Wireless Connectivity Overview

Freescale Solutions

2015
Agenda

• Winning Technologies in IoT Today
• Megatrends Visible Today
• Freescale Strategy and Vision
• Hardware and Software Roadmaps
• Enablement and Support
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

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!

Power of Legacy
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

Application Layer / Profiles
- HomeKit
- AllJoyn
- IoTivity
- IPSO
- M2M
- MQTT
- Remote Controls (ZRC)
- Home Automation (HA1.2)
- Light Link (ZLL)
- Smart Energy (SE1.x)

Network Layer / Transport Layer
- Bluetooth Host Stack
- TCP / UDP
- IPv4 / IPv6
- 6LoWPAN
- RF4CE
- ZigBee PRO

Physical / Link Layer (PHY/MAC)
- Bluetooth Link Layer
- IEEE 802.11n (high data rate networking)
- IEEE 802.15.4e
- IEEE 802.15.4 (low power networking)

Wearables → Gateways → Sub-1 GHz → 2.4 GHz Home Automation & Control Networks

Border Routers → Industrial Wireless

Industrial Wireless → 2.4 GHz Home Automation & Control Networks
### 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
- Communication co-existence
- Blind spots
- Over engineering
- Compatibility with legacy products
- Ecosystem to enable seamless integration
Freescale Strategy and Vision

• **Differentiate through Software**
  - Deliver all our software integrated in the Kinetis MCU 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
  - 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
Freescale BLE Stack Facts & Figures

• Memory footprint
  – **100 KB flash** and **12 KB RAM** for a full application and profile (including KSDK, RTOS and drivers)
  – **70 KB flash** and **4 KB RAM** just the stack itself
• Runs on a Cortex-M0+ @32MHz (20% CPU bandwidth max.)
• Pending compliance to the Bluetooth® LE v4.1 specification
• It is **RTOS agnostic** and can run in a non-preemptive mode (bare-metal). Some loop-based scheduling is still required.
• Coexists with the 802.15.4 MAC and upper network stacks in the same **dual mode firmware** for KW40Z
• Currently available with **IAR Embedded Workbench** support
Introducing Kinetis KW40Z Wireless MCUs

- **Multi-Protocol Radio** – High-performance radio supporting Bluetooth Low Energy v4.1 and IEEE 802.15.4 based standards
- **Low-Power Operation** – Low transmit, receive and standby currents help maximize battery life including standard coin-cells
- **High-precision Analog** – DC-DC Converter with Buck or Boost configuration, high precision DAC and a 16-bit ADC for highly accurate sensor measurement for wireless sensor networks
- **Robust Software Package** – Fully compliant, certified Bluetooth Low Energy, 802.15.4 MAC, Thread and ZigBee® protocol stacks
Kinetis KW40z MCU Block Diagram

- 2.4GHz Radio
- 2.4GHz Radio
- Flash 160KB
- SRAM 20K
- DMA
- Cortex-M0+
- MCG
- Debug
- Cryptographic AES Acceleration
- True Random Number Generator
- Clock Management
- Power Management and DC-DC (Buck & Boost Modes)
- Cross Bar Switch (XBS)
- Peripheral Bridge
- 3x Timer/TPM
- Periodic Interrupt Timer
- Low Power Timer
- 16-bit ADC
- Temp Sensor
- Battery Mon
- 12-bit DAC
- 2xSPI
- UART
- 2xI2C
- CMT
- CMP
- GPIO with IRQ Capability
- Touch Sense I/F

External Use
Kinetis KW40 MCU 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

- Part-number: FRDM-KW40Z
Freescale Thread Stack Facts & Figures

- Routed mesh network based on industry standards: IEEE 802.15.4 and IETF 6LoWPAN
- IPv6 addressability at every node, with auto-configuration
- Scales across multiple device categories:
  - Low-power end nodes:
    - simple sensors or actuators, multi-year battery life
    - recommended devices: Kinetis KW20Z, Kinetis KW40Z, Kinetis+CR20A, Kinetis KW2xD
    - recommended memory configuration: 160KB-256KB flash, 12-32KB RAM
  - Mesh routers and border routers:
    - mains powered, act as parents for end devices, may forward to external IP networks
    - recommended devices: Kinetis KW2xD, Kinetis K64F, Kinetis+CR20A
    - recommended memory configuration: 256KB-1MB flash, 64-128KB RAM
  - Border routers running high-level OS (Linux):
    - advanced IP network provisioning and routing
    - advanced UI and applications (e.g.: hubs, gateways)
    - recommended devices: i.MX hosts with Kinetis-Wireless combos
- Advanced security and key exchange: AES128, elliptic curve cryptography (ECC), DTLS, J-PAKE
- Built for simple, secure commissioning of new devices via smartphone apps
- Wi-Fi and Ethernet add-ons for border routers
- Multiple interface support for 2.4GHz and Sub 1-GHz IEEE 802.15.4 PHYs
- Able to concurrently run with BLE and ZigBee stack on multi-mode and DualPAN Kinetis devices.
Kinetis KW2xD MCU Block Diagram

**Core Features**
- 50 MHz Cortex M4 CPU core
- Up to 512KB Flash & up to 64KB SRAM
- Typical current: 250 uA/MHz run, 1.7uA RTC standby

**RF Features**
- 2.4 GHz frequency ISM band, including MBAN
- -102dBm receive sensitivity
- Up to + 8dBm programmable output power
- TX 17mA at 0dBm and RX 19mA typical
- Cryptography: DES, 3DES, AES 128-256, SHA-1, SHA-256, MD5, RNG
- Active and passive tamper detection
- Dual-PAN support (personal area network)
- Fast antenna diversity supporting 2 antennas
- Low component count for Balun & Match

**System Features**
- -40 °C to 105 °C
- 1.8 to 3.6 V
- 8x8 Laminate QFN 63-pin
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
- AES Hardware encryption/decryption
- True Random Number Generator
- Dual-PAN support (personal area network)
- Fast antenna diversity supporting 2 antennas
- Low component count for Balun & Match

System Features
- -40 °C to 105 °C
- 1.8 to 3.6 V
- 5x5 Laminate QFN 32-pin
Kinetis KW2xD MCU 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
- Is moving to volume production right now

• Part-number: FRDM-KW24D512
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
• 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
Support Available for You Now!

- [https://community.freescale.com/community/wireless-connectivity](https://community.freescale.com/community/wireless-connectivity)
- [https://community.freescale.com/community/iot-center](https://community.freescale.com/community/iot-center)
The Best Solution is the One that Works!

- Clear trend towards **IP-based** solutions
- **Software** is a key selection criteria
- Understanding **system- and SoC-level security** will impact both hardware and software
- **Partnering** with **external companies** is required for the Internet of Things