EMERGING MEMORIES FIND THEIR DIRECTION

COUGHLIN ASSOCIATES
San Jose, California
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EMERGING MEMORIES
FIND THEIR DIRECTION

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and
Jim Handy, Objective Analysis

COUGHLIN ASSOCIATES
SAN JOSE, CALIFORNIA
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>THE AUTHORS</td>
<td>16</td>
</tr>
<tr>
<td>EXECUTIVE SUMMARY</td>
<td>17</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>19</td>
</tr>
<tr>
<td>WHY EMERGING MEMORIES ARE POPULAR</td>
<td>23</td>
</tr>
<tr>
<td><strong>Scaling Limits for Entrained Technologies</strong></td>
<td>23</td>
</tr>
<tr>
<td>3D NAND Flash Technologies</td>
<td>23</td>
</tr>
<tr>
<td>Future Flash Memories</td>
<td>27</td>
</tr>
<tr>
<td>Embedded NOR and SRAM Scaling Challenges</td>
<td>28</td>
</tr>
<tr>
<td>Standalone NAND &amp; DRAM Scaling Concerns</td>
<td>30</td>
</tr>
<tr>
<td>Technical Advantages</td>
<td>31</td>
</tr>
<tr>
<td>Potential Cost/GB Advantages</td>
<td>32</td>
</tr>
<tr>
<td>Which Applications Want Emerging Memories First?</td>
<td>32</td>
</tr>
<tr>
<td>HOW A NEW MEMORY LAYER IMPROVES COMPUTER PERFORMANCE</td>
<td>33</td>
</tr>
<tr>
<td>How Persistence Changes the Memory/Storage Hierarchy (Storage Class Memories)</td>
<td>33</td>
</tr>
<tr>
<td>Standardizing the Persistent Memory Software Interface</td>
<td>38</td>
</tr>
<tr>
<td>In-Memory Computing Possibilities</td>
<td>39</td>
</tr>
<tr>
<td>UNDERSTANDING BIT SELECTORS</td>
<td>40</td>
</tr>
<tr>
<td>RESISTIVE RAM, RERAM, RRAM, MEMRISTOR</td>
<td>48</td>
</tr>
<tr>
<td>ReRAM Device Function</td>
<td>49</td>
</tr>
<tr>
<td>3D Resistive RAM Technology</td>
<td>55</td>
</tr>
<tr>
<td>ReRAM CMOS Integration</td>
<td>55</td>
</tr>
<tr>
<td>3D NAND Approach to ReRAM</td>
<td>57</td>
</tr>
<tr>
<td>ReRAM and Artificial Intelligence</td>
<td>57</td>
</tr>
<tr>
<td>Current ReRAM Status</td>
<td>59</td>
</tr>
<tr>
<td>FERROELECTRIC RAM, FERAM, FRAM</td>
<td>60</td>
</tr>
<tr>
<td>Operation of FRAM</td>
<td>65</td>
</tr>
<tr>
<td>FRAM Device Characteristics</td>
<td>67</td>
</tr>
<tr>
<td>Ferroelectric Field Effect Transistor RAM (FeFET)</td>
<td>69</td>
</tr>
<tr>
<td>3D FeFET FRAM</td>
<td>69</td>
</tr>
<tr>
<td>Antiferroelectrics and Ferroelectric Tunnel Junctions</td>
<td>70</td>
</tr>
<tr>
<td>The Future of FRAM</td>
<td>71</td>
</tr>
<tr>
<td>PHASE CHANGE MEMORY (PCM)</td>
<td>72</td>
</tr>
</tbody>
</table>

© 2020 Coughlin Associates and Objective Analysis
COMBINED EMERGING MEMORY ESTIMATES ................................................................................... 169

ESTIMATES OF MRAM CAPITAL EQUIPMENT DEMAND ............................................. 173

ION BEAM ETCHING EQUIPMENT ................................................................................. 174
PATTERNING EQUIPMENT ................................................................................................. 176
PHYSICAL VAPOR DEPOSITION EQUIPMENT ................................................................. 178
TEST AND OTHER EQUIPMENT ......................................................................................... 180
SUMMARY OF MRAM EQUIPMENT DEMAND ................................................................. 182

COMPANY INFORMATION: ................................................................................................. 185

MEMORY AND APPLICATIONS COMPANIES ................................................................. 185
SEMICONDUCTOR FAB COMPANIES ................................................................................. 195
CAPITAL EQUIPMENT COMPANIES .................................................................................. 196
LIST OF TABLES

TABLE 1. COMPARISON OF VARIOUS SOLID STATE MEMORY TECHNOLOGIES................................................................. 35
TABLE 2. SUMMARY OF EMERGING MEMORY TECHNOLOGIES......... 117
TABLE 3. SOME MRAM PROCESS EQUIPMENT VENDORS ...................... 125
TABLE 4. $/GB ESTIMATES FOR BASELINE STANDALONE DRAM, NAND, NOR, SRAM, MRAM AND 3D XPOINT FROM 2018 THROUGH 2030 .......... 154
TABLE 5. ANNUAL BASELINE PETABYTE SHIPMENTS FOR VARIOUS STANDALONE MEMORY TECHNOLOGIES FROM 2018 THROUGH 2030 . 156
TABLE 6. ASSUMPTIONS FOR BASELINE STANDALONE MRAM MODEL 157
TABLE 7. ANNUAL BASELINE REVENUE ESTIMATES FOR VARIOUS STANDALONE MEMORY TECHNOLOGIES FROM 2019 THROUGH 2030 ($M) 159
TABLE 8. COMPARISON OF STANDALONE MRAM MEMORY WAFER ESTIMATES FOR THREE SCENARIOS COMPARED TO BASELINE CASE 160
TABLE 9. COMPARISON OF EMBEDDED MRAM MEMORY WAFER ESTIMATES FOR HIGH AND LOW SCENARIOS COMPARED TO BASELINE CASE ...... 161
TABLE 10. COMPARISON OF COMBINED MRAM MEMORY WAFER ESTIMATES FOR HIGH AND LOW SCENARIOS COMPARED TO BASELINE CASE ............................................................................................................. 163
TABLE 11. ANNUAL HIGH, BASELINE AND LOW COMBINED PETABYTE SHIPMENT ESTIMATES FOR MRAM ................................................................. 164
TABLE 12. ANNUAL HIGH, BASELINE AND LOW COMBINED REVENUE ESTIMATES FOR MRAM ................................................................. 165
TABLE 13. ANNUAL HIGH, BASELINE AND LOW PETABYTE SHIPMENT ESTIMATES FOR 3D XPOINT ........................................................................ 166
TABLE 14. ANNUAL HIGH, BASELINE & LOW REVENUE 3D XPOINT ESTIMATES .............................................................................................................. 167
TABLE 15. HIGH COMBINED PETABYTE SHIPMENT ESTIMATES FOR MRAM AND 3D XPOINT.................................................................................................................. 169

TABLE 16. BASELINE COMBINED PETABYTE SHIPMENT ESTIMATES FOR MRAM AND 3D XPOINT.................................................................................................................. 169

TABLE 17. LOW COMBINED PETABYTE SHIPMENT ESTIMATES FOR MRAM AND 3D XPOINT.................................................................................................................. 170

TABLE 18. HIGH REVENUE ESTIMATES FOR MRAM AND 3D XPOINT ($M)171

TABLE 19. BASELINE REVENUE ESTIMATES FOR MRAM AND 3D XPOINT ($M) ........................................................................................................................................ 171

TABLE 20. LOW REVENUE ESTIMATES FOR MRAM AND 3D XPOINT ($M)172

TABLE 21. BASELINE EQUIPMENT SHIPMENT ESTIMATES FOR MRAM ION BEAM ETCHING EQUIPMENT FROM 2019 THROUGH 2030......................... 174

TABLE 22. ANNUAL BASELINE SPENDING ESTIMATES FOR MRAM ION BEAM ETCHING EQUIPMENT FROM 2019 THROUGH 2030 ($M) ..................... 175

TABLE 23. BASELINE EQUIPMENT ESTIMATES FOR MRAM PATTERNING EQUIPMENT FROM 2019 THROUGH 2030................................................................. 176

TABLE 24. BASELINE ANNUAL REVENUE ESTIMATES FOR MRAM PATTERNING EQUIPMENT FROM 2018 THROUGH 2030 ($M) ...................... 177

TABLE 25. BASELINE EQUIPMENT ESTIMATES FOR MRAM PHYSICAL VAPOR DEPOSITION EQUIPMENT FROM 2019 THROUGH 2030............................. 178

TABLE 26. BASELINE ANNUAL SPENDING ESTIMATES FOR MRAM PHYSICAL DEPOSITION EQUIPMENT FROM 2019 THROUGH 2030 ($M) .................. 179

TABLE 27. BASELINE EQUIPMENT UNIT SHIPMENT ESTIMATES FOR MRAM TEST AND OTHER EQUIPMENT FROM 2019 THROUGH 2030......................... 180

TABLE 28. PRICE ESTIMATES FOR MRAM TEST AND OTHER EQUIPMENT FROM 2019 THROUGH 2030 ($M)........................................................................... 180

TABLE 29. BASELINE ANNUAL SPENDING ESTIMATES FOR MRAM TEST AND OTHER EQUIPMENT FROM 2019 THROUGH 2030 ($M) .......................... 181

TABLE 30. BASELINE EQUIPMENT UNIT SHIPMENT ESTIMATES FOR MRAM EQUIPMENT FROM 2019 THROUGH 2030......................................................... 182

TABLE 31. ANNUAL BASELINE SPENDING ESTIMATES FOR MRAM EQUIPMENT FROM 2019 THROUGH 2030 ($M) ......................................................... 183
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>FIGURE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIGURE 1. MEMORY DENSITY AND POWER REQUIREMENTS BY APPLICATION CATEGORY</td>
<td>19</td>
</tr>
<tr>
<td>FIGURE 2. SOLID-STATE MEMORY/STORAGE TECHNOLOGIES</td>
<td>21</td>
</tr>
<tr>
<td>FIGURE 3. 3D NAND FLASH MEMORY TOPOLOGY</td>
<td>24</td>
</tr>
<tr>
<td>FIGURE 4. TOSHIBA'S BICS AND SAMSUNG'S TCAT 3D NAND STRUCTURES</td>
<td>25</td>
</tr>
<tr>
<td>FIGURE 5. COST OF TRANSITION FROM ONE NAND MANUFACTURING PROCESS TO THE NEXT</td>
<td>26</td>
</tr>
<tr>
<td>FIGURE 6. PROJECTED NAND FLASH CHIP TECHNOLOGY ROADMAP</td>
<td>28</td>
</tr>
<tr>
<td>FIGURE 7. SRAM CELL SIZES SHRINK MORE SLOWLY THAN PROCESSES</td>
<td>29</td>
</tr>
<tr>
<td>FIGURE 8. COMPARISON OF MEMORY AND STORAGE TECHNOLOGIES BY PRICE PER GIGABYTE AND PERFORMANCE</td>
<td>34</td>
</tr>
<tr>
<td>FIGURE 9. EVERSPIN 1 GB STT MRAM CHIP</td>
<td>36</td>
</tr>
<tr>
<td>FIGURE 10. PROGRESSION OF STORAGE TECHNOLOGIES WITH NONVOLATILE SOLID-STATE STORAGE</td>
<td>37</td>
</tr>
<tr>
<td>FIGURE 11. CONTRIBUTORS TO NONVOLATILE SOLID-STATE STORAGE LATENCY WITH LEGACY AND CURRENT SOLID-STATE NONVOLATILE TECHNOLOGIES</td>
<td>39</td>
</tr>
<tr>
<td>FIGURE 12. RERAM SYSTEM ON CHIP</td>
<td>39</td>
</tr>
<tr>
<td>FIGURE 13. BIT SELECTORS - 3-TERMINAL (LEFT) 2-TERMINAL (RIGHT)</td>
<td>41</td>
</tr>
<tr>
<td>FIGURE 14. OVERHEAD VIEW OF A SIMPLE CROSSPOINT ARRAY</td>
<td>41</td>
</tr>
<tr>
<td>FIGURE 15. READING WHEN ONE BIT IS IN A LOW-RESISTANCE STATE</td>
<td>42</td>
</tr>
<tr>
<td>FIGURE 16. SNEAK PATHS OCCUR WHEN MULTIPLE BITS ARE IN A LOW RESISTANCE STATE</td>
<td>43</td>
</tr>
<tr>
<td>FIGURE 17. SPACE PENALTY OF A 3-TERMINAL SELECTOR</td>
<td>44</td>
</tr>
</tbody>
</table>
FIGURE 18. BIDIRECTIONAL DIODE SELECTOR ...................................................... 45
FIGURE 19. A 1TNR SELECTOR CONFIGURATION .............................................. 46
FIGURE 20. 3D CROSSPOINT ARRAY STACKING ................................................. 47
FIGURE 21. STACKED CROSSPOINT MEMORY ARRAY ........................................ 47
FIGURE 22. RERAM FILAMENT CELL CONDUCTION AND SWITCHING .......... 49
FIGURE 23. RERAM SCALING .............................................................................. 50
FIGURE 24. RERAM RESISTANCE SCALING ...................................................... 50
FIGURE 25. TAOX RERAM DEVICE ..................................................................... 52
FIGURE 26. CURRENT LEVELS AND VOLTAGES FOR RERAM SWITCHING52
FIGURE 27. COMPARING CERAM CELL STRUCTURE TO RERAM ................. 53
FIGURE 28. RERAM STACKED CROSSPOINT ARRAY ......................................... 54
FIGURE 29. RERAM MEMORY BANK ............................................................... 55
FIGURE 30. RERAM CMOS INTEGRATION .......................................................... 56
FIGURE 31. TWO-MASK RERAM ELEMENT IN TUNGSTEN VIAS ................. 56
FIGURE 32. 3D RERAM STRUCTURE/PROCESS ................................................. 57
FIGURE 33. A SIMPLIFIED VIEW OF A NEURAL NETWORK. ............................. 58
FIGURE 34. EARLY FERROELECTRIC MEMORY - 1955 BELL LABS 256-BIT
DEVICE ................................................................................................................. 61
FIGURE 35. HYSTERESIS CURVE OF FERROELECTRIC MEMORY ................. 62
FIGURE 36. PUBLICATION COUNT FOR FEFET RESEARCH PAPERS ...... 63
FIGURE 37. AMORPHOUS, CRYSTALLINE, AND FERROELECTRIC HAFNIUM
OXIDE ..................................................................................................................... 64
FIGURE 38. PZT AND HFO CAPACITORS, SHOWING TYPICAL DIMENSIONS65
FIGURE 39. FRAM PEROVSKITE DISPLACEMENT ............................................ 66
FIGURE 40. MEMORY PROPERTIES OF FERROELECTRIC HAFNIUM OXIDE AS
DERIVED FROM EXPERIMENTS AND EXPECTED MATERIAL LIMITS ............ 67

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FIGURE 108. VEECO NEXUS IBE-420I ION BEAM ETCHING SYSTEM ..... 140
FIGURE 109. ASML DEEP UV PHOTOLITHOGRAPHY TOOL ..................... 141
FIGURE 110. NIKON PHOTOLITHOGRAPHIC PRODUCT LINES ............... 141
FIGURE 111. CANON LITHOGRAPHIC I-LINE STEPPER PRODUCT LINE 142
FIGURE 112. TOKYO ELECTRON MRT300 MAGNETIC ANNEALING TOOL143
FIGURE 113. ISI WLA 3000 WAFER LEVEL QUASI-STATIC TESTER ...... 144
FIGURE 114. HPROBE 3D HIGH MAGNETIC FIELD WAFER PROBE ........ 145
FIGURE 115. KEYSIGHT TECHNOLOGY NX5730A MRAM TEST PLATFORM145
FIGURE 116. MICROSENSE (KLA/TENCOR) POLAR KERR SYSTEM FOR PERPENDICULAR STT MRAM.................................................... 146
FIGURE 117. AFM EQUIPMENT .......................................................... 147
FIGURE 118. APPLIED MATERIALS ENDURA IMPULSE FOR PCM AND RERAM ............................................................................. 149
FIGURE 119. SEMI'S WAFER FAB EQUIPMENT SPENDING HISTORY AND FORECAST................................................................. 150
FIGURE 120. EQUIPMENT SPENDING BY REGION ............................. 151
FIGURE 121. NUMBER OF VOLUME FABS STARTING BY REGION (ALL SEMICONDUCTORS, INCLUDING DISCRETES).............................. 152
FIGURE 122. PROFITABILITY OF NAND FLASH MANUFACTURERS ...... 153
FIGURE 123. CHART OF BASELINE $/GB FOR STANDALONE MEMORY TECHNOLOGIES FROM 2018 THROUGH 2020 .............................. 155
FIGURE 124. CHART OF ANNUAL BASELINE PETABYTE SHIPMENTS FOR STANDALONE MEMORY TECHNOLOGIES FROM 2018 THROUGH 2030 . 157
FIGURE 125. CHART OF BASELINE REVENUE ESTIMATES FOR MEMORY TECHNOLOGIES FROM 2019 THROUGH 2030 ($M) ................................................. 159
FIGURE 126. CHART OF STANDALONE MRAM MEMORY WAFER ESTIMATES FOR THREE SCENARIOS COMARED TO BASELINE CASE.......................... 161
FIGURE 127. CHART OF EMBEDDED MRAM MEMORY WAFER ESTIMATES FOR HIGH AND LOW SCENARIOS COMPARED TO BASELINE CASE ...... 162
FIGURE 128. CHART OF COMBINED MRAM MEMORY WAFER ESTIMATES FOR HIGH AND LOW SCENARIOS COMPARED TO BASELINE CASE...... 163

FIGURE 129. CHART OF COMBINED MRAM MEMORY PETABYTE SHIPMENT ESTIMATES FOR HIGH/LOW SCENARIOS COMPARED TO BASELINE CASE164

FIGURE 130. CHART OF COMBINED MRAM MEMORY REVENUE ESTIMATES FOR HIGH/LOW SCENARIOS COMPARED TO BASELINE CASE........... 165

FIGURE 131. CHART OF HIGH, BASELINE AND LOW PETABYTE SHIPPING ESTIMATES FOR 3D XPOINT................................................... 167

FIGURE 132. CHART OF HIGH, BASELINE AND LOW REVENUE 3D XPOINT ESTIMATES........................................................................................................ 168

FIGURE 133. CHART OF COMBINED HIGH, BASELINE AND LOW PETABYTE SHIPPING ESTIMATES FOR EMERGING MEMORIES ........................................ 170

FIGURE 134. CHART OF HIGH, BASELINE AND LOW REVENUE ESTIMATES FOR EMERGING MEMORIES ($M)................................................................. 172

FIGURE 135. CAPITAL EQUIPMENT ESTIMATE PROCESS FLOW ........ 173

FIGURE 136. CHART OF LOW, BASELINE AND HIGH SPENDING ESTIMATES FOR MRAM ION BEAM ETCH EQUIPMENT FROM 2019 THROUGH 2030 . 175

FIGURE 137. CHART OF LOW, BASELINE AND HIGH SPENDING ESTIMATES FOR MRAM PATTERNING EQUIPMENT FROM 2019 THROUGH 2030 ($M)177

FIGURE 138. CHART OF LOW, BASELINE AND HIGH SPENDING ESTIMATES FOR MRAM PHYSICAL VAPOR EQUIPMENT FROM 2019 THROUGH 2030 ($M) .............................................................. 179

FIGURE 139. CHART OF BASELINE SPENDING ESTIMATES FOR MRAM TEST AND OTHER EQUIPMENT FROM 2019 THROUGH 2030 ($M)............. 181

FIGURE 140. CHART OF LOW, BASELINE AND HIGH SPENDING ESTIMATES FOR MRAM TEST AND OTHER EQUIPMENT FROM 2019 THROUGH 2030 ($M) ........................................................................................................... 182

FIGURE 141. CHART OF BASELINE SPENDING ESTIMATES FOR MRAM EQUIPMENT FROM 2019 THROUGH 2030 ($M) ........................................ 183

FIGURE 142. CHART OF LOW, BASELINE AND HIGH TOTAL SPENDING ESTIMATES FOR MRAM EQUIPMENT FROM 2019 TO 2030 ($M) ............ 184
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He was the founder and organizer of the Storage Visions Conferences as well as the Creative Storage Conferences. He was general Chairman of the annual Flash Memory Summit for 10 years. Coughlin Associates provides market and technology analysis as well as data storage technical and market consulting. For more information go to [www.tomcoughlin.com](http://www.tomcoughlin.com)

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Jim Handy, a widely recognized semiconductor analyst, comes to Objective Analysis with over 30 years in the electronics industry including over 20 years as an industry analyst for Dataquest (now Gartner), Semico Research, and Objective Analysis. His background includes marketing and design positions at market-leading suppliers including Intel, National Semiconductor, and Infineon.

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A frequent presenter at trade shows, Mr. Handy is known for his widespread industry presence and volume of publication. He has written hundreds of articles for trade journals, Dataquest, Semico, and others, and is frequently interviewed and quoted in the electronics trade press and other media.

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EXECUTIVE SUMMARY

Current memory technologies including flash memory (NAND and NOR), DRAM and SRAM are facing potential technology limits to their continued improvement. As a result, there are intense efforts to develop new memory technologies. Most of these new technologies are nonvolatile memories and can be used for long-term storage or to provide a memory that does not lose information when power is not applied. This offers advantages for battery and ambient powered devices and also for energy savings in data centers.

The memories addressed in this report include PCM, ReRAM, FRAM, MRAM, STT MRAM and a variety of less mainstream technologies such as carbon nanotubes. Based upon the level of current development and the characteristics of these technologies, resistive RAM (ReRAM) may be a potential replacement for flash memory. However, flash memory has several generations of technologies that will be implemented before a replacement is required. Thus, this transition will not fully occur until the next decade at the earliest.

Micron and Intel’s introduction of 3D XPoint Memory, a technology that has high endurance, performance much better than NAND, although somewhat slower than DRAM, and higher density than DRAM, could impact the need for DRAM. Intel introduced NVMe SSDs with its Optane technology (using 3D XPoint) in 2017 and began to ship NVDIMM Optane products in 2019, in support of its newest generation of server processors, the Second-Generation Intel Xeon Scalable Processors. 3D XPoint uses a type of phase change technology.

Magnetic RAM (MRAM) and spin transfer torque RAM (STT MRAM) will start to replace some NOR, SRAM and possibly DRAM within the next few years and probably before ReRAM replaces flash memory. The rate of development in STT MRAM and MRAM capabilities will gradually result in lower prices, and the attractiveness of replacing volatile memory with high speed and high endurance nonvolatile memory make these technologies very competitive, assuming that their volume increases to reduce production costs (and thus purchase prices).

Ferroelectric RAM (FRAM) and some ReRAM technologies have some niche applications and with the use of HfO FRAM the number of niche markets available for FRAM could increase.

Moving to a nonvolatile solid-state main memory and cache memory will reduce power usage directly as well as enable new power saving modes, provide faster recovery from power off and enable more stable computer architectures that retain their state even when power is off. Eventually spintronic technology, that uses spin rather than current for logic processes, could be used to make future microprocessors. Spin-based logic could enable very efficient in-memory processing. Several emerging memory technologies are also being used in neuromorphic computing experiments.
The use of a nonvolatile technology as an embedded memory combined with CMOS logic has great importance in the electronics industry. NOR flash reached its scaling limit at 28nm, and soon will be replaced with one of these new technologies. As a replacement for a multi-transistor SRAM, STT MRAM could reduce the number of transistors and thus provide a low cost, higher-density solution. A number of enterprise and consumer devices use MRAM, based on field switching, to act as an embedded cache memory, and this trend will continue.

The availability of STT MRAM has accelerated this trend. Because of the compatibility of MRAM and STT-RAM processes with conventional CMOS processes, these memories can be built directly on top of CMOS logic wafers. Flash memory doesn’t have the same compatibility with conventional CMOS. The power savings of nonvolatile and simpler MRAM and STT MRAM when compared with SRAM is significant. As MRAM $/GB costs approach those of SRAM, this replacement could cause significant market expansion.

We project that 3D XPoint Memory, with significant gigabyte shipments in 2020-2021, and with its important price advantage versus DRAM will grow to a baseline level of 90.0EB (exabytes) of shipping capacity by 2030. 3D XPoint baseline revenues are projected to reach $25.3B by 2030.

It is projected that total MRAM and STT MRAM baseline annual shipping capacity will rise from an estimated 18TB in 2019 to 315PB in 2030. Standalone MRAM and STT-RAM baseline revenues are expected to increase from $35M in 2019 to about $10B by 2030. Much of this revenue gain will be at the expense of SRAM, NOR flash and some DRAM, although STT-RAM is developing its own special place in the pantheon of shipping memory technologies.

The demand for MRAM and STT-MRAM will drive demand for capital equipment to manufacture these devices. While MRAM and STT-MRAM can be built on standard CMOS circuits supplied by large semiconductor fabricators, MRAM and STT MRAM do require specialized fabrication equipment for the MRAM layers that is similar to or the same as that used in manufacturing the magnetic read sensors in hard disk drives.

The increasing demand for nonvolatile memory based upon MRAM and STT MRAM will cause total manufacturing equipment revenue used for making the MRAM devices to rise from an estimated $43.8M in 2019 to between $225M to $1.29B by 2030 with a baseline projected spending of $696M.

Thus, total emerging standalone memory shipments by 2030 could range from about 163.5 Exabytes to 17.2 Exabytes with a baseline value of 90.3 Exabytes. The majority of the capacity shipments are for 3D XPoint. The revenue will range between a low of about $7.6B and a high of about $64.7B in 2030 with a baseline value of about $35.6B.
EMERGING MEMORIES FIND THEIR DIRECTION Available June, 2020

This report, jointly produced by Objective Analysis and Coughlin Associates, provides an exhaustive look at emerging memory technologies and their interaction with standard memories, both as discrete devices and in embedded applications (the memories within logic chips like ASICs and MCUs). The report provides a well of technical information, market dynamics, forecasts, and competitive analyses of the leading companies. Forecasts show how the markets will grow not only for the technologies themselves, but also for the capital equipment used to produce them. Read this to understand the competitive landscape and market drivers for these new memories, and to learn how to profit from tomorrow’s market.

Table of Contents (Top Level):
EXECUTIVE SUMMARY ................................................................. 17
INTRODUCTION: ............................................................................. 19
WHY EMERGING MEMORIES ARE POPULAR .................................. 23
HOW A NEW MEMORY LAYER IMPROVES COMPUTER PERFORMANCE .... 33
UNDERSTANDING BIT SELECTORS ................................................. 40
RESISTIVE RAM, RERAM, RRAM, MEMRISTOR: ................................... 48
FERROELECTRIC RAM, FERAM, FRAM: ............................................. 60
PHASE CHANGE MEMORY (PCM): .................................................. 72
INTEL/MICRON 3D CROSSPOINT MEMORY ....................................... 77
MRAM (MAGNETIC RAM), STT MRAM (SPIN TRANSFER TORQUE MRAM) .... 81
OTHER EMERGING MEMORY TYPES ............................................... 101
LITHOGRAPHY: .............................................................................. 104
3D MEMORY CIRCUIT DESIGN: ....................................................... 113
SUMMARY OF SOLID-STATE MEMORY & STORAGE TECHNOLOGIES .... 115
EMERGING MEMORIES AND NEW MATERIALS .................................. 118
EMERGING MEMORY PROCESS EQUIPMENT ..................................... 120
MEMORY IS DRIVING SEMICONDUCTOR CAPITAL SPENDING ............ 150
MARKET PROJECTIONS FOR MRAM, AND 3D XPOINT MEMORY .......... 153
ESTIMATES OF MRAM CAPITAL EQUIPMENT DEMAND .................... 173
COMPANY INFORMATION: ............................................................. 185

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or https://Objective-Analysis.com/reports/#Emerging