

# HP StorageWorks Enterprise Virtual Array (EVA) Storage Solutions: High-Performance and Low-Cost Disk Drives



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## Abstract

Reference data is growing at an exponential rate and until recently users did not have many options for placing their data on cost-effective media, with good performance, based on the data's value, critical business needs, age, frequency of use, and application use. A user's choices were primarily high-performance disk, tape, and optical media.

A new category of high-capacity, lower-cost, and lower-performing disk is now available to provide users with an additional storage option. This new disk drive category is known as Near-Online, Nearline, or Midline, and complements high-performance disk drives and tape/optical products. Moreover, creation of this new category provides an additional option for users to match the data type to a specific quality of service and storage media.

This overview describes using Near-Online storage, low-cost Fibre Attached Technology Adapted (FATA) disk drives, in the HP StorageWorks Enterprise Virtual Array (EVA), to supplement the high-performance disks and complement the use of tape and optical storage resources. Solutions using high-performance disk, low-cost FATA disks, and tape drives are also included in this paper.

## Summary

Users are continuously looking to maximize the value of their storage resources and constantly challenged with expanding capacity requirements. Moreover, these challenges become even greater with the need to provide timely backups and quick restoration as the data sets continue to grow. Additionally, based on federal regulations and requirements, IT managers are eager to acquire storage that is easily managed and cost effective.

For many years, tape has been the preferred type of media for data backup, archiving, and security. However, new low-cost and lower-performing disk storage will now play a role in the departmental and enterprise computing environments.

Low-cost and lower-performing disk storage has a price point greater than tape but less than high-performance disks while providing benefits of rapid backup and recovery, data reference, and data archiving.

Many applications do not access data frequently, for example, document imaging and static data required by the Health Insurance Portability and Accountability Act (HIPPA) and the Sarbanes-Oxley Act, but require relatively fast access to the data when the need arises. Until now, the user's only choice was to place data on more costly high-performance storage resources to achieve fast access of the data. Advanced Technology Attachment (ATA) disks, Parallel ATA (PATA), Serial ATA (SATA), and the new FATA disk complement the use of high-performing disk and tape and are the preferred storage resource choice over high-performance disk or tape for applications that access files infrequently, but need access to the data at disk speed.

As the importance of storage continues to grow in the data center, managers will substantially benefit not needing to increase their people resources to manage the addition of low-cost storage in the EVA.

The EVA's tiered storage capability, implementing high-performance and low-performance/low-cost disk drives, is another step in the HP plan for a simpler path to the Adaptive Enterprise and delivering Information Lifecycle Management (ILM) solutions with a fully integrated/consolidated infrastructure.

The EVA is a vital solution for organizations that desire investment protection and want to gain additional efficiencies from their storage infrastructure. The EVA provides a consolidated and simple management solution for users who want an embedded set of tiered disk storage within the same frame. Simply stated, the EVA provides the infrastructure for users to be able to migrate differently valued data types, based on the data's perceived value, to the most appropriate storage type to meet availability, performance, regulatory compliance, and cost goals.

## FATA disk drive

The FATA disk drive is the first in a family of “hybrid” Fibre Channel (FC) drives. The FATA disk drive is a low-cost, high-capacity drive built specifically for FC enterprise class array. Moreover, the drive is considered a hybrid drive because it has many characteristics of higher performance FC drives such as a large command queue as well as a large data cache. There are additional drive feature comparisons in Table 1. The FATA drive is ATA-like in the sense that the random I/O performance will be similar to PATA and SATA drives based on a drive-to-drive comparison. However, due to the EVA’s data placement algorithms and virtualization techniques, the random I/O performance with a group of FATA disk drives is much better than what can be accomplished with one individual drive; the sequential performance is essentially the same as the high-performance 10K RPM disk drives.

### FATA versus PATA/SATA versus high-performance disks

Enterprise class disk drives offer the highest performance, reliability, availability, and functionality compared to PATA/SATA disks.

PATA disks, and more recently SATA disks, have been introduced as low-cost storage for tiered storage applications. These disk drives provide lower cost storage solutions, but have the limitation of lower performance and lower reliability (if not used as intended) compared to the enterprise class disk drive counterpart.

The FATA hybrid FC disk architecture places it between the enterprise class disk and PATA/SATA disks for performance, reliability, availability, and functionality.

The FATA disk drive coupled with the EVA’s optimized data placement algorithms and virtualization techniques make it the preferred low-cost solution for many applications such as archiving, backup/restore operations, and high bandwidth applications such as video editing, streaming, and so on.

The FATA hybrid FC disk drive does not require a conversion from FC to the SATA interface or to PATA interface. Therefore, the FATA disk drive includes the same dual ported 2-Gb/s FC channel interface used on HP high-performance drives that ensure compatibility and investment protection by using the EVA’s existing disk drive enclosure. This is a key differentiator between the HP solution and other solutions. In addition, the FATA hybrid drive includes Self-Monitoring, Analysis and Reporting Technology (SMART) capability, optimized sequential addressing capability (seek ordering and rotational optimization algorithms), and FC protocol native data integrity and error event handling capability found in higher performing enterprise class FC disk drives.

### PATA, SATA, FATA, and FC primary differences

#### **PATA drive (Designed for desktop PC)**

The PATA disk drive has been the storage interface for the desktop/PC disk drive for nearly 20 years. With its limited, maximum interface speed of 133 MB/s and large 40-connection parallel ribbon cable, the drive is seldom considered for new designs.

Capabilities:

- Designed for eight Power On Hours (POH) per day, single user, low workloads
- Lower performance than enterprise class drives
- Designed for minimal sequential and minimal random I/O activity, approximately 20% duty cycle
- Good reliability when used in environments for which it is designed

### **SATA drive (Designed for desktop and arrays)**

The SATA disk drive is a single port interface on an ATA disk. The SATA interface allows a point-to-point connection enabling multiple ports (disk drive connections) aggregated on a single controller.

The SATA interface supports performance capabilities of approximately 150 MB/s. SATA also has plans to evolve to 300MB/s and 600 MB/s interfaces over the next several years.

Capabilities:

- May support limited command queuing dependent on disk drive vendor
- Disk can be replaced with power applied (hot pluggable/hot swap)
- Designed for 24 POH per day; multi-user and array use
- Lower performance than enterprise class drives, better than PATA
- Designed for sequential I/O, low random I/O activity 10–20% duty cycle (vendor and model dependent)
- Good reliability when used in environments for which it is designed

### **Enterprise class FC and FATA drive (Designed for FC arrays)**

High-performance FC disk drives and FATA drives use the same FC dual port arbitrated loop interface. The EVA can support 240 drives of the high-performance disk, FATA disk, or any mix of both disks in the standard EVA drive enclosure.

Both the high-performance disk drives and FATA disk drive support a command queue depth of 128. The EVA will load the command queue to a depth, for both the high-performance drives and FATA drive, which ensures optimal performance. Moreover, the high-performance disk drives and FATA drive include the electronics and algorithms to support optimized rotational positioning in addition to optimized seek positioning. The optimized rotational positioning capability is a feature that may not be implemented in PATA/SATA disk drives.

High-performance FC disks and FATA disks can be replaced with power applied.

The FC interface supports performance capabilities of 2 Gb/s, approximately 200 MB/s. FC also has plans to evolve to 4 Gb/s, 8 Gb/s, and 10 Gb/s.

#### *Enterprise class FC drive*

Capabilities:

- Designed for 24 POH per day; multi-user and array use
- Best performance compared to PATA, SATA, and FATA
- Designed for sequential I/O and high random, 100% activity
- Best reliability

#### *FATA drive*

Capabilities:

- Designed for 24 POH per day; multi-user and array use
- Better performance compared to PATA and SATA
- Designed for sequential I/O, random I/O activity approximately 30% of the time
- Good reliability when used in environments for which it is designed

## I/O activity—duty cycle defined

Random I/O duty cycle can be expressed as a ratio or a percentage. For example, considering a random I/O duty cycle of 30% with FATA disks is 18 minutes out of 60 minutes ( $18/60 = 30\%$ ).

- PATA/SATA—Many PATA and SATA disk drives are not designed for high random I/O activity, that is, seeks occurring in a random fashion across the media, and are best suited for limited random I/O environments and where the dominate type of transfer is sequential.
- FC—High-performance disks, enterprise class drives, are designed for both continuous sequential transfers as well as high random I/O activity.
- FATA—The EVA’s data placement algorithms, combined with FATA’s hybrid design using a 128 deep command queue, provide the capability to use the FATA drive in sequential I/O environments and a greater degree of random I/O environments than PATA or SATA technologies.

## Drive difference summary

Table 1 summarizes the primary differences between PATA/SATA, FATA, and high-performance disk drives.

Table 1. PATA/SATA/FATA/high-performance disk

	Near-Online Solutions		High Performance Solutions
Data based on disks => 200 GB	PATA/SATA	EVA FATA - “hybrid disk”	EVA High Performance Disk
Interface	Parallel/Serial ATA; Single port	Native Fibre Channel/dual port	Native Fibre Channel/dual port
S.M.A.R.T.	Vendor dependent	Yes	Yes
Command Queue (Seek Optimization)	<= 32 depth	128 depth; best optimization	128 depth; best optimization
Rotational Optimization	Unlikely	Yes	Yes
Avg. seek time	~ 9 ms – 10 ms	~10 ms FATA~SATA>High Performance <sup>1</sup>	~ 5 ms
Spindle Speed	5400, 7200	FATA ~ High Performance <sup>1</sup>	10K, 15K
Transfer Rate	133, 150 MB/s	200 MB/s	200 MB/s
Cache	2, 8 MB	8 MB	8 MB
MTBF	Good when used for Near-Online applications	Better than PATA/SATA when used for Near-Online applications	Best: High performance or Near-Online applications

Note<sup>1</sup>: Individual drive performance specifications are NOT a true indication of actual performance when used in the EVA due to its data placement algorithms and virtualization techniques. Vdisk performance is better than individual disk performance.

## Near-Online storage cost advantages

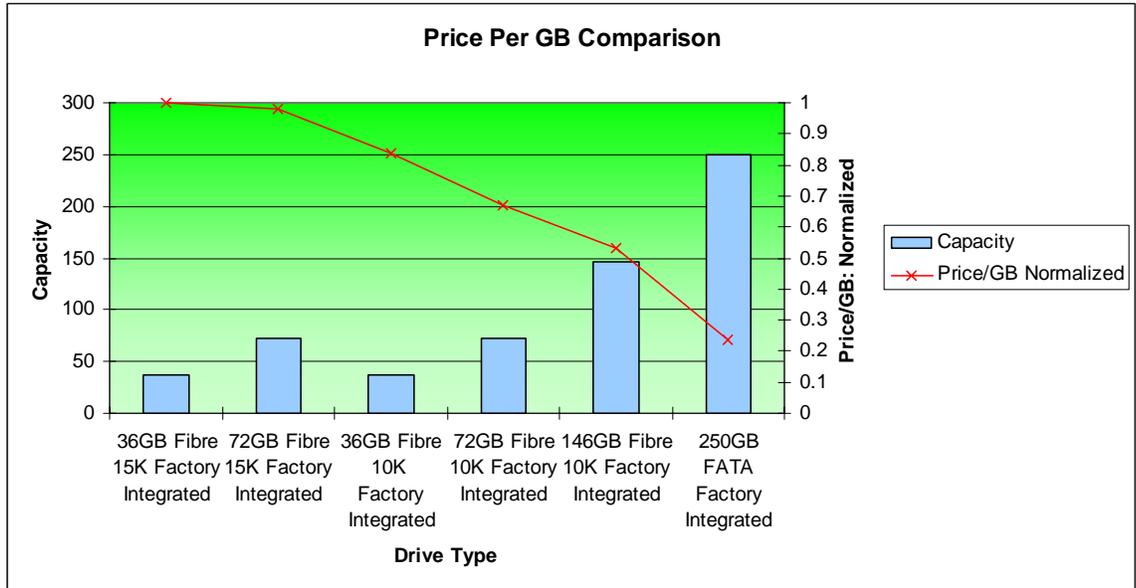
The primary advantage of PATA, SATA, and FATA disk drives is the lower cost. Enterprise class drives use more robust, more costly components with tighter tolerances and are designed for random I/O duty cycles in excess of 70%, 24 hours per day. Additionally, the Mean Time Between Failure (MTBF) of the enterprise class drives is over a million hours when exercised at this rate.

Near-Online disk drives are typically designed with less costly components and built to be exercised in sequential transfer environments with random I/O duty cycles in a 20%–30% range. The MTBF of disk drives in the Near-Online category vary widely by vendor and respective models. The FATA disk, due to its hybrid design, has one of the better MTBFs in the industry at approximately one million hours when used for Near-Online types of applications.

## Price comparison

There are numerous pricing variables for disk drives based on how they are implemented into a solution, capacity, performance, vendor, and so on. This document compares PATA, SATA, and FATA disk drive prices as used in the enterprise class of computing and does not provide a comparison of the drive prices in the departmental class of computing. Chart 1 illustrates a normalized price per gigabyte of the FATA disk drive in association with other drives used in the EVA.

Chart 1. Price per GB comparison



## Performance—Virtual disk (Vdisk) is better than the disk

Individual disk drive performance specifications are a guide and not a true indicator of the performance that a user may observe unless the disk drive is used as an individual volume. Typically, SATA and PATA Near-Online solutions will implement the disk drives configured as members of a RAID set, or in the case of the FATA disk, as members of an HP StorageWorks Enterprise Virtual Array disk group. An EVA disk group consists of eight or more disk drives logically coupled.

The EVA implements advanced data placement algorithms and virtualization techniques to optimize performance across the members of a disk group. The more disk drives that are members of a group typically result in better performance of the virtual disk (Vdisk). This is true of enterprise class high-performance disks as well as FATA disks.

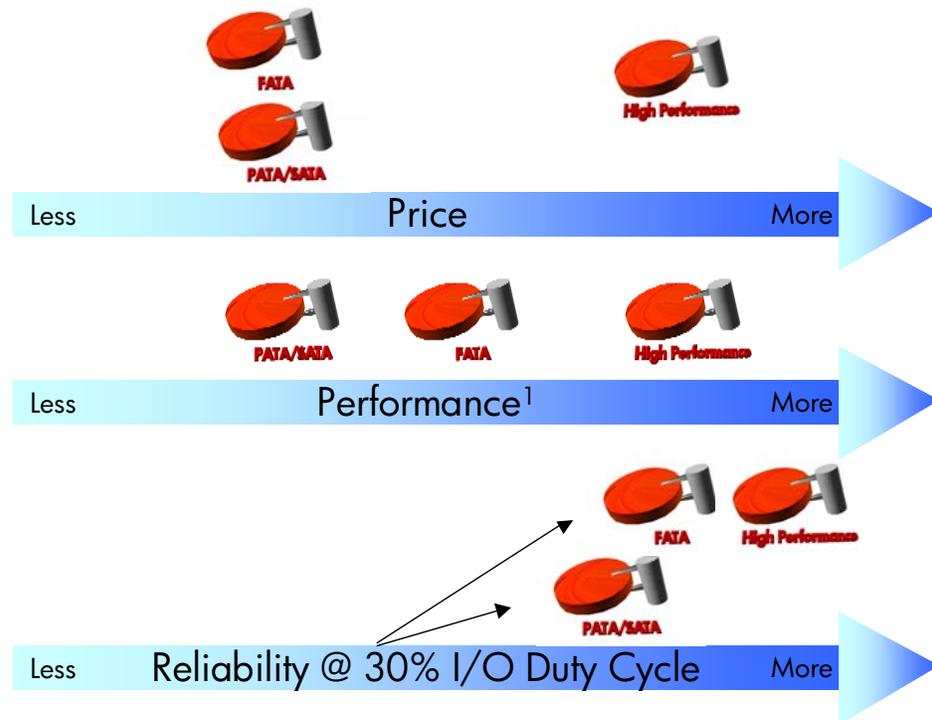
A wide variety of tests were run on sixteen 146-GB 10K disk drives and sixteen FATA disk drives to have a base line performance comparison. The resulting data indicated that the random I/O of the sixteen-member FATA group was approximately 25% less than the random I/O of the 146-GB 10K sixteen-member group. The sequential performance of the FATA group was essentially the same as the 146-GB group.

## Price/reliability/performance

A chart illustrating all three components—price, reliability, and performance—is a guideline for users to help decide which type of storage best meets their business need.

As seen in Figure 1, all Near-Online types of disk drives have similar reliability to high-performance disks when they are used for their intended purpose. However, the FATA drive is noticeably better in reliability and performance, compared with PATA/SATA drives, due to its hybrid characteristics.

Figure 1. Price/reliability/performance



Note<sup>1</sup>: Individual drive performance specifications are NOT a true indication of actual performance when used in the EVA due to its data placement algorithms and virtualization techniques. Vdisk performance is better than individual disk performance.

## Comparison of PATA/SATA and FATA in an FC array solution

Many array-based solutions, using low-cost disks, are being introduced into the enterprise storage market place. Generally, there are two basic types currently implemented using low-cost storage devices interfaced to enterprise class of arrays.

The first type of solution uses an FC interface from the array to the storage enclosure (shelf). The shelf serves as the translation interface, which converts FC protocol of the array to SATA protocol of the drive. In some cases, an additional translation of protocols may occur in the drive. Some disk drives based on PATA protocol include additional logic, which converts SATA protocol to PATA protocol, enabling the use of a SATA drive enclosure.

The second type of solution, used by HP, does not use conversion logic to translate protocol from the native FC interface. The FATA hybrid disk drive uses 2-GB/s dual port native FC interface to provide low-cost Near-Online storage without requiring any hardware infrastructure changes or additions to the EVA. Figure 2 summarizes the two basic types of implementation differences.

**Figure 2.** Near-Online solution comparisons

Company	HP	Other Vendor Solutions
Product Characteristics	EVA family	-
Drive Enclosure	Existing EVA shelves	New shelf required; price > FC shelf
Drive type	FC FATA "hybrid"	PATA or SATA
Drive capacity	250 GB	250 GB or 320 GB
Native FC interface	Yes. Dual port/2Gb FC interface to "hybrid" disk	No. Shelf logic converts FC to SATA
Online and Near-Online drive mix	Online or Near-Online or mix in same shelf. Best practices guide	Some minimum of FC drives required in frame and cannot be mixed in same shelf or cannot mix FC and SATA using common controller
RAID 5 requirements	Best practices but not shelf dependent	May require one drive per shelf for highest availability
Boot from Near-Online storage	Yes	Vendor dependent
Higher functions supported, CA, BC	Yes	Vendor dependent

## Back up to disk or back up to tape

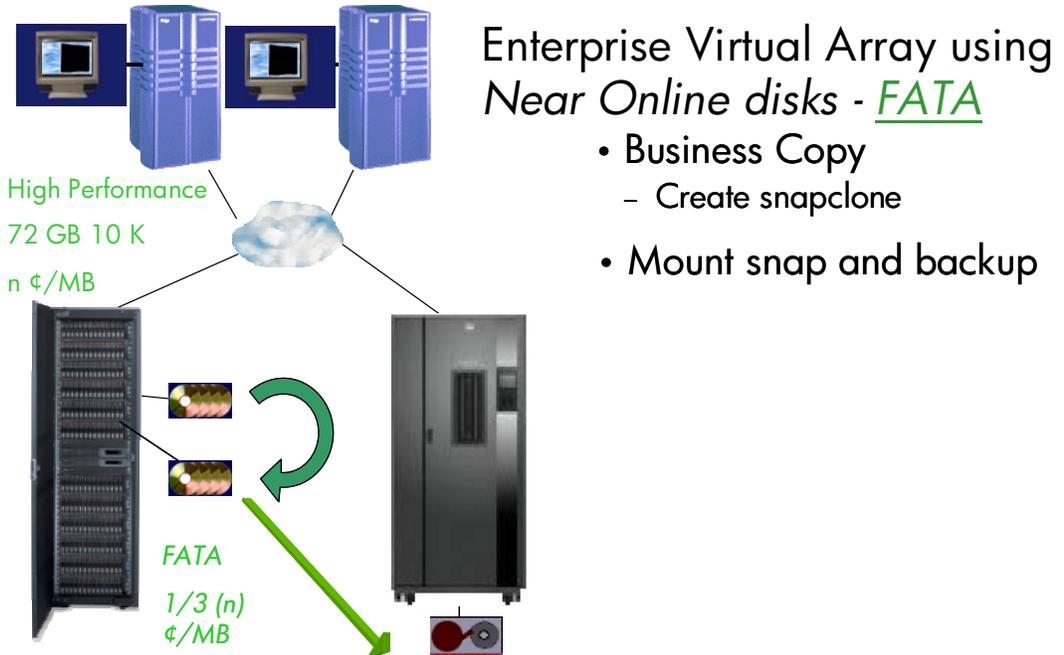
Tape drives continue to be an excellent choice for longer-term archiving data and longer-term security of data. However, with the availability of FATA disk storage users now have the option of using the lower cost FATA disks to stage backup, that is disk-to-disk backup, and then stage the lower cost copy of data to tape. The snapclone feature of the EVA enables the quick creation of a copy of the production data that is then staged for backup to tape. Additionally, Business Copy (BC) software for the EVA enables the user to automate the entire process through a simple to use interface and scripting procedures. Figure 3 provides an example of using low-cost FATA drives for staging data to tape and demonstrates that the FATA storage is about a third the price per MB when compared with a 72-GB disk drive.

Staging data to the EVA FATA disks provides the benefit of easily managed backups for users with small backup windows.

Figure 3. Staging backup

## Online/Near-Online Storage Use

### Example – Business Copy



### Fast recovery of data

In many cases, critical data has a four-hour recovery goal, second tier data has a multi-day recovery goal, while third tier does not have a specific goal. Depending on the size of the data set and the targeted restoration time, users now have an additional option, FATA disk drives, for restoring data. Moreover, users can keep their data sets for longer periods on low-cost disk after completing backup procedures.

A four-hour restoration will usually only be obtained, in many computing environments, if the data is from disk.

## More than just a low-cost tape substitute for backup/restore

Storage and applications continue to grow due to the explosion of captured information, coupled with extensive data mining on the information and the need to tune business intelligence.

In many industries, health care, manufacturing, and natural resource exploration/development for example, the computer-produced data is the core value of the business. Allocating large capacities of disk storage, hundreds of gigabytes to terabytes, is common. Table 2 provides a high-level comparison of Online enterprise class, Near-Online, and Tape.

**Table 2. Typical low-cost storage use**

Application Criteria	Online Enterprise Disk Storage	Near-Online SATA/PATA/FATA	Nearline Tape Storage
Highest performance	X		
Frequent file access	X		
Four-hour restoration goal	X	X	
Near continuous operation (disaster tolerance); remote datacenter/continuous data synchronization	X	X	
Site disaster	X	X	X
Infrequent but fast file access		X	
Disk-to-disk backup		X	
Disk-to-tape backup		X	
Virus attack recovery		X	X
Multi-day recovery			X
Maximum security/data vaulting/hacker attack recovery			X

The EVA, with its capability of supporting high-performance and low-cost storage in the same frame, meets the needs of the high-performance applications as well as those applications not requiring the same level of performance to fine tune a company's business intelligence or capture data that is vital to a business' core value.

HP StorageWorks Enterprise Virtual Array with FATA disk drives is a key component of the HP Adaptive Enterprise and sets the foundation for ILM of the user's data. The lower cost of the technology in the same footprint and ability to repurpose existing technology facilitate managing costs and maximizing return. The user can choose the appropriate resource to meet an application's storage requirements.

The EVA high-performance and lower-performance/lower-cost storage implementation also provides additional benefits for the IT manager since no additional EVA software is required.

## FATA use—departmental and enterprise environments

### Data reference/data archive/fixed content applications

The medical industry and many other industries are required to capture and retain large amounts of data to address legal and regulatory requirements. In addition, the data must be able to be retrieved relatively quickly. The data types accessed infrequently in these industries consist of medical records, email archives, as well as legal and financial archives.

### Streaming applications

Many applications exist that primarily transfer data in a sequential fashion. Near-Online storage is a prime candidate for these applications where the random I/O is less intense. Examples of industries that use streaming applications are the natural resource/development industry for capturing large amounts of exploration data as well as the entertainment and broadcast industry for capturing and editing video and audio.

### Remote copies/disaster recovery

In many business-critical environments, a remote copy of data is required to restore data to the primary site or bring a secondary site online. Figure 4 illustrates just one example of using low-cost FATA drives for replication to a remote site.

Dependent on the disaster recovery strategy, users may have only FATA disk at the remote site or a combination of high-performance disk and FATA disk at the primary and remote sites to maximize their flexibility and data availability.

Figure 4. Remote site copy

## Online/Near Online Storage Use

### Example – Continuous Access

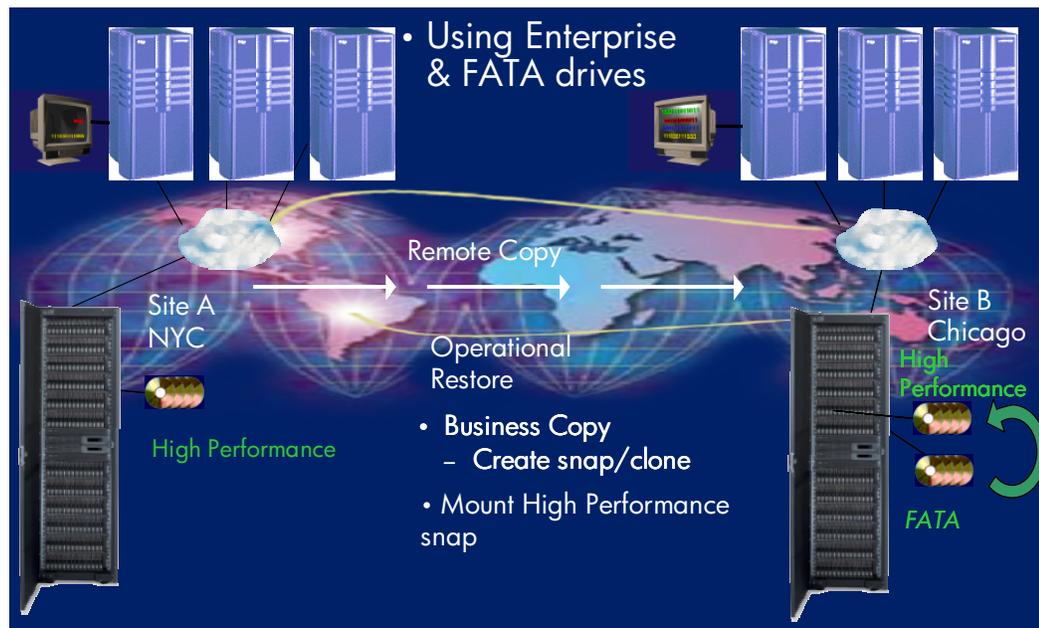


Table 3 lists additional examples of application use for Near-Online (FATA) disk and Online (high performance) disk.

**Table 3. Application disk use**

Online/high-performance disks	Near-Online/FATA disks
All applications part of FATA list	Fixed content
Databases	Snapshots and clones
Enterprise Resource Planning (ERP)	Instant archive
Bank transactions	Fast file recovery
Financial applications	Offsite recovery
Customer Relationship Management (CRM)	Two stage backup
Online purchases	Data migration
Other number-crunching applications	Temporary files
	E-mail archiving
	Medical imaging
	Web serving
	File and print
	Fixed content
	Application testing
	Video Imaging

## Tiered storage—an evolution

Different types of data require different levels of accessibility and throughput. Many IT managers and users are knowledgeable about different classes of storage and are ready to begin tiered implementation due to tight budgets and growing capacity needs. Moreover, many organizations desire easily managed, tiered storage solutions because they must comply with long-term data retention requirements and must be able to access the data instantaneously. They also are looking to gain additional efficiencies from their existing storage infrastructure.

Based on existing procedures for reference data, test data, backup, and disaster tolerance, many organizations currently have different classes of applications and are ready to implement different classes of storage.

## Information Lifecycle Management

Companies that have undertaken the formal process of conducting a Business Impact Analysis (BIA) for data classification have typically found that their stored data falls within one of the following classes of restoration:

1. 0 hours to restore
2. Approximately 3–4 hours to restore
3. Approximately 2–3 days to restore
4. No specified time to restore

Furthermore, those companies that conducted a BIA found that the classifications of data will change based on its business value and its classification varies based on critical business needs, age, frequency of use, application use, legal requirements, and regulations.

The HP StorageWorks Enterprise Virtual Array with high-performance disk and FATA disk storage provides the framework for a tiered storage solution in a single frame. Users can direct data to the appropriate storage media based on its perceived business value, thus minimizing costs and maximizing the use of their storage resources. FATA disks in the EVA provide users a low-cost storage solution for the intermediate storage case where their data may need to be migrated quickly between low-cost and high-performance devices.

Some users insist that their data must always be accessible. This type of user promotes another class of restoration, which is not formally categorized, and provides an interesting case for the Near-Online storage implementations.

Many companies face personnel disputes and are confronted by users who believe their data is the most important, must be online, and quickly accessible at all times. FATA drives provide a low-cost storage solution for those companies that are challenged to implement ILM policies based on users who may exaggerate that their data is most important and that their data must be continuously online.

## Exploiting an existing or a new EVA

Storage area networks (SAN) are over three years old, mature, and users are actively pursuing ways to enhance their value.

Users now have the ability to create vast amounts of data. Video imaging and editing and data analysis are only a couple of examples of applications that lend themselves to lower-performing disk storage.

The EVA with both high-performance and low-cost/lower-performing disk provides the capability to actively and simply transform their enterprise into support for multiple tiered applications. Continuing cost pressures make the EVA a cost-effective solution for organizations interested in capacity-oriented and tiered storage in the SAN.

Most organizations that examine the types of data stored will uncover a substantial number of infrequently accessed files. Many of these files are personal and consist of documents, images, music, and video. Other infrequently accessed files are files that have been replicated many times, may be old or obsolete versions of data that hold no value, data that has multiple versions, or older versions that hold no value.

HP StorageWorks Enterprise Virtual Array with FATA disk drives is a key component of the HP Adaptive Enterprise and sets the foundation for ILM of the user's data. The lower cost of the technology in the same footprint and ability to repurpose existing technology facilitate managing costs and maximizing return. The user can choose the appropriate resource to meet an application's requirements.

### Simple steps to EVA tiered storage

1. Develop data classification management policies and implement policies to fulfill business needs.
2. Categorize key applications to appropriate Online and Near-Online storage pool.
3. Identify capacity requirements for the Online and Near-Online pools.
4. Consolidate EVA storage into Online and Near-Online pools in the same frame.

## Benefits of FATA disk in the EVA

The capability to implement FATA disk and high-performance disk in the Enterprise Virtual Array frame will increase the Quality of Service and mitigate risk.

The ability to use disk drives in this way helps an organization create a more adaptive enterprise because it makes it easy to adapt the technology, thus making it easier to implement change. Moreover, the lower cost of the technology in the same footprint and the ability to expand the use of an existing device will help customers unlock the value of assets and increase operational efficiency.

### **Integrated performance and capacity**

Using the FATA disks in the EVA provides a “capacity” storage class within the array and provides a very high value solution for users who desire seamlessness with their storage software whether the drives are performance or capacity oriented. Moreover, the HP solution of using the existing EVA hardware infrastructure to consolidate and provide tiered storage in the same frame eliminates added complexity in the data center.

### **FATA does not mean giving up data availability**

When FATA drives are used for their intended purpose, data replication, data archiving, data reference, and similar applications that access data infrequently, the failure rate of the drives is comparable to the high-performance disk drives. Moreover, for data availability, FATA drives are managed in the same way as high-performance disks and are supported by the EVA’s virtualization techniques, data placement algorithms, and disk sparing policy. Therefore, data protection and application availability are not compromised when using the lower-cost FATA disk drives for their intended purpose.

## Conclusion

IT executives realize that all data does not have the same value and does not require the same performance. In addition, industry analysts predict the need for low-cost bulk disk storage will significantly increase over the next few years.

The HP StorageWorks Enterprise Virtual Array with its capability to support high-performance disk, FATA disk, or a mix of both in the same frame provides a solution for organizations that desire investment protection and want to gain additional efficiencies from their storage infrastructure. Customers who implement tiered storage in the EVA will recognize benefits of easily managed storage, simplified processes to meet compliance requirements, reduced costs, enhanced operational efficiency, and a greater ability to incorporate IT strategies with business objectives.

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