

# Seamless TinyML lifecycle management

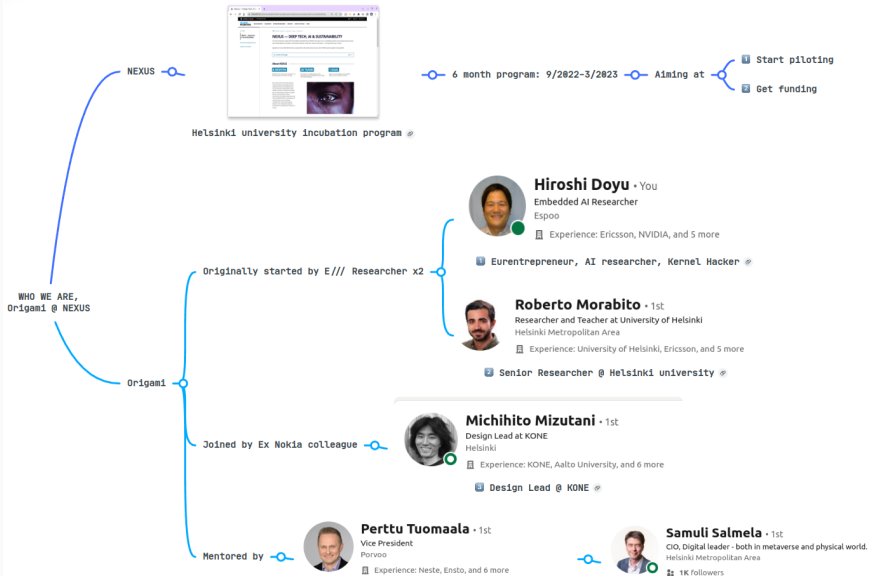
---

In Software Engineering Project with University of Helsinki CS

16/1/2023

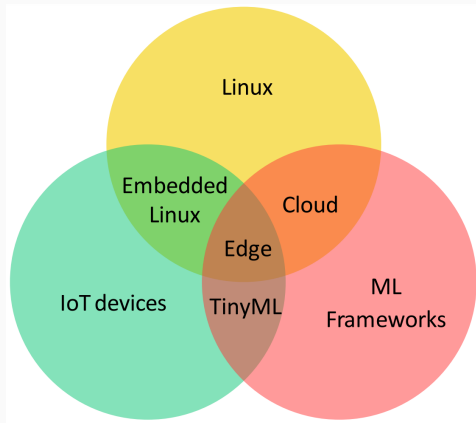
Origami@NEXUS: Hiroshi Doyu, Roberto Morabito, Michihito Mizutani

# Who we are, Origami\*



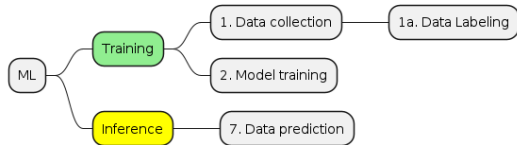
## Project goal

*“The main goal of this software engineering project is to develop a solution that enables a seamless **TinyML lifecycle management**. In particular, the idea is to build a framework that **in an automated fashion** performs the different steps of the TinyML lifecycle management.”*, from **the original application**

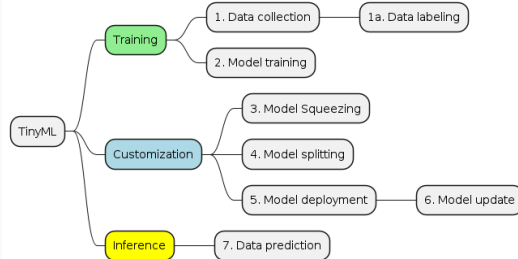


# Lifecycle of: ML vs TinyML

## (Cloud) ML

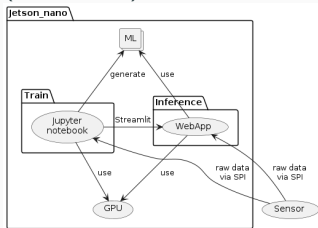


## TinyML

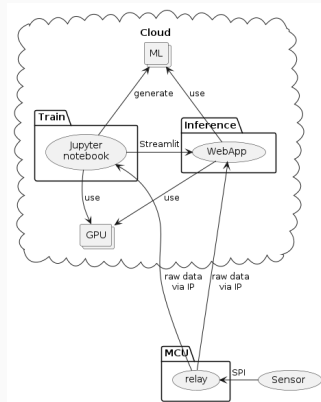


# Arch: Edge ML vs Cloud ML vs TinyML

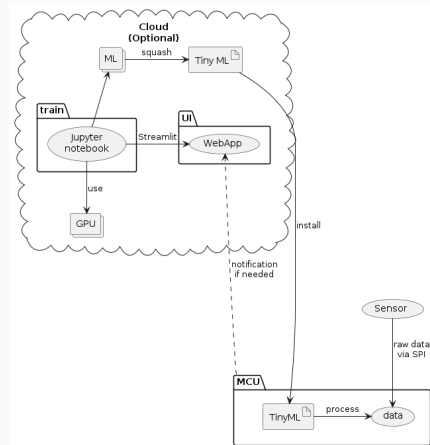
## Edge ML (Local ML)



## Cloud ML



## TinyML



# TensorFlow Lite for Microcontrollers\*

## ML model Examples

- hello\_world
- magic\_wand
- memory\_footprint
- micro\_speech
- mnist\_lstm
- network\_tester
- person\_detection

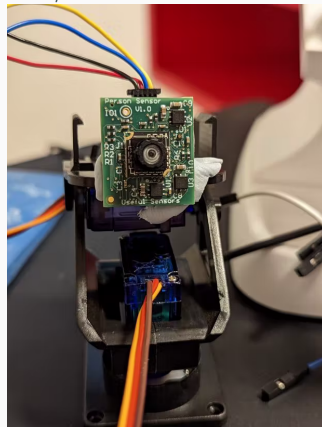
## Supported platforms

TensorFlow Lite for Microcontrollers is written in C++ 11 and requires a 32-bit platform. It with many processors based on the [Arm Cortex-M Series](#) architecture, and has been ported including [ESP32](#). The framework is available as an Arduino library. It can also generate pre environments such as Mbed. It is open source and [can be included in any C++ 11 project](#).

The following development boards are supported:

- [Arduino Nano 33 BLE Sense](#)
- [SparkFun Edge](#)
- [STM32F746 Discovery kit](#)
- [Adafruit EdgeBadge](#)
- [Adafruit TensorFlow Lite for Microcontrollers Kit](#)
- [Adafruit Circuit Playground Bluefruit](#)
- [Espressif ESP32-DevKitC](#)
- [Espressif ESP-EYE](#)
- [Wio Terminal: ATSAM51](#)
- [Himax WE-I Plus EVB Endpoint AI Development Board](#)
- [Synopsys DesignWare ARC EM Software Development Platform](#)
- [Sony Spresense](#)

## Realtime Face-Following Pan/Tilt Stand\*

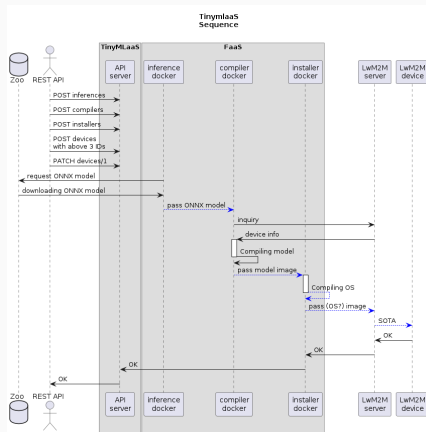


# Automate lifecycle with TinyML as-a-Service

## OpenAPI spec for TinyMLaaS (Old)

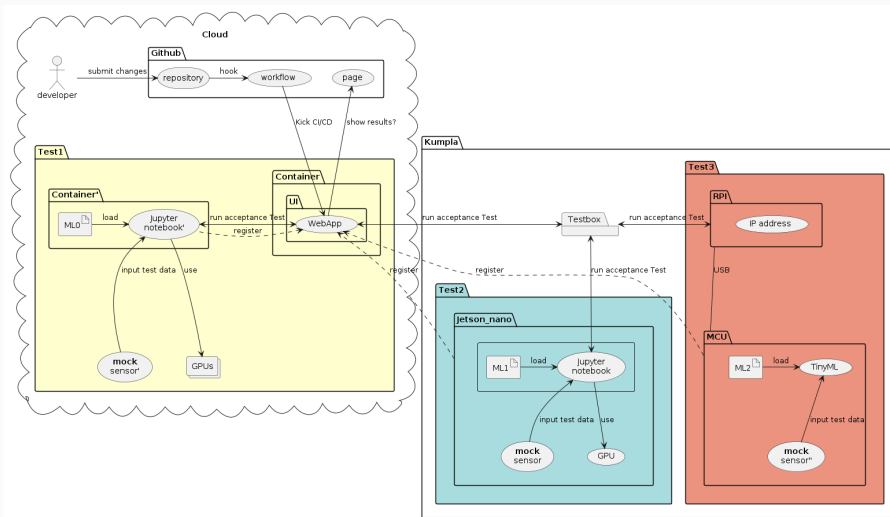
SwaggerHub interface showing the OpenAPI specification for TinyMLaaS. The interface displays the API endpoints and their details, including parameters, request bodies, and responses. The API is titled 'loop-back\_appli...' and version '1.0.0'.

## Function as-a-Service (FaaS)



TinyMLaaS orchestrates TinyML on *any IoT system*.

# CI / CD / ATDD

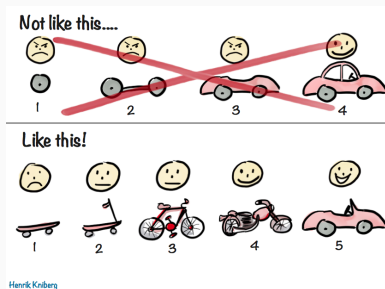


The simplest **Test1**: *TFLite micro Hello World* in x86 container w/o HW.



# MVP iteration

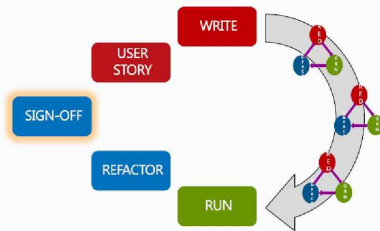
## Runnable MVP at Day1



## ATDD<sup>a</sup>

(Acceptance Test Driven Development)

- ▶ Select User story
- ▶ Write Acceptance Test
- ▶ Implement User Story
- ▶ Run Acceptance Test
- ▶ (Refactor)
- ▶ Get Sign-Off



<sup>a</sup>How to ATDD with Streamlit in Gitlab

## User story: *As a [persona], I [want to], [so that]*

### **As a Data Scientist, at training,**

- I want to collect data to train
  - I want to label data to train
- I want to train models to use devices
- I want to store models to assign

### **As a on-site IT operator,**

- I want to register:
  - IoT devices to observe
  - models to update
  - toolchain to compile
- I want a control panel:
  - to assign models
  - to build ML pipelines

### **As a Tech support, I want:**

- a dashboard to observe devices
- automated dry-run of a whole lifecycle to sort support requests

### **As a Financial, I want to:**

- compare Cloud vs TinyML in cost
- pipeline Cloud & TinyML for flexibility

.....

### **Origami**

<https://Origami-TinyML.github.io/blog/about.html>