

# tinyML<sup>®</sup> EMEA

*Enabling Ultra-low Power Machine Learning at the Edge*

## tinyML EMEA Technical Forum 2021 Proceedings

June 7 – 10, 2021

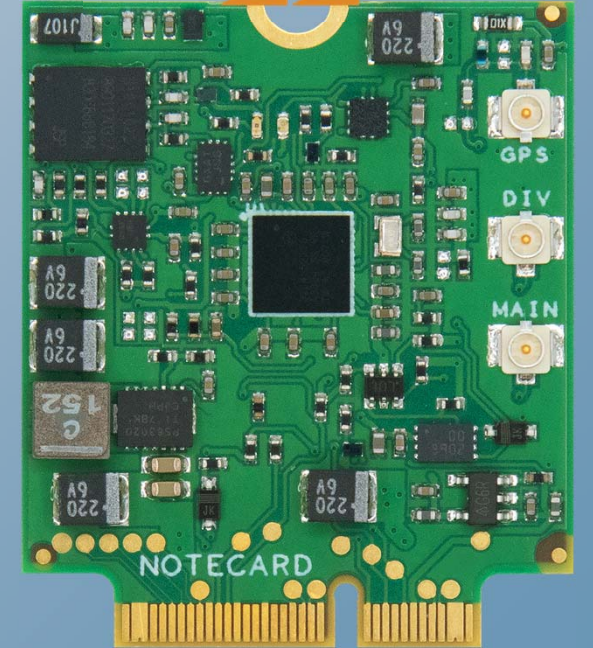
Virtual Event



[www.tinyML.org](http://www.tinyML.org)



# Remote Birding with TensorFlow Lite and Raspberry Pi



**Rob Lauer**

Developer Relations Lead

 blues wireless



**Simon Holland** ✓

@simoncholland



And just like that I turned into a person that calls people to come look at the bird feeder.

7:41 AM · Feb 28, 2021



1.5K



172



Copy link to Tweet



**Simon Holland** ✓

@simoncholland



A device

~~And just like that I turned into a person~~ that calls people to  
come look at the bird feeder.

7:41 AM · Feb 28, 2021



1.5K



172



Copy link to Tweet

# Machine Learning FTW!



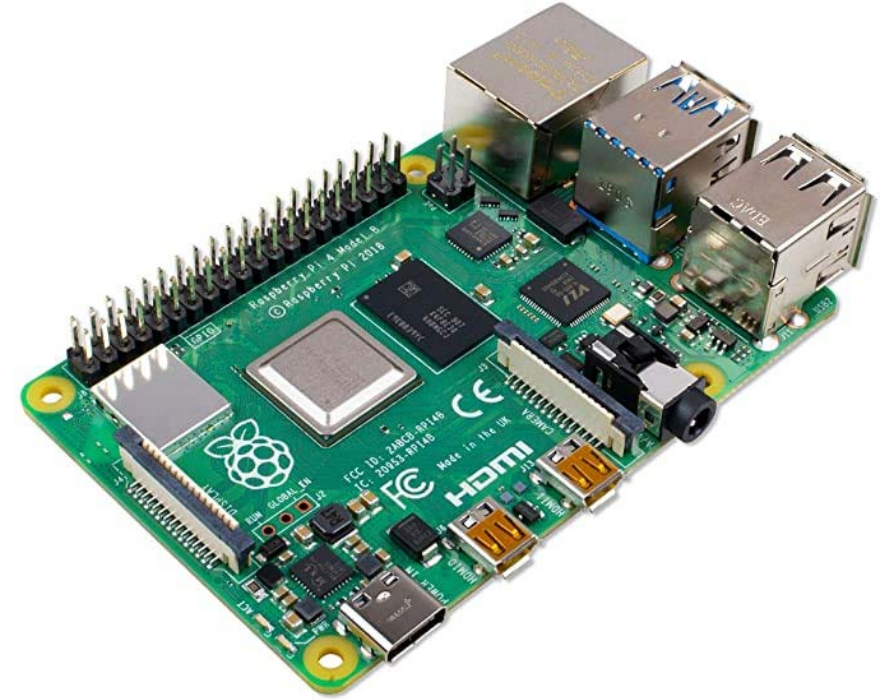
# However...

- Compute Resources?
- Off-Grid Deployment?
- No Access to Wi-Fi?



## ✓ Compute Resources?

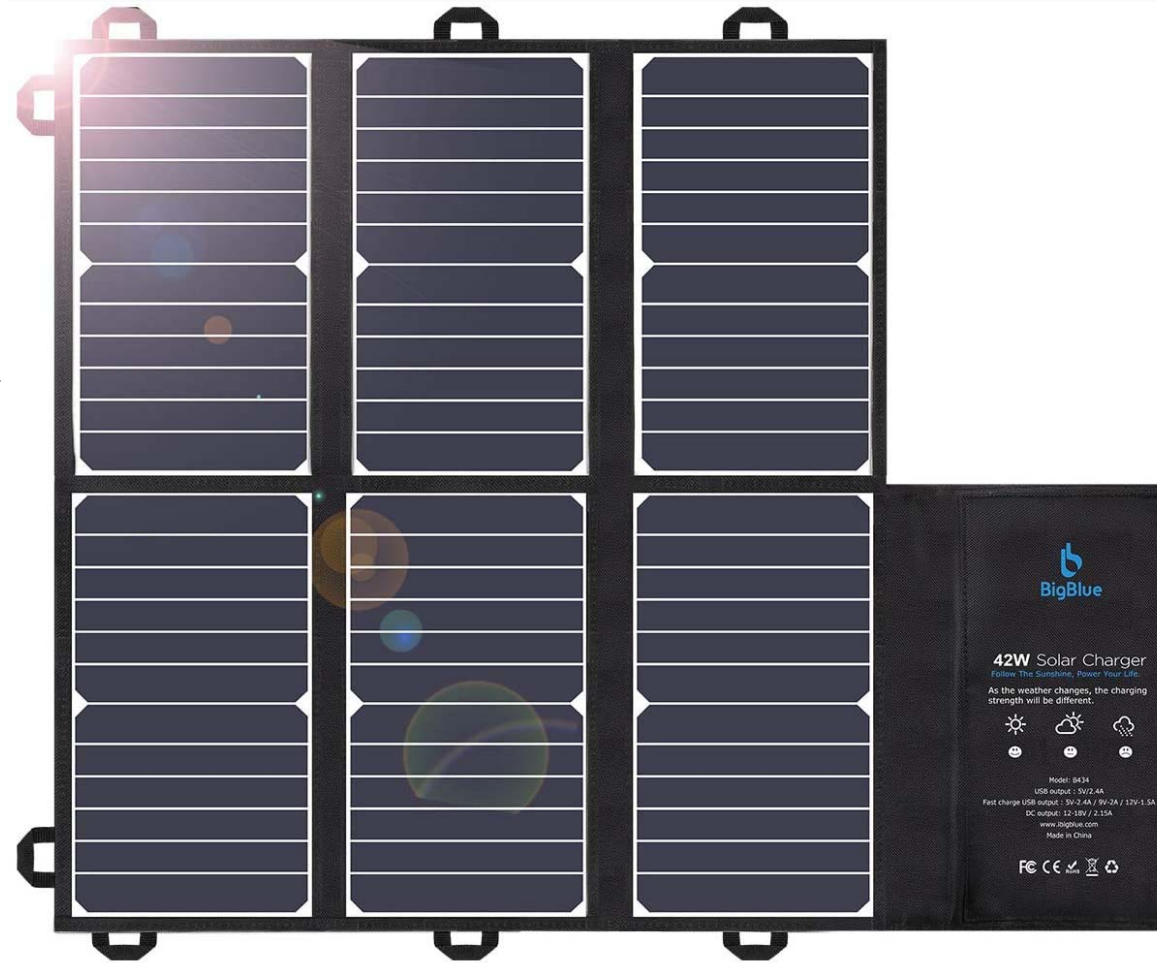
- Raspberry Pi 4
- TensorFlow Lite



# TensorFlow Lite

## ✓ Off-Grid Deployment?

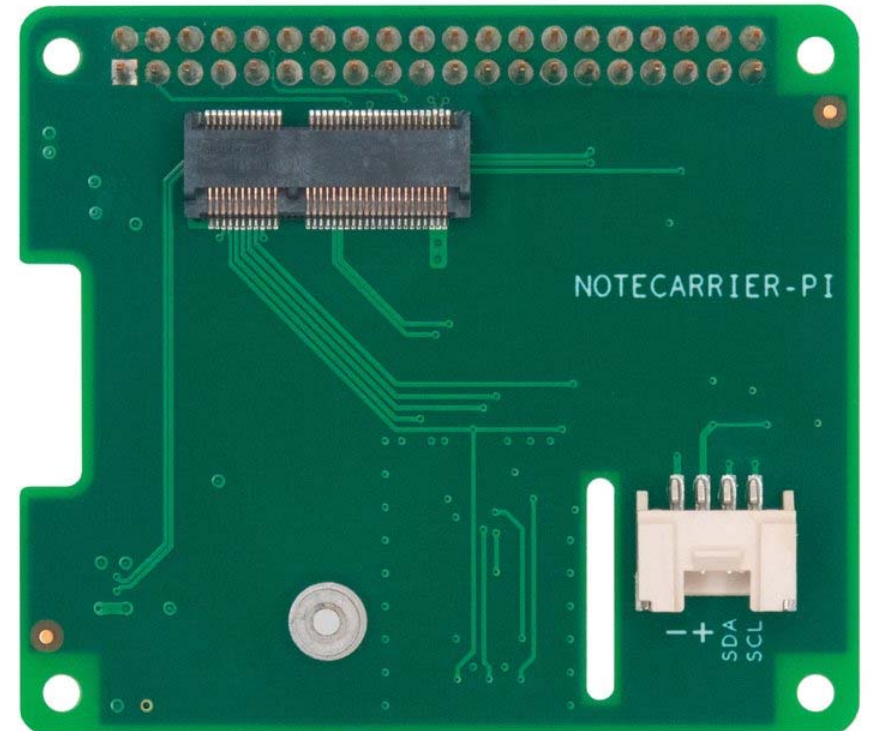
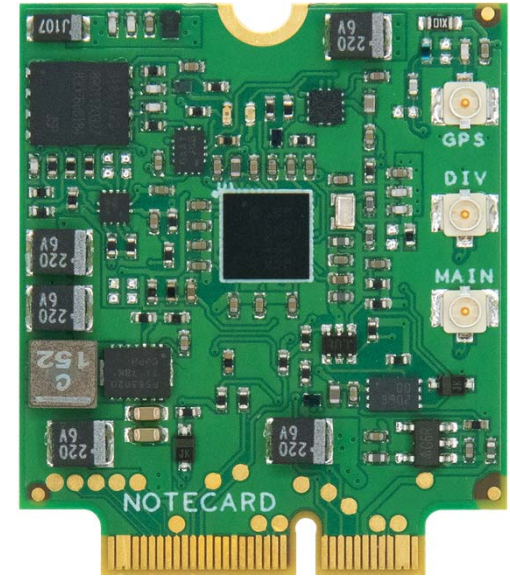
- 30,000 mAh USB-C Power Bank
- 42W Portable Solar Array





## ✓ No Access to Wi-Fi?

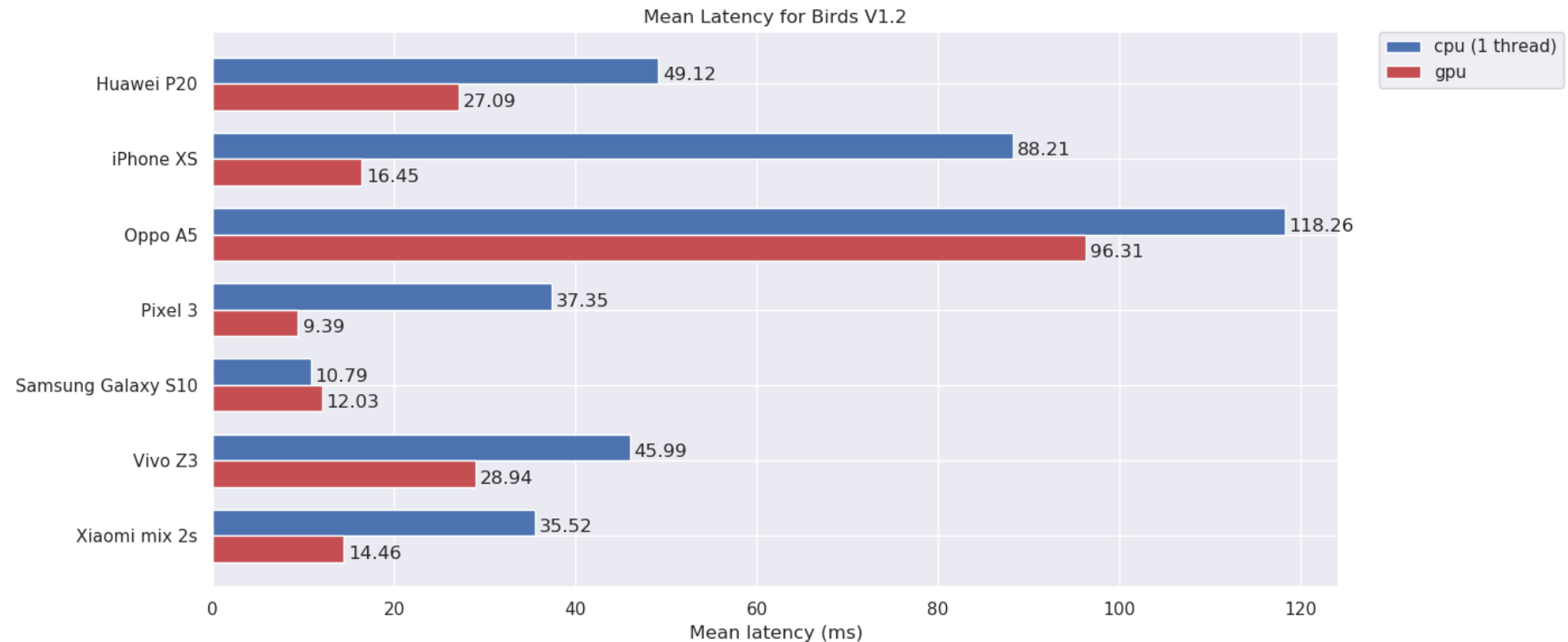
- Blues Wireless Notecard for Cellular
- Notecarrier-Pi Host HAT
- ~8mA when Idle

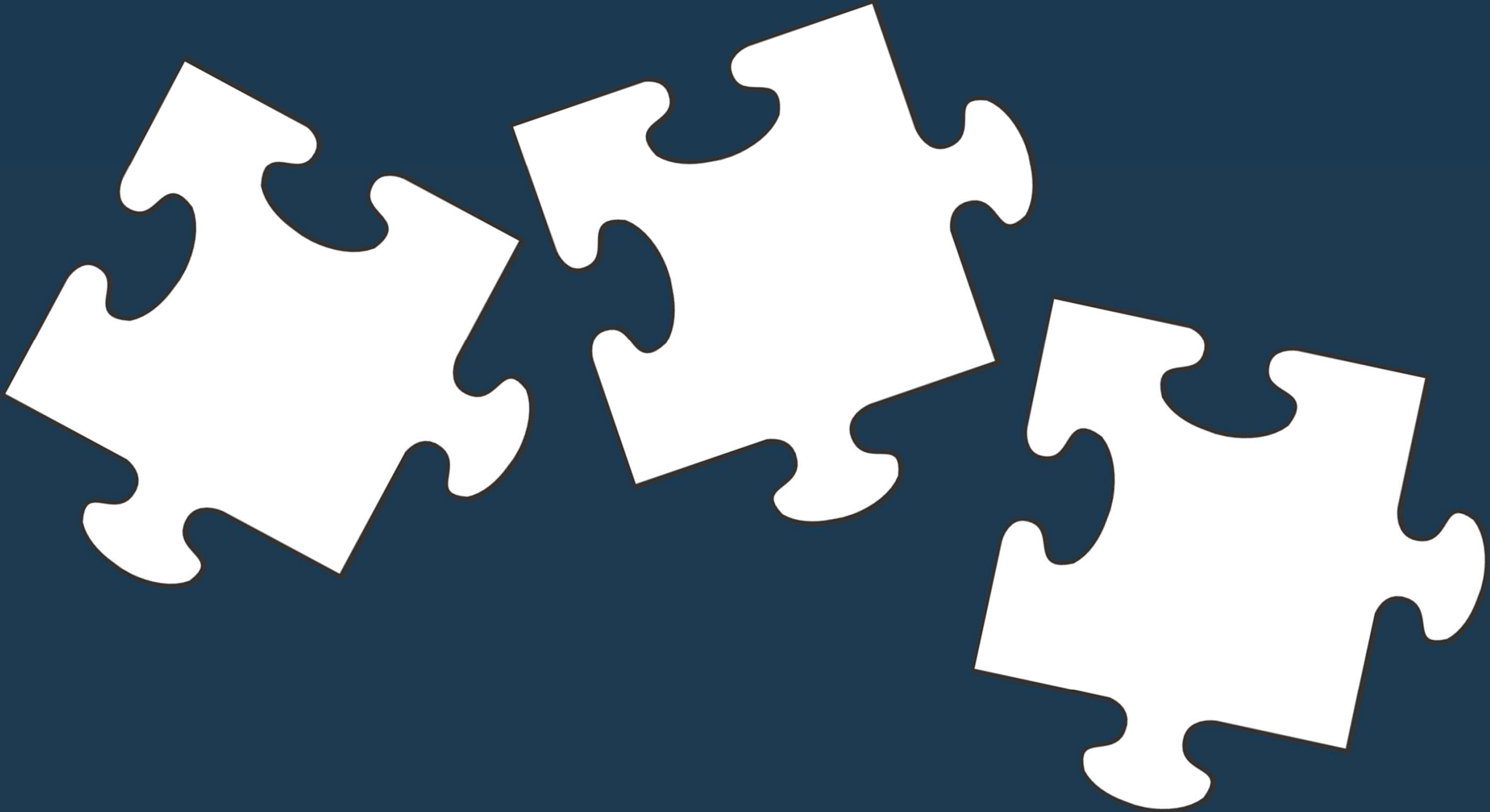


# TensorFlow

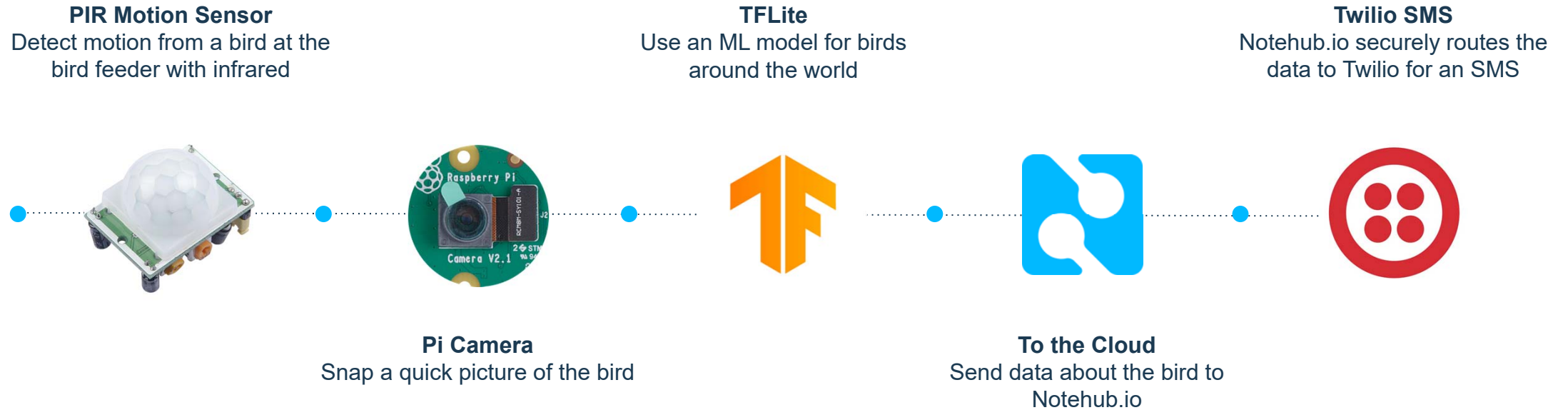
## Hub

- Pre-defined Model for Bird Identification
- Incredible Latency Benchmarks





# Remote Birding Workflow



```

def set_input_tensor(interpreter, image):
    tensor_index = interpreter.get_input_details()[0]['index']
    input_tensor = interpreter.tensor(tensor_index())[0]
    input_tensor[:, :] = image

def classify_image(interpreter, image, top_k=1):
    """ return a sorted array of classification results """
    set_input_tensor(interpreter, image)
    interpreter.invoke()
    output_details = interpreter.get_output_details()[0]
    output = np.squeeze(interpreter.get_tensor(output_details['index']))

    # if model is quantized (uint8 data), then dequantize the results
    if output_details['dtype'] == np.uint8:
        scale, zero_point = output_details['quantization']
        output = scale * (output - zero_point)

    ordered = np.argsort(-output, top_k)
    return [(i, output[i]) for i in ordered[:top_k]]

```



EXPLORER



bird.py 8 x

PIBIRD

images

.gitattributes

.gitignore

bird.py 8

birds-label.txt

birds-model.tflite

keys.py

LICENSE

README.md

bird.py

104

105

106

107

108

109

110

111

112

113

114

115

116

117 while True:

118 | main()

119

```
def send_note(bird, prob):
```

```
    """ upload the json note to notehub.io """
```

```
    req = {"req": "note.add"}
```

```
    req["file"] = "bird.qo"
```

```
    req["start"] = True
```

```
    req["body"] = {"bird": bird, "prob": prob,  
                  "from": sms_from, "to": sms_to}
```

```
    rsp = card.Transaction(req)
```

```
    # print(rsp) # debug/print request
```

```
while True:
```

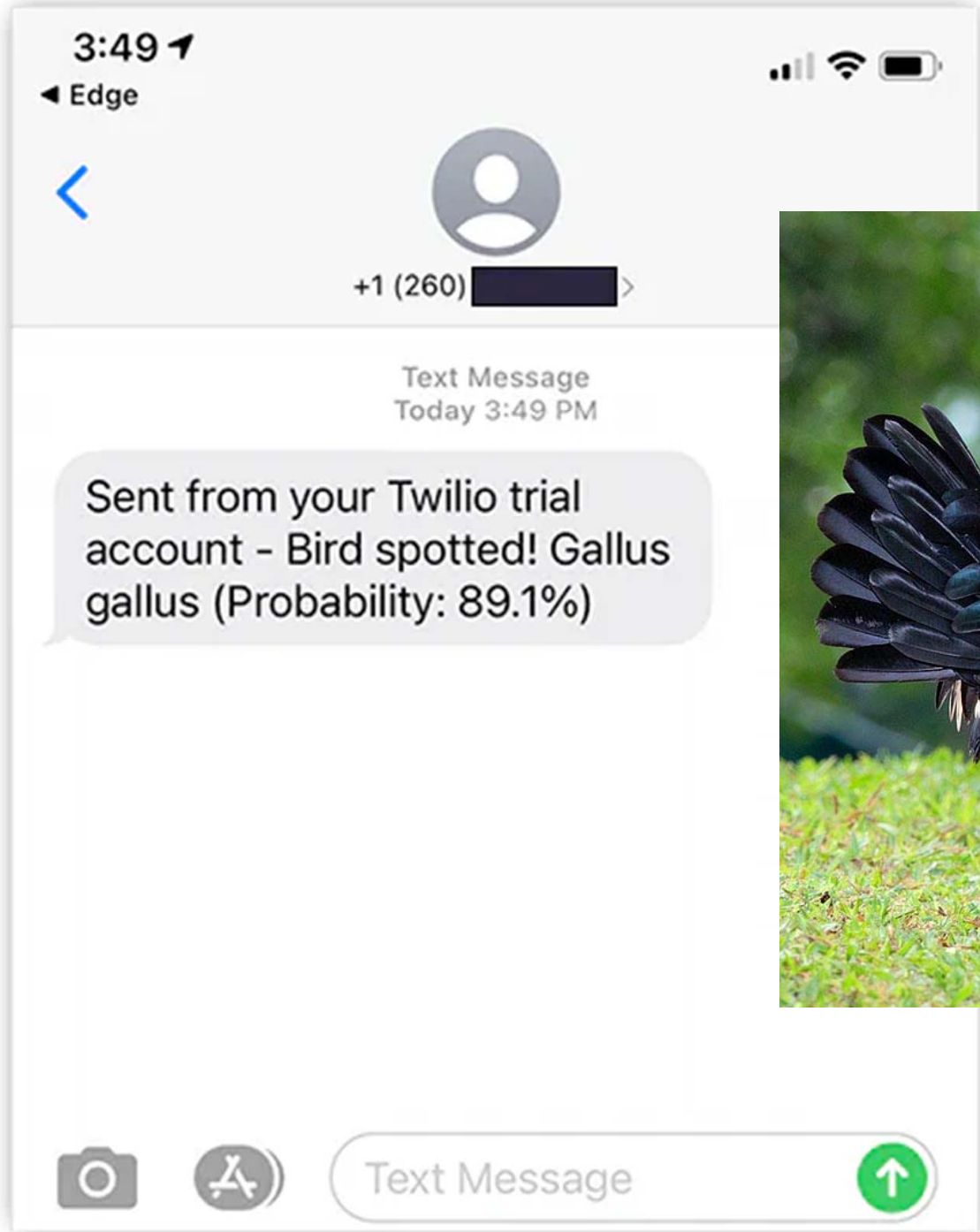
```
    main()
```





“60% of the time it works every time”





# Future

## Improvements

- Low-Power MCU (e.g. Raspberry Pi Pico)
- TFLite Model Optimized for Local Birds



# Resources

- Hackster Tutorial @ [bit.ly/pi-bird](https://bit.ly/pi-bird)
- Cellular IoT @ [blues.io](https://blues.io)
- Rob on Twitter @ [RobLauer](https://twitter.com/RobLauer)





# Premier Sponsor



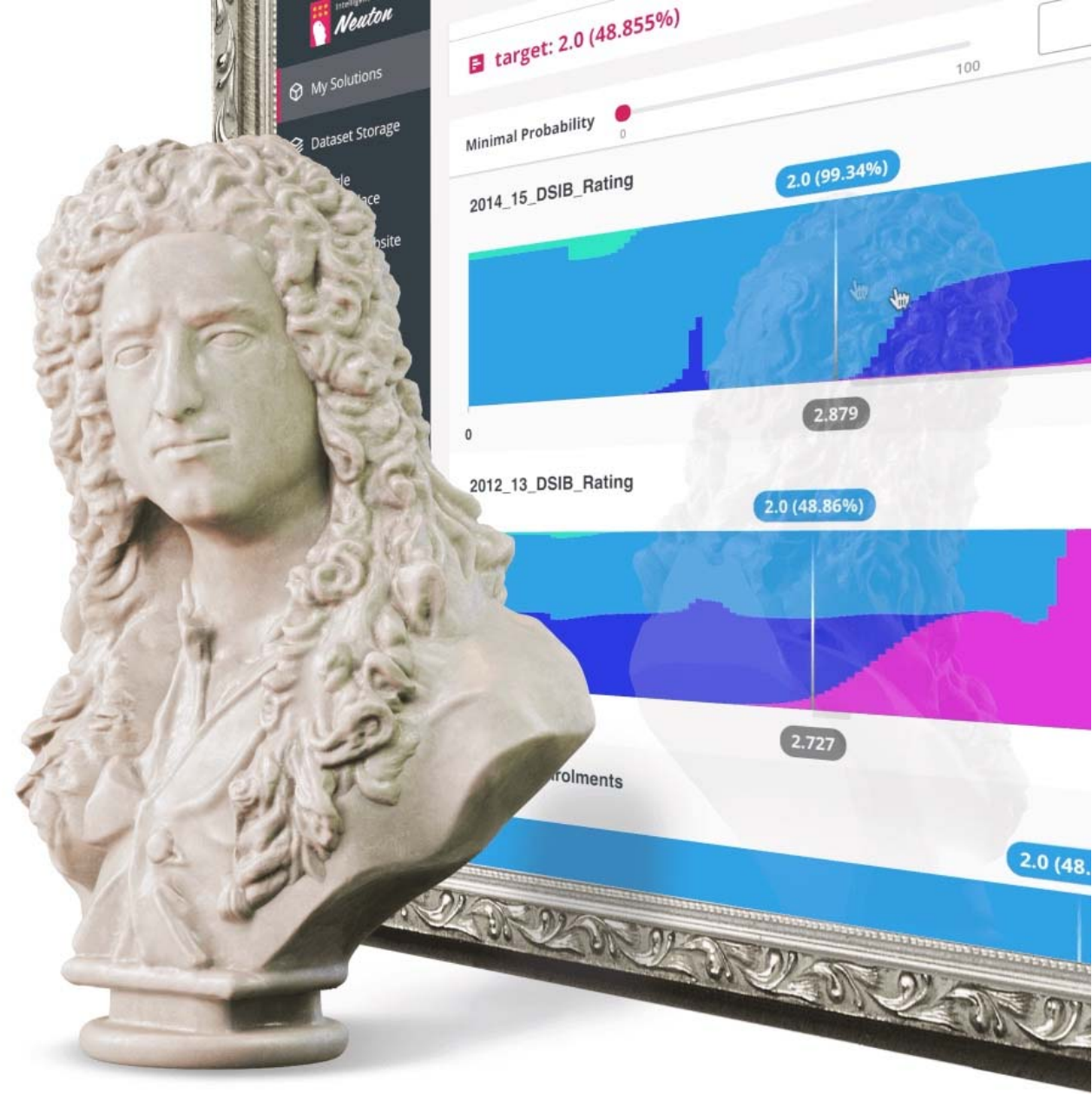
# Automated TinyML

Zero-code SaaS solution

**Create tiny models, ready for embedding,  
in just a few clicks!**

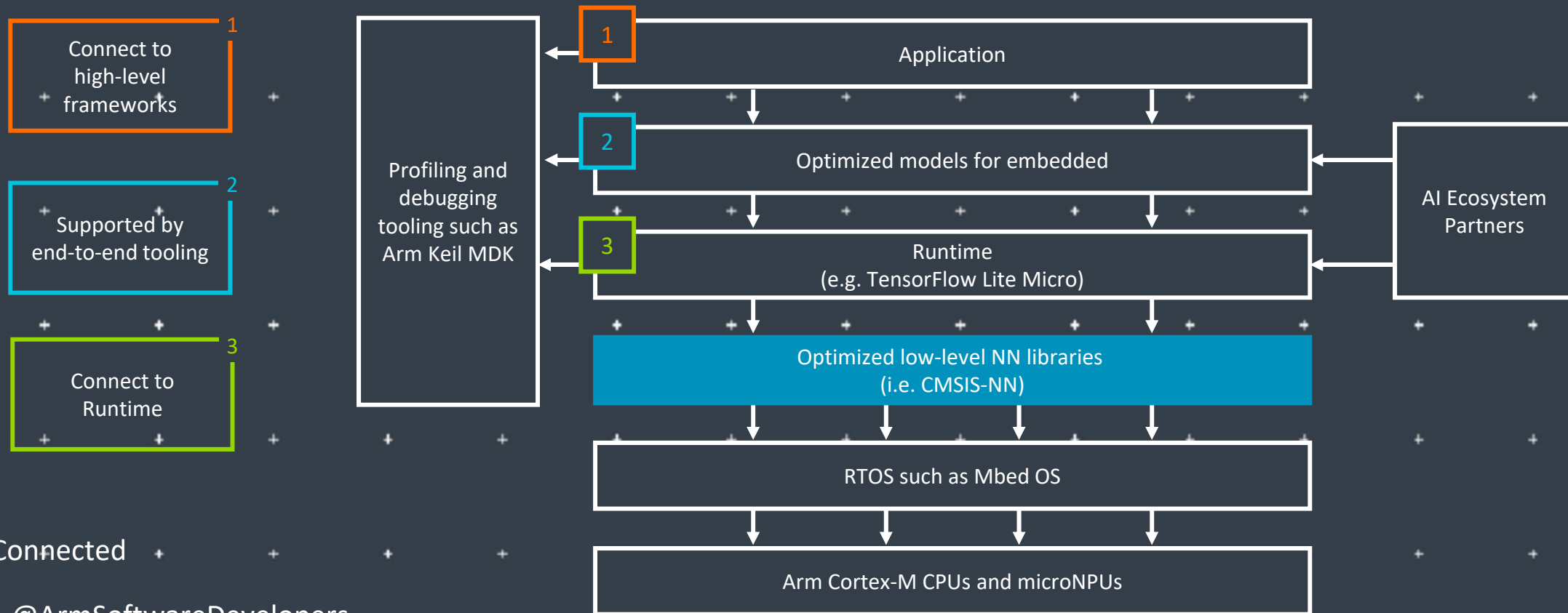
Compare the benchmarks of our compact models to those of TensorFlow and other leading neural network frameworks.

***Build Fast. Build Once. Never Compromise.***



# Executive Sponsors

# Arm: The Software and Hardware Foundation for tinyML



Stay Connected

 @ArmSoftwareDevelopers

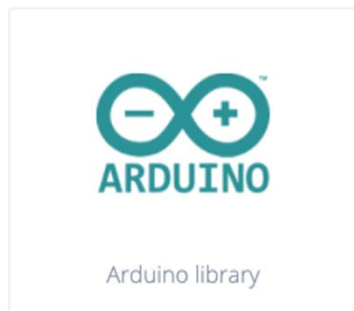
 @ArmSoftwareDev

Resources: [developer.arm.com/solutions/machine-learning-on-arm](https://developer.arm.com/solutions/machine-learning-on-arm)

# TinyML for all developers



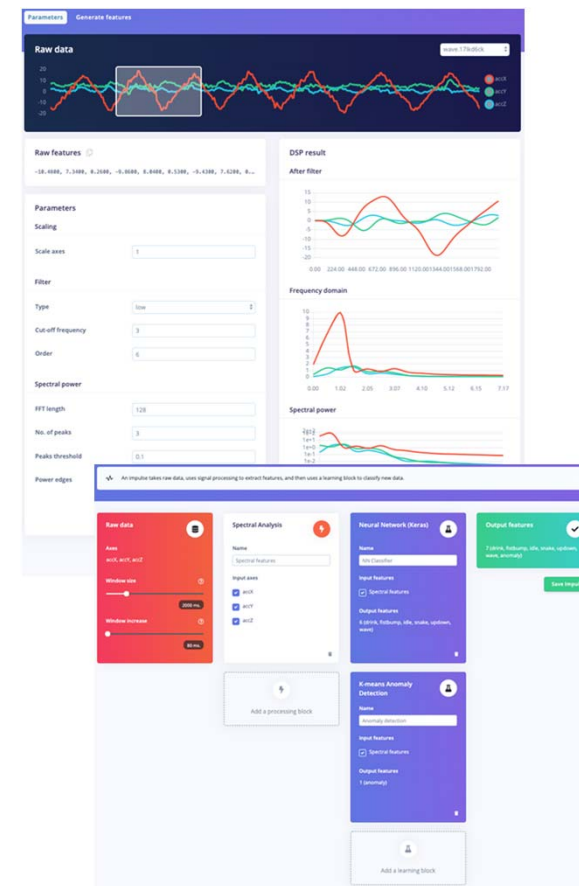
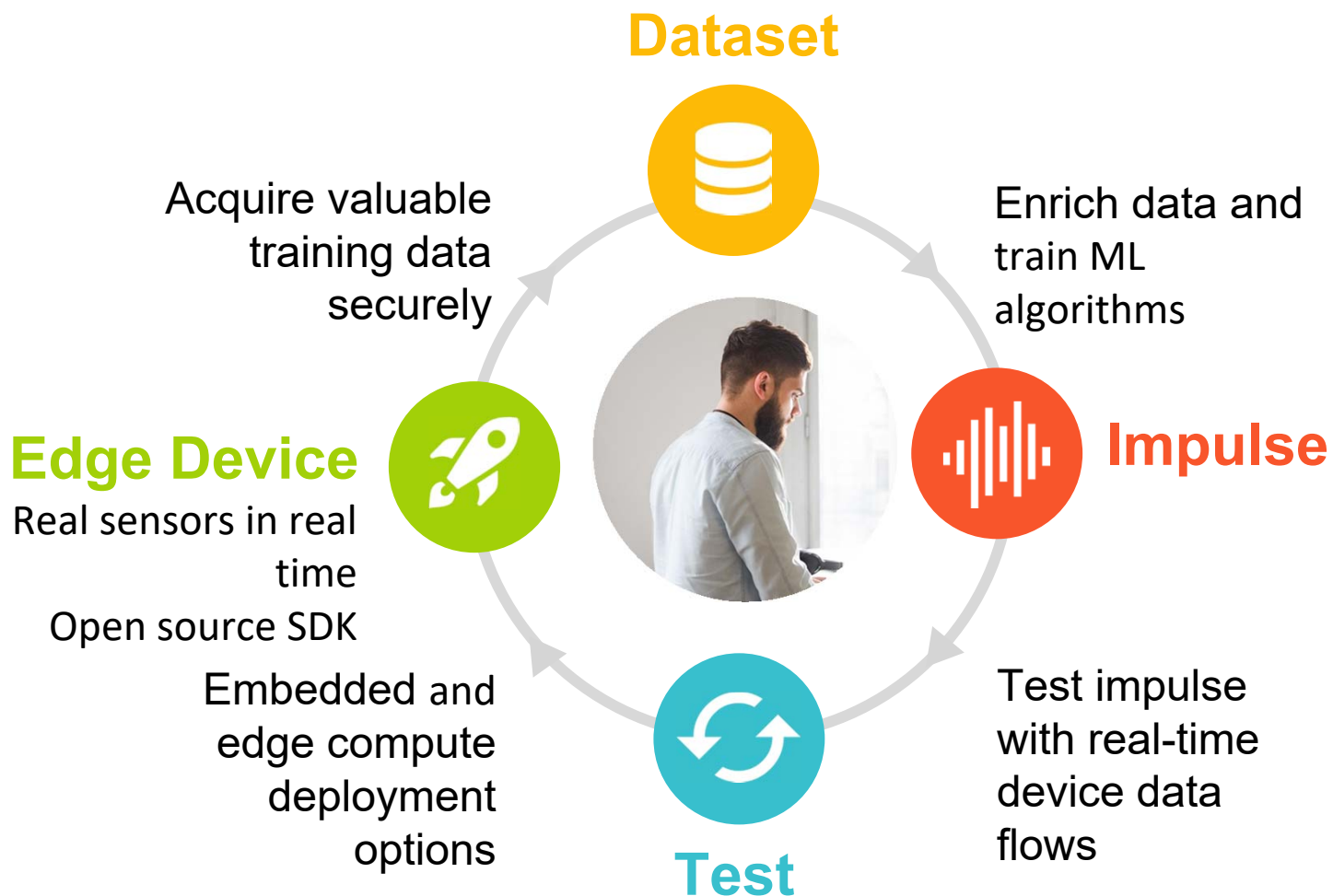
C++ library



Arduino library



WebAssembly



[www.edgeimpulse.com](http://www.edgeimpulse.com)



**Qualcomm**  
AI research

# Advancing AI research to make efficient AI ubiquitous

## Power efficiency

Model design, compression, quantization, algorithms, efficient hardware, software tool

## Personalization

Continuous learning, contextual, always-on, privacy-preserved, distributed learning

## Efficient learning

Robust learning through minimal data, unsupervised learning, on-device learning

## A platform to scale AI across the industry



**Perception**  
Object detection, speech recognition, contextual fusion



**Reasoning**  
Scene understanding, language understanding, behavior prediction



**Action**  
Reinforcement learning for decision making



Edge cloud



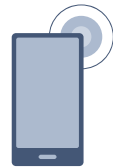
Cloud



IoT/IIoT



Automotive



Mobile

# SYNTIANT

[Syntiant Corp.](#) is moving artificial intelligence and machine learning from the cloud to edge devices. Syntiant's chip solutions merge deep learning with semiconductor design to produce ultra-low-power, high performance, deep neural network processors. These network processors enable always-on applications in battery-powered devices, such as smartphones, smart speakers, earbuds, hearing aids, and laptops. Syntiant's Neural Decision Processors™ offer wake word, command word, and event detection in a chip for always-on voice and sensor applications.

Founded in 2017 and headquartered in Irvine, California, the company is backed by Amazon, Applied Materials, Atlantic Bridge Capital, Bosch, Intel Capital, Microsoft, Motorola, and others. Syntiant was recently named a [CES® 2021 Best of Innovation Awards Honoree](#), [shipped over 10M units worldwide](#), and [unveiled the NDP120](#) part of the NDP10x family of inference engines for low-power applications.

[www.syntiant.com](http://www.syntiant.com)



@Syntiantcorp

# Platinum Sponsors



Part of your life. Part of tomorrow.

[www.infineon.com](http://www.infineon.com)



# Reality AI<sup>®</sup>

## Add Advanced Sensing to your Product with Edge AI / TinyML

<https://reality.ai>



[info@reality.ai](mailto:info@reality.ai)



[@SensorAI](https://twitter.com/SensorAI)



[Reality AI](https://www.linkedin.com/company/reality-ai)

### Pre-built Edge AI sensing modules, plus tools to build your own

#### Reality AI solutions

Prebuilt sound recognition models for  
indoor and outdoor use cases

Solution for industrial anomaly detection

Pre-built automotive solution that lets cars  
“see with sound”

#### Reality AI Tools<sup>®</sup> software

Build prototypes, then turn them into  
real products

Explain ML models and relate the function  
to the physics

Optimize the hardware, including  
sensor selection and placement



# Gold Sponsors



# LatentAI

Adaptive AI for the Intelligent Edge

[Latentai.com](https://latent.ai)



# Build Smart IoT Sensor Devices From Data

SensiML pioneered TinyML software tools that auto generate AI code for the intelligent edge.

- End-to-end AI workflow
- Multi-user auto-labeling of time-series data
- Code transparency and customization at each step in the pipeline

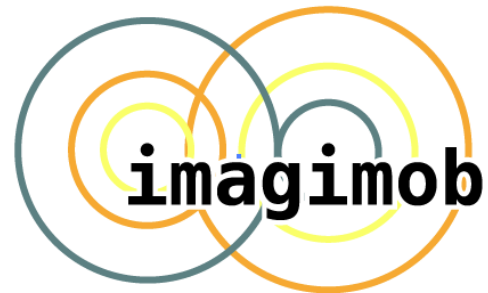
We enable the creation of production-grade smart sensor devices.



[sensiml.com](https://sensiml.com)



# Silver Sponsors





# Copyright Notice

The presentation(s) in this publication comprise the proceedings of tinyML® EMEA Technical Forum 2021. The content reflects the opinion of the authors and their respective companies. This version of the presentation may differ from the version that was presented at tinyML EMEA. The inclusion of presentations in this publication does not constitute an endorsement by tinyML Foundation or the sponsors.

There is no copyright protection claimed by this publication. However, each presentation is the work of the authors and their respective companies and may contain copyrighted material. As such, it is strongly encouraged that any use reflect proper acknowledgement to the appropriate source. Any questions regarding the use of any materials presented should be directed to the author(s) or their companies.

tinyML is a registered trademark of the tinyML Foundation.

[www.tinyML.org](http://www.tinyML.org)