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WF-202

Low-Power Wi-Fi Applications for Home

Sylvain Cormier, Scott Farester | August 2023

Agenda

01 Battery Powered Shades

02 Neutral-less Wi-Fi Switches

03 Home Sensors

04 Battery Powered Security Cameras

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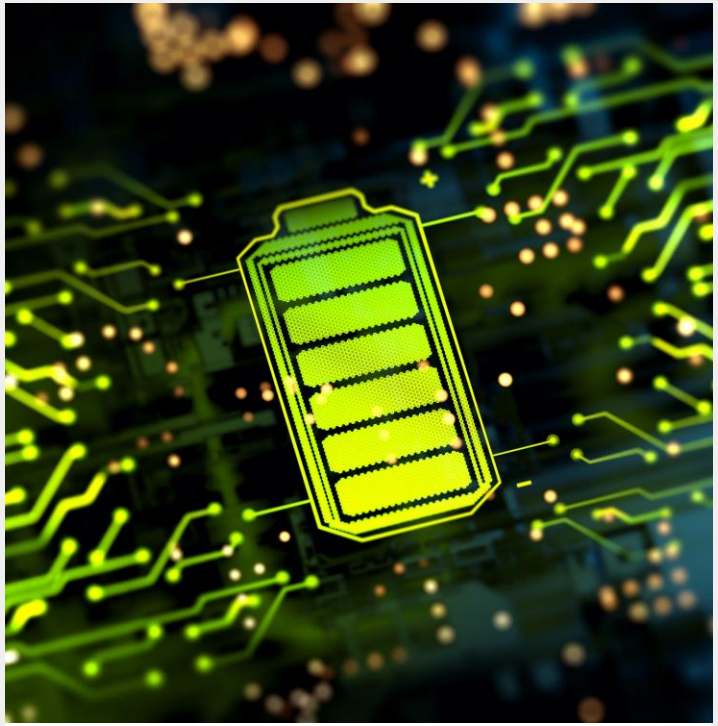
Battery Powered Shades

Windows Shades and Blinds Challenges



POWER

Battery operation is easier than running power and wires

How to maximize battery life and recharging intervals

CONTROL

Always on Wi-Fi cloud connectivity for instant response and reduced latency

New control opportunities – Voice, automation, phone

DEVELOPMENT

How to minimize development and design costs for multi-protocol solutions

How to integrate and certify with multiple Ecosystems

How to simplify design and accelerate time to market

Why Choose 917 Wi-Fi Shades? (1/2)

SINGLE-CHIP SOLUTION

SiWx917 – A single SoC for all your Wi-Fi shade needs:

- Wi-Fi 6, Matter, Bluetooth LE
- Dedicated ARM core for application
- Large RAM, 8 MB Flash, ext. PSRAM option

Integrated AI/ML accelerator & Bluetooth LE co-existence

LOWEST POWER

SiWx917 – The lowest power Wi-Fi 6

- ~50% compared to the closest competing SoCs
- WLAN Rx Active Current 62.7 mW (19 mA at 3.3 V)
- WLAN standby mode 168.3 µW (51 µA at 3.3 V)

Always on Cloud connectivity with ~50% lower power than closest competing SoCs

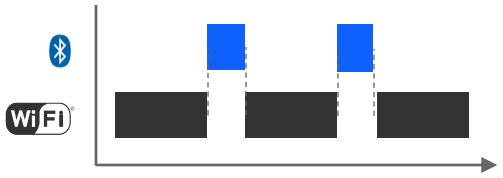
HIGH-PERFORMANCE WI-FI

Reliable Wi-Fi connectivity in every room and beyond

- Wi-Fi 6 (802.11ax) with OFDMA, TWT, UL/DL MU-MIMO, beamforming, and more
- High TX power of +21 dBm & great RX sensitivity of -98 dBm on SiWx917
- Always-on cloud connectivity reduces latency between command and action for shade control

MULTIPROTOCOL CO-EX

- Bluetooth Low Energy Co-existence for easy commissioning
- Bluetooth Dual-mode with Classic Audio on RS9116



(Programmable, Switched, Dynamic, and Concurrent)

RF-CERTIFIED MODULES

- Fast Time to Market
- Built-in Antenna, EMC shielding, BoM simplification, worldwide RF certifications

Save 9 months and hundreds of thousands of $

Launch 9 months earlier – Reduce product costs!

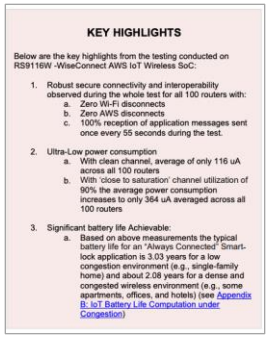
BEST WI-FI SECURITY

- **Best Wi-Fi IoT Security** equivalent to PSA Level 2 on SiWx917 and SiWx915
- The only vendor supporting PSA Certification Level 2, WPA3, and TLS 1.3 for Wi-Fi

Why Choose 917 for Wi-Fi Shades? (2/2)

MAXIMUM AP COMPATIBILITY

- **Independently tested Wi-Fi stack (RS9116)**
- 100s of Wi-Fi Access Points
- Exceptional interoperability, power saving, battery life improvement



KEY HIGHLIGHTS

Below are the key highlights from the testing conducted on RS9116W -WiseConnect AWS IoT Wireless SoC:

1. Robust secure connectivity and interoperability observed during the whole test for all 100 routers with:
   a. Zero Wi-Fi disconnects
   b. Zero AWS disconnects
   c. 100% reception of application messages sent once every 55 seconds during the test.
2. Ultra-Low power consumption
   a. With clean channel, average of only 116 uA across all 100 routers
   b. With 'close to saturation' channel utilization of 90% the average power consumption increases to only 364 uA averaged across all 100 routers
3. Significant battery life Achievable:
   a. Based on above measurements the typical battery life for an "Always Connected" Smart-lock application is 3.03 years for a low congestion environment (e.g., single-family home) and about 2.08 years for a dense and congested wireless environment (e.g., some apartments, offices, and hotels) (see Appendix B: IoT Battery Life Computation under Congestion)

SIMPLIFIED DEVELOPMENT

- **Simplified IDE and GSDK** for all IoT protocols, Silicon Labs' technologies, and IoT Ecosystems
- Common APIs and sample examples for Improved OOBE
- Unified platform for path to series 3

Shade

SENSOR HUB

- **Saves Battery**
- Receive sensor data in standby/sleep modes
- Make decisions locally on the MCU or ML Accelerator (MVP) in standby mode
- Wakeup wireless only when cloud connection needed

INTEGRATED AI/ML ACCELERATOR

- **SiWx917 integrated AI/ML accelerator**
- 4X faster ML inferencing with 1/6th of power consumption
- ML processing on the Wi-Fi SoC, without waking up and occupying the main MCU

Enables Voice Control and Adaptive Automation for Shades

IOT-OPTIMIZED WI-FI PROFILE

- ***Wi-Fi 6 Single-band 2.4 GHz -***
- Supports congested, high-density Wi-Fi environments without power-hungry 5 GHz and dual-band designs
- Better RF propagation, wall penetration, and interference tolerance than 5 GHz
- 2.4 GHz is better for low power than 5 GHz

...AND MANY MORE BENEFITS!

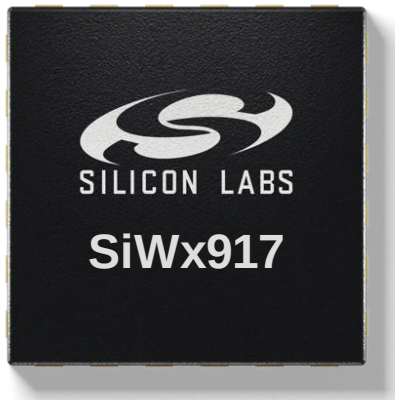
- Multi-operational modes: RCP, NCP, SoC
- Integration across all tools and MCUs
- One-stop-shop for SW, HW, and support for all IoT protocols
- Seamlessly integrated & tested solutions
- CPMS: Order Wi-Fi SoCs with customized security and Matter Certificates injected in the Silabs fab

SiWx917: Ultra-low-power, High-Performance Wi-Fi 6 IoT SoC

Ultra Low Power

Secure

Multi Protocol



Wi Fi 6 + Bluetooth

Single Stream Wi-Fi 6

- 2.4GHz, 20MHz 1x1 stream IEEE 802.11 b/g/n/ax
- 802.11ax OFDMA, UL/DL MU-MIMO, Target Wake Time
- Quad Threaded ThreadArch® Wireless CPU up to 160MHz
- TX: Up to +21dBm; Rx Sens as low as -98 dBm
- Data Rates: 802.11ax MCS0 to MCS7

Bluetooth Low Energy 5.x

- Tx Up to +19 dBm; Rx Sens -106 dBm @ 125Kbps
- Data rates: 1, 2 Mbps, and LR (125 kbps, 500 kbps)

Memory

- Embedded SRAM up to 672kB, opt ext. PSRAM
- Flash up to 8MB

Ultra Low-power Consumption

- Wi-Fi Standby Assoc mode current: 50 µA @ 1-second
- Deep sleep current <1 µA,
- Sleep/Standby current (RAM retention) < 10 µA
- Low MCU active current: 19uA/MHz in LP mode

Machine Learning

- AI/ML Hardware Accelerator

Operating Condition

- Wide operating supply range: 1.75 V to 3.63 V
- Operating temperature: -40 °C to +85/105 °C

Compact Package Size

- 7 mm x 7 mm x 0.85 mm QFN 84

ARM® Cortex® M4 Processor with FPU Subsystem

- High performance core up to 180 MHz
- Digital Peripherals - SDIO, UART, SPI, I2C, I2S, SIO, PWM, RTC, Timers, Up to 46 GPIOs (GPIO Multiplexer)
- Analog Peripherals - ADC/DAC, Op-Amp, Comparator, Temp Sensor, Cap Touch

Security – PSA L2 Certifiable

- QSPI Secure XIP from Flash
- Secure Zone, Secure Boot and OTA
- Separated TEE, TRNG, Root of Trust (PUF)

Software and Protocol Support

- Matter over Wi-Fi with BLE commissioning
- Integrated Wi-Fi stack, Bluetooth stack supporting wireless coexistence
- Wireless Security WPA2/WPA3 personal and enterprise
- Integrated TCP/IP stack - HTTP/HTTPS, SSL/TLS1.3, DHCP, MQTT
- Supports host-less (SoC) and hosted (RCP/NCP) operating modes

Development Environment

- Simplicity Studio v5

Wi-Fi Connected Motorization for Window Covering

America's Premier window covering company

Application and Use Case

- Wired and battery powered wireless products
- Blinds automation
- Compatible with major ecosystems for enhanced user experience

Products

- SiWG917
- EFR32ZG23
- Matter protocol

Why they chose Silicon Labs

- Low power Wi-Fi solution increasing battery life
- Wi-Fi 6 for enhanced performance (power, range, network density)
- Developer Services help with Software Development
- Matter/Wi-Fi support on SiWG917
- A strong relationship with the SiLabs sales team

Why Choose Silicon Labs

Power

- Industry-leading low-power solution
- Eliminate wiring
- Extend battery life

Always-on

- 50% lower power for Always-on cloud connectivity
- Minimizing latency

AI/ML

- Innovate control
- Voice & Adaptive automation

Cost Savings

- Faster Time-to-Market with RF-certified modules
- Ecosystem pre-validated solutions
- Multi-Protocol co-existence on a single chip

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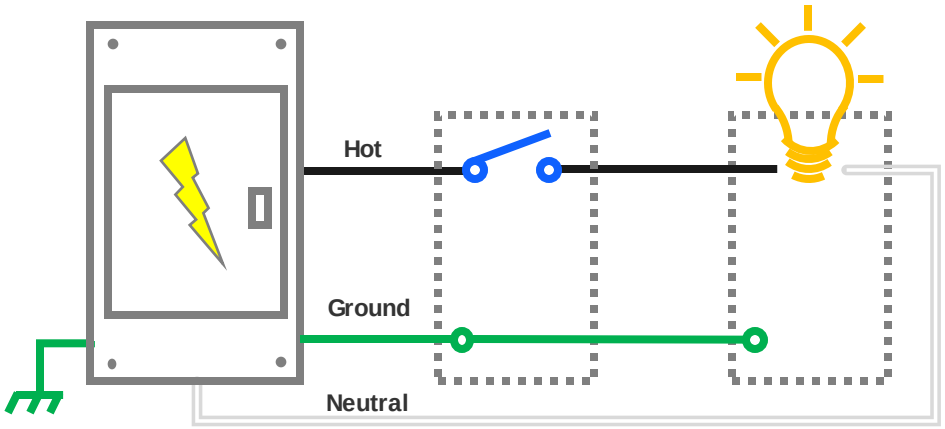
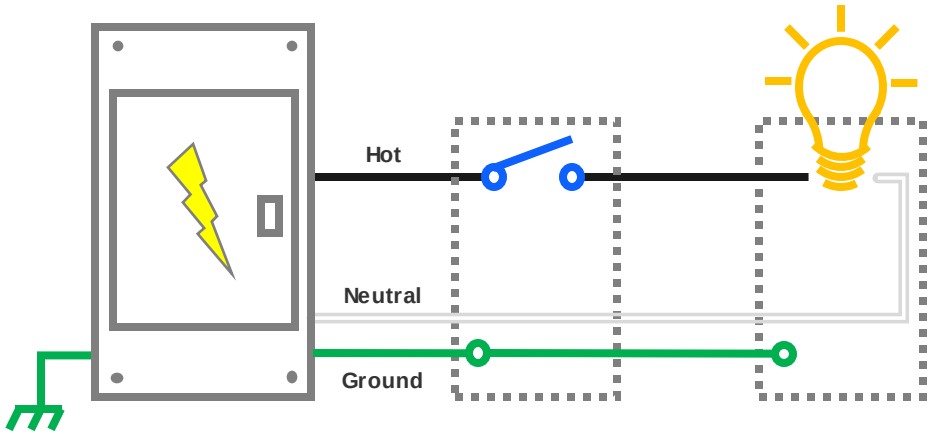
Neutral-less Wi-Fi Switches

Evolution of Wiring Regulation



- Ground conductor was added throughout the system for user safety



- Sensor control switch development prompted the need for a complete current path in the switch box
- 2011 NEC updated to require switch box neutral for new construction
- 3-wire switch box made smart switch design for new construction easy
- 40% of US homes are still without a neutral wire making replacement/retrofit more challenging

Neutral-less Home Consumer View

PROBLEM

I want smart switches, but have no neutral wire available to take advantage of 3-wire switch designs

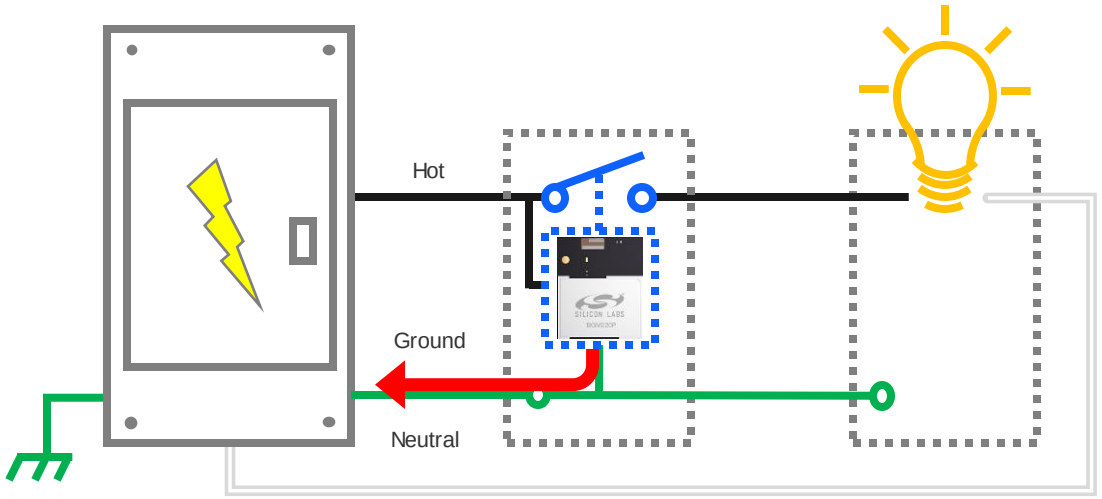
SOLUTIONS

Hire an expensive professional electrician to add neutral wiring to my home

Purchase a “one-wire” neutral-less smart switch design

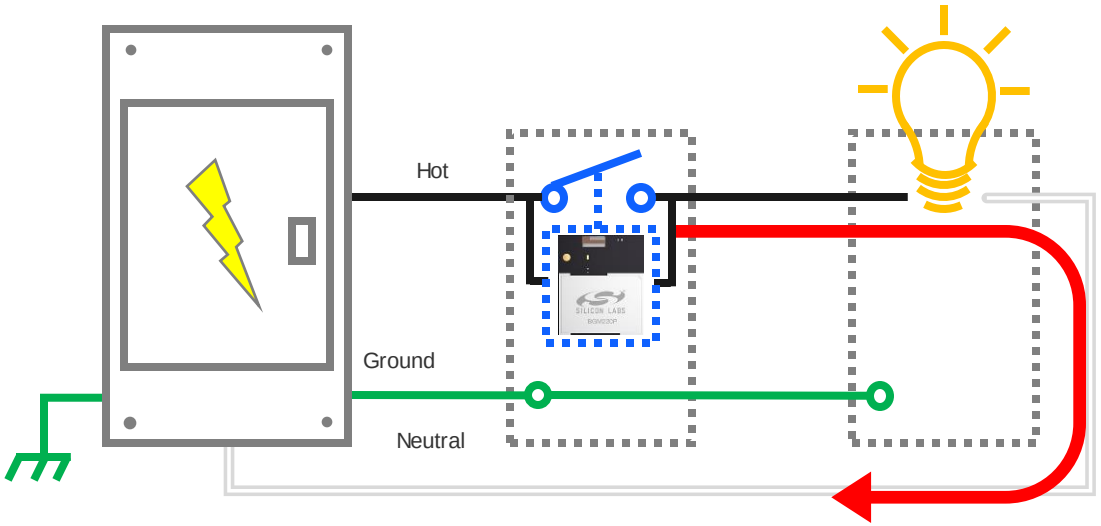
Neutral-less Switch Design Options

GROUND CURRENT PATH (2-WIRE)



- Uses equipment ground for current return path
- Limited by electrical standards for leakage current
- Good for low power automation devices

LOAD CURRENT PATH (1-WIRE)

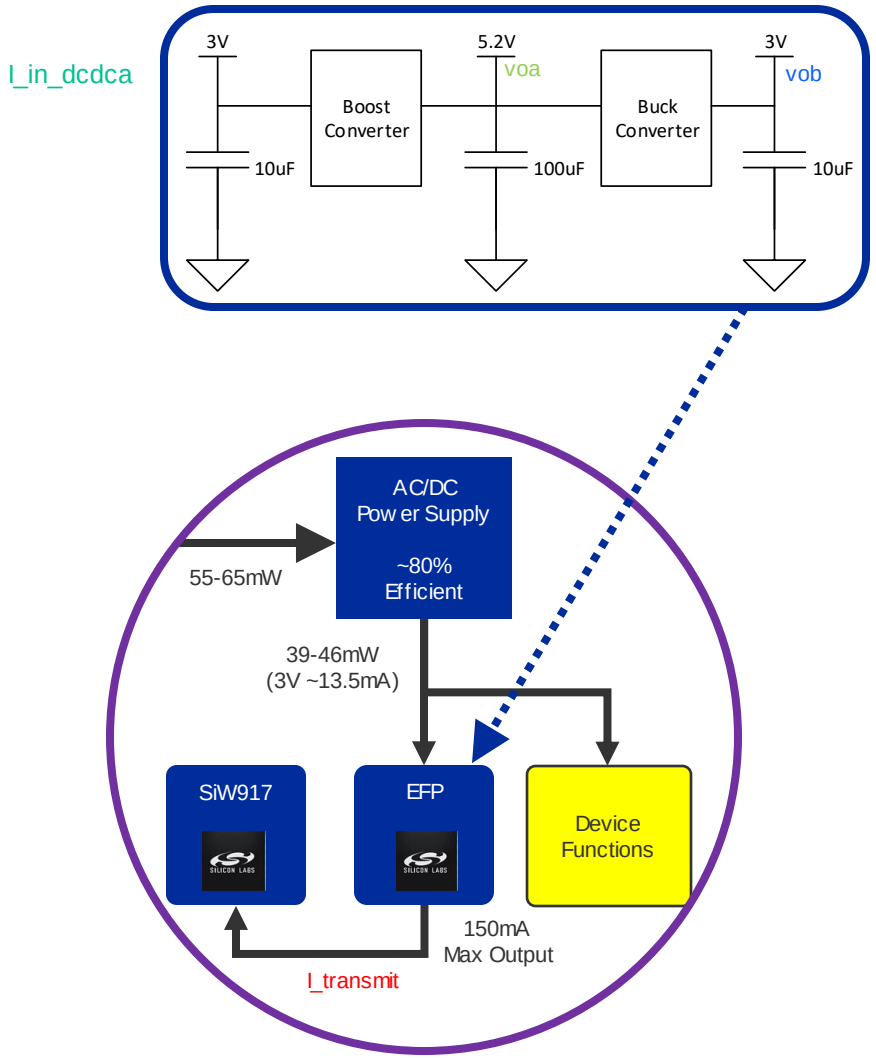


- Trickles current through the load circuit to complete circuit for switching controls
- Works well with higher load wattages

Ground Connection Regulatory Standards

Regulation	Requirement	Exception Summary
2020 NEC 404.2(C) – Switches Controlling Lighting Loads	The grounded conductor shall be extended to any switch location as necessary and shall be connected to switching devices that require line-to-neutral voltage to operate the electronics of the switch in the standby mode and shall meet the requirements of 404.22.	The requirement shall not apply to replacement or retrofit switches installed in locations prior to local adoption and where the neutral conductor cannot be extended without removing finish materials. Electronic lighting control **switch quantity shall not exceed 5 on a branch circuit and 25 on the main bonding jumper**.
2020 NEC 404.22 - Electronic Control Switches	Electronic control switches shall not introduce current on the equipment-grounding/bonding conductor during normal operation.	Electronic control switches that introduce current on the equipment grounding conductor shall be permitted for applications covered by 404.2(C), Exception.
UL 1472 - Solid-State Dimming Controls	4.6.5 - Circuitry shall be arranged such that an equipment-grounding/bonding connection or conductor does not carry current.	**Leakage current not exceeding 0.5mA** through an equipment-grounding/bonding conductor or connection is permitted if a neutral connection is not provided.

Wi-Fi Feasibility using EFP0111 Boost Bootstrap



- Higher transmit peaks require active current management
- Simulations show the EFP0111 paired with a 100uF Bulk cap can stay within our budget using active current limiting to support a 10dBm peak transmit draw
- Wi-Fi feasibility investigations continuing

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Home Sensors

Using Sensor Hub

Requirements of Wi-Fi in IoT Devices

- **Traditional Wi-Fi is better for PC/smartphone**
  - Meant for infrastructure, high bandwidth, or mains-powered devices
  - Used with highly resourced hardware (CPU, memory) running Linux/Android/iOS/Windows
  - Move towards 5GHz or 6E (6GHz) bands for high bandwidth and power

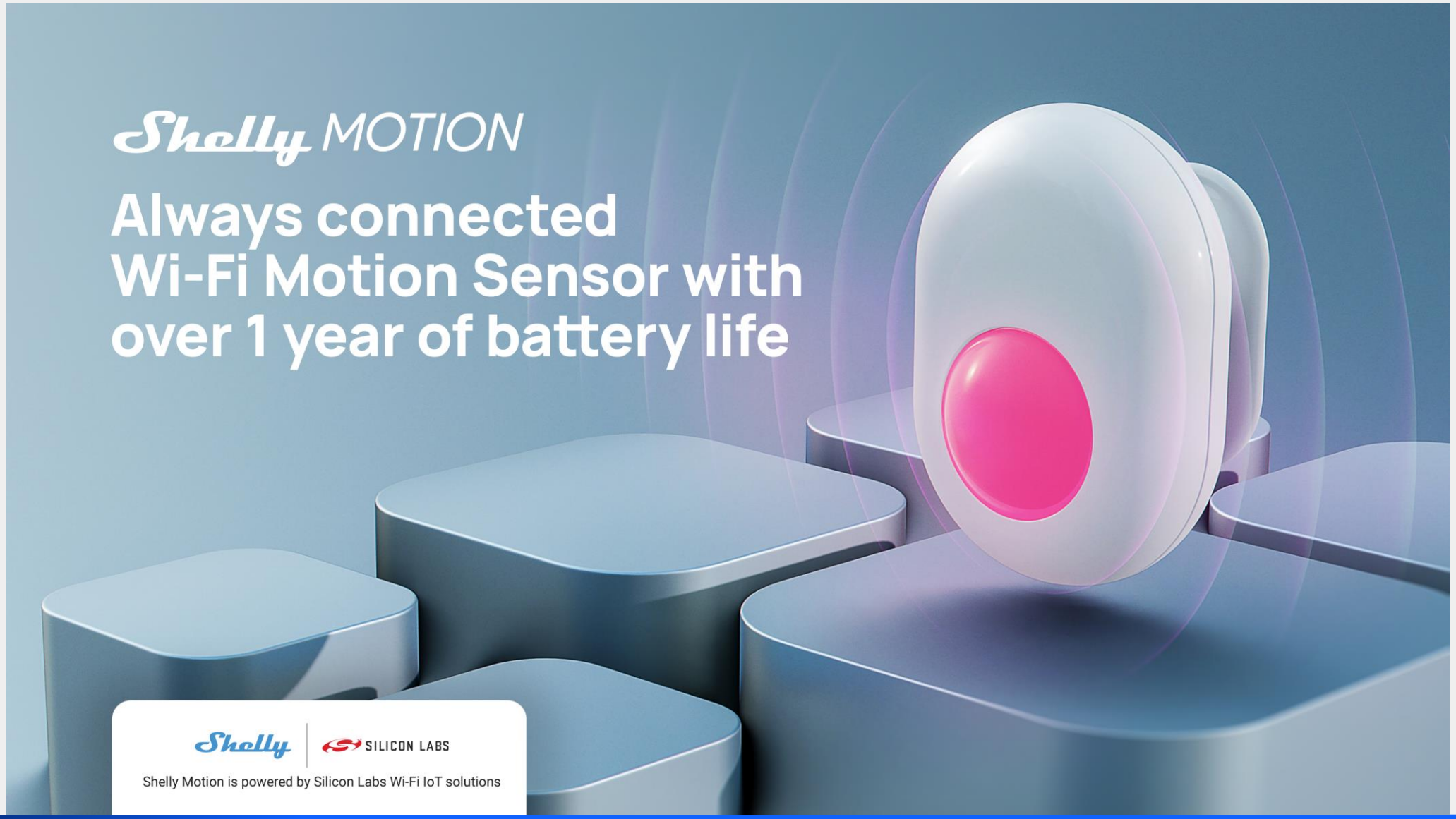
- **Wi-Fi for IoT is different**
  - Low power consumption (battery operated)
  - Coexistence, interoperability and long range (2.4 GHz)
  - Secure connectivity, prevent online and physical attacks
  - Limited device resources (MCU, memory etc.)
  - Wireless, networking stack integration
  - Simplified provisioning – lack of rich UI interfaces
  - Cost and size-constrained devices
  - Challenges from crowded RF spectrum
  - Cloud connectivity to multiple cloud providers

Typical Home Sensors

zigbee THREAD

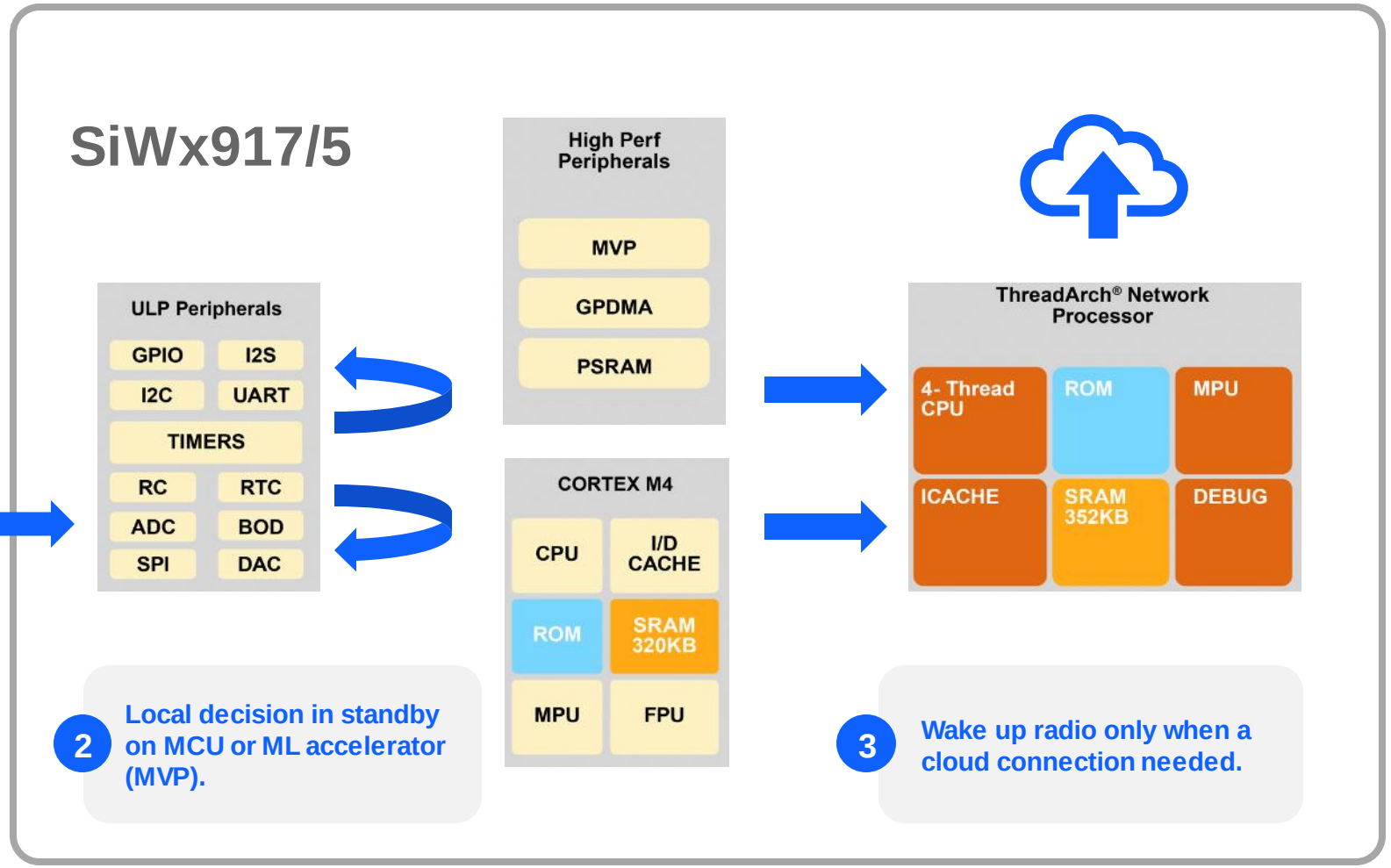
Z-WAVE Bluetooth® Proprietary

W-Fi Sensor Success Story



Extending Battery Life using Sensor Hub

Save Battery!



1. Receive sensor data via ULP peripherals in standby mode.
2. Local decision in standby on MCU or ML accelerator (MVP).
3. Wake up radio only when a cloud connection needed.

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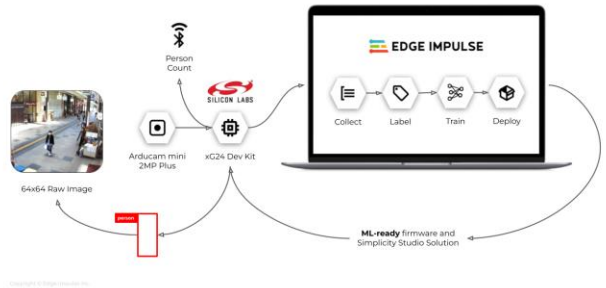
Battery Powered Security Cameras

Market Application Expansion – More Than Just Cameras

ADDING AI/ML PREMIUM OFFERINGS

AI and software features will be primary differentiator for brands



A COMPLETE HOME SECURITY

Detect and deter – Camera Manufacturers adding Security System in response to Alarm Provider Threat

SMART SPEAKERS WITH CAMERAS

Audio analytics will start to complement video analytics

SECURITY FOR EVERY ROOM

Including cameras as a part of whole-home automation systems – example - Lighting Product Suppliers adding Camera

TRAIL CAMS – SECURITY ANYWHERE

Trail & Game Camera Providers adding Remote Security via cellular

DOORBELL, LOCK, AND CAMERA

Door lock Brands offering Vision enabled Door locks combining features

Security Market Product Segmentation

LINE POWERED – OUTDOOR/INDOOR

BATTERY POWERED - OUTDOOR

LINE POWERED – PAN TILT ZOOM (PTZ)

BATTERY POWER - DOORBELL

LINE POWERED - DOORBELL

OTHER BATTERY POWERED

SiWG917 enables longer Battery life feature demanded by consumer

Introducing SiWx917 Wi-Fi 6 + Bluetooth LE SoC

Longest Battery Life Wi-Fi 6 SoC for Cloud Connected IoT Devices

- **Ultra-Low Power Wi-Fi 6 + Bluetooth LE**
  - Multiprotocol combo with Matter support
  - Integrated applications MCU, SRAM, FLASH, AI/ML Accelerator
  - PSA L2 certifiable security engine and power management subsystem
- **Supports Wi-Fi 6 IoT Expansion**
  - Higher bandwidth, better coverage
  - Robust interoperability, security and longer battery life
  - Bluetooth LE multiprotocol for easy provisioning
  - Matter support for coexistence with multiple ecosystems and protocols
- **Single-chip solution to simplify design, reduce cost and speed up time to market**
  - Integrated with Simplicity Studio

Today's Architecture – Value Proposition vs Competition

Parameter	Competition	Silicon Labs SiWx917
WLAN Rx Active Current	76 mW	64.9 mW
Sleep (Standby)	169.2 uW	43 uW
Deep Sleep	4.8 uW	2.97 uW
WLAN Standby Associated (1 sec)	322 uW	167 uW

Option 1: Listen interval based power save :

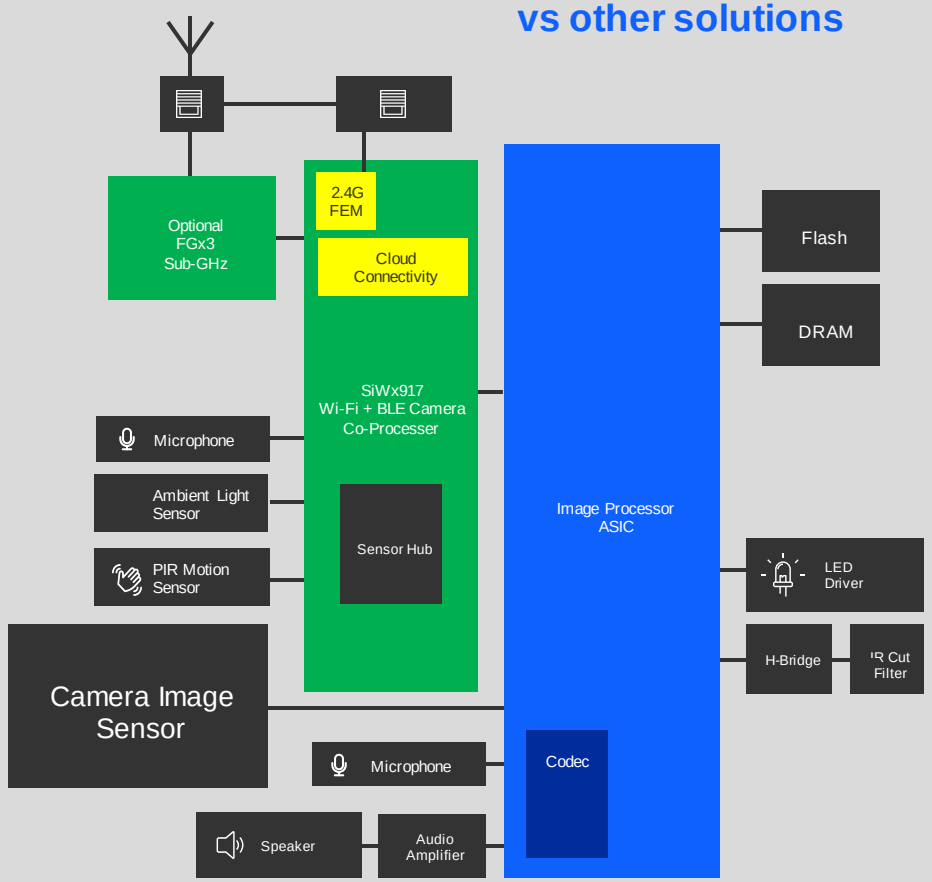
	DTIM configured at AP side		
Listen interval(LI)	**DTIM-1**	**DTIM-3**	**DTIM-10**
LI =1 sec	52.22uA	51.19uA	50.53uA
LI = 600ms	70.27uA	69.01uA	67.5uA

Option2: DTIM based power save; device wake up based on AP's DTIM period.

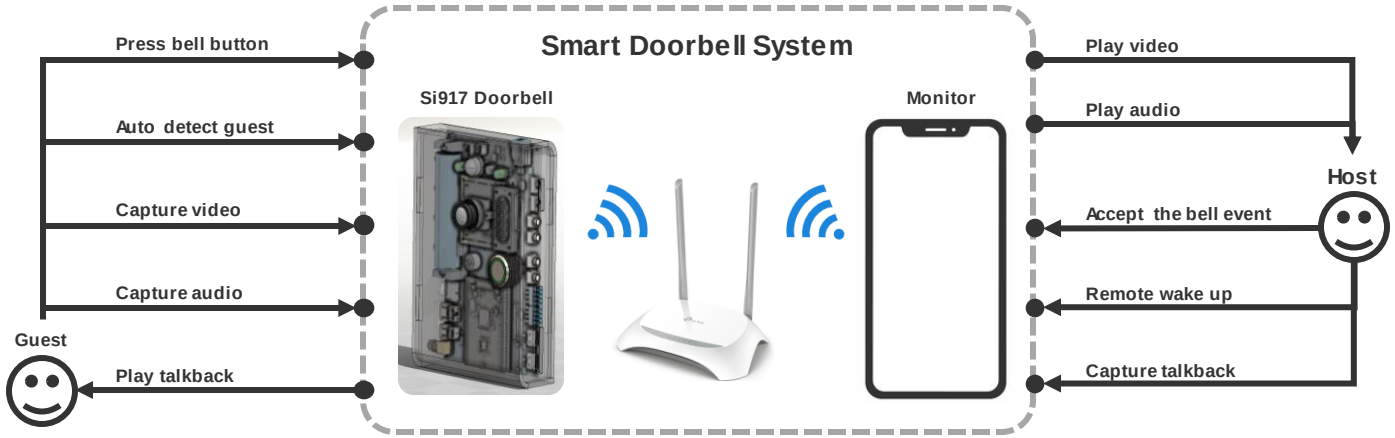
DTIM based wake-up	DTIM-1	DTIM-3	DTIM-10
Current	270.897uA	107.56uA	50.09uA

* Please note that we suggest customers to use Listen Interval based power save method compared to option 2 (DTIM)

Lowest Power Wi-Fi6 w/ BLE providing longer battery life vs other solutions



Battery Powered Smart Doorbell Reference Design



- **Support for Wi-Fi 6 and BLE**
- **Demonstrating support for Wired or Battery Powered Camera System**
- **In Low Power Camera Applications – Si917 monitors Sensors and Cloud while remaining system in sleep or powered down**

Customer Benefits

- **Minimize Battery Replacement and Recharging Hassle for the Users**
  - Increase customer satisfaction & sustainability image
  - Always-on cloud Connectivity & Matter with minimal power usage
  - Lowest Power Wi-Fi 6 SoC provides multi-year battery life for IoT devices such as smart locks
- **Improve User Experience with a Superior Wireless Performance & Easy Device Commissioning**
  - Long Range connects devices in every room of the house and beyond
  - Wi-Fi 6 improves connectivity in high-density environments
  - Wi-Fi + Bluetooth LE coexistence for easy commissioning
- **Protect your Devices, Users, Brand, and Revenue from Cyber-Threats**
  - Best-in-Class Security for Wi-Fi - PSA Level 2 Certifiable, WPA3, TLS 1.3, AI/ML engine
- **Accelerate Time-to-Revenue**
  - A single chip solution with MCU, SRAM, and Flash for Customer Application
  - Reduce BoM, board footprint, design complexity, and development costs
  - Multiprotocol – One wireless design and SKU for many protocols (e.g., Ext 3-wire PTA with Zigbee/Thread)
- **Maximum Wi-Fi Gateway Compatibility – Independently Tested**
  - Reduce user frustration, customer care costs, and Improve brand loyalty
- **Seamless integration with Silicon Labs development solutions**
  - Simplicity Studio 5 streamlines the development process, reducing costs and accelerating time-to-revenue

SiWx917: Ultra-Low Power for Wi-Fi 6 + Bluetooth LE 5.2 IoT Devices

Longest Battery Life Wi-Fi 6 SoC for Cloud Connected IoT Devices

- **Ultra-low power Wi-Fi 6 and Bluetooth LE SoC**
  - Matter over Wi-Fi with Bluetooth LE provisioning in a single SoC
- **Fast streaming, OTA updates, coverage for entire home**
  - Wi-Fi 6 high bandwidth, robust connectivity and range
- **Best-in-class security with ML edge processing**
  - PSA L2 security, WPA3, TLS 1.3; AI/ML accelerator
- **Robust integrated wireless stacks, networking stacks, cloud connectivity**
  - Provides seamless wireless connectivity and minimizes host load
- **Reduced BOM and board footprint**
  - Embedded MCU/SRAM/Flash for customer applications
- **Simplified customer development experience**
  - Integration with Simplicity Studio and Silicon Labs solutions

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Q&A

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Thank you!