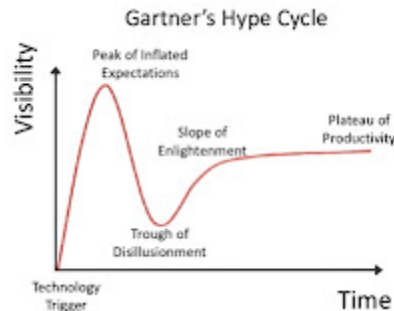


## Emerging Memories Enter the Trough



Emerging Memories have "emerged"... into the Trough Of Disillusionment. It was a fun ride until now.

Less papers on new memories, Optane cancellation, and multiple options allowed by CXL for NAND d DRAM and shared resources have stamped out the enthusiasm for emerging memories.

What we know:

- 1) Optane was the most successful emerging memory in terms of development and revenue. 100s of Millions in revenue was more that all other emerging memory combined.
- 2) The applications were niche. Too small and narrow to allow widespread development, Capex, and support. Slower than DRAM, More expensive than NAND didn't work. Optane/3D Xpoint was abandoned
- 3) MRAM has small markets (<\$100M/year) and great applications for discrete chips. Companies have viable business models TODAY and moderate growth. it could reach \$800M by 2031 if all goes very well.
- 4) MRAM (and RRAM) are great for embedded memory and should replace embedded flash in all applications and should enable optimization on SOCs. The memory is <10% of the chip area typically and we can't track revenue just like we don't track revenue for eDRAM, SRAM, or registers.
- 5) Other Memories (DNA, NRAM, FeRAM, SOT, etc) are 10 years from volume. None of these will replace DRAM or NAND. Only possible caveat is IF new memory is added existing NAND or DRAM architecture with <20% Fab process changes. Many are working on this but there are no wins yet.

CONCLUSION: So with Optane ramping down, Emerging memory from discrete will DROP over the next 5 years. After that if MRAM (and RRAM) grow as expected and applications emerge, Emerging Memory could become a 1-2 Billion dollar business buy 2031. While embedded revenue is not meaningful, we do expect 10% of foundry parts >14nm could have embedded MRAM or RRAM in them. This will not be for leading edge chips. If you allocated Area of chip\*number of chips\*price per chip one guesstimate would be \$600M in revenue by 2031.

**Emerging Memories could hit \$2-3Billion in revenue if we include all sources and all embedded by 2031.**

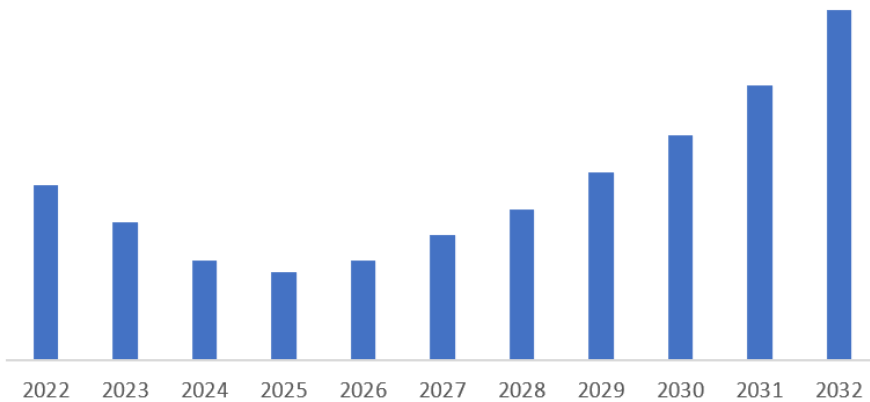
Intel invested big, took the risk for all of us. It didnt work out. Follow on memories may not be as lucky as Optane.

What will happen and allow growth:

- 1) Niche markets are great, grow moderately with solid applications
- 2) Spend capital if the market takes off.
- 3) Look to replace NOR, not NAND and DRAM

Revenue Projections (Revenue from Embedded cannot be calculated)

### Emerging Memory Revenue



We have scenarios for each memory, what it takes and where the researchers are.... and what they need to do to be successful ..... Set up time with us to discuss next week

Mark Webb

[www.mkwventures.com](http://www.mkwventures.com)

[Mark@mkwventures.com](mailto:Mark@mkwventures.com)

505-681-7614