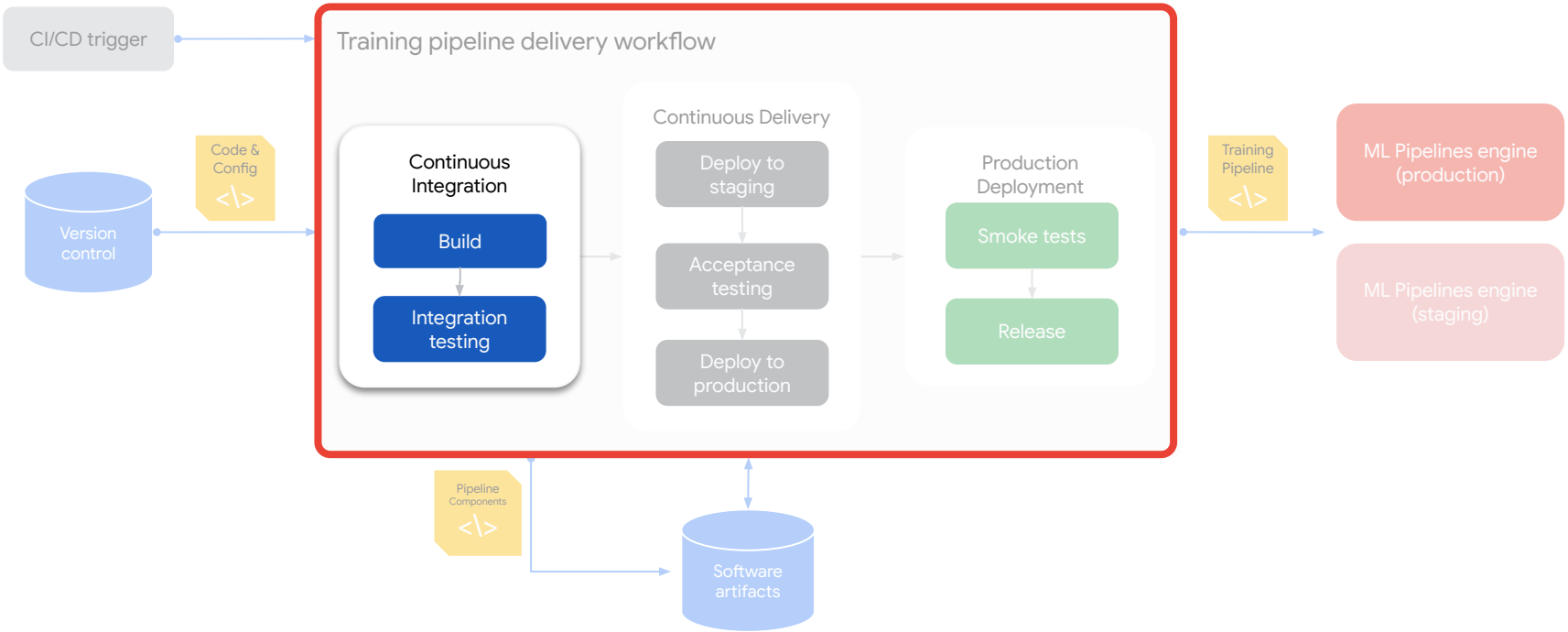
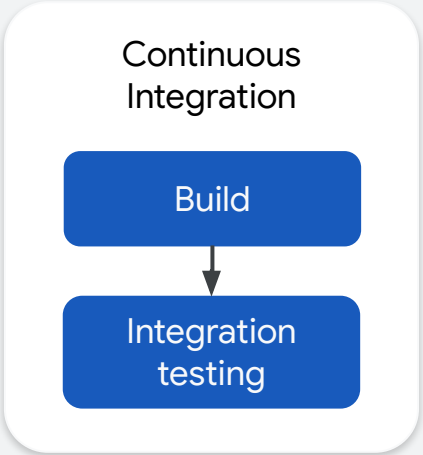
Continuous Integration

MLOps: Training Operationalization



TinyML CI Questions

- What does the **build environment** look like?
- What **types of assets** do I need to consider writing for testing?



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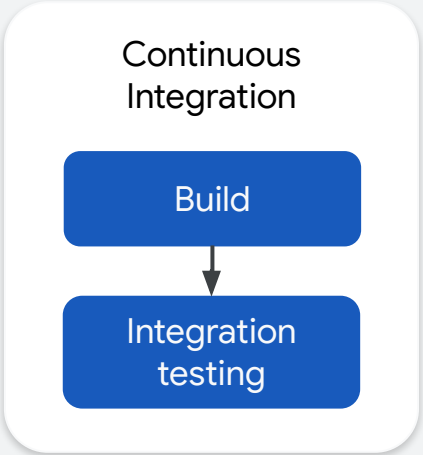
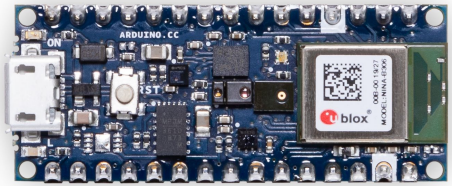
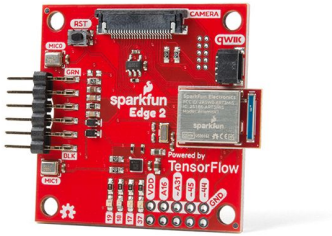
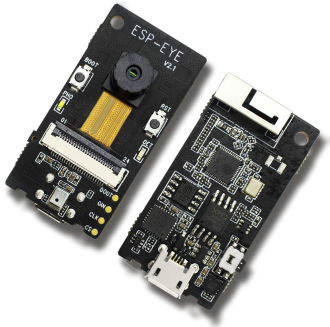


What Does the Build Environment Look Like?



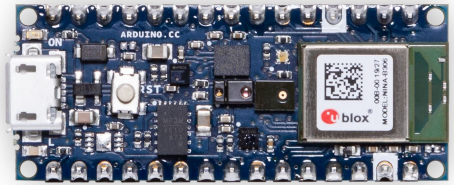




What Does the Build Environment Look Like?

	Board	MCU / ASIC	Clock	Memory	Sensors	Radio
	Himax WE-I Plus EVB	HX6537-A 32-bit EM9D DSP	400 MHz	2MB flash 2MB RAM	Accelerometer, Mic, Camera	None
	Arduino Nano 33 BLE Sense	32-bit nRF52840	64 MHz	1MB flash 256kB RAM	Mic, IMU, Temp, Humidity, Gesture, Pressure, Proximity, Brightness, Color	BLE
	SparkFun Edge 2	32-bit ArtemisV1	48 MHz	1MB flash 384kB RAM	Accelerometer, Mic, Camera	BLE
	Espressif EYE	32-bit ESP32-D0WD	240 MHz	4MB flash 520kB RAM	Mic, Camera	WiFi, BLE

Arduino Example



on our **computer**

Code (C / C++)

Binary **firmware**

upload via USB

on the **Arduino**

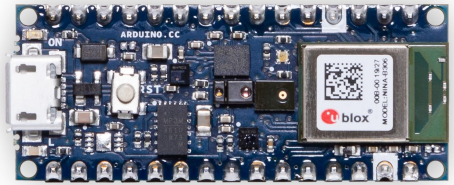
for running tasks

Binary **firmware**

premade, load at startup

Bootloader

Arduino Example



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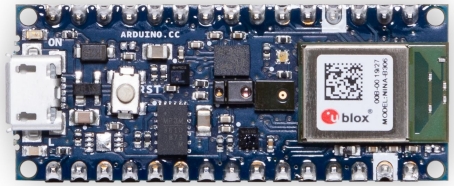

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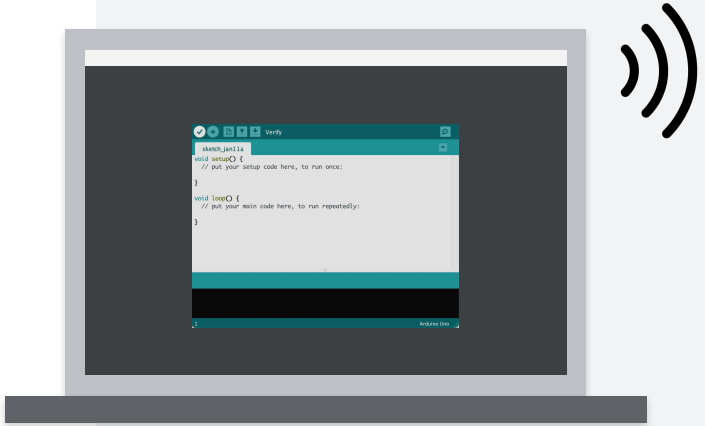
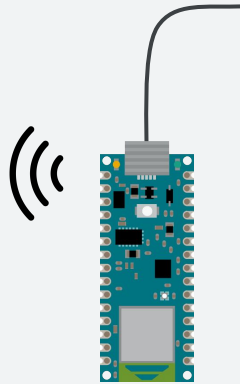
Arduino Example

- Firmware is updated via a physical device connection
- **Possible to update (some) devices over the air (OTA)**





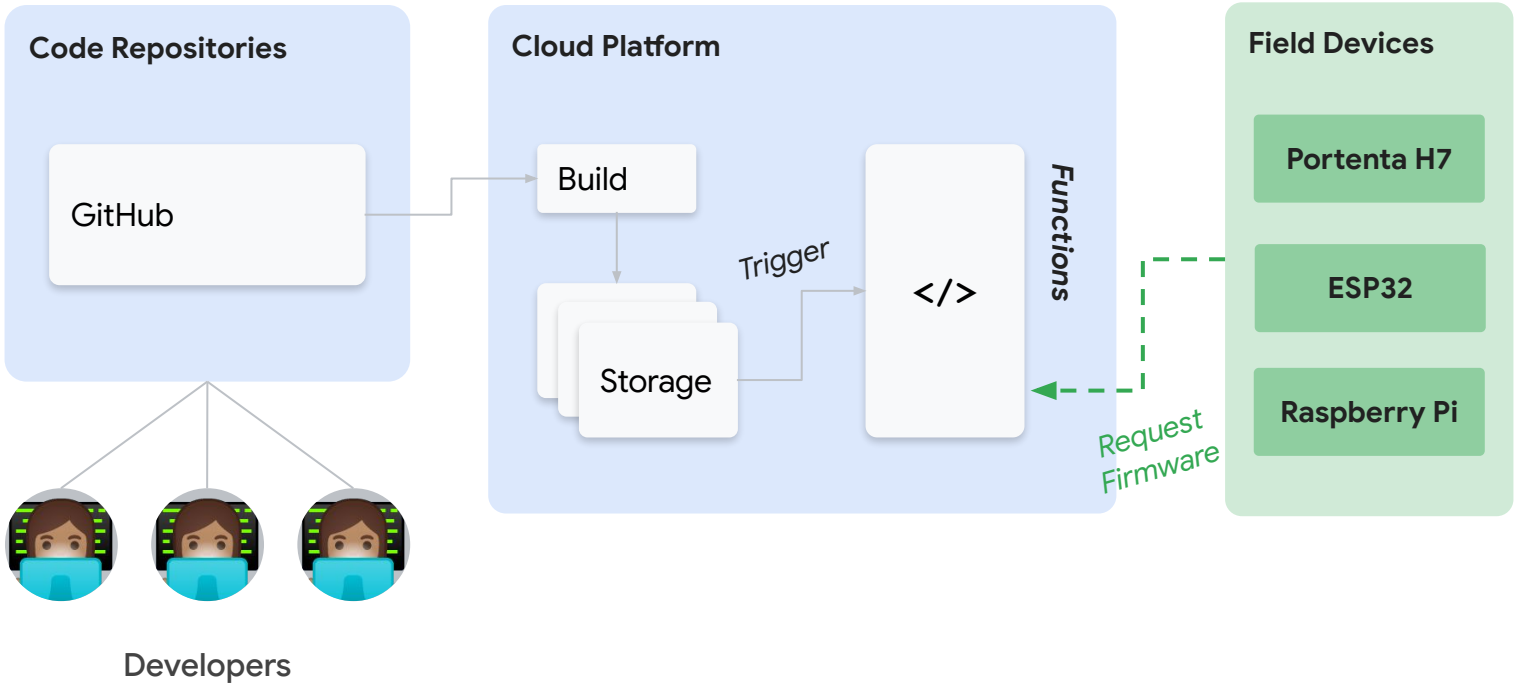
Arduino Example

- Firmware is updated via a physical device connection
- **Possible to update (some) devices over the air (OTA)**
  - MKR WiFi 1010
  - Nano 33 IoT
  - Portenta H7

Arduino Cloud

OTA

Continuous Integration Architecture



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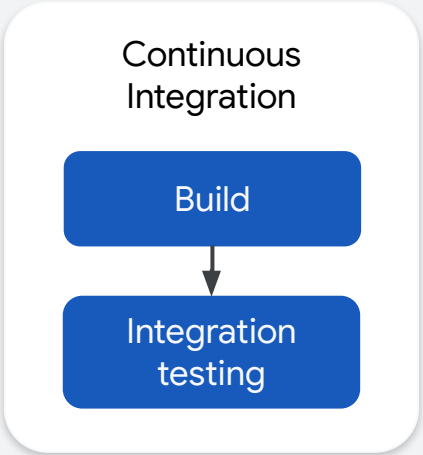
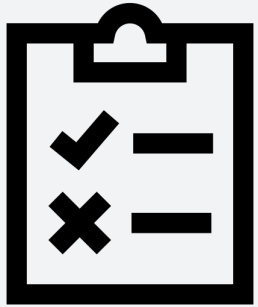


What to **test**?

1. Code
2. Model
3. Data
4. Sensors



What to **test**?

1. **Code**
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- **Unit Tests**
  - Definition
  - Types
  - Methods
  - Approaches
  - Levels

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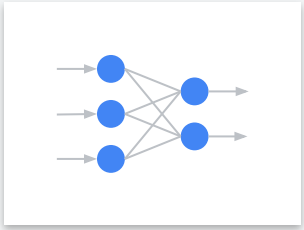

- **Model Concerns**
  - Size
  - Latency
  - Accuracy
  - Energy-efficiency
  - Licensing

What to **test**?

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- **Data Concerns**
  - Baseline dataset
  - Expand to different datasets
  - Synthetic datasets
  - Verify on production data

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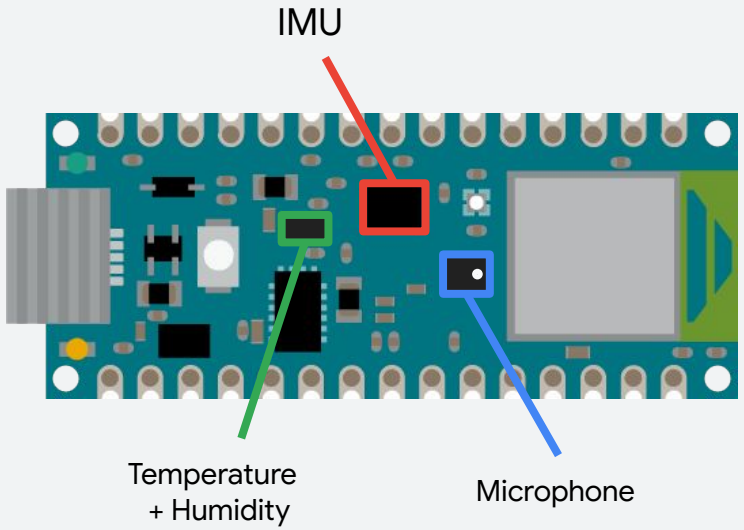

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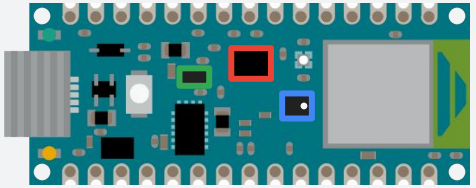

- Do you test functionality on the **physical** devices?
  - Access to devices & sensors
  - Physical testing lab
  - Sensor variability

What to **test**?

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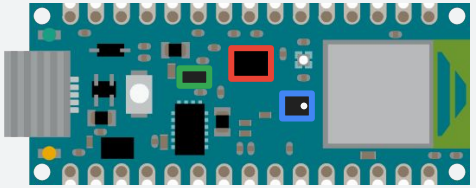

- Do you test functionality on **emulation** devices?
  - Emulators cannot support all sensors
  - Cannot mimic sensor variations

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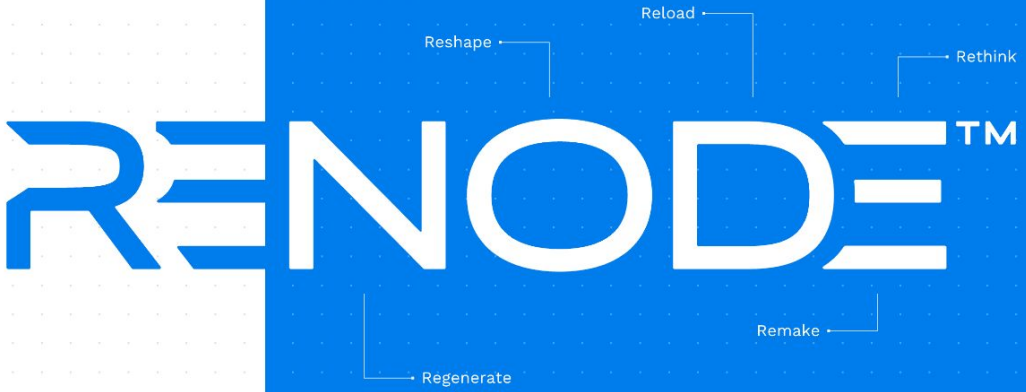

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SCROLL

By: antmicro

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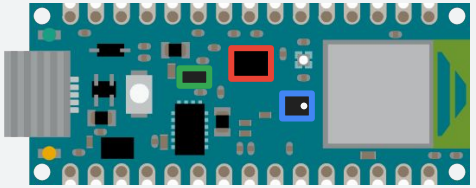

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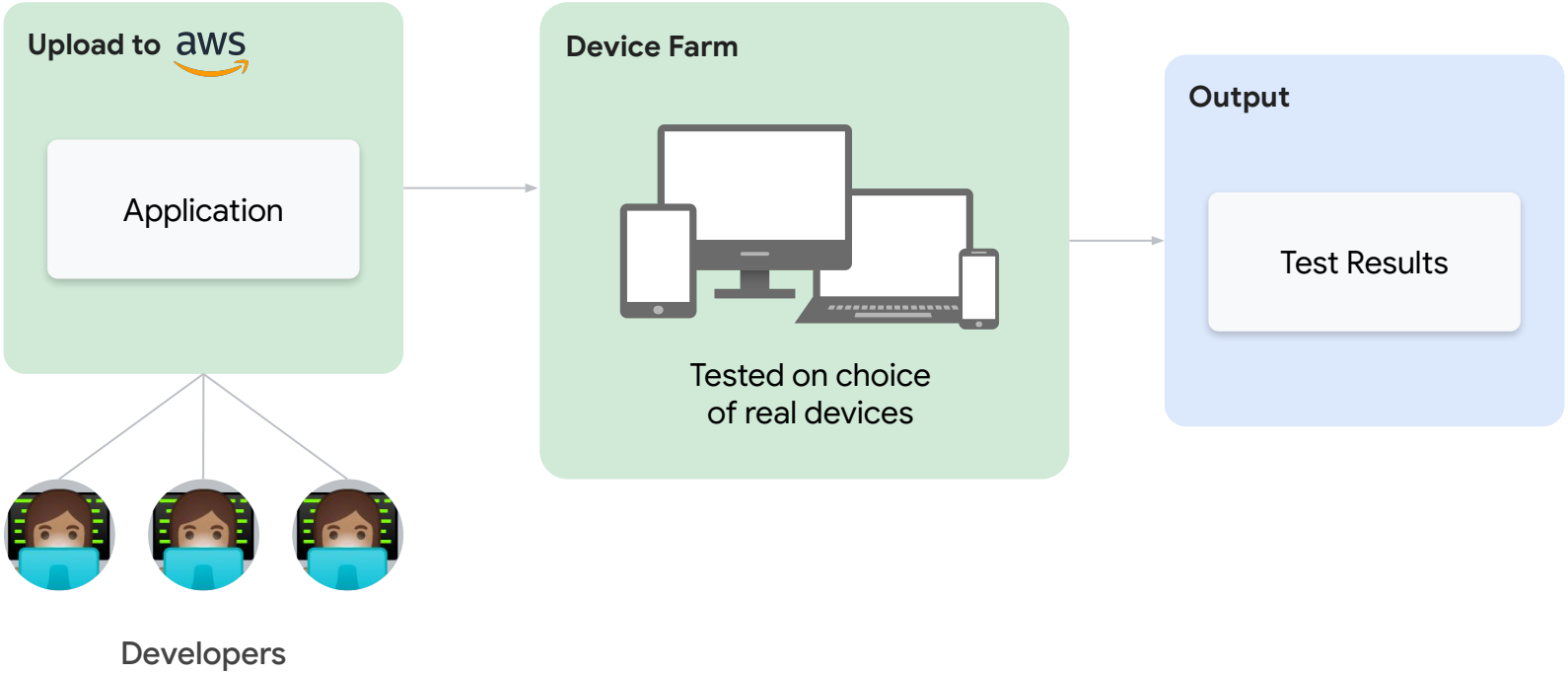
Smartphones

Device Farm



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