Welcome to the final Tech Talk of the series!

tech talks

Tuesday, June 14	Wi-Fi: Coexistence with RS9116

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We will begin in: 0:00

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Welcome

Wi-Fi: Coexistence with RS9116

Rich Lysaght

Agenda

- **WiFi Portfolio Overview**
- **RS9116 Overview**
- **Coexistence**
  - Unmanaged
    - Separating channel frequencies
    - Separating radio locations
  - Managed
    - Packet Traffic Arbitration - PTA
  - RS9116 PTA Setup
    - Configuration Bits
    - Pin Usage
- **Demonstration: PTA Usage between RS9116 and EFR32**

The Leader in IoT Wireless Connectivity

100%
IoT Focused

Bluetooth · Multiprotocol · Proprietary
Thread · Wi-Fi · Wi-SUN · zigbee
Z-Wave · amazon sidewalk · matter

Breadth and Depth of Wireless IoT Protocols

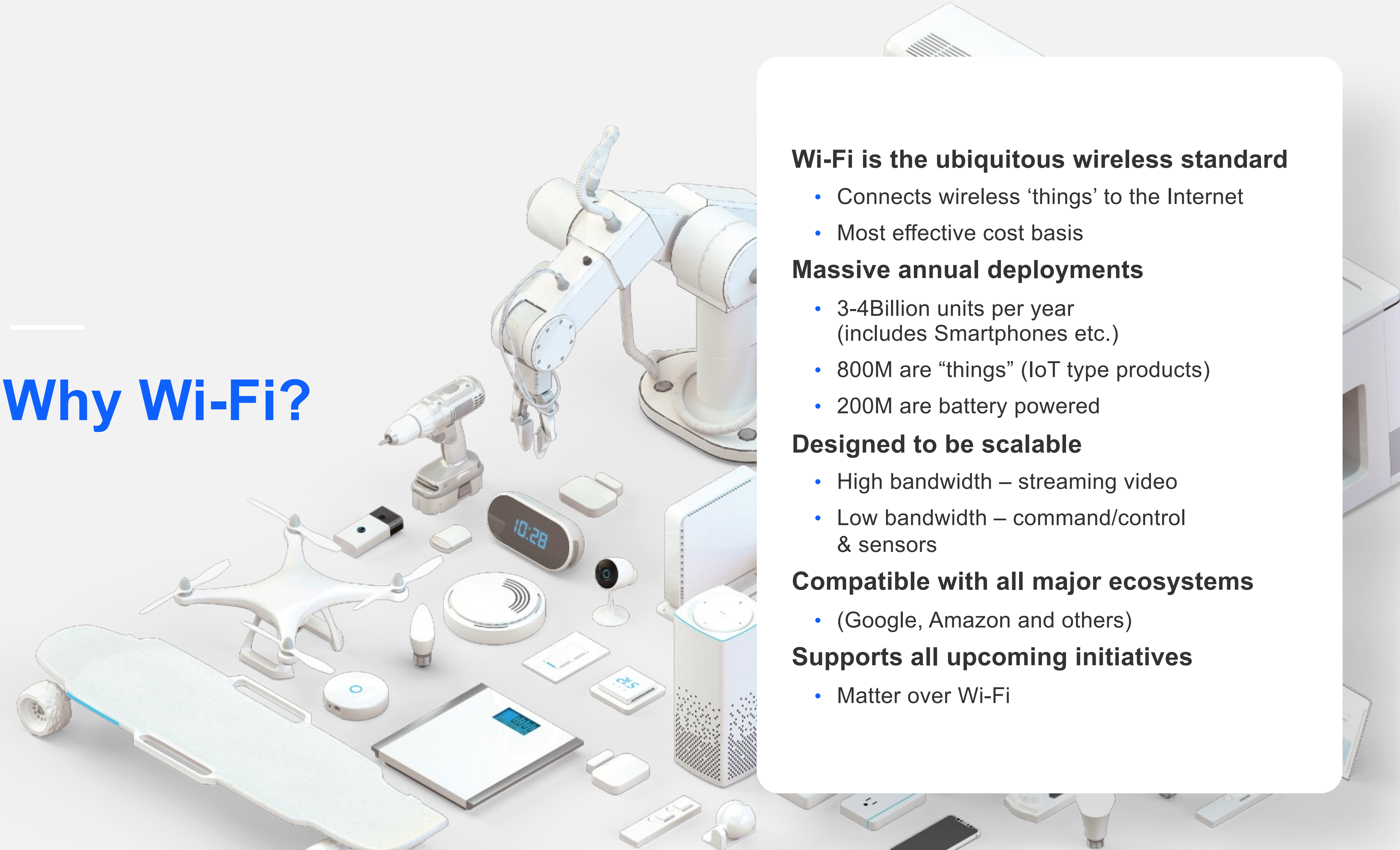
#1
Share in Mesh

1st
To Market with Multiprotocol, BLE Mesh, BLE 5.1

Innovation
Performance, Power, CoEx, Modules, Secure Vault™

ember	2012	Software ZigBee SoC
Energy Micro	2013	Low-power 32-bit MCUs
bluegiga	2015	BT Smart Modules
telegesis	2015	ZigBee/Thread Modules
Micrium	2016	Software RTOS
ZENTRI	2017	Cloud Connected Wi-Fi
Z-Wave	2018	Smart Home Protocol
Redpine Signals	2020	Ultra Low Power Wi-Fi

Why Wi-Fi?



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
- Matter over Wi-Fi

Wi-Fi IoT Device Requirements

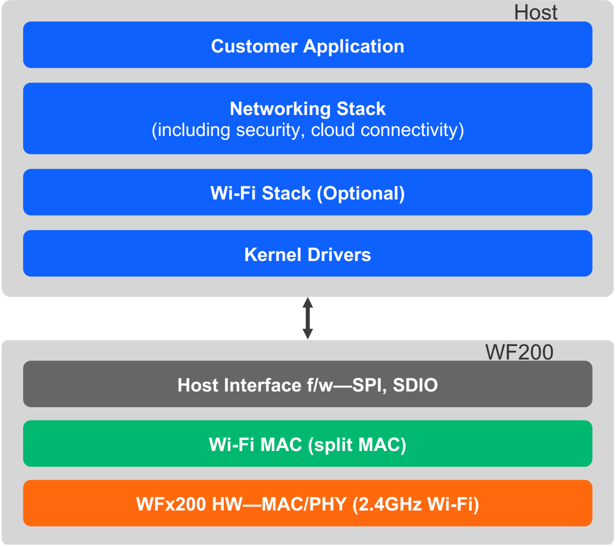
- **Traditional Wi-Fi is not well suited for IoT**
  - Meant for infrastructure, high bandwidth or mains powered devices
  - Used with highly resourced hardware (CPU, memory) running Linux/Android/Windows
- **Wi-Fi for IoT is different**
  - Limited device resources (MCU, memory etc.)
  - Low power consumption
  - 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

Wi-Fi Product Family

TRANSCEIVER SOCs & MODULES

NETWORK CO-PROCESSOR (NCP) SOCS & MODULES

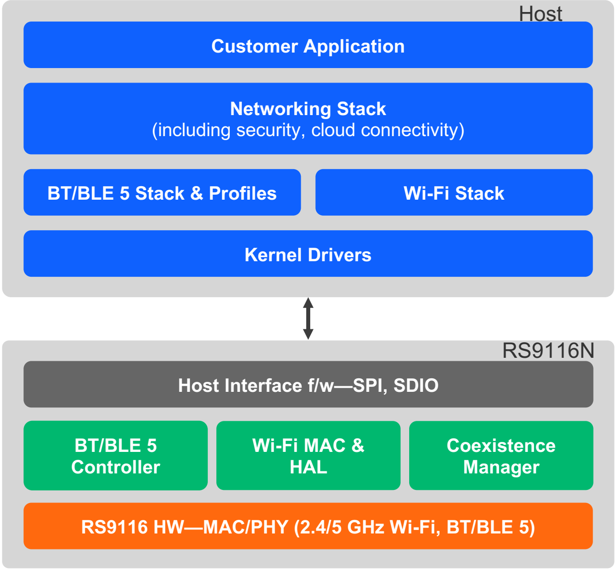
WF200/WFM200S



2.4 GHz Wi-Fi

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

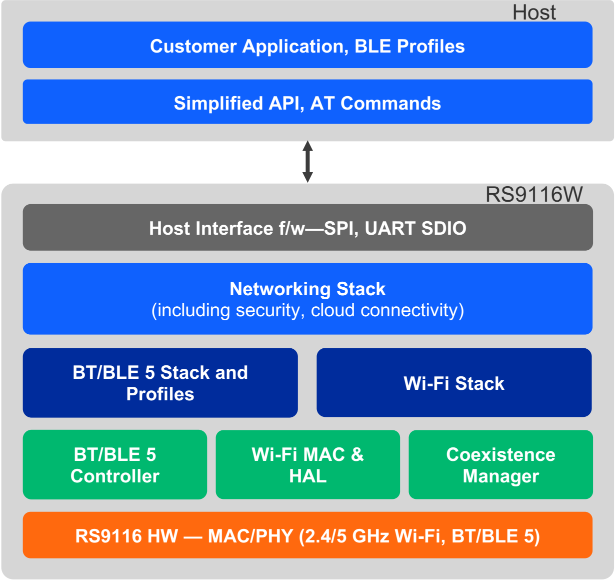
RS9116 N-LINK



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

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

RS9116 WISECONNECT

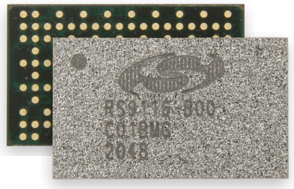


2.4/5 GHz Wi-Fi + BT + BLE 5

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

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

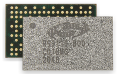
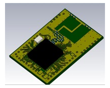
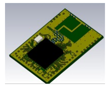
Compact Size
7x7 mm 2.4GHz QFN (QMS IC)
4.63 x 7.9 mm 2.4GHz SiP
9.1 x 9.8 mm 2.4/5GHz SiP

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)

RS9116 Supported IC and Module Packages

	 QMS IC	 B00 Module	 RS916 AC0 Module*	 RS916 AC1 Module*	 CC0 Module	 CC1 Module
Package	QFN 84 pin	LGA 126	LGA 71	LGA 71	LGA 173	LGA 107
Size	7 x 7 x 0.85 mm	4.63 x 7.9 x 0.9 mm	16 x 21.1 x 2.3 mm	16 x 21.1 x 2.3 mm	9.1 x 9.8 x 1.2 mm	15 x 15 .7 x 2.2 mm
Format	SoC	SiP	PCB Module	PCB Module	SIP	PCB Module
Focus Market	Home, Industrial	Wearables	Home, Industrial	Home, Industrial	Industrial, Medical, Home	Industrial, Medical, Home
Wi-Fi Support	B/G/N	B/G/N	B/G/N	B/G/N	A/B/G/N	A/B/G/N
Bluetooth Support	5.0 (BT + BLE)	5.0 (BT + BLE)	5.0 (BT + BLE)	5.0 (BT + BLE)	5.0 (BT + BLE)	5.0 (BT + BLE)
Antenna	No	No	No (RF Pads)	Yes (PCB)	No	Yes (PCB & u.FL)
Temperature Range	-40 °C to +85 °C	-40 °C to +85 °C	-40 °C to +85 °C	-40 °C to +85 °C	-40 °C to +85 °C	-40 °C to +85 °C
Regulatory Certifications**	N/A	FCC, IC, CE, TELEC	Q3' 2022	Q3' 2022	FCC, IC, CE, TELEC	FCC, IC, CE, TELEC
Compliance Certifications	BTSIG	BTSIG	BTSIG	BTSIG	BTSIG	BTSIG
	Single Band (2.4GHz)				Dual Band (2.4/5GHz)	

(*) New - Under Development
(**) SRRC for modules are being planned

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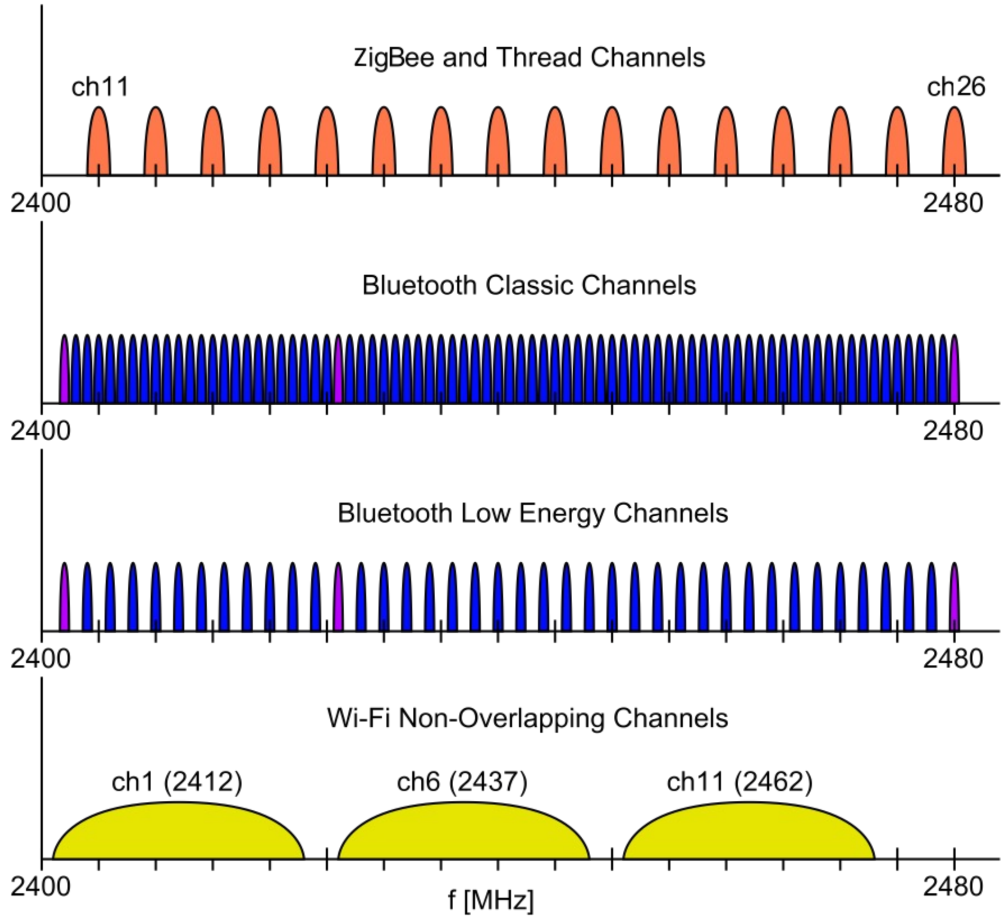
Coexistence

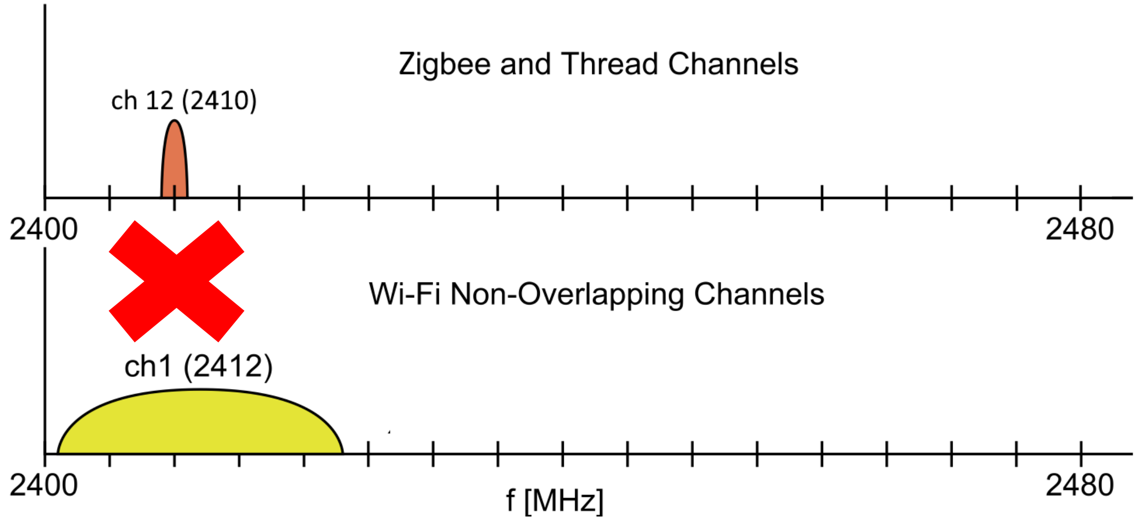
2.4GHz ISM Band Coexistence Challenge

- Several wireless protocols chare the same 2.4GHz ISM Band: Wi-Fi, Bluetooth Classic, BLE, Zigbee and Thread
- These wireless protocols have different modulation schemes, channel frequencies and bandwidth
- When different ISM bands are co-located, the modulation schemes may overlap
- Signals intended for one modulation scheme will look like noise to another protocol
- If the desired receive signal is weaker than the “noise” received from co-located radio, messages could be interfered with and end up not being received as intended.



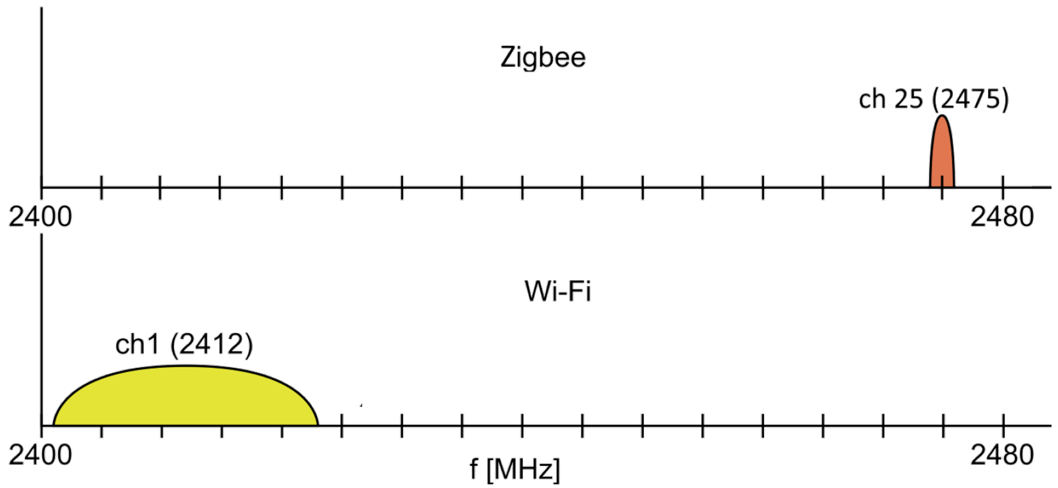
Coexistence Impact: Co-Channel Example

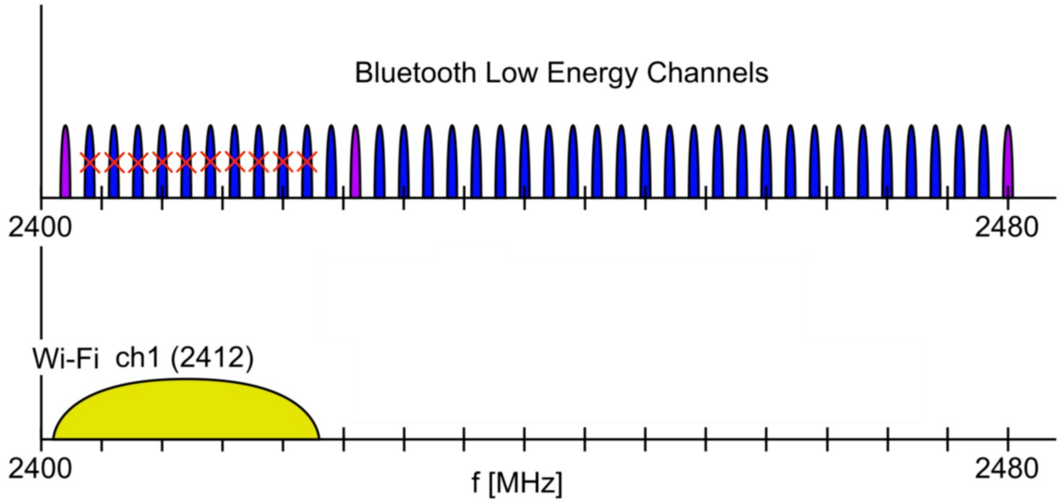
- In this example Zigbee channel 12 is co-channel with Wi-Fi channel 1.
- The Zigbee channel would be blocked if the co-channel Wi-Fi signal is stronger at the Zigbee receiver than the signal being received from a remote Zigbee device
- Zigbee uses CCA (Clear Channel Assessment to test the channel prior to transmitting. The transmit would be blocked if energy is detected > -75dBm (per 802.15.4 spec).



Improving Coexistence: Unmanaged

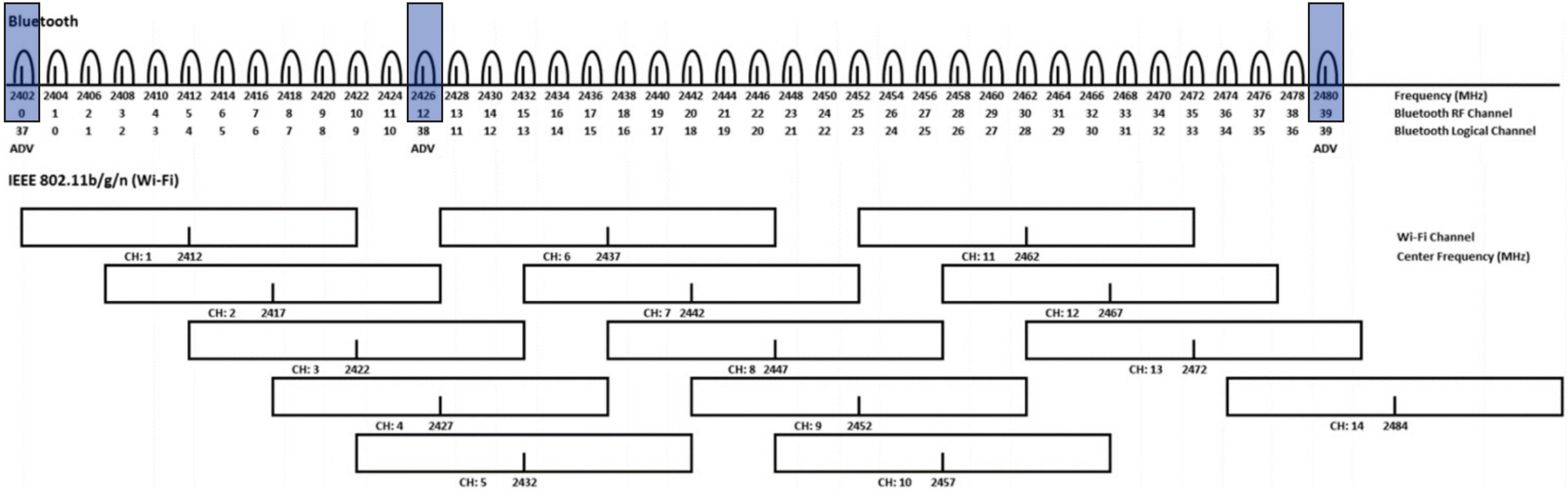
- Frequency Separations
  - Zigbee – select channels as far away from 2.4GHz Wi-Fi channel as possible
  - Bluetooth Low Energy – Advertisements/Beacons occur on three channels (seen here is purple). The low, mid and high advertising frequencies tend to squeeze in between the most frequently used Wi-Fi channels (Wi-Fi Channels 1, 6 & 11)
- Antenna Isolation
  - Provide as much isolation between IoT and 2.4GHz Wi-Fi antennas as possible
- Use 20MHz Wi-Fi bandwidth (avoid 40MHz)
- Rely on protocol retry mechanisms





Improving Coexistence: Unmanaged (continued)

- Wi-Fi (IEEE 802.11b/g/n) supports 14 overlapping 20/22MHz bandwidth channels with transmit powers up to +30dBm
- BLE supports 40 non-overlapping channels at 2MHz spacing with transmit powers up to +20dBm.
- BLE Beaconing occurs on 3 advertising channels (channels 37, 38 & 39). The channels are located at 2402MHz, 2426 MHz & 2480MHz



FCC Co-Location Testing Policy

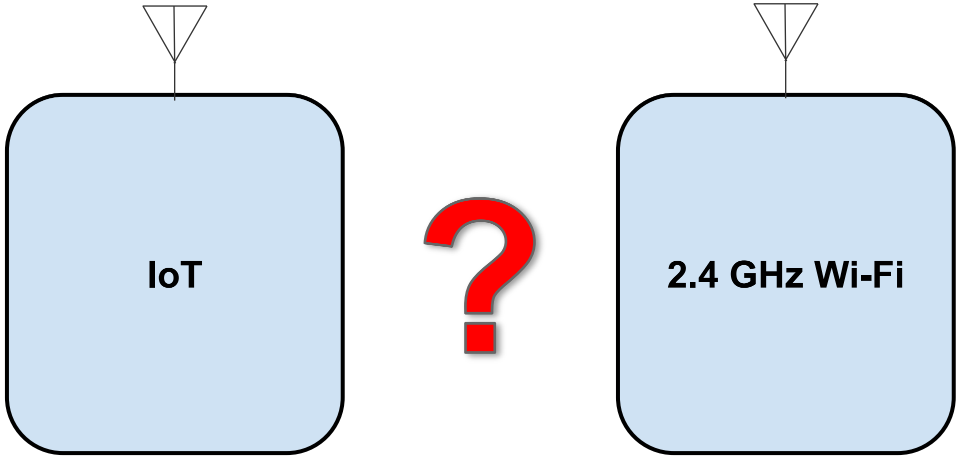
EMC Co-Location Testing Policy

- Policy for EMC evaluation of co-located independent transmitters in a single enclosure (e.g. laptop, handheld). This does not apply to multi-radio systems with coordinated transmitters (e.g. beam forming systems, multi-sector radio systems).
- Simultaneous transmission data (radiated and antenna conducted) is required to be submitted only when the devices can transmit simultaneously and share a common antenna.
- The grantee is still responsible for compliance, even though we no longer require simultaneous transmission data to be submitted, (except for above exception).
- When a co-located, independent and non-coordinated transmitter is added, the evaluation of RF exposure conditions may still be required along with a filing of a Class II Permissive change request. However, no additional EMC test data need to be submitted.

Coexistence with PTA

Improving Coexistence: Managed

- Goals of Managed Coexistence
  - Separate the two radio's activities in time
  - This requires coordination between the radios
- Is there an easy way for the different radios sharing the 2.4GHz band within a single product to communicate and coordinate their communications?



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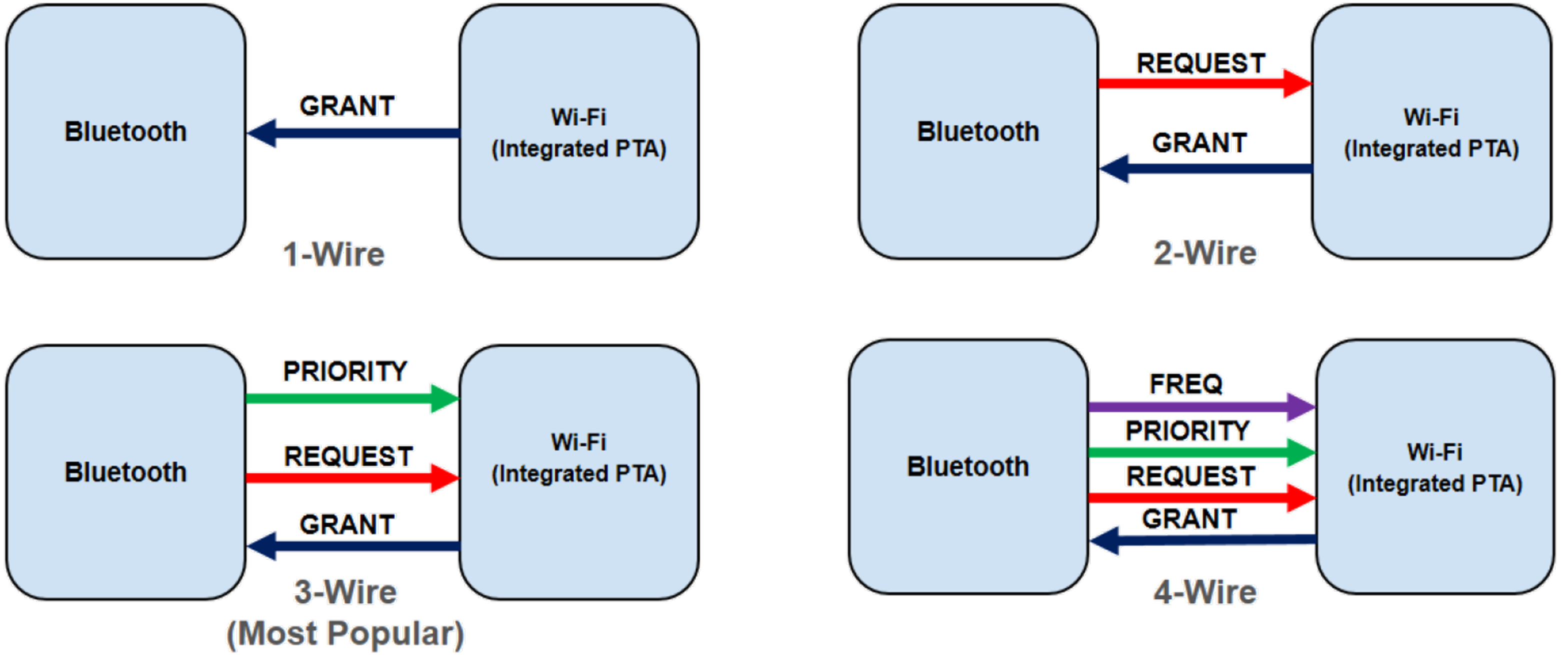
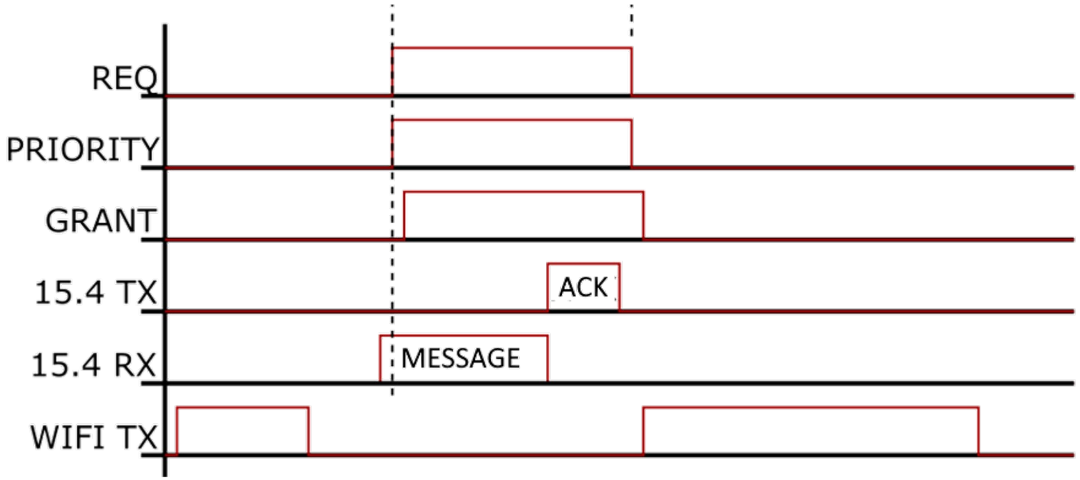
Managed Coexistence: Packet Traffic Arbitration

- Packet Traffic Arbitration aka “PTA” is a means for allowing collocated radios a means to arbitrate and choose which radio can transmit at any given time.
- This was originally created managed coexistence between Bluetooth Classic and Wi-Fi devices
- There are four different wiring schemes used by PTA (see below).
- The 3-wire PTA tends to be the most popular.



Packet Traffic Arbitration Basics

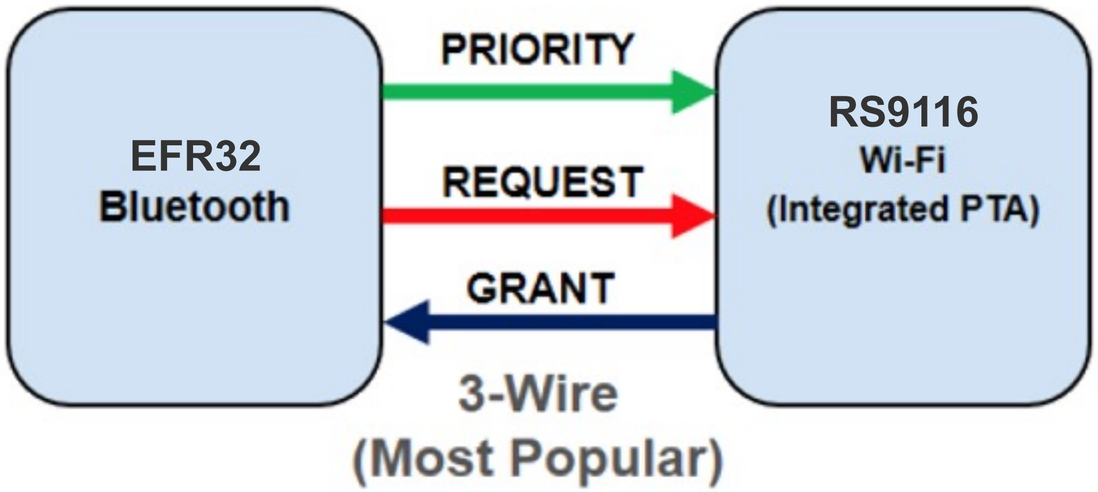
- IoT device asserts REQUEST and optionally asserts the PRIORITY signal
- If the Wi-Fi device can grant airtime, it asserts the GRANT signal back to the IoT device
- The Wi-Fi device is expected to stop transmitting prior to asserting GRANT signal and is expected not to begin a new transmission while GRANT is asserted.
- When the IoT transaction is completed, the IoT device de-asserts REQUEST and the Wi-Fi device follows by de-asserting GRANT.



RS9116 PTA Setup

Managed Coexistence: RS9116 Uses 3-Wire PTA

- RS9116 Uses a 3-Wire PTA Scheme
- In this case, EFR32 BLE device will REQUEST permission to transmit and assert a PRIORITY
- The RS9116 will GRANT permission for EFR32 to transmit.
- Configuration bits in the RS9116 govern how aggressively permission is GRANTED.



Managed Coexistence: RS9116 PTA Configurations

- To use PTA with the RS9116, Bit 21 in the **config_feature_bit_map** enables 3-Wire PTA.
- Bits 22 & 23 determine the configuration of the 3-Wire PTA
- Bit 31 in **ext_txp_ip_feature_bit_map** must be set to enable **config_feature_bit_map** settings.
- https://docs.silabs.com/rs9116-wiseconnect/latest/wifibt-wc-sapi-reference/opermode#rsi-config-feature-bitmap

BIT 23	BIT 22	Config
0	0	Reserved
0	1	Config 1
1	0	Config 2
1	1	Config 3

Managed Coexistence: RS9116 PTA Configurations (continued)

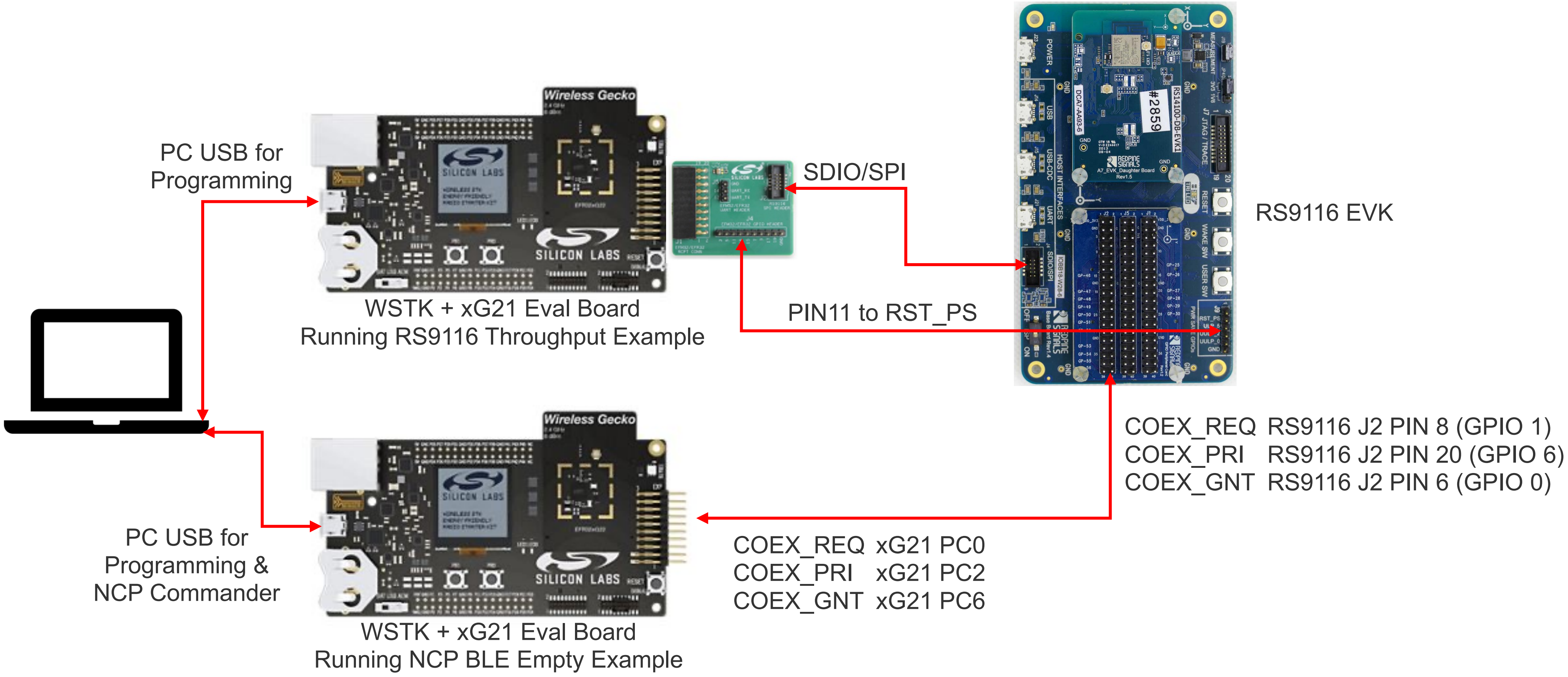
PTA Config	Description
Config 1	PTA Master will aggressively assert GRANT if the REQUEST is asserted irrespective of PRIORITY being asserted or not. This will mean anything ongoing transmission on Wi-Fi will be aborted and GRANT will be provided to the PTA slave.
Config 2	PTA Master will aggressively assert GRANT if the REQUEST is asserted irrespective of PRIORITY being asserted or not, with only one exception of an ongoing ACK/Block ACK Transmission in response to a Wi-Fi reception. In case there is an ongoing ACK/Block ACK transmission in response to a Wi-Fi Reception, PTA MASTER will GRANT access if PRIORITY is asserted along with REQUEST.
Config 3	If there is an ongoing Wi-Fi Transmission (Including ACK/BLOCK ACK) then PTA MASTER will not assert GRANT to an asserted REQUEST. However, if PRIORITY and REQUEST both are asserted then PTA MASTER will assert GRANT.

Managed Coexistence: RS9116 PTA GPIO

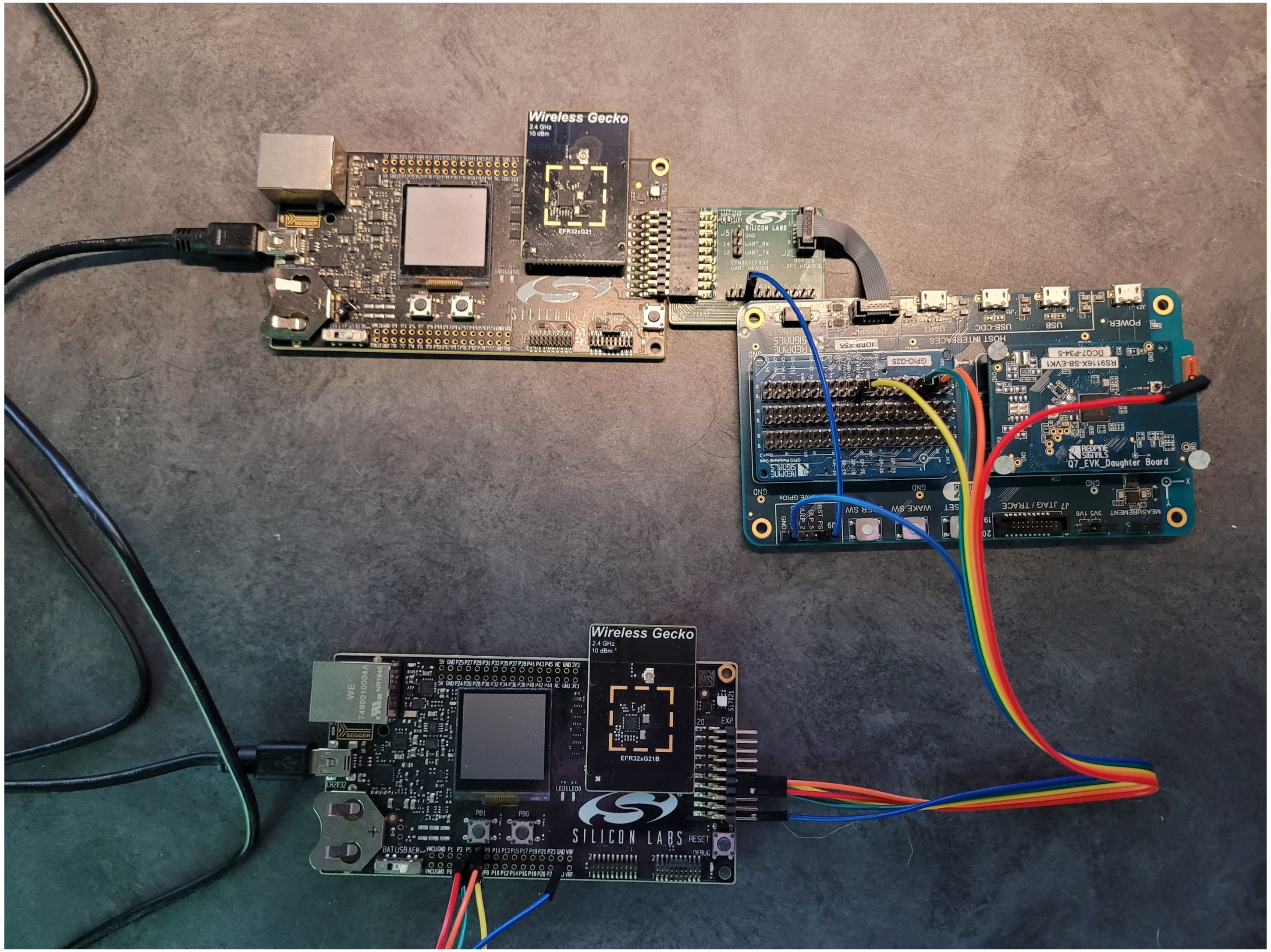
Pin Description	RS9116 GPIO Pin	EVK Peripheral Card	EFR32 Pin
REQUEST	ULP_GPIO_1	J2 – PIN 8	Programmable
PRIORITY	ULP_GPIO_6	J2 – PIN 20	Programmable
GRANT	ULP_GPIO_0	J2 – PIN 6	Programmable

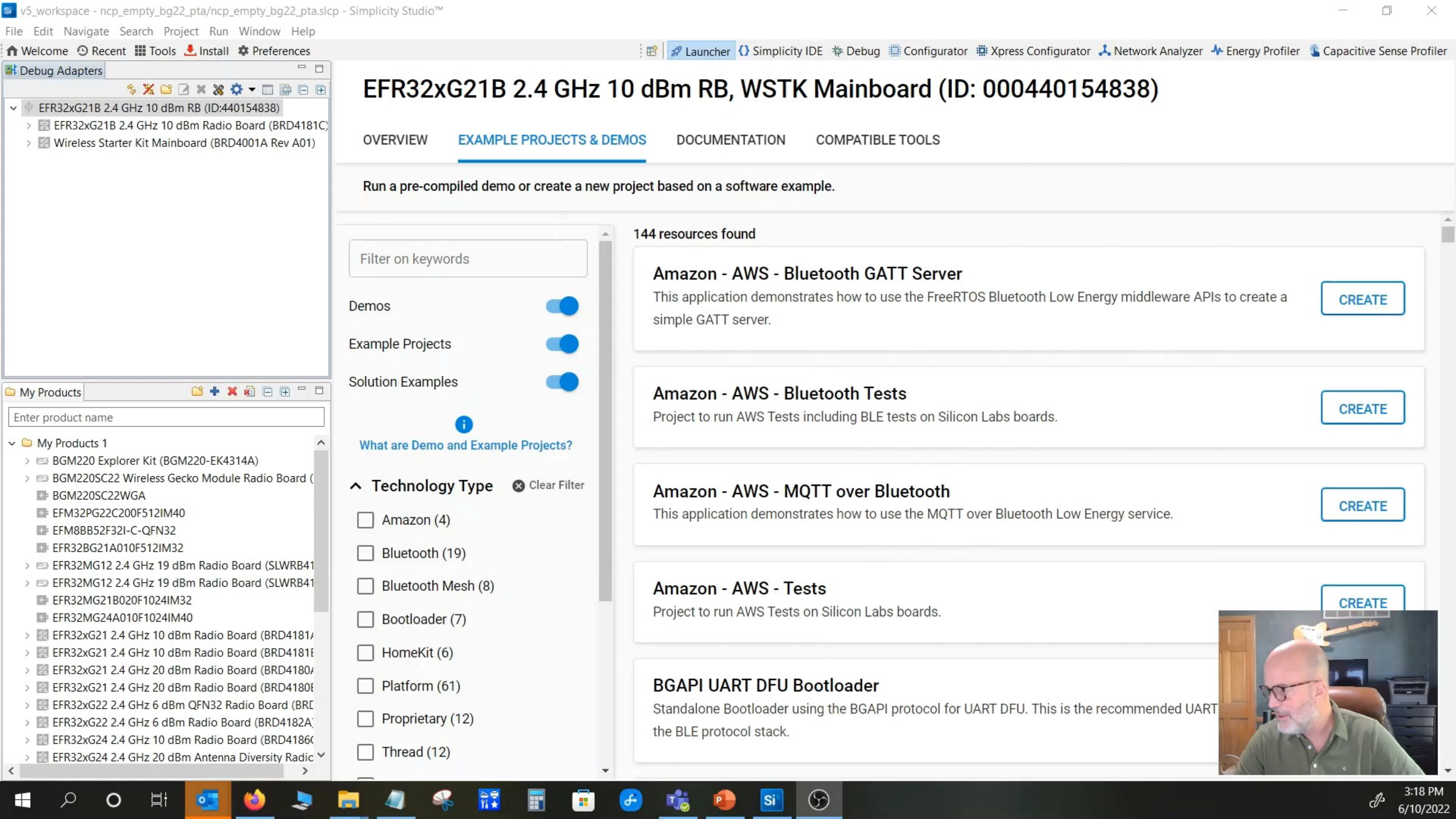
PTA Demo

Demo: PTA Block Diagram

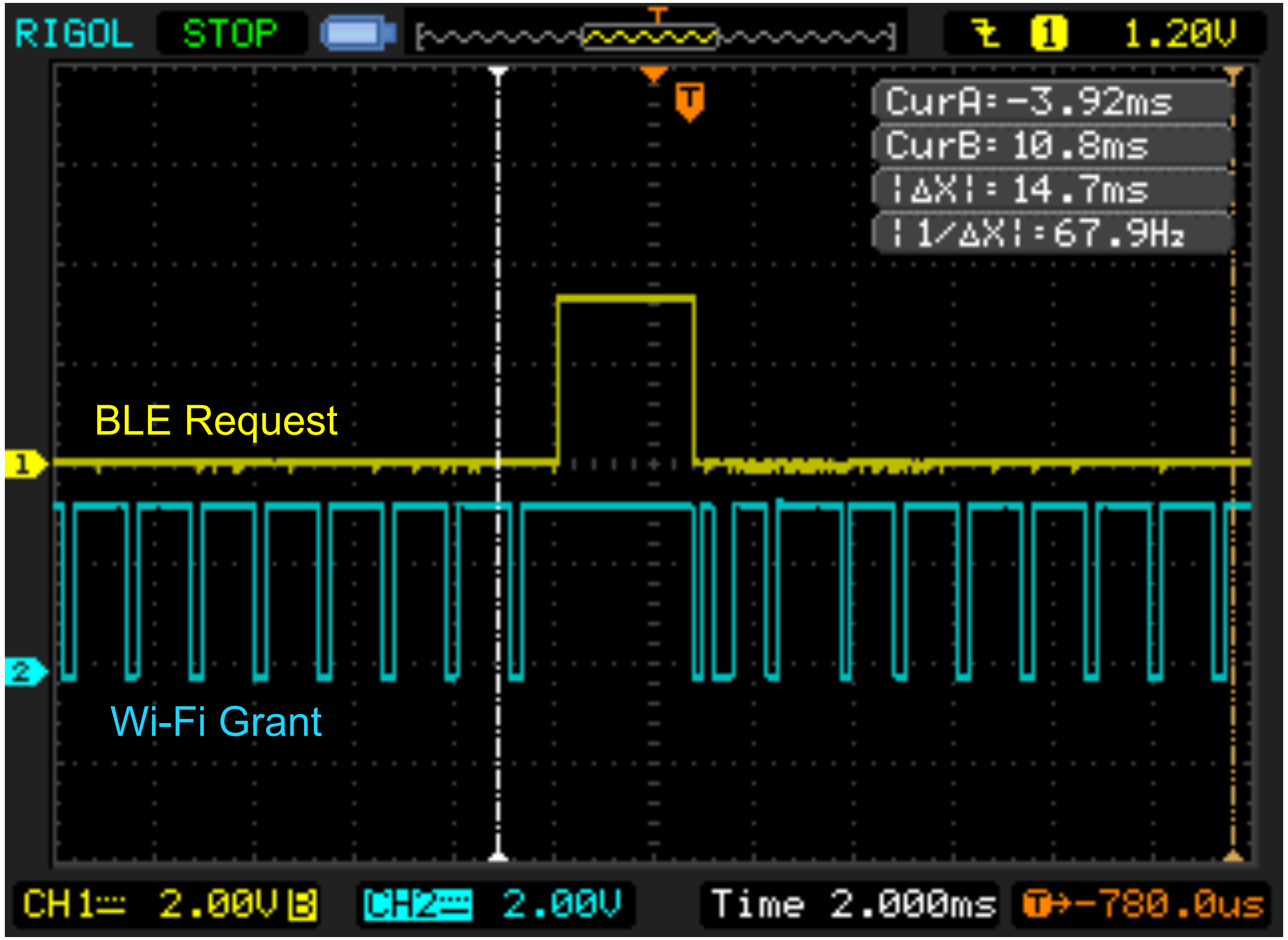


Demo: PTA Actual Demo Picture




v5_workspace - ncp_empty_bg22_pta/ncp_empty_bg22_pta.slcp - Simplicity Studio™
File Edit Navigate Search Project Run Window Help
Welcome Recent Tools Install Preferences
Launcher Simplicity IDE Debug Configurator Xpress Configurator Network Analyzer Energy Profiler Capacitive Sense Profiler
Debug Adapters
EFR32xG21B 2.4 GHz 10 dBm RB (ID:440154838)
EFR32xG21B 2.4 GHz 10 dBm Radio Board (BRD4181C)
Wireless Starter Kit Mainboard (BRD4001A Rev A01)
My Products
Enter product name
My Products 1
BGM220 Explorer Kit (BGM220-EK4314A)
BGM220SC22 Wireless Gecko Module Radio Board (
BGM220SC22WGA
EFM32PG22C200F512IM40
EFM8BB52F32I-C-QFN32
EFR32BG21A010F512IM32
EFR32MG12 2.4 GHz 19 dBm Radio Board (SLWRB41
EFR32MG12 2.4 GHz 19 dBm Radio Board (SLWRB41
EFR32MG21B020F1024IM32
EFR32MG24A010F1024IM40
EFR32xG21 2.4 GHz 10 dBm Radio Board (BRD4181
EFR32xG21 2.4 GHz 10 dBm Radio Board (BRD4181
EFR32xG21 2.4 GHz 20 dBm Radio Board (BRD4180
EFR32xG21 2.4 GHz 20 dBm Radio Board (BRD4180
EFR32xG22 2.4 GHz 6 dBm QFN32 Radio Board (BRD
EFR32xG22 2.4 GHz 6 dBm Radio Board (BRD4182A
EFR32xG24 2.4 GHz 10 dBm Radio Board (BRD4186
EFR32xG24 2.4 GHz 20 dBm Antenna Diversity Radio
EFR32xG21B 2.4 GHz 10 dBm RB, WSTK Mainboard (ID: 000440154838)
OVERVIEW
EXAMPLE PROJECTS & DEMOS
DOCUMENTATION
COMPATIBLE TOOLS
Run a pre-compiled demo or create a new project based on a software example.
Filter on keywords
Demos
Example Projects
Solution Examples
What are Demo and Example Projects?
Technology Type
Clear Filter
Amazon (4)
Bluetooth (19)
Bluetooth Mesh (8)
Bootloader (7)
HomeKit (6)
Platform (61)
Proprietary (12)
Thread (12)
144 resources found
Amazon - AWS - Bluetooth GATT Server
This application demonstrates how to use the FreeRTOS Bluetooth Low Energy middleware APIs to create a simple GATT server.
CREATE
Amazon - AWS - Bluetooth Tests
Project to run AWS Tests including BLE tests on Silicon Labs boards.
CREATE
Amazon - AWS - MQTT over Bluetooth
This application demonstrates how to use the MQTT over Bluetooth Low Energy service.
CREATE
Amazon - AWS - Tests
Project to run AWS Tests on Silicon Labs boards.
CREATE
BGAPI UART DFU Bootloader
Standalone Bootloader using the BGAPI protocol for UART DFU. This is the recommended UART
the BLE protocol stack.
3:18 PM
6/10/2022

Demo: Oscilloscope Capture



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References

- **Silicon Labs Wi-Fi Solutions:** https://www.silabs.com/wireless/wi-fi
- **RS9116 Wi-Fi Transceiver Modules:** https://www.silabs.com/wireless/wi-fi/rs9116-wi-fi-transceiver-modules
- **Wireless Coexistence Tech Talk:** https://www.silabs.com/support/training/wireless-coexistence
- **RS9116 Feature Bitmap:** https://docs.silabs.com/rs9116-wiseconnect/latest/wifibt-wc-sapi-reference/opermode#rsi-config-feature-bitmap
- **FCC Basics of Unlicensed Transmitters:** https://transition.fcc.gov/oet/ea/presentations/files/oct07/Oct_07-Basics_of_Unlicensed_Trans-JD.pdf

Thank You

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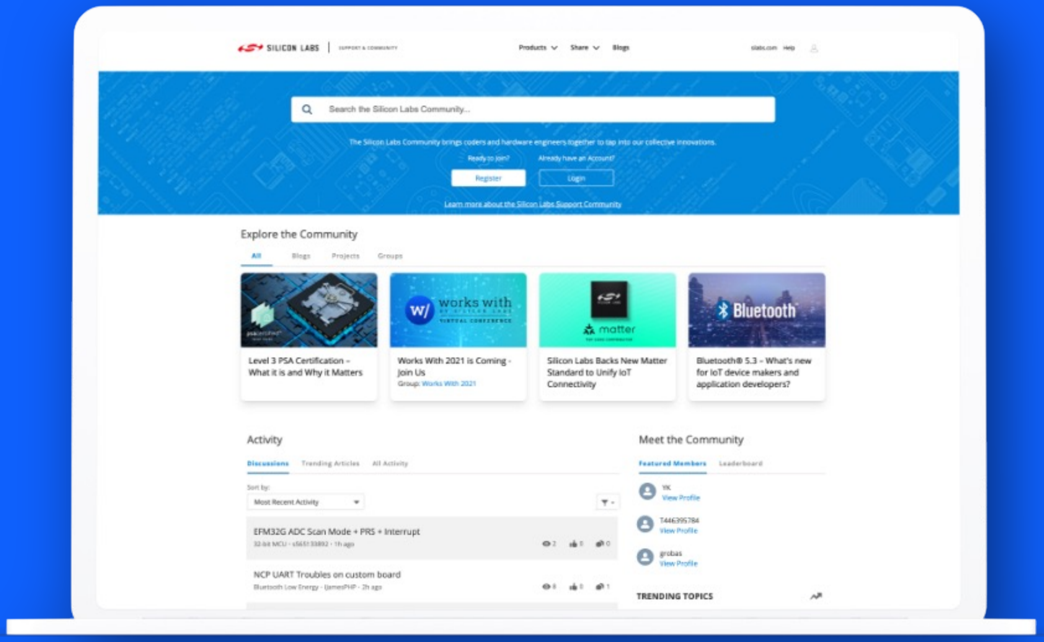
Q&A

Continue Discussion in Our Community!



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- “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

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Proprietary Sub-GHz: Leaping RF Performance and Improving Low Power Performance with FG23	**February 22, 2022**
Wi-Fi: Developing with Matter over Wi-Fi on the RS9116	**March 8, 2022**
Z-Wave: Unboxing the New 800 Series	**March 22, 2022**
Wi-Fi: Optimizing Battery Life with Low-power Wi-Fi on the RS9116	**April 5, 2022**
Bluetooth: The Latest Bluetooth Low Energy Updates in GSDK 4.0	**April 19, 2022**
Matter: Developing with Matter on the MG24	**May 3, 2022**
AI/ML: Bringing Intelligence to the Edge on the MG24	**May 17, 2022**
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Wi-Fi: Coexistence with RS9116	**June 14, 2022**

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