NXP's Heterogeneous Power – CPU/ GPU/ NPU Dance Together in the Robot

NXP异构之力—当CPU、GPU、NPU共舞于机器人躯壳

申靓 Elyn Shen

恩智浦大中华区高级市场经理

2025年7月

Exciting new applications & use-cases are emerging in key market segments

Factory automation

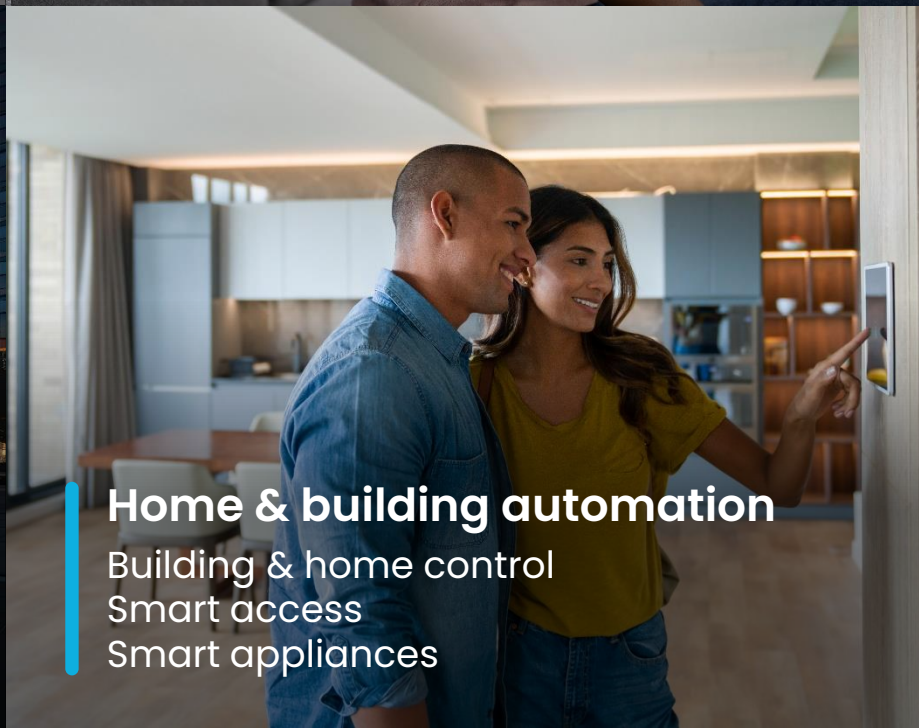
Real-time control
HMI
Robotics

Healthcare

Patient monitoring
Medical instruments
Personal health

Power & energy

Energy management
Green energy
Electrification



Home & building automation

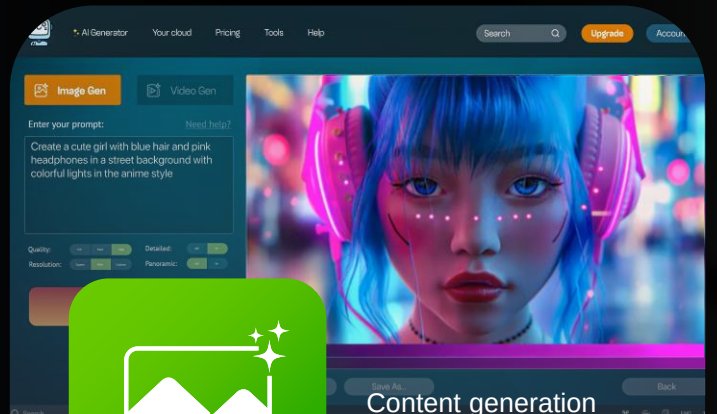
Building & home control
Smart access
Smart appliances

Perception AI

Perception

- Object detection
- Computer vision
- Speech recognition

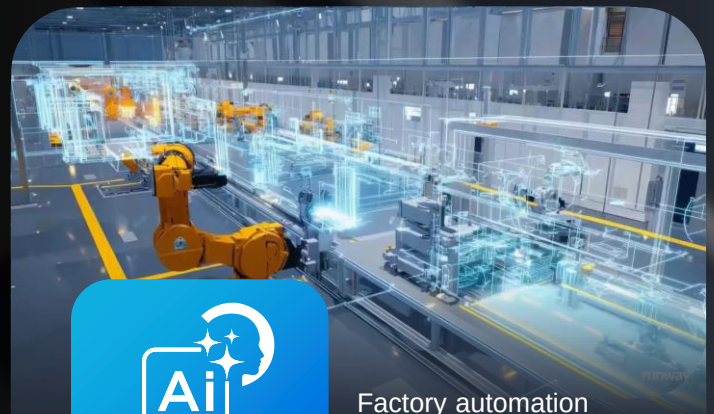
Generative AI



Generative

- Content generation
- Image generation
- Code generation

Agentic AI



Agentic

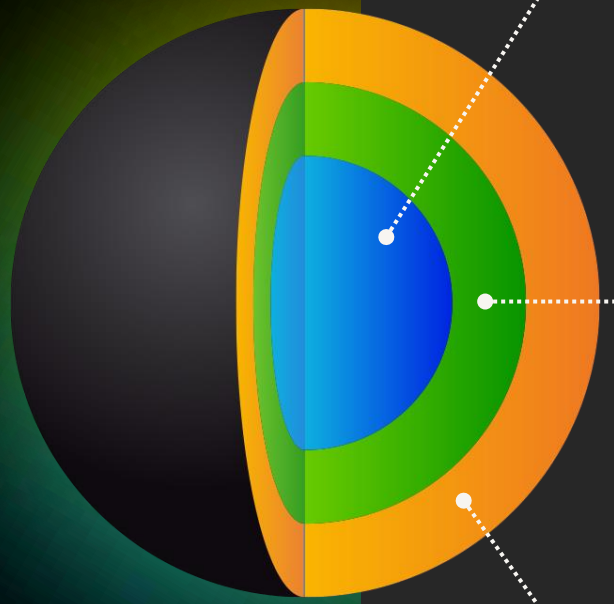
- Factory automation
- Healthcare application
- Power reallocation

The intelligent Edge

Where AI meets the physical world

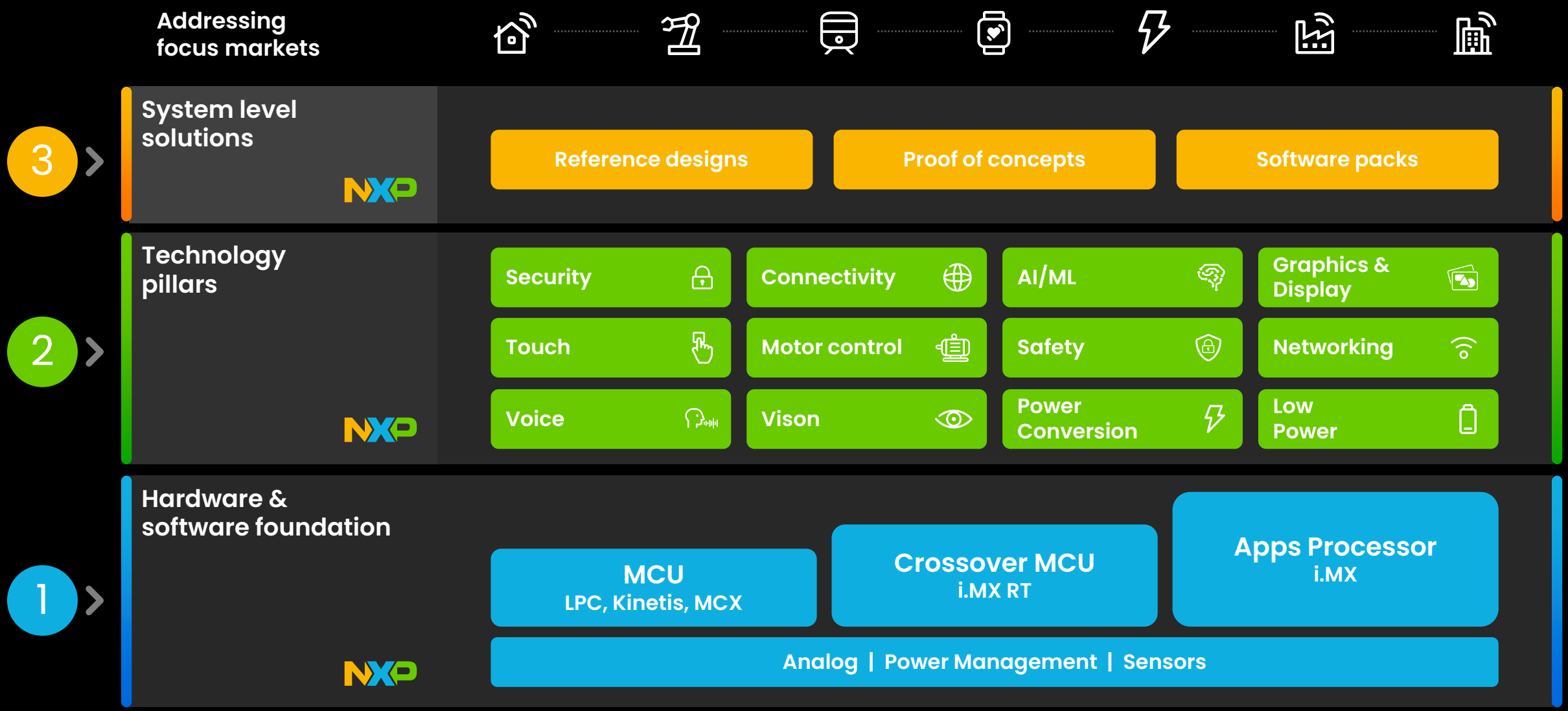
Bandwidth **Real-time** **Energy efficiency** **Trust**

Solving the complexity factors

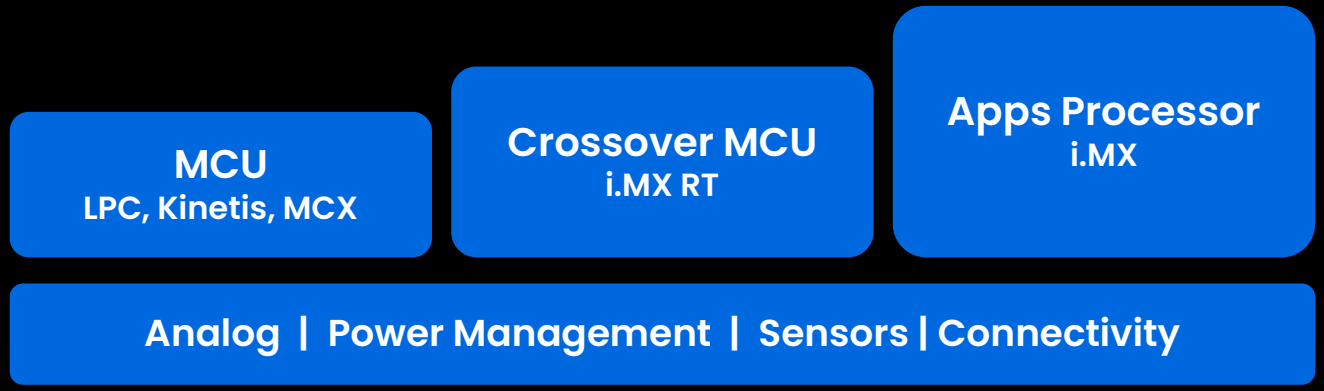


1. The hardware foundation
2. Technology requirements
3. Application level software development

Cut through complexity and scale



Scalable hardware platform
World-class IP makes world-class processors



"Fit-for-purpose" processors

High differentiation

Full system offering

Product longevity

Scalable from 100s of DMIPS to 100,000+ DMIPS

3,000+ MCU SKUs

400+ applications processors SKUs

A history of firsts

First MCU with NPU

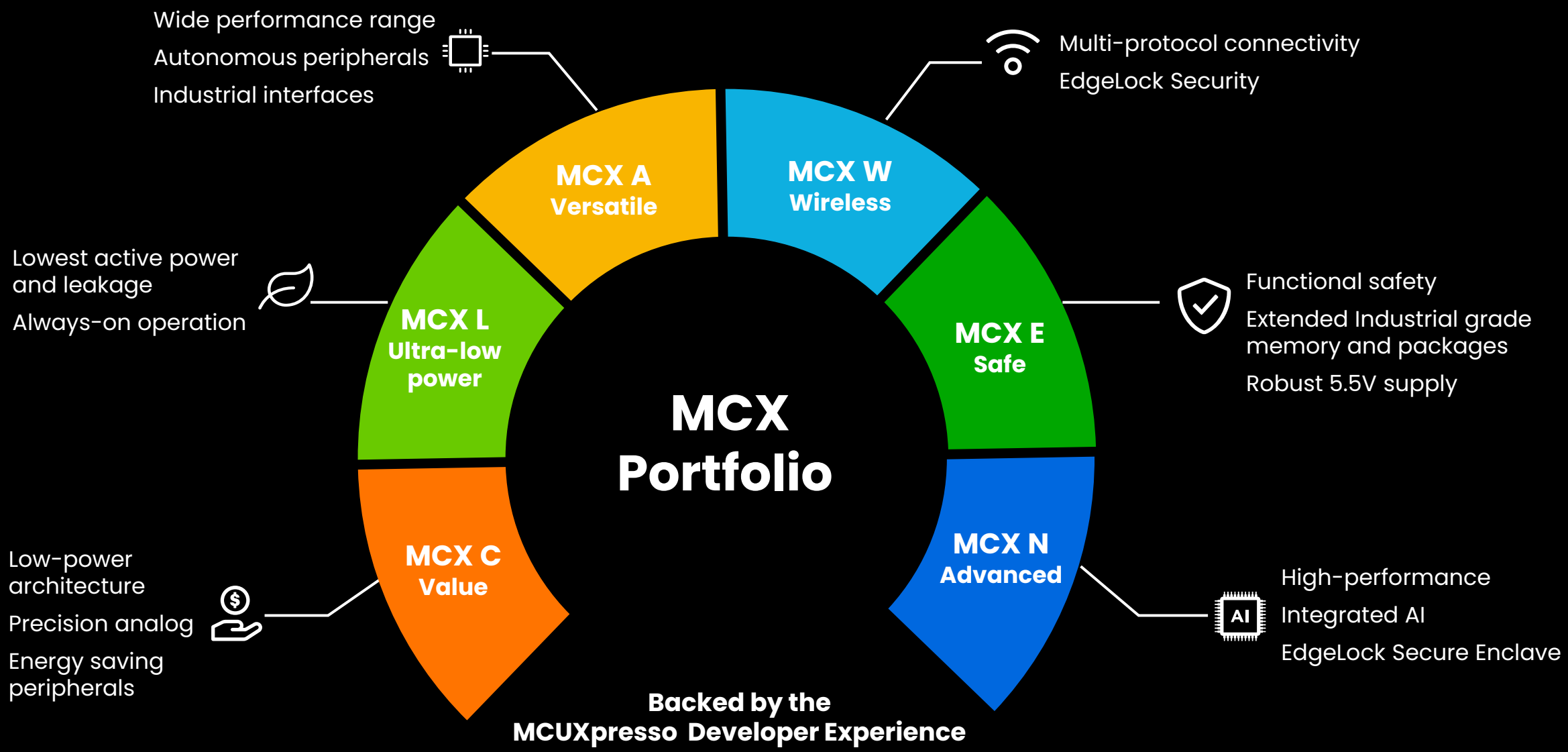
First MCU to break 1 GHz

First to integrate full MCUs into apps processors

1 2 3

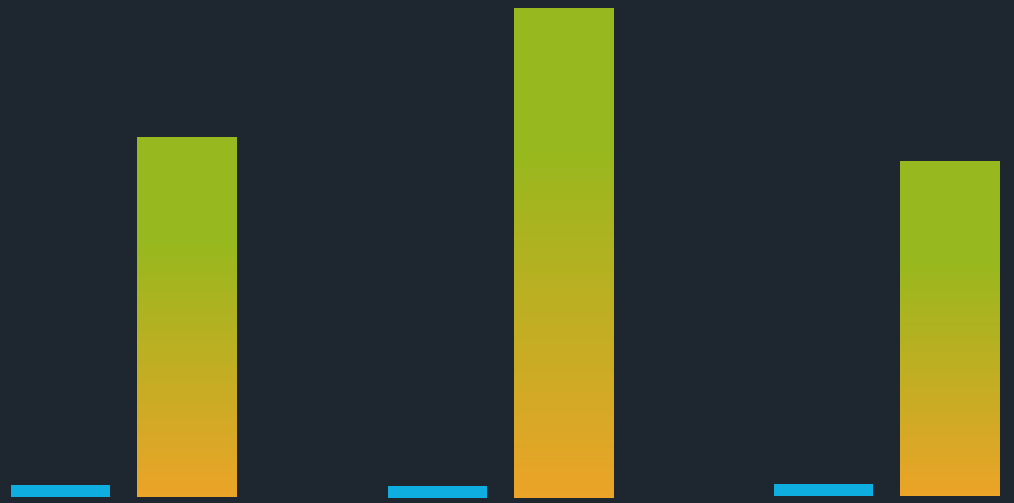
1. NXP internal estimates.

Diverse, broad MCX MCU portfolio



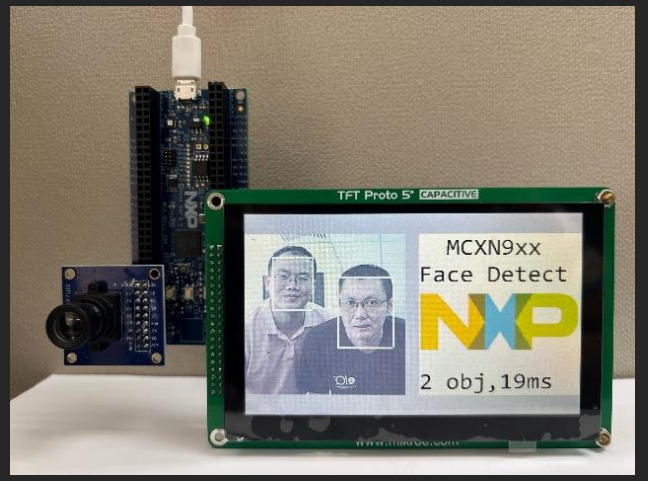
MCX N MACHINE LEARNING FOR MICROCONTROLLERS

- ~30x ML throughput compared to Cortex-M33
- NXP eIQ® software development environment



ML Operator Acceleration Achieved with MCX NPU

Game Changer for TinyML
MCU-based ML for Object Detection



	i.MX RT1062 M7(600MHz)	MCX N9xx M33(150MHz)	MCX N9xx Neutron+M33
Anomaly Detection	2.67ms 427uJ	8.82ms 832uJ	1.37ms (6.4x) 170uJ (4.9x)
Key Word Spot	10.13ms 2,612uJ	91.244ms 8,436uJ	24.276ms (3.8x) 3,005uJ (2.8x)
Image Classify	36.37ms 9,287uJ	366.521ms 33,887uJ	7.306ms (50x) 905uJ (37x)
Visual Wake Word	33.65ms 8,264uJ	274.682ms 25,396uJ	6.589ms (42x) 815uJ (31x)
(Live) Face detection 64x64	27.12ms 6,993uJ	305.794ms 28,272uJ	18.5ms (17x) 2,288uJ (12x)
(Live) 10 category image classification 32x32	26.51ms 6,835uJ	335.153ms 30,986uJ	8.606ms (39x) 1,065uJ (29x)

MCX A34x series highlights

Performance

- Boosting main frequency to 180MHz (4.10 CoreMark/MHz)
- MAU (Math Accelerator Unit),only 5 cycles for SIN/COS/SQRT/RECIP/ATAN, significantly enhanced the computational performance in trigonometric functions.
- Up to 1MB Flash, 256KB SRAM, and 8 KB SRAM with ECC

Optimized Innovation

- FRO180M with 1% accuracy in room temperature and 1.5% in full temperature
- LPUART providing 24MHz communication, with TX/RX swap

Advanced Motor Control

- Up to 2x FlexPWM, generate 8 complementary PWM pairs with dead zone insertion
- 2x eQDC(enhanced Quadrature Detector Controller)
- 2x AND/OR Invert

Essential Security

- Security monitoring with tamper & intrusion detection
- Device lifecycle management
- Memory and debug access control

MCX A34x

Arm® Cortex®-M33

Low Power and Intelligent Peripherals

- SmartDMA, co-processor for flexible applications
- 5x 32b CTimer generate total 15 PWM with duty cycle adjustable

Communication Peripherals

2xLPSPI, Up to 4xLPI2C,
Up to 6xLPUART,
Up to 2x FlexCAN w/ FD

Packages

LQFP 144/100/64/48
HVQFN 48/32
BGA 169/112/64
Pin to pin compatible with MCXA products.

Rich Analog

- Up to 4x 16bit 3.2Msps ADC, up to 82ch on a dedicated package
- Up to 4x OpAmp
- 12bit DAC
- 3x Analog comparator

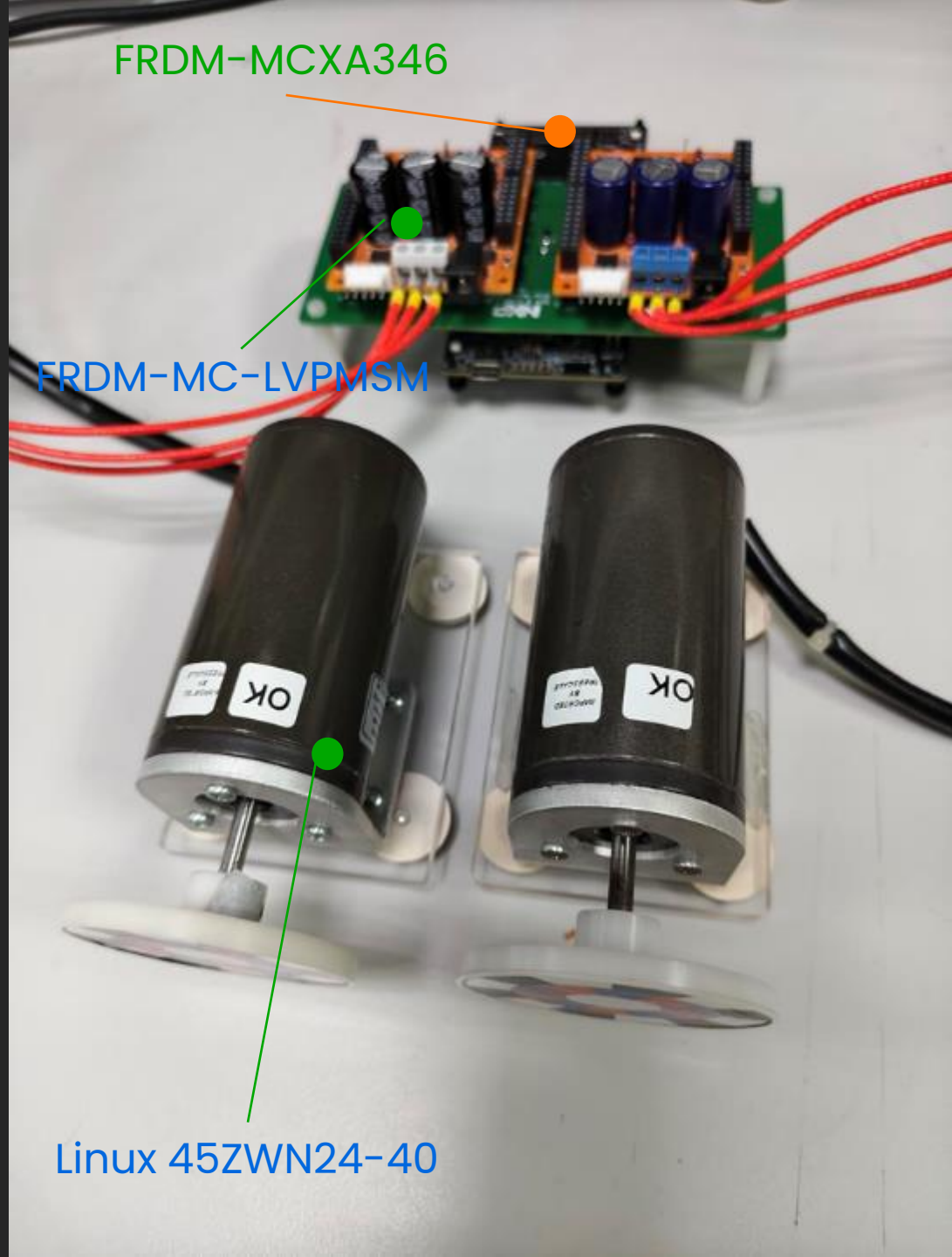
FRDM-MCXA346 demos

Motor Control applications

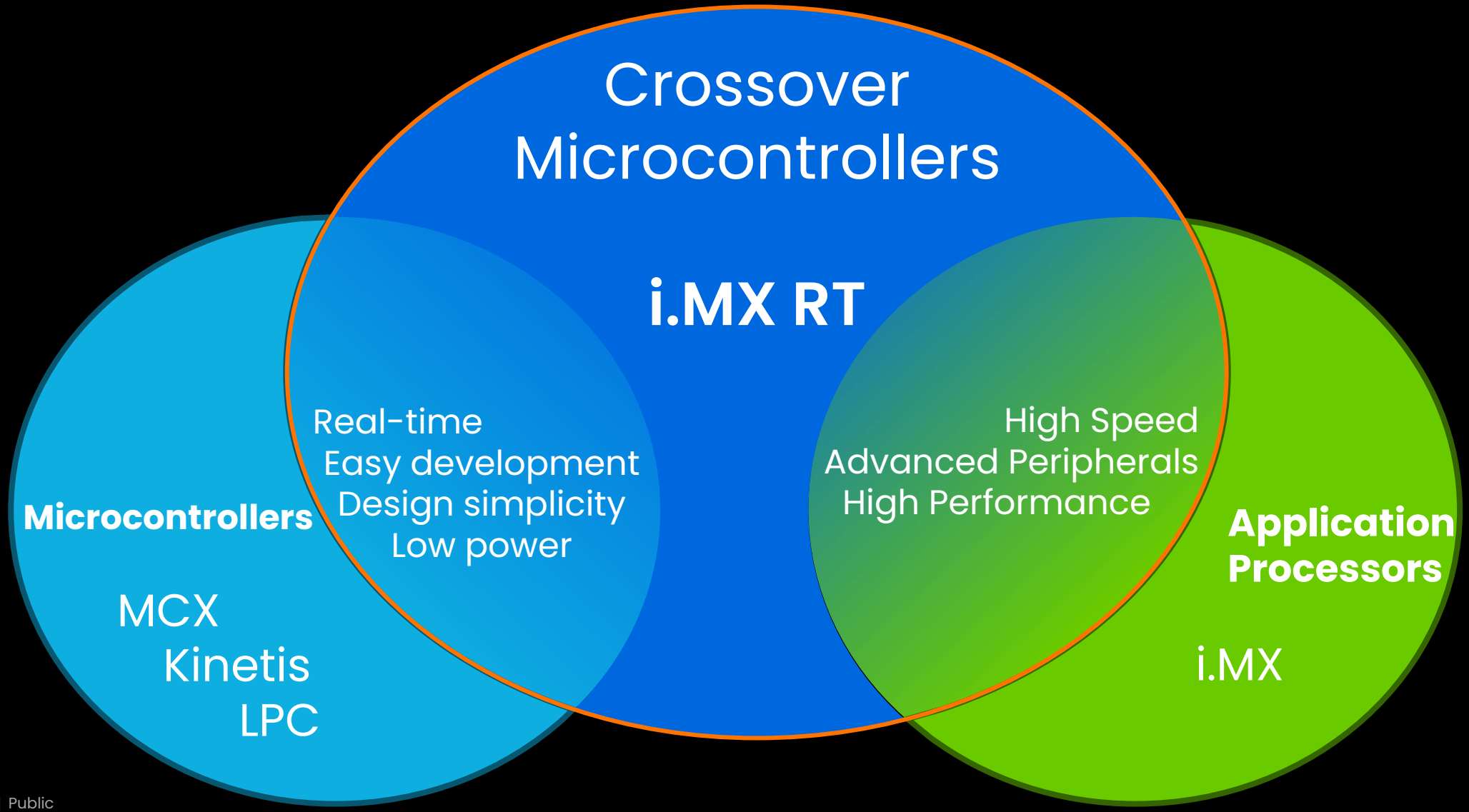
Dual PMSM control on MCXA34x

- Dual Sensorless PMSM Field-Oriented Control(FOC)
- NXP Real Time Control Embedded Software Motor Control and Power Conversion Libraries(RTCESL) 4.8.1
- BEMF observer algorithm for sensorless control
- 16KHz current control loop and 1KHz speed control loop for each motor
- 12.8us current loop process time and 1.8us speed loop process time for each motor, totally 41.3% CPU loading(12.8/62.5*2 + 1.8/1000*2)
- 1.5us saved in current loop process time if MAU enabled(to calculate sine, cosine, arctangent and square root)

*demo code coming soon on Application Code Hub



Crossover Microcontrollers Positioning
The best of two worlds



i.MX RT Series – current portfolio overview

Runtime Performance

i.MX RT10xx
Cortex-M7 Core
Essential Security

Value	Networking	Graphics	Graphics & Networking	
i.MX RT101x	**i.MX RT102x**	**i.MX RT104x**	**i.MX RT105x**	**i.MX RT106x**
Cortex-M7 500MHz	Cortex-M7 500MHz	Cortex-M7 600MHz	Cortex-M7 600MHz	Cortex-M7 600MHz
128KB SRAM	256KB SRAM	512KB SRAM	512KB SRAM	1MB SRAM
LQFP80/100	Ethernet	2D GFX	2D GFX	2D GFX
	LQF100/144	BGA169	Ethernet	Ethernet
			BGA196	BGA196/225

i.MX RT11xx
Cortex-M7 Core
2nd Cortex-M Core
Networking
Graphics

Graphics & Networking		Advanced Networking
i.MX RT116x	**i.MX RT117x**	**i.MX RT118x** New
Cortex-M7 600MHz	Cortex-M7 1GHz	Cortex-M7 800MHz
Cortex-M4 240MHz	Cortex-M4 400MHz	Cortex-M33 240MHz
1MB SRAM	2MB SRAM	1.5MB SRAM
2D GFX	2D GFX	Ethernet with TSN
Ethernet	Ethernet	Ethernet Switch with TSN
Advanced Security	Advanced Security	EtherCAT
BGA289	BGA289	EdgeLock Secure Enclave
		BGA289

Ultra-Low Power Performance

i.MX RT 3-Digit
Cortex-M Core(s)
HiFi DSP(s)

Power Efficiency	Performance	Power Efficiency & Performance
i.MX RT5xx	**i.MX RT6xx**	**i.MX RT7xx** New
Cortex-M33 275MHz	Cortex-M33 300MHz	Cortex-M33 325MHz
Fusion DSP	HiFi 4 DSP 600MHz	HiFi 4 325 MHz
2.5D GFX	4.5MB SRAM	Cortex-M33 250MHz
5MB SRAM	Essential Security	HiFi 1 250MHz
Essential Security	FOWLP249, BGA176, WLCSP114	eIQ Neutron NPU 38Gops
FOWLP249, WLCSP141		2.5D GPU
		7.5 MB SRAM
		EdgeLock Secure Enclave
		FOWLP324, WLCSP256

i.MX RT1180 - high-performance, secure, and flexible solution for Industry 4.0

Advanced Security

- EdgeLock® Secure Enclave
- IEC 62443 system compliance support

Efficient Processing

- 800MHz M7 with 512KB TCM
- 300MHz M33 with 256KB TCM

Communication Peripherals

- 3x CAN FD
- 12x UARTs
- 6x LSPI
- 2x USB 2.0 OTG w/PHY

Robustness

- All memory w/ ECC
- Extended Indus. & Auto Qualifications (up to 125C Tj)
- IEC61508 support

i.MX RT1180

Real-time networking

Industrial Networking

- 5-ports TSN Switch with 1Gbps
- TSN based protocols support
- Multiprotocol real-time Ethernet support (Profinet, Ethernet/IP, EtherCAT, DLR,...)

Advanced Industrial Peripherals

- SINC filter for Delta-Sigma demodulation
- Motor control PWM (FlexPWM)
- Audio interfaces (digital mic, SPDIF, SAI, ASRC)

Packages

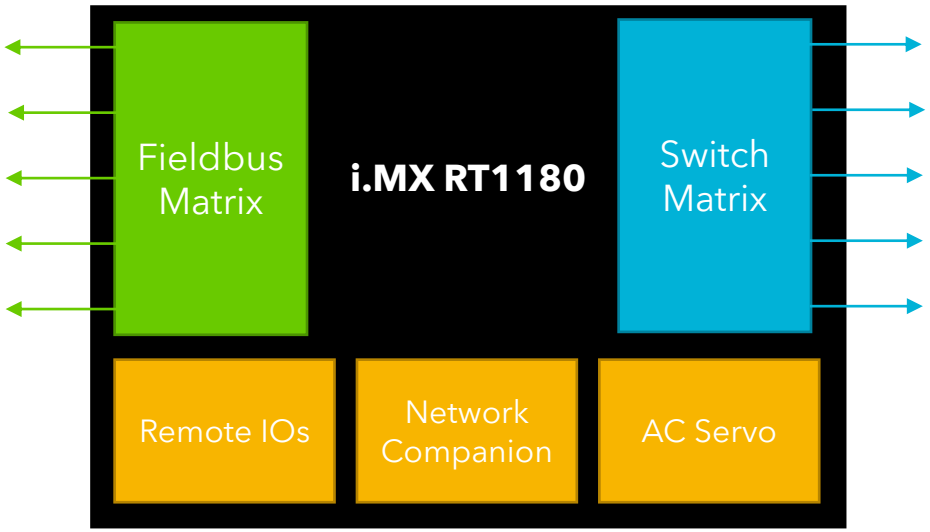
- BGA289 (14x14mm)
- BGA196 (12x12mm)
- BGA144 (10x10mm)

Advanced Analog

- 2x 16b 4Mbps ADC
- 1x 12b DAC
- Integrated DCDC and LDOs

i.MX RT1180 Crossover MCU

- Dual core with Arm Cortex M7 at up to 800MHz and ARM Cortex M33 at up to 240MHz
- Enabling IEC 62443 system-level compliance, and IEC 60802 industrial profile support
- Enhanced drive capability
- Secure, compact and low power



Industrial Communication Engine

Time Sensitive networks

TSN Industrial Ethernet · OPC UA · CC-Link IE TSN · PROFINET Over TSN

Serial Fieldbus

PROFIBUS · Modbus · CANopen · IO-Link

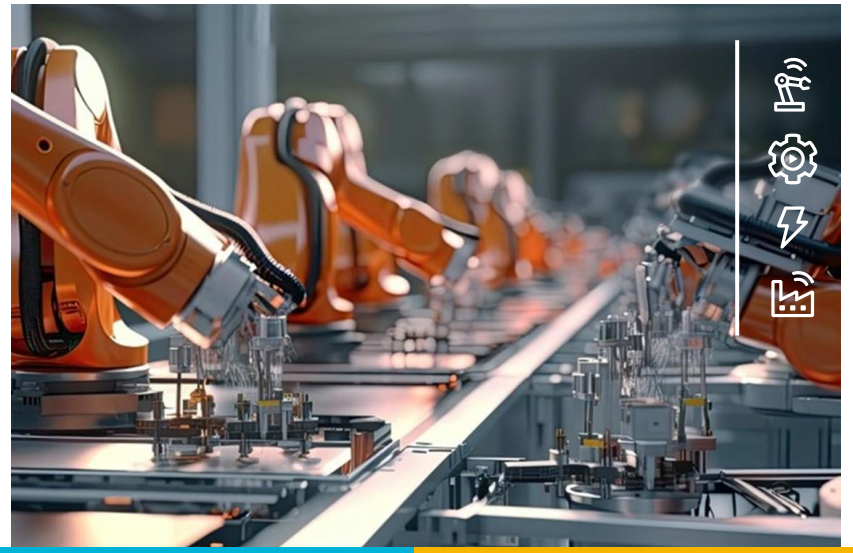
Industrial Real-time Networks

PROFINET · EtherCAT · EtherNet/IP · CC-Link IE Industrial Ethernet · ETHERNET POWERLINK

Redundancy networks

HSR · PRP · MRP · .1cb · ERPS

NXP i.MX 95 Family for Automotive Edge, Industrial, & IoT



Safety

Ditch the hypervisor and simplify building safety capable platforms with the first-generation on-die i.MX functional safety framework. Featuring NXP Safety Manager, Safety Documentation, & NXP Professional support to enable ISO26262 (ASIL-B) / IEC61508 (SIL-2) computing platforms, including 2D display pipeline.

Intuitive Decisions

Deliver increased accessibility and augment complex interfaces with Generative AI-enhanced voice command & control with the first i.MX applications processor to integrate the new, efficient NXP eIQ® Neutron neural processing unit.

Connect & Secure

Build secure, private applications with peace of mind based on the combined capabilities of integrated security and authentication acceleration, including post-quantum cryptographic capabilities, and lifecycle management.

Visualize & Act

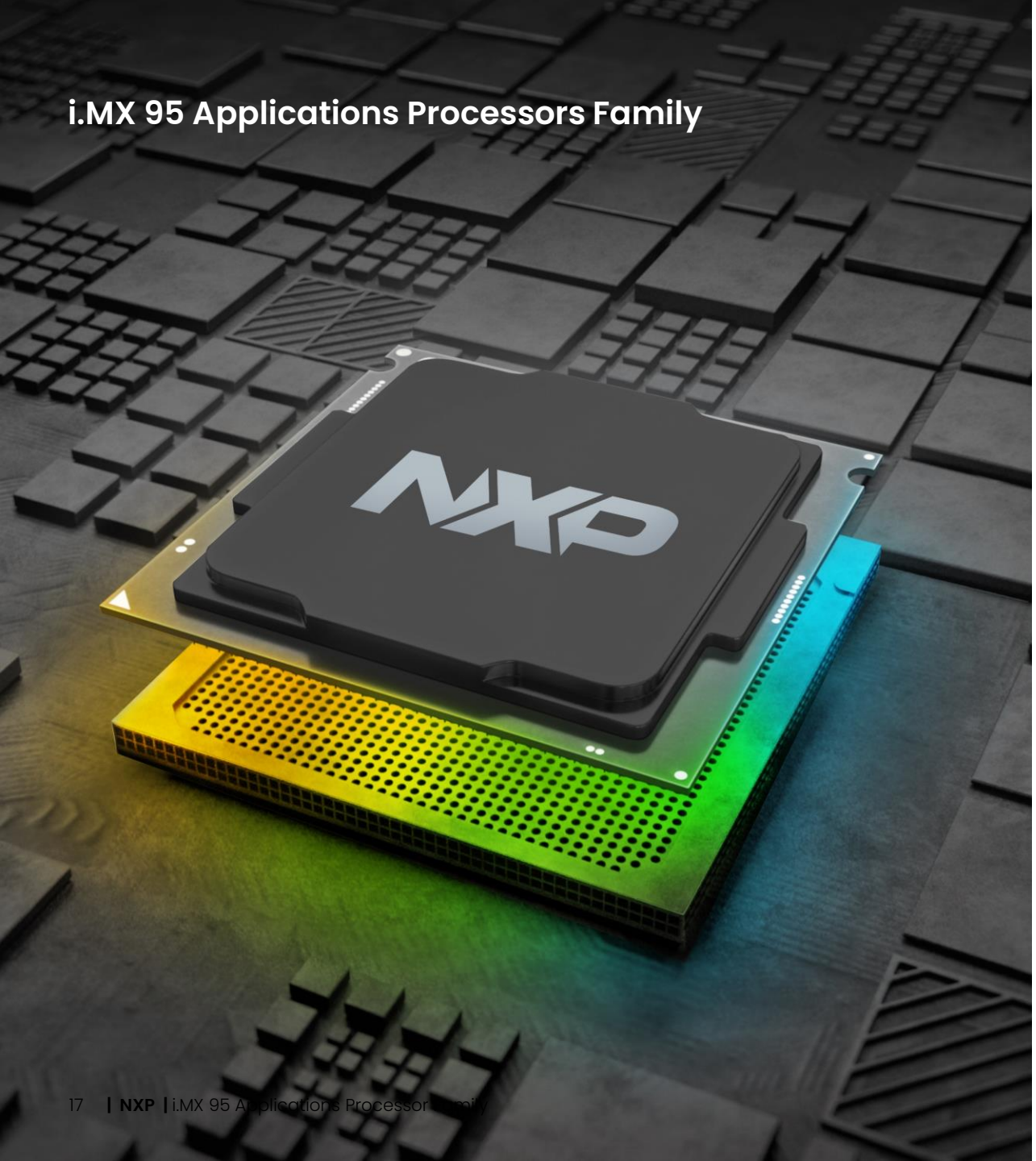
Responsive HMI for IoT, Industrial, and Automotive applications are easily created with NXPs partner ecosystem, unlocked by a powerful modern 3D graphics processor combined with strong, efficient hexacore application processor performance.

Learn More:
NXP.com/iMX95

Connectivity Leadership:
UWB, Wi-Fi, NFC, RFID, & BT

Co-Developed Platforms:
PMIC, Wi-Fi, Sensors, & More

Deep Application Insights:
26,000 Customers & Growing



Technology Highlights

Powerful Application Domain for Android & Linux

- 6x Arm® Cortex-A55 Multi-core complex

Integrated State-of-the-Art Functional Safety

- SafeAssure Software Framework + H/W Safety Checkers

Real-Time Domain

- Arm® Cortex-M7 CPU

Edge AI/ML Acceleration

- NXP eIQ® Neutron Neural Processing Unit

Immersive Graphics

- Arm® Mali™ G310 3D GPU + Dedicated 2D GPU

Ultrawide Display Capability

- 3840x1440P60 / 4K30P; plus 2x 1080P60 for up to 3 displays

High Speed Networking

- 1x 10GbE + 2x 1GbE w/Time Sensitive Networking

High Speed Memory

- Up to LPDDR5 (Up to 6.4GT/s) / LPDDR4X (up to 4.2GT/s)

4K Vision Processing

- NXP ISP w/RGB-IR & 8MP Camera Support

Multi-Camera Capability

- Up to 8 image sensors via 2x MIPI-CSI 4-lane I/F with virtual channels

Embedded Security

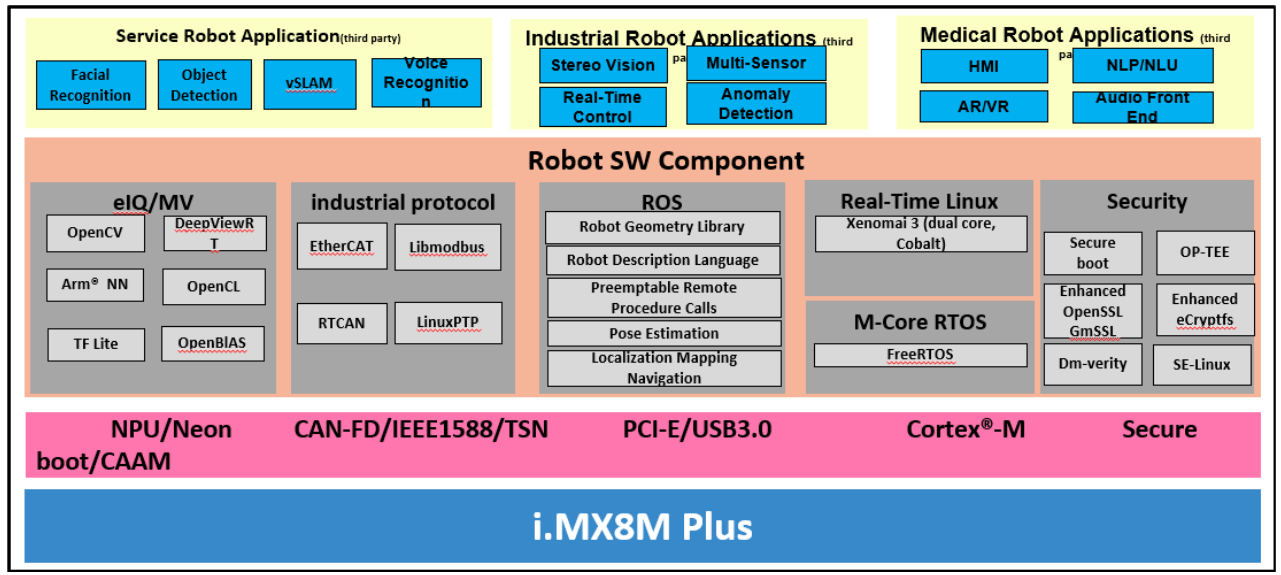
- Edgelock® Secure Enclave + V2X Cryptographic Accelerator

High Speed I/O

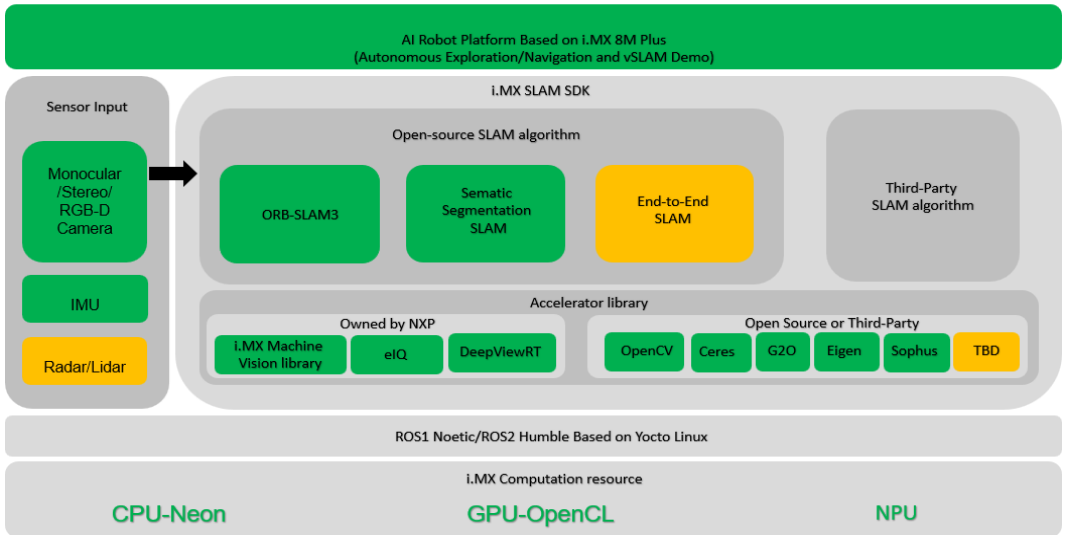
- 2x PCIe Gen 3 x1 & 1x USB 3 5Gbps

NXP SOFTWARE

ROBOTICS OS—ROS/ROS2

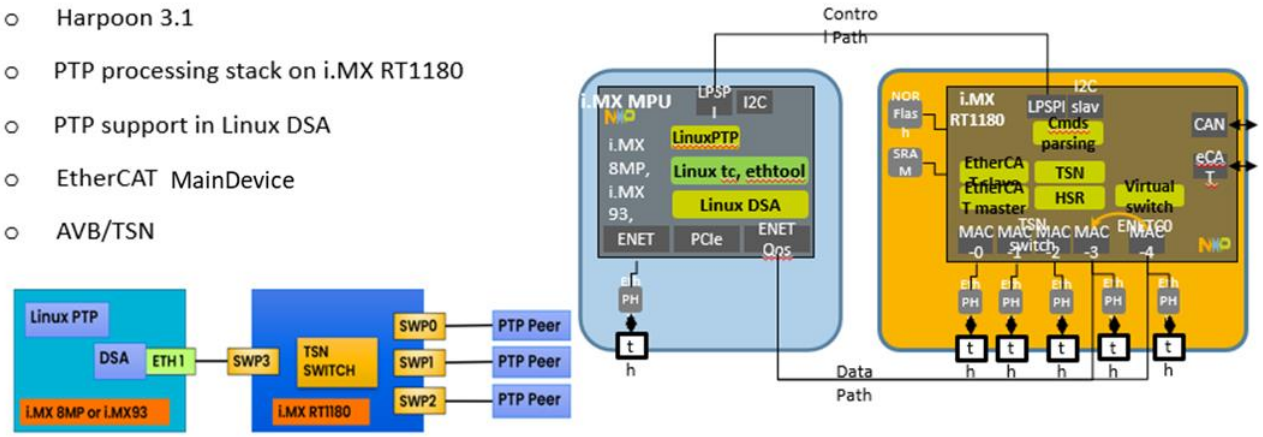


COMPUTER VISION– VSLAM

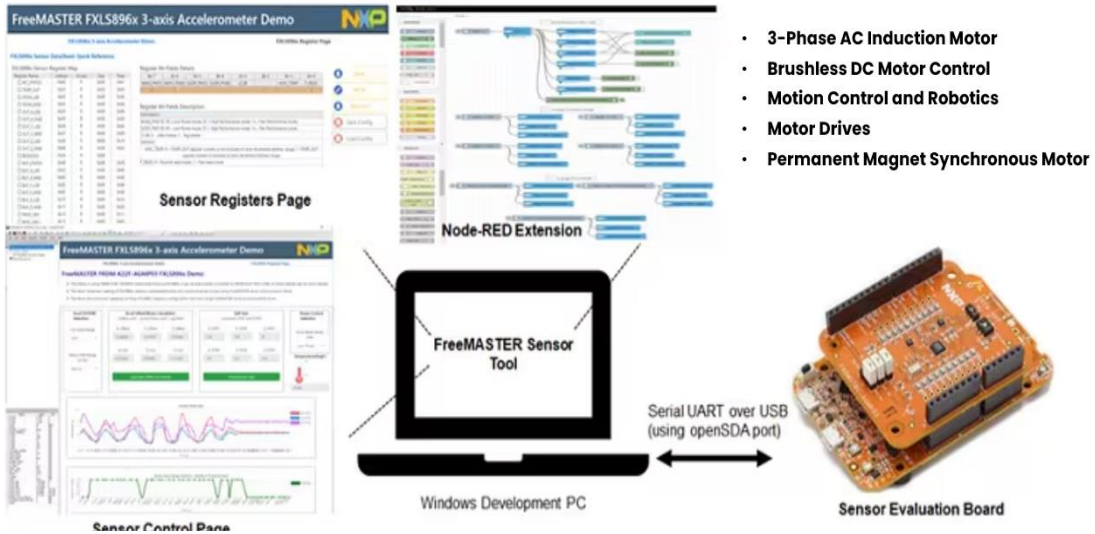


REALTIME–EDGE OS

- Preempt-RT Linux 6.6.3-rt16(tag lf-6.6.3-rt-1.0.0)
- Harpoon 3.1
- PTP processing stack on i.MX RT1180
- PTP support in Linux DSA
- EtherCAT MainDevice
- AVB/TSN

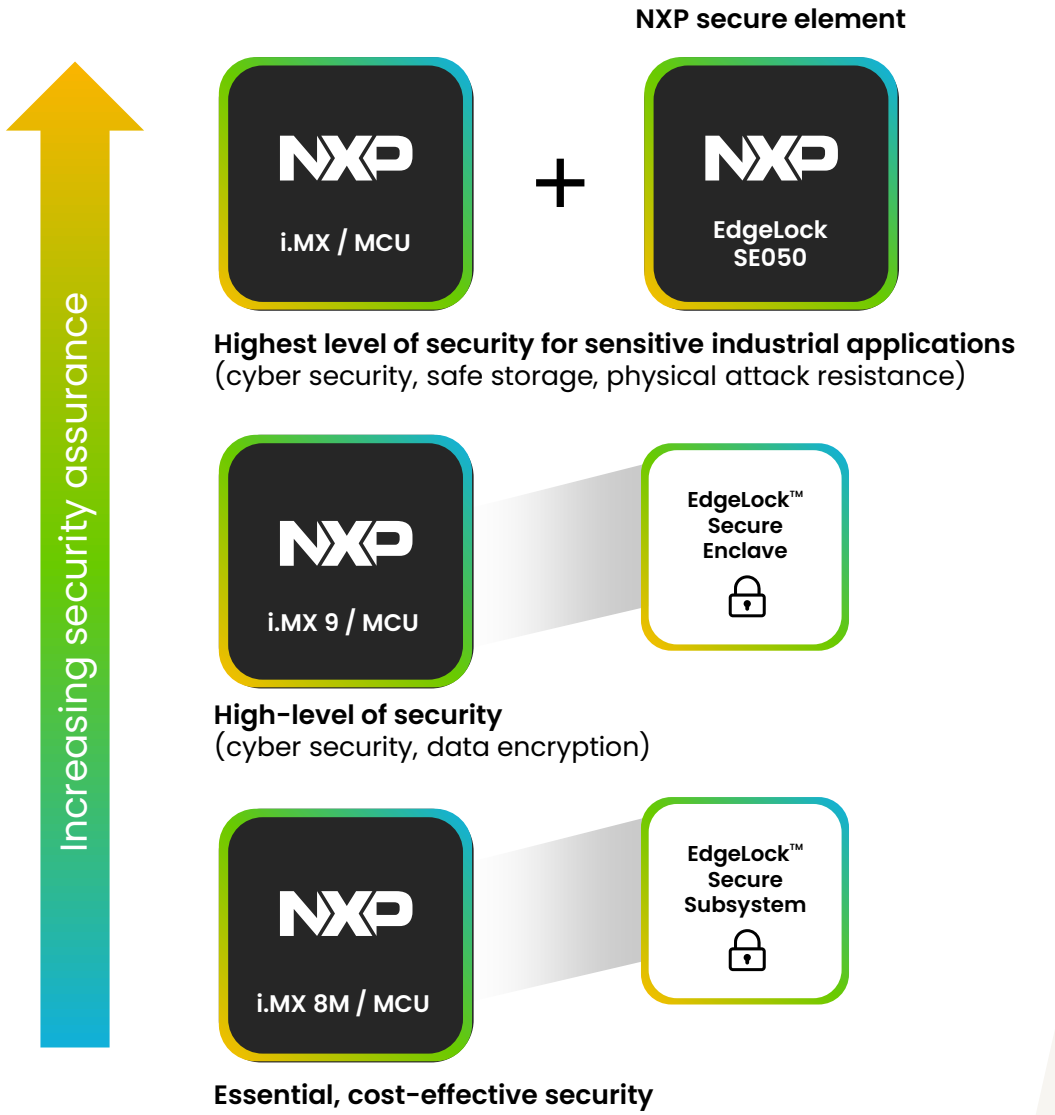


MOTOR CONTROL DEV SUITE



- 3-Phase AC Induction Motor
- Brushless DC Motor Control
- Motion Control and Robotics
- Motor Drives
- Permanent Magnet Synchronous Motor

Comprehensive security solutions



EdgeLock™ 2GO

Secret key injection & key management service

NXP's innovative ML solution – eIQ

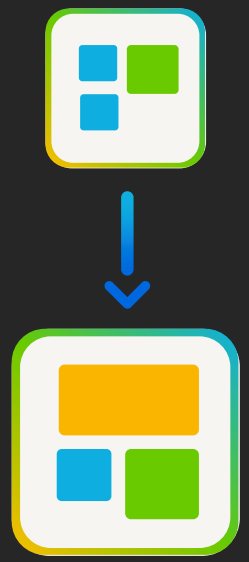
eIQ® Neutron
Neural Processing Unit

NXP-developed ML accelerator

Scalable from 10 giga to multi -trillion ML operations/second

Integrated into NXP processors

From MCX MCUs



to i.MX 9 Apps Processors

+

NXP eIQ
ML software toolkit

Supports all NXP processors

ML models for Industrial & IoT applications

ML training, inference, and optimization for maximum performance

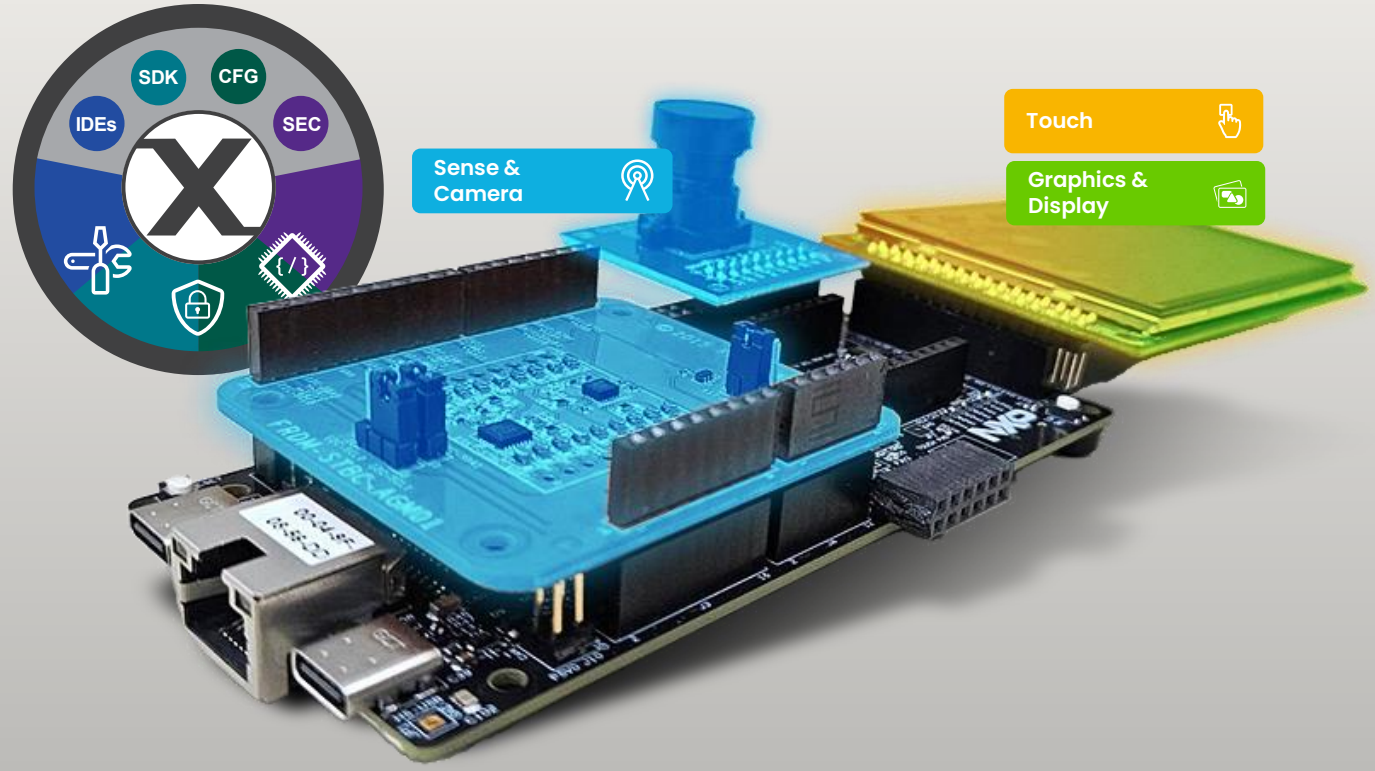
Example ML applications

- Command recognition
- Machine vision
- Anomaly detection
- Cyber security
- Identity recognition
- Presence detection

Enabling the freedom to innovate

Stackable expansions to enable solutions

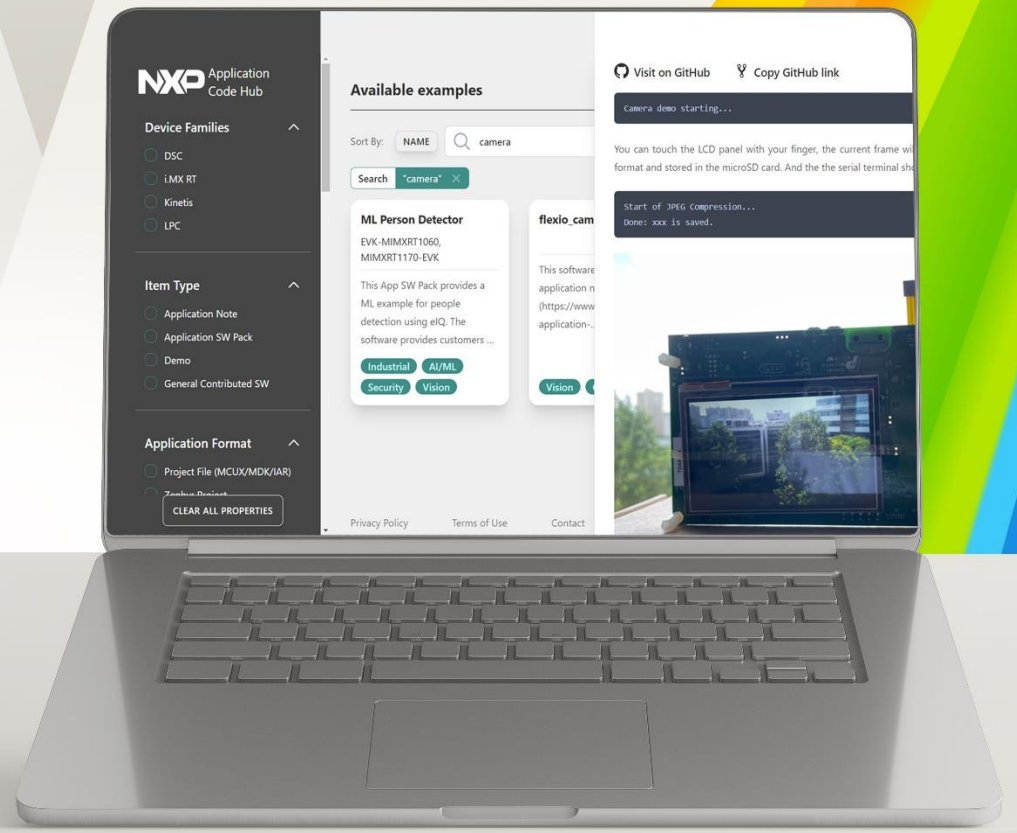
Touch
Sense & Camera
Voice
Graphics & Display
Motor control
Connectivity
AI/ML
Analog FE



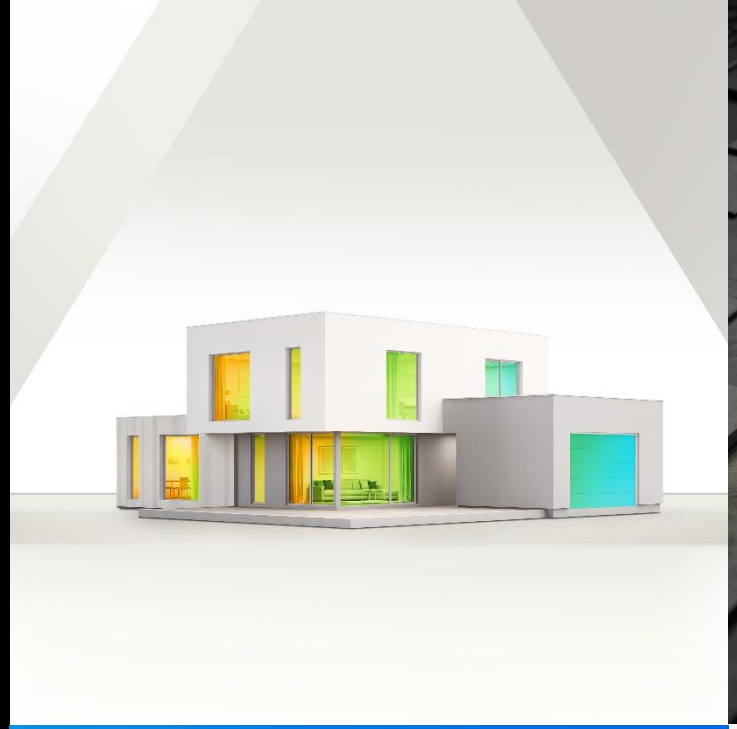
Enabling the freedom to innovate

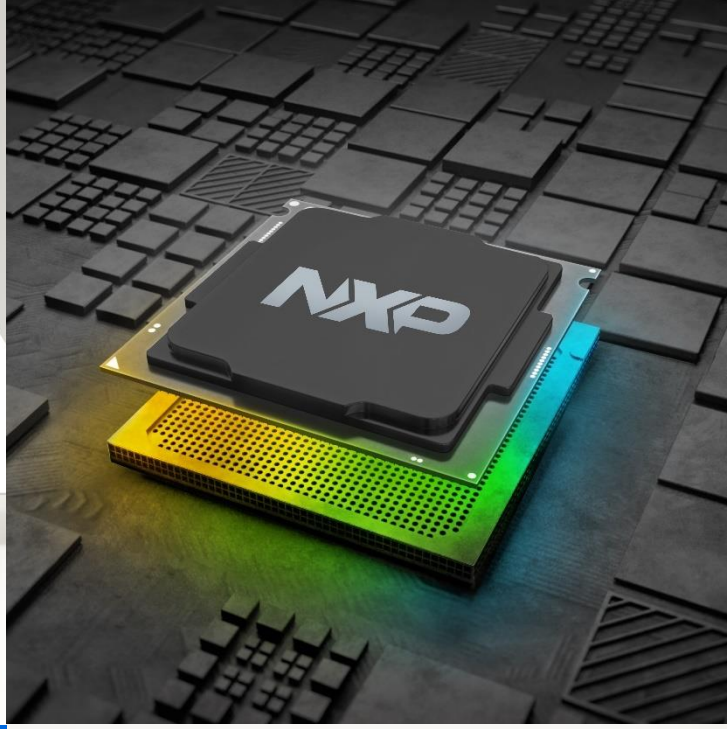
Introducing our new application code hub for developers

Free downloadable application code for a variety of Industrial & IoT use cases



Together, we make the future bright.





- Technology leader
- Trusted partner
- Innovative solutions