

# IoT Standards and Protocols

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# Agenda

1

IoT  
Characteristics

2

IoT challenges

3

IoT Protocol  
Stack?

4

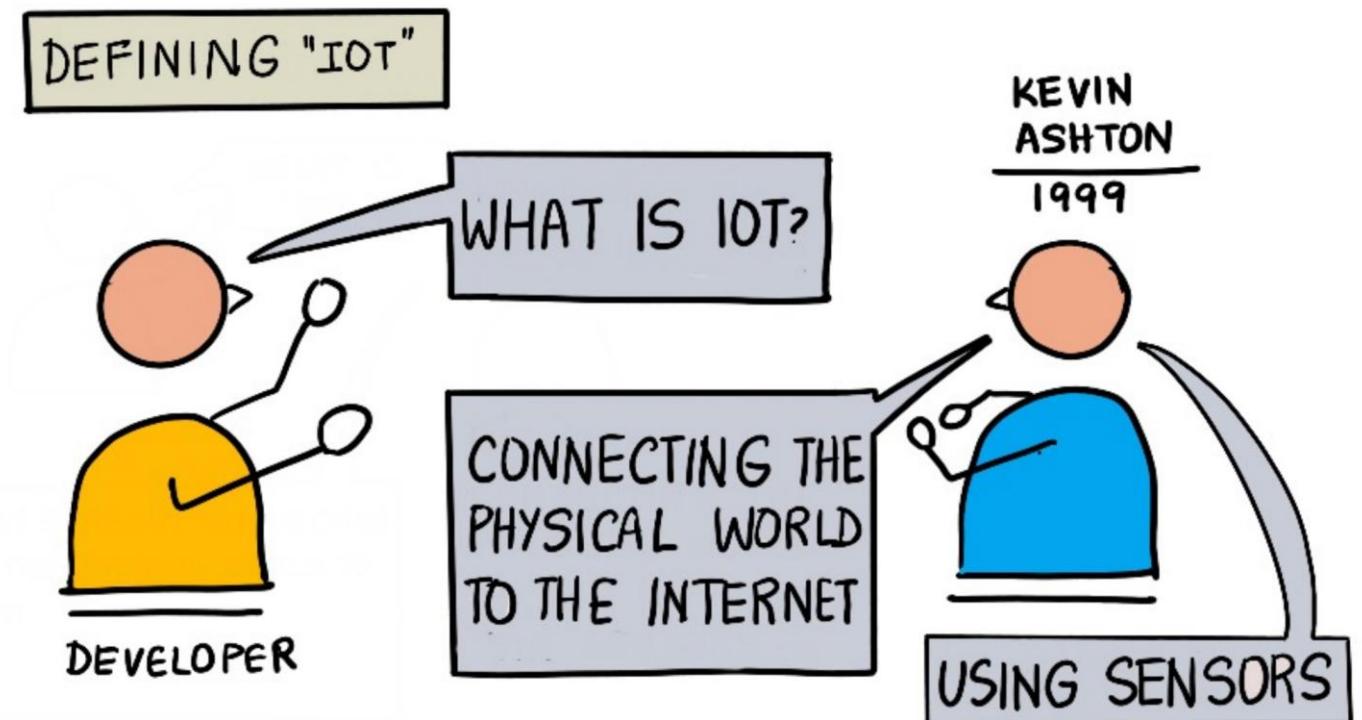
Plan for the  
Future...

5

What you  
need to know.

# IoT Characteristics

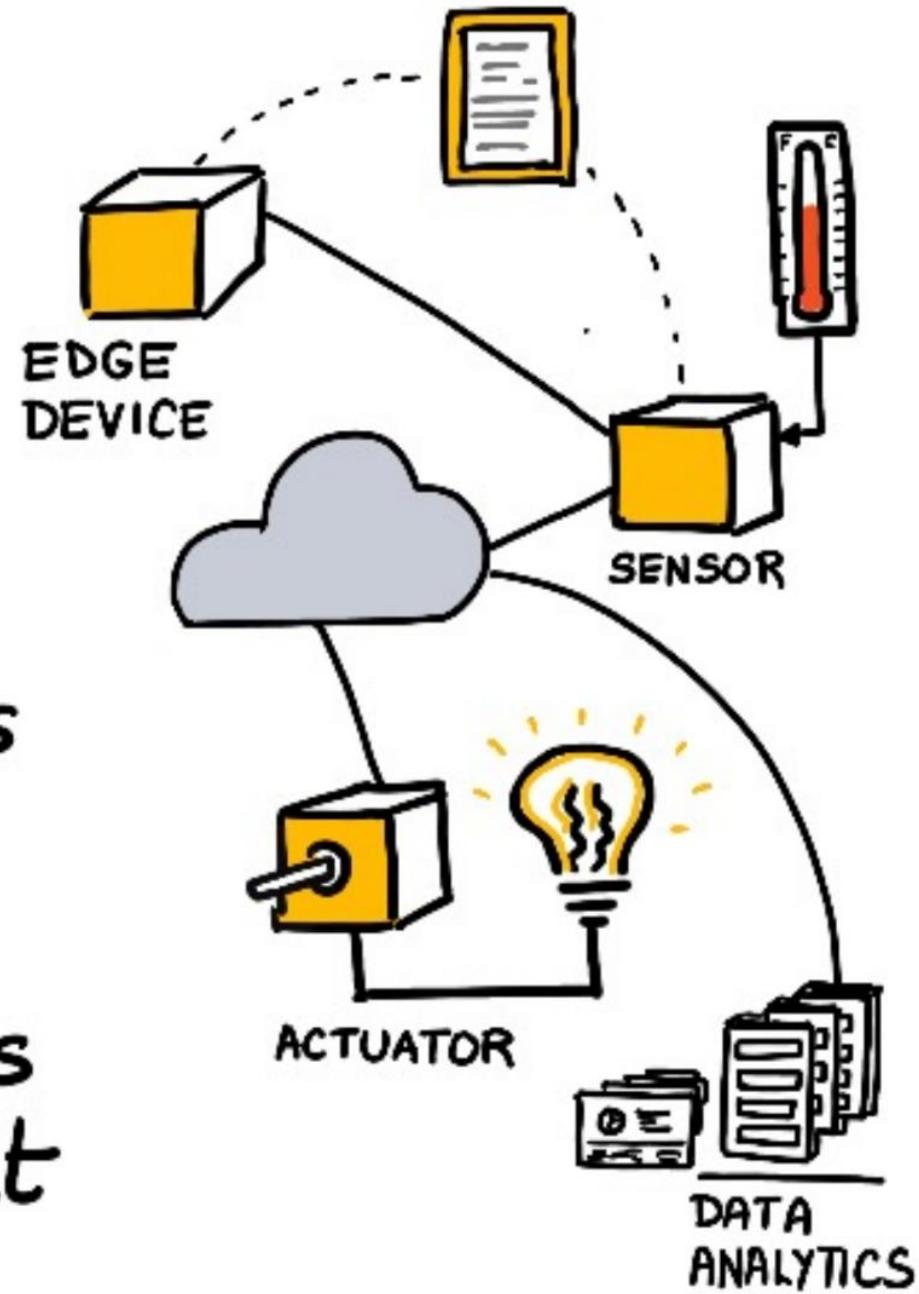
- Everyday objects with embedded technology to sense, connect, and communicate.
- Empowered by:
  - Sensors, cheap and accessible compute power (microcontrollers), ubiquitous connectivity, networking and internet protocols.
- Transforms isolated, passive things to connected things with compute power.
- Collaborate to enable ground breaking applications.



## INTERNET OF THINGS ...

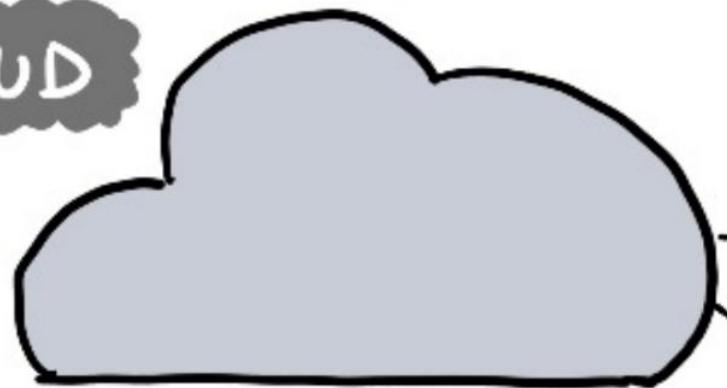
THING OF IT AS A LARGE ECOSYSTEM WHERE DEVICES

- ✓ GATHER DATA using sensors
- ✓ INTERACT using actuators
- ✓ CONNECT with peer devices and the Internet



## BUT IOT IS MORE THAN DEVICES

CLDUD

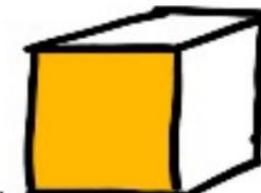


### CLOUD SERVICES

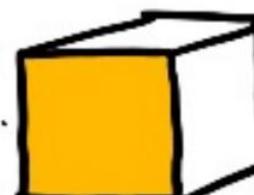
- ✓ PROCESS
- ✗ DISPATCH

SENSOR DATA  
ACTUATOR REQUESTS

using AI  
models trained  
in the cloud!



EDGE



EDGE

### PROCESSING

- ✗ DON'T NEED CONNECTIVITY
- ✓ PROCESS DATA LOCALLY

More characteristics...

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simplilearn

**WHAT IS  
IOT?**



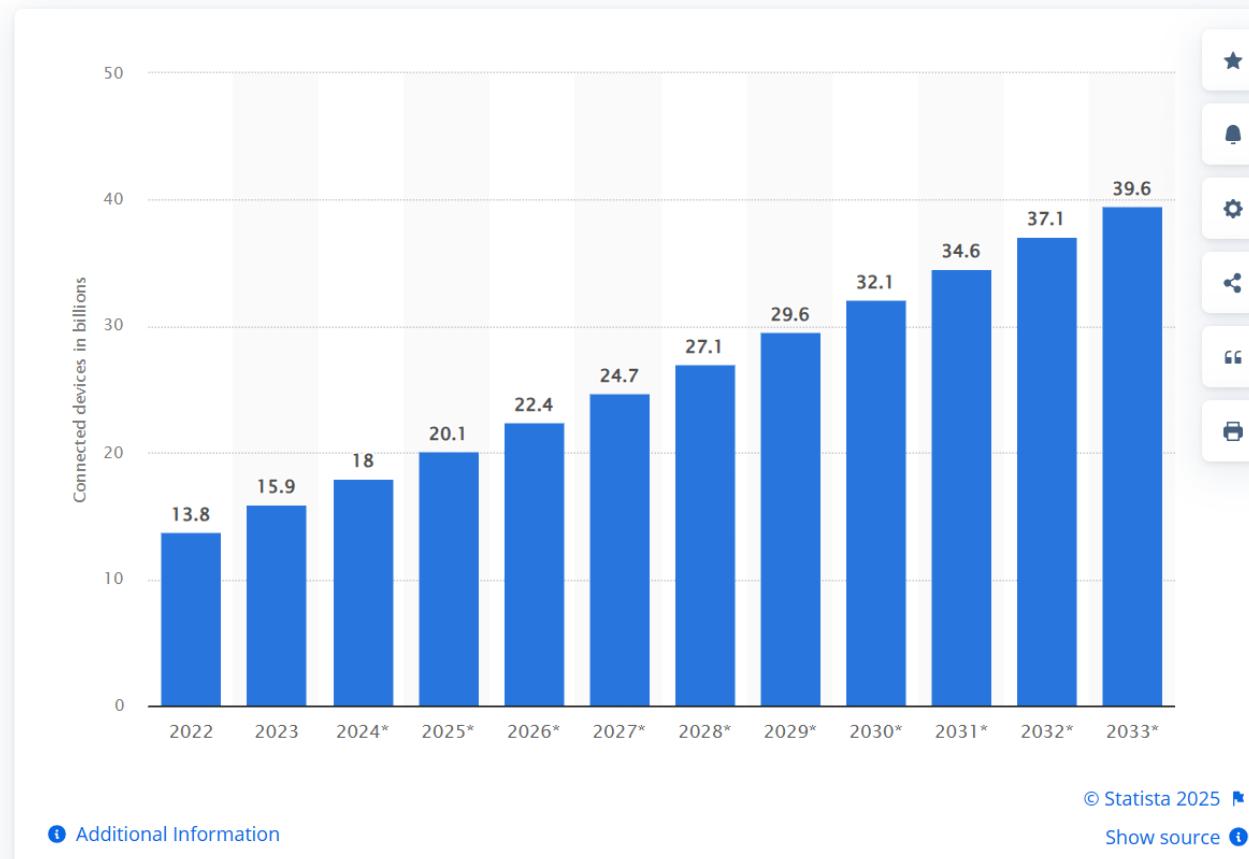
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# IoT Growth

- 20 Billion in 2025
- 80 ZB of data collected!
  - 1 zettabyte = **1 trillion gigabytes (GB)**
  - $10^{21}$  bytes
- Data is key to most IoT applications

Number of Internet of Things (IoT) connections worldwide from forecasts from 2024 to 2033

(in billions)





QI

Stands for Quite Interesting  
(I think so anyway!)

- How much of the data created by IoT do we use?
- Is there waste?
- How can we minimise this?

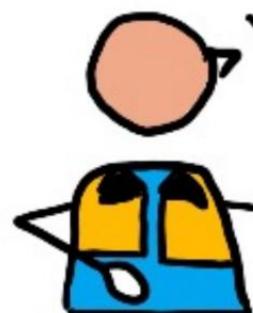


# The “Thing” about IoT

**LET'S TALK ABOUT DEVICES !**

**IOT**  
↓  
“Things”

THINGS REFERS TO THE  
DEVICES THAT INTERACT  
WITH THE PHYSICAL WORLD



IN PRODUCTION  
DEVICES DEPLOYED FOR  
COMMERCIAL USE ARE OFTEN  
CUSTOM MADE FOR ENVIRONMENT

FOR DEVELOPMENT

START WITH ‘DEVELOPER  
KITS’ = GENERAL PURPOSE  
DEVICES TAILEDRED FOR  
DEV USE (NOT PRODUCTION!)

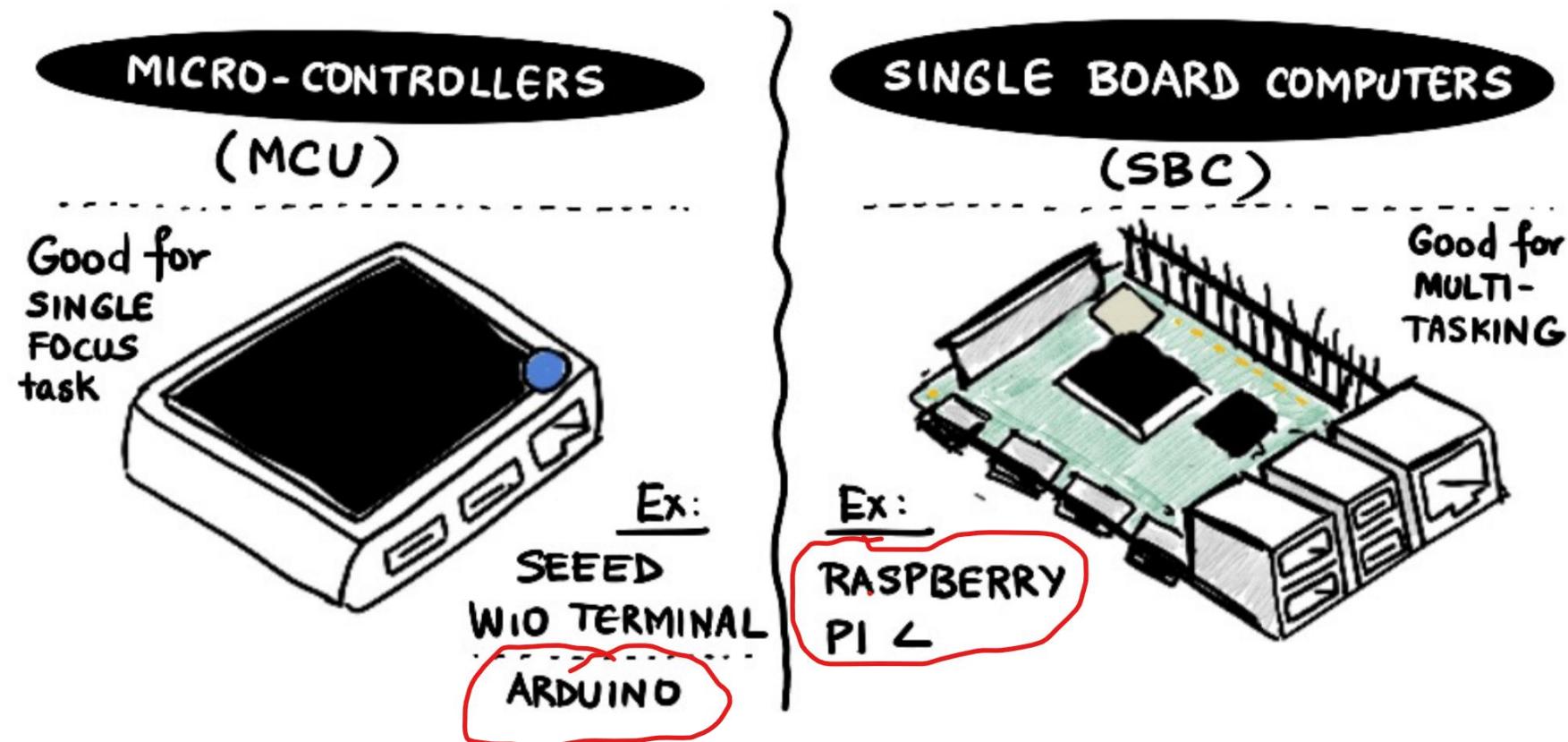
- EXPOSE PINS  
(FOR I/O)
- ADDED HARDWARE  
(SUPPORT DEBUG)

DEV-KIT

- CUSTOM CPU OR  
CIRCUIT BOARDS
- SMALL, RUGGED  
FOR REGULAR USE

# IoT Development

- “kits” generally fall into 2 categories:



# WHAT IS A MICRO CONTROLLER?

Special  
Purpose



LOW COST COMPUTING  
DEVICE WITH BASIC  
SENSORS & ACTUATORS

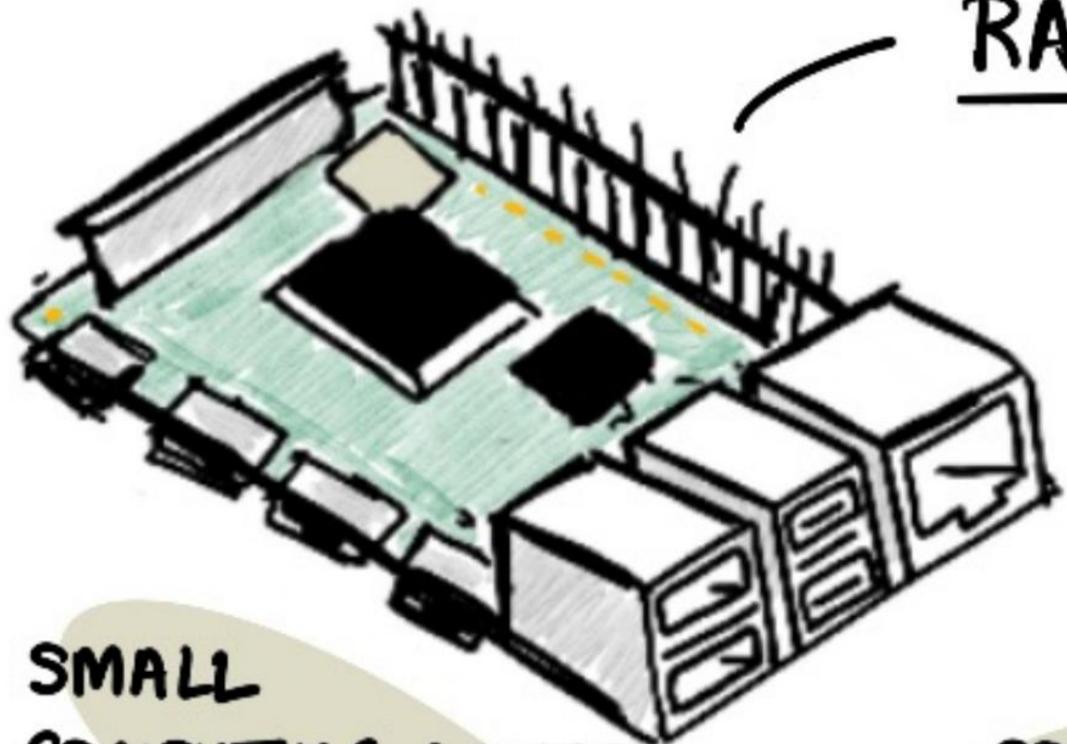
DEV KITS CAN BE REALLY  
CHEAP (< \$4) FOR CORE  
COSTS RISE WITH FEATURES

WIO TERMINAL (\$30)

- \* SENSORS + ACTUATORS
- \* DISPLAY SCREEN
- \* BLUETOOTH + WI-FI
- \* ARDUINO COMPATIBLE

# WHAT IS A SINGLE BOARD COMPUTER?

General  
Purpose



## RASPBERRY PI

- \* CPU, MEMORY, I/O (like MCU)
- \* **PLUS** GRAPHICS CHIP (drive display)
- \* **PLUS** USB PORTS (add peripherals)
- \* **PLUS** SD CARD (store code, data ..)

SMALL  
COMPUTING DEVICE  
WITH ALL ELEMENTS OF  
A COMPLETE COMPUTER

SPECS CLOSE TO  
DESKTOP (MAC/PC)  
BUT CHEAPER, SMALLER,  
LESS POWER USAGE

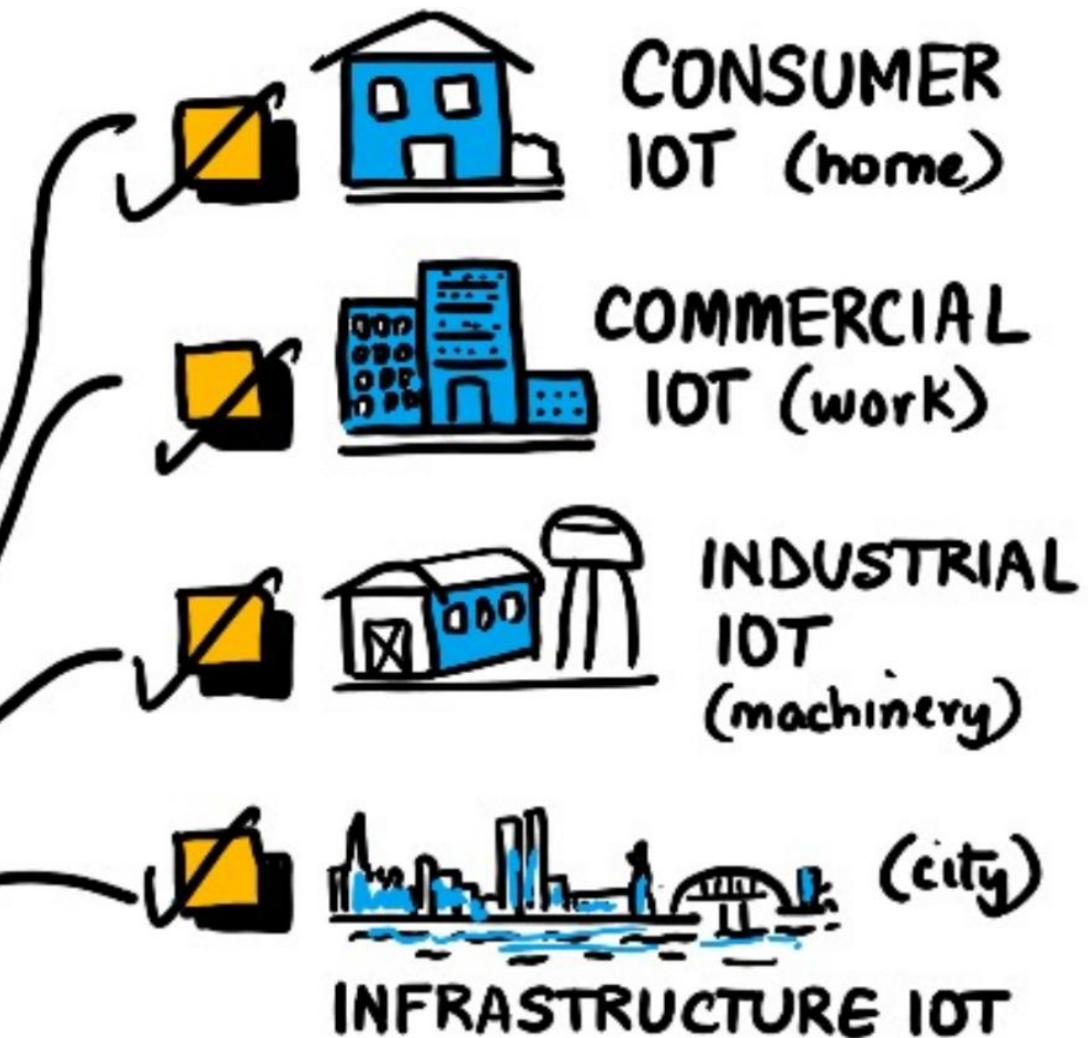
PROGRAMMABLE  
IN ANY LANGUAGE

Python used  
typically for IoT

# IoT Applications

HUGE RANGE OF USE  
CASES FOR IoT APPS

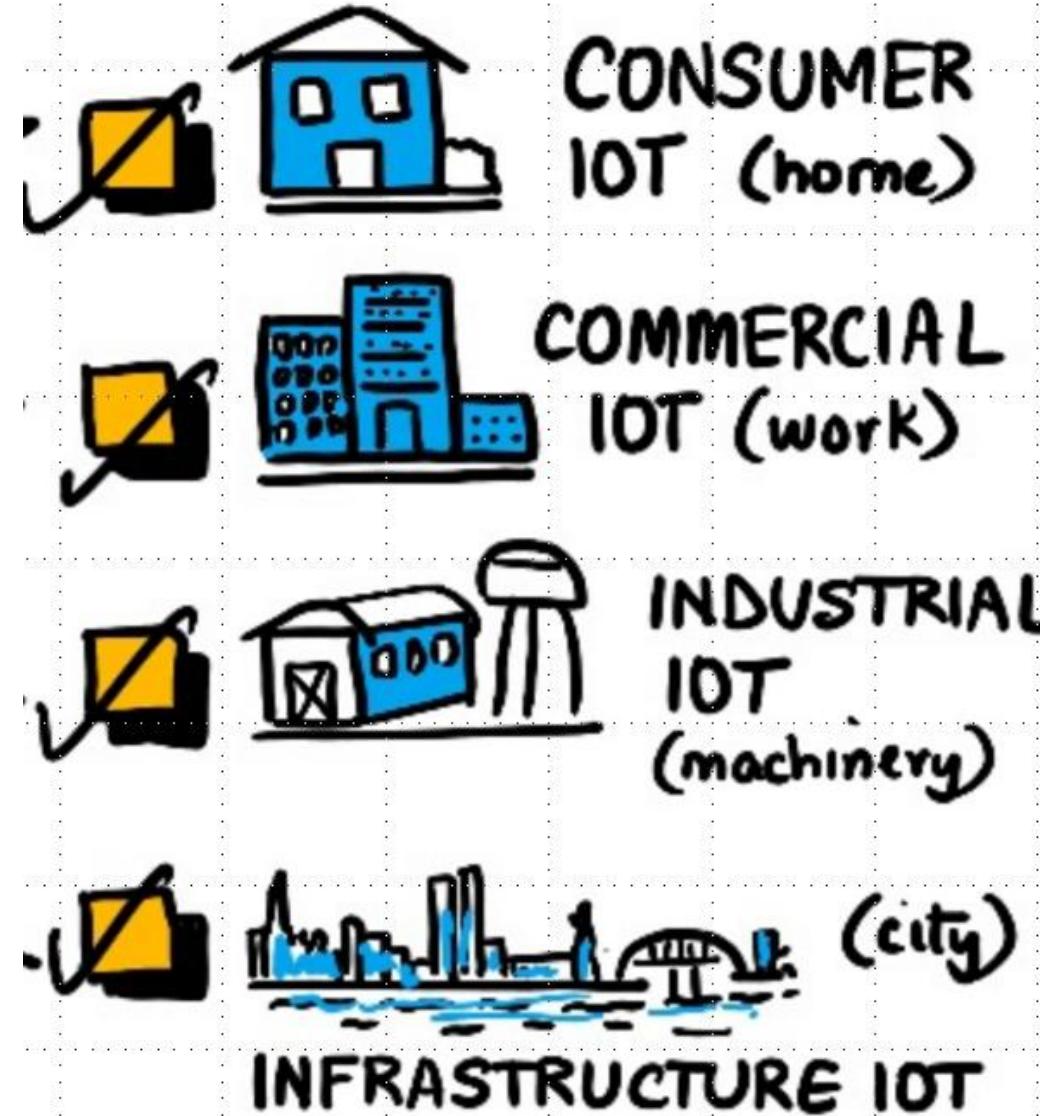
4 BROAD GROUPS





QI

- For the 4 IoT areas, find one real-world example of each.
- Do you use any Consumer IoT application?



## ① CONSUMER IOT

DEVICES THAT CONSUMERS  
USE AROUND THEIR  
HOME



EMPOWER MORE USERS  
ESPECIALLY PERSONS WITH  
A DISABILITY ...

- SMART SPEAKERS
- ROBOTIC VACUUMS
- VOICE CONTROLLED OVENS, TAPS etc.
- HEALTH MONITORS
- TIME TRACKERS
- etc.

## ② COMMERCIAL IoT



- OCCUPANCY SENSORS
- MOTION TRACKERS
- SAFETY MONITORING
- TEMPERATURE TRACKING
- VEHICLE TRACKING

COVERS USE OF IoT  
IN THE WORKPLACE

etc.

### ③ INDUSTRIAL IOT



- PREDICTIVE MAINTENANCE
- PREDICT HARVEST READINESS
- TRACK SOIL MOISTURE,  
MONITOR CROP  
HEALTH AT SCALE
- SAFETY  
MONITORING

CONTROL AND MANAGE MACHINERY ON  
A LARGE SCALE · EX: FACTORIES, DIGITAL AGRICULTURE

## ④ INFRASTRUCTURE IOT

BETTER ANALYTICS : SENSING ENVIRONMENTS



SMART GRIDS

SMART CITIES

MONITOR & CONTROL GLOBAL INFRASTRUCTURE PEOPLE USE

DAILY

TRANSPORTATION

PARKING

POLLUTION

POWER USAGE

EFFICIENT USE

SUSTAINABILITY

## EXAMPLES OF IoT DEVICES

INCREASING NUMBER OF  
INTERNET- CONNECTED OR  
EDGE- BASED DEVICES

AROUND US

- SENSORS
- ACTUATORS
- CONNECTIVITY

DATA  
COLLECTION  
+  
ANALYTICS



FRIDGE



DISH WASHER.



STEREO  
SYSTEM



DOORBELL



SMART  
TV



VOICE  
CONTROL

# Fundamental parts for IoT

Devices

- Send and Receive data

Network

- Data is transmitted, routed

Edge Computing

- Data is normalised, filtered,

Storage

- Databases and data stores

Applications

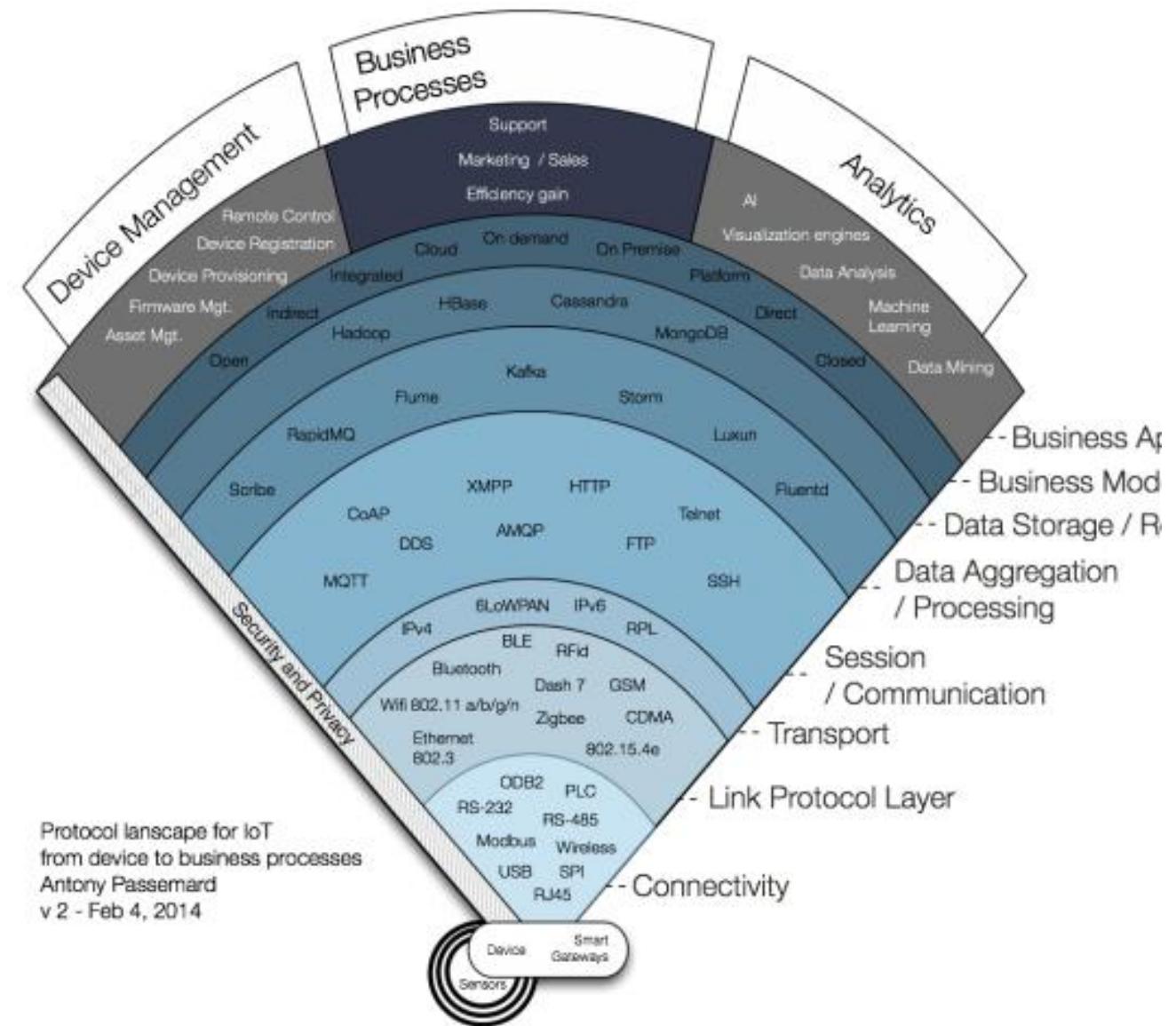
- Process and use data

People

- Act and collaborate

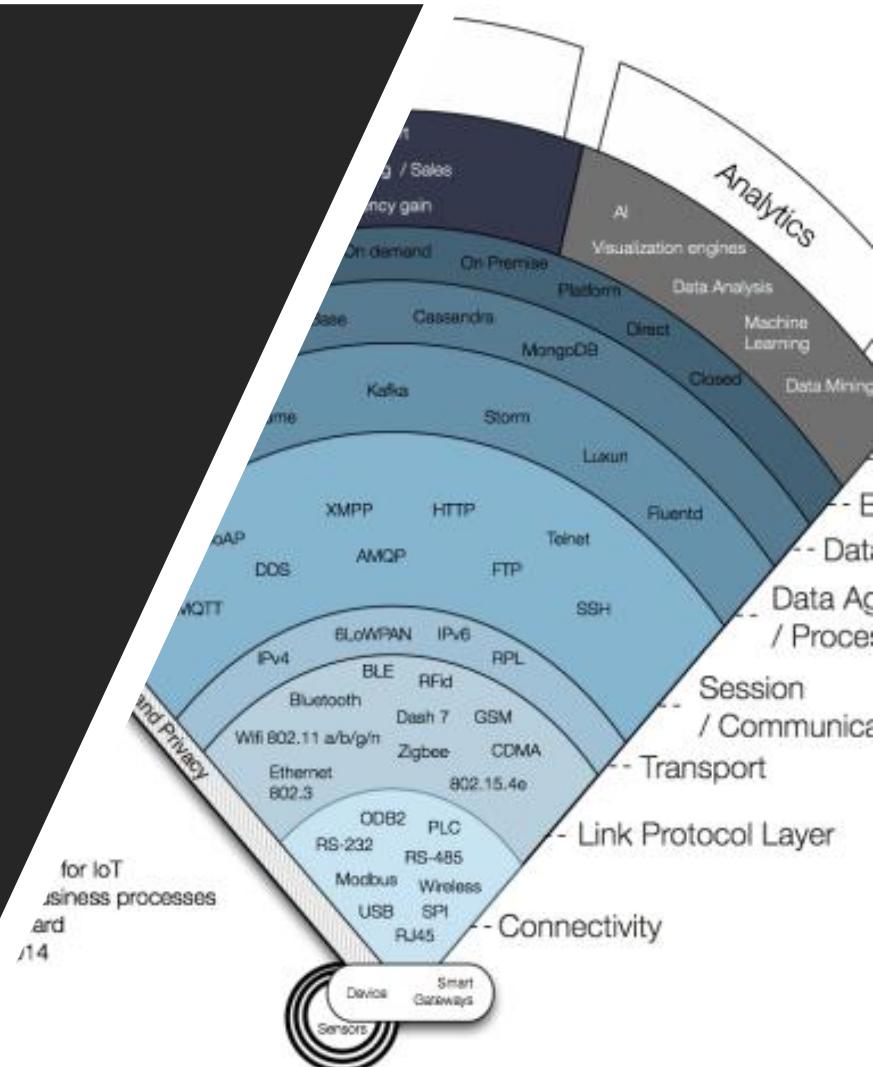
# IoT Protocol Stack?

- many protocols, many standards.  
Starting to consolidate
- Some strong standards starting to emerge that address the IT/OT link
- We will try to look a protocol in each layer, building a reference app that combines several.



# IoT Stack Protocols.

- **Connectivity layer:** The Actual physical connectors. RJ45 (usually for Ethernet), RS-232, ModBus, USB (as a connector type, not the communication protocol), SPI, ODB2 (in Cars), and Wireless (no connector!). Gateways can convert physical connectors into wireless.
  - **Link Protocol:** How do those device actually send the data. Ethernet **802.3**, Wifi 802.11a/b/g/n, BlueTooth, BLE, ZigBee, Rfid, 6LoWPAN, 802.14.5e, **CAN, SigFox, LoRa**
  - **Transport:** IPv4 and **IPv6**
  - **Session / Communication:** **MQTT**, a subscribe and publish protocol that is used by Facebook for its mobile app, XMPP and AMQP , FTP, Telnet and SSH,
  - **Data Aggregation / Processing:** When device send data, lots of data, you need an end point to do something with it.
  - **Data Storage / Retrieval:** The realm of Big Data backend and NoSQL solutions.



# Plan for the Future...

- Idea is to realise a prototypical full stack IoT solution which uses open standards and protocols to integrates IT and OT.
- Project style approach
  - Have a working artefact that demonstrates skills from other modules on the course.
- Use things
  - Raspberry Pi + SenseHAT, SmartPhone
- Use languages
  - Python, Javascript, Shell Scripting
- Use cloud platforms
  - Thingspeak,

