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# Toshiba Hybrid Drive with Large Capacity and High-Speed Performance

-- An HDD integrated with NAND flash memory --

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## Abstract

The hybrid drive, which combines the bit cost advantage of rotating media with the high performance of NAND flash memory (NAND), has recently been attracting attention as a new storage device. The combination of a hard disk drive (HDD) and NAND makes it possible to deliver a solid-state drive (SSD)-like user experience with high-speed performance and ample storage capacity through Toshiba's optimization of cache algorithm.

## Features

### ◆ Self-learning caching algorithm

In hybrid drives, read/write speeds can be improved by making use of 3-tiered storage system consisting of DRAM, NAND, and a magnetic disk. Please see Figure 1 below.

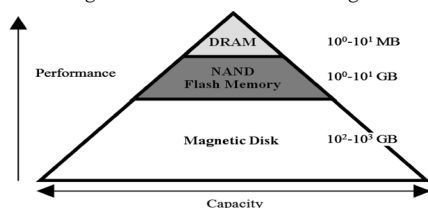


Fig. 1 Basic Configuration of Hybrid Drive

Toshiba's cache algorithm dynamically studies data access patterns and stores frequently accessed data in non-volatile NAND, allowing access performance to be improved even if no cache hits occur in DRAM during, for example, booting the PC. Thus, the algorithm can realize performance close to that of SSDs.

### ◆ Compatibility

Toshiba hybrid drive offers the same in physical size and in interface with the traditional 2.5 inch type HDD. PC systems recognize it just as they do conventional HDDs and SSDs. Therefore, no additional software is needed and existing HDDs or SSDs can be replaced directly with this drive.

## Product Configuration

### ◆ Hardware

On our MQ01ABD-H series product, NAND read/write controller is developed as a bridged chip positioned between the System on a Chip (SoC) and NAND. Synchronous DRAM (SDRAM) is also connected in parallel to the Double

Data Rate 2 (DDR2) SoC interface. Since MQ01ABD-H series could not mount more than one NAND, we performed a cost/performance trade-off analysis and selected the 8GB SLC.

### ◆ Software

When the system requests that data be written, the hybrid drive will write the data to NAND before writing the data to the magnetic disk (data will be written to disk later). When the system requests that data be read from a specific address, the drive will check whether the data requested is stored in NAND. If the data is present in NAND, the drive will quickly send it to the system. If not, the drive will read the data from the magnetic disk and send the data to the system, then copy the data to NAND memory. Please see Figure 2 below.

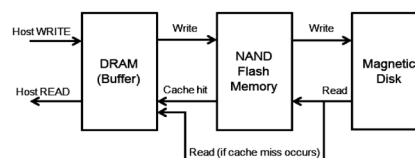


Fig. 2 Design Concept of Write / Read / Cache

## Applications

Figure 3 shows an example time comparison in which an HDD, hybrid drive, and SSD were installed in three otherwise identical PCs. The time to load the same application was then measured. The load time required for the hybrid drive is much less than that of the conventional HDD and is roughly equal to that of the SSD.

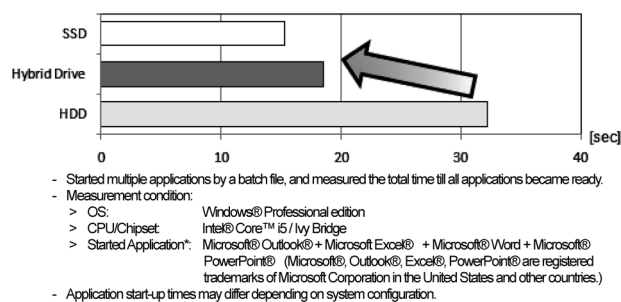


Fig. 3 Comparison of Application Start-up Times

For further details, please visit our web site below:  
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