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Tivoli software
IBM TotalStorage™

IBM storage solutions: Delivering high availability



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Executive summary

Today’s key business initiatives such as enterprise resource planning (ERP), supply chain management (SCM), e-commerce, customer relationship management (CRM) and e-business can no longer function without information technology: data, software, hardware, networks, call centers – even mobile computers. The financial and intangible damage that a company can suffer if critical business applications are unavailable can be staggering (see Figure 1).

The goal, now, for companies with no business tolerance for downtime is to achieve a state of business continuity, where critical systems and networks are continuously available, no matter what happens.

Industry	Cost per hour of downtime
Securities industry	U.S.\$29301
Manufacturing industry	U.S.\$26761
Banking industry	U.S.\$17093
Transportation industry	U.S.\$9435

Figure 1. Average financial loss per hour of disk array downtime.¹

To help IT managers improve business results by delivering highly available applications, IBM is working to deliver storage solutions that:

- *Virtualize file system and volume management to help eliminate key contributors to storage-related planned downtime*
- *Help administrators add autonomic capabilities into their storage networks to minimize unplanned downtime*
- *Integrate with key clustering software, data-replication techniques and applications to speed recovery following a worst-case disaster*

Organized under both the IBM Tivoli® software and IBM TotalStorage™ brands, IBM delivers comprehensive storage software and hardware solutions that help IT managers evolve to an on demand operating environment.² This paper focuses on the following current and upcoming members of IBM’s comprehensive storage portfolio (see highlights on page 2) and a selected list of their integrated capabilities for delivering high availability.



Highlights

- *IBM TotalStorage Virtualization Family*
 - *IBM TotalStorage SAN Volume Controller*
 - *IBM TotalStorage SAN File System*
 - *IBM TotalStorage SAN Integration Server*
- *IBM TotalStorage Enterprise Storage Server™*
- *IBM Tivoli Storage Area Network Manager*
- *IBM Tivoli Storage Resource Manager*
- *IBM Tivoli Storage Manager*

Evolving to an on demand operating environment can be a key step in engineering the application availability required for business continuity.

Application availability—the key to business success

Information technology has become embedded in the fabric of virtually every aspect of business. Computing is no longer something done in the background. Key business initiatives such as ERP, SCM, e-commerce, CRM and e-business in general have all made continuous, ubiquitous access to information crucial to an organization.

This means business can no longer function without information technology: data, software, hardware, networks, call centers—even mobile computers. A company that sells products on the Web, for example, or supports customers with an around-the-clock call center, must be operational 24x7—or customers will go elsewhere. A company's reputation, customer base, and revenue and profits are at stake.

The New York-based research firm FIND/SVP calculates the average financial loss per hour of disk array downtime at U.S.\$29 301 in the securities industry, U.S.\$26 761 for manufacturing, U.S.\$17 093 for banking and U.S.\$9435 for transportation. More difficult to calculate are the intangible damages a company can suffer: delays in key project timelines, diverted resources, regulatory scrutiny, unrecoverable data and a tainted public image. In this climate, executives responsible for company performance now find their personal reputations at risk. Routinely, companies that experience online business disruptions for any reason make headlines the next day with individuals singled out by the press. Corporate directors can be identified as responsible for the consequences of business interruption or loss of business-critical information. And, increasingly, adequate protection of data may be required by law, particularly for a public company, financial institution, utility, health care organization or government agency.



Highlights

New architectures in virtualized file system and volume management are designed to help IT managers eliminate key contributors to storage related downtime—data movement and storage reconfiguration.

The goal, now, for companies with no business tolerance for downtime is to achieve a state of business continuity, where critical systems and networks are continuously available, no matter what happens.

Evolving to an on demand operating environment can be a key step in engineering the application availability required for business continuity.

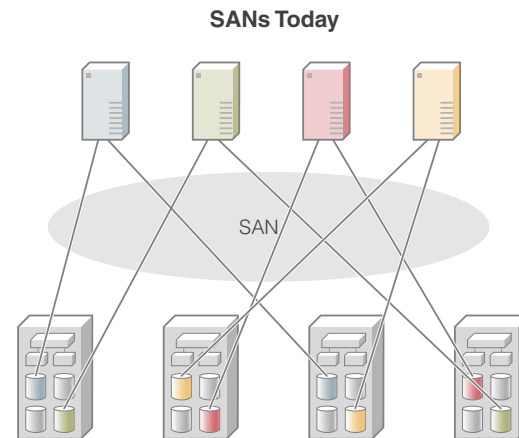
Improving application availability with IBM storage solutions

IBM is delivering solutions to help IT managers reduce storage downtime and the availability impact to business applications. Organized under both the IBM TotalStorage and IBM Tivoli software brands, these integrated solutions are modular in design, each component with well-defined functions and open interfaces, making it possible for IT managers to construct, upgrade or enhance their on demand operating environment one component at a time.

Help eliminate planned downtime

A common goal of many businesses with no tolerance for application outages is to eliminate the drivers that necessitate the need for planned downtime. Today, new architectures in virtualized file system and volume management are designed to help IT managers eliminate key contributors to storage-related downtime – data movement and storage reconfiguration.

In *traditional environments*, applications, and the host systems they run on, are very aware of the physical storage devices on which their data is stored (see Figure 2). Hosts mount the physical devices, organize them into volume groups, format them with a file system, replicate them and, in the case of some database systems, write data on the raw, unformatted devices. In this type of environment, movement of data or changes in the physical hardware – due to growth, reconfiguration or lease expiration, for example – often necessitate application outages while the host system view of the physical storage is updated.



Servers are mapped to specific physical disks ("physical mapping")

Figure 2. Traditional environment with host systems involved in physical management of storage.

One of the goals of the new, virtualized architectures is to separate the logical view of storage that host systems and applications have from the actual physical implementation of that storage. This is accomplished by taking the traditional volume and file system management functions that hosts must get involved with, and moving them off the hosts and storage subsystems into a new architectural layer in the storage network. This new, virtualization layer separates the logical view of storage from the physical implementation. With this separation, IT managers are now free to plan data movement or physical hardware changes while minimizing interruption to business applications.

Two modular storage components that have been designed to help IT managers evolve to an on demand operating environment are the *IBM TotalStorage SAN Volume Controller*—designed to virtualize the host view of physical volumes—and the *IBM TotalStorage SAN File System*—designed to virtualize the host view of the file system. These are both part of the new IBM TotalStorage Virtualization Family—planned for release in mid-2003.

The SAN Volume Controller will transform the traditional connection that a host has with its volume manager. SAN Volume Controller will be implemented in the storage network between the hosts and the physical storage providing a common volume management “utility” that all hosts use. The physical disks will be discovered and organized into virtual disks that can be constructed from any portion or combination of physical disks that the administrator chooses. These new virtual disks are then presented to the host systems (see Figure 3).

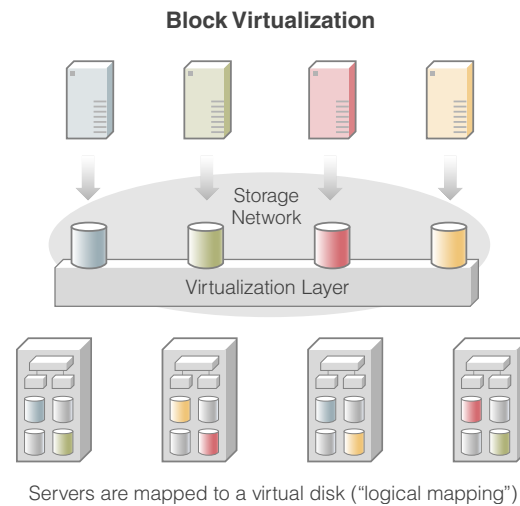


Figure 3. IBM TotalStorage SAN Volume Controller provides a common volume management utility, separating the logical view of storage that hosts have from the physical implementation.

With the SAN Volume Controller in place, data can be moved from one physical disk to another—or even from one vendor’s disk to another—without affecting the virtual disks that the host systems see. This way, IT managers can more effectively plan for physical changes in the storage infrastructure without interruption to business applications.

Another variation of volume management virtualization offerings from IBM is the *IBM TotalStorage SAN Integration Server*, also a planned (mid-2003) member of the Virtualization Family. This solution will be integrated, at manufacturing time, combining the SAN Volume Controller along with other components (IBM TotalStorage SAN switch, IBM TotalStorage FAS*t*T storage, IBM Tivoli Storage Area Network Manager, rack, and cabling) into a complete SAN environment.

The goal is to make it easier for IT administrators to install new SANs with all the benefits of virtualization.

Next, turning to virtualized file management, the IBM TotalStorage SAN File System – planned for release in late 2003 – has been designed to transform the traditional connection that a host has with its file system. With SAN File System, host machines will “plug in” to a common, SAN-wide file structure giving them “visibility” to all data. “Access” and “usage” are then controlled by policies governing security and quotas (see Figure 4).

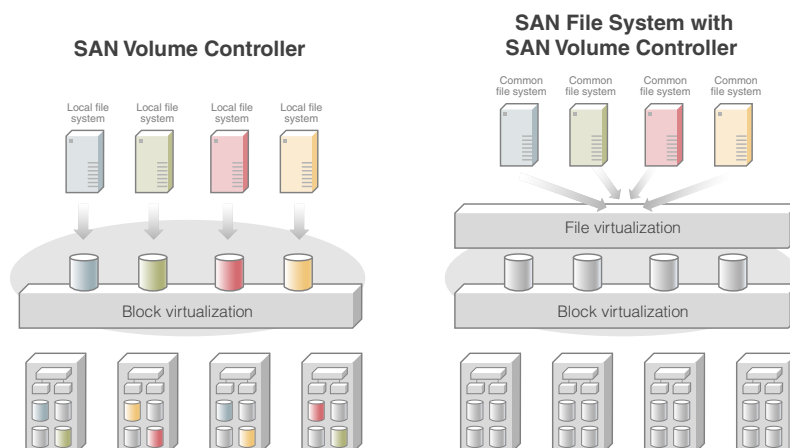


Figure 4. IBM TotalStorage SAN File System provides a common SAN-wide file structure, enabling policy-based data movement without disruption to host applications.

With SAN File System, IT managers will be able to move individual files or directory structures – to improve availability characteristics or to correct a performance “hot spot” for example – without interruption to business applications. SAN File System also enables IT managers to perform file management functions – like backup, virus scanning or storage resource management – from surrogate management hosts instead of from hosts that are dedicated to business applications. This helps to reduce or prevent any potential impact that these file management functions might have on application availability or performance.

Highlights

As a part of IBM's comprehensive database performance, availability and storage management offering, IBM Tivoli Storage Resource Manager for Databases answers key questions that help IT managers better control the storage used by databases.

Reduce unplanned downtime

With major sources of planned downtime controlled by new architectures in virtualized file system and volume management, IT managers can turn their attention to managing their on demand operating environment proactively to minimize unplanned downtime. Two areas of focus that can result in significant reductions in the occurrences of unplanned downtime are preventing application out-of-space conditions and both engineering and managing the storage network for high availability.

As the foundation for many of the applications used to enable on demand businesses, supporting the availability of database management systems is an area of considerable attention. As part of IBM's comprehensive database performance, availability and storage management offering, *IBM Tivoli Storage Resource Manager for Databases* can help answer key questions that help IT managers better control the storage used by databases:

- *How full are the databases on my hosts and which ones are more likely to have space-allocation problems soon?*
- *Which user or tablespace is leading to database space-allocation problems?*
- *How am I using up my allocated file system and database space over time?*

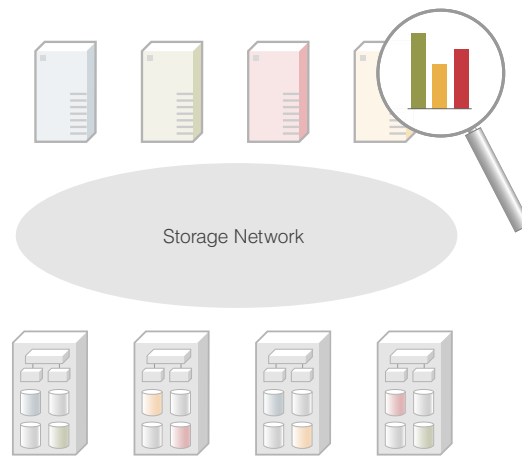


Figure 5. IBM Tivoli Storage Resource Manager for Databases answers key questions that help IT managers better control the storage used by databases.

Highlights

Tivoli SAN Manager employs advanced rule sets and predictive techniques to isolate faults and proactively alert administrators before these faults can impact business applications.

Based on this information, administrators can direct Tivoli Storage Resource Manager to trigger automated responses to situations that might result in application outages – an out-of-space condition on a critical database for example.

Providing well-managed databases with a fault-tolerant storage network to run on is a second area of focus for IT managers. Another key enabler of an on demand operating environment, *IBM Tivoli Storage Area Network (SAN) Manager*, helps IT managers design and validate fault-tolerant storage network configurations (see Figure 6).

- *What firmware levels are loaded on all my host bus adapters (HBAs)?*
- *What firmware levels are loaded on all my SAN switches?*
- *How are the logical zones configured?*
- *Does a given host have alternate paths through the storage network?*
- *Do those alternate paths use alternate switches?*
- *If available, are those alternate paths connected to alternate controllers on the storage device?*

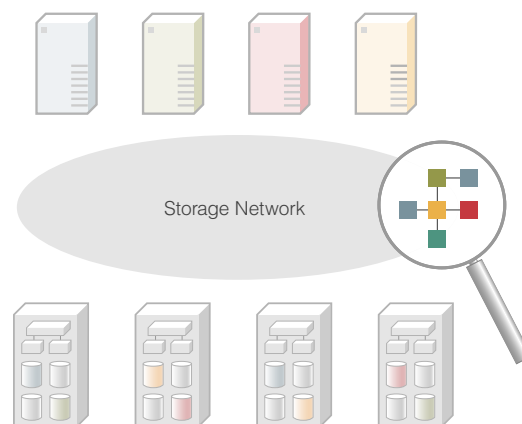


Figure 6. IBM Tivoli SAN Manager helps IT managers design and validate fault-tolerant storage network configurations.



Highlights

Often, tight integration between multiple components of the infrastructure is required to minimize disruption to applications caused by worst-case disaster events.

As the term implies, these configurations “tolerate faults.” As an added level of protection, Tivoli SAN Manager delivers autonomic functions – employing advanced rule sets and predictive techniques to detect changes in network performance and throughput levels, and to correlate those changes with error rates and events in the network. Tivoli SAN Manager uses this information to isolate faults and proactively alert administrators before these faults can impact business applications.

Accelerate recovery

Even in the best-managed environments, there can be unforeseen, worst-case events that can result in the disruption of an application’s access to its data. Often, in these cases, tight integration between multiple components of the infrastructure is required to minimize the length of the disruption.

One of the more aggressive approaches to avoid disruptions is synchronous disk mirroring or Peer-to-Peer Remote Copy (PPRC). As an option for both the *IBM TotalStorage Enterprise Storage Server™* and the *IBM TotalStorage SAN Volume Controller*, PPRC can give IT managers the ability to maintain a real-time mirror of application data at a remote location. Tight integration between PPRC and host clustering software, like the integration between the IBM TotalStorage Enterprise Storage Server PPRC function and IBM AIX® High Availability



Cluster Multi-Processing (HACMP) software for example, means that applications and their data can automatically switch to a remote processing center if the primary center is impacted by an unforeseen event (see Figure 7).

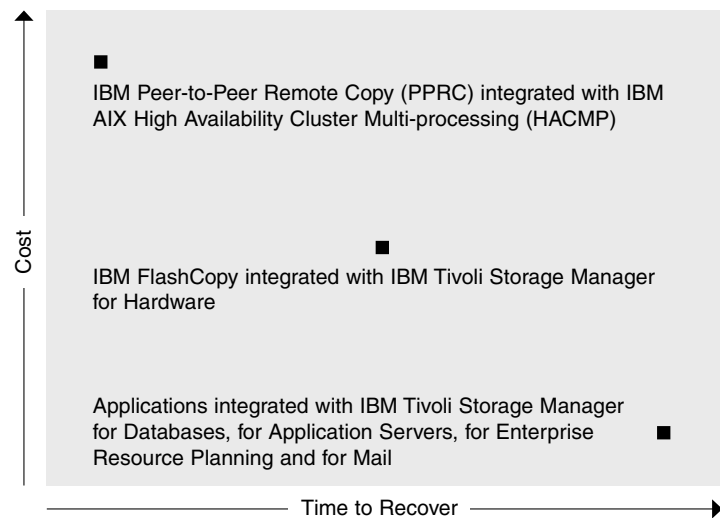


Figure 7. Tight integration between components of an on demand operating environment can minimize the length of application disruption caused by a worst-case disaster.

A somewhat less aggressive and less costly approach is the FlashCopy® feature. Also available as an option for the Enterprise Storage Server and the SAN Volume Controller, FlashCopy gives IT managers the ability to take an instantaneous point-in-time copy of application data. FlashCopy offers IT managers the flexibility to choose between making a full background copy of the data at the time the FlashCopy is invoked or to simply capture a set of virtual pointers to the data. If no background copy is made, one physical copy of the data is maintained with two sets of virtual pointers, one representing the active data and one representing the FlashCopy. Following the creation of the second set of FlashCopy virtual pointers, as updates arrive for the active copy, FlashCopy makes a physical copy of the blocks before the changes are applied. This way, the integrity of the FlashCopy is maintained without requiring a complete background copy of the physical data. Tight integration between FlashCopy and



data protection software, like the integration between the Enterprise Storage Server FlashCopy function and *IBM Tivoli Storage Manager for Hardware*, means that a reliable recovery point for application data can be captured while avoiding impact to application availability or performance.

A third approach is direct integration between backup software and business applications. With its *IBM Tivoli Storage Manager for Databases, for Application Servers, for Enterprise Resource Planning* and *for Mail* modules, Tivoli Storage Manager integrates with applications to make backup copies of critical application data while the application is operational. With either FlashCopy or application integration, Tivoli Storage Manager is able to capture a consistent recovery point for application data making it possible for IT managers to restore business operation reliably following a worst-case disaster. To help streamline the recovery process, IBM Tivoli Storage Manager Extended Edition facilitates the creation and tracking of additional copies of critical business data at an off-site location. Tivoli Storage Manager Extended Edition also prepares and keeps up-to-date a text file with detailed recovery steps and automated computer scripts – the “recovery plan.” Should a worst-case disaster strike, this plan and the off-site data copies can greatly speed business recovery.

Conclusion

With IT now embedded in most business processes, delivering highly available applications has become crucial to an on demand business. To help IT managers deliver high availability, IBM is delivering open storage solutions that can help eliminate key contributors to storage-related, planned downtime, help administrators engineer their storage networks with autonomic capabilities to minimize unplanned downtime and integrate to speed recovery following a worst-case disaster. These integrated solutions are offered in modular components so IT managers can construct, upgrade or enhance their on demand operating environment one component at a time

For more information about IBM e-business on demand™ and storage, ibm.com/ondemand, ibm.com/totalstorage and ibm.com/tivoli



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¹ Patrowic, Lucie Juneau, "A River Runs Through It." CIO Magazine, April 1, 1998.

² For a more complete discussion of the value of an on demand operating environment, see the IBM white paper *IBM Storage Solutions: Evolving to an on demand operating environment*.

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5600 Cottle Road
San Jose, CA 95136
U.S.A.

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