Double-Take® Replication in the VMware Environment:

Building DR solutions using Double-Take and VMware Infrastructure and VMware Server

Protect business-critical production servers with virtualized disaster recovery systems…

Double-Take® Software and VMware® provide proven protection for multiple production application servers by leveraging real-time data replication and virtualization technologies to create cost-effective, simplified disaster recovery architectures. Simply put, VMware virtual machines enable Double-Take to replicate application data from multiple production servers to a single disaster recovery target and failover to the disaster recovery target in the event of an outage. This document describes how VMware software can be used with Double-Take from Double-Take Software to provide solutions for challenging high availability and disaster recovery problems.

What is VMware Infrastructure?
VMware Infrastructure is the most widely deployed software suite for optimizing and managing industry standard IT environments through virtualization – from the desktop to the data center. The only production-ready virtualization software suite, VMware Infrastructure is proven to deliver results in a variety of environments and applications at more than 20,000 customers of all sizes. The suite is fully optimized, rigorously tested and certified for the widest range of hardware, operating systems and software applications. VMware Infrastructure provides built-in management, resource optimization, application availability and operational automation capabilities - delivering transformative cost savings and increased operational efficiency, flexibility and service levels.

VMware ESX Server is datacenter-class virtual infrastructure software for partitioning, consolidating and managing systems. ESX Server, included in Virtual Infrastructure, provides a highly scalable virtual machine platform with advanced resource management capabilities that can be managed by VMware VirtualCenter. ESX Server runs directly on x86 hardware, providing high performance and complete hardware resource control.

VMware Server is the next generation of the enterprise-class VMware Server software for x86-based servers. It is ideal for server consolidation, disaster recovery and streamlining software development processes. Support for all x86-based platforms makes VMware Server the most flexible server virtualization product available. Tight integration with VirtualCenter delivers unrivalled manageability and scalability. In contrast to ESX Server, the VMware Server runs as an application within an operating system installed on the x86 system.

VMware VirtualCenter delivers centralized management, operational automation, resource optimization and high availability to IT environments. Virtualization-based distributed services equip the data center with unprecedented levels of responsiveness, serviceability, efficiency and reliability. VirtualCenter delivers the highest levels of simplicity, efficiency, security and reliability required to manage virtualized IT environments of any size.

A Primer on Server Virtualization Technology

Server virtualization technology, pioneered by VMware, allows one physical platform to run multiple virtual machines simultaneously. Each virtual machine has its own processor(s), memory, disks and network interfaces.

VMware ESX server provides a highly efficient virtualization platform that runs on the hardware platform and does not need any *host* operating system. In other words, it is a bare metal virtualization server.

Functionally, each virtual machine is autonomous and unaware that the hardware is being shared. This allows multiple servers (even of different operating systems or versions) to run on one hardware platform.
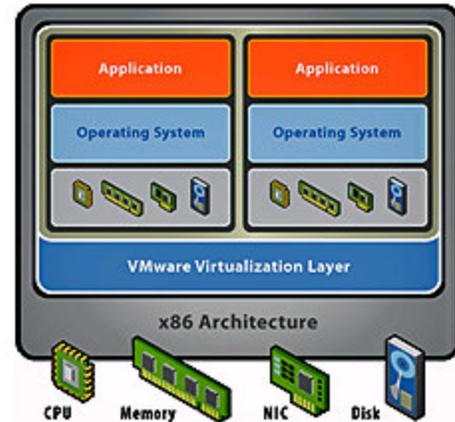

Figure 1 – VMware Server Architecture

One solution that this enables, for example, is for a single physical machine to support three different virtual machines:
- Microsoft® Windows® NT 4 running Microsoft Exchange 5.5
- Microsoft Windows Server® 2003 running Microsoft Exchange Server 2003
- A domain controller

The third virtual machine in the example above, a virtualized domain controller (DC), is useful for distributed branch offices that require a local DC but do not want to pay for the physical asset.

You can also run one virtual machine with Microsoft SQL Server and other virtual machines with Oracle® and/or Lotus® Notes. Normally, these applications mandate separate hardware to avoid incompatibility issues and to maximize performance.

The key to these solutions is in the complete autonomy between virtual machines and their respective operating systems and applications.

Using Double-Take with VMware Virtualization

One of the unique challenges of protecting virtual machines is the storage methods used within them – namely virtual disks and raw disks. With virtual disks, a group of related virtual disk files exists on the host server and presents itself as a storage device to the virtual machine OS. This causes encapsulation of the virtualized system's data into a single file set on the host server, which provides benefits in its autonomy, but complexity in its protection. The second storage method, use of raw disks, allows virtual machines to access a physical partition on the host server directly to store the virtualized system's data.

Virtual machines and their associated disk files created with either an ESX Server or a VMware Server can benefit from the replication capabilities and data protection innovation found in Double-Take. Many customers have realized the value of using Double-Take with VMware Server and ESX Server for high availability and disaster recovery in virtualized environments.

Double-Take is uniquely able to address these challenges due to its patented architecture and feature set. Most notably, Double-Take is able to protect the virtual disks, regardless of whether they are configured as virtual disk images or "raw disk" partitions. Whereas hardware-based synchronous replication is often proprietary for each storage vendor and provides no cross-vendor replication, and as long as storage is locally attached, Double-Take has no affinity to any hardware or storage provider or storage architecture (SCSI, FibreChannel, iSCSI). Additionally, Double-Take is server agnostic and will run on any Wintel AMD-based server, allowing Double-Take to be used on existing heterogeneous storage infrastructures.

Double-Take and VMware software can be used together to provide robust protection solutions:

- The most common customer need is to protect unique and sometimes conflicting applications on multiple servers to a single recovery server. While Double-Take inherently supports this many-to-one model for data replication, certain applications cannot co-exist on the same server due to conflicts or operational requirements, thus limiting the high availability options. By leveraging virtual machines on the target platform, each failed source can be protected and made available by an independent virtual machine target.

- Isolating data into secure locations and restricting unauthorized access is a priority for outsourcing providers and their customers that are looking for outsourced disaster recovery hot-site services or other off-site vaulting of data. This can be a significant challenge without purchasing separate physical machines for each client. And purchasing separate physical systems for each client quickly becomes cost prohibitive. By using designated virtual machines for each customer, data can be isolated from other customers while still allowing the hot-site provider to use their physical servers and floor space in the most efficient way possible.

- Similarly, some enterprise customers also have a need to segment servers, perhaps for security reasons, by business unit. This can be accomplished by designating separate virtual machines as independent Double-Take targets. In both of these cases, the server virtualization software from VMware ensures autonomy, while Double-Take provides efficient data replication and failover to the alternate data sites.

How Does Double-Take Protect a Virtual Machine?

Double-Take is a data protection solution for Microsoft Windows Server that combines continuous real-time replication and automatic failover capabilities for disaster recovery, high availability, and centralized backup. It supports applications like Windows File/Print services, Microsoft SQL Server and Microsoft Exchange Server as well as many others. Double-Take utilizes patented replication and failover capabilities that continuously capture byte-level changes as they happen and replicate those changes to another server either locally or over any WAN link.

One can enable Double-Take replication within a guest OS or on the host OS, as long as either is running a Windows Server OS.

If replicating from a guest OS (Windows Server 2000 or 2003), the process is just like replicating from a traditional physical server so no special considerations are necessary. This approach offers the flexibility of providing file-level selection for replication of individual files within the virtual disks belonging to a virtual machine. Replicating from the guest can be used anytime the guest is a Windows Server operating system, even when the virtual machine is not running on a Windows-based host OS.

If the host OS *is* Windows Server, Double-Take can also be run directly on the host server. From a Double-Take perspective, VMware Server and virtual machines running on it are like any other application that resides on top of the operating system, file system and hardware components of the server.
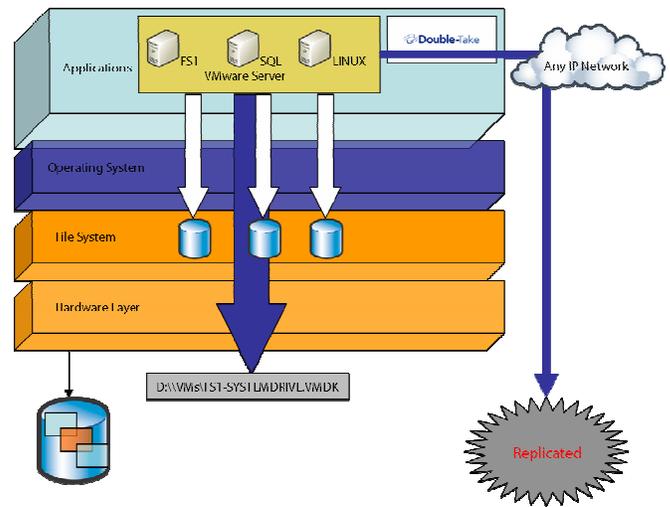

Figure 2 – How Double-Take replicates virtual disks

Double-Take captures disk-writes at the host's file system layer while all applications (including virtual machines writing to virtual disks) operate above the actual file system layer. This allows Double-Take to transparently and reliably protect that data, by replicating the data via its normal mechanisms to a target server running another copy of Double-Take.

In addition, replicating from the host OS (running VMware Server for Windows) offers the benefit of replicating non-Windows guest operating systems (e.g. Linux, Solaris x86, or NetWare). This allows customers to extend the protection of Double-Take to additional operating systems.

On the target side, Double-Take simply applies the same file update commands to the duplicate files that reside on the target server – sending only real-time byte-level changes across any IP connection.

VMware and Double-Take Solutions

VMware Server runs as an application on a Windows or Linux host OS. By using the Windows server based solution, users have the choice of replicating data from within the guest operating system or from the host operating system.

Replicating from a Windows host OS using Double-Take and VMware Server provides the following capabilities:

- The ability to replicate non-Windows OS virtual machines because the replication software on the host OS sees only changes to the virtual disk files regardless of what operating system is loaded in the virtual machine.

- Allows multiple guest operating systems to be protected with a single license of Double-Take because the replication license is based on the host OS instead of requiring licenses for each guest OS.

- "Whole system" failover capability of the guest OS because everything in the virtual machine's system volume (including system files, registry settings, INIs, DLLs, etc.) is encapsulated within the virtual machine's mounted disks or virtual disk files which are being replicated. Failover of the virtual machine to an alternate machine running VMware Server is simply a matter of recovering the virtual machine's configuration files and importing virtual machine on the second host.

VMware ESX Server 3 runs directly on x86 systems without using a host OS. ESX Server installs a virtualization layer directly on server hardware. Double-Take cannot be installed directly onto ESX Server, however, Double-Take can still be installed within any Windows-based guest operating system.

Replicating data from within Windows-based guest operating systems using Double-Take provides the following capabilities:

- The flexibility to select individual files and directories for replication. Being able to select only critical data files and directories for replication helps reduce replication overhead and improves the recovery point objective (RPO) of the solution.

- The ability to replicate changes to data running on Windows servers that are virtualized on non-Windows host operating systems.

SCENARIO 1 –VMware/Double-Take Solution for Virtual to Virtual Protection

VMware customers are deploying virtual machines on standard x86-based hardware to provide standardization of software and support tools and ease deployment of new platforms. When many critical applications are consolidated, it is much more important to protect the applications from Disaster. Leveraging real-time replication and application failover capabilities provided by Double-Take allows these customers to adequately protect their data and applications in the event of a disaster or major outage.

In this scenario, the production server platform might be running Windows Server 2003 as the host OS and VMware Server as the virtualization software. One virtual machine could be configured with Microsoft Windows NT 4.0 as its operating system running Microsoft SQL Server 2000. The guest OS hard drive is actually a file that resides on the host machine (e.g. D:\vms\server1\sys-drive.vmdk), while the host machine's other volumes might contain other virtual disk files or be used to store other types of data.

In order to provide fault tolerance across any IP network (LAN or WAN), Double-Take can be installed to replicate the bytes of data that change to another Windows server somewhere in the enterprise.

Solution 1A – Replication From the Guest OS
Double-Take can be installed within the guest OS. This allows Double-Take to replicate any part of the logical files or directories within the virtual machine's disks. The target server has no recognition that the source server is a virtual machine and not real hardware. Upon failover, the Double-Take target server would assume the name, IP, file shares and services of the failed guest OS.

Solution 1B – Replication from the Host OS
Double-Take can be installed on the host OS and maintain replicas of all of the VMware virtual disk and configuration files on the target server. The target server would "monitor" the guest OS for failure but instead of actually assuming the name, IP, file shares and services, it would simply invoke a script that would initialize VMware Server on the target server. The VMware Server instance would then utilize the replicated virtual disk files which hold the actual configuration and data from the guest OS.

Solution 1B also illustrates how the entire guest OS, including its system state and other key settings, can be replicated and failed over to a target server.

SCENARIO 2 – Enhanced "Many-to-One" Failover for Physical to Virtual Protection

One of the most interesting uses of virtualization technology in relation to disaster recovery is the use of virtual machines as disaster recovery targets. In a lot of customer situations, proliferation of hardware at the disaster recovery site is a burden on their budgets both from an acquisition as well as a maintenance perspective. While consolidating multiple production applications to a single OS image at the disaster recovery site is sometimes possible, it is often complex and difficult to support. By leveraging virtual machines as disaster recovery targets, customers can achieve a "many-to-one" failover scenario for their physical servers and reduce both the operating costs and complexity associated with their disaster recovery architecture. An example of this scenario (outlined below) illustrates four Double-Take source production servers replicating and failing over to one physical target:

- Database server SQL1 running Windows Server 2003 and SQL 2005 for the Sales department
- Database server SQL2 running Windows Server 2000 and SQL 7.0 for the Marketing department
- Database server ORCL2 running Windows 2000 and Oracle 9i
- Database server NOTES01 running Windows 2003 and Lotus Domino Server

One potential problem would be if SQL1 and SQL2 both experienced an outage simultaneously. Microsoft SQL Server 7.0 and Microsoft SQL Server 2005 were not intended to run on the same machine. While there might be a way to mount both datasets, this would complicate a high availability solution.

Also, while each of these applications may run fine as the only application on each server, compatibility issues may arise by having three database applications (SQL, Notes and Oracle) installed and running on the same target server.

Using VMware virtualization, Double-Take can provide for failover for all of these servers to one physical machine. The target server (running VMware Server or VMware ESX Server) would be configured with four virtual machines – each running the appropriate Windows OS version and application version. During normal operation, the applications would be in a "down" state, allowing Double-Take to replicate changes to the protected data to these virtual machines in real-time. At failover time, the appropriate application services would be started within a corresponding virtual machine and Double-Take would orchestrate the seamless redirection of users from the original production server to the standby server running within a virtual machine at the DR site. This would allow

the target to provide high-availability for each of the protected servers without running the workloads on the same instance of Windows on the host.

> *"We have 25 Windows servers including 5 SQL servers in production in San Francisco, replicating with Double-Take to a VMware server in New York. I can't imagine how we could have implemented anything else as effective for disaster recovery. Double-Take*

Customer Example

A Double-Take customer has seven production servers with a variety of hardware manufacturers, operating systems and applications. Despite these differences, the customer still requires the same level of recovery across all the following platforms while utilizing only one physical target server:

- Windows Server 2000 and SQL 7
- Windows NT Server 4.0 and Exchange 5.5
- Windows Server 2003 Domain Controller
- Windows Server 2000 and Custom Application
- Windows-Powered NAS File Server
- Windows 2003 and IIS Web Server
- Windows 2003 File Server

This is a common request from customers and highlights why host-based, byte-level file replication software like Double-Take is a flexible, cost-effective solution. While Double-Take supports many-to-one solutions without virtualization, the variety of applications in some customer situations warrants keeping each application separate during failover.
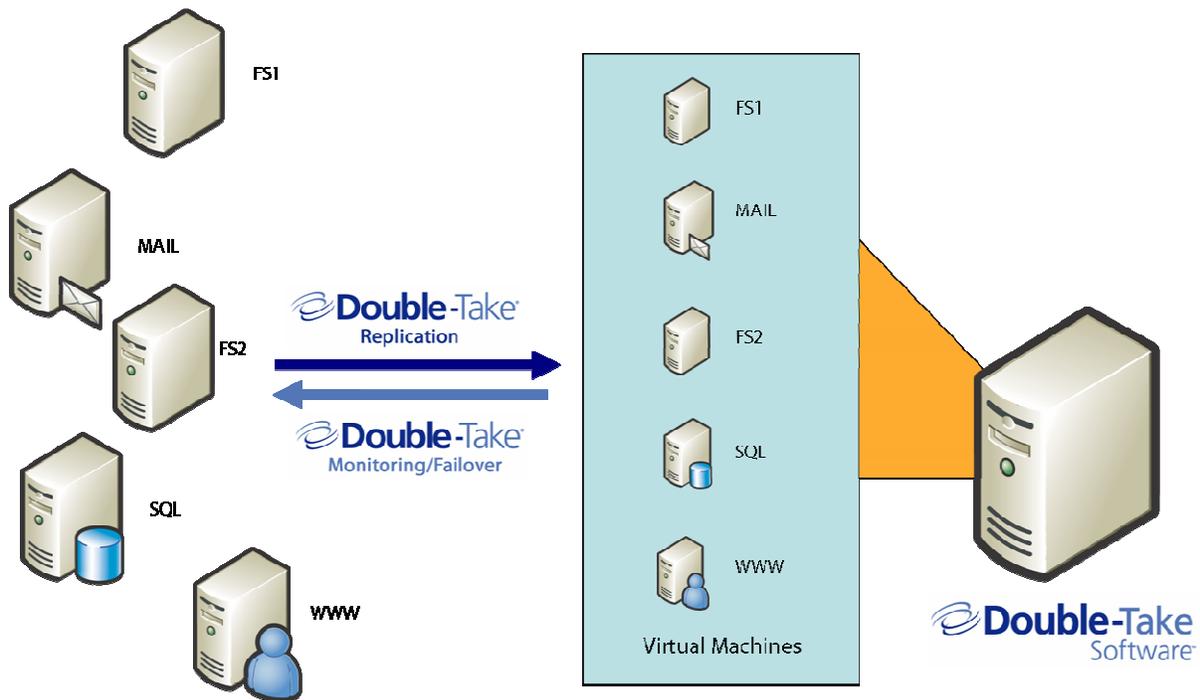

Figure 3 – "Many to One" with virtual machines on the target

To accomplish this, the Windows 2003 target server was configured with Double-Take and VMware Server. A copy of Double-Take was also installed on each of the production servers. Then, seven VMware virtual machines and their respective guest operating systems were configured.

Failover of one or more failed servers is accomplished by simply starting the appropriate services within a virtual machine on the target running a similarly configured OS, mounting the appropriate data sets and seamlessly redirecting end users. This failover process is achieved quickly and allows the application to continue to serve the user community during an outage.

About Double-Take Software

Double-Take® Software provides the world's most relied upon solution for accessible and affordable data protection for Microsoft® Windows® applications. The Double-Take product is the standard in data replication, enabling customers to protect business-critical data that resides throughout their enterprise. With its partner programs and professional services, Double-Take delivers unparalleled data protection, centralized back-up, high availability, and recoverability. It's the solution of choice for thousands of customers, from SMEs to the Fortune 500 in the banking, finance, legal services, retail, manufacturing, government, education and healthcare markets. Double-Take is an integral part of their disaster recovery, business continuity and overall storage strategies. For more information, please visit www.doubletake.com.

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About VMware

VMware is the global leader in virtual infrastructure software for industry-standard systems. The world's largest companies use VMware solutions to simplify their IT, fully leverage their existing computing investments and respond faster to changing business demands. VMware is based in Palo Alto, California. For more information, visit www.vmware.com or call 650-475-5000.