

Differentiate with the World's Only Sub-1-GHz + BLE Wireless MCU CC1350

Tony Cave

China FAE Summit

Low Power Connectivity



CC1350 Dual Band Wireless MCU Introduction

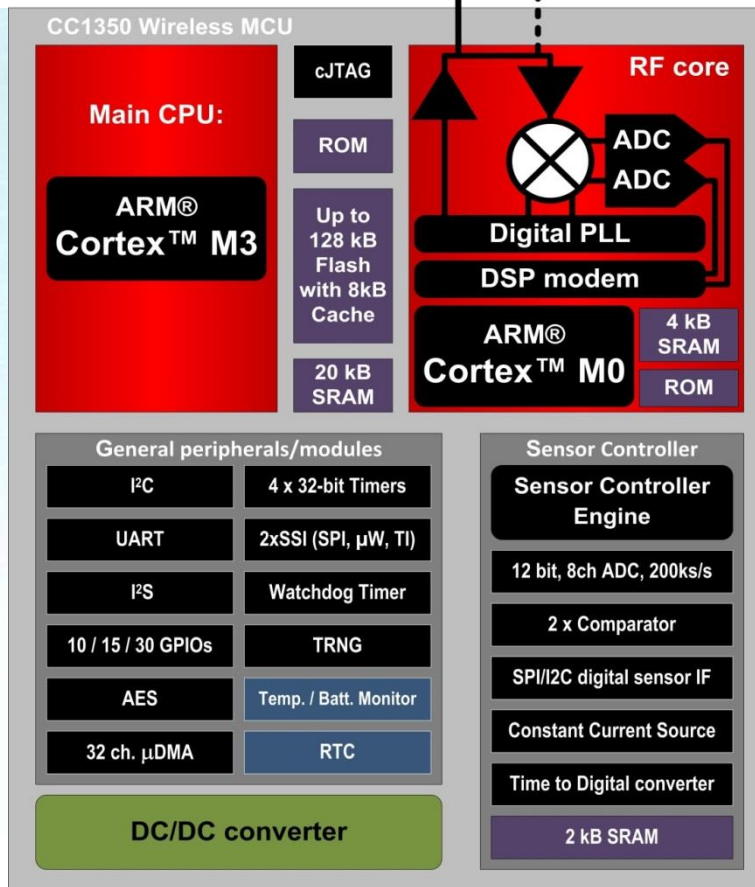
CC1350 Dualband Wireless MCU

Application MCU

- Very Low Power ARM Cortex M3
- 128k Flash
- 20k ultra low leakage RAM, 8k cache
- 200k ROM

Peripherals/Modules

- DC/DC integrated in the system ensuring low power and stable RF performance over VDD range
- 4x4 & 7x7 Packages



RF Core

- Software configurable MODEM
- Multi standard support (BLE, 802.15.4g)
- 0-4 Mbits/s data rate

Sensor Controller Engine

- ADC, 2x Comparators, Time to Digital Converter (TDC)
- Flexible very low power sequencing & control
- 0.95μA for 1 Hz ADC sampling

CC1350 Key benefits

Lowest Power Sub-1 GHz



- 5.4 mA Radio RX current
- 13.4 mA Radio TX @ +10 dBm
- 24.4 mA Radio TX @ +14 dBm
- 51 μ A / MHz ARM Cortex M3 @ 48 MHz
- 0.7 μ A sleep current w/RTC + retention



Up to 20 year battery life for sensor nodes

Low Power BLE



- 6.4 mA Radio RX consumption
- 10.5 mA Radio TX @ +0 dBm



Enabling ULP Smart Phone Connection

Long Range Sub-1 GHz



- +14 dBm output power
- -124 dBm sensitivity @ 0.625 kbps
- -110 dBm sensitivity @ 50 kbps
- 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 Smart Phone Connection

Most Integrated



- 20k SRAM, 8k cache
- 128k Embedded flash
- Sub-1GHz + BLE RF Transceiver
- Cortex M3 Application Processor
- 200k ROM
- Sensor Controller Engine (SCE)
- 4x4 QFN
- On-chip DCDC
- TI-RTOS + RF Driver in ROM



*Dualband Wireless MCU
on a finger-tip size*

Get started fast! Development kit offering



CC1350 Launchpad

- Low-cost MCU evaluation kits and plug-in modules for quick development
- \$29 through TI Store and distribution
- CC1350LP – 868/915MHz+2.4GHz
- CC1350LP – 433MHz+2.4GHz (2H2016)

Coming Soon!



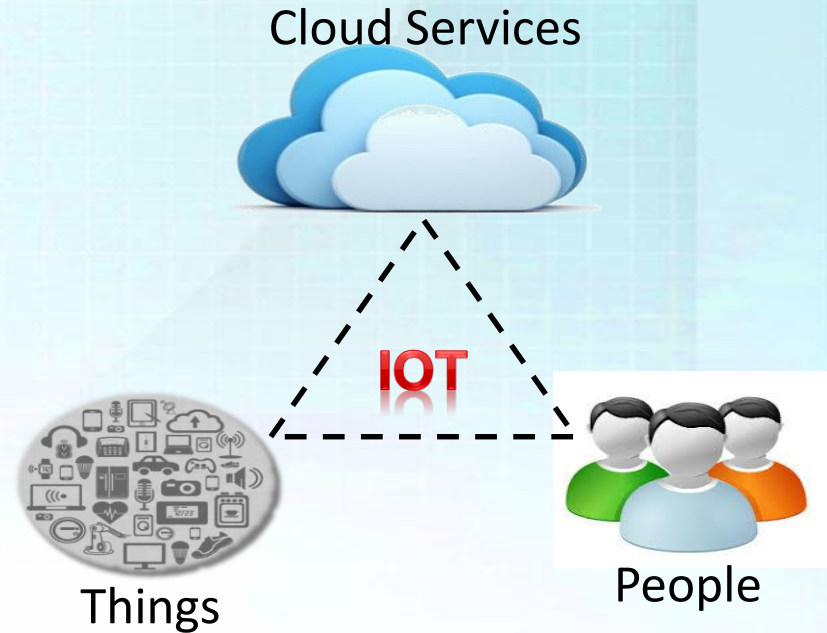
CC1350 SensorTag kit

- Sensor-based development kit for IoT and Long Range applications
- Get connected to the cloud in 3 minutes
- Free app for iOS & Android
- \$29 through TI Store and distribution
- CC1350STK - 868/915MHz+2.4GHz (3Q2016)
- CC1350STK - 433MHz+2.4GHz (2H2016)

Sub1G and BLE in IoT space

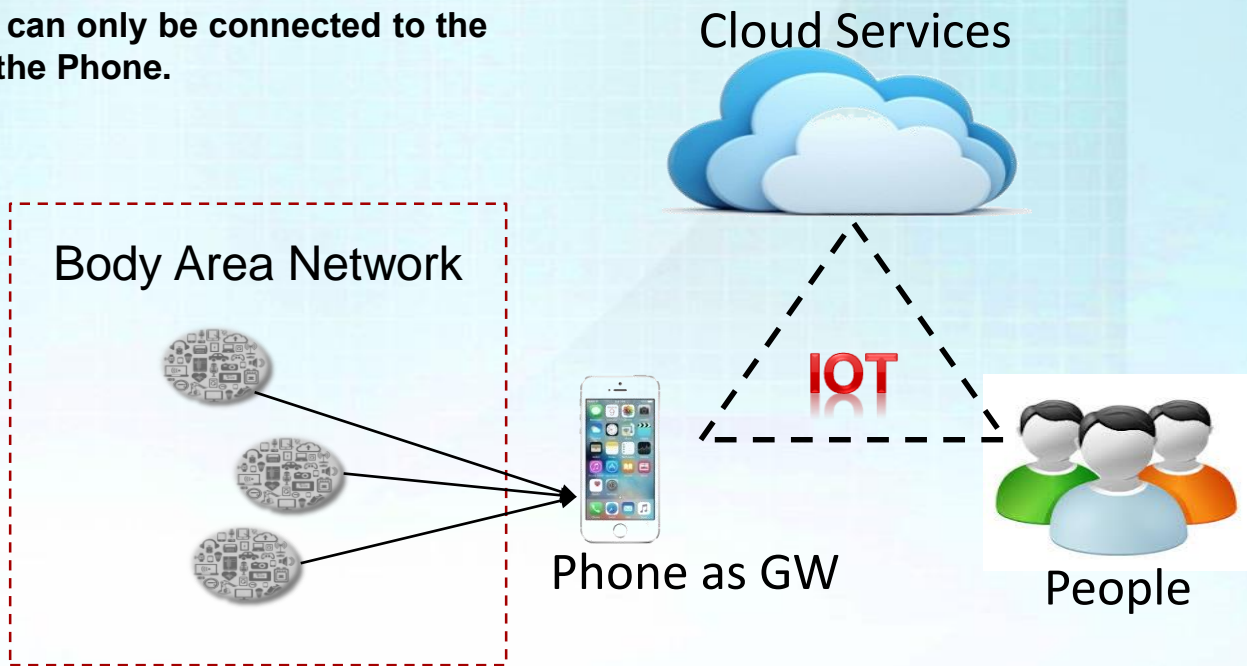
What is the IoT ?

Things, People and Cloud services get connected using the Internet



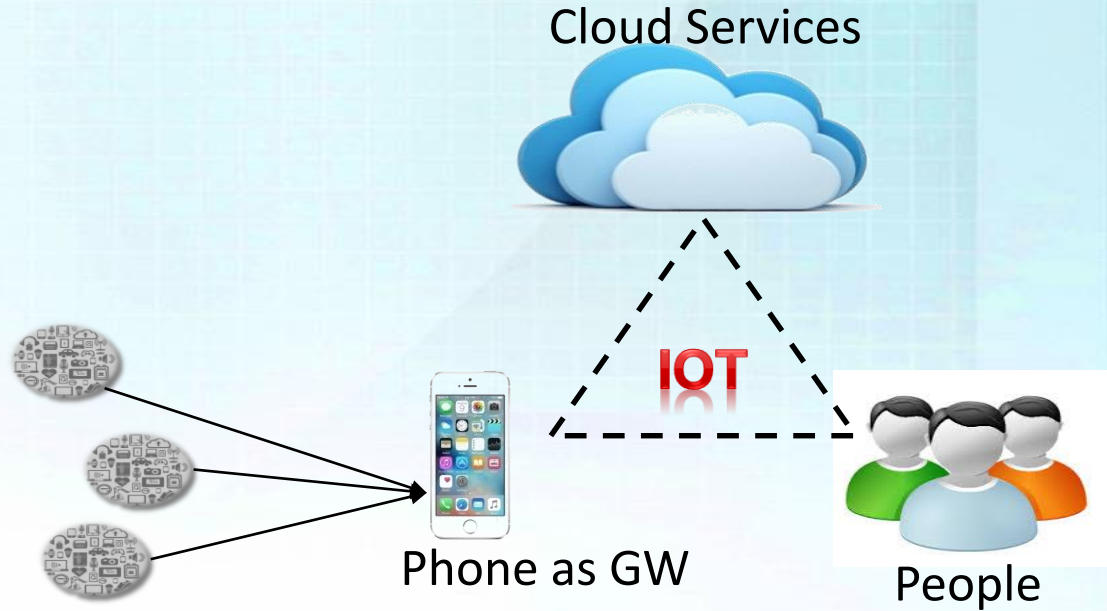
Where Does BLE Fit?

- Low Power 'Things' with BLE connectivity can connect to the internet via a Smart Phone Application.
- This means that the 'Things' can only be connected to the internet when within 10m of the Phone.
- Typical application are Sport and Fitness Devices that are part of a body area network.
- However typical Home/Building Control applications require connectivity at all times and not just when the phone is close to the device.



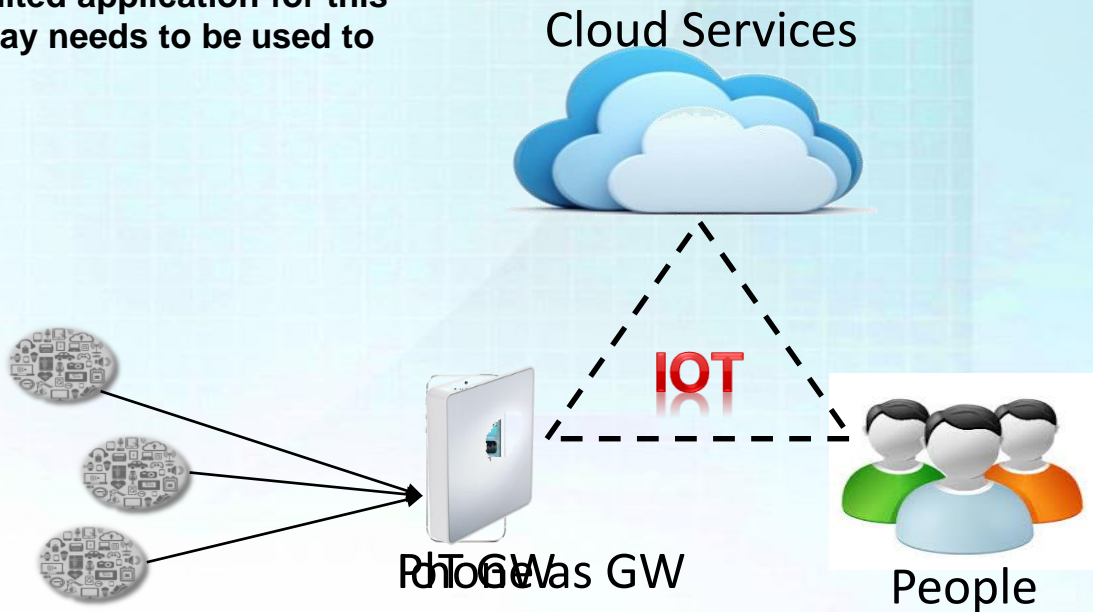
Where Does Sub1Ghz + BLE Fit?

- Body Area networks are not the right Market for Sub1Ghz + BLE.



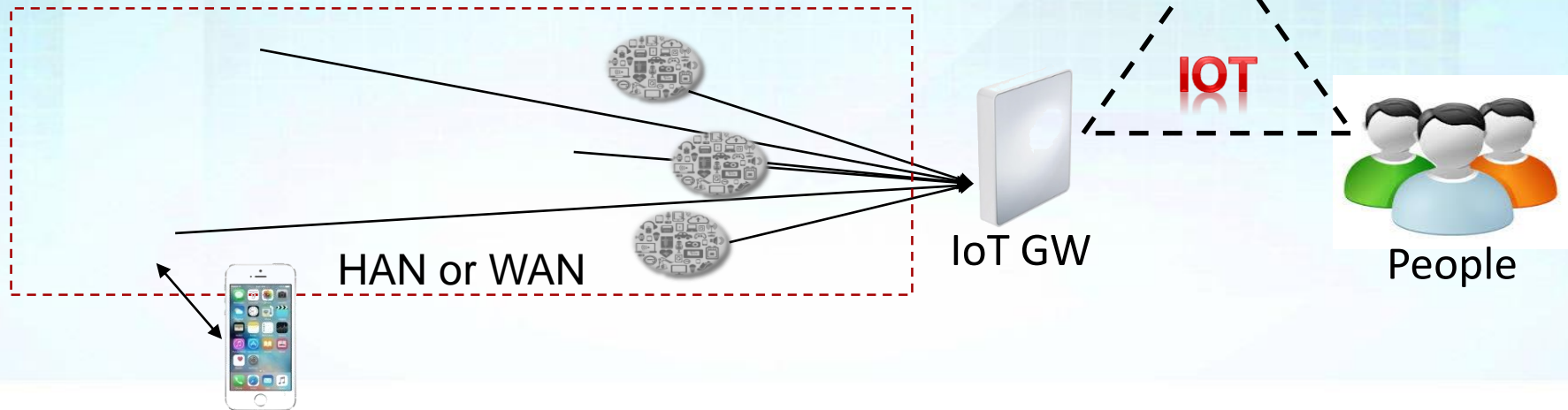
Where Does Sub1Ghz + BLE Fit?

- Body Area networks are not the right Market for Sub1Ghz + BLE.
- The Smartphone as a Gateway has limited application for this type of solution. Instead an IoT Gateway needs to be used to connect the 'Things' to the internet.



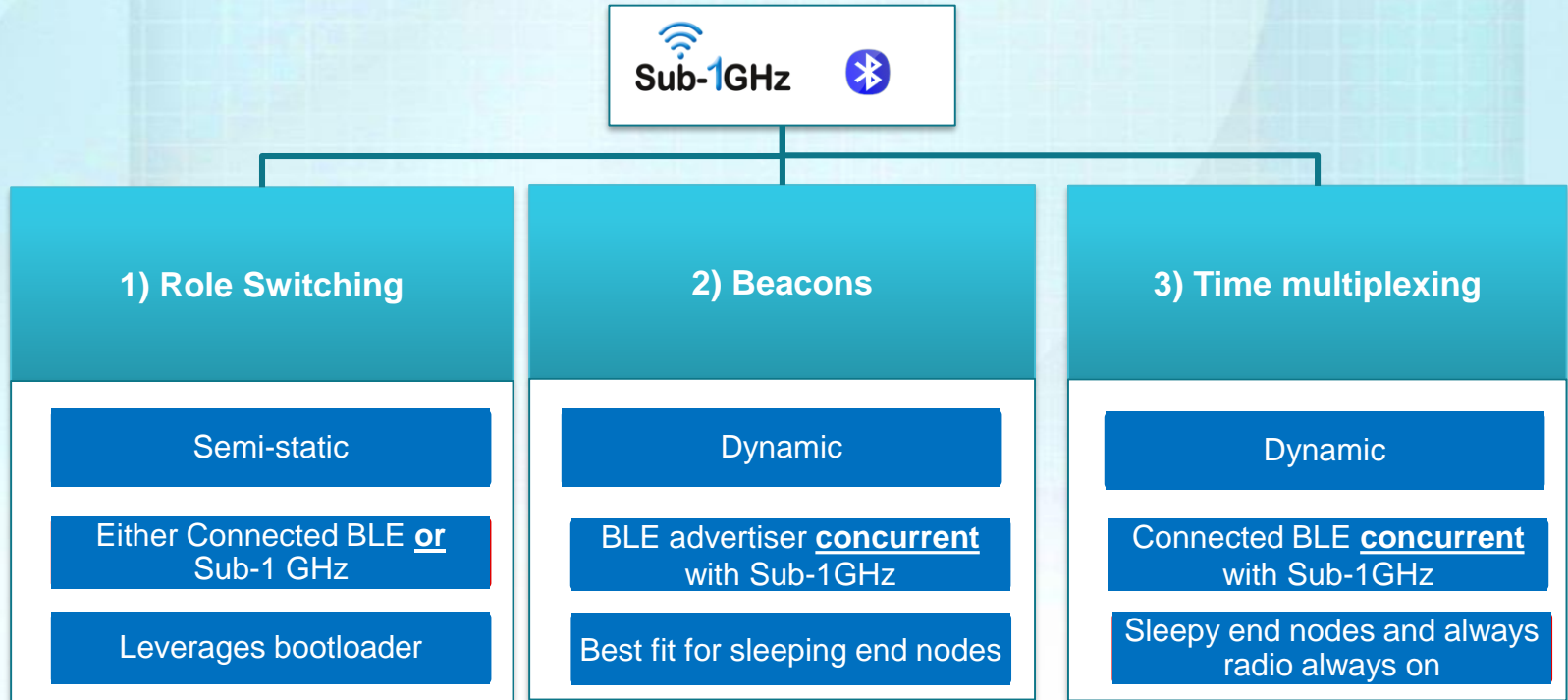
Where Does Sub1Ghz + BLE Fit?

- Body Area networks are not the right Market for Sub1Ghz + BLE.
- The Gateway as a Phone has limited application for this type of solution. Instead an IoT Gateway needs to be used to connect the 'Things' to the internet.
- Extending the range of the 'Things' that can be connected.
- In this solution BLE is useful for a local phone connection to the RF nodes.



Sub 1G + BLE Use cases study + End Equipment

CC1350 Dual-Band Software Configurations



Supported in TI-RTOS 2.20

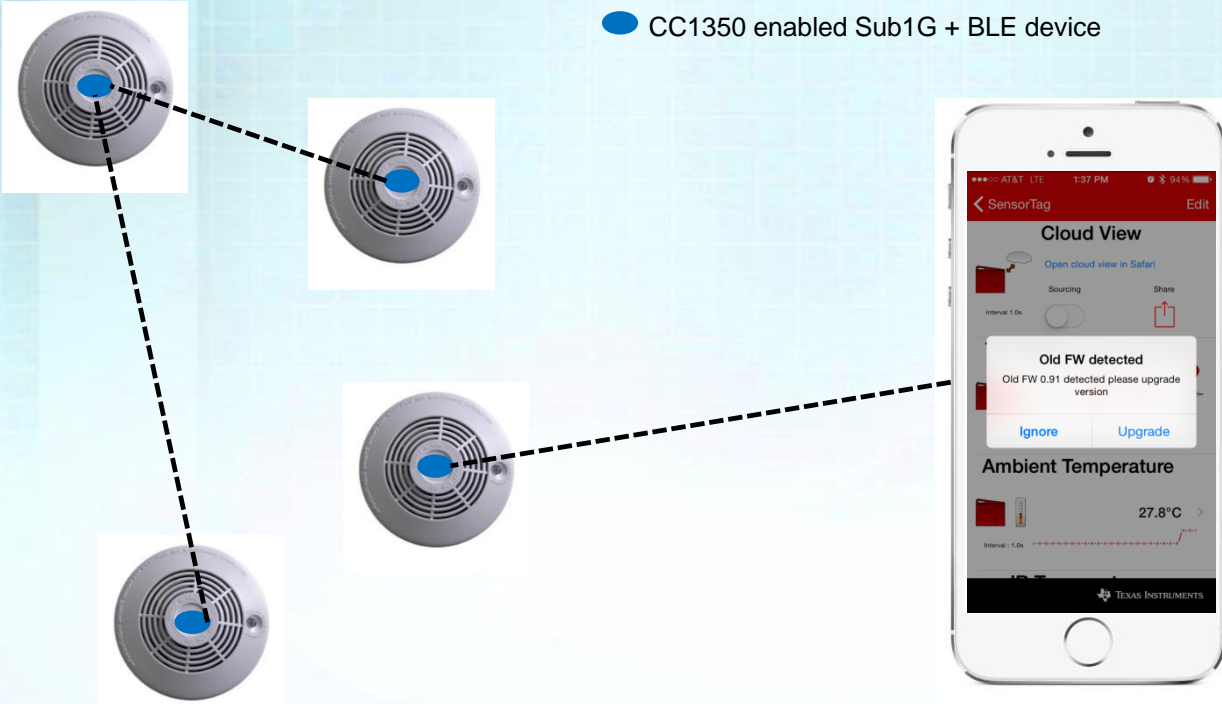
- Contiki
- TI-RTOS 2.20
- TI-15.4STACK 2.1 (4Q16)

Coming 1Q2017!

Role Switching - OAD

- Updating FW of devices in a “closed” Sub1GHz network

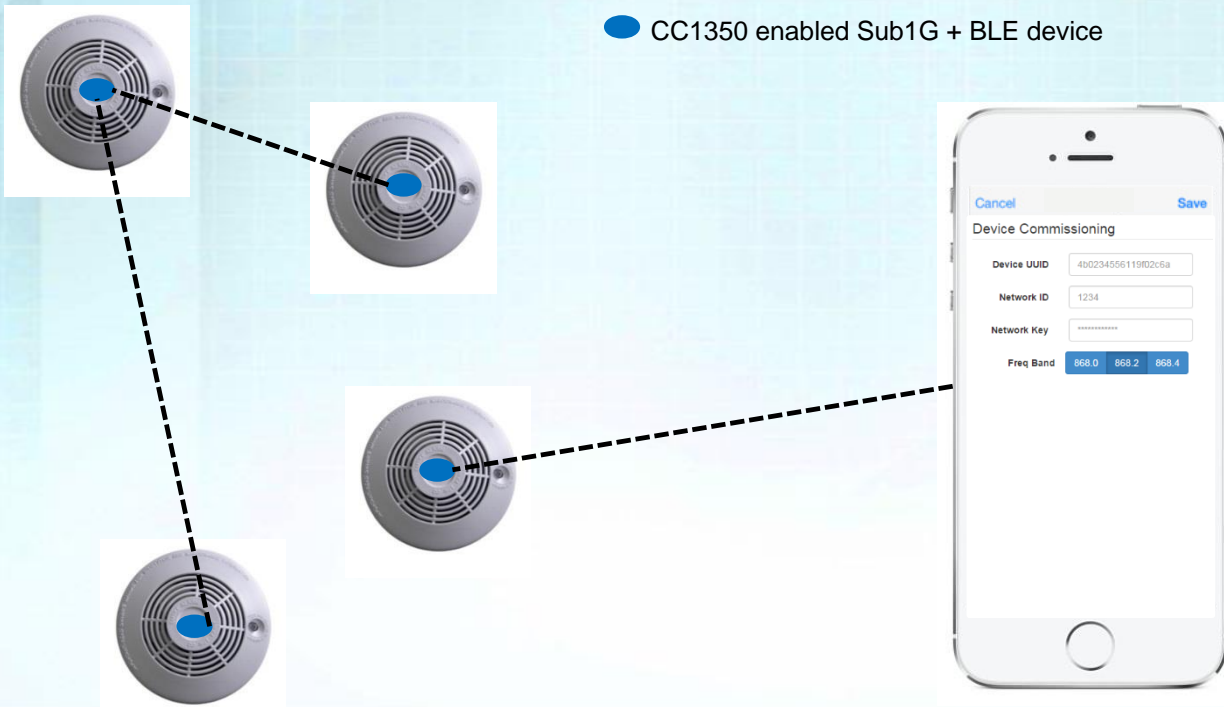
● CC1350 enabled Sub1G + BLE device



Role Switching - Commissioning

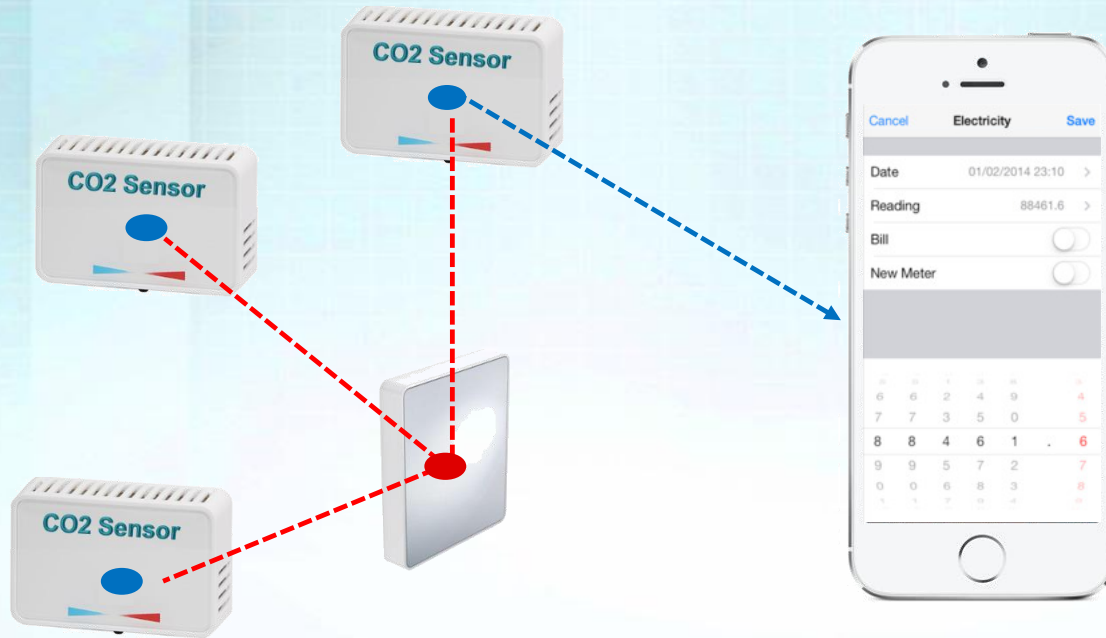
- Commissioning devices to a Sub1G network

● CC1350 enabled Sub1G + BLE device



Beacons - Remote Display

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



● CC1310 enabled Sub-1 GHz device

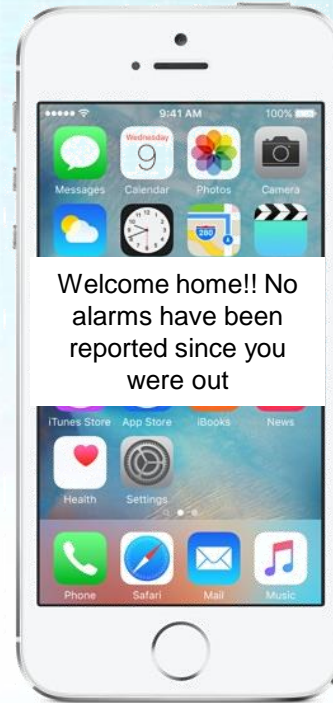
● CC1350 enabled Sub-1 GHz + BLE device

Beacons - Proximity

- Devices send BLE advertisements (beacons) with unique user ID, while concurrently operating in the sub-1 GHz network

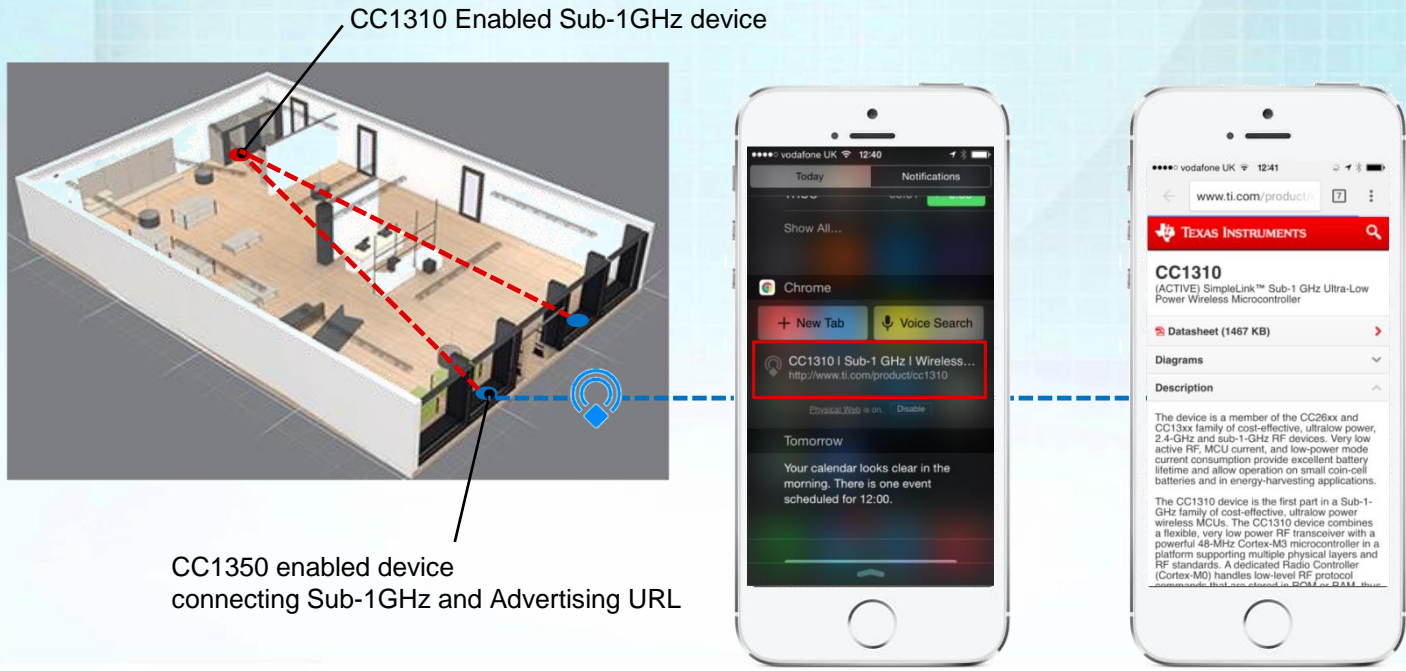
● CC1310 enabled Sub-1 GHz device

● CC1350 enabled Sub-1 GHz + BLE device



Beacons - Remote Beacon Management

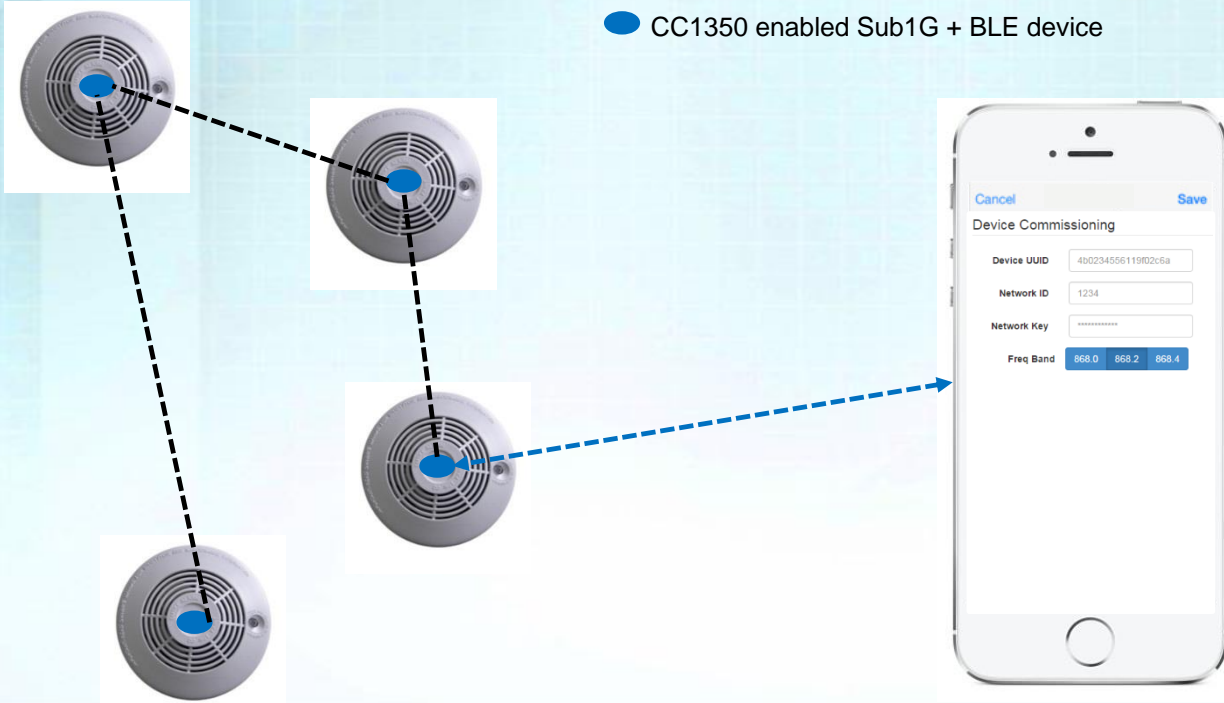
- Configuring BLE advertisements (e.g. Google Eddystone) via a long range Sub-1GHz server
- Low power dynamic [Google Physical web](#) update



Time Multiplexing- Network Management

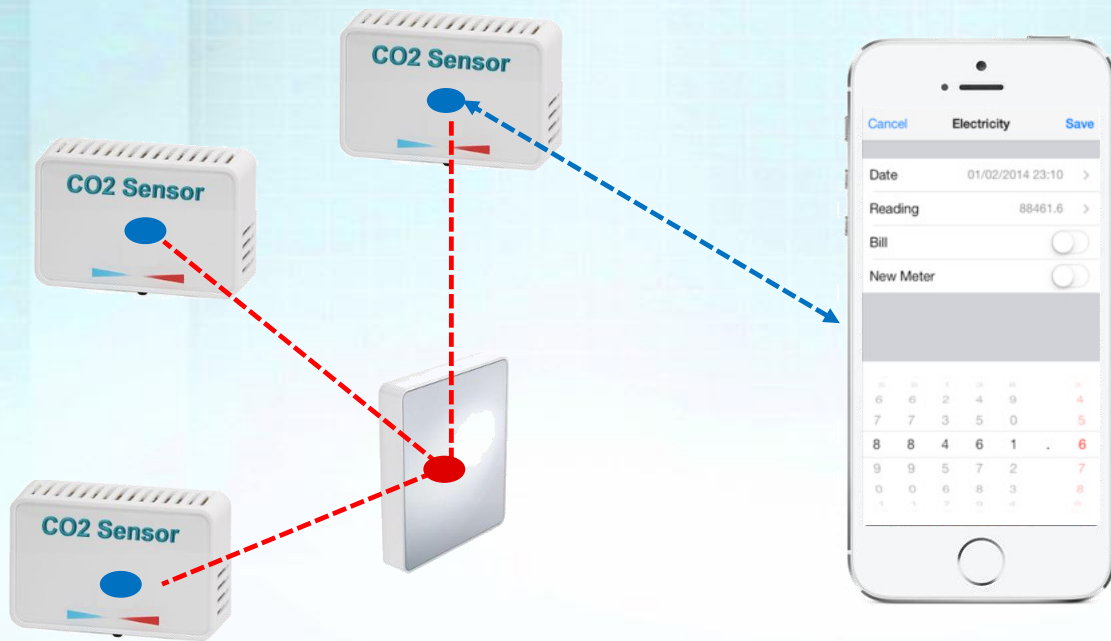
- Network Management – Onboarding, live commissioning.

● CC1350 enabled Sub1G + BLE device



Time Multiplexing- Remote Display

- Extracting information from the Sub-1GHz network directly from the node at high data rates
- Run-time data sending while in Sub-1GHz, using connected BLE as uplink/downlink channel

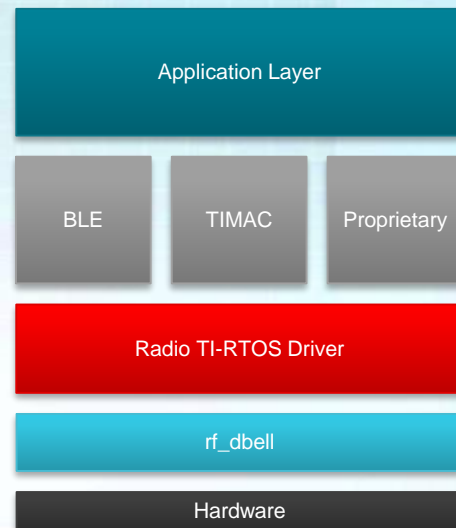


- CC1310 enabled Sub-1 GHz device
- CC1350 enabled Sub-1 GHz + BLE device

Dual Mode RF driver implementation and limitations

RF Driver

- Distributed as a part of TI-RTOS
- Standardized way to use the RF core
 - Used by all TI stacks
- Makes it easy to write low-power applications that uses the radio
 - Uses the TI-RTOS Power Manager to enter Standby
- Simple API
 - Asynchronously and synchronously send commands
 - Callbacks with updates on command state
- Built on top of the lower layer DriverLib
- Support for Multiple clients (multi phy)
- Supports driver level and RF core level chaining

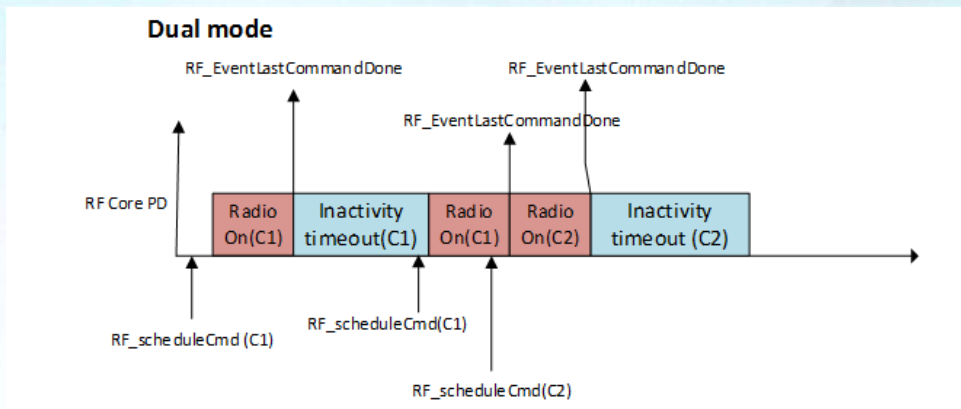


RF Driver Dual Mode Overview

- The RF driver has been enhanced to support multiple Clients.
- On CC1350 this can be used for multiple 2.4GHz protocols, Multiple Sub1GHz protocols or multiple mixed Sub1GHz and a 2.4GHz protocols.
- New API's have been created to accommodate the multi client features
 - RF_scheduleCmd: Schedule a command supplying the timing and intra client priorities
 - RF_requestAccess: Request sole access to the RF driver for an amount of time
 - RF_yield: Yield access and allow the RF Core to power down
 - RF_getInfo: Get info on the next available slot and priority.
- The RF driver is thread safe allowing multiple clients to run in separate TIRTOS Tasks
- It is not recommended to run multiple synchronous RF protocols as these protocols typically require tight timing which can not be maintained for more than 1 client.

RF Driver – Multi Mode Command Scheduling

- The RF Driver arbitrates between multiple clients trying to access the RF Core based on priority, other schedules commands and access requests.
- The RF driver reconfigures the RF Core for the correct Phy setting when a command is scheduled.



The End

Thank you for your attention