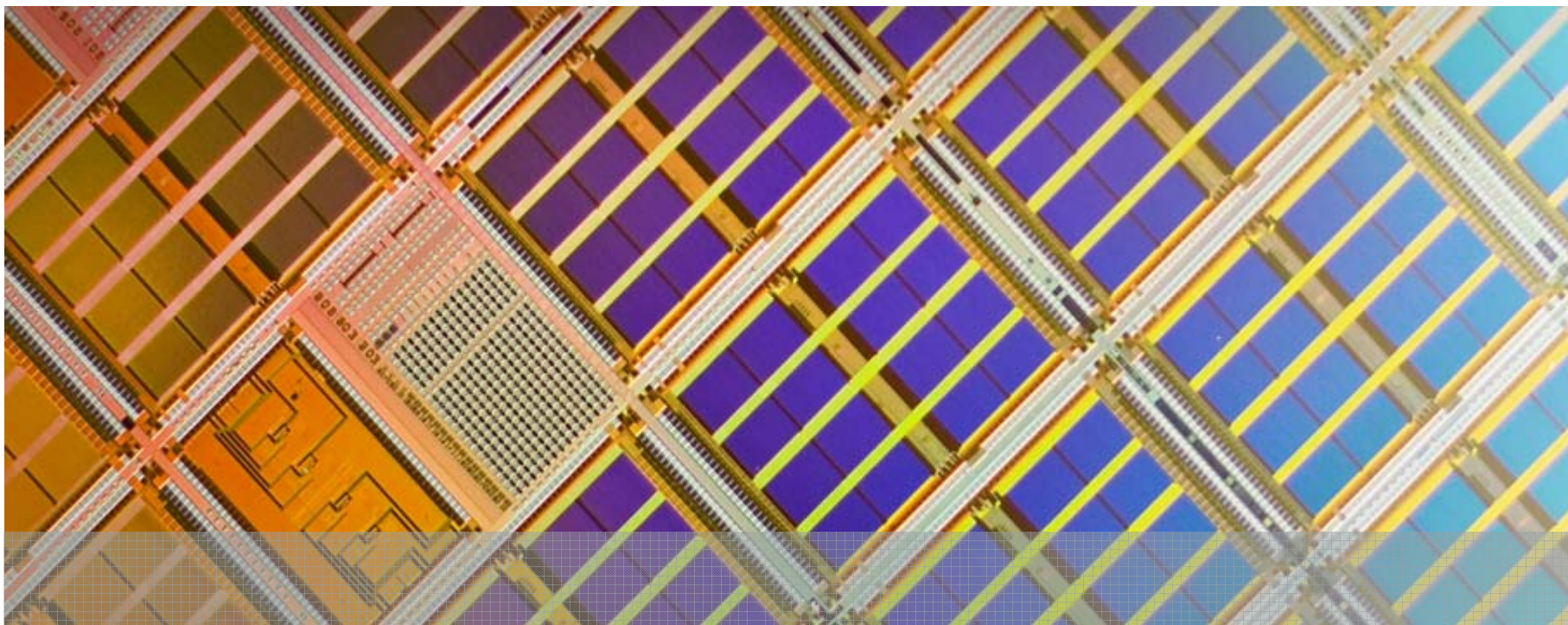
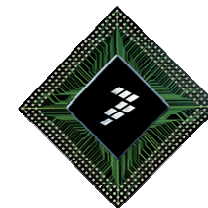




September 26, 2006

Freescalé's MRAM

–a new kind of memory chip



Matt Trumm–MRAM Launch Marketer
John Salter–MRAM Product Development Manager

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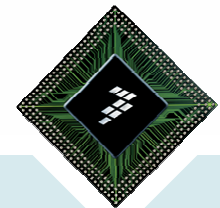


Agenda

► Freescale's MRAM

- What is it?
- How does it work?
- Why is it better than existing memory solutions?
- When will it be available?

What is it?



Motorola / Freescale MRAM History

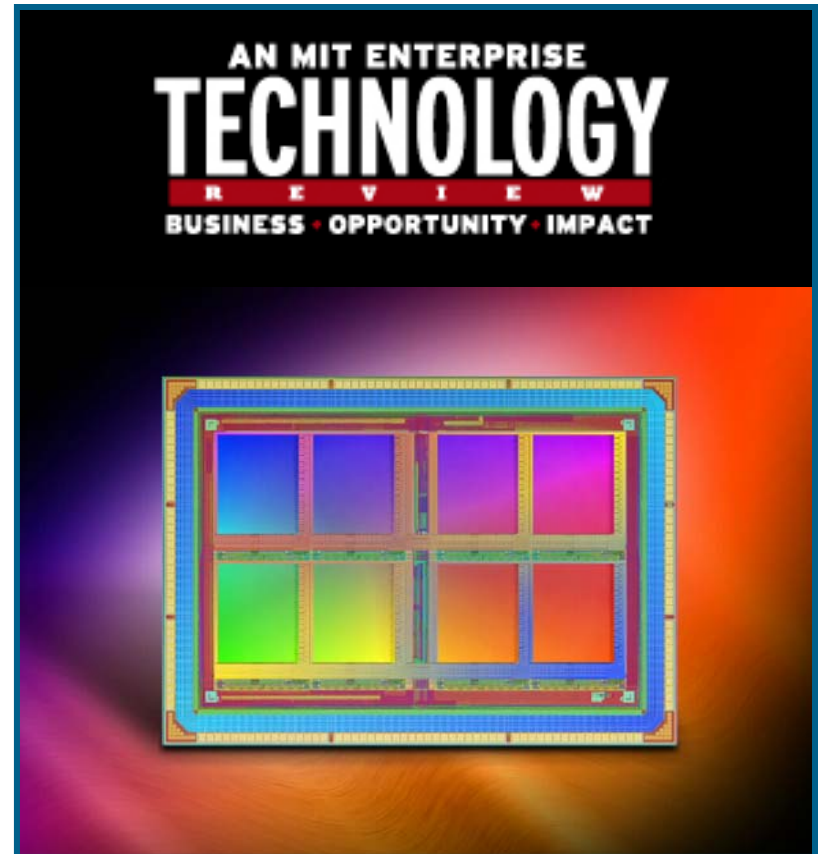
Timeline

1995	Initial research was started by the Motorola Labs-Physical Sciences Research Lab (PSRL) in conjunction with DARPA- US government agency.
2000	Significant investment was made in advanced, production ready, 200mm MRAM tool set.
2001	Development for commercialization began in the MOS12 Wafer Fab facility in Arizona.
2002	256Kb and 1Mb test vehicles were successfully demonstrated by Motorola using 0.60um technology.
2003	Motorola delivered the first 4Mb MRAM samples using 0.18um technology and functionality was demonstrated on customer's board.
2004	Freescale spun off from Motorola. All MRAM activity transferred to the new company.
2006	Qualification Complete. Qualified products are currently shipping. The world's first MRAM product.

Freescal – Recognition as Industry Leader

► Industry Recognition

- MIT Technology Review
 - Selected MRAM “Toggle” as one of the key discoveries of 2003
 - Recognized as one of 5 Killer Patents in the May 2004 “Invention” issue



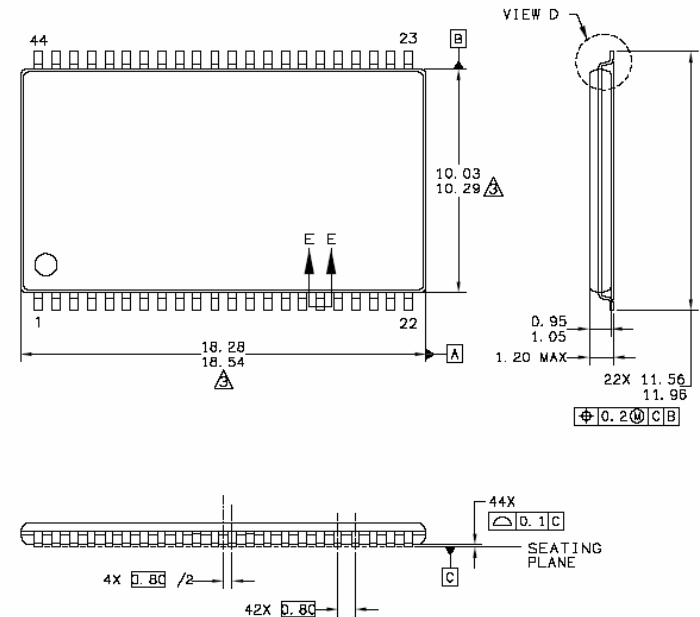
Freescal's MRAM – Key Features

Nonvolatile	Data Retention - ≥ 10 years Stable & Reliable Data stored by polarization, not charge
Fast	Symmetrical Read/Write – 35ns Byte writeable – bit level granularity
Unlimited Cycles	Unlimited Endurance - $\geq 10^{16}$ Non-destructive read No leakage, no soft errors
Viable	4Mb Memory Device Qualified Compatible with Embedded Designs Integrated with Existing CMOS Baseline

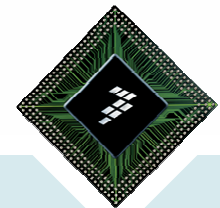
Additional Features

► Features

- Capacity
 - 4Mbit memory array
- Configuration
 - X16 configuration (8/16-bit access capability)
 - 256Kx16bit organization
- Power Requirements
 - 3.3V single power supply
 - Low Voltage Inhibit
 - Prevents writes on power loss
- Package
 - In-Package Magnetic Shielding
 - SRAM compatible pinout
 - RoHS Compliant 44-Pin TSOP type-II package
 - Moisture sensitivity level MSL3
 - $\theta_{ja} = 60$ degrees C/W
- Temperature Range
 - Commercial Temperature (0-70°C)
- I/O TTL compatible
- Technology
 - Contains Freescale's revolutionary "toggle" bit cell



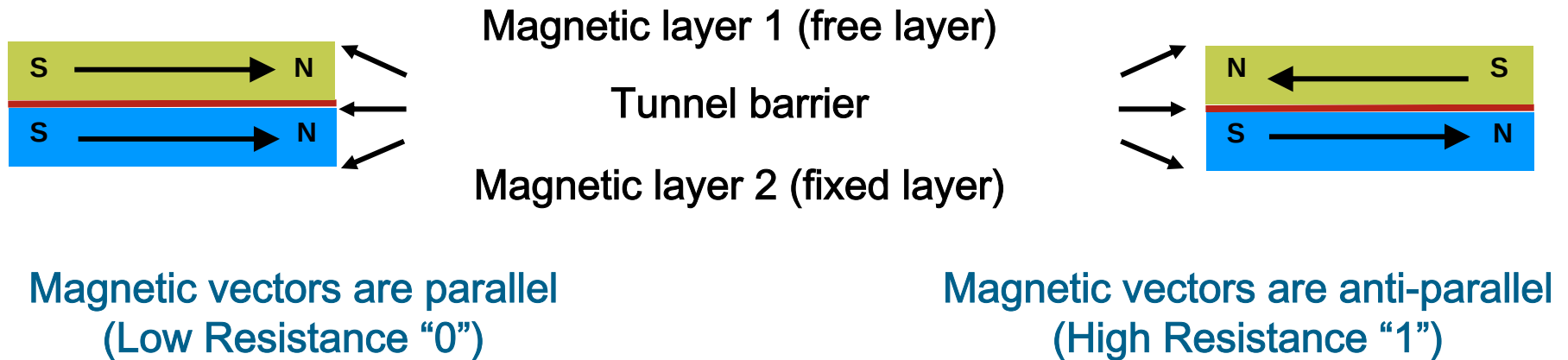
How Does it Work?



How Freescale's MRAM Works

► Key Features

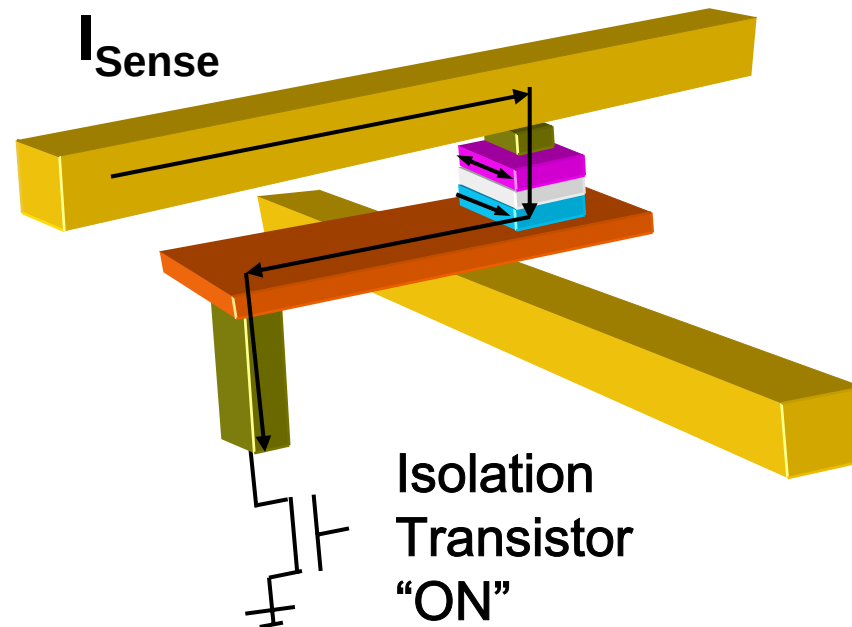
- Information is stored as magnetic polarization, not charge
- The state of the bit is detected as a change in resistance



Freescal's MRAM – Memory Cell Operation (Read Mode)

► Read Mode

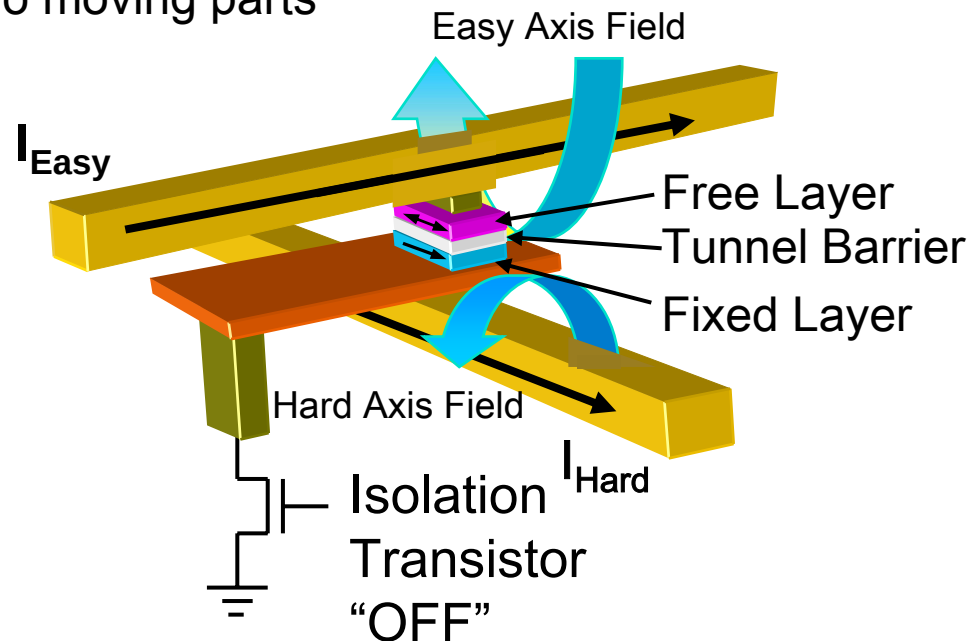
- Current is passed through the bit
- Resistance of the bit is sensed



Freescal's MRAM – Memory Cell Operation (Write Mode)

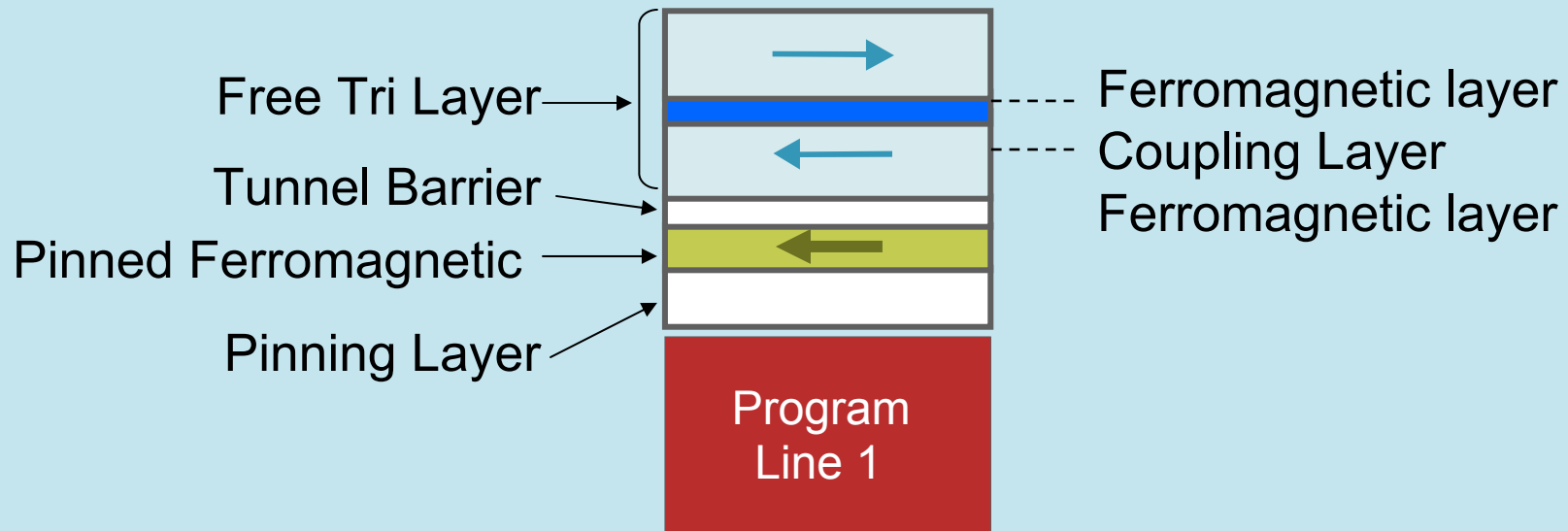
► Write Mode

- Current is passed through the programming lines generating programming lines generating magnetic fields
- The sum of the magnetic field from both lines is needed to program the bit
- There are no moving parts

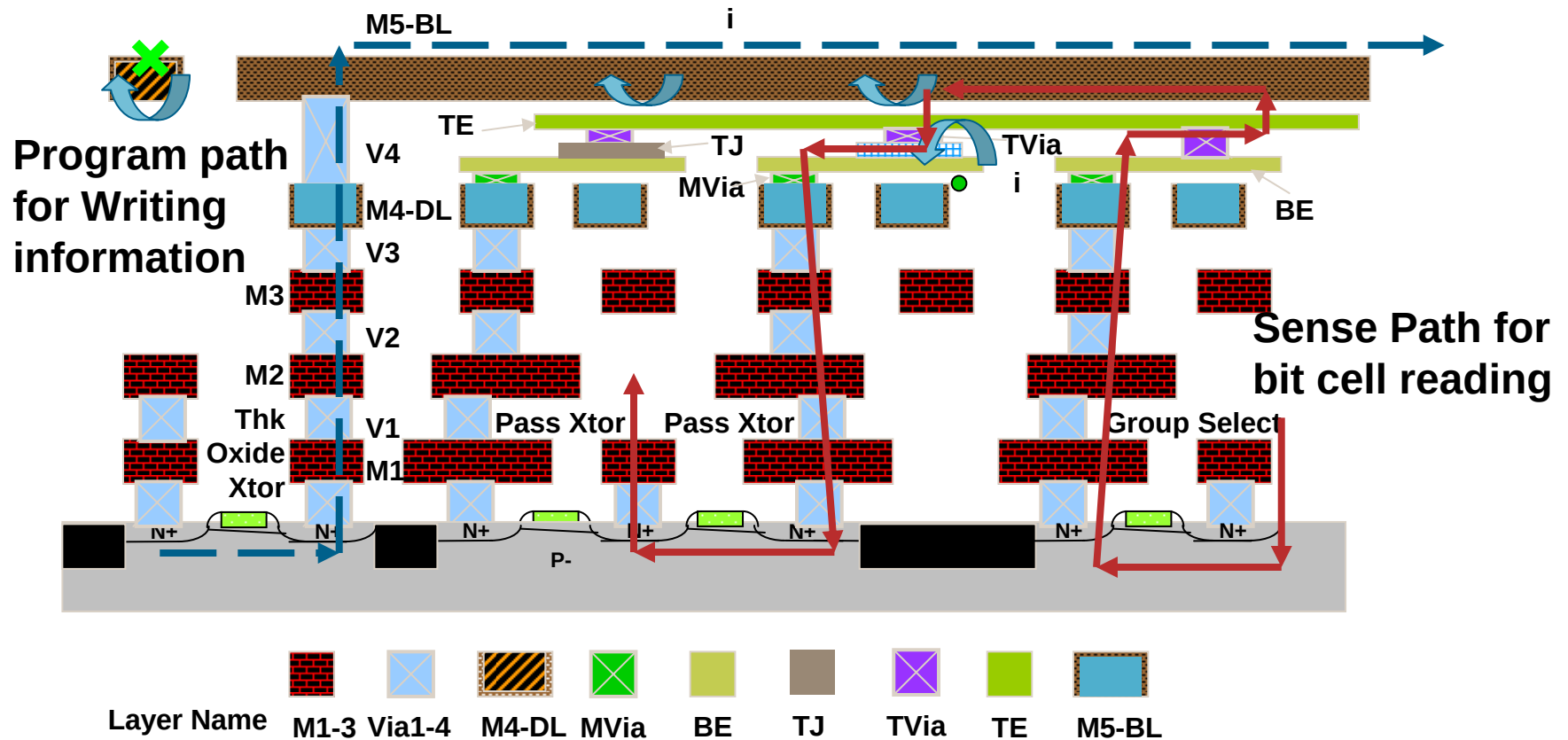


Freescal's MRAM Toggle Bit Cell

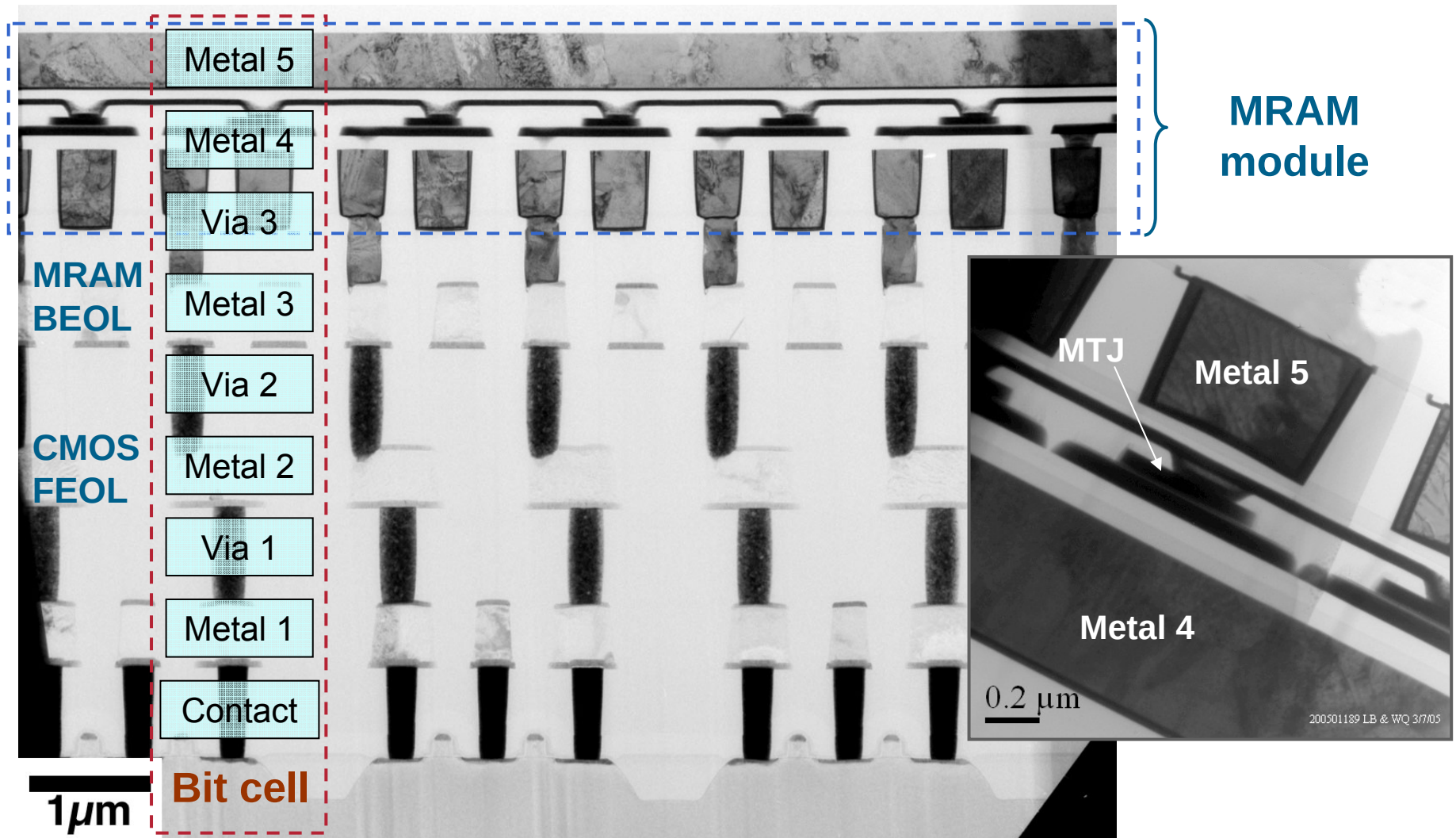
Program Line 2



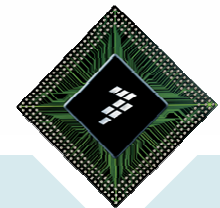
Freescal's MRAM – 4bit Memory Cell



Freescal... Technology Leadership



Why is it Better than Existing Memory Solutions?



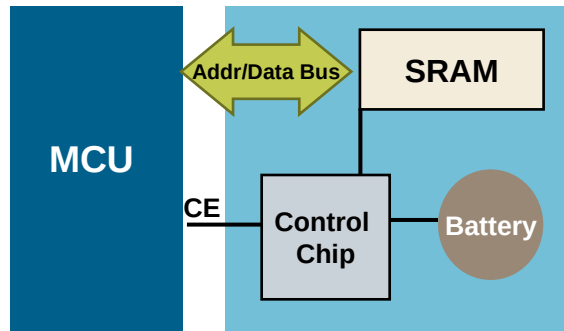
Technology Comparison

	MRAM	SRAM	DRAM	Flash	FeRam
Read Speed	Fast	Fastest	Medium	Fast	Fast
Write Speed	Fast	Fastest	Medium	Low	Medium
Array Efficiency	Med/High	High	High	Med/Low	Medium
Future Scalability	Good	Good	Limited	Limited	Limited
Cell Density	Med/High	Low	High	Medium	Medium
Non-Volatility	Yes	No	No	Yes	Yes
Endurance	Infinite	Infinite	Infinite	Limited	Limited
Cell Leakage	Low	Low/High	High	Low	Low
Low Voltage	Yes	Yes	Limited	Limited	Limited
Complexity	Medium	Low	Medium	Medium	Medium

► Key Features

- High performance – symmetrical read and write timing
- Small size and scalable for future technologies
- Nonvolatile with virtually unlimited read-write endurance
- Low leakage and low voltage capable

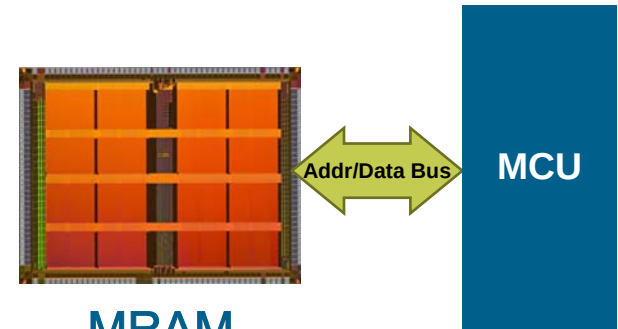
Sample Application – Battery Backed SRAM Replacement



“Built-in-house” Components

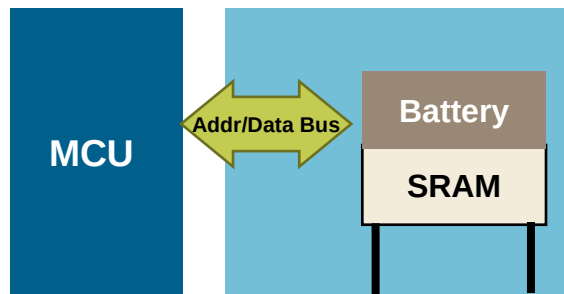
Problems

- System design complexity
- Board space and weight
- Battery life
- Manufacturing complexity
- Environmental concerns



Solutions

- Single chip solution
- Simple, low cost system design
- Manufacturing simplification
- No battery
- Unlimited life
- Smaller profile
- Higher performance
- Environmentally friendly

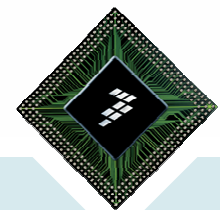


“Off-the-shelf” components

Problems

- Cost
- Manufacturing complexity
- Battery life
- Low performance
- Environmental concerns

When Will it be Available?

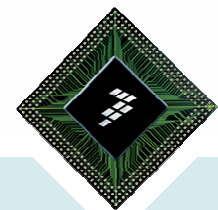


Freescal MRAM Production and Sample Timeline

Timeline

Now	4Mb Qualification Samples. 0 – 70C, 35ns
Now	4Mb Production. 0 – 70C, 35ns
1Q07	4Mb Qualification Samples. -40 – 105C
2Q07	4Mb Production Volumes. -40 – 105C
2007	Derivative Products – To Be Announced

Q&A



John Salter
–MRAM Product Development Manager

Thank You

To learn more about MRAM please contact

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or visit

www.freescale.com/mram

