works with
by SILICON LABS

WF-202

Getting Started with Application Development & AI/ML on the SiWx917 (Demo)

Divya Chilukoti
Engineer – Product & System Apps

Yamini Sri Kolluru
Engineer – Product & System Apps

Designed from the ground up for IoT - SiWx917 Wi-Fi 6 SoC

DIFFERENTIATED FEATURES

Ultra-Low Power

- Increases Battery life and Recharging Interval

IoT-Optimized Wireless Performance

- 2.4GHz: Long-range, low-power, effective wall penetration, high-throughput
- Wi-Fi, Bluetooth LE, and Matter in single package

Edge Computing + System Integration

- AI/ML accelerator
- Application MCU and Wireless Processor with Networking off loads
- Rich Peripherals, High GPIO count, and Large Memory

DEVICE SPECIFICATIONS

Wide Range of Memory configurations

- 672 kB on-die SRAM with configurable split between Cortex-M4 and Network Wireless processor
- In-package 8MB Flash/PSRAM, 16MB External Flash/PSRAM
- Single-Chip Matter over Wi-Fi Solution

Multiprotocol Co-Existence

- High-performance Wi-Fi 6 and Bluetooth Low Energy 5.4

Robust Security

- A High Level of Security for the Device, Wi-Fi Protocol, and Networking

Agenda

Optimize Code and Hardware

Creating a low power application starts with optimizing both code and hardware usage for energy efficiency.

Power Consumption Analysis

Utilize tools like Energy Profiler to measure and analyze power consumption, ensuring the app operates within desired energy limits.

Efficient Algorithms

Executing an AI/ML keyword detection app involves focusing on using efficient algorithms to reduce power consumption.

Create an IoT Cloud Application

SILICON LABS

CONNECTED INTELLIGENCE

Exercise Flow

STEP 1

Choose a Base Project

Create, understand, execute the wifi_station_ble_provisioning_ aws example

STEP 2

Analyze the Needed Functionalities

I2C to read on-board temperature sensor data

STEP 3

Select Reference Examples, Understand Pin Mapping & Code Flow

sl_si91x_si70xx example

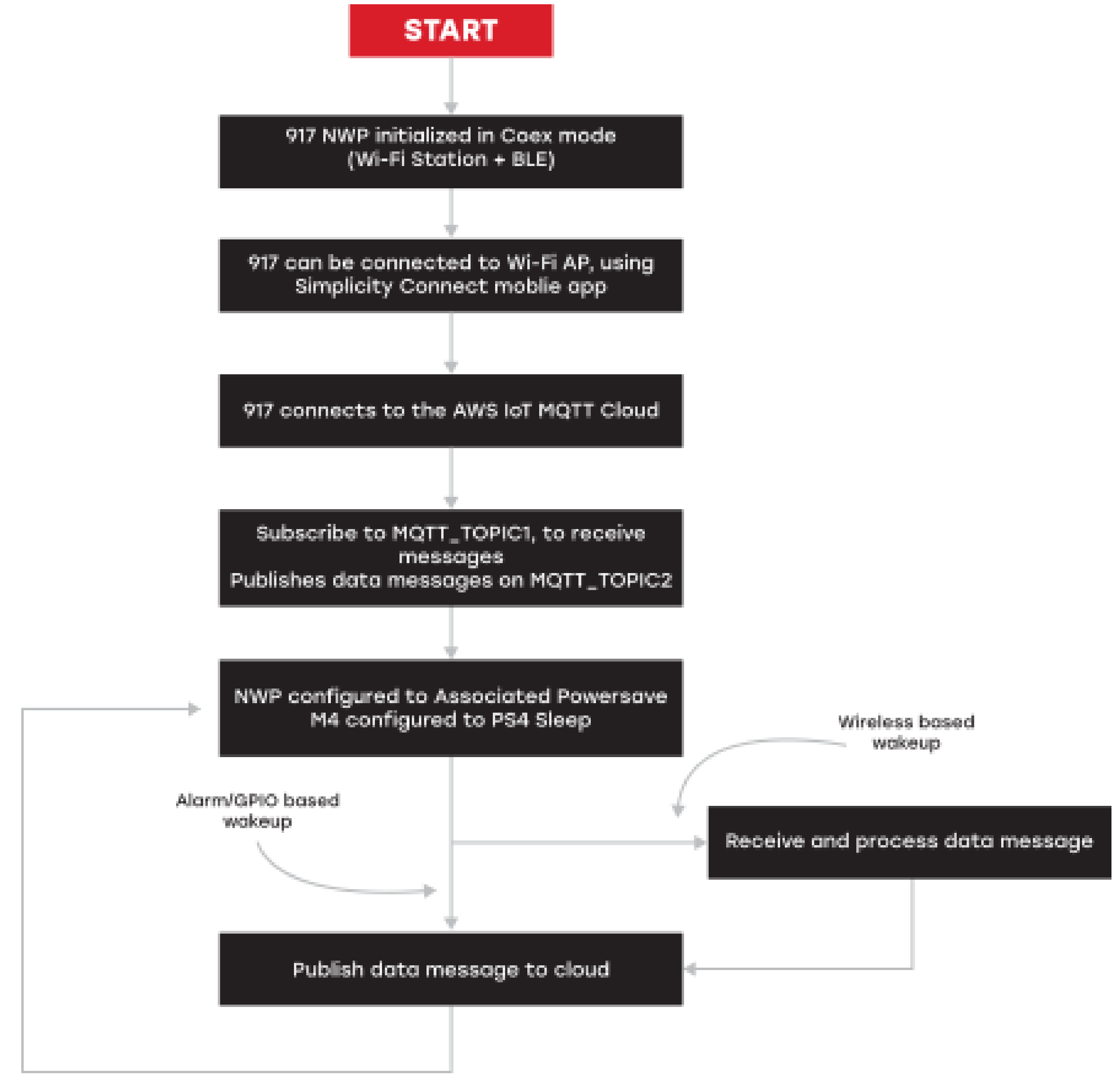
sl_si91x_i2c_driver_leader example

STEP 4

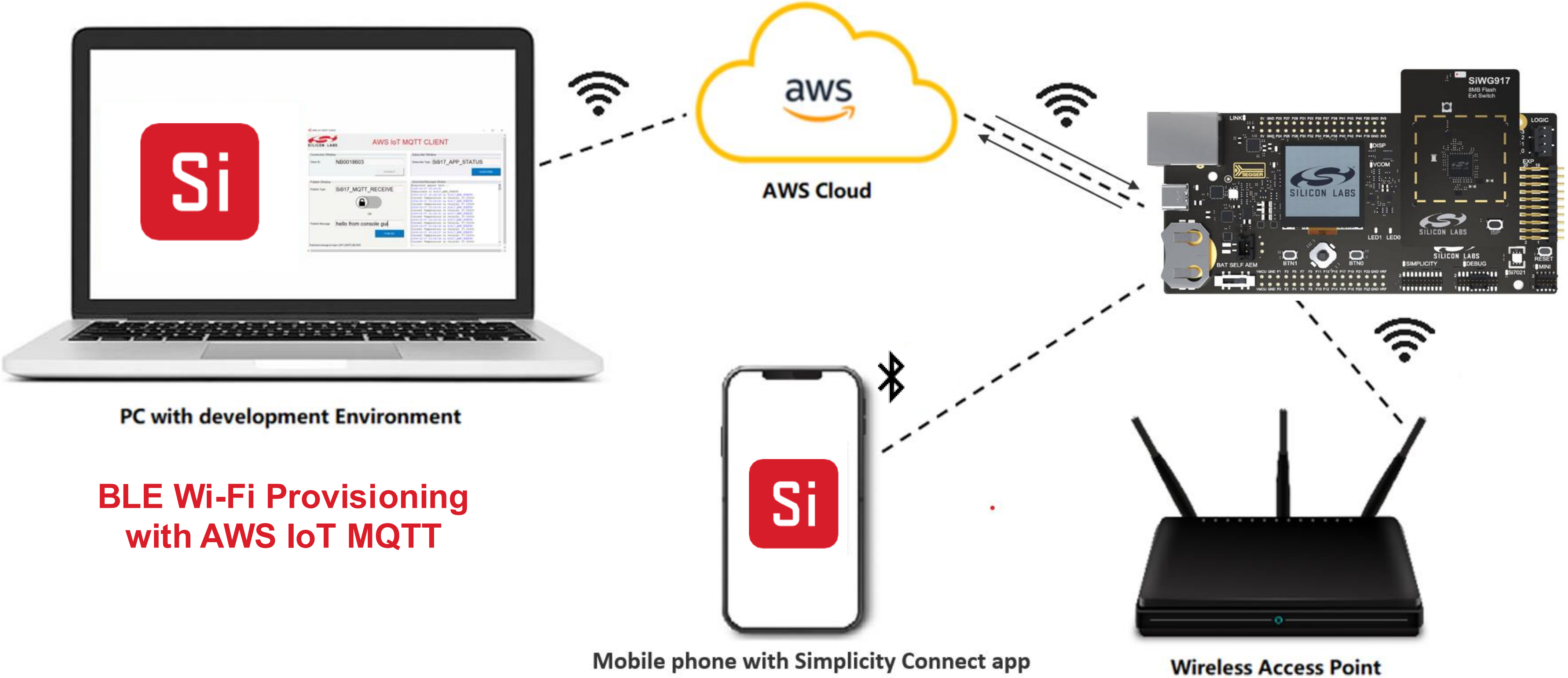
Add Functionalities to the Base Project

Add I2C and Si70xx temperature sensor components

Application Flow Chart

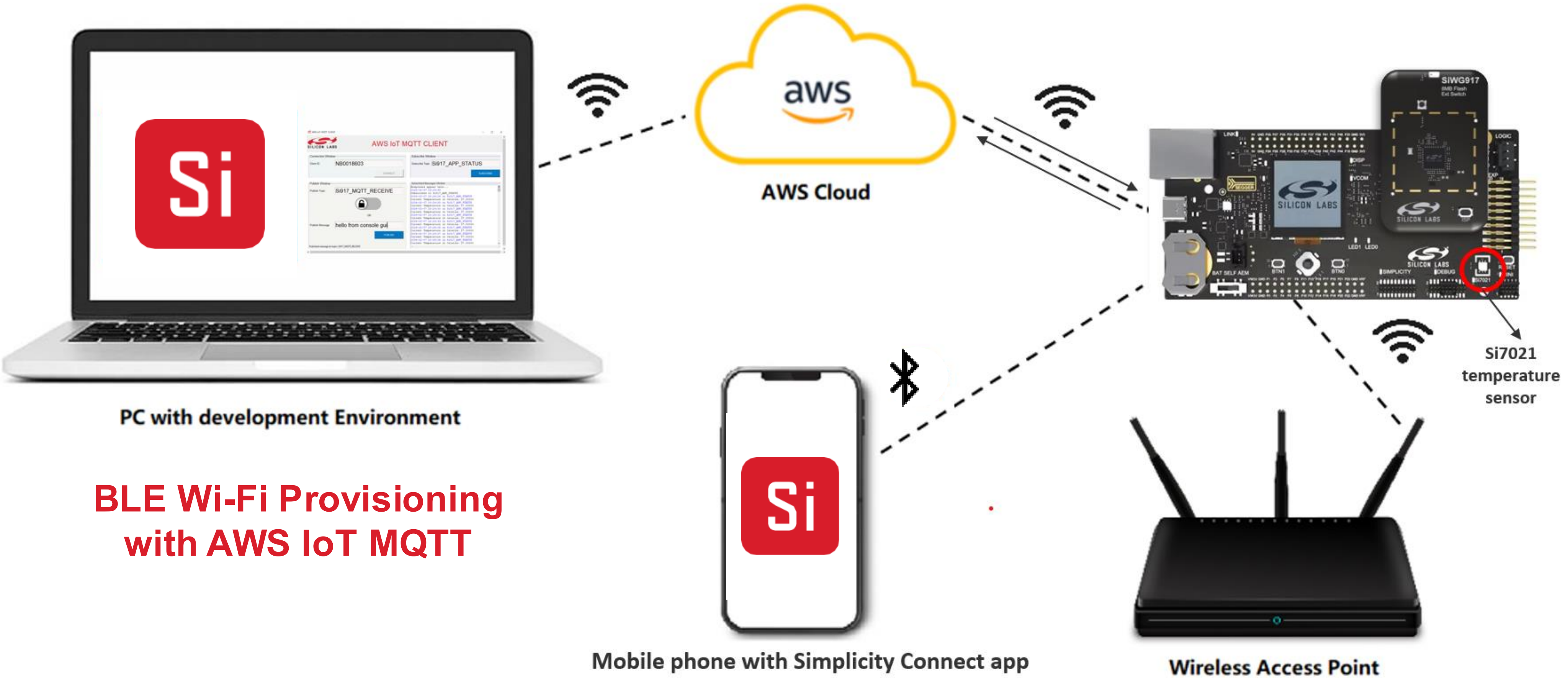


Base Project Analysis

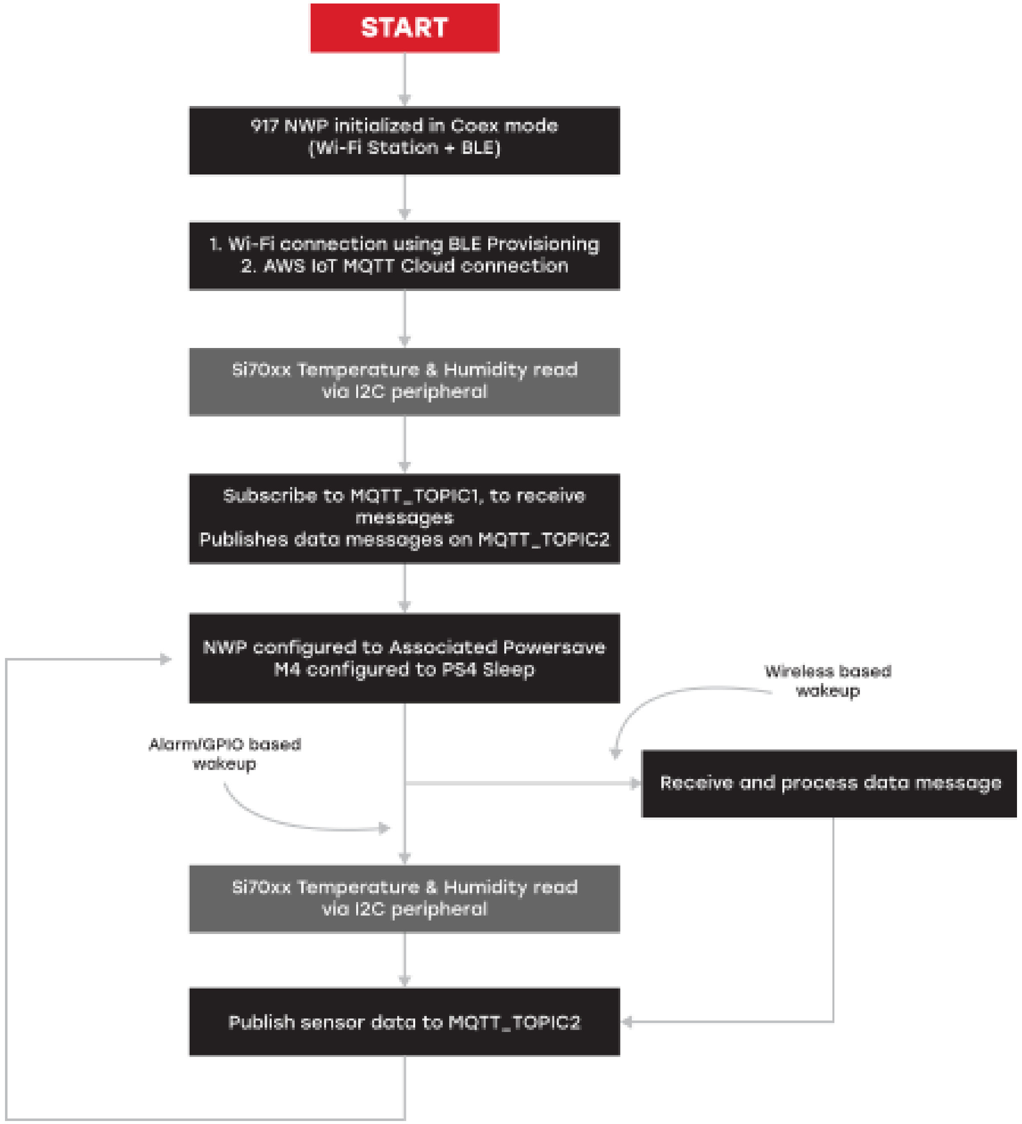


BLE Wi-Fi Provisioning with AWS IoT MQTT

Include Temperature Sensor Functionality



Application Flow Chart



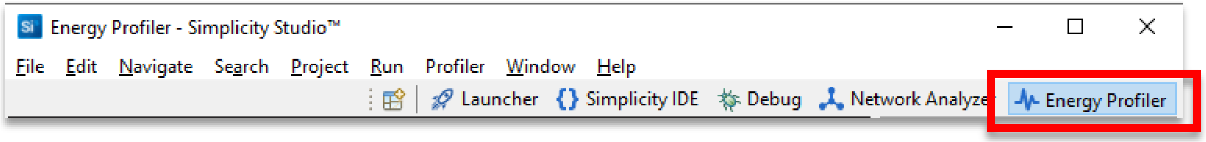
Measure Power Using Energy Profiler

SILICON LABS

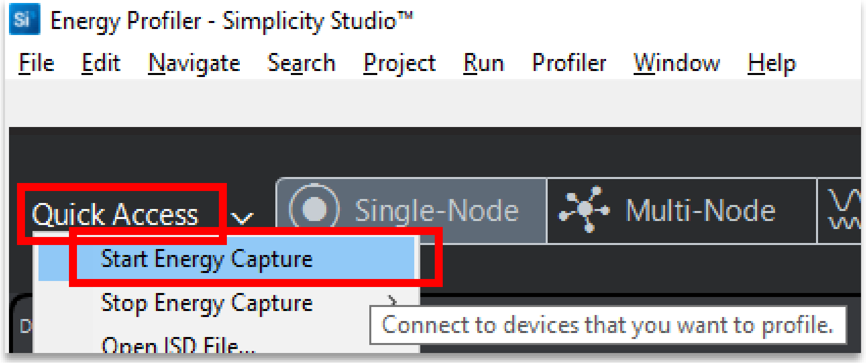
CONNECTED INTELLIGENCE

Measuring Power with Simplicity Studio

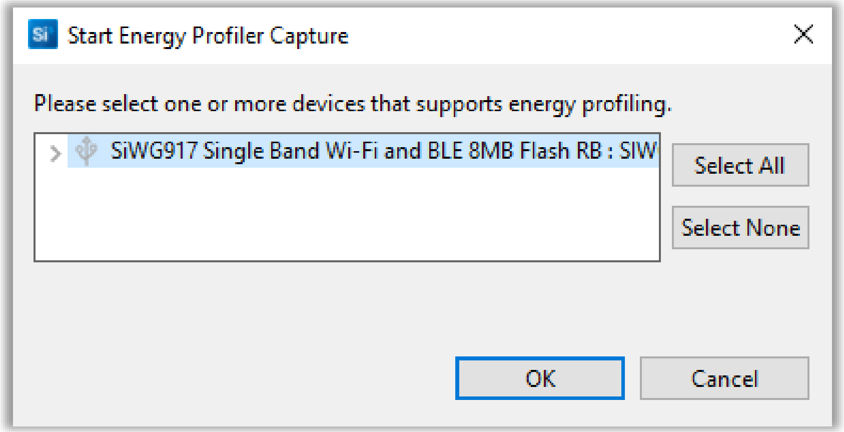
1. **Start the Energy Profiler:**



2. **Start Energy Capture:**



3. **Select connected device:**



[See 5-minute introduction video]

Note:
No debugging while in power saving

works with by SILICON LABS

Energy Profiling Wi-Fi Provisioning over BLE with AWS IoT MQTT Example

works with by SILICON LABS

Power-Optimized RTOS

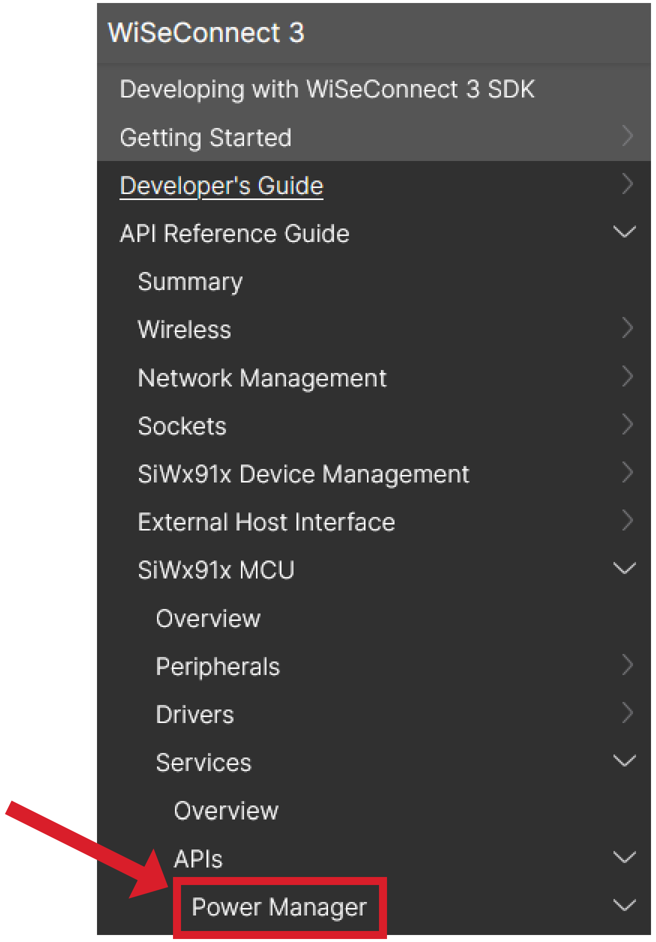
- Integrated FreeRTOS Tickless Idle mode
- Accessed via power manager API

```
sl_si91x_power_manager_add_ps_requirement(SL_SI91X_POWER_MANAGER_PS0)
```

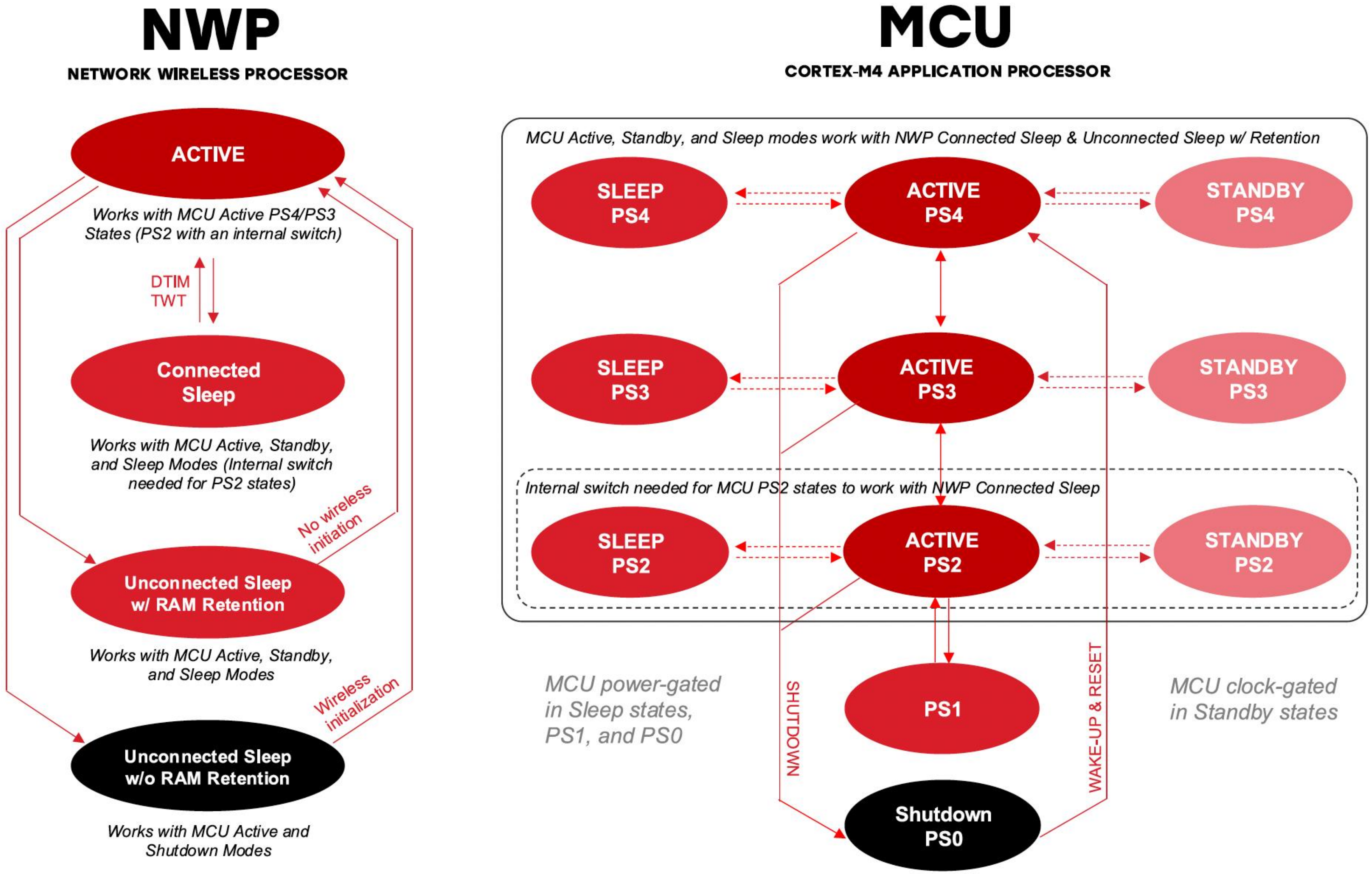
- **See detailed documentation at** https://docs.silabs.com/wiseconnect/latest/wiseconnect-api-reference-guide-si91x-services/power-manager

- **Examples to reference:**
  - SL Si91x - Power Manager M4 Wireless
  - Wi-Fi - Powersave Deep Sleep (SoC)

Documentation index



SiWx917 Power Modes and States



Power Optimized RTOS

- **Add and remove requirements**
  - Can add power state (ps) or peripheral requirements
    sl_si91x_power_manager_add_ps_requirement()
    sl_si91x_power_manager_remove_ps_requirement()
    sl_si91x_power_manager_add_peripheral_requirement()
    sl_si91x_power_manager_remove_peripheral_requirement()
- **Subscribe to events**
  - Get notified when the system transitions from one power state to another power state.
    sl_si91x_power_manager_subscribe_ps_transition_event()
    sl_si91x_power_manager_unsubscribe_ps_transition_event()
- **Sleep**
  - When all threads are waiting for an event, the system goes to sleep.

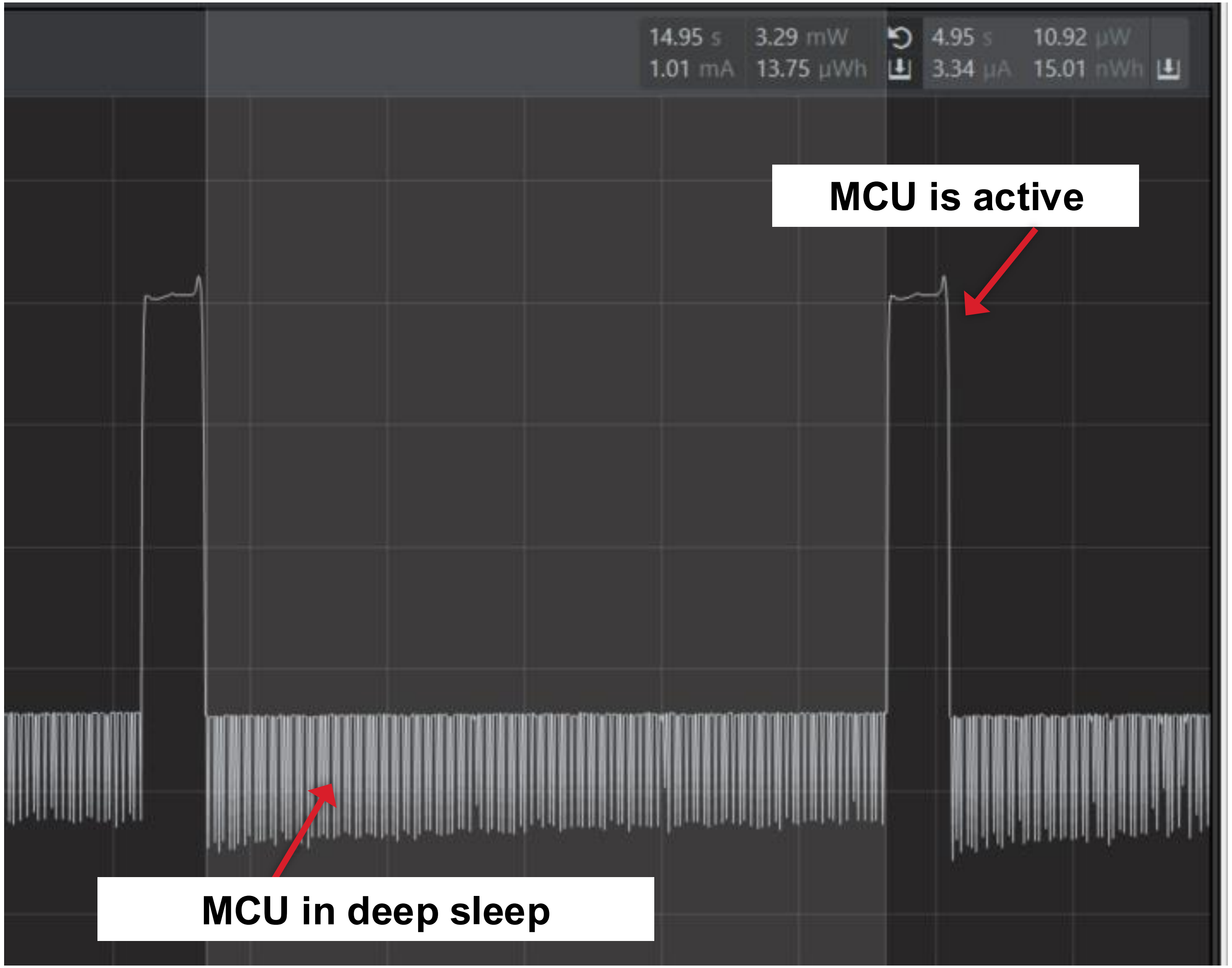
sl_power_state_t

```
sl_power_state_t
```

Enumeration for the power states.

Enumerator	
SL_SI91X_POWER_MANAGER_PS0	PS0 Power State.
SL_SI91X_POWER_MANAGER_PS1	PS1 Power State.
SL_SI91X_POWER_MANAGER_PS2	PS2 Power State.
SL_SI91X_POWER_MANAGER_PS3	PS3 Power State.
SL_SI91X_POWER_MANAGER_PS4	PS4 Power State.
SL_SI91X_POWER_MANAGER_SLEEP	Sleep.
SL_SI91X_POWER_MANAGER_STANDBY	Standby.
LAST_ENUM_POWER_STATE	Last enum for validation.

Power Optimized RTOS - Wi-Fi - Powersave Deep Sleep

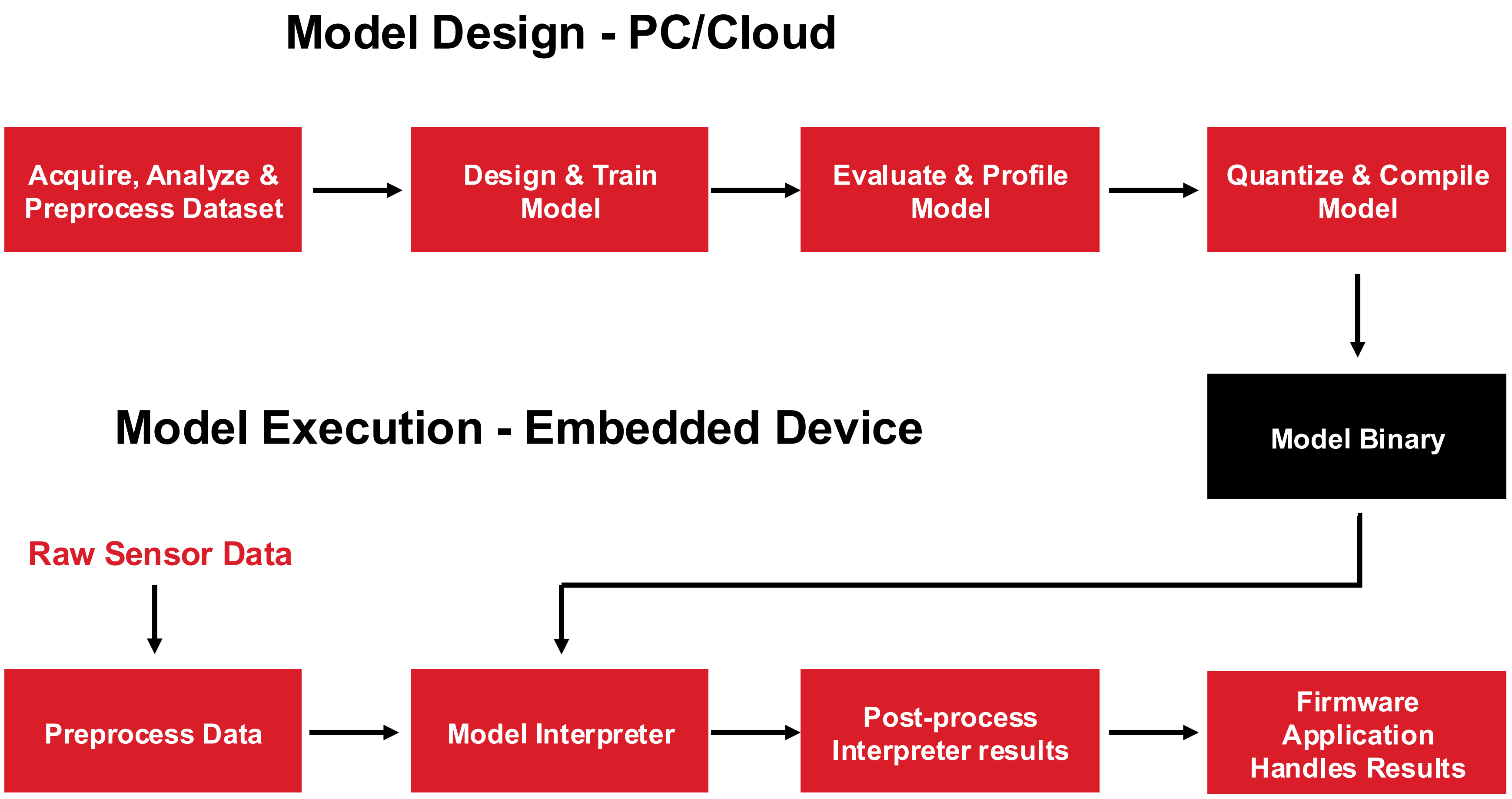


works with by SILICON LABS

AI/ML Keyword Spotting Example

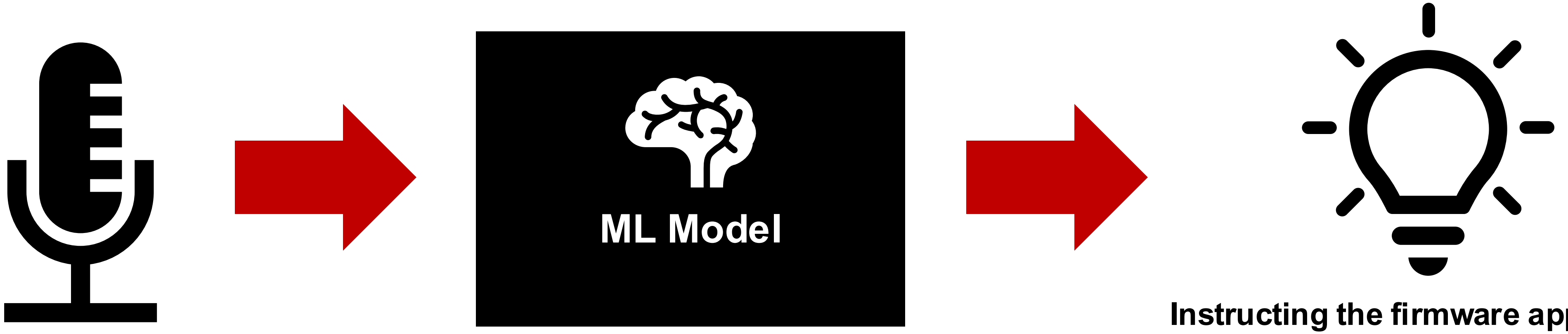
SILICON LABS
CONNECTED INTELLIGENCE

Typical Machine Learning Development Flow



Keyword Spotting

Typical keyword spotting example: Voice Controlled Smart Light

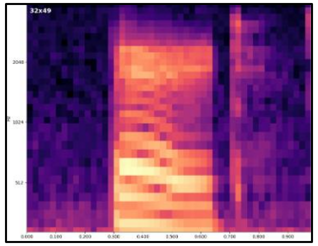


Instructing the firmware application
to turn the light ON/OFF

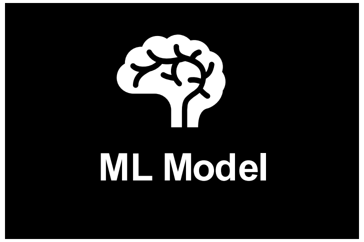
Implementing Keyword Spotting

Capture microphone audio

Convert to 2D spectrogram



Run spectrogram through the model



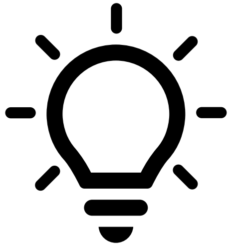
Output: Probability of each keyword being in the spectrogram

Classification:

On	95%
Off	4%
Silence	0.3%
Unknown	0.7%

```
IF MAX(averaged_predictions) > threshold:
   keyword_id = ARGMAX(averaged_predictions)
   notify_application(keyword_id)
```

Optional: Repeat this step 1-3 times and calculate a running average of each keyword's probability

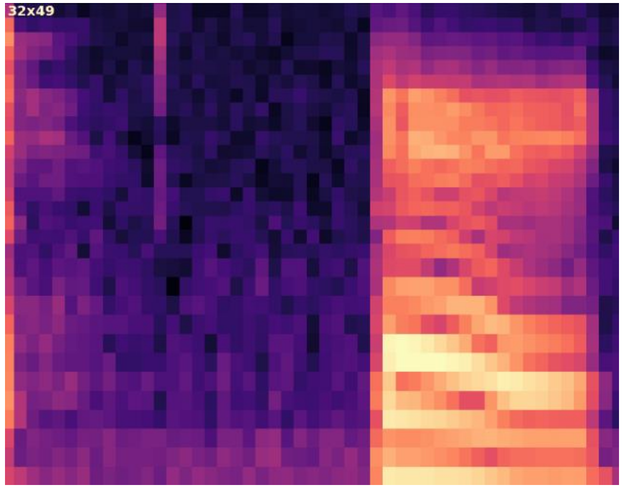


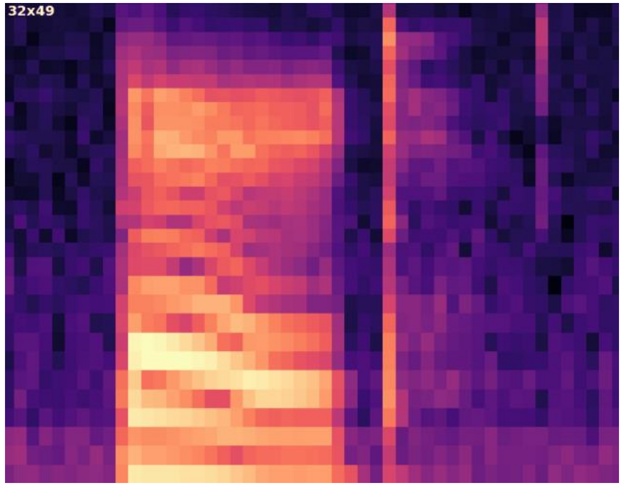
If the probability of a keyword exceeds a threshold, the keyword is considered detected. Instruct the application.

works with
by SILICON LABS

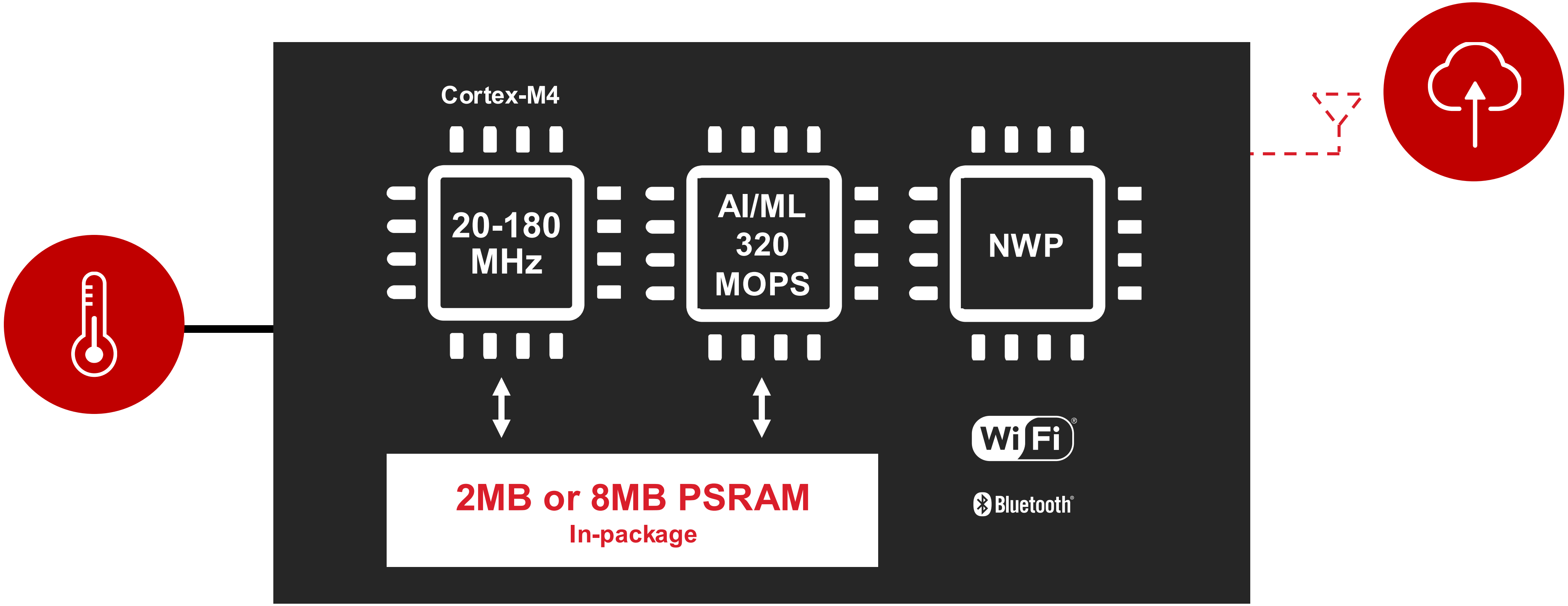
Keyword Spotting Latency Considerations

- Keyword detection requires the sample to be "seen" multiple times by the ML model for its average probability to exceed the threshold
- Processing time directly affects the device's ability to detect keywords
- The longer the device takes to process the audio sample, i.e., <Spectrogram generation time> + <ML interface time>, the fewer times a keyword is processed, which reduces the averaging, and the detection confidence
- 1 sec audio sample being processed in increments of 100ms vs 400ms





SiWG917 AI/ML Memory Configuration



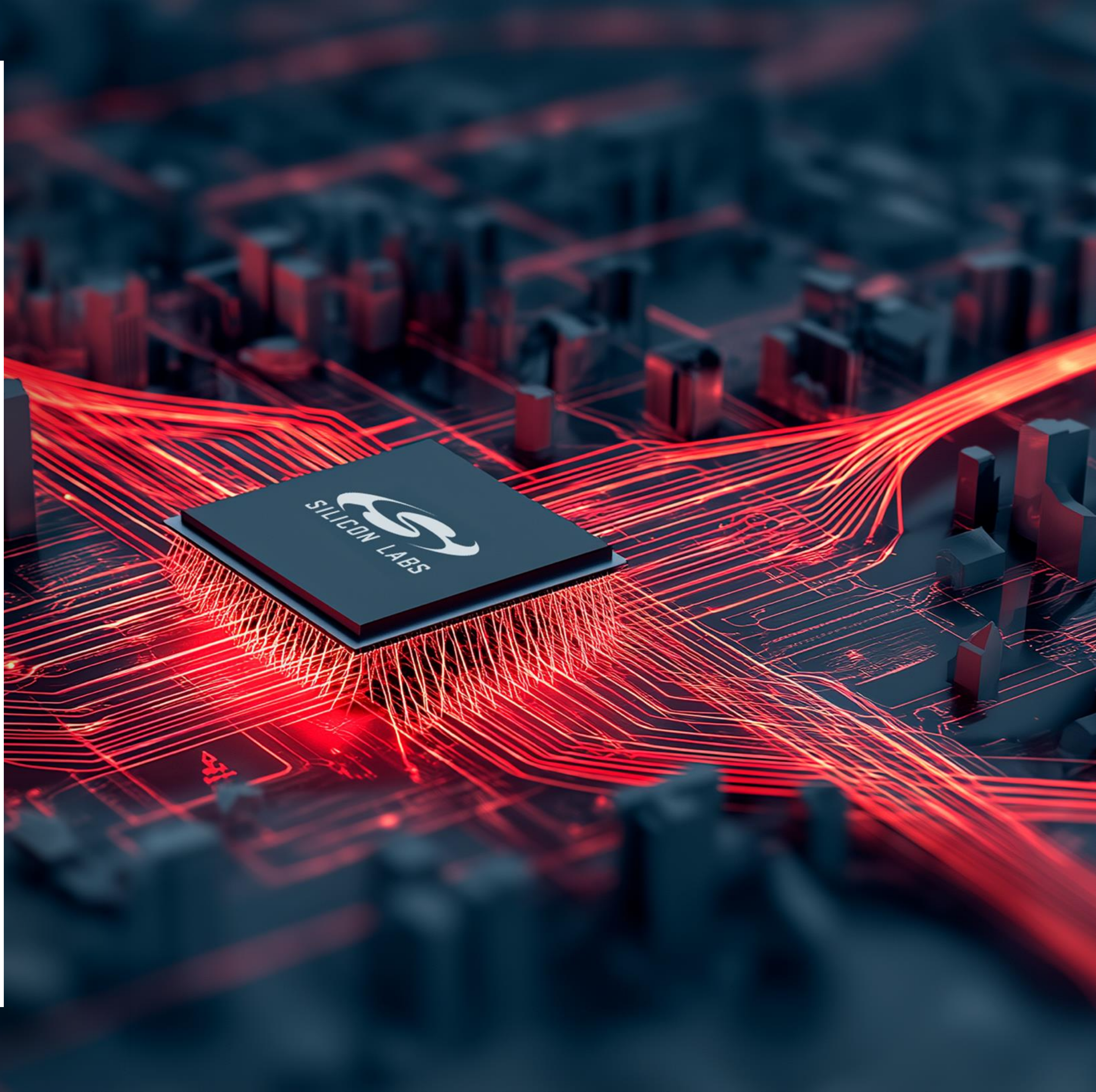
Large PSRAM available for Cortex-M4 and AI/ML accelerator

AI/ML Keyword Detection Example App

- **Voice assistant**
  - 10 words command set for smart appliance
  - Wake-word detection (Always-On voice)
  - Smart device voice control
- **Typical resource requirements**
  - RAM: 256kB
  - Ops/s: 50M-500M

Summary

- Get started on low power development
- Glimpse into modifying an AI/ML application
- Get started with energy efficient Application and AI acceleration on the Edge



SILICON LABS

CONNECTED INTELLIGENCE