

Netsol Introduction

A Global leader in
Standalone MRAM Solutions



ARCOTEK

Authorized Distributor

1Q. 2024

01

Netsol Memory Vision

NEXT-GENERATION MEMORY(MRAM) SUPPLIER

SUPERIOR RELIABLE NON-VOLATILITY

LOW WRITE ENERGY

HIGH ENDURANCE

FAST WRITE SPEED

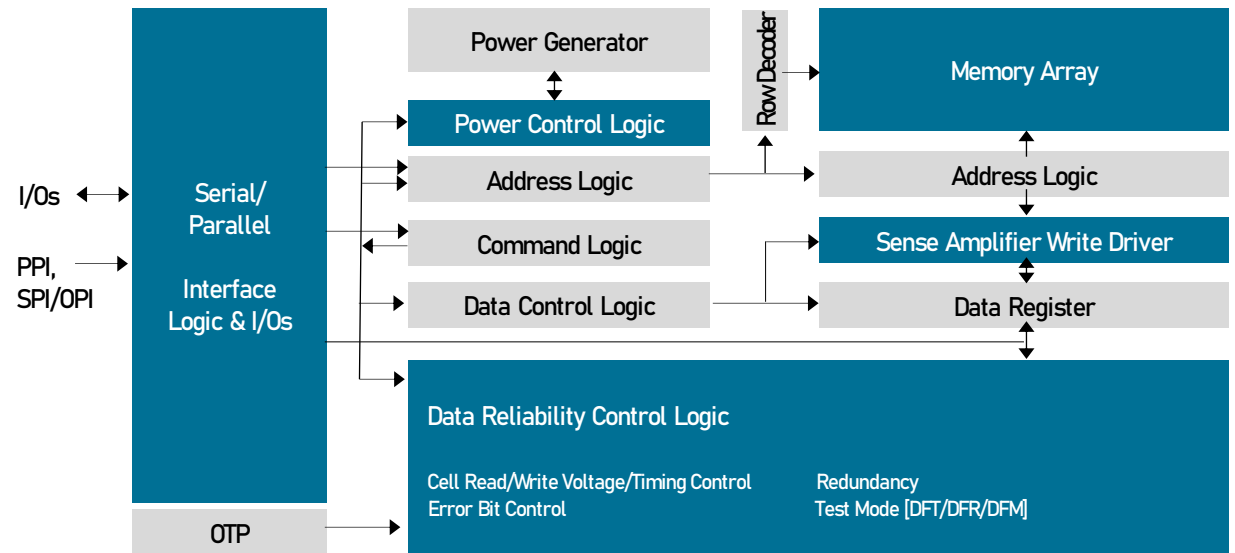
HIGH RETENTION QUALITY

USER CONVENIENCE

Technology

Design Technology			
Chip Architecture	High Reliability technique	Low power technique	High-performance technique
Smallest chip size High Performance & low power	DFR/DFT for weak-cell screen Efficient repair algorithm Bit error management DFT verification Power noise reduction	Power management Low-power analog Optimal logic Heuristic technique for memory types	High Performance Logic High Performance I/O

Memory Architecture Overview



Technology

Test Technology & Quality Control

In-House Wafer Test

Quality control & monitor
Yield improvement Feed Back to Foundry
Technical analysis for test coverage
Mass production test
On Time Delivery

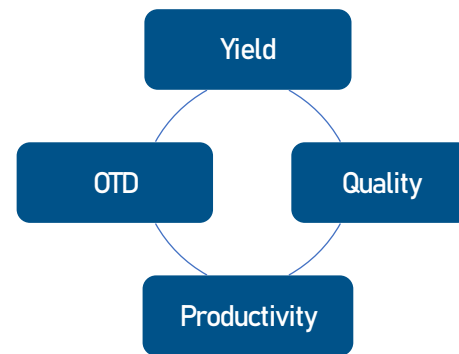
Quality Management

Maverick Lot Control System
[WF Test & PKG Test]
WAT & ET Data management
PRT/AQL Control & Monitor System

SPC Control System

Control Yield & Special Bin [SBL Control]
Statistical yield & subbin limit management

In-House Wafer Test Line



02

Product-Line up

STT-MRAM

Status	Memory Type	Product	Applications
Mass Production Product	STT-MRAM [28nm]	1Mb~32Mb Single/Dual/Quad SPI	Smart Meter, IoT, Industrial, Smart factory, Gaming Machine, etc.
		1Mb~64Mb PPI	
Under Development	STT-MRAM [14nm]	128Mb~512Mb[1Gb] Octal SPI	Automotive, Hearing Aids, Wearable, TWS, 5G, AIoT, Medical, Enterprise Storage, etc.
		128Mb~512Mb[1Gb] Single/Dual/Quad SPI	

02

Manufacturing Site

Manufacturing Site by Product

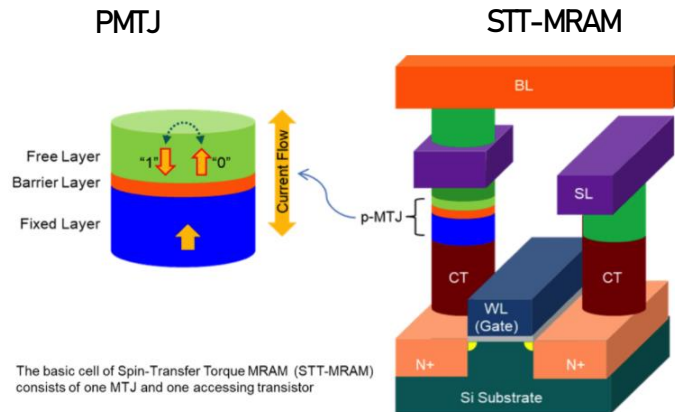
Product	Foundry	Wafer Test	Assembly	PKG Test
STT-MRAM 28nm[MP],14nm[UD]	 Samsung Foundry In Korea	 Netsol	 SFA Semicon Korea for BGA	 SFA Semicon In Korea
			 SFA Semicon China for TSOP, WSON	

02

Next Generation Memory STT-MRAM

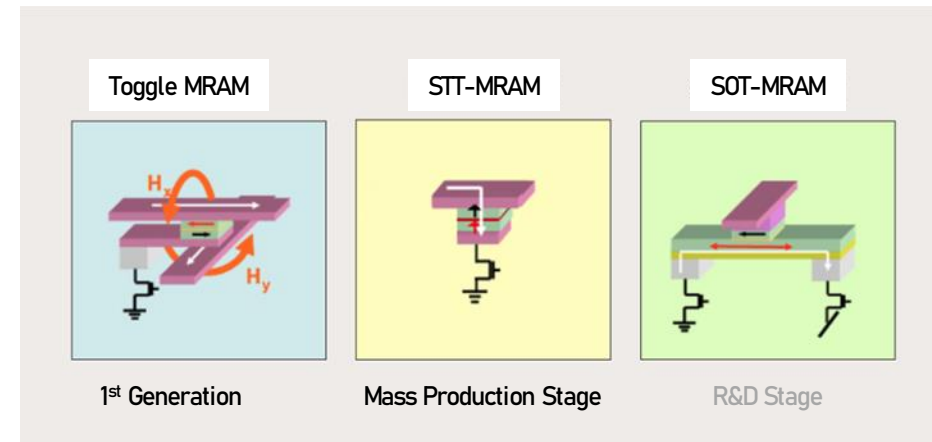
STT-MRAM with the high speed of DRAM and non-volatility of Flash Memory

STT-MRAM Structure, MTJ(Magnetic Tunnel Junction)



- Non-volatile : Flash/ROM Like
- Fast Write Time : DRAM Like
- Endurance : Virtually unlimited
- Scalability : High Density
- Low power consumption

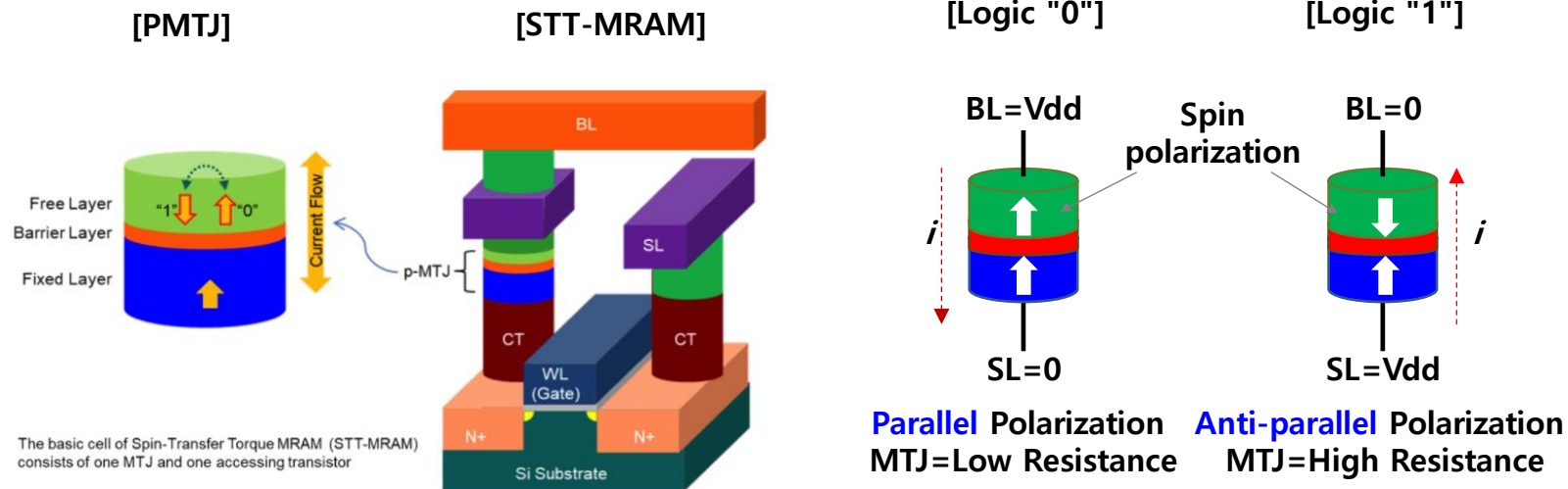
Advanced MRAM Technology, STT-MRAM



MRAM technology & product specification
Improvement

Next Generation Memory STT-MRAM

Working principle of STT-MRAM



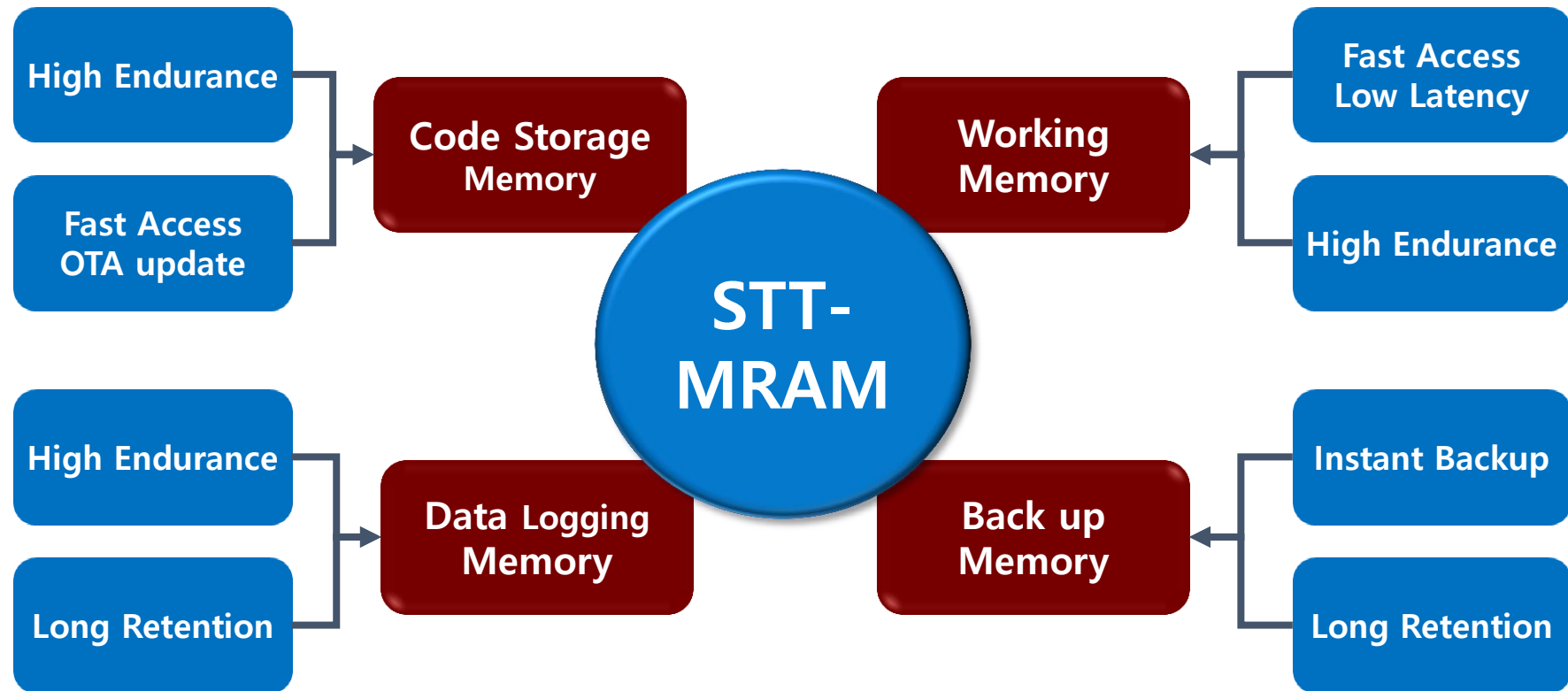
- Store data "0" and "1" separately depending on the relative orientation of spin magnetization between the ferromagnetic free layer and the pinned layer

Pinned Layer	Free Layer	Resistance	Data
↑	↑ (parallel)	Low	0
↑	↓ (antiparallel)	High	1

02

STT-MRAM Unified Memory's Convergence Trend

MRAM is the best unified memory



02

Next Generation Memory STT-MRAM

NETSOL 1st MRAM Products

Process Technology

- 28nm, Samsung Foundry



• Serial Interface (SPI) STT-MRAM

Density	SPI Mode	Vcc	PKG	Operating Temp.	Speed (Operating Frequency)
1Mb / 2Mb / 4Mb / 8Mb / 16Mb / 32Mb	Single, Dual, Quad	3.3V 1.8V	8WSO (6x5mm) 8SOIC (150mil)	-40°C ~ 85°C	108MHz *133Mhz for 32Mb

* Compatible with SPI-NOR, SPI-FRAM, SPI-pSRAM (IoT RAM)

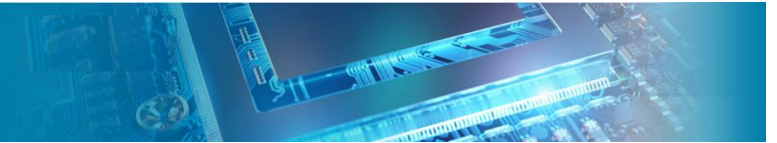
• Parallel Interface (PPI) STT-MRAM

Density	I/O Org.	Vcc	PKG	Operating Temp.	Speed (Access Time)
1Mb / 2Mb / 4Mb / 8Mb /16Mb / 32Mb/64Mb	x8/ x16	3.3V 1.8V	44TSOP2 54TSOP2 48FBGA (6x8mm)	-40°C ~ 85°C	70ns

* Compatible with PPI FeRAM /low- power SRAM

Next Generation Memory STT-MRAM

Comparison with FeRam



MRAM Advantage

- **Low price**
 - MRAM price < FeRAM price
 - Advanced process : MRAM(28nm) vs FeRAM(90nm)
- **High density**
 - MRAM 32Mb > FeRAM 16Mb
- **High reliability/endurance**
 - FeRAM : 10^{13} read and write cycles
 - MRAM : 10^{14} write cycles

	FeRAM	Winner	STT-MRAM
Endurance	10^{13} cycles (read and write)	➔	10^{14} cycles (only write)
Density	1Kb~16Mb	➔	1Mb~32Mb
Scalability	Not Good (90nm)	➔	Good (28nm)
Price	High	➔➔	Low

※ The endurance of FeRAM is affected not only by write operation but also by read operation, but the endurance of MRAM is affected only by write operation. There are usually more read operations than write operations on the system. Considering this, MRAM's endurance can be said to be more than 20 times higher than that of FeRAM.

02

Next Generation Memory STT-MRAM

Comparison with NOR

_MRAM Advantage

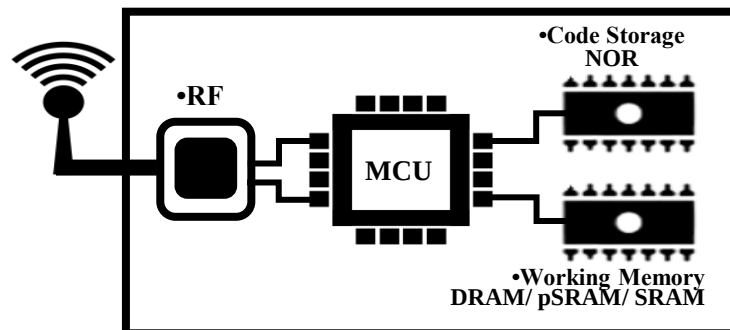
- **Much faster write speed than NOR**
 - OTA(Over The Air)
 - No extra RAM required
- **Much longer write endurance**
 - much longer life time
- **No page/block size and fast write time**
 - Efficient storage area utilization
ex) 32Mb NOR being replaced with 16Mb MRAM
- **Low write energy**
 - very small write energy

	NOR	Winner	STT-MRAM
Write Speed	Page Program Time : 0.4~3ms Sector Erase Time : 45~400ms Ex) 1-sector erase/program time ~52ms	→→	tCSDW Time : 20~350ns No Erase Function Required Ex) 1-sector write time ~ 0.083ms *
Endurance/Reliability	P/E 10 ⁵ cycles Wear leveling required``	→→	Write 10 ¹⁴ cycles No wear leveling required
Random Accessibility	Limited by page/block size and slow P/E time	→→	No Limit and fast write time
Write Energy	~6.8mJ (1-sector erase/program)	→→	~6.8uJ (1-sector write) *

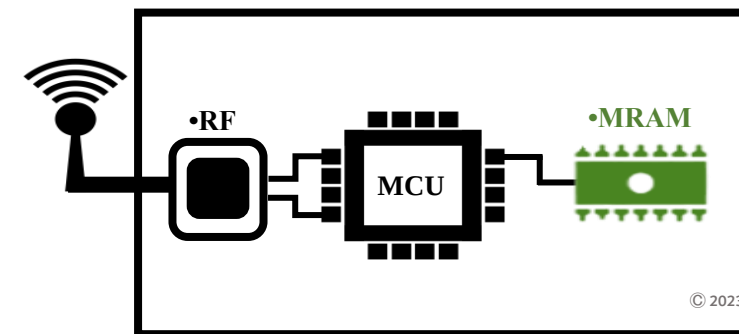
* 4-4-4, 100MHz

IoT terminal example

[NOR case]



[MRAM case]



02

Next Generation Memory STT-MRAM

Comparison with SRAM

MRAM Advantage

- **No need of Battery**

- Removing Battery, Battery socket, Vcc monitor circuit
- No Battery maintenance, reducing Cost of Quality

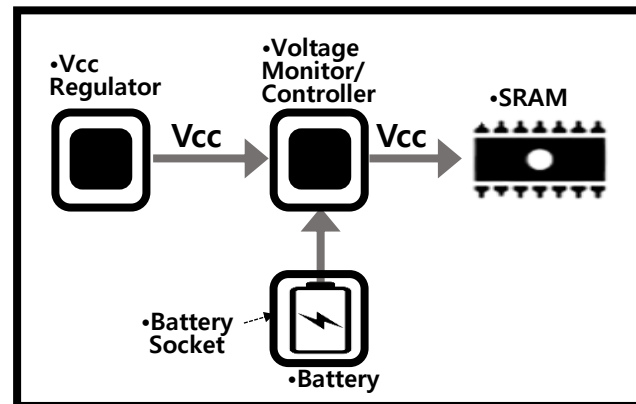
- Simple SMT process
- Longer Retention Time
; Battery 7 years, MRAM 10 years

	SRAM	Winner	STT-MRAM
Read /Write Speed*	55ns~70ns	←←	70n/ 320ns (240ns as of Jan 2024)
Battery Requirement	YES	→→	NO
Retention Time	7 years (Battery Life Time)	→	10 years

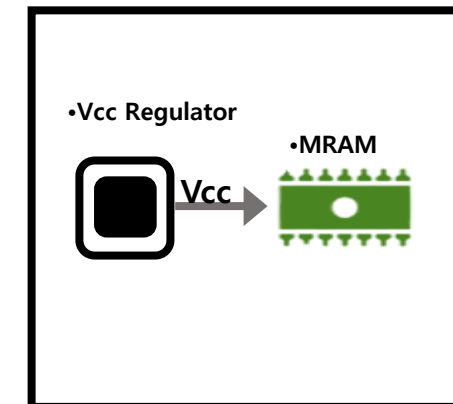
*Note : PPI interface

Battery Backup System Example

[SRAM case]



[MRAM case]



MRAM Applications

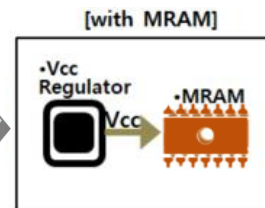
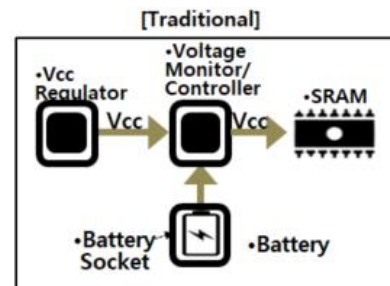
Multi Functional Printer



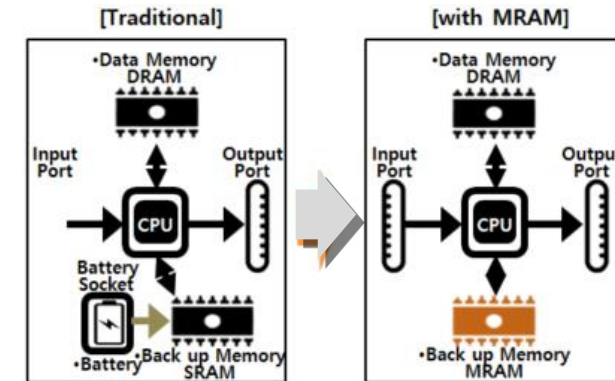
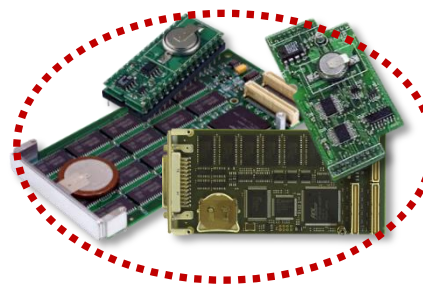
Industrial PC



FA/PLC



[Battery backed SRAM module]



➔ Not required when using MRAM

03

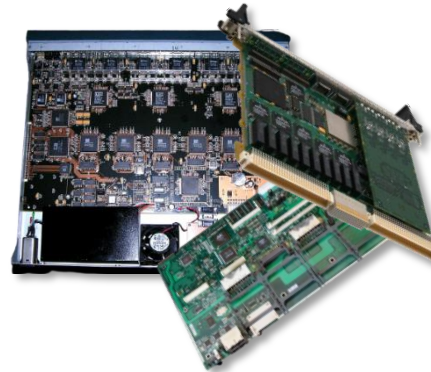
MRAM Applications

Network Systems

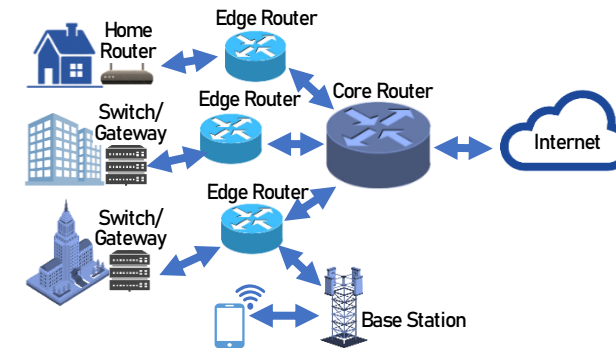
[Network Router]



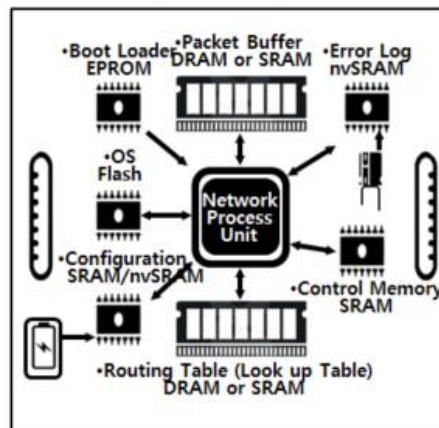
[Network Board]



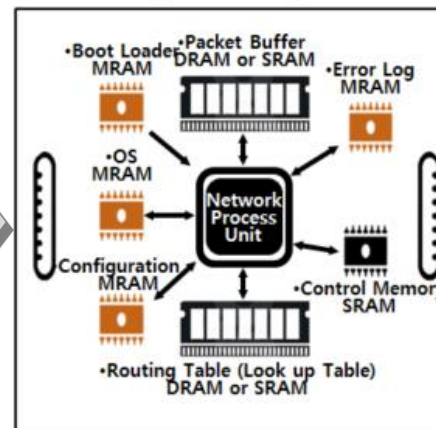
[Network overview diagram]



[Traditional]



[with MRAM]



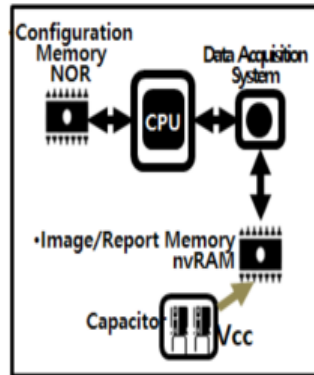
- Battery and battery socket not required
 - Simplification of system assembly process
 - Reduce quality control burden
 - Immediate data backup in case of power failure
 - Reduce system recovery time
 - Excellent number of repeated writes (Write Endurance)
- Increased system life

MRAM Applications

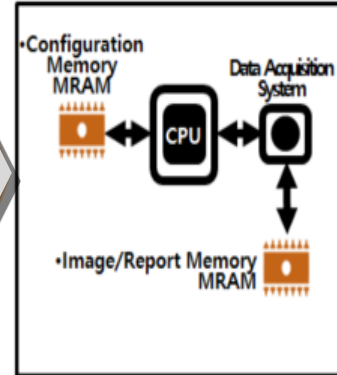
Medical Instruments



[Traditional]



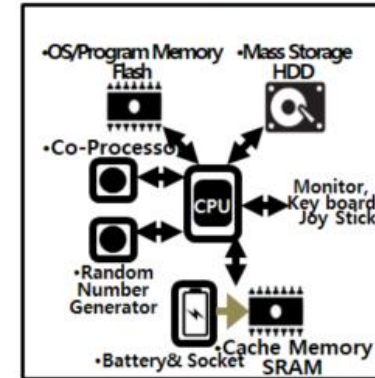
[with MRAM]



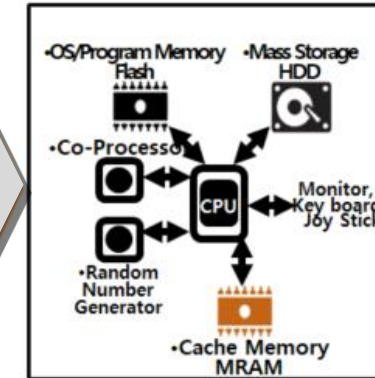
Game Machine



[Traditional]



[with MRAM]



03

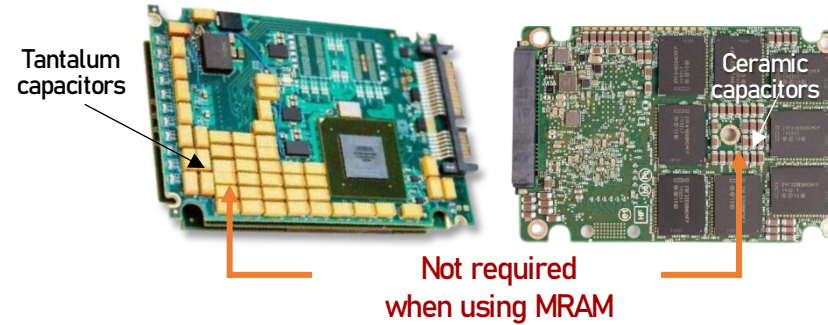
MRAM Applications

Data Center/ Enterprise-SSD

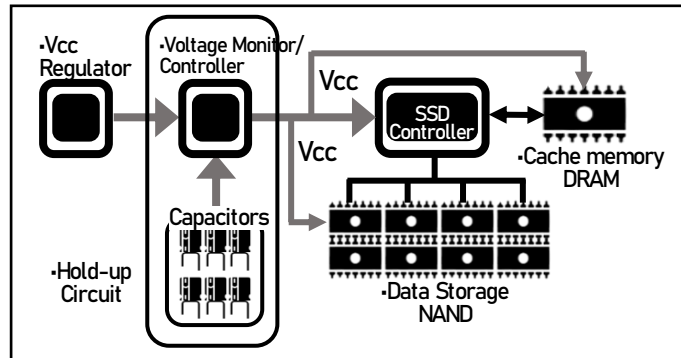
[Enterprise SSD]



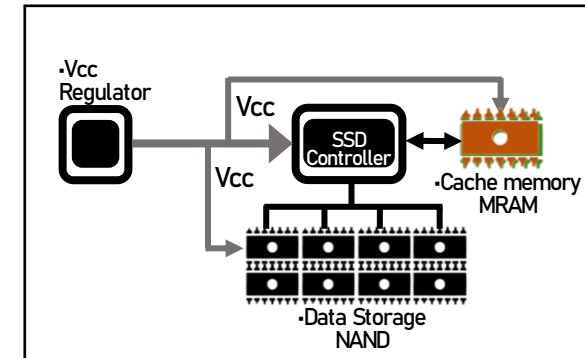
[Enterprise SSD board]



[Traditional]



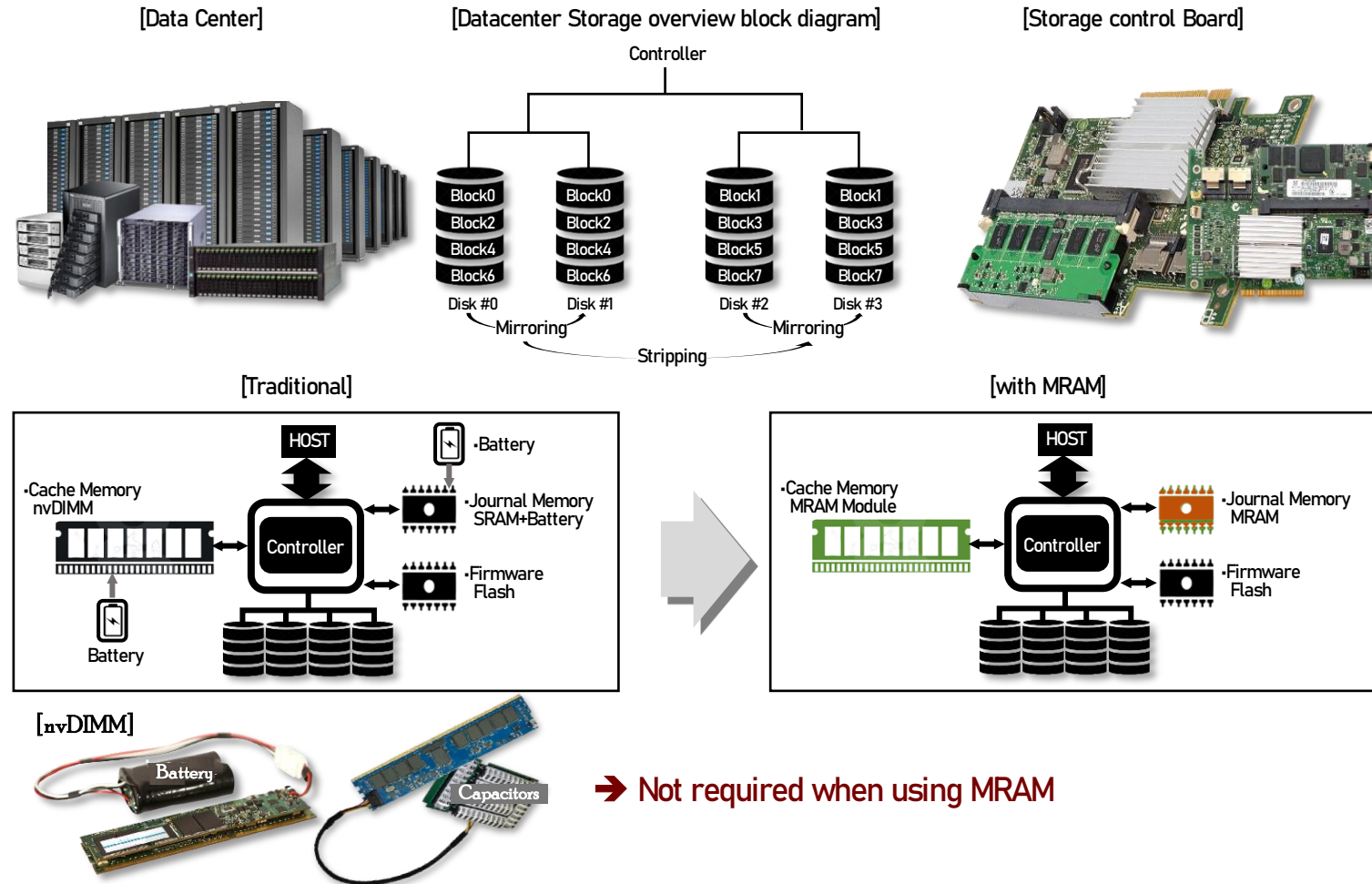
[with MRAM]



03

MRAM Applications

Server/RAID Controller Card



03

MRAM Applications

Data Logging

Process of repeatedly collecting and storing important system data

- events for tracking
 - environmental parameters
 - other data for analyzing purposes
 - history of usage
 - status of the machine
- ; Requires fast write speeds, high number of repeat writes,
non-volatile memory

- No need for batteries and capacitors
- Reduce quality control burden
- Replaces NOR Flash and FRAM with fast writing speed and high endurance
- Instant Data Backup and System recover



Press release

News

- **STT-MRAM info** ([Article Link](#)) Posted : Aug.30.2023 by Ron Mertens

NETSOL launches a stand-alone STT-MRAM product fabricated in Samsung Foundry's 28nm FDSOI process



NETSOL MRAM products are ideal for applications that need to store and retrieve data quickly and frequently due to STT-MRAM's virtually unlimited endurance and fast-write features. Ideal for code storage, data logging, backup and working memory in industrial devices/ equipment, it can replace NOR Flash, FeRAM, low-power SRAM and nvSRAM products, among others with unmatched performance and non-volatile features.

"NETSOL is delivering a memory solution that integrates both Flash and RAM products into one for the global niche memory semiconductor market with \$USD 4 billion constituting NOR Flash, FeRAM, PSRAM and low-power SRAM products, delivering better customer convenience and cost-effectiveness."

- **Forbes** ([Article Link](#)) Posted : Jan.10.2023 by Tom Coughlin

2023 MRAM Forum Shows MRAM For Automotive And Other Applications



Netsol thinks that although currently MRAM is using existing memory interfaces, new memory interfaces will be needed for high performance standalone non-volatile memories. Netsol's roadmap has 14nm MRAM products introduced in late 2025 or 2026.

"At the 2023 MRAM Forum, a key event by the IEEE Magnetics Society tied to the IEDM conference, Mr. Noh, Chief Technology Officer at [Netsol](#), provided an overview of the company's advancements in MRAM technology."

Press release

News

- **The ELEC** Posted : Aug.10.2023 by Noh Taemin

SRAM firm Netsol to supply Chinese firm with MRAM this year



South Korean chip fabless company Netsol is planning to supply its first magnetic random access memory (MRAM) to a Chinese customer, the company CEO told TheElec. Niche memory chips, excluding DRAM and NAND flash, accounted for 5% of the total memory chip market, Netsol CEO Kim Woo-jin said.

"The MRAM will be supplied to a Chinese industrial chip maker, which has placed a purchase order worth around US\$20,000. Netsol plans to use Samsung's 28-nanometer process for the chip. Netsol is also planning to start development of next-generation 14nm spin transfer torque (STT)-MRAM after supplying its first MRAM."

- **MRAM-info** ([Article Link](#)) Posted : Jan.10.2023 by Ron Mertens

Netsol Unveils First Standalone MRAM Using 28nm Process, Shares the Outlook for Standalone MRAM at 2023 MRAM Forum

15th MRAM Global Innovation Forum		
Hilton Union Square, San Francisco		
December 14, 2023		
Speaker	Affiliation	Topic
Yong Hwan Noh	Netsol	Introduction to standalone nvRAM based on Samsung 28nm STT-MRAM and outlook for standalone MRAM features

At the 2023 MRAM Forum, a key event by the IEEE Magnetics Society tied to the IEDM conference, Mr. Noh, Chief Technology Officer at Netsol, provided an overview of the company's advancements in MRAM technology.

"Mr. Noh revealed Netsol's ongoing project: a 14nm Flash-like MRAM boasting high densities ranging from 128Mb to 1Gb, targeted specifically for the automotive application and expected to be released in the beginning of 2026. .."

Press release

News

- **Yahoo! finance** Posted : Feb.1.2024

NETSOL Drives Automotive Innovation With Flash-like MRAM Breakthrough

yahoo!finance

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Finance

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S&P Futures

4,970.25

-10.00 (-0.20%)

Dow Futures

38,694.00

-71.00 (-0.18%)

Nasdaq Futures

17,696.50

-36.25 (-0.20%)

Russell 2000 Futures

1,961.80

-8.80 (-0.45%)

Crude Oil

72.70

+0.42 (+0.58%)

Gold

2,047.50

-6.20 (-0.30%)

U.S. markets open in 8 hours 53 minutes

YAHOO FINANCE CHARTBOOK: 33 charts that explain markets and the economy

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Thu, February 1, 2024 at 11:00 PM GMT+9 · 2 min read

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HWASEONG-SI, SOUTH KOREA / ACCESSWIRE / February 1, 2024 / Memory innovator

Netsol has announced a major leap in the memory technology with the development of a Flash-like MRAM.

Quote Lookup

TRENDING

1. UPDATE 1-New Zealand expects defence capability report in June

2. Hedge Funds' Mega Returns Set Off Demand Spiral for Catastrophe Bonds

3. Turkey Braced for Inflation Jump in Test for Peak Interest Rates

4. Billionaire-backed KoBold says open to partners as it plans \$2 bln Zambian copper mine

5. Best new artist Grammy winner Victoria Monet follows big names



NETSOL MRAM

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The Best is yet to come

THANK YOU!



New Evolution of Technology and SOLution

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