Introduction of FeRAM Usage

September 2024

RAMXEED

Introduction Flow

1 Overview | **Overview of FeRAM**

2 Usage | **Applications using FeRAM**

3 Requirements | **Requirements to Memory**

4 Features | **Four Features of FeRAM**

5 Solutions | **Solutions by FeRAM to Customer Issues**

1. Overview of FeRAM

What is FeRAM?

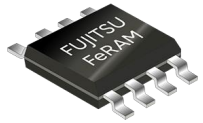
- A type of **non-volatile memory**
- Stands for **Ferroelectric Random Access Memory**
- Data storage by **Electric Polarization**

Features of FeRAM

- Non-volatility
- High Read/Write Endurance
- Fast Writing Speed
- Low Power Consumption

FeRAM Packages

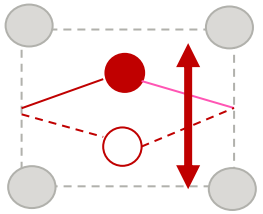
8pin DFN



8pin SOP

Data storage by Polarization

FeRAM Cell Structure



Polarization by moving of atoms

Position of atoms in center forms data “0” or “1”

1. Overview of FeRAM

FeRAM Lineup

- Three interface: I2C, SPI, and Parallel
- Memory density: 4Kbit to 8Mbit
- Temperature range: Operating at maximum 125℃

Interface	I2C	SPI	Parallel
Density	**4K to 1Mbit**	**16K to 8Mbit**	**256K to 8Mbit**
Supply Voltage	1.7 to 1.95V / 1.8 to 3.6V 2.7 to 3.6V / 2.7 to 5.5V	1.65 to 1.95V / 1.7 to1.95V 1.7 to 3.6V / 1.8 to 3.6V 2.7 to 3.6V / 2.7 to 5.5V	1.8 to 3.6V 2.7 to 3.3V
Operating Temperature	-40°C to +125°C -40°C to +105°C -40°C to +95°C -40°C to +85°C	-40°C to +125°C -40°C to +105°C -40°C to +95°C -40°C to +85°C	+40°C to +105°C -40°C to +85°C
Package	SOP, SON, DFN	SOP, SON, DFN, WL-CSP	SOP, TSOP, FBGA

＊: Please confirm detailed specs by each product.

[As of September 2024]

1. Overview of FeRAM

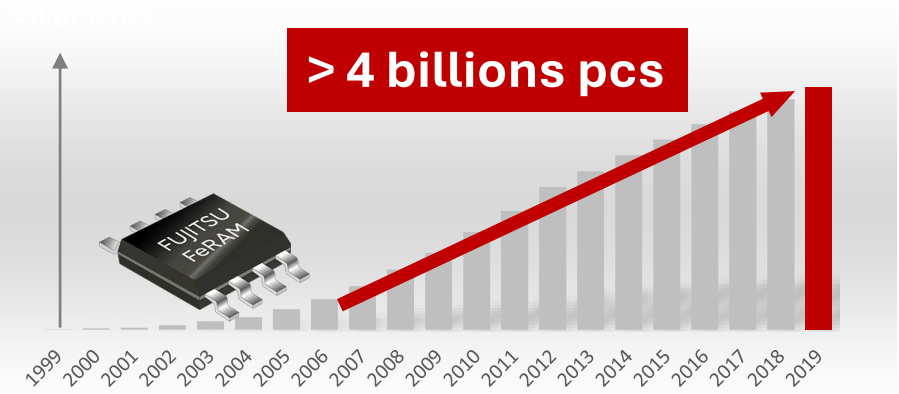
Quantity of FeRAM shipped

Production since 1999, total shipment is more than **4 billion pcs**

Countries FeRAM shipped

Used in over **60 countries**, more than **200 types of applications**

Shipped Quantity

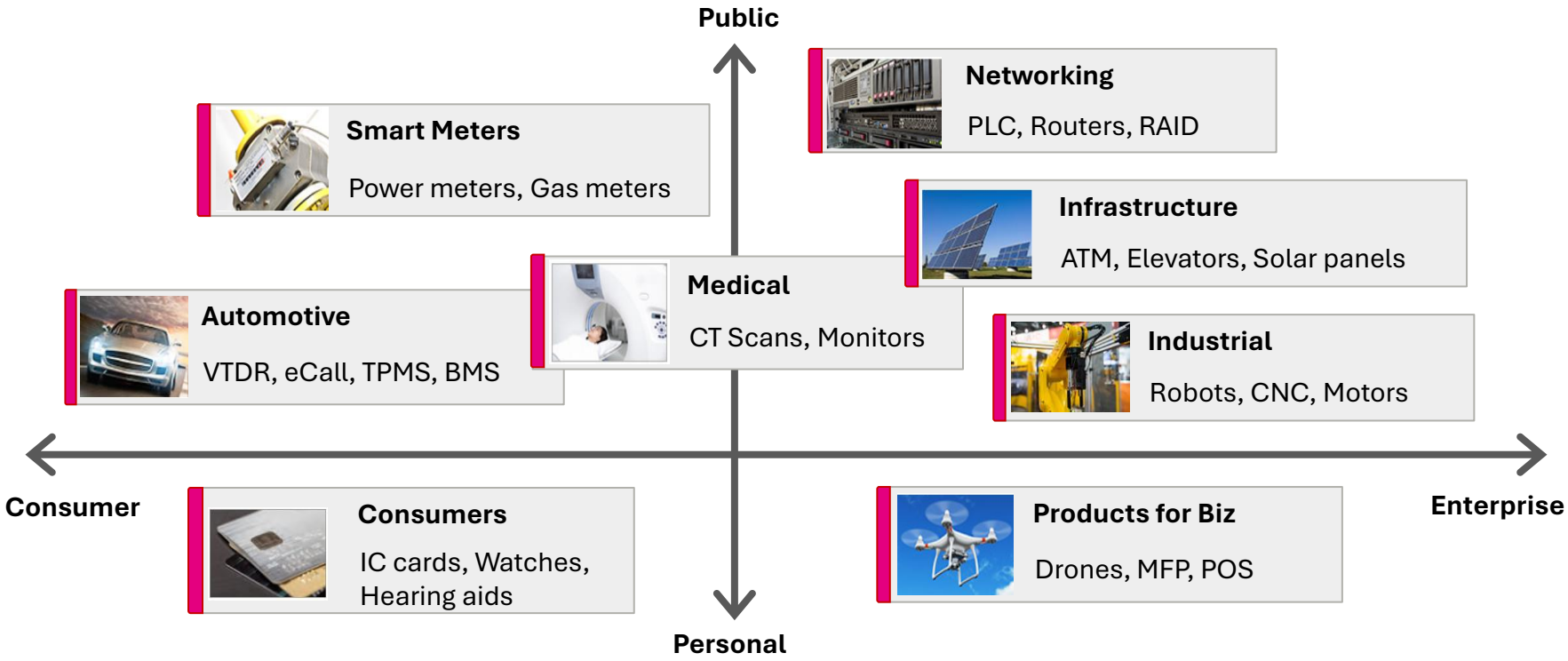


Countries FeRAM Shipped

2. Applications using FeRAM

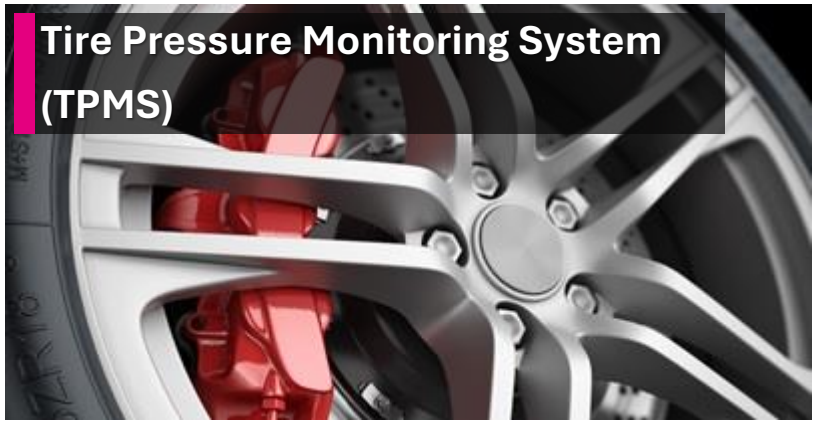
Where is FeRAM used?

- Used in all kinds of market segments, especially strong in the public services
- Suitable for frequent data logging requirement



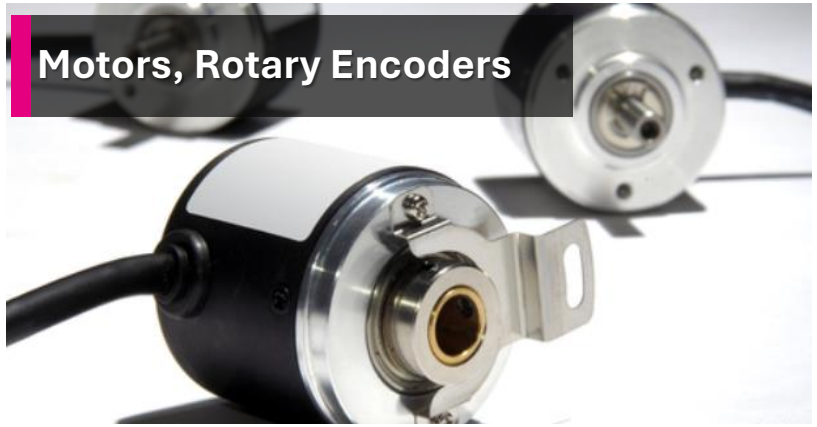
2. Applications using FeRAM

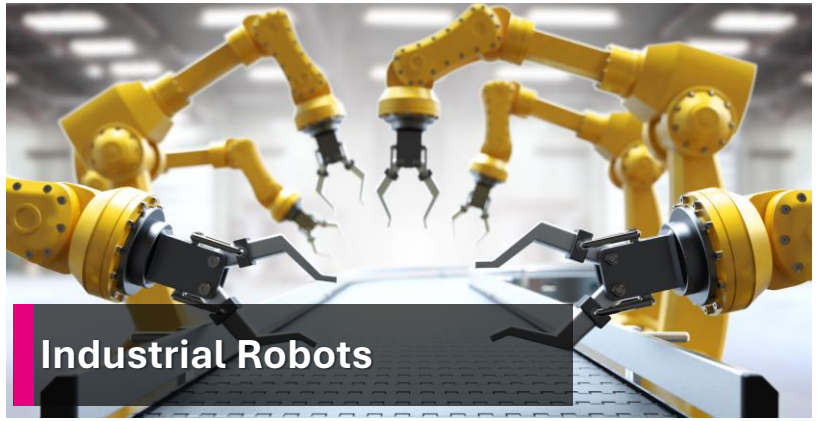
Automotive



2. Applications using FeRAM

Industrial (for factory)





2. Applications using FeRAM

Infrastructure

2. Applications using FeRAM

Business/Consumer

3. Requirements to Memory

Requirements to Memory

Memory needs **4 types of features** to meet the requirements

Summary of FeRAM Usage

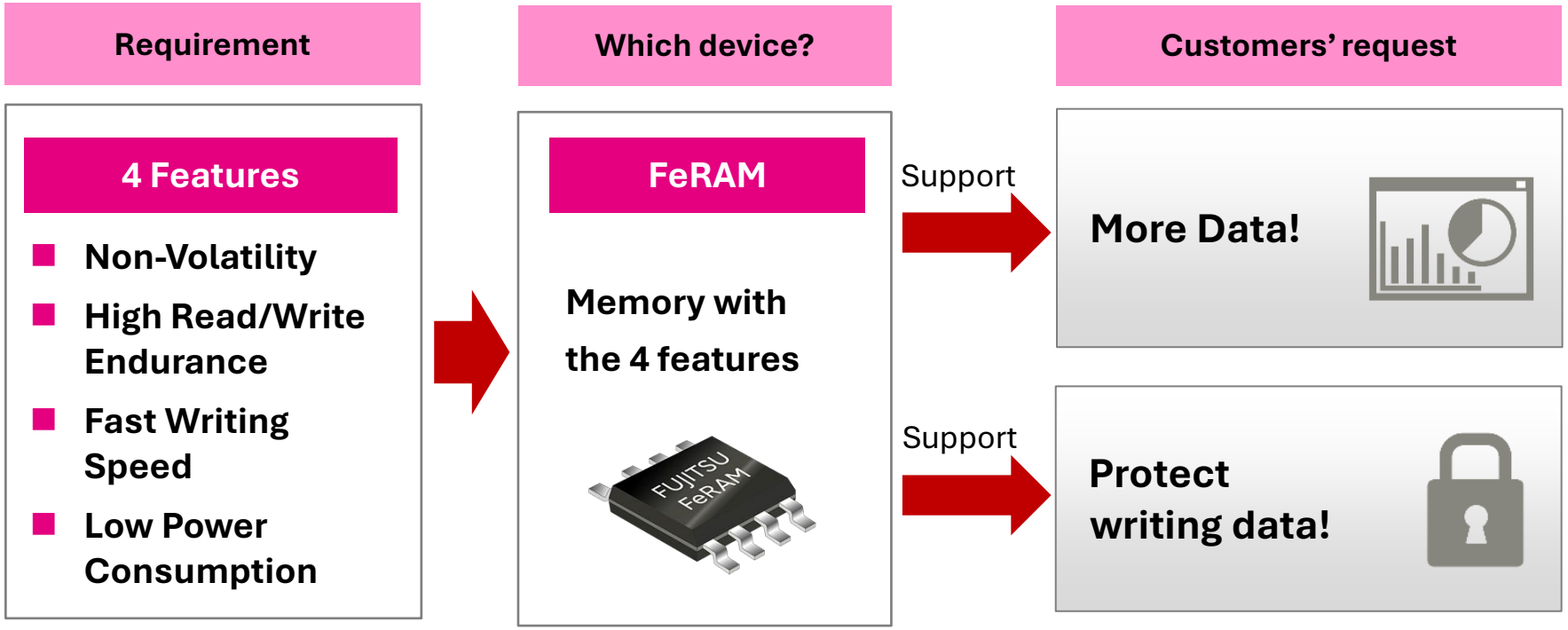
Summarized as 4 features!

No	Applications	Requirements to Memory	Required Features
1	Automotive	Driving data logging in real time Writing data protected in accident	**Non-volatility,** **High read/write endurance,** **Fast writing speed**
2	Industrial	Positioning data logging in real time Writing data protected in power outage	
3	Infrastructure	Continuous logging of data from sensors Writing data protected in accident	
4	Consumer	Frequent read/write of data Low power to extend battery life	**High read/write endurance,** **Low power consumption**
5	Products for biz	Continuous data logging in real time Writing data protected in power outage	**Non-volatility,** **High read/write endurance,** **Fast writing speed**

4. Features of FeRAM

Memory's Features required from customers

- Requirement to memory: Having 4 features
- Solution: Using FeRAM with 4 features



4. Features of FeRAM

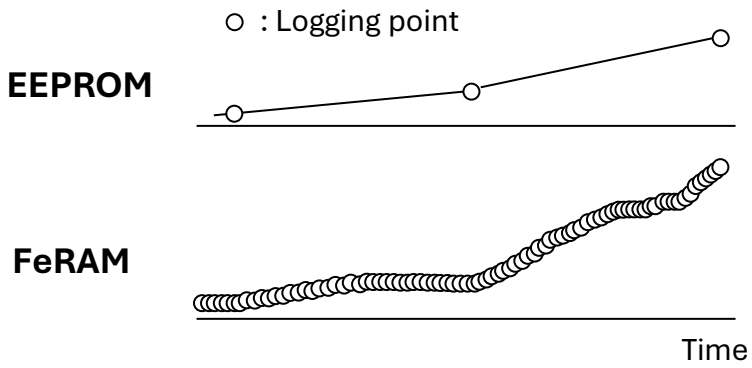
FeRAM Feature – High Read/Write Endurance

- Spec: Max. 100 trillion read/write cycles guaranteed
- Benefits: Highly frequent and accurate data

Read/write cycle times after 10 years

Once per 1 second	for 10 years	>300 million times
Once per 0.003ms	for 10 years	**100 trillion times**

Benefit by high endurance



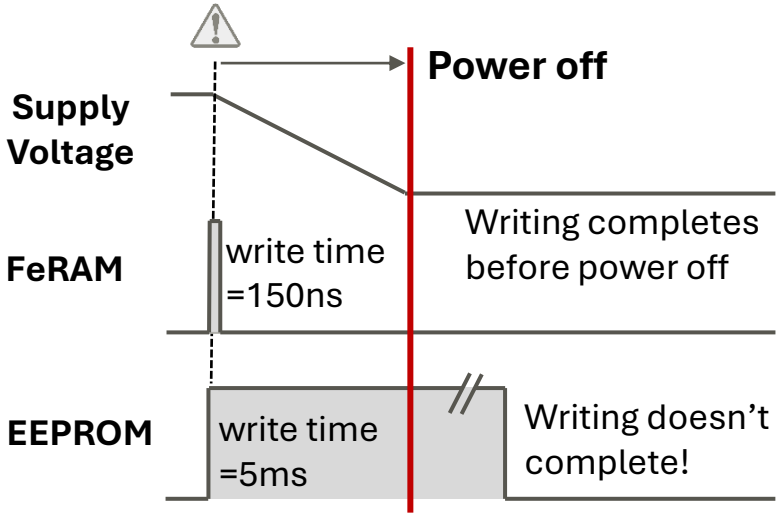
Get highly accurate data with very frequent logging

4. Features of FeRAM

FeRAM Feature – Fast Writing Speed

- Spec: Write time Max. 120 ns
- Benefits: Protect data from sudden power outage

Comparison of write time at power off



Result on data writing failure test

Tests using our demo-boards below.

Item	FeRAM	EEPROM
Failure frequency	Zero	Once per three tests

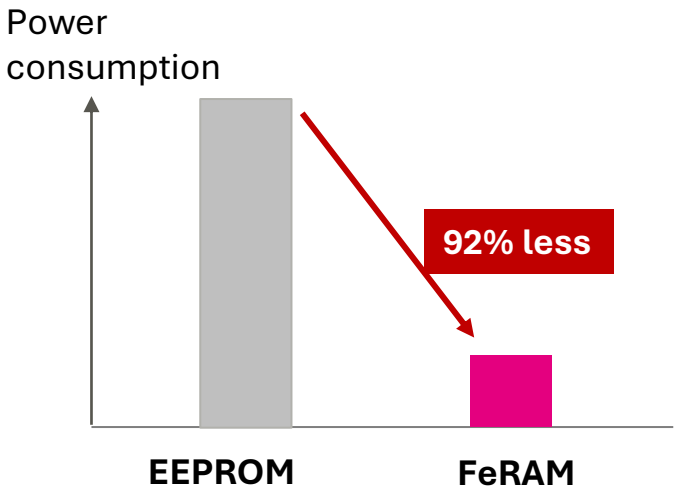
*: To confirm if data is protected from sudden power off. Tested >100 times in 2017.

4. Features of FeRAM

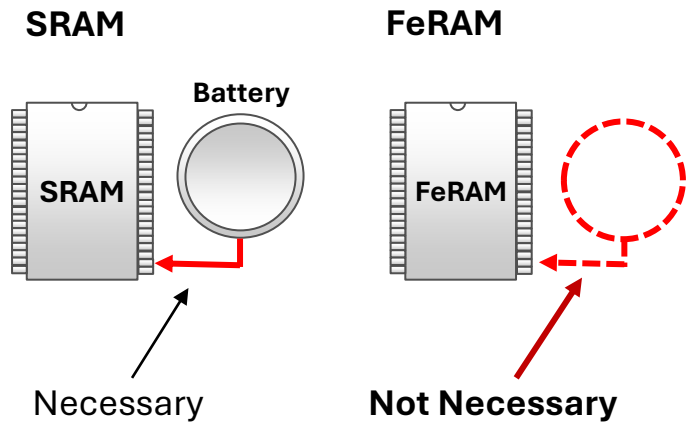
FeRAM Feature – Low Power Consumption

- Spec: Low write current (e.g., Icc=2.3mA max. in writing@40MHz)
- Benefits: Extends battery-life in wearable/mobile devices
  No batteries for data retention

Power consumption in data writing



Necessity of data retention current

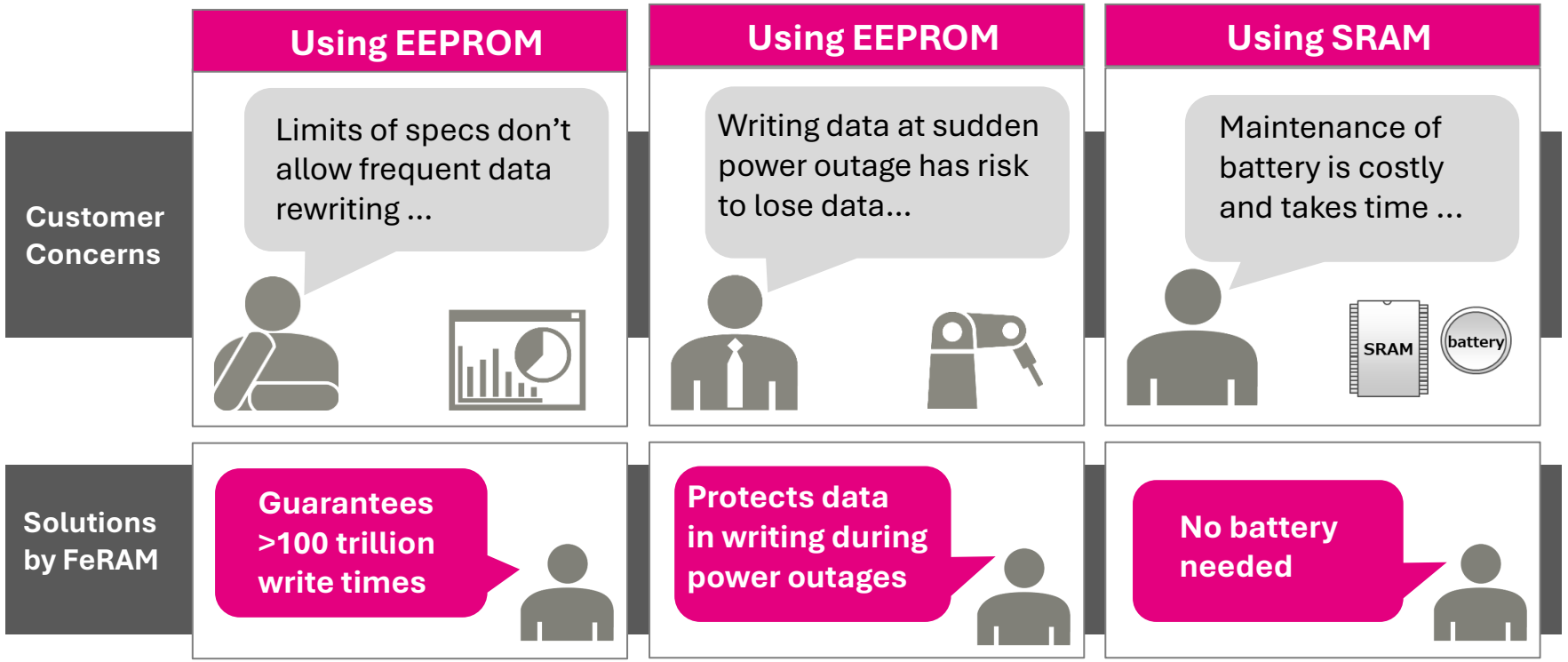


Conditions:
2Mbit, 3V, SPI I/F, 2KB writing, 5MHz, 1s

5. Solutions by FeRAM to Customer Issues

Customer Issues and Solutions

If you have the following concerns, consider solution by FeRAM



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Our Memory, Your Future.