TMT ANALYTICS

4DS hits key performance milestone

Time to generate broader industry interest

4DS announced it has achieved an endurance milestone for its Interface Switching (IS) ReRAM technology, i.e. 97% of the more than 1,000 memory cells the company has tested, achieved the minimum required number of switching cycles of 400 in a linear endurance test. A linear endurance test means that each cell is tested after every switch (a state change of the resistance level). So in total, all tested cells were switched more than 800 times at switching voltage of 20nA (set) and 10nA (reset). Achievement of this endurance milestone triggered the conversion of 67.6M performance shares.

In addition to achievement of the endurance milestone, the company has also demonstrated that it can drive endurance of individual cells well beyond this number of cycles through endurance optimization. Certain cells have achieved "well in excess" of 10,000 cycles (20,000 state changes per cell), which indicates that the cells should potentially be suitable for storage class memory applications, such as data storage in data centers and mobile devices at GB scale.

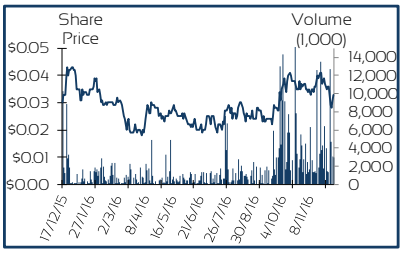
In NAND Flash memory today, Single Level Cells (SLC) can be switched approximately 100,000 times before failure, even though Flash vendors often limit the number of cycles to just 1,000 to prevent data loss. Therefore, we believe that 4DS will be able to achieve similar if not better endurance levels with its IS ReRAM cells, given that Interface Switching is a more durable technology. The 10,000+ cycles put IS ReRAM well within the realm of commercial applicability.

Western Digital Analyst Day feedback: All-in on ReRAM

During its Analyst Day on 6 December, Western Digital (NASDAQ: WDC), the parent company of 4DS' development partner HGST, updated the market on its current and next generation technology roadmaps. While WDC previously regarded ReRAM as a lower cost alternative to current 3D NAND Flash, the company has now stated that it also regards ReRAM as having superior performance characteristics than 3D NAND.

More importantly, WDC regards ReRAM as better scalable than 3D XPoint, a technology engineered by Intel and Micron, which is saying quite a lot given that 3D XPoint technology is considered to having substantial benefits in the areas of speed, endurance and scalability, albeit at a premium price. So WDC stating that it considers ReRAM to be better scalable than 3D XPoint, is extremely bullish for 4DS, in our view.

4DS Memory Limited	
Number of shares (m)	845.6
Number of shares FD (m)	947.2
Market capitalisation (A$ m)	27.9
Free Float (%)	85%
12 month high/low A$	0,046/0,018
Average daily volume (k)	1,810



Flash Note

4DS.ASX

Semiconductors & Semiconductor Equipment

Australia

Risk: High

4DS Memory Limited (4DS.ASX) is a semiconductor development company aiming to provide an enterprise grade storage memory for cloud and data center storage markets. The company is developing a proprietary Interface Switching ReRAM technology leveraging expertise from a strategic partnership with a leading data storage player.

BUY

Current price: A$ 0.033

Price target: A$ 0.12

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Its now time to start generating broader industry interest

During the past two and a half years, 4DS has closely cooperated with its joint development partner HGST. We believe the JDA has been instrumental in getting 4DS to where it is today. It also makes WDC the most likely candidate to be 4DS' first licensee or potential acquirer of the company, especially after the statements made at WDC's Analyst Day two days ago. Given that non-exclusive licenses for this sort of Intellectual Property (IP) are highly unusual in the semiconductor industry, i.e. companies would rather acquire the IP developer outright to avoid having to share the IP with competitors, an exclusive license is the most likely outcome in a scenario in which 4DS licenses out its IP

However, given the acquisitive nature of the semiconductor industry in the past thirty years, which only seems to have strengthened in the past 18 to 24 months, we expect 4DS will become a take-over target if it can continue to demonstrate progress towards commercial viability in 2017.

Western Digital is not the only game in town

While the close ties with HGST, and thus WDC, make WDC a prime candidate to acquire 4DS, we would note that a market with just one interested buyer can safely be labeled a buyers' market, which will likely limit the valuation upside for 4DS shareholders. Consequently, good governance would dictate that 4DS starts taking the pulse of the market and gauge strategic interest from parties other than WDC. Assuming 4DS keeps hitting its development targets, we believe there may be several semiconductor manufacturers potentially interested in acquiring the IP, not least of all a few highly ambitious Chinese players.

China's US$ 108BN ambition

Generally speaking, China's main semiconductor manufacturers are trailing US, European, Korean and Taiwanese industry peers in terms of manufacturing capabilities, design and R&D. Given the strategic nature of the semiconductor industry, for instance for defense purposes, China's current economic plan calls for more than > US$ 100BN in semiconductor investments at the national and provincial level. This includes investments in joint ventures, acquisitions and the purchase of foreign semiconductor IP. Because of this strong, state-backed push to develop a more advanced semiconductor industry, including a more advanced memory subsector, we would expect several of China's large manufacturers to be interested in IS ReRAM technology as a future GB memory solution.

SMIC: the most obvious Chinese player to be interested in IS ReRAM

With US$ 2.2BN in revenues SMIC is China's largest semiconductor manufacturer as well as its most ambitious one when it comes to developing emerging non volatile memory technologies. Current products include NOR Flash down to 65nm as well as embedded Flash and EEPROM.

Regarding emerging memory technologies, SMIC is working on Phase Change Memory (PCM), Magneto resistive RAM (MRAM) as well as ReRAM. (Please refer to our initiating research report of 4DS for more background on these emerging memory technologies).

Early in 2016 SMIC formed a strategic partnership with Crossbar Inc to develop and manufacture Crossbar's ReRAM technology at the 40nm resolution to be embedded into micro controller units and Systems on a Chip (SoCs). However, while 4DS' technology will likely be positioned for GB storage requirements (data centers, mobile devices etc), Crossbar's technology is better suited to smaller units of storage, e.g. for connected devices on the Internet of Things (IoT), such as sensors as well as wearables and automotive, consumer and industrial applications.

In other words, we believe Crossbar's and 4DS' respective technologies are complementary rather than in competition with each other. Consequently, given SMIC's forward thinking regarding emerging storage technology, we would expect the company to be highly interested in potentially licensing 4DS' technology.

XMC (now part of state-owned Yangtze River Storage Technology)

Wuhan Xinxin Semiconductor Manufacturing Corporation (XMC), one of China's largest Flash memory foundries, currently manufactures NOR Flash at feature sizes of 45nm up to 90nm. The company also has strong ambitions in the 3D NAND Flash memory market and is currently constructing a NAND Flash fab. The company has teamed up with US-based Cypress Semiconductor (Spansion unit) to develop Flash memory expertise. Beyond 3D NAND Flash, we believe almost by default XMC will be very interested in various ReRAM technologies.

Huahong Grace

Huahong Grace provides foundry capacity for embedded Non-Volatile Memory (eNVM), such as eFlash and eEEPROM for smart cards, microcontrollers and SoC's at trailing edge resolutions down to 130nm. In the bigger scheme of things, Grace is a small manufacturer, generating US$ 650M in revenues in 2015. While not a large-scale manufacturer, given its activities in NVM, Grace will likely have at least a technological interest in IS ReRAM.

The usual suspects

In addition to the above-mentioned Chinese players, we believe other obvious memory players likely to be strategically interested in 4DS, if and when the company can demonstrate commercial viability, are SK Hynix, Toshiba, Intel, Micron, Samsung and of course WDC, which acquired large Flash memory player SanDisk in May 2016.

> *Given where 4DS is in its development cycle, i.e. the company has started to validate its technology across various resolutions for endurance, data retention and access speeds, we believe the time is right for 4DS to actively start generating and cultivating industry interest beyond just WDC to maximize shareholder value in a potential take-over scenario.*

Next steps: optimizing for endurance, data retention and speed down to 40nm

The recently tested cells have resolutions between 140nm and 50nm, so the logical next step for 4DS will be to start endurance tests with cells at 40nm, a resolution at which the company recently successfully tested working IS ReRAM cells. Given the behavioral consistency demonstrated so far in cells from 140nm down to 50nm, we expect 40nm testing to show similar test results.

Additionally, with the initial endurance tests passed, we expect the company to start optimizing memory cells for data retention and power consumption. Also, read speeds improve when using higher electrical currents. Ultimately, potential licensees will be able to optimize these variables themselves, depending on product requirements. This optimization and extended testing will need to be done across various resolutions to demonstrate consistency of the technology as it scaled down to 40nm.

Not only will this demonstrate commercial viability of the technology at 40nm to potential licensees, but it will also provide potential licensees a certain level of confidence that the technology will show similar behaviour should they choose to scale down beyond 40nm. While IS ReRAM may not need to be scaled down beyond 40nm in 3D structures, providing behavioural consistency down to 40nm will be pivotal in generating strategic interest in the company, in our view.

We reiterate our BUY rating and price target of A$ 0.12 per share

4DS has taken another major step on the path to commercial viability, which should ultimately lead to IP license agreement(s) or an outright strategic acquisition of the company by one of the aforementioned semiconductor manufacturers.

Furthermore, WDC's remarks during their Analyst Day on December 6th strengthen us in our belief that ReRAM has a big future in Storage Class Memory, while WDC's candidacy to acquire 4DS at some point only seems to have become more obvious.

Compared to a peer group of other pre-revenue ASX-listed semiconductor companies, we have previously valued 4DS in excess of A$100M, or A$ 0.12 per share. Consequently, given the reported progress we reiterate our BUY rating for 4DS as well as our A$ 0.12 price target.

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