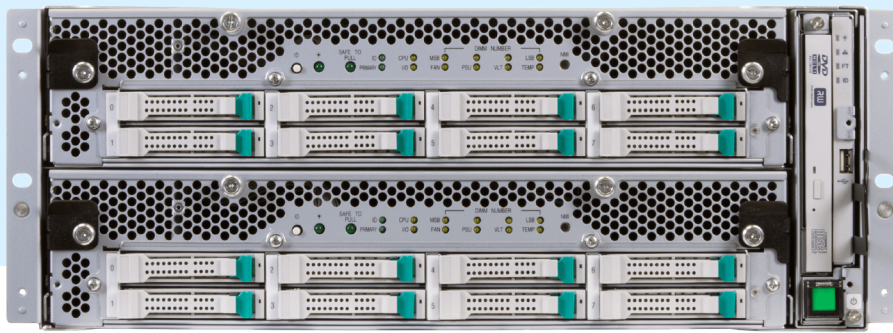# FAULT TOLERANCE EASE OF SETUP COMPARISON: NEC HARDWARE-BASED FT VS. SOFTWARE-BASED FT

Achieve scalable fault tolerance with less hassle
with the NEC Express5800/R320d-M4 server powered by Intel®

36.6% fewer steps

Fewer required components

compared to a software-based fault-tolerance solution

Because no enterprise can afford downtime or data loss when a component of one of their servers fails, fault tolerance is vital. While many effective software-based fault-tolerance solutions are available, a hardware-based approach such as that employed by the NEC Express5800/R320d-M4 servers, powered by Intel Xeon® processors E5-2670 v2, can be simpler to set up.

In the Principled Technologies datacenter, we found that setting up the NEC Express5800/R320d-M4 for fault tolerance and creating FT virtual machines required 36.6 percent fewer steps than performing these same tasks using a software-based FT approach, NEC Express5800/R120d-M1 servers with VMware® vSphere®. It also required fewer components.

IT staff time is precious, and managing an enterprise datacenter full of servers can be time-consuming and expensive. Having extra components to procure, maintain, and worry about can also add to IT work burden. If your staff can streamline the process of setting up fault-tolerant servers and VMs, they won't need to spend precious time ensuring that VMs are running in fault-tolerance mode and will be able to work on more important issues.

EXECUTIVE SUMMARY

Enterprises need their servers to run mission-critical applications reliably. Because any server component is subject to failure, it is essential to employ some form of fault tolerance. In a fault-tolerant computer system, the failure of a component doesn't bring the system down; rather, a backup component or procedure immediately takes over and there is no loss of service.

There are two primary approaches to fault tolerance: it can be provided with software or embedded in hardware. In the Principled Technologies datacenter, we tested two fault-tolerant server solutions:

- NEC Express5800/R320d-M4 servers, powered by Intel Xeon E5-2670 v2 processors, which employ hardware fault tolerance
- NEC Express5800/R120d-M1 servers using VMware vSphere software-based fault tolerance

This report compares the relative ease of setting up the two solutions and configuring eight fault-tolerant VMs on each. We also compare the number of hardware components each solution requires. In a companion report,[1] we compare how well the two solutions performed.

In Figure 1, we present the total number of steps necessary to prepare the system for fault tolerance and configure the VMs for fault tolerance using each of the two approaches we tested.
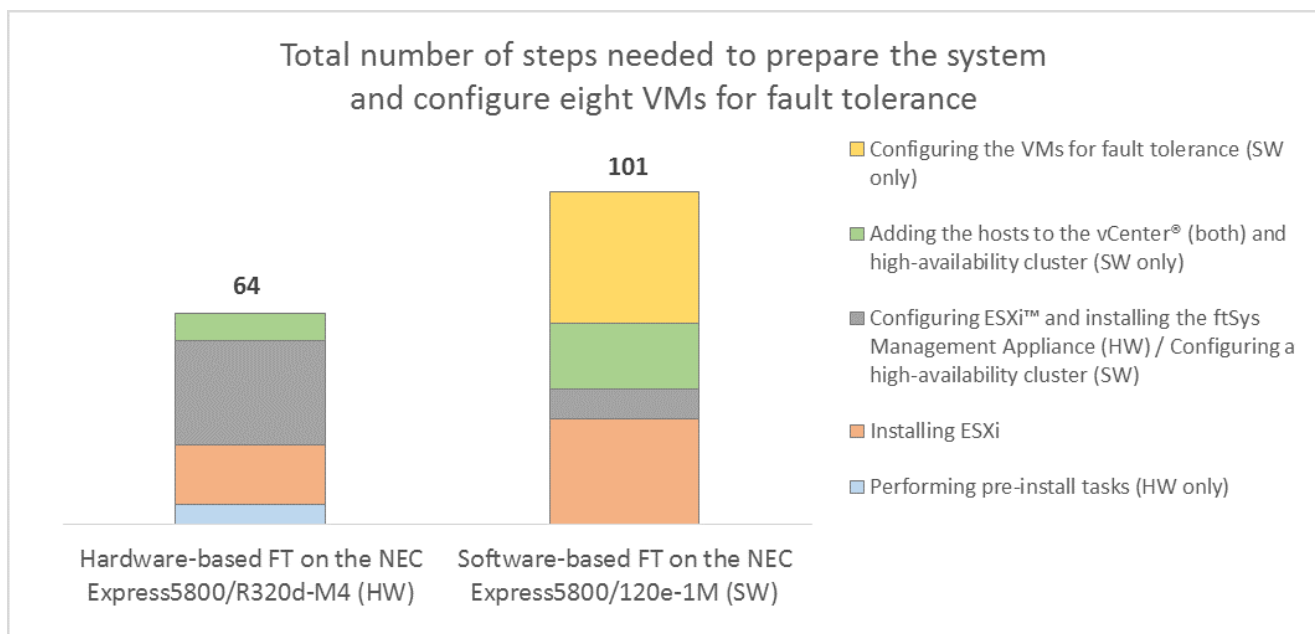

Figure 1: The hardware-based FT on NEC Express5800/R320d-M4 required 36.6 percent fewer steps than the software-based FT solution.

---

[1] Fault tolerance ease performance comparison: NEC hardware-based FT vs. software-based FT, available at www.principledtechnologies.com/NEC/Fault_tolerance_performance_1015.pdf

As Figure 1 shows, the NEC Express5800/R320d-M4 servers' hardware-based approach requires 36.6 percent fewer steps, which has the potential to save your organization considerable time. This time savings can translate to money saved and can free your IT staff to pursue innovation.

To understand better how the NEC Express5800/R320d-M4 hardware approach streamlines the process of implementing fault tolerance, note the yellow block at the top of the column for the software-based solution. This block represents the 40 steps needed to configure the eight VMs in our test scenario for fault tolerance; every additional VM you needed to make fault-tolerant would add 5 steps to that final phase. On the NEC Express5800/R320d-M4, once you have prepared the system for fault tolerance, every VM you create automatically becomes fault tolerant.

In addition to streamlining the process of implementing fault tolerance, the NEC Express5800/R320d-M4 hardware approach also used only three hardware components, whereas the solution using a software approach to fault tolerance required six components.

By requiring fewer steps and fewer components, the NEC Express5800/R320d-M4 hardware approach to fault tolerance can simplify life for your IT staff.

SOFTWARE-BASED FAULT TOLERANCE AND HARDWARE-BASED FAULT TOLERANCE

Introduced in ESX® 4.0, the VMware vSphere fault tolerance package is designed to allow vital virtual machines to maintain greater uptime. It does so by running two virtual machines simultaneously: one VM on the primary host and a second VM on a backup host. If the primary host fails, the VM quickly and silently changes over to the backup host, preventing a loss of data.

The hardware-based fault tolerance in the NEC Express5800/R320d-M4 works differently. Its two servers operate in lockstep with each other, from their hard drives (each disk is mirrored in a RAID 1 with the disk on the other server) to their CPUs. Using a special FT appliance to achieve this, the two servers operate as one, and present themselves as one server to all other machines. In this way, any virtual machine placed on the Express5800/R320d-M4 machines is automatically fault tolerant.

FEWER STEPS REQUIRED TO IMPLEMENT FAULT TOLERANCE

In Figure 2, we present the specific steps necessary to prepare the system for fault tolerance and configure eight VMs for fault tolerance using each of the two approaches we tested.

Hardware-based FT on the NEC Express5800/R320d-M4	Software-based FT on the NEC Express5800/120e-1M
Preparing the system for fault tolerance	
Performing pre-install tasks on the NEC Express5800/R320d-M4 1. Pull all drives from the NEC Express5800/R320d-M4 storage except the first drive on node 0. 2. Disconnect all network cables, and make sure there's nothing except power connected to either server. 3. Press F2 to enter the BIOS of the server during POST. 4. In the BIOS, change the following settings: • Advanced → PCI Configuration → SAS Option ROM Scan: Disabled • Advanced → PCI Configuration → LAN1-4 Option ROM Scan: Disabled • Advanced → PCI Configuration → PCI Slot 1-4 Option ROM: Disabled • Server → OS Boot Monitoring: Disabled 5. Navigate to Save & Exit, and select Save Changes and Exit. 6. When asked to confirm your changes, select Yes.	Note: This step is not necessary on the NEC Express5800/120e-1M.
Installing ESXi 1. Insert NEC's build of ESXi 5.5 Update 2 into the server, and boot into the ESXi installation. 2. At the Welcome screen, press Enter to start. 3. At the confirmation screen, press F11 to begin the ESXi installation. 4. At Select a Disk to Install or Upgrade, select your installation drive, and press Enter. 5. At Please select a keyboard layout, select your language, and press Enter. 6. At Enter a root password, enter your password, and press Enter. 7. At Confirm Install, press F11 to start the installation.	**Installing ESXi** 1. Insert the installation disk into the first server, and boot into the ESXi installation. 2. At the Welcome screen, press Enter to start. 3. At the confirmation screen, press F11 to begin the ESXi installation. 4. At Select a Disk to Install or Upgrade, select your installation drive, and press Enter. 5. At Please select a keyboard layout, select your language, and press Enter. 6. At Enter a root password, enter your password, and press Enter. 7. At Confirm Install, press F11 to start the installation.

Hardware-based FT on the NEC Express5800/R320d-M4	Software-based FT on the NEC Express5800/120e-1M
8. When the installation is complete, plug a network cable into the first 1Gb slot on each server, and press Enter to reboot.	8. When the installation is complete, press Enter to reboot.
9. When the machine reboots, press F2 to log in.	9. When the machine reboots, press F2 to log in.
10. Enter your username and password, and press Enter.	10. Enter your username and password, and press Enter.
11. Navigate to Configure Management Network, and press Enter.	11. Navigate to Configure Management Network, and press Enter.
12. Select Network Adapters, and press Enter.	12. Select Network Adapters, and press Enter.
13. In Network Adapters, select the NIC you wish to use, and press Enter.	13. In Network Adapters, select the NIC you wish to use, and press Enter.
14. Navigate to IPv4 Configuration, and press Enter.	14. Navigate to IPv4 Configuration, and press Enter.
15. In IPv4 Configuration, enter your IPv4 address and subnet mask, and press Enter.	15. In IPv4 Configuration, put in your IPv4 address and subnet mask, and press Enter.
16. When prompted to restart your management network, press Y to restart your management network.	16. When prompted to restart your management network, press Y to restart your management network.
17. Return to the main menu, the select Troubleshooting Options, and press Enter.	17. Insert the installation disk into the second server, and boot into the ESXi installation.
18. Enable SSH, and press Escape.	18. At the Welcome screen, press Enter to start.
	19. At the confirmation screen, press F11 to begin the ESXi installation.
	20. At Select a Disk to Install or Upgrade, select your installation drive, and press Enter.
	21. At Please select a keyboard layout, select your language, and press Enter.
	22. At Enter a root password, enter your password, and press Enter.
	23. At Confirm Install, press F11 to start the installation.
	24. When the installation is complete, press Enter to reboot.
	25. When the machine reboots, press F2 to log in.
	26. Enter your username and password, and press Enter.
	27. Navigate to Configure Management Network, and press Enter.
	28. Select Network Adapters, and press Enter.
	29. In Network Adapters, select the NIC you wish to use, and press Enter.
	30. Navigate to IPv4 Configuration, and press Enter.

Hardware-based FT on the NEC Express5800/R320d-M4	Software-based FT on the NEC Express5800/120e-1M
	31. In IPv4 Configuration, enter your IPv4 address and subnet mask, and press Enter.
	32. When prompted to restart your management network, press Y to restart your management network.
Configuring ESXi and installing the ftSys Management Appliance 1. With the vSphere client, log into your ESXi server. 2. Click the Configuration tab. 3. Click Security Profile. 4. In Security Profile, scroll to Firewall, and click Properties. 5. In Firewall Properties, scroll to syslog, check its checkbox, and click OK. 6. Insert NEC's FT control software install DVD into the host running vSphere client. Then, in the vSphere client, select File → Deploy OVF template. 7. In Deploy OVF Template, navigate to the ftSysMgt appliance OVA (if you have mounted the DVD on your D: drive, it is located at D:\appliance\ftSysMgt-5.1.1-233_OVF10.ova), and click Next. 8. In OVF Template Details, click Next. 9. Accept the EULAs, and click Next. 10. In Name and Location, enter the name of your appliance, and click Next. 11. In Storage, select the local storage for the ESXi server, and click Next. 12. In Disk Format, select Thick Provision Lazy Zeroed, and click Next. 13. In Ready to Complete, check the Power on after deployment checkbox, and click Finish. 14. After the appliance has been deployed, right-click it, and select Open Console. 15. When the VM has finished booting, navigate to Configure Network, and press Enter.	**Configuring a high-availability cluster** 1. Log into vCenter. 2. Right-click your datacenter and select New Cluster. 3. Name your cluster, check Turn On vSphere HA, and click Next. 4. In vSphere HA, leave settings on defaults, and click Next. 5. In Virtual Machine Options, leave settings on defaults, and click Next. 6. In VM Monitoring, leave settings on defaults, and click Next. 7. In VMware EVC, check Enable EVC for Intel Hosts, select Intel "Ivy Bridge" Generation, and click Next. 8. In VM Swapfile Location, leave the settings on the default recommended option, and click Next. 9. In Ready to Complete, click Finish.

Hardware-based FT on the NEC Express5800/R320d-M4	Software-based FT on the NEC Express5800/120e-1M

16. In the network configuration Main Menu, type 6, and press Enter.
 17. Type your IP address (it must be in the same subnet as the host), and press Enter.
 18. Type your subnet, and press Enter.
 19. Type 1, then press Enter to exit network configuration.
 20. Navigate to Login, and press Enter.
 21. Log in with username `root` and password `ftServer`.
 22. Change the password to your desired password with the command `passwd root`.
 23. Insert a hard drive into slot 0 on node 1.
 24. Mount NEC's FT control software install DVD to the appliance.
 25. After the DVD is mounted, run the following command:
 `/opt/ft/sbin/ft-install`
 `/dev/cdrom`
 26. Enter the IP address of the ESXi host, and press Enter.
 27. Enter the root username of the ESXi host, and press Enter.
 28. Enter the root password of the ESXi host, and press Enter.
 29. When asked to review your system documentation, press Y to continue.
 30. If you get any more prompts, press Y to continue.
 31. Finally, a prompt to reboot the host will appear. Press Y to reboot the host.
 32. After several reboots (and roughly 90 minutes after the host has finished rebooting), node 0 will synchronize with node 1 and the host will become fault tolerant.	

Hardware-based FT on the NEC Express5800/R320d-M4	Software-based FT on the NEC Express5800/120e-1M
Adding the host to the vCenter 1. Log into your vCenter. 2. Right-click the datacenter for your FT server, and select Add Host. 3. Enter the hostname or IP address, then the authentication credentials, and click Next. 4. If prompted, click Yes to accept the security credentials for your new host. 5. At Host Information, click Next. 6. At Assign License, apply the relevant license to your host, and click Next. 7. At Lockdown Mode, leave at defaults, and click Next. 8. At Ready to Complete, verify your settings, and click Finish.	**Adding the hosts to the vCenter and high-availability cluster** 1. Right-click the HA cluster, and select Add Host. 2. Enter the hostname or IP address of the first host, then the authentication credentials, and click Next. 3. If prompted, click Yes to accept the security credentials for your new host. 4. At Host Information, click Next. 5. At Assign License, apply the relevant license to your host, and click Next. 6. At Lockdown Mode, leave the defaults, and click Next. 7. At Ready to Complete, verify your settings, and click Finish. 8. Click your new host, and click the Manage tab. 9. Click the Networking tab, and click Edit settings on the host's VMkernel port. 10. In Port properties, check vMotion traffic and Fault Tolerance logging, and click OK. 11. Right-click the HA cluster, and select Add Host. 12. Enter the hostname or IP address of the second host, then the authentication credentials, and click Next. 13. If prompted, click Yes to accept the security credentials for your new host. 14. At Host Information, click Next. 15. At Assign License, apply the relevant license to your host, and click Next. 16. At Lockdown Mode, leave the defaults, and click Next. 17. At Ready to Complete, verify your settings, and click Finish. 18. Click your new host, and click the Manage tab. 19. Click the Networking tab, and click Edit settings on the host's VMkernel port. 20. In Port properties, check vMotion traffic and Fault Tolerance logging, and click OK.

Hardware-based FT on the NEC Express5800/R320d-M4	Software-based FT on the NEC Express5800/120e-1M
Preparing the VMs for fault tolerance	
Note: This step is not necessary on the NEC Express5800/R320d-M4 because once the system is prepared for fault tolerance, every VM is automatically fault tolerant.	**Configuring a VM to be fault tolerant** 1. Right-click the first VM you want to become FT, and select Fault Tolerance → Turn On Fault Tolerance. 2. If a verification popup window appears, click Yes. 3. In Select datastores, select the appropriate backup datastores for your secondary VM (we chose the same datastore as the VM, but normally it is recommended to split the VMs across multiple datastores), and click Next. 4. In Select host, select the second host in your cluster, and click Next. 5. In Ready to complete, verify the details of your VM, and click Finish. 6. Right-click the second VM you want to become FT, and select Fault Tolerance → Turn On Fault Tolerance. 7. If a verification popup window appears, click Yes. 8. In Select datastores, select the appropriate backup datastores for your secondary VM (we chose the same datastore as the VM, but normally it is recommended to split the VMs across multiple datastores), and click Next. 9. In Select host, select the second host in your cluster, and click Next. 10. In Ready to complete, verify the details of your VM, and click Finish. 11. Right-click the third VM you want to become FT, and select Fault Tolerance → Turn On Fault Tolerance. 12. If a verification popup window appears, click Yes. 13. In Select datastores, select the appropriate backup datastores for your secondary VM (we chose the same datastore as the VM, but normally it is recommended to split the VMs across multiple datastores), and click Next. 14. In Select host, select the second host in your cluster,

Hardware-based FT on the NEC Express5800/R320d-M4	Software-based FT on the NEC Express5800/120e-1M
	and click Next.
	15. In Ready to complete, verify the details of your VM, and click Finish.
	16. Right-click the fourth VM you want to become FT and select Fault Tolerance → Turn On Fault Tolerance.
	17. If a verification popup window appears, click Yes.
	18. In Select datastores, select the appropriate backup datastores for your secondary VM (we chose the same datastore as the VM, but normally it is recommended to split the VMs across multiple datastores), and click Next.
	19. In Select host, select the second host in your cluster, and click Next.
	20. In Ready to complete, verify the details of your VM, and click Finish.
	21. Right-click the fifth VM you want to become FT, and select Fault Tolerance → Turn On Fault Tolerance.
	22. If a verification popup window appears, click Yes.
	23. In Select datastores, select the appropriate backup datastores for your secondary VM (we chose the same datastore as the VM, but normally it is recommended to split the VMs across multiple datastores), and click Next.
	24. In Select host, select the second host in your cluster, and click Next.
	25. In Ready to complete, verify the details of your VM, and click Finish.
	26. Right-click the sixth VM you want to become FT, and select Fault Tolerance → Turn On Fault Tolerance.
	27. If a verification popup window appears, click Yes.
	28. In Select datastores, select the appropriate backup datastores for your secondary VM (we chose the same datastore as the VM, but normally it is recommended to split the VMs across multiple datastores), and click Next.
	29. In Select host, select the second host in your cluster, and click Next.

Hardware-based FT on the NEC Express5800/R320d-M4	Software-based FT on the NEC Express5800/120e-1M
	30. In Ready to complete, verify the details of your VM, and click Finish.
	31. Right-click the seventh VM you want to become FT, and select Fault Tolerance → Turn On Fault Tolerance.
	32. If a verification popup window appears, click Yes.
	33. In Select datastores, select the appropriate backup datastores for your secondary VM (we chose the same datastore as the VM, but normally it is recommended to split the VMs across multiple datastores), and click Next.
	34. In Select host, select the second host in your cluster, and click Next.
	35. In Ready to complete, verify the details of your VM, and click Finish.
	36. Right-click the eighth VM you want to become FT, and select Fault Tolerance → Turn On Fault Tolerance.
	37. If a verification popup window appears, click Yes.
	38. In Select datastores, select the appropriate backup datastores for your secondary VM (we chose the same datastore as the VM, but normally it is recommended to split the VMs across multiple datastores), and click Next.
	39. In Select host, select the second host in your cluster, and click Next.
	40. In Ready to complete, verify the details of your VM, and click Finish.

Figure 2: The steps required to implement fault tolerance using the two solutions.

FEWER COMPONENTS REQUIRED TO IMPLEMENT FAULT TOLERANCE

Because fault tolerance is incorporated into the server itself, the NEC Express5800/R320d-M4 obviates the need for many components that would otherwise be required for a normal fault tolerance setup. In terms of hardware, the Express5800/R320d-M4 only needs itself and a 1Gb switch to be fully FT (see Figure 3).
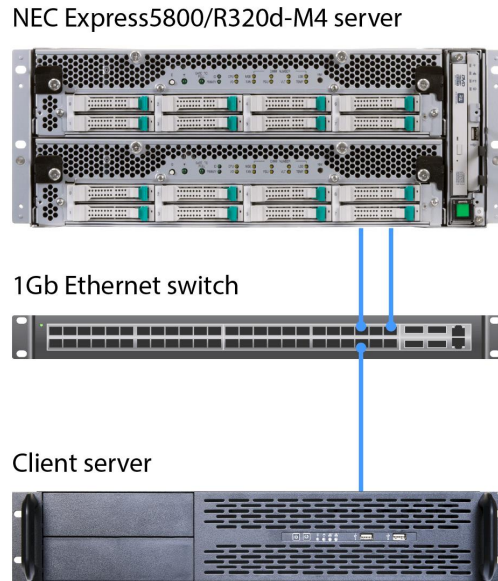
NEC Express5800/R320d-M4 server

1Gb Ethernet switch

Client server

Figure 3: Testbed diagram for the NEC Express5800/R320d-M4 servers.

In contrast, VMware's FT package requires several additional components. In addition to a 1Gb switch for management traffic, a 10Gb switch is necessary to handle the FT logging. Additionally, you need to use external storage for your VMs in order for VMware FT to work. If you're using fiber storage, you'll need a fiber switch as well. All told, using VMware's FT adds multiple layers of additional complexity (see Figure 4).
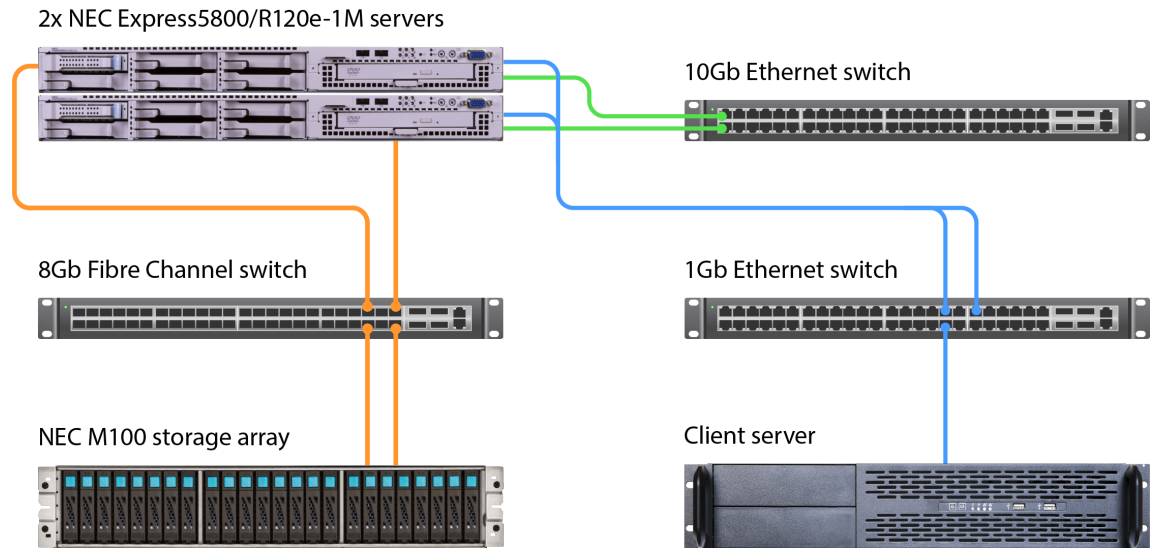
2x NEC Express5800/R120e-1M servers

10Gb Ethernet switch

8Gb Fibre Channel switch

1Gb Ethernet switch

NEC M100 storage array

Client server

Figure 4: Testbed diagram for the NEC Express5800/R120d-M1 servers.

CONCLUSION

For enterprise datacenter staff, time is of the essence. While using a software-based FT solution such as VMware vSphere Fault Tolerance is an effective way to eliminate downtime, the five extra steps required to configure every single VM can add up.

In our hands-on tests, setting up a server with eight fault-tolerant virtual machines took only 41 steps on the NEC Express5800/R320d-M4, vs. 60 steps when we used a VMware vSphere Fault Tolerance, a difference of 36.6 percent. With a greater number of VMs per server, this difference would increase. Hardware-based fault tolerance on the NEC Express5800/R320d-M4 also reduced the number of necessary hardware components required by half compared to the software-based based FT approach.[2]

With dozens of servers hosting hundreds of VMs, your IT staff can benefit enormously from the hardware-based fault tolerance that the NEC Express5800/R320d-M4 delivers.

---

[2] Note: While the setup required fewer steps, and took us less time in almost every stage, the process of synchronizing the two nodes of the NEC Express5800/R320d-M4 can be lengthy, making the installation time for the hardware fault-tolerance solution technically longer than for the software fault-tolerance solution.

APPENDIX A – SYSTEM CONFIGURATION INFORMATION

Figure 5 provides detailed configuration information for the test systems.

System	NEC Express5800/R120e-1M	NEC Express5800/R320d-M4
Power supplies		
Total number	1	1
Vendor and model number	Delta Electronics® DPS-800QB A	Delta Electronics DPS-800QB A
Wattage of each (W)	800	800
Cooling fans		
Total number	8	4
Vendor and model number	Sanyo® Denki® 9CRN0412P5J003	San Ace® 9G0812P1K121
Dimensions (h × w) of each	1.5" × 2.25"	3" × 3"
Volts	12	12
Amps	1.0	1.8
General		
Number of processor packages	2	2
Number of cores per processor	10	10
Number of hardware threads per core	20	20
System power management policy	Balanced	Balanced
CPU		
Vendor	Intel	Intel
Name	Xeon	Xeon
Model number	E5-2670v2	E5-2670v2
Socket type	FCLGA2011	FCLGA2011
Core frequency (GHz)	2.50	2.50
Bus frequency	8 GT/s	8 GT/s
L1 cache	32 KB + 32 KB (per core)	32 KB + 32 KB (per core)
L2 cache	256 KB (per core)	256 KB (per core)
L3 cache	25 MB	25 MB
Platform		
Vendor and model number	NEC Express5800/R120e-1M	NEC Express 5800/R320d-M4
Motherboard model number	Micro-Star MS-S0821	DG7LGE
BIOS name and version	4.6.4012	7.0:25
BIOS settings	Default	Default
Memory module(s)		
Total RAM in system (GB)	192	192
Vendor and model number	Samsung® M393B2G70QH0-YK0	Samsung M393B2G70QH0-YK0
Type	PC3L-12800R	PC3L-12800R
Speed (MHz)	1,600	1,600
Speed running in the system (MHz)	1,600	1,600
Timing/Latency (tCL-tRCD-tRP-tRASmin)	11-11-11-35	11-11-11-35
Size (GB)	16	16
Number of RAM module(s)	12	12

System	NEC Express5800/R120e-1M	NEC Express5800/R320d-M4
Chip organization	Double-sided	Double-sided
Rank	2Rx4	2Rx4
Hypervisor #1		
Name	VMware ESXi 6.0.0	VMware ESXi 5.5 Update 2
Build number	2809209	1746018
File system	Ext4	Ext4
Language	English	English
RAID controller		
Vendor and model number	Emulex® Light Pulse LPe12002-M8-N	LSI® SAS2008
Firmware version	UB2.02a2	V7.23.01.00
Cache size (MB)	N/A	N/A
Hard drives #1		
Vendor and model number	Seagate® ST9500620NS	Seagate ST300MP0005
Number of drives	1	8
Size (GB)	500	300
RPM	7,200	15,000
Type	SATA 6.0 Gb/s	SAS
Ethernet adapter #1		
Vendor and model number	Broadcom® BCM5718B0KFBG	Intel 82576
Type	Integrated	Integrated
Driver	Tg3	ftSys_igb
Ethernet adapter #2		
Vendor and model number	NEC N8190-154	NEC D4G7LDR Gigabit X540-AT2
Type	PCIe®	PCIe
Driver	Bnx2x	ftSys_ixgbe

Figure 5: System configuration information for the test systems.

ABOUT PRINCIPLED TECHNOLOGIES

![Principled Technologies logo]

Principled Technologies, Inc.
1007 Slater Road, Suite 300
Durham, NC, 27703
www.principledtechnologies.com

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.

When the assessment is complete, we know how to present the results to a broad range of target audiences. We provide our clients with the materials they need, from market-focused data to use in their own collateral to custom sales aids, such as test reports, performance assessments, and white papers. Every document reflects the results of our trusted independent analysis.

We provide customized services that focus on our clients' individual requirements. Whether the technology involves hardware, software, Web sites, or services, we offer the experience, expertise, and tools to help our clients assess how it will fare against its competition, its performance, its market readiness, and its quality and reliability.

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.