High availability cloud cluster

Intel® Xeon® processor E5-2690-based server cluster migrated VMs quickly and seamlessly with little to no service disruption

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Intel Xeon processor E5-2690-based Cisco® UCS® B200 M3 Blade Server cluster

Today's powerful servers enable you to pack more and more virtual machines (VMs) onto each system in your cloud infrastructure. In another recent study,[1] we tested the ability of an Intel Xeon processor E5-2690-based Cisco blade server to consolidate database VMs. Thanks to its high core count and many I/O optimizations, like Integrated I/O, support for PCIe Gen 3, and Data Direct I/O, this processor delivered excellent performance with our data-intensive tasks as well as a high consolidation ratio.

Running many critical applications on a single server may cause data center managers to have concerns about high availability. Being able to rapidly move your running virtual machines from one server in your cloud to another is extremely important for business continuity. Users rely on being able to access their data around the clock, and significant interruptions and periods of downtime are unacceptable. Whether a server goes down for planned maintenance or fails unexpectedly, you need to know that its VMs will migrate to another server and run there until the original server becomes available again.

In this study, we addressed these concerns by testing the ability of a cloud cluster of two Intel Xeon processor E5-2690-based Cisco blade servers running VMware® vSphere® 5 to execute planned and unplanned migrations. The VMs migrated quickly and seamlessly, with zero downtime with the planned outage and less than a minute of downtime with the unexpected outage.

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[1] Database server consolidation with an Intel Xeon processor E5-2690-based server
http://www.principledtechnologies.com/clients/reports/Intel/Xeon_E5-2690_consolidation_0312.pdf.

LITTLE TO NO SERVICE DISRUPTION

We configured a cluster of two Cisco UCS B200 M3 blade servers powered by Intel Xeon processor E5-2690s running VMware vSphere Server 5. We also configured a VMware vCenter™ Server to manage cluster activity. The cluster was configured to run with VMware High Availability mode, which ensures VM migration in the event of an unexpected failure.

Our cluster was comprised of six VMs (three VMs per server), each supporting a Microsoft® SQL Server® 2008 R2 SP1 database and running a benchmark to measure database performance. While the benchmark was running at a rate sufficient to induce a load of approximately 60% on the processors, we tested two outage scenarios: (1) a server going down for planned maintenance and (2) a server failing unexpectedly. In the planned maintenance scenario, we saw no downtime in our VMs before, during, or after the failover. In the unexpected failover scenario, the VMs from the failed host were available on the secondary host after only 40 seconds. Note: We measured the time only for the VM to become responsive again after the outage. Your actual time will depend on the applications you are running as well as other factors.

Workload

To create our ecommerce workload, we used the DVD Store Version 2.1 (DS2) benchmarking tool. DS2 models an online DVD store, where customers log in, search for movies, and make purchases. DS2 reports these actions in orders per minute (OPM) that the system could handle, to show what kind of performance you could expect for your customers. The DS2 workload also performs other actions, such as adding new customers, to exercise the wide range of database functions you would need to run your ecommerce environment. For more information about the DS2 tool, see http://www.delltechcenter.com/page/DVD+Store.

No downtime for planned maintenance

Most companies schedule periods to perform preventative maintenance on their servers. Ideally, these planned maintenance times do not interfere with the server's availability to the end user. VMware vMotion allows administrators to migrate VMs with zero downtime—the VMs maintain constant availability. During the vMotion process, the source server prepares the VM for migration, the state of the active virtual machine is transmitted over the VMkernel network designated for vMotion, and the VM is registered on the new host; the entire process is transparent to the user with no data loss or downtime.

To see how our cloud cluster handled a planned outage, at the 10-minute mark in our test, we selected all the VMs on one of the two servers and began a migration to

the other server. This initiated the vMotion process, and all VMs moved to the second server with no downtime and little performance degradation.

Bounce back quickly after unexpected failures

Even the most conscientiously maintained servers occasionally fail for one reason or another. To see how our cloud cluster handled an unexpected outage, at the 10-minute mark in our test, we forcibly powered down one of the servers by holding down its power button for 10 seconds. Within seconds, the cluster identified a server failure and migrated the VMs to the remaining server, which then booted the VMs and resumed operation. It took only 40 seconds for the VMs to become available again from the time of the unexpected outage, which is very little interruption for the end user. This number may vary based on the level of activity in database, the speed of the storage subsystem and other factors.

WHAT WE FOUND

During our testing, we recorded the time it took the cluster to successfully migrate VMs in both scenarios. Figure 2 summarizes our findings. Our pre-migration workload used 61.6 percent processor, and delivered an average 72,099 OPM per VM. We saw no detectable downtime in the planned maintenance scenario. We saw only 40 seconds of downtime in the unexpected outage scenario after which all six VMs ran on one server. After migration, the processor utilization increased to 98.5 percent yet was still able to deliver 56,653 OPM per VM across our six VMs.

Test results	
Average processor utilization prior to migration	61.6%
Average processor utilization after migration	98.5%
Average OPM per VM prior to migration (3 VMs per server)	72,099
Average OPM per VM after migration (6 VMs per server)	56,653
Time before VMs became available again in planned maintenance scenario	No detected downtime
Time before VMs became available again in the unexpected outage scenario	40 seconds

Figure 2. Performance metrics from our testing.

IN CONCLUSION

Keeping your database servers up and running for your cloud users is of the utmost importance – there is a serious cost to businesses when servers fail and users are unable to access data for extended periods of time. We found the Intel Xeon processor E5-2690-based servers in our cloud cluster could seamlessly migrate VMs using from one server to another with no downtime for planned maintenance and only a 40-second interruption when the outage was not planned. Choosing Intel Xeon processor E5-2690-based servers running VMware vSphere 5 can provide your business with a high-availability configuration that reduces downtime and provides continuous operation for end users.

APPENDIX A – SERVER AND STORAGE CONFIGURATION INFORMATION

Figure 3 provides detailed configuration information about the test servers.

System	Intel Xeon processor E5-2690-based server
General	
Number of processor packages	2
Number of cores per processor	8
Number of hardware threads per core	2
System power management policy	OS Control
CPUs	
Vendor	Intel
Name	Xeon
Model number	E5-2690
Stepping	6
Socket type	LGA2011
Core frequency (GHz)	2.90
Bus frequency	8.0 GT/s
L1 cache	32 KB + 32 KB
L2 cache	256 KB (per core)
L3 cache	20 MB
Platform	
Vendor and model number	Cisco UCSB-B200-M3
Motherboard model number	Cisco FCH153271DA
BIOS name and version	Cisco B200M3.1.0.2.29c.121220110014 ver. 2.0 (1.104d)B
BIOS settings	OS Power Control
Memory module(s)	
Total RAM in system (GB)	384
Vendor and model number	Samsung M393B2G70BH0-YK0
Type	PC3L-12800R
Speed (MHz)	1,600
Speed running in the system (MHz)	1,333
Timing/Latency (tCL-tRCD-tRP-tRASmin)	9-9-9-27
Size (GB)	16
Number of RAM module(s)	24
Chip organization	Double-sided
Rank	Dual
Hard disk	
Vendor and model number	Seagate ST9146803SS
Number of disks in system	1
Size (GB)	146
Buffer size (MB)	16
RPM	15,000
Type	SAS

System	Intel Xeon processor E5-2690-based server
RAID controller	
Vendor and model	Cisco UCS-VIC-M82-4P
Controller firmware	2.0(1.104d)
Operating system	
Name	VMware ESXi 5.0.0
Build number	515841
Language	English
Ethernet	
Vendor and model number	Cisco UCS-VIC-M82-4P
Type	Mezzanine

Figure 3. Server configuration information.

Figure 4 provides detailed configuration information about the blade enclosure.

Cisco UCS 5108 Blade Enclosure	
Power supplies	
Total number	4
Wattage of each (W)	2,500
Cooling fans	
Total number	8
Dimensions (h x w) of each	3-5/8" x 5-1/2"

Figure 4. Blade enclosure configuration information.

Figure 5 provides detailed configuration information about the storage we used for testing.

Storage system	
Total number of disks tested in solution	103
Storage connectivity (Fibre Channel, SAS, SATA, iSCSI)	Fibre Channel
Storage model and OS/firmware revision	EMC CX3-40
Storage memory	8 GB
Number of storage controllers	2
Number of storage ports	4

Figure 5. Storage configuration information.

APPENDIX B – HOW WE TESTED

Test configuration overview

Figure 6 presents our test infrastructure. We used six load generator virtual machine clients for the two scenarios. Each client VM targeted a corresponding target VM (three on each server). Each client VM was a two-vCPU VM running with 4GB of RAM, running Windows Server® 2008 R2 SP1 Enterprise.
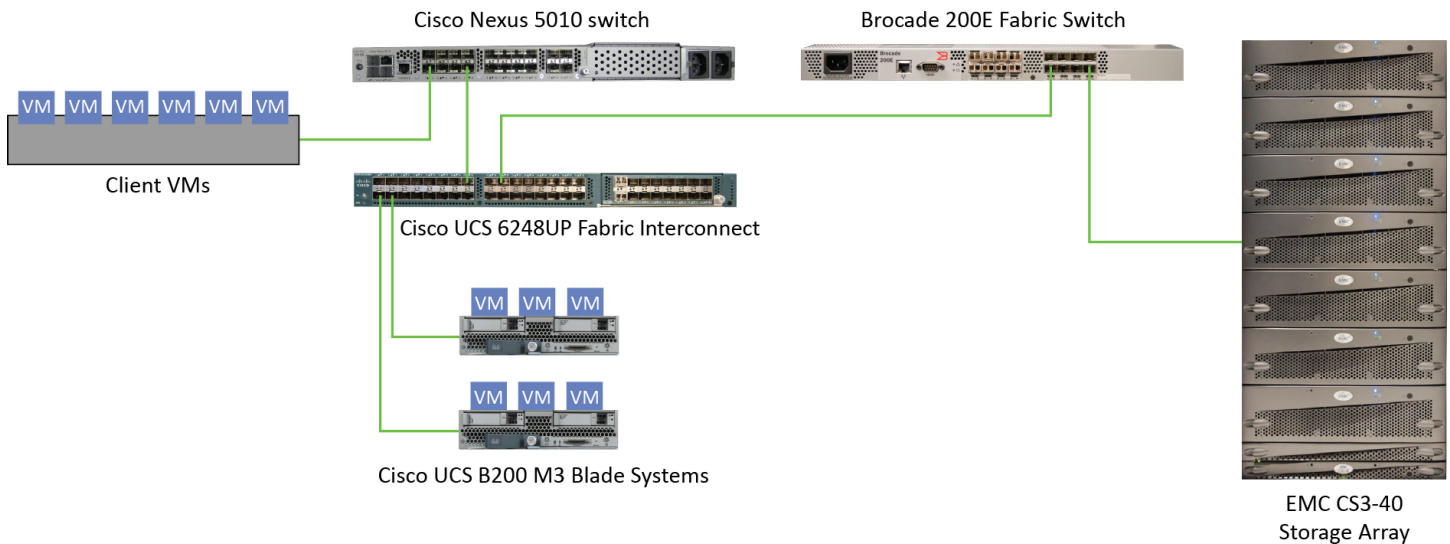

Figure 6. Our test infrastructure.

Setting up and configuring the EMC storage

We used an EMC® CLARiiON® Fibre Channel-connected SAN for this testing. The CX3-40 has two storage processors, SP-A and SP-B. We cabled an HBA port to each SP (A and B) on the SAN to balance the load between SPs. We used seven enclosures of disks on the SAN; with one exception, each enclosure had 15 disks. One of the trays only had 13 disks.

We ran one SQL Server 2008 R2 instance per VM. We created eight RAID groups for our test server, one for VM operating systems and seven for VM databases/logs. Each of the six RAID groups was composed of 14 disks, and set up as a RAID 10. We then created eight 400GB LUNs, one on each RAID group.

Setting up the VMware vSphere 5 environment

Installing VMware vSphere 5.0 (ESXi)

1. Insert the disk (or attach the ISO), and select Boot from disk.
2. On the Welcome screen, press Enter.
3. On the End User License Agreement (EULA) screen, press F11.
4. On the Select a Disk to Install or Upgrade Screen, select the relevant volume to install ESXi on, and press Enter.
5. On the Please Select a Keyboard Layout screen, press Enter.
6. On the Enter a Root Password Screen, assign a root password and confirm it by entering it again. Press Enter to continue.
7. On the Confirm Install Screen, press F11 to install.
8. On the Installation complete screen, press Enter to reboot.

Configuring ESXi

1. On the 5.0.0 ESXi screen, press F2, enter the root password, and press Enter.
2. On the System Customization screen, select troubleshooting options, and press Enter.
3. On the Troubleshooting Mode Options screen, select enable ESXi Shell, and press Enter.
4. Select Enable SSH, press Enter, and press Esc.
5. On the System Customization screen, select Configure Management Network.
6. On the Configure Management Network screen, select IP Configuration.
7. On the IP Configuration screen, select set static IP; enter an IP address, subnet mask, and default gateway; and press Enter.
8. On the Configure Management Network screen, press Esc. When asked if you want to apply the changes, type Y.

Installing vSphere client on a management workstation

1. Configure your management workstation to be on the same subnet as your vSphere server. In Internet Explorer, navigate to the IP address of your vSphere server.
2. Accept certificate warnings by clicking Continue to this website (not recommended), and continue.
3. Click Download vSphere Client to download the vSphere client.
4. Choose Run to Install.
5. Choose your language, and click OK.
6. At the Welcome screen, click Next.
7. Read the End-User Patent Agreement, and click Next.
8. Accept the license terms, and click Next.
9. Enter user and organization details, and click Next.
10. At the Destination folder screen, click Change if you wish to change your install destination; otherwise click Next.
11. Click Install.
12. To complete the installation, click Finish.

Configuring the external volumes in VMware vSphere 5

1. In the vSphere client, select the first host.
2. Click the Configuration tab.
3. Click Storage, and click Add Storage…
4. Choose Disk/LUN.
5. Select the disk, and click Next.
6. Accept the default of VMFS-5 for the file system.
7. Review the disk layout, and click Next.
8. Enter the datastore name, and click Next.
9. Accept the default of using maximum capacity, and click Next.

10. Click Finish.
11. Repeat steps 3 through 10 for the remaining LUNs.

Configuring VM networking on ESXi

1. Using the vSphere client from your management workstation, connect to the ESXi server.
2. Add the necessary vSwitch for the network that DVD Store traffic will use:
   a. Click the host, click the Configuration tab, and click Networking.
   b. Click Add Networking.
   c. Choose Virtual Machine, and click Next.
   d. Choose create a vSphere standard switch.
   e. Choose the NIC associated with VM traffic.
   f. Assign the network label, and assign IP settings.
   g. Click Finish.

Configuring the vMotion network

1. Using the vSphere client from another machine, connect to the vCenter Server, and perform the following steps on each server in the cluster.
2. Add the necessary vSwitch for the network that vMotion traffic will use:
   a. Click the host, click the Configuration tab, and click Networking.
   b. Click Add Networking.
   c. Choose VMkernel, and click Next.
   d. Choose the 10Gb NIC associated with vMotion traffic, and click Next.
   e. Assign the network label, and check the box Use this port group for vMotion.
   f. Click Next.
   g. Assign IP settings, and click Next.
   h. Click Finish.
   i. Click Properties for the new vSwitch.

Configuring the external volumes in VMware vSphere 5.0

1. In the vSphere client, select the host.
2. Click the Configuration tab.
3. Click Storage, and click Add Storage…
4. Choose Disk/LUN.
5. Select the disk, and click Next.
6. Accept the default of VMFS-5 for the file system.
7. Review the disk layout, and click Next.
8. Enter the datastore name, and click Next.
9. Accept the default of using maximum capacity, and click Next.
10. Click Finish.
11. Repeat steps 3 through 10 for the remaining LUNs.

Setting up vCenter Server

We set up a client VM server using the steps above. The vCenter installation mentioned below takes place on a VM on the client VM server.

1. On your client server, import the OVF containing the vCenter Server appliance from VMware.
2. Start the vCenter Server and perform basic installation steps, such as setting the name, IP, credentials, etc.
3. Connect to the vCenter Server VM via the vSphere client, create a cluster, and add both Cisco B200 M3s to the cluster.

Configuring the VMs on the system under test

See the above sections regarding the initial creation of the virtual machines on each hypervisor. We provide steps below for installing the operating system, Microsoft SQL Server, and configuring the VMs.

Creating a virtual machine with vSphere

1. In the vSphere client, connect to the vCenter Server and browse to the ESXi host.
2. Click the Virtual Machines tab.
3. Right-click, and choose New Virtual Machine.
4. Choose Custom, and click Next.
5. Assign a name to the virtual machine, and click Next.
6. Select the OS datastore on the external storage, and click Next.
7. Choose Virtual Machine Version 8, and click Next.
8. Choose Windows, and choose Microsoft Windows Server 2008 R2 (64-bit), and click Next.
9. Choose 6 virtual processors (1 virtual socket with 6 virtual cores per socket), and click Next.
10. Choose 16GB RAM, and click Next.
11. Click 1 for the number of NICs, select vmxnet3, and click Next.
12. Leave the default virtual storage controller, and click Next.
13. Choose to create a new virtual disk, and click Next.
14. Make the OS virtual disk size 30 GB, choose thick-provisioned lazy zeroed, specify the OS datastore on the external storage, and click Next.
15. Keep the default virtual device node (0:0), and click Next.
16. Click Finish.
17. Right-click the VM, and choose Edit Settings.
18. On the Hardware tab, click Add…
19. Click Hard Disk, and click Next.
20. Click Create a new virtual disk, and click Next.
21. Specify 40GB for the virtual disk size, choose thick-provisioned lazy zeroed, and specify the datastore for that VM's SQL Server data usage (storage pool 2).
22. Choose SCSI(0:1) for the device node, and click Next.
23. On the Hardware tab, click Add…
24. Click Hard Disk, and click Next.
25. Click Create a new virtual disk, and click Next.
26. Specify 20GB for the virtual disk size, choose thick-provisioned lazy zeroed, and specify the datastore for SQL Server log usage (storage pool 3).
27. Choose SCSI (1:0) for the device node, and click Next.
28. Click Finish, and click OK.

Installing Windows Server 2008 R2 SP1 Enterprise Edition on the VMs

1. Insert the installation DVD for Windows Server 2008 R2 x64 into the ESXi host's DVD drive.
2. In vSphere, right-click the virtual machine, and choose Edit Settings.
3. Click CD/DVD drive 1, click the Host Device radio button, and choose the appropriate drive.
4. Click OK.
5. Right-click the machine, and choose Power→Power On.
6. Right-click the machine, and choose Open console.
7. At the Language Selection Screen, click Next.
8. Click Install Now.
9. Select Windows Server 2008 R2 SP1 Enterprise (Full Installation), and click Next.
10. Click the I accept the license terms check box, and click Next.

11. Click Custom.
12. Click Drive options (advanced).
13. Ensure you select the proper drive, and click New.
14. Click Apply.
15. Click Next.
16. At the User's password must be changed before logging on warning screen, click OK.
17. Set the Administrator password, and click the arrow to continue.
18. At the Your password has been changed screen, click OK.

Installing VMware Tools on the VM

1. Right-click the virtual machine, select Guest→Install/Upgrade VMware Tools.
2. Click OK to close the VMware Tools warning.
3. Right-click the VM, and choose Open Console.
4. Double-click Run setup.exe
5. At the Welcome screen, click Next.
6. Select Typical Installation, and click Next.
7. Click Install.
8. After installation is complete, click Finish, and restart the virtual machine.

Installing system updates in Windows Server 2008 R2 SP1

We installed all updates available on December 14, 2011 on each virtual machine.

Installing SQL Server 2008 R2 SP1 on the VM

1. Load the SQL Server 2008 R2 iso on your computer or insert the DVD into the ESXi host's DVD drive.
2. Click the connect CD/DVD button. Choose CD\DVD Drive 1, Connect to host device.
3. On the Autoplay menu, click Run SETUP.EXE.
4. If the application prompts you to install the .NET Framework, click OK to install.
5. At the SQL Server Installation Center screen, select Installation.
6. Click New Installation or add features to existing installation.
7. At the Setup Support Rules page, click OK.
8. Enter the product key, and click Next.
9. At the License Terms screen, accept the license terms, and click Next.
10. At the Support Files screen, select Install.
11. At the Setup Support Rules screen, click Next.
12. At the Setup Role screen, select SQL Server Feature Installation, and click Next.
13. At the Feature Selection screen, choose Database Engine Services, Client Tools Connectivity, Client Tools Backwards Compatibility, Management Tools – Basic, and Management Tools – Complete, and click Next.
14. At the Installation Rules screen, click Next.
15. At the Instance Configuration screen click Next.
16. At the Disk Space Requirements screen, click Next.
17. At the Server Configuration screen, type `Administrator` as the account name and `Password1` as the password for the SQL Server Agent and the SQL Server Database Engine services, and click Next.
18. At the Database Engine Configuration screen, select Mixed Mode as the authentication mode, enter your password for the (sa) account, and click Add Current User to add the Administrator to the SQL server administrator's account. Click Next.
19. At the Error Reporting screen, click Next.
20. At the Installation Configuration Rules screen, click Next.
21. At the Ready to Install screen, click Install.
22. At the Complete screen, click Close.

23. Create a SQL Server login for the ds2user (see the [Configuring the database server (DVD Store) section](#) for the specific script to use).
24. Copy the pre-created DVD Store backup to the specified backup VHD volume.
25. Click Start→All Programs→Microsoft SQL Server 2008 R2→Configuration Tools, and click SQL Server Configuration Manager.
26. Expand SQL Server Network Configuration, and click Protocols for MSSQLSERVER.
27. Right-click TCP/IP, and select Enable.
28. Download and install Microsoft SQL Server 2008 R2 SP1.

Setting up network configuration on the VM

1. Click Start→Control Panel.
2. Click Network and Internet.
3. Click View network status and tasks.
4. Click the Local Area Connection assigned to client/server network traffic.
5. Click Properties.
6. Select Internet Protocol Version 4 (TCP/IPv4), and click Properties.
7. In the Internet Protocol Version 4 (TCP/IPv4) Properties screen, select the Use the following IP address radio button.
8. Enter a valid static IP address, subnet mask, and default gateway.
9. Click OK, and click Close to exit.

Configuring additional VMs on VMware vSphere 5.0

1. Log into the vCenter Server, which manages the host.
2. Right-click the first VM, and choose Clone.
3. Name the new VM.
4. Choose the cluster, and select the host.
5. For the storage screen, choose advanced and direct the new virtual disks to the applicable datastores. Again, we used a round-robin approach to spread our VM database files to the first 6 of the 8 LUNs. For example, the database for VM 1 was placed on LUN 1, the database for VM2 was placed on LUN 2, and so on.
6. Choose to customize using the customization wizard. Save the clone details as a new customization specification.
7. Continue cloning each VM, modifying the customization specification as necessary for IP addressing and other settings.
8. Ensure in each VM that the necessary virtual disks are all online and the IP addressing was properly assigned by the customization wizard.
9. To configure automatic start for your specified number of VMs, click the Host configuration tab in the vSphere client, and click Virtual Machine Startup/Shutdown.

Configuring the database (DVD Store)

Data generation overview

We generated the data using the Install.pl script included with DVD Store version 2.1 (DS2), providing the parameters for our 10GB database size and the database platform on which we ran: Microsoft SQL Server. We ran the Install.pl script on a utility system running Linux. The Install.pl script also generated the database schema.

After processing the data generation, we transferred the data files and schema creation files to a Windows-based system running SQL Server 2008 R2 SP1. We built the 10GB database in SQL Server 2008 R2 SP1, and then performed a full backup, storing the backup file on the C: drive for quick access. We used that backup file to restore on

both servers between test runs. We performed this procedure once, and used the same backup file for both VMware vSphere 5.0 VMs and the legacy server.

The only modification we made to the schema creation scripts were the specified file sizes for our database. We explicitly set the file sizes higher than necessary to ensure that no file-growth activity would affect the outputs of the test. Besides this file size modification, the database schema was created and loaded according to the DVD Store documentation. Specifically, we followed the steps below:

1. We generated the data and created the database and file structure using database creation scripts in the DS2 download. We made size modifications specific to our 10GB database and the appropriate changes to drive letters.
2. We transferred the files from our Linux data generation system to a Windows system running SQL Server.
3. We created database tables, stored procedures, and objects using the provided DVD Store scripts.
4. We set the database recovery model to bulk-logged to prevent excess logging.
5. We loaded the data we generated into the database. For data loading, we used the import wizard in SQL Server Management Studio. Where necessary, we retained options from the original scripts, such as Enable Identity Insert.
6. We created indices, full-text catalogs, primary keys, and foreign keys using the database-creation scripts.
7. We updated statistics on each table according to database-creation scripts, which sample 18 percent of the table data.
8. On the SQL Server instance, we created a ds2user SQL Server login using the following Transact SQL (TSQL) script:

```
USE [master]
GO
CREATE LOGIN [ds2user] WITH PASSWORD=N'',
                DEFAULT_DATABASE=[master],
                DEFAULT_LANGUAGE=[us_english],
                CHECK_EXPIRATION=OFF,
                CHECK_POLICY=OFF
GO
```

9. We set the database recovery model back to full.
10. We created the necessary full text index using SQL Server Management Studio.
11. We created a database user and mapped this user to the SQL Server login.
12. We then performed a full backup of the database. This backup allowed us to restore the databases to a pristine state relatively quickly between tests.
    Figure 7 shows our initial file size modifications.

Logical name	Filegroup	Initial size (MB)
Database files		
Primary	PRIMARY	3
cust1	DS_CUST_FG	5,632
cust2	DS_CUST_FG	5,632
ind1	DS_IND_FG	2,560
ind2	DS_IND_FG	2,560

Logical name	Filegroup	Initial size (MB)
Database files		
ds_misc	DS_MISC_FG	2,560
orders1	DS_ORDERS	2,560
orders2	DS_ORDERS	2,560
Log files		
ds_log	Not Applicable	13,312

Figure 7. Our initial file size modifications.

ABOUT PRINCIPLED TECHNOLOGIES

Principled Technologies, Inc.
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We provide industry-leading technology assessment and fact-based marketing services. We bring to every assignment extensive experience with and expertise in all aspects of technology testing and analysis, from researching new technologies, to developing new methodologies, to testing with existing and new tools.

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Our founders, Mark L. Van Name and Bill Catchings, have worked together in technology assessment for over 20 years. As journalists, they published over a thousand articles on a wide array of technology subjects. They created and led the Ziff-Davis Benchmark Operation, which developed such industry-standard benchmarks as Ziff Davis Media's Winstone and WebBench. They founded and led eTesting Labs, and after the acquisition of that company by Lionbridge Technologies were the head and CTO of VeriTest.