by Stratus Technologies, The Availability Company® February 2008

Benefit From

VMware® Infrastructure 3 and Stratus® Servers

A Manufacturing Industry Guide to Maximizing Application Uptime and Minimizing Lifecycle Management Costs

vmware®

Stratus® Technologies™

Abstract

With the increasing deployment of plant-level IT solutions including manufacturing execution systems (MES), the productivity of the entire facility suffers any time those systems are down. Managing the uptime and complexity of these application environments has never been more vital. But it must be done while keeping technology and staff costs under control.

Virtualization is a technology being widely applied today with excellent operational and financial results. It allows manufacturers to take advantage of computing power that would otherwise go to waste in typical plant environments. The bottom line benefits don't hurt, either. Fewer servers, lower energy costs and reclamation of expensive square footage are all part of the virtualization package. As virtualization goes mainstream, with multiple virtual machines and applications being supported on a single server, the availability of the hardware and underlying virtualization software becomes even more important.

This paper details nine ways the combination of VMware® Infrastructure 3 (VI3) virtualization and Stratus® fault-tolerant ftServer® systems work together to better address challenges that range from hardware and software failures, to ongoing maintenance and upgrades, to disaster recovery and business continuity. Also presented is a usage scenario that shows how VMware VI3 and Stratus ftServer systems can benefit mission-critical applications at the plant.

Continuous Availability and Virtualization in Lifecycle Management

Advanced applications such as MES, scheduling, laboratory information management systems (LIMS), data historian, plant-level enterprise resource planning (ERP) components, quality systems and maintenance management have become indispensable to running production and maintaining required records at manufacturing sites. The risk and cost of service interruptions are rising as these computer-driven applications grow more powerful, interdependent and necessary to more processes and more workers.

To keep staffing costs down, however, companies have been reluctant to add IT staff at the plant to support these applications. These conditions present very real challenges in managing IT complexity, and in ensuring that unplanned outages and planned downtime for maintenance do not undermine productivity.

Because they are engineered to promote the uptime, performance and integrity of IT-driven operations, fault-tolerant Stratus ftServer systems have become the premier server platform for MES and mission-critical automation projects. As virtualization gains ground in plant environments, manufacturers can now look to Stratus for an ftServer platform based on VMware that provides the enterprise-strength availability that these production settings demand.

Stratus has paired VMware Infrastructure 3 — the most widely deployed software suite for optimizing and managing industry-standard IT environments through virtualization with its continuously available ftServer systems and world-class services to provide a comprehensive virtualization solution.

Addressing Availability and Complexity Challenges

VMware VI3, encompassing VMware ESX Server and other components, complements Stratus Continuous Availability servers to address availability and complexity concerns throughout the lifecycles of manufacturing applications. The combination of VMware and Stratus' technology innovations excels at meeting nine common challenges that span unplanned outages, planned downtime, disaster recovery/business continuity and ongoing support.

Figure 1: VMware VI3 and Stratus Continuous Availability

Availability/ Complexity Challenge	VMware VI3	Stratus ftServer Systems
Server failure	• Failure detection and virtual machine restart with VMware HA	• Prevent server failure; no application downtime or loss of transactions or data • Server consolidation with virtualization increases the workload on each server making server hardware failure more costly
Operating system failure	• VMware reliable hypervisor • Failure detection and virtual machine restart with VMware HA	• Stratus hardened drivers • Mask and ride through all hardware errors
Application failure	• Isolate applications in virtual machines, eliminating application conflicts • Restart application within virtual machine on same or different server	• Mask and ride through all hardware errors • Eliminate application downtime caused by server failure
Server maintenance	• VMotion online migration frees server for maintenance with zero application downtime	• Online hardware maintenance
Operating system maintenance	• Install and test changes in new virtual machine, then migrate to new virtual machine during off-hours	
Application maintenance	• Install and test changes in new virtual machine, then migrate to new virtual machine during off-hours	
Disaster recovery/ business continuity	• Removes physical configuration dependencies of remote site equipment • Allows production virtual machine definitions to be used with only minor edits at the backup site	
Support		• Single-vendor support covers hardware, ESX Server and guest OS, including ability to root-cause problems in any area
Virtualization services		• Suite of virtualization services focused on Continuous availability, including VMware installation, virtualization assessment, design, implementation and migration

Server Hardware Failure

Unplanned outages can be caused by a range of hardware and software problems, including server hardware failure, operating system failure and application software failure.

In the case of hardware failure, VMware ESX Server with VMware High Availability (HA) (now included with VMware Infrastructure 3 Standard Edition) can provide automatic restart of virtual machines running on a failed conventional server. However, users will be faced with downtime of a few minutes or more, loss of in-process transactions and loss of in-memory application data as well as application state information.

Stratus ftServer systems eliminate downtime associated with server hardware failures and protect in-process transactions as well as in-memory application data. These fault-tolerant servers rely on a duplicated hardware architecture with core CPU-memory components that run together in lockstep. The systems automatically detect their own hardware failures and remove a malfunctioning component from service while a partner component continues uninterrupted operation. Proven in the field to deliver greater than 99.999% uptime, the ftServer architecture uses Intel® Xeon® processors and industry-standard operating systems.

Operating System Failure

VMware ESX Server provides a highly reliable, small-footprint hypervisor that manages physical x86 hardware and I/O devices. Operating systems, such as Microsoft® Windows®, Linux® and x86 Solaris™, run as guests. Each virtualized guest OS instance typically runs a reduced set of applications compared with a non-virtualized server environment. A reduction in application interaction combined with virtualization of hardware and I/O dramatically reduces the complexity of the guest OS environment, resulting in improved operating system availability. In the event of an unpreventable OS crash, VMware ESX Server allows the associated virtual machine to be restarted quickly for fast recovery.

Stratus Continuous Availability technology adds hardened drivers to ESX Server to further reduce the chances of driver-induced failures. Stratus ftServer systems also recover transparently from hardware component failures and mask these failures from the hypervisor and guest operating systems, eliminating another possible cause of operating system failure.

Application Failure

VMware ESX Server allows applications to run in fully isolated virtual machines, eliminating application conflicts typical of non-virtualized environments. Such conflicts are a leading cause of application failure. This is particularly true of Windows environments, which helps explain the predominance of those environments in the initial move to virtualization. Recovery from unpreventable application failures can be performed rapidly by restarting the associated virtual machine on the same server or on a different server, which minimizes application downtime.

Stratus ftServer systems further improve application availability by masking all hardware component errors from the application and by eliminating server failures that would otherwise introduce application downtime.

Server Hardware Maintenance

Downtime for maintenance must be managed conscientiously to keep manufacturing production lines from standing idle. Proper procedures and attentive execution are required to minimize how long applications are offline, and to ensure changes do not introduce problems that escalate into major disruptions and compromise product quality.

To allow a server to be taken offline for maintenance, VMware ESX Server allows all virtual machines to be moved from the running server to another designated server. The VMware DRS host maintenance mode can be used to move virtual machines online to without having to take the application offline. After completing maintenance on the target server, virtual machines can be moved back to the updated server to rebalance the workload within the server pool.

Stratus ftServer systems support online maintenance for most hardware maintenance operations. This capability reduces the operational time associated with offloading and rebalancing virtual machines for servers that must be taken down for maintenance.

Operating System Maintenance

The most common maintenance operation associated with operating systems is the application of minor updates and patches. The introduction of new service packs, major update releases or new operating system versions is less frequent, but can result in more significant interruptions to the IT infrastructure.

VMware ESX Server virtualization significantly reduces downtime and improves the reliability of operating system maintenance by allowing operating system updates, either major or minor, to be implemented and tested in a non-disruptive virtual machine test environment that accurately duplicates the production environment. After changes are implemented and tested, updates are applied to the production environment by stopping production virtual machines and restarting them using the updated virtual machine image. These steps involve only a few minutes of downtime that can be scheduled for off-hours.

Operating system maintenance includes VMware ESX Server itself. ESX Server maintenance is best handled by migrating all virtual machines from the target physical server to other servers using the DRS host maintenance mode. Updates or new versions are installed on the target server, and then the virtual machines are migrated back to the target server — again, using DRS. This process permits ESX Server maintenance with zero application downtime but does require the extra capacity of at least one additional server.

Application Maintenance

Application maintenance operations range from simple patches to major version upgrades that include database structure changes. The burden of limiting the impact of application upgrades falls on the application developer.

VMware ESX Server does provide some assistance for application upgrades. Similar to operating system upgrades, ESX Server allows upgrades to be installed and tested within a contained virtual machine environment and then moved into production by stopping the old virtual machines and starting the new ones. Any database conversions must be managed separately.

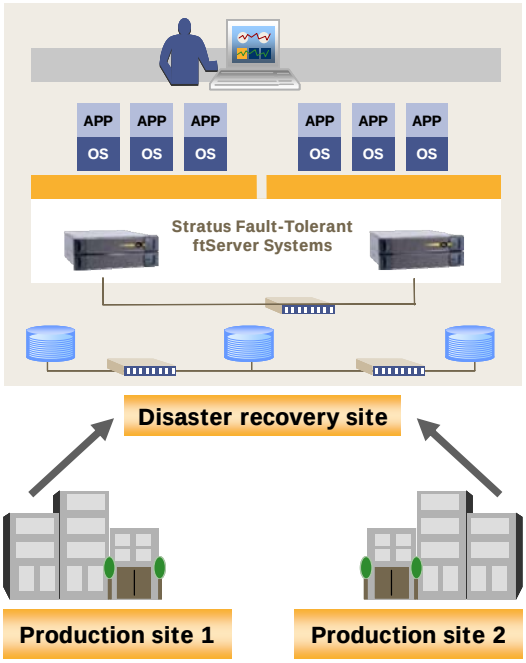
Disaster Recovery/Business Continuity

In the days when islands of automation handled production and information was recorded mainly on paper, appropriate backup could be as simple as filing copies of product recipes offsite. Disaster recovery is due for an update when plant operations become dependent on manufacturing applications. A new set of considerations apply to securing and recovering that critical information in today's all-electronic settings.

VMware ESX Server virtualization removes the configuration dependencies of servers at the backup site by abstracting the underlying hardware. In a traditional environment, servers at the production and backup sites must be identical to assure application compatibility and a smooth failover in the case of an outage with the production machine. In a virtualized environment, a single set of equipment can be used to provide backup for applications running at multiple production sites and the underlying hardware platform does not need to be a duplicate of the production system. System performance should be considered to assure that the backup hardware can meet the minimum needs for running the applications.

Benefits include significant equipment savings and reduced maintenance costs. Production virtual machine definitions can be moved to a backup site and used with only minor edits — primarily the assignment of different IP addresses. Disaster recovery testing is also simpler because of the ease of configuring the virtual environment, and the flexibility to use far less hardware in a test environment.

Figure 2: Disaster Recovery Using Virtualization



A single disaster recovery site that supports multiple production sites becomes an option. Virtualization removes hardware and configuration dependencies between sites and enables five-nines availability by allowing Stratus ftServer systems to be deployed as the underlying hardware.

Customer Support and Service

One-stop support for VMware environments continues the Stratus tradition of 24/7, worldwide support for critical applications in the world's largest global corporations. A comprehensive Stratus support offering will cover the ftServer hardware and software, VMware ESX Server and both Windows and Red Hat® Enterprise Linux guest operating systems. Support will be available for other operating systems as well. Guest OS support may be obtained directly from the OS supplier or from another supplier.

These support services will make use of the Stratus ActiveService™ network for proactive, remotely enabled event resolution:

- The VMware ESX Server Subscription Service will include the unique capability of root-cause analysis for any problems associated with ESX Server.

- Virtual Machine Root Cause (vmRC) Support will add the unique capability of root-cause analysis for Windows or Red Hat Linux guest operating systems purchased directly from Stratus.

Professional Services

In addition, Stratus Professional Services will be offered to get virtualization efforts up and running quickly, and to support uptime requirements throughout the solution lifecycle. Services for ESX Server, virtualization design and virtualization deployment include:

- VMware Jumpstart installation service
- Virtualization Assessment
- Virtualization Design and Implementation
- Physical to Virtual Server Migration

Usage Scenario: The Manufacturing Plant

Though virtualization is most frequently associated with the data center — due to the high concentration of servers, applications and IT expertise present there — the benefits of virtualization are just as great, if not greater, in the manufacturing plants. These sites, often distant from the corporate data center, have rigorous availability requirements that VMware and Stratus address while simplifying many of the IT support tasks involved in deploying and maintaining complex IT solutions.

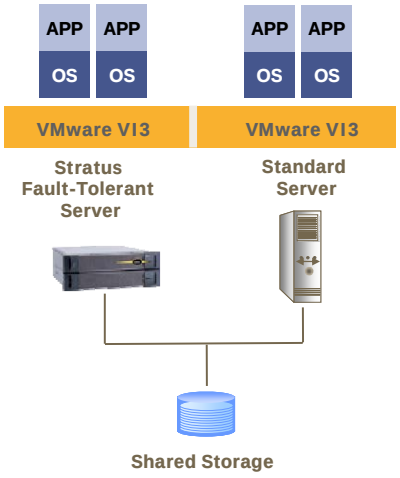
VMware and Stratus can provide extremely high levels of availability at the plant level without requiring the extensive infrastructure found at the data center, including the switched fabric SAN that typically comes with virtualization. Options are:

- **A single-system option** offers a single fault-tolerant Stratus server running VMware ESX Server. This configuration provides protection for all classes of hardware and software failure, but will require downtime for ESX Server upgrades. The benefits of VMware HA, DRS and VMotion are not available in this configuration.

- **A dual-system option** includes ftScalable™ storage, a shared-storage subsystem available from Stratus. This configuration adds the capabilities of VMware HA, VMware DRS and VMotion purchased and supported by a single supplier.

In addition, ESX Server virtual machines will run identically on Stratus and non-Stratus server hardware. VMware HA, VMware Distributed Resource Scheduler (DRS) and VMotion will work between Stratus and non-Stratus server hardware. A Stratus server along with a standard server, both connected to Stratus' ftScalable storage can provide the benefits of VI3 in a simple, affordable configuration.

Figure 3: Virtualization Example at the Manufacturing Plant



Above, five-nines applications run on the Stratus ftServer system. A non-fault-tolerant server can stand in for the Stratus server during periods of planned maintenance.

Desirable Benefits Without Undesirable Risks

As previously discussed, VMware VI3 and Stratus Continuous Availability ftServer systems together offer outstanding capabilities for handling unplanned outages, planned downtime, disaster recovery/business continuity and ongoing support. This extremely reliable base likewise lets manufacturers benefit from sought-after advantages of virtualization with the highest possible confidence:

- **Server consolidation.** Among the applications that have become integral to daily production and recordkeeping at manufacturing facilities are MES, data historian and distributed human-machine interface (HMI) software. Today each of these applications may be deployed on its own physical server hardware, even though a given application tends to use only a small percentage of the hardware's computing capacity. Virtualization provides a path to server consolidation, but unacceptable exposure exists if the underlying platform — including hardware, virtualization software layer and drivers — is not robust enough.

- **Extended application lifecycles.** Manufacturing companies want to ensure stability and reduce risk by avoiding changes to the software application and the operating system for as long as possible. Virtualization removes hardware dependencies, permitting older OS versions to run as virtualized guests with the newest processors and I/O devices. The ability to upgrade to newer hardware allows the lifecycles of applications to be readily extended.

- **Speed and ease of provisioning.** Standardized virtual machine(s) can be created that consist of software files including the application and an operating system. The virtual machine can be copied onto a server in a matter of minutes when additional capacity is required, or when an identical application configuration is needed at another site. The virtual machine can be qualified and tested in advance to verify it will work as expected.

- **Application development and testing.** Development and testing have traditionally required separate hardware for each different software environment and hardware configuration used in production. With virtualization, using a much smaller set of hardware — or perhaps even shared use of production hardware — becomes possible. Test and development environments can be isolated on their own virtual machine(s); separate virtual environments can be set up for each unique software configuration.

Conclusion

With VMware VI3, the most widely deployed virtualization software suite, and Stratus ftServer systems, the premier Continuous Availability servers, manufacturers are gaining new options for managing uptime and complexity of MES and other mission-critical applications across their lifecycles. As market leaders in their respective areas, VMware and Stratus are well-positioned to deliver on the high productivity, low costs and risk reduction that are priorities at the plant level.

About Stratus Technologies

Stratus Technologies is a global solutions provider focused exclusively on helping its customers achieve and sustain the availability of information systems that support their critical business processes. Based upon its 28 years of expertise in server and services technology for continuous availability, Stratus is a trusted solutions provider to customers in manufacturing, life sciences, telecommunications, financial services, public safety, transportation & logistics and other industries. **For more information, visit www.stratus.com.**