

新唐科技 2022 智慧工業物聯網與新能源方案研討會

Time	Duration (Minutes)	Topic		Speaker
13:30 – 13:40	10	Nuvoton Technology Corporation Introduction		Robert Ling Senior Technology Manager
13:40 – 13:45	5	Nuvoton Technology Corporation Japan Introduction		Koyama Kazuhiro President
13:45 – 13:50	5	Smart IIoT Solution	Smart IIoT Trend	Chris Hsieh Technology Manager
13:50 – 14:20	30		Smart Industrial Control Solution	
14:20 – 15:00	40		Automotive Solution	Jim Wang Senior Technology Manager
15:00 – 15:10	10		IoT Security Solution	Benson Yu Senior Engineer
15:10 – 15:50	40	Demo Time / Tea Break		
15:50 – 16:30	40	New Energy Solution	Battery Management System Solution	Robert Ling Senior Technology Manager
16:30 – 17:00	30		High Performance Motor Control	Jenny Wang Technology Manager
17:00 – 17:15	15	NuDeveloper Ecosystem – Make the engineers' job easier.		Matt Yang Technology Manager
17:15 – 17:30	15	Lottery		



Joy of innovation
nuvoTon

Nuvoton Technology Company Introduction

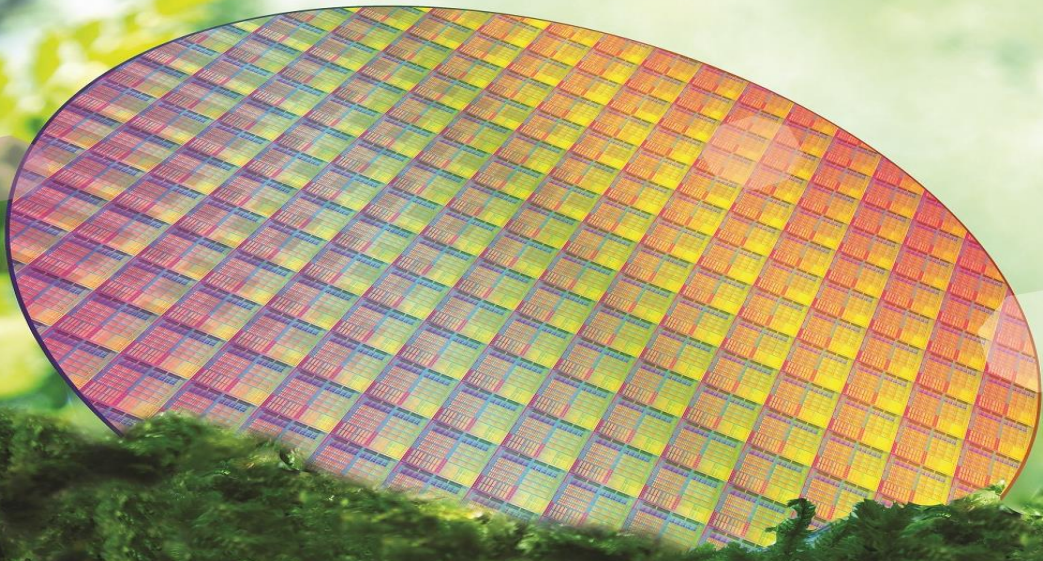
Hsin-Lung Yang

President

Vision Statement

以綠色半導體技術豐富人類生活的隱形冠軍

Be a hidden champion in providing sustainable semiconductors to enrich human life.



| Company Overview

Nuvoton Technology Corporation

Number of employees	Over 4,200 worldwide
Capital	NT\$4,198 million
Date of Establishment	2008/7/1
Date of IPO	2010/9/27 (TSE:4919)
Chairman	Yuan-Mou Su
President	Hsin-Lung Yang
Headquarters	Hsinchu Science Park, Taiwan
Main Shareholder	Winbond holds 51.2% share

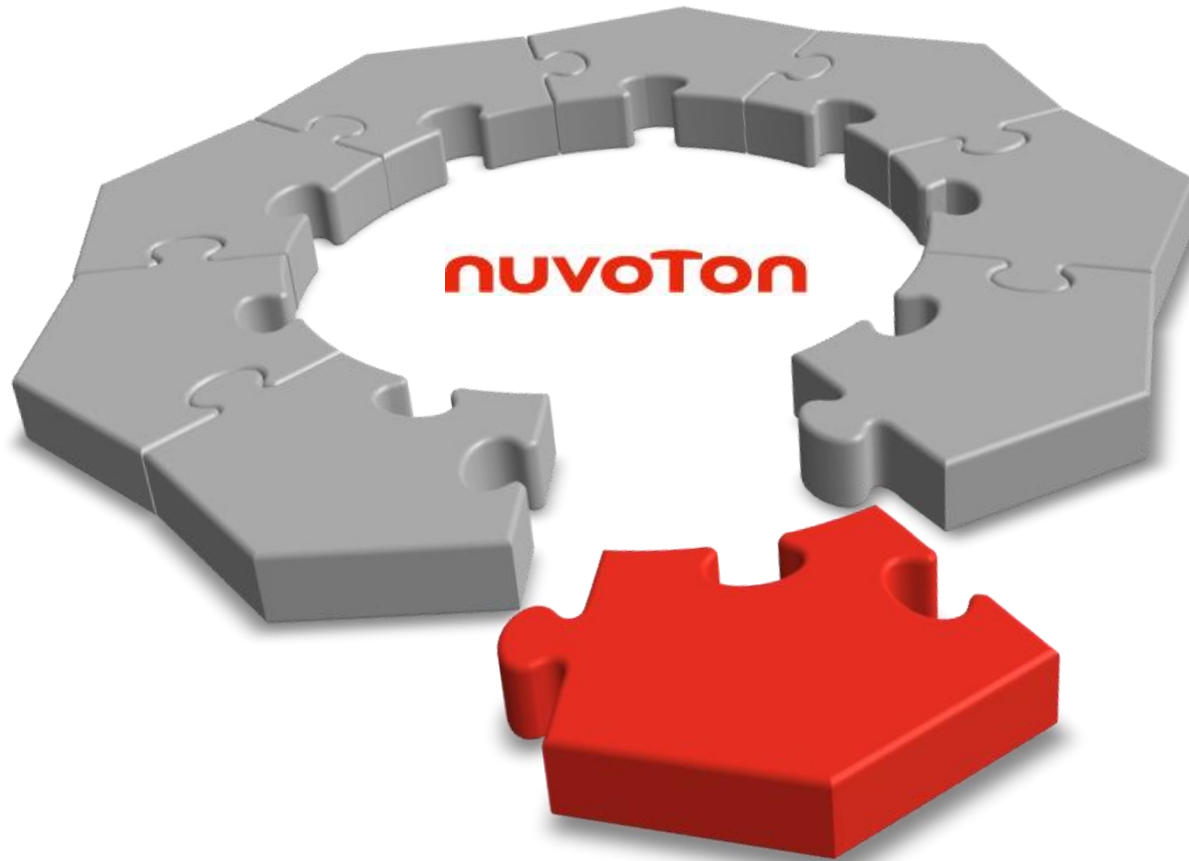


Zhubei Building
Photo By Jeffrey Cheng



Headquarters

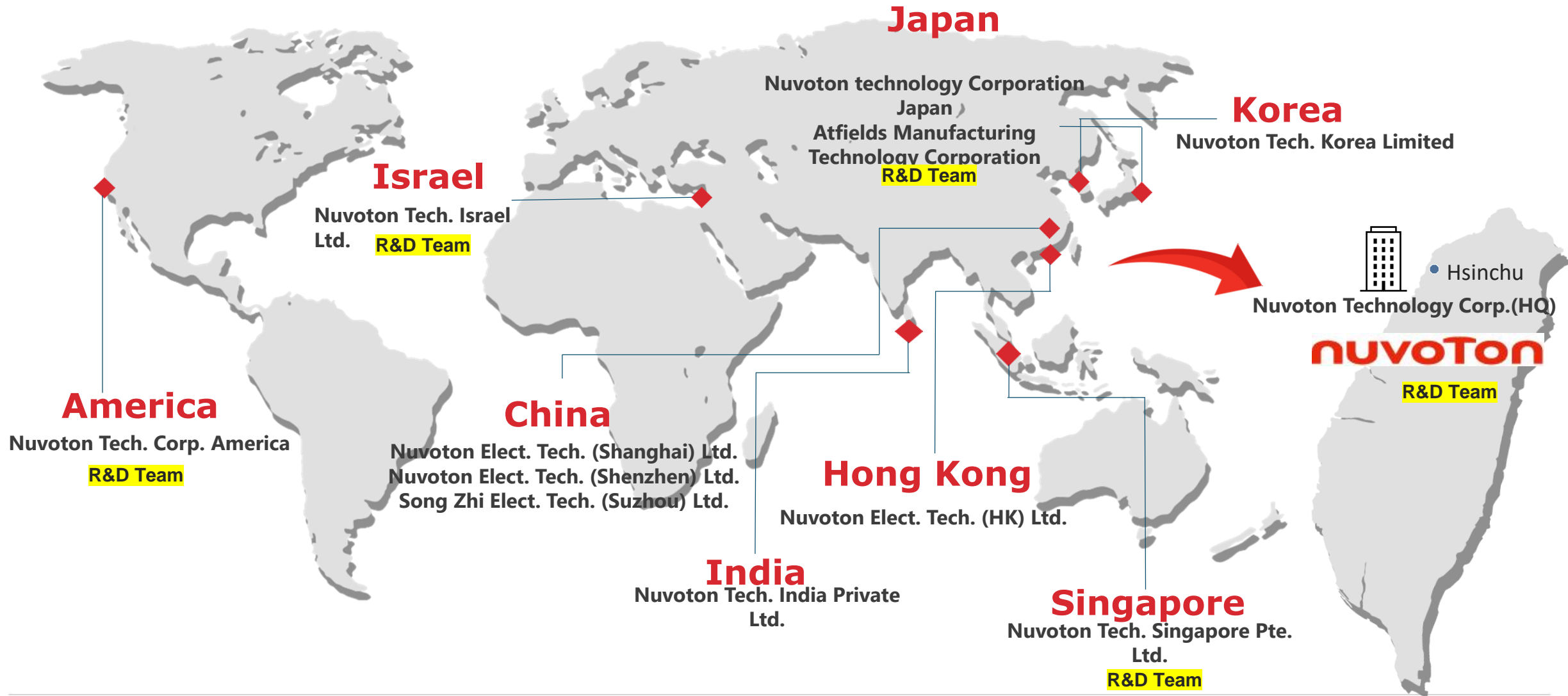
| Company Performance



Worldwide **Top 10**
Supplier of General purpose MCU

Worldwide **Top 1** Supplier of
MOSFET for smartphone

| Worldwide Location



| Business Groups



Microcontroller

MCU and MPU Platform

- NuMicro® MCU
- NuMicro® MPU
- NuMicro® IoT Platform

Core Technology

- Low Power with Analog Integration
- IoT Security
- Eco-system Platform



Smart Home Audio

Audio MCU and Component

- Audio MCU / DSP with Audio Enhancement
- Audio Component (Smart AMP, CODEC)
- NuSpeech / NuVoice / ChipCorder

Core Technology

- Low-power Mixed Mode Design
- Smart Home / AIoT



Cloud Security

Computing Security

- Secure Embedded Controller and Super I/O
- Trust Platform Module (TPM)
- Server Baseboard Management Controller (BMC)

Core Technology

- Security
- System Integration / Protection
- Mixed Mode ASIC



Foundry

Foundry Service

- 30 years of operations
- Highly efficient fab focused on high voltage and customized power process

Core Technology

- BCD Process
- UHV Process
- HVIC Process



Component

Power Component

- CSP MOSFET
- RF-GaN

Core Technology

- Ultra Low Impedance
- Small Size
- High Efficiency



Visual Sensing

Spatial Sensing Solution

- Image Sensor (3D TOF)
- DSP (HMI Display, Audio)

Core Technology

- High Quality Image, Depth and Sound
- Enhanced Graphic Processing
- Software Platform



Battery and Analog Solutions

Analog IC's for Battery / Power Application

- Battery Monitoring IC
- Motor Driver IC

Core Technology

- Analog Design
- SOI (Silicon on Insulator) Process



IoT with Security

MCU and Communication / Interface IC's

- Motor & Power Control MCU
- High Speed IF
- NFC Tag IC

Core Technology

- Low Power, Security
- High Speed Analog
- System Knowledge



Laser & GaN Technology

Laser & GaN Component

- High Power Laser Diode
- GaN Foundry

Core Technology

- High Power and High Reliability Laser Diode
- Epitaxial and full process service for GaN Power device

| Part of Our Valued Customers



Smart IIoT Solutions

Market Trend

謝欣志 Chris Hsieh

Microcontroller Marketing and Application Division

Technology Manager



| Smart IIoT Market Trend

IIoT

(Industrial Internet of Things)

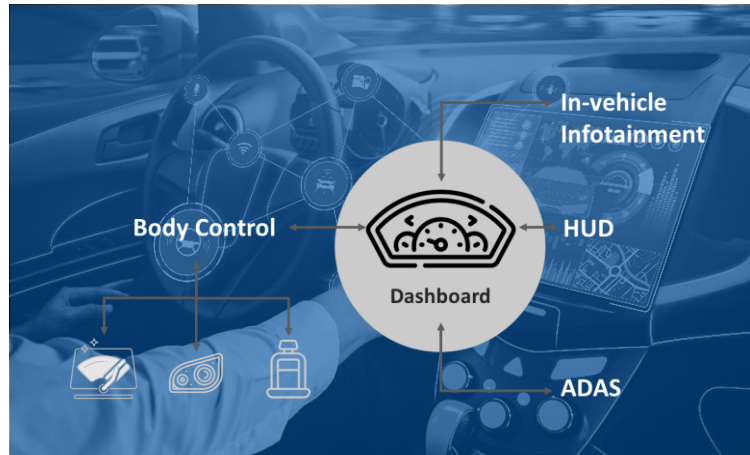
V2X

(Vehicle-to-everything)

Infrastructure

Industrial Internet of Things (IIoT), Vehicle-to-everything (V2X), Infrastructure and other industrial applications provide new opportunities for semiconductor developments and drive the growth of the semiconductor market.

These industries not only yearn for the ability to process large amounts of data in less time, there is a growing demand for faster, more advanced chips in industrial applications, and higher safety function is needed in the automotive market.



| Key Feature Insights

- High-computing Power



- Advanced Safety Level
- Diverse Product Models



- Higher Performance
- High Immunity



- Security Mechanisms
- Small Package



- Precise Analog Peripheral
- High-speed Connectivity



Smart Industrial Control

- **HMI Solution**
- **Gateway Solution**
- **5G Data Center**

謝欣志 Chris Hsieh

Microcontroller Marketing and Application Division
Technology Manager



| HMI Application Scenario

Smart Home

COM-SEG LCD with Touch Key



Smart Home Appliance

Small Size TFT-LCD with Capacitive Touch



Smart Factory / Industrial Control HMI

Large Size TFT-LCD with Resistive Touch



| The Graphics Acceleration for Advanced HMI

For better user experience in graphic HMI, Advanced HMI **integrates** high performance cores, display I/F, graphic engine, touch sensor I/F and communication I/F.



High Performance and Real-time Processing

- Dual 64-bit Arm Cortex-A35 up to 1 GHz
- Stacking a large DDR up to 512 MB
- Integrates the 2D graphics engine and Codec
- Operating system: RTOS, Linux



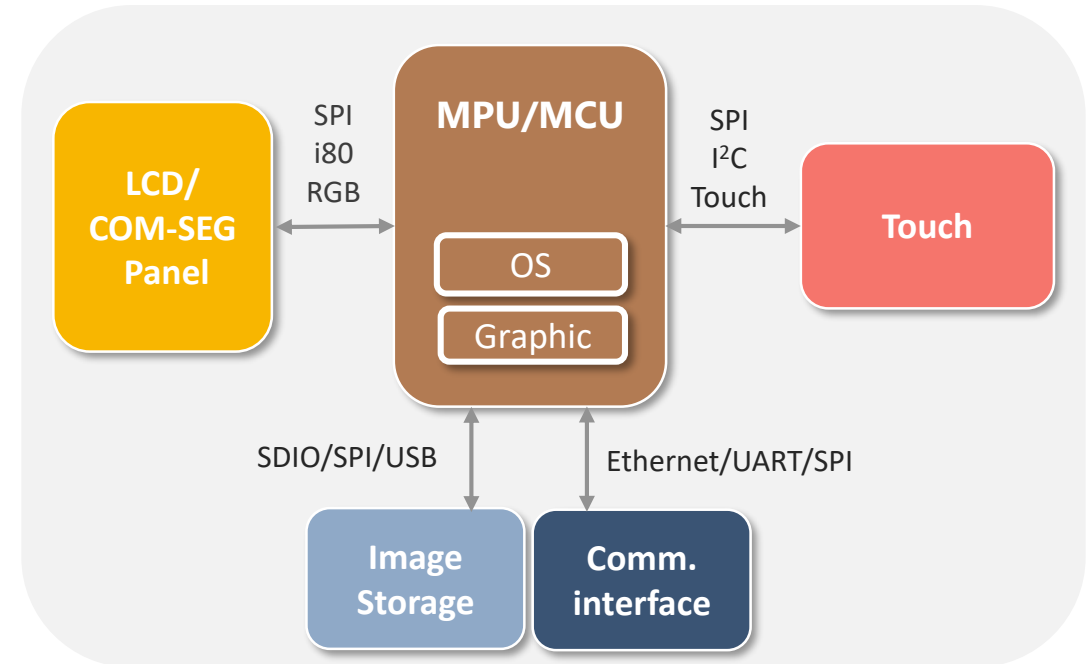
Display/ Touch interface

- RGB, SPI, i80 Display interface
- Capacitive and Resistive Touch interface



Connectivity & Storage

- Gigabit Ethernet, USB2.0 HS, SDIO, CAN FD, UART, SPI, I2C etc.



| NuMicro® M254/ M256/ M258 Series MCU

8x44 COM-SEG LCD, with 24 Touch Keys

Power Consumption

138 μ A/MHz (Normal-Run)
2.0 μ A (Power-down, RTC on)
1.6 μ A (Deep-power-down, RTC off, LVR on)



Segment LCD Driver

Drives up to 8 COM x 44 SEG
Charge pump for battery device



Capacitive Touch Sensing

Supports up to 24 channels
with water proof and noise resistance features
Only spend 10ms to complete 24 touch keys scanning



USB 2.0 FS with BC 1.2

USB 2.0 Full speed crystal-less function
Up to 12 endpoints equal to 3 VCOM ports
Supports 5V 1.5 Amp battery charging efficiency



3-in-1 Low-Power Microcontroller
(USB + LCD driver + Touch keys)

- Arm® Cortex®-M23 core
- Runs up to 48 MHz
- Operating voltage:
1.75V to 5.5V
(5V tolerance I/O)
- Operating temperature:
-40°C to +105°C
- High immunity:
EFT 4.4 kV, ESD HBM 7 kV

NuMicro® M460 Series MCU

For Small Size TFT-LCD, < 480 x 272

High Performance & Low Power



200 MHz Arm Cortex-M4 with DSP, FPU

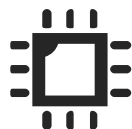
134 $\mu\text{A}/\text{MHz}$ (Normal-Run)

140 nA (Deep-power-down)

Advanced Memory Structure

1024 KB Flash Memory with FOTA & XOM function

512 KB SRAM



HyperBus Interface to connect with HyperRAM

SPI Master plus 16 KB cache to extend code Flash

Graphics Acceleration

SPI and i80 interface

2 sets of PDMA

Floating point unit (FPU)

Touch Key



Advanced Connectivity

10/100 Mbps Ethernet

USB HS OTG with PHY

Up to 4 sets of CAN FD



Extended Flash and SRAM with security function
Suitable for industrial applications

- **Arm® Cortex®-M4 core**
- **Runs up to 200 MHz**
- **Operating Voltage:**
1.7V to 3.6V
- **Operating Temperature:**
-40°C to +85°C/+105°C

Sub Series:

- M467: Ethernet + Crypto + CAN FD + USB HS OTG + USB FS OTG
- M463: AES + CAN FD + USB HS OTG

NuMicro[®] MA35D1 Series MCU

For Large Size TFT-LCD, < 1920 x 1080

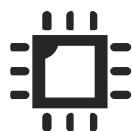
High-Performance and Real-Time Ability



Dual cores 64-bit A35 processor up to 1 GHz
One Cortex-M4 processor up to 180 MHz

Stacking a large DDR up to 512 MB

Reducing the PCB layers, Size, and EMI interference
Saving production cost



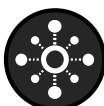
Graphics Acceleration

A LCD display I/F, resolution up to 1080P
2D graphics engine
Integrates JPEG and H.264 decoder
Supports 4/5-wire resistive touch without an external IC



Rich Peripheral

High-speed connectivity Giga Ethernet, SDIO3.0,
USB HS Host/Device, CAN-FD



Cortex-A35 Offers more Efficiency over Cortex-A7



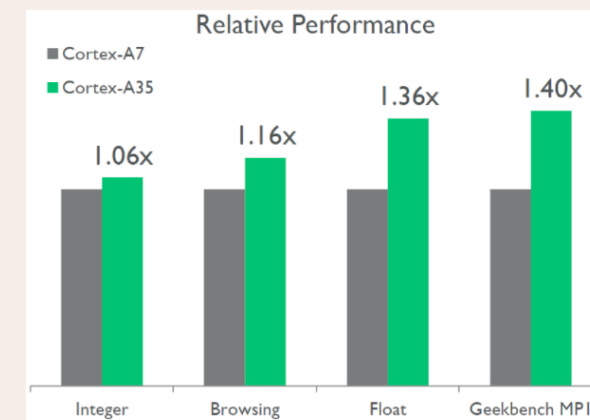
10% low power



6% to 40% performance uplift



64b capable with full backwards compatibility



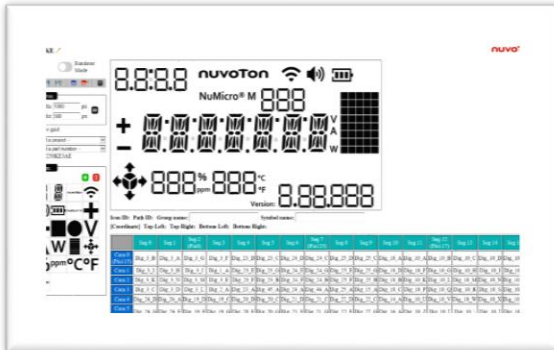
*Comparisons assume same process technology and implementation for both processors
*Captured from Arm Community blogs

| NuMicro® HMI Platform – GUI Tools and Resource

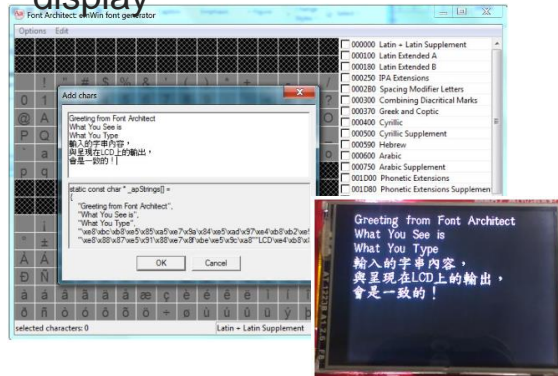
- Provides **GUI tools for HMI applications**, ease your development & save your time
- Provides **diverse graphics library**, such as **emWin**, **LVGL**, **Qt** for creating GUI easily
- **Nuvoton is licensed with the SEGGER emWin graphics library**; users can use it **for free** on the HMI platforms

COM-SEG LCD

Nuvoton
LCDView & LCD
Touch Key



Nuvoton FontArchitect
Supports multi-language
display



TFT-LCD

Graphics
Library



NuMicro® HMI Platform



COM-SEG LCD



COM-SEG LCD +
Touch Key

COM-SEG LCD		
Series	M254 ML54	M258 M256 ML56
COM-SEG LCD Driver	Up to 8x44	Up to 8x44
Touch Key	-	24 CH
OP Voltage (V)	1.8 ~ 5.5	1.8 ~ 5.5
CPU Core & Speed	Up to 48 MHz, M23	Up to 48 MHz, M23
Flash	256 KB	256 KB
RAM Size	32 KB	32 KB



Small Size TFT-
LCD



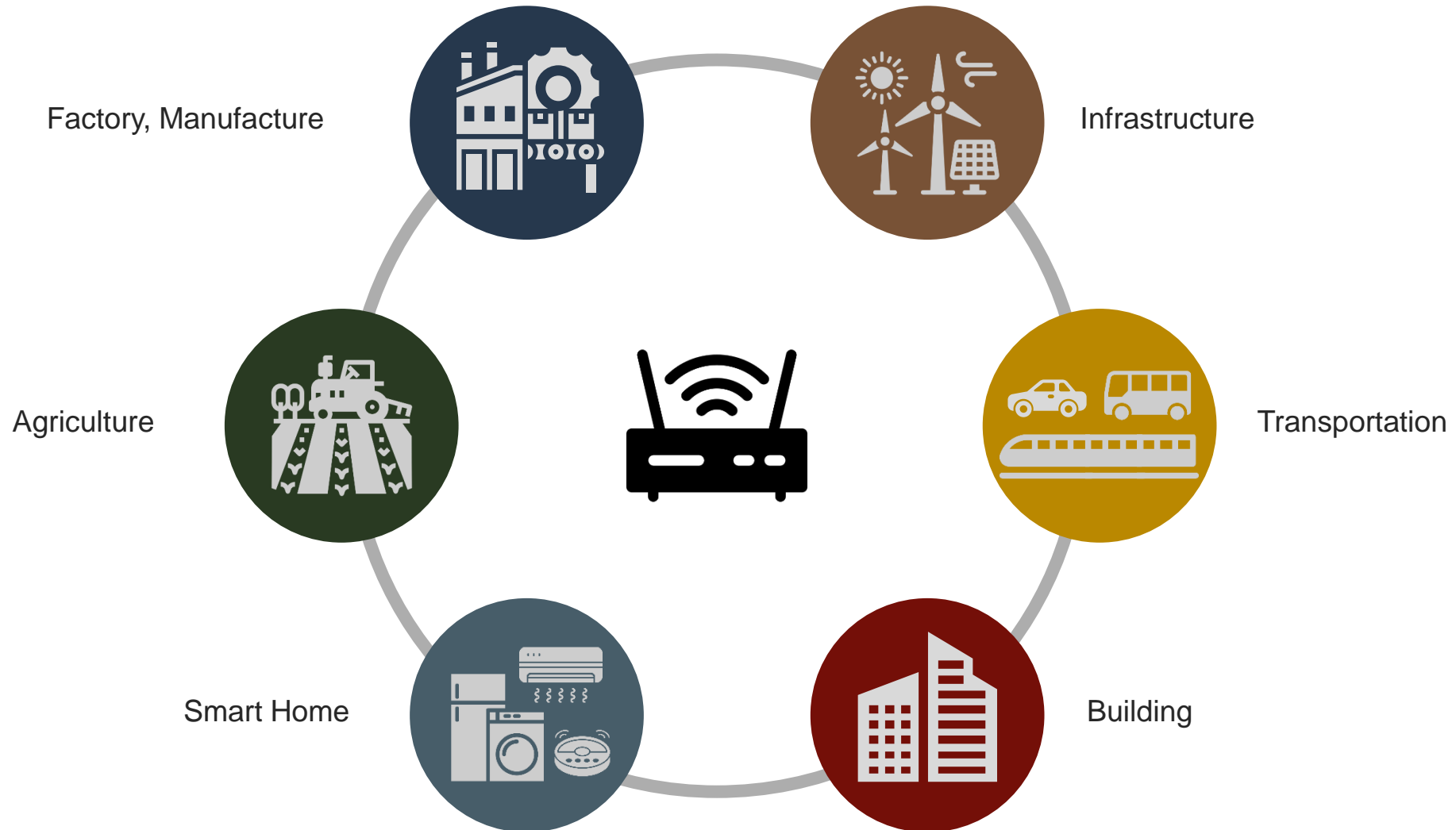
Median Size TFT-
LCD



Large Size TFT-
LCD

TFT-LCD			
Series	M460 M480 M2354 M032	N9H20 N9H26 N9H30	MA35D1
LCD Resolution (Recommendation)	< 480 x 272	< 1024 x 768	1920 x 1080
LCD Interface	SPI / i80	SPI / i80 / RGB	SPI / i80 / RGB
CPU Speed	Up to 200 MHz, M4	Up to 300 MHz, Arm9	Up to 1 GHz, Dual Cores A35
Flash	1024 KB	External	External
RAM Size	512 KB	Up to 128 MB	Up to 512 MB
Video Codec		JPEG & H.264 Codec	JPEG & H.264 Decoder
2D GFx		●	●
OS	RTOS	Mbed, FreeRTOS, RT-Thread	FreeRTOS, RT-Thread
	Linux	●	●

IIoT Gateway Everywhere



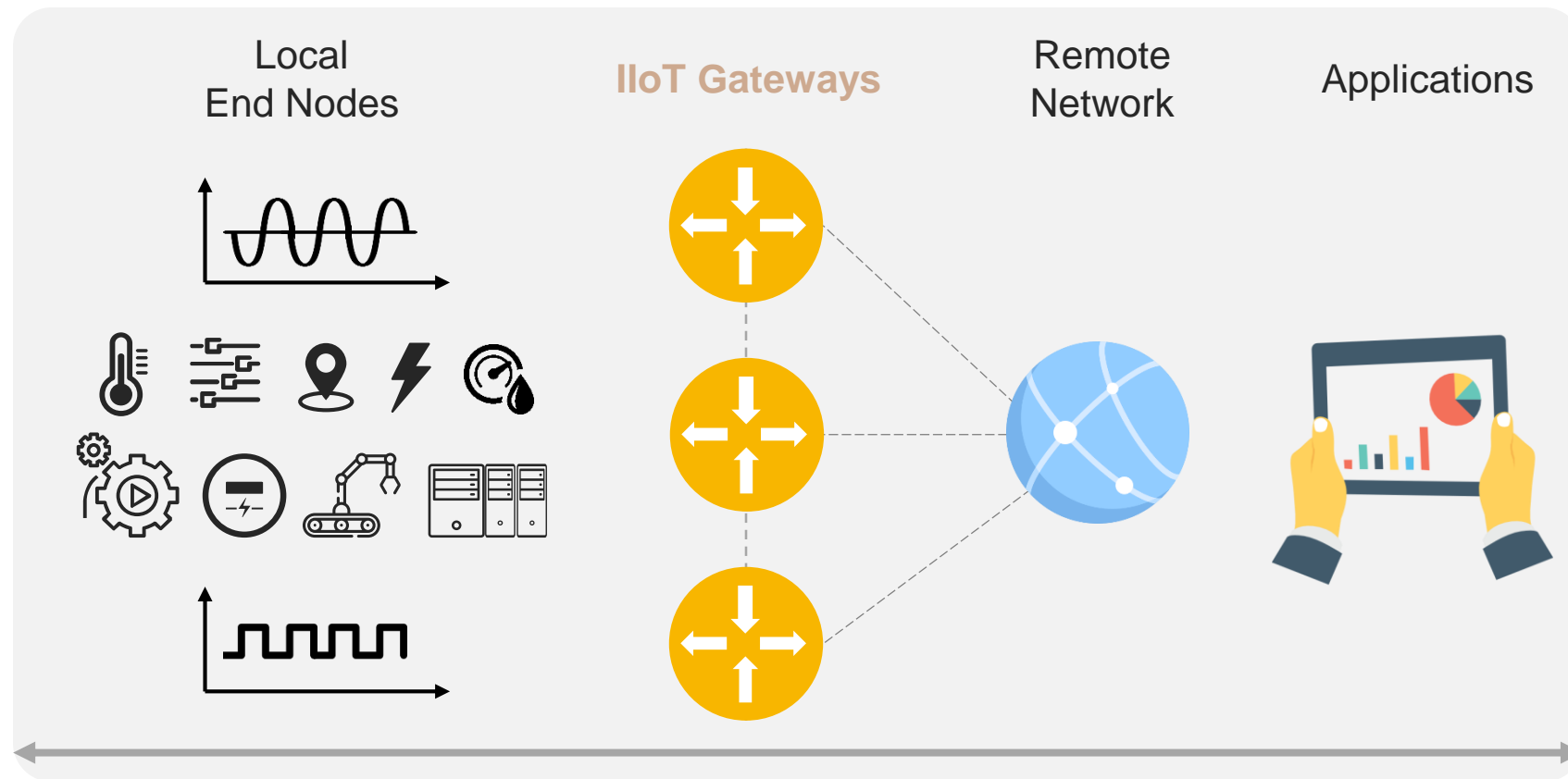
IIoT Gateway Application Scenario

Key Features of Gateway:

Connectivity

Security

Software & Protocol



High Performance and Advanced Security for Edge Gateway

For increased data processing and connection ability, we provide products equipped with advanced security, high performance cores, PDMA and high-speed connectivity.

High Performance and Real-time Processing

- Dual 64-bit Arm Cortex-A35 up to 1 GHz
- Arm Cortex-M4 up to 200 MHz

Advanced Security

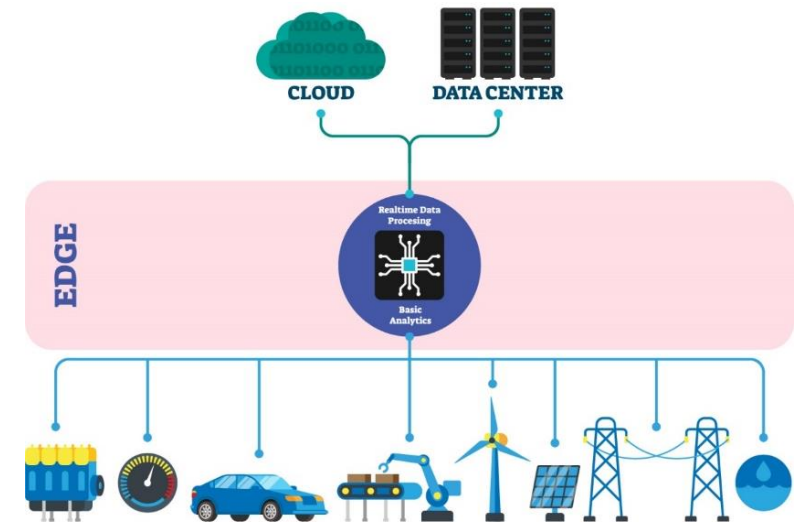
- TrustZone
- Nuvoton unique secure hardware - TSI
- Secure data transfer by TLS encryption

Connectivity

- Gigabit Ethernet x2, USB2.0 HS x2, SDIO 3.0, CAN FD x4, UART x17 etc.
- Ethernet, Wi-Fi, 4G/5G, NB-IoT, LoRa, BLE, sub-1G, etc.

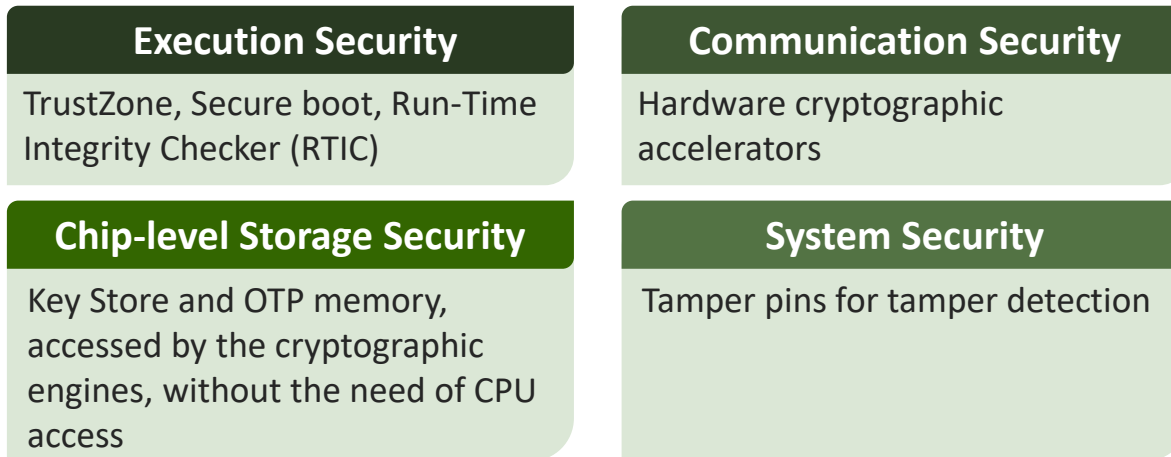
Software & Protocol

- Network protocols -TCP, UDP, HTTP(S), MQTT, CoAP, etc.
- Public cloud client references to Azure, AWS, etc.

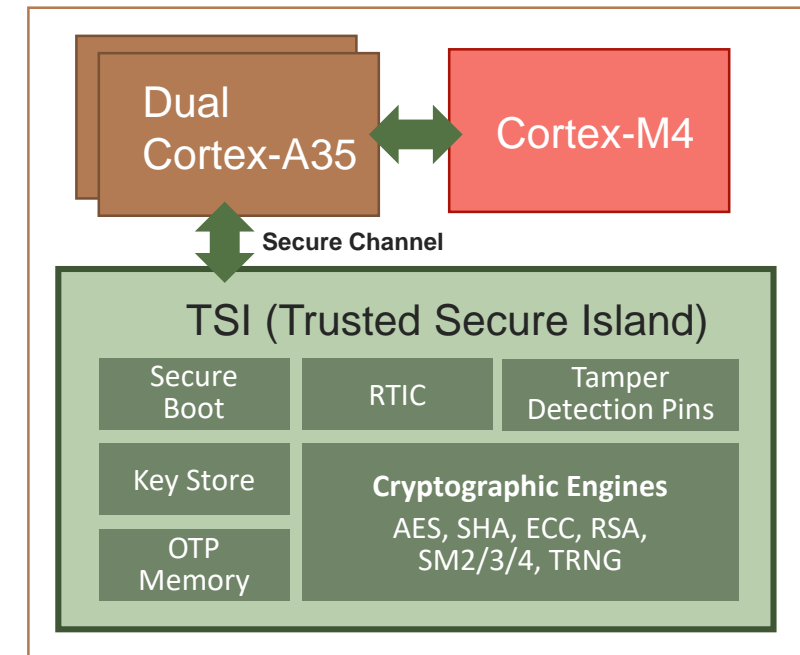


Advanced Security Features for Cyber Security

- Easy to establish



- The secure environment and features realize the **Protection**, **Detection**, and **Recovery** for IoT products.
- The **Nuvoton Trusted Secure Island (TSI)** is an isolated secure hardware unit.
- Built-in cryptographic accelerators, Key Store, and OTP memory.
- Performs all the security operations, including secure boot and tamper pins detection.



The MA35D1 is a trusted system for IoT products' security requirements

IIoT Gateway Segments

	Entry	Advanced	Superior
	M460	NUC980	MA35D1
Performance	Cortex-M4@200 MHz 512 KB SRAM	ARM9@300 MHz MCP 128 MB	Dual Cortex-A35 Up to 1 GHz + Cortex-M4 MCP 512 MB
Connectivity	10/100M Ethernet UART x10 CAN-FD x4 USB x2	10/100M Ethernet x2 UART x10 CAN x4 USB x2	1G Ethernet x2 UART x17 CAN-FD x4 USB x2
Security	Secure Boot, Crypto Engines, Secure MEM	Crypto Engines	Nuvoton TSI (Secure Boot, Crypto Engines, Secure MEM)
Software & Protocol	Mbed, RTOS Azure, AWS TCP, UDP, HTTP(S), MQTT, CoAP	Linux, OpenWRT and RTOS Azure, AWS TCP, UDP, HTTP(S), MQTT, CoAP	Linux and OpenWRT Azure, AWS TCP, UDP, HTTP(S), MQTT, CoAP

NuMicro[®] M460 Platform

Hardware Features

- Arm **Cortex-M4@200MHz**, DSP, FPU
- Flash and SRAM are **1 MB** and **512 KB**
- **HyperBus Interface** for external HyperRAM as data buffer

Network Connectivity

- 10/100M **Ethernet**
- UART, I²C, SPI, PWM, GPIO, USB HS/FS, CAN FD, MicroSD
- Extended support 4G LTE, NB-IoT, BLE, LoRa, etc.

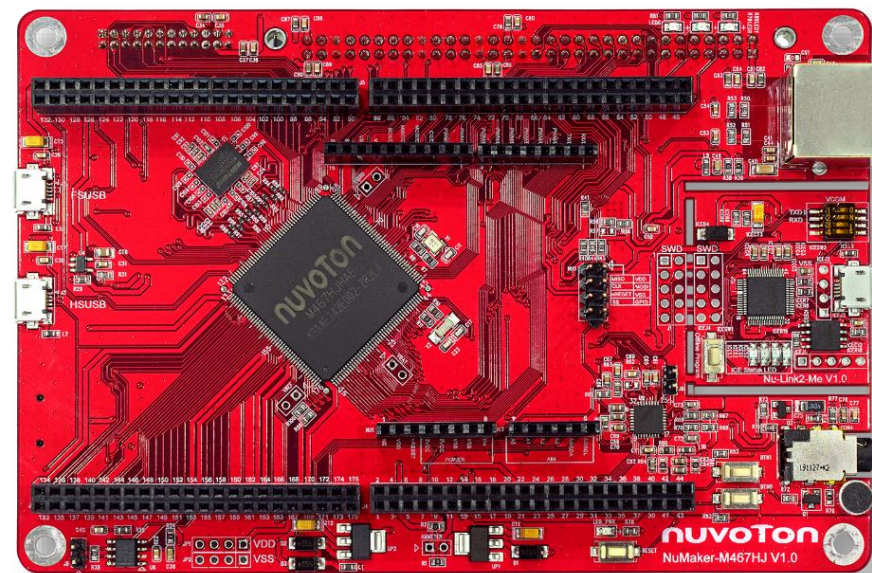
Software & Protocols

- RTOS support **Mbed OS**, RT-Thread, etc.

Security

- AES, ECC, RSA, and SHA Hardware Crypto engines
- TRNG, XOM, Key Store

NuMaker-M467HJ



NuMicro[®] NUC980 Platform

Hardware Features

- **ARM926EJ-S@300 MHz**, MCP 64 or 128 MB DDR

Network Connectivity

- 10/100M **Ethernet** on board
- UART, I²C, SPI, PWM, GPIO, USB FS/HS, MicroSD
- Extended support Wi-Fi, 4G LTE, NB-IoT, LoRa, BLE, and sub-1G, etc.

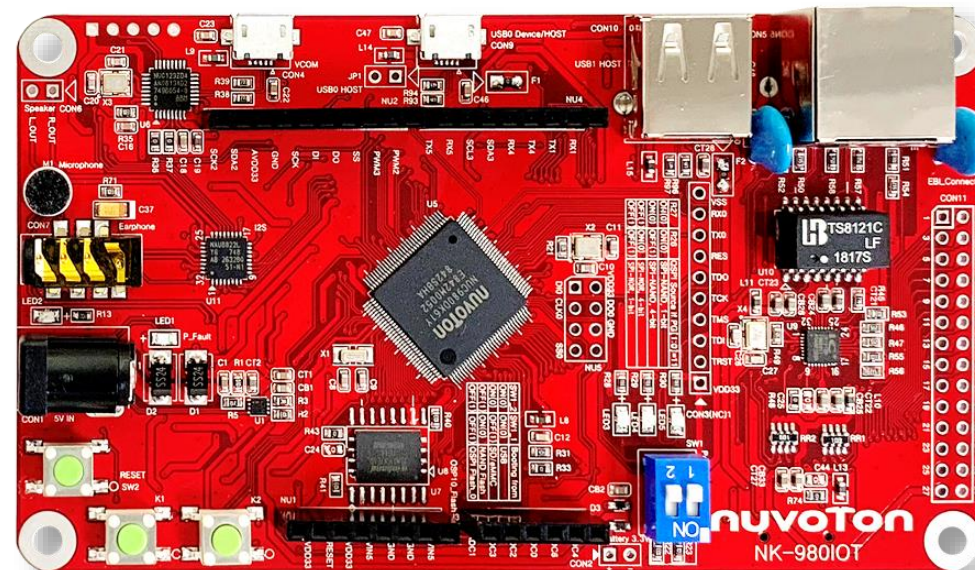
Software & Protocols

- **Linux v4.4**, **OpenWRT**, u-boot and **RTOS** are ready for development
- **TLS 1.2** encryption for data encryption

Security

- AES, ECC, RSA, and SHA Hardware Crypto engines

NuMaker-IIoT-NUC980



| NuMicro® MA35D1 Platform

Hardware Features

- **Dual Arm Cortex-A35@800 MHz + M4 + TSI, MCP 512MB DDR**
- **NAND Flash 1 GB, QSPI-NAND Flash 512 MB**

Network Connectivity

- **Gigabit Ethernet, Megabit Ethernet**
- **USB 2.0 HS, CAN FD, RS485, UART, Camera I/F, MicroSD slot**
- **Extended support Wi-Fi, 4G LTE, NB-IoT, LoRa, BLE, and sub-1G, etc.**

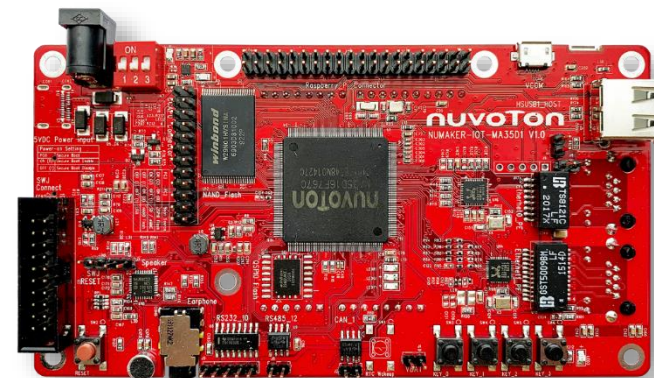
Software & Protocols

- **Linux v5.4, OpenWRT, and u-boot** are ready for development
- **TLS 1.3** encryption for data encryption

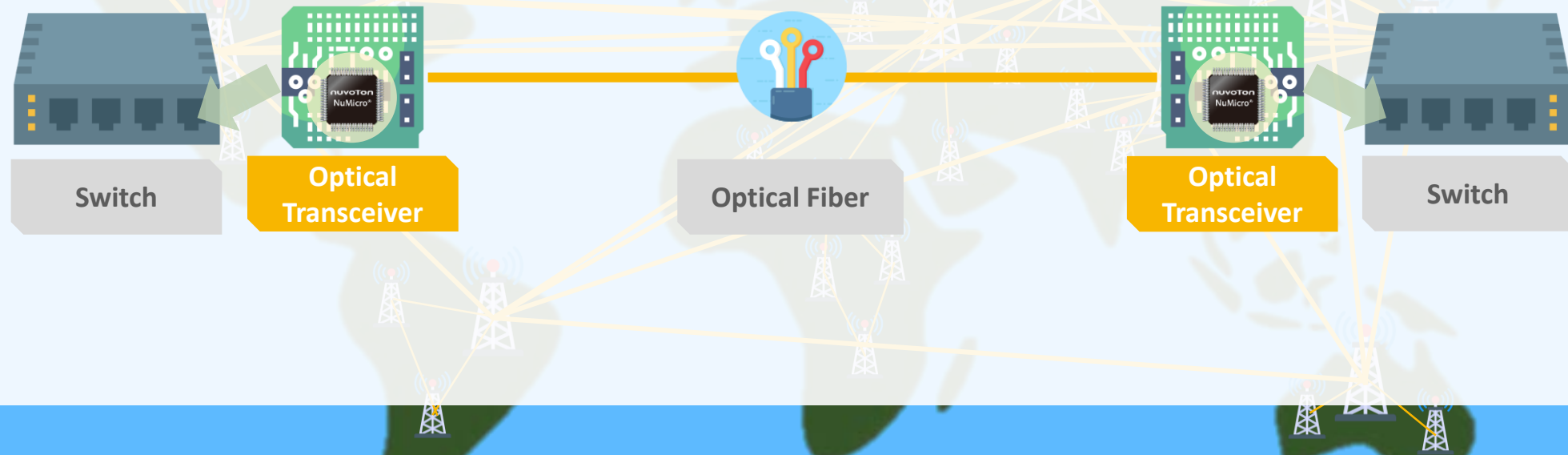
Security: Nuvoton Trusted Secure Island (TSI)

- **TrustZone/ Secure Boot**
- **AES, ECC, RSA, SHA, SM2/3/4 Hardware Crypto engines**
- **RTIC, TRNG, Key Store, OPT memory, Tamper Detection Pin**

NuMaker-IoT-MA35D1-A1



NuMicro® M029G/M030G/M031G



NuMicro[®] M029G/M030G/M031G for Optical Transceiver



Accurate Temp. Sensor

Build-in Temp.
Sensor
 $\pm 2\text{ }^{\circ}\text{C}$ ($-40^{\circ}\text{C}\sim 105^{\circ}\text{C}$)



Small Package

QFN24 3x3 mm
QFN33 4x4 mm



Strong I²C

400K/1MHz Slave
Mode
Non-Stretch Mode
I²C Bootloader



Manchester Codec

Hardware Implement
With CRC Support



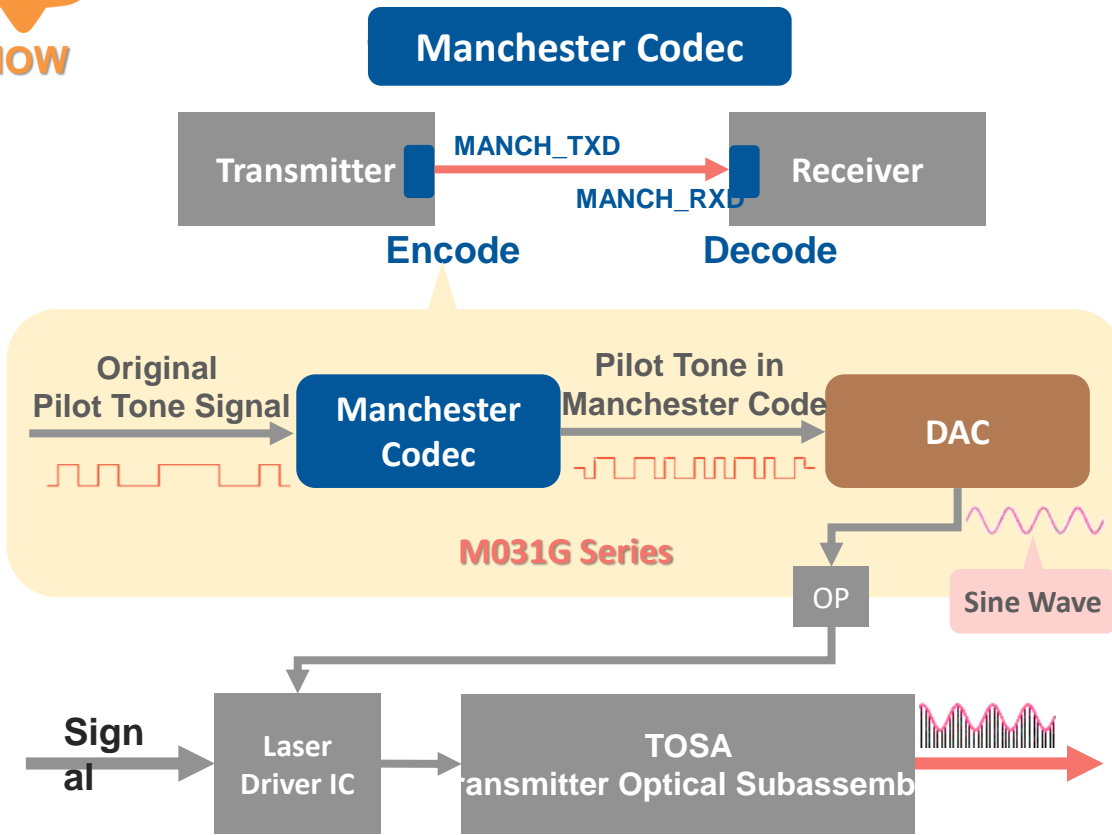
Premium DAC

Auto Data Generation

M029G/M030G for General Optical Transceiver

M031G for Pilot Tone Optical Transceiver

NuMicro[®] M029G/M030G/M031G for Optical Transceiver




Manchester Codec

Hardware Implement
With CRC Support


Premium DAC

Auto Data Generation

M031G for Pilot Tone Optical Transceiver

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

Smart IIoT Solutions

RF GaN PA Module for 5G Base Station

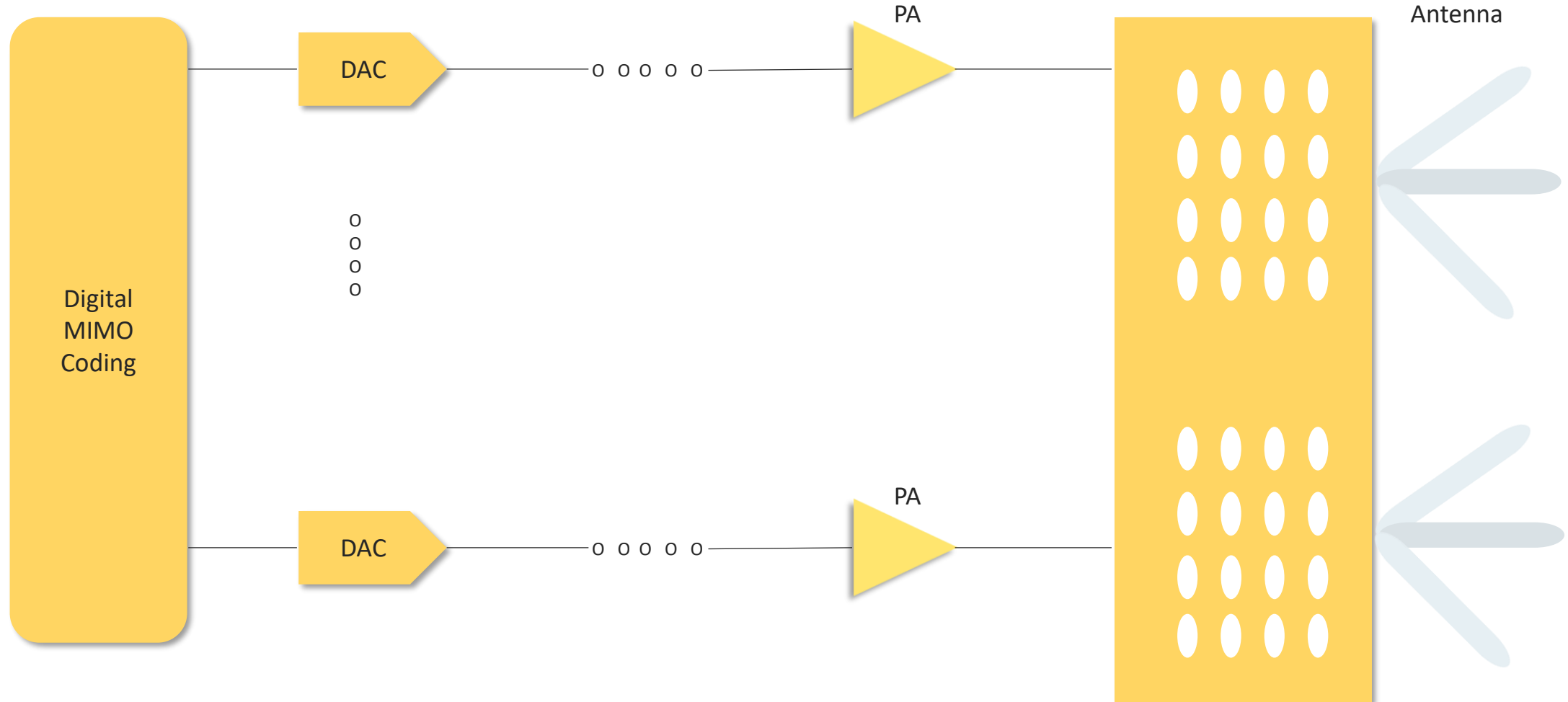
楊良吉 Jim Yang

Marketing and Application Division

Senior Technology Manager

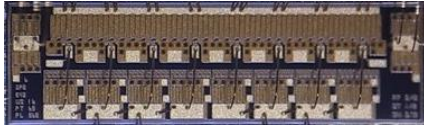


| 5G RF PA (Power Amplifier)



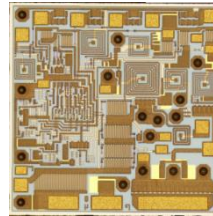
| Nuvoton RF-GaN PA Module

GaN



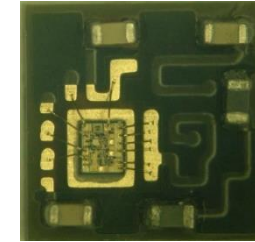
GaN HEMT on Si

GaAs



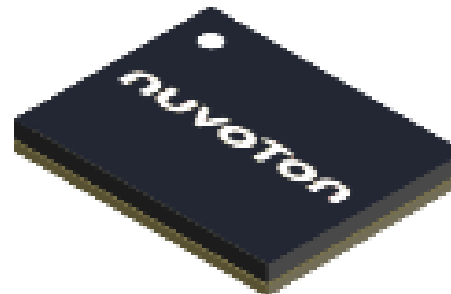
BiFET (HBT+HEMT)

Module



Multilayer plastic PKG

5G_{sub6} PA Module



Market Activity

First 5G PA Module in Japan

(Deployed for subscription service in Q2 / 2020)

- **2019 RUGBY WORLD CUP**
- **2020 TOKYO**



UN0HD-SERIES

UN0HD374 - 3.6 to 3.8GHz

UN0HD464 - 4.5 to 4.6GHz

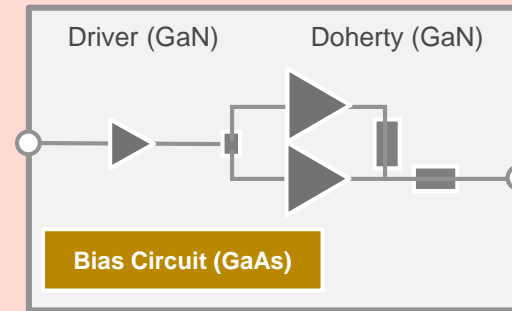
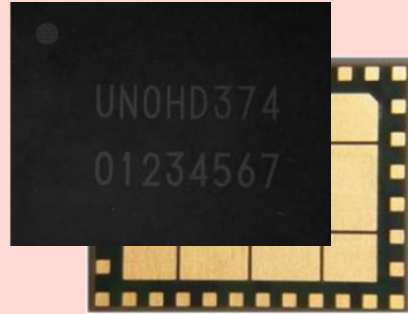
3-stage GaN Power Amplifier.
with bias circuit for GaN.



International Stadium, Yokohama, Japan

| Nuvoton PA Module for RAN

Sub-6GHz highly integrated PA module



- ✓ Driver and Doherty Amp.
- ✓ 50 ohm matching circuit
- ✓ Bias circuit (optional)
- ✓ 4.9GHz Band support

1 Capacity

5G NR Sub-6GHz

Wide band, High efficiency

2 Compact

Highly integrated

Doherty, Driver & Bias circuit

3 Coverage

High Power

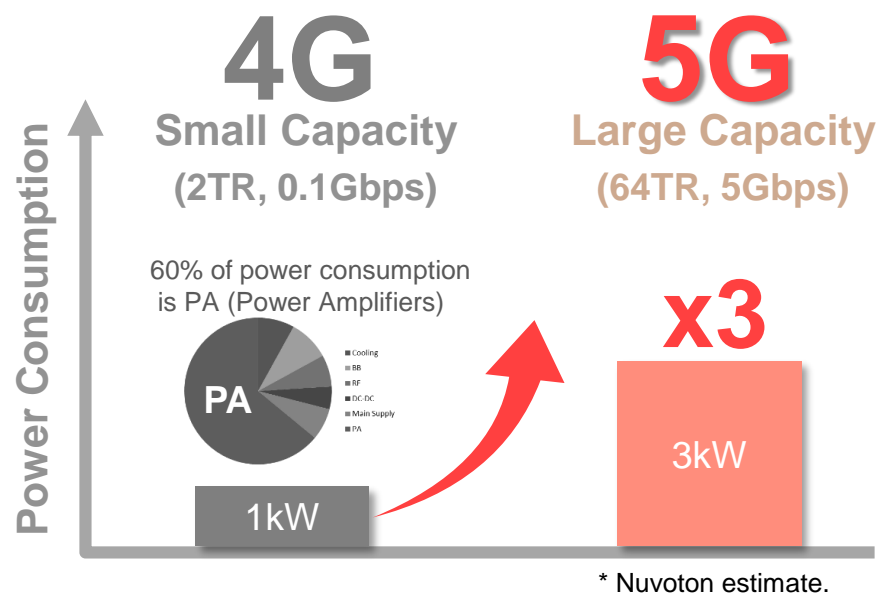
16W to cover suburb

Proposal – ① Capacity

✓ 5G RAN issue

Large capacity requires high power consumption

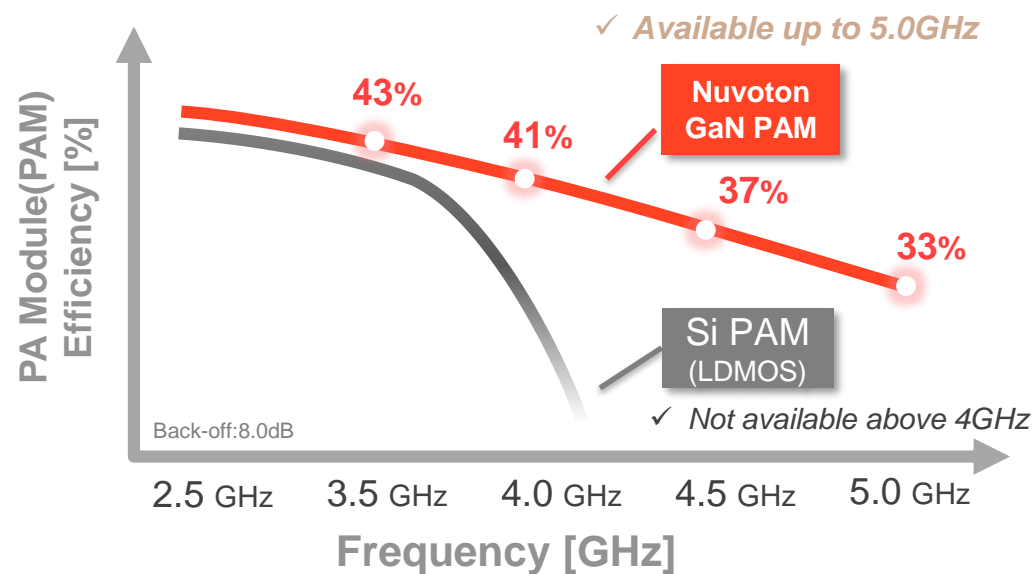
3x power consumption



✓ Nuvoton Proposal

Reduce power consumption

Helps reduce power consumption



I Proposal – ② Compact

✓ 5G RAN issue

Requires compact radio units

Small Cells
to be installed anywhere.



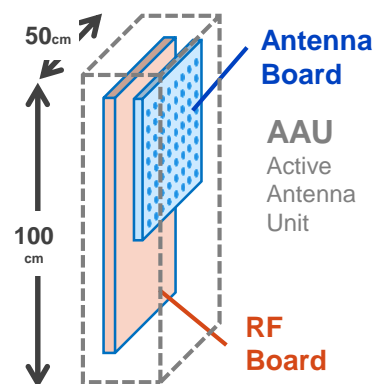
✓ Nuvoton Proposal

Compact unit size

Helps make radio unit smaller

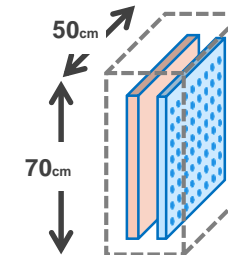
with Discrete PA

- ✓ Only Doherty Amp.
- ✓ Without matching circuit
- ✓ Without bias circuit



with Nuvoton PA Module

- ✓ Driver and Doherty Amp.
- ✓ 50 ohm matching circuit
- ✓ **Bias circuit**



30% Reduction

* Nuvoton estimate.

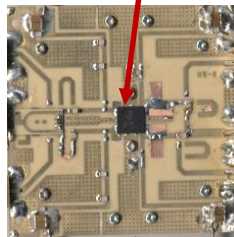
I Proposal – 2 Compact

✓ 5G RAN issue

RF design complexity

Requires RF circuit &
tuning for Power supply

with Discrete PAs



- ✓ Only Doherty Amp.
- ✓ Without matching circuit
- ✓ Without bias circuit

RF Board of radio unit

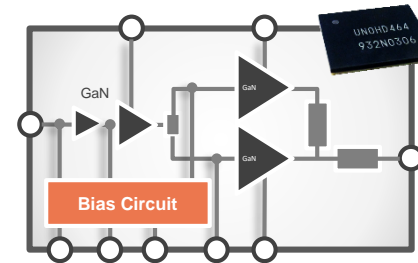
- ✓ Requires matching circuit
- ✓ Power supply tuning

✓ Nuvoton Proposal

Compact & simple RF design

Available without tuning

with Nuvoton PAM



- ✓ Driver and Doherty Amp.
- ✓ 50 ohm matching circuit
- ✓ Bias circuit

Tuning Free

Simply connect with a 50Ω line

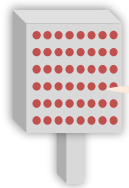
I Proposal – ③ Coverage

✓ 5G RAN issue

Narrow coverage
with high band

5G bands difficult to reach

4G



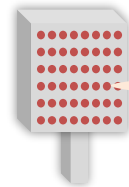
2.5GHz

Easier to reach



5G

bands difficult to reach



3.5GHz

Range shortened by 30%

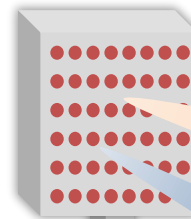


✓ Nuvoton Proposal

Wide coverage
with high power PAM

16W PAM for suburban area
that requires wide coverage

mMIMO



with 16W PAM

With 8W PAM



| Target Application

- Focus on “Massive MIMO” and “Small Cell, Local 5G”

Massive MIMO Base station



Area : 0.5 to 1.0 km

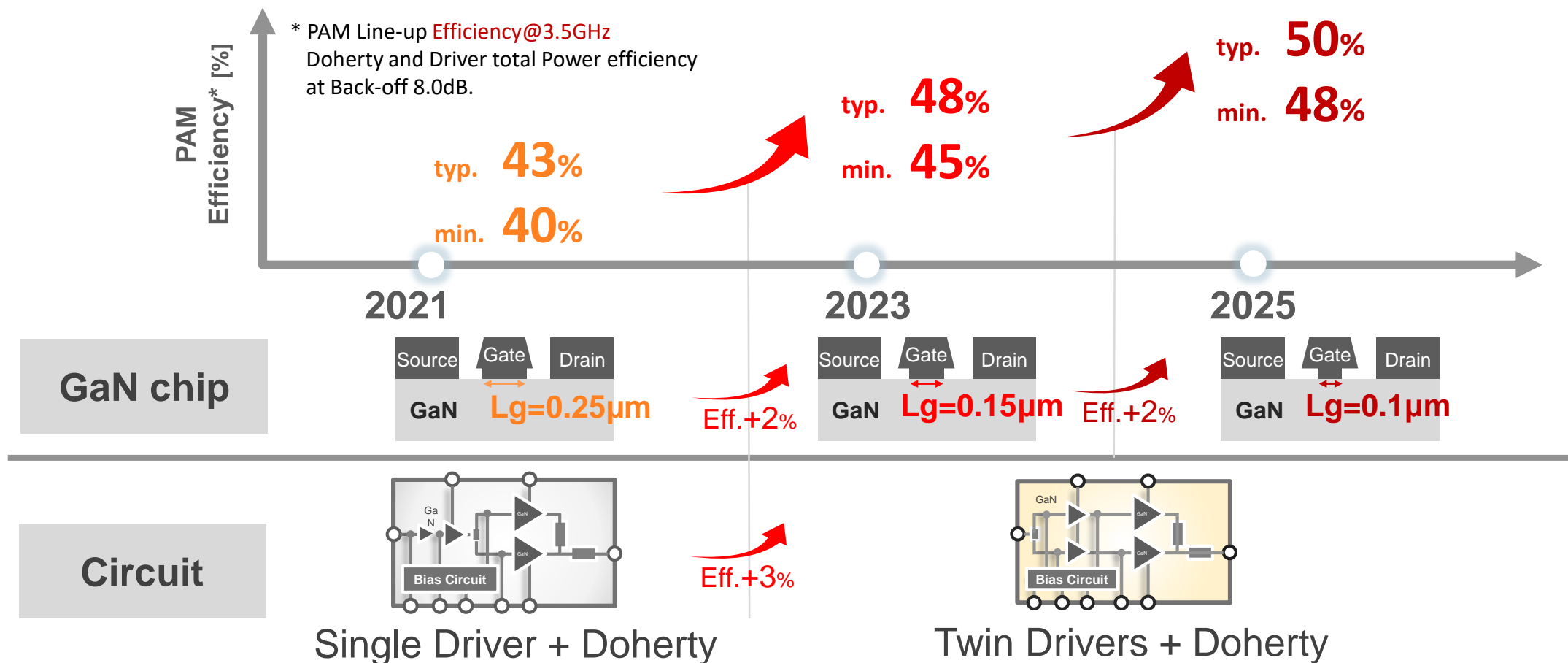
Small Cell, Local 5G Base station








Area : 0.2 km

Technology Roadmap

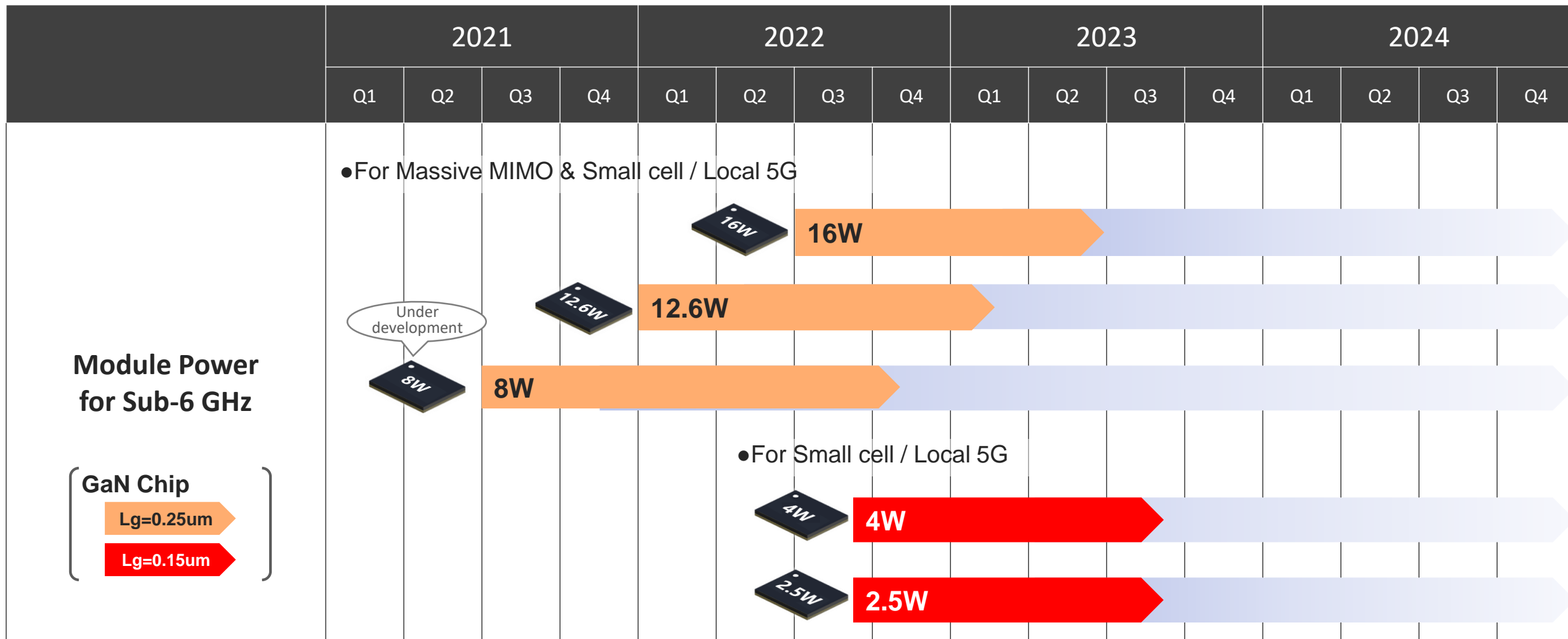
- High efficiency by GaN with finer gate and Twin drivers



Development Schedule

	2022												2023		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
 KU0HC358 3.3-3.8GHz	Previous Latest		▼ WS	▼ ES	▼ ES	▼ CS		▼ MP		▼ CS		▼ MP			
NEW  KU0HC388 3.7-3.98GHz	Latest					▼ WS	▼ ES				▼ CS		▼ MP		
 KU0HC478 4.5-4.9GHz	Previous Latest		▼ WS	▼ ES	▼ ES	▼ CS		▼ MP		▼ CS		▼ MP			
 KU0HC35C 3.3-3.8GHz	Previous Latest		▼ WS		▼ ES			▼ ES		▼ CS		▼ MP	▼ CS		▼ MP
 KU0HC47C 4.5-4.9GHz	Previous Latest				▼ WS		▼ ES	▼ ES		▼ CS		▼ MP	▼ CS		▼ MP

Product Roadmap



Note)
 Left edge = First Sample  Right edge = Mass Production

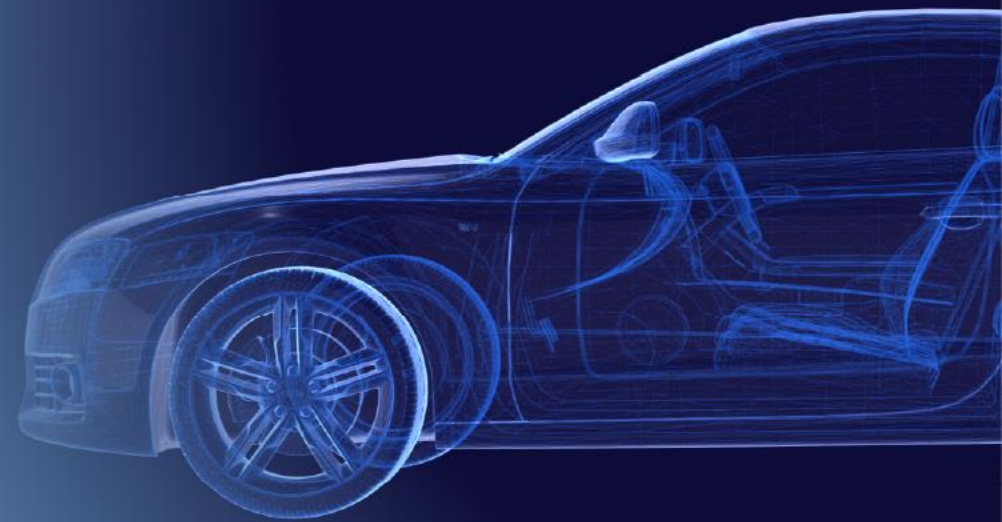
Automotive Solutions

- **Human Machine Interface Display LSIs (Gerda® Series)**
- **3D ToF**

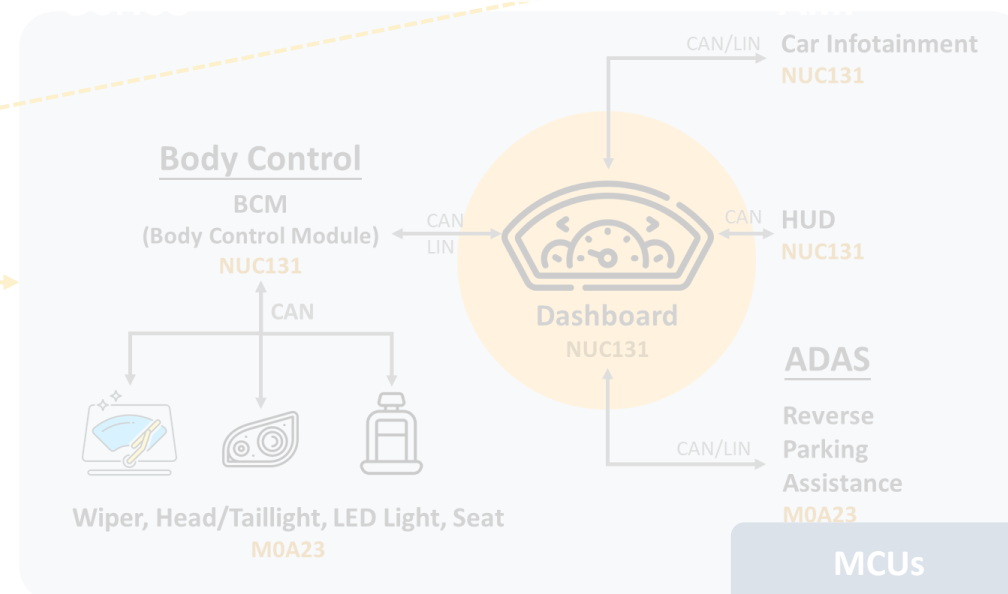
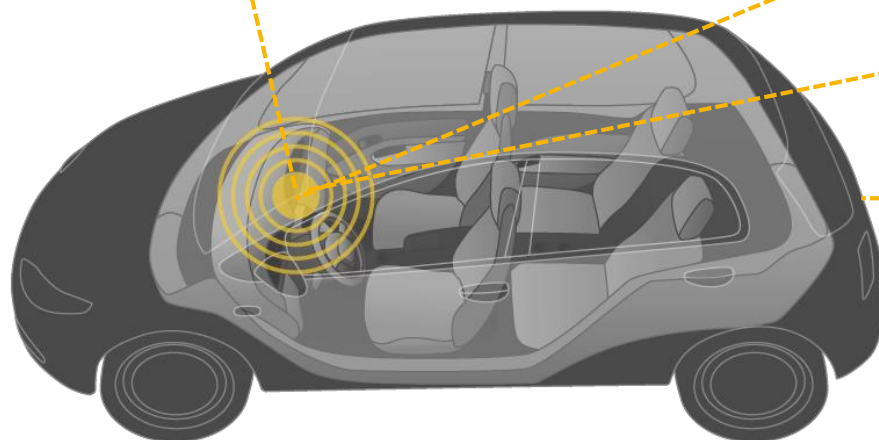
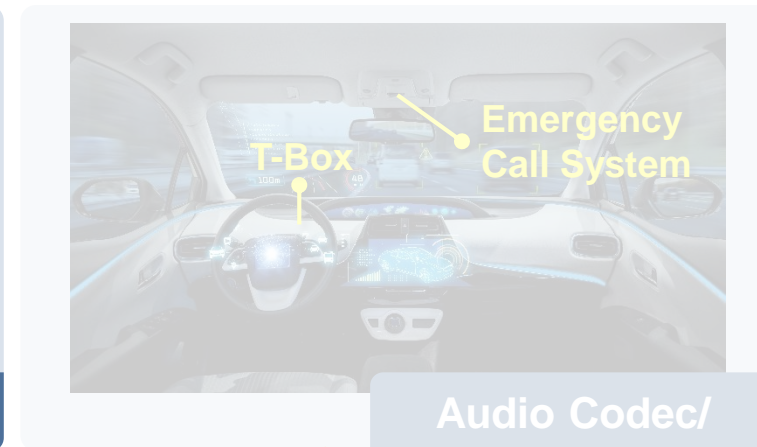
楊良吉 Jim Yang

Marketing and Application Division

Senior Technology Manager



Nuvoton Automotive Solutions



| Gerda® Series Features

COCKPIT Edge Solution

Good Cost Performance

- Image compression / Memory minimization technology (4L)
- Streamlined system with built in RAM 3.5MB(ZWEI) · 5MB(4L) · 10MB(EINS)

Security

- Full support for EVITA
- Digital signature Supports **SHA256** and **RSA**
- Encryption / Decryption Compliant with **AES128**

Scalability

- Provides a broad range of optimal devices to low-price zone
- Gerda HMI common APIs (software)

Functional Safety

- Compliant with ISO26262 standards
- Supports ASIL-B safety
- Safety manual and FMEDA support (4 L/ZWEI)

Graphics/Video

- High-end 2.5DGFX
- Super resolution technology (Clear image)

Compact Design

- QFP package
- Minimum footprint SDK (Approx. 200KB)

High Functionality

- High-definition distortion correction engine / tool (4L/EINS)
- Supports FOTA (Update Firmware in operation)

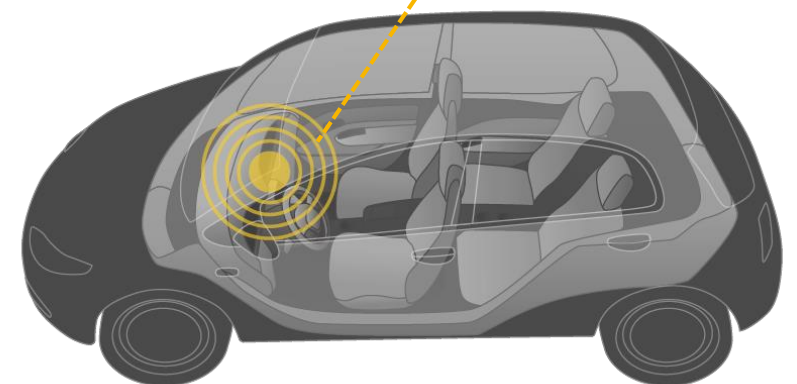
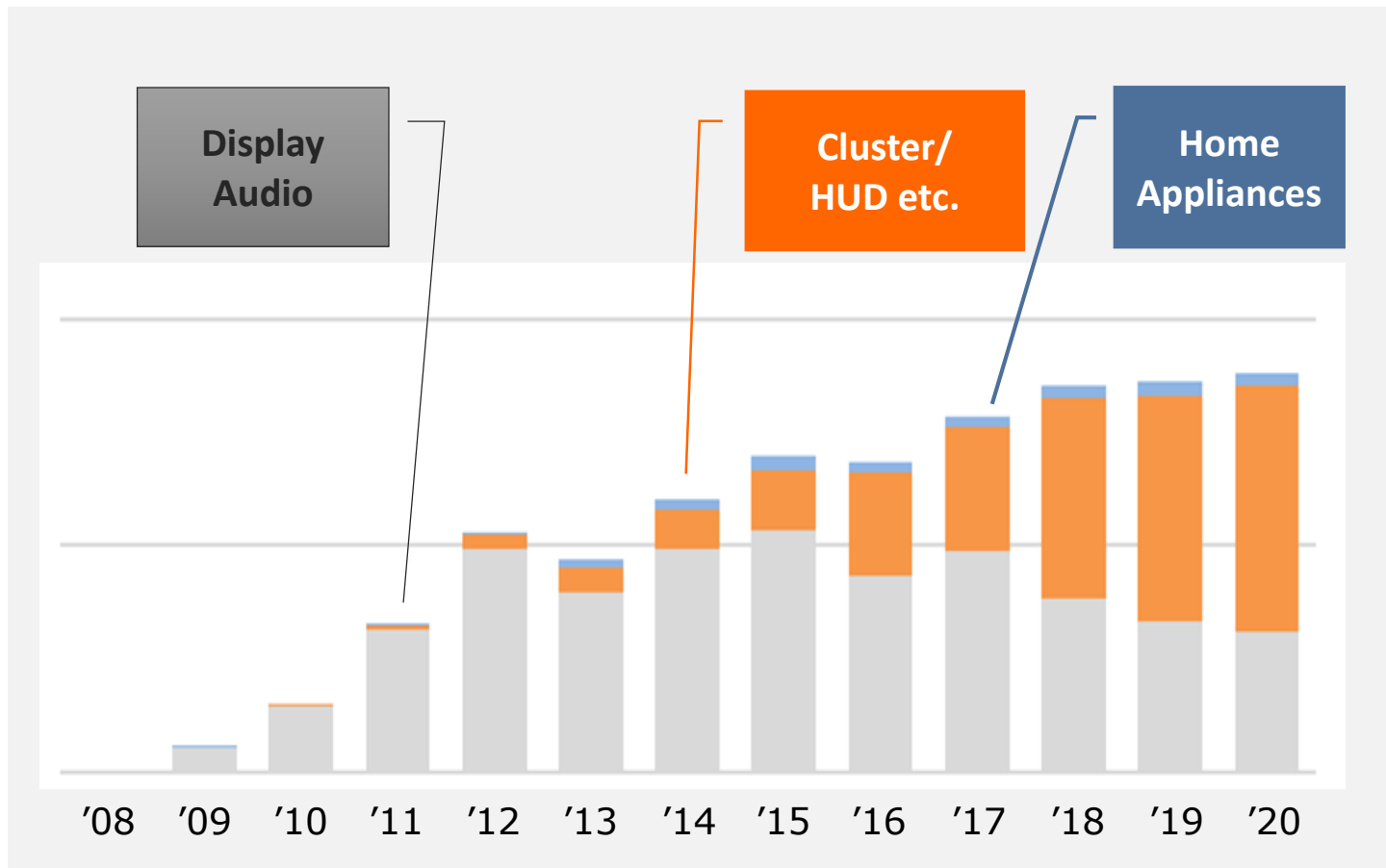
Support

- SDK **Web download (Under study)**
- To provide evaluation boards and HMI tools



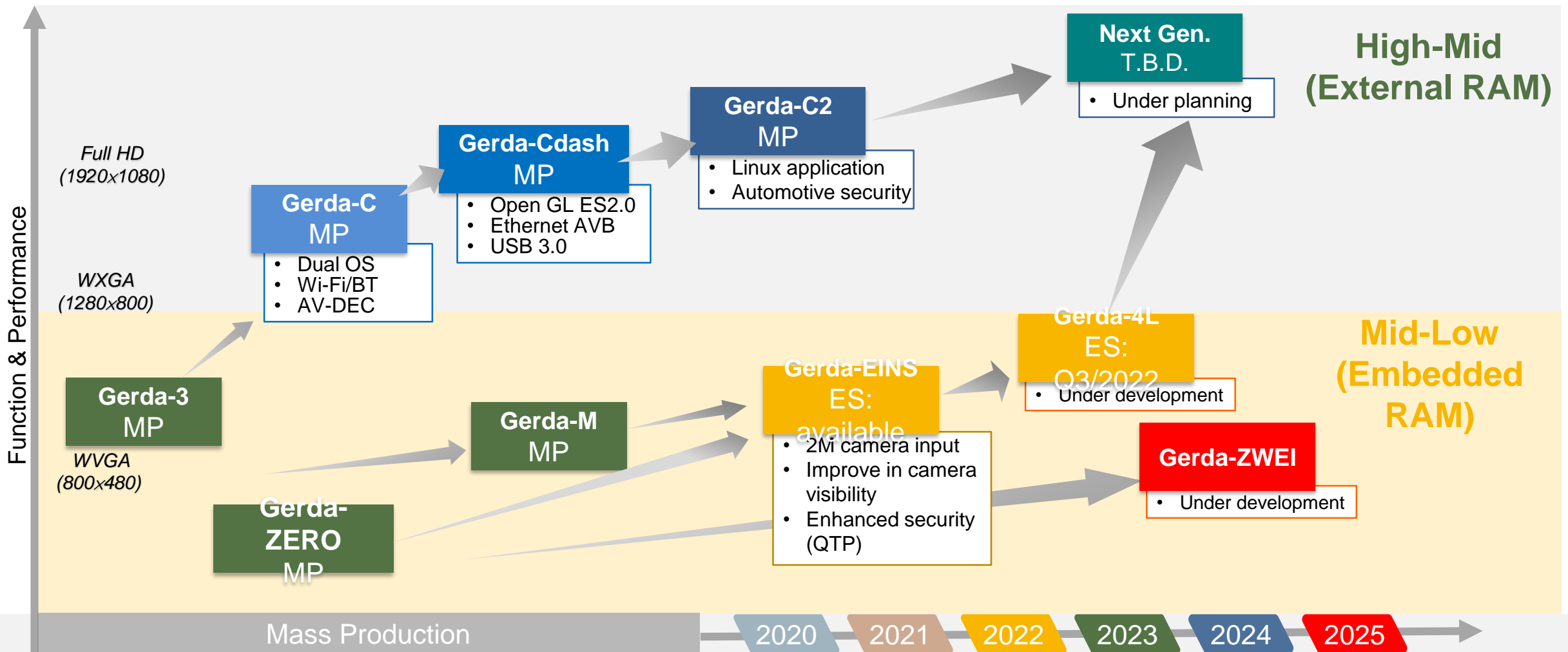
Shipment in the Market

Over 55Mil. pcs of Gerda® Series devices have been delivered since 2009.



Gerda[®] Roadmap

Name
Schedule
• Features / Status



User Experience

Graphics

2.5D / 3D graphics

- 7 inch WVGA



- 12 inch Full-HD

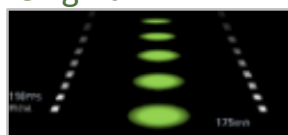


Superimpose graphics on input video

Various Enhancement

Distortion correction

- Original



HUD navigation



Back Monitor

- After



Low latency



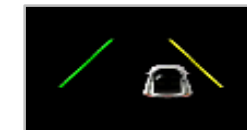
Safety

Abnormal image detection

- Tell-tales check
- Diagnost



- Color check



Correct



Wrong

Notify attention

Better Visibility

Super resolution

- Before
- After



Clearer image

Anti-glare

Local contrast correction

- Before
- After



Better night vision

| Gerda[®] Meter Cluster Features

- High Quality Meter Cluster Provided by Gerda original Graphics Engine
- Colorful Display Available by Texture Material(ROM) and Image Compression Technology (RAM)

Translucent

Add Strength with Translucent processing for icons like Alert

High Quality Display

Smooth Gradation Color with Dithering

Display High Quality

Anti-Aliasing Function to smoothen the outline of meter needle pointer

Colorful Display

By 3D Icon Texture, Colorful Expression Available with 2.5D Engine

Efficient Flash Memory Design

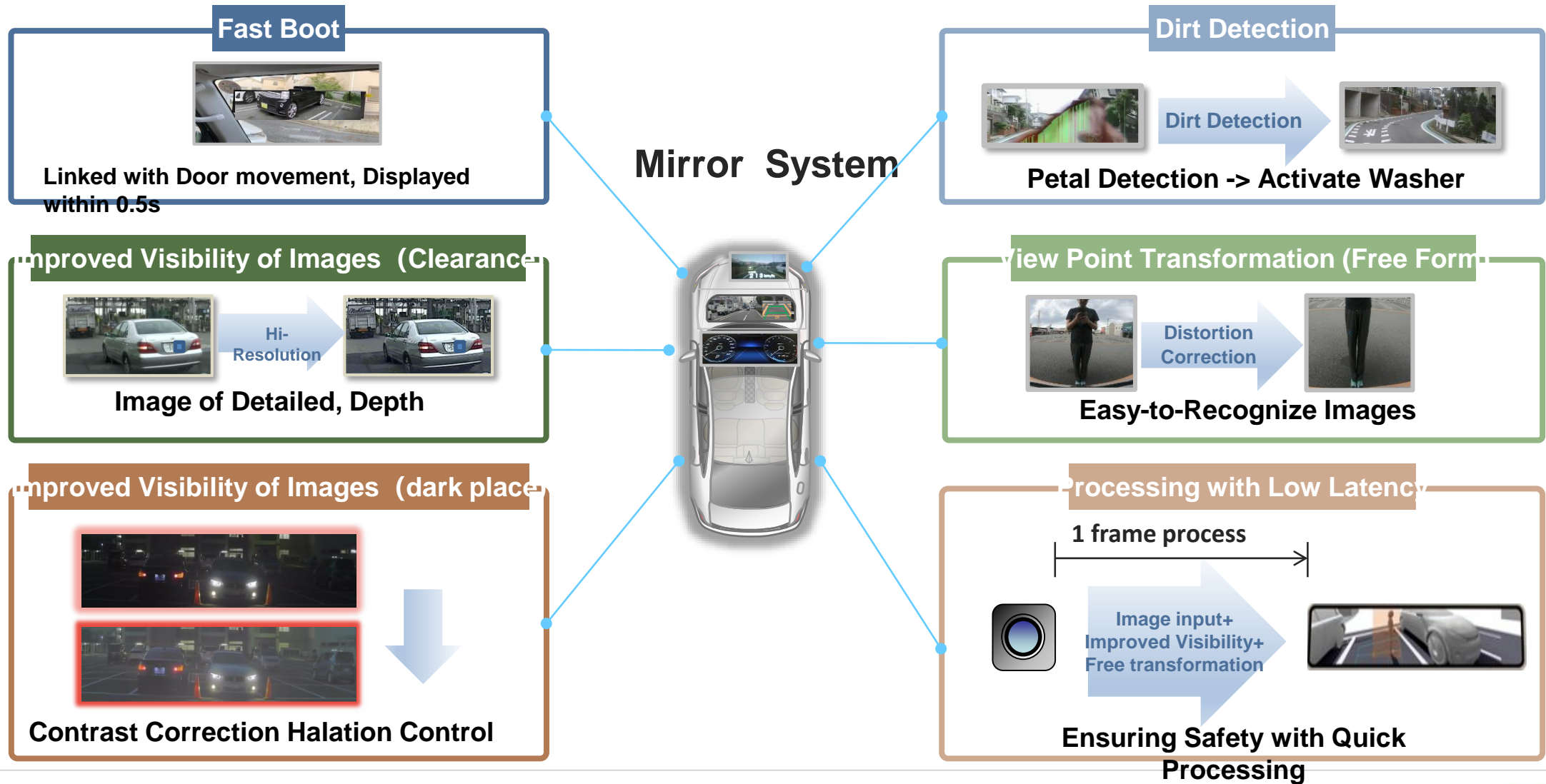
Various Expression like Animation or Multi-language By Texture Material Compression Technology (Compressibility : approx. 25-50%)

Efficient Image Memory (RAM) Design

High Resolution and Clear Image By Frame Memory Compression Technology

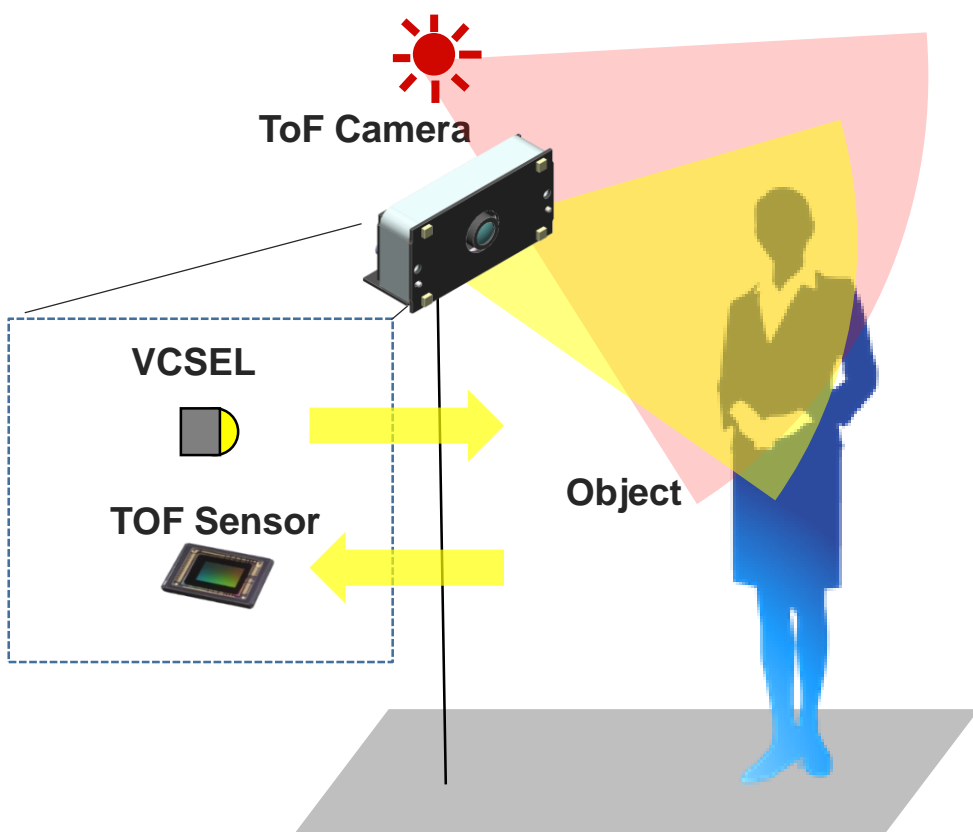


| Gerda[®] E-Mirror Features

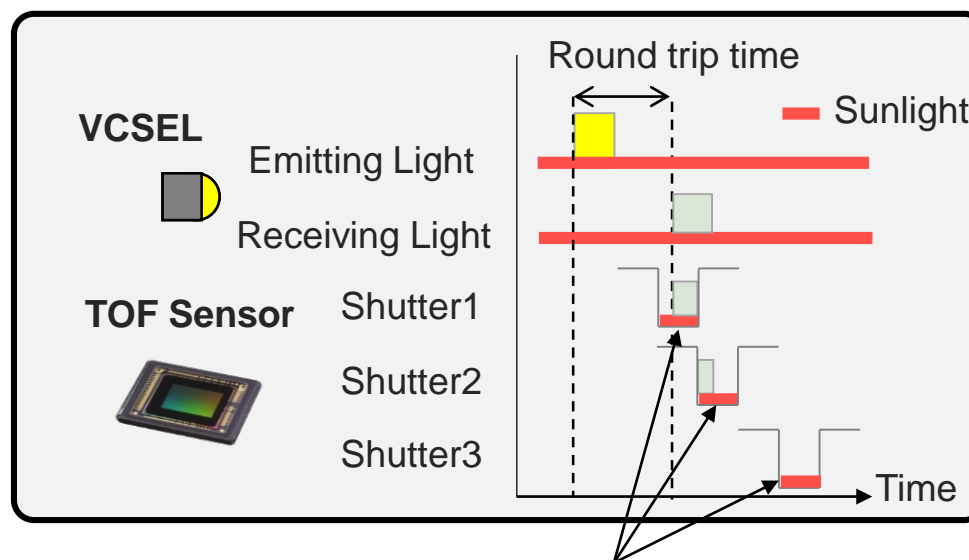


Measurable Under Sunlight (iTOF with Pulse-ToF)

- Calculating distance to objects by measuring the round-trip time of pulsed NIR by ToF sensor
- This system can output NIR-2D image & 3D image without background light



Pulse-ToF Light/Shutter pulse timing



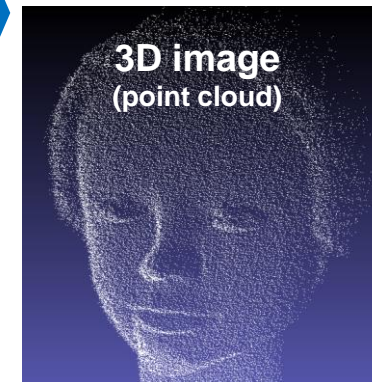
Measure the amount of background light and remove it from the receiving light

Output image

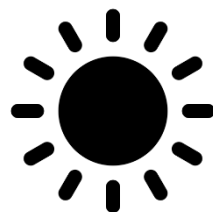
NIR-2D image



3D image
(point cloud)

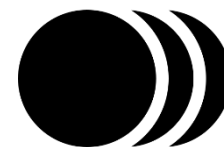


| Characteristics of Nuvoton ToF Sensor



Sunlight Resistance

- ✓ You can measure even in the dark or under sunlight

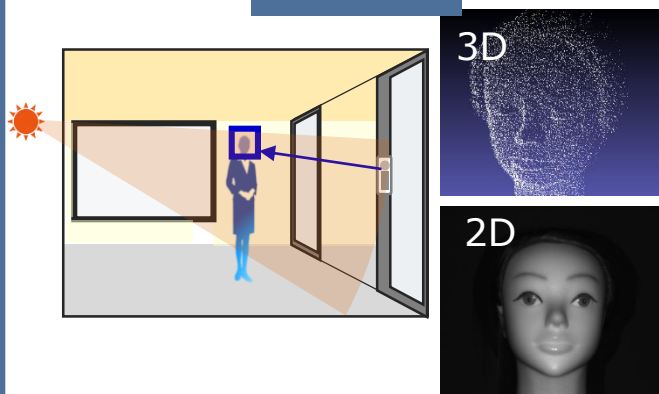


Low Motion Blur

Major Applications

ToF Sensor is used at outdoor (0.1~150k lux) and Long range (~13m)

Smart Lock



Face authentication

Driver monitoring



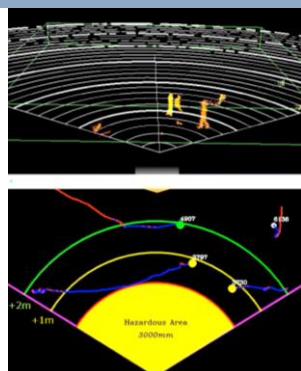
Inattention, drowsiness and driving posture detection

XR (VR/AR)



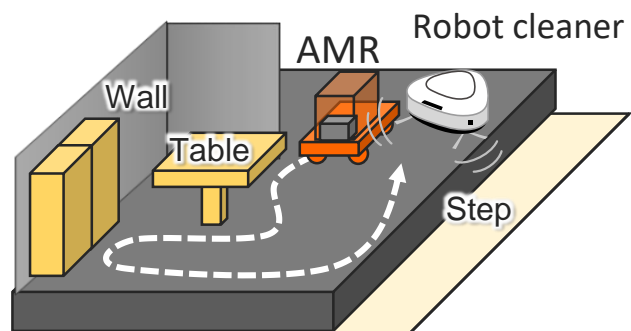
Gesture & Spatial recognition

Marketing for Retail



People flow detection

AMR (Indoor)



Obstacle detection, SLAM

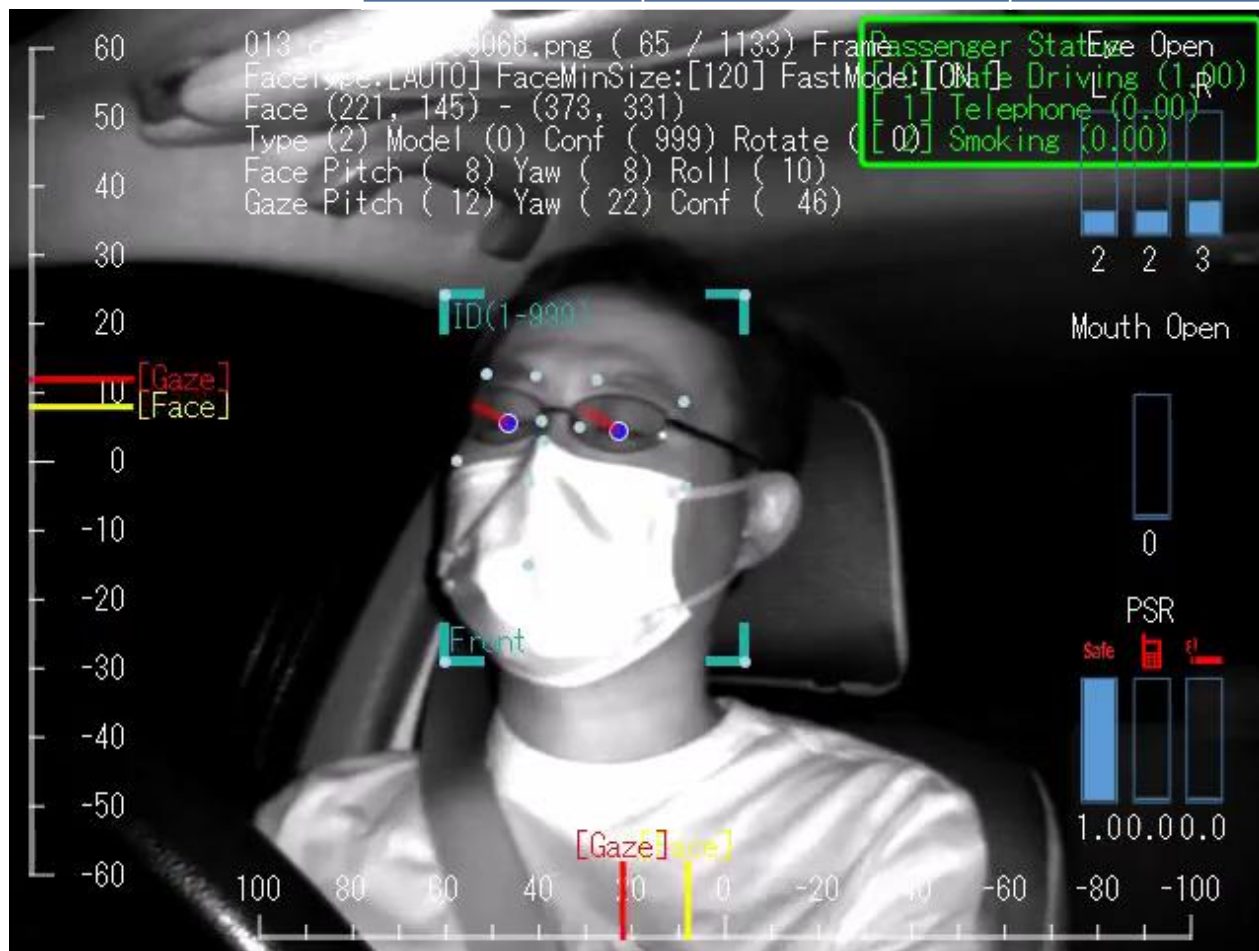
AMR (Outdoor)



Obstacle detection, SLAM

Demonstration Video of Existing DMS Function

Fine	with Glasses	Mask on the mouth	Sunlight on the face
------	--------------	-------------------	----------------------



NTCJ ToF Camera



General NIR Camera (2D)

| Detailed Comparison of Motion Blur Performance

KW3300

0



Low motion
blur

Company M's

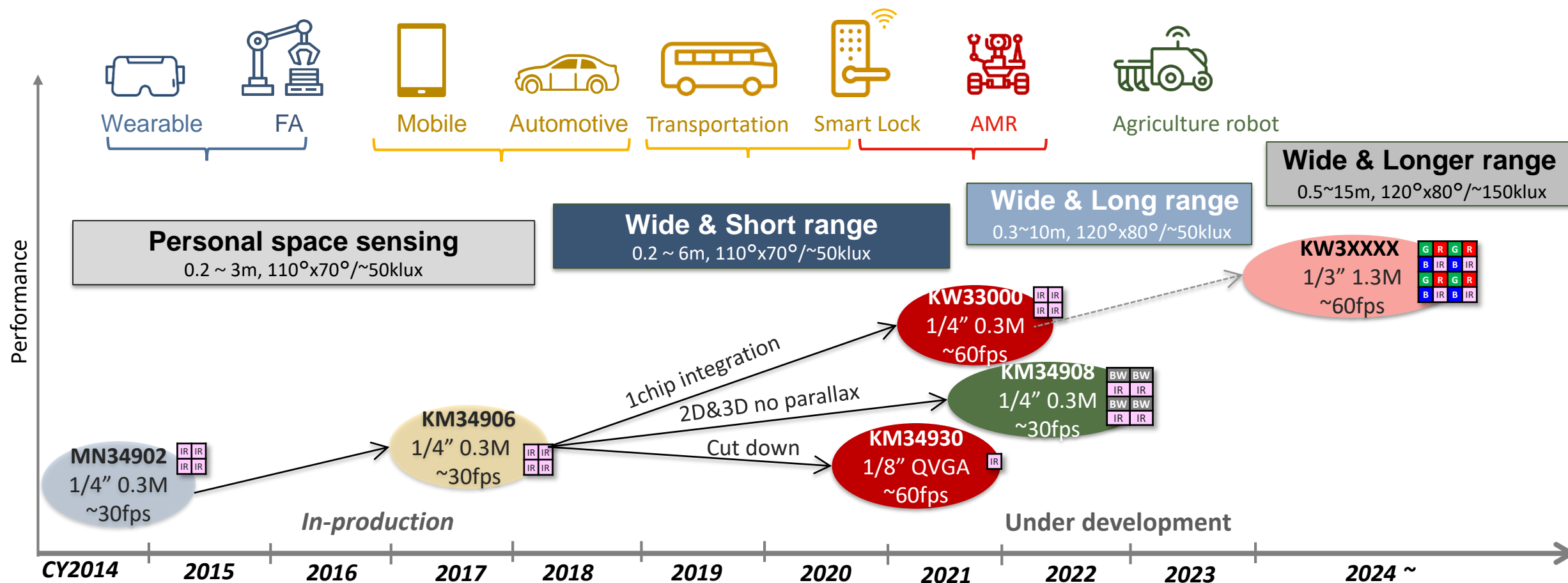
One frequency mode
sensor



Middle motion blur

ToF Product & Solution Roadmap

- KW33000: ES available MP 2022/Q4, KM34930: ES available MP:2022/Q4



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

Automotive Solutions

- **Voice Prompt**
- **Body Control**

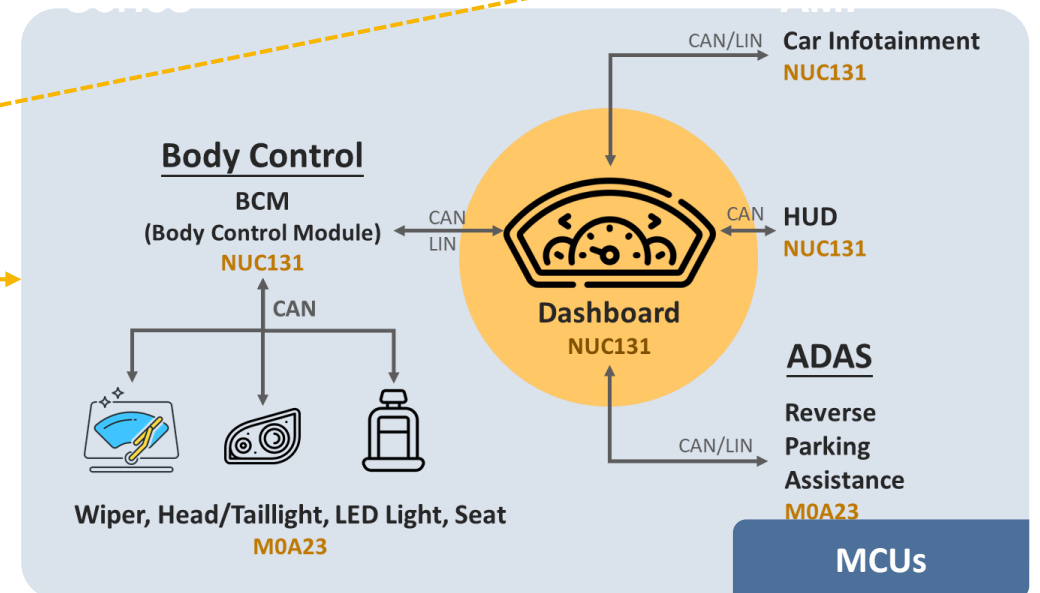
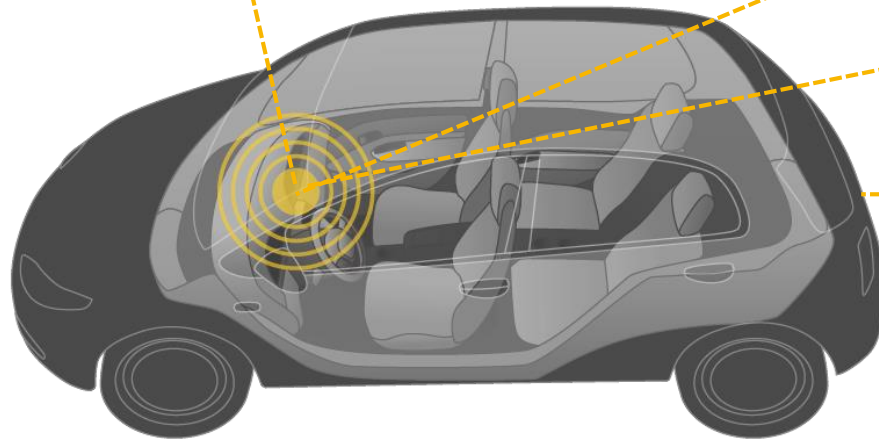
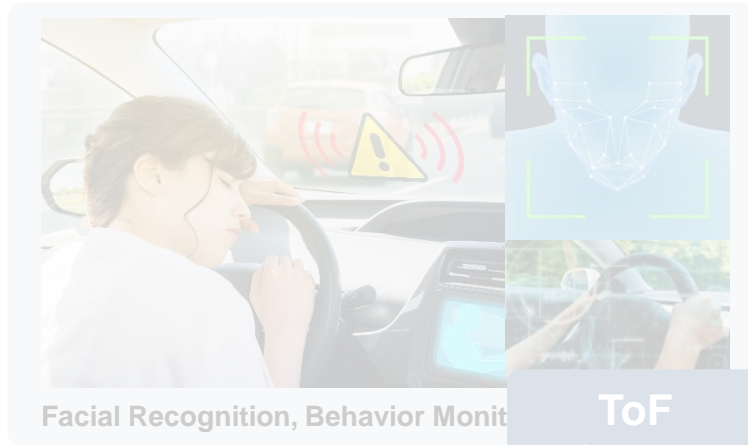
余遠欣 Benson Yu

Audio Product Marketing Division

Senior Engineer



Nuvoton Automotive Solutions



| What is the T-Box?

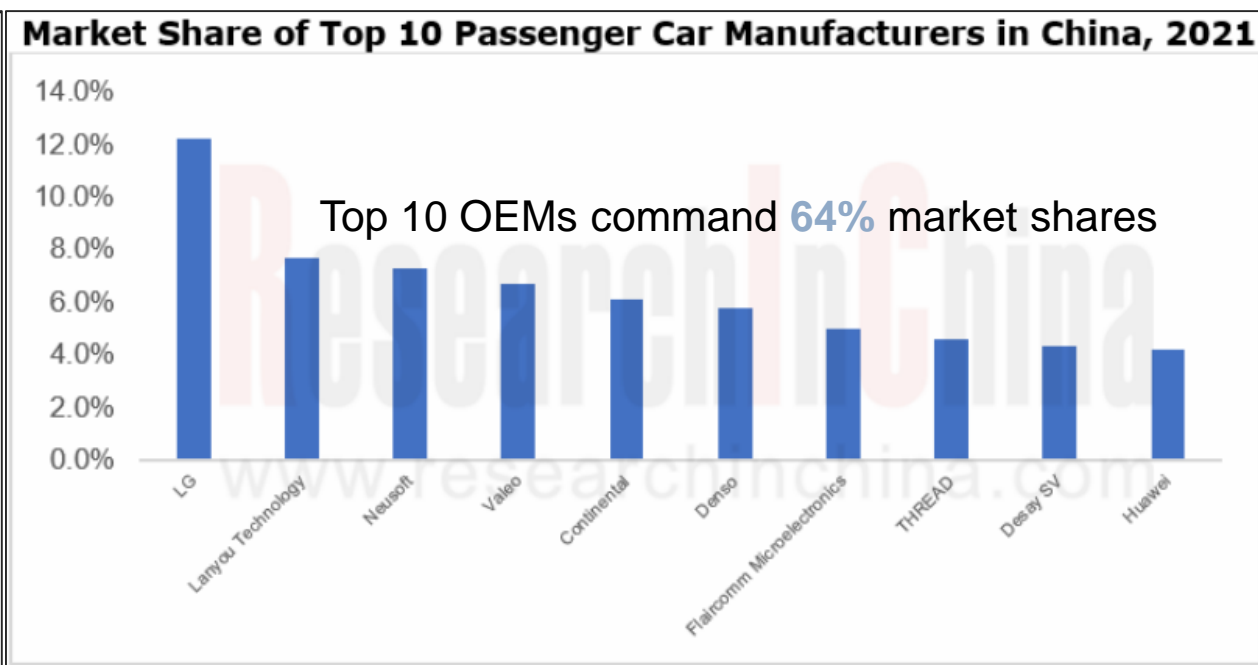
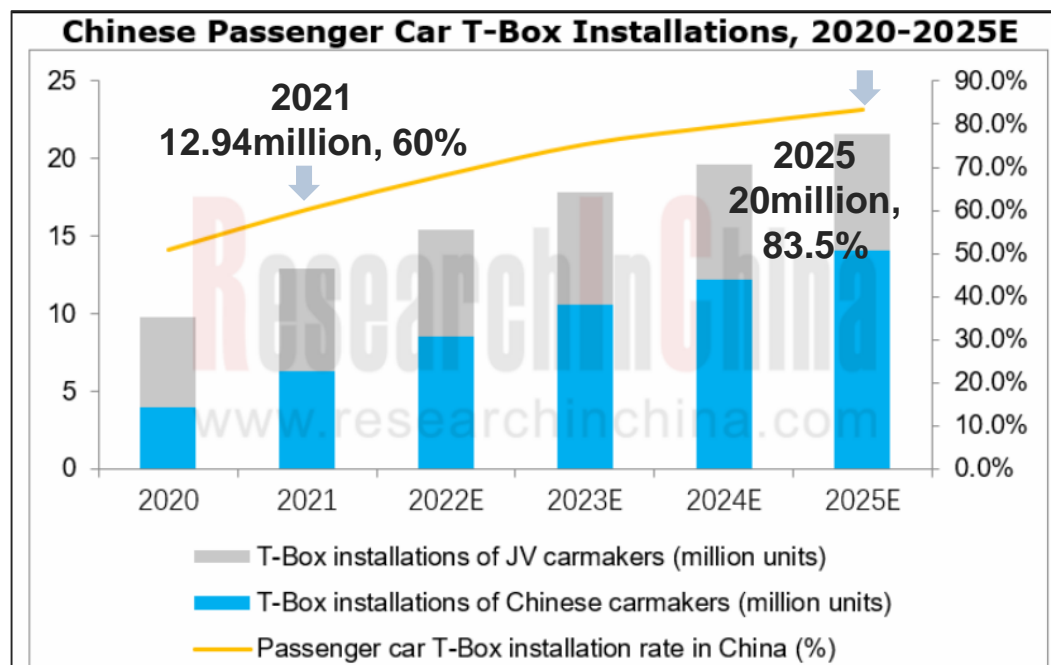
- **Telematics BOX**

A Telematics Smart Box, also known as a black box, is a small device that collects data about your driving. They've been used in emergency and commercial vehicles.



T-Box Installation Market Survey in China

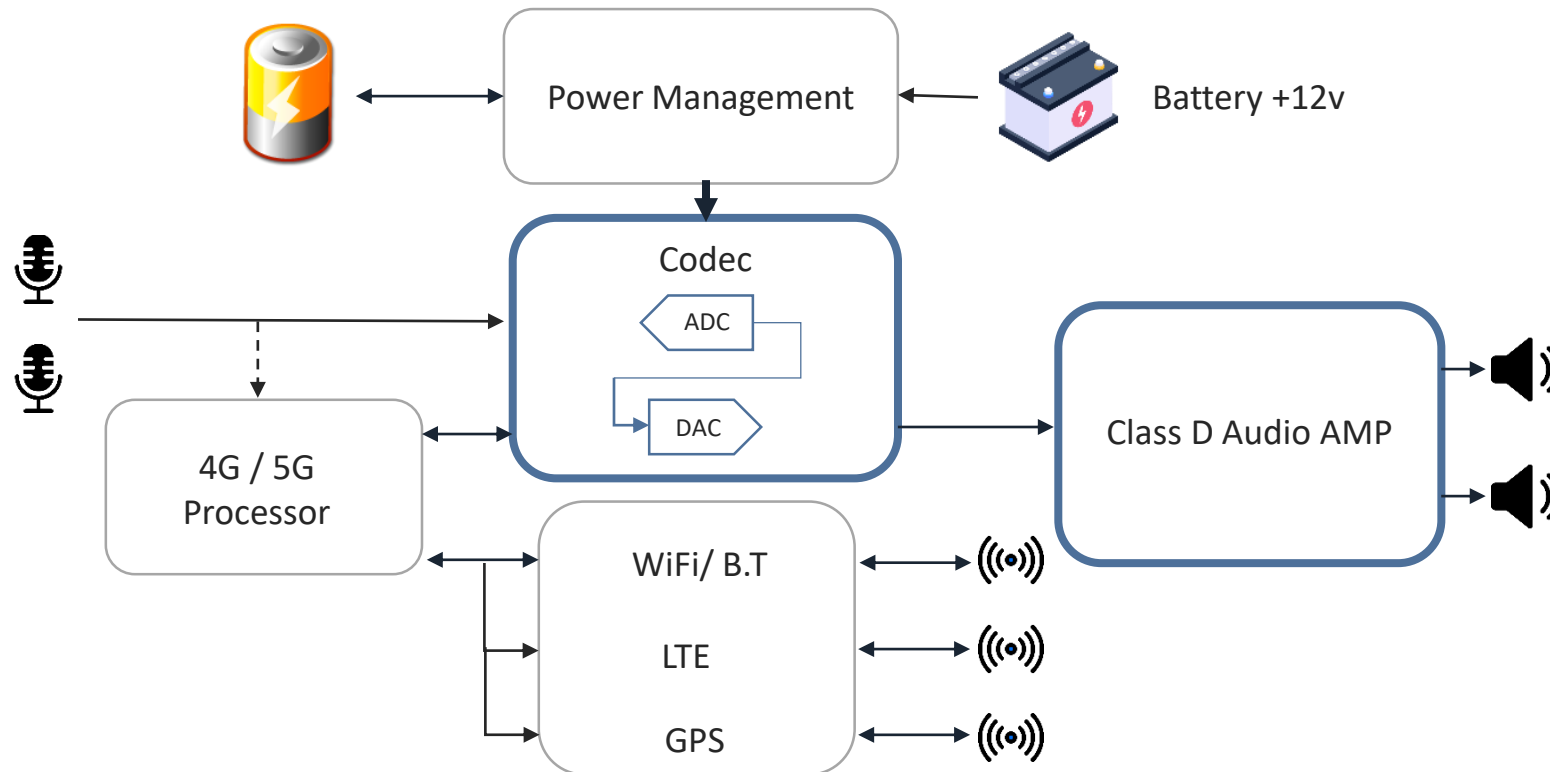
- In **2021**, **12.94 million** passenger cars were installed with T-Box by OEMs in China; the installation rate hit **60%**, up about 10 percentage points from last year.
- By **2025**, **over 20 million** passenger cars will be equipped with T-Box, and the **installation rate will climb to 83.5%**, and T-Box are growing indispensable to passenger cars.



Source: ResearchInChina

T-Box Audio Block Diagram

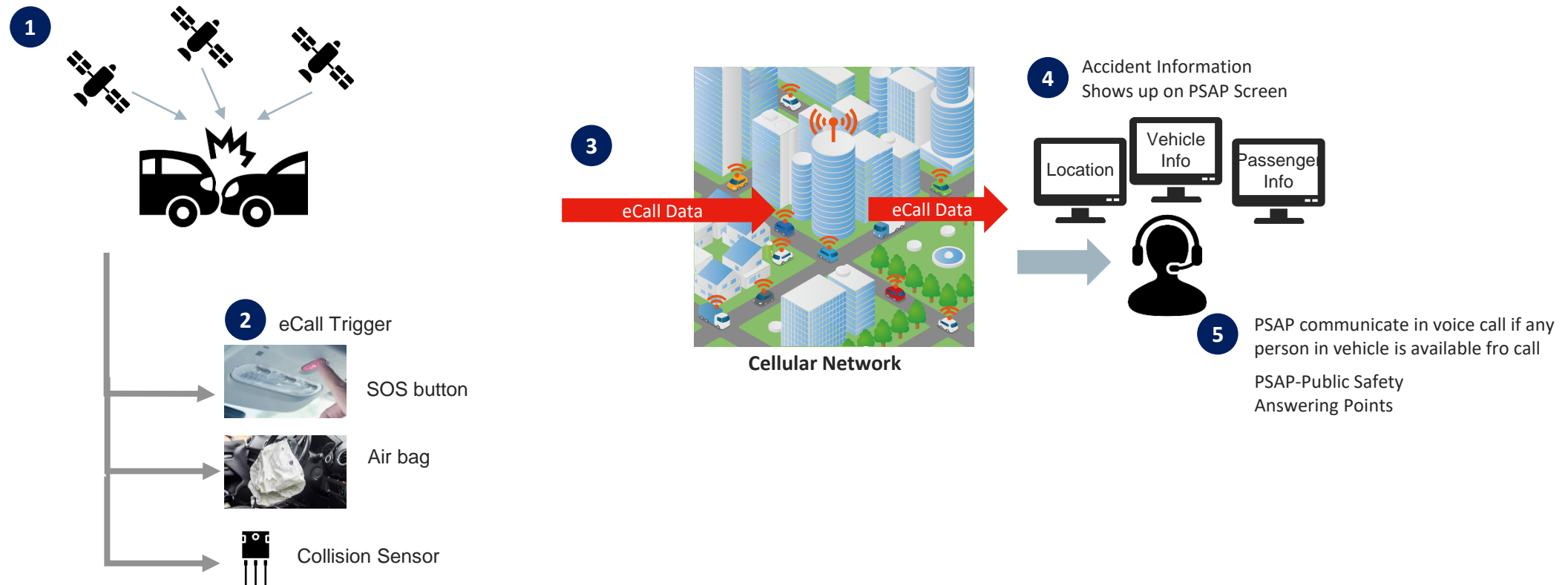
- Independent Power management system
- One to dual microphones become the main stream
- CODEC, Class D Audio Amp are also independent with the infotainment system



| What is the Emergency Call (eCall)?

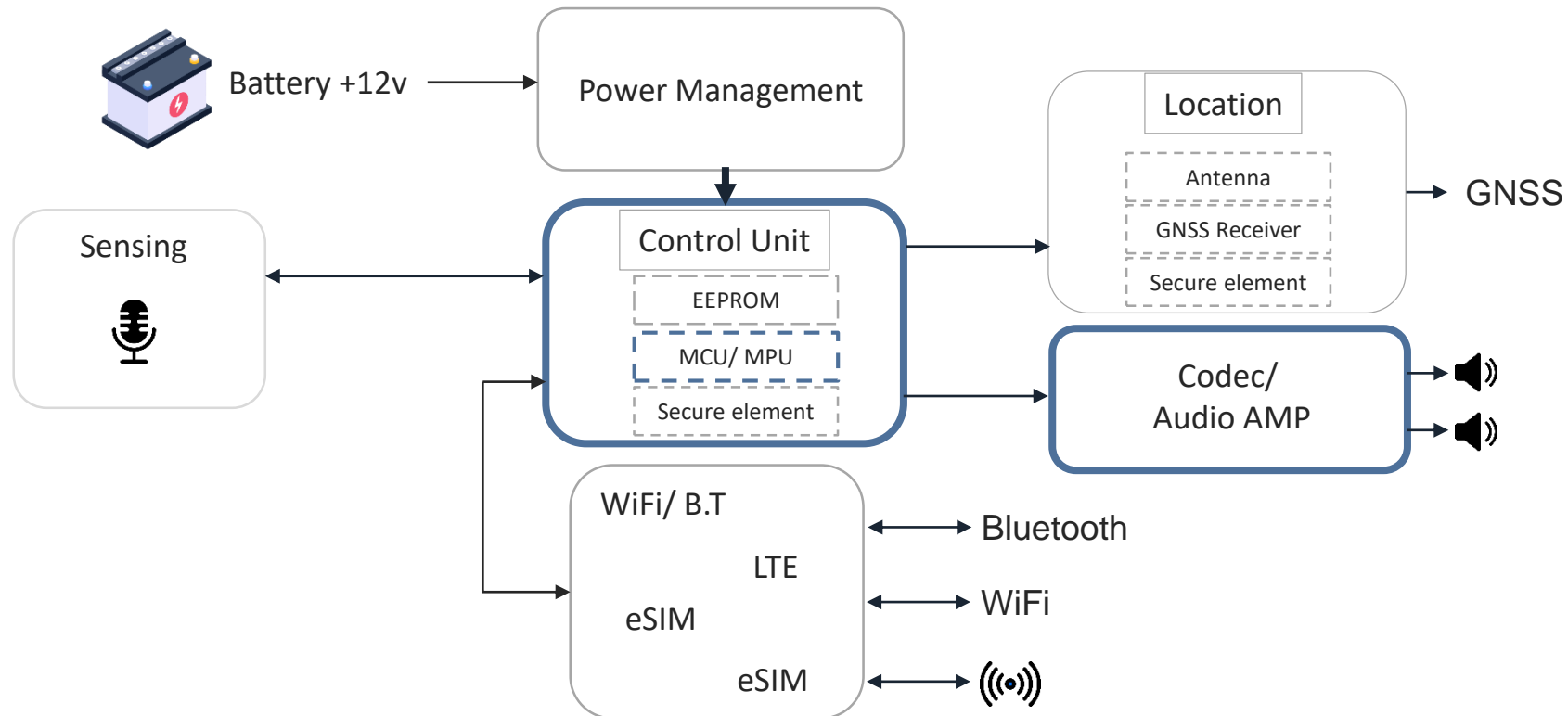
- **Emergency Call System**

E-Call is a pioneering European emergency-call system for vehicles that aims to bring rapid assistance to road traffic incidents anywhere in the European Union.



eCall Block Diagram

- Independent Power management system
- One to dual microphones become the main stream
- CODEC/ Class D Amp are also independent with the infotainment system



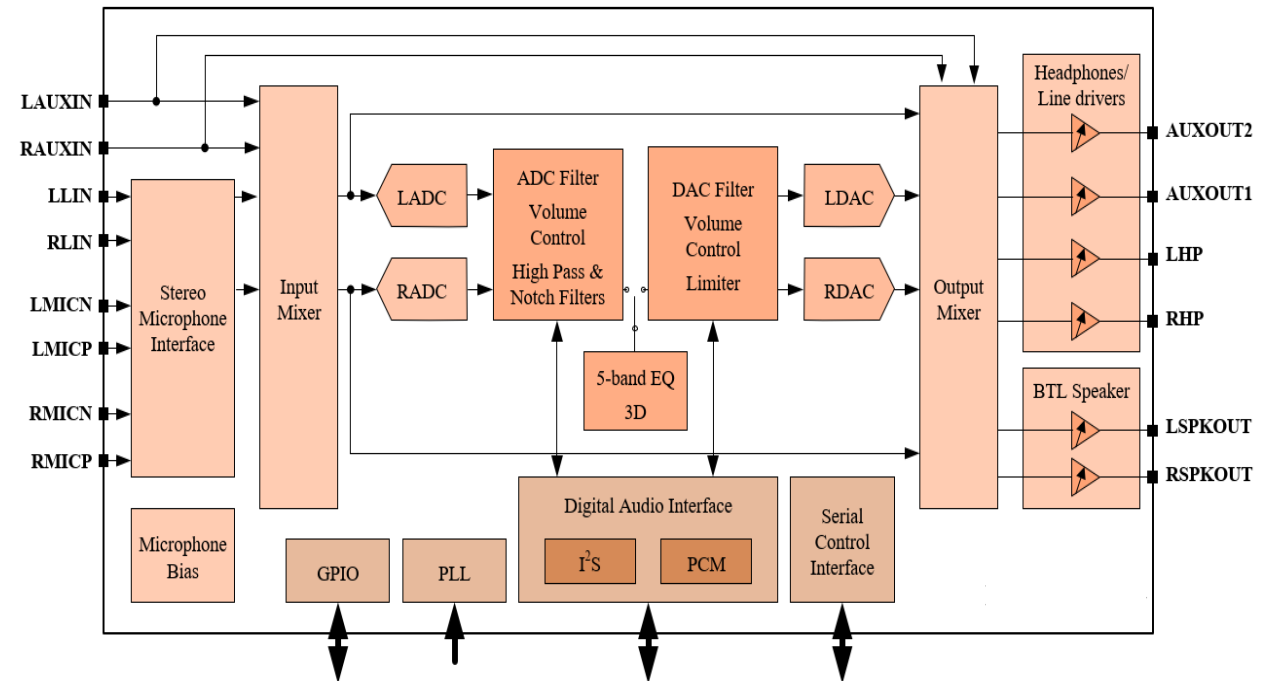
NAU88U20A

24-bit Stereo Audio Codec with Speaker Driver – Automotive Grade AEC-Q100 Qualification

- **Applications:** IPC, Automotive eCall, T-Box

- **Features:**

- DAC: 94dB SNR, -84dB THD
- ADC: 90dB SNR, -80dB THD
- Sampling rate from 8KHz to 48KHz
- Integrated Speaker/ headphone driver
 - 1W@8Ω/ 40mW@16Ω
- On-chip PLL
- Integrated DSP:
 - Input automatic level control (ALC/AGC)/limiter
 - Output dynamic-range-compressor/limiter
 - 5-Band Equalizer
 - 3-D audio enhancement
 - Notch filter and high pass filter



| NAU8315 Mono 3W Class-D I2S AMP

Features

- **Simplified Control**
 - Pin Selectable Gain Setting
 - Pin Selectable I2S L/R Ch selection
 - Pin Selectable PCM time slot
- **Low Output Noise: 12 μ VRMS**
- **80dB PSRR @217Hz**
- **Low Current Shutdown and Standby Modes**
- **Click-and Pop Suppression: 26 μ VRMS**
- **Sampling rate from 8K to 96 KHz**
- **Powerful Mono Class-D Amplifier:**
 - 3.2W (4 Ω @ 5V, 10% THD+N)
 - 1.76W (4 Ω @ 4.2V, 1% THD+N)
 - 1.8W (8 Ω @ 5V, 10% THD+N)
 - 1.0W (8 Ω @ 4.2V, 1% THD+N)

| NAU8325 Stereo 3W Class-D I2S AMP

Features

- **Low SPK_VDD Quiescent Current**
 - 2.1mA at 3.7V for 2 channels
 - 3.2mA at 5V for 2 channels
- **Gain Setting with 2 wire interface**
 - 22dB to -62dB (plus mute)
- **Low Output Noise**
 - 18 μ VRMS @0dB gain
- 80dB PSRR @217Hz
- Low Current Shutdown Mode
- Click-and Pop Suppression
- **Powerful Stereo Class-D Amplifier**
 - 2ch x 3.0W (4 Ω @ 5V, 10% THD+N)
 - 2ch x 1.32W (4 Ω @ 3.7V, 1% THD+N)
 - 2ch x 1.72W (8 Ω @ 5V, 10% THD+N)
 - 2ch x 0.75W (8 Ω @ 3.7V, 1% THD+N)

NuMicro® Automotive Product Portfolio

Memory				
1024 KB Flash				M467 Series
512 KB Flash	M487 Series	M487 Series		
256 KB Flash	M483 Series M453 Series	M483 Series M463 Series	M483 Series	
128 KB Flash	M253 Series	NUC230 NUC240 Series		
68 KB Flash	NUC131 Series			
32 KB Flash	M0A23 Series			
CAN	CAN x 1	CAN x 2	CAN x 3	CAN x 4

NuMicro® M0 Family

- **NUC230/240 Feature**
 - 72 MHz core speed
 - USB FS Device
 - CAN x2
- **M253 Feature**
 - 48 MHz core speed
 - USB FS Device
 - CAN-FD
- **NUC131 Feature**
 - 50 MHz core speed
 - CAN x1
 - AEC-Q100 Grade 2
- **M0A23 Feature**
 - 48 MHz core speed
 - CAN x1
 - AEC-Q100 Grade 1

NuMicro® M4 Family

- **M467 Feature**
 - 200 MHz core speed
 - USB 2.0 FS/HS OTG
 - 100M Ethernet MAC
 - CAN-FD x4
- **M487 Feature**
 - 192 MHz core speed
 - USB 2.0 FS/HS OTG
 - 100M Ethernet MAC
 - CAN x2
- **M463 Feature**
 - 200 MHz core speed
 - USB 2.0 HS OTG
 - CAN-FD x2
- **M483 Feature**
 - 192 MHz core speed
 - USB 2.0 FS/HS OTG
 - CAN x3
- **M453 Feature**
 - 72 MHz core speed
 - USB 2.0 FS OTG
 - CAN x1

NuMicro[®] M0A21/ M0A23 Series MCU

Flash/SRAM (Kbytes)	Package	
	SSOP20 (5.3 x 7.2 mm)	TSSOP28 (4.4 x 9.7 mm)
32 / 4	M0A23OC1ACU	M0A23EC1ACU
	M0A23OC1AC	M0A23EC1AC
16 / 4	M0A21OC1AC	M0A21EC1AC
	M0A21OB1AC	M0A21EB1AC

- Arm[®] Cortex[®]-M0 core
- Runs up to 48 MHz
- Operating temperature:
-40°C ~ +125°C
- HIRC with ±2 % precision from -40°C to +125°C
- High immunity:
EFT 4.4 kV, ESD HBM 6 kV

Automotive AEC-Q100 Grade 1

- M0A23OC1ACU
- M0A23EC1ACU

Industrial CAN

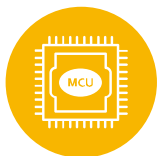
- M0A23OC1AC
- M0A23EC1AC

Industrial LIN

- M0A21OC1AC
- M0A21OB1AC
- M0A21EC1AC
- M0A21EB1AC

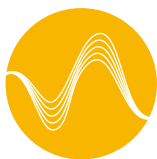
| NuMicro® M0A23 Series Features

AEC-Q100 Grade 1 Qualified MCU



System

- Arm® Cortex®-M0
- Runs up to 48 MHz
- 32 KB Flash Memory, 4 KB SRAM
- Hardware divider
- 5-channel PDMA
- Operating voltage: 2.5 V ~ 5.5V
- Operating temperature: -40°C ~ +125°C



Analog

- Programmable Internal V_{REF}
- 17-channel 12-bit ADC
- Built-in temperature sensor
- Internal band-gap reference voltage
- 2 sets of rail-to-rail ACMP
- 5-bit DAC



Peripherals

- 1 set of CAN 2.0A/B
- 2 sets of UART
- 2 sets of USCI (UART, I²C, SPI)
- 4 sets of timers
- 6 channels of PWM



Highlight

- AEC-Q100 Grade 1
 - M0A23OC1ACU
 - M0A23EC1ACU

NuMicro® NUC131 Series MCU

Flash/SRAM (Kbytes)		
68 / 8	NUC131LD2AEU	NUC131SD2AEU
	NUC131LD2AE	NUC131SD2AE
	NUC1311LD2AE	
36 / 8	NUC131LC2AE	NUC131SC2AE
	NUC1311LC2AE	
Package	LQFP48 (7 x 7 mm)	LQFP64 (7 x 7 mm)

- Arm® Cortex®-M0 core
- Runs up to 50 MHz
- Operating voltage:
2.5 V ~ 5.5 V
- Operating temperature:
-40°C ~ +105°C
- 1 set of CAN, 3 sets of LIN, 6 sets of UART

Automotive AEC-Q100 Grade 2

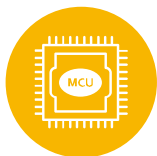
- NUC131SD2AEU
- NUC131LD2AEU

Industrial Grade

- NUC131SD2AE
- NUC131LD2AE
- NUC1311LD2AE
- NUC131SC2AE
- NUC1311LC2AE

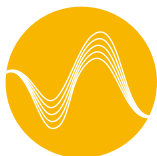
| NuMicro® NUC131 Series Features

AEC-Q100 Grade 2 Qualified MCU



System

- Arm® Cortex®-M0 core
- Runs up to 50 MHz
- 68 KB Flash Memory, 8 KB SRAM
- Operating voltage: 2.5 V ~ 5.5 V
- **Operating temperature: -40°C ~ +105°C**
- EFT: 4.4 kV



Analog

- 8-channel 12-bit ADC
- BOD/LVR



Peripherals

- **1 set of CAN 2.0B**
- 3 sets of LIN
- 6 sets of UART, 1 set of SPI, 2 sets of I²C
- 24-channel 100 MHz PWM

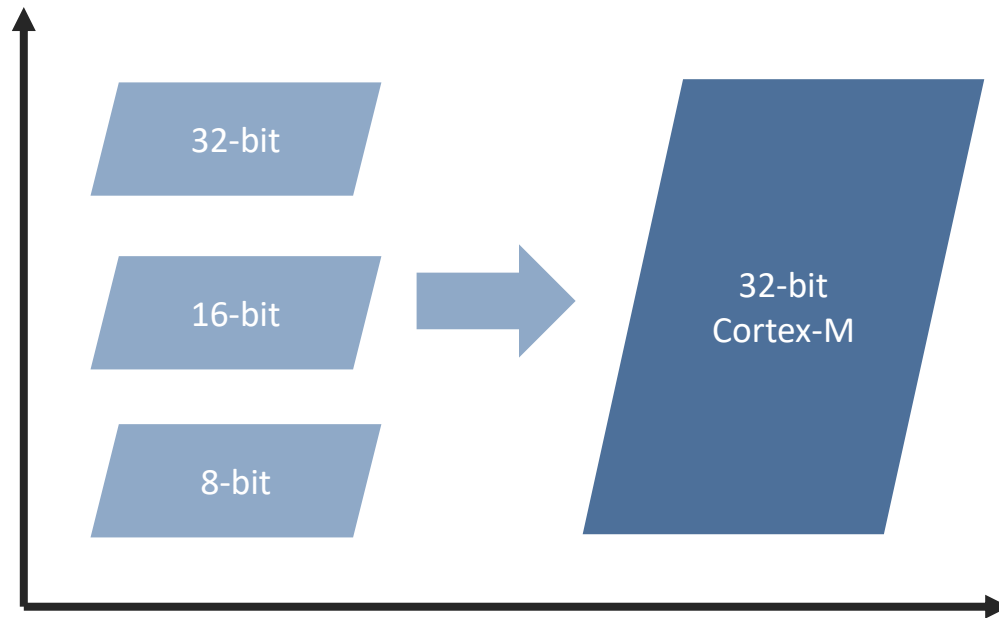


Highlight

- **AEC-Q100 Grade 2**
 - NUC131SD2AEU
 - NUC131LD2AEU

| New General Propose Automotive Platform

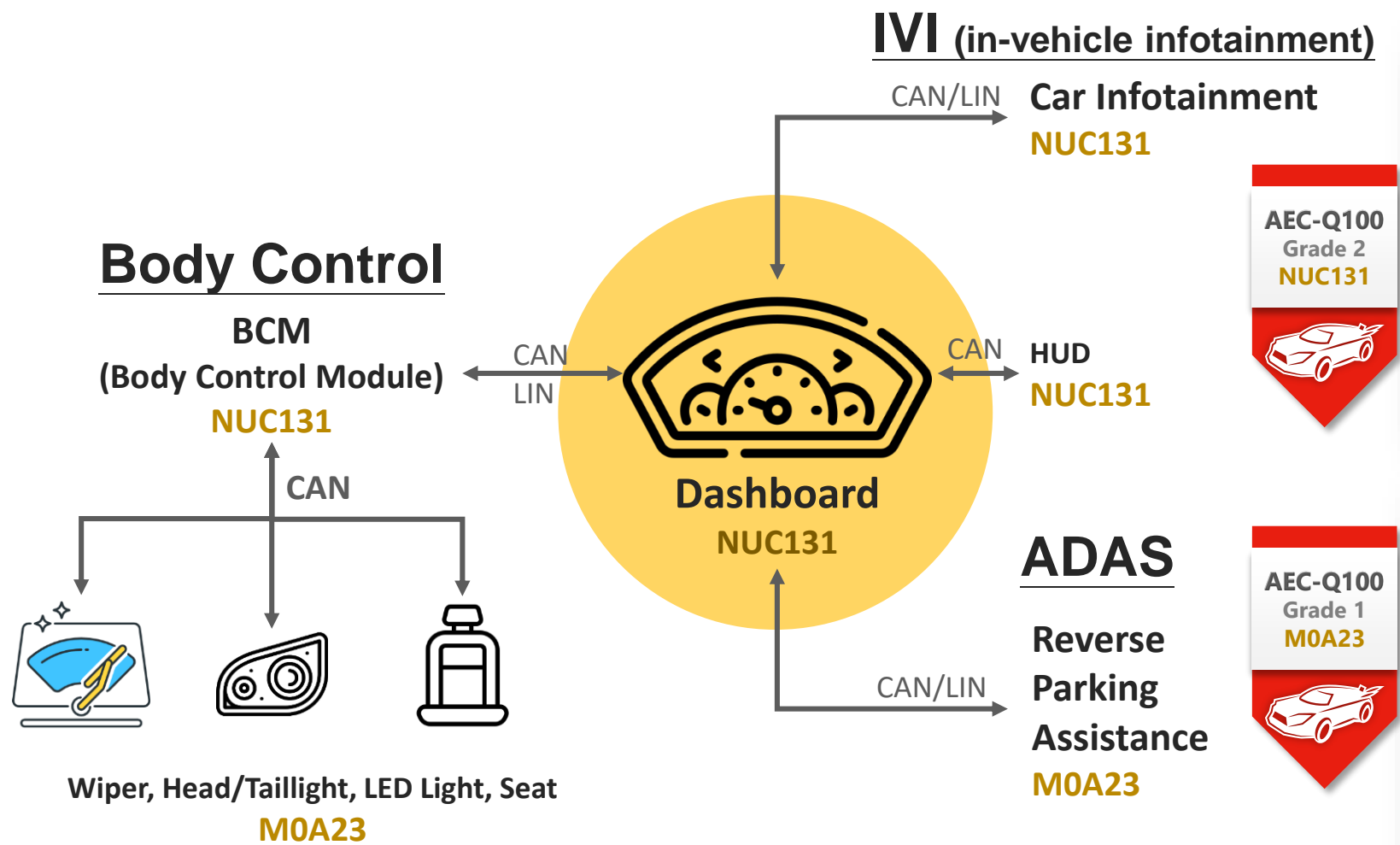
- Moving to the ARM Cortex-M architecture



Unified Platform:

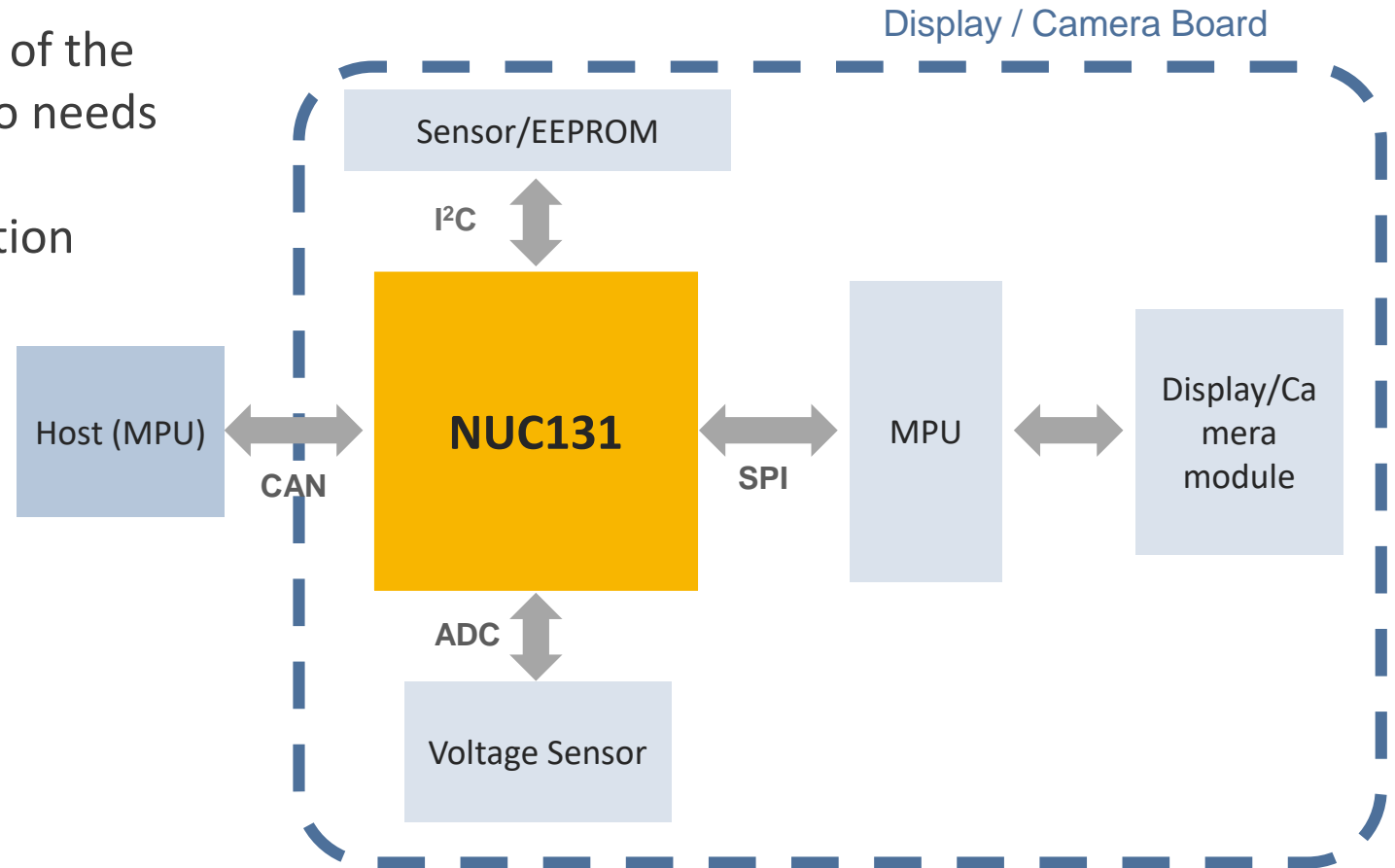
- Software development kit
- P2P
- Free IDE: Keil
- Unified ICE/SWD interface
- Bootloader (LDROM): CAN/UART/I²C/SPI
- Easy to use: Development tool
 - PIN Configure
 - PIN View
 - Clock configure

Nuvoton Automotive MCU Solution



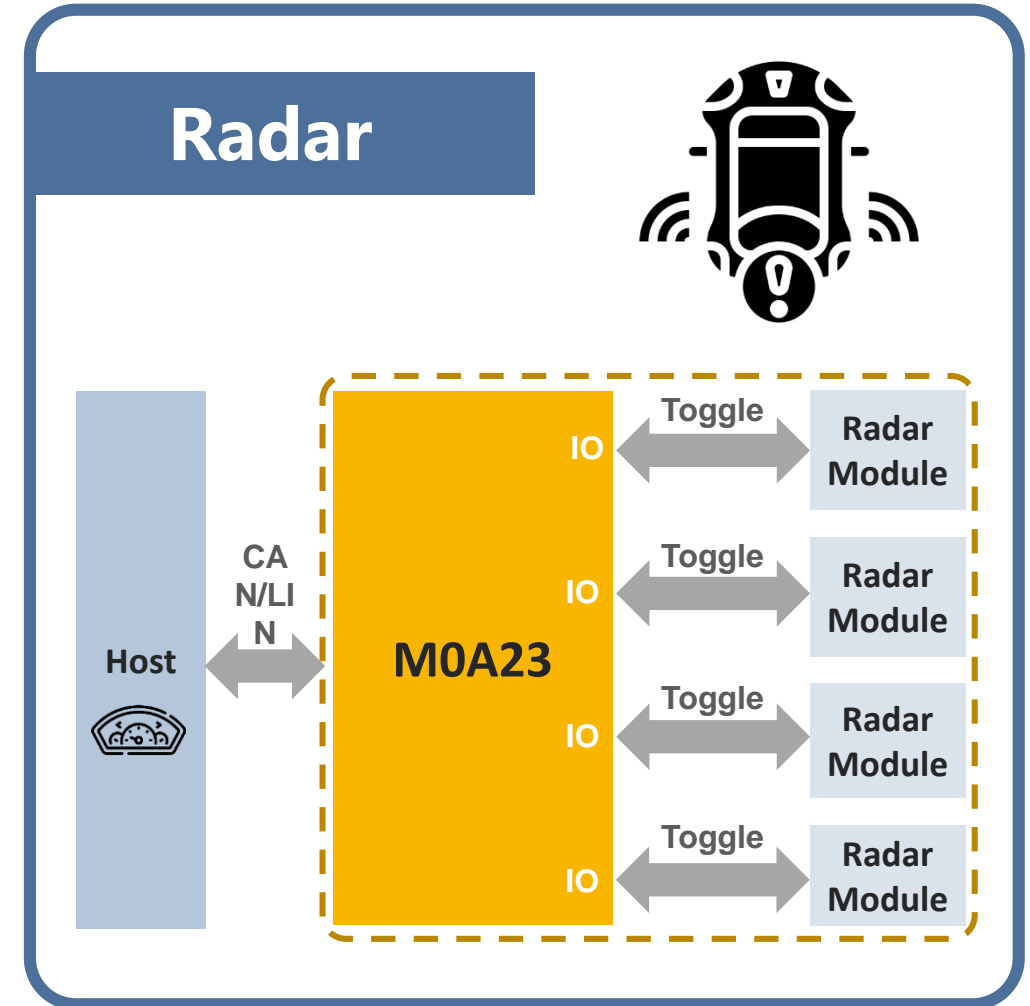
CAN Bridge – Display / Camera Module

- In addition to the graphics processing of the MPU, the Cluster/Camera module also needs an MCU. This MCU is used for power management, IO control and information transmission.
- **NUC131 Series Provides:**
 - CAN: Information transmission
 - SPI: Connect to MPU
 - I²C: Sensor, EEPROM
 - 8 sets of ADC:
 - Power management
 - Knob, Voltage sensor



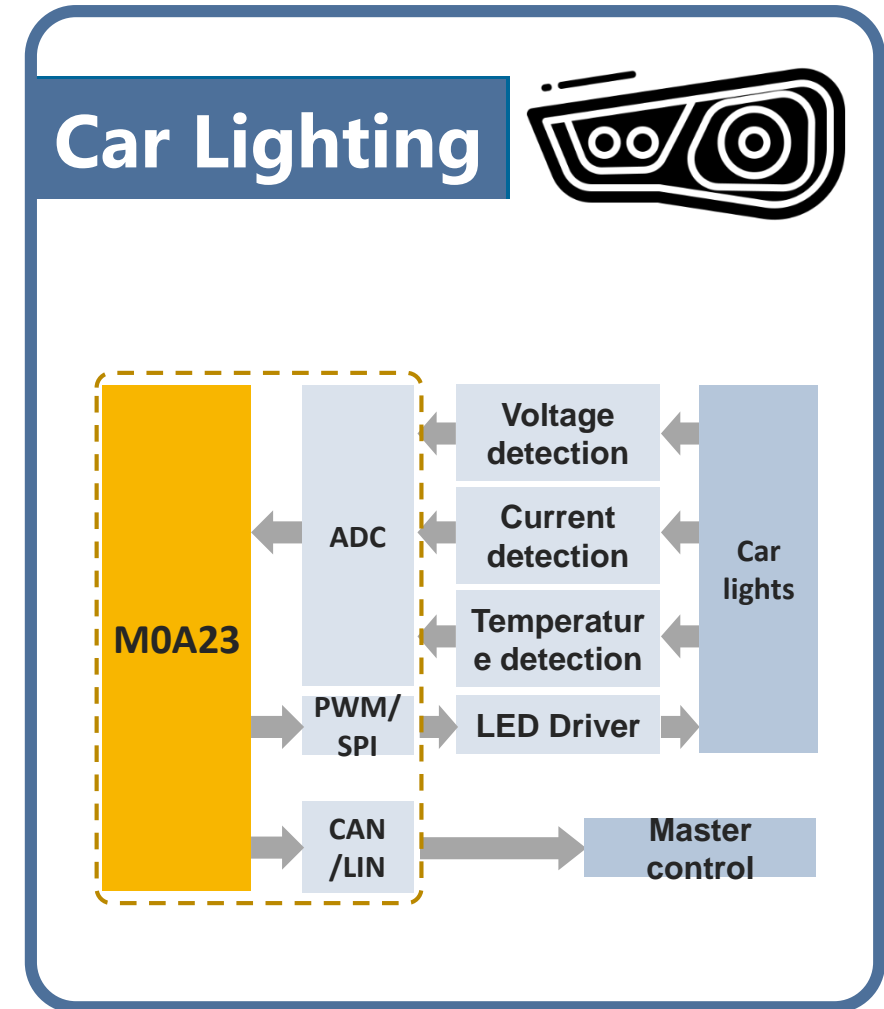
| NuMicro® M0A23 Series Application – Radar

- **M0A23 Series Provides:**
 - AEC-Q100 Grade 1
 - Radar Sensor Communication:
 - Timer x4
 - IO x8
 - Host Communication:
 - CAN/LIN
 - Operating temperature: up to 125°C



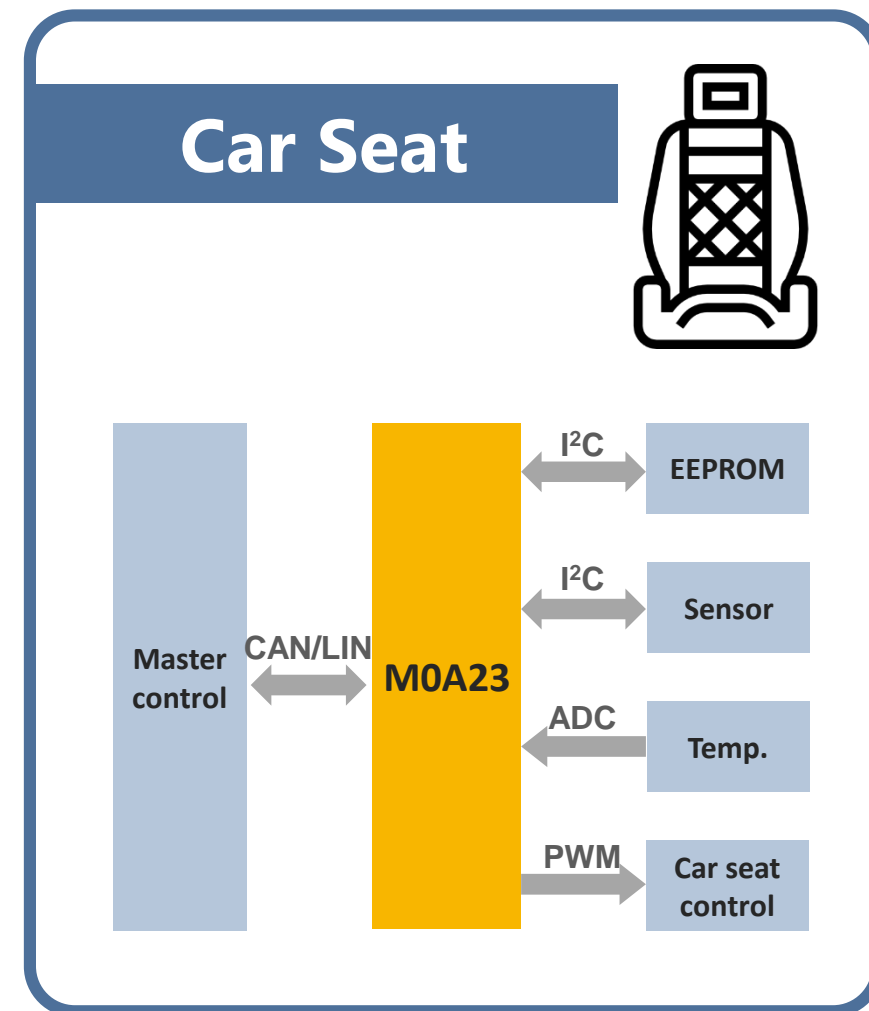
| NuMicro[®] M0A23 Series Application – Car Lighting

- M0A23 Series Provides:
 - AEC-Q100 Grade 1
 - LED Driver:
 - 6-channel PWM
 - I²C / SPI
 - Voltage/Current measure: 8-channel ADC
 - Host communication: CAN / LIN



| NuMicro[®] M0A23 Series Application – Car Seat

- **M0A23 Series Provides:**
 - AEC-Q100 Grade 1
 - Car seat control: 6-channel PWM
 - Host communication: CAN/LIN
 - EEPROM, sensor module: I²C
 - Temp. / voltage measure: ADC



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Cảm ơn

IoT Security Solutions

Security Technologies

凌立民 Robert Ling

Microcontroller Application Business Group

Senior Technology Manager



| Common IoT Security Threats (1)

- Unsafe communication, unauthorized access

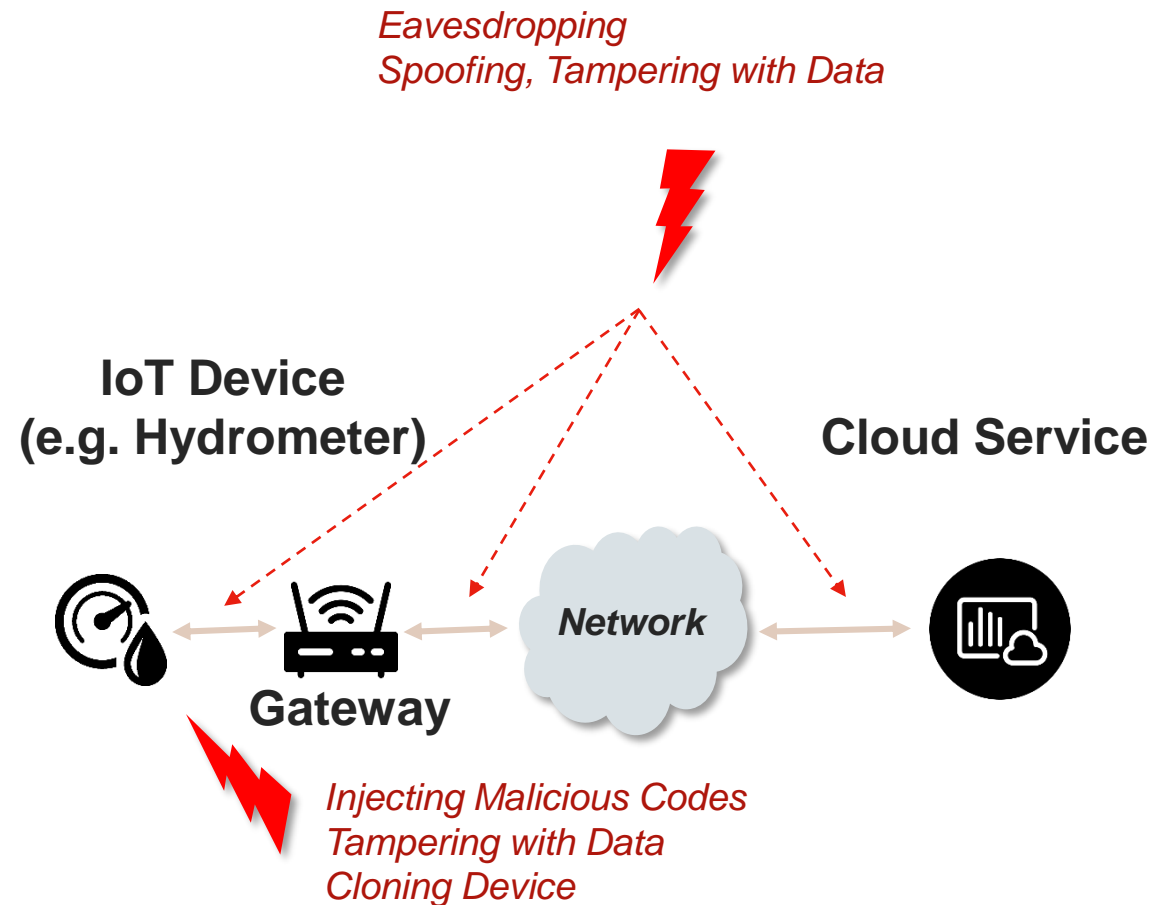
Remote Access, private Information Leaks, home Invasions,

How do we protect the connection?

- Secure Socket Layer (SSL) or Transport Layer Security (TLS) protocol
- Digital certificates
- Symmetric and asymmetric key system, authentication

Security blocks from MCU

- Secure storage for unique ID, certifications, keys, etc.
- Unpredictable random number generator
- Cryptographic Accelerator: ECC, AES, DES/3DES, ...



| Common IoT Security Threats (2)

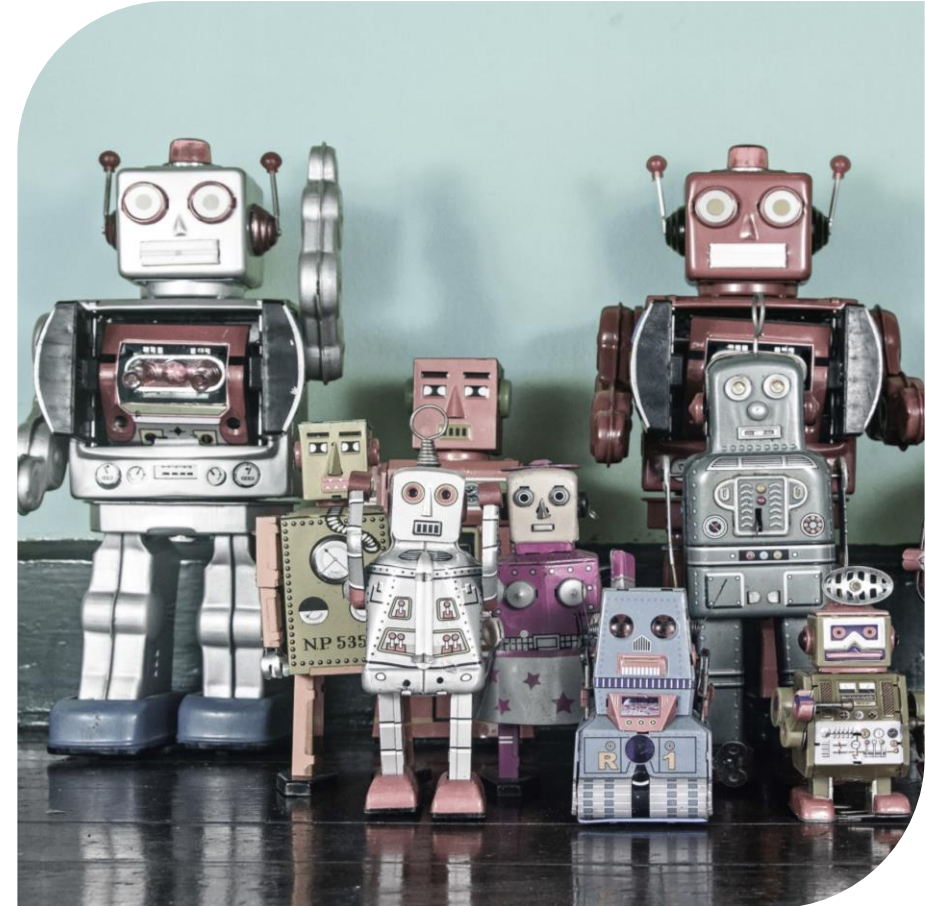
- Unsafe communication or access
- **Compromised IoT devices**

Botnet attack, malware attack, ...

How do we authorize the embedded firmware image and firmware update?

Security building blocks from MCU

- Secure boot and secure OTA
- Secure storage for certifications, keys, signature, etc.
- Cryptographic Accelerator: ECC, SHA, and HMAC-SHA
- Trust Zone to limit access
- OTP for life cycle management



| Common IoT Security Threats (3)

- Unsafe communication or access
- Compromised IoT devices
- **Physical attack**

Physical tampering, JTAG access, clocking

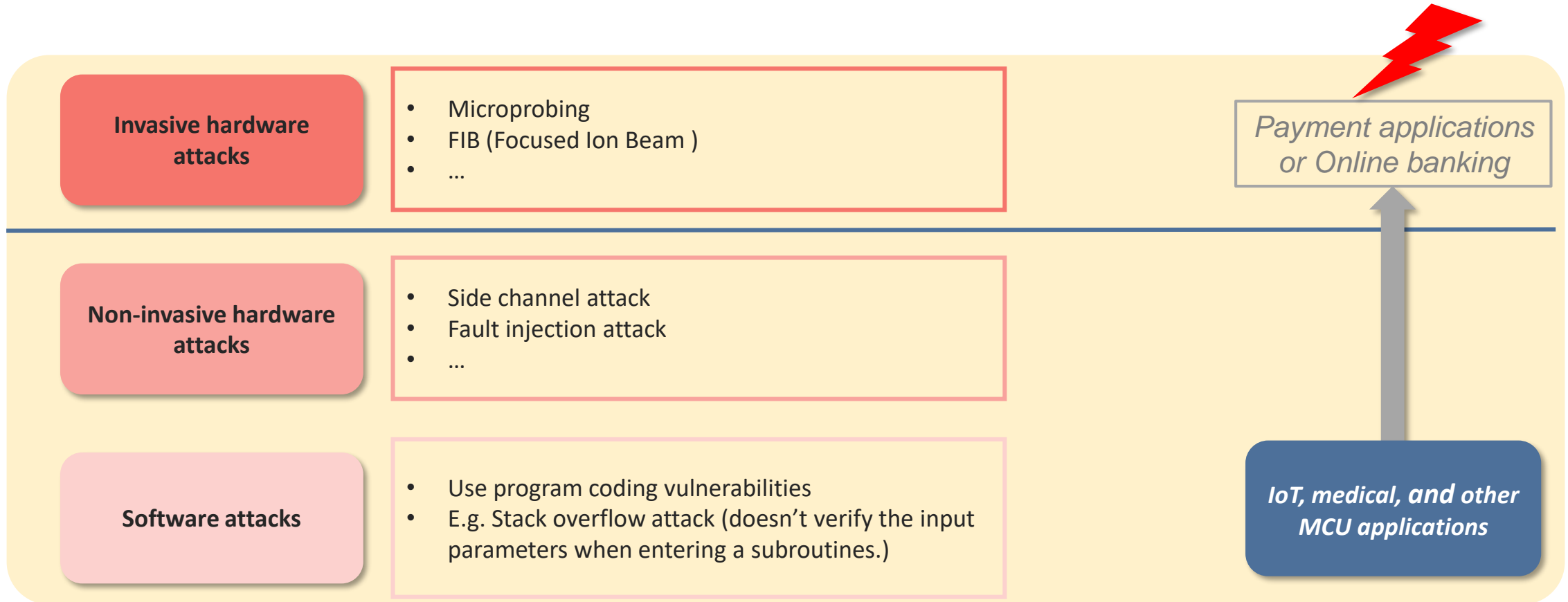
Security building blocks from MCU

- Physical tempering detection
- Protected flash memory
- Trust Zone to limit access
- Clock monitoring and voltage glitch detection



| MCU Security Target

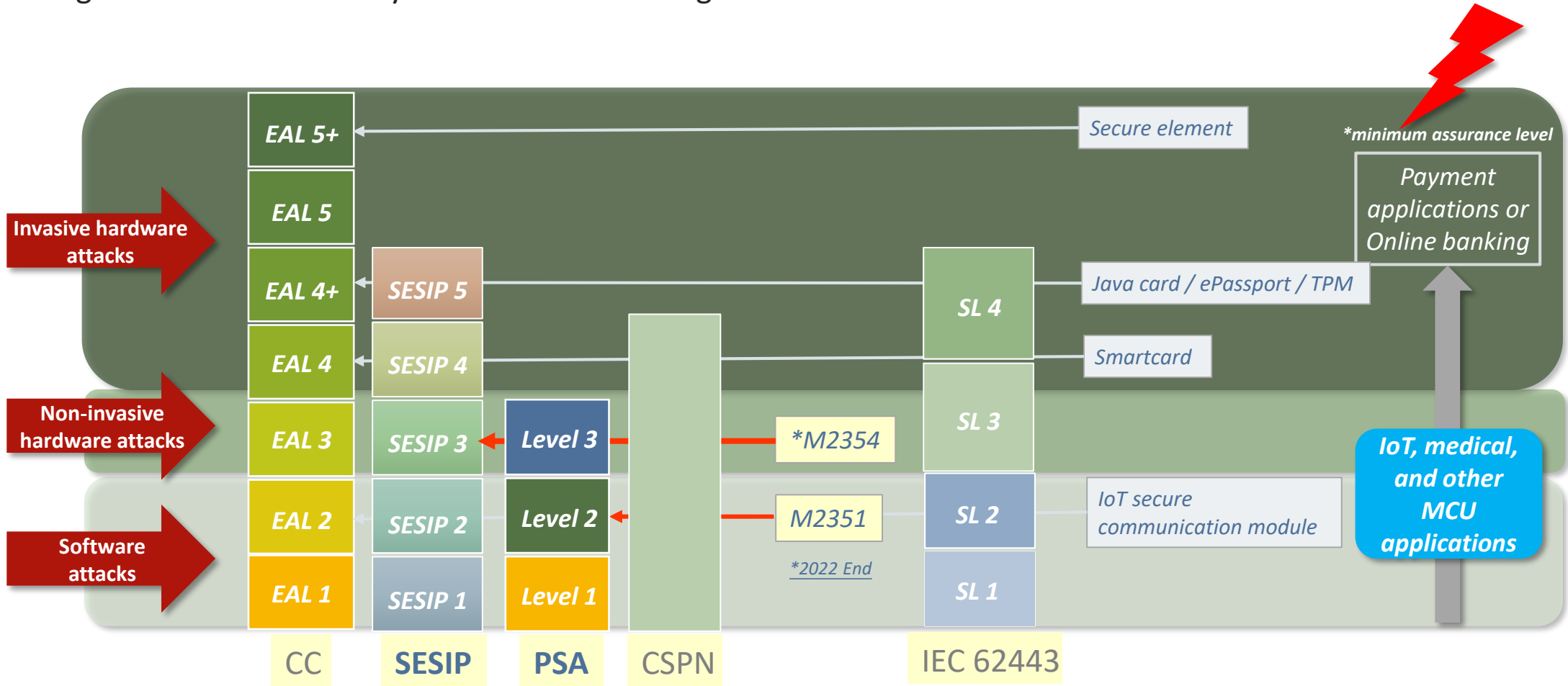
- Implement the security features to defend against **software attacks** and **non-invasive hardware attacks**.



Attacks types on MCU

Current Progress of IoT Security Related Certifications

- Integrate sufficient security features to defend against **software attacks** and **non-invasive hardware attacks**.



Certification schemes / assurance levels / target applications

M235x Security Features at a Glance

Device & Customer identification (UID, CID)

Integrity check and secure firmware upgrade

Hardware authentication for updating Flash memory

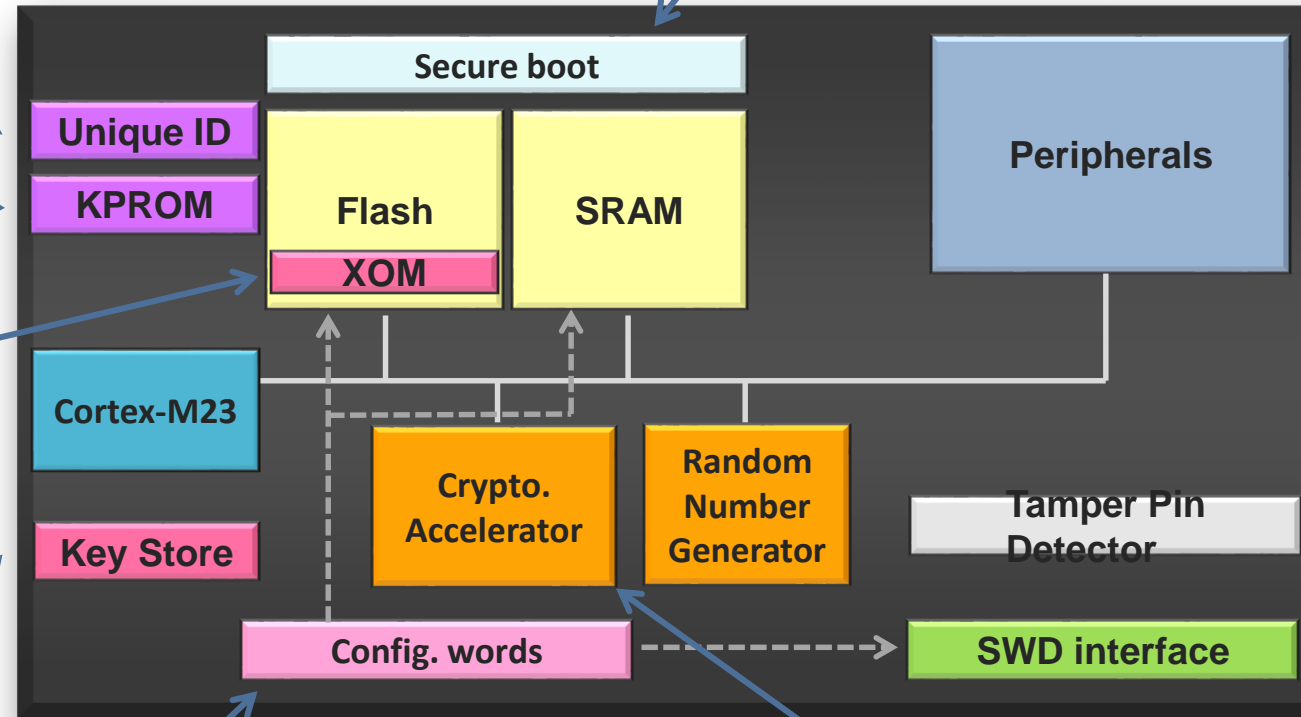
eXecute-Only Memory region for SW IP protection

TrustZone Isolation, Voltage and Clock glitches detection and protection

Chip-Level Active Shield (M2354)

Multiple level setting for Flash lock, SWD disabled for Secure Debug

Countermeasures to Side-Channel Monitoring for encryption and decryption operations (M2354)



Detect input state transition

Secure Debug Interface and Function

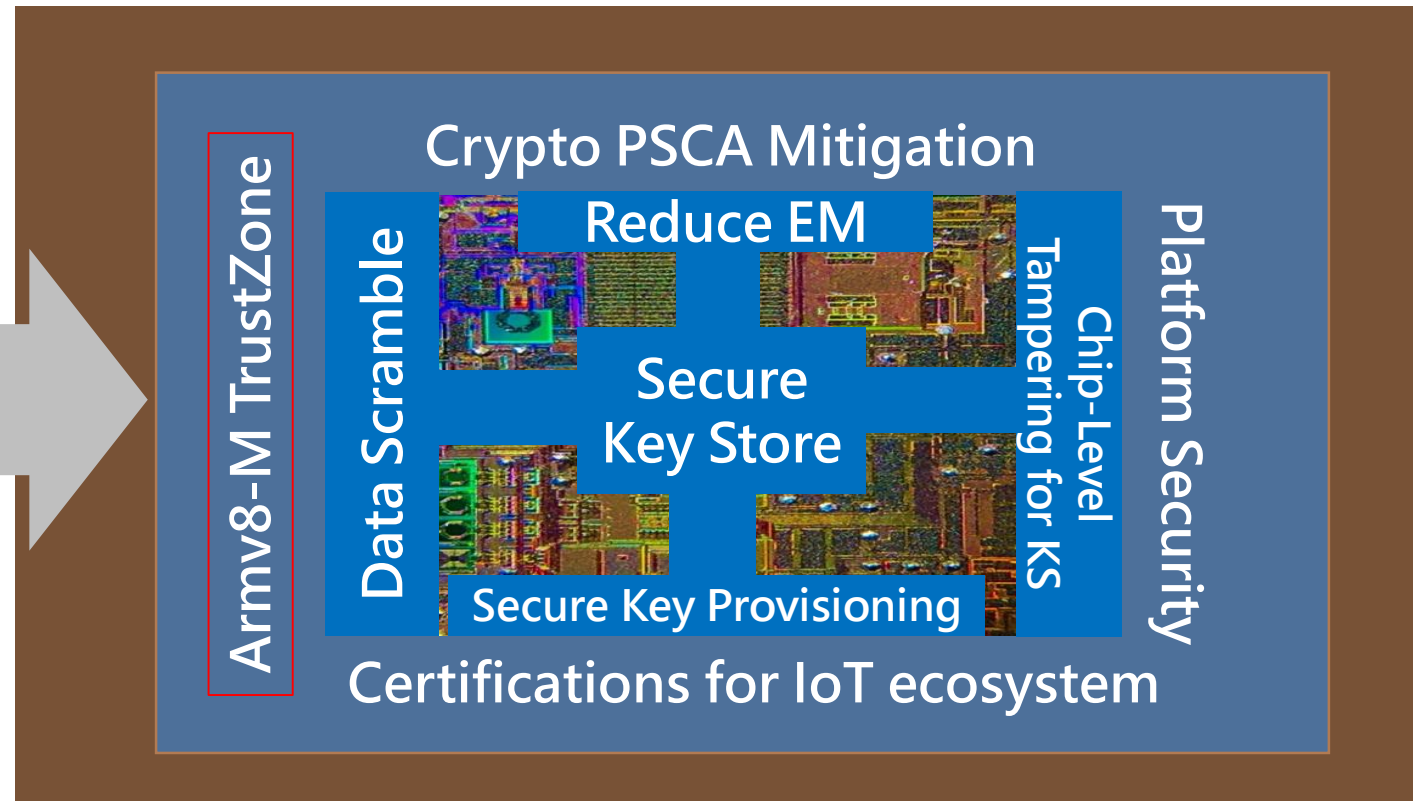
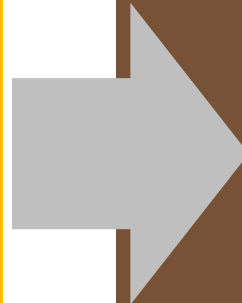
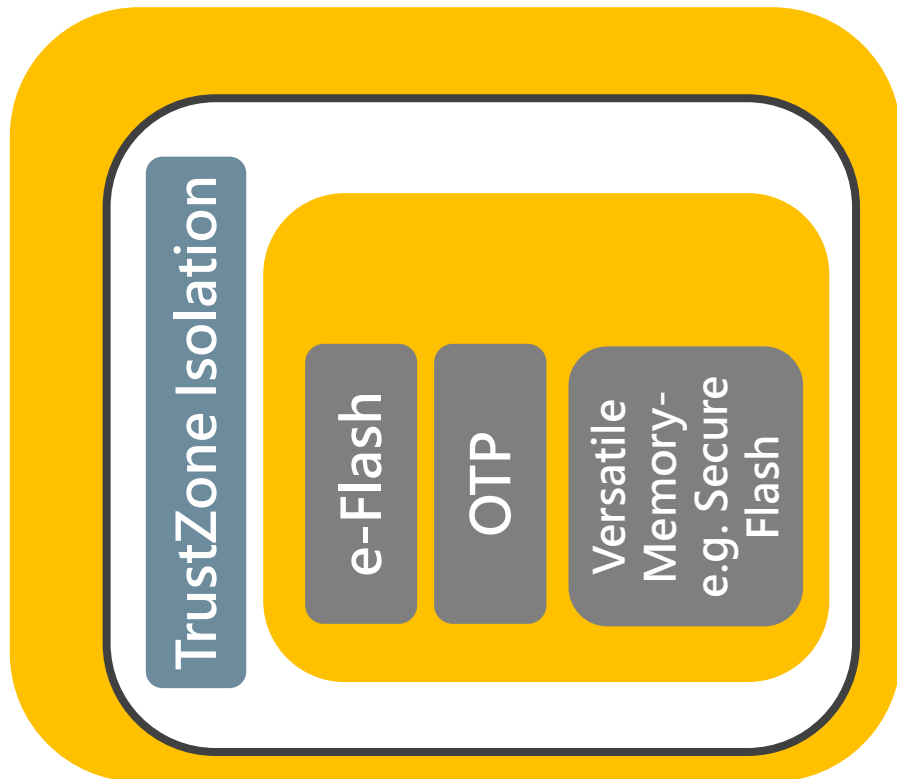
| M235x IoT Security Microcontroller

M2351

TZ-CPU (SW RoT) + Crypto + PCB
Tampering

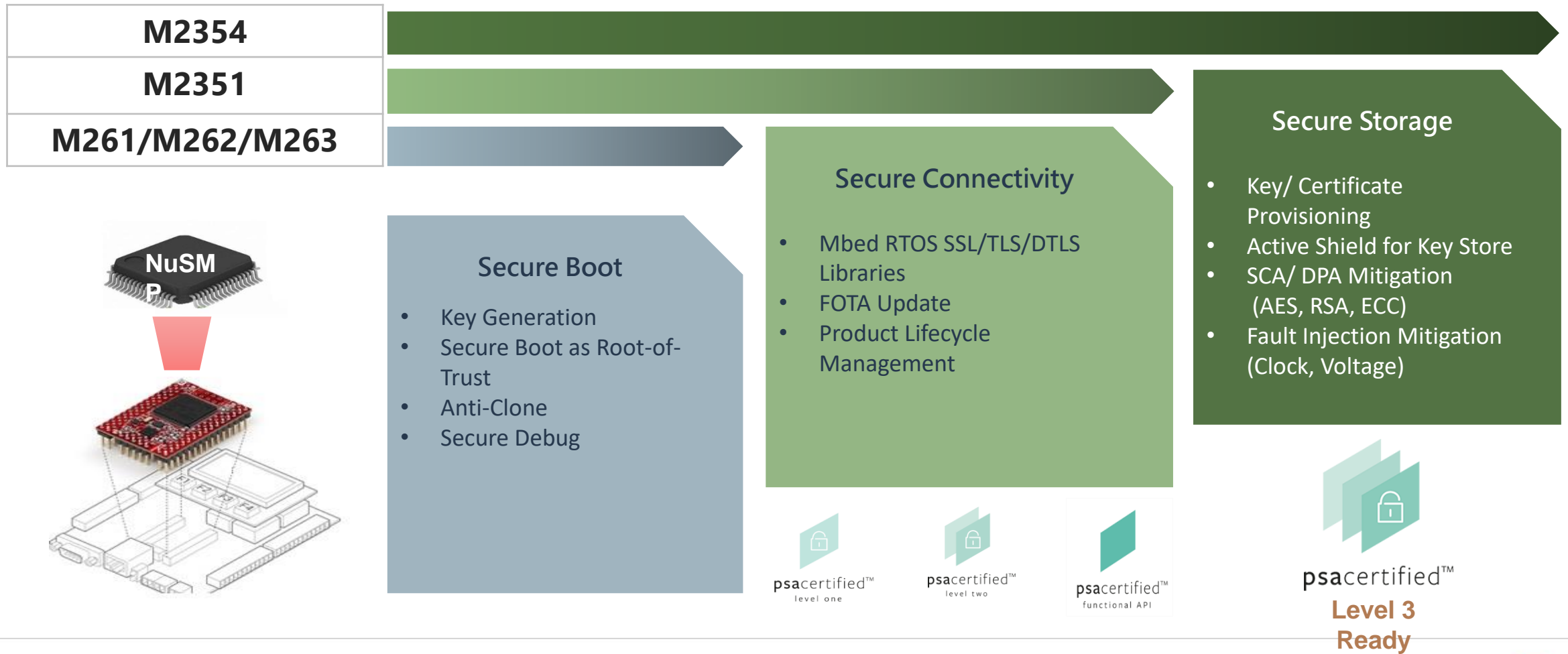
M2354

TZ-CPU + HW RoT (KS) + Crypto with PSCA mitigation +
Platform Security + Certification

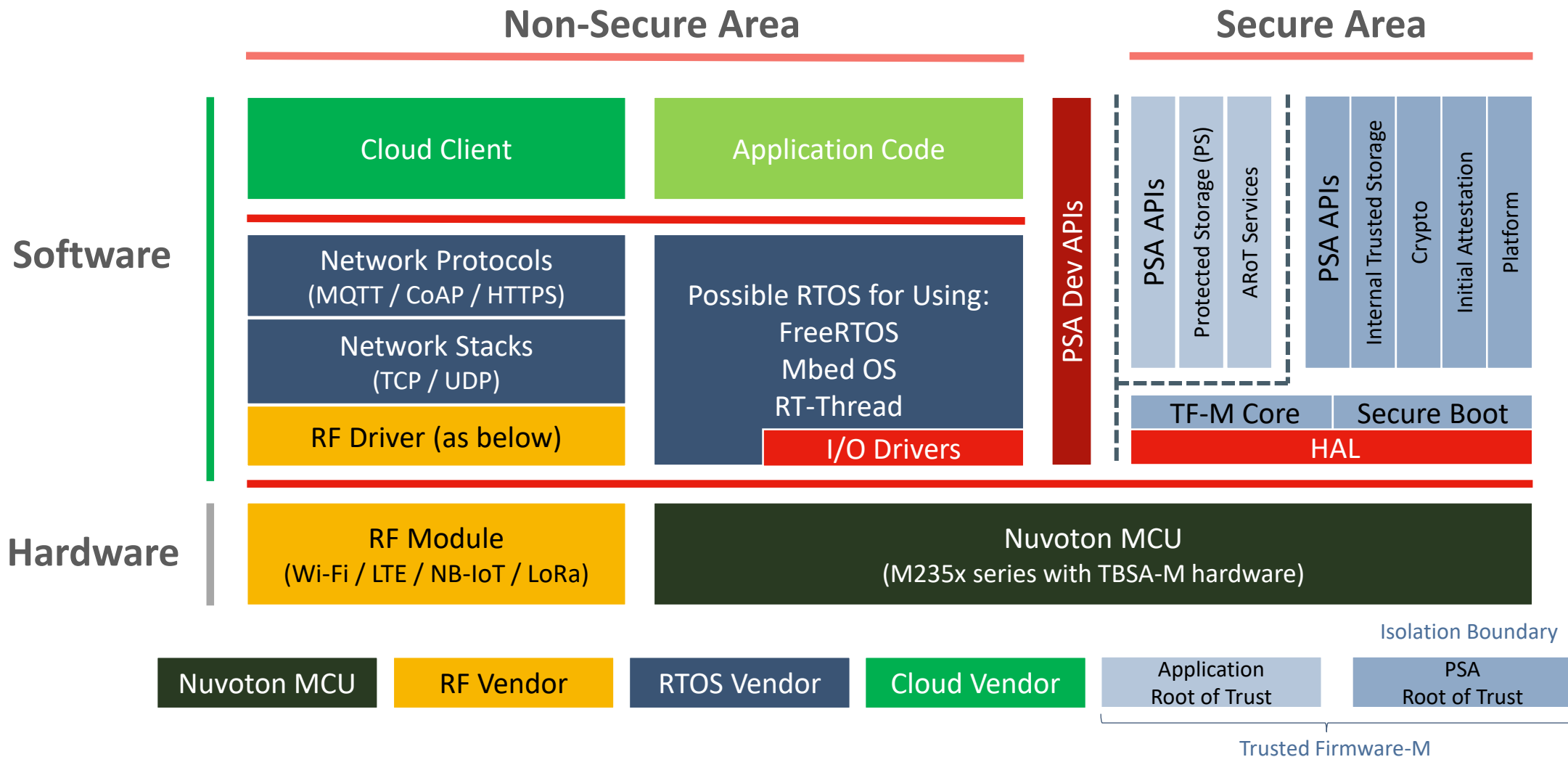


| Main Security Features of NuMicro[®] M235x

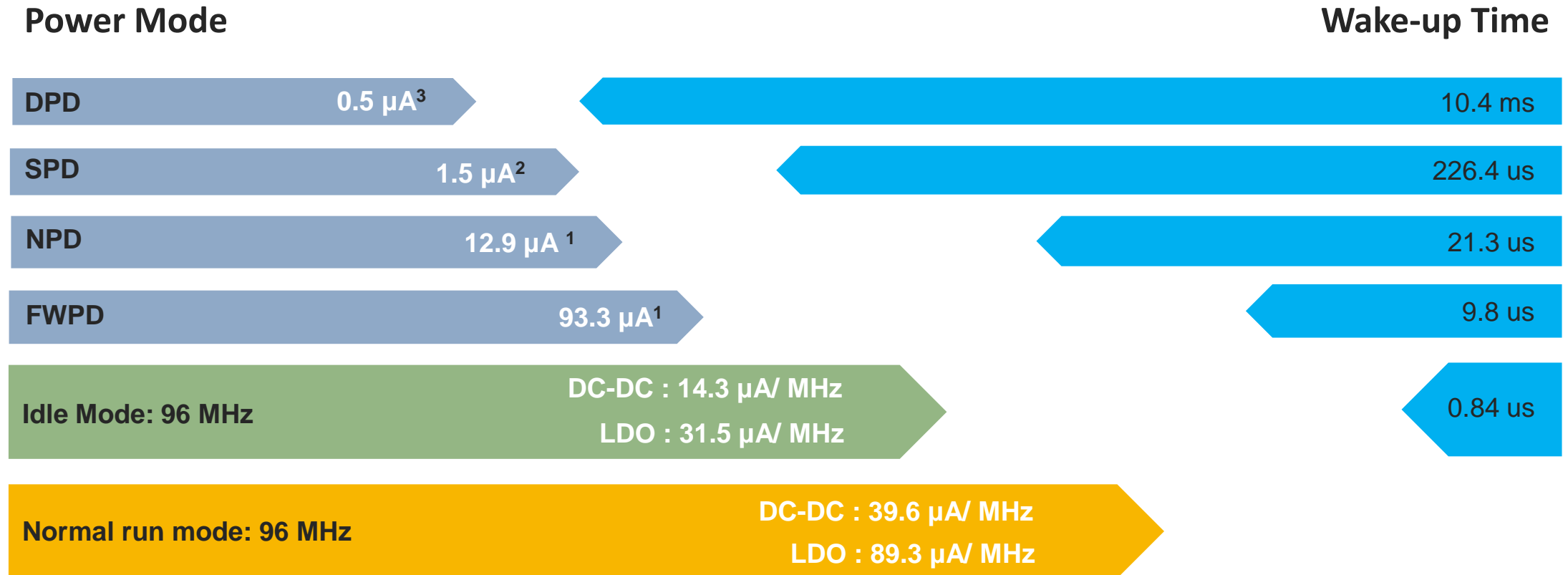
- NuMicro[®] Secure Microcontroller Platform: Secure Boot, Secure Connectivity, Secure Storage (**NuSMP**).



M2354 IoT Platform with TF-M (Q4, 2022)



| M2354 Series Power Performance



Note: 1. Keep all SRAM retention
2. Only keep 4 KB SRAM retention
3. With RTC register 80 bytes retention

| Support Multiple Real-Time Operating Systems

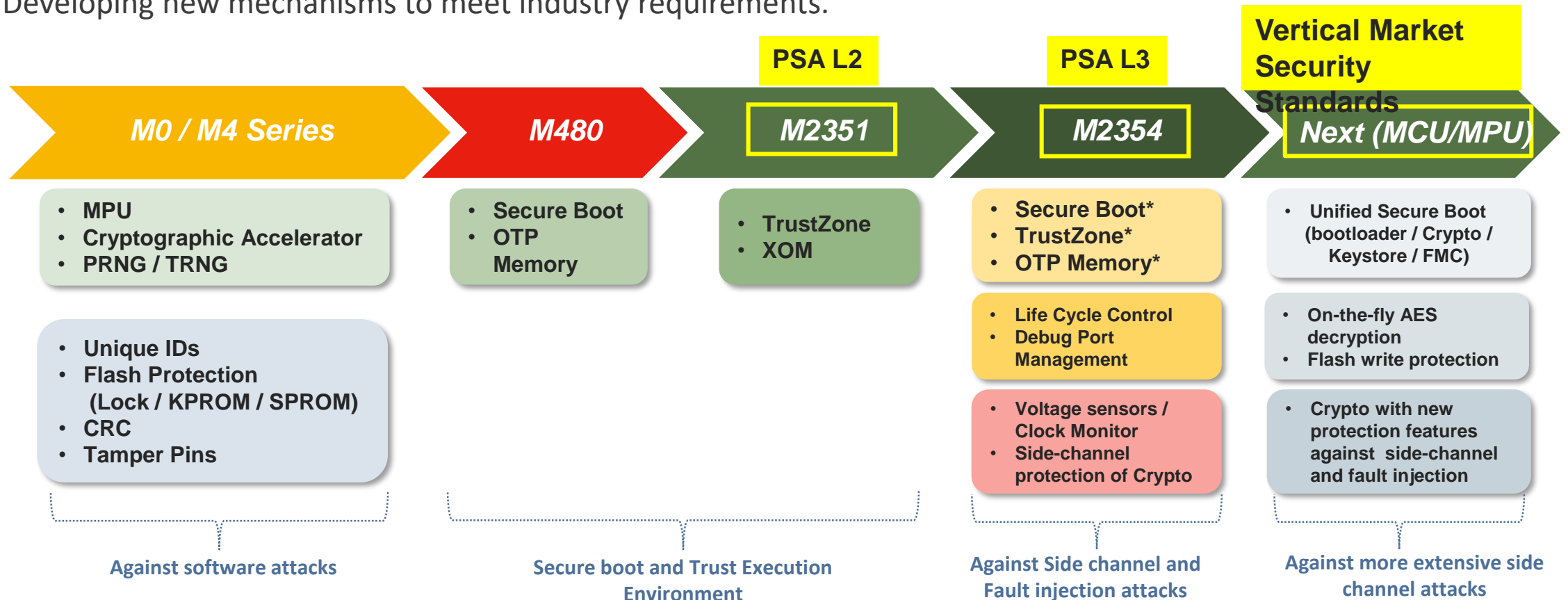
- Speed up your RTOS porting - OS ready solution to save your OS porting time.

Core	NuMaker Boards/ NK + Extension Boards	IP Connectivity Ready				Support RTOS			Support Cloud		
		Wi-Fi	NB-IoT	802.15.4 Thread + ZigBee	LoRa (915 MHz, 470 MHz)	Mbed OS	FreeRTOS	RT-Thread	Arm Pelion Device Manager	Amazon AWS IoT	Microsoft Azure IoT Hub
Cortex-M23	NK-BEDM2351 (w/ 802.15.4 module)	●		●		●	●	●	●	●	●
	NuMaker-IoT-M263A	●	●			●	●	●	●	●	●
	NK-BEDM2354	●				●	●	●	●	●	●
	NuMaker-IoT-M2354	●		●	●	●	●	●	●	●	●



Nuvoton Security Technology Roadmap

- Able to against **software attacks** and **lightweight hardware attacks** as well as provide **Secure boot** and **Trust Execution Environment**.
- Developing new mechanisms to meet industry requirements.



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| NuMicro[®] IoT Security Technology Summary

MCU System Security



Secure Boot

Secure Bootloader in ROM with Driver APIs



Device Identification

Unique ID, Customer Unique ID



Isolation

TrustZone-M, TrustZone-A, Peripheral Privileged Mode, Trusted Secure Island (TSI for MPU)



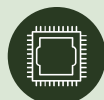
Flash Memory Protection

Read/Write Protection, eXecute-Only Memory (XOM), Dual-Bank with Bank Swap



System Anti-Tampering

Tamper Detection Pins, RTC Domain Backup Registers



Chip-Level Security

Temperature Sensor, Clock Function Monitor, Voltage Glitch Detection

Crypto Security



TRNG, Hardware Accelerators, Secure Storage

TRNG, DES/3DES, SHA, AES, RSA, ECC, Power Side-Channel Attack Mitigation for AES/RSA/ECC, Secure Key-Store, China SM2/SM3/SM4

Product Lifecycle Security



Product Lifecycle Management

Booting Status Monitor, Lifecycle Management, Firmware Version Counter



Secure Debug

Debug Authentication (temporarily unlock), Debug Port Management (DPM)

Software and Service



Security Reference Software and Provisioning

Key Generation Tool, Firmware Image Signing Tool, OTA Update, Key/Certificate Provisioning Service

New Energy Solutions

Battery Management System

王榆甄 Jenny Wang

Microcontroller Marketing and Application Division
Technology Manager

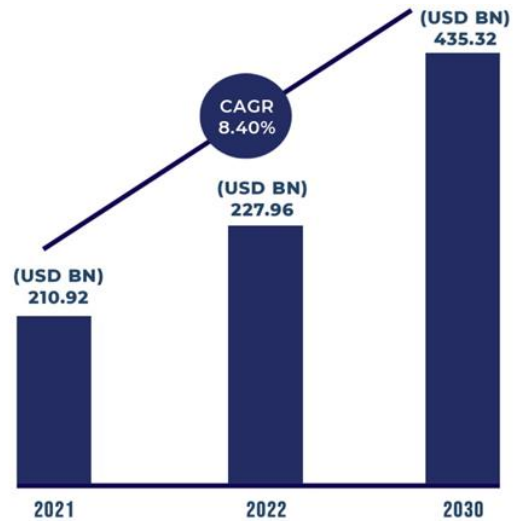




2022年 供應鏈的減碳元年

| Energy Storage System (ESS) Market Overview

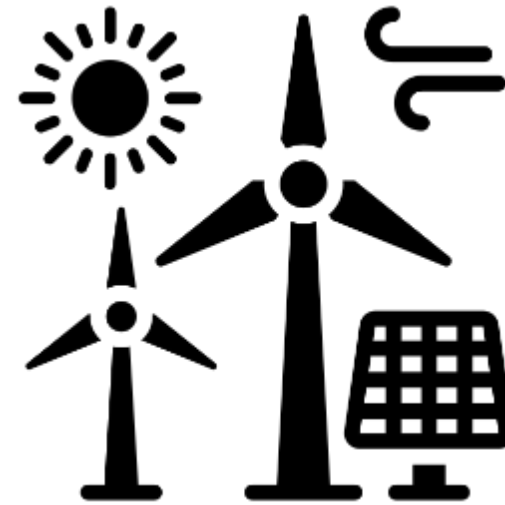
- Global market size is projected to surpass around US\$ 435 B by 2030 and [CAGR of 8.4% from 2022 to 2030](#)
 - The environment protection and reduction of carbon footprint
 - Development of sustainable energy sources for utility application



(Source: Precedence Research, 2022)

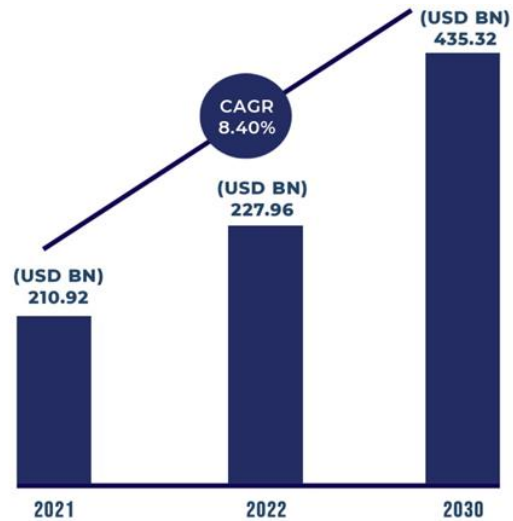


Solar and wind energy are the most prominent renewable energy types that are stored in grids. However, the concealing of the sun by clouds or fluctuating currents leads to variations in the process of energy generation



| Energy Storage System (ESS) Market Overview

- 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

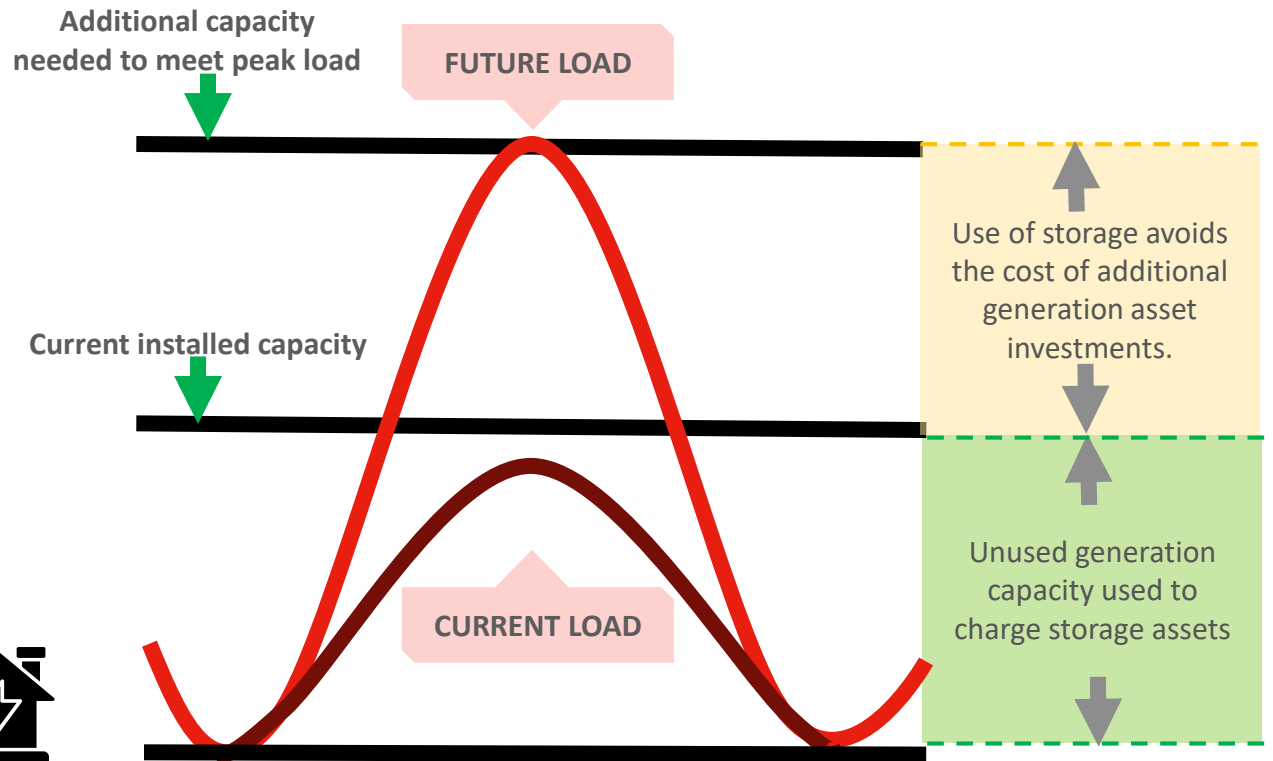
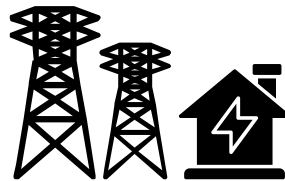


(Source: Precedence Research, 2022)

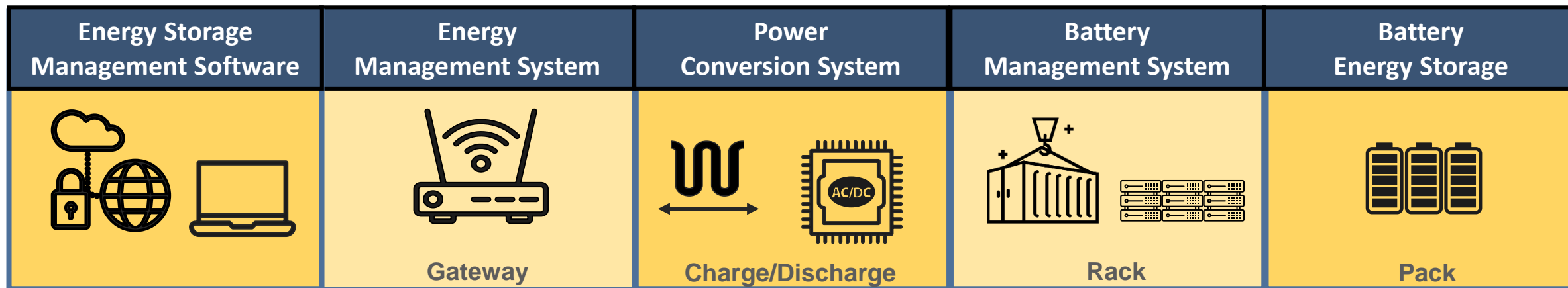


Benefit

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



| Energy Storage System Architecture

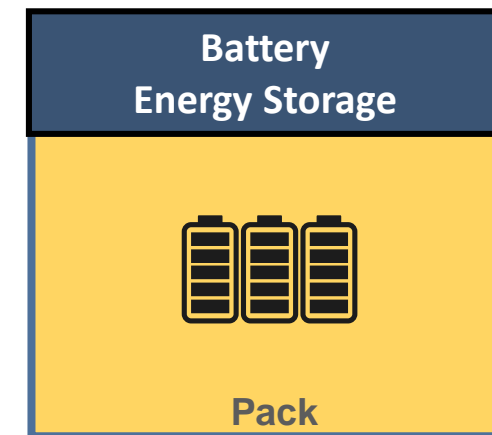


PCS: Power Conditioning System
BMS: Battery Management System
EMS: Energy Monitor System

| 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

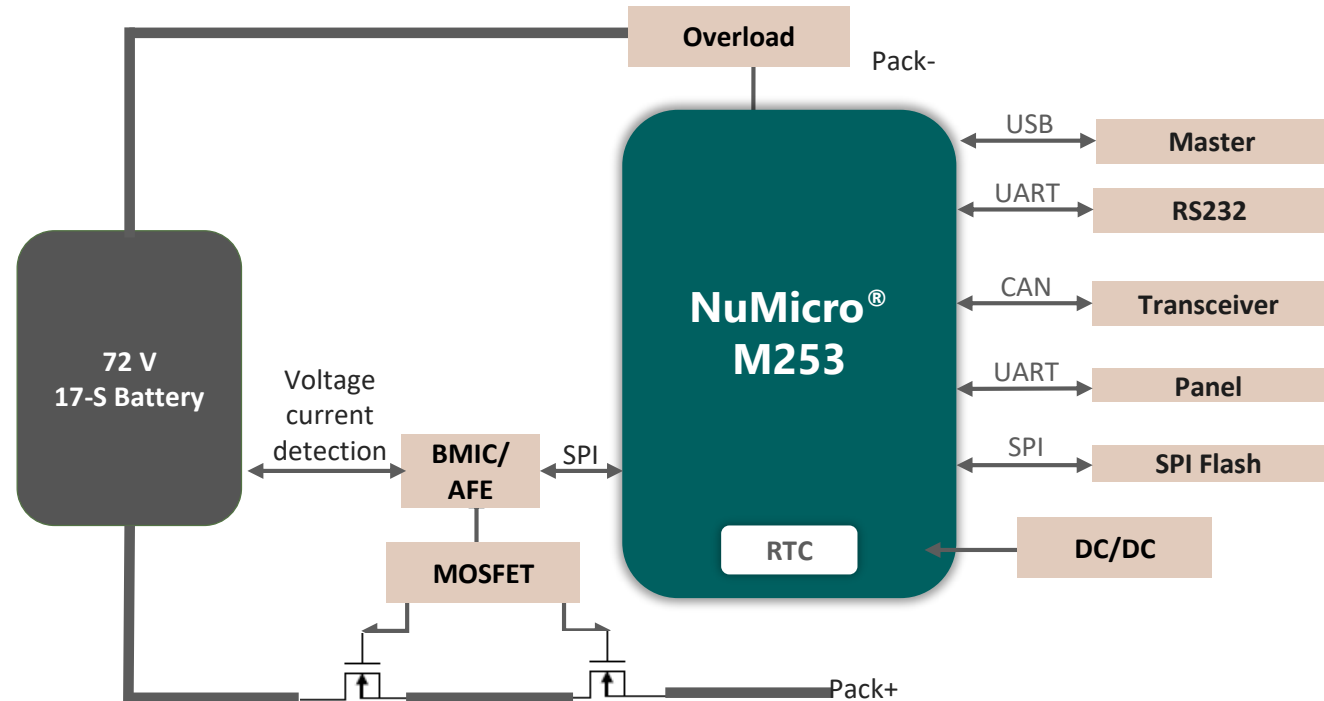


PCS: Power Conditioning System
BMS: Battery Management System
EMS: Energy Monitor System

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

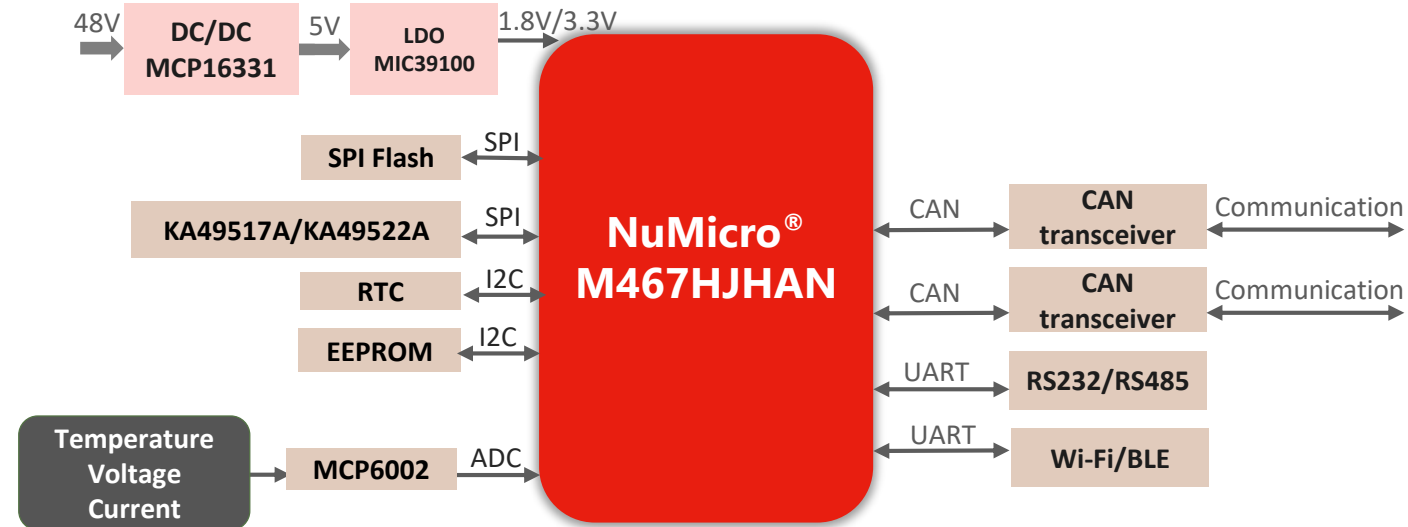


PCS: Power Conditioning System
BMS: Battery Management System
EMS: Energy Monitor System

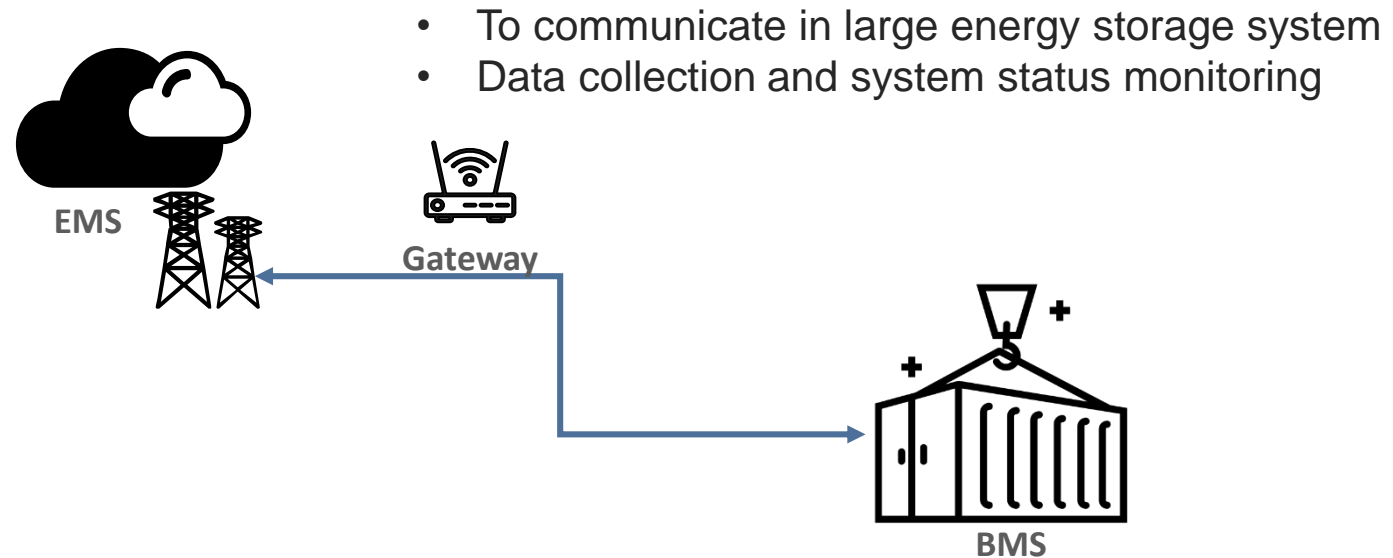
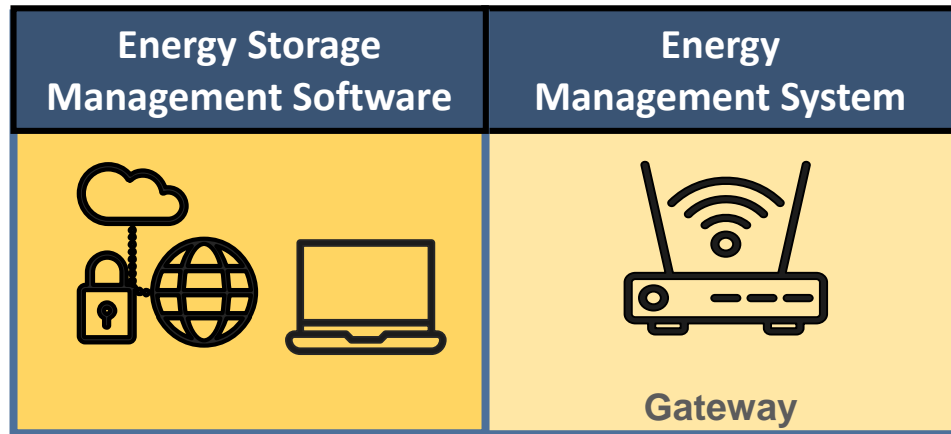
Battery Management System

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



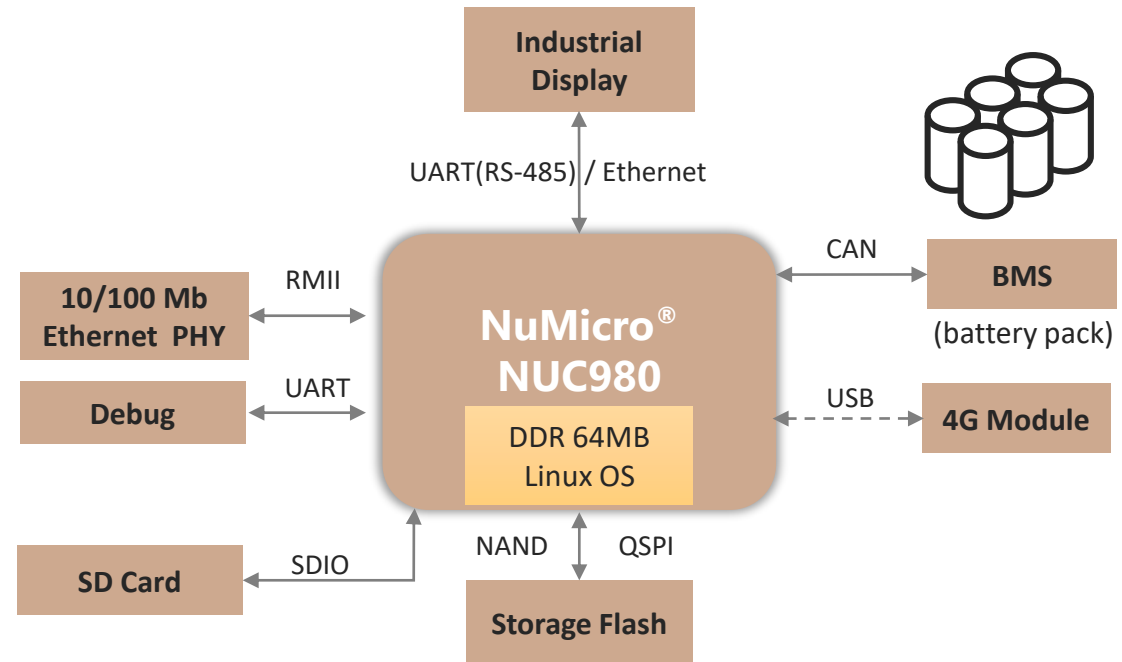
3rd Layer NuMicro[®] NUC980

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

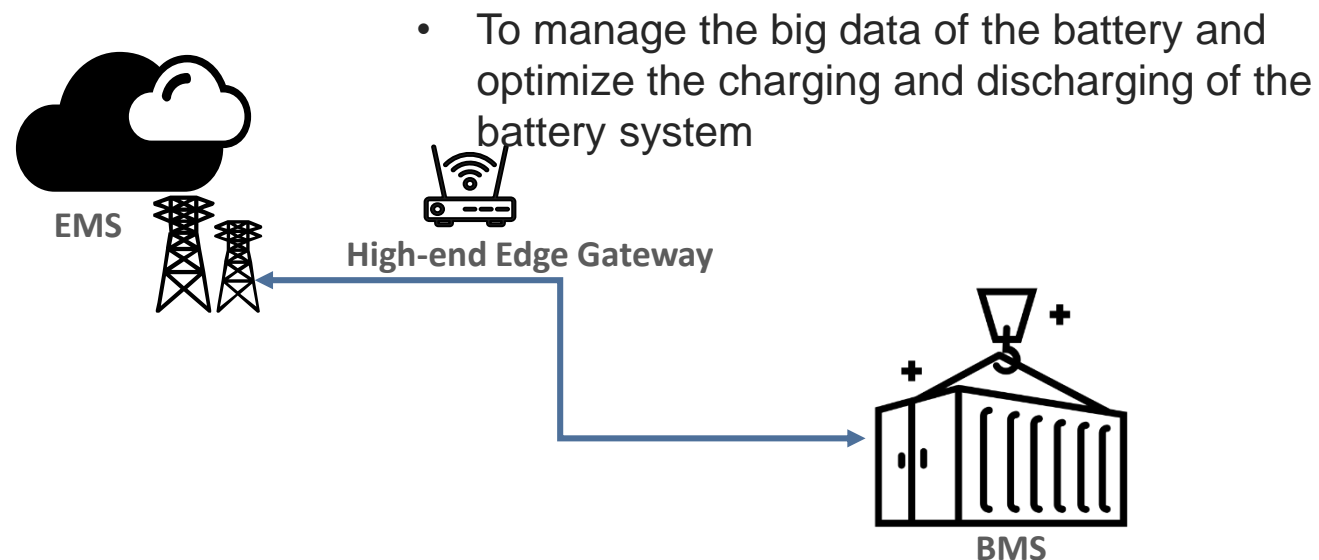
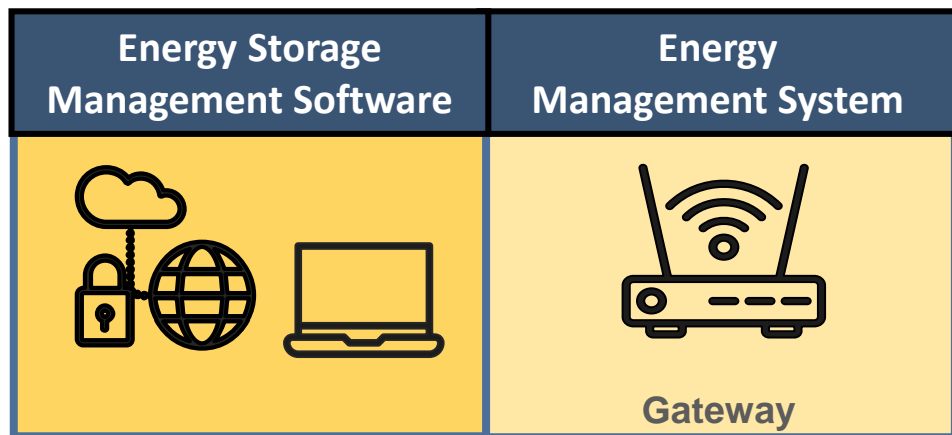
| Energy Storage System Gateway

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

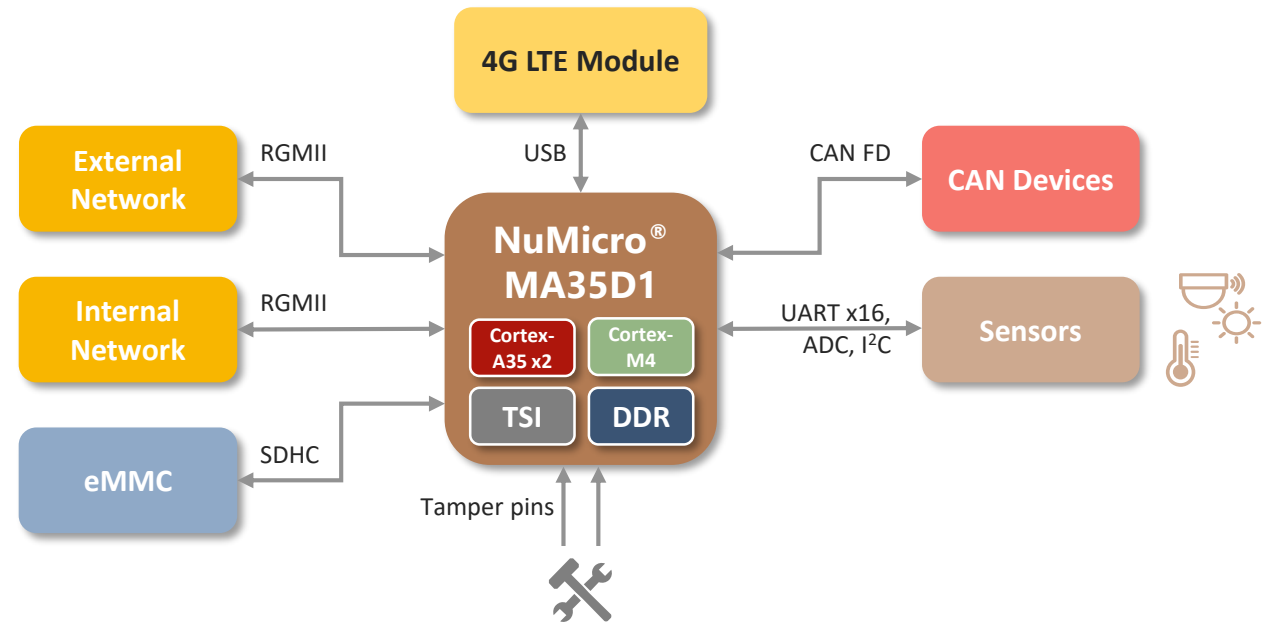
New Energy Gateway

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

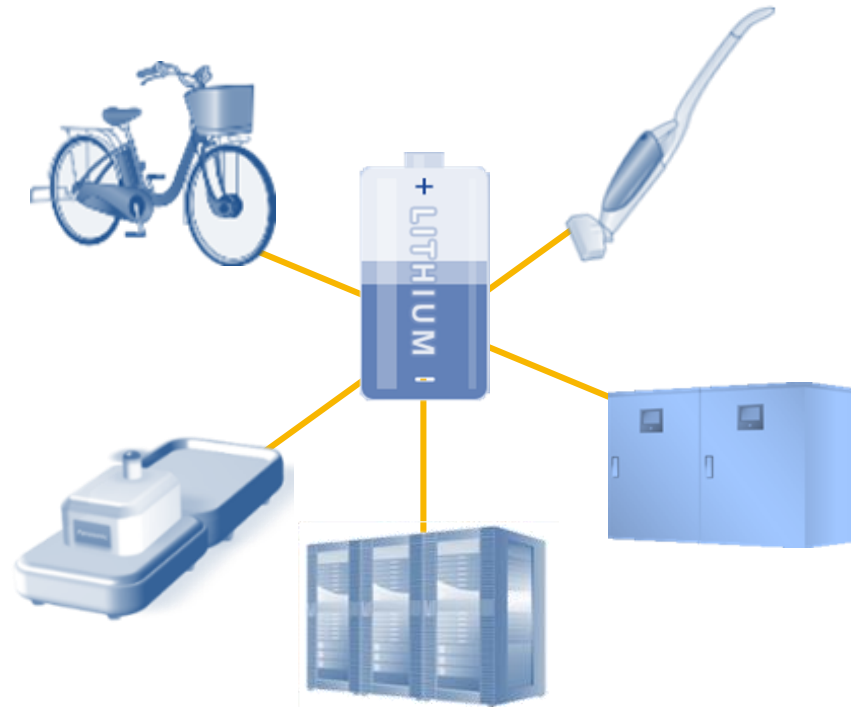
- Linux v5.4, OpenWRT
- Richer network protocols – TCP, UDP, HTTP(S), MQTT, CoAP, WebSockets.



| 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



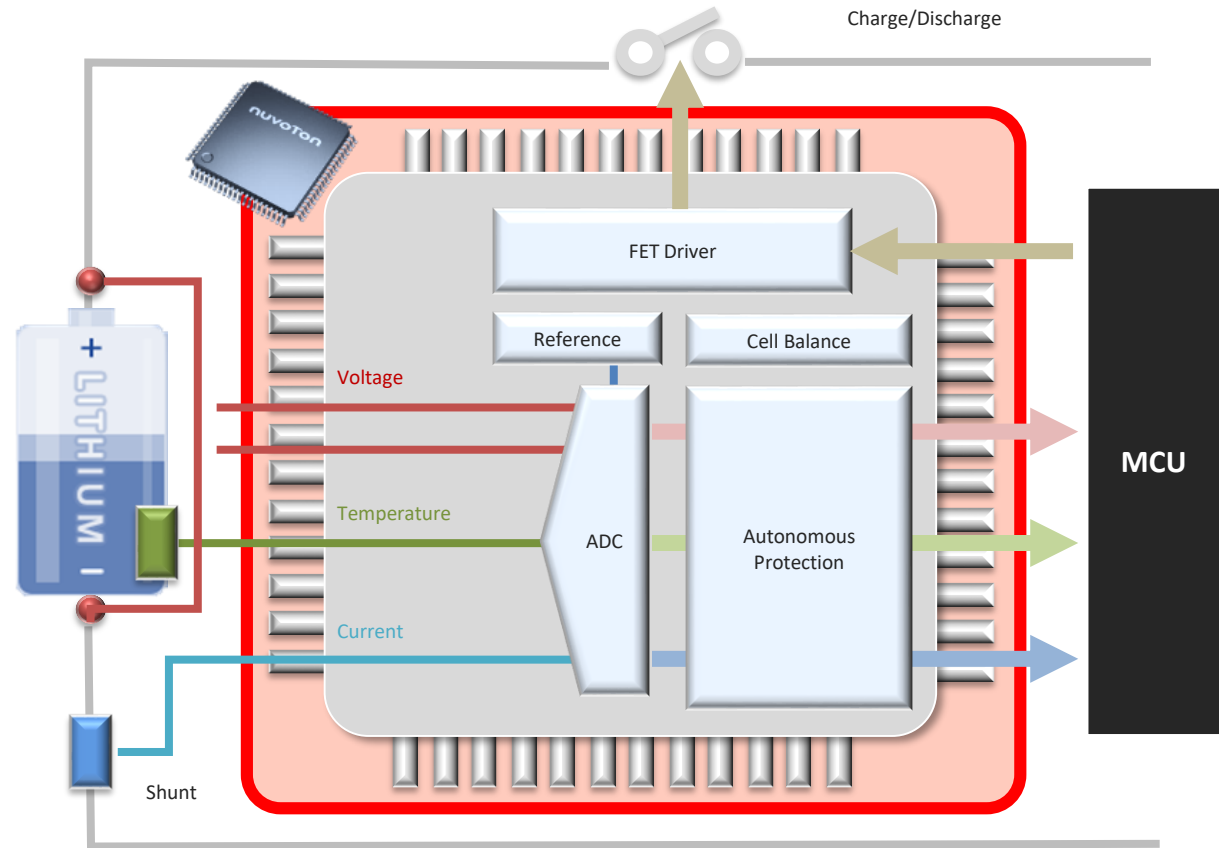
Simplicity

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

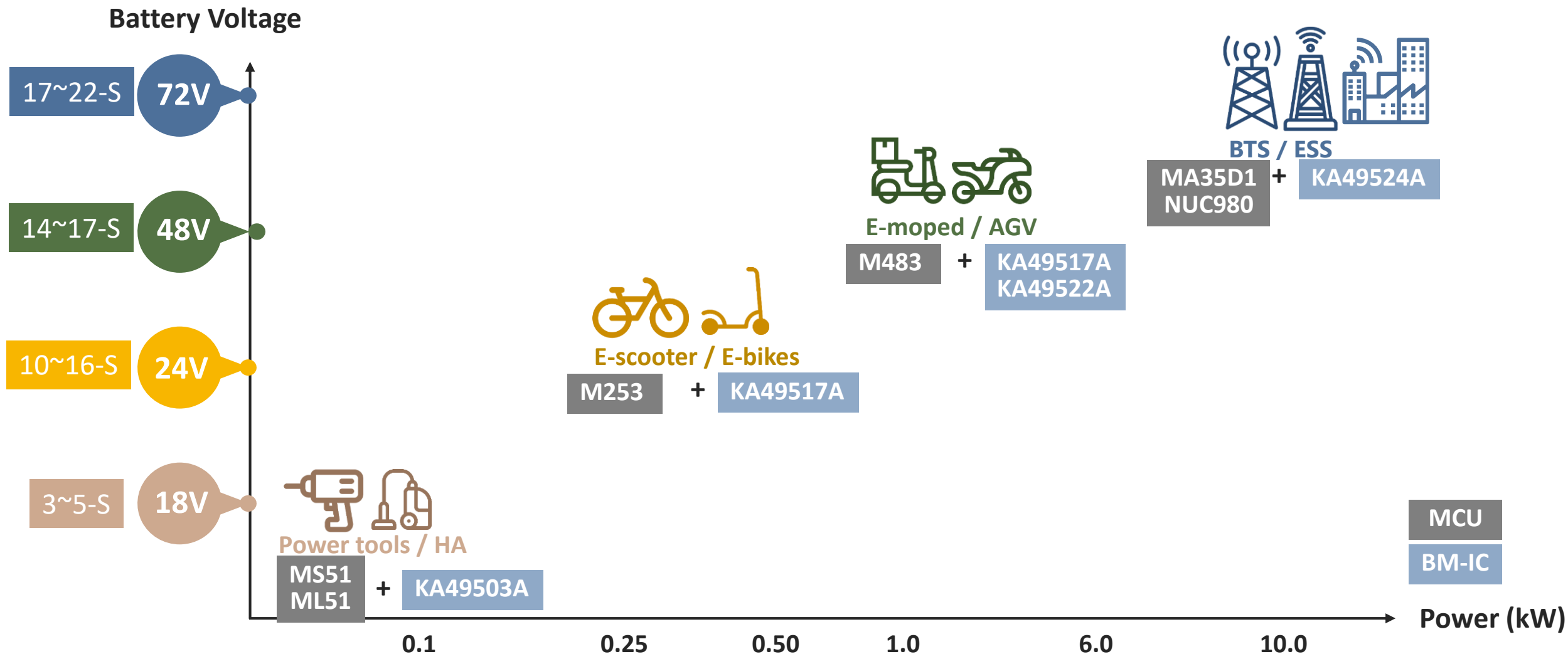
Save 25% BOM cost



Scalability

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

Battery Management System Product Matrix



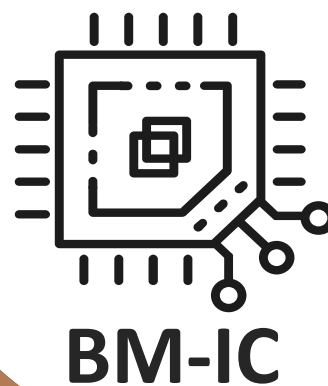
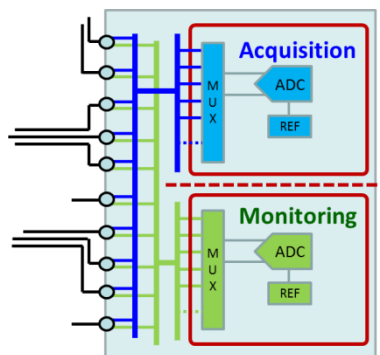
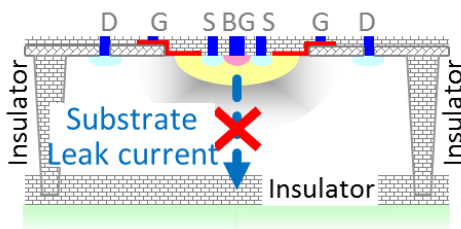
| What BMIC Provides

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

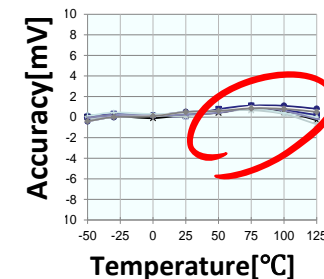


BM-IC

Cruising Distance

Expansion of available SOC

- ✓ High accuracy



Scalability

Developing cost reduction for ECU

- ✓ Line up (14ch / 20ch / 25ch)

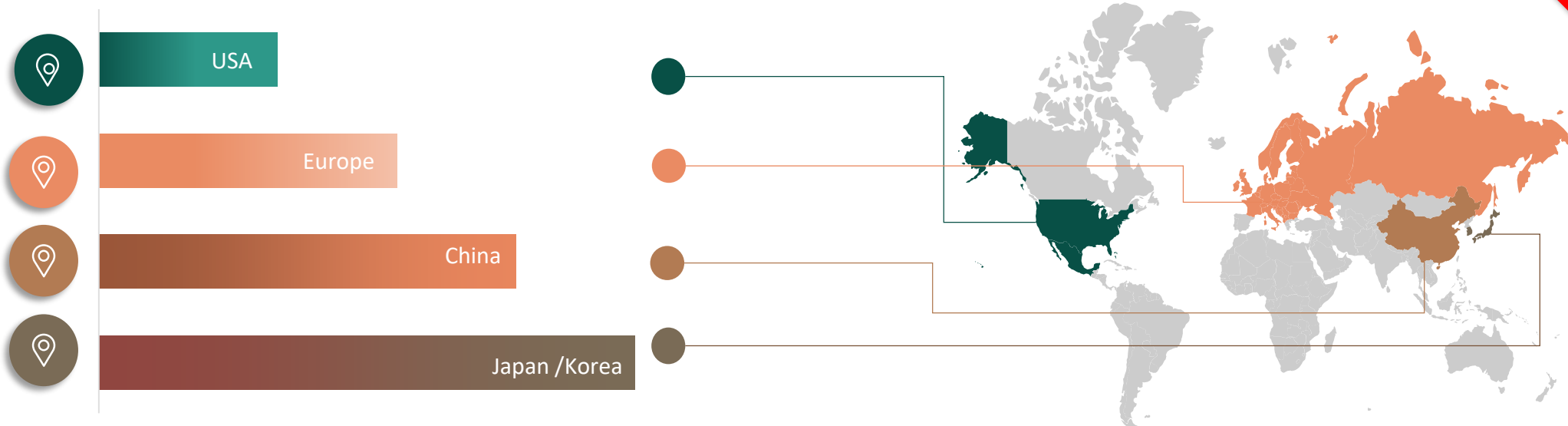
| Automotive BM-IC Market Experience

ASIL-C
ASIL-D

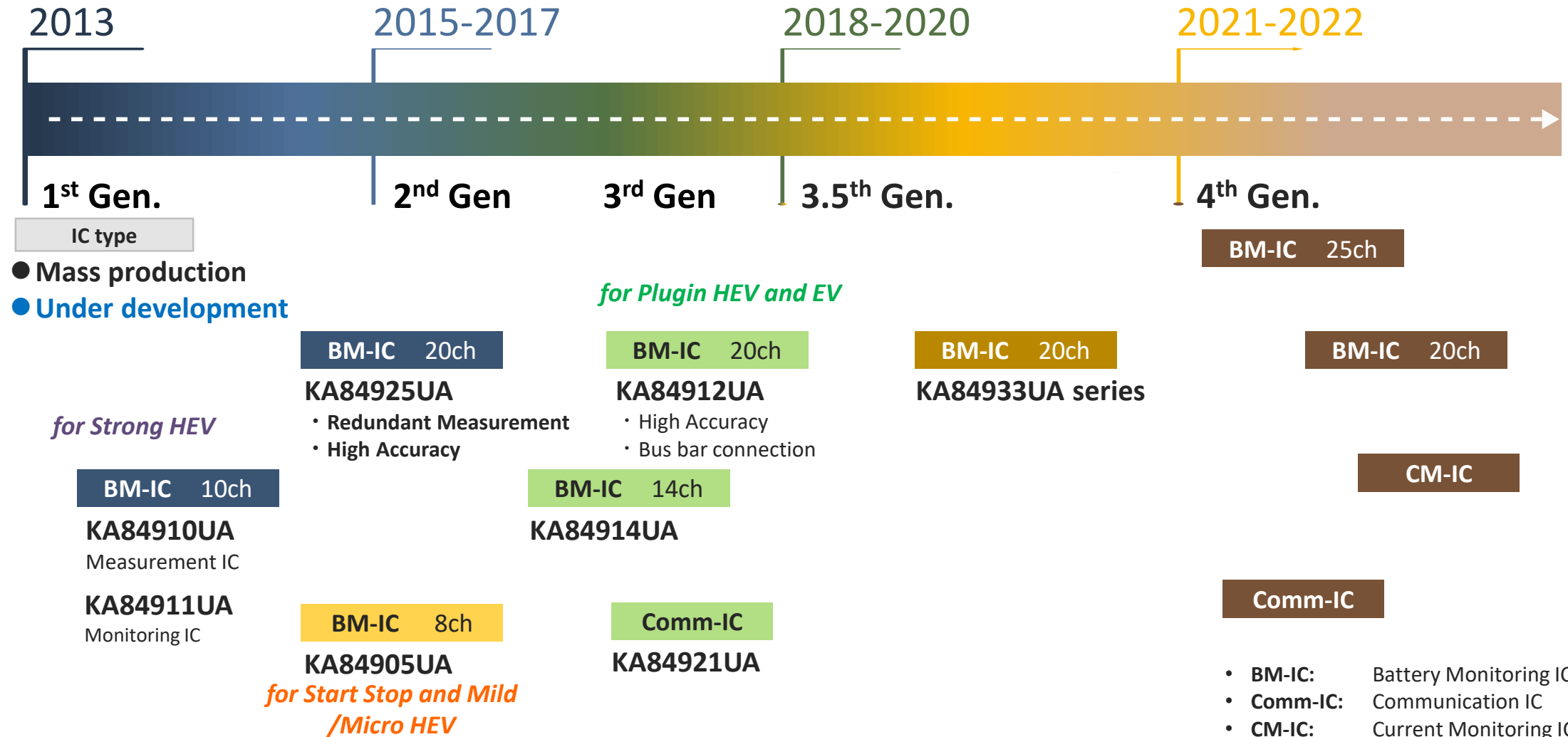


12 years market experience

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



BMIC Roadmap



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Bedankt

Thank you

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Battery Management System

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

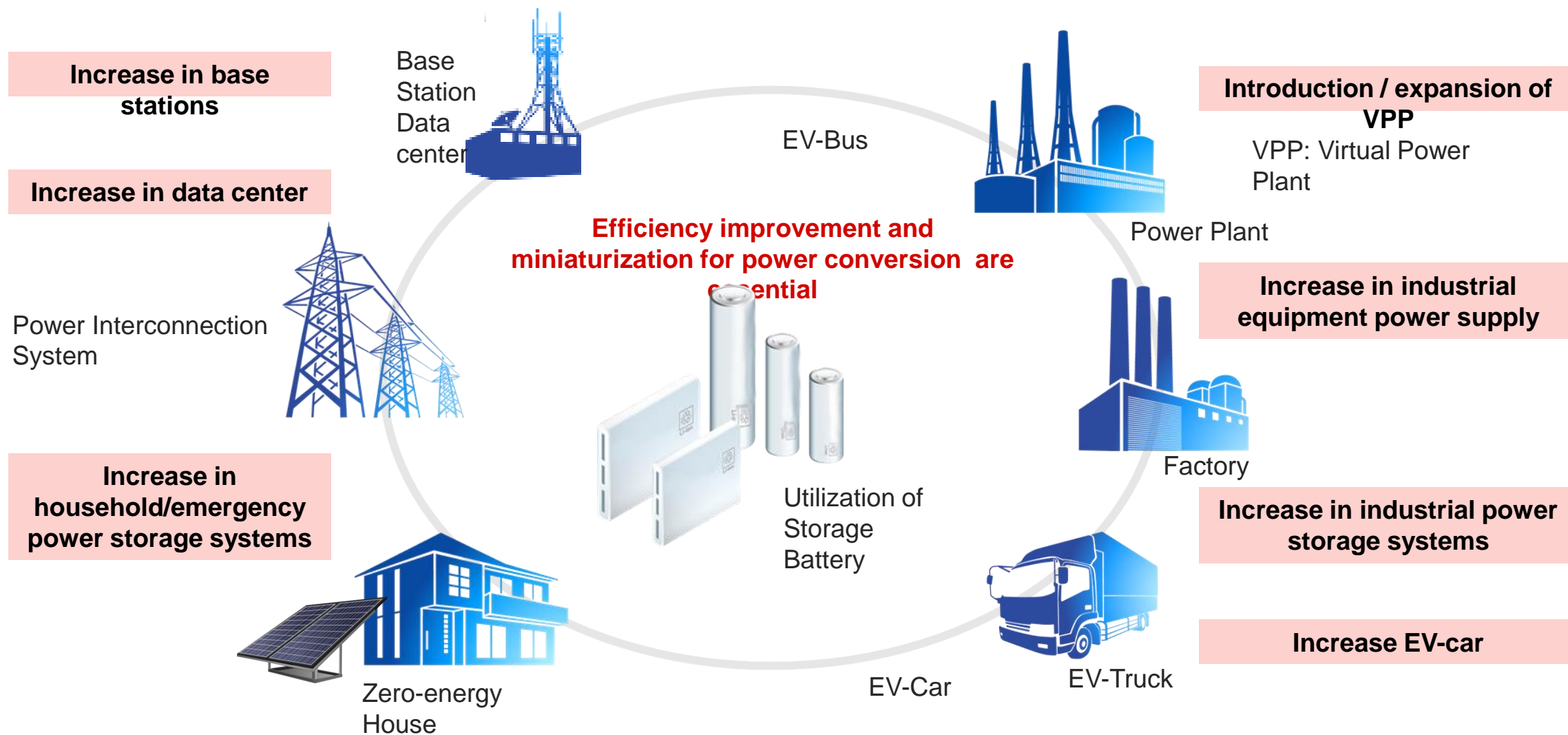
楊博承 Matt Yang

Marketing and Application Division

Technology Manager

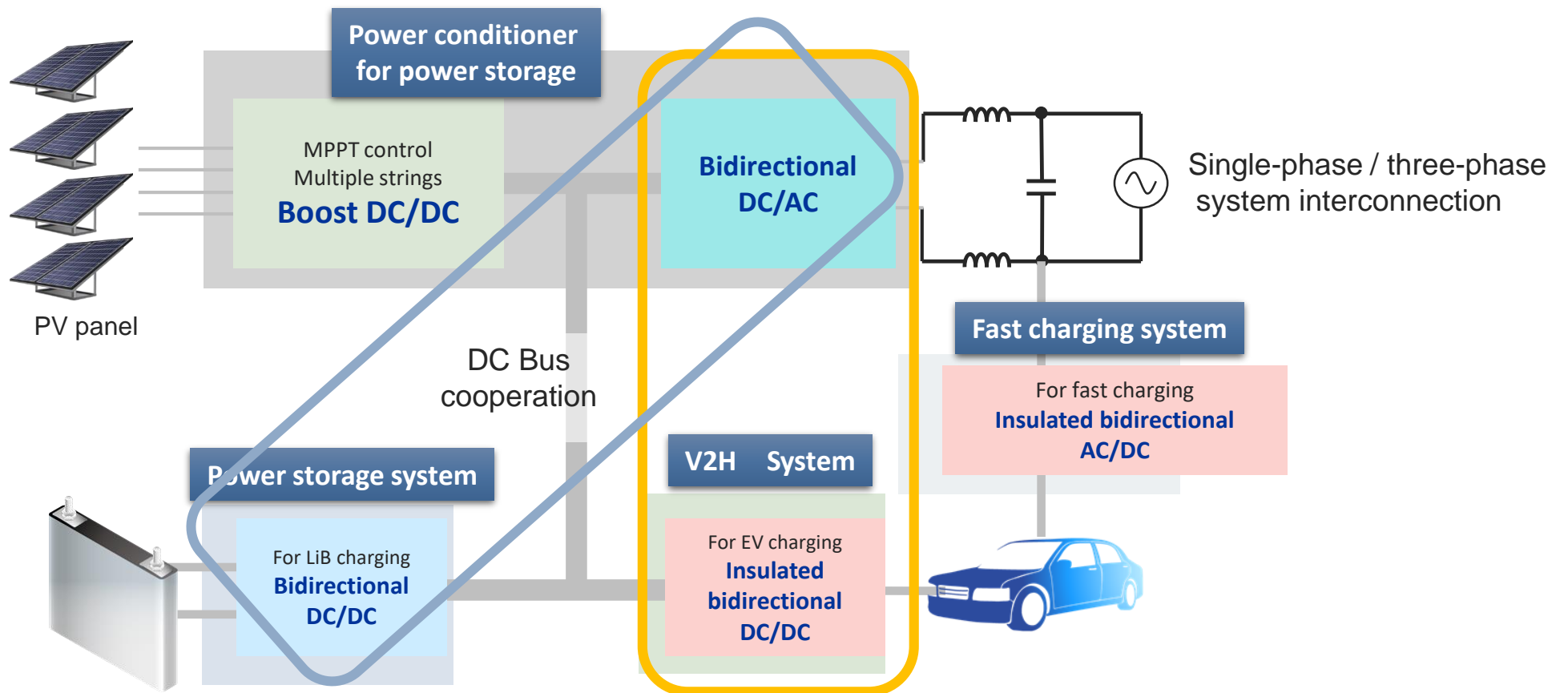


Surrounding Power System



Power Conversion Technology

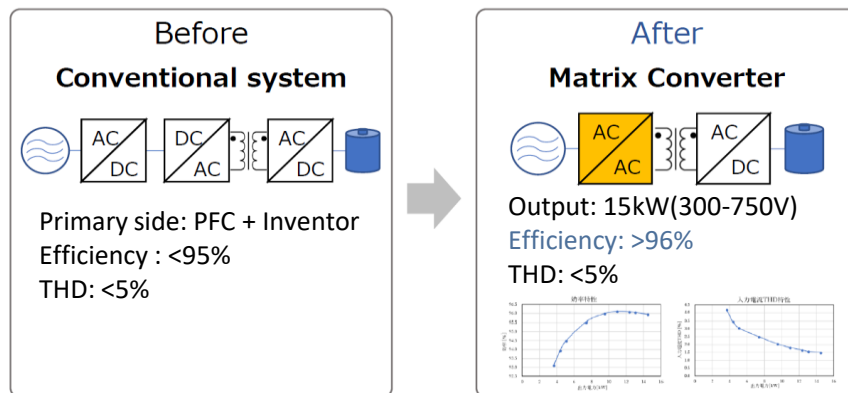
- Accelerate “digitalization” in power conditioner/ power supply/ battery makers
- Utilize next-generation power device to increase the constructor’s benefits by reducing size and weight



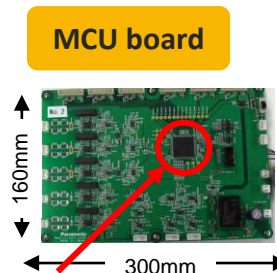
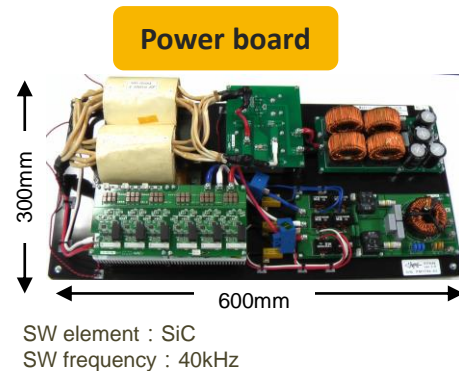
Matrix Converter Control Power Reference

Function

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



15kW Matrix converter reference board



Controlled by NTCJ MCU equipped with PWM for matrix converter control

Cooperated by Nagaoka Power Electronics Co., Ltd.

Feature

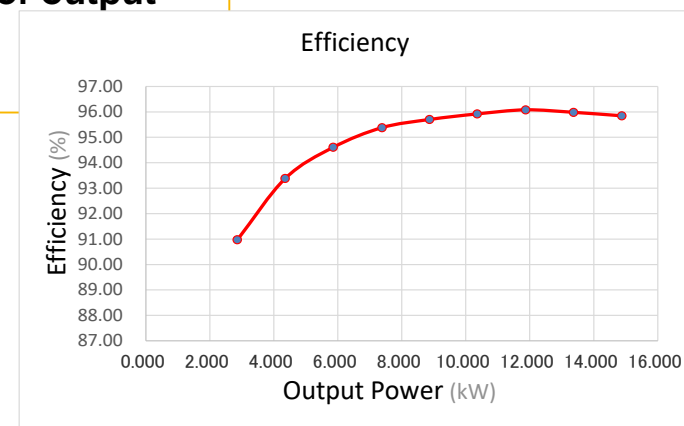
- **Built-in control circuit:**
Built-in functions required by matrix converter control
- **Optimal control:**
Achieves high-speed feedback control with a high-performance NTCJ MCU

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

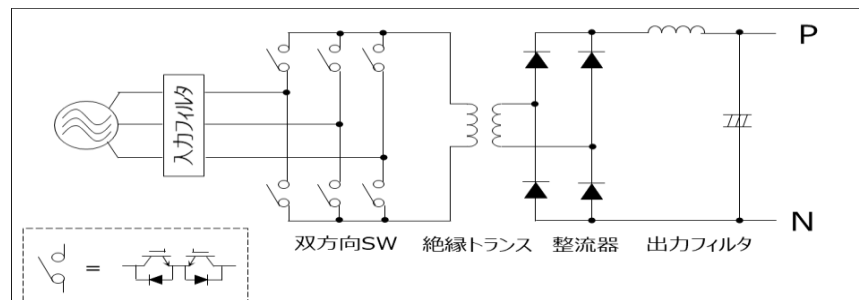
Industry-first

- ◆ 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

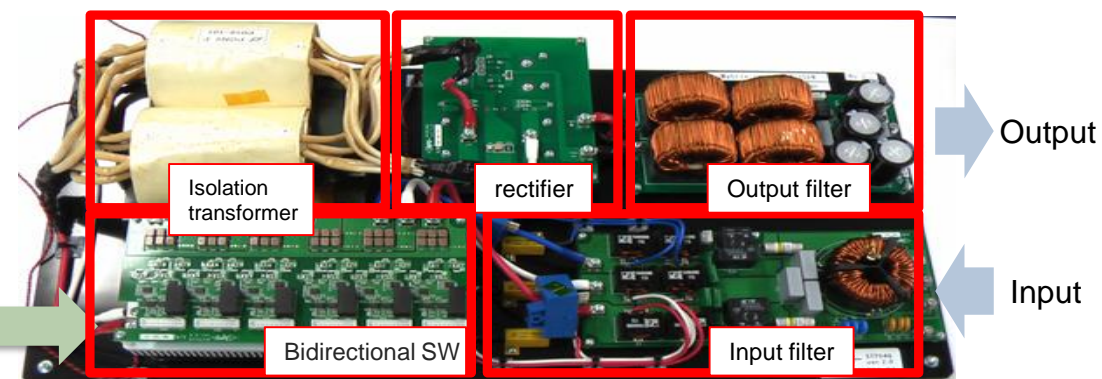
- ◆ Control reference software
- ◆ Document
- ◆ Reference board
 - ⊖ 15kW matrix converter board
 - (2) Control board with MCU
 - (* ⊖ Board rental is available)

Principle / Configuration



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

15kW
Matrix converter



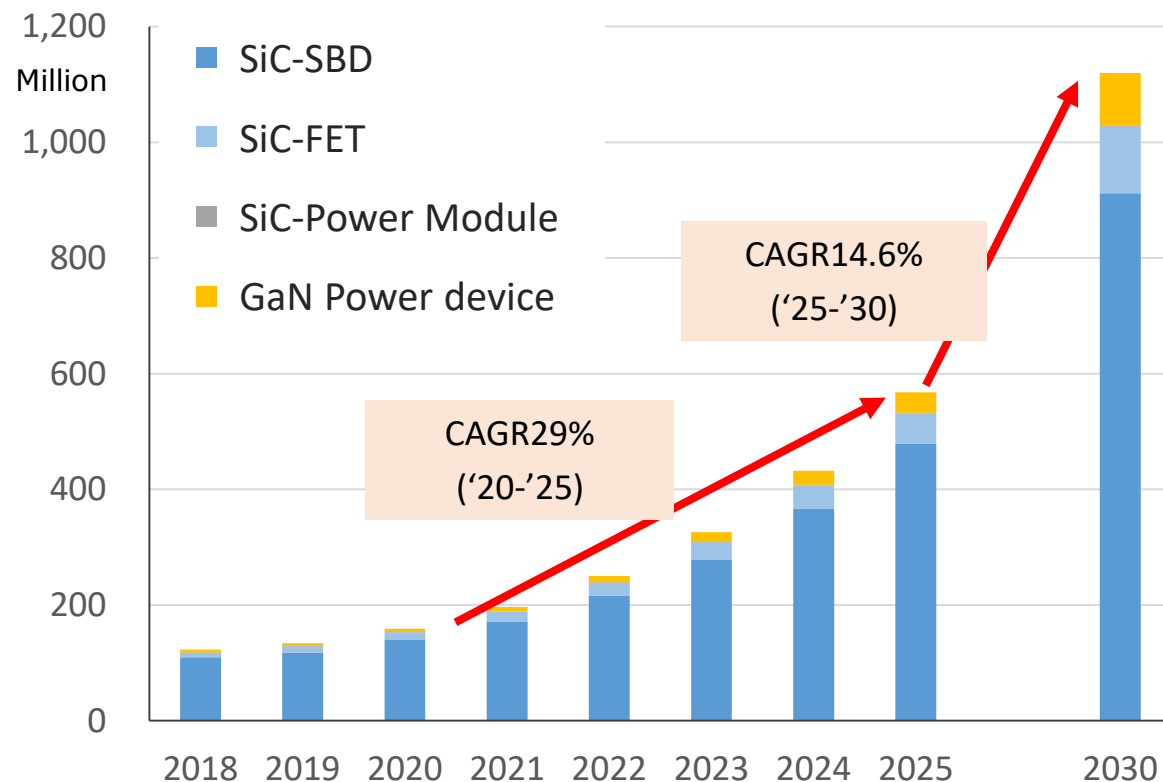
MCU for Power Solution **KM1M7AF Series**

CPU: 160MHz Arm® Cortex®-M7
ADC: 12bit x 3units, Conv. time 0.5us
PWM: 208ps

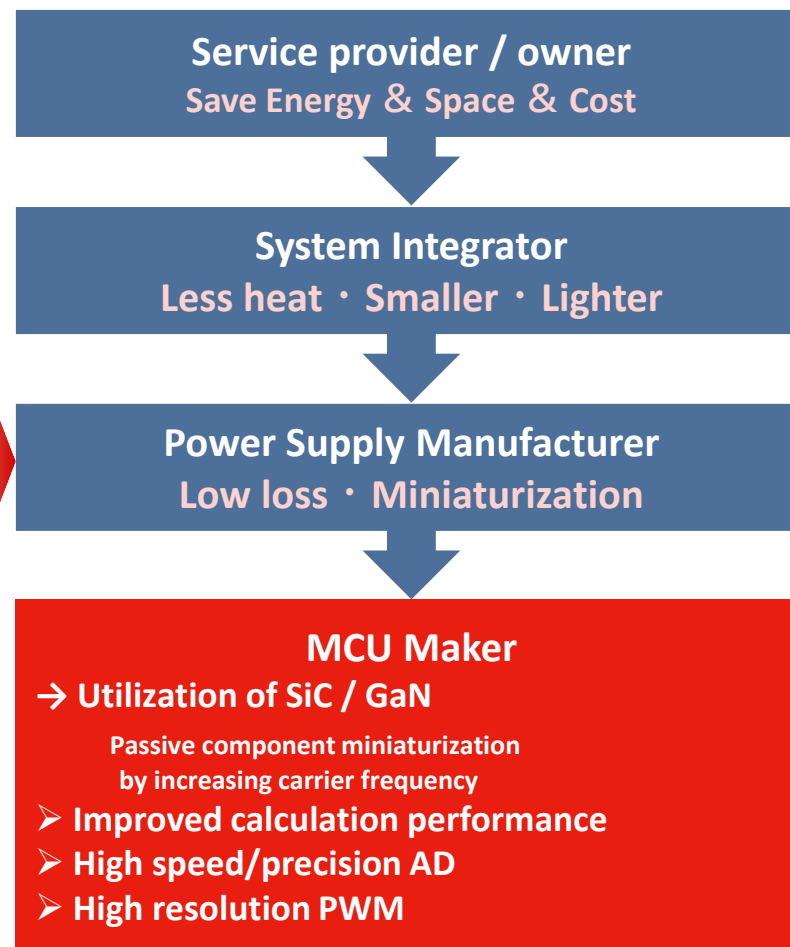
SW element : SiC
SW frequency : 40kHz
Input : 3-phase 380V
Output : 15kW(300-750V)

SiC / GaN Market Size and Requirements for MCU

SiC / GaN Market Size

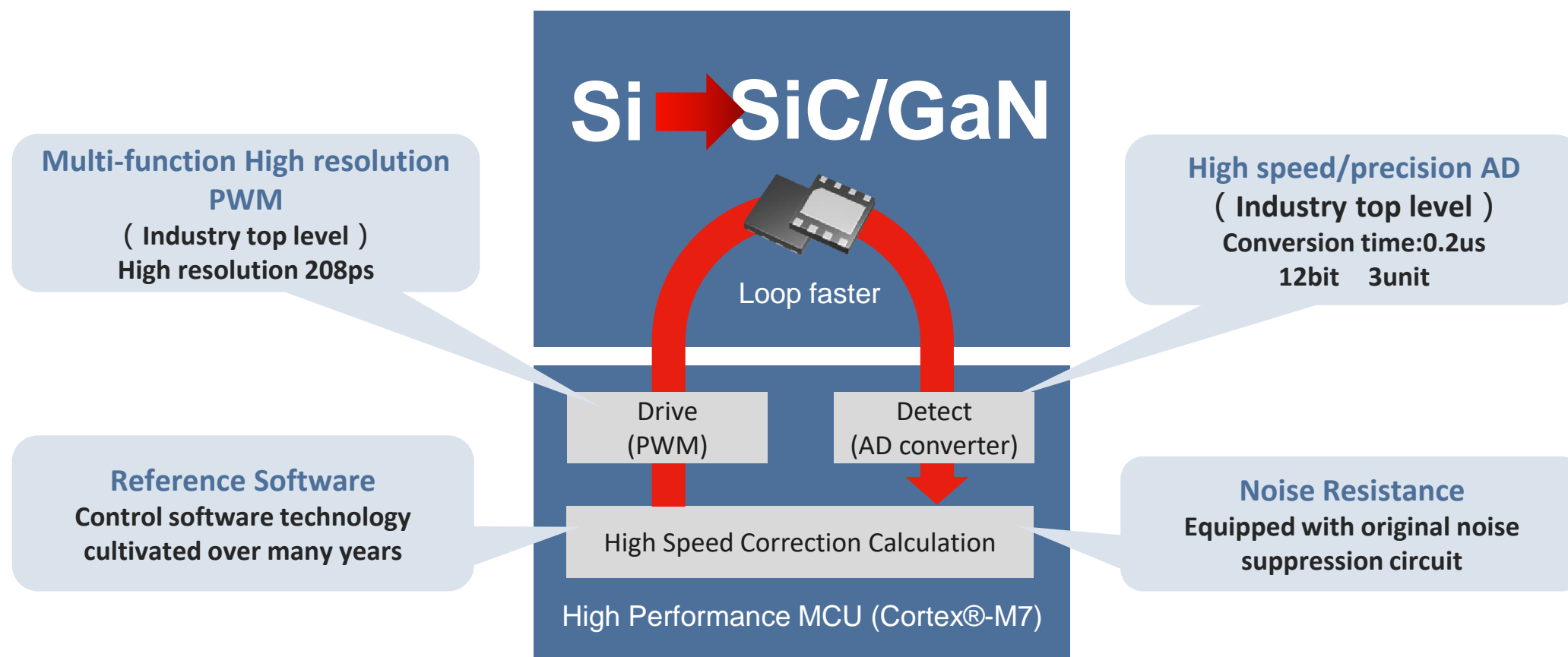


Source: Fuji Keizai Co., Ltd. "2020 version of next-generation power device & power electronics related equipment market status and future prospects"

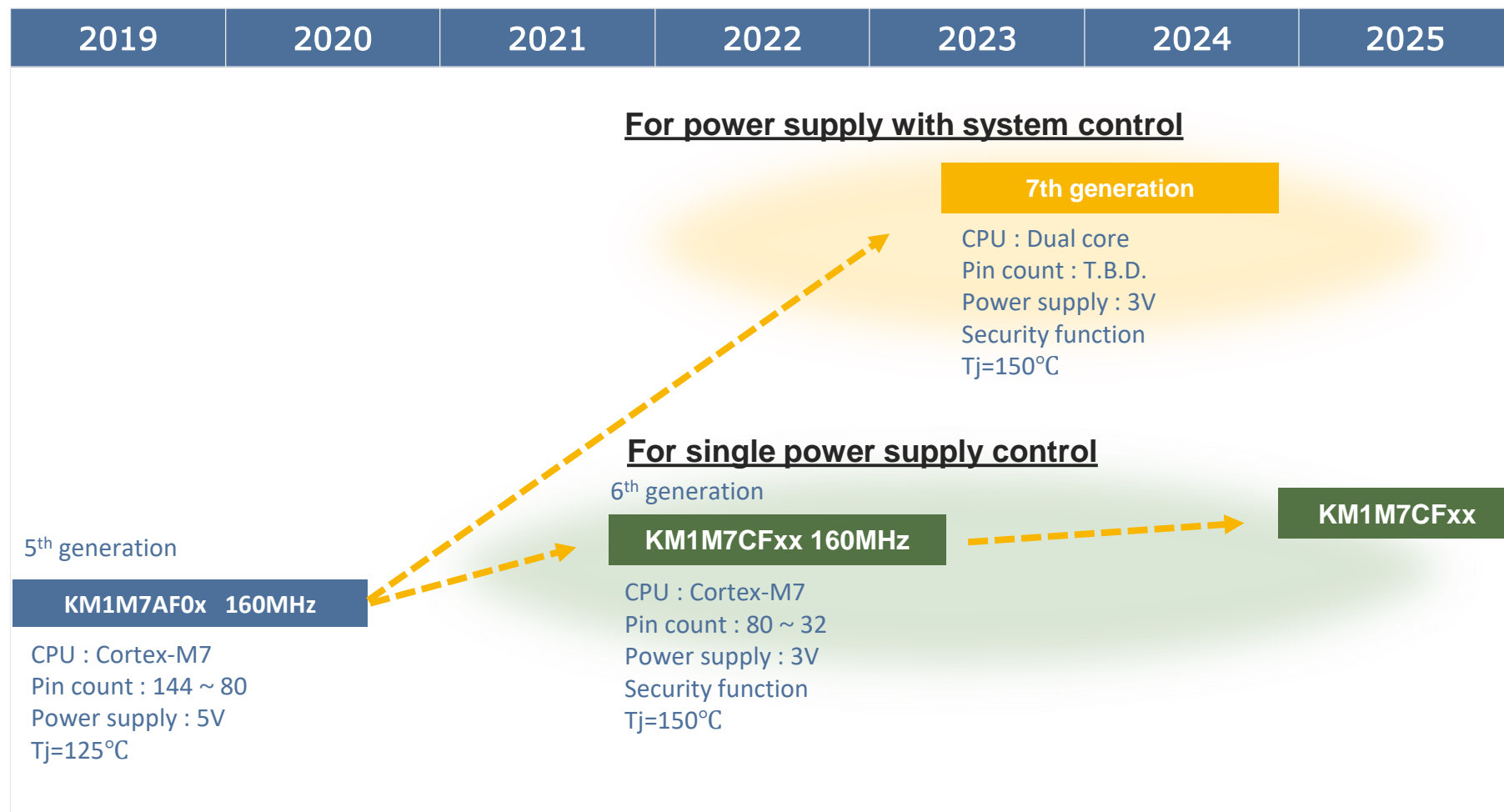


| Features of our MCU

Digital Power Control System

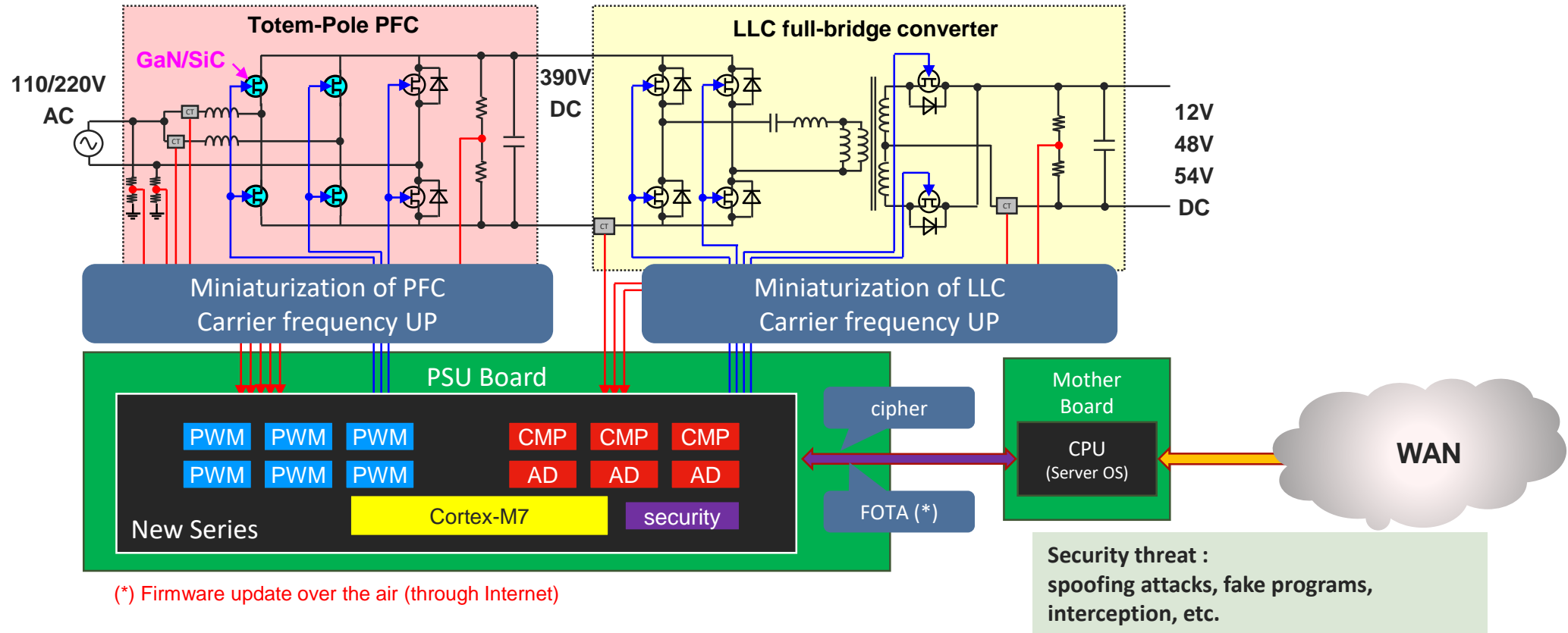


Digital Power Control MCU Roadmap



Next Generation Digital Power Control MCU Concept

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



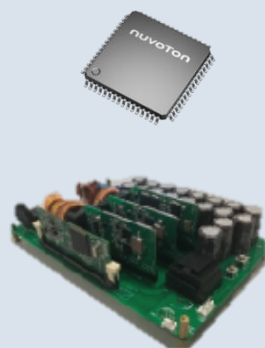
Support Menu

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



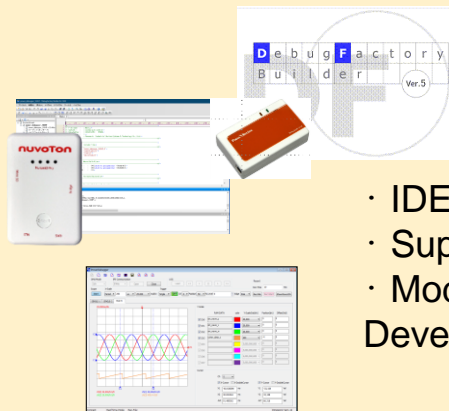
Hardware

Software

Digital power control solution

Tools

Support



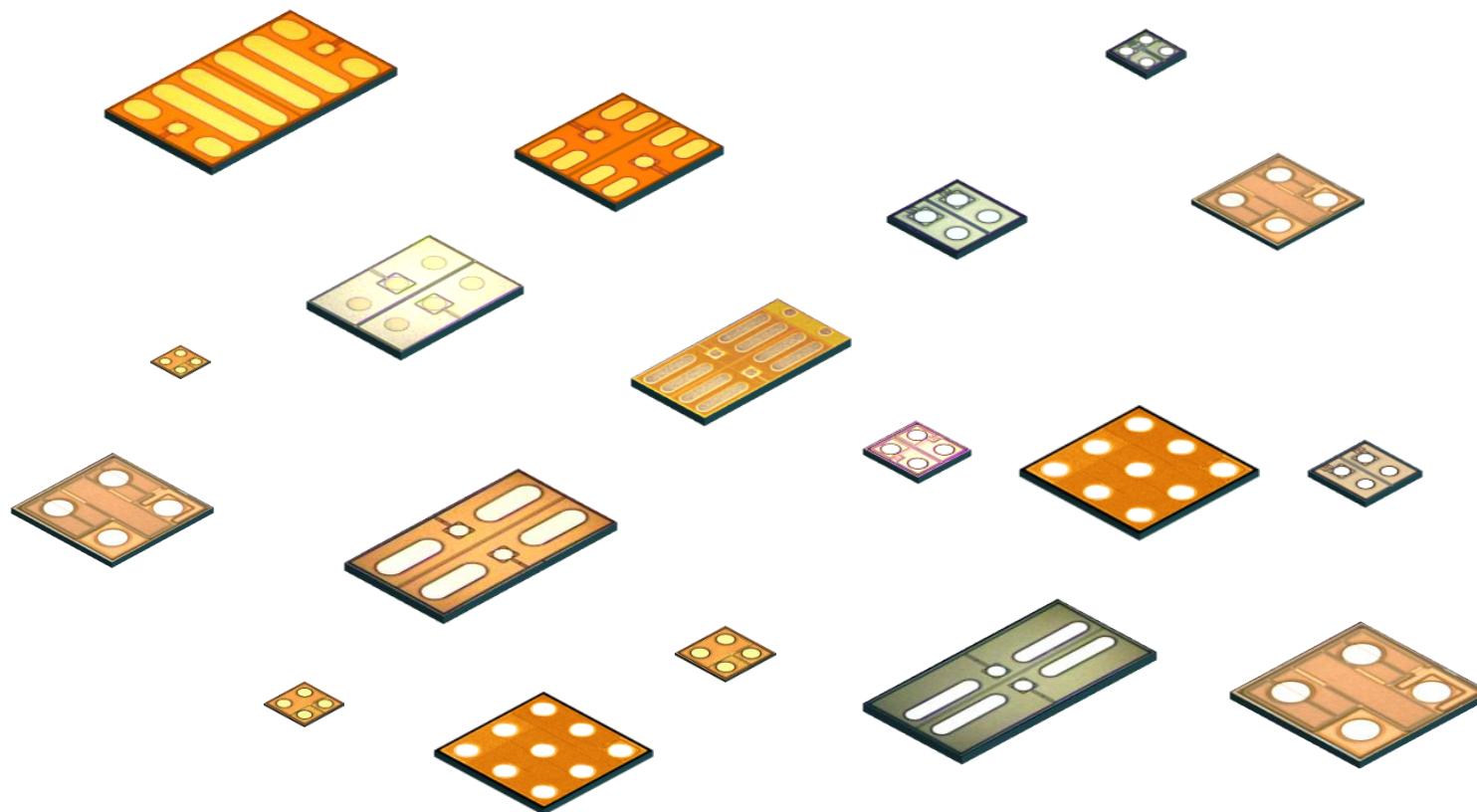
- IDE
- Support tool for development
- Model Based Development tool

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



CSP-MOSFET

Chip Scale Package



CSP-MOSFET Applications

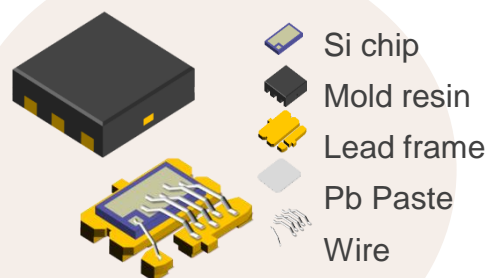
No.1 market share for small devices with built-in Lithium battery.

Bring small automotive applications a miniaturized solution.



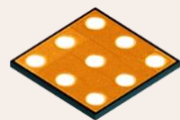
CSP-MOSFET Value Proposition

Mold Package



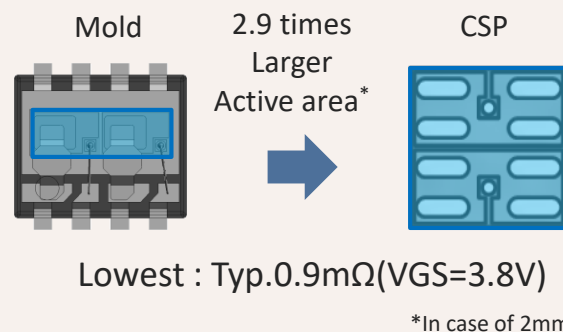
More materials

CSP

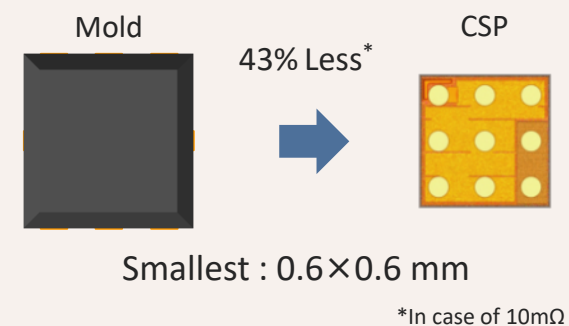


1 material only

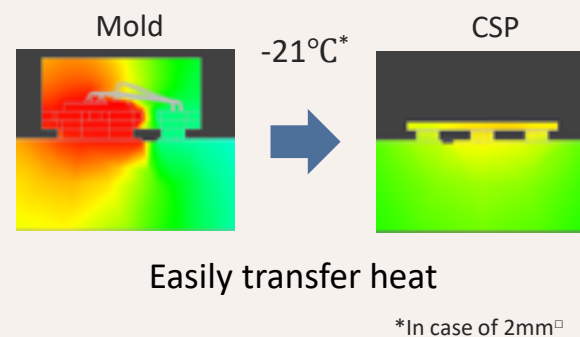
Low On Resistance



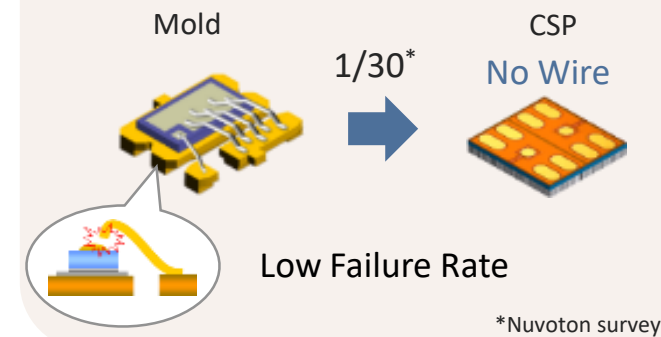
Smaller Size



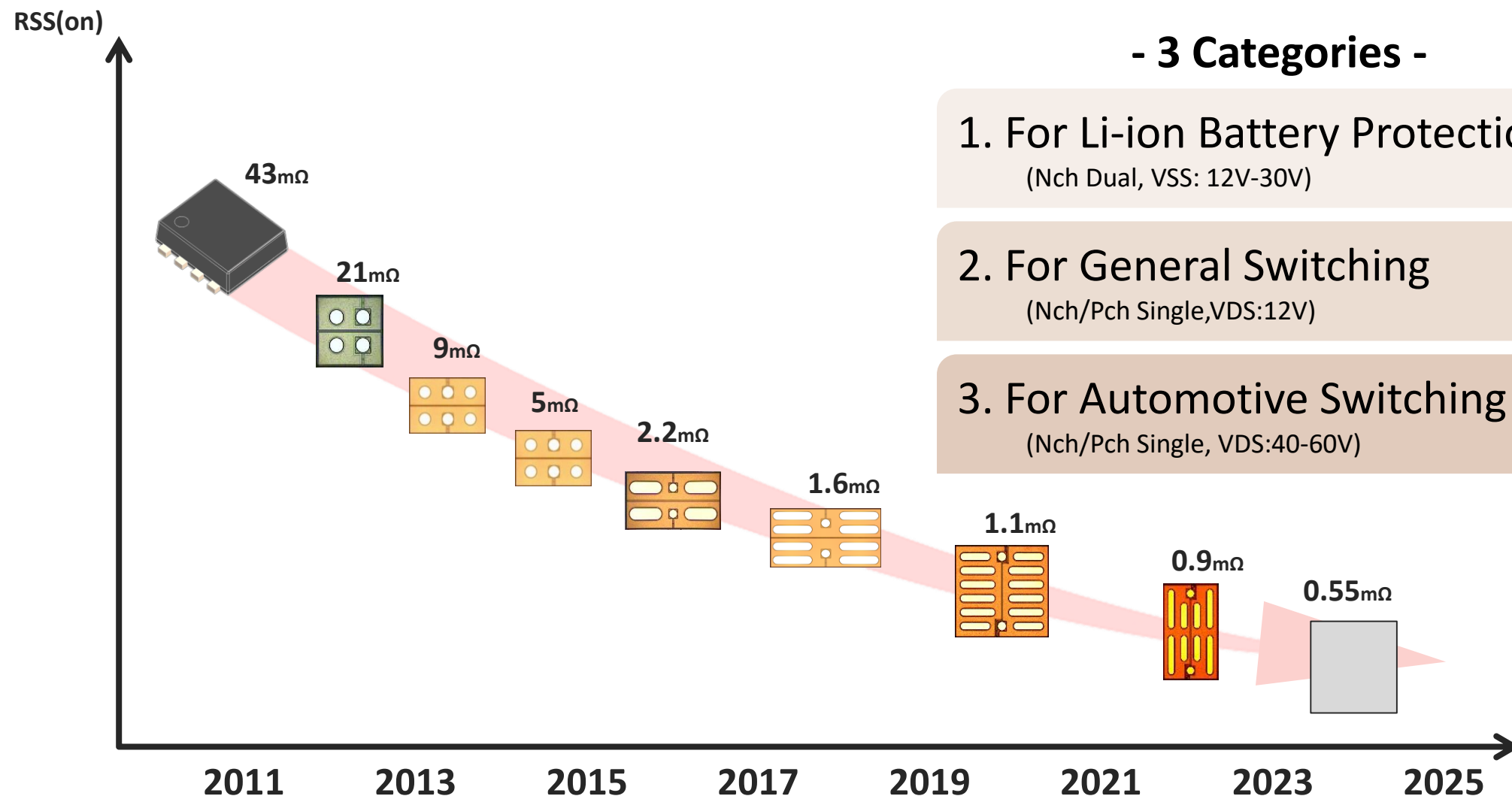
High thermal performance



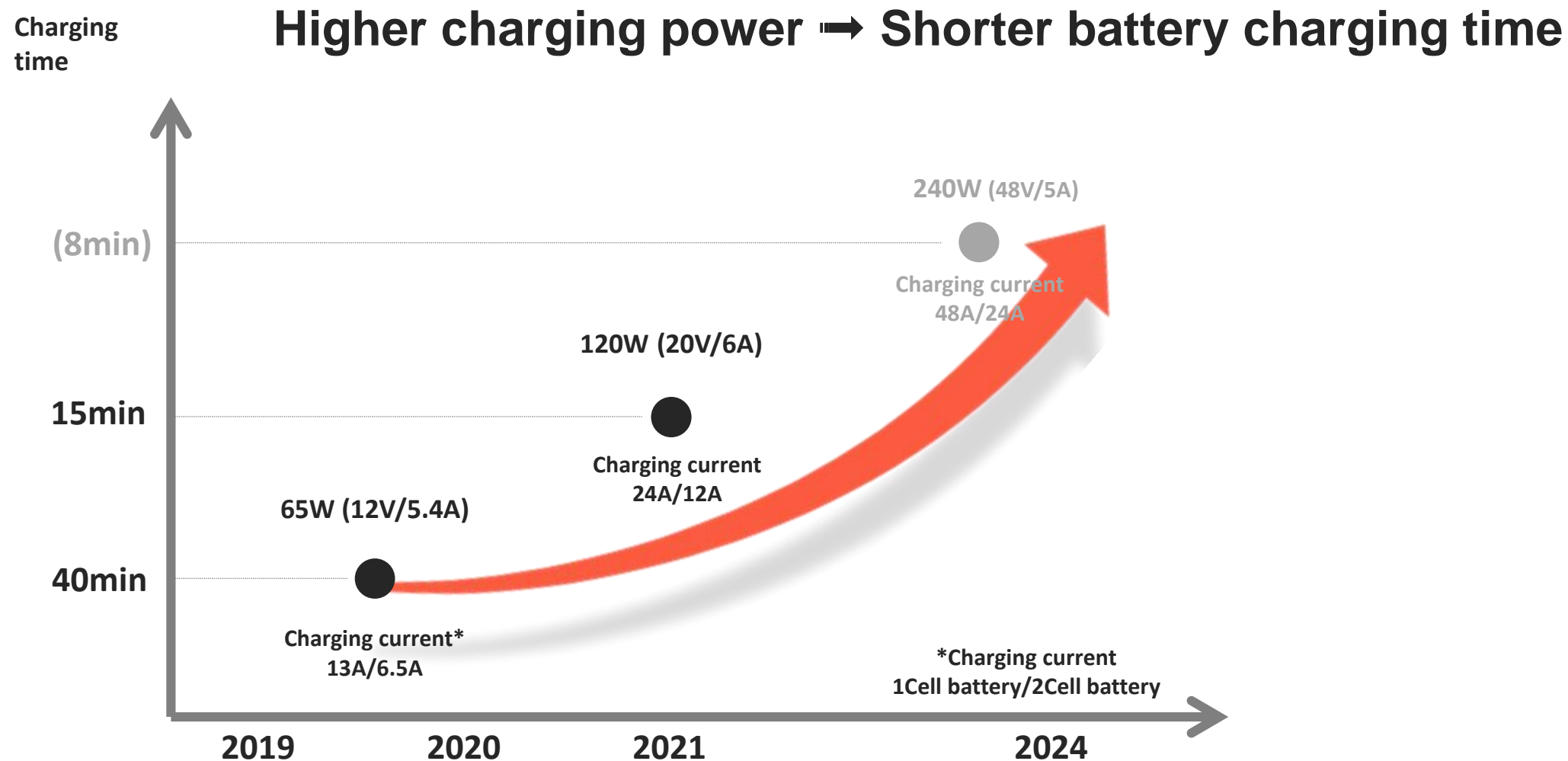
High Quality



CSP-MOSFET Market Roadmap



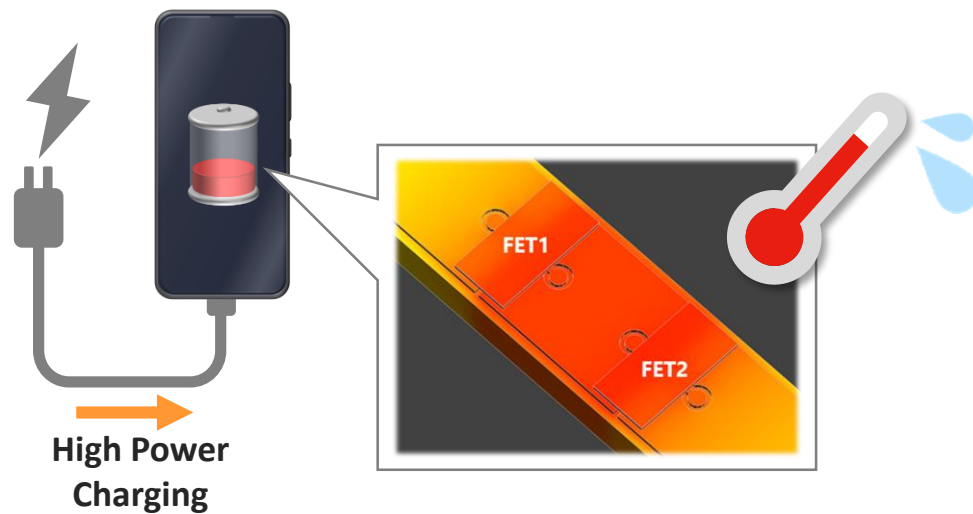
Battery Charging Trend



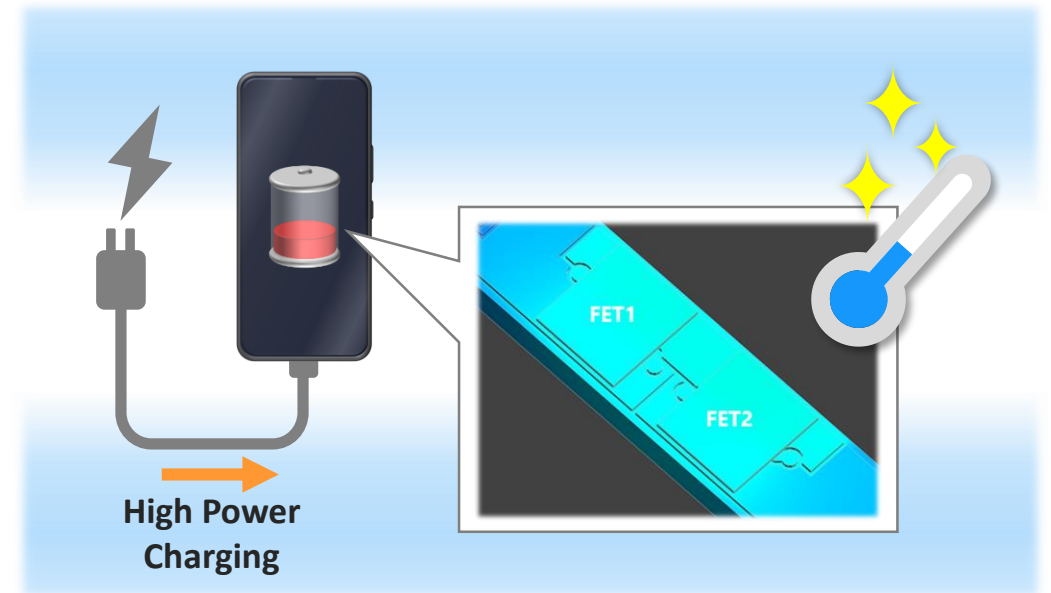
| Customer Value Proposition

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

Recommend **Ultra Low Ron** MOSFET



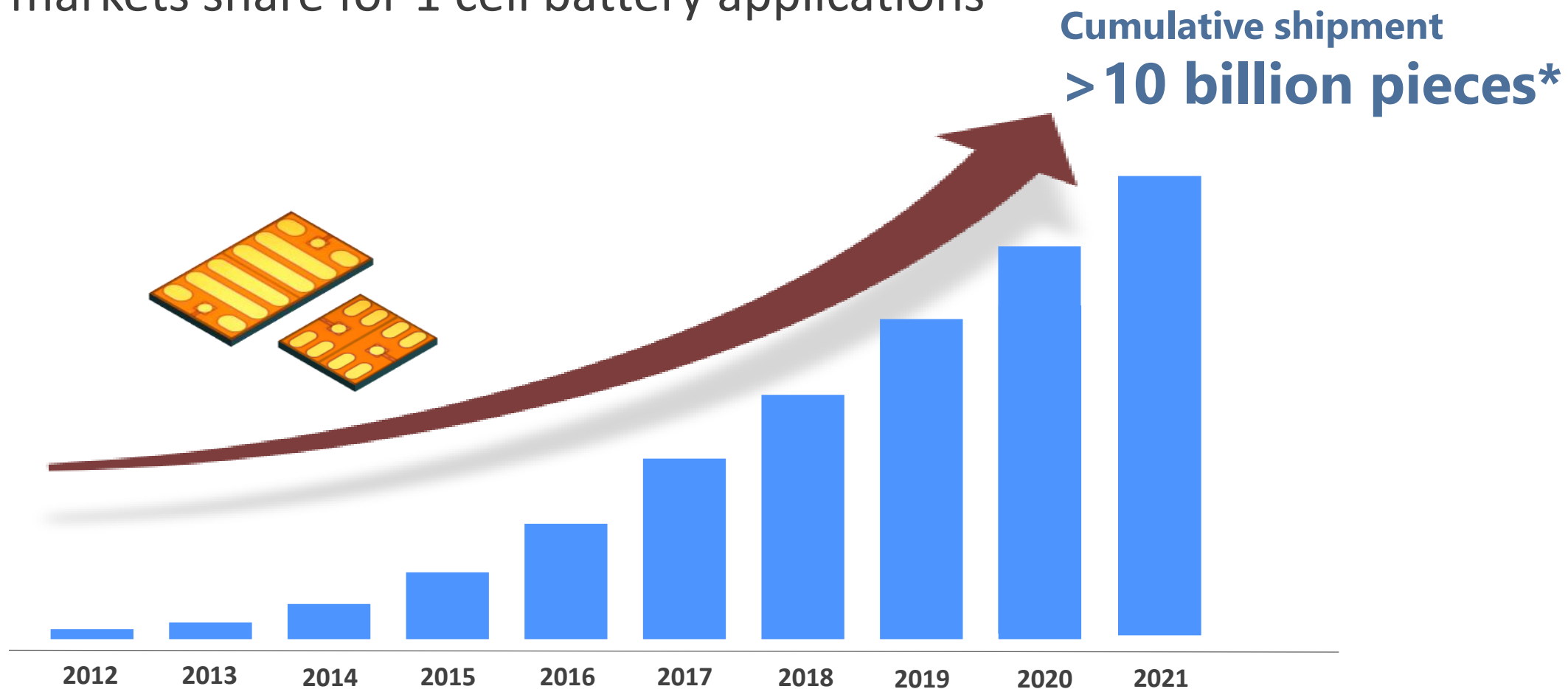
Higher Ron , More Heat



Lower Ron , Less heat

CSP-MOSFET Outstanding Position

- Top markets share for 1 cell battery applications



| Support Menu

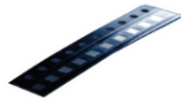
1 MOSFET Selection

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

High Performance Motor Control Solution

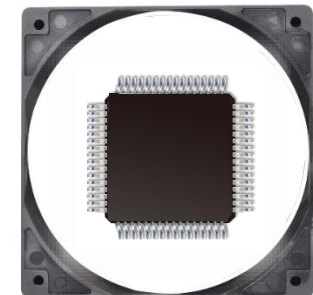
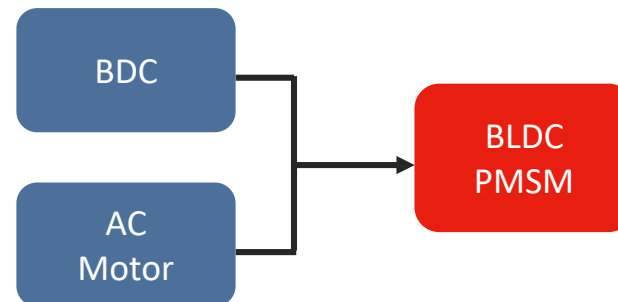
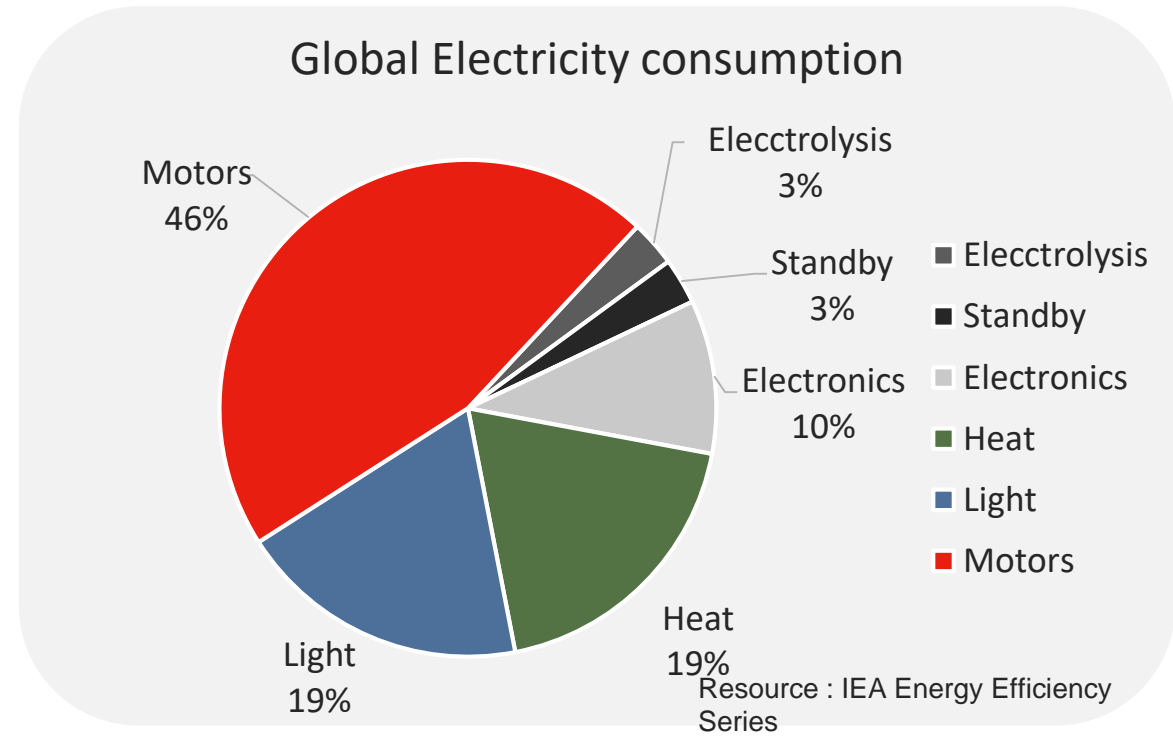
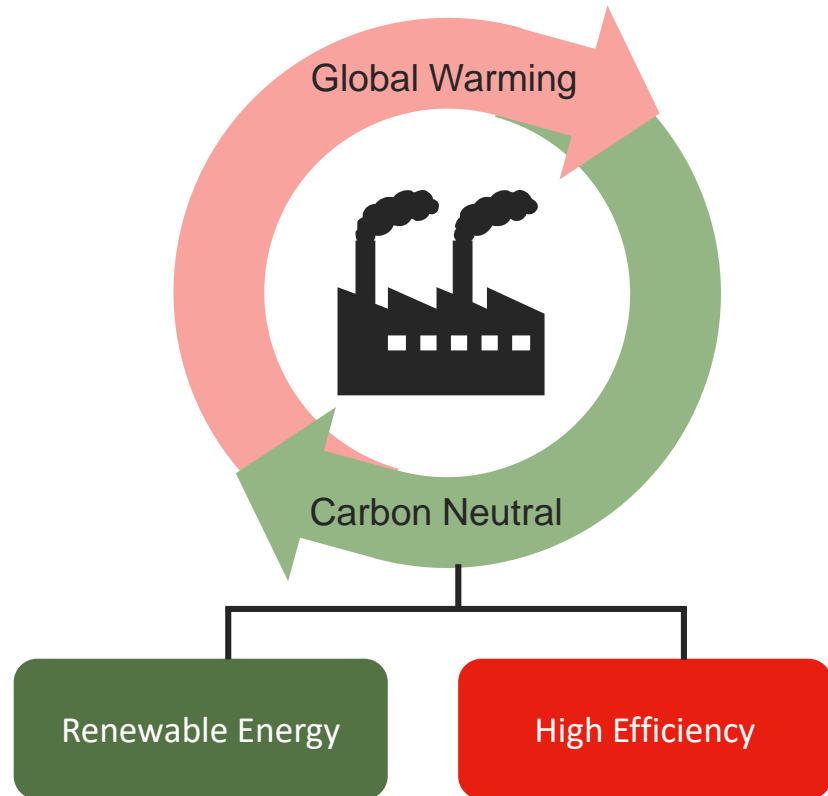
黃暉舜 Wei-Shuen Huang

Motor Application Marketing Department

PM & Technology Manager



| Motor Application Market Trend



| Product Lines for Motors in Nuvoton

NM Series

MCU based
General-purposed



KA Series

ASIC
Dedicated

nuvoTon
新唐科技

KM

Series
MCU based
Home Appliance



| Product Lines for Motors in Nuvoton

NM Series

MCU based
General-purposed



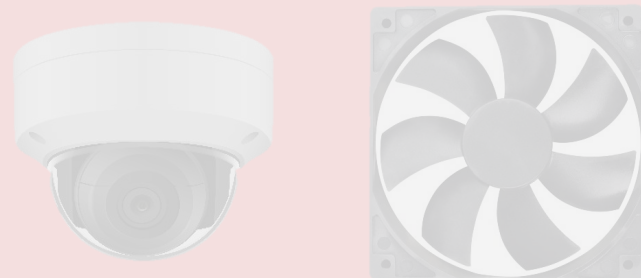
KA Series

ASIC
Dedicated







nuvoTon
新唐科技

KM Series

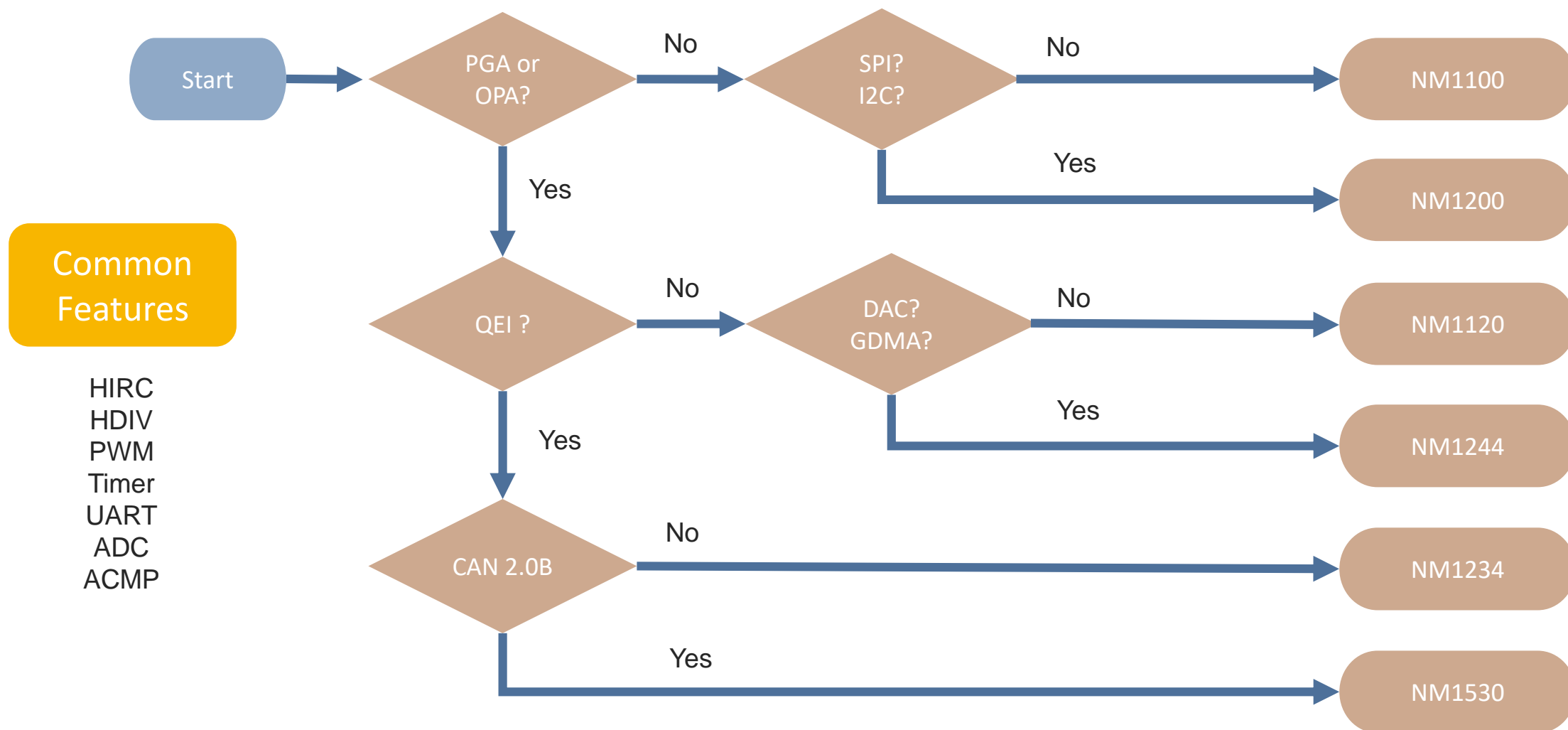
MCU based
Home Appliance



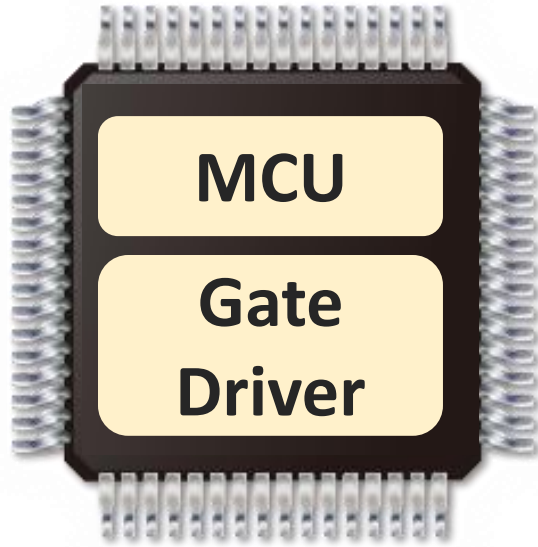
NuMotor MCU Series Product Roadmap

128 kB	NM1530	Cortex-M0, HDIV, -40~105°C, 2.5V~5.5V, HIRC 1%@25°C, 16-bit PWM, 24-bit Timer, 12/10-bit ADC, UART, ACMP	<u>LQFP48</u> (7x7mm ²) <u>LQFP64</u> (10x10mm ²) <u>LQFP100</u> (14x14mm ²)	CAN2.0b/MDU/ OPA x 2/QEI/2 motors compatible 72MHz, 8kB/16kB RAM, I ² C x 1, SPI x 3, ECAP	
64 kB	NM1234		<u>LQFP48</u> (7x7mm ²)	72MHz/OPA x 3/PGA x1/DAC x 2 /QEI 8kB/16kB RAM, I ² C x 3, SPI x 2 , ECAP	
	NM1244		<u>QFN48</u> (7x7mm ²) <u>LQFP48</u> (7x7mm ²)	60MHz/Standby < 1μA/ DAC x 2/DMA 8kB RAM, I ² C x 2, SPI x 1, ECAP , OPA x 1	
29.5k B	NM1120		<u>QFN20</u> (4x4mm ²) <u>TSSOP20</u> (4.4x6.5mm ²) <u>TSSOP28</u> (4.4x9.7mm ²)	48MHz/PGA x 1 4kB RAM, I ² C x 2, SPI x 2, ECAP	
17.5k B	NM1200		<u>QFN33</u> (5x5mm ²) <u>LQFP48</u> (7x7mm ²)	48MHz 2kB RAM, I ² C x 1, SPI x 1	
	NM1100		<u>TSSOP20</u> (4.4x6.5mm ²)	48MHz 2kB RAM	

| Selection Guide for MCU Series



NuMotor MCP Series Product Roadmap

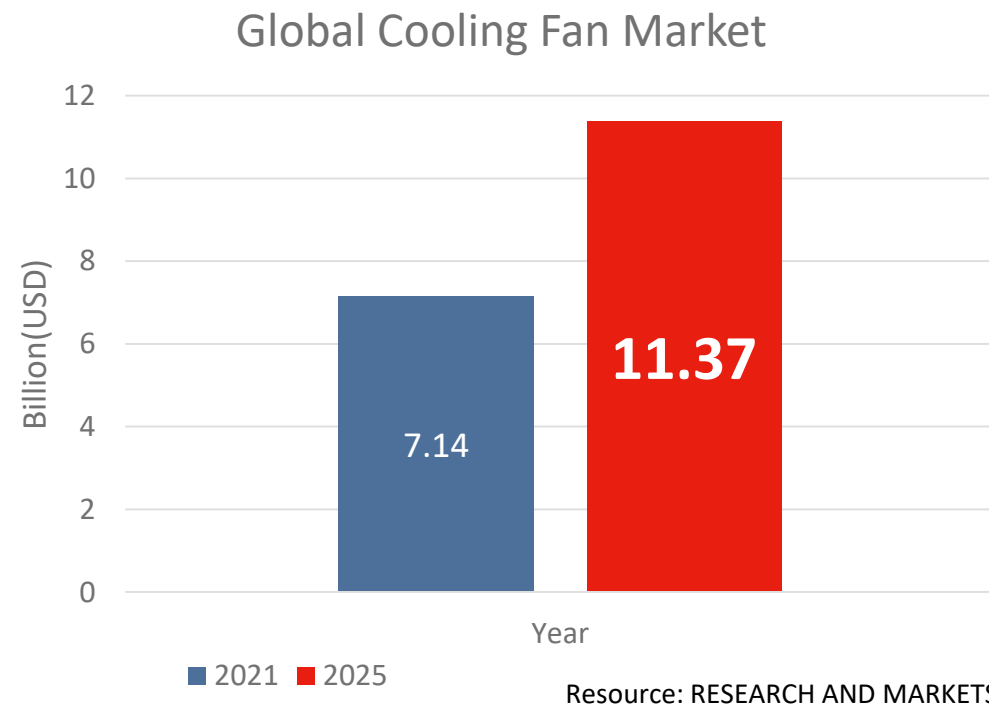
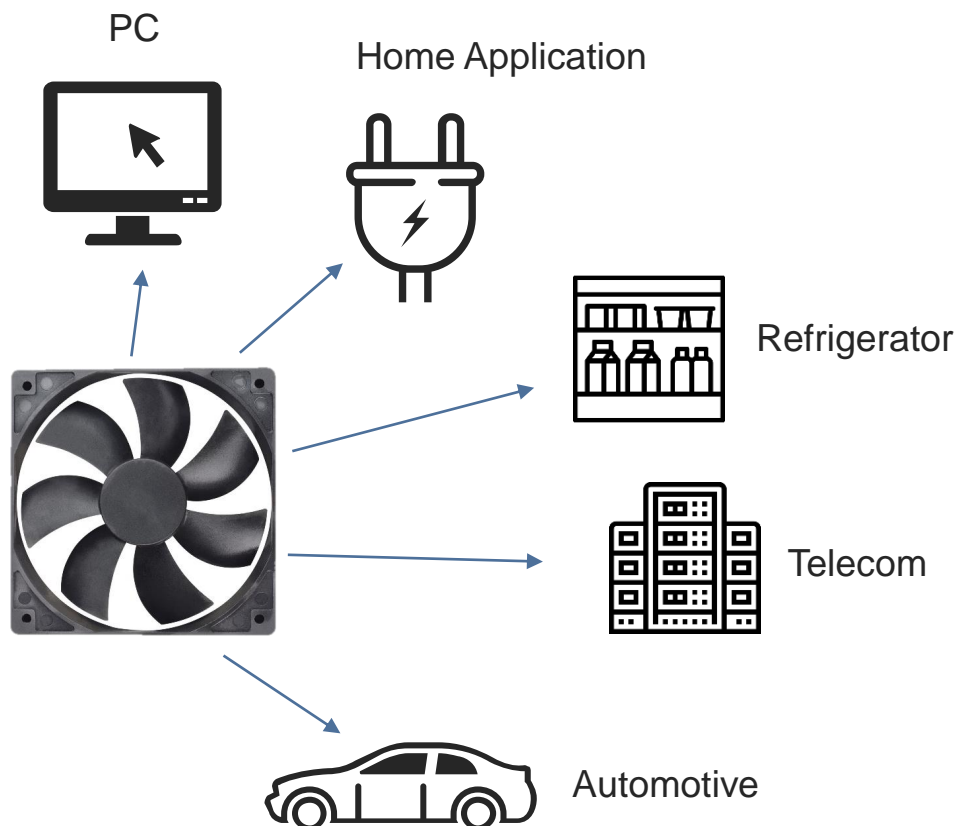


Built-in functions:

- 5V LDO
- Comparators
- Shoot-through protection
- Thermal protection
- UVLO

	600V		NM1817 LQFP44(10x10)	
	200V			NM18440 LQFP48(7x7)
	40V	NM18002 QFN24(4x4)	NM18107 QFN32(5x5)	
MCU		MS51	NM1120	NM1244
Application		Single phase	Three phase	

| Market for Cooling Fan

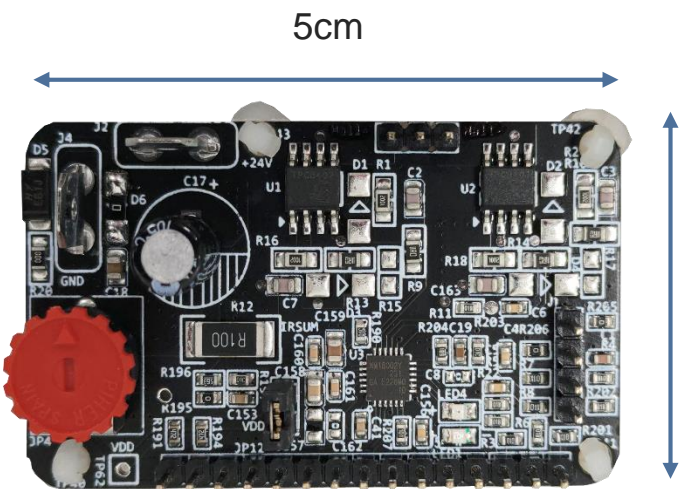


CAGR is about **12.34%**.

NM18002Y

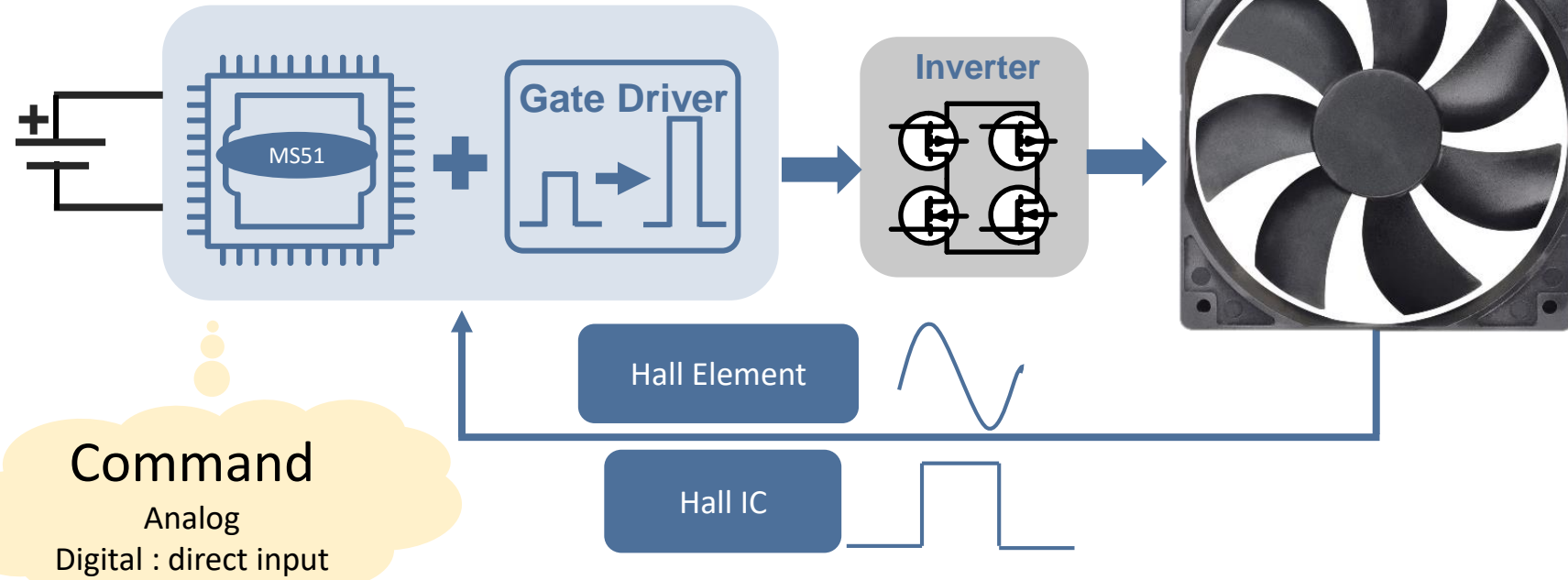
Highlights

- 12V-24V Fan
- PN gate driver
- Supports 4-Wire Programming
- Passive part → Active control unit

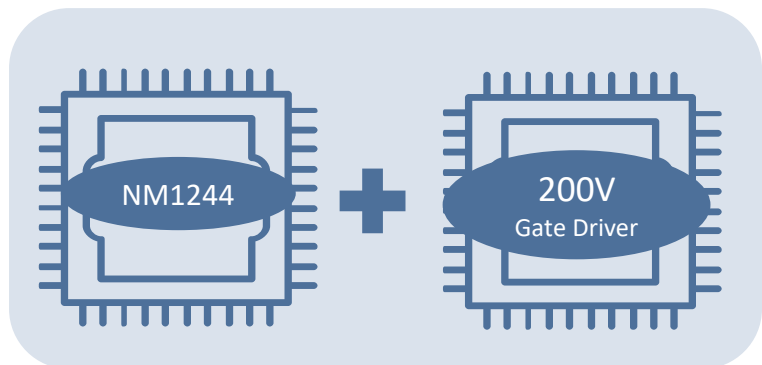


Communication
UART/I²C

Detection

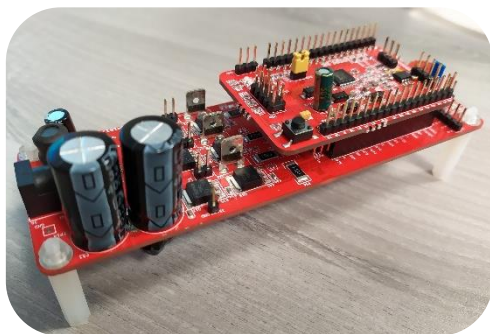


| NM18440D



Highlights

- 200V application : 110VAC, 24~96VDC
- LQFP48(7x7)
- Up to 29 GPIO



Cooling fan
in
refrigerator

Hand Drier



Ceiling fan

Soy-milk
maker



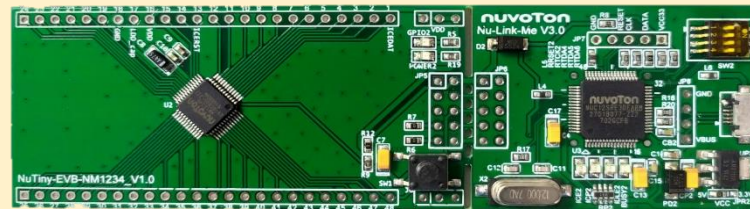
| Tools for Development



Tiny Board

NT-NM1200
NT-NM1120
NT-NM1230
NT-NM1240
NT-NM1530

Hardware



MCU + NuLink

Software

NM1200_BSP_CMSIS
NM1120_BSP_CMSIS
NM1230_BSP_CMSIS
NM1240_BSP_CMSIS
NM1530_BSP_CMSIS

Motor System Board

NK-NM1200L NK-NM1120L
NK-NM1230L NK-NM1240L
NK-NM1530L

NK-NM18107L NK-NM18002 NK-
NM18440 NK-NM1817H



MCU + GateDriver +MosFET

NuMotor_NM1200
NuMotor_NM1120
NuMotor_NM1240
NuMotor_NM1230
NuMotor_NM1530
NuMotor_NM18002Y

| We Provide.....



Balanced Product Line



Technical consult



Shipment > 100kk



High quality



Long life cycle



| Product Lines for Motors in Nuvoton

NM Series

MCU based
General-purposed



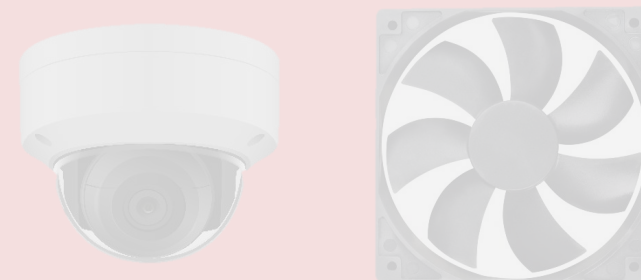
KA Series

ASIC
Dedicated

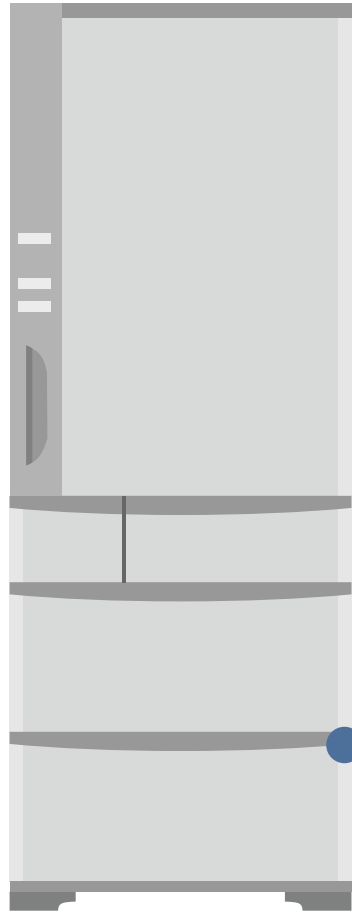
nuvoTon
新唐科技

KM

Series
MCU based
Home Appliance



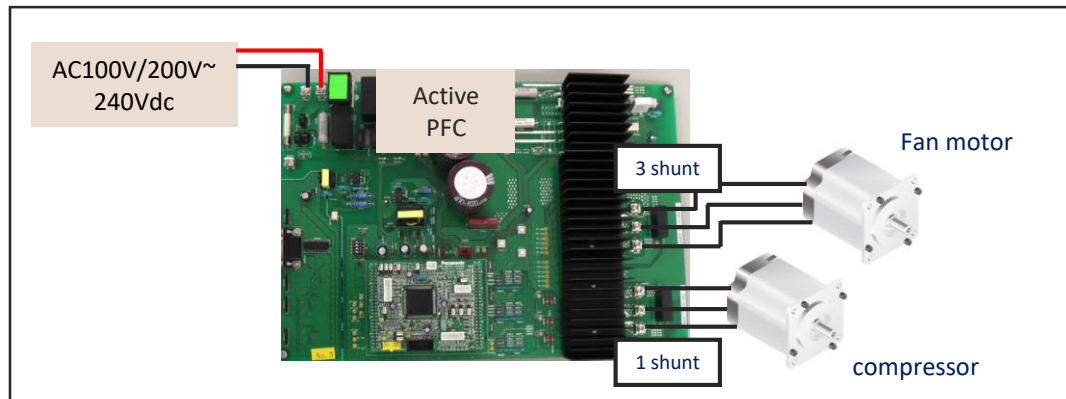
| Home Appliance



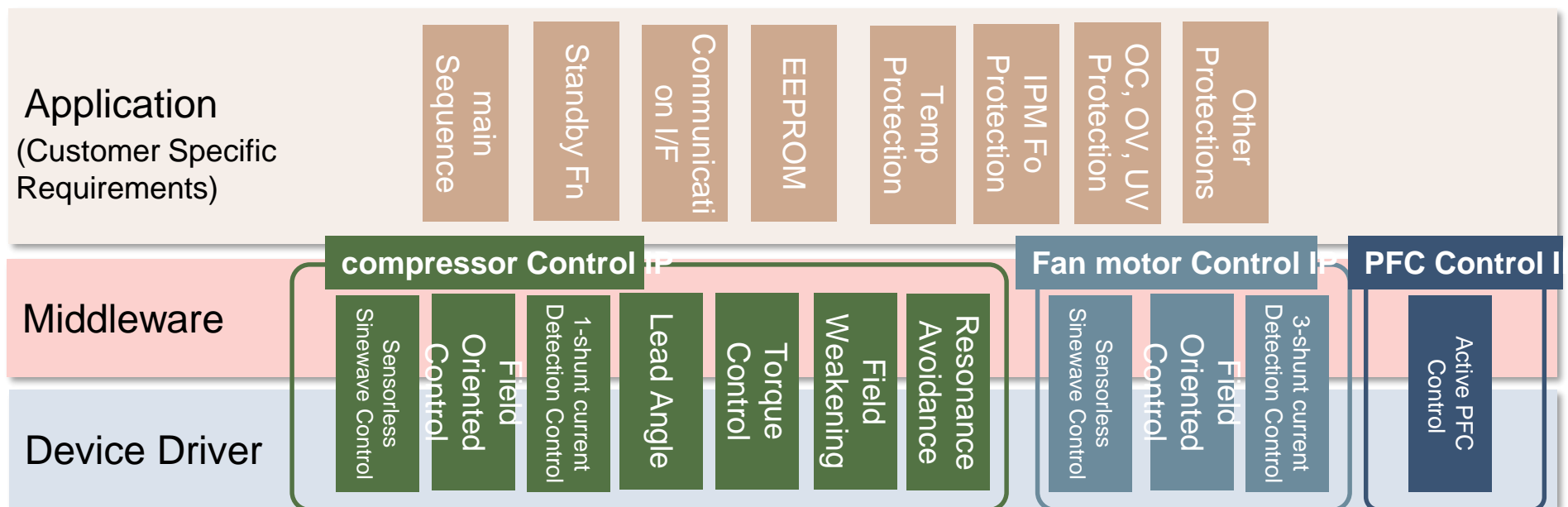
- **High-end Model**
Inverter controller
- **High-end model**
 - Core: Cortex-M7 160MHz
 - Flash: 256~512KB
 - Data Flash: 64KB
 - PIN: 100~144
- **Middle-end Model**
Middle-end model
 - Core: AM32R 120MHz
 - Flash: 128~512KB
 - Data Flash: 16~64KB
 - PIN: 48~144
- **Low-end model**
- **Low-end Model**
 - Flash: 128~256KB
 - Data Flash: 8~32KB
 - PIN: 48~100



Reference for Air conditioner



It is easy to use because it implements the required IP.



| NTC Inverter MCU Concepts

- With our 20 years of experience in Inverter MCU technology development and production knowhow, we can offer **“3S”**

Speed up development

Product development is always a battle against schedule.
⇒ Simple is best.

- Motor parameters are extracted in 1 minute (accuracy No. 1 in industry) and then automatically adjusted.
- Ensure processing time by synchronizing so that multiple motor control tasks do not conflict.
- AD and comparator pin assignments are stress-free with internal settings

Safety ensuring

Destruction of power devices can lead to fire.
⇒ Safety is first.

- Various protection circuits protect devices from multiple perspectives
- The internal mask function can avoid accidental system stop due to noise.
- Supports certification such as ISO60730

Save system cost

Parts around the microcomputer
⇒ Built-in is implemented.

- Built-in operational amplifier (differential input and negative input are supported)
- Each comparator has an internal reference voltage(external reference with noise isn't required)
- The number of parts can be reduced and wiring can be simply routed.

Inverter MCU Series Product



New ArmCortex-M4
series
New Arm Cortex-M7
series

KM7BFBF_x
KM103HFB_x
KM103HFD_x

performance	Type name ROM/RAM			KM1M7BF02N 512kB/64kB		KM1M7BF00N 512kB/64kB
160MHz +iRAM				KM1M7BF02M 384kB/48kB		KM1M7BF00M 384kB/48kB
				KM1M7BF02K 256kB/32kB		KM1M7BF00K 256kB/32kB
	KM1M7CF05K 256kB/64kB Under planning	KM1M7CF04K 256kB/64kB Under planning	KM1M7CF03K 256kB/64kB Under planning	Now planning ARM-M7 Higher performance		
120MHz +iRAM			KM103HFD5N 512kB/32k	KM103HFD6N 512kB/32k	KM103HFD7N 512kB/32k	KM103HFD8N 512kB/32k
		KM103HFD4M 408kB/20kB	KM103HFD5M 408kB/20kB	KM103HFD6M 408kB/20kB	KM103HFD7M 408kB/20kB	KM103HFD8M 408kB/20kB
		KM103HFD4K 264kB/16kB	KM103HFD5K 264kB/16kB	KM103HFD6K 264kB/16kB	KM103HFD7K 264kB/16kB	
120MHz		KM1M4BF04K 264kB/16kB	KM1M4BF03K 264kB/16kB	KM1M4BF02K 264kB/16kB	<div>New M4-series Under development</div>	
	KM1M4BF05G 136kB/16kB	KM1M4BF04G 136kB/16kB	KM1M4BF03G 136kB/16kB	KM1M4BF02G 136kB/16kB		
80MHz	KM103HFB3K 264kB/20kB	KM103HFB4K 264kB/20kB	KM103HFB5K 264kB/20kB	KM103HFB6K 264kB/20kB		
	KM103HFB3G 132kB/16kB	KM103HFB4G 132kB/16kB				
QFP48		QFP64	QFP80	QFP100	QFP128	QFP144

| Product Lines for Motors in Nuvoton

NM Series

MCU based
General-purposed



KA Series

ASIC
Dedicated



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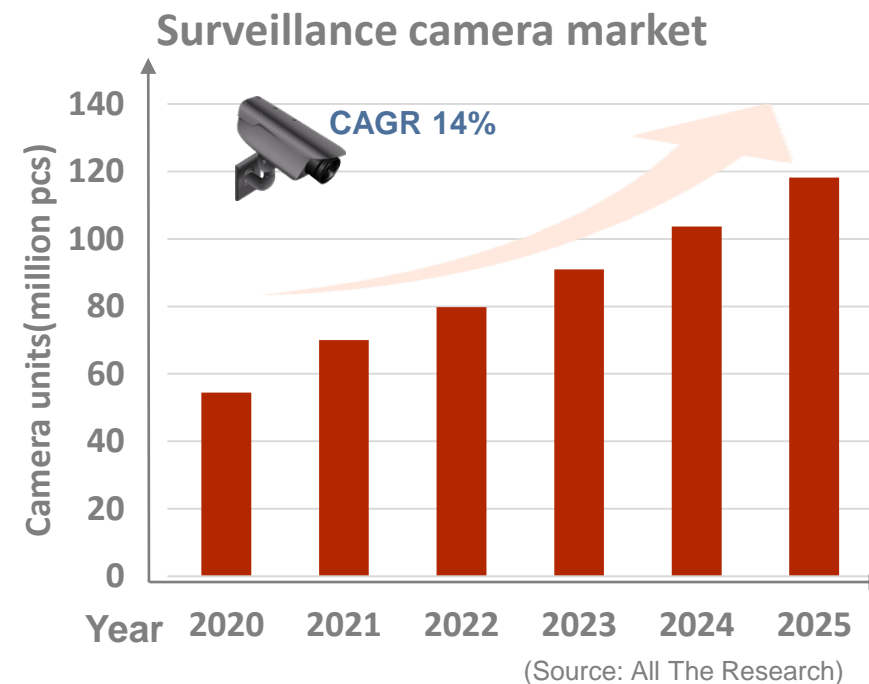
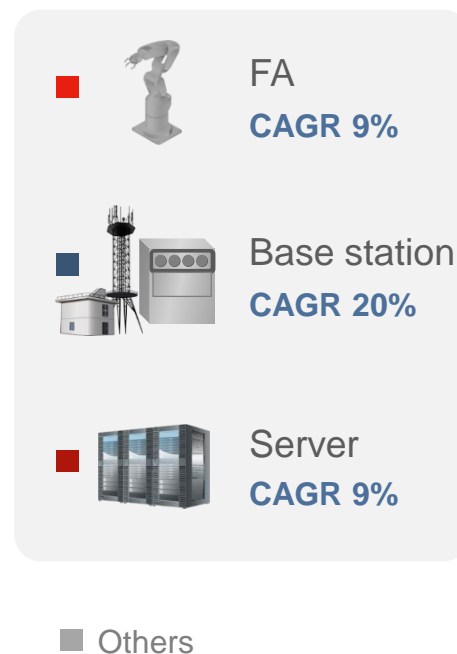
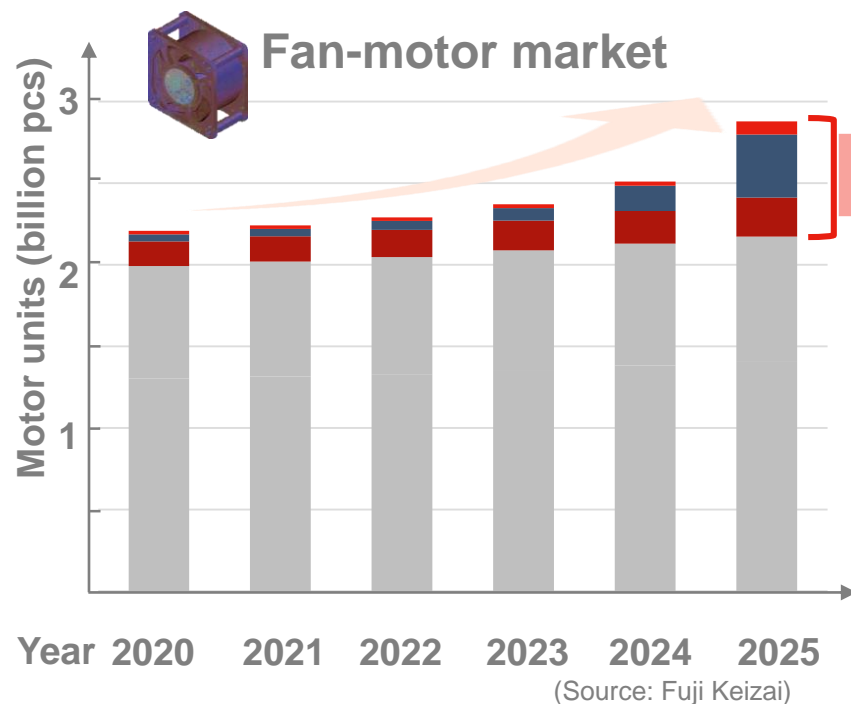
KM

Series
MCU based
Home Appliance



| Global Market Trend

- The Applications needed for “Smart Factory” have significant growth rate

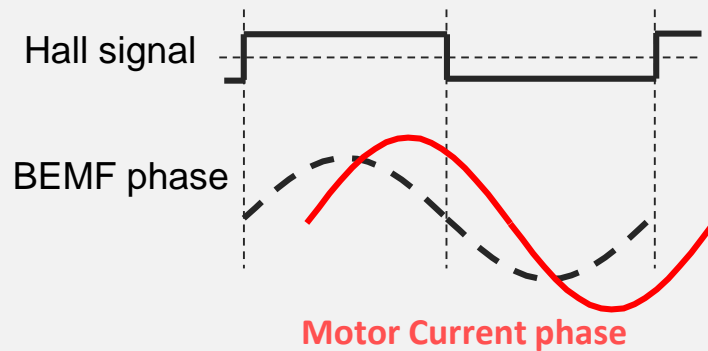


| Our Solution

Solution

- Customize “Core Technology” to realize our proposal

(Core Technology) Phase Control



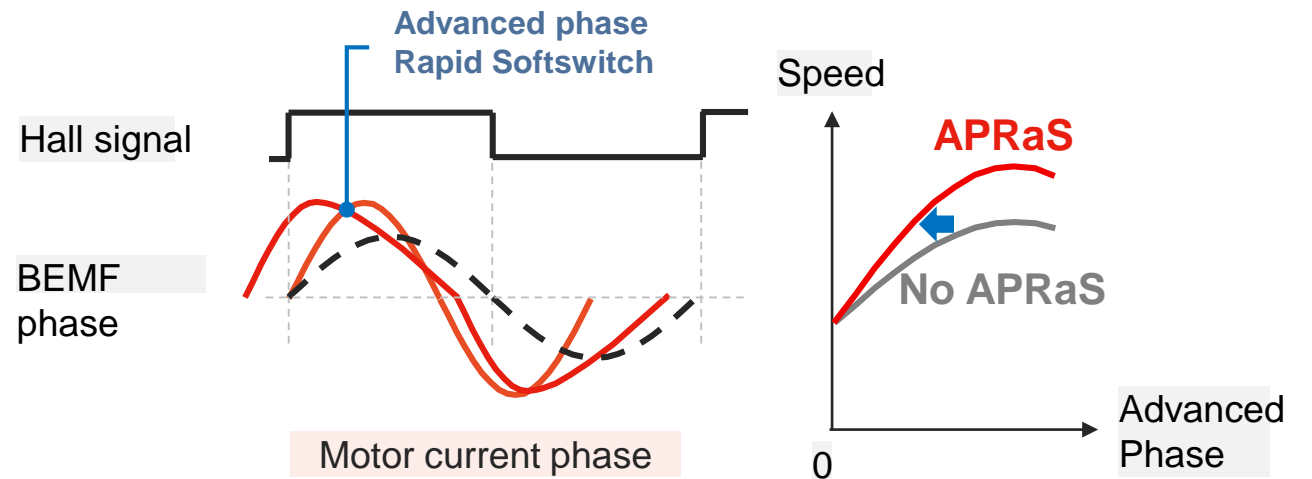
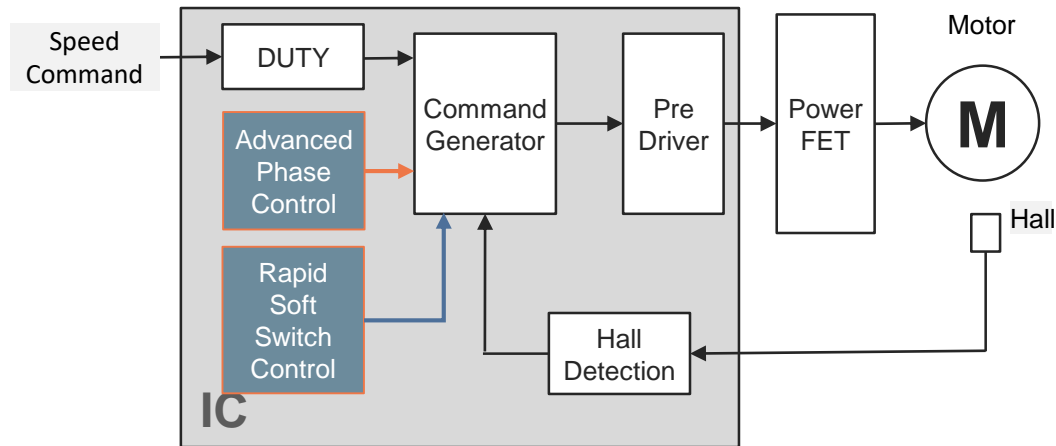
For High Speed
Advanced Phase
& Rapid Softswitch

For Low Vibration
Correction
Amplitude & Phase

| What is APRaS

- APRaS optimizes motor performance and enable to set more than 100 krpm

APRaS

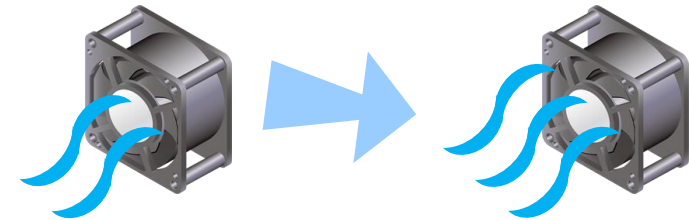
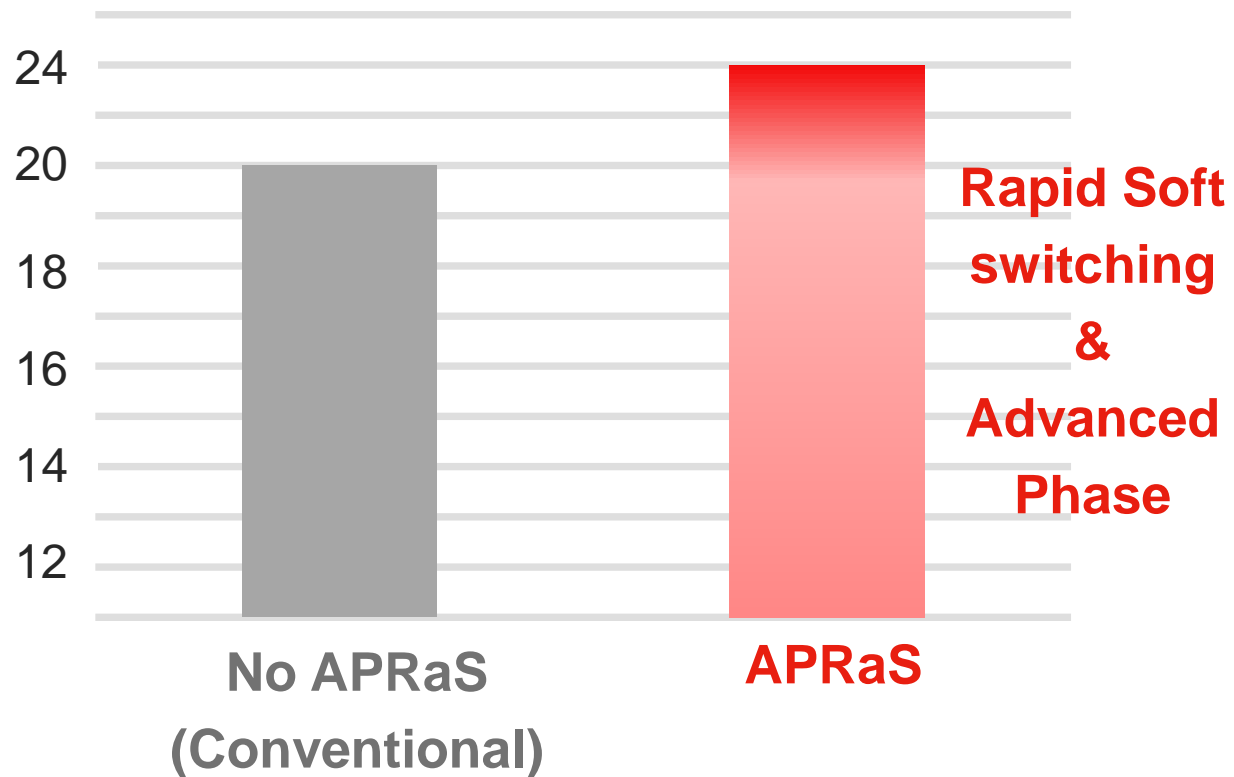


APRaS optimizes waveforms at high speed.

Benefit High Air flow

- APRaS increases maximum rotation speed

Speed [krpm]



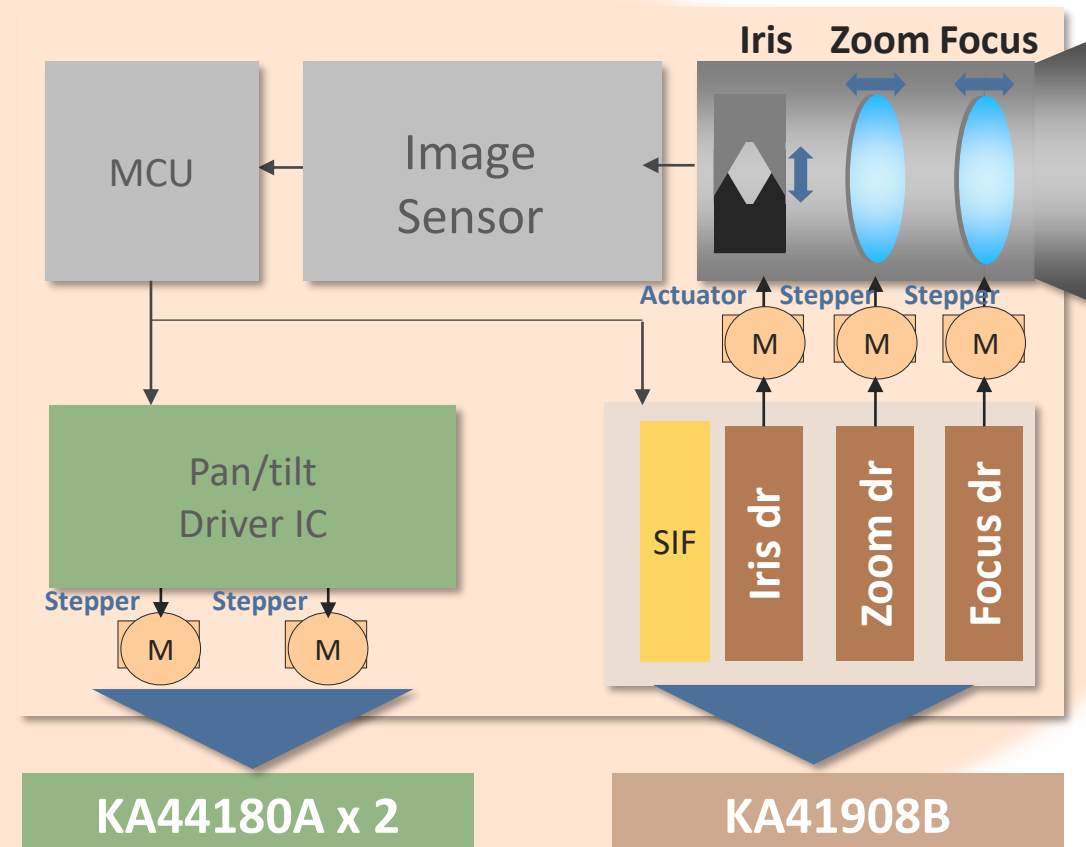
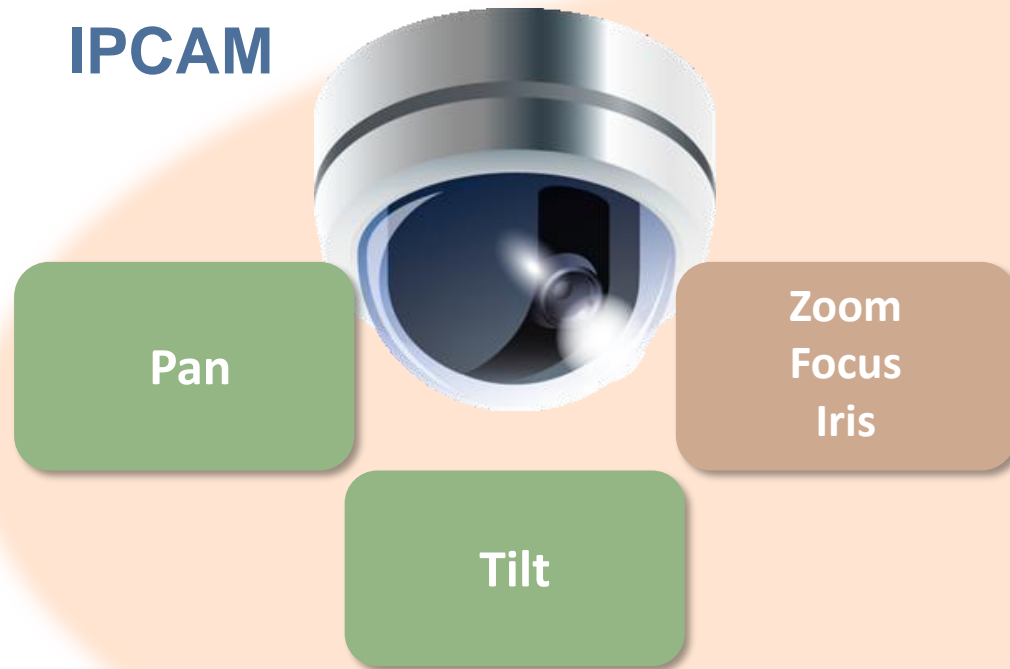
If same size,
⇒ Realize high air flow

Realize High Speed Operation

Use Case (Lens Driver)

Market

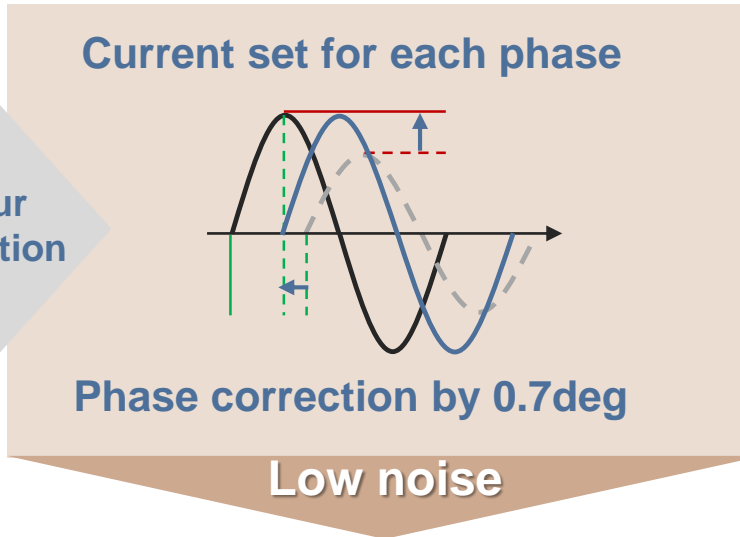
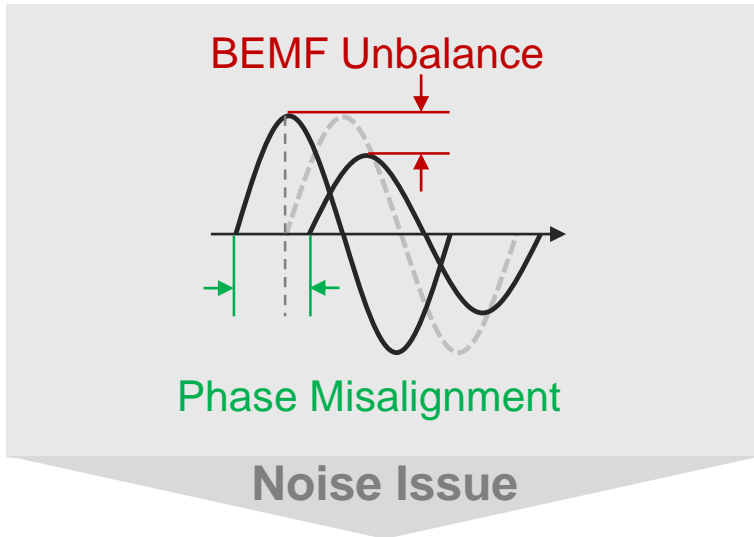
Surveillance IPCAM



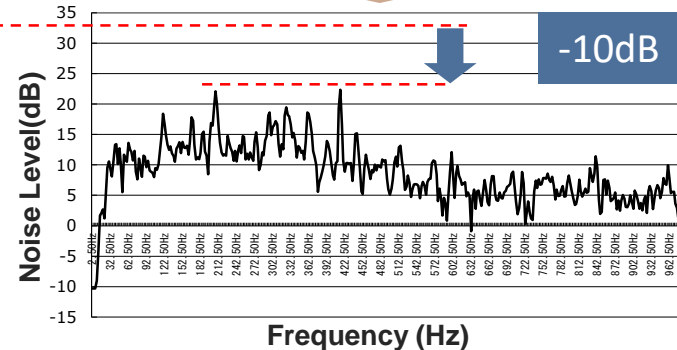
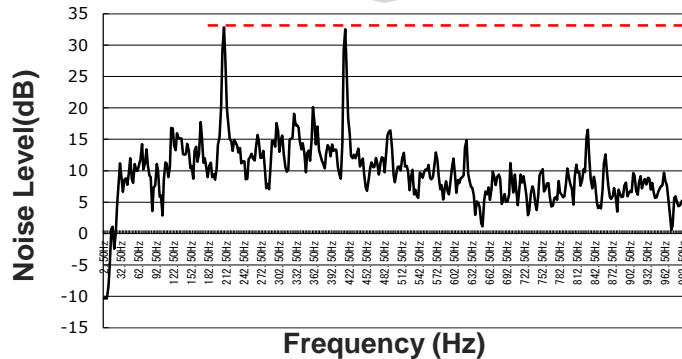
What is CAP

- CAP (Correction Amplitude & Phase) function reduces Acoustic noise
Due to manufacture variation

CAP function







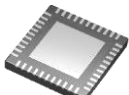
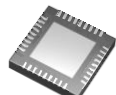
Realize
Low vibration
& Quick Monitoring



KA Series Portfolio

Line-up

Fan MTD	For Single Phase					For Three Phase
	KA44171A	KA44168A	KA44169A	KA44169AB	KA44170A	KA44143A
Package	 HQFN20 3mm x 3mm 0.4mm pitch	 MSOP8 3mm x 4.9mm 0.65mm pitch			TSSOP14 5mm x 6.4mm 0.65mm pitch	 HQFN24 4mm x 4mm 0.4mm pitch
Absolute max. rated voltage/current	39V/ Pre-Driver	35V/1.4A	36V/1.4A		36V/ 1.6A	28V/2.2A
Ron (Upper + Lower)	External FET	1.6Ω	1.6Ω		1.25Ω	1.0Ω
Phase control	APRaS	APC				APC
IF : INPUT / OUTPUT	PWM or VSP / FG or LD	Non / FG	PWM / FG+LD	VSP / FG	PWM / FG+LD	PWM or VSP /FG+LD
Feature	High speed (~100Krpm)	Smallest driver	General function		High speed (~15Krpm)	1 Hall /Silent drive

Stepper MTD	For Lens driver	For General purpose
	KA41908B	KA44180A
Package	 HQN44 6mm x 6mm 0.4mm pitch	 HQN36 5mm x 5mm 0.4mm pitch
Absolute max. rated voltage/current	MVCC:6V, DVDD:4V / 0.25A(Stepper), 0.15A(Actuator)	37V/1.5A
Ron (Upper + Lower)	2.5Ω(Stepper) , 5Ω(Actuator)	1.4Ω
Stepper Driver	2ch (for Zoom / Focus)	1ch
Actuator Driver	1ch (for Iris)	-
IF : INPUT / OUTPUT	SPI / SPI	Parallel / NFALT
Feature	Built-in Hall Iris control	High speed/High torque

| Product Lines for Motors in Nuvoton

NM Series

MCU based
General-purposed



KA Series

ASIC
Dedicated

nuvoTon
新唐科技

KM

Series
MCU based
Home Appliance



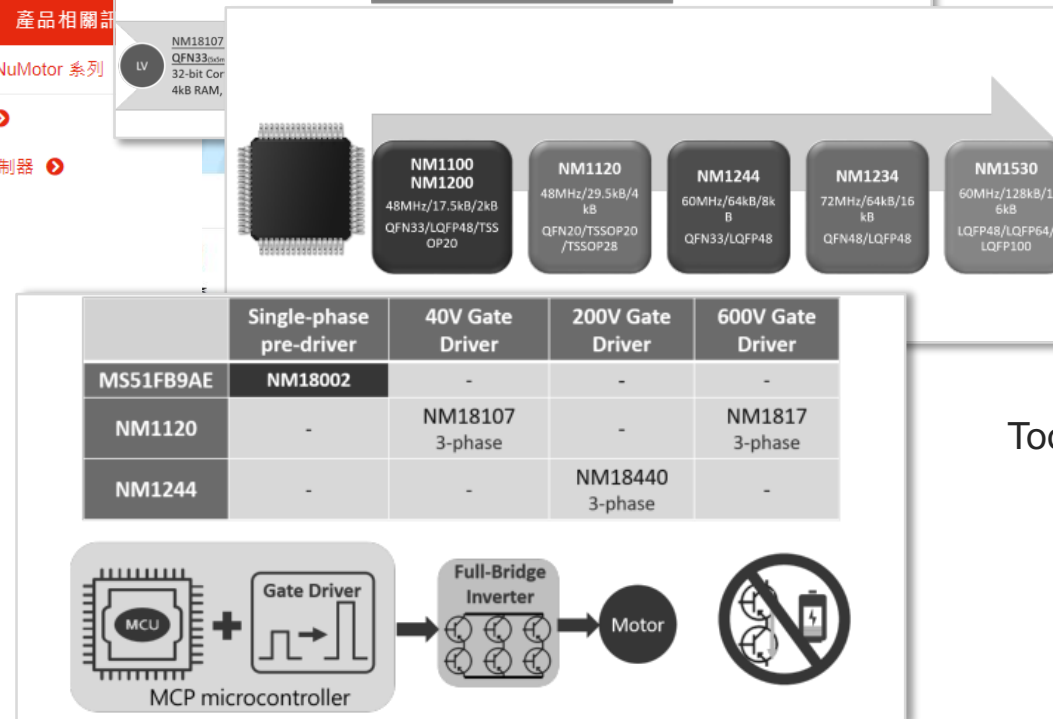
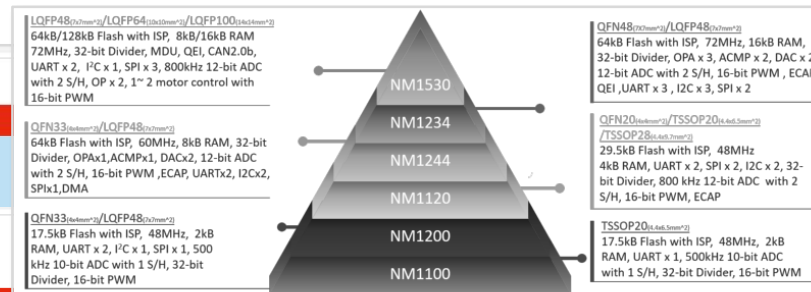
Synchronize with Nuvoton NOW!

1 創新產品 × 前瞻應用 ▾ 軟體與工具 ▾ 產品相關資訊 ▾

2 馬達專用控制晶片 - NuMotor 系列 ▾

微控制器(593) ▾
微處理器(43) ▾
模擬 IC(8) ▾
特殊應用系統晶片(12) ▾
電池管理(11) ▾
雲端運算(44) ▾
通信與接口 LSI(3) ▾
DSP / ISP(13) ▾
圖像傳感器(9) ▾
激光二極管(1) ▾
MOSFET(32) ▾
馬達驅動器(8) ▾
氣體感測器 ▾

馬達專用控制晶片 - NuMotor 系列
NuMotor 微控制器
NuMotor 合封型微控制器



www.nuvoton.com

Tools, Datasheets, BSPs, Example Codes, Circuits, Manuals are

Ready!

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

NuDeveloper Ecosystem

Make the engineers' job easier.

黃俊豪 Howard Huang

Microcontroller Marketing and Application Division

Senior Engineer

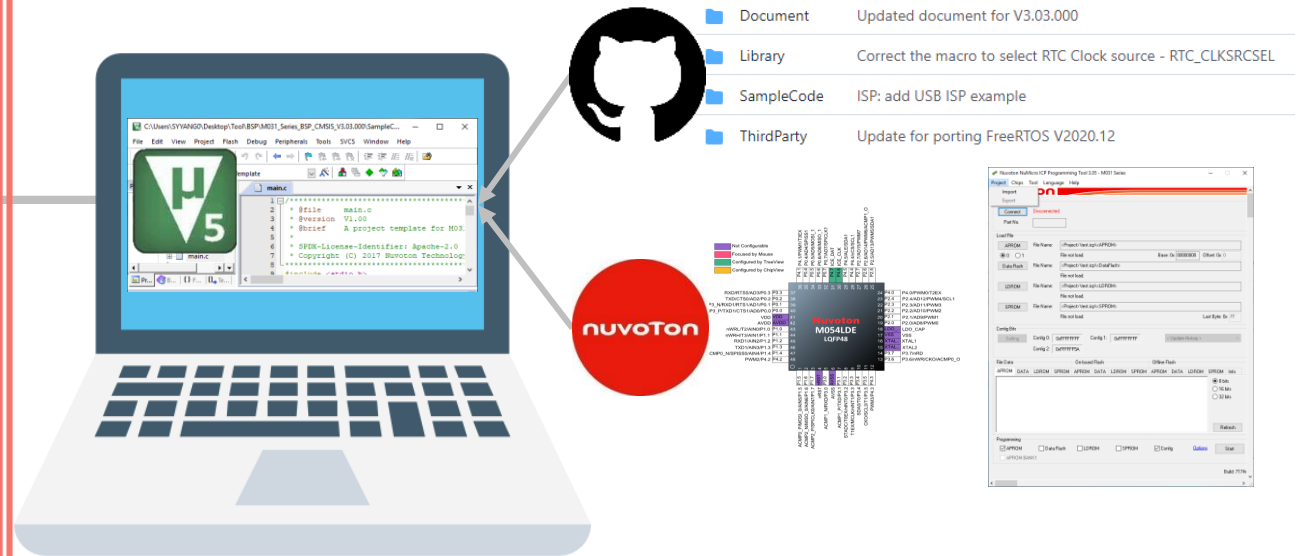
Joy of innovation
nuvoTon

NuDeveloper Ecosystem Use Case

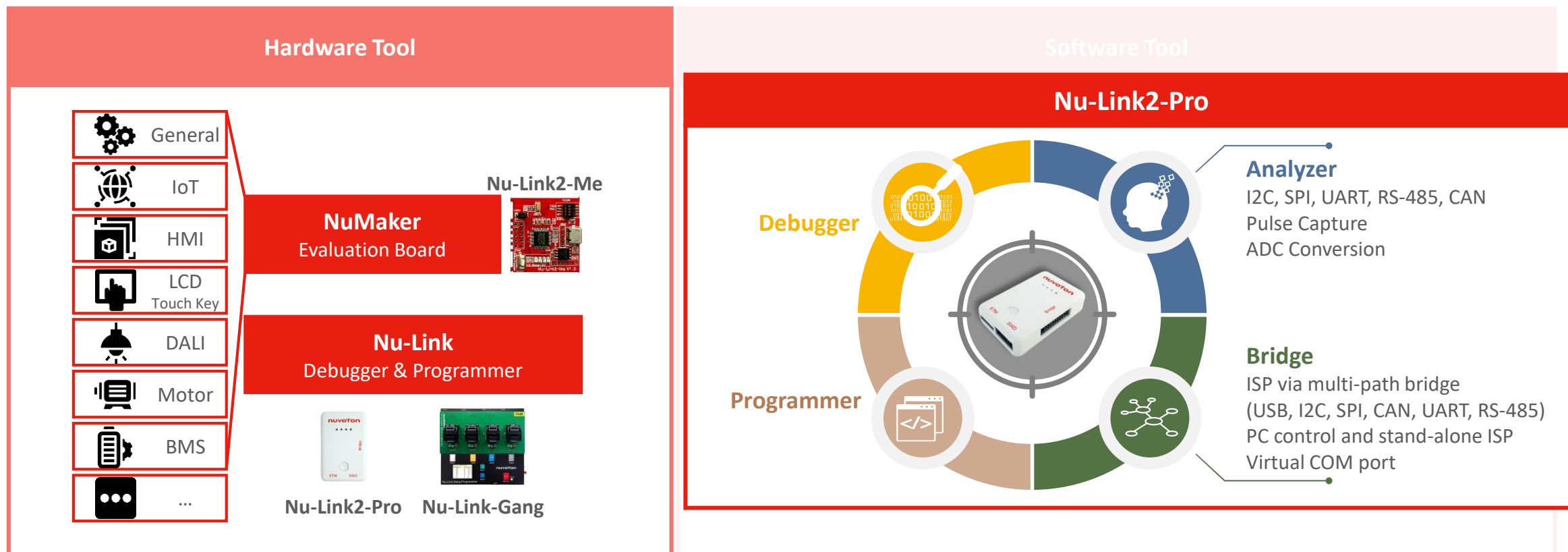
Hardware Tool



Software Tool

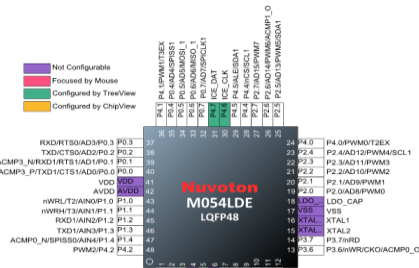


All in 1 to Make Job Easier



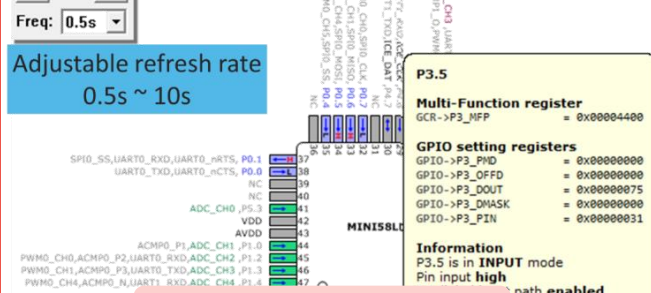
All in 1 to Make Job Easier

PinConfigure



Graphical I/O setting

PinView



Software Tool

IDE

KEIL™
Tools by ARM

IAR

NuEclipse

Free-to-use for
NuMicro M0/M23
Special offer for all
NuMicro Series

Free-to-use for
NuMicro
M0/M23/M4,
1T 8051 Coming
soon!!

BSP

Board Support Package

- Comprehensive drivers
- Plentiful peripheral examples
- API compatibility

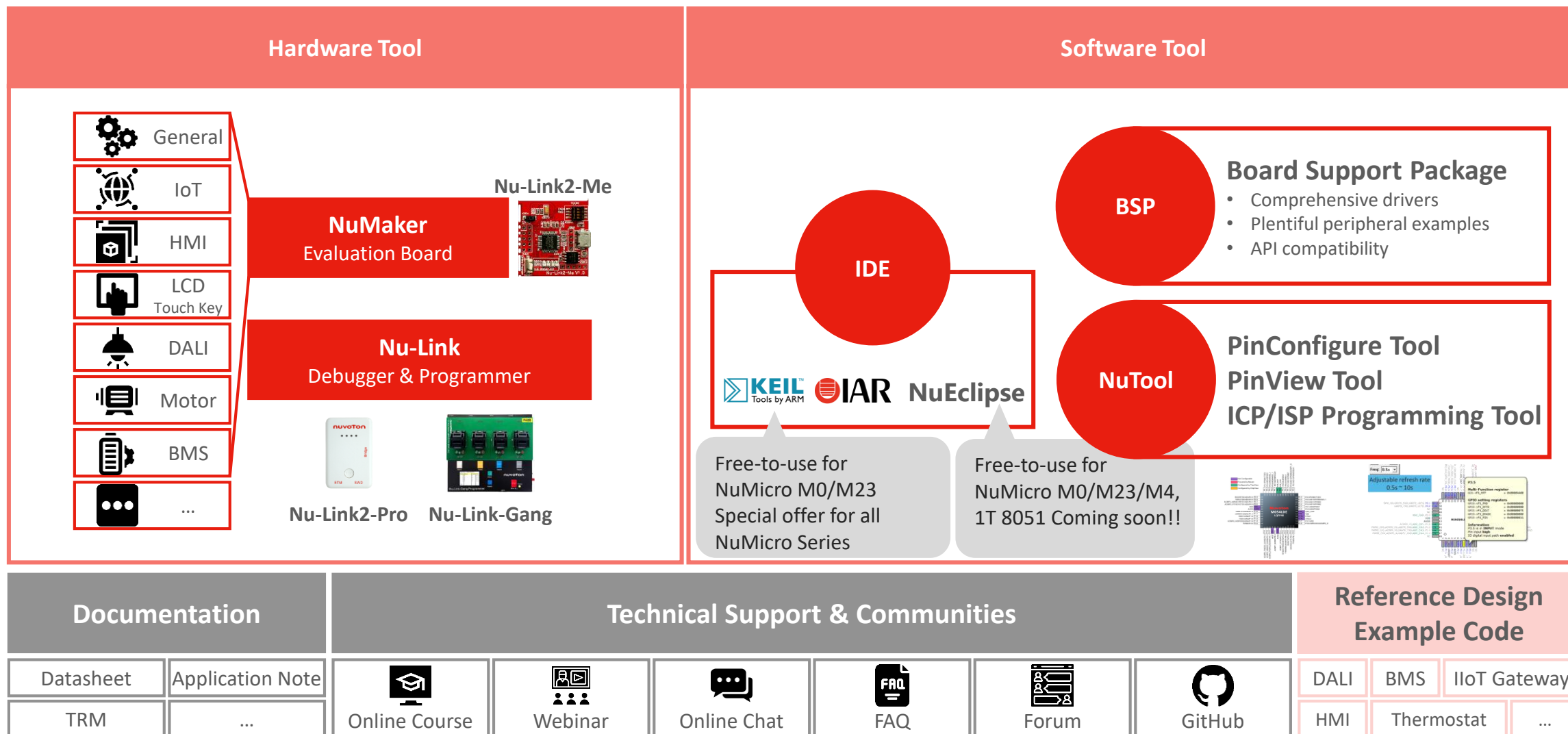
NuTool

PinConfigure Tool

PinView Tool

ICP/ISP Programming Tool

All in 1 to Make Job Easier



| All in 1 to Make Job Easier

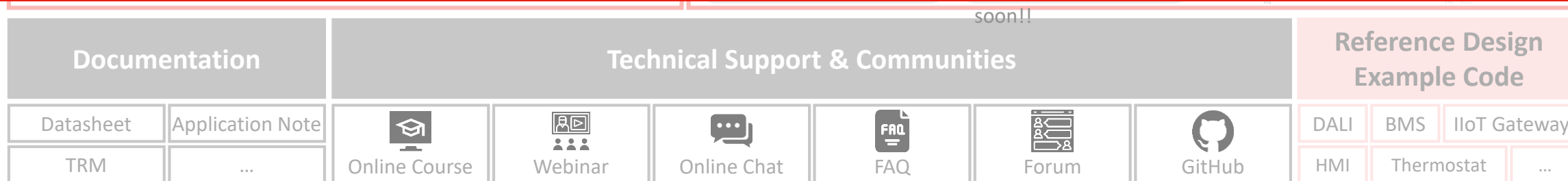


The Way to Implement
3 Steps by
1 Platform

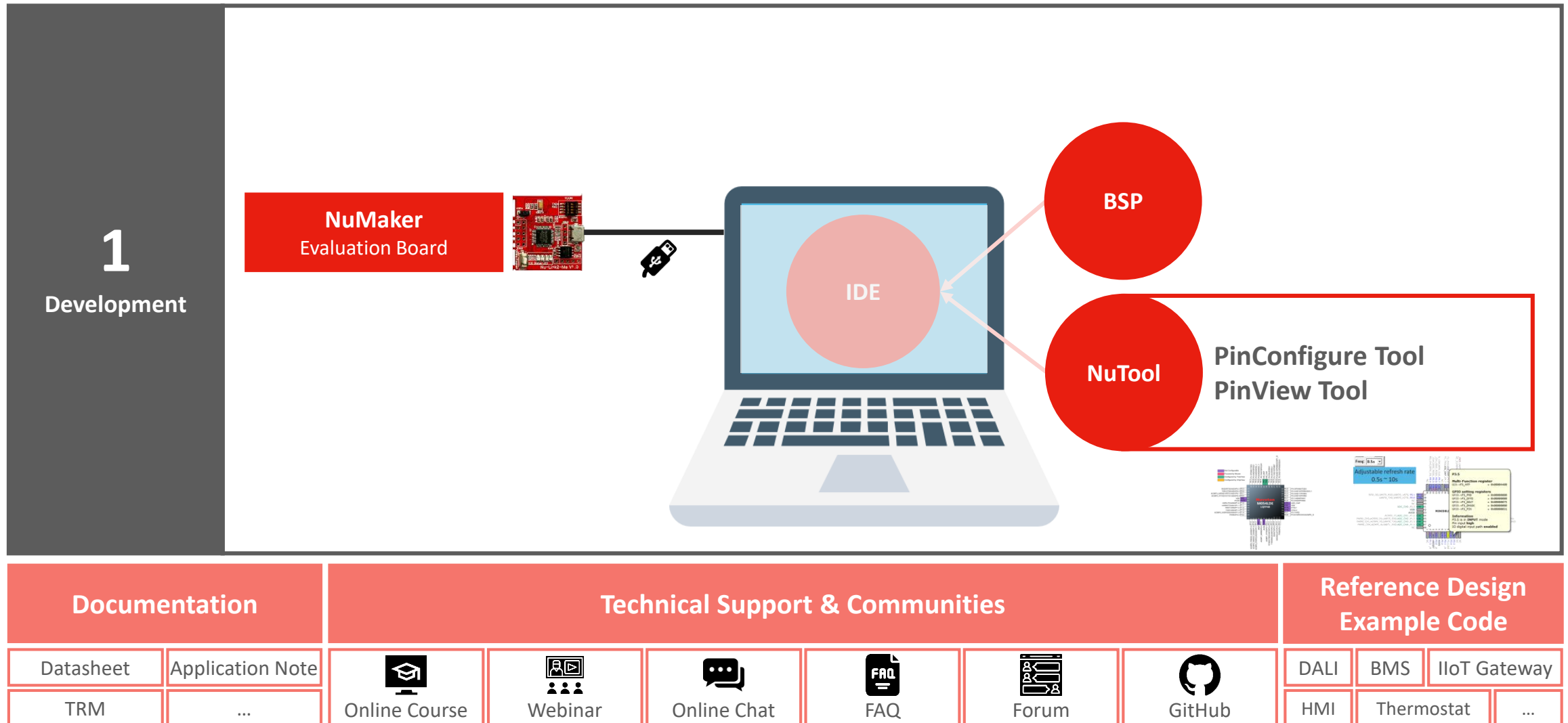
1
Development

2
Mass Production

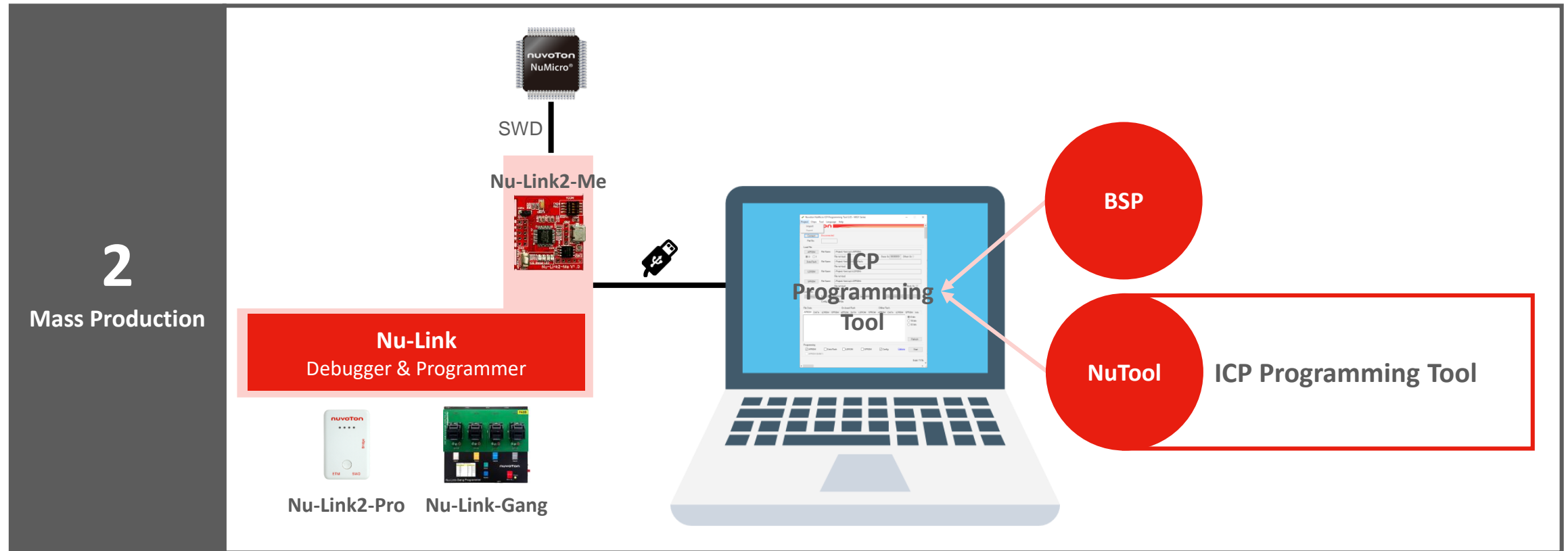
3
Upgrade



All in 1 to Make Job Easier



| All in 1 to Make Job Easier



Documentation

Datasheet

Application Note

TRM

...

Technical Support & Communities



Online Course



Webinar



Online Chat



FAQ



Forum



GitHub

Reference Design Example Code

DALI

BMS

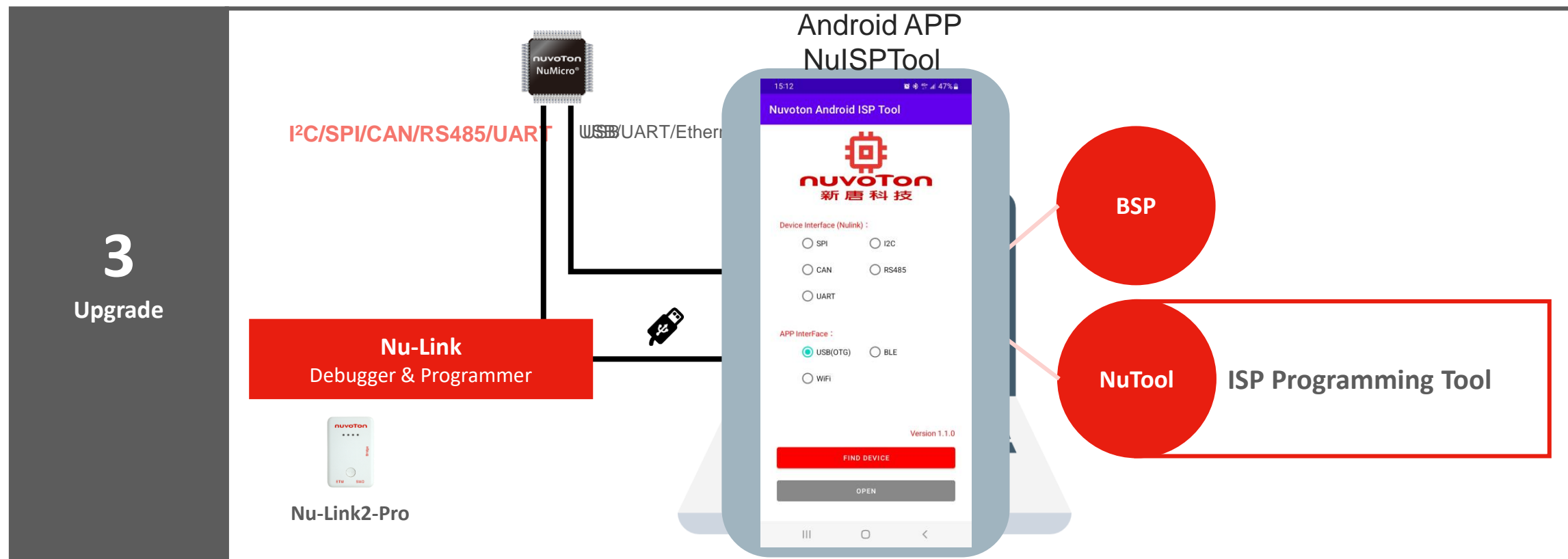
IIoT Gateway

HMI

Thermostat

...

| All in 1 to Make Job Easier



Documentation

Datasheet

Application Note

TRM

...



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Webinar



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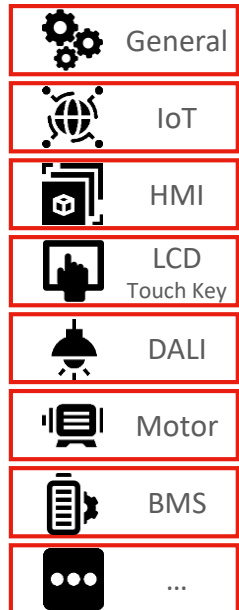
Thermostat

...

All in 1 to Make Job Easier

Up-to-Date Tools for Specific Applications

Hardware Tool



NuMaker
Evaluation Board

Nu-Link2-Me



Nu-Link
Debugger & Programmer



Nu-Link2-Pro



Nu-Link-Gang

Software Tool

IDE



NuEclipse

Free-to-use for
NuMicro M0/M23
Special offer for all
NuMicro Series

Free-to-use for
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1T 8051 Coming soon!!

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NuTool

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PinView Tool
ICP/ISP Programming Tool



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Datasheet

Application Note

TRM

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Technical Support & Communities



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Reference Design Example Code

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BMS

IIoT Gateway

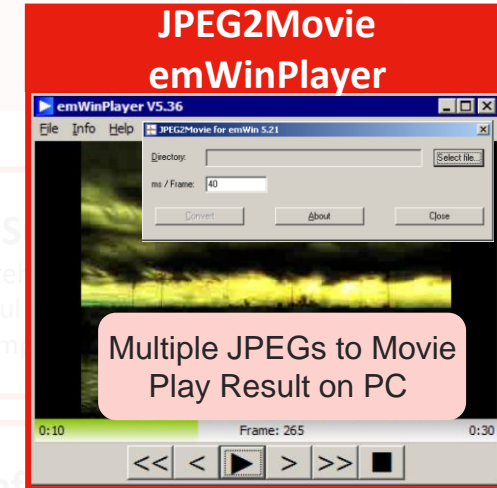
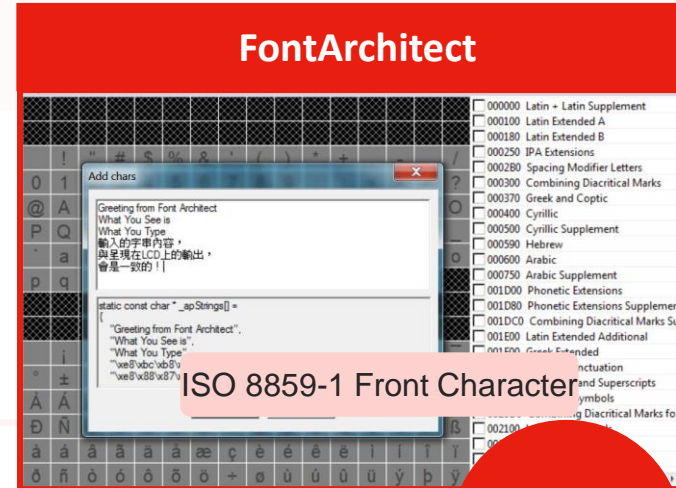
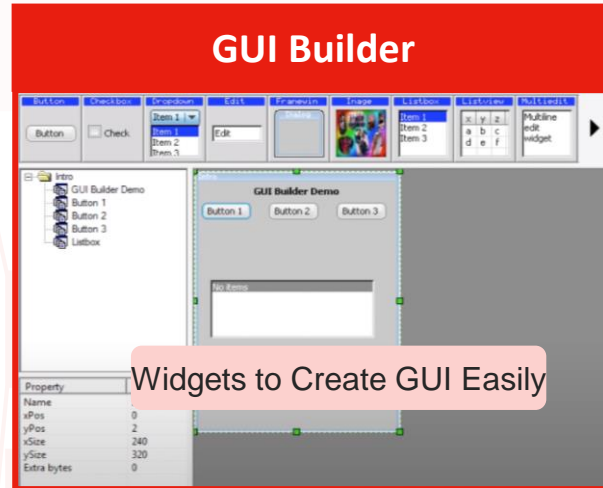
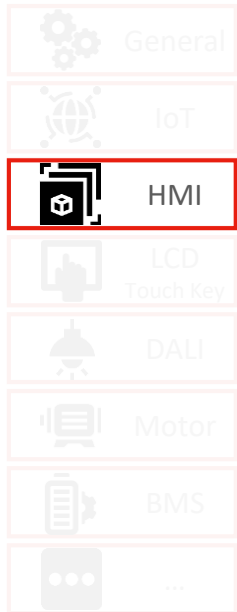
HMI

Thermostat

...

All in 1 to Make Job Easier

Up-to-Date Tools for Specific Applications



NuTool



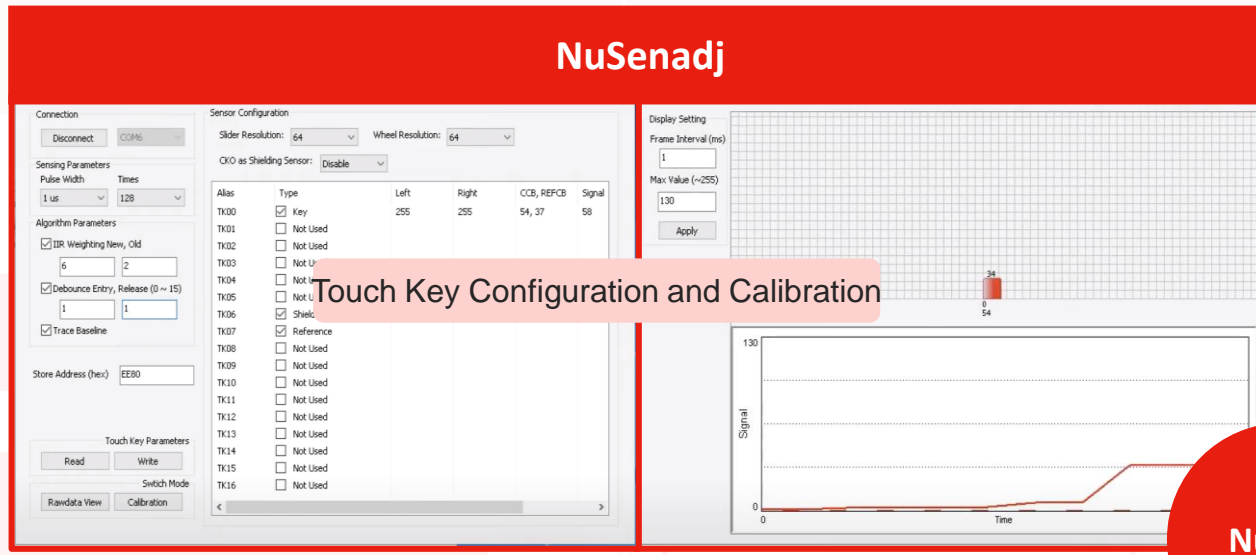
NuMaker-HMI-M487

Ease Your Development & Save Your Time

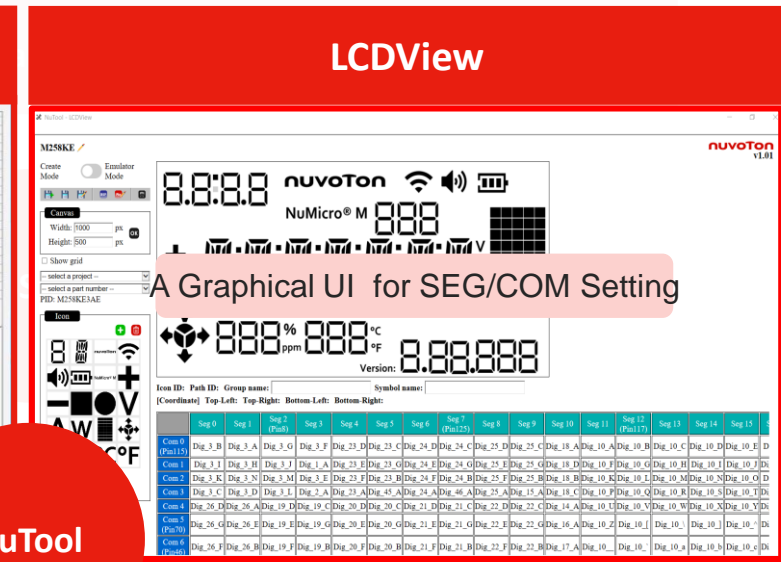
All in 1 to Make Job Easier

Up-to-Date Tools for Specific Applications

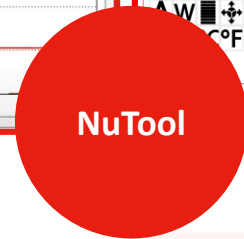
- General
- IoT
- HMI
- LCD Touch Key**
- DALI
- Motor
- BMS
- ...



Touch Key Configuration and Calibration



A Graphical UI for SEG/COM Setting



NuMaker-M258KE+TN-LCD Extension

Ease Your Development & Save Your Time

KEIL IAR NuEclipse ICP/ISP Programming Tool

All in 1 to Make Job Easier

Up-to-Date Tools for Specific Applications

DALIController

Discovery | DALI Commands | Monitoring

DALI Command

- DIRECT ARC POWER CONTROL

Data value

Dec 0 Hex 0

Send command to:

☒ All (broadcast)

☐ All (broadcast Unaddressed)

☐ Group 0

☐ Address 0

Initialization, Commands and Monitoring

Command

Dec Hex

☐ 103 Command 0

Response

Dec Hex

Software Tool

BSP

Board Support Package

- Comprehensive drivers
- Plentiful peripheral examples
- API compatibility

IDE

KEIL IAR NuEclipse

NuTool

PinConfigure Tool

PinView Tool

ICP/ISP Programming Tool

Master

Slave

Ease Your Development & Save Your Time

NuMaker-DALI-NDA102SD2+DALI Slave NDA102EC1

All in 1 to Make Job Easier

Up-to-Date Tools for Specific Applications

*also supports AM32R core

Inverter Motor

- HMI
- LCD Touch Key
- DALI
- Motor**
- BMS
- ...

NuMotor

SmartInverter

Motor ID

Tuning

Motor ID

Tuning

Inverter Motor System

Inverter Board

MCU Board

NuTool

Nu-MDA-NMxxxx

+

Gate Driver

+

Nu-LVMDM-MOS

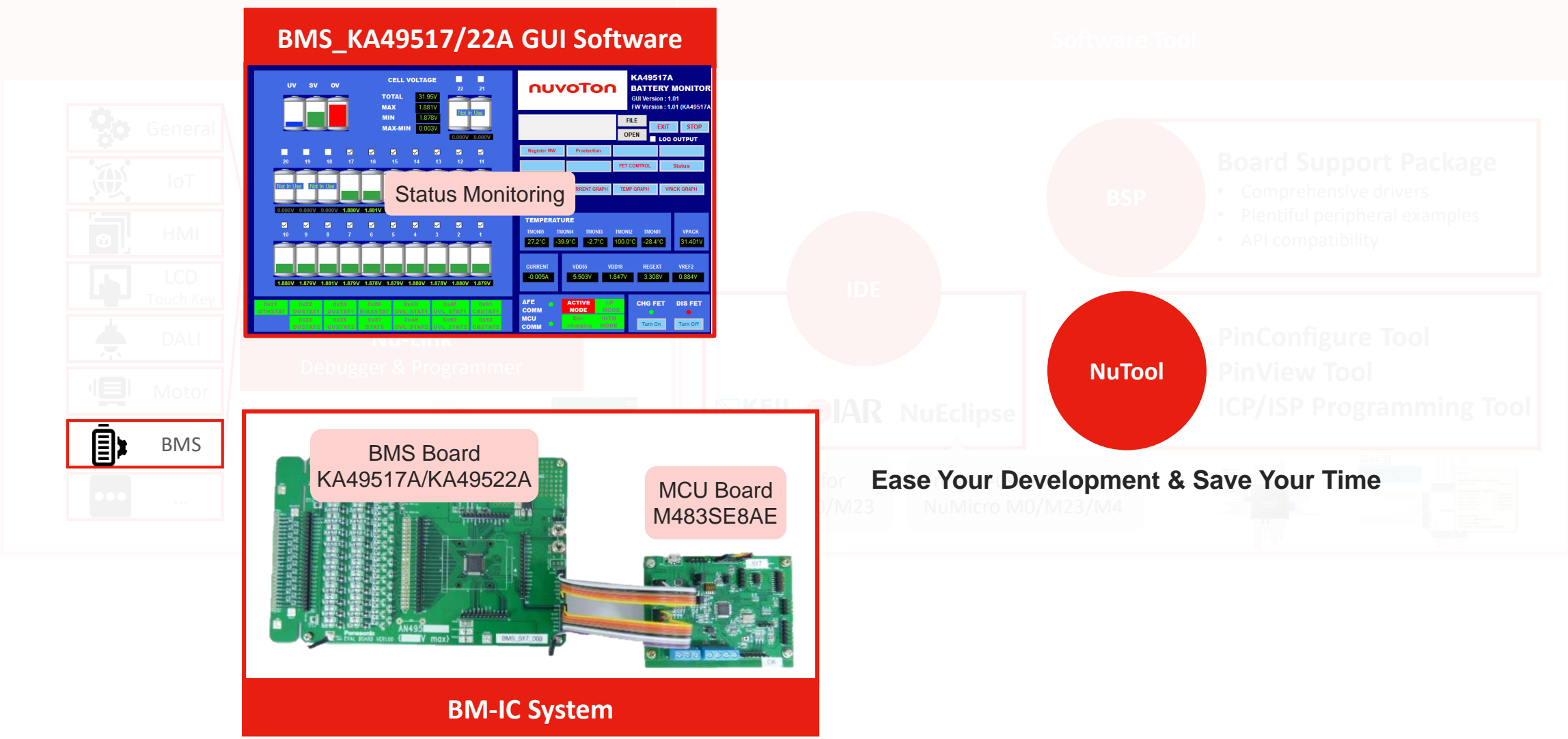
→

NK-1200L/1120L/1230L/1240L/1530L

Ease Your Development & Save Your Time

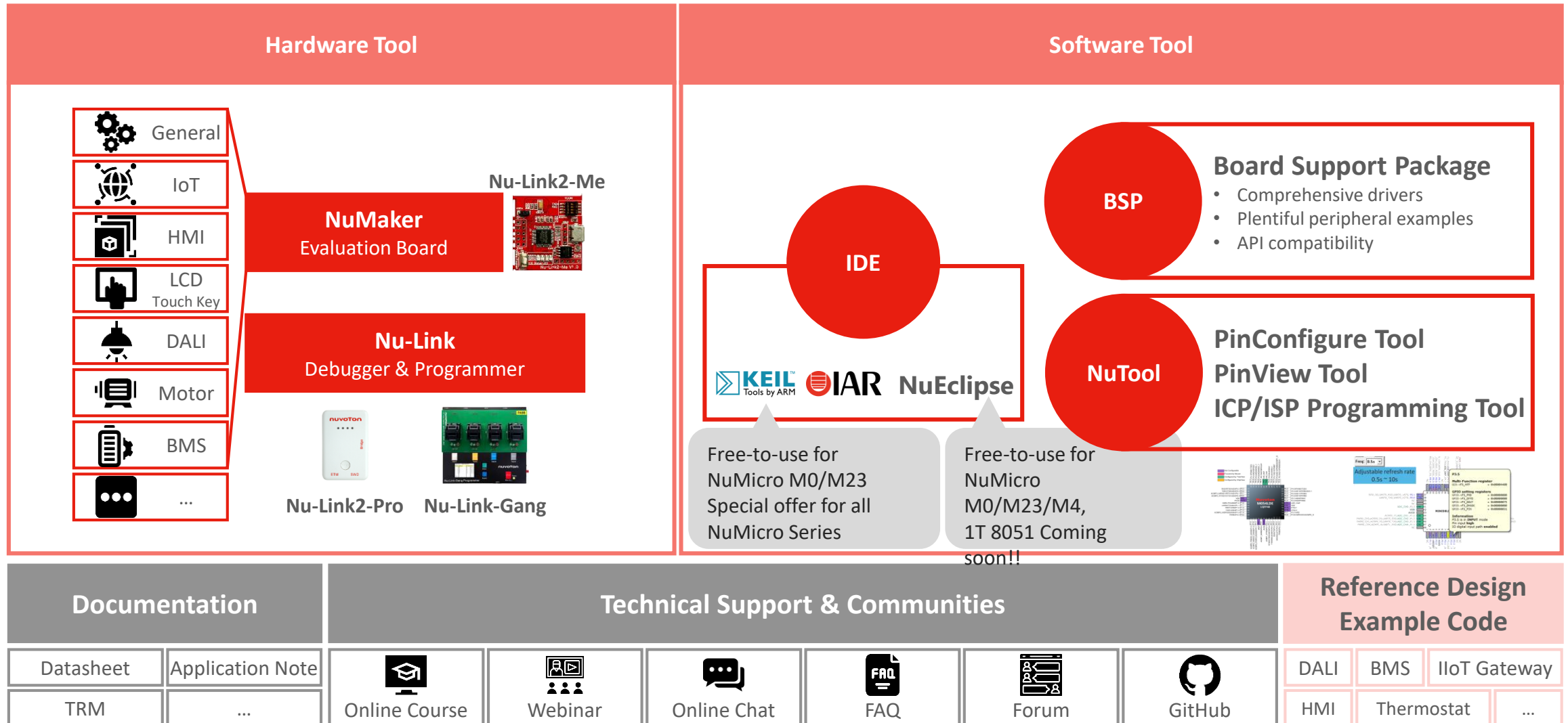
All in 1 to Make Job Easier

Up-to-Date Tools for Specific Applications



All in 1 to Make Job Easier

Up-to-Date Tools for Specific Applications



NuDeveloper Ecosystem

Make the Engineers' Job Easier

Hardware and Software Tool for General Use or Applications
Complete Tool Kits



| Digital Platform



Nuvoton.com

- Information Hub
- Online Support



**Nuvoton
NuMicro MCU**

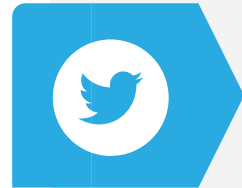


Nuvoton Direct

- Official eStore
- Online Support



NuForum



NuvotonMCU



Digikey

- Online Dist. Channel



**Nuvoton
NuMicro**



**Nuvoton
Technology
Corporation**



TechDesign

- Partner Channel

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