Freescale and Thread - Making the Connected Home a Reality

EUF-SNT-T1228

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O C T . 2 0 1 5

Agenda

- Winning Technologies in IoT Today
- Megatrends Visible Today
- Wireless Connectivity Strategy and Positioning
- Kinetis Wireless Portfolio
- Introduction to Thread

Addressing the Need for Secure, Connected Solutions

Critical Attributes

Security

Driving enhanced protection for customer IP and end customer personal information with standard on-chip cryptographic accelerators and industry-leading security mechanisms

Connectivity

Improving customer time to market with rapid and easy prototyping and development tools and software (RTOS, SDK, Design Studio IDE), turnkey designs and strategic ecosystem

Low-Power

Leading innovation with an optimized ultra-low-power architecture designed for maximum flexibility with efficient ARM® cores, low-power boot capabilities, smart peripherals and various power modes

Selection Criteria for Connectivity

Range

Many applications have a prerequisite that forces the selection of the frequency spectrum. Home automation is a great example of an application domain where there is no ‘one size fits all’!

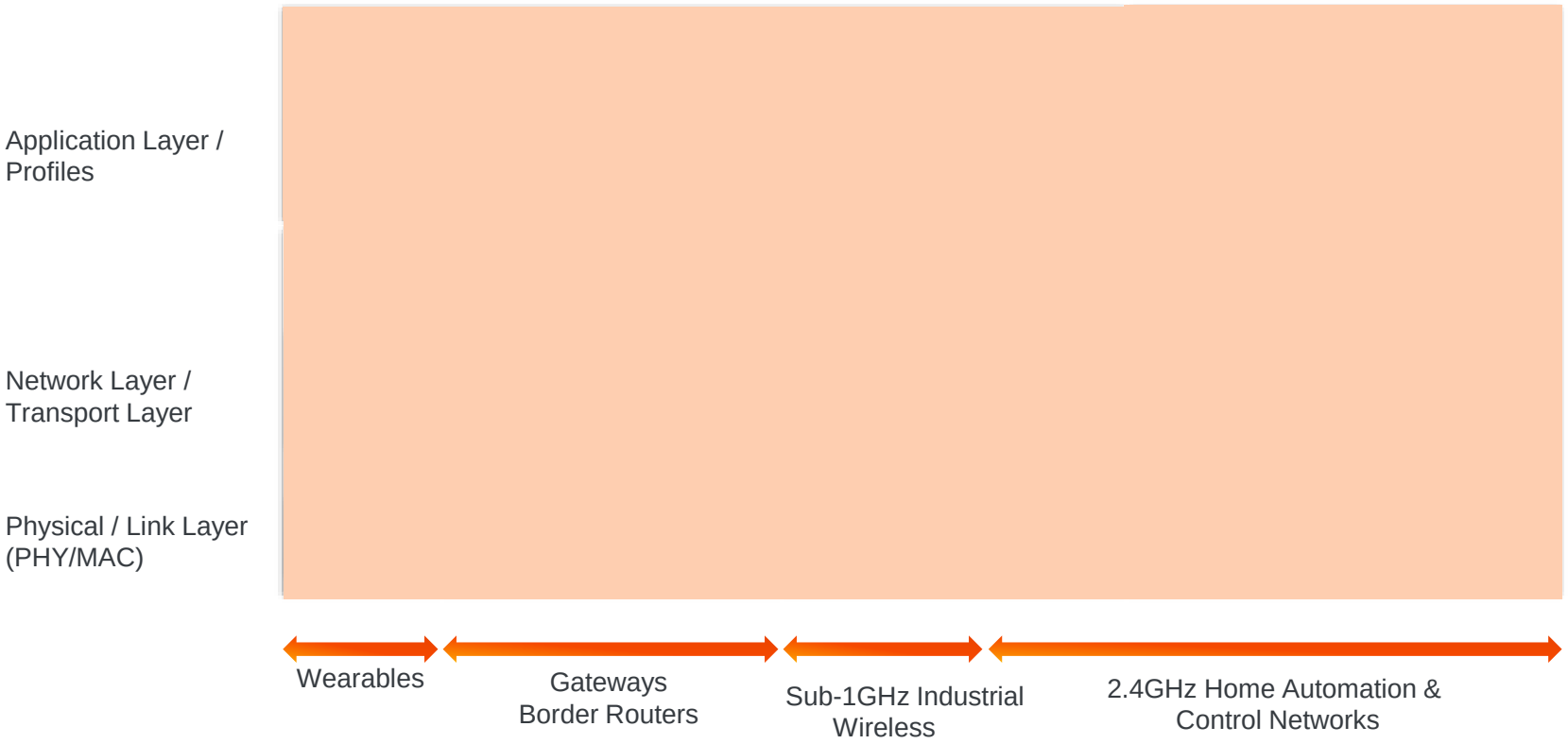
Network Topology

Point-to-point is simple. A star configuration can benefit to the power consumption of the entire system. A mesh can enable a great number of connections. A combination of everything can be a real challenge!

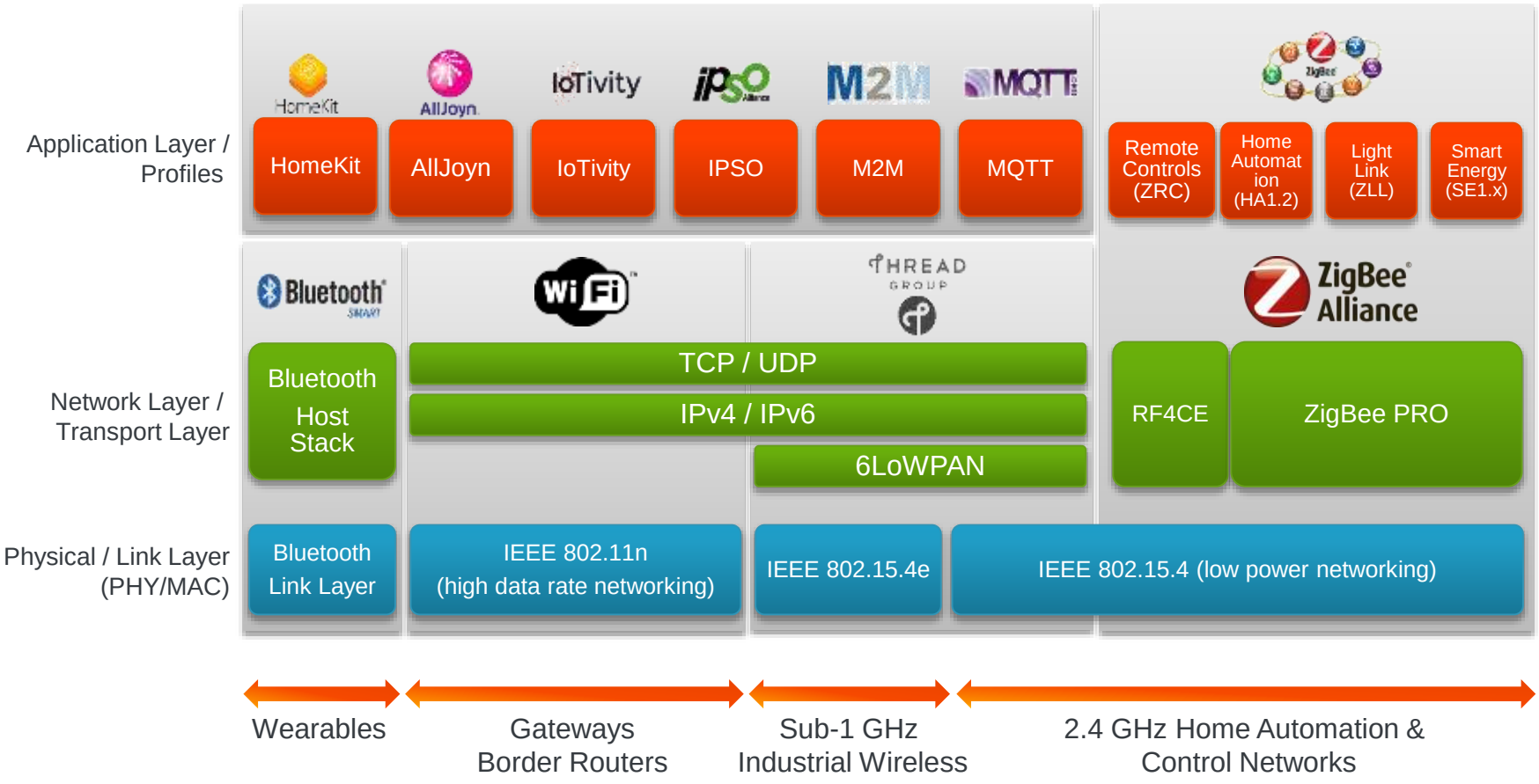
Protocol

Selecting a new protocol can be the right thing to do technically. Now other commercial considerations have their words to say.

Diversity of Connectivity Solutions



Diversity of Connectivity Solutions



Megatrends that are Visible Today

Opportunities

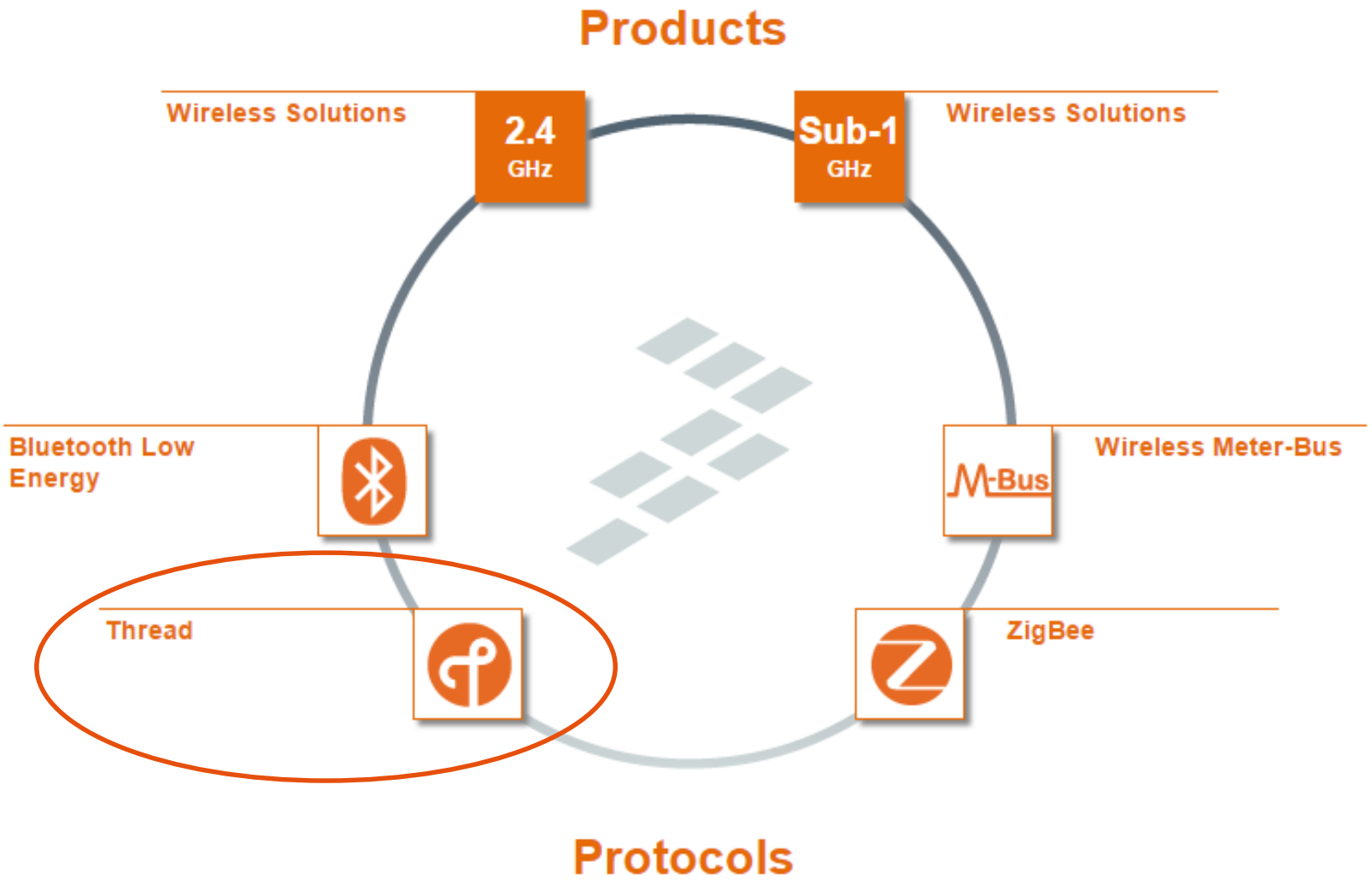
- Multi-protocol solutions
- New interaction with the user
- Power scheme optimization
- Adding new security schemes
- Move to IP-based networks
- Connecting to the cloud

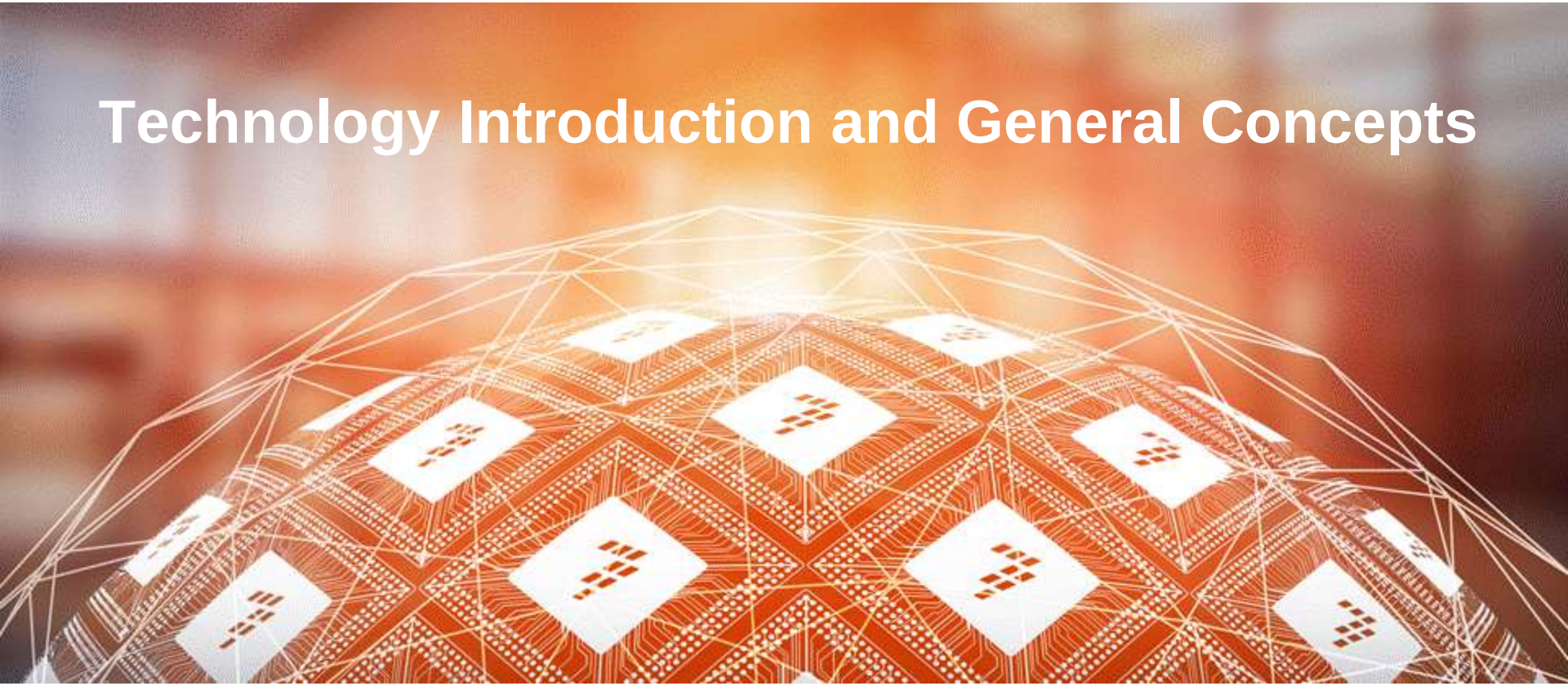
Challenges

- Radio co-existence (HW)
- Communication co-existence (SW)
- Blind spots
- Lack of standards for IoT
- Compatibility with legacy products
- Ecosystem to enable seamless integration

Wireless Connectivity HomePage

http://www.freescale.com/webapp/sps/site/homepage.jsp?code=WIRELESS-CONNECTIVITY





Technology Introduction and General Concepts

Why a New Technology ?

Internet of Computers →

Internet of Mobility → Wi Fi™

Internet of Peripherals → Bluetooth®

Internet of Things → THREAD

IP Everywhere

Internet of Tomorrow

THREAD The Need for a New Wireless Network

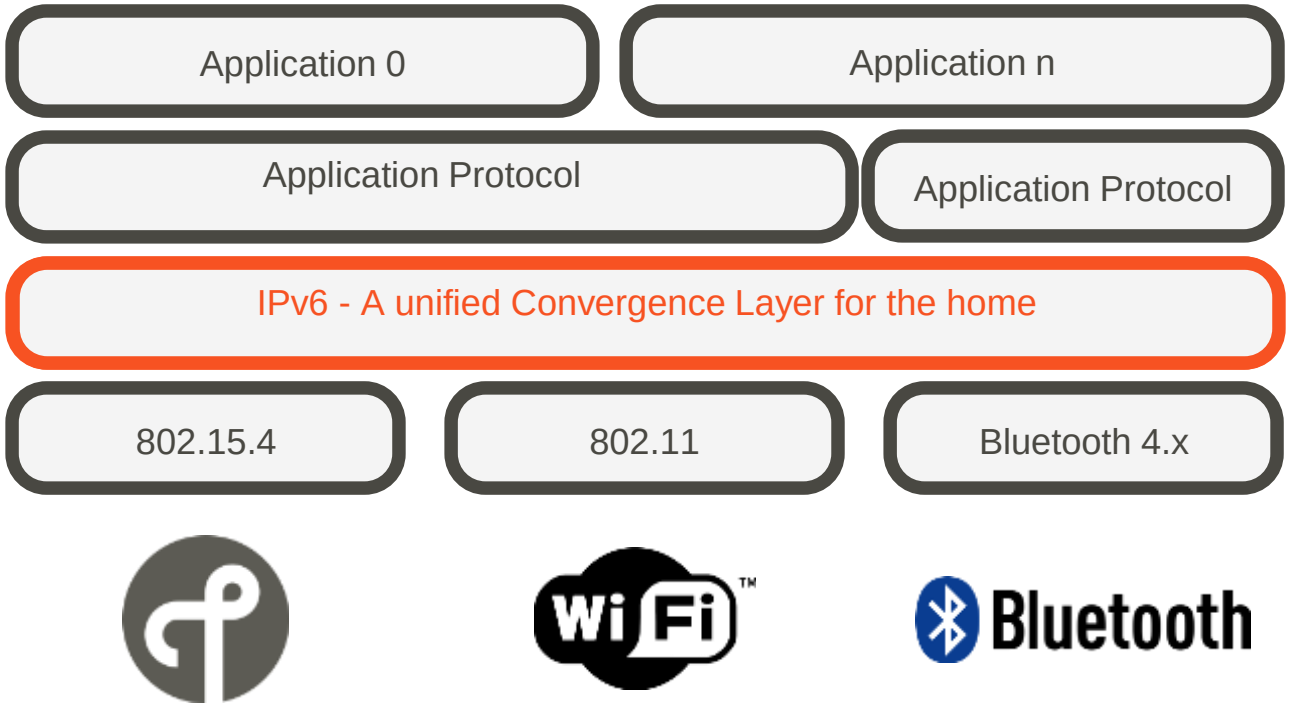
- We are entering a new era of connected products
- We wanted to use an existing wireless mesh protocol
- After talking with other companies it was clear that they shared the same concerns

Requirements:

New wireless home network

- ✓ Low power
- ✓ Resilient (mesh)
- ✓ IP-based
- ✓ Open protocol
- ✓ Secure and user friendly
- ✓ Fast time to market
- ✓ Existing radio silicon

Why IP?

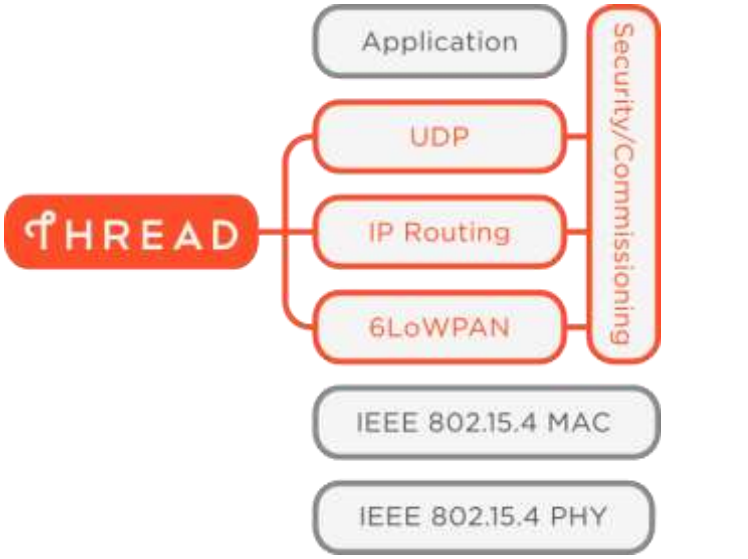

Application 0
Application n
Application Protocol
Application Protocol
IPv6 - A unified Convergence Layer for the home
802.15.4
802.11
Bluetooth 4.x
Wi Fi
Bluetooth

THREAD What it Delivers

A secure wireless mesh network for your home and its connected products

- Built on well-proven, existing technologies
- Uses 6LoWPAN and carries IPv6 natively
- Runs on existing 802.15.4 silicon
- New security architecture to make it simple and secure to add / remove products
- 250+ products per network
- Designed for very low power operation
- Reliable for critical infrastructure

Can support many popular application layer protocols and platforms



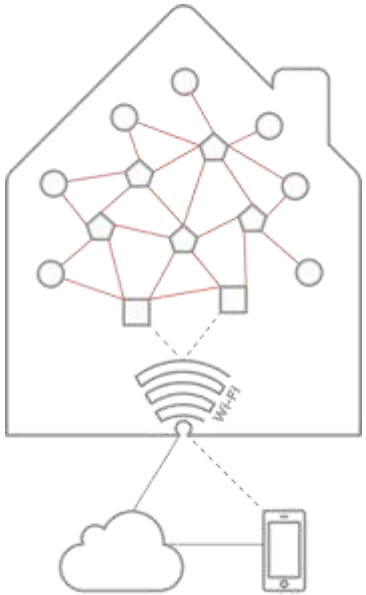
A software upgrade can add Thread to currently shipping 802.15.4 products

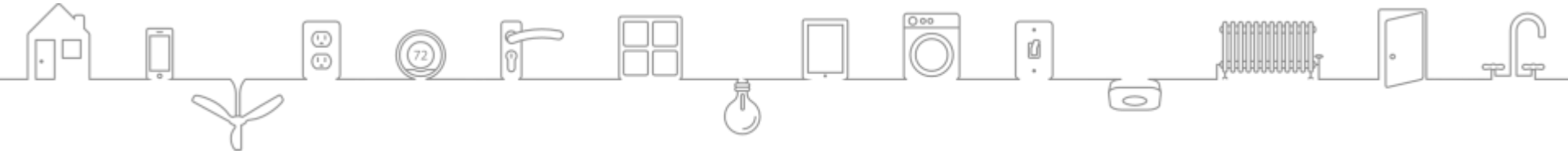
THREAD Target Applications

Thread is designed for all sorts of products in the home

- Access control (Door locks)
- Climate control (HVAC, Thermostats, Radiators valves)
- Energy management (Meters, Smart plugs, in-home displays)
- Lighting
- Safety (CO Detector)
- Security (Glass break sensor, Window/Door sensor, Occupancy sensors)

Devices working together to form a cohesive mesh network





THREAD Group

Founding Members

ARM

BIGASS FANS No Equal

freescale

nest

SAMSUNG

SILICON LABS

Yale

Sponsors

somfy

tyco

QUALCOMM

THREAD Group

64 Contributors

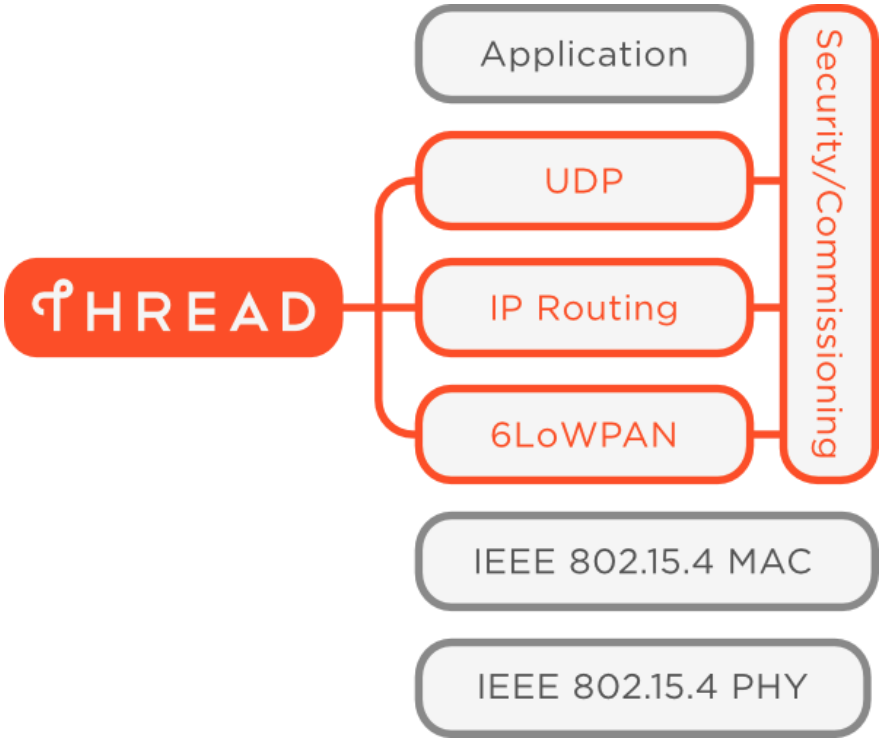
Affiliates

87 companies

THREAD What it Delivers

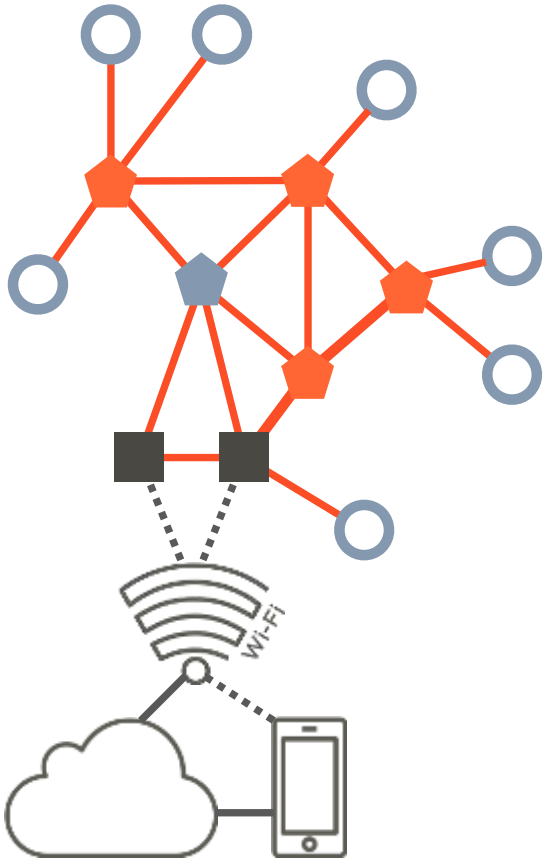
- A secure wireless mesh network for your home and its connected products
  - Built on well-proven, existing technologies
  - Uses 6LoWPAN and carries IPv6 natively
  - Runs on existing 802.15.4 silicon - Product development can start today
  - Designed with a new security architecture to make it simple and secure to add and remove products
  - Supports 250+ products per network
  - Designed for very low power operation

Thread can support many popular application layer protocols



A software upgrade can add Thread to currently shipping 802.15.4 products

THREAD Network Architecture



End Device or Router Eligible

Thread Router

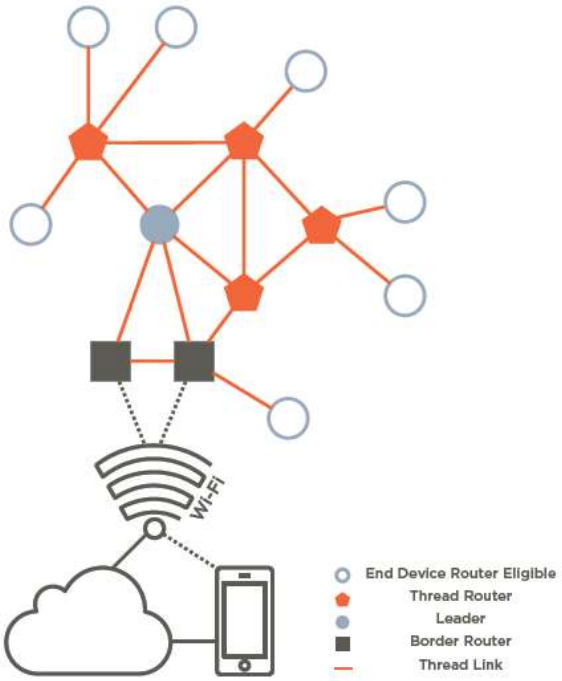
Leader

Border Router

Thread Link

THREAD Direct Addressability of Devices

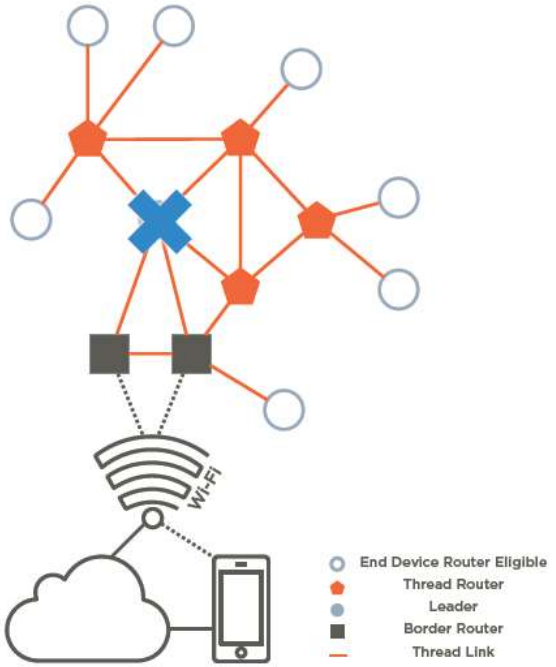
- All devices have IPv6 addresses plus short address on HAN
- DHCPv6 used for router address assignment
- Home Network can directly address devices through Border Routers
- Cloud Services can address devices from the Internet
- Devices can address local devices on HAN or off network devices using normal IP addressing



THREAD No Single Point of Failure

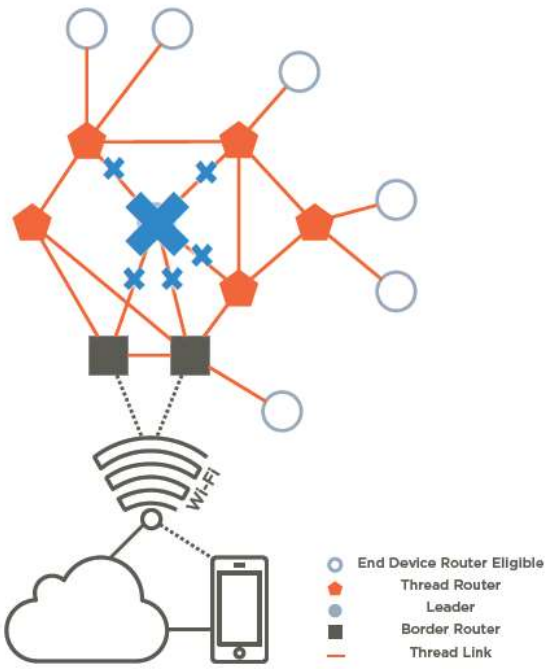
- No need to recognize specialized devices within the network

- Leader makes decisions but can fail and another router will become Leader



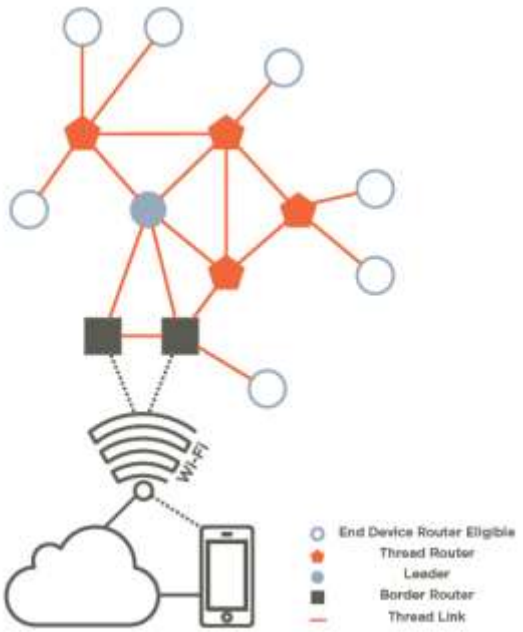
THREAD No Single Point of Failure

- No need to recognize specialized devices within the network
- Leader makes decisions but can fail and another router will become Leader
- Network will add routers to improve connectivity when required

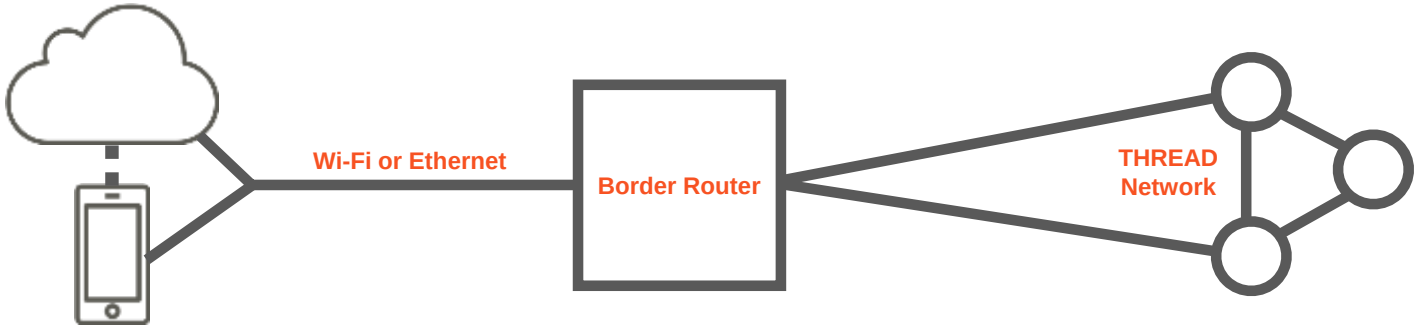


THREAD Low-Power Operation

- Sleeping devices poll parents for messages (or remote device if application configured)
- Sleeping device not required to check in allow lower power operation
- Parents hold messages for sleeping devices
- Sleeping device automatically switches parent if it loses connectivity



System Messaging Model



Cloud Connectivity

Cloud connectivity for control when not at home

When within the home, phone or tablet must go direct to gateway to eliminate latency
of going to the cloud

Has to be seamless to consumer using device

Border Router

Border Router forwards data to cloud

Also provides Wi-Fi connectivity to phone, tablet or other devices in the home network.

Device Communication

Expect device to device communication within the Thread network for operations in the home

Freescale Wireless Connectivity Solutions

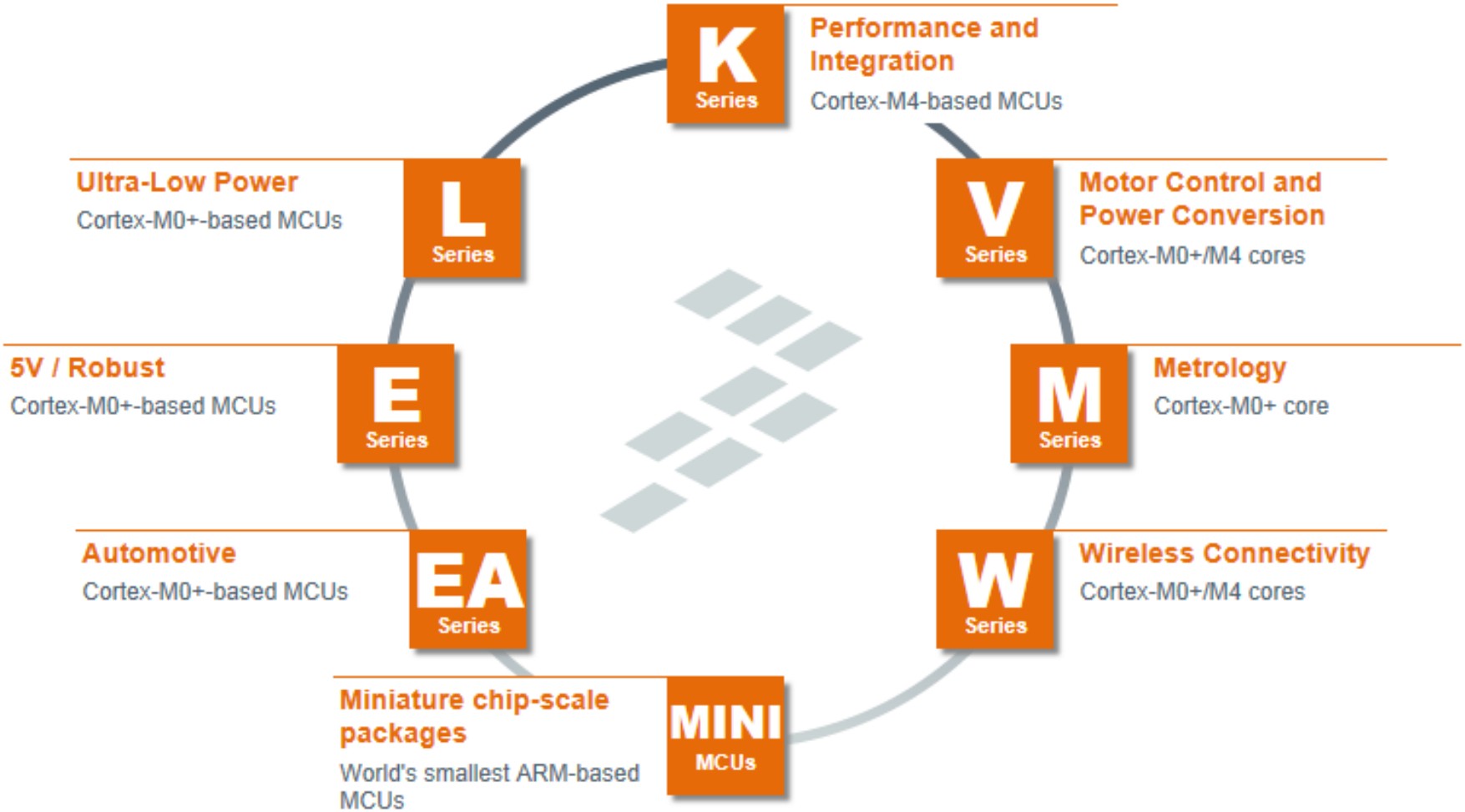
Freescale Strategy and Vision

- **Differentiate through Software**
  - Deliver all our software integrated in the Kinetis environment
  - Deliver all our software packaged with FreeRTOS and MQX
  - Optimize our PHY/MAC, network & transport layers

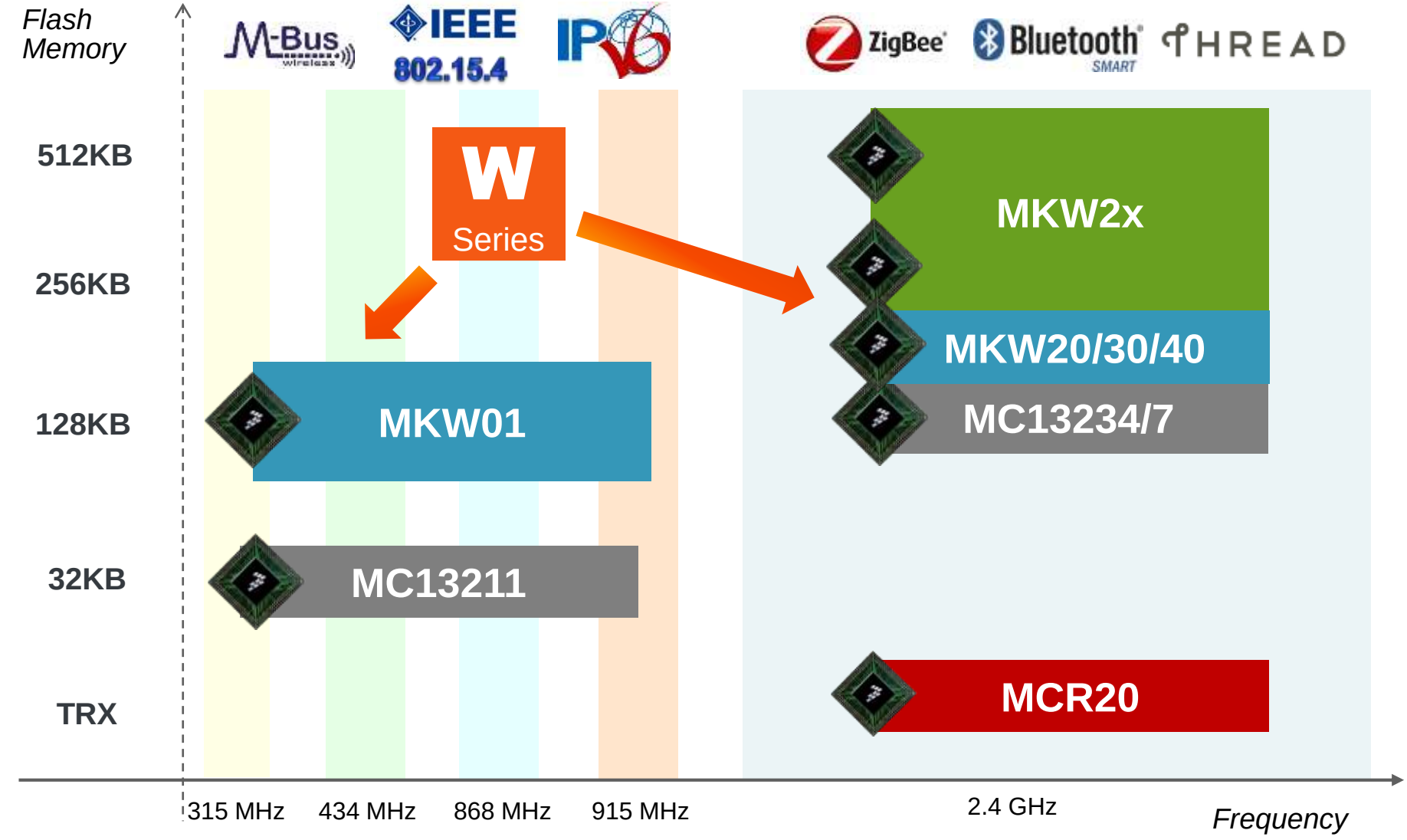
- **Deliver Compelling SoC based Solutions**
  - Implement complete convergence between our MCU and Connectivity products
  - Deliver solutions for 2.4GHz and sub-1GHz, Narrow-Band and WiFi
  - Focus on multi-protocol devices

- **Provide a Complete Development Environment**
  - Re-use our MCU experience to deliver outstanding support
  - Create best-in-class connectivity tools and ref. designs
  - Work with partners when Freescale does not have the best offer

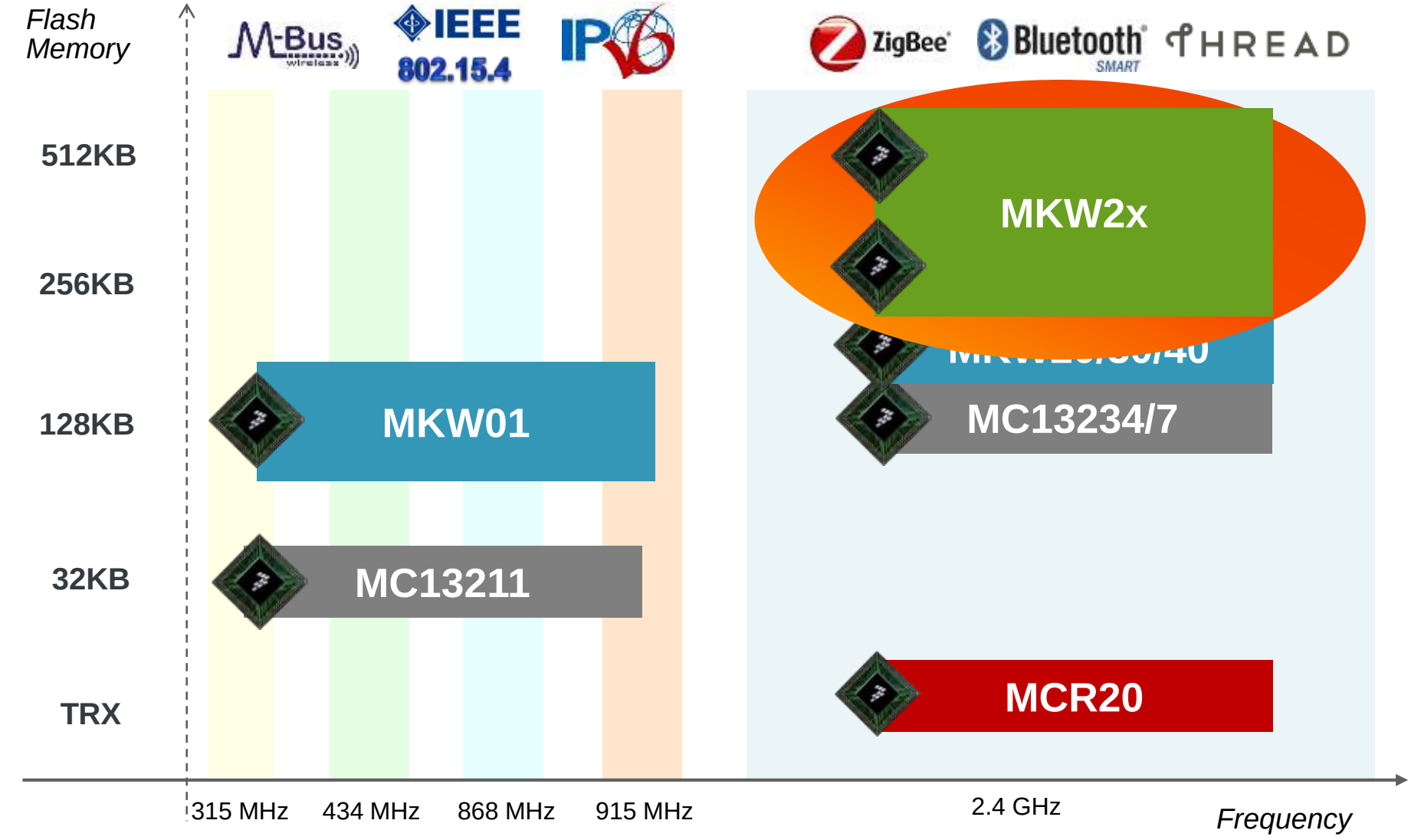
Wireless in Kinetis Portfolio



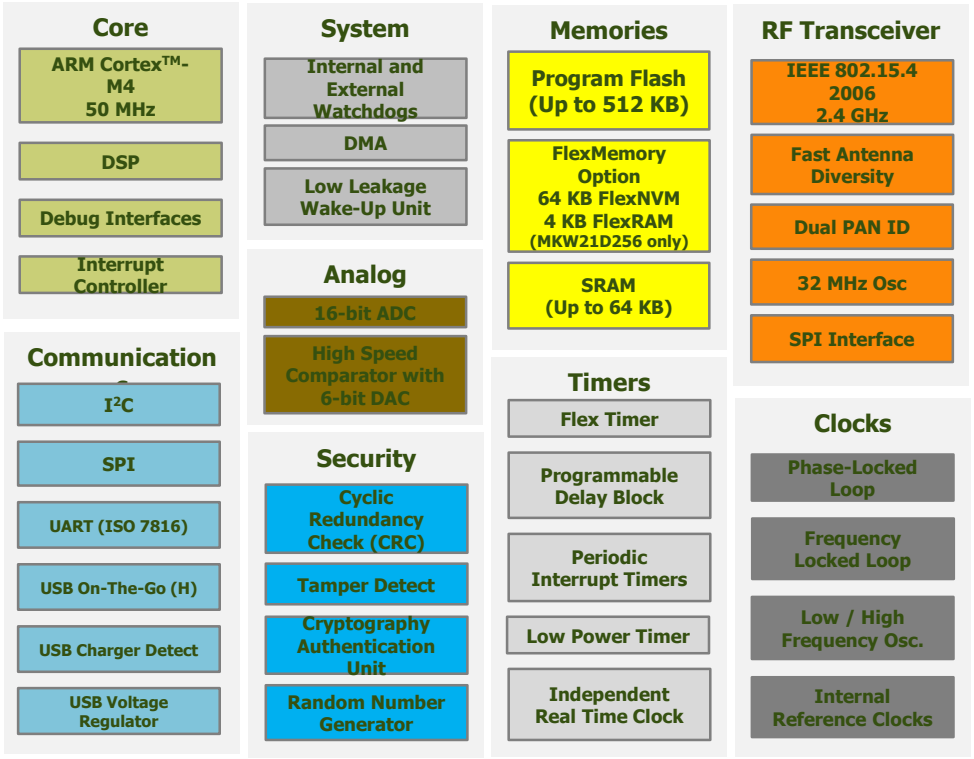
Wireless Connectivity Solutions



Wireless Connectivity Solutions



Kinetis MKW2xD Wireless MCU (2.4 GHz)



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

CPU

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

Radio Transceiver, 2.4 GHz

- IEEE-802.15.4 compliant
- -102 dBm RX sensitivity and +8 dBm TX output power
- Peak typical current: 17mA TX and 19mA RX

Security

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

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, -40°C to +105°C

freescale™

MKW2xD Unique Features

- **Dual PAN Support**
  - Ability to participate in two networks simultaneously
  - Maintains two sets of network parameters
  - Hardware block : No extra software bandwidth required

- **Antenna Diversity**
  - Maximize the communication link quality
  - No loss from orthogonal antennas
  - Ideal if no freedom in device orientation
  - Hardware block : No extra software bandwidth required

- **Security Block**
  - Active and passive tamper detection with RTC timestamp
  - Cryptographic Encryption engine: DES, 3DES, AES 128-256, SHA-1, SHA-256, MD5, RNG

MKW2xD Development Kit

Kit Features

- Can use PCB “F” antenna or bypass for external antenna via RF connector
- Open-SDA debugging
- USB port to interface with PC
- Configurable I/O access
- LEDs and switches for demonstration, monitoring and control
- Full software stacks and applications
- BeeStack (ZigBee Pro, RF4CE, part of BeeKit)
- Flexible IPv6 Stack (6LoWPAN toolbox)
- Quick Start Guide

USB-dongle Form Factor

- Use is as sniffer hardware
- Host processors

USB-KW24D512

- *An external antenna needs to purchased separately*

MKW2xD Freedom Kit

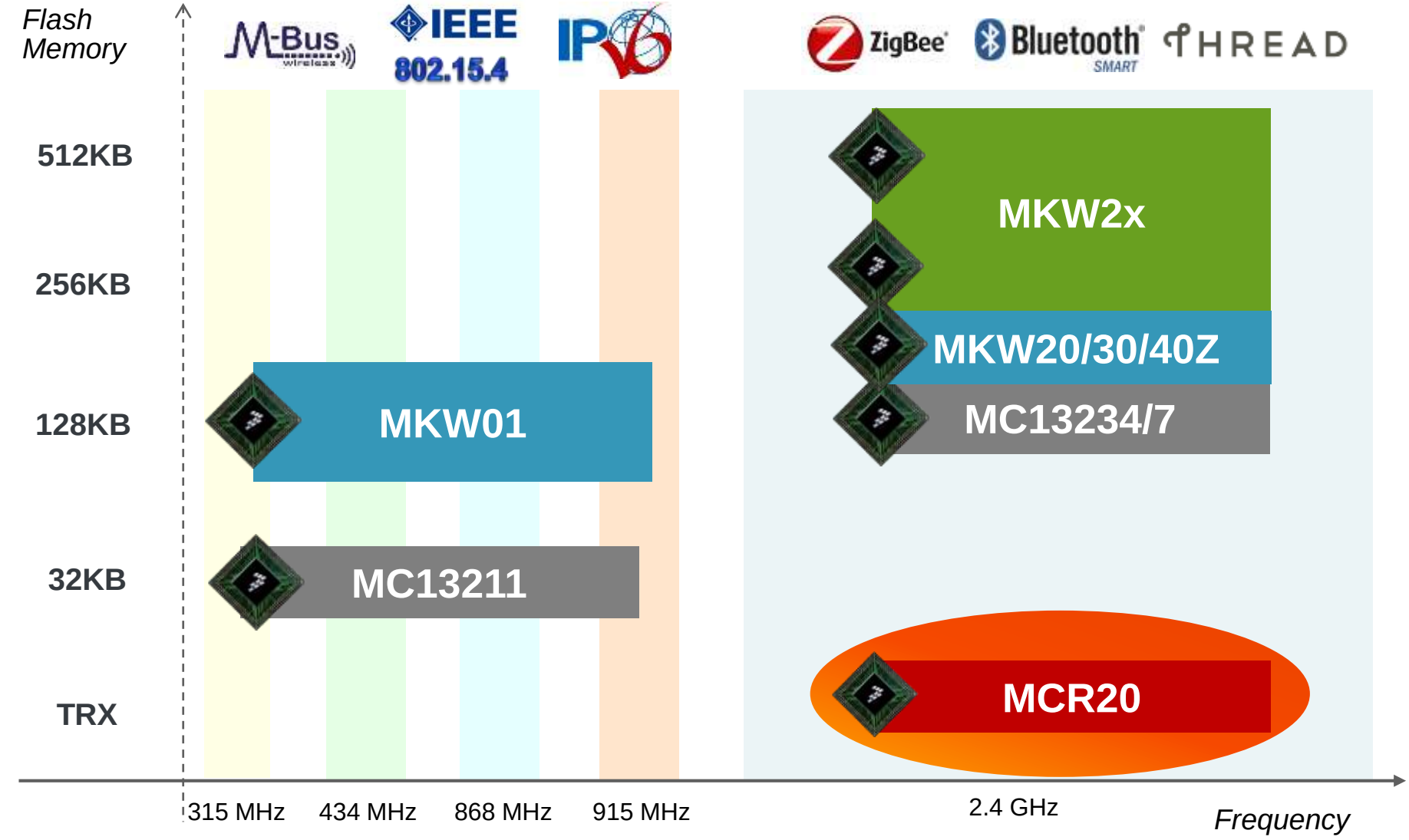
Board Features

- Compliant FCC Part15 & EN300 328
- PCB inverted F-type antenna
- SMA RF Connector can be jumped in
- Minimum number of matching components and external BALUN
- Full KSDK support
- Complete documentation available
- Is moving to volume production right now

- Part-number: **FRDM-KW24D512**
- Suggested Resale: **$195**. Availability in September 2015
- The **USB-KW24D512** dongle can be used for sniffing

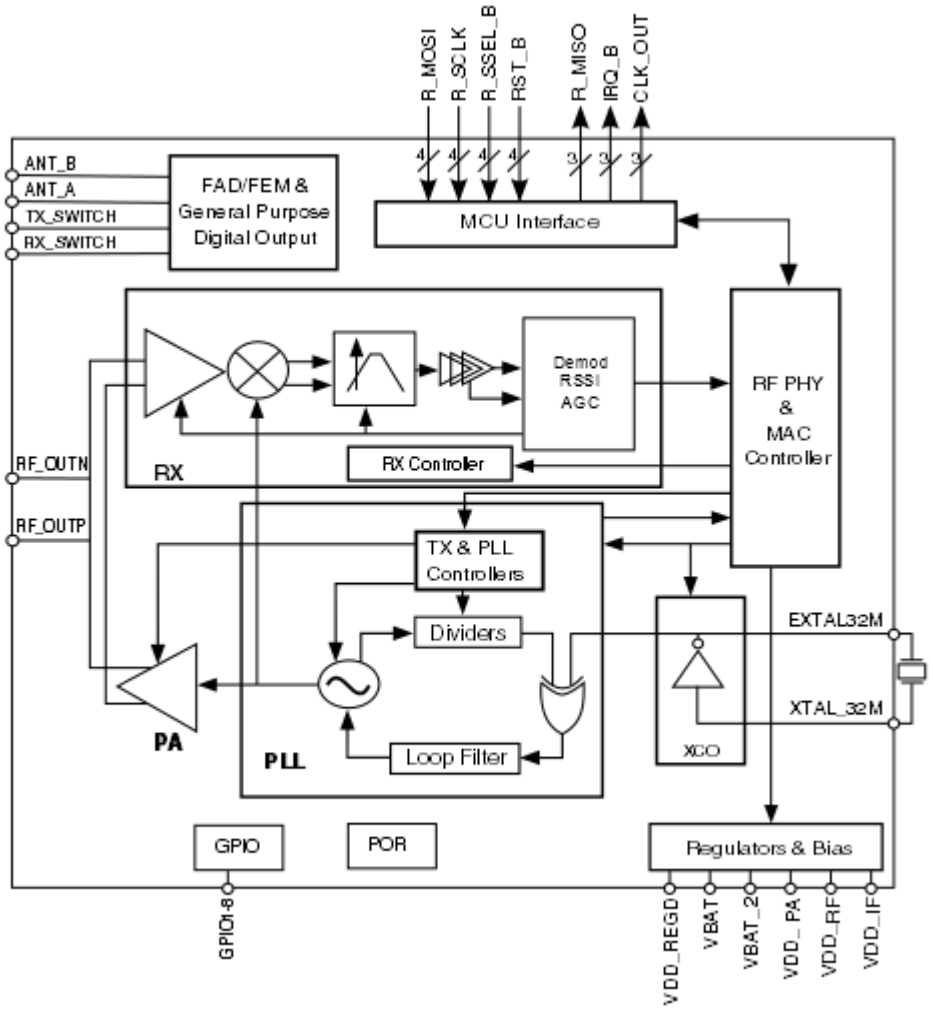
- **News: the kit will include 2 FRDM boards!**

Wireless Connectivity Solutions



MCR20AVHM 802.15.4 Transceiver Highlights

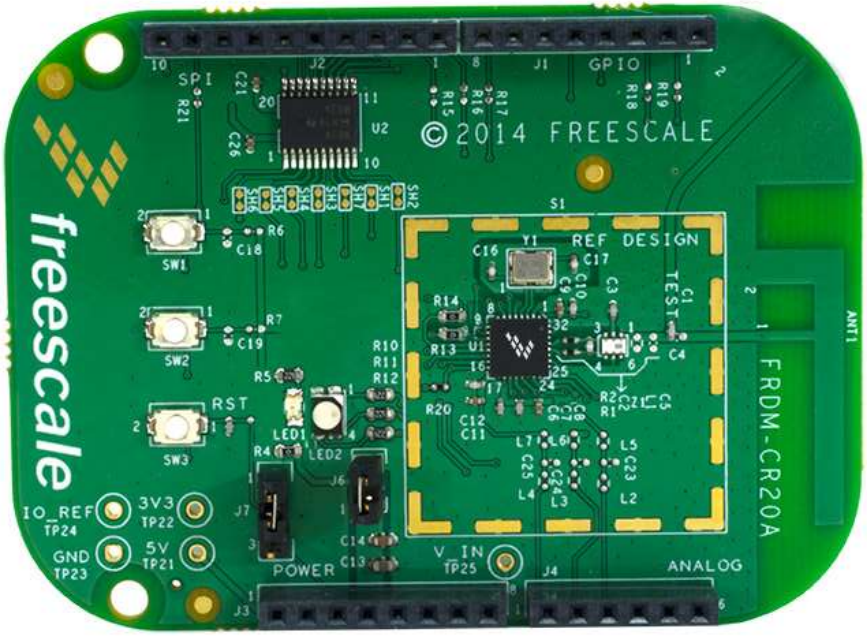
- **RF Features**
  - 2.4 GHz frequency ISM band, including MBAN
  - -102dBm receive sensitivity
  - Up to + 8dBm programmable output power
  - TX 17 mA at 0dBm and RX 19 mA typical
- **System Features**
  - AES Hardware encryption/decryption
  - Packet processor for hardware acceleration
  - Supports single ended and diversity antenna options
  - Dual-PAN support
  - True Random Number Generator
  - -40 °C to 105 °C
  - 1.8 to 3.6 V
  - 5x5 LGA 32-pin



MCR20A Freescale Freedom Development Platform

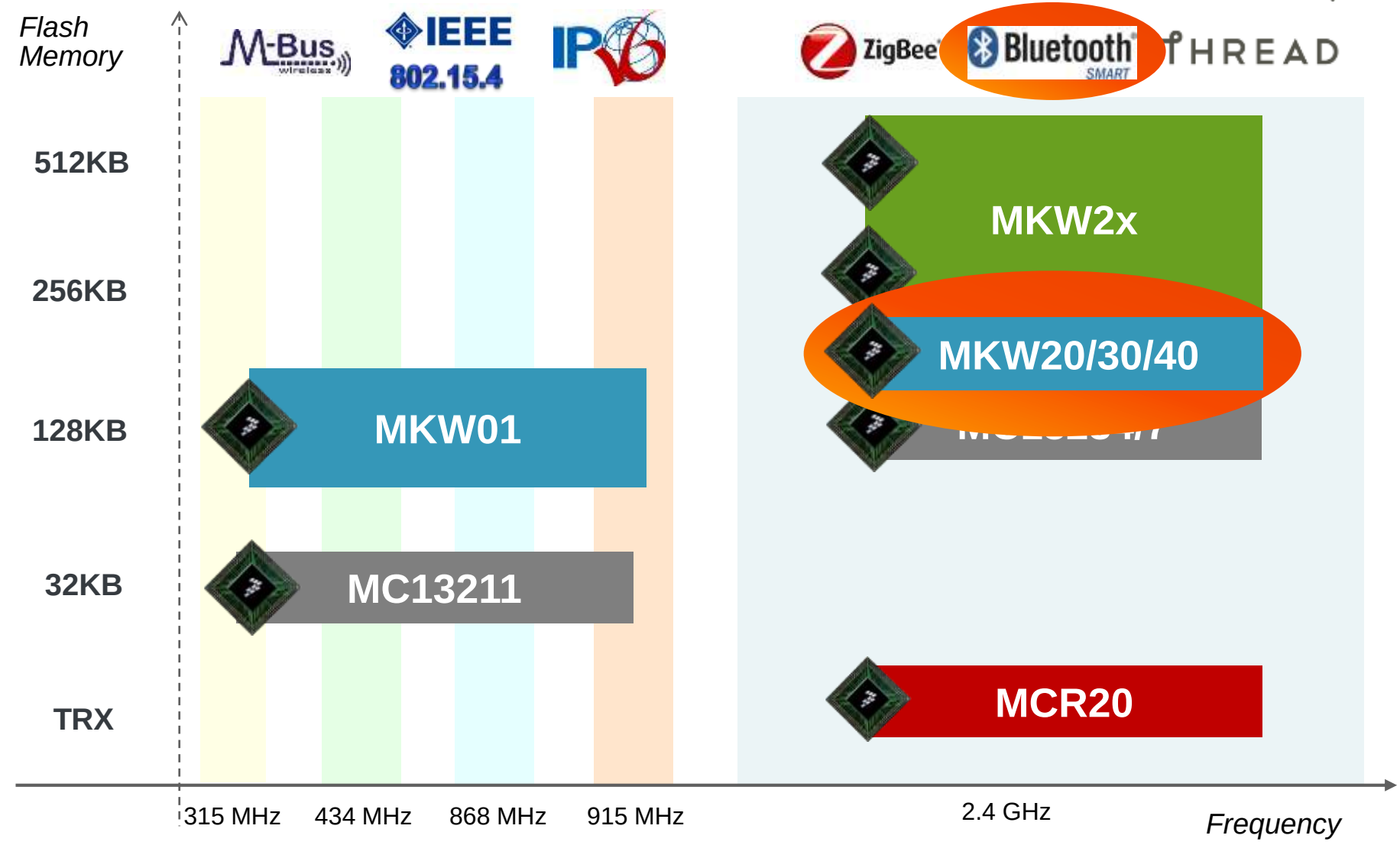
Board Features

- Compliant FCC Part15 & EN300 328
- PCB inverted F-type antenna
- SMA RF Connector can be jumped in
- Minimum number of matching components a
- 1 RGB LED indicator
- 2 push button switches
- Arduino compatible
- 2-Layer metal, 0.062 inch thick board
- Full KSDK support
- Complete documentation available



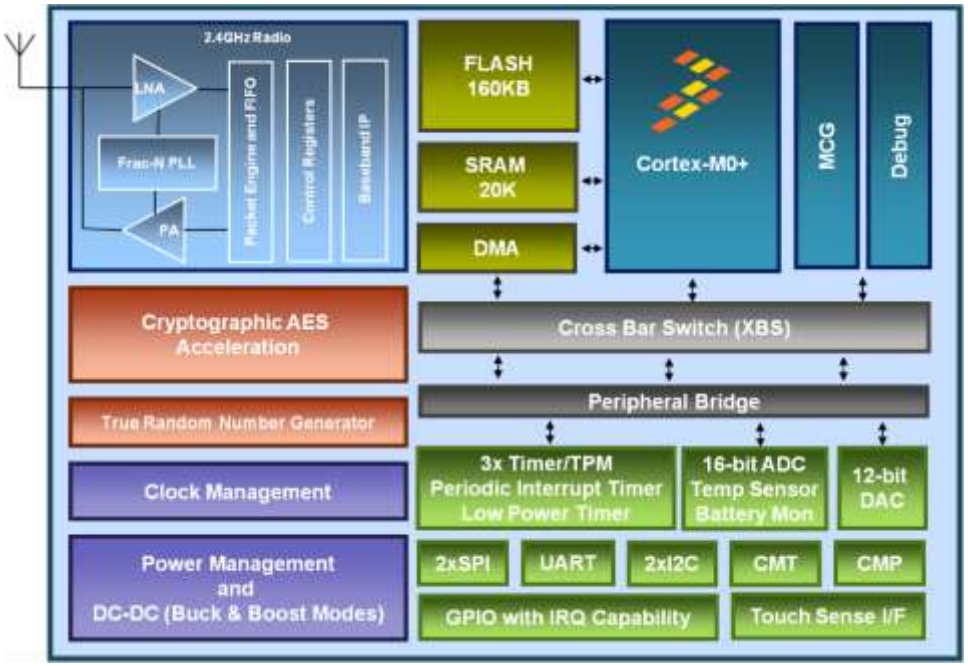
- Orderable using **FRDM-CR20A**
- Can be directly connected to the FRDM-K64F & FRDM-KL46
- Suggested Resale: $89

Wireless Connectivity Solutions



MKW40Z160 First Dual-mode 2.4 GHz Kinetis SoC

- **RF Features**
  - Dual-mode concurrent BLE and 802.15.4 radio capability
  - 6.4/8.5 mA typical Rx & Tx currents with DC/DC activated
  - Excellent selectivity and blocking
  - Solid link budget performance
- **System Features**
  - Buck Boost DC/DC working from 0.9V to 4.2V
  - Excellent on-chip analog integration (16bit ADC, 12bit DAC, 6xCMP)
  - -40 °C to 105 °C
  - 1.8 to 3.6 V
  - 5x5 and 7x7 32-pin and 48-pin package options



MKW40 Freescale Freedom Development Platform

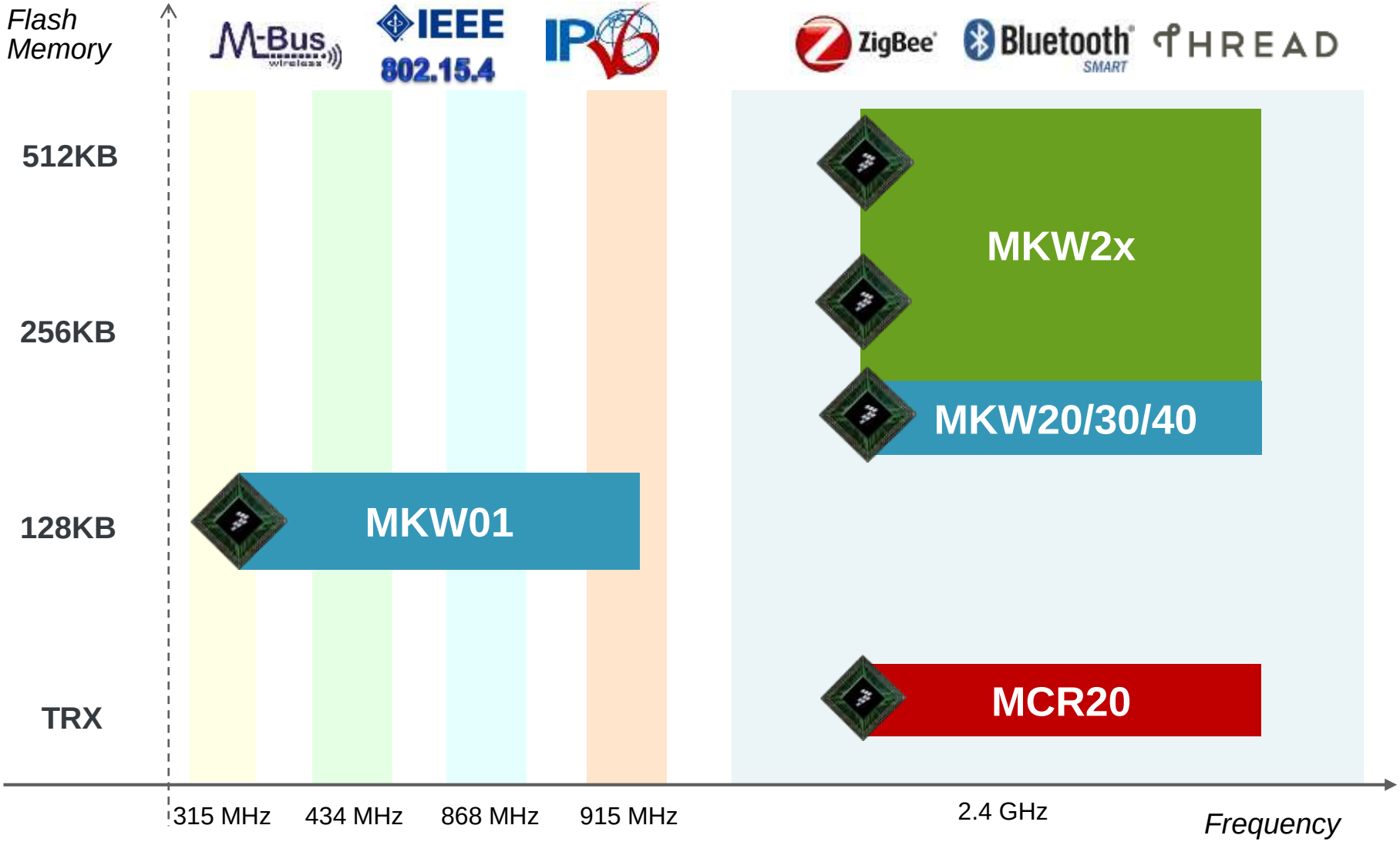
- **Board Features**
  - Compliant FCC Part15 & EN300 328
  - PCB inverted F-type antenna
  - SMA RF Connector can be jumped in
  - Minimum number of matching components and external BALUN
  - Full KSDK support
  - Complete documentation available
  - Needs to go through one cycle of tweaking in order to make it a shield

  - Will be orderable using **FRDM-KW40Z**
  - Suggested Resale: $99
  - Will complement the **USB-KW40Z** that wi be used for sniffing applications

Kinetis W Cortex-M0+ based SoC Family

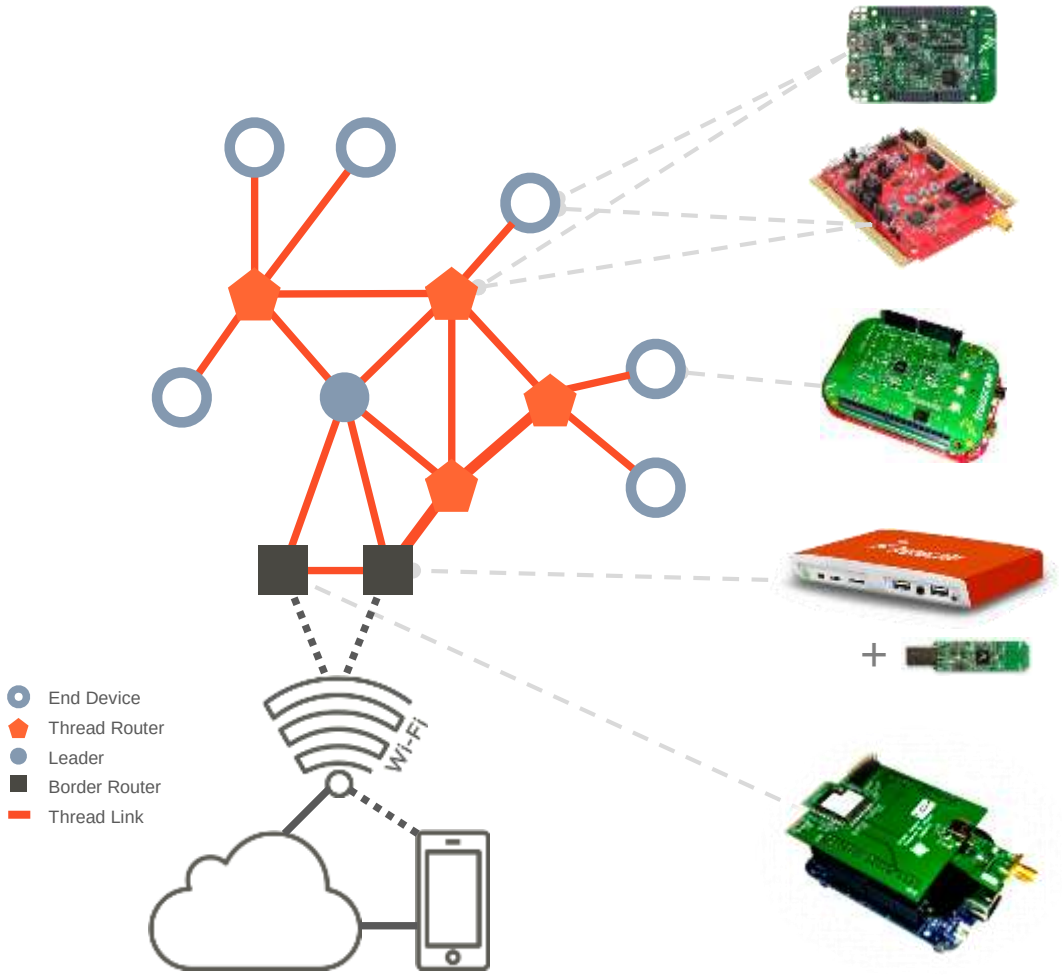
Device	Protocol	Package
MKW20Z160VHT4/R	802.15.4 Only	7x7 48-pin LGA
MKW30Z160VHM4/R	BLE Only	5x5 32-pin LGA
MKW40Z160VHT4/R	BLE & 802.15.4	7x7 48-pin LGA

Key Wireless Connectivity Solutions



Freescale Thread Hardware Options

Freescale Thread Hardware Offering



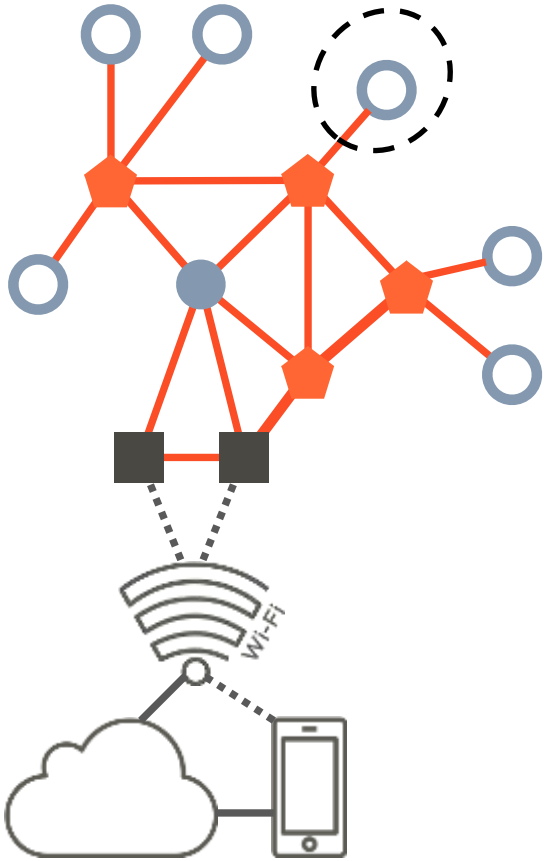
Freescale Kinetis KW2x
Mesh Network Router / End Device
Thread and IEEE 802.15.4 compliant
Tower Board and Freedom Board coming up soon
Runs FreeRTOS and MQX for Kinetis SDK

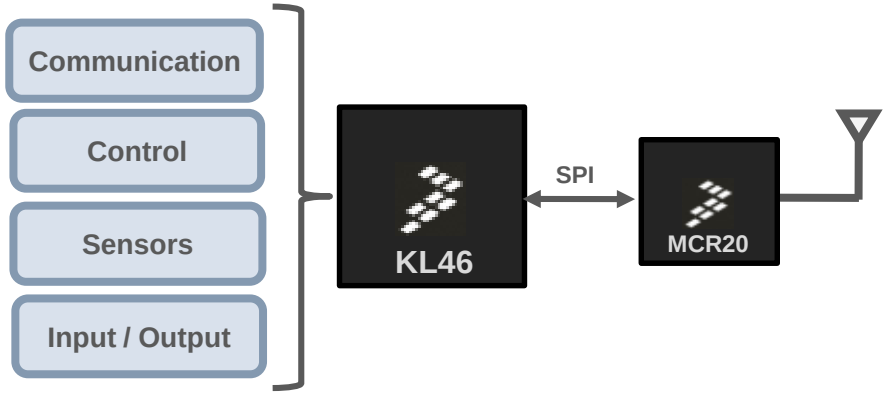
Freescale Kinetis KL46 + MCR20A Transceiver
Mesh Network End Device
Thread and IEEE 802.15.4 compliant
Freedom Board format
Runs MQX for Kinetis SDK

Freescale i.MX6 IoT Gateway
Freescale Kinetis KW2x USB
Border Router / Cloud gateway
Provides IP data routing and infrastructure integration
Runs Linux operating system

Freescale Kinetis K64F + MCR20A Transceiver + WiFi
Border Router with Ethernet and WiFi support
Thread and IEEE 802.15.4 compliant
Freedom Board format
Runs FreeRTOS and MQX for Kinetis SDK

Thread End Node





Kinetis L devices with 32K RAM can run 802.15.4 MAC/PHY, Thread Network and Application as an End Node when paired with the MCR20A 2.4GHz Transceiver

Freescale Combo Solutions – cont.

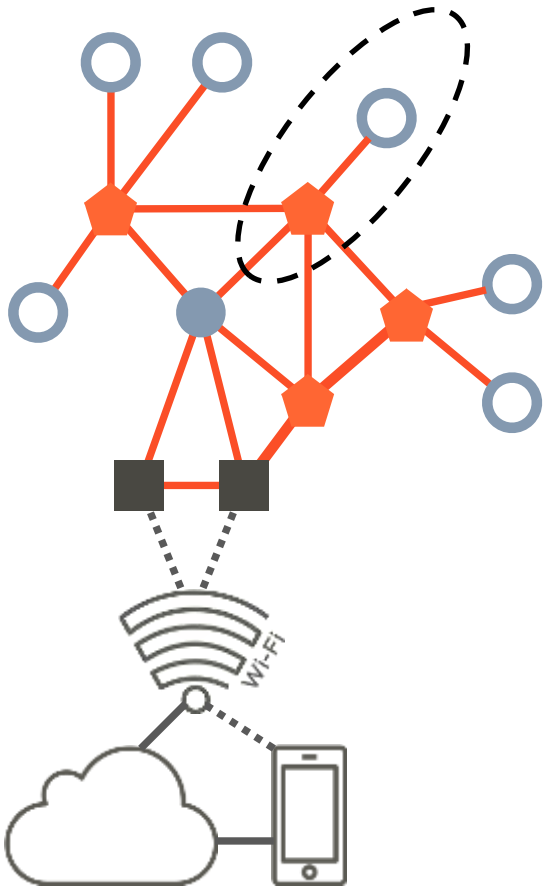
FRDM-KL46Z

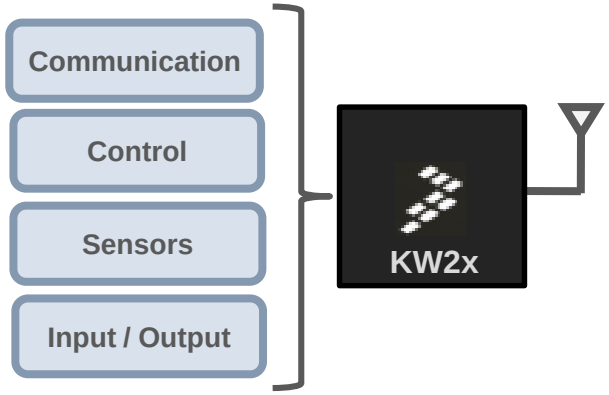
+

FRDM-MCR20A

= THREAD End Node

Thread Router and End Node





KW devices with 32K RAM can run 802.15.4 MAC/PHY, Thread Network and Application

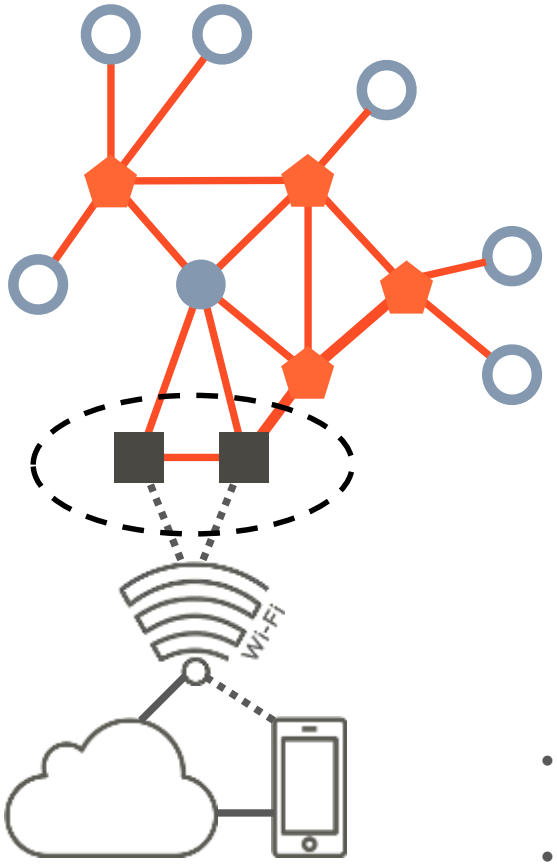
THREAD Existing Freescale Kinetis-W Platforms

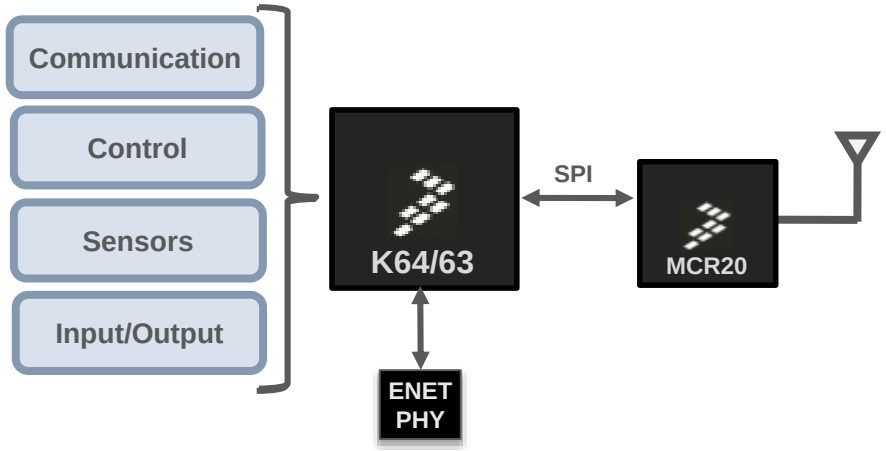
Freescale TWR-KW2x

Freescale USB-KW24D512

FRDM-KW24

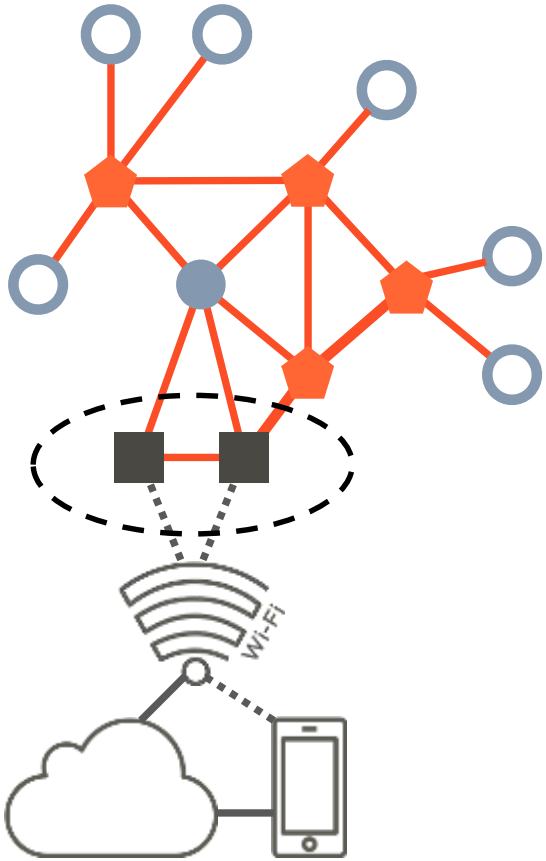
Thread Border Router (Ethernet)

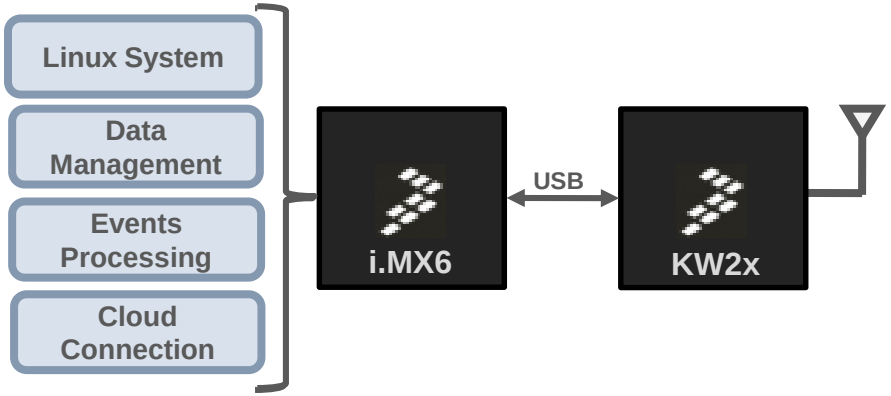




- K64 is standalone MCU with up to 1MB Flash, up to 256K RAM and embedded Ethernet
- K63 adds tamper protection DryIce module
- MCR20 is a 2.4GHz 802.15.4 transceiver

Thread Border Router (i.MX 6 & KW2x)





- KW2x device runs the Thread Border Router functionality while the
- I.MX6 Linux system handles Data Management and Analytics, Events Processing and Cloud Connection

THREAD Freescale Combo Solutions – cont.

FRDM-K64F

ETH

FRDM-MCR20A

15.4

= Thread – Ethernet Border Router

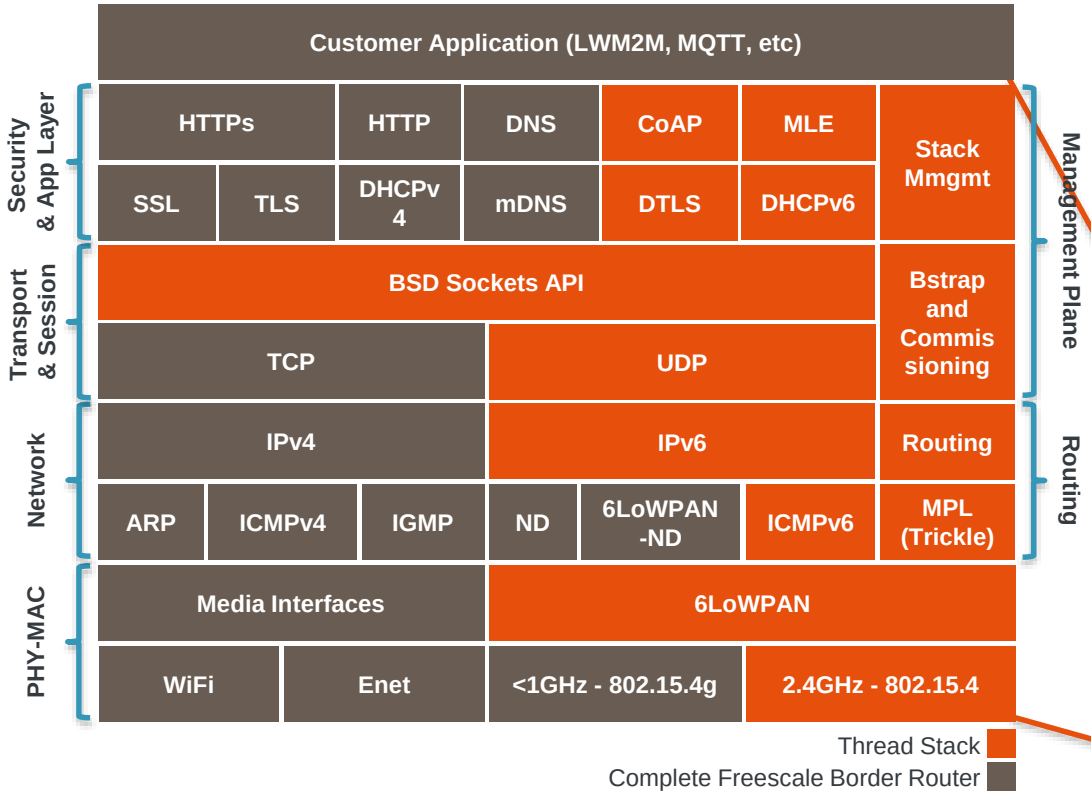
Freescale IoT Gateway

Freescale USB-KW24D512

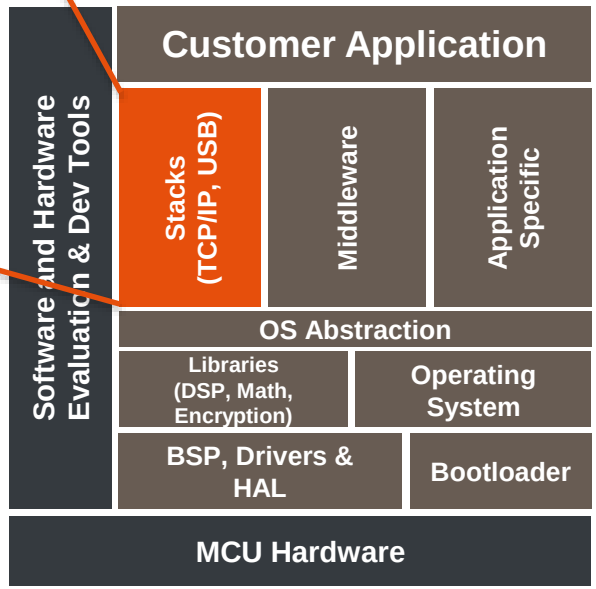
= THREAD Border Router (ETH, Wi-Fi)

Freescale Thread Software

Freescale Thread Stack Overview



- **Product Features:**
  - Built **on top of Kinetis SDK (1.2)**
  - **Multiple OS support** via Kinetis SDK OSA
  - **Thread stack successfully proven** interoperability with other vendors.



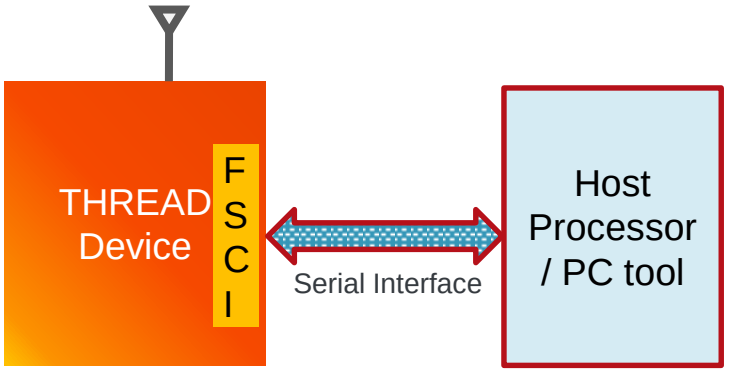
- **Product Features:**
  - **Flexible, configurable and scalable** Dual Stack IPv4 & IPv6 for constrained resources devices
  - **Multiple interfaces support: 802.15.4 & 802.15.4g with 6LoWPAN**, Ethernet and Wi-Fi
  - **Designed for Low Power**, Quick Wake-up Time and Low Memory footprint

THREAD Freescale Serial Connectivity Interface (FSCI)

- Allows interfacing the THREAD stack with a **Linux** or **Kinetis** host processor as well as with a PC tool

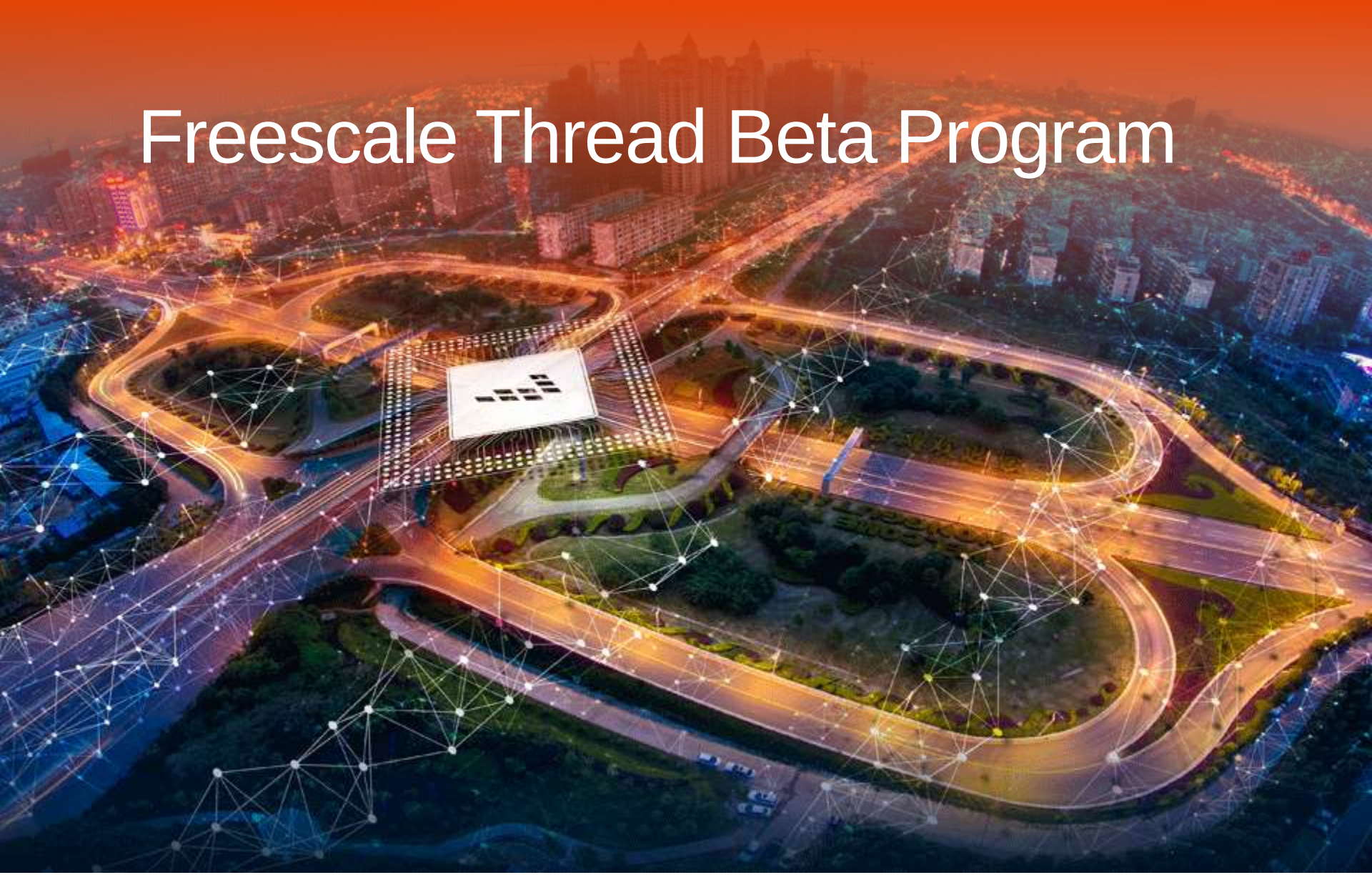
- Can be used in two ways:
  - To test / debug THREAD stack functionalities.
  - As a communication protocol in a host - blackbox scenario.

- Currently supported serial interfaces are: UART, USB, SPI and I²C.

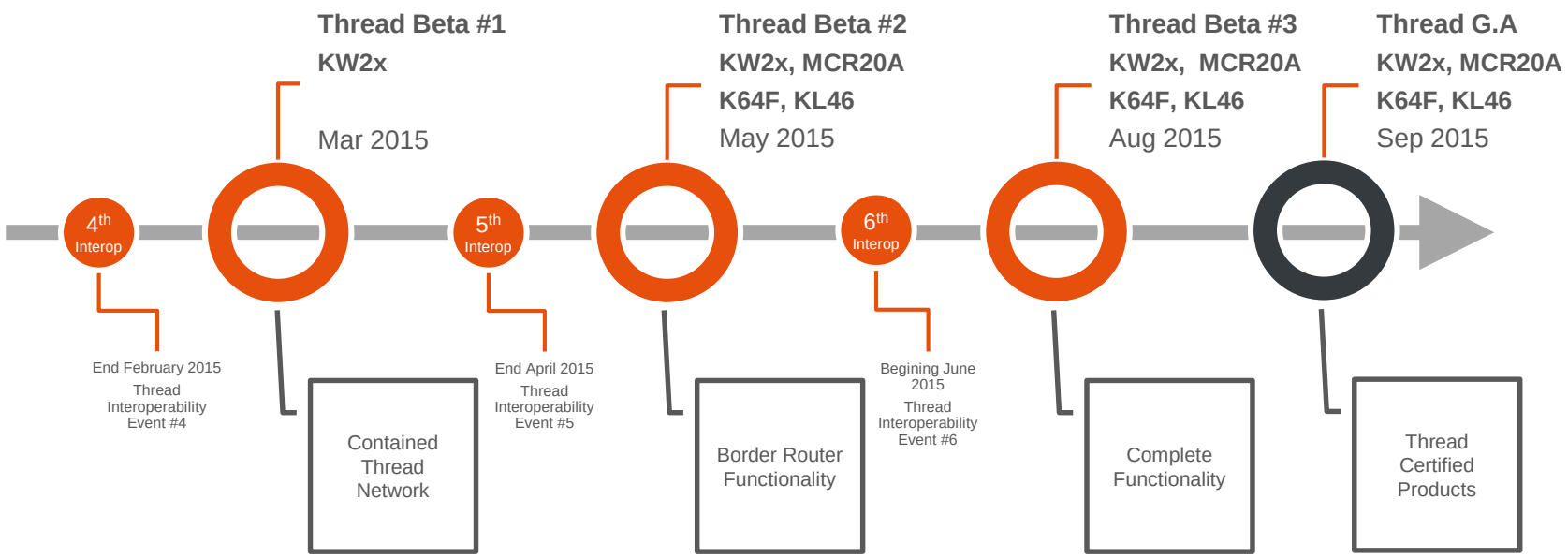


- FSCI Messaging Types
  - Socket Messages (data plane)
  - Network Configuration Messages (management plane)
  - Network Utilities Messages (events and indications)
  - IP Tunnel Messages (available only for VTUN configuration)

Freescale Thread Beta Program



Freescale Thread Launch Timeline



500 Million Smart Home Wireless Sensor Network Chipset Shipments in 2020 *(OnWorld 2015)*

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