

Centre de formació i ocupació

Enginyers
Industrials de Catalunya

**IoT amb Arduino i Raspberry Pi.
Microcontroladors d'ús professional**

IoT amb Arduino i Raspberry Pi. Microcontroladors d'ús professional

<https://formacio.eic.cat/cursos/1125401>

Grup de Treball IoT & Embedded Systems

Xavier Pi

Vicepresident GT IoT & Embedded Systems
Comissió Indústria 4.0 Enginyers de Catalunya
www.linkedin.com/in/xavierpi

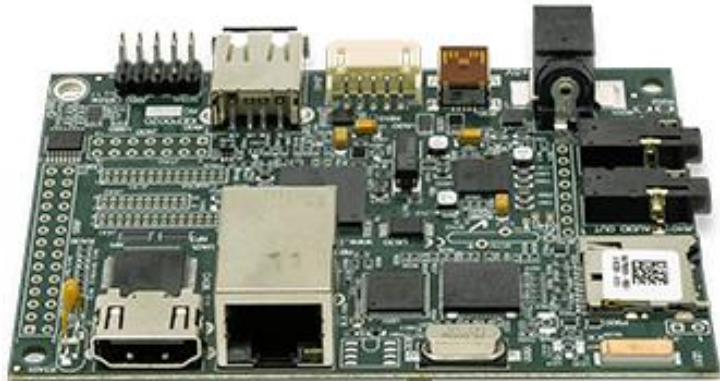
Índex

- Introducció a la Raspberry Pi. Diferències amb Arduino. Avantatges i inconvenients
- Instal·lacions i configuracions de la Raspberry Pi segons les nostres necessitats
- Connexió de perifèrics a la Raspberry Pi
- Introducció bàsica a GNU / Linux
- Maneres de programar una Raspberry Pi (Python, BASH, C++, Qt)
- Automatització de processos amb la Raspberry Pi
- Comunicació entre la Raspberry Pi i l'Arduino
- Raspberry Pi com a dispositiu IoT. APIs de serveis en el núvol

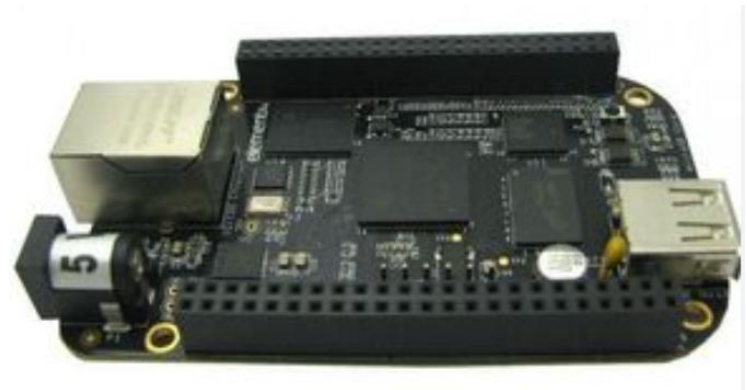
Introducció a la Raspberry Pi. Diferències amb Arduino. Avantatges i inconvenients

Sistemes embedded escala sofisticada

Sèrie IGEP (Dissenyada per Agustí Fontquerni al 2008 - www.somdevices.com)



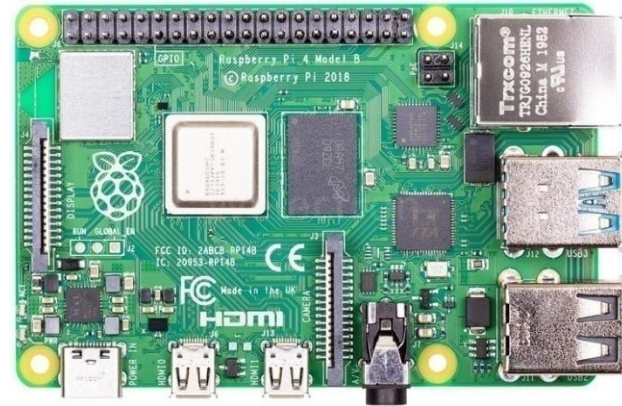
<https://en.wikipedia.org/wiki/IGEPv2>



<https://en.wikipedia.org/wiki/BeagleBoard>

Sistemes embedded escala sofisticada

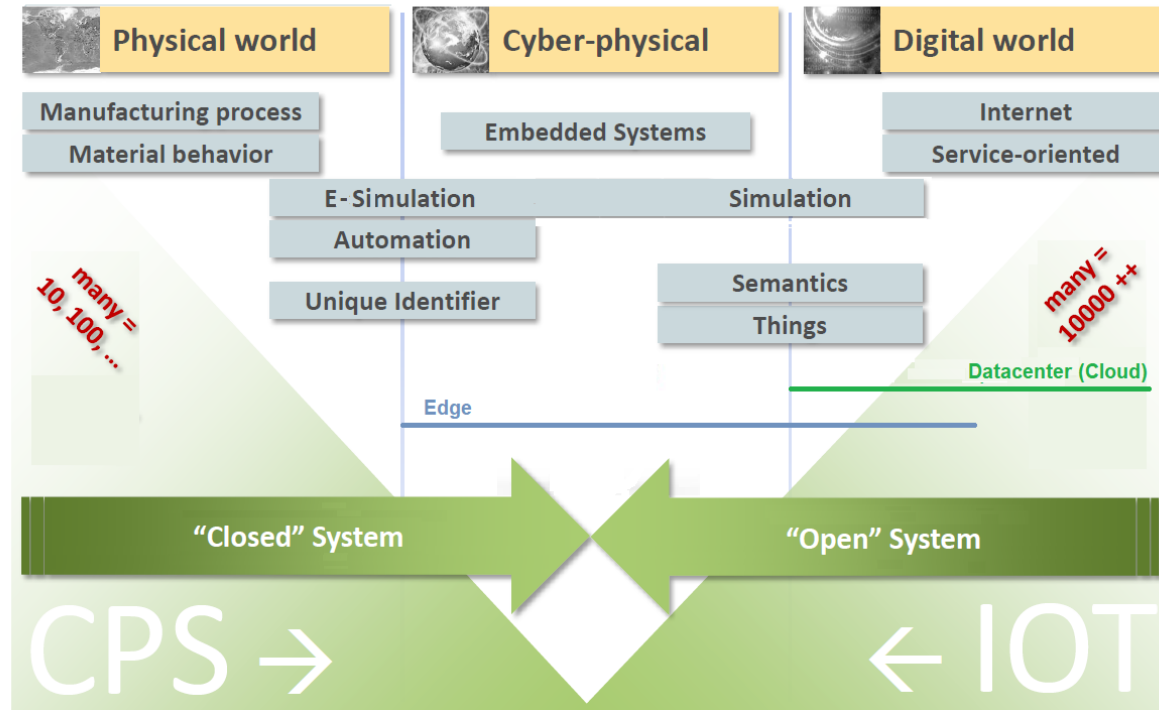
Raspberry Pi



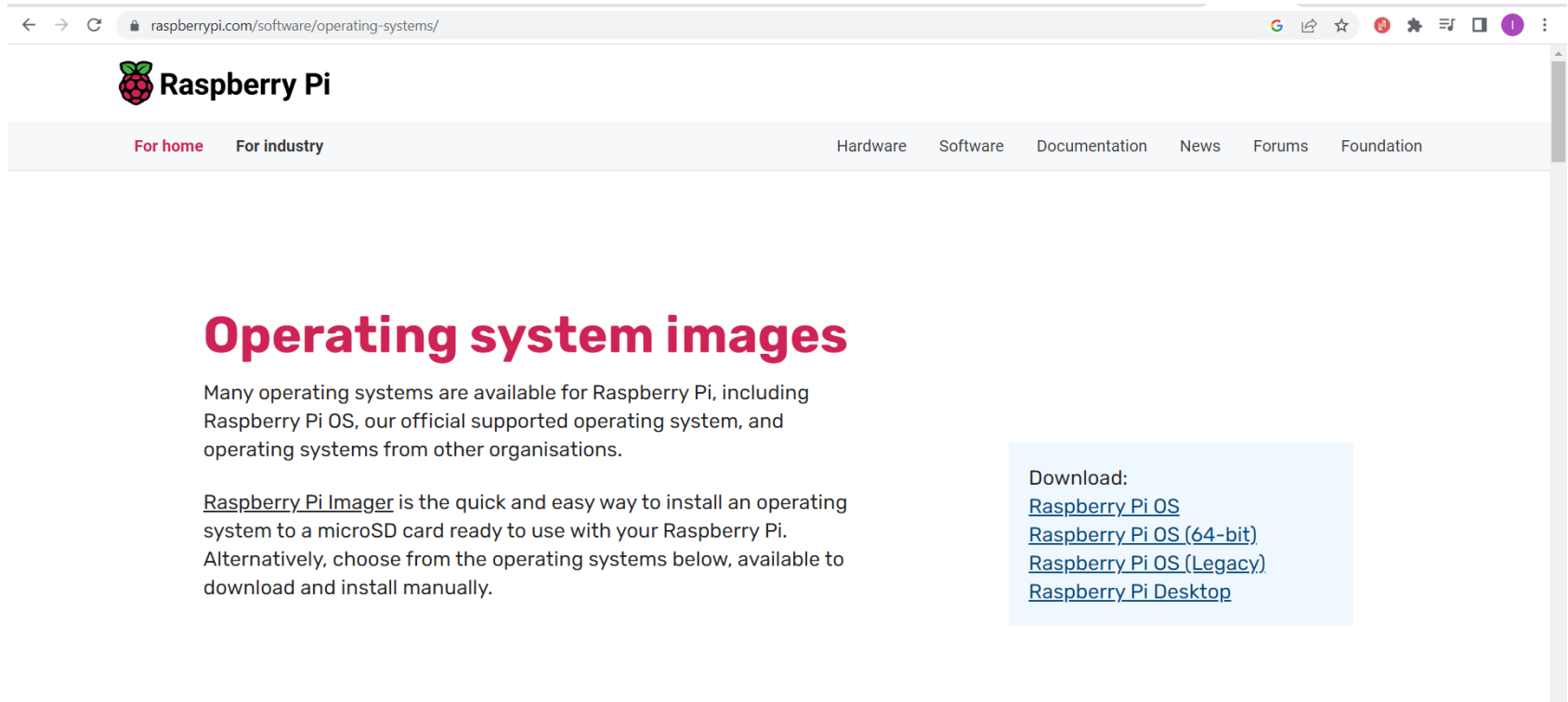
https://en.wikipedia.org/wiki/Raspberry_Pi

Elements centrals de la Indústria 4.0

Two Worlds coming together




Imatges Raspberry Pi



The image shows a browser window displaying the Raspberry Pi website. The address bar shows the URL 'raspberrypi.com/software/operating-systems/'. The page features the Raspberry Pi logo and navigation links for 'For home', 'For industry', 'Hardware', 'Software', 'Documentation', 'News', 'Forums', and 'Foundation'. The main heading is 'Operating system images' in a large, bold, pink font. Below it, a paragraph explains that many operating systems are available for Raspberry Pi, including the official Raspberry Pi OS. A second paragraph highlights the 'Raspberry Pi Imager' as a quick and easy installation method. To the right, a light blue box contains a 'Download:' section with links to 'Raspberry Pi OS', 'Raspberry Pi OS (64-bit)', 'Raspberry Pi OS (Legacy)', and 'Raspberry Pi Desktop'.

raspberrypi.com/software/operating-systems/

 **Raspberry Pi**

[For home](#) [For industry](#) [Hardware](#) [Software](#) [Documentation](#) [News](#) [Forums](#) [Foundation](#)

Operating system images

Many operating systems are available for Raspberry Pi, including Raspberry Pi OS, our official supported operating system, and operating systems from other organisations.

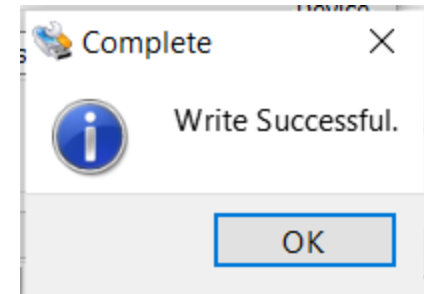
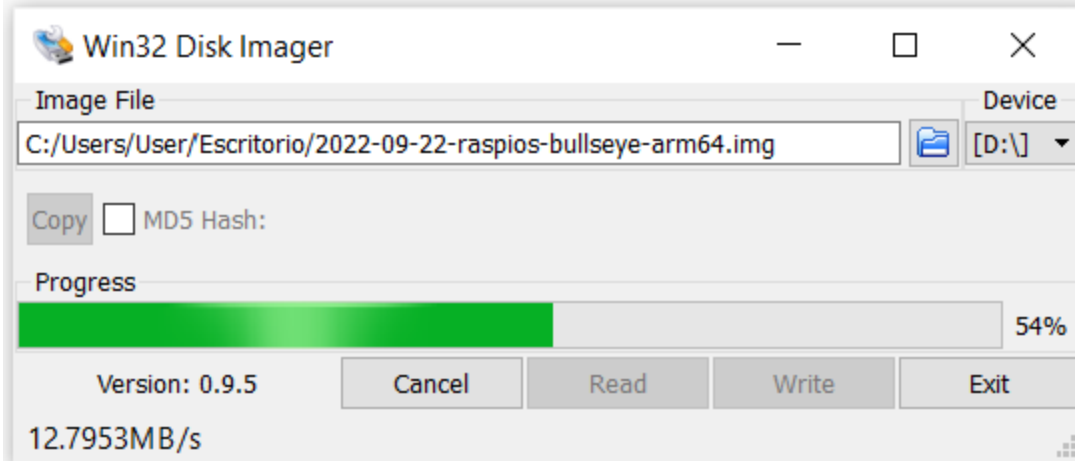
[Raspberry Pi Imager](#) is the quick and easy way to install an operating system to a microSD card ready to use with your Raspberry Pi. Alternatively, choose from the operating systems below, available to download and install manually.

Download:
[Raspberry Pi OS](#)
[Raspberry Pi OS \(64-bit\)](#)
[Raspberry Pi OS \(Legacy\)](#)
[Raspberry Pi Desktop](#)

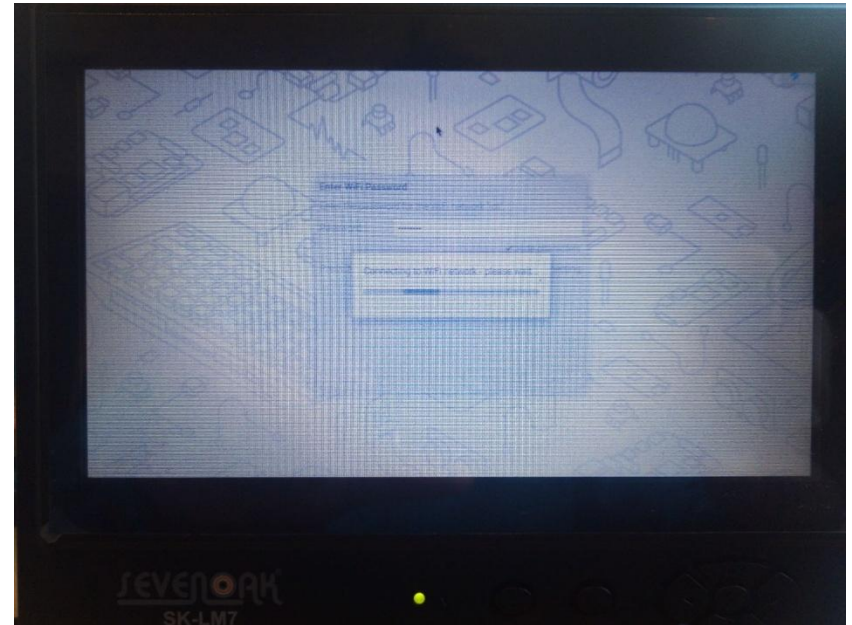
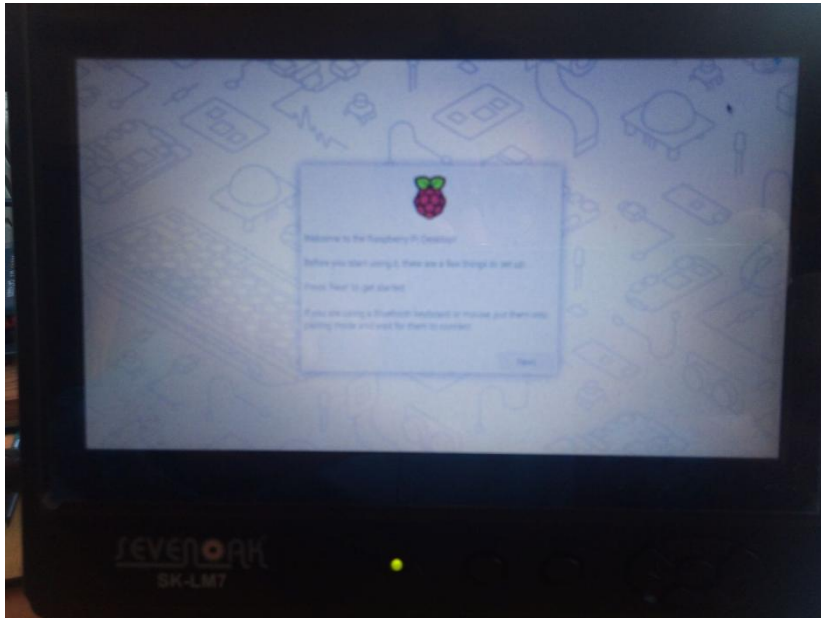
Gravar imatge

2022-09-22-raspios-bullseye-arm64.img

2022-09-22-raspios-bullseye-arm64.img.xz

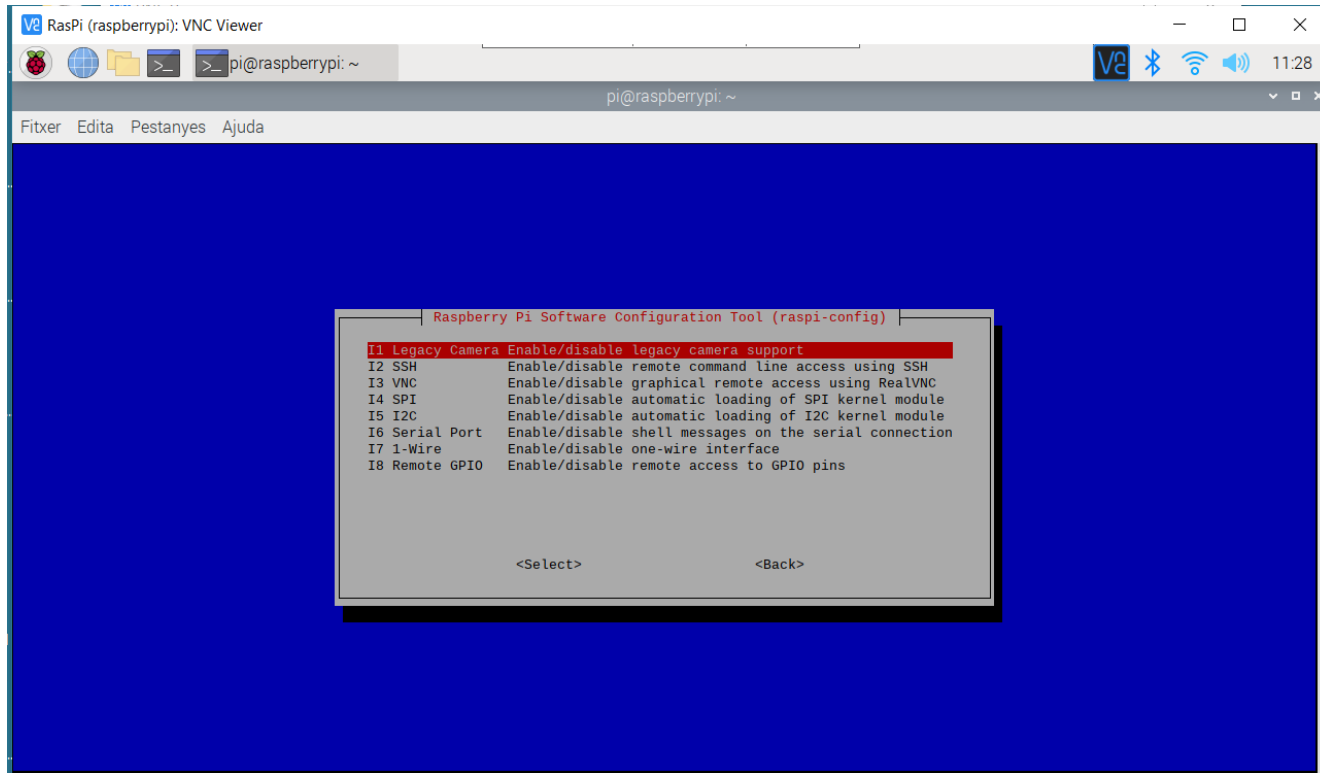


Iniciar sistema

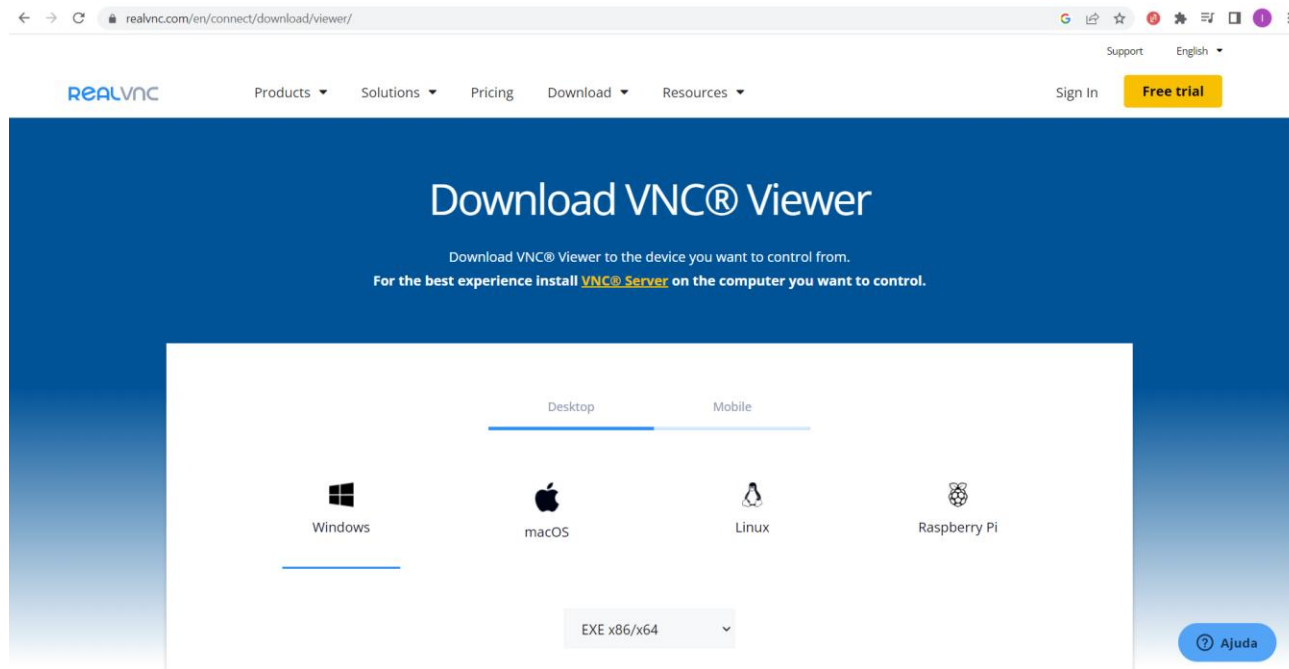


Demana config teclat, idioma i xarxa WiFi

Accés remot



Accés remot



The screenshot shows the RealVNC website's download page. The browser address bar displays 'realvnc.com/en/connect/download/viewer/'. The navigation menu includes 'Products', 'Solutions', 'Pricing', 'Download', and 'Resources'. A 'Sign In' link and a yellow 'Free trial' button are visible. The main heading is 'Download VNC® Viewer', with a sub-heading: 'Download VNC® Viewer to the device you want to control from. For the best experience install VNC® Server on the computer you want to control.' Below this, there are tabs for 'Desktop' and 'Mobile'. Under the 'Desktop' tab, there are four options: Windows, macOS, Linux, and Raspberry Pi. A dropdown menu is set to 'EXE x86/x64'. A blue 'Ajuda' button is in the bottom right corner.

Per poder accedir via VNC, els usuaris han de ser sudoers: `sudo usermod -aG sudo a01`

Impacte del DiY en la recerca

[Published: 06 April 2017](#)

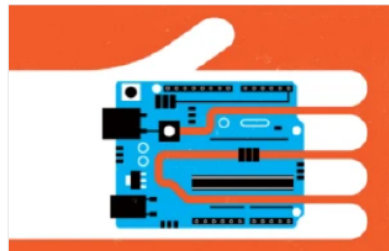
The DIY electronics transforming research

[Daniel Cressey](#)

[Nature](#) **544**, 125–126 (2017) | [Cite this article](#)

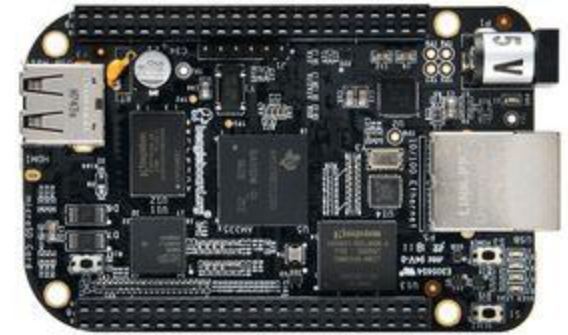
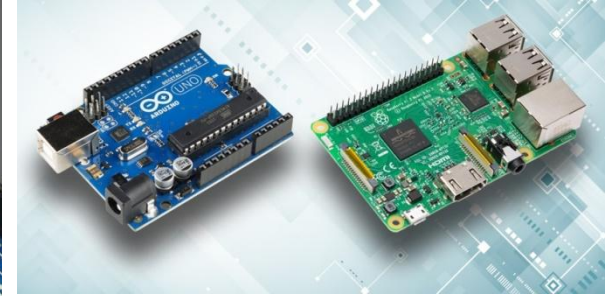
537 Accesses | **34** Citations | **336** Altmetric | [Metrics](#)

Cheap, stripped-down microcontrollers are allowing users to pack huge amounts of computing power into tiny spaces.



www.nature.com/articles/544125a

Impacte del DiY en la indústria



Proveïdors











- www.diotronic.com
- <https://es.rs-online.com>
- <https://es.farnell.com>
- <https://www.mouser.es>
- <https://www.digikey.es>
- www.amazon.com
- www.aliexpress.com
- www.industrialshields.com
- <https://rpilocator.com>

Diferències, avantatges i inconvenients

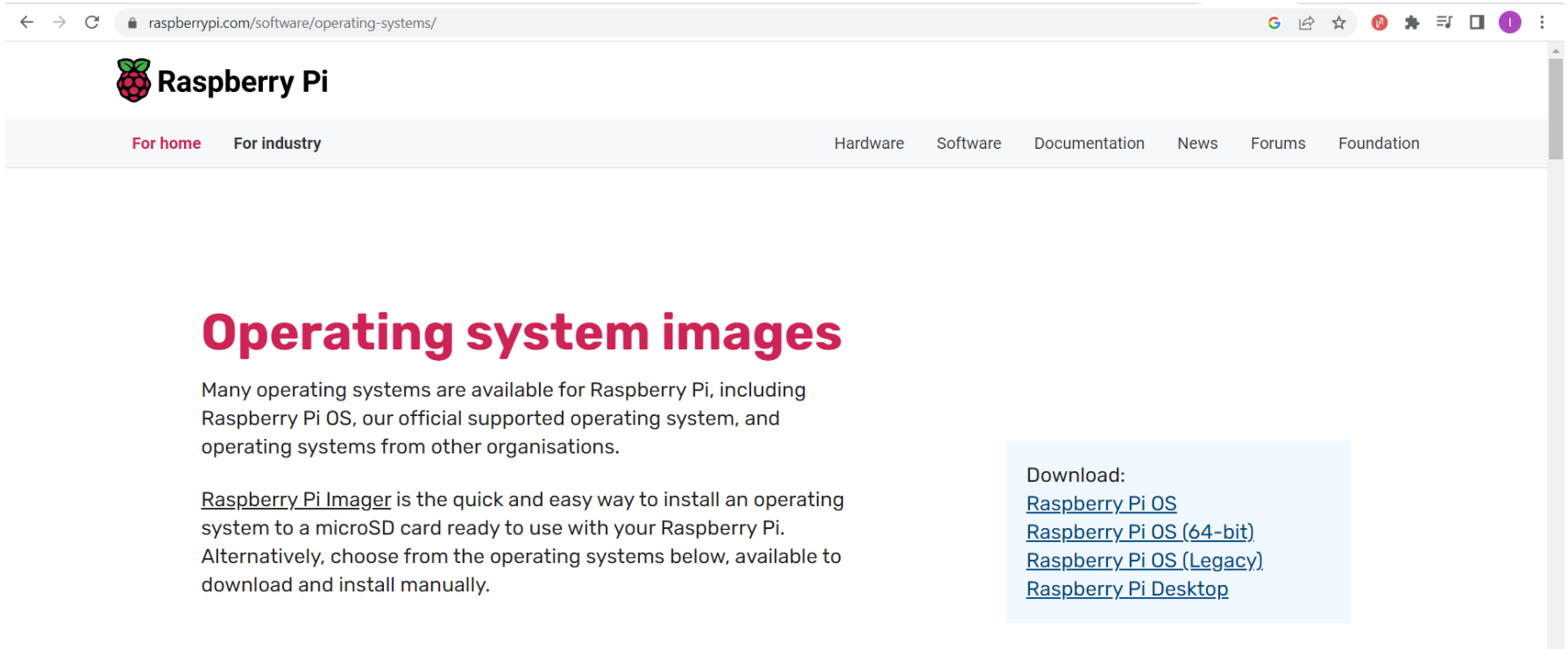
- Sistemes escala petita i mitjana
 - Immunes als problemes de reboot
 - Molt robustos
 - Poc flexibles
 - Potència de càlcul petita
- Sistemes escala sofisticada
 - Sensibles als problemes de reboot
 - Flexibles
 - Potents

Instal·lacions i configuracions de la Raspberry Pi segons les nostres necessitats









Configuracions Raspberry (Hardware)


<u>Raspberry Pi 4 B</u>	<u>Raspberry Pi 3 Model A+</u>	<u>Raspberry Pi 3 B+</u>	<u>Raspberry Pi Zero WH</u>	<u>Raspberry Pi Zero W</u>
				
2019 Jun 24	2018 Nov 15	2018 Mar 14	2018 Jan 12	2017 Feb 28
US\$35.00	US\$25.00	US\$35.00	US\$15.00	US\$10.00
<hr/>				
<u>Raspberry Pi A+</u>	<u>Raspberry Pi 3</u>	<u>Raspberry Pi Zero</u>	<u>Raspberry Pi 2</u>	<u>Raspberry Pi B</u>
				
2014 Nov 10	2016 Feb 29	2015 Nov 30	2015 Feb 1	2012 Feb 15
US\$35.00	US\$35.00	US\$5.00	US\$35.00	US\$35.00

Configuracions Raspberry (Software)



The screenshot shows a web browser window with the URL `raspberrypi.com/software/operating-systems/`. The page features the Raspberry Pi logo and a navigation menu with links for 'Hardware', 'Software', 'Documentation', 'News', 'Forums', and 'Foundation'. The 'Software' link is highlighted. The main content area is titled 'Operating system images' in a large, bold, pink font. Below the title, there is a paragraph explaining that many operating systems are available for Raspberry Pi, including the official Raspberry Pi OS. A light blue box on the right side of the page contains a 'Download:' section with four links: 'Raspberry Pi OS', 'Raspberry Pi OS (64-bit)', 'Raspberry Pi OS (Legacy)', and 'Raspberry Pi Desktop'.

← → ↻ raspberrypi.com/software/operating-systems/        

 **Raspberry Pi**

For home For industry Hardware Software Documentation News Forums Foundation

Operating system images

Many operating systems are available for Raspberry Pi, including Raspberry Pi OS, our official supported operating system, and operating systems from other organisations.

[Raspberry Pi Imager](#) is the quick and easy way to install an operating system to a microSD card ready to use with your Raspberry Pi. Alternatively, choose from the operating systems below, available to download and install manually.

Download:
[Raspberry Pi OS](#)
[Raspberry Pi OS \(64-bit\)](#)
[Raspberry Pi OS \(Legacy\)](#)
[Raspberry Pi Desktop](#)

Imatges del SO Raspbian

raspberrypi.com/software/operating-systems/#raspberry-pi-os-32-bit



Raspberry Pi OS

Our recommended operating system for most users.

Compatible with:

[All Raspberry Pi models](#)

Raspberry Pi OS with desktop

Release date: September 22nd 2022
System: 32-bit
Kernel version: 5.15
Debian version: 11 (bullseye)
Size: 894MB
[Show SHA256 file integrity hash](#)
[Release notes](#)

[Download](#)

[Download torrent](#)
[Archive](#)

Raspberry Pi OS with desktop and recommended software

Release date: September 22nd 2022
System: 32-bit
Kernel version: 5.15
Debian version: 11 (bullseye)
Size: 2,700MB
[Show SHA256 file integrity hash](#)
[Release notes](#)

[Download](#)

[Download torrent](#)
[Archive](#)

Raspberry Pi OS Lite

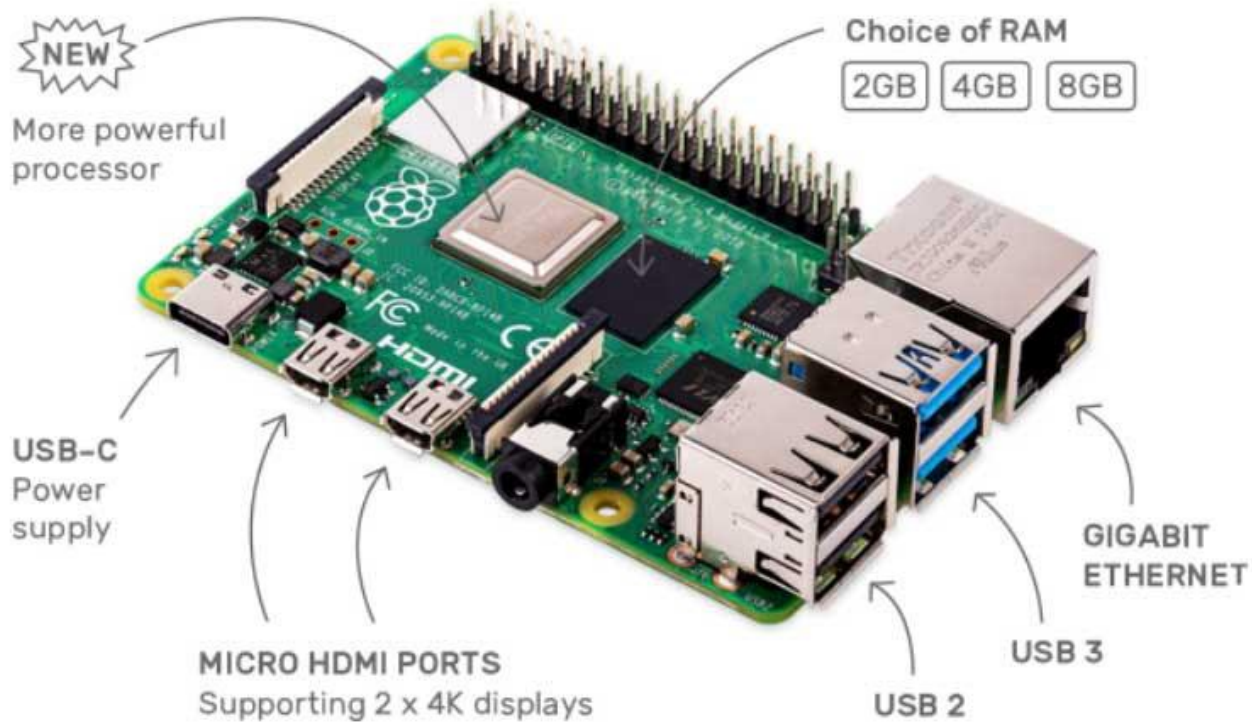
Release date: September 22nd 2022
System: 32-bit
Kernel version: 5.15
Debian version: 11 (bullseye)
Size: 338MB
[Show SHA256 file integrity hash](#)
[Release notes](#)

[Download](#)

[Download torrent](#)
[Archive](#)

Connexió de perifèrics a la Raspberry Pi

Raspberry model 4



SSH (Secure Shell)

- https://ca.wikipedia.org/wiki/Secure_Shell
- `ssh -p <port> user@hostname/IP`
- `ssh pernet`
 - Sessions interactives (com Telnet, però encriptat)
 - Túnel inversos
 - Transfetrència d'arxius (Filezilla Client, com FTP però encriptat)
- El port per defecte és el 22, tant per sessions interactives com per transferència d'arxius.

Túnelos inversos (I)

- Cal l'ajut d'un tercer ordinador, normalment al núvol.
- Sistemes econòmics disponibles al núvol: Els VPS (Virtual Private Server) són Infraestructura as a Service (IAAS)
- Proveïdor més important d'Europa d'IAAS: OVH
- www.ovh.com
- Cal habilitar el tunneling al SSH del servidor:
- A `/etc/ssh/sshd_config` habilitar `GatewayPorts` yes
- Reiniciar el servei: `sudo systemctl reload sshd.service`

Túnel inversos (II)

- Per a crear el tunnel invers.

```
ssh -N -f -R vps656540.ovh.net:2222:127.0.0.1:22  
a65@vps656540.ovh.net
```

- Per a accedir a la Raspberry:

```
ssh -p 2222 vps656540.ovh.net
```

Introducció bàsica a GNU / Linux

Linux (Command Line)

- Distributions Linux (https://en.wikipedia.org/wiki/Linux_distribution)
- Gestors de paquets: Aptitude (`apt-get install <programa>`)
- Tutorial Linux commands:
<https://kalitut.com/raspberrypi-command-line>
- Debian Cheat Sheet:
<https://www.linuxtrainingacademy.com/linux-commands-cheat-sheet>
- Editors nano, vi

Maneres de programar una Raspberry Pi (Python, BASH, C++, Qt)

Programació amb Raspberry Pi

- Python (Pi: Python Interpreter)
- Bash (Shell scripts .sh, Shebang `#!/bin/bash`)
- C++

<https://www.onlinegdb.com>

- Qt (QML - <https://qmlonline.kde.org>)

<https://replit.com/languages/python3>

- Node.js
- Node-RED

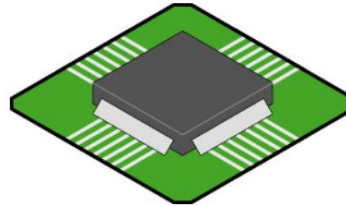
Programació amb Node-RED

- Condepte de Low-Code
- Node-RED (Iniciativa d'IBM, basada en Node.js – www.nodejs.org)



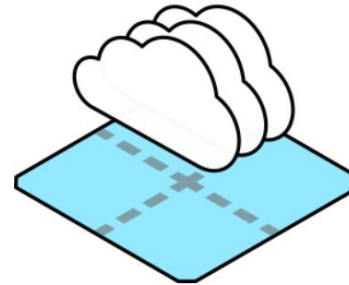
Run locally

- Getting started
- Docker



On a device

- Raspberry Pi
- BeagleBone Black
- Interacting with Arduino
- Android



In the cloud

- IBM Cloud
- SenseTecnica FRED
- Amazon Web Services
- Microsoft Azure
- FlowForge
- VPS

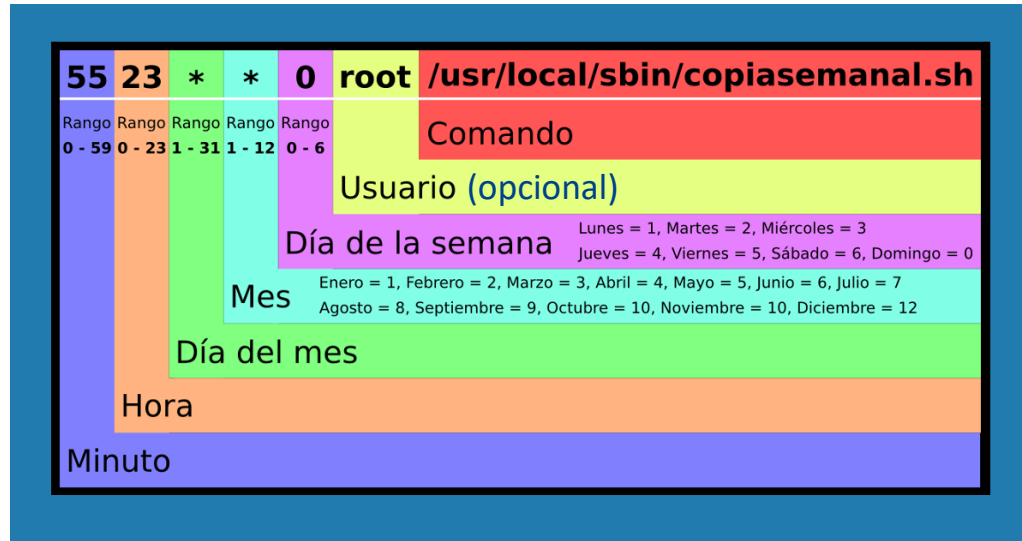
Edge

Cloud

Automatització de processos amb la Raspberry Pi

crontab

- Programador de tareas
- Consultar: crontab -l
- Editar: crontab -e

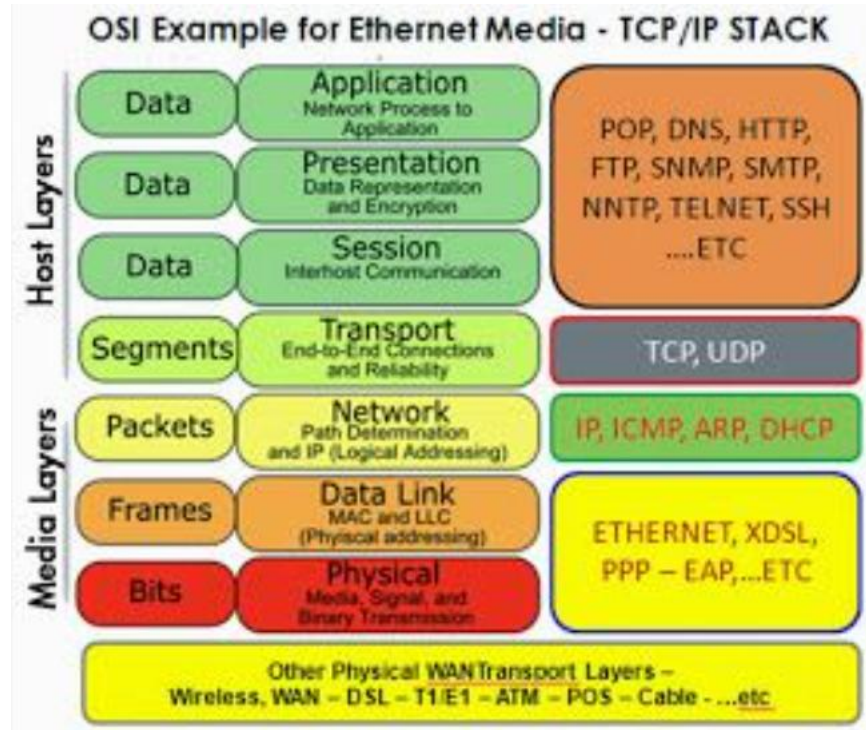


Comunicació interprocessos

- Els protocols de la IoT es poden utilitzar per a intercomunicar processos
 - HTTP
 - curl
 - Browsers
 - Combinació crontab – curl – Node-RED

Comunicació entre la Raspberry Pi i l'Arduino

Arquitectura de capes OSI de la ISO



Comunicació Raspberry Pi

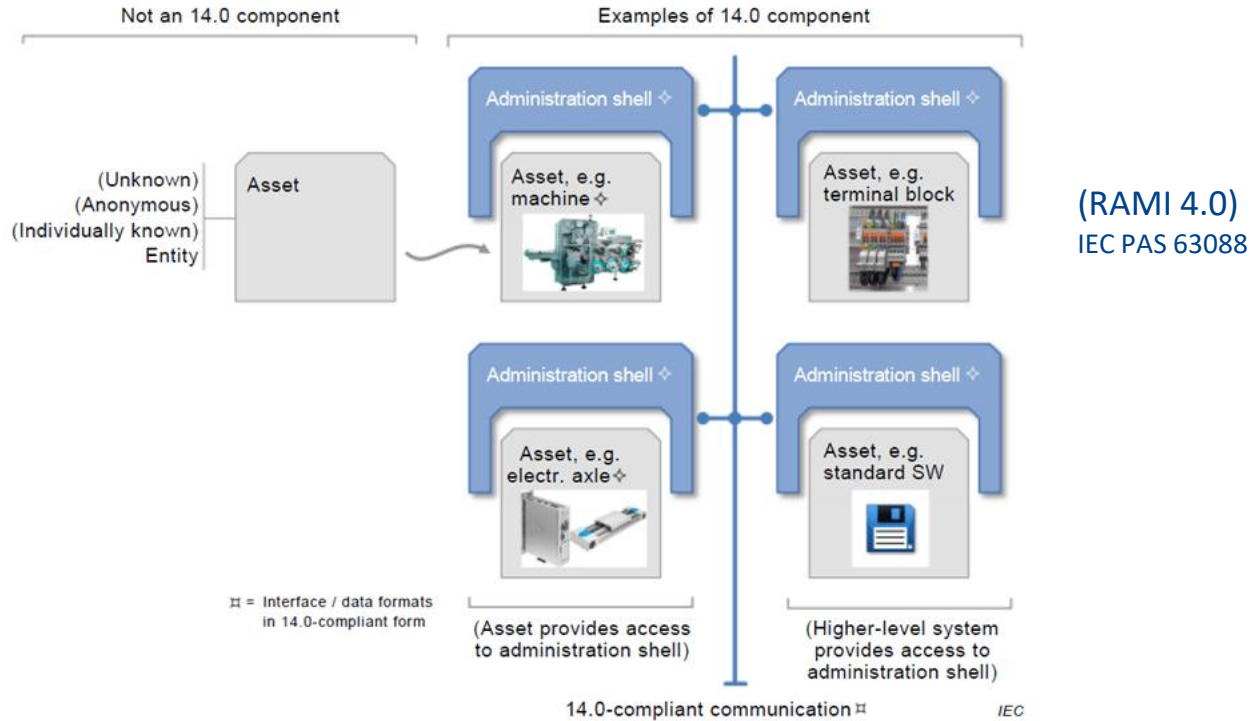
- Els protocols de la IoT es poden utilitzar per a intercomunicar l'Arduino i la Raspberry Pi
- Arquitectura RAMI 4.0
- Nivell 2 OSI (Modbus, CAN Bus, Serial, I2C...)
- Nivells 3-4 OSI
 - TCP/IP
 - WiFi
 - Cable
- Nivells 5-7 OSI (MQTT, HTTP)

Raspberry Pi com a dispositiu IoT. APIs de serveis en el núvol

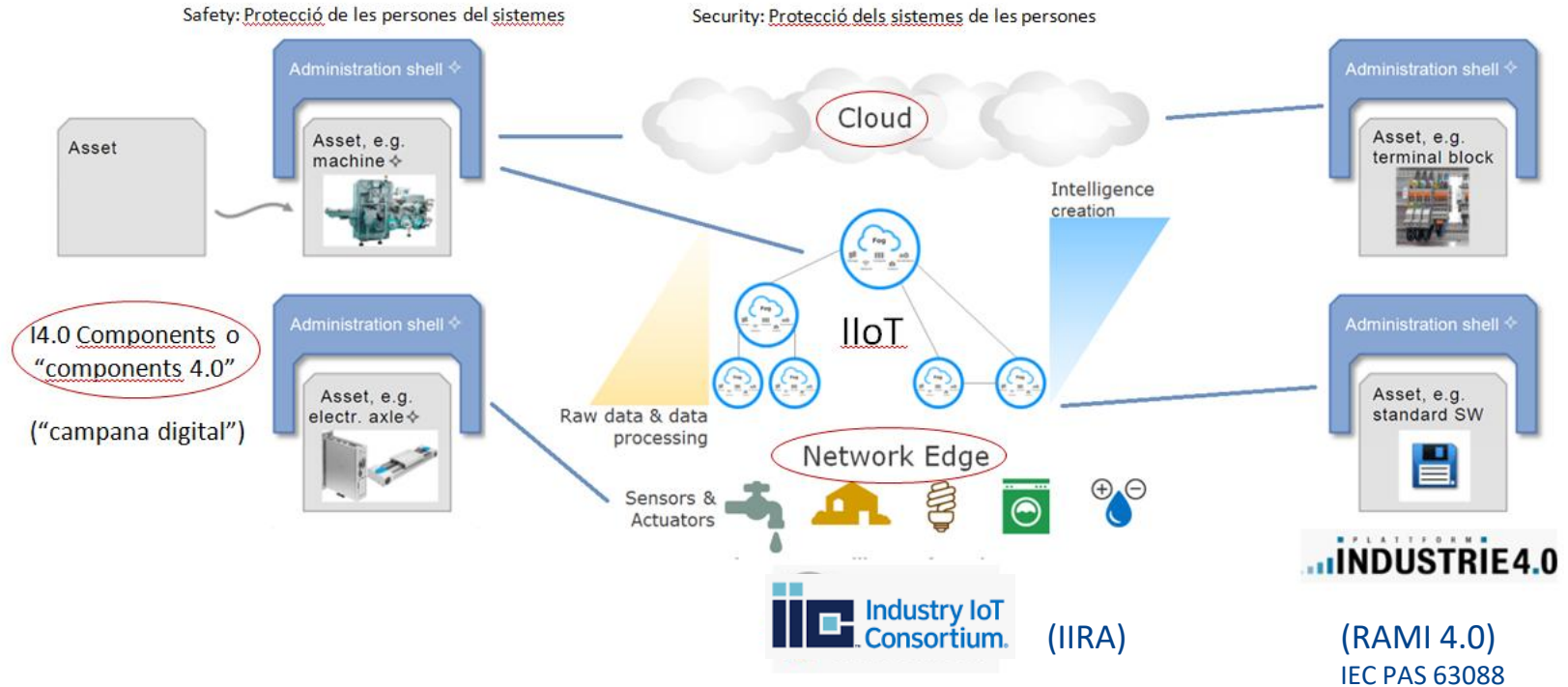
Concepte de Passarela IoT (IoT Gateway)

- Formalització del conceptes de cloud i edge
 - Arquitectura IIRA
 - Cloud amb VPS
 - Edge amb Raspberry Pi
- Conversió de protocols
- Node-RED com a eina







Noció de núvol. Cloud i Edge computing




Noció de núvol. Cloud i Edge computing



Protocol MQTT. PubSub vs client-server

← → ↻ github.com/pixavier/mqtt4snap      

W Corporate social res...  Nueva pestaña

☰ README.md 

MQTT4Snap !

MQTT4Snap ! is a Snap ! library for using [MQTT](#) in [Snap !](#) (in the cloud) and [Snap4Arduino](#) (in the edge).

MQTT is an open and [secure](#) publish-subscribe protocol for the Internet of Things, suitable for industrial applications and [Digital Twins](#).

There are several [MQTT public server/brokers](#) for rapid testing purpose, such as [test.mosquitto.org](#), [mqtt.eclipseprojects.io](#) or [www.emqx.com/en/mqtt/public-mqtt5-broker](#). Never use these servers for production. One way to start is using [Mosquitto](#) on your own server, which is a popular open-source option available for Linux, Windows and Mac, fast and easy to install. For accessing directly to a MQTT broker from a browser, [WebSockets support must be activated on the broker](#). To monitor de broker activity, [MQTT Explorer](#) is an excellent free tool.

[Snap !](#) can be considered a block-based [low-code programming language](#), unlike [Node-RED](#), that can be regarded as a flow-based low-code tool.

Hello World!

This Hello World! example shows how PubSub-based aqchitectures let implement IoT with no friction.




Blocks and usage

Old library


Packages

No packages published
[Publish your first package](#)

Contributors 3

-  [pixavier](#) Xavier Pi
-  [bromagosa](#) Bernat Romagosa
-  [jump-pi](#)

Environments 1

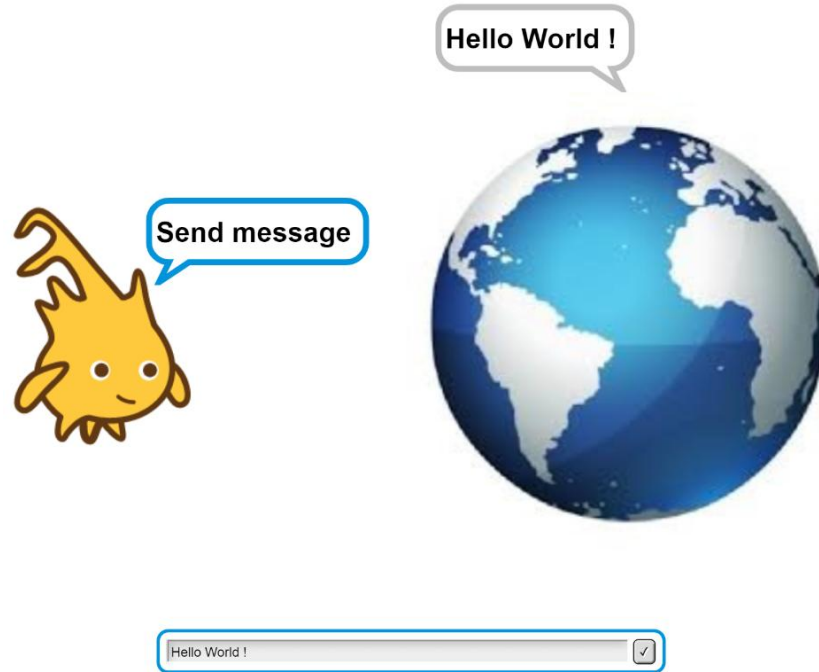
 [github-pages](#) Active

Languages



<https://github.com/pixavier/mqtt4snap>

Protocol MQTT: Hello World !



<http://extensions.snap.berkeley.edu/snap/snap.html#run:http://raw.githubusercontent.com/pixavier/mqtt4snap/master/examples/HelloWorld.xml>

Llenguatges low-code de blocs (Snap!, Scratch)

The screenshot shows the Snap! IDE interface with a script titled "Demo". The script is designed to demonstrate MQTT functionality and is divided into several steps:

- Step 0:** Connect to the broker using the "MQTT connect to" block.
- Step 1:** Subscribe to a topic using the "MQTT subscribe to" block.
- Step 2:** Publish a message using the "MQTT publish to" block.
- Synchronous client-Server:** A section where the client sends a "Hello World!" message.
- MQTT response:** A section where the client receives a response from the broker.
- MQTT request:** A section where the client sends a request to the broker.

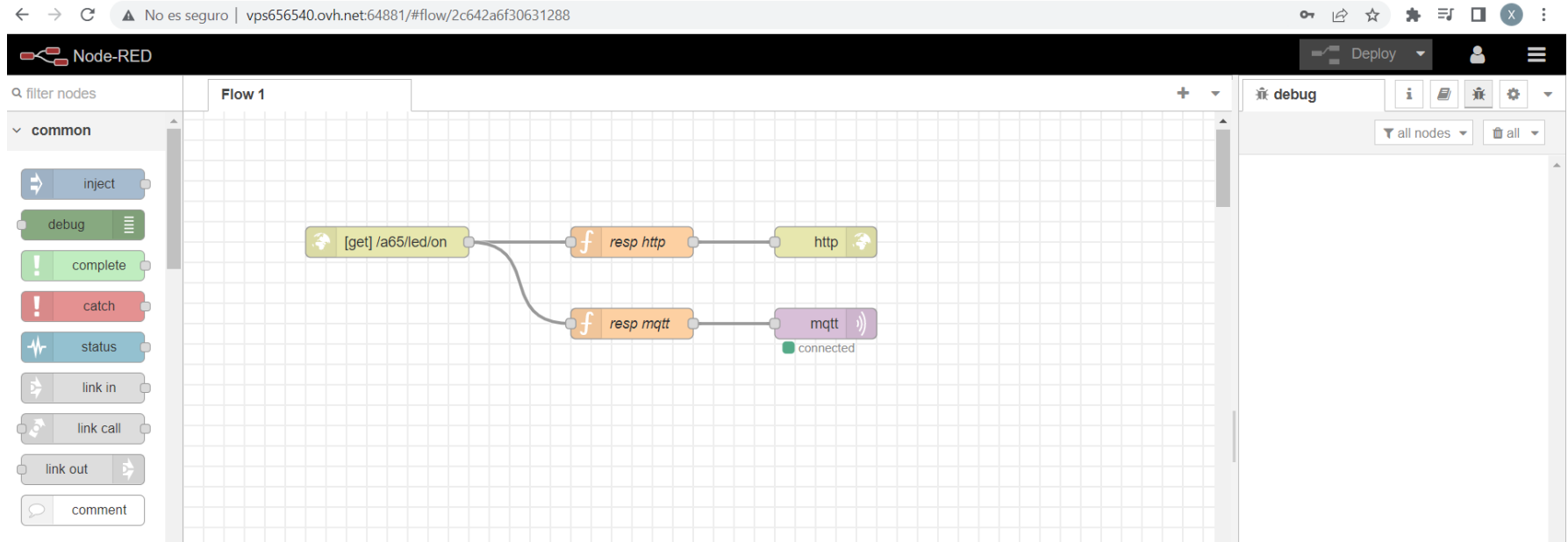
The script uses various Snap! blocks from the MQTT category, including "MQTT connect to", "MQTT subscribe to", "MQTT publish to", "MQTT response", and "MQTT request". The script also includes a "say" block to display messages on the stage.

Llenguatges low-code de fluxos (Node-RED)

The screenshot displays the Node-RED web interface in a browser. The address bar shows the URL: `vps656540.ovh.net:51800/#flow/d775676113e223e0`. The interface includes a top navigation bar with a 'Deploy' button and a user profile icon. On the left, there is a 'filter nodes' search bar and a list of nodes categorized into 'common' and 'function'. The 'common' category includes nodes like 'inject', 'debug', 'complete', 'catch', 'status', 'link in', 'link call', 'link out', and 'comment'. The 'function' category includes 'function', 'switch', 'change', and 'range'. The main workspace, titled 'Flow 1', contains a flow with two nodes: a blue 'timestamp' node connected to a green 'msg.payload' node. On the right side, a 'debug' console is open, showing the following output:

```
node: 417da6efa7f6c383  
msg.payload: number  
1651022933026
```

Bridge HTTP-MQTT



Gràcies !

Xavier Pi

xpi@enginyers.net

<https://www.eic.cat/content/gt-embedded-systems-iot>

www.comissioindustria40.cat

Centre de formació i ocupació

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