.NET IoT and AI Hack Days - Session 2

@CPTMSDUG

.NET – A unified development platform

CLOUD

Azure

WEB

ASP.NET

Blazor

DESKTOP

.NET MAUI

WPF

WinForms

MOBILE

.NET MAUI

Xamarin

GAMING

Unity

IoT

ARM32

ARM64

AI

ML.NET

.NET for Apache Spark

.NET 7

COMMON BASE LIBARIES/APIs

INFRASTRUCTURE

RUNTIME COMPONENTS

COMPILERS

LANGUAGES

ECOSYSTEM

NuGet

GitHub

Components, tools, library vendors

TOOLS

Visual Studio

Visual Studio for Mac

Visual Studio Code

CLI

What is Session 2 about?

- Getting started with Raspberry Pi and basic electronics – recap
- Quick hands-on recap on Azure IoT Central
- Learning about HaT’s
- Continuing learning about electronics
- Building A Raspberry Pi robot platform
- Controlling the robot with .NET

Foundation for more complex sessions

Recap of Session 1

- What .NET is
- Devices
    - Microcontrollers
    - Microcomputer SBCs
    - Hardware Interfacing
        - I2C
        - GPIO
- Module 1
    - Running a .NET Application locally and remotely on a Raspberry Pi
    - Installing .NET 7
    - Connecting to a Raspberry Pi via SSH

Recap of Session 1

- Module 1
  - Running a .NET Application locally and remotely on a Raspberry Pi

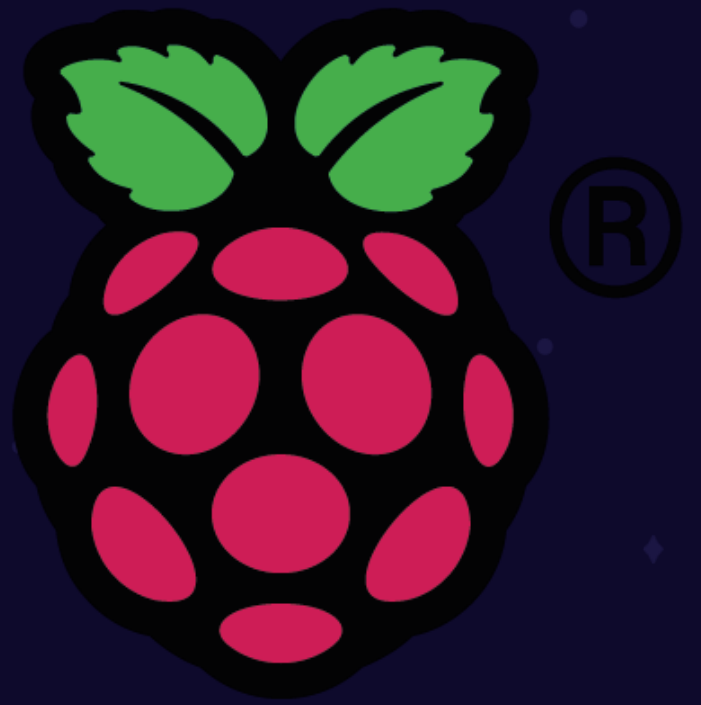
  - Installing .NET 7
  - Connecting to a Raspberry Pi via SSH – PUTTY
  - Remoting to a Pi with VNC
  - WINSCP to copy files to Raspberry Pi

  - Running your first .NET 7 application via SSH
  - Remote compilation / cross compilation for ARM in VS Code and remote deployment to the Pi.
  - Visual Studio Remote Debugger

Recap of Session 1

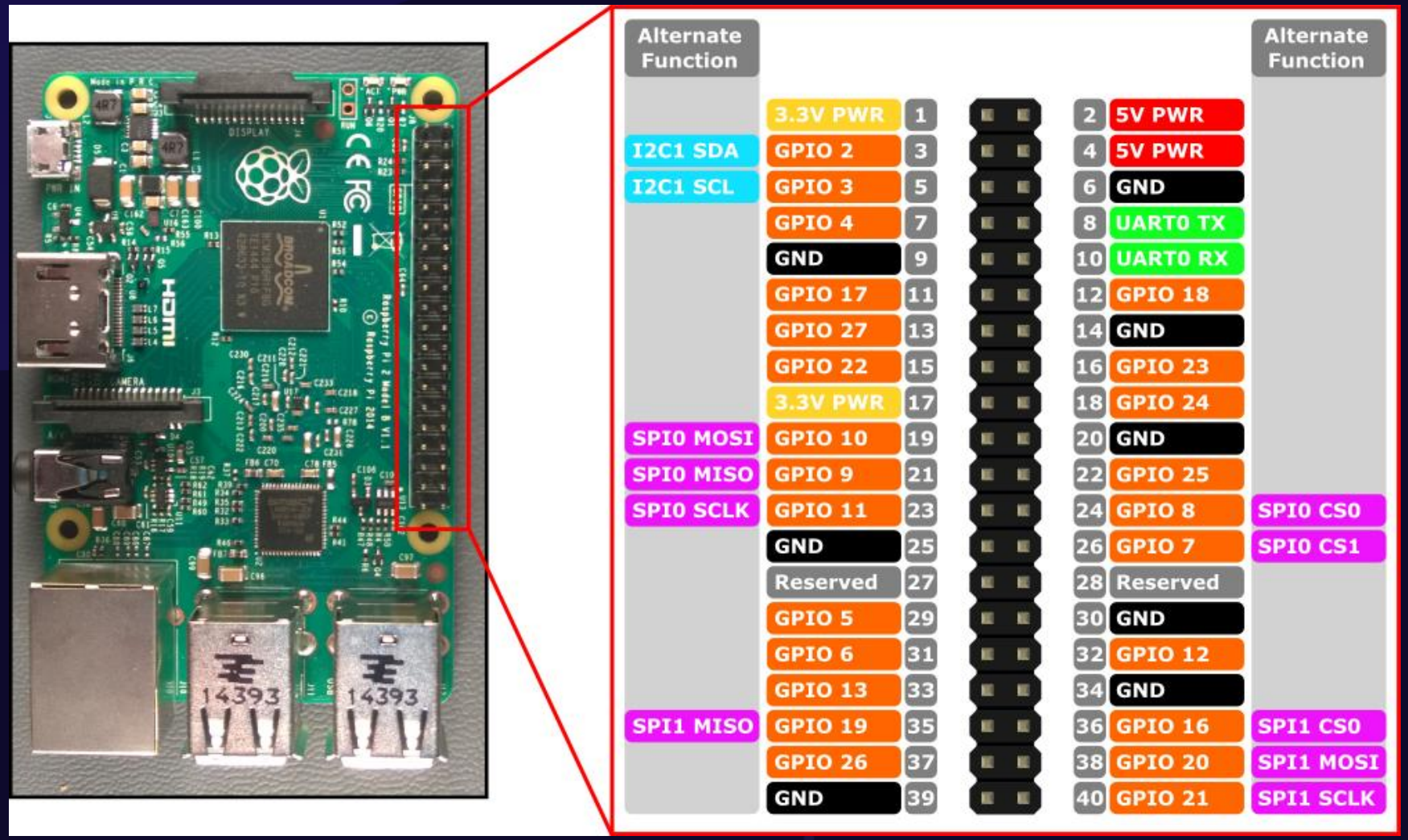
- Module 2
  - Getting started with Hardware and Sensors connected to a Raspberry Pi with .NET
  - Connecting Sensors to the Raspberry PI
  - Azure IoT and Azure IoT Central

Module 2



Getting started with Hardware and Sensors connected to a Raspberry Pi with .NET

Interfacing to the Raspberry Pi



Interfacing to the Raspberry Pi

GPIO - General-purpose input/output

Switching things on, switching things off

Analog

No just 1 (on) and 0 (off)
Variable Input and Output voltage.
Raspberry Pi has no Analog pins. Requires an Analog to Digital Converter

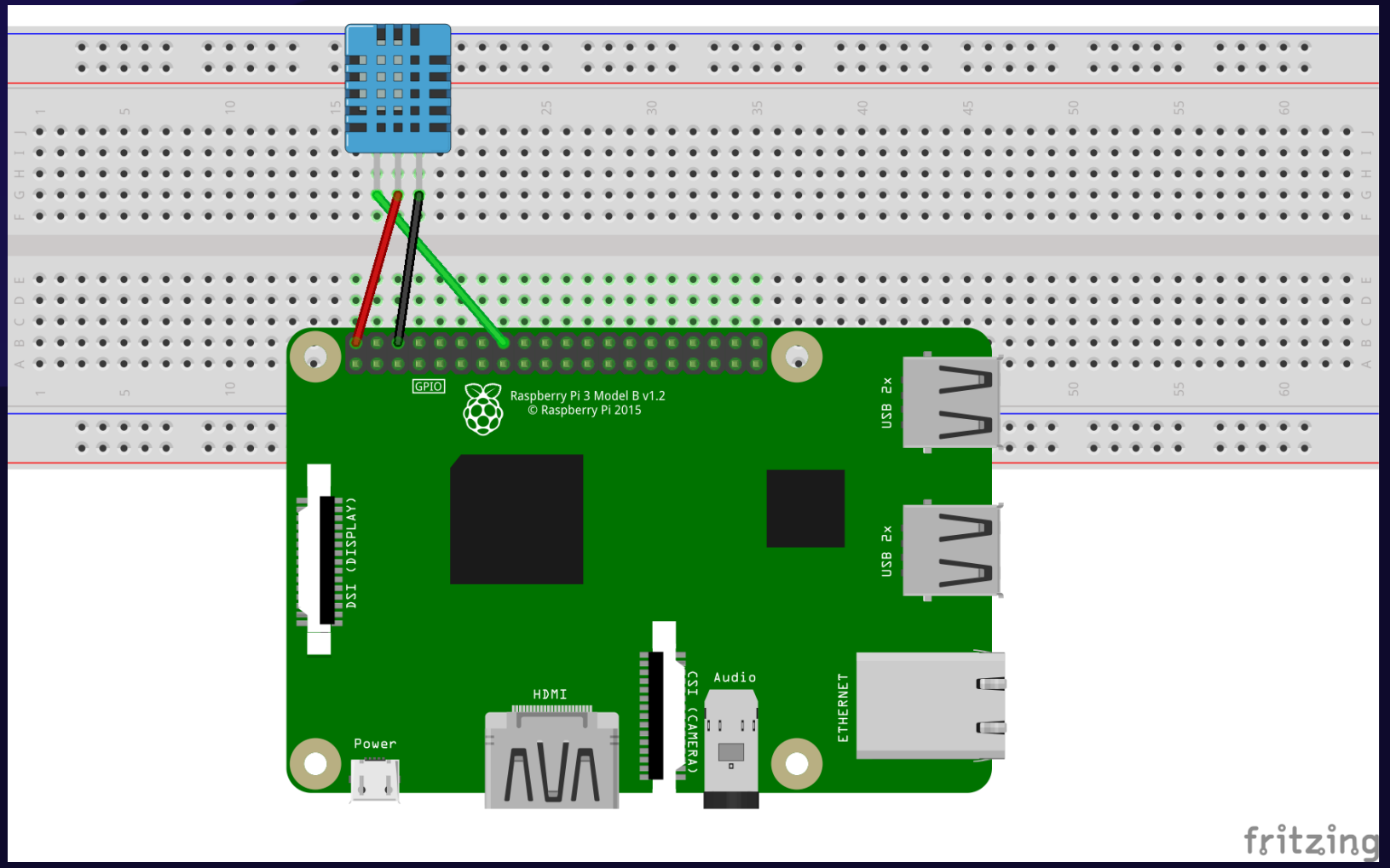
I2C

Serial communication Bus
Handy as it’s usually 2 wires for complex data communication

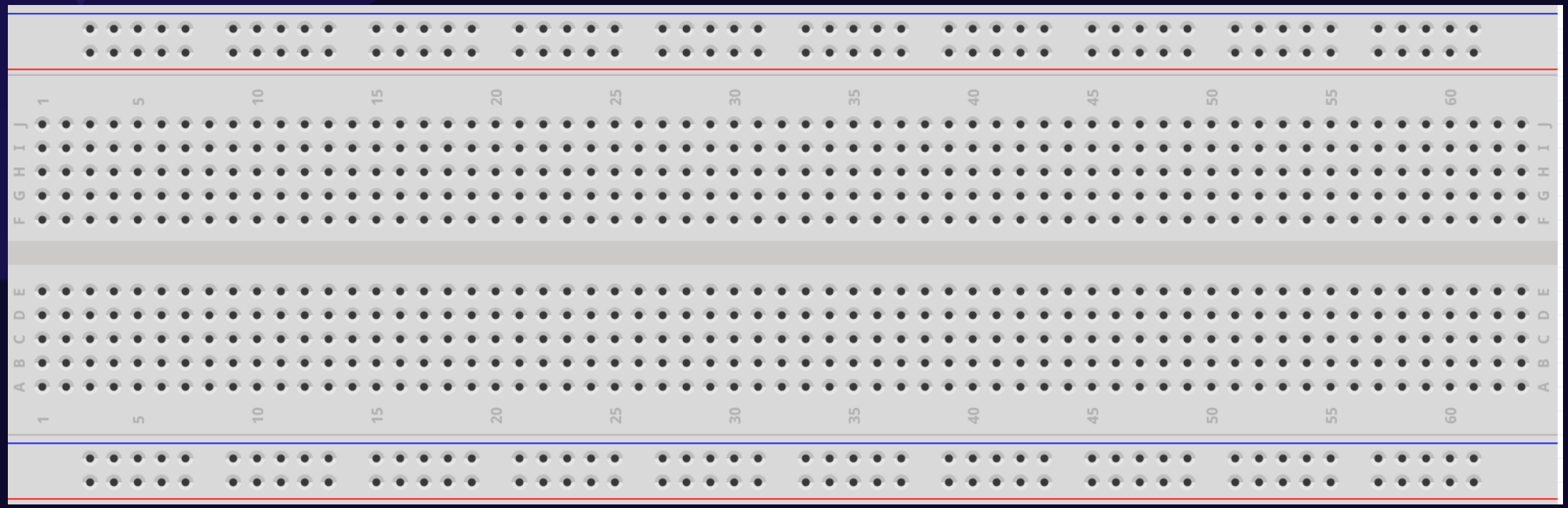
SPI (Serial Peripheral Interface)

Serial communication bus
Usually 3 wire communication

Let’s Build an Environment Monitor



The breadboard



The breadboard

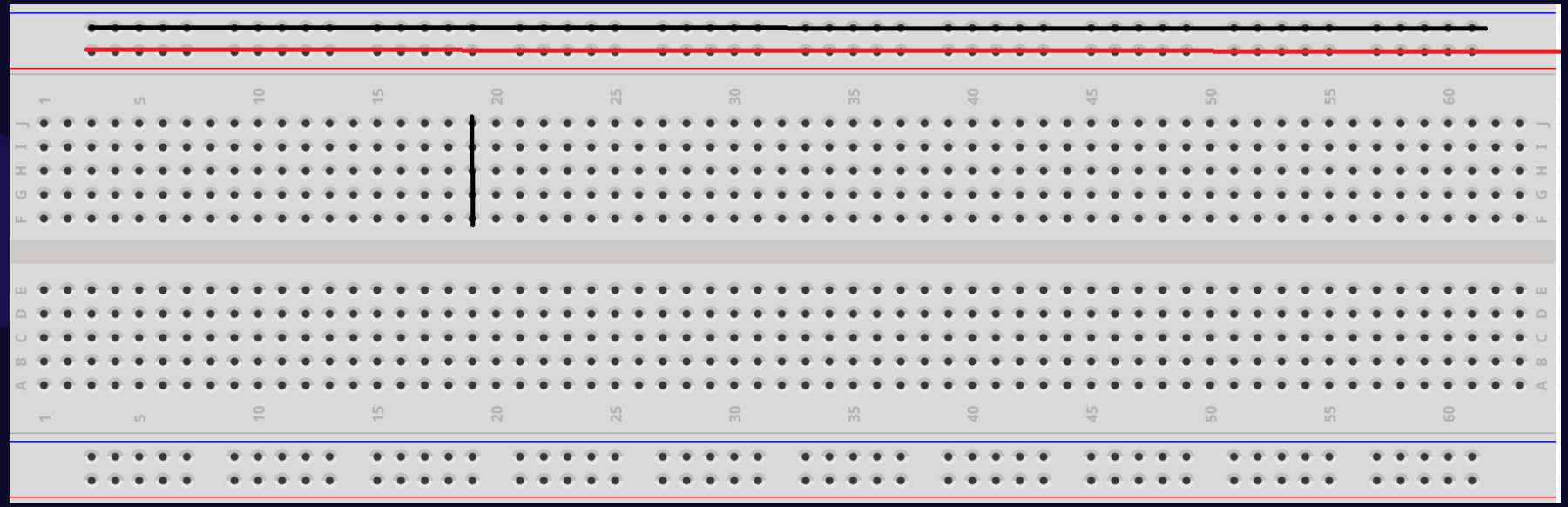
Pins Connected Horizontally

Pins connected vertically

Divider (splits board electrically)

Pins connected vertically

Pins Connected Horizontally

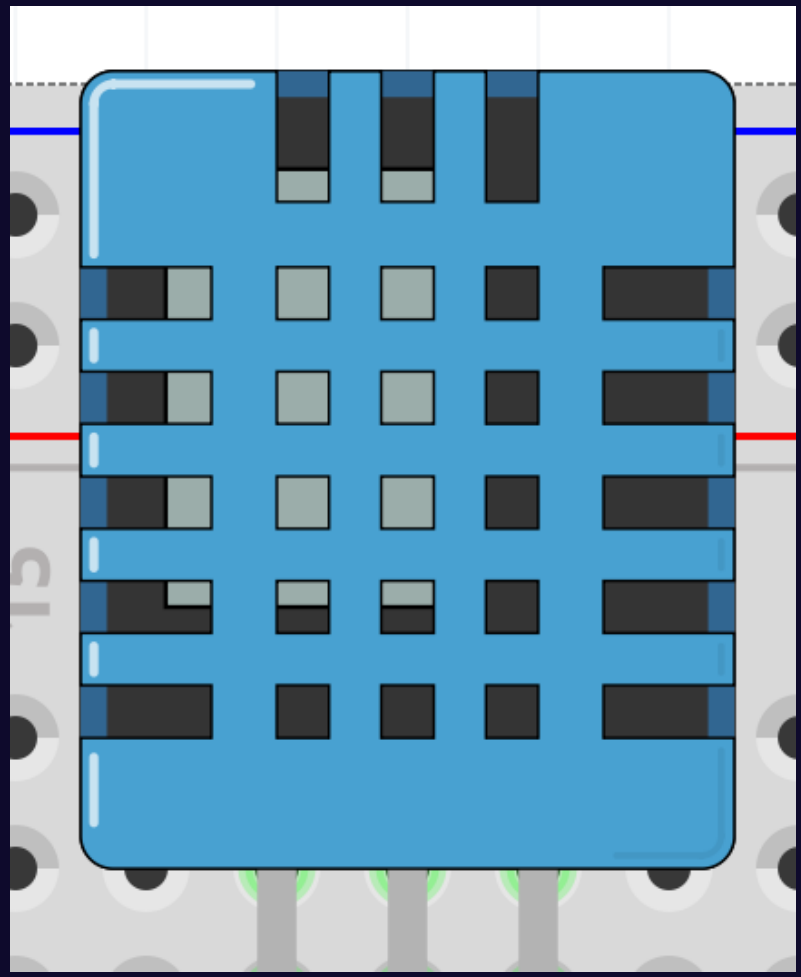


Used only for experimenting and prototyping

DHT 11

Temperature and humidity sensor

Serial Data



DHT 11

Pin 2 - Vcc

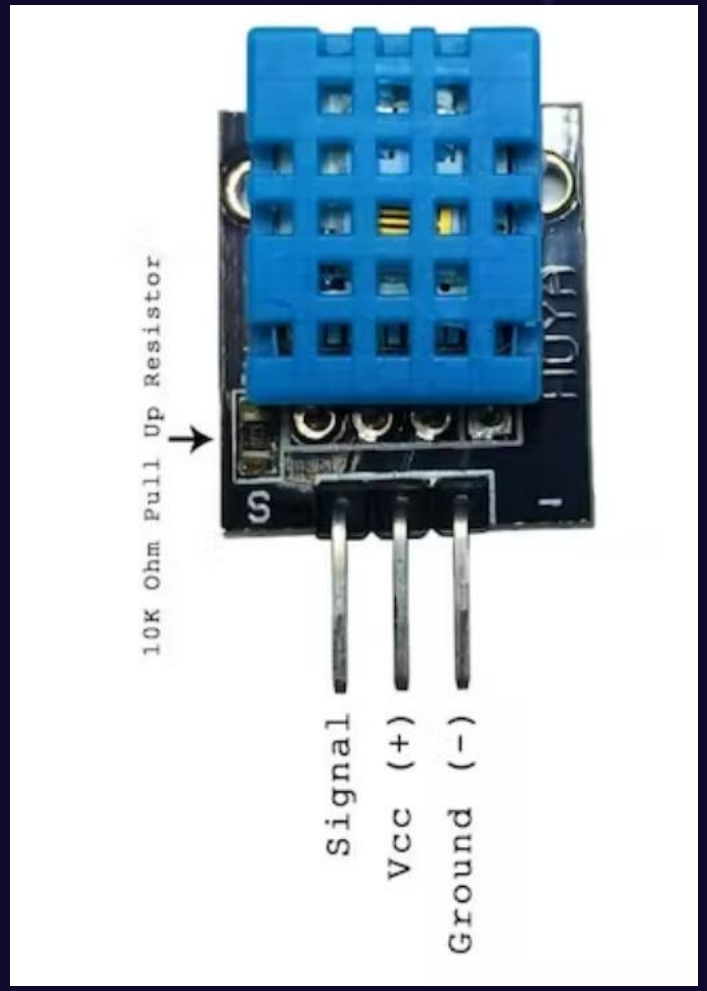
Power supply 3.5V to 5.5V

Pin 1 - Data

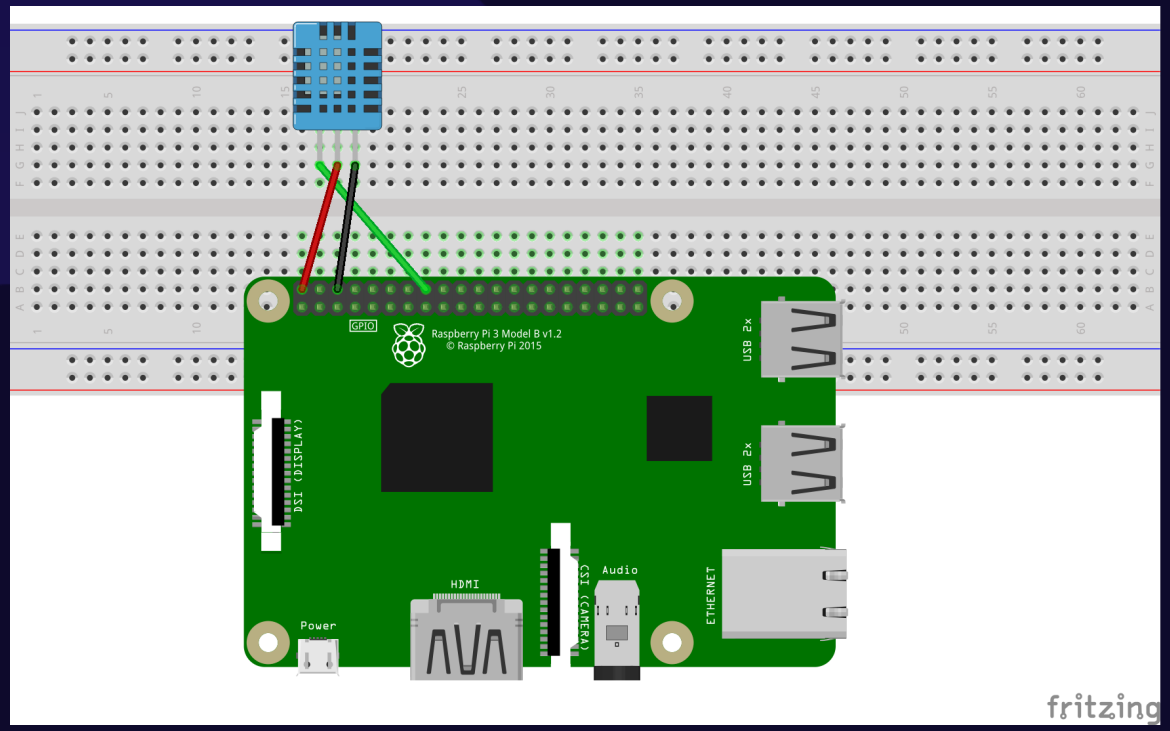
Outputs both Temperature and Humidity through serial Data

Pin 3 - Ground

Connected to the ground of the circuit



Try it out!



Using the component pack, build the circuit using your Raspberry Pi, breadboard, DHT11 and wires.

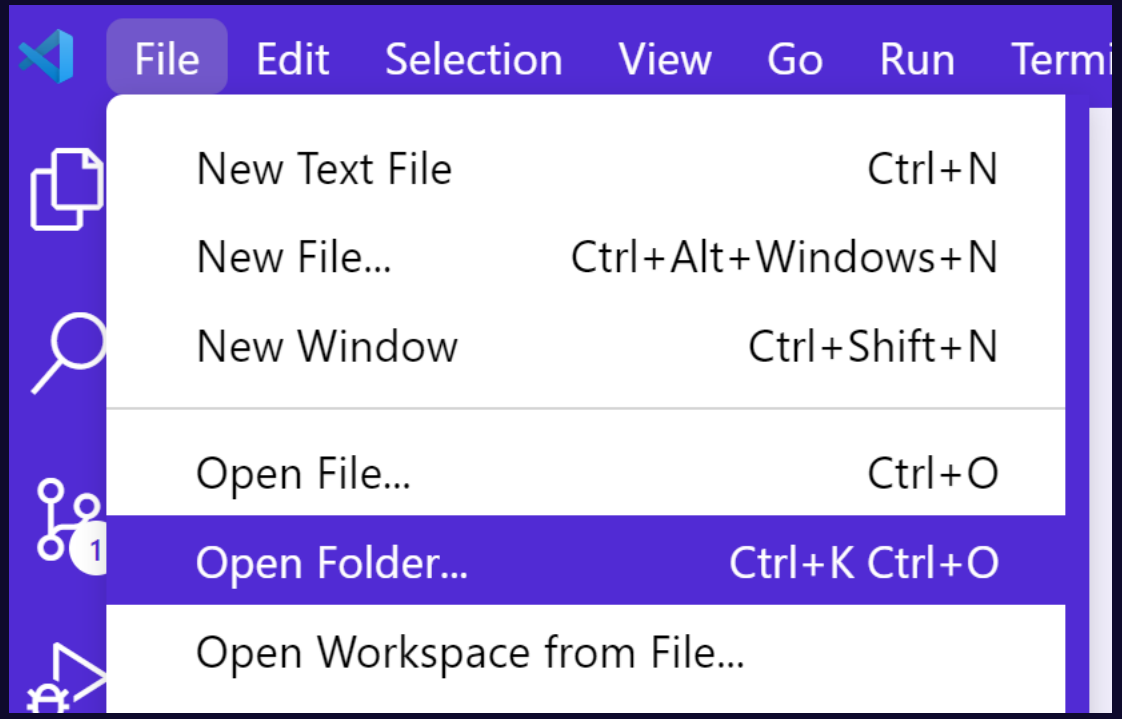
5V from the Raspberry Pi to the middle pin of the DHT 11 Sensor (VCC)

Ground from the Raspberry Pi to the right pin of the DHT Sensor (Ground)

GPIO Pin 23 from the Raspberry Pi to the left pin on the DHT Sensor (Data / Signal)

Try it out!

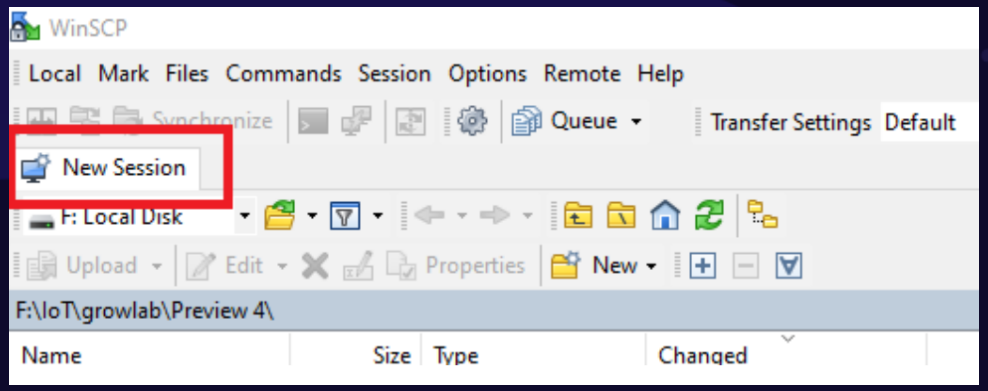
In VS Code open the folder SensorEnd from the code cloned from Github



Git clone https://github.com/CPTMSDUG/IoTHackDaysSession2DotNet

Ensure WinSCP is set up!

WinSCP



Try it out!!

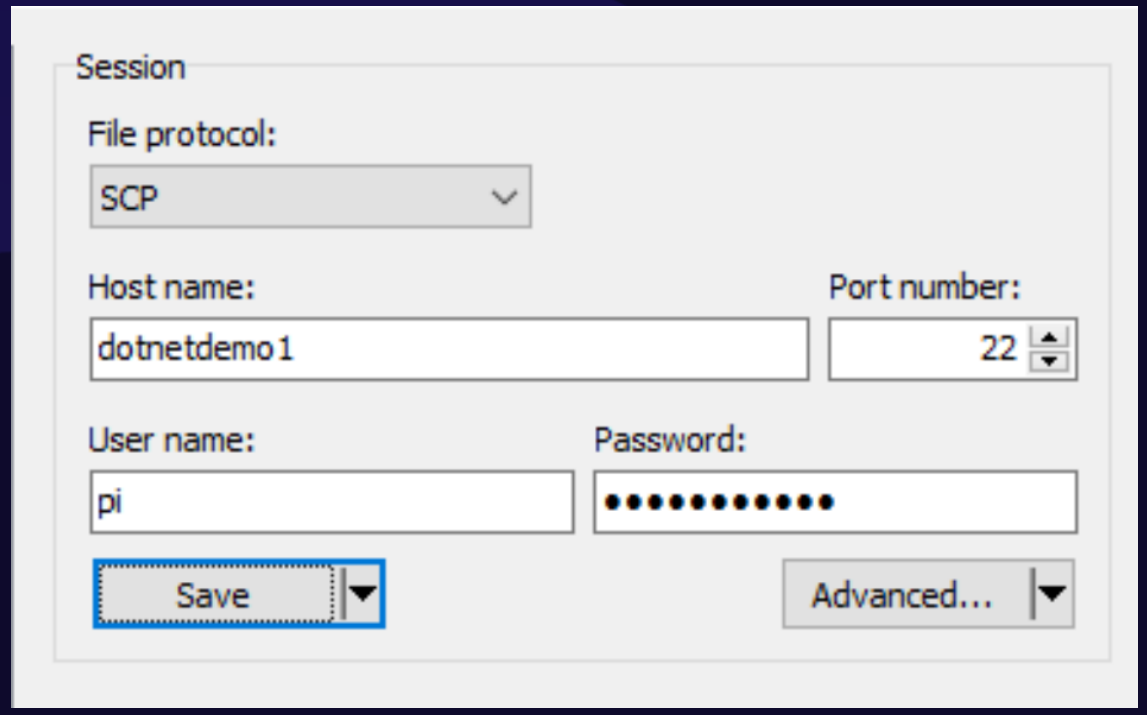
Switch your Raspberry PI on

Run WinSCP

Create New Session

Development Tools

WinSCP



Protocol SCP

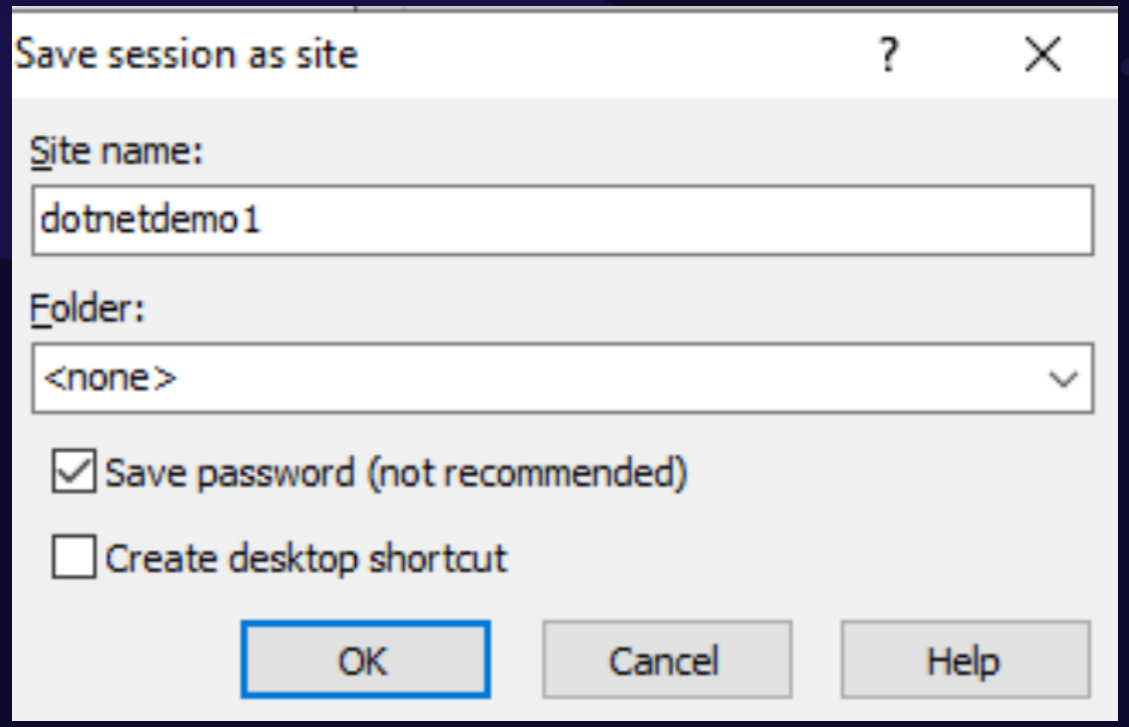
Host name: your ipaddress (on wired network use hostname – sticker on Pi)

Username: pi

Password: mxchip12345

Development Tools

WinSCP



Save

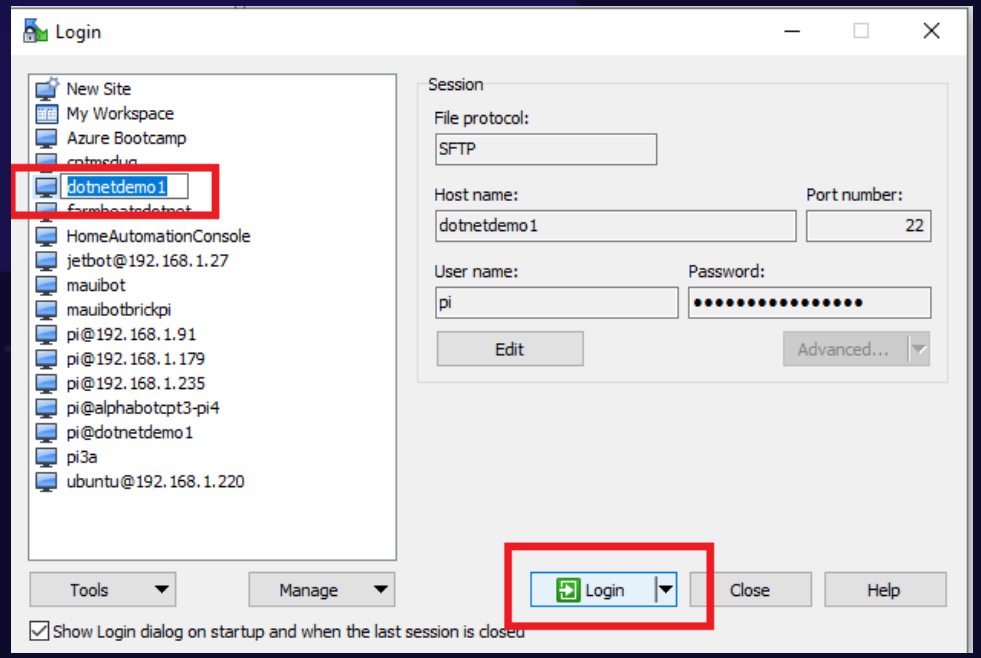
Site name: The name of your pi. Use the sticker on the pi, eg: E1163323

Save Password

Remember this name for the .env file (WinScpSite)

Development Tools

WinSCP



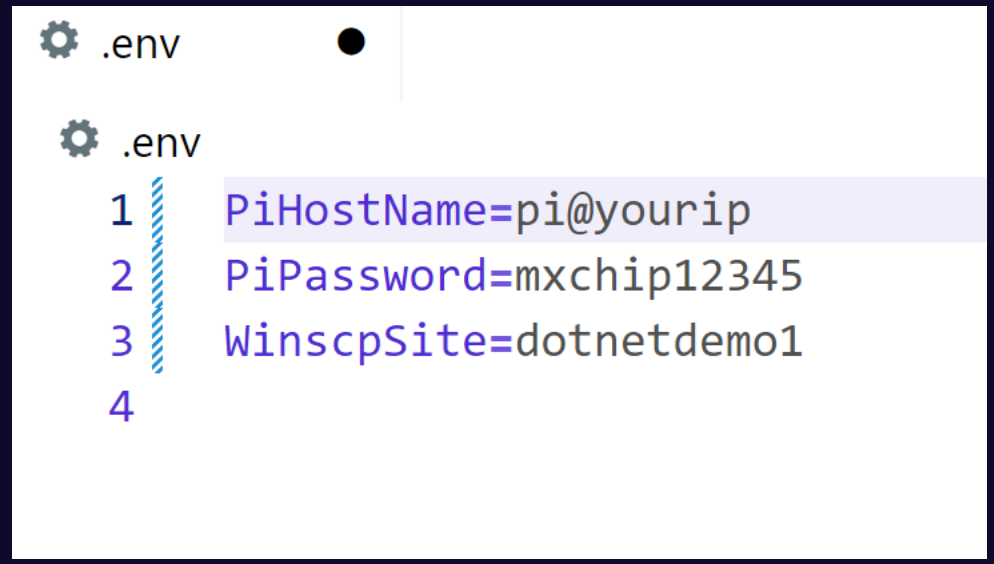
Login

Choose the name of your pi from the sites.

Click login

Try it out!

Don’t forget to edit the .env file with the details of your Raspberry Pi



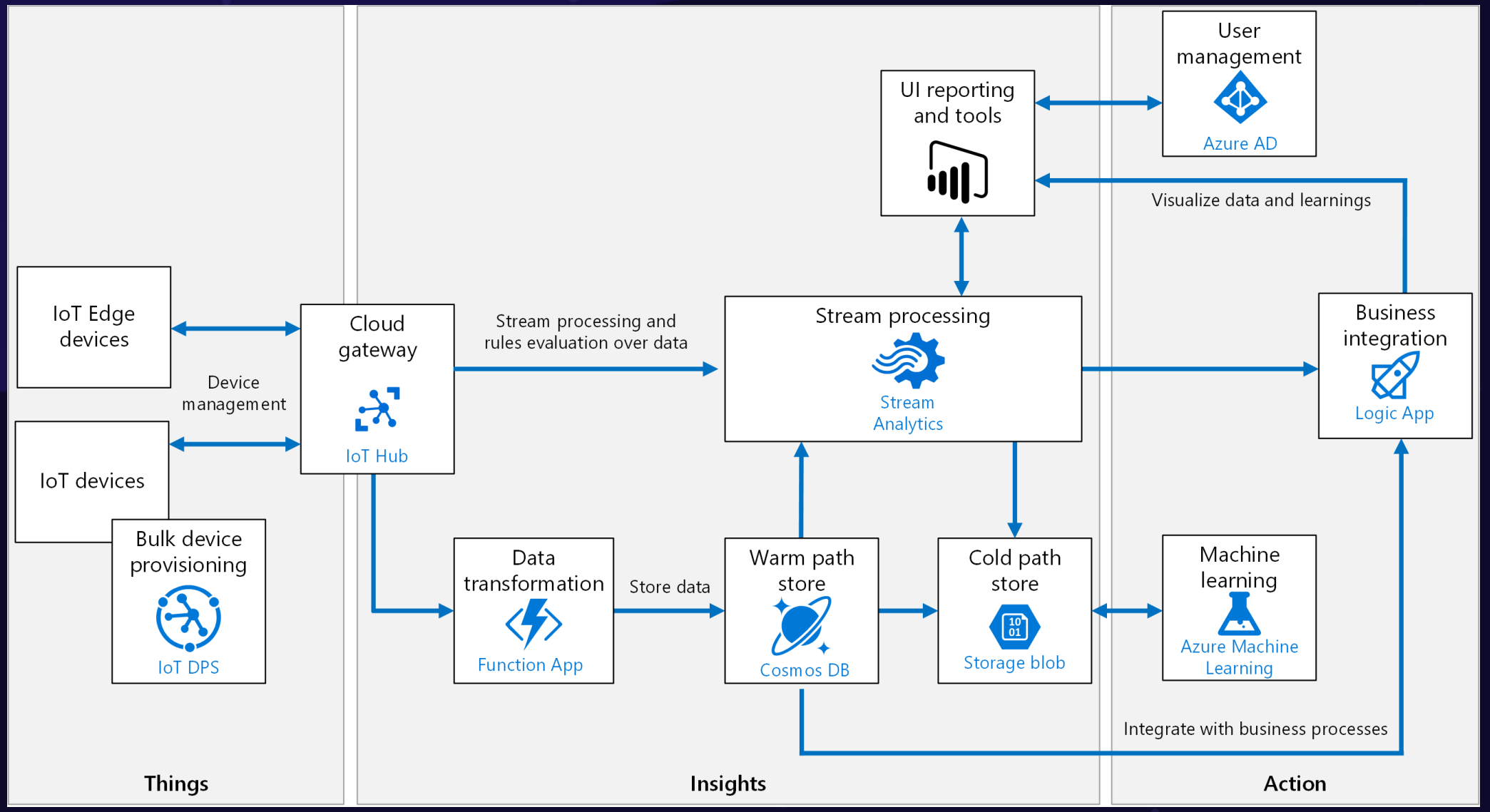
On wired network, use your host name
(the sticker on the Raspberry Pi)

Module 3

Azure IoT Central

Getting Started with Azure IoT with Azure IoT Central

Azure IoT Reference Architecture



IoT Solutions – IoT Central

Fast and easy

- Start in minutes and create a finished solution in hours
- Build without any cloud development expertise

Scalable and secure

- Connect your devices at any scale without worrying about infrastructure
- Get best-in-class security

Enterprise grade

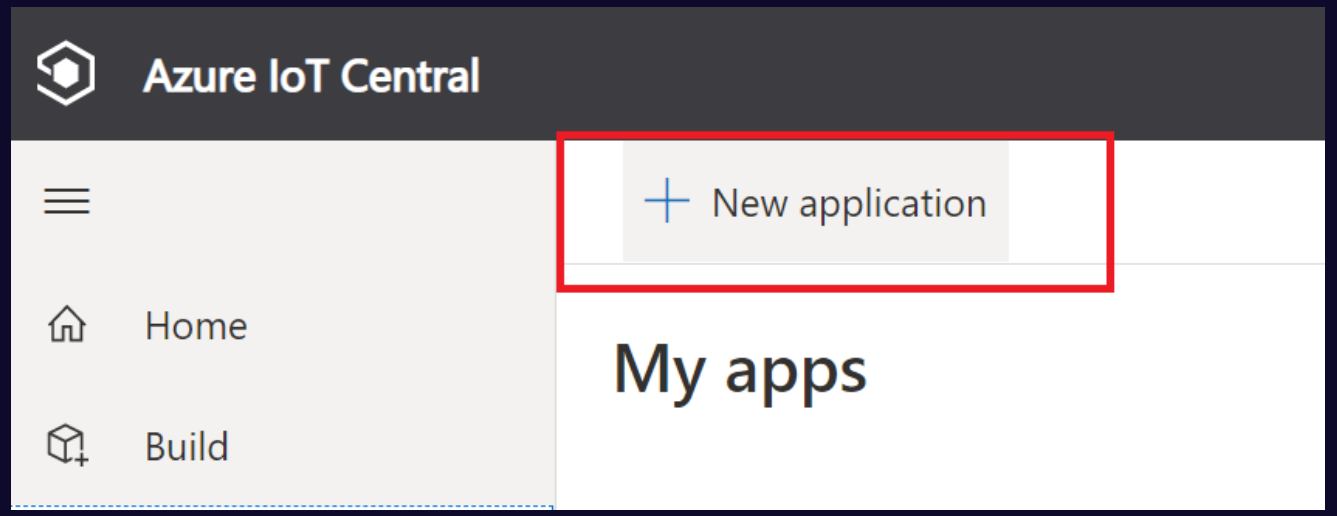
- Built on proven enterprise-grade Azure services
- Full integration into your existing business systems and processes

Try it Out!

Log into Azure IoT Central

https://apps.azureiotcentral.com/

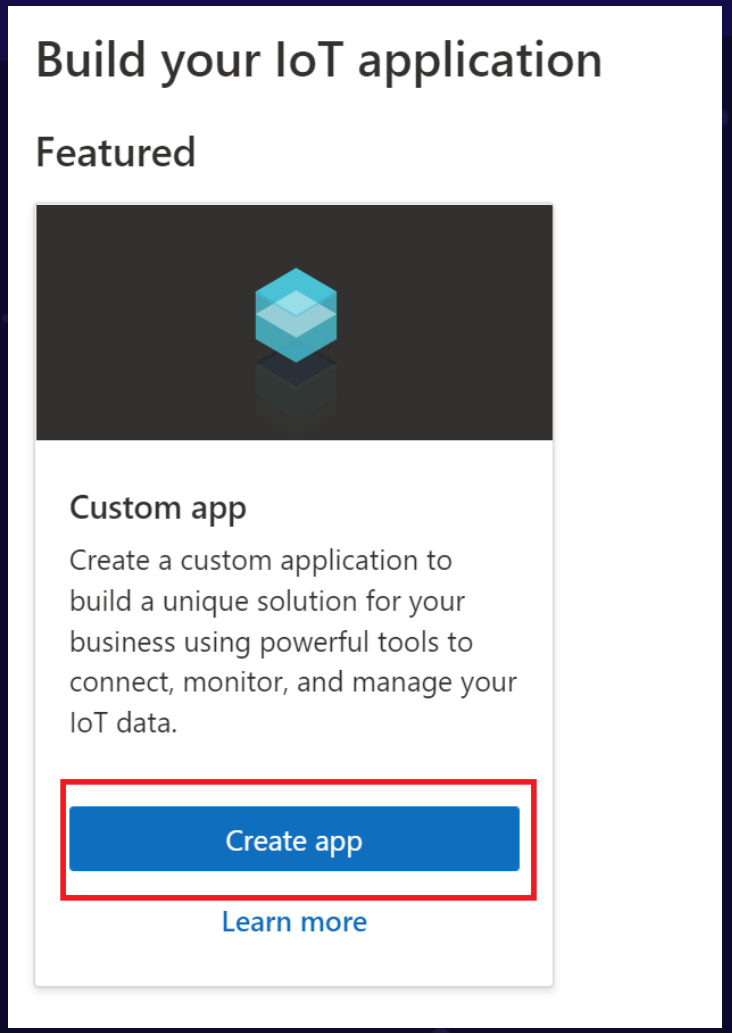
Create a New Application



This Requires an Azure Subscription!

Try it Out!

Create Custom App

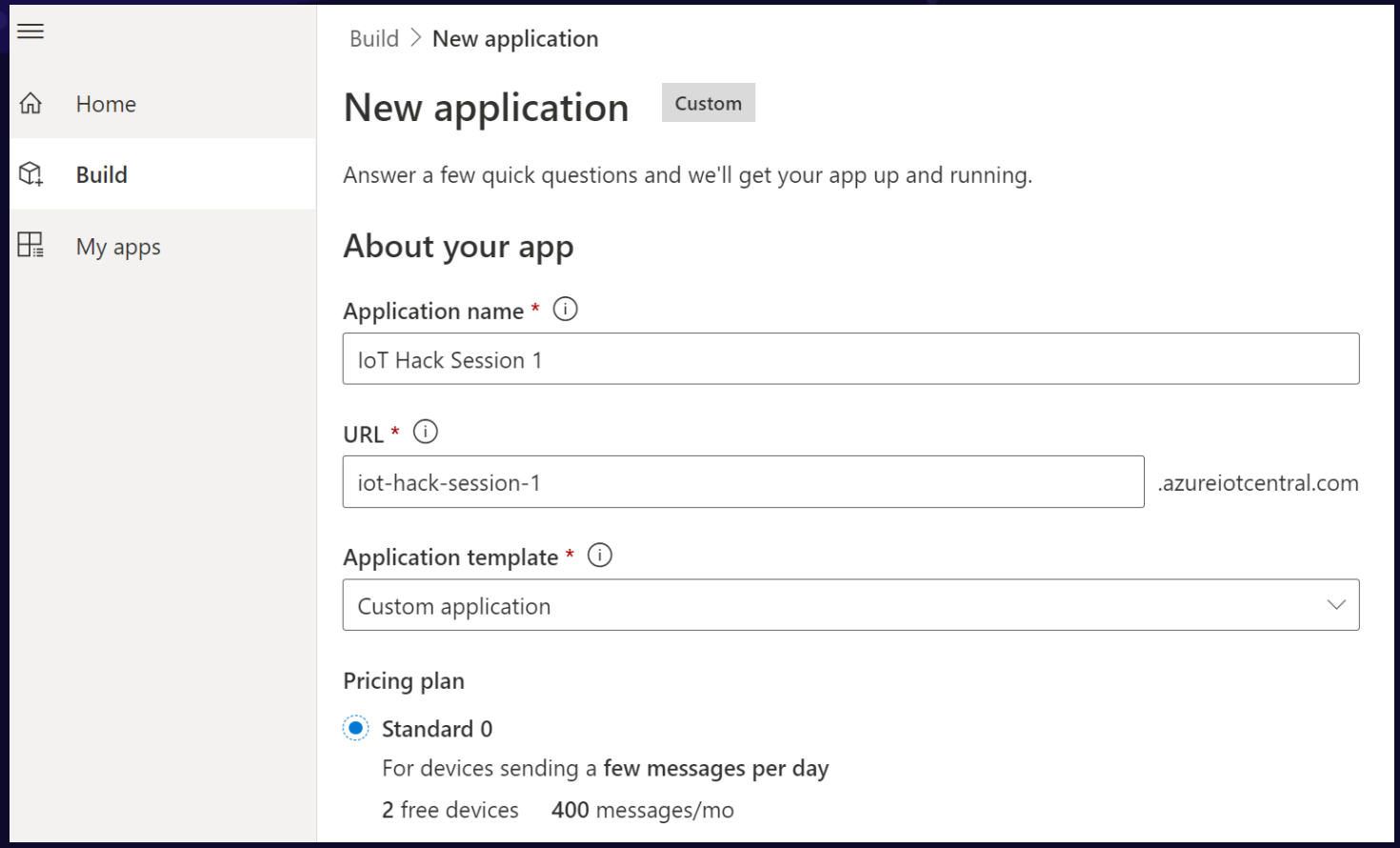


This Requires an Azure Subscription!

Try it Out!

Give your Application a Name

Chose the Standard 0 Price Plan (2 devices free)

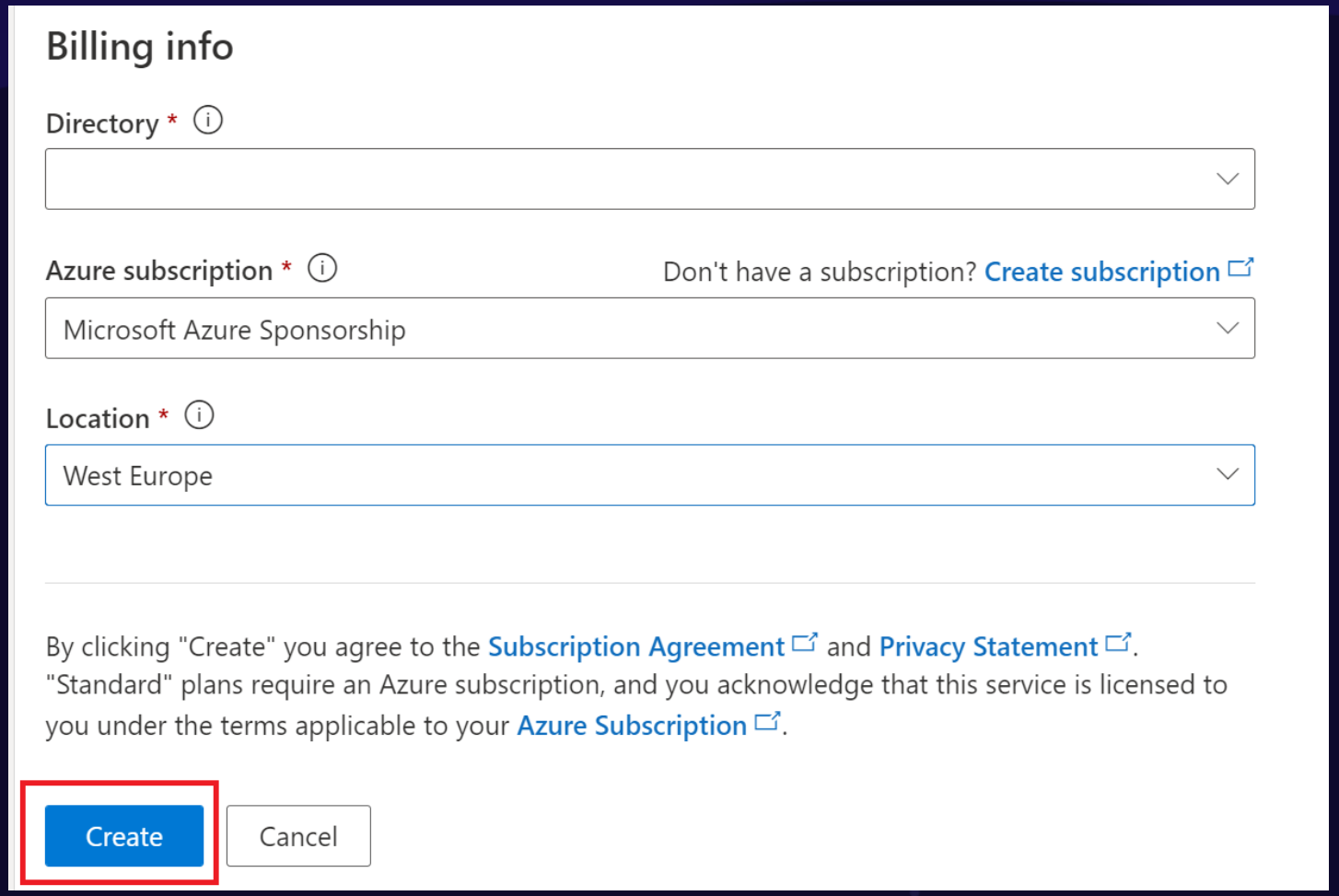


This Requires an Azure Subscription!

Try it Out!

Choose an Active Azure Subscription

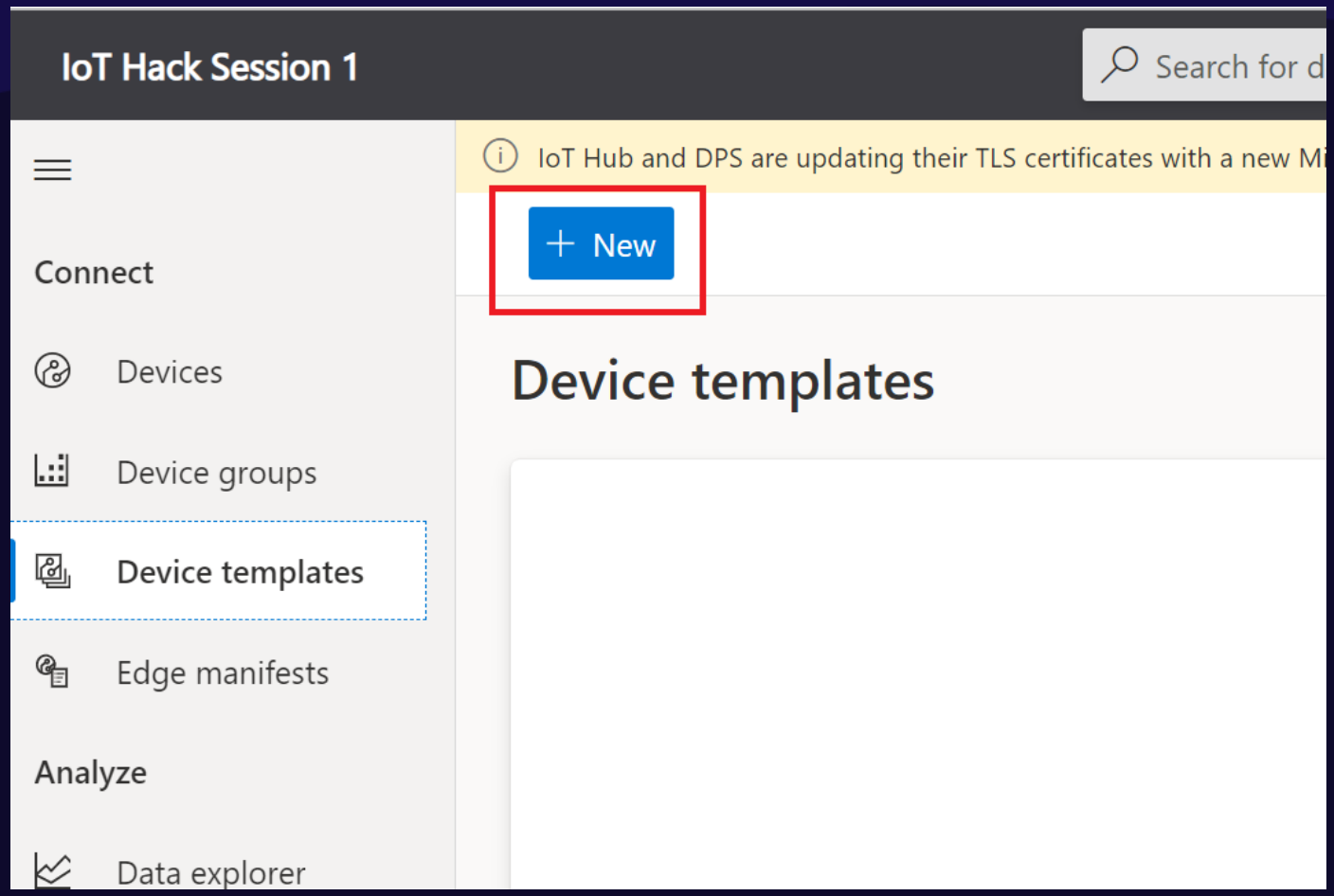
Create the Application



This Requires an Azure Subscription!

Try it Out!

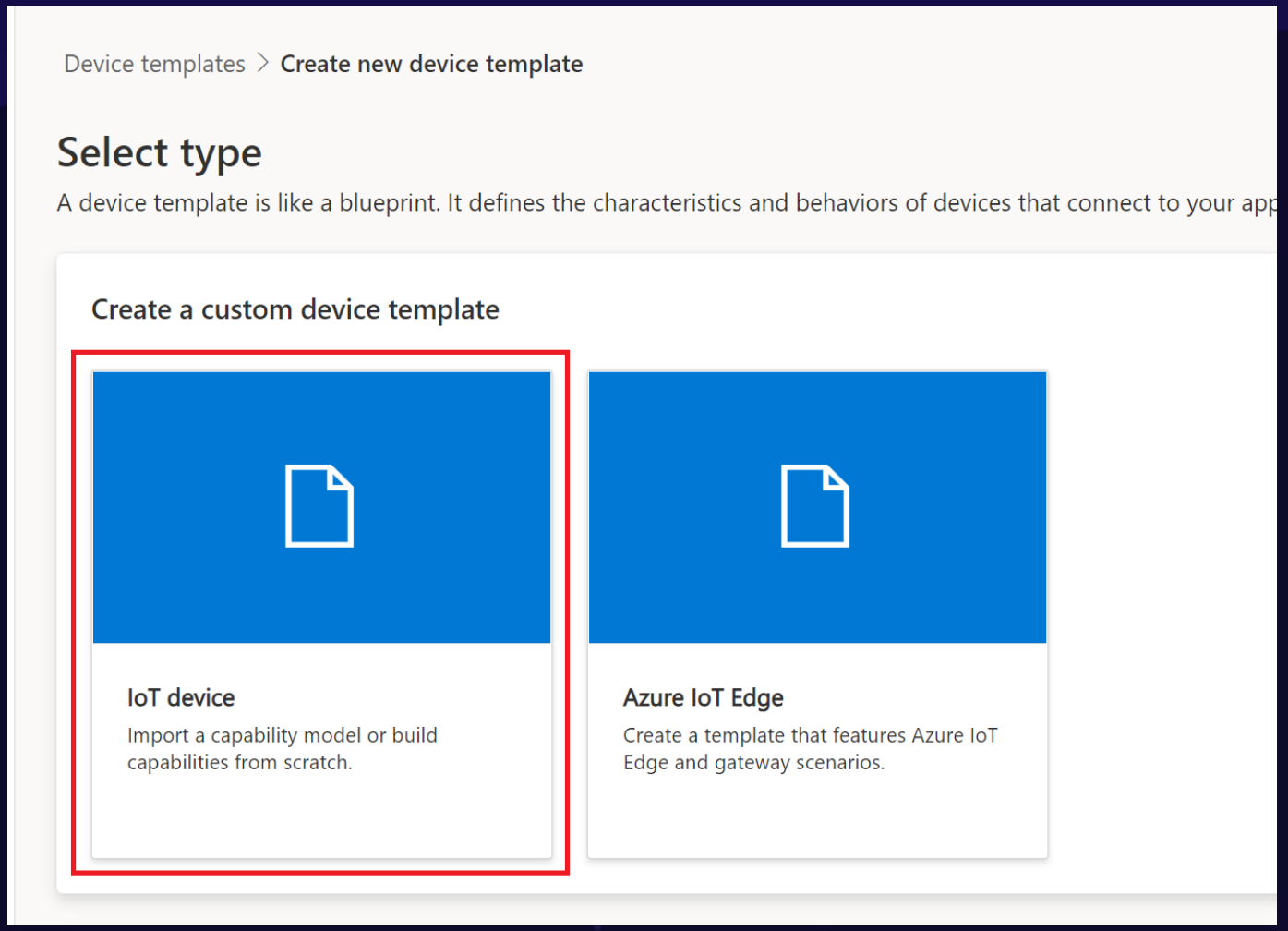
Create a Device Template



This Requires an Azure Subscription!

Try it Out!

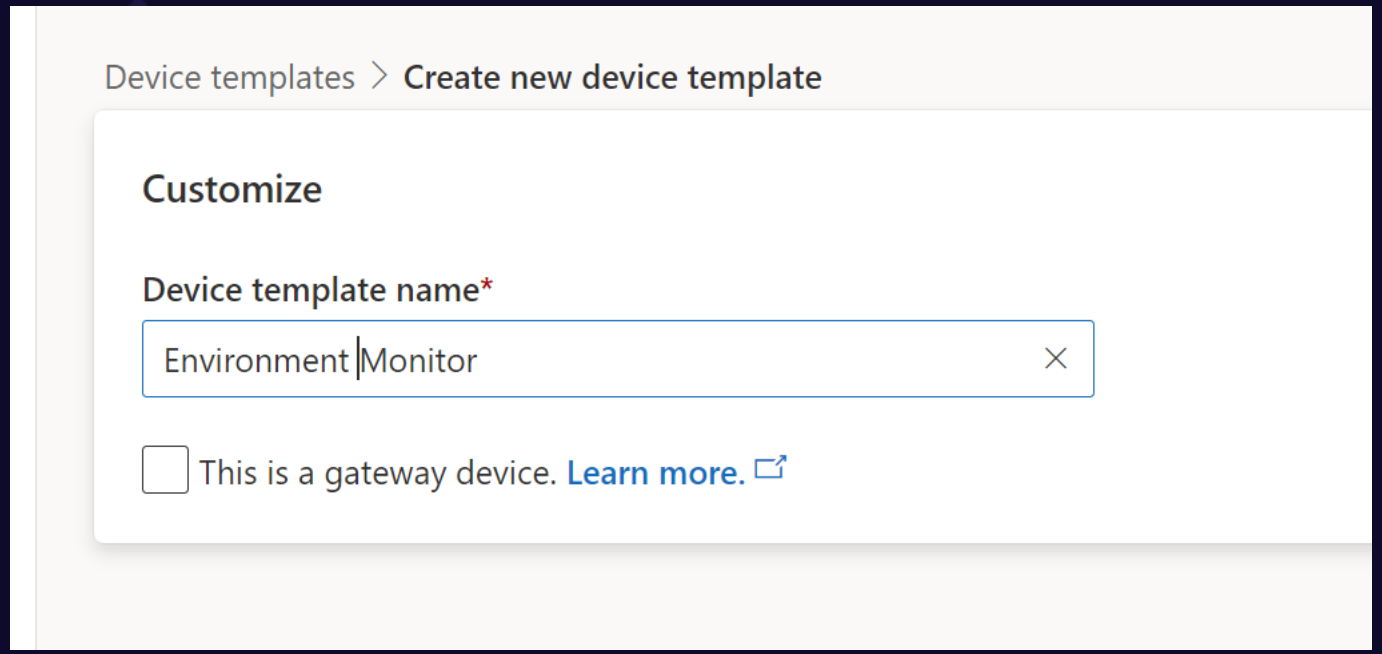
Select IoT Device



This Requires an Azure Subscription!

Try it Out!

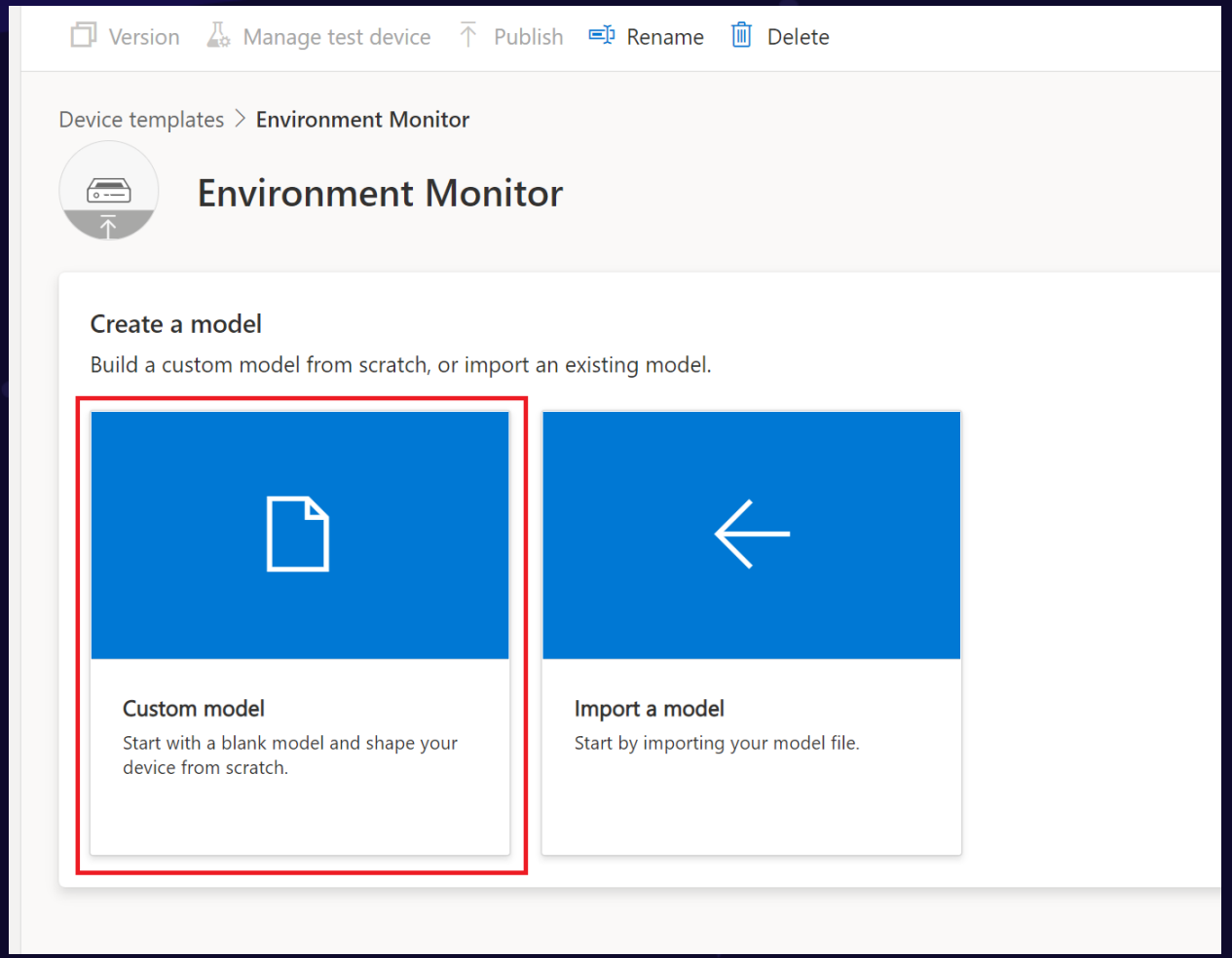
Provide the Template a name



This Requires an Azure Subscription!

Try it Out!

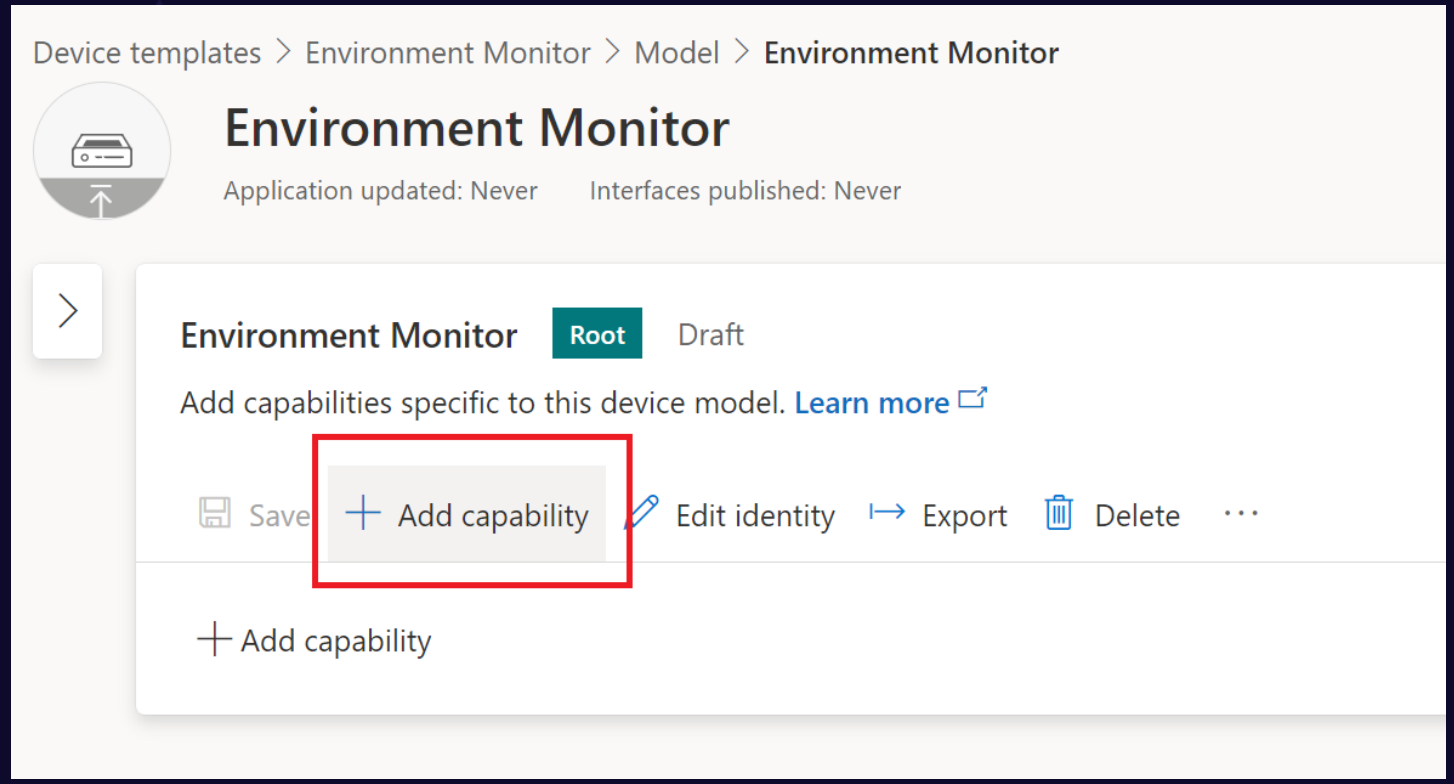
Create a Custom Model for the Device Template



This Requires an Azure Subscription!

Try it Out!

Add a Capability



This Requires an Azure Subscription!

Try it Out!

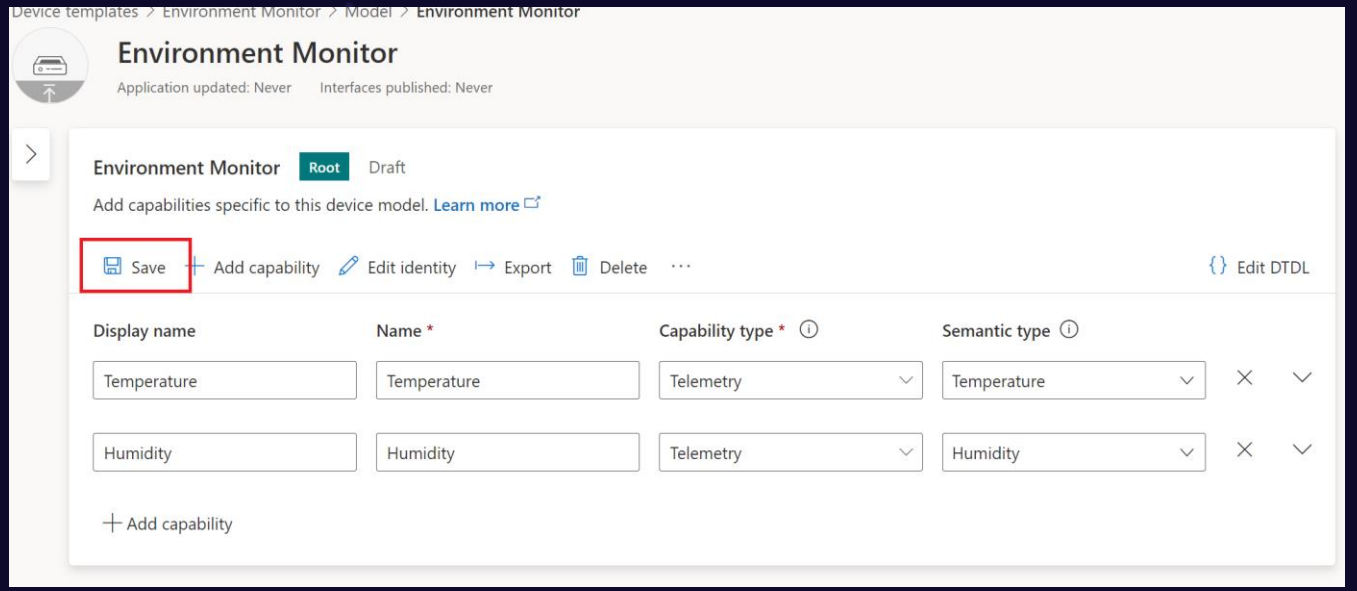
Add a Capability for Temperature

- Semantic Type Temperature

Add a Capability for Humidity

- Semantic Type Humidity

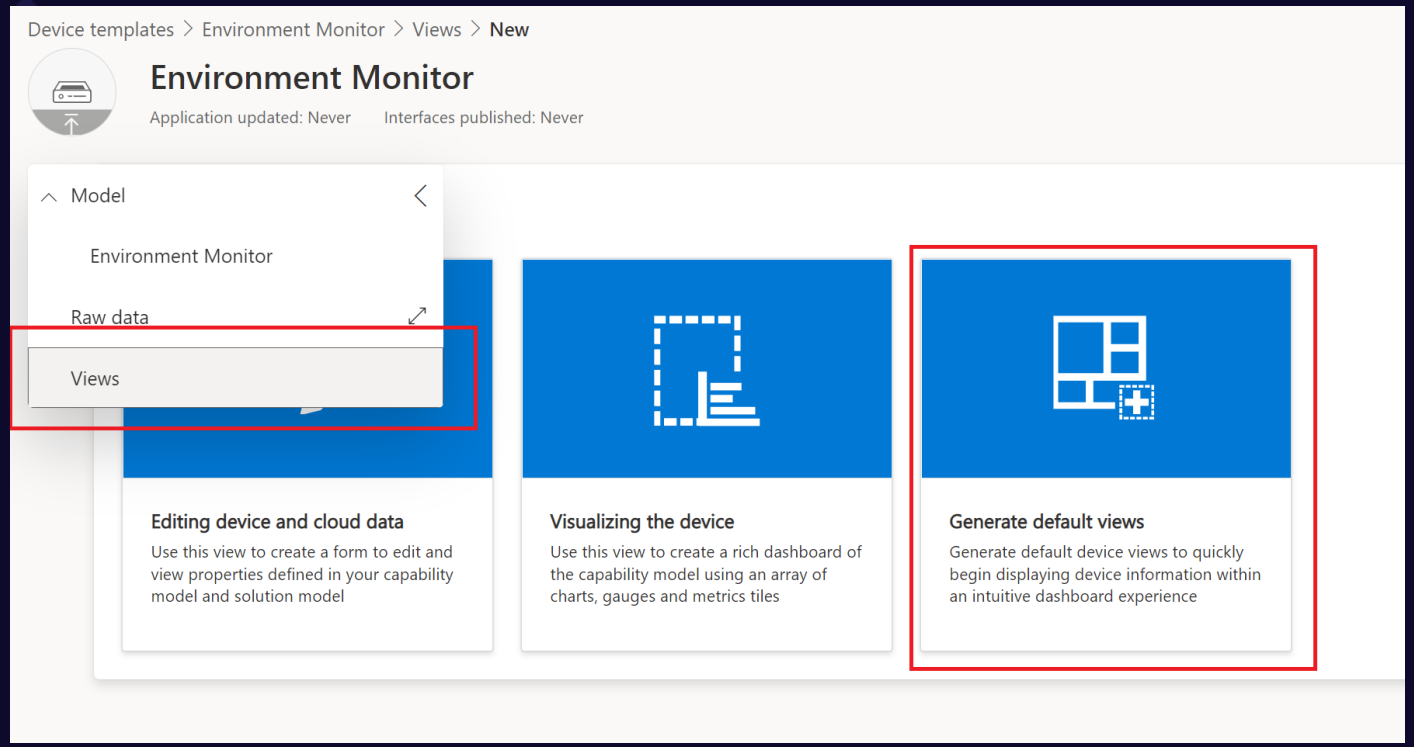
Make sure you Save



This Requires an Azure Subscription!

Try it Out!

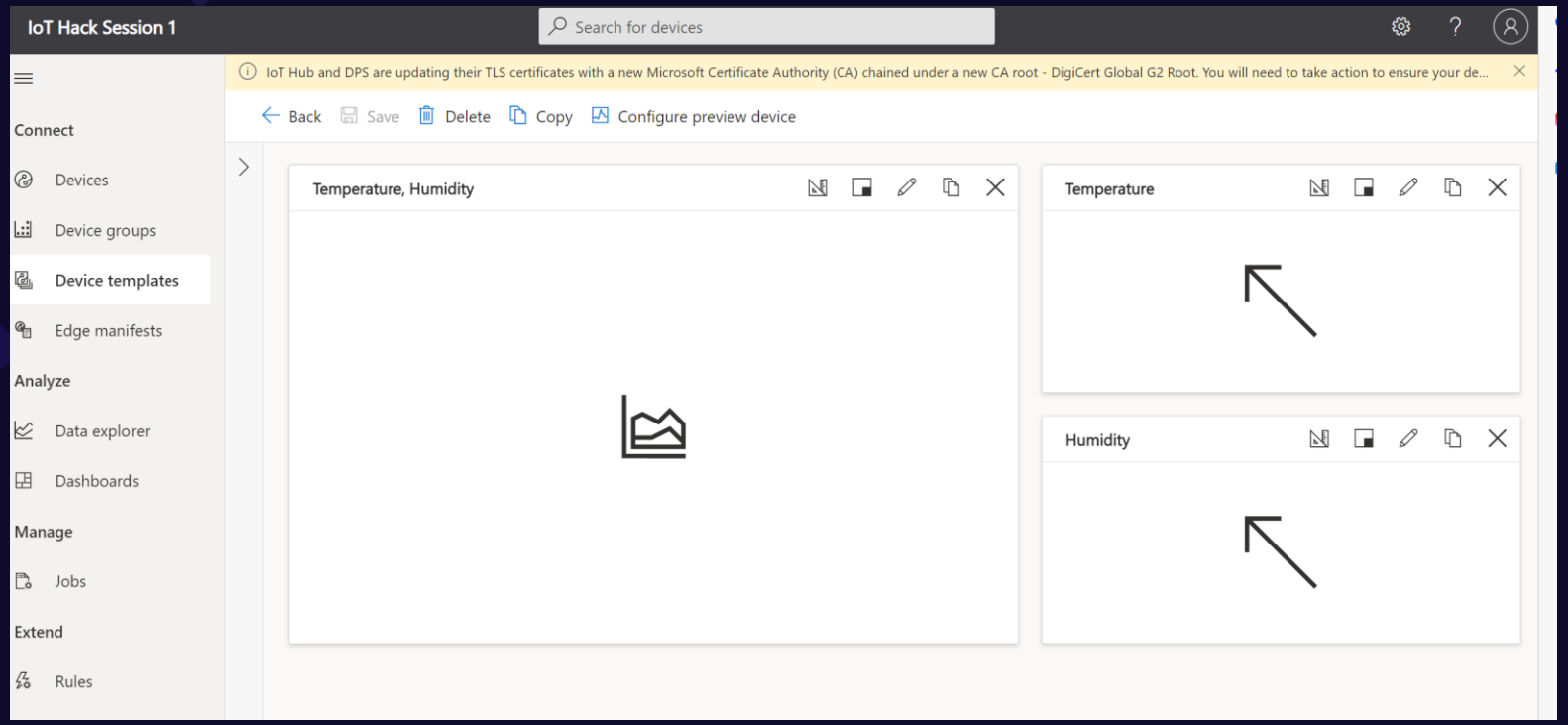
Auto-generate a view / dashboard from the model created.



This Requires an Azure Subscription!

Try it Out!

Generated Views

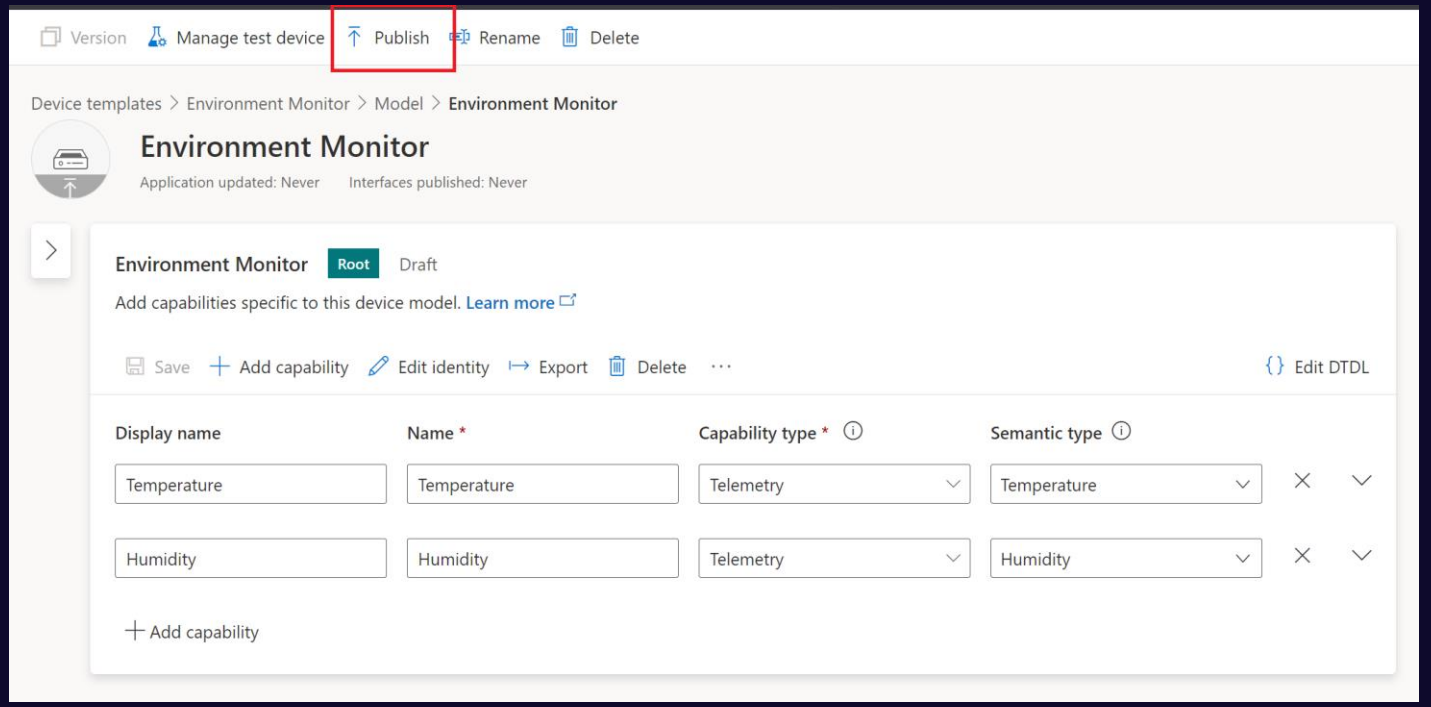


This Requires an Azure Subscription!

Try it Out!

Publish a version of the model

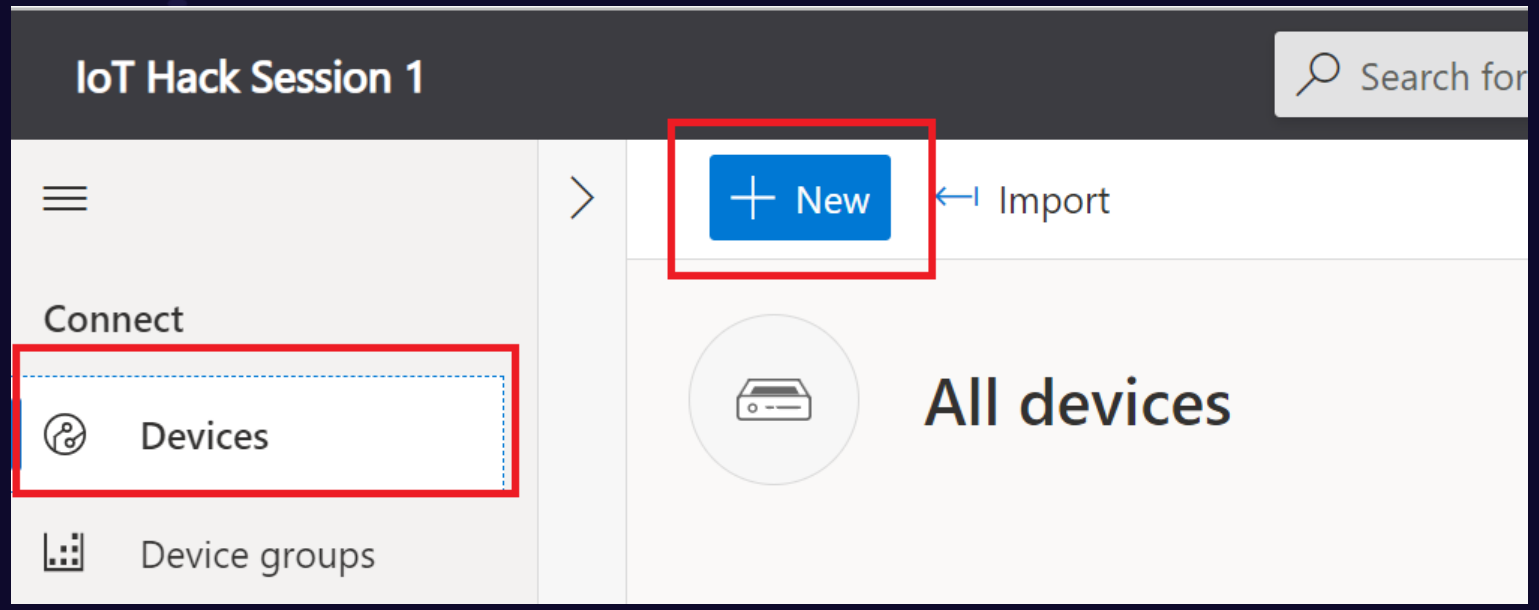
The versioned model can now be used as a device.



This Requires an Azure Subscription!

Try it Out!

Now create an instance of a device based on the model created



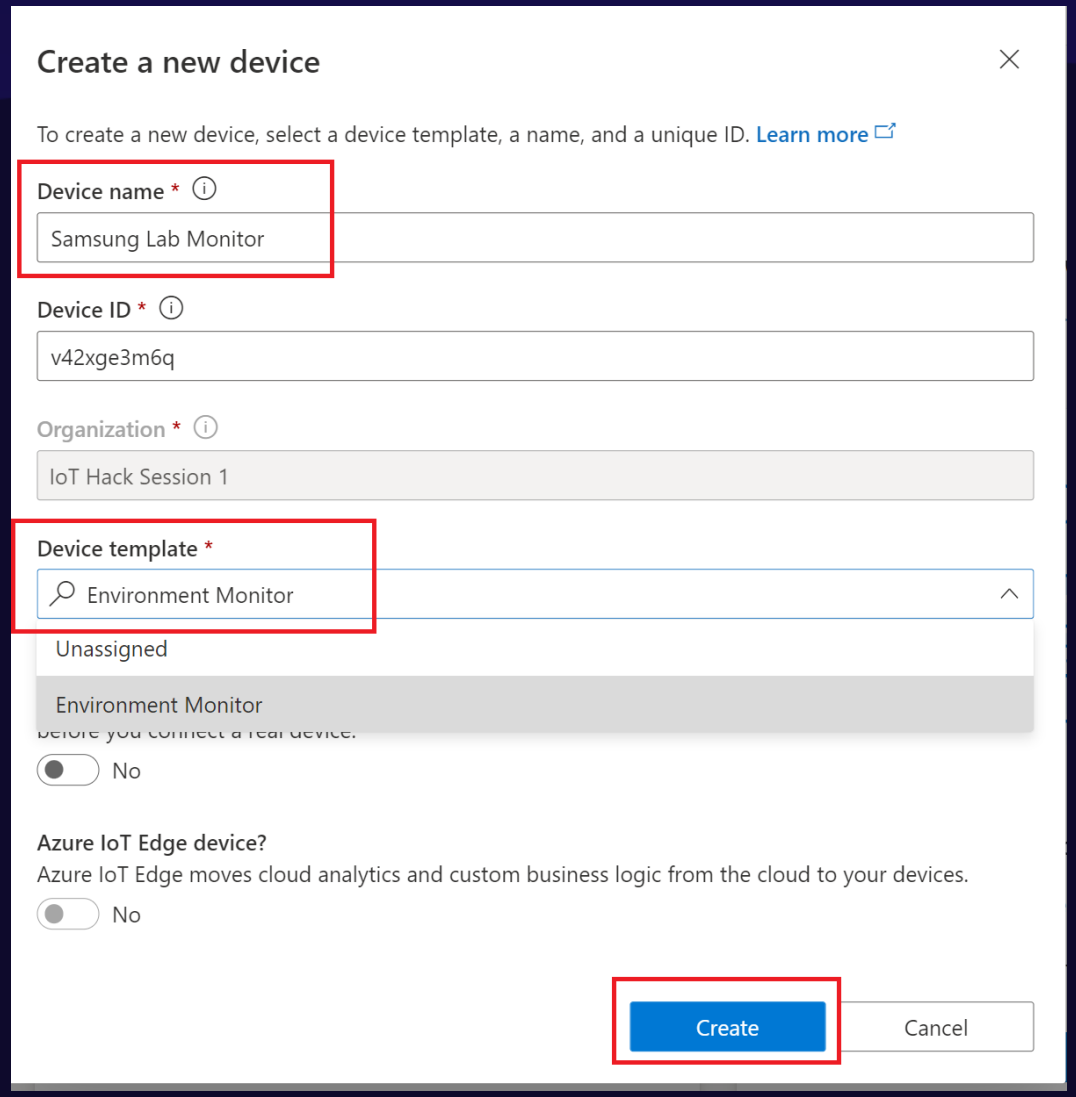
This Requires an Azure Subscription!

Try it Out!

Give the device a name

Assigned the previously created device template to this instance of the device

Create the Device

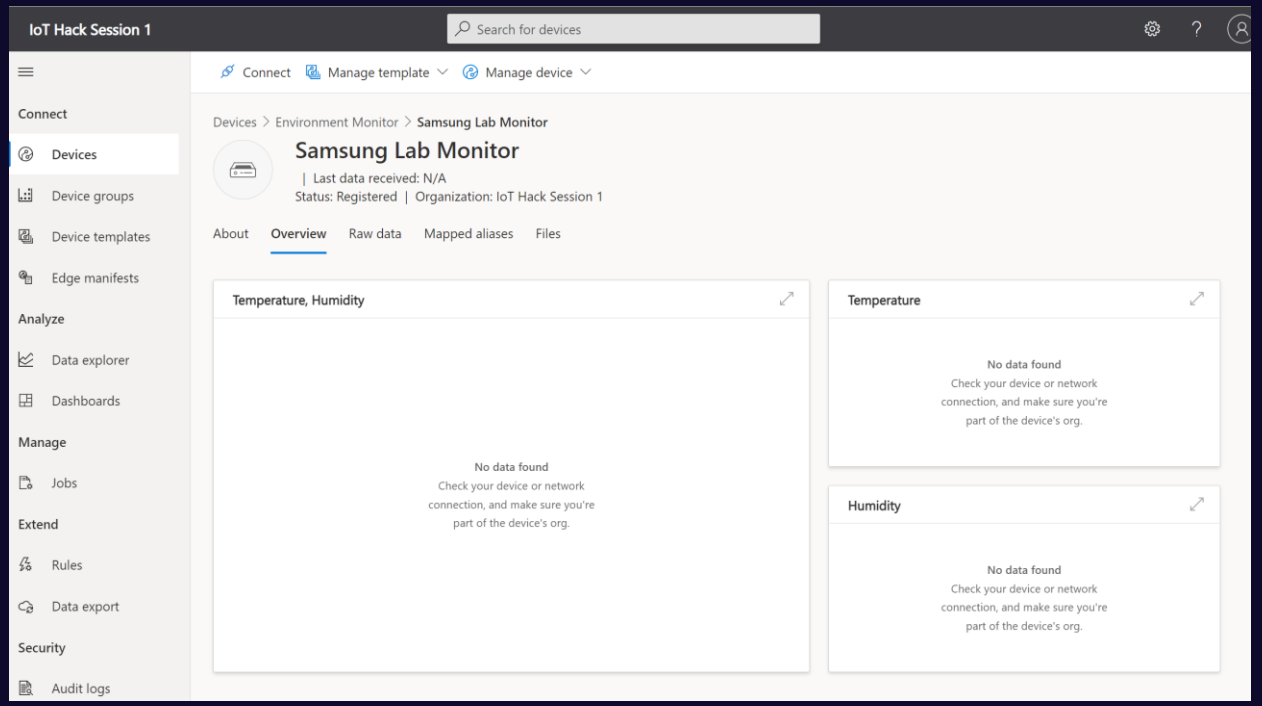


This Requires an Azure Subscription!

Try it Out!

The device has been created in Azure IoT Central.

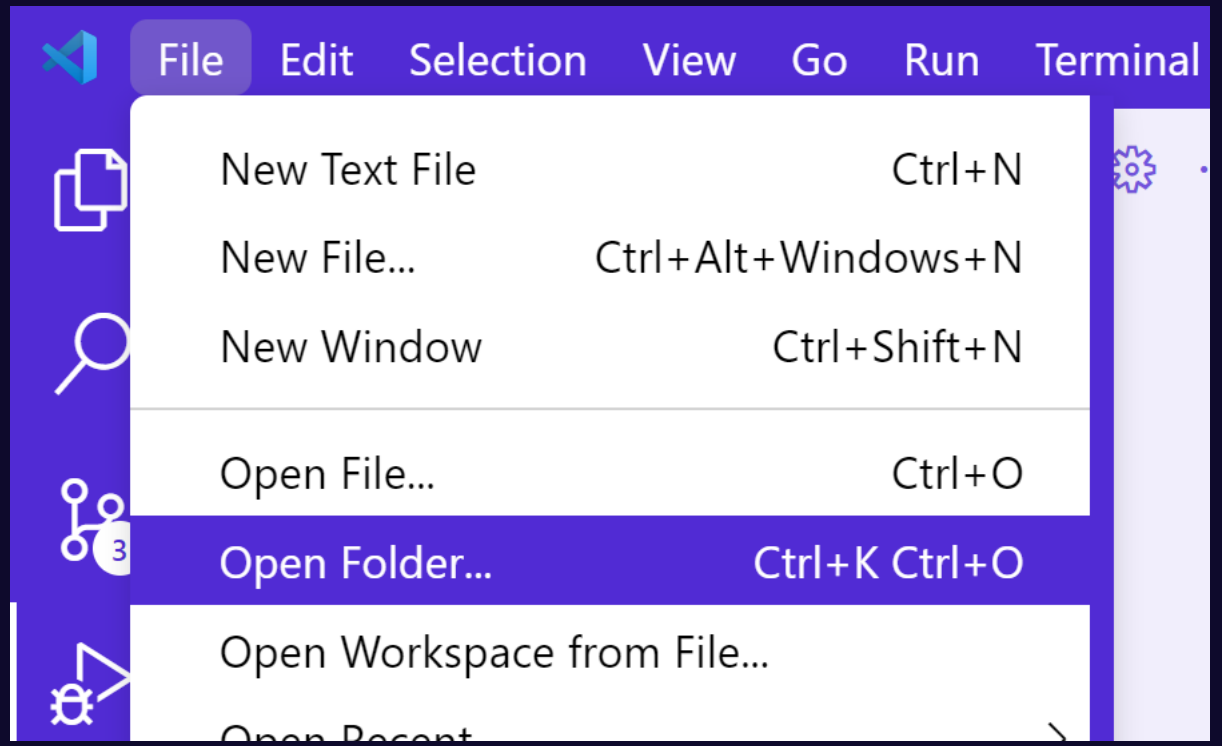
Now lets send it some telemetry from our DHT 11 sensor and Raspberry Pi



This Requires an Azure Subscription!

Try it Out!

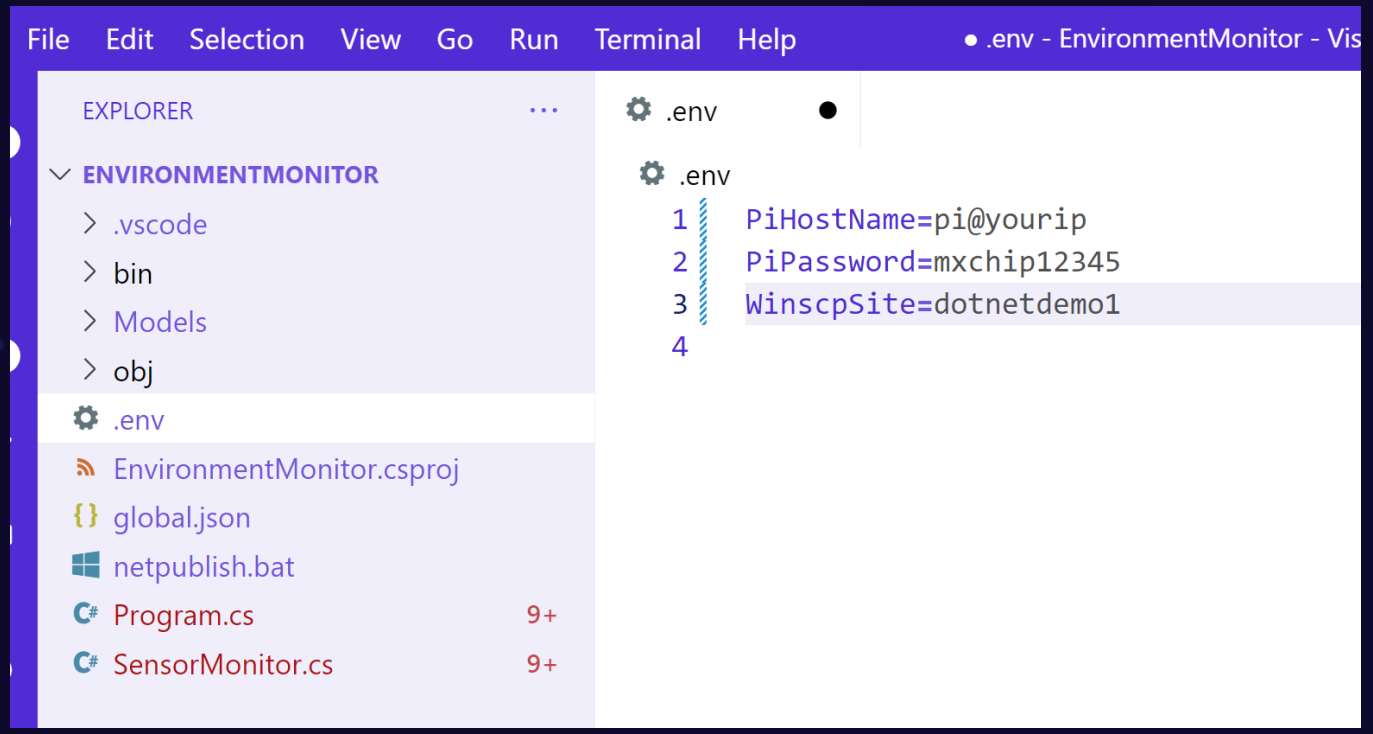
Open the Environment Monitor folder in Visual Studio Code



This Requires an Azure Subscription!

Try it Out!

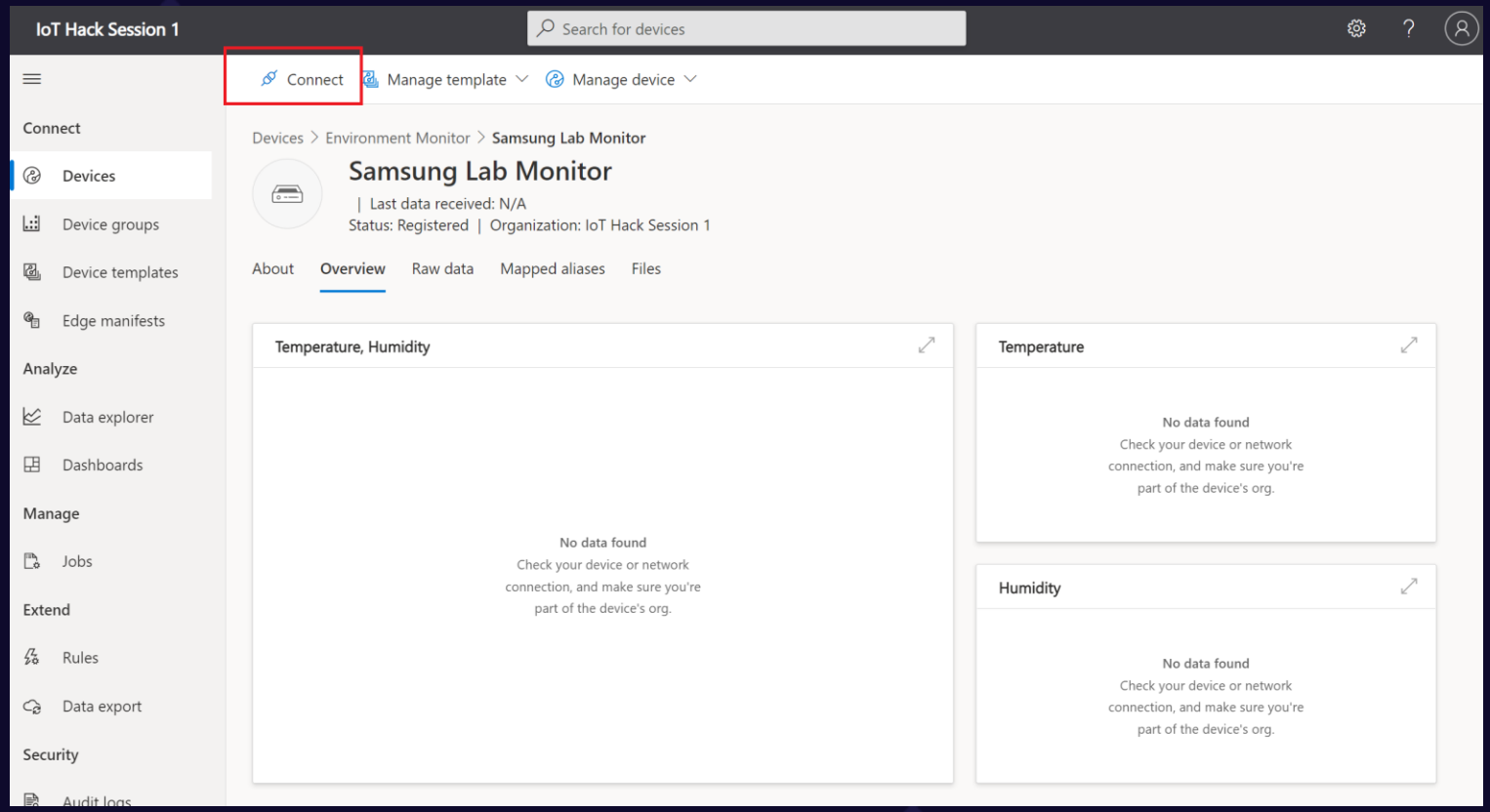
Configure the .env file with your Raspberry Pi's details



This Requires an Azure Subscription!

Try it Out!

Within IoT Central select the device and press the “Connect” button.

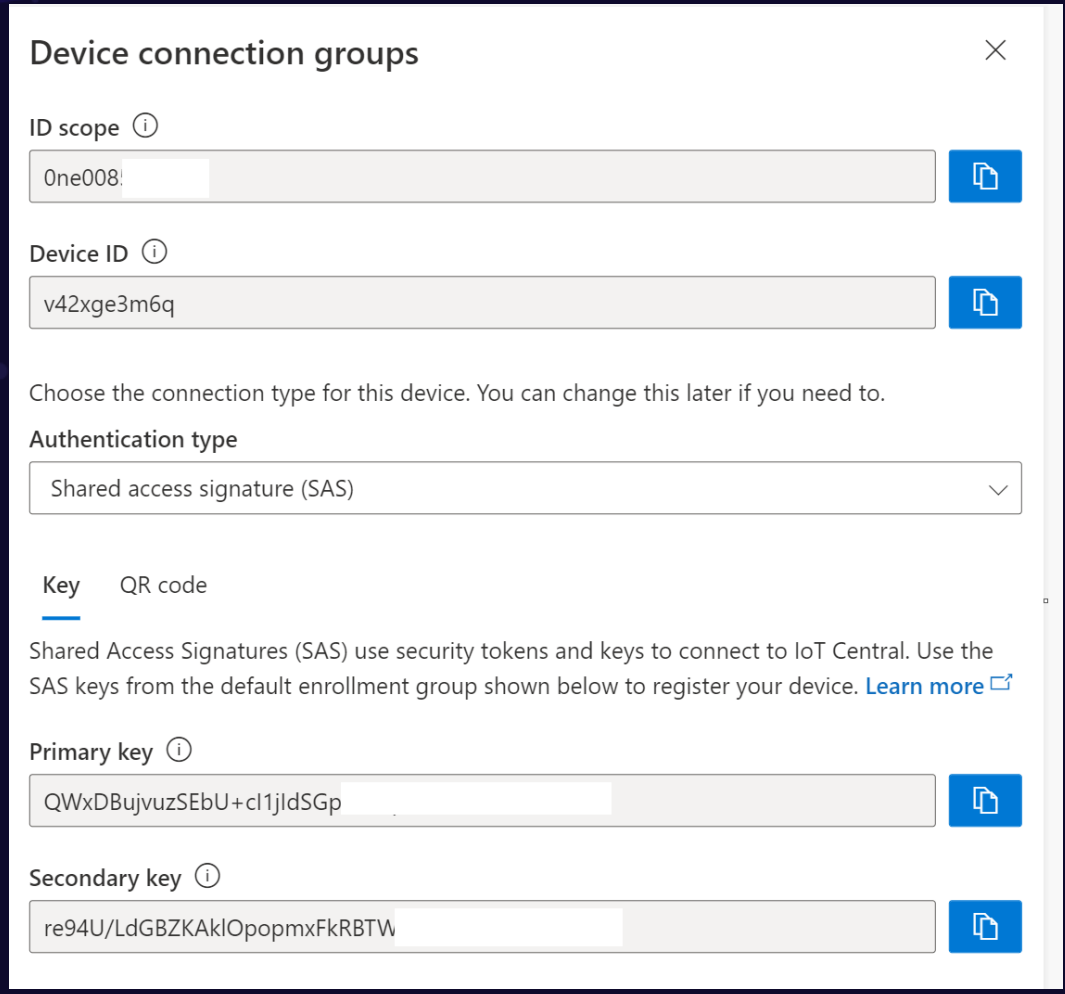


This Requires an Azure Subscription!

Try it Out!

Take note of the:

ID Scope
Device ID
Primary Key

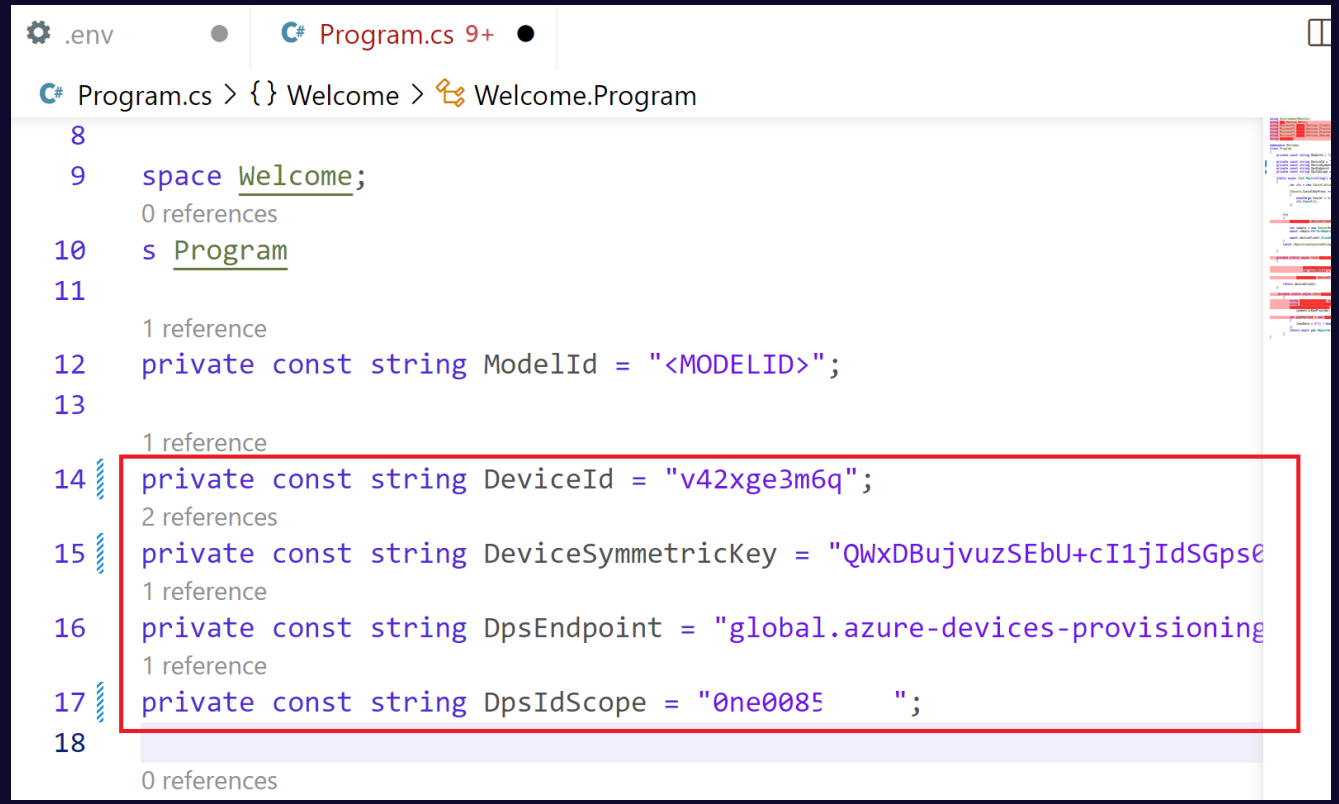


This Requires an Azure Subscription!

Try it Out!

In Visual Studio Code fill in the Programs.cs file

ID Scope -> DpsIdScope
Device ID -> DeviceId
Primary Key -> DeviceSymmetricKey

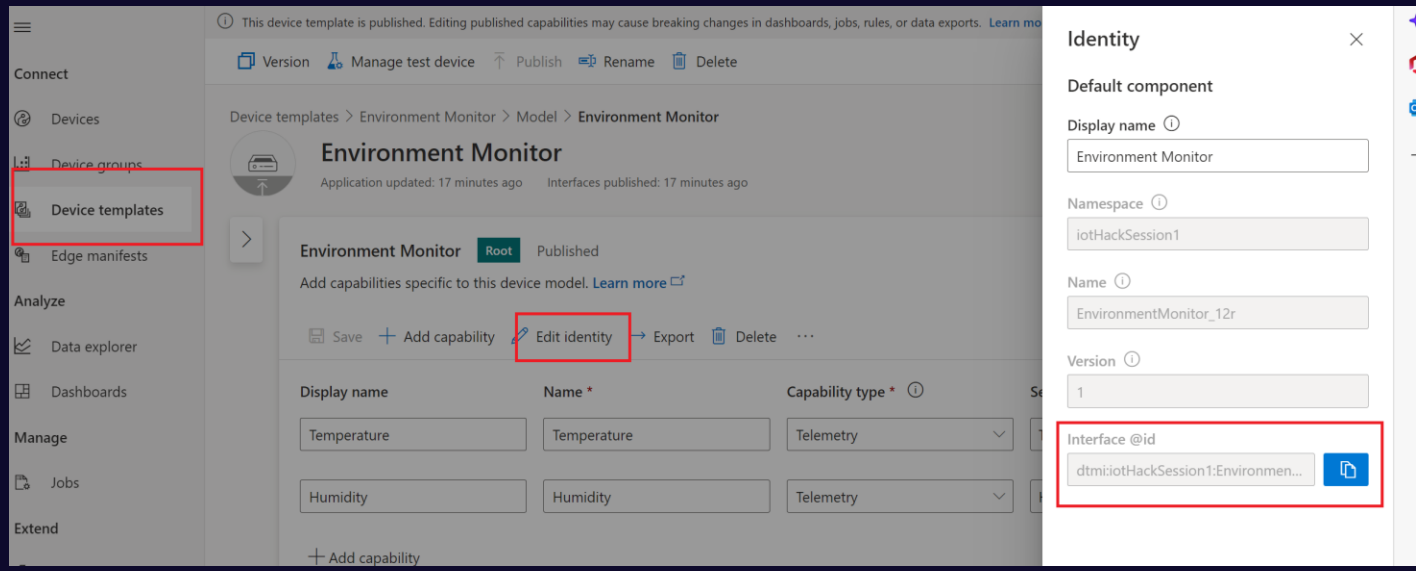


This Requires an Azure Subscription!

Try it Out!

Within IoT Central take note of the

Interface @id



This Requires an Azure Subscription!

Try it Out!

In Visual Studio Code fill in the Programs.cs file

Interface @id -> ModelId

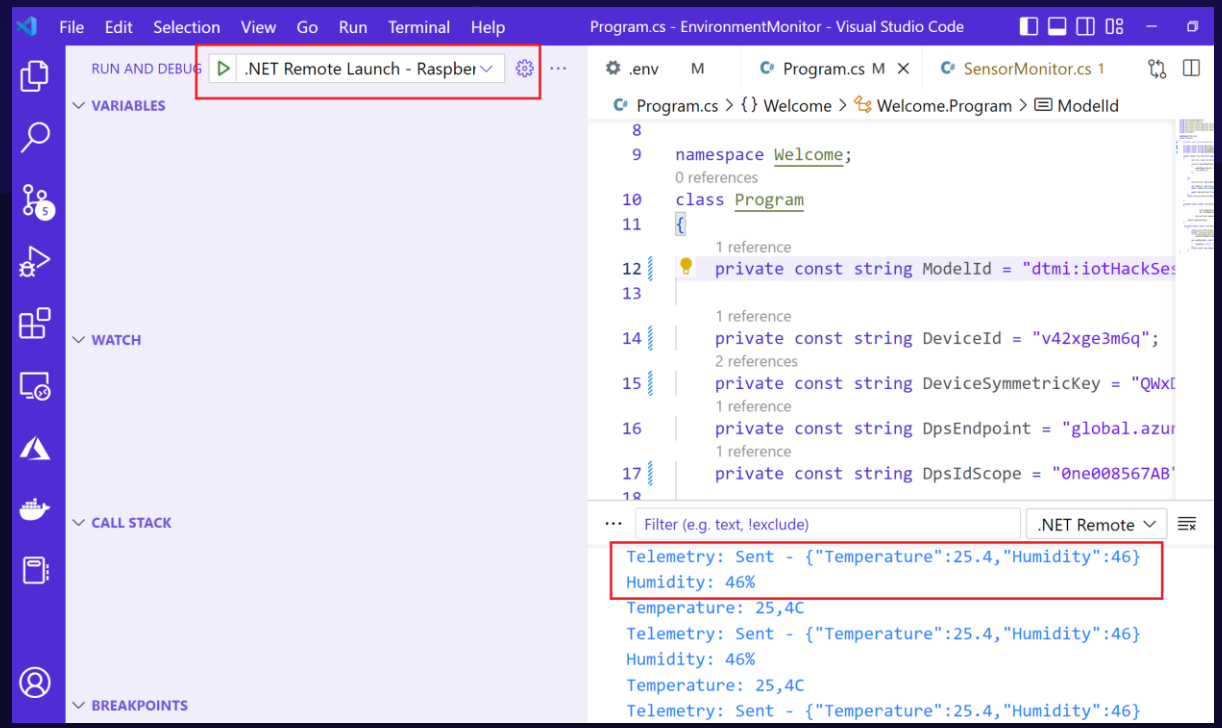
```
8
9   namespace Welcome;
    0 references
10  class Program
11  {
        1 reference
12      private const string ModelId = "dtmi:iotHackSession1:Environment
13
        1 reference
14      private const string DeviceId = "v42xge3m6q";
        2 references
15      private const string DeviceSymmetricKey = "QWxDBujvuzSEbU+cI1jId
        1 reference
16      private const string DpsEndpoint = "global.azure-devices-provisi
        1 reference
```

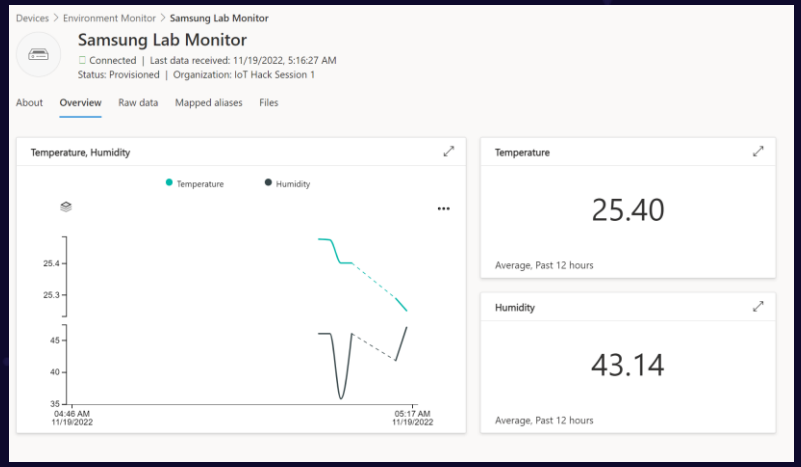
This Requires an Azure Subscription!

Try it Out!

In Visual Studio Code fill in the Programs.cs file

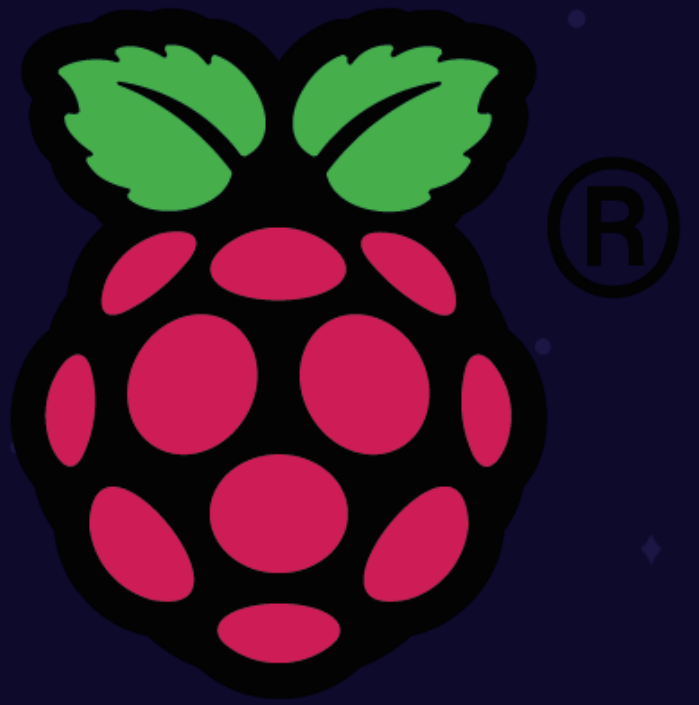
Interface @id -> ModelId





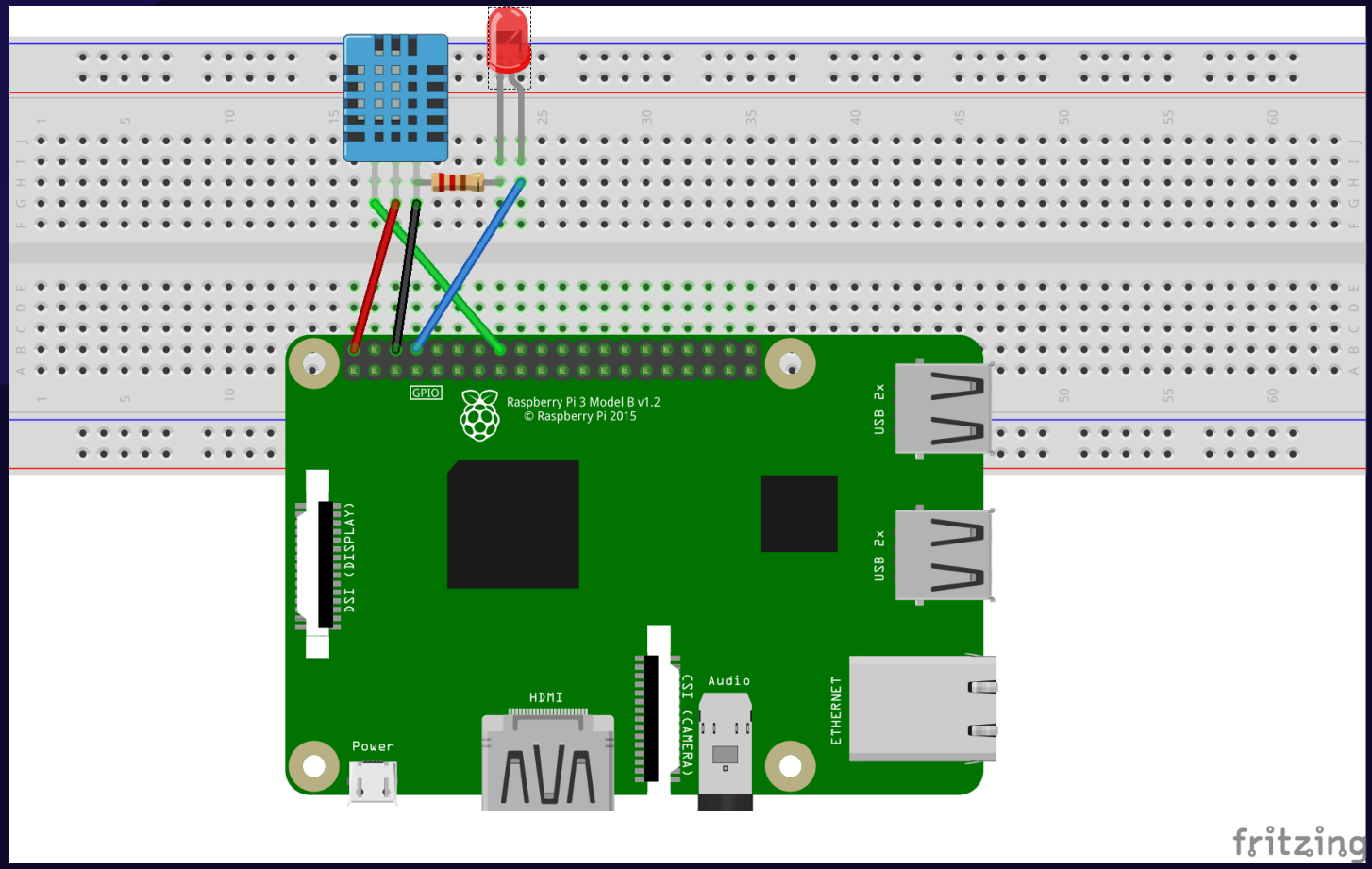
This Requires an Azure Subscription!

Module 4

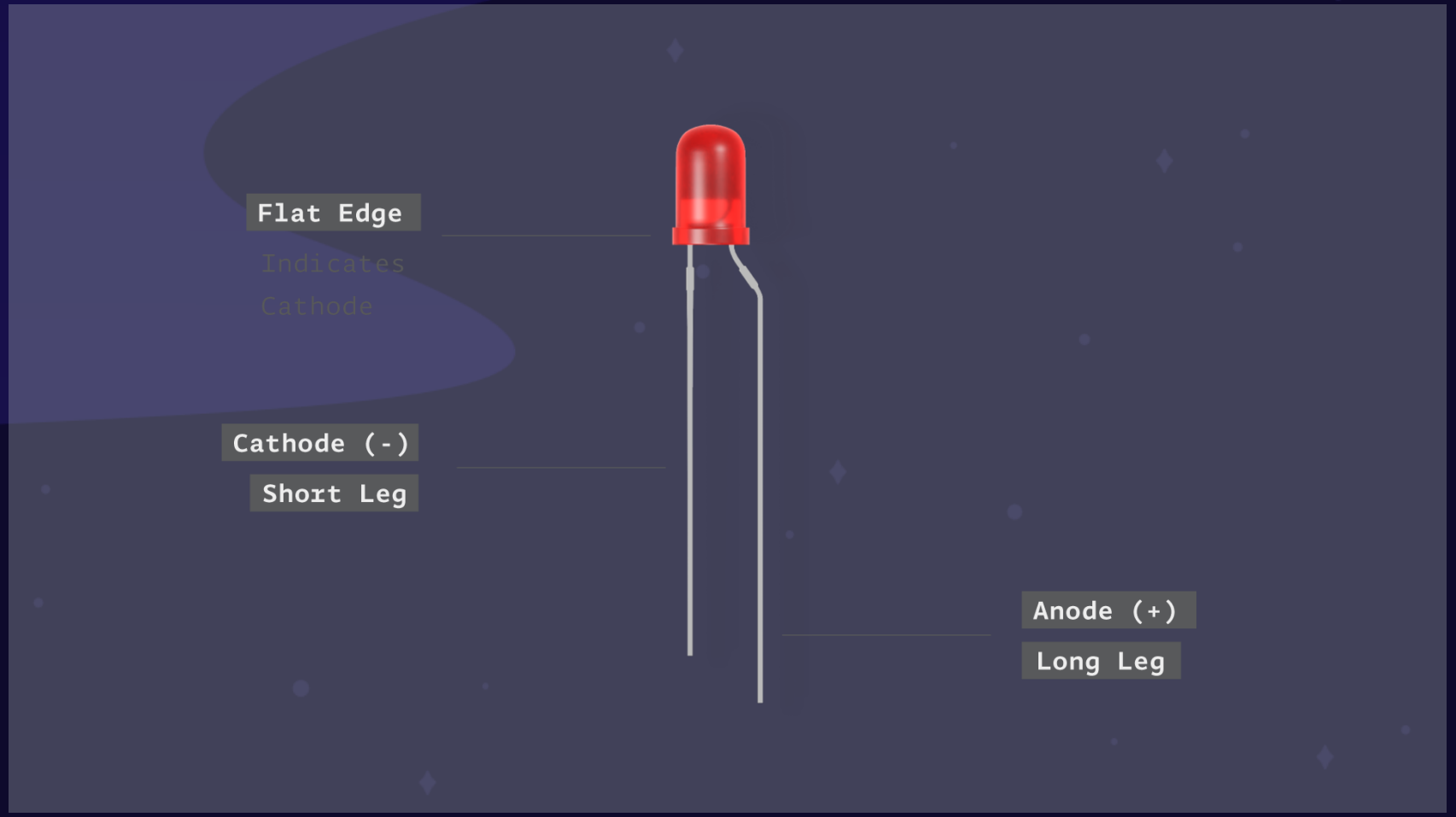


LED Fun

IoT is not IoT without a LED!



IoT is not IoT without a LED!



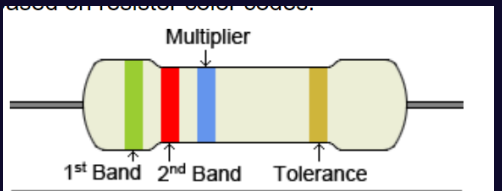
IoT is not IoT without a LED!

Why the resistor?

(Vsupply– VF)/ IF= (3.3 -1.7) / 7mA = 220 Ω

In this circuit the resistor is used to reduce current flow.

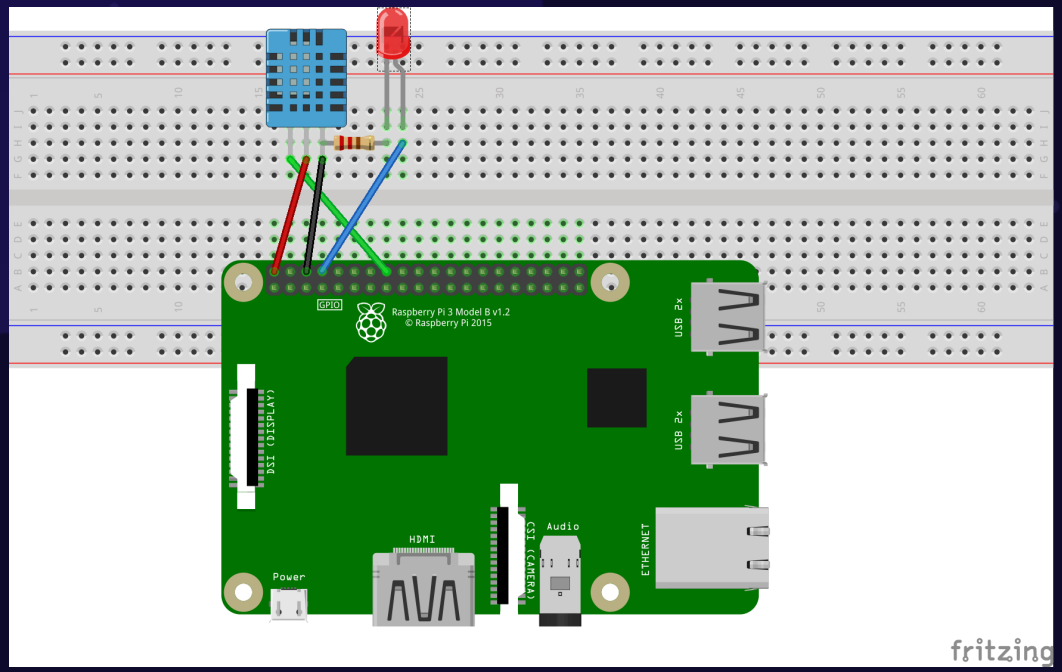
The Raspberry Pi is designed to only provide 23 mA max current. A resistor is important to not damage both the Raspberry Pi and the LED



Color	1st, 2nd Band Significant Figures	Multiplier	Tolerance
Black	0	× 1	
Brown	1	× 10	±1% (F)
Red	2	× 100	±2% (G)
Orange	3	× 1K	±0.05% (W)
Yellow	4	× 10K	±0.02% (P)
Green	5	× 100K	±0.5% (D)
Blue	6	× 1M	±0.25% (C)
Violet	7	× 10M	±0.1% (B)
Grey	8	× 100M	±0.01% (L)
White	9	× 1G	
Gold		× 0.1	±5% (J)
Silver		× 0.01	±10% (K)

https://www.calculator.net/resistor-calculator.html

IoT is not IoT without a LED!



Using the component pack, build the circuit using your Raspberry Pi, breadboard, LED, resistor and wires.

Connect resistor from ground (on DHT11) to LED cathode (short leg)

GPIO Pin 14 from the Raspberry Pi to LED anode

Try it out!

Coding Challenge

Turn the LED on when a certain temperature is reached. (check ambient temperature and use that as a starting point)

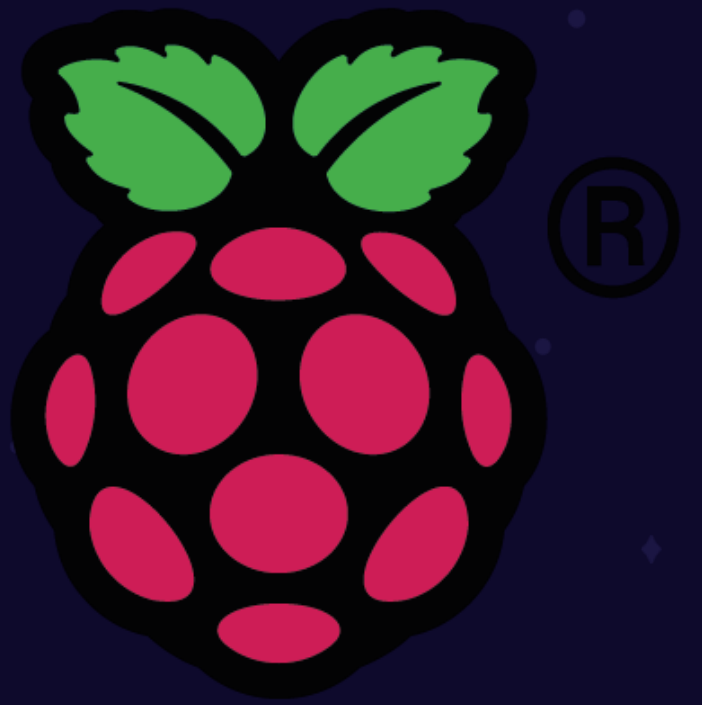
Hints

```
int ledPin = 14;

var controller = new GpioController();


controller.OpenPin(ledPin,PinMode.Output)

 controller.Write(ledPin,PinValue.High);
```

https://learn.microsoft.com/en-us/dotnet/api/system.device.gpio.gpiocontroller?view=iot-dotnet-latest

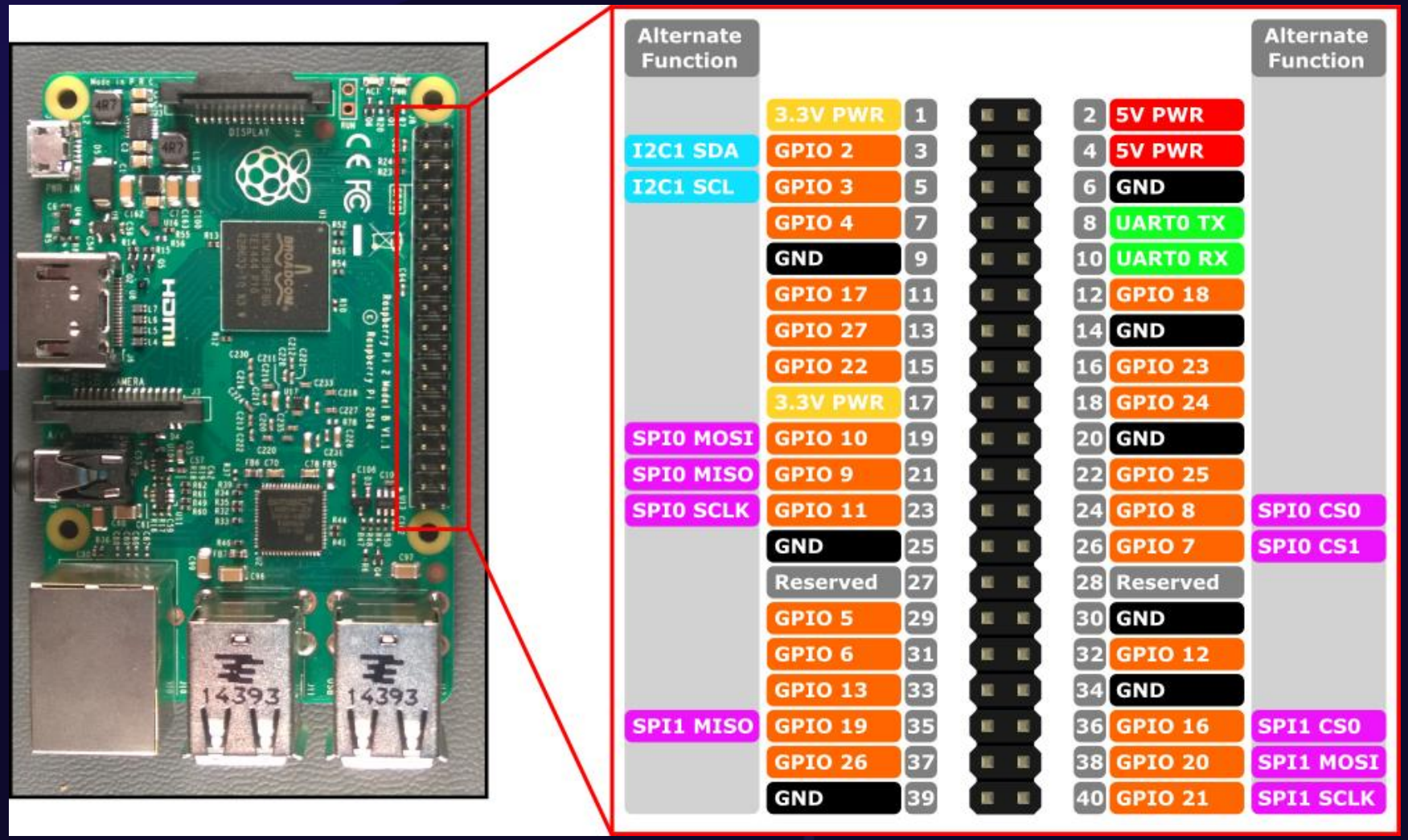
System.Device.Gpio

Module 5



Raspberry Pi Hardware + HATS

Interfacing to the Raspberry Pi



Interfacing to the Raspberry Pi

GPIO - General-purpose input/output

Switching things on, switching things off

Analog

No just 1 (on) and 0 (off)
Variable Input and Output voltage.
Raspberry Pi has no Analog pins. Requires an Analog to Digital Converter

I2C

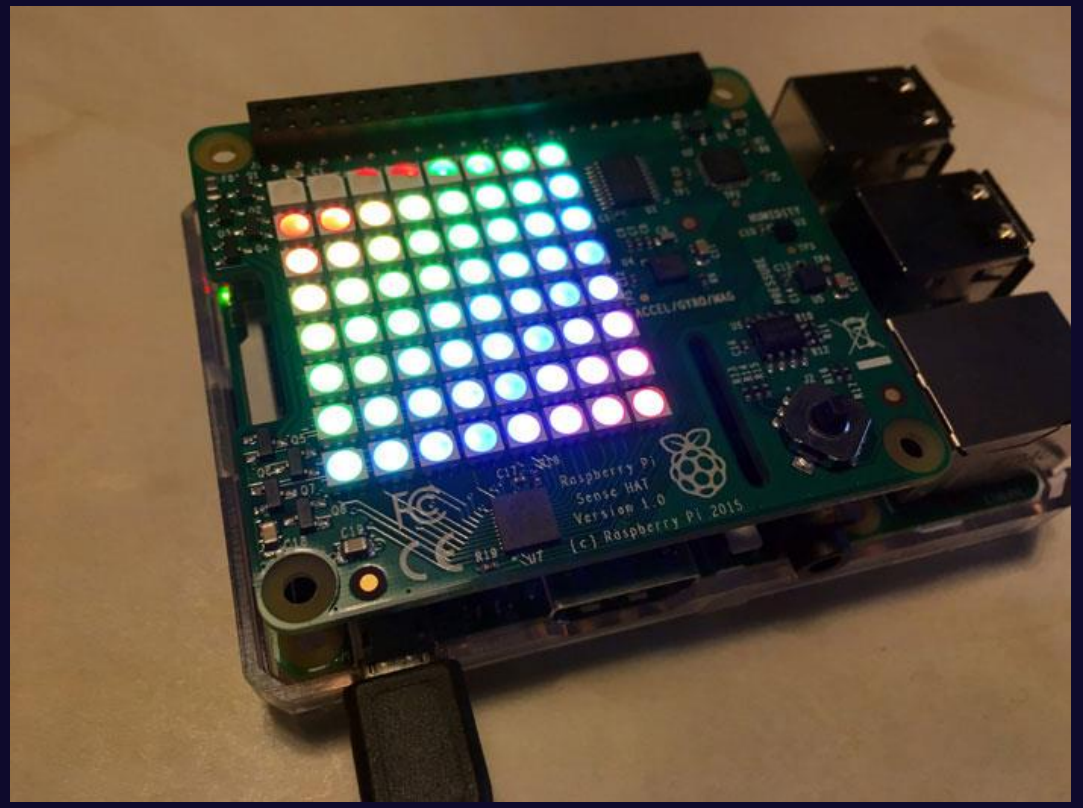
Serial communication Bus
Handy as it’s usually 2 wires for complex data communication

SPI (Serial Peripheral Interface)

Serial communication bus
Usually 3 wire communication

What is a HaT?

- Hardware Attached on Top
- Add-on board
- Fits onto the GPIO pins
- Input/output ports, sensors, displays, motor controllers
- Plug-and-play



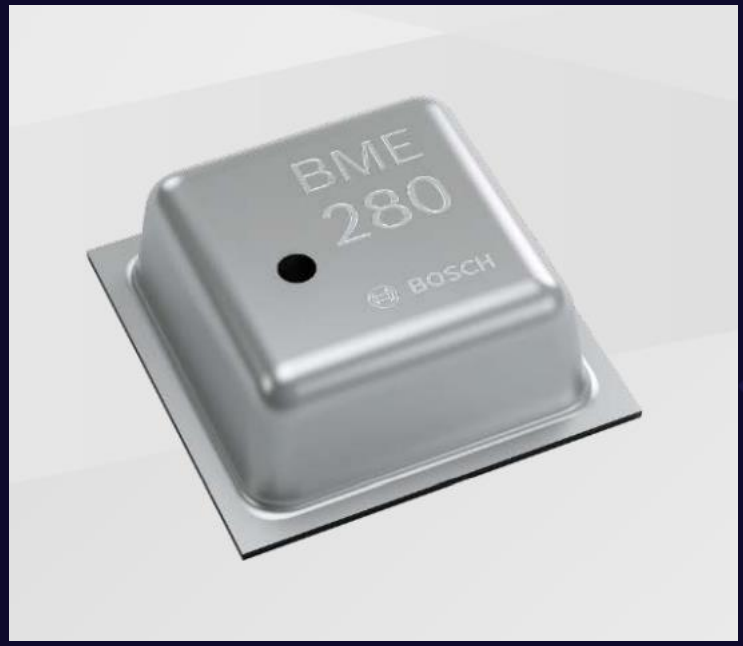
Enviro for Raspberry Pi

- pHAT

- BME280 temperature, pressure, humidity sensor
- LTR-559 light and proximity sensor
- MICS6814 analog gas sensor
- ADS1015 analog to digital converter (ADC)
- MEMS microphone
- 0.96" colour LCD (160x80)
- Particulate matter (PM) sensor

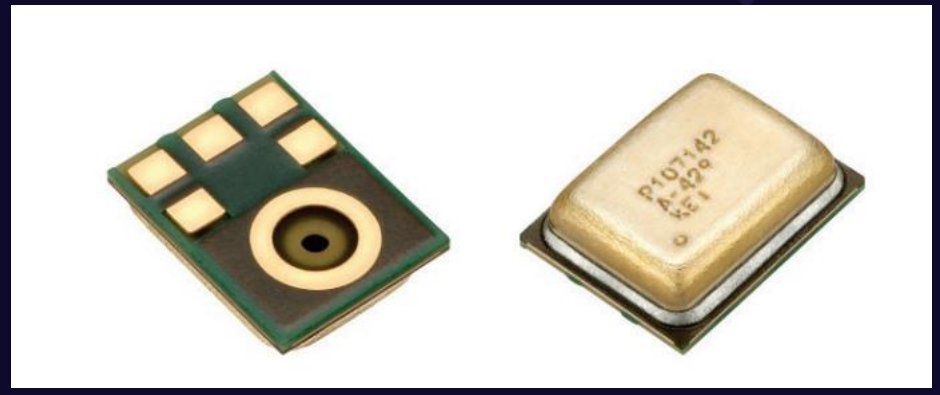
BME 280

- Pressure
- Humidity
- Air Pressure
- I2C or SPI interface
- Weather monitoring, indoor climate control, and industrial automation



MEMS Microphone

- Electro-acoustic transducer housing a sensor
- High SNR of 65dB(A)
- Low Current of typ. 600µA
- I2C interface



Small portable devices: wearables
Set-top boxes: TV, gaming, remote controllers
Smart home devices, Internet of Things,
Connected equipment

Particulate Matter Sensor

- Monitor air pollution
- PM1, PM2.5, PM10
  - Respiratory
  - Cardiovascular problems in humans
- Smoke, dust, pollen, metal and organic particles
- Fan that sucks air through the sensor and past a laser
- Detect number / concentration and size of particles

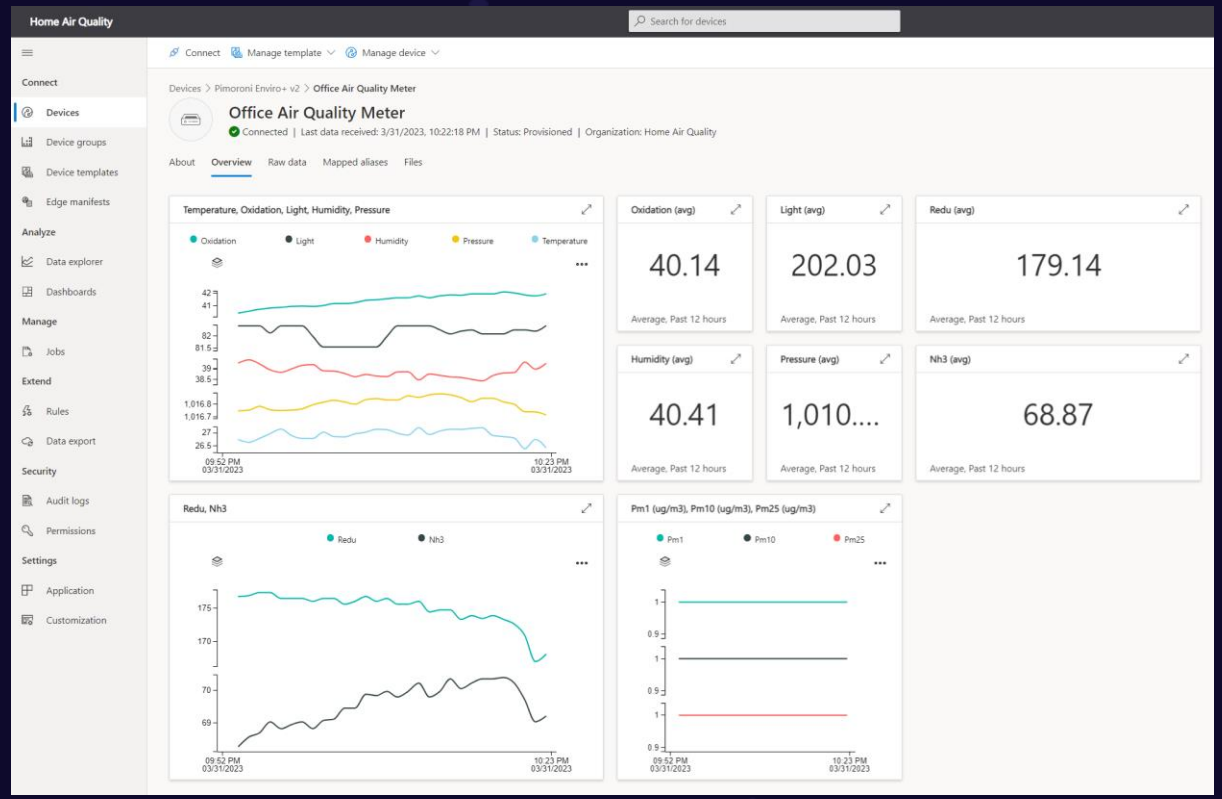
MICS6814

- Analog gas sensor
- MEMS sensor
- Detectable gases
  - Carbon monoxide CO 1 – 1000ppm
  - Nitrogen dioxide NO2 0.05 – 10ppm •
  - Ethanol C2H5OH 10 – 500ppm •
  - Hydrogen H2 1 – 1000ppm •
  - Ammonia NH3 1 – 500ppm •
  - Methane CH4 >1000ppm •
  - Propane C3H8 >1000ppm •
  - Iso-butane C4H10 >1000ppm

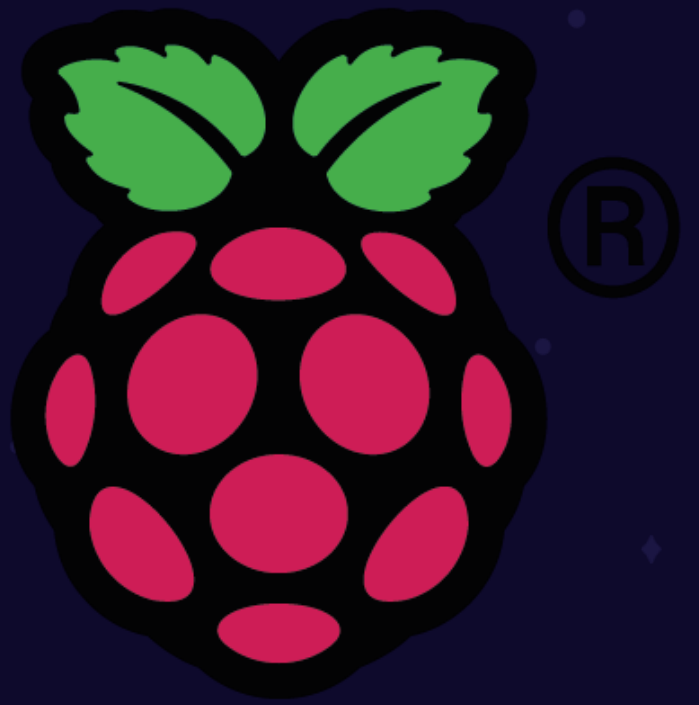
- Detection of pollution from automobile exhausts
- Agricultural / industrial odours
- Dangerous gases in the environment

Enviro for Raspberry Pi in Action

```
2023-03-31 21:36:34.192 INFO     Displays readings from all of Enviro plus' sensors

Press Ctrl+C to exit!


- [onconnect] => status:0
        - [onmessagesent] =>
2023-03-31 21:36:43.988 INFO     temp: 14.6 C
2023-03-31 21:36:43.998 INFO     pres: 673.0 hPa
2023-03-31 21:36:44.009 INFO     humi: 43.1 %
2023-03-31 21:36:44.025 INFO     ligh: 82.1 Lux
2023-03-31 21:36:44.133 INFO     oxid: 453.1 kO
2023-03-31 21:36:44.136 INFO     redu: 117.5 kO
2023-03-31 21:36:44.139 INFO     nh3: 21.5 kO
2023-03-31 21:36:44.145 INFO     pm1: 0.0 ug/m3
2023-03-31 21:36:44.149 INFO     pm25: 0.0 ug/m3
2023-03-31 21:36:44.153 INFO     pm10: 0.0 ug/m3
Sending telemetry..
2023-03-31 21:37:04.257 INFO     temp: 24.4 C
2023-03-31 21:37:04.268 INFO     pres: 1016.7 hPa
2023-03-31 21:37:04.280 INFO     humi: 43.1 %
2023-03-31 21:37:04.292 INFO     ligh: 82.1 Lux
2023-03-31 21:37:04.359 INFO     oxid: 20.7 kO
2023-03-31 21:37:04.362 INFO     redu: 192.4 kO
2023-03-31 21:37:04.365 INFO     nh3: 48.4 kO
2023-03-31 21:37:04.372 INFO     pm1: 0.0 ug/m3
2023-03-31 21:37:04.375 INFO     pm25: 1.0 ug/m3
2023-03-31 21:37:04.379 INFO     pm10: 1.0 ug/m3
Sending telemetry..
```



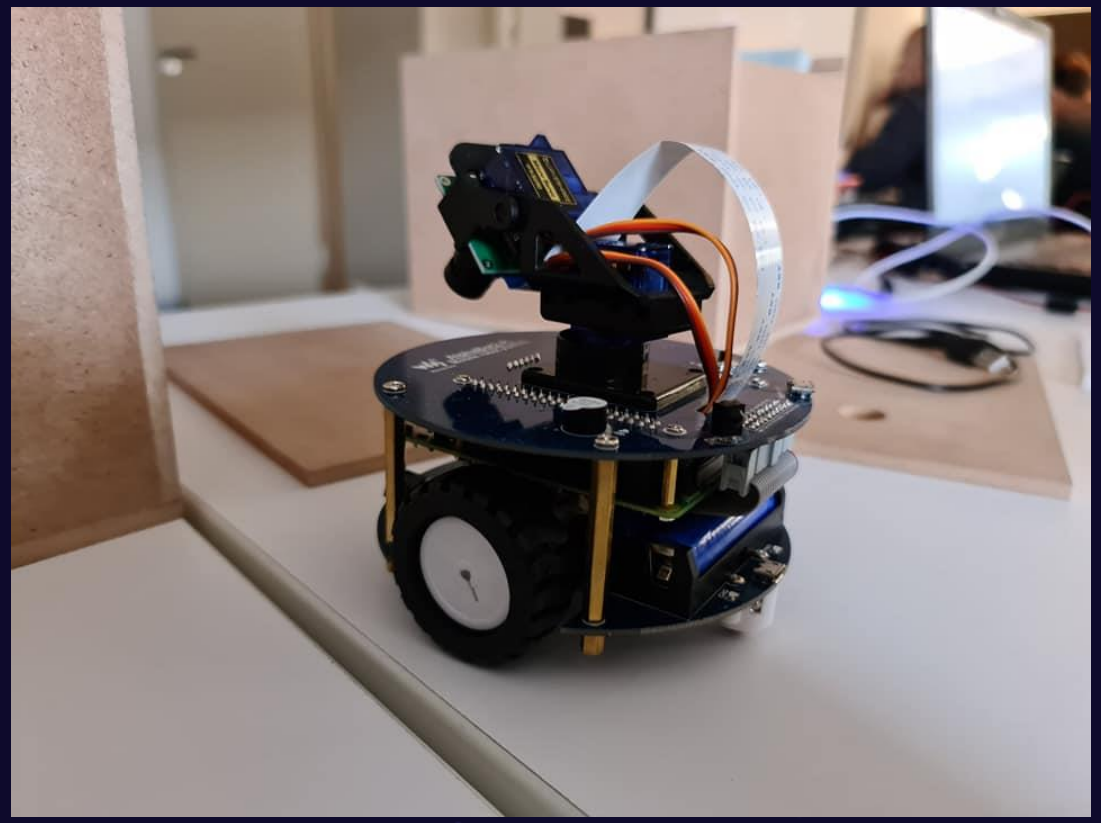
Module 6



The Alphabot 2

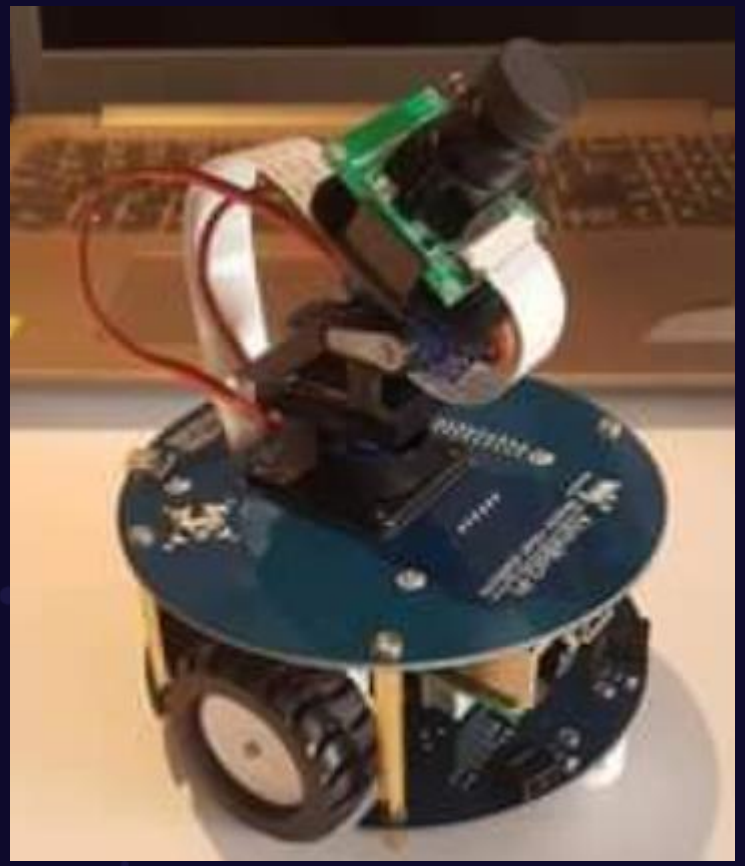
Module 6

The Alphabot 2



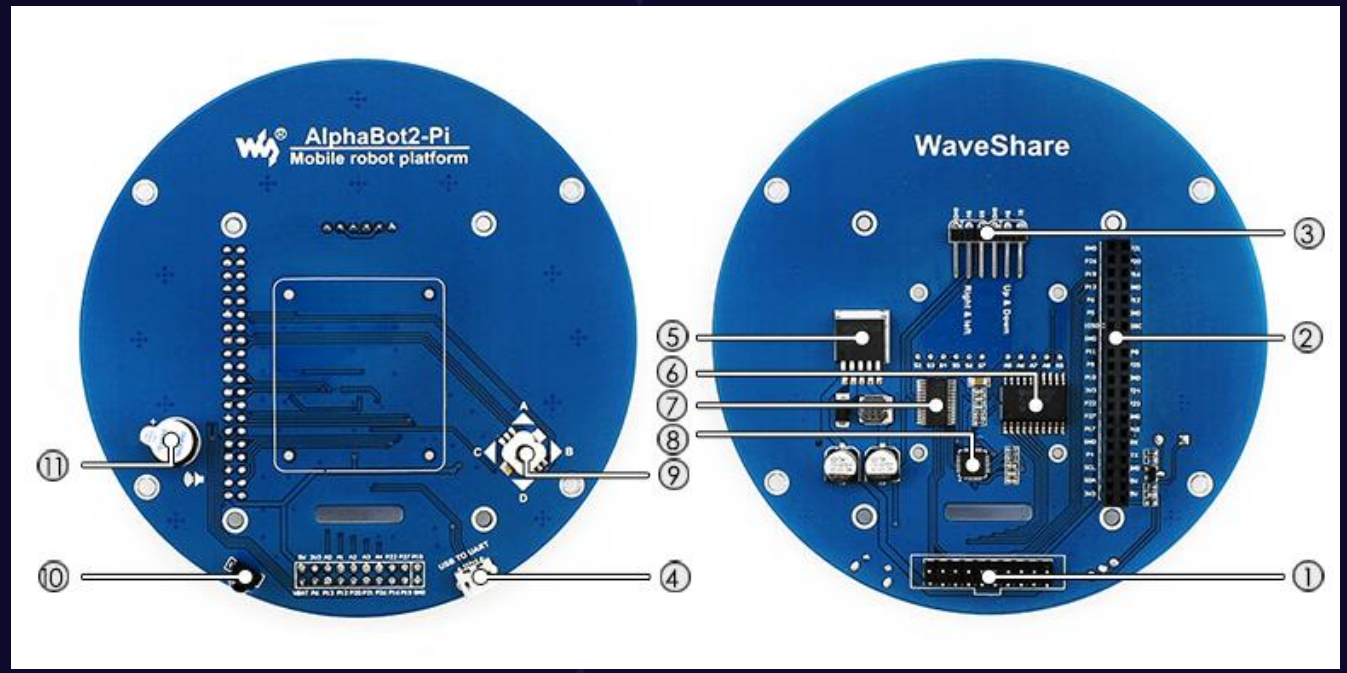
What is an Alphabot 2?

- HaT for a Raspberry Pi
- Robot Platform
- Supports Raspberry Pi 3 + 4



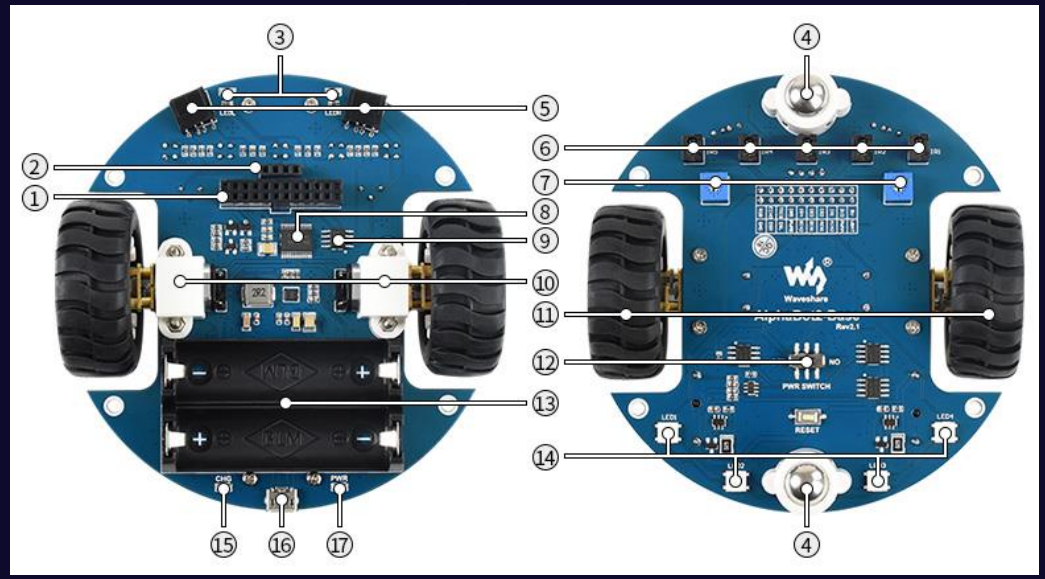
What's in it?

1. AlphaBot2 control interface: for connecting AlphaBot2-Base
2. Raspberry Pi interface: for connecting Raspberry Pi 3 / 4 Model B
3. Servo interface
4. USB TO UART: easy for controlling the Pi via UART
5. LM2596: 5V voltage regulator
6. TLC1543: 10-bit AD acquisition chip, allows the Pi to use analog sensors
7. PCA9685: servo controller, make it more smoothly to rotate the pan head
8. CP2102: USB TO UART converter
9. Joystick
10. IR receiver
11. Buzzer



What’s in it?

1. AlphaBot2 control interface: for connecting sorts of the controller adapter board
2. Ultrasonic module interface
3. Obstacle avoiding indicators
4. Omni-direction wheel
5. ST188: reflective infrared photoelectric sensor, for obstacle avoiding
6. ITR20001/T: reflective infrared photoelectric sensor, for line tracking
7. Potentiometer for adjusting obstacle avoiding range
8. TB6612FNG dual H-bridge motor driver
9. LM393 voltage comparator
10. N20 micro gear motor reduction rate 1:30, 6V/600RPM
11. Rubber wheels diameter 42mm, width 19mm
12. Power switch
13. Battery holder: supports 14500 batteries
14. WS2812B: true-color RGB LEDs
15. Battery charging indicator
16. 5V USB battery charging port
17. Power indicator

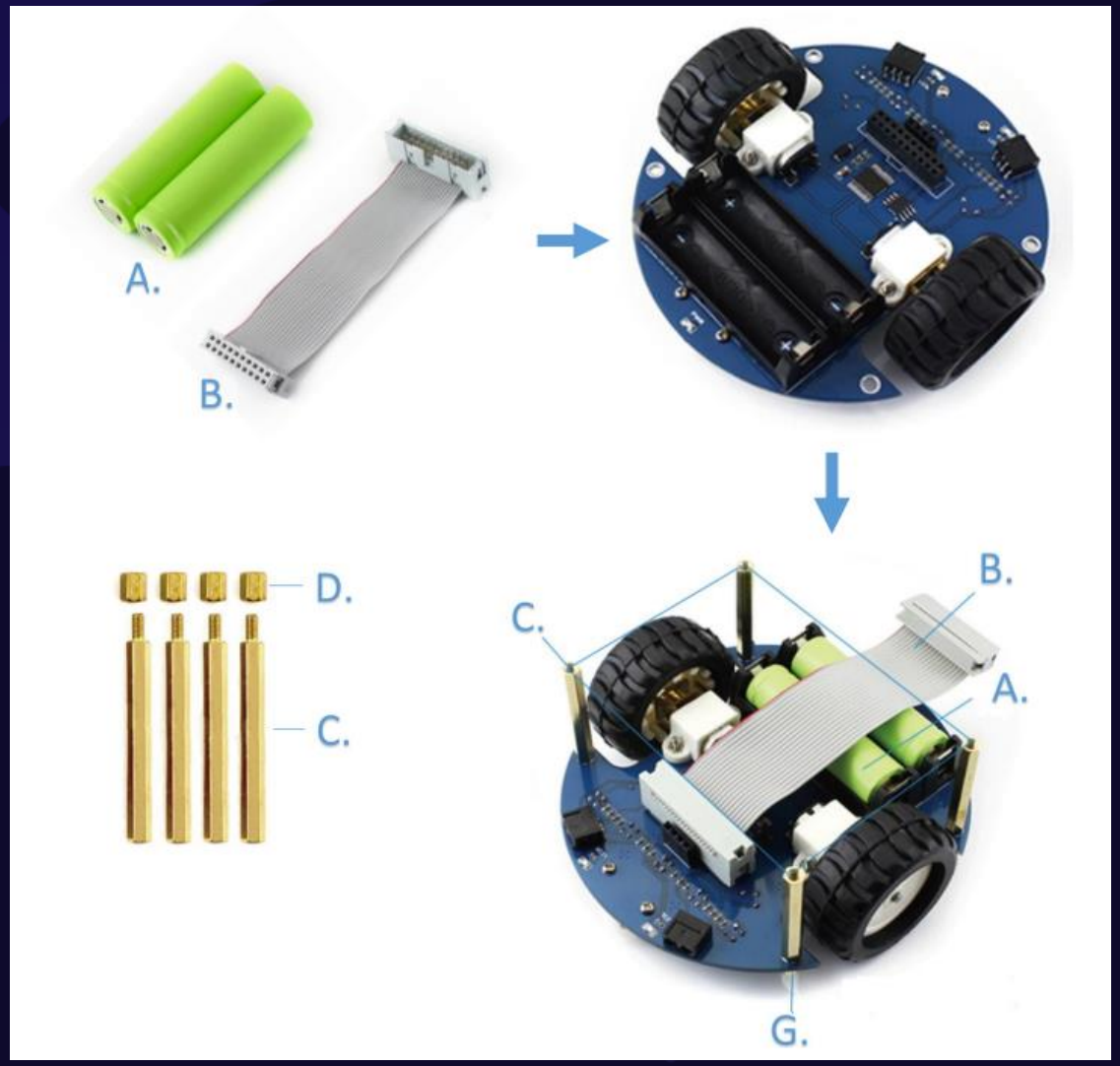


Let’s Build a Bot

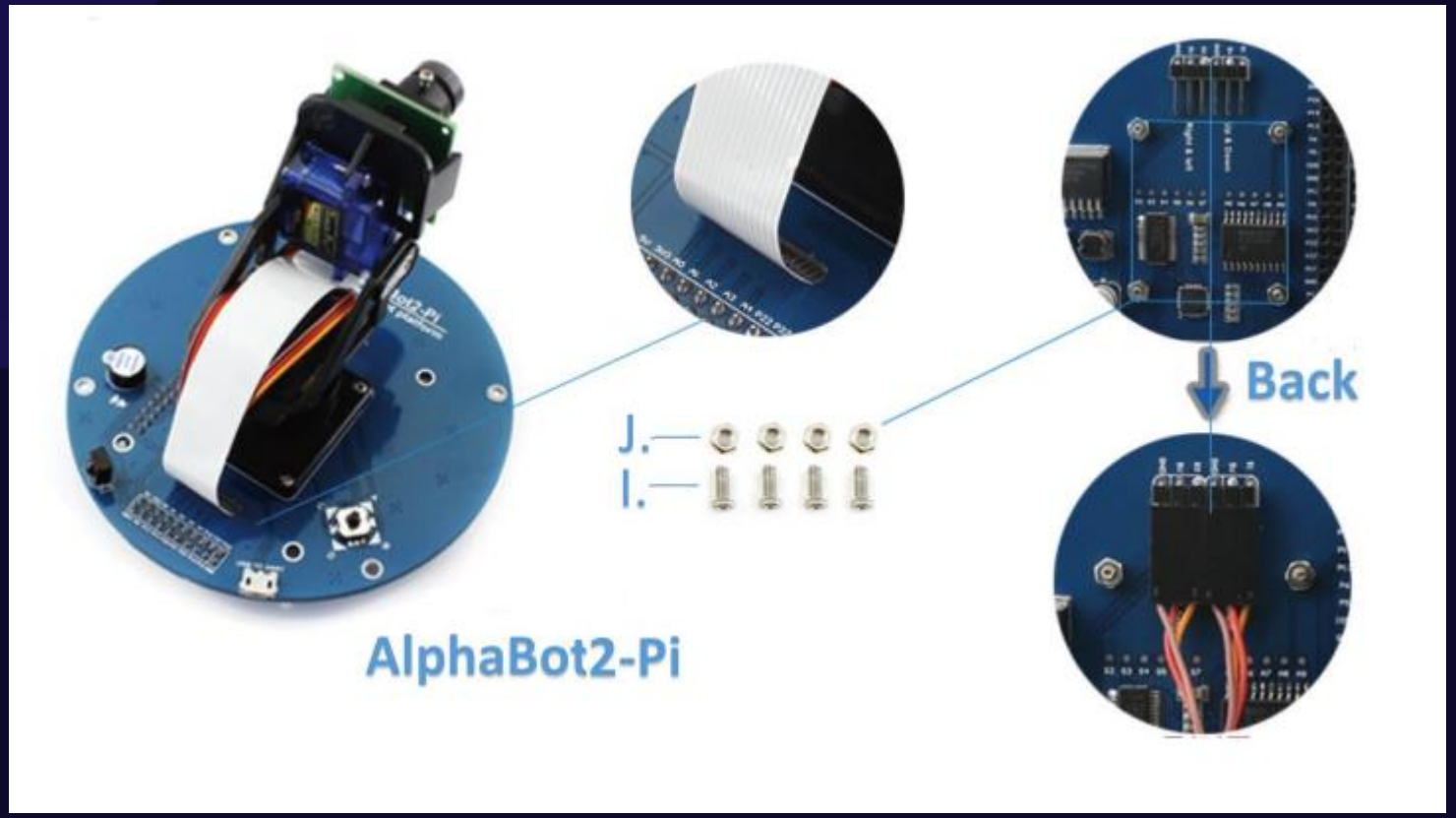
Before you start. Write down your host name!!!

The sticker on your Pi.

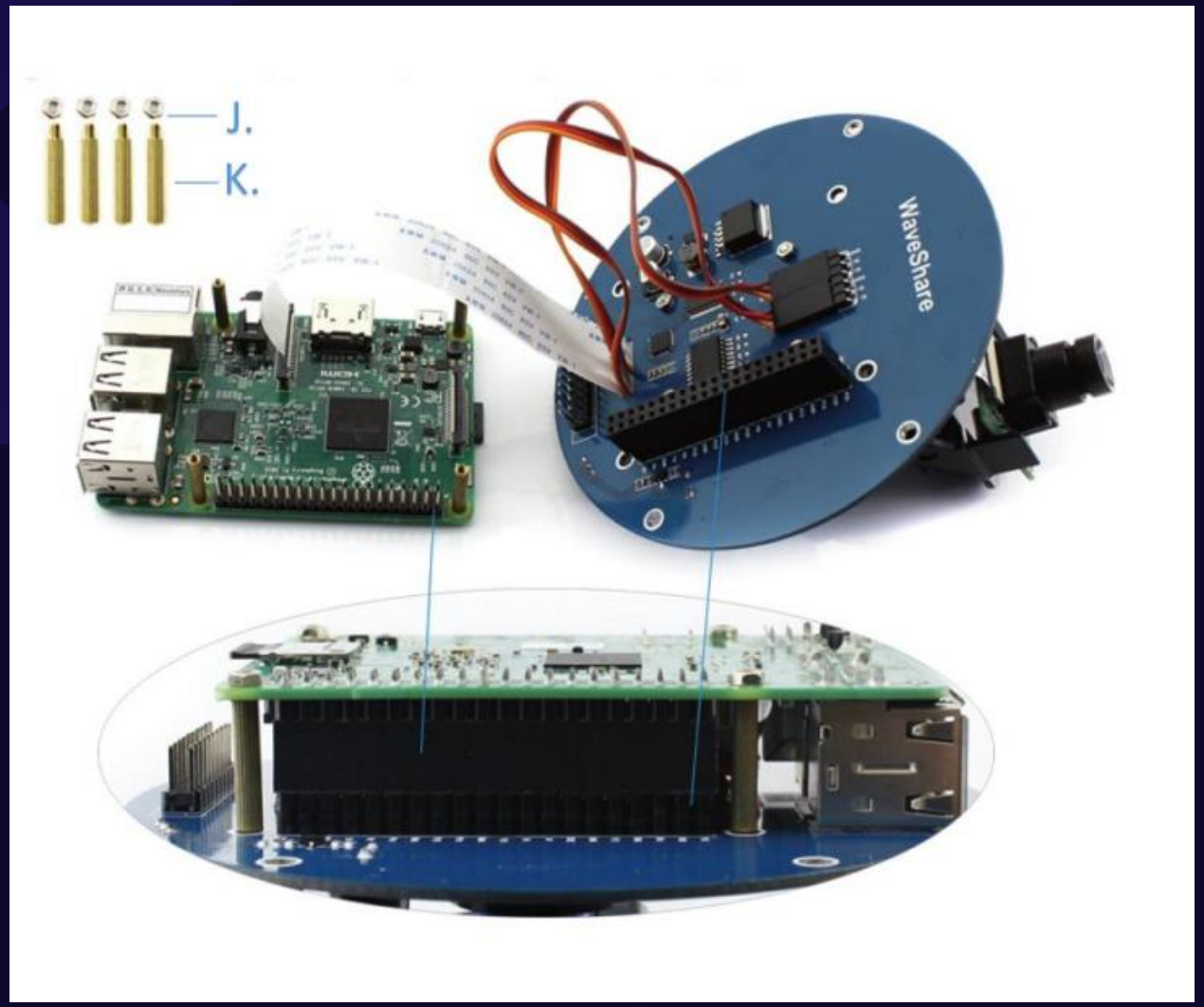
Let’s Build a Bot



Let’s Build a Bot

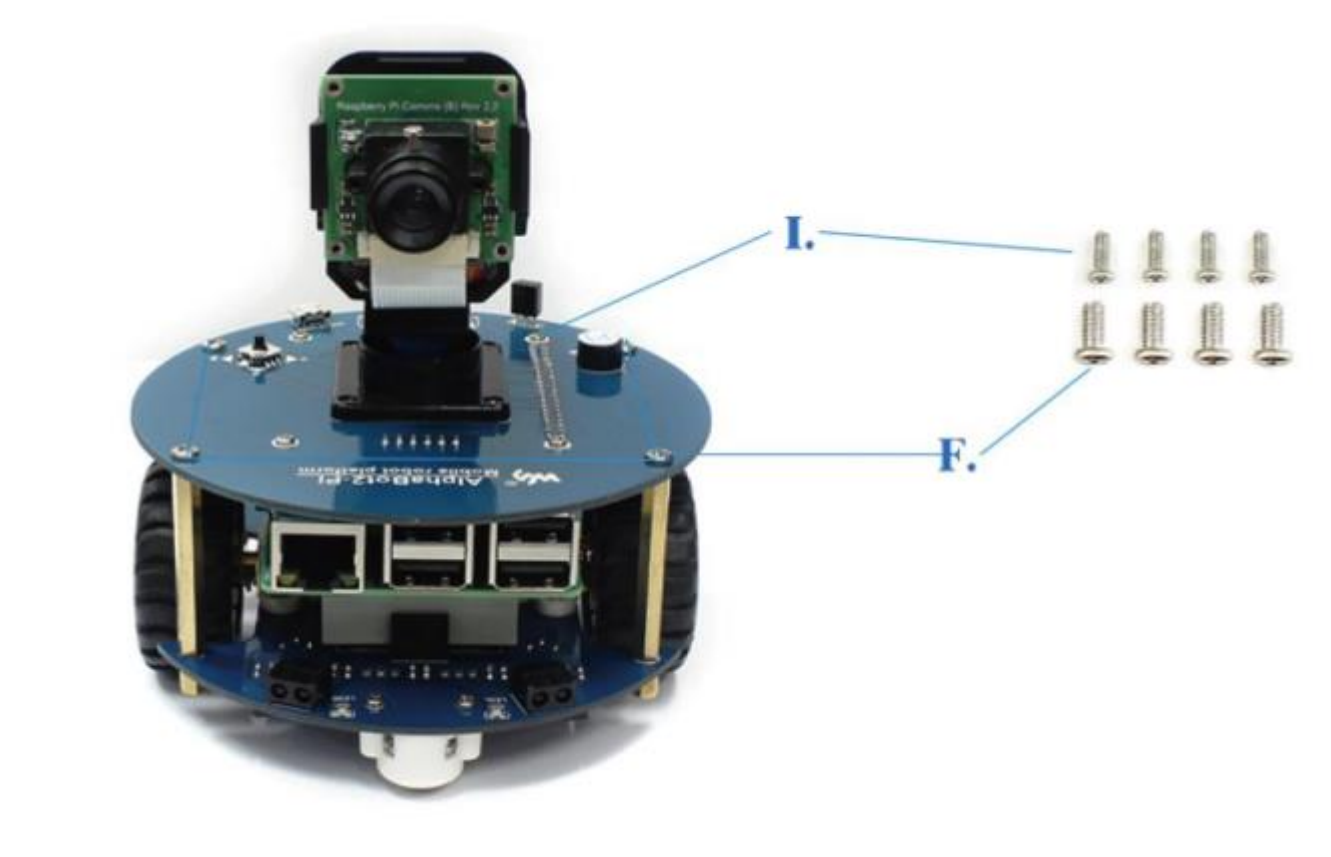


Let’s Build a Bot



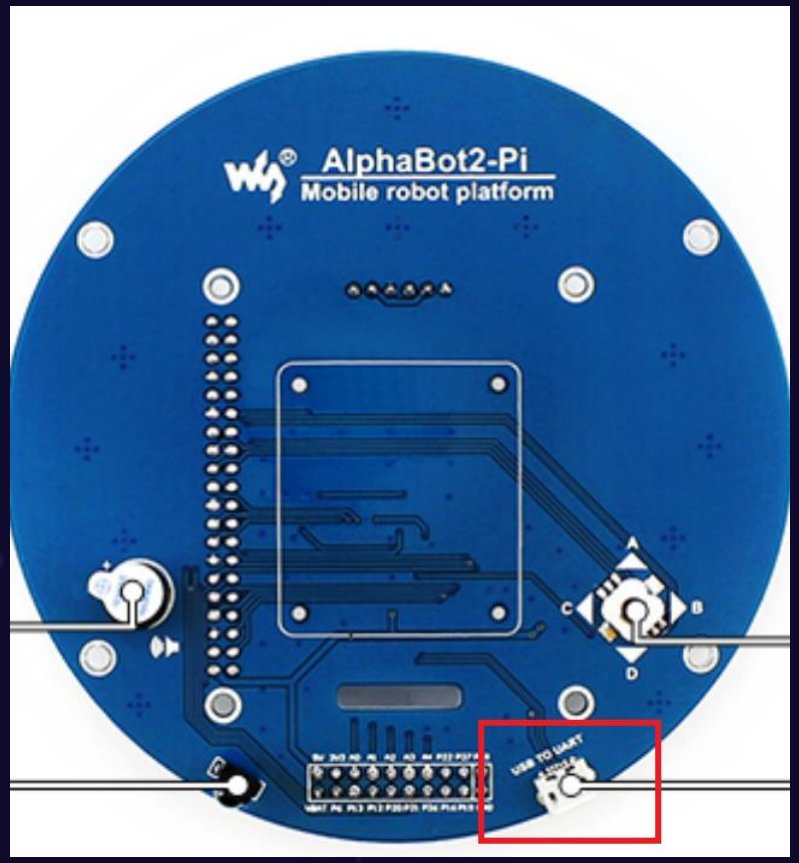
Let’s Build a Bot

Let’s Build a Bot



Plug your Bot in

- Plug in Ethernet network cable
- You can power the Bot with the power supplies provided or a USB cable in the UART port.



Check if your bot is alive!

- SSH to
- User Na
- Passwo

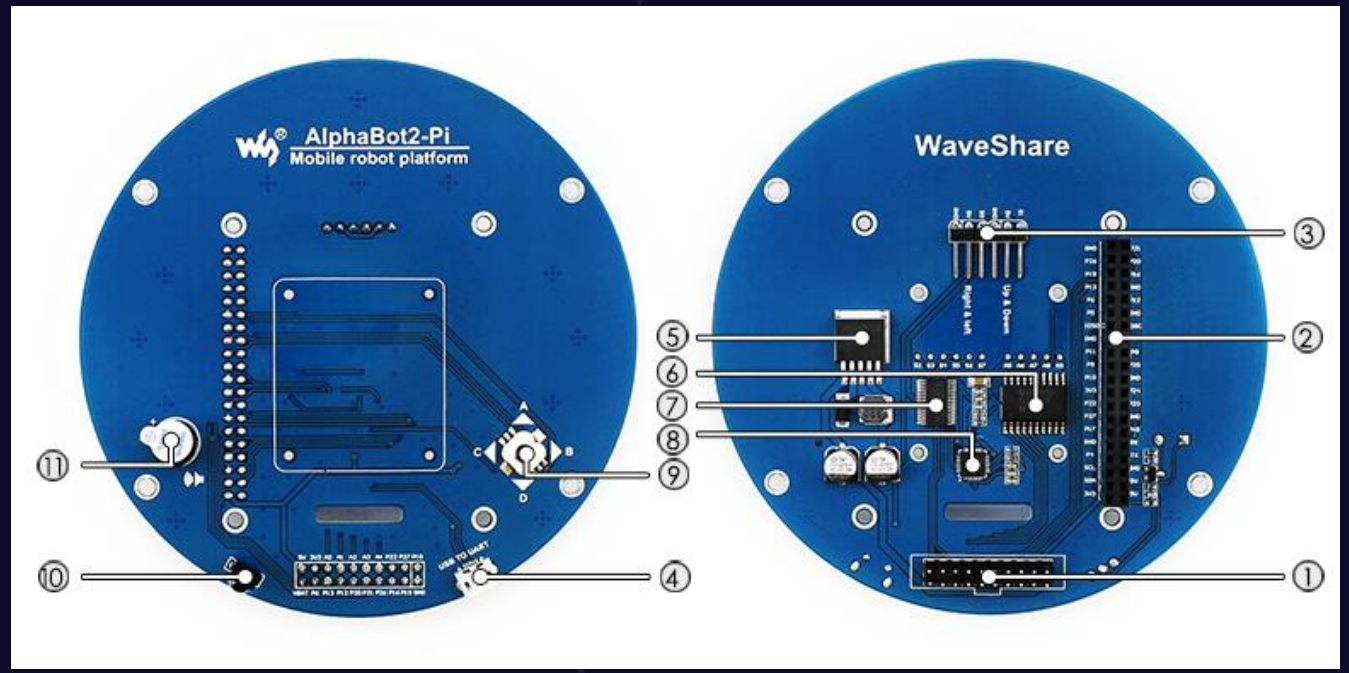
```
C:\Events\iothackdays2wip>ssh pi@E1163153
pi@e1163153's password:
Linux E1163153 4.19.75-v7+ #1270 SMP Tue Sep 24 18:45:11 BST 2019 armv7l

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Sat Apr  1 06:44:26 2023 from 192.168.1.16
pi@E1163153:~ $
```

A closer look at the hardware

6. TLC1543: 10-bit ADC acquisition chip

- ADC (Analog to Digital Controller)
- Allows the Pi to use analog sensors

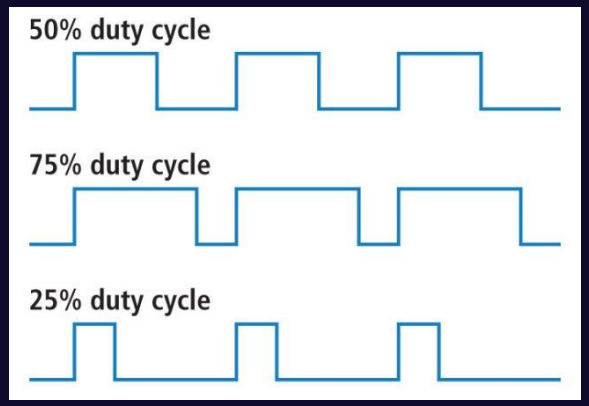
- Voltage signal from a sensor might range from 0 to 5 volts
- Digital (0 or 1)

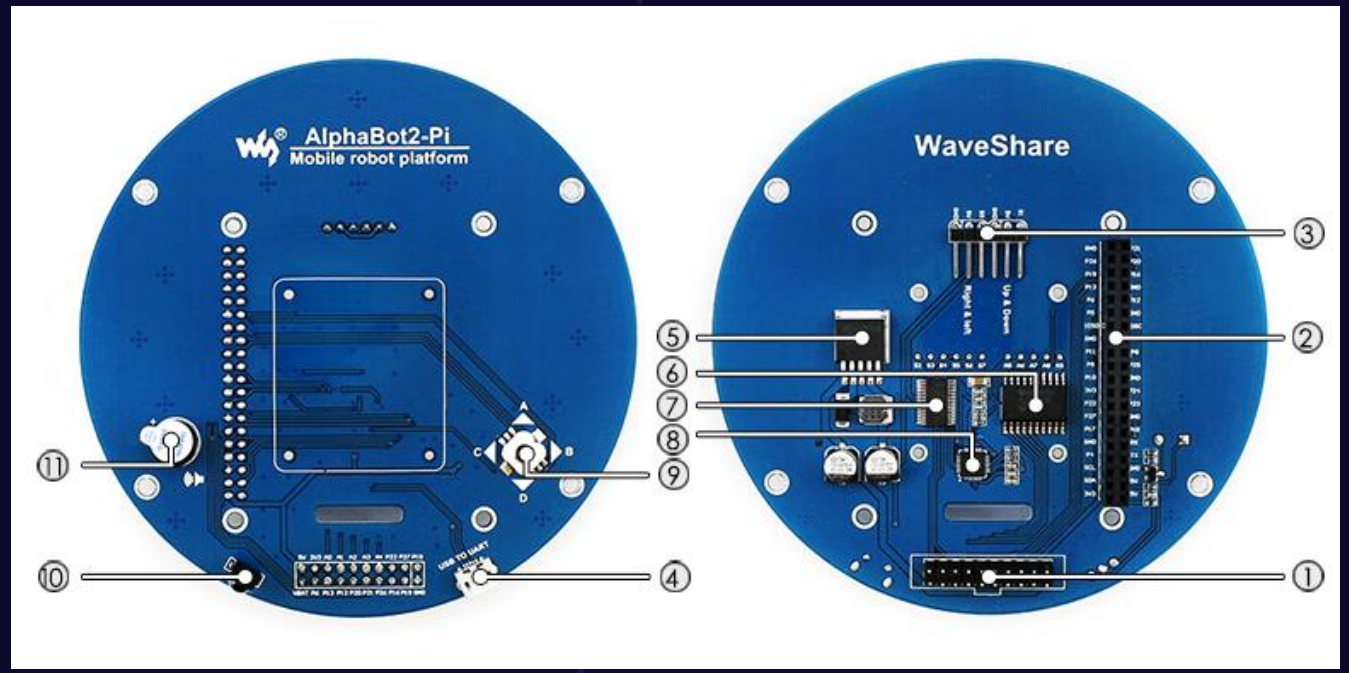


A closer look at the hardware

7 - PCA9685: servo controller

- Allows Pan and Tilt Camera to move
- 16-Channel 12-Bit PWM (Pulse Width Modulation) Servo Driver
- Power delivered to motor by switching it on and off rapidly.



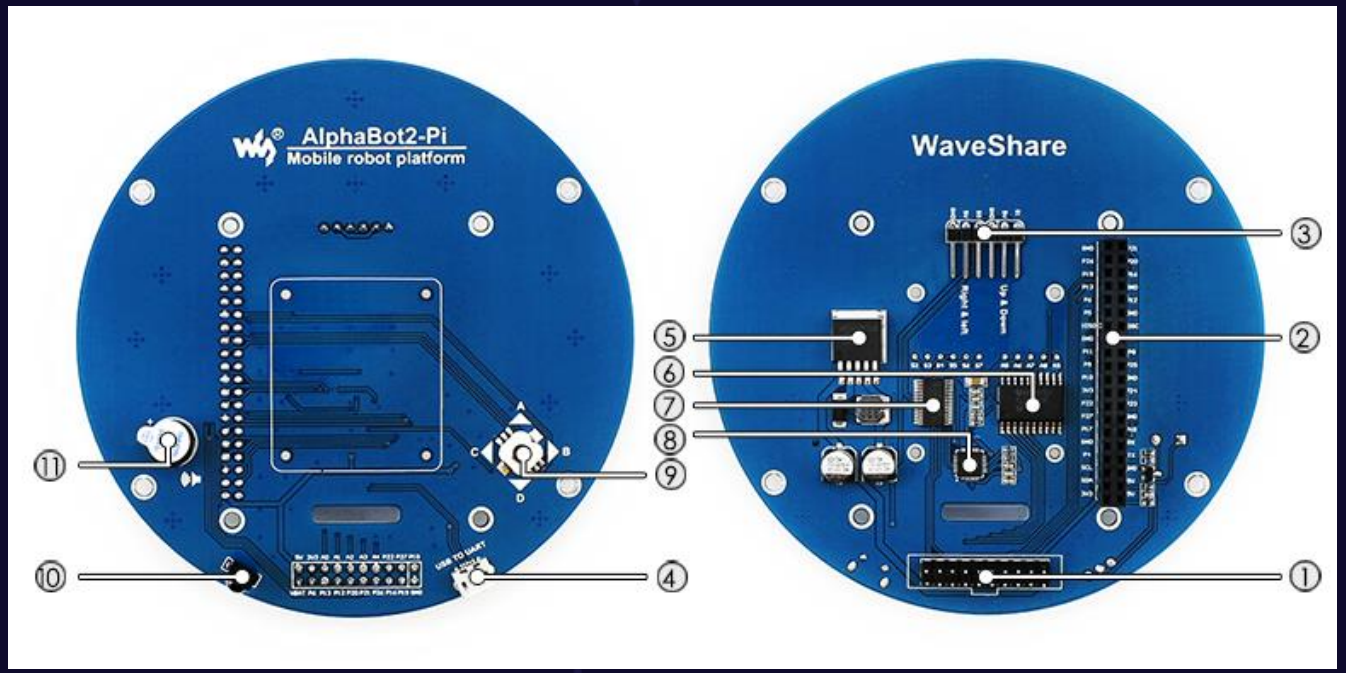


A closer look at the hardware

9. Joystick

- 4 Way directional control
- Center button

Allows you to go: Pew Pew! 😊



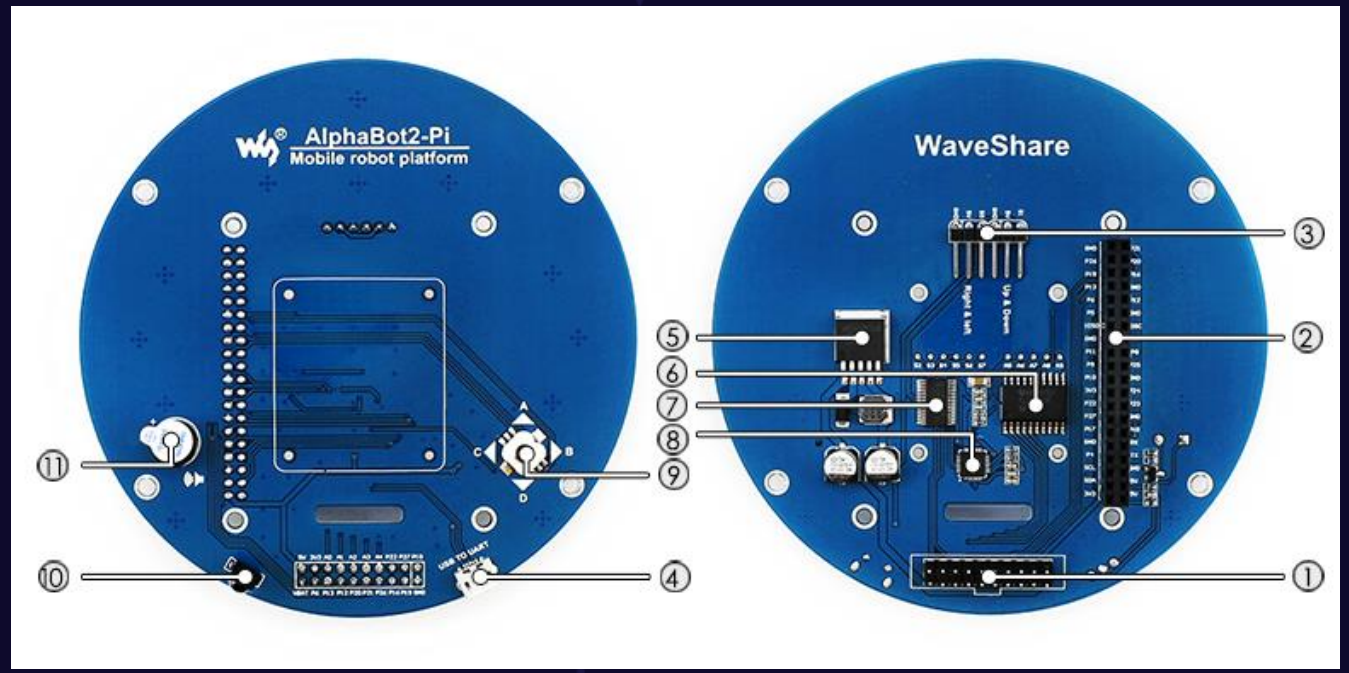

```
pi@E1163153:~ $ cd IoTHackDaysSession2/AlphabotTest/
pi@E1163153:~/IoTHackDaysSession2/AlphabotTest $ python Joystick.py
```

A closer look at the hardware

10 IR receiver

- IR (Infrared) receiver
- Receives and decode signals sent from an IR remote control.

- Photodiode
  - Converts infrared light into an electrical signal
- Preamplifier
  - Amplifies the signal
- Demodulator
  - Removes noise or interference
- Decoder
  - Translates the signal into a digital code

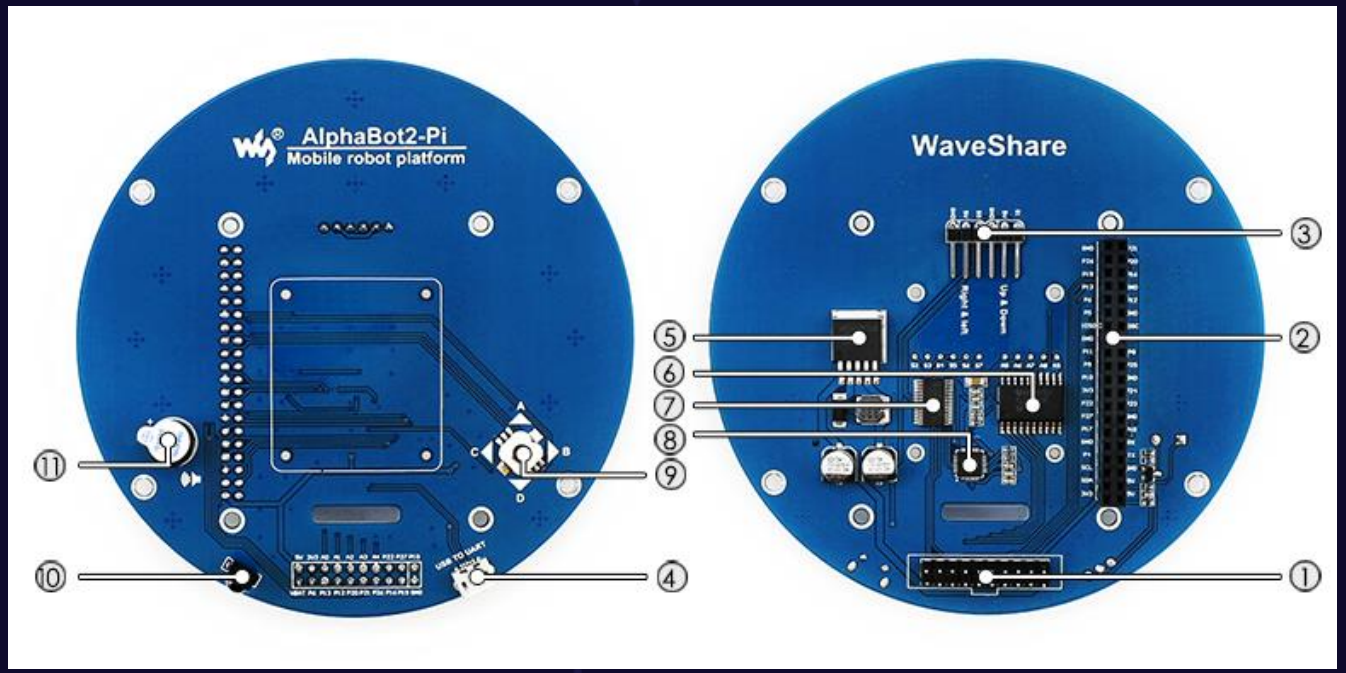



```
pi@E1163153:~/IoTHackDaysSession2/AlphabotTest $ python IRremote.py
IRremote Test Start ...
```

A closer look at the hardware

11. Buzzer

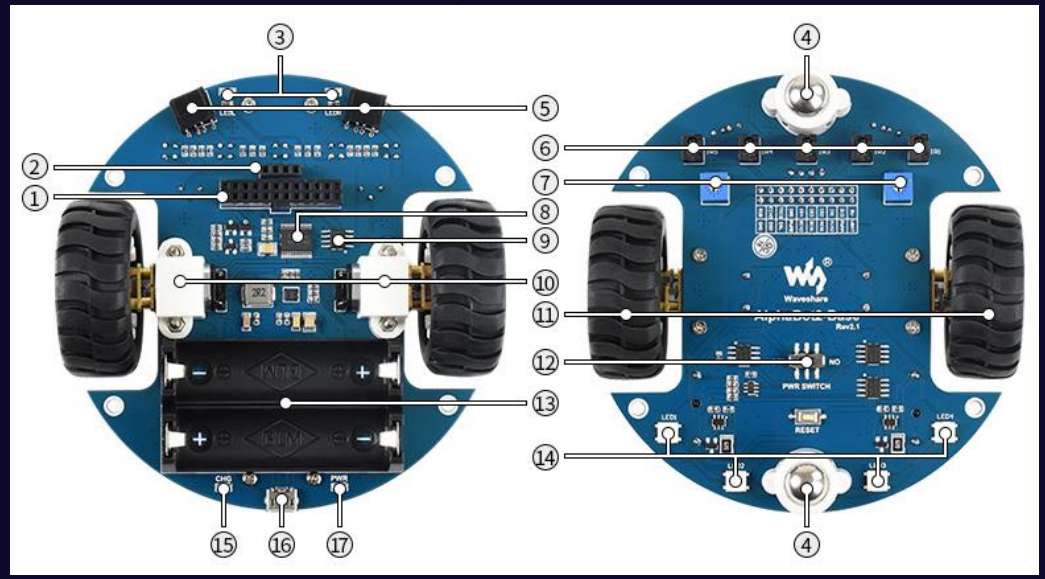
- Allows you to raise audible alarms or give feedback



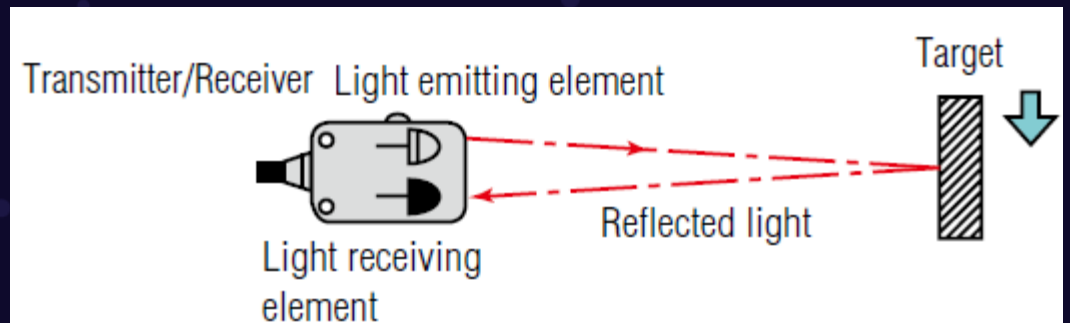
A closer look at the hardware

3 Obstacle avoiding indicators

5 ST188: Reflective infrared photoelectric sensor

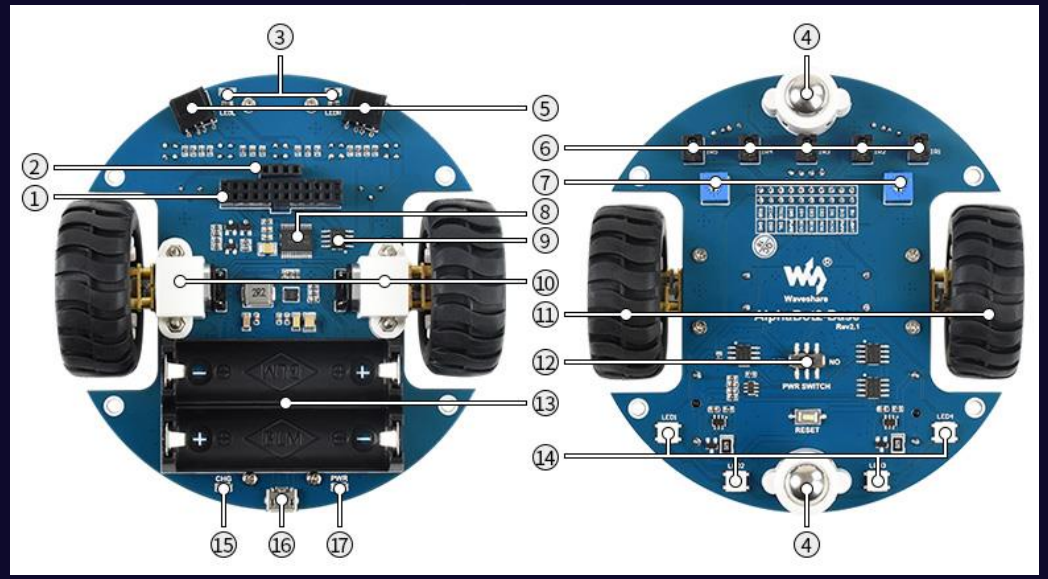


- Obstacle avoiding indicator – LED
- Reflective infrared photoelectric sensor bounces light of an object
  - Infrared emitter (LED)
  - Receiver (photodiode)



A closer look at the hardware

6. ITR20001/T: reflective infrared photoelectric sensor



- Detect the presence or absence of an object.
- Works by emitting a beam of light and then measuring the amount of light that is reflected back

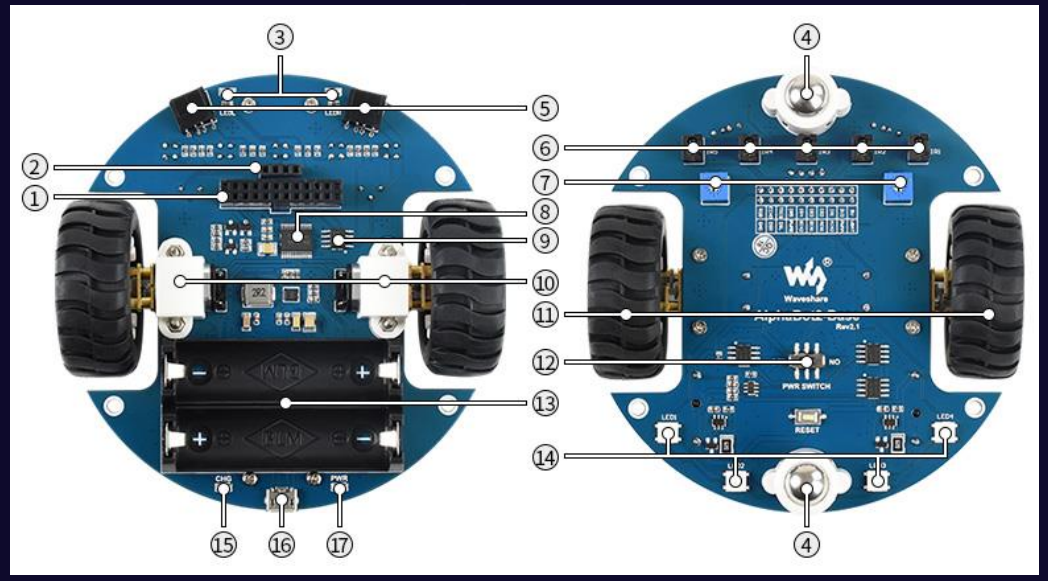
- Used for line tracking
  - Detects light and dark

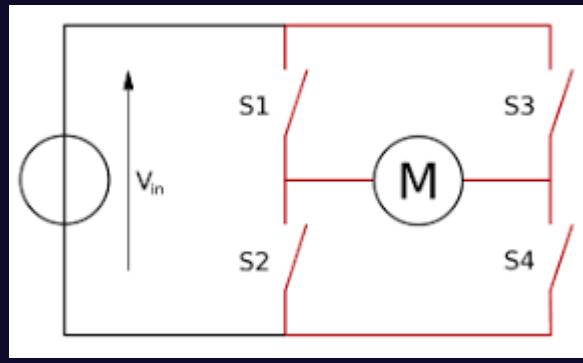
```
pi@E1163153:~/IoTHackDaysSession2/AlphabotTest $ python TRSensors.py
TRSensor Example
[776, 926, 936, 949, 795]
[777, 926, 937, 950, 795]
```

A closer look at the hardware

8. TB6612FNG dual H-bridge motor driver

- Controls the direction and speed of a DC motor
- Four switches arranged in the shape of an "H“
- Two pairs, each pair controlling the current flow to the motor in either direction
- One pair are turned on and other pair are turned off, current flows in one direction through the motor.
- First pair are turned off and second pair are turned on, current flows in the opposite direction through the motor.

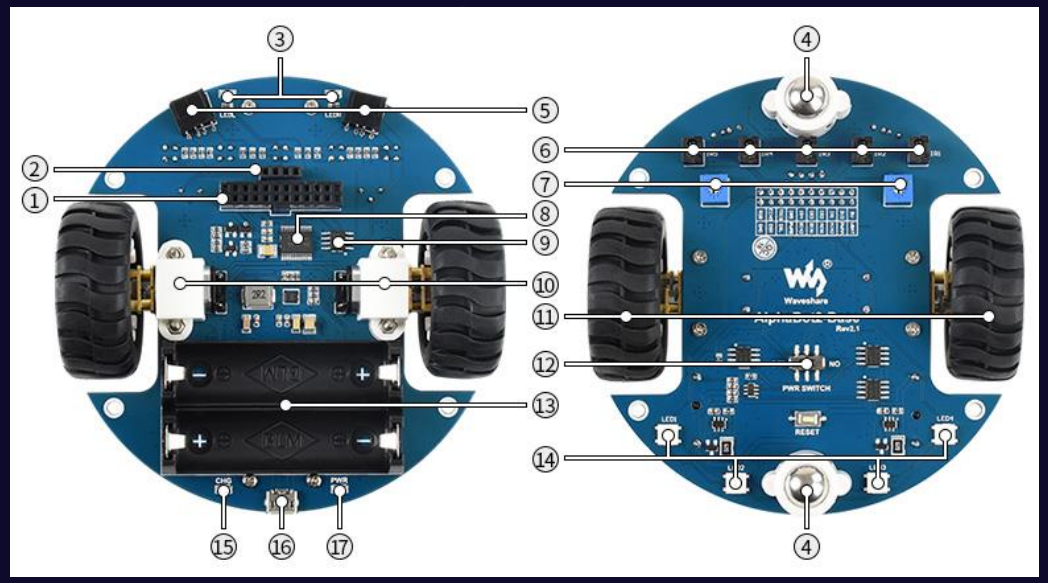




A closer look at the hardware

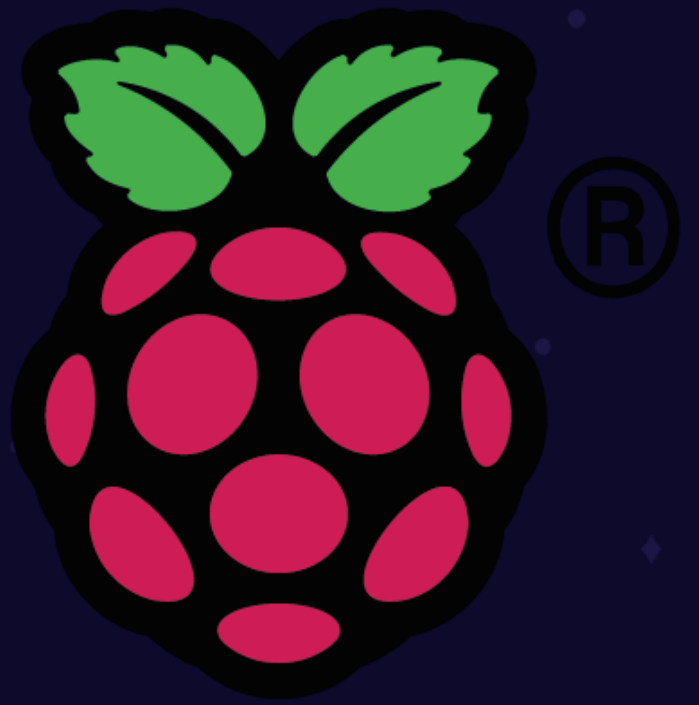
14. WS2812B: true-color RGB LEDs

- Addressable RGB LED Strip
- Multiple light-emitting diodes (LEDs)
- RGB (Red, Green, Blue)
- (PWM) function that can control the brightness



```
pi@E1163153:~/IoTHackDaysSession2/AlphabotTest $ sudo python LightShow.py
Press Ctrl-C to quit.
Use "-c" argument to clear LEDs on exit
Color wipe animations.
Theater chase animations.
```

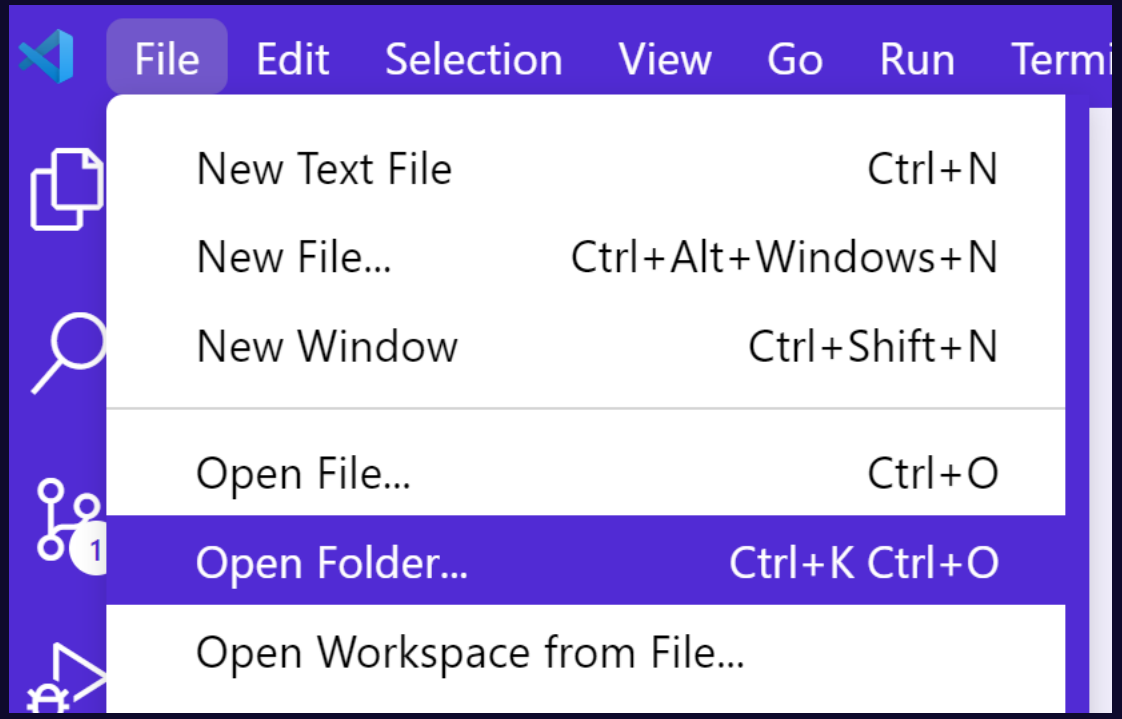
Module 7



The Alphabot 2 - .NET

Try it out!

In VS Code open the folder Alphabot2Dotnet from the code cloned from Github



Git clone https://github.com/CPTMSDUG/IoTHackDaysSession2DotNet

Controlling the Motors (PWM)

```
 private GpioController _controller;

            _pwmA = new SoftwarePwmChannel(_ena, frequency: 500, usePrecisionTimer: true, dutyCycle: _pa,
controller: _controller);
            _pwmB = new SoftwarePwmChannel(_enb, frequency: 500, usePrecisionTimer: true, dutyCycle: _pb,
controller: _controller);
            _pwmA.Start();
            _pwmB.Start();

public void Stop()
        {
            _pwmA.DutyCycle = 0;
            _pwmB.DutyCycle = 0;

            _controller.Write(_ain1, PinValue.Low);
            _controller.Write(_ain2, PinValue.Low);
            _controller.Write(_bin1, PinValue.Low);
            _controller.Write(_bin2, PinValue.Low);
        }
```

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Controlling the Motors (PWM)

```
 private GpioController _controller;

            _pwmA = new SoftwarePwmChannel(_ena, frequency: 500, usePrecisionTimer: true, dutyCycle: _pa,
controller: _controller);
            _pwmB = new SoftwarePwmChannel(_enb, frequency: 500, usePrecisionTimer: true, dutyCycle: _pb,
controller: _controller);
            _pwmA.Start();
            _pwmB.Start();

public void Forward()
        {
            _pwmA.DutyCycle = _pa;
            _pwmB.DutyCycle = _pb;
            _controller.Write(_ain1, PinValue.Low);
            _controller.Write(_ain2, PinValue.High);
            _controller.Write(_bin1, PinValue.Low);
            _controller.Write(_bin2, PinValue.High);

            Console.WriteLine("Forward");
        }
```

Git clone https://github.com/CPTMSDUG/IoTHackDaysSession2DotNet

Controlling the Motors (PWM)

```
public void Left()
        {
            _pwmA.DutyCycle = 0.5;
            _pwmB.DutyCycle = 0.5;
            _controller.Write(_ain1, PinValue.High);
            _controller.Write(_ain2, PinValue.Low);
            _controller.Write(_bin1, PinValue.Low);
            _controller.Write(_bin2, PinValue.High);

            Console.WriteLine("Left");
        }

        public void Right()
        {
            _pwmA.DutyCycle = 0.5;
            _pwmB.DutyCycle = 0.5;
            _controller.Write(_ain1, PinValue.Low);
            _controller.Write(_ain2, PinValue.High);
            _controller.Write(_bin1, PinValue.High);
            _controller.Write(_bin2, PinValue.Low);

            Console.WriteLine("Right");
        }
```

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Controlling the Buzzer

```
const int BuzzerPin = 4;


_gpioController.OpenPin(BuzzerPin, PinMode.Output);

        public void Buzz()
         {
             _gpioController.Write(BuzzerPin, PinValue.High);
         }

         public void Silence()
         {
             _gpioController.Write(BuzzerPin, PinValue.Low);
         }
```

Git clone https://github.com/CPTMSDUG/IoTHackDaysSession2DotNet

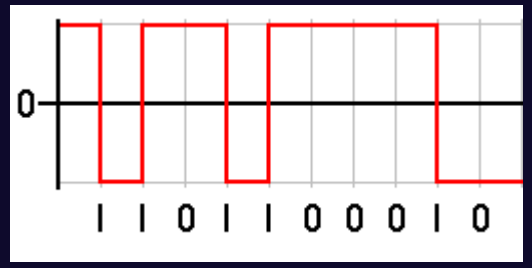
Controlling the Led Strips (WS2812)

```
var controller = settings.AddController(16, Pin.Gpio18, StripType.WS2812_STRIP, ControllerType.PWM0, 255, false);

using (var rpi = new WS281x(settings))
{
    var colors = GetAnimationColors();
    while (cycleIndex < colorCycles)
    {

        for (int i = 0; i <= controller.LEDCount - 1; i++)
        {
            var colorIndex = (i + colorOffset) % colors.Count;
            controller.SetLED(i, colors[colorIndex]);
        }

        rpi.Render();

        if (colorOffset == int.MaxValue)
        {
            colorOffset = 0;
        }
        colorOffset++;
        Thread.Sleep(50);

        cycleIndex++;
    }
```

Git clone https://github.com/CPTMSDUG/IoTHackDaysSession2DotNet

Controlling the Joystick

.NET Events and Event Handlers on Rising or Falling Pins



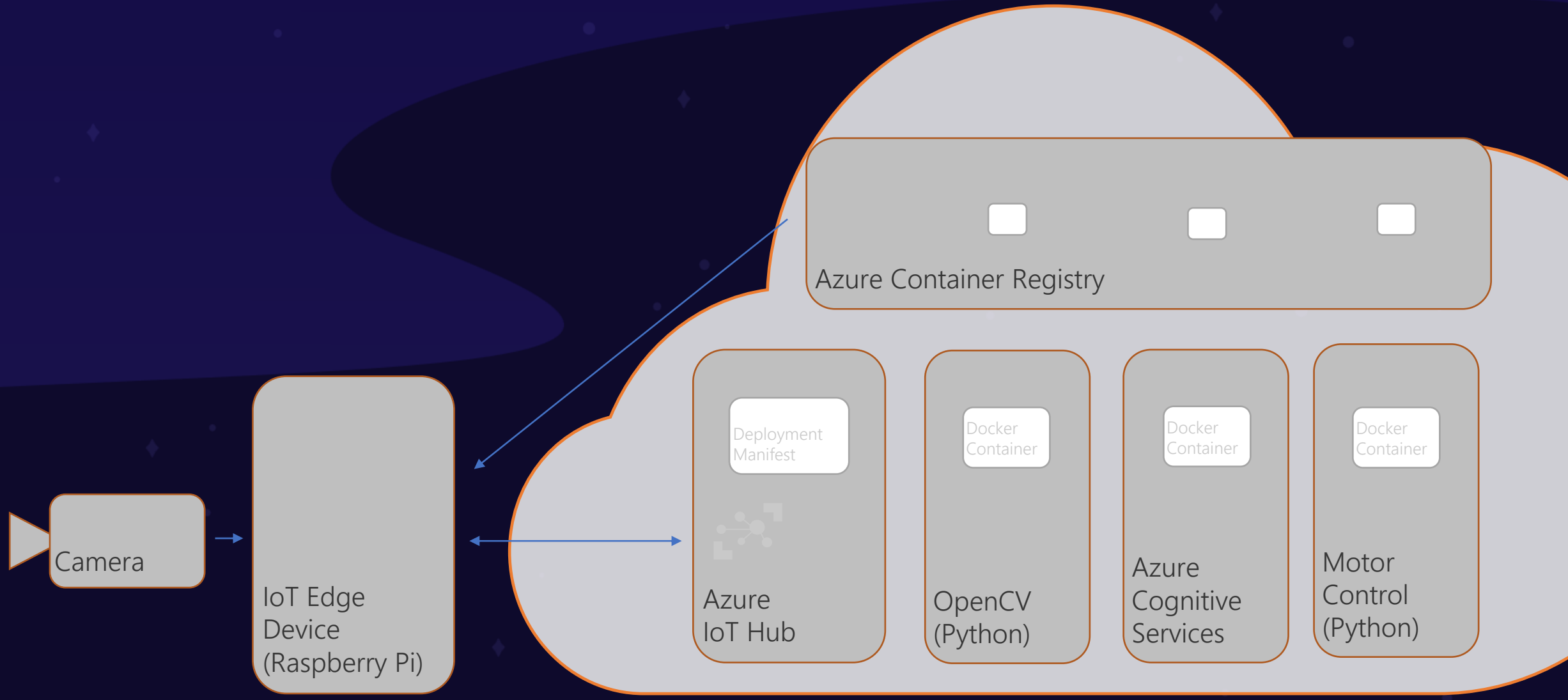

```
  _gpioController = controller;


            _gpioController.OpenPin(Ctr, PinMode.InputPullUp);
            _gpioController.OpenPin(A, PinMode.InputPullUp);
            _gpioController.OpenPin(B, PinMode.InputPullUp);
            _gpioController.OpenPin(C, PinMode.InputPullUp);
            _gpioController.OpenPin(D, PinMode.InputPullUp);

            _gpioController.RegisterCallbackForPinValueChangedEvent(Ctr,
PinEventTypes.Falling, CenterPressed);
            _gpioController.RegisterCallbackForPinValueChangedEvent(A,
PinEventTypes.Falling, APressed);
            _gpioController.RegisterCallbackForPinValueChangedEvent(B,
PinEventTypes.Falling, BPressed);
            _gpioController.RegisterCallbackForPinValueChangedEvent(C,
PinEventTypes.Falling, CPressed);
            _gpioController.RegisterCallbackForPinValueChangedEvent(D,
PinEventTypes.Falling, DPressed);
        }

        private void APressed(object sender, PinValueChangedEventArgs
pinValueChangedEventArgs)
        {
            _alphabot.Forward();
        }

        private void BPressed(object sender, PinValueChangedEventArgs
pinValueChangedEventArgs)
        {
            _alphabot.Right();
        }
```

Controlling the Collision Detector

```
        _gpioController.OpenPin(DR, PinMode.InputPullUp);
        _gpioController.OpenPin(DL, PinMode.InputPullUp);

        _gpioController.RegisterCallbackForPinValueChangedEvent(DL, PinEventTypes.Falling, DetectLeftCallback);
        _gpioController.RegisterCallbackForPinValueChangedEvent(DR, PinEventTypes.Falling, DetectRightCallback);

    }

    private void DetectLeftCallback(object sender, PinValueChangedEventArgs pinValueChangedEventArgs)
    {
        LeftCollision?.Invoke(this, pinValueChangedEventArgs);
        Collision?.Invoke(this, pinValueChangedEventArgs);
    }

    private void DetectRightCallback(object sender, PinValueChangedEventArgs pinValueChangedEventArgs)
    {
        RightCollision?.Invoke(this, pinValueChangedEventArgs);
        Collision?.Invoke(this, pinValueChangedEventArgs);
    }
```

Git clone https://github.com/CPTMSDUG/IoTHackDaysSession2DotNet

Next Session – Azure IoT Edge and AI



@CPTMSDUG

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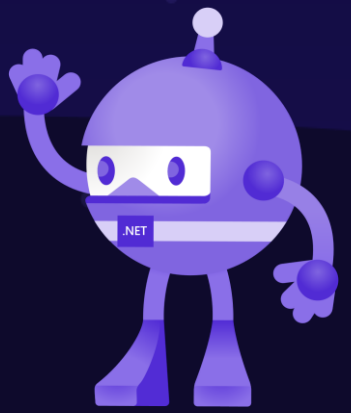
- Blog: https://explorationspace.co.za

- Raspberry Pi South Africa
- https://www.facebook.com/groups/1493503984198019

Thank you!!

Resources



Getting Started with .NET

https://learn.microsoft.com/en-us/dotnet/standard/get-started

Visual Studio Remote Debugger

https://www.hanselman.com/blog/remote-debugging-with-vs-code-on-windows-to-a-raspberry-pi-using-net-core-on-arm

Getting Started with Alphabot

https://www.waveshare.com/wiki/AlphaBot2

Azure IoT Central

https://azure.microsoft.com/en-us/products/iot-central/

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