Seamless TinyML lifecycle management

In Software Engineering Project with University of Helsinki CS

16/01/2023

Origami@NEXUS

Basic info (1/2)

- Here's the original announcement
- Here's our proposal, Seamless TinyML lifecycle management
- 5 students are assigned to our project.
- 15 working hours / week / student is expected.
- The project duration, 14 weeks (week 3-16), is scheduled.
  - 15 hours * 14 weeks * 5 students
  - = 1050 hours / 7.5 hour
  - = 140 man days / 22
  - = 6.4 man month

Basic info (2/2)

Milestone

1. MWC is at the end of FEB on week 9.
2. NEXUS Demo day is on 27th March on week 13.

Project duration:

1. Originally, 14 weeks, week 3-16
2. Preferably, 12 weeks, week 3-14
3. Ideally, 10 weeks, week 3-12

Weekly work hours

- 15 hours * 14 weeks = 210 hours
  1. Originally, 210 hours / 14 weeks = 15 hours/week
  2. Preferably, 210 hours / 12 weeks = 17.5 hours/week
  3. Ideally, 210 hours / 10 weeks = 21 hours/week

Can UI (Dashboard & Control panel) parts be prioritized to meet some milestones?

Project goal (1/2)

We will reproduce Roberto's demo video, adding its ML training phase, along with TinyML MCU. While this demo uses relatively large hardware which may not belong to TinyML strictly (e.g. TinyML should run on RTOS but not on Linux), we are gradually migrating to TinyML MCUs. There are 4 benefits of starting with the original setting:

1. Jetson nano is a standalone GPU, where we run the following app locally at once before starting pipelining on other nodes.
   - Computer Vision apps, inc. ML models
   - dashboard on a webserver
   - Jupyter notebook

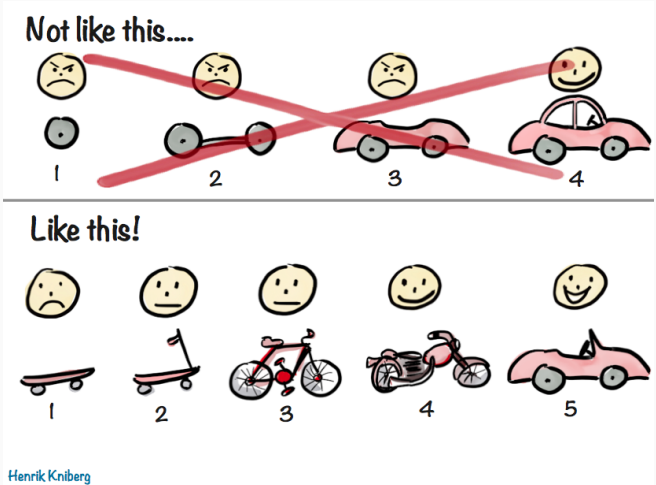
Project goal (2/2)

2. We could learn from Jetson nano mature tool-stack what kind of tool-stack is still missing to implement TinyMLaaS.
3. We could start with this existing demo immediately with runnable CI, and
4. We are polishing it more fancy gradually towards TinyML as-a-Service.
5. We could gradually migrating to TinyML by adding or replacing a node one by one.
    - For example, we could replace the data acquistion node with:
        a. Camera sensor + Arduino Nano 33 BLE Sense + RPI (for IP)
        b. Camera sensor + RPI pico with WiFi

Although Our final goal is to run ML on a mirocontrooler node, it's better to start with the safer configuration at first.

MVP journey

We should always have a runnable MVP automatically generated by CI/CD at every Sprint (or PR).



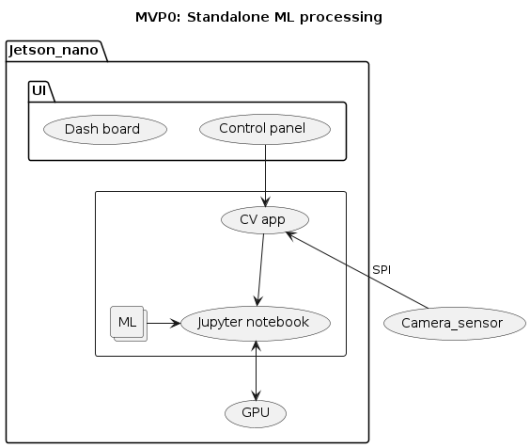
MVP0

Jetson nano is almost a laptop with GPU so that everything should work standalone.

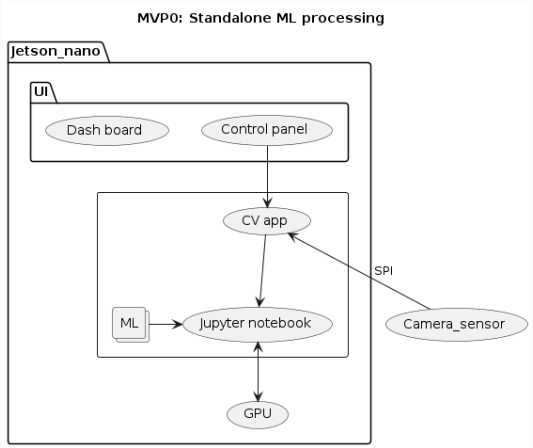
ML pipeline

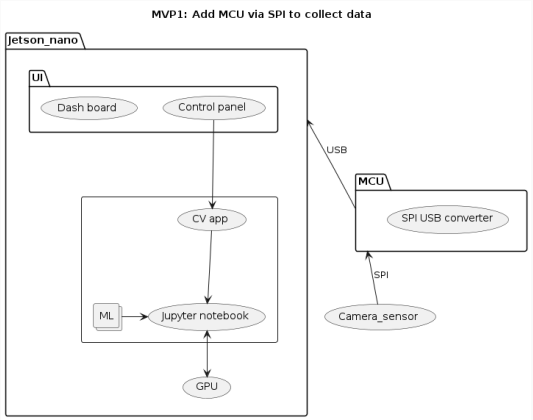
1. Object detection
2. -> face detection
3. -> Person identificaion pipeline

A VM can be used to test the similar functionality with mock camera.



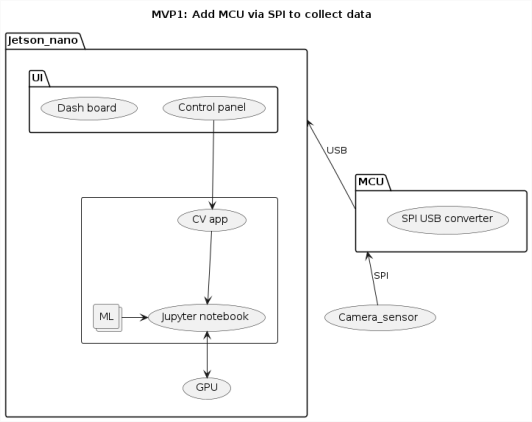
MVP0 -> MVP1

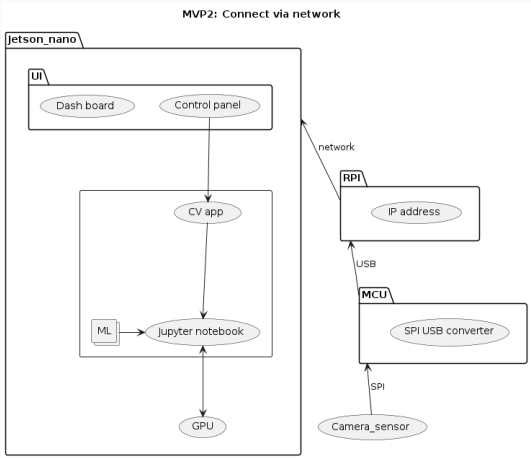




At first, we could push sensor part out via USB.

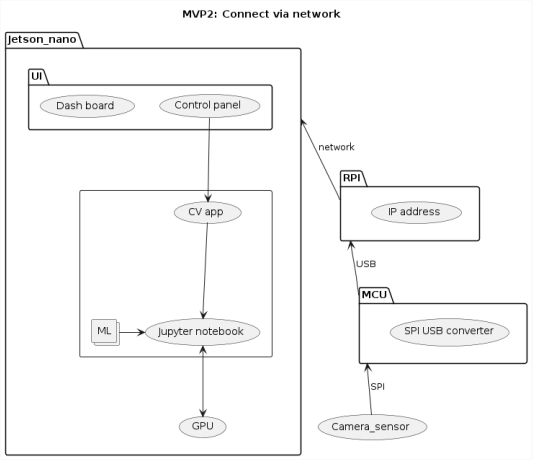
MVP1 -> MVP2

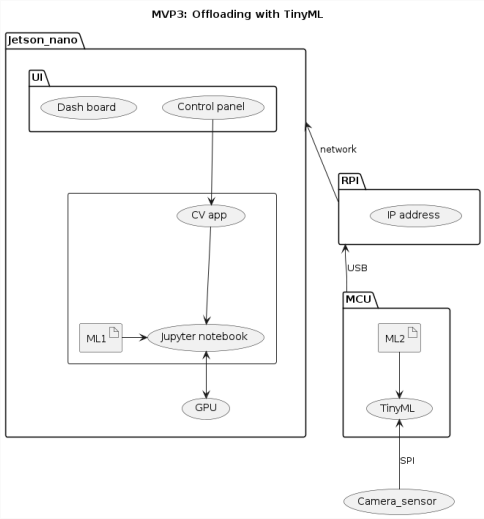




To orchestrate ML, IP connection is convenient so that we insert RPI between Jetson and MCU.

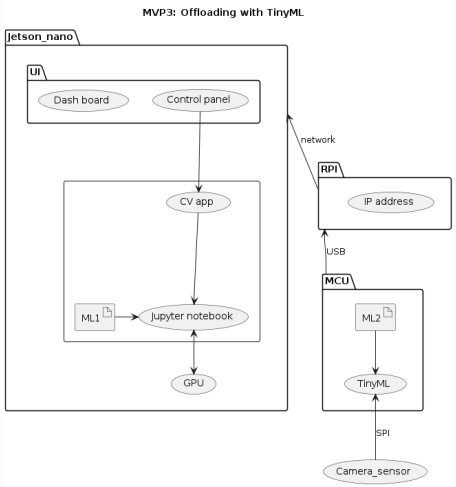
MVP2 -> MVP3

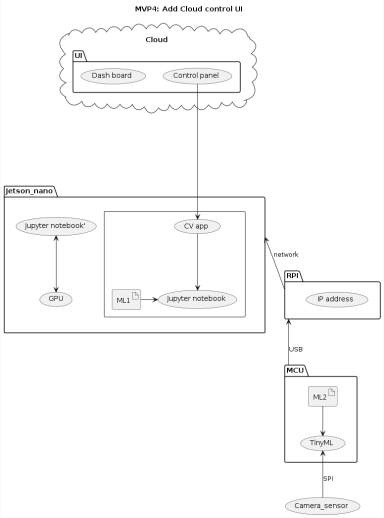




Run a small part of ML processing (ML2) as TinyML on MCU.

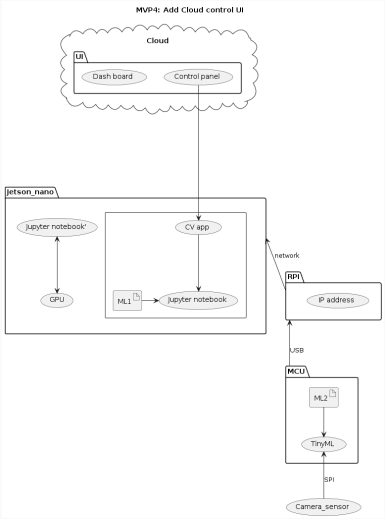
MVP3 -> MVP4

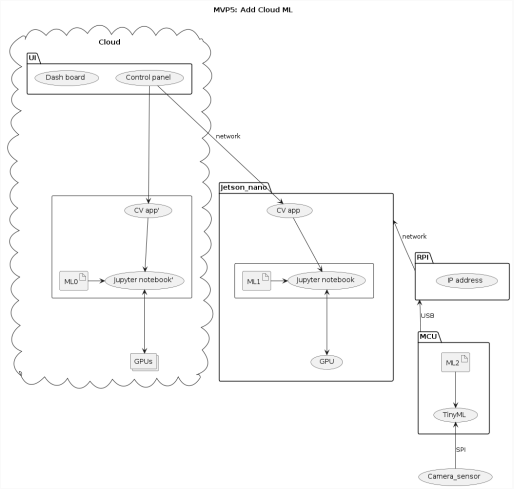




Cloud'ification should be done earlier independently to meet early demo (e.g. MWC)

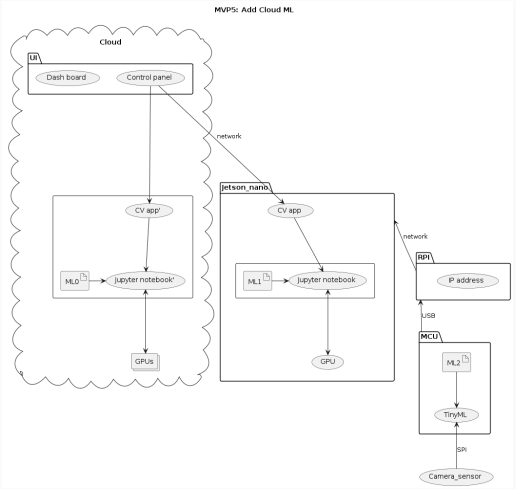
MVP4 -> MVP5

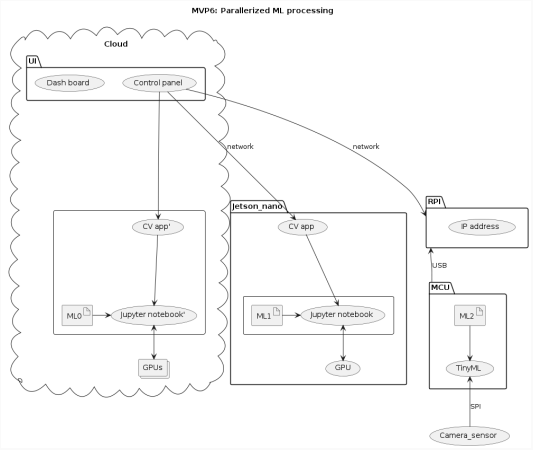




Run some part of ML processing (ML0) on Cloud.

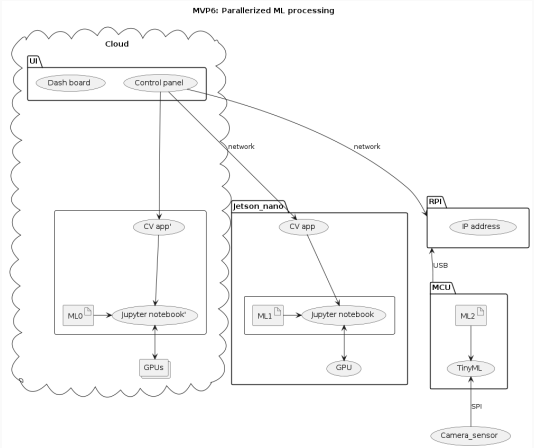
MVP5 -> MVP6

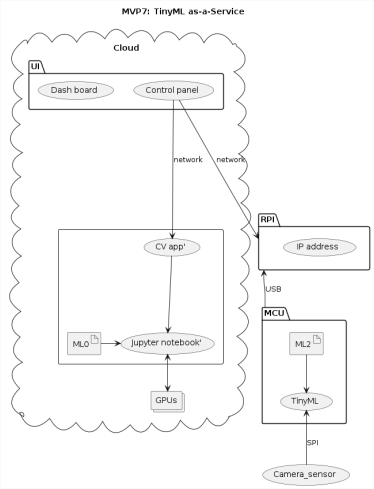




No cascading MLs but parallerizing with nodes.

MVP6 -> MVP7



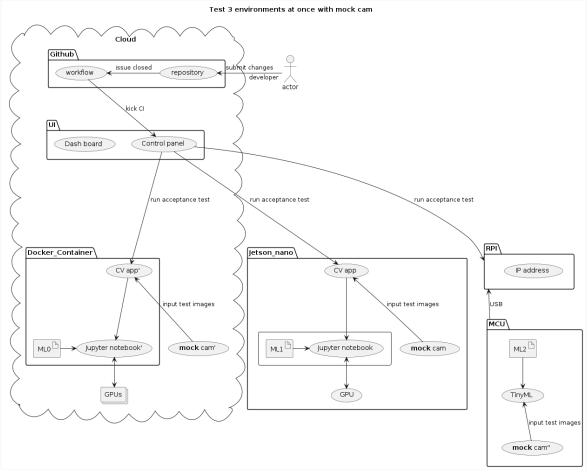


Get rid of Jetson nano but only with TinyMLaaS.

TDD / CI / CD / Acceptance test

How it works

1. Developer sends PR to repository
2. Kicked Github workflow (action)
3. Starts CI / CD
4. Run acceptance tests on 3 envs
   a. Container with **mock** Cam
   b. Jetson nano with **mock** Cam
   c. MCU with **mock** Cam
5. Merge Changes once all tests pass.
6. Store Artifacts
   - installable images
7. Always Runnable system to demo



Kick-off meeting Agenda (1/4)

Scheduled on 16th JAN (MON)

Get familiar with all participants. Everyone introduces oneself

1. What one can do
2. What one wants to do
3. How one sees this project

Will explain Project goal

- We should present demo video 1 & demo video 2

Kick-off meeting Agenda (2/4): SCRUM team

Role	Name	Note
SM	Michihito Mizutani	
PO	Roberto Morabito	
Developer	5 students	names to fill here
ML support	Hiroshi Doyu	
Customer	Perttu, Samuli	Review incremental

Kick-off meeting Agenda (3/4)

User story mapping

- Specify PBIs always as GitHub issues, which need to be a PR and it automatically runs CI/CD as acceptance tests.
- PBI == SBI?
- Estimate PBI effort (PBI workload unit?)
- Specify acceptance tests and implement in CI before implement features
- the 1st increment == 1 sprint
- For the rest, 1 increment == 2 sprint
- 1st sprint planning should be done on 16th.

Kick-off meeting Agenda (4/4)

Agree on WoW in SCRUM

- Use Github project KANBAN
- Use Discord channel to communicate or Slack?
- Agree on scheduling a Daily meeting day & time
- 1 increment == 2 sprint
- 1st sprint should have some Architecture investigation to find out which components are reusable.
- 1st sprint should have a ZFR (Zero Feature Release) to make sure that CI/CD works on Github workflow (action) without any features (or just with existing components)
- We should run CI/CD to reproduce the current Roberto's demo story at first, without a training part. If HW is not available, it could be simulated.

Architecture investigation @Roberto?

- How should we understand Roberto's demo architecture?
  - Any architecture document?
  - Any architecture block diagram?
  - Any flow diagram?
  - Any list of components used? which could be reused and which not, since the outcome of this project would be opensource'ed.
  - Any list of software frameworks each components uses?
- Should we map each Seamless TinyML lifecycle management's phase on this demo scenario?
- Should we make sure which phases are still missing? (e.g. "2. Model training")

Mapping 6 Seamless TinyML lifecycle to this project

Phase #	Name	Early phase	Demo
1	Data collection	Simulated	RPI pico + Cam
2	Model training	Missing	On Cloud VM?
3	Model squeezing	ML compiler	ML compiler
4	Model splitting	Standalone	Pipelining
5	Model deployment	Standalone	TBI
6	Model update	Dashboard	Control panel

Remaining questions

- What's the main purpose of this project from students' perspective? (e.g. experience Agile development)
- How long can the 16th meeting be allocated? (e.g. 3-4 hours with lunch break)
- What kind of competency are students generally expected? (e.g. Python, JS, Java, Frontend, Embedded)
- Can student's weekly working hours be negotiable? (e.g. 15 hours with 14 weeks -> 17.5 hours with 12 weeks)

Contact information

Origami

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