

## Solid-state drive prices to dive (think MacBook Air)

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Future versions of the MacBook Air will pack larger-capacity but lower-cost solid-state drives, emblematic of the next generation of flash storage that will make a quick descent from current stratospheric pricing.

Today, a consumer pays dearly for a solid-state drive (SSD). For example, for only 64GB of SSD storage on the MacBook Air, a consumer must pay a premium of about \$1,000 over the 80GB hard disk drive model.

But the cost per gigabyte of solid-state drive storage will drop as notebook PC makers like Apple switch to solid-state drives with capacities above 100GB based on multilevel cell (MLC) technology. Adoption by notebook PC makers is expected to start in the third quarter, according to industry sources.

Virtually all SSD manufacturers have moved from single-level cell (SLC)--which is used in products like the MacBook Air, the ThinkPad X300 and HP 2510p--to MLC technology.

"Compared to the price you're paying today for a 64GB drive. You'll get a 128GB of storage for less than half the price (of the 64GB drive)," said Patrick Wilkison, vice president of marketing and business development at STEC, a supplier of MLC-based solid-state drives.

STEC offers solid-state drives with capacities up to 256GB in a 1.8-inch form factor, the same physical size as those drives used in ultra-light, ultra-slim notebooks today. These drives are based on MLC technology and offer better performance than hard disk drives.

Wilkison said that his company's drives offer read speeds in excess of 100 megabytes-per-second (MBps) and write speeds better than 65MBps. This compares favorably with standard 2.5-inch hard disk drives. The STEC products page lists enterprise SSDs with read/write performance of 200MBps and 100MBps, respectively.

Intel is set to move into the high-capacity SSD market on the back of its multilevel cell technology and current SSD manufacturers such as Samsung and Toshiba have also moved from single-level cell to multilevel cell. MLC is a more sophisticated technology than current SLC. Its advantages are not only lower cost but higher capacity. Instead of the relatively small-capacity 64GB SLC-based drives being offered today in notebook PCs, manufacturers are targeting MLC-based drives ranging up to 256GB by the end of this year or early next year. The disadvantage is more complexity, which can result in lower performance. "Inherently, MLC is slower and inherently (has) less write cycling endurance," Intel has stated in the past.

Avi Cohen, managing partner of Avian Securities, sees it that way too. "You lose some speed and you lose some reliability when you move to MLC," he said. "Errors per cell with MLC is an order of magnitude worse than SLC, which isn't that great to begin with," Cohen said.

But manufacturers like Intel and STEC say they mitigate the reliability problem and boost performance with proprietary controller chips. "We spend 85 percent of our time grappling with this reliability issue" when talking to customers, said Wilkison. "NAND (flash memory) will forever have limitations...It will be subject to a finite number of program and erase (record and delete) cycles," he said.

"There's a lot of background operations happening to manage the media. Moving the data around to make sure you're evenly wearing down the drive. You're not necessarily pounding on one specific spot and then killing a (memory) cell prematurely," Wilkison said. "This is all controller intelligence."

The kind of technology to optimize the longevity of the drive is generally referred to as wear leveling. Error detection and error correction technologies are also used, Wilkison said.

Wilkison said he believes these techniques result in solid-state drives that are just as reliable as hard disk drives. And he expects a surge in adoption of solid-state drives in notebooks. Whereas today there is only one notebook model per company that comes with a solid-state drive, the number of models offered with such drives will increase exponentially in the second half of the year, he said.

"Today it's a very boutique option. Volumes are very trivial," according to Wilkison. "It's one thing I do have visibility into" (because STEC is in talks with a number of computer makers). "It's an exponential number of platforms that are moving

forward with SSD," he said. "What was one platform (model) per company in the first half of the year is going to be six in the second half of the year."

There will still be a "price delta" between hard disk drives and solid-state drives but that will continue to come down with MLC technology, he said. Reports have cited Intel pricing as approaching \$1 per gigabyte.

Solid-state drives have no moving parts. Hard disk drives, in contrast, use read-write heads that hover over spinning platters to access and record data. With no moving parts, solid-state drives avoid both the risk of mechanical failure and the mechanical delays of hard drives. Therefore, solid-state drives are generally faster and in some respects more reliable.