2023 tech talks WEBINAR SERIES

Welcome

Machine Learning in Predictive Maintenance and Safety Using MG24

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SILICON LABS

BLUETOOTH SERIES

tech talks UPCOMING SESSIONS

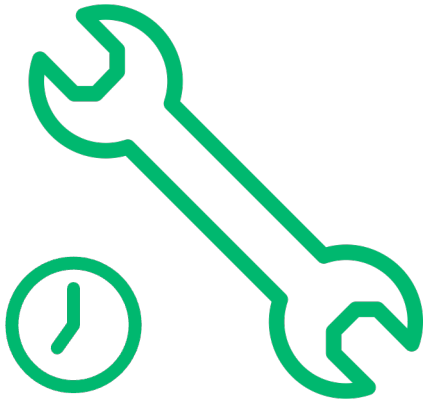
FEB 23RD	ML in Predictive Maintenance and Safety Applications
MAR 23RD	Unboxing: What's New With Bluetooth
APR 20TH	What's New with Bluetooth Mesh 1.1
MAY 18TH	Bluetooth Portfolio: What's Right for Your Application
JUN 15TH	The Latest in HADM With Bluetooth LE

Agenda

- What is Predictive Maintenance?
- Use of AI/ML at the Edge for Predictive Maintenance
- Silicon Labs' Solutions
- Machine Learning Tools
- Machine Learning Demonstration
- Summary & Available Resources
- Q&A

Predictive Maintenance and AI/ML

Preventative vs Predictive vs Reactive Maintenance

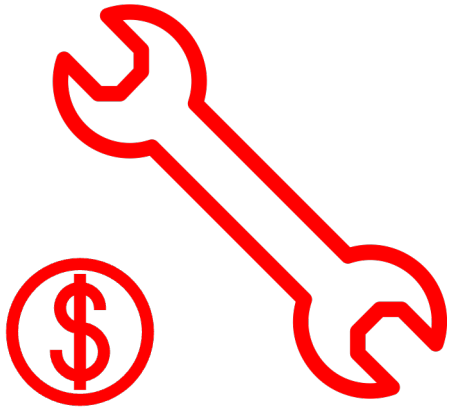


REACTIVE MAINTENANCE

Extended downtime, specific and expensive

PREVENTATIVE MAINTENANCE

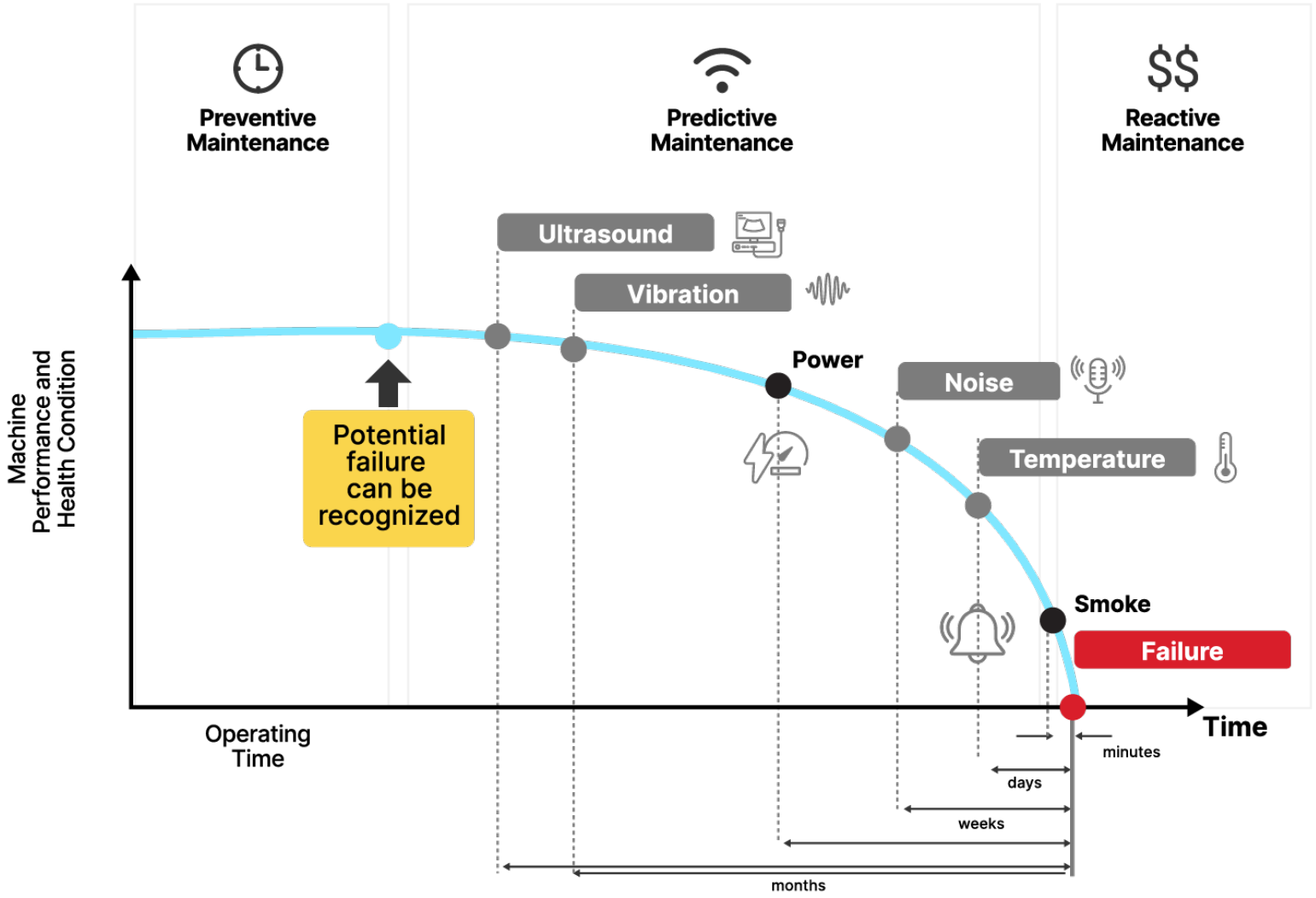
Routine downtime, unspecific, unintelligent and time-consuming



PREDICTIVE MAINTENANCE

Insightful, intelligent, automated, adaptable, scalable and efficient

Sensors for anomaly detection



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Why AI/ML at the Edge?

Low Latency Required

- Mission or safety-critical applications require real-time reactions
- Large data to process - typically at vision use cases - no time to upload to anywhere to process

Privacy and IP Protection, Security

- Data never leaves the sensing device, only inference result/metadata is transferred
- Less sensitive data to transmit, less chance to be hacked
- Protecting IP

Bandwidth and Power Constraints

- Long range, low power, and slow networks can't transfer all TimeSeries data to process somewhere else
- Overloading of mesh network is an issue
- Large data to chunk
- Process vs. transmit tradeoff in power cons.

Offline Mode Operation

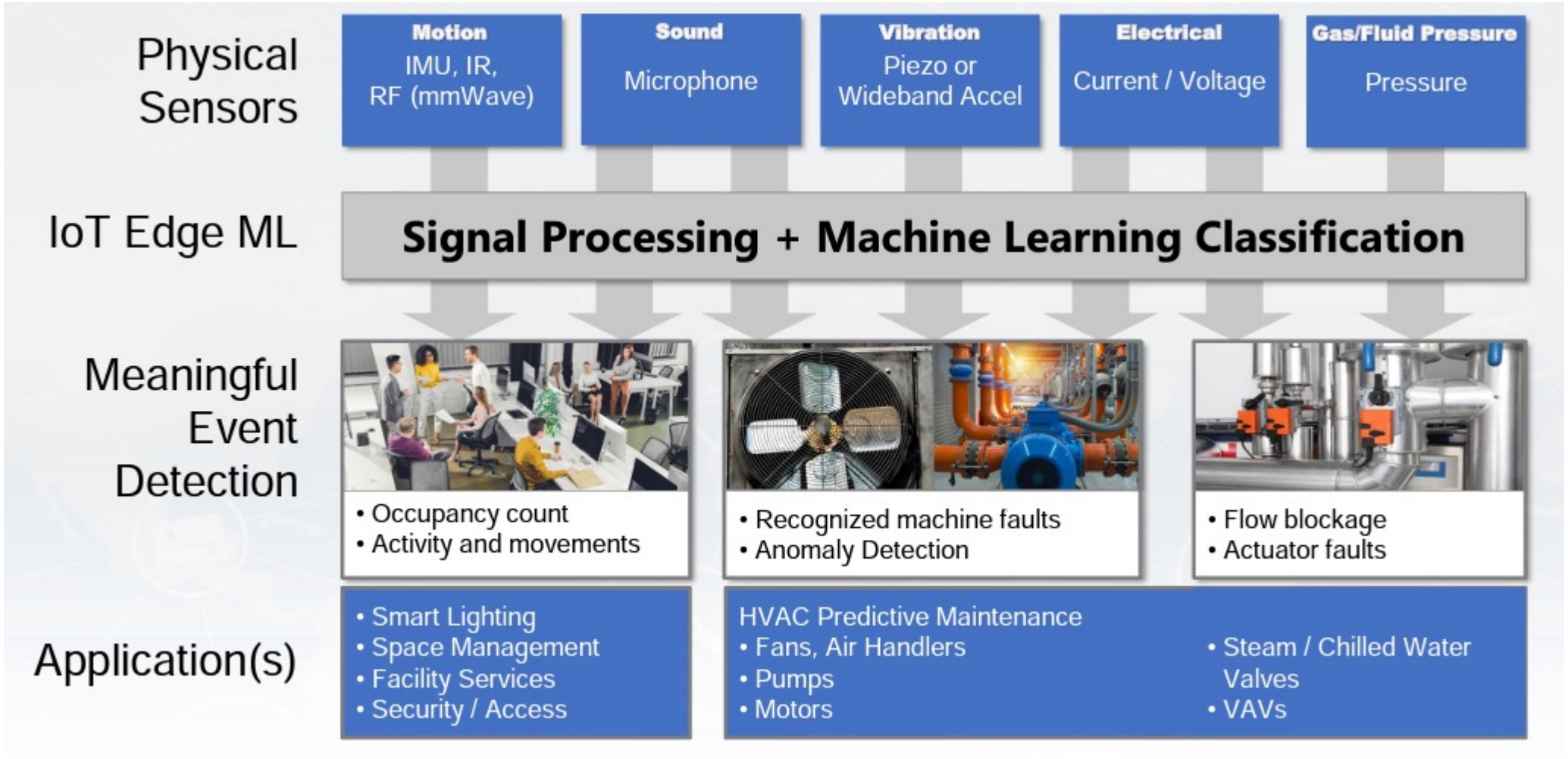
- Local system keeps operating standalone in case of any network issue
- Connectivity is occasional or blocked by admin

Cost Reduction

- Network and infrastructure costs
- Data ingestion costs
- Data storage costs
- Cloud services
- Ops, maintenance
- Compact edge with ML solutions integrated to wireless SoC

Data processing is more efficient with AI/ML at the Tiny Edge – various new use cases enabled

Use Cases for AI/ML at the Edge in Predictive Maintenance



- **Source:** SensiML – WorksWith 2021

Silicon Labs' Solutions for Predictive Maintenance

Silicon Labs' Predictive Maintenance Solutions

- *Silicon Labs* solutions cover a **variety of IoT protocols** suited for different range, power and topography.
  - **Wi-Fi 6** for long range and dense networks
    - With cloud connection and **Bluetooth LE** combo
  - Long-range low-power **Sub-Gig**
    - With **Bluetooth LE** and **Wi-SUN**
  - **Proprietary, 15.4** and **Wirepas Mesh**

- *Silicon Labs* hardware comes with state-of-the-art Security and **advanced MVP HW acceleration engines for AI/ML for ADC and GPIO time-series sensor** applications

BG24 and MG24: Optimized for Battery Powered IoT Mesh Devices

Sensing at the Edge

AI/ML Hardware Accelerator Key Features

- Optimized Matrix processor to accelerate ML inferencing with a lot of processing power **offloading the CPU**
- Real and complex data
- **up to 8x faster** inferencing over Cortex-M
- Up to **6x lower power** for inferencing
- Dedicated **Math library** to accelerate matrix and vector lin algebra ops

Low-Power SoCs and Modules Optimized for Battery Powered IoT Mesh Devices

High Performance Radio
-Up to +19.5 dBm TX
-97.6 dBm RX @ BLE 1 Mbps
-105.7 dBm RX @ BLE 125 kbps
-104.5 dBm RX @ 15.4
Improved Wi-Fi Coexistence
RX Antenna Diversity

Low Power
5.0 mA TX @ 0 dBm
19.1 mA TX @ +10 dBm
4.4 mA RX (BLE 1 Mbps)
5.1 mA RX (15.4)
33.4 µA/MHz
1.3 µA EM2 with 16 kB RAM

World Class Software
Simplicity Studio 5
Matter[1]
Thread[1]
Zigbee[1]
Bluetooth (1M/2M/LR)
Bluetooth mesh
Dynamic multiprotocol[1]
Proprietary

ARM® Cortex®-M33
78 MHz (FPU and DSP)
Trustzone®
Up to 1536kB of Flash
Up to 256kB of RAM

Dedicated Security Core
Secure Vault™ - Mid
Secure Vault™ - High

Low-power Peripherals
EUSART, USART, I2C
20-bit ADC, 12-bit VDAC, ACMP
Temperature sensor +/- 1.5°C
32kHz, 500ppm PLFRCO

AI/ML
AI/ML Hardware Accelerator

SoCs and Modules
5x5 QFN40 (26 GPIO) -125ºC
6x6 QFN48 (28/32 GPIO) -125ºC
7x7 SiP Module (+10 dBm)
12.9x15.0 PCB Module (+10 dBm)

[1]Requires MG24

AI/ML on Silicon Labs' Wireless SoCs

EFR32 Series 2 and Wi-Fi SoCs

Higher Performance Platform
- ARM Cortex M33 (78 MHz)
- Improved radio performance
- Lower power (MCU active, TX/RX)

Improved Security
- Secure Vault - Mid
- Secure Vault - High (select OPNs)

Acceleration - MVP
- AI/ML acceleration
- Faster AoA/AoD calculation
- Math library (matrix and vector ops)

AI Software
- TensorFlow Lite for Microcontrollers with accelerated kernels in GSDK
- 3rd Party end-to-end tools

All Series 2 SoCs support ML

EFR32xG24	SiWx917
SILICON LABS BG24	SiWx917 NEW
78MHz CortexM33	180MHz CortexM4
AI/ML accelerator	160 MHz NWP
1.5MB / 256kB	**AI/ML accelerator**
2.4 GHz radio	Up to 8MB / 672kB
20 dBm TX Power	2.4 GHz radio
Secure Vault	21 dBm TX Power
Low power	PSA L2 Security
	Low power

xG24-DK2601B Developer kit

Broad Range of Sensors
- 9-axis Inertial Sensor
- 2 Digital Microphones
- PIR sensor
- Pressure Sensor
- Relative Humidity and Temperature Sensor
- UV and Ambient Light Sensor
- Hall-effect Sensor

Ready to demonstrate ML
- Sample applications in GSDK
- Examples on GitHub
- Examples and tutorials in MLTK
- Many sample applications and demos from partners
- Plug&Play Sensor extensions with Sparkfun Qwiic

sparkfun ELECTRONICS

TensorFlow Lite

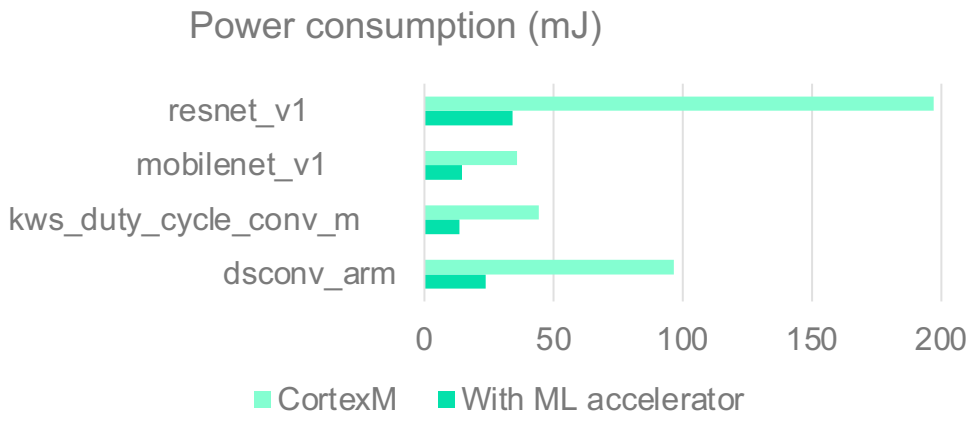
Common Machine Learning software and tools on our Wireless SoC portfolio

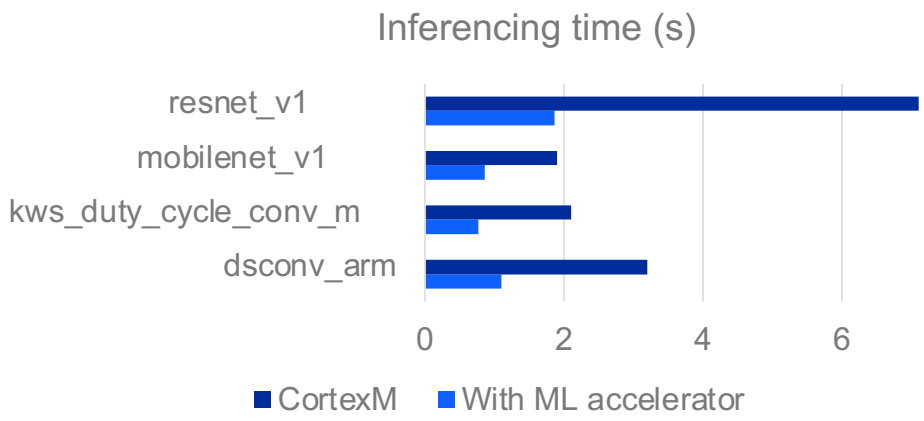
Use cases are dependent on RAM and wireless stack

Benefits of the ML Hardware Accelerator

- Dedicated **ML computing subsystem** next to the CPU
- Optimized Matrix Vector Processor (MVP) to accelerate ML inferencing with a lot of processing power **offloading the CPU**
- **Up to 8x faster** inferencing over Cortex-M
- Up to **6x lower power** for inferencing
- Dedicated OPNs for MVP accelerated parts → EFR32MG24B[2]… or [3]

Inferencing with ML hardware accelerator vs. CortexM*





*Internal performance benchmarking with standard ML models. Results are for inferencing only (not for the complete application)

Machine Learning Tools

Software and Tool Support

ML Expert

Python scripts and tutorials

SILICON LABS
Machine Learning Toolkit*

siliconlabs.github.io/mltk

TensorFlow

TFLite Flatbuffer

TFLite-micro Interpreter

CMSIS-NN Kernels | Silicon Labs HW-based Kernels

Cortex M | MVP (NPU)

ML Explorer

GUI Developer Tools

EDGE IMPULSE
edgeimpulse.com

SensiML™
sensiml.com

Anomaly Detection

Micro.ai
micro.ai

TFLite-micro Interpreter

CMSIS-NN Kernels | Silicon Labs HW-based Kernels

Cortex M | MVP (NPU)

ML Solutions

Solution Libraries

Wake Word / Voice Command

sensory
sensory.com

System Integrators

KLIKA·TECH GLOBAL IOT SOLUTIONS

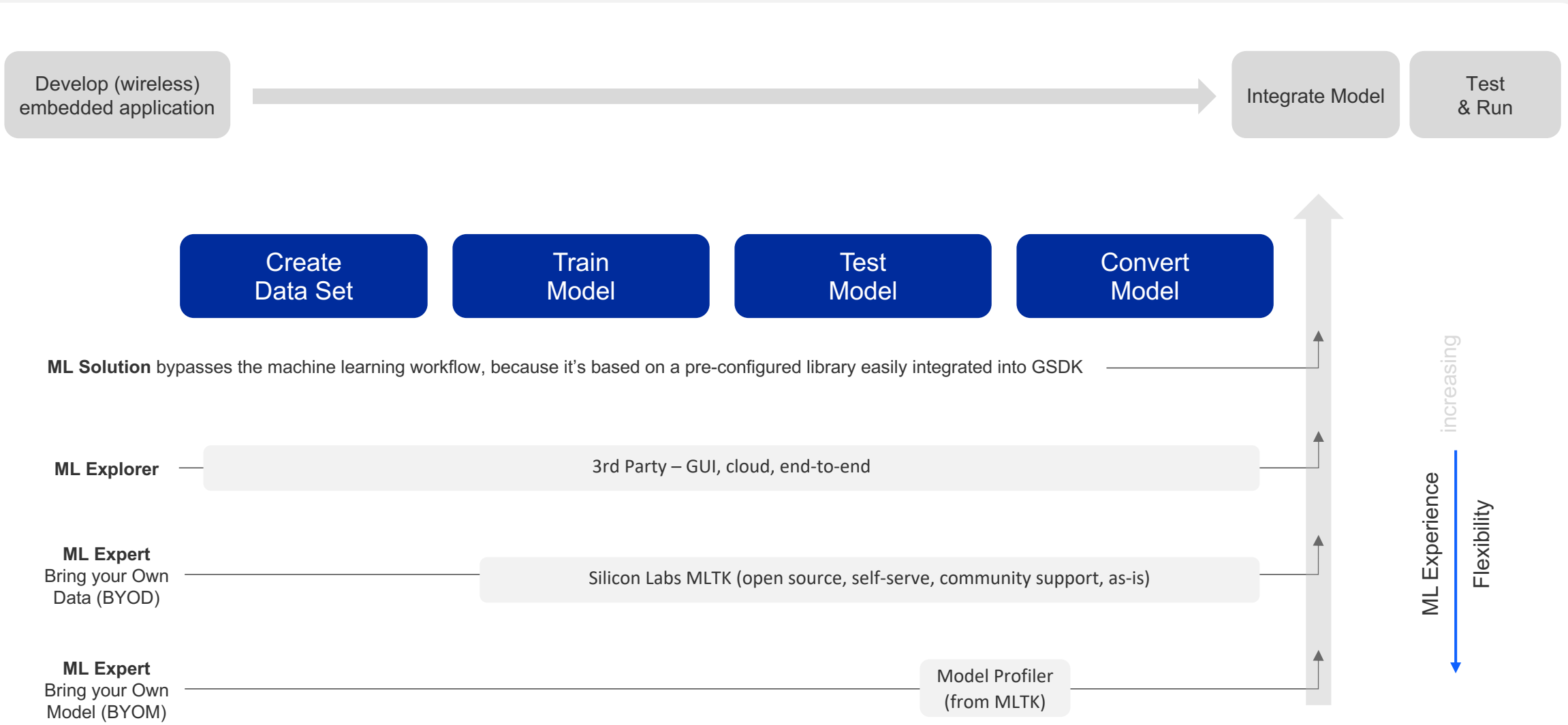
AITAD

Talent·Technology·Solutions Bellintegrator

Cortex M (& MVP)

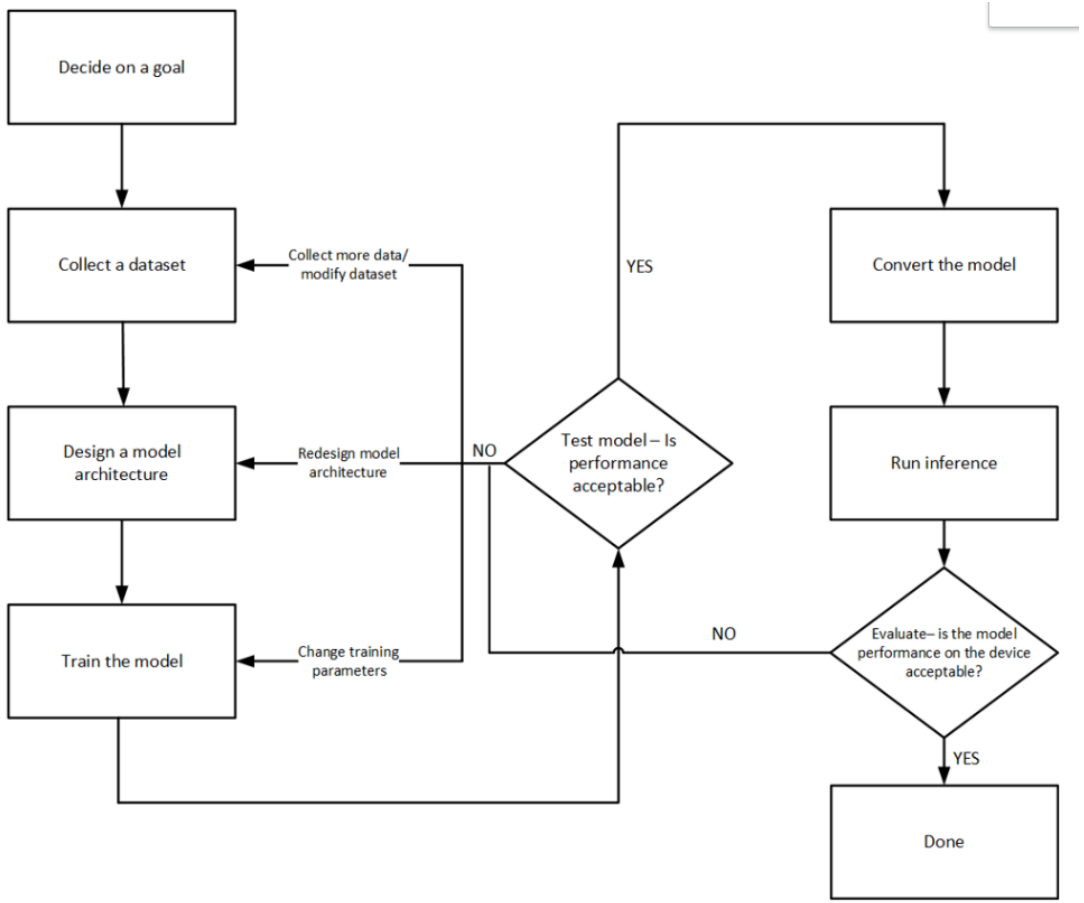
*Machine Learning Toolkit is public but pre-alpha release

Embedded Development with Machine Learning (supervised)



Machine Learning Development Steps

- **Goal**
  - What are you trying to achieve?
- **Collect a dataset**
  - Construct a dataset that you will use to train the model, some will be kept aside for testing the model.
- **Design Model architecture**
  - It is not the raw data that is inputted into the model, it is the pre-processed data.
  - Therefore, we must choose a pre-processing block that is relevant for the type of data we are dealing with.
- **Train the Model**
  - About 80% of the dataset should be used at this stage.
  - the desired output is good predictions on generalized inputs.
  - Need to avoid underfitting and overfitting.
- **Test the Model**
  - check the performance of the model

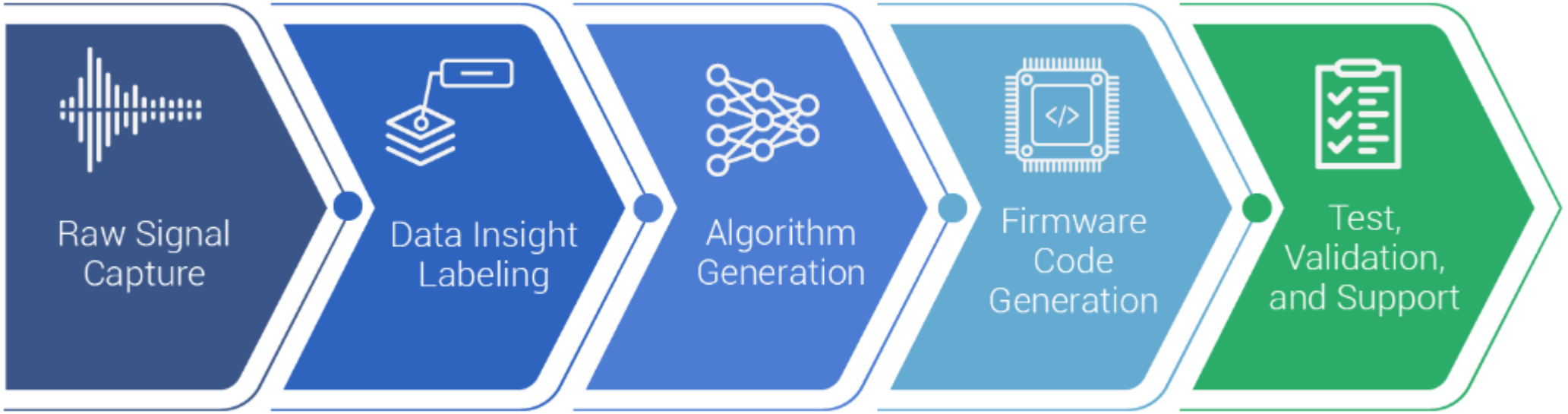


Benefit of Adding Bluetooth LE

- Is a long range, high data rate, low latency wireless technology that has become ubiquitous.
- Has become the ‘defacto’ means of provisioning a device.
- Is very useful in particular in ML-based applications where we expect it can support the training of a model in the field, as well as local data access where necessary.
- BLE Mesh is used in some applications as the primary bearer in Industrial space today, and thus provides a cost-effective option for a ML sensor application where perhaps 15.4 is not proscribed.

Machine Learning Demonstration

Example ML Process – SensiML



Example ML Process

SensiML · GitHub | SensiML™ Analytics Studio

github.com/sensiml?q=xg24&type=all&language=&sort=

SiLabs Links | Silabs Internal | Silabs Miscell | SiLabs KB | Security Info | SiLabs Training | Software Dev | Other | RAIL: RAIL Library | Micrium Document... | duel | Gecko Bootloader... | Search Results | Sili... | Knowledge Base - B... | psd | News / Blogs

6 results for **all** repositories matching **xg24** sorted by **last updated**

Clear filter

sensiml_xG24_dual_audio_imu_capture Public
Example of dual IMU and Audio recognition
C ☆ 2 2 1 1 Updated on Sep 16, 2022

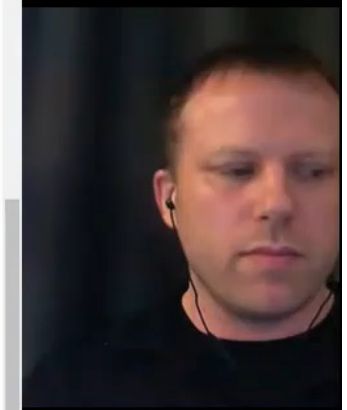
sensiml_xG24_recognition_dual_IMU_audio Public
Recognition app that uses both IMU and audio sensor data
C ☆ 1 BSD-3-Clause 2 0 0 Updated on Sep 14, 2022

SensiML_xG24_Microphone_Recognition Public
Example of using Sensiml tools to build a microphone recognition app for the Silicon Labs xG24 demo board
C ☆ 0 0 0 0 Updated on Aug 25, 2022

SensiML_xG24_IMU_Recognition Public
Example app for the Silicon Labs xG24 to recognize up/down and side/side
C ☆ 0 0 0 1 Updated on Apr 27, 2022

SensiML_xG24_Microphone_Capture Public
Project to demonstrate capturing microphone data on an XG24
C ☆ 0 0 0 0 Updated on Apr 27, 2022

SensiML_xG24_IMU_Capture Public
App to capture accelerometer and gyroscope data from xG24 dev board
C ☆ 0 0 0 0 Updated on Apr 27, 2022



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Summary & Resources

Machine Learning Development Kit

xG24-DK2601B Dev Kit (on MG24)

- **Wireless SoC with multi-protocol radio**
- **ARM® Cortex-M33 with TrustZone, 256 kB RAM and 1536 kB Flash, 80 MHz**
- **AI/ML Hardware Accelerator**
- **Broad Range of Sensors**
  - 9-axis Inertial Sensor
  - 2 Digital Microphones
  - Pressure Sensor
  - Indoor Air Quality and Gas Sensor
  - Relative Humidity and Temperature Sensor Si7021
  - UV and Ambient Light Sensor
  - Hall-effect Sensor Si7210
- **https://www.silabs.com/development-tools/wireless/efr32xg24-dev-kit**

Resources

- **Demos Available:**
  - SensiML Predictive Maintenance Demo
- **Silicon Labs AI/ML Resources:**
  - ML Web Landing Page
  - ML Doc Landing Page
  - Machine Learning Fundamentals
- **Partners' Resources:**
  - Edge Impulse
  - SensiML
  - MicroAI

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Join Us Next Month

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MAR 23RD	Unboxing: What's New With Bluetooth
APR 20TH	What's New with Bluetooth Mesh 1.1
MAY 18TH	Bluetooth Portfolio: What's Right for Your Application
JUN 15TH	The Latest in HADM With Bluetooth LE

Bluetooth LE Workshops

Attend an in-person workshop that will enable you to quickly develop an IoT product leveraging Bluetooth LE

- Free MG24 Multiprotocol Explorer Kit
- Locations and dates in the US, Canada, and Europe now through June
- Customized workshops for smart home, industrial, healthcare, and consumer applications

Sign up here

2023 tech talks
WEBINAR SERIES

Thank You

Watch ON DEMAND