I.MX RT1170 AUTO OVERVIEW

AP BL ADAS & eCockpit S&AE Team
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JUNE 2021

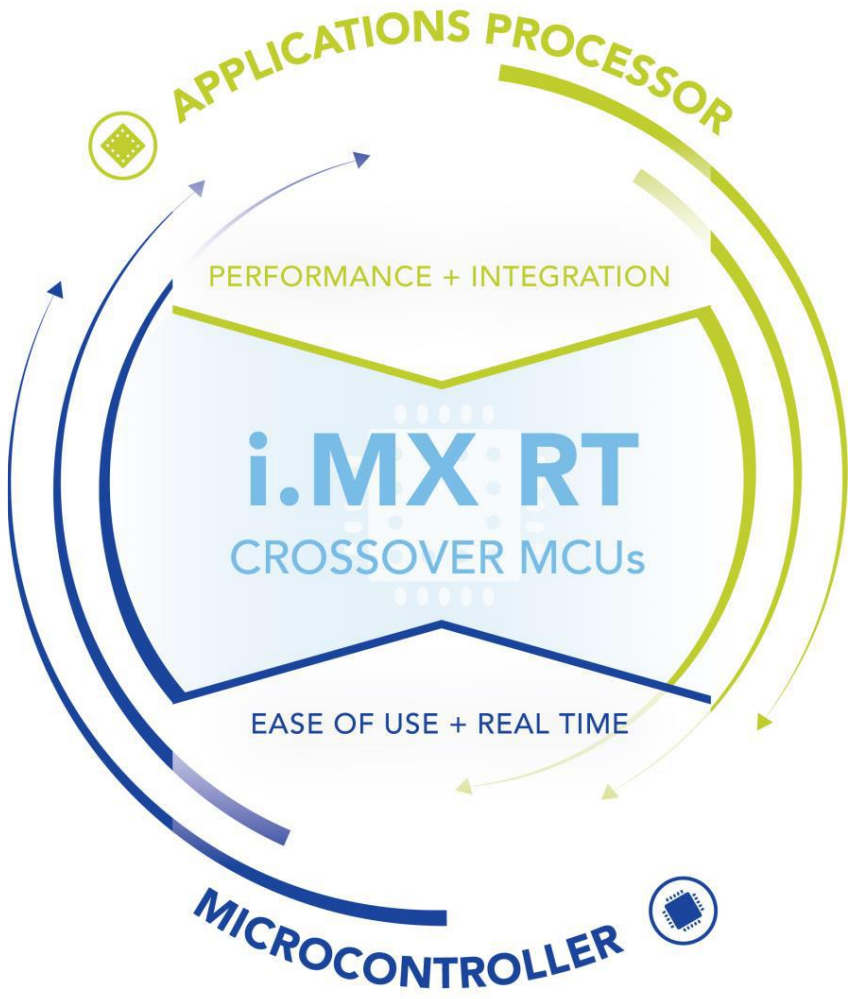
SECURE CONNECTIONS FOR A SMARTER WORLD

Agenda

- Overview
- Key Features for Auto
- Target Applications for Auto

i.MX RT1170: Overview

SECURE CONNECTIONS
FOR A SMARTER WORLD



High Performance

Advanced Security

Rich Feature Set

Low power

I.MX RT1170 FEATURES

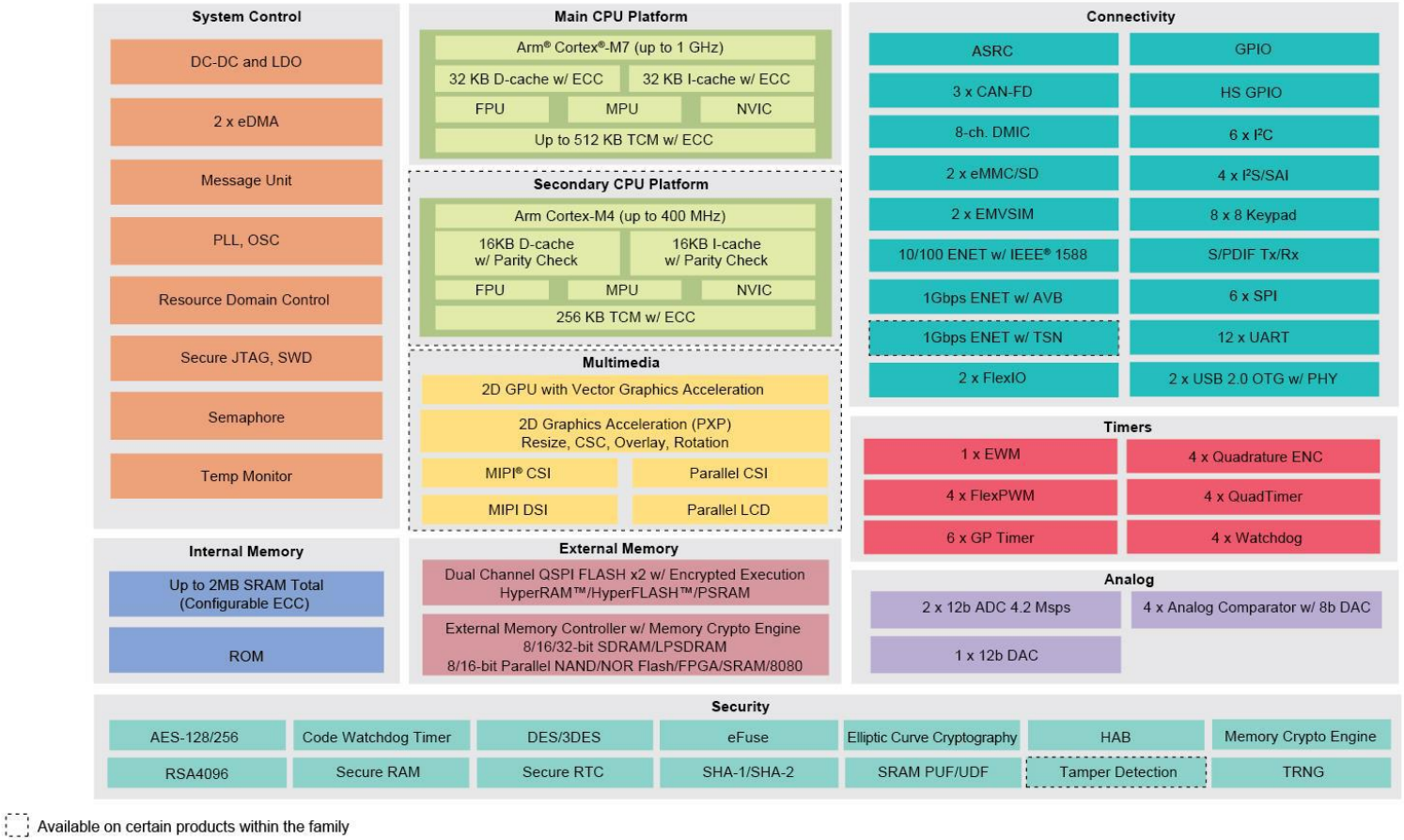
- Arm Cortex-M7 processor, 1 GHz, Arm Cortex-M4 processor, 400MHz

- 2MB on-chip SRAM

- Parallel LCD Display up to WXGA (1280x800) @60fps
- 8/16/24-bit Parallel Camera Sensor Interface
- 2-lane MIPI CSI and 2-lane MIPI DSI
- 2D GPU & Graphics Accelerator

- 8/16/32-bit SDRAM controller up to 200MHz
- 8/16-bit Parallel NOR FLASH / NAND FLASH / SRAM
- 2x Dual-channel FlexSPI Interfaces with On-the-Fly decryption, supporting serial NOR, serial NAND, HyperBUS devices

- 2x eMMC 5.0/SD 3.0/SDIO Port
- 2x USB 2.0 OTG, HS/FS, Device or Host with PHY
- Audio: 4x I2S/SAI, 1x S/PDIF Tx/Rx, ASRC, 8-ch digital microphone input
- 3x ENET: 1Gbps ENET w/ AVB + 10/100 ENET w/ IEEE 1588 + 1Gbps ENET w/ TSN



- 2x 12-bit ADC, 4.2Msample/s, up to 20 input channels total
- 4x Analog comparator, 1x 12-bit DAC

- Full PMU Integration, DCDC+LDOs

I.MX RT1170 SERIES

	i.MX RT1171	i.MX RT1172	i.MX RT1173	i.MX RT1175	i.MX RT1176
ISO26262 Safety	QM level	QM level		QM level	QM level
Cortex-M7	1GHz / 800MHz*	1GHz / 800MHz*	800MHz	1GHz / 800MHz*	1GHz / 800MHz*
Cortex-M4	-	-	240MHz	400MHz / 240MHz*	400MHz / 240MHz*
MIPI CSI / DSI	-	Y	Y	-	Y
OpenVG 1.1 (2DGPU)	-	Y	Y	-	Y
CSI / LCDIF / PXP	-	Y	Y	-	Y
Ethernet	Y	Y	Y	Y	Y
TSN	-	-	-	-	Y
Tamper Protection	-	-	Y	-	-
HAB / AES / DES	Y	Y	Y	Y	Y
Package	289 MAPBGA	289 MAPBGA	289 MAPBGA	289 MAPBGA	289 MAPBGA
Qualification / *Temperature (Tj)	Commercial / 0 C to 95 C Industrial / -40 C to 105 C *Automotive / -40 to 125 C	Commercial / 0 C to 95 C Industrial / -40 C to 105 C Automotive / -40 to 125 C	Industrial / -40 C to 105 C	Commercial / 0 C to 95 C Industrial / -40 C to 105 C Automotive / -40 to 125 C	Commercial / 0 C to 95 C Industrial / -40 C to 105 C Automotive / -40 to 125 C
Part Numbers	**MIMXRT1171AVM8A (Auto)** MIMXRT1171DVMAA MIMXRT1171CVM8A	**MIMXRT1172AVM8A (Auto)** MIMXRT1172DVMAA MIMXRT1172CVM8A	- - MIMXRT1173CVM8A	**MIMXRT1175AVM8A (Auto)** MIMXRT1175DVMAA MIMXRT1175CVM8A	**MIMXRT1176AVM8A (Auto)** MIMXRT1176DVMAA MIMXRT1176CVM8A

* Second speed listed is for Automotive/Industrial. First speed listed is speed for consumer qual.

- Two new part numbers are added: i.MX RT117H/i.MX RT117F. These parts mainly target to vision and voice solution in IoT.
- **Automotive Temperature/Performance Conditions**
  - 800MHz @ 125C requires external PMIC (PF5020) to meet DCDC (The application note will be ready later)
  - 600MHz @ 125C w/ internal DCDC @1.0V
  - 800MHz @ 105C w/ internal DCDC @1.1V

MIMXRT1170-EVK DEVELOP PLATFORM

Part Numbers: MIMXRT1170-EVK -$159
Display (5.5'):RK055HDMIPI4M-$79

Processor
- NXP Semiconductors MIMXRT1176DVMAA
- **1GHz Arm® Cortex®-M7**
- **400 MHz Arm® Cortex®-M4 cores**

Memory
- 512Mbit SDRAM memory
- 512 Mbit Octal Flash
- 128 Mbit QSPI Flash
- 2 Gbit Raw NAND Flash
- 64 Mbit LPSPI Flash
- TF socket for SD card

Graphics
- MIPI LCD connector
- MIPI Camera Sensor connector

Audio
- Audio Codec
- 4-pole Audio Headphone Jack
- External speaker connection
- Microphone(Analog & Digital)
- SPDIF Connector

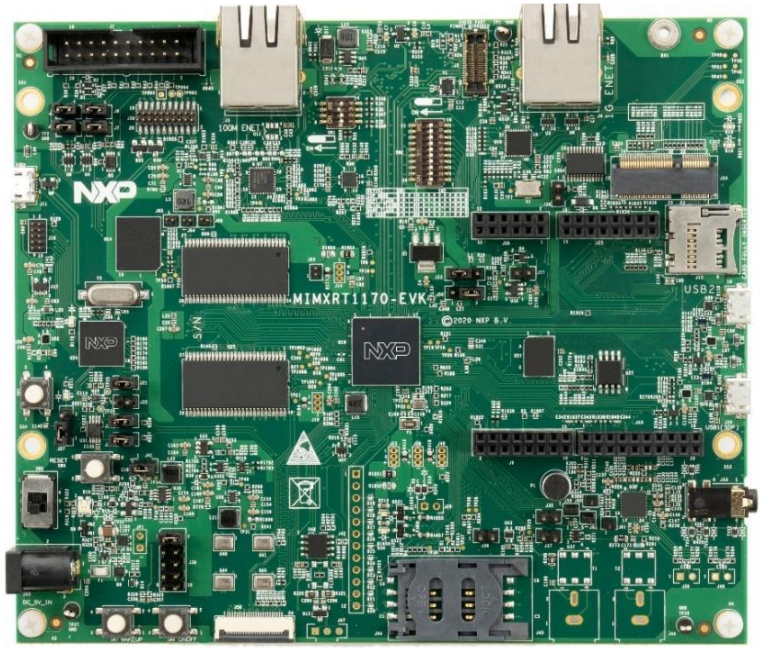
Connectivity
- 2x Micro USB OTG connectors
- Ethernet (10/100/1000M) connector
- Ethernet (10/100M) connector
- M.2 connector
- CAN Transceivers
- ARDUINO interface
- FRDM Motor control interface
- SIM card slot

Debug
- JTAG connector
- On-board DAP-Link debugger

Sensor
- 6-Axis Ecompass (3-Axis Mag, 3-Axis Accel) sensor FXOS8700CQ

Tools & OS Support
- MCUXpressoSoftware & Tools, including MCUXpressoSDK with Amazon FreeRTOS™
- IAR Embedded Workbench® IDE
- Keil® IDE

Others
- All-in-one board design
- 6-layer through hole PCB



I.MX RT1170 SW DEVELOPMENT ENVIRONMENT

Core Technologies from NXP

- MCUXpresso IDE
- MCUXpresso SDK
- MCUXpresso Config Tools
- MCUXpresso Secure Provisioning Tool

Enabling Software Technologies

- Run time software libraries and middleware
- Enable customers to focus on differentiation
- From NXP and partners

Enabling Tools Technologies

- Partner IDEs (incl. IAR EWARM and Keil uVISION)
- Debug Probes (incl. NXP, SEGGER, PE Micro)
- Development Boards
- FreeMASTER

Core Technologies from NXP

MCUXpresso IDE

- Edit
- Compile
- Debug
- Optimize

MCUXpresso Config Tools

Online and desktop tool suite for system configuration and optimization

MCUXpresso SDK

Runtime software including:

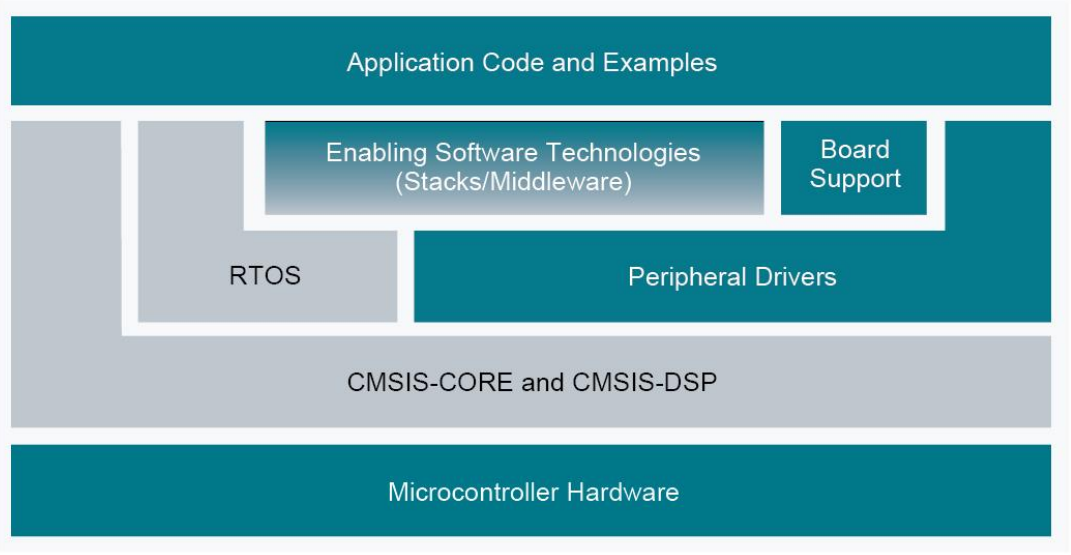
- Drivers
- Middleware
- RTOS
- Demos
- Others

MCUXpresso Secure Provisioning Tool

Graphical and command line tool for securely provisioning and programming MCUs with secure boot

www.nxp.com/mcuxpresso/sdk

MCUXPRESSO SDK
SOFTWARE FRAMEWORK AND DRIVERS



Architecture:
- CMSIS-CORE compatible
- Single driver for each peripheral
- Transactional APIs w/ optional DMA support for communication peripherals

Integrated RTOS options:
- FreeRTOS
- Azure RTOS*
- RTOS-native driver wrappers

Enabling Technologies:
- Audio/Voice
- Connectivity (wired and wireless)
- Graphics/HMI
- Motor Control
- eIQ (ML/AI)
- Cloud connectivity
- Security
- Sensor processing
- Storage
- Accelerators and specialized peripherals

Reference Software:
- Peripheral driver usage examples
- Application demos
- RTOS usage demos

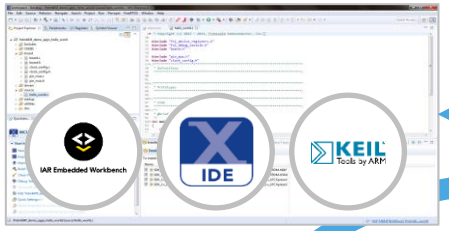
License:
- BSD 3-clause for startup, drivers, USB stacks
- All code Black Duck scanned

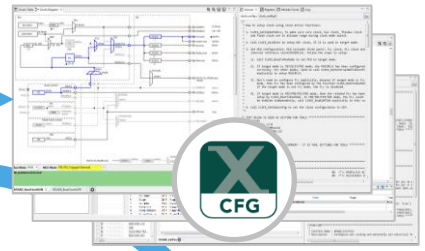
Toolchains:
- MCUXpresso IDE
- IAR®, ARM® Keil®, GCC w/ Cmake
- PE Micro and SEGGER probe support

Quality:
- Production-grade software
- MISRA 2012 compliance
- Checked with Coverity® static analysis tools

STREAMLINED MCUXPRESSO DEVELOPMENT FLOW FOR I.MX RT11XX CROSSOVER MCUS

Leading IDEs options from NXP and partners





Device and peripheral configuration

Enabling Technologies from NXP and partners

in MCUXpresso SDK
or direct from our partners

Eval Kit

Proto

Final product

Secure production programming tools

Device programming partners

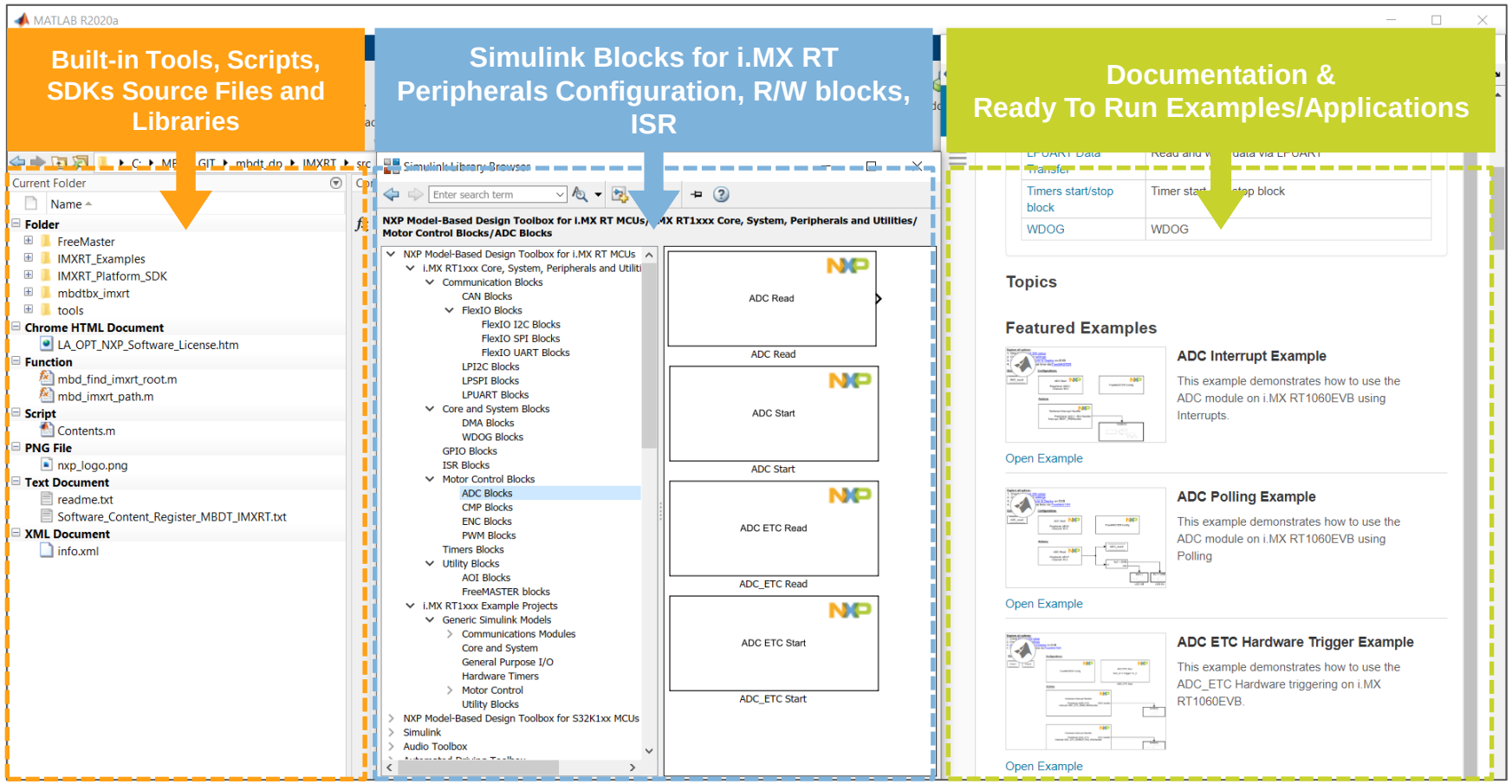
FreeMASTER

Debug visualization and control

Device selection → Evaluate/ Learn → Proof of concept → Prototype bring up → Develop → Trial production → Mass production

MCUSNXP MODEL-BASED DESIGN TOOLBOX FOR I.MX RT1170 MCUS

- Collection of NXP Tools & Libraries & Drivers designed to **Assist** customers with:
  - *Export-Function models* for NXP MCUs
  - *Full-Executable* rapid prototyping for NXP Evaluation Boards/Kits
- MCU Peripherals **Initialization & Configuration & Control** through UI from Simulink® and MCUXpresso
- No need for C-coding codding. Everything is done with **drag & drop visual programming**
- Enables a variety of MathWorks toolboxes to work with NXP MCUs
- Customer **Support** and **Training**: https://community.nxp.com/community/mbdt
- For More information: https://www.nxp.com/mbdt



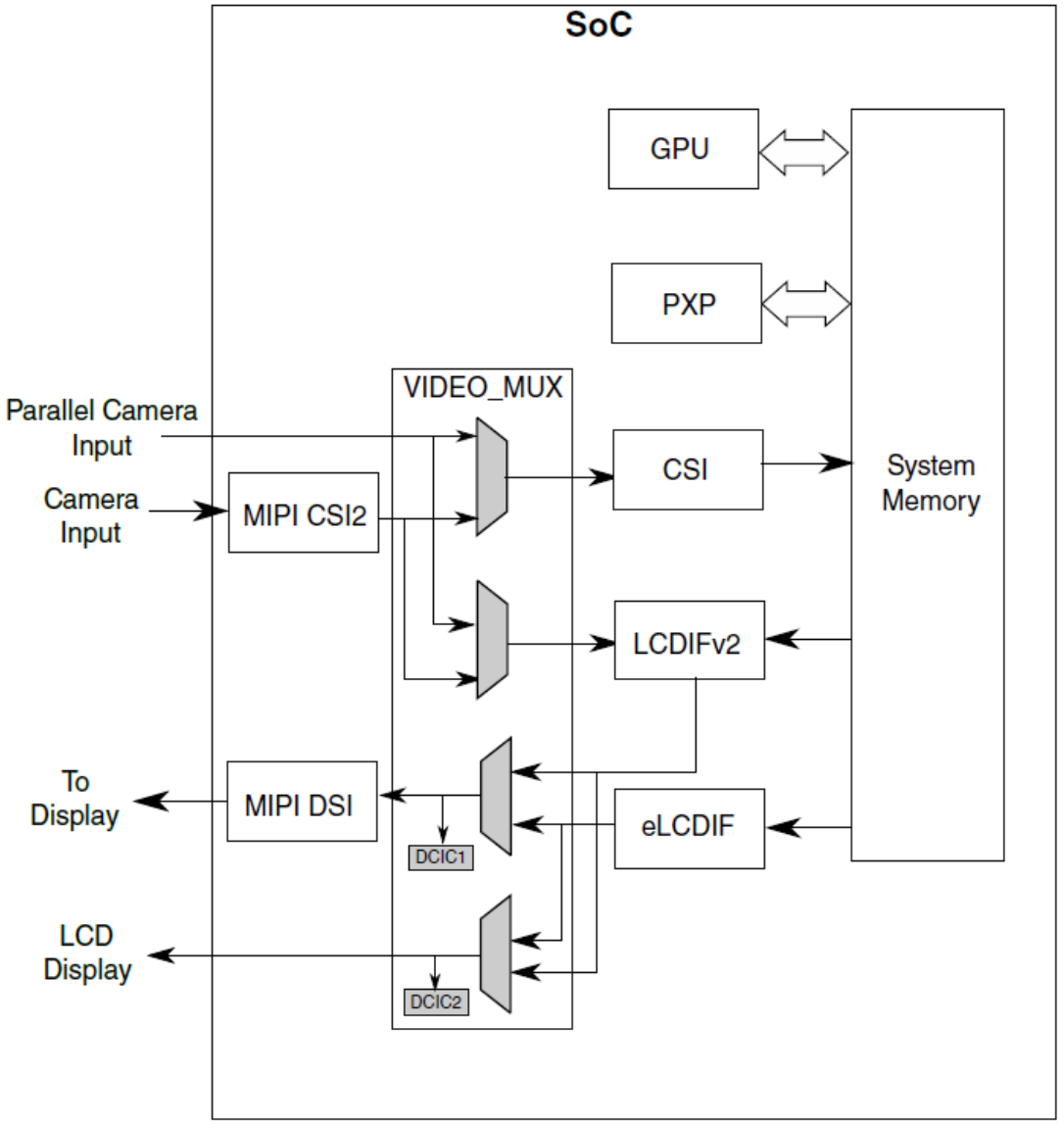
i.MX RT1170: Key Features for Auto

SECURE CONNECTIONS FOR A SMARTER WORLD

Multimedia

I.MX RT1170 DISPLAY AND CAMERA

- **eLCDIF**: 8 / 16 / 18 / 24-bit RGB LCD interface
- **LCDIFv2**: advanced LCD interface with multilayer blending
  - Support up to 8 layers blending
  - Support multiple color formats
  - Support a parallel camera interface input and its data format
- **MIPI DSI / CSI**: display / camera interface supporting MIPI protocol
- **VIDEO_ MUX**: MUX between display and camera interface
  - Modules that can be controlled: parallel CSI, MIPI CSI-2, CSI, MIPI DSI, parallel LCDIF, LCDIFv2, eLCDIF, DCIC
  - Support dual screen display



I.MX RT1170 CMOS Sensor Interface and Display Interface

CMOS Sensor Interface

- Two CSI Interfaces
  - 1x Parallel CSI Interface
  - 1x MIPI-CSI 2-lane Interface
- Data bus
  - Up to 24-bit
  - Also support 8-bit, 10-bit, 16-bit
- Variety of data formats
  - YUV 4:2:2/4:4:4
  - RGB 16/24 bpp
  - CCIR656
  - Other: as generic data, including compressed streams
- Frame resolution
  - Essentially unlimited (up to 65535 x 65535 pixels)
- Input rate
  - 75 MPixel/s peak

Display Interface

- Two Display Interfaces
  - 1x Parallel RGB Interface
  - 1x MIPI-DSI 2-lane Interface
- Display Data Bus
  - Up to 24-bit
  - Also support 8-bit/16-bit/18-bit
- Display Resolution
  - Support up to WXGA@60fps with rich UI & application
  - Typical pixel rate: 27~74.25 MP/sec
- Other Features
  - 8-bit to 24-bit color lookup table
  - Fully programmable Panel Interface Generator

i.MX RT1170 2D GPU & PXP

2D GPU

- **OpenVG Core**
  - Up to 500MHz
- **Support OpenVG 1.1 API**
  - It provides a device-independent and vendor-neutral interface for sophisticated 2D graphical applications.
  - Target on applications like: GUI, game, low-level graphics device interface, map, and so on
- **Vector Graphics Functions**
  - Clip, fill, filtering, change transparency, and so on

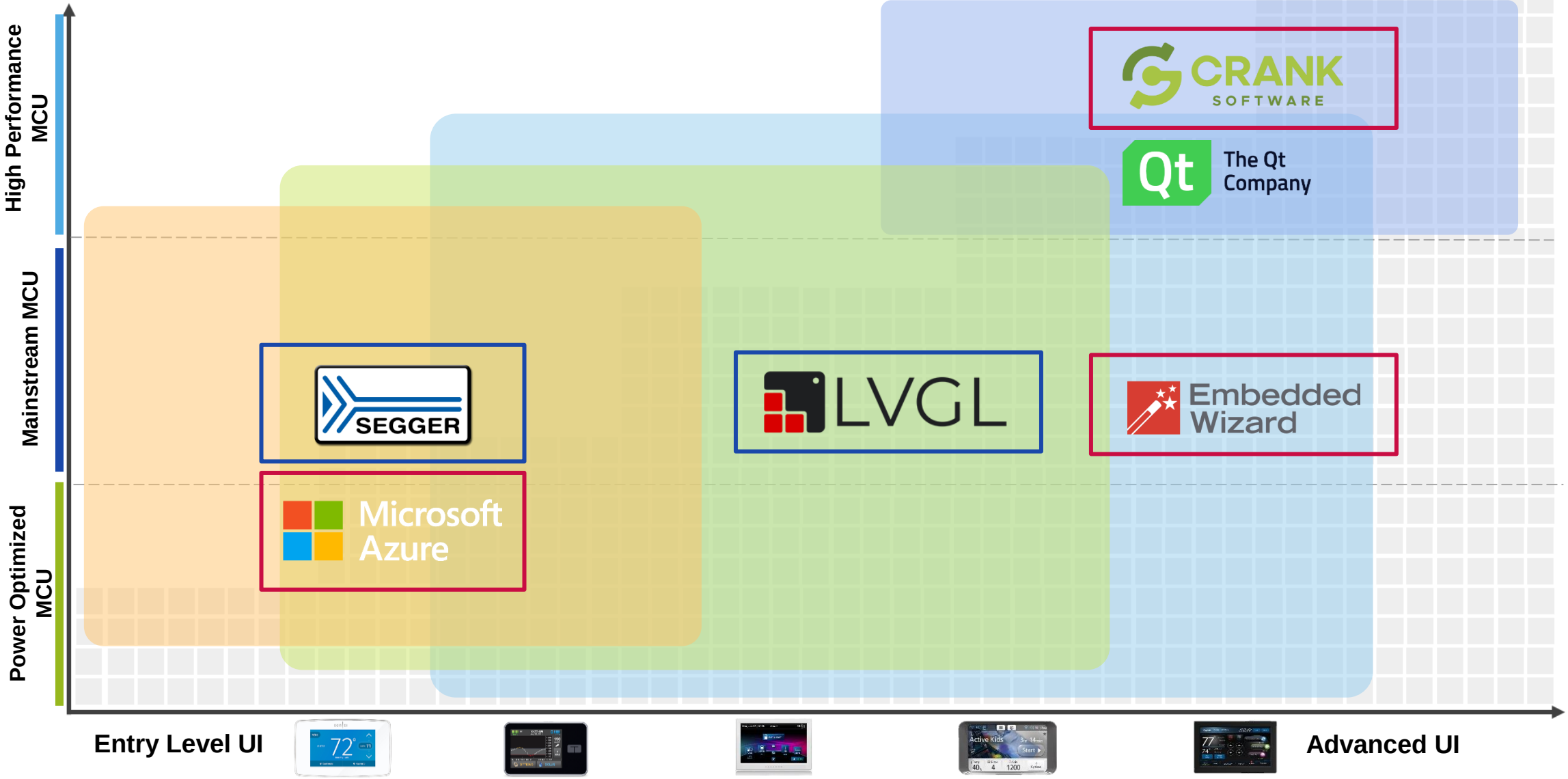
PXP

- **PXP is High-efficiency graphics 2D and image processing engine:**
  - BitBlit
  - Flexible image composition options (alpha, color key, Porter-Duff blending)
  - Color space conversion from YUV to RGB for PS
  - Single-pass processing for Resize, CSC, Overlay and Rotation (90º, 180º, 270º)
  - Support data pipeline mode with LCDIF to for DRAM bandwidth saving

EMBEDDED IMAGE PROCESSING SW

Available in the i.MX RT1170 SDK

Coming soon in the i.MX RT1170 SDK



GRAPHICS MIDDLEWARE OVERVIEW

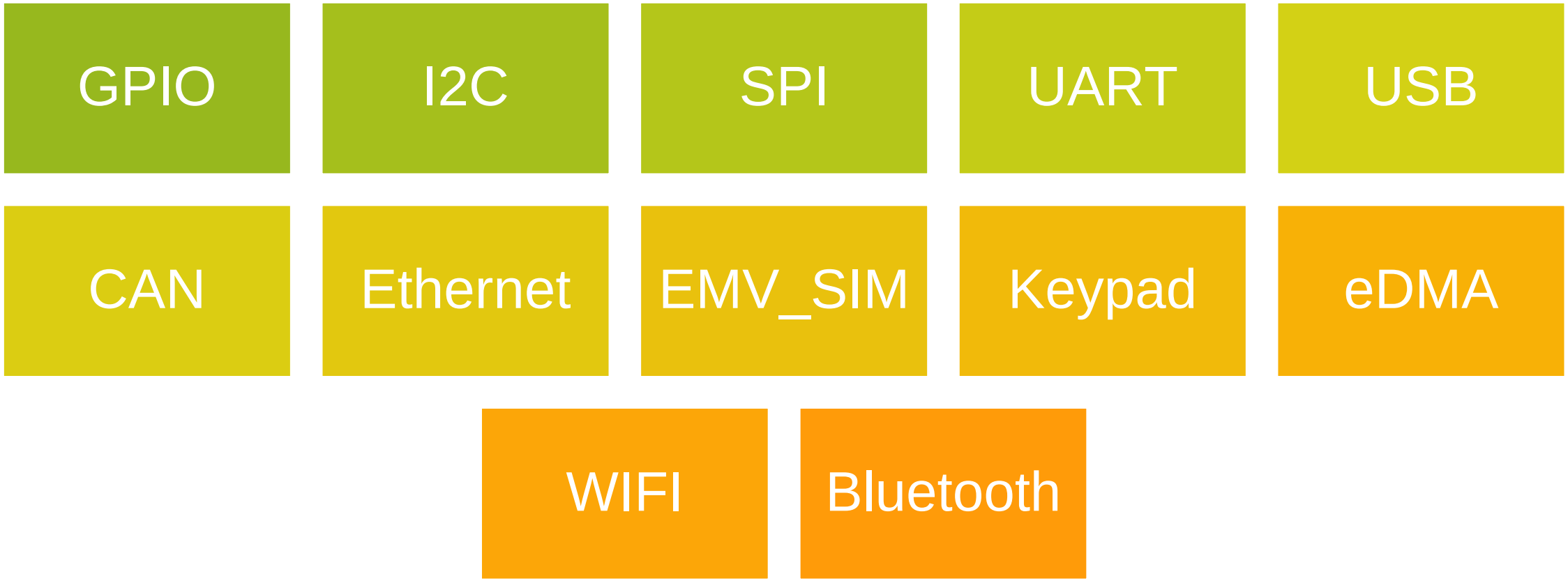
PROVIDER / PRODUCT	TYPE	BUSINESS MODEL	UI DEVELOPMENT TOOL	RTOS REQUIRED	OPTIMIZATION
SEGGER	Free	Free pre-compiled libraries via NXP MCUXpresso SDK (source code license available from SEGGER)	AppWizard	Optional (any)	-
LVGL	Free	Open source	GUI Guider by NXP	Optional (any)	PXP, VGLite
Embedded Wizard GUI Solutions by TARA Systems	Premium	Developer seats, volume-based product line license	Embedded Wizard Studio	Optional (any)	PXP, VGLite
CRANK SOFTWARE	Premium	Developer seats, volume-based product line license	Storyboard Designer	Optional (any)	PXP, VGLite
Microsoft Azure	Free	Free via NXP MCUXpresso SDK (for supported devices)	Azure RTOS GUIX Studio	Azure RTOS ThreadX	-
Qt The Qt Company	Premium	Developer seats, volume-based product line license	Qt Design Studio, Qt Creator	Optional (any)	PXP, VGLite

GRAPHICS MIDDLEWARE SUPPORT MATERIAL

- Segger – EmWin
  - MCU Tech Minute | Tips & Tricks for GUI development with emWin and AppWizard
  - SEGGER emWin Forum: https://forum.segger.com/index.php/Board/12-emWin-related/
  - Technical Support: https://www.segger.com/support/technical-support/
- LVGL
  - Documentation: https://docs.lvgl.io/v7/en/html/get-started/quick-overview.html
  - Forum: https://forum.lvgl.io/
  - LVGL Academy: https://lvgl.academy/
- Embedded Wizard
  - Knowledge Base: https://doc.embedded-wizard.de/
  - Master Class Video Library: https://www.embedded-wizard.de/master-class-mondays
  - Community: https://ask.embedded-wizard.de/
  - Training Options: https://www.embedded-wizard.de/services/training
- Crank
  - Help Center: support.cranksoftware.com/hc/en-us
  - Videos: www.cranksoftware.com/learn/video-library
  - Advanced Training Webinars: www.cranksoftware.com/learn/webinars#aut-webinars
- Microsoft Azure
  - Professional support plans available from Microsoft: https://azure.microsoft.com/en-us/support/options/
  - Documentation: https://docs.microsoft.com/en-us/azure/rtos/guix/
  - Microsoft Q/A for Azure IoT: docs.microsoft.com/en-us/answers/products/azure?product=iot
  - IoT Tech Community: aka.ms/iottechcommunity
- Qt
  - Videos: https://resources.qt.io/nxp
  - Collateral: https://www.qt.io/microcontrollers-nxp
  - Training: https://resources.qt.io/nxpteam, https://resources.qt.io/qt-mcus

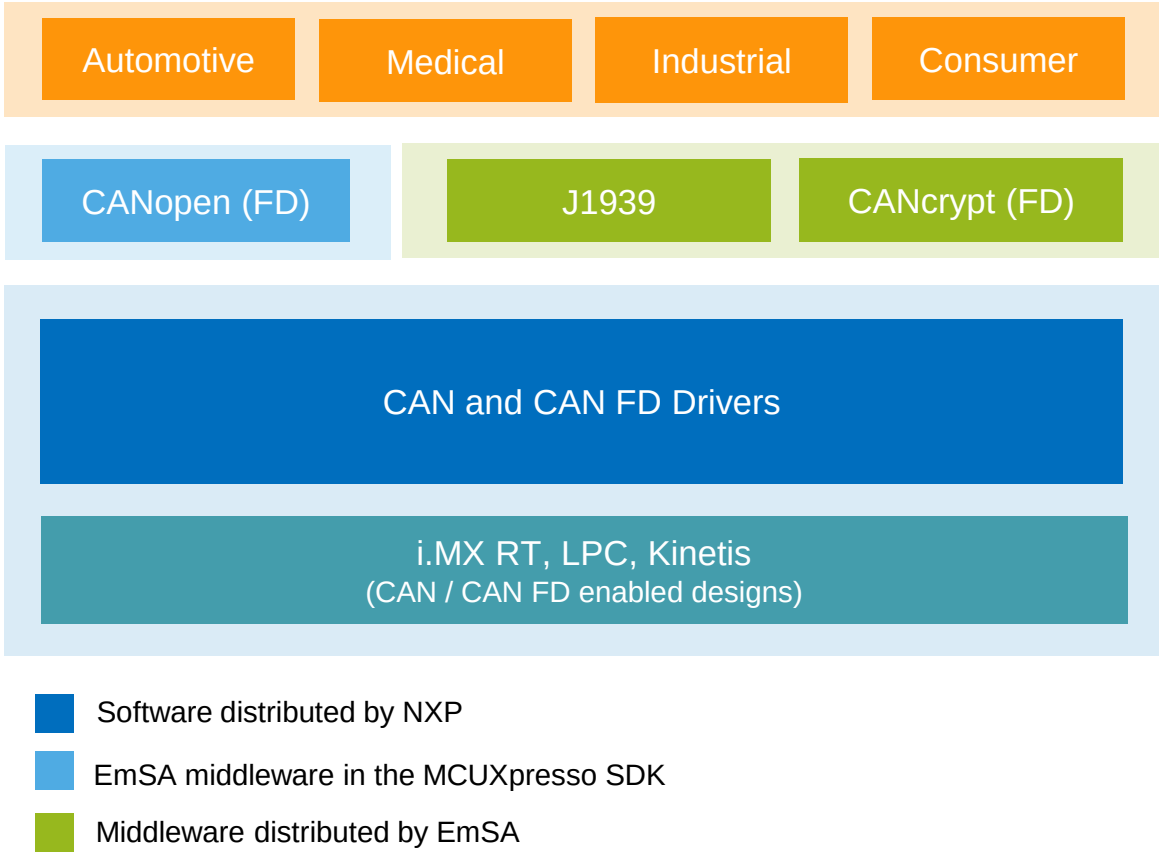
Connectivity

CONNECTIVITY HIGHLIGHTS



CAN (FD) SOFTWARE FOR NXP MCUS

- NXP provides CAN and CAN FD drivers through the i.MX RT117x/6x MCUXpresso SDK
- Long-time NXP partner EmSA provides middleware for CAN-based higher-layer protocols
- Evaluation versions integrated in MCUXpresso SDK
  - CANopen FD
- Also available from EmSA
  - CANopen
  - J1939
  - CANcrypt and CANcrypt FD



INTRODUCTION TO EMSA

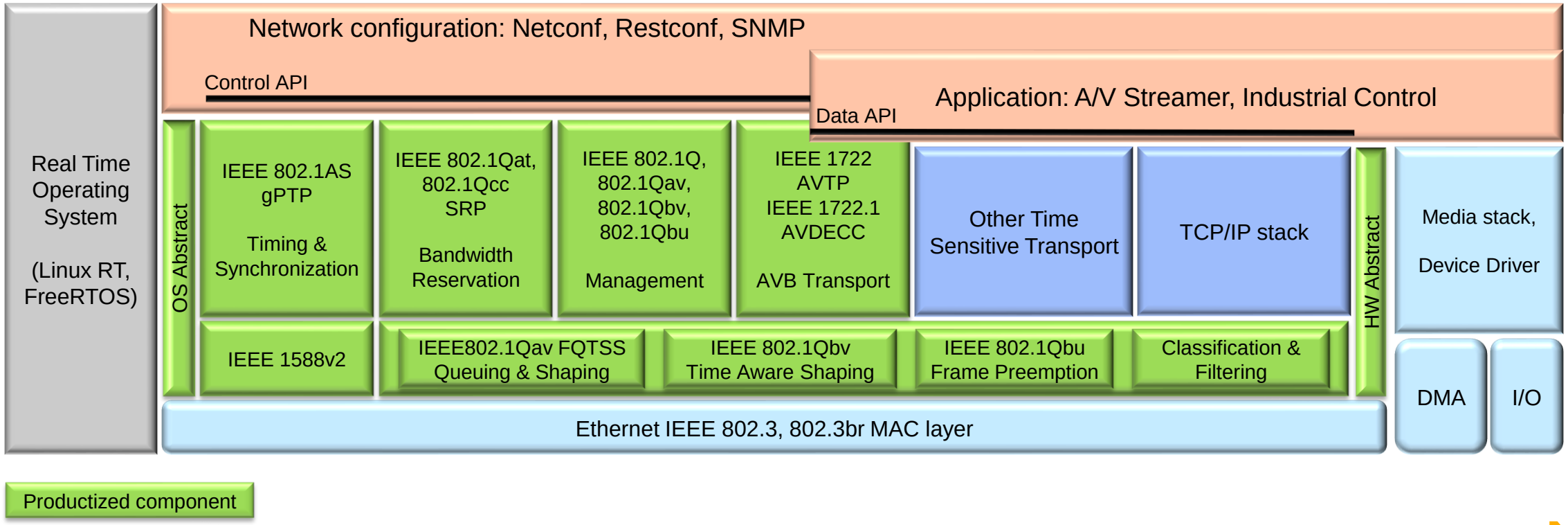
- Founded in 1999 in Silicon Valley, CA
- Initially originated as a training and consulting company
- Now offer middleware, software, security, training and consulting for CAN (FD), CANopen (FD), J1939, and Bootloading
- Current product offerings for NXP MCUs include:
  - CANopen (FD) middleware
  - CANcrypt (FD) middleware
  - J1939 middleware
  - CANopen Magic (https://www.canopenmagic.com/index.php/en/)
  - Flash Magic (https://www.flashmagictool.com/)
- Active participants in CiA (CAN in Automation) standardization (https://www.can-cia.org/)
- https://www.esacademy.com/

MICROCANOPEN (FD) MIDDLEWARE

- MicroCANopen Plus is a small-footprint, commercial-grade CANopen and CANopen FD stack with advanced features
  - Device and manager/master
  - Available as library or source code
- Memory footprint: 7K - 14K bytes (for CANopen Slaves)
  - Dependent upon processor and options selected
- Passes official CANopen conformance test
- Fully integrated libraries based on MicroCANopen Plus v7.0 is available in the MCUXpresso SDK for i.MX RT1170
- Examples to help you get started with your CAN or CAN FD application
  1. CANopen Generic I/O example (CiA 401)
  2. CANopen Manager example
  3. CANopen FD Generic I/O example (CiA 401)
  4. CANopen FD Manager example
- For more information visit www.canopenstore.com/pip/microcanopen-plus.html

AVB/TSN STACK DIAGRAM

- All protocol components are provided (as defined by IEEE)
  - Scalable as per **AVnu** profiles (Automotive, ProAudio, Industrial)
  - Available for **Endpoint** nodes
  - OS Abstract: FreeRTOS as reference, portable to other RTOS
  - HW Abstract: to run on NXP MPU/MCU platform families

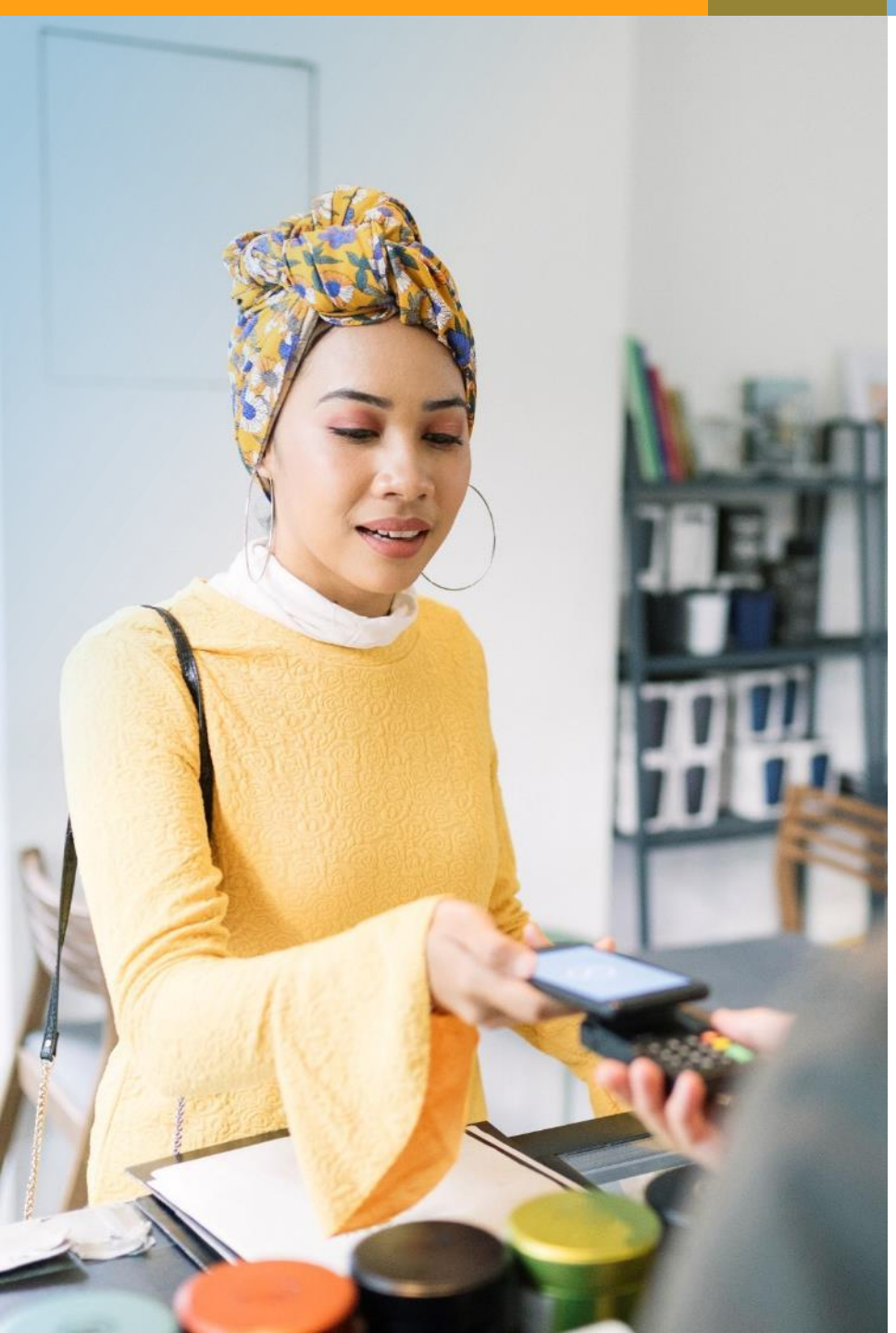


i.MX RT1170 TSN FEATURES (HW/SW)

- TSN Endpoint, and AVB Endpoint (Audio) modules available
- Stack and example applications are free for use with NXP MCUs, and compatible with the MCUXpresso SDK
  - Direct links to download GenAVB/TSN packages are available here*
  - Stack provided as object code; FreeRTOS-based examples available as source code

Standard	Description
802.1Qav	Forwarding and Queuing Enhancements (AVB) including Credit Based Shaping
802.1Qbv	Time-aware shaping (per-queue based)
802.1Qbu, 802.3BR	Frame pre-emption
802.1Qat	Stream Reservation Protocol (SRP)
802.1Qcc	SRP Enhancements and Performance Improvements
802.1AS-2020	Timing and synchronization in bridged LAN (gPTP) Includes 802.1AS-rev enhancements (redundant GM clocks, GM failover)

*TSN software will be available for selection in the SDK Builder in a future release (January 2022)



Security

i.MX RT1170 SECURITY

Crypto Engine

- CAAM
  - AES-128/256, DES/3DES, RSA up to 4096, ECC up to 1024, SHA up to 512 bit
- IEE
  - AES 128/256
- OTFAD
  - AES-128bit

Random Number Generation

- NIST-Complaint Pseudo Random Number Generator

Tamper Protection

- Up to 10 tamper pins, active/passive
- Temperate / Voltage / Frequency monitor

Supply Chain Integrity

- 256-bit manufacture protection key

Secure Debug

- 128-bit protection key

On-chip OTP

- Up to 8K bit OTP fuse, 5x 256-bit user keys
- Flexible permission control, including read-protect, write-protect and program-protect

Key Protection

- UDF module for key scrambling
- PUF key for chip unique secrets

Secure Storage

- Up to 64K Secure RAM
- 256 bits of key storage, powered by Coin Cell battery
- 4KB RAM powered by Coin Cell Battery

Bus Encryption

- On-the-fly decryption when XIP from QSPI
- In-Line Encryption encryption/decryption for SDRAM / HyperRAM
- Independent memory regions cipher policy management

Access Permission Control

- Flexible access permission control with RDC/XRDC
- Can be locked after configuration

Secure Boot

- Support High Assurance Boot
- Support encrypted boot from SD/eMMC/QSPI/NOR
- Support XIP from encrypted QSPI

AI / ML

MACHINE LEARNING LIBRARIES AND DEVELOPMENT TOOLS

Deploying open-source inference engines

Integration and optimization of inference engines

- i.MX RT MCU: Glow, TensorFlow™ Lite, Arm CMSIS-NN, DeepViewRT™

Suite of classical ML algorithms such as support vector machine (SVM), decision tree, and random forest

Integrating into MCUXpresso SDK

Complimentary tools from NXP, with no separate SDK or release to download:

- MCU: eIQ is integrated in MCUXpresso SDK middleware

Supporting materials for ease of use

End-to-end examples demonstrating customer use-cases, e.g. camera → inference engine

Documentation: eIQ User's Guide, Release Notes, Demo User's Guide

Guidelines for importing pretrained models based on popular NN frameworks, e.g. TensorFlow, PyTorch

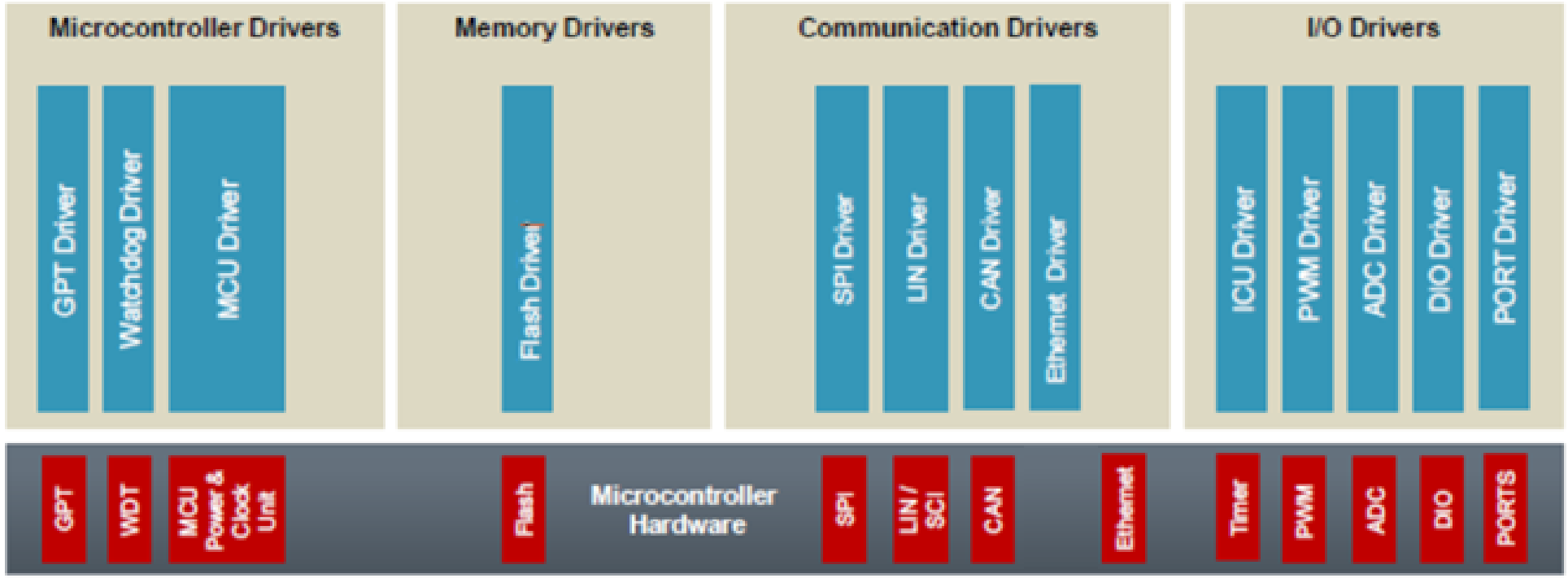
Technical training collateral, e.g. lectures, hands-on, video

www.nxp.com/eiq
https://community.nxp.com/community/eiq/overview

AUTOSAR – Premium Software

I.MXRT117X CLASSIC AUTOSAR MCAL SOFTWARE

- Autosar 4.x MCAL: Tested Running from RAM using NXP EVB
- FlexRay, and WDG-External can be Provided as Custom Complex Drivers
- All Plugins Components Configurable in any AUTOSAR-Compliant Configuration Tool
- Developed using EB tresos Studio™
- MCALs has been Also integrated using Vector DaVinci Configuration Tool



I.MXRT117X AUTOSAR CLASSIC PLATFORM (CP) 4.3.1 MCAL M4/M7

- Autosar CP 4.3.1 Compliant*
- QM or ASIL B
- Tested running from RAM
- Targeted GHS Compiler *
- Tested using EB tresos Studio™ Configuration Tool

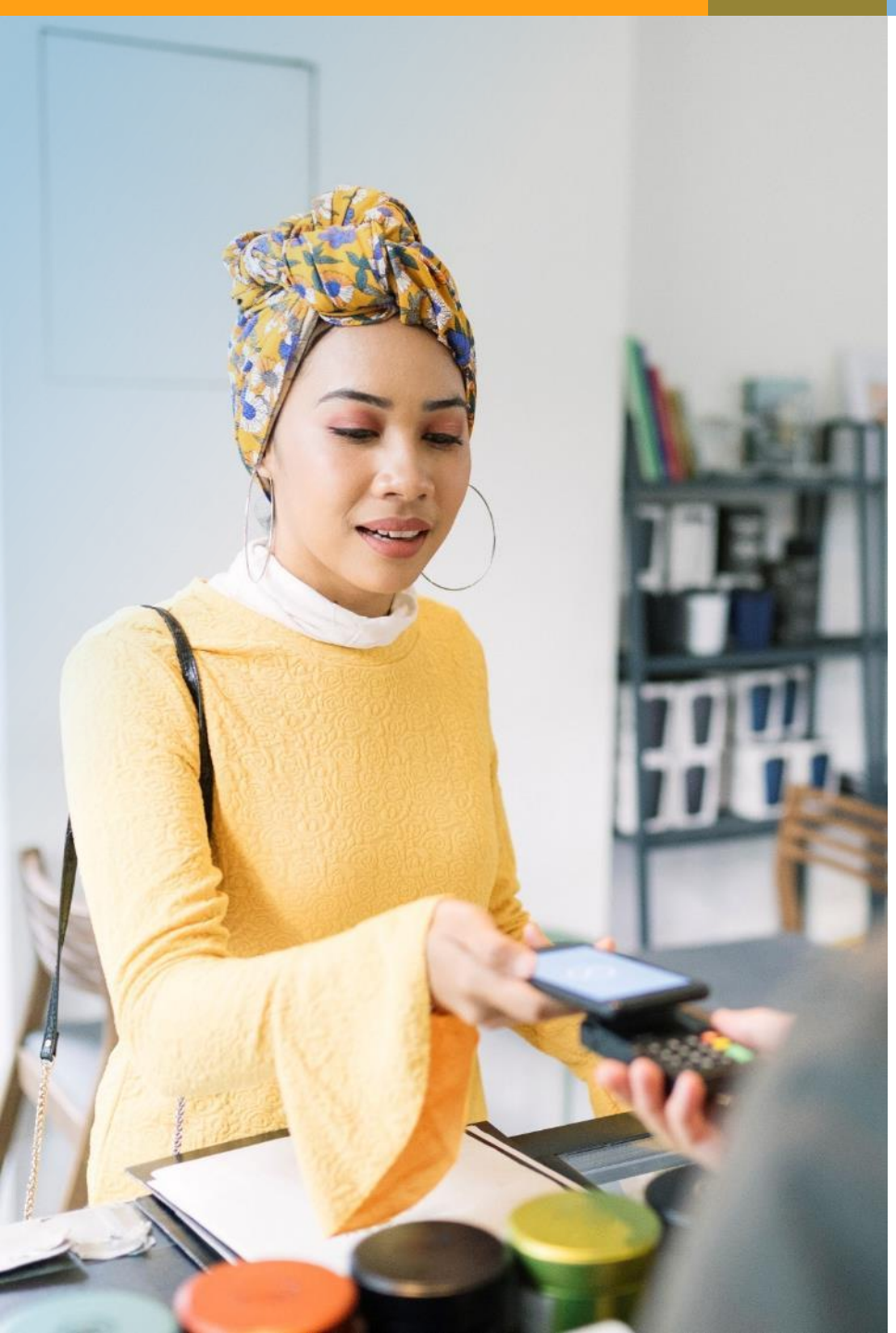
* Other AUTOSAR CP Release or Compiler can be requested and timing can be provided per customer specification

Release	Date
i.MXRT1117x AUTOSAR MCALs 4.3.1 Beta	**Available**
i.MXRT1117x AUTOSAR MCALs 4.3.1 RTM	**Within 4weeks From Beta**

Licensing	Model
Project AUTOSAR OS 4.3.1, M4 Core, Specific Compiler, tested using NXP EVB HW. Includes 1Year of Support.	Project License Product Line License Family Multi-Project
Support and Maintenance	20% of License
Professional Services for additional drivers	SOW

OTHER ENABLEMENT COMING IN 2021 (PLAN)

- Zephyr RTOS (base support in May, full i.MX RT1170 to be completed by Q1 2022)
- Voice Intelligent Technology (VIT) (July 2021)
- Azure RTOS (will be ready in SDK 2.10, has been partly ready in SDK 2.9)
- OpenVG (will be ready in SDK 2.10 , has been partly ready in SDK 2.9)
- WIFI/Bluetooth (will be ready in July 2021)
- TSN support as standard SDK item (will be ready in SDK 2.11)



Safety

I.MX RT1170 SAFETY FEATURES

- Safety-related components:
  - Arm Cortex-M cores x2 (M7 & M4)
  - ECC M7 TCM, Cache, OCRAM
  - ECC M4 TCM
  - 30ns interrupt latency
  - Watchdog Modules x4
  - External Watchdogs
  - Domain Partitioning
  - DCIC display integrity check
  - Ext. ECC SLC NAND FLASH, SDRAM

i.MX RT1170:
Target Applications for Auto

SECURE CONNECTIONS
FOR A SMARTER WORLD

I.MX RT1170 TARGET APPLICATIONS FOR AUTO

In-vehicle HMI

Entry level 2D digital cluster

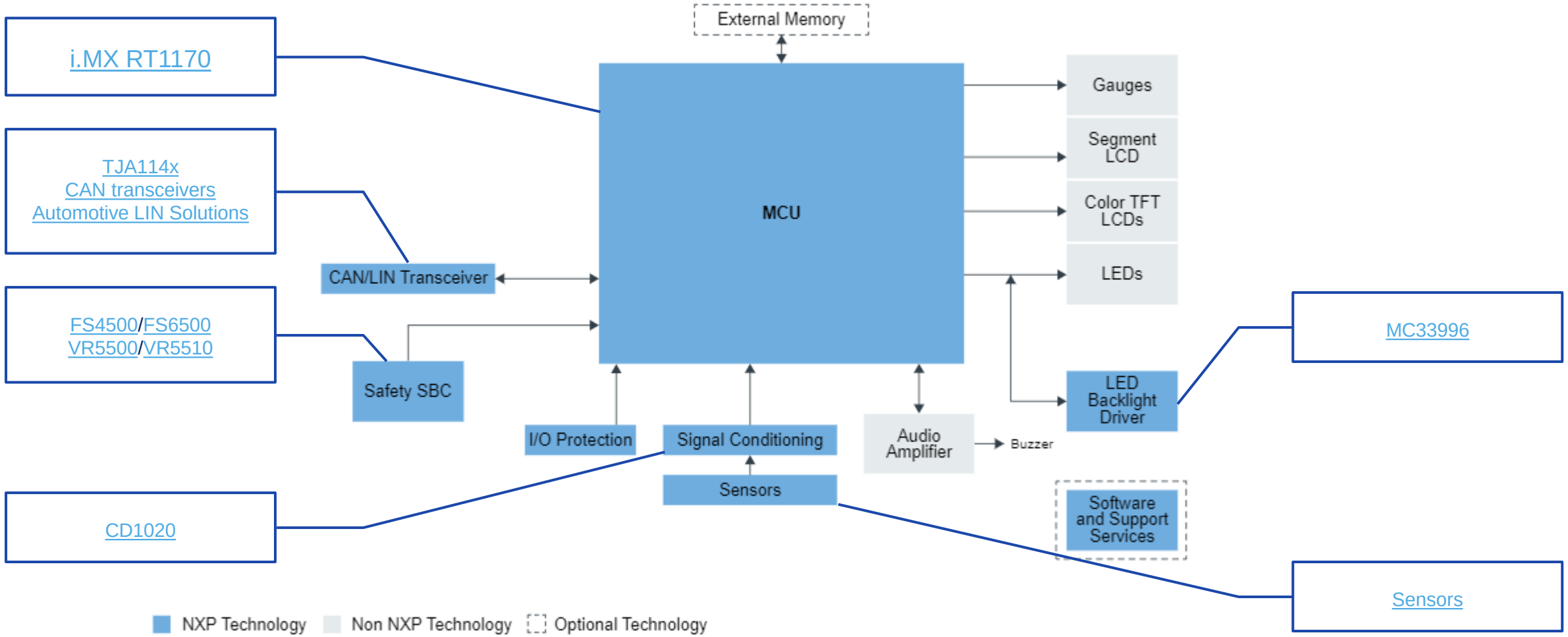
DMS

HUD

Voice command

…

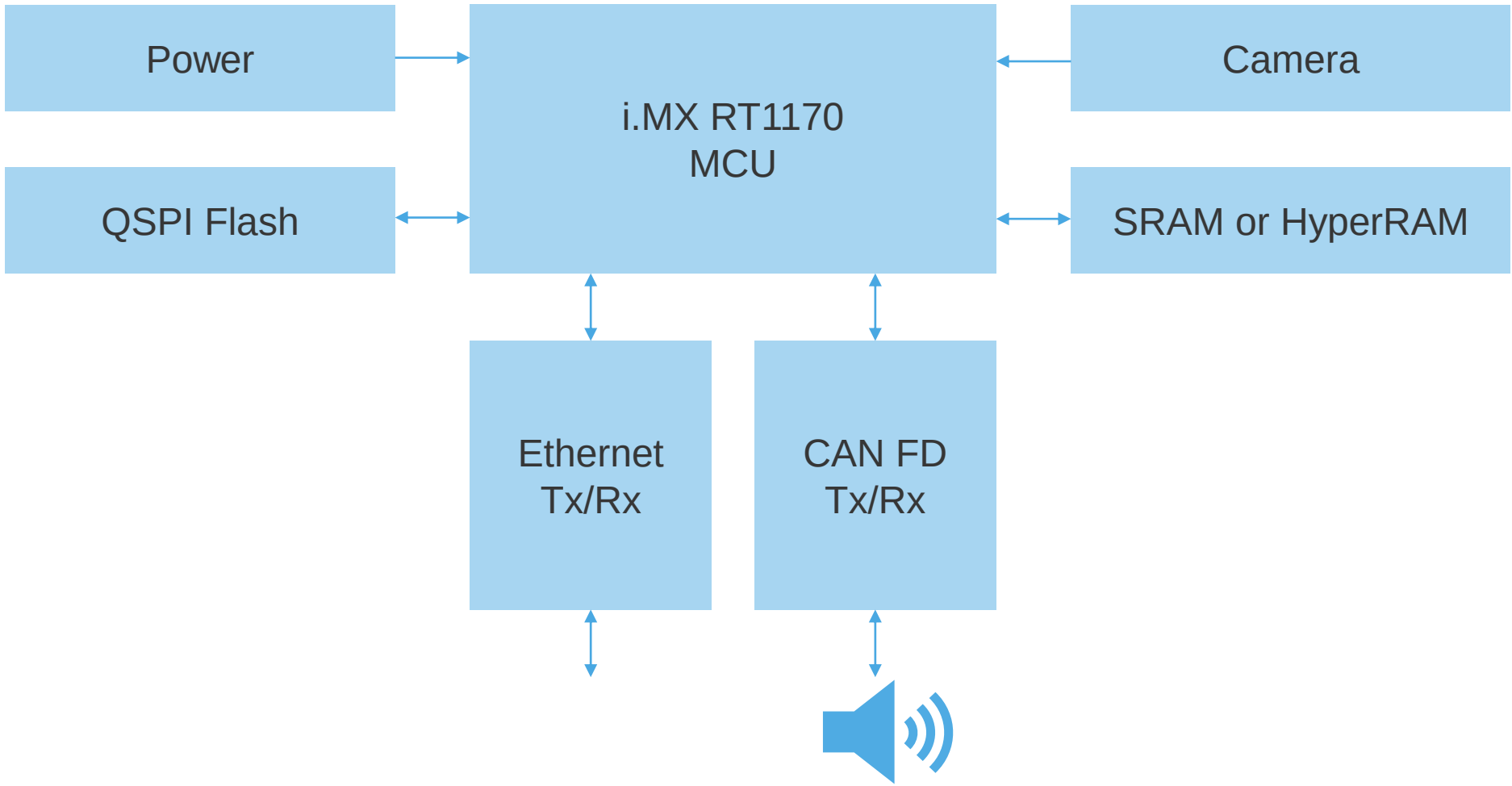
I.MX RT1170 TARGET APPLICATION – 2D INSTRUMENT CLUSTER / HMI



You may watch the demo in:

- e-Car cluster demo 1
- e-Car cluster demo 2

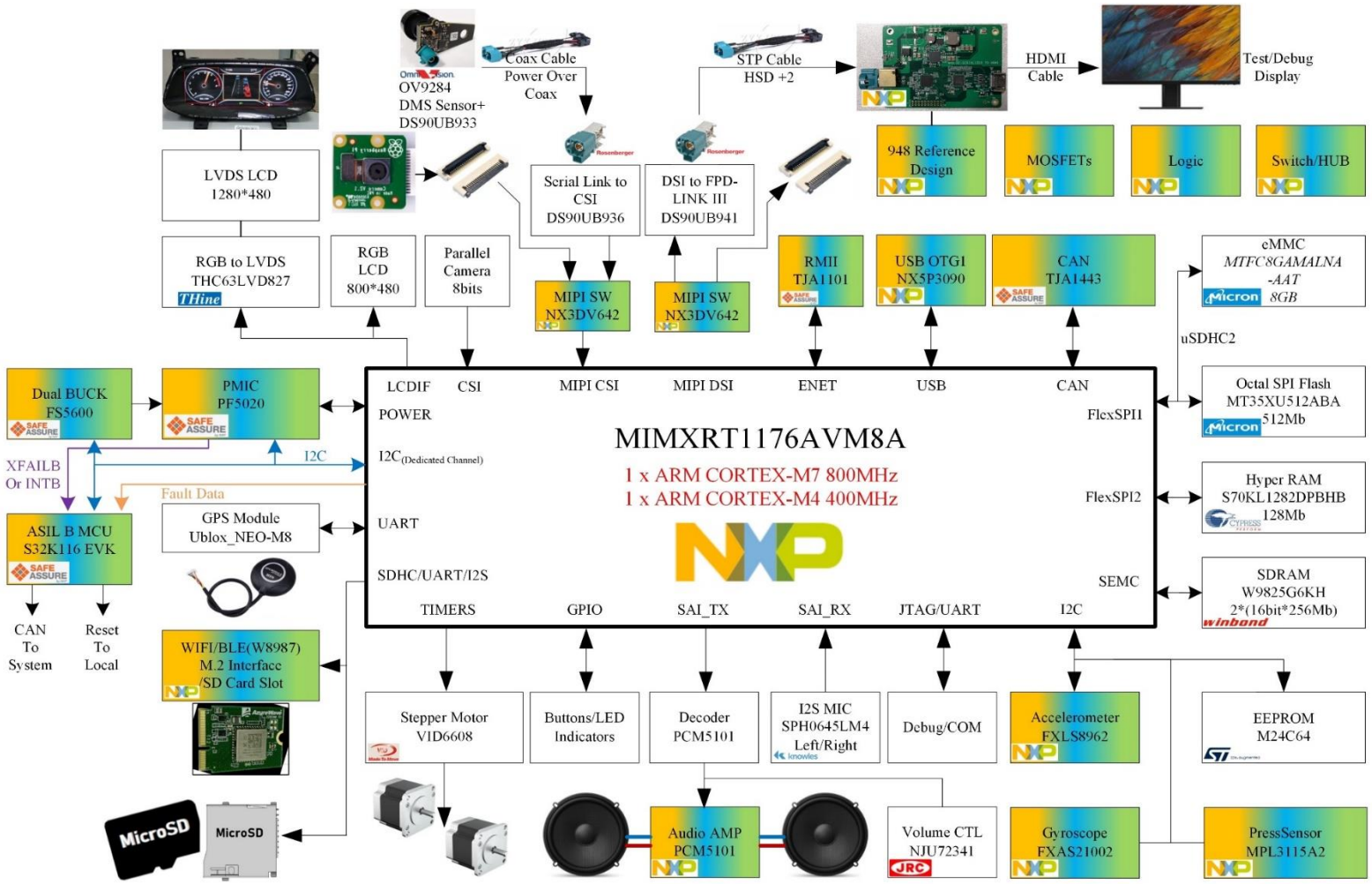
I.MX RT1170 TARGET APPLICATION – DMS

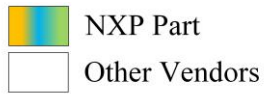


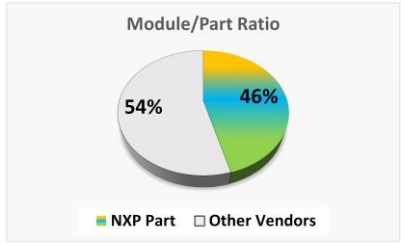
You may watch the demo in: https://showroom.nxp.com/

start – AUTOMOTIVE – IN-VEHICLE EXPERIENE – Driver Monitoring

I.MX RT1170 AUTO DEVELOPMENT PLATFORM (ADP) – IN PROCESS







Why i.MX RT1170 ADP:

- High performance auto-grade MCU
- Rich multimedia interface
- RTOS
- Integrate ASIL B devices
- External PMIC solution

The information may change during development.

Q & A

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