TRENDS AND APPLICATIONS FOR EMERGING MEMORY TECHNOLOGIES

Thomas M. Coughlin[1] and Jim Handy[2]

1) Coughlin Associates, Inc., tom@tomcoughlin.com

2) Objective Analysis, Jim.Handy@Objective-Analysis.com

I. COMPARING EMERGING NON-VOLATILE MEMORY TECHNOLOGIES

Applications such as the Internet of Things (IoT) and big data analysis, including machine learning, are driving the needs for increasing storage and memory capacity, performance and power savings. To meet these needs, the conventional memory and storage hierarchy is being transformed by new storage interfaces, such as NVMe as well as new architectures, such as memory-centric computing. New non-volatile memories are needed to serve many of these new applications and to enable power efficient instant on devices. This poster will examine the array of emerging memory technologies and their application with a focus on uses and projections for MRAM technology.

These non-volatile memory technologies include Ferroelectric RAM (FeRAM), Magnetic RAM (MRAM), Resistive RAM (ReRAM) and Phase Change Memory (PCM) as well as the version of PCM offered by Intel and Micron's 3D Xpoint memory. Important characteristics of these non-volatile memory technologies are compared to NAND flash (a common solid-state non-volatile memory) and DRAM (a common volatile memory) in Table 1.

II. MRAM APPLICATIONS AND TRADE-OFFS

MRAM, particularly spin tunnel torque MRAM (see Figure 1), has performance and endurance characteristics that approach those of DRAM and even SRAM, while requiring lower operating power due to the non-volatile storage characteristics of MRAM. However, MRAM products trade off storage capacity, data retention at elevated temperatures and endurance to meet requirements for various applications where it might replace SRAM, NOR Flash or DRAM.

These applications include standalone MRAM chip applications, such as those served by companies such as Everspin (claiming over 70 million MRAM chips shipped) as well as applications using MRAM as internal memory in embedded industrial and consumer devices and potentially for data center applications in FPGAs and ASICS. These embedded memory uses could create a significant market for MRAM and has driven a number of semiconductor companies to announce plans to ship MRAM embedded products in 2018.

This poster will compare the current and projected state for the next five years for various emerging non-volatile memory technologies, talk about where they will find applications and make market and technology projections about the growth of stand-alone chip as well as embedded MRAM memory. It will also explore the various trade-offs for applications, including automotive embedded memory and embedded memory in IoT industrial and consumer applications as well as data center applications, illustrated in Figure 2. Growth in MRAM and other emerging memory applications will also drive the growth of specialized capital manufacturing equipment used to make these products and we will give some indications of the resulting capital equipment spending required to equip the manufacturing lines.

This poster is based upon data from the 2018 Emerging Memory and Storage Technologies Report and their Manufacture Report, published by Coughlin Associates, Inc. and Objective Analysis

REFERENCES

1) T. Coughlin and J. Handy, 2018 Emerging Memory and Storage Technologies and their Manufacture Report, Coughlin Associates and Objective Analysis (2018).

THOMAS M. COUGHLIN
E-mail: tom@tomcoughlin.com
tel: +1-408-202-5098

Table I. Characteristics of Emerging Memory Technologies.

Technology	FeRAM	MRAM	ReRAM	PCM	3D Xpoint	NAND Flash	DRAM NVDIMM
Endurance	10^{12}	10^{12}	10^{6}	10^{8}	10^{6} - 10^{7}	10^{3}	10^{15}
Byte Addressable	yes	yes	yes	yes	yes	no	yes
Latency R/W	70ns-100ns	70ns/70ns	100ns/100µs	20ns/65ns	100ns/500ns	10µs/10µS	40-180ns
Power Consumption	Low	Medium/ Low	Low	Medium	Medium	Low	High
Interface	DRAM	DDR3 DDR4	Flash-like	Proprietary	Proprietary	Toggle ONFI	DDR3 DDR4
Density Path	Low	Gigabit+	Terabit	64Gb+	64Gb+	Gigabit+	Gigabit+

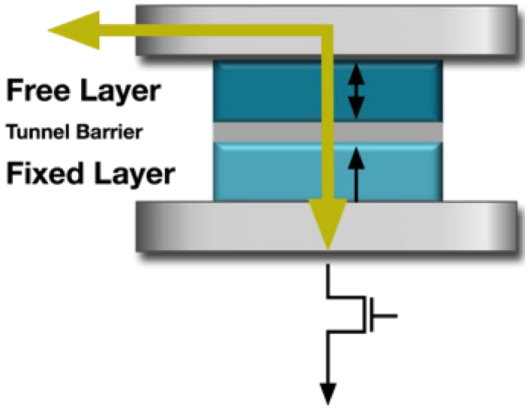

Fig. 1 STT MRAM Structure (After Everspin Corp. Presentation, February 2018).

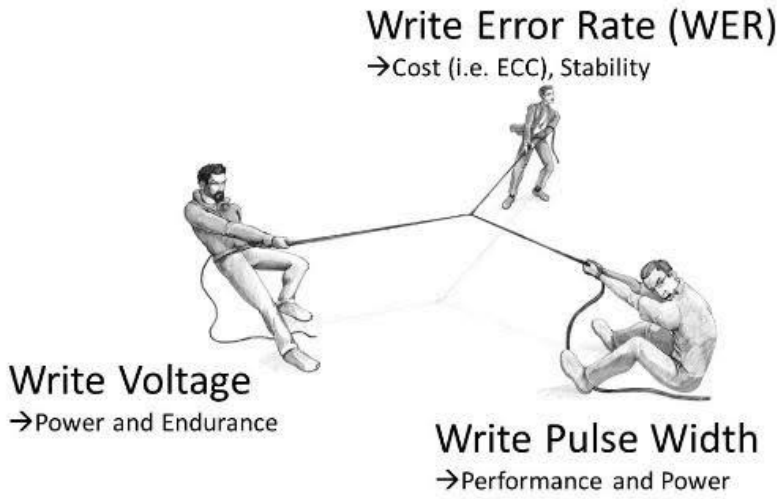

Fig. 2 STT MRAM Trade-offs (after Spin Transfer Technology Presentation, September 2016).