

# 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: **0:00**



# Welcome

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

Ryan Orton

# Agenda

April 5<sup>th</sup>, 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



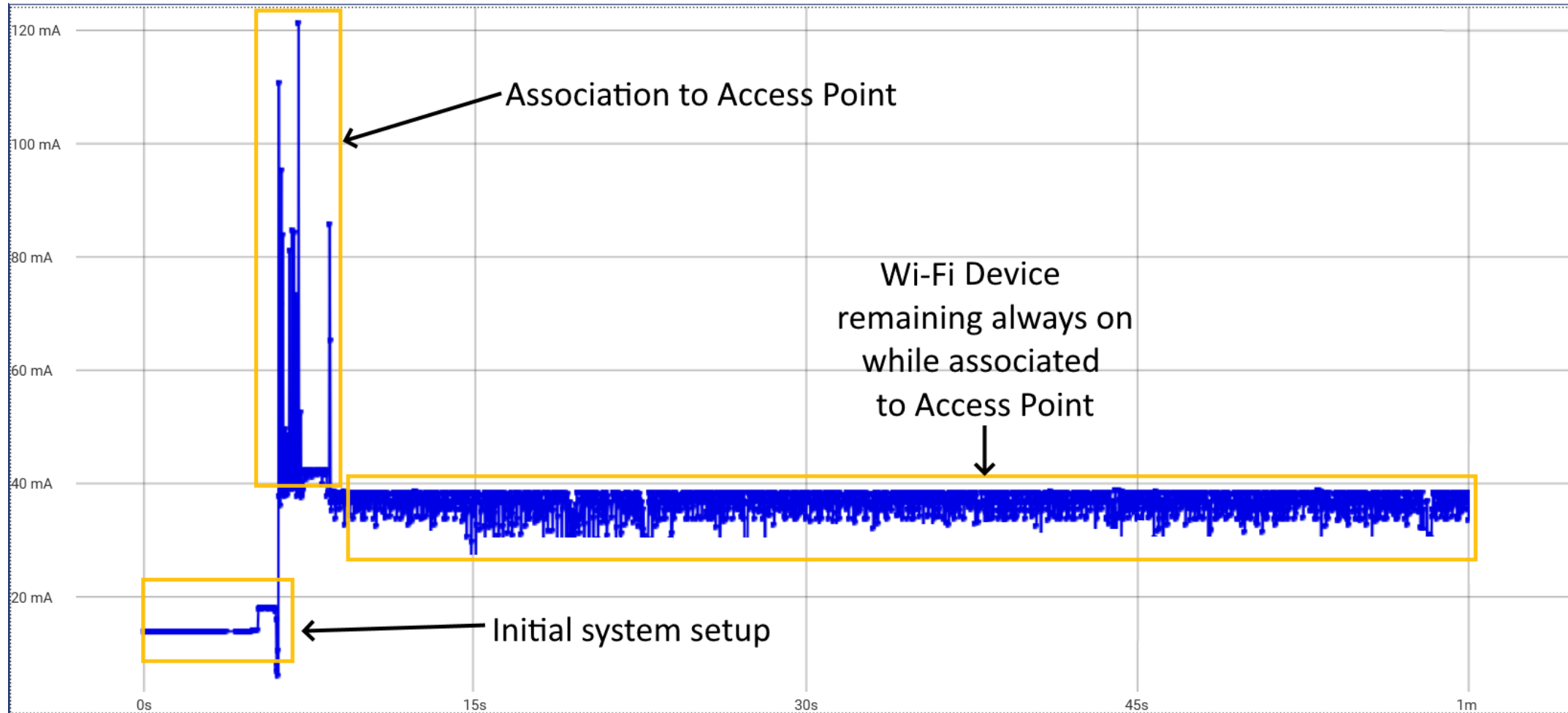
- **Traditional Wi-Fi is not well suited for IoT**
  - Meant for infrastructure, high bandwidth or mains powered devices
  - Used with highly resourced hardware (CPU, memory) running Linux/Android/Windows
- **Wi-Fi for IoT is different**
  - Limited device resources (MCU, memory etc.)
  - Low power consumption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



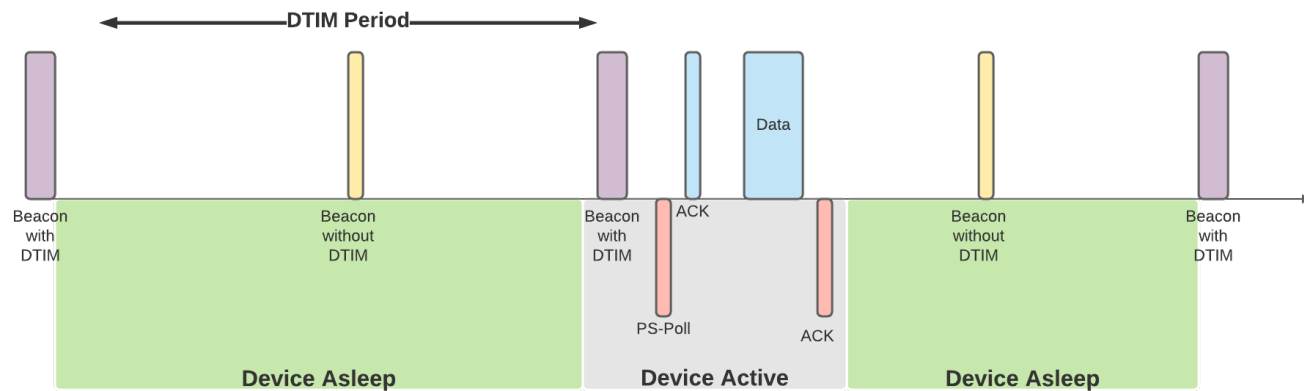


# Standard Always on Wi-Fi application

- Complete one minute current profile – avg current 35 mA

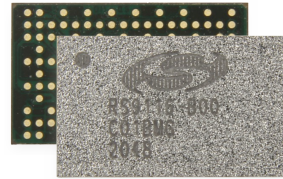


# How the Wi-Fi Standard Allows Devices to Save Power



- 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

## 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  $\mu$ A Standby Associated at 1s listen Interval  
1Mbps Listen current: 14 mA  
Deep Sleep Current: <1  $\mu$ A  
<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

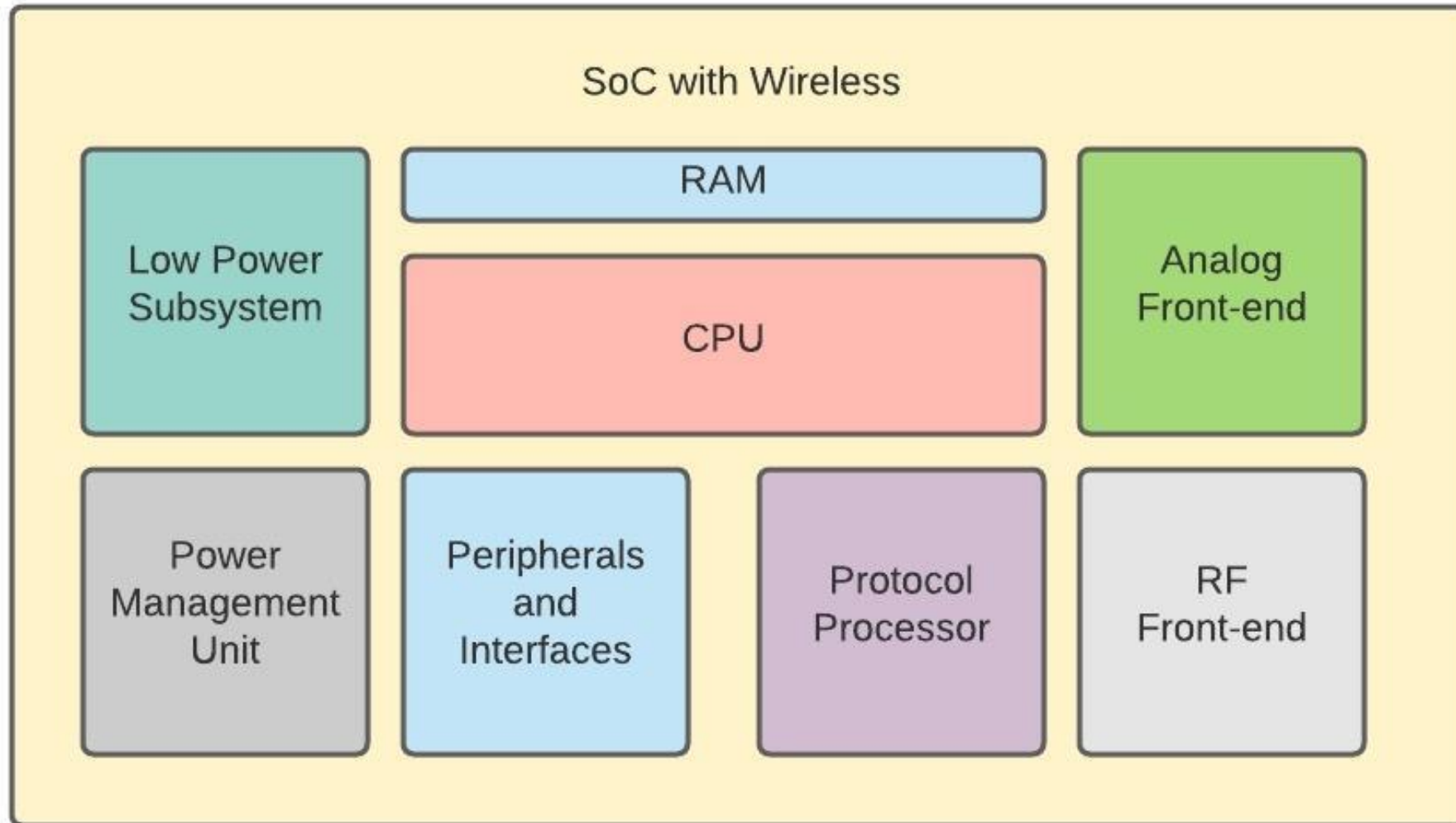
#### Certifications

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

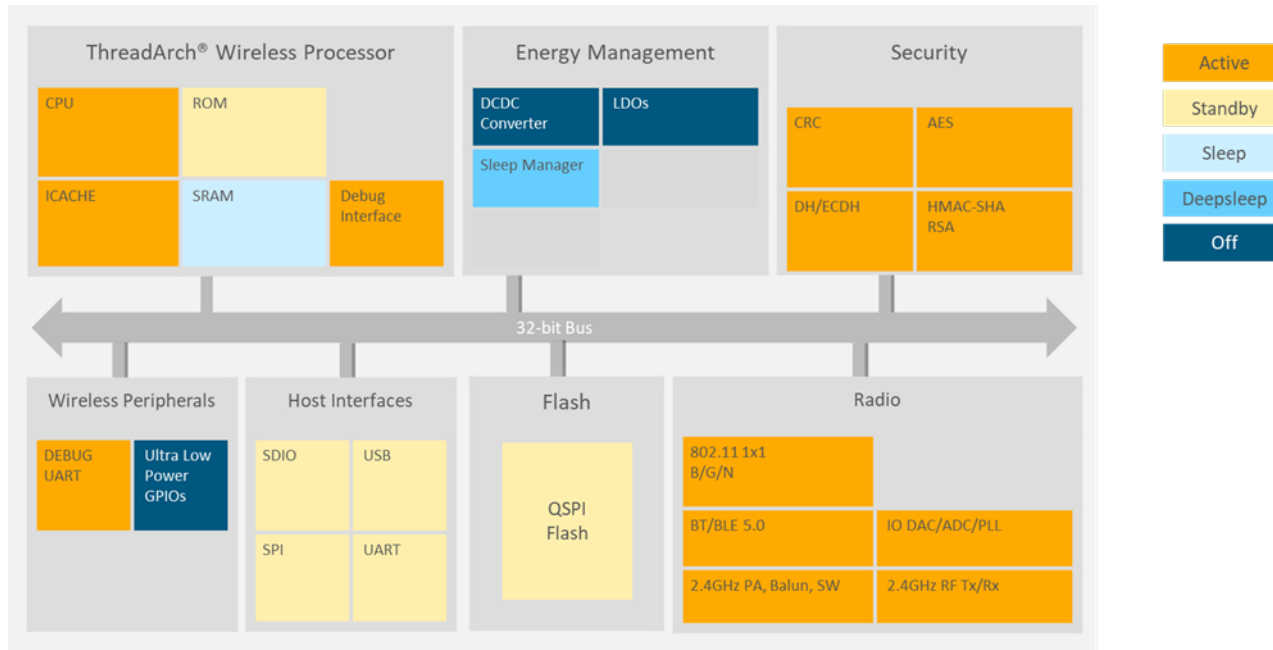


# Power Reduction in the SoC

## Power Domains

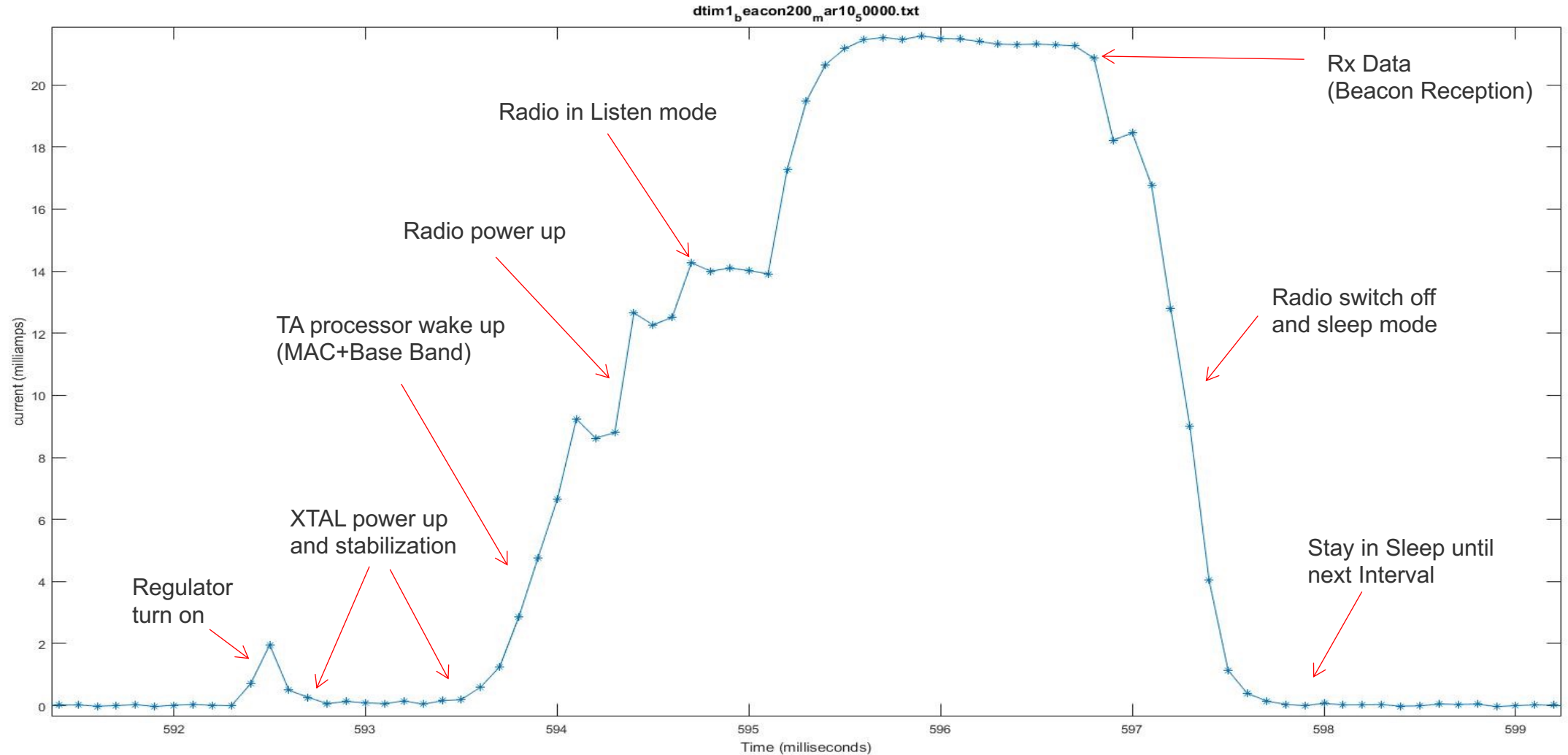


# RS9116 Power Save Techniques in the Device

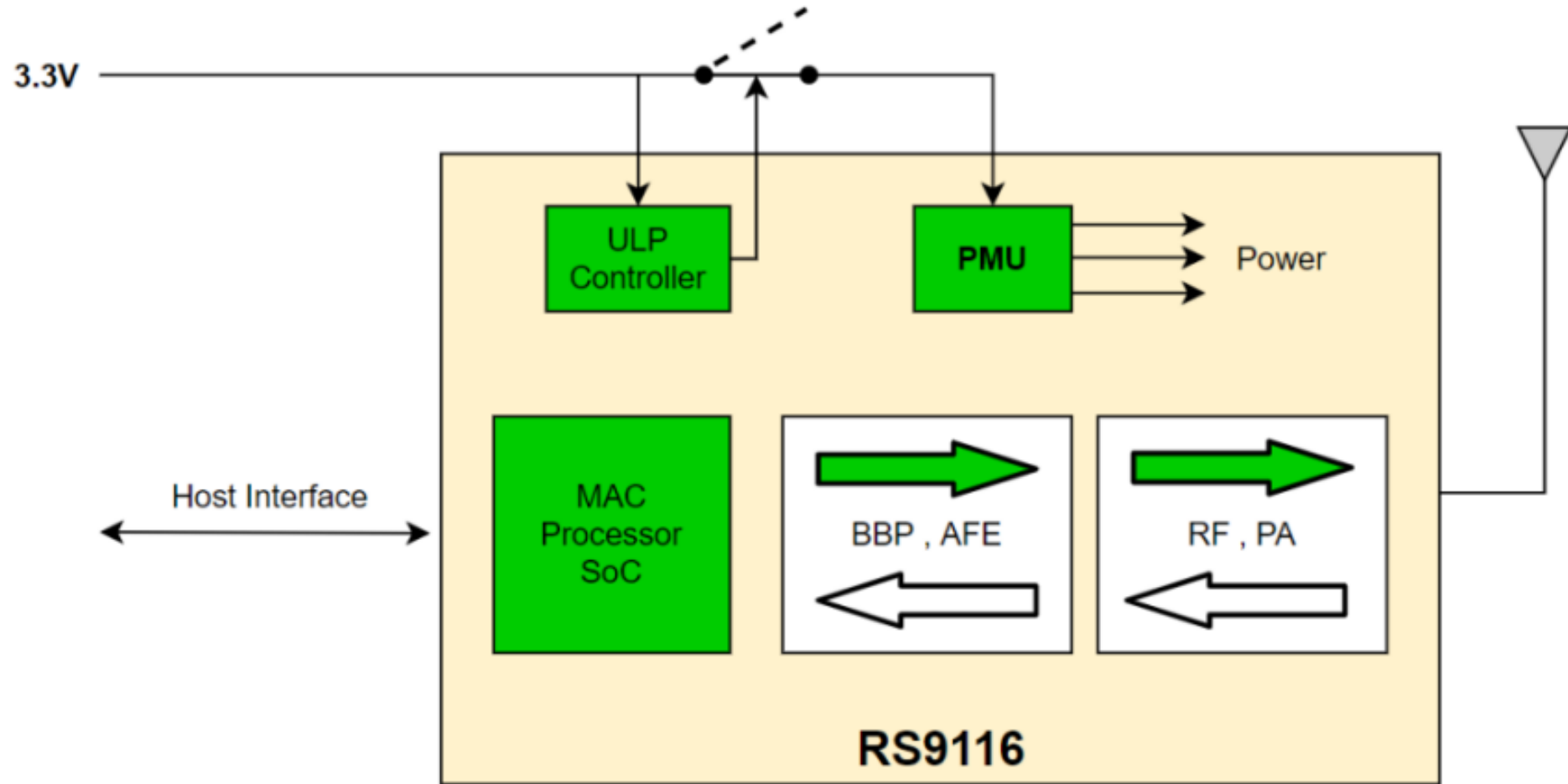


- **Big Little Radio Design (listen/Beacon)**
- **Dynamic voltage scaling**
- **Clock Scaling**
- **Using low leakage cells**
- **Power islands**
- **Using DC-DC convertors**

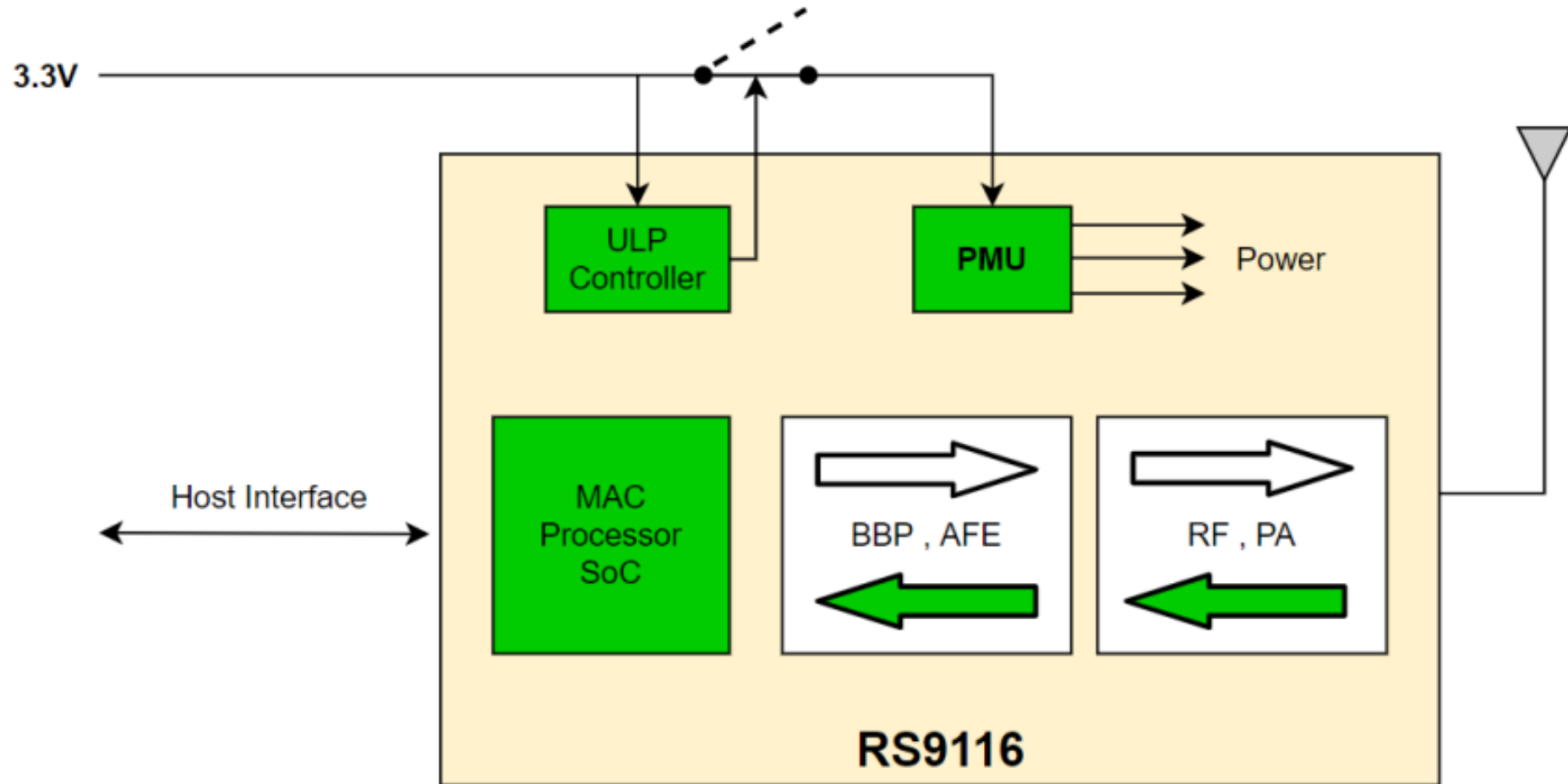
# How power is further optimized at each device wake-up



# Transmit Mode

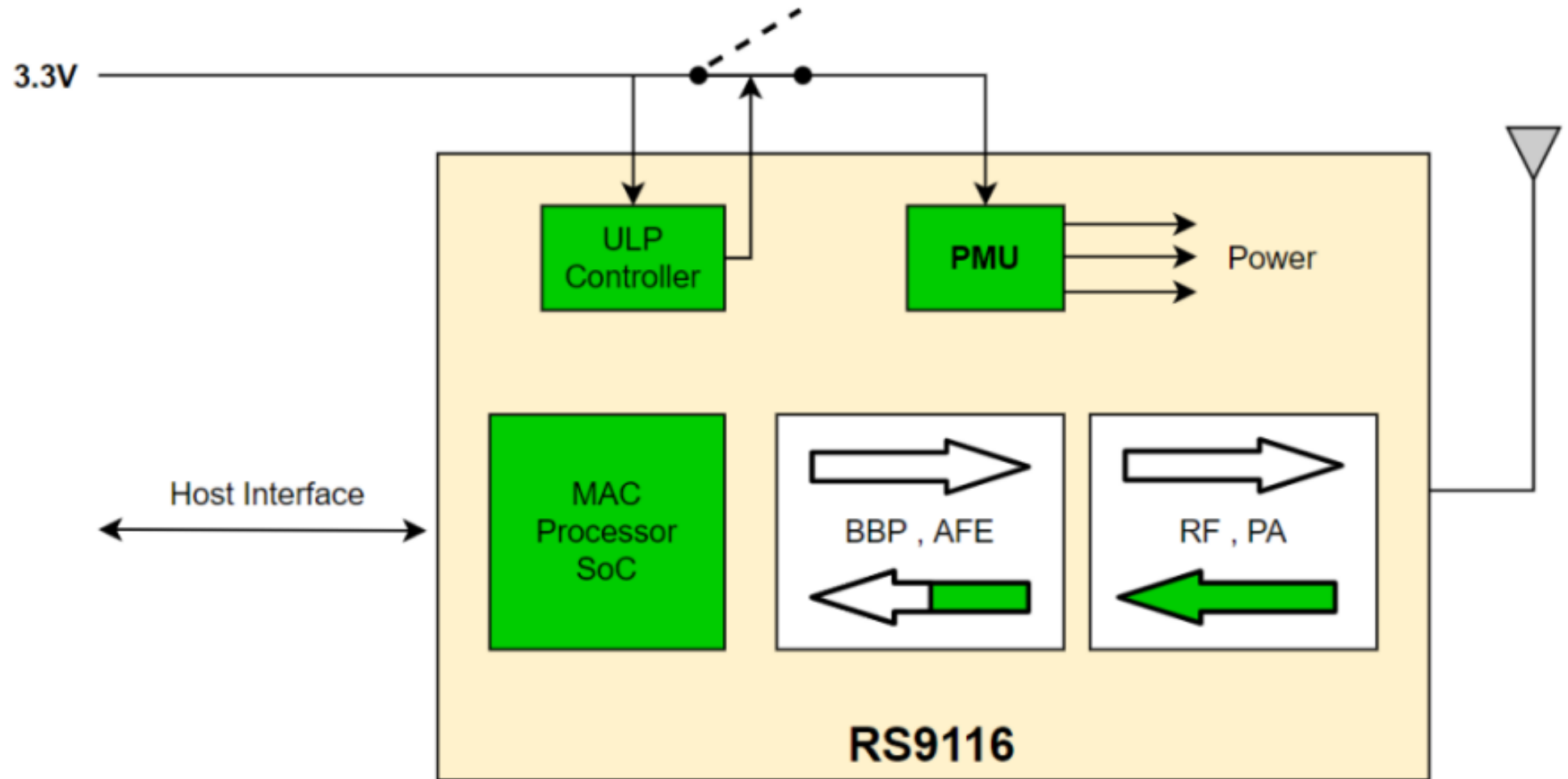


# Receive Mode

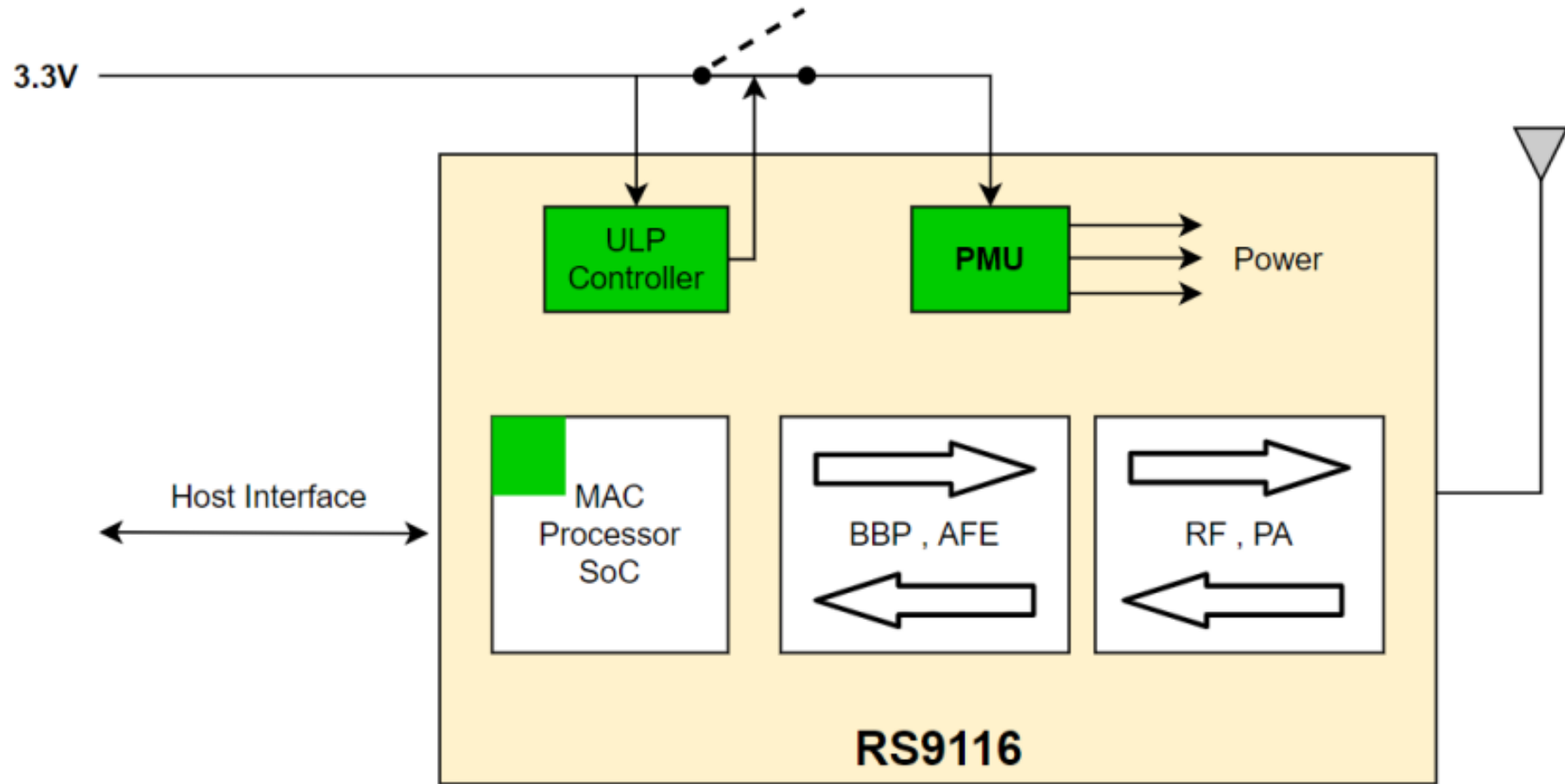




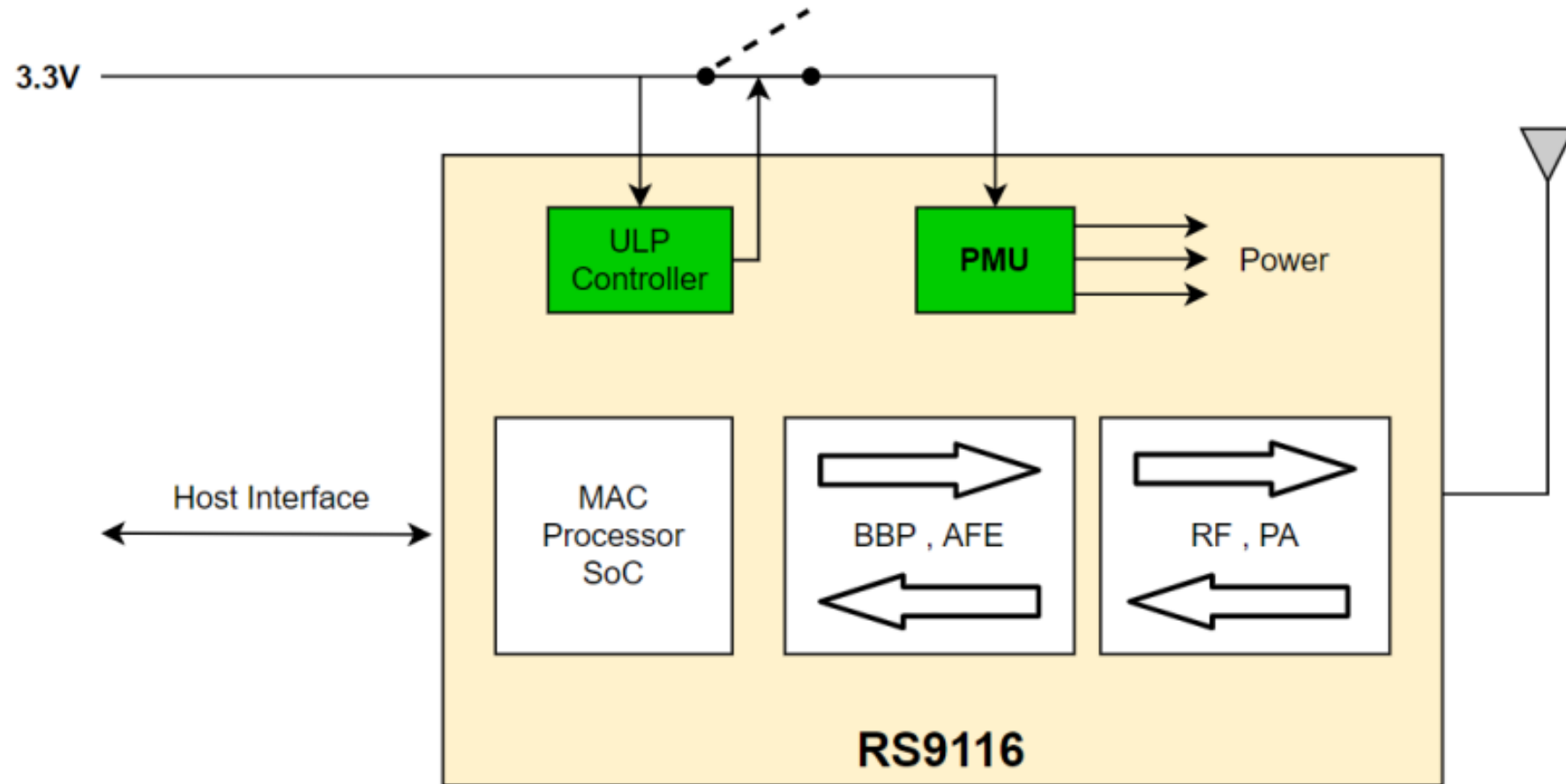
# Listen Mode



# 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

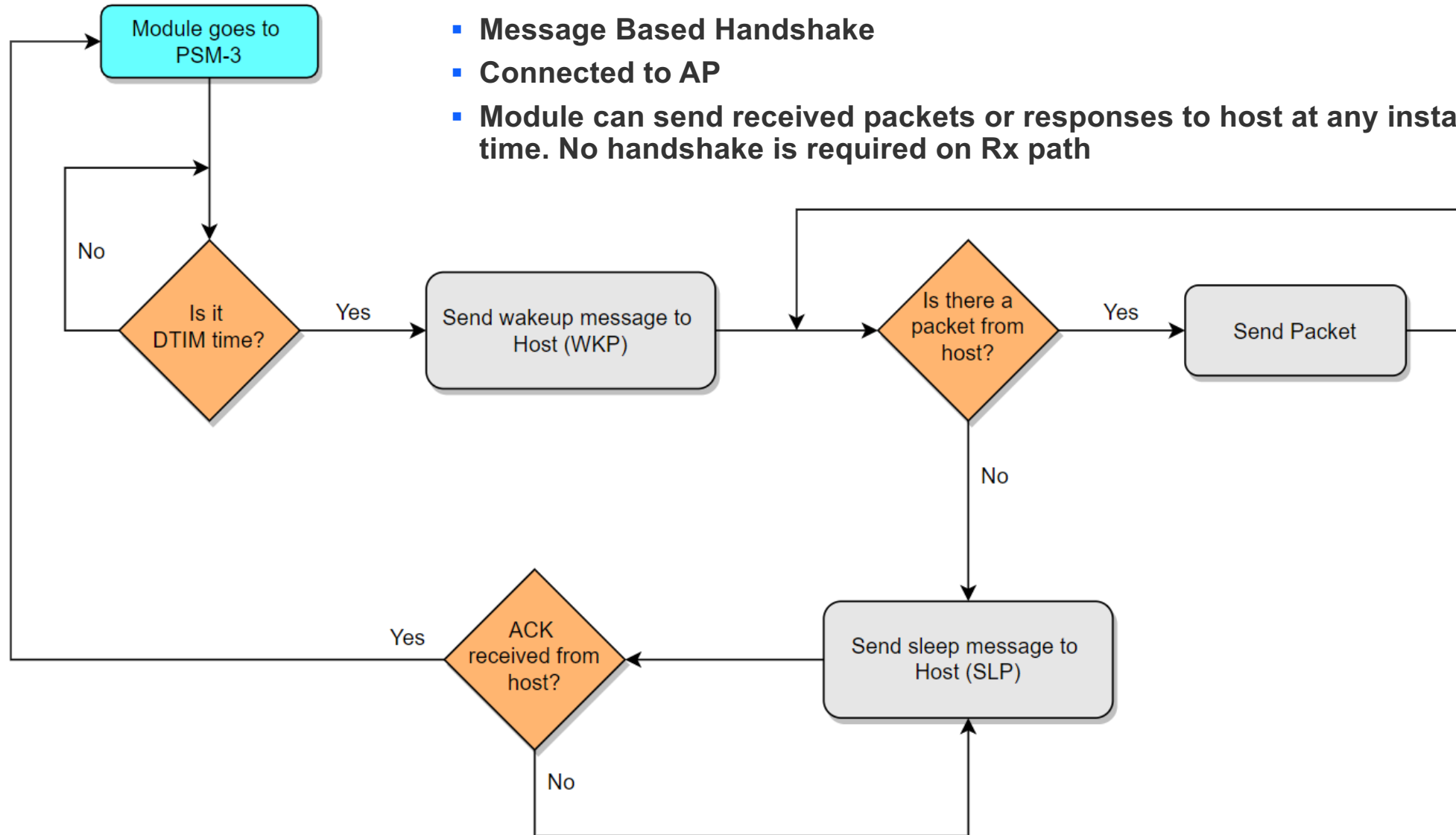
## Different Power Save Modes

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)

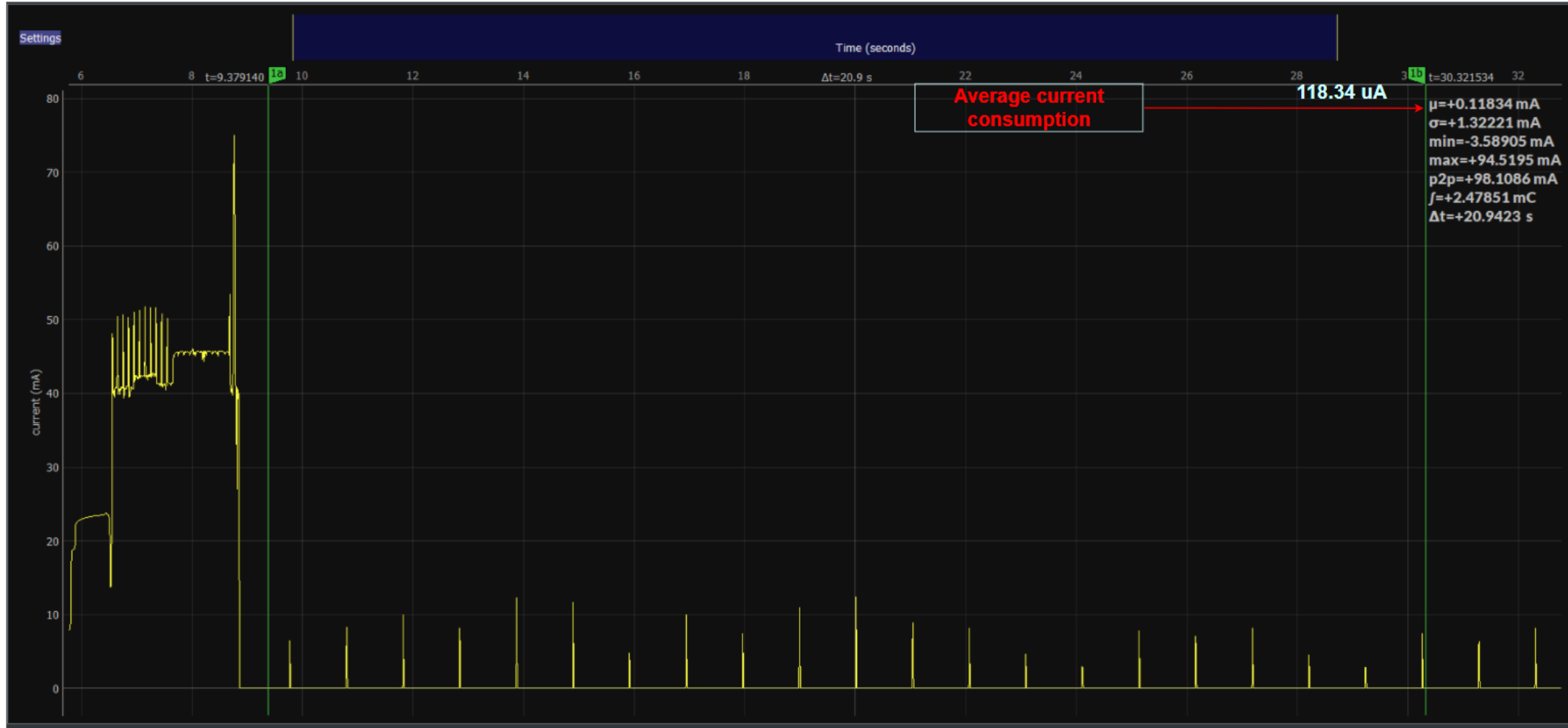


# Power Save Mode 3

- **Message Based Handshake**
- **Connected to AP**
- **Module can send received packets or responses to host at any instant of time. No handshake is required on Rx path**



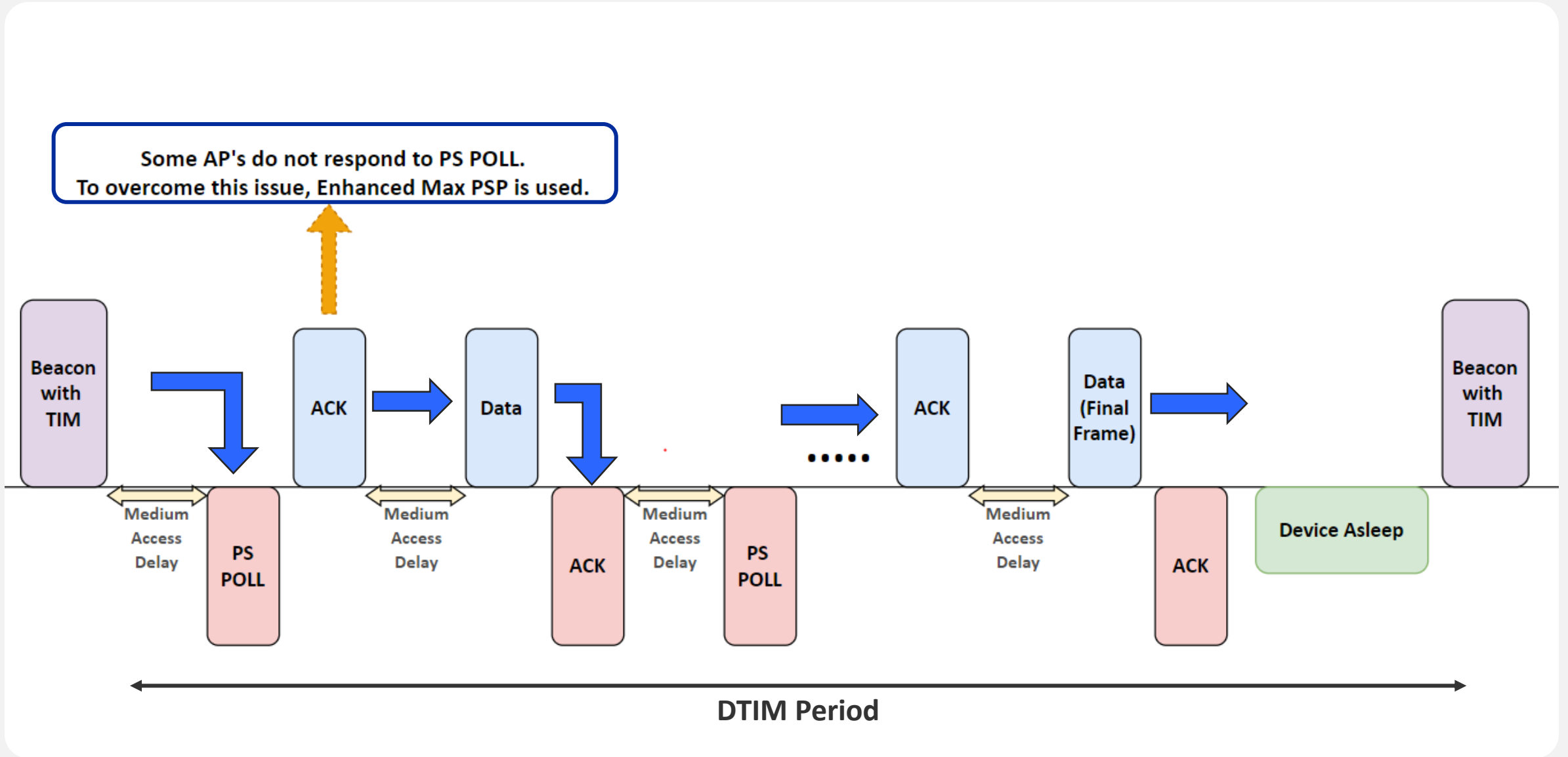
# Power Save Mode 3



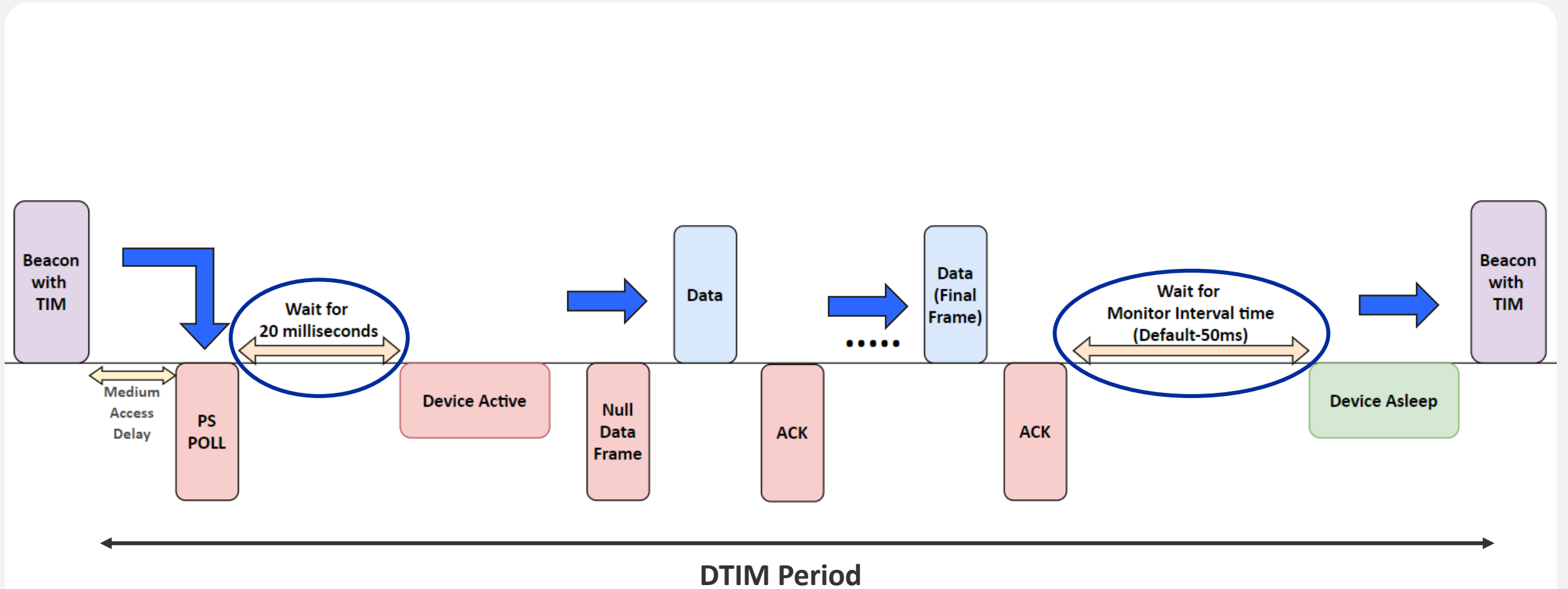
# Other Factors Affecting Current Consumption

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

# Max PSP



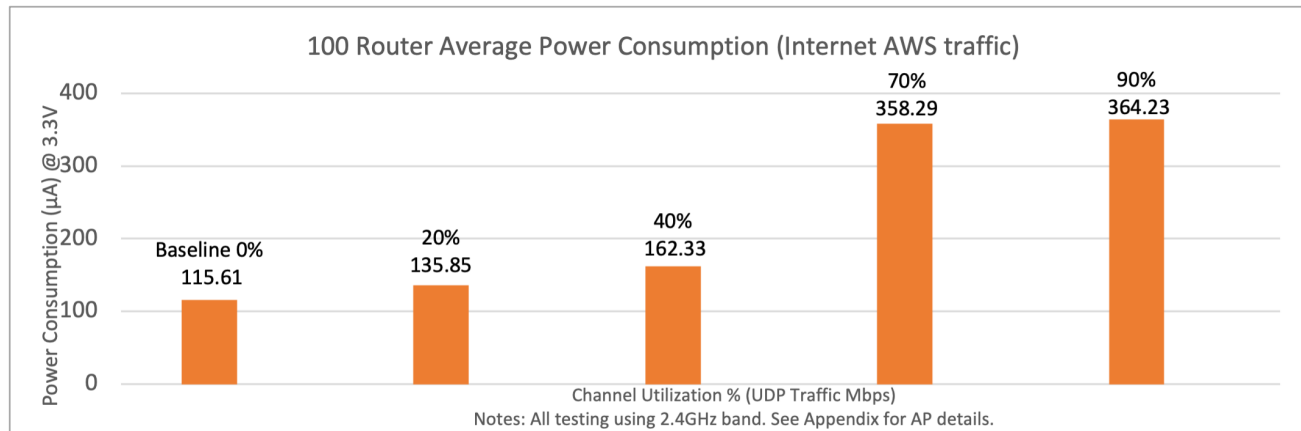
# Enhanced Max PSP



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

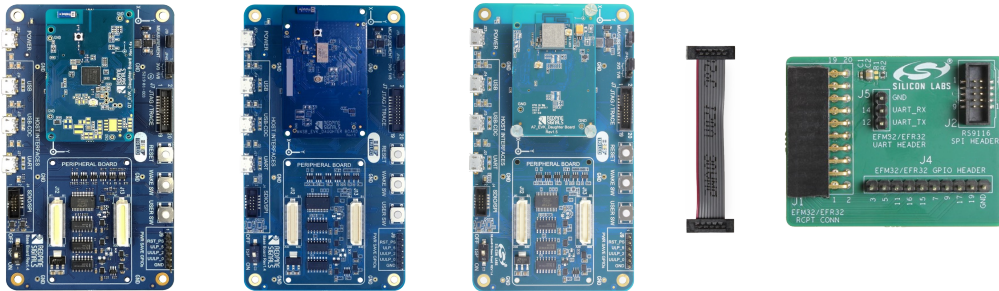
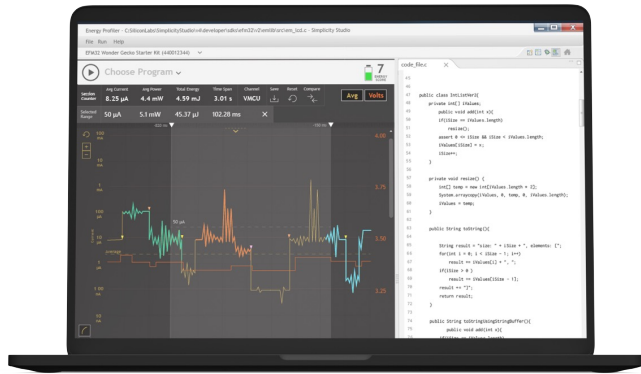


# Robust Interoperability with Routers Worldwide



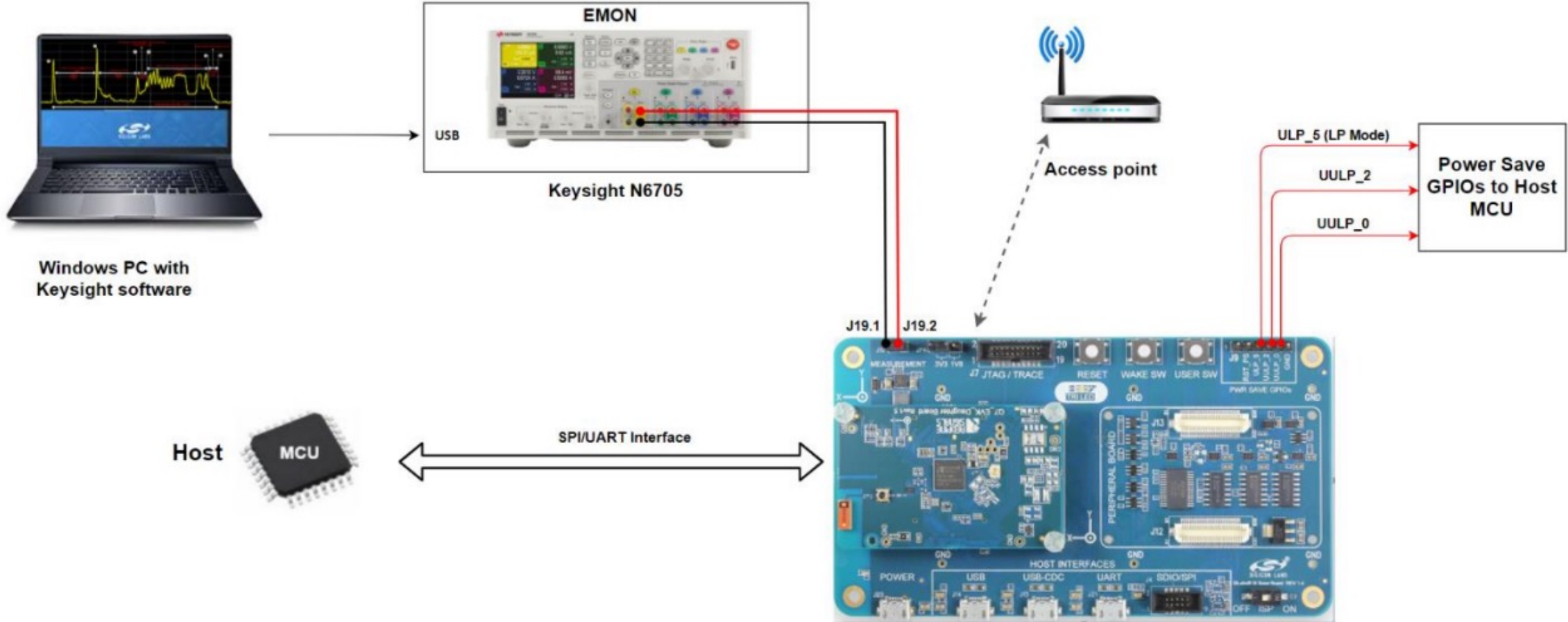
- **Robust secure connectivity and interoperability observed during the whole test for all 100 routers with:**
  - Zero Wi-Fi disconnects
  - Zero TCP disconnects
  - 100% reception of application messages sent once every 55 seconds during the test.
- **Ultra-Low power consumption**
  - With clean channel, 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

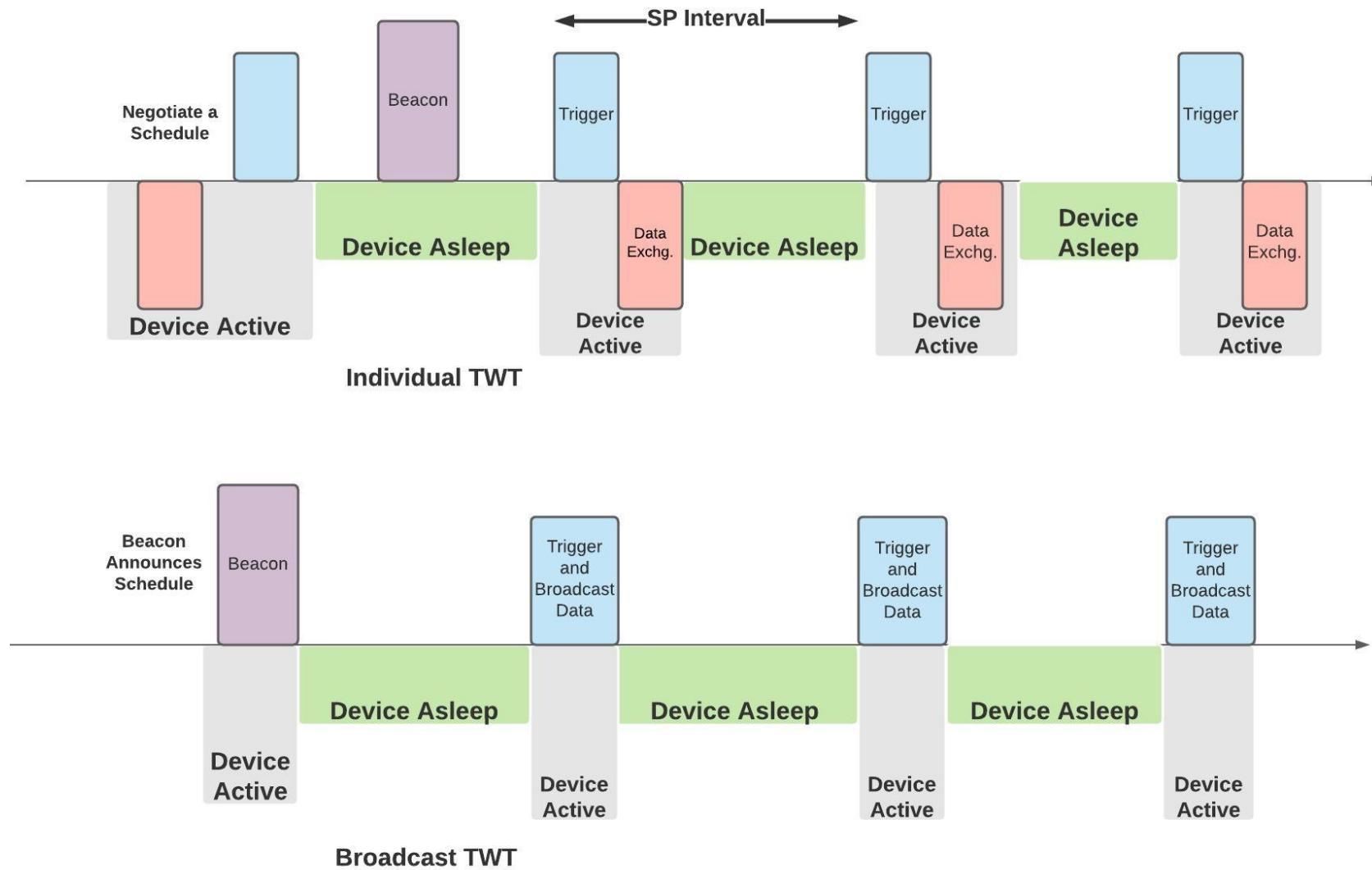


IEEE Protocol	802.11ax
WFA Naming	Wi-Fi (CERTIFIED) 6
Year Introduced	2019
Band(s) (GHz)	2.4, 5, 6 (SB, DB, TB)
Channel Bandwidth (MHz)	20, 40, 80, 160
Allowable Streams	8
Max Data Rates (Mbps)	143 (20MHz, 1 SS) 600 (80MHz, 1 SS) 9607 (160MHz, 8 SS)
MIMO	Multi User (DL MU-MIMO)
Subcarrier Spacing (KHz)	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**

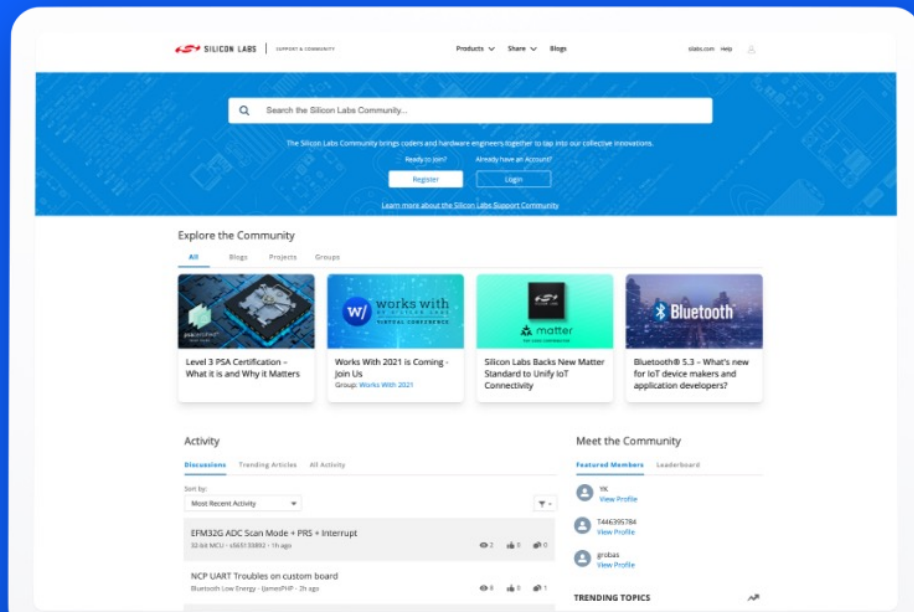
- **Industry leader in ultra-low-power Wi-Fi + BT/BLE 5**
  - 55  $\mu$ A stand-by associated current at DTIM10
- **Integrated wireless stacks, networking stacks, cloud connectivity and security**
  - Seamless wireless co-existence, minimize host load
- **Industry leader in small form-factor certified 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



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**Q&A**

# Continue Discussion in Our Community!



## 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](https://community.silabs.com)



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WEBINAR

# Bluetooth: The Latest Bluetooth Low Energy Updates in GSDK 4.0

APRIL 19 | 10 AM CDT







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# Thank You