2097152
Debug_Outfile=/tmp/server1.txt
TRANSLOG_AutoFixup=1
TRANSLOG_UseAll=1
TRANSLOG_Style=0
TRANSLOG_Performance=1
TRANSLOG_MaxSize=4096
TRANSLOG_Path=/
TRANSLOG_Status=0

[illegible]

```
;=====NotesBench's Parameters=====
Max_Users=10000
NSF_DBcache_Maxentries=10000
Log_Sessions=0
LOG_DISABLE_SESSION_INFO=1
Server_Pool_Tasks=100
NSF_BUFFER_POOL_SIZE_MB=256
Server_Max_Concurrent_Trans=1000
MAILLOGTOEVENTSONLY=1
LOG_MAILROUTING=10
SERVER_SHOW_PERFORMANCE=1
;MAILUSEPROCESSES=0
No_Force_Activity_Logging=1
Notes_SHARED_DPOOLSIZE=41943040
SHARED_DPOOLSIZE=41943040
Notes_PRIVATE_DPOOLSIZE=2097152
PRIVATE_DPOOLSIZE=2097152
CleanSetup=1
MTEnabled=0
Debug_Outfile=/tmp/server4.txt
TRANSLOG_AutoFixup=1
TRANSLOG_UseAll=0
TRANSLOG_Style=1
TRANSLOG_Performance=2
TRANSLOG_MaxSize=1500
TRANSLOG_Status=0
```

NOTES.INI FOR ONE OF THE CHILD DRIVERS

```
[Notes]
Directory=c:\ntest\data
KitType=1
InstallType=2
WinNTIconPath=c:\ntest\data\W32
Timezone=5
DST=1
Domain=Test
$$HasLANPort=1
WWWDSPP_SYNC_BROWSERCACHE=0
WWWDSPP_PREFETCH_OBJECT=0
EnableJavaApplets=1
EnablePlugins=1
Preferences=-1073476495
AltNameLanguage=en
ContentLanguage=en-US
WeekStart=1
ViewWeekStart=2
NavWeekStart=2
XLATE_CSID=52
SPELL_LANG=1033
Region=en-US
Passthru_LogLevel=0
Console_LogLevel=2
```

[illegible]

Ports=TCPIP
DisabledPorts=LAN0,VINES,SPX,COM1,COM2,COM3,COM4,COM5
KeyFilename=user.id
CertificateExpChecked=user.id 06/30/2002
MailFile=mail1.nsf
TemplateSetup=66
Setup=62
Location=Server1,9A2,CN=mail1/O=Test
\$IEVersionMajor=5
\$headlineClientId=089D7937:177D99AA-85256BCA:00349FE1
PhoneLog=2
Log=log.nsf, 1, 0, 7, 40000
SERVERS_FRAME_PERCENT=20
MONITOR_SCALE=1
ADMINMAXIMIZED=1
DESKWINDOWSIZE=-4 -4 808 580
MAXIMIZED=1
WinNTIconCommonConfig=Universal
WinNTIconSize=2
WinNTIconPos=2
WinNTIconHidden=1
WinNTIconRect=0 0 0 24
ECLSetup=3
BROWSERSIZE=101
DebugWinSplitterPos=602
DesignWinSplitterPos=118 -1
HELPWINDOWSIZEWIN=-4 -4 1288 1032
DESIGNMAXIMIZED=1
;
;NotesBench Start
;
ResultsDirectory=z:\notesbench\results
NodeName=driver1
debug_outfile=z:\notesbench\results\res1
NormalMessageSize=10000
NumMailNotesPerUser=100
NumMessageRecipients=3
NthIteration=6
MaxDocToDelete=10000
MailTemplate=mail50.ntf
UseServerNAB=1
ThreadStagger=.8
;
;Notesbench End
;
FileDlgDirectory=c:\ntest\data
AdminSetup=502
CertifierIDFile=h:\install\files\cert.id
NewUserServer=CN=server1/O=Test
Win32InfoboxPos=4 111
NAMES=names.nsf
\$headlineDisableHeadlines=0
EmptyTrash=0
MIMEPromptMultilingual=1
MIMEMultilingualMode=1
EnableActiveXInBrowser=1

EnableJavaScript=1
EnableJavaScriptErrorDialogs=1
EnableLiveConnect=1
ShowAccelerators=1
DisableImageDithering=1
AdminLastServer=CN=server1/O=Test
MailServer=CN=Server1/O=Test
UseServerNAB=1

Appendix E: Network Configuration Files

The network used Red Hat Linux Advanced Server's native TCP/IP capability. The /etc/hosts file; here is the file from the SUT:

```
#
# Internet host table
#
192.168.1.140 server1 #this is the first partition's IP address
192.168.1.143 server4 #this is the second partition's IP address
```

Appendix F: Guidelines for Information Usage

This report is for use by Red Hat and IBM customers and resellers. It may be freely copied and distributed provided the entire report remains intact.

Appendix G: Pricing

The table provides the Red Hat and IBM List Price for the U.S. only. Actual prices may vary, and prices may also vary by country. Prices are subject to change without notice. For additional information and current prices, contact your local IBM/Red Hat representative.

Mfr	Model	Description	Base	Quantity	Total
Server					
IBM	86692RX	eServer xSeries 342, Single PIII 1.13 Ghz, 256 MB Memory, Integrated 10/100 Nic	\$2,259.00	1	\$2259.00
IBM	24P3512	xSeries 1.13 GHz/133 MHz - 512 Cache Upgrade with Pentium III Processor	\$599.00	1	\$599.00
IBM	31P8300	1GB PC133 ECC SDRAM RDIMM	\$989.00	4	\$3956.00
IBM	06P5736	ServeRaid-4Mx Ultra160 SCSI Adapter	\$999.00	1	\$999.00
IBM	36L8772	9.1GB UW Hot swappable w/tray 80pin (internal drives)	\$275.00	3	\$825.00
IBM	35311RU	EXP 300 Drive Enclosure (FIRST STORAGE ARRAY)	\$3,179.00	1	\$3179.00
IBM	35301RU	EXP 200 Drive Enclosure (SECOND STORAGE ARRAY) (Note: using EXP 300 price, EXP 200 no longer available)	\$3,179.00	1	\$3179.00
IBM	06P5754	18.2 GB 10K -rpm Ultra 160 SCSI Hot-Swap SL HDD (FOR FIRST STORAGE	\$275.00	10	\$2750.00

		ARRAY)			
IBM	06P5751	36.4 GB 10K -rpm Ultra 160 SCSI Hot-Swap SL HDD (second storage array)	\$499.00	10	\$4990.00
Princeton Graphics	EO14	15" Monitor	\$179.00	1	\$179.00
Red Hat	RHF0090US	Red Hat Advanced Server 2.1	\$799.00	1	\$799.00
IBM		IBM Domino Server	\$4995.00	1	\$4995.00
			Total Cost		\$ 28,709.00

Appendix H: Additional Information

None

First Edition – August 2002

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