최신 MCU 기술 동향 및 프리스케일 Kinetis 로드맵

프리스케일 심한섭 부장

SEP15.2015

freescale™

External Use

Agenda

- 시장 동향
- MCU 개발 환경 변화
- Kinetis MCU의 종류와 특징

시장 동향

MCU 개발 환경의 변화

Today's market expects **increased performance** and **functionality**, **smarter peripherals**, **integrated HMI** and improved **power efficiency**. However, product advancements are not enough; software is critical to success. **Freescale understands this requirement and is delivering** to help customers bring innovative applications to market in record time.

Kinetis MCU

ARM Cortex-M0+ Core
Up to 48MHz, 1.77 CoreMark/MHz, 2-Stage Pipeline, 1-Cycle GPIO, Micro Trace Buffer

ARM Cortex-M4 Core
50-180MHz, 3.40 CoreMark/MHz, HW-divide, MAC, DSP-commands, FPU option

Differentiators
Low-power, Performance, Flex-Memory, Mixed-Signal, Security, HMI Features

Special Functions
Analog Pre-Processing, 24b-Sigma Delta ADC, sub -1GHz & 2.4 GHz Transceiver

Enablement

Freescale Bundle

Hardware
Freedom board, Tower Platform

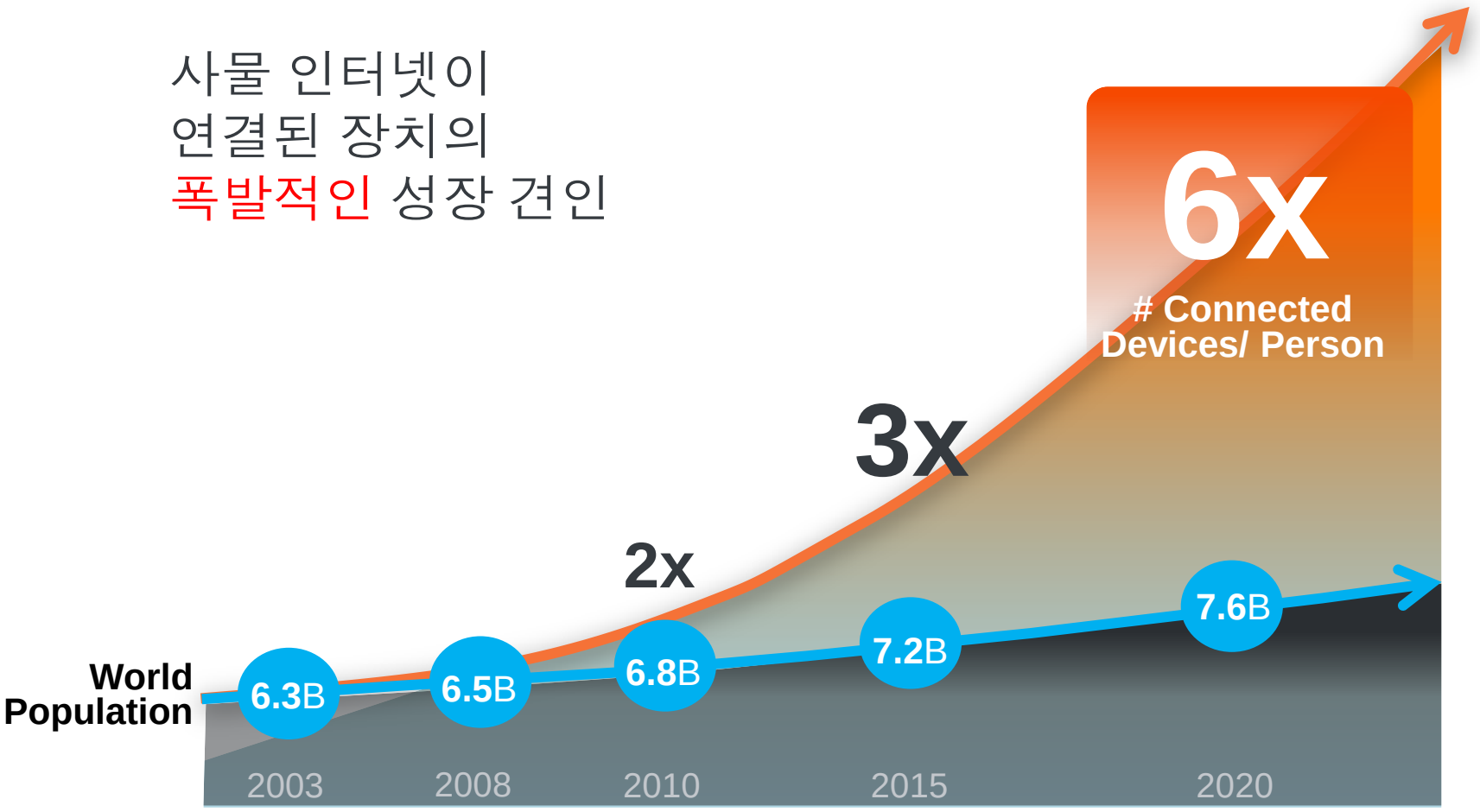
Software
CodeWarrior, Processor Expert, Driver Suite, eGUI, PEG, FreeMASTER

RTOS
MQX, MQX Lite

ARM Eco System

IoT (사물 인터넷)시장

사물 인터넷이
연결된 장치의
폭발적인 성장 견인

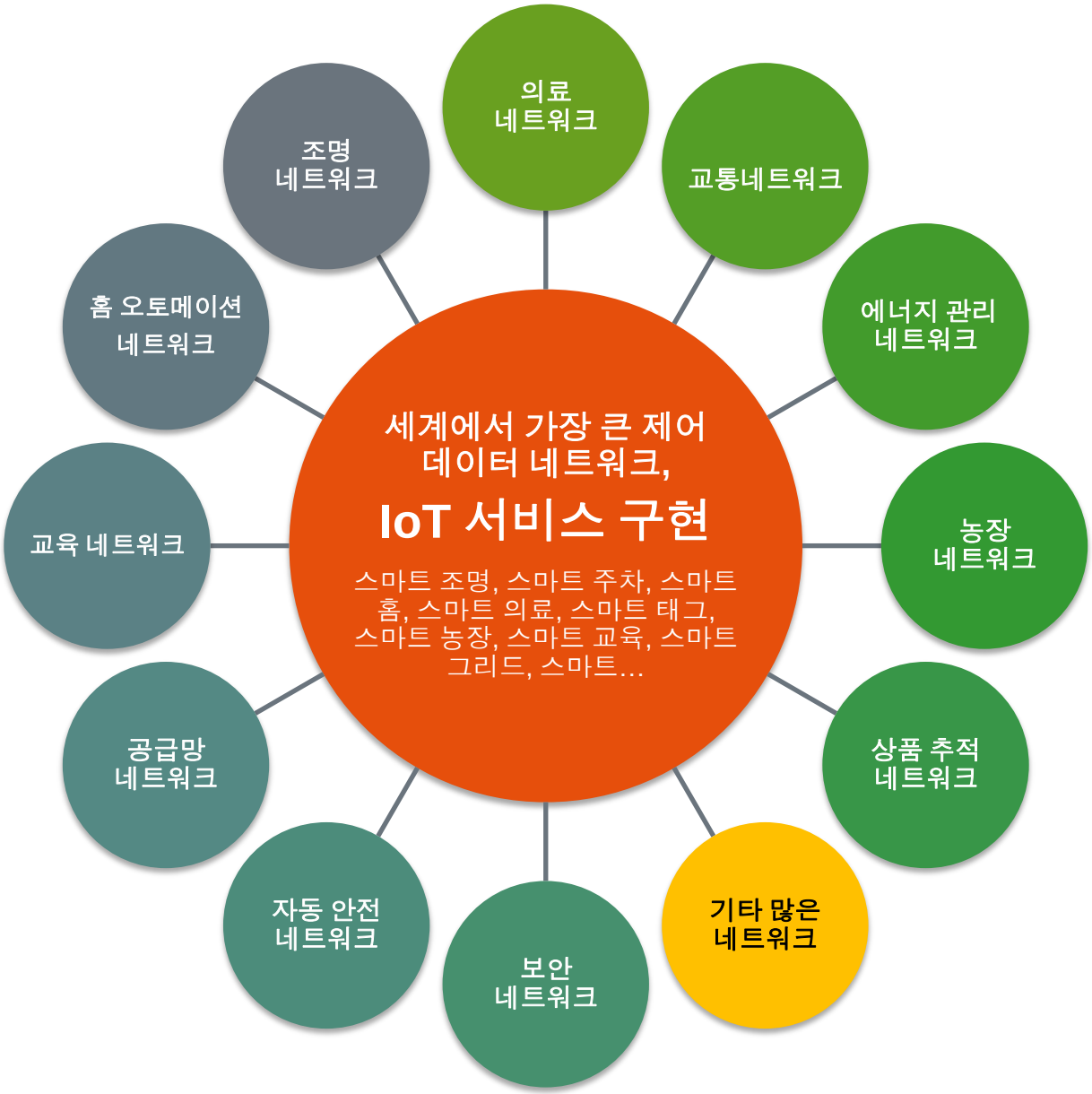


사물 인터넷

모든 네트워크의 네트워크 -
세계 최대의 제어 데이터
네트워크를 통해 연결됨

핵심은 서비스 계층 인프라.

핵심은 서비스,
서비스에 맞는 확장성과 보안



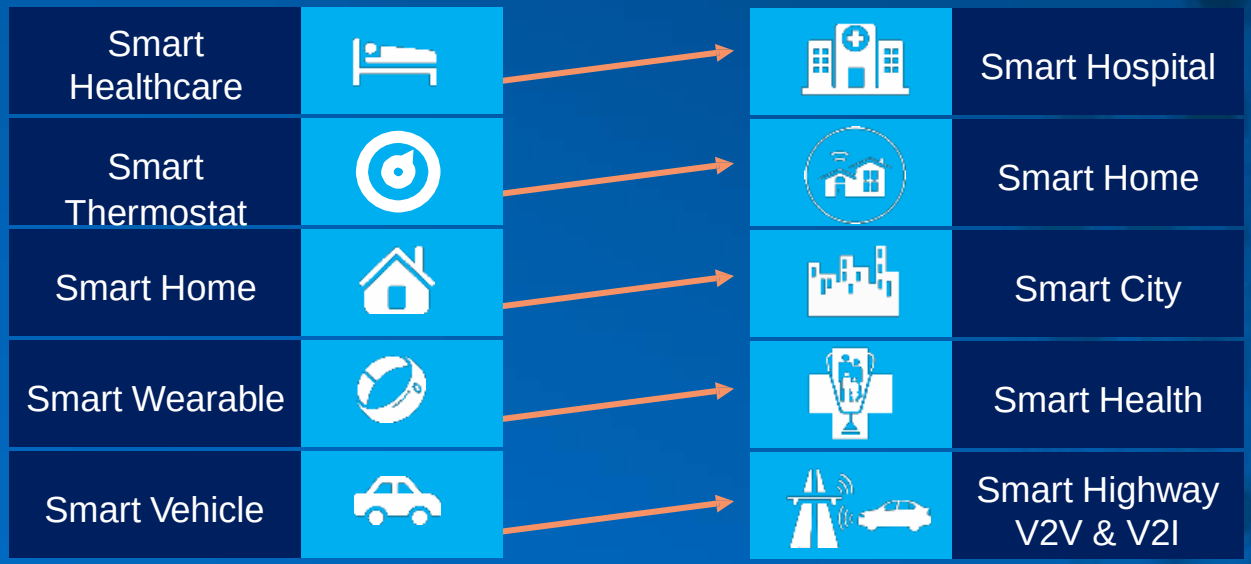
IoT 구조

End Node

Energy Efficient
Optimum Performance
Highly Integrated

Secure
Small Form Factor
Cost-Effective

Scalable Solutions



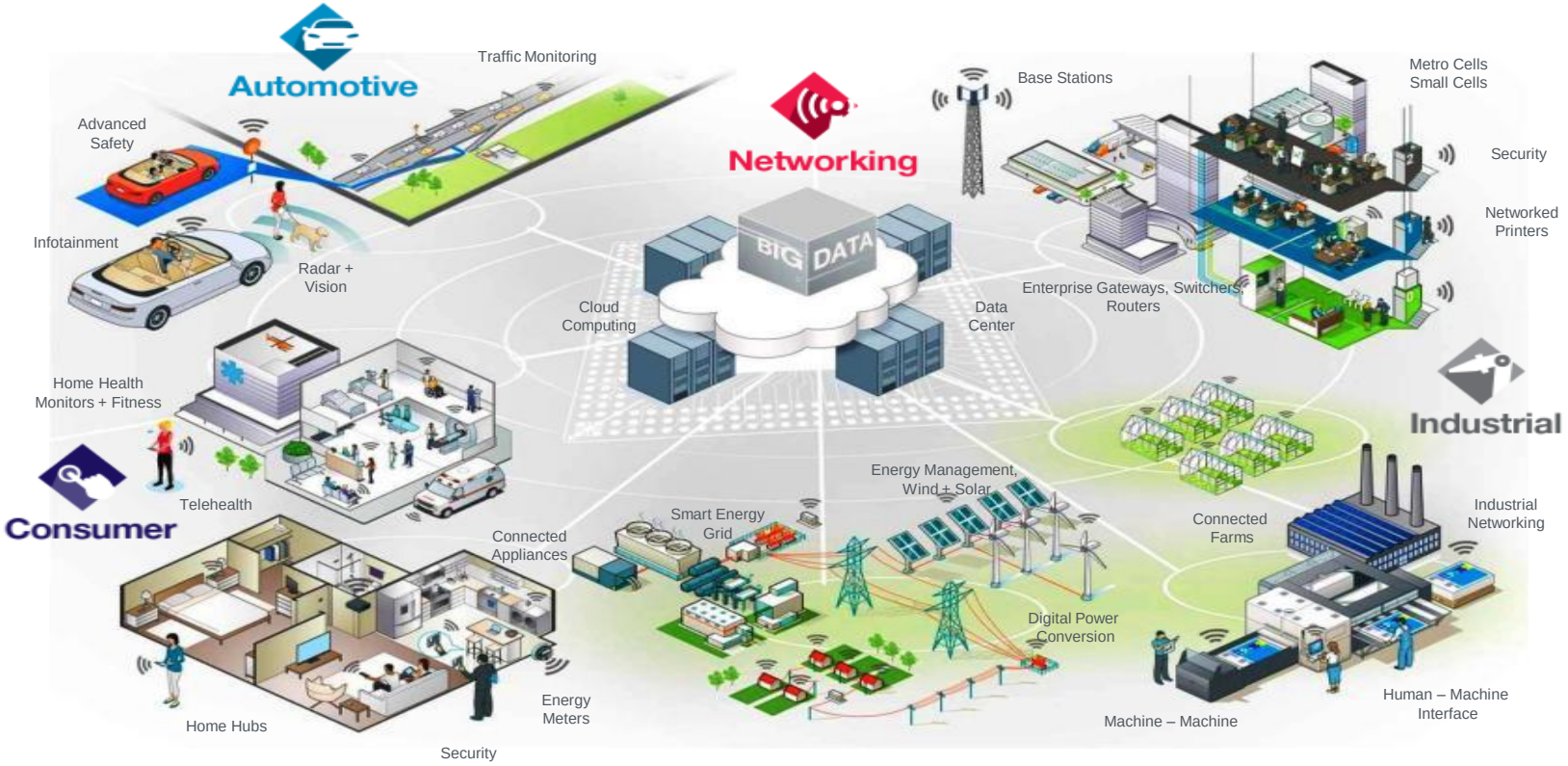
SCALABLE SOLUTIONS

Sensors – Analog – MCU – RF – Applications Processors – Networking Processors

Increasing Complexity of Data Collection, Handling & Processing

Our Products Power The Internet of Things

Microcontrollers | Digital Networking | Auto MCU | Analog and Sensors | RF



IoT 애플리케이션을 지원하기 위한 가장 폭넓은 포트폴리오

프리스케일은 다른 어떤 공급업체보다 더 많은 시장에서 활동

- 업계에서 가장 폭넓은 ARM 기반 제품 포트폴리오
- 제품 포트폴리오 내에서 세계적인 수준의 확장성과 유연성
- 사물간 인터넷(IoT)의 개발 수요에 맞는 제품
- 프리스케일 센서로 지원됨

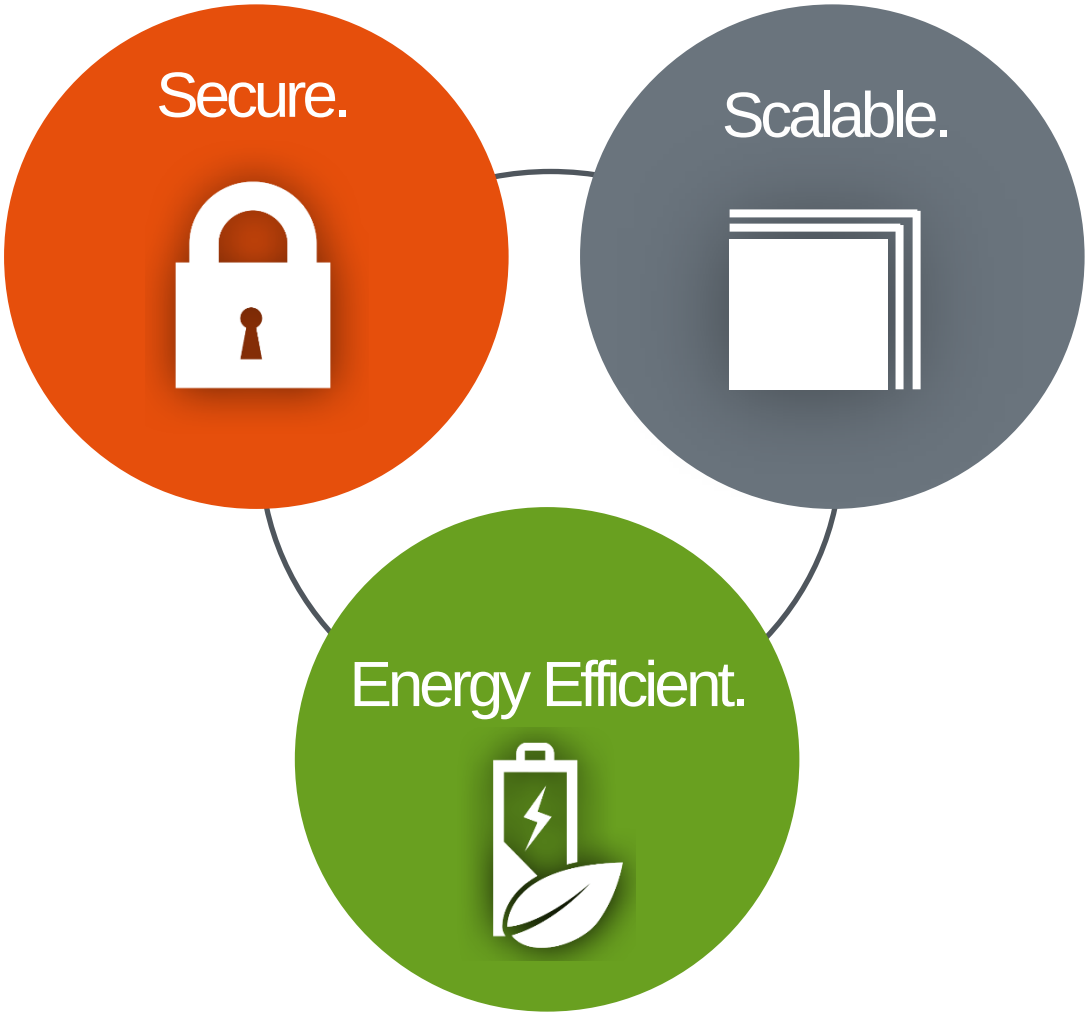
웨어러블 디바이스

착용하는 제품으로 감지, 연결 및 데이터 처리를 통해 사용자 환경을 강화하는 제품

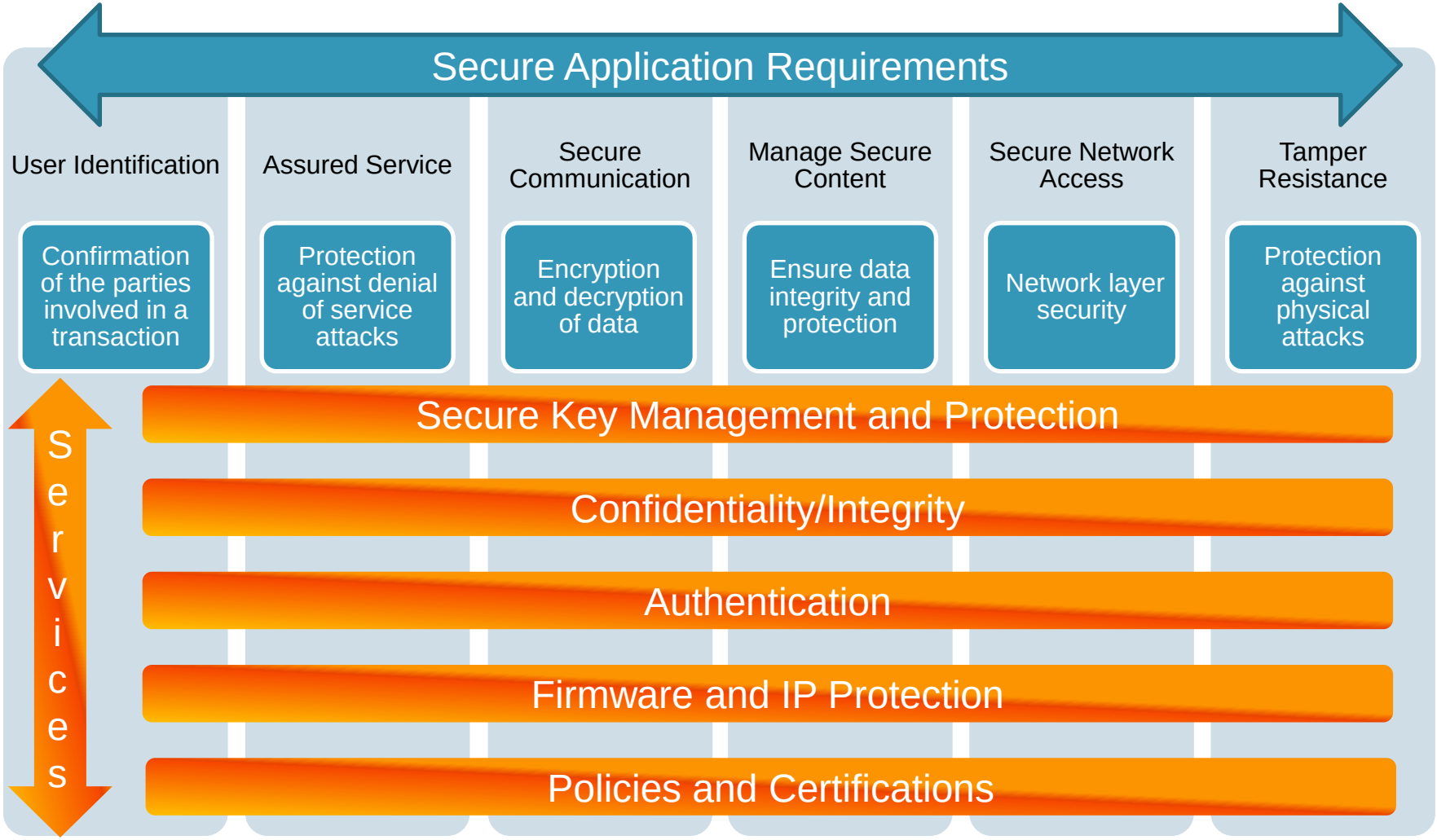
착용형 제품의 주요 기술 시장 동향:

- 초소형화
- 저전력
- 무선 연결 기술
- 여러 센서

시장 변화에 따른 MCU 선정 시 고려 사항



Needs of a Secure Embedded Application



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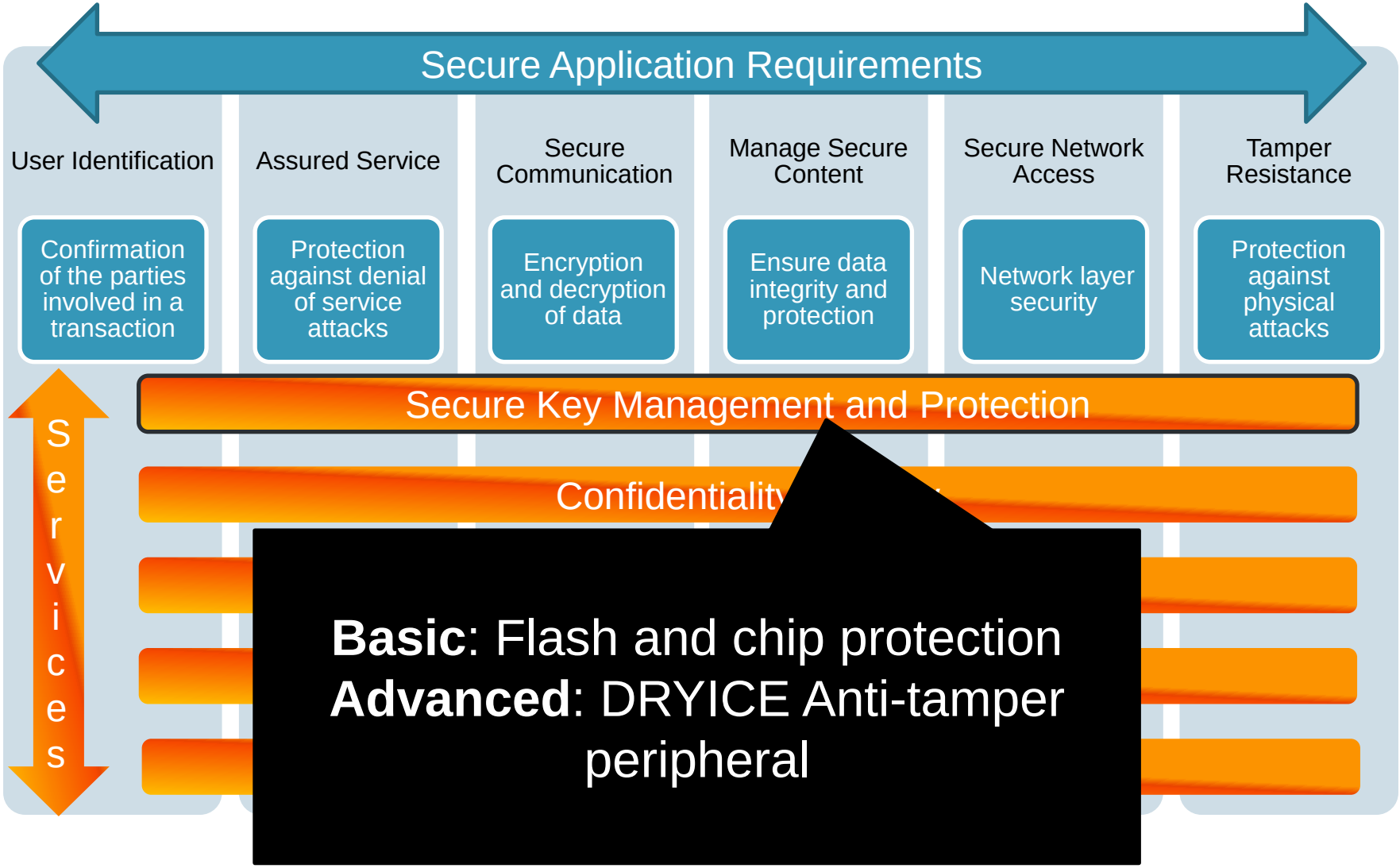

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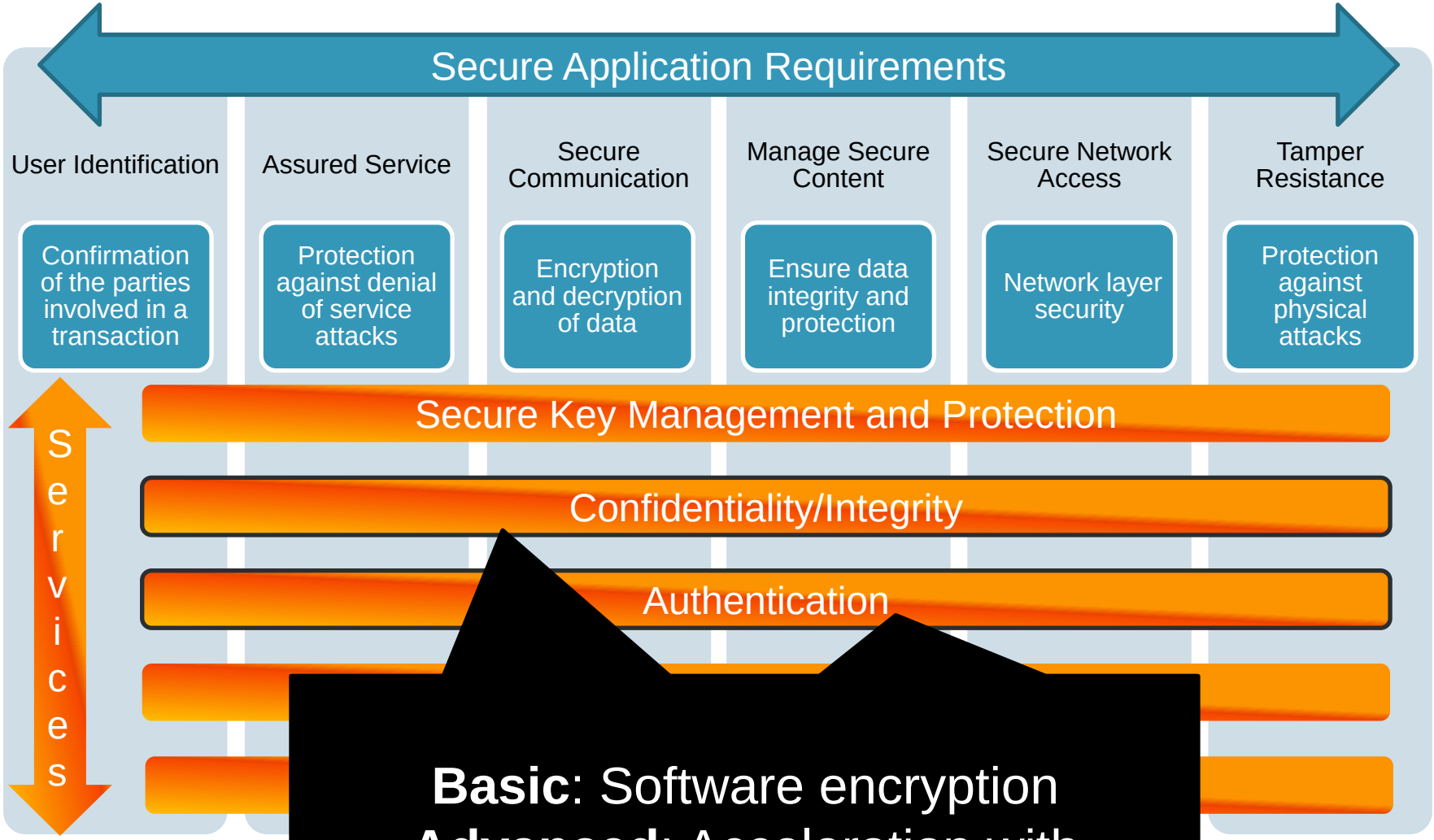

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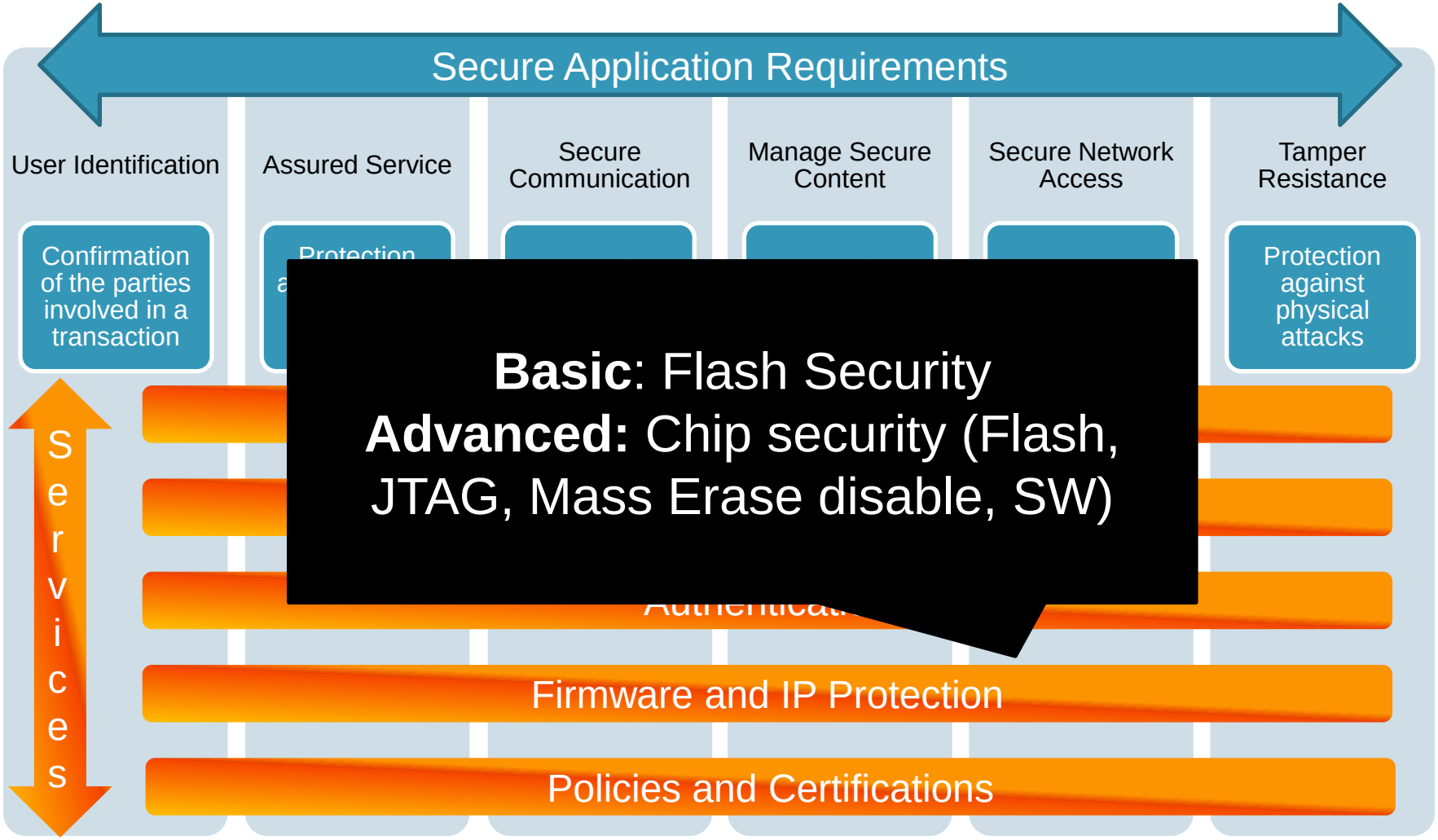
Needs of a Secure Embedded Application



Kinetis MCU 종류 및 장점

Leadership in Cortex-M

World's Broadest, Most Scalable Portfolio

Cortex M	Vendor
750+	**Freescale - Kinetis**
650	ST Micro
250	NXP
250	SiLabs / Energy Micro
280	Atmel
50	Texas Instruments
None	Renesas
None	Microchip

1st to market Cortex-M4

1st to market Cortex-M0+

Freescale Leadership with Kinetis MCUs

2010
Industry's first Cortex-M4-based MCU

2011
Kinetis MCUs set industry records with benchmark tests, further demonstrating leadership in product capabilities

2012
Industry's first Cortex-M0+-based MCU

2012
Industry's first sub-gigahertz wireless MCU
Using the world's most energy-efficient 32-bit core

2013
New Kinetis series enable cost-Effective meters with highest level of accuracy & security

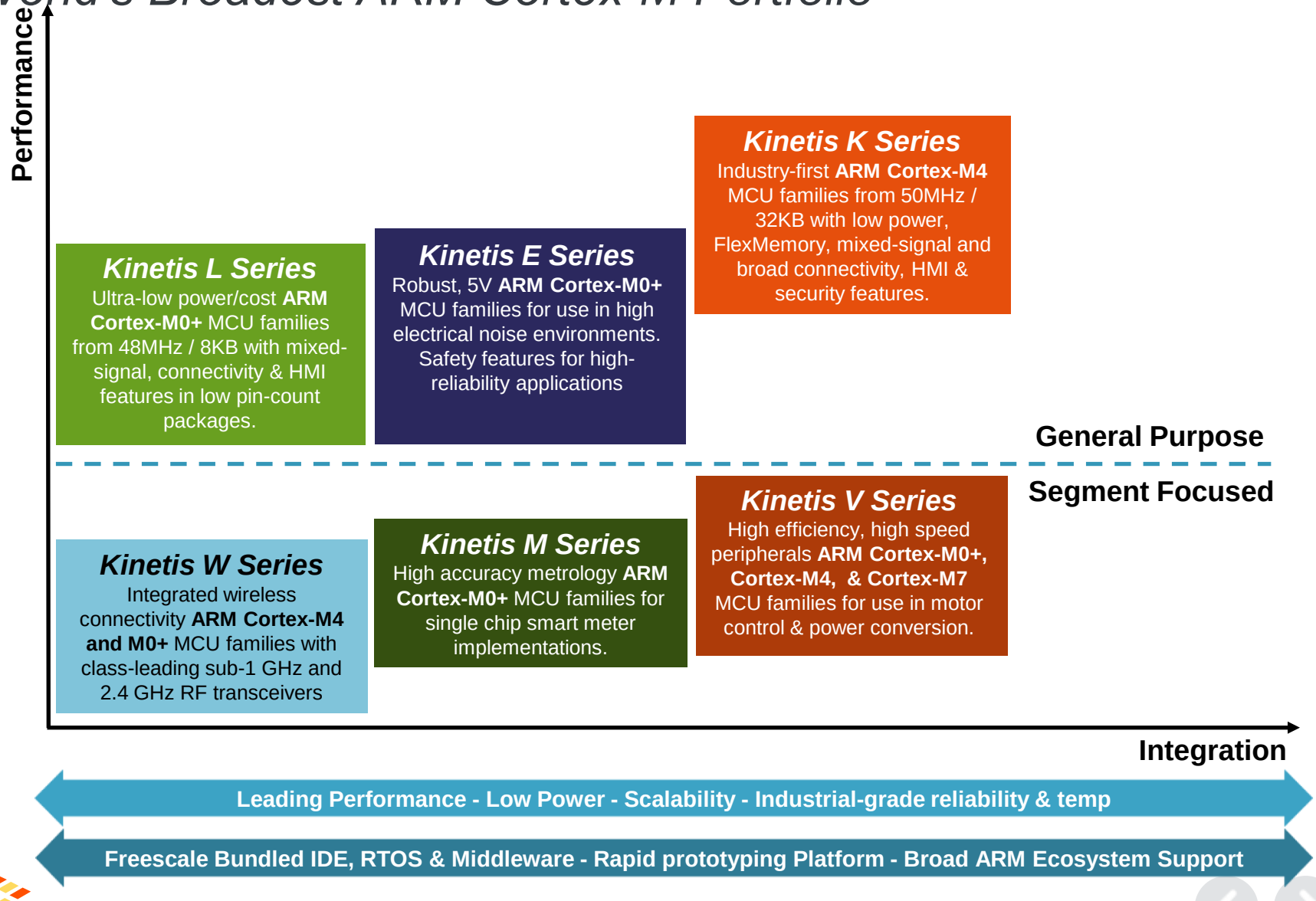
2013
World's first Cortex-M0+-based MCU with 5V support

2014
Streamlining next-generation motor control and digital power conversion with Kinetis V series MCU

2014
Delivering new levels of performance to the embedded market with early adoption of ARM Cortex-M7 core

Kinetis Microcontrollers

World's Broadest ARM Cortex-M Portfolio

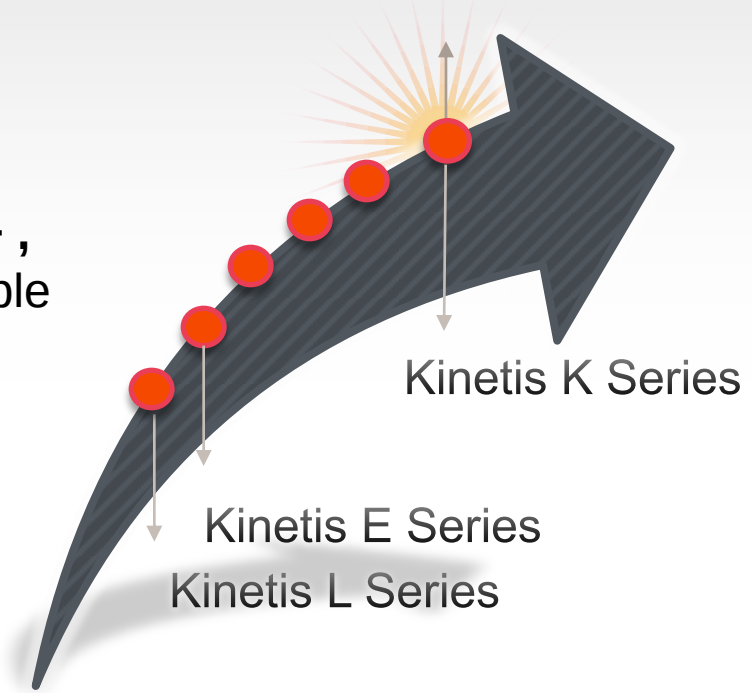


Kinetis MCU – 최소형, 최다제품, 최저전력

1. **Smallest size CSP packaging technology -** 35% smaller area package than the next competing small solution

2. **Product breadth ARM® Cortex®-M0+ , M4 and M7** with multiple code compatible and pin compatible devices that span multiple families

3. **Lowest power to highest functionality** Energy efficient battery powered products to analog intensive medical products.



Kinetis WLCSP

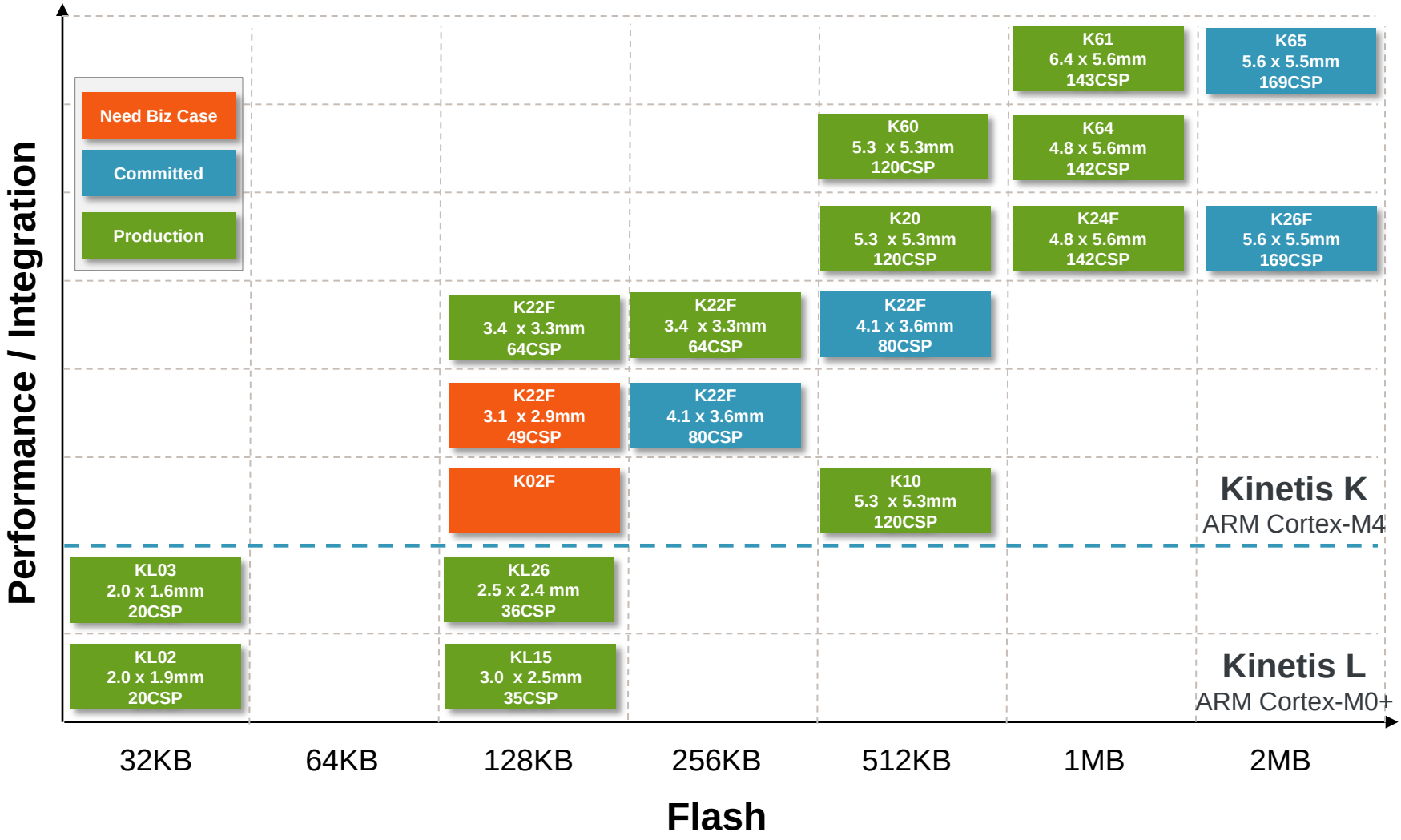
based on the ARM® Cortex®-M0+/M4 core

Miniature Packages. Massive Potential.

Industry-leading portfolio of ARM-based solutions in chip-scale packages (CSPs) that offer smaller size and greater functionality than competing solutions

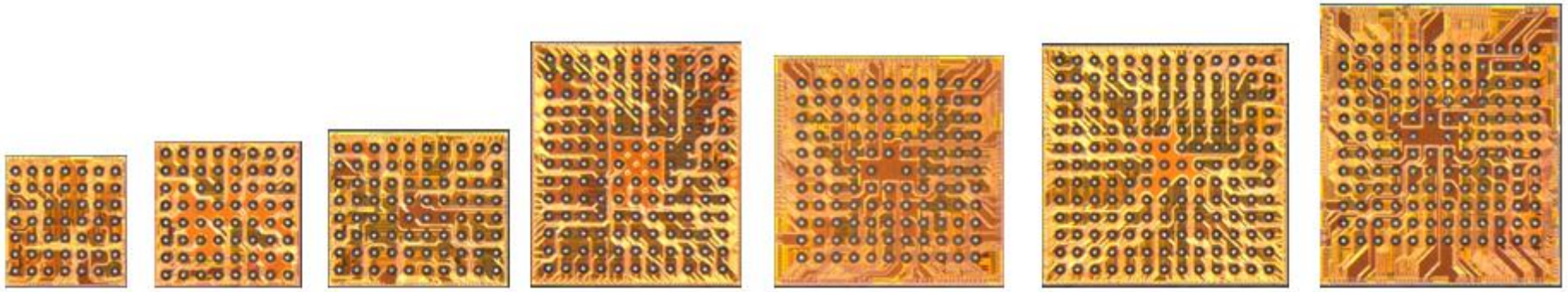
- **Smallest Form Factor**
  Package equivalent to die size; assembled at Wafer level; KL-03- world's smallest ARM based MCU
- **PCB Area Reduction**
  No bond wires or interposer connections required, solder balls attached to the silicon, minimal PCB inductance, enhanced thermal conduction characteristics
- **Complete Set of Features**
  Kinetis K mini MCUs for high performance and enhanced integration
  Kinetis L mini MCUs for lowest power consumption

Kinetis WLCSP - Roadmap



Kinetis WLCSP – Package Size Comparison

K Series (Cortex-M4)



49WLCSP
2.92 x 3.14 mm

64WLCSP
3.35 x 3.32 mm

80WLCSP
4.12 x 3.55 mm

142WLCSP
4.83 x 5.58 mm

120WLCSP
5.29 x 5.28 mm

169WLCSP
5.63 x 5.49 mm

143WLCSP
6.44 x 5.55 mm

L Series (Cortex-M0+)

20WLCSP
1.99 x 1.6 mm

20WLCSP
1.99 x 1.94 mm

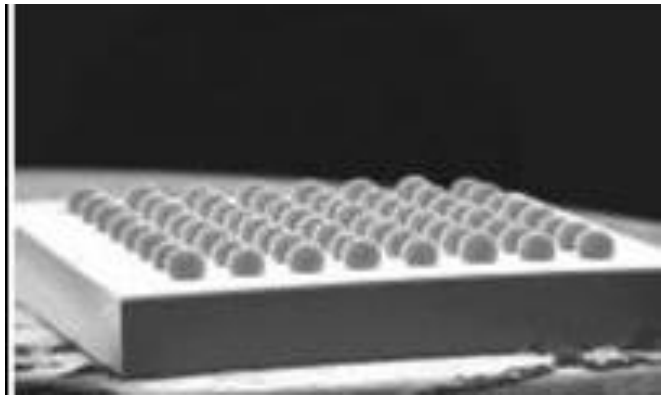
36WLCSP
2.37 x 2.46 mm

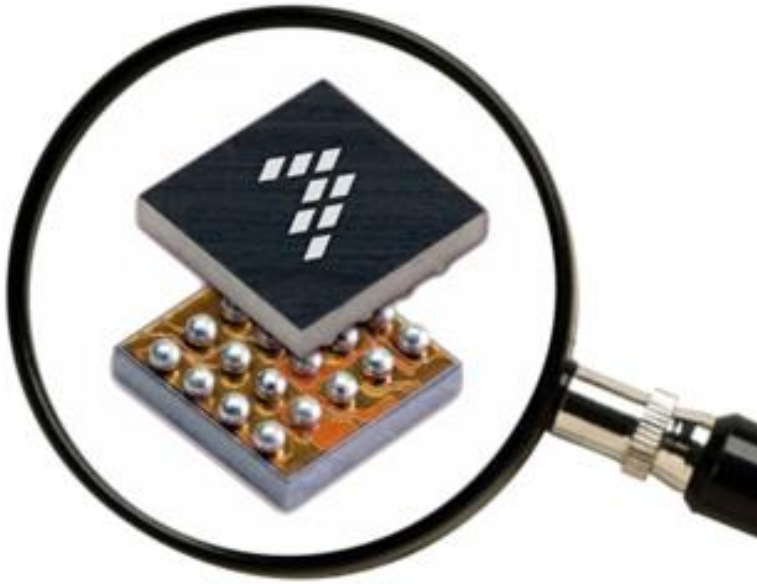
35WLCSP
2.53 x 2.98 mm

In-depth Look at WLCSP

WLCSP is an integrated circuit at the wafer level which makes the resulting package of the same size as die. A pattern of bumps or solder balls is used for connections.

- No bond wires or interposer connections are required.
- Die to PCB inductance is minimized
- Reduced package size
- Enhanced thermal conduction characteristics





For more information, visit freescale.com/KinetisMinis

WLCSP Advantages and Applications

Key Advantages:

- Small form factor allows **miniaturization of applications** while delivering outstanding processing performance, integration **(K-series)** and ultra low-power operation **(L-series).**

- Ideal for **any space constrained application in** consumer, healthcare and industrial markets.

Target Applications

Consumer

- Wearables
- IOT devices, edge nodes
- Smartphone, tablet, Laptop
- Digital cameras
- Gaming accessories
- Portable navigation devices

Healthcare

- Health and fitness trackers
- Portable medical monitoring
- Remote monitoring
- Invasive and non-invasive sensing
- Disposable devices

Industrial

- Industrial sensors
- Embedded control in motors

Kinetis K Series

based on the ARM® Cortex®-M4 core

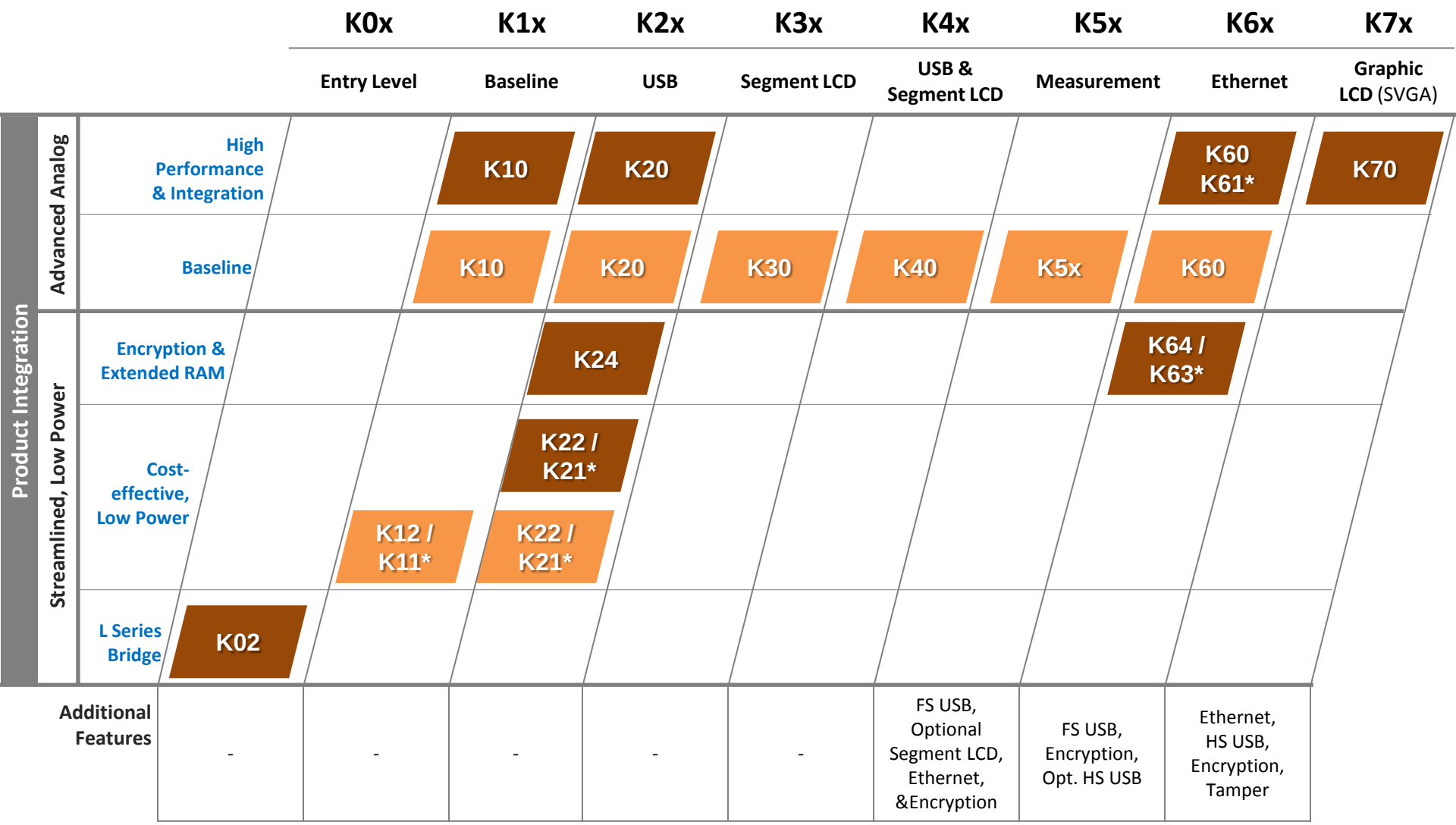
High Performance and Integration.

Designed for scalability, performance efficiency, integration, connectivity, communications, HMI and security. Kinetis K offers industry-leading low power and significant BOM savings through smart on-chip integration.

- **Power Efficiency**
- **Security**
- **Connectivity**
- **Product and Software Scalability**

Kinetis K Series – Decoding our Portfolio

Hundreds of products, from **32 KB to 2 MB** of program flash, along with a broad range of peripheral combinations for **measurement** and **control**, **connectivity** and **security.**



* Device Tamper Detection over Frequency, Voltage and Temperature

Kinetis K Series MCU Product Family Features

Common Features

System

ARM Cortex-M4 core w DSP features
Multi LP Modes and Peripherals
Low Power Boot, Clock Gating
Direct Memory Access (DMA) Controller
PMC (internal regulator, POR and LVD)
1.71-3.6V, 5V tolerance (1), -40 to 105°C

Memory

90nm TFS Flash
SRAM
Internal Memory Security/Protection
Flash Writte 1.71V

Analog Peripherals

Up to 4x 16-bit ADC w PGA (1,15µs) (1)
Analog Comparators

Serial Interfaces

UART / SPI / I2C
I2S

Timers

Flextimers (GP, PWM, Quad decoder)
Low-Power Timer
Periodic Interrupt Timer (PIT)
Programmable Delay Block (PDB)
Hardware and Software Watchdog

Oscillators

Main Osc. 32-40KHz / 3-32MHz
RTC (32KHz Osc, Vbat)
MCG (FLL and PLL)

Security

Cyclic Redundancy Check (CRC) module

Program and Test

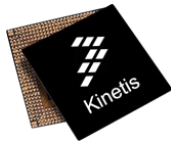
JTAG, cJTAG, SWD Debug
TPIU, FPB, DWT, ITM Trace
Serial Programming Interface

K70 Family	K70	120-150MHz	1MB Flash	128KB RAM	256 Pins	FPU	CAN driver	Ethernet IEEE 1588	USB FS w PHY	USB HS w PHY	Encrypt. Tamper	TFT driver SVGA
K6x Family	K64	120MHz	640KB-1MB Flash	192-256KB RAM	100-144 Pins	FPU	CAN driver	Ethernet IEEE 1588	USB FS crystal-less	Tamper		
	K63	120MHz	1MB Flash	256KB RAM	144 Pins	FPU	CAN driver	Ethernet IEEE 1588	USB FS crystal-less	Encrypt. Tamper		
	K61	120-150MHz	1MB Flash	128KB RAM	143-256 Pins	FPU	CAN driver	Ethernet IEEE 1588	USB FS w PHY	USB HS w PHY	Encrypt Tamper	
	K60	100-150MHz	256KB-1MB Flash	64-128KB RAM	100-144 Pins	FPU(2)	CAN driver	Ethernet IEEE 1588	USB FS w PHY	USB HS(3) w PHY	Tamper	
K5x Family	K53	100MHz	512KB Flash	64-128KB RAM	144 Pins	Analog	USB FS w PHY	Ethernet driver	LCD driver 320 Segm	Tamper		
	K52	100MHz	512KB Flash	128KB RAM	144 Pins	Analog	USB FS w PHY	Ethernet driver	Tamper			
	K51	72-100MHz	160-512KB Flash	32-128KB RAM	64-144 Pins	Analog	USB FS w PHY	LCD driver 320 Segm				
	K50	72-100MHz	160-512KB Flash	32-128KB RAM	64-144 Pins	Analog	USB FS w PHY					
K40 Family	K40	72-100MHz	96-512KB Flash	32-128KB RAM	64-144 Pins	LCD driver 320 Segm	USB FS w PHY					
K30 Family	K30	72-100 MHz	96-512KB Flash	32-128KB RAM	64-144 Pins	LCD driver 320 Segm	CAN driver					
K2x Family	K24	120MHz	1MB Flash	256KB RAM	100-144 Pins	FPU	CAN	USB FS crystal less	Encrypt.			
	K22	50-120MHz	192KB-1MB Flash	32-128KB RAM	48-144 Pins	FPU(2)	CAN(1)	USB FS w PHY				
	K21	50-120MHz	192KB-1MB Flash	32-128KB RAM	80-144 Pins	FPU(2)	CAN(1)	USB FS w PHY	Encrypt. Tamper			
	K20	50-120MHz	32KB-1MB Flash	8-128KB RAM	32-144 Pins	FPU(2)	CAN(1)	USB FS w PHY	USB HS(3) w PHY			
K1x Family	K12	50MHz	192-512KB Flash	32-64KB RAM	48-121 Pins							
	K11	50MHz	192-512KB Flash	32-64KB RAM	80-121 Pins	Encrypt. Tamper						
	K10	50-120MHz	32KB-1MB Flash	8-128KB RAM	32-144 Pins	FPU(2)	CAN(1)					
K0x Family	K02	100MHz	64-128KB Flash	16KB RAM	32-64 Pins	FPU						

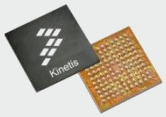
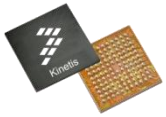
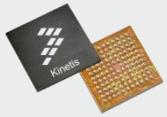
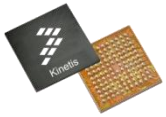
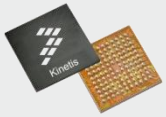
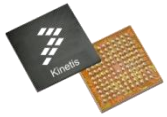
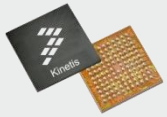
(1) All excepted 50MHz versions
(2) Only 120 or 150MHz versions
(3) USB HS on 120 or 150MHz versions

A Very Broad Portfolio of Packages

BGA

					
64 MAPBGA 5x5x1.2 mm 0.5 mm pitch **(K10/2x)**	**121 MAPBGA** 8x8x1.5 mm 0.65 mm pitch **(K1x/2x/30/40/5x/60)**	**121 XFBGA** 8x8x**0.5** mm 0.65 mm pitch **(K22/24/64)**	144 MAPBGA 13x13x1.7 mm 1.0 mm pitch **(K10/2x/30/40/5x/6x)**	169 MAPBGA 9x9x1.2 mm 0.65 mm pitch **(K65)**	256 MAPBGA 17x17x1.7 mm 1.0 mm pitch **(K61/70)**

WLCSP

						
49 WLCSP 2.9x3.1x0.56 mm 0.4 mm pitch **(K22)**	64 WLCSP 3.4x3.3 x 0.56 mm 0.4 mm pitch **(K22)**	80 WLCSP 4.1x3.6x0.56 mm 0.4 mm pitch **(K22)**	142 WLCSP 4.8x5.6x0.56 mm 0.4 mm pitch **(K24/64)**	120 WLCSP 5.3x5.3x0.56 mm 0.4 mm pitch **(K10/20/60)**	169 WLCSP 5.6x5.5x0.56 mm 0.4 mm pitch **(K65)**	143 WLCSP 6.4x5.6x0.56 mm 0.4 mm pitch **(K61)**

QFN

	
32 QFN 5x5x0.9 mm 0.5 mm pitch **(K02/K10/20)**	48 QFN 7x7x0.9 mm 0.5 mm pitch **(K10/20)**

QFP

				
48 LQFP 7x7x1.6 mm 0.55 mm pitch **(K02/1x/2x)**	64LQFP 10x10x1.6 mm 0.5 mm pitch **(K02/1x/2x/30/40/5x)**	80 LQFP 12x12x1.6 mm 0.5 mm pitch **(K1x/2x/30/40/5x)**	100 LQFP 14x14x1.7 mm 0.5 mm pitch **(K10/2x/30/40/5x/6x)**	144 LQFP 20x20x1.6 mm 0.5 mm pitch **(K10/2x/30/40/5x/6x)**

Tomorrow's Portfolio

Kinetis K80F, K81F

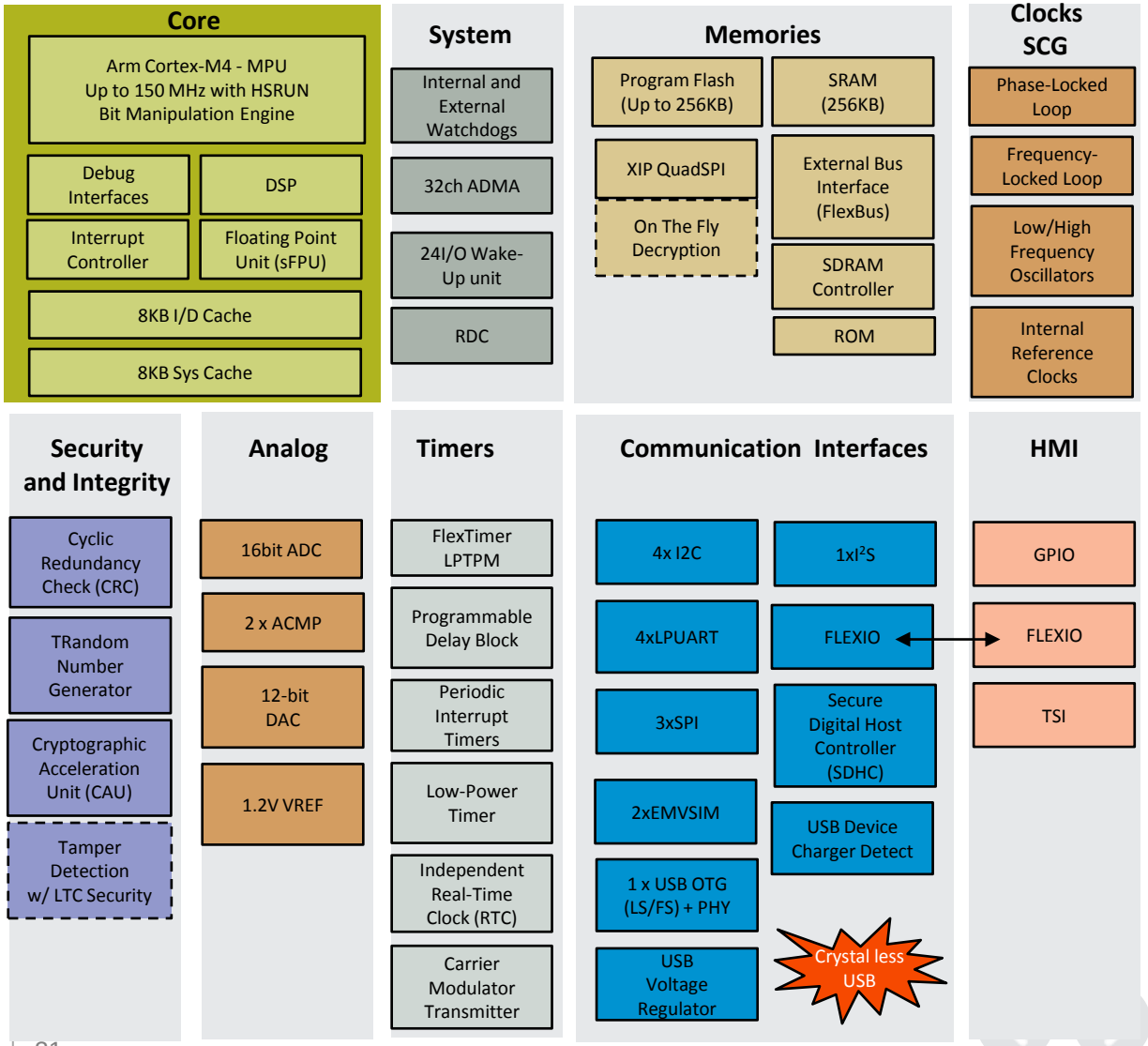
Early Access Repository:
http://compass.freescale.net/go/232861479
(Alpha Program)

Key Product Features

- Portfolio Scalability
- CPU Performance
- Static/Dynamic Low Power
- Crystal-less USB
- FlexIO
- Tamper Detection
- LP Trusted Crypto
- Memory Interfaces
- Extended SRAM
- Asynchronous DMA
- Smarter Peripherals
- FlexMemory / EEPROM
- Program Flash Security
- Boot ROM
- Quad SPI XIP
- Separate Voltage Domain
- Large I/D Cache
- VBAT Voltage Range
- Enablement Tools

Links to: Energy Efficient Solutions by Freescale | Product Longevity

Block Diagram



** Dashed Line Represents Optional Features*

Some of our latest technical advantages

Portfolio Scalability	Consistent product and software experience across K-series
CPU Performance	High CPU max frequency, including High Speed Run option
Static/Dynamic Low Power	Advanced techniques that leverage process/flash technology, design and system architecture
Crystal-less USB	Allows full-speed device operation without need of external crystal
FlexIO	Configurable peripheral to support multiple protocols, inc. custom display interface
Tamper Detection	Tamper Detection to Protect Against Threats over Voltage, Frequency and Tamper
LP Trusted Crypto	Hardware accelerators supporting in-line AES256/192/128, RSA2048, ECC 3DES, RNG
Memory Interfaces	SDRAM, PNOR, SNOR
Extended SRAM	Up to 256 KB of integrated SRAM
Asynchronous DMA	Off-load basic data movement tasks from CPU to reduce power consumed
Smarter Peripherals	Power conscious peripherals, with asynchronous operation in STOP mode (VLPS) to reduce CPU load, increase performance and power consumed
FlexMemory / EEPROM	Memory block that can be configured as EEPROM and/or program flash
Program Flash Security	Highly reliable and fast access with four levels of protection for code security/protection
Boot ROM	ROM to be used for program flash bootloader and firmware updates
Quad SPI XIP	Access to external fast serial NOR with execution in place functionality
Separate Voltage Domain	Independent VDDIO PORT E power domain eliminates need for level translators. Supports Shelf mode with RTC. MCU operation at 1.8V with USB
Large I/D Cache	Fast, local storage to enable potentially zero-wait state performance for most critical portions of application. Reducing need to access slow memory blocks; improves bus bandwidth for DMA/peripherals.
VBAT Voltage Range	Input voltage increased to 4.2 V for direct RTC connection to battery
Enablement Tools	Software Development Kit (SDK), Flashloader, IDE support, Freescale Freedom, Various IDEs

Key Product Features

Kinetis L

ARM Cortex M0+

Ultra Low Power, Ultra Small Scale, Super Easy to Use, Leading Scalability and Integration as an ideal solution for Internet of Things edge nodes

World's Most Energy Efficient ARM based Microcontroller

Architected for power efficiency, the Kinetis L series takes advantage of ARM's ultra low power Cortex-M0+ processor and features peripherals that help you optimize power consumption. Kinetis L series provide ultra low dynamic consumption, ultra low static consumption, rich low power modes and innovative low power peripherals.

World's Smallest ARM based Microcontroller

Built on Freescale leading technology, Kinetis L series provide rich package options from 8x8mm2 121XFBGA, 10x10mm2 100LQFP all the way down to world's smallest KL03 20WLCSP with 1.6x2mm2 ultra small scale device.

World's Leading Scalability and Integration with Super Ease of Use

Built on the ARM Cortex-M0+ core, the Kinetis L series simplifies development with an upward migration path to Kinetis K and X series. With a comprehensive enablement bundle including low cost Tower System and Freedom Tools, Kinetis Design Studio IDE, Kinetis Software Development Kit, MQX RTOS and the ARM support ecosystem, development is super simple. Expanding on well-known features of the Kinetis platform with leading scalability, best-in-class integration with rich analog features and low-power connectivity, the Kinetis L series redefines entry-level.

Kinetis L Series MCUs Feature Overview

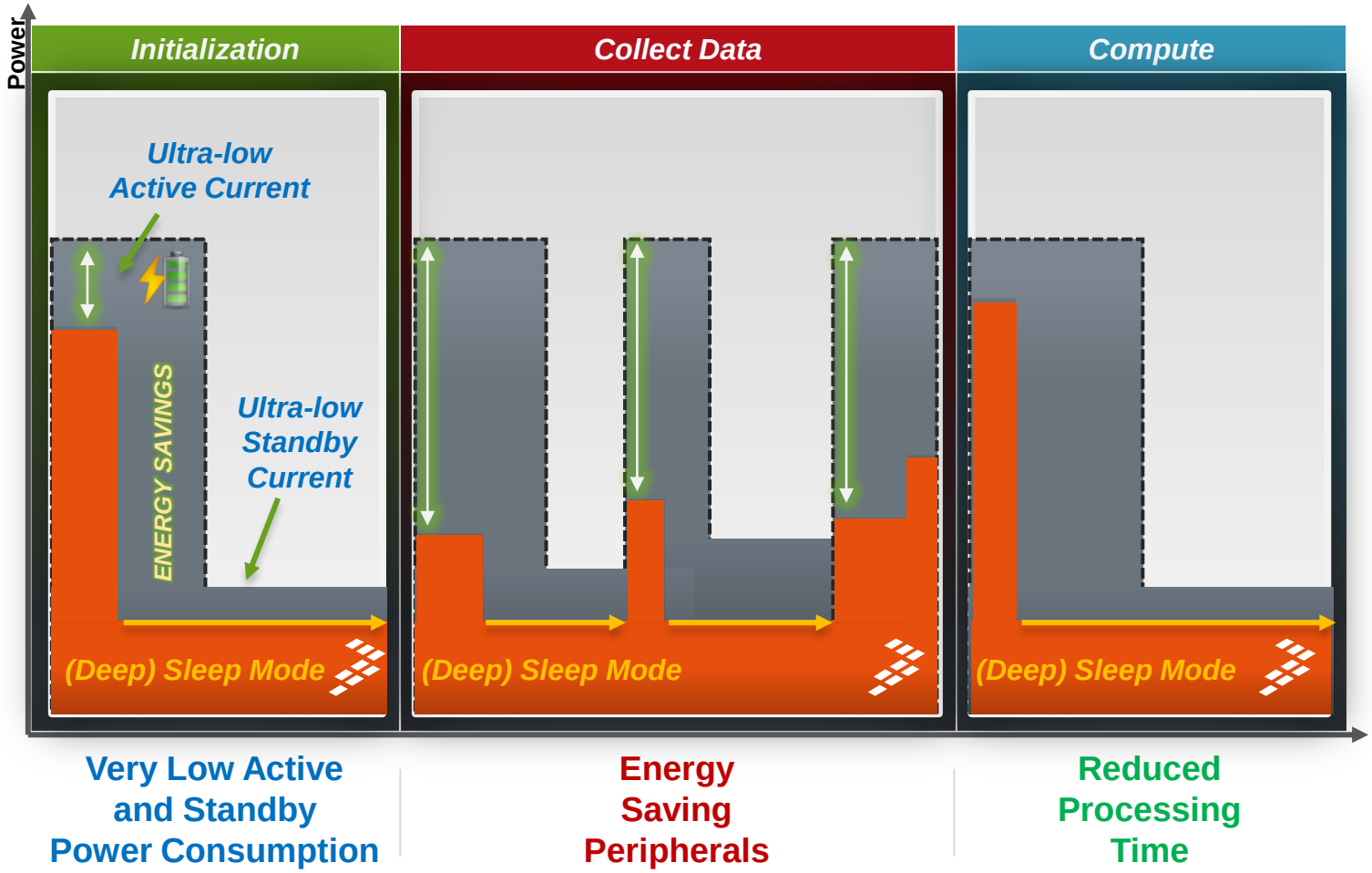
Common Features
System
Cortex-M0+ Core, 48/72MHz
Multi-Low-Power Modes and Peripherals, Low-Power Boot, Clock Gating
1.71-3.6 V, –40 °C to 105 °C [1]
Memory
90 nm TFS Flash, SRAM
Internal Memory Security/Protection
Analog Peripherals
12/16-bit ADC
High-Speed Comparator
Serial Interfaces
UART (Including 1 LPUART)
SPI, I²C
Timers
Real-Time Clock [2]
16-bit Low-Power TPMs (GP Timer/PWM)
Low-Power Timers
32-bit Periodic Interrupt Timer

Optional Features															
Family	Flash	SRAM	Pin Count	Key Features											
				USB	FlexIO	SLCD	DMA	RTC	ADC	12-bit DAC	I2S	TSI	Boot	VREF	Security
KL46	128-256 KB	16-32 KB	64-121	OTG		Y	Y	Y	16-bit	Y	Y	Y			
KL43	128-256 KB	16-32 KB	64	Slave	Y	Y	Y	Y	16-bit	Y	Y		Y	Y	
KL36	64-256 KB	8-32 KB	64-121			Y	Y	Y	16-bit	Y	Y	Y			
KL34	64 KB	8 KB	64-100			Y	Y	Y	12-bit						
KL33	32-256 KB	4-32 KB	48~80		Y	Y	Y	Y	16-bit	Y	Y		Y	Y	
KL28	256-512 KB	128 KB	64-121	OTG	Y		Y	Y	16-bit	Y	Y	Y	Y	Y	Y
KL27	32-256 KB	8-32 KB	32-64	Slave	Y		Y	Y	16-bit	Y[3]	Y		Y	Y[3]	
KL26	32-256 KB	4-32 KB	32-121	OTG			Y	Y	16-bit	Y	Y	Y			
KL25	32-128 KB	4-16 KB	32-80	OTG			Y	Y	16-bit	Y		Y			
KL24	32-64 KB	4-8 KB	32-80	OTG			Y	Y	12-bit						
KL17	32-256 KB	8-32 KB	32-64		Y		Y	Y	16-bit	Y[3]	Y		Y	Y[3]	
KL16	32-256 KB	4-32 KB	32-64				Y	Y	16-bit	Y	Y	Y			
KL15	32-128 KB	4-16 KB	32-80				Y	Y	16-bit	Y		Y			
KL14	32-64KB	4-8 KB	32-80				Y	Y	12-bit						
KL05	8-32 KB	1-4 KB	24-48				Y	Y	12-bit	Y		Y			
KL04	8-32 KB	1-4 KB	24-48				Y	Y	12-bit						
KL03	8-32 KB	2 KB	16-24					Y	12-bit				Y	Y	
KL02	8-32 KB	1-4 KB	16-32						12-bit						

[1] Feature not available on CSP packages
[2] For KL02, use software to support
[3] DAC is not available in 32/64 KB flash KL27/17, VREN is not available in 128/256 KB flash 32QFN KL27/17

Low-Power Kinetis MCUs

- Low-power philosophy – “Reducing the area under the energy curve”

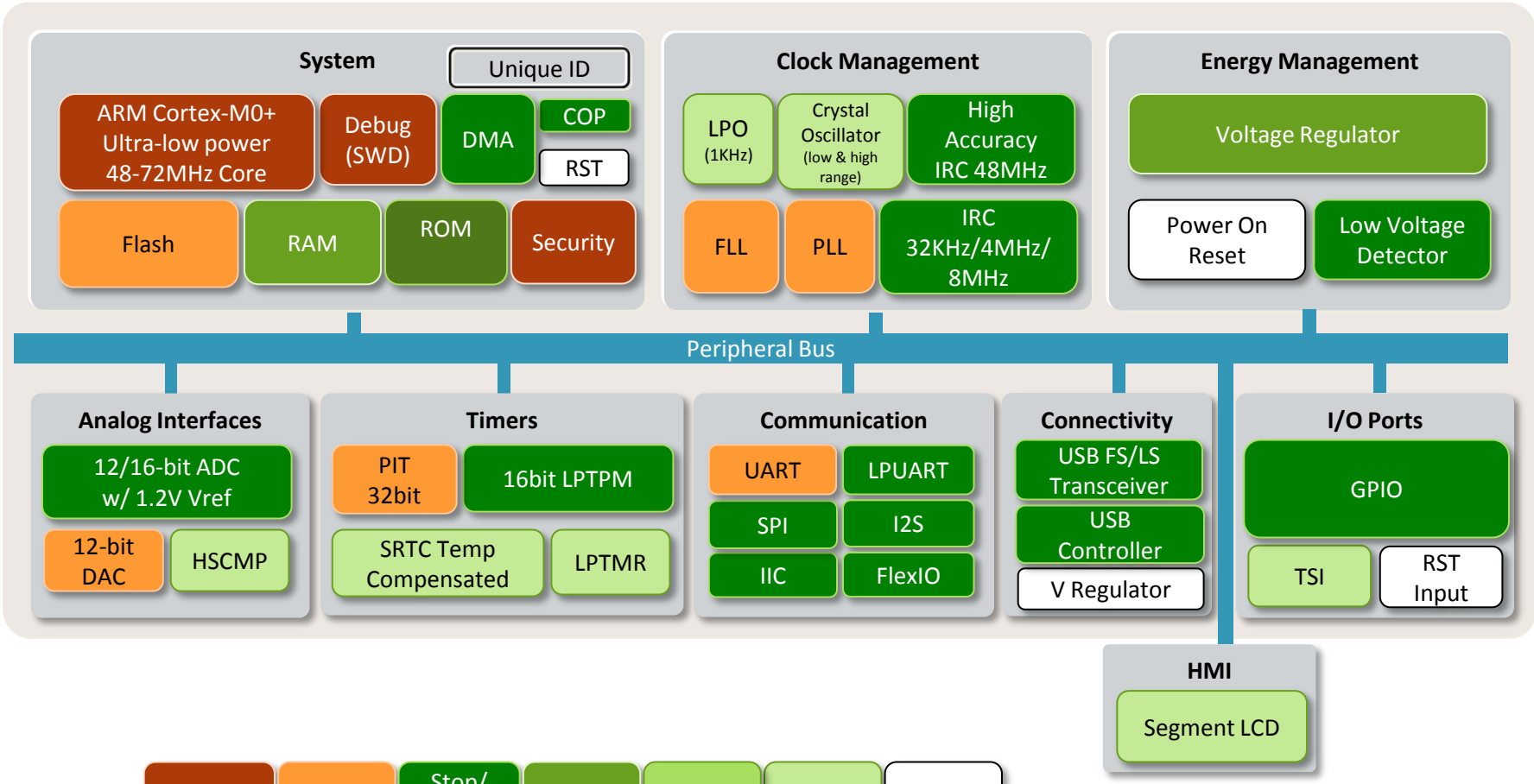


Ultra-low Power Modes

Expands beyond typical run, sleep and deep sleep modes with power options designed to maximize battery life in varying applications

	Mode	Definition
RUN	Run	MCU can be run at full speed. Supports Compute Operation clocking option where bus and system clock are disabled for lowest power core processing and energy-saving peripherals with an alternate asynchronous clock source are operational.
RUN	VLP Run (VLPR)	MCU maximum frequency is restricted to 4MHz core/platform and 1 MHz bus/flash clock. Supports Compute Operation clocking option. LVD protection is off and flash programming is disallowed.
SLEEP	Wait	Allows all peripherals to function, while CPU goes to sleep reducing power consumption. No Compute Operation clocking option.
SLEEP	VLP Wait (VLPW)	Similar to VLP Run, with CPU in sleep to further reduce power. No Compute Operation clocking option.
DEEP SLEEP	Stop	MCU is in static state with LVD protection on. Energy-saving peripherals are operational with Asynchronous DMA (ADMA) feature that can wake-up DMA to perform transfer and return to current mode when complete. AWIC detects wake-up source for CPU. Lowest power mode with option to keep PLL active. Partial stop clocking options for more peripheral functionality available.
DEEP SLEEP	VLP Stop (VLPS)	MCU is in static state with LVD protection off. Energy-saving peripherals are operational with ADMA feature. AWIC detects wake-up source for CPU.
DEEP SLEEP	LL Stop (LLS)	MCU is in low leakage state retention power mode. LLWU detects wake-up source for CPU including LPTMR, RTC, TSI, CMP, and select pin interrupts. Fast <4.3us wake-up.
DEEP SLEEP	VLL Stop 3 (VLLS3)	MCU is placed in a low leakage mode powering down most internal logic. All system RAM contents are retained and I/O states held. LLWU controls wake-up source for CPU similar to LLS mode.
DEEP SLEEP	VLL Stop 1 (VLLS1)	Similar to VLLS3 with no RAM or register file retention.
DEEP SLEEP	VLL Stop 0 (VLLS0)	Pin wakeup supported. LPTMR, RTC, TSI and CMP wake-up supported with external clock. No RAM or register file retention. Optional POR brown-out detection circuitry.

Kinetis L Series: Operating modules under low power modes



Operation in: Run | Wait | Stop/ VLPS | VLLS3 | VLLS2 | VLLS1 | VLLS0

KL28

Expanding Kinetis L portfolio to large flash and RAM, dual Cortex-M0+ core, advanced smart peripherals for low power and security features

High Performance and Large Memory Size

- Up to 72MHz core frequency
- Up to 512KB flash memory and 128KB SRAM

Advanced Smart Low Power Peripherals

- Low Power IIC to work as master in low power mode
- Low Power SPI to work as master in low power mode
- Crystal-less USB with keep alive in low power mode

Security

- True Random Number Generator
- AES/DES/SHA/MD5
- Flash Access Control and Security

KL81/82

Expanding Kinetis L portfolio to advanced security IoT and payment terminal applications with low power

High Performance and Large Memory Size

- Up to 72MHz core frequency
- Up to 128KB flash memory and 96KB SRAM with XIP QSPI external flash

Advanced Security Capabilities

- True Random Number Generator
- RSA2048 (3 decrypt and 1 encrypt <750ms), ECC
- 3DES with HW DPA, AES256/192/128 with DPA
- SHA1/224/256
- Flash Access Control and Security
- Total 160 bytes of secure storage with tamper protection (KL81 only)

Smart and Rich Peripherals

- Architected specifically for EMV compliance
- EMV Level 1 compliant stack
- Up to 32ch FlexIO

Kinetis V

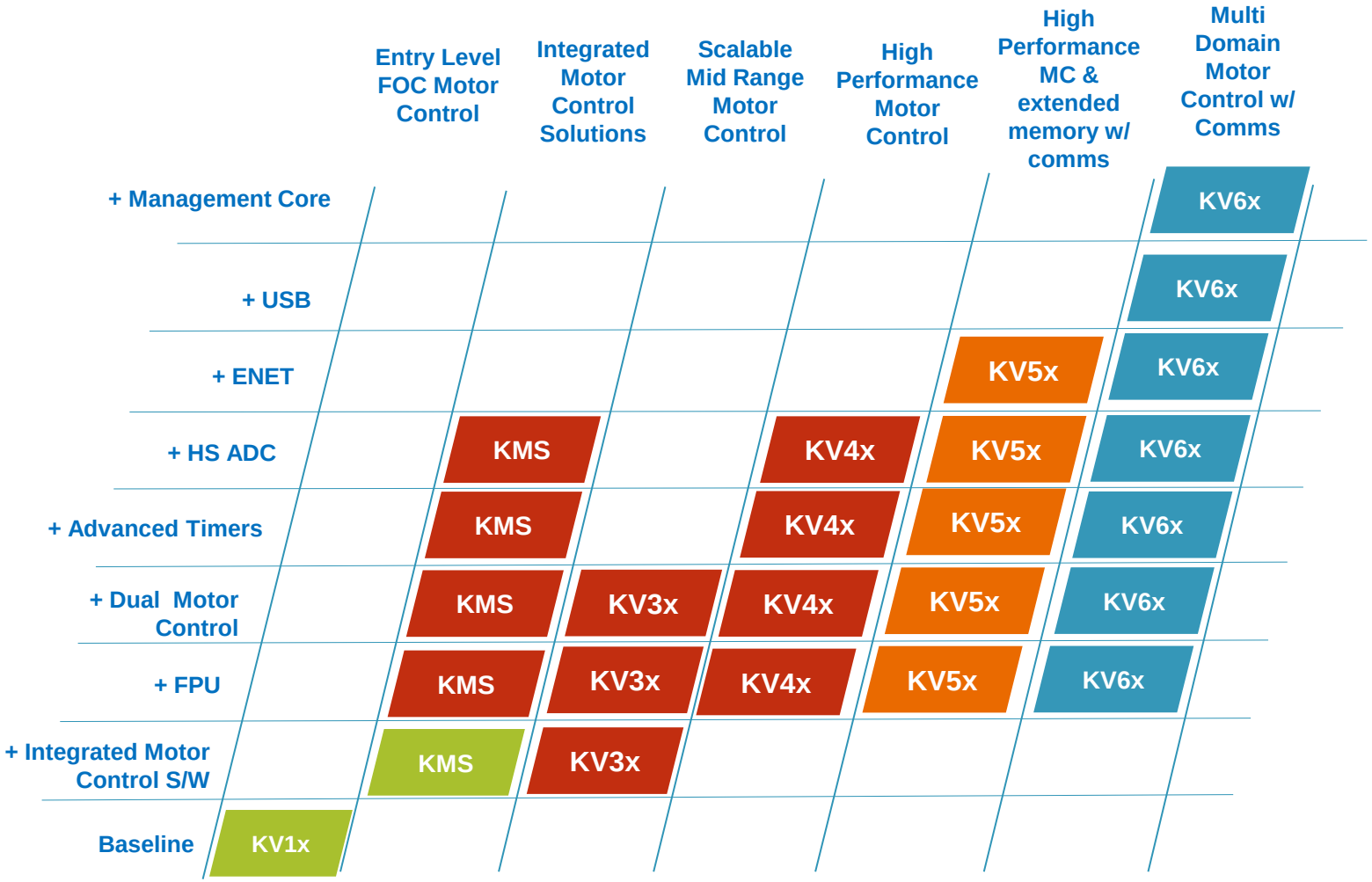
모터 및 전력전자

Kinetis V series MCUs based on ARM® Cortex® cores

For Motor Control & Digital Power Conversion

- Freescale's extensive motor and power control expertise and the latest ARM Cortex-M0+, M4 and M7 cores bring secure, connected, high efficiency motor control and power conversion to the mass market
- Efficient, next generation BLDC, PMSM and ACIM designs are enabled by optimized MCU performance and high speed/resolution analog and timing peripherals. High resolution eFlexPWMs support digital power conversion
- Performance and feature scalable MCU families from entry-level 75MHz MCUs, to advanced 240MHz MCUs, maximize hardware & software reuse and end product flexibility
- Enablement including Freescale Tower and Freedom development boards, Embedded Software Libraries and Kinetis motor suite reduce motor control learning curve and speed time to market

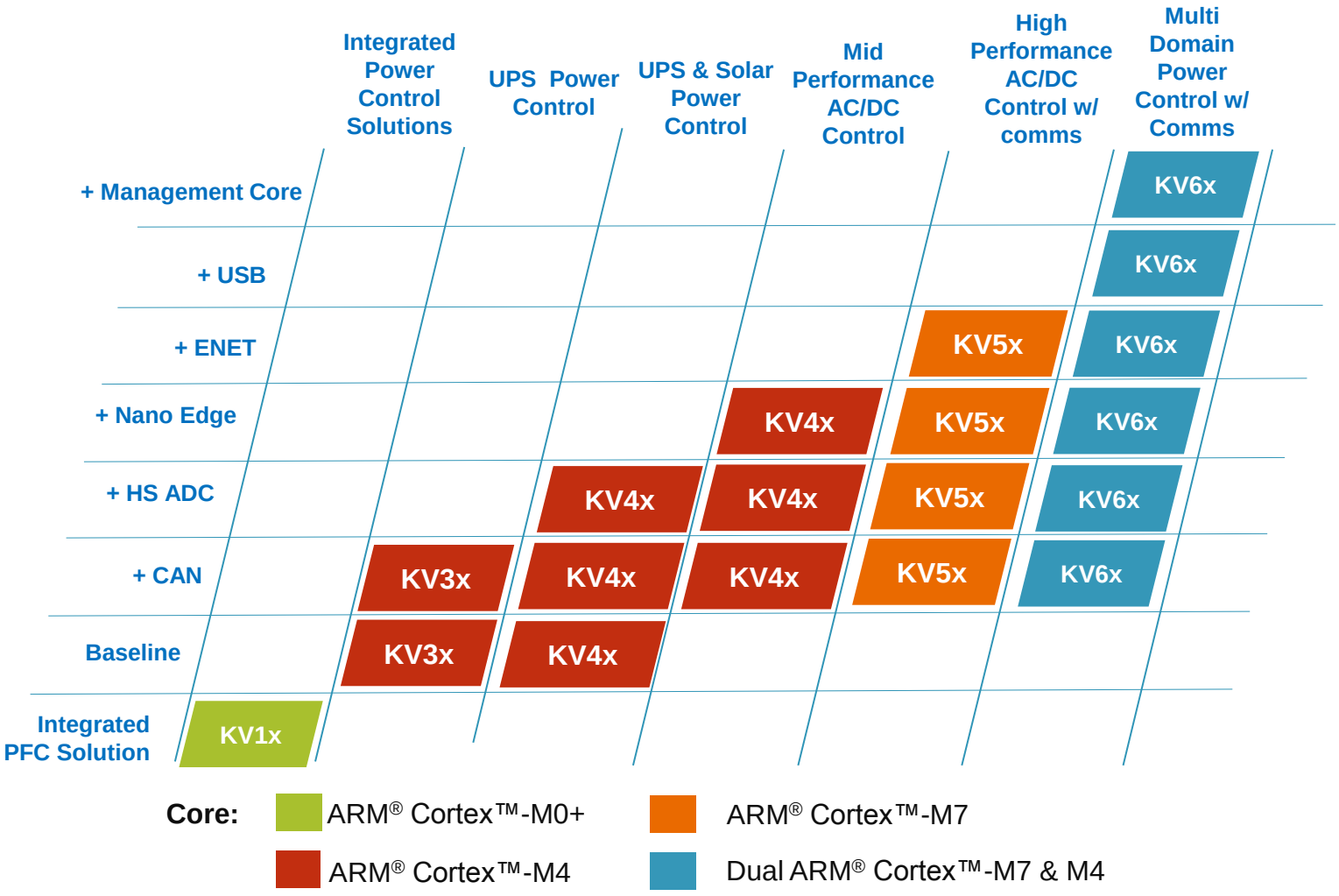
Kinetis V-Series: 3 Phase Motor Control



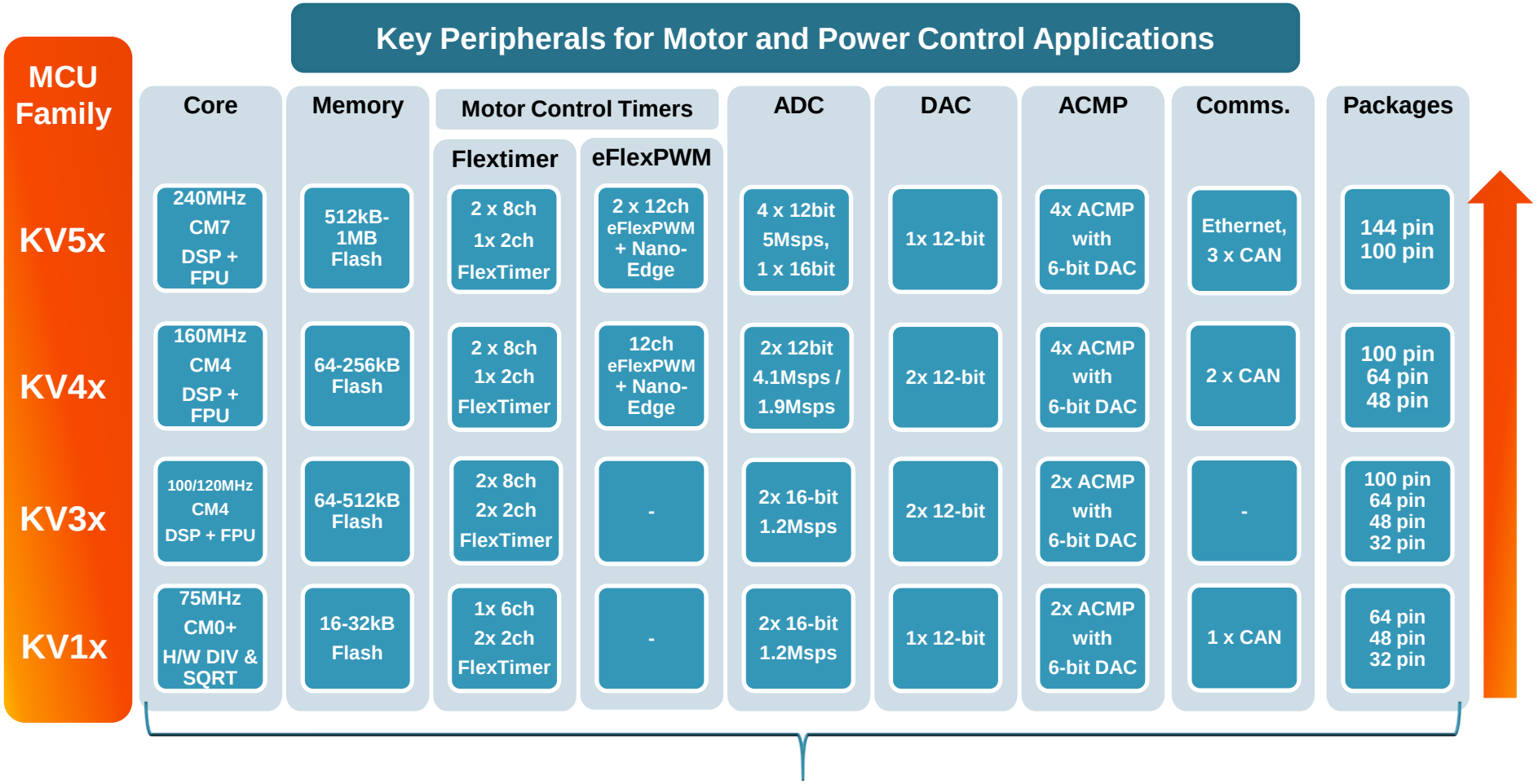
Core:

- ARM® Cortex™-M0+
- ARM® Cortex™-M7
- ARM® Cortex™-M4
- Dual ARM® Cortex™-M7 & M4

Kinetis V-Series: Power Conversion



Kinetis V Series: Performance and Feature Scalability



Scalable performance, timing and analog functionality based on application need

Kinetis V Series: KV5x Quadcopter Demo

New FSL ESC Module (KV5x MCU & GD3000 Motor Driver IC)

- **1x KV5x MCU** driving all 4 motors using 6-step BLDC open loop control algorithm

  Replaces 4x 8-bit MCUs!!
- KV4x (Cortex-M4) design also available

- **4x MC34GD3000 motor pre-drivers** - existing MC34937A in 56QFN, 8x8mm **Replaces 24 transistors**!!

- KV5x ESC design could be expanded to include
  - FOC algorithm…for quieter motor operation e.g. filming applications
  - 'NAZA' Flight Stability Controller using FSL GYRO

Kinetis E

5V Vdd, EMC 강화

Kinetis E Series

Strong Robustness – EMC/ESD design technology ensure strong noise immunity performance

High Efficiency – Cortex-M0+ core up to 48MHz and 40x more than 8/16-bit MCUs

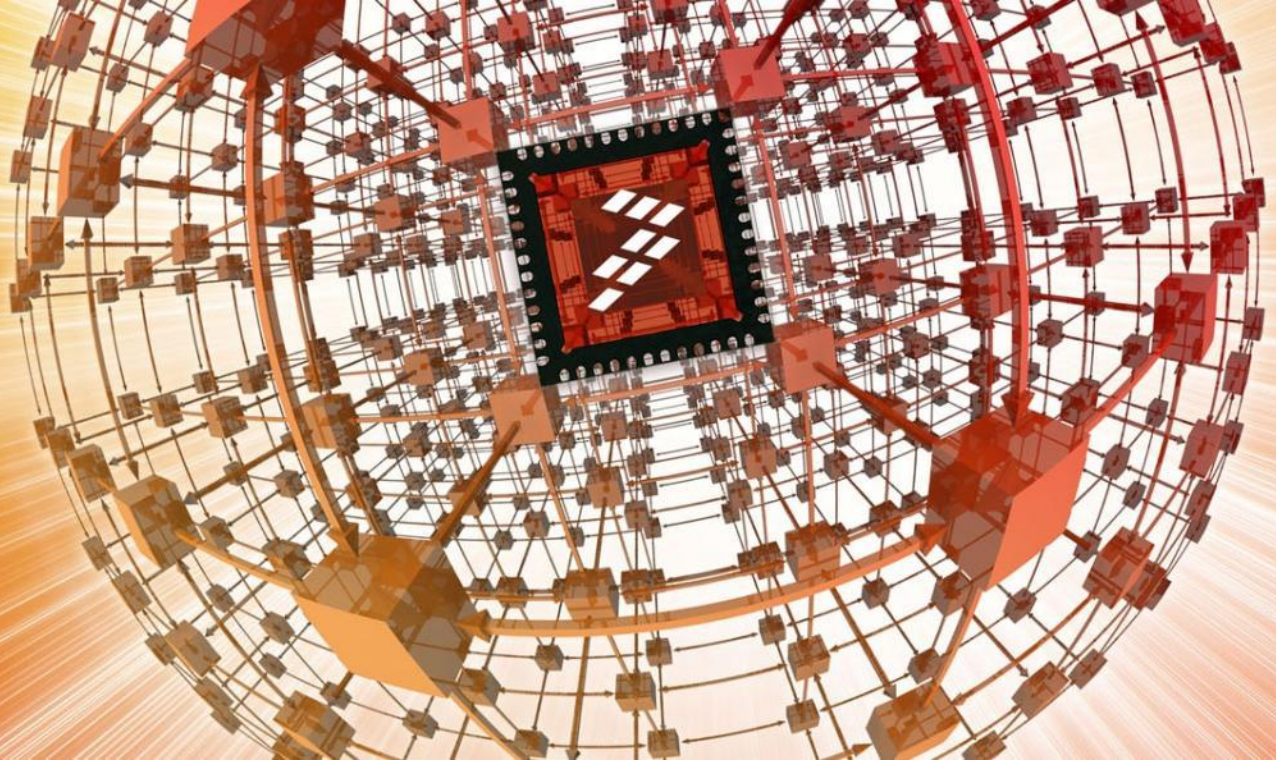
Low Cost – Optimized for cost-sensitive applications offering low pin count option

Kinetis E Series: Families

Common Features
System
ARM Cortex-M0+/M4 Core
Multiple power modes, Clock Gating,
2.7V to 5.5V, -40 to 105°C
Clock Management
External OSC, 4~24MHz, 32KHz
Internal OSC
Analog Peripherals
ADC
Analog Comparators
Serial Interfaces
SCI
SPI, IIC
Timers
Real Time Clock
16bit Flex timers
32bit Periodic Interrupt Timer

Optional Features									
Family	Core	Speed	Flash	SRAM	Key Features				
					Boot ROM	ADC	DAC	CAN	TSI
KE18F	M4	150MHz	256K-512K	32K	√	3	√	2	
KE16F	M4	150MHz	256K-512K	32K	√	3	√	1	
KE14F	M4	150MHz	256K-512K	32K	√	3	√		
KE18Z	M0+	72MHz	128K-256K	16K-32K	√	2		2	√
KE17Z	M0+	72MHz	16K-256K	2K-32K	√	1-2		1	√
KE16Z	M0+	72MHz	16K-256K	2K-32K	√	1-2		1	
KE15Z	M0+	72MHz	16K-256K	2K-32K	√	1-2			√
KE14Z	M0+	72MHz	16K-256K	2K-32K	√	1-2			
KE06Z	M0+	48MHz	64K-128K	8K-16K		1		1	
KE04Z	M0+	48MHz	8K, 64K~128K	1K, 8K~16K		1			
KE02Z	M0+	40MHz	16-64K	2-4K		1			

Available today



Kinetis W Series MCUs

Wireless Connectivity Microcontroller Solutions

RF Integration	Integrating RF functionality to the Kinetis MCU portfolio
Flexibility	Ability to integrate the right combination of memories and peripherals to meet a variety of customer demands
Enablement	Part of the Kinetis MCU ecosystem including KSDK environment using MQX and third-party support from IAR, KEIL or other ARM ecosystem providers

Kinetis W - Nomenclature

Wireless MCU

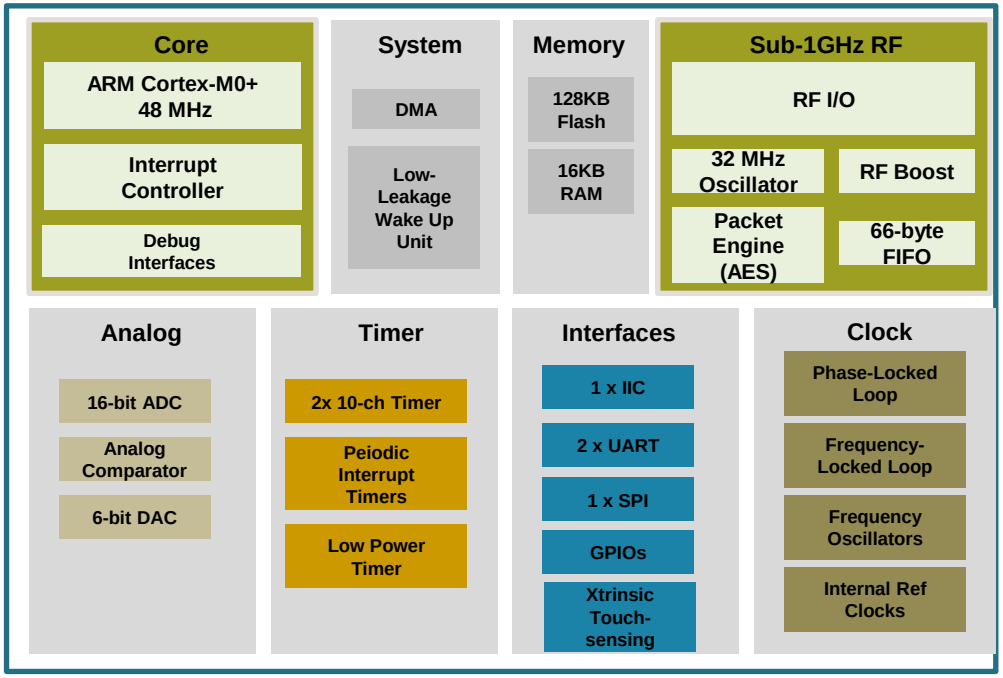
- KW4x - Multimode (ZigBee, BLE, etc.)
- KW3x - BLE
- KW2x - 802.15.4 (2.4 GHz)
- KW0x - Sub-1 GHz

Radio (Transceiver Only)

- MCRxxx

Kinetis KW01 Wireless MCU (Sub 1-GHz)

- **CPU**
  - 32-bit ARM Cortex M0+ 48MHz Core
  - 128KB Flash and 16KB SRAM
- **Radio transceiver, Sub 1-GHz**
  - Supports 290-344MHz, 424-510MHz, and 862-1020MHz frequency bands
  - FSK, GFSK, MSK, GMSK and OOK modulations up to 600kbps
  - Up to -120dBm Rx sensitivity @ 1.2kbps
  - -18 to +17dBm Tx output power in steps of 1dBm
- **Ultra low power for battery operated devices**
  - Typical consumption
    - 1.7µA standby with 4.3µs wake-up time
    - <50 uA/MHz CPU system run mode
    - 16 mA Rx peak
    - 20 mA Tx peak at 0 dBm, 33 mA at +10 dBm
- **Software**
  - Simple-MAC, user modifies for their proprietary protocols
- **System**
  - 16-bit ADC, Cap Touch Sensors, I2C, UART, SPI, Timers
  - Operating Range: 1.8V to 3.6V, -40C to +85C



Device	Flash / Flex	RAM	Package
MKW01Z128CHN	128 KB	16 KB	8x8 56-pin LGA

Kinetis MKW2xD Wireless MCU

Cortex

ZigBee
Control your world

CPU

- 50 MHz Cortex M4 CPU core
- Up to 512KB Flash & up to 64KB SRAM
- Optional (MKW21D256): 64 KB FlexNVM & 4 KB FlexRAM
- Typical current: 250 uA/Mhz run, 1.7uA RTC standby

Radio Transceiver, 2.4GHz

- IEEE-802.15.4 compliant
- -102 dBm Rx sensitivity and +10 dBm Tx output power
- Peak typical current: 17mA Tx and 19mA Rx
- Dual Personal Area Network (PAN) support in hardware
  - Run two RF networks simultaneously
- Antenna diversity with automatic antenna selection

Security

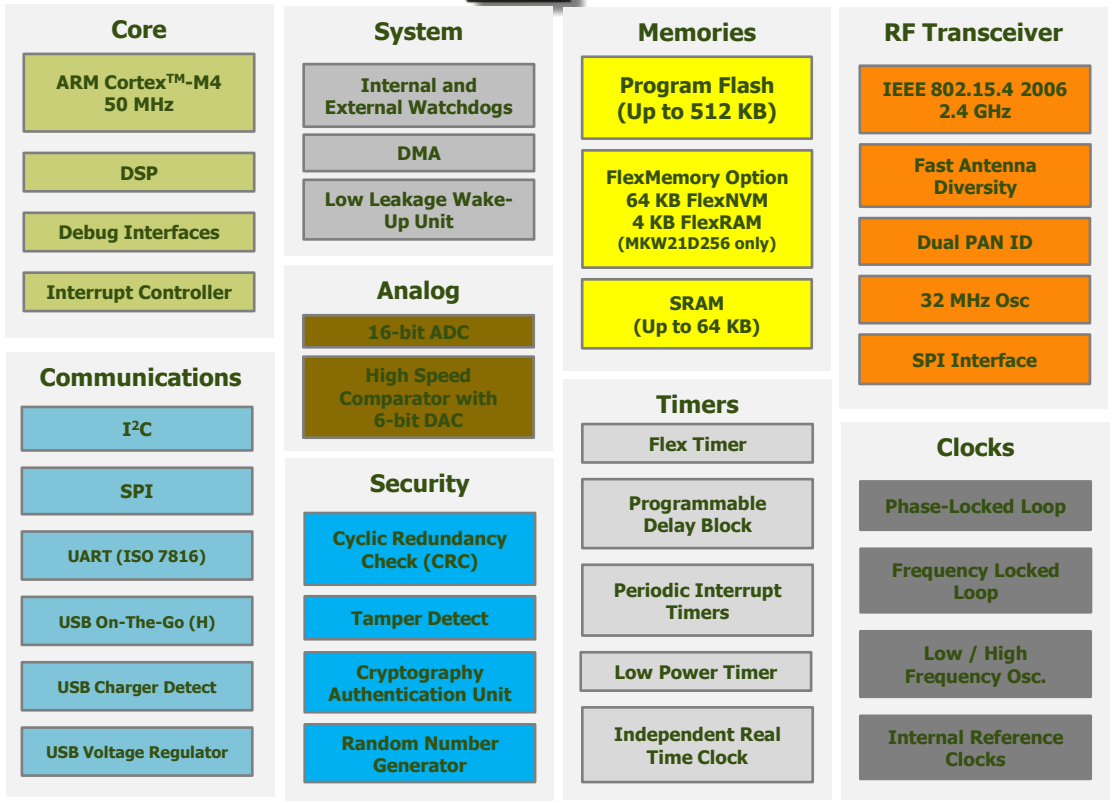
- Active and passive tamper detection with RTC timestamp
- Crypto engine: DES, 3DES, AES 128-256, SHA-1, SHA-256, MD5, RNG

Software

- 812.15.4 2006 MAC
- RF4CE, ZigBee PRO, ZigBee IP
- ZigBee Profiles: ZSE, ZHA, ZHC, ZRC
- Freescale IPv6 Mote Stack
- MQX Lite RTOS

System

- UART, SPI, I2C, optional USB 2.0 FS/LS H/D/OTG
- 16-bit ADC
- Operating range: 1.8 V to 3.6 V, -40C to +105C



Device	Flash	RAM	Feature	Package
MKW21D256VHA5	256 KB	32 KB	No USB	8x8 63-pin LGA
MKW21D512VHA5	512 KB	64 KB	No USB	8x8 63-pin LGA
MKW22D512VHA5	512 KB	64 KB	USB	8x8 63-pin LGA
MKW24D512VHA5	512 KB	64 KB	USB and Smart Energy 2.0	8x8 63-pin LGA

Kinetis KW40Z/30Z/20Z

Core/Memory/System
- Cortex-M0+ running up to 48 MHz
- 160 kB Flash
- 20 kB SRAM
- Four independently programmable DMA controller channels

Radio
- Support for BLE v4.1, 802.15.4-2011
- -91 dBm in BLE mode, -102 dBm in 802.15.4 mode
- -20 to +5 dBm programmable output power
- 6.5 mA Rx & 8.4 mA Tx (0dBm) current target (DC-DC enabled)
- <2uA low power current

Communications/HMI/Timers
- 2xSPI, LP-UART, 2xI2C, GPIO with IRQ capability (KBI)
- Carrier Modulated Timer (CMT)
- Hardware Capacitive Touch Sensing Interface (TSI)
- 3xFlexTimer (TPM) with PWM & quadrature decode support
- Low Power (LPTMR), Programmable Interrupt (PIT) and RTC timers

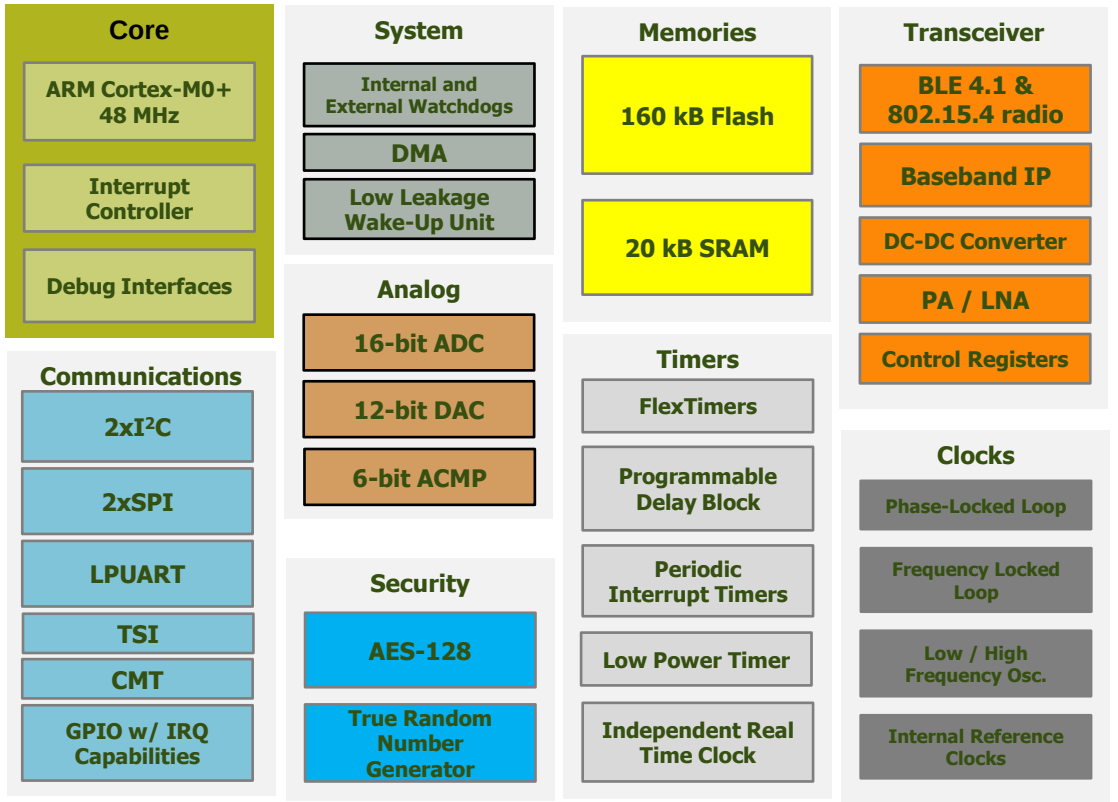
Analog
- 16-bit ADC with integrated temperature sensor and battery monitor
- 12-bit DAC and 6-bit High-speed Comparator

Security
- AES Accelerator and True Random Number Generator

Integrated DC/DC Converter
- Normal: 1.71V to 3.6V
- Buck : 2.1V to 4.2V for coin cell operation
- Boost : 0.9V to 1.795V for single alkaline battery operation

Unique Identifiers
- 80-bit device ID programmed at factory
- 40-bit unique number can be used for Bluetooth Low Energy or IEEE 802.15.4 MAC Address

-40ºC to +105ºC



Device	Memory	Protocol	Package
MKW20Z160VHT4/R	160K Flash, 20K RAM	802.15.4	7x7 48-pin Laminate QFN
MKW30Z160VHM4/R	160K Flash, 20K RAM	BLE	5x5 32-pin Laminate QFN
MKW40Z160VHT4/R	160K Flash, 20K RAM	BLE & 802.15.4	7x7 48-pin Laminate QFN

Features	Description
Software and Protocol Stacks	Bluetooth Low Energy Host Stack & Profiles Thread Stack (supports end node only) ZigBee 3.0 IEEE 802.15.4 MAC SMAC w/ Connectivity Test and Wireless UART KSDK, MQX/FreeRTOS
Availability	Samples – August'15 General Availability/Production – Q4'15

개발 환경의 변화

Growing Importance of Enablement

Average MCU Flash size grew x8 in the last decade

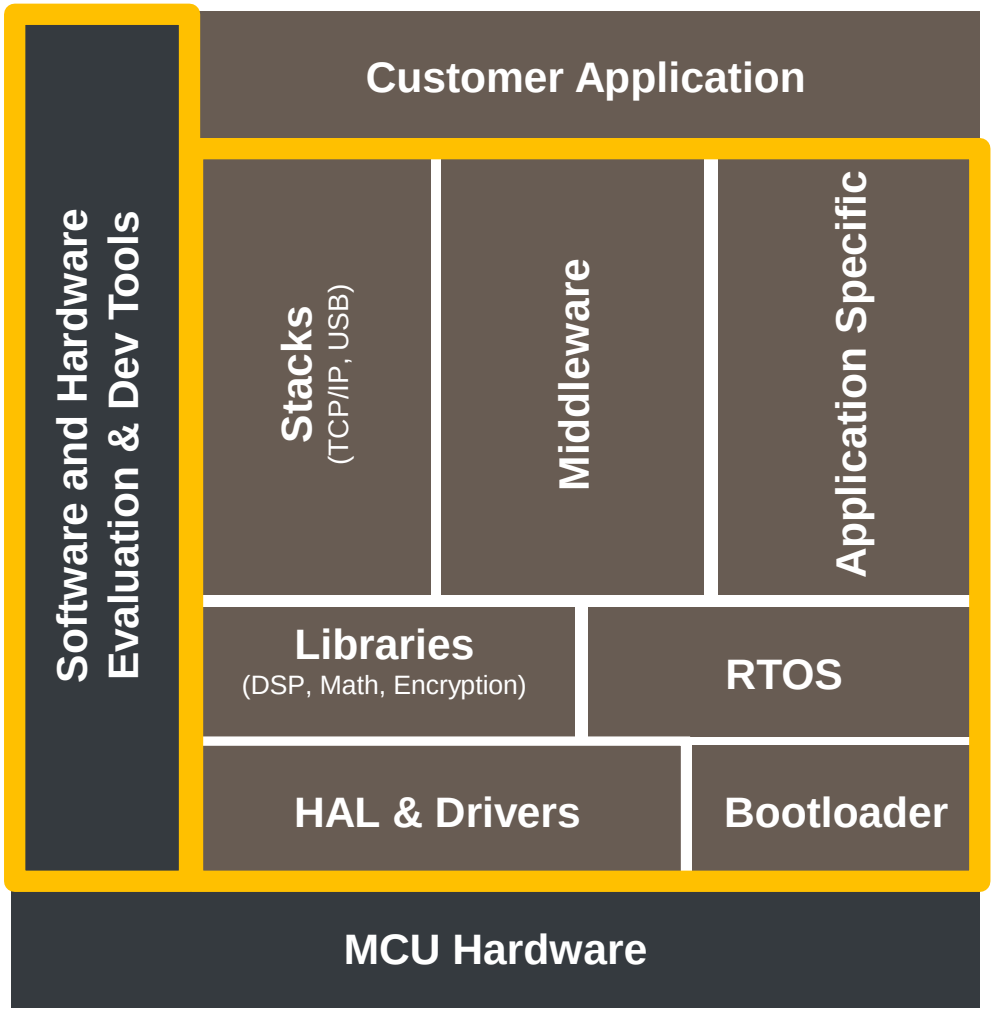
+

FIRMWARE now accounts for 83% of MCU implementation cost

+

53% of projects are delayed >3months due to FIRMWARE

Firmware is MCU developers **BIGGEST** pain point



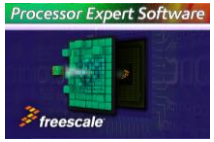
Kinetis Development Software

freescale Kinetis Design Studio

mbed Enabled

IDEs

- ARM ecosystem of IDEs
- **Kinetis Design Studio** – Eclipse and GCC-based IDE, complimentary and unlimited for all Kinetis MCUs
- **mbed** – web-based IDE for rapid prototyping with robust community support



Development Tools

- **Processor Expert (PEx)** – configuration and code generation tool
- **SDK**- complete software framework
- **Bootloader** – in-system flash programming via serial port

Application Specific

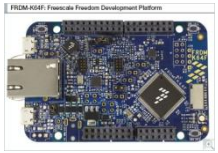
- **PEG** - high performance, high value tool for medium to high end MCUs with a licence fee associated
- Motor Control, Connected Audio Solutions, Wireless Charging, Sensor Fusion, and more.

MQX

RTOS

- **MQX** - free real-time operating system with USB & Ethernet stacks and file system
- **MQX Lite** - free and lightweight RTOS for small microcontrollers

Kinetis Development Hardware



Freedom Platform

- The Freescale platform for Kinetis L, K and E MCUs as well as Xtrinsic sensors
- Compatible with Arduino shields

Tower System

- The established and proven modular platform with highest flexibility and re-usability
- Over 50 peripheral modules available

Device Specific

- Evaluation boards addressing special functions and capabilities of Kinetis devices

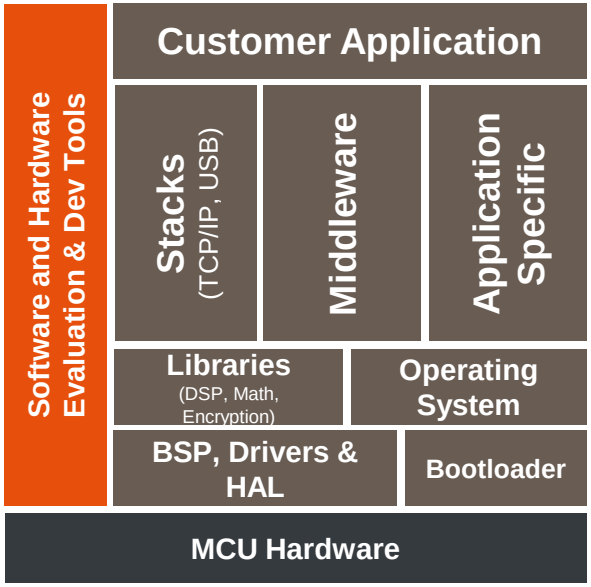
Reference Designs

- Home Energy Gateway, 1ph Meter, 3ph Meter, pre-/post-paid Meter, Home Area Network, Home Display, …
- Available through Freescale RSM

Kinetis Design Studio

No-cost integrated development environment (IDE) for Kinetis MCUs

Eclipse and GCC-based IDE for C/C++ editing, compiling and debugging



Product Features

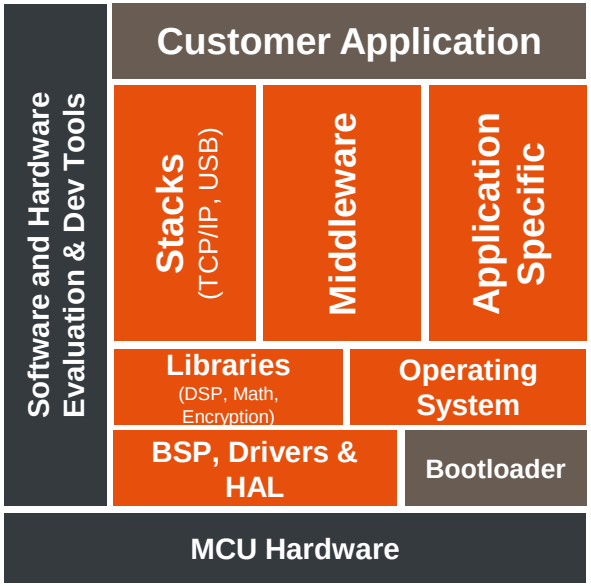
- A free of charge and unlimited IDE for Kinetis MCUs
- A basic IDE that offers robust editing, compiling and debugging
- Based on Eclipse, GCC, GDB and other open-source technologies
- Includes Processor Expert (PEx) with Kinetis SDK integration
  - Supports all existing Kinetis devices via PEx and new project wizard
  - All new Kinetis devices will also feature the Kinetis SDK with PEx configurability
- Host operating systems:
  - Windows 7/8 (32 and 64-bit)
  - Linux (Ubuntu, Redhat, Centos)
  - Mac OS X (coming Q3 2014)
- Support for SEGGER, P&E and Open SDA/CMSIS-DAP debugger targets
- Support for Eclipse plug-ins including RTOS-awareness (i.e. MQX, FreeRTOS)

Kinetis Software Development Kit (SDK)

SDK

A complete software framework for developing applications across all Kinetis MCUs

HAL, peripheral drivers, libraries, middleware, utilities, and usage examples; delivered in C source



Open Source Initiative

CMSIS COMPLIANT ARM® Cortex™ Microcontroller Software Interface Standard

Product Features

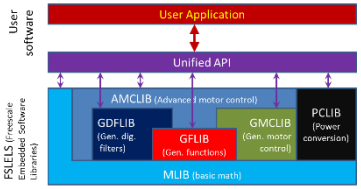
- Open source hardware abstraction layer (HAL) provides APIs for all Kinetis hardware resources
- BSD-licensed set of peripheral drivers with easy-to-use C-language APIs
- Comprehensive HAL and driver usage examples and sample applications for RTOS and bare-metal
- GUI configurable projects and peripheral drivers using Processor Expert
- CMSIS-CORE compatible startup plus CMSIS-DSP library and examples
- RTOS Abstraction Layer (OSA) with support for Freescale MQX, FreeRTOS, Micrium uC/OS, and bare-metal
- Integrates new Freescale unified USB stack, open source TCP/IP stack (lwIP), open source FAT file system, encryption math/DSP libraries, and more and
- Support for multiple toolchains including GNU GCC, IAR, Keil, and Kinetis Design Studio

S/w Enablement Guide

Embedded Software Libraries

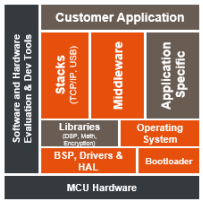
- Integrated h/w & s/w tools that allow any developer to identify, tune and control any type of 3-ph synchronous or asynchronous motor of any power level
- Disturbance rejection control algorithm ensures high performance even in highly dynamic operating conditions
- Motor control algorithms pre-programmed into the MCU
- Intuitive GUI for easy motor configuration & tuning
- Cost: ~20% adder to standard MCU price
- Supported devices
  - KV3x Q315, then KV1x & KV4x

Kinetis Motor Suite



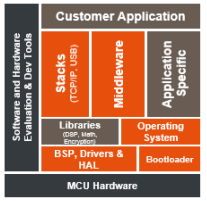
- Libraries of software algorithms for Math, Motor Control, Power Conversion, Filters and Advanced functions. ~200 algorithms available
- Core self test library for IEC60730 with UL Certifications for CM0+
- Free option: binary code released through FSL.com
- Paid option: source code, optimized code, advanced functions (including patented)
- **Cost: free of charge**
- Supported devices
  - KV1x, KV3x, KV4x,
  - KV5x (Sept ‘15)

Kinetis SDK & Processor Expert Code Generator



- SDK – a complete software framework for developing applications across all Kinetis MCUs. h/w abstraction, peripheral drivers, stacks, RTOS’s, utilities, and usage examples; delivered in C source
- Processor Expert – GUI Eclipse plug-in tool for creating and configuring software and peripheral drivers quickly & easily
- **Cost: free of charge**
- Supported devices
  - KV1x, KV3x & KV4x
  - KV5x (Sept’15)

MQX RTOS



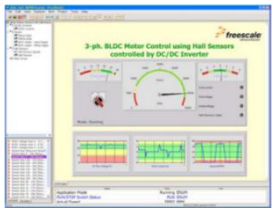
- Commercial-grade MCU software platform at no cost with optional support packages
- RTOS Kernel, Real Time TCP/IP Communication Suite, File System, USB Host/Device Stack and Board Support Packages
- **Cost: free of charge**
- Supported devices
  - KV3x & KV4x
  - KV5x (Sept ‘15)

S/w Enablement Guide

FreeMASTER

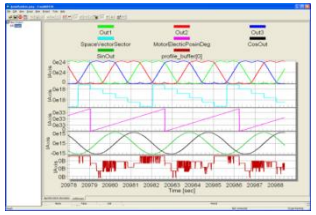
- GUI based FreeMASTER plug-in tool that provides real-time monitoring, tuning and updating of motor control system parameters
- Provided as a plug-in for the FreeMASTER tool. Designed to work with FSL Ref. Design s/w
- http://www.youtube.com/watch?v=ZsLQzSTnhgo
- **Cost: free of charge**
- Supported devices
  - KV1x, KV3x, KV4x,
  - KV5x (Sept ‘15)

MCAT (Motor Control Application Tuner)



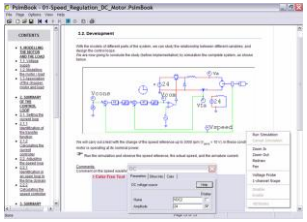
- Complimentary GUI based run-time debug monitor and data visualization tool
- Replaces debugger in situations when the core can not be simply stopped, ideal for motor control and power conversion application development
- http://www.youtube.com/watch?v=vKVlxu8ecdg
- **Cost: free of charge**
- Supported devices
  - KV1x, KV3x, KV4x,
  - KV5x (Sept ‘15)

Motor Control Toolbox



- MATLAB™/Simulink™ modelling environment motor control plug-in tool for automatic code generation. Supports multiple compilers. FreeMASTER compatible.
- http://www.youtube.com/watch?v=5pTuOEWq78g
- Cost: $8K license cost
- Supported devices
  - KV1x, KV3x, KV4x
  - KV5x (Q3/5 2015)

POWERSIM Motor Control Design Suite



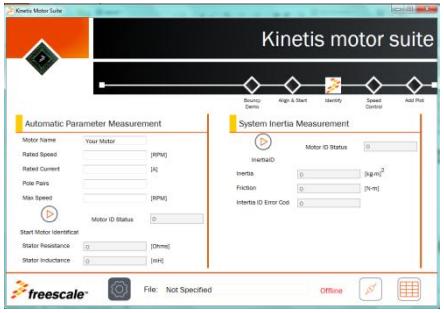
- Simulation software specifically designed for power electronics and motor drives
- Cost: $700 (1st license)
- Supported devices
  - KV3x (Q3 2015)
  - Others to follow

Motor control-
Design a new application in just 7 Steps !!

1 **Create Project**

2 **Identify Motor & Inertia**

- Spin your motor & automatically measure feedback

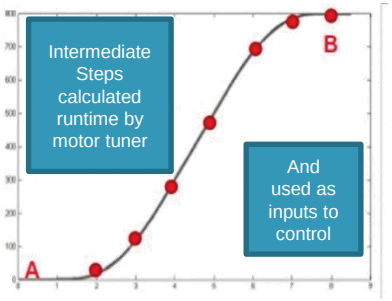


3 **Set controller limits**

- Single Dial Control to set speed and position

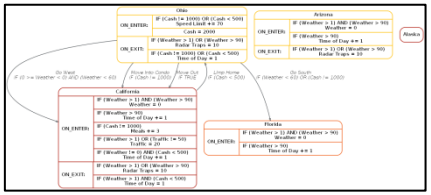
4 **Build your trajectories**

- Set smooth transitions from 1 speed to the next



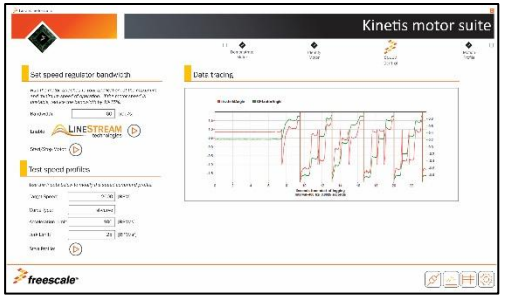
5 **Plan your motion sequence**

- Easily define your operating states & transitions



6 **Fine Tune you setup**

- Test reference speeds and bandwidths across range

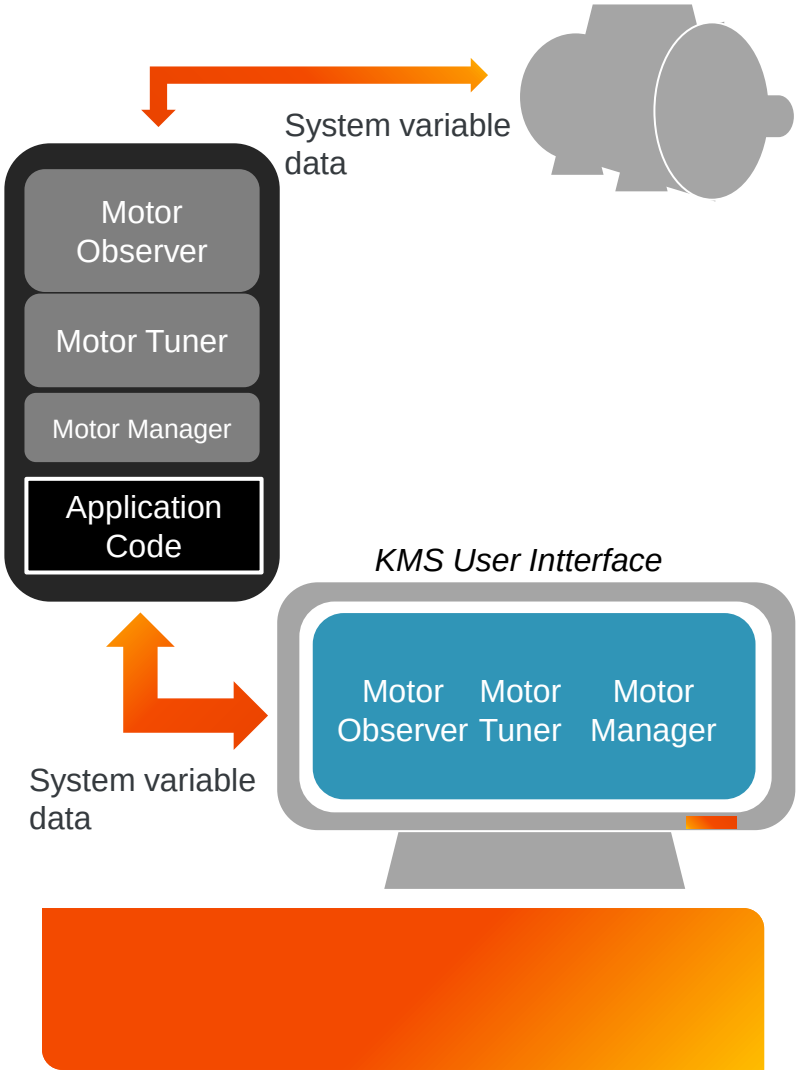


7 **Add Application Profile & Debug**

- Build in your motor application profile
- Debug the application

Application Development Timeline

New Kinetis Motor Suite

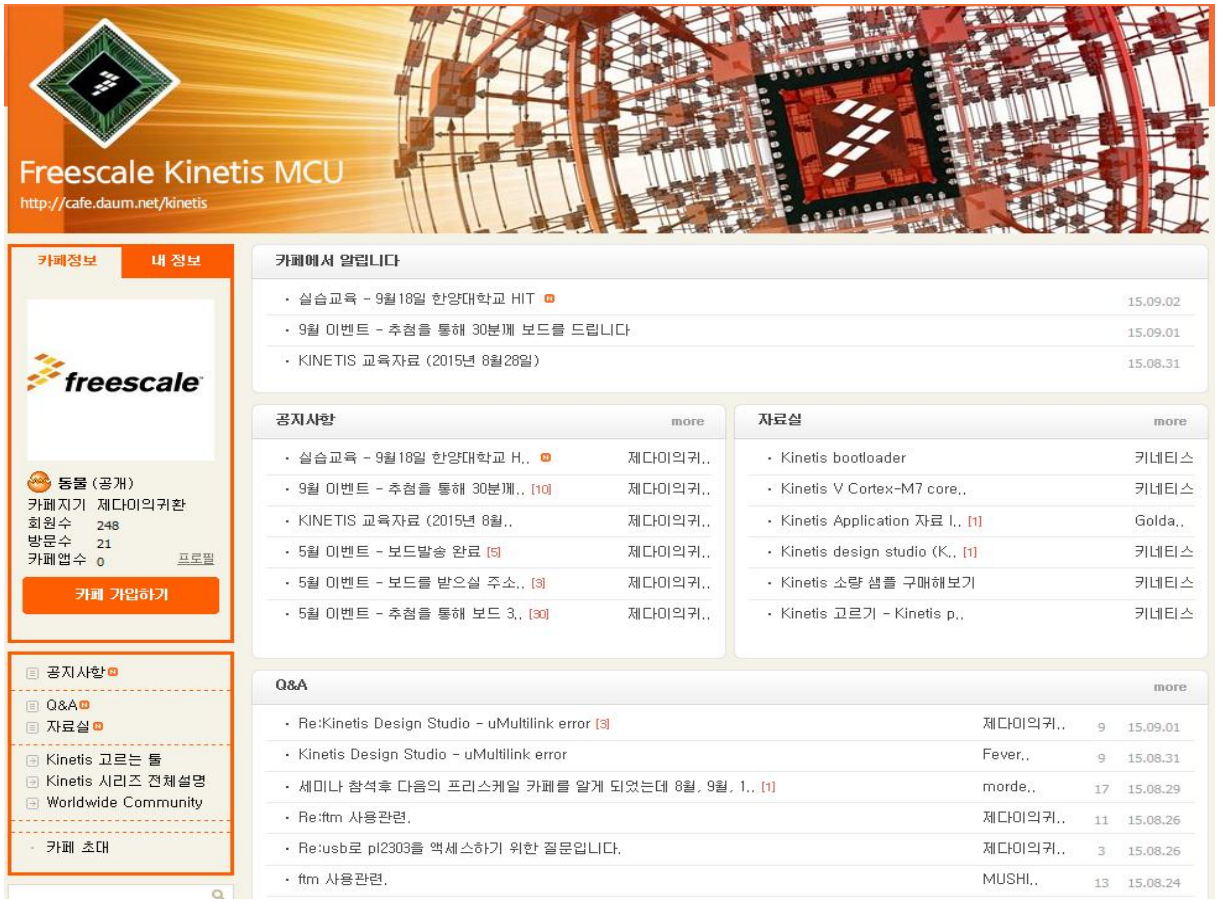


Customer Design Flow

1. Identify Motor Parameters
2. Identify Application Inertia
3. Tune Speed Regulator
4. Build Motion Profiles and Application State Machine
5. Test Profiles with real application loads and debug.

Freescale Kinetis Community

- http://cafe.daum.net/kinetis
- 기술 문의, 교육 일정 공지



www.Freescale.com