SCALABILITY: LENOVO THINKSERVER RD540 SYSTEM AND LENOVO THINKSERVER SA120 STORAGE
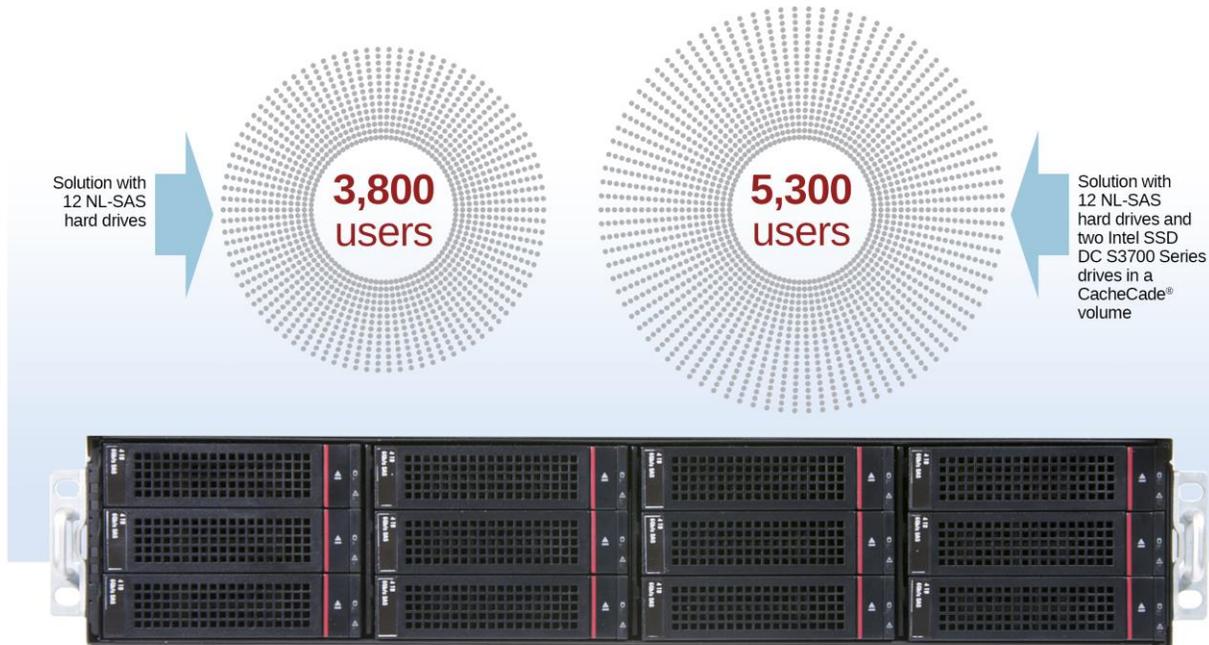
Lenovo® ThinkServer® RD540 and Lenovo ThinkServer SA120 DAS
with Intel® SSD DC S3700 Series drives supported up to 5,300 Microsoft® Exchange users

Solution with 12 NL-SAS hard drives → **3,800 users**

5,300 users ← Solution with 12 NL-SAS hard drives and two Intel SSD DC S3700 Series drives in a CacheCade® volume

Businesses of all sizes want high-performance server and storage solutions that can scale out as their company grows. This is especially important for transactional applications like Microsoft Exchange Server, which are very storage intensive and require performance and capacity to scale as the number or users increases.

The Lenovo ThinkServer RD540 system, combined with the Lenovo ThinkServer SA120 direct-attached storage (DAS) array, provide a complete mailbox database back-end solution for storage-intensive transactional applications. When environments require greater throughput performance in addition to large storage capacity, Lenovo offers the cost-effective CacheCade storage-caching technology, which combines with Intel SSDs to transform the SA120 into a high-performance, multi-tier storage platform.

In the labs at Principled Technologies, we put the Lenovo ThinkServer RD540 to the test using Microsoft Exchange Server 2013 as a representative storage-intensive transactional application workload. First, we tested using high-capacity NL-SAS HDDs in the ThinkServer SA120 DAS array. Then, we added CacheCade and two Intel DC S3700 series 400GB SSDs to determine how many additional users the upgraded configuration could support.

In our testing, we found that the Lenovo ThinkServer RD540 with the ThinkServer SA120 DAS array using an HDD configuration provided an excellent platform as a Microsoft® Exchange Server 2013 mailbox database back-end, supporting 3,800 Exchange users. With Intel SSDs and optional CacheCade technology, the Lenovo solution scaled out to support 39.5 percent more users.

ABOUT THE LENOVO SOLUTION

The ThinkServer RD540 is a mainstream server that runs popular business applications on various operating systems. With up to two Intel® Xeon® processors E5-2600 v2 and up to 24 cores, the 1U ThinkServer RD540 offers up to 320 GB of memory. The server has capacity for up to four 3.5-inch and eight 2.5-inch hot-swappable disk bays and supports up to 16 TB of internal 3.5-inch SATA storage or up to 12 TB of internal 3.5-inch SAS storage.

The Lenovo ThinkServer SA120 is a direct-attached storage array. With up to two 6Gbps I/O modules, twelve 3.5-inch front drive bays (up to 48 TB), and four rear-panel 2.5-inch SSD drive bays (up to 3.2 TB), the SA120 significantly expands the storage capacity of the Lenovo ThinkServer RD540.

Available with the ThinkServer LSI9286CV-8E adapter, the CacheCade option is a low-cost upgrade that, when coupled with Intel SSDs, can yield significant performance benefits.[1] CacheCade supports up to 500 GB of SSD storage in a cache volume. This technology intelligently caches hot spots—the most frequently accessed data in the CacheCade volume—to help reduce latency and increase performance to HDD-based volumes. Figure 1 shows the flow of data with CacheCade technology.
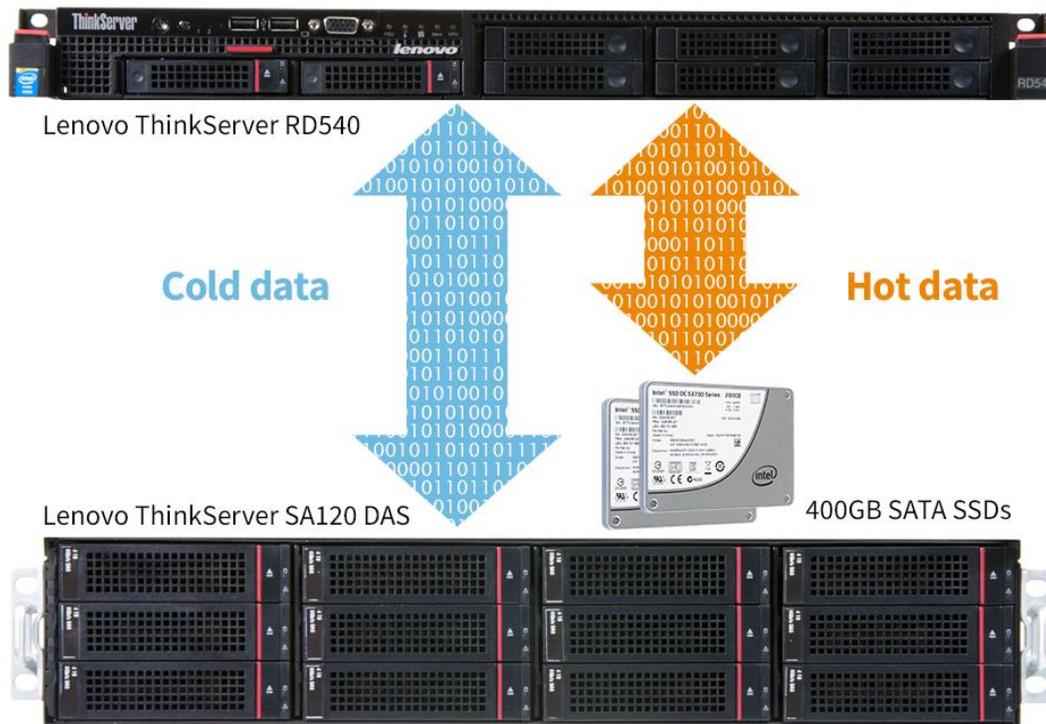

Figure 1: The flow of information in a CacheCade volume.

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[1] For Lenovo pricing options, visit
shop.lenovo.com/SEUILibrary/controller/e/web/LenovoPortal/en_US/builder.workflow:Enter?sb=:00000025:00003868:.

WHAT WE FOUND

Adding a few Intel SSDs as a CacheCade volume into your ThinkServer SA120 can help you maintain strong performance as you add Exchange users.

To see how many Exchange Server users the Lenovo solution could support, we used the Microsoft Load Generator 2013 (LoadGen) benchmark, which performs tasks that simulate a high level of user-generated mail activity in Microsoft Exchange Server 2013. We tested the Lenovo solution using two external storage drive configurations:

- 12 NL-SAS HDDs
- 12 NL-SAS HDDs and two Intel DC S3700 series 400GB SSDs in a CacheCade pool

For detailed system configuration information, see Appendix A. For more information on our testing and on the LoadGen benchmark, see Appendix B.

As Figure 2 shows, the HDD solution supported 3,800 users. When we added the two Intel SSDs as a CacheCade volume, the number of supported users increased by 39.5 percent over the HDD solution.

Figure 2: The Lenovo ThinkServer RD540 and ThinkServer SA120 DAS array supported 3,800 users in the HDD-only solution and 5,300 users in the CacheCade solution.
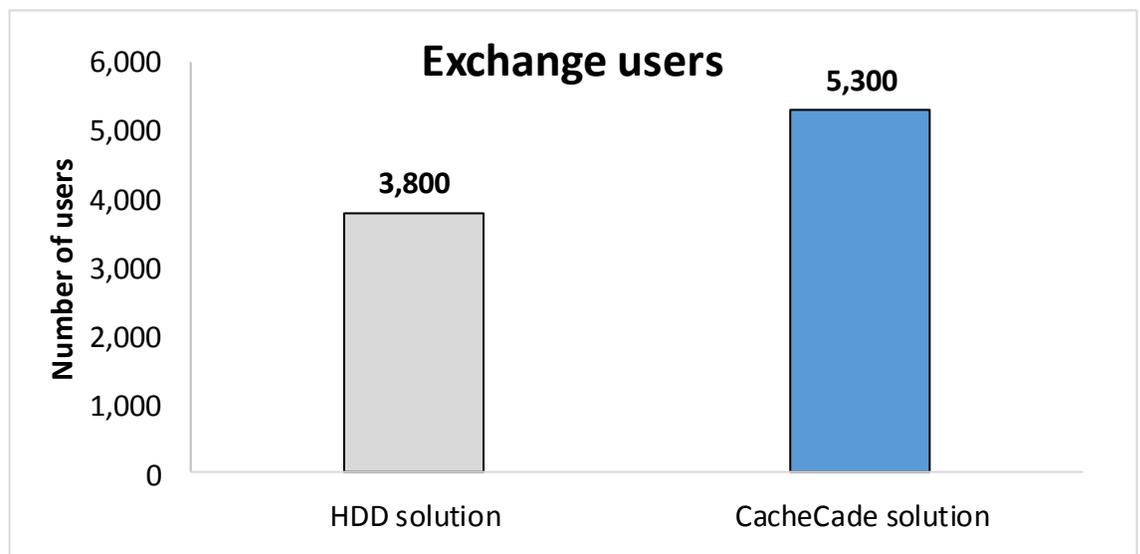
In addition to increased performance, the CacheCade solution also provided an improvement in response time. This translates to less waiting for users as the server completes a task. An average response time of 20 milliseconds or less is an industry standard.[2] When users must wait longer than this, the wait time becomes noticeable and productivity can suffer. Both solutions delivered response times below the recommended threshold.

In our tests, the HDD solution supported 3,800 users with a latency time of 15.3 milliseconds, within Microsoft's latency recommendations. When we added the Intel SSDs as a CacheCade volume, the solution supported 39.5 percent more

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[2] http://technet.microsoft.com/en-us/library/ff367871(v=exchg.141).aspx

users while delivering a better user experience through lower latency, with response time dropping to 10.1 milliseconds, a 33.7 percent decrease (see Figure 3).

	Number of users	Average response time (ms)
HDD solution	3,800	15.3
CacheCade solution	5,300	10.1

Figure 3: Median latency (I/O database reads average latency) for the two solutions. The median test run was determined using the median CPU utilization.

IN CONCLUSION

Enterprises and SMBs need servers that can provide reliable performance with the ability to scale out to match growth. The Lenovo ThinkServer RD540 and the ThinkServer SA120 DAS array can run transactional applications such as Microsoft Exchange Server while providing scalable storage to support these critical workloads. We found that in the HDD configuration, the ThinkServer RD540 and ThinkServer SA120 DAS device provided support for 3,800 Exchange users. When we added just two Intel 400GB SSDs as a CacheCade volume, the ThinkServer RD540 and ThinkServer SA120 not only supported 5,300 users—a 39.5 percent increase—but did so while improving response time 33.9 percent.

APPENDIX A – SYSTEM CONFIGURATION INFORMATION

Figure 4 provides detailed configuration information for the test system and Figure 5 does the same for the storage array.

System	Lenovo ThinkServer RD540
Power supplies	
Total number	2
Vendor and model number	Delta Electronics DPC-800RB
Wattage of each (W)	800
Cooling fans	
Total number	8
Vendor and model number	AVC DB04056B12U
Dimensions (h × w) of each	1.5" x 1.5"
Volts	12
Amps	1.4
General	
Number of processor packages	2
Number of cores per processor	10
Number of hardware threads per core	2
System power management policy	Default
CPU	
Vendor	Intel
Name	Xeon
Model number	E5-2680 v2
Socket type	FCLGA2011
Core frequency (GHz)	2.80
Bus frequency	8 GT/s
L1 cache	32 KB + 32 KB (per core)
L2 cache	256 KB
L3 cache	25 MB
Platform	
Vendor and model number	Lenovo ThinkServer RD540
Motherboard model number	FRU03T7724
BIOS name and version	Lenovo A1TS66A 1/25/2014
BIOS settings	Default
Memory module(s)	
Total RAM in system (GB)	128
Vendor and model number	Samsung M393B2G70BH0
Type	PC3-12800R
Speed (MHz)	1,600
Speed running in the system (MHz)	1,600
Timing/Latency (tCL-tRCD-tRP-tRASmin)	11-11-11-28
Size (GB)	16
Number of RAM module(s)	8

System	Lenovo ThinkServer RD540
Chip organization	Double-sided
Rank	Dual
Operating system	
Name	Microsoft Windows Server 2012 R2
Build number	9600
File system	NTFS
Kernel	6.2.9600.16452
Language	English
Graphics	
Vendor and model number	Aspeed AST2300
Graphics memory (MB)	512
Driver	9.0.10.98
RAID controllers	
First RAID controller	
Vendor and model number	LSI MegaRAID SAS 9260-8i
Firmware version	2.130.383-2750
Driver version	6.506.2.0
Cache size (MB)	512
Second RAID controller	
Vendor and model number	LSI MegaRAID SAS 9286CV-8e
Firmware version	3.290.05-2720
Driver version	6.506.2.0
Cache size (MB)	1024
Hard drives	
OS hard drives	
Vendor and model number	Lenovo 0A91278
Number of drives	2
Size (GB)	300
RPM	10k
Type	SAS
Data hard drives	
Vendor and model number	Lenovo 0A91280
Number of drives	6
Size (GB)	600
RPM	10k
Type	SAS
Ethernet adapters	
First network adapter	
Vendor and model number	Intel 82574L Gigabit
Type	Integrated
Driver	12.6.47.1

System	Lenovo ThinkServer RD540
Second network adapter	
Vendor and model number	Intel I350 Gigabit
Type	Integrated
Driver	12.8.26.0

Figure 4: System configuration information for the test system.

Storage array	Lenovo ThinkServer SA120
Number of storage controllers per array	2
RAID level	10
Number of drives per array	12
Drive vendor and model number	Seagate ST4000NM0023
Drive size	4 TB
Drive buffer size (MB)	128
Drive RPM	7200
Drive type	6Gb SAS

Figure 5: Detailed configuration information for the SA120 storage array.

APPENDIX B – HOW WE TESTED

About Microsoft Exchange Load Generator 2013 (LoadGen)

According to Microsoft, the Microsoft Exchange Load Generator 2013 (LoadGen) is intended for use "as a simulation tool to measure the impact of MAPI, OWA, ActiveSync, IMAP, POP and SMTP clients on Exchange 2013 servers" and with only Microsoft Exchange 2013 servers. It tests "how a server running Exchange 2013 responds to e-mail loads." We run LoadGen to simulate transfer of messaging requests. The tests "send multiple messaging requests to the Exchange server, thereby causing a mail load." LoadGen can be a useful tool:

- To size servers and confirm the legitimacy of a deployment plan
- To determine if servers can handle a potential load
- To help certify an overall solution

For more details about LoadGen, see www.microsoft.com/en-us/download/details.aspx?id=40726

Testing overview

We configured the SA120 JBOD as a RAID 10 volume, with two virtual drives, one for Exchange data and one for logs. When generating the users for the Exchange configuration, we distributed the users evenly into four mailbox databases. We used the I/O database reads average latency counter (MSExchange Database\I/O Database Reads (Attached) Average Latency) to determine the maximum number of users each configuration could support. We began with a user count that exceeded the latency threshold of 20ms average and then dropped the user count by multiples of 100 users until the latency remained consistently below 20ms and the Load Generator test completed successfully. We conducted three test runs and present the results from the median run. To obtain a more realistic performance measurement from each configuration, and in particular, the CacheCade configuration, we ran a lighter warm up workload prior to each test run.

For our workloads, we used the following settings:

- Mailbox Profile: 256MB mailboxes
- Action Profile: Outlook_500
- Client Type: Outlook 2007 Cached

Configuring the Active Directory server

Installing Microsoft Windows Server 2012 Datacenter Edition

1. Insert the installation media into the CD/DVD drive, and restart the server.
2. When the option appears, press F11 to enter the Boot Manager.
3. Select SATA Optical Drive, and press Enter.
4. Press any key when prompted to boot from DVD.
5. When the installation screen appears, click My language is English.
6. Leave language, time/currency format and input method as default, and click Next.
7. Click Install now.
8. When the Windows Setup window appears, click No thanks when prompted to go online to install updates.
9. Select Windows Server 2012 Datacenter (Server with a GUI), and click Next.
10. Check I accept the license terms, and click Next.
11. Click Custom: Install Windows only (advanced).

12. Press Alt+A to open advanced partition options. Delete any partitions until there is only Drive 0 Unallocated Space.
13. Select Drive 0 Unallocated Space, and click Next, at which point Windows will begin installing, and will restart automatically after completing.
14. When the Settings page appears, fill in the Password and Reenter Password fields with the same password.
15. Log in with the previously set up password.

Configuring Windows Update

1. In the left pane of the Server Manager window, click Local Server.
2. In the main frame, next to Windows Update, click Not configured.
3. In the Windows Update window, in the main pane, click Let me choose my settings.
4. Under Important updates, select Never check for updates (not recommended), and then click OK.
5. In the left pane, click Check for updates, and install all available updates.
6. Close the Windows Update window.

Configuring Windows Firewall

1. In Server Manager, click Tools→Windows Firewall with Advanced Security.
2. In the Overview section, click Windows Firewall Properties.
3. In the Domain Profile tab, for Firewall state, click Off.
4. In the Private Profile tab, for Firewall state, click Off.
5. In the Public Profile tab, for Firewall state, click Off.
6. Then click OK.
7. Close the Windows Firewall Properties window.

Setting up Remote Desktop

1. In the Local Server tab of the Server Manager window, next to Remote Desktop, click Disabled.
2. In the System Properties window that appears, in the Remote Desktop section, select the Allow remote connections to this computer radio button, and click OK when the warning message appears.
3. Uncheck Allow connections only from computers running Remote Desktop with Network Level Authentication (recommended), and click OK.

Disabling IE Enhanced Security Configuration

1. In the Local Server tab of the Server Manager window, next to IE Enhanced Security Configuration, click On.
2. In the Internet Explorer Enhanced Security Configuration window, select the Off radio buttons for both Administrators and Users, and click OK.

Installing the Active Directory Domain Services role

Before completing this step, you will need to apply an appropriate IP address for the server. In our case, we used 192.168.1.1.

1. Launch Server Manager, and select Add roles and features.
2. Click Next at the Add Roles and Features Wizard.
3. Select Role-based or feature-based installation, and click Next.
4. Select the AD server from the server pool, and click Next.
5. Select Active Directory Domain Services from the list of Roles, click the Add Features button to add features that are required by Active Directory Domain Services, and click Next.

6. Accept the defaults selected by setup at the Select Features screen, and click Next.
7. Click Next at the AD DS screen.
8. Select Restart the destination server automatically if required at the confirmation screen, and click Install.
9. Click Promote this server to a domain controller.
10. Select Add a new forest, type in the Root domain name (fqdn), and click Next. For our testing, we used test.local
11. Type in and confirm the password, and click Next.
12. Click Next at the DNS Options screen.
13. Verify the NetBIOS name, and click Next.
14. Accept the default paths, and click Next.
15. Review the options, and click Next.
16. Verify the prerequisite check passes successfully, and click Install.

Installing Exchange Server 2013 SP1 Mailbox and Client Access Server roles

Install Windows Server 2012 R2 on the two internal drives on the Lenovo ThinkServer RD540, assign an IP and join the domain. Then, install Exchange Server 2013 SP1 mailbox role with all updates. Repeat this for installing the two Client Access Server roles on the Lenovo ThinkServer RD530.

1. Log into the server using domain administrator credentials.
2. Open Windows PowerShell and run the following command:

```
Install-WindowsFeature AS-HTTP-Activation, Desktop-Experience, NET-
Framework-45-Features, RPC-over-HTTP-proxy, RSAT-Clustering, RSAT-
Clustering-CmdInterface, RSAT-Clustering-Mgmt, RSAT-Clustering-PowerShell,
Web-Mgmt-Console, WAS-Process-Model, Web-Asp-Net45, Web-Basic-Auth, Web-
Client-Auth, Web-Digest-Auth, Web-Dir-Browsing, Web-Dyn-Compression, Web-
Http-Errors, Web-Http-Logging, Web-Http-Redirect, Web-Http-Tracing, Web-
ISAPI-Ext, Web-ISAPI-Filter, Web-Lgcy-Mgmt-Console, Web-Metabase, Web-Mgmt-
Console, Web-Mgmt-Service, Web-Net-Ext45, Web-Request-Monitor, Web-Server,
Web-Stat-Compression, Web-Static-Content, Web-Windows-Auth, Web-WMI,
Windows-Identity-Foundation
```

3. Restart the server.
4. Download the Microsoft Unified Communications Managed API 4.0, Core Runtime 64-bit. (go.microsoft.com/fwlink/p/?linkId=258269)
5. Run UcmaRuntimeSetup.exe.
6. When the installation completes, click Finish.
7. Download and install the Microsoft Office 2010 Filter Pack 64bit. (go.microsoft.com/fwlink/p/?linkID=191548)
8. When the installation completes, click OK.
9. Download and install the Microsoft Office 2010 Filter Pack SP1 64bit (go.microsoft.com/fwlink/p/?LinkId=254043)
10. When the installation completes, click OK.
11. Navigate to the location of the installation media, and double-click Setup.exe.
12. At the Check for Updates? screen, check the Connect to the Internet and check for updates checkbox, and click Next.
13. When the updates complete, click Next.
14. At the Introduction screen, click Next.
15. At the License Agreement screen, check the box to accept the terms, and click Next.

16. At the Recommended Settings screen, check the Don't use recommended settings checkbox, and click Next.
17. At the Server Role Selection, select Mailbox or Client Access role, and click Next. Install each Mailbox role first, and then install each Client Access role. For our testing, we chose the Mailbox role on the Lenovo ThinkServer RD540, and two Client Access role machines on the Lenovo ThinkServer RD530.
18. At the Installation Space and Location screen, leave the default location for the installation, and click Next.
19. At the Exchange Organization screen, enter a name for your organization. Click Next.
20. At the Malware Protection Settings, select yes to disable, and click Next.
21. At the Readiness Checks screen, allow the verification to complete. If there are no failures, click Install.
22. When the installation completes, click Finish, and restart the server.
23. Open the Exchange Admin Center by using a browser and navigating to https://localhost/ecp
24. Enter the domain administrator credentials, and click Sign in.
25. If prompted, select the language and time zone, and click save.
26. In the left pane, click mail flow, then click send connectors.
27. On the Send connectors page, click the New icon.
28. In the new send connector wizard, specify SMTP as the name and select Internet as the type. Click next.
29. In the Network settings screen, choose MX record associated with recipient domain and click next.
30. In the Address space screen, click the Add icon.
31. In the Add domain window, enter * in the Fully Qualified Domain Name (FQDN) field, and click save.
32. Click Next.
33. In Source server screen, click the Add icon.
34. In the Select a Server window, select the Exchange server, click Add, and then click OK.
35. Click Finish.
36. In the left pane of the EAC, click servers, select the name of the Exchange server and click Edit.
37. Click Outlook Anywhere, and enter the appropriate FQDN of the Client Access Server for the external and internal hostname field, and click save. For example, exchangeserver.test.local.
38. Click virtual directories and then click the Configure external access domain icon.
39. In the Select the Client Access servers to use with the external URL window, click the Add icon.
40. Select the Exchange server, and click Add. Then, click OK.
41. Type `exchangeserver.test.local` in the Enter the domain name you will use with your external Client Access servers, and click Save.
42. Log into the Active Directory server using administrator credentials, and complete the following steps:
   a. Open Server Manager, then click Tools→DNS
   b. In DNS Manager, expand the Active Directory server name→Forward Lookup Zones→test.local in the left pane.
   c. In the right pane, verify or create the following DNS records:

FQDN	DNS record type	Value
Test.local	MX	Exchangeserver.test.local
Exchangeserver.test.local	A	192.168.1.100
Owa.test.local	CNAME	Exchangeserver.test.local

43. In the EAC, create three new mailbox databases, placing the database files on the D:\ volume corresponding to the SA120 JBOD.
44. In the EAC, set the maintenance schedule and enable circular logging for each mailbox database.
45. Open Exchange Management shell, and enter the following: Move-DatabasePath -Identity "Mailbox Database 0086447749" -EdbFilePath D:\Mailbox1\MailboxDatabase01.edb to move the first database to the D:\ volume corresponding to the SA120 JBOD
46. When prompted, type A and press enter.
47. Open Exchange Management Shell, and enter the following Set-OutlookAnywhere –Identity "Exchangeserver\rpc (Default Web Site)" -ExternalClientAuthenticationMethod:Ntlm

Installing and configuring the Exchange 2013 mail test clients and completing LoadGen configuration on the Exchange 2013

For our testing, we used 10 virtual client machines to distribute the LoadGen workload evenly for each of the solutions. To create the mail clients, we installed several software components. First, we made sure to statically assign an IP address for each client. We followed this process for each installation:

Installing Windows Server 2008 R2 SP1 Enterprise Edition

1. Insert the installation DVD for Windows Server 2008 R2 SP1 Enterprise into the DVD drive.
2. At the Language Selection Screen, click Next.
3. Click Install Now.
4. Select Windows Server 2008 R2 Enterprise (Full Installation), and click Next.
5. Click the I accept the license terms checkbox, and click Next.
6. Click Custom.
7. Click Next.
8. At the User's password must be changed before logging on warning screen, click OK.
9. Enter the desired password for the administrator in both fields, and click the arrow to continue.
10. At the Your password has been changed screen, click OK.
11. Click Start, type change power-saving settings and press Enter.
12. Click Change plan settings.
13. Change the Turn off the display drop-down menu to Never.
14. Click Save changes, and close the Power Options, Screen Saver Settings, and Personalization screens.

To set up this server, we had to install several additional software components. The following subsections detail the necessary installation processes.

Joining the domain

1. Select Start→Control Panel→Network Connections→Local Area Connection.
2. Click Properties.
3. Highlight Internet Protocol (TCP/IP), and click Properties.
4. Select the Use the following DNS server addresses radio button, and enter the IP of the DNS server in the Preferred DNS server field. Click OK.

5. Right-click My Computer, and select Properties.
6. Under the Computer Name tab, click Change.
7. In the Computer Name Changes screen, under the Member of section, select the Domain radial box, and type `test.local`
8. Select OK to start joining the domain.
9. When the screen appears asking for a person qualified on the domain, type `Administrator` as the username and `Password1` as the password.
10. At the Welcome pop-up window and the window warning that you must reset the computer for the changes to take effect, click OK.
11. At the System Properties screen, click OK.
12. When a pop-up appears asking if you want to restart now, click Yes to restart your computer.

Installing Internet Information Services

1. Click Start→Administrative Tools→Server Manager.
2. On the left pane, click Roles.
3. Click Add Roles.
4. Click the Application Server checkbox.
5. When the Add features required for Application Server? screen appears, click Add Required Features.
6. Click Next.
7. Click Next.
8. At the Select Role Services page for Application Server, click the Web Server (IIS) Support checkbox.
9. Click Add Required Support Role Services.
10. Click Next.
11. Click Next.
12. At the Select Role Services page for Web Server (IIS), click IIS 6 Management Compatibility, ASP, and CGI checkboxes; and click Next.
13. Click Install.
14. Click Close.

Installing Load Generator

Download and install Load Generator using all defaults.

Preparing Load Generator

1. Log into the mail client.
1. Select Start→All Programs→Microsoft Exchange→Exchange Load Generator 2013.
2. When the Load Generator screen appears, select Start a new test.
3. Select Create a new test configuration, and click Continue.
4. Change the total length of simulation to 1 hour.
5. In the Specify test settings screen, type `Password1` as the Directory Access Password and Mailbox Account Master Password, and click Continue with recipient management.
6. Create 6,000 users in the Mailbox Database, and click Continue.
7. To accept defaults for Advanced recipient settings, click Continue.
8. In the Specify test user groups screen, select the plus sign to add a user group.

9. Change the Client Type to Outlook 2007 Cached, the action profile to Outlook_500, and the Mailbox size to 250 MB, and click Continue.
10. In Remote configurations, check the checkbox to enable distributing the workload, enter the computer names of all of the test clients, and click Continue.
11. Click Save the configuration file as, and name it `testcfg.xml`
12. Click Start the initialization phase (recommended before running the test).

Once you have initialized the database, create a backup copy of the Exchange mailbox databases.

ABOUT PRINCIPLED TECHNOLOGIES

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