

Hands-On Workshop: i.MX RT Cross-Over Processors

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SECURE CONNECTIONS
FOR A SMARTER WORLD

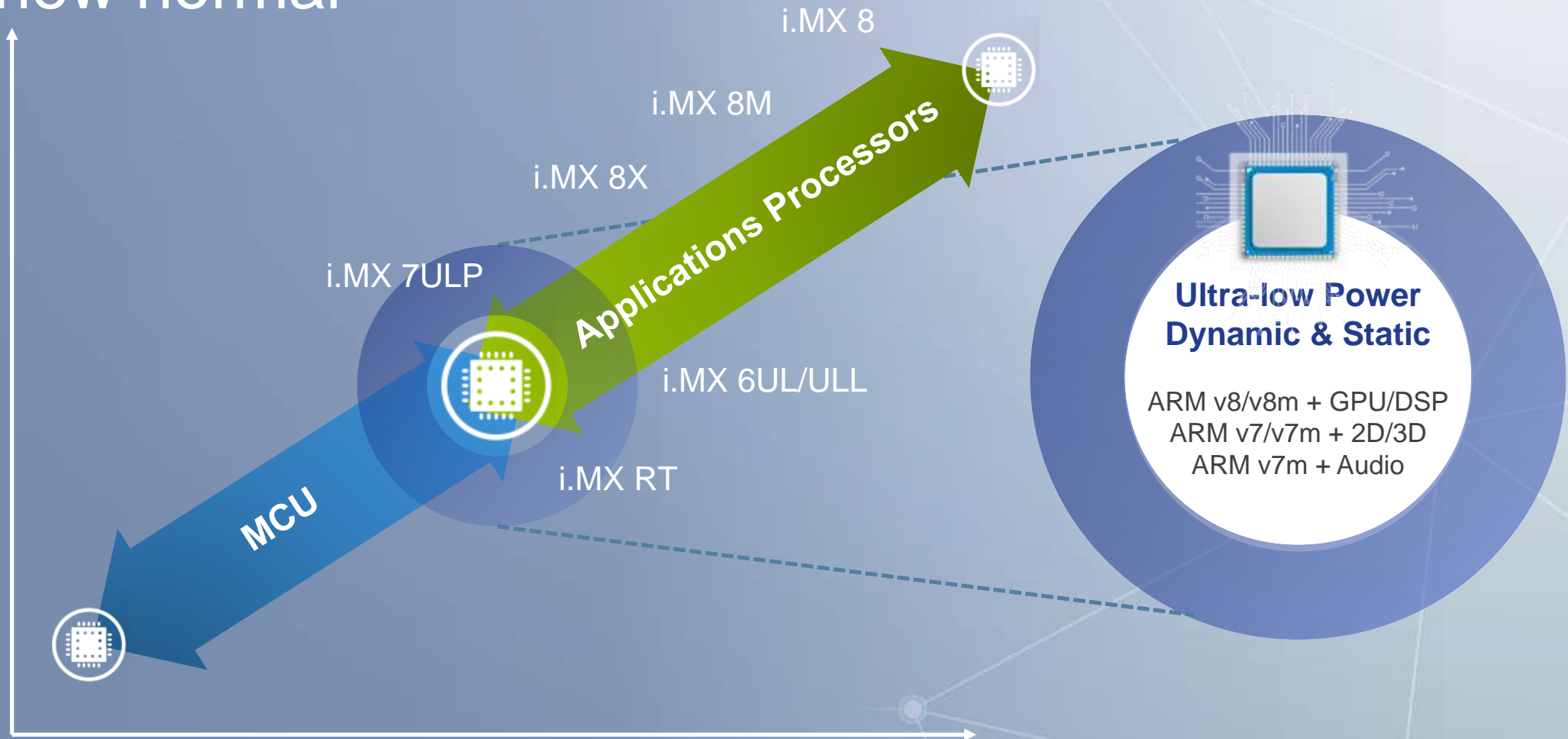
Agenda

- i.MXRT Introduction
- i.MXRT Roadmap
- i.MXRT Family
- i.MXRT Enablement
- MCUXpresso Tools
- Lab 1 : Hello World PLus
- Lab 2 : Pin Tool
- Lab 3 : lwIP

i.MX RT Introduction



Scalability of Embedded Processing the new normal



ESTABLISHED MARKET LEADERSHIP

High Performance MCUs & Cross-over Processors
>220MHz



General Purpose MCUs
50 – 220 MHz



Entry-level MCUs
15 – 50 MHz



Best Of Both Worlds: Microcontroller + Application Processor

i.MX

APPLICATIONS PROCESSORS

- ARM Cortex-A class and Cortex-M cores
- 600 MHz to 2 GHz performance
- Rich HMI experience
- Full open-source OS platforms



APPLICATIONS PROCESSOR

PERFORMANCE + INTEGRATION



CROSSOVER PROCESSORS

EASE OF USE + REAL TIME

MICROCONTROLLER

- ARM Cortex-M cores
- Performance up to 300 MHz
- Embedded memory
- Easy to use tools
- RTOS support



MCUXpresso

RTOS

KINETIS & LPC

MCUs

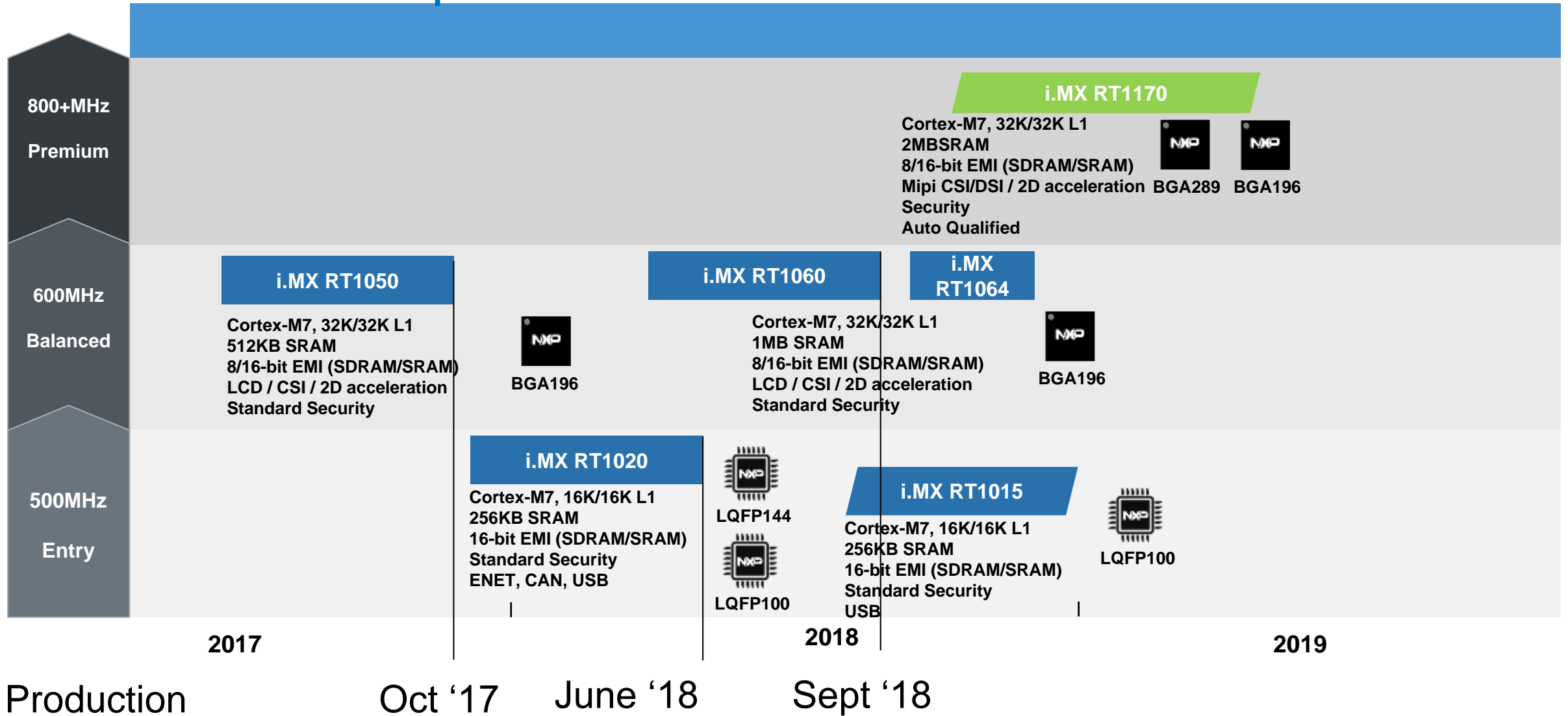
Best Of Both Worlds: i.MX RT Series Crossover Embedded Processors



i.MX RT ROADMAP



i.MX RT Roadmap



i.MX RT FAMILY



i.MX RT1050

1st Crossover processor

High performance 600MHz Cortex-M7

i.MX RT1020

Lowest Cost i.MX product, Providing LQFP packages

High performance 500MHz Cortex-M7

i.MX RT1060

On-chip SRAM expansion and increased real-time features

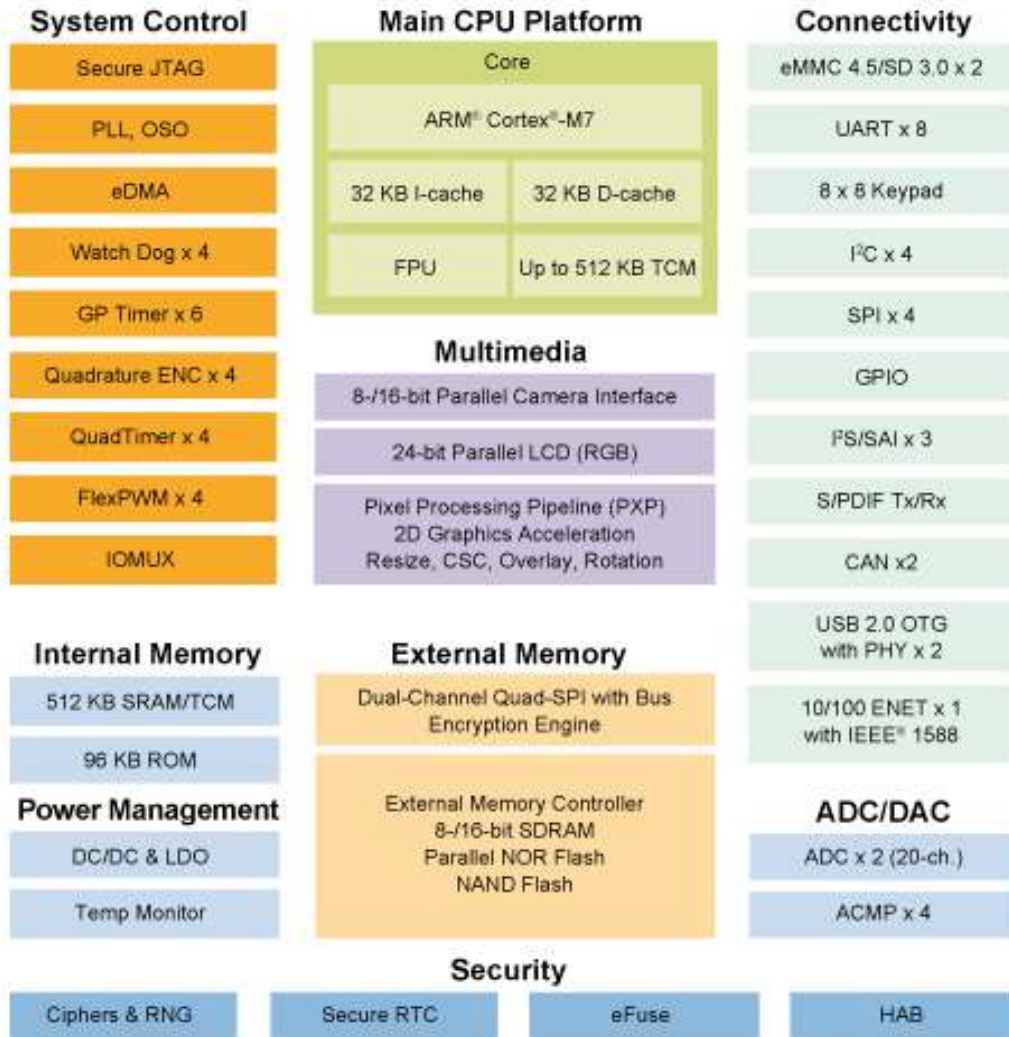
High performance 600MHz Cortex-M7

i.MX RT1064

4MB QSPI Flash + On-chip SRAM expansion and increased real-time features

High performance 600MHz Cortex-M7

i.MX RT1050 Block Diagram



Key Features and Benefits

Specifications

- Package: MAPBGA196 | 10x10mm², 0.65mm pitch (130 GPIOs)
- Temp / Qual: -40 to 105°C (Tj) Industrial / 0 to 95°C (Tj) Consumer

High Performance Real Time system

- Cortex-M7 up to 600MHz , 50% faster than any other existing M7 products
- 20ns interrupt latency, a TRUE Real time processor
- 512KB SRAM, configurable to 512KB TCM

Rich Peripheral

- Motor Control: Flex PWM X 4, Quad Timer X 4, ENC X 4
- 2x USB, 2x SDIO, 2x CAN, 1x ENET with 1588, 8xUART, 4x SPI, 4X I2C
- 8/16-bit CSI interface and 8/16/24-bit LCD interface
- Qual-SPI interface, with Bus Encryption Engine
- Audio interface: 3x SAI/ SPDIF RX & TX/ 1x ESAI

Security

- TRNG&PRNG(NIST SP 800-90 Certified)
- 128-AES cryptography
- Bus Encryption Engine: Protect QSPI Flash Content

Ease of Use

- MCUXpresso with SDK
- FreeRTOS
- Comprehensive ecosystem

Low BOM Cost

- Competitive Price
- Fully integrated PMIC with DC-DC
- Low cost package, 10x10 BGA with 0.65mm Pitch
- SDRAM interface

i.MX RT1050 2nd package

- Package size difference of 1st package (10*10 MAPBGA P0.65mm) and 2nd package(12*12 MAPBGA P0.8mm) due to ball pitch increase from 0.65mm to 0.8mm.

	10*10 196MAPBGA P0.65mm	12*12 196MAPBGA P0.8mm
Solder ball diameter	0.3mm	0.4mm
Package thickness	1.40mm	1.50mm

- Samples - July 2018
- Production - August 2018

Note: Ballmap will be identical between iMX RT1050 0.65mm & 0.8mm pitch package versions

i.MX RT1020 - From RT1050 to Low Cost LQFP Solutions



196BGA, 10x10



144LQFP, 20x20
100LQFP, 14x14

RT1050

Cortex-M7 up to 600MHz
32KB/32KB I/D Cache
512KB SRAM / TCM
4x Flex PWM, 4x Quad Timer, 4x ENC
2x HS USB, 2x SDIO, 2x CAN, 1x ENET
8x UART, 4x SPI, 4x I2C
Qual-SPI interface
External Memory Controller (SDRAM, NOR, NAND)
3x SAI/ SPDIF RX & TX/ 1x ESAI
2x ADC, 4x ACMP
PxP for 2D acceleration
Parallel Camera Interface
Parallel LCD Interface
TRNG&PRNG
128-AES cryptography
Bus Encryption Engine
Integrated PMIC

Package:
- 196BGA, 10x10, 0.65p

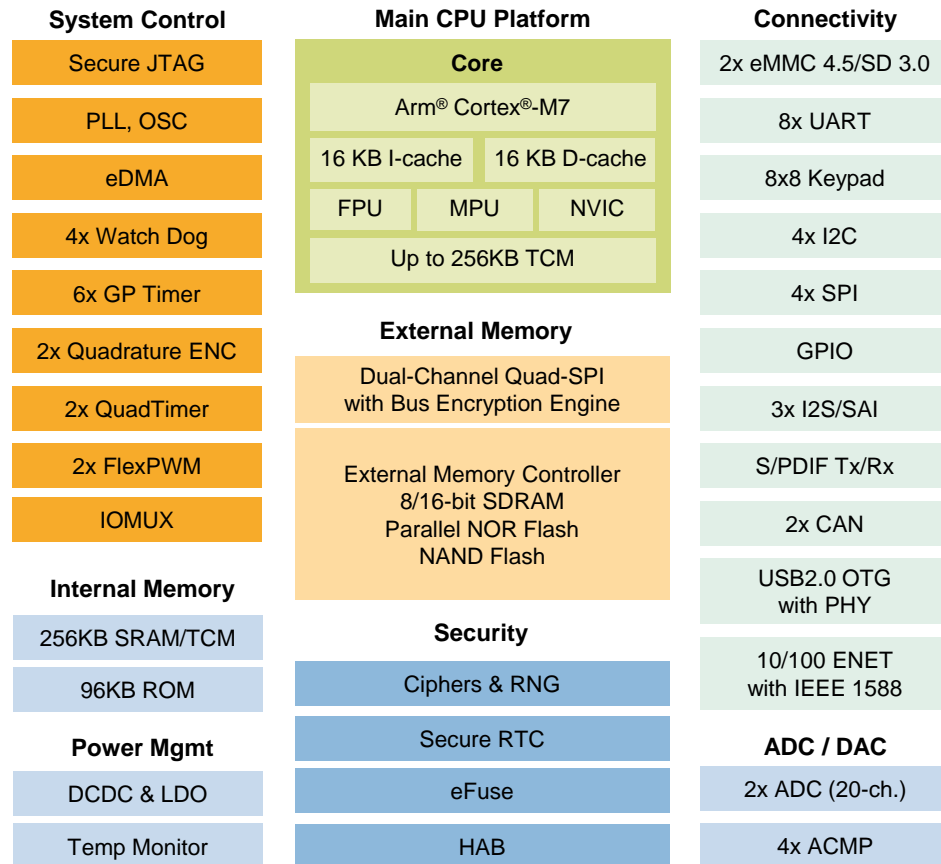
RT1020

Cortex-M7 up to **500MHz**
16KB/16KB I/D Cache
256KB SRAM / TCM
2x Flex PWM, **2x** Quad Timer, **2x** ENC
1x HS USB, 2x SDIO, 2x CAN, 1x ENET
8x UART, 4x SPI, 4x I2C
Qual-SPI interface
External Memory Controller (SDRAM, NOR, NAND)
3x SAI/ SPDIF RX & TX/ 1x ESAI
2x ADC, 4x ACMP
PxP for 2D acceleration
Parallel Camera Interface
Parallel LCD Interface
TRNG&PRNG
128-AES cryptography
Bus Encryption Engine
Integrated PMIC

Package:
- 144LQFP, 20x20, 0.5p
- 100LQFP, 14x14, 0.5p

Red indicates change from RT1050

i.MX RT1020 Block Diagram



High Performance and Integration

- Cortex-M7 up to 500MHz with 16KB/16KB I/D cache
- High Speed USB with PHY
- Multi PWM for dual motor control
- Security (On-The-Fly FlexSPI decryption)
- Rich Audio features

Low cost and easy to develop

- Starting from \$2.18 @ 10Ku
- LQFP Packages enable low cost 2-layer PCB design
- Integrated power management module reduces complexity of external power supply
- FreeRTOS with SDK
- MCUXpresso / Keil / IAR

Specifications

- Package: 144LQFP, 10x10, 0.5p
100LQFP, 14x14, 0.5p
- Temp / Qual: -40 to 105°C (Tj) Industrial
0 to 95°C (Tj) Consumer

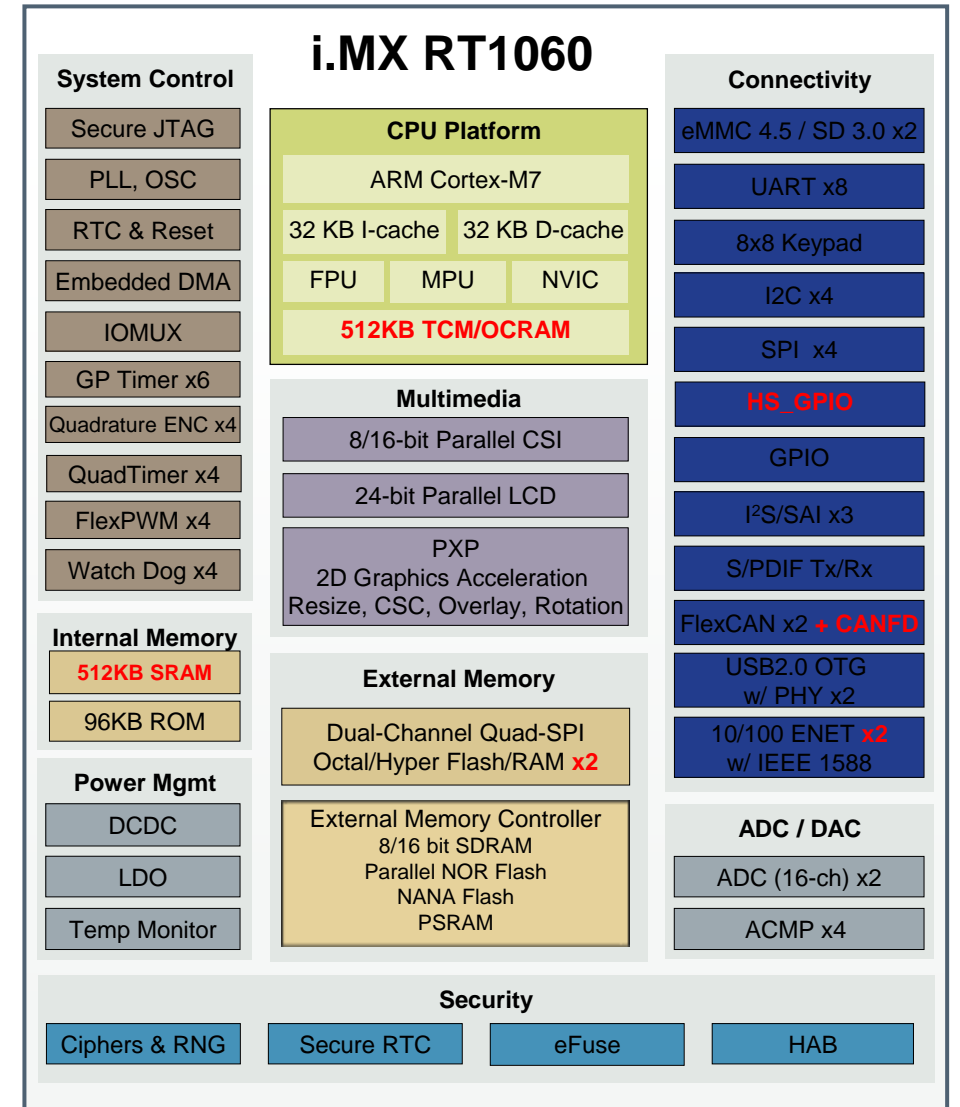
i.MX RT1060 Overview

Key Features and Advantages

- ARM Cortex-M7 processor, 600MHz, 32KB I-Cache, 32KB D-Cache, **512KB TCM/OCRAM**
- 512KB on-chip SRAM**
- High Speed GPIO**
- 8/16-bit SDRAM controller
- Parallel LCD Display up to WXGA (1366x768)
- 8/16-bit Parallel Camera Sensor Interface
- 8/16-bit Parallel NOR FLASH / PSRAM
- 2x** Dual-channel Quad-SPI NOR FLASH
- 2x MMC 4.5/SD 3.0/SDIO Port
- 2x USB 2.0 OTG, HS/FS, Device or Host with PHY
- 2x FlexCAN + **1x CANFD**
- Audio: 3x I2S/SAI, 1x S/PDIF Tx/Rx
- 2x** 10/100 Ethernet with IEEE 1588
- 2x 12-bit ADC, up to 20 input channels
- Full PMU Integration, DCDC+LDOs
- Security Block: TRNG, Crypto, Secure Boot

Specifications

- Process: SMIC40LL
- Core voltage: 0.9~1.3V
- Package: 196 MAPBGA, 10x10mm, 0.65mm pitch
(Pin to Pin compatible with RT1050)
- Temperature: -40C to 105C (Tj)



Key Differences: i.MX RT1050 / i.MX 1060

Feature	i.MX RT1050	i.MX 1060	i.MX 1064
CPU	600MHz Cortex-M7 32KB I-Cache/32KB D-Cache 1200 DMIPS	600MHz Cortex-M7 32KB I-Cache/32KB D-Cache 1200 DMIPS	600MHz Cortex-M7 32KB I-Cache/32KB D-Cache 1200 DMIPS
L2 Cache (TCM) / On-Chip RAM	Total 512KB shared between TCM and OCRAM	Total 512KB shared between TCM and OCRAM + 512KB dedicate OCRAM	Total 512KB shared between TCM and OCRAM + 512KB dedicate OCRAM
High Speed GPIO	-	HSGPIO	HSGPIO
Flash	-	-	4MB
Serial Flash I/F	Dual-ch DDR QuadSPI / Octal/Hyper Bus x1	Dual-ch DDR QuadSPI / Octal/Hyper Bus x2	Dual-ch DDR QuadSPI / Octal/Hyper Bus x1
NAND/NOR Flash	Async 8/16-bit NAND/NOR	Sync /Async 8/16-bit NAND/NOR	Sync/Async 8/16-bit NAND/NOR
DRAM interface	8/16-bit SDRAM @ 166MHz	8/16-bit SDRAM @ 166MHz	8/16-bit SDRAM @ 166MHz
Ethernet	1x 10/100 with IEEE1588	2x 10/100 with IEEE1588	2x 10/100 with IEEE1588
USB	2x USB OTG HS w/PHY	2x USB OTG HS w/PHY	2x USB OTG HS w/PHY
UART, SPI, I2C, FlexIO	8, 4, 4, 2	8, 4, 4, 3	8, 4, 4, 3
SD/MMC I/F	2	2	2
CAN	2x FlexCAN	2x FlexCAN + 1x CANFD	2x FlexCAN + 1x CANFD
12-bit ADC/ACMP	2, 4	2, 4	2, 4
Touch Controller	4-wire / 5-wire resistive touch	4-wire / 5-wire resistive touch	4-wire / 5-wire resistive touch
PWM/Timer/Position Sensor IF	Motor control grade PWM x32, 22, 4	Motor control grade PWM x32, 14, 2	Motor control grade PWM x32, 14, 2
CSI	24-bit parallel	24-bit parallel	24-bit parallel
Audio	I2S x2; Multi-channel I2S x 1 SPDIF Tx/Rx	I2S x2; Multi-channel I2S x 1 SPDIF Tx/Rx	I2S x2; Multi-channel I2S x 1 SPDIF Tx/Rx
Image Processing	PXP v2.0-lite CSC, Resize, Combine, Rotate, BitBlit	PXP v2.0-lite CSC, Resize, Combine, Rotate, BitBlit	PXP v2.0-lite CSC, Resize, Combine, Rotate, BitBlit
Display I/F	1x 24-bit RGB up to WXGA	1x 24-bit RGB up to WXGA	1x 24-bit RGB up to WXGA
eFuse	1.5Kb	2Kb	2Kb
Package	BGA 10x10, 0.65mm pitch	BGA 10x10, 0.65mm pitch	BGA 10x10, 0.65mm pitch

i.MX RT1060 - Qual: 10x10 Sept, 12x12 Oct

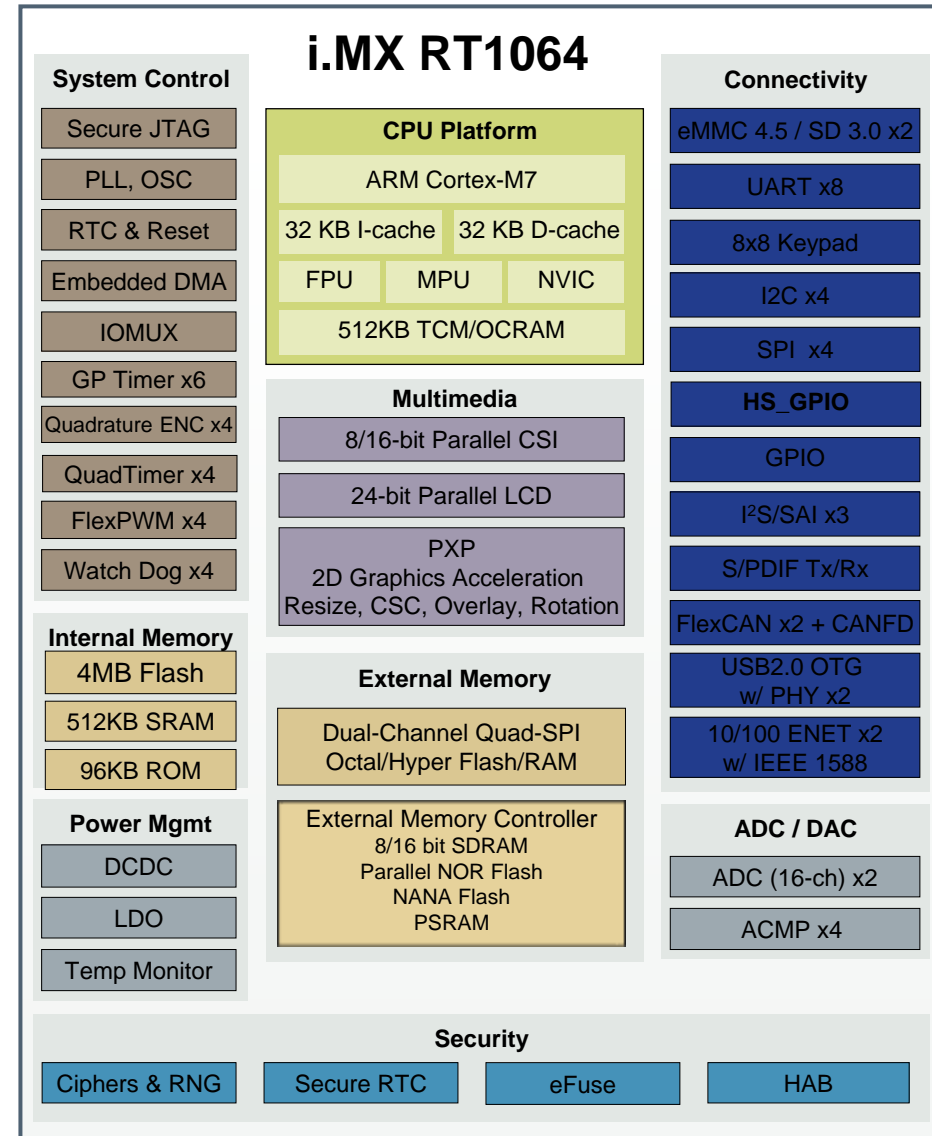
Description	Production Part #	Qualification	Package	Frequency	Features
i.MXRT1060 Industrial 10x10	MIMXRT1062CVL5B	Industrial	196MAPBGA 10mm X 10mm 0.65pitch	528M	528MHz, Industrial Grade for general purpose - basic security, with LCD/CSI , PXP , CAN x2, CAN-FD, 2xEthernet , EMMC 4.5/sd 3.0 x2,USB OTG x2, UART x8, SAI x3, Timer x4, PWM x4, I2C x4, SPI x4
i.MXRT1060 Industrial 10x10	MIMXRT1061CVL5B	Industrial	196MAPBGA 10mm X 10mm 0.65pitch	528M	528MHz, Industrial Grade for general purpose - basic security, no LCD/CSI , PXP , CAN x2, CAN-FD, 2x Ethernet , EMMC 4.5/sd 3.0 x2,USB OTG x2, UART x8, SAI x3, Timer x4, PWM x4, I2C x4, SPI x4
i.MXRT1060 Commercial 10x10	MIMXRT1062DVL6B	Commercial	196MAPBGA 10mm X 10mm 0.65pitch	600M	600MHz,Commercial Grade for general purpose - basic security, with LCD/ CSI , PXP , CAN x2, CAN-FD, 2x Ethernet , EMMC 4.5/sd 3.0 x2,USB OTG x2, UART x8, SAI x3, Timer x4, PWM x4, I2C x4, SPI x4
i.MXRT1060 Commercial 10x10	MIMXRT1061DVL6B	Commercial	196MAPBGA 10mm X 10mm 0.65pitch	600M	600MHz, Commercial Grade for general purpose - basic security, no LCD/CSI , PXP , CAN x2, CAN-FD, 2x Ethernet , EMMC 4.5/sd 3.0 x2,USB OTG x2, UART x8, SAI x3, Timer x4, PWM x4, I2C x4, SPI x4
i.MXRT1060 Industrial 12x12	MIMXRT1062CVJ5B	Industrial	196MAPBGA 12mm X 12mm 0.8 pitch	528M	528MHz, Industrial Grade for general purpose - basic security, with LCD/CSI , PXP , CAN x2, CAN-FD, 2x Ethernet , EMMC 4.5/sd 3.0 x2,USB OTG x2, UART x8, SAI x3, Timer x4, PWM x4, I2C x4, SPI x4
i.MXRT1060 Industrial 12x12	MIMXRT1061CVJ5B	Industrial	196MAPBGA 12mm X 12mm 0.8 pitch	528M	528MHz, Industrial Grade for general purpose - basic security, no LCD/CSI , PXP , CAN x2, CAN-FD, 2x Ethernet , EMMC 4.5/sd 3.0 x2,USB OTG x2, UART x8, SAI x3, Timer x4, PWM x4, I2C x4, SPI x4
i.MXRT1060 Commercial 12x12	MIMXRT1062DVJ6B	Commercial	196MAPBGA 12mm X 12mm 0.8 pitch	600M	600MHz,Commercial Grade for general purpose - basic security, with LCD/ CSI , PXP , CAN x2, CAN-FD, 2x Ethernet , EMMC 4.5/sd 3.0 x2,USB OTG x2, UART x8, SAI x3, Timer x4, PWM x4, I2C x4, SPI x4
i.MXRT1060 Commercial 12x12	MIMXRT1061DVJ6B	Commercial	196MAPBGA 12mm X 12mm 0.8 pitch	600M	600MHz, Commercial Grade for general purpose - basic security, no LCD/CSI , PXP , CAN x2, CAN-FD, 2x Ethernet , EMMC 4.5/sd 3.0 x2,USB OTG x2, UART x8, SAI x3, Timer x4, PWM x4, I2C x4, SPI x4
MIMXRT1060 Development Platform	MIMXRT1050-EVK			600M	Micro USB Host connector, Micro USB OTG connector, Ethernet (10/100T) connector, CAN Transceivers, ARDUINO interface, Parallel LCD connector, Camera Connector, 6-Axis Ecompass (3-Axis Mag, 3-Axis Accel) sensor FXOS8700CQ, Audio Codec, 4-pole Audio Headphone Jack, External speaker connection, Microphone, SPDIF Connector
4.3" Display	RK043FN02H-CT			-	4.3" LCD Display

i.MX RT1064 – Oct '18 Qual

• Key Features and Advantages

- ARM Cortex-M7 processor, 600MHz, 32KB I-Cache, 32KB D-Cache, 512KB TCM/OCRAM
- 512KB on-chip SRAM
- 4MB Flash
- 4MB Flash
- High Speed GPIO
- 8/16-bit SDRAM controller
- Parallel LCD Display up to WXGA (1366x768)
- 8/16-bit Parallel Camera Sensor Interface
- 8/16-bit Parallel NOR FLASH / PSRAM
- Dual-channel Quad-SPI NOR FLASH
- 2x MMC 4.5/SD 3.0/SDIO Port
- 2x USB 2.0 OTG, HS/FS, Device or Host with PHY
- 2x FlexCAN + 1x CANFD
- Audio: 3x I2S/SAI, 1x S/PDIF Tx/Rx
- 2x 10/100 Ethernet with IEEE 1588
- 2x 12-bit ADC, up to 20 input channels
- Full PMU Integration, DCDC+LDOs
- Security Block: TRNG, Crypto, Secure Boot

- Package: 196 MAPBGA, 10x10mm, 0.65mm pitch (**Pin to Pin compatible with RT1060, RT1050**)
- Temperature: -40C to 105C (Tj)



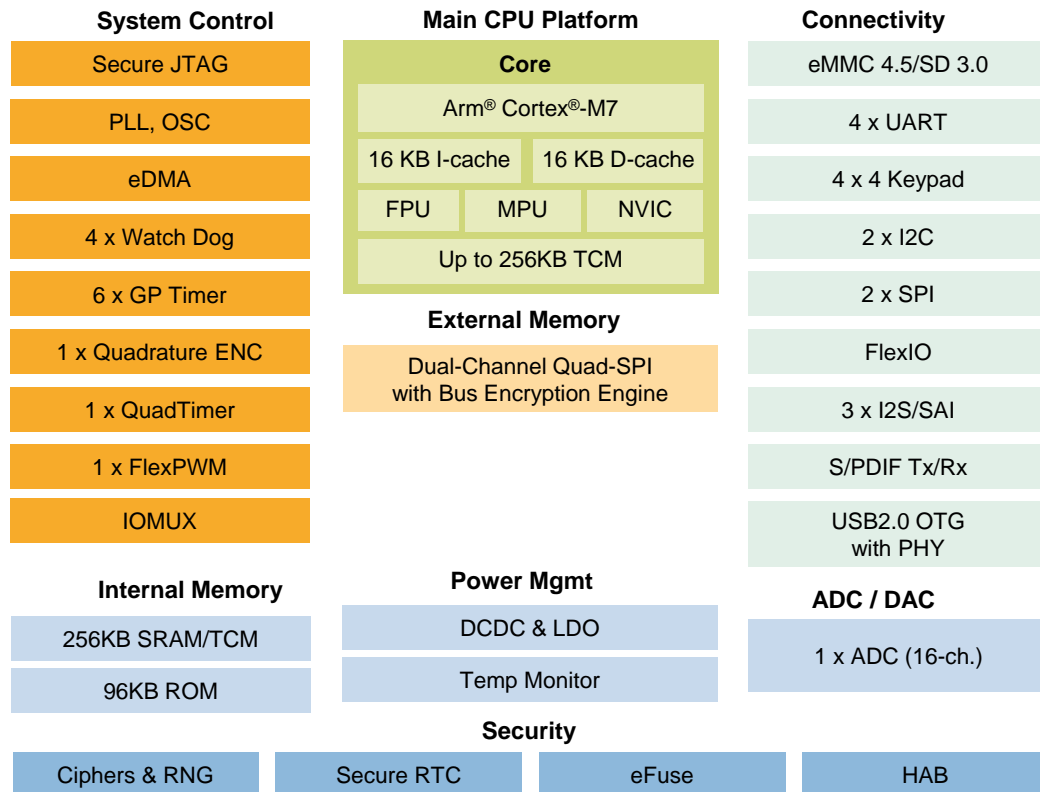
Sample in Q3, Launch in Q4.

i.MX RT1015

Lowest Cost i.MX product, LQFP100 14x14
High performance 500MHz Cortex-M7



i.MX RT1015 Block Diagram



High Performance and Integration

- Cortex-M7 up to 500MHz with 16KB/16KB I/D cache
- High Speed USB with PHY
- Security (On-The-Fly FlexSPI decryption)
- Rich Audio features

Low cost and easy to develop

- Starting from \$1.49 @ 10Ku
- LQFP Packages enable low cost 2-layer PCB design
- Integrated power management module reduces complexity of external power supply
- FreeRTOS with SDK
- MCUXpresso / Keil / IAR

Specifications

- Package: 100LQFP, 14x14, 0.5p
- Temp / Qual: -40 to 105°C (Tj) Industrial
0 to 95°C (Tj) Consumer

i.MX RT1015 and i.MX RT1020 Comparison

Feature	i.MX RT1020 (LQFP100)	i.MX RT1015 (LQFP100)
Core	ARM Cortex-M7	ARM Cortex-M7
Speed	500 MHz at 1.275V 400 MHz at 1.175V	500 MHz at 1.275V 400 MHz at 1.175V
Cache	16 KB-I, 16KB-D	16 KB-I, 16KB-D
TCM & OCRAM	256KB in total	256KB in total
Ethernet	10/100 MB x 1	0
USB with PHY	OTG, HS/FS x 1	OTG, HS/FS x 1
CAN	2	0
Security	Crypto Engine (AES-128, SHA1/SHA256), TRNG, No Secure RAM, Secure Boot	Crypto Engine (AES-128, SHA1/SHA256), TRNG, No Secure RAM, Secure Boot
I2S(SAI)	3	3
S/PDIF	1	1
MQS	1	1
QSPI	1x 2-ch	1x 2-ch
SDIO	SD3.0/eMMC4.5 x1	SD3.0/eMMC4.5 x1
UART/SPI/I2C	8/4/4	4/2/2
QTimer/FlexPWM/ENC	2/2/2	1/1/1
GPT/PIT	2/4	2/4
12-bit ADC	10ch, 1Msps at dual-sampling x2	10ch, 1Msps at dual-sampling x1
Comparator	4	0
Keyboard (8x8)	Yes (4x4)	Yes (4x4)
PMIC Integration	Single 2.8V-3.6V supply Integrated DCDC for core supply, high efficiency Integrated LDOs for analog	Single 2.8V-3.6V supply Integrated DCDC for core supply, high efficiency Integrated LDOs for analog
Package	LQFP100, 14x14 mm, 0.5mm pitch	LQFP100, 14x14 mm, 0.5mm pitch
Temperature	-40C to 105C (Tj)	-40C to 105C (Tj)
Pin-to-Pin Compatible	RT1015 LQFP 100	RT1020 LQFP100

i.MX RT1015 Part Numbers

Description	Production Part #	Qualification Tier	Package	CPU Frequency	10Ku RSL	Features
i.MXRT1015 Industrial 14x14	MIMXRT1015CAF4A	Industrial	100LQFP, 14mm x 14mm, 0.5mm pitch	400M	\$1.64	400MHz, Industrial Grade for general purpose - 256K RAM, EMMC 4.5/sd 3.0 x1, USB OTG x1, SAI x3, SPIDIFx1, Timer x2, PWM x1, UART x4, I2C x2, SPI x2, ADCx1
i.MXRT1015 Commercial 14x14	MIMXRT1015DAF5A	Commercial	100LQFP, 14mm x 14mm, 0.5mm pitch	500M	\$1.49	500MHz, Commercial Grade for general purpose - 256K RAM, EMMC 4.5/sd 3.0 x1, USB OTG x1, SAI x3, SPIDIFx1, Timer x2, PWM x1, UART x4, I2C x2, SPI x2, ADCx1
Development Platform	MIMXRT1015-EVK			500M	\$49	Micro USB OTG connector, ARDUINO interface, 6-Axis Ecompass (3-Axis Mag, 3-Axis Accel) sensor FXOS8700CQ, Audio Codec, 4-pole Audio Headphone Jack, External speaker connection, Microphone

Samples in Oct 2018, Production in December 2018
 Pin-to-pin compatible w/ i.MX RT1020 LQFP100

i.MX RT1170

• Specifications

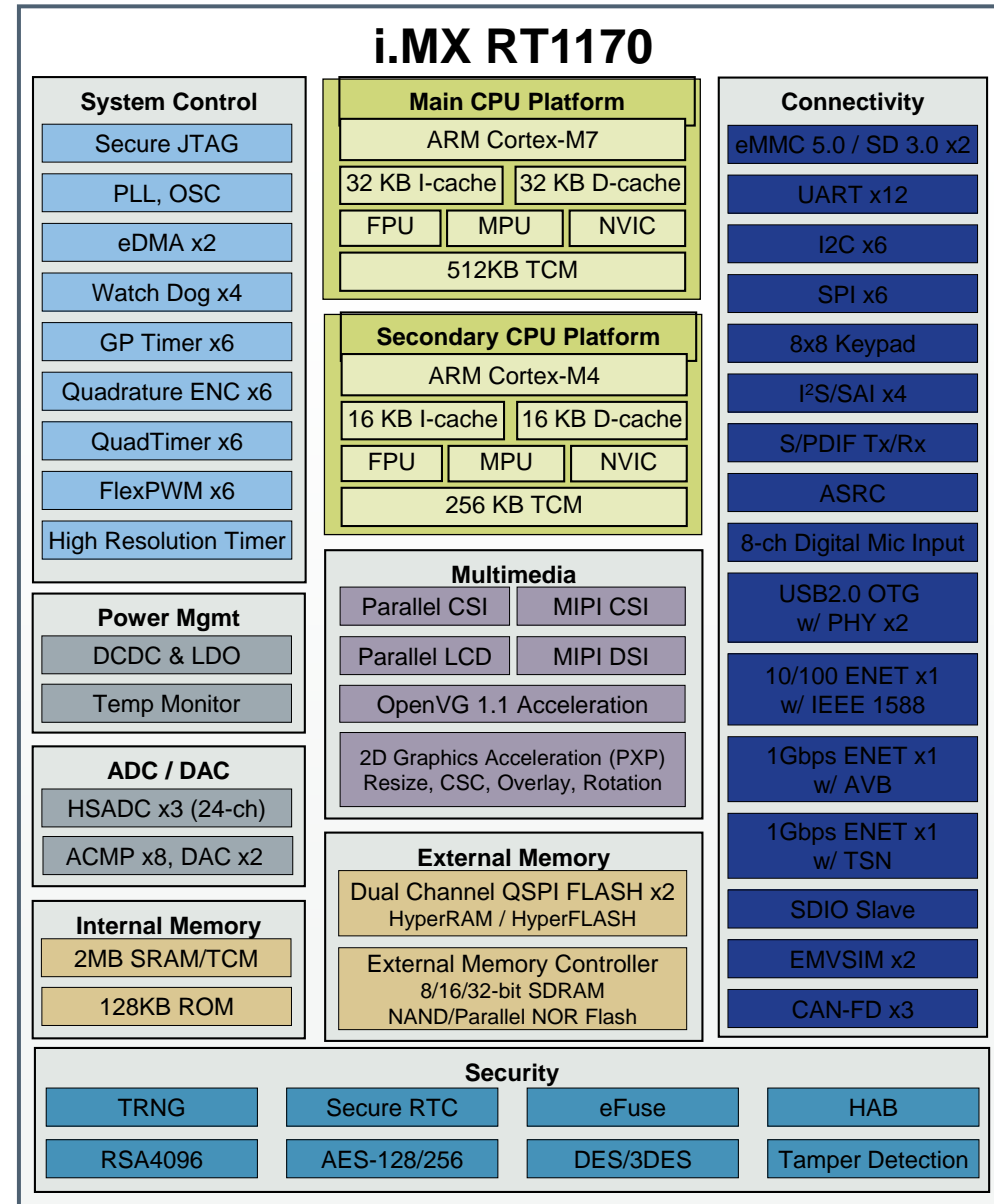
- **Process:** SEC 28FD-SOI
- **Core Voltage:** 1.0V
- **Package:** MAPBGA289, 14x14mm, 0.8mm pitch
MAPBGA196, 10x10mm, 0.65mm pitch
- **Temperature:** -40C to 125C (Tj)

• Key Features and Advantages

- ARM **Cortex-M7** processor, **1 GHz**, 32KB/32KB L1 Cache, 512KB TCM
- ARM Cortex-M4 processor, 400MHz, 16KB/16KB L1 Cache, 256KB TCM
- **2MB on-chip SRAM** (including TCM for CPU core)
- Parallel LCD Display up to **WXGA (1280x800)**
- 8/16-bit Parallel Camera Sensor Interface
- 2-lane **MIPI CSI** and 2-lane **MIPI DSI**
- 2D Graphics Acceleration & OpenVG Acceleration
- 8/16/32-bit **SDRAM** controller up to 200MHz
- 8/16-bit Parallel NOR FLASH / NAND FLASH / PSRAM
- 2x QSPI NOR FLASH / HyperRAM / HyperFLASH Interface
- 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**, **digital microphone input**
- 3x ENET: **1Gbps ENET w/ AVB** + 10/100 ENET w/ IEEE 1588 + **1Gbps ENET w/ TSN**
- 3x 12-bit ADC, **2Msamples/s**, up to 24 input channels total
- 8x Analog comparator, 2x DAC
- **Full PMU Integration**, DCDC+LDOs
- Secure Boot, TRNG, RSA4096, Tamper Detection, Secure Key Storage

• Enablement

- **MCUXpresso, FreeRTOS with SDK**
- **Autosar**



i.MX RT ENABLEMENT



i.MX RT Enablement – Easy to Develop

Runtime Software

NXP Solutions:

MCUXpresso Software and Tools

- IDE
- SDK
- Config Tools

For NXP Cortex-M controllers:

- Kinetic MCUs
- LPC Microcontrollers
- i.MX Application Processors

RTOS, Middleware Partners:

Comprehensive frameworks and solutions for low-power, connected, and secure embedded systems

Software Development Tools

IDE / Toolchains:

Hardware Development Tools

Evaluation Kits:



Partner Solutions

Low cost hardware platforms for evaluation and application development. Partner solutions for hardware debugging solutions

Application Specific

- Graphics
- Touch HMI
- Camera interface
- Motor Control
- Voice activation
- Audio

- Sensor Fusion
- Cloud Connectivity

Connectivity Solutions

Software frameworks and development tools for targeted applications and certified connectivity solutions

Support

Broad Market:

- NXP Community
- Solution Designs
- Application Notes
- Schematics



High Touch:

- Professional Support
- Professional Services

Get started quickly and get the support you need, when you need it

Development Platform

– Real 2 Layer PCB Design

Part Numbers: MIMXRT1015-EVK (\$49)

Processor

- NXP Semiconductors MIMXRT1015DAF5A
500MHz ARM Cortex-M7, 100LQFP

Memory

- 64 Mbit QSPI Flash
- TF socket for SD card

Audio

- Audio Codec
- 4-pole Audio Headphone Jack
- External speaker connection
- Microphone

Connectivity

- Micro USB OTG connector
- ARDUINO interface

Sensor

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

Debug

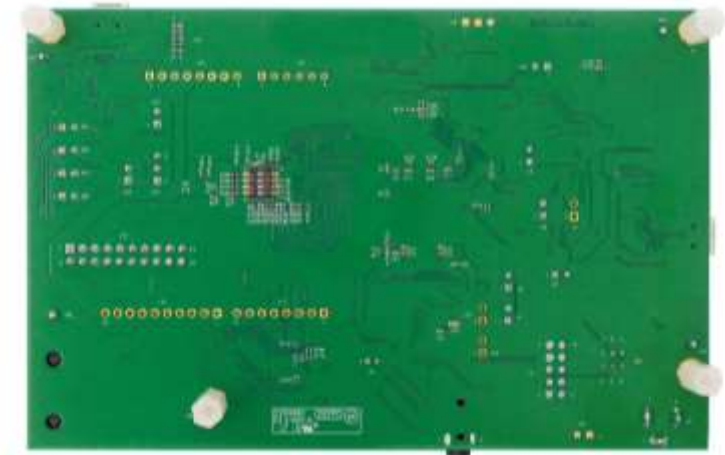
- JTAG connector
- On board DAP-Link debugger

Tools & OS Support

- IAR, MDK
- SDK with FreeRTOS

Others

- All in one board design
- **2 layer through hole PCB**



i.MX RT Feature Summary

Red indicates change from column to the left

Feature	i.MX RT1015	RT1020	RT1050	RT1060	RT1170
Core	ARM Cortex-M7	ARM Cortex-M7	ARM Cortex-M7	ARM Cortex-M7	ARM Cortex-M7 + ARM Cortex-M4
Speed	500MHz	500MHz	600MHz	600MHz	1GHz
Cache	16 KB-I, 16KB-D	16 KB-I, 16KB-D	32 KB-I, 32KB-D	32 KB-I, 32KB-D	32 KB-I, 32KB-D
On-Chip RAM/TCM	256KB	256KB	512KB	1MB	2MB
External Memory	-	8/16-bit Interface for	8/16-bit Interface for	8/16-bit Interface for	8/16/32-bit Interface for
	QSPI	SDRAM, SRAM, NOR, NAND	SDRAM, SRAM, NOR, NAND	SDRAM, SRAM, NOR, NAND	SDRAM, SRAM, NOR, NAND
SDIO	SD3.0/eMMC4.5 x1	SD3.0/eMMC4.5 x2	SD3.0/eMMC4.5 x 2	SD3.0/eMMC4.5 x 2	SD3.0/eMMC5.0 x 2
QSPI / Octal / HyperBus	Dual Channel / 8-bit	Dual Channel / 8-bit	Dual Channel / 8-bit	2x Dual Channel / 8-bit	2x Dual Channel / 16-bit
Ethernet	-	10/100Mbps x1	10/100Mbps x1	10/100Mbps x 2	10/100Mbps x1 + 1Gbps ENET AVB x 1
USB with PHY	OTG, HS/FS x 1	OTG, HS/FS x 1	OTG, HS/FS x 2	OTG, HS/FS x 2	OTG, HS/FS x 2
CAN	-	FlexCAN x 2	FlexCAN x 2	FlexCAN x2 + CANFD x 1	CAN-FD x 3
Graphics	-	-	PxP for 2D acceleration	PxP for 2D acceleration	2D Graphics Acceleration, & OpenVG Acceleration
CSI	-	-	8/10/16-bit Parallel	8/10/16-bit Parallel	8/10/16-bit Parallel + MIPI-CSI
LCD	-	-	8/16/18/24-bit Parallel	8/16/18/24-bit Parallel	8/16/18/24-bit Parallel + MIPI DSI
Security	TRNG, AES-128, SHA, Secure Boot	TRNG, AES-128, SHA, secure Boot	TRNG, AES-128, SHA, secure Boot	TRNG, AES-128, SHA, secure Boot	TRNG, AES-256, SHA, DES, 3DES, RSA4096/ECC, Secure Boot, Tamper Monitor,
UART / SPI / I2C / FlexIO	8/4/4/2	8/4/4/2	8/4/4/2	8/4/4/3	12/6/6/3
I2S / SPDIF / ASRC	3/1/0	3/1/0	3/1/0	3/1/0	4/1/1
ADC	1M sample/s x 1	1M sample/s x 2	1M sample/s x 2	1M sample/s x 2	2M sample/s x 3
ACMP / DAC	0/0	4/0	4/0	4/0	8/2
Quad ENC/Quad Timer/FlexPWM	2/2/2	2/2/2	4/4/4	4/4/4	6/6/6
GP Timer / WDOG	6/4	6/4	6/4	6/4	6/4
High Resolution Timer	0	0	0	0	1
High Speed GPIO	-	-	-	HSGPIO	HSGPIO
Package	LQFP-100	LQFP-100, LQFP-144	BGA-196	BGA-196	BGA-196, BGA-289
Temperature	Consumer: 0C to 95C (Tj) Industrial: -40C to 105C (Tj)	Consumer: 0C to 95C (Tj) Industrial: -40C to 105C (Tj)	Consumer: 0C to 95C (Tj) Industrial: -40C to 105C (Tj)	Consumer: 0C to 95C (Tj) Industrial: -40C to 105C (Tj)	Consumer: 0C to 95C (Tj) Industrial: -40C to 105C (Tj) Automotive: -40C to 125C(Tj)

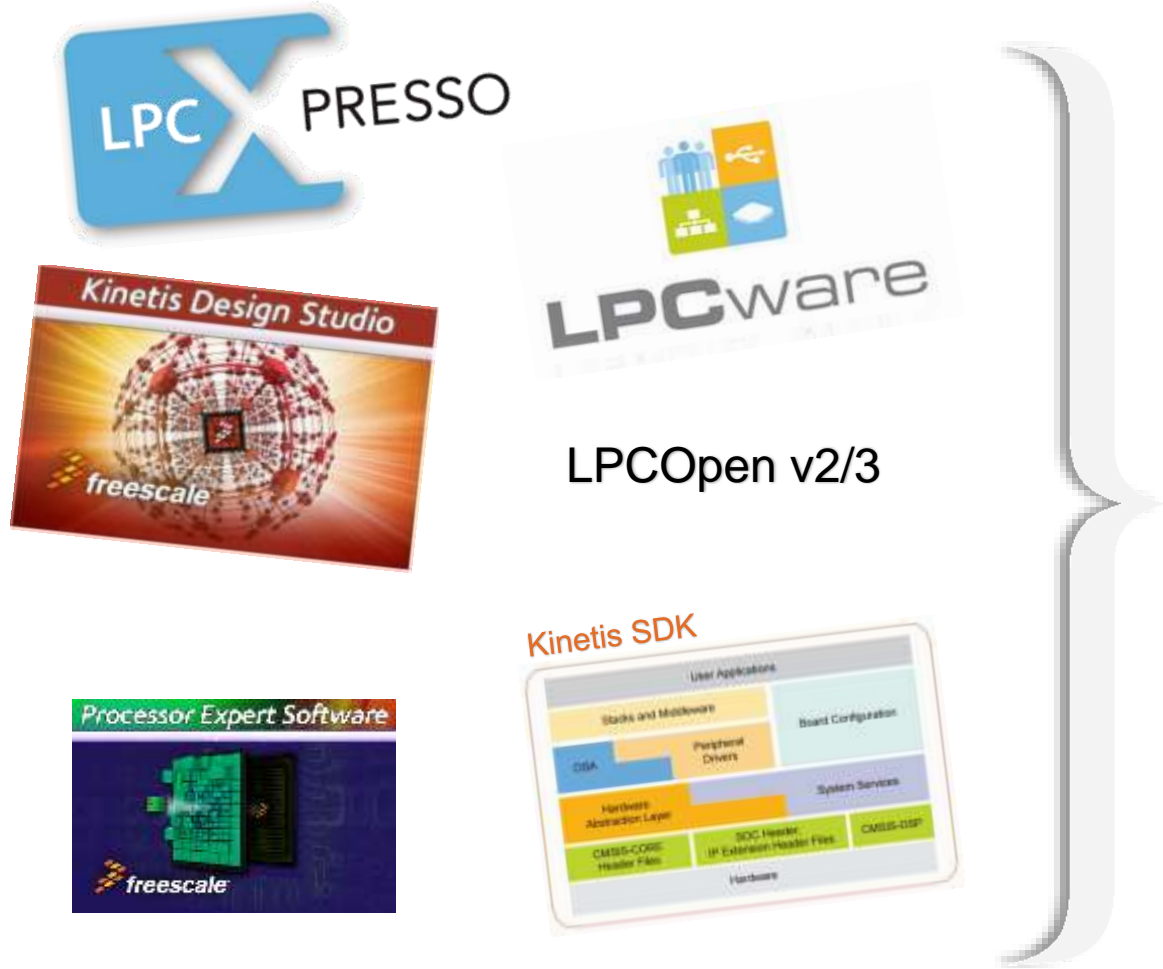
MCUXpresso Config Tools

The new Processor Expert


MCUXpresso Software and Tools Product Marketer



NXP Microcontroller Enablement Consolidation



2015 – 2016




MCUXpresso Software and Tools

- IDE
- SDK
- Config Tools

For NXP Cortex-M controllers

- Kinetis MCUs
- LPC Microcontrollers
- i.MX RT Crossover Processors



The image shows a large rounded rectangle containing the 'MCUXpresso Software and Tools' logo, a list of tool types (IDE, SDK, Config Tools), a list of supported hardware (Kinetis MCUs, LPC Microcontrollers, i.MX RT Crossover Processors), and three icons labeled IDE, SDK, and CFG.

2017-2018

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TOOLS FOR EASY
DEVELOPMENT
WITH NXP MCUs



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MCUXpresso Software and Tools

for LPC & Kinetis MCUs and i.MX RT crossover processors



MCUXpresso IDE

Edit, compile, debug and optimize in an intuitive and powerful IDE



MCUXpresso SDK

Runtime software including peripheral drivers, middleware, RTOS, demos and more



MCUXpresso Config Tools

Online and desktop tool suite for system configuration and optimization



MCUXpresso IDE

Eclipse Framework for C/C++, extendible with many plug-ins

Integrated MCUXpresso Config Tools – Pins, Clocks, Peripherals

Quickstart Panel

Support for SDK and LPCOpen for ARM® Cortex®-M Cores

Combined Development Perspective

Peripheral View

Power Measurement

Advanced Build Steps

Instruction Trace

SWO Trace / Profiling

New Project Wizard

Linker and Memory Configuration

Data Watching

FreeRTOS Kernel Awareness

ARM GCC

ARM GDB

newlib

newlib-nano

RedLib

CMSIS-DAP

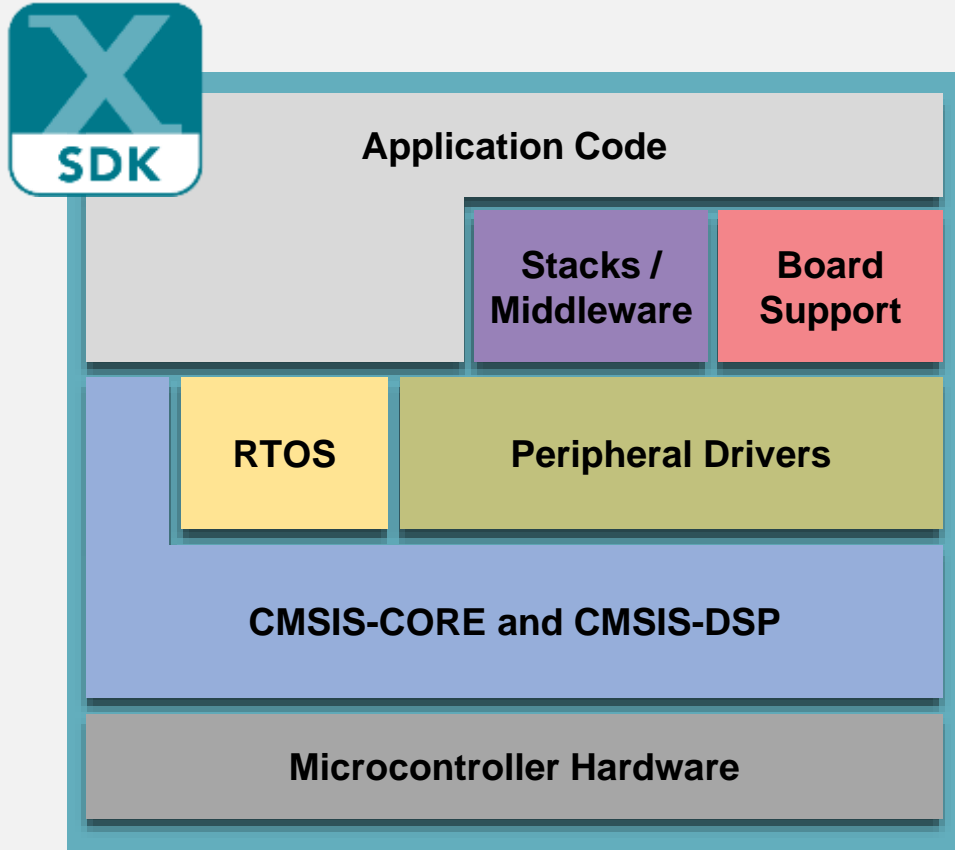
P&E

SEGGER

MCUXpresso IDE

Free Eclipse / GCC-based development

- **Feature-rich, unlimited code size**, optimized for ease-of-use, based on industry standard Eclipse framework for NXP's **Kinetis** and **LPC** MCUs and **i.MX RT** crossover processors
- Application development with Eclipse and GCC-based IDE for advanced editing, compiling and debugging
- Supports custom development boards, Freedom, Tower and LPCXpresso boards with debug probes from NXP, P&E and Segger
- **Free:** Full Featured, unlimited Code Size, no special activation needed, community based support, advanced trace capabilities, MTB and ETB instruction trace
- Works in conjunction with **MCUXpresso Config Tools** and **MCUXpresso SDK** to provide complete development environment



MCUXpresso SDK

Software framework and drivers

Architecture:

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

Reference Software:

- Peripheral driver usage examples
- Application demos
- FreeRTOS usage demos
- AWS WiFi and lwIP examples

License:

- Clear BSD 3-clause for startup, drivers, USB stack

Integrated RTOS:

- Amazon FreeRTOS
- RTOS-native driver wrappers

Toolchains:

- MCUXpresso IDE
- IAR®, ARM® Keil®, GCC w/ Cmake

Integrated Stacks and Middleware:

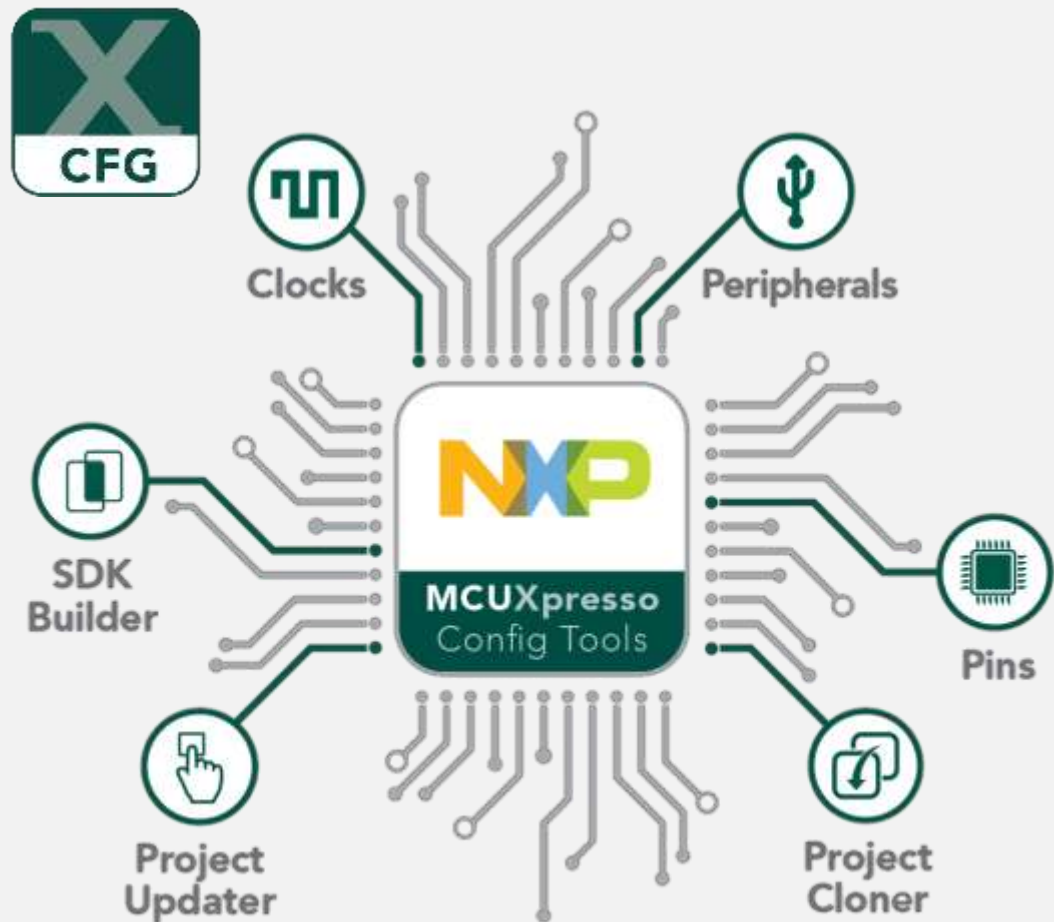
- USB Host, Device and OTG
- lwIP, FatFS, LittleFS
- Crypto acceleration plus wolfSSL & mbedTLS
- SD and eMMC card support

Quality:

- Production-grade software
- MISRA 2004 compliance
- Checked with Coverity® static analysis tools



Open Source Initiative



MCUXpresso Config Tools

Configuration and Code Generation



SDK Builder packages custom SDKs based on user selections of MCU, evaluation board, and optional software components.



Pins, Clocks, and **Peripheral** tools generate initialization C code for custom board support. Features validation of inputs and cross-tool conflict resolution.



Project Update works directly with existing SDK-based IDE projects with generated Pins, Clocks, and Peripheral source files.



Project Cloning creates a standalone SDK project based on an example application available within SDK release.

From PEX to Config Tools



What happened to Processor Expert?

- Processor Expert provided a graphical user interface to aid in the generation of **Logical Device Drivers** (LDD) as a Hardware Abstraction Layer to supported devices.
- The LDD components were then organized as needed into higher level **peripheral/software components**.
- Processor Expert provided **code generation** of the LDD and **validation** rules to ensure user specified values were within valid settings given other configured settings.

MCUXpresso SDK – New Software Architecture

- MCUXpresso SDK provided a new software architecture with:
 - ARM and DSP standard libraries
 - CMSIS-compliant device header files (for direct peripheral access)
 - **Peripheral Drivers** with stateless, high-performance, ease-of-use APIs
 - Higher-level **transactional APIs** for communication peripherals
 - Support for FreeRTOS, with **native RTOS driver** support
 - **Stacks and Middleware** (provided by NXP and external providers)
 - **Consistence API** across multiple NXP portfolios: Kinetis, LPC, i.MX RT
- Software enablement no longer has a reliance on computer-generated LDDs

MCUXpresso SDK – Required enablement

- SDK Peripheral Drivers
 - provides a consistent API with complete peripheral coverage for devices supported with the MCUXpresso SDK
- What are the expected challenges faces by customers?
 - Clock Configuration and Pin Muxing were identified as the most concerning efforts
- MCUXpresso Config Tools – Current implementation
 - Pin Tool
 - Support for Pin Muxing, functional groups, electrical properties
 - New support for basic GPIO initialization (majority of devices supported as of v4.1)
 - Clock Tool
 - Support for Clock Configuration with visual clock diagram, tooltip hints, and nearest value calculations
 - Peripheral Tool
 - Support for most common peripheral on key devices, support SDK peripheral driver initialization structure
 - Top priority focused on i.MX RT with additional rollout plan for additional Kinetis and LPC devices throughout 2018

MCUXpresso CONFIG TOOL



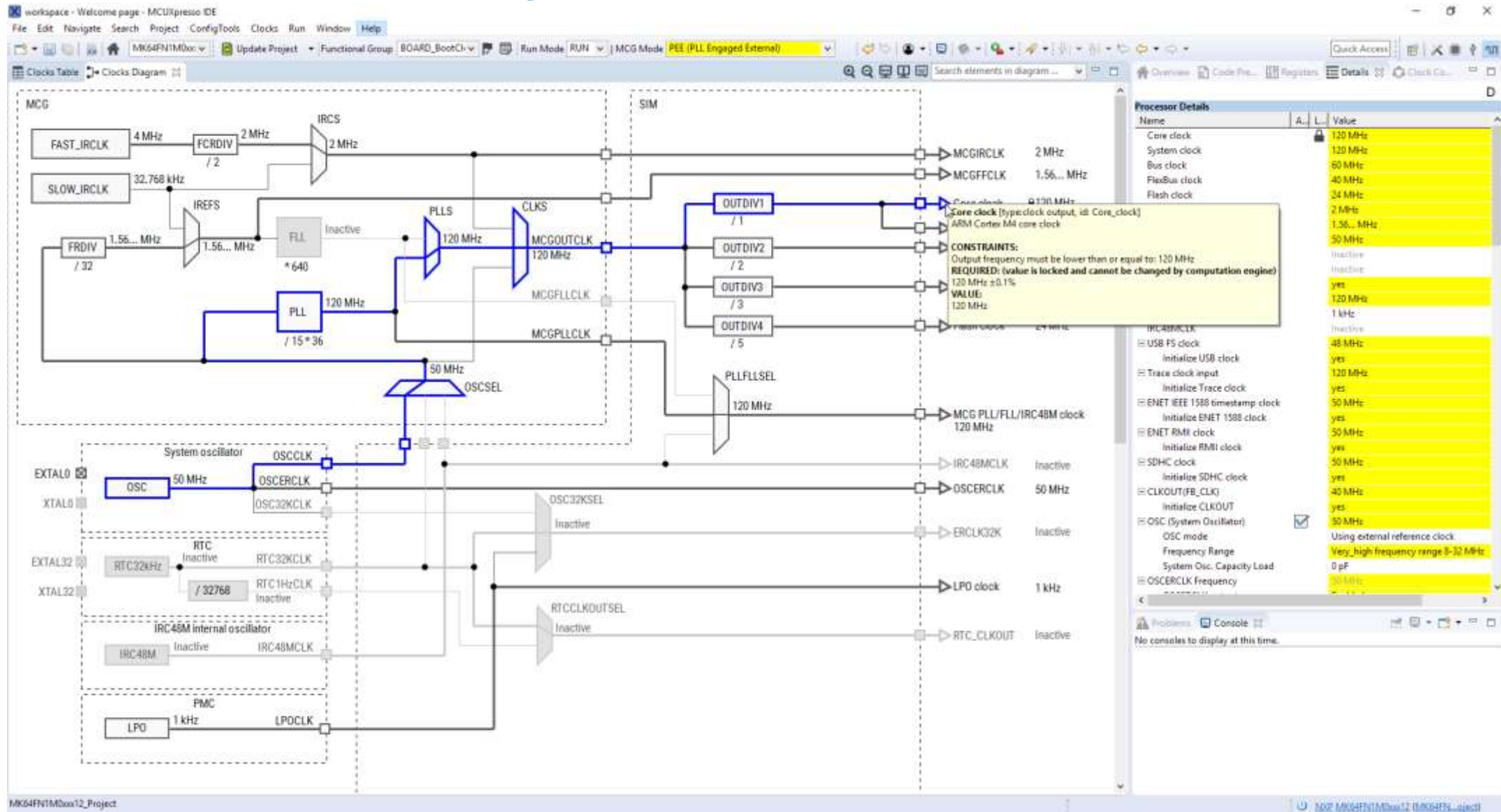
MCUXpresso Config Tool - Pins

The screenshot displays the MCUXpresso Config Tool interface for configuring pins on a MK64FN1M0VLL12-LQFP 100 package. The main window is divided into several panes:

- Pins Table:** A table listing pins with columns for Pin, Pin name, Label, Identifier, GPIO, UART, FTM, and ADC. Pins 1 through 64 are listed, with various peripheral functions assigned to them.
- Peripheral LPTMR0 Dialog:** A dialog box titled "Peripheral LPTMR0" showing "All LPTMR0 signals for routing". It lists three signal alternatives:
 - ALT_0 = CMP0_output
 - ALT_1 = [51] XTAL0/PTA19/FTM1_FLT0/FTM_CLKIN1
 - ALT_2 = [77] PTCS/LLWU_P9/SPI0_SCK/LPTMR0_ALT2
 A tooltip for "Signal ALT_0" provides details: "Pulse counter input pin 0; Digital Input; features: interrupt, wakeup, dedicated". A note states "Routed after reset pins / signal routes: CMP0_output". Buttons for "Route All", "Unroute All", and "Done" are visible.
- Routed Pins Table:** A table showing the results of the routing process. It includes columns for Peripheral, Signal, Route to, Label, Identifier, Direction, GPIO initial state, GPIO interrupt, Slew rate, Open drain, Drive strength, Pull select, Pull enable, Passive filter, and Digital filter.

Peripheral	Signal	Route to	Label	Identifier	Direction	GPIO initial state	GPIO interrupt	Slew rate	Open drain	Drive strength	Pull select	Pull enable	Passive filter	Digital filter
GPIOB	GPIO_21	PTB21	D12[3]/LEDRGB_BLUE	LED_BLUE	Output	Logical 1	n/a	Slow	Disabled	Low	Pulldown	Disabled	Disabled	n/a
GPIOB	GPIO_22	PTB22	D12[1]/LEDRGB_RED	LED_RED	Output	Logical 1	n/a	Slow	Disabled	Low	Pulldown	Disabled	Disabled	n/a
GPIOE	GPIO_26	PTE26	J2[1]/D12[4]/LEDRGB_GREEN	LED_GREEN	Output	Logical 1	n/a	Slow	Disabled	Low	Pulldown	Disabled	Disabled	n/a
- Problems Panel:** A panel on the right side of the interface showing a list of issues, with columns for Level, Issue, and Origin. It is currently empty.

MCUXpresso Config Tool - Clocks



MCUXpresso Config Tool - Peripherals

The screenshot displays the MCUXpresso Config Tool interface for configuring the LPTMR_1 peripheral. The interface is divided into several panes:

- Peripherals List:** A list of peripherals with checkboxes. LPTMR0 and PIT are checked, with LPTMR_1 and PIT_1 listed in the 'Used in' column.
- Configuration Panel:** Shows settings for LPTMR_1, including Mode (General), Peripheral (LPTMR0), and General LPTMR configuration (Default setting for LPTMR). The LPTMR interrupt is disabled. The LPTMR configuration section includes:
 - Time or pulse counter mode: Time Counter mode
 - LPTMR pulse input per select: ALT_0 = CMP0_output
 - Input per priority: Pulse Counter input source is active-high
 - Free running: Disabled
 - Bypass prescaler/glitch filter: Enabled
 - Clock source: LPO clock - BOARD_BootClockRUN: 1 kHz; BOARD_BootClockVLPB: 1 kHz
 - Clock source frequency: 1 kHz (BOARD_BootClockRUN)
 - Prescaler or glitch filter value: Clock divided by 2, glitch filter disabled
 - Timer period or offset: 1000000 us
 - Resulting input clock frequency: 1 kHz
- Code Preview:** Shows the generated C code for peripherals.c and peripherals.h, including definitions for peripheral ID, clock source frequency, prescaled clock source frequency, timer period, timer period in microseconds, and timer period in ticks.
- Problems/Console:** A table for displaying any issues or console output.

Timer period or offset [type:string, id: timerPeriod]
In free running mode, this property represents offset (delay) between counter overflow and interrupt invocation. The value is lower than interrupt period (defined by timer overflow). Otherwise, the time in this property represents interrupt period. The value can be defined as a period or as a frequency by adding unit (default unit is [us]).
VALUE:
1000000 us

MCUXpresso Config Tools – Overview / Project Update

The image displays the MCUXpresso Config Tools Overview window and the Update Project Files dialog. The Overview window is divided into several sections:

- Configuration - General Info:** Name: MK64FN1M0xxx12_Project.mex, Path: C:\Users\lwa06675\Documents\MCUXpresso IDE 10.2.0_739\workspace\MK64FN1M0xxx12_Project, Description: Configuration imported from MK64FN1M0xxx12_Project.
- Configuration - HW Info:** Processor: MK64FN1M0xxx12, Part number: MK64FN1M0VLL12, Core: Cortex-M4F, Board: FRDM-K64F, SDK Version: ksdk2_0.
- Project:** Project name: MK64FN1M0xxx12_Project, Toolchain: MCUXpresso_IDE, Processor: MK64FN1M0xxx12, Part number: MK64FN1M0VLL12, Core: Cortex-M4F.
- Pins:** Tool for pin routing configuration, including pin functional/electrical properties, power rails, and run-time configurations. (Toggle: ON)
- Clocks:** The Clocks Tool configures the system clock (core, system, bus, and peripheral clocks). (Toggle: ON)
- Peripherals:** The Peripherals Tool configures peripheral initialization. (Toggle: ON)
- Generated code:** Update project code enabled. Files: board.pin_mux.h, board.pin_mux.c, board.clock_config.h, board.clock_config.c, board.peripherals.h, board.peripherals.c.
- Functional groups:** BOARD_InitPins, BOARD_InitButtons, BOARD_InitLEDs, BOARD_InitDEBUG_UART, BOARD_InitOSC, BOARD_InitACCEL, BOARD_InitENET, BOARD_InitSDHC, BOARD_InitUSB.

The Update Project Files dialog shows the following options:

- Pins
 - board\pin_mux.h - no change
 - board\pin_mux.c - no change
- Clocks
 - board\clock_config.c - diff
 - board\clock_config.h - diff
- Peripherals
 - board\peripherals.c - diff
 - board\peripherals.h - diff
- Configuration
 - MK64FN1M0xxx12_Project.mex - modified

The C Compare window shows the differences between the original and newly generated files:

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On disk: board\clock_config.c
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The C Compare Viewer shows the newly generated code for board\clock_config.c, which is identical to the original code in this case.

Options:

- Always show details before Update Project
- Return to 'Debug' perspective after project update

Buttons: OK, Cancel

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MCUXpresso Software and Tools

Download the Config Tools

MCUXpresso IDE: www.nxp.com/mcuxpresso/ide

- Download the MCUXpresso IDE, which includes an integrated version of the Config Tools

The integrated version of the MCUXpresso Config Tools works seamlessly with the MCUXpresso IDE. Allowing IDE project to be updated directly, supporting the addition of MCUXpresso SDK drivers as configured within the Config Tools and taking advantage of the IDE new project creation and SDK project cloning.

Standalone or 3rd Party IDEs: www.nxp.com/mcuxpresso/config

- Download the standalone version of the MCUXpresso Config Tools for use with IAR, Keil, and GCC toolchains

The standalone version of the MCUXpresso Config Tools is designed to support 3rd party IDEs (IAR, KEIL, and CGG toolchains). The standalone Config Tools can clone SDK example projects directly, and can generate a set of configuration files base on an existing IDE project, allowing these projects to be updated directly using the Config Tool code generation. MCUXpresso Config Tools can also be used standalone to generate configuration files that can be used to specific a customer board implementation for use with any support IDE project.

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Additional Resources

Web pages

- MCUXpresso Software and Tools – www.nxp.com/mcuxpresso
 - MCUXpresso SDK: www.nxp.com/mcuxpresso/sdk
 - MCUXpresso IDE: www.nxp.com/mcuxpresso/ide
 - MCUXpresso Config Tools: www.nxp.com/mcuxpresso/config

Communities

- MCUXpresso Software and Tools - <https://community.nxp.com/community/mcuxpresso>
 - MCUXpresso SDK: <https://community.nxp.com/community/mcuxpresso/mcuxpresso-sdk>
 - MCUXpresso IDE: <https://community.nxp.com/community/mcuxpresso/mcuxpresso-ide>
 - MCUXpresso Config Tools: <https://community.nxp.com/community/mcuxpresso/mcuxpresso-config>

Supported Devices

- [Supported Devices Table \(Community Doc\)](#)

SDK Differences

- We are using hardware with previous revision of silicon and EVK board desing.
- Currently shipping EVK**B** (**latest silicon**)
- EVK uses SDK_2.x_EVK-MIMXRT1050 (2.3.0)
- EVK**B** uses SDK_2.x_EVK**B**-IMXRT1050 (2.4.2)

- There are more examples, full MCUXpresso Support (lwIP, emWin,..), Default target is flash, support for i.MXRT105x derivatives and new silicon, etc..

LAB 1



Lab 1

- This lab will use MIMXRT1050-EVK and iMX RT SDK2.3 for MCUXpresso 10.2.xx “Hello world” demo example to run the application from different memory targets – TCMs, SDRAM and HyperFLASH

LAB 2



Lab 2

- This lab demonstrates ***Pin Tool*** used for pin configuration of ***i.MX RT1050 - Hello World Plus Lab***.

LAB 3



Lab 1

- This lab will use MIMXRT1050-EVK and a new iMXRT1050 lwip_httpsrv demo example to demonstrate the usage of the new crossover i.mx-RT family in a wired networking application. Lwip is part of the optional middleware the users can find in the MCUXpresso SDK.



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