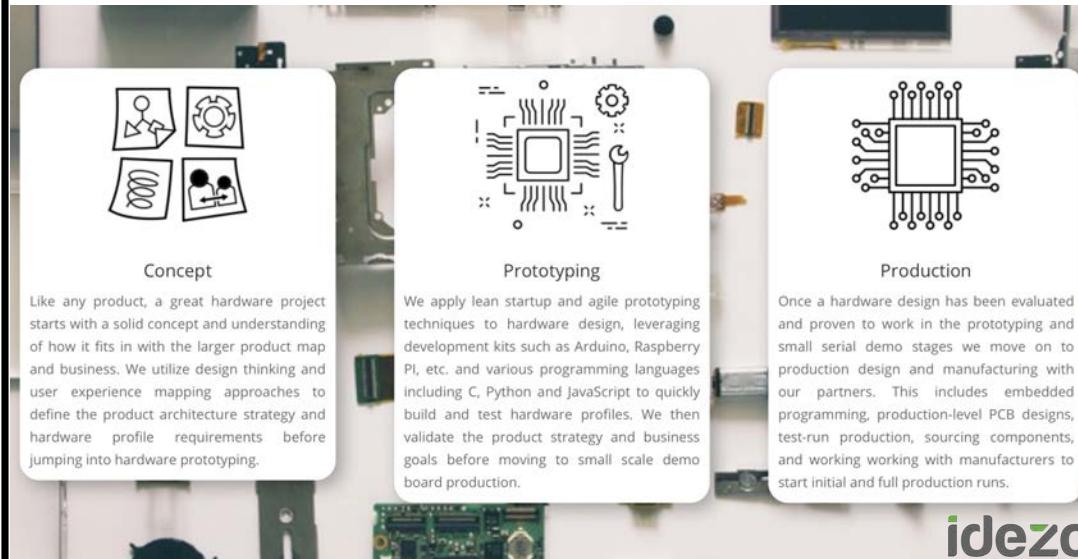


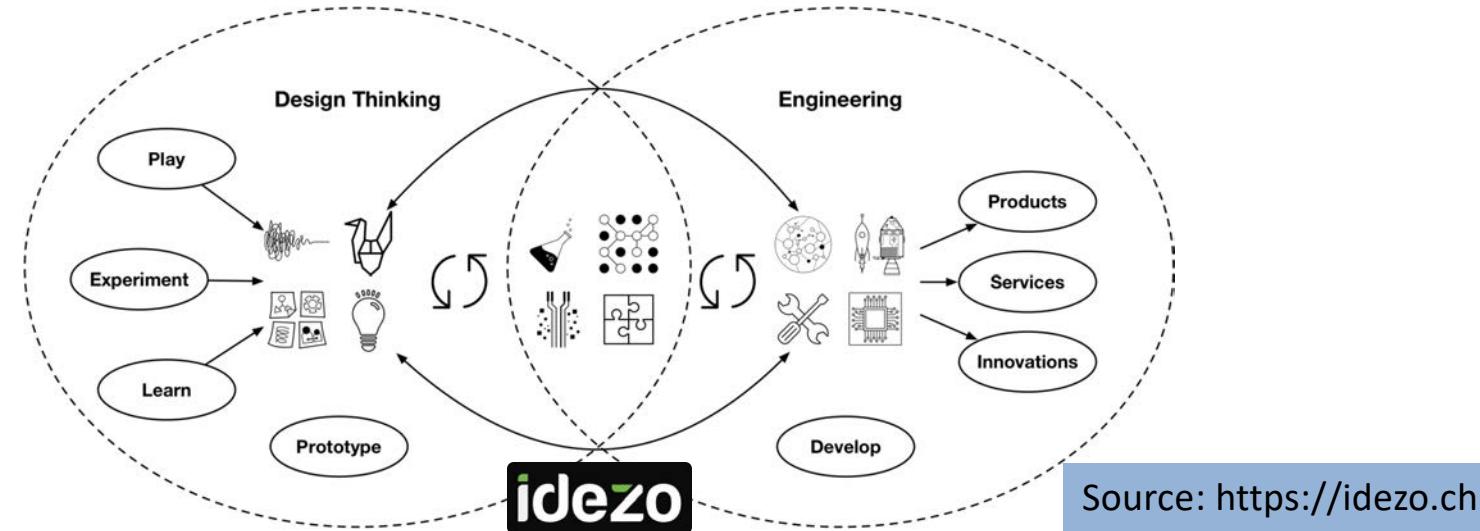
HANDS ON APPROACH TO

Data Science for (the) IoT



Rob van der Willigen

HANDS ON APPROACH TO DATA SCIENCE for (the) IoT



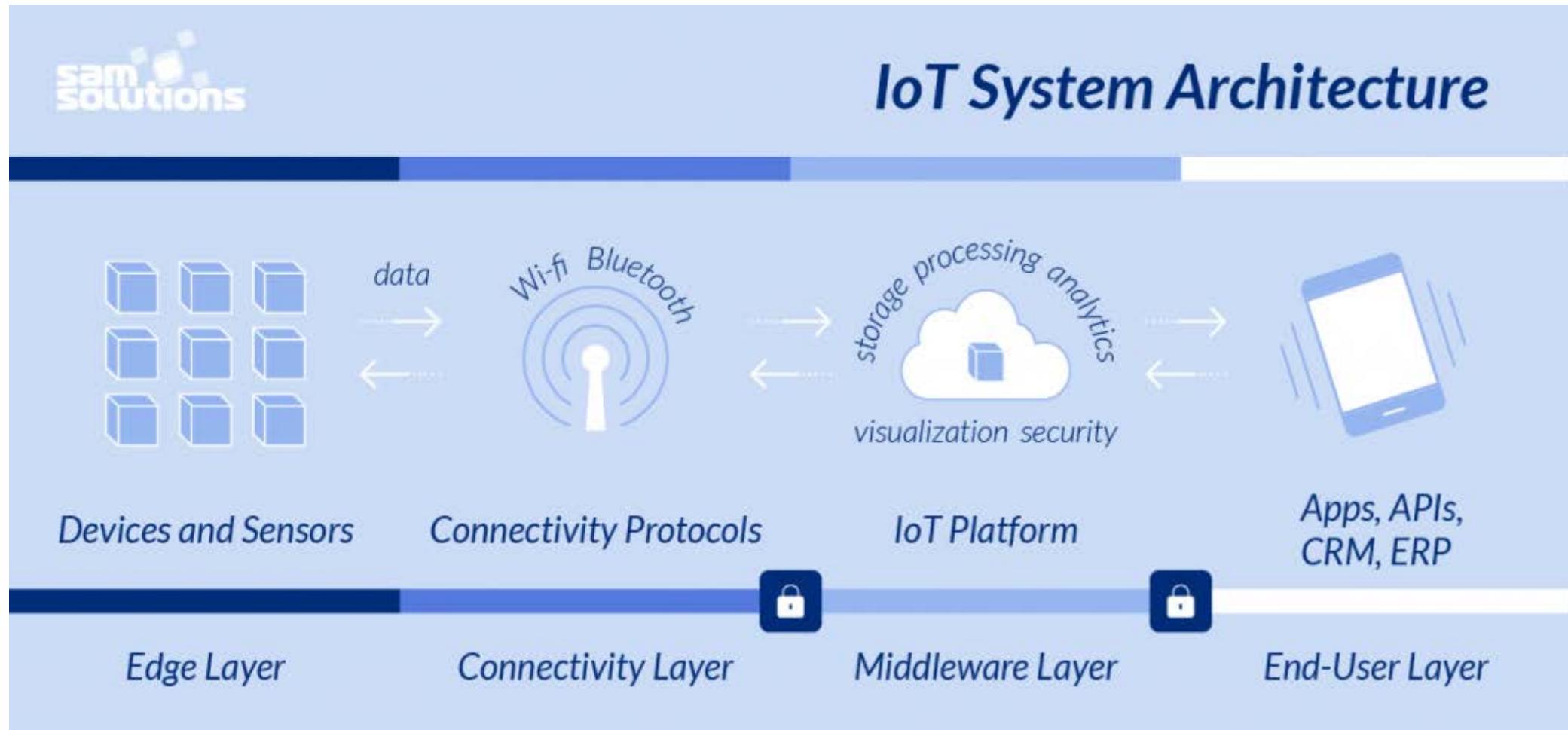
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This Data Science Course was developed for keuzevak- program of the [School of Communication, Media and Information Technology \(CMI\)](#) at the Hogeschool Rotterdam (**Rotterdam University of Applied Sciences, RUAS**).

If you find errors or omissions, please contact the author, Rob van der Willigen, at r.f.van.der.willigen@hr.nl. Materials of this course and code examples used will become available at:

<https://github.com/robvdw/CMIDAT01K-DATA-SCIENCE-for-IOT>



<https://www.sam-solutions.com/blog/top-eight-internet-of-things-platforms/>

The Internet of Things: Five Myths and Realities

Exploring the technology's true nature and capabilities

The Internet of Things (IoT) is a concept that describes a totally interconnected world. It's a world where devices of every shape and size are manufactured with "smart" capabilities that allow them to communicate and interact with other devices, exchange data, make autonomous decisions and perform useful tasks based on preset conditions.

It's a world where technology will make life richer, easier, safer and more comfortable. Or is it?

Like many emerging technologies, the Internet of Things is vulnerable to hype and exaggeration. To some people, it sounds like a vague and distant prospect; to others, it sounds threatening and dangerous.

This executive brief will explore five of the most common myths associated with the Internet of Things and shed some light on the true nature of the technology and its capabilities.

Any new technology involves a certain amount of uncertainty and business risk. In the case of the Internet of Things, however, many of the risks have been exaggerated or misrepresented.



3

Will the Internet of Things create serious privacy and security challenges?

Security and privacy are major concerns—and addressing these concerns is a top priority.

Inevitably, discussions of an Internet of Things evoke images of a future dystopia where personal privacy—and personal freedom—is a thing of the past. In addition, as a seemingly endless stream of data-breach incidents and hacker attacks prove, stolen or misused digital data is already a very real, and rapidly growing, concern.

These are legitimate concerns. New technology often carries the potential for misuse and mischief, and it's vital to address the problem before it hinders personal privacy and security, innovation or economic growth.

Manufacturers, standards organizations and policy-makers are already responding on several levels:

- Existing privacy enhancing technology (PET) infrastructure standards, such as virtual private networks and DNS Security Extensions, that can be easily adapted to protect sensitive data as it moves between devices or through the cloud.
- Government regulations such as the U.S. Health Insurance Portability and Accountability Act (HIPAA) that mandate the protection of sensitive personal information—no matter where it is stored or how it is transmitted.
- Other security frameworks proposing DTLS secured light CoAP running on UDP, which has also been adopted by ETSI.
- As well as many other activities by multiple members of the ecosystem.

Course Setup

Lesson 01: week 02 **Discovering the IoT Data Science Domain**

Lesson 02: week 03 **Defining project requirements**
 + Cost calculation/estimate

Lesson 03: week 04 **Learn to write code**

Lesson 04: week 05 **Data Science: How to start your own IoT Project**

Lesson 05: week 06 **IoT Platforms & MiddleWare**

Lesson 06: week 07 **Core IoT Concepts + setting-up your IoT-device**

Lesson 07: week 08 **Summary + Q & A**

Week 09 / 10: FEEDBACK + GRADING

lesson six

IoT Core-Concepts

IoT Core Concepts

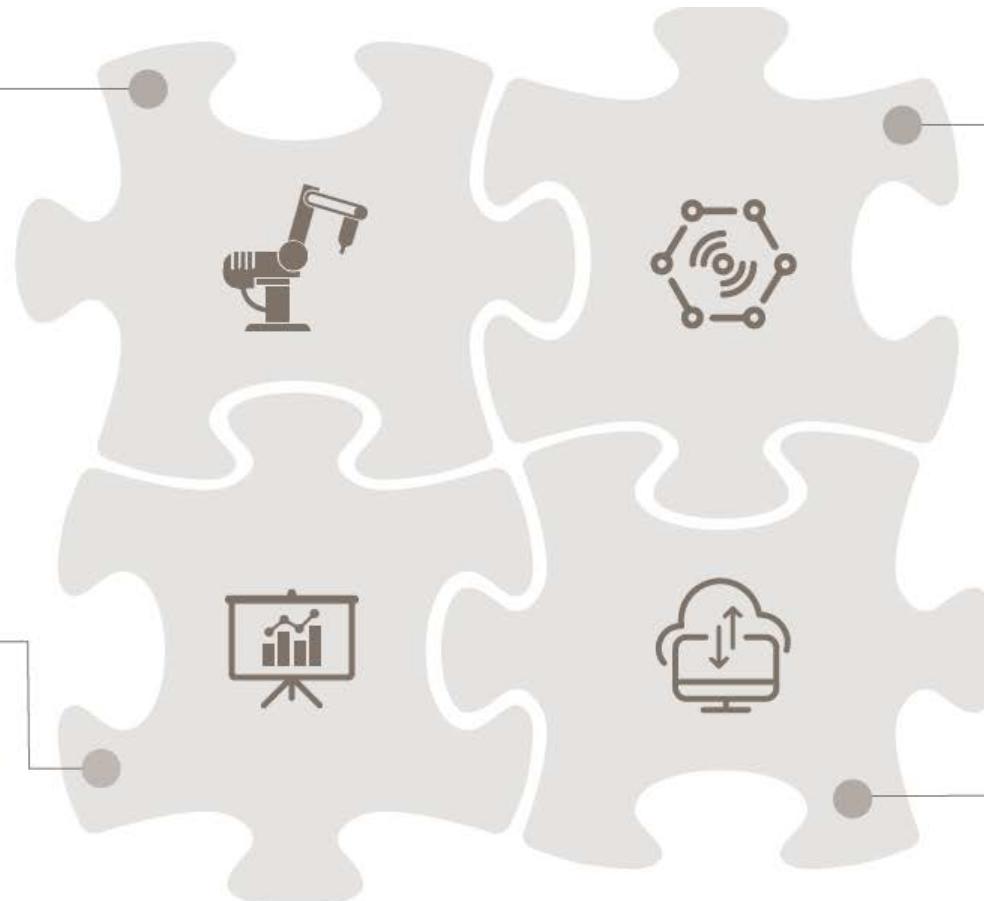
Devices

- Sensors
- Actuators
- Machines



Business Model

- Outcome driven
- Product as a service
- Leverage existing investment



Connectivity

- Network
- Protocol
- Security



Platform

- Storage
- Analytics
- Visualization
- Integration



IoT Landscape

THE THINGS	LIFE SAFETY	HOME SECURITY	TAGS & TRACKERS	HOME AUTOMATION	AUTO-MOTIVE	COMMUNI-CATION	LIFESTYLE & ENT.	WEARABLES	FITNESS & HEALTHCARE	INDUSTRIAL INFRA.	TOYS
	nest roost 1leeo birdi	August HOMEBOY dropcam Lockitron	hereO TrackR+ infinity GOkey Yale	SmartThings Control4 PHILIPS Logitech	CARGO Zbie AUTOMATIC cobra metromile	goTenna OnBeep Beartooth FireChat	GoPro 360° LEAP TRACE magic leap recon navdy Narrative	WATCH GLASS BASIS MIZFIT pebble UP	fitbit NIKE+ FUELBAND Withings proteus awarepoint TEL CARE Misimo	OP@WER eMeter enevo Aldis	orboux 3DR V. wonder
	APP MARKETPLACE	HOME AUTOMATION	CONTROLLER/HUB	IoT OPERATING SYSTEMS	IoT DEV FRAMEWORK	BIG DATA/ANALYTICS	DEV TOOLS/CM	DISTRIBUTED APP			
CLOUD / SCALE / PLATFORMS	Google play App Store amazon	iRule SAVANT verizon comcast	IFTTT	MessageSight Axeda Weaved	sumologic CloudHelix splunk AppDynamics New Relic	docker ANSIBLE opbeat puppet Ansible CHEF	amazon awservices Google mesosphere				
	CRESTRON	HomeKit	ELAN	Control4	Logitech						
API / CLOUD SERVICES	cloudera amazon web services	rackspace Google	DigitalOcean	datalogix TURNSTILE staminus Experian	OpenDNS NS ONE ULTRA DNS FLYING DNS						
HARD INFRA-STRUCTURE	INFRASTRUCTURE HARDWARE	NETWORK / CDN /TRANSPORT	FIBER	DATA CENTER	POWER/ BATTERIES						
	CISCO D-Link NETGEAR Alcatel-Lucent UBIQUITI BROCADE ERICSSON	Akamai IX Megaport at&t verizon	Google Fiber lighttower zayo Sprint	EQUINIX DuPont Fabtex Technology DIGITAL REALTY edgeconnect	VPS freeWire Bloomenergy						
			Level(3)								

World Wide Web (WWW) vs IoT

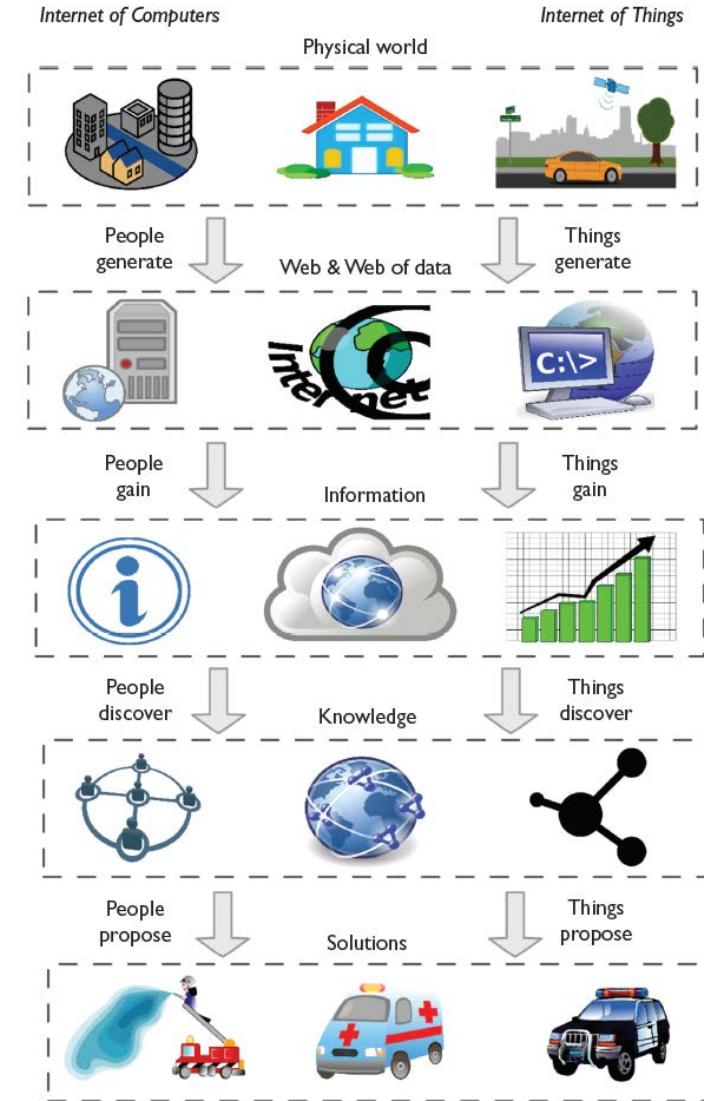
WWW:

In the Internet of Computers (WWW), the main data producers and consumers are human beings.

IoT:

The main actors become things, where things are the majority of data producers and consumers.

Qin, Y., Sheng, Q. Z., & Curry, E. (2015). Matching over linked data streams in the internet of things. *IEEE Internet Computing*, 19(3), 21-27.



IoT Platform + User-Types



Hobbyists



Consumer



Industrial



Industry

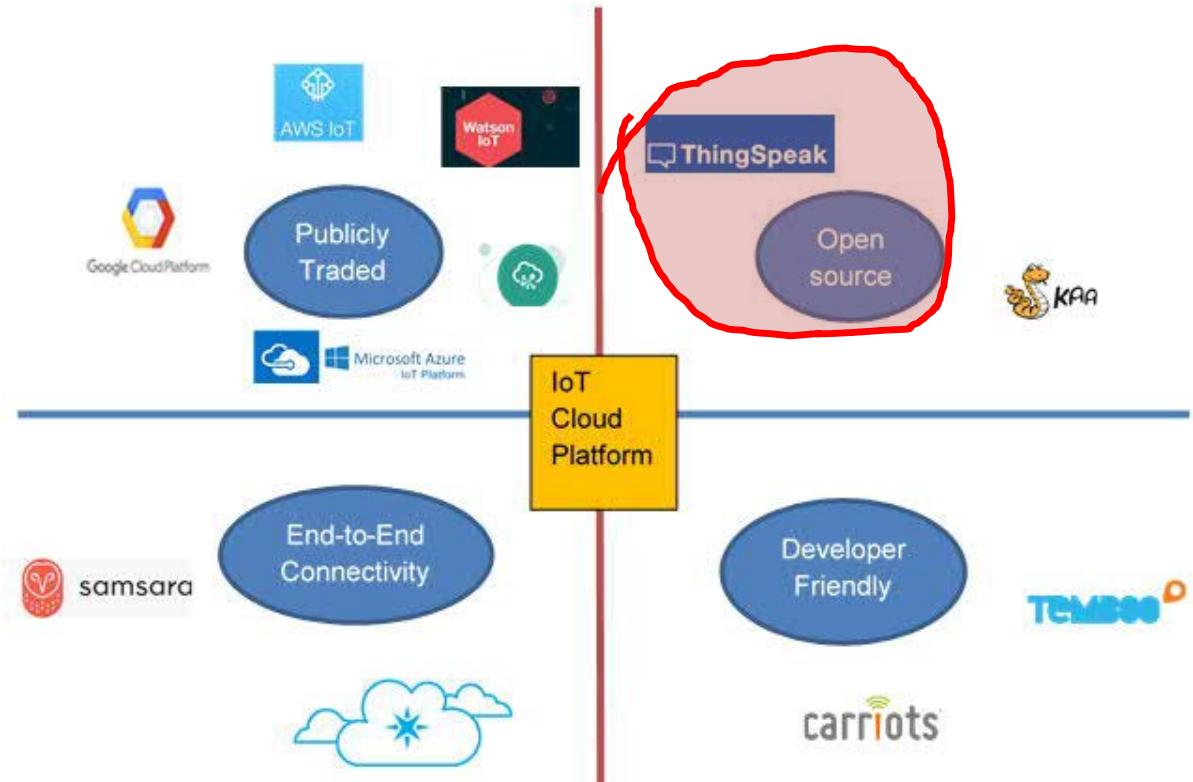
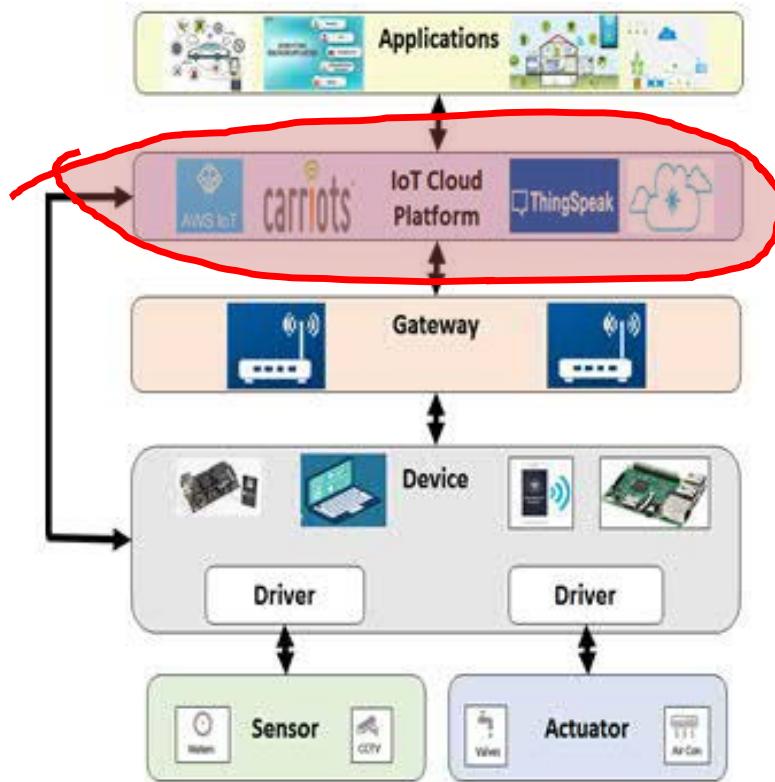
The Internet of Things is a state where the things on the face of the earth connect to the internet and start talking to each other. Things here can be electronic, electrical, mechanical, or electro-mechanical objects.



The number of connected things is projected to grow at an annual compound rate of 23.1% between 2014 to 2020, reaching 50.1 billion things in 2020.¹



IoT Platforms == MiddleWare



<http://www.thetips4you.com/iot-best-open-source-applications-open-source-industrial-iot-platform>

IoT Application Domains

Consumers



- Connected gadgets
- Appliances
- Wearables
- Domestic robots
- Participatory sensing
- Social Web of Things

Automotive Transport



- Autonomous vehicles
- Multimodal transport
- Logistics
- Traffic management

Retail Banking



- Micro payments
- Retail logistics
- Product life-cycle info
- Shopping assistance

Environmental



- Pollution
- Air, Water, Soil
- Weather, Climate
- Noise
- Erosion, fires

Infrastructures



- Buildings, Homes
- Roads, Rail

Utilities



- Smart Grid
- Water management
- Gas, Oil, Renewables
- Waste management
- Heating, Cooling

Health Well-being



- Remote monitoring
- Assisted living
- Behavioral change
- Treatment compliance
- Sports, Fitness

Smart Cities



- Integrated environments
- Optimized operations
- Convenience
- Socioeconomics
- Sustainability
- Inclusive living

Process industries

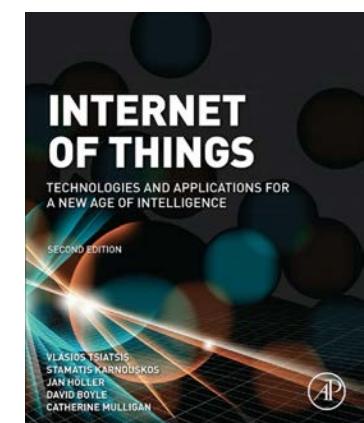


- Robotics
- Manufacturing
- Natural resources
- Remote operations
- Automation
- Heavy machinery

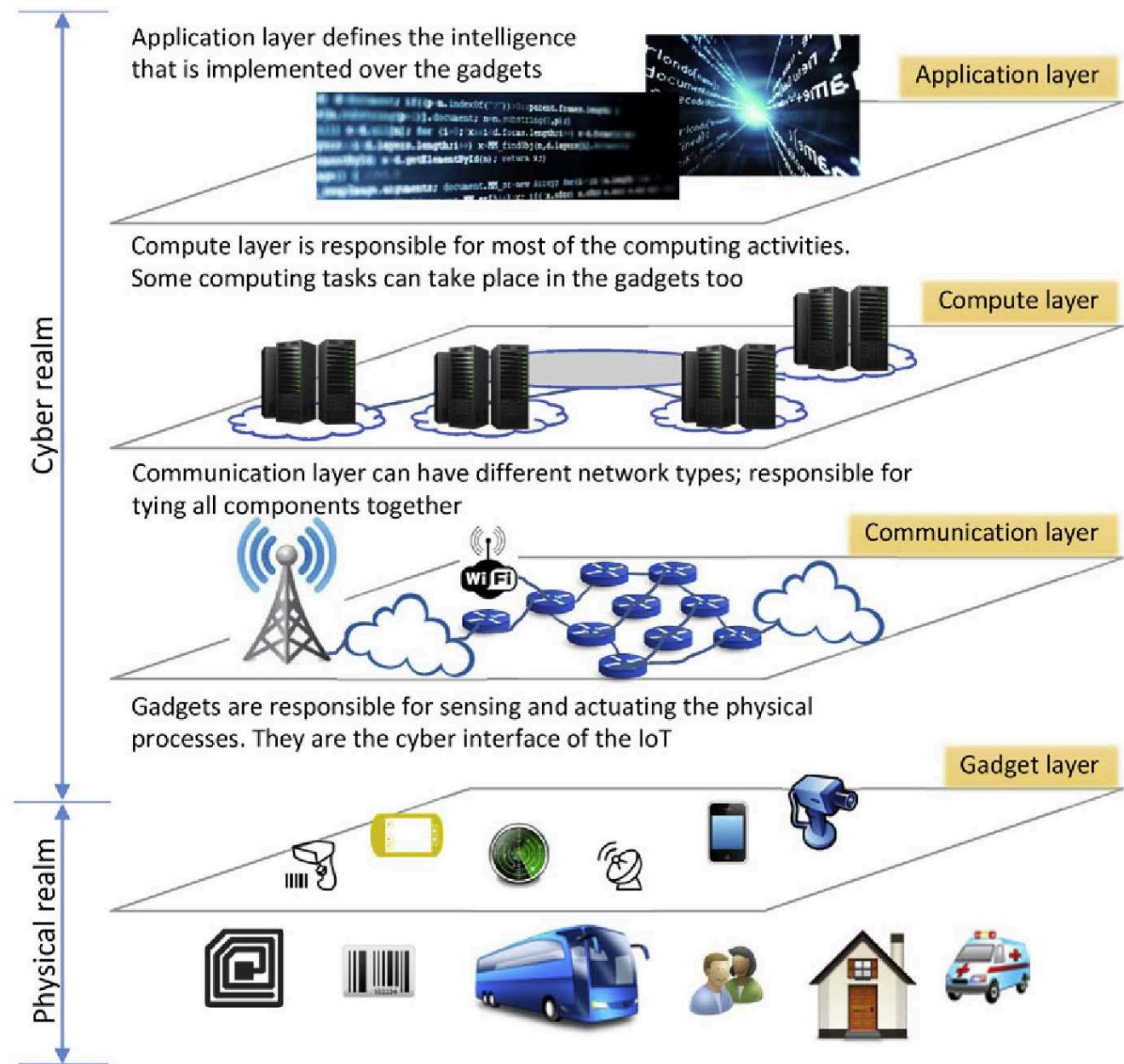
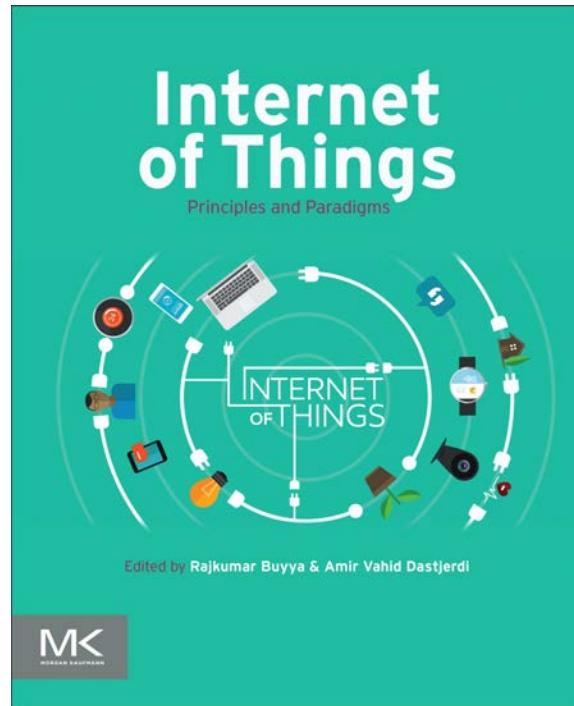
Agriculture



- Forestry
- Crops and farming
- Urban agriculture
- Livestock, Fisheries



IoT Layers



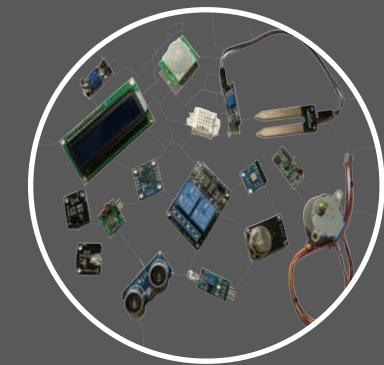
Technologies enabling IoT

WIRELESS TECHNOLOGIES	TCP/IP PROTOCOLS	AUTHORIZATION & AUTHENTICATION TECHNOLOGIES
802.11, 802.15.4, Zigbee, Bluetooth, BLE, CDMA, GSM, LTE	Sockets, IPv4, IPv6, TCP, UDP, ICMP, QoS, SNMP, IMAP, POP3, IPMI, etc.	Oauth2, PAM, LDAP
NETWORK TECHNOLOGIES	MOBILE TECHNOLOGIES	PLATFORMS AND CPU ARCHITECTURES
Ethernet, CAN, rs485/rs422/rs232, 1-wire, i2c, SPI, ModBus/MudBusRTU, IPMI, iSCSI	Android SDK, Qt, iOS SDK, Objective C, Java, Swift	ARM, X86, PowerPC, AVR, PIC
WEB SERVICE TECHNOLOGIES	PROTOCOL TECHNOLOGIES	PROGRAM / SCRIPTING LANGUAGES
SOAP, REST, WSDL, XML, JSON, UDDI, WebSockets	HTTP, JMS, AMQP, D-Bus	Java, C/C++, C#, JavaScript, Ruby, Groovy, Python, Tcl/Tk, ASM, Bash

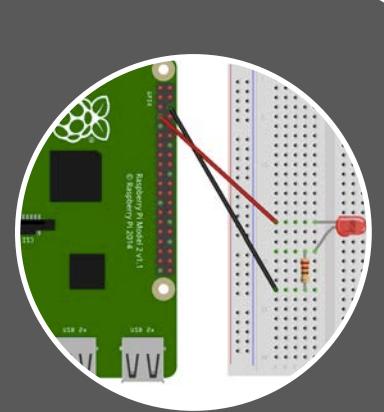
<https://doi.org/10.15779/Z38WW0V>

<https://doi.org/10.1016/j.eswa.2019.05.014>

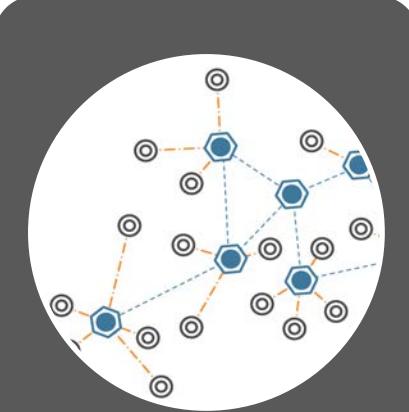
Engineering a IoT Data Pipeline



Sensors &
Actuators



Micro-
Processors/
Controllers
(Development
Boards)



Network /
Protocols



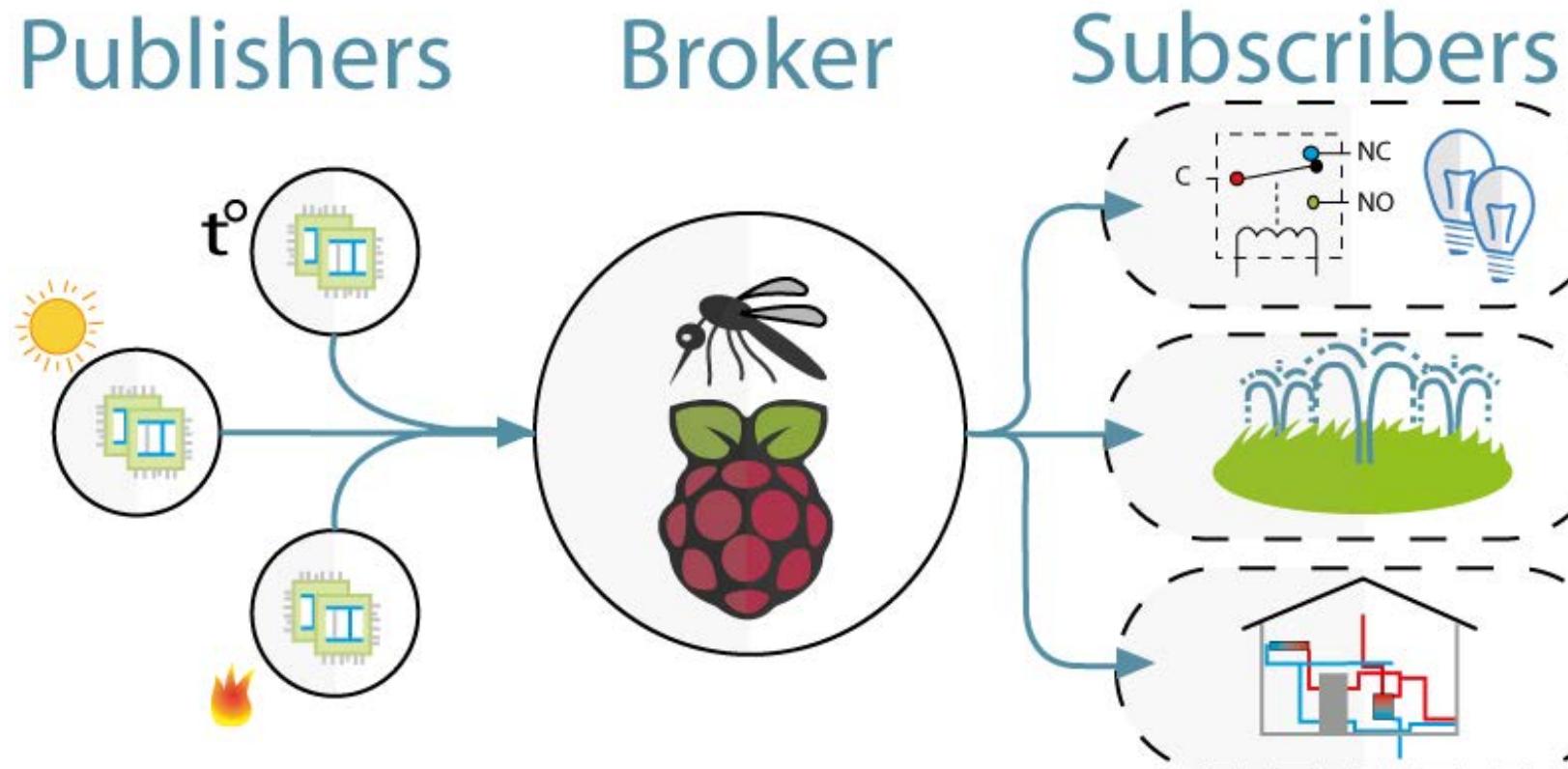
Platforms,
Cloud &
Data Analytics

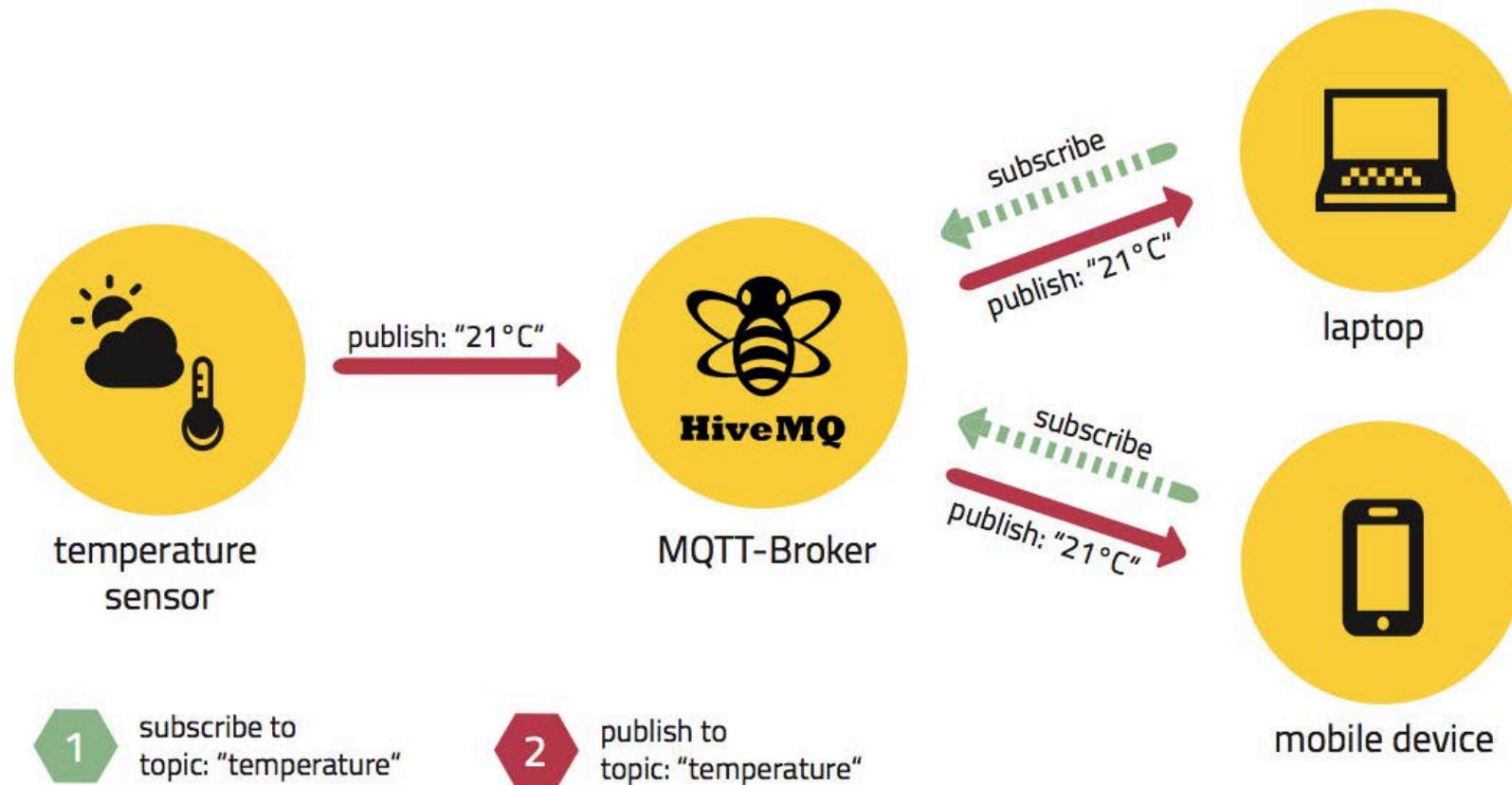
IoT Communication

The Broker: The broker acts as a gateway; it receives messages from a publisher (a client) and delivers the messages to a subscriber (another client). Brokers are sometimes referred to as *servers*.

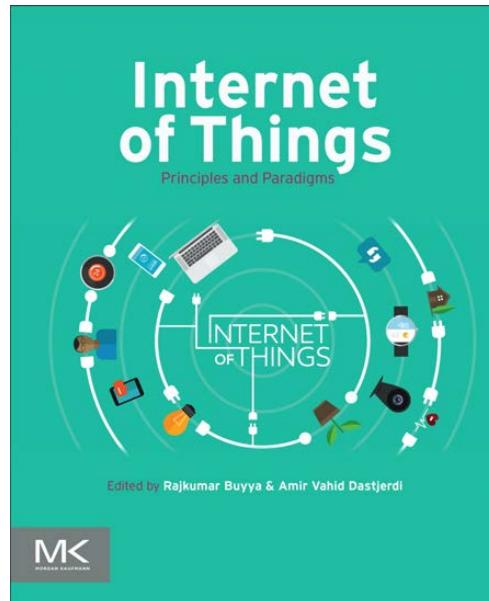
The Subscriber: The subscriber declares its topics of interest to the broker, and the broker sends messages published to those topics.

The Publisher: The publisher sends messages to the broker using a name-space or a topic name, and the broker forwards the messages to the respective subscribers.





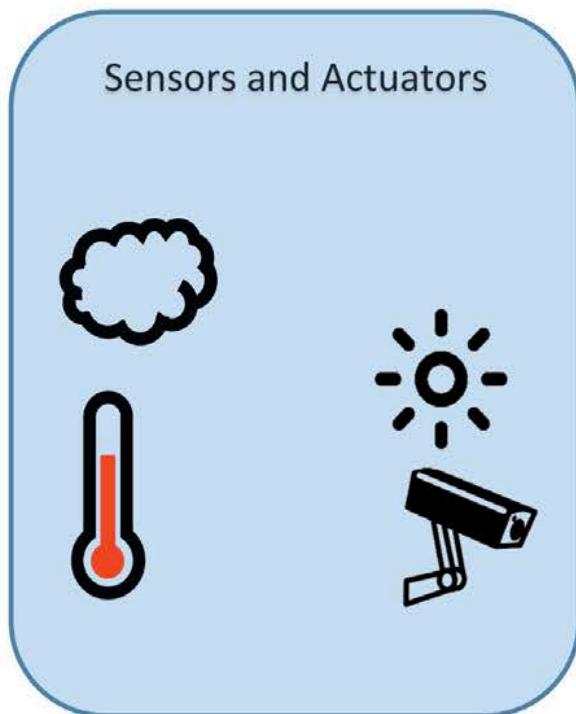
IoT-device communication protocols



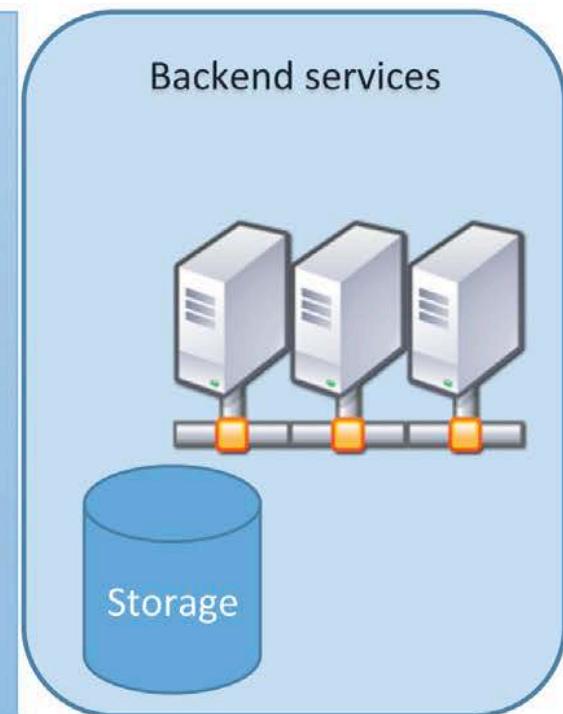
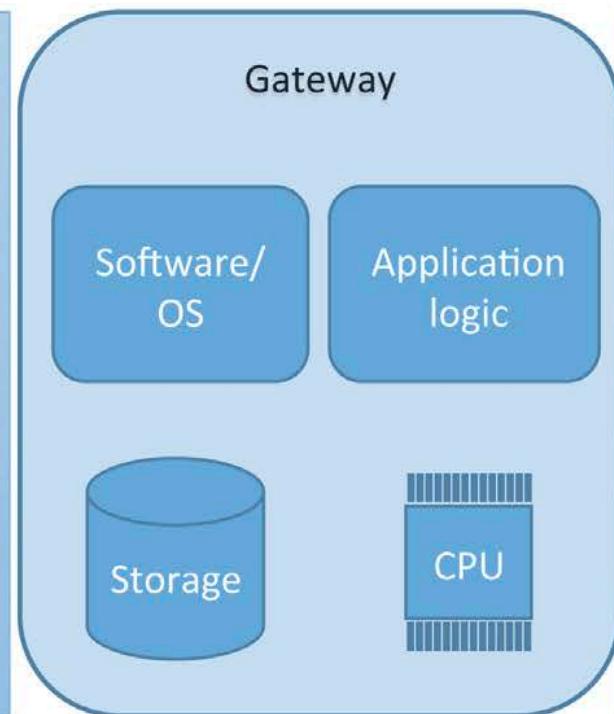
Protocol Name	Transport Protocol	Messaging Model	Security	Best-Use Cases	Architecture
AMPQ	TCP	Publish/Subscribe	High-Optional	Enterprise integration	P2P
CoAP	UDP	Request/Response	Medium-Optional	Utility field	Tree
DDS	UDP	Publish/Subscribe and Request/Response	High-Optional	Military	Bus
MQTT	TCP	Publish/Subscribe and Request/Response	Medium-Optional	IoT messaging	Tree
UPnP	—	Publish/Subscribe and Request/Response	None	Consumer	P2P
XMPP	TCP	Publish/Subscribe and Request/Response	High-Compulsory	Remote management	Client server
ZeroMQ	UDP	Publish/Subscribe and Request/Response	High-Optional	CERN	P2P

IoT communication Protocols

Publisher



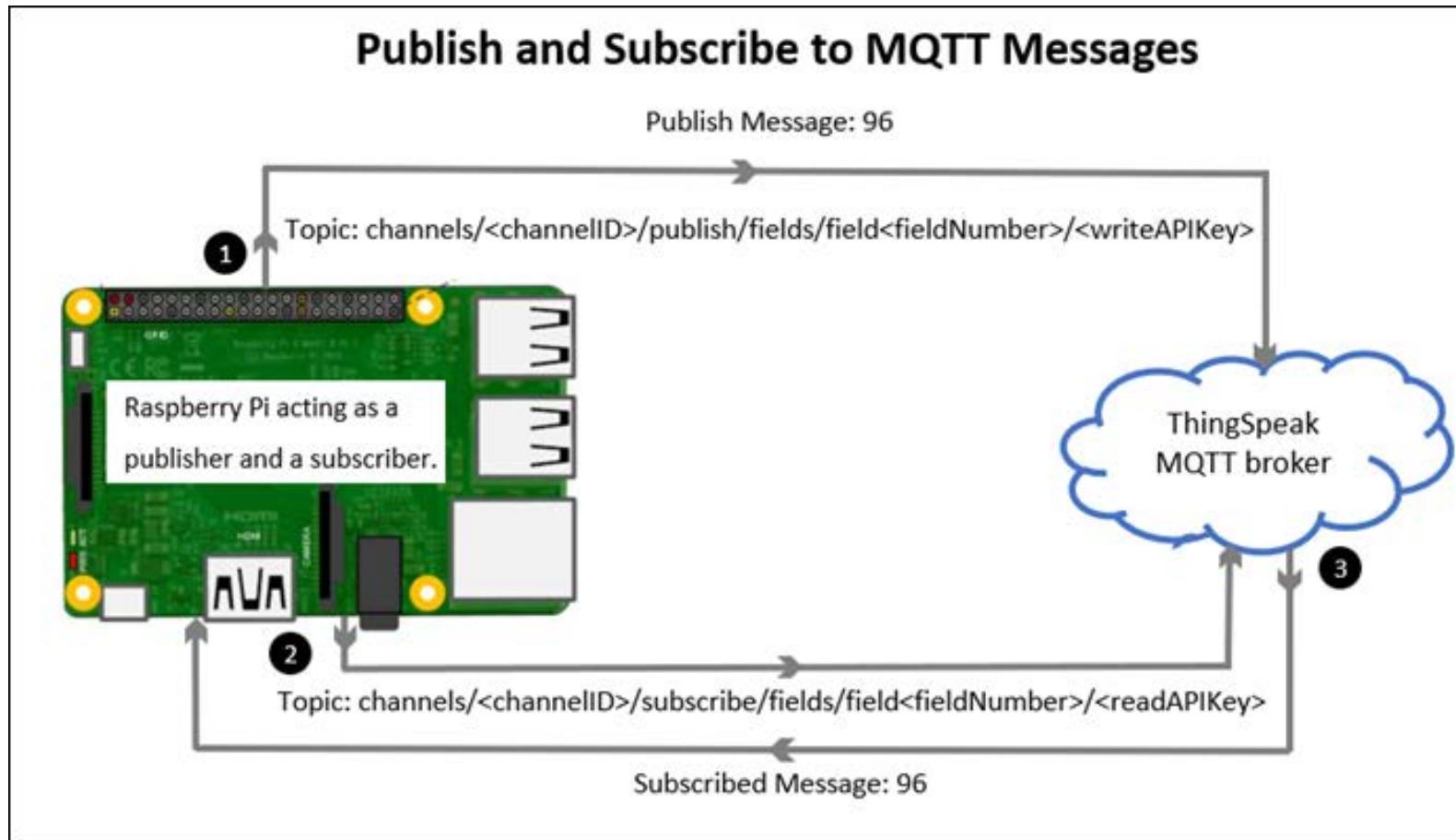
Broker



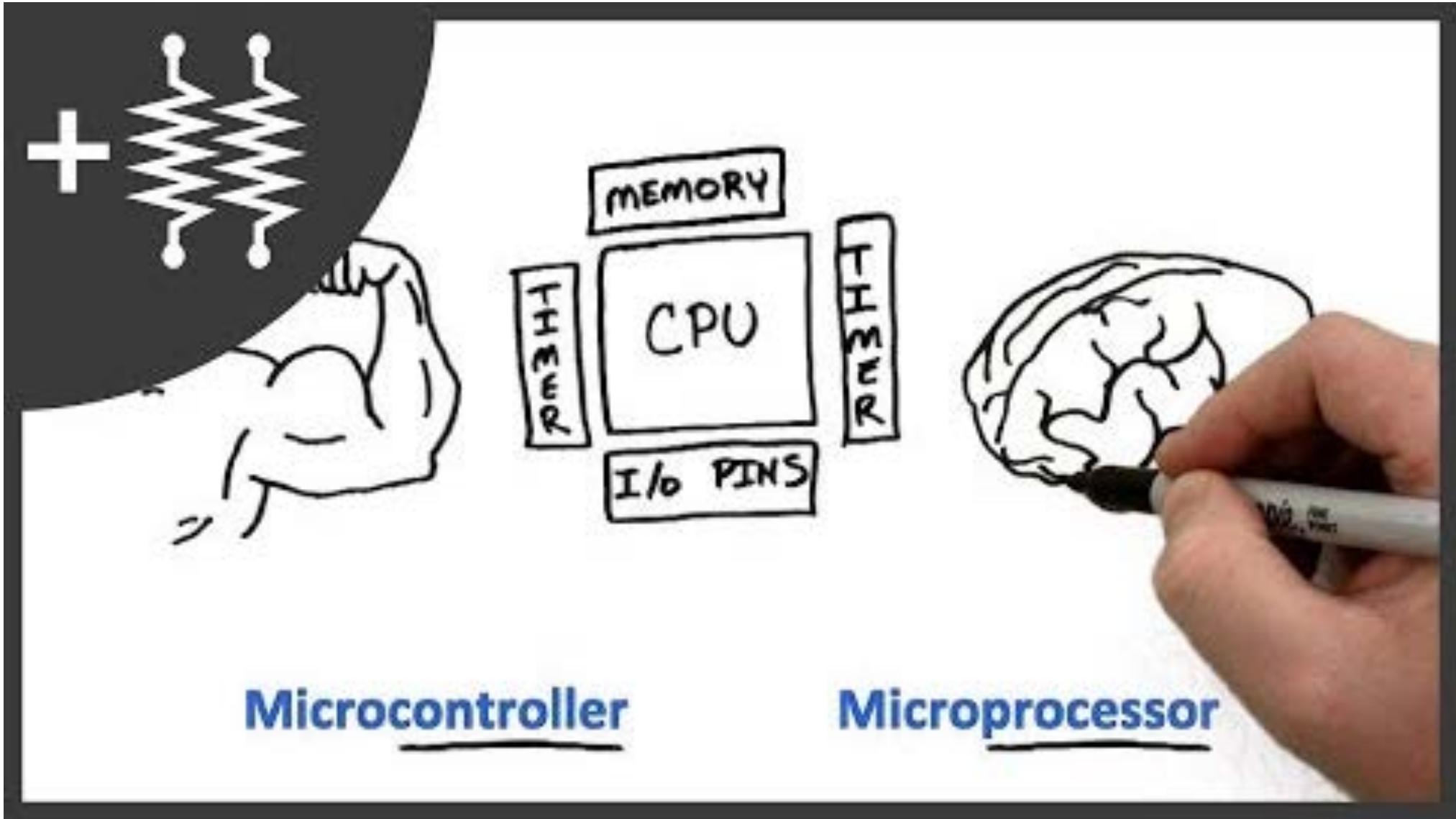
SENSOR TO GATEWAY COMMUNICATION

Setting Up Your IoT Device

{IoT device == micro-controller== Raspberry Pi}



Micro- controller/processor Core-Concepts



<https://www.youtube.com/watch?v=7vhvnaWUZjE>

Enterprise Internet of Things Handbook

Build end-to-end IoT solutions using popular
IoT platforms



Packt

Microprocessor Microcontroller

Only CPU; other
peripherals are
interfaced via the
CPU bus

CPU + (Flash) Memory + RAM +
ROM + I/O + Timers + UARTS +
ADC + DAC and so on on a single
chip

General purpose

Single purpose

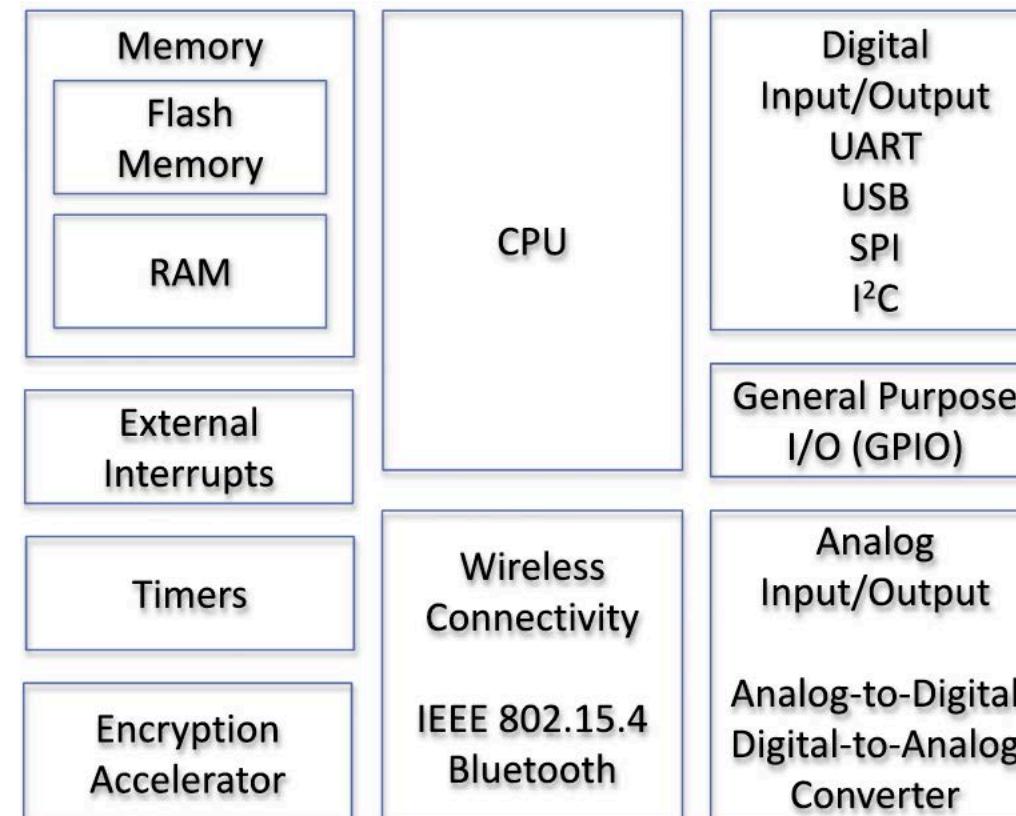
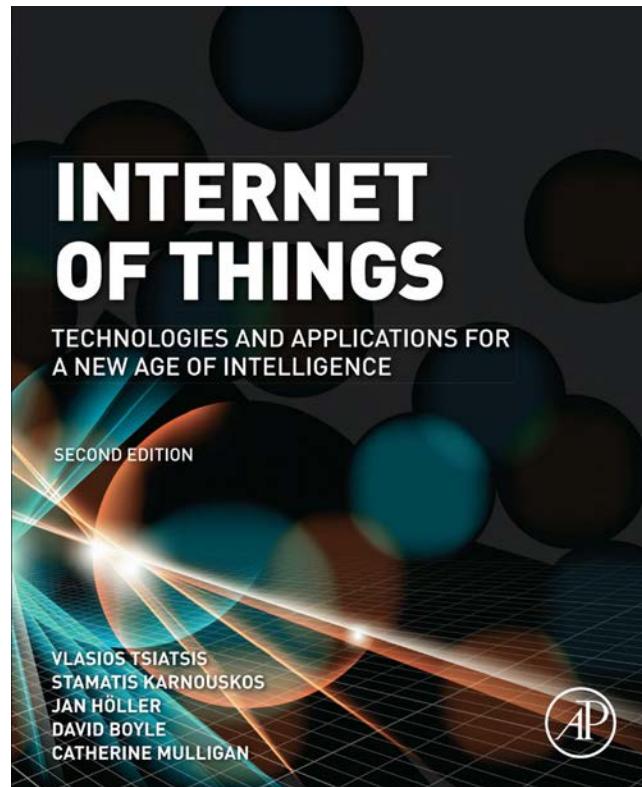
High processing
power

Low processing power

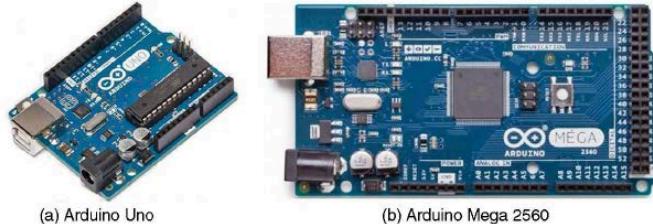
Power hungry

Can work on a battery

Micro-controller/processor Internal Architecture



(micro)Controllers (hardware requirements)

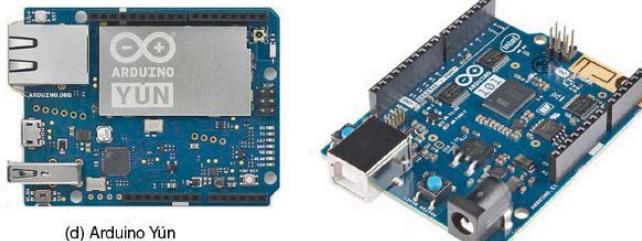


(a) Arduino Uno

(b) Arduino Mega 2560



(c) Arduino Due

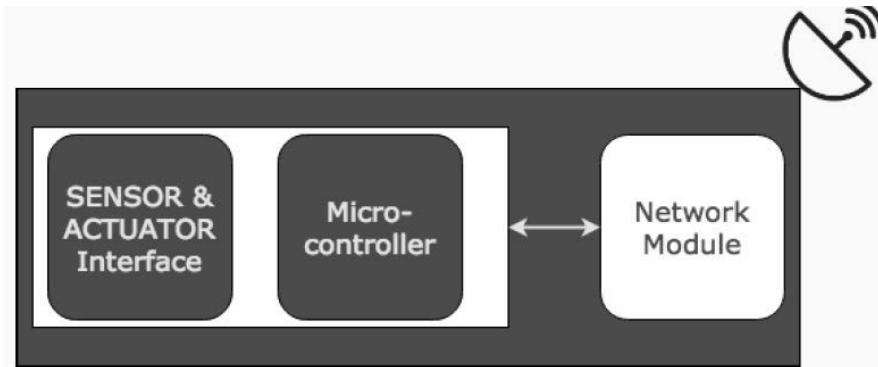


(d) Arduino Yún

(e) Arduino 101



(f) Arduino MKR1000



Board name	Microcontroller			Memory/storage		
	MCU chip	Processor bit	Clock speed	RAM	EEPROM (kb)	Flash memory (kb)
Uno	ATmega328	8	16 MHz	2 KB	1	32
Mega 2560	ATmega2560	8	16 MHZ	8 KB	4	250
Due	AT91SAM3X8E	32	84 MHz	96 KB	–	512
Yún	ATmega32U4	8	16 MHz	2.5 KB	1	32
	AR9331	8	16 MHZ	64 MB, 2.5 KB	1	16
101	Intel Quark SE SoC	32	32 MHz	24 KB	–	196
MKR1000	ATSAMW25 SoC	32	48 MHz, 32.768 KHz	32 KB	–	256

(micro)Controllers (hardware requirements)



(a) Raspberry Pi Zero



(b) Raspberry Pi Zero W



(c) Raspberry Pi 1 B+



(d) Raspberry Pi 2 B

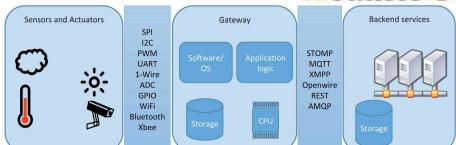


(e) Raspberry Pi 3 B

Raspberry Pi	Onboard connectivity	GPIO pins	USB ports	Display ports/interfaces	Camera port	Other hardware interfaces
Zero	–	40	1 mini	Mini-HDMI	CSI	UART, SPI, I2C
Zero W	Wi-Fi, Bluetooth 4.1, BLE	40	1 mini	Mini-HDMI	CSI	UART, SPI, I2C
1 B+	Ethernet	40	4	HDMI, DSI, 3.5 mm Video Jack	CSI	UART, SPI, I2C
2 B	Ethernet	40	4	HDMI, DSI, 3.5 mm Video Jack	CSI	UART, SPI, I2C
3 B	Ethernet, Wi-Fi, Bluetooth 4.1, BLE	40	4	HDMI, DSI, 3.5 mm Video Jack	CSI	UART, SPI, I2C

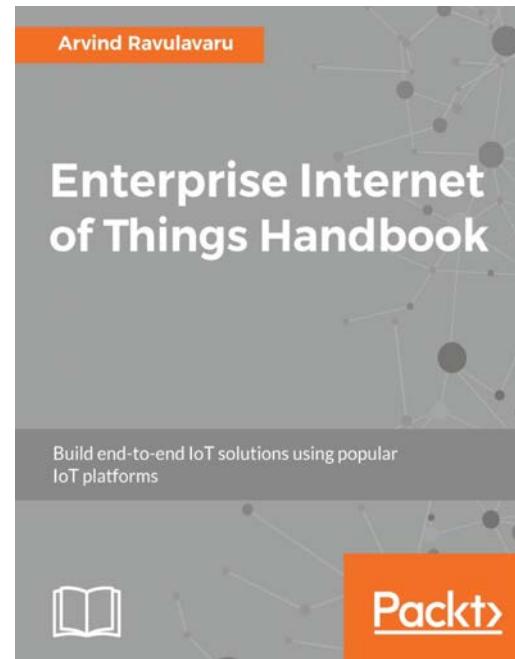
(connecting) SENSORS

Sensor	Interface	Processor/Hardware	Power
Wind vane	Analog	Switched resistors	—
Anemometer	GPIO interrupt	Reed switch	—
Rain gauge	GPIO interrupt	Reed switch	—
UV intensity	Analog	ML8511	1,000 µW
Humidity and temperature	2-wire serial	SHT15	80 µW
Barometric pressure	I ² C	BMP180	30 µW
Luminosity	I ² C	TSL2561	720 µW
Lightning sensor	SPI + GPIO interrupt	AS3935	100 µW
Geiger counter	RS-235	LND712	147,000 µW
Weather board	I ² C	Si7020	540 µW
Weather board	I ² C	BMP180	30 µW
Weather board	I ² C	Si1132	1,419 µW



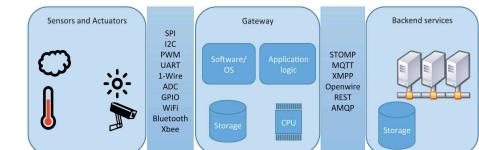
Sensor/Actuator IoT

Microcontroller interfacing protocols



There are multiple protocols with which communications can happen. The most commonly used ones are:

- GPIO
- Analog/voltage reading
- UART
- SPI
- I²C



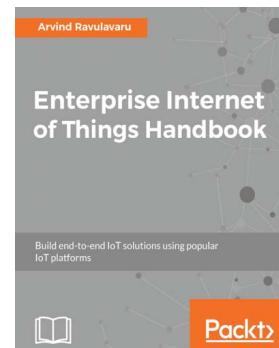
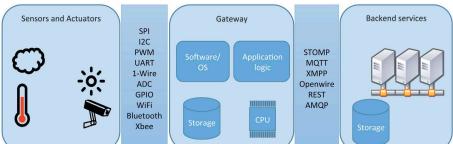
Sensor/Actuator IoT

Microcontroller interfacing protocols

GPIO

General Purpose Input Output (GPIO) is a simple communication mechanism that involves one pin between the controller and the sensor/actuator. This protocol is pretty good for sending a few bits of data.

A relay can be controlled via a GPIO pin. DHT11's temperature can be read using the digital pin.



I²C

Inter-Integrated Circuit, pronounced as I-Squared-C or I-two-C, uses a single data line and a clock to communicate between multiple sensors connected to the controller. This protocol is very good for on-board or short-range communication.

For example, the BH1750 from the ROHM semiconductor is an ambient light sensor that measures the ambient light around the sensor in Lux. This sensor exposes its data to the controller over the I²C bus. Read more about BH1750 here: <http://www.mouser.com/ds/2/348/bh1750fvi-e-186247.pdf>.

This protocol can be used for controller-to-controller communication as well.



Micro-controller to Cloud Communication Protocol

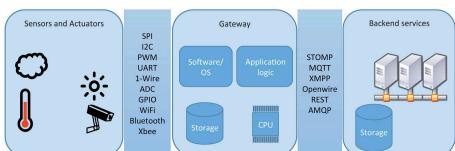
Message Queuing Telemetry Transport

The **Message Queue Telemetry Transport (MQTT)** protocol is a battery-friendly, small footprint message broker that implements an extremely lightweight publish/subscribe protocol. MQTT is suitable when working with power- and computation-constrained devices.

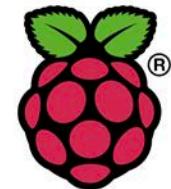
MQTT for Sensor Networks

MQTT for Sensor Networks (MQTT-SN) caters for more non-TCP/IP embedded devices, where MQTT runs using a TCP/IP stack.

MQTTS and MQTT-SN are different. MQTTS is MQTT over SSL.



Sensor / Actuator Core-Concepts



Internet of Things 101: Building IoT
Prototype with Raspberry Pi
Feb 9 and 11, 2016 at Forward 4 Conf

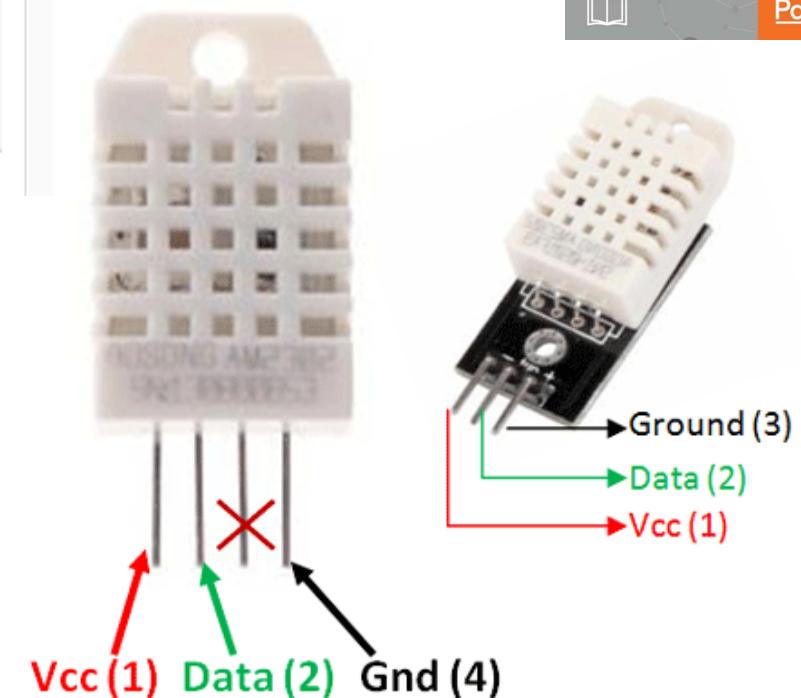
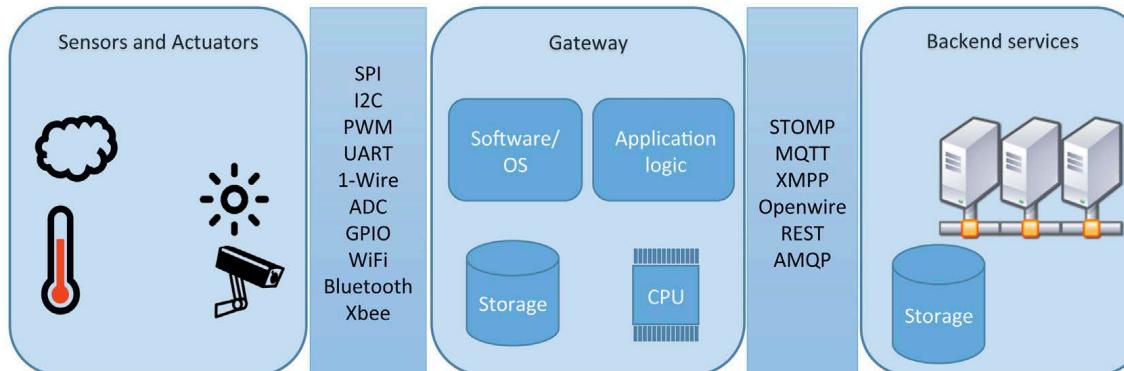
<https://github.com/pubnub/workshop-raspberrypi>

Sensor name

Temperature and humidity sensor (DHT11)

Datasheet link

<https://akizukidenshi.com/download/ds/aosong/DHT11.pdf>

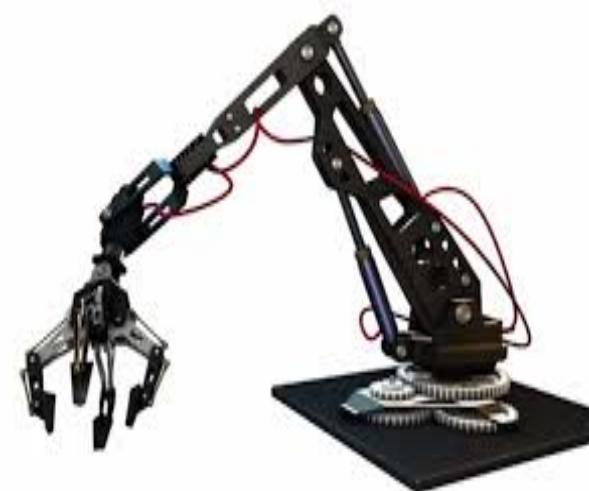


ACTUATORS

An actuator is a component of a machine that is responsible for moving or controlling a mechanism or system. An actuator requires a control signal and a source of energy.

The control signal is relatively low energy and may be electric voltage or current, pneumatic or hydraulic pressure, or even human power.

ACTUATORS



ACTUATORS

Actuators

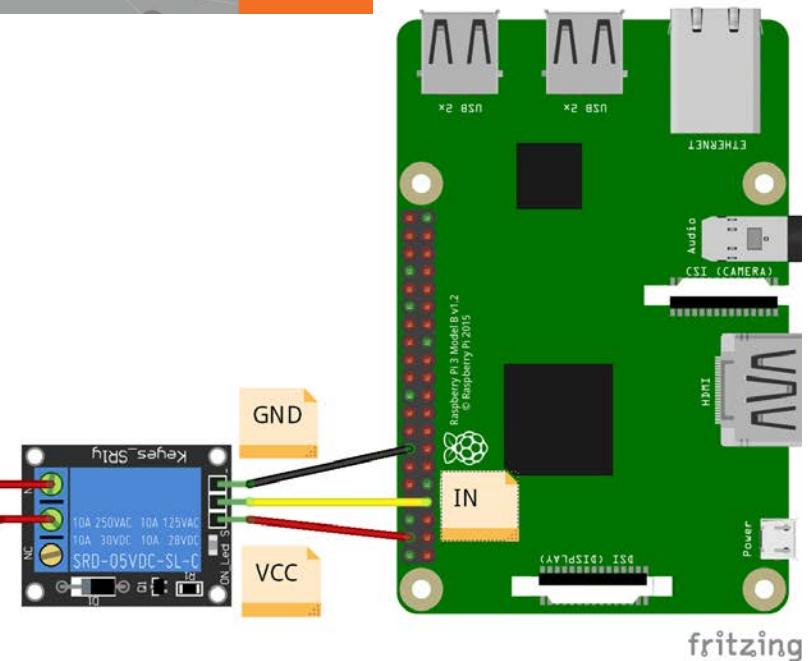
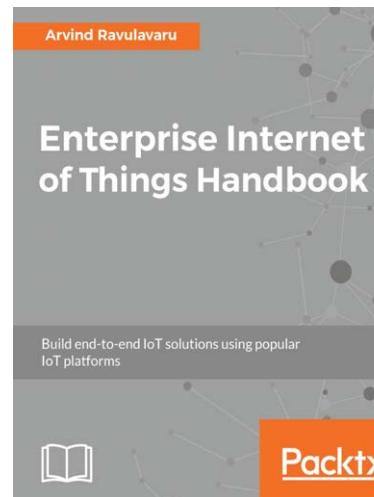
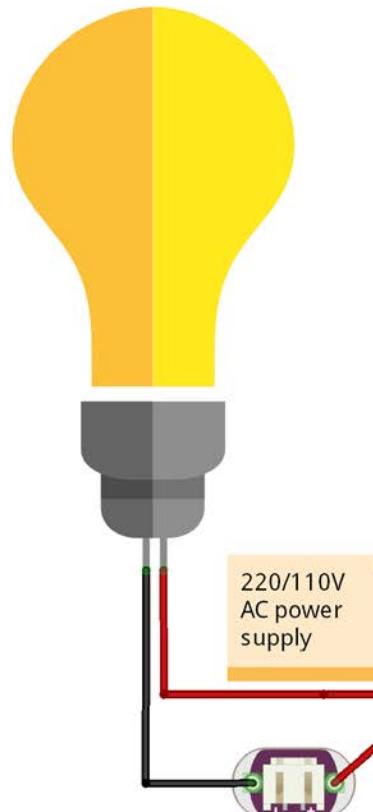
While sensors sense the environment around them, an actuator is responsible for controlling a system by actuating (open/close or on/off). For example, a switch that can be used to turn a light on or off can be controlled via an actuator.

An actuator generally takes a signal which indicates the nature of an operation. For example, if we need to turn a switch on or off, we use a relay.

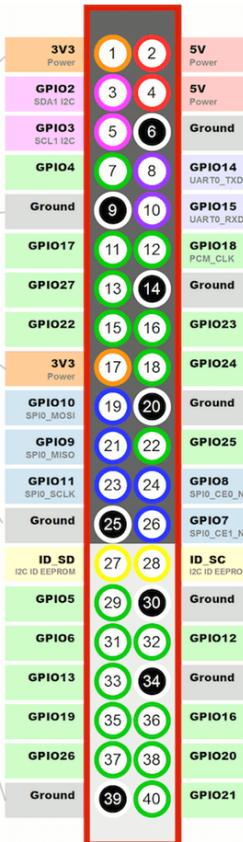
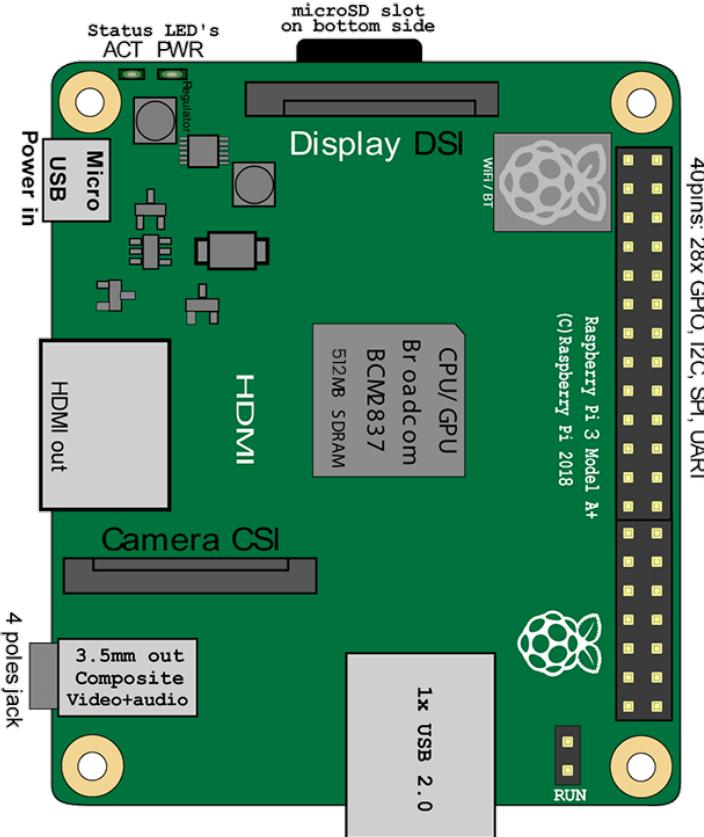
A relay is an electromagnetic switch that takes in the AC mains power supply at one end and a digital signal at other. The general state of the relay is open and that means there is no power supply flowing through from the mains to our load. Once there is a digital high or a digital low signal (depending on the type of relay), the relay moves to a closed state where the load and mains are short and the power flows through.

To get a better understanding of how a relay works and how to use it, take a look at *How to use a relay, the easy way*: <https://www.youtube.com/watch?v=T1fNQjelojs>.

A relay is one of several core actuator components, which are then reused in other actuators such as a solenoid valve.



Raspberry Py 3A+



GPIO

schematics of the Raspberry Pi 3 A Plus hardware.

Shown also are general positioning of all the vital circuitry on the board.

The Raspberry Pi 3 A+ is a cut down version of the Pi 3B. As you can tell by its diagram, it features a single USB 2.0 Port. Its only means of network connectivity is the inbuilt Wi-Fi.

CPU: 1.4 GHz quad core ARM Cortex-A53

GPU: 250MHz Broadcom VideoCore IV

RAM: 512mb (Shared with GPU)

Storage: Micro SD

USB 2.0 Ports: 1

USB 3.0 Ports: 0

Networking: 802.11b/g/n/ac dual band 2.4/5 GHz wireless, Bluetooth 4.2 LS BLE

Video Input: 15-pin MIPI camera interface (CSI) connector

Video Outputs: HDMI 1.3, MIPI display interface, DSI

Audio Inputs: Audio over I2S

Audio Outputs: 3.5mm phone jack, Digital Audio via HDMI

Low-Level peripherals: 17 x GPIO, +3.3v, +5v, ground, Plus the following that can be used as GPIO: UART, I2C Bus, SPI bus with two chip select, I2S audio

Power Source: 5v via MicroUSB or GPIO header

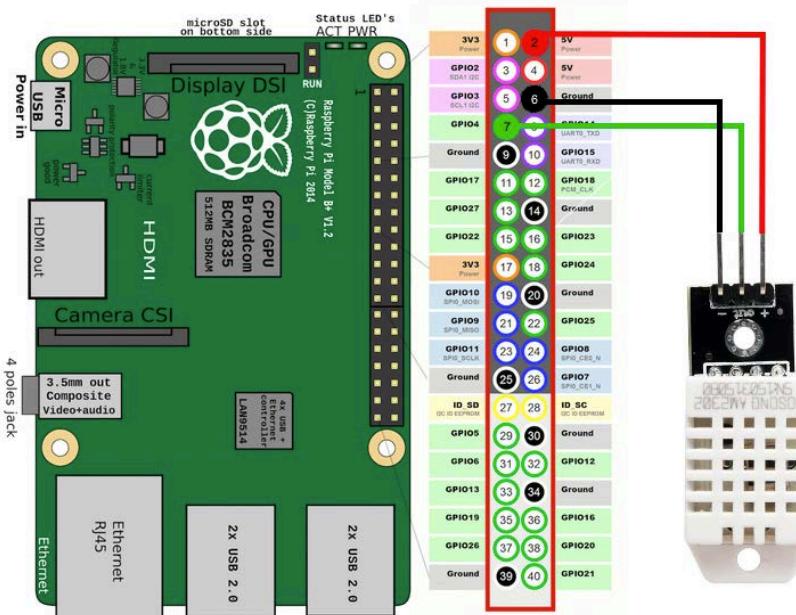
Size: 65.00mm x 56.50mm x 17mm

Weight: 23 g (0.81 oz)

Raspberry Pi Sensor to ThingsBoard using Constrained Application Protocol

Installation

Connecting the sensor



To connect the DHT22 sensor to the RPi:

1. Connect the `-` output on the sensor to pin 6 on the RPi.
2. Connect the `+` input on the sensor to pin 2 on the RPi.
3. Connect the `out` pin on the sensor to pin 7 on the RPi.

<https://github.com/Silver292/rpi-coap>

Introduction

This script is designed to be run on Raspberry Pi 3 hardware running the Raspbian 9.6 operating system.

It is also assumed that a DHT22 temperature and humidity sensor is connected to the Raspberry Pi (RPi) using GPIO 4 pin.

The process of connecting the sensor is described here.

The script creates a Constrained Application Protocol (CoAP) client on the RPi and repeatedly polls the attached DHT22 sensor for temperature and humidity data.

This data is then formatted to JavaScript Object Notation (JSON) and is sent to a CoAP endpoint provided by the ThingsBoard Cloud Platform.

This data is then displayed on the ThingsBoard dashboard that shows the current temperature and humidity as well as historical readings in a graph form.

IoT & Node-RED

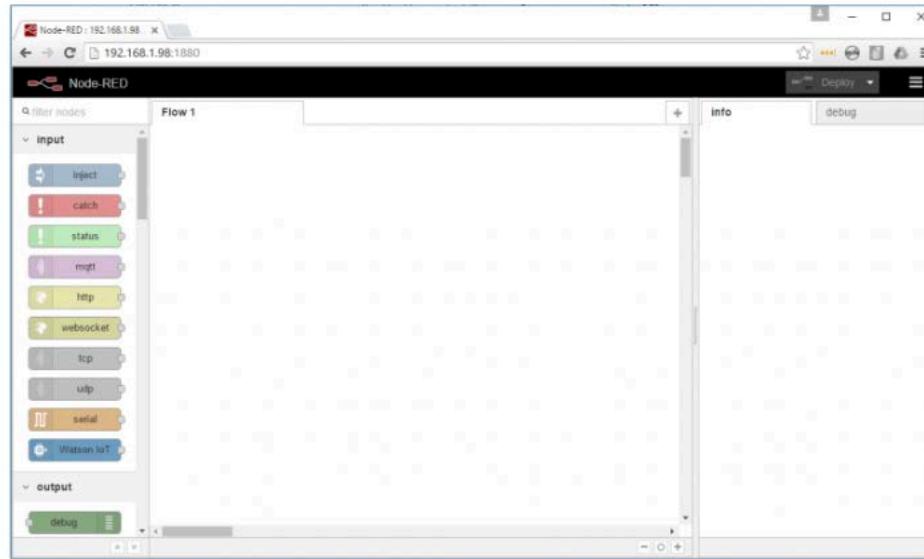
Tools that make it easier for developers & designers at all levels to bring together the different streams of events, both Physical and Digital that make up the IoT

What's Node-RED?

Node-RED is a powerful open source tool for building Internet of Things (IoT) applications with the goal of simplifying the programming component.

It uses a visual programming that allows you to connect code blocks, known as **nodes**, together to perform a task.

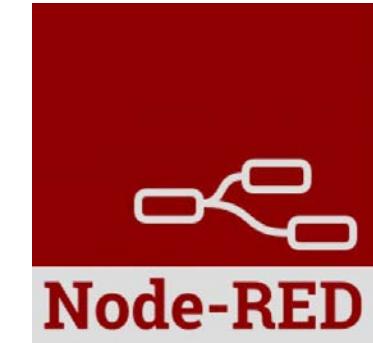
The nodes when wired together are called **flows**.



<https://randomnerdtutorials.com/getting-started-with-node-red-on-raspberry-pi/>

17 INTERNET OF THINGS CONTROLECENTRUM MET NODE-RED

IN DIT PROJECT GA JE EEN INTERNET OF THINGS (IOT) APP MAKEN OM JE FAVORiete HUISHOUDELIJKE ELEKTRONICA VANAF EEN WEBSERVER AAN TE STUREN MET NODE-RED, EEN KRACHTIG EN GEBRUIKSVRIENDELIJK HULPMIDDEL VOOR IOT-TOEPASSINGEN.



IoT & Node-RED

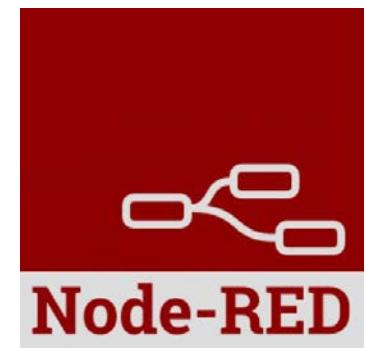
What can you do with Node-RED?

Node-RED makes it easy to:

- Access your RPi GPIOs
- Establish an MQTT connection with other boards (Arduino, ESP8266, etc)
- Create a responsive graphical user interface for your projects
- Communicate with third-party services (IFTTT.com, Adafruit.io, Thing Speak, etc)
- Retrieve data from the web (weather forecast, stock prices, emails. etc)
- Create time triggered events
- Store and retrieve data from a database

Here's a library [with some examples of flows and nodes](#) for Node-RED.

<https://randomnerdtutorials.com/getting-started-with-node-red-on-raspberry-pi/>



Setting up Node.js on the Raspberry Pi

Open a new Terminal and run the following commands:

```
$ sudo apt update
$ sudo apt full-upgrade
```

This will upgrade all the packages that need upgrades. Next, we will install the latest version of Node.js.

We will be using the Node 7.x version:

```
$ curl -sL https://deb.nodesource.com/setup_12.x | sudo -E bash -
$ sudo apt install nodejs
```

This will take a moment to install and once your installation is done you should be able to run the following commands to see the version of Node.js and npm:

```
$ node -v
$ npm -v
```

```
pi@raspberrypi:~ $ node -v
v12.14.0
pi@raspberrypi:~ $ npm -v
6.13.4
```



Original author(s)	Isaac Z. Schlueter
Developer(s)	Rebecca Turner, Kat Marchán, others
Initial release	12 January 2010; 9 years ago ^[1]
Stable release	6.12.0 / 8 October 2019; 2 months ago ^[2]
Repository	github.com/npm/cli ↗
Written in	JavaScript
License	Artistic License 2.0
Website	www.npmjs.com ↗



12.14.0 LTS

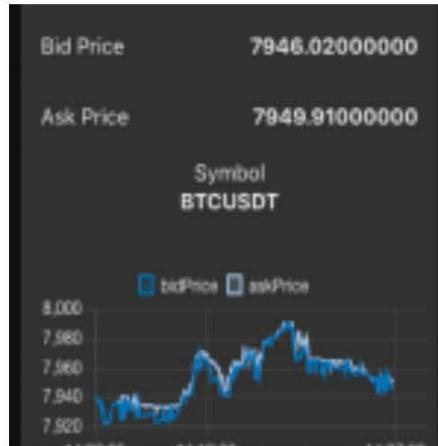
Recommended For Most Users

13.5.0 Current

Latest Features

Node-RED Programming Guide to the IoT

<http://noderedguide.com/>



[Node-RED: Lecture 7 – Dashboards and UI techniques](#). In this lecture you will take a look a few techniques to allow you to visualize data passing through flows. We'll focus on three approaches;

- [PART 1](#): the use of a third party dashboard tool – FreeBoard,
- [PART 2](#): using the standard Node-RED default UI nodes
- [PART 3](#): using a standard external JavaScript charting library (Morris.JS).

<http://noderedguide.com/lecture-7-dashboards-and-ui-techniques-for-node-red/>

What you need to do (lesson 6)

- Make a new Mini Project Repository on your GitHub Account by providing insights on Core IoT Concepts you learned in this lesson
- Studie ***README.md***
on <https://github.com/robvdw/CMIDAT01K-DATA-SCIENCE-for-IOT>
- Studie ***GRADING***
on <https://github.com/robvdw/CMIDAT01K-DATA-SCIENCE-for-IOT/blob/master/Docs/BEOORDELINGS%20MODEL%20DS%20for%20IoT%20V24%20npv%202020.pdf>

DEADLINE OPLEVERING

Om voor beoordeling in aanmerking te komen lever je een ascii text file (.txt) aan met de link (URL) van jouw Git-Hub account met de IoT-repository.

De repository bevat een beschrijving van het IoT-Project waarin bewijzen
---zoals video-materiaal / code / design concept / data organisatie---
zijn opgenomen van op basis van de door jouw bedachte/geteste IoT data-pipeline/Prototype
zoals beschreven op <https://github.com/robvdw/CMIDAT01K-DATA-SCIENCE-for-IOT>

Deze text-file moet je uploaden via de LMS **INLEVER_MAP_OP2**
van de CURSUS CMIDAT01k Data Science for IoT (2020-2021).

Deadline is: 27 APRIL (vanaf 28 april kun je niet meer inleveren).

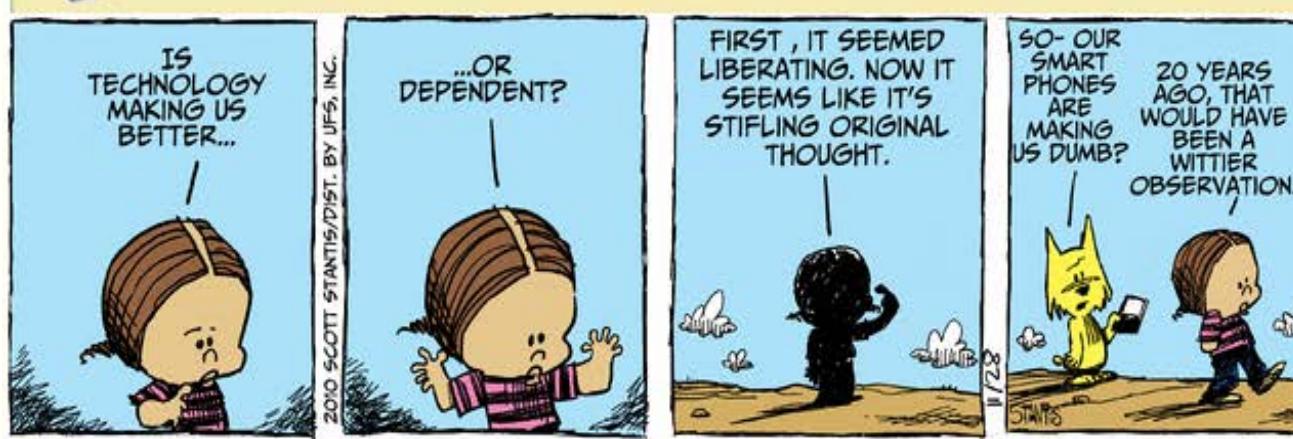
Beoordeling vindt plaats conform het beoordelingsmodel:

https://github.com/robvdw/CMIDAT01K-DATA-SCIENCE-for-IOT/blob/master/Docs/BEOORDELINGS_MODEL_DS_for_IoT_V24_npv_2020.pdf

Deze mededeling wordt als E-mail bericht wordt verstuurd (20 APRIL)
in week 10 OP3 collegejaar 2020-2021

Nota Bene! Stuur een Reply op deze E-Mail
als je voor beoordeling van de cursus: CMIDAT01k Data Science for IoT (2020-2021) in aanmerking wilt komen.





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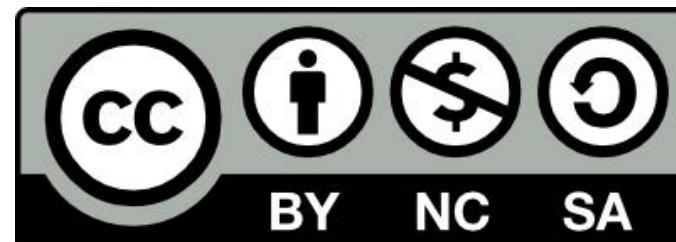
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No Derivatives		
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This lesson was developed by:

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CMD, Hogeschool Rotterdam
NOV 2019



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