

SandForce – Forcing a Solid State Reconsideration

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Abstract: By enabling the safe use of less expensive flash storage in enterprise solid state disk implementations—and adopting a heterogeneous, ‘co-opetition’ based marketing strategy—SandForce has the potential to change an accepted ‘norm’ in the SSD market and thereby increase the rate of enterprise SSD adoption.

SandForce – and what it is bringing to the solid state market

The odds are that you have not heard of SandForce. In many areas of the storage market, that could be considered a negative comment; however, SandForce is a relatively new player in the newly exciting area of solid state storage, where the unknown could well be the best. It is part of a market where there are no declared winners—certainly not yet, and certainly not in terms of the vendors, let alone the technology implementation(s) that will garner the best returns. There is everything to play for, and hundreds of millions of dollars of both VC money and ‘regular’ R & D is being poured into the efforts to figure how best to derive and deliver the optimum user benefits from the promise of the current—and future—raw solid state storage.

With so many players in the fray—from the giants of the IT industry to tiny start-ups—it is abundantly clear that today’s solid state products represent a significant new chapter in the story of storage. But of course it is also, quite simply, a very crowded space. There are roughly the same number of companies (up towards 100) developing products in the solid state market as there were in the heyday of spinning hard disk drives (HDDs)—following all the usual Darwinian market changes, that HDD market is now supplied by fewer than 10. The aim of SandForce is—of course—to thrive and be one of the eventual winners in solid state. A ‘me-too’ approach is unlikely to succeed—does SandForce look to have what it might take?

The Company: In a couple of months SandForce will celebrate its third anniversary. Funded by several leading investors, including some existing storage companies, it completed its ‘B Round’ early last year. It is a FAB-less semiconductor supplier, concentrating instead on IP to better enable NAND flash in the enterprise, and has 20 patents pending.

The Approach: First and foremost, SandForce isn’t selling solid state—or, more accurately, solid state disks (SSDs) per se. Instead it is concentrating on the development of (to use its own words) “highly integrated Flash SSD processors.” In other words, it is *enabling* and optimizing solid state devices. Specifically, it is emphasizing the enterprise integration of MLC (Multi Level Cell) technology, something that is definitely not the norm in enterprise storage (where the more expensive SLC—Single Level Cell—technology has been preferred to date). The company is thus part of a very limited cadre that is seeking to combine superior management and processing capabilities with low cost commodity MLC NAND flash in order to deliver the optimum mix of enterprise class performance and reliability at a far more attractive price point than the ‘traditional’ SLC implementations allow.

The Product Offering: Before analyzing the opportunity, it’s worth a succinct summary of what the company actually produces. In essence it is the controller for solid state—the device that determines how the actual silicon storage appears to a system as well as what levels of data protection and features it offers. The basics of the SandForce SF-1500 SSD Processor include:

- Support for up to 16 flash memory devices, of pretty much whatever type and from any manufacturer that an integrator or user specifies. Not only varying capacities, but of course, should it be demanded, SLC flash is just as supportable as the MLC preferred by SandForce (and would enjoy the same protections described below).

- 3GB/sec SATA interface.
- AES 128 encryption.
- ‘DuraClass Technology’ which combines advanced ECC and wear leveling algorithms (including ‘disturbance’ management and bit recycling) as well as the SandForce ‘RAISE’ technology—Redundant Array of Independent Silicon Elements, which is part of the company’s secret sauce and deals with data integrity.
- 5+ year ‘enterprise’ lifecycle support.
- Super-capacitor support for power failure data protection.
- 30,000 IOPS (based on 4KB random read/write transfers) and 250MB/sec throughput (based on 128KB sequential read/write transfers)—very impressive performance statistics for a SATA device that does not require any of the cache DRAM or system memory which is the case in some of the far more expensive competing solutions.
- 0.65W of typical power consumption. Admittedly it’s ‘just’ the processor, but users won’t need to turn off many light bulbs to make up for the measly power usage.
- Real shipments are imminent, but FPGA emulation systems have been with system manufacturers and integrators for over 9 months, in order to prove out the formulas that SandForce has developed and modeled.

The strategic intent of SandForce is to maximize the performance and reliability of SSDs while minimizing the cost. Digging into the specs for an example, it is noteworthy that the protection SandForce offers—1 unrecoverable read error per 10^{17} bits read—is actually an order of magnitude better than leading current HDDs. As packaged and protected by SandForce, this is neither ‘your father’s SSD’ (the earliest solid state was shipped in 1978!) nor some overgrown USB stick. It is designed as an enterprise class product.

The Solid State Market and How SandForce Fits

Even a casual market observer cannot fail to notice that solid state storage and SSDs are hot topics. It’s easy to see why—the promise of high performance, without waste, is attractive for I/O intensive applications. The logic is undeniable, and the attention of just about every vendor on the planet ensures that solid state will be a self fulfilling prophecy to some extent. The questions are, ‘in what form?’ and ‘to what extent?’ The answers to such questions will be determined by many factors—but they can be summarized as ‘suitability’ and ‘economics.’ And it is on these two areas that SandForce has focused.

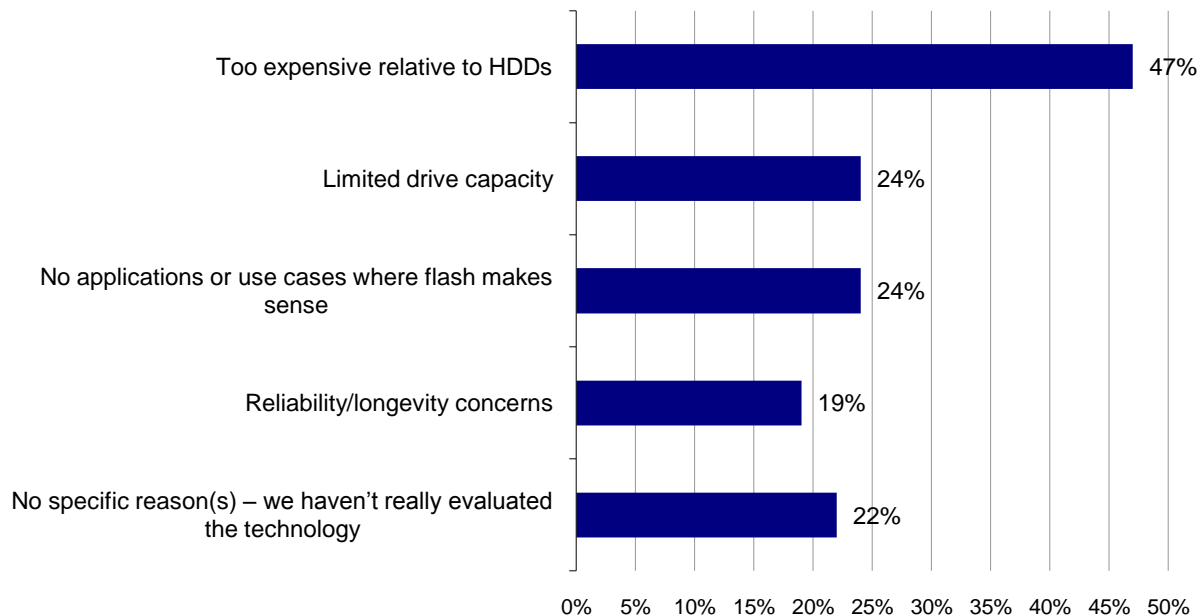
‘Suitability’: While rapidly decreasing per-GB prices are the natural result of rapidly increasing NAND flash densities, these do not come without compromise and complexity; endurance, data retention capabilities, and media reliability can all suffer as a result. The standard approaches to ‘fix’ such issues are not fixes at all, but band-aids and masking tape. Such things as adding DRAM, over-provisioning or limiting the writes, or warranted usage are all effective, but come with downsides of their own—such as more cost and less lifespan. The SandForce approach is to be more efficient—developing real fixes to address the root causes and adding value into the bargain. This is good, but is only a partial victory.

‘Economics’: The second part of the equation is good old money. Although the raw cost of SSDs is declining, they are still relatively expensive compared to HDDs. The delta is shrinking—and at an increasing pace—but the fact remains that a mixture of inertia and lack of deep SSD experience means most users still—whether or not it’s right and whether or not we like it—largely measure storage by its raw cost per GB. We can argue the merits of this, but we can’t argue the facts. Price matters. To compound the issue, there is a perceived opinion that only SLC (lower density and capacity, hence higher price/GB) is suitable for the enterprise. However the ‘suitability’ factors from SandForce are just as applicable to MLC *and thus SandForce is able to support MLC for SSDs in the enterprise*. The importance of this can be highlighted by a recent piece of ESG Research¹. As Figure 1 shows, when users were asked why their organizations had no interest in flash-based SSDs at the moment, the most frequently stated reason (by 47%, and roughly double the next nearest fact) was the relatively high cost compared to HDDs.

¹ ESG Research: *Enterprise Storage Survey*, December 2008.

FIGURE 1: STATED REASONS FOR A LACK OF INTEREST IN SOLID STATE DISKS

Why do you believe your organization has no interest in storage systems with flash-based SSDs at this time? (Percent of respondents, N=86, multiple responses accepted)



Source: Enterprise Strategy Group, 2009

The Implications for SandForce

The implications of this ability to competently and confidently use the higher capacity/lower cost per GB MLC technology in the enterprise are clear. Even if all else were to be equal, price is the number one obstacle to a further and faster adoption of SSD in the enterprise. When ESG asked (in the previously mentioned research), “at what price point relative to HDD technology do you believe your organization would consider increased deployment of flash-based SSDs?”, 85% of respondents answered with a statement that they would adopt more at some price increment (the increments ranged from 1% to over 50%). A further 10% indicated they would move more at price parity. Looking at the increments in more detail, the largest number (35%, which is included in the 85%) chose a price premium of 11-24% for SSDs compared to HDDs as their ‘tipping point.’

As to the actual use of MLC in the enterprise, there are always naysayers to new uses of any technology in IT, especially as ‘cheaper’ or ‘less robust’ products gradually (and at times, it feels, inexorably) move into the enterprise space. Recent examples are iSCSI and SATA—even servers—which were maligned as ‘not enterprise worthy’...at least until experience proved otherwise! Additionally, the technological route that SandForce has chosen to employ—firmware implemented via a highly optimized, ASIC-based processor—is also a model that has worked successfully to simultaneously bring both added features and improved value to other markets before. Some innovative storage vendors and the IP router world are good examples.

The Bottom Line

It is not too strong a statement to say that non-volatile solid state technology has the potential to usher in a new era for storage architectures by delivering extremely high performance and scalability at a far lower per-I/O cost. Although common in consumer applications, the solid state storage market is in its early stages for enterprise computing. There is too much operational logic, economic value, and vendor investment behind solid state for it to fail. Indeed, right now, it appears that there’s a ‘perfect storm’ in favor of solid state storage—the technologies themselves have improved and are appearing in a world where HDD advances are slowing, CPU performance is

outpacing the ability of those HDDs to deliver their I/O needs, the rate of data growth is exceeding the rate of storage price decline, and the consequent drive to better utilize all resources is bolstered by a desire to be less profligate with the world's resources (a.k.a., green).²

From a technology viewpoint, SandForce has a good value position. Using MLC—protected by its 'suitability' cloak—means that SandForce can help address the number one obstacle to the adoption of SSD—price. This alone would be interesting but it is the SandForce marketing strategy that gives it the potential to be one of the remaining players as the solid state market goes through its Darwinian machinations over the next decade or so. First, the company's technology has the advantage that it will work with any NAND flash vendor's memory. As such, it is not competing with, but rather is really co-operating with many others. Thus, IF everything plays out as SandForce would like, its product becomes the processor of choice to support multiple types of solid state storage integration.

Of course, it's not all plain sailing. The biggest opportunity for SandForce is also its biggest obstacle—and that is simply that it is different. Its marketing challenge is thus significant, as it must convince both the user community (SandForce management is smart enough to understand the importance of 'pull-marketing' along the lines of 'Intel inside') as well as the systems vendors. As mentioned before, the solid state market is busy, crowded, and noisy. Differentiation can fall victim to diffidence, and so SandForce must find ways to speak loudly over the 'static.' That said, its position is intriguing because it offers a heterogeneous, agnostic approach. And even many of its potential vendor competitors are ultimately in the business of wanting to sell the storage itself, so may be prepared to 'deal' on the processor. Indeed, maintaining its independence is most probably the company's optimum route to success—there was an old commercial tagline for BASF that went something like "we don't make the things you use, we make the things you use better." By enabling MLC (or any other NAND flash) in the enterprise, and by not seeking to become a standard storage vendor itself, SandForce has a genuine opportunity to "make things better" both for users and multiple other vendors....and in doing so, of course, to make things pretty good for itself too.

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² This paragraph is taken from the ESG Report, *The State of Solid State*, April 2009.