

# La cuarta revolución industrial: Internet de las cosas y sistemas ciberfísicos

Xavier Pi ([xpi@enginyers.net](mailto:xpi@enginyers.net))

Abril 2015 – Hispack

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# Fouth Industrial Revolution: Internet of things and cyber- physical systems

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- 02** The 3th DIY wave: Makers movement (Citizens empowerment)

00

Presentation and framework

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## About our background

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- EIC is a Catalan Industrial Engineers association
- The Embedded Systems Working group in this association has members from various fields, such as designers, manufacturers, integrators and academia.
- The group is open to members from other associations and there are some profiles from economy, political science and innovators.

## About our background

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- From the beginning the group has been building a simple framework that includes:
  - Some definitions
  - A small taxonomy (classifications) of embedded systems
  - A group slogan
- So far it has proved to be useful as a tool to facilitate communication between us

## Some definitions

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- System (taken from INCOSE):  
*"A system is a construct or collection of different elements that together produce results not obtainable by the elements alone"*
- Embedded System:  
*"An embedded system is a combination of hardware and software aimed to support a finite and numbered set well-defined functions, often with real-time process capabilities, integrated into a larger system"*

## Taxonomy (classifications)

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- In order to characterize and classify the embedded systems building blocks we take into consideration classify by:
  - Complexity
  - Intellectual property approach
  - Form factor



## Taxonomy (classifications)

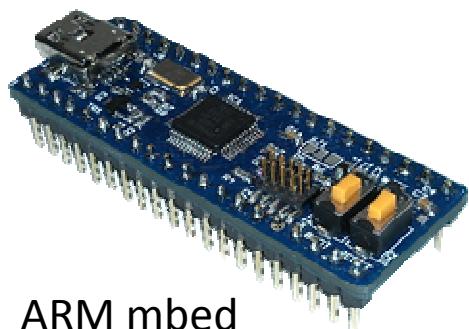
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- Classification by complexity (Taken from professor Raj Kamal):
  - Small Scale Embedded Systems (No operating system, microcontrollers)
  - Median Scale Embedded Systems (Signal processors, DSPs)
  - Sophisticated Embedded Systems (Operating system based, like Linux or others)

# Complexity

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Small scale



ARM mbed



ATTiny



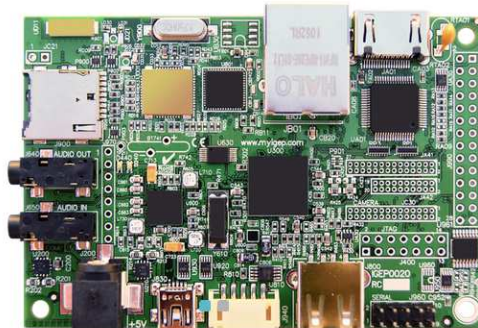
Arduino Micro

Sophisticated scale



ISEE IGEP 3730 ARM A8

Embedded professional



Raspberry Pi

Embedded hobby (Makers)

## Taxonomy (classifications)

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- Classification by intellectual property approach
  - Proprietary (Software and/or hardware)
  - Open source (Software and/or hardware, a lot of variations, MIT, Creative Commons ...)
  - Hybrid (Royalty-free patents)
- How open source is related to low cost ?

## Royalty-free patents

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www.ipwatchdog.com/2015/01/20/toyota-motors-one-ups-tesla-makes-thousands-of-royalty-free-patents-available/id=53744

# Toyota Motors One-Ups Tesla, Makes Thousands of Royalty-Free Patents Available



By [Steve Brachmann](#) on January 20, 2015



TWITTER



FACEBOOK



Print Article

Toyota is attempting to boost collaborative innovation in the field of vehicle fuel cell technologies by opening up thousands of patents for royalty-free use by other automakers. On January 6th, the corporation announced that it would [enable cost-free licensing for 5,680 of its patents](#). Toyota is hoping that the decision will encourage wider development of hydrogen technologies for vehicles over the next few years.

This announcement marks an interesting trend for patent activities in the sphere of alternative energy vehicles. During July of last year [we covered a similar announcement by Elon Musk](#), founder of Tesla Motors, who said that his company would allow others to use

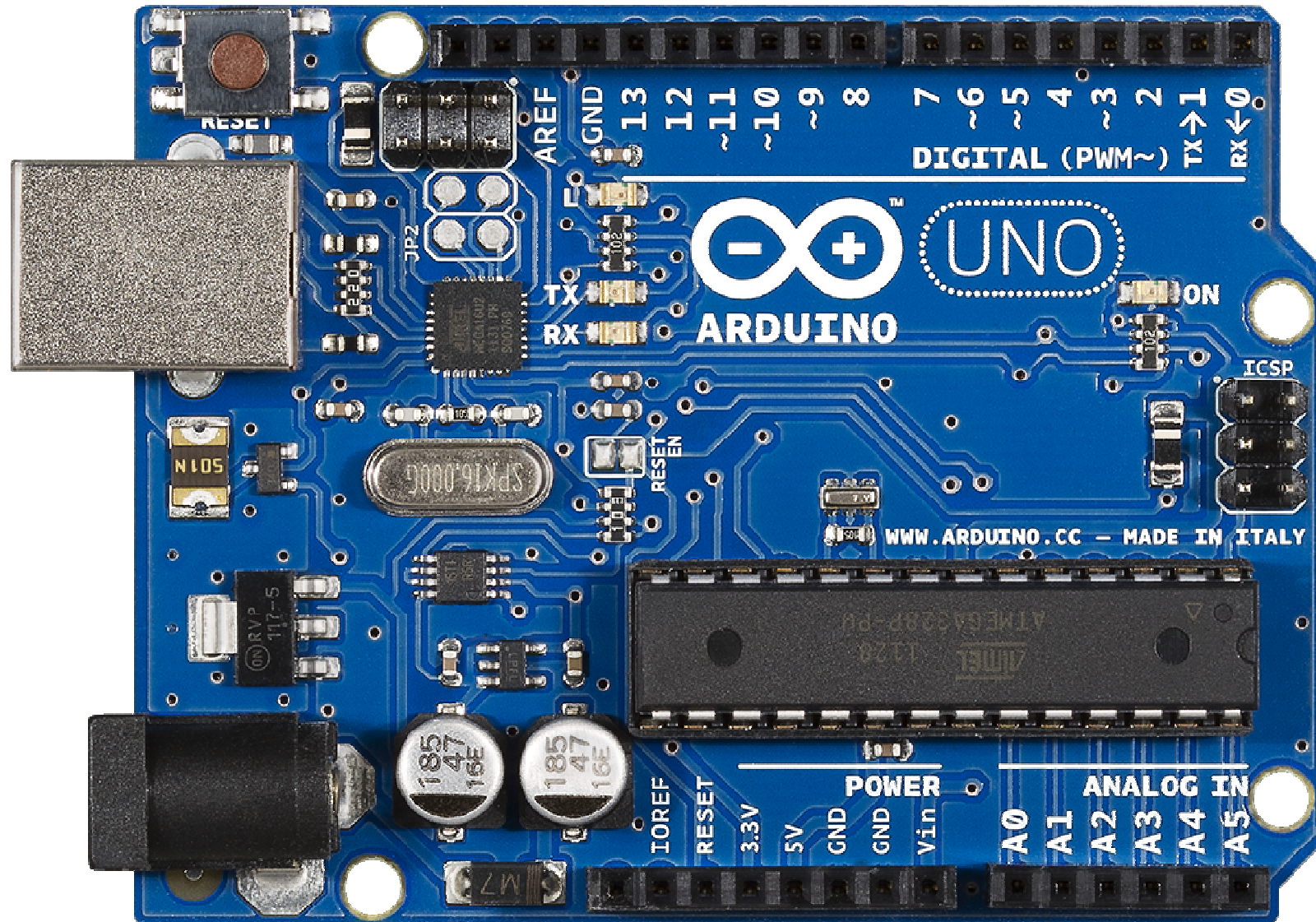
## Taxonomy (classifications)

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- Classification by form factor
  - Standard form factor used
  - Custom form factor used
- We understand Form Factor as a replacement criteria (physical dimensions and connections)

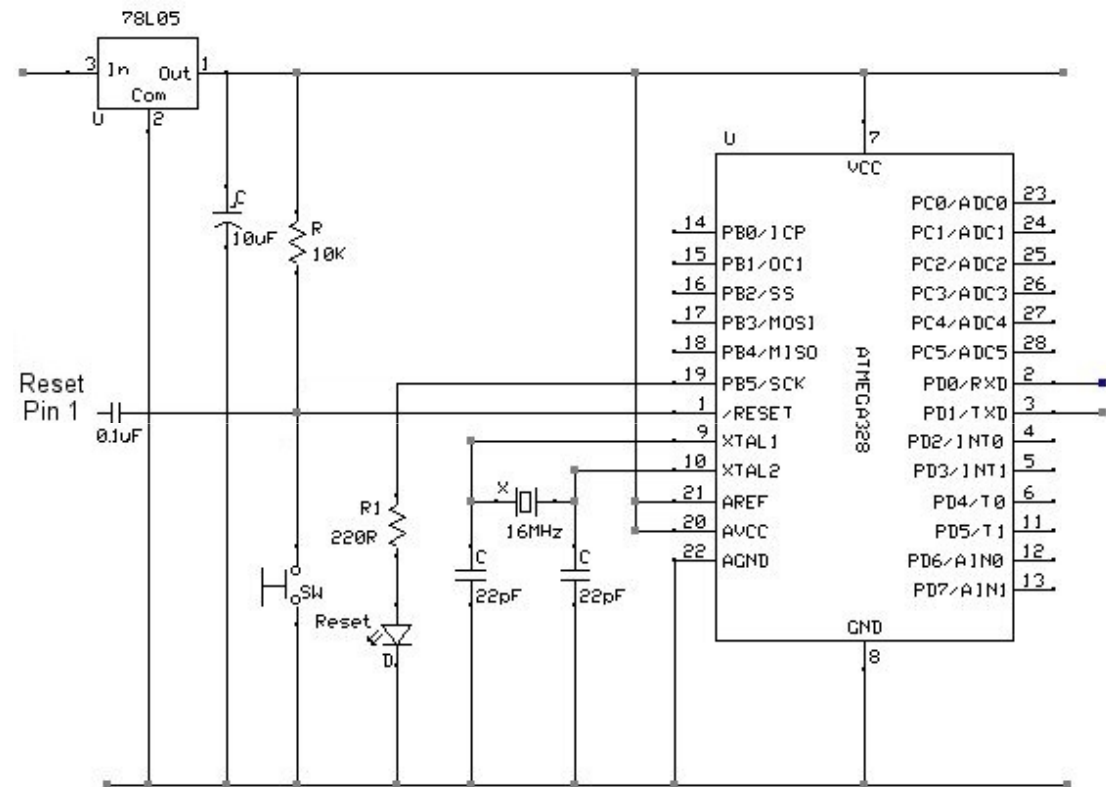
“De facto” standard form factor

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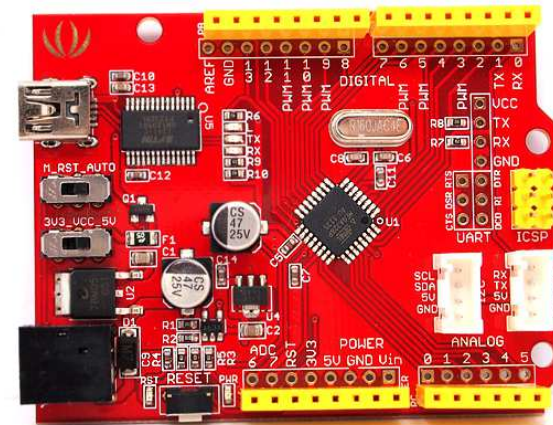
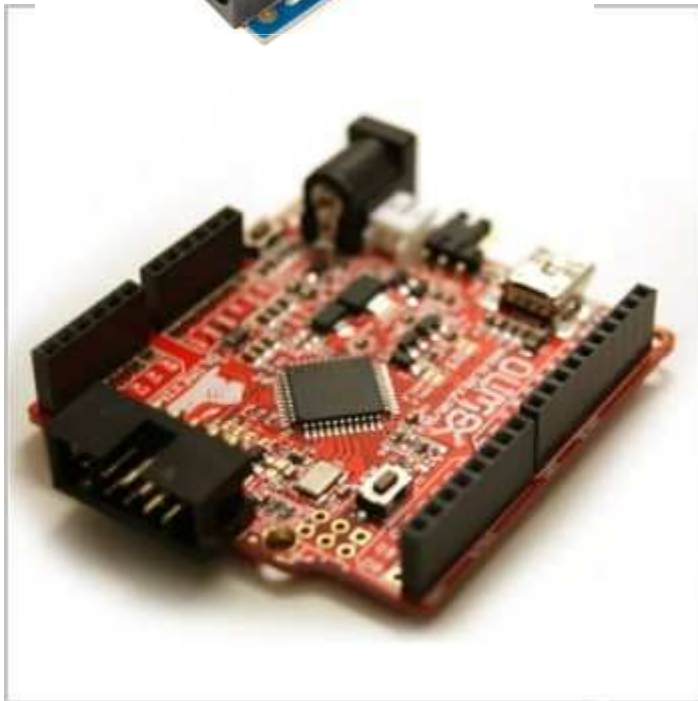
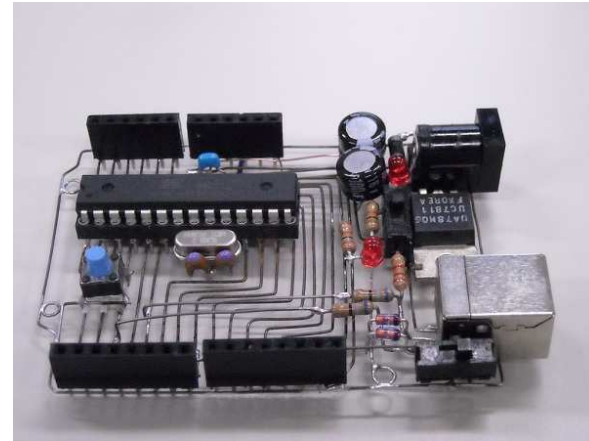
# The basis: Atmel ATmega328



**IDEA: Eliminating obstacles and letting people do, new and unexpected forms of innovation can emerge**

# Arduino form factor

---





# Arduino and its clones

www.techunboxed.com/2013/08/ktuluino.html

Saturday, August 31, 2013

## Ktuluino - How to Build Your Own Arduino Clone



5v only

green

black

reset

digital

analog

Ktuluino

Why settle for a lesser evil?

techunboxed.com

16Mhz

22pF

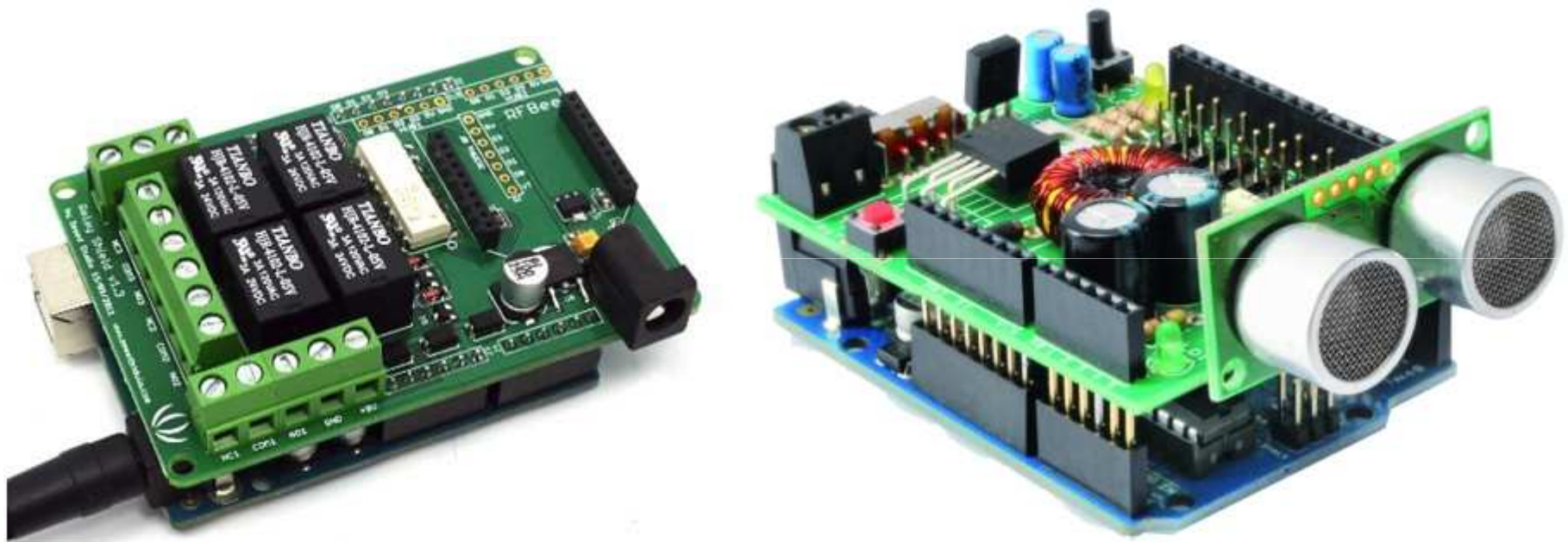
0.1µF

0.1µF

v1.2

# The notion of shield

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Shields are add-ons or extension shields that can be plugged over the Arduino shield

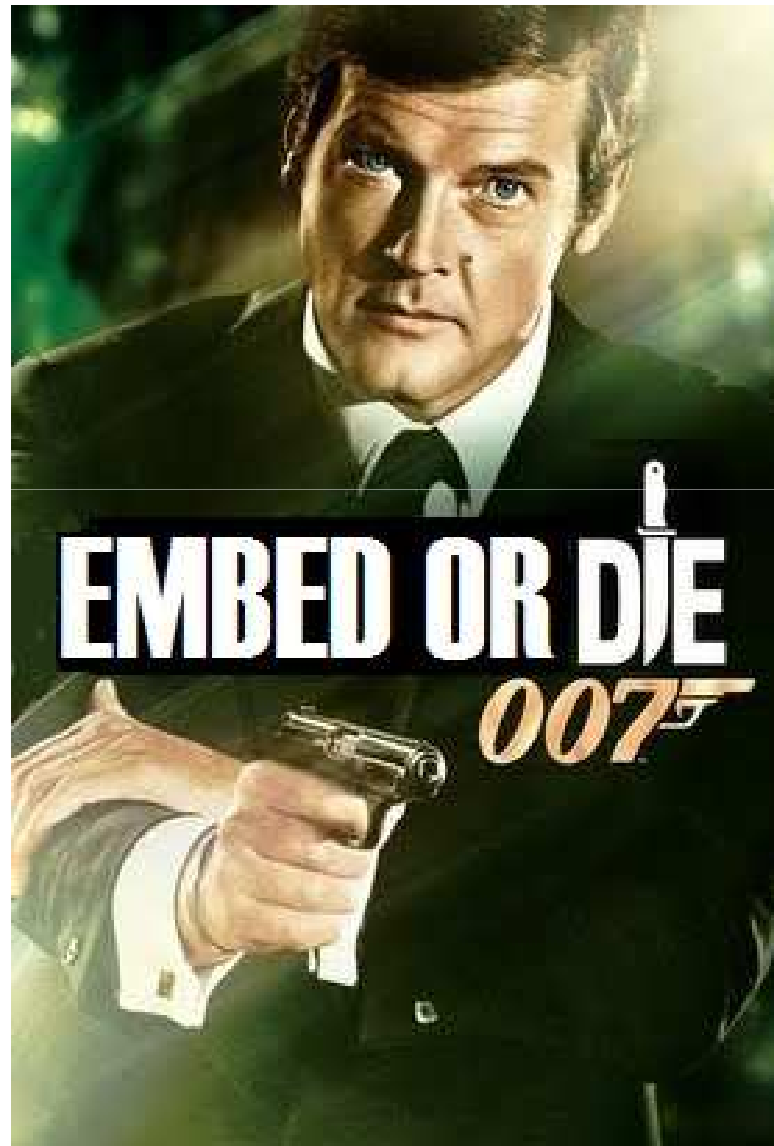
## Embedded Systems Working Group

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- And we have and slogan

## Embedded systems revolution ?

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**01**

# The Fourth Industrial Revolution

**B**

**C**

# The seminal paper

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**Forschungsunion**

Wirtschaft und Wissenschaft  
begleiten die Hightech-Strategie

**acatech**

NATIONAL ACADEMY OF  
SCIENCE AND ENGINEERING

Securing the future of German manufacturing industry

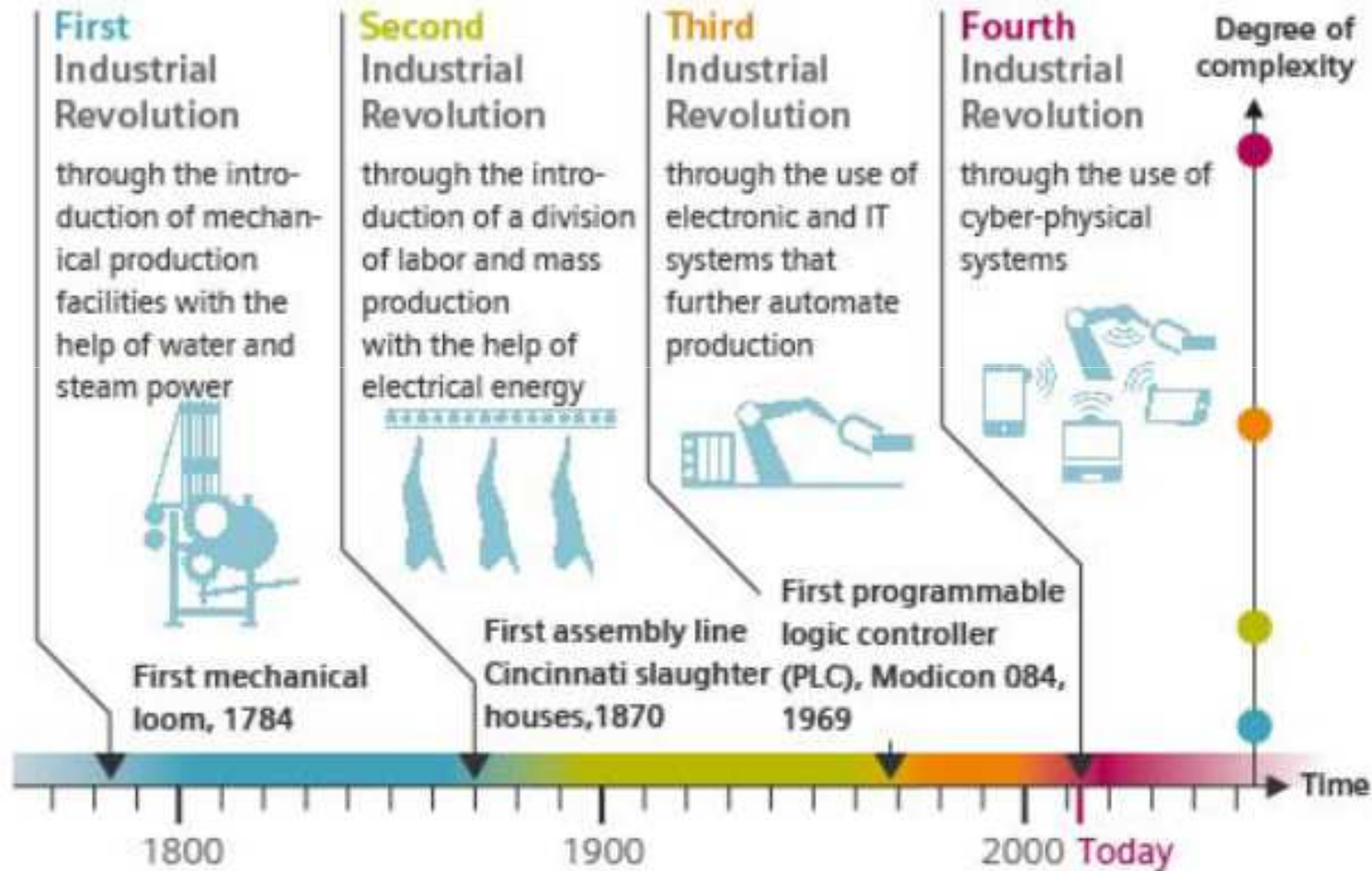
## Recommendations for implementing the strategic initiative INDUSTRIE 4.0

Final report of the Industrie 4.0 Working Group



# The 4th Industrial Revolution

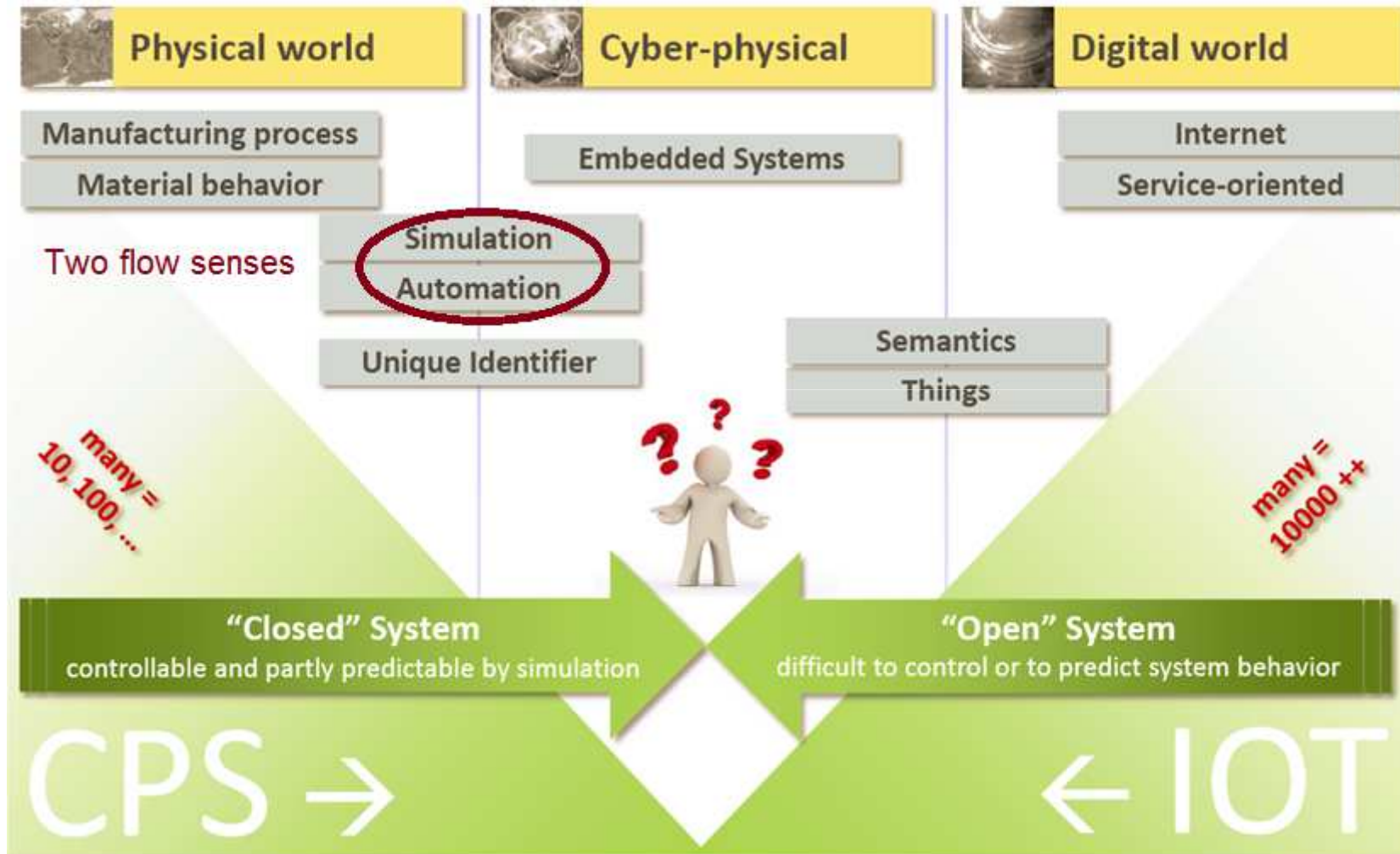
## From Industry 1.0 to Industry 4.0



Source: DFKI (2011)

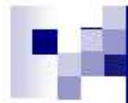


# IoT and CPS

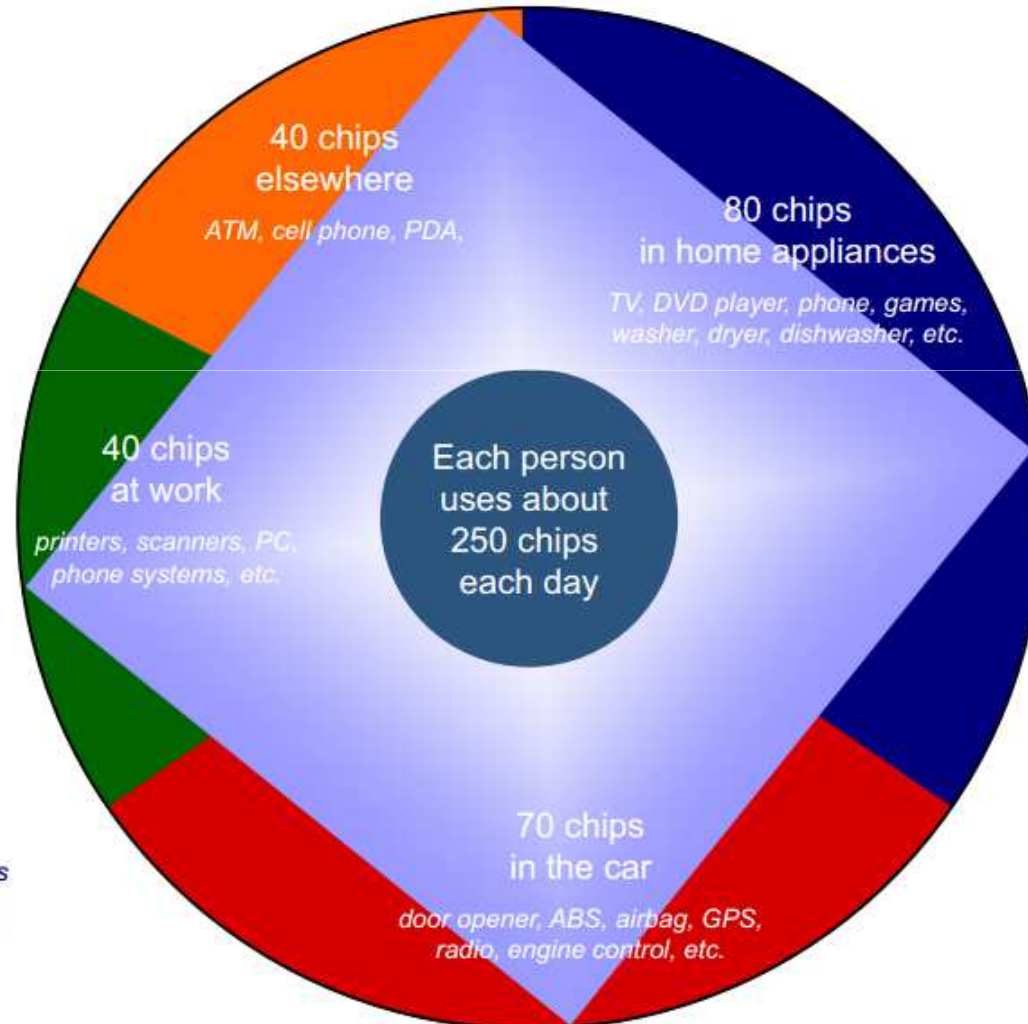




# Transversality



## Embedded Systems are Everywhere



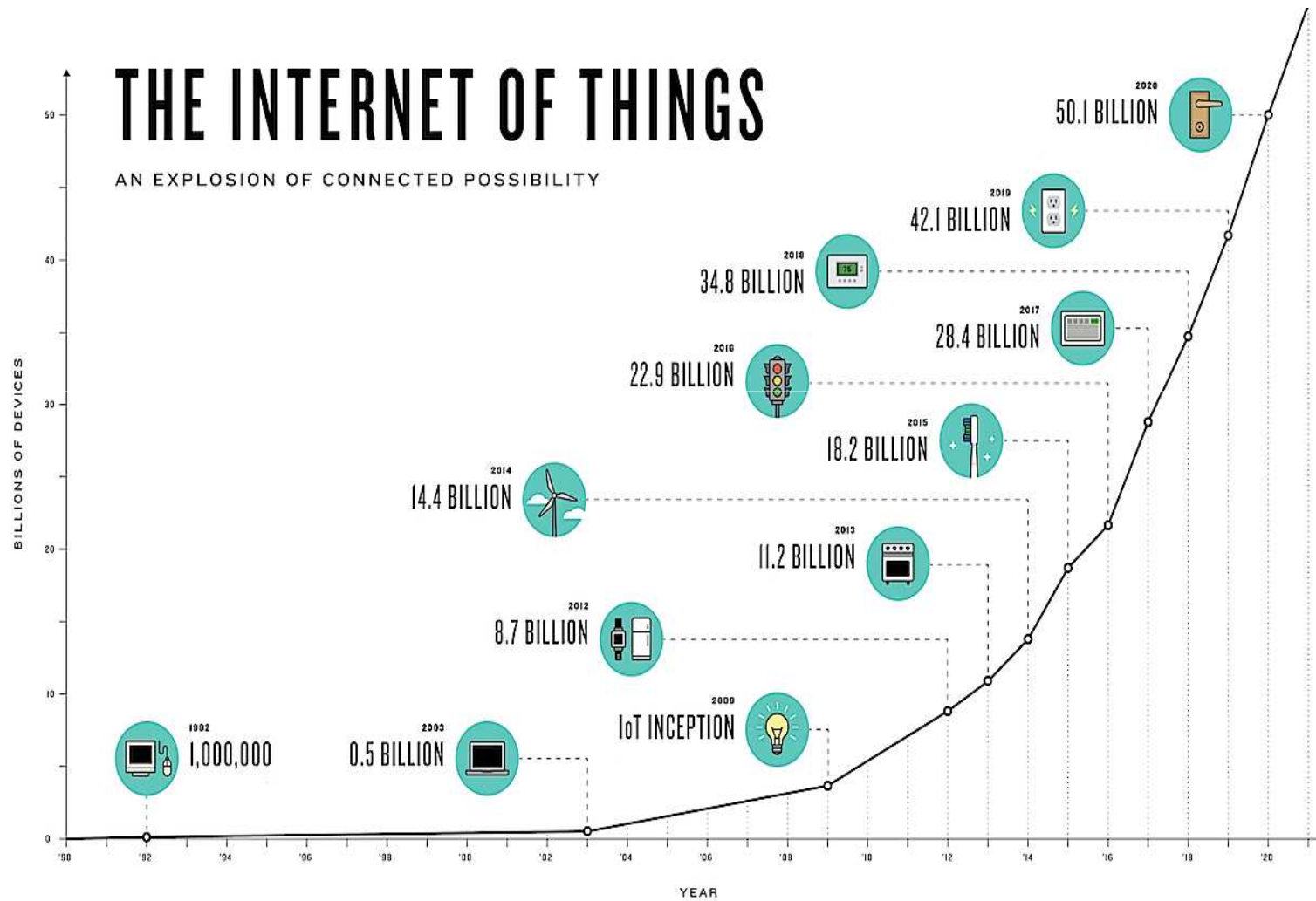
1 billion transistors used per person each day (2008)

# Transversality

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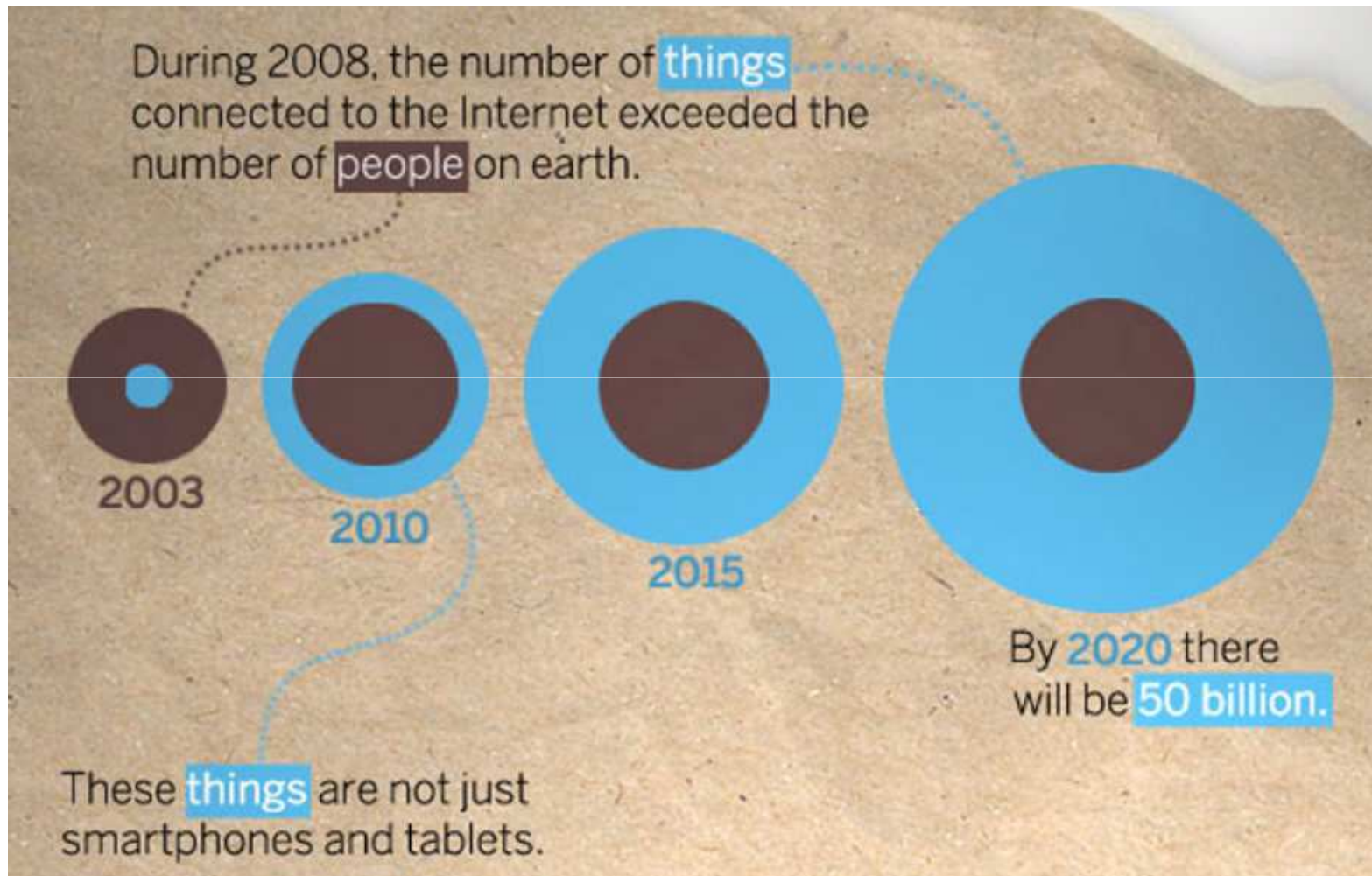


# First pillar: Internet of Things (IoT)

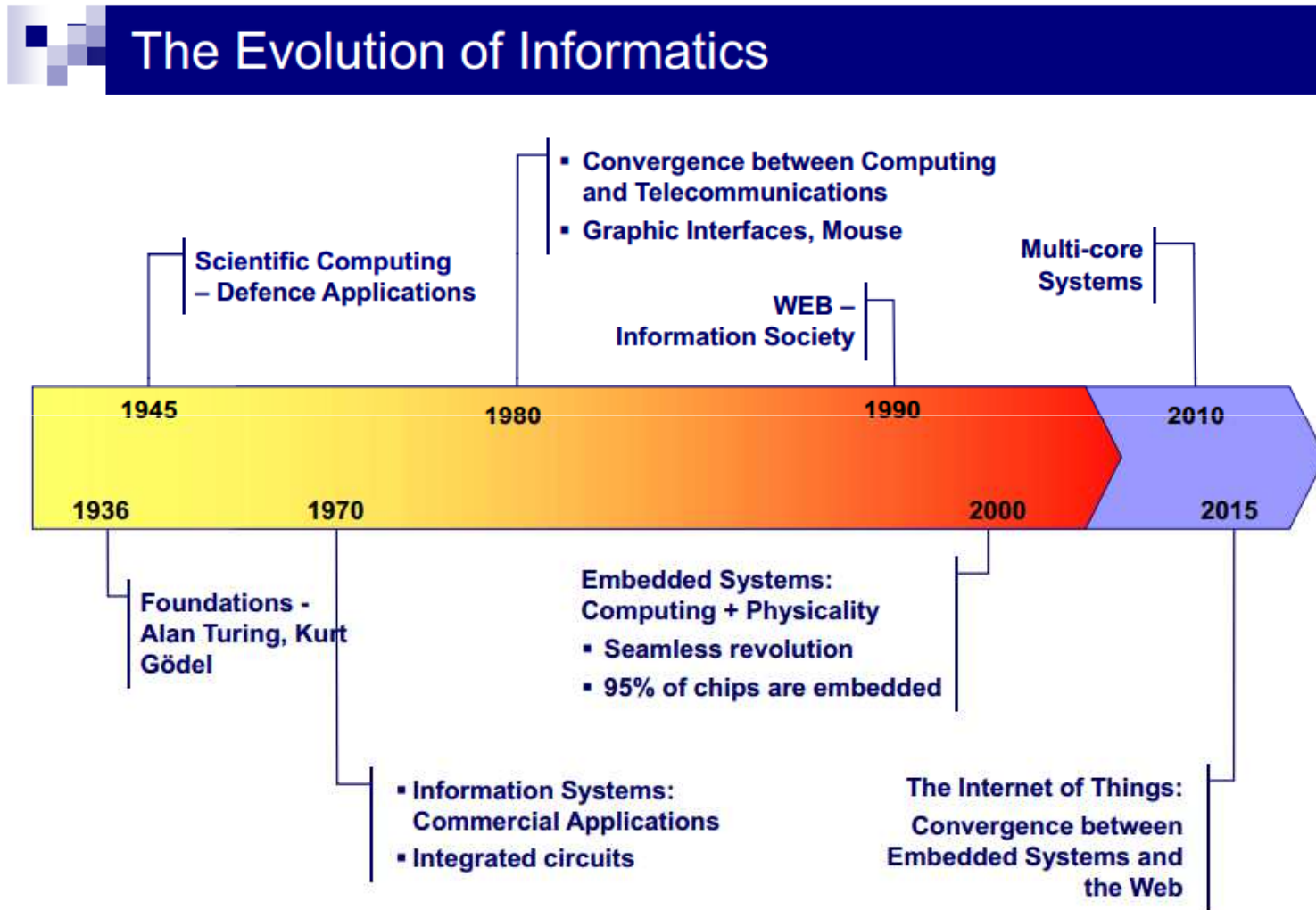


## First pillar: Internet of Things (IoT) - II

---



## Second pillar: Cyberphysical systems



*Informatics is a young discipline, driven by exponential growth of components and their applications.*



# Cyber-physical systems: Joseph Sifakis (Turing Prize 2007)

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## Proposed Vision

By their nature, **Embedded Systems** need results and paradigms from both **Computing Systems** and **Physical Systems** Engineering

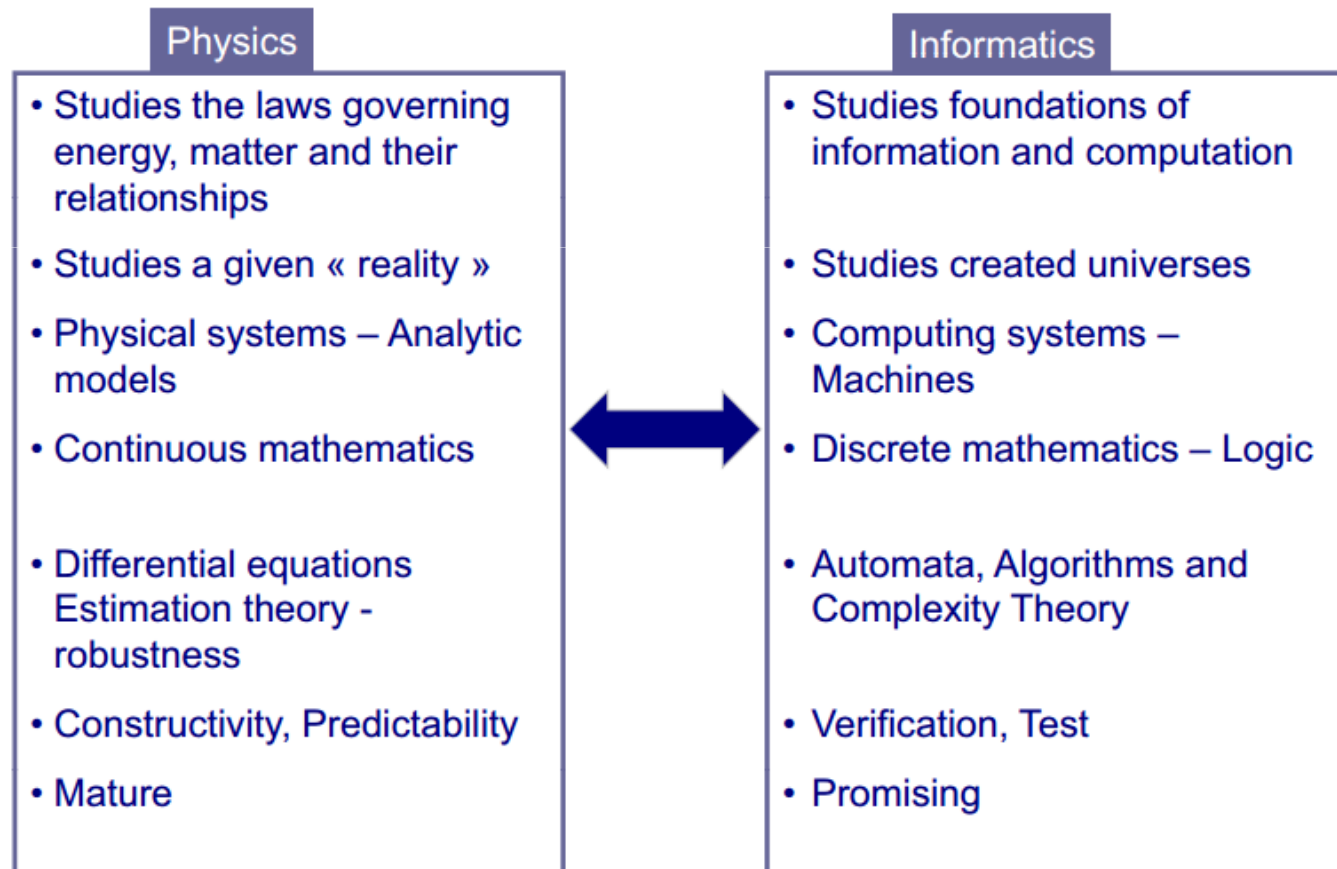
We need a new formal foundation for **Embedded Systems**, which systematically and even-handedly marries **computation** and **physicality** **performance** and **robustness**

↑  
What is being  
computed? At what cost?

↑  
How does the performance  
change under disturbances?  
(change of context; change of  
resources; failures; attacks)

# Prevision for 2015 (“The marriage”)

## Marry Physicality and Computation



## Example of practical discourse

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- How apply Internet Of Things?
  - Any measure we could read could be accessed immediately via web-service (for example a display)
  - Any actuation could be activated immediately via web-service (on/off actions are the simplest, ...)
- If these rules are applied to every equipment rules will change (prediction):
  - Dramatic increase of engineering integration tasks with an exponential growing of combinations possibilities.
  - Consolidation of open approaches (open standards, open protocols, open source software, open source hardware, TCP/IP, Bluetooth 4.0, ...)



# 02

The 3th DIY wave: Makers movement  
(Citizens empowerment)

**B**

**C**

# Maker Movement



## Las olvidadas tiendas de electrónica renacen gracias al fenómeno 'maker'

Los comercios digitales ganan el pulso a las webs | Muchos extranjeros visitan en BCN estos locales, chinas de venta gracias a su inmediatez y atención | que ya han desaparecido en numerosos países

**CRISTINA SALLA / GARCÍA JIMÉ**  
BARCELONA

Las pocas tiendas de electrónica de toda la vida que aún quedan en Barcelona han experimentado de la deceleración gracias al auge de la informática hecha en casa, la impresión en 3D y el creciente atractivo de los makers, movimiento que propugna construir las cosas sencillas con esas viejas tecnologías e conexión a internet.

Son las tiendas digitales de internet, en las que cada año cuando de la electrónica se enciende a pequeña escala, y que en otras ciudades europeas, a excepción de Berlín, se ya han extinguido. En sus estanterías guardan diodos, LEDs, transistores, placas de procesadores, sensores y resistencias USB. Material del siglo XXI con el que se fabrican desde las tarjetas de memoria del iPhone.



Las dependientes de Diótroto, en Muntzenar, que atienden con atención a los clientes y resuelven sus dudas.

que no se separan de los vidrios de YouTube -el gran guardián del internet- y los fabricantes de los componentes de la electrónica y han logrado tener una tienda física en el local y competir incluso con las mil barracas web chinas de componentes, gracias a su mayor rapidez y al tradicional secreto del pequeño comercio, que permite conocer el estado

**itinerarios**  
ESPACIOS PARA INTERCAMBIAR

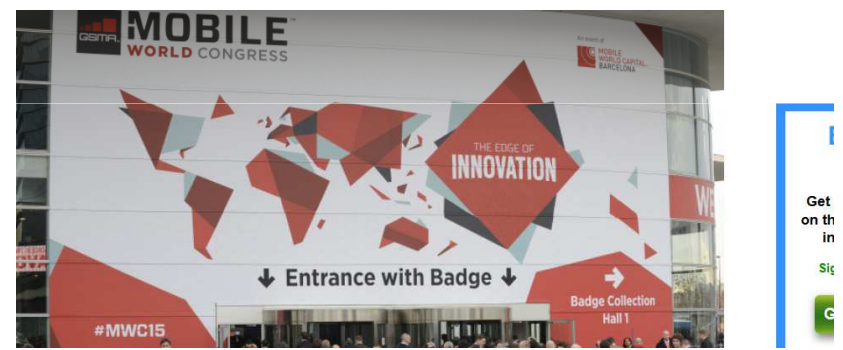
**LUGARES DE ENCUENTRO**  
Los makers encuentran su espacio físico en las tiendas de electrónica y en centros como el MOC (Maker of Barcelona) de la calle de Balmes, el Club de Coruña, Hanager y los talleres de fabricación digital que ha impulsado el Ayuntamiento de Barcelona en Les Corts y Clot del Muntzenar.

**EL BAR MÁS ACTIVO**  
El FabCafe (Balmes, 11) es un activo punto de encuentro de los makers. Además de tartas, tienen sala con máquinas de hacer el propio queso QD.

**RED DE COOPIALES**  
Allí los vecinos, profesores y estudiantes -en su mayoría que residen en edificios en alquiler- se reúnen en un espacio para aprender (los makers se reúnen) o simplemente hacer cosas con electrónica y componentes, como cuando por redes como Meetup.

## Marriage of IoT, Maker Movement Paves Way for 'Fourth Industrial Revolution'

Jennifer Baljko  
09 March 2015  
Share | Tweet | Email



Intel, for instance, has been a proponent from some time. At the Make Fair in Rome in 2013, the chipmaker announced a partnership with Arduino, and its Galileo Gen 2 board was the first product specifically designed for makers, students, educators and DIY electronics enthusiasts.

Atmel, too, has had a track record in this area, with its microcontrollers often powering a number of Arduino boards. The company operates a "Tech on Tour" mobile trailer that travels to locations throughout the U.S. in an effort to reach out to the maker community.

Outreach to the maker community from these semiconductor companies and others is evidence that the industry sees the potential for innovation coming from new sources--and wants to be a part of it.

As author Chris Anderson recently wrote in the Guardian, "The Maker movement has a long way to go before it can really be said to have come of age. But that doesn't mean it should be ignored or regarded solely as a hobbyist's or niche manufacturer's paradise. It represents the first steps in a different way of doing business."

Questions or comments on this story? Contact Jennifer.baljko@ihs.com

## Living Labs (Ateneus de fabricació / Manufacturing Atheneus)

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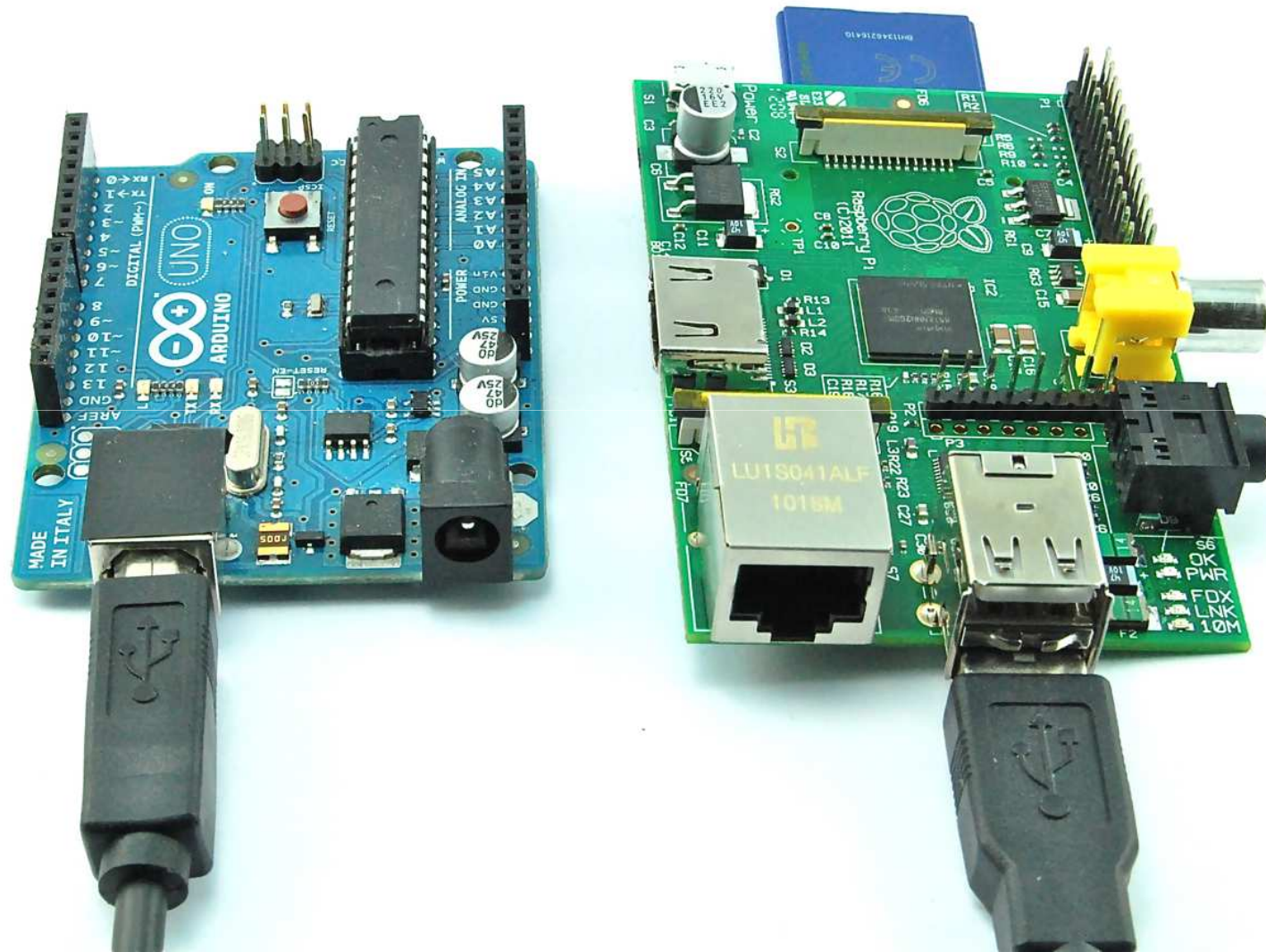
## Home Labs (The myth of the Apple Garage). What happens at citizen homes?

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# Popular boards: Arduino and Raspberry Pi

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## Arduino and Raspberry Pi

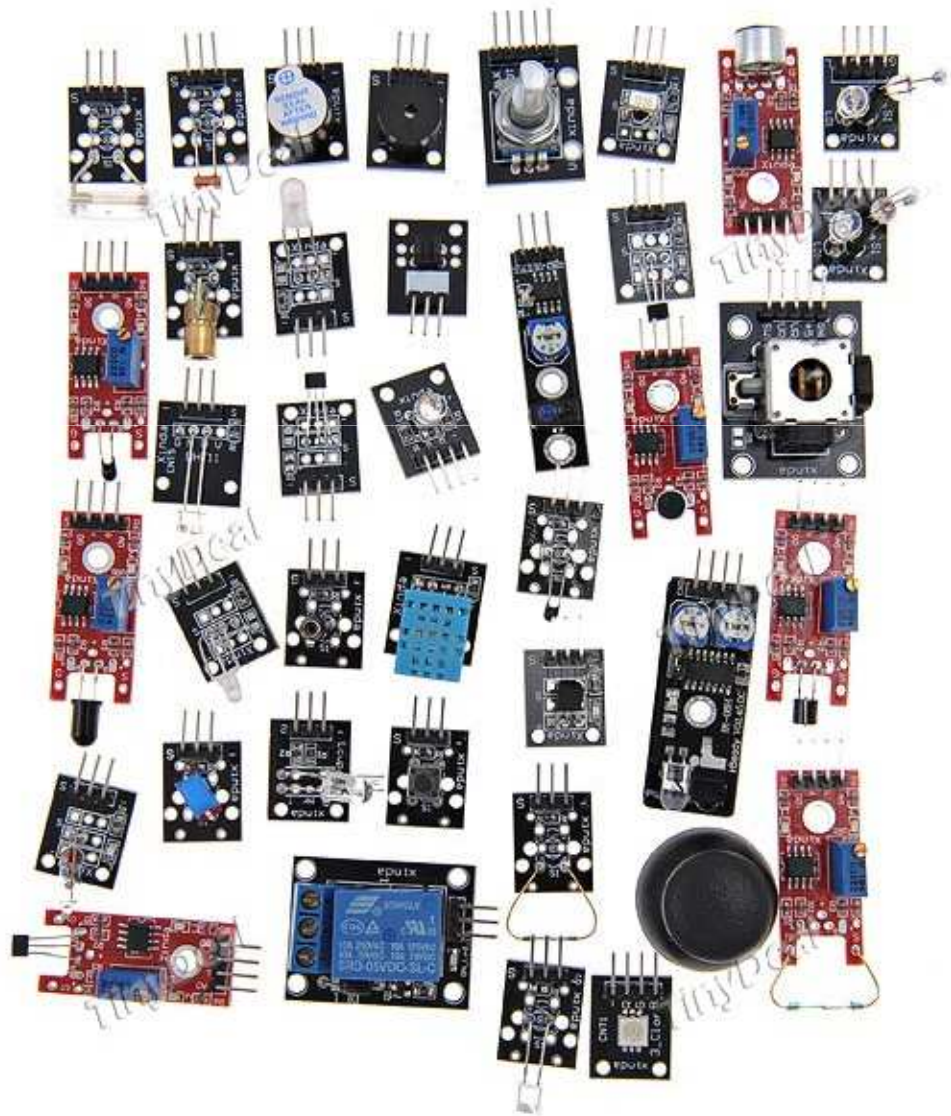
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- Arduino is a project born in Ivrea in 2005, Olivetti's historical headquarters, that consists of a small controller conceptually similar to an industrial PLC (Programmable Logic Controller). It is the *Open Source Hardware* world reference.
- Raspberry Pi is a project born in the University of Cambridge in 2009, that consists of a small card with a full fledged Linux computer.



# Sensors (Arduino)

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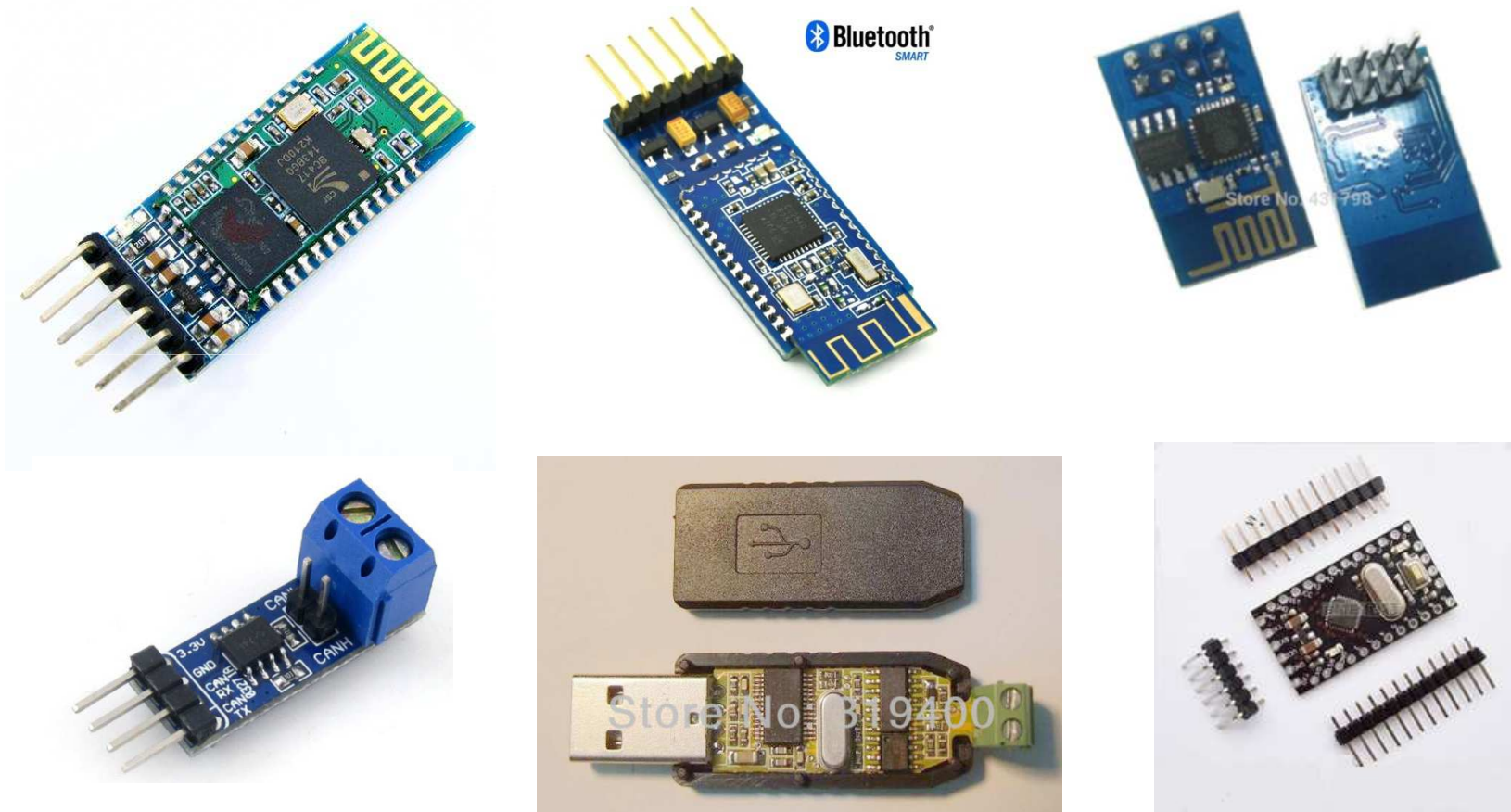


- All kind of sensors for Arduino:
  - Temperature
  - Pressure
  - Gas
  - Light
  - Etc

“37-in-1 Sensor Module Kit for Arduino (ECT-219472)”

# Commodity communication modules

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Low cost Bluetooth, Bluetooth LE, Wi-Fi, CAN Bus, RS-485 (Modbus), Arduino



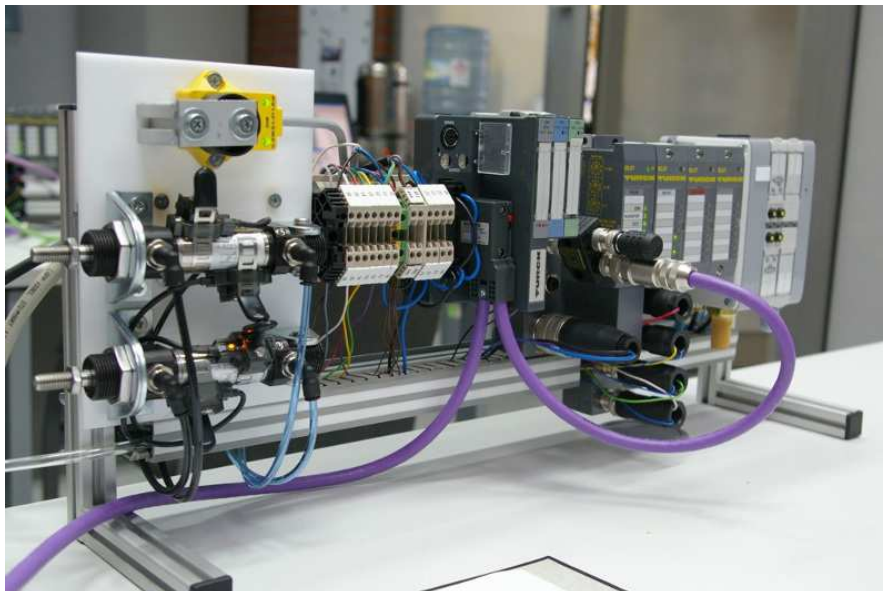
# Industrials sensors

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# Industrials actuators

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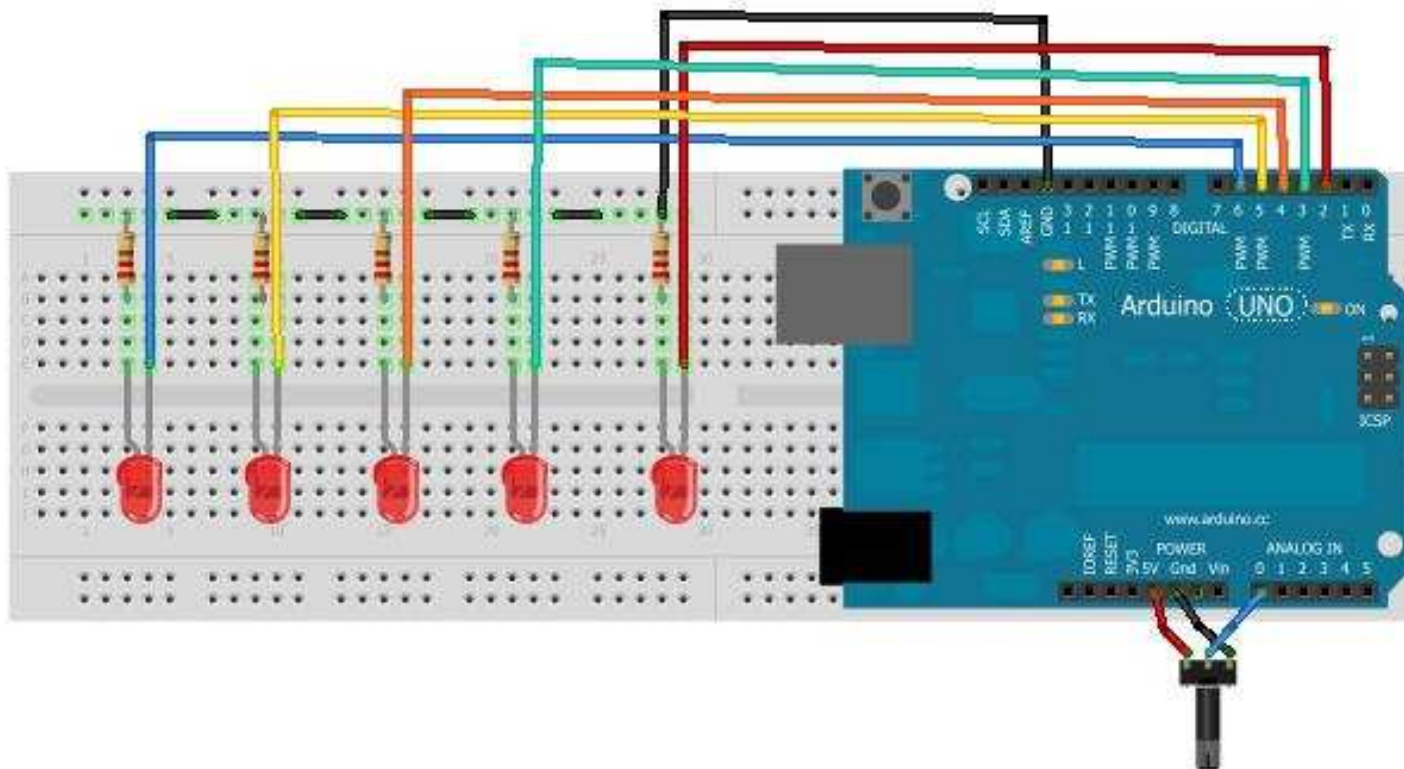


ROS  
Open Source Robotics Foundation

## Levels of difficulty in electronics DIY

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- External protoboard



Usually is the maker starting point

# Using simulations

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123D Circuits / Circuits Components Circuit Scribe Shop Search Sign up Sign in

## Simulate Arduino online and easily create custom circuit boards

Design and simulate circuit boards with our breadboard, schematic and PCB editor. Share your designs and collaborate as a team.

Get started designing electronics online!

Show me an example!

**DRAW CONDUCTIVE TRACES**

Easily create and simulate Circuit Scribe sketches online.

Circuit Scribe is a rollerball pen that writes with

<https://www.google.es/webhp?hl=es>

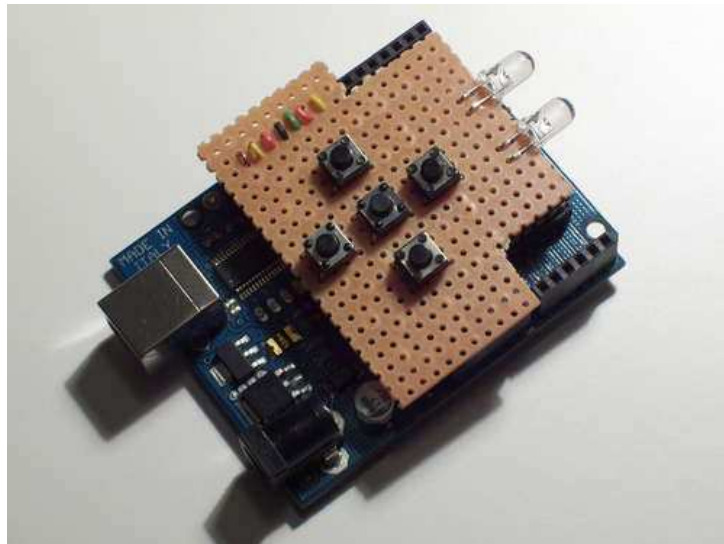
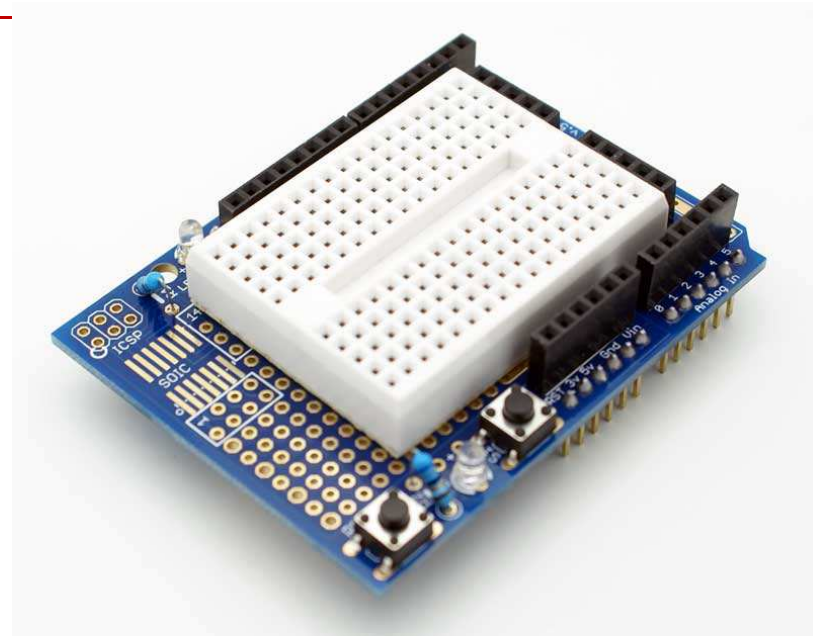
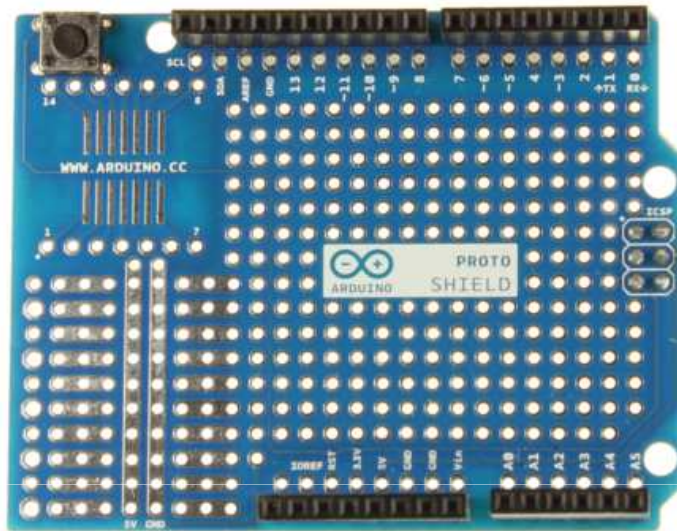


# Levels of difficulty in electronics DIY

The screenshot shows the DesignSpark PCB website home page. The browser address bar displays [www.rs-online.com/designspark/electronics/eng/page/designspark-pcb-home-page](http://www.rs-online.com/designspark/electronics/eng/page/designspark-pcb-home-page). The page features a navigation menu on the left with items like HOME, DESIGN CENTRES, FREE 3D SOFTWARE, DESIGNSHARE, DESIGNSPARK PCB, MODELSOURCE, BLOG, FORUM, TOOLS, RS UNIVERSITY, MEMBERS, and PRODUCTS & REVIEWS. The main content area is titled "DESIGNSPARK PCB HOME" and includes a search bar, a "CONTRIBUTE TO DESIGNSPARK" button, and a central promotional banner for "DesignSpark PCB Home" with 1450029 views and a "FOLLOW" button. The banner features the DesignSpark PCB logo and the text "Your Electronics Design Software for Rapid Prototyping". Below the banner are buttons for "DOWNLOAD DESIGNSPARK PCB" and "ACTIVATE DESIGNSPARK PCB", along with a note that Version 7 is now available for download. A footer note states: "\*Free for commercial or non-commercial use, no limitations or licensing." On the right side, there is a "MODELSOURCE" section describing it as an on-line database of FREE engineering models, and a "FREQUENTLY ASKED QUESTIONS (FAQS)" section with links to various FAQ topics.

# Prototyping extensions and DIY

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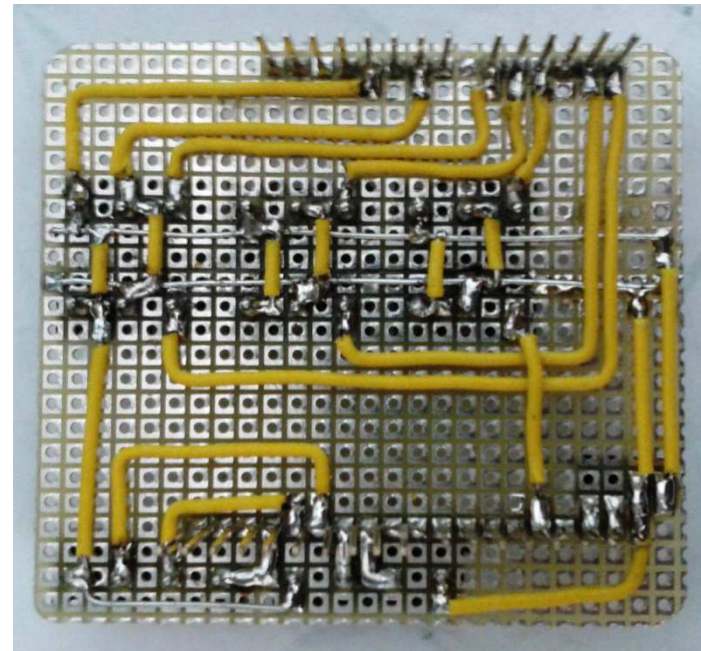
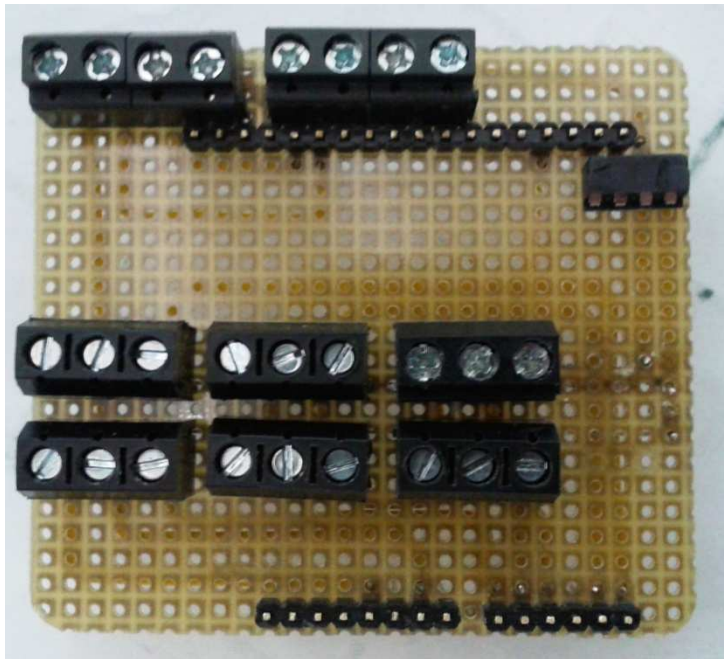


Classical universal boards

## Levels of difficulty in electronics DIY

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- Universal boards for soldering

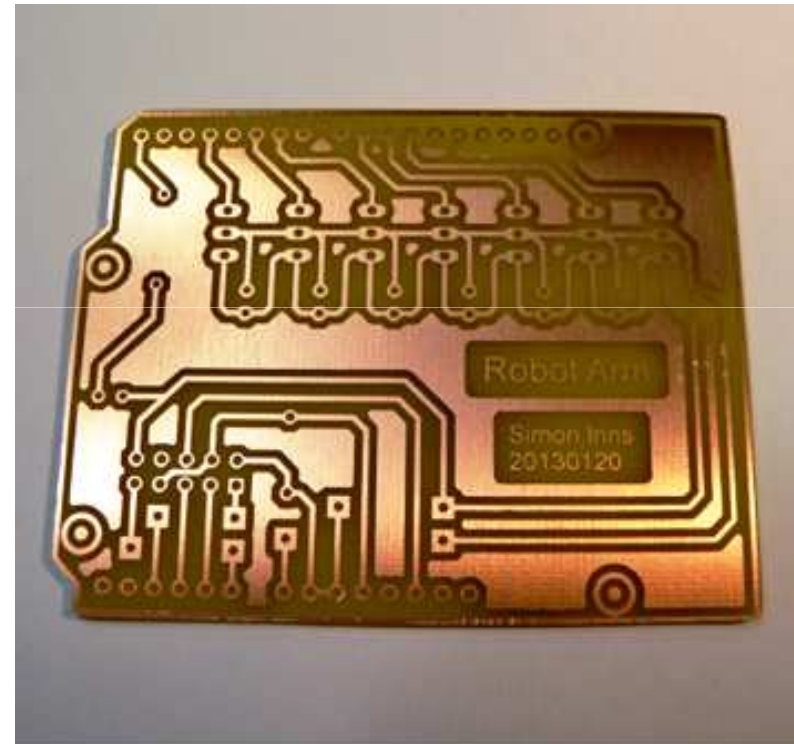
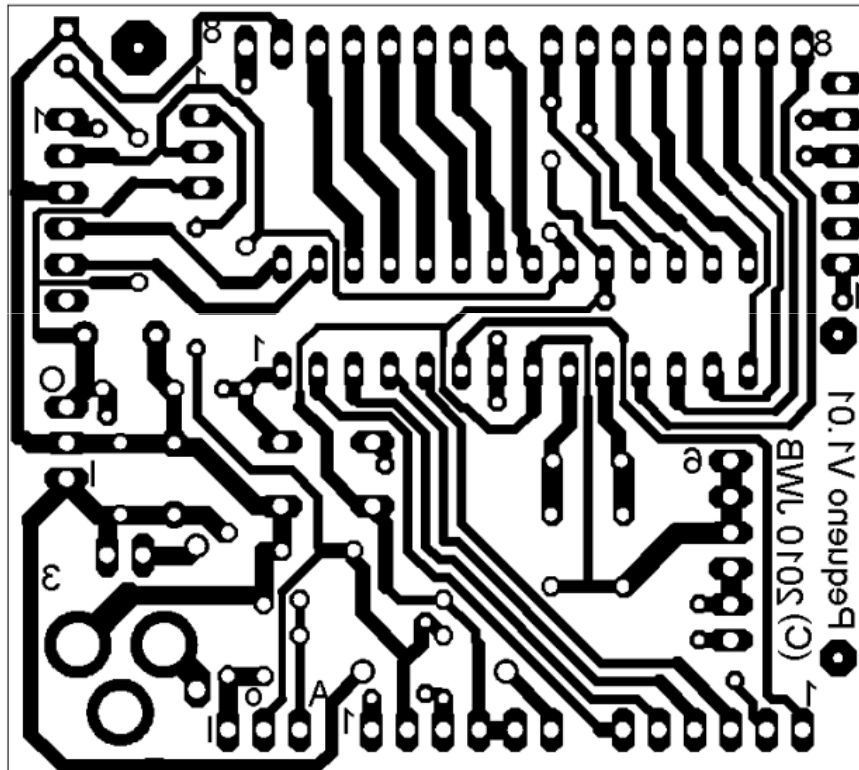




## Levels of difficulty in electronics DIY

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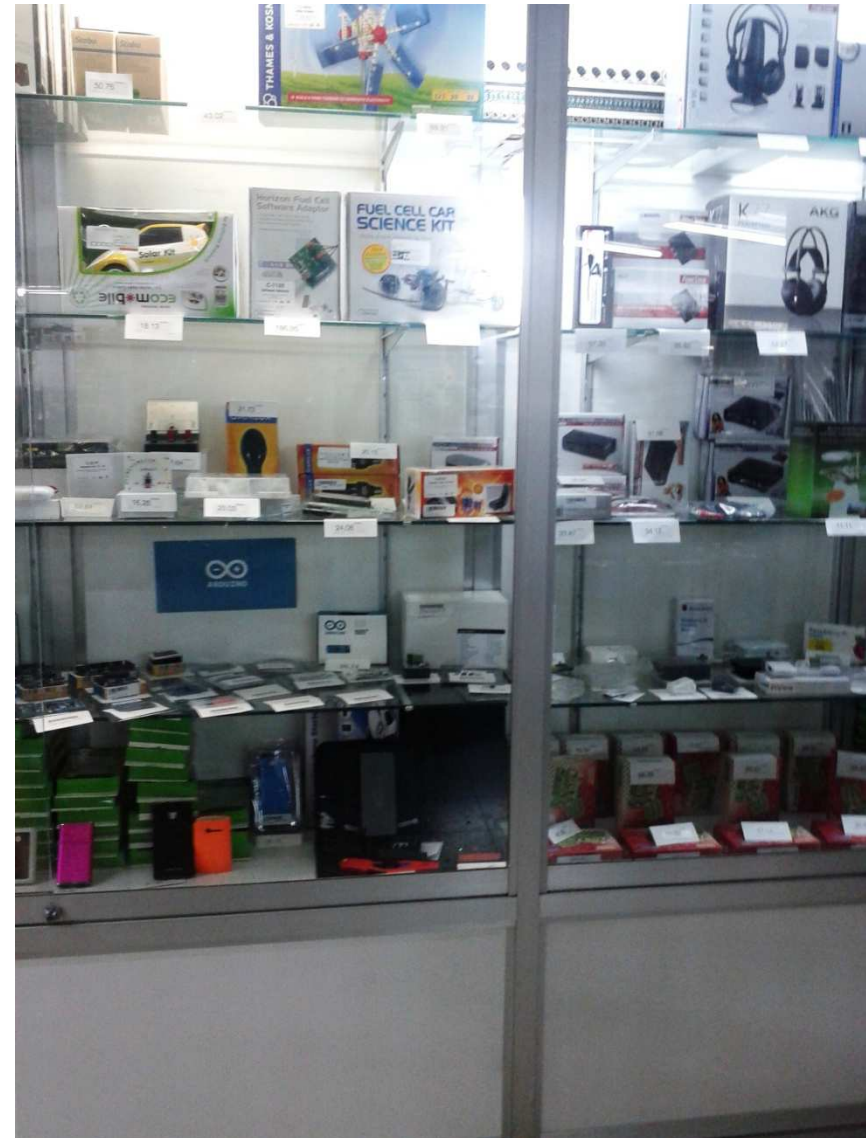
- Printed Circuits Boards



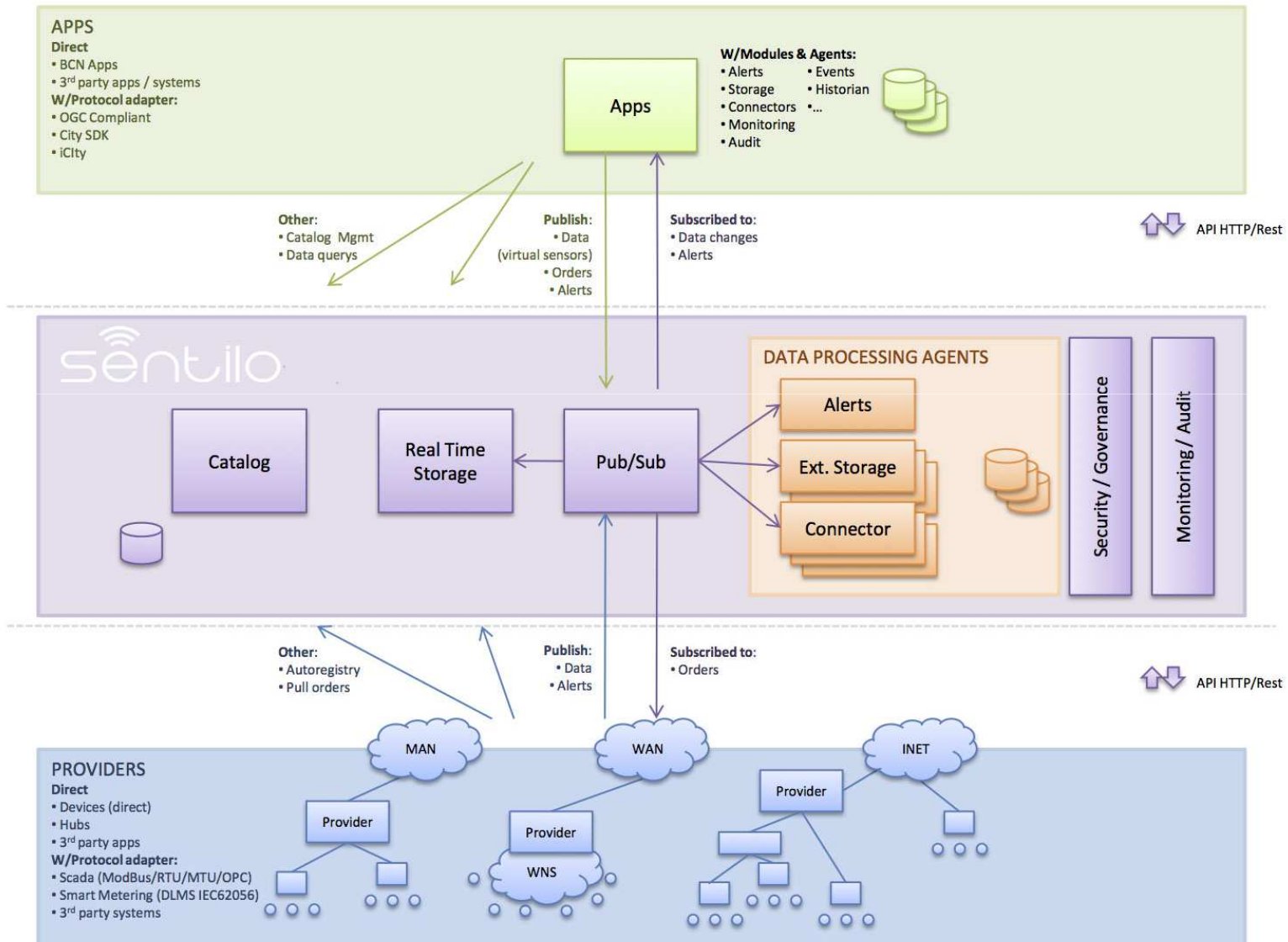
Difficult, but it is the previous phase to high production

# Boom Arduino and Raspberry Pi i traditional electronic components shops

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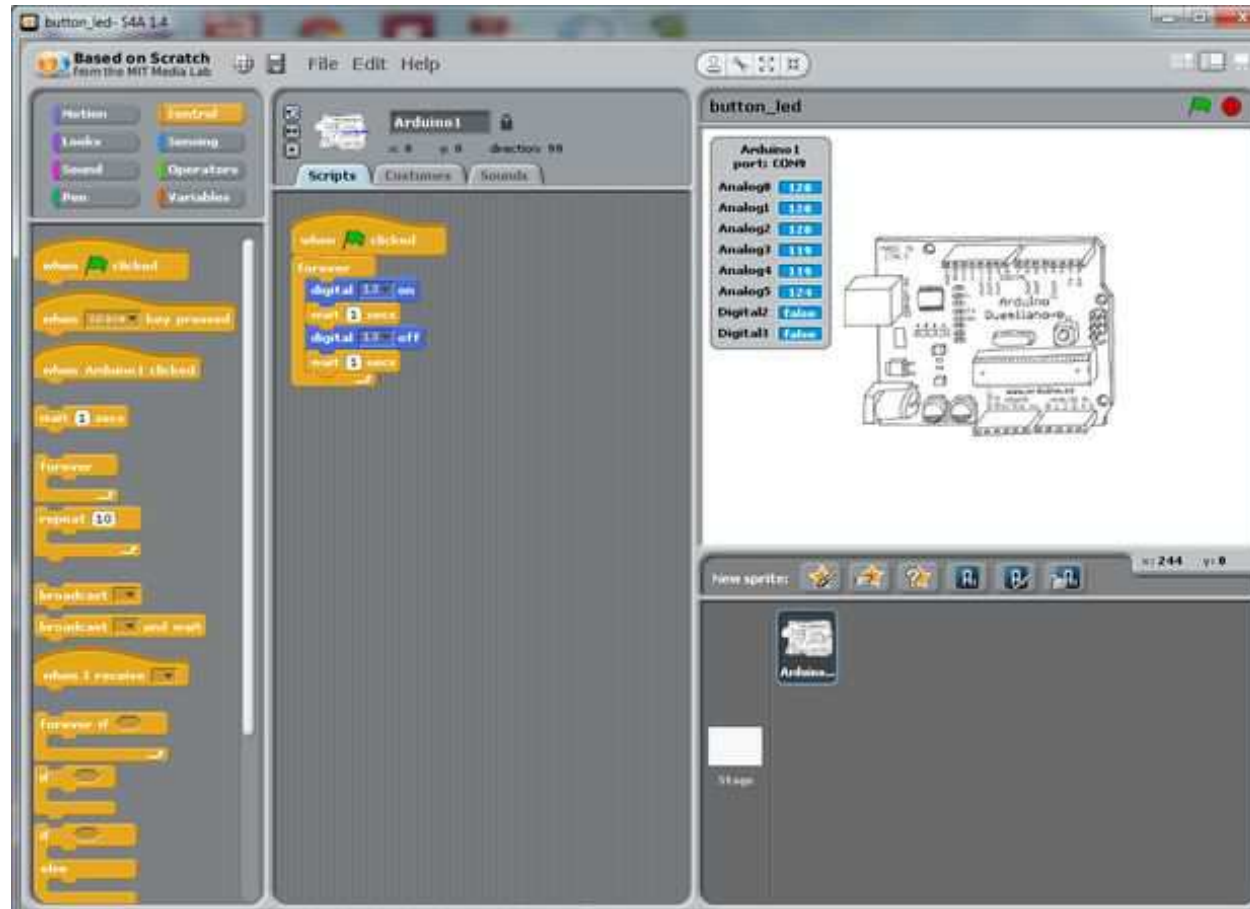


# Sentilo Barcelona sensor platform (Open source) [www.sentilo.io](http://www.sentilo.io)



## Minimizing knowledge barriers: Scratch for Arduino (S4A)

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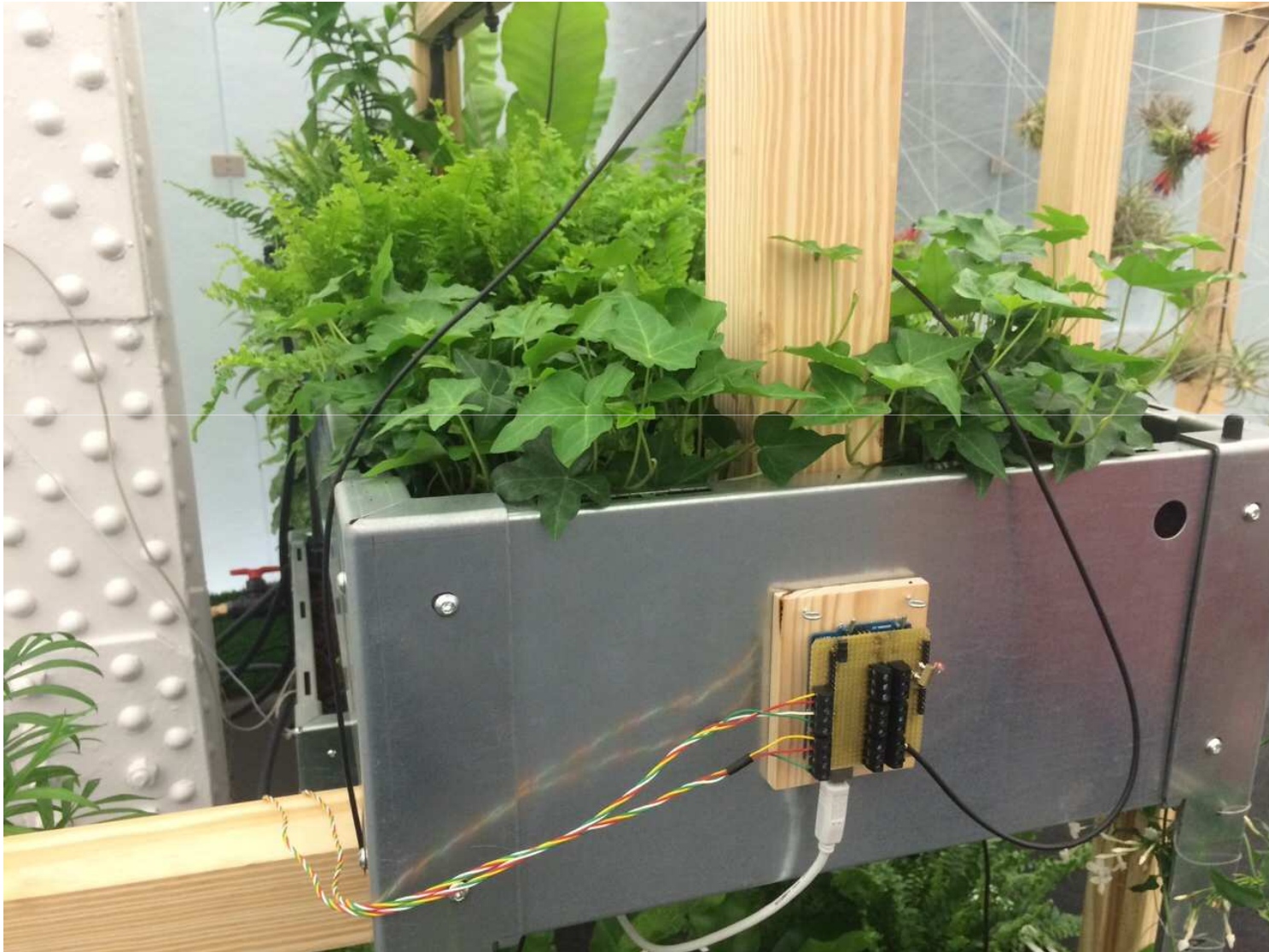


- Arduino can be controlled from a PC or a Raspberry Pi by kids using the Scratch program language



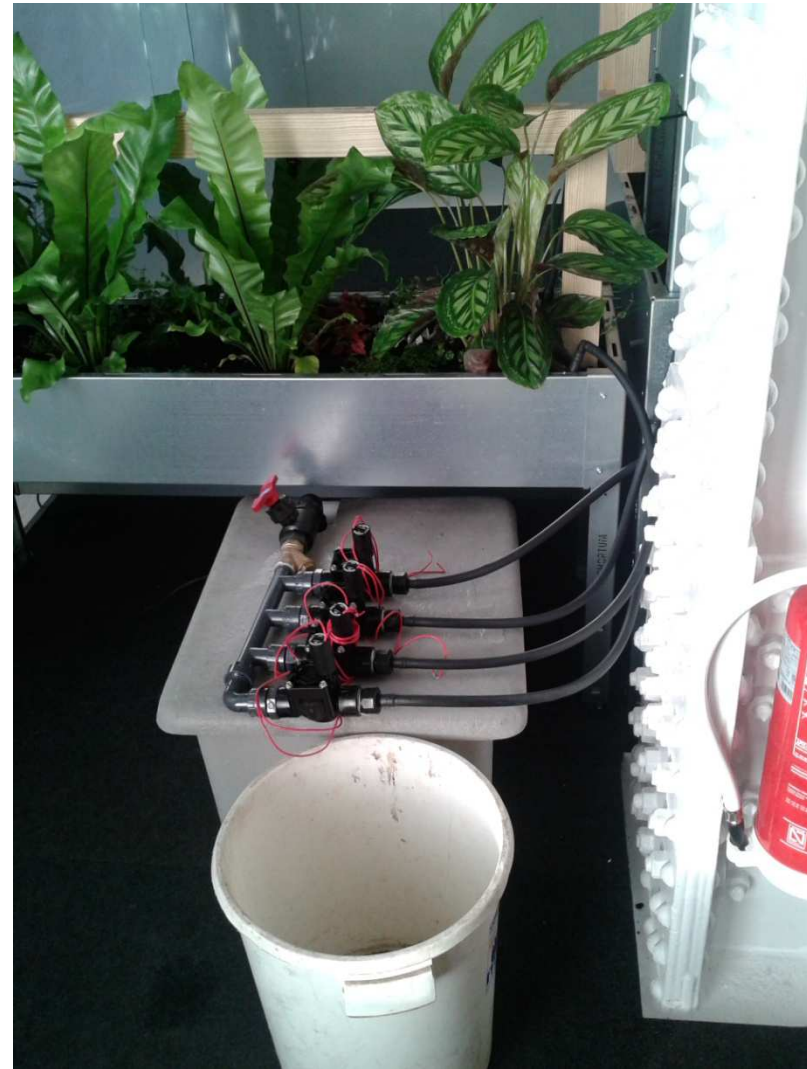
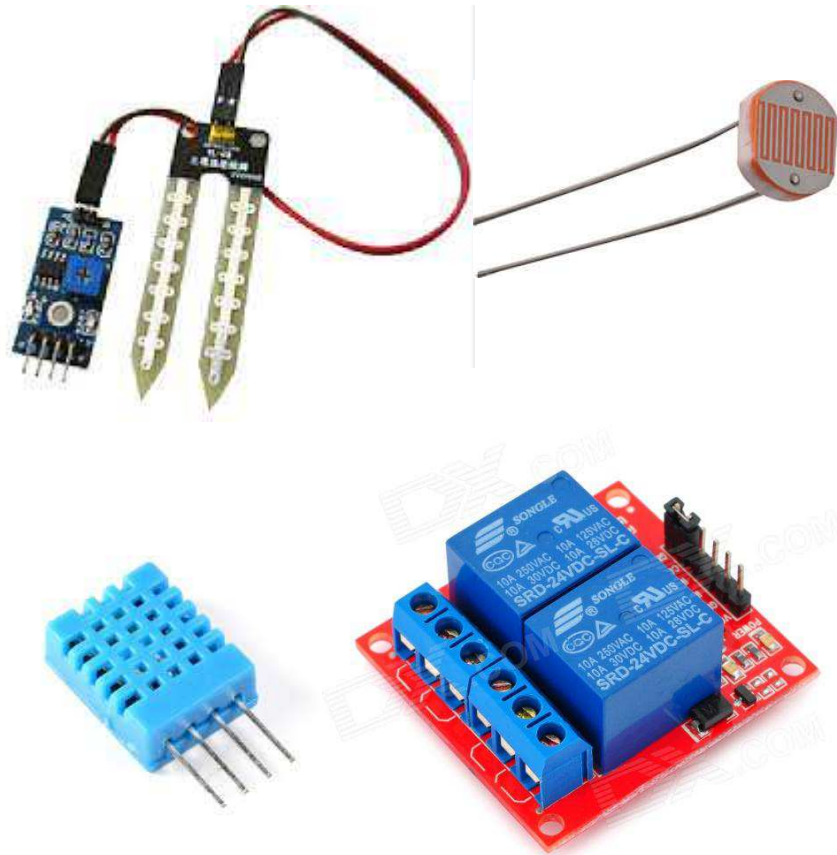
## Case study at Mobile World Center (BCN)

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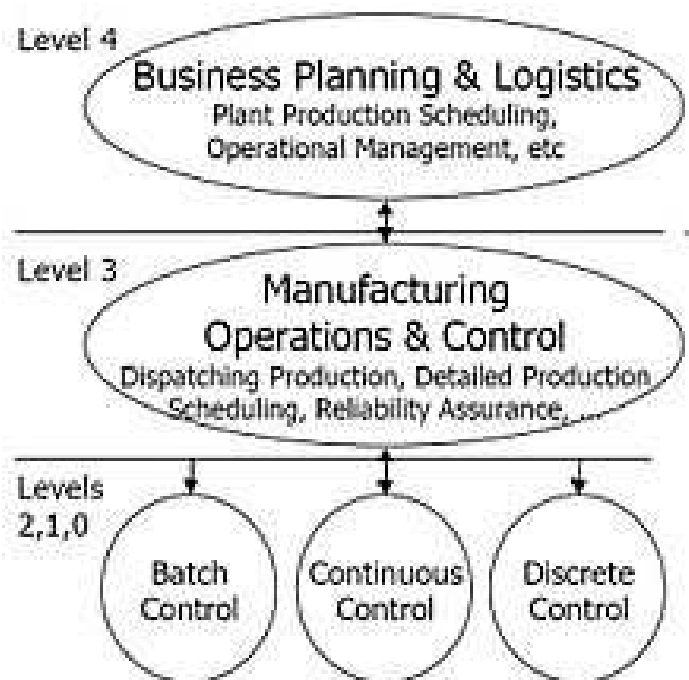
# Sensors and actuators of the case study

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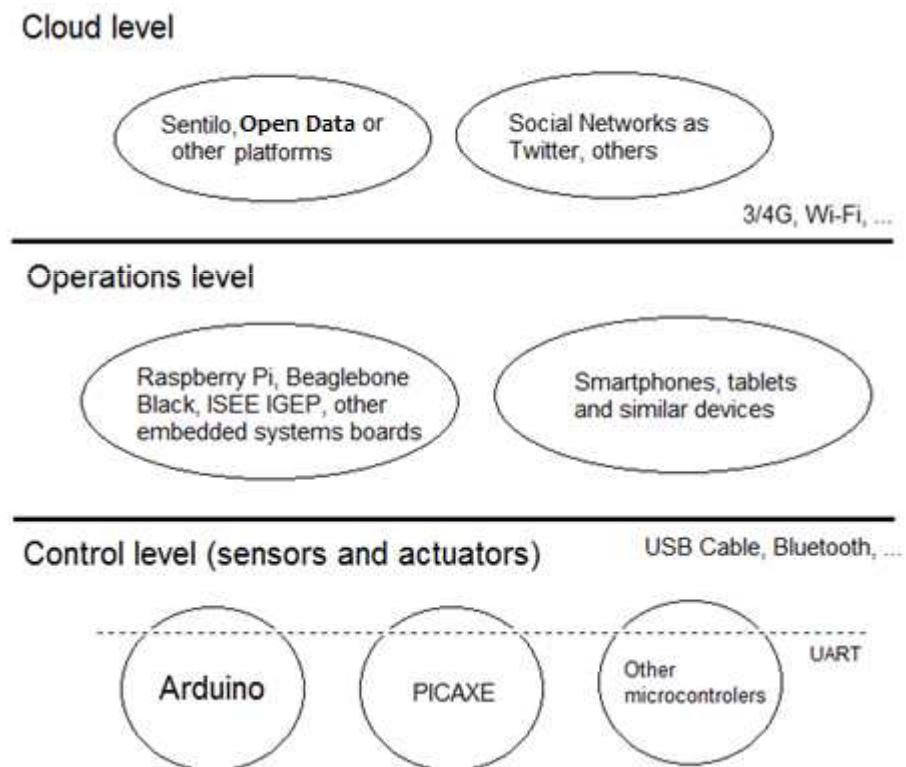


## Fiting all together (From Barcelona City Council Innovation Dept)

- RaspBCN architecture is inspired by Purdue Industrial Network Architecture in the context of the 4<sup>th</sup> Industrial Revolution.



Purdue Architecture

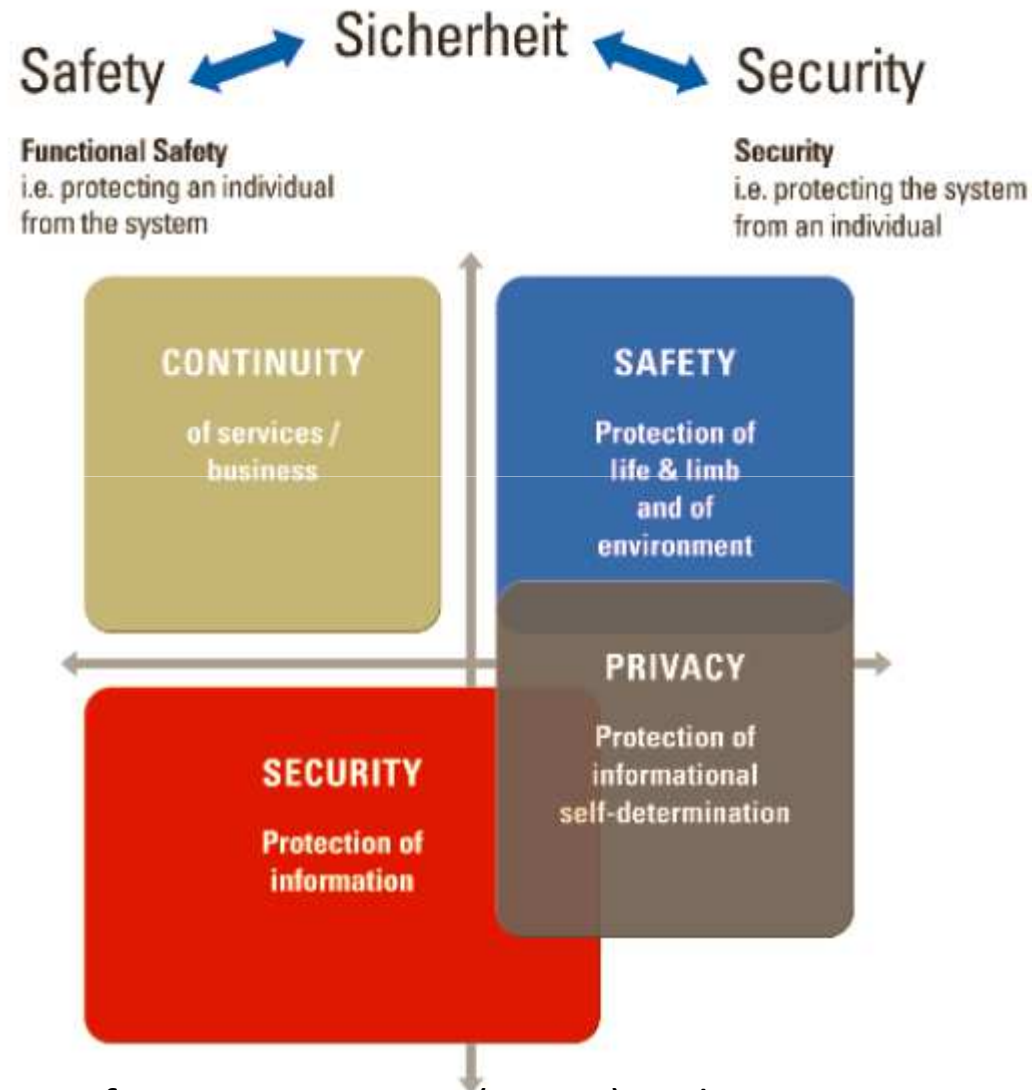


RaspBCN Architecture



# A Big Challenge: Safety & Security

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TÜV offer dual certification IEC 62443 (ISA 99) and IEC 61508

Thank you

---

Xavier Pi

[xpi@enginyers.net](mailto:xpi@enginyers.net)

Embedded Systems chair at EIC ([www.eic.cat](http://www.eic.cat))