Lab Validation Report

NEC Express5800 Fault Tolerant Server

Simply Affordable Fault Tolerance for Virtual Server Environments

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ESG Lab Reports

The goal of ESG Lab reports is to educate IT professionals about emerging technologies and products in the storage, data management and information security industries. ESG Lab reports are not meant to replace the evaluation process that should be conducted before making purchasing decisions, but rather to provide insight into these emerging technologies. Our objective is to go over some of the more valuable feature/functions of products, show how they can be used to solve real customer problems and identify any areas needing improvement. ESG Lab's expert third-party perspective is based on our own hands-on testing as well as on interviews with customers who use these products in production environments. This ESG Lab report was sponsored by NEC Corporation of America.

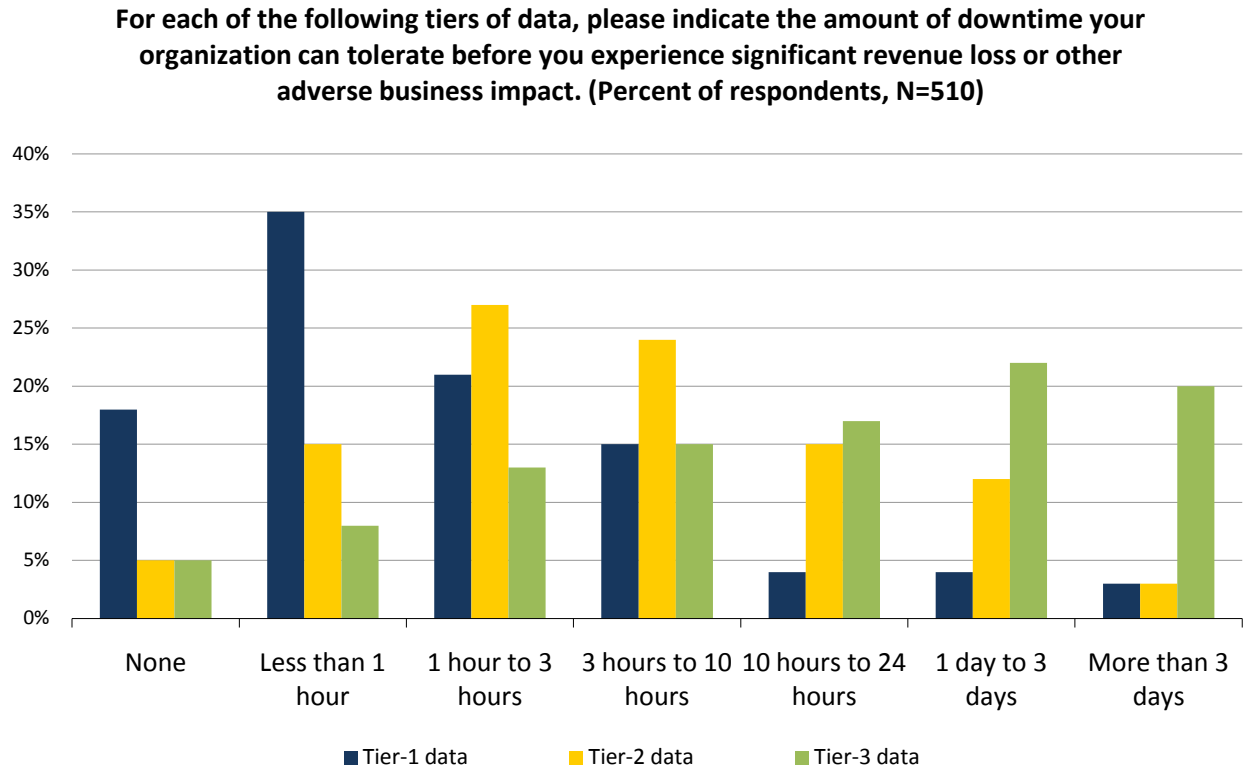
Introduction

This report documents ESG Lab hands-on testing and analysis of the NEC Express5800 Fault Tolerant server with a focus on the operational simplicity, continuous availability, and cost effectiveness of turn-key fault tolerance in a consolidated virtual server environment. Testing in a VMware environment is used to highlight the simplicity and savings of an NEC server with fault tolerance built into the hardware compared to traditional VMware clustering with fault tolerance implemented in software running on a pair of servers.

Background

A growing number of businesses rely on mission-critical IT applications—applications that, if unavailable, would have significant business consequences. Lack of mission-critical application availability or loss of vital information can result in missed business opportunities, reduced productivity, lost revenue, dissatisfied customers, damage to the company's reputation, and even legal liability; it follows, then, that more than half (53%) of respondents to a recent ESG survey indicated that downtime for their tier-1 data cannot exceed more than an hour without causing adverse business impact (see Figure 1). Even more telling is that nearly one-fifth (18%) of organizations stated that *any downtime at all* is not acceptable for their tier-1 data.[1]

Figure 1. Downtime Tolerance, by Importance of Data



Source: Enterprise Strategy Group, 2011.

As more organizations deploy production applications on virtual servers (nearly three-quarters of respondents to a recent ESG survey[2]), avoiding downtime is becoming even more important. In these consolidated environments, a single hardware failure can impact multiple applications, resulting in downtime and lost productivity. Clustering at the virtual server or application level can reduce the risk, but it adds cost and complexity in the form of additional hardware and software that must be purchased and managed.

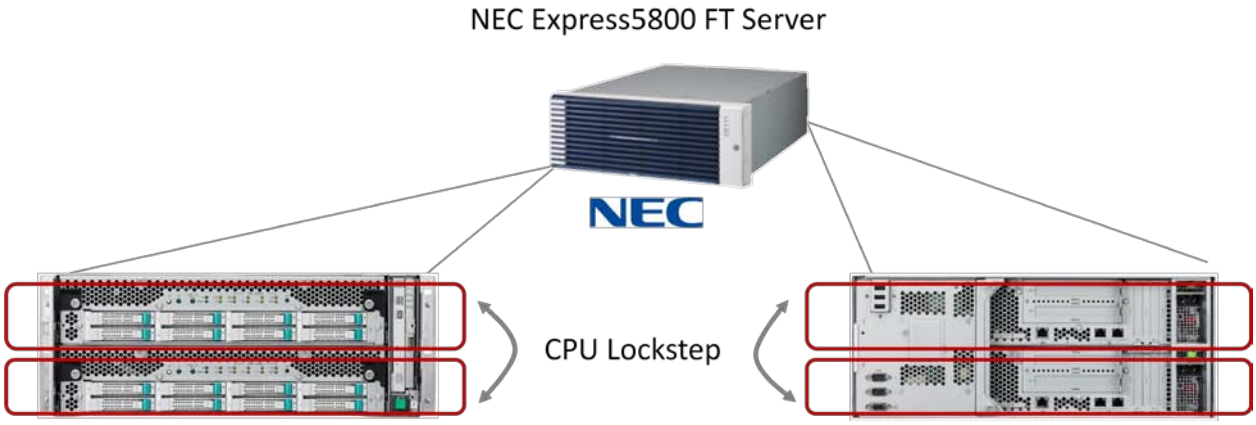
[1] Source: ESG Research Report, *2010 Data Protection Trends*, April 2010
[2] Source: ESG Research Report, *The Evolution of Server Virtualization*, November 2010.

NEC Express5800 FT Server

First introduced in 2000 and now in its sixth generation, the NEC Express5800/R320 is the product of a hardware partnership between NEC and Intel, and of a software partnership with Intel. It is a fault tolerant server that's ideally suited for mission-critical virtualization, database, and e-mail services. The R320 is a 4U rack-mounted server with two six-core Intel Xeon CPU modules that are kept in lockstep. The CPU lockstep design results in a fully fault tolerant server than can endure a CPU, motherboard, network, or storage hardware failure with no interruption to applications and end-users. The continuous high availability of the Express5800 works transparently with applications, operating systems, and virtual server software as it eliminates the need for host-based clustering software, cluster-aware applications, and SAN attached storage.

The 4U Express5800 chassis hosts a pair of servers that work together in a fault tolerant configuration, presenting themselves as a single logical server. CPU lockstep, developed by NEC, is implemented between the motherboards at the hardware level. As shown on the left side of Figure 2, the front of the each server is configured with a drive bay that holds eight 2.5 SAS drives for a combined capacity of up to 2.4 TB of internal storage. Also located on the front is a status light used to indicate when the system is in full duplex mode. As shown on the right side of Figure 2, the back of each server houses a pair of 1000BASE-T network connections, two (gen-1) PCIe low profile slots, two (gen-2) PCIe slots, and a system power supply.

Figure 2. NEC Express5800 FT Server



Express5800/R320 Series Specifications:

- Fully redundant 4U chassis
- One or two socket Multi-Core Intel 5500 and 5600 series Xeon Processors
- Up to 96 GB of memory
- Up to 2.4 TB of storage
- Two or four PCIe slots per customer replaceable unit

Express5800/R320 Supported Operating Systems:

- Windows Server 2003 Enterprise Edition R2 (32bit)
- Windows Server 2008 Enterprise Edition R1 (64bit)
- Windows Server 2008 Enterprise Edition R2 with Hyper-V
- Red Hat Enterprise Advanced Platform Version 5
- VMware vSphere 4.0 Update 2

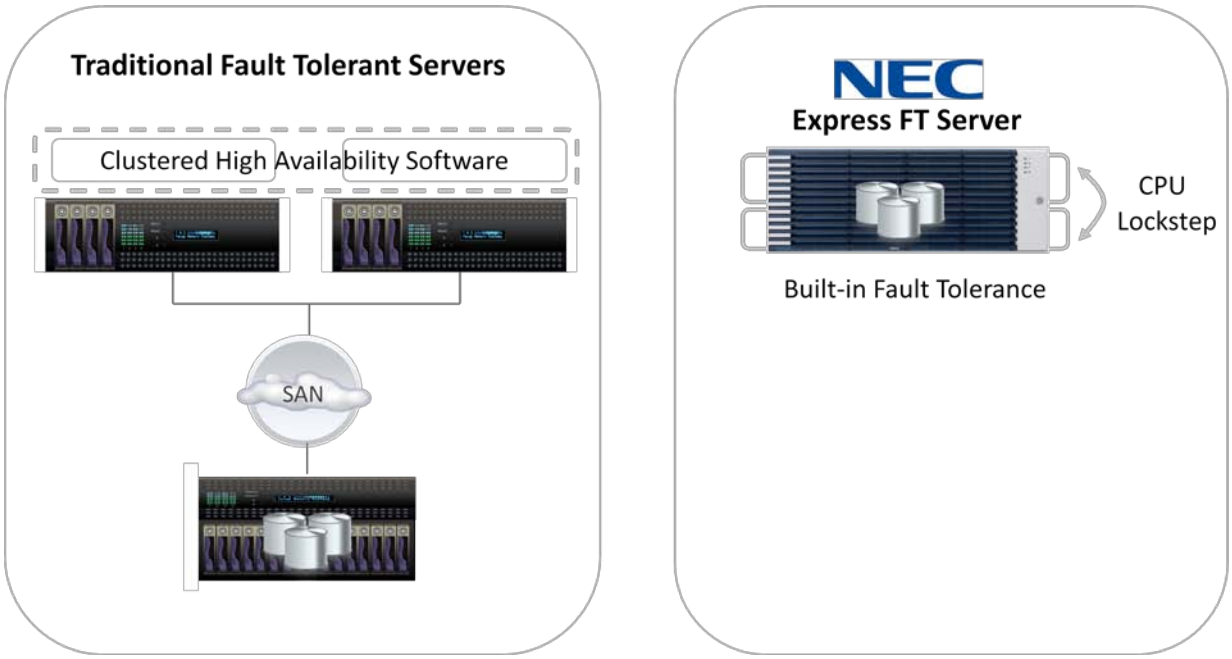
It's important to note the NEC Express5800 FT Servers are supported in physical (e.g., Windows) and virtual server environments (e.g., VMware). This is due to the fact that the NEC Express5800 FT Server implements fault tolerance transparently in hardware. From the operating system or virtualization layer's perspective, it's a traditional Intel server. From an application's perspective, it's totally transparent. Regardless of whether your mission critical

applications are qualified to run on a physical or virtual server, and regardless of whether those applications are cluster-aware, non-stop availability is simple and cost effective with NEC Express58000 FT Servers.

Unlike the traditional clustering shown on the right side of Figure 3, the Express5800 does not require external shared storage typically presented from a SAN, additional network resources for cluster monitoring, nor multiple OS or application instances and licenses for each cluster node.

Removing these requirements simplifies management and reduces cost. No special expertise is required for SAN and storage subsystem administration, network port and NIC requirements are reduced, complex cluster configuration is eliminated, and software/operating system licensing and maintenance is reduced.

Figure 3. Traditional vs. NEC Express5800 Fault Tolerance



Compared to traditional fault tolerant methods, the Express5800 paradigm:

- Eliminates the need for expensive and complicated SAN attached storage
- Reduces the number of servers that need to be purchased and maintained
- Works transparently with applications that haven't been certified as cluster-aware
- Reduces the network resources required for cluster monitoring
- Reduces the cost of virtualization, operating system, and software licenses

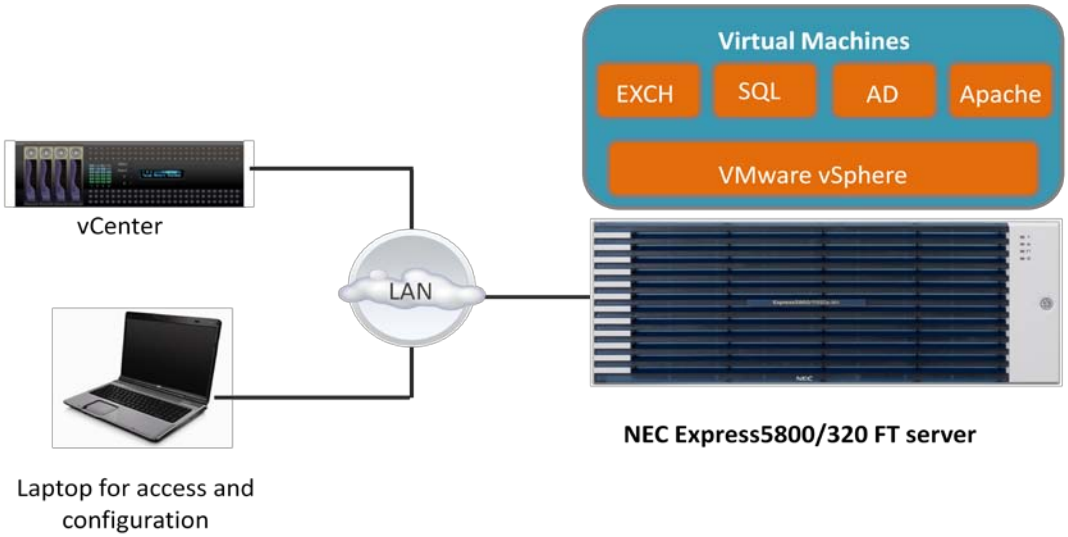
ESG Lab Validation

ESG Lab performed hands-on evaluation and testing of the NEC Express5800 FT server using a facility provided by an NEC business partner located in Billerica, Massachusetts. Testing was designed to demonstrate how fault tolerant servers from NEC can be used to reduce downtime while avoiding the cost and complexity of traditional host-based clustering.

Getting Started

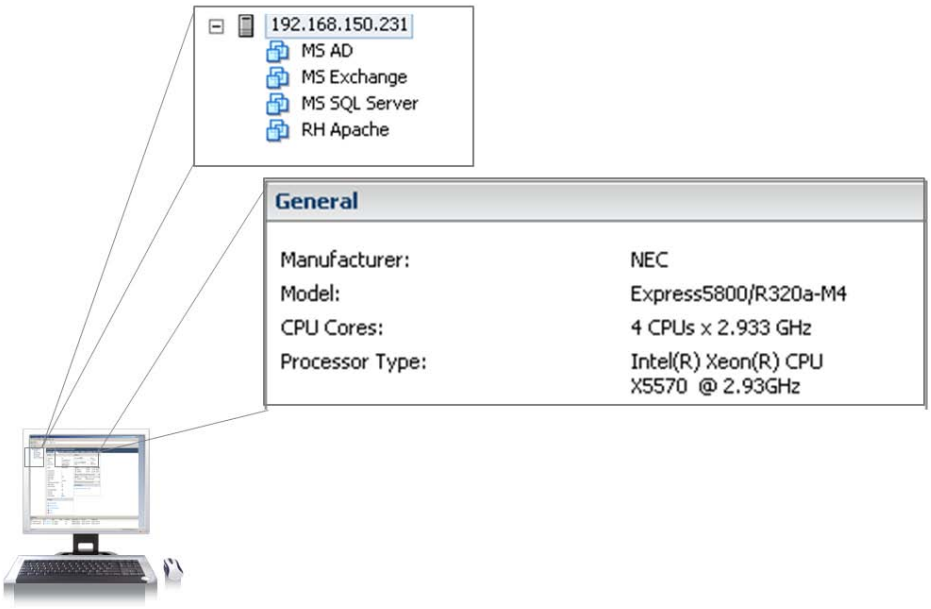
The configuration used for ESG Lab testing is shown in Figure 4. An Express5800 server was implemented with VMware vSphere 4.0 update 2. A physical vCenter server, shown at left, was used to manage the environment. VMware vSphere Client was installed on a laptop for vCenter connectivity and administration. Windows and Linux virtual machines were created on the Express5800 server using vCenter templates.

Figure 4. ESG Lab Test Bed



A VMware vCenter view of the test bed is shown in Figure 5. The vCenter view shows the system detail of the Express5800 vSphere server as well as a view of the virtual machines it hosts. The test bed was first configured with Microsoft Active Directory, MS Exchange, MS SQL, and Red Hat Apache server. Later, a Windows 2008 Server was added to the test bed as a virtual machine.

Figure 5. A VMware View of the ESG Lab Test Bed



The Express5800 solution can be just as easily deployed in a Microsoft Hyper-V environment. Based on testing of Microsoft Hyper-V during a number of previous ESG Lab validations, ESG Lab believes that the Express5800 solution is particularly well suited for business critical Microsoft application workloads running in a consolidated Hyper-V virtual server environment.[3]

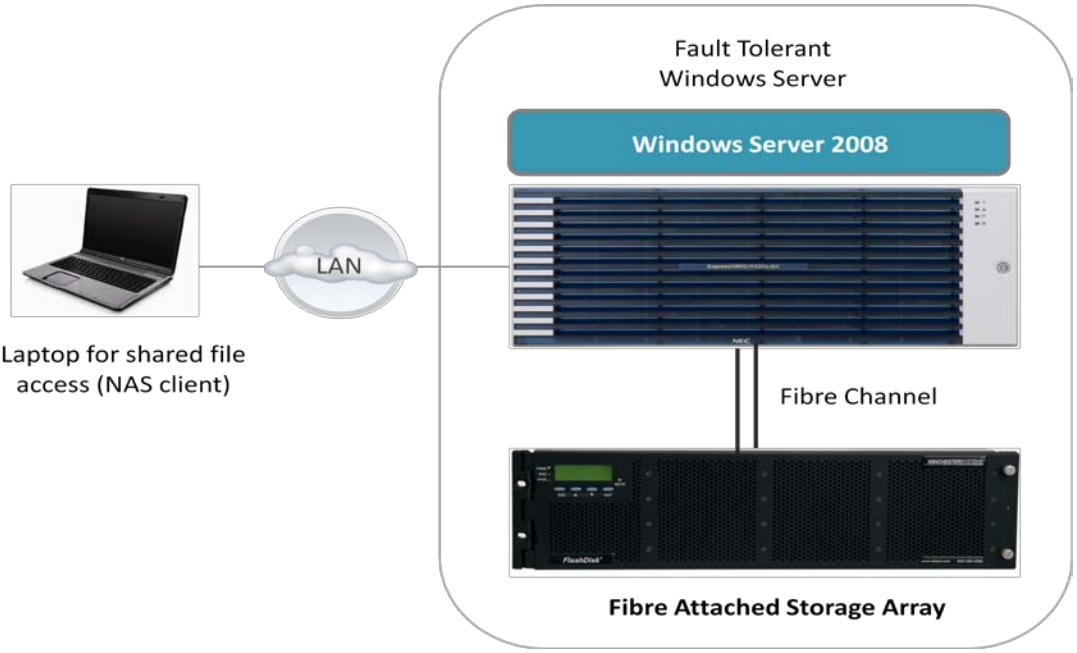
[3] For more information on the performance and scalability of mission-critical SQL Server workloads running in a Microsoft Hyper-V virtual server environment, see ESG Lab Validation Report, *Microsoft SQL Server 2008 R2 and Hyper-V R2 SP1 Performance Analysis*, June 2011.

NEC Express5800 servers can optionally be deployed with a direct attached disk array to meet the needs of fault tolerant applications requiring lots of disk capacity. Storing images from security cameras in casinos, medical images from a CAT scan or MRI, insurance claim images, or files on a corporate shared network drive are examples of applications that can be deployed in this manner.

With fault tolerance built into the Express5800 server, turning an application into a fault tolerant solution is simple; as far as the application is concerned, it's running on a single traditional server. With the Express5800 server handling lock-step synchronization and automated failover, there's no need for the application to be cluster-aware.

A fault tolerant Windows server solution tested by ESG Lab is shown in Figure 6. Windows Server 2008 software was installed on an Express5800 server to create a fault tolerant network file serving solution. A Fibre attached storage array with the ability to tier data across traditional disk and SSD was used to augment the internal storage capacity of the Express5800 server. Taking advantage of the shared IO architecture of the two motherboards within the Express5800 server, the disk array was connected to the server using a pair of Fiber Channel connections, eliminating the cost and complexity of Fibre Channel switching.

Figure 6. NEC/Fibre Channel Storage Array Fault Tolerant NAS Test Bed



Why This Matters

IT managers are increasingly being asked to do more with less as they increase the availability of business critical applications. Simple, fault tolerant solutions are needed to meet these often conflicting demands.

An NEC Express5800 server, with built-in fault tolerance, increases the availability of business critical applications as it eliminates the cost and complexity of clustering software, elaborate storage infrastructures, and highly specialized administrative skill sets.

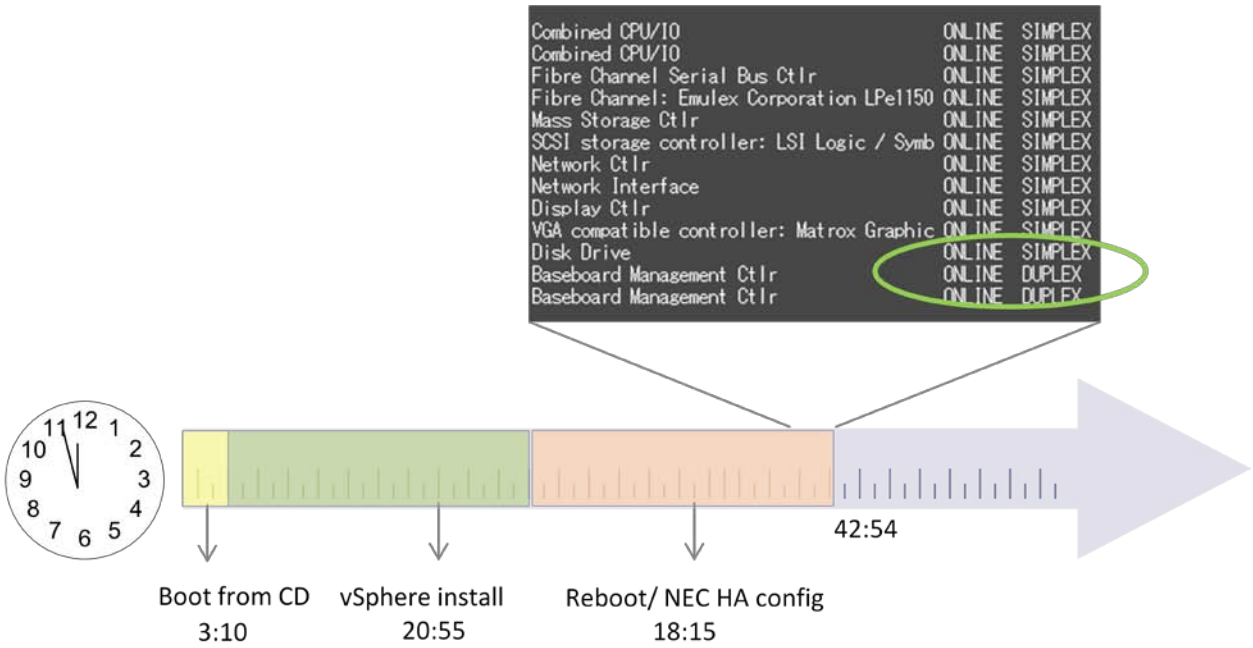
Ease of Deployment

Ease of deployment is the ability to quickly and easily implement an Express5800 solution without the need for highly specialized skills and excessive external infrastructure hardware and software dependencies.

ESG Lab Testing

ESG Lab implemented an Express5800 solution in less than 45 minutes. As shown in Figure 7, the install process started with a system boot from the NEC Express5800 installation media, taking just over three minutes and requiring three clicks. Next, vSphere was installed on the system, taking just over 22 minutes and requiring 17 clicks. The procedure was completed by running the NEC (ft_configure) script. The fault tolerant configuration took slightly more than 18 minutes, including a reboot.

Figure 7. Express5800 Deployment



Why This Matters

According to ESG research, business process improvement initiatives were the second most important factor impacting IT spending decisions.[4] Long deployment cycles delay the business's ability to realize the benefit of new technology, increase IT costs, and hinder process improvements for both business and IT.

With the NEC Express5800 solution, ESG Lab was able to deploy a fault tolerant solution in about the same time it takes to configure a simple Windows, Linux, or virtual server. Speedy implementation reduces cost and accelerates technology-enabled business efficiency.

[4] Source: ESG Research Report, *2010 IT Spending Intentions Survey*, January 2010.

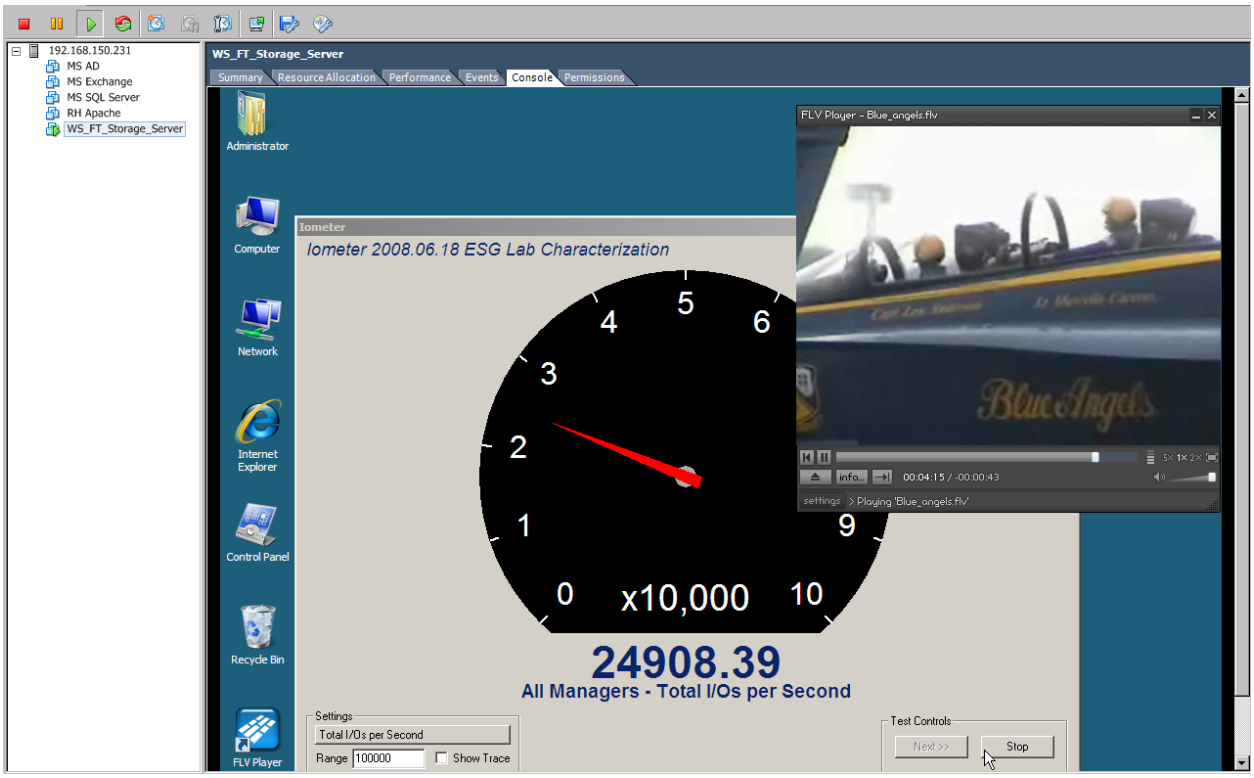
Continuous Availability

Failover with the NEC Express5800 is automatic and transparent to the OS, virtualization software, applications, and users. The environment can survive a drive, motherboard, CPU, RAM, bus, power supply, and fan failure.

ESG Lab Testing

To validate the Express5800's fault tolerant functionality, ESG Lab configured a background workload running in a virtual machine. As shown in Figure 8, the industry standard Iometer utility was used to simulate a multi-user database workload while a video was also playing. ESG Lab removed a field replaceable motherboard to simulate a server failure and observed no interruption to the video. The database IO workload continued without interruption and no errors were logged by VMware, Windows, or the applications.

Figure 8. Server Failover Testing



Why This Matters

Downtime hurts business productivity. For many organizations, the ability to access information anytime from anywhere is not simply desired, it is expected.

ESG Lab has confirmed that an NEC Express5800 server can be used to create a fault tolerant platform for mission-critical applications that's simple to deploy and manage. It starts with mature sixth generation technology and observes a "simple is better" paradigm: less component dependencies means less can go wrong. And that means less system downtime.

Affordability

NEC Express5800 servers with built-in clustering reduce complexity and costs compared to traditional host-based clustering. For illustration purposes, consider the differences between traditional VMware Fault Tolerance and NEC Express fault tolerance, shown in Figure 9 and summarized in Table 1.

The first and most obvious difference is the need for shared SAN attached storage with VMware fault tolerance. This adds the cost and complexity of Fibre Channel storage, adapters, and switches compared to the NEC Express5800 solution which uses internal drives that are automatically shared between two built-in motherboards. Another obvious difference is the need for two physically separate servers with the VMware solution.

Aside from the amount of hardware that needs to be purchased and configured, the traditional solution requires more VMware licenses. A more expensive VMware Advanced license is needed on both of the physical servers with traditional VMware fault tolerance. With NEC Express, the fault tolerance is built in and transparent to the VMware software layer and virtualized applications deployed with VMware. As a result, a more affordable VMware Essential license is needed—for half the number of processors.

Figure 9. VMware vs. NEC Express Fault Tolerance

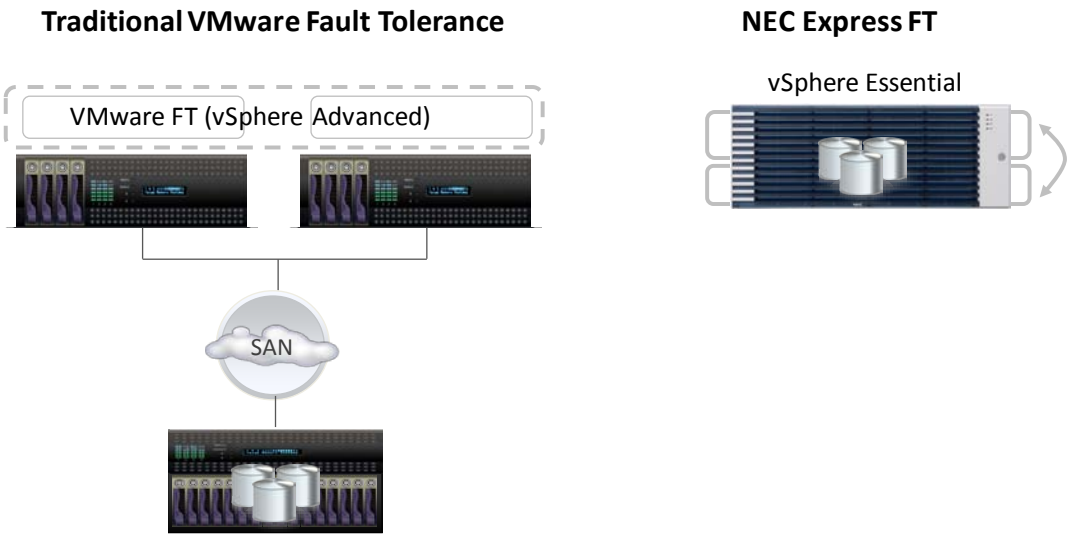


Table 1. ESG VMware vs. NEC Express Fault Tolerance Cost Analysis

	VMware Fault Tolerance	NEC Express Fault Tolerance
Servers	2	1
Processors to license	4	2
VMware edition	Advanced	Essential
FC disk array	Needed	Not Required
FC adapters/switches/cables	Needed	Not Required
VMware Foundation	Needed	Not Required

Another added cost with the VMware method is the need for a VMware Foundation software license which includes the vSphere client used to configure and manage clustered failovers. Failover is transparent and automated with NEC Express5800; the additional cost of VMware Foundation is not required. [5]

An NEC Express5800 server not only reduces hardware and software acquisition costs, it also reduces ongoing operational costs. With IT operational expenses often running several times greater than hardware and software acquisition costs over the lifetime of a server, these costs need to be factored into a cost of ownership analysis. An NEC Express5800 solution cuts the number of servers that need to be managed in half as it eliminates the complexity of configuring and managing traditional clustering software. Management costs are further reduced in the unlikely event of a server hardware failure as failover and failback are totally automated. Ongoing hardware and software maintenance costs are reduced as well.

Finally, the differences between VMware high availability (HA) and fault tolerance need to be considered. It is a common misconception that virtual machine HA is the same as fault tolerance. While multiple technologies can be used to move or restart applications on another server, a fault tolerant solution is needed for applications to run transparently after a physical server failure without data loss. So VMware HA is used to restart a virtual machine on another server after a failure, but this incurs a brief period of interruption to end-users and applications with loss of data written just before the failure. In contrast, VMware and NEC Express5800 can actually eliminate data loss and interruption after a server failure.

ESG Lab Cost Analysis

ESG Lab compared the cost of acquiring and operating VMware and NEC Express fault tolerance over three years. The analysis focused on differences in the cost of hardware, software, maintenance, and manpower.

The price of an NEC Express5800 320 server was compared to the price of a pair of servers using pricing for a generally available server with similar specifications. The NEC Express server was configured with 12 internal SAS drives. The traditional VMware solution was configured with a 4 Gbps FC SAN attached disk array with the same number of drives as the NEC Express solution.

The cost of VMware licenses and maintenance were obtained from VMware's website.[6] The estimated cost of maintaining physical servers in a virtualized environment was derived from a VMware report which documents the savings that have been achieved by existing VMware customers as they migrated from physical to virtual servers. Costs for a VMware customer in the insurance industry were used in ESG's model.[7]

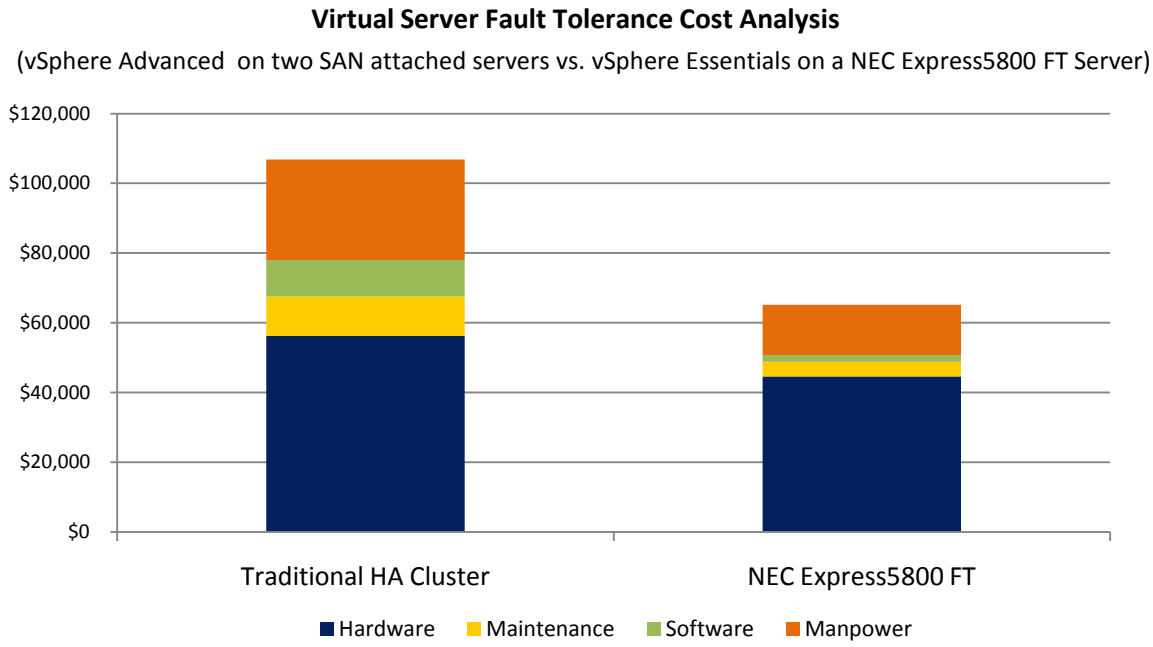
[5] While not required, the relatively low cost of VMware Foundation may be justified with NEC Express5800 FT solution due to the ability to manage, and migrate, many virtual servers from a single console.

[6] http://www.vmware.com/products/vsphere/pricing.html

[7] http://www.vmware.com/pdf/TCO.pdf

The results of ESG Lab's cost analysis are summarized in Figure 10.

Figure 10. Virtual Server Fault Tolerance Cost Analysis



What the Numbers Mean

- An overall cost savings of 39% was achieved with the NEC Express5800 solution.
- While the NEC Express5800 server was more expensive than a traditional server, the total cost of hardware and maintenance was less with the NEC solution as there was no need for an additional server or SAN storage.
- With fewer processors to license and the ability to use VMware Essentials instead of VMware Advanced and VMware Foundation, the cost of VMware software was 81% less for the NEC Express5800 solution.
- The NEC solution was 53% less expensive to manage—less server and storage hardware is needed to be installed and monitored and the complexity of VMware clustering software was avoided.

Why This Matters

For the past three years, cost reduction has been the number one factor impacting IT spending decisions.[8] Affordability remains a top priority in the decision process when implementing new technology solutions.

By implementing fault tolerance at the hardware level and presenting the Express5800 as a single logical server, NEC reduces hardware and software dependencies, complex configuration and administration, and the license requirements associated with multi-node software cluster configurations, creating a cost effective infrastructure for mission-critical business applications.

[8] Source: ESG Research Report, *2011 IT Spending Intentions Survey*, January 2011.

ESG Lab Validation Highlights

- ☑ ESG Lab explored the benefits of implementing fault tolerance at the hardware level with the traditional approach of software-based clustering. The single logical server approach used by NEC not only reduced the amount of hardware and software resources required for highly available systems, but also simplified configuration, administration, and maintenance.
- ☑ Ease of deployment was confirmed by installing and configuring VMware vSphere 4.0 update 2 on an Express5800 server. The Express5800 insulation media was booted, vSphere was installed, and a configuration script was run—in less than 45 minutes, the system was running in fault tolerant mode.
- ☑ Fault tolerant capabilities of the Express5800 were validated by removing one of the hot swappable motherboards while the system was under load. A simulated database workload and a streaming video failed over with no errors logged in Windows or vSphere.
- ☑ ESG Lab compared the costs associated with deploying a traditional VMware fault tolerant solution to an NEC Express5800 solution with built-in fault tolerance and found an overall 39% reduction in cost could be achieved with the NEC solution, with savings across the board from hardware and software to maintenance and manpower.

Issues to Consider

- ☑ The Express5800 has a growing list of supported virtualization software and operating systems, but not every operation environment and not every revision is included. When considering the Express5800 for a fault tolerant environment, proper planning is required to ensure platform supportability.
- ☑ Though the Express5800 delivers a reliable, mature fault tolerant solution, it doesn't eliminate the need for backup—compliance, regulations, site failure, and data corruption are all examples that highlight the need for complete and data protection practices. Incorporating the Express5800 into an existing data protection schema presents no solution-specific challenges. In fact, its simple, straightforward approach makes it easy to add to existing backup or application-level protection solutions.

The Bigger Truth

Ensuring that mission-critical applications are protected from failures and available to users when needed can be a daunting task. Such high availability is typically associated with expensive infrastructure, complex configurations, and countless hours of specialized administration. Traditional software-based solutions can get expensive quickly and often require access to shared storage resources, additional licenses, and specialized skill sets. To top it off, without constant care and feeding, you may not get the desired protection results when an error occurs; even something as simple as an application update not installed on one cluster host might prevent a failover from completing, leaving users without access to data and administrators scrambling to correct the problem.

With the NEC Express5800 solution, availability is moved from the software to the hardware. This simple approach removes dependencies from the applications through the operating system all the way down to the storage. With fault tolerance implemented transparently in hardware, an NEC Express5800 FT solution can be used to protect mission critical applications running on physical or virtual servers. Leveraging the power and cost effectiveness of industry standard Intel processors, the entire solution can be maintained in 4U footprint with at up to 2.4 TB of capacity. For environments where more than 2.4 TB of storage is required, the Express5800 can be easily connected to external storage and still maintain its single logical server paradigm for simple, efficient fault tolerance.

ESG Lab explored ease of implementation for the Express5800 and found that creating a fault tolerant solution compared closely to the effort required to implement a simple server. Availability was confirmed by removing the active motherboard—ESG Lab observed uninterrupted failover to the secondary motherboard while under load. Moving to the bottom line, ESG confirmed that a single NEC FT Express server with built-in fault tolerance reduces costs by 39% compared to a pair of traditional SAN-attached servers with VMware fault tolerance implemented in software.

In today's fast paced, always-on mobile business environment, even the smallest amount of downtime can have a major impact. ESG Lab believes the NEC Express5800 FT solution helps solve these problems, making affordable non-stop business a reality for organizations both large and small.

Appendix

Table 2. Test Bed Overview

NEC Fault Tolerant Server Configuration	
NEC Express5800 FT	Model Express5800/R320a-M4 Four X5570 2.9GHz Intel processors Two Emulex Lpe1150 Fibre Channel HBAs
External Storage Configuration	
Fibre Channel Storage Array	4Gb Dual Controllers One RAID 5 Configured 1.9 TB Logical Volume
Software – Virtualization	
VMware vSphere	Version 4.0 update 2
VMware vCenter	Version 4.0
Software – Guest OS	
Microsoft Windows	Version 2008
Red Hat Enterprise Linux	Version 5.3
Software – Middleware and Applications	
Microsoft Exchange	Version 2010
Microsoft SQL	Version 2008 R2
Apache HTTP Server	Version 2.2

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