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Smart Appliances: Enhancing the Connected Smart Home Experience

Janani Ram, DC Seward | August 2023



What Drives Smart Appliances Consumption?



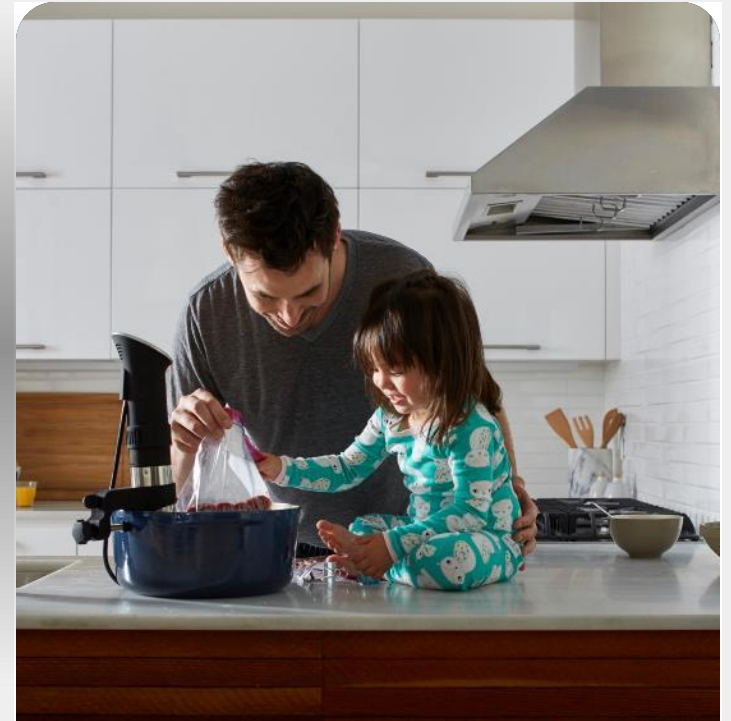
ENVIRONMENTAL AWARENESS

Energy-efficient smart appliances save customers money and support an environmentally sustainable lifestyle.



WORK-LIFE BALANCE

Enhanced features, wireless connectivity, and ecosystem integration make living more convenient and save time and effort in daily chores.



EXPERIENCE

Spend more time on experiencing at home instead of mundane chores – fine cooking, chores automation, voice control, etc.

Smart Appliances Solutions – How We Can Help?



CONNECTIVITY

- Standards based interoperable technology - Smart Home Devices are controlled through mobile devices, and Wi-Fi
- Allows seamless control of smartphones, tablets
- Multiprotocol solution– BLE for commissioning, Wi-Fi for cloud connectivity and Matter for device interoperability



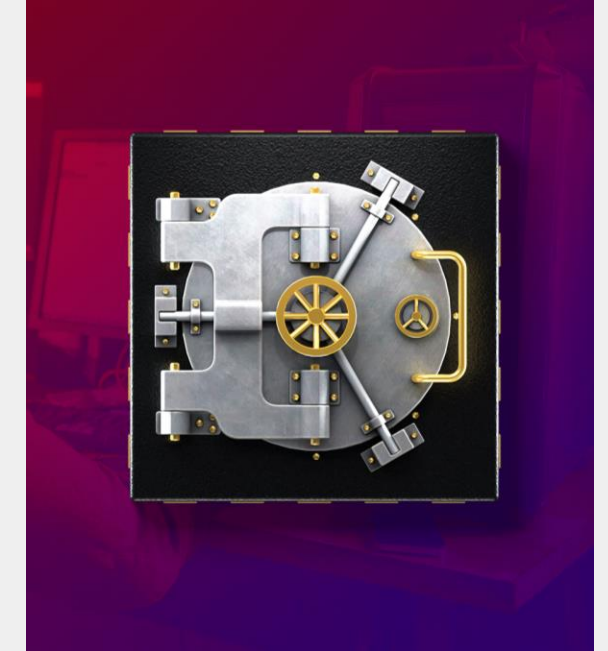
ENERGY EFFICIENT

- Battery-powered appliances like smart toothbrushes leverage the Sensor Hub, Wi-Fi 6, and Silicon Labs' ingenious power management to extend battery life and recharging interval



ECOSYSTEM

- Matter over Wi-Fi makes it easy to setup and control smart appliances with multiple ecosystems
- Device makers are choosing Matter solutions to work towards a unified open-source approach to IoT device development



SECURITY

- Common smart home device attacks include data breach, device hijacking and spoofing
- Silicon Labs provides the most advanced security in Wi-Fi with proven WPA3

8 Design Considerations for a Smart Appliance System

- 1 Energy Efficiency** – Ultra-low-power is critical for battery-operated and rechargeable appliances like smart toothbrushes (DC-DC boost, Coulomb counter, 16-bit ADC)
- 2 Temperature** – Wi-Fi large appliances like ovens need IC's that can withstand high temperatures
- 3 Home Coverage** – Wi-Fi is the most ubiquitous protocol across households worldwide
- 4 Multiprotocol** – Bluetooth LE for commissioning, Matter/Wi-Fi/15.4 for cloud connectivity
- 5 AI** – AI/ML will be a critical enabler on smart appliances for failure detection, predictive maintenance, diagnostics, troubleshooting, user experience, voice control
- 6 RF Certifications** – Pre-certified modules with an antenna can radically reduce time to market and development costs for Wi-Fi appliances
- 7 Memory** – High memory accommodates more features, OTA, and room for code growth. PSRAM options for memory-intensive applications
- 8 Size** – Small appliances vs. Large appliances designs are different
 - Small appliances like toothbrushes – Battery life, size, radio integrated
 - Large appliances like ovens, dishwasher – Wireless connectivity, Small footprint

Appliances Product Segmentation



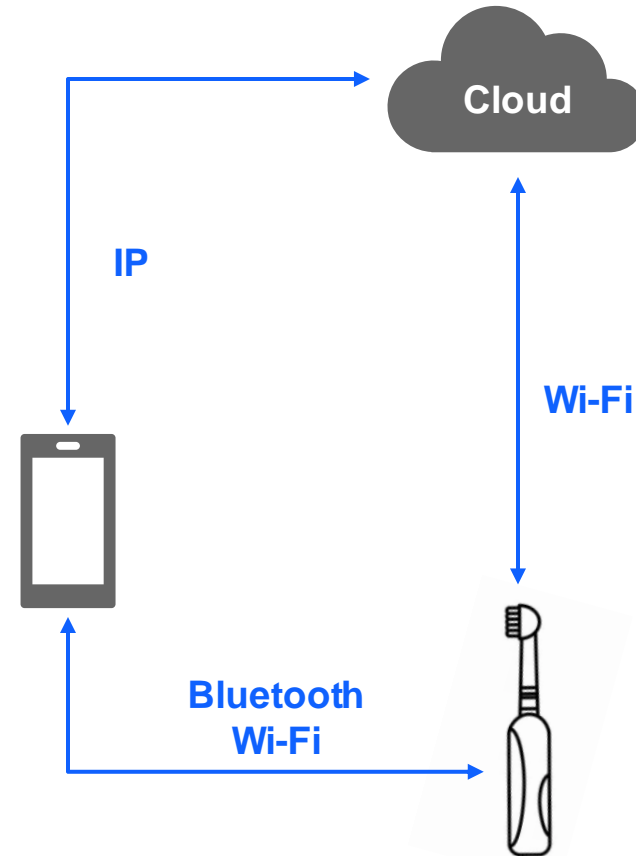
Line Powered Devices

Battery Powered Devices

Smart Home Devices and Home Network performance improves with Wi-Fi 6

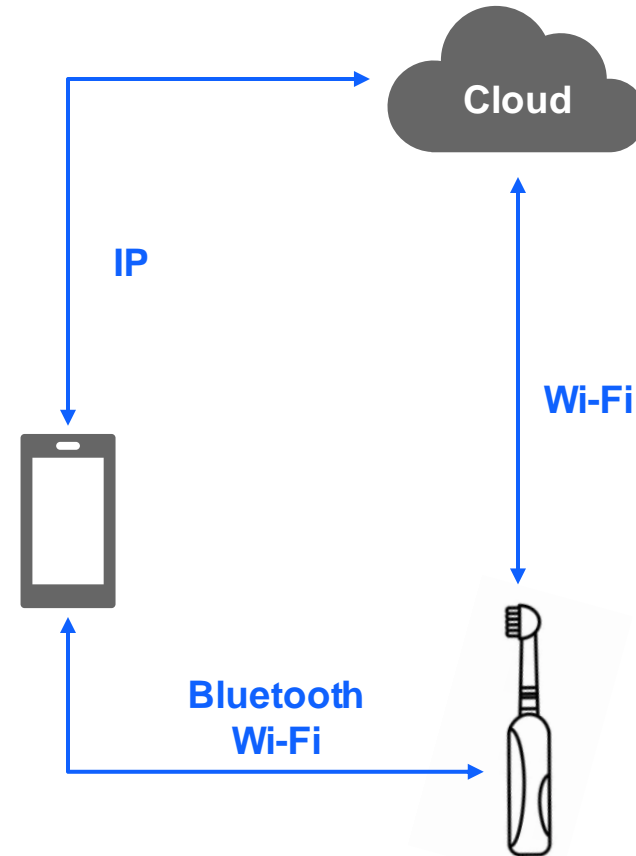
Components of a Smart Appliance System

- **Phone Application** connects to an Appliance through direct connection or via the cloud
- **The appliance** can connect to the cloud directly or via the phone
- **Use cases:**
 - Enhanced UI
 - Schedule a coffee maker to brew at 6:00 am
 - Remote control
 - Monitor cookware when not at home
 - Collect data
 - Follow trends in brushing teeth
 - Telemetry
 - Tumble dryer sensing vent obstruction
 - Remote troubleshooting

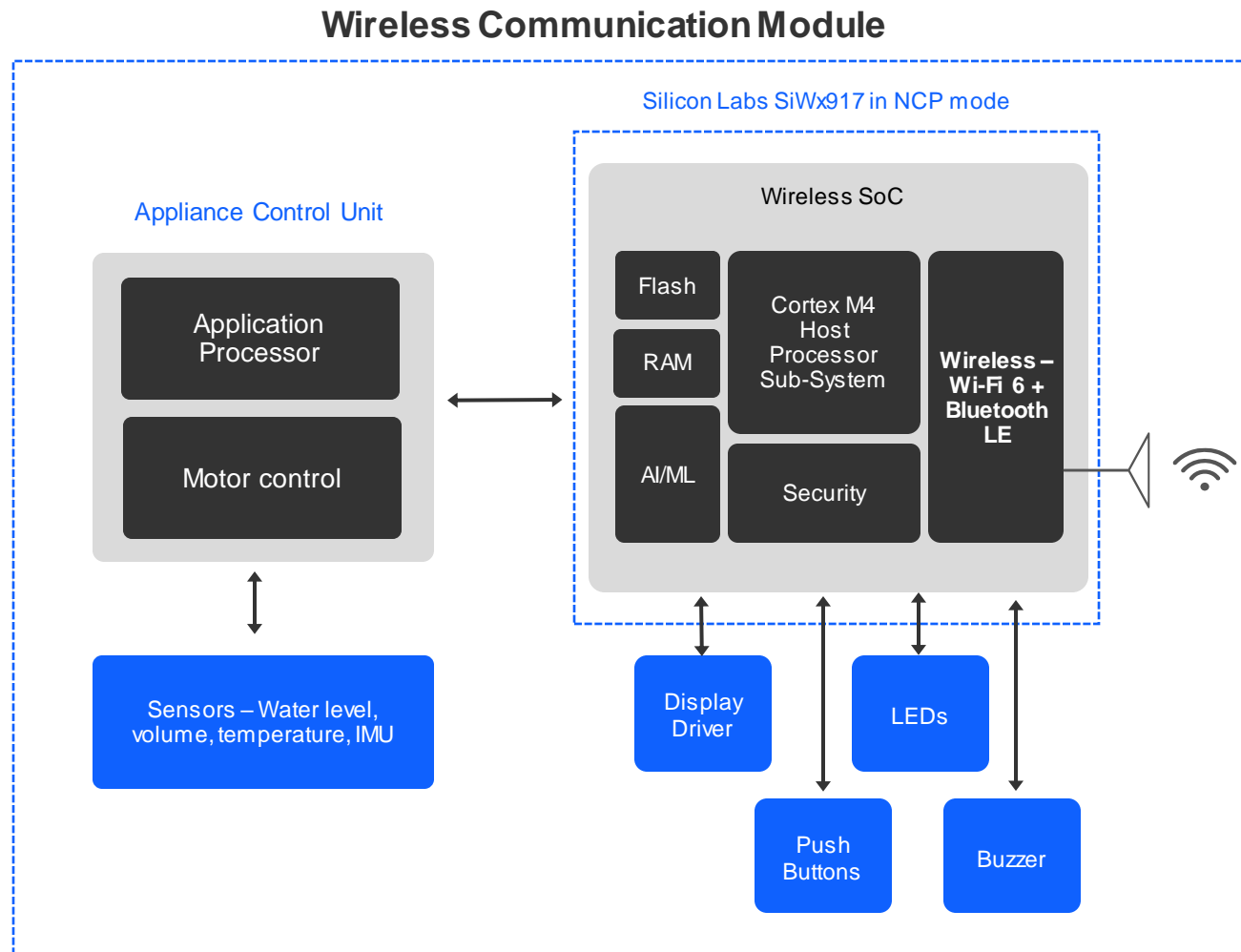


System Design Considerations

- **What telemetry data do you need to improve the product performance?**
 - Ex. Which components wear out more quickly in different use cases to improve future designs
 - Ex. Remote diagnostics
- **What data/functionality do you want to present to the user that requires enhanced UI?**
 - Ex. Temperature alerts for cooking
 - Over/under temperature alerts for HVAC systems
- **What user data do you want to store long-term and present back to the user?**
 - Ex. Filter usage for water-dispensing refrigerator

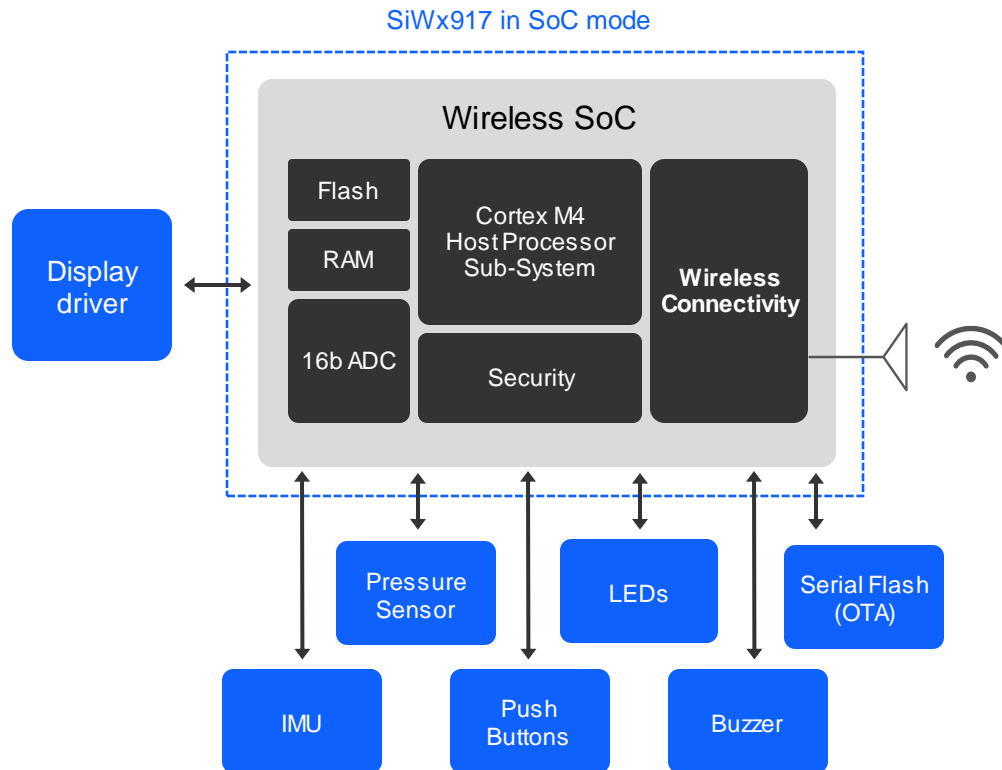


High-end/Large Appliances



- Large appliance manufacturers prefer a common Comms module plugged into multiple products and models
- Large appliance system is typically a 32-bit non-communicating micro with 1 MB flash and 96 KB RAM
- Internet connection through Wi-Fi
 - Enhanced UI: Easier to control functions from a smartphone app
 - Remote monitoring: Real-time feedback, such as oven temperature, cycle status
- Some interest in using Bluetooth for easier commissioning
- Some interest in Matter over 802.15.4 or Wi-Fi in the future

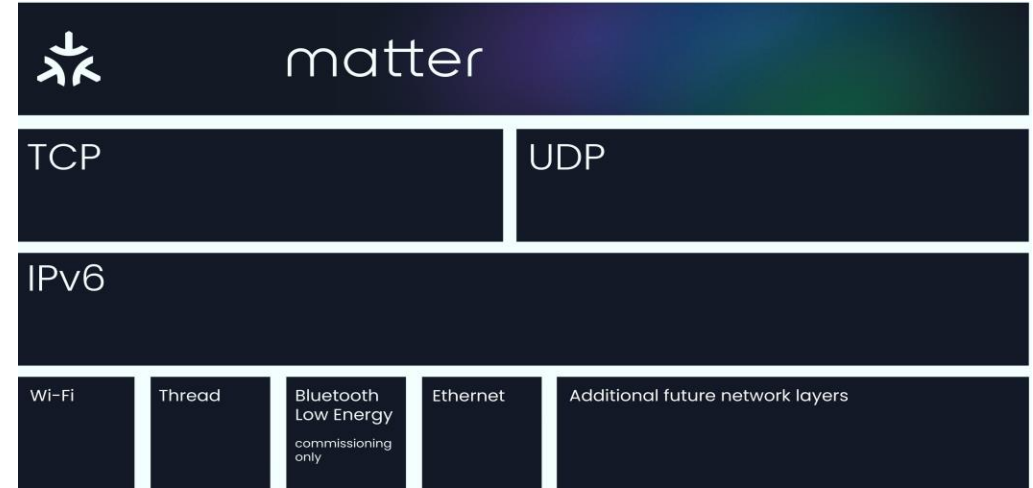
Entry-level/Small Appliances



- For smaller and medium-sized appliances, manufacturers prefer full system integration with a Radio
- Use GPIOs and ADCs to connect to buttons, sensors, activators
- May include LCD and Buzzer for richer user interface in some designs
 - Often a separate LCD chip with an opportunity to integrate
- Today: Bluetooth limits connectivity to "in the home"
- Wi-Fi can provide remote monitoring and control, similar to large appliances
- Connectivity primarily for enhanced user interface

What is Matter and its benefits for Smart Appliances

- **Matter - application layer for smart device communications using IP protocols**
 - Not an entirely new protocol, aims to improve device compatibility and security
 - Describes most common ways different devices can communicate and present data
 - Matter works over Wi-Fi, Ethernet and Thread
- **Matter drives the convergence between the major IoT ecosystems**
 - Easy, reliable, and secure wireless protocol to connect all IoT devices and networks
 - Interoperability with multiple ecosystems like Google, Apple, Amazon, Samsung
- **Matter designed security at its core**
 - Secure joining and transport layers for data and communication protection and prevent unwanted access of your device
- **Matter controls device commissioning**
 - Certification program makes it easy for Matter devices to join your network
 - Prevents unauthorized devices from joining your Matter network
- **Matter is designed for embedded devices**
 - Simple data models will fit into smaller, cheaper microprocessors



Simplicity
Easy to use



Interoperability
Devices from multiple brands work natively together

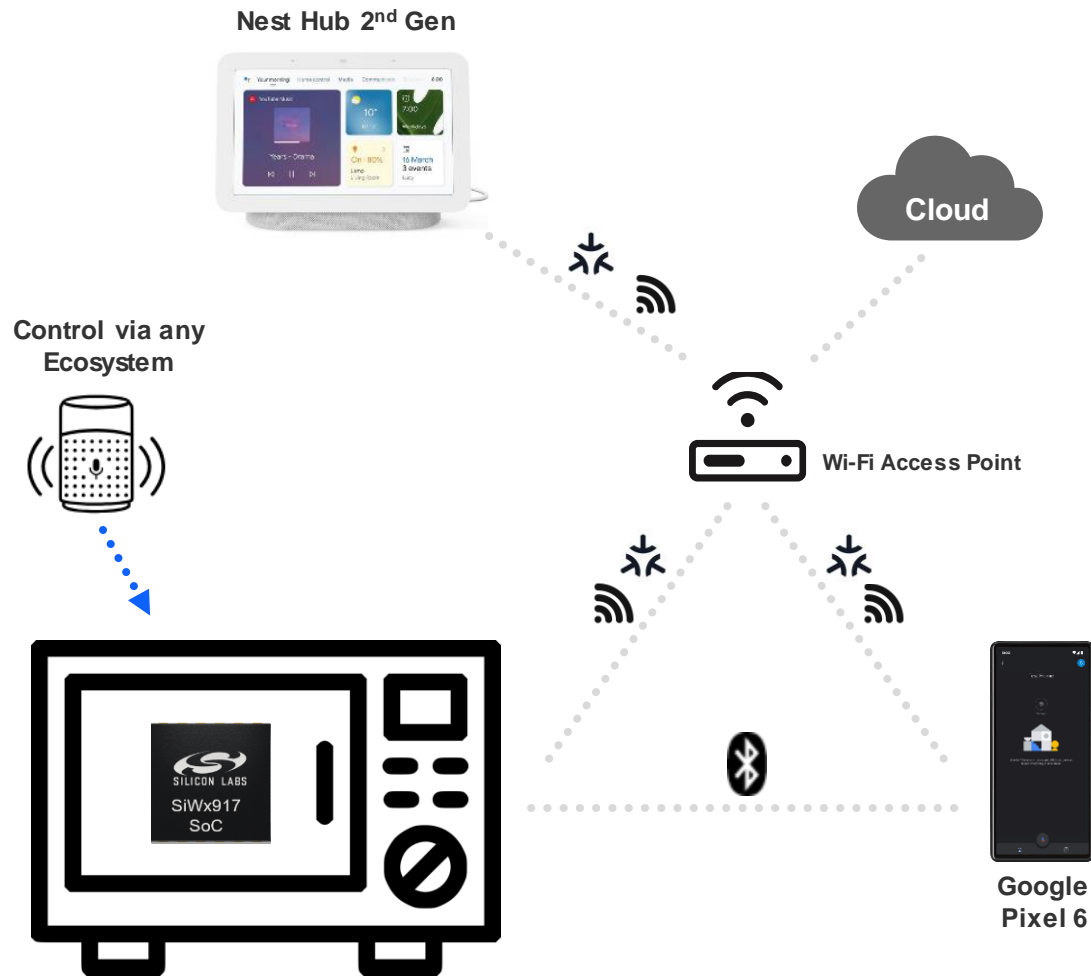


Reliability
Consistent and responsive local connectivity



Security
Robust and streamlined for developers and users

SiWx917 Use-case with a Smart Oven Using Matter



Smart Appliance Use-case with SiWx917

- Using Bluetooth LE commissioning to connect a smart oven to an AP for Cloud connectivity
- After the device is connected to AP it establishes Matter connection
- Control the oven with voice commands through any Matter Controller Hub in your home
- Or control the oven with Google Pixel using Matter over Wi-Fi
- Any status updates to the oven can be updated to the Cloud securely over a Wi-Fi network.

Optimal Wi-Fi 6 + Matter SoC solution

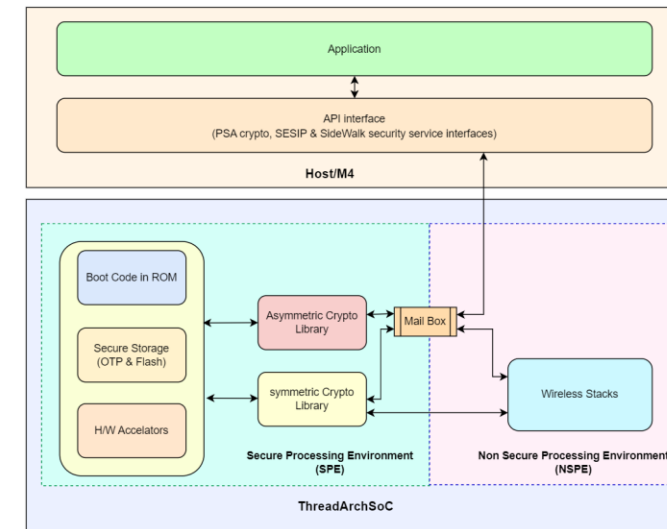
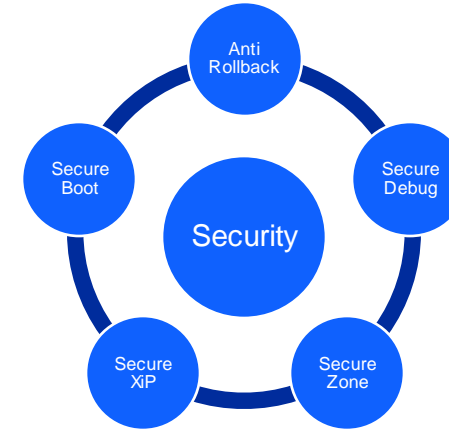
Popular AI/ML Use Cases in Smart Appliances



Product segment	White Goods	Kitchenware	Consumer Appliances	Toys, Robots
Use-case	Monitor and predict failures, prevent appliance break-down	Monitor cooking, frying, microwave oven contents, avoid accidents (ex. overcooking)	Brand protection/Policy – coffee capsule logo and print reading	Voice command control
Benefit of AI/ML	Identify various types of deviations or anomalies from normal signal variation	Identify various types of deviations or anomalies from normal signal, audio, vision signal	Classify capsules based on text, image, color	Better detection accuracy, improve user-experience
ML Method	Time-series data anomaly detection	Time-series data, audio, vision anomaly detection, pattern matching	Image/object classification and detection	Audio pattern matching

SiWx917 Security benefits

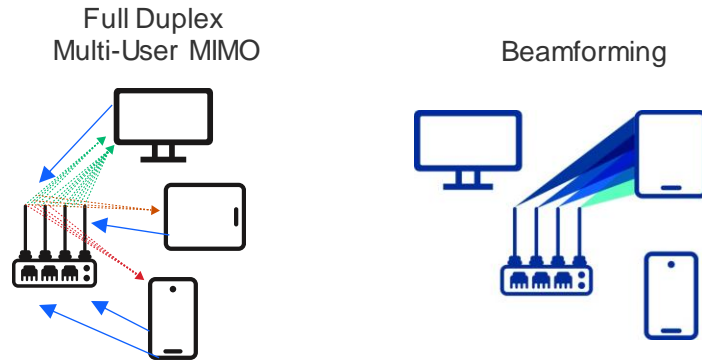
- **Secure Boot**
 - Authenticate flash contents, Wireless and MCU firmware based on digital signature, MIC before booting based on device configurations.
 - Flash Image can be encrypted and authenticated using signatures.
- **Anti Rollback**
 - When enabled, downgrading of the firmware to a lower version will not be allowed.
- **Secure Debug**
 - Wireless and MCU debug ports are disabled by default in hardware
 - Debug ports can be enabled in software using host interface commands based on token exchange between an authorized host and bootloader
- **Secure Zone**
 - Logically idea is similar to Secure Vault implementation(barrier between secure and non-secure stuff)
 - **Access to memory and hardware registers to security processor is disabled from external devices including On Chip M4 processor.**
- **Secure XIP**
 - Images are saved in encrypted format and decrypted using PUF intrinsic keys specific to each device while executing.
 - Key holder holds PUF keys
 - In-line decryption based on-the-fly AES engine(based on PUF keys)
 - Supported modes: XTS & CTR



Wi-Fi 6 Key Features and Benefits for IoT Devices

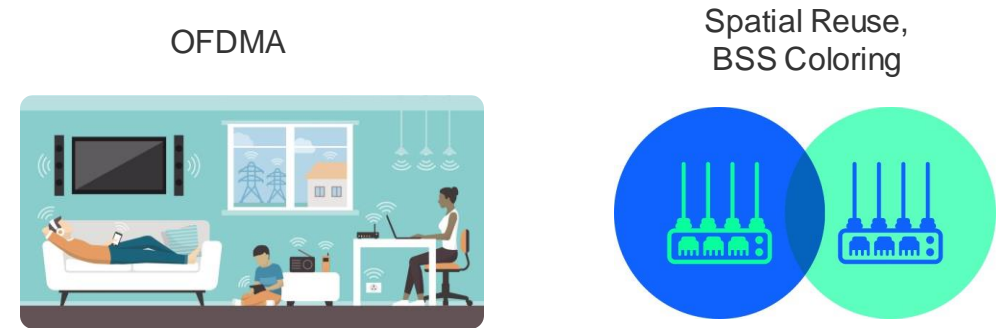


Better Performance



Higher Throughput, Reduced Overhead

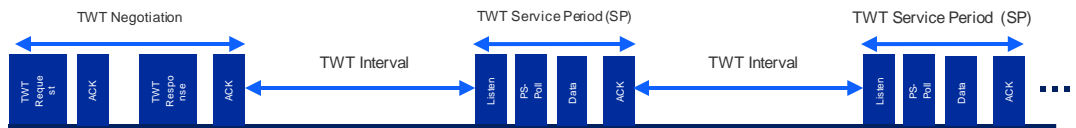
Support Denser Environments



Network Efficiency

Longer Battery Life

Target Wake Time



2.4GHz, 20 MHz Channel

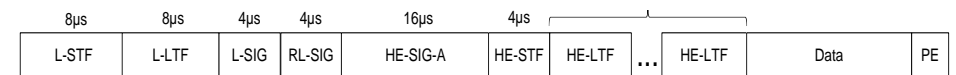


BSS Max Idle



Improved coverage/Longer Range

Extended range packet structure



Enhanced delay spread protection-long guard interval









0.8µs

1.6µs 11ax

3.2µs 11ax

Silicon Labs' Wi-Fi Portfolio Summary



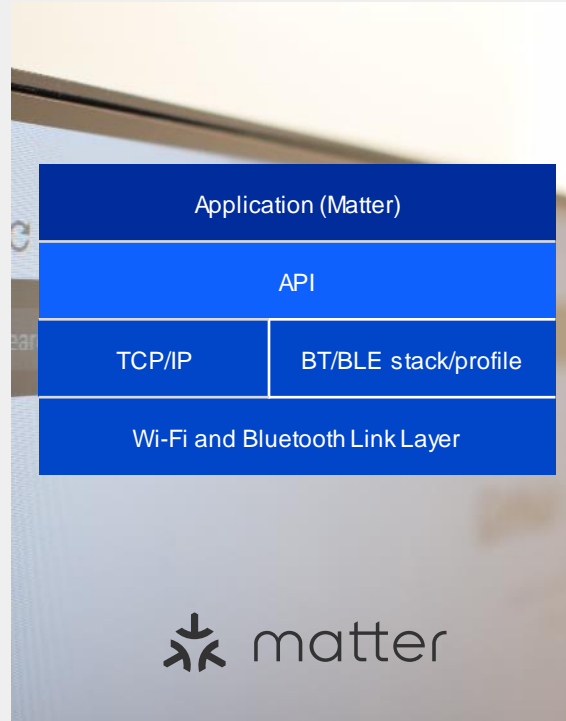
Features	WF200  	RS9116  	SiWx917  	SiWx915  
Wi-Fi	Wi-Fi 4	Wi-Fi 4	Wi-Fi 6	Wi-Fi 6
BT Low Energy (LE)		✓	✓	✓
BT Classic (Audio)		✓		
Low Power Modes	PS-POLL	PS-POLL, Listen Interval	PS-POLL, Listen Interval, TWT	PS-POLL, Listen Interval, TWT
Wi-Fi Features	OFDM	ODFM	OFDM, OFDMA, MU-MIMO	OFDM, OFDMA, MU-MIMO
Wi-Fi WPA3 Security	✓	✓	✓	✓
Matter over Wi-Fi	✓	✓	✓	✓
Co-processor Modes (RCP, NCP)	✓	✓	✓	✓
SoC Mode (ARM® Apps MCU)			✓	✓
AI/ML Accelerator, PSRAM			✓	
MCU Security (PSA-L2)			✓	✓
Temp range	-40 to +105 C	-40 to +85C	-40 to +105 C	-40 to +85 C
Ultra Low Power		✓	✓	
Modules	✓	✓	✓	✓

Silicon Labs - Complete Solution for Enabling Wi-Fi Products



SOCS AND MODULES

Industry-leading Ultra-Low-Power Wi-Fi 4 and 6 SoCs with pre-certified modules



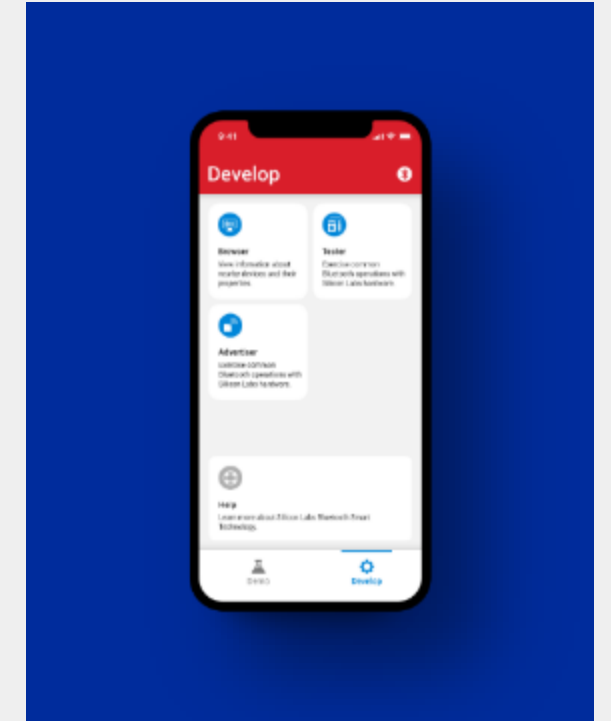
EMBEDDED SOFTWARE

Wi-Fi SDK with Integrated Wi-Fi, BT/BLE, IP networking stacks, Cloud and Matter support



DEVELOPMENT TOOLS

Evaluation Kit hardware plus Studio software to simplify development and speed time to market



MOBILE APPLICATIONS

Readily available EFR Connect app for Wi-Fi Provisioning with Bluetooth Low Energy

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The End

A large, bold, blue lowercase letter 'w' is positioned on the left side of the slide. It is partially overlaid by a thick blue diagonal line that runs from the top left towards the bottom right. The background features several parallel, semi-transparent blue diagonal lines that create a sense of depth and movement.

Back Up

What is Matter

- Matter is an IP-friendly application layer for smart device communications
 - Descended from the ZigBee application layer
 - Describes most of the common ways different devices can communicate and present data
- Matter designed security at its core
 - Secure joining and transport layers prevent hackers from accessing your device and communications
- Matter controls device commissioning
 - Certification program makes it easy for Matter devices to join your network
 - Prevents unauthorized devices from joining your Matter network
- Matter is designed for embedded devices
 - Simple data models will fit into smaller, cheaper microprocessors
- Matter application layer works across IP protocols
 - Most commonly used with WiFi or Thread, but Matter can work over any IP protocol