

# I.MX RT 'CROSSOVER' PROCESSOR OVERVIEW

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HIGH-END MICROPROCESSORS

JULY 2018



SECURE CONNECTIONS  
FOR A SMARTER WORLD

PUBLIC

## i.MX

### APPLICATIONS PROCESSORS

- ARM® Cortex® -A class and Cortex® -M cores
- 600 MHz to 2 GHz performance
- Thousands of applications
- 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



APPLICATIONS PROCESSOR



PERFORMANCE + INTEGRATION



**CROSSOVER PROCESSORS**

EASE OF USE + REAL TIME

MICROCONTROLLER



**i.MX RT**

CROSSOVER PROCESSORS

- ARM® Cortex-M cores
- Over 600 MHz performance
- Deterministic instructions
- Short latency
- Easy to use tools
- RTOS support



MCUXpresso

RTOS

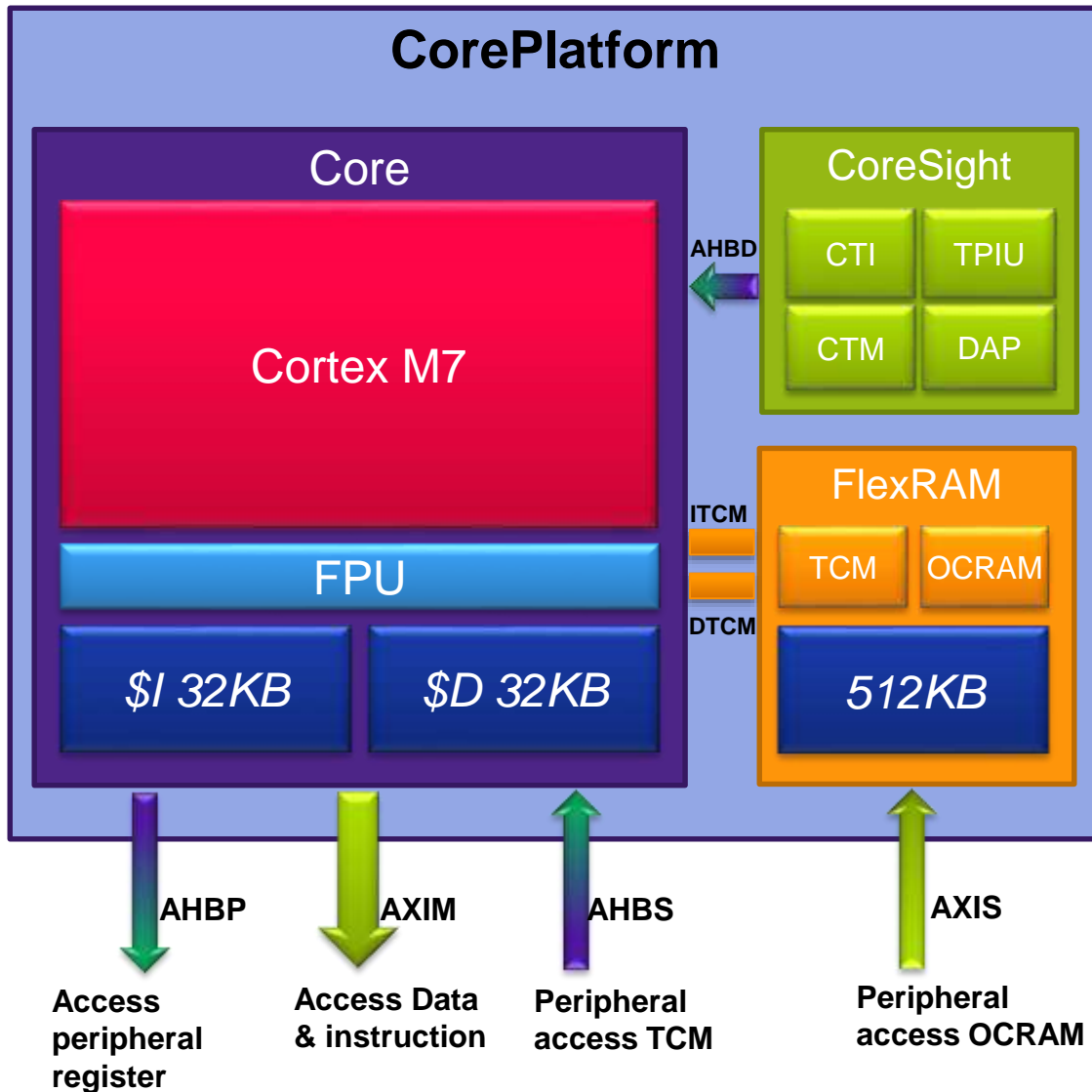


# ARM® Cortex® -M7 Key Features



- High-performance processor with DSP capabilities.
  - **6-stage, superscalar pipeline**
  - Dual issue execution for most instructions
  - Powerful **DSP instructions & DP floating point** (in new ARM® VFPv5 module)
- Flexible Memory system
  - **Tightly coupled memories** for real-time determinism, 64-bit bus to *Text*, 2x32-bit to Data
  - **64b AXI memory interface** with I-cache and D-cache and multiple outstanding transfers
- Continuum of Cortex-M series
  - **100% binary forward compatibility** from Cortex-M4.
- Safety features
  - MPU

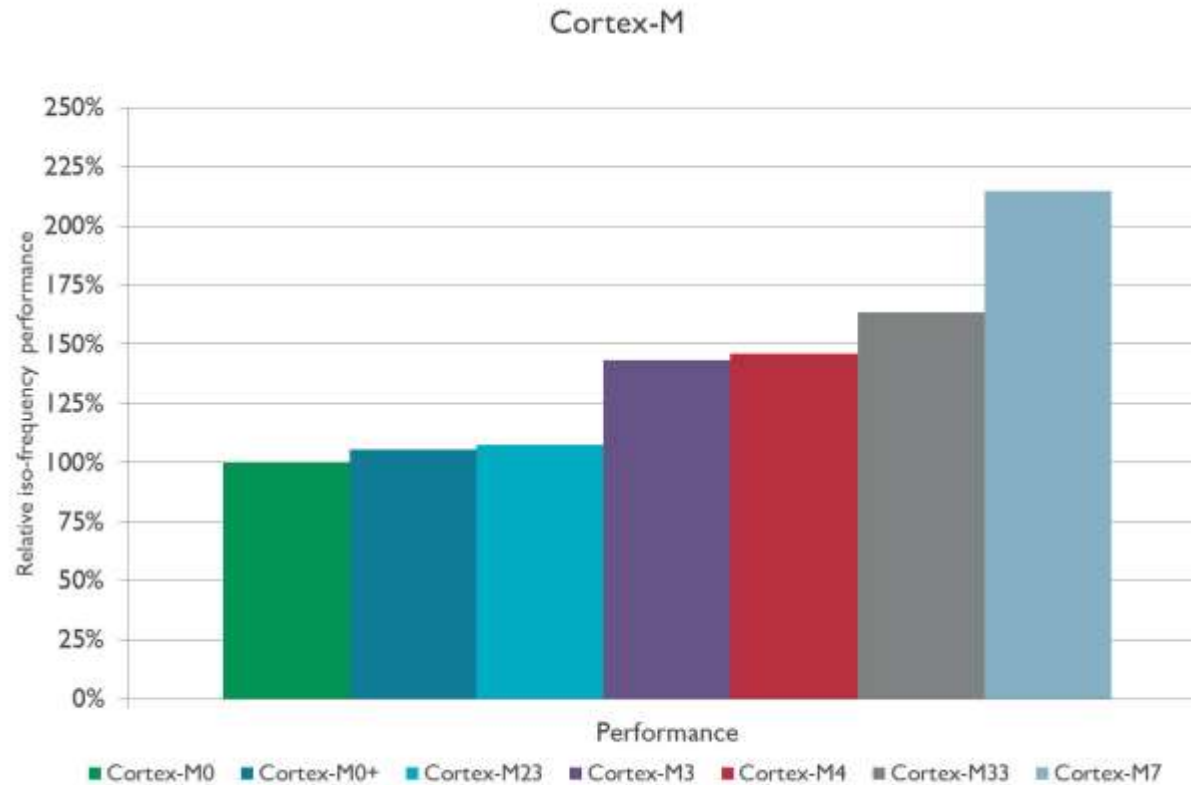
# Cortex<sup>®</sup>-M7 CPU Platform



- 32 KB L1 Instruction Cache
- 32 KB L1 Data Cache
- 512KB TCM and OCRAM shared SRAM
- Floating Point Unit (FPU) with support of the VFPv5 architecture for Double Precision
- Integrated Nested Vector Interrupt Controller (NVIC)
- Separate AMBA AXI/AHB bus connection architecture – high efficiency & low latency
- Cortex<sup>®</sup> M7 debug architecture that complies with the CoreSight debug/trace architecture

# Cortex<sup>®</sup>-M7

## Highest Performance Microcontroller

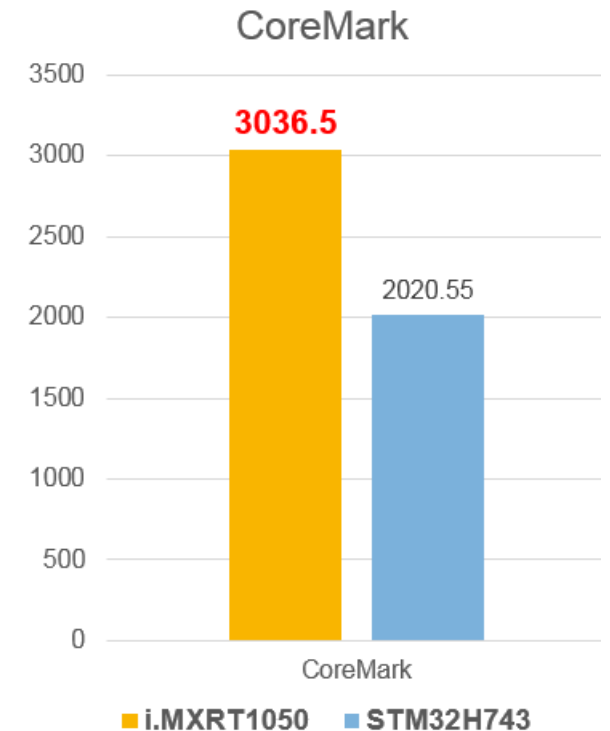


<http://www.arm.com/-/media/arm-com/products/processors/Cortex-M-series-performance-graph.jpg?la=en>

# Measured CoreMark

```
COM29 - Tera Term VT
File Edit Setup Control Window Help
CoreMark starting with CACHES...
2K performance run parameters for coremark.
CoreMark Size      : 666
Total ticks       : 198812148
Total time (secs) : 13.254143
Iterations/Sec    : 3017.924237
Iterations        : 40000
Compiler version  : IAR 7.80
Compiler flags    : -high -speed -no size constraints
Memory location   : STACK
seedcrc          : 0xe9f5
[0]crclist       : 0xe714
[0]crcmatrix     : 0x1fd7
[0]crcstate      : 0x8e3a
[0]crcfinal      : 0x25b5
Correct operation validated. See readme.txt for run and reporting rules.
CoreMark 1.0 : 3017.924237 / IAR 7.80 -high -speed -no size constraints / STACK
Core clock frequency (MHz): 600.000000
CoreMark 1.0 per MHz: 5.029874
```

## CoreMark



# i.MX RT1050 – Launch Device, Key Highlights



## High Performance Real-Time Processing

- Cortex<sup>®</sup>-M7 up to 600MHz (50% faster than current existing M7 products)
- 20ns interrupt latency
- Up to 512KB Tightly Couple Memory



## Low BOM Cost

- Competitive Pricing
- Fully integrated PMIC with DC-DC
- Low cost package, 10x10 BGA, enabling 4 Layer PCB design
- SDRAM interface



## High level of Integration

- High Security enabled by AES-128, HAB and On-the-fly QSPI Flash Decryption
- 2D graphics acceleration engine
- Parallel camera sensor interface
- LCD display controller up to WXGA (1366x768) (\*)
- Audio interface with three I2S for multichannel high performance audio



## Easy to Use

- MCU customers can leveraging their current toolchain (MCUXpresso, IAR, Keil)
- Rapid and easy prototyping and development with NXP FreeRTOS, SDK, ARM mbed and the global ARM ecosystem
- Single voltage input simplifies power circuit design
- Scalability to Kinetis & i.MX products



# Reduced Systems-level Costs for Customers with i.MX RT Series



## Lower Bill-of-Materials cost

- Large internal SRAM removes the need for external DRAM
- Low cost package options enable 2-layer or 4-layer PCB designs
- Integrated PMIC with DC-DC
  - Lowest active power consumption among all Cortex-M7 based processors

## Lower cost of programming with off-chip memories

- Faster programming speeds with external serial flash due to simplicity of direct programming
  - 2MB external NOR **can be up to 60% faster** to program than MCUs with 2MB embedded flash
- Lower set-up and handling costs with i.MX RT
  - Lower pin count and homogeneity of external flash suppliers simplifies programming house logistics
  - Eliminates set-up & handling costs of complex high-pin count MCUs & vendor variability of MCUs
- Secure external storage enabled by On-the-fly decryption (AES-128)



# i.MX RT1050 Overview

## Specifications

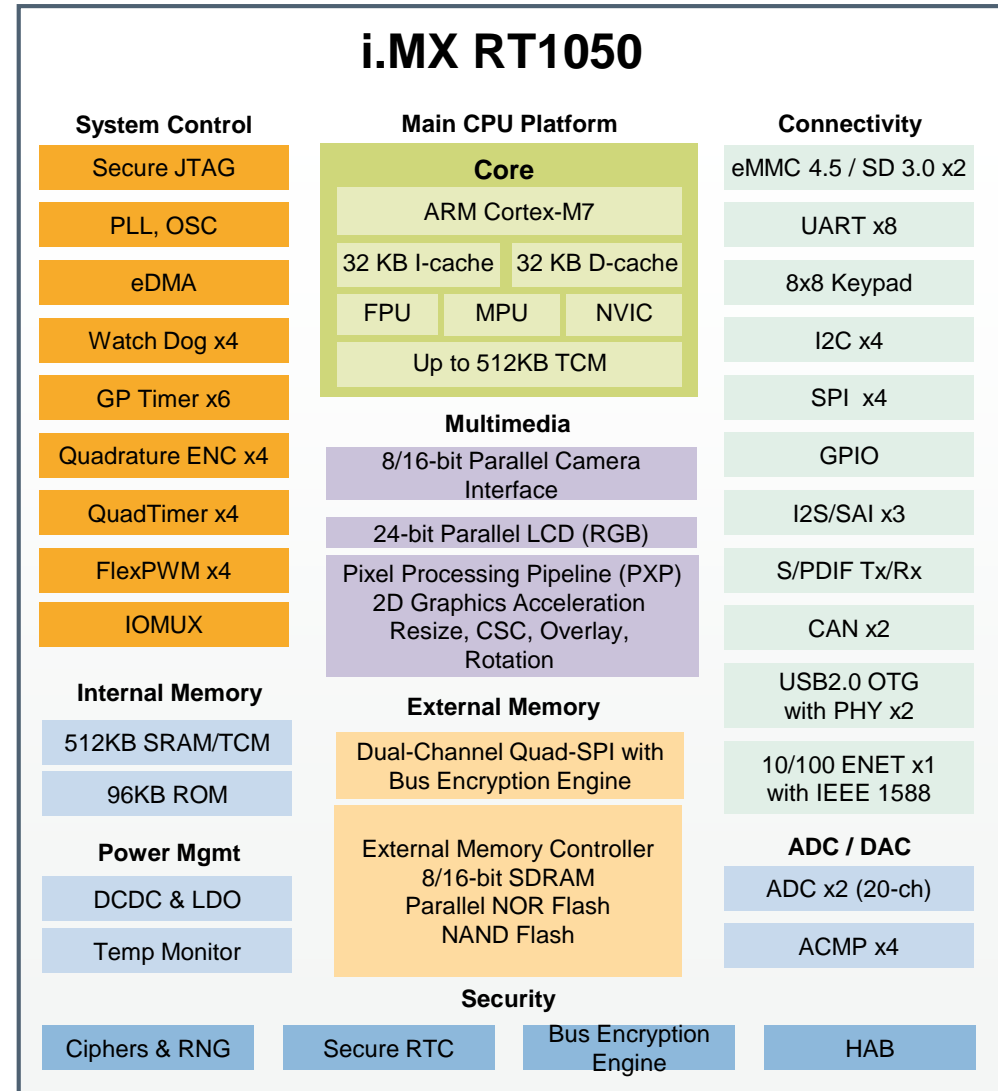
- Package: MAPBGA196 | 10x10mm<sup>2</sup>, 0.65mm pitch (130 GPIOs)
- Temp / Qual: -40 to 105°C (Tj) Industrial / -40 to 95°C (Tj) Consumer

## Key Features and Advantages

- ARM® **Cortex®-M7** processor, **600MHz**
  - 32KB I-Cache, 32KB D-Cache
  - 512KB Tightly Coupled Memory (TCM) shared with on-chip SRAM
- 8/16-bit SDRAM controller, 8/16-bit Parallel NOR FLASH / PSRAM
- Dual-channel Quad-SPI NOR FLASH
- Parallel LCD Display up to WXGA (1366x768)
- 8/16-bit Parallel Camera Sensor Interface
- Pixel Processing Pipeline (PXP) - 2D Graphics Acceleration
- 2x eMMC 4.5/SD 3.0/SDIO Port
- 2x USB 2.0 OTG, HS/FS, Device or Host with PHY
- Audio: 3x I2S/SAI, 1x S/PDIF Tx/Rx
- 1x 10/100 Ethernet with IEEE 1588
- 2x 12-bit ADC, up to 20 input channels total, 4x Analog comparators
- 4x Quadrature Encoder, 4x Quadtimer and 4x FlexPWM
- Full PMU Integration, DCDC+LDOs
- Security: TRNG, Crypto AES-128, High Assurance Boot (HAB), Bus Encryption Engine

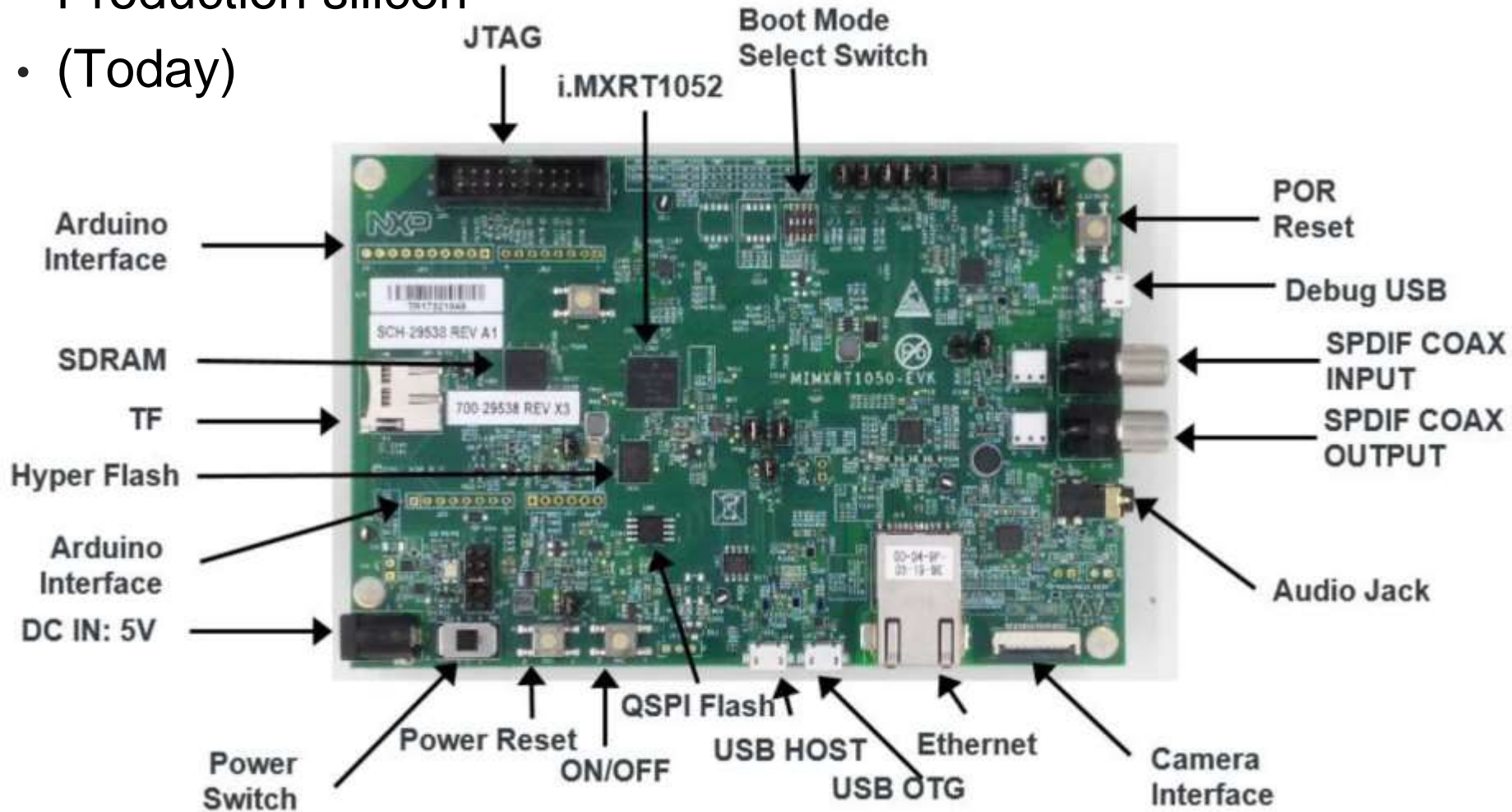
## Enablement

- MCUXpresso
- FreeRTOS with SDK



# IMXRT1050-EVKB

- Production silicon
- (Today)





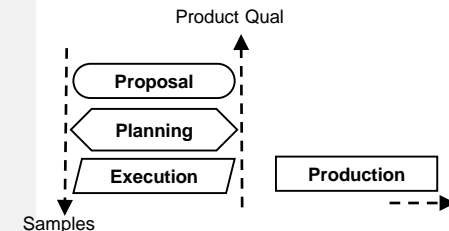
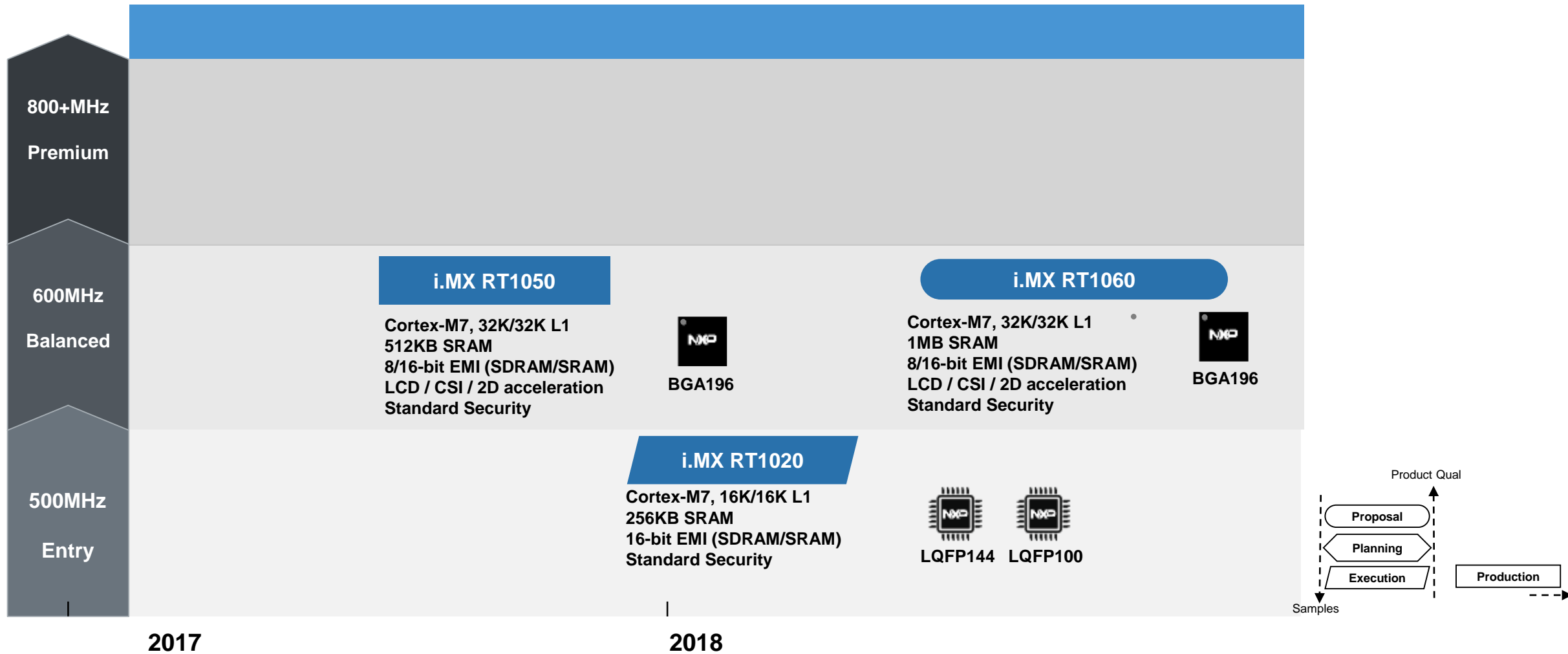
# Strength in Product Longevity

## i.MX RT1050: 10-year program

- NXP (both NXP LPC and former Freescale) have longstanding track records of **providing long-term production support** for our products
- NXP has a **formal product longevity program** for the market segments we serve
  - For the automotive and medical segments, NXP will make a broad range of solutions available for a minimum of **15 years**
  - For all other market segments in which NXP participates, NXP will make a broad range of solutions available for a minimum of **10 years**
  - **Life cycles** begin at the time of launch
  - Includes NXP's standard end-of-life notification policy
- For a complete list of participating products, visit, [nxp.com/productlongevity](http://nxp.com/productlongevity)



# i.MX RT1000 Roadmap



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



196BGA, 10x10  
196BGA, 12x12



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,
- 196BGA, 12x12, 0.8p

## RT1020

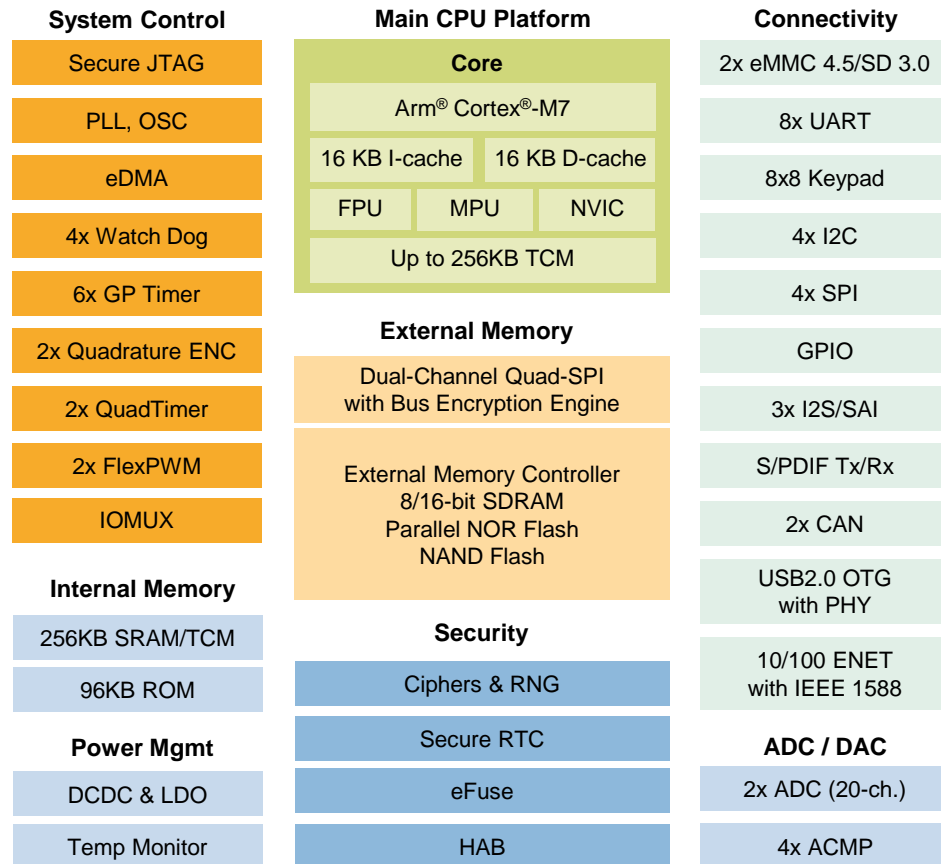
Cortex®-M7 up to **500MHz**  
**16KB/16KB** I/D Cache  
**256KB** SRAM / TCM  
**2x** Flex PWM, **2x** Quad Timer, **2x** ENC  
**1x** HS USB, 2x SDIO, 2x CAN, 1x ENET  
8x UART, 4x SPI, 4x I2C  
Qual-SPI interface  
External Memory Controller (SDRAM, NOR, NAND)  
3x SAI/ SPDIF RX & TX/ 1x ESAI  
2x 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

- 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 RT1020 - From RT1050 to Low Cost LQFP Solutions



196BGA, 10x10  
196BGA, 12x12



196BGA, 10x10  
196BGA, 12x12

## 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
- 196BGA, 12x12, 0.8p

## RT1060

Cortex®-M7 up to 600MHz  
32KB/32KB I/D Cache  
512KB SRAM / TCM, **512KB OGRAM**  
4x Flex PWM, 4x Quad Timer, 4x ENC  
2x HS USB, 2x SDIO, 2x CAN, **1 x CAN FD, 2 x ENET**  
8x UART, 4x SPI, 4x I2C  
**2 x** 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
- 196BGA, 12x12, 0.8p

Red indicates change from RT1050



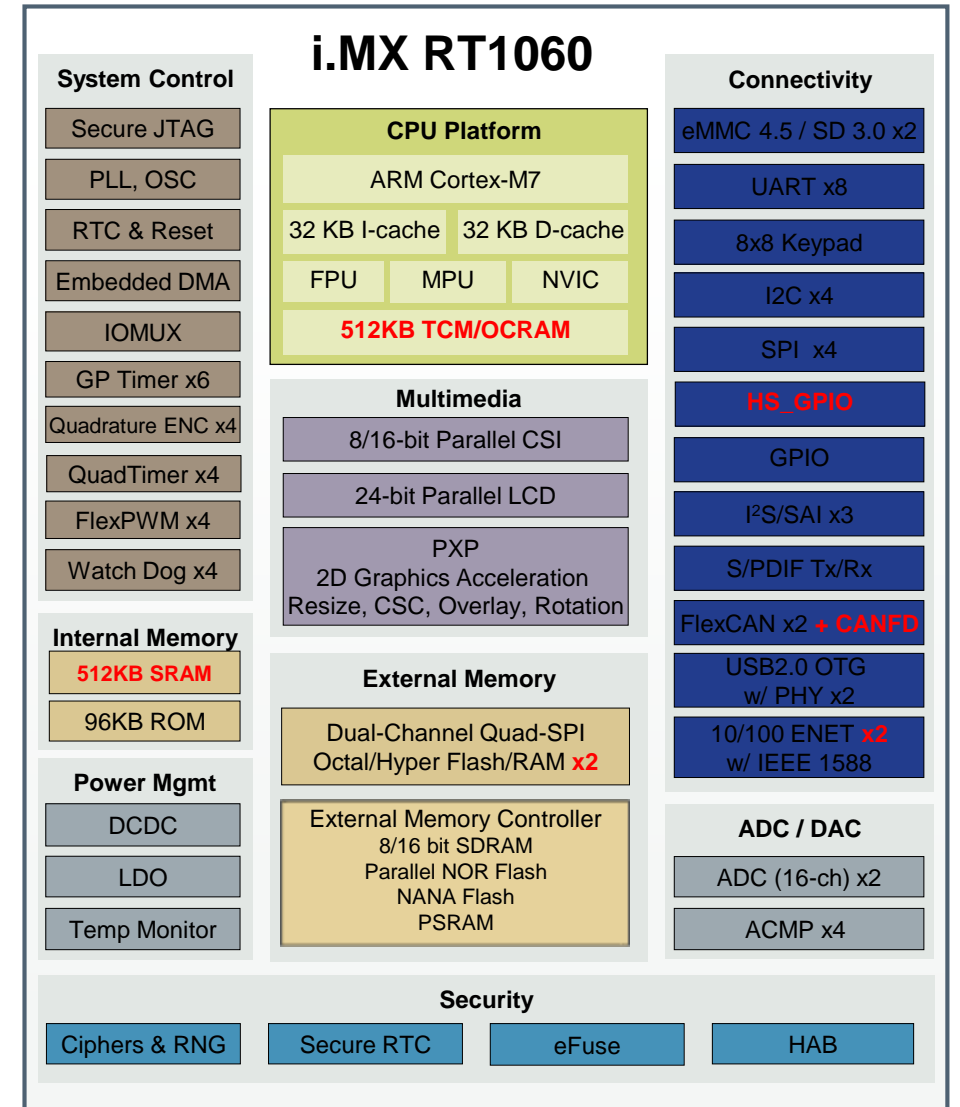
# i.MX RT1060 Overview

## • 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 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



# RT Status Summary i.MX NPI status

NPI	Description	Engineering Samples	Mass Production
i.MX RT1020	ARM® Cortex®-M7, up to 500MHz, 256K SRAM/TCM, Connectivity, Motor Control, 20x20 (.5) 144, 14x14(.5)100 LQFP	February 2018	June 2018 (100 LQFP) October 2018 (144 LQFP)
i.MX RT1050	ARM® Cortex®-M7, up to 600MHz, 512K SRAM/TCM, 2D Graphic, Connectivity, Motor Control, 10x10 (.65) 196 MAPBGA	Now r1.1(0.65mm pitch) July 2018 r1.1 (0.8mm pitch)	Now r1.0 (0.65mm pitch) April r1.1(65mm pitch) October r1.1 (0.8mm pitch)



# Enablement

# MCUXpresso Software & Tools — Products

## Software Development Kit (SDK)



- The software framework and reference for application development with NXP's MCUs based on ARM® Cortex®-M cores
- Includes production-grade software with integrated RTOS, integrated stacks and middleware, reference software, and more
- Highest quality with MISRA compliance on all drivers; checked with Coverity® static analysis tools
- Available in custom downloads based on user selections of MCU, evaluation board, and optional software components

## Integrated Development Environment (IDE)



- Offers edit, compile, debug, and many more tools with an intuitive and powerful interface
- Brings “best of” legacy IDEs (LPCXpresso and Kinetis® Design Studio) together, including GNU tool integration and library, multicore capable debugger, as well as trace functionality
- Debug connections that support all Freedom, Tower®, and LPCXpresso development boards plus industry leading commercial debug probes

## System Configuration Tools



- Integrated configuration and development tools for Kinetis, LPC and i.MX products
- A suite of evaluation and configuration tools that helps guide users from first evaluation to production software development
- Includes SDK builder, power estimator, pins and clocks tools (with peripherals and power analyzer tools coming in 2017)
- Available in online and desktop versions

# MCUXpresso SDK



The software framework and reference for Kinetis & LPC MCU application development

## Product Features

### Architecture:

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

### Integrated RTOS:

- FreeRTOS v9
- RTOS-native driver wrappers

### Integrated Stacks and Middleware

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

### Reference Software:

- Peripheral driver usage examples
- Application demos
- FreeRTOS usage demos

### License:

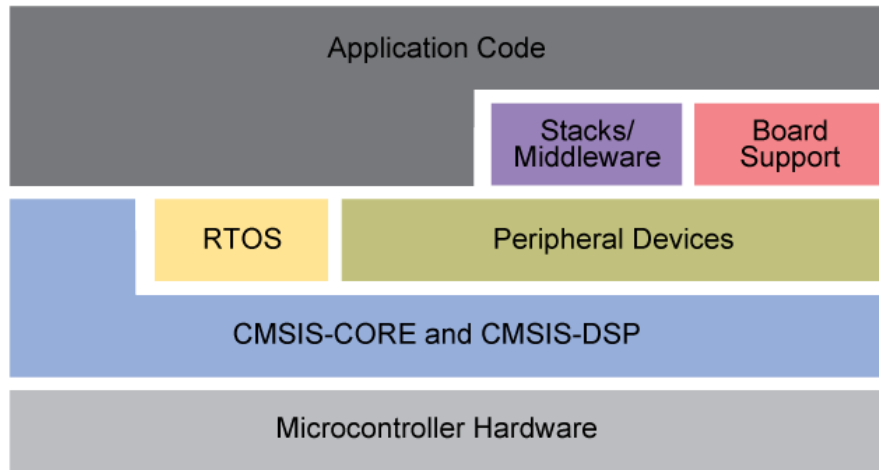
- BSD 3-clause for startup, drivers, USB stack

### Toolchains:

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

### Quality

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

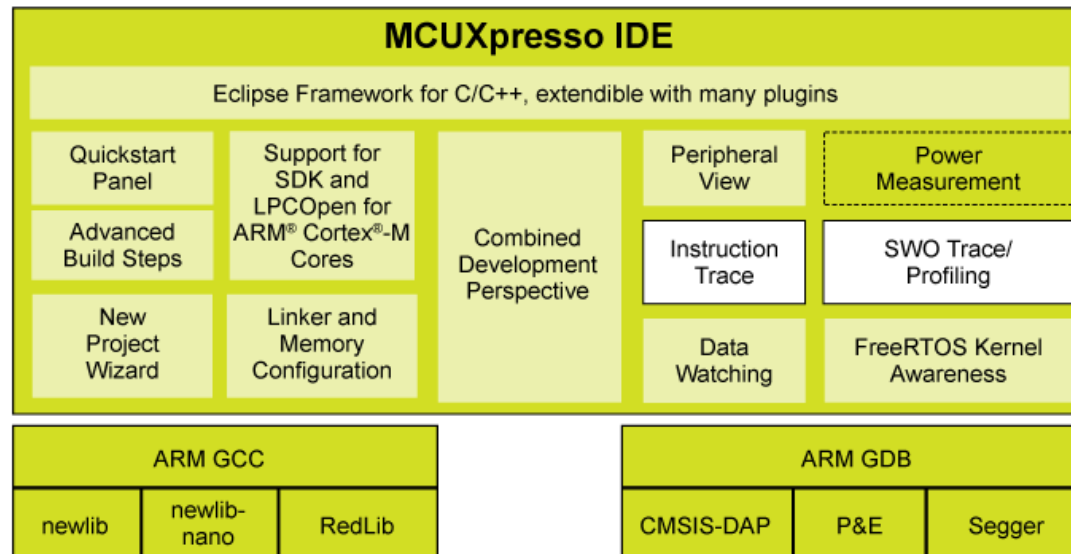


# MCUXpresso IDE



Free Eclipse and GCC-based Integrated Development Environment (IDE) for C/C++ development on Kinetis and LPC MCUs

MCUXpresso BLOCK DIAGRAM



 For supported boards     With supported probes



## Product Features:

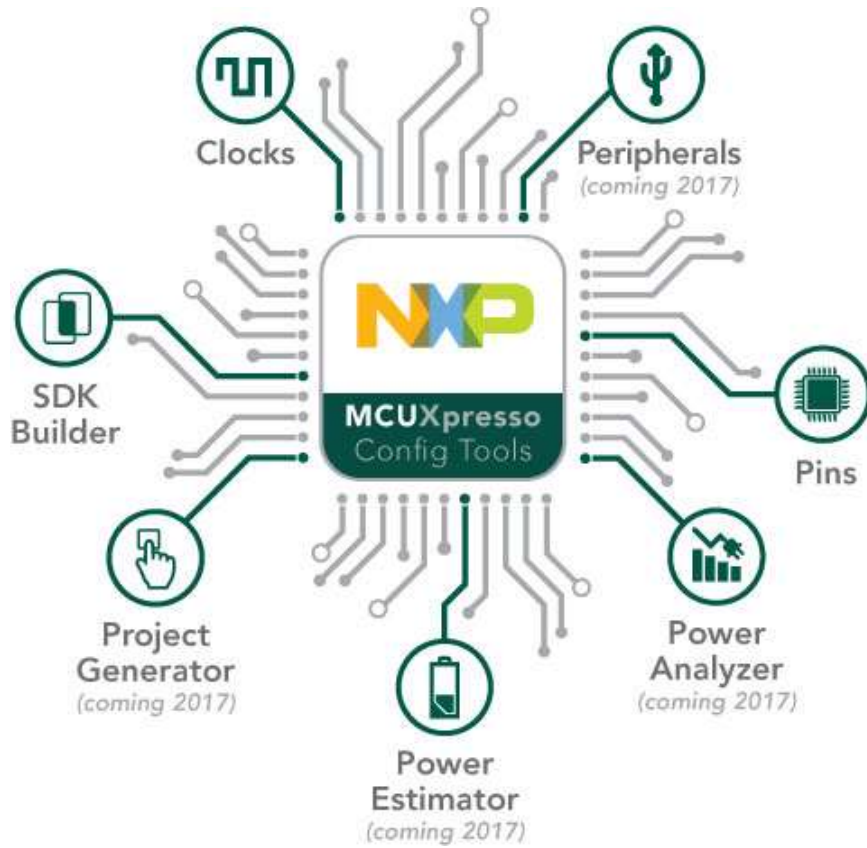
- A free-of-charge, code size unlimited IDE
- Eclipse platform plus many ease-of-use improvements for MCU application development and optimization
- GNU toolchain with a choice of an optimized C library or the standard GNU Newlib/Nano library
- Support for LPC Cortex-M MCUs, as per LPCXpresso IDE v8.2
- Support for Kinetis SDKv2 devices, as per KDS v3.2
- Supports LPC and Kinetis MCUs via MCUXpresso SDK
- Support for CMSIS-DAP debug probes, including SW trace via LPC-Link2
- Support for P&E and SEGGER debug probes
- FreeRTOS aware debugging
- Host operating systems:
  - Microsoft® Windows® 7/8/10
  - Linux® (Ubuntu®, Fedora/Redhat, Centos) (64 bit)
  - Mac OS X 10.10 and later
- Pro Edition available for purchase, providing additional features and support entitlement



# MCUXpresso Config Tools



Integrated configuration and development tools for LPC and Kinetis® MCUs



**MCUXpresso Config Tools** is a suite of evaluation and configuration tools that helps guide users from first evaluation to production software development. Available in online and desktop editions.



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



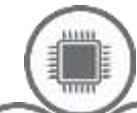
**Project Generator<sup>1</sup>** creates new SDK projects or clones existing ones.



**Power Estimation** tool provides energy and battery-life estimates based on a user's application model



**Power Analyzer<sup>1</sup>** measures and displays energy consumption data



**Pins, Clocks, and Peripheral<sup>1</sup>** tools generate initialization C code for custom board support.



<sup>1</sup>Coming 2017



# RTOS Support

- FreeRTOS
  - NXP Mainline RTOS. Maintained & preintegrated into SDK. Amazon FreeRTOS with AWS components planned.
- MQX v5.x
  - High performance, commercial contract RTOS + IoT Reference Platform integration which allows easy integration of comms protocols like RESTful API, SNMP, email, Lua Scripts etc.
- Zephyr OS
  - Opensource RTOS emerging into market with increasing number of contributors. Hosted as collaborative project with Linux Foundation. Pre-integrates key connectivity blocks, middleware in modular framework.
- uCLinux
  - BSP integrated and managed by emCraft



# Optimized GUI for i.MX RT

Provider / Product	Type	Language	GUI builder tools	Business model	RTOS required?
Crank /Story Board	Library + API	C / C++	Yes	Developer seats, volume based product line license	Optional (any)
Draupner / TouchGFX	Library + API	C++	Yes	Free developer tools, volume based product line license	Recommended (any)
MicroEJ	Library + API	C/C++ / Java	Yes	Developer seat licenses, volume based licenses	Yes (MicroEJ)
SEGGER / emWIN	Library + API	C	Yes	Free/no royalty object (via NXP), per product source license available from SEGGER	Optional (any)
TARA / Embedded Wizard	Source code generator	C / Javascript	Yes	Developer seats, volume based product line license	Optional (any)

# MIMXRT1050 Development Platform Key Features

**Part Numbers:** MIMXRT1050-EVKB (\$79)  
**Display (4.3”):** RK043FN02H-CT (\$29)

## Processor

- NXP Semiconductors MIMXRT1052DVL6A  
600MHz ARM® Cortex® -M7

## Memory

- 256 Mbit SDRAM memory
- 512Mbit Hyper Flash
- Footprint for QSPI Flash
- TF socket for SD card

## Display

- Parallel LCD connector
- Camera Connector

## Audio

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

## Connectivity

- Micro USB Host connector
- Micro USB OTG connector
- Ethernet (10/100T) connector
- CAN Transceivers
- ARDUINO interface

## Debug

- JTAG connector
- On board DAP-Link debugger

## Sensor

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

## Tools & OS Support

- IAR, MDK
- SDK with FreeRTOS

## Others

- All in one board design
- 4 layer through hole PCB



# i.MX RT SOM Partners

## Embedded Artists

- Distributors:
  - Future, Digi-key, Mouser
- <http://www.embeddedartists.com>
- [http://www.embeddedartists.com/products/oem/imxrt1052\\_oem.php](http://www.embeddedartists.com/products/oem/imxrt1052_oem.php)
- [http://www.embeddedartists.com/products/kits/imxrt1052\\_kit.php](http://www.embeddedartists.com/products/kits/imxrt1052_kit.php)

### i.MX RT1050 Developer's Kit

- Separate Carrier Board (updated design from existing)
- Support LCD
  - 4.3", 5" and 7", RTC/CTP



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## Future Design Inc

- Distributor:
  - Avnet, Digi-key, Mouser,
- <http://www.teamfdi.com/>

[uEZ® GUI](#), Standalone LCD GUI

[ELI®](#) , Easy LCD Interface

These product families are “off-the-shelf” solutions for quick and cost effective upgrades to user interfaces

# MIMXRT1020 Development Platform

## – Real 2 Layer PCB Design

**Part Numbers:** MIMXRT1020-EVK (\$49)

### Processor

- NXP Semiconductors MIMXRT1021DAG4A  
**500MHz ARM Cortex-M7, 144LQFP**

### Memory

- 256 Mbit SDRAM memory
- 512Mbit Hyper Flash
- Footprint for QSPI Flash
- TF socket for SD card

### Audio

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

### Connectivity

- Micro USB OTG connector
- Ethernet (10/100T) connector
- CAN Transceivers
- 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 RT1050 App Notes

- How to enable Boot from QuadSPI
- Boot from HyperFlash & SD Card
- Developing Camera Applications
- Power consumption & measurement
- How to use iMX RT Low Power Features
- Migration Guide from 6ULL to RT
- Migration Guide from Kinetis to RT
- Using Multi Channel features of SAI
- Measuring Interrupt Latency
- Using L1 Cache
- Using FlexRAM

# i.MX RT Enablement Overview

## 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:

## Software Development Tools

IDE / Toolchains:

## Hardware Development Tools

Evaluation Kits:

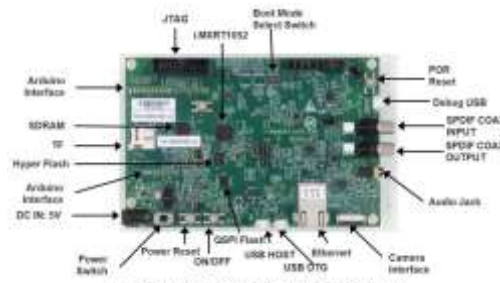


Figure 2. Overview of the MMRT1000 EVK Board (Front side)

Partner Solutions

## Application Specific

- Graphics
- Touch HMI
- Camera interface
- Motor Control
- Voice activation
- Audio
- Sensor Fusion
- Cloud Connectivity

## Connectivity Solutions

## Support

Broad Market:

- NXP Community
- Solution Designs
- Application Notes
- Schematics

High Touch:

- Professional Support
- Professional Services

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

Industry leading IDE support and intuitive software configuration tools to accelerate application development

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

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

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



SECURE CONNECTIONS  
FOR A SMARTER WORLD