

## Wireless ZigBee® and Sub-GHz Solution SoC/SiP Supporting Internet of Things (IoT)

AMF-IND-T0274

**Derrick Klotz** 

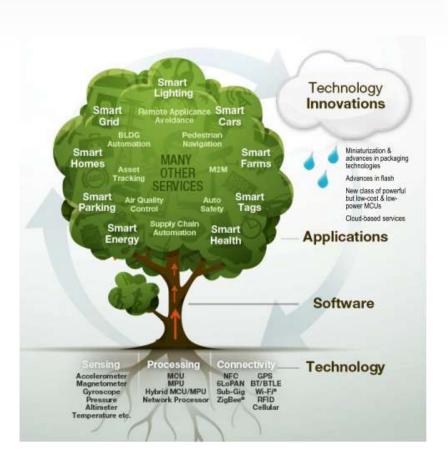


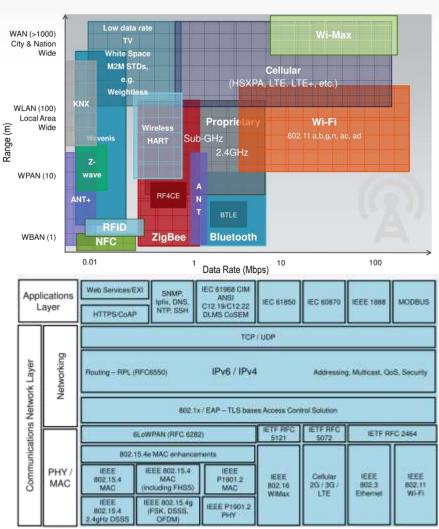
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## Wireless connectivity for the IoT







Professor David E. Culter University of California, Berkeley CWISN Keynote, Sept. 26, 2011

## MCU/MPU Portfolio - Current & Future

Performance

#### Kinetis L Series

Ultra-low power/cost ARM Cortex-M0+ MCU families from 48MHz / 8KB with mixed-signal, connectivity and HMI features in low pin-count packages.

#### Kinetis E Series

Robust, 5V ARM
Cortex-M0+ & ARM
Cortex-M4 MCU families
for use in high electrical
noise environments.
Safety features for highreliability applications.

#### Kinetis K Series

Industry-first ARM
Cortex-M4 MCU families
from 50MHz / 32KB with
low power, FlexMemory,
mixed-signal and broad
connectivity, HMI and
security features.

## i.MX Applications Processors

Your Interface to the

## Vybrid Controller Solutions

Rich Apps in Real Time.

**General Purpose** 

**Segment Focused** 

#### Kinetis W Series

Wireless & PLC wired connectivity ARM
Cortex-M4 and M0+
MCU families with class-leading sub-1 GHz and 2.4 GHz RF transceivers.

#### Kinetis M Series

High accuracy metrology ARM Cortex-M0+ MCU families for single chip smart meter implementations.

Integration





Power Generation, Transmission, Monitoring & Control, Renewable Sources

MPC8xxx, QorlQ, Kinetis

Distribution & Substation Automation, Protection, Control and Monitoring

MSC9130 , MPC8xxx, QorIQ, Kinetis Data Concentrator

P102x, MPC8308, i.MX28

Neighborhood Area Network (NAN)

RF: Sub Gig 802.15.4g Kinetis KW01

PLC: G3/ PRIME OFDM - Kinetis Smart Electricity Meters

1-ph, 2-ph, 3-ph, Sub-Metering

Kinetis, Vybrid

Home Area Network (HAN)

> ZigBee Kinetis KW2x

Home Energy Management (HEM)

> i.MX283 Vybrid





# **KW2x – 2.4 GHz Smart Energy & Home Automation Solution from Freescale**





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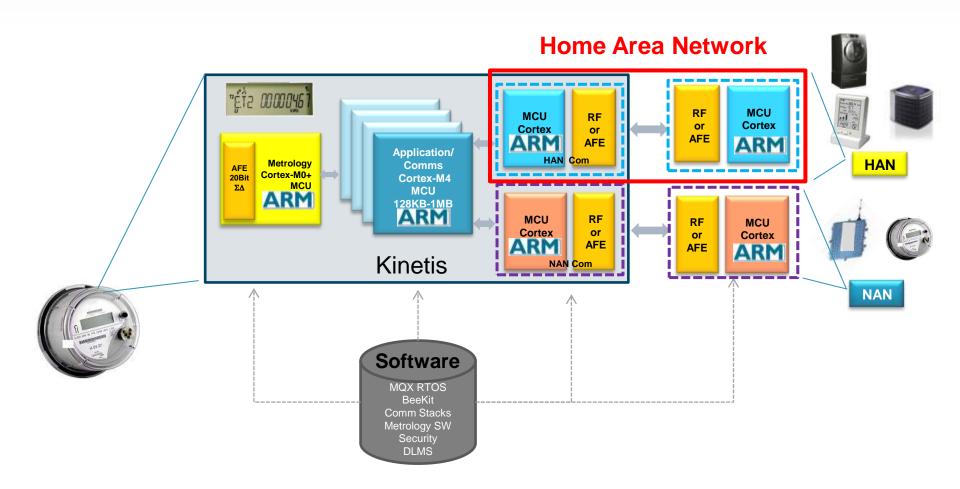


### What is Kinetis KW2x?

- The new Kinetis KW2x is Freescale next generation 2.4 GHz 802.15.4 platform
- The Kinetis KW2x platform integrates a class leading RF transceiver, ARM Cortex-M4 core and a robust feature set for a reliable, secure and low-power IEEE® 802.15.4 wireless solution.
- Wireless protocol software is seamlessly integrated into Kinetis software development tools for rapid creation of embedded systems.



## Leescale Smart Metering Solutions – Home Are Network







## Kinetis MKW2x Wireless MCU







- 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

#### 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

#### Core

ARM Cortex<sup>™</sup>-M4 50 MHz

DSP

**Debug Interfaces** 

**Interrupt Controller** 

#### Communications

I<sup>2</sup>C

SPI

**UART (ISO 7816)** 

USB On-The-Go (H)

**USB Charger Detect** 

USB Voltage Regulator

#### System

Internal and External Watchdogs

DMA

Low Leakage Wake-Up Unit

#### Analog

16-bit ADC

High Speed
Comparator with
6-bit DAC

#### Security

Cyclic Redundancy Check (CRC)

**Tamper Detect** 

Cryptography Authentication Unit

Random Number Generator

#### **Memories**

Program Flash (Up to 512 KB)

FlexMemory Option 64 KB FlexNVM 4 KB FlexRAM (MKW21D256 only)

> SRAM (Up to 64 KB)

#### Timers

Flex Timer

Programmable Delay Block

Periodic Interrupt Timers

**Low Power Timer** 

Independent Real Time Clock

#### RF Transceiver

IEEE 802.15.4 2006 2.4 GHz

> Fast Antenna Diversity

**Dual PAN ID** 

32 MHz Osc

SPI Interface

#### Clocks

nmable Phase-Locked Loop

Frequency Locked

Low / High Frequency Osc.

Internal Reference Clocks

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





### Cortex-M4 MCU

- ARM Cortex M4 with DSP
- Supports up to 50Mhz (1.25 DMIPS/MHz)
- 16-channel DMA
  - Supports up to 128-bit data values
  - Programmable
- Configurable nested vector interupt controller (NVIC)
- Wake-up Interrupt Controller (WIC)
- · Advanced debug and trace
- Hardware CRC
- Independent-clocked COP
- External watchdog
- 10 low power modes
  - Low-leakage wake-up, low power timer and low power RTC
  - Fast wakeup times
- FlexTimers
  - Programmable Interrupt Timer (PIT)
  - PWM support
- Carrier Modulator Timer

#### Core

ARM Cortex<sup>™</sup>-M4 50 MHz

DSP

**Debug Interfaces** 

**Interrupt Controller** 

#### **Communications**

I<sup>2</sup>C

SPI

**UART (ISO 7816)** 

USB On-The-Go (H)

**USB Charger Detect** 

**USB Voltage Regulator** 

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SRAM (Up to 64 KB)

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IEEE 802.15.4 2006 2.4 GHz

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**Dual PAN ID** 

32 MHz Osc

**SPI Interface** 

#### Clocks

Phase-Locked Loop

Frequency Locked Loop

Low / High Frequency Osc.

Internal Reference Clocks





## **Connectivity and Communication**

- SPI
  - Full-duplex
  - Master and slave mode
  - Buffered transmit and receive with FIFOs
  - DMA support for FIFOs
- Inter-Integrated Circuit (I2C)
- I2C SMBus version 2 compatible
- Up to 100 Kbps
- Multi-master operation
- DMA support
- UART
  - Full-duplex operation
  - Programmable TX/RX polarity
  - Idle line or address mark wakeup
  - Hardware parity
  - DMA request
- USB Interface OTG
  - USB 2.0 compliant
  - On-chip FS and LS transceiver
  - USB host mode
  - USB device mode
  - Suspend mode /low power
  - Supports HS with off-chip transceiver

Core

ARM Cortex<sup>TM</sup>-M4 50 MHz

DSP

**Debug Interfaces** 

**Interrupt Controller** 

Communications

I<sup>2</sup>C

SPI

**UART (ISO 7816)** 

USB On-The-Go (H)

**USB Charger Detect** 

**USB Voltage Regulator** 

**System** 

Internal and External Watchdogs

DMA

Low Leakage Wake-Up Unit

**Analog** 

16-bit ADC

High Speed Comparator with 6-bit DAC

Security

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Cryptography Authentication Unit

Random Number Generator **Memories** 

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> SRAM (Up to 64 KB)

> > **Timers**

**Flex Timer** 

Programmable Delay Block

Periodic Interrupt Timers

**Low Power Timer** 

Independent Real Time Clock **RF Transceiver** 

IEEE 802.15.4 2006 2.4 GHz

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32 MHz Osc

SPI Interface

Clocks

**Phase-Locked Loop** 

Frequency Locked Loop

Low / High Frequency Osc.

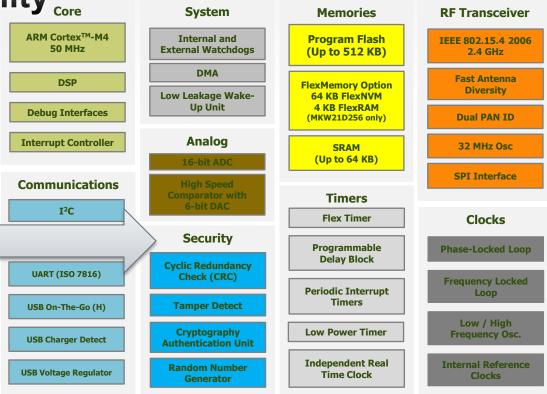
Internal Reference Clocks





## Security and Reliability core

- Tamper detect
  - External tamper detect
  - 256-bit secure storage (erased on tamper)
- CRC
- Hardware encryption
- Cryptography Acceleration Unit (CAU)
- Random Number Generator (RNG)
  - FIPS compliant



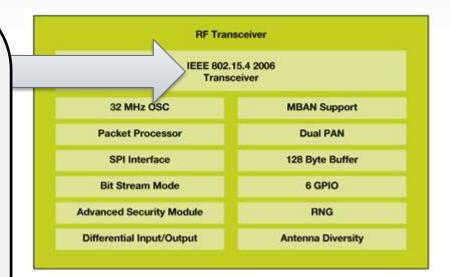




## **Transceiver Features**

#### **Transceiver Features**

- · 2.4 GHz frequency band
  - Supports 2.36 to 2.4 GHz Medical Band
- 802.15.4 compliant
  - 250 kbps data rate
  - O-QPSK modulation
  - DSSS with 5 MHz channels
  - 16 selectable channels
- Supports packet and bit stream mode
- 802.15.4 Packet Processor
- Output power varience +/- 2 dBm
- Programmable output power from -30 to +10 dBm
  - 2dB steps
- Low power receive mode
- 32 Mhz crystal oscillator with on board trim capability

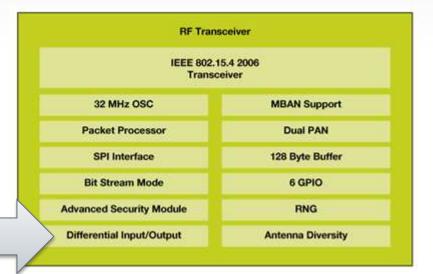






## **RF Front End**

- Differential input/output port
  - Supports external PA/LNA
- Single ended antenna option
  - Integrated transmit/receive switch
- Antenna diversity option
- Automatic Gain Control (AGC)
- Receive Strength Signal Indicator (RSSI)
- Temperature compensation



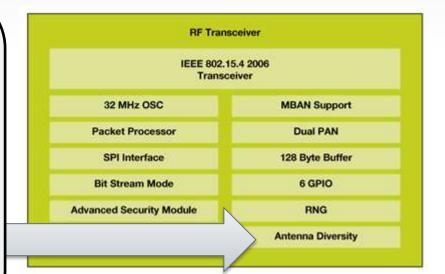




## **Antenna Diversity**

## **Diversity**

- GPIO for Antenna Diversity control
- FAD (Fast Antenna Diversity)
  - Off
  - Preamble detect







Ability to participate in two networks simultaneously

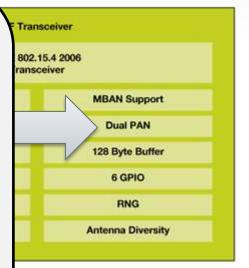
- Maintains two sets of network parameters
  - PAN, MAC address (short and long), Channel

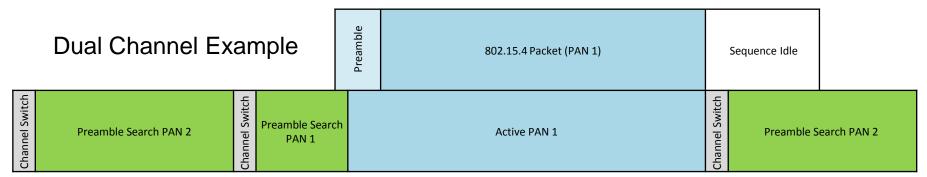
#### 2 channels, 2 PANs

- Manual mode software controls which PAN is active
- Automatic mode hardware controls which PAN is active
  - Time to dwell on channel can be set from .5 mS to 3.2 seconds
  - If PAN is active when timer expired, sequence will complete before channel switch occurs
- Channel switch is 56 uS
  - Time to switch, poll, receive packet and switch back is <10mS</li>

#### 1 channel, 2 PANs

- Address filtering is done simultaneously
- No channel switch is necessary



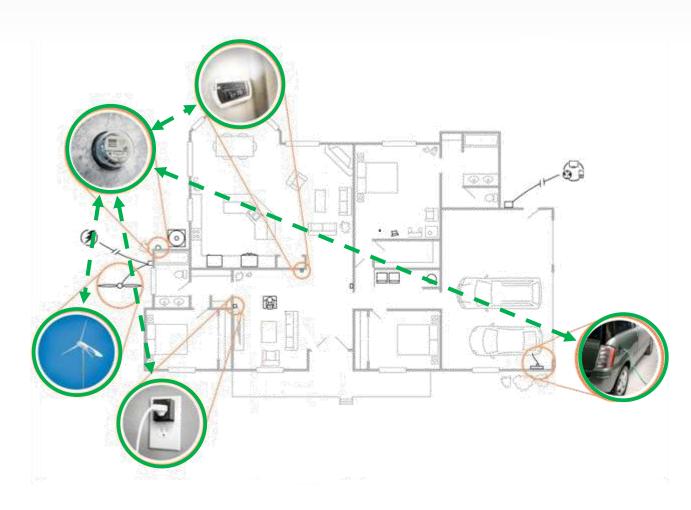






## **Dual PAN Use Case**

Smart Energy Network (Utility)



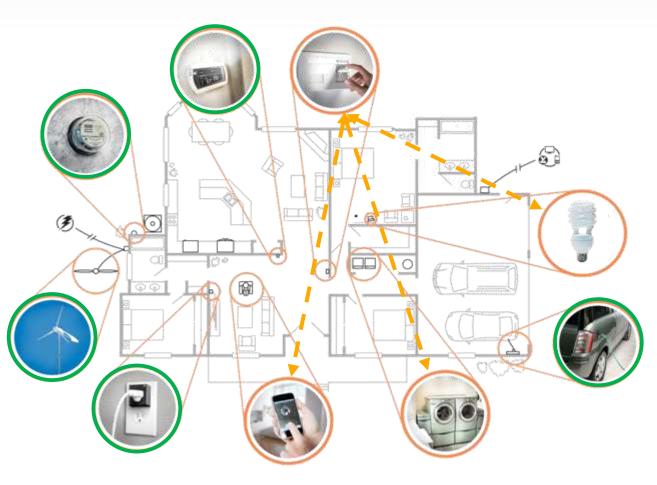




## **Dual PAN Use Case**

Smart Energy Network (Utility)

Home
 Automation
 Network
 (Home Owner)







**Home Automation** 





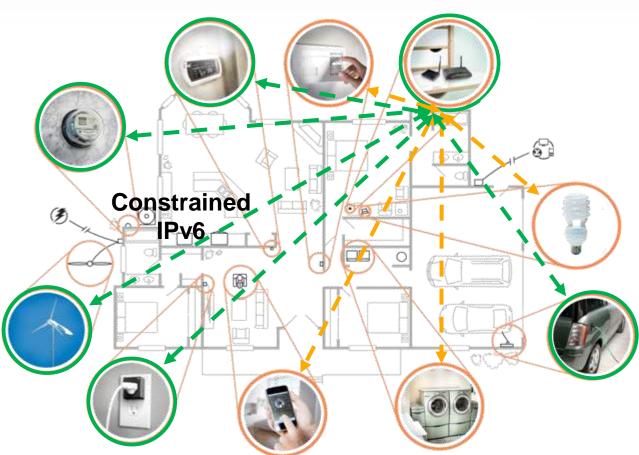
## **Dual PAN Use Case**

 Smart Energy Network (Utility)

Home
 Automation
 Network (Home
 Owner)

Dual PAN

Smart Energy &HomeAutomation













## **Features and Benefits**

Features	Benefits		
RF			
Class-leading link budget	<ul> <li>112 dB link budget provides greater range, reducing the need for external power amplifiers and lowering cost.</li> </ul>		
Low power consumption	<ul> <li>17mA TX / 19 mA RX power consumption extends battery life</li> </ul>		
Dual PAN support	<ul> <li>System can actively participate in 2 networks, eliminating the need for multiple radios.</li> </ul>		
Diversity Support	<ul> <li>Freescale's FAD (Fast Antenna Diversity) allows the hardware to automatically select between 2 antennas, improving reliability in high interference environments.</li> </ul>		





## **Features and Benefits**

Features	Benefits			
MCU				
<ul> <li>ARM® Cortex™-M4 core with DSP</li> </ul>	<ul> <li>Up to 50 Mhz core provides a broad range of application support</li> </ul>			
<ul> <li>Up to 512 KB of Flash and 64 KB of RAM</li> </ul>	<ul> <li>Provides enough memory to run complicated protocols or dual stacks and user applications on a single IC</li> </ul>			
256 KB of FlexMemory (MKW21 only)	<ul> <li>Allows user to define configuration of memory between Flash and EEPROM</li> </ul>			
Secure Flash	<ul> <li>Protects the code and data from unauthorized access or modification</li> </ul>			
Tamper detect	<ul> <li>Protects critical IP by detecting tamper events (NDA required)</li> </ul>			
Cryptography Acceleration Unit	<ul> <li>Reduces code size and execution time through hardware support for advanced security protocols</li> </ul>			
128-bit Random Number Generator	<ul> <li>Meets the FIPS 140 Security Requirements for Cryptographic Modules</li> </ul>			





## **MKW2x Enablement**

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## **KW2x 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
- BeeKit Tool with stacks and applications
  - ZigBeePro R20 with SE 1.1.x, HA 1.1, HC 1.0 profiles
  - Simple MAC and RF Test Tool
  - Dual-PAN example
  - Over-The-Air programming example
  - Coming: ZigBeelP and SE 2.0 profile
- Quick Start Guide

#### **Tower Form Factor**

- Use standalone or in Tower System
- · Boards sold individually
- Combine as many boards as needed



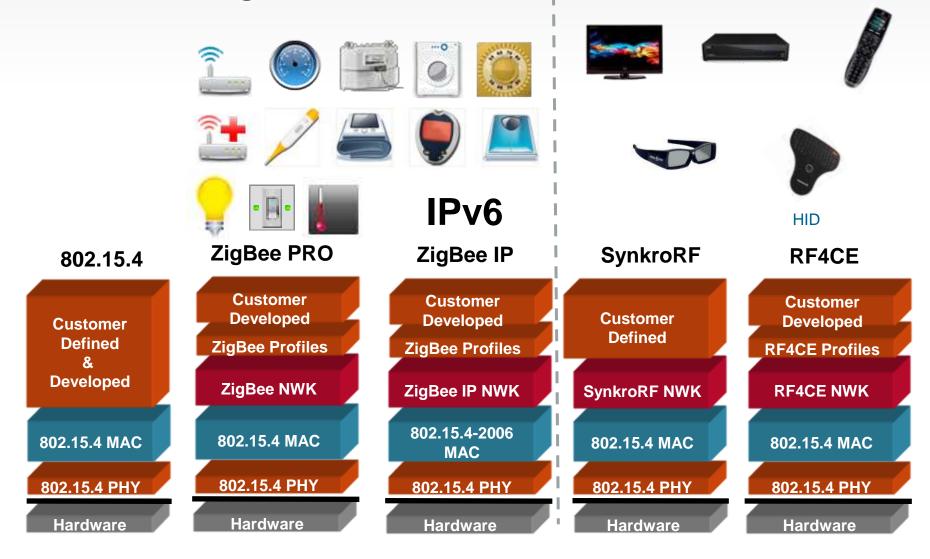
#### Part Numbers:

TWR-KW21D256 TWR-KW24D512





## Freescale ZigBee Stacks







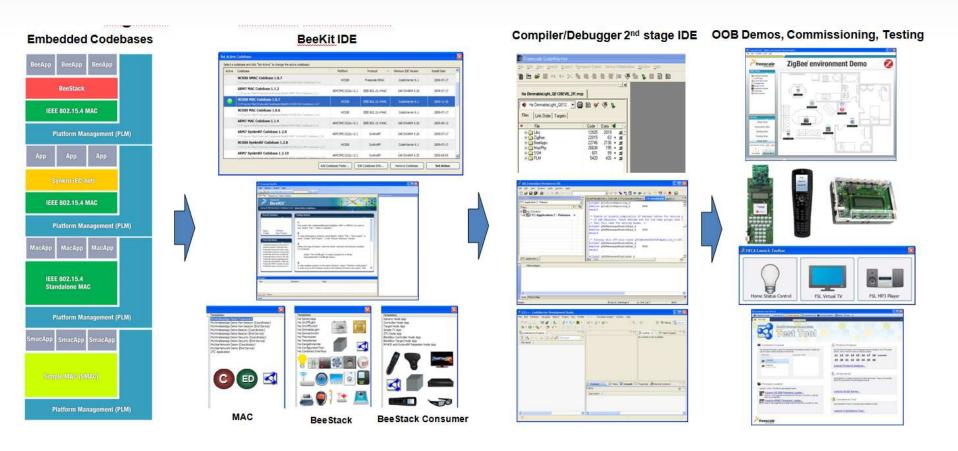
## 802.15.4 Protocol Stack Comparison

Feature	SMAC	802.15.4 MAC	SynkroRF®	ZigBee® RF4CE	ZigBee® Pro	ZigBee® IP
Applications						
Cable Replacement	✓	✓	✓		✓	
Remote Control	✓	✓	✓	✓	✓	
Home Control			✓	✓	✓	
Home Automation					✓	
Health Care					✓	
Building Automation						
Smart Energy					✓	✓
Network Stack	No	No	Yes	Yes	Yes	Yes
Application Profiles	No	No	No	Yes	Yes	Yes
Memory Requirements	4-8K	32K	<40K	<40K	128-160K	256K
Network	Point-to- Point	Peer-to-Peer	Co-existing Star	Co-existing Star	Tree	Mesh
Topology	Star	Tree			Mesh	
Typical # of Nodes	2-100	2-1000	32 per Controlled Device	32 per Target Device	2-1000 ZigBee Pro	2-32
Typical Data Throughput	50-115K	90-115K	70-100K	70-100K	30-70K	<50K





## Freescale BeeKit Toolchain







## Leveraging the Kinetis Ecosystem for KW2x







## **KW2x – Summary**

#### ARM Cortex-M4

- Up to 50 Mhz core provides a broad range of application support

#### Dual PAN Capability

 System can simultaneously participate in 2 ZigBee networks, eliminating the need for multiple radios

#### Fast Antenna Diversity

 Fast Antenna Diversity allows the hardware to automatically select between 2 antennas

#### Integrated 64K SRAM

 Provides enough memory to run complicated protocols stacks and user applications on a single IC

#### USB Connectivity

- Additional Connectivity





## KW01 – Sub GHz Smart Radio Solution from Freescale





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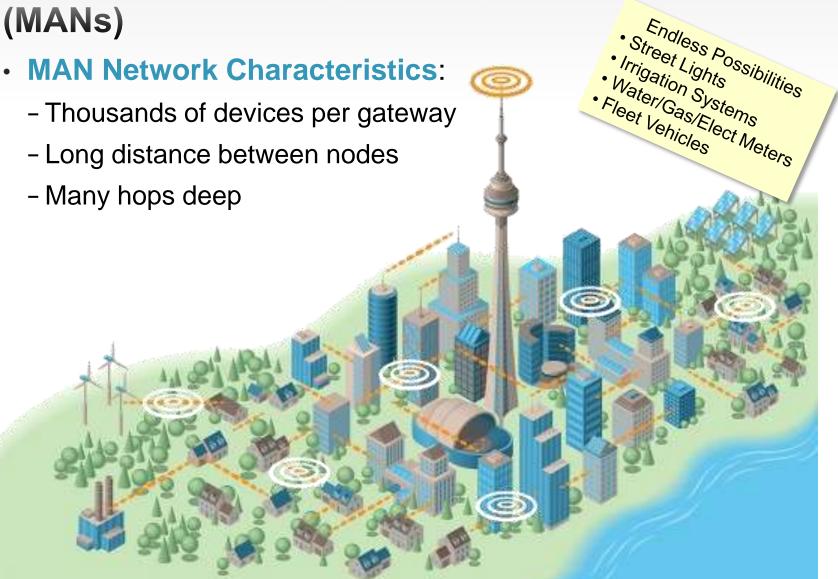
## What is KW01?

- World's first integrated ARM Cortex-M0+ based sub-1 GHz smart radio
  - Integrates Kinetis MCU (ARM Cortex M0+ 128KFlash/16K RAM)
     with a sub 1 GHz transceiver
- Targeted for Automated Meter Reading and mesh-networked smart sensors applications



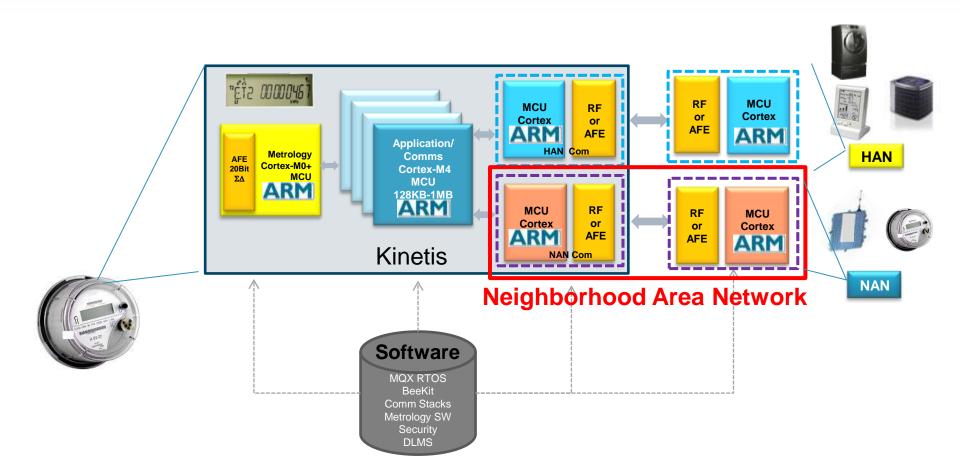


ne Internet of Things: Metropolitan Area Networks (MANs)





## Leescale Smart Metering Solutions – Neighborhood Area Network







## Kinetis KW0x Sub-1 GHz Smart Radio

Freescale offers the world's first Kinetis ARM Cortex-M0+ based sub-1 GHz smart radio for automated meter reading and mesh-networked smart sensor applications in building/home control.

**Ultra Low Power** 

Performance & Flexibility

Ease-of-Use

Market leading supplier provides best in class RF performance with 32-bit ARM Cortex-M0 for low-power, speed, MCU capability.

Flexibility to adapt to multiple communication protocols covering a wide range of frequencies worldwide.

Variety of development tools, software and documentation to accelerate the design cycle.





## 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

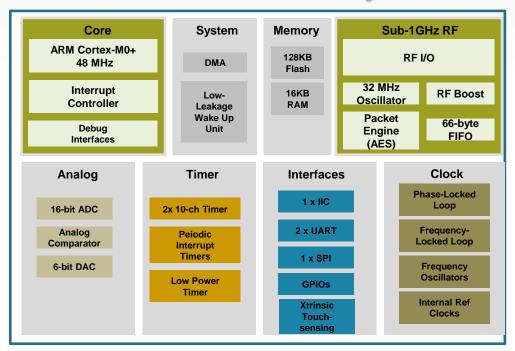
- Typical consumption
- 1.7µA standby with 4.3µs wake-up time
- <50 uA/MHz CPU system run mode
- 16 mA Rx peak
- 20 mA Tx peak at 0 dBm, 33 mA at +10 dBm

#### 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





## **Sub-1 GHz Target Applications**

#### **Metering and Building Control**

Metering
Thermostats
Lighting control
HVAC unit monitors
Water heaters
Window coverings
Ceiling fan

#### Medical/Healthcare/Wellness

Glucose monitors
Cardiac rhythm tracking
Hearing appliance remotes
Infusion pumps
Blood pressure monitoring
Pulse oximetry monitoring
Weight management monitoring

#### Fire/Security

Smoke/heat sensing and monitor
Fire alarm
Room occupancy
Intruder alarms
Motion detectors
Access control

#### **Wireless Sensors Networks**

Liquid or gas flow detect and alarm
Usage data collection
Asset control (acceleration/theft)
Maintenance monitoring
Measurement data collection
Humidity monitor and control
Hazardous environment monitor
Vibration alerts







## **KW01 – Transceiver Features**

- Frequency bands (61 Hz steps):
  - 290 to 340 MHz
  - 424 to 510 MHz
  - 862 to 1020 MHz
- Bitrate to 300 (MC12311) or 600 (MKW01) kbps
- -120 dBm @ 1.2kbps sensitivity
- IIP3 = -18 dBm, IIP2 = +35 dBm
- 16mA RX current
- AGC, AFC
- -18 to +17 dBm TX Pout
- FSK, GFSK, MSK, GMSK, OOK Modulation
- Built-in Bit Synchronizer, Packet Engine, AES128 encryption, FIFO.
- Built-in temperature sensor, low battery indicator
- Configurable for single TX/RX input/output for low parts count or separate TX out/RX in allowing off chip LNA, PA, switch, filter etc.





## **KW01 – Microcontroller Features**

- 48 MHz CPU clock frequency/24 MHz bus frequency.
  - External crystal options 32 to 40 KHz or 3 to 32 MHz.
  - FLL, PLL & internal oscillator options.
- Vectored interrupt, Wake up & non-maskable Interrupts.
- DMA, SWD debug
- 128KB P-flash, 64 byte flash, 16 KB RAM
- Low leakage modes & standby memories.
- 16-bit ADC, 12-bit DAC
- High Speed Comparator with 6-bit DAC
- Several Timers
- SPI, IIC, UART (SPI MCU to XCVR interface on chip)
- GPIO, Touch Screen Sensor
- 1.8 to 3.6V Supply, -40 to +85 C temp range.
- 56 pin 8x8mm (+4) PLGA Package.





## **KW01 MCU: Ultra-low Power Modes**

	Mode	CPU/Bus Freq.	Details	Peripheral Clocks	Typical Idd @ 3V, 25C	Recovery Time
RUN	RUN	48/24 MHz		ENABLED	6.38mA (133uA/MHz)	-
		48/24 MHz	MAXIMUM CPU/Bus frequency. Compute clocking option SUPPORTED	DISABLED	4.44mA (93uA/MHz)	-
		48/- MHz		Compute Operation*	3.98mA (83uA/MHz)	-
	VLPR	4/1 MHz		ENABLED	219uA (55uA/MHz)	-
		4/1 MHz	RESTRICTED CPU/Bus frequency. Compute clocking option SUPPORTED LVD OFF. Flash programming NOT supported	DISABLED	170uA (43uA/MHz)	-
		4/- MHz	EVD Of F. Flash programming 140 F supported	Compute Operation*	156uA (39uA/MHz)	-
(DEEP SLEEP) (SLEEP)	WAIT	48/24 MHz	MAXIMUM CPU/Bus frequency. CPU in SLEEP, peripherals functional. Compute clocking option NOT supported	DISABLED	3.88mA	-
	VLPW	4/1 MHz	RESTRICTED CPU/Bus frequency. CPU in SLEEP, peripherals functional. Compute clocking option NOT supported. LVD OFF. Flash programming NOT supported	DISABLED	112uA	4us
	STOP	-	MCU in static state, LVD ON. Energy-saving peripherals functional with ADMA.  AWIC detects wake-up source for CPU.	-	309uA	4.3us
	VLPS	-	Same as STOP mode. LVD OFF.	-	2379nA	4.3us
	LLS	-	MCU in low-leakage state retention power mode. LLWU detects wake-up source for CPU including LPTMR, RTC, TSI, CMP, and select pin interrupts. Fast wake-up.	-	1738nA	4.6us
	VLLS3	-	MCU in low-leakage mode, most internal logic OFF. All RAM contents retained and I/O states held. LLWU controls wake-up source for CPU similar to LLS mode.	-	1344nA	53us
	VLLS1	-	Similar to VLLS3	-	713nA	115us
	VLLS0	-	Pin wakeup supported. LPTMR, RTC, TSI and CMP wake-up supported with external clock. Optional POR brown-out detection circuitry.	-	411nA (POR) / 205nA (no POR)	115us

<sup>\*</sup>Compute Operation shuts off bus and system clock for lowest power core processing. Peripherals with an alternate asynchronous clock source can continue to operate.





## **MKW01** Product Differentiator

- Very low power suitable for battery operated equipments
  - Cortex M0+ Breakthrough power efficiency
  - Low-power features such as 100nA with radio configuration retention.
- High Integration Level
  - Includes the exclusive ARM Cortex M0+ core with up to 48MHz performance, embedded 128KB Flash and 16KB of RAM supporting wireless communication protocol + application in one chip
- Demonstrates exceptional RF performance with a budget link up to +137dB
- Flexibility and Compliancy with Multiple Standards
- Full set of peripherals
  - Offers multiple 16-bit timers,. 13-bit port keyboard interrupt and Touch Sensing Interface, 16-bit ADC, SCI, I2C, SPI





## **Features and Benefits**

Features	Benefits
ARM Cortex M0+ CPU core	Lowest power industry core
Single-chip with MCU + Radio + Memory	Save size and cost versus a 2 to 3 chip solution
High radio link budget	Very long point to point wireless range without the need for repeaters or costly amplifying devices.
Flexible RF configuration	Adapt to global standard requirements and local (regional) regulations





## **MKW01 Enablement**

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## **KW01 – Development System**

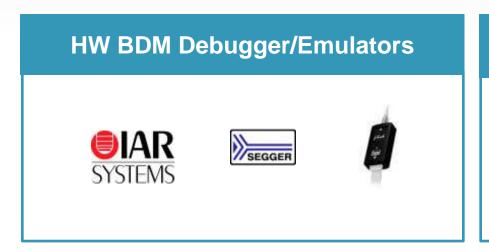
- Modular Reference Board (MRB).
- Can run stand-alone with on-board mini-USB.
- Can plug into TWR-RF.
- SMA for Antenna or cable.
- Available with 30 or 32 MHz XTAL for frequency/spurious management.
- Available for 868/915 MHz, 434 MHz bands, can be tuned to 315 MHz.



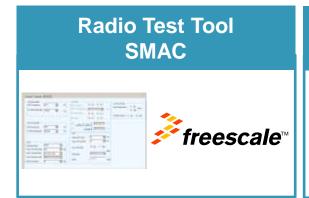




## Leveraging the Kinetis Ecosystem for KW01







IEEE 802.15.4g IPv6

IPv6/6loWPAN (Q4 '13)











## **KW01 Development Kits**

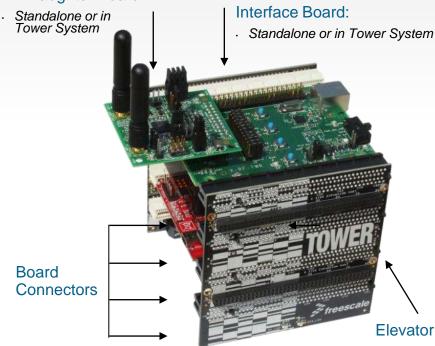
#### Leverages the Tower system

- Quickly combine Tower Modules to build a prototype of your application
- Software support from Freescale and Third Parties
- Growing community of Third Party hardware support
- On-line community: <a href="www.towergeeks.org">www.towergeeks.org</a>

#### Kit Features

- Flash reprogramming and in-circuit hardware debugging
- USB port to interface with PC
- Configurable I/O access
- LEDs and switches for demonstration, monitoring and control
- Out-of-box application
- Quick Start Guide





#### **Part Numbers:**

MRB-KW019032NA MRB-KW019032EU

MRB-KW019030JA

An antenna needs to be purchased before using this kit. In addition, customer requiring Tower integration need the RF kit (TWR-RF)





## **KW01 Software**

- Simple Proprietary MAC (SMAC)
  - Wireless UART
- Sub-GHz MAC/PHY
  - IEEE 802.15.4e/g MAC/PHY Layer
  - CSL (Coordinated Sample Listening) is supported
  - Compatible with the TTC JJ-300.10 spec
- Wireless MBUS
  - Base EN13757-4 a generic 868 MHz layer 1 & 2 Wireless Meter-Bus stack (EN13757-4: 2005 and EN13757-4:2013 mode C, when released) for modes R, S and T
  - Evaluation version a cut-down implementation of the Full version designed as a free-to-download simplified stack to allow users to evaluate the Freescale Wireless Meter-Bus solution.
  - Full version a comprehensive implementation of EN13757-4: 2005 and EN13757-4:2013 mode C, when released. Available through preferred partner.





#### KW01 is World's first Cortex M0+ based wireless MCU

- Very low power suitable for battery operated equipments

## KW01 is Flexible and Compliant with Multiple Standards (including IEEE 802.15.4 for Smart Utility Networks)

## KW01 is a Modem-in-a-chip for easily adding connectivity to many applications

- Smart Metering Last Mile connectivity
- Sub-Metering
- Building Control and Automation





