Tech Talks LIVE Schedule – Presentation will begin shortly





Tuesday, April 5	Optimizing Battery Life with Low-Power Wi-Fi on the RS9116
Tuesday, April 19	Bluetooth: The latest Bluetooth Low Energy updates in GSDK 4.0
Tuesday, May 3	Matter: Developing with Matter on the MG24
Tuesday, May 17	AI/ML: Bringing Intelligence to the Edge on the MG24

We will begin in:







Welcome



Optimizing Battery Life with Low-Power Wi-Fi on the RS9116

Ryan Orton

Agenda

April 5th, 2022

- Wi-Fi for the IoT
- RS9116 Overview
- Optimizing Power Consumption
 - Low-power modes
 - Power save profiles
- Enablement
 - Dev kits and power profiling
- What's new?
 - Wi-Fi 6



Requirements of Wi-Fi in IoT Devices



Traditional Wi-Fi is not well suited for IoT

- Meant for infrastructure, high bandwidth or mains powered devices
- Used with highly resourced hardware (CPU, memory) running Linux/Android/Windows

Wi-Fi for IoT is different

- Limited device resources (MCU, memory etc.)
- Low power consumption
- Cost and size constrained devices
- Challenges from crowded RF spectrum
- Wireless, networking stack integration
- Cloud connectivity to multiple cloud providers
- Security from online and physical attacks
- Coexistence and Interoperability
- Limited User Interface options



5

Wi-Fi is the ubiquitous wireless standard

- Connects wireless 'things' to the Internet
- Most effective cost basis

Massive annual deployments

- 3-4Billion units per year (includes Smartphones etc.)
- 800M are "things" (IoT type products)
- 200M are battery powered

Designed to be scalable

- High bandwidth streaming video
- Low bandwidth command/control & sensors

Compatible with all major ecosystems

• (Google, Amazon and others)

Supports all upcoming initiatives

Project Matter (formerly CHIP)

Standard Always on Wi-Fi application

Complete one minute current profile – avg current 35 mA





How the Wi-Fi Standard Allows Devices to Save Power



- Wi-Fi Client (Stations) can go to 'sleep' when they have nothing to send
- They wake up at 'Listen Interval or DTIM' intervals to check whether any data is pending for them
- They send 'PS-POLL/NULL' to the AP to retrieve their data
- They go to sleep again after retrieving all available data – enables power savings between data transfers



RS9116: Optimized Combo Wi-Fi + BT/BLE for IOT



IoT End Nodes





Ultra-Low Power Wi-Fi + BT/BLE 5 for Always-on IoT Devices

Multi-protocol Support

Wi-Fi 4 (2.4/5 GHz) Bluetooth 2.1 + EDR BLE 4.0/4.1/4.2/5.0

Ultra-Low Power

55 μA Standby Associated at 1s listen Interval 1Mbps Listen current: 14 mA Deep Sleep Current: <1 μA <8mA TX in BT5 mode at 2Mbps

Wi-Fi Radio

+20 dBm TX -98 dBm RX 20 MHz Bandwidth 1Mbps to MCS7 data rates

BT/BLE Radio

+20 dBm TX -95 dBm RX (LE) -106 dBm RX (LR) Dual mode Bluetooth 5 125 kbps to 2Mbps BLE rates

World Class Software

Transceiver and Full NCP modes Open-Source Linux driver for transceiver mode Integrated Wi-Fi, BT/BLE stack Integrated Networking stacks Cloud connectivity Support for Simplicity Studio Compact Size

7x7 mm 2.4GHz QFN (QMS IC) 4.63 x 7.9 mm 2.4GHz SiP 9.1 x 9.8 mm 2.4/5GHz SiP

Security

WPA/WPA2-Personal, WPA/WPA2 Enterprise for Client (WPA3 in roadmap)

Accelerators

AES128/256 in Embedded Mode

Certifications

FCC/IC/CE certified modules (TELEC, SSRC in roadmap) BTSIG certification Wi-Fi alliance certification (roadmap)



Power Reduction in the SoC

Power Domains



RS9116 Power Save Techniques in the Device



- Big Little Radio Design (listen/Beacon)
- Dynamic voltage scaling
- Clock Scaling
- Using low leakage cells
- Power islands
- Using DC-DC convertors



How power is further optimized at each device wake-up





Transmit Mode





Receive Mode





Listen Mode





Low Power Mode





Ultra-Low Power Mode





Handshake Mechanisms

- A Handshake mechanism means the method which is used to wake up the module(RS9116) by the host and the module giving wake-up indication to the host
- There are two Handshake Mechanisms used in RS9116:
 - GPIO Based
 - Message Based



Different Power Save Modes

Power Mode Value	Power Mode	Handshake with Host
1	Power Mode 1	No Handshake
2	Power Mode 2	GPIO Based Connected Sleep
3	Power Mode 3	Message-Based Connected Sleep
8	Power Mode 8	GPIO Based Deep Sleep(Unconnected sleep)
9	Power Mode 9	Message-Based Deep Sleep(Unconnected sleep)



Power Save Mode 3





Power Save Mode 3





Other Factors Affecting Current Consumption

- Access Point
- DTIM configured
- Distance between RS9116 and AP
- Environment
 - Density of devices
 - Traffic



Max PSP





Enhanced Max PSP



If AP is sending data within 20msec, RS911x operates in Max PSP mode.



Robust Interoperability with Routers Worldwide





- Robust secure connectivity and interoperability observed during the whole test for all 100 routers with:
 - Zero Wi-Fi disconnects
 - Zero TCP disconnects
 - 100% reception of application messages sent once every 55 seconds during the test.

Ultra-Low power consumption

- With clean channel, average of only 115uA across all 100 routers
- With 'close to saturation' channel utilization of 90% the average power consumption increases to only 364µA averaged across all 100 routers



RS9116 Evaluation Kits





- Same EVK for Transceiver and Full NCP
- All accessories and software included
 - Sample examples for reference
- Adaptor card for interfacing with EFx boards and SS v5
- OPNs for Single and Dual Band EVKs
 - Single Band (QMS): RS9116X-SB-EVK1
 - Single Band (B00): RS9116X-SB-EVK2
 - Dual Band (CC1) RS9116X-DB-EVK1



Power Measurement Setup





Wi-Fi 6 Benefits for IoT Devices



IEEE Protocol	802.11ax		
WFA Naming	Wi-Fi (CERTIFIED) 6		
Year Introduced	2019		
Band(s) (GHz)	2.4, 5, 6 (SB, DB, TB)		
Channel Bandwidth (MHz)	20, 40, 80, 160		
Allowable Streams	8		
Max Data Rates (Mbps)	143 (20MHz, 1 SS)		
	600 (80MHz, 1 SS)		
	9607 (160MHz, 8 SS)		
MIMO	Multi User (DL MU-MIMO)		
Subcarrier Spacing (KHz)	78.125		
Symbol Duration (us)	12.8		
Guard Interval (us)	0.8, 1.6 , 3.2		
PHY Modulation	DSSS, OFDM, HT-OFDM, VHT-OFDM, OFDMA		
Multi-user Operation	Uplink and Downlink OFDMA - 72 Simultaneous Users		
	Downlink MU MIMO - 8 Users (R2 adds UL MU MIMO)		
Highest Order Modulation	1024-QAM		
Power Saving Mechanisms	Target Wake Time		
Spatial Reuse Mechanisms	BSS Coloring		

Single Band Wi-Fi 6 (20 MHz BW) critical for low power IoT applications!

- Larger number of coexisting devices in dense environment (OFDMA, MU-MIMO)
- Lower power consumption due to TWT (Target Wake Time)
- Improved range (Beam forming and MU-MIMO)
- Higher connection reliability
- Wi-Fi 6 infrastructure deployments are ongoing – IoT end devices to grow significantly by 2023

Wi-Fi 6 - Advanced Power-Save for IoT – Target Wake Time (TWT)





RS9116 Benefits



Ultra-Low Power Consumption for Battery Operated Devices

- Industry leader in ultra-low-power Wi-Fi + BT/BLE 5
 - 55 µA stand-by associated current at DTIM10
- Integrated wireless stacks, networking stacks, cloud connectivity and security
 - Seamless wireless co-existence, minimize host load
- Industry leader in small form-factor certified module design (4.63 mm x 7.90 mm)
 - Perfect for small form-factor devices
- Integration with Silicon Labs' MCU/Wireless solutions, Simplicity Studio v5 (SSv5)
 - Simplified Development Experience





Q&A



Continue Discussion in Our Community!

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How to Navigate:

- "Products" to troubleshooting forums
- "Applications" to discuss IoT
- "Share" to view example projects and existing groups
- "Blogs" to view and discuss thoughts from our specialists

community.silabs.com





WEBINAR

Bluetooth: The Latest Bluetooth Low Energy Updates in GSDK 4.0

APRIL 19 | 10 AM CDT



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Thank You