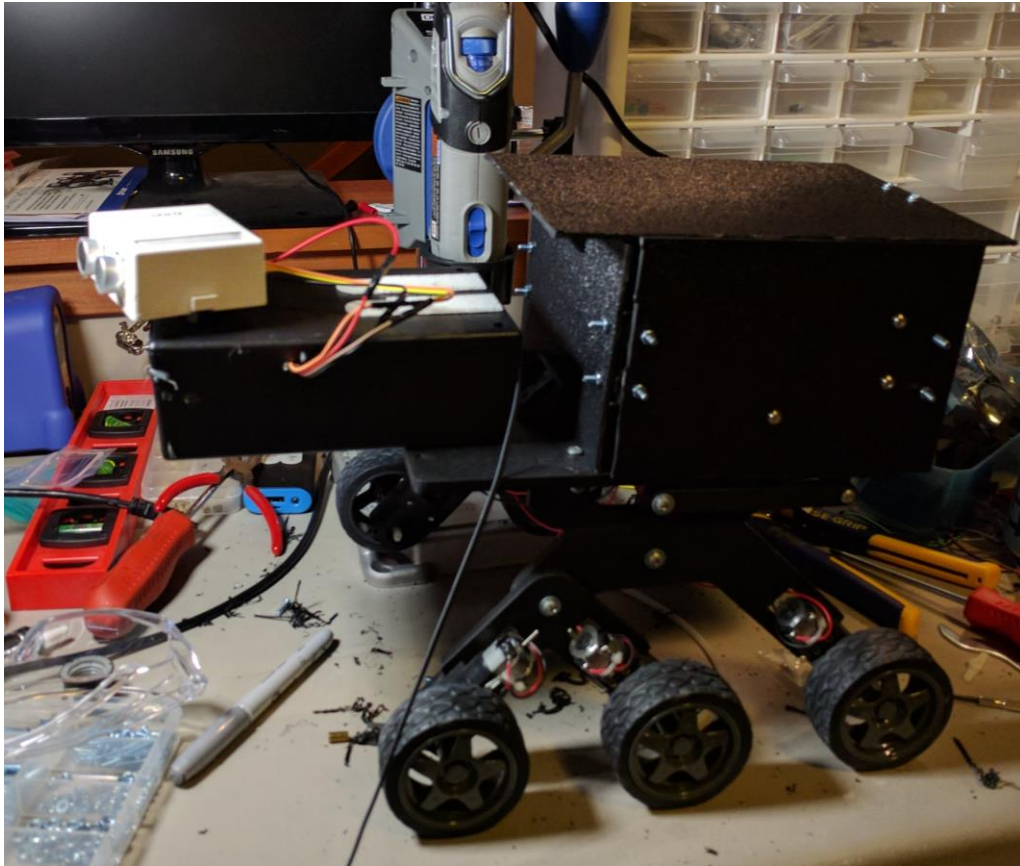


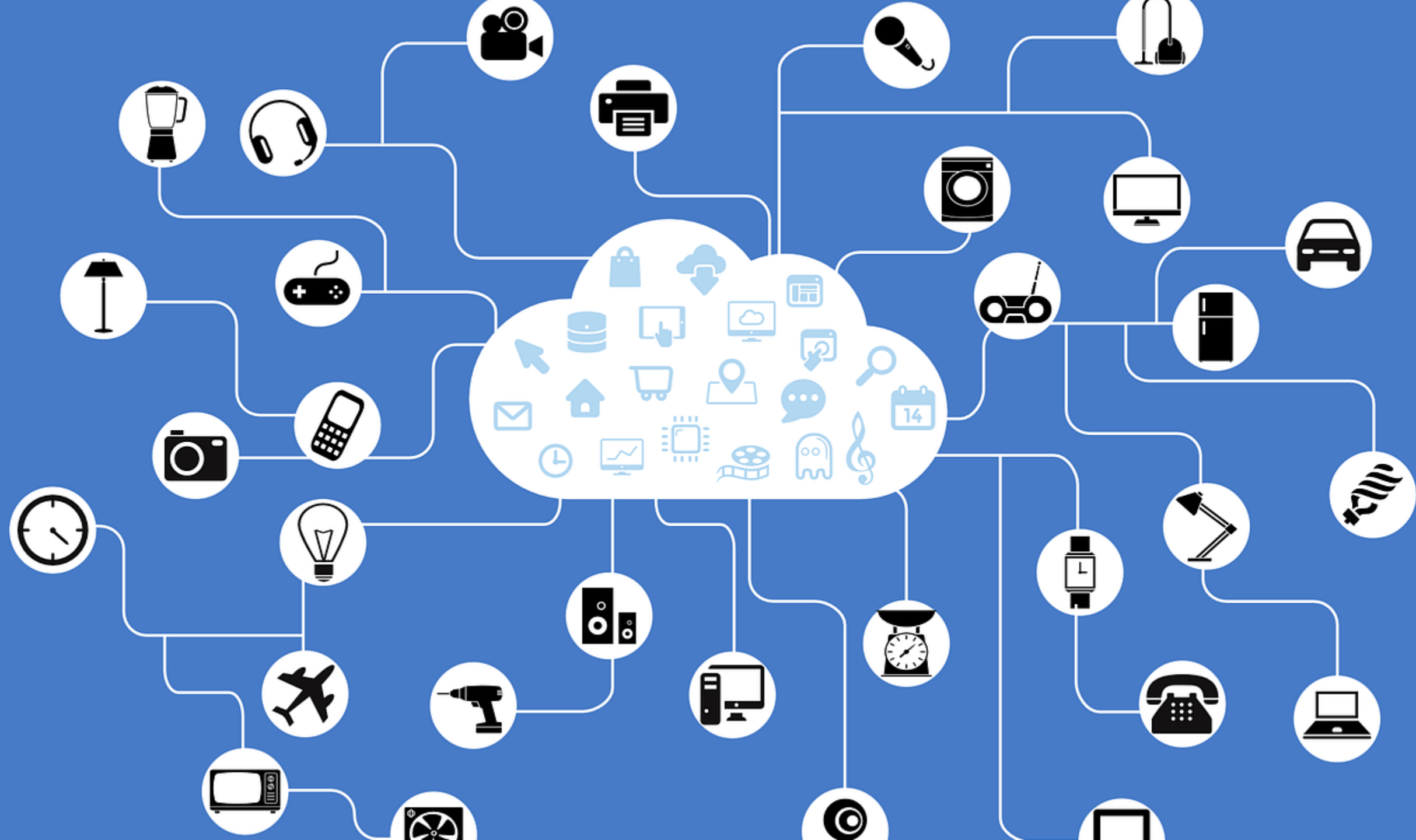
IoT real world applications and an overview of end to end solutions

Ian Macnichol



- Consultant in the business Solutions Group at HMB
- SharePoint developer for about 8 years
- IoT has been a hobby

About me



IoT Devices



IoT Growth

Growth in cloud availability

Increased of community and ease of use of development tools

You can connect from anywhere

HUGE drop in hardware cost, and availability

What is IoT about

- Monitoring
- Analysis
- Prediction
- Insight into the real world
- Decisions based on more data

Business cases

Inventory tracking

Machine preventative
maintenance

Connected factories

Agenda

IoT Architecture

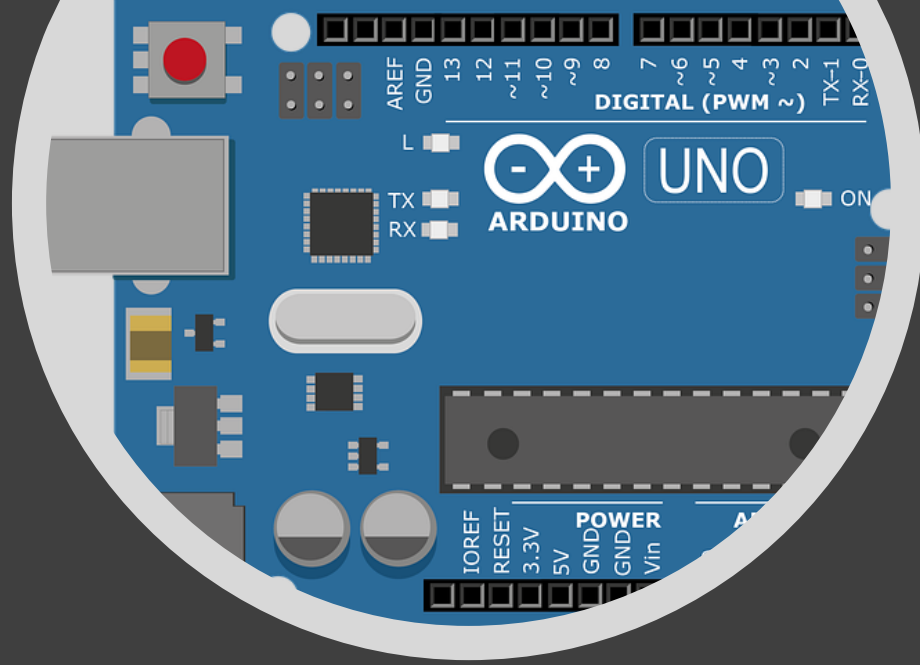
Raspberry Pi

Arduino

Windows IoT Core

Microsoft Azure IoT services

IoT Architecture



IoT Messaging

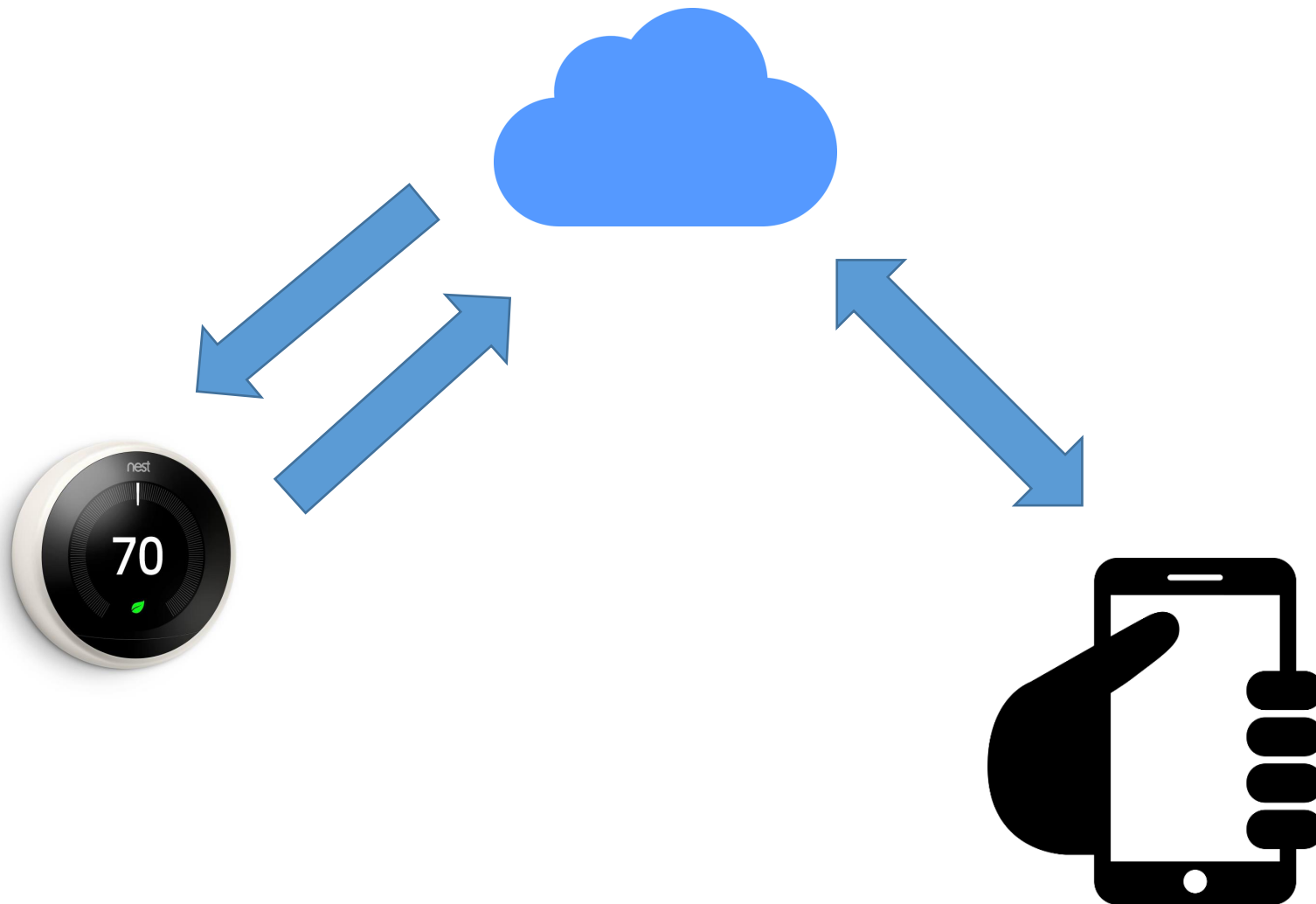


Device-to-Cloud

- Allows for the transmission of telemetry, messaging or other data from IoT device to Cloud
 - Sensor data
- Is ingested and stored

Cloud-to-Device

- Allows for commands or other data to be sent from the cloud to the device
 - Hey! Reboot! / Send data more often



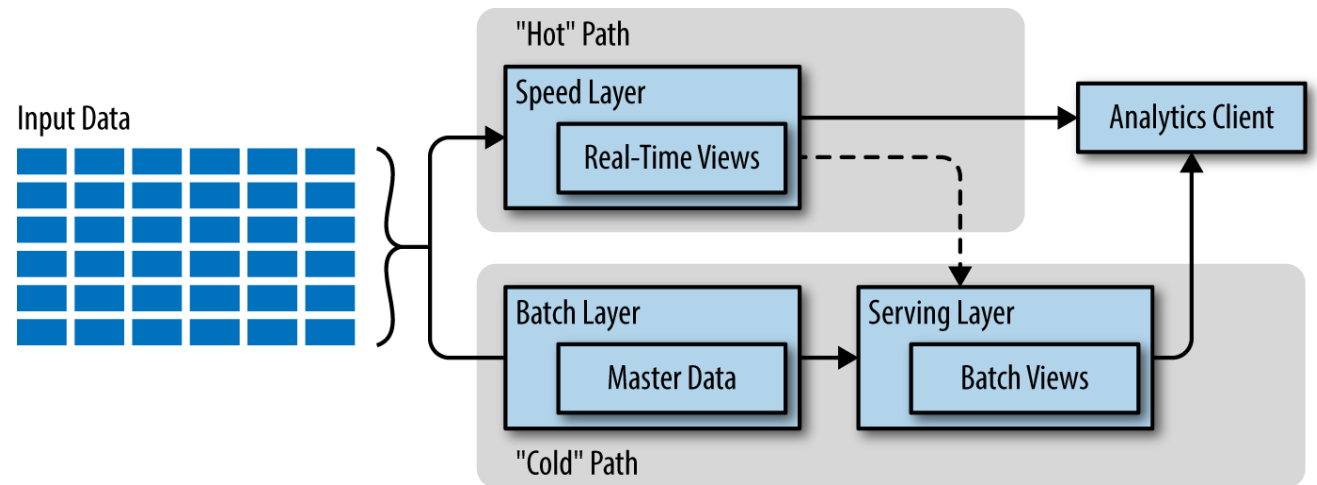
Lambda Architecture

- Hot path

- FAST
- Real time data
- Real time actions

- Cold path

- SLOW
- Batching
- Storing



IoT gateways

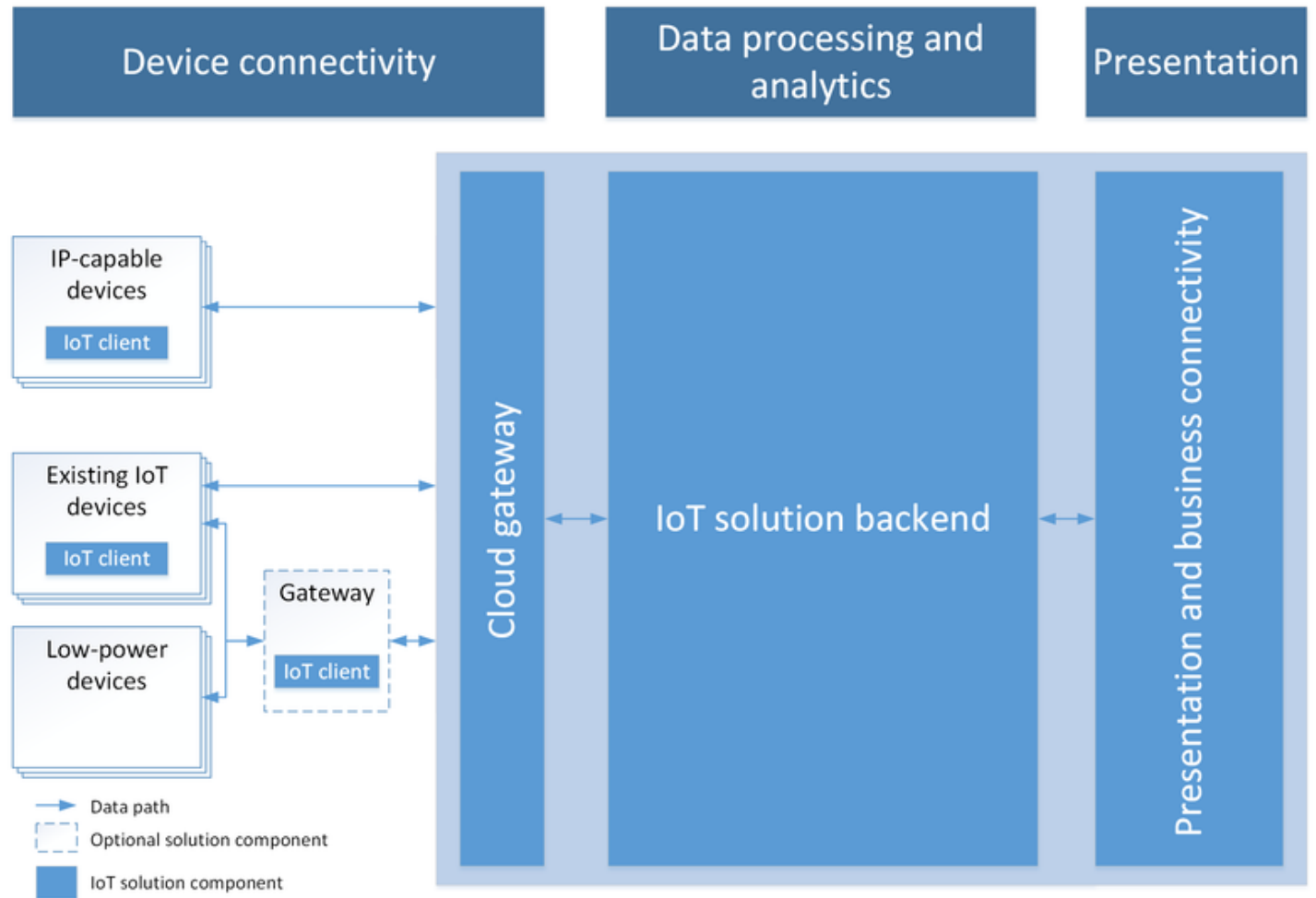
Telemetry aggregation point

- Message brokers
- Message Queues

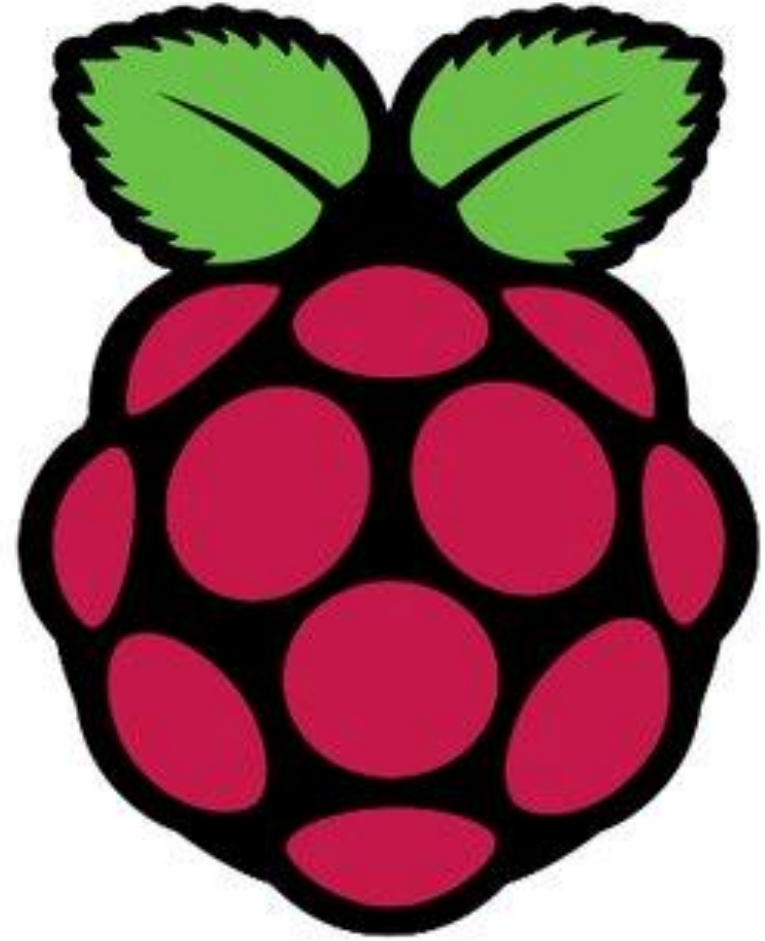
Two primary types of gateways

- Field Gateway
 - Low powered devices, maybe no encryption supported on device
- Protocol Gateway
 - Protocol adaptation

IoT Architecture



Yum, Pi



Raspberry Pi

- Designed originally to help teach basic computer science in schools
- Very active community

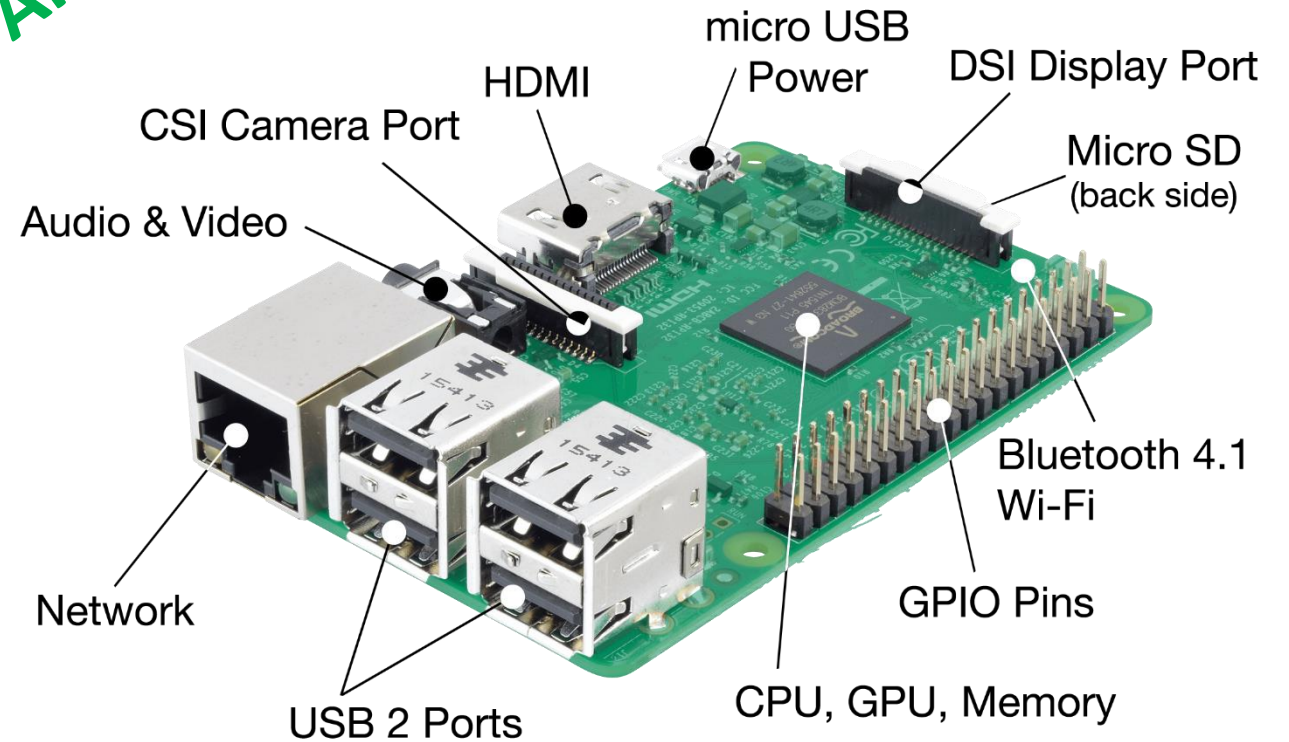


<http://www.raspberrypi.org>

Raspberry Pi 3 Model B+

- 1.4GHz 64-bit quad-core ARM Cortex-A53 CPU
- 1GB RAM
- Integrated:
 - WIFI 802.11n
 - Bluetooth 4.1 w/BLE

Around \$35!

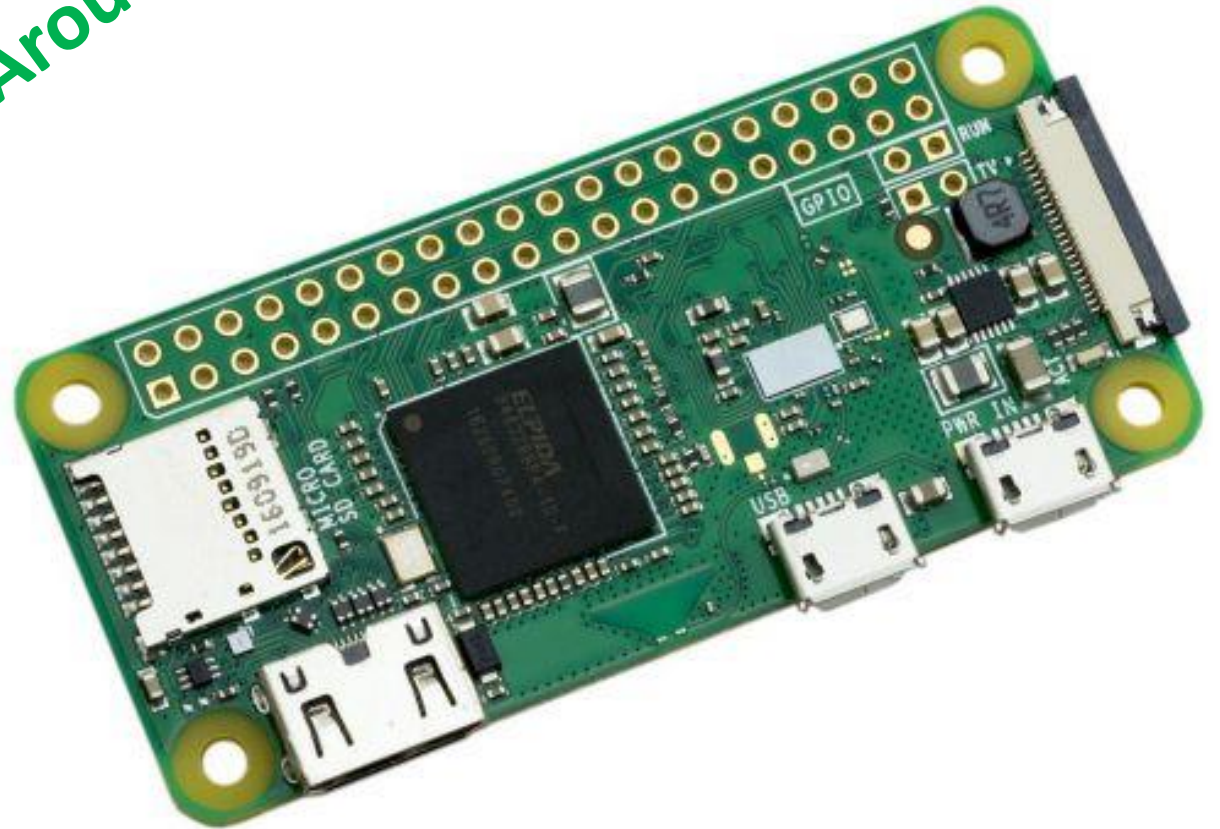


https://elinux.org/RPi_HardwareHistory#Raspberry_Pi_3_Model_B.2B

Raspberry pi zero W

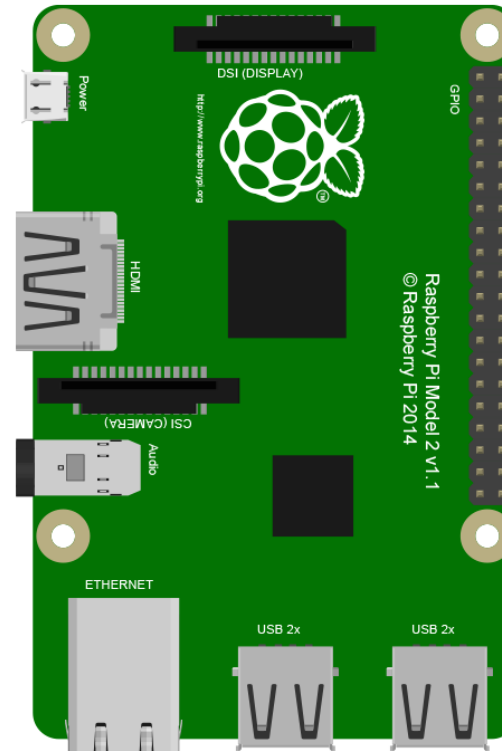
- About half the size of the Raspberry Pi
- Released 2017
- WIFI 802.11n built in
- Not as powerful as full Pi
- Can't run Windows IoT Core
- Does run Raspbian

Around \$10!



Raspberry Pi GPIO pins

- 40 GPIO Pins
- 5V and 3.3V
- I2C
- SPI
- UART



Raspberry Pi 2 Model B (J8 Header) pinout

WiringPi	BCM(Name)	Physical	Physical	BCM(Name)	WiringPi
3v3 Power		1	2	5v Power	
8	BCM 2 (SDA)	3	4	5v Power	
9	BCM 3 (SCL)	5	6	Ground	
7	BCM 4 (GPCLK0)	7	8	BCM 14 (TXD)	15
Ground		6	10	BCM 15 (RXD)	16
0	BCM 17	11	12	BCM 18 (PCM_C)	1
2	BCM 27 (PCM_D)	13	14	Ground	
3	BCM 22	15	16	BCM 23	4
3v3 Power		17	18	BCM 24	5
12	BCM 10 (MOSI)	19	20	Ground	
13	BCM 9 (MISO)	12	22	BCM 25	6
14	BCM 11 (SCLK)	23	24	BCM 8 (CE0)	10
Ground		25	26	BCM 7 (CE1)	11
	BCM 0 (ID_SD)	27	28	BCM 1 (ID_SC)	
21	BCM 5	29	30	Ground	
22	BCM 6	16	32	BCM 12	26
23	BCM 13	33	34	Ground	
24	BCM 19 (MISO)	35	36	BCM 16	27
25	BCM 26	37	38	BCM 20 (MOSI)	28
Ground		39	40	BCM 21 (SCLK)	29

Programming languages

Raspbian / Linux

- C, C++, Python, Java, Javascript
- Very open to IDE

Windows IoT Core

- Familiar experience for many of us
- Visual Studio
- Windows Universal Platform (UWP) Apps

Azure Certified for IoT starter Kit

This kit includes:

1x Assembled Adafruit Feather M0 WiFi w/ Feather Stacking Headers

1x FeatherWing OLED - 128x32 OLED Add-on

1x Assembled BME280 I2C or SPI Temperature/Humidity/Pressure Sensor

1x Micro Servo

1x PIR (motion) Sensor

1x Fast Vibration Switch

1x Magnetic Contact Switch (door sensor)

1x Full-sized Breadboard

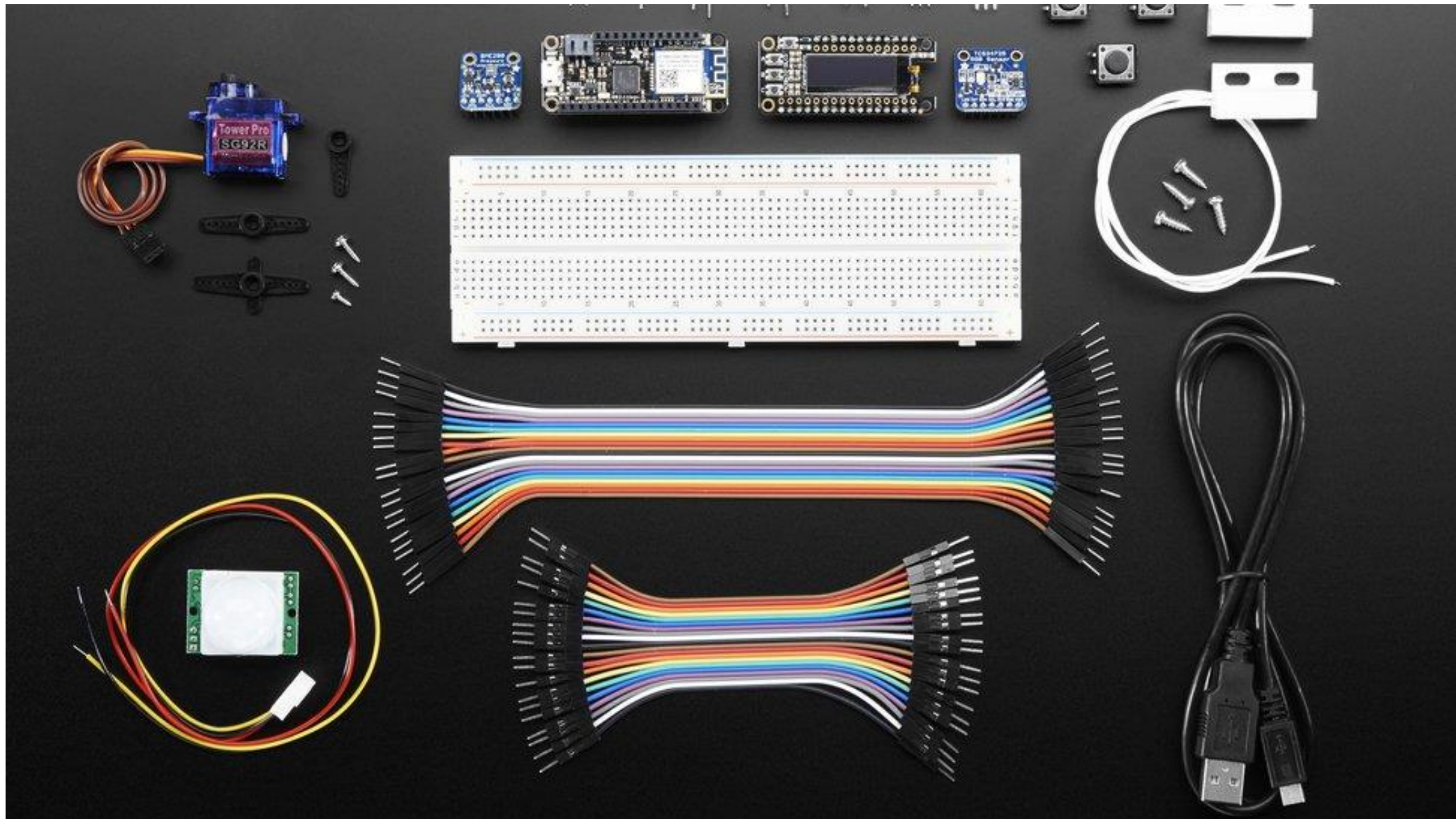
1x Assembled TCS34725 RGB Color Sensor

1x Premium Male/Male Jumper Wires - 20 x 6"

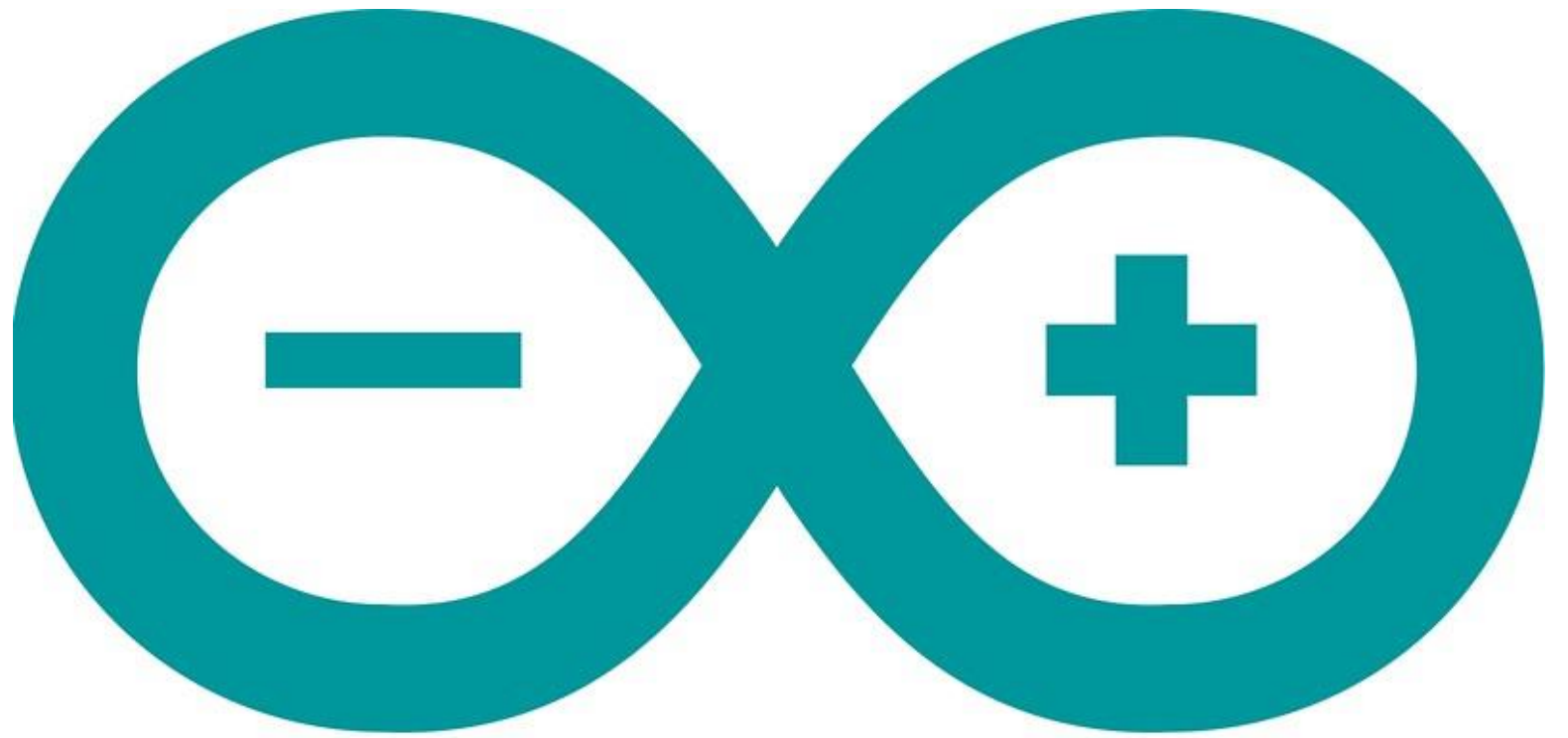
1x Premium Male/Male Jumper Wires - 20 x 3"

1x USB Cable - A/Micro B

<https://www.adafruit.com/product/3031>



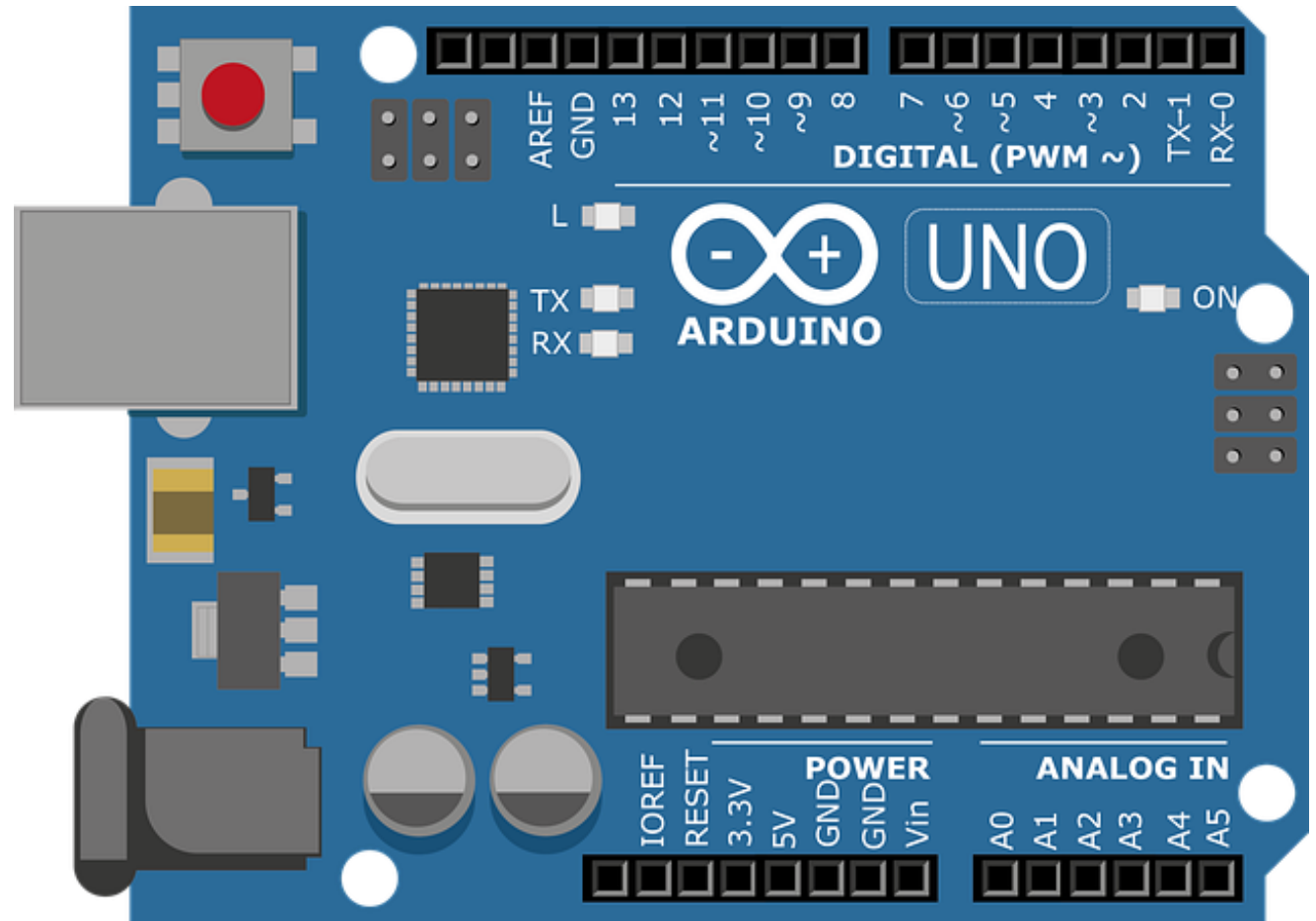
Arduino



ARDUINO

Arduino specs

- Open Source electronics prototyping platform
- First released 2005
- Many different boards and in various sizes / features
- Microcontroller
- Many shields available



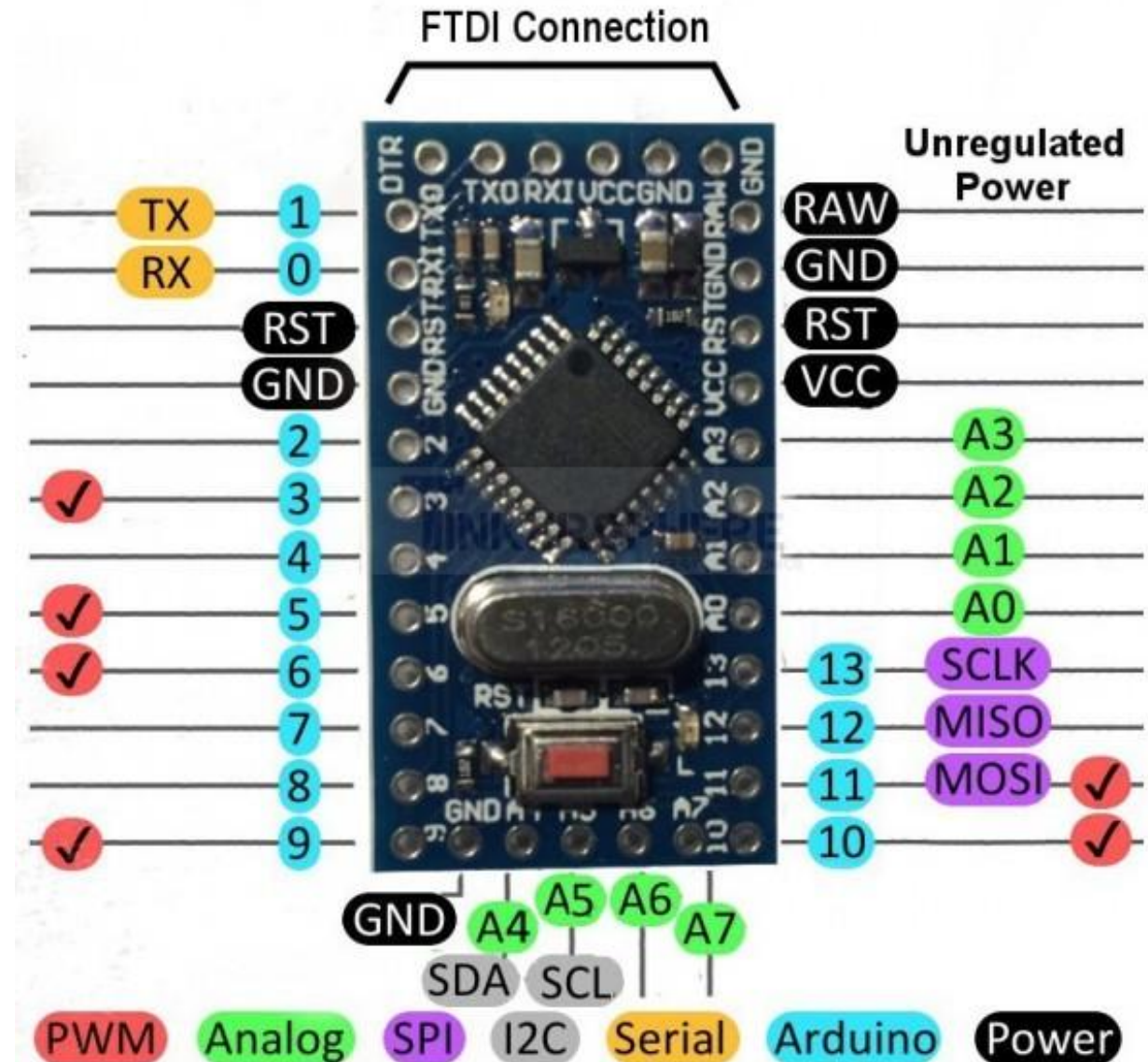
<https://Arduino.cc>

Boards overview

ENTRY LEVEL	UNO	LEONARDO	101	ESPLORA	MICRO	NANO	MINI	MKR2UNO ADAPTER	STARTER KIT	LCD SCREEN							
ENHANCED FEATURES	MEGA	ZERO	DUE	MEGA ADK	MO	MO PRO	MKR ZERO	MOTOR SHIELD	USB HOST SHIELD	PROTO SHIELD	MKR PROTO SHIELD	4 RELAYS SHIELD	MEGA PROTO SHIELD	MKR RELAY PROTO SHIELD	ISP	USB2SERIAL MICRO	USB2SERIAL CONVERTER
INTERNET OF THINGS	YÚN	ETHERNET	TIAN	INDUSTRIAL 101	LEONARDO ETH	MKR FOX 1200	MKR WAN 1300	MKR GSM 1400	MKR1000	YUN MINI	YÚN SHIELD	WIRELESS SD SHIELD	WIRELESS PROTO SHIELD	ETHERNET SHIELD V2	GSM SHIELD V2	MKR IoT BUNDLE	
EDUCATION	CTC 101																
WEARABLE	GEMMA	LILYPAD ARDUINO USB	LILYPAD ARDUINO MAIN BOARD	LILYPAD ARDUINO SIMPLE	LILYPAD ARDUINO SIMPLE SNAP												

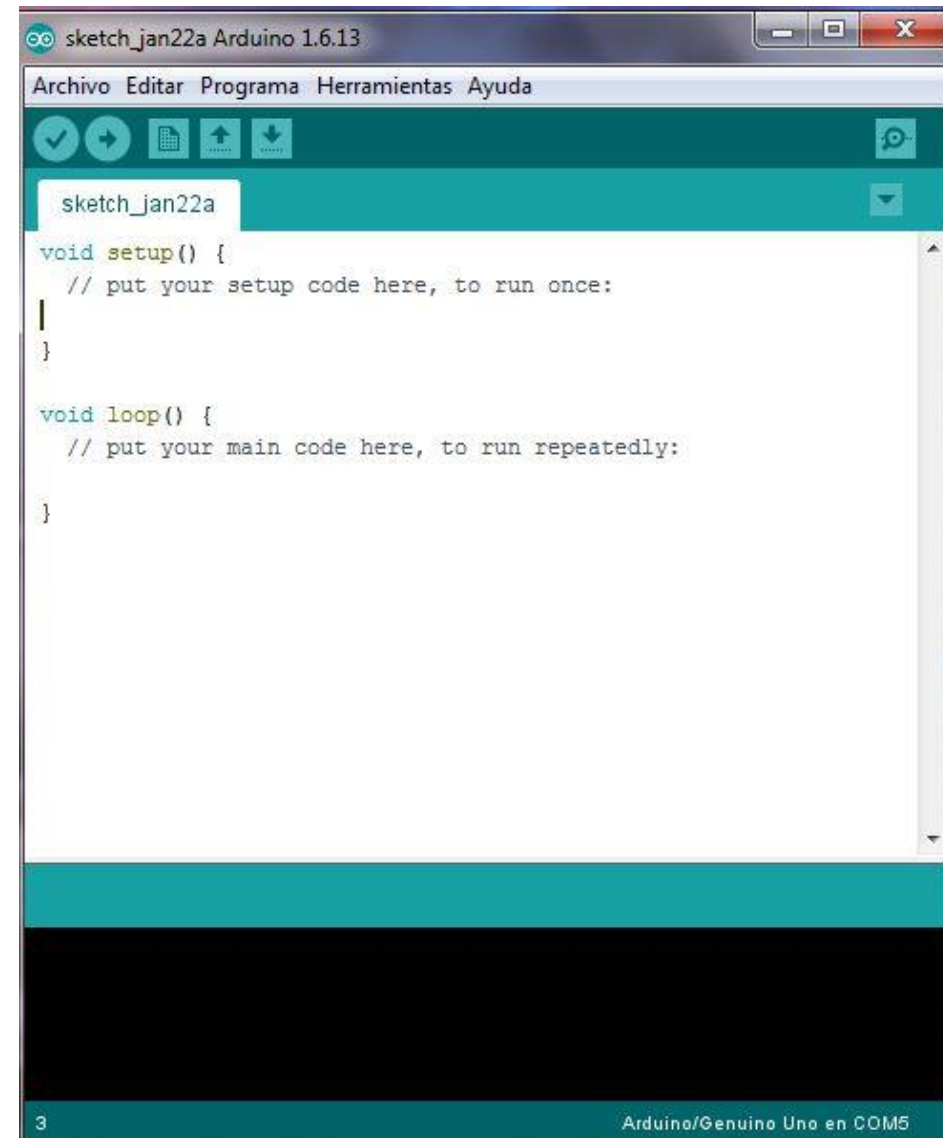
BOARDS MODULES SHIELDS KITS ACCESSORIES COMING NEXT

GPIO for Arduino



How to program an Arduino

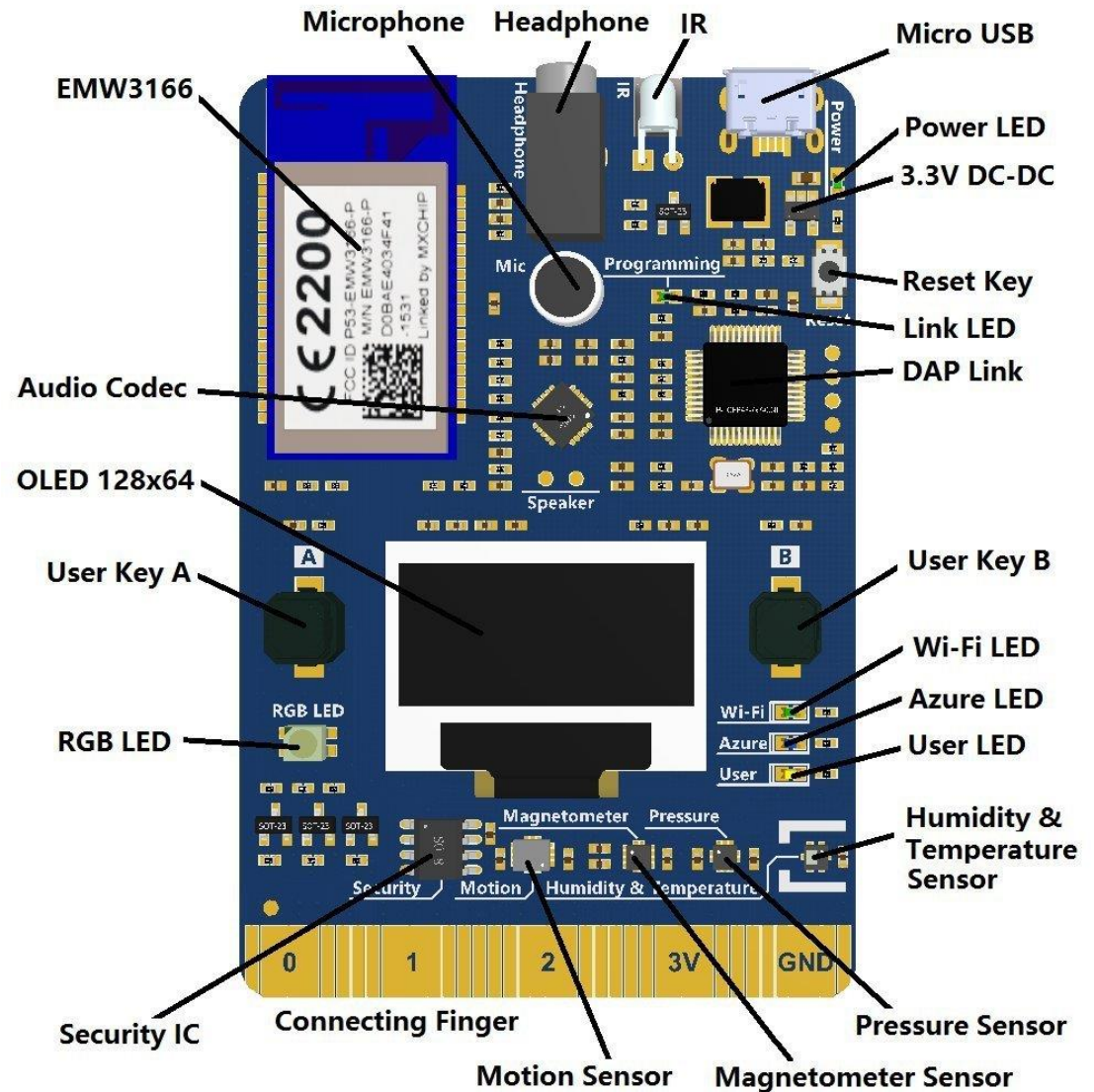
- Arduino IDE
 - Open source IDE
 - Released under GPL v2
 - Cross-Platform
- Use VSCode as well



Additional Arduino Hardware

Microsoft Azure IoT Developer Kit

- Arduino compatible
- Integrated hardware
 - Sensors
 - OLED display
 - Buttons
 - WIFI
- About \$45





Windows 10 IoT Core

Windows IoT Core



- Runs with or without a display
- Supports Auto-update over windows update
- Is mainly supported by the larger boards, but you still have options
- IS FREE to use

Windows IoT core Dashboard

- Assists in flashing SD card
- Configures device settings
 - Device name
 - Administrator Password
 - WIFI network

The screenshot shows the 'Set up a new device' page in the Windows IoT Dashboard. The left sidebar contains navigation links: 'My devices', 'Set up a new device' (highlighted), 'Connect to Azure', and 'Try some samples'. At the bottom of the sidebar are 'Sign in' and 'Settings' links. The main content area is titled 'Set up a new device' and includes the instruction 'First, let's get Windows 10 IoT Core on your device.' Below this are several configuration fields: 'Device type' (set to 'Raspberry Pi 2 & 3'), 'OS Build' (set to 'Windows 10 IoT Core (16299)'), 'Drive' (set to 'Insert an SD card into your computer.'), 'Device name' (set to 'minwinpc'), 'New Administrator password' (empty), and 'Confirm Administrator password' (empty). On the right, there is a 'Wi-Fi Network Connection' section with a checked checkbox and a dropdown menu showing 'CollisionErrorComebacklater-2ghz'. Below this is a note: 'Only 2.4 Ghz WiFi networks that have already been connected to will appear in this list'. At the bottom right, there is an unchecked checkbox for 'I accept the software license terms' and a 'Download and install' button. At the bottom left of the main area, there are three links: 'View software license terms', 'View the list of recommended SD cards', and 'View the list of supported Wi-Fi adapters'.

<https://developer.microsoft.com/en-us/windows/iot/downloads>

Working with the device



- Windows Device Portal
- Remote Display
- Command-Line Utilities (PowerShell)
- Device web portal

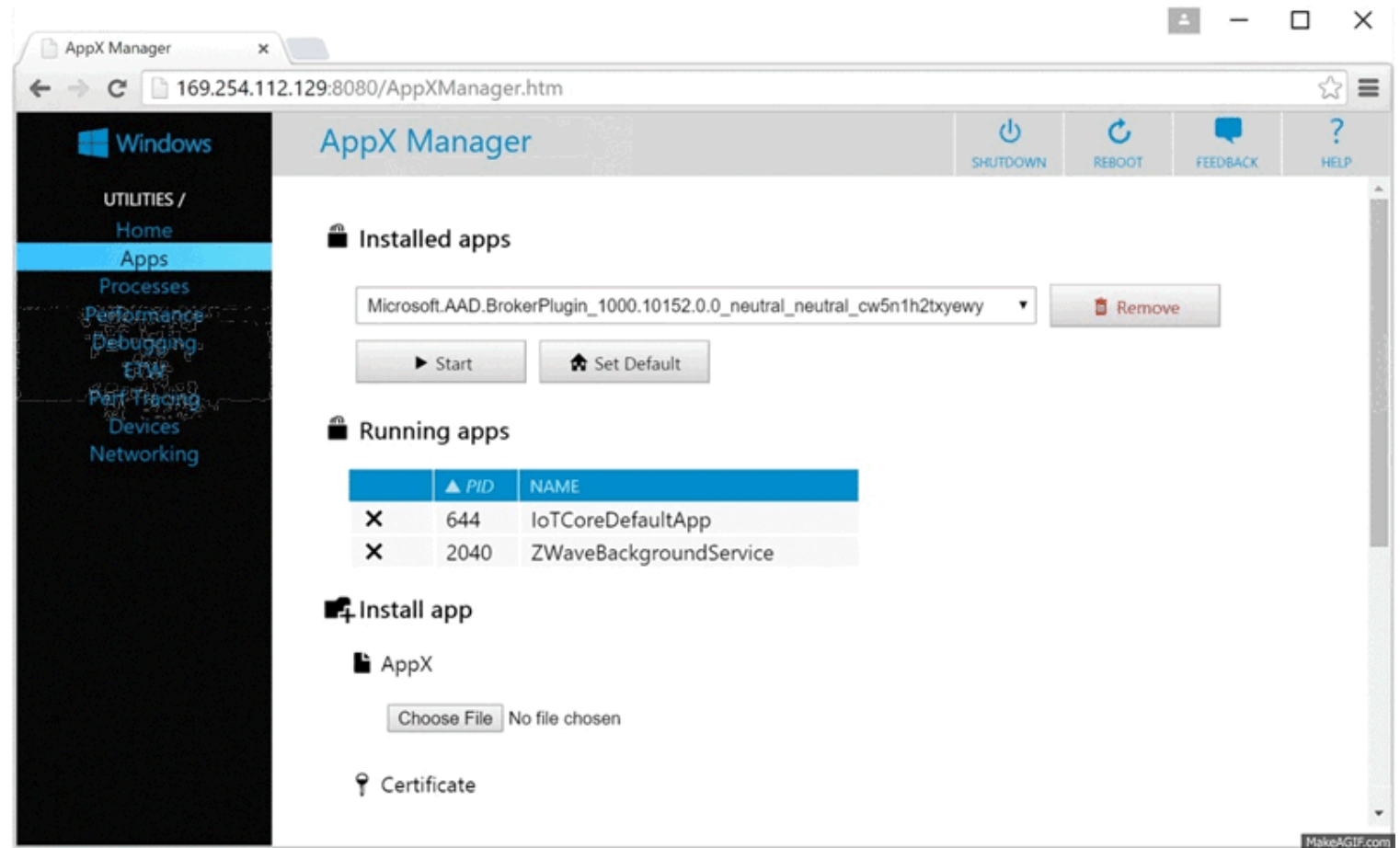
Device interface

- Device name
- Network and IP address
- Windows Version
- Command line access
- Settings



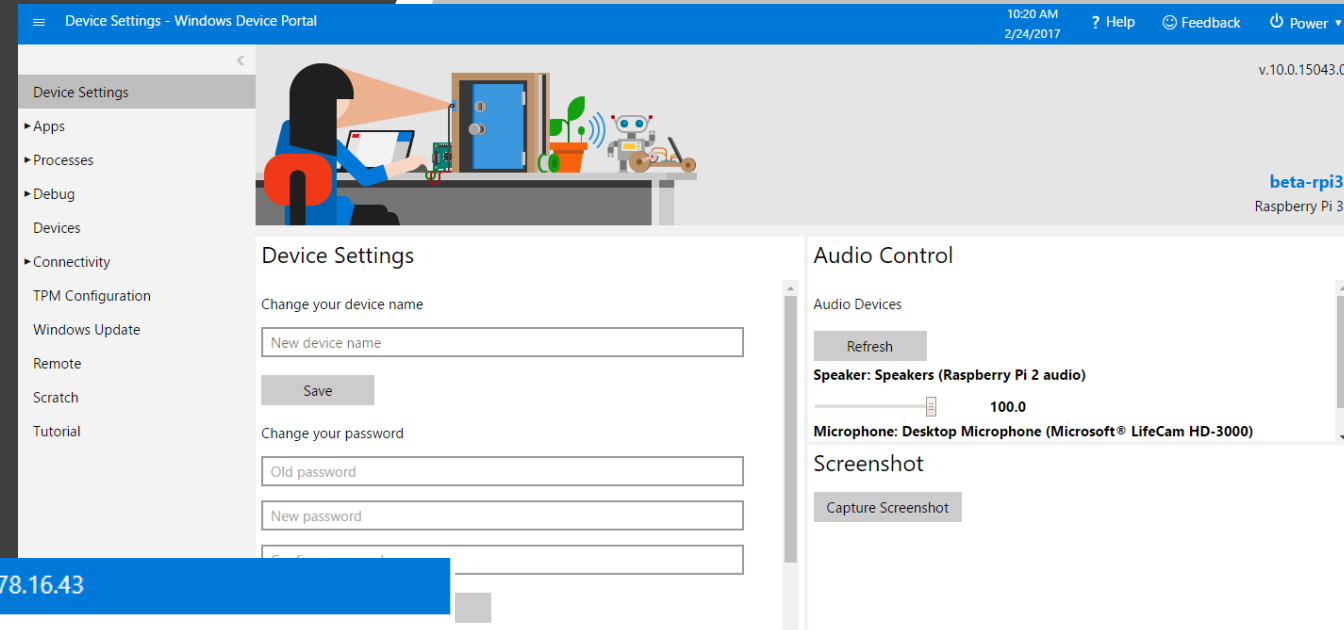
Device web portal with the windows device portal

- Headless management
- `http://{IP}:8080`
- Login: Administrator
- Password when you flashed it





Windows Device Portal


- Launch right from the device dashboard
- Configure and manage your device remotely





beta-rpi2	Raspberry Pi 2 Model B	10.0.15139.1000	10.178.16.43	
imorri-rpi		10.0.15041.0	10.178.16.56	2001:4898:d8:303f:e575:4d4c
IoTSmart		10.0.15010.1000	10.178.17.214	
jshih-SM		10.0.15010.1000	10.178.17.235	
Imorri-clc		10.0.15041.0	10.178.16.8	2001:4898:d8:303f:1051:2a75
mdpi	Model B	10.0.15026.1000	10.178.16.74	
minwinp		10.0.15035.1001	10.178.16.24	


 Open in Device Portal


 Launch PowerShell


 Launch IoT Remote Client


 Open network share


 Copy IPv4 address

 Copy IPv6 address

 Copy device name

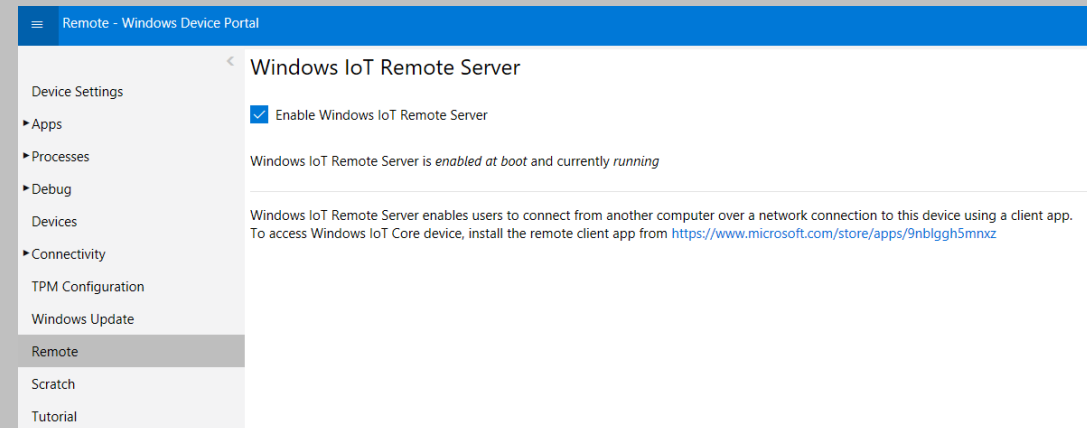
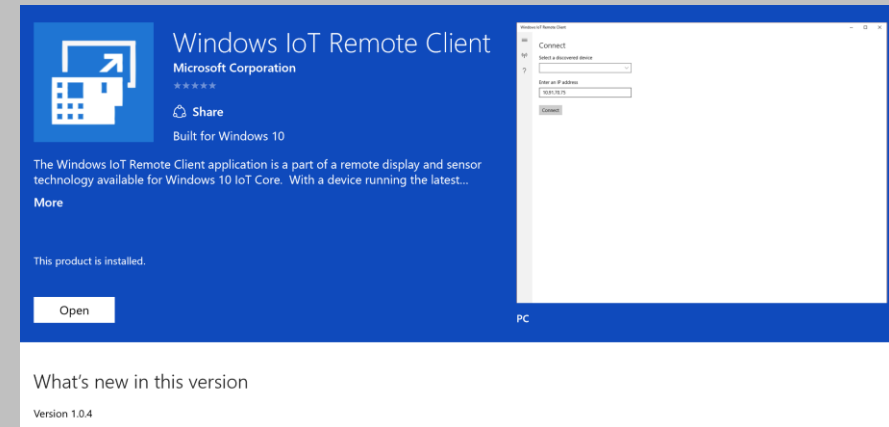
 Shutdown

 Restart

 Send feedback

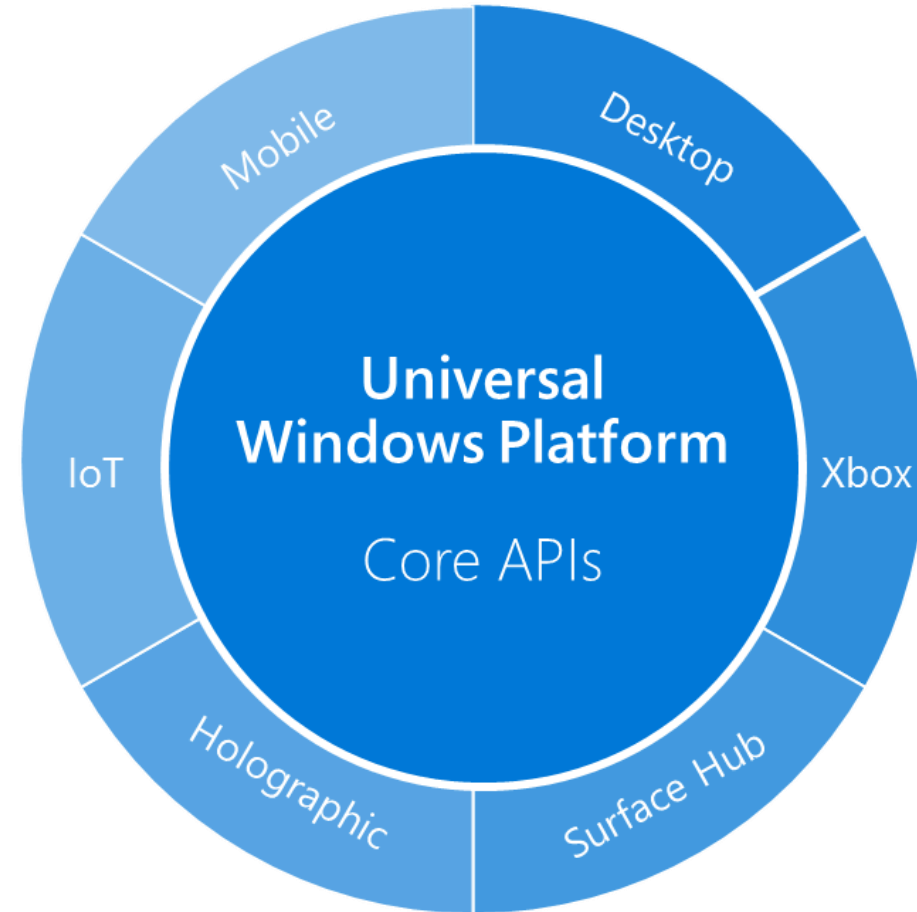
Windows IoT remote client

- Required to enable the Windows IoT Remote Server
- Connect and see running UWP apps on the device



IoT Development with IoT core

- Universal Windows Apps (UWP) API
 - Not install from the store
 - Same development tools as:
 - Windows 10
 - HoloLens
 - Etc
 - Visual studio



Windows 10 IoT Editions

Windows 10 IoT for industry devices

Desktop Shell, Win32 apps, Universal apps and drivers

Minimum: 1 GB RAM, 16 GB storage

x86/x64

Windows 10 IoT for mobile devices

Modern Shell, Mobile apps, Universal apps and drivers

Minimum: 512 MB RAM, 4 GB storage

ARM

Windows 10 IoT Core

Universal Apps and Drivers

No shell or MS apps

Minimum: 256MB RAM, 2GB storage

x86/x64 or ARM



Windows
Updates



Visual Studio &
UWP



New User
Interfaces



Security &
Identity



AllJoyn

Integrated
Device
Connectivity



Microsoft
Azure IoT

IoT core Enterprise



Windows 10 IoT Enterprise

Windows 10 IoT Enterprise is a full version of Windows 10 that delivers enterprise manageability and security to IoT solutions. It is designed for powerful industry devices used in retail, manufacturing, healthcare, and other industries. Note: Windows 10 IoT Enterprise is a binary equivalent to Windows 10 Enterprise.

	Windows 10 IoT Core	Windows 10 IoT Enterprise
User experience	Single UWP app running at startup with supporting background apps and services.	Traditional Windows Shell with Advanced Lockdown Features
Headless supported	Yes	Yes
App architecture supported	UWP only	UWP and Win32
Cortana	<i>Cortana SDK</i>	Yes
Domain join	AAD only	AAD and Traditional Domain
Management	MDM	MDM
Device Security Technologies	TPM, Secure Boot, BitLocker, Device Health Attestation, and Device Guard for IoT	TPM, Secure Boot, BitLocker, Device Guard, Defender ATP, and Device Health Attestation
CPU Architecture support	x86, x64, and ARM	x86 and x64
Licensing	Online Licensing Agreement and Embedded OEM Agreements, Royalty-free	Direct and Indirect Embedded OEM Agreements
Usage scenarios	Digital Signage, Smart Building, IoT Gateway, HMI, Smart Home, Wearables	Industry Tablets, POS, Kiosk, Digital Signage, ATM, Medical Devices, Manufacturing Devices, Thin Client



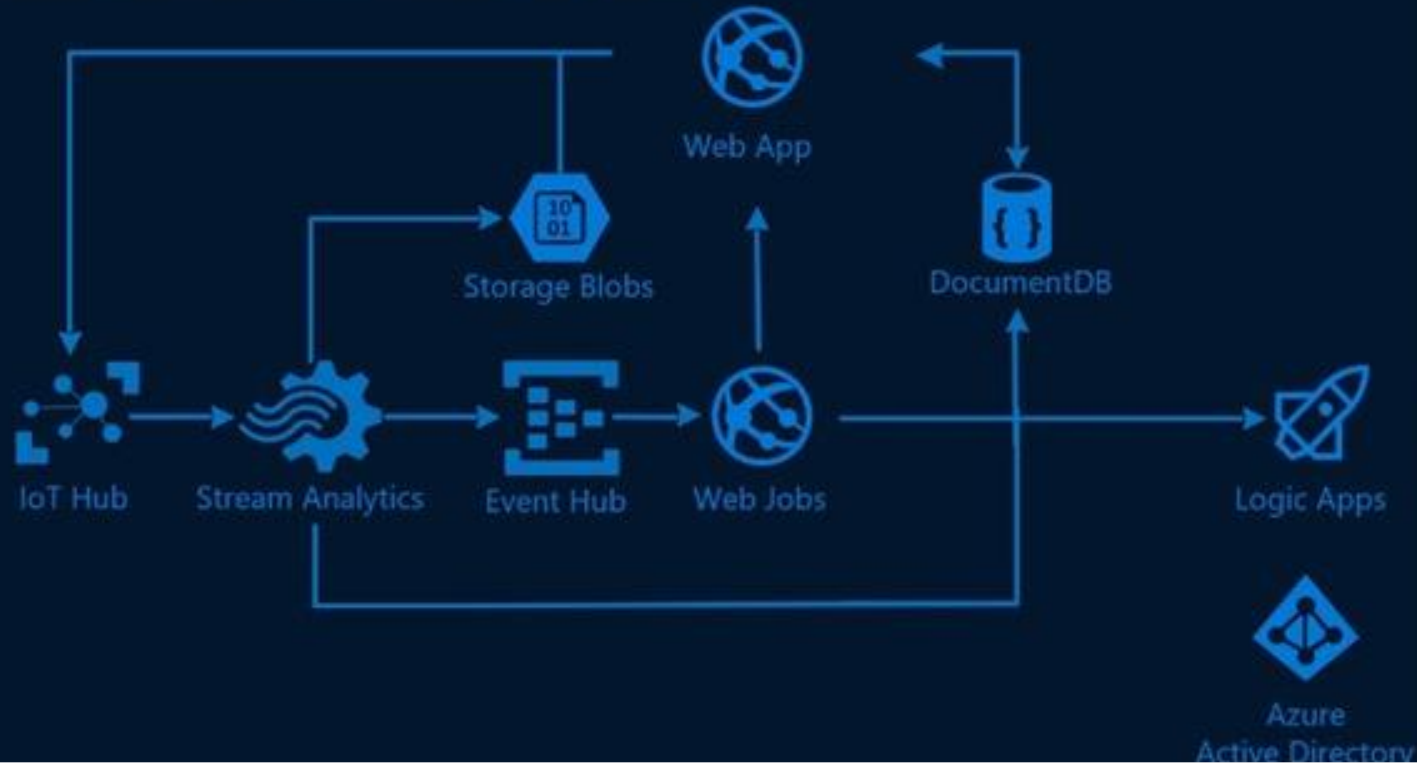
Microsoft Azure

Devices

Azure IoT Device SDK (OSS)
Linux, RTOS, mBed, Windows,
Android, iOS



Azure IoT Suite Remote Monitoring



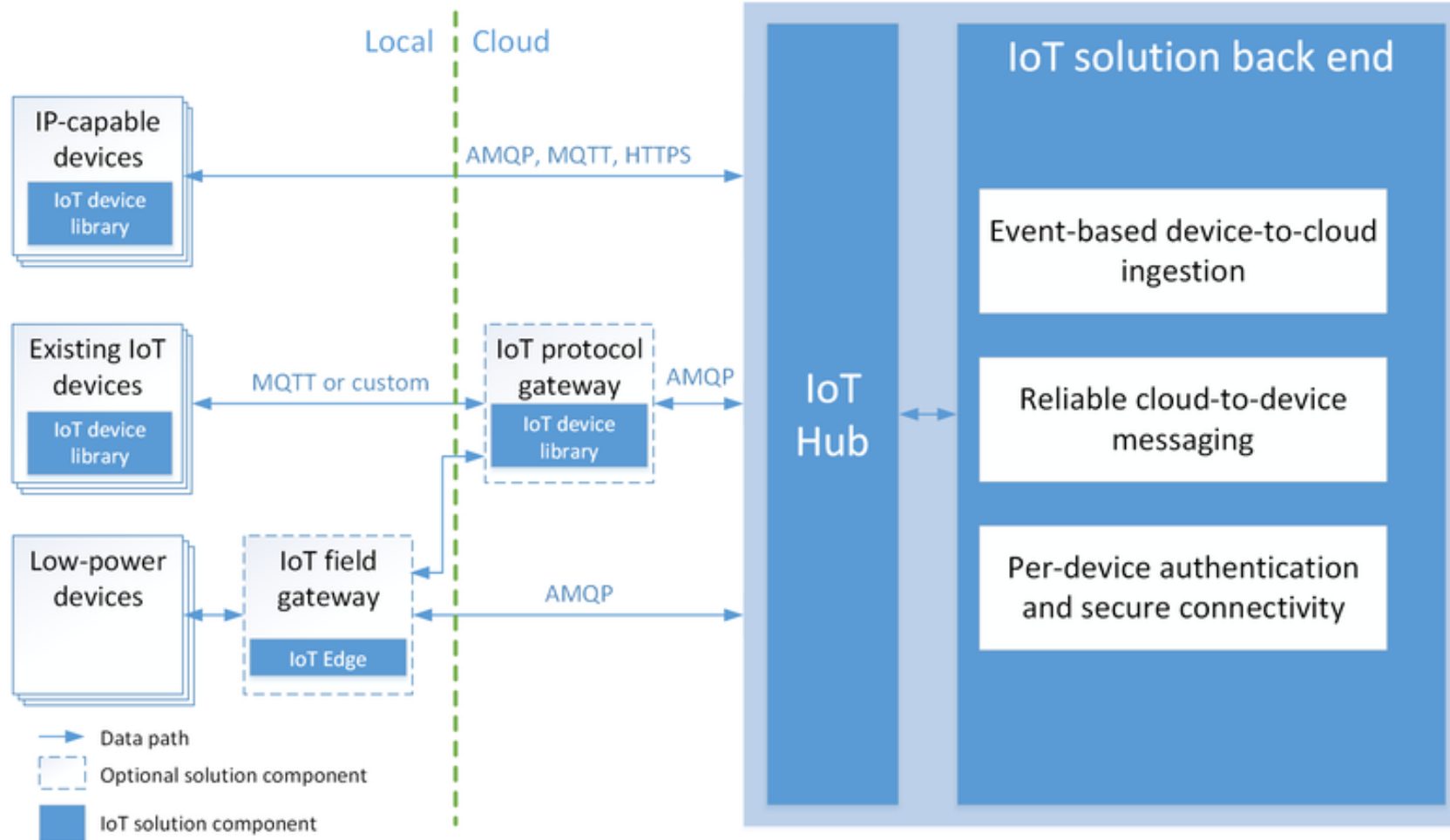
Azure IoT Suite

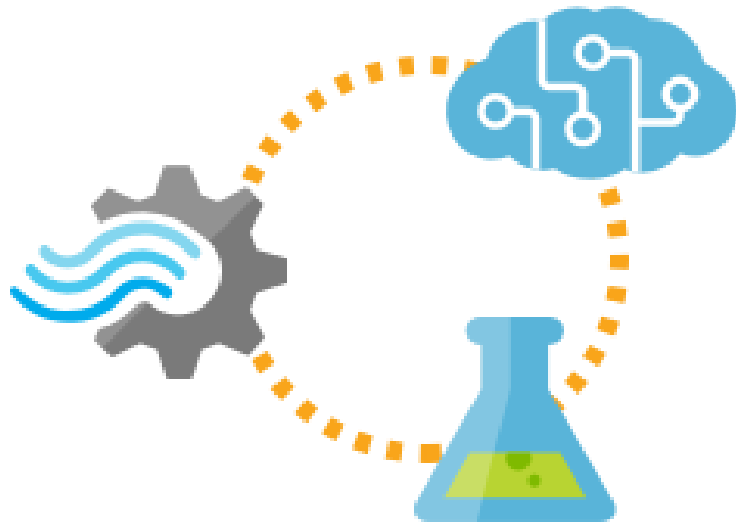
IoT hub

- Device-2-cloud messaging
 - Supports AMQP, MQTT, HTTP/1
- Cloud-2-Device messaging
- Massively scalable
- Ability to manage individual devices / secure devices
- Azure IoT Gateway SDK
 - Open source SDK for building IoT gateways

Device connectivity

Data processing and analytics





- Enable AI and advanced analytics at the edge
- Reduce IoT solution Cost
- Store and forward
- Protect your data

IoT Edge



Notification Hub

- Send push notifications to any platform
- Supports all major platforms
 - iOS, Android, Kindle, etc
- Highly scalable
 - Millions of mobile devices and billions of notifications

Event Hub

- Less concurrent connection
- One way communication
- No device level security





Stream analytics

- Real-time stream processing
 - Millions of events per second
- Can handle multiple inputs and Outputs
 - Inputs: IoT hubs, Event Hubs, Blob Storage
 - Output: SQL Database, Azure Storage, Event Hubs, Power Bi, Queues
- Uses SQL-like query syntax for input to Output mapping

Stream analytics basic query

AzureBootCamp2018PolarisSA

Query



Save



Discard



Test

▼ Inputs (1)



AzureBootCampIOTHUB

...

▼ Outputs (2)



computeLaterTable

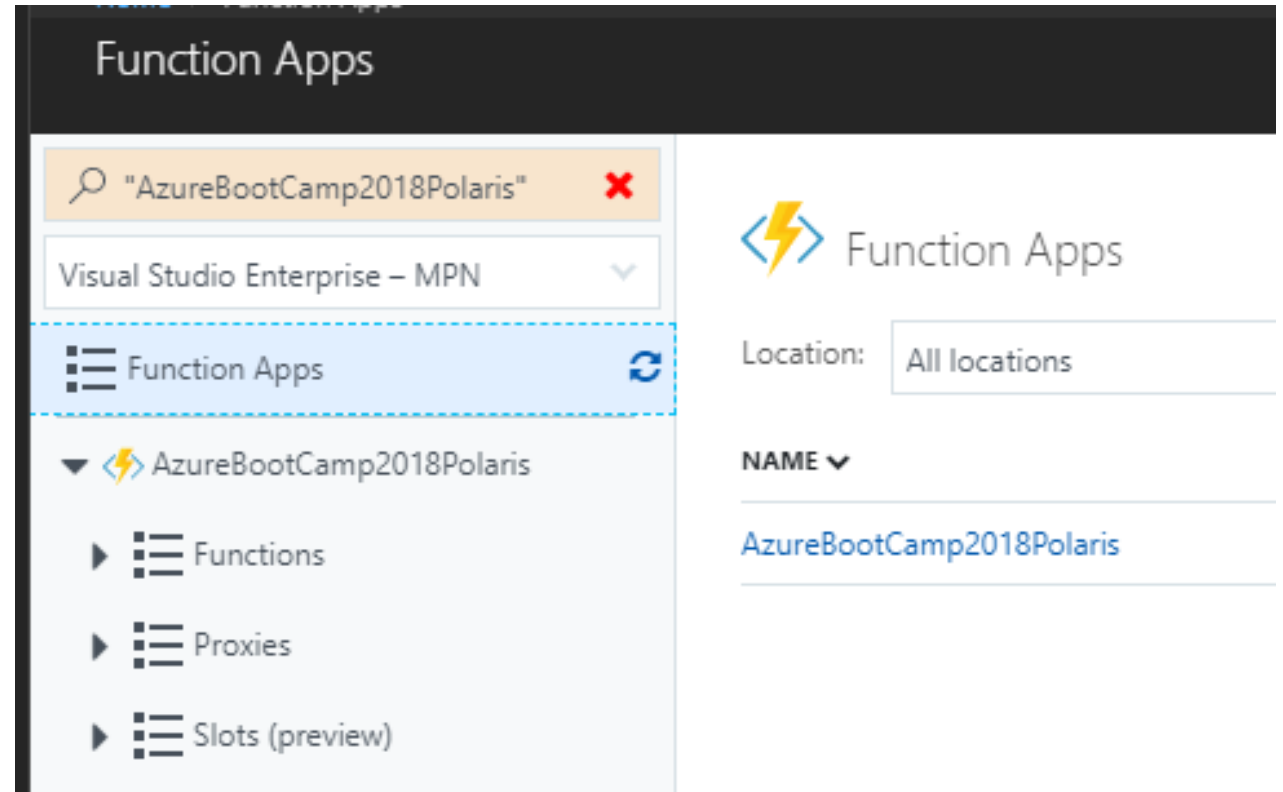
ProcessNowFunction

Need help with your query? Check out some of the m

```
1 SELECT
2 | *
3 INTO
4 | [computeLaterTable]
5 FROM
6 | [AzureBootCampIOTHUB]
7
8 SELECT
9 | *
10 INTO
11 | [ProcessNowFunction]
12 FROM
13 | [AzureBootCampIOTHUB]
14 WHERE
15 | [Error] = 1
```

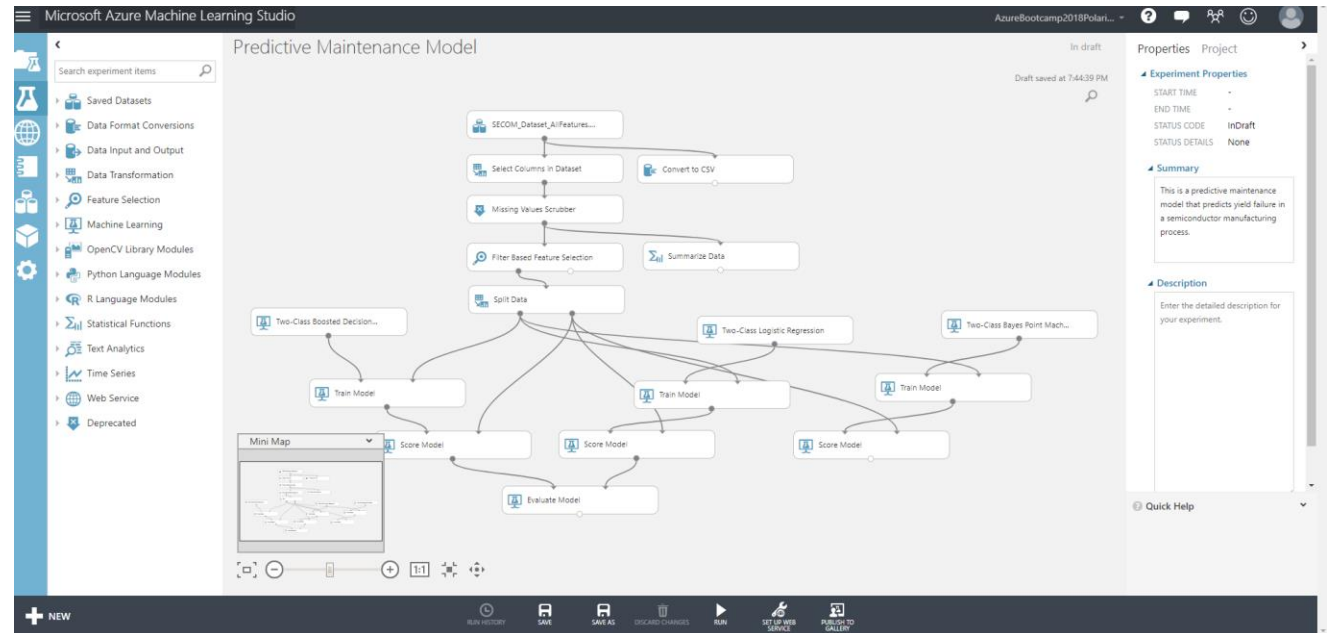
Azure Functions

- Multiple trigger types
 - HTTP
 - Timer
 - Queue trigger
 - Blob trigger
 - Event Hub Trigger



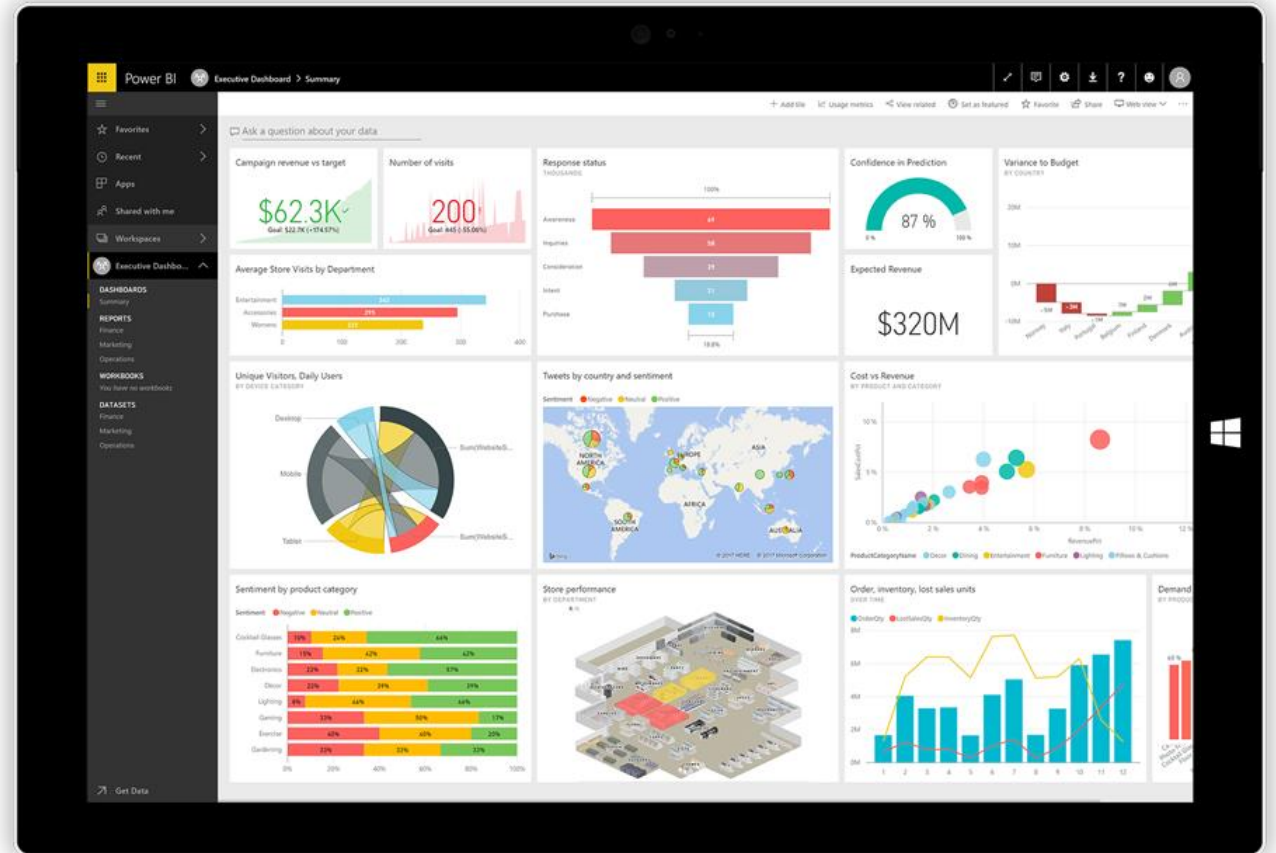
Machine learning

- Created with ML studio
- Outputs a Web service that can be run on a schedule and connected to a database
- Add intelligence to apps and IoT solutions



Power BI

- PaaS service
- Create In depth reports
- Embed BI dashboard into other apps



Tying it all
together

Monitor

- Devices
- IoT Hub
- Data storage



Analysis

- Stream Analytics
- Function Apps



Predict

- Machine Learning
- HDInsight



Present

- Custom application
- Power Bi
- Notification Hubs

Beyond IoT Suite

- Processing data
 - Azure App service
 - Function Apps
- Storage
 - Azur storage Blobs, Tables, Queues
 - SQL Database
- Most Azure services can be used, but watch throughput

Lab

<https://github.com/Azure-Samples/iot-hub-dotnet-simulated-device-client-app/archive/master.zip>

<https://www.microsoft.com/en-us/download/details.aspx?id=51657>

What are we building

