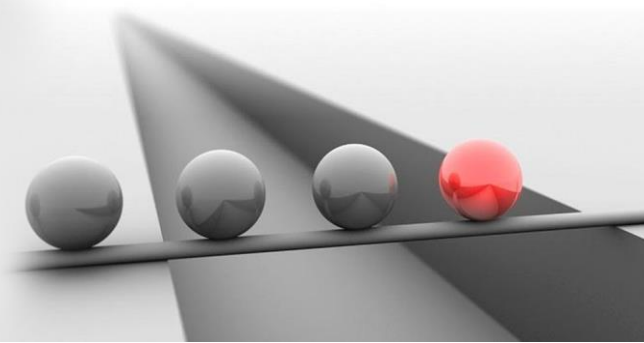




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Author:

Neil Shah

Research Director

neil@counterpointresearch.com

+91 99 3021 8469

Counterpoint's Analyst Contacts:

Tom Kang

Research Director

tom@counterpointresearch.com

+82 10 2874 8133

Peter Richardson

Research Director

peter@counterpointresearch.com

+44 20 3239 6411

Jeff Fieldhack

Research Director

jeff@counterpointresearch.com

(858) 603-2703

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analyst@counterpointresearch.com

Storage Solution Trends in the Consumer Notebook Market

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The last fifteen years have seen significant shifts in the global personal computing (PC) marketplace. On the one hand, manufacturing and technology breakthroughs have given rise to a wide range of PC form-factors; on the other hand, a growing reliance on the internet and cloud-based services has given rise to new computing platforms, software, even whole classes of applications. As of 2016, the PC installed base is comprised of more than 1.5 *billion* units.

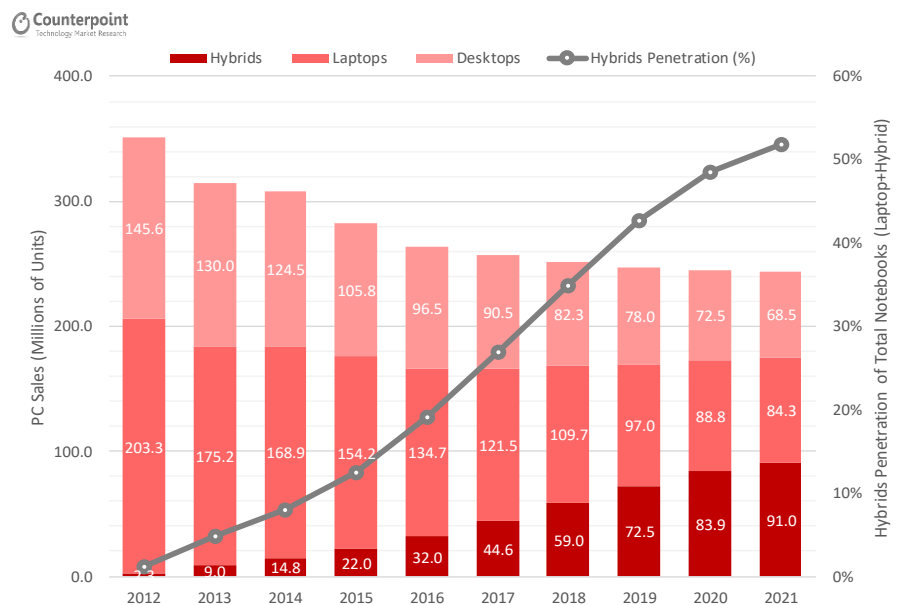
Since 2010, the PC industry has seen the rise of thinner and lighter PC form factors. Progress comes thanks to semiconductors based on advanced process nodes, which not only drive higher speeds but also pack more processing power into a smaller footprint every year. This progress is further fuelled by increasing consumer demand for thinner, lighter, and faster hardware experiences (overflowing from smartphone and tablet advancements). The rise of Flash memory storage in the PC segment has also been a key factor in driving advanced industrial designs which are state-of-the-art, sleek, and most importantly, highly mobile.

Exhibit 1: New PC Form-Factors: Hybrids: 2 in 1s, Ultrabook's



At the same time, the global PC market is mature and in the midst of a slowing growth phase. Back in 2012, more than 351 million PCs were sold, nearly 349 million of which were laptop/notebook or desktop systems. Fast forward to 2015, only 282 million PCs were sold, of which only 260 million were desktops or laptops. This means that more than 22 million of the PCs sold in 2015 fell into a relatively new class of “hybrid” devices.

Exhibit 2: PC Sales Forecast by Form-factor



Overall, the PC market saw a 9% decline in total devices sold and a 25% decline in the sales of traditional desktop and laptop/notebook systems between 2012 and 2015. Concurrently, there has been a rise of adoption of tablet form-factor devices. Casual computing users have been migrating from laptop and desktop systems to tablets, which are ideal for content consumption, shopping, and other light usage scenarios (where content creation is not an absolute need).

At the same time, the portable PC (laptop/notebook) segments been benefiting from the evolution and uptake of these tablet form factor devices. With lower power semiconductor chipsets (almost exclusively 14nm today), advanced Flash storage, and multi-modal interfaces (touch, keyboard, or both), the portable PCs of 2015 have become thinner, lighter, and more tablet-like. These new PCs come in many versions and are known by many names, including “hybrids,” “2-in-1s,” “convertibles,” “detachable tablet PCs,” and “Ultrabook’s.” Typically, they are physically smaller than traditional laptop PCs, and as such may impose some trade-offs in content creation and productivity features compared to traditional laptops. On the other hand, they make up for these trade-offs in greater mobility and more attractive industrial designs.

Sales of hybrid devices currently represent only about 10% of total PC sales, but they are the fastest growing category in the PC segment. Hybrids sales are expected to constitute more than 50% of notebooks and more than a third of the total PC sales by 2021.

Flash Storage Trends in PC Industry

All these shifts in the PC marketplace have an impact on – and in turn are impacted by – storage solutions. As hard disk drive (HDD) technologies have grown smaller, laptops using HDD have been able to slim down from 25mm thick to around 18mm thick – without sacrificing storage capacity. Other trends in the industry have also helped slim down these devices, including the removal of optical disk drives, the elimination of fans, and the adoption of polymer batteries.

Flash storage has been the key to enabling traditional laptops to more closely resemble the ultra-thin format of a tablet – a lighter and thinner design that consumers clearly prefer to the heavier, chunkier laptops of yesteryear. In these new slate-like designs, PC manufacturers are replacing conventional HDDs with one of two forms of Flash-based storage: Solid State Drives (SSD) and embedded storage (e.MMC). SSDs have seen a healthy adoption in corporate and premium consumer laptop/notebook segments for several years. e.MMC-based storage solutions, which enable a sleeker form factor at a lower price point, are seeing rapid adoption in the entry-level tier, including consumer laptops/notebooks, Windows hybrids, and Chromebooks.

Embedded Flash Storage (e.MMC) in Notebooks Gains Traction

From a supply-side point of view, SSDs sold in 2015 stored an average of around 280GB per unit. For HDDs, the average hovered around 700GB per unit. However, with more and more cloud-based storage options becoming available, many consumers feel that 256GB of storage is more than sufficient for the applications and data (including multimedia) that they will want to keep on their computer. For these consumers, the average SSD and HDD are both larger than necessary.

This has stoked an interest among manufacturers in e.MMC-based storage solutions for the sub-\$400 consumer notebook space, the PC industry's current growth area. e.MMC memory storage solutions in the 32GB to 128GB range are less costly than SSDs and have a smaller footprint than HDDs. Currently, the sub-\$400 notebook space garners more than 33% of the total consumer notebooks segment, representing a significant TAM (Total Available Market) opportunity.

Another segment attracted to e.MMC-based storage solutions is education. The ubiquity of the Google cloud and the proliferation of Android apps via Chromebooks are appealing within the education space due to a “mobile phone-like” user experience. The cost advantages of these solutions in this price sensitive space are also well-received. OEMs targeting education will be well-positioned to gain share with solutions using e.MMC as the market gravitates towards lower price points.

We believe that e.MMC will continue to appeal to the manufacturers supplying computing devices conforming to this mass-market laptop/notebook form-factor until the cost per GB of an SSD falls closer to today's HDD cost-per-GB levels. Until that time, e.MMC-based solutions will

be more attractive than SSDs because of cost scalability and more appealing than HDDs because of their higher performance.

Today, where storage capacities greater than 256GB are still required, HDDs will continue to be a great fit. Where high performance *and* high capacities are required, SSDs will remain the preferred storage solution. Once the cost-per-GB of an SSD falls to the cost-per-GB level of today's HDDs, SSDs will become the preferred storage medium for the mass market laptop/notebook segment.

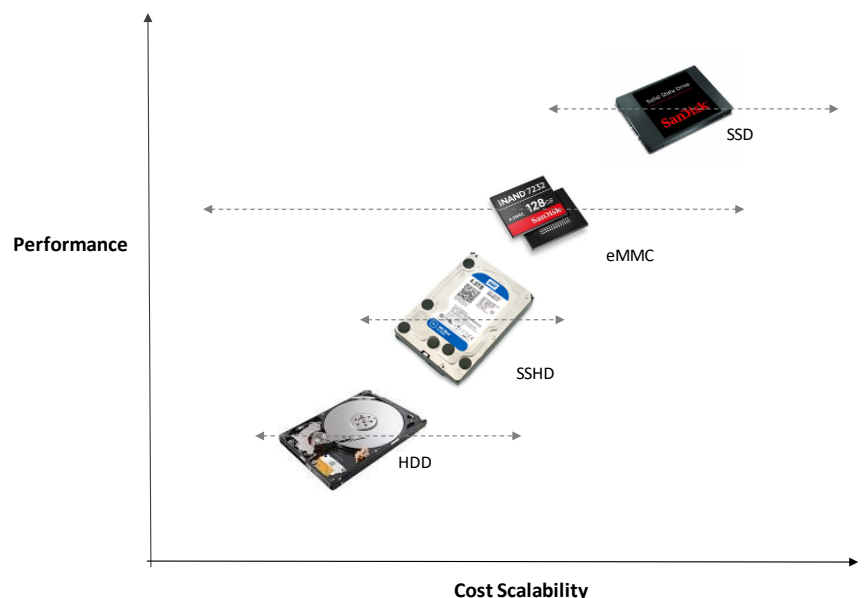
Cost Scalability of e.MMC

Storage solutions based on e.MMC are highly cost-scalable. 32GB and 64GB storage configurations can be ideal for entry-level consumer notebooks and cost less than a 500GB HDD. We estimate that the cost of a 128GB e.MMC Flash storage solution will be on par with (if not less than) a 500GB HDD by 2017.

Larger e.MMC storage configurations – in the 128GB to 256GB range – are ideal for mid-tier consumer laptops/notebooks and should be priced on par with, if not less expensive than, a 1TB HDD in the near future.

It is worth noting that the e.MMC solutions are ubiquitous in a range of environments – from smartphones to automobiles, from industrial devices to sensors on the Internet of Things (IoT) – and adoption in all these environments leading to economies of scale is contributing to the increasing affordability of e.MMC storage solutions.

As for SSDs, we do not expect to see the price of a 256GB SSD fall to the level of a 1TB HDD before 2018.

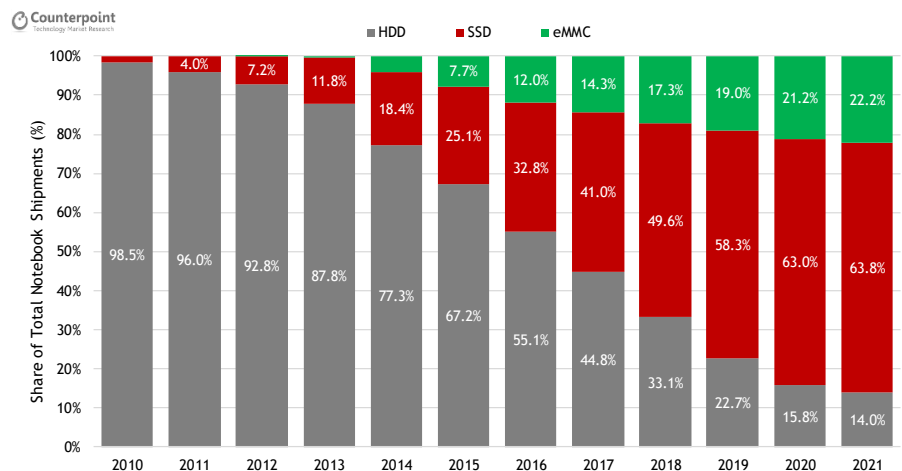


Performance of e.MMC

From a performance standpoint, e.MMC-based storage systems are vastly superior to HDD-based storage systems. As a type of NAND Flash storage, e.MMC delivers at least 10x more I/O operations per second (IOPS) than a typical HDD, which results in a faster throughput and a more responsive user experience. e.MMC has no moving parts to break and makes no noise. It simply delivers “instant-on” performance and reads and writes data at very high speeds.

e.MMC Adoption in Notebooks Segment Forecast

We estimate that 15 million e.MMC-based notebooks were shipped in 2015, a figure that represents a market penetration of close to 9% (and a growth rate of almost 95% YoY since 2010). By 2021, we project that 40 Million laptops/notebooks – 22% of all laptops/notebooks sold – will contain e.MMC-based storage solutions.



Conclusion:

The laptop/notebook PC segment is undergoing a significant form-factor evolution as increasing numbers of consumers demand sleeker hardware, lighter weight and snappier performance. These outcomes are possible only with the adoption of a smaller, thinner, lighter storage solution. Since high performance SSDs remain costly and HDDs remain bulky, e.MMC-based storage solutions offer an ideal balance of price, size, and performance to meet the demands of consumers seeking a “mobile computing” solution.

For additional comments and inquiries please reach out to **analyst (at) counterpointresearch.com**

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