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The IoT development experience can be better.

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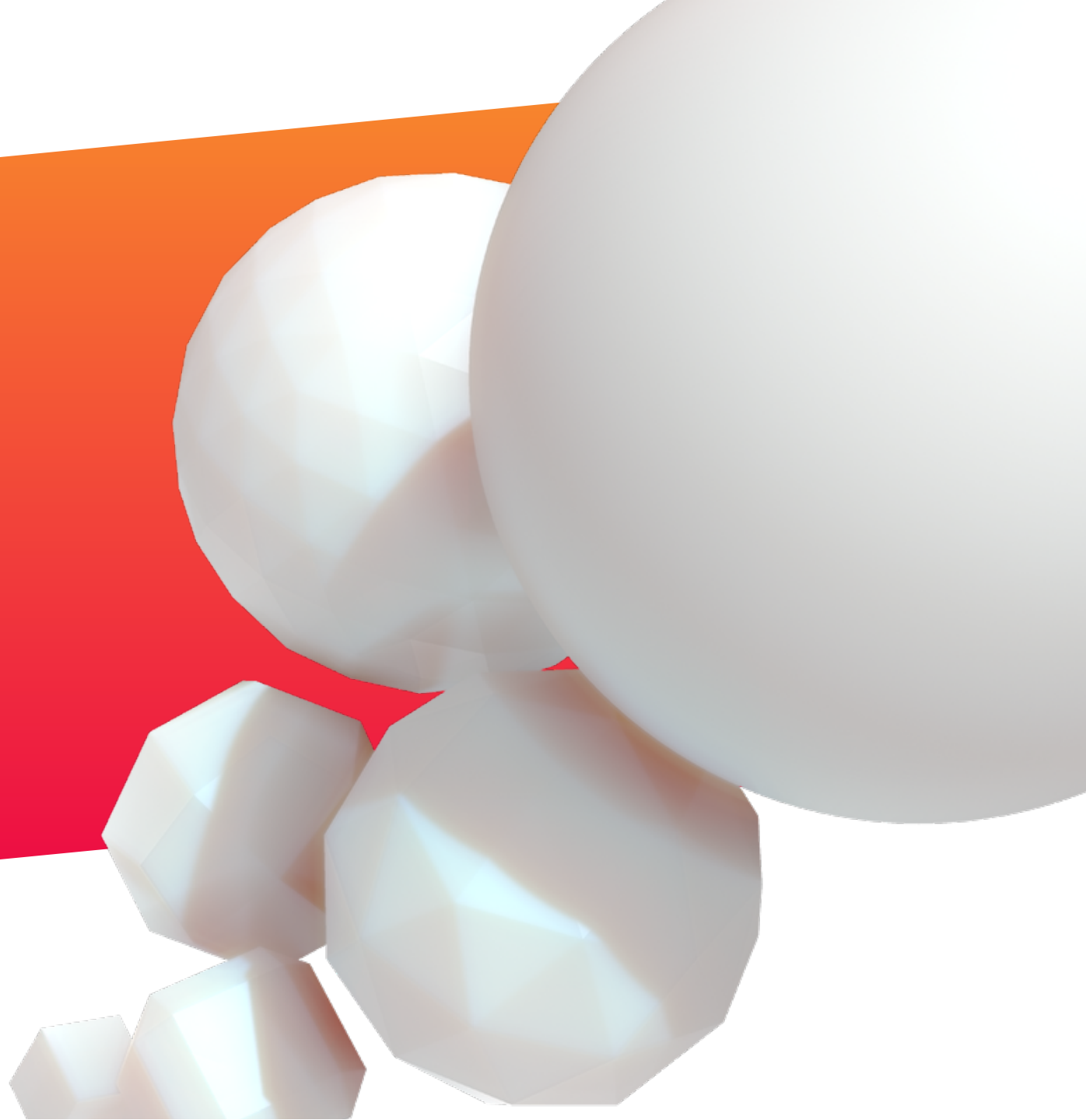
Taking IoT Programming to a Higher Level

with Instantiations and Toit



Seth Berman

President & CEO

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Kasper Lund

Co-Founder & CEO

Toit

Mariano Martinez Peck

Senior Software Engineer

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Instantiations, Inc.

- Founded in 1988 – Headquartered in Raleigh, NC
- Developer of the **VAST Platform**
  - A comprehensive integrated development environment (IDE) that works with a Smalltalk language runtime
  - Advancing both the IDE and Virtual Machine (VM)
- Provider of technology services
  - Custom software development
  - Consulting
  - Training
  - IoT
- Our software and services are leveraged by
  - Fortune 100/500 companies
  - Small and medium-sized businesses
  - Solo developers/entrepreneurs

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Why is a higher-level development experience better?

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Advantages of higher-level languages

- Deal with high-level abstractions (objects, functions, prototypes)
- More productive
- Memory-safe
- Easier to debug
- More human readable

VAST Platform

- A comprehensive integrated development environment (IDE) that works with a Smalltalk language runtime
- For Windows® and Linux® operating systems
- Intel®/AMD® and ARM® processor support (32/64-bit)
- Purely object-oriented
- Extremely productive and performant
- Almost 30 years of enterprise-proven stability
- Can be used for IoT orchestration or edge devices

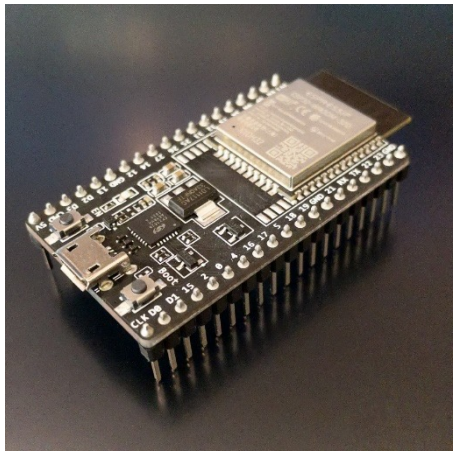
VAST Platform

What about microcontrollers?

Toit: The Programming Language

- An open-source, object-oriented language purpose-built for IoT programming
- Uses open-source hardware (ESP32) that's small and energy efficient, and available from dozens of reputable sources
- 20x faster than MicroPython

Toit



ESP32 Development Board

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Toit

with Kasper Lund, co-founder and CEO

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Kasper Lund, co-founder and CEO of Toit

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I joined Google in 2006 to build something new …

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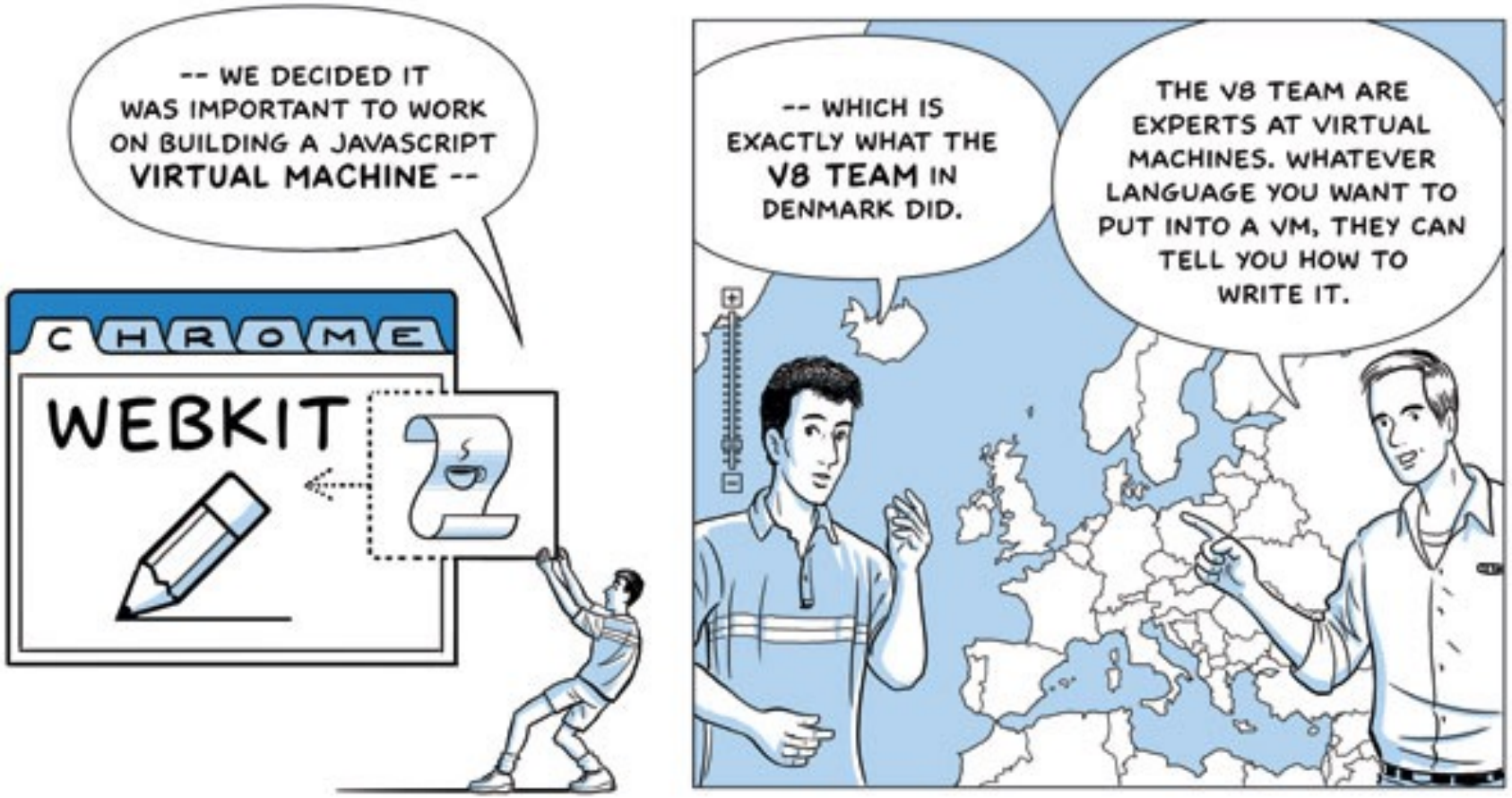
I am located in Aarhus, Denmark



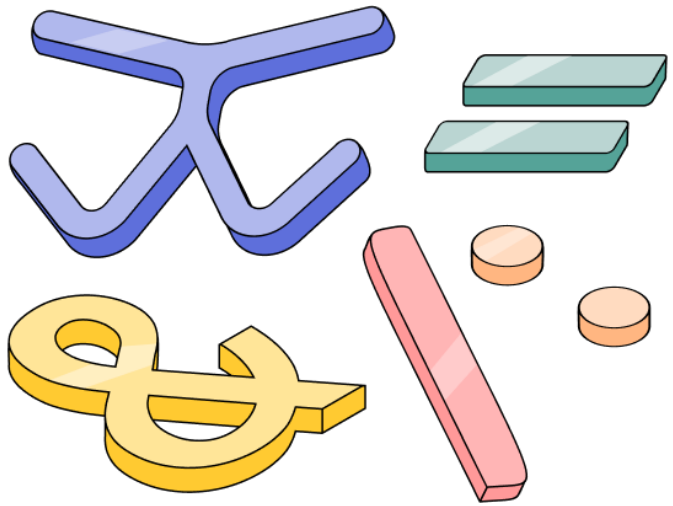
I have a deeply technical background

Flutter

I am driven by enabling others to be more productive

Virtual machines

Operating systems



Developer tooling

Programming languages

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I ❤️ Smalltalk!

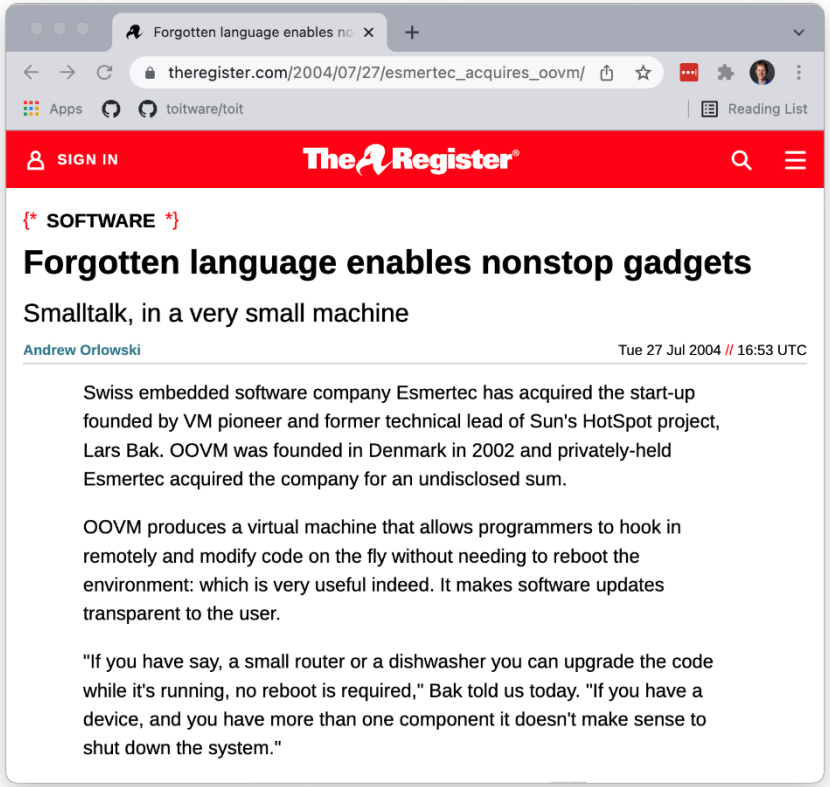
Revolutionizing Embedded Software

Kasper V. Lund and Jakob R. Andersen

Master's Thesis

Department of Computer Science
University of Aarhus
Denmark

https://verdich.dk/kasper/RES.pdf



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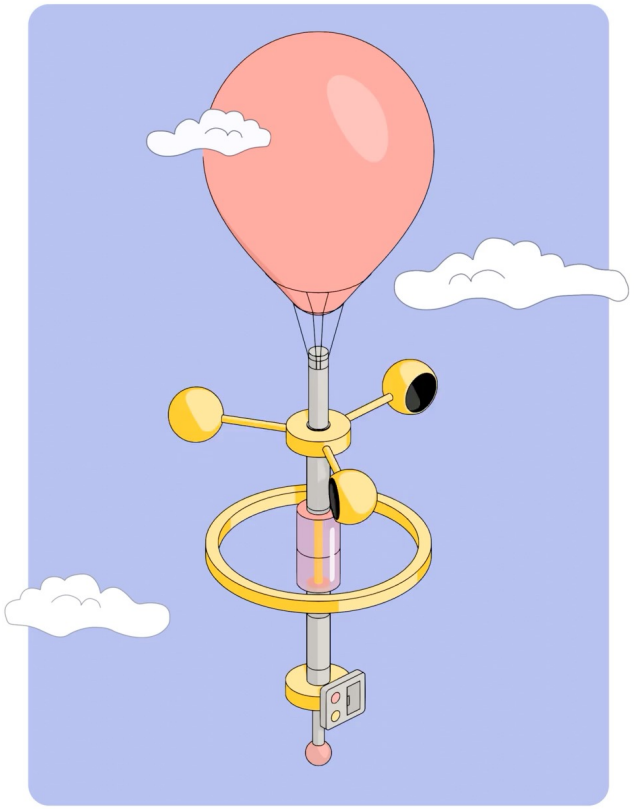
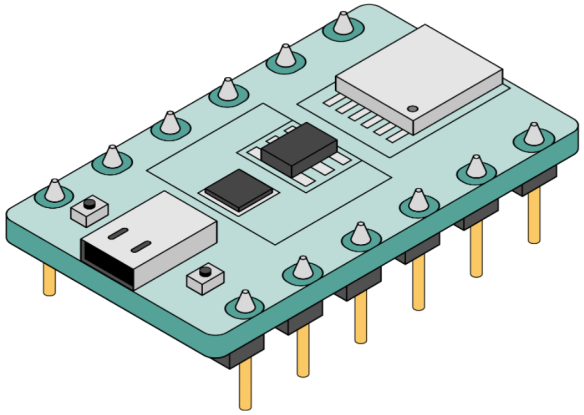
I am excited to be presenting with Instantiations

- Worked with fantastic ex-Instantiations folks at Google
- Indirectly collaborated in the Dart and Flutter ecosystems
- Shared passion for developer experience and languages



I learned of the ESP32 back in 2018 ...



Powerful

Dual-core 240 MHz RISC CPU
520 KB RAM, 4MB+ Flash
Built in WiFi / Bluetooth

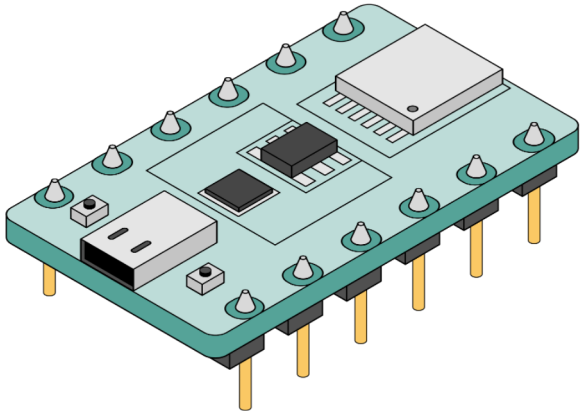
Runs on batteries

Practical drain in sleep mode is ~10 uA
Runs for years on AA batteries

Inexpensive

Development kit costs $10
Standalone chip costs less than $2

For a lot of interesting use cases, this is a ...



... compelling alternative to the Raspberry Pi

I am *just* a software engineer.

How can I write code for an ESP32?

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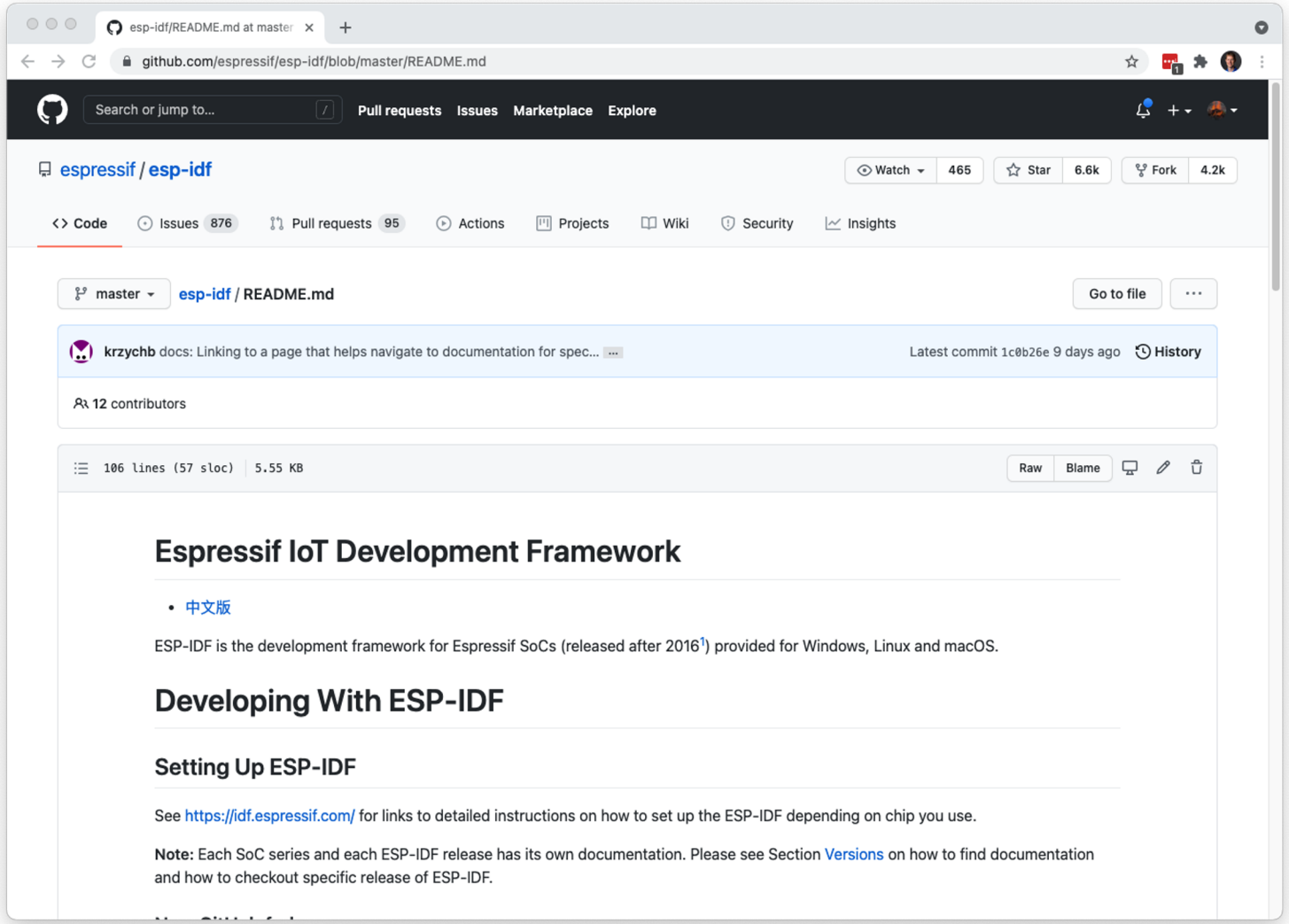
I found the ESP32 development framework on GitHub!



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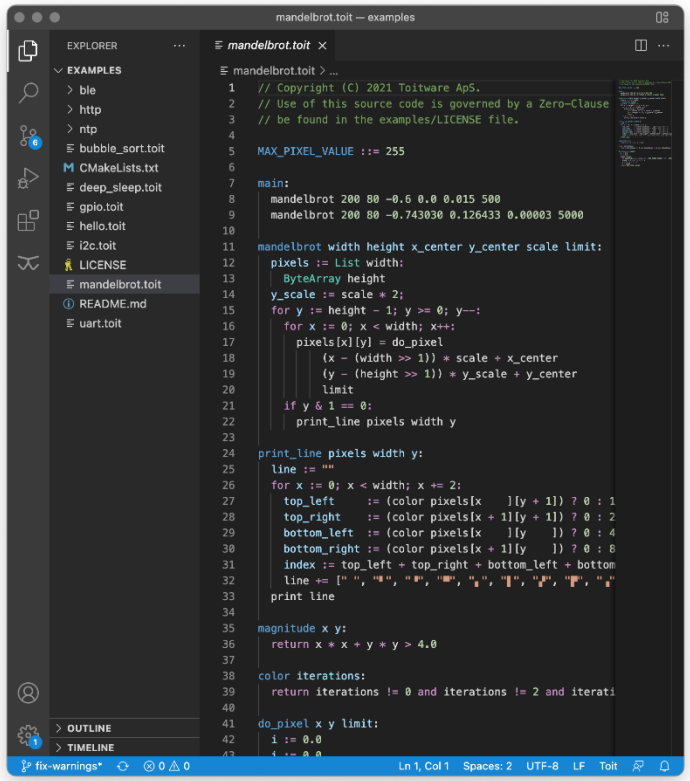
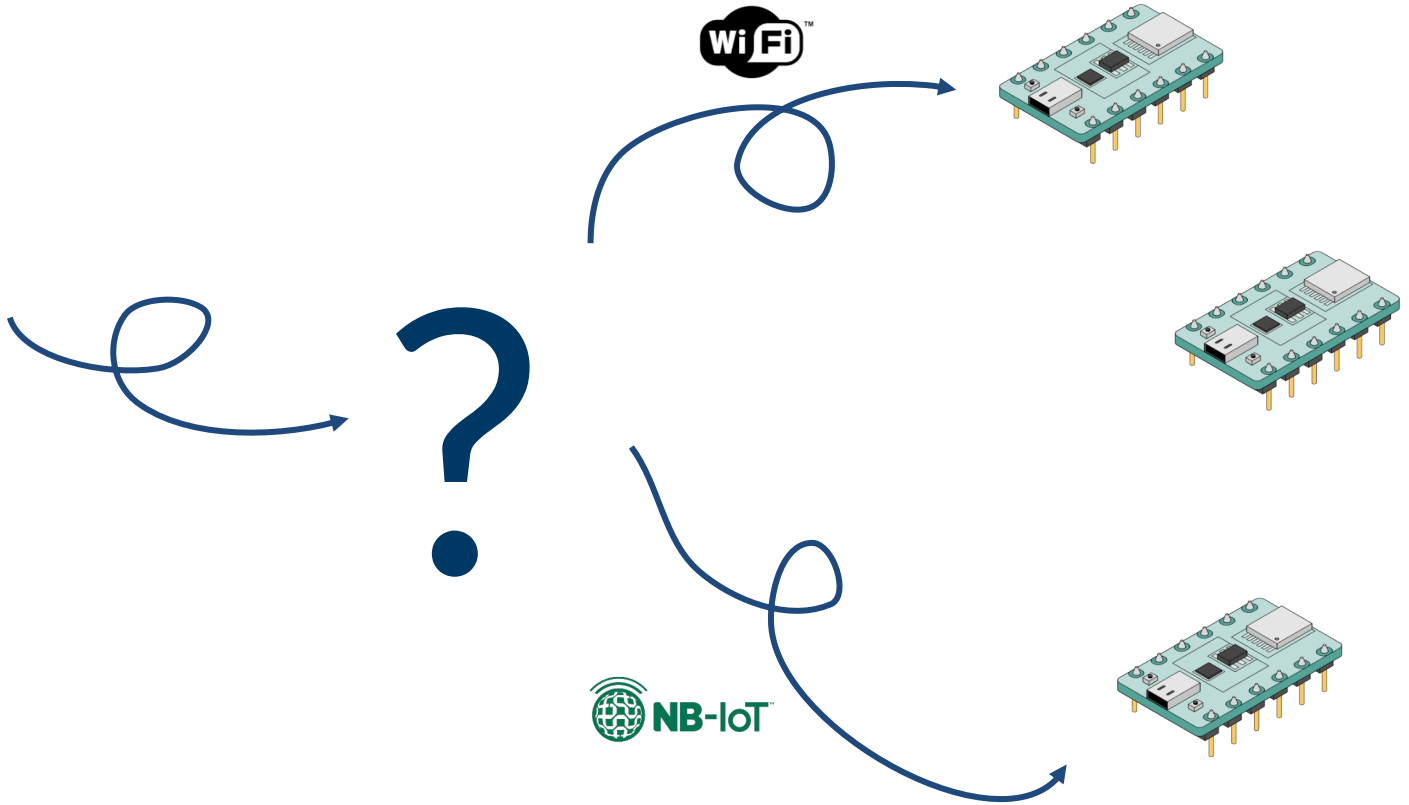
I still find that developing for microcontrollers sucks ...

- Thin, if any, separation between application, drivers, and OS
- Monolithic, close-knit system software tied to specific hardware
- Common source languages are C and assembly
- Application errors often result in crashing the entire device
- Development cycles are looooong

In spite of the hardware advances in microcontrollers,
the development experience just doesn't compare favourably
to server, desktop, or mobile development.

How can we enable and empower software engineers?





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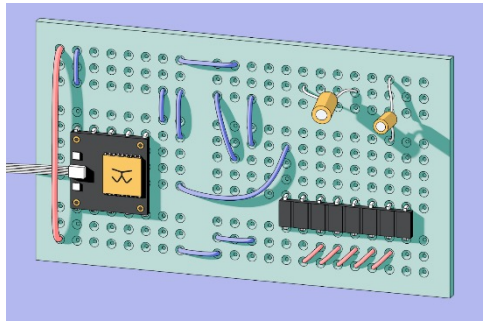
https://toitlang.org/

Open source language implementation for microcontrollers

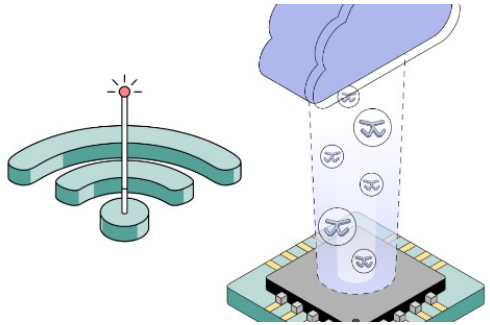


Productive and high level developer tooling for your ESP32s.
No C developers? No problem.

?

https://toit.io/

Cloud-managed containers on microcontrollers



Cloud-managed environment for your ESP32 code, fully controlled through a rich programmatic API.

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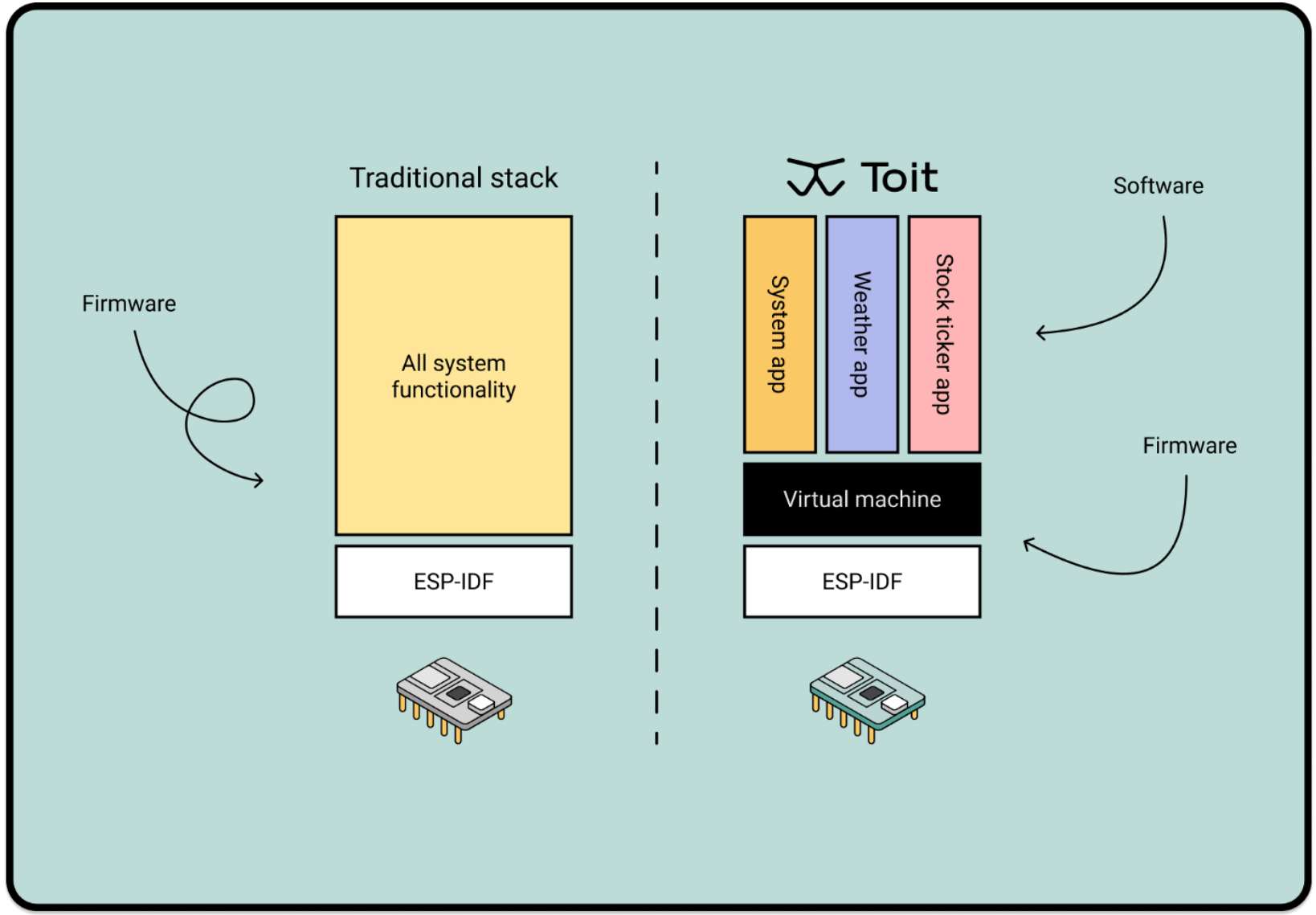
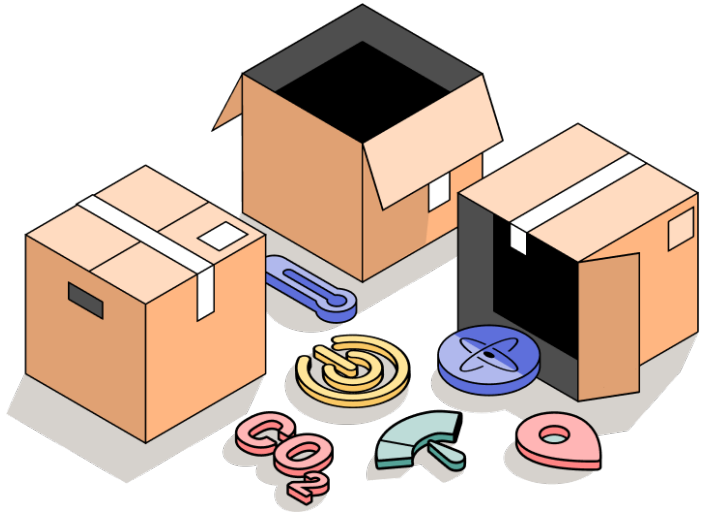


We have been tackling this since 2018

- Innovate at the fundamental technology level so you don’t have to
- Build the foundation for the future of all microcontroller functionality
- Enable software engineers to use their skills on battery-operated devices



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Hands-on demo with Toit

Jump-start your knowledge of the Toit language and platform

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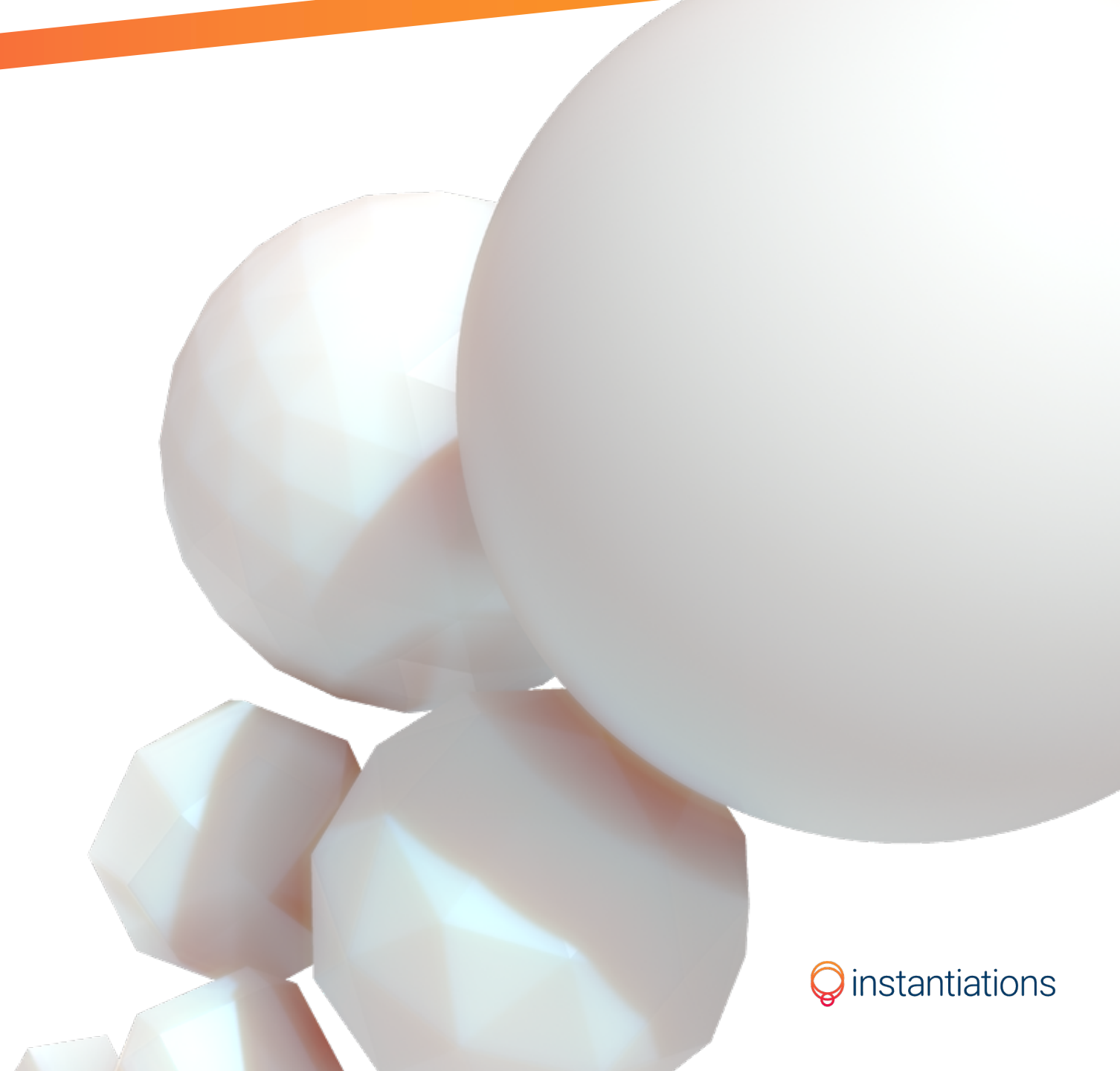
Let’s get started

- Preparing for the demo
- Hardware and Toit setup
- ‘Hello World’ program
- ‘Date and Time Logger’ program
- ‘Traffic Light’ app
- ‘Fleet device update’ demo
- Preparing your ESP32 for home usage



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Preparing for the demo

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Preparing for the demo

Go to: instantiations.com/riot-dev-day-2022

1. Sign up for the Toit platform
2. Provide your Toit account email to us
3. Install Toit CLI
4. Install USB serial drivers
5. Confirm Chrome/Edge is up-to-date
6. **Download a PDF of the slides (now available)**

Hardware and Toit setup

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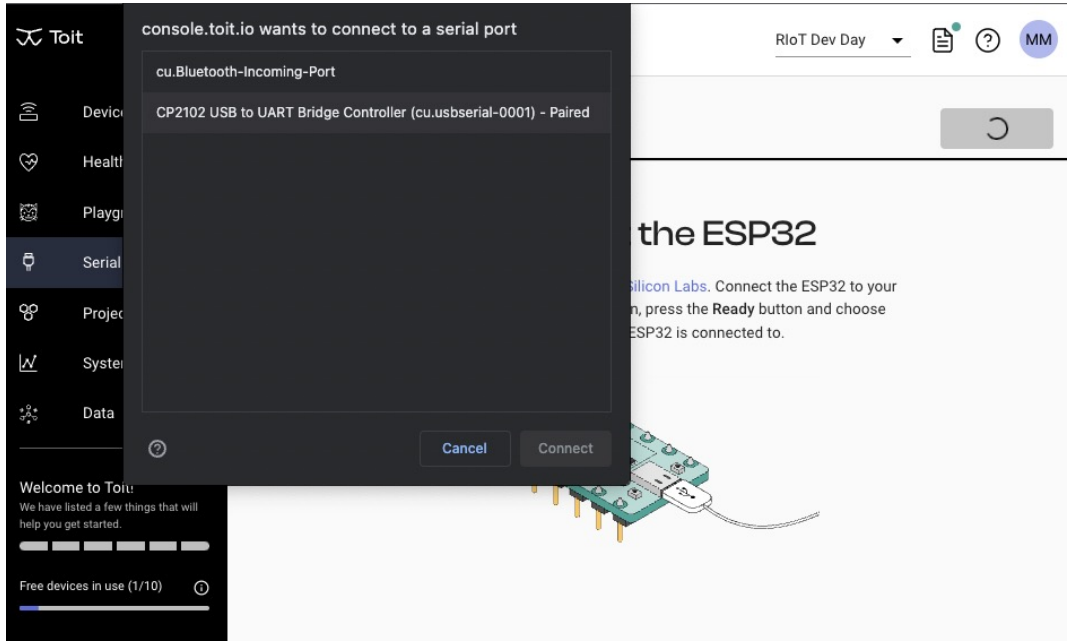
Unpack your Tech Demo Kit

Each kit includes:

- ESP32 Development Board
- Micro USB to USB-A cable
- GPIO Traffic Light

Provisioning the Hardware via Toit's Web Console

1. Sign in to https://console.toit.io
2. Select "RIoT Dev Day" project
3. Plug the ESP32 to your computer with USB cable
4. Go to the "Serial" Tab and provision the hardware with the "Ready >" button
5. SSID is "waketech" and no password



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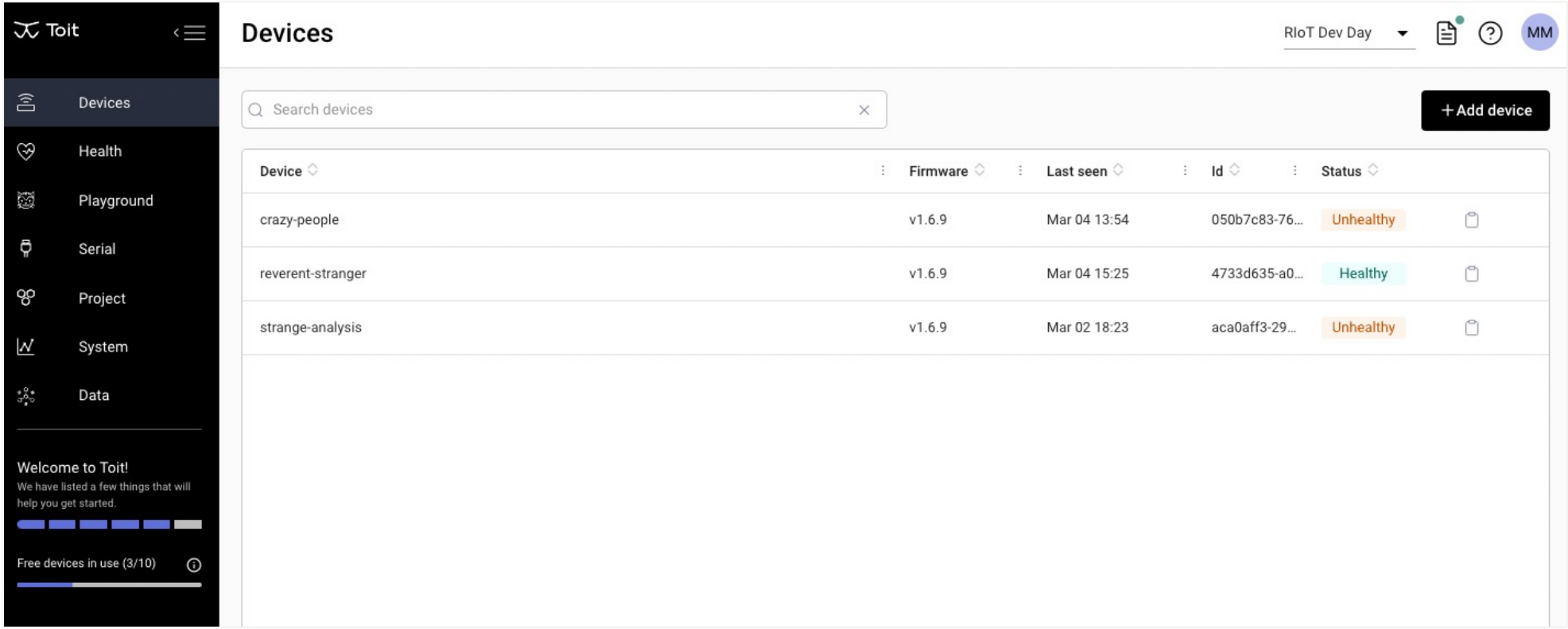
Confirming the Setup

1. Go to the “Devices” tab
2. Your device should be up and running! (as status “Healthy”)



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Once your ESP32 is provisioned with Toit, it's very energy efficient and can run on any power source.

It no longer needs to be plugged into your computer. All further communications will be over-the-air.

Wi-fi, Cellular, and Ethernet are supported.

‘Hello World’ program

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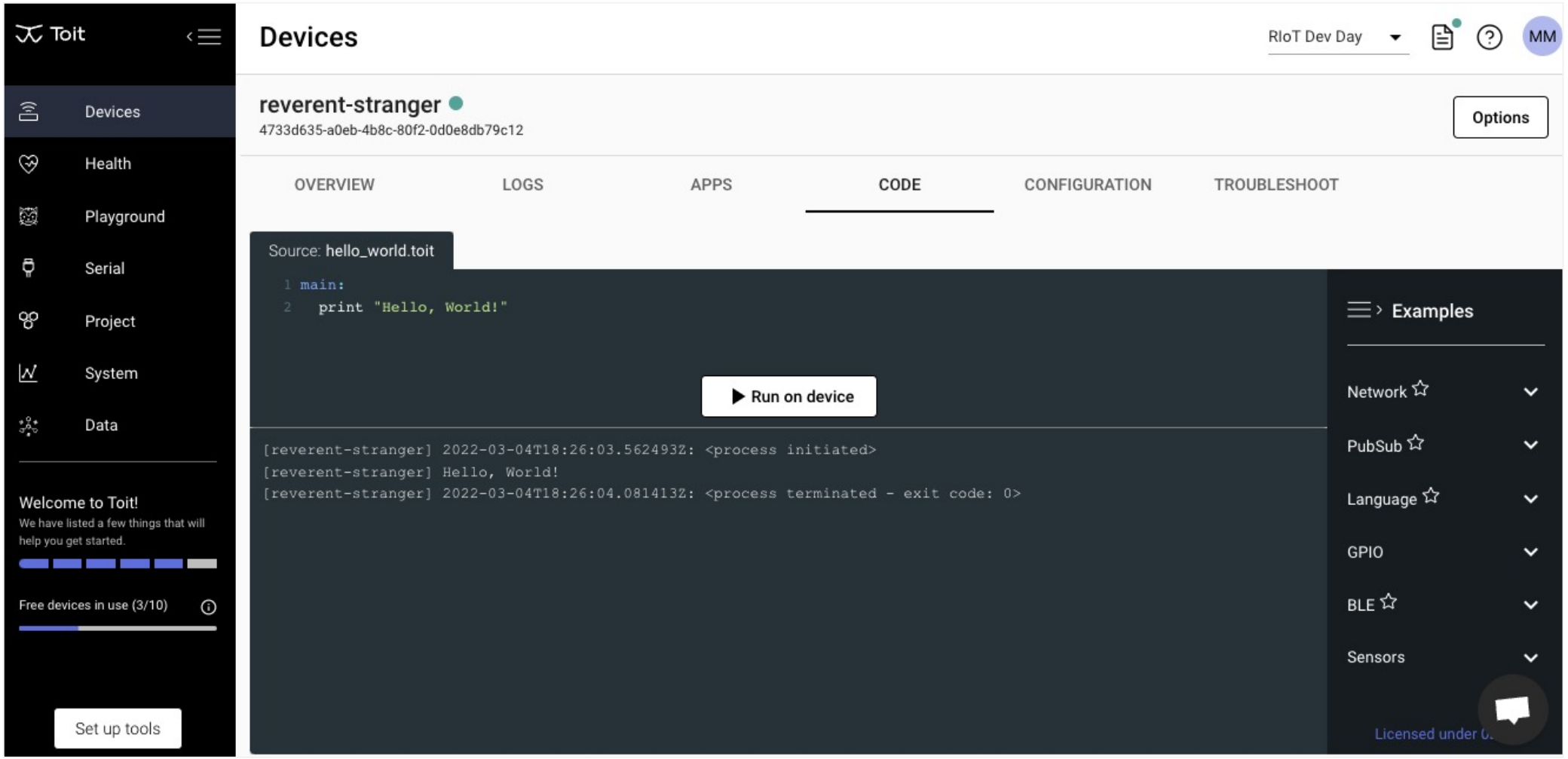
‘Hello World’ Program from web console



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‘Date and Time Logger’ program

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Set default project and device

Set your ESP32 as the default one for you:

1. `$ toit project use "RIoT Dev Day"`
2. `$ toit device use <<device-name>>`

```
mariano@MacBook-Pro-2 ~/T/I/I/Toit
❯ toit devices
+--------------------------------------+---------------+----------+----------+
|              DEVICE ID               |     NAME      | LAST SEEN | FIRMWARE |
+--------------------------------------+---------------+----------+----------+
| 47b619e6-f610-48ac-ace7-be3e8ebefcde | final-square  | Now       | v1.1.3   |
| 6d0eba1e-3fc7-42db-ba78-b72c21177dde | relaxed-store | Now       | v1.1.3   |
+--------------------------------------+---------------+----------+----------+

mariano@MacBook-Pro-2 ~/T/I/I/Toit
❯ toit device use relaxed-store
relaxed-store is now your default device

mariano@MacBook-Pro-2 ~/T/I/I/Toit
❯
```

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Date and Time Logger “Program” from CLI

1. Grab code from:

    github.com/instantiations/devday2022-demo-toit

2. Save code in a new file named: dateAndTime.toit
   (if you didn’t clone it)

3. Run it:
   - `$ toit run dateAndTime.toit`

```
mariano@MacBook-Pro-3 ~/T/I/C/D/g/d/s/date-time-logger main : ?
❯ toit run dateAndTime.toit
2022-03-10T14:33:23.998812Z: <process initiated>
Time: 15:33
Date: 2022-03-10
2022-03-10T14:33:24.401103Z: <process terminated - exit code: 0>
```

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‘Traffic Light’ app

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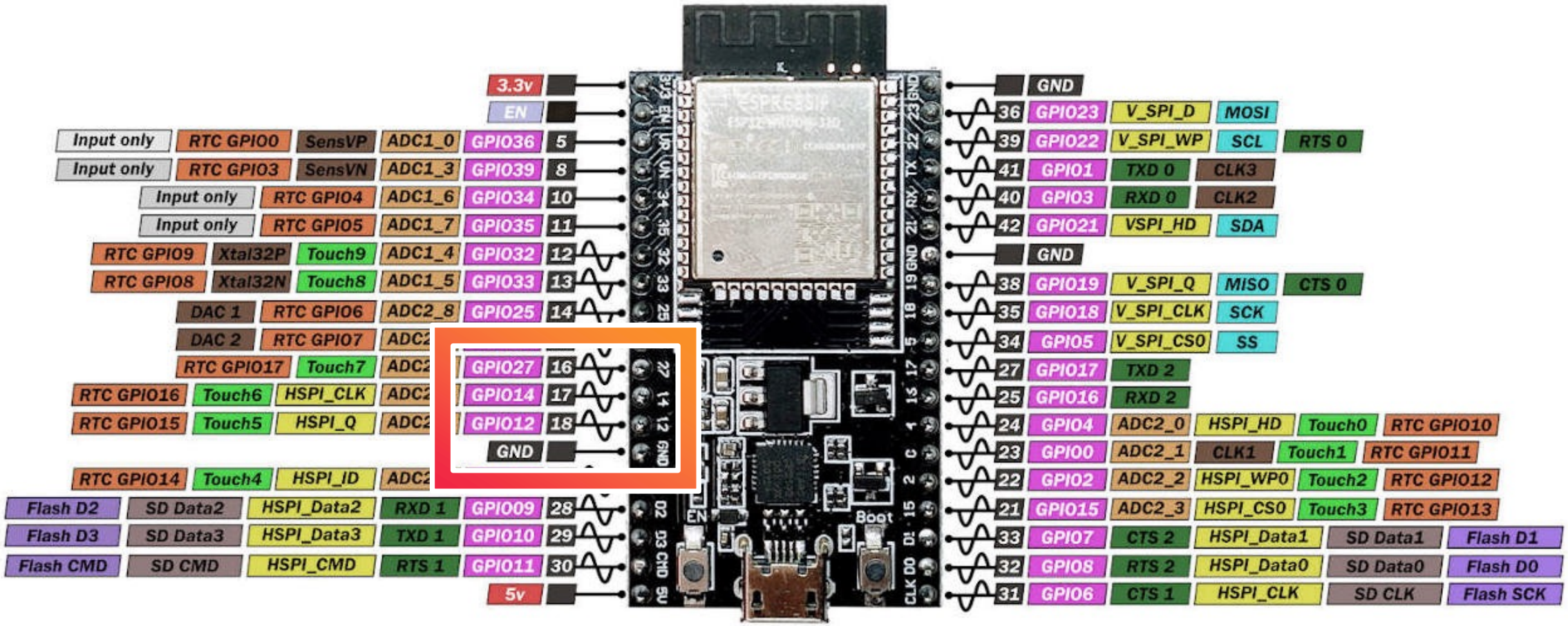
Application Code

1. Grab code from:

    github.com/instantiations/devday2022-demo-toit

2. Save code in new files named: traffic-light.yaml and traffic-light.toit
   (if you didn't clone it)

ESP32 Dev Board Pin Layout



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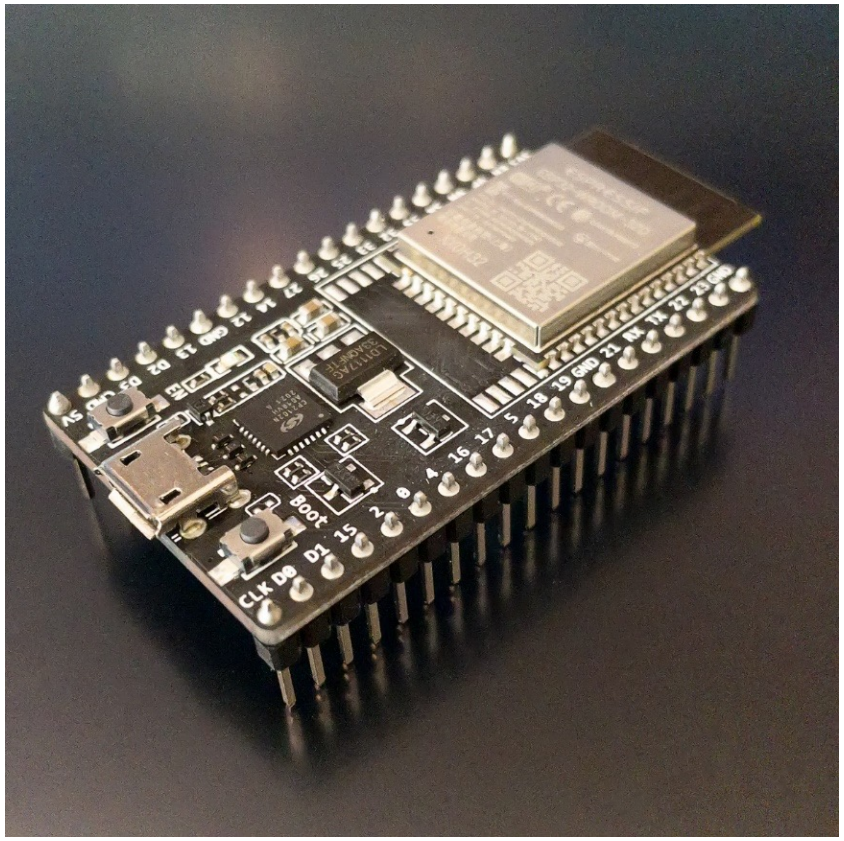
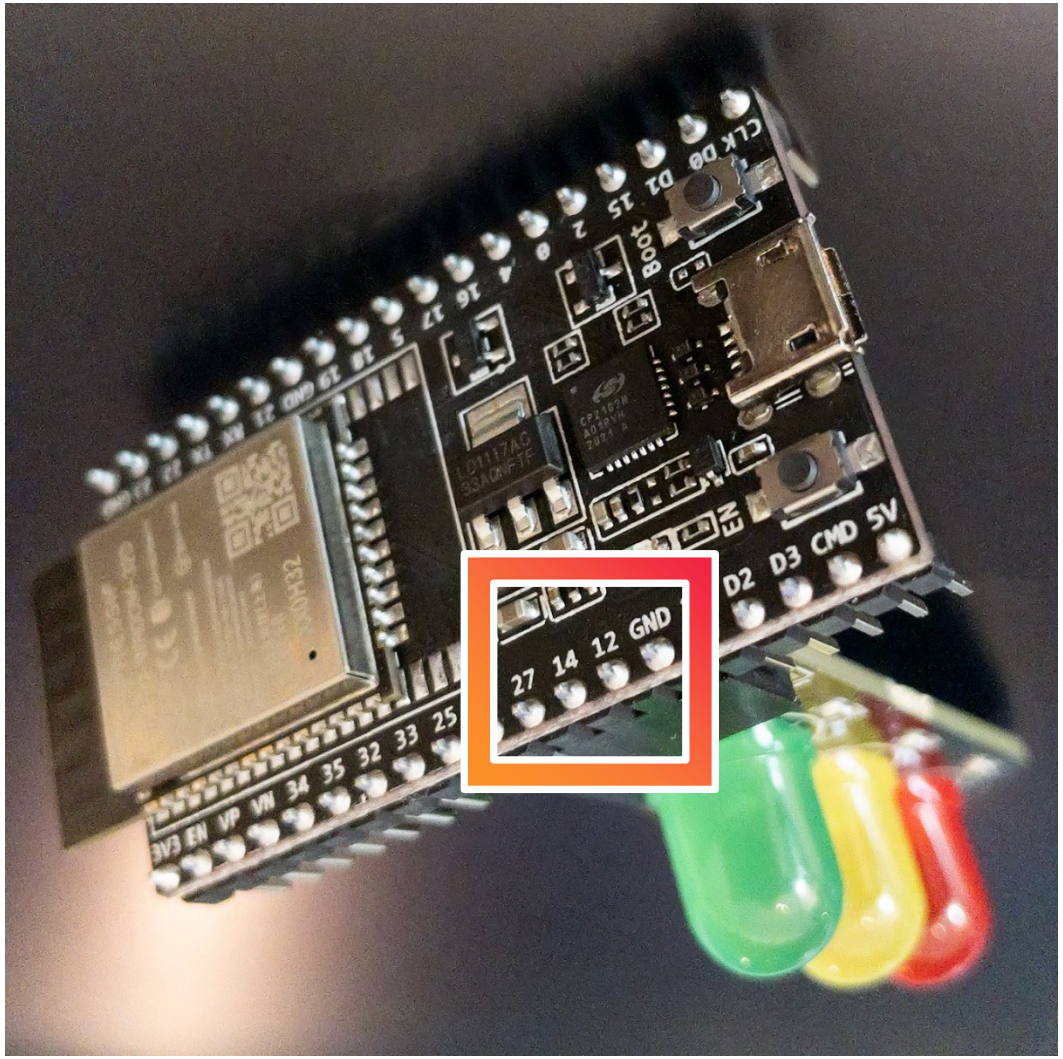
Traffic Light Connection



ESP32 Development Board



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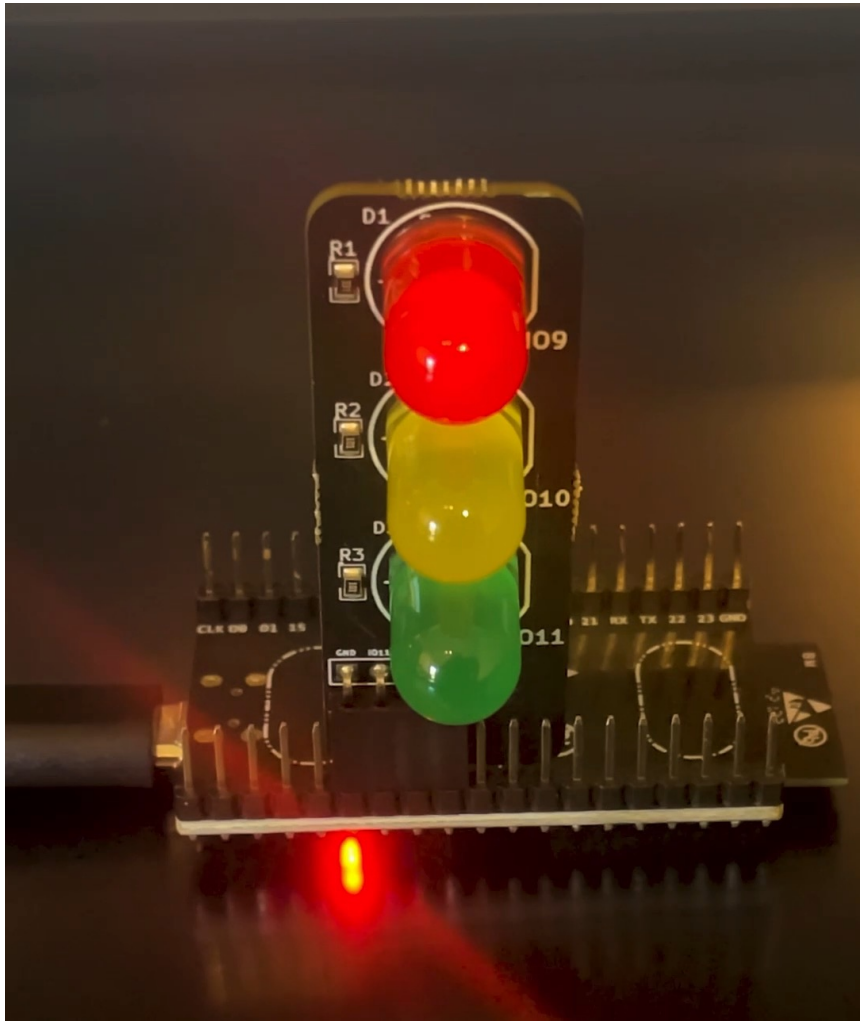
Deploy the app

```
$  toit deploy traffic-light.yaml
```

```
❯ toit deploy traffic-light.yaml
Successfully deployed the job Traffic Light on 'reverent-stranger'
The job will be installed on 'reverent-stranger' next time it connects to the Toit console
```

The Result



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‘Fleet Device Update’ demo

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Updating our fleet of devices

1. Change code to make the lights switch faster

2. Update app on all devices over the air

```
$ toit fleet deploy traffic-light.yaml
```

```
mariano@MacBook-Pro-3 ~/T/I/I/Toit
 ❯ toit fleet deploy traffic-light.yaml
No device name prefix provided. Are you sure you want to proceed? [y/n] y
   ◦ Device 'crazy-people': Job 'Traffic Light' successfully deployed
   ◦ Device 'reverent-stranger': Job 'Traffic Light' successfully deployed
   ◦ Device 'strange-analysis': Job 'Traffic Light' successfully deployed
```

Preparing your ESP32 for home

…if you're not sticking around longer

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Preparing your ESP32 for home

1. Move device to “MyProject”
   1. `$ toit device unclaim`
   2. `$ toit project use "MyProject"`
2. Re-provision again your device (ensure it’s plugged in via USB)
   1. `$ toit serial provision --skip-identity-detection --device-name <<device-name>> -p wifi.ssid="waketech" -p wifi.password=""`
   2. `$ toit device -d <<device-name>> config connection -c "wifi:<<home-ssid>>:<<home-password>>" -c "wifi:waketech:"`
3. Your username will be removed from the “RIoT Dev Day” project after this session.

Additional resources

- https://toit.io/
- https://toitlang.org/
- https://docs.toit.io/
- https://pkg.toit.io/
- https://www.instantiations.com/news/bridging-the-gap-with-toit-a-rich-dev-experience-for-microcontrollers/

Hardware used in this demo:

- https://www.digikey.com/en/products/detail/espressif-systems/ESP32-DEVKITC-32D/9356990
- https://www.amazon.com/Pi-Traffic-Light-Raspberry-pack/dp/B00P8VFA42/
- https://www.amazon.com/Anker-3-Pack-Powerline-Micro-USB/dp/B015MJLEUS/

So, what's next?

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Thank you for attending!

Any more questions? Let's hear them.

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