

New Energy Solutions

Battery Management System

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Technology Manager

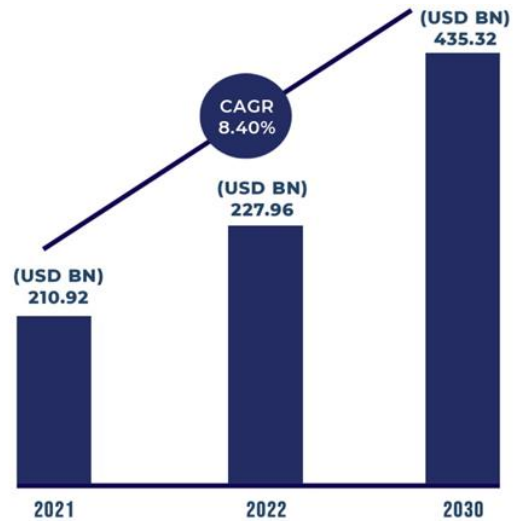




2022年 供應鏈的減碳元年

| Energy Storage System (ESS) Market Overview

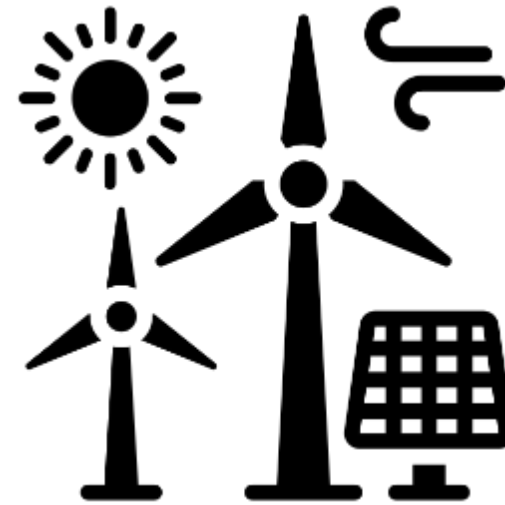
- Global market size is projected to surpass around US\$ 435 B by 2030 and [CAGR of 8.4% from 2022 to 2030](#)
 - The environment protection and reduction of carbon footprint
 - Development of sustainable energy sources for utility application



(Source: Precedence Research, 2022)

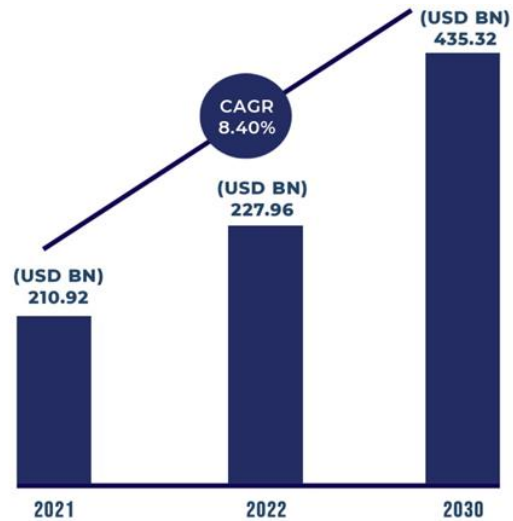


Solar and wind energy are the most prominent renewable energy types that are stored in grids. However, the concealing of the sun by clouds or fluctuating currents leads to variations in the process of energy generation



| Energy Storage System (ESS) Market Overview

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 - Development of sustainable energy sources for utility application

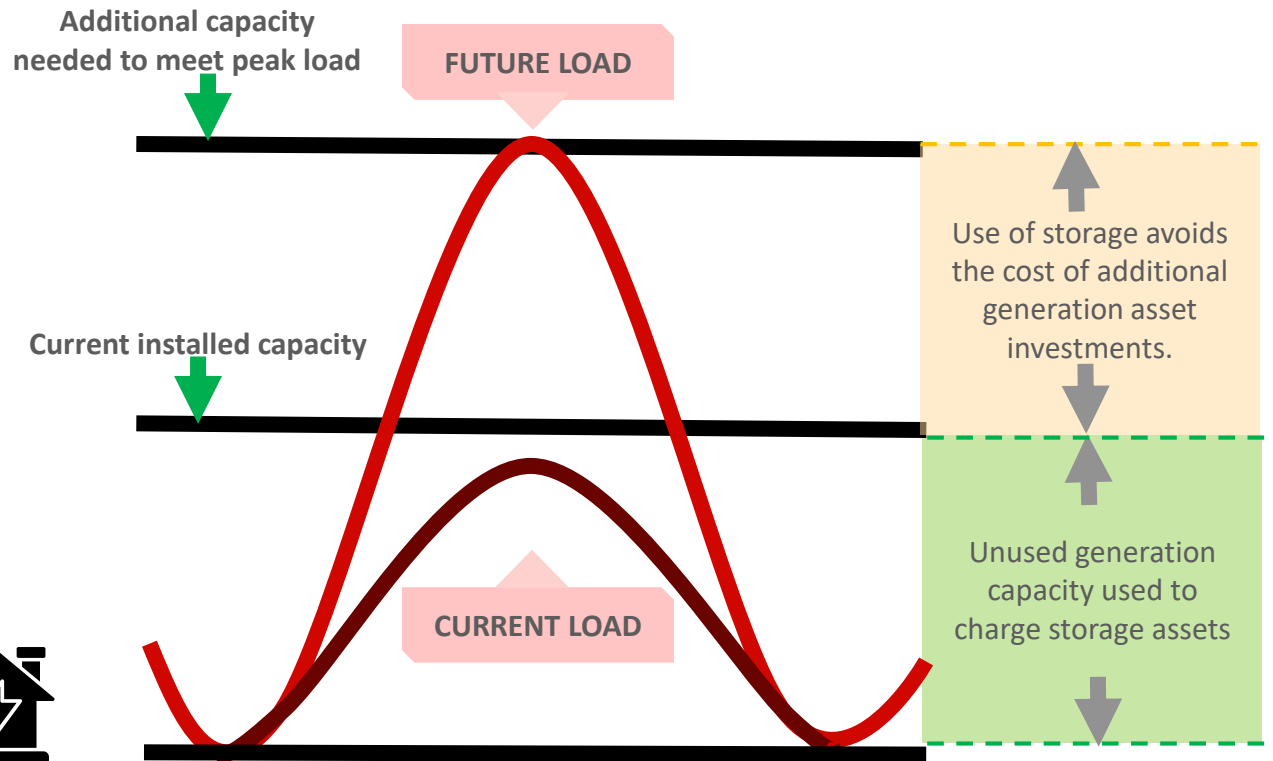
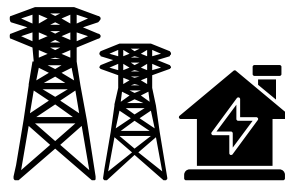


(Source: Precedence Research, 2022)

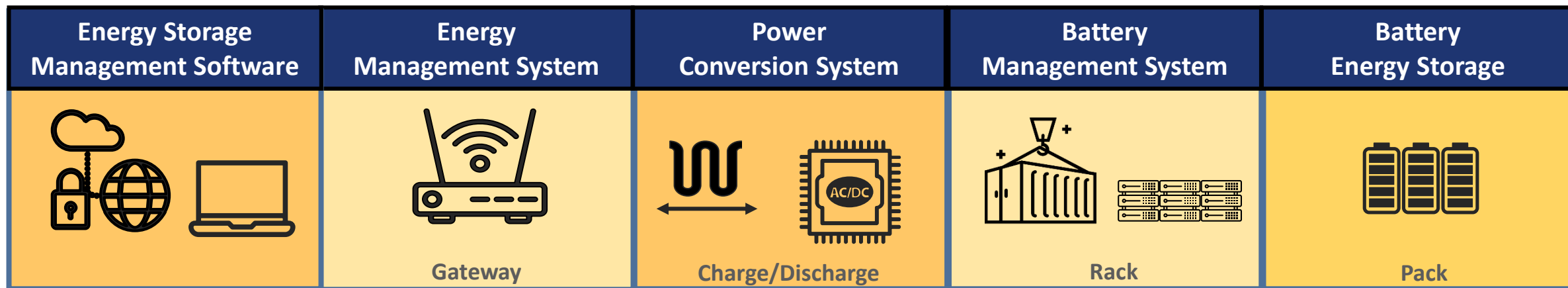


Benefit

To help grid operators save electricity when the electricity generated exceeds the electricity demand.



| Energy Storage System Architecture

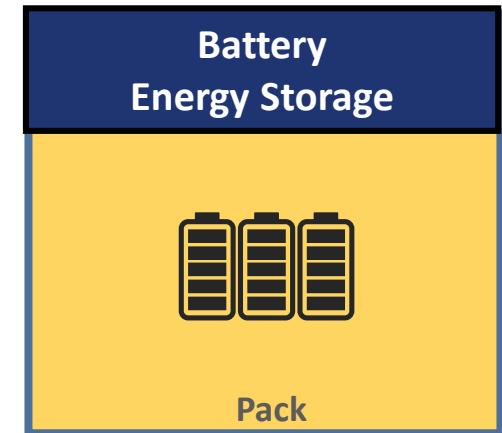


PCS: Power Conditioning System
BMS: Battery Management System
EMS: Energy Monitor System

| Energy Storage System Architecture

ESS	1 st Layer
BMS	MCU + Analog Front-End
MCU P/N	M253
AFE P/N	KA49503A / KA49517A

1st Layer
NuMicro[®] M253 to manage battery status

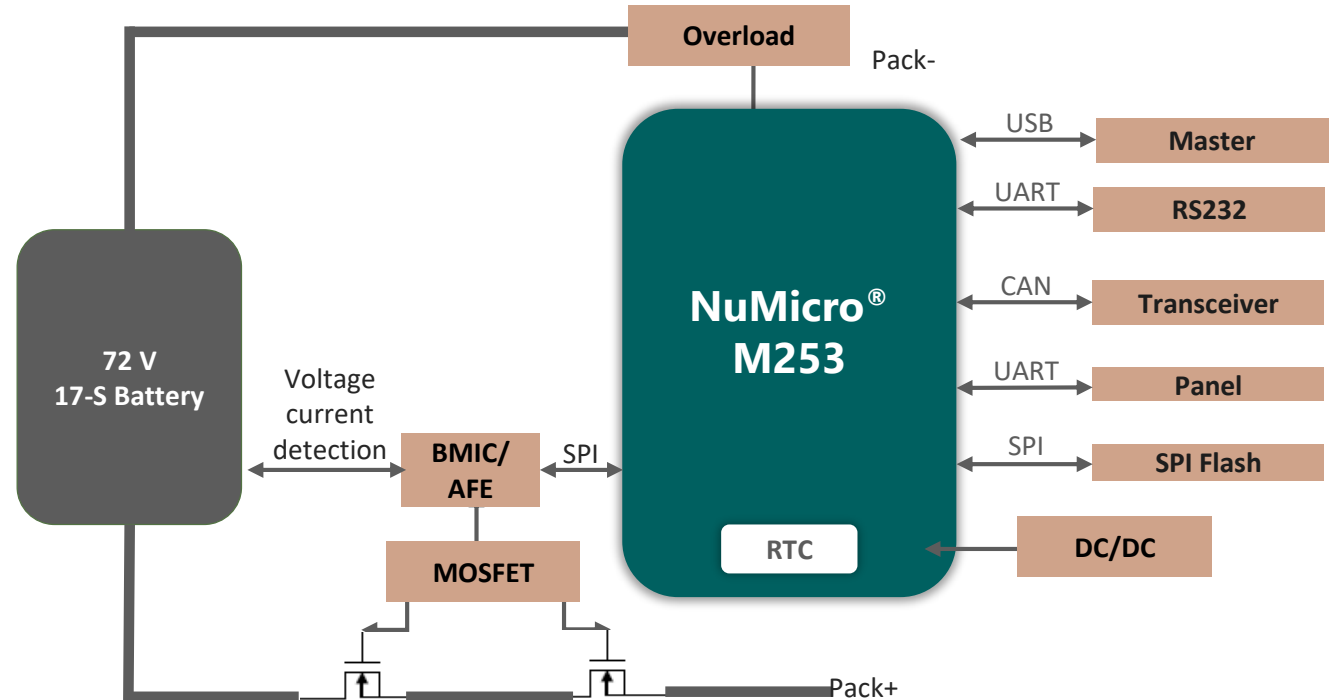


PCS: Power Conditioning System
BMS: Battery Management System
EMS: Energy Monitor System

BMS of Battery Energy Storage

Features

- Operating Voltage supported from 1.75V to 5.5V
- 128K Flash / 16kB RAM
- UART@5ch /SPI/I²C
- 1 set of built-in CAN FD interface
- Provides two packages, QFN33 and LQFP48
- Built-in RTC to record time event
- Supports 2 μ A power-down current
- Supports 5V operating voltage
- Supports IEC-60730 STL



| Energy Storage System Architecture

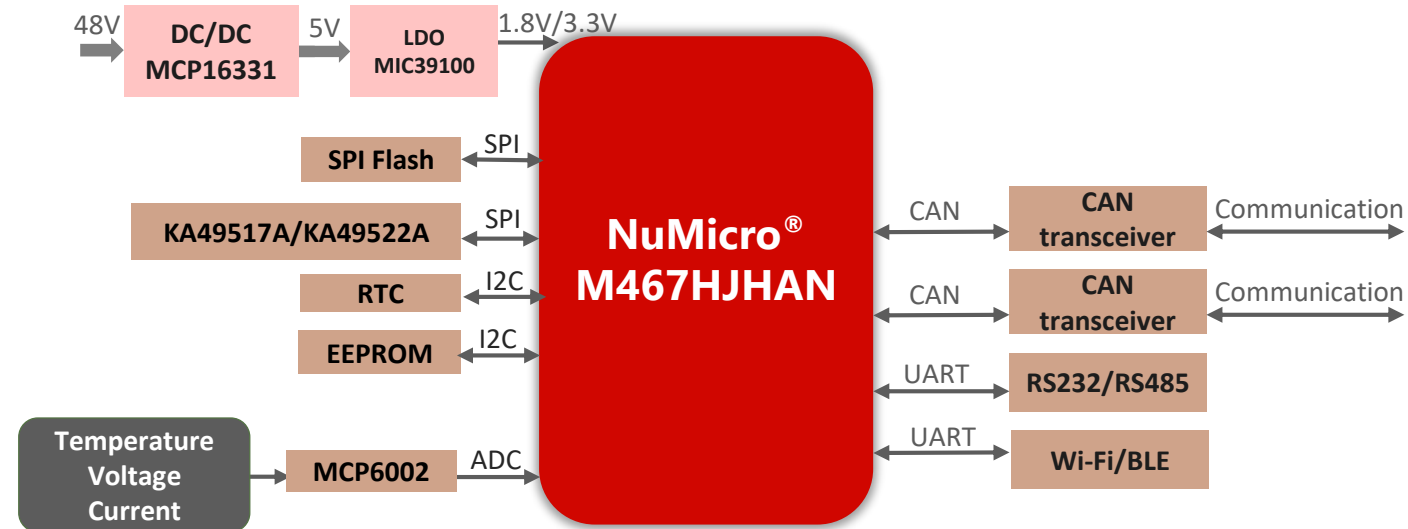


PCS: Power Conditioning System
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EMS: Energy Monitor System

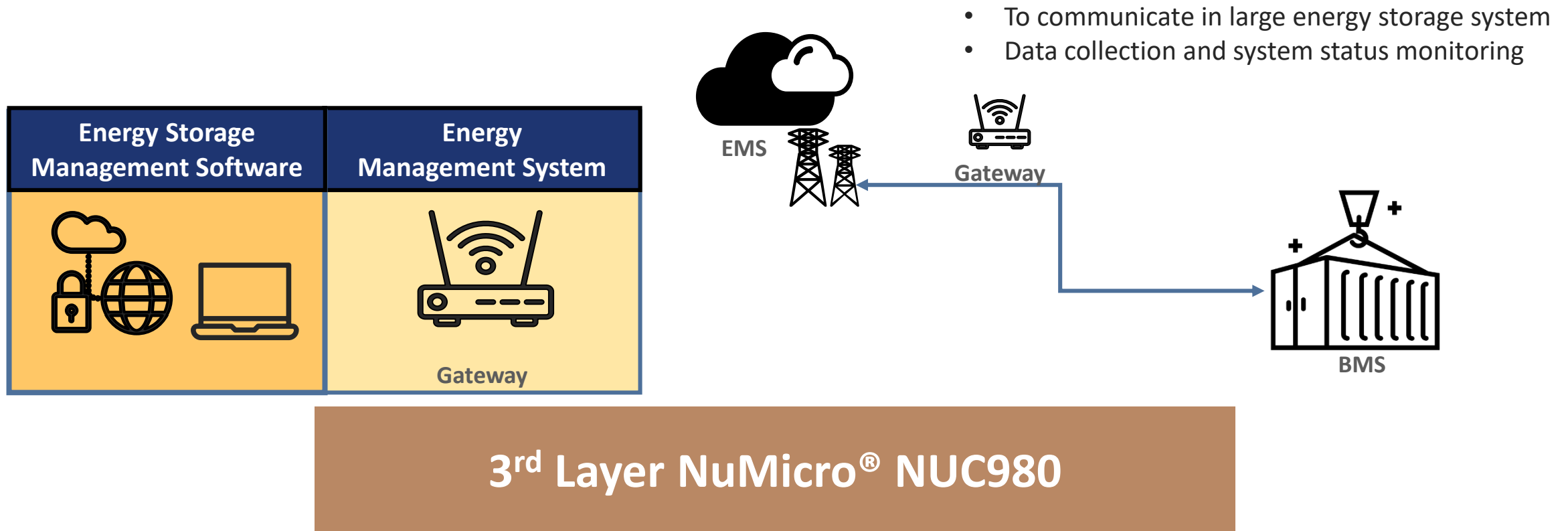
Battery Management System

Features

- Cortex M4 with 192 MHz core speed, provides DSP/FPU to accelerate the processing power of algorithm
- Supports up to 4 sets of CAN FD interfaces to save the external transceivers
- Supports up to 10 sets of UART interface for Wi-Fi/ BLE/ RS232/ RS485 communications
- Multiple RTOS
 - Mbed OS
 - RT Thread
- Supports up to 3 sets of 12-bit 5 Msps ADC, up to 28 channels to monitor the battery cell voltage, temperature



| Energy Storage System Architecture

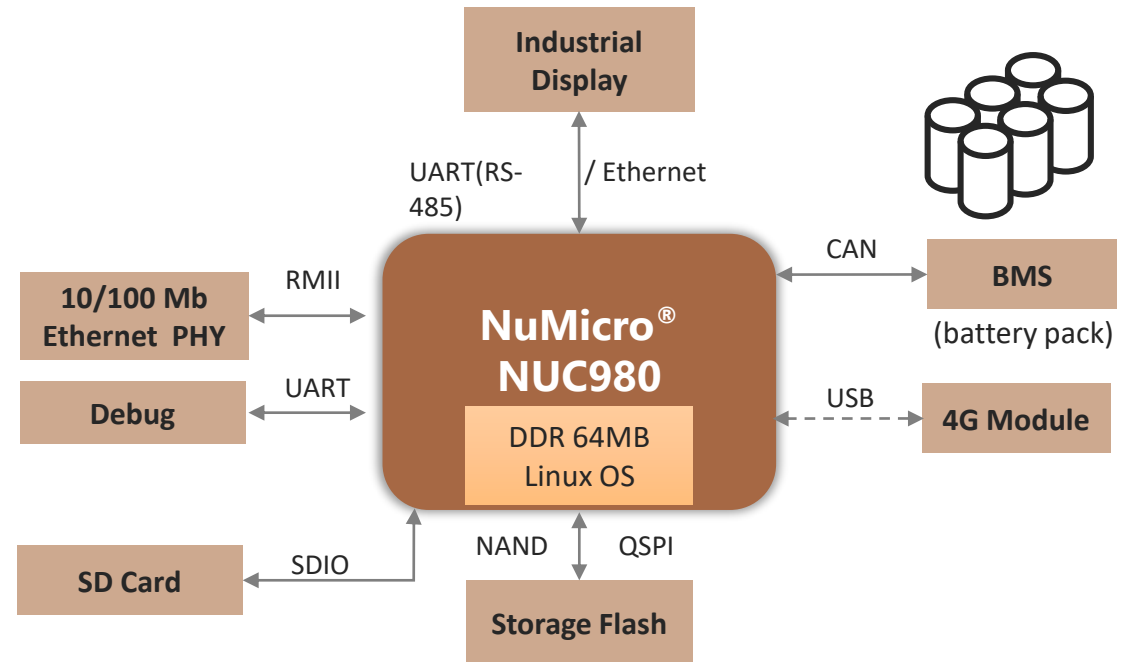


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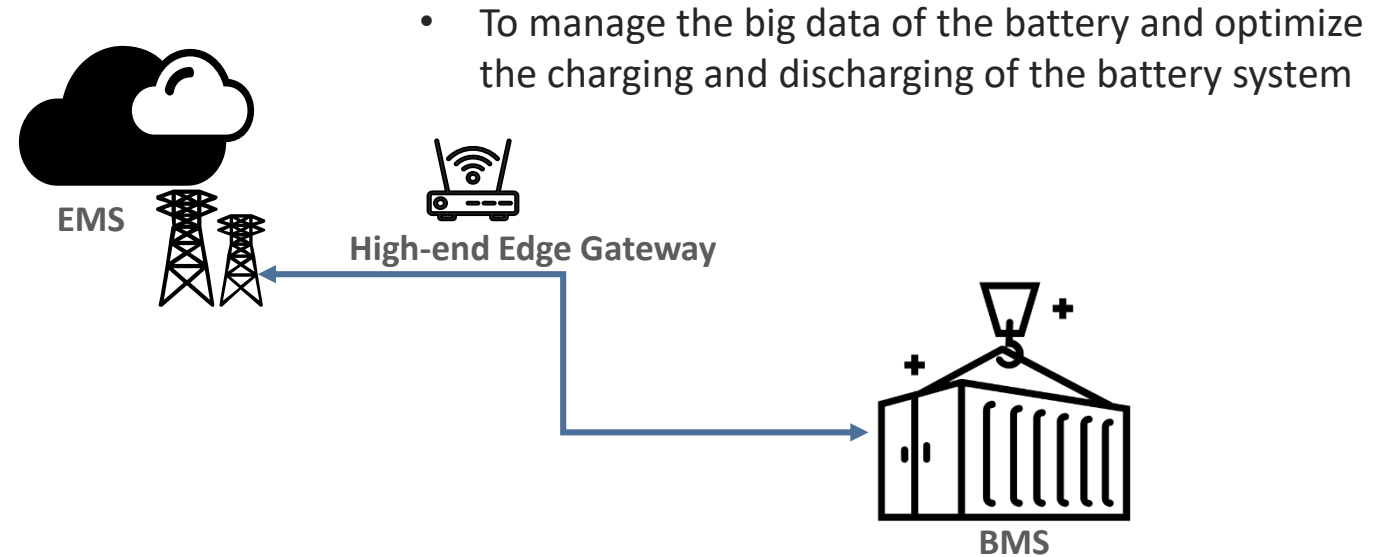
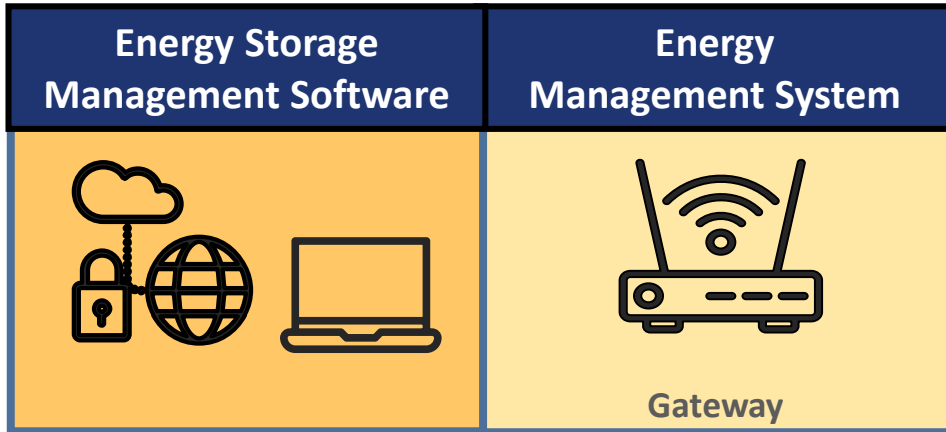
| Energy Storage System Gateway

NUC980DK63YC Features

- CAN for BMS (battery pack)
- USB for 4G/5G module
- Dual Ethernet for communication (& HMI)
- LQFP – MCP 64 MB DDR
- Linux OS (Protocols)



| Energy Storage System Architecture



PCS: Power Conditioning System
BMS: Battery Management System
EMS: Energy Monitor System

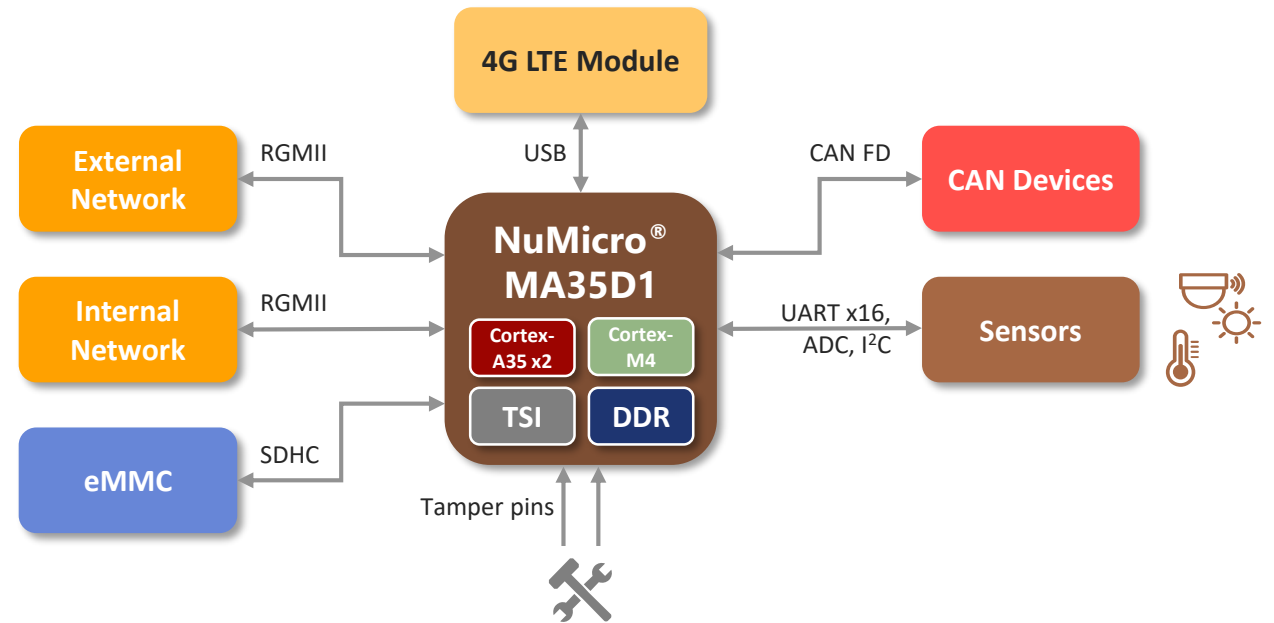
New Energy Gateway

Features

- Stacking DDR up to 512 MB
- Up to 2 sets of Gigabit Ethernet
- Up to 4 sets of CAN FD
- Up to 16 sets of UART (up to 9.5 Mbps), and I²C, ADC for connecting sensors
- 1 set USB 2.0 HS Host
- 1 set SD3.0 Host
- TSI (Trusted Secure Island) for Security
 - Secure Boot, OPT, Key Store, TRNG
- Operating Temperature -40°C to +85°C

Software

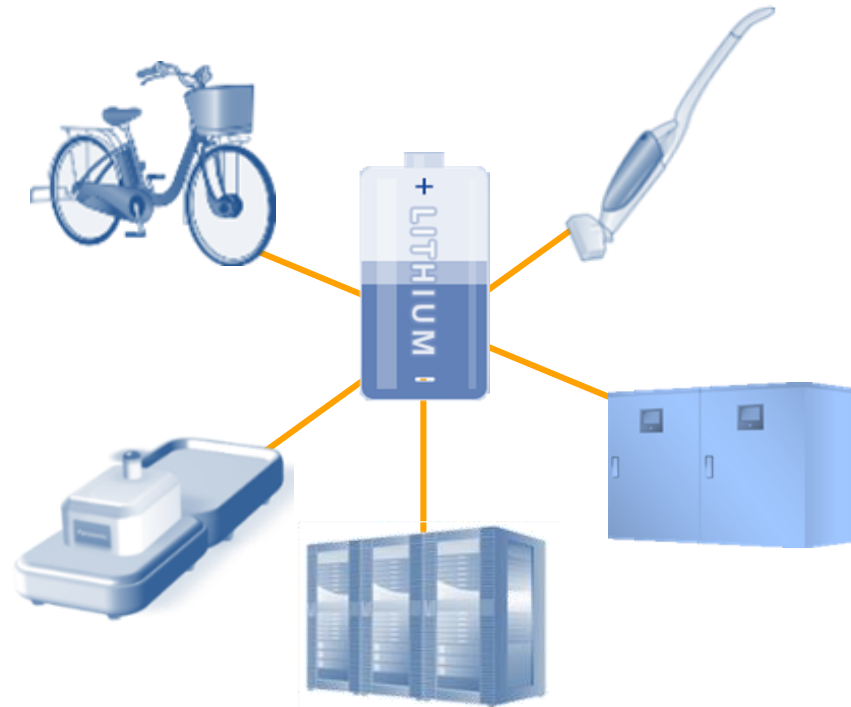
- Linux v5.4, OpenWRT
- Richer network protocols – TCP, UDP, HTTP(S), MQTT, CoAP, WebSockets.



| Value for Battery Management System

A Safer and Scalable BMS Solution

Application



| Nuvoton BM-IC Features



Simplicity

All in one, simplified BOM
Cells voltage, current,
temperature AD measurement
Internal/External passive type cell
Balance
High-side charge and discharge
FET drive



Safety

Integrated safety functions
Battery Cell Protection
Power Supply Detectors
Various Functions Self Diagnostic
Thermal Protection
Communication Watchdog Timer



Scalability

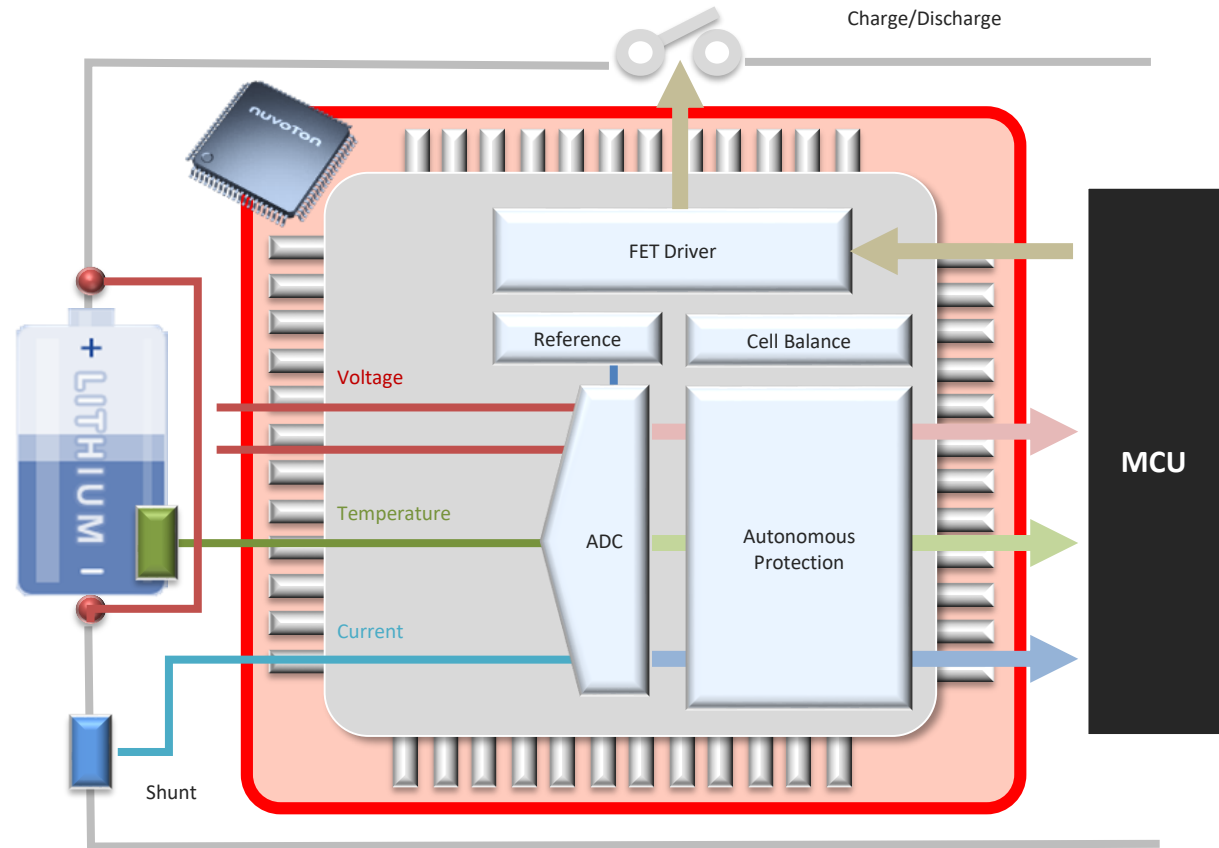
Form 36V to 72V Portfolio
17 and 22 channel cell voltage
measurement
Match all Li-ion Cell type

Nuvoton BM-IC Features








Simplicity

All in one, simplified BOM
Cells voltage, current,
temperature AD measurement
Internal/External passive type cell
Balance
High-side charge and discharge
FET drive



Nuvoton BM-IC Features

Application	Competitor	Nuvoton
72V (22cell)	 15ch	 22ch
72V (20cell)	 15ch	
60V (17cell)	 10ch	 17/22ch

Save 20% BOM cost

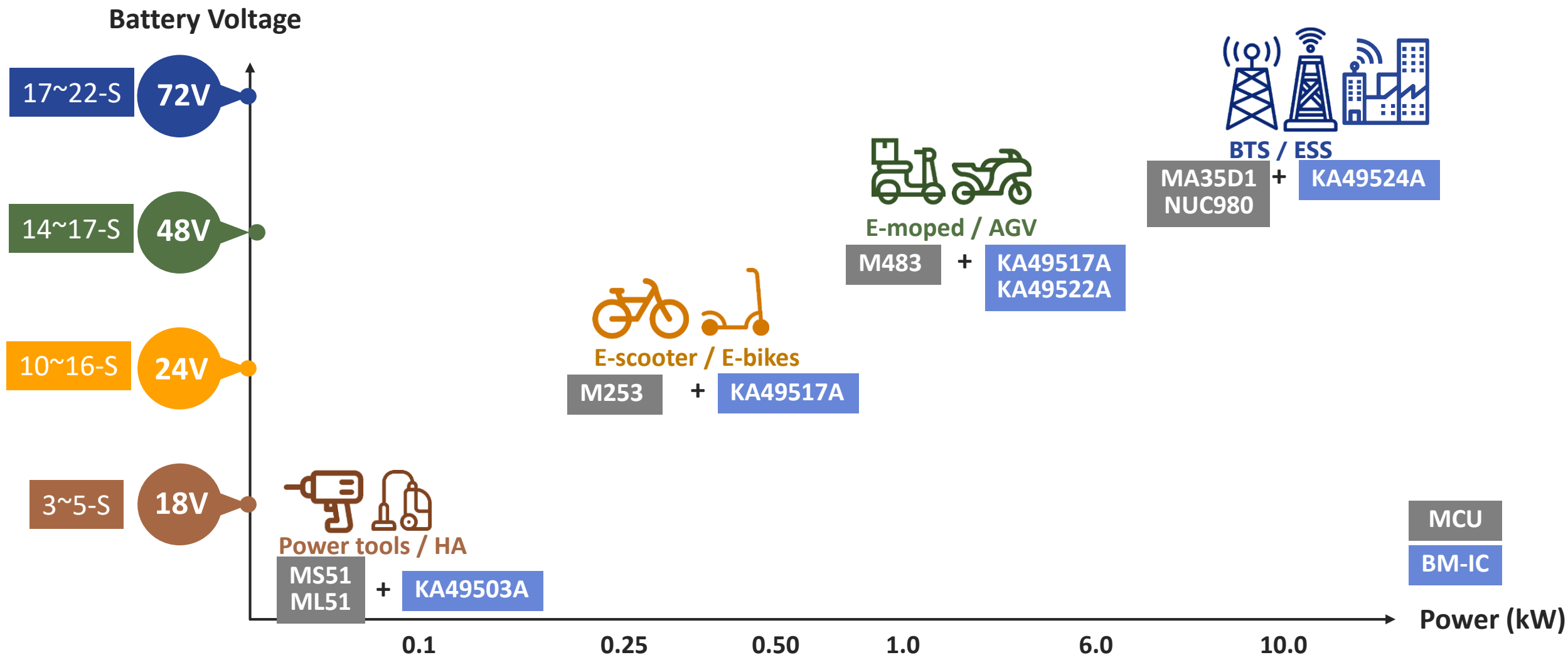
Save 25% BOM cost



Scalability

Form 36V to 72V Portfolio
17 and 22 channel cell voltage
measurement
Match all Li-ion Cell type

Battery Management System Product Matrix



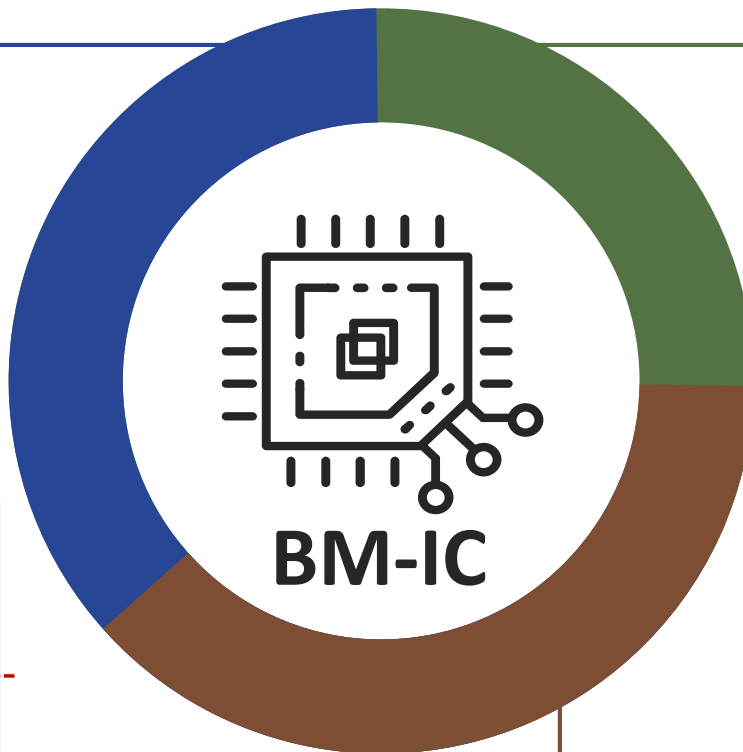
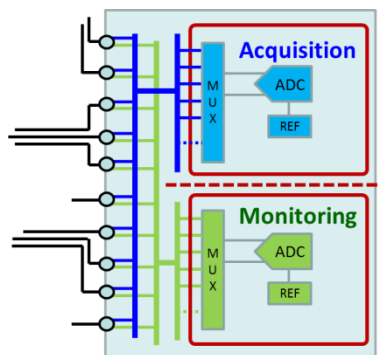
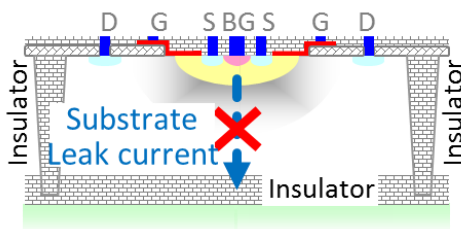
| What BMIC Provides

The unique technology brings safe, accurate and scalable solution

Safety

Intrinsic Safety / Functional Safety

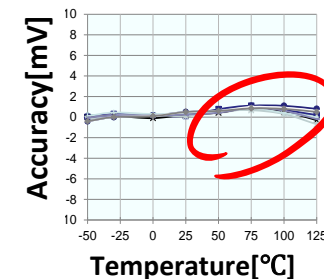
- ✓ Isolation for High voltage / Redundancy
 - SOI : Silicon On Insulator
 - SOC : State of Charge



Cruising Distance

Expansion of available SOC

- ✓ High accuracy



Scalability

Developing cost reduction for ECU

- ✓ Line up (14ch / 20ch / 25ch)

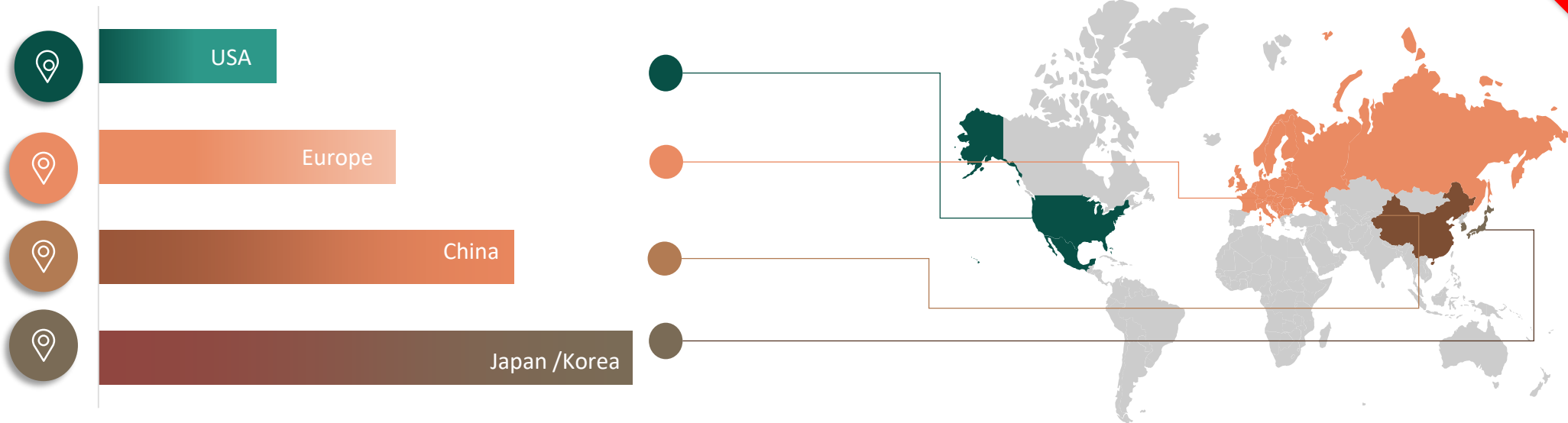
| Automotive BM-IC Market Experience

ASIL-C
ASIL-D

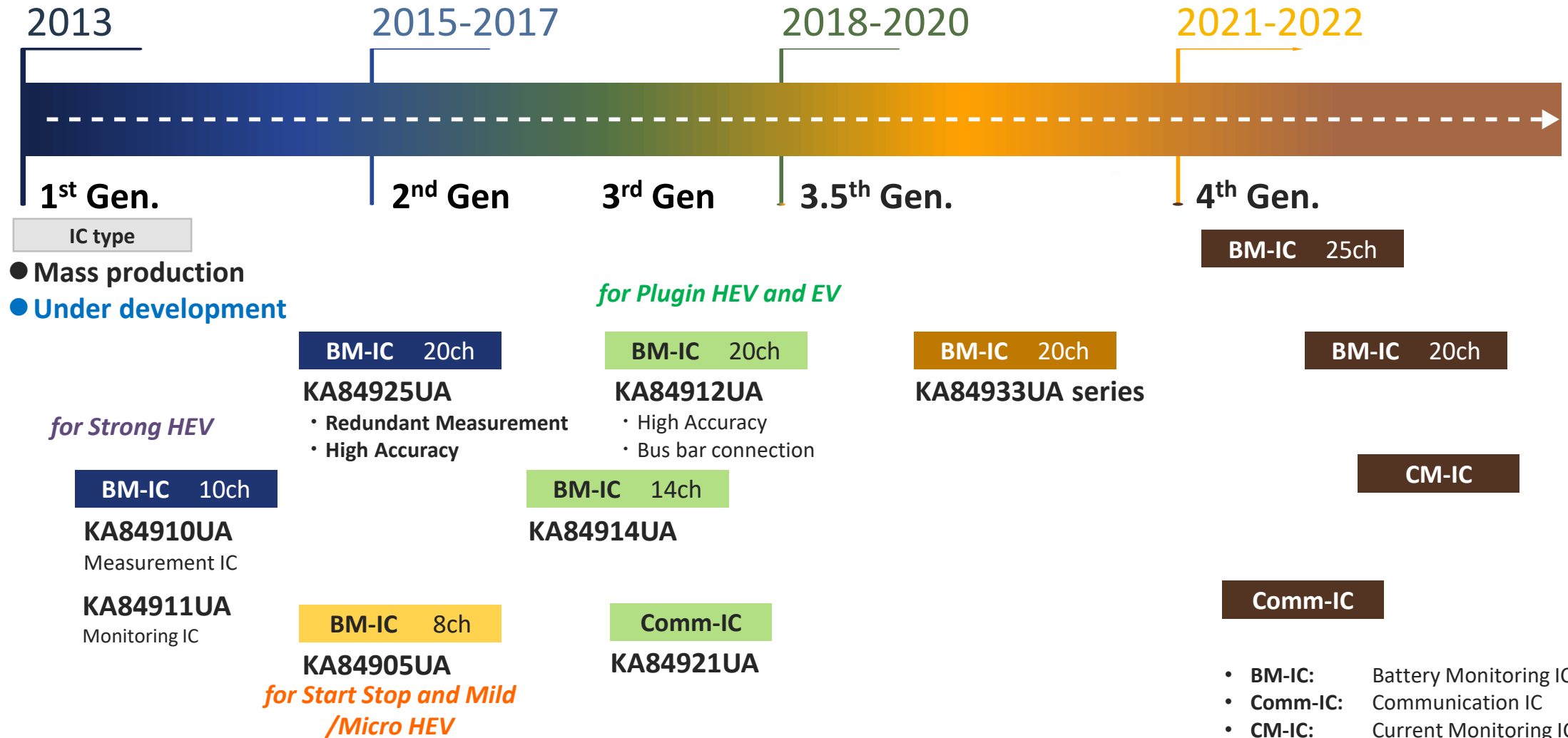


12 years market experience

Around 15 million pcs of IC delivered to 11 automakers in CY2021



BMIC Roadmap



Joy of innovation
nuvoTon

谢谢

謝謝

Děkuji

Bedankt

Thank you

Kiitos

Merci

Danke

Grazie

ありがとう

감사합니다

Dziękujemy

Obrigado

Спасибо

Gracias

Teşekkür ederim

Cảm ơn

Battery Management System

- Digital Power Control MCU
- CSP-MOSFET for Fast Battery Charger

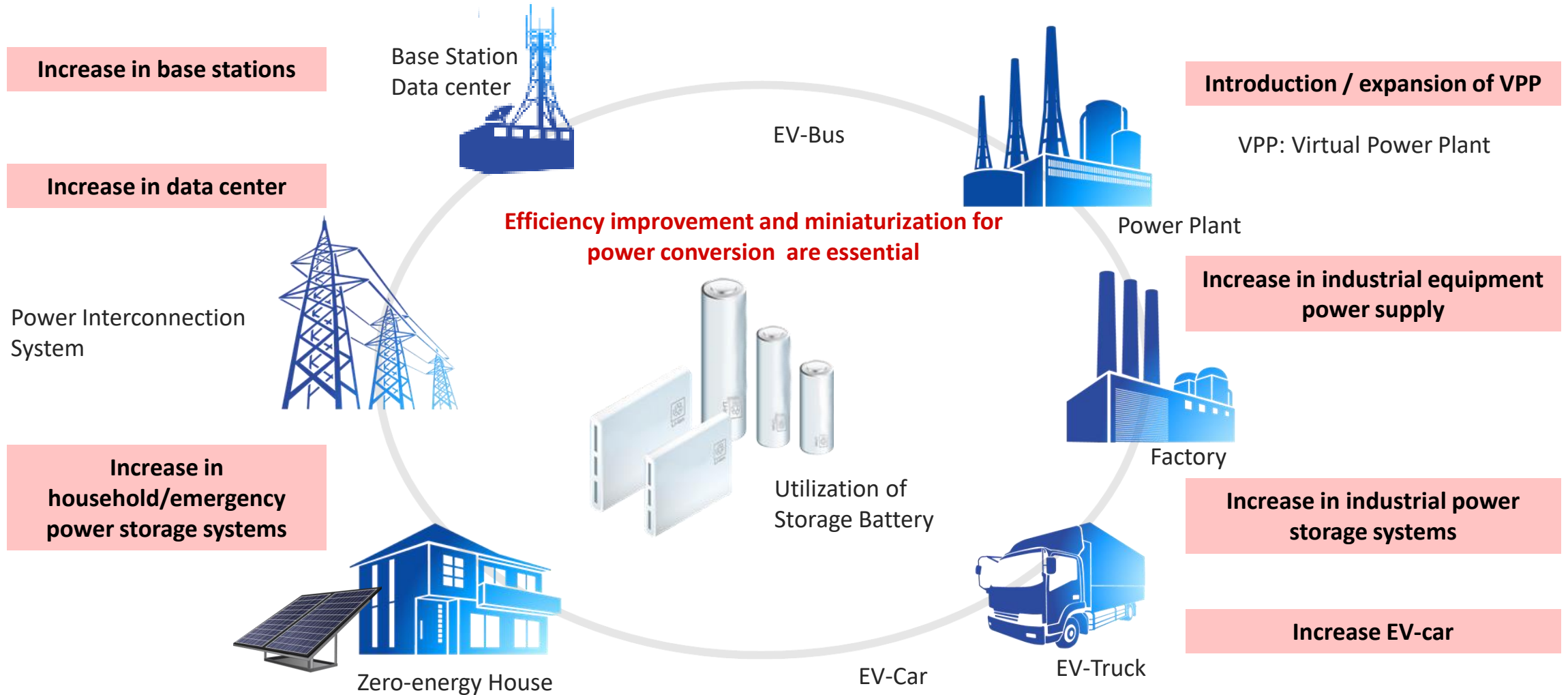
楊博承 Matt Yang

Marketing and Application Division

Technology Manager

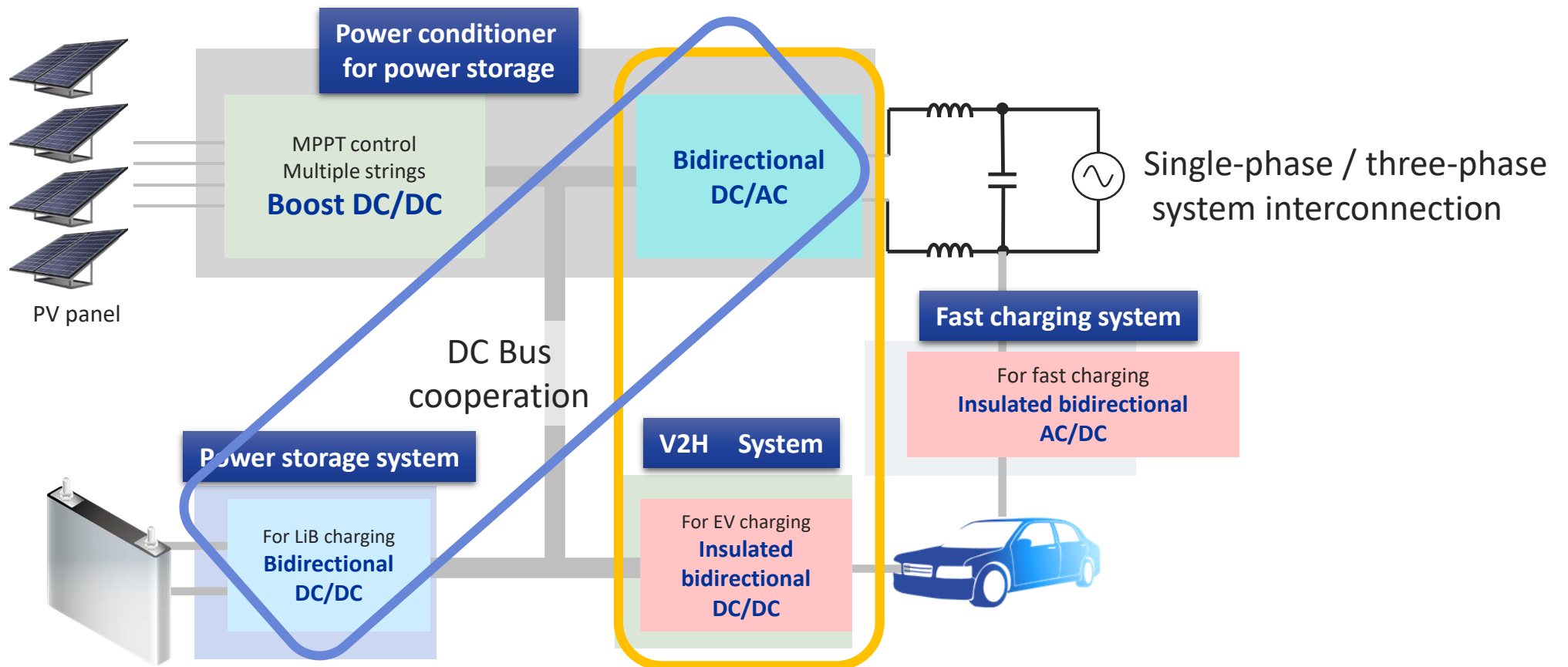


| Surrounding Power System



| Power Conversion Technology

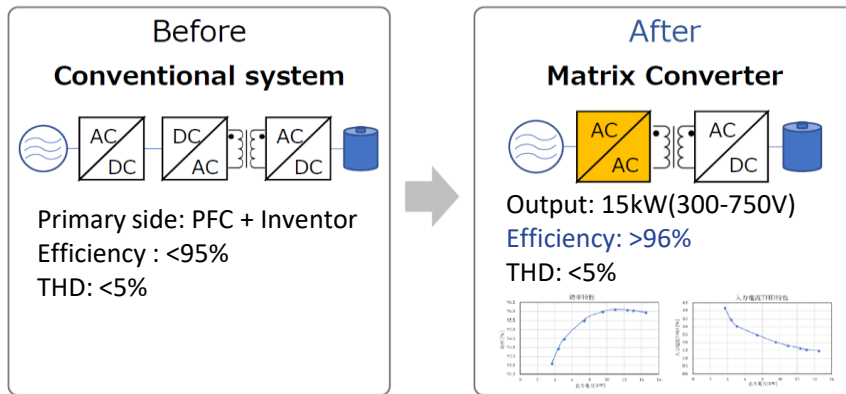
- Accelerate “digitalization” in power conditioner/ power supply/ battery makers
- Utilize next-generation power device to increase the constructor’s benefits by reducing size and weight



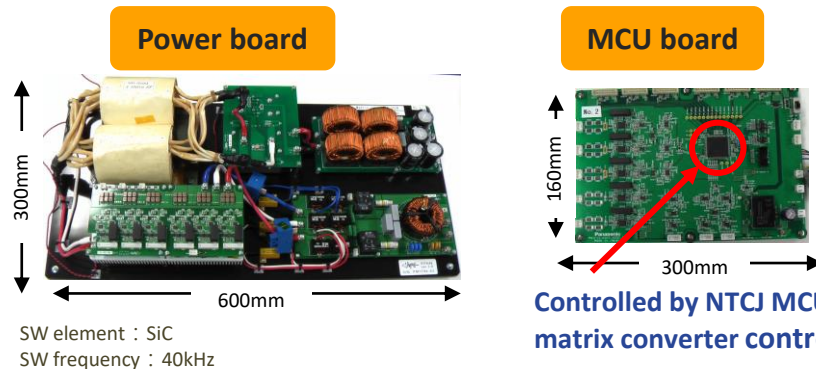
Matrix Converter Control Power Reference

Function

- Higher efficiency, longer life of EV quick charger
- Miniaturization, reduction of the number of parts (electrolytic capacitors, etc.)



15kW Matrix converter reference board



Cooperated by Nagaoka Power Electronics Co., Ltd.

Feature

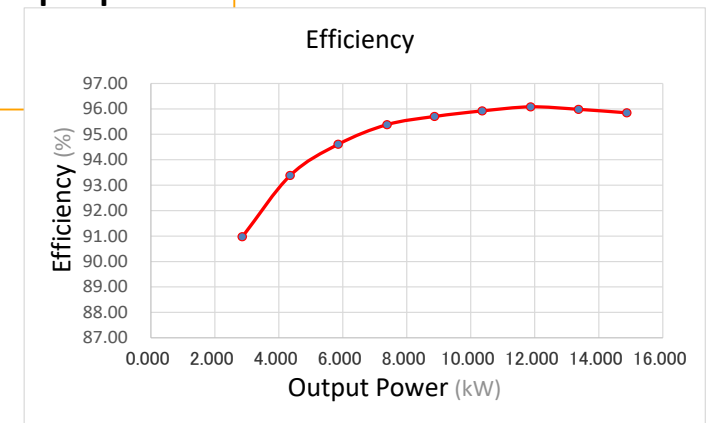
- **Built-in control circuit:**
Built-in functions required by matrix converter control
- **Optimal control:**
Achieves high-speed feedback control with a high-performance NTCJ MCU

Spec

- Input: 3-phase 380V
- Output: 15kW (300V-750V)
- Efficiency: > 96 %

Test result

- Evaluate the efficiency of output power 3kW to 15kW
- Max efficiency : 96.1%



Matrix Converter Features – Offers – Principles

Features / Strengths

Industry-first

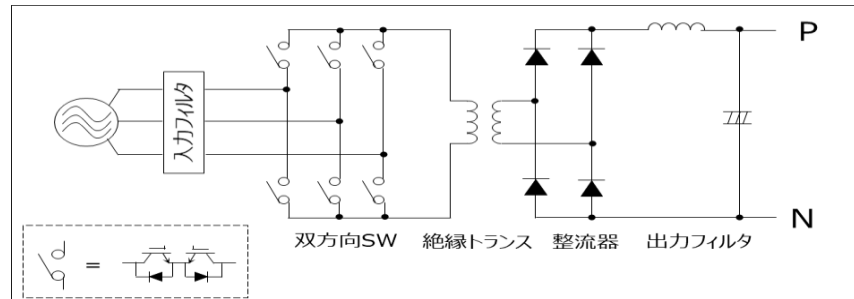
◆ Matrix converter control is possible with a single MCU

- FPGA isn't needed
- Shorten the development period with reference boards and software
- Simplification of complex matrix converter control

Offers

- ◆ Control reference software
- ◆ Document
- ◆ Reference board
 - ⊖ 15kW matrix converter board
 - (2) Control board with MCU
 - (* ⊖ Board rental is available)

Principle / Configuration

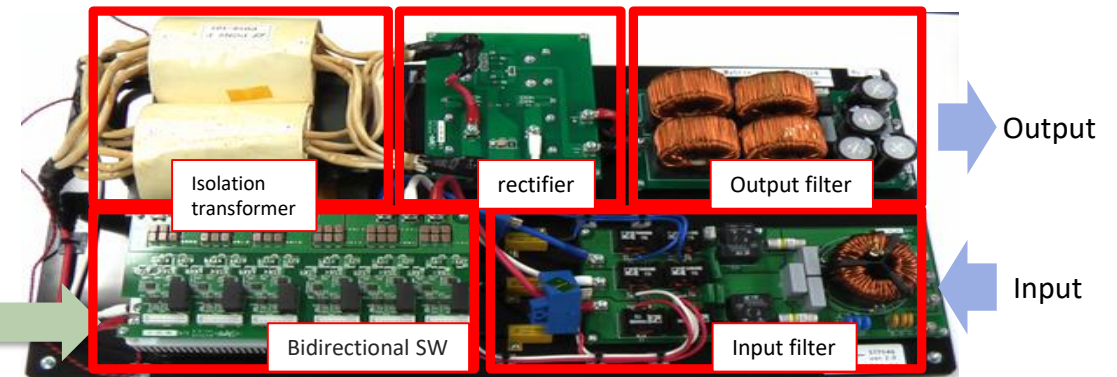


Power supply circuit configuration
using matrix converter
(Adopt virtual AC/DC/AC method)

15kW
Matrix converter



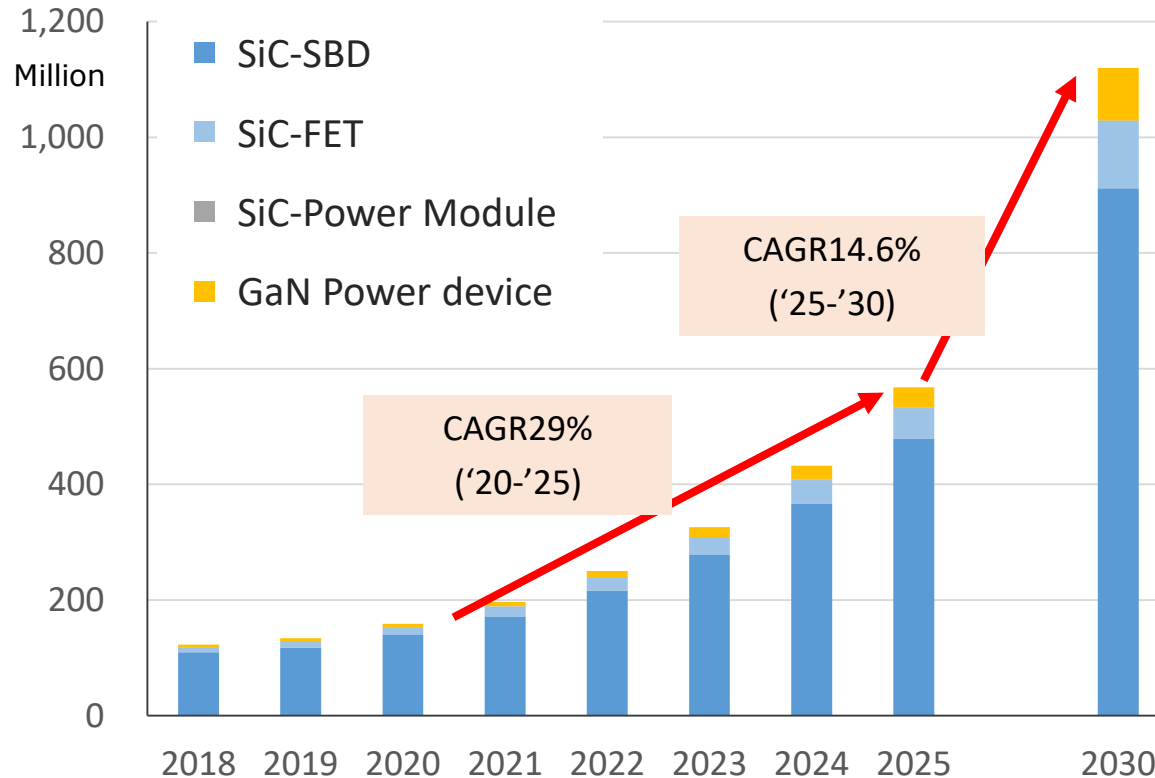
MCU for Power Solution **KM1M7AF Series**
CPU: 160MHz Arm® Cortex®-M7
ADC: 12bit x 3units, Conv. time 0.5us
PWM: 208ps



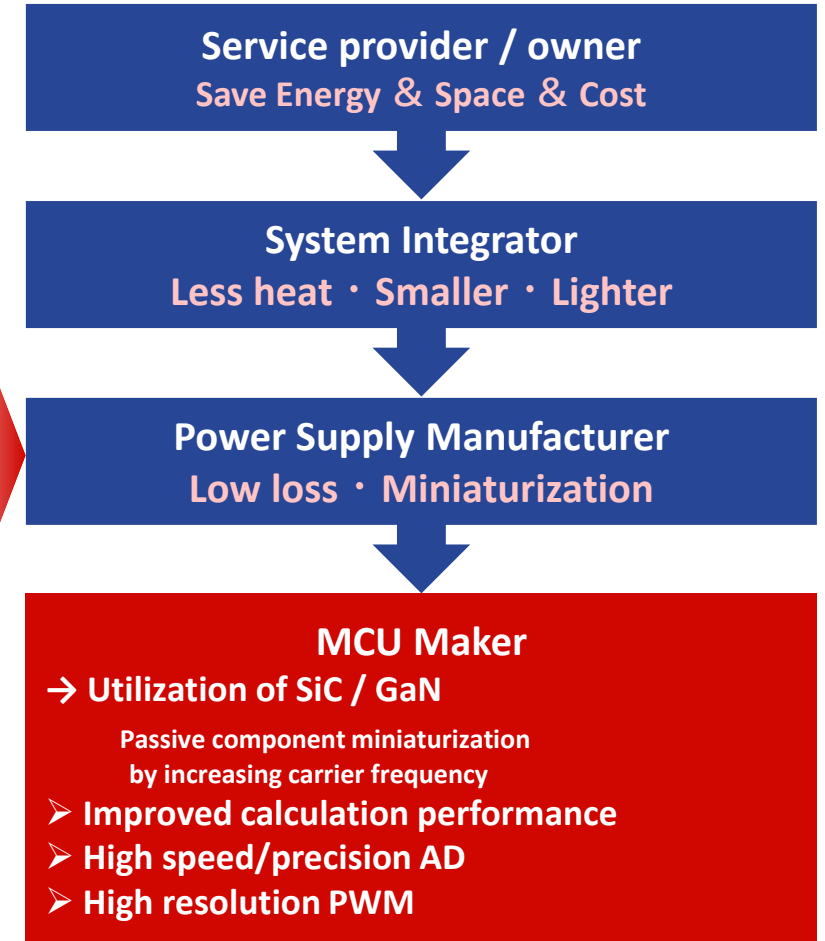
SW element : SiC
SW frequency : 40kHz
Input : 3-phase 380V
Output : 15kW(300-750V)

SiC / GaN Market Size and Requirements for MCU

SiC / GaN Market Size

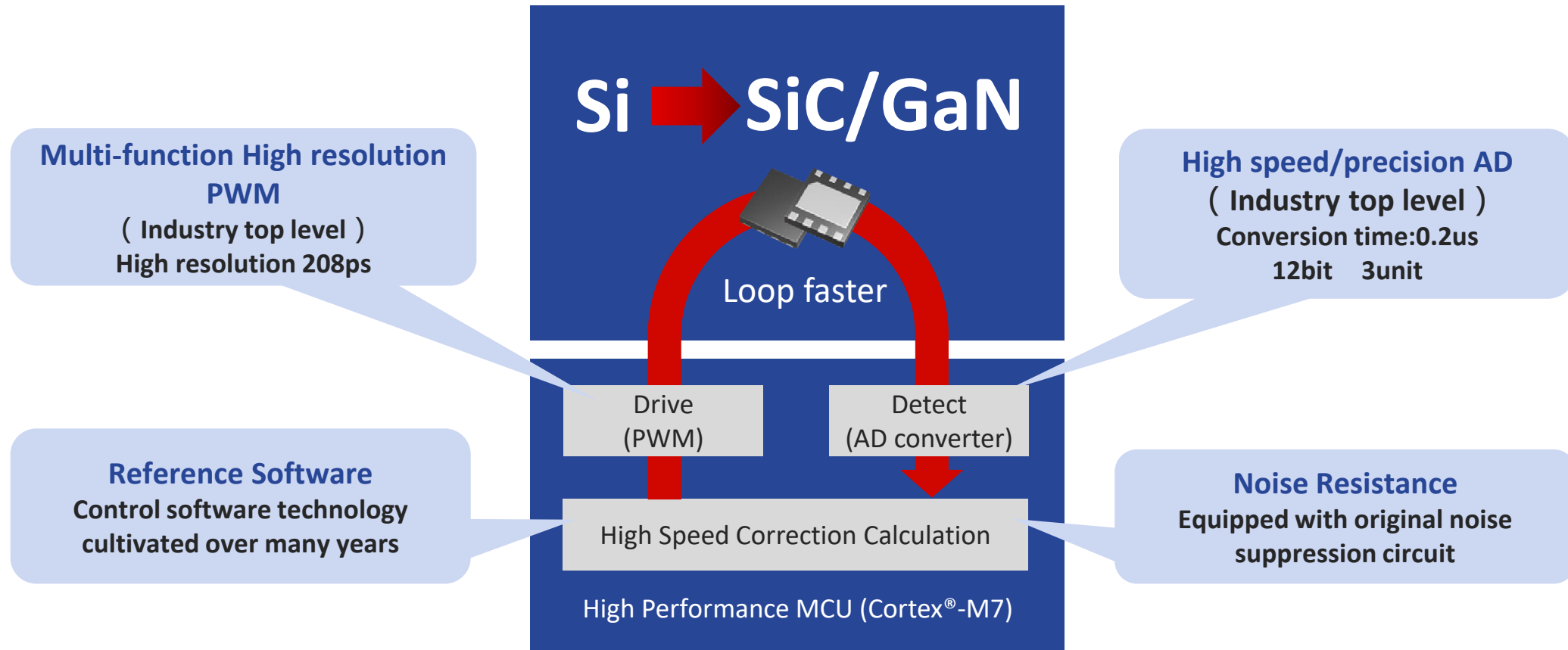


Source: Fuji Keizai Co., Ltd. "2020 version of next-generation power device & power electronics related equipment market status and future prospects"

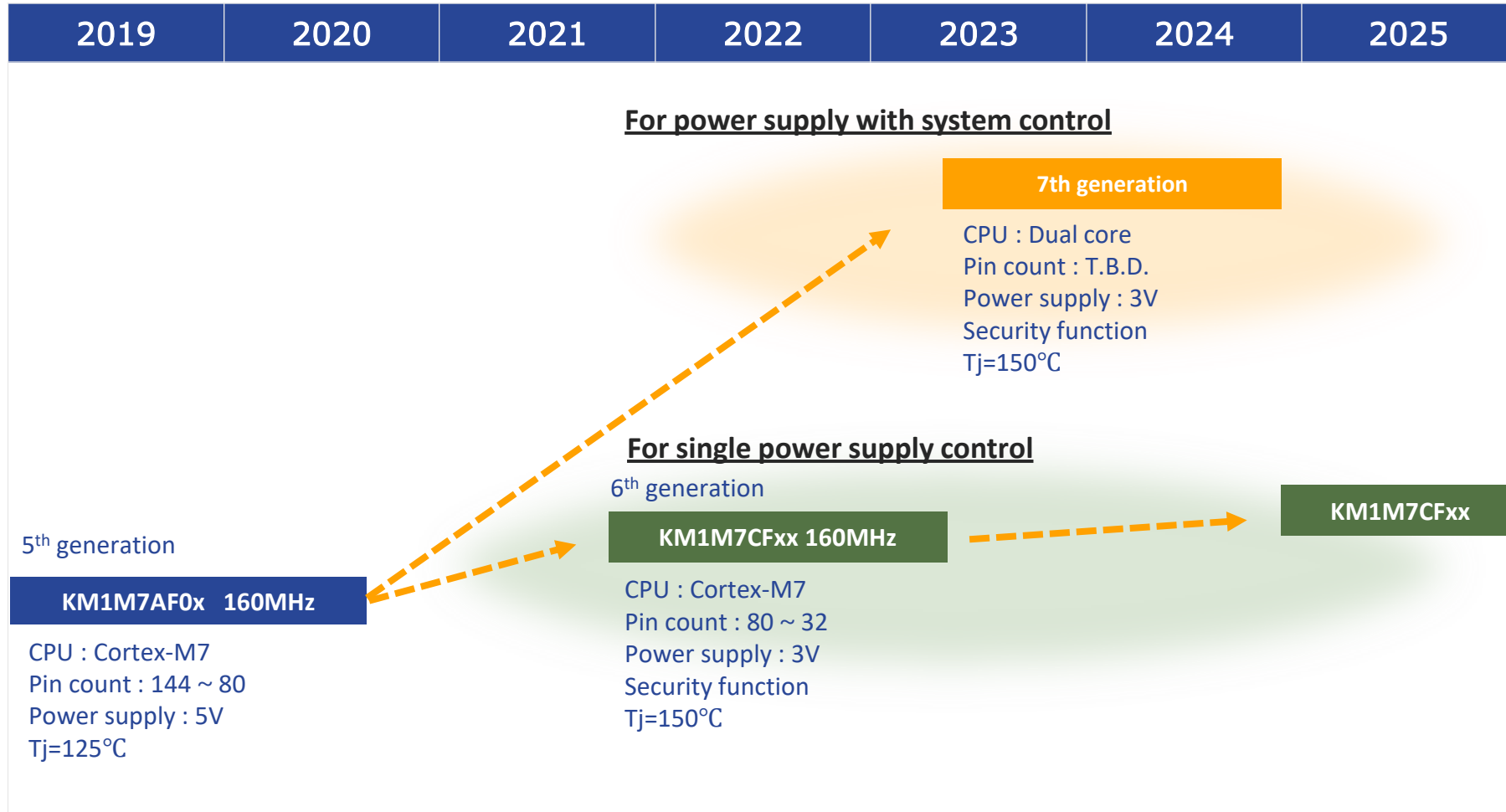


| Features of our MCU

Digital Power Control System

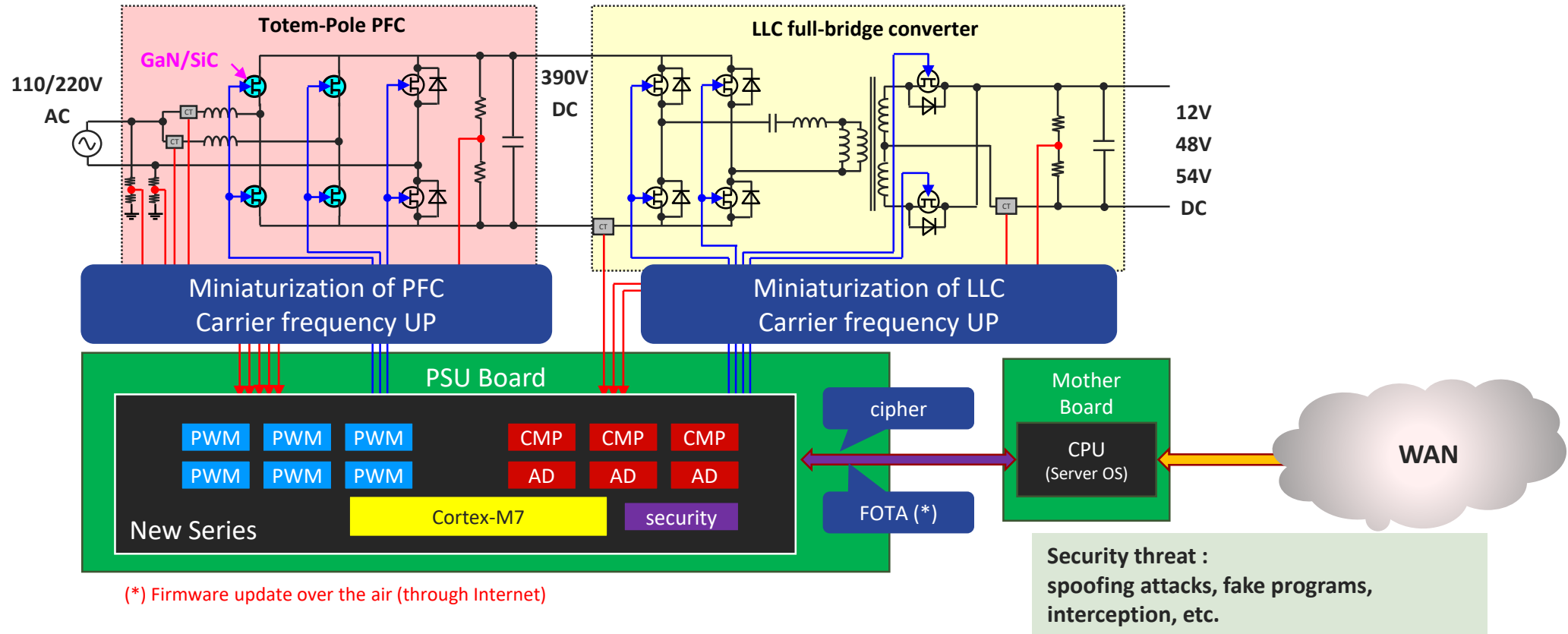


| Digital Power Control MCU Roadmap



Next Generation Digital Power Control MCU Concept

- Equipped with security function
 - Achieve both miniaturization of the product board and security measures



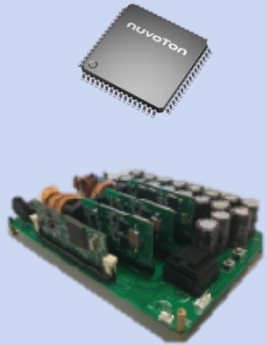
| Support Menu

Reduce
development TAT

Improve soft quality

Minimize rework

Quick support



- MCU
- Evaluation board
- MCU evaluation board

- Power control application note
- Reference control software
- Driver sample
- IEC60730, etc



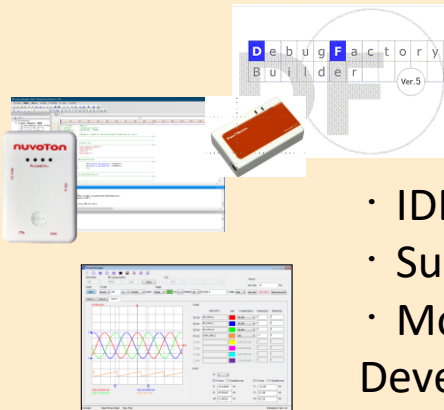
Hardware

Software

Digital power control solution

Tools

Support



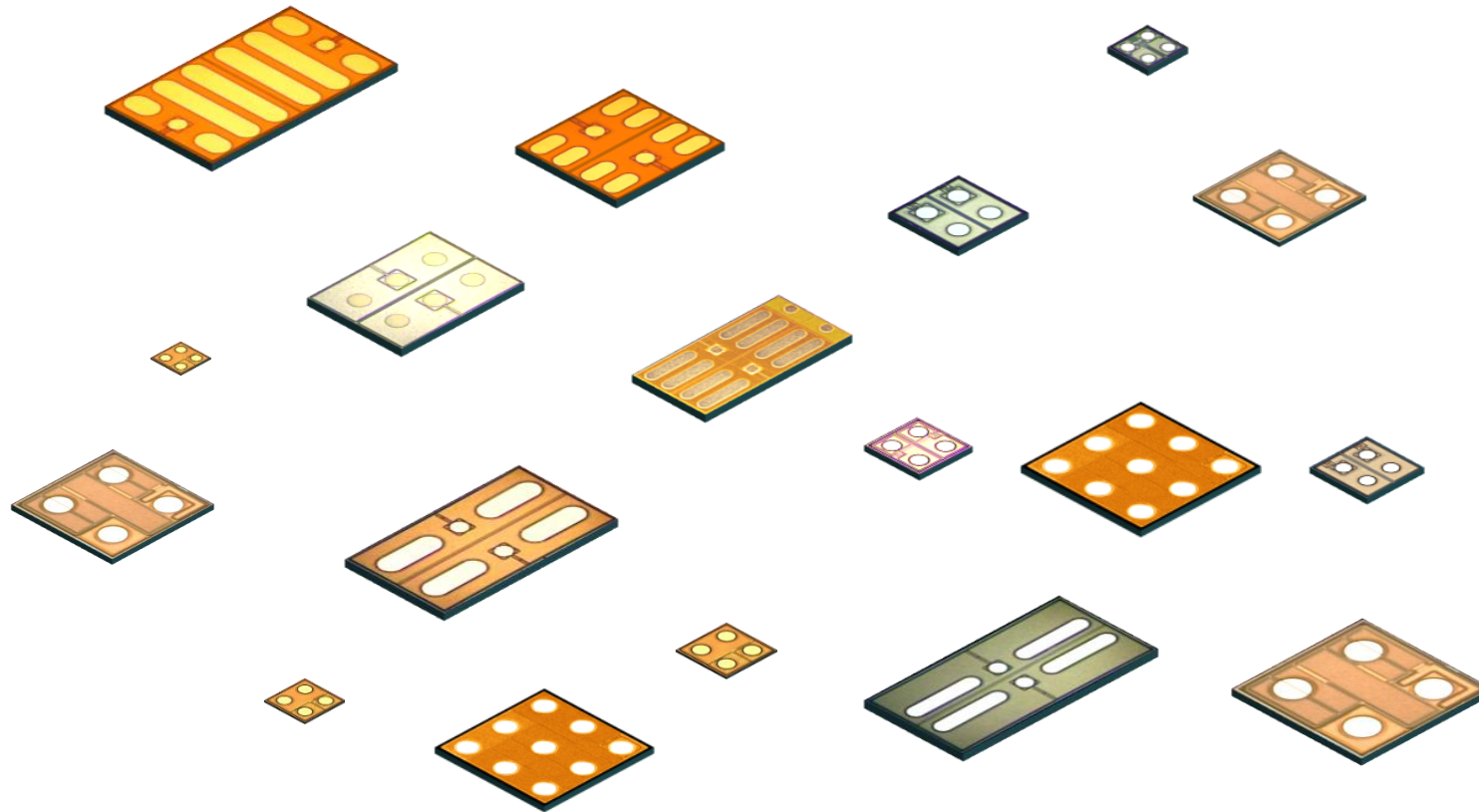
- IDE
- Support tool for development
- Model Based Development tool

- Software development contract (Including software porting)
- Technical support (Onsite, QA, seminar)



| CSP-MOSFET

Chip Scale Package



CSP-MOSFET Applications

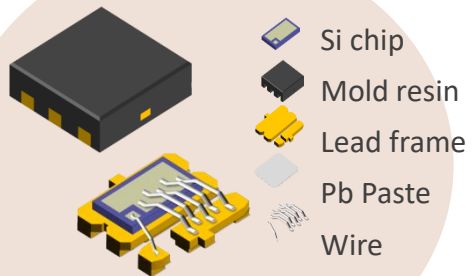
No.1 market share for small devices with built-in Lithium battery.

Bring small automotive applications a miniaturized solution.



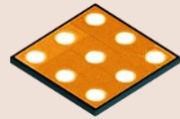
CSP-MOSFET Value Proposition

Mold Package



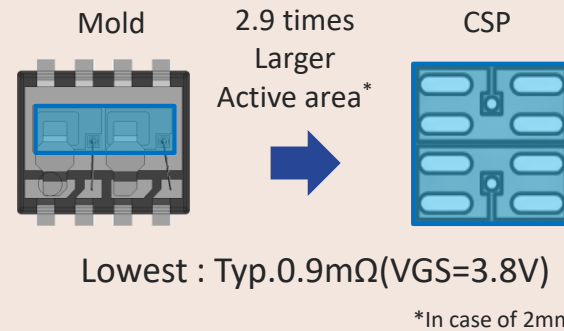
More materials

CSP

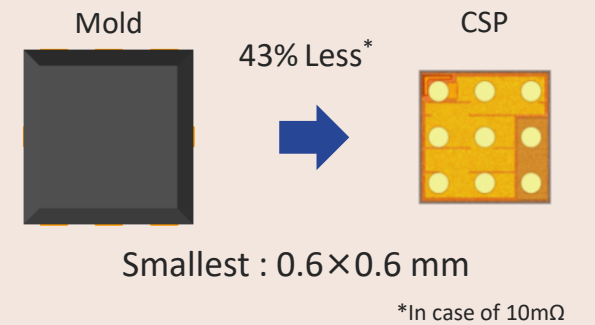


1 material only

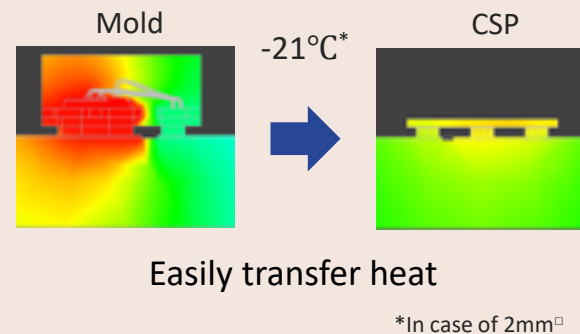
Low On Resistance



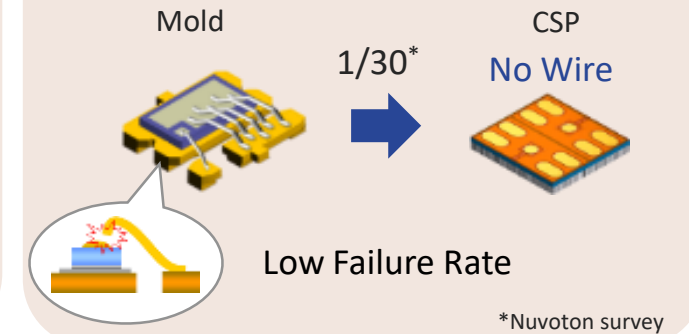
Smaller Size



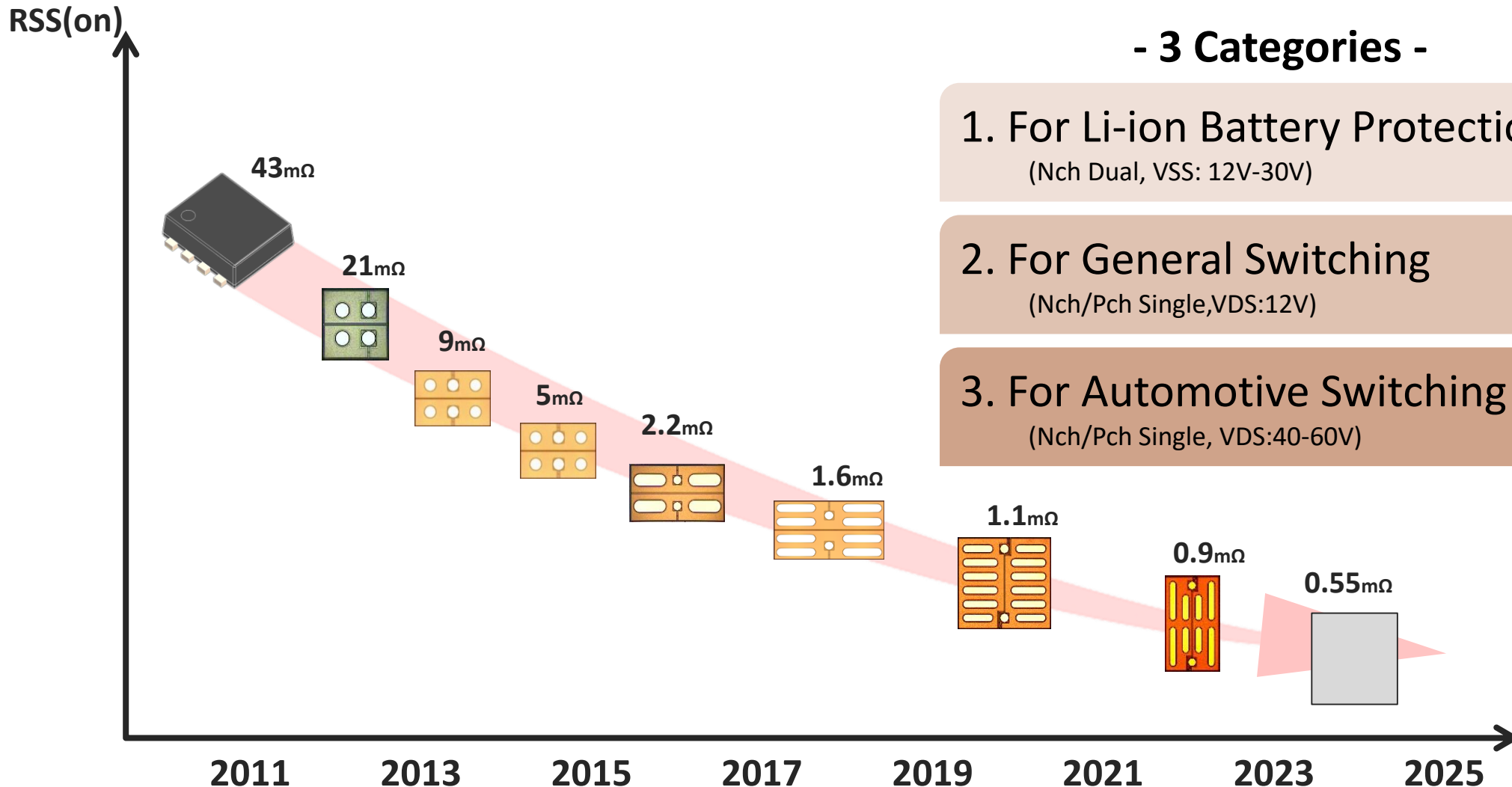
High thermal performance



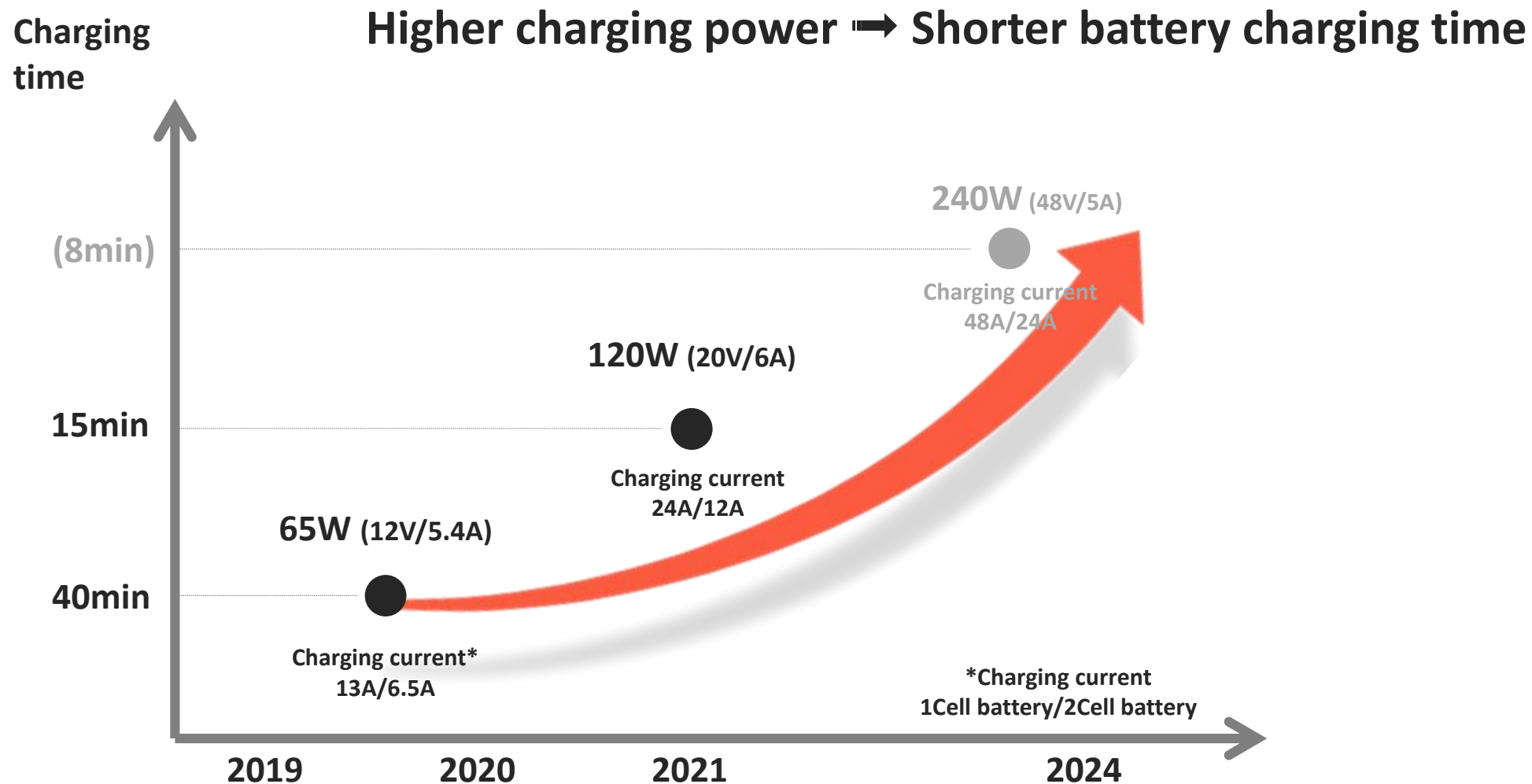
High Quality



CSP-MOSFET Market Roadmap



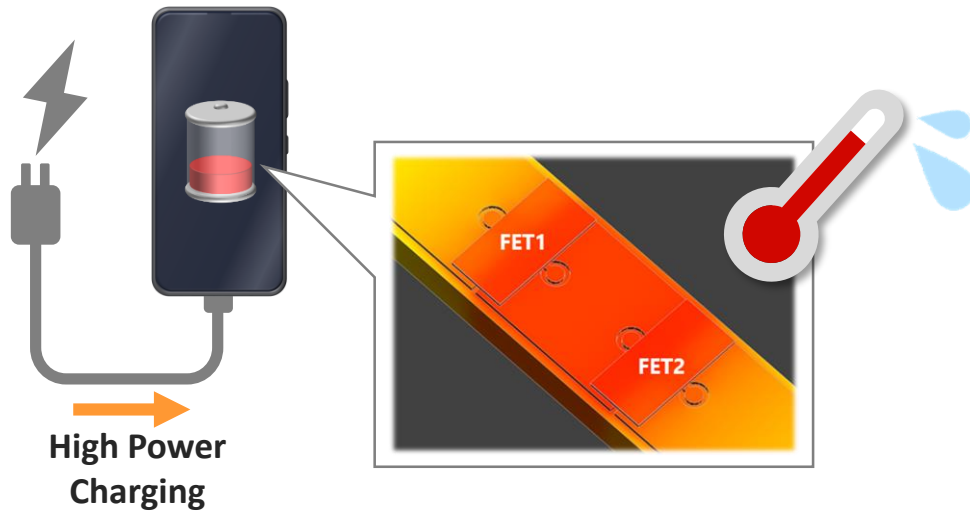
| Battery Charging Trend



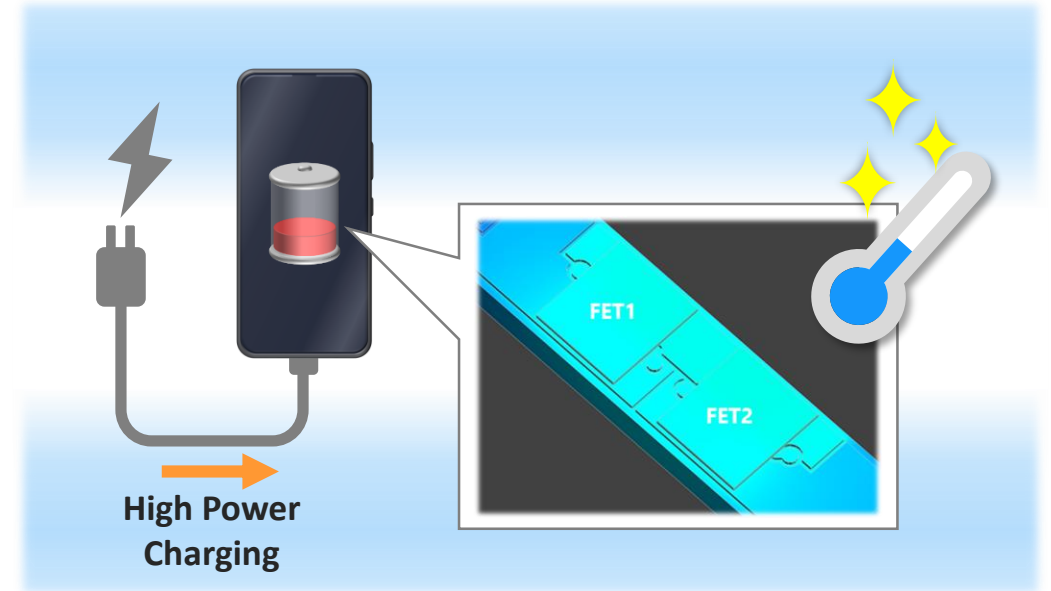
| Customer Value Proposition

$$\text{Charging current}^2 \times R_{\text{DS(on)}} \propto \text{FET Temperature}$$

Recommend **Ultra Low Ron** MOSFET



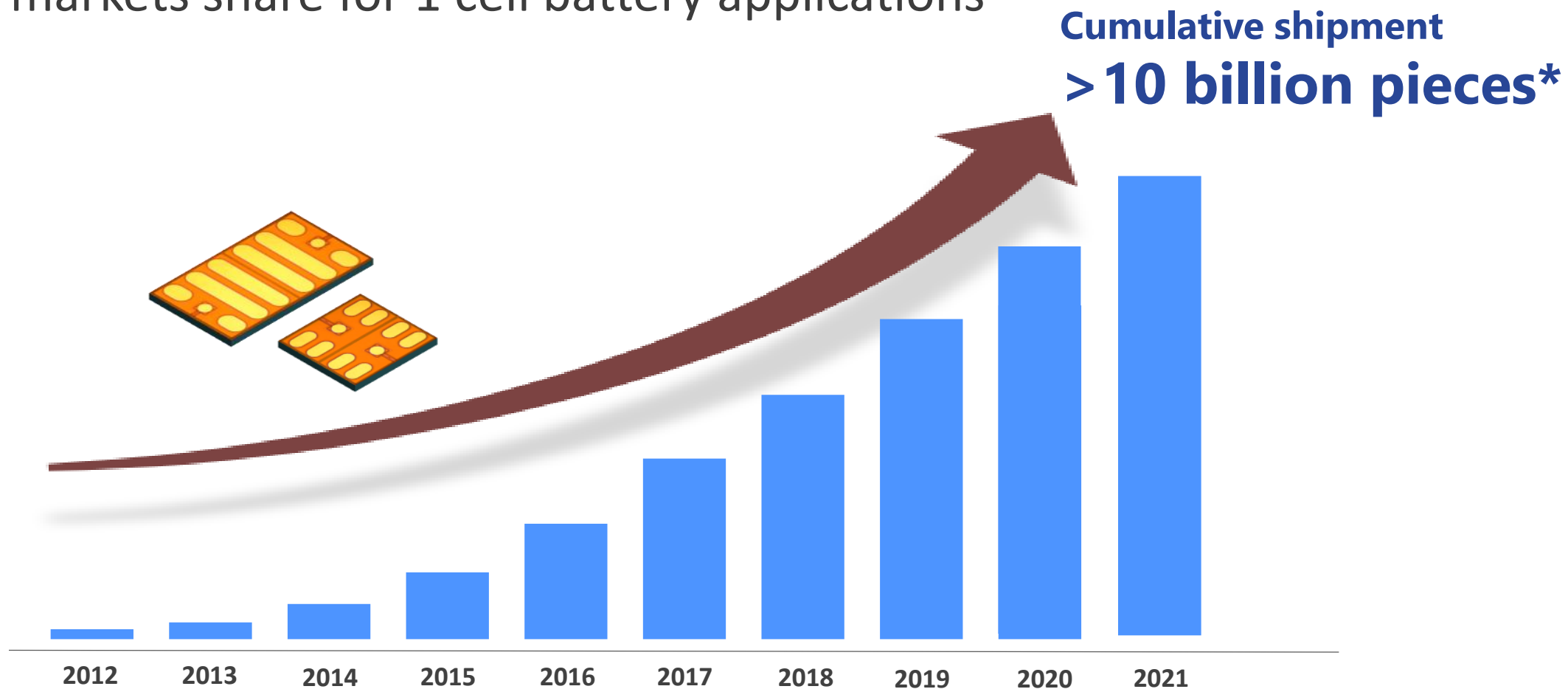
Higher Ron , More Heat



Lower Ron , Less heat

| CSP-MOSFET Outstanding Position

- Top markets share for 1 cell battery applications



| Support Menu

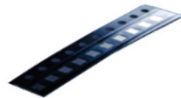
1 MOSFET Selection

2 Sample

Evaluation Board



Cut tape



Reel



3 CSP Mount support

4 Technical support

5 Document

- Data sheet
- Spice
- RoHS/REACH
- Mount application note
- CSP Advantages
- CSP FAQ etc

Joy of innovation
nuvoTon

谢谢

謝謝

Děkuji

Bedankt

Thank you

Kiitos

Merci

Danke

Grazie

ありがとう

감사합니다

Dziękujemy

Obrigado

Спасибо

Gracias

Teşekkür ederim

Cảm ơn