



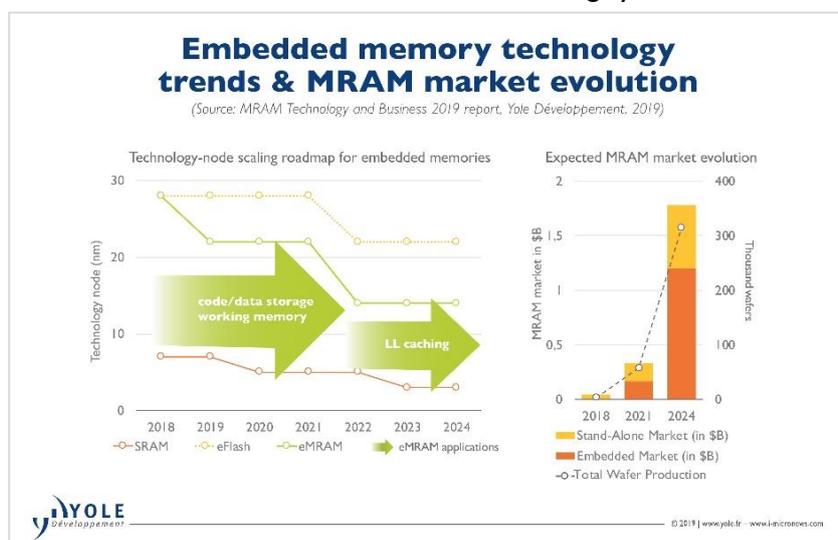
FOR IMMEDIATE RELEASE:

MRAM¹, a promise beyond eFlash

Extracted from:

- Yole Développement's reports and monitors: MRAM Technology and Business - Status of the Memory Industry - NAND Service – Memory Research & DRAM Service – Memory Research
- System Plus Consulting report, Leading-edge 3D NAND Memory Comparison
- Executives Memory Breakfast on August 6 in Santa Clara

LYON, France – August 8, 2019: “Embedded MRAM is picking up steam thanks to the strong involvement of top foundry/IDM² players and equipment suppliers”, comments **Simone Bertolazzi, PhD. Technology & Market Analyst at Yole Développement (Yole)**. Nowadays, there is broad consensus in the memory industry that the 28nm/22nm silicon lithography nodes will be the last technology nodes for eFlash³. This is not because of fundamental scalability limitations, but because of economic barriers. Therefore a new embedded NVM⁴ for code/data storage is needed. At the same time, scaling of volatile SRAM⁵ is slowing down due to cell footprint degradation occurring at advanced nodes. A denser working embedded memory would therefore be highly desirable.



Thanks to the support of a large number of leading companies, the embedded memory market has the potential to reach US\$1.2 billion by 2024, growing with a 295% CAGR over this period. In parallel, the stand-alone (STT-)MRAM market is expected to grow less vigorously than its embedded counterpart, with revenues up to about US\$580 million in 2024, announces Yole in its

latest [MRAM Technology and Business report](#), released last week and presented at the [MRAM Developer Day](#) this week in Santa Clara. Simone Bertozzi had the opportunity to present the latest technology trends and a relevant market update to the memory community. His presentation is now available on [i-Micronews.com](#).

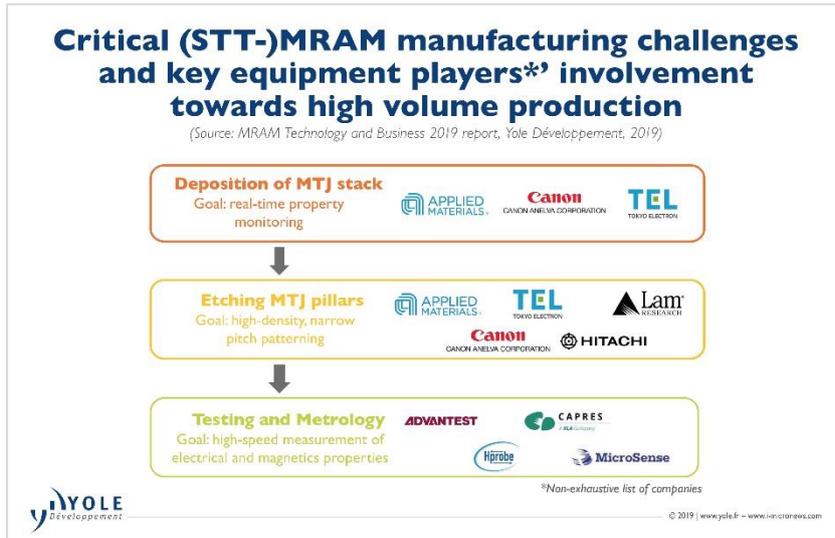
¹ MRAM : Magnetoresistive RAM

² IDM : Integrated Device Manufacturer

³ eFlash : Embedded Flash

⁴ NVM : Non Volatile Memory

⁵ SRAM : Static Random Access Memory



MRAM promises life beyond eFlash: the embedded MRAM market is taking off. Yole & System Plus Consulting memory team offers you today a relevant snapshot.

Among various emerging NVM technologies, spin transfer torque magnetoresistive RAM (STT-MRAM) is gaining significant momentum. It is poised to become the next embedded memory solution for a

variety of IC⁶ products manufactured at the 28nm node and below. That includes low-power wearables and IoT⁷ devices, MCUs⁸, automotive, imaging and display ICs, edge AI⁹ accelerators, and other ASICs¹⁰ and ASSPs¹¹.

“In 2018, the embedded STT-MRAM market was still limited, with no volume shipments”, explains Simone Bertolazzi from Yole. “2019 is expected to be the year this market takes off. Samsung has recently started mass production of embedded STT-MRAM, and Yole expects other major foundry/IDMs to enter the race soon.”

At the same time, multiple equipment suppliers like Applied Materials, Tokyo Electron Limited (TEL), Canon, and Lam Research, and logic companies like Qualcomm, ARM and Synopsys are increasing their research spending on MRAM. This is further propelling the development of the embedded STT-MRAM business.

On the other hand, the stand-alone memory market is expected to grow less vigorously, with a 54% CAGR between 2018 and 2024. According to Yole’s analysts, it will remain below US\$600 million in 2024. So far, the growth has been driven by low-density (STT-)MRAM devices at 16Mb and below manufactured by a few key players, such as Everspin and Avalanche/Sony. In coming years, the stand-alone market will be mainly driven by enterprise storage applications. These include SSD¹² caching and storage/network accelerators, which are served by high-density STT-MRAM chips at 256Mb and above. The latter are typically sold to IDMs and system makers in the enterprise storage business. These companies require 12-18 months to develop new systems, so the ramp-up of STT-MRAM sales has taken a relatively long time.

⁶ IC : Integrated Circuit

⁷ IoT: Internet-of-Things

⁸ MCU: Microcontroller Unit

⁹ AI : Artificial Intelligence

¹⁰ ASIC : Application Specific IC

¹¹ ASSP: Application Specific Standard Part

¹² SSD: Solid State Drive

Notably, 1Gb 28nm devices from Everspin have recently moved into the pilot-production phase at GlobalFoundries. Their forthcoming availability in the market could trigger further growth of enterprise storage applications. Yole's analysts had the opportunity to debate with Martin Mason, Senior Director of Embedded Memory at GlobalFoundries. Martin Mason and Simone Bertolazzi discuss the company's view on embedded MRAM, the technology status and roadmap for the coming years. This interview is available on i-micronews.com.



This week also, Yole and its partner System Plus Consulting welcomed leading memory companies at their first [Executives Memory Breakfast](#) in Santa Clara, during the Memory week¹³. During 3 hours, analysts detailed the status of the memory business with key figures and market shares. They shared their vision of the industry during a Q&A session: DRAM, NAND, emerging NVM... were part of the program.

Mike Howard, VP of DRAM & Memory Research at Yole, comments the inevitable DRAM market consolidation: “DRAM consolidation took more than 30 years as new participants continually entered the market with the aid of IP¹⁴ from distressed suppliers and government-backed capital”, asserts. And he adds: “Prior to 2013, DRAM prices fell 75% of the time...since consolidation in 2013 they have only fallen 50% of the time...”

Walt Coon, VP of NAND & Memory research at Yole also comments the evolution of the NAND industry: “Over the past 2 decades, the NAND market has experienced tremendous growth but has been plagued by significant volatility and prolonged downturns.” In addition, Walt Coon observes possible consolidation scenarios...

“NAND Manufacturers continue to meet the progressive demand of high-performing Flash memories with higher capacity by increasing the number of layers and reducing the die size,” says **Belinda Dube, Cost Analyst at System Plus Consulting**. “The recent generation allows manufacturers to produce increased Gigabytes per wafer. 3D technology continues to meet the market demands but the complexity of the 3D structure with added layers presents different manufacturing challenges. Future generations will see manufacturers altering their manufacturing process and memory design.”

Yole & System Plus Consulting presentations are now available on [i-micronews](http://i-micronews.com) as well.

With no possible turning back, Yole Group of Companies expertise is growing and its market positioning towards the memory market segment is confirmed. This [Executive Memory Breakfast](#) was the first

¹³ The Memory Week is taking place this week in Santa Clara, with two key memory conferences: DRAM Developer Day and the Flash Memory Summit. More info. on i-micronews.com.

¹⁴ IP : Intellectual Property

of a long series of dedicated and valuable events, the group will organize.

With an impressive collection of technology, market, structural, process & cost reports, monitors and custom services, Yole and System Plus Consulting propose their customers a comprehensive understanding of the memory business at short, middle and long terms. Market figures, market shares, detailed analyses of the strategy of leading companies, detailed description of the technology and latest innovative solutions... all are part of [Yole Group's services](#).

Make sure to be aware of the memory market evolution and technical challenges and follow us on i-micronews.com.

ABOUT THE MEMORY ACTIVITIES:

Yole Développement and its partners have launched a global Memory Service to deliver world class research, data, and insight to ensure our clients are well-versed in all aspects of this dynamic industry ecosystem.

- **New monitor services - DRAM & NAND focus**

Market monitor:

An Excel and PowerPoint based quarterly report that includes both historical and forecast data covering pricing forecast - Detailed supply/demand analysis - Supplier shipments, revenue, and market shares - Detailed analysis of key demand segments including smartphones, compute, data center, automotive and Solid State Drive (SSD) analysis - Memory technology.

Pricing monitor:

A monthly snapshot of market pricing across a variety of products, including components and packaged solutions spanning multiple densities and technologies

A detailed description is available on i-micronews.com: [DRAM](#) - [NAND](#)

- **Reports**

- [MRAM Technology and Business 2019](#)

MRAM promises life beyond eFlash: the embedded MRAM market is taking off and is expected to reach \$1.2B by 2024 – Performed by Yole Développement.

Companies listed in this report:

A*STAR, Advantest, Aeroflex, Antaios, Applied Materials, Avalanche, Canon, Capres-KLA, CEA Leti, CNE, Crocus, CXMT, Cypress, Despatch, Dow, Evaderis, Evatec, Everspin, JHICC, GlobalFoundries, H-Grace, HFC Semiconductor, Hikstor, Hitachi, Honeywell, HP, Hprobe, Huawei, IBM, Imec, Infineon, Intermolecular, Inston, Intel, ITRI, Lam Research, Macronix, Maxim, Materion, Mediatek, Merk, Microchip, Micron, MicroSense Mythic, Nantero, Nanya, National Tsing Hua University, Nokia, Numen, NVE Corporation, NXP, OHT, Panasonic... [More](#)



About the authors:

- **Simone Bertolazzi**, PhD is a Technology & Market analyst at Yole Développement (Yole) working with the Semiconductor & Software division. He is member of the Yole's memory team and he contributes on a day-to-day basis to the analysis of nonvolatile memory technologies, their related materials and fabrication processes. Previously, Simone carried out experimental research in the field of nanoscience and nanotechnology, focusing on emerging semiconducting materials and their opto-electronic device applications. He (co-) authored more than 15 papers in high impact scientific journals and was awarded the prestigious Marie Curie Intra-European Fellowship. Simone obtained a PhD in physics in 2015 from École Polytechnique Fédérale de Lausanne (Switzerland), where he developed novel flash memory cells based on heterostructures of two-dimensional materials and high-k dielectrics. Simone earned a double M. A. Sc. degree from Polytechnique de Montréal (Canada) and Politecnico di Milano (Italy), graduating cum laude.
- **Emilie Jolivet** is Director of the Semiconductor & Software Division at Yole Développement, part of Yole Group of Companies, where her specific interests cover package & assembly, semiconductor manufacturing, memory and software & computing fields. Based on her valuable experience in the semiconductor industry, Emilie manages the expansion of the technical and market expertise of the Semiconductor and Software Team. The team interacts daily with leading companies allowing semiconductor & software analysts to collect a large amount of data and integrate their understanding of the evolution of the market with technology breakthroughs. In addition, Emilie's mission focusses on the management of business relationships with semiconductor leaders and the development of market research and strategy consulting activities inside the Yole group. Emilie Jolivet holds a Master's degree in Applied Physics specializing in Microelectronics from INSA (Toulouse, France).

[Status of the Memory Industry](#)

A 360° analysis of the memory industry and its competitive landscape. – Performed by Yole Développement

[Leading-edge 3D NAND Memory Comparison 2018](#)

A deep technology analysis and cost comparison report on cutting edge 3D NAND memory chips from Toshiba/SanDisk, Samsung, SK Hynix and Intel/Micron – Performed by System Plus Consulting

[Emerging Non Volatile Memory](#)

After more than 15 years in development, PCM has finally taken off in stand-alone applications. STT-MRAM will lead the embedded memory race. – Performed by Yole Développement

[3D Non-Volatile Memory](#)

The 3D Non-Volatile Memory field is changing fast. How the Chinese players can find a place in a crowded space? – Performed by Knowmade

[AMD Radeon Vega Frontier Edition](#)

New GPU is AMD's first with Samsung 8-Hi second generation high bandwidth memory and the latest 2.5D chip-on-wafer packaging from SPIL – Performed by System Plus Consulting

[Memory Packaging Market and Technology](#)

Wire bond is still the dominant interconnect for memory packaging, but flip-chip is making inroads into mainstream memory packaging – Performed by Yole Développement

ABOUT YOLE GROUP OF COMPANIES



Specializing in patent analysis and scientific information, **Knowmade** provides technology intelligence and IP strategy consulting services. The company supports R&D organizations, industrial companies, and investors in their business development by offering them a deep understanding of their IP environment and technology trends. Knowmade operates in the following industrial sectors: Compound Semiconductors, Power Electronics, RF & Microwave Technologies, LED/OLED Lighting & Display, Photonics, Memory, MEMS & Sensors, Manufacturing & Advanced Packaging, Batteries & Energy Management, Biotechnology, Pharmaceuticals, Medical Devices, Medical Imaging, and Agri-Food & Environment.

Knowmade's experts provide prior art search, patent landscape analysis, scientific literature analysis, patent valuation, IP due diligence, and freedom-to operate analysis. In parallel, the company offers litigation/licensing support, technology scouting, and IP/technology watch services. Knowmade's analysts combine their technical and patent expertise with powerful analytics tools and proprietary methodologies to deliver relevant patent analyses and scientific reviews. More information on www.knowmade.com and follow [Knowmade on LinkedIn](#).



System Plus Consulting specializes in the cost analysis of electronics, from semiconductor devices to electronic systems. Created more than 20 years ago, System Plus Consulting has developed a complete range of services, costing tools and reports to deliver in-depth production cost studies and estimate the objective selling price of a product.

System Plus Consulting engineers are experts in Integrated Circuits - Power Devices & Modules - MEMS & Sensors - Photonics – LED - Imaging – Display - Packaging - Electronic Boards & Systems. Through hundreds of analyses performed each year, System Plus Consulting offers deep added-value reports to help its customers understand their production processes and determine production costs. Based on System Plus Consulting's results, manufacturers are able to compare their production costs to those of competitors. System Plus Consulting is a sister company of Yole Développement. More info on www.systemplus.fr and on [LinkedIn](#) and [Twitter](#).



Founded in 1998, **Yole Développement (Yole)** has grown to become a group of companies providing marketing, technology and strategy consulting, media and corporate finance services, reverse engineering and reverse costing services and well as IP and patent analysis. With a strong focus on emerging applications using silicon and/or micro manufacturing, the Yole group of companies has expanded to include more than 80 collaborators worldwide covering MEMS & Sensors - Imaging - Medical Technologies - Compound Semiconductors - RF Electronics - Solid State Lighting - Displays - Photonics - Power Electronics - Batteries & Energy Management - Advanced Packaging - Semiconductor Manufacturing - Software & Computing - Memory and more...

The “More than Moore” market research, technology and strategy consulting company Yole Développement, along with its partners System Plus Consulting, PISEO and KnowMade, support industrial companies, investors and R&D organizations worldwide to help them understand markets and follow technology trends to grow their business. . For more information, visit www.yole.fr and follow Yole on [LinkedIn](#) and [Twitter](#).

- Consulting & Financial Services: Jean-Christophe Eloy (eloy@yole.fr)
- Reports: David Jourdan (jourdan@yole.fr)

Yole Développement, System Plus Consulting, Knowmade, PISEO and Blumorpho are part of Yole Group of Companies. Yole Group of Companies - Press Relations & Corporate Communication: Sandrine Leroy (leroy@yole.fr).

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