

White Paper

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The 2.5-inch Hard Disk Drive Delivers Home Entertainment

Trends, Advances and Opportunities in the Consumer Electronics Market

The 2.5-inch hard disk drive (2.5" HDD) has rapidly developed to handle the demands of an increasingly competitive consumer electronics (CE) market. As consumers look for smaller devices and peripherals with greater storage, speed, power and efficiency, 2.5" HDDs now give device manufacturers the ability to create a new class of storage-centric set-top boxes like digital video recorders (DVRs), cable boxes with integrated HDDs, and home media centers.

The DVR in particular presents a rapidly expanding market opportunity for manufacturers. Already, more than a fifth of all U.S. households utilize a DVR (such as Tivo®) for recording their favorite shows and movies. By 2010, as many as half will use DVRs to save an increasing array of high-definition programming, which will require ever more storage. Traditional set-top boxes, however, don't yet meet the design, size, power, and other requirements for today's digital living room. Namely, they're large, loud and power hungry. The 2.5" HDD provides a key component to advancing DVRs beyond these humble beginnings.

This paper highlights the consumer trends, technical advances and design opportunities that 2.5" HDDs present to device manufacturers to deliver new DVR solutions to a burgeoning market.

A Growing Opportunity: The Living Room

In 1999, Tivo® unleashed a device that in just a few short years has become a living room phenomenon. In just a few more years, the DVR, with its ability to record and play back any television show and skip commercials, will be a standard partner for most of America's televisions. According to Leichtman Research Group, more than 20 percent of U.S. living rooms utilized a DVR-type device in 2007, and this year the analysts expect that number to grow to more than a quarter of all households. By 2010, Forrester Research expects half of all households across the country will be recording their favorite programs with these devices.

Simultaneous with this explosion of DVR use comes an explosion of high-definition programming. The living room is becoming a digital hub with ever more peripheral devices like DVRs, stereo systems, game consoles and even computers demanding additional shelf space. While television screens are getting bigger, the appetite for smaller and smaller CE devices like mobile phones, digital music players, ultra-light laptops and DVRs is also increasing. Aside from televisions, with each new product generation, consumers consistently want their entertainment peripherals to take up a smaller portion of the living room.

However, cable and satellite boxes, and DVRs are often the biggest consumer of space on the shelf, and have changed little in the previous five years. Their design is chiefly restricted by one key component—the 3.5" HDD. These drives have traditionally allowed DVRs to record an immense amount of programming, but at the great expense of size, power and ambient sound.

Today's 2.5" HDD technology now exceeds the storage and retrieval requirements for DVR technology, while delivering a more power-friendly, quiet and space-saving design. Manufacturers must start taking advantage of these drives to bring smaller size, better design and higher performance to home entertainment devices.

2.5" HDD Technology Arrives

According to *Scientific American*, the quantity of information disk drives can record per square inch was 50 million times bigger in 2005 than it was upon the creation of the drive in 1956. The last three years of expansion have also continued at a rapid rate, so much so that Fujitsu now manufactures 2.5" HDDs with 500GB capacities.

In general, this growth has easily kept pace with the expanding data needs of consumers and businesses, while also helping to drive the rapid shift to digital entertainment. In particular, this new capacity led to the creation of smaller and smaller drives, beginning with IBM's two-foot-diameter disks and resulting today in the mainstream use of 3.5" and 2.5" HDDs storing hundreds of gigabytes of data on laptops, PCs and servers. More and more, entire music and video collections are held on tiny music players and laptops, streamed and stored across the Internet and the home.

Most recently, HDD storage technology was propelled even further by the development of Perpendicular Magnetic Recording (PMR). Prior to PMR, HDDs held magnetized data bits

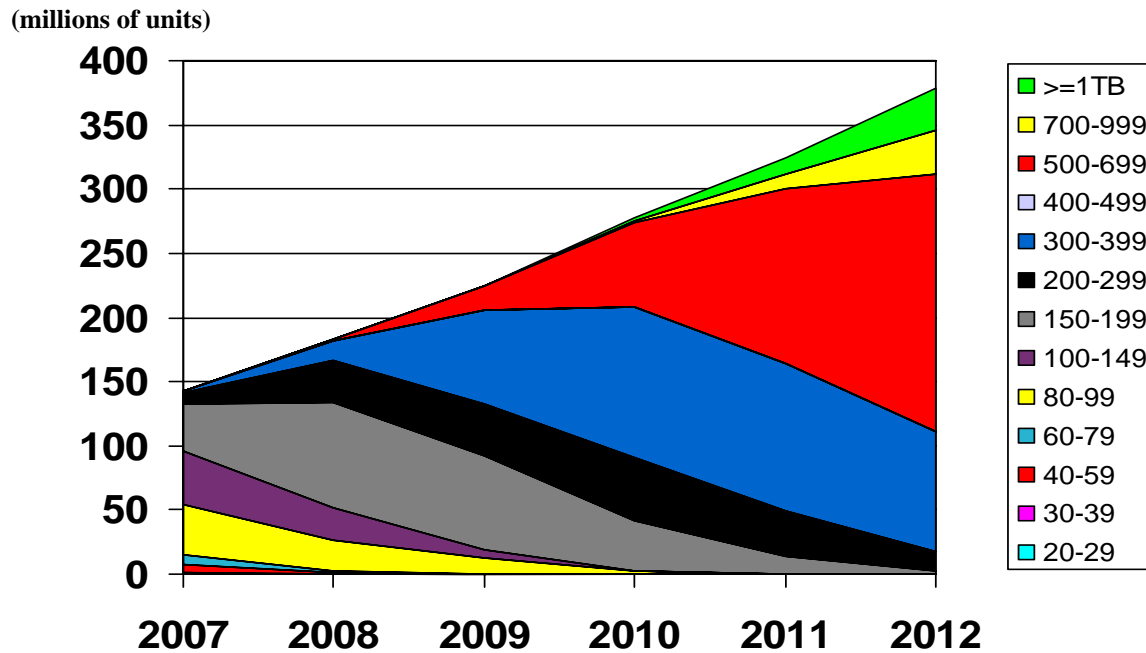


horizontally along the media, fittingly enough called Longitudinal Magnetic Recording, or LMR. In PMR, the orientation of the data bits are aligned vertically, or perpendicular to the disk's surface, allowing many more bits to be placed on the same storage area. Introduced in 2006, PMR immediately increased HDD capacity by some 25 percent over previous drives. PMR technology will ultimately allow densities up to 1TB per square inch.

Upon its introduction in 2006, Fujitsu's first generation 2.5" PMR drives provided 160GB capacity. Just a year later, Fujitsu had developed 320GB capacity 2.5" HDDs. The company's 4200RPM 2.5" HDD offerings reached 300GB in 2007, and this year's offering has expanded to 500GB of storage. Today these 2.5" drives already easily meet the capacity requirements of DVRs and set-top boxes, which to this point utilized 3.5" HDDs almost exclusively. These new capabilities have allowed 2.5" HDD to become a viable option for DVR-type applications.

In fact, device manufacturers have realized the 2.5" drives' potential: according to market research firm TRENDFOCUS, these higher capacity drives now represent a growing portion of the 2.5" HDD market, which stands at roughly 200 million units. By the end of 2011, 2.5" HDDs with capacities greater than 500GB are poised to make up a bulk of the more than 350 million total 2.5" HDD shipments worldwide. (See Figure 1).

2.5" Mobile HDD Capacity Migration



Source: TRENDFOCUS

Figure 1

Not Just Capacity, but also Size, Power and Noise Reduction

Acceptable storage capacity isn't the only attribute manufacturers look at in determining 2.5" drives' suitability for the DVR market. Other numerous trends and developments have pushed them to further consider these smaller storage devices.

First, there are the obvious and glaring size differences. 2.5" drives are an astounding one-fifth the total size, with a volume of about 67,000 mm³ and weigh just 100 grams, compared to 3.5" drives at nearly 400,000 mm³ and 710 grams. This drastically smaller storage component footprint—roughly a paperback book versus an iPod Video—allows manufacturers to create sleeker, smaller, more design-friendly electronic consumer devices which reside in the living room.

Second, 2.5" HDDs fit naturally within Green initiatives, which are now an important aspect of every technology sector. While consumers fill up their hybrid cars (or nearly as often, get wait-listed for one) and replace incandescent bulbs with compact fluorescents, they're looking for even more opportunities to reduce their environmental impact and as importantly, cut their energy bills. Using a 5V power supply, the latest 2.5" HDD consumes just .5 Watts while idle, nearly 10 times fewer Watts than a 3.5" HDD. In read/write mode, the 2.5" HDD requires only 1.8 Watts, while a 3.5" drive consumes 11 Watts. This low-power supply module also reduces manufacturing costs, while appealing to end-users as an energy-saving alternative.

Cost savings from a smaller HDD can also be found in the drastic heat generation cuts—running up to 30 percent cooler than 3.5" HDDs (See Figure 2). The 2.5" HDD also operates at only 20 decibels while the typical 3.5" HDD is three times louder. Larger 3.5" HDDs require a fan, which is another contributor to noise generation, so not only does the 2.5" HDD remove the ceaseless hum from the living room DVR, it negates the need of a fan, further reducing the overall size of the device. Finally, 2.5" HDDs have three times the shock tolerance of their bigger counterparts, saving both consumers and manufacturers from the frustration of receiving goods damaged in transit.

2.5" HDD Thermal Reduction

HDD Type	With Fan	Without Fan
Fujitsu 2.5" HDD	~28C	~44C
3.5" HDD	~35C	~62C

Figure 2



2.5" HDDs and the Future of the DVR

With all of these advantages, alongside newly expanded capacity of 500GB, 2.5" HDDs are now positioned for today's DVR drive requirements. With the rapid proliferation of high-definition content, and as digital sources expand from the DVR to include Internet-based videos, personal recordings and home computer content, the ability to record from and play to multiple sources will certainly become an additional selling point for DVR manufacturers. (See Figure 3).

DVR performance requirements for high-definition programming and viewing necessitate roughly 3MB/sec streaming capabilities, and in recent Fujitsu tests, 2.5" HDDs were able to maintain six HD streams simultaneously. While 2.5" drives are capable of up to 7200RPM—but rarely necessary for consumer electronics—this multi-stream content delivery was realized using a 4200RPM hard disk drive. Also, the smaller size, despite the subsequently slower spin, delivers faster seek operations than 3.5" HDDs, allowing users to find and play back desired content at a quicker pace.

2.5" HDD advances can allow manufacturers to offer cable companies and consumers new features, functions and designs that better serve the new digital living room. For instance, software and PC makers, as well as Tivo®, have already offered up desktop, set-top box and media-PC based solutions that allow subscribers to stream content virtually anywhere across the household. Cable and satellite providers are sure to follow suit, and DVR manufacturers must be able to provide boxes that account for these new capabilities, like recording multiple television shows in the living room, while streaming one to a PC in the home office, another to the TV in the bedroom, and vice-versa.



Figure 3

Now Moving to the 2.5" HDD

Digital living rooms are soon to have several common features: flat-screen televisions, high definition programming, stereos, and streamed content to and from multiple sources around the household. At the center of this entertainment complex, set-top boxes, computers and DVRs must meet new and engaging demands for fast, uninterrupted content delivery and storage.

This environment, and the rapidly expanding market for DVR devices, presents intriguing possibilities and huge business potential to those device manufacturers that can capitalize on it. Consumers, and the cable and satellite providers courting them, will look for the best technology in a sharply designed box.

The 2.5" HDD is now positioned to meet these needs, giving DVR and set-top box manufacturers an opportunity to create designs with smarter, quieter, faster, more efficient components than ever before. As the entertainment landscape shifts further to digital and high definition programming, manufacturers must create DVR products that not only deliver an aesthetically pleasing look to the living room, but also require less power to operate, run quieter, are more rugged, and advance the functionality of the device itself.