TI SimpleLink™ dual-band CC1350 wireless MCU

Sub-1 GHz and Bluetooth low energy in a single-chip

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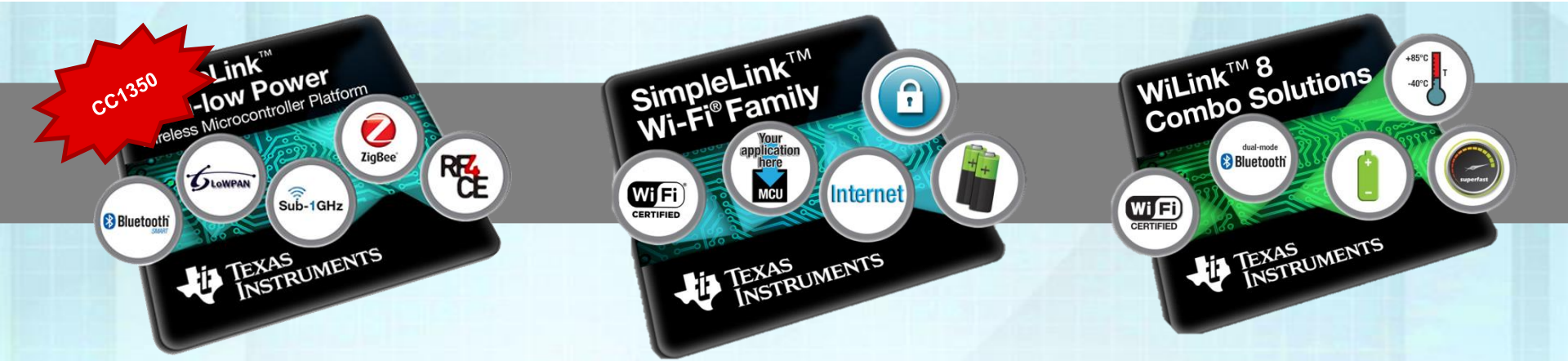
Agenda

- Wireless Connectivity Overview
- SimpleLink Wireless MCU Overview
- CC1350 Architecture, Features, Benefits
- Dual band roles and Use cases
- How to get started!

Broadest Wireless Portfolio: A solution for any application



SimpleLink™ Ultra-Low Power Platform

- The lowest power
- Multi-standard platform
- Easiest to design with

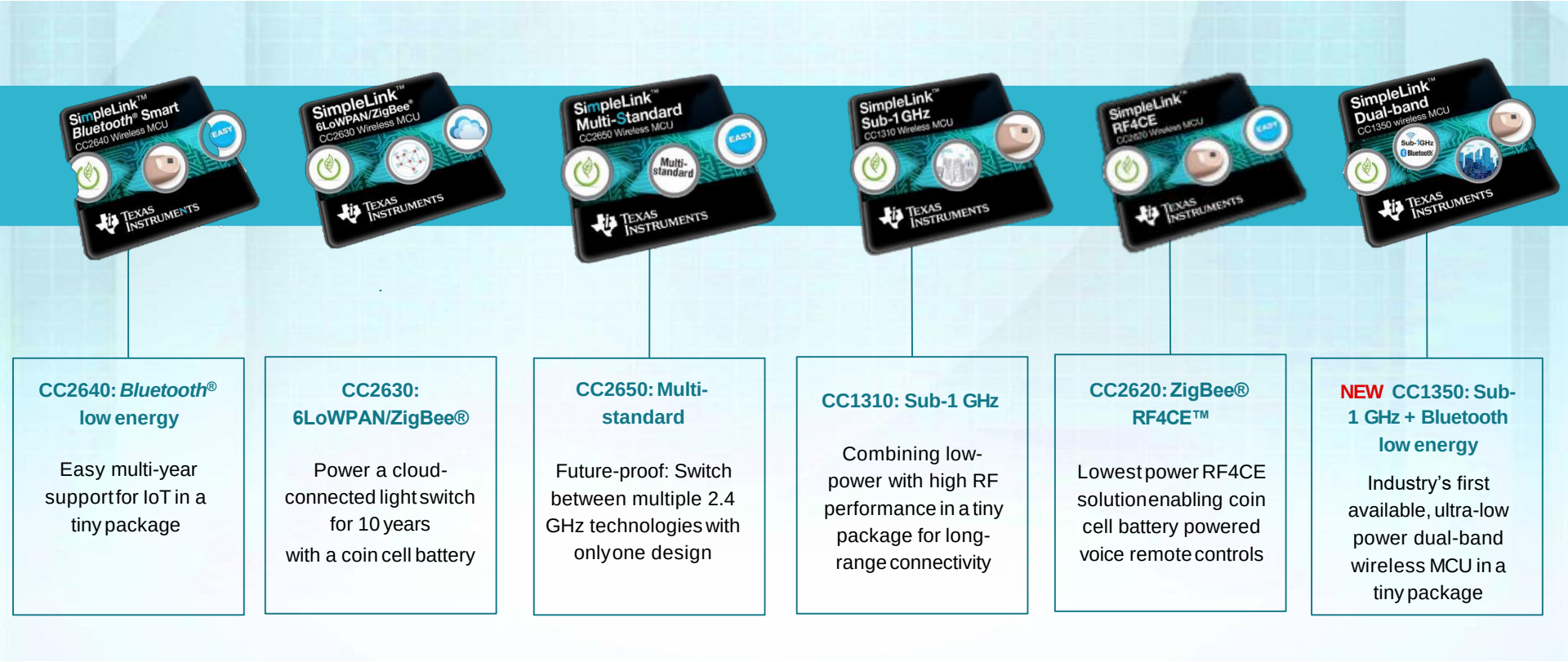
SimpleLink Wi-Fi®

- Low power
- Easy to use
- Integrated security

WiLink™ 8

- Integrated and scalable
- High performance
- Certified and easy to use

SimpleLink™ ultra-low power platform



CC2640: *Bluetooth*® low energy

Easy multi-year support for IoT in a tiny package

CC2630: 6LoWPAN/ZigBee®

Power a cloud-connected light switch for 10 years with a coin cell battery

CC2650: Multi-standard

Future-proof: Switch between multiple 2.4 GHz technologies with only one design

CC1310: Sub-1 GHz

Combining low-power with high RF performance in a tiny package for long-range connectivity

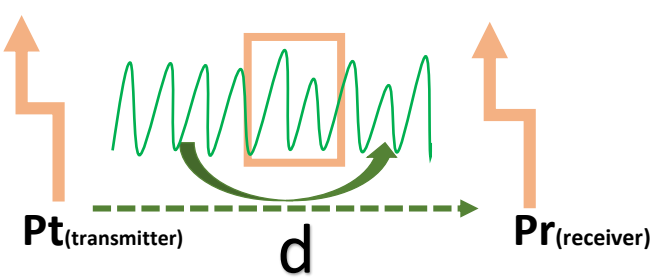
CC2620: ZigBee® RF4CE™

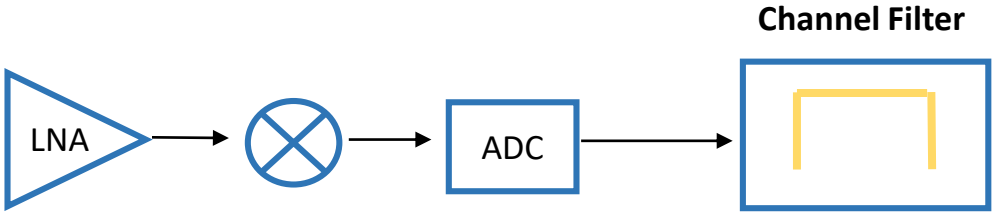
Lowest power RF4CE solution enabling coin cell battery powered voice remote controls

NEW CC1350: Sub-1 GHz + Bluetooth low energy

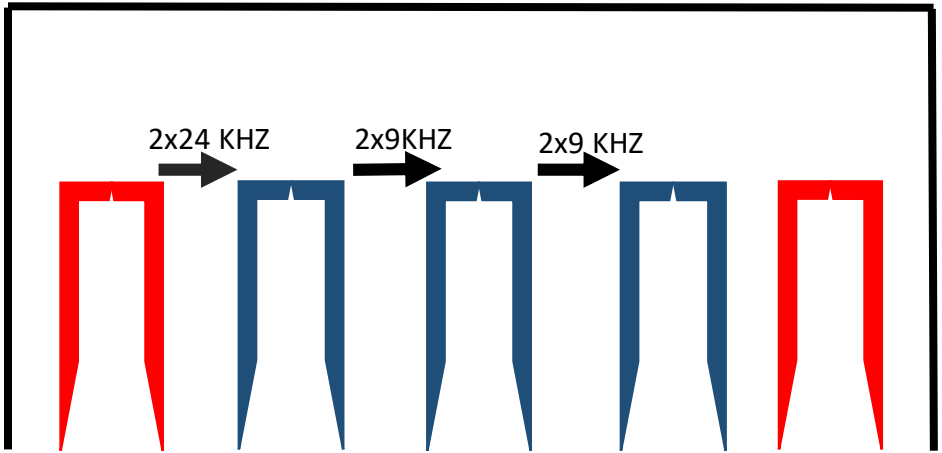
Industry's first available, ultra-low power dual-band wireless MCU in a tiny package

Why Sub-1Ghz ? and Benefits





$$Pr \ \alpha \frac{Pt}{d^2 f^2}$$



Monitor IoT networks from your handheld device

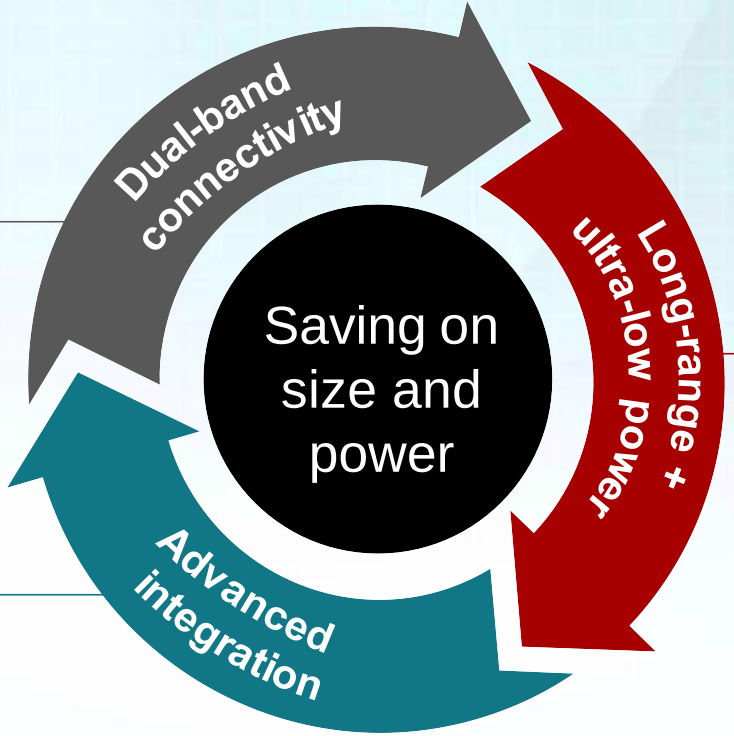
Dual-band CC1350 wireless MCU

Access to long-range data at your fingertips

Expand the functionality of your Sub-1 GHz network with Bluetooth low energy implementations to enable over the air updates, smart commissioning, beaconing, remote display and proximity detection with your smartphone

Reduce board space for smaller, more compact products

Move from a three chip solution to a tiny single chip with a full software stack, without compromising on long range or functionality



Connect things at a long distance without changing a battery

Achieve up to 20 km for over 10 years on a coin cell battery thanks to a dedicated sensor controller combined with a reliable radio transceiver.

CC1350 wireless MCU: Key features and benefits

Lowest-power Sub-1 GHz

- 5.5 mA Radio RX current
- 12.9 mA Radio TX @ +10 dBm
- 22.6 mA Radio TX @ +14 dBm
- 51 µA / MHz ARM® Cortex®-M3 @ 48 MHz
- 0.6 µA sleep current w/RTC + retention

Up to 20 year battery life for sensor nodes

Low-power BLE

- 6.5 mA Radio RX consumption
- 10.2 mA Radio TX @ +0 dBm

Enabling ULP smartphone connection

Long-range Sub-1 GHz

- -110dBm sensitivity@ 50 kbps
- -124dBm sensitivity@ 0.625 kbps
- +14 dBm output power
- Strong co-existence
  - Up to 90 dB blocking

Full building to city-wide RF coverage

Long-range BLE

- +9 dBm Output Power
- -87 dBm Sensitivity

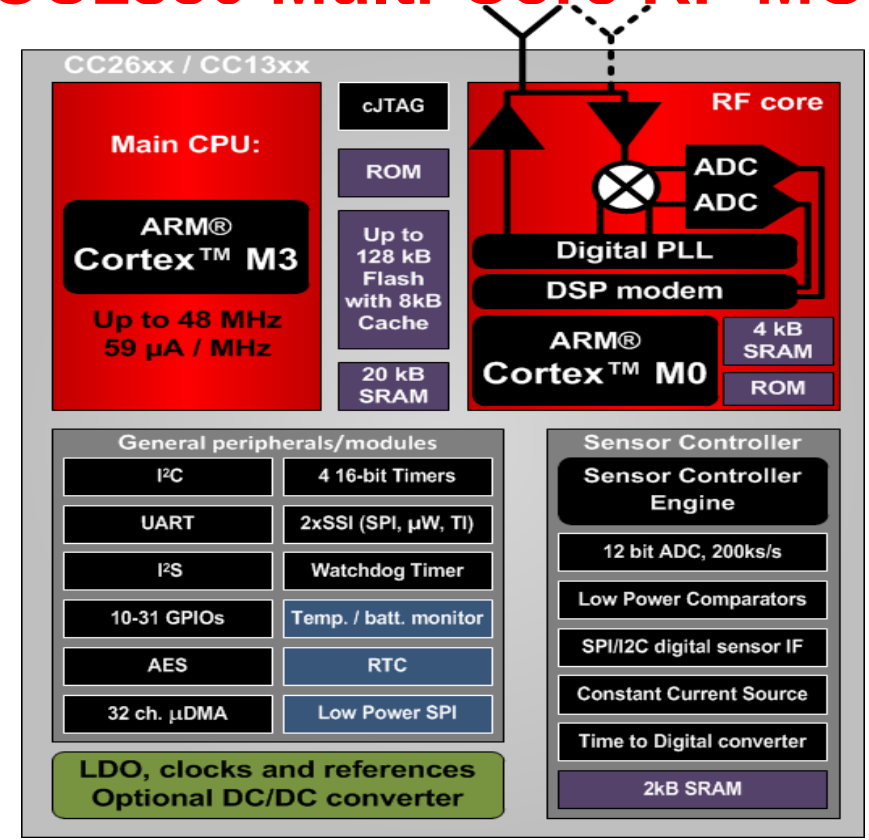
Up to 100m smartphone Connection

Most integrated

- Sub-1GHz + BLE RF Transceiver
- ARM Cortex-M3 application processor
- 128k Embedded flash
- 116k ROM
- 20k SRAM
- Sensor Controller Engine (SCE)
- 4x4 QFN
- On-chip DCDC
- TI-RTOS + RF Driver in ROM

Dual-band wireless MCU
on a finger-tip size

CC1350 Multi-Core RF MCU



Ultra-low Power Consumption
- 51 µA / MHz ARM Cortex M3
- 0.6 µA sleep with RTC with RAM retention
- 2.4 GHz:
  - 6.5 mA RX
  - 6.5 mA TX @ 0 dBm
- Sub-1GHz:
  - 5.5 mA RX
  - 12 mA TX @ +10 dBm
- Sub-1 mA RX SniffMode

SoC Key Features
- Autonomous sensor controller
- 4x4, 5x5 and 7x7 mm QFN
- Flash-based
- 1.65 – 3.8 V supply range

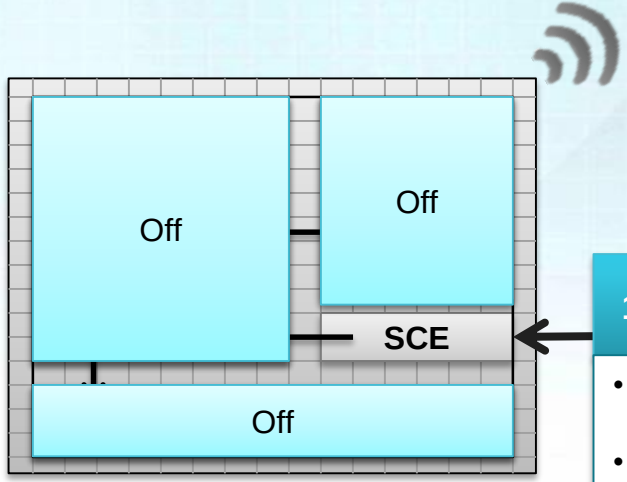
RF Key Features
- 2.4 GHz
  - +10 dBm output power
- 315-950 MHz
  - +14 dBm output power

CC1350 Whole system example

- Requirement:
  - Sample value of external sensor once per second
  - Send encrypted radio alarm if the value is above the threshold

3. RF Core

- Configured by the **Main CPU**
- Automously creates and sends radio message
- Reports back when done



2. Main CPU

- Awoken by **SCE**
- Uses the AES in **Peripherals** for encryption
- Configure **RF Core** and start transmission

1. Sensor Controller Engine

- Wakes up once per second and reads sensor
- If above threshold, wake **Main CPU**

Average current consumption: ***1.6 µA*** *48 MHz, 3.3V, 1 packet per minute, 16 bytes payload, +12.5 dBm*

Get started fast! Development kit offering

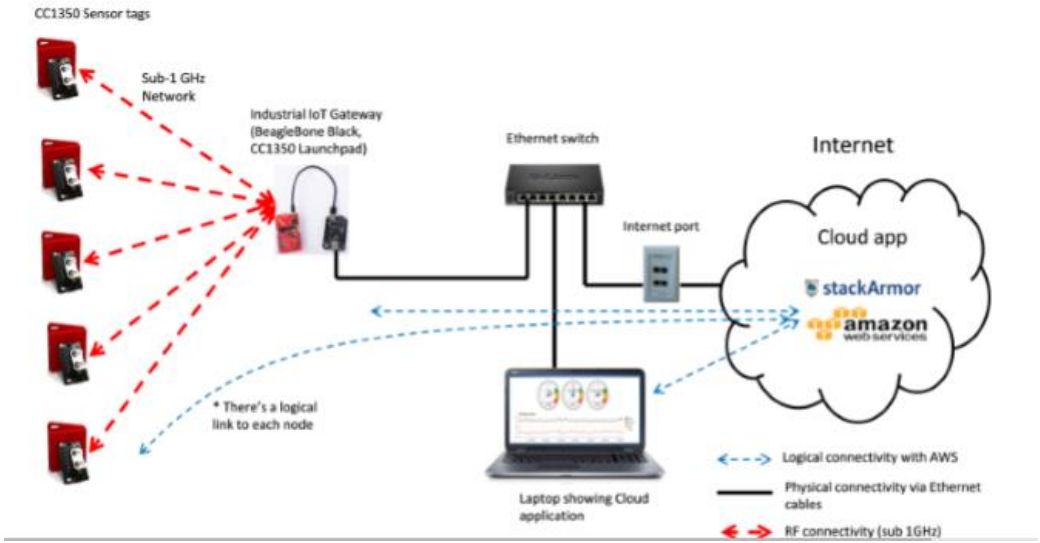
CC1350 LaunchPad™ development kit

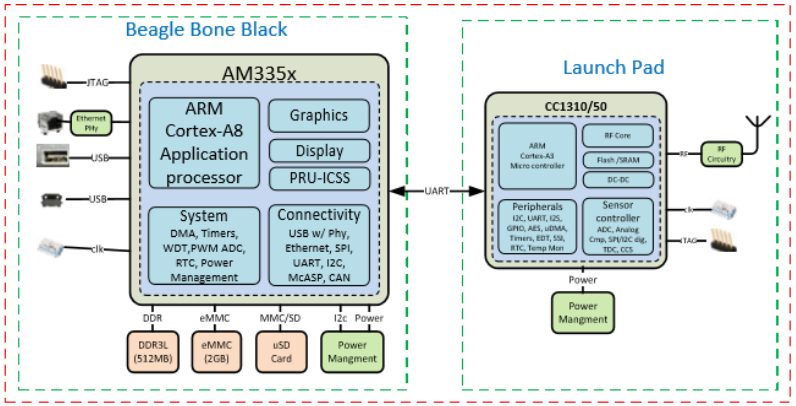
- Low-cost MCU evaluation kits and plug-in modules for quick development
- $29 through TI Store and distribution
- LAUNCHXL-CC1310 – 868/915MHz
- LAUNCHXL-CC1350 – 868/915MHz + BLE
- LAUNCHXL-CC1350 – 433MHz + BLE

CC1350 SensorTag demo kit –

- Sensor-based development kit for IoT and Long Range applications
- Get connected to the cloud in 3 minutes
- Free app for iOS and Android
- $29 through TI Store and distribution
- CC1350STK - 868/915MHz+2.4GHz (4Q2016)

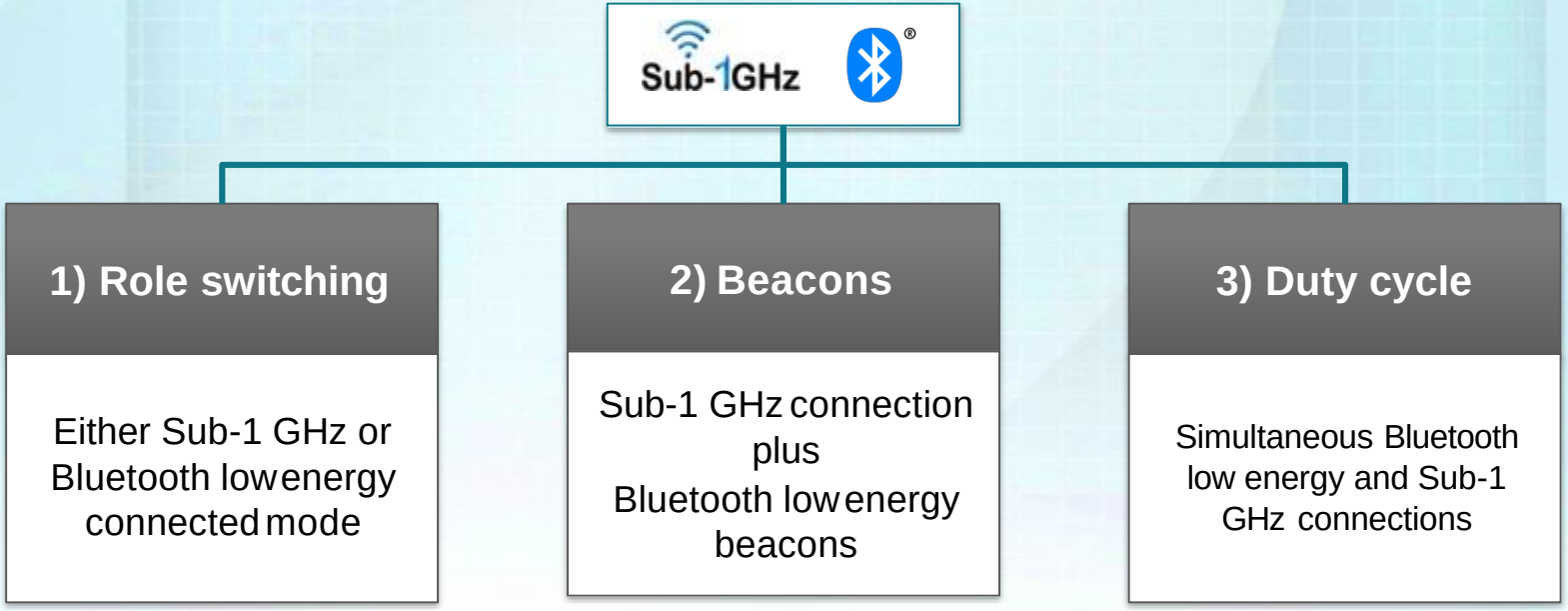
TIDEP0084: Sub-1 GHz Sensor to Cloud Industrial Internet of Things (IoT) Gateway Reference Design





Dual-band roles, use cases and applications

CC1350 wireless MCU: Dual-band in practice



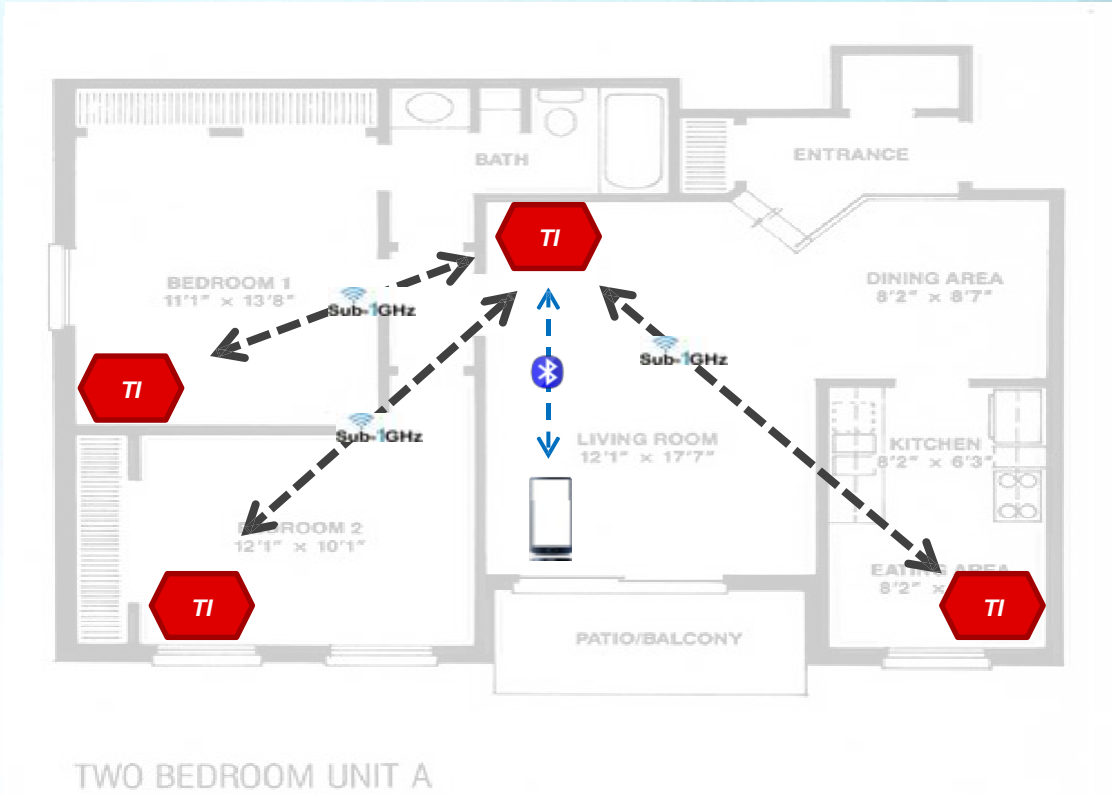
Supported in latest BLE-Stack on ti.com

Supported:
- *TI-RTOS SDK*
- *Open Source Contiki OS*

Coming soon!

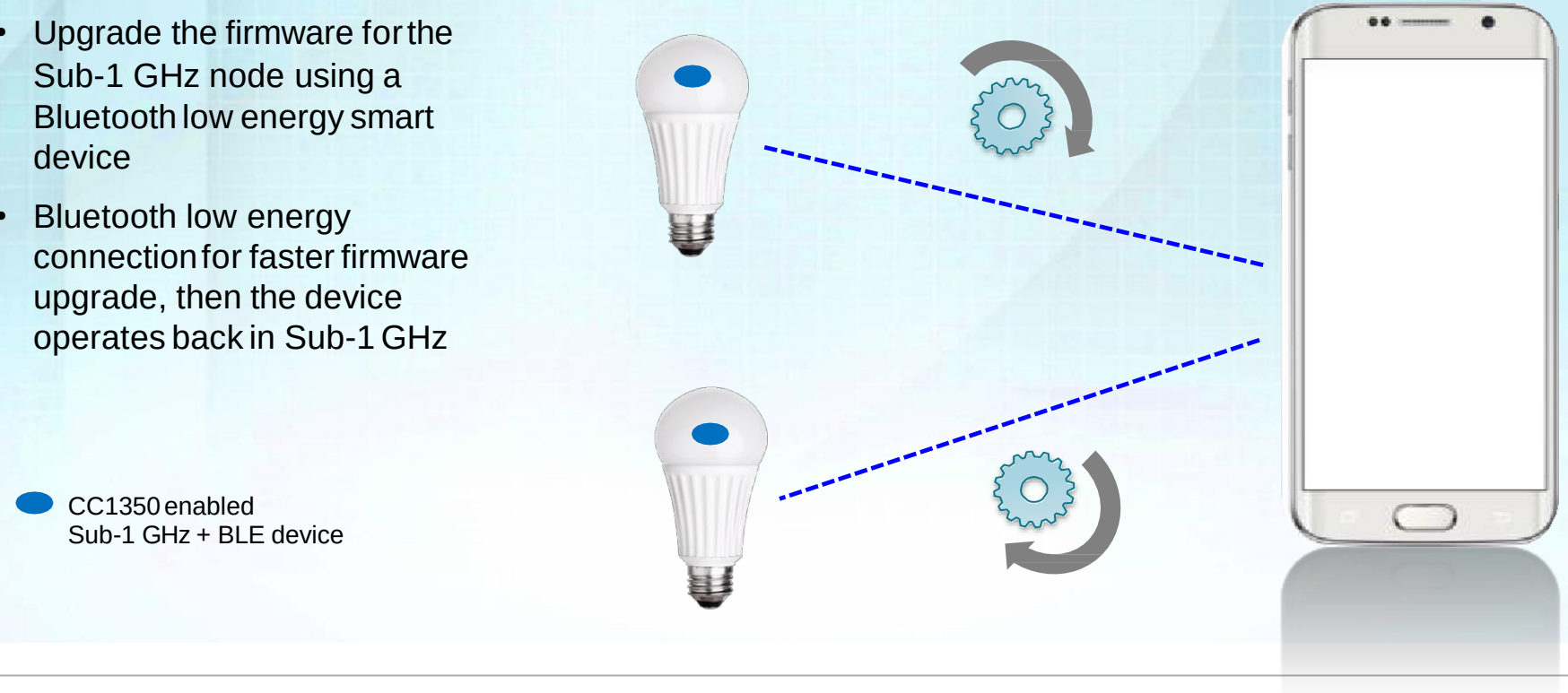
1) Role Switching: Sub-1 GHz + Bluetooth low energy

- **Either in Sub-1 GHz or Bluetooth low energy connected mode**
- **Full house Sub-1 GHz coverage**
- **Use e.g. button to switch mode**
  - E.g. single button interface to make it Bluetooth low energy connectable
  - Full Bluetooth low energy connection
    - Full-duplex communication
  - Full app integration
    - Device configuration or even image can be changed via phone, tablet or PC



Role switching use case: OTA firmware update

- Upgrade the firmware for the Sub-1 GHz node using a Bluetooth low energy smart device
- Bluetooth low energy connection for faster firmware upgrade, then the device operates back in Sub-1 GHz



Role switching use case: Commissioning

- Commissioning devices to a Sub-1 GHz network, i.e. give credentials via BLE connection
- First runs in full Bluetooth low energy connected mode, then the device takes part of Sub-1GHz network

CC1350 enabled
Sub-1 GHz + BLE device

Sub-1 GHz network

2) Beacons: Sub-1 GHz + Bluetooth low energy

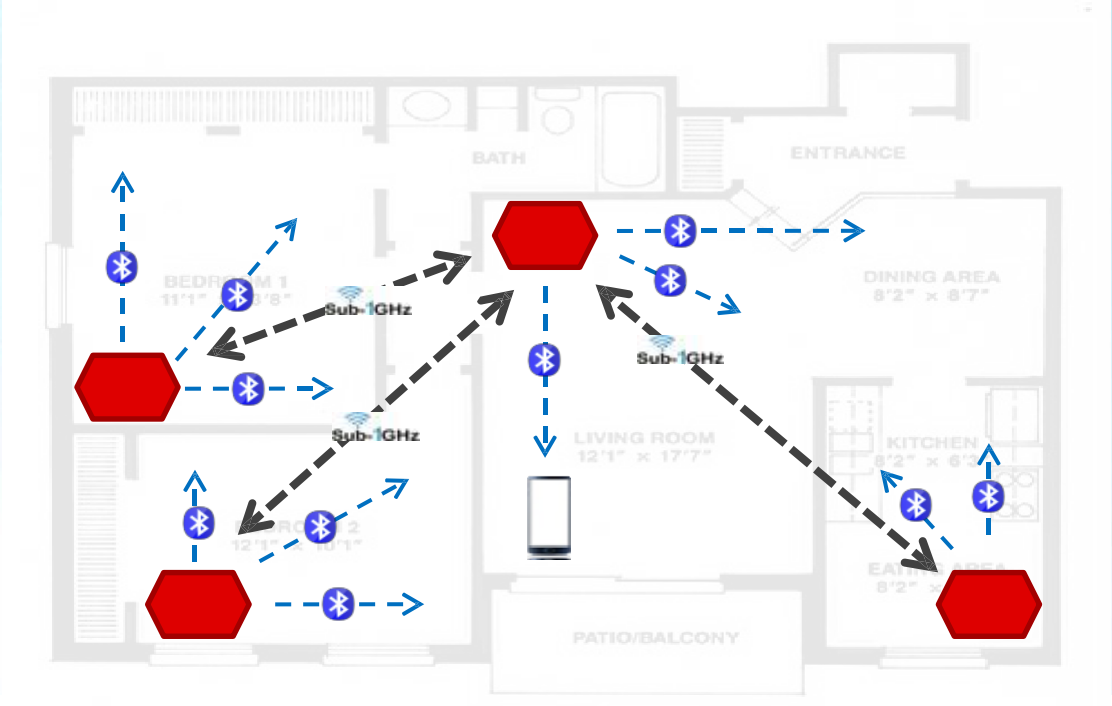
- Device switches between sub-1GHz operation and BLE beacon operation
- Full house Sub-1GHz coverage
- Local Bluetooth low energy beacon content

Google Eddystone

iBeacon

Proprietary

Pros
Non-intrusive to Sub-1 GHz network • Does not affect Sub-1 GHz link • Send beacons when radio is available **Very light-weight** • No need for the entire Bluetooth Smart stack
Cons
One way broadcast communication • Beacon can only TX **Limited amount of data payload** • 31 bytes of payload **Multiple payload standards**

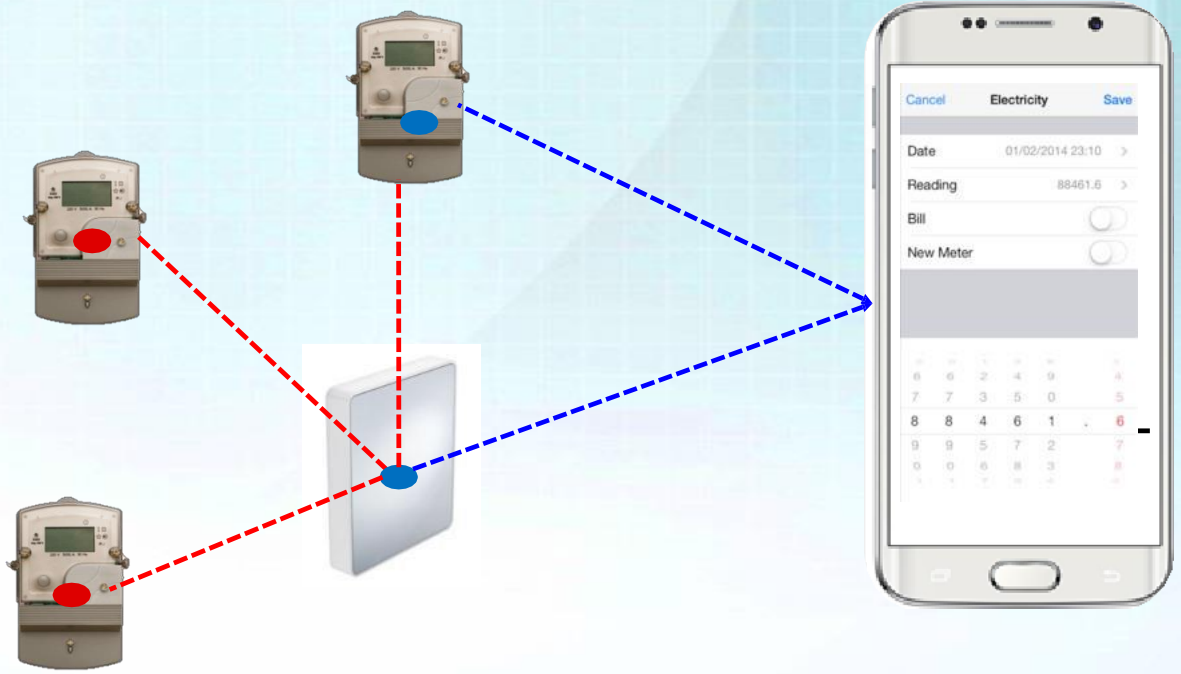


Beacon use case: Remote display

- Extracting information from the Sub-1 GHz network directly from the node
- Run time data sending while in Sub-1 GHz, using the Bluetooth low energy advertisement as uplink channel

CC1350 enabled
Sub-1 GHz + BLE device

CC1310 enabled
Sub-1 GHz device

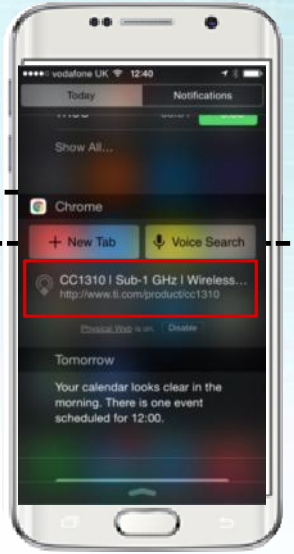


Beacon use case: Remote beacon management

- Configuring Bluetooth low energy advertisements (e.g Google physical web) via a long range Sub-1GHz server
- Low power dynamic physical web update

CC1350 enabled device connecting Sub-1 GHz and Advertising URL

CC1310 enabled Sub-1 GHz device



Easy-to-use: Software, support and more

Software

Common software

Across all SimpleLink ULP products:

- TI-RTOS operating system
- Code Composer Studio integrated development environment
- IAR Embedded Workbench

Available software:

Fits developer's network needs:

- EasyLink: Point-to-point communication examples
- wM-Bus protocol stack
- BLE-Stack 2.2 supporting Bluetooth 4.2 specification
- www.ti.com/tool/cc13xx-sw

Support

Comprehensive

Development documentation, guides and wikis available online

E2E online support

TI E2E™ community – answers at your fingertips from engineers

Training

Online videos and other resources to learn more about the parts and tools

And more…

TIDesigns

TI reference designs online

TI IoT cloud ecosystem

TI store 24/7

Samples & kits on TI Store

Low Power Connectivity Support

Web:

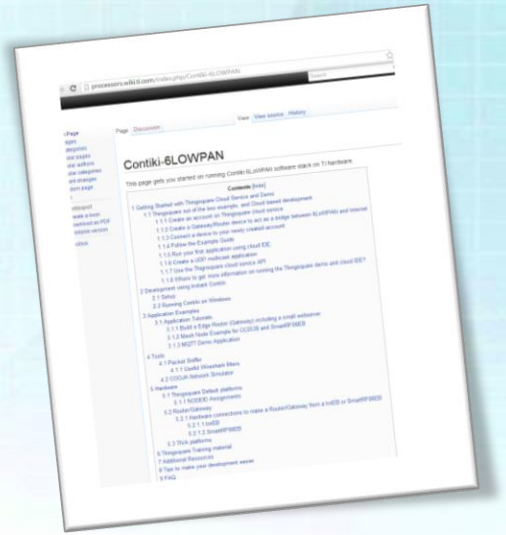
- http://www.ti.com/product/CC1310
- Application notes
- Software & tools downloads and updates
- Order evaluation and development kits
- www.ti.com/6lowpan - general 6LoWPAN information

Wiki's:

- CC13xx Internal wiki
- TI Contiki 6LoWPAN wiki

Engineer 2 Engineer Community, Support Forums:

- Wireless Connectivity Forum



For latest CC13xx schedule information, please see the CC1310 intro deck located on the internal wiki.

TI WIFI Solution and Cloud Connectivity

Erem Irmak

empa:::electronics

Connecting Applications with TI Wi-Fi®

Wi-Link™

WL18xx

Highest Performance & Integration

Wi-Fi, BT/BLE & GNSS combos
Attaches to MPUs
TI certified module

WL127x

High Performance

Wi-Fi, BTH/BLE combos
Attaches to MPUs
3P Modules available

Portable consumer & enterprise, Automotive, Connected Home, Smart Energy, Health




SimpleLink™

CC3100

Wi-Fi Network Processor

Deeply embedded
Attaches to MCUs
3P & TI modules available

CC3200

Cortex M4 Apps MCU + Wi-Fi Network Processor

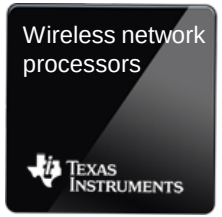
System on a chip

Home automation, Smart energy, connected appliances, M2M communication, Health & fitness






Portfolio positioning

SimpleLink™ Solutions			WiLink™ Solutions
Existing Products – proven foundation of millions of devices shipped in the market			
Smart RF Transceivers	Wireless Network Processors (WNPs)	Wireless Microcontrollers (MCUs)	Wi-Fi Combo Devices
			
Application	Application	Application	Application
Wireless Stack	Wireless Stack	Wireless Stack	Wireless Stack
RF Radio	RF Radio	RF Radio	RF Radio

- **SimpleLink**: Broad offering of RF transceiver, wireless network processors and wireless microcontrollers
- **WiLink**: High performance Wi-Fi + Bluetooth/BLE combo devices

SimpleLink Wi-Fi CC3100 & CC3200 brings…

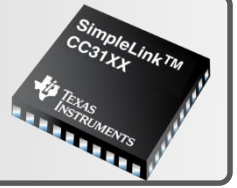
Industry's first single-chip Wi-Fi solution with built-in programmable MCU

Ability to run on two AA batteries for over a year, bringing the capabilities of Wi-Fi to battery-operated end-equipments

All you need to easily create IoT solutions - robust security, quick connection, cloud support and more

CC3100 and CC3200 Product Highlights

Next generation embedded Wi-Fi® network processor connecting new classes of devices to the IOT



Ease of Use

- **Highly integrated**
  - ❑ 2.4/5GHz embedded Wi-Fi
  - ❑ Embedded TCP/IP stack
  - ❑ Integrated Apps MCU option
- **Low-cost HW design**
  - ❑ QFN package *or*
  - ❑ Certified module
  - ❑ No RF expertise needed
- **Quick software development**
  - ❑ Tiny device driver
  - ❑ Works with any MCU or no MCU

Secure

- **Secured protocols**
  - ❑ WPA2 personal & enterprise
  - ❑ SSL 3.0 / TLS 1.2
- **On-Chip HW encryption**
  - ❑ Real-time encryption
  - ❑ Fast TLS connection in 150mSec
- **Secure device**
  - ❑ On-chip 128 bit secret key
  - ❑ Applications and user data encryption on NVMEM
  - ❑ Secure boot

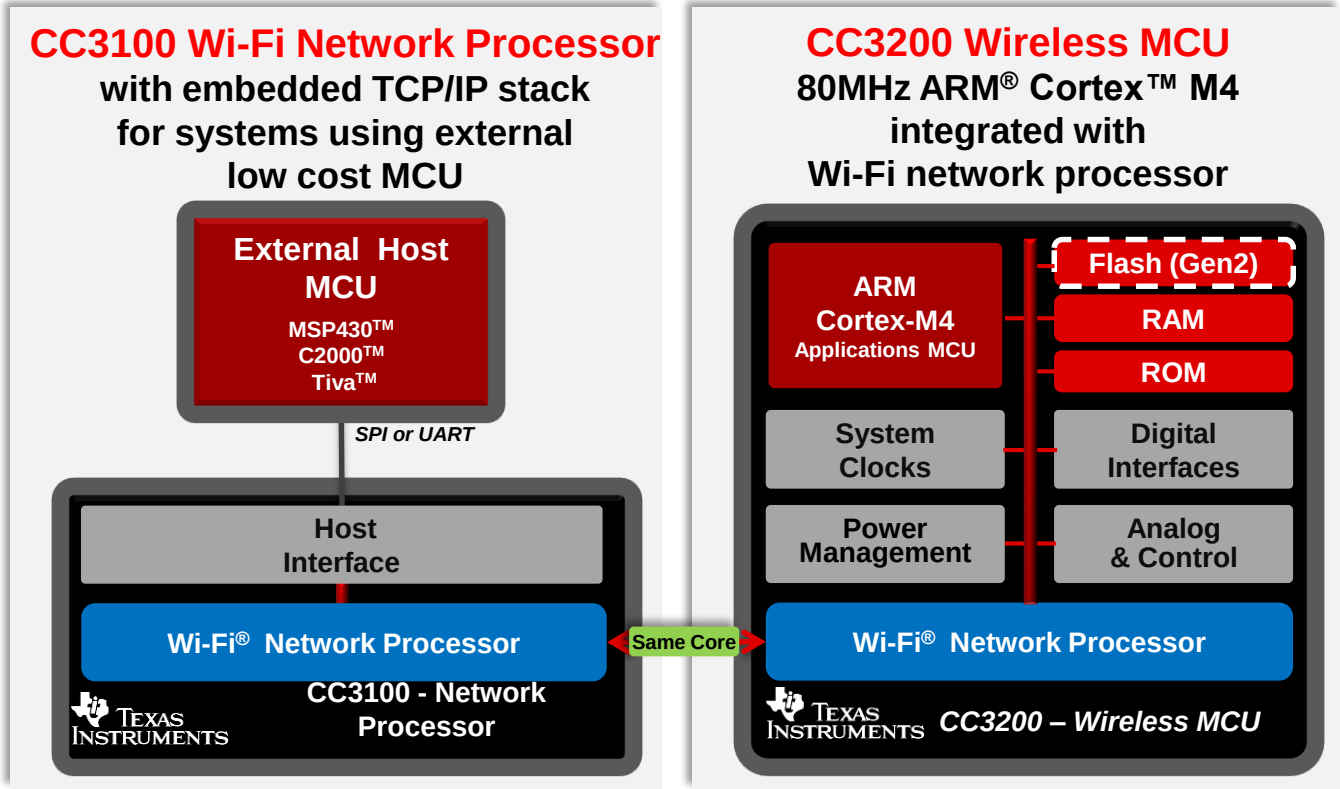
Low Power

- **Low power radio**
  - ❑ 33 mA listen
  - ❑ 53 mA receive
- **Low power modes**
  - ❑ 4 uA hibernate
  - ❑ 85 uA sleep
- **Wi-Fi sensors running on 2xAA batteries over 1 year**

CC31xx/CC32xx SimpleLink™ Wi-Fi®

CC32xx\CC31xx Architecture

Two product variants based on the same Wi-Fi® network processor core



SimpleLink™ Wi-Fi® CC3100 Solution

Features/Benefits

- **Supported protocols and roles** – 802.11 b/g/n, Station, Access Point, and Wi-Fi Direct with fully integrated radio, baseband, and MAC
- **Wi-Fi network processor** – on-chip WLAN and TCP/IP stack, industry standard API. No previous Wi-Fi experience needed
- **Embedded Crypto engine** – 256-bit encryption, SSL/TLS, personal and enterprise security, allows fast secure connection
- **Low power** – low power radio with advanced low power modes enabling battery powered Wi-Fi (2AA over a year)

Design Kits & EVMs

CC3100 BoosterPack + EMU board – CC3100BOOST-CC31XXEMUBOOST

CC3100 Boosterpack with MS430F5529 LP

CC3100BOOST-CC31XXEMUBOOST-EXP430F5529LP

Note: CC31XXEMUBOOST must be purchased to flash CC3100BOOST plus other functions

Dev Tools & Software

- **Flexible Provisioning** - AP mode, WPS, SmartConfig™, + 1
- **Uniflash, RF Performance Tool, PLT**
- **CC3100 SDK Download** – Driver, 30+ sample apps
- **SimpleLink™ Studio for CC3100** – MCU dev on PC

CC3100 Network Processor

Temperatures: -40 °C to 85 °C

Wi-Fi Network Processor + Crypto Engine

Radio
- 2.4 GHz
- Wi-Fi 802.11 b/g/n
- STA, AP, Wi-Fi Direct
- WPA2 Personal
- WPA2 Enterprise
- WPS2
- 802.1x
- EAP

Protocol
- IPv4 TCP/IP Stack
- SSL 3.0
- TLS 1.2

Data Protection
- DES
- DES3
- AES256
- MD5
- SHA2
- RSA
- ECC

Interfaces
- SPI (Host I/F)
- UART (Host I/F)

Power & Clocking
- DC2DC
- BAT Monitor
- Hibernate RTC
- Oscillators

Packages
- 64-pin 9x9mm QFN
- 17.5 x 20.5mm Module

Memory
- Embedded ROM
- Host Memory Footprint
- 10 KB (Flash)
- 2 KB (RAM)

Target Applications

- **Home Automation** – lighting, access control
- **Home Appliance** – washer & dryer, refrigerator
- **Safety and Security** – wireless camera, video surveillance
- **Smart Energy** – smart meter, thermostat control, smart plug
- **Industrial M2M Communication** – web interface industrial control
- **Wireless audio streaming** - speakers, remote controls, sound bars

SimpleLink™ Wi-Fi® CC3200 Wireless MCU

Features/Benefits

- **Supported protocols and roles** – 802.11 b/g/n, Station, Access Point, and Wi-Fi Direct with fully integrated radio, baseband, and MAC
- **On-chip ARM Cortex M4** – 80MHz processor allows custom APIs to be done on-chip, lower total BOM cost
- **Wi-Fi network processor** – on-chip WLAN and TCP/IP stack, industry standard API. No previous Wi-Fi experience needed
- **Additional embedded Crypto engine** – 256-bit encryption allows fast secured connection to the cloud

Design Kits & EVMs

CC3200 LauchPad - CC3200-LAUNCHXL

Dev Tools & Software

- **Flexible Provisioning** - AP mode, WPS, SmartConfig™, + 1
- **Uniflash, RF Performance Tool, PLT**
- **CC3200 SDK Download** – Driver, 40+ sample apps
- **Code Composer Studio™ & IAR IDE** support

CC3200 Wireless MCU

Temperatures: -40 °C to 85 °C

ARM ® Cortex™ M4 + Wi-Fi Network Processor

+ Crypto Engine

Radio
- 2.4 GHz
- Wi-Fi 802.11 b/g/n
- STA, AP, Wi-Fi Direct
- WPA2 Personal
- WPA2 Enterprise
- WPS2
- 802.1x
- EAP

Memory
- Embedded ROM
- Up to 256KB RAM

Protocol
- IPv4 TCP/IP Stack
- SSL 3.0
- TLS 1.2

Data Protection
- DES
- DES3
- AES256
- MD5
- SHA2
- RSA
- ECC

Interfaces
- Prallel Camera I/F
- McASP (I2S)

Analog
- 4-Ch ADC
- 4 PWM Control

Comms Peripherals
- SD/MMC
- 2x UARTs
- 2x SPI
- I2C

Power & Clocking
- DC2DC
- BAT Monitor
- Hibernate RTC
- Oscillators

System Modules
- DMA
- Timers
- GPIO
- EPI

Packages
- 64-pin 9x9mm QFN
- 17.5 x 20.5mm Module

Target Applications

- **Home Automation** – lighting, access control
- **Home Appliance** – washer & dryer, refrigerator
- **Safety and Security** – wireless camera, video surveillance
- **Smart Energy** – smart meter, thermostat control, smart plug
- **Industrial M2M Communication** – web interface industrial control
- **Wireless audio streaming** - speakers, remote controls, sound bars

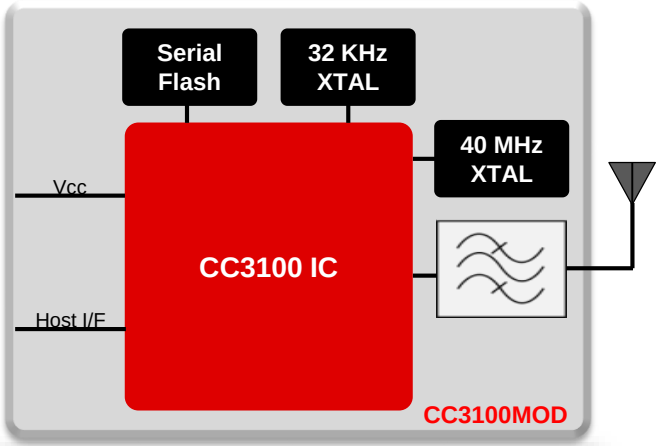
SimpleLink Wi-Fi Modules Now Available

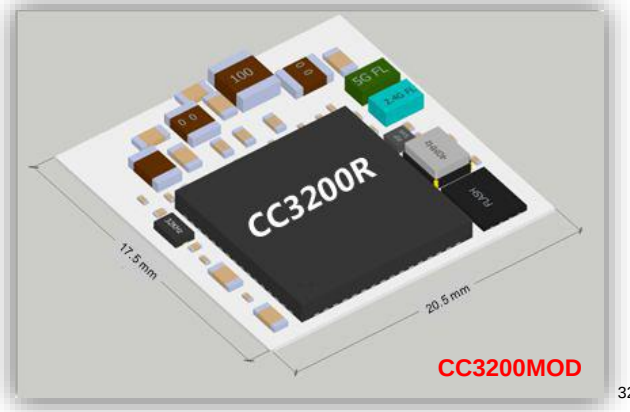
Key module features

- Includes on module clocks, SPI Flash, and passives
- Connects to an external on-board antenna
- 17.5x20.5 mm Land Grid Array footprint with 1.27mm pitch for low cost PCB design
- Modular FCC, IC, CE & TELEC Certifications to save customer effort, time and money
- CC3100 Wi-Fi network processor and CC3200 wireless MCU pin to pin compatibility

Resources

- **Hardware Design**
  - **CC3200 module TI Design**
  - **CC3100 module TI Design**
- **Software – same as for QFN Device**
  - **CC3200 SDK & Firmware**
  - **CC3100 SDK & Firmware**
- **Evaluation Tools and Support**
  - Module LaunchPad CC3200MODLAUNCHXL
  - Module BoosterPack CC3100MODBOOST
  - CC3100MODBOOST-CC31XXEMUBOOST
  - CC3100MODBOOST-CC31XXEMUBOOST-MSP-EXP430FR5969
  - E2E Support Forum





WiLink8™

Wi-Fi®, Bluetooth®

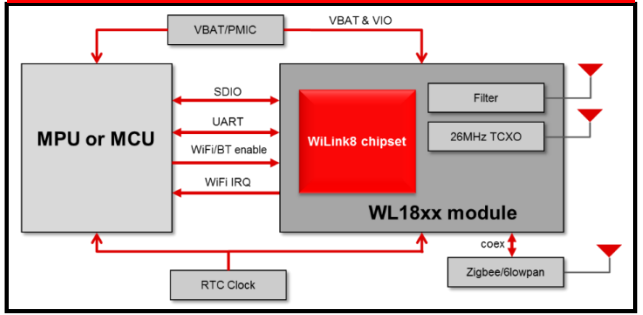
Certified combo modules available for fast and easy time-to-market
September 2015

WiLink™ 8: Large combo product family

Overview

- Wi-Fi / Bluetooth / GNSS combo ICs
- Wi-Fi / BT modules from TI
- Wi-Fi / BT / GNSS / Zigbee modules (3rd party)
- SoM with AM335, AM437, i.MX6 (3rd party)
- Software offering for Linux / Android / RTOS
- TI Bluetooth stack
- Complete platforms with TI and non TI MPU

System



Key Features

- IEEE 802.11a,b,g,n MIMO up to 100Mbps
- Bluetooth 4.0 with on chip Wi-Fi coex
- Rock solid performance: Stability, robustness, throughput and co-existence
- Battery or line powered applications
- Multirole features (STA / AP / P2P)
- Available Industrial temp -40 to 85 C
- Fully certified TI modules (FCC, IC, CE, Telec)

Applications

- Security Camera
- Portable Data Terminal
- Gateways
- Wireless Audio
- Industrial Panel/ HMI
- Professional Camera
- Wearable

Wilink™ Combo solutions

high-performance WiFi + Bluetooth/Bluetooth Low Energy

Value Propositions

Tools/modules for easy development

- **Performance and low power:** 100Mbps with the lowest power (800uA IDLE)
- **Certified and easy to use:** Pre-integrated, certified, production ready solutions, software downloadable. Open documentation (Wiki), Forums (E2E), TI and 3rd party network
- **Integrated and scalable**: single chip multi-combo with pin to pin compatible variants, consumer, industrial (85 degree C) and automotive grade (Q100)

Products

- WL18xx Combo
  - WiFi Only
  - WiFi + BT/BLE
  - WiFi + BT/BLE + GNSS
- TI Modules
  - WL1801MOD
  - WL1805MOD
  - WL1831MOD
  - WL1835MOD
  - WL1807MOD
  - WL1837MOD
- 3d Parties modules

Features

- Combo BT Dual Mode + WiFi on one single-chip
- Rock solid performance: long distance, stability, robustness, throughput and co-existence with BT 4.0
- Connect to processors(high level OS)
- Industrial temp -40 to 85 C
- 2.4GHz and 5GHz support
- Fully certified module (FCC, IC, CE, Telec)

Applications

- Security Camera
- Portable Data Terminal
- Gateways
- Audio
- Industrial Panel/ HMI
- Professional Camera
- Wearable

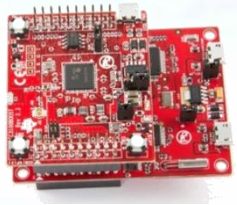
Kits, Tools & Software

CC3100 and CC3200 kits

Platform	Kits & Bundles
CC3200 Industry's first single-chip Wi-Fi solution with user-dedicated programmable microcontroller (MCU)	Kits • NEW Module LaunchPad CC3200MODLAUNCHXL • QFN Device LaunchPad CC3200-LAUNCHXL
CC3100 Internet-on-a-chip™ solution Connect any MCU to the Internet of Things	Kits • NEW Module BoosterPack CC3100MODBOOST • QFN Device BoosterPack CC3100BOOST • BOOST required to Flash CC3100 - CC31XXEMUBOOST Bundles are also available on www.ti.com


LaunchXL


MOD LaunchXL


Boost + Emulator

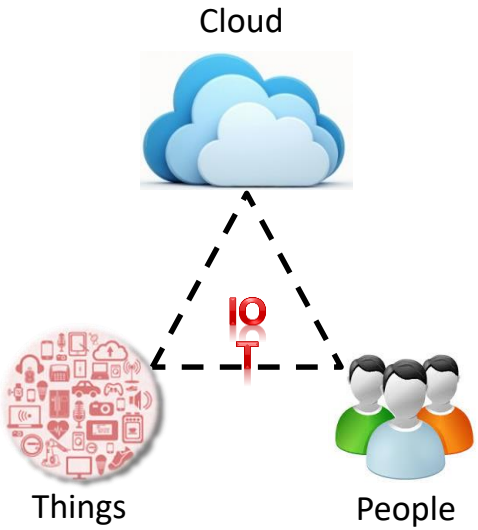

MODBoost + Emulator


Stand Alone Emulator

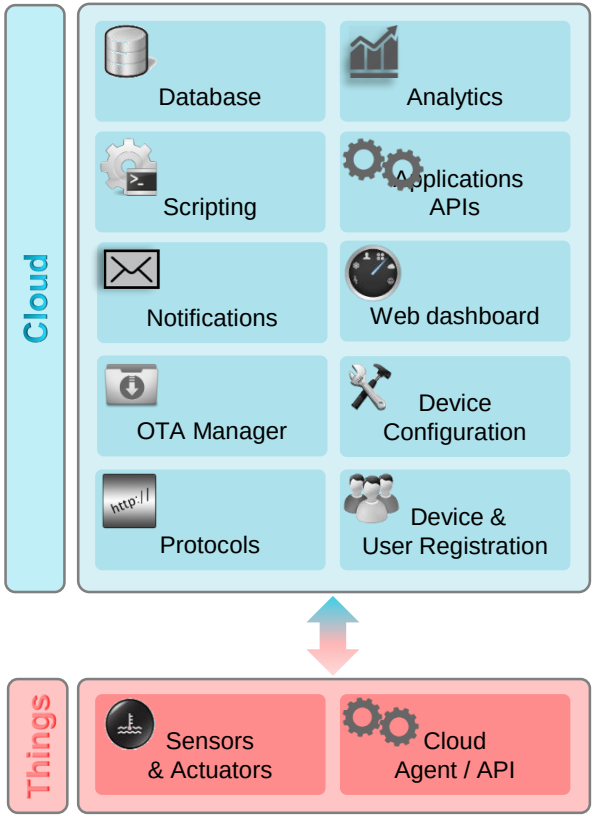
IoT and Cloud Ecosystem

How does the Internet of Things work?

- The Internet of Things connects Things, People and Cloud services
- Things are installed behind fire walls and are not accessible directly from the remote
- Messaging cloud services allow things and people to communicate securely over the internet
- Additional cloud services such as analytics, notifications and applications unleash new used cases
- Things communicate with a cloud service through set of protocols and APIs



Cloud services for IoT



- **Store data**
- **Analyze data and create business reports**
- **Create applications that run on the cloud**
- **Interface with other business applications such as CRM**
- **Create email & text notifications on events**
- **Present data on a web site**
- **Manage device firmware updates**
- **Configure device's properties**
- **Manage user and device access**
- **Device communication using standard protocols**

Wireless connectivity solutions supporting a wide range of Internet protocols enable an easy connection to the cloud

The TI IoT cloud ecosystem

- The TI IoT cloud ecosystem includes industry leading IoT cloud service providers
- Embedded libraries and demos are provided for TI EVMs and SDKs
- TI devices and SDKs include built-in internet protocols and security for easy integration with any cloud solution
- Supported protocols by the TI IoT Wireless Connectivity products: TCP, UDP, HTTP, CoAP, XMPP, MQTT, SSL, TLS, DTLS

TI Clouds Tools

Thank you!

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