



# Freescale and Thread: **Making the Connected Home a Reality**

FTF-SNT-F1228

Sujata Neidig | Business Development

Cristian Cotiga | Connectivity Software Product Manager

JUNE . 2015



External Use



# Agenda

- Introduction to Thread
- Thread Technical Overview
- Freescale's Thread Platform
- Freescale's Thread Software & Enablement
- Freescale's Thread Demo

# Introduction to Thread



# Why another wireless network?

A new era of connected products for the home.  
Existing wireless mesh protocols didn't meet requirements.  
Other companies shared the same concerns.

Thus, Thread was founded.

# Thread Requirements

## Requirements

New wireless home network

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

# Thread Requirements

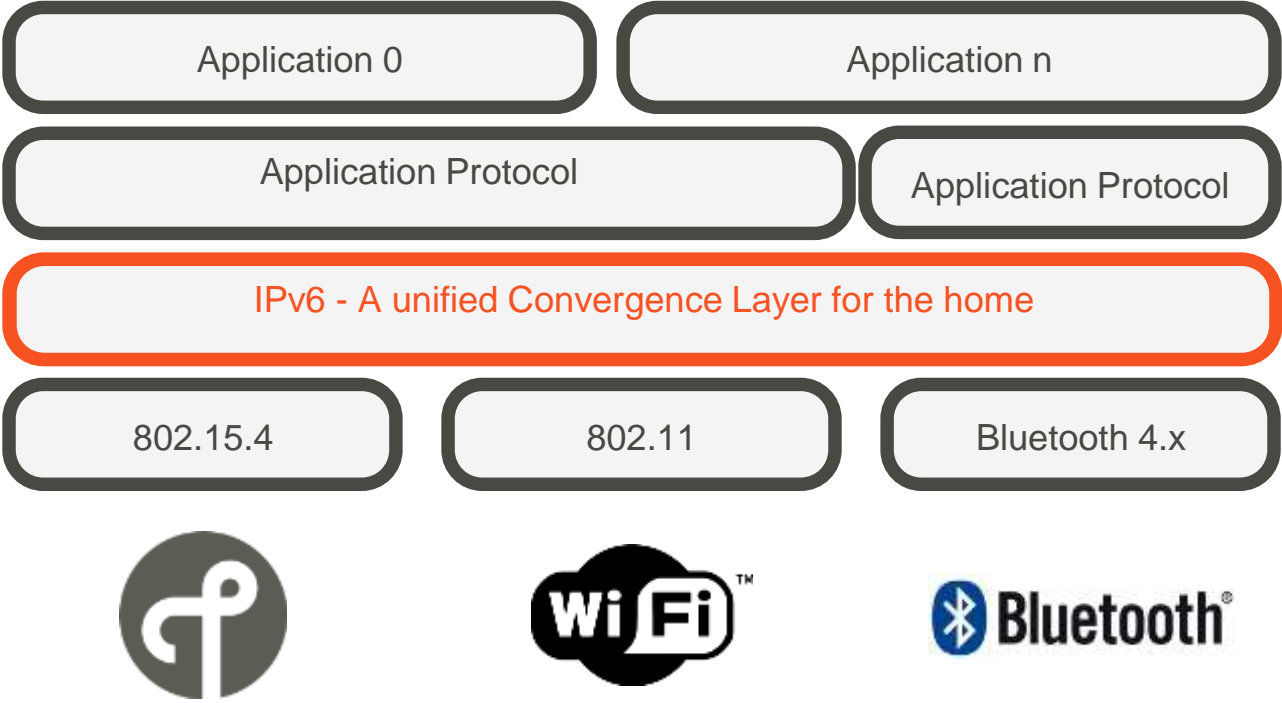
## Requirements

New wireless home network

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

- ✓ No single point of failure
- ✓ Self-healing
- ✓ Interference robustness
- ✓ Self-extending
- ✓ Reliable enough for critical infrastructure

# Why IP?

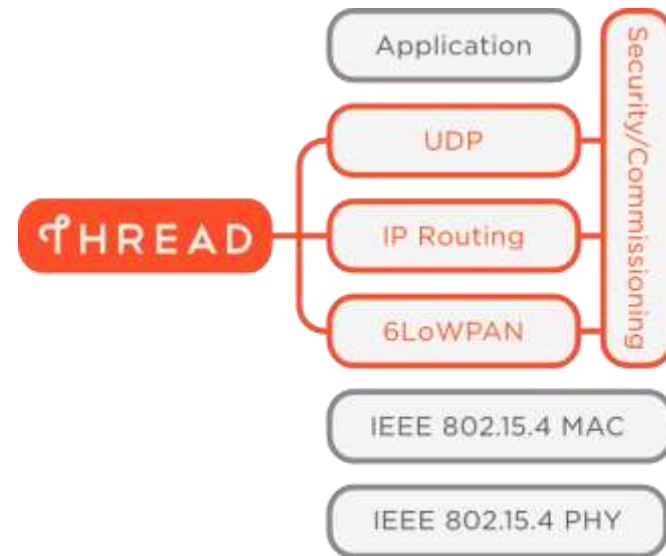


# What Thread Delivers

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

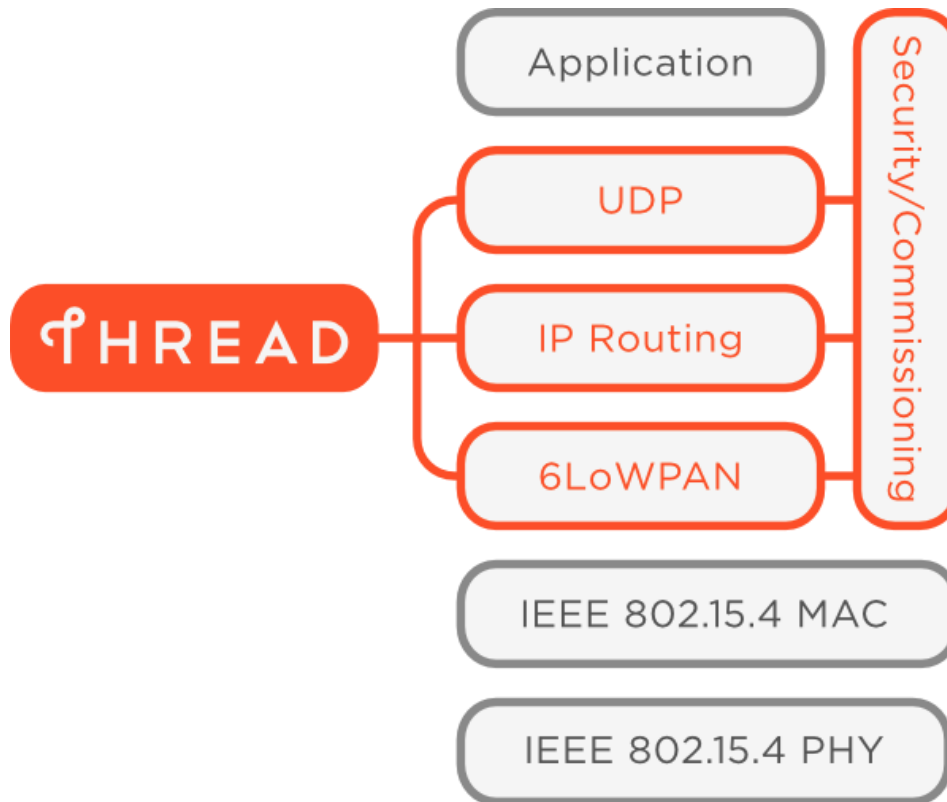
Can support many popular application layer protocols and platforms



A software upgrade can add Thread to currently shipping 802.15.4 products



# Thread Stack Overview



Can support many popular application layer protocols and platforms

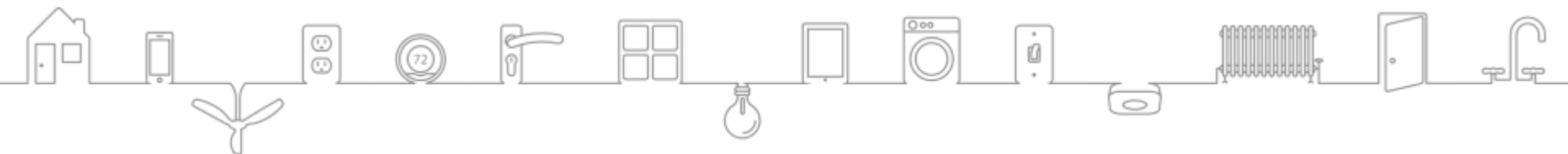
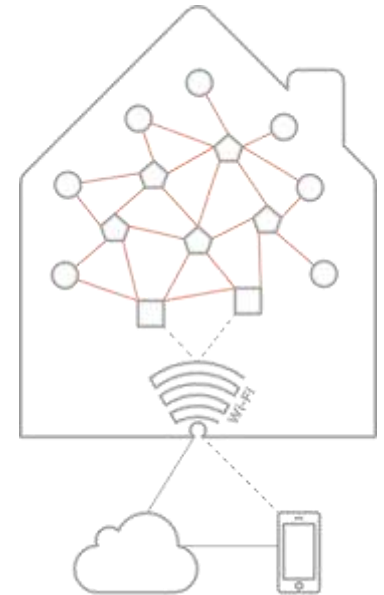
A software upgrade can add THREAD to currently shipping 802.15.4 products

# Target Applications

Thread is designed for all sorts of products in the home

- Appliances
- Access control
- Climate control
- Energy management
- Lighting
- Safety
- Security

Devices working together to form a cohesive mesh network



# Leverages Internet of Things

- Applications are targeted toward **convenience, energy management and whole home connectivity**
- THREAD provides for **integration of multiple systems** (lighting, HVAC and security) that are separate today
- Applications are targeted toward **reducing Total Cost of Ownership (TCO)** in areas such as energy cost
- **Direct** addressability to all devices
  - Device to device
  - Device to **cloud**

# Thread Group



# About Thread Group

A Delaware 501 ( c ) ( 6 ) Non-Profit Corporation for the mutual benefit of its members  
Independent, vendor-neutral and open to all - Any entity can join

Organizational membership only - one membership, one vote

Thread Group manages the delivery of enabling solutions:  
Specifications, Certification Programs, Website, Trademarks,  
Copyrights, Logos/Seals

# About Thread Group

7 Founding Companies, grown to 9  
Sponsor Companies

Not another standards body

A market education group offering  
product certification

Promoting Thread's use in  
connected products for the home

Thread will offer rigorous product  
certification to ensure security and  
interoperability

Board of Directors

**President: Chris Boross - Nest Labs**

**VP of Marketing: Sujata Neidig - Freescale**

**VP of Technology: Skip Ashton - Silicon Labs**

**Secretary: Bill Curtis - ARM**

**Treasurer: Kevin Kraus - Yale Security**

**Director: Landon Borders - Big Ass Fans**

**Director: Mark Trayer - Samsung Electronics**

Director: Tim Meyers – Tyco

Director: Jean-Michel Orsat - Somfy



# Thread Media and Industry Attention

**380M+** impressions

**355+** articles published

**120+** feature stories

**10+** speaking events



@TheThreadGroup

## Media Coverage...

THE WALL STREET JOURNAL



Forbes

Mashable

The New York Times

PCWorld



Google-backed Thread Group racks up new members to work on Internet of Things

FierceWirelessTech

Thread Group IoT Consortium Grows to 50-Plus Members



Thread Group Adds Members, Launches Enabler Program



Interview with Chris Boross, President of the Thread Group



How Will Thread Stitch Together A Home Network?

TWICE

Thread, ZigBee Knit IoT Stacks  
Zigbee Cluster Library will run over Thread



Thread Group Enables Startups to Accelerate Innovation



# Organization Status

9

Sponsor companies

130+

Member companies



# Business Benefits

Membership to Thread comes with its benefits:

Access to the technology

Immediate product planning and development

Access to technical documentation prior to spec release

Use Thread Certification Program and test suite

Participation in Marketing and PR campaigns

Network with an ecosystem of companies building connected products for the home

Help promote Thread and Thread-enabled products

# Marketing Benefits

There will be some great marketing benefits:

The Thread Group will help promote your Thread-compliant products

Engage in press activities and receive media coverage

Participate in industry events with Thread

Evangelize at high exposure speaking opportunities

Use Thread Group marketing collateral and assets

Build awareness through Thread online and social media

# Membership Tiers

Membership Benefits	Affiliate	Contributor	Sponsor
Receive member communications	✓	✓	✓
Participation in general or annual meetings	✓	✓	✓
Access to members only website	✓	✓	✓
Use of Alliance Member Logo	✓	✓	✓
Participation in press articles & interviews	✓	✓	✓
Access Final Deliverables	✓	✓	✓
Chair Committees and/or Work Groups		✓	✓
Certify Compliant Products and Utilize Certification Logo		✓	✓
Access Draft Deliverables		✓	✓
Participate and Vote in Work Groups		✓	✓
Participation and Vote in Committees		✓	✓
Approve Operating Budget			✓
Approve Final Deliverables			✓
Initiate Work Groups or Committees			✓
Can be admitted as Sponsor after launch			✓
Automatic Seat on Board of Directors			✓
Annual Fee	\$2,500	\$15,000	\$100,000

# Membership Process

Submit Application via [www.threadgroup.org](http://www.threadgroup.org)

Agreements provided for legal and business review

Membership complete once agreements signed and payment processed

Members will be granted access to the Thread Group Members Only Portal

The Portal will include technical documentation, certification info and marketing plans  
(as available)

# IPR Policy

IPR policy is designed to maximize the adoption of the Thread technology

IPR Policy for Thread Group membership balances interests of all stakeholders

Commitment to grant a RAND-RF (royalty free) license to members for patents essential to the Thread specification

- Applies to all Thread members
- Avoids patent confusion
- Accelerates market acceptance

Thread Group copyrights, trademarks are licensed to participants royalty free

# Innovation Enabler

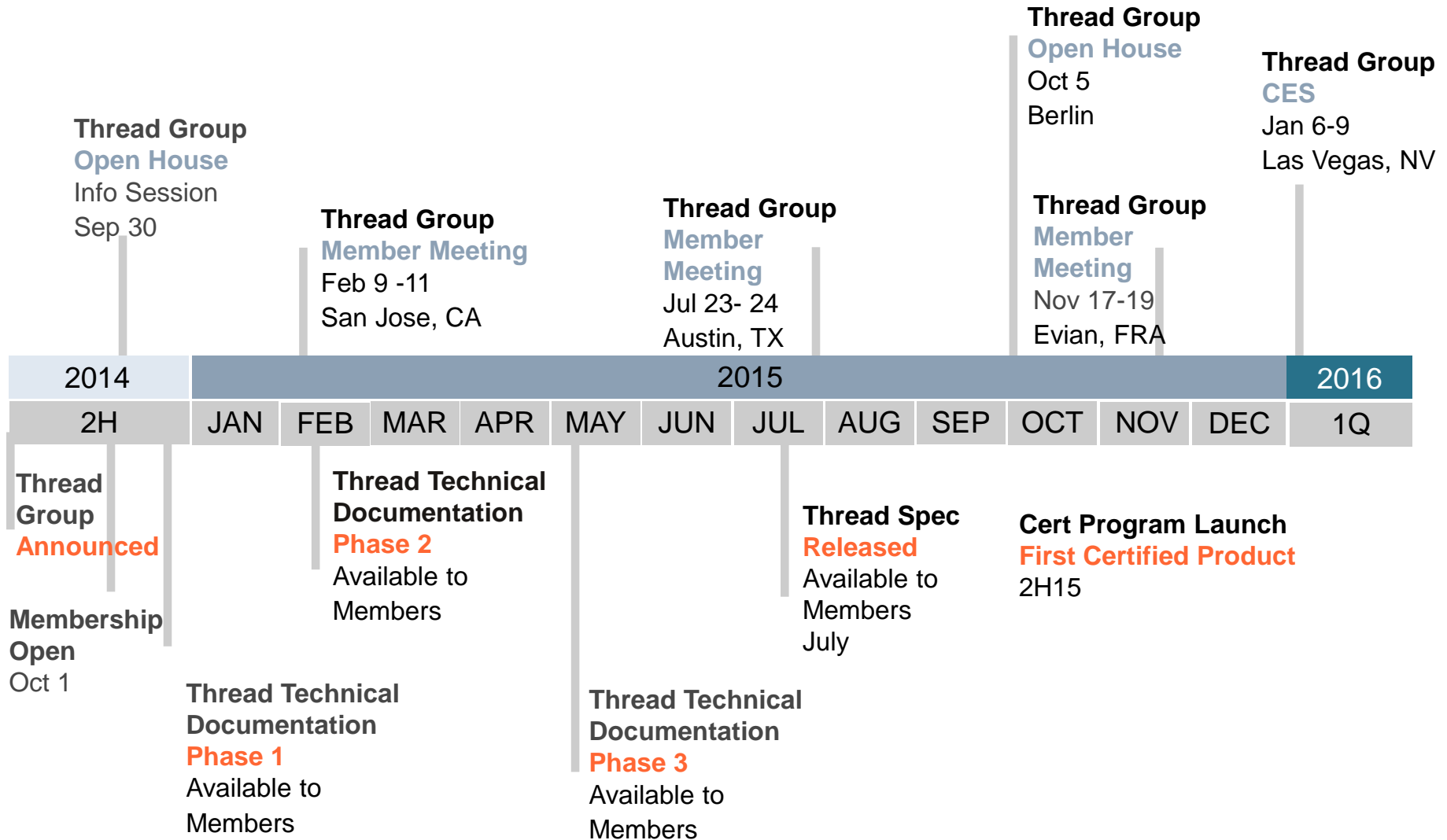
Much of the innovation in the Connected Home is coming from start-up companies who can't necessarily afford membership fees

Thread Group want to help these small, innovative companies launch Thread-enabled products

To do this we'll give away a free membership to the Group

One start-up chosen per quarter

# Milestones



# Thread Technical Overview





# Connected Home Requirements

Direct addressability to all devices – device to device or device to cloud

Simplified forming and joining of network

Limit special devices or customer knowledge of concepts like coordinator vs. router vs. end device

Scalable to 250-300 devices in a home

Latency less than 100 milliseconds for typical interactions

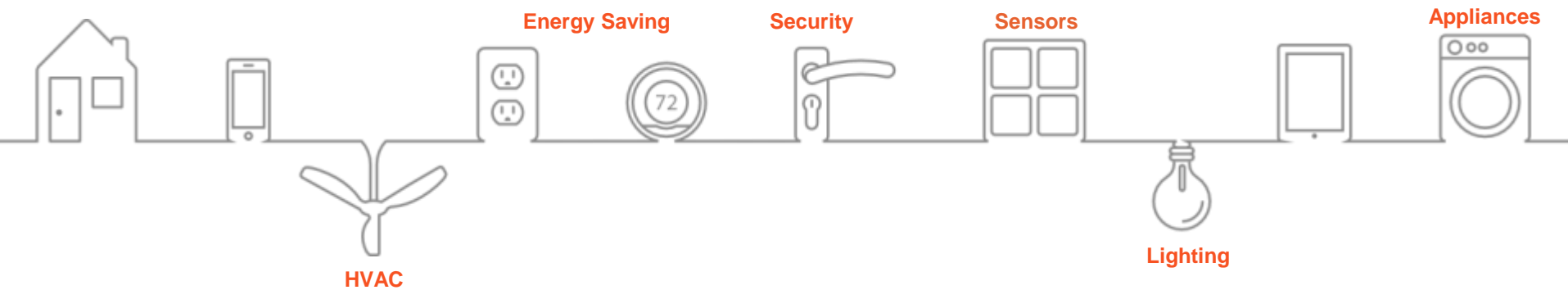
Allow the use of multiple border routers

Seamless connectivity to user interaction on device of choice in the home

(dedicated display, smart phone, tablet, etc.)

Battery operated devices with years of expected life – door locks, security sensors etc

# Connected Home Applications



## Normally Powered

- Gateway
- Lighting
- Appliances
- Smart Meter
- Garage door opener
- HVAC equipment
- Smart Plugs
- Fans

## Powered or battery

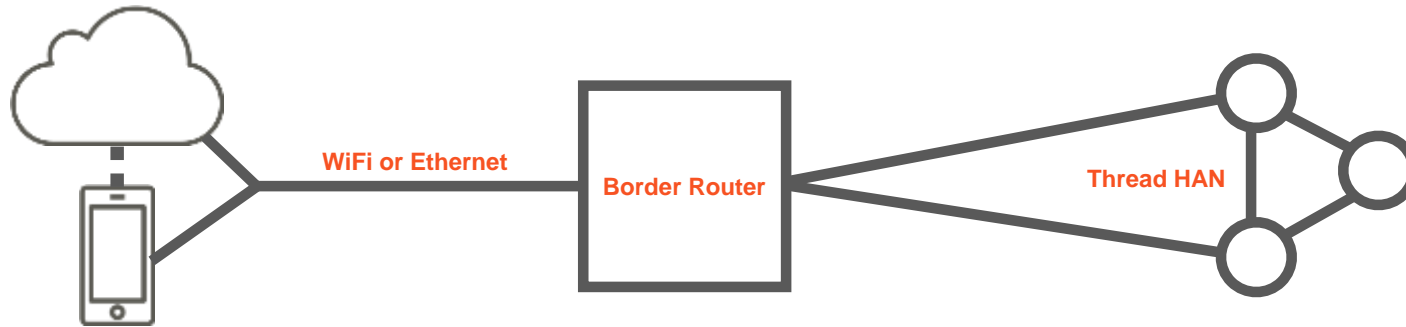
- Thermostat
- Light switches
- Smoke Detectors
- CO detectors
- In home display
- Shade or blinds control
- Door bell
- Glass break sensors
- Robots/cleaners

## Normally Battery

- Door sensors
- Window sensors
- Motion sensors
- Door locks
- Radiator valves
- Body sensors (health care)

Consideration for devices that rely on energy harvesting is also a requirement

# 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 or tablet in the home

## Device Communication

Expect device to device communication within HAN for operations in the home

# Overview

IPv6 based

Lightweight and low latency

Not a whole new standard

Collection of existing IEEE® and IETF® standards

Runs on existing 802.15.4 based products

250+ devices on a PAN

Direct Addressability of devices

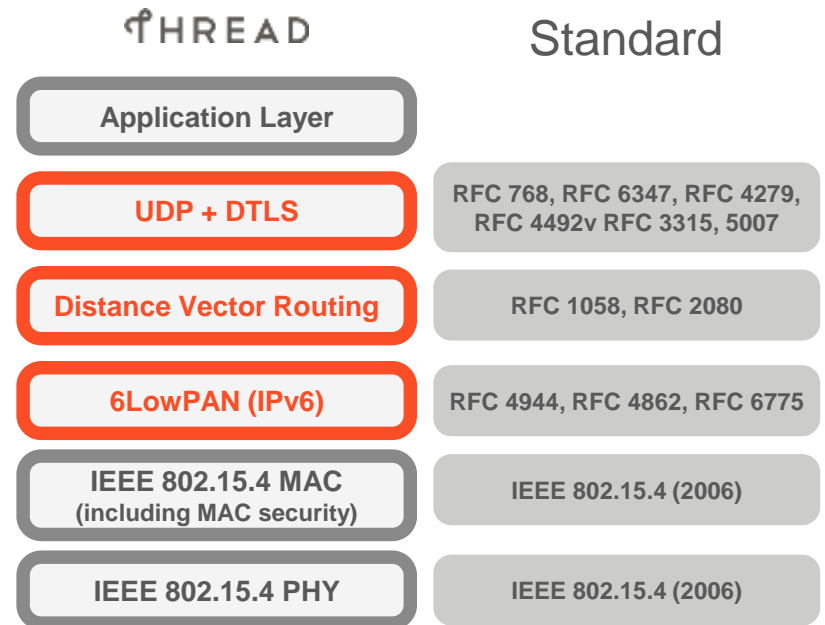
Flexible network with full point to point connectivity of all devices

No single point of failure

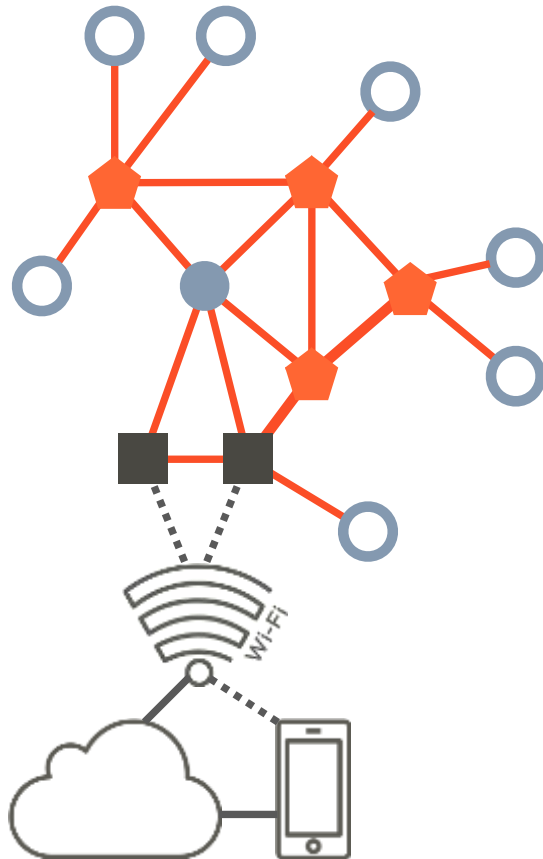
Enable low cost bridging to other IP networks

Simple security and commissioning

Low Power support for sleeping devices



# Network Architecture



- End Device or Router Eligible
- ⬠ Thread Router
- Leader
- Border Router
- Thread Link

# Application Layers

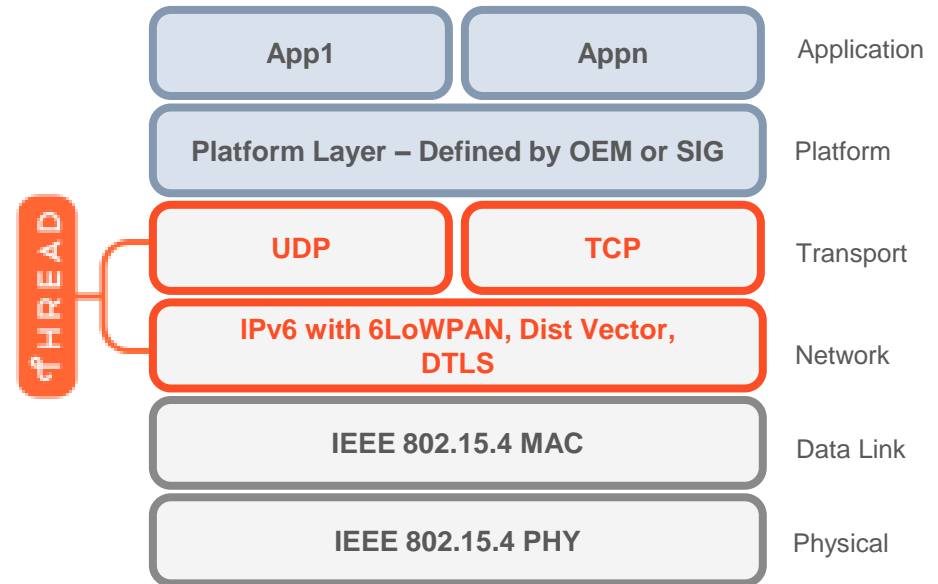
Thread provides basic services required for applications

UDP messaging and acknowledgement

Multicast messaging

Thread allows use of many application layers using IP services

Those application layers not using IP services would need some adaptation



# Certification

All Thread devices will require network certification

Validation of device behavior

Commissioning

Network functionality and interoperability

Device operation in network

Members will have access to free standard test harness

Certification through a 3<sup>rd</sup> party test lab

Certification program will launch in 3Q 2015



# Current Status

Interoperability ongoing

Specification being used as part of testing, being refined and completed

Publishing prior to All Member Meeting on Jul 23-24

Technical documentation available since Nov 2014

Certification test plan / test harness in development

Certification program will launch in 3Q 2015

## Thread 1.0

Technical Specification

Table of Contents

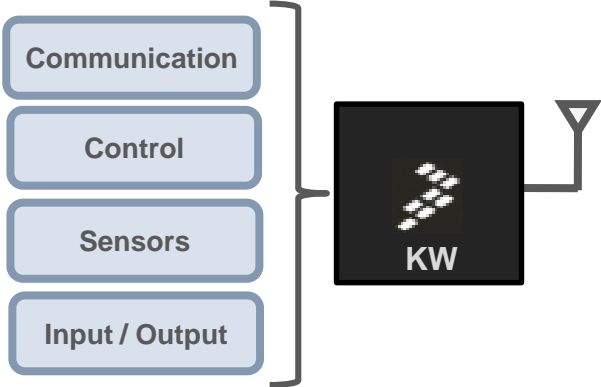
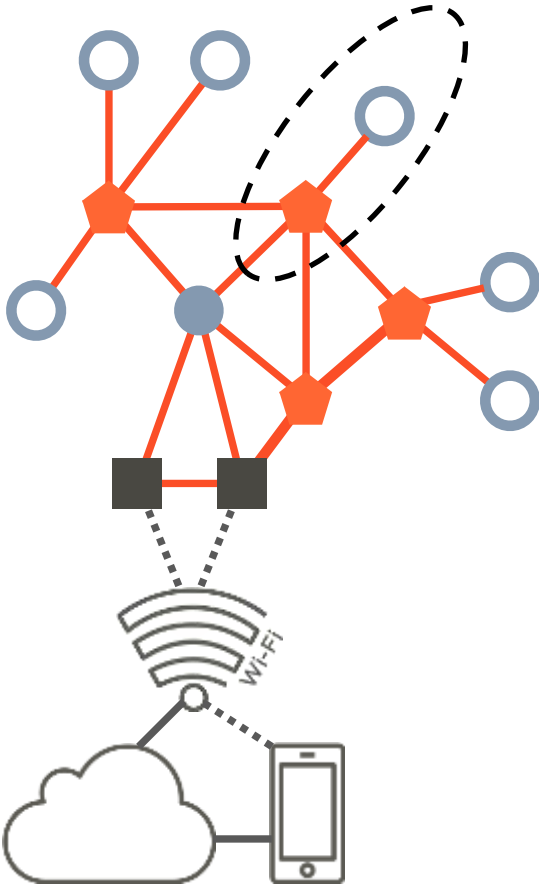
1. Overview
2. Supporting Information
3. PHY/MAC/6LowPAN
4. Network Layer
5. Transport Layer
6. Security
7. Border Router
8. Commissioning
9. Management
10. Functional Description



# Freescale's Thread Platform



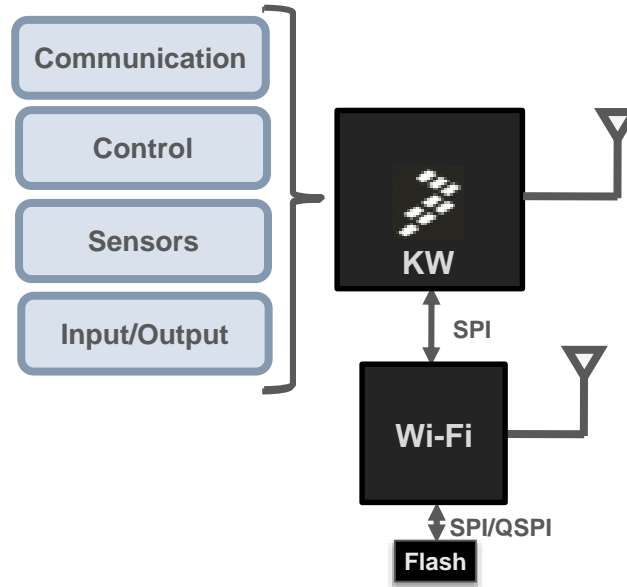
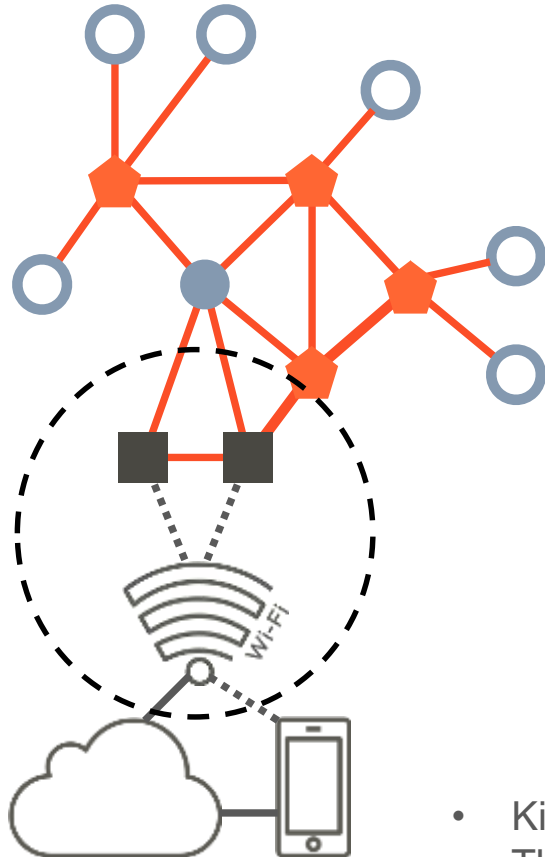
# Thread Router and End Node



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



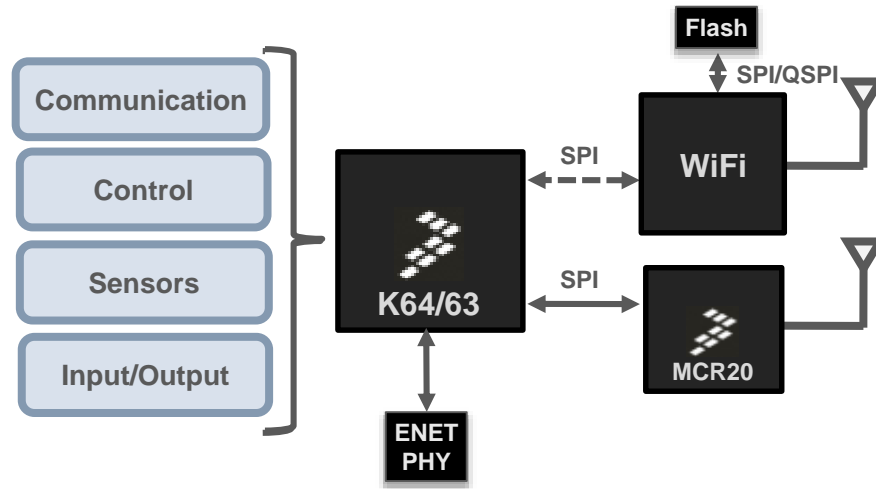
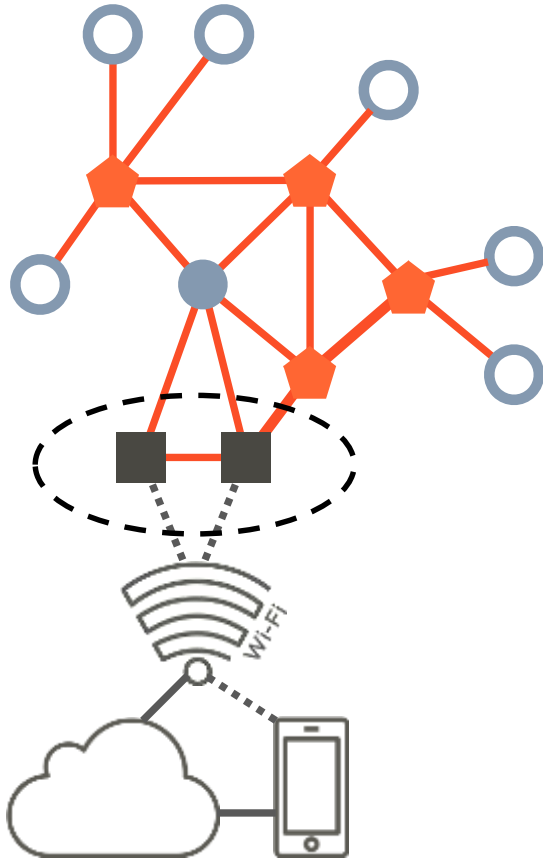
# Thread Border Router (Wi-Fi Only)



- Kinetis KW MCUs with 64K RAM can run 802.15.4 MAC/PHY, Thread Network, Wi-Fi Driver and Application
- SPI connection with DMA enabled yields Wi-Fi throughput of 10-12 Mbps



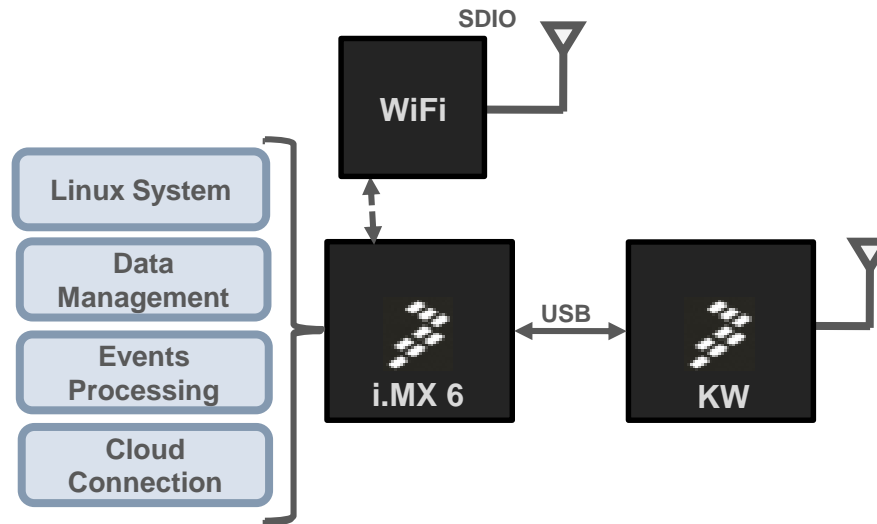
# Thread Border Router (Ethernet/Wi-Fi)



- Kinetis K64 is standalone MCU with up to 1MB Flash, up to 256K RAM and embedded Ethernet
- Kinetis K63 MCU adds tamper protection DryIce module
- MCR20 is an 802.15.4 transceiver
- Thread, Wi-Fi and Ethernet would share same IP stack



# Thread Linux Border Router (Ethernet/Wi-Fi)



Kinetis KW2x MCU runs the Thread Border Router functionality while the i.MX 6 Linux system handles Data Management and Analytics, Events Processing and Cloud Connection



# Kinetis KW2x Wireless MCU

## 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

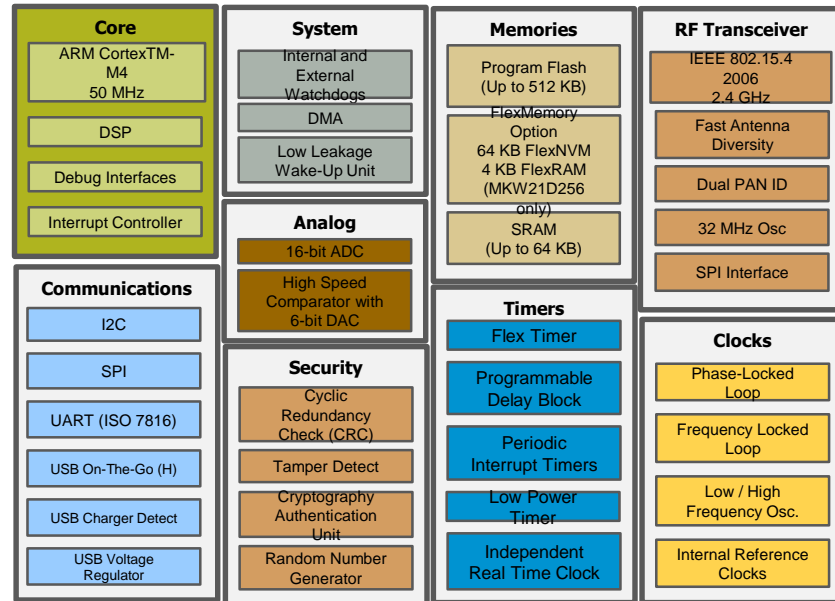
- IEEE-802.15.4 compliant
- -102 dBm Rx sensitivity and +10dBm Tx output power
- Peak typical current: 17mA Tx and 19mA Rx
- Dual Personal Area Network (PAN) support in hardware
- Run two RF networks simultaneously
- Antenna diversity with automatic antenna selection

## Security

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

## System

- UART, SPI, I2C
- Optional USB 2.0 FS/LS H/D/OTG
- 16-bit ADC, 6-bit DAC
- 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

# Kinetis K63/K64 120MHz MCUs (1MB Flash, 256KB RAM)

## Core/System

- Cortex-M4 up to 120MHz with FPU

## Memory

- up to 1MB Flash,
- up to 256KB SRAM
- up to 4KB EEPROM (FlexMemory)

## Communications

- USB OTG FS/LS w/ PHY and USB Vreg
- Ethernet w/ IEEE1588
- CAN
- Multiple serial ports

## Analog

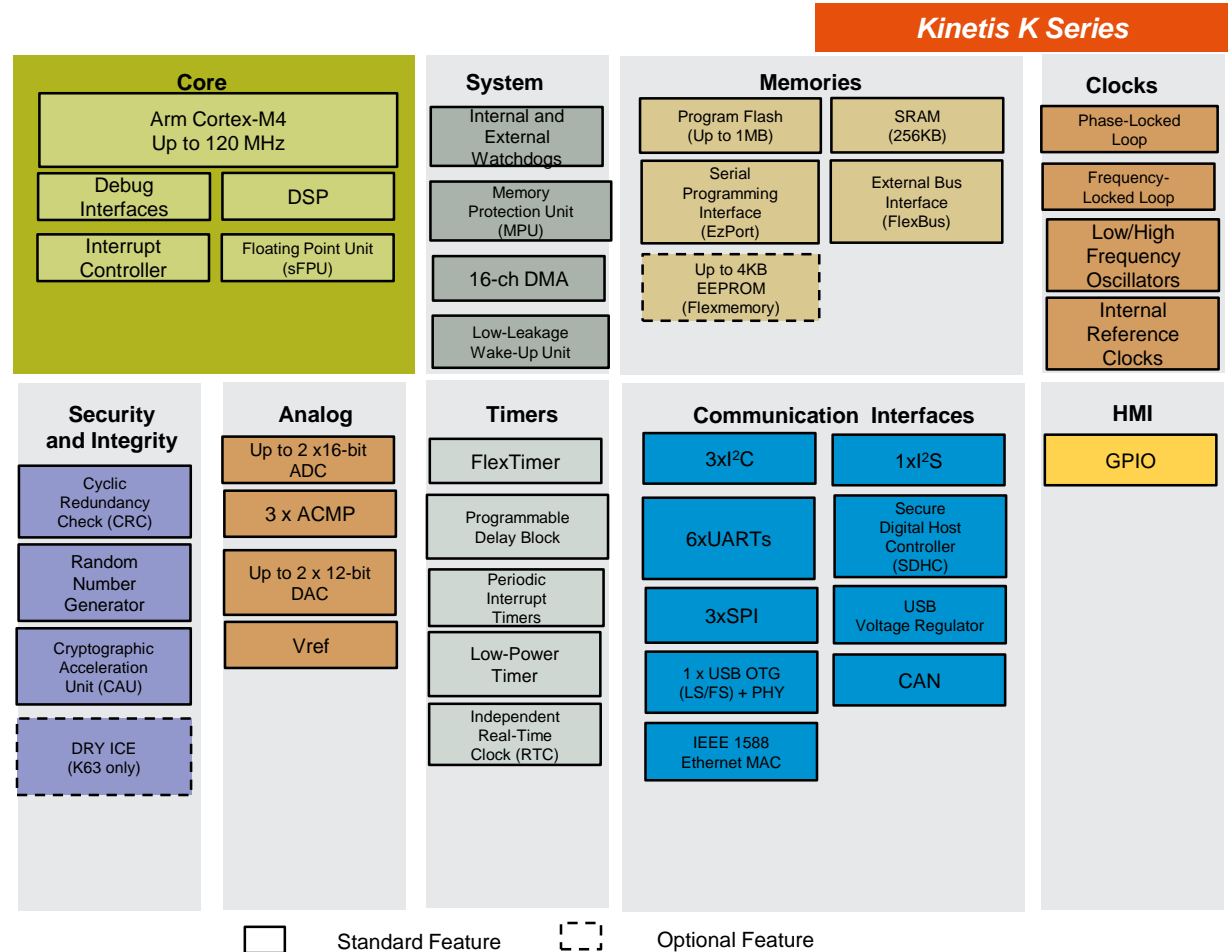
- 2x 16-bit ADC
- 2 x 12-bit DAC; 3 x ACMP

## Timers

- 2x8ch FTM (PWM)
- 2x2ch FTM (PWM/Quad Dec.)
- Low Power Timer
- RTC with independent Vbat supply

## Others

- 1.71V-3.6V; -40 to 105oC
- Up TBD to x I/Os (5V tolerant)
- Tamper and Crypto acceleration



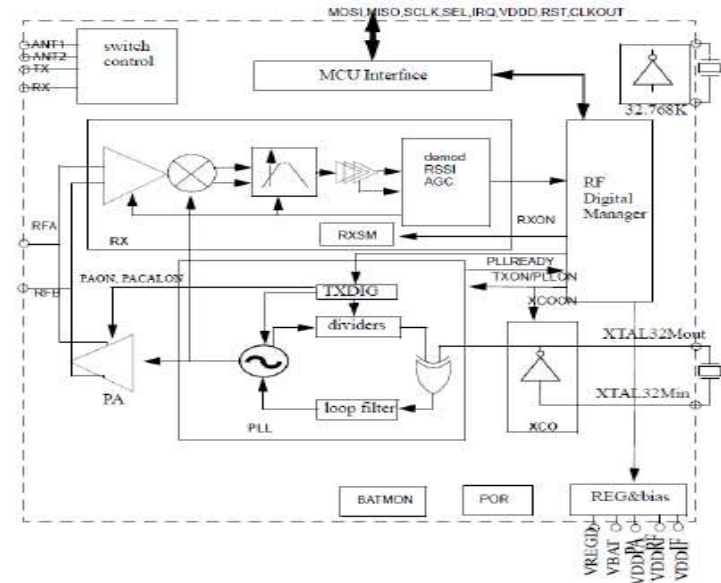
# MCR20 High-Performance 802.15.4 Transceiver

## RF Features

- High performance 2.4 GHz IEEE 802.15.4 RF transceiver
- Support for MBAN frequencies (2.36-2.4 GHz)
- Packet processor for hardware acceleration
- Supports single ended and diversity antenna options
- Dual-PAN support
- -30 to + 8 dBm power output
- Support for external PA/LNA (FEM)
- -102 dBm sensitivity
- Tx 17mA @ 0dBm
- Rx 15mA LPPS mode, 19mA full Rx
- AES Hardware encryption/decryption
- True Random Number Generator
- SPI Interface (memory mapped)
- 6 GPIO

## System Features

- -40°C to 105°C
- 1.8 to 3.6 V
- 5x5 32-pin LGA
- Samples Now, Production Summer



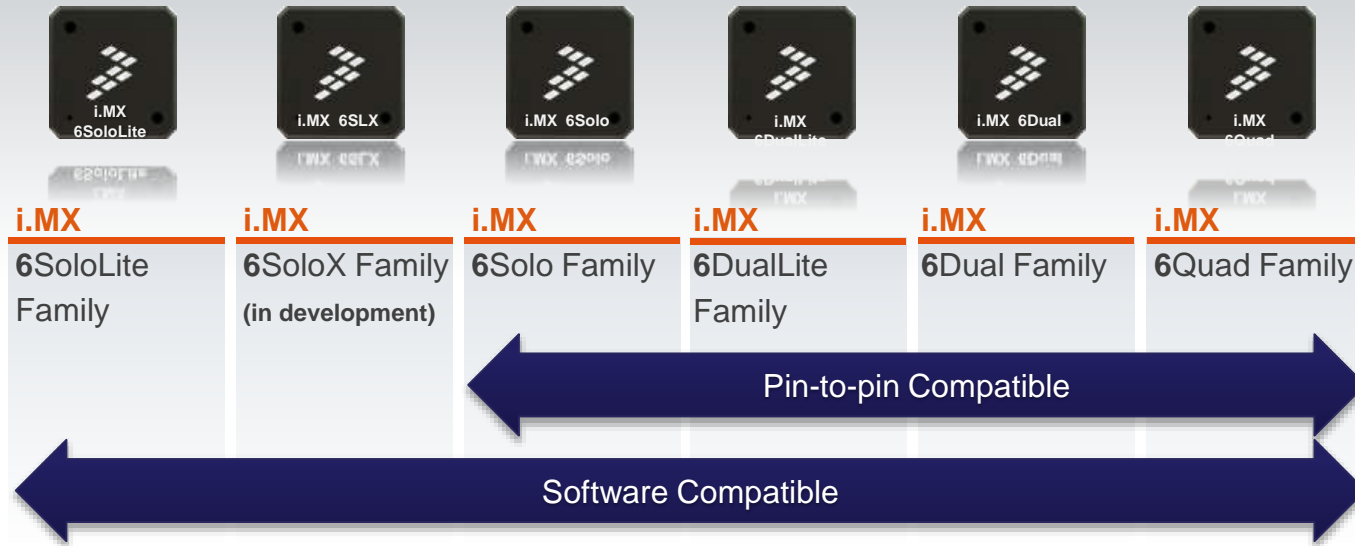
Ordering Part Number: **MCR20AVHM**



# i.MX 6 Series: Supreme Scalability and Flexibility

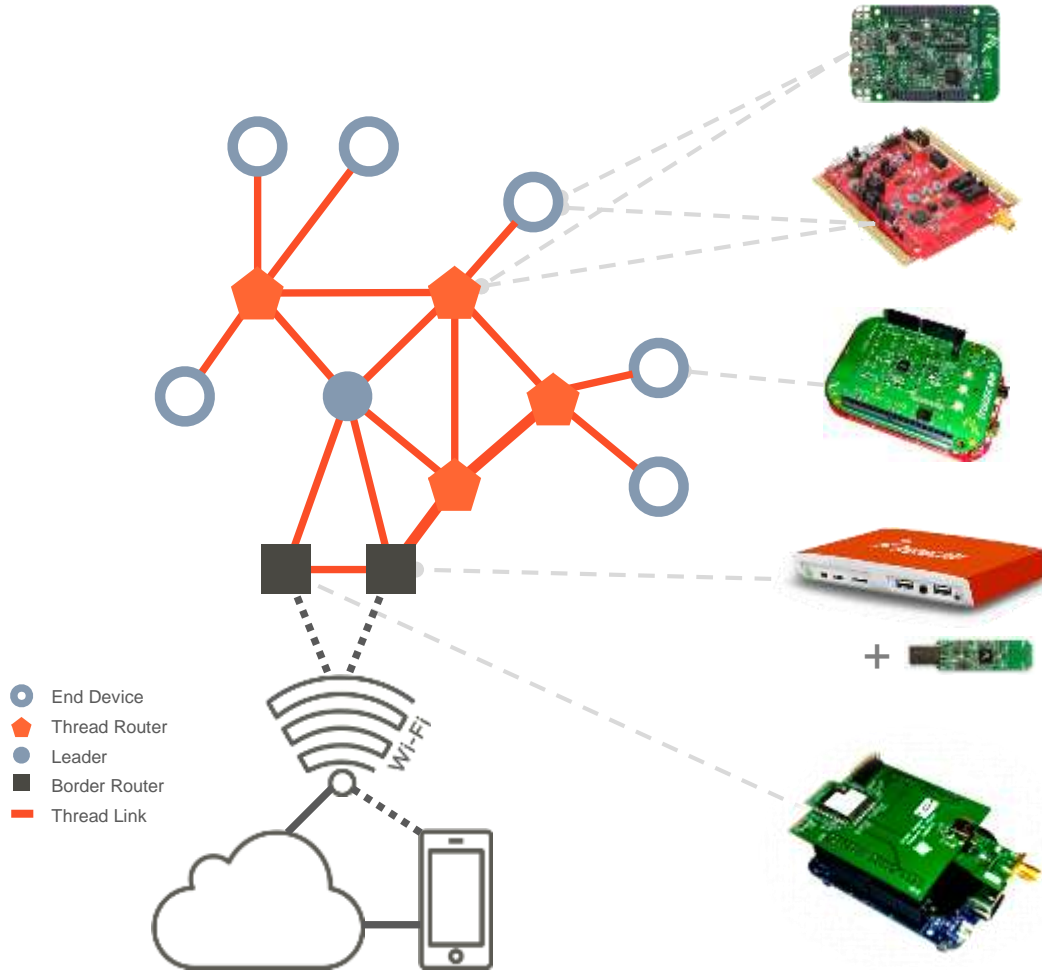
## Leverage One Design Into Diverse Product Portfolio

Scalable series of **SIX** ARM Cortex-A9-based SoC Families





# 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

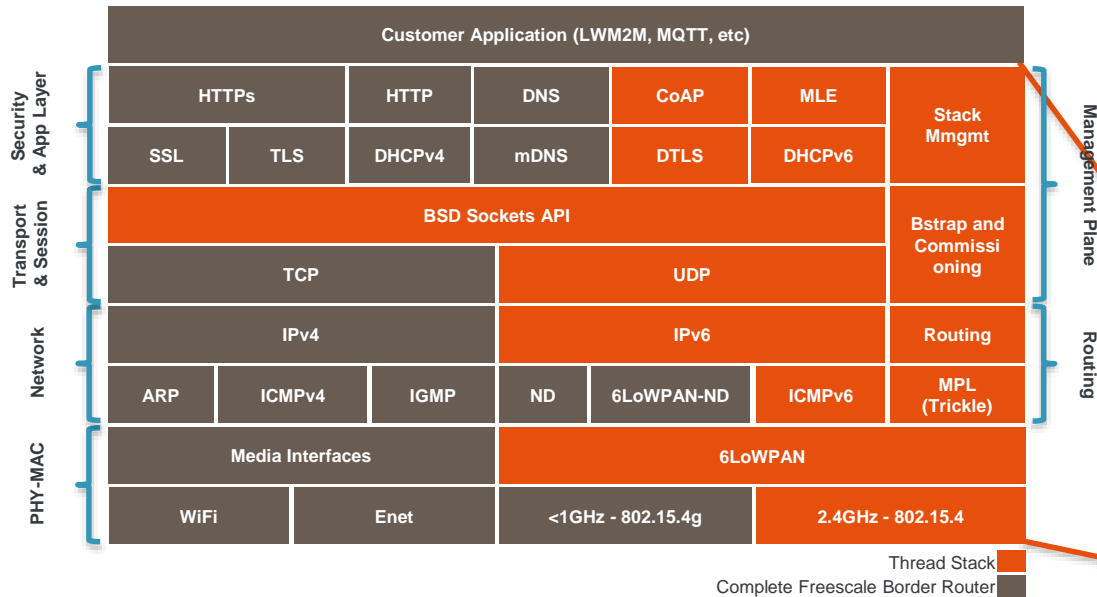
Border Router / Cloud gateway  
 Provides IP data routing and infrastructure integration  
 Runs Linux operating system

## 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

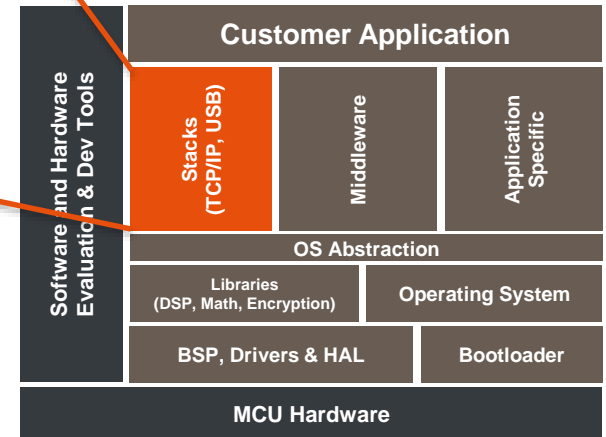


# Freescale Thread Stack Overview



• **Product Features:**

- **Multiple OS support via Kinetis SDK OSA** running on MQX and possible to port to FreeRTOS, uCOS and even Bare Metal
- **6LoWPAN and IPv6 stack successfully proven** interoperability with other vendors in various alliances.



The Freescale THREAD stack implementation is available as library for Cortex-M4 and Cortex-M0+



**freescale**<sup>TM</sup>  
THREAD



[www.Freescale.com](http://www.Freescale.com)