

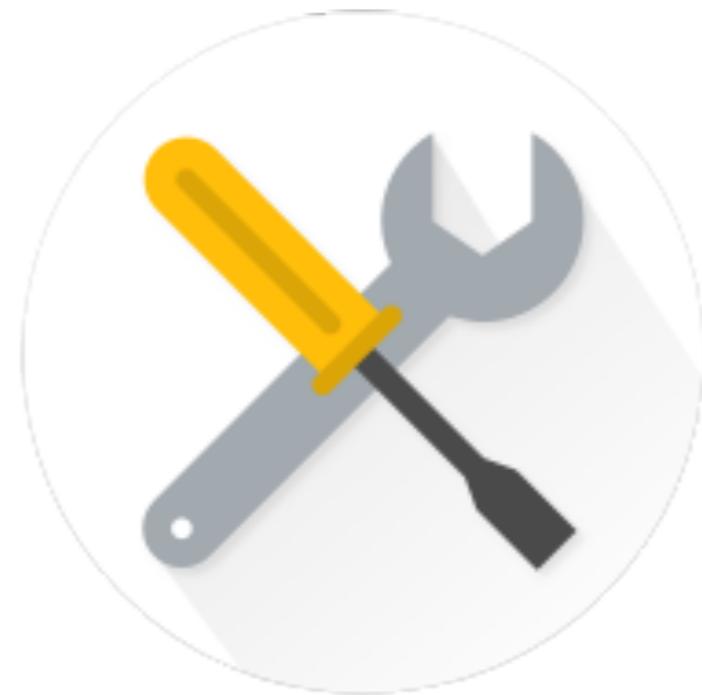
# **Lecture #1**

# **Introduction to IoT**

**Android Things 2020**

# Prerequisites

- Modern programming language
- Object oriented
- Statically types
- IDE - IntelliJ/Android Studio



# What you should know...

- Basics:
  - Object-oriented programming
  - Classes, methods
  - Exception handling
  - Android



---

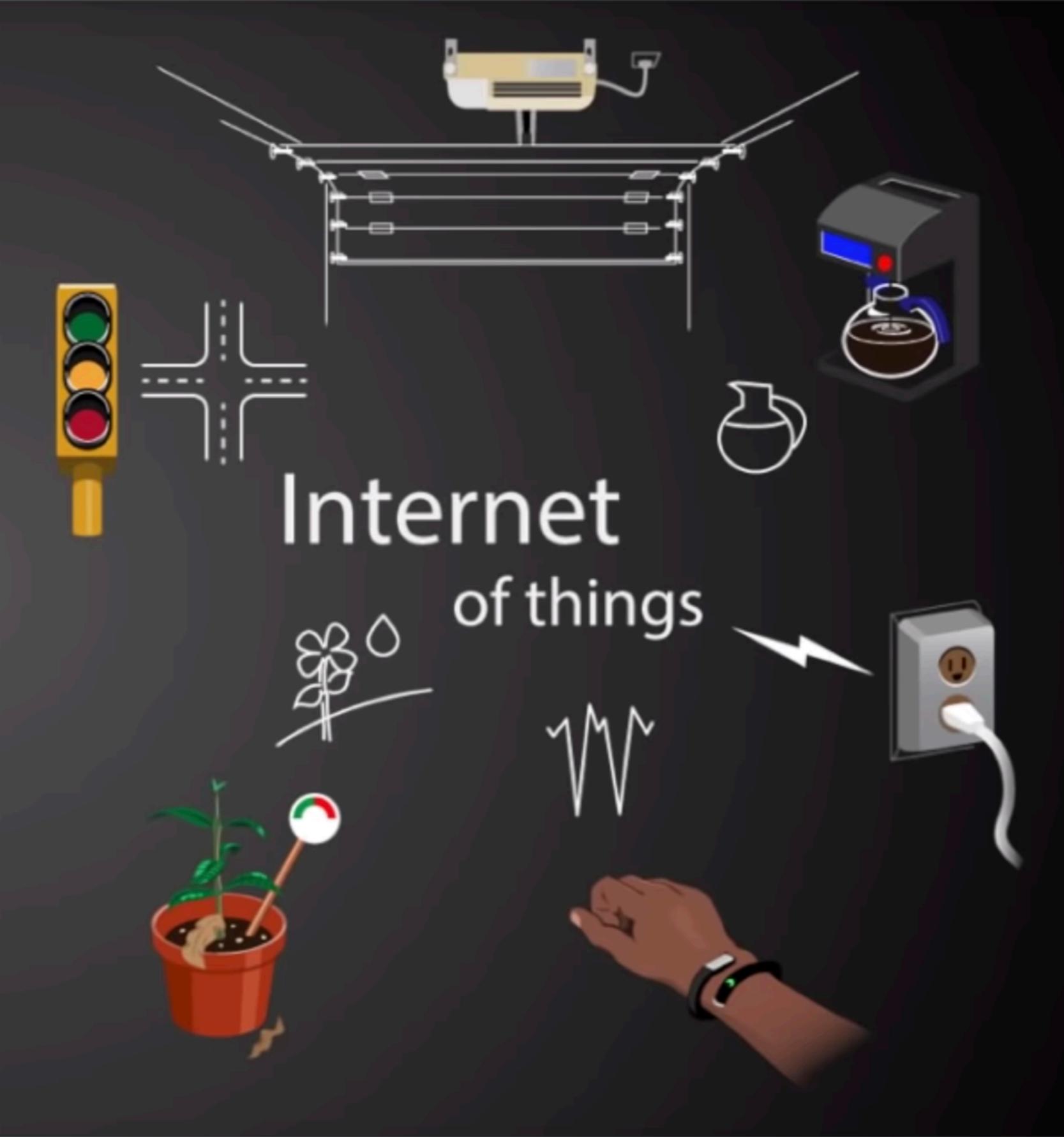
# Bonus

- Functional Programming
- Lambdas
- Higher Order Functions
- Reactive Programming
- Kotlin



# Internet of people





# Internet of things

# Why

- Collect and aggregate data.
- Remote control devices.
- Automate certain tasks.



Image source: <https://newsignature.com/articles/iot-now-eric-stein-new-signature-solutions-architect/>

# What

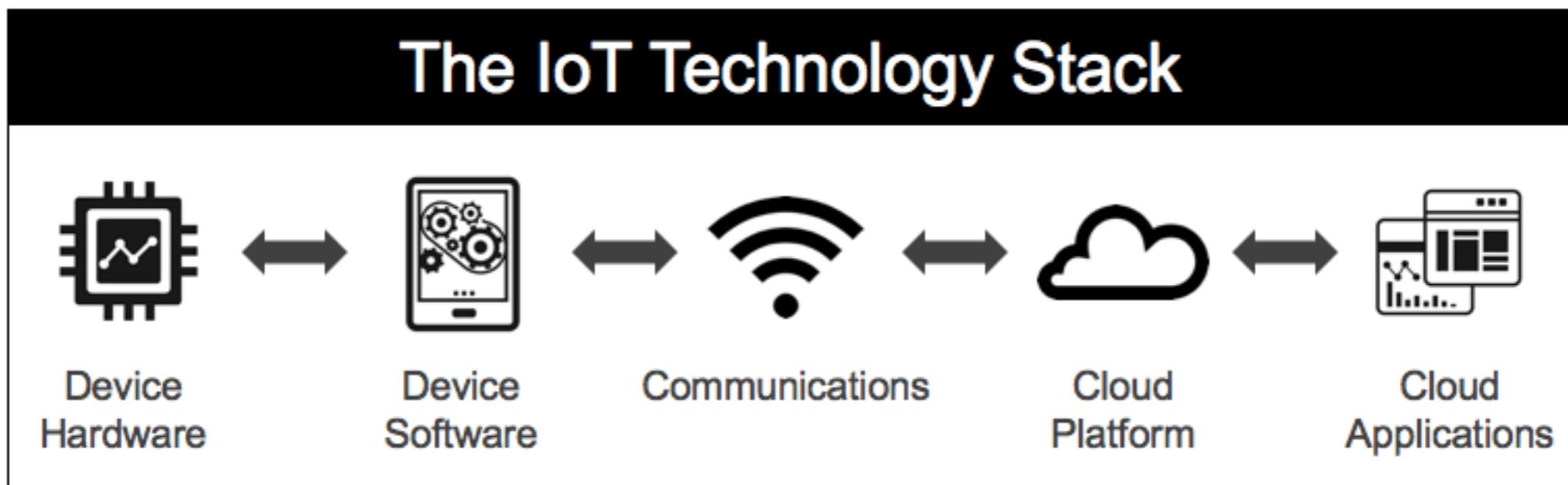
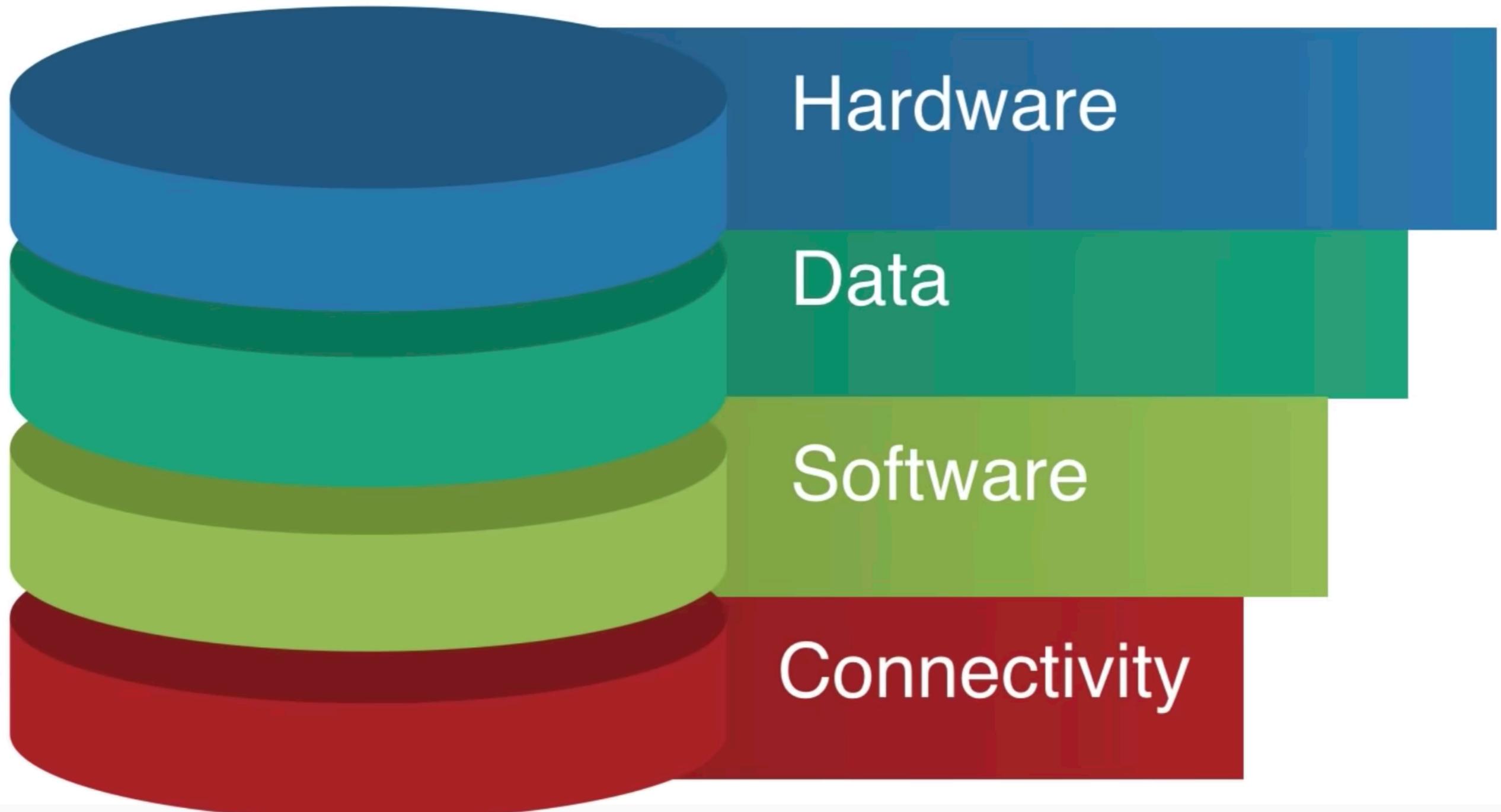
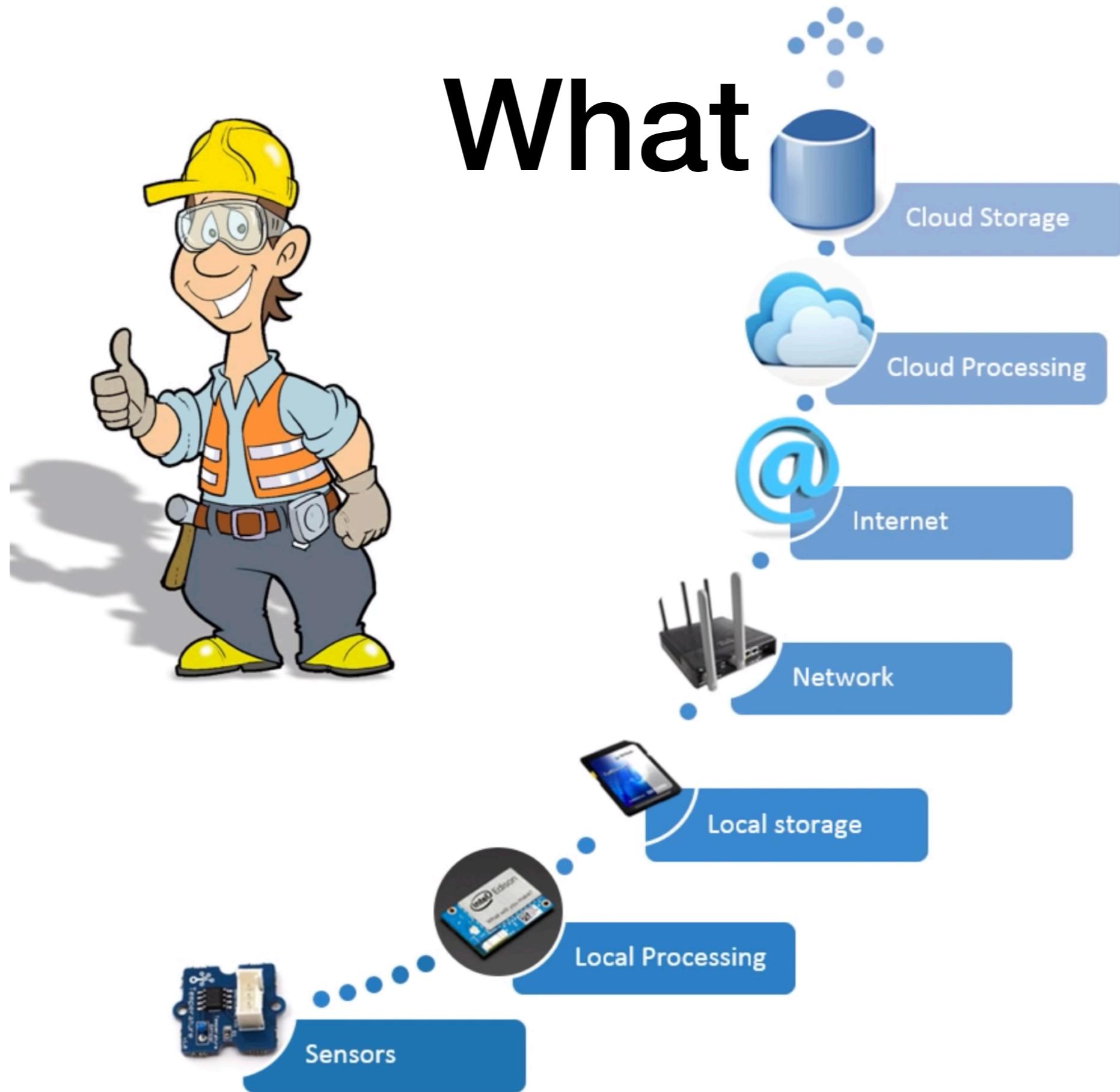


Image source: <https://www.iotforall.com/iot-product-managers-guide-iot-technology-stack/>

# What





# What

Internet of Things



# What

Internet of Things



# What

Internet of Things



A Google Home smart speaker is the central focus, positioned on a light-colored wooden coffee table. In the background, a person wearing a green t-shirt is standing near a sofa. A red balloon is visible on the right side of the frame.

Introducing  
**Google Home**

<https://www.youtube.com/watch?v=KECfgrw02fU>

A Google Home smart speaker is the central focus, positioned on a light-colored wooden coffee table. In the background, a person wearing a green t-shirt is standing near a sofa. A red balloon is visible on the right side of the frame.

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<https://www.ratp.fr/en/groupe-ratp/engineering/fully-automated-century-old-metro-lines>

[Mission](#)[Technology](#)[Journey](#)[What's Next](#)[Early Riders](#)

<https://waymo.com/>

**"The Internet of everything will have five to 10 times  
the impact on society as the Internet itself"**

Cisco CEO John Chambers

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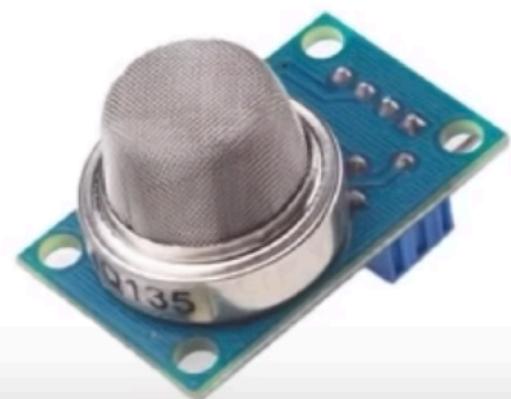
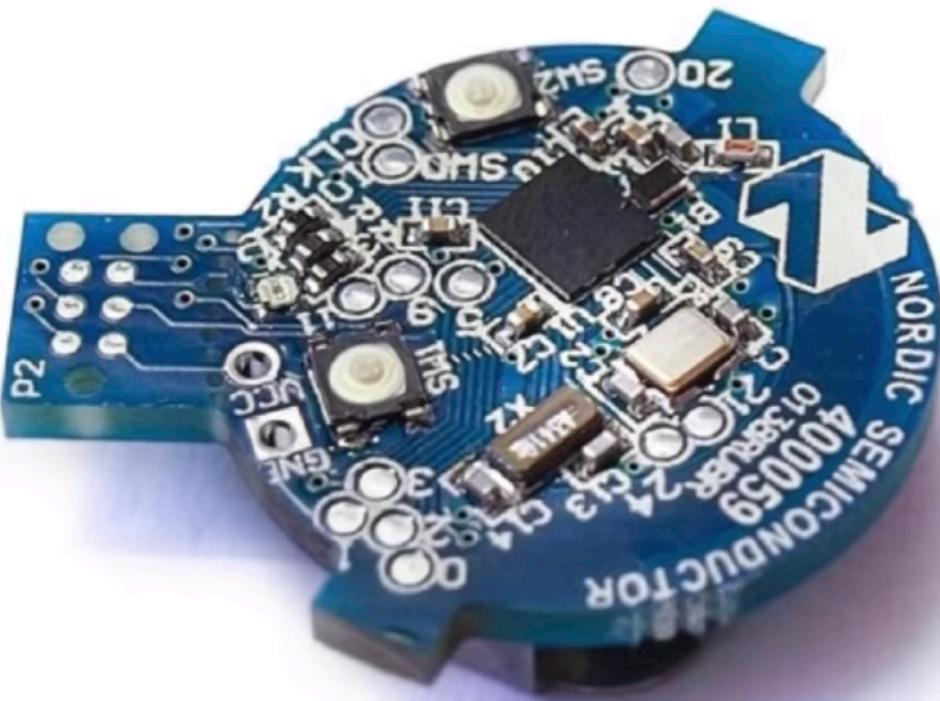
**\$19 trillion in economic benefit and value over the next decade.**

# Sensors

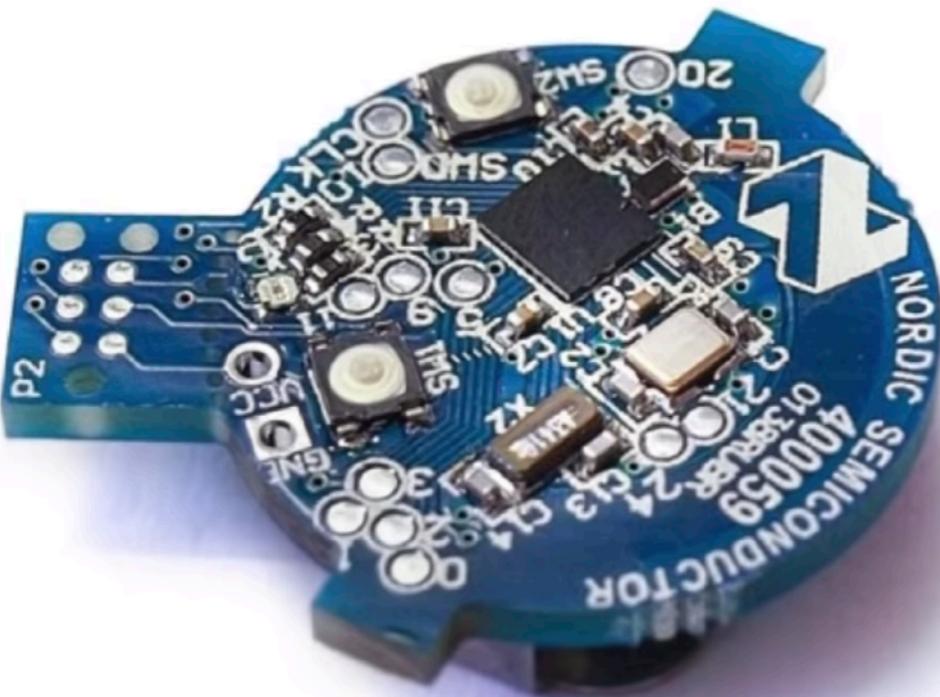
- Measure values.
- Send raw data.
- Low power.
- Almost no maintenance needed.



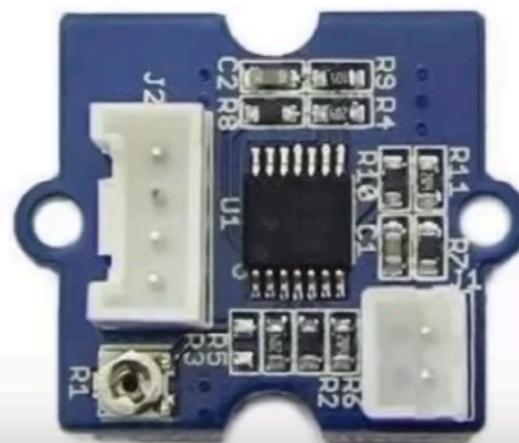
# Sensors



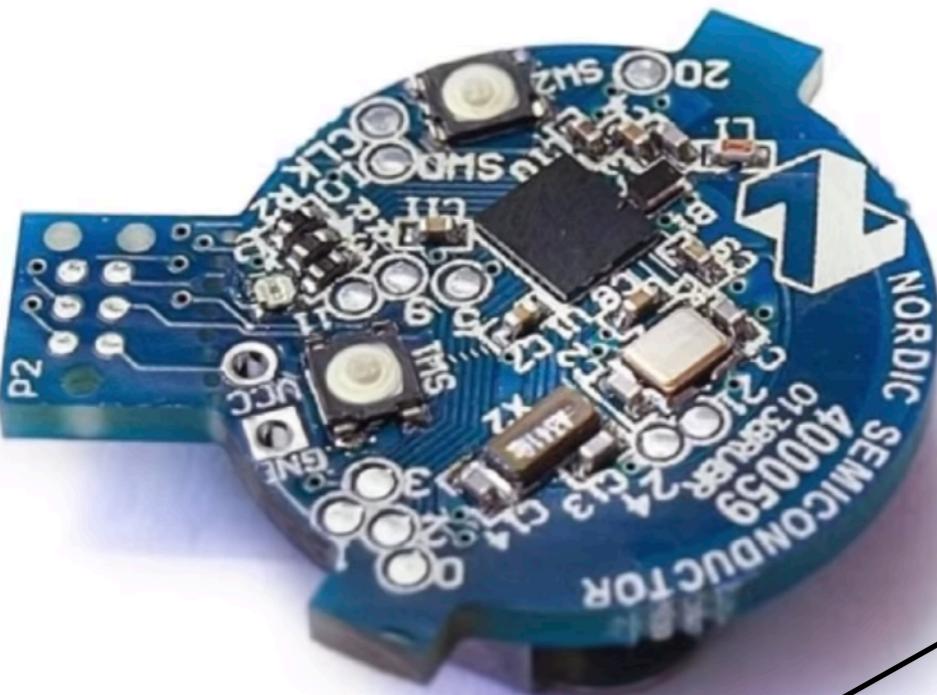
# Sensors



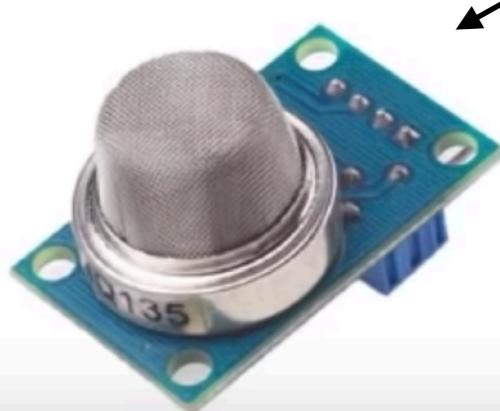
Bluetooth Beacon



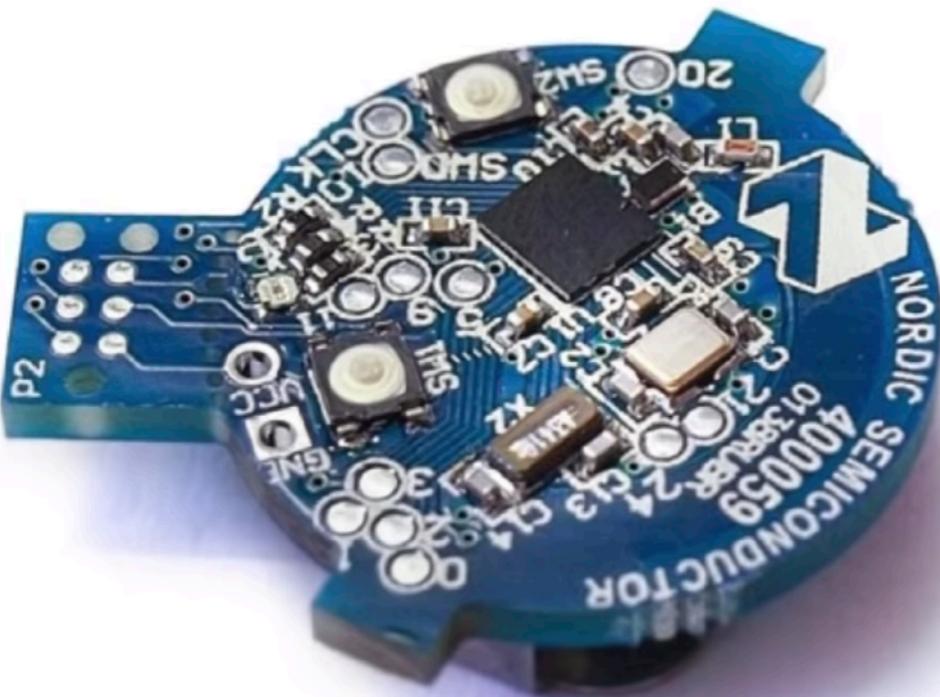
# Sensors



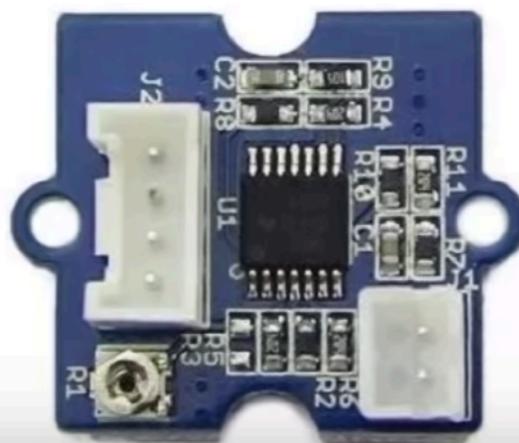
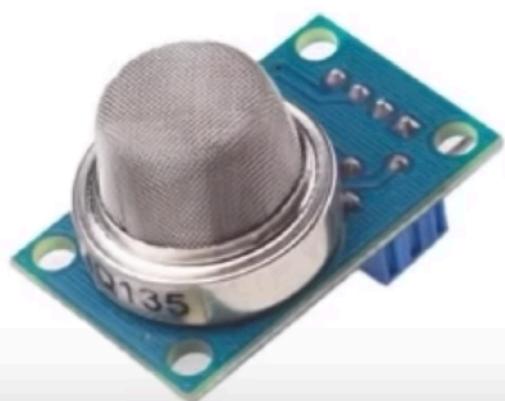
Air Quality Sensor



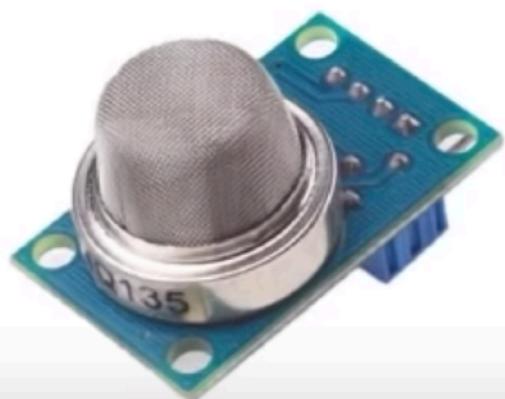
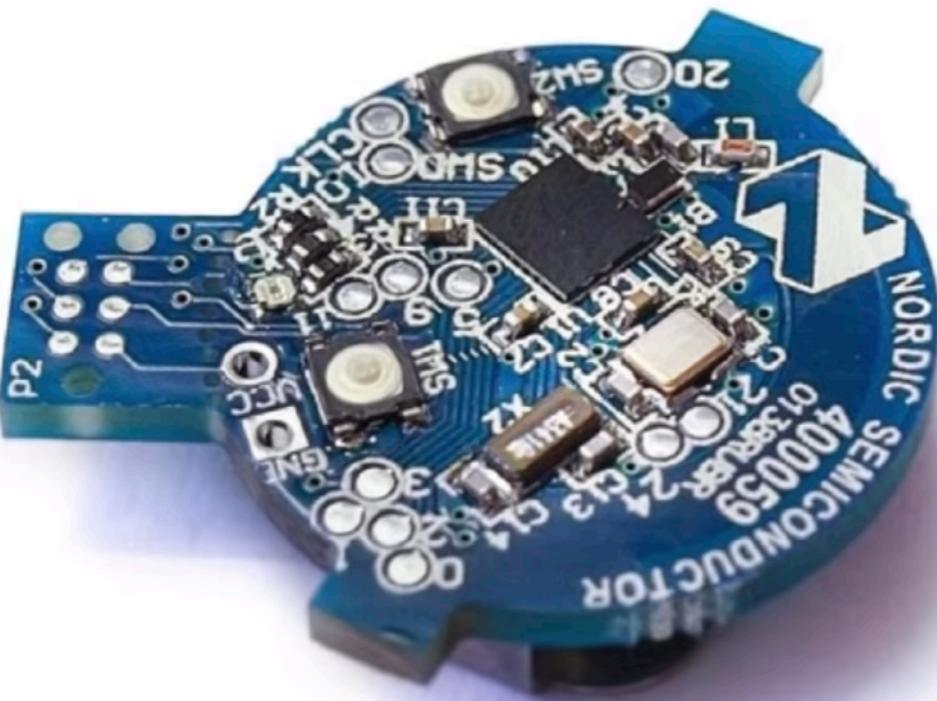
# Sensors



**Galvanic Skin  
Response Sensor**



# Sensors



Consumer Products

# Local Processing

- Collects sensor data.
- Light processing.
- Uploads data to the cloud.

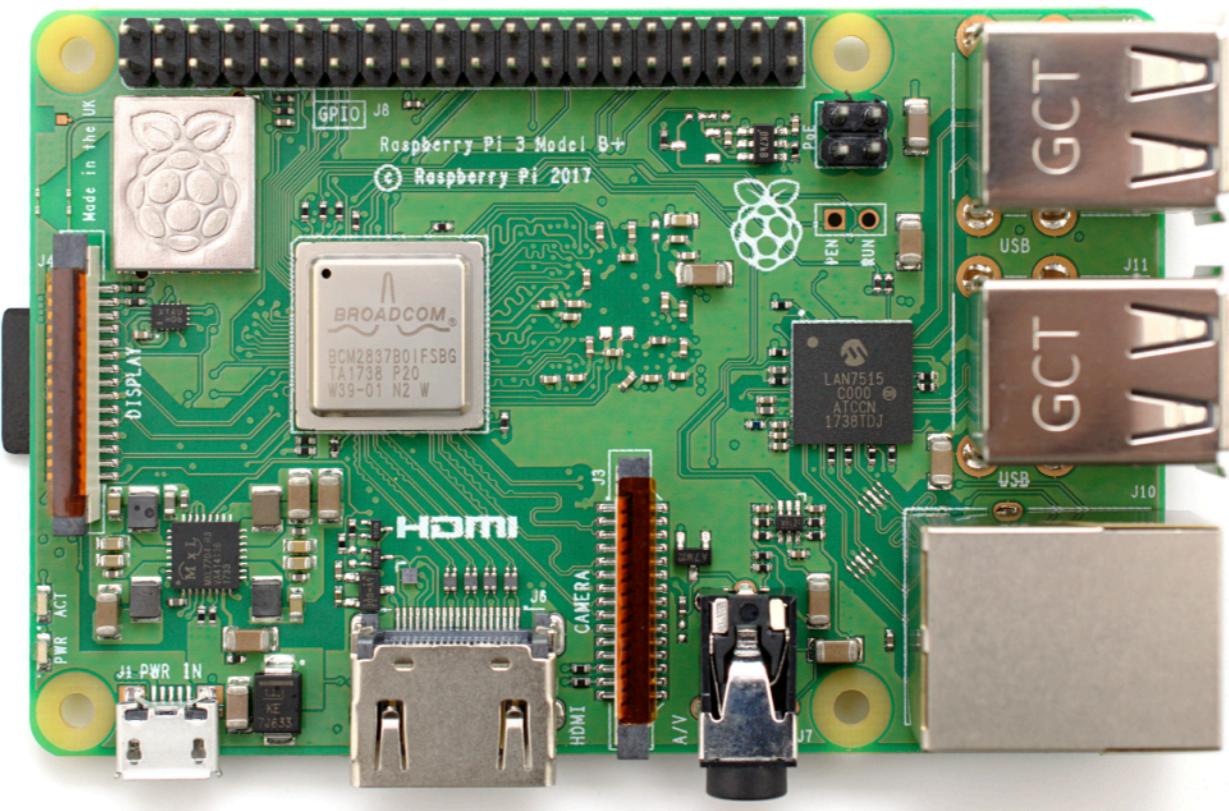


Image source: <https://www.flickr.com/photos/120586634@N05/39906369025/>

# Local Processing

- Collects sensor data.
- Light processing.
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**Edge/Fog Computing**

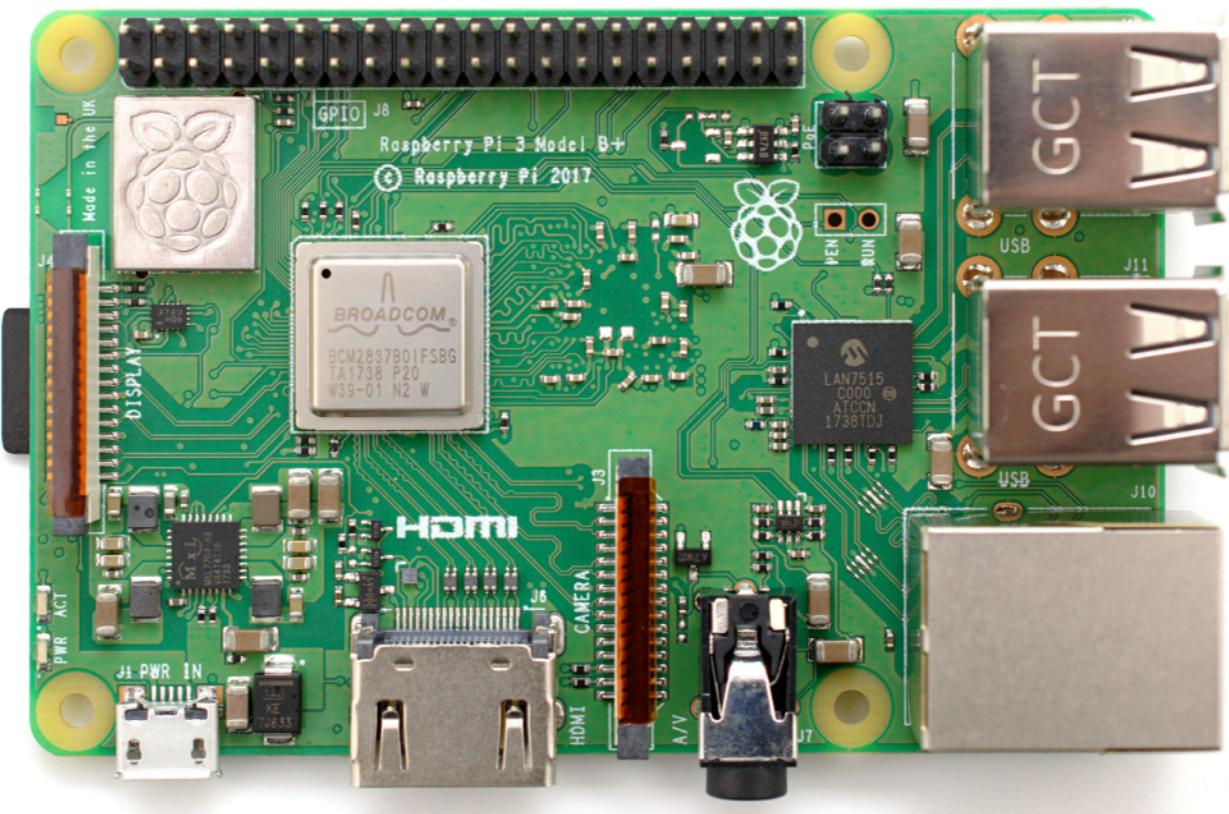
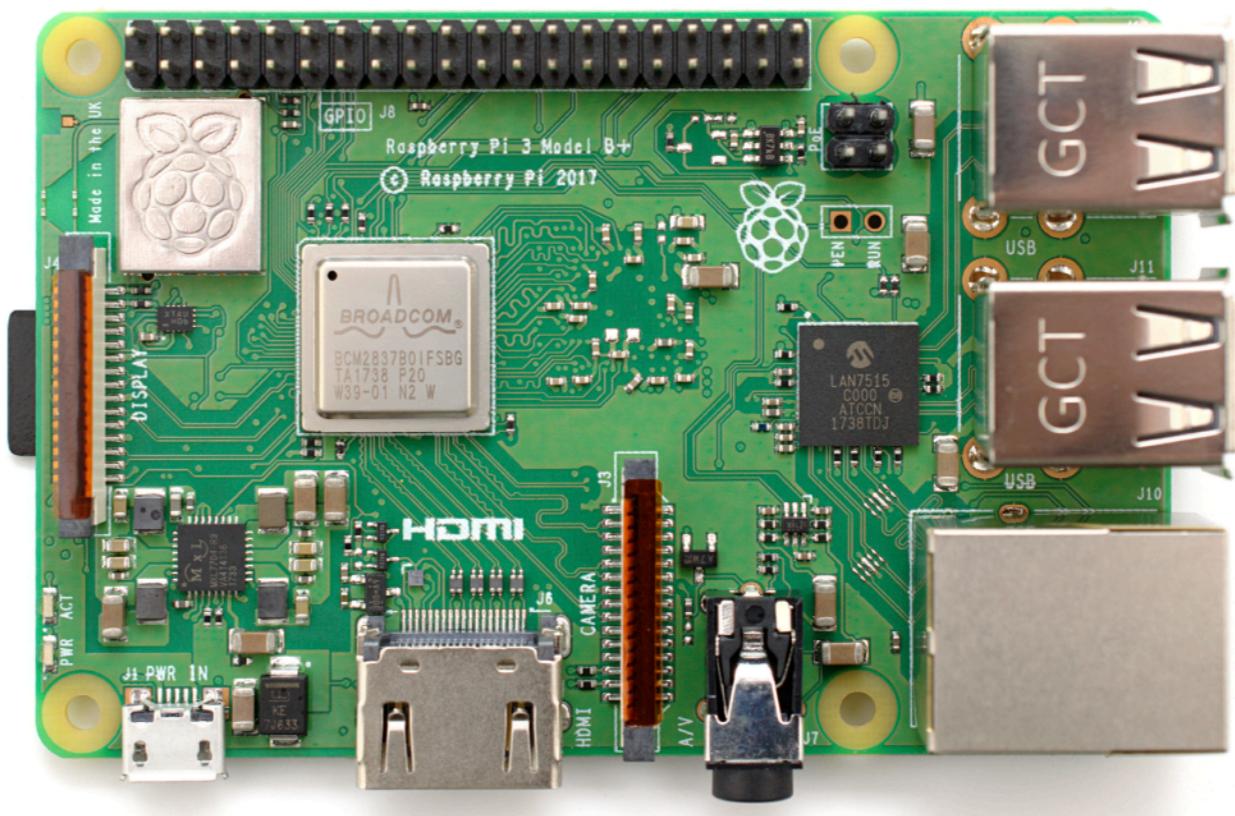


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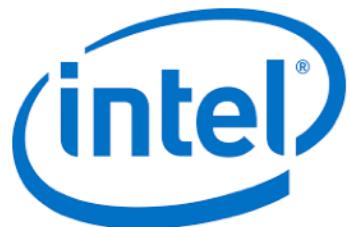
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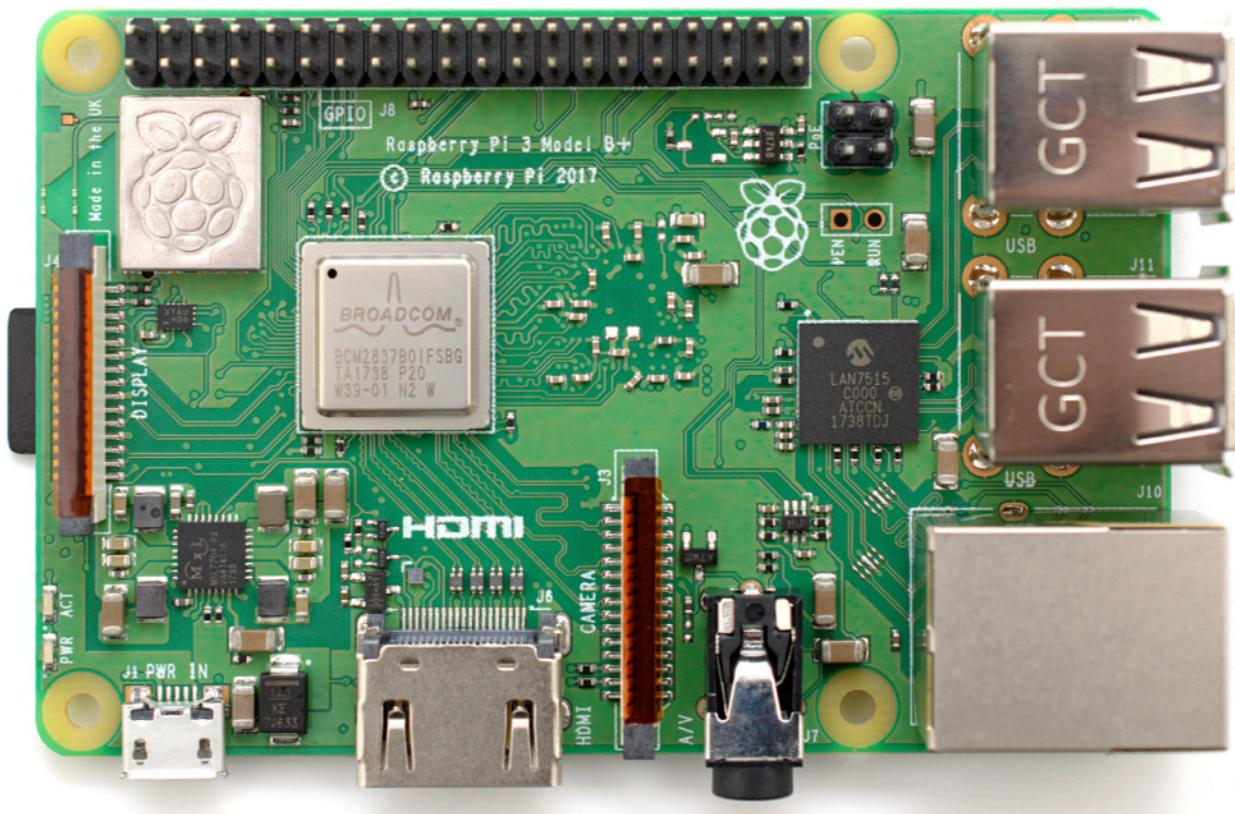
**Edge/Fog Computing**

Image source: <https://www.flickr.com/photos/120586634@N05/39906369025/>



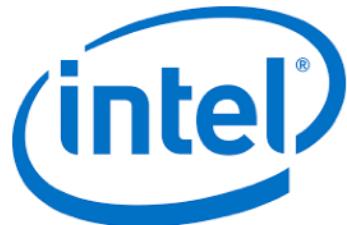
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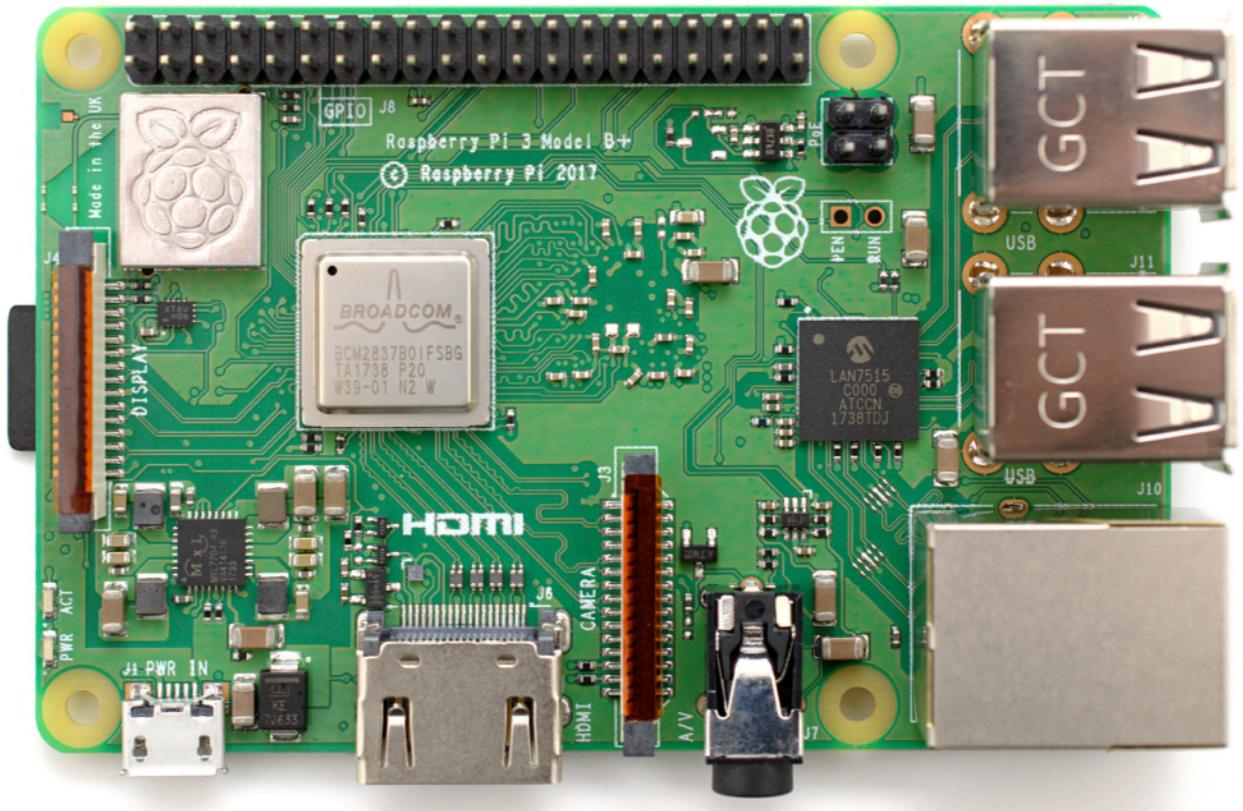


**Edge/Fog Computing**

Image source: <https://www.flickr.com/photos/120586634@N05/39906369025/>



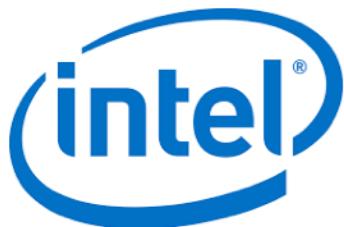
# Local Processing



- Collects sensor data.
- Light processing.
- Uploads data to the cloud.

**Edge/Fog Computing**

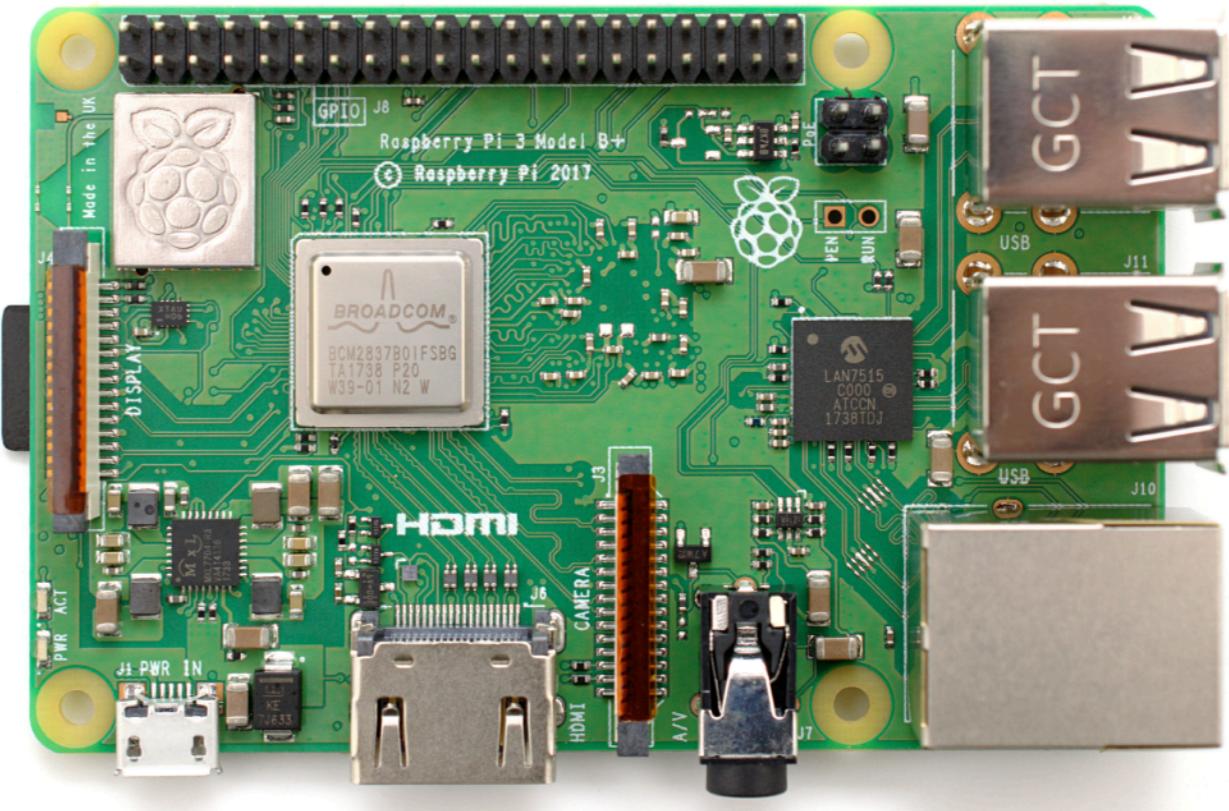
Image source: <https://www.flickr.com/photos/120586634@N05/39906369025/>



# Local Processing Persistence

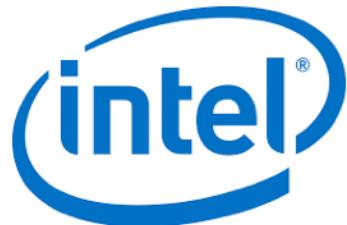


- Collects sensor data.
- Light processing.
- Uploads data to the cloud.



**Edge/Fog Computing**

Image source: <https://www.flickr.com/photos/120586634@N05/39906369025/>



# Network & Internet

- IoT Gateways.
- Connects multiple sensors and local processing units.
- Protocols:
  - CoAP
  - MQTT
  - HTTP
  - XMPP



Image source: <https://commons.wikimedia.org/wiki/File:Linksys-Wireless-G-Router.jpg>

# Network & Internet

- IoT Gateways.
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Image source: <https://commons.wikimedia.org/wiki/File:Linksys-Wireless-G-Router.jpg>

# Network & Internet

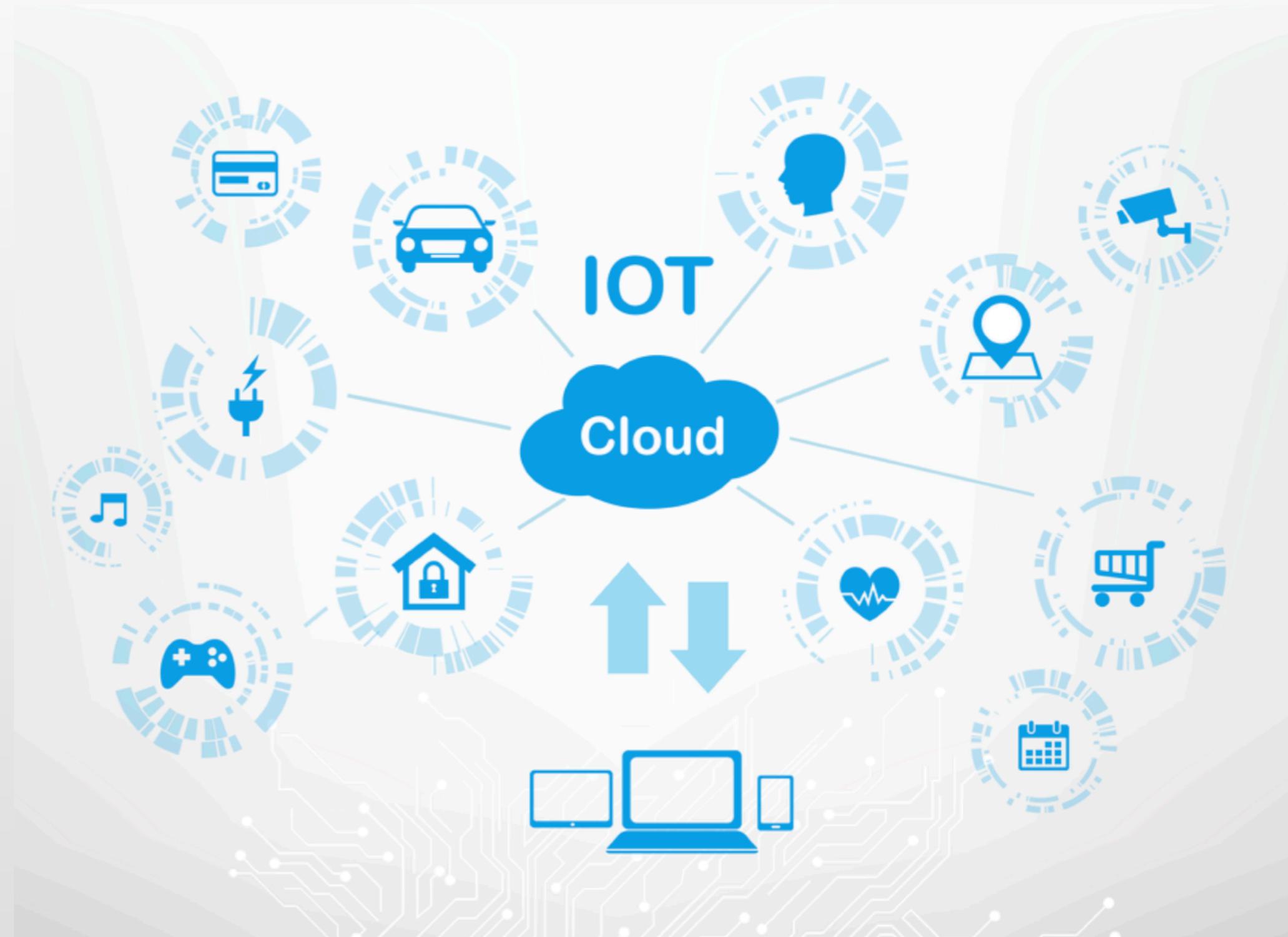
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  - XMPP <https://xmpp.org>



Image source: <https://commons.wikimedia.org/wiki/File:Linksys-Wireless-G-Router.jpg>

# Cloud Processing & Storage

- Aggregate.
- Store.
- Analyze.
- Predict.



# How it started

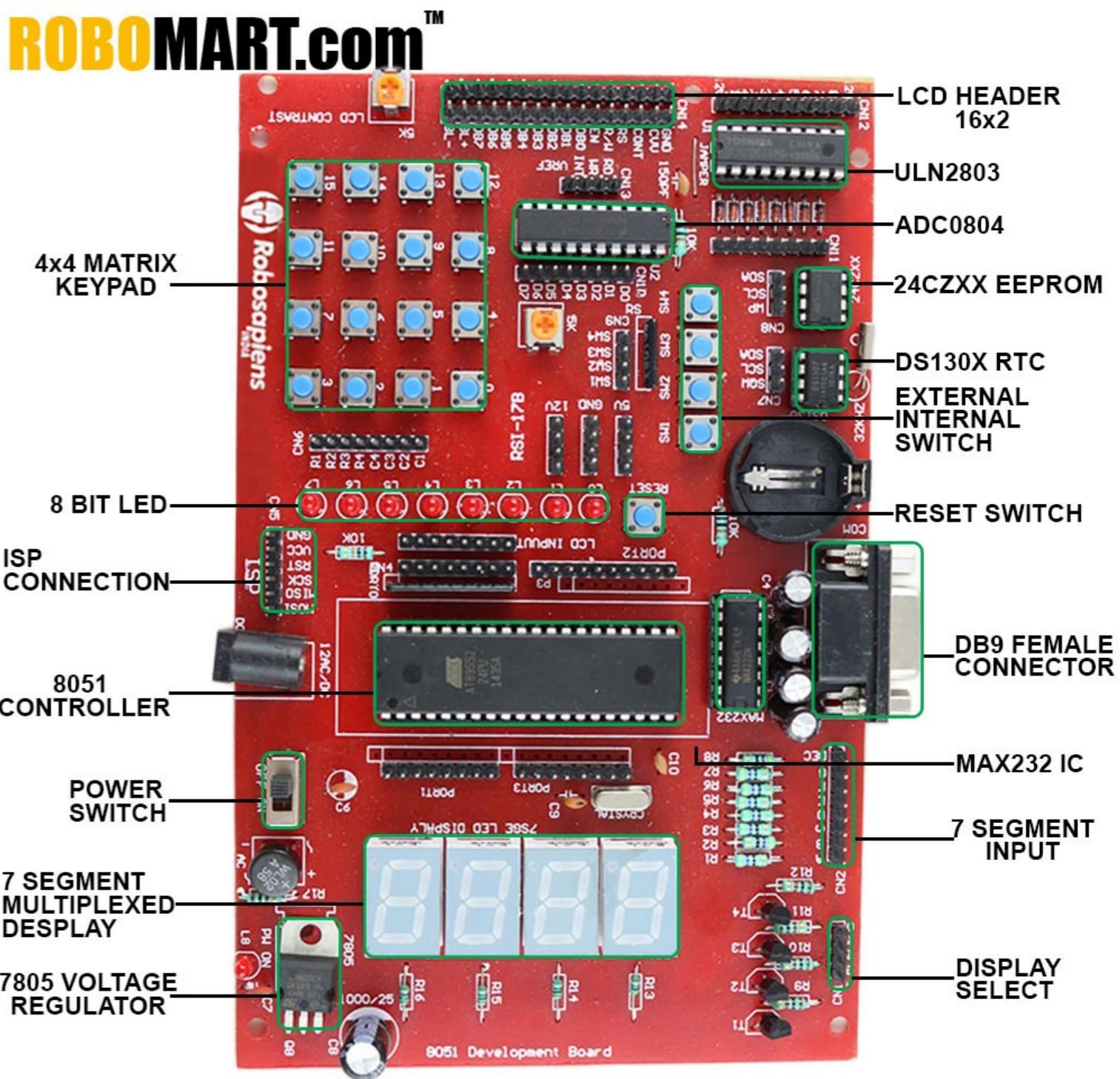
- August 26th, 1997
  - Bruce Perens
  - <https://lists.debian.org/debian-announce/1997/msg00026.html>



Image source: <https://www.oshwa.org/open-source-hardware-logo/>

# Microcontroller

- Small programmable devices.
- Easily connectable.

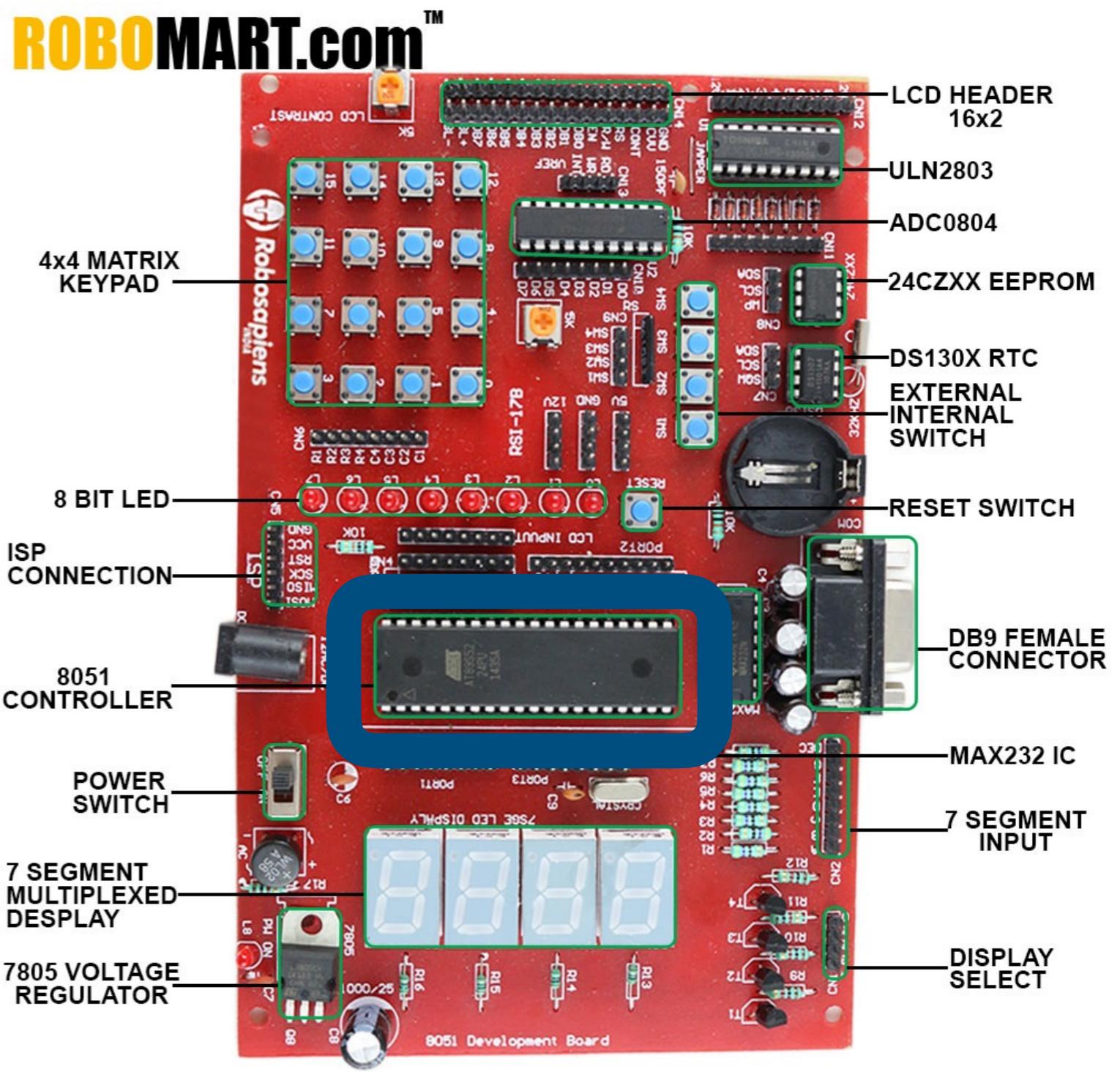


NOTE:THE PRODUCT MAY BE DIFFER FROM IMAGE GIVEN ABOVE

Copyrights by Robomart.com

# Microcontroller

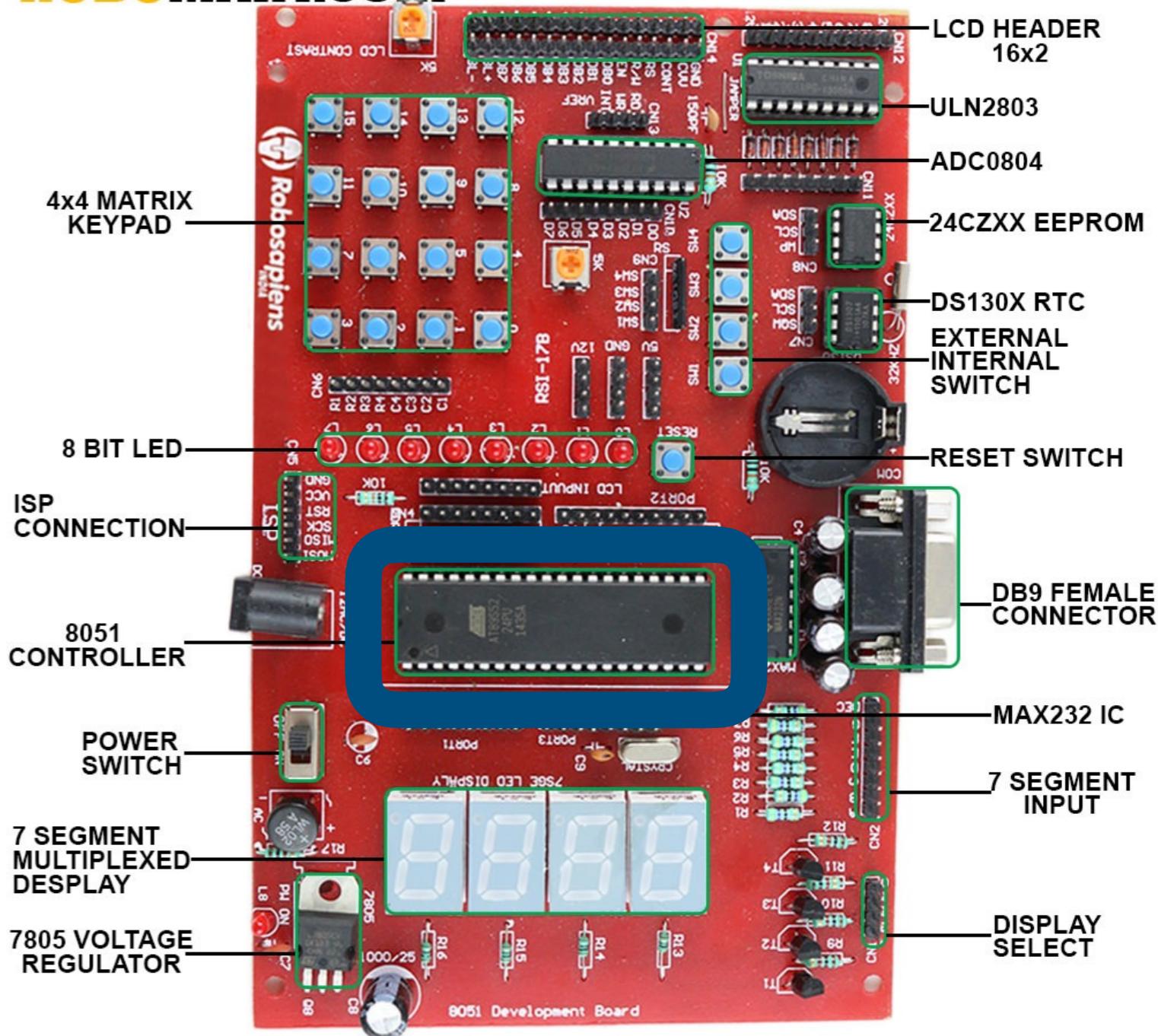
- Small programmable devices.
- Easily connectable.



# Microcontroller

**ROBOMART.com™**

- Small programmable devices.
- Easily connectable.





1972

# Microcontroller

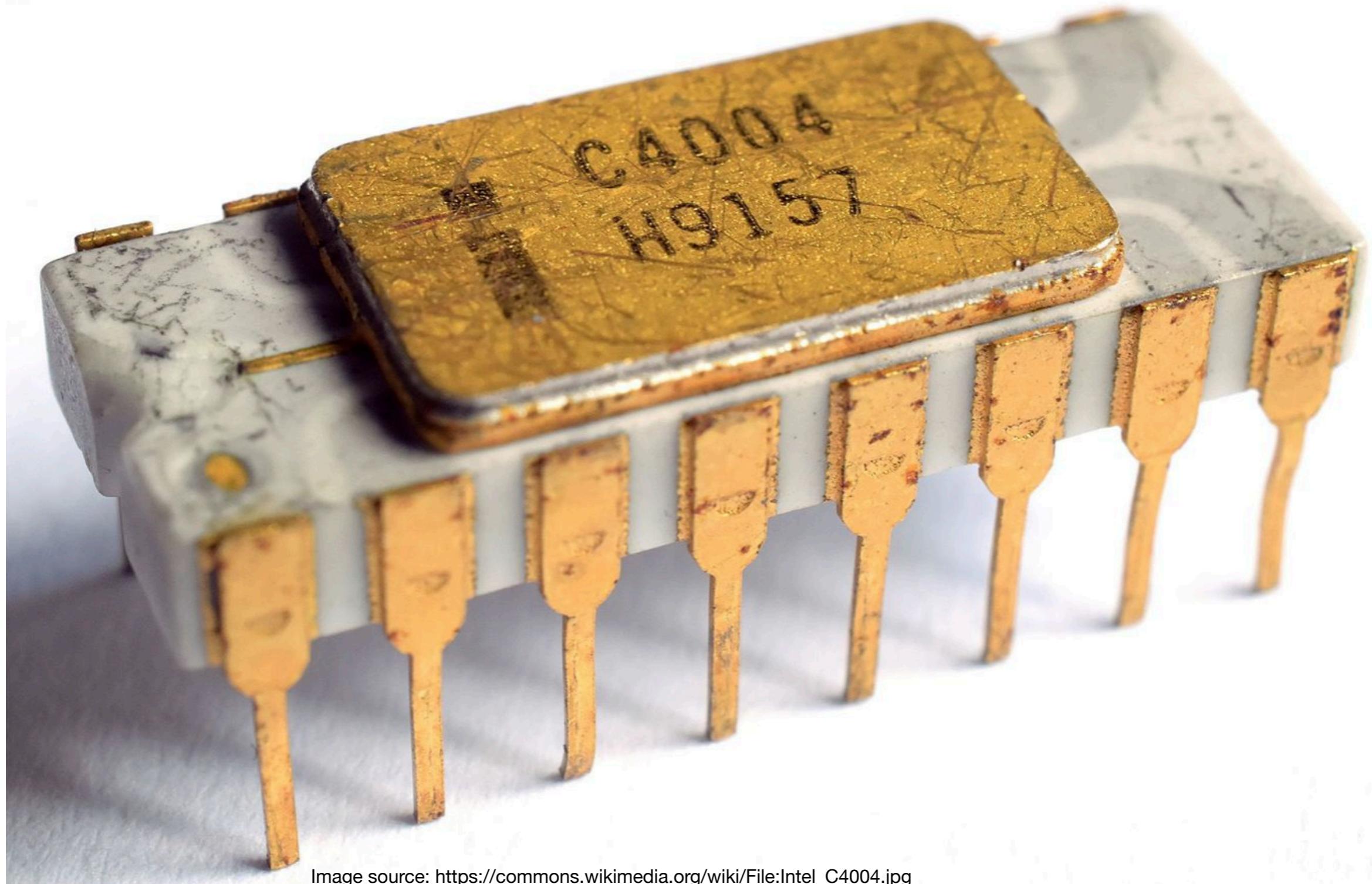


Image source: [https://commons.wikimedia.org/wiki/File:Intel\\_C4004.jpg](https://commons.wikimedia.org/wiki/File:Intel_C4004.jpg)

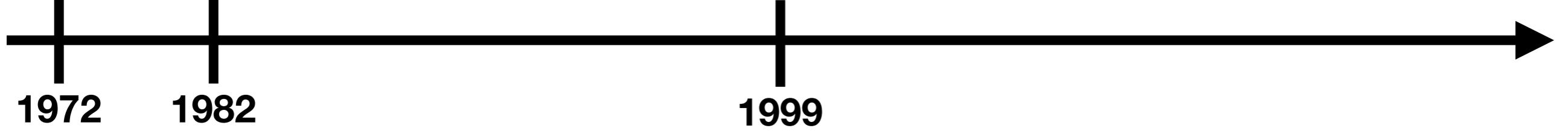


# First Internet Connected Device



CMU's connected Coke machine

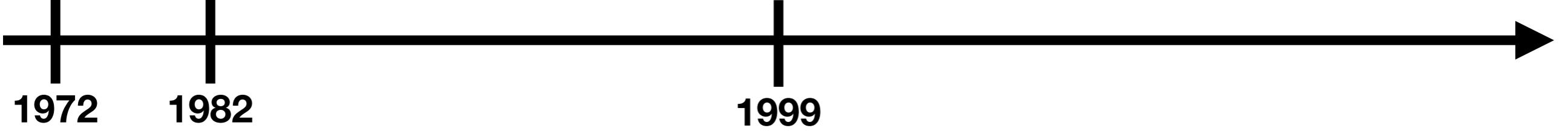
[https://www.cs.cmu.edu/~coke/history\\_long.txt](https://www.cs.cmu.edu/~coke/history_long.txt)



# Internet of Things



**Kevin Ashton**



# Internet of Things

The image is a composite of several elements. On the left, the Tide logo is displayed within a yellow circle with red and blue concentric arcs. In the center, there is a portrait photograph of a man with short hair, identified as Kevin Ashton. To the right, a screenshot of the Procter & Gamble (P&G) website is shown, featuring a blue header with the P&G logo and navigation links for "Our Brands", "Our Impact", "Our Story", and "Coupons". Below the header, the Tide logo is integrated into the design. The overall background has a dark blue gradient with yellow circular patterns.

Our Brands ▾ Our Impact ▾ Our Story ▾ Coupons ↗

P&G

Tide

Kevin Ashton A FORCE FOR GOOD  
A FORCE FOR GROWTH  
2018 CITIZENSHIP REPORT ↗



# Internet of Things

[Our Brands](#) ▾

[Our Impact](#) ▾



[Our Story](#) ▾

[Coupons ↗](#)

The background features the Tide logo on the left and a portrait of Kevin Ashton in the center. The P&G logo is in the top right corner.

**Tide**

**Kevin Ashton** A FORCE FOR GOOD  
A FORCE FOR GROWTH  
2018 CITIZENSHIP REPORT ↗

An icon of a square RFID tag with concentric circles and the word "RFID" in the center.



1972

1982

1999

# Internet of Things

The image is a composite of several elements. On the left, the Tide logo is displayed within a yellow and orange circular swirl. In the center, there is a portrait photograph of Kevin Ashton. To the right of the portrait is a white rectangular box containing text and an image of an RFID tag. The background features abstract blue and yellow circular patterns.

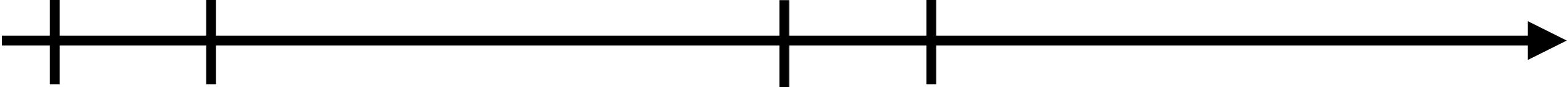
Our Brands ▾ Our Impact ▾ Our Story ▾ Coupons ↗

**Tide**

**Kevin Ashton** A FORCE FOR GOOD  
A FORCE FOR GROWTH  
2018 CITIZENSHIP REPORT ↗

P&G





# 1999

# 2003

# Arduino

- Programmable device.
- Easily connectable.
- Open source.
- Simple to use software.

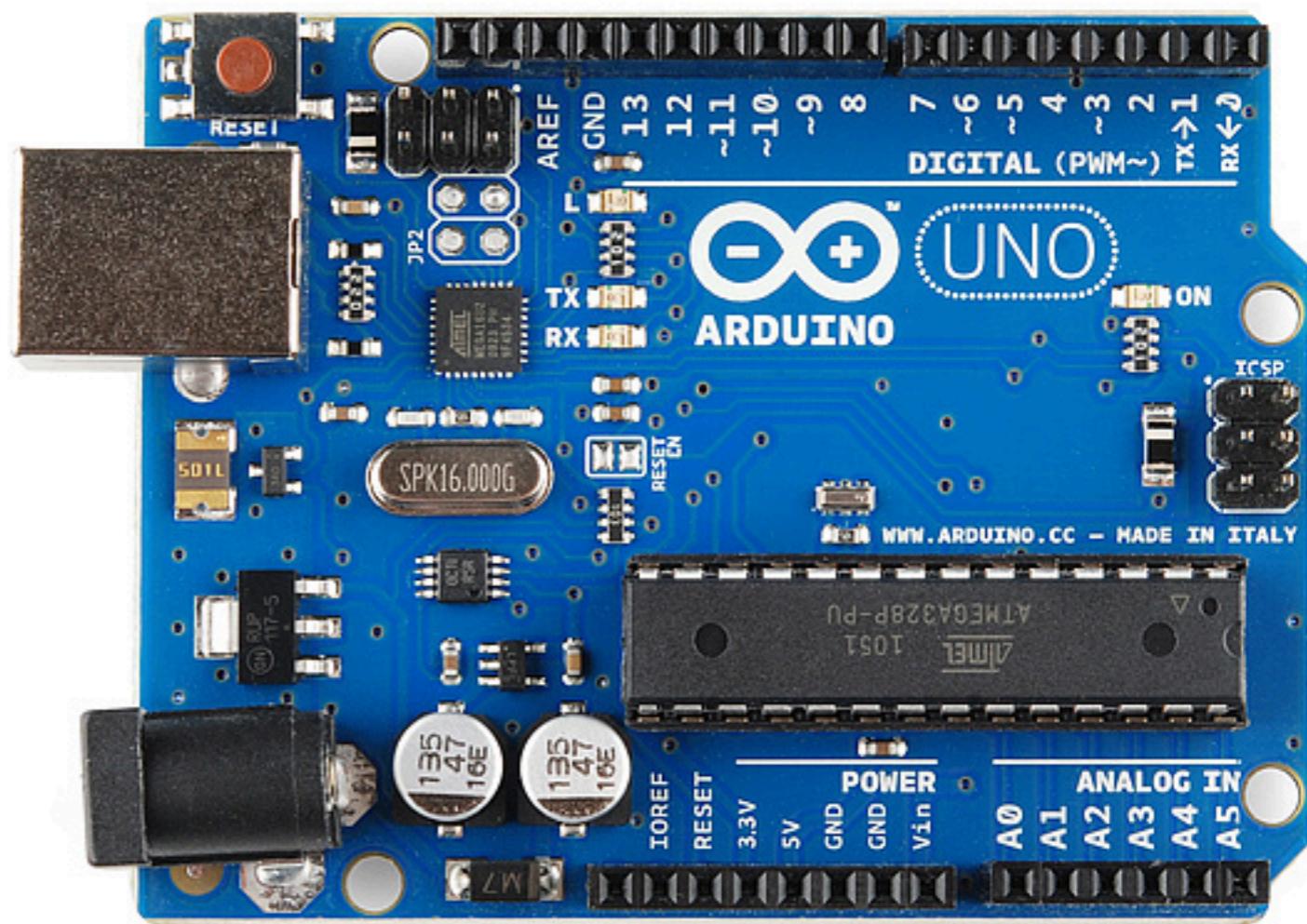
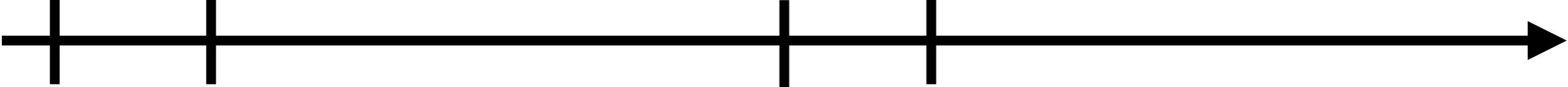


Image source: <https://learn.sparkfun.com/tutorials/what-is-an-arduino/all>



1972 1982

1999

2003

# Arduino

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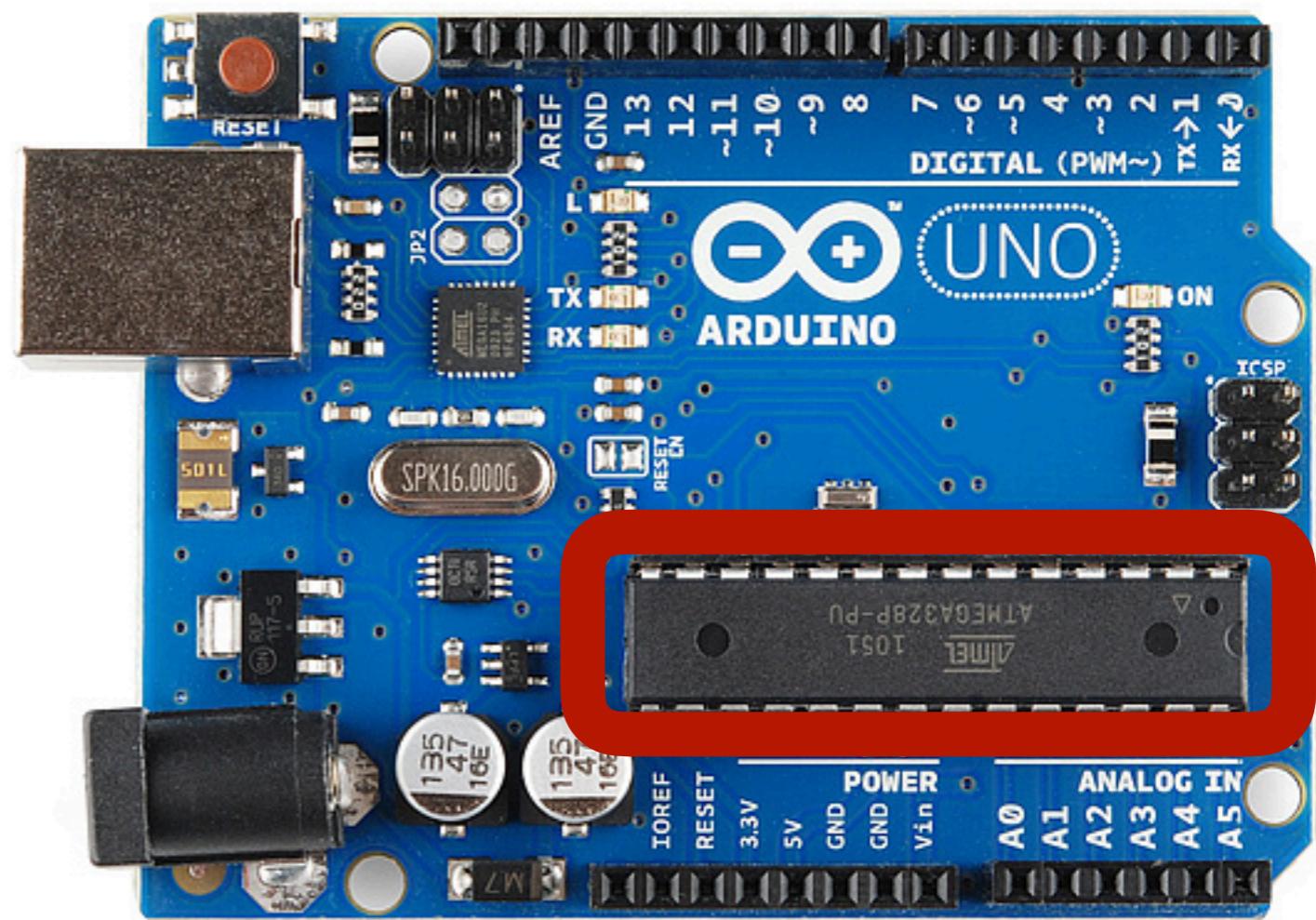
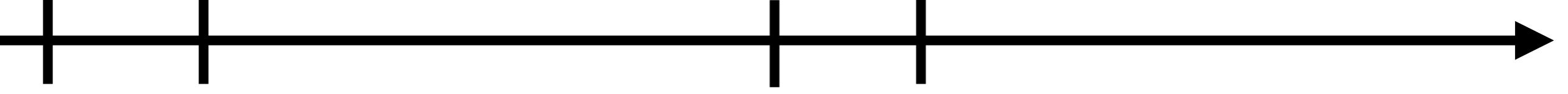


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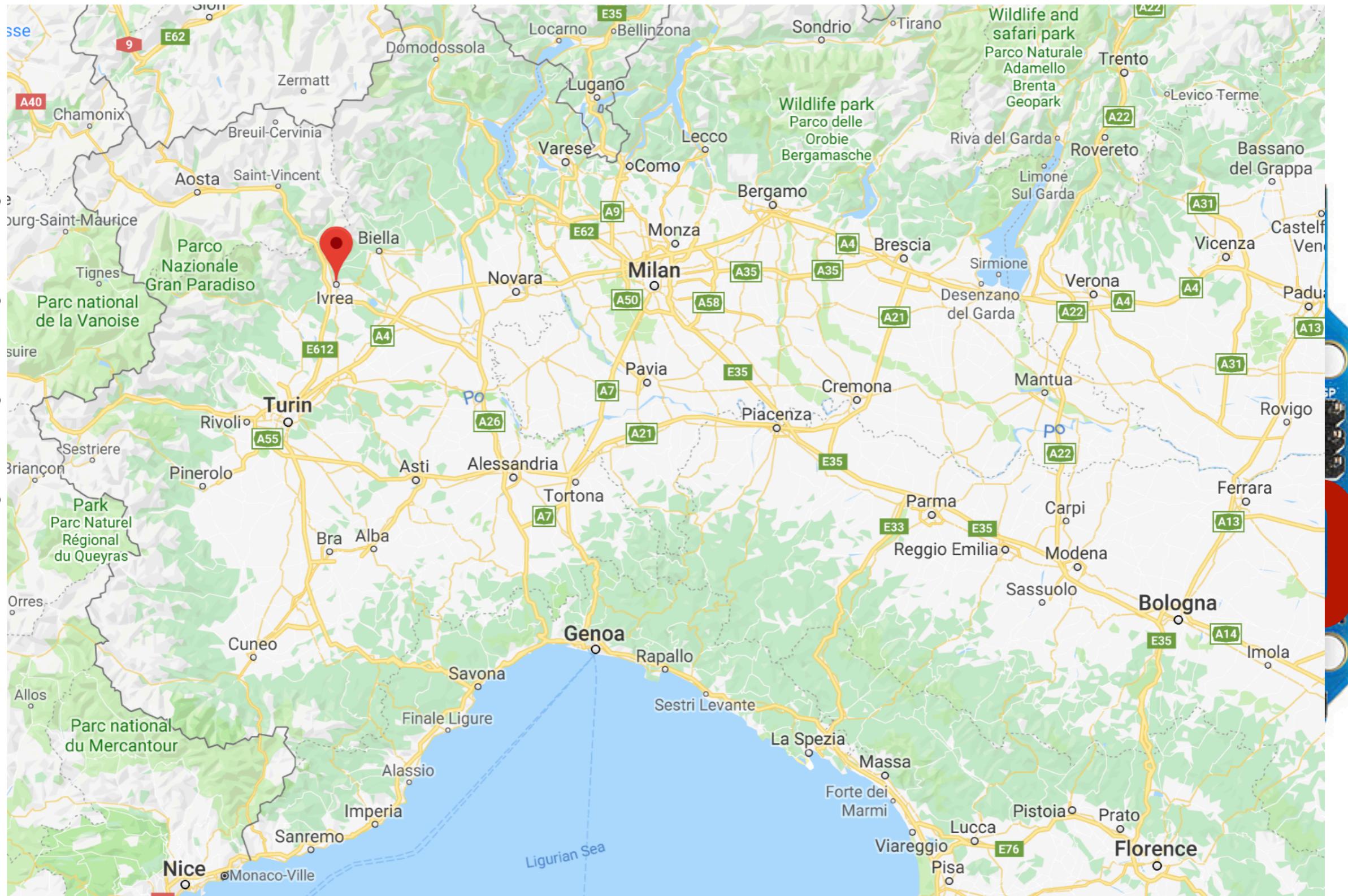


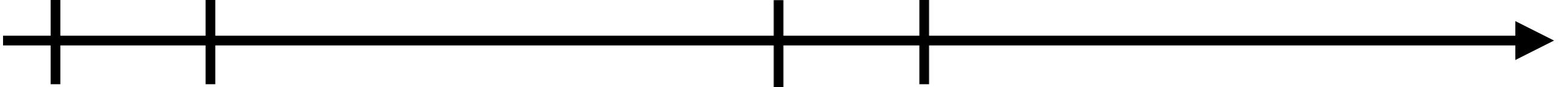
1972 1982

1999

2003

# Arduino





1972 1982

1999

2003

# Arduino

The screenshot shows the Arduino IDE interface with the title bar "Blink | Arduino 1.0.3". The code editor displays the "Blink" sketch. The code is as follows:

```
/*
  Blink
  Turns on an LED on for one second, then off for one second, repeatedly.

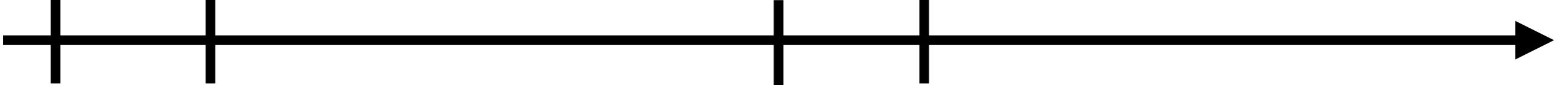
  This example code is in the public domain.
*/

// Pin 13 has an LED connected on most Arduino boards.
// give it a name:
int led = 13;

// the setup routine runs once when you press reset:
void setup() {
  // initialize the digital pin as an output.
  pinMode(led, OUTPUT);
}

// the loop routine runs over and over again forever:
void loop(){
  digitalWrite(led, HIGH);    // turn the LED on (HIGH is the voltage level)
  delay(1000);               // wait for a second
  digitalWrite(led, LOW);     // turn the LED off by making the voltage LOW
  delay(1000);               // wait for a second
}
```

At the bottom of the screen, there is a black status bar with the text "Arduino Mega (ATmega1280) on /dev/tty.usbserial-A600enbz".



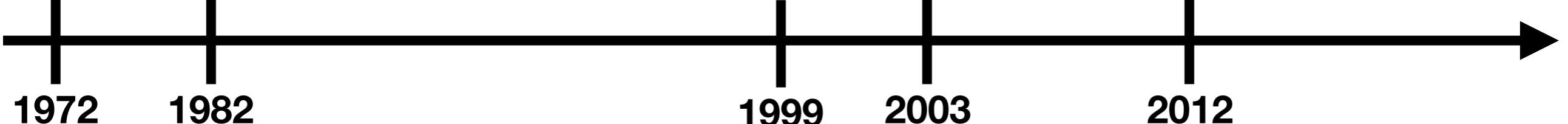
1972 1982

1999 2003

# Arduino Ethernet

- Programmable device.
- Easily connectable.
- Open source.
- Simple to use software.
- Has network connectivity.





# Raspberry Pi

- Computer.
  - Linux inside.
  - Programming oriented.
  - Full network stack.

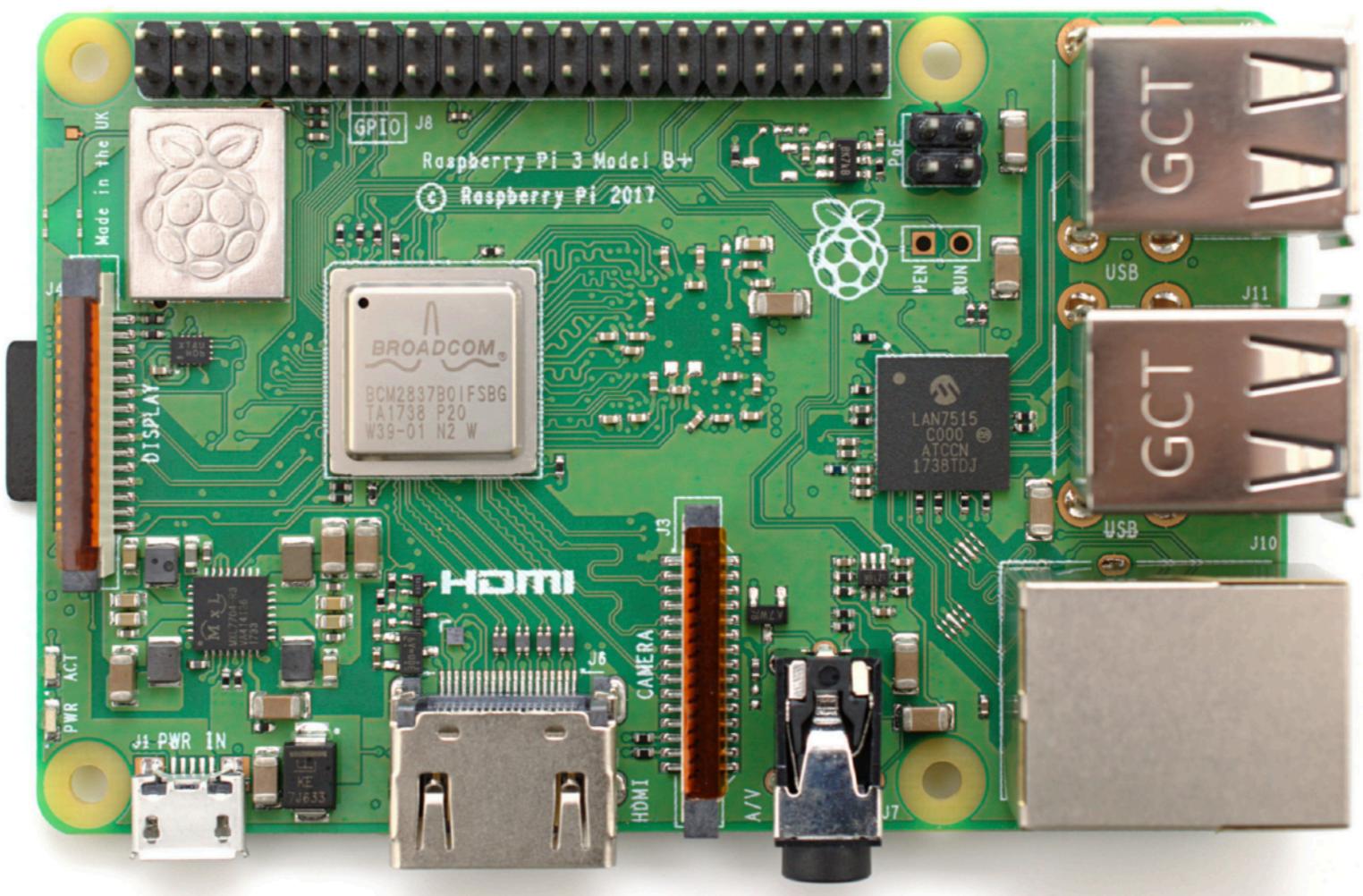
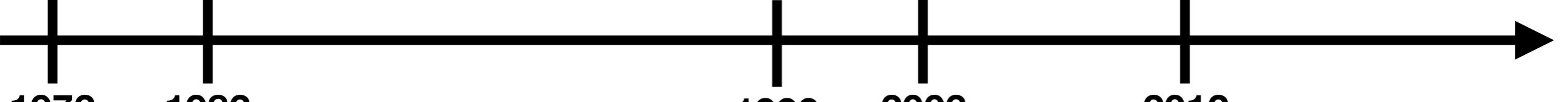


Image source: <https://www.flickr.com/photos/120586634@N05/39906369025/>



# Raspberry Pi

- Computer.
- Linux inside.
- Programming oriented.
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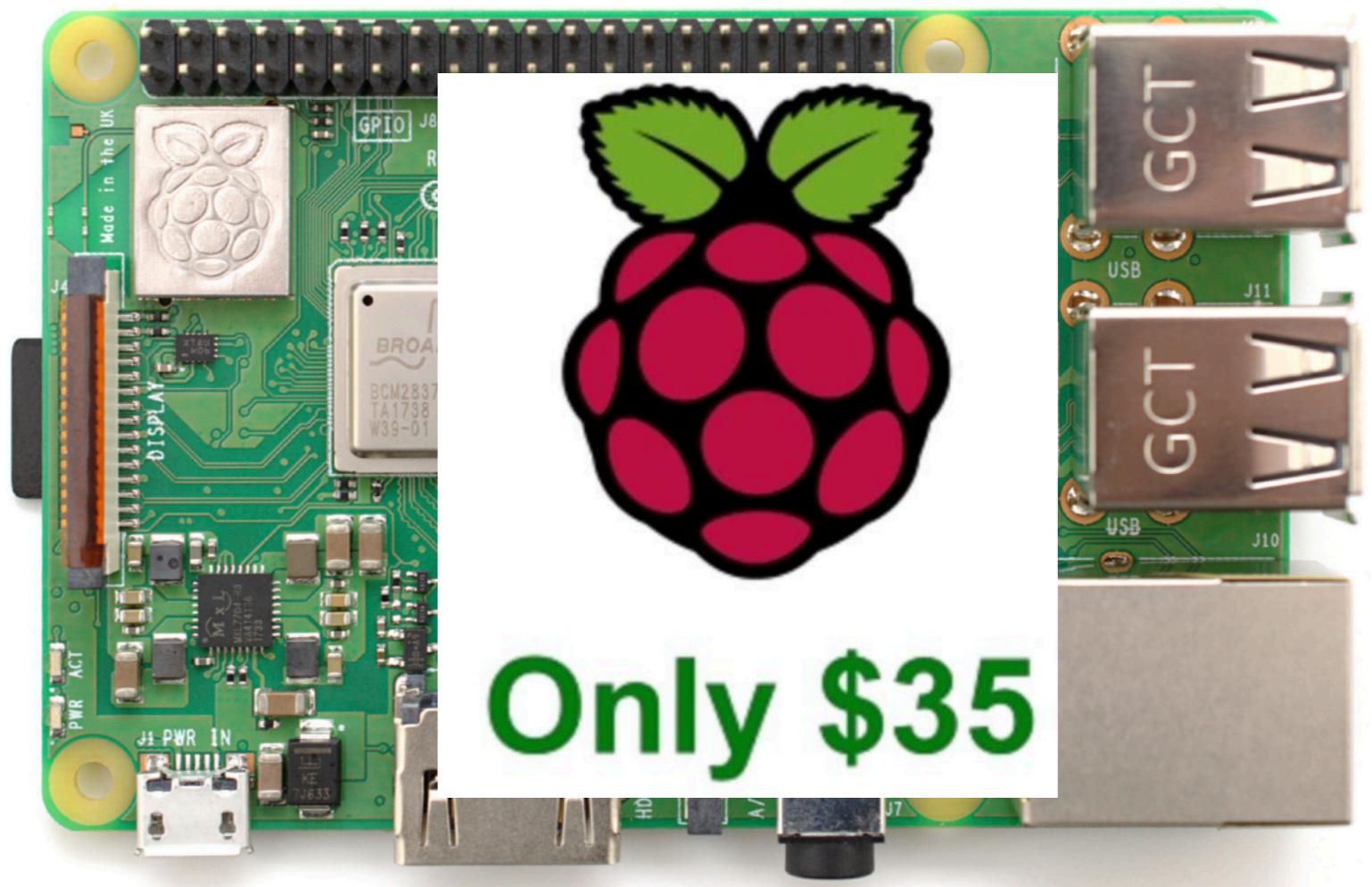


Image source: <https://www.flickr.com/photos/120586634@N05/39906369025/>



# Raspberry Pi

February 29th, 2012

- Computer.
- Linux inside.
- Programming oriented.
- Full network stack.

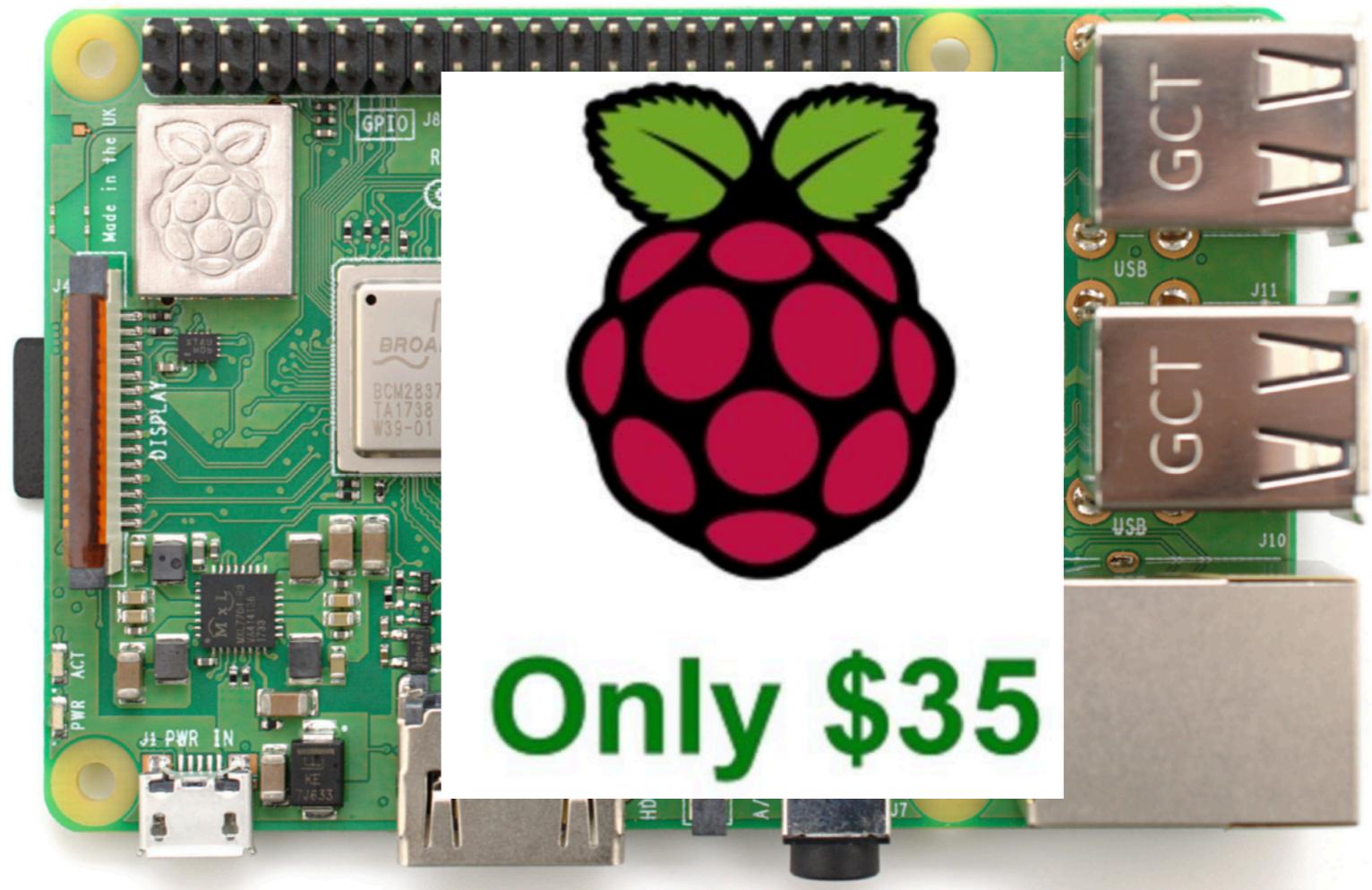
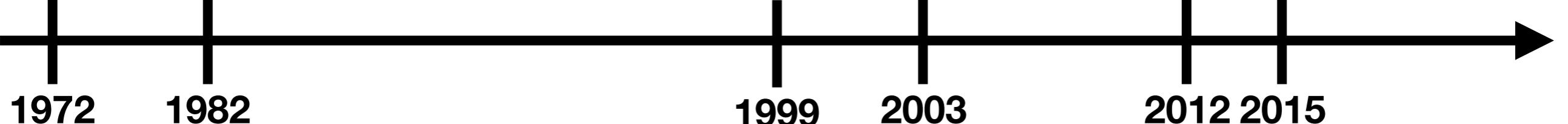


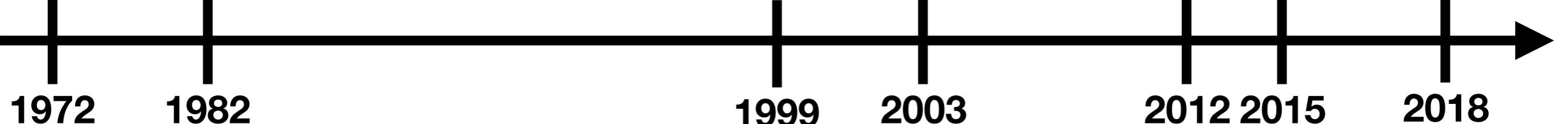
Image source: <https://www.flickr.com/photos/120586634@N05/39906369025/>



# Raspberry Pi Zero

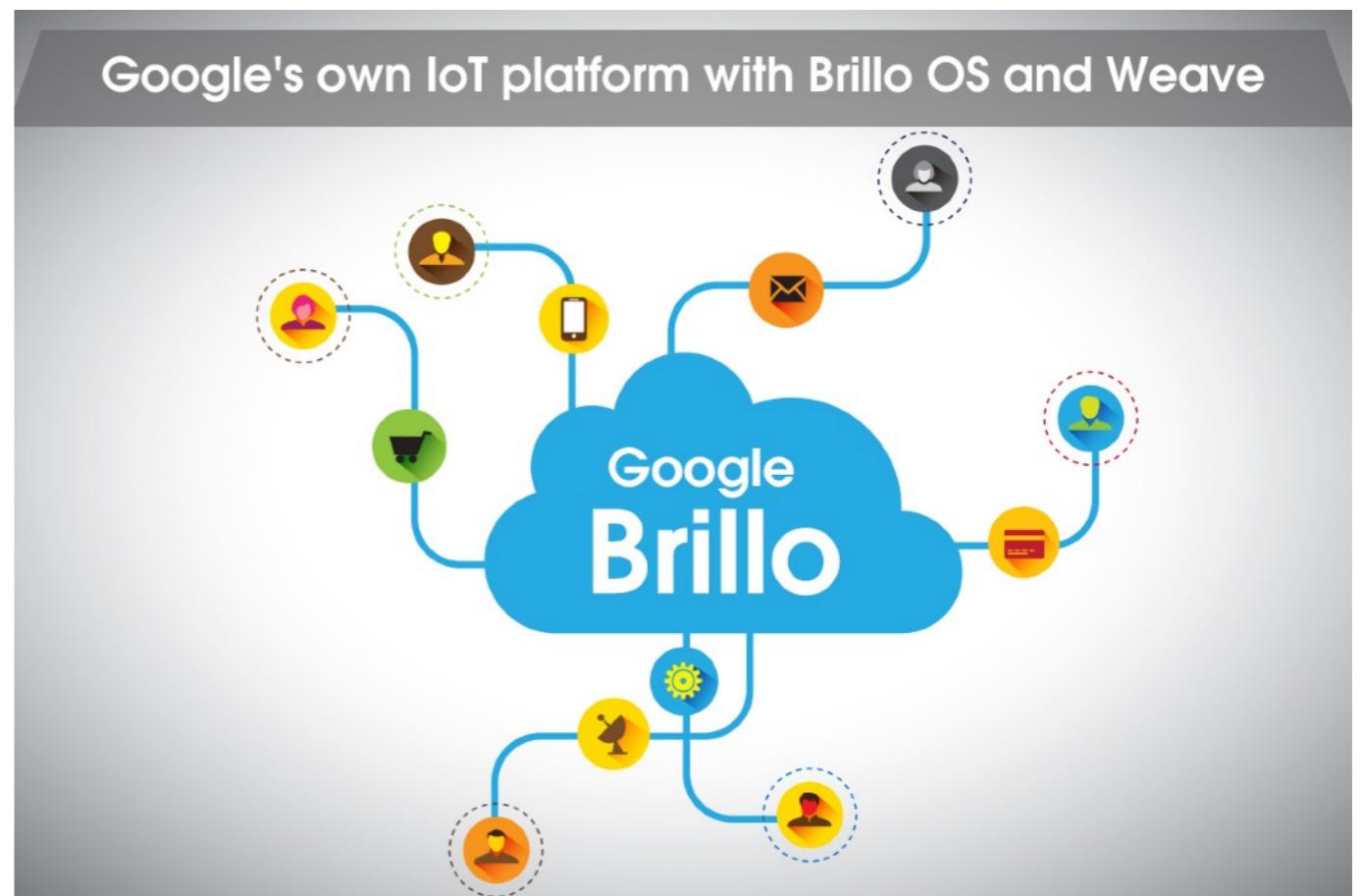
- A Broadcom BCM2835 application processor
- 1GHz ARM11 core
  - 40% faster than Raspberry Pi 1
- 512MB of LPDDR2 SDRAM
- A micro-SD card slot
- A mini-HDMI socket for 1080p60 video output
- Micro-USB sockets for data and power
- An unpopulated 40-pin GPIO header
- Small form factor, at 65mm x 30mm x 5mm





# Android Things

- Android Things lets you experiment with building devices on a trusted platform, without previous knowledge of embedded system design:
  - Develop using the Android SDK and Android Studio.
  - Access hardware such as displays and cameras natively through the Android framework.
  - Connect your apps with Google services.
  - Integrate additional peripherals through the Peripheral I/O APIs.
  - Use the Android Things Console to push over-the-air feature and security updates.



# Good with Sensors

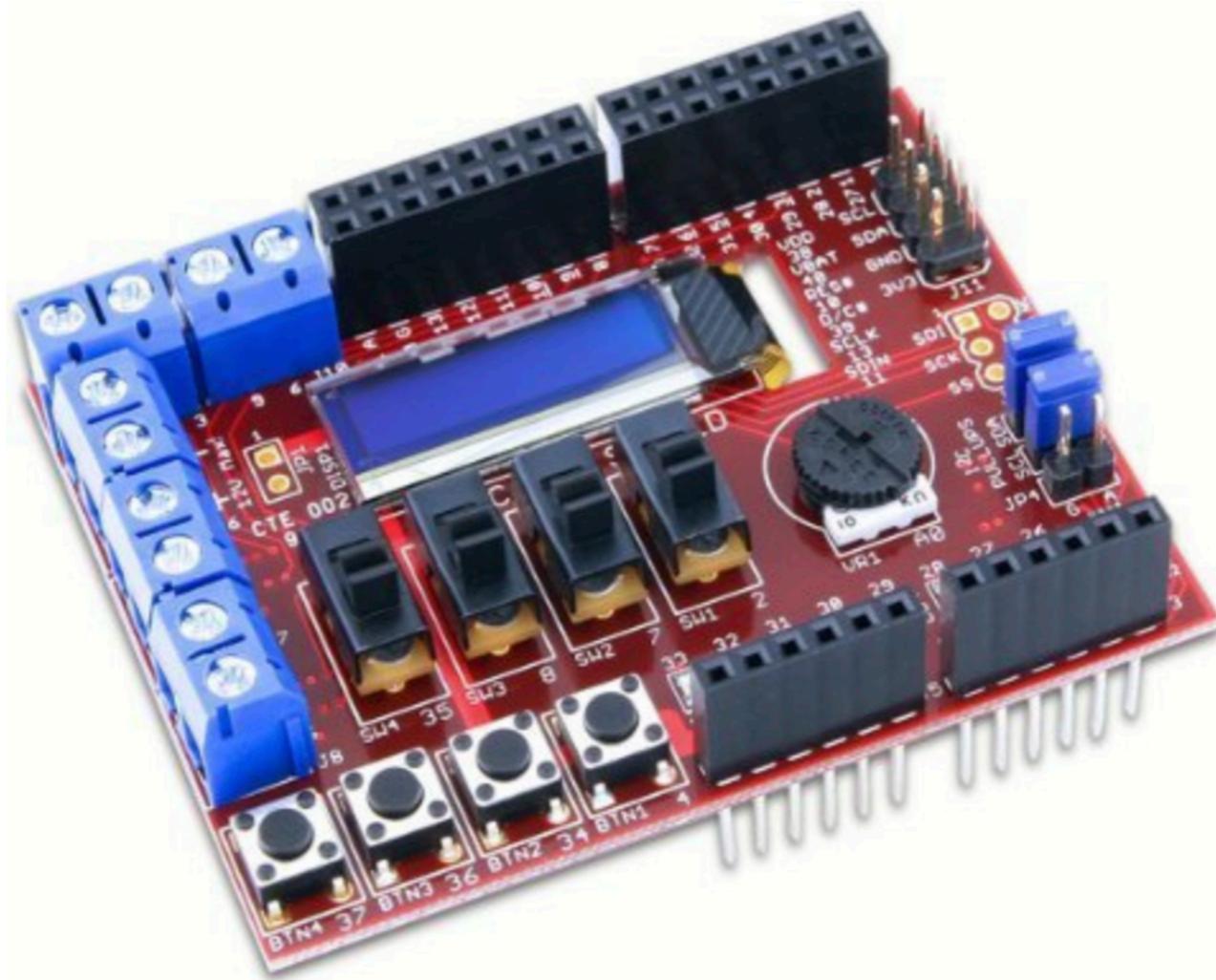


# Arduino Uno

20\$

# ATmega328P

# Good with Sensors

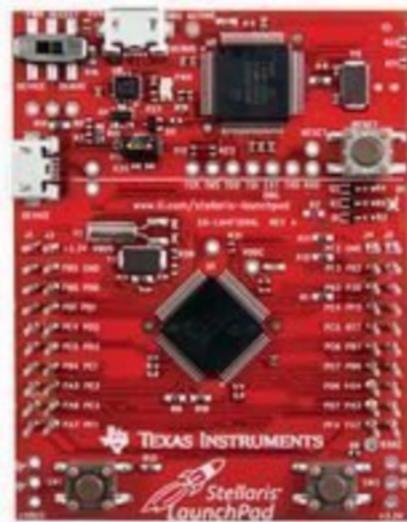


chipKIT Basic I/O Shield

40\$

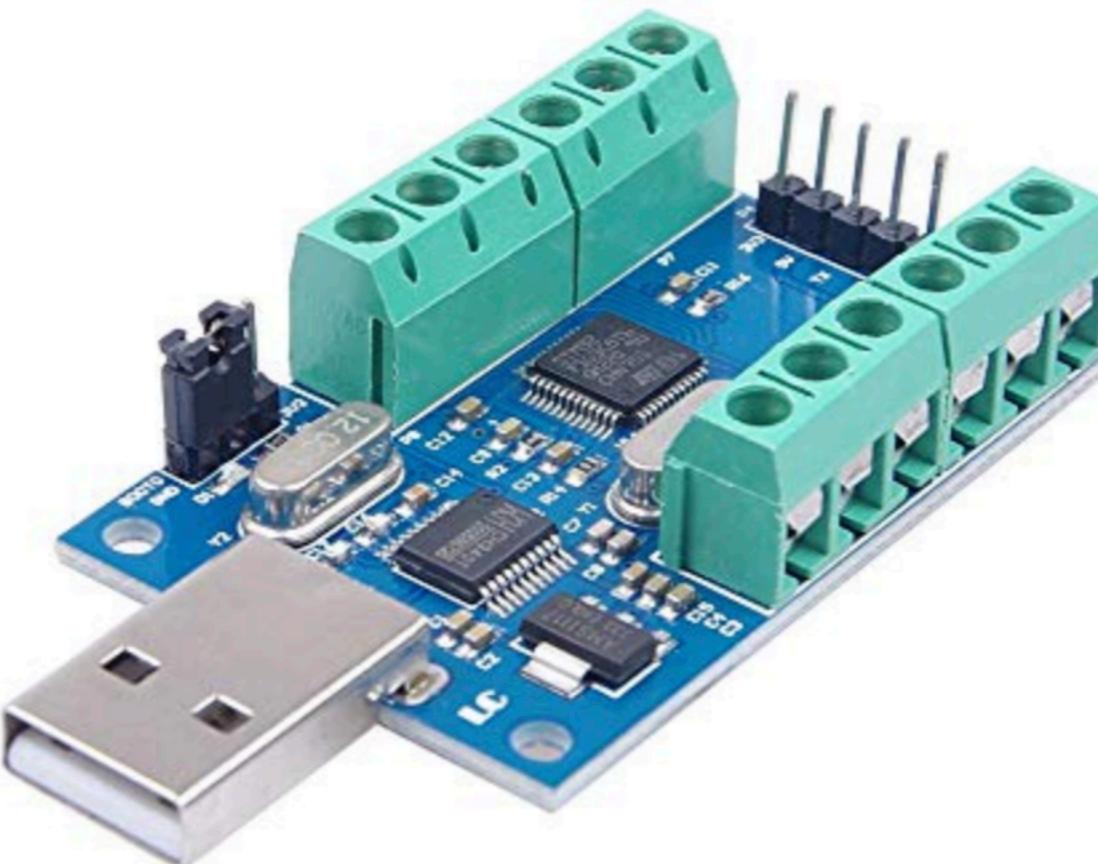
PIC

# Good with Sensors



LAUNCHPAD  
25\$  
LM4F120

# Good with Sensors and for Processing

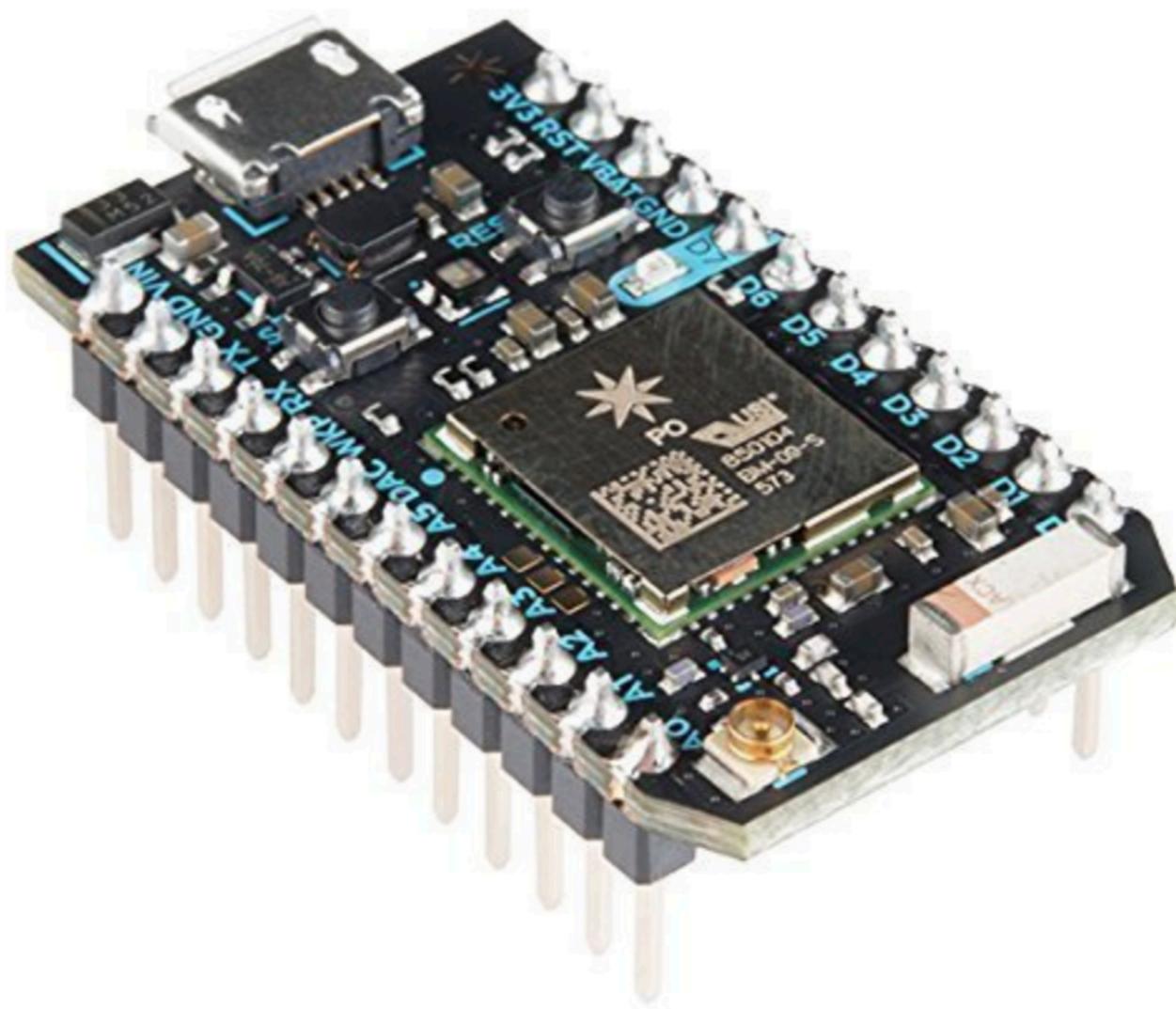


**STM32**

**13\$**

**CH340 ADC Module**

# Good with Sensors and for Processing



**Particle**

**20\$**

**ARM**

# Good with Sensors and for Processing

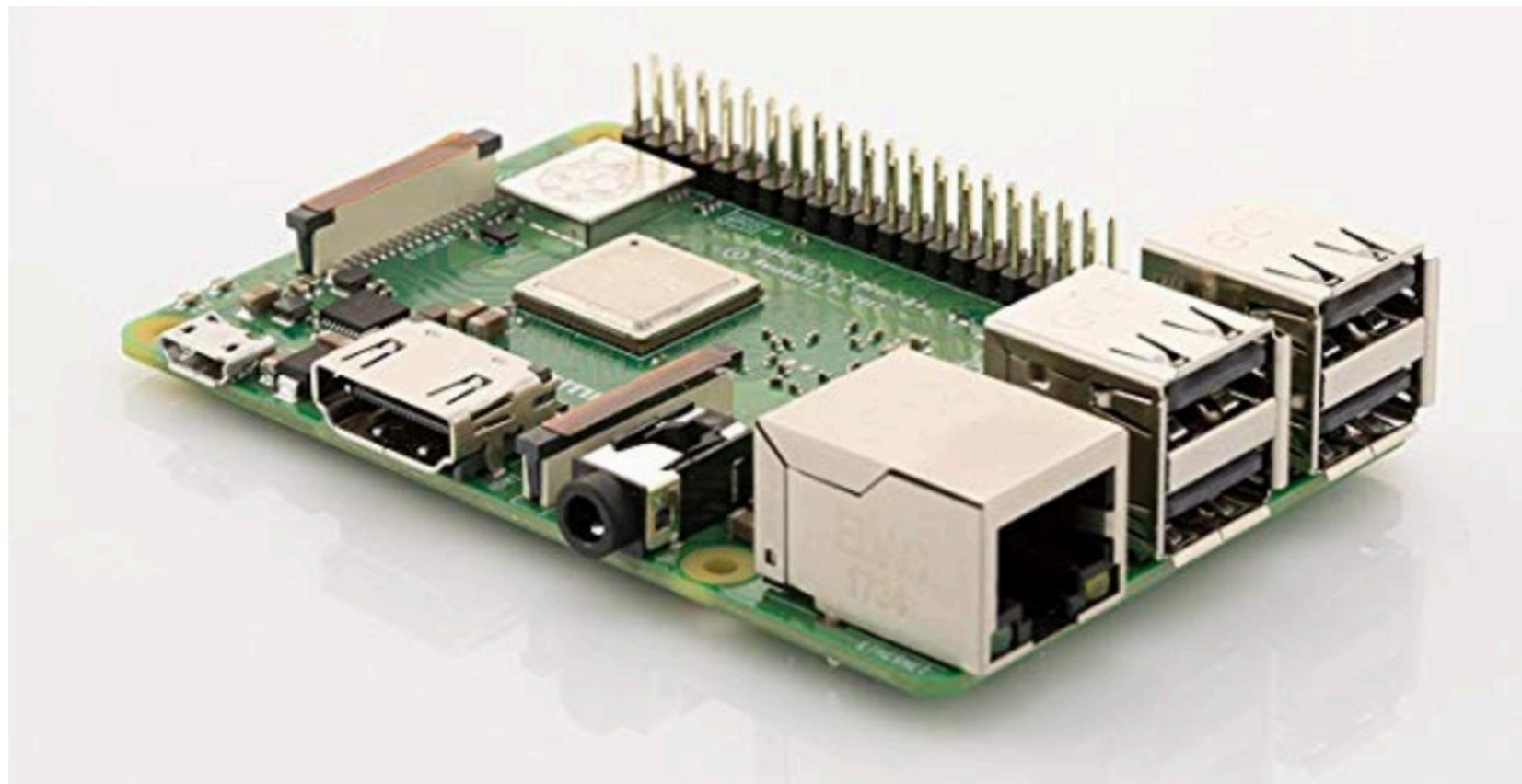


Raspberry Pi Zero

5\$

ARM

# Good for Processing and Network



**Raspberry Pi 3 B+**

**35\$**

**ARM - 1GB RAM**

# Good for Processing and Network



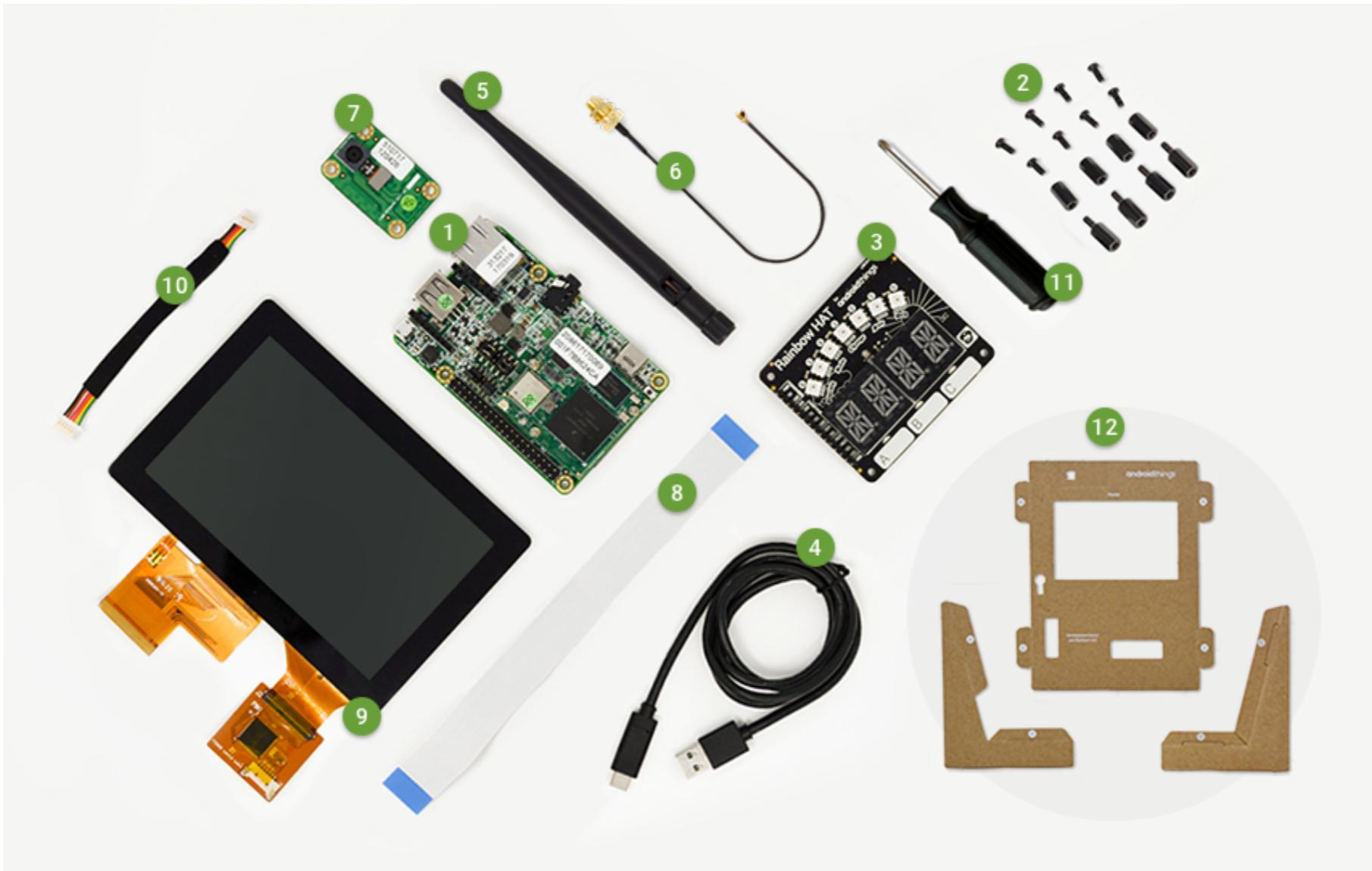
**Intel Galileo Gen 2P**

**50\$**

**Quark SoC - 400MHz - 256MB RAM**

# Android Things

# NXP i.MX7D Starter Kit



ARM Cortex-A7 + M4

200\$

<https://shop.technexion.com/pico-pi-imx7-startkit-rainbow-hat.html>

# Android Things Raspberry Pi Kit



ARM Cortex A53

100\$

<https://androidthings.withgoogle.com/#!/kits/raspberry-pi-3-starter-kit>

# IDE Options

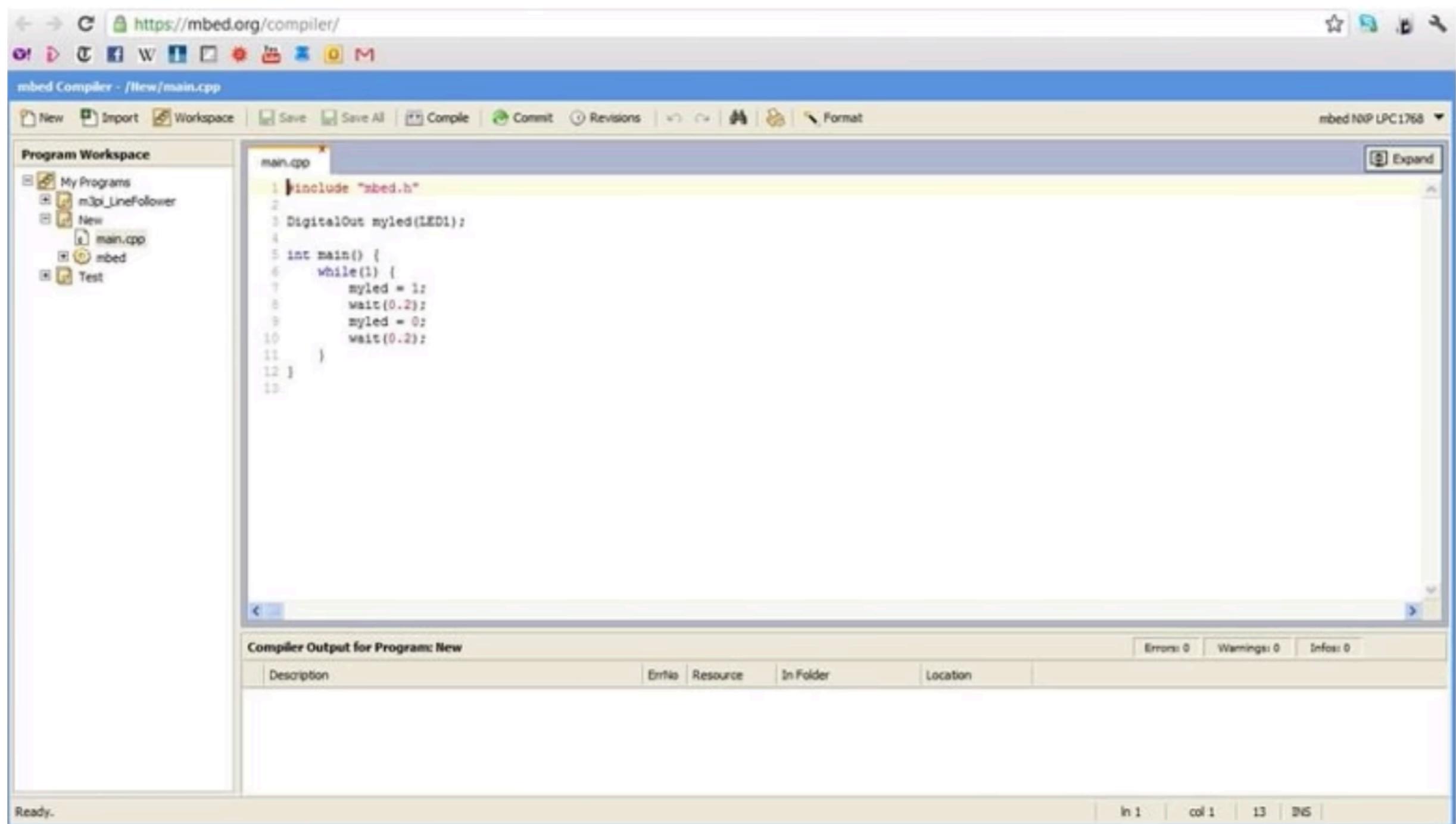
The screenshot shows the Arduino IDE's Sketchbook interface. On the left, a teal sidebar menu includes options like Editor, Sketchbook (which is selected), Examples, Libraries, Monitor, Help, and Preferences. The main area features a large upload icon and text encouraging users to import sketches to their online Sketchbook. A central search bar allows users to search the sketchbook. To the right, a specific sketch named "sketch\_feb24a" is displayed. It includes a header section with a checkmark, a right arrow, and a "Select Board or Port" dropdown. Below this, the sketch file "sketch\_feb24a.ino" is shown with its code:

```
1 /*
2 */
3 /*
4 */
5 void setup() {
6 }
7 }
8
9 void loop() {
10
11 }
```

The sketch also includes a "ReadMe.adoc" file and a dropdown menu.

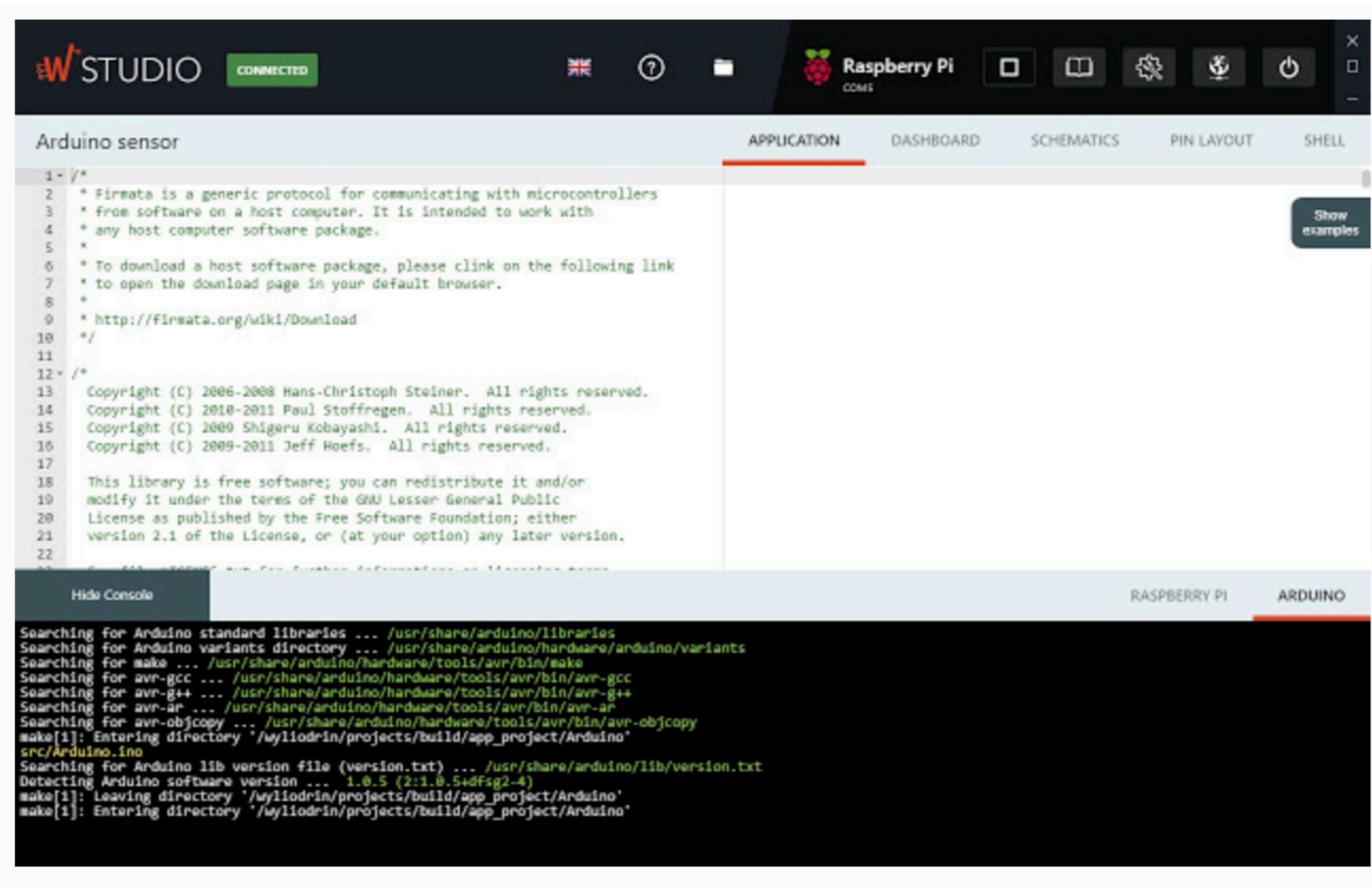
<https://create.arduino.cc>

# IDE Options



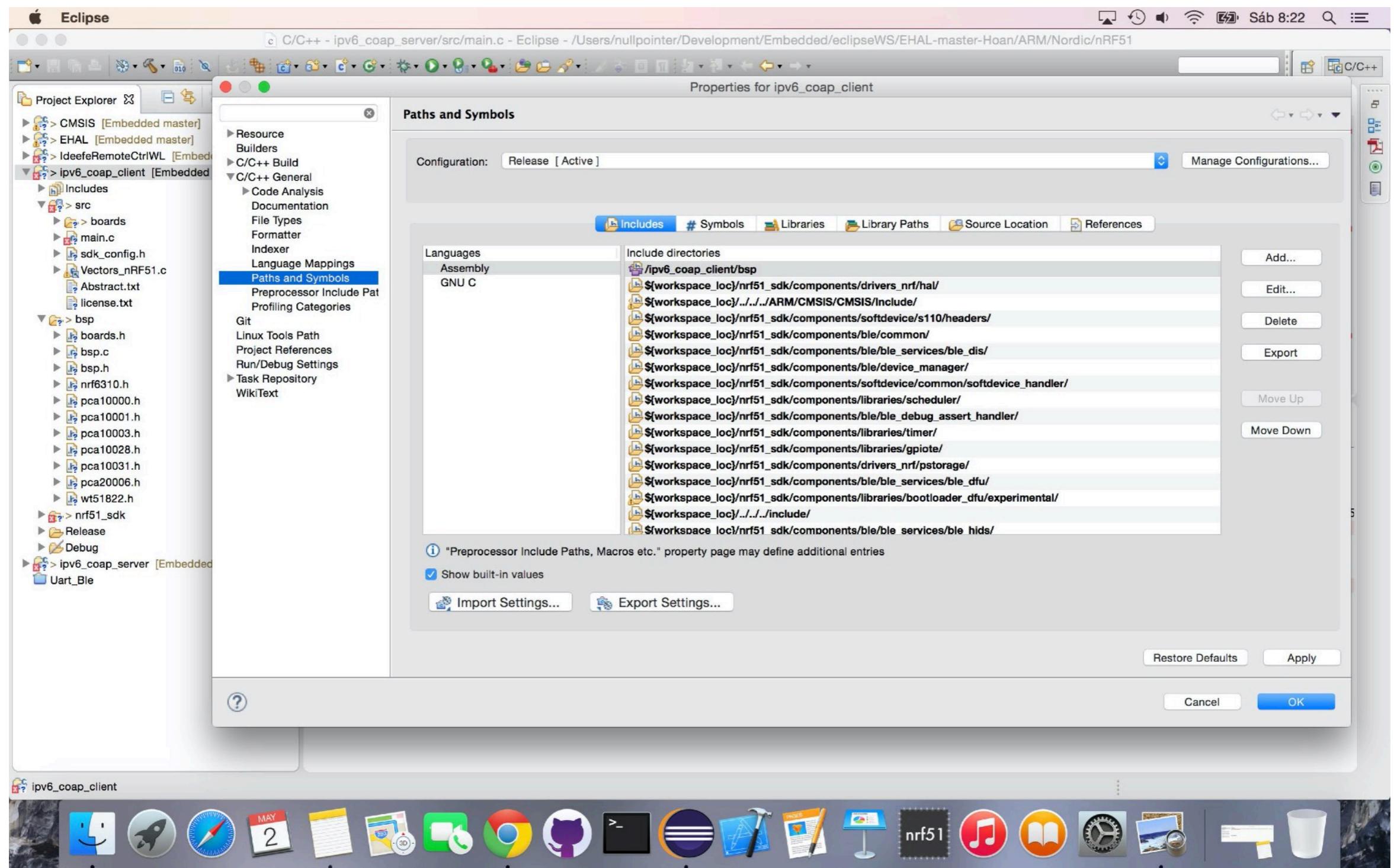
<https://os.mbed.com/>

# IDE Options

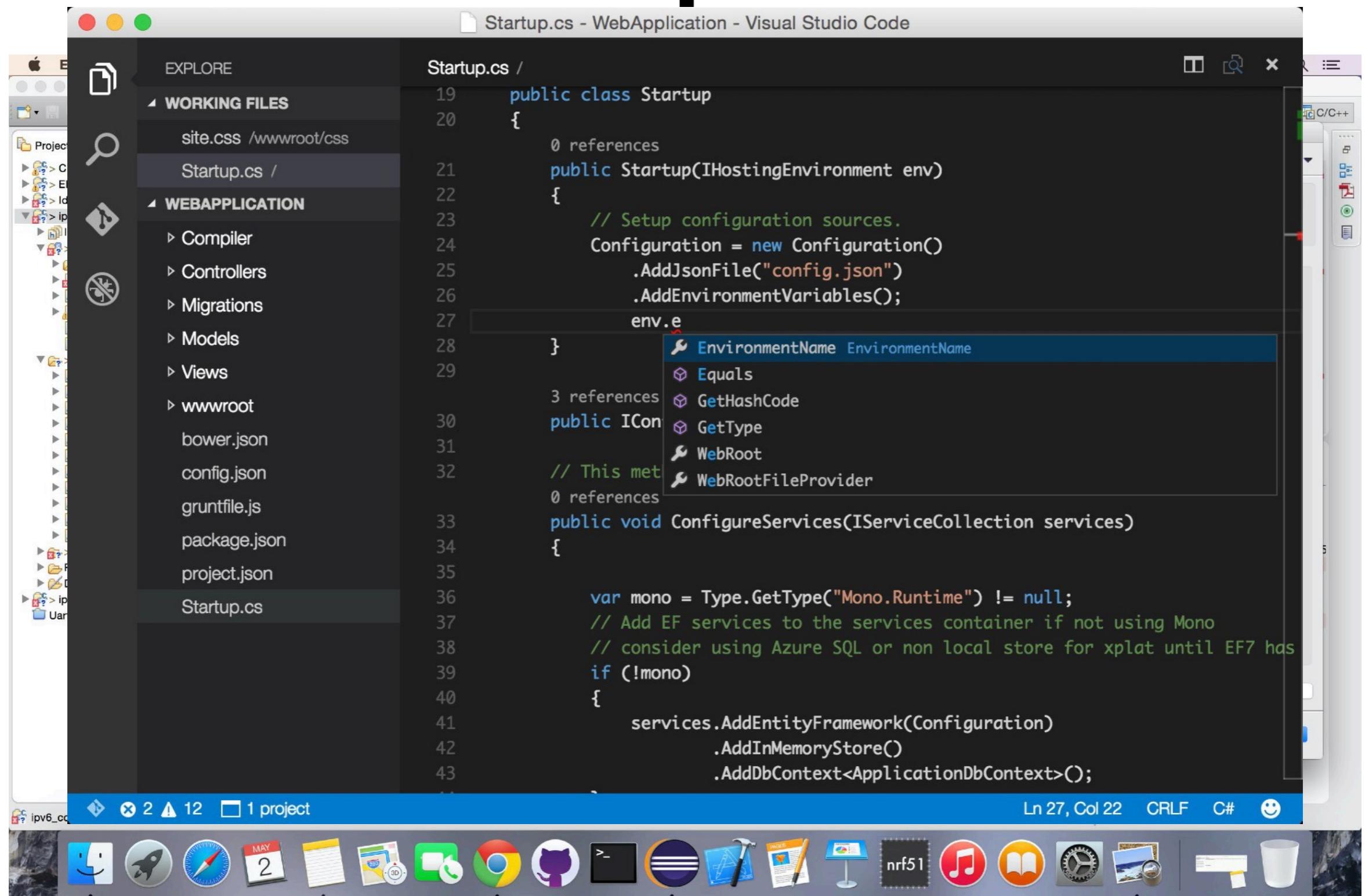


<https://wyliodrin.com/>

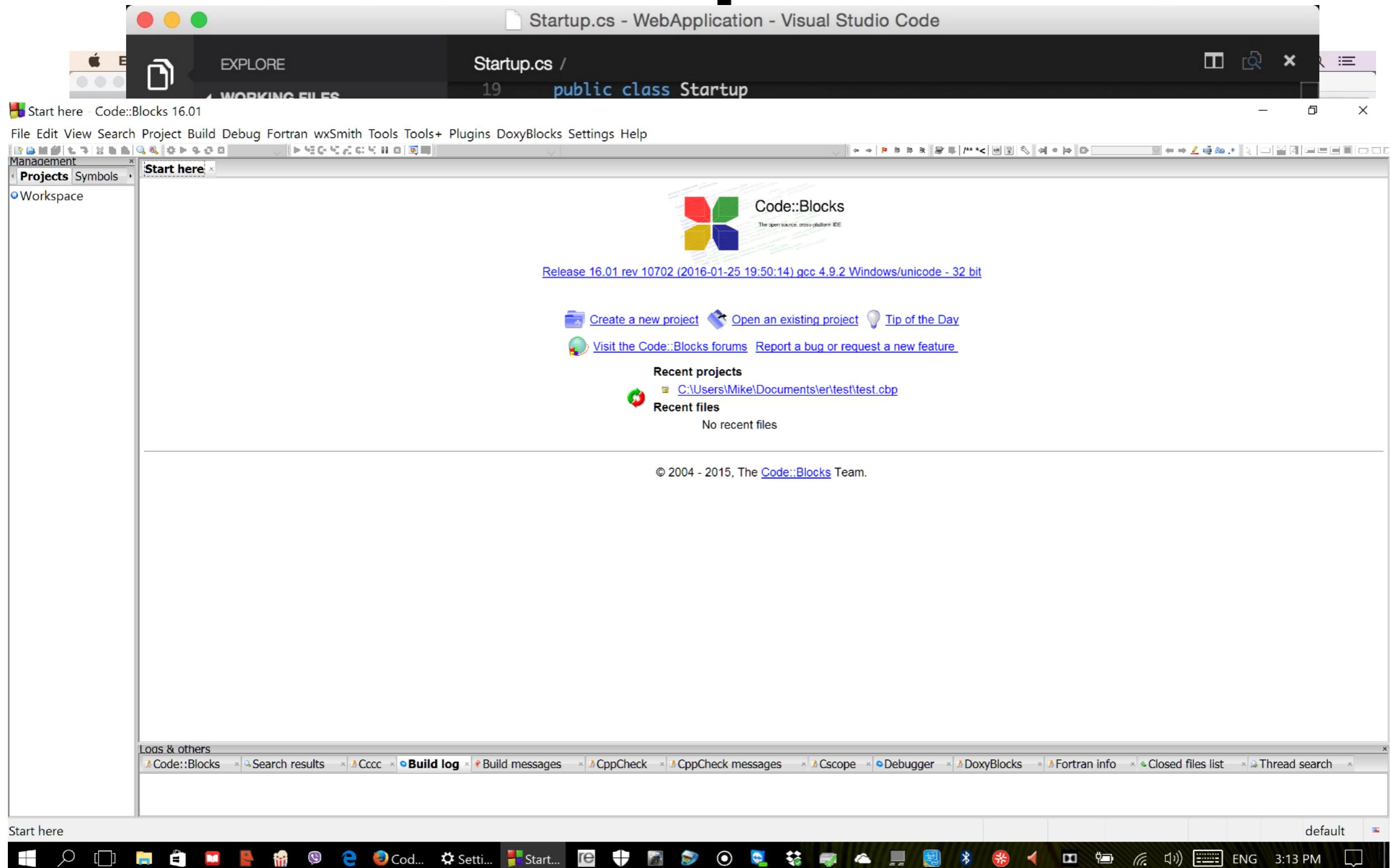
# IDE Options



# IDE Options



# IDE Options



# IDE Options

The screenshot shows a terminal window with a file tree on the left and a code editor on the right.

**File Tree:**

- controllers/
- helpers/
- jobs/
- mailers/
- models/
- views/
  - layouts/
    - \_footer.html.erb
    - \_header.html.erb
    - \_rails\_default.html.erb
    - \_shim.html.erb
  - application.html.erb
  - mailer.html.erb
  - mailer.text.erb
- static\_pages/
  - about.html.erb
  - contact.html.erb
  - help.html.erb
  - home.html.erb
- bin/
- config/
- db/
- lib/
- log/
- public/
- test/
  - controllers/

**Code Editor (Startup.cs - WebApplication - Visual Studio Code):**

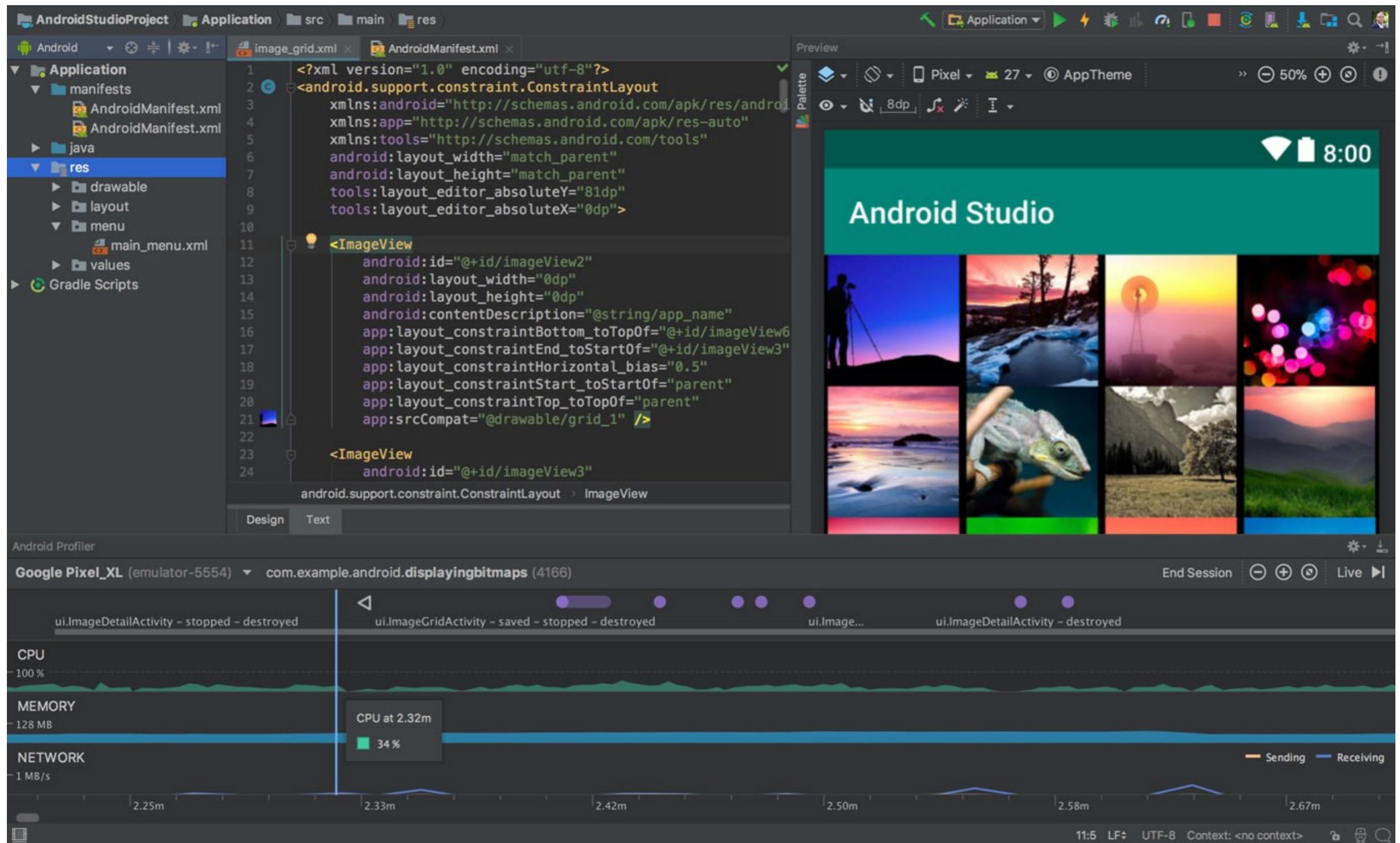
```
10     assert_response :success
11 end
12
13 test "should get home" do
14   get root_url
15   assert_response :success
16   assert_select "title", @base_title
17 end
18
19 test "should get help" do
20   get help_path
21   assert_response :success
22   assert_select "title", "Help | #{@base_title}"
23 end
24
25 test "should get about" do
26   get about_path
27   assert_response :success
28   assert_select "title", "About | #{@base_title}"
29 end
30
31 test "should get contact" do
32   get contact_path
33   assert_response :success
34   assert_select "title", "Contact | #{@base_title}"
35 end
36 end
```

**Terminal:**

- [3] pry(main)> [4] 0:ruby 1:ruby 2:vim\* 3:fish- 4:irssi# 5:mutt
- [5] static\_pages\_controller\_test.rb
- [6] NERD >> NORMAL >> <\_controller\_test.rb[+] < setup < ruby << 100% : 36: 1 <rder > static\_pages\_controller\_test.rb
- [7] | Rendered /Users/dave/.rvm/gems/ruby-2.3.1/gems/web-console-3.1.1/lib/web\_console/templates/console.js.erb within layouts/javascript (58.5ms)
- [8] | Rendering /Users/dave/.rvm/gems/ruby-2.3.1/gems/web-console-3.1.1/lib/web\_console/templates/main.js.erb within layouts/javascript
- [9] | Rendered /Users/dave/.rvm/gems/ruby-2.3.1/gems/web-console-3.1.1/lib/web\_console/templates/main.js.erb within layouts/javascript (0.3ms)
- [10] | Rendered /Users/dave/.rvm/gems/ruby-2.3.1/gems/web-console-3.1.1/lib/web\_console/templates/index.html.erb (115.3ms)
- [11] |

[Thu Aug 18] 02:15 pm |

# IDE Options



<https://developer.android.com/studio>

# Laboratory Projects

- Two projects:
  - Individual project - 60% of the final grade.
  - Team project - 40% of the final grade.



Image source:  
<http://inkawall.com>

# Individual Project



- A project similar to the samples available here:
  - <https://androidthings.withgoogle.com/build/#!/samples/>
  - Or enhance an existing sample.

Image source:  
<http://ceelo.org/individual-leader/>

# Individual Project

- A project similar to the samples available here:
  - <https://androidthings.withgoogle.com/build/#!/samples/>
- Or enhance an existing sample.
- Due: Last laboratory before Easter holiday.
  - Either **April 9th** or **April 16th**, depending on your laboratory frequency.
- Deliverables:
  - The source code should be hosted in a github classroom repository.
  - A webpage presenting the project results, similar to:
    - <https://androidthings.withgoogle.com/#!/samples/doorbell>
  - A short video presenting the results.



Image source:  
<http://ceelo.org/individual-leader/>

# Team Project



Image source:  
<https://www.contractingbusiness.com>

- A team of 3 or 4 students to tackle a real-world problem.
- Either:
  - Choose an existing project proposed by the lab instructor.
  - Define a new one, together with the lab instructor.

# Team Project

- A team of 3 or 4 students to tackle a real-world problem.
- Either:
  - Choose an existing project proposed by the lab instructor.
  - Define a new one, together with the lab instructor.
- Due: Last laboratory.
  - Either **May 14th** or **May 21st**, depending on your laboratory frequency.
- Deliverables:
  - The source code should be hosted in a github classroom team repository.
  - A webpage presenting the project results, similar to:
    - <https://androidthings.withgoogle.com/#!/samples/doorbell>
  - A short video presenting the results.
  - A companion mobile app to manage the IoT app.



Image source:  
<https://www.contractingbusiness.com>

# Lecture outcomes

- Understand the available hardware and software options.
- IDE options.
- Project details.

