



Expanding Home Storage can be a Big Problem

WHITE PAPER



STORAGE VISIONS 2005 CONFERENCES

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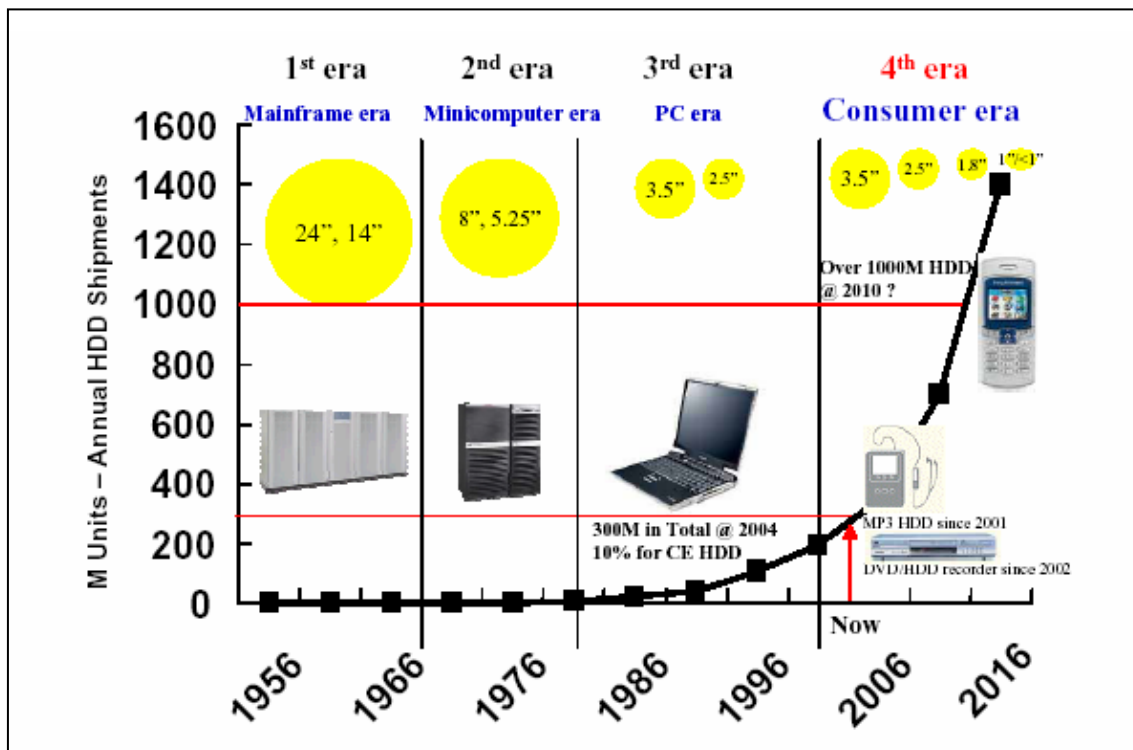
1. Introduction

Increasingly, the home PC is being used to store critical data such as personal media libraries that include irreplaceable family pictures, music and video content. When legacy consumer storage methods are used to store this library of digital content, it is even more vulnerable to data loss than before, and to fix this problem the solution doubles the cost of storing the digital library.

Is there a solution that can maintain high performance and provide protection, without doubling the cost of storage or cutting reliability in half? Yes. A Netcell Storage Processor provides the functionality for Next Generation Desktop Storage and delivers high performance and extreme reliability.

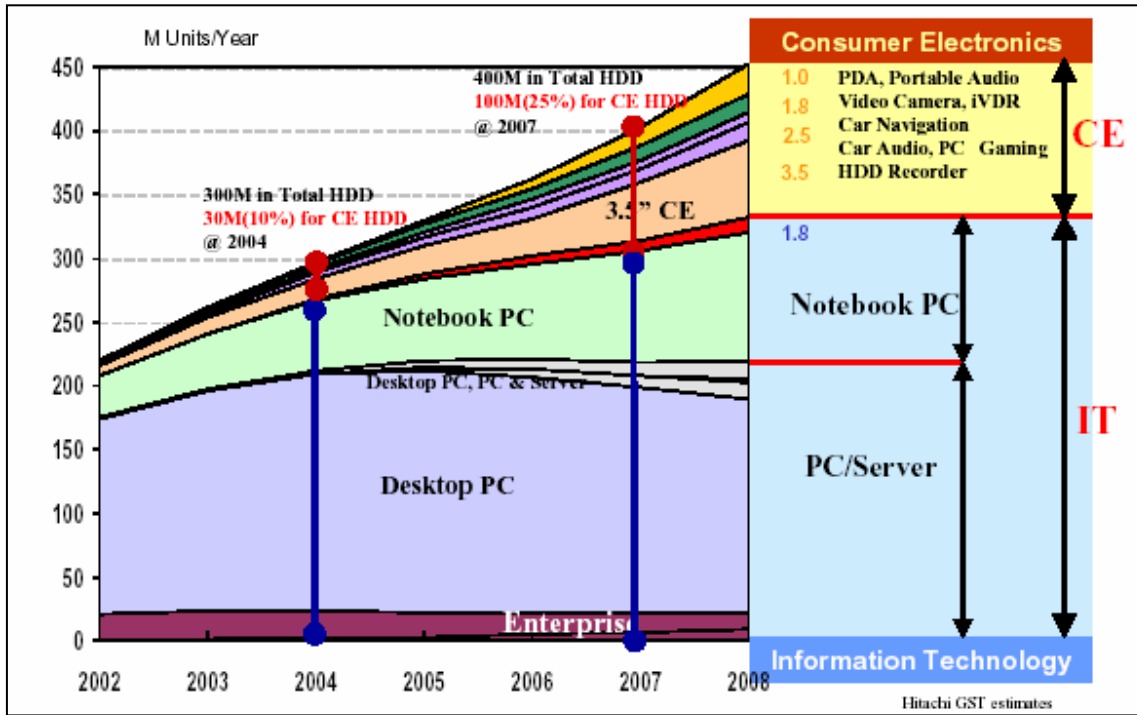
The problem is not limited to price/performance and reliability alone, it requires a Netcell Storage Processor which provides seamless expansion technology and delivers the un-exhaustible protected rich media storage.

As you can see from this figure, the fourth era for hard disk drives is consumer applications and smaller drive formats.

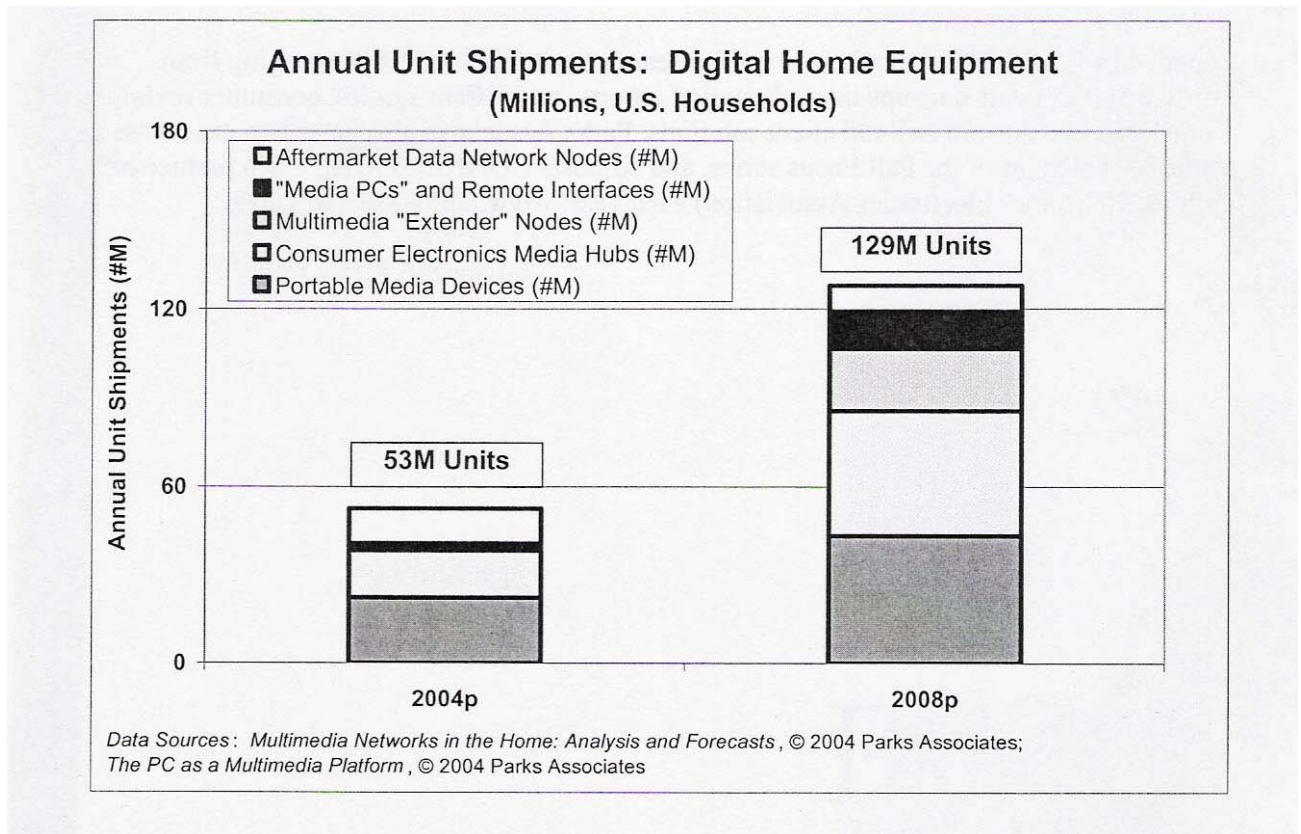


Source: This figure was shown at the 2004 DiskCON event by Hitachi GST.

As you can see from the following figures, by 2007 the Consumer Electronics use of hard disk drives will exceed 100 million units per year.

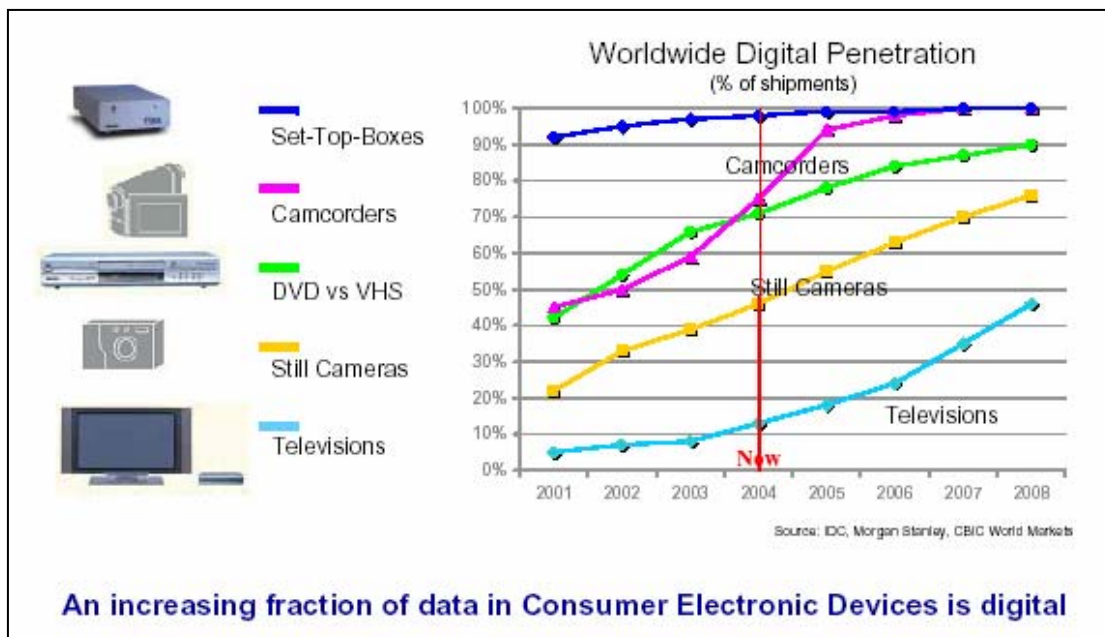


Source: This figure was shown at the 2004 DiskCON event by Hitachi GST.



2. The Need for Home Storage Solutions

In today's digital world, most home users are beginning to employ the Digital Library features bundled with every new system. It is no longer just the A/V Digital Studio user, who has the need for Digital Library Protection. Just one small home video and a photo album, not to mention all of the audio files for your digital jukebox, can eat up a tremendous amount of storage and demand more data bandwidth and more capacity than one mainstream hard drive. As you can see from the digital penetration graph below, consumers are moving to rich digital media in all areas of their electronic goods consumption (not to mention MP3).



As an example let's look at the Digital Camera and a Slide Viewer Application;

Photo Storage

- 5 Mega-Pixel cameras produce ~3MByte image files
- 1000 photos would be 3GBytes of storage
- Over 5 years the slides grow to 10,000 photos or ~ 30GBytes

Photo Bandwidth

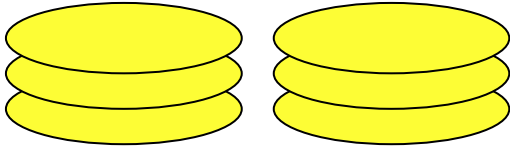
- A photo slide show set to 2.5 seconds per picture requires 9.6Mbit/sec (this is faster than today's DVD-Video format which requires 4.5Mbit/sec)

So the situation which the consumer faces is a growing capacity issue and an expanding need for bandwidth. The final problem is the need to secure the data. Each year the risk of losing data grows and the need to expand capacity and performance in an easy way, without reconfiguring programs or rebuilding the PC.

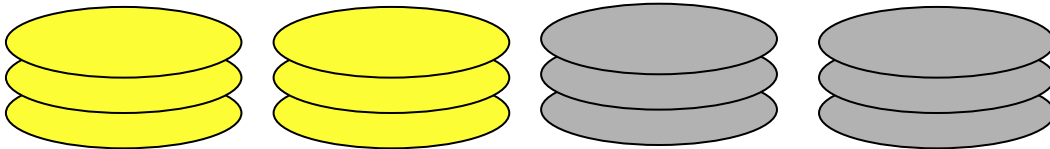
So what is the current solution to this problem?

3. Home Storage Solutions Today

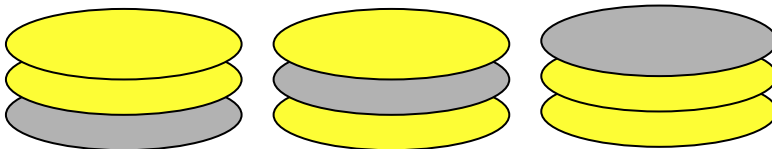
The current low cost solution is to expand the storage on your PC and use two drives while striping their content to act as one double speed hard drive. This performance stripe method improves performance, doubles capacity.



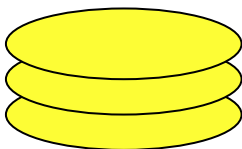
The next generation designs using consumer motherboards implement a drive mirror architecture to fix the reliability situation. A mirror drive is needed for each data drive, and therefore the reliability is improved and a single drive failure can be tolerated without data loss like the enterprise class arrays.



Some early PC enthusiast's, seeking more protection for their storage systems turned to designs adapted from the enterprise arrays. These arrays are block striped with the secure data spread across all the drives (grey is secure data).

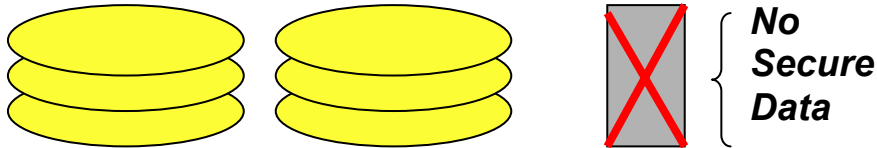


Another example: The time shifting storage devices built into SetTops have an insatiable need for expanded capacity and protection. Legacy SDTV video using MPEG-2 compression requires 10GBytes for 10 hours of video storage. Typically this is done with a single large drive.



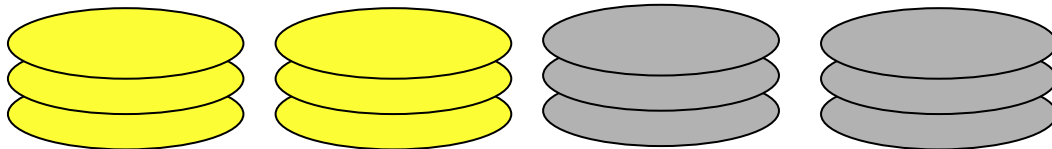
This is the current universe for storage solutions. These solutions introduce problems to the consumer and make them less than optimal.

4. Problem with Current Home Storage Solutions



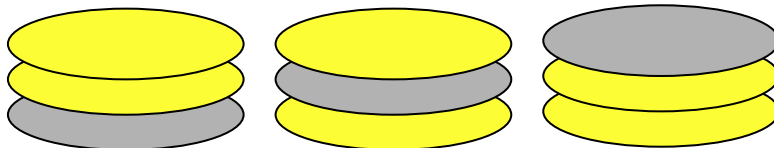
- **Significantly lower reliability, lower productivity during failures**

This performance stripe method improves performance, doubles capacity, but neglects data protection and even doubles the probability of drive failures. This lower reliability is due to the fact that, if either of the drives has a problem, all data is lost on both drives.



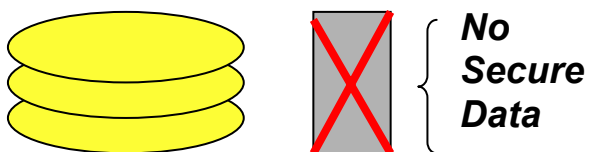
- **Significantly higher cost without extra capacity, lower productivity during failures**

A mirror drive for each data drive doubles the cost of each storage array. The reliability is improved and a single drive failure can be tolerated without data loss like the enterprise class arrays, however the performance doubling is lost, as well as the capacity expansion provided by the simple performance striping.



- **Lower productivity during failures, do not boot from the array**

These new high-end architectures or system solutions using enterprise arrays, bring another problem when a drive fails, it's called down-time for rebuilding. This rebuild time hurts productivity to such a degree that enterprise drives remain smaller than consumer drives in order to minimize rebuild downtime.



- **No reliability beyond a single drives ability**

Time shifting storage devices use single drives and have ignored securing the data in anyway. This is problem waiting to be exposed as consumers store more.

From the above discussion it should be clear the needs of the consumer are different from those of the enterprise user and those of current solutions.

Enterprise arrays are designed to fit the needs of corporations and they function most effectively as email and database servers.

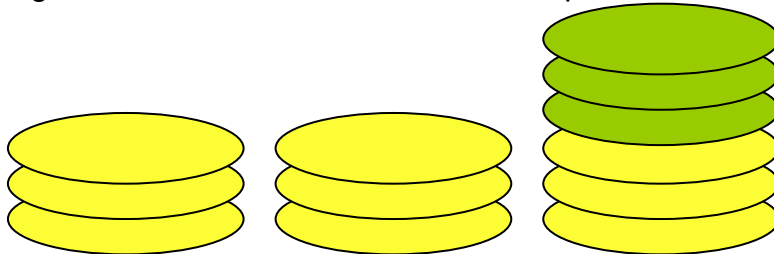
What is needed is a true consumer solution that preserves the performance striping and the reliability of enterprise arrays without the rebuild downtime issues which hurt sustained productivity. This solution is called the Storage Processor from Netcell.

5. Introduction to the Netcell Storage Processor

Storage adapters are typically storage controllers, which can cache and forward commands to the drives. The CPU and the host application make all of the decisions with regard to storage usage. A Storage Processor (SP) is an intelligent processor that can provide enhanced features, like automatic capacity expansion and performance consumer striping array support.

Automatic capacity expansion support;

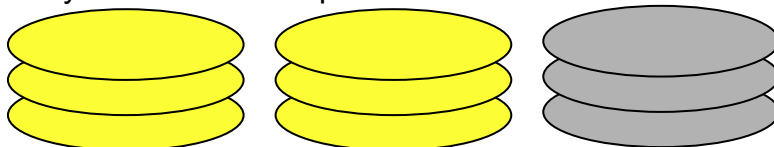
When a new drive is replaced in the system, the SP copies the stored data in the background. This mechanism creates an automatic un-exhaustable storage array not formerly possible before the SP. The consumer does not need to re-configure or change the array settings and the SP automatically allocates storage as possible. In this case the third drive is bigger than the first two and a second logical drive is allocated on the unused portion of the new drive.



- **Automatic capacity allocation when new drive added**

Consumer performance striping;

This method of hard drive array storage uses performance striping across multiple drives, and uses a single drive to store the secure data. The benefit to this array architecture is found in the ease of use, performance, reliability and productivity measurements. As a storage device it appears to the system as a single hard drive making it easy to use and configure and equals the speed of the simple performance striped arrays. The reliability level equals an enterprise array and can repair a drive failure without any data loss. When a drive fails this new array continues at full performance until a there is convenient time to rebuild.

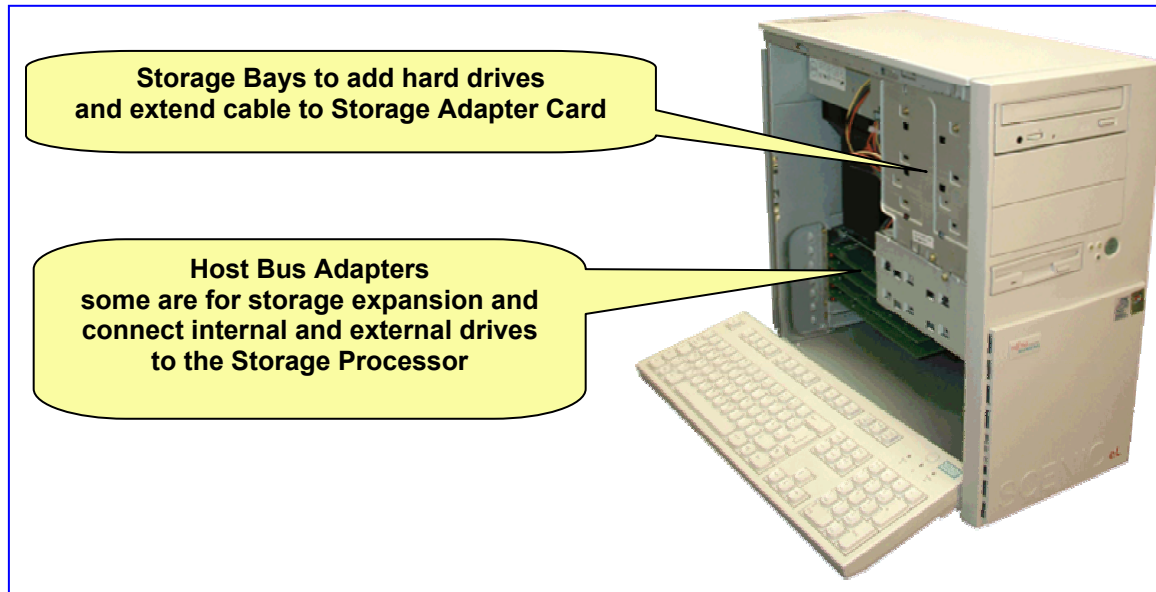


- **Reliability, productivity, performance, ease-of-use, boot from array**

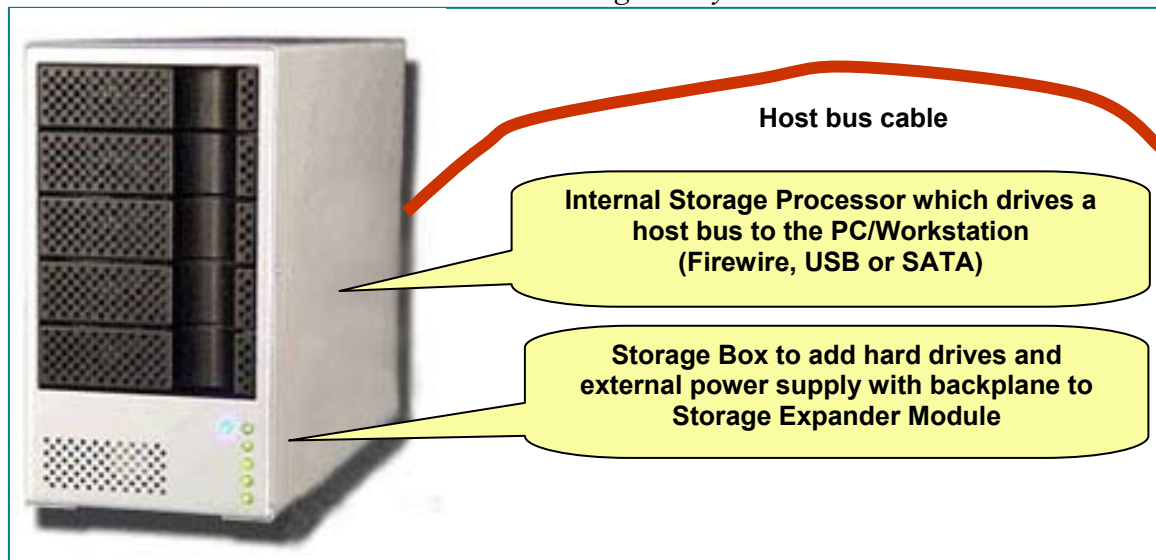
As you can see from the figure above, the secure data is confined to a single volume. This allows writes to happen at full speed, just as if it were a performance striped array without secure data storage. The secure data protects the entire array so that a single drive failure cannot cause a loss of data.

6. Solutions to Home Storage Problems

There are two basic storage architectures which can use the SP solution. First there is the internal storage array when a consumer expands the storage using a tower PC chassis. Second is the direct attached storage array which remains external to the PC or Workstation.

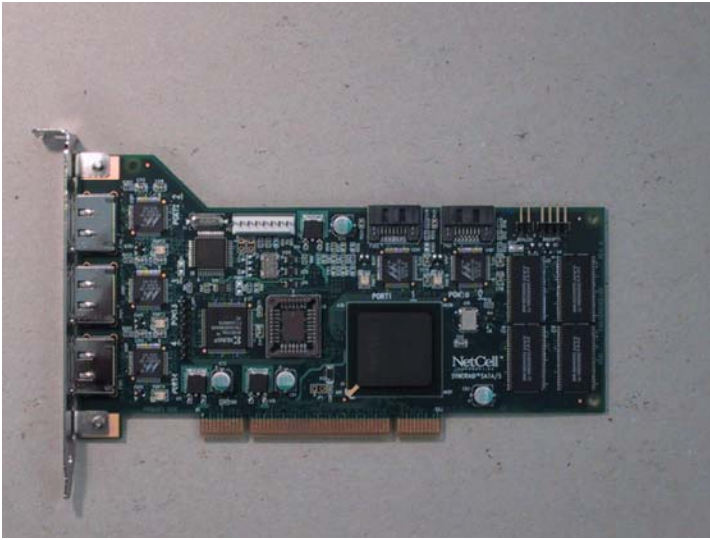


Internal Storage Array



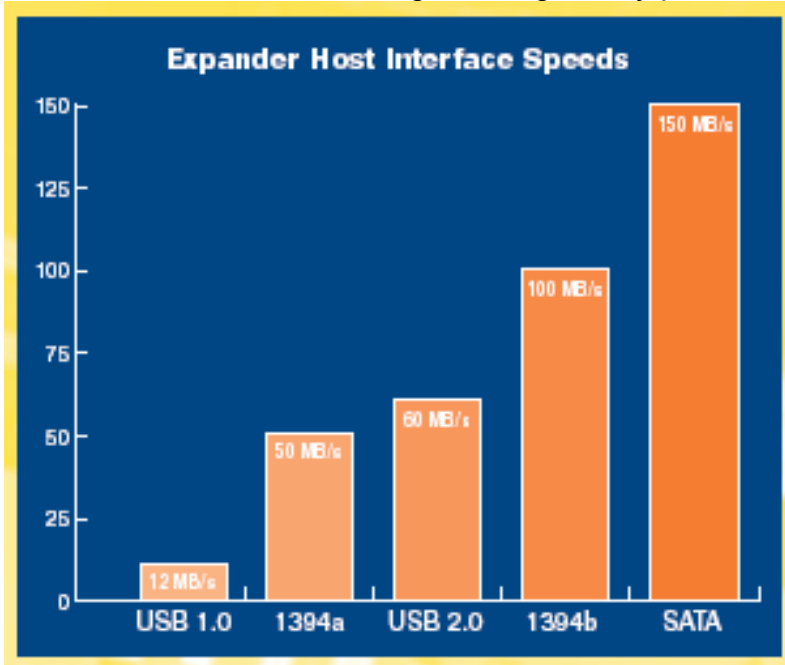
Direct Attach Storage Array

The direct attached storage array uses a host bus cable to connect to an internal host bus adapter or the external host bus connector in the adjacent PC.



Here is the new board from Netcell with three external SATA (eSATA) ports and two internal ports.

Of the host buses, the External SATA cable is the most efficient, see the peak numbers below. When adding a storage array performance is important.



Of the two system solutions above, each is able to have the drives replaced with an automatic capacity allocation, and is viewed by the OS as a single drive to enhance ease of use. This provides full performance striping and delivers enterprise level reliability which dramatically improves user productivity. If we compare the three basic types of arrays discussed, it's clear that the Consumer Array is better for most users.

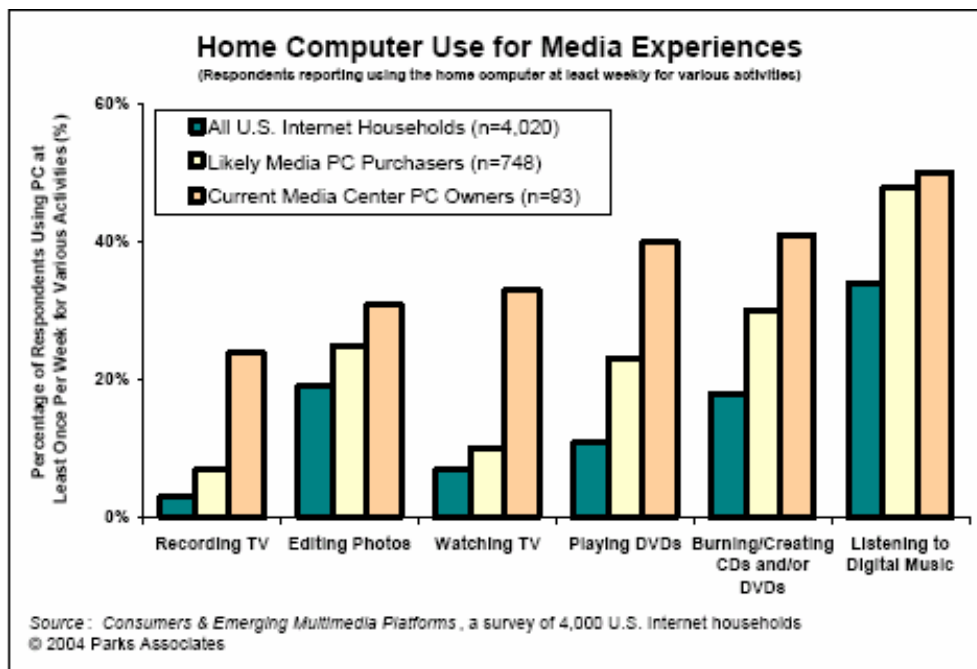
Comparison table for Enterprise vs. Consumer RAID

	Enterprise array	Consumer array	Legacy or Typical Performance Stripe + Mirror
PC Cost	5* drives	3 drives	4 drives
Config time	long, detailed	very short, easy	medium
Boot OS	not recommended	yes	no
Driver	SCSI	None (uses OS)	SCSI
Best usage	email/database	Multimedia	Both
Best file	small, reads	large, writes and reads	Both
CPU load	Can be high	No load	High
Write speed	Medium	Fast	Fast
Reliability	one drive failure	one drive failure	one drive failure
Failover	lose performance	no performance lost	Lost data

*requires an additional boot drive

7. Conclusion

Home computer users are expanding their storage requirements in a big way. See the following data from Parks Associates.



The future is for rich media users or lovers of digital media. If a typical future (2007) user bought and ripped 1000 songs, found on the internet 10,000 songs, stored 1000 photos and stored 40 hours of SDTV video, it would take about 124GBytes. This is a BIG amount of media stored by an average future consumer and will cause a storage problem. The answer to the problem requires the Netcell Storage Processor, it delivers, added performance, added protection, enhanced productivity and ease of use.