

IoT Standards and Protocols

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Agenda

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IoT
Characteristics

2

IoT challenges

3

IoT Protocol
Stack?

4

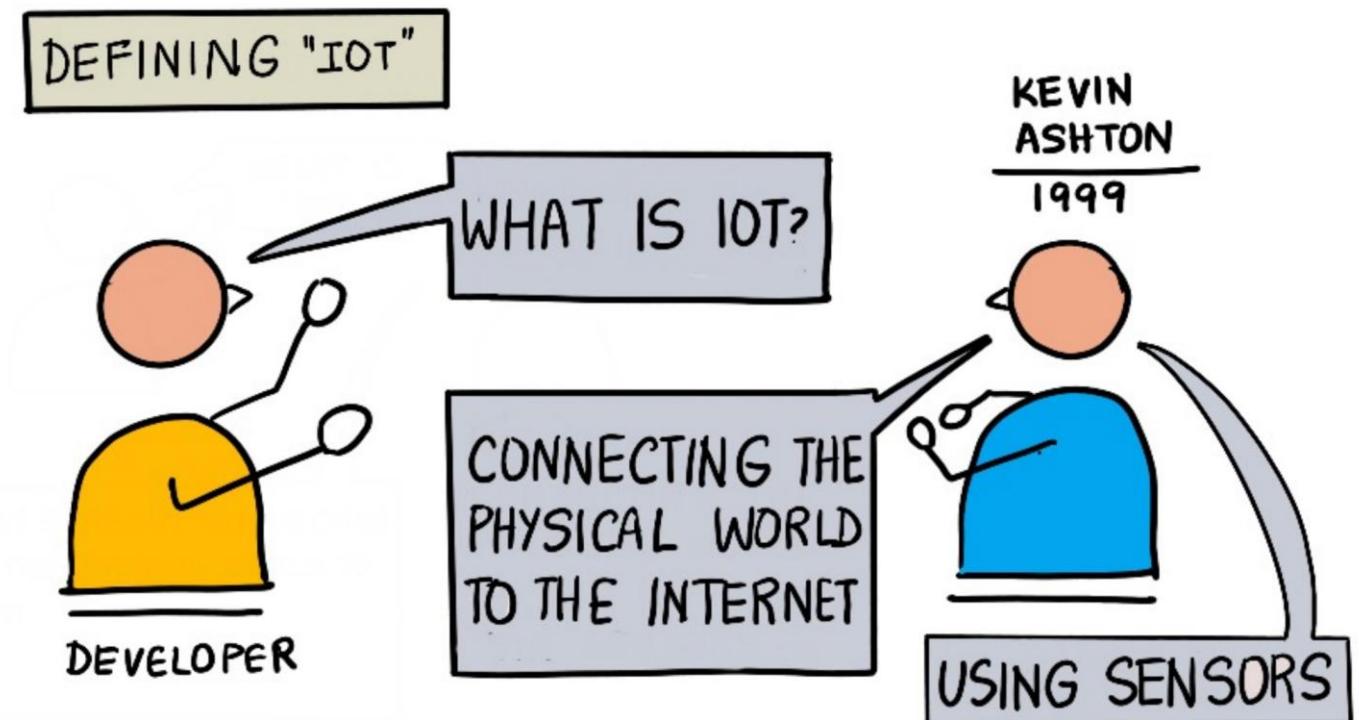
Plan for the
Future...

5

What you
need to know.

IoT Characteristics

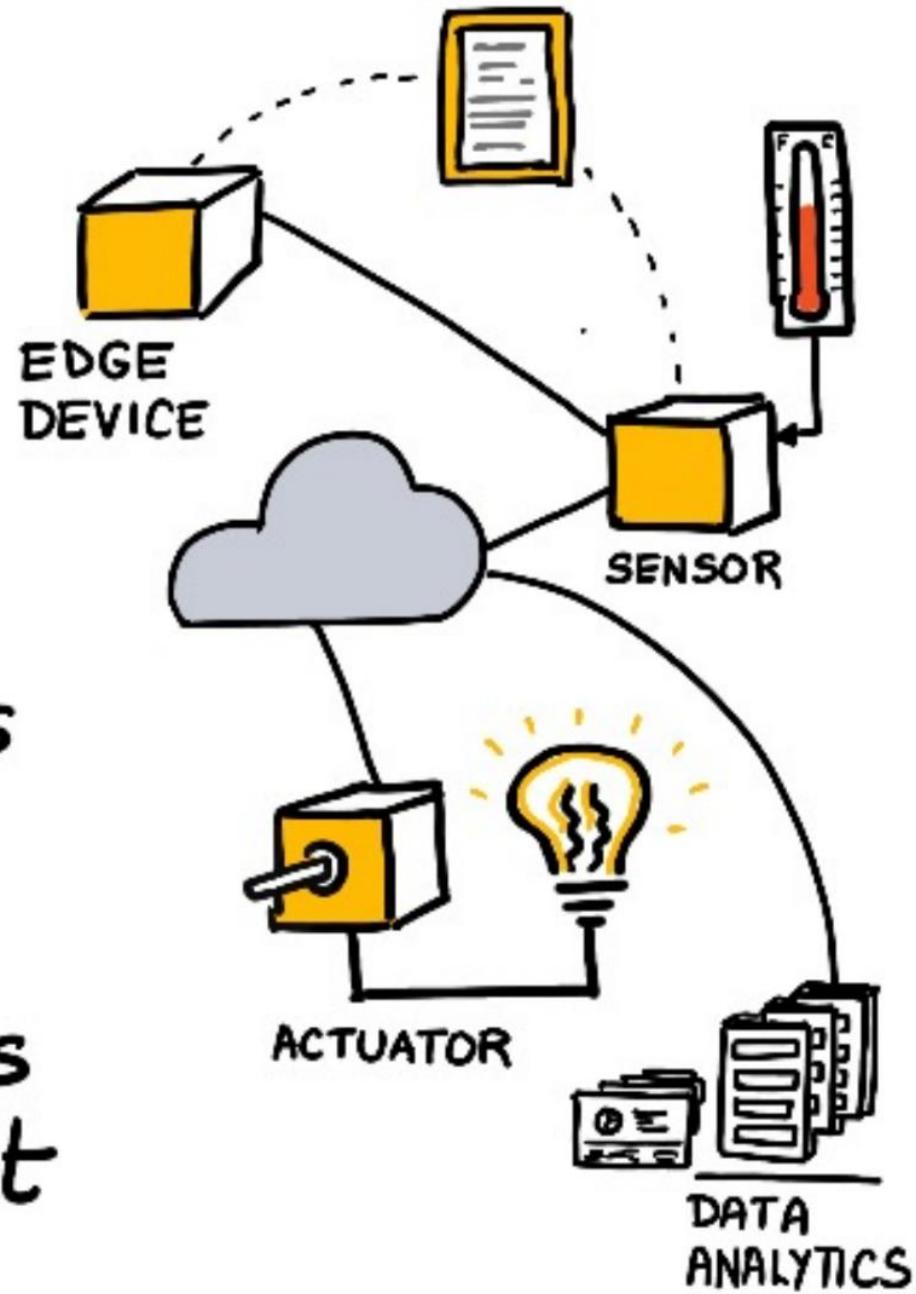
- Everyday objects with embedded technology to sense, connect, and communicate.
- Empowered by:
 - Sensors, cheap and accessible compute power (microcontrollers), ubiquitous connectivity, networking and internet protocols.
- Transforms isolated, passive things to connected things with compute power.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



INTERNET OF THINGS ...

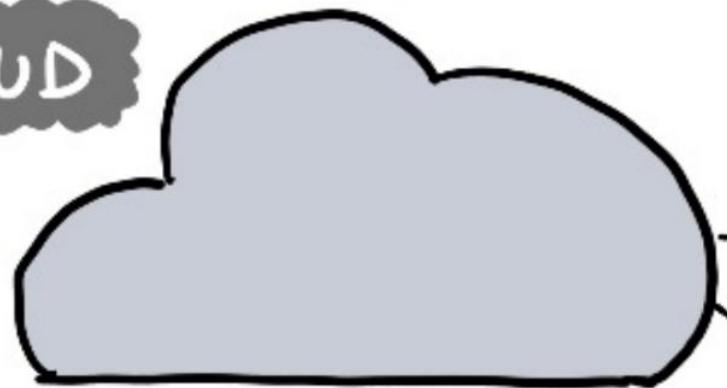
THING OF IT AS A LARGE ECOSYSTEM WHERE DEVICES

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



BUT IOT IS MORE THAN DEVICES

CLDUD

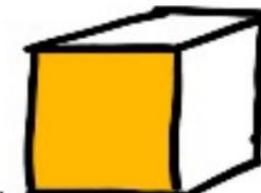


CLOUD SERVICES

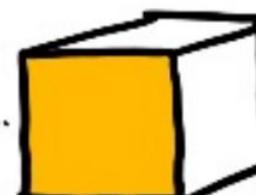
- ✓ PROCESS
- ✗ DISPATCH

SENSOR DATA
ACTUATOR REQUESTS

using AI
models trained
in the cloud!



EDGE



EDGE

PROCESSING

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

More characteristics...

simplilearn

**WHAT IS
IOT?**

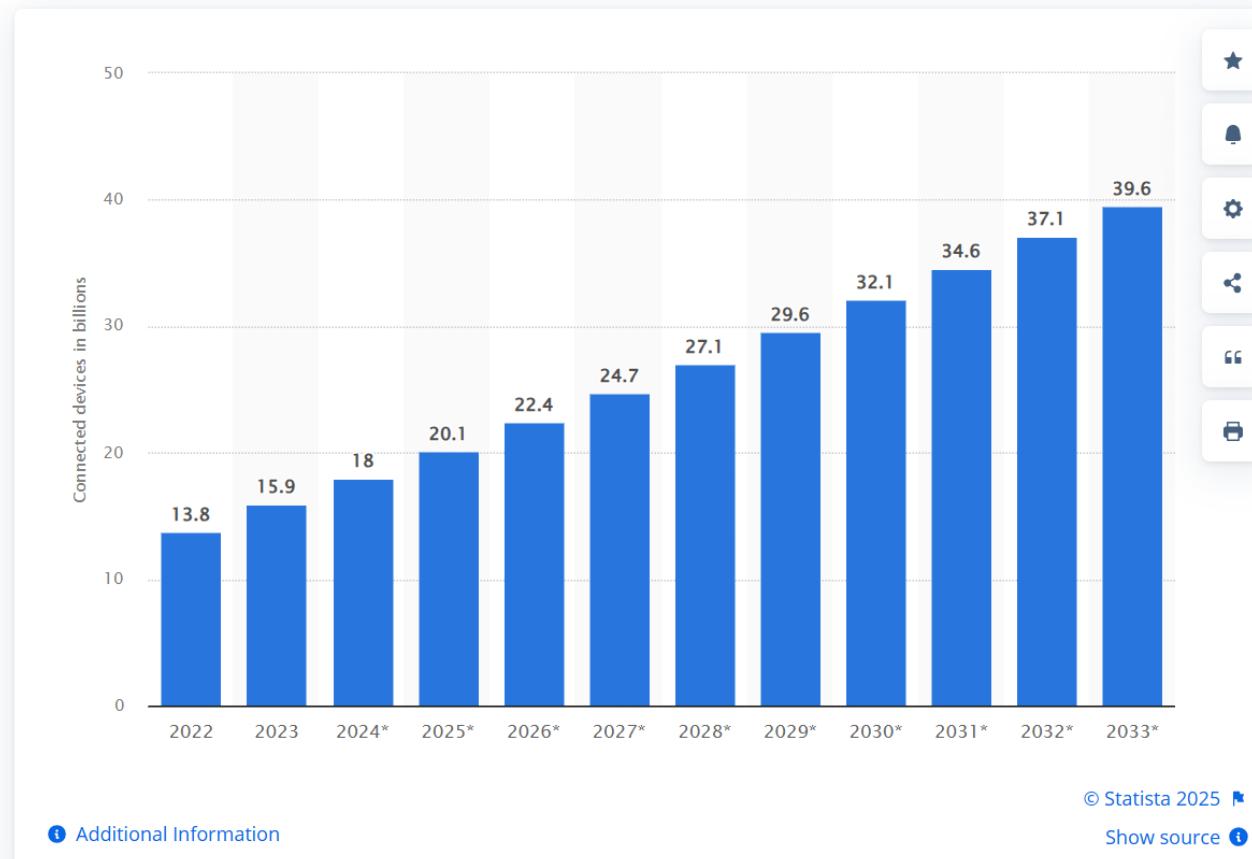


IoT Growth

- 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!)

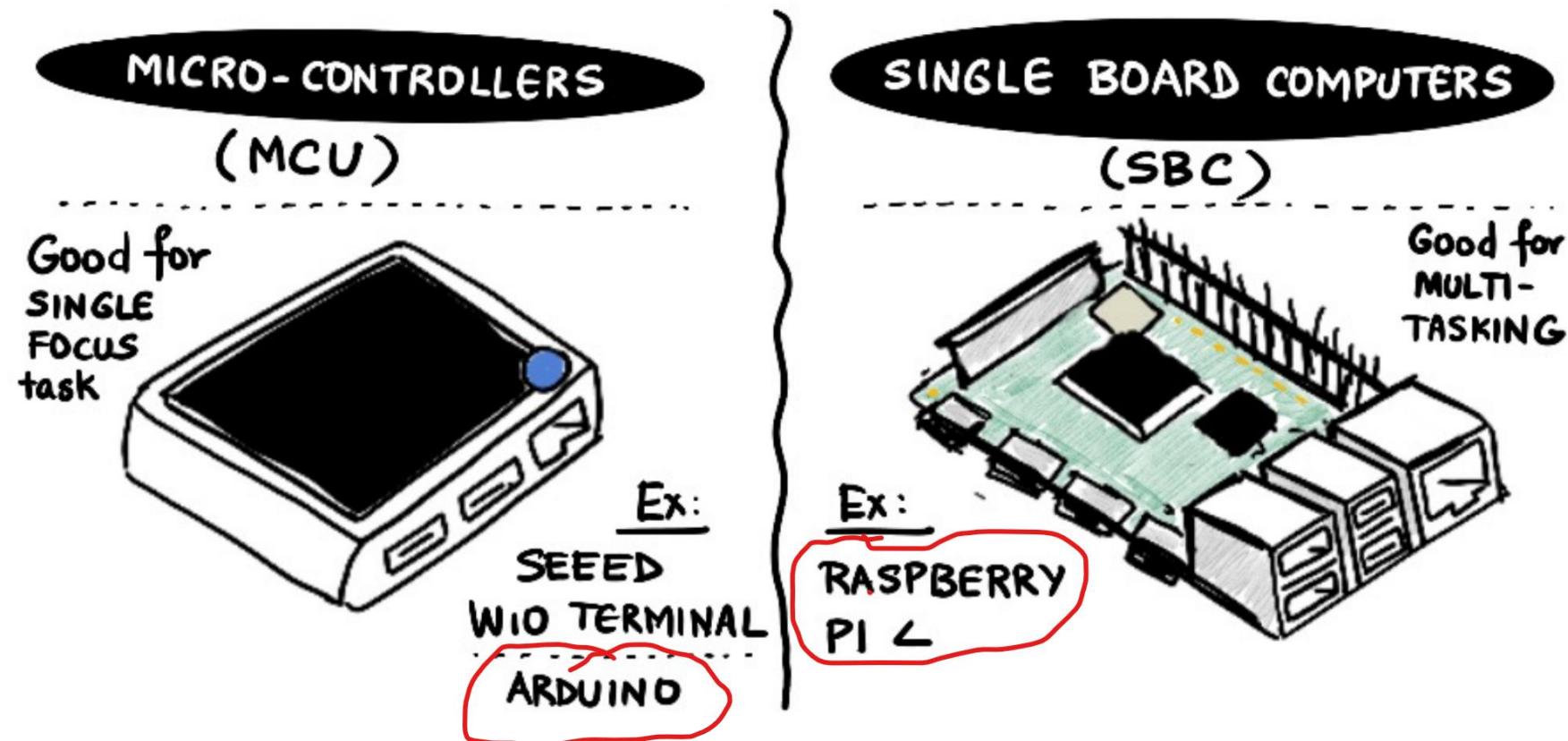
- EXPOSE PINS
(FOR I/O)
- ADDED HARDWARE
(SUPPORT DEBUG)

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

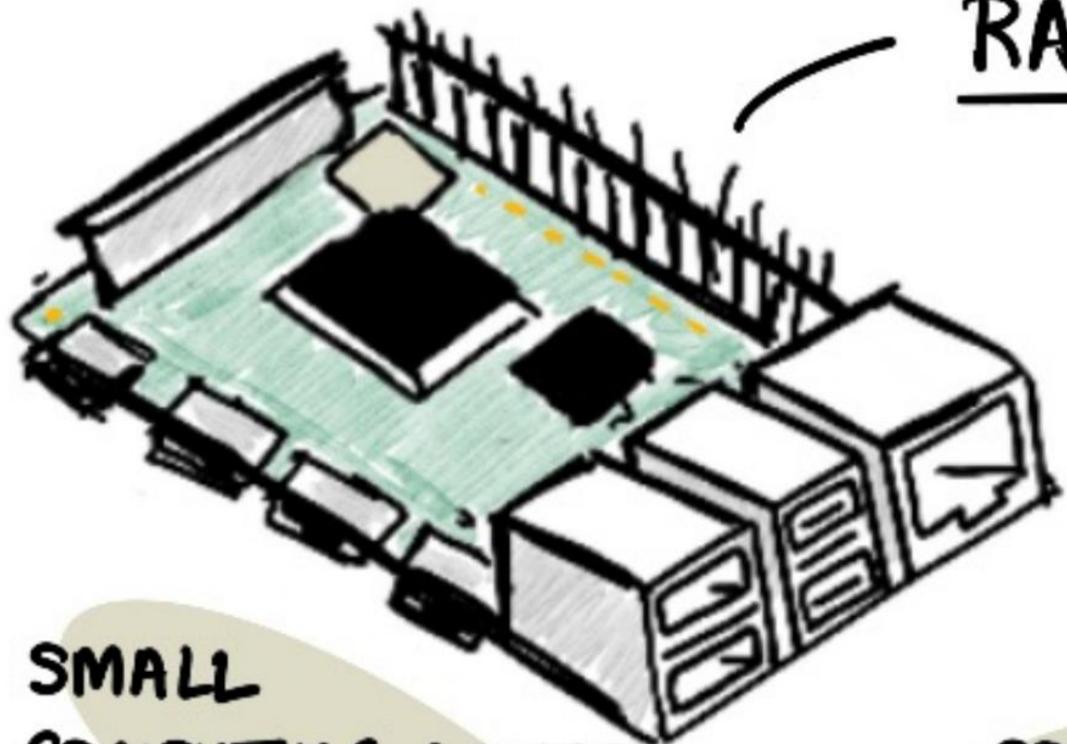
DEV KITS CAN BE REALLY
CHEAP (< \$4) FOR CORE
COSTS RISE WITH FEATURES

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

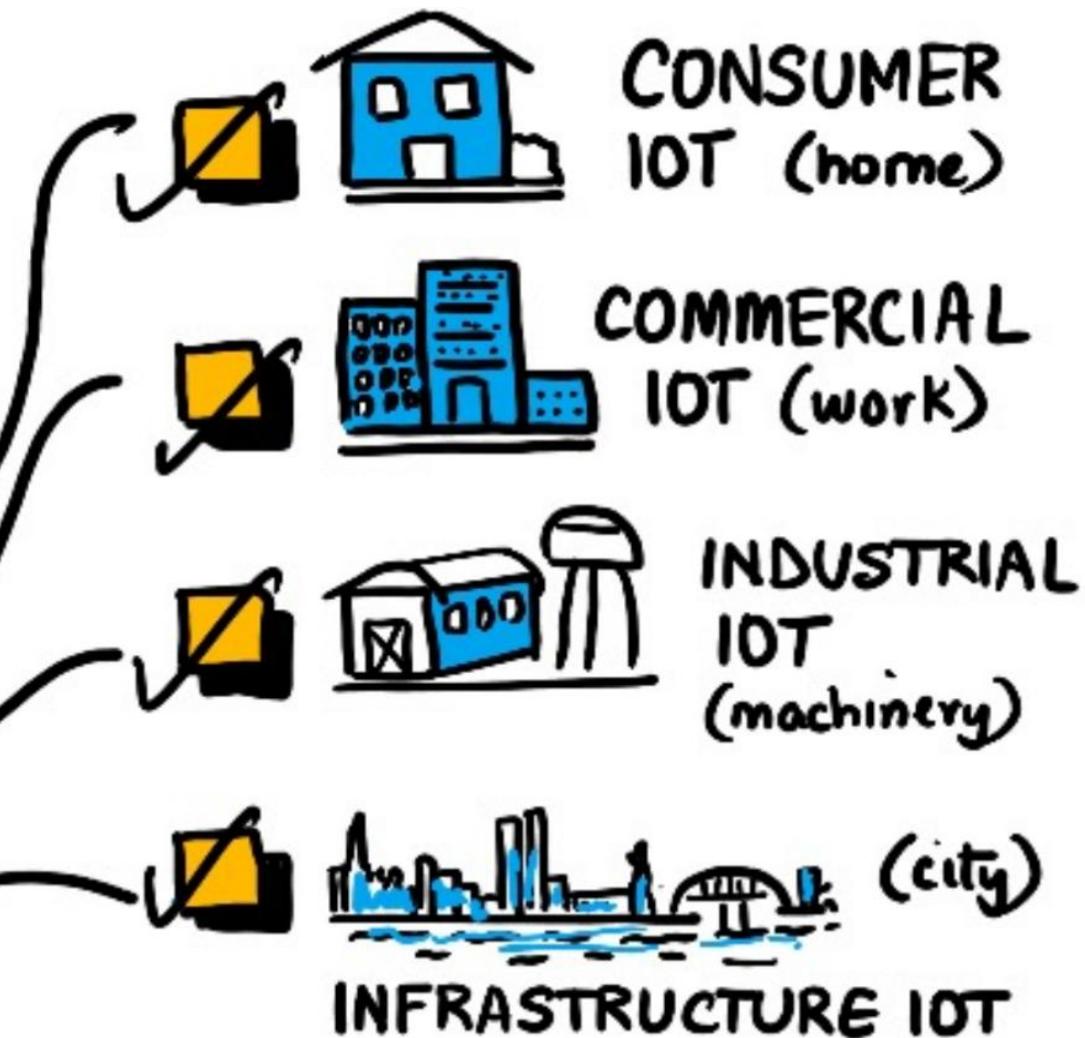
PROGRAMMABLE
IN ANY LANGUAGE

Python used
typically for IoT

IoT Applications

HUGE RANGE OF USE
CASES FOR IoT APPS

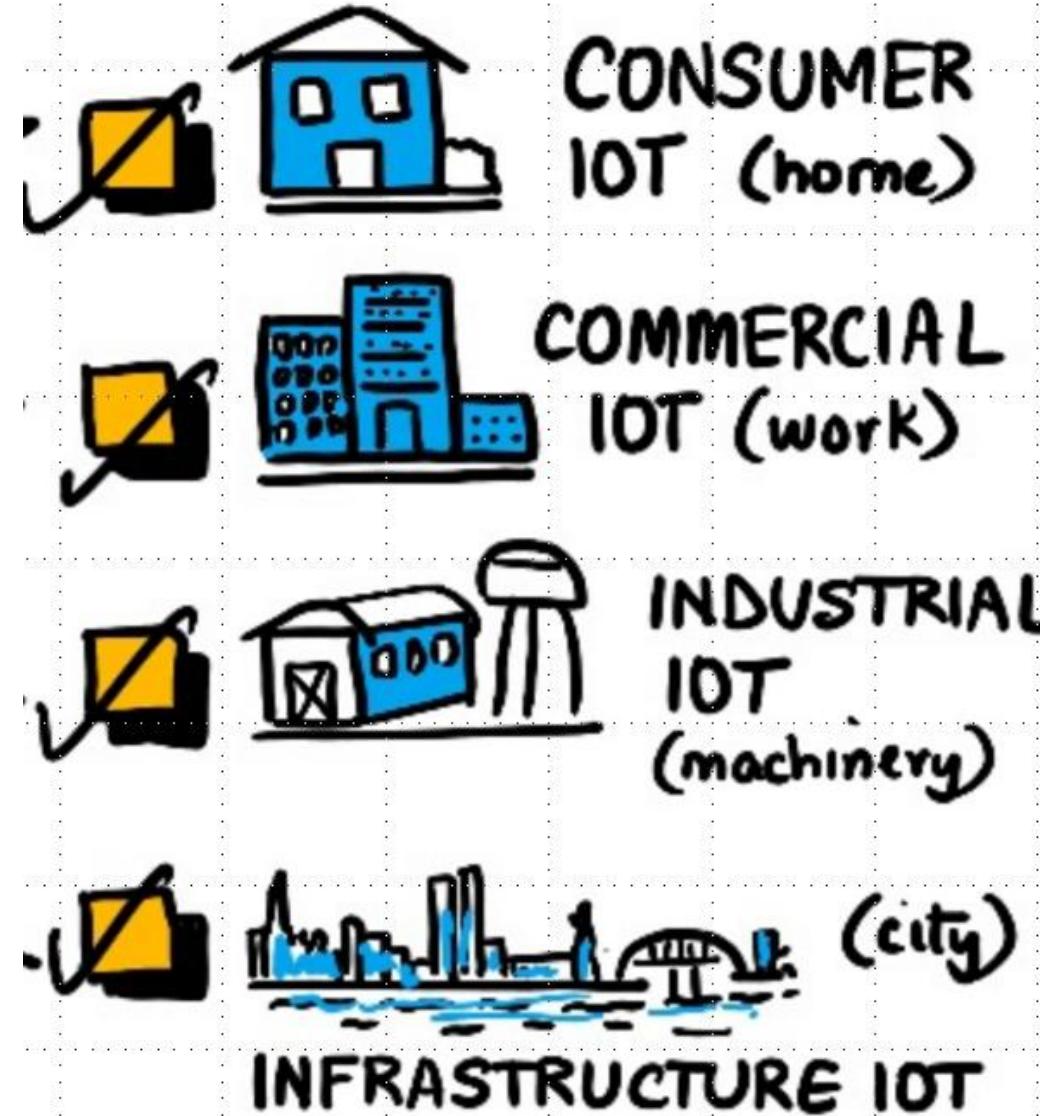
4 BROAD GROUPS





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



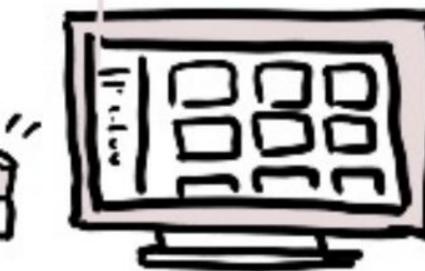
DISH WASHER.



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

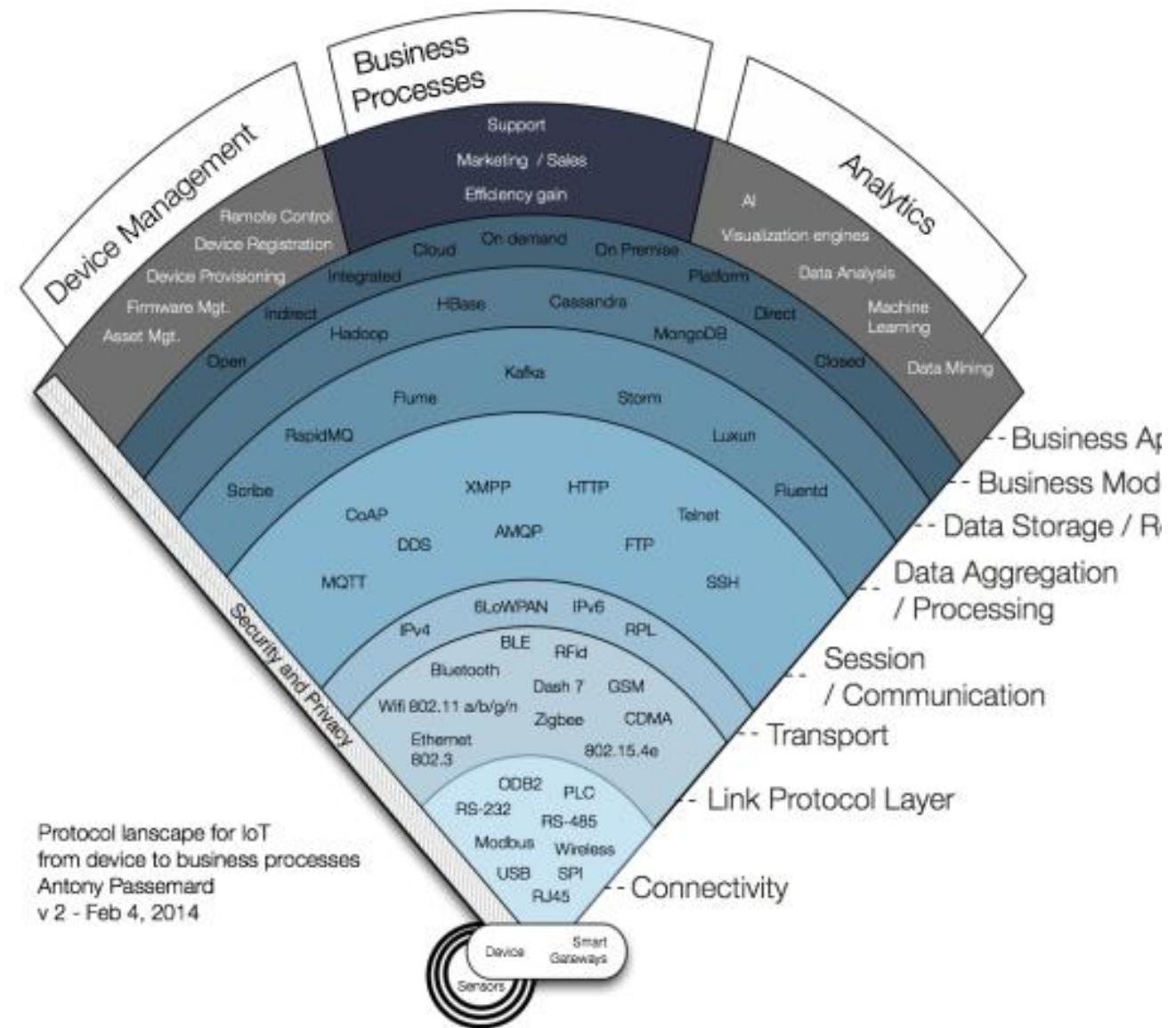
- Process and use data

People

- Act and collaborate

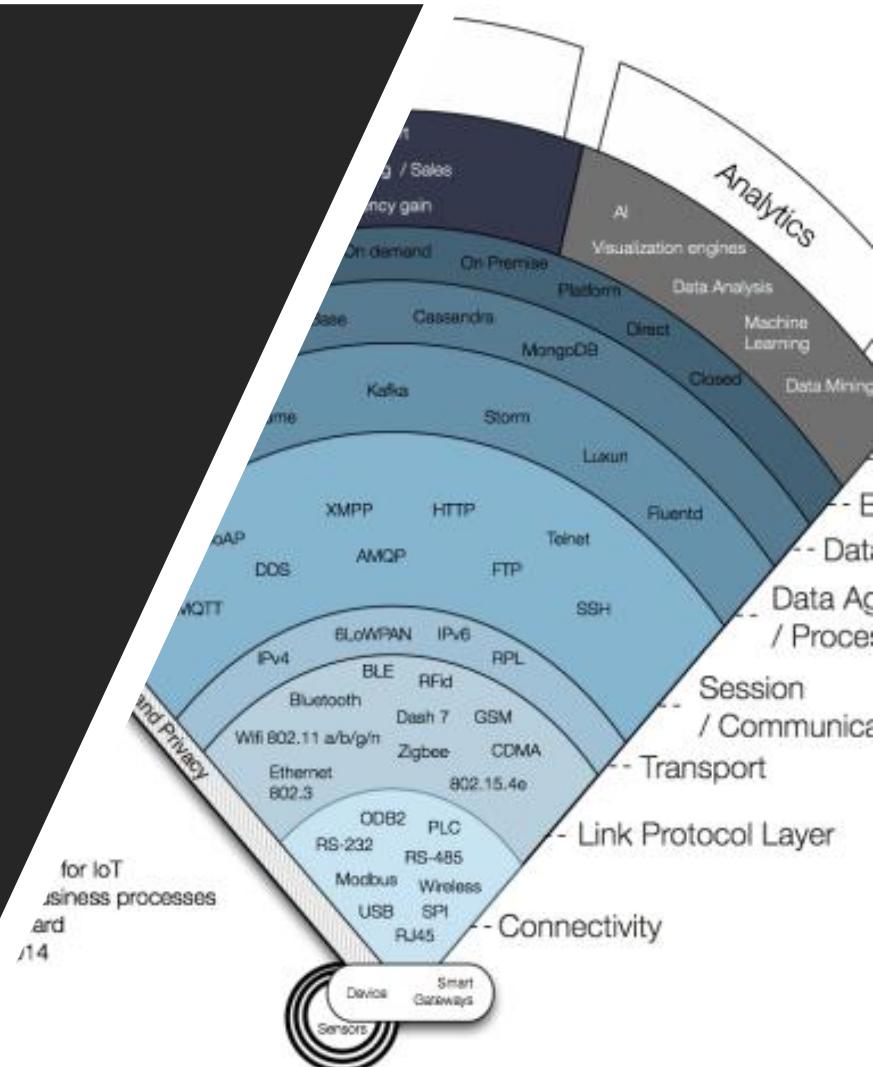
IoT Protocol Stack?

- 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.



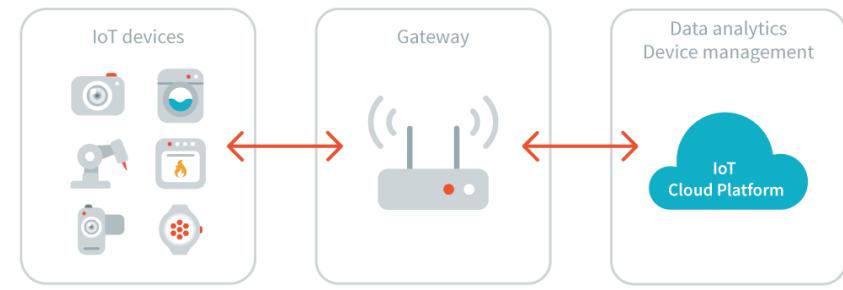
IoT Stack Protocols.

- **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 explore prototypical IoT solutions 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 + Sensors, SmartPhone
- Use languages
 - Python, Javascript, Shell Scripting
- Use cloud platforms
 - Thingspeak, Blynk



What You'll need

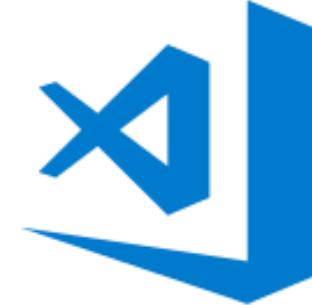
- VS Code
- Access to Moodle
- Raspberry Pi (pending)
- Sensors and Acutators(pending)
- Conterfit (See lab)



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Visual Studio Code

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