The 19th Annual International Conference on RFID

IEEE RFID 2025

Atlanta, Georgia
22-24 April 2025
2025.ieee-rfid.org

Tutorial: **RFID in AIoT**

Jeffrey Dungen
reelyActive

April 22, 2025

RFID in AIoT

Abstract: Hype comes in waves: first **RFID**, then **IoT**, currently **AI**. Taking the analogy that **AI** is the brain, then **IoT** is the nervous system which lets it make sense of the physical world. Together, that's **AIoT**, but how does **RFID** fit into the analogy? In this tutorial we'll examine the big picture of how these elements can work together in harmony, taking the time to identify (no pun intended) the gaps that will need to be filled in to achieve such harmony at scale. We'll also explore the curious phenomenon of how **AI** is being used to advance **IoT** and **RFID** research so that, in turn, **RFID** and **IoT** can better inform **AI** about what's really happening in the real world in real time.

The IEEE RFID tutorial journey…

2017

2019

2022

2023

2024

The motivation for this tutorial

raddec: Elevating **IoT** Interoperability Through a Common Radio Decoding Data Format

Jeffrey Dungen, reelyActive

My paper

So, I presented a paper at IEEE WF-IoT 2024…

➔ Has **AI** taken over everything?
➔ Are **RFID** and **IoT** still relevant?
➔ How do they all fit together?

I can make that into a 90 minute tutorial at IEEE RFID 2025! 🤓

Optimising something kinda IoT-related **using AI**

Almost Everyone Else

Other papers

Has AI taken over everything?

> Artificial intelligence (AI) has significantly impacted many aspects of our lives, but **it hasn't taken over everything yet**.

Response from the Brave browser LLM

PART

1

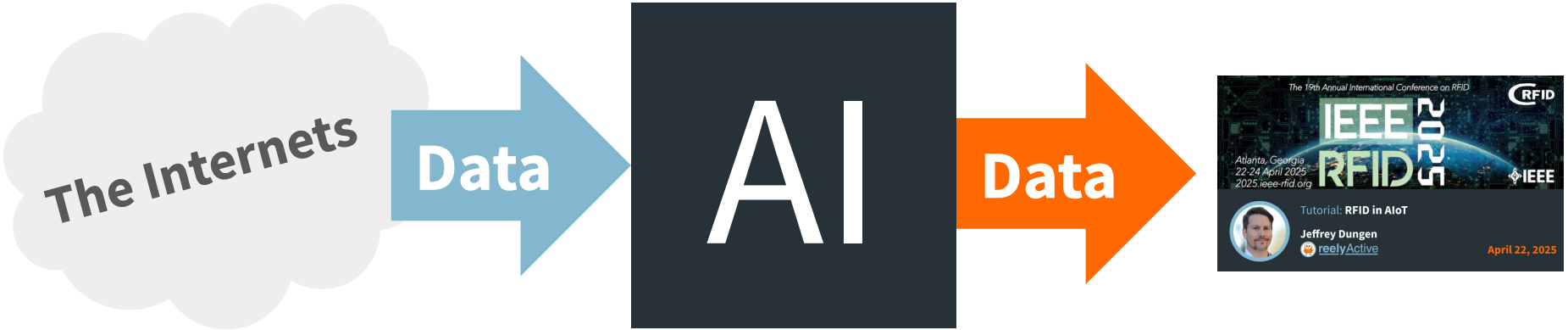
Can **AI** take over everything?

What's the utility of RFID/IoT when artificial general intelligence can do everything, *right?*

An oversimplification of AI

It’s all about the data.

The Internet as a source of data

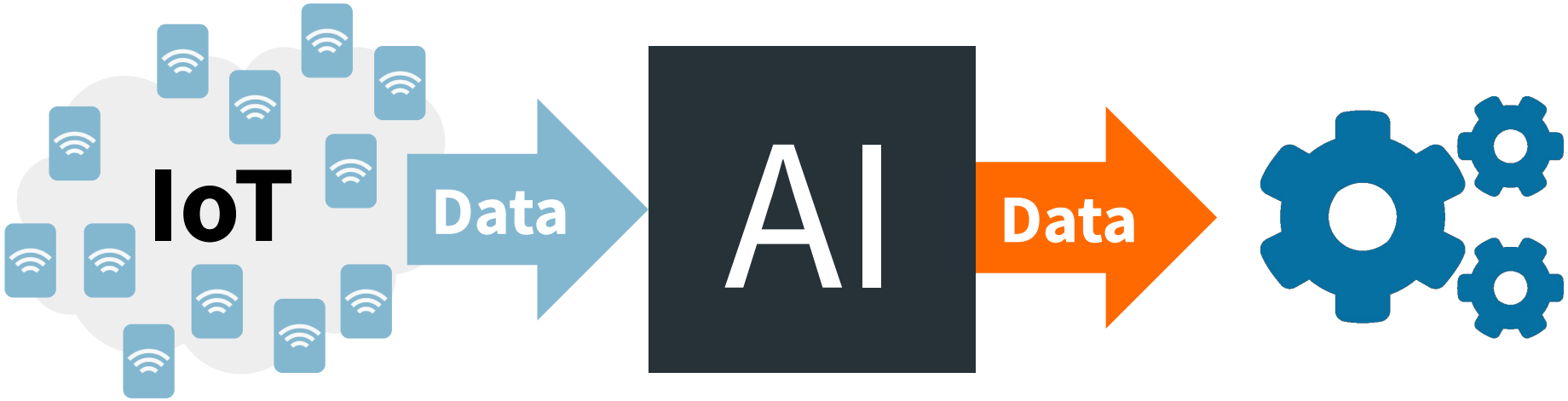


"Please ***create*** a 90 minute presentation on RFID in AIoT."

Generative AI and LLMs are fun!

But what if I have a question about the **real-time state of the physical world** in which we humans live?

Enter the Internet of Things



"Please ***configure*** the HVAC to balance efficiency and comfort for the current occupants in this room."

Hello AIoT!

"[**AI** is] about making computers that can help us, that can **do the things that humans can do**, but our current computers can't."

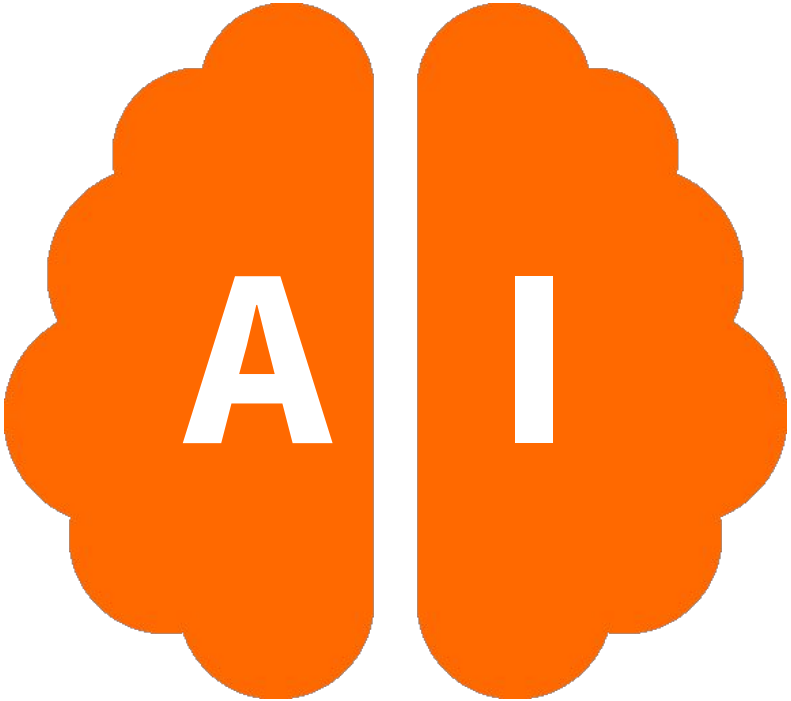
—Yoshua Bengio

Sources: ROSS Intelligence, 2017
Wikipedia, 2025

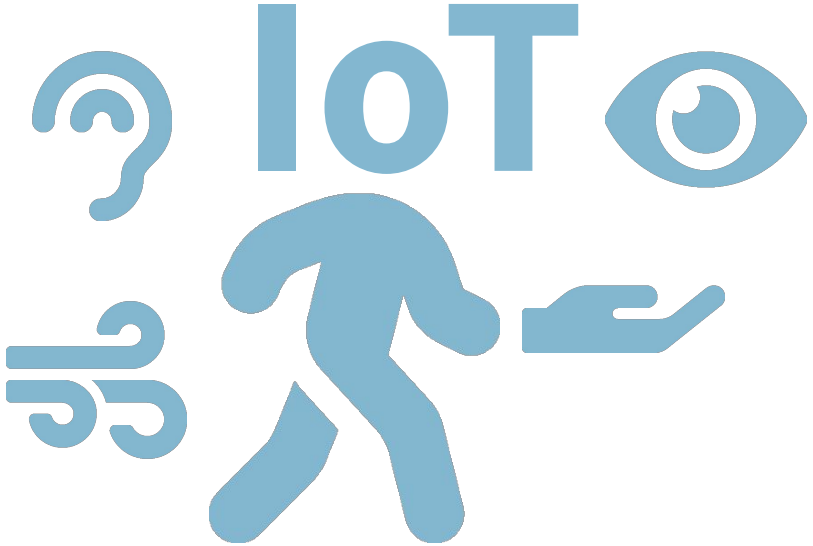
"[**IoT** will] empower computers with their own means of **gathering information**, so they can see, hear and smell the world for themselves, in all its random glory."

—Kevin Ashton

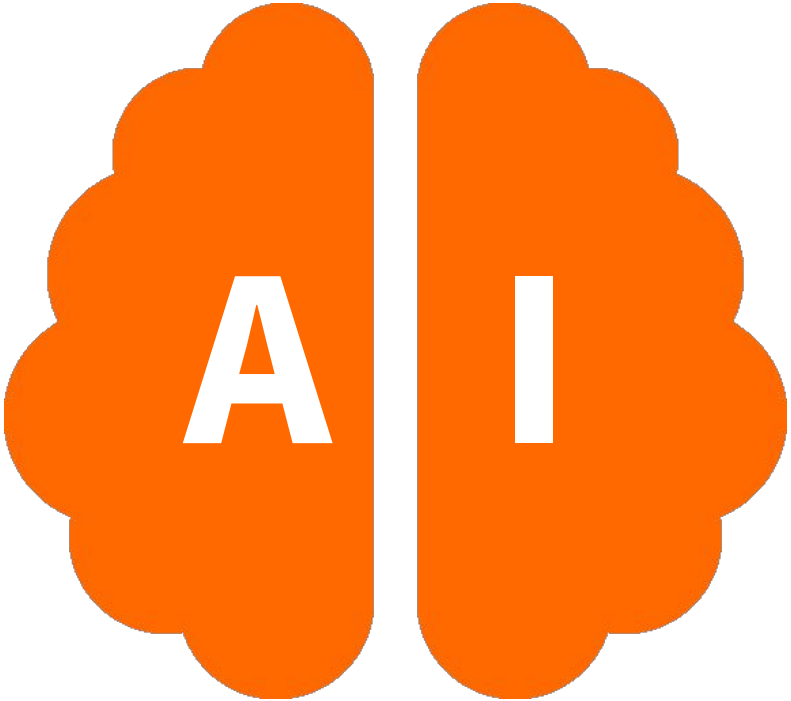
Source: RFID Journal, 2009



The Brain

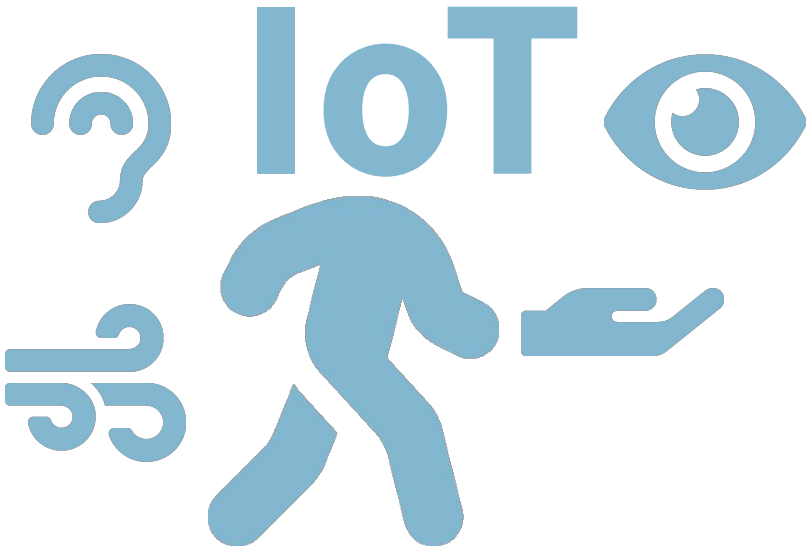


The Senses



What's a **brain** without any **senses**?

Answer: _____



What are **senses** without a **brain**?

Answer: _____

Where's the RFID in AIoT?

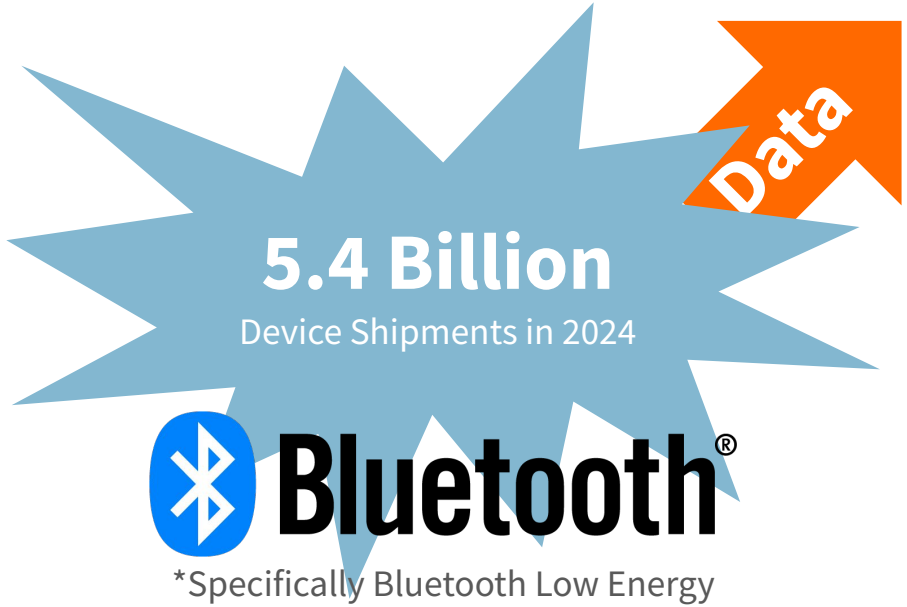
"**RFID** and sensor technology enable computers to observe, identify and understand the world—*without the limitations of human-entered data.*"

—Kevin Ashton

Source: RFID Journal, 2009

Mo RFID Mo Data

Source: RAIN Alliance



Source: Bluetooth SIG

Summary: PART 1

AI has *not* taken over everything,

nor can it without an ability to sense the physical world,

which is the complementary role of **IoT** (including **RFID**).

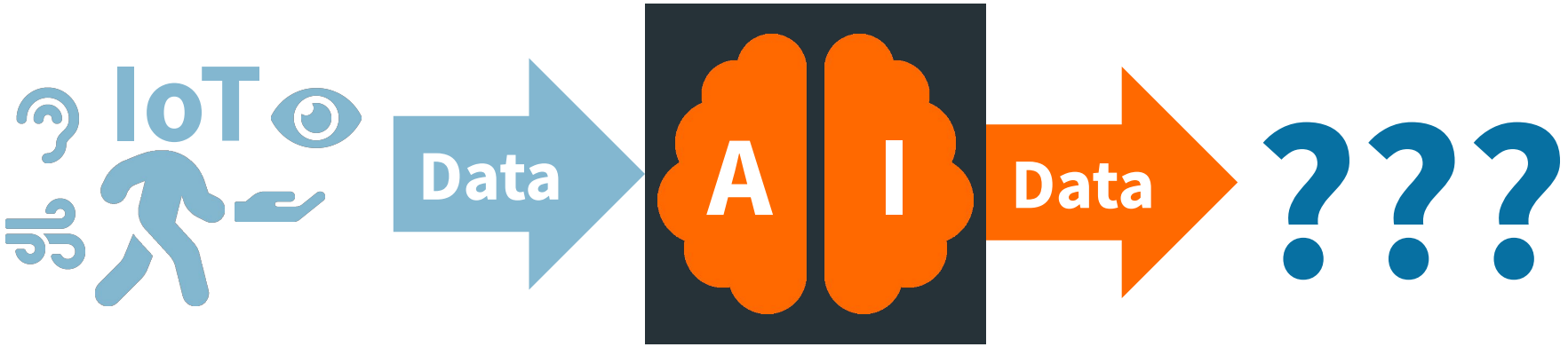
That's AIoT. ✓

PART

2

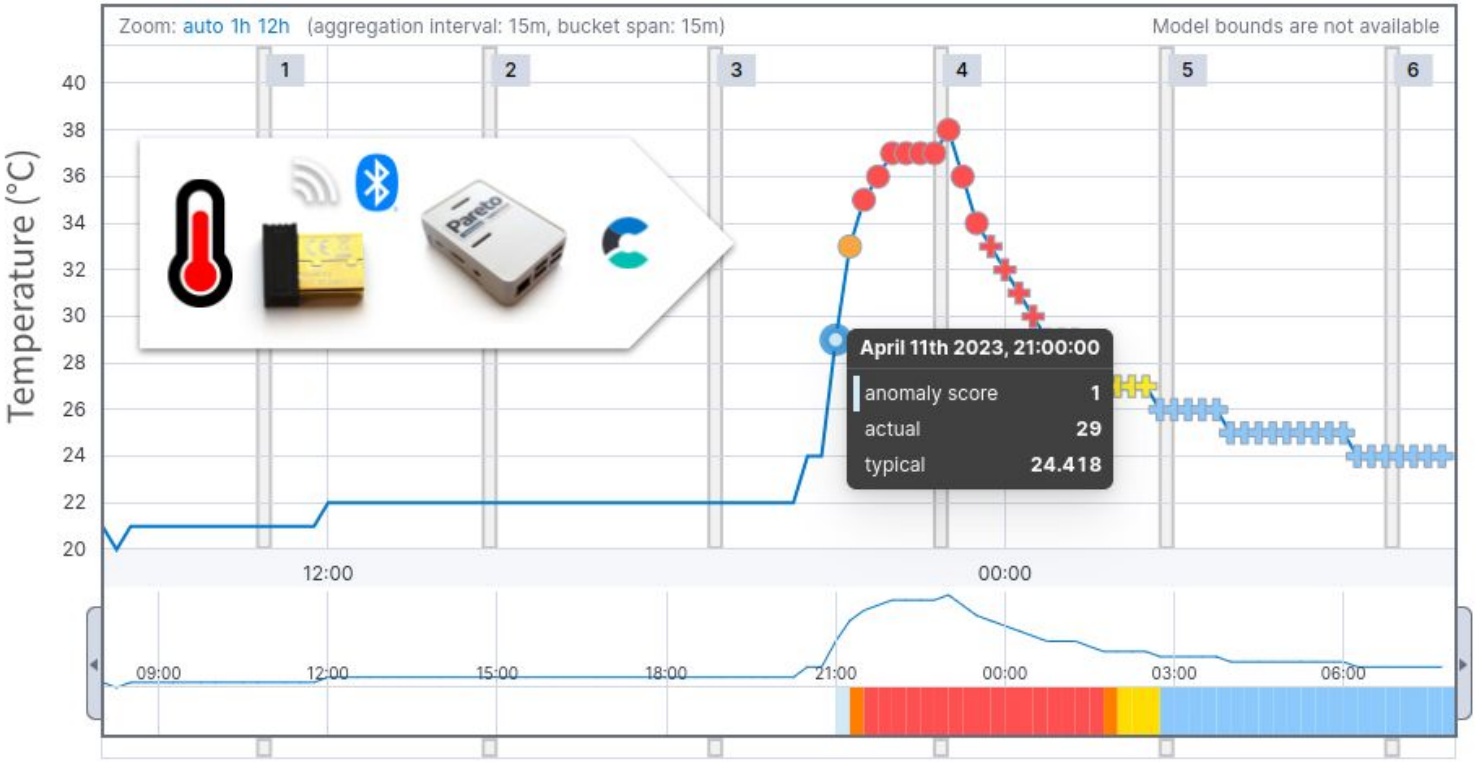
What's the state of **AIoT** today?

What can AIoT do for you today?

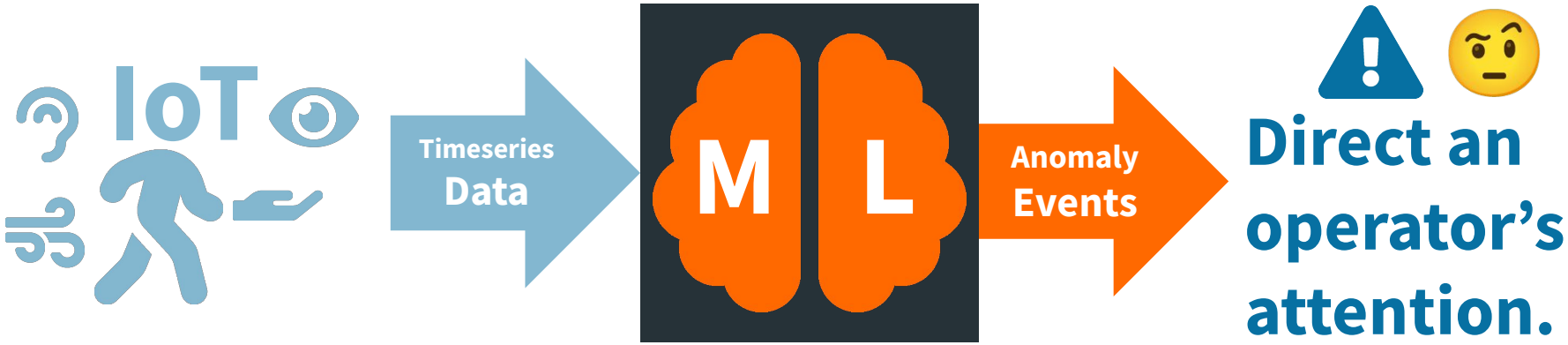


Is it more than mere hype?

Anomaly Detection (AI?) of RFID Temperature



Anomaly detection: *arguably* AIoT!



Does **M**achine **L**earning satisfy our definition of AI?

Cold Chain

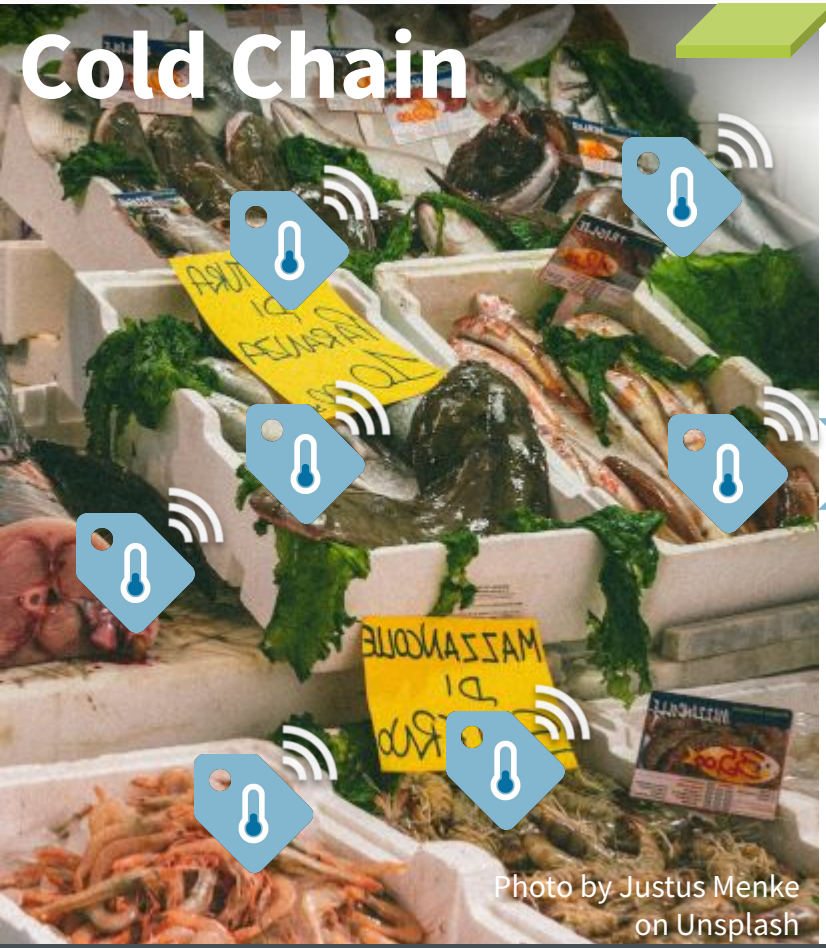


Photo by Justus Menke on Unsplash

IoT Middleware

HUMAN-ENTERED

Rules Engine

Temperature out of bounds!

TEMPERATURE TIME SERIES

Anomaly Detection

Something is *fishy!* 😂

UNSUPERVISED

Seafood cold chain AIoT *deeper dive* 😂

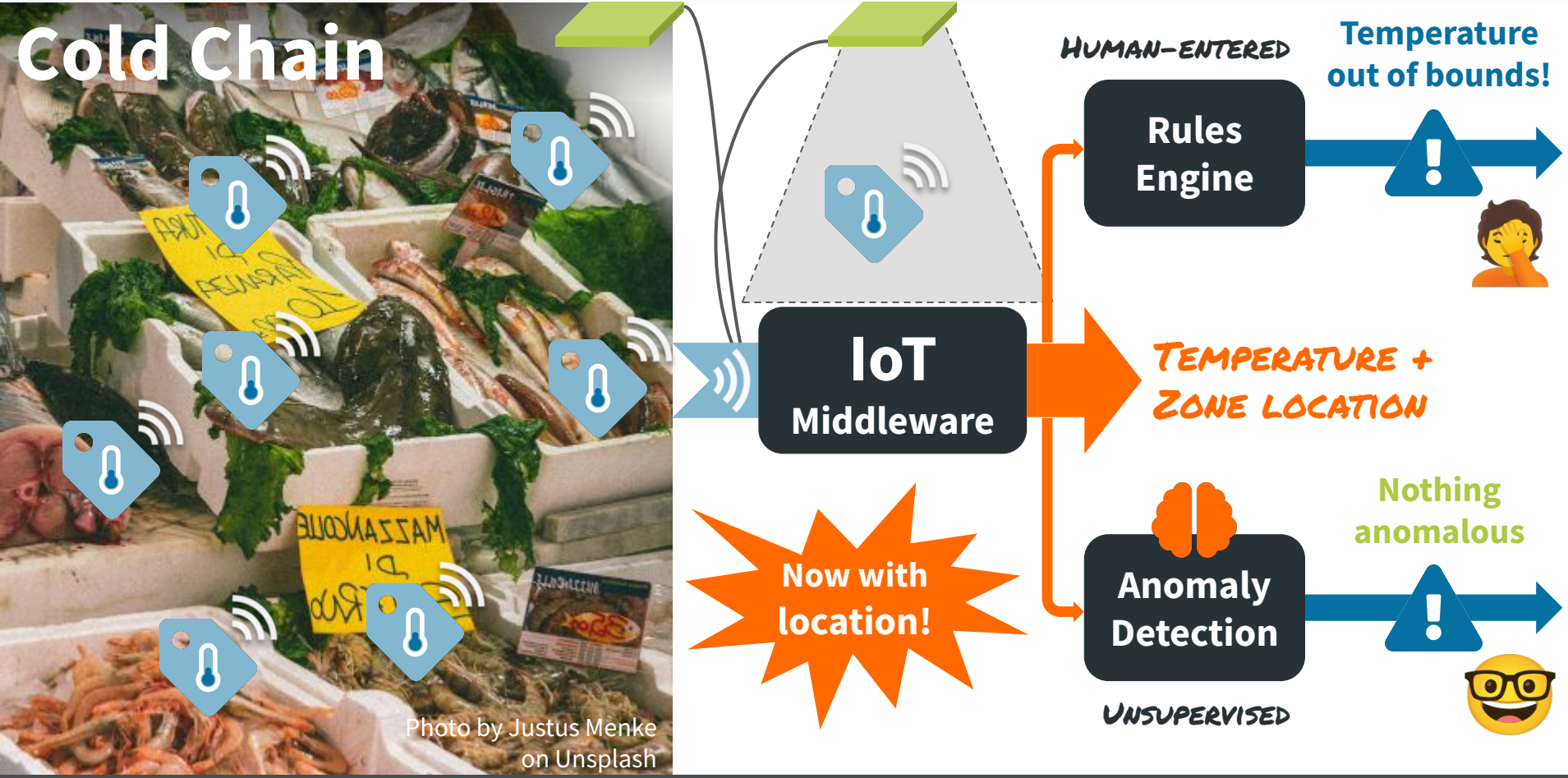
- ☑ **RFID**: RAIN, BLE, … all support temperature sensing
- ☑ **IoT**: “without the need for *human-entered* data”
- ☑ **AI**: *human-level* insights about anomalous trends

All the temperatures are rising *together*…
…perhaps there’s a refrigeration issue?

✓ **RFID** in **AIoT**

Cold Chain

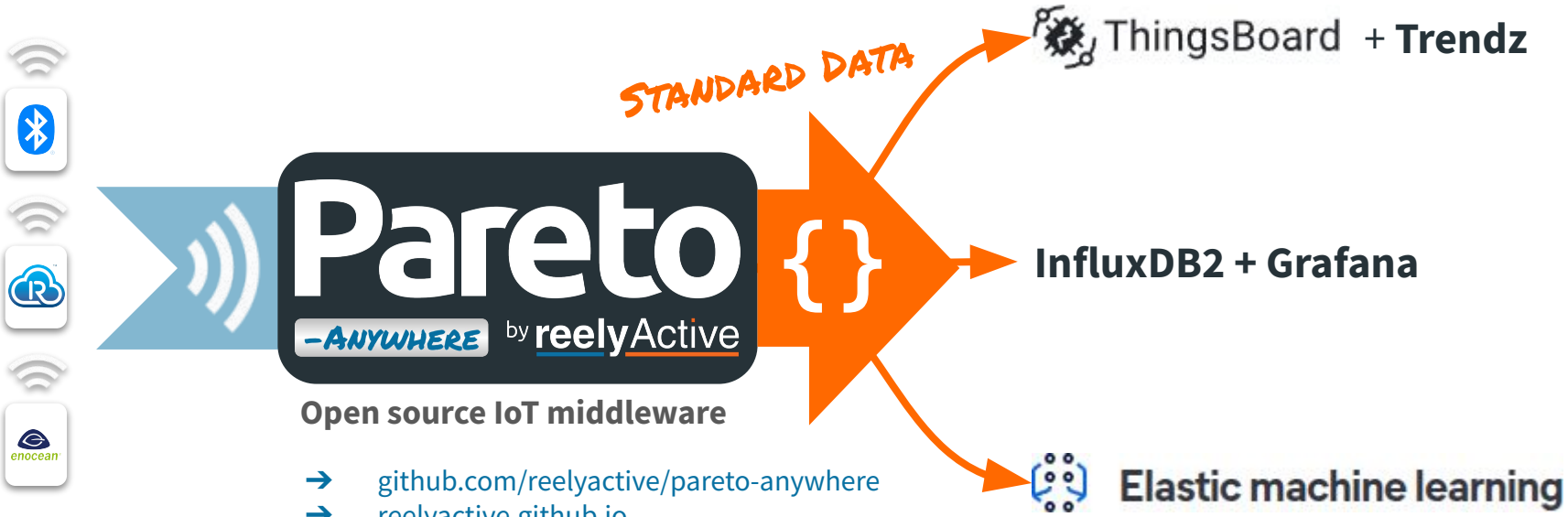
Photo by Justus Menke on Unsplash



AI handles multi-variable patterns well

Overcomes the limitations of *human-entered* (rules) data.

Open source AIoT anomaly detection



Open source IoT middleware

- github.com/reelyactive/pareto-anywhere
- reelyactive.github.io

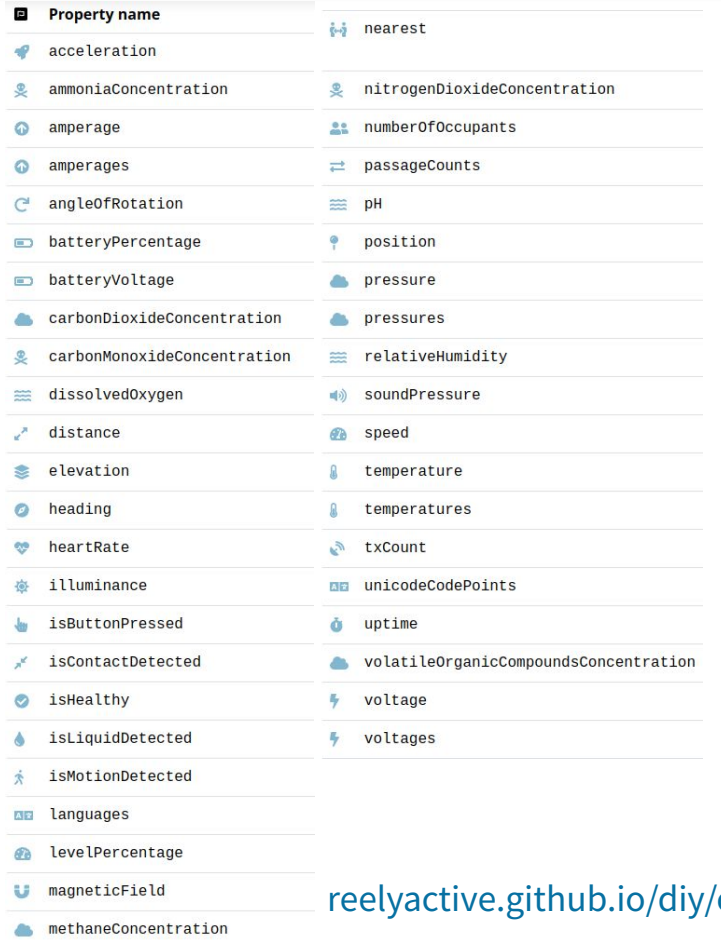
Standard data

Any sensor

Any vendor

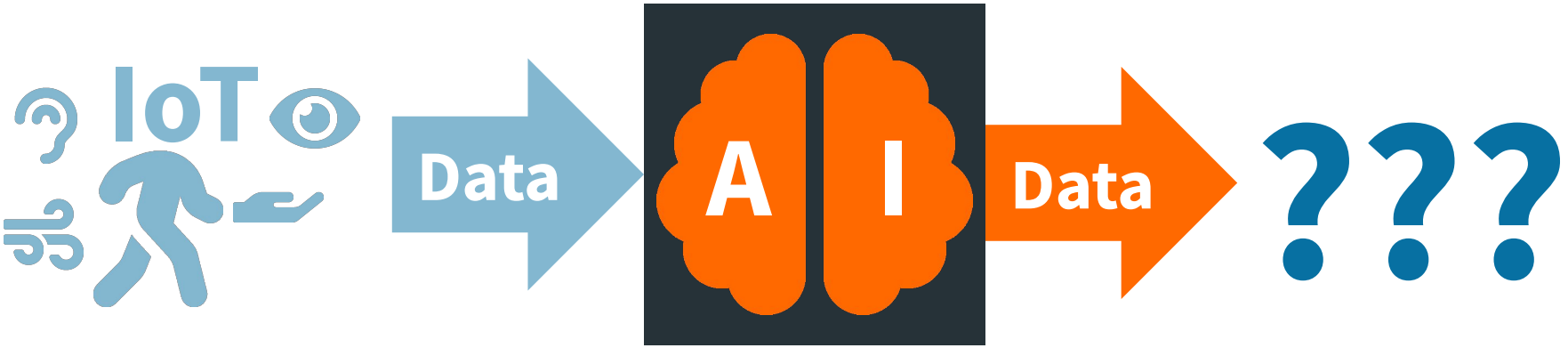
Any technology

Same properties



reelyactive.github.io/diy/cheatsheet

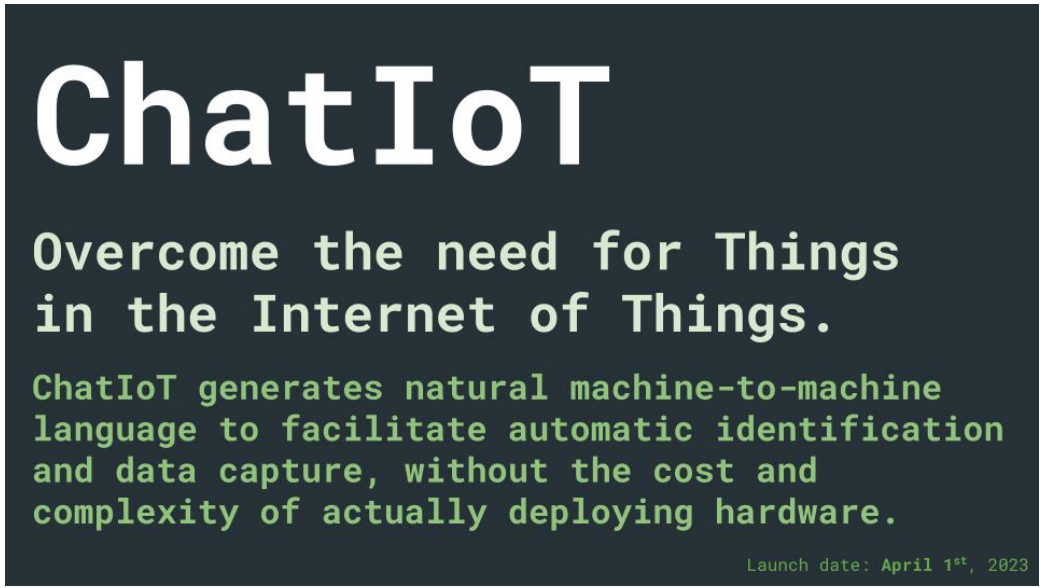
What *else* can AIoT do for you?



How do most people use AI today?

“I have a question”: LLMs in AIoT?

YOU'VE HEARD OF CHATGPT, BUT WHAT ABOUT CHATIOT?



April Fools’ 2023

blog.reelyactive.com/2023/**04/01**/chatiot/

Speaking of asking questions…

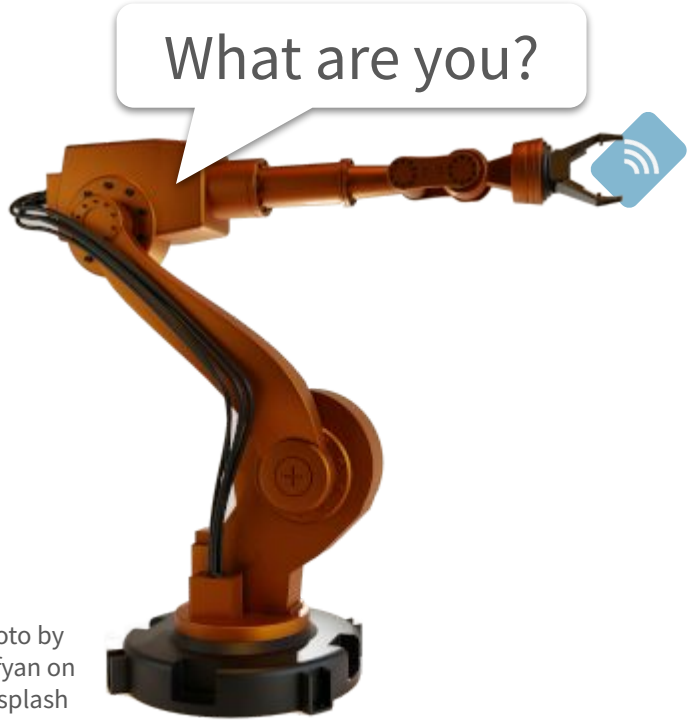
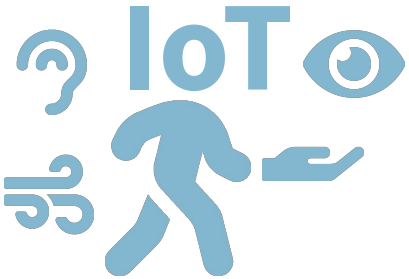


Photo by Sufyan on Unsplash

According to Sanjay Sarma, MIT Auto-ID Lab co-founder David Brock was interested in RFID to enable robots to simply “ask” what it was that they were picking up!

www.aimglobal.org/aim-1990/
youtu.be/VFzbzp9Op6c

Now you're speaking my language!



Natural Language

Large Language Model

Natural Language

Which machine is running at the highest temperature now?

There are 13 machines with temperature sensors and the hottest is **the printer** which is currently reading **72°C**.

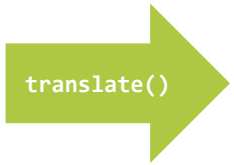
In Fahrenheit please.

Right, **the printer** is currently reading **162°F**.

Can IoT Data be natural language?

```
{
  deviceId: "5e7504",
  temperature: 72,
  timestamp: 1745339400000
  tags: [ "machine" ],
  uri: "did:twin/1234"
}
```

```
{
  "@type": "schema:Product",
  "schema:name": "Printer"
}
```

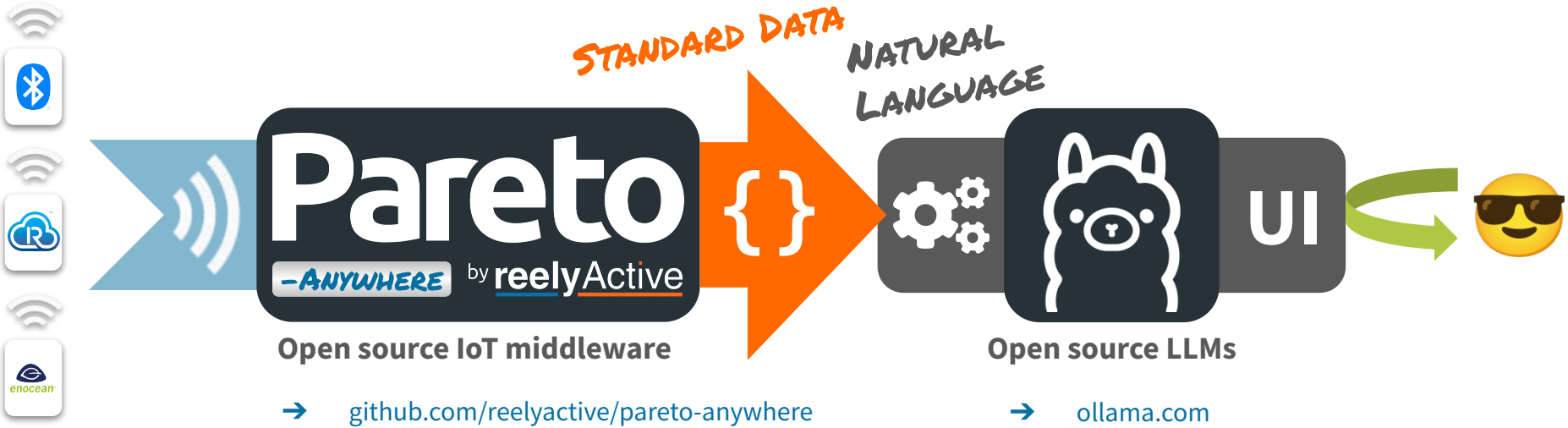


The **temperature** of
the **machine** called **Printer**
is **72°C** at 12:30:00
on Tuesday, April 22nd, 2025.

Sure, why not!?!

*You could even ask a LLM to write you **the translator code**!

Open source natural language AIoT



Open source IoT middleware

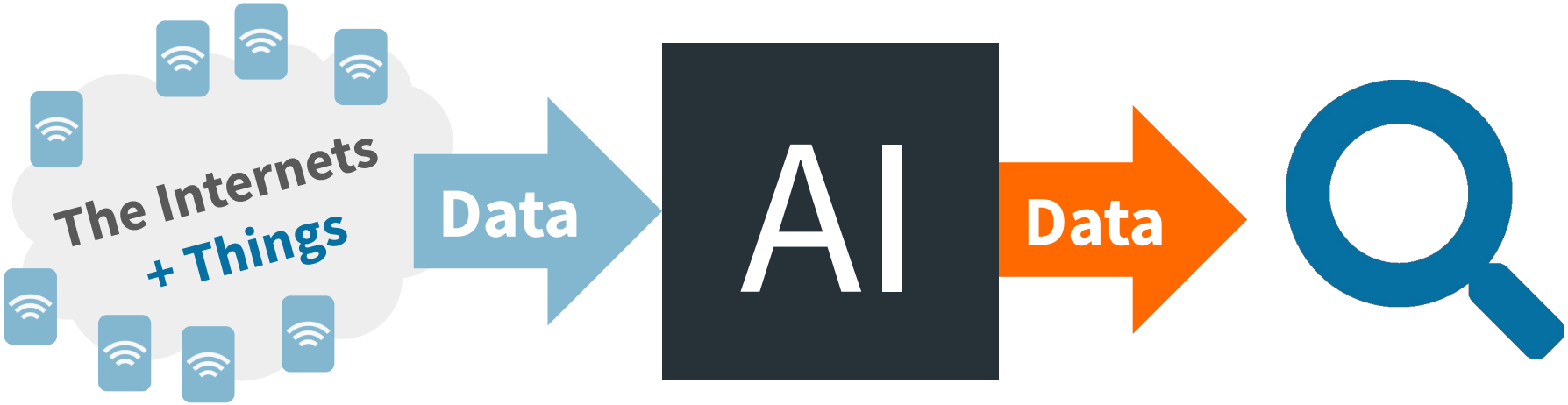
- github.com/reelyactive/pareto-anywhere
- reelyactive.github.io

Open source LLMs

- ollama.com

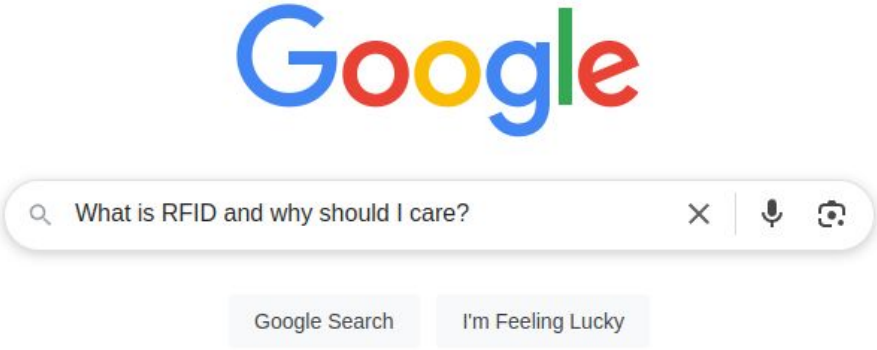
*Ask a LLM to write you the **backend code** and the **UI**!

AI-augmented search in the IoT era?



What might be the future of search?

Internet Search



IoT Search

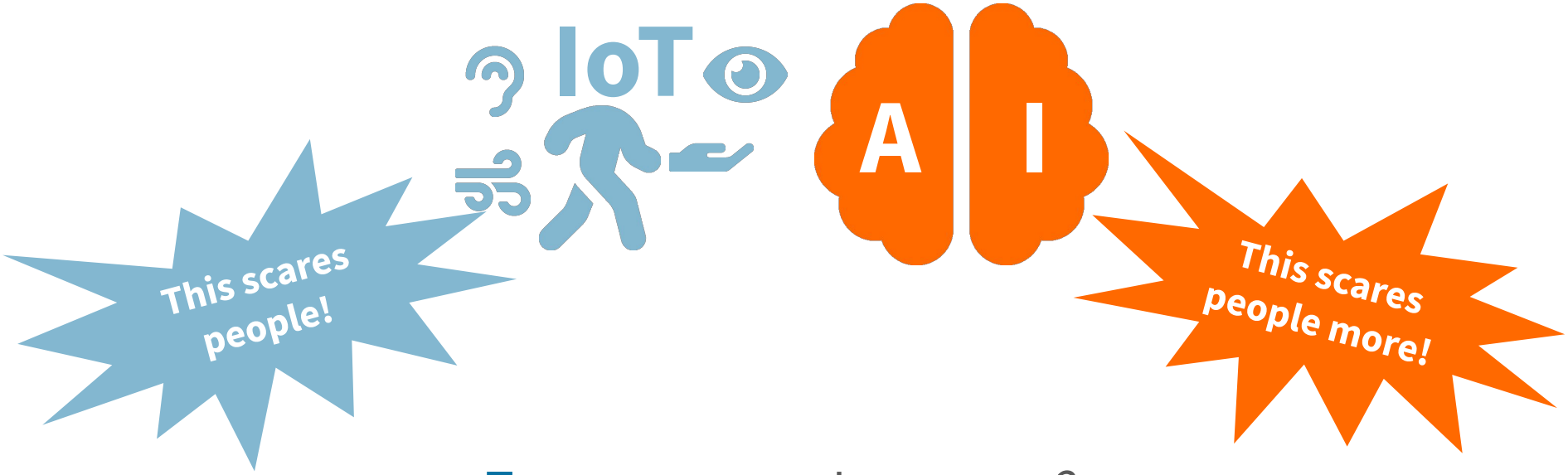
YOUR LOGO HERE!

Where is the nearest available seat with an AC outlet?

Search

What do ***you*** wish you could search for, real world, real-time?

Public Service Announcement



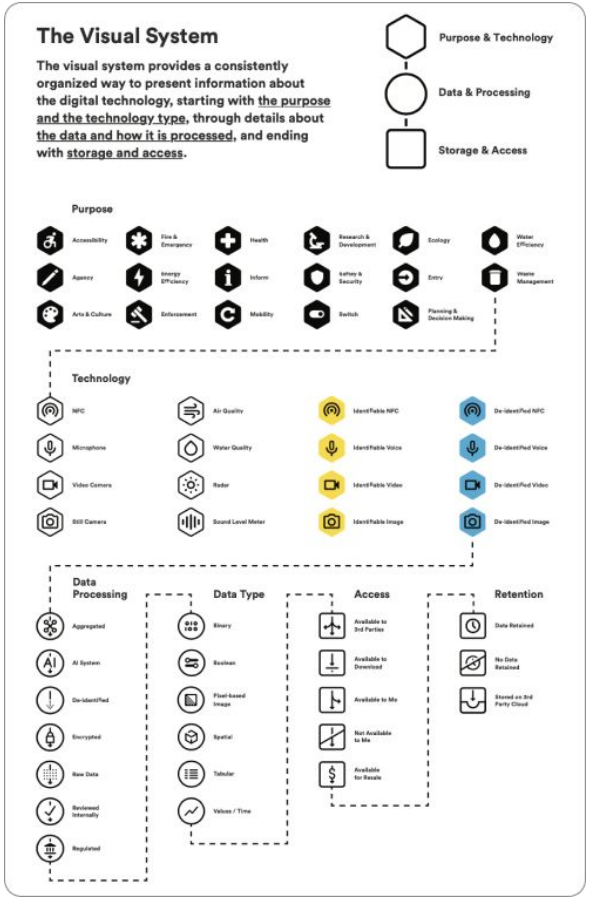
Transparency = Less scary?

DTPR.io

Digital Trust for Places & Routines

“DTPR was designed to describe **sensors collecting data in public space**. [...] Today, a comprehensive digital transparency program would be incomplete if it did not include **transparency on the role AI or algorithms** used in public decision making.”

https://github.com/Helpful-Places/dtpr/issues/228



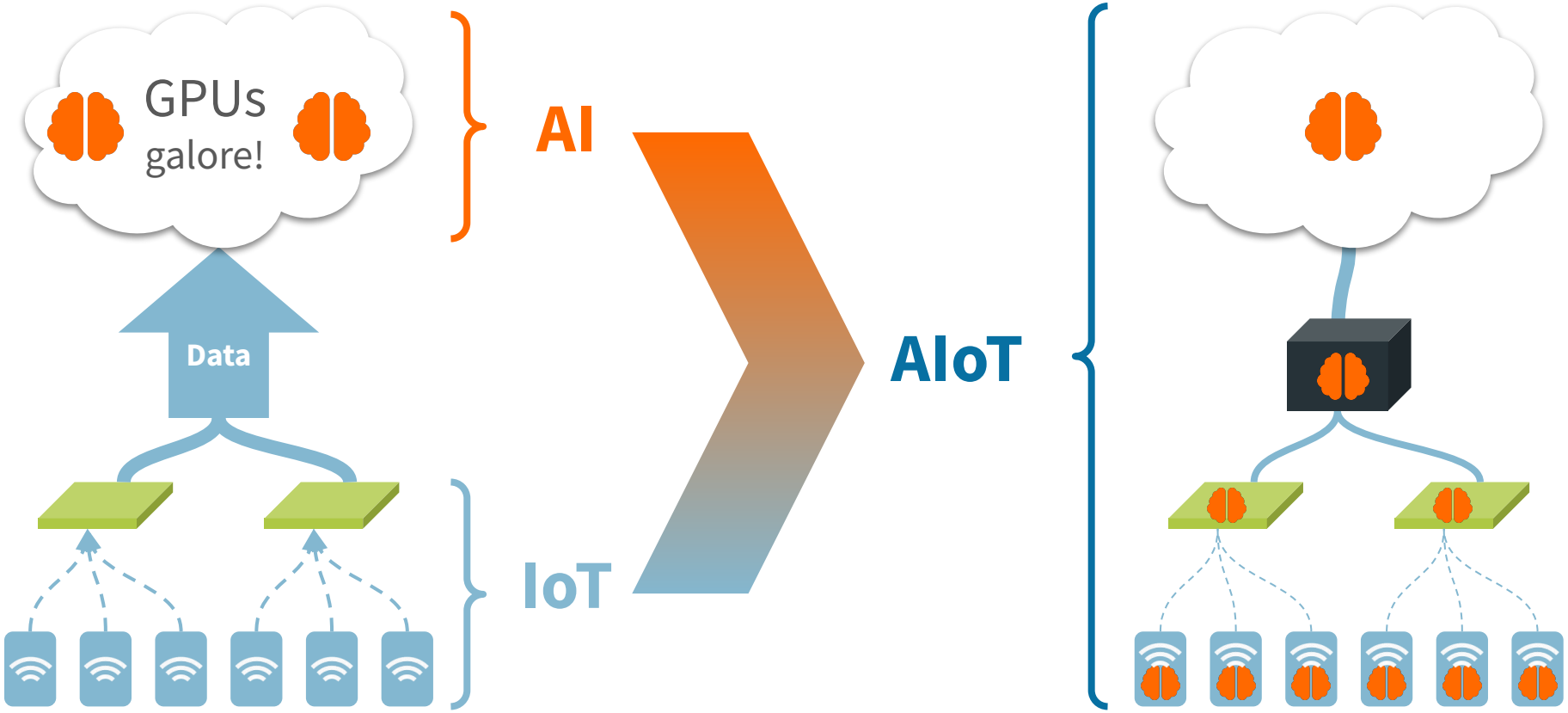
Summary: PART 2

AIoT is really “a thing” today,
with plenty of unrealised potential and
the promise of an exciting (~~scary~~) future!

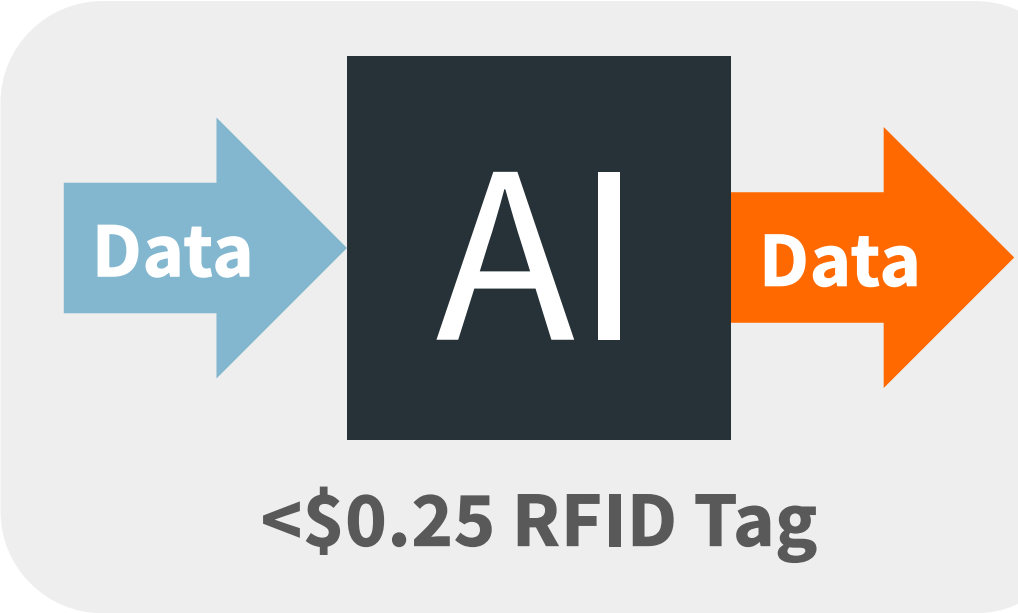
AIoT is here (for good). ✓

PART 3

How pervasive does **AIoT** become?


GPUs
galore!
AI
Data
IoT
AIoT

AI at the *extreme* edge?

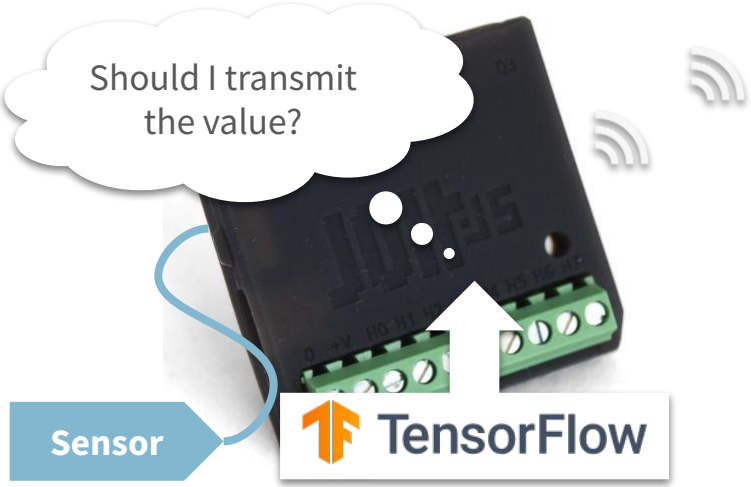


Espruino Jolt.js

JavaScript-programmable **BLE** (RFID) sensor/actuator

“Dumb” updates

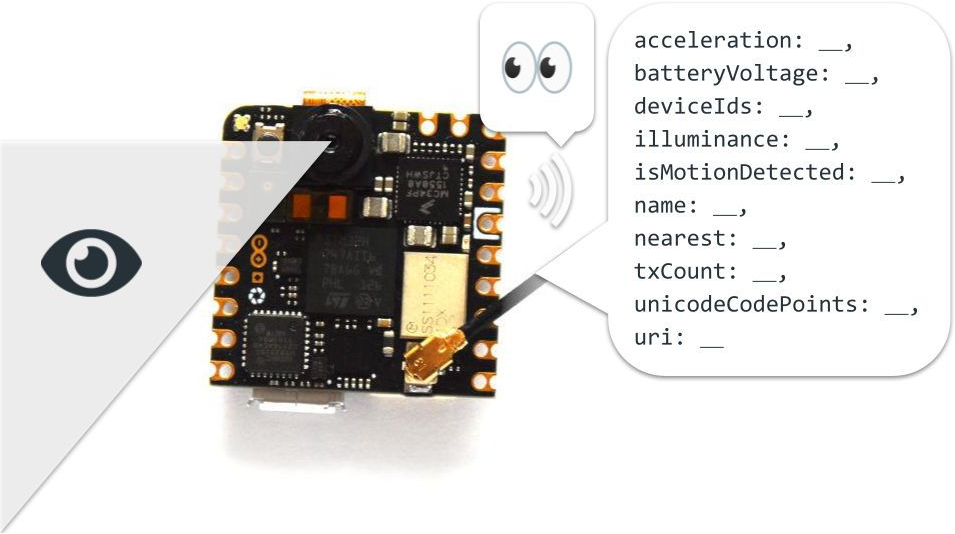
“Smart” updates

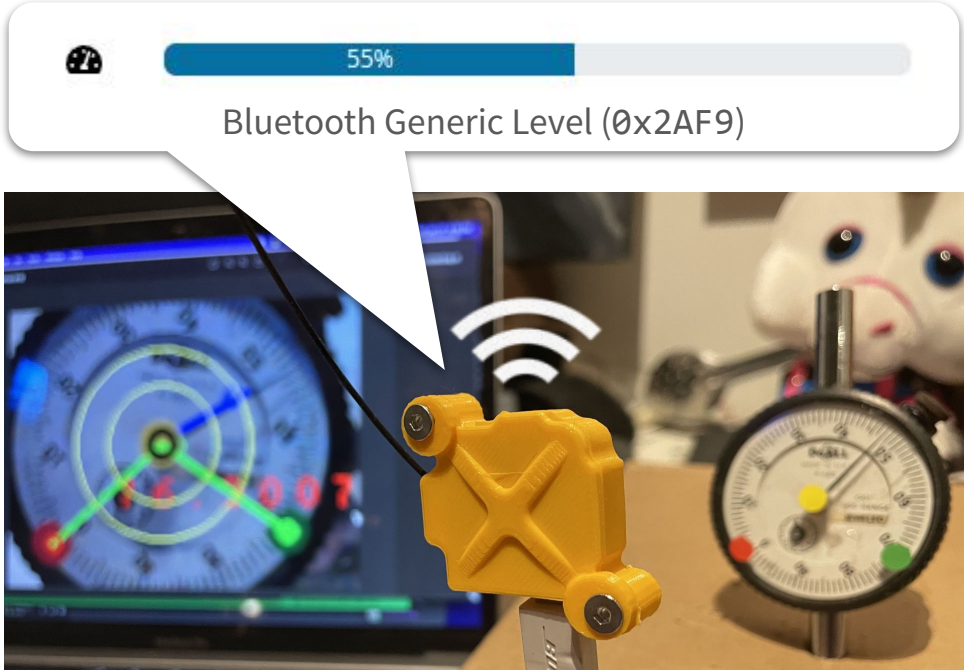


reelyactive.github.io/diy/joltjs-dev/

Arduino Nicla Vision

BLE (RFID) + **TinyML** (AI?)

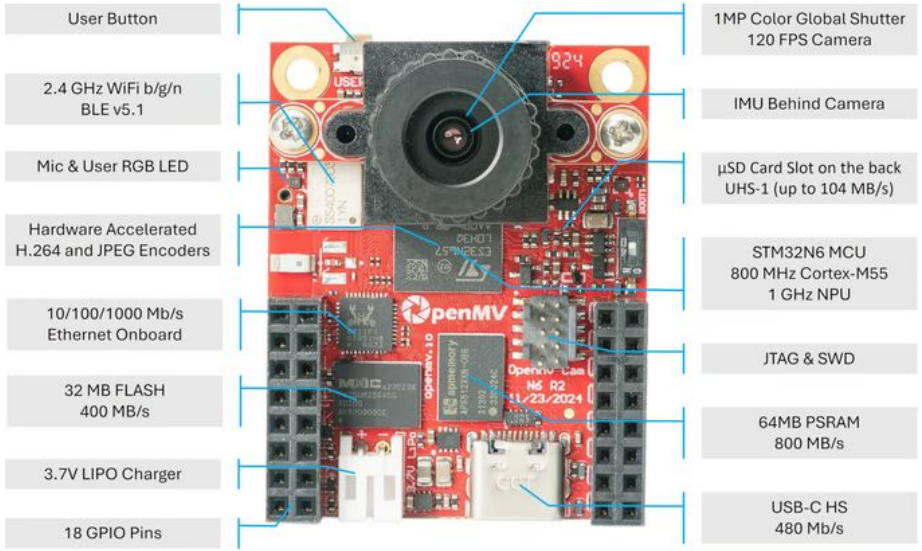




reelyactive.github.io/diy/nicla-vision-dev/
reelyactive.github.io/diy/nicla-vision-gauge-reader-config/

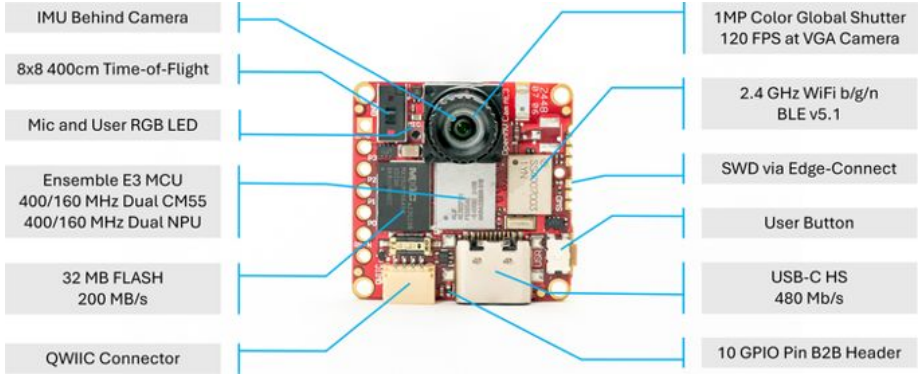
OpenMV N6

BLE (RFID) + 1GHz NPU (AI)



OpenMV AE3

BLE (RFID) + Dual NPU (AI)



openmv.io

www.kickstarter.com/projects/openmv/openmv-n6-and-ae3-low-power-python-programmable-ai-cameras

Ubiquitous computing names the third wave in computing, just now beginning. First were mainframes, each shared by lots of people. Now we are in the personal computing era, person and machine staring uneasily at each other across the desktop. Next comes ubiquitous computing, or the age of calm technology, when technology recedes into the background of our lives.

—Mark Weiser

Circa 1988

Summary: PART 3

AIoT is ubiquitous computing,
extending further and further to the edge,
perhaps to the extent of RFID tags!

AIoT in RFID. ✓

RFID in AIoT

Presented by Jeffrey Dungen
Co-founder & CEO of reelyActive
at IEEE RFID 2025 in Atlanta, GA

www.reelyactive.com | reelyactive.github.io