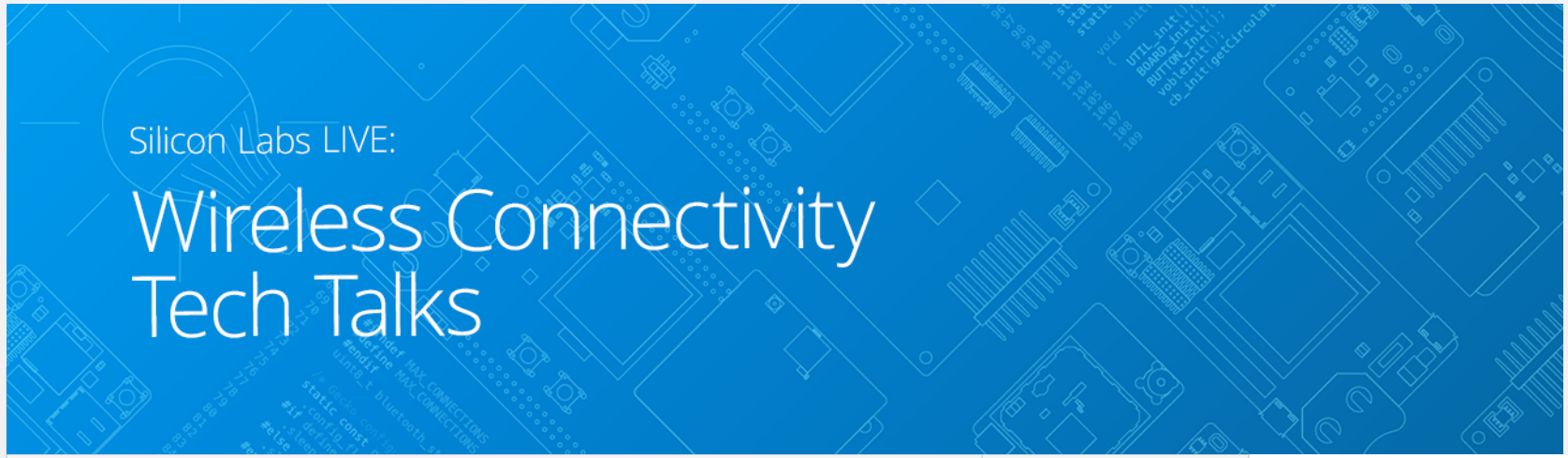
Tech Talks LIVE Schedule – Presentation will begin shortly



How to Measure and Debug Network Performance - Using Silicon Labs Network Analyzer	Thursday, May 7
RF Regulatory and Qualification Testing for Bluetooth, Zigbee & Z-Wave	Tuesday, May 12
Simplicity Studio Tips & Tricks: Our FAEs Know All The Tricks - Improve Your Life in Simplicity Studio	Thursday, May 14
Wireless Module vs Wireless SoC Tradeoffs and Decision Making Criteria	Tuesday, May 19
Thunderboard BG22 Unboxing. You Have Our Kit… What Can You Do With It?	Thursday, May 21
Designing in Bluetooth using Bluetooth Xpress Modules with Minimal Code Writing	Tuesday, May 26
Overview of Silicon Labs Wi-Fi Solutions (Including Redpine Signals Wi-Fi Solutions)	**Thursday, May 28**

Find Past Recorded Sessions at:
https://www.silabs.com/support/training

WELCOME

Silicon Labs LIVE:

Wireless Connectivity Tech Talks

Overview of Silicon Labs Wi-Fi Solutions

ALFREDO PEREZ GROVAS - MAY 2020

Presentation Agenda

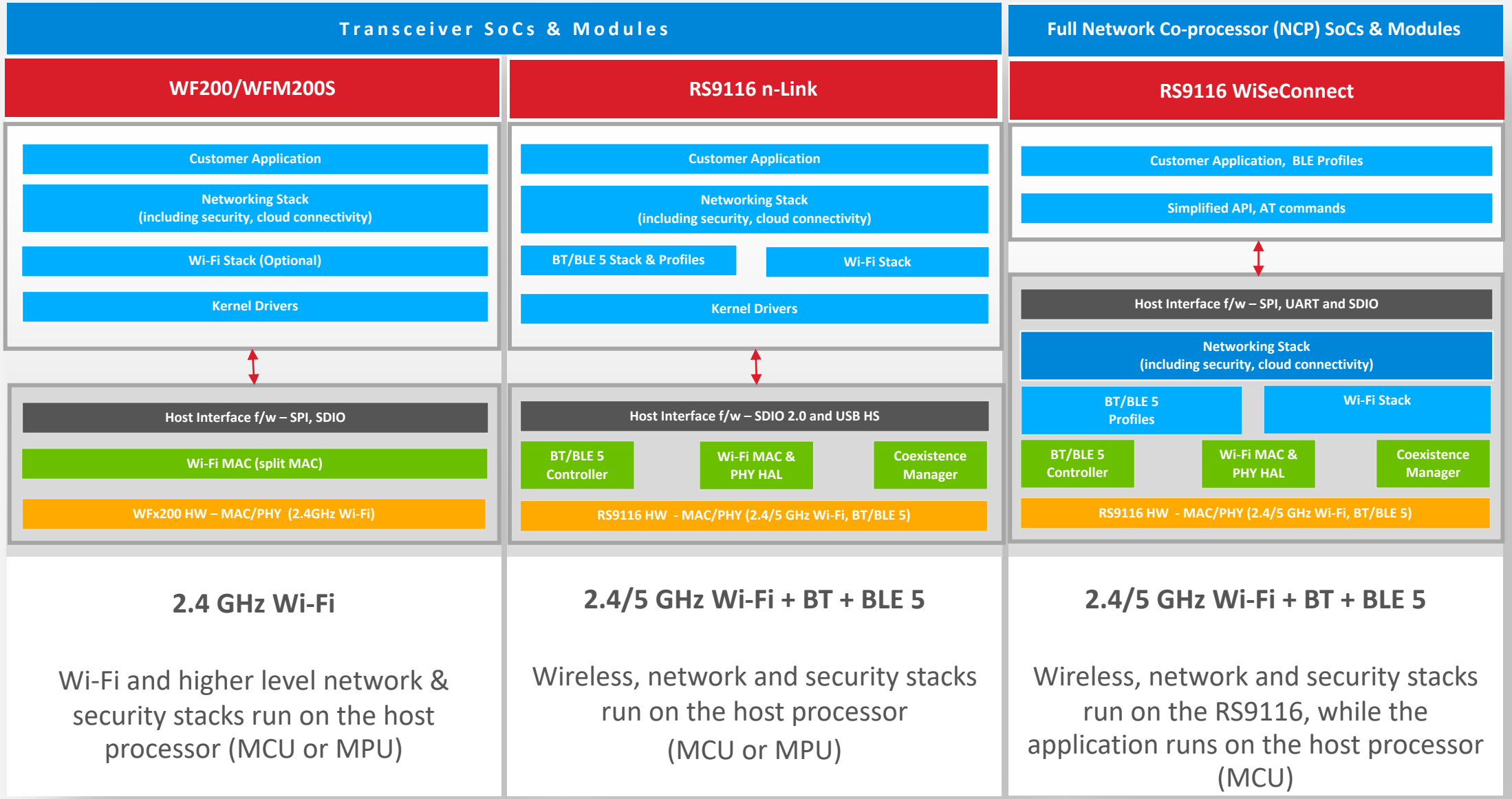
- Introduction to Silicon Labs RS9116
- RS9116 IoT Application Examples
- Optimizing current consumption for IoT Wi-Fi products

Silicon Labs RS9116 At a Glance – Redpine is now part of Silicon Labs!!!

- RS9116 comes from three generations of wireless products
  - RS9110 – 2007: 2.4/5 GHz Wi-Fi only (Gen 1)
  - RS9113 – 2013: 2.4/5 GHz Wi-Fi + BT/BLE 4.1 (Gen 2)
  - RS9116 – 2018: 2.4/5 GHz Wi-Fi + BT/BLE 5 (Gen 3)

- Key Technologies
  - OFDM, Ultra-Low Power
  - Multi-protocol (802.11, BT/BLE 5), Multi-threaded processors
- Embedded Wireless & Networking Software
- Multiple target markets
  - Smart home, Fitness/Wearable, Healthcare, Industrial

The Silicon Labs Wi-Fi Product Family



2.4 GHz Wi-Fi

Wi-Fi and higher level network & security stacks run on the host processor (MCU or MPU)

2.4/5 GHz Wi-Fi + BT + BLE 5

Wireless, network and security stacks run on the host processor (MCU or MPU)

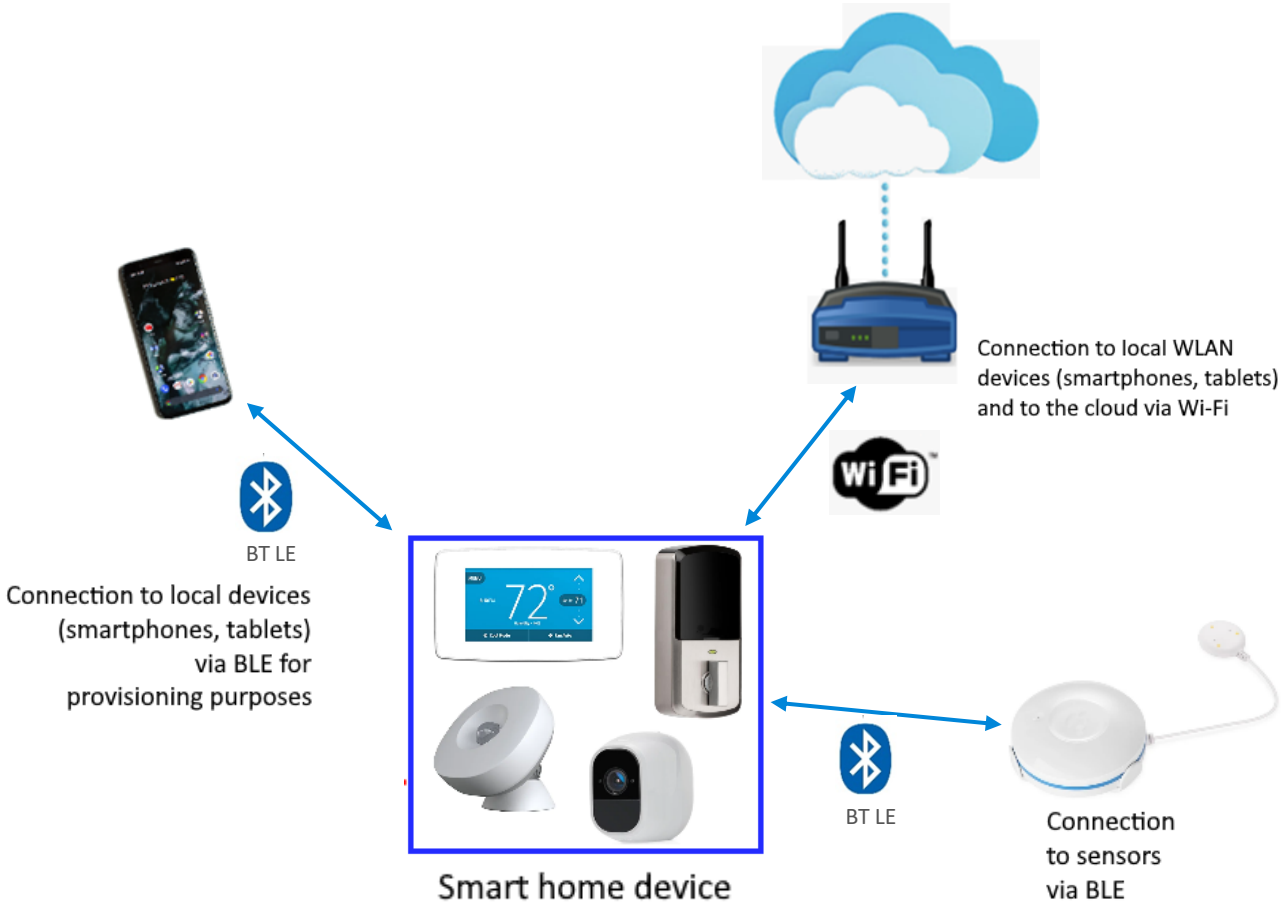
2.4/5 GHz Wi-Fi + BT + BLE 5

Wireless, network and security stacks run on the RS9116, while the application runs on the host processor (MCU)

RS9116 IoT Application Examples

- Smart Home Multi Protocol Use Case
- Wearable Device Multi Protocol Use Case

RS9116 Smart Home Use Case



Application Requirements

- Wi-Fi communication for local and cloud control of smart home devices (locks, cameras, thermostats, etc.)
- Variable communications requirements:
  - Light payloads for devices such as smart locks and thermostats
  - Heavy payloads for devices such as security cameras
- BLE communication to provision smart home device to home Wi-Fi network during installation
- Low current consumption for battery operated smart home devices such as sensors and smart locks

How RS9116 Enables Smart Home Applications

- Wi-Fi + Bluetooth Classic + BLE support in a single SoC
- Ultra low power modes with best in class current consumption for long battery life
- High throughput for Wi-Fi applications requiring it
- Highest BLE power (up to +18 dBm)
- Management of Wi-Fi and Bluetooth LE coexistence through built-in coexistence manager
- Extensive security support (SSL, WPA/WPA2 and enterprise security) to ensure end user security

RS9116 Wearable Device Use Case

Application Requirements

- Heavy Communications in 2.4 GHz ISM
- Wi-Fi Connected to the cloud through AP with downloads/streaming/notifications/updates/etc.
- BT EDR Wireless A2DP Music Streaming
- BLE Peripheral Connections to Smartphones/Tablets
- BLE Central Connections to Sensors
- Ultra low power consumption – Long battery life

How RS9116 Enables Wearable Applications

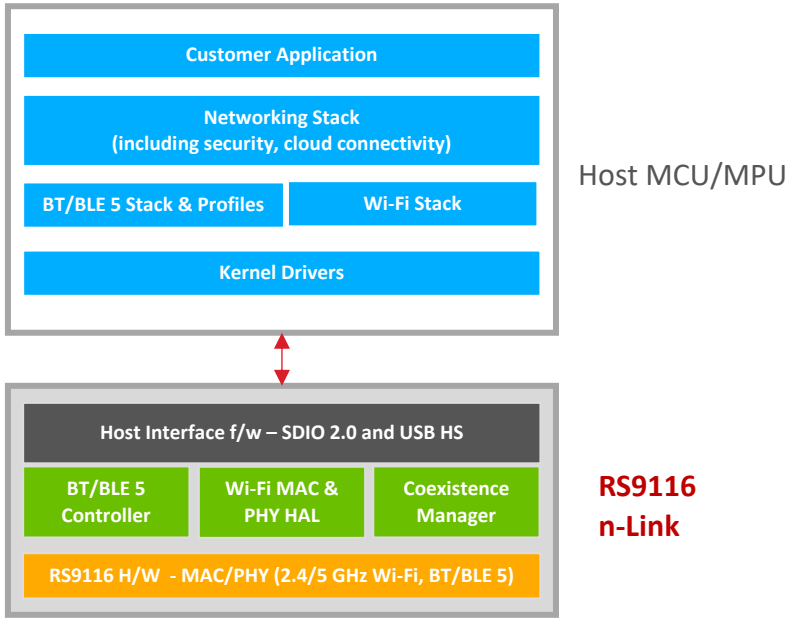
- Wi-Fi + Bluetooth Classic + BLE support in a single SoC
- Ultra low power modes with best in class current consumption for long battery life
- Highest BLE power (Up to +18 dBm)
- Management of Wi-Fi, Bluetooth and BLE coexistence through built-in coexistence manager
- Industry's smallest modules and SoCs ideal for wearable devices

How the RS9116 enables IoT Applications

- RS9116 n-Link Product Overview
- RS9116 WiSeConnect Product Overview

RS9116 n-Link Product Overview

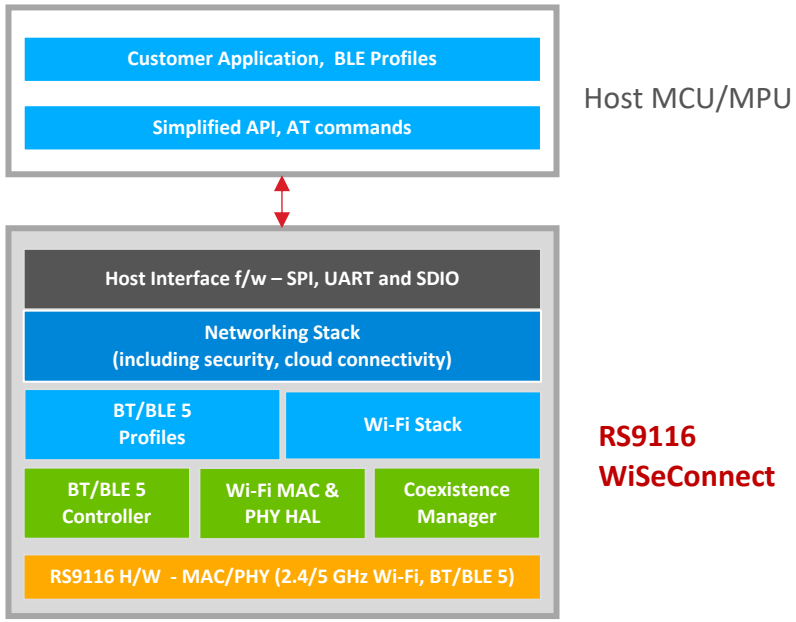
- Product and package variants
  - Single band SoCs and modules with 2.4 GHz Wi-Fi, BT/BLE 5
  - Dual band modules with 2.4/5 GHz Wi-Fi, BT, BLE5
- RS9116 n-Link needs a 32-bit external host processor
- High performance (Up to 100 Mbps at 40 MHz and 50 Mbps at 20 MHz)



- Operating system support: Linux OS
- Host interface support:
  - SDIO
  - USB
- Multi Protocol Operating Modes
  - Wi-Fi Station, AP or concurrent mode
  - Bluetooth Classic / BLE
  - Wi-Fi + Bluetooth Classic + BLE Coexistence Mode
- Multiple power modes for reducing system power
  - Wi-Fi PS, Low power and Ultra Low Power Modes
- Wi-Fi Support with multiple levels of security
  - Personal and enterprise security
  - Roaming with enterprise security
- Interfaces with Bluetooth stack using HCI interface
  - BT EDR 2.1, BLE 4.0/4.1/4.2, BLE 5
  - Support for BLE long range, data rates up to 2 Mbps, advertising extensions
  - BLE dual role (central and peripheral) support

RS9116 WiSeConnect Product Overview

- Product and package variants
  - Single band SoCs and modules with 2.4 GHz Wi-Fi, BT/BLE 5
  - Dual band modules with 2.4/5 GHz Wi-Fi, BT, BLE5
- RS9116 WiSeConnect can operate with an 8/16/32-bit external MCU with or without any RTOS
- Throughput above 40 Mbps in 40 MHz and 20 Mbps in 20 MHz channel bandwidth



- Integrated stack and profiles
  - Wi-Fi stack, BT/BLE stack and profiles
  - TCP/IP (IP v4/6) Networking stack with SSL/TLS, HTTP/HTTPS, Websockets, MQTT
  - SPI, UART, SDIO host interfaces
- Multi Protocol Operating Modes
  - Wi-Fi Station, AP or concurrent mode
  - Bluetooth Classic / BLE
  - Wi-Fi + Bluetooth Classic + BLE Coexistence Mode
- Multiple power modes for reducing system power
  - Wi-Fi PS, Low power and Ultra Low Power Modes
- Wi-Fi Support with multiple levels of security
  - Personal and enterprise security
  - Roaming with enterprise security
- Bluetooth and BLE Support
  - BT EDR 2.1, BLE 4.0/4.1/4.2, BLE 5
  - Support for BLE long range, data rates up to 2 Mbps, advertising extensions
  - BLE dual role (central and peripheral) support
  - BT Profiles: A2DP, AVRCP, SDP, SPP, RFCOMM, L2CAP
  - BLE Profiles: GATT, GAP

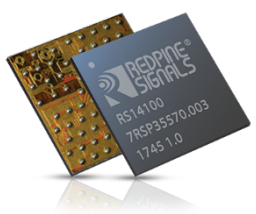
RS9116 Solution Offerings

SoCs AND MODULES

SoC

7.0 mm

7.0 mm
QFN (QMS)



3.51 mm

3.60 mm
WLCSP (WMS)

Single Band (2.4 GHz) Module

4.63 mm

7.90 mm
LGA Module (B00)

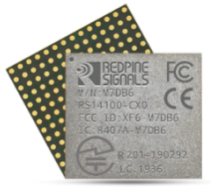
14.0 mm

15.0 mm *
LGA Module (AA0)

16.0 mm

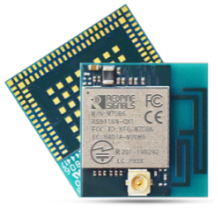
27.0 mm *
LGA Module (AA1)

Dual Band (2.4/5 GHz) Module



9.1 mm

9.8 mm
LGA Module (CC0)



15.7 mm

15.0 mm
LGA Module (CC1)

Optimizing Current Consumption for IoT Wi-Fi Products

- Challenges for battery-powered Wi-Fi IoT devices
- Current consumption of standard Wi-Fi and low-powered optimized Wi-Fi solutions
- Silicon Labs' RS9116 is ideal for this purpose

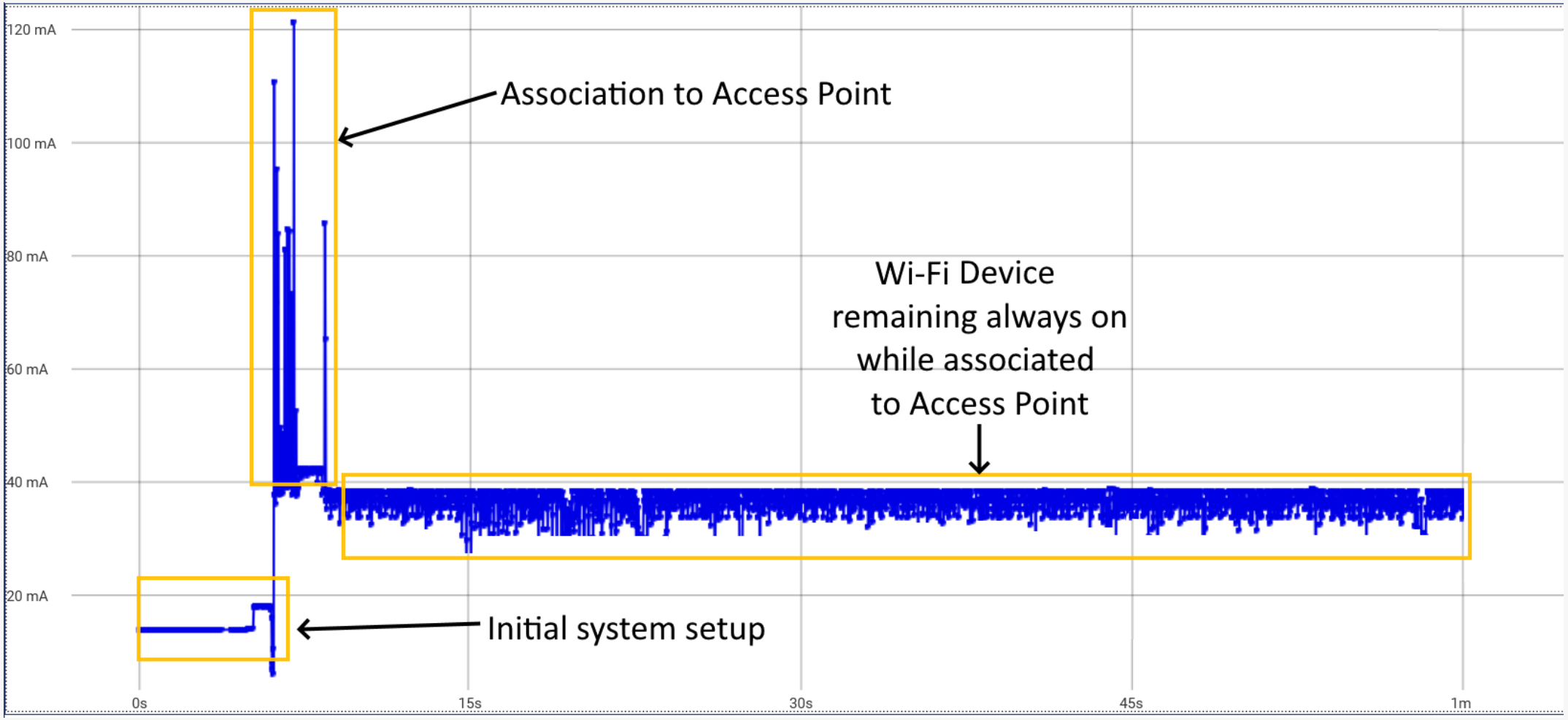
Challenges for battery-powered Wi-Fi IoT devices

- Wi-Fi was not meant as a low-power technology for the following reasons:
  - It supports large bandwidth (20/40/80/160 MHz channel bandwidths)
  - It typically supports high output power to achieve high throughput and range targets
  - It is an always-on CSM/CA technology

- Wi-Fi client devices consume large amounts of current performing the following tasks:
  - Association and authentication to an access point
  - Continuous / always-on radio receive activity

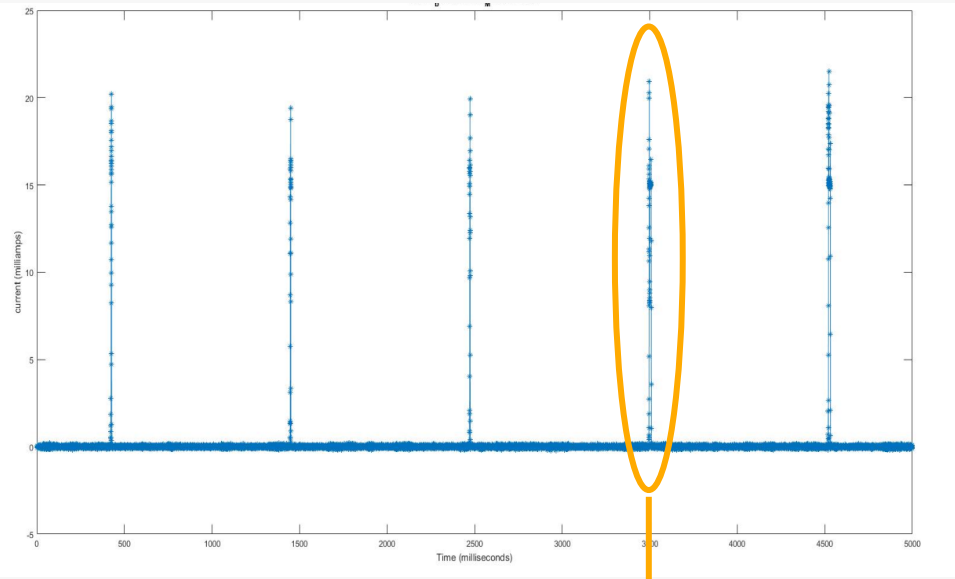
Standard Always on Wi-Fi application

- Complete one minute current profile – avg current 35 mA

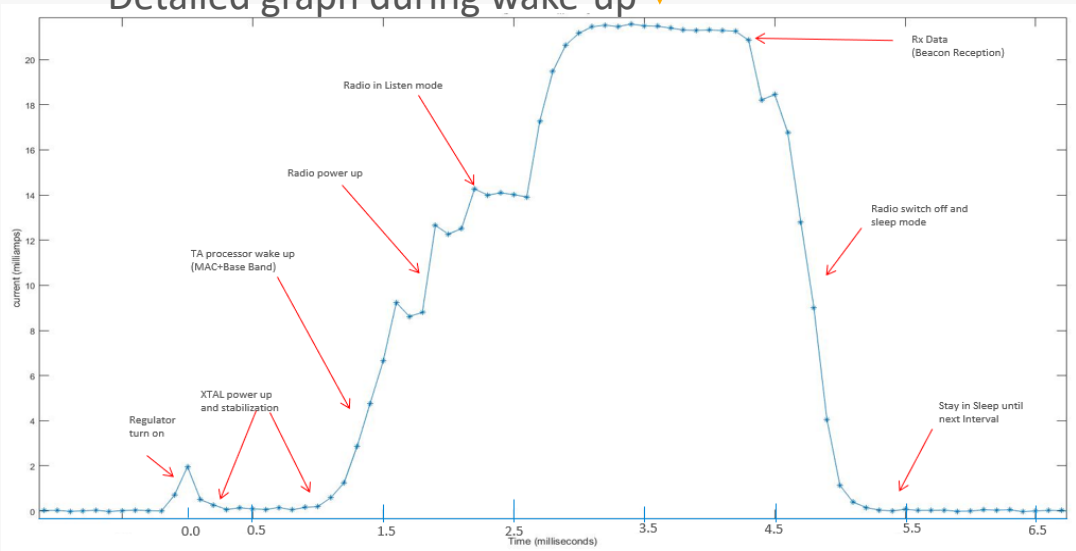


RS9116 Low Power Application – Standby – Associate (1 sec)

- Wake every second and receive beacons (DTIM = 10, avg current 59uA)



Detailed graph during wake-up



- **Multiple Low Power Modes and embedded stack enable ultra low system power consumption**
- **Low power Mode (LP) – with only host interface active**
  - Supported with SDIO/SPI/USB/UART
- **Ultra Low Power mode (ULP) with only sleep timer active (deep sleep)**
  - Supported with SDIO/SPI/UART (With and without RAM retention)
  - Wake-Up based on GPIO, RTC timer, or event/interrupt based – host can go to sleep
- **Wi-Fi Standby associated with automatic periodic wake-up**
  - DTIM or listen interval based
  - Device remains associated to AP

Low Power Comparison Report with 3 Competitors (By Tolly Group)

TEST REPORT

Tolly.

#218146

December 2018

Commissioned by
Redpine Signals, Inc.

IoT Wi-Fi & Bluetooth Power Consumption

Redpine Signals vs Cypress Semiconductor, Qualcomm Tech. & Texas Instruments

EXECUTIVE SUMMARY

The ever-growing Internet of Things (IoT) relies heavily on battery power. Unlike mobile phones and tablets, IoT devices such as doorbells, smart locks and remote sensors cannot easily be recharged. Other devices like wearables have very small battery sizes imposing tighter power constraints. Thus, prolonging battery life by minimizing power consumption becomes a critical concern in IoT.

Redpine Signals commissioned Tolly to evaluate two of their IoT SoCs, the RS9116 and the RS14100 and compare their power consumption with competing IoT offerings from Cypress Semiconductor, Qualcomm Technologies and Texas Instruments. Tests included Wi-Fi and Bluetooth Low Energy (BLE) scenarios and benchmarked power consumption in Wi-Fi Standby Associated Mode, while running a secure TCP stack (with and without co-channel traffic) and in a multi-protocol scenario using BLE.

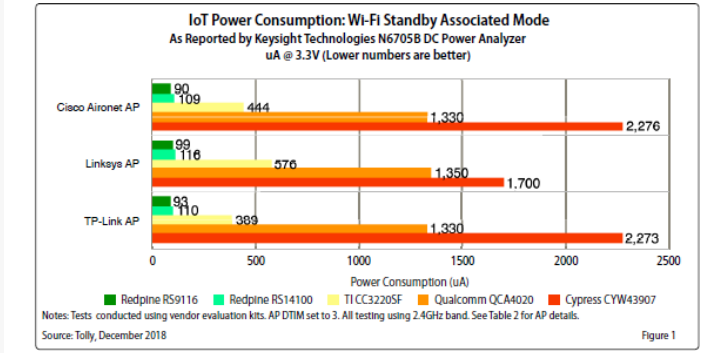
The power consumption of the Redpine Signals solutions was dramatically lower than the competition in every test scenario. ...<continued on next page>

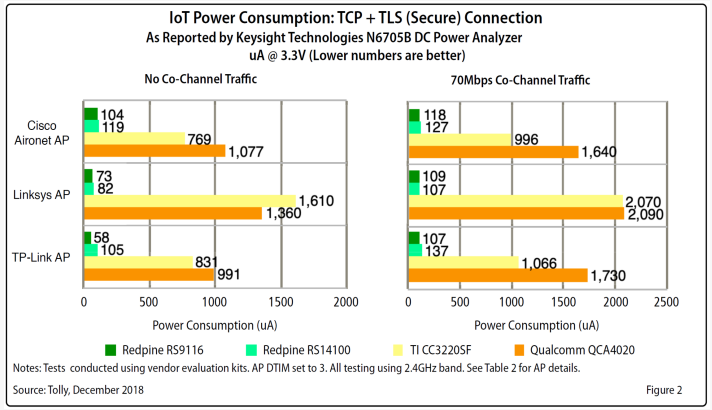
THE BOTTOM LINE

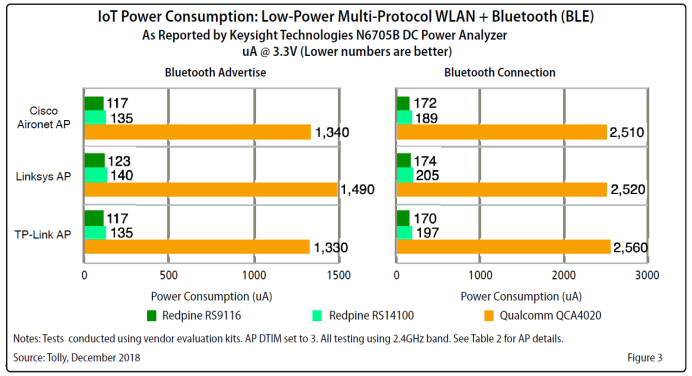
The Redpine Signals SoCs delivered dramatically lower power consumption than the competing chips in all tests:

1. 4x to 25x lower in Wi-Fi standby mode tests
2. 18x to 22x lower in Wi-Fi TCP + TLS tests
3. 10x to 15x lower in multi-protocol Wi-Fi + Bluetooth Low Energy (BLE) tests
4. Projected improvement in battery life for smart lock application: 3 years with Redpine chips (greater than 3x improvement) compared to 9 months using competitor chips.

More details at: http://reports.tolly.com/DocDetail.aspx?DocNumber=218146







[1] The Cypress platform was not included because power consumption in early tests was overly high.

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Q
AND
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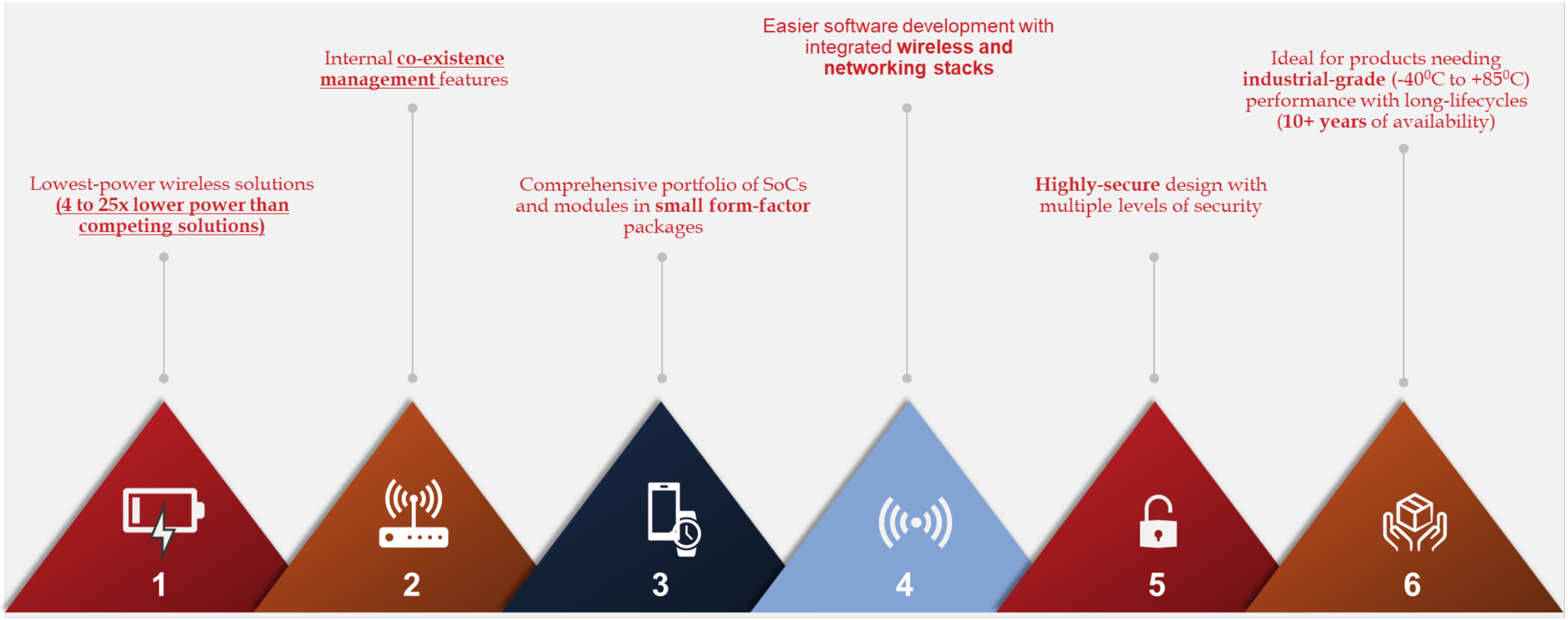
RS9116 Value Proposition Summary – Ideal for IoT Applications



Thank you!

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