TI 无线连接方案实现
无线智能的能源管理设计

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TI 现场应用工程师

Leading wireless innovation for 20 years

Scalable solutions for all applications

Sub-1GHz

- Best range, up to 20km
- 15 years battery life
- Star or mesh network
- Grid, BA, and more

First TRX in market
First integrated IC in market

Bluetooth

- Best in class BLE
- Low cost
- Low power
- Star or BLE mesh

First BLE chip in the market
First XTAL free chip

zigbee

- Robust low power mesh for smart home and buildings
- Sub1GHz arriving!

ZB board from the beginning
Driving ZB over Sub1GHz

matter

- Unifying standard for reliable connectivity
- Targeting smart home
- TI development kit available

In the alliance from the beginning.
Source code contributor

Wi Fi CERTIFIED

- Best IoT Wi-Fi solution
- Most robust in the market
- Best in class security

First WiFi IoT chip in the market
First IC vendor with modules

amazon sidewalk

- Secure IP access from crowd sourced network
- No need to build gateways
- Get started kit available

Leading IC vendor

Wi SUN

- Long range mesh for large networks
- Frequency hopping interference tolerance

TI owned SW stack

THREAD

- IPv6 base mesh protocol for home and building automation
- Flexible network

In the alliance from the beginning

Multi-protocol

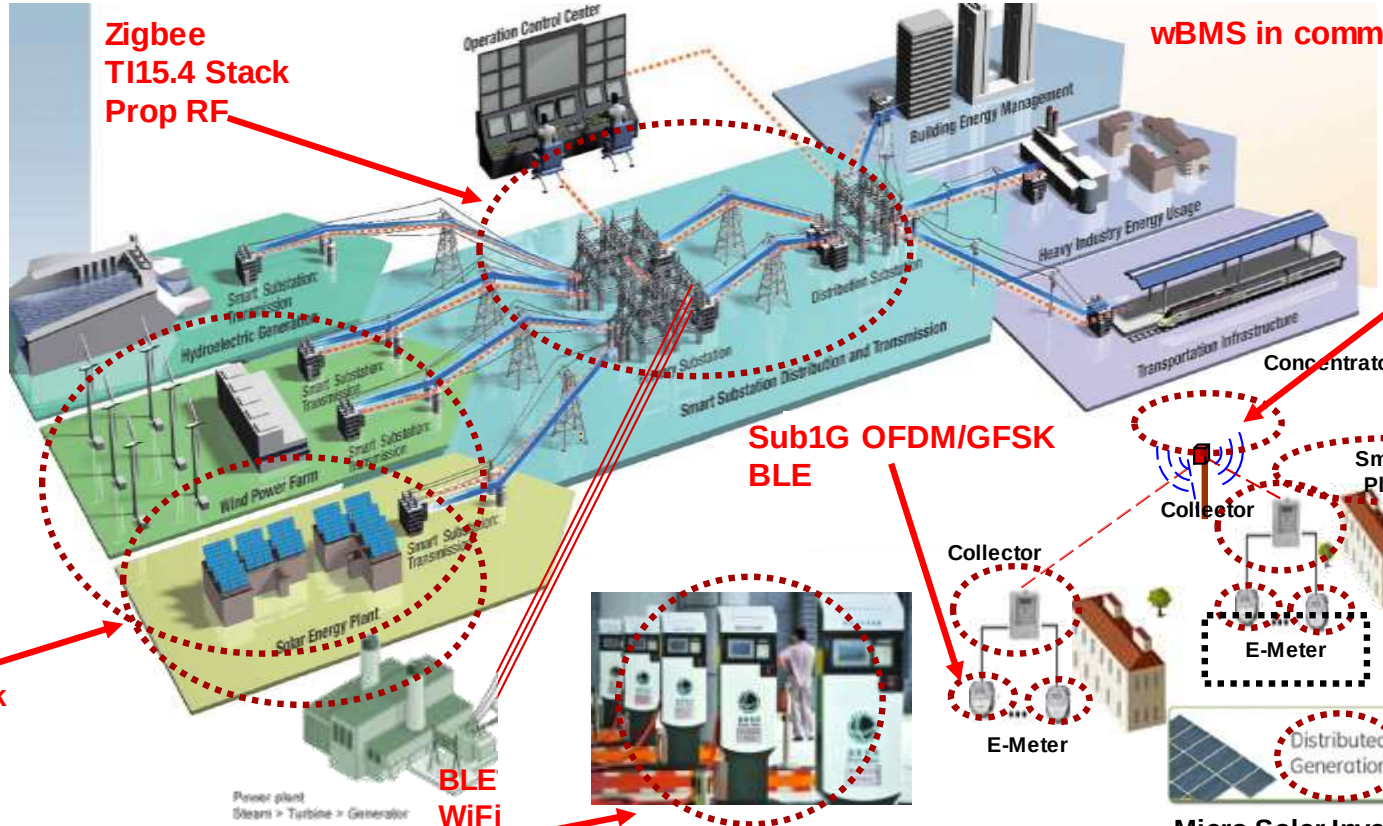
- Best in class multi-band solutions (DMM)

SW defined radio enable the space

Proprietary and other

- Use our TI MAC15.4 stack or build your own protocol from scratch
- MIOTY, 6LoWPAN, wMBUS and more
- Automotive solutions

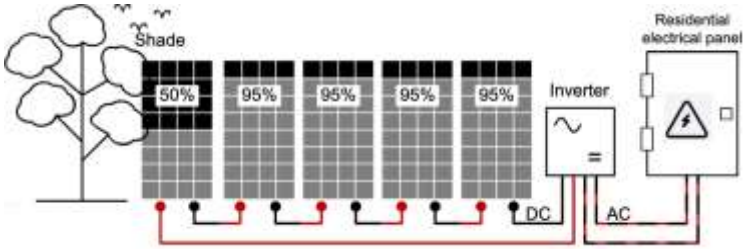
Wireless technology in smart grid & energy



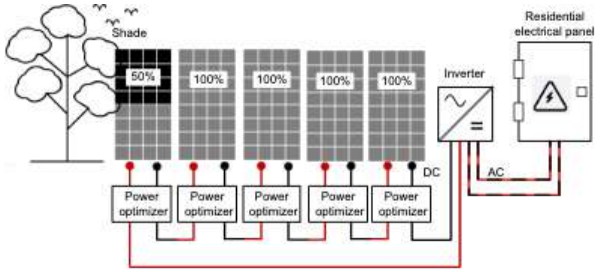
议程

- Sub1G 方案
- WiFi 方案
- 2.4G 方案
- wBMS

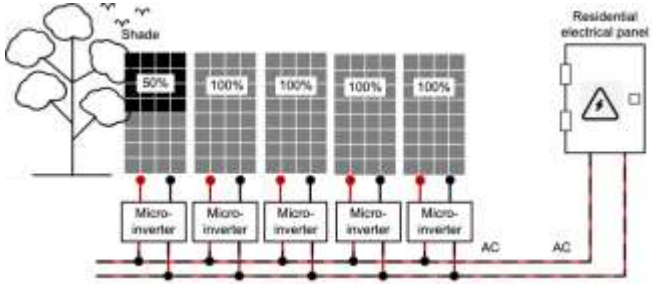
太阳能系统架构



串式逆变器

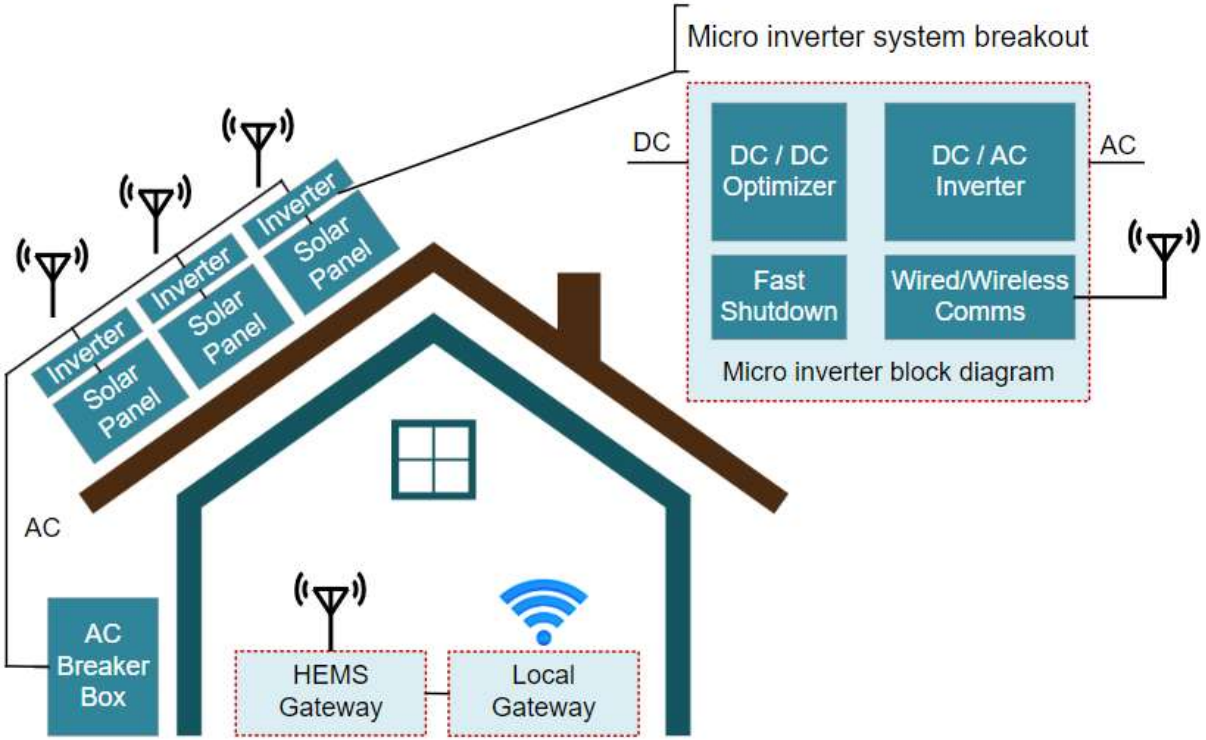


功耗优化器



微型逆变器

方框图 | 太阳能微型逆变器连接



HEMS - 家庭能源管理系统

技术比较

参数	PLC	TI WSMS-Star	TI WSMS-Mesh	Zigbee 2.4GHz	WiFi
快速关断	是	是	是	是	是
数据速率（面板监控）	低成本 PLC - <1kbps OFDM PLC - 31kbps	5kbps 至 200kbps	**50kbps 至 300kbps**	250kbps	>1Mbps
干扰	低成本 PLC - 受影响 OFDM PLC - 稳健	**通过跳频实现稳健性**	**通过跳频实现稳健性**	仅通过网状路由避免干扰	无网状路由且无跳频
距离/链路预算	低成本 PLC < 50m OFDM PLC ~ 1000m	**1000m/125dB**	**1000m/124dB**	50m/105dB	50m/105dB
安全	是 (AES MAC)	是（AES MAC + 预共享网络密钥）	是（AES MAC + 证书交换 + 预共享密钥）	是（AES MAC + 预共享密钥）	是（AES MAC + 预共享密钥）
设置和维护	共享面板的问题	无问题且调试过程简单	无问题且调试过程简单	无问题且调试过程简单	无问题且调试过程简单
组网	< 5 分钟	< 5 分钟	100 个节点 5 分钟	< 5 分钟	< 5 分钟
生产测试支持	不可用	集成射频诊断和传播测试模式	集成射频诊断和传播测试模式	不可用，可以实现	不可用，可以实现
附加网关/附加中继器	需要/不需要	需要/不需要	需要/不需要	需要/可选	可选（阳台安装）/可选
噪声防护	强烈推荐	不需要	不需要	不需要	不需要
面板数量方面的实际限制	20（低成本 PLC） >20 (OFDM PLC)	< 50	**100+**	< 50	< 10
无线协议	非基于 IP	非基于 IP	**IPV6**	非基于 IP	IPV4 和 IPV6

粗体 - 在某些国家/地区是强制性要求

TI 无线太阳能管理系统 (WSMS) 优势

TI 无线太阳能管理系统 (WSMS)

优势

- 带跳频功能的自愈式网状网络具有高度的稳健性
- Sub-1GHz 频段，每个区域配备专用 PHY，可实现最远传输距离

TI 的优势

- 低成本、小型解决方案 - 最低闪存占用空间
- 极低待机电流 (< 1uA)
- 高效集成 PA
- 将硬件无缝迁移至更大存储器设备，实现完整的网络解决方案

开始使用

- 使用 LaunchPad 扩展到全面开发

WSMS| 为什么要使用无线技术？– 功能更多！

稳健的远距离协议
基于 IEEE 802.15.4 标准的远距离、自愈式网状网络拓扑、跳频无线协议

可扩展网络
可扩展数据速率，网络容量为 50kbps 至 300kbps，最多支持 50 个节点

优化的协议性能
快速加入、网络拓扑管理和低延迟广播选项

无线更新
允许 OTA（无线）**软件更新**和持续软件更新。

基于标准的多层安全性
IPv6、RCMPv6、RPL、6LowPAN、EAP-TLS、802.11i、802.1X

WSMS 特性

特性	对普通客户的益处	如何启用
仅加入特定边界路由器	网络拓扑管理	客户可实施可选的 API 以将允许/禁止列表发送到调用此功能的路由器
预配置的 MAC 密钥	减小代码大小 缩短加入时间	编译时选项
小型网络快速加入	缩短加入时间 （1BR+50N，小于 5 分钟）	编译时选项
生产测试模式	提高置信度 生产测试和部署采用相同图像 允许多线并行运行	编译时选项
小型网络低延迟广播 （<100 个节点）	大量广播消息 可支持多跳	编译时选项
性能指标监控功能	客户可从节点获取网络性能信息	编译时选项

Sub-1GHz | 大型网络测试设置

硬件设置

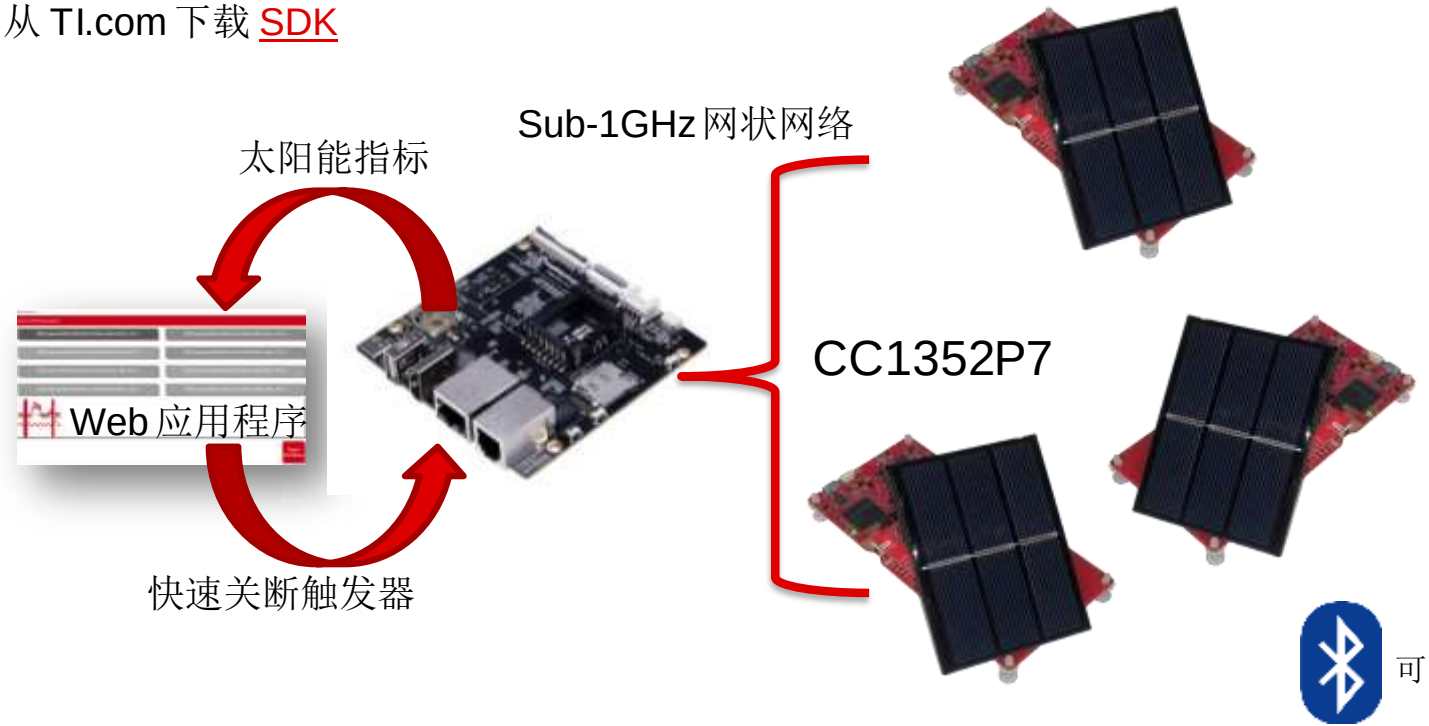
- CC131x 和 CC135x Launchpad™ 开发套件的组合

测试目标

- 确保软件产品的稳健性/可靠性
- 测量指标为测试期间尝试传输的消息数量与目标成功接收的消息数

使用 WSMS 进行太阳能微型逆变器监控

- 2 个 CC1352P7 LaunchPad 作为微型逆变器节点的一部分
- BeaglePlay 作为边界路由器 (HEMS)
- 从 TI.com 下载 SDK



总结

- TI 推出了基于 Sub-1GHz 技术的新型无线太阳能管理系统。
- 该解决方案包括用于设计、测试、安装和维护太阳能微型逆变器和跟踪器的硬件和软件。
- 支持星形和网状拓扑，符合全球规范。
- 可立即用于评估和开发
- 如需了解更多信息，请访问：
  - 太阳能设计资源 | 德州仪器 TI.com.cn
  - 适用于太阳能微型逆变器和跟踪器的无线技术
- 如有技术问题，请访问我们的在线支持论坛 E2E

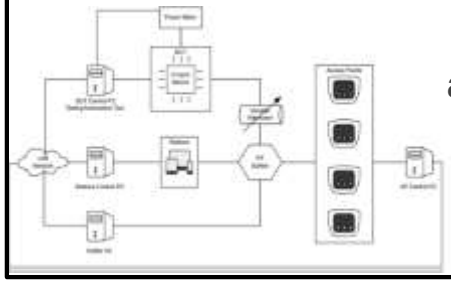
Wireless Connectivity Solutions

Enabling reliable and secure IoT Wi-Fi systems

Wi-Fi | World class reliable Wi-Fi solutions

It just works anywhere & It is built to last

Learn more about TI's test strategy



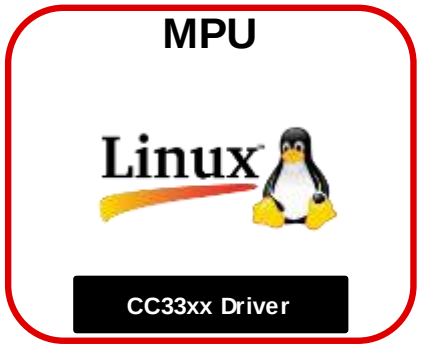
Validation of robustness, stability, and functional features to Achieve reliable wi-fi connection

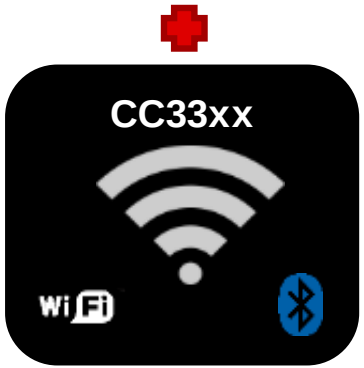
Visit Interoperability test Lab

230+ Access points

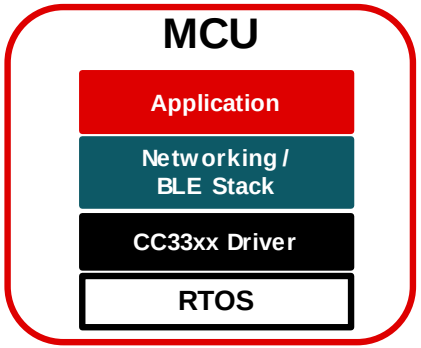
Ensures dependable worldwide connectivity

Wi-Fi Architectures | A solution for each IoT end node

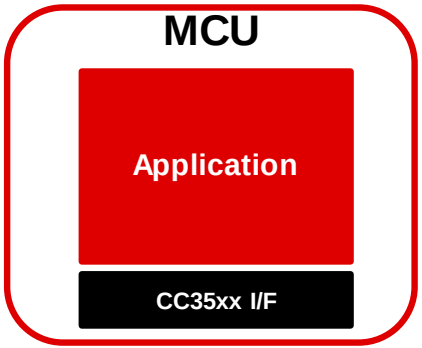


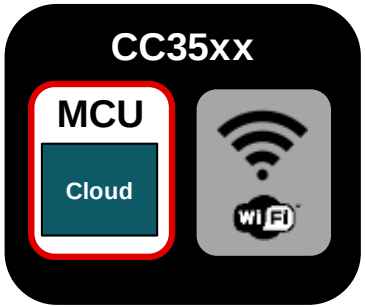


Easily add Wi-Fi 6 & BLE to any Linux system

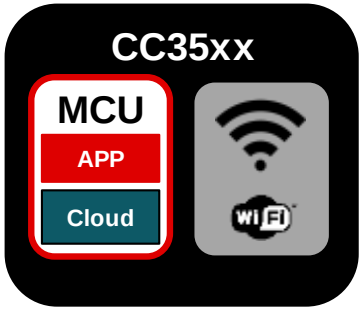


Lowest cost to add Wi-Fi 6 & BLE to an MCU





Add full networking connectivity to any system



All-in-one MCU, cloud connectivity solution

Wi-Fi | Product overview

TI Wi-Fi 4 (802.11 a / b / g / n)

Reliable performance and embedded security

TI Wi-Fi 6 (802.11 ax) for Industrial IoT

Cutting edge, flexible, affordable

Companion Devices

- WL1831MOD — 2.4GHz, 1x1 SISO, WPA3, BT5.1 (BT + BLE) — TRX, Coex, MOD
- WL1835MOD — 2.4GHz, 2x2 MIMO/MRC, WPA3, BT4.0 (BT + BLE) — TRX, Coex, MOD
- WL1837MOD — 2.4/5GHz, 2x2 MIMO/MRC, WPA3, BT5.1 (BT + BLE) — TRX, F, B, MOD
- WL1801MOD — 2.4GHz, 1x1 SISO, WPA3 — TRX, MOD
- WL1805MOD — 2.4GHz, 2x2 MIMO/MRC, WPA3 — TRX, MOD
- WL1807MOD — 2.4/5GHz, 2x2 MIMO/MRC — TRX, B, MOD

Wi-Fi Wireless MCU

- CC3220SF — 2.4GHz, 256kB RAM + 1MB Flash — M4, MOD
- CC3230SF — 2.4GHz, WPA3, 256kB RAM + 1MB Flash — M4, Coex
- CC3235SF — 2.4/5GHz, 256kB RAM + 1MB Flash — M4, F, B, MOD
- matter SF Devices Only
- CC3220R & S — 2.4GHz, 256kB RAM — M4, MOD
- CC3230S — 2.4GHz, WPA3, 256kB RAM — M4, Coex
- CC3235S — 2.4/5GHz, 256kB RAM — M4, F, B, MOD

Released

- CC3301 — 11ax, 2.4GHz, BLE 5.4 — TRX
- CC3300 — 11ax, 2.4GHz — TRX
- CC3351 — 11ax, 2.4/5GHz, BLE 5.4 — TRX, B
- CC3350 — 11ax, 2.4/5GHz — TRX, B

Available Now

- CC3501 — 11ax, 2.4GHz, BLE 5.4 — M33, MOD
- CC3500 — 11ax, 2.4GHz — M33, MOD
- CC3551 — 11ax, 2.4/5GHz, BLE 5.4 — M33, MOD
- CC3550 — 11ax, 2.4/5GHz — M33, MOD

Pre-production

Reliable
20 years of Wi-Fi experience, interoperability tests, validation

Integrated Security
WPA3, Hardware accelerators, IoT and MCU security, **FIPS** validated

Easier to Use
RF **certified modules,** SDK examples **Cloud** agents

BT/BLE COEX options

- Secure File system
- F FIPS
- B 5GHz band support +6GHz in Wi-Fi 6
- Bluetooth LE support
- Wi-Fi 6, 802.11ax
- 105C support
- MOD TI Module
- Matter support
- Low Power

Production

Sampling

CC3551E Multiband Wi-Fi 6 & BLE 5.4 Wireless MCUs

Latest connectivity standards for IoT

- Wi-Fi 6: 802.11 ax @ 2.4GHz and 5GHz
  - Single stream 20MHz channels
  - OFDMA for efficient traffic in congested network
  - Trigger frames, Target Wake Time (TWT) for better power management
- Vpa =3.0-3.6v, Vs=1.8v, Vio=1.8/3.3V

Integrated *Bluetooth Low Energy 5.4*

- 2M MAC/PHY, long range support, Low power beacon mode & locationing

Integrated Coexistence support for 2.4GHz radios

- Integrated coexistance algorithm manages Wi-Fi & BT5.4 communication
- Available 3-Wire PTA Coex interface for external Thread/Zigbee radio

Excellent RF performance

- Tx output power: +20dBm;
- Rx Sensitivity: -99dBm @ 1Mbps
- Throughput: 20Mbps (UDP)

Integrated ARM Cortex M33 @ 160MHz

- Fully dedicated MCU for applications development
- Execution from external flash (XIP) and optional external RAM
- Integrated Peripherals
- ~1.1 MB of embedded SRAM

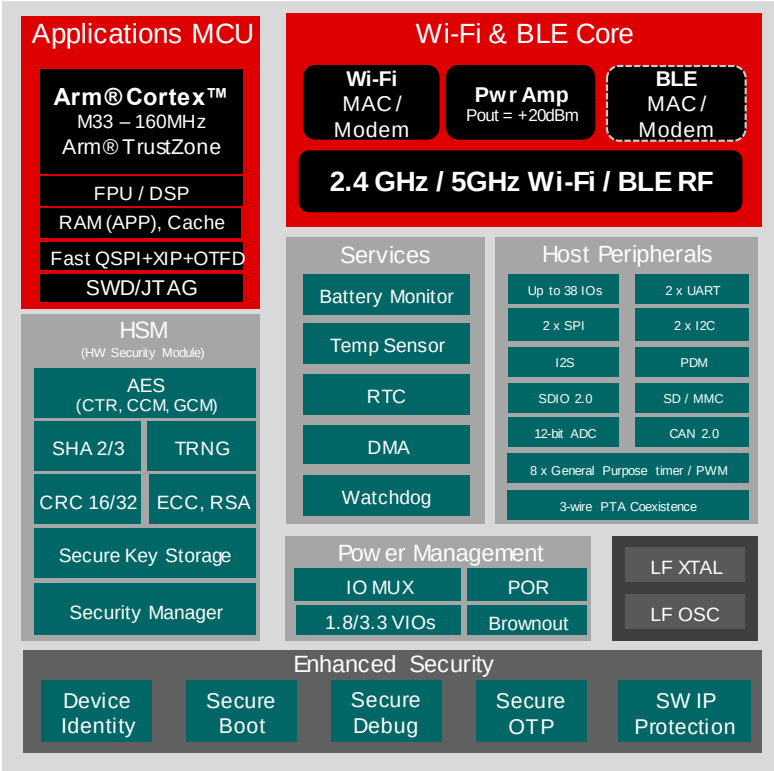
Advanced Security features include

- ARM® TrustZone, WPA3, integrated HW cryptos, secure boot, IP protection
- On-the-fly decryption support on XIP interface
- Key management, trusted execution, OTA support, anti-rollback protection

Small packages pin-to-pin compatible across CC35xxE:

- IC: 7X7 QFN56; Modules: (follows IC release)
- Extended temperature range: -40 to 105C

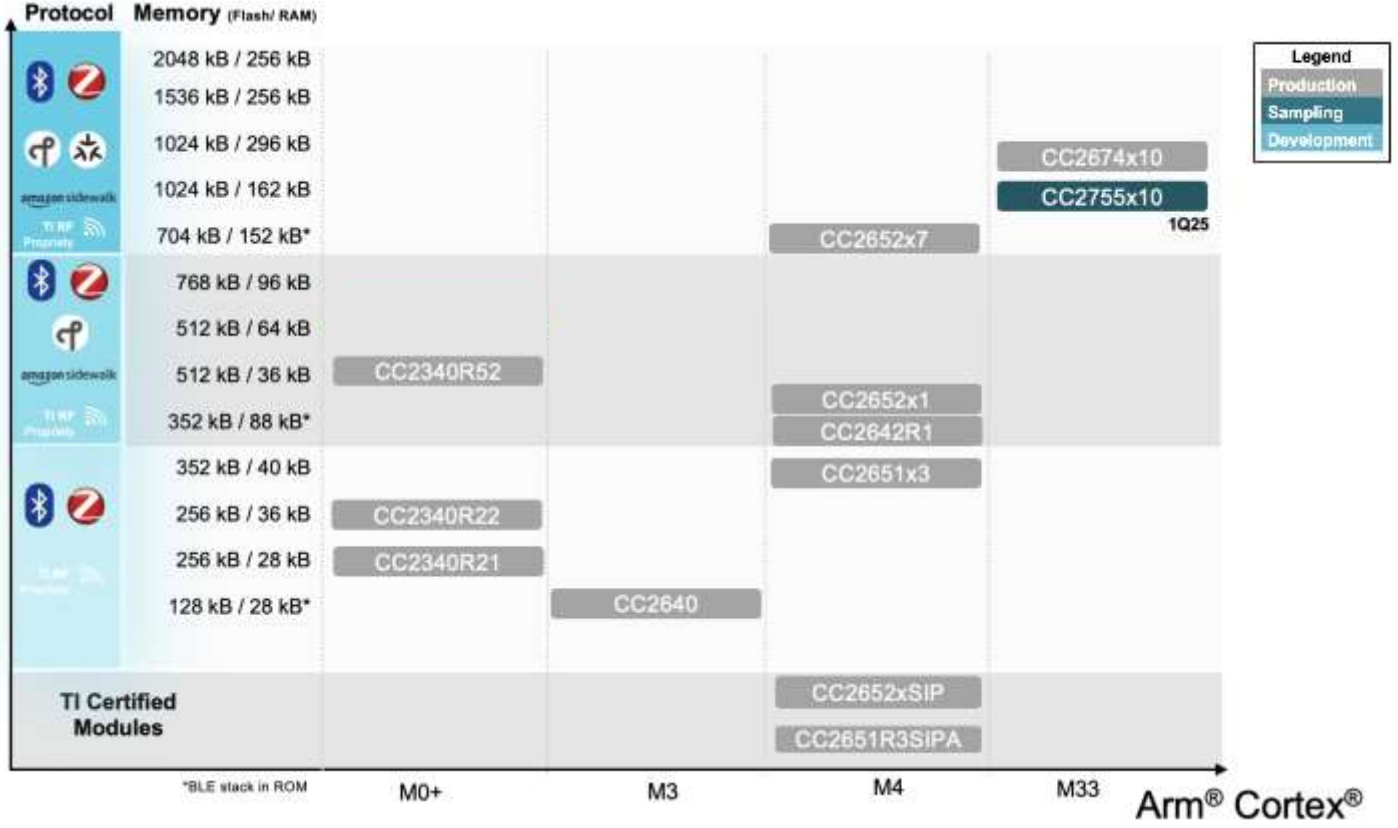
Part Number	2.4GHz WLAN SISO	5 GHz WLAN SISO	BLE 5.4
CC3550E	✓	✓	
CC3551E	✓	✓	✓



Sampling

TI Low Power Connectivity
2.4Ghz IND & PE

2.4 GHz Ind and PE | Portfolio



CC2340R5(3) | Device Overview

Preliminary proposal

Radio

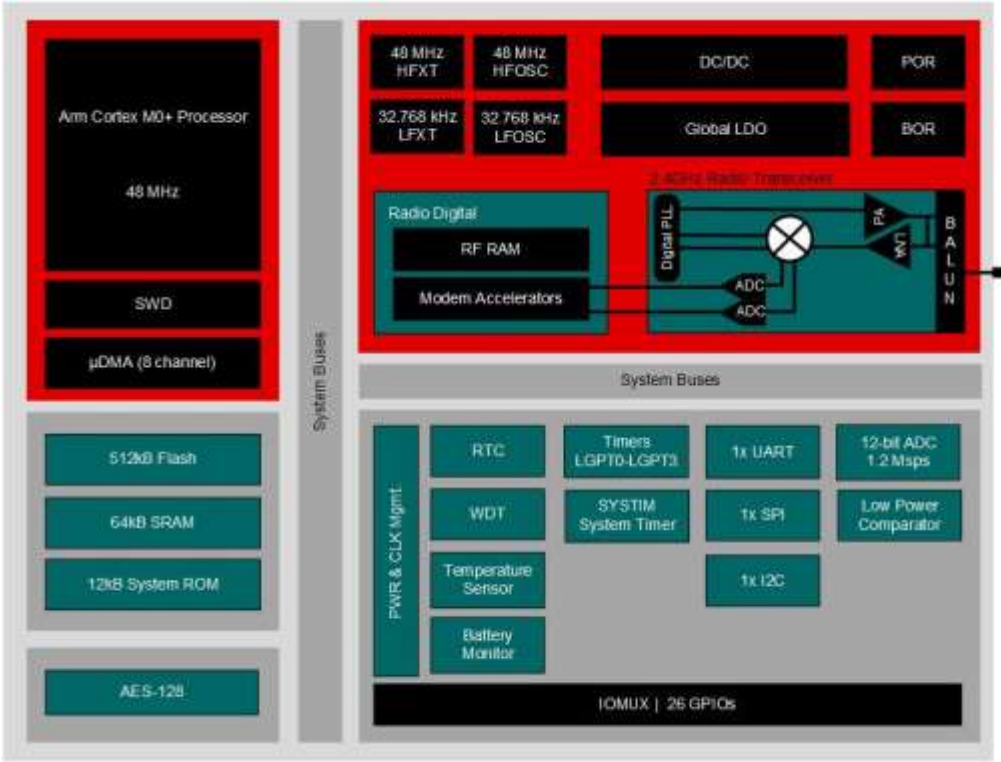
- 2.4GHz RF Transceiver
- Bluetooth LE 5.3, 1M, 2M PHY
- TX output power: up to +8dBm
- RX sensitivity: -97dBm, 1Mbps

Core, Memory

- Cortex M0+, 48MHz
- 512kB Flash, 64kB RAM
- On-chip dual image OAD
- ROM serial bootloader

Package & Temperature

- 5x5 QFN40 (26 GPOIs)
- WCSP (8 IOs)
- Tj -40 to 125C



System BOM Optimization

- Clock Management: 32kHz Crystal-less Op*
- Integrated BALUN

Low Power Consumption

- Standby current <800nA (RTC, RAM retention)
- Radio Rx 5.3mA, 3V
- Tx @0dBm, 3V, 5.1mA
- Tx @4dBm, 3V, 7.7mA
- Average Radio currents, TX @0dBm, 3V
  - 1s CONN : ~6uA
  - 1s CONN ADV : ~10uA

Peripherals

- 1xUART, 1xSPI, 1xI2C
- WDT, RTC, 1xTimers

Security: AES-128

** non-central roles*

CC2755x10 | Device Overview

Radio

- Matter, Multiprotocol
- BLE 5.3, BLE Mesh, DF
- IEEE 15.4 Zigbee, Thread
- Prop 2.4GHz, Fast mode
- 2.4GHz Transceiver

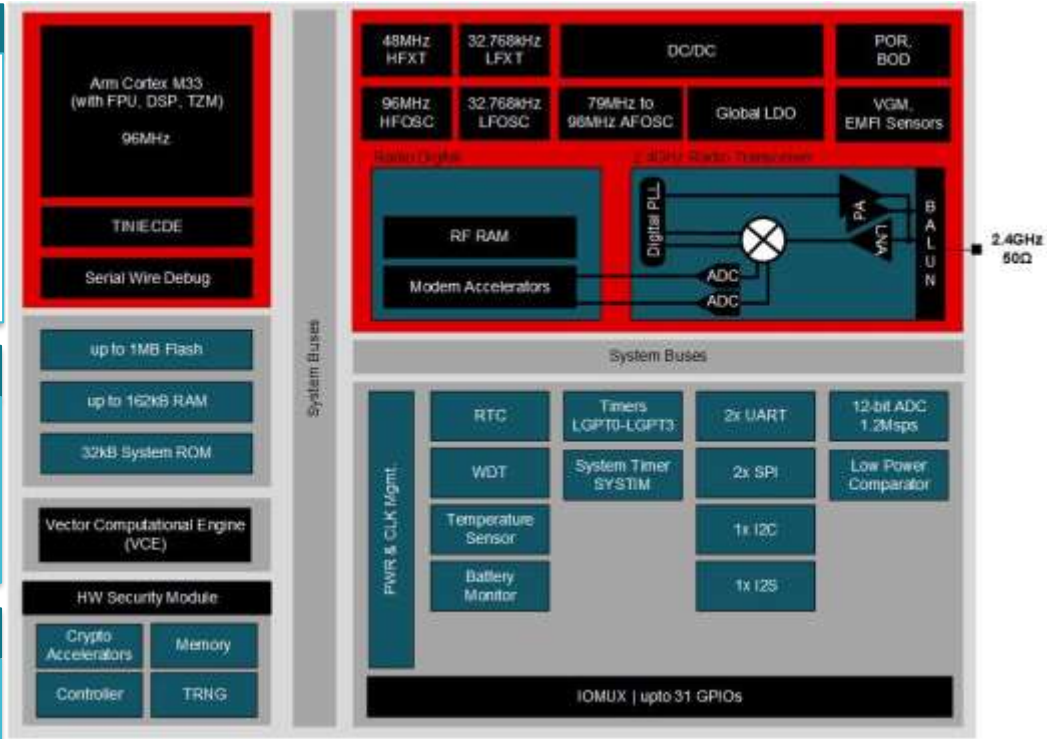
- TX power: +10dBm, +20dBm
- RX sensitivity: -96dB, 1Mbps

Core, Memory

- Cortex CM33, 96MHz
- AI Accelerator
- 1MB flash, 162kB RAM
- Onchip dual image OAD
- Secure ROM Boot

Packages & Temperature

- WCSP (31 GPIOs)
- QFN40 6x6 (23 GPIOs)
- Tj -40ºC to 125ºC



System BOM Optimization

- Clock Management: 32kHz Crystal-less Op*
- Integrated BALUN

Low Power

- Standby current ~1.1uA (RTC, Full RAM retention)
- Radio Rx ~6.1mA
- Radio Tx 0dBm ~7.5mA

Security

- HSM Secure key storage
- TRNG, Crypto HW: AES, SHA, PKA
- TZ-M SW isolation
- IoT Physical Security
- PSA, SESIP L3 certified

Peripherals

Serial Comm.
- 2xUART, 2xSPI, 1xI2C

Digital modules:
- WDT, RTC, 4xTimer, I2S

Analog modules:
- 1x COMP, 12-bit ADC

*except BLE central roles

wBMS

Wireless BMS | Why Wireless? – more Versatility!

Robust, low latency Protocol
Unique wireless protocol that complies with ISO21434 and provides a cabel replacement solution.

Scaleable netwrok size
Up to 32 nodes with a single main
Dual-main support can be added for further nodes and throughput.

Flexible Appliction Layer
Open approach to allow customer customization and differentiated IP development
Common interface for Wired and Wireless

Over The Air Updates
Allows OTA (Over The Air) **software updates** and continues software updates.

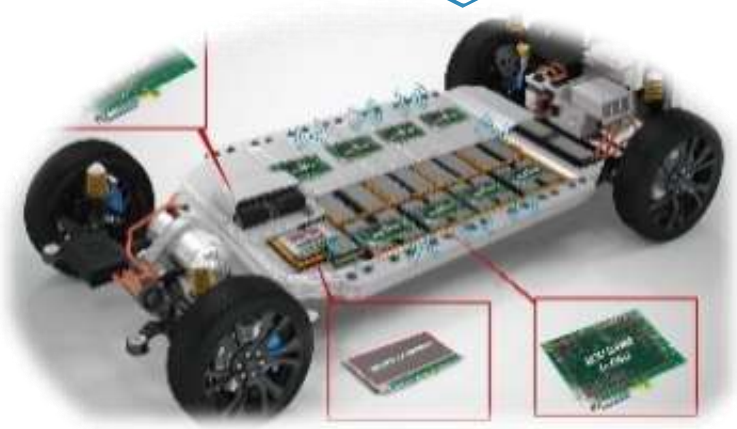
Interchangable communication
Wired or Wireless with multi-protocol radio
Supporting TI's **WBMS** of **Bluetooth** standard for 2nd life. Allows platform level flexibility.

Wireless BMS | Why Wireless? – more Versatility!

Open and Flexible Software Layer
OTA enabled for continues improvements

Lower total vehicle weight, therefore **higher driving range**

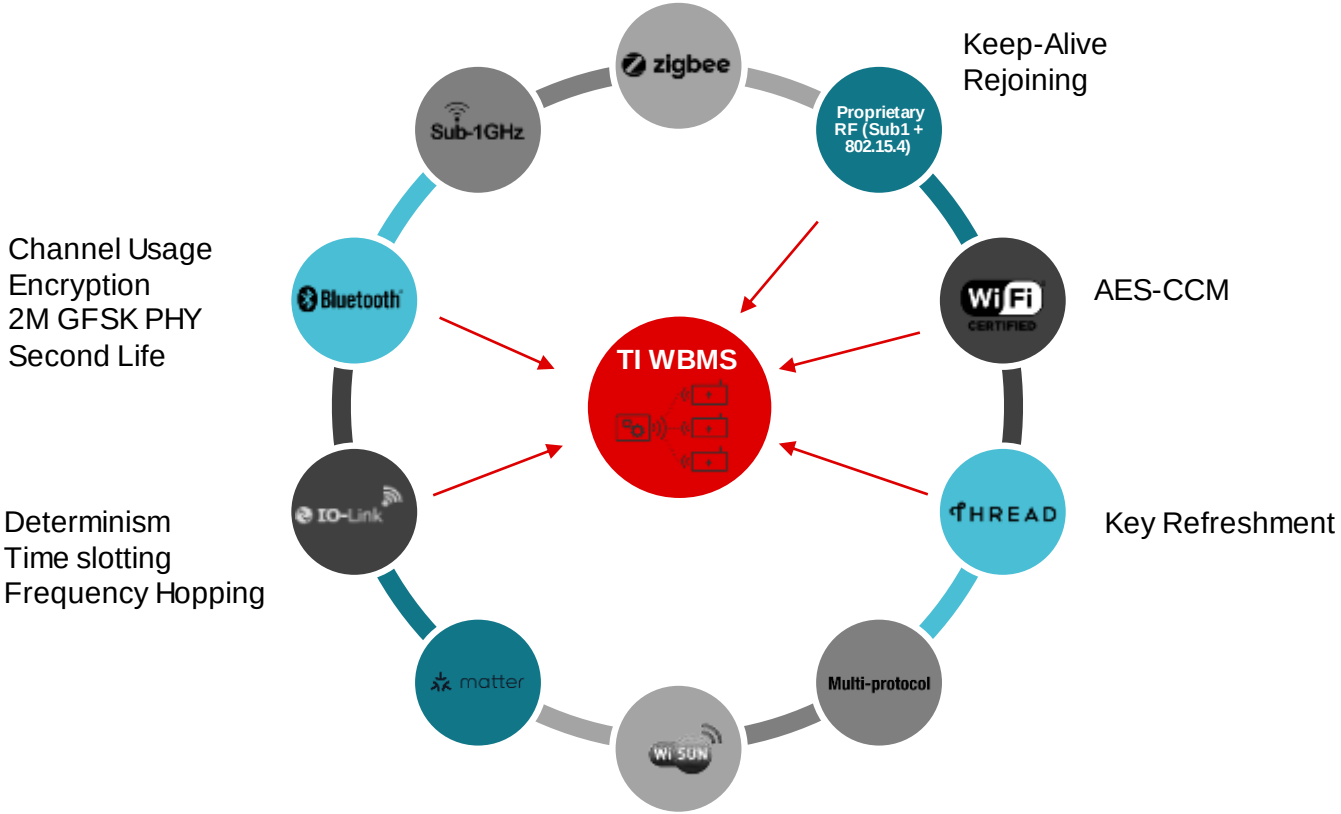
Cost and time reduction during the manufacturing (more automation)



Enables a **highly modular** and **flexible** BMS architecture

Minimize mechanical failures of connectors, cables and wiring harness

Wireless BMS 2.0 | Innovation Elements



Leading wireless innovation for 20+ years

Texas Instruments

Wireless BMS | Value Proposition

System

Reliable and Secured

- **99.999%** network reliability
- Functional safety & Cyber security CAL4 **certified**

Most affordable solution

- Lowest IC and system cost
- Open and royalty free software
- Flexible configurations

Software and Integration

Multiple operational modes

- Manufacturing & Diagnostics
- Testing/Production
- Integration, Shipping, Low power modes.

Various Sensor Integration

- Single design with multiple BMIC support
- Pressure/Temperature/Gas sensors integration

Scalable Solution

- Single or Multi Main configurations
- Daisy chaining for multi-cell support
- Flexible radio configuration for BLE or WBMS

Supply and Quality

Ready to Market

- Proven solution, tested on running systems
- Meeting requirements for Automotive and ESS solutions

Smart Edge

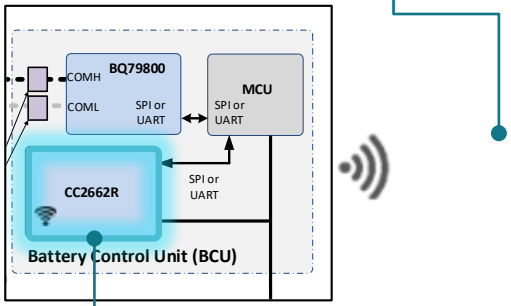
- Battery passport
- Store and track cell data
- Smart sensor integration

Supply Resilience

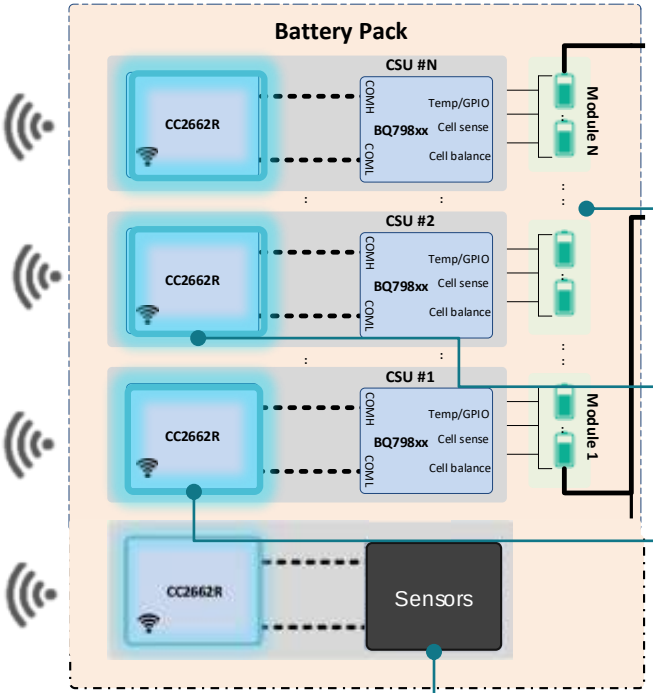
- Internal manufacturing investments supporting a geopolitical dependable capacity strategy

EV HV wBMS System Block Diagram

99.999% network reilability



Collect network statistics collection,
Set network configuration and settings



Scaleable channel count & network size

Network 'Keep alive' reverse and forward wakeup

Battery passport infomration storage

Flexible sensor integration support

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