Welcome

Unboxing SiWx917
Wi-Fi 6 + Bluetooth LE Pro Kit

Tom Nordman, Nik Von Huben

tech talks

Agenda

01 General SiWx917 Introduction

02 SiWx917 Development Tools

03 Software Overview

04 How to get started

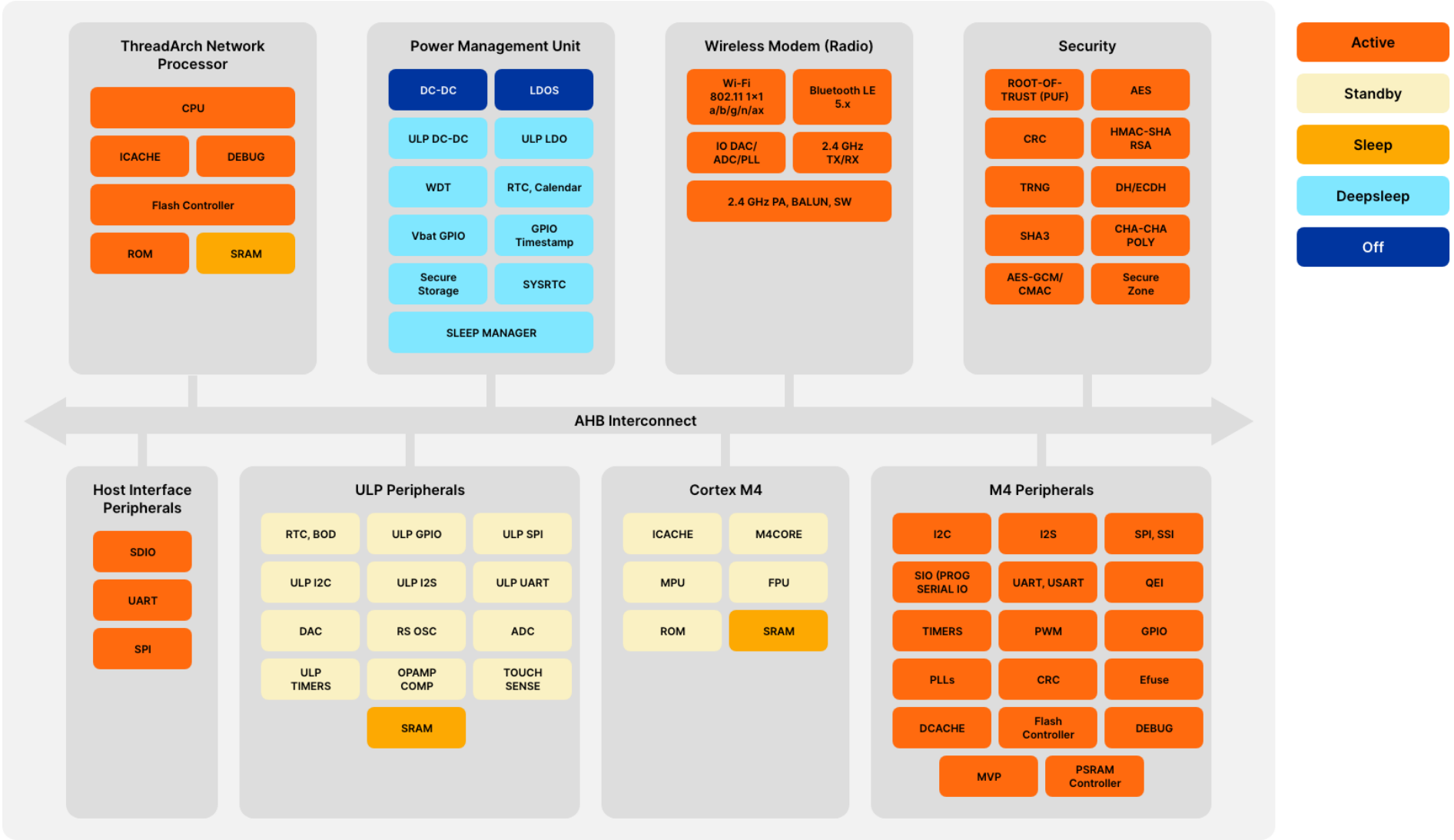
Introducing SiWx917 Wi-Fi 6 SoC

Wi Fi 6 Bluetooth® matter

- **Ultra-Low Power**
  - Increases Battery life and Recharging Interval
- **IoT-Optimized Wireless Performance**
  - 2.4GHz: Long-range, low-power, effective wall penetration, high-throughput
- **Multiprotocol Co-Existence**
  - High-performance Wi-Fi 6 and Bluetooth Low Energy 5.4
- **Large Memory**
  - Up to 672kB RAM, 8MB Flash/PSRAM, 16MB External Flash/PSRAM
- **Single-Chip Matter over Wi-Fi Solution**
  - Wi-Fi, Bluetooth LE, and Matter in One Package
  - Certified Solution
- **Edge Computing + System Integration**
  - Separate Application MCU and Wireless Processor
  - Rich Peripherals, Sensor Hub, High GPIO
- **Robust Security**
  - A High Level of Security for the Device, Wi-Fi Protocol, and Networking

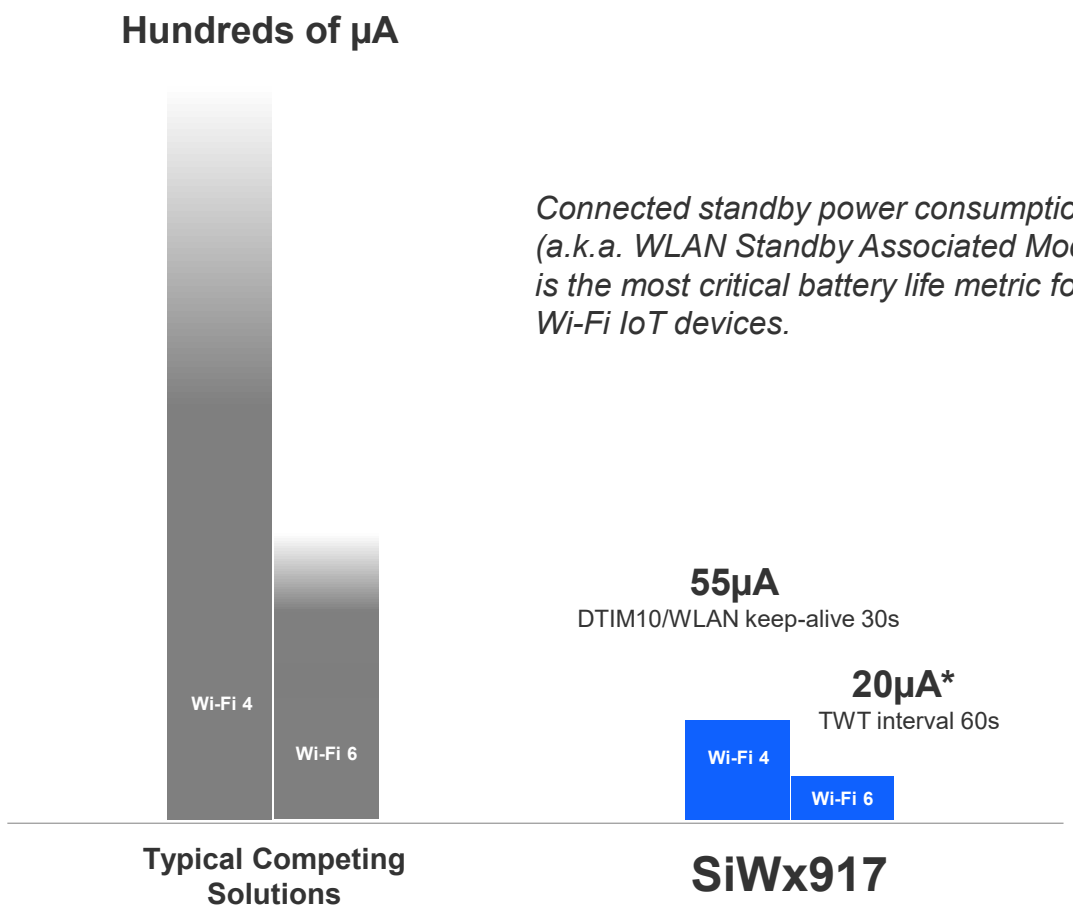
The Most IoT-Optimized Wi-Fi SoC

Optimized for Low-Power IoT Designs - SiWx917 IC Block Diagram



SiWx917: Lowest Wi-Fi Power – Longest IoT Battery Life

Wi-Fi Standby Power Consumption



Connected standby power consumption (a.k.a. WLAN Standby Associated Mode) is the most critical battery life metric for Wi-Fi IoT devices.

** Wi-Fi 6 TWT with auto config feature enabled. TWT Rx latency 60s with 8ms wakeup duration. WLAN keep-alive every 60s. 352K RAM retention.*

SiWx917 Battery Life Estimation

How the battery life of up to 2.5 years was estimated:

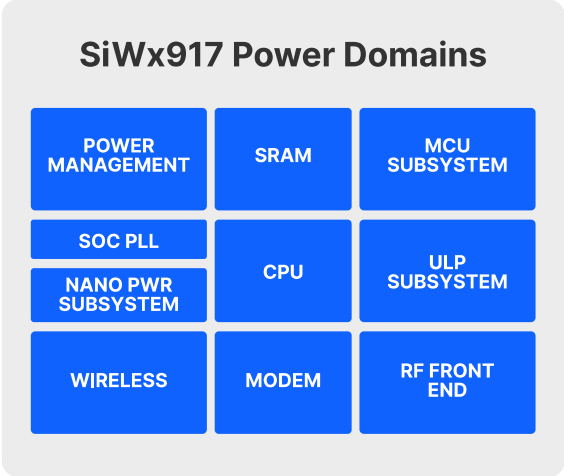
- *Assuming typical sleepy IoT applications such as sensors and smart locks*
- *Measurements are taken in optimal RF conditions (chamber)*
- *Average power consumption ~30µA at 3.3V*
- *802.11ax TWT with Auto Config feature enabled*
- *No TCP keep-alive*
- *TWT Rx latency 30 secs with 8ms wakeup duration*
- *WLAN keep-alive 30 secs. 352K RAM retention*
- *Arm Cortex-M4 operates in sleep mode (PS4). 320kB RAM retention*
- *Battery capacity 1000mAh (example AAA rechargeable battery)*

SiWx917 Intelligent Power Management

- **More Flexible Power Optimization**
  - Multiple optimized power domains. Power management per domain.
  - Four Power Modes, each with Power States
  - Power States per domain for perfected optimization
  - Turn On/Off different portions of the IC to use power only where needed
- **Dynamic Gear Shifting**
  - Switch from one power state to another based on processing requirements via SW triggers
  - Fast wakeup time – e.g., 200usec from Sleep to Active in PS2
- **Dynamic Voltage/Frequency Scaling (DVFS)**
  - The system adjusts supply voltage per domain for different clock speeds automatically to reduce current draw while simplifying development
- **Symmetric SW Processing**
  - Can run the same code in Ultra-low-power and High-performance modes
  - Avoids the typical limitations of asymmetric dual-core designs: inter-core communication, limited instruction set of the smaller core, code incompatibility, code redundancy – Simplifies software development!

Lowest Power for Wi-Fi 6: ~20 µA*

MCU Subsystem Active current:
- **32 µA/MHz at 20MHz Low-Power mode**
- **50 µA/MHz at 180MHz High-performance mode**



Power Modes	Power States	Functions
Active	PS4 PS3 PS2 PS1	Different voltage and CLK frequencies and SRAM PS1-ULP peripherals active
Standby	PS4 PS3 PS2	Different voltage and CLK frequencies and SRAM PS2 Sleep peripherals off
Sleep	PS4 PS3 PS2	CLK frequencies
Deep Sleep	PS0	No Retention

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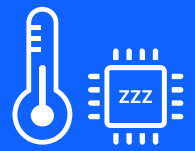
SiWx917 Ultra-Low-Power Sensor Hub

CONFIGURE

Simplify Sensor Configuration and Management

- Hardware Abstraction Layer (HAL) hides complexities
- Software decoupled from peripheral and sensor drivers
- Easy-to-use Sensor Configurator
- Many interfaces: I2C, UART, SPI, ADC, GPIO
- Connect many sensors

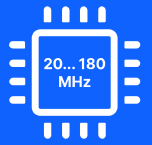
SENSE



Receive & Store Sensor Data in the ULP Mode

- Receive through ULP peripherals
- Store in ULP RAM
- M4 MCU sleeps
- PS1 power state is supported for ADC-based sensors, PS2 for other sensors.

COMPUTE



Process Sensor Data in Different Power Modes

- Low-power computing
  - PS2 at 20MHz (32uA/MHz)
- High-performance computing
  - PS4 at 180MHz (65uA/MHz)
- Dynamic Gear Shifting
- Fast wake-up time

CONNECT

Enter High-performance Mode to Send Data to Cloud

- Establish Wi-Fi Cloud connection only when needed (Active PS4)
- Save power
- Otherwise, stay at ULP WLAN Associated Mode with 23uA

BENEFITS

- **Minimize Power & Extend Battery Life**
- **Offload Main MCU**
- **Compute Locally at Low-power**
- **Simplify Sensor Configuration & Management**

ULP – Ultra-Low Power
HP – High-performance

SiWx917 - Large Memory

672kB RAM

- **A large internal RAM allowing more space to run application and stacks**
- **Three software-configurable MCU application memory options for sharing the RAM between the wireless, system, and application:**
  - For application: 192 / 256 / 320 kB

8MB Embedded Flash or PSRAM

- **A large Embedded Flash or PSRAM to accommodate application, OTA, Matter, and code growth**
- **Embedded Flash: 0, 4, or 8 MB**
- **Embedded PSRAM: 0, 2, or 8 MB**
- **Encrypted XiP**

16MB External Flash or PSRAM

- **Supports a Large External Flash or PSRAM for ultimate design flexibitility, space, and growth**
- **External Flash or PSRAM up to 16MB**
- **Encrypted XiP**

Get More Space for Your Application, OTA, Matter, and Future Growth!

SiWx917 – A Rich Set of Peripherals

- **Enables a wide range of use cases on a single design**
- **Runs multiple peripherals at the same time**
- **Many Ultra-low-power Peripherals**
  - Operate even when SiWx917 is on Standby
  - Long battery life

DIGITAL PERIPHERALS

- 1x Universal Synchronous/Async Receiver Transmitter (USART)
- 3x Inter-Integrated Circuit (I2C)
- 2x Inter-IC Sound Bus (I2S)
- Serial Peripheral Interface (SPI)
- 2x QSPI (M4)
- Serial Input Output (SIO)
- Pulse Width Modulation (PWM)
- Quadrature Encoder Interface (QEI)

Host Interface Peripherals:

- Secure Digital Input Output (SDIO) 2.0 secondary
- 2x Universal Asynchronous Receiver Transmitter (UART)
- Serial Peripheral Interface (SPI)

GPIO:

- Up to 45 General Purpose Input Outputs
- GPIO multiplexer

Timers:

- 4x 16/32-bit
- 1x 24-bit
- Watchdog Timer (WDT)
- Real Time Counter (RTC)

ANALOG PERIPHERALS

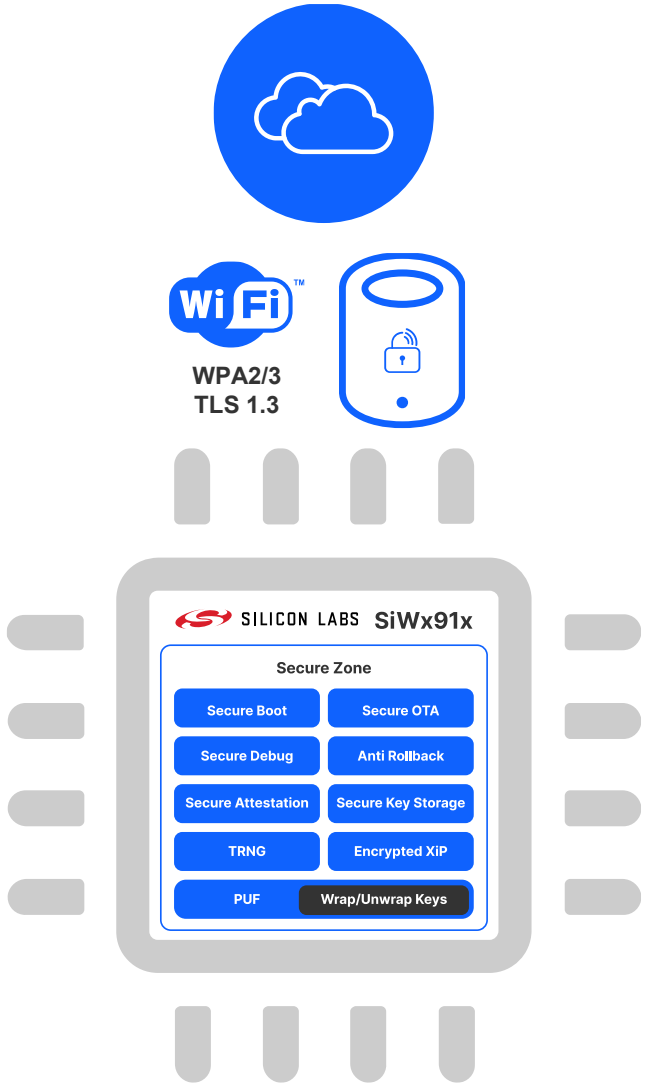
- 12-bit 16-ch, 5 Mbps Analog to Digital Converter (ADC)
- 10-bit Digital to Analog Converter (DAC)
- 3x Op-amps
- 2x Comparators
- InfraRed (IR) detector and Temperature Sensor
- 8 capacitive touch sensor inputs

ULTRA-LOW-POWER (ULP) PERIPHERALS

- Real Time Counter (RTC)
- Brown-out Detect (BOD)
- ULP I2C
- ULP I2S
- ULP UART
- ULP GPIO
- ULP Timers

High Level of Security for the Device and Networking

Wi-Fi Protocol & Networking Security	• WPA2 Personal/Enterprise, WPA3 Personal, TLS 1.3
Secure Boot & Secure OTA	• **Ensures your device runs authentic code** in the boot and OTA update to eliminate malware insertion threats • Secure Immutable Primary (First Stage) Bootloader in ROM. Authenticates* signatures of all other SW using public keys in Flash. Protocol and Application flash images can be encrypted with separate keys.
True Random Number Generator	• **Generates high-entropy random numbers** based on RF noise, increasing the effort/time needed to expose secret keys
Secure Zone	• **A barrier between the Security/Protocol core and Application core**. No access to the security processor, memory, and HW registers from external peripherals, including the Cortex-M4
Secure Key Storage	• **Unlimited PUF wrapped key storage in flash**
Secure Debug	• **Debug ports are disabled in HW by default** and can be enabled in SW using cryptographically secure host interface commands validated by immutable bootloader
Anti Rollback	• **Firmware downgrade to a lower version is prohibited** through OTP to prevent the use of older, potentially vulnerable FW version
Encrypted XiP	• **Execute SW directly from Flash** instead of copying it into RAM • Images are saved in encrypted format and decrypted using device-specific PUF intrinsic keys while executing. In-line decryption based on-the-fly AES engine (based on PUF keys). Multiple protection levels can be set for flash, including unmodifiable. XTS/CTR modes supported.
Secure Attestation	• **Allows a device to authenticate its identity** using a cryptographically signed token and exchange of secret keys
Crypto Accelerators	• AES-GCM/CMAC/ECB/CBC/CTR mode (Key support of 128,192,256), Chacha-poly, CRC, DES/3DES, DH, ECDH, HMAC, IID, SHA, SHA3, TRNG



** Authentication of flash contents like user configurations MBR, keys etc. happens using OTP keys. Authentication of ThreadArch and Cortex-M4 FW happens through flash keys.*

Wi-Fi 6 – 2.4 GHz and 5 GHz Benefits

Wi-Fi 6 Features		2.4 GHz	5 GHz	Benefits to IoT Applications
	Range & Indoor Propagation	★★★★	★★	• Robust and full home coverage - 2.4GHz travels almost TWICE as far as 5GHz • 2.4GHz has better penetration through walls - attenuation is less at lower frequency
	Battery Life	★★★★	★★	• 2.4 GHz devices consume significantly less current than 5 GHz devices enabling longer battery life • 2.4 GHz Wi-Fi devices are better suited for low power IoT applications
	Throughput	★★★	★★★★	• 2.4 GHz supports up to 86 Mbps data rates, enough for most IoT applications including video streaming • 5 GHz offers even higher data rates, but very few IoT applications will ever require those rates
	Device Density	★★★★	★★★★	• Wi-Fi 6's OFDMA, MU-MIMO, Beamforming, BSS coloring, and Target Wake Time, allow for higher bandwidth and denser 2.4 GHz deployments, reducing the need to move to 5GHz
	Regulatory Certifications	★★★★	★★★	• 2.4 GHz solutions use the ISM frequency band with no RADAR restrictions and fewer regulatory steps for worldwide deployment than 5 GHz (additional regulatory testing needed for DFS Radar channels)
	Lower Cost and Design Complexity	★★★★	★★★	• Support for dual-band is more expensive and complex due to support needed for higher frequency 5GHz front end and antenna components.

2.4 GHz is Optimized for IoT, Considering the Range, Power, Throughput, and Cost Balance!

Target Markets and Application Examples

Home and Life

Smart Home
Security Cameras
HVAC
Smart Sensors
Smart Appliances
Health and Fitness
Pet Trackers

Industrial and Commercial

Smart Cities
Smart Meters
Industrial Wearables
Smart Buildings
Asset tracking
Smart Hospitals

Q&A

Unboxing Demo Video

Nik Von Huben
Senior Software Engineering Manager

Q&A

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How to Develop Wi-Fi 6 Software applications with SiWG917 SoC

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01 Introduction for different development modes

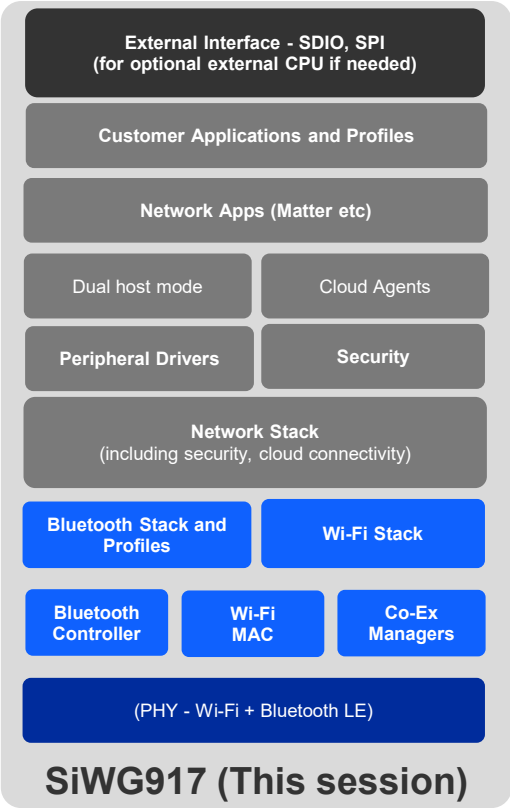
02 CLI Demo Example App + QA

03 Low Power Mode Demo + QA

SiWx917 IC Software Architecture – Different Operational Modes

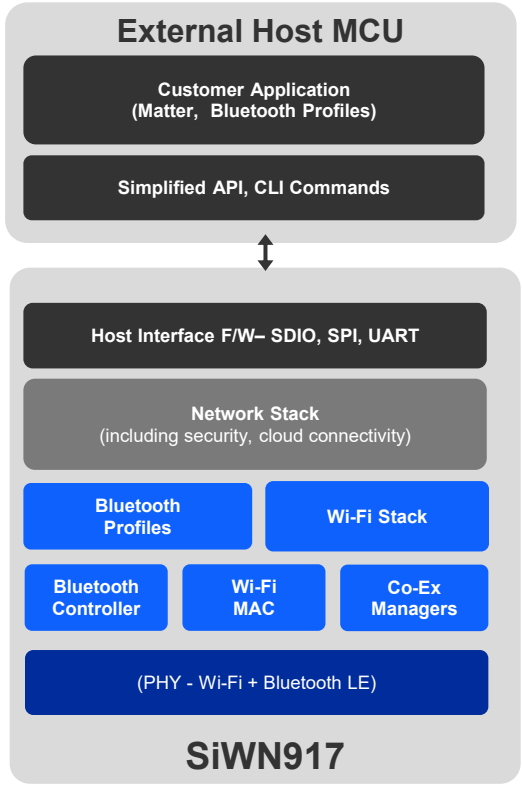
SOC – WIRELESS MCU

- Hostless – No external host needed
- All of the code (wireless, networking stacks and application code) runs on SiWx91x



NCP- NETWORK CO-PROCESSOR

- Hosted – Network Co-Processor (NCP)
- Host MCU runs RTOS, application code, cloud agent, and Matter
- SiWx91x runs Wi-Fi and Bluetooth radios, wireless and networking stacks



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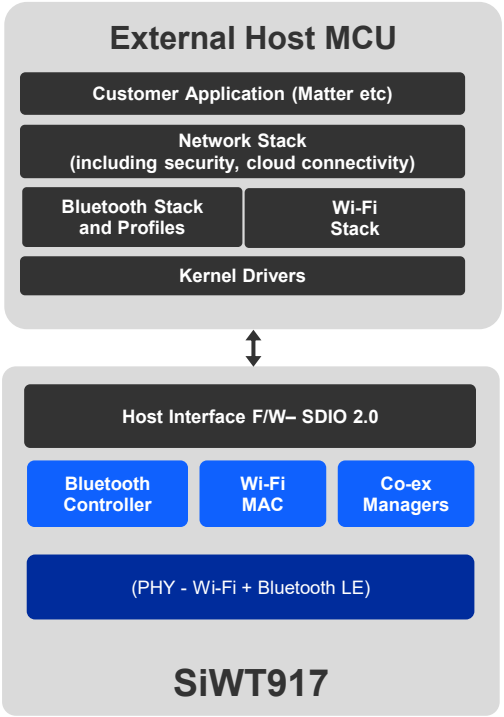
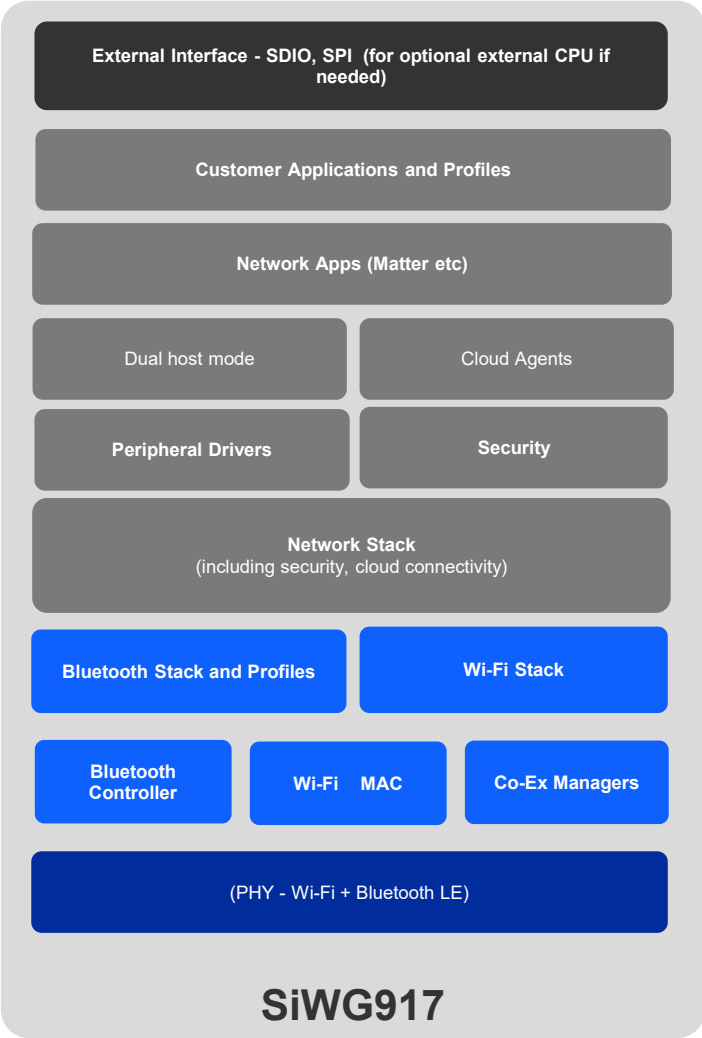


SiWG917 SoC Mode Overview



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  - Wi-Fi stack, Bluetooth LE 5.4 stack, PSRAM support
  - Networking Stack - TCP/IP, TLS 1.3, HTTP/HTTPS, DHCP, MQTT
  - ARM Cortex-M4F processor for customer application with floating point unit
  - SPI/SDIO for optional external processor if needed by the application
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  - Wi-Fi 6 Target Wake Time (TWT) for improved efficiency and long battery life
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- **Amazon FreeRTOS Support; AWS IoT Cloud Connectivity**
- **IDE – Simplicity Studio 5**

SiWG917 SW Development Process – SoC Mode

1. Get a Development Kit

- Pro Kit SiWx917-PK6031A is recommended for application development in the SoC mode (i.e. wireless MCU)

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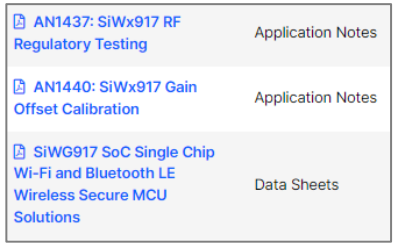

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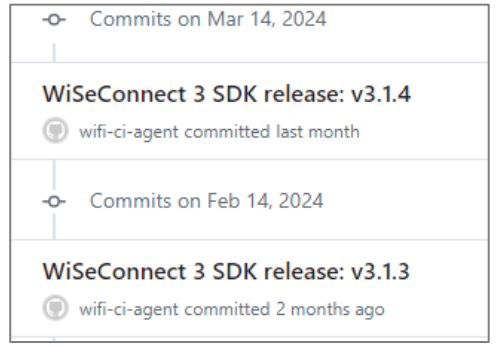

https://github.com/SiliconLabs/wiseconnect/issues

CLI Demo
Example App

Nik Von Huben
Senior Software Engineering Manager

Low Power Mode Demo
“Associated and Deep Sleep”

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Thank You

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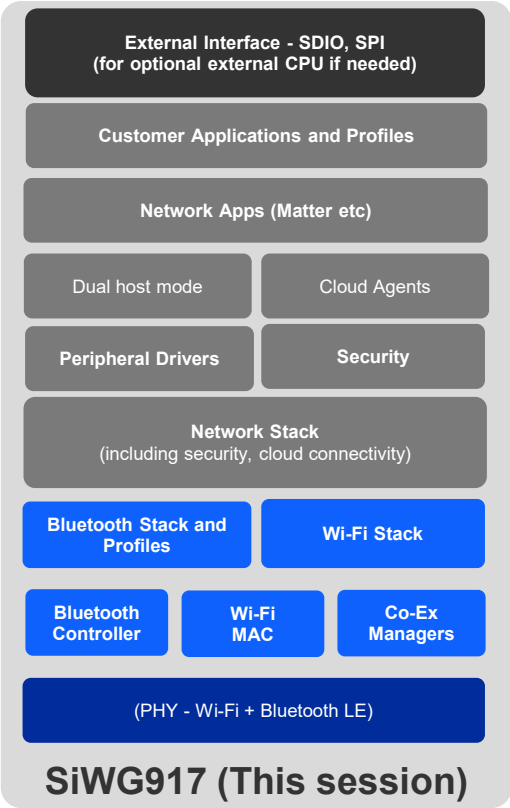

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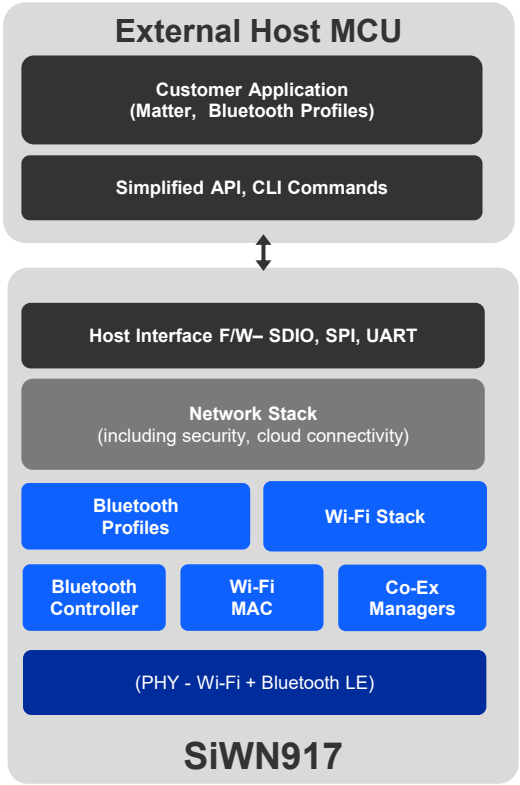

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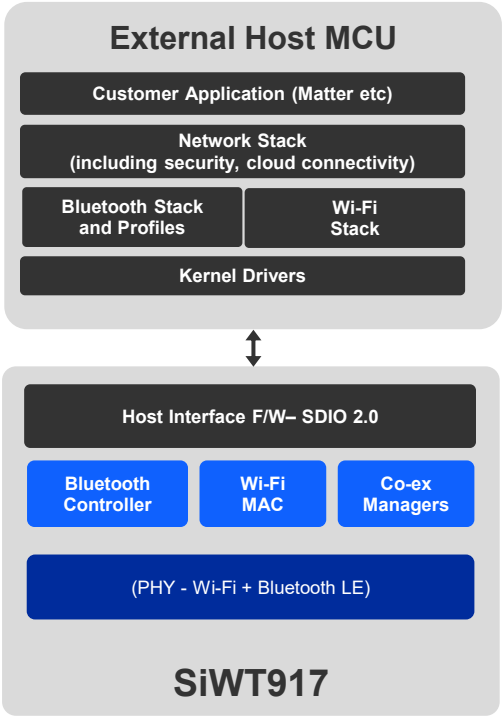

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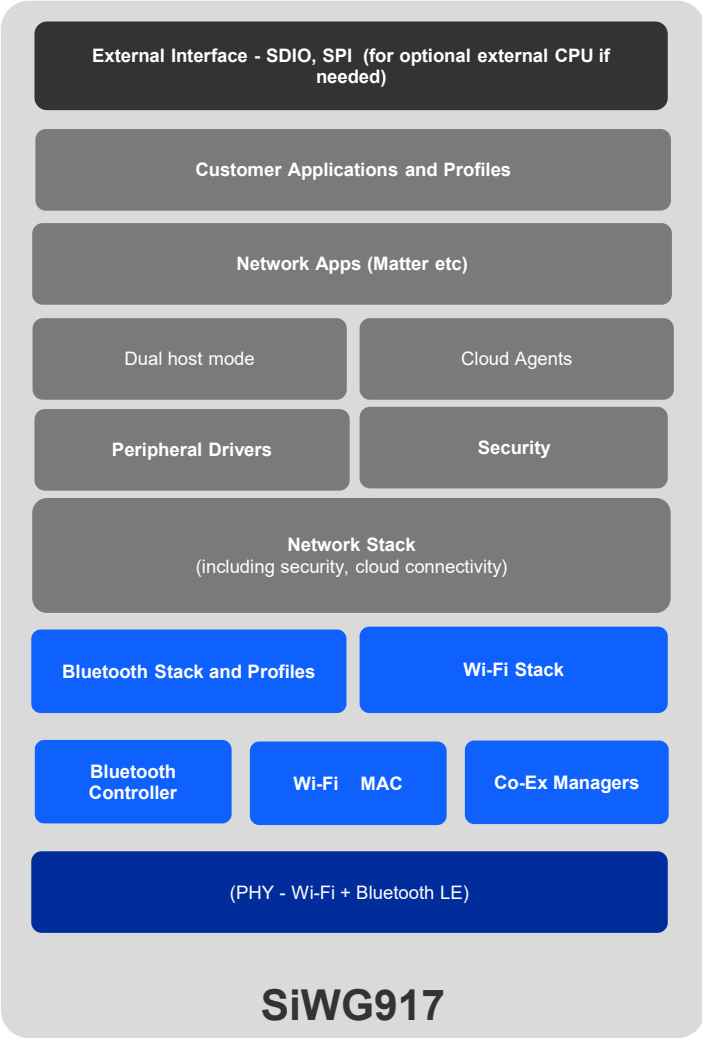

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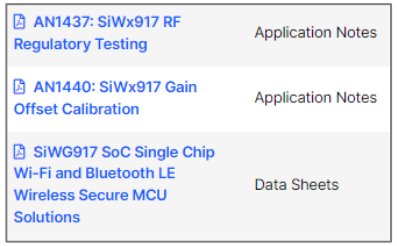

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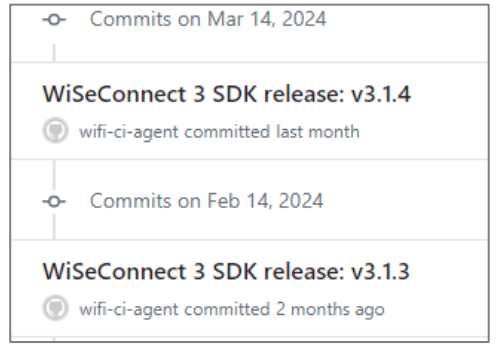

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