Internet of Things:

Presentazione del corso

Anno Accademico 2019-2020

Prof. Luciano Bononi

Prof. Marco Di Felice

DIPARTIMENTO DI INFORMATICA – SCIENZA E INGEGNERIA (DISI)

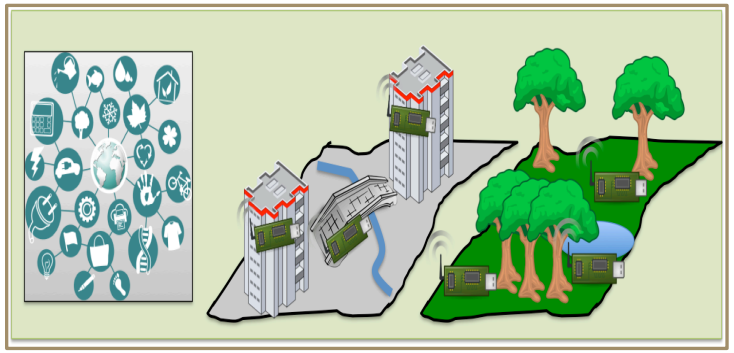
Internet of Things: Info generali

Anno	**Secondo**
Semestre	**Secondo**
Numero Crediti	**6**
Lingua	**Italiano (materiale in inglese)**
Docenti (2 moduli)	**Prof. Luciano Bononi,** **Prof. Marco Di Felice**
Sito web	**http://site.unibo.it/iot** **Materiale su IOL**

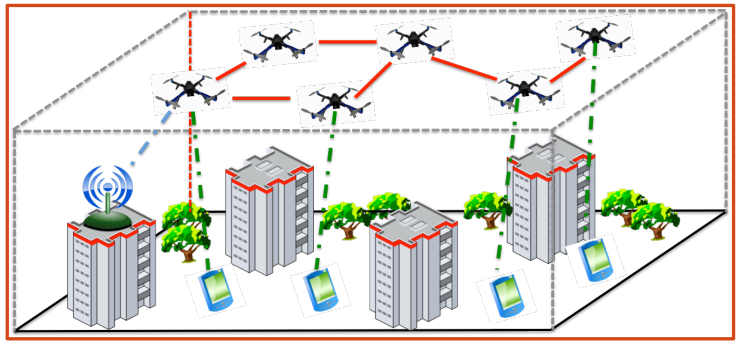
Internet of Things: Info generali

Lezioni	• **Martedì 15-18 (Aula Ercolani 1)** • **Venerdì 9-12 (Aula VII Piano, Dip. di Matematica)**
Esame	**Progetto di gruppo + Seminario**

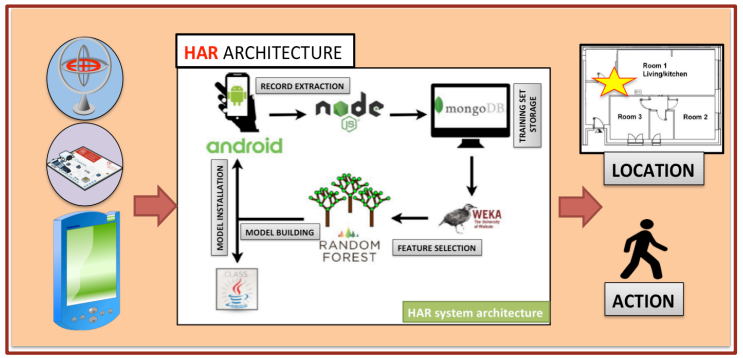
Internet of Things: Info generali



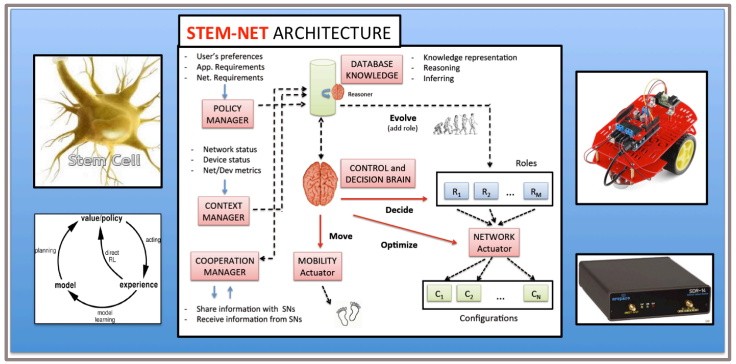
SENSOR NETWORKS AND THE IOT



ROBOTIC WIRELESS NETWORKS



CONTEXT-AWARE SYSTEMS

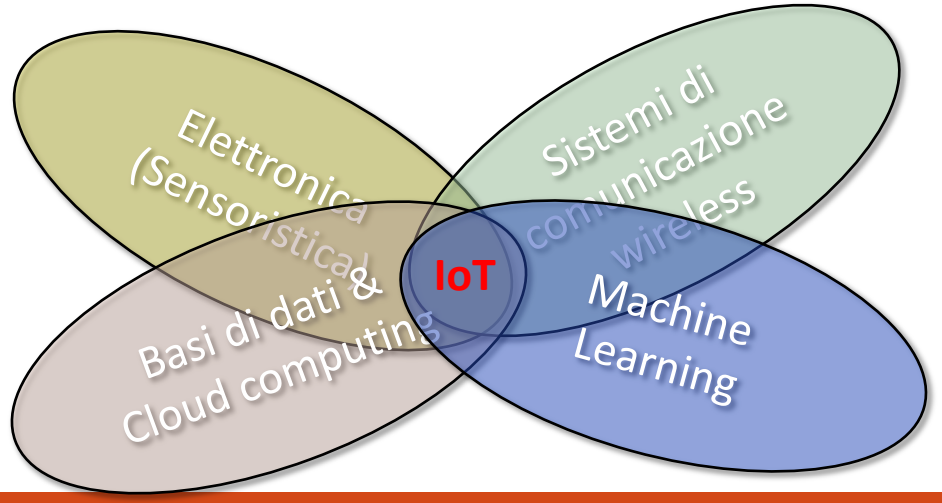


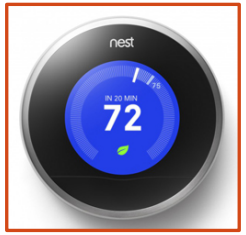
SELF-ORGANIZING NETWORKS

https://site.unibo.it/iot/

Internet of Things: di cosa si parla

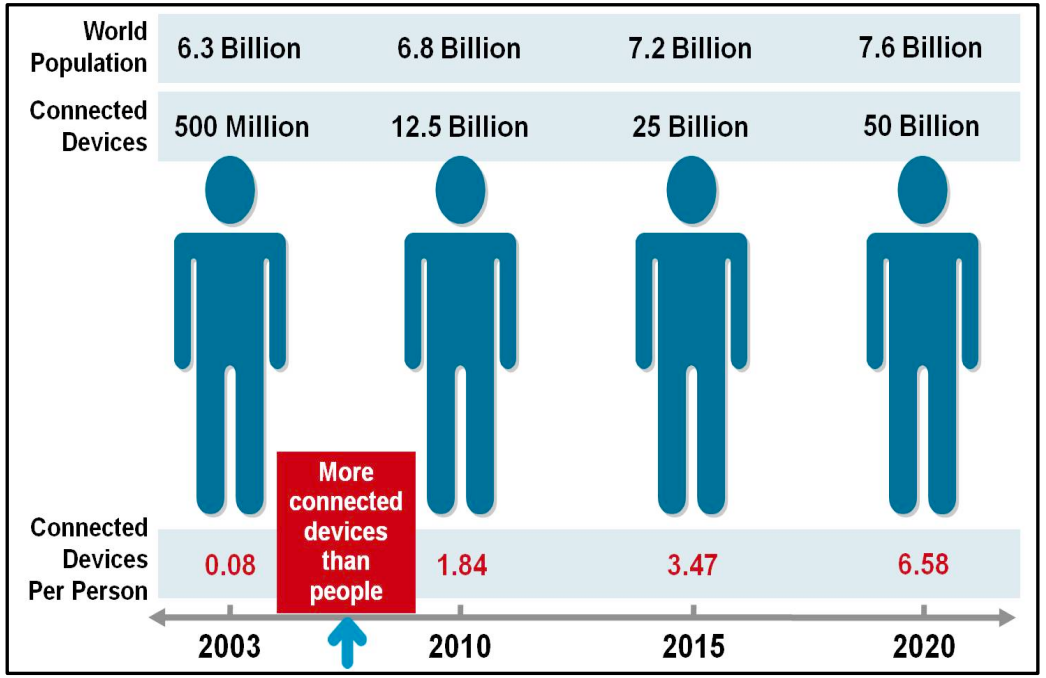
- Espressione della **pervasività** dell'ICT, integrata all'interno di oggetti
- Estensione del paradigma della connettività Internet
- Things → **Oggetti fisici**, dotati di nuove capacità di produrre dati digitali, di inviare dati verso una rete (Internet), di ricevere comandi dall'esterno …

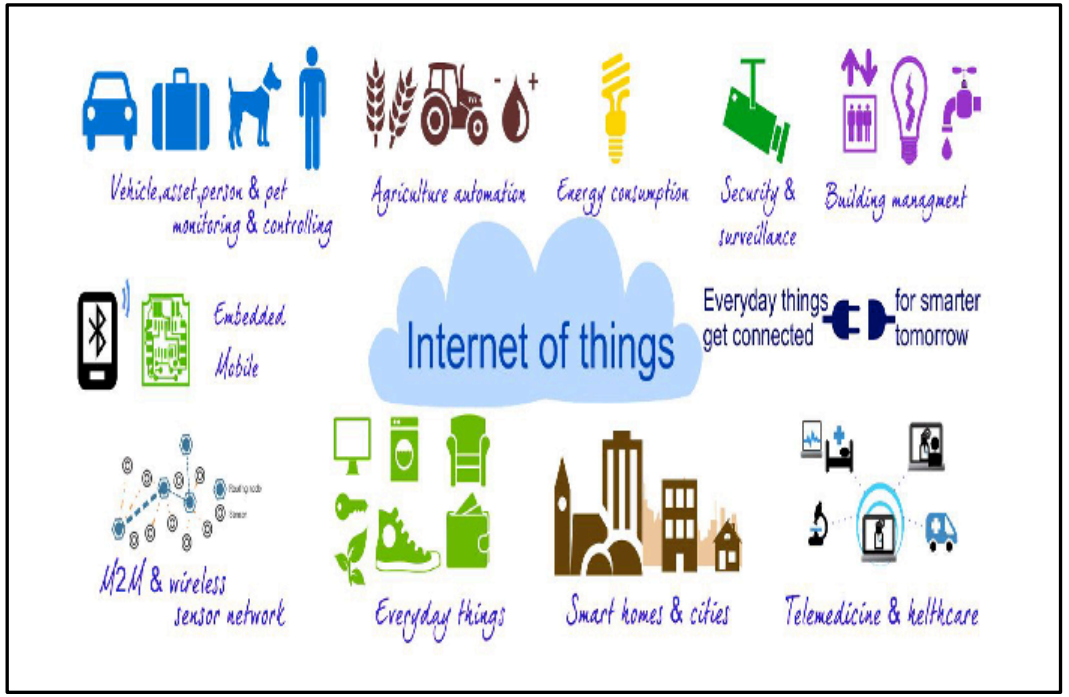




Internet of Things: a cosa serve

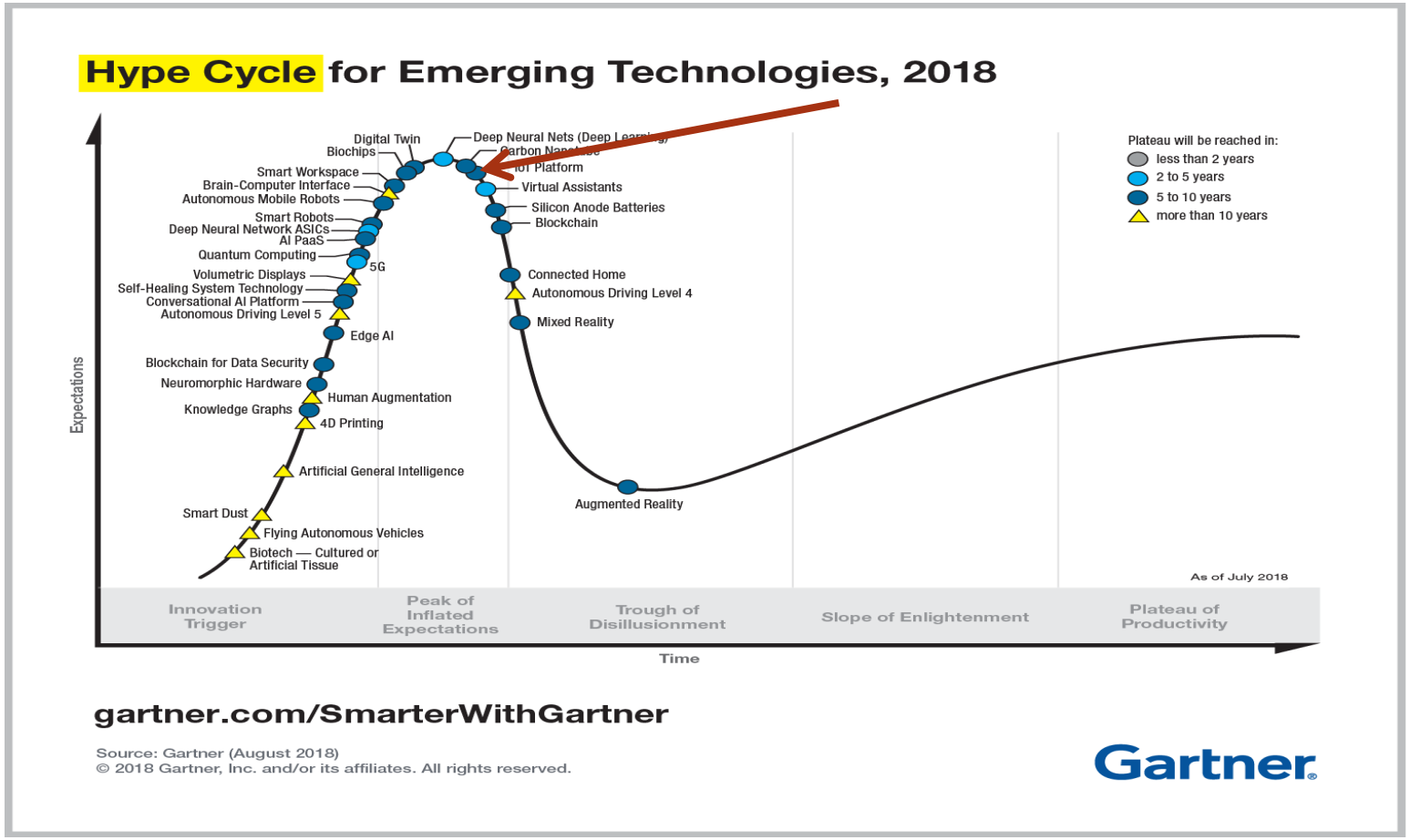
✧ Dall'Internet degli uomini, **all'Internet delle cose** …



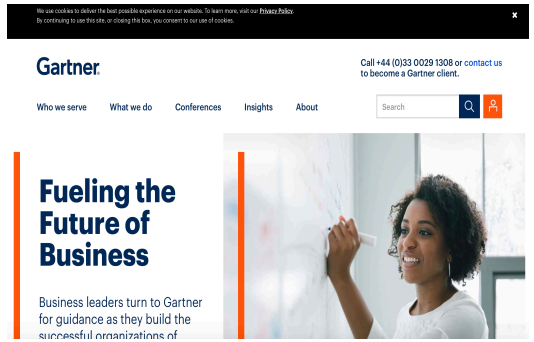


✧ **Un paradigma**, tantissime applicazioni …

IoT is … trendy

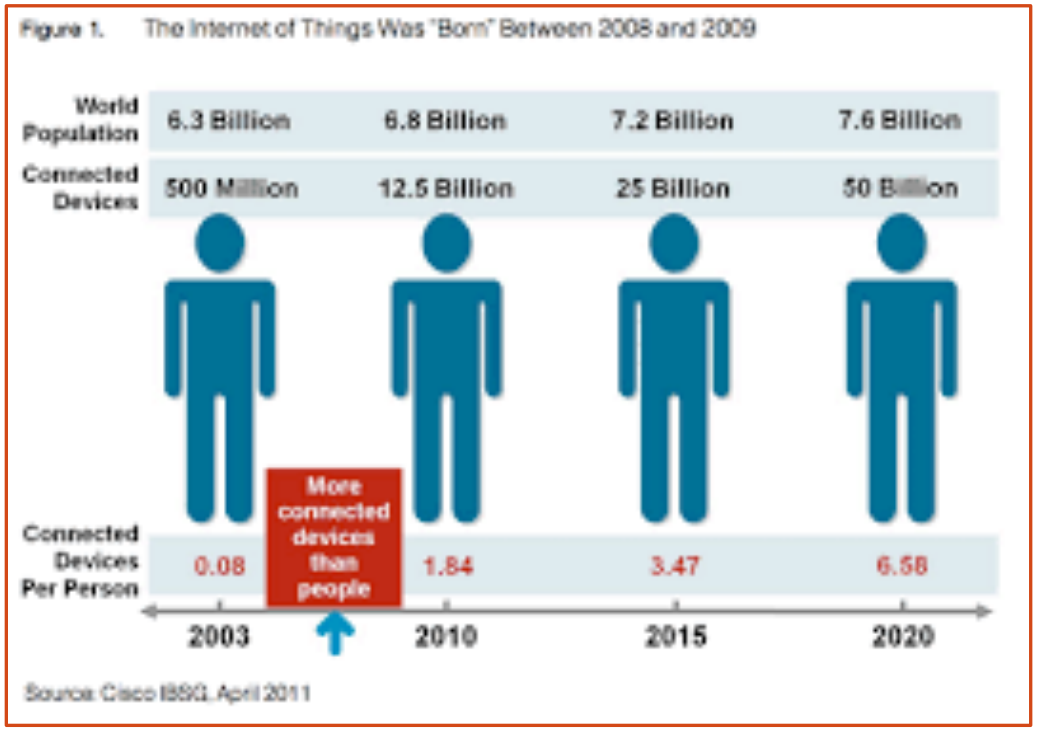


GARTNER HYPE CYCLE (2018)

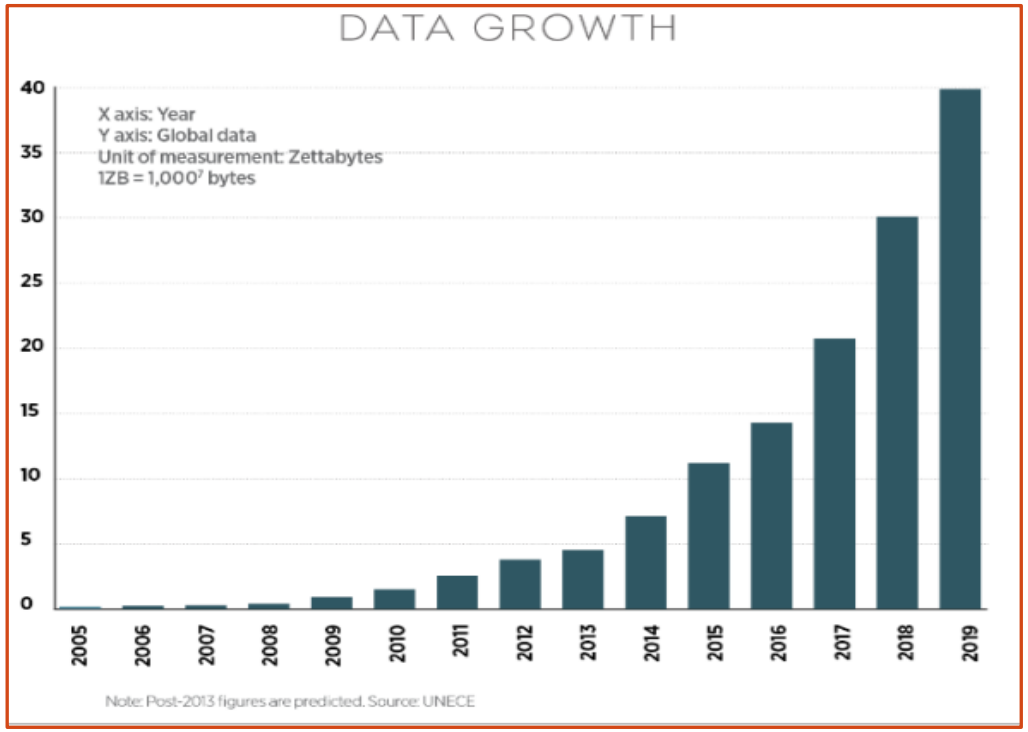


Source: https://www.gartner.com

IoT is … big

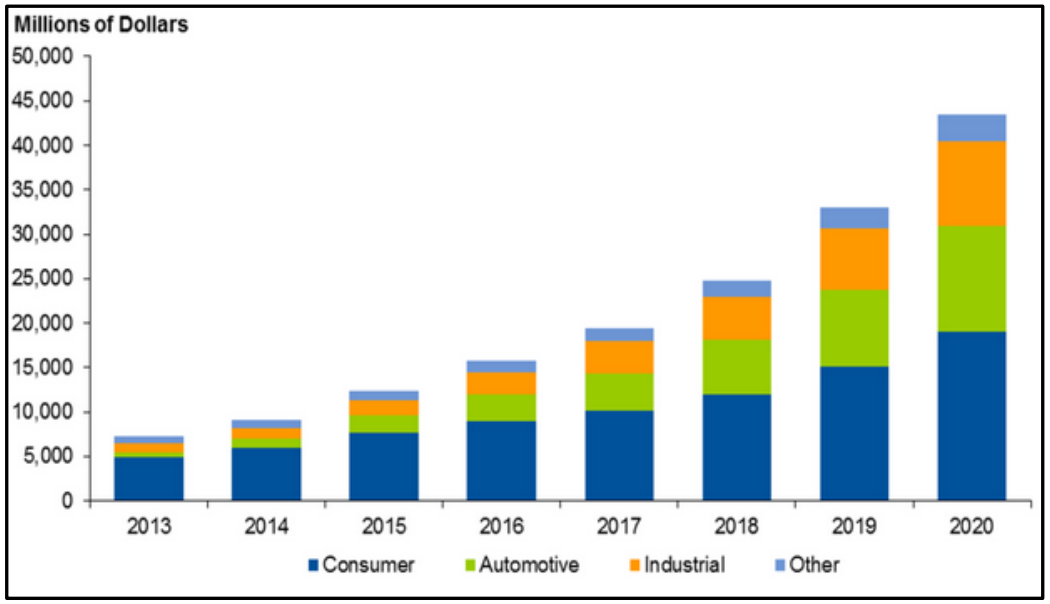


Source: CISCO, 2011

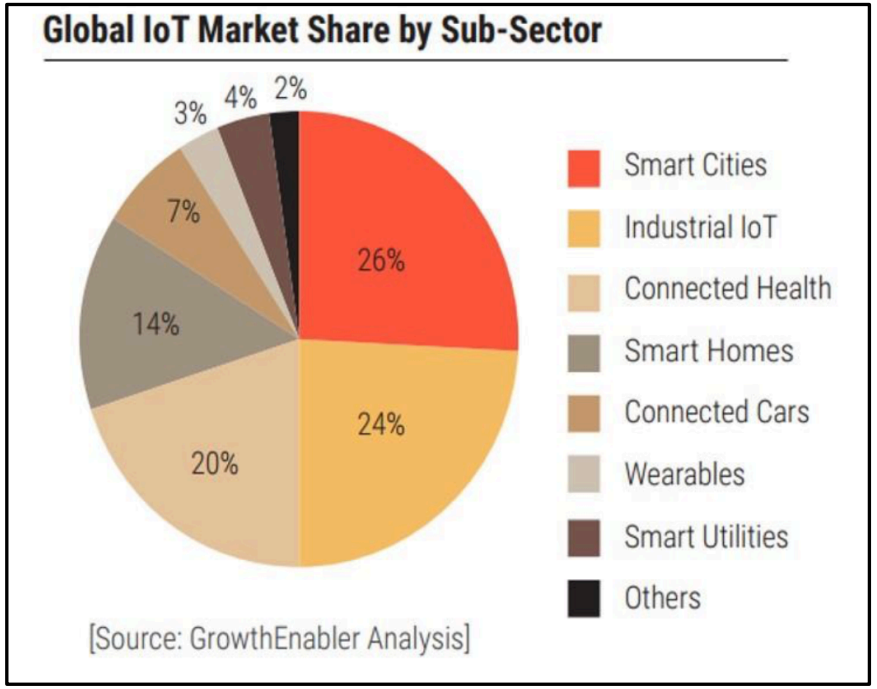


Source: https://www.sdintl.com/2018/04/30/big-data-friend-or-foe/

IoT is … profitable ($$$)



IoT Revenues worldwide, source: Gartner



https://www.forbes.com/sites/louiscolumbus/2017/12/10/2017-roundup-of-internet-of-things-forecasts/#7136007a1480

IoT is … multiperspective

IoT Analytics – *Quantifying the connected world* **Q1/2015**

Company	Ranking vs. Q4/14	Category	Overall rank[1]	Scores [2]	[3]	[4]	[5]
1 intel	+5	Semiconductor	72%	1k	2.6k	4k	616
2 Microsoft	+2	Software	69%	480	1.6k	26k	545
3 cisco	+2	Hardware	66%	1k	1.4k	5k	719
4 Google	-3	Several	59%	390	3.1k	21k	99
5 IBM	-3	Software	55%	720	1.5k	7k	504
6 SAMSUNG	+3	Consumer prod.	34%	590	1.6k	5k	29
7 Apple	-4	Consumer prod.	31%	170	1.3k	15k	37
8 SAP	0	Software	26%	320	0.4k	5k	260
9 Gartner	-2	Market research	24%	390	1.2k	3k	40
10 ORACLE	0	Software	22%	170	0.3k	6k	277
11 ARM	+3	Semiconductor	20%	90	1.0k	9k	57
12 GE	0	Ind. equipment	19%	70	0.4k	3k	319
13 accenture	+11	Consulting	17%	170	0.4k	<1k	249
14 amazon.com	-3	Software	15%	110	0.4k	7k	67
15 HEWLETT PACKARD	+3	Software	15%	90	0.1k	7k	151
16 ARDUINO	-3	Hardware	15%	390	0.5k	<1k	-
17 IDC	-2	Market research	15%	210	0.4k	5k	30
18 BlackBerry	new	Software	13%	210	0.3k	4k	25
19 PTC	+10	Software	12%	110	0.6k	<1k	123
20 verizon	-2	M2M	11%	70	0.2k	6k	51

1. The highest ranking company in each aspect received a rating of 100%, with all other receiving a lower percentage in linear relation to the actual frequency. The overall result is the average of all four categories 2. Searches on Google in conjunction with IoT. 3. Tweets on Twitter in conjunction with IoT 4. Newspaper and blog mentions in conjunction with IoT 5. Number of employees that carry the tag "Internet of Things" on Linkedin. All numbers valid for Dec 2014 to Feb 2015. Sources: Google, Twitter, LinkedIn, Company websites, IoT Analytics

ICT COMPANIES

NON- ICT INDUSTRIES

ROME

Maker Faire®

THE EUROPEAN EDITION

DIGITAL **MAKERS**

RESEARCH

IoT is … multiperspective

EXAMPLE: Video-surveillance applications

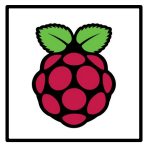
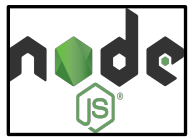
GOOGLE NEST CAMERA
https://store.google.com/product/nest_cam

ICT PERSPECTIVE

RESEARCH




EFFICIENT OBJECT DETECTION USING DRONE CAMERAS

DIGITAL **MAKING**

IoT is … chaotic

Table 2
Capillary IoT technologies. Some of the data were cross-checked with [87].

Name	Spectrum	Bandwidth	Peak DR	Range	Topology	PHY Modulation	MAC Access
BLE	2.4 GHz	2 MHz	1 Mbps	100 m	Star	GFSK (FHSS)	TDMA
Thread 6LowPAN	2.4 GHz	5 MHz	250 kbps	10–75 m	Mesh	OQPSK (DSSS)	CSMA/CA
ZigBee	2.4 GHz	2 MHz	250 kbps	10–75 m	All	OQPSK (DSSS)	S-CSMA/CA
ZigBee	915 MHz	1.2 MHz	40 kbps	10–75 m	All	BPSK (DSSS)	S-CSMA/CA
ZigBee	868 MHz	600 kHz	20 kbps	10–75 m	All	BPSK (DSSS)	S-CSMA/CA
WirelessHART	2.4 GHz	3 MHz	250 kbps	30–90 m	Mesh	OQPSK (DSSS)	TDMA
ISA 100.11a	2.4 GHz	5 MHz	250 kbps	30–90 m	Mesh	OQPSK (DSSS)	TDMA
Z-Wave	868/908 MHz	200 kHz	9.6–40 kbps	30–100 m	Mesh	FSK	TDMA
Z-Wave 400	2.4 GHz	–	200 kbps	30–100 m	Mesh	FSK	TDMA
INSTEON	908 MHz	–	38.4 kbps	45 m	Mesh	FSK	TDMA
EnOcean	868/315 MHz	62.5 kHz	125 kbps	30 m	Mesh	ASK, FSK	TDMA
D7AP Hi-Rate	433/868/915 MHz	200 KHz	166.67 kbps	10 m	Tree	GFSK	CSMA/CA
D7AP	433/868/915 MHz	200 KHz	55.55 kbps	100 m	Tree	GFSK	CSMA/CA
DECT ULE	1.8/1.9 GHz	1.728 MHz	1152 kbps	70–300 m	Star	GFSK	TDMA

Table 3
LPWAN technologies operating in unlicensed bands. Some of the data were cross-checked with [87].

Name	Spectrum	Bandwidth	Peak DR UL	Peak DR DL	Range	PHY Modulation	MAC Access
D7AP Lo-Rate	433/868/915 MHz	25 kHz	9.6 kbps	9.6 kbps	~5 km	GFSK	CSMA/CA
SigFox	868–915 MHz	192 kHz	~100 bps	~100 bps	>20 km	GFSK/DBPSK (UNB)	ALOHA
Ingenu MN	2.4 GHz	1 MHz	~30 kbps	~30 kbps	~15 km	FSK, PSK (DSSS)	RPMA
LoRa	868–915 MHz	125 kHz	~50 kbps	~50 kbps	~11 km	CSS	ALOHA
Weightless-N	868 MHz	200 Hz (?)	~100 kbps	–	~5 km	DBPSK (UNB)	S-ALOHA
Weightless-P	868 MHz	12.5 kHz	~100 kbps	100 kbps	~2 km	GMSK, OQPSK (UNB)	FDMA,TDMA
Weightless-W	470–790 MHz	6-8 MHz	~10 Mbps	~10 Mbps	~10 km	DBPSK/QPSK /16-QAM (DSSS)	FDMA,TDMA

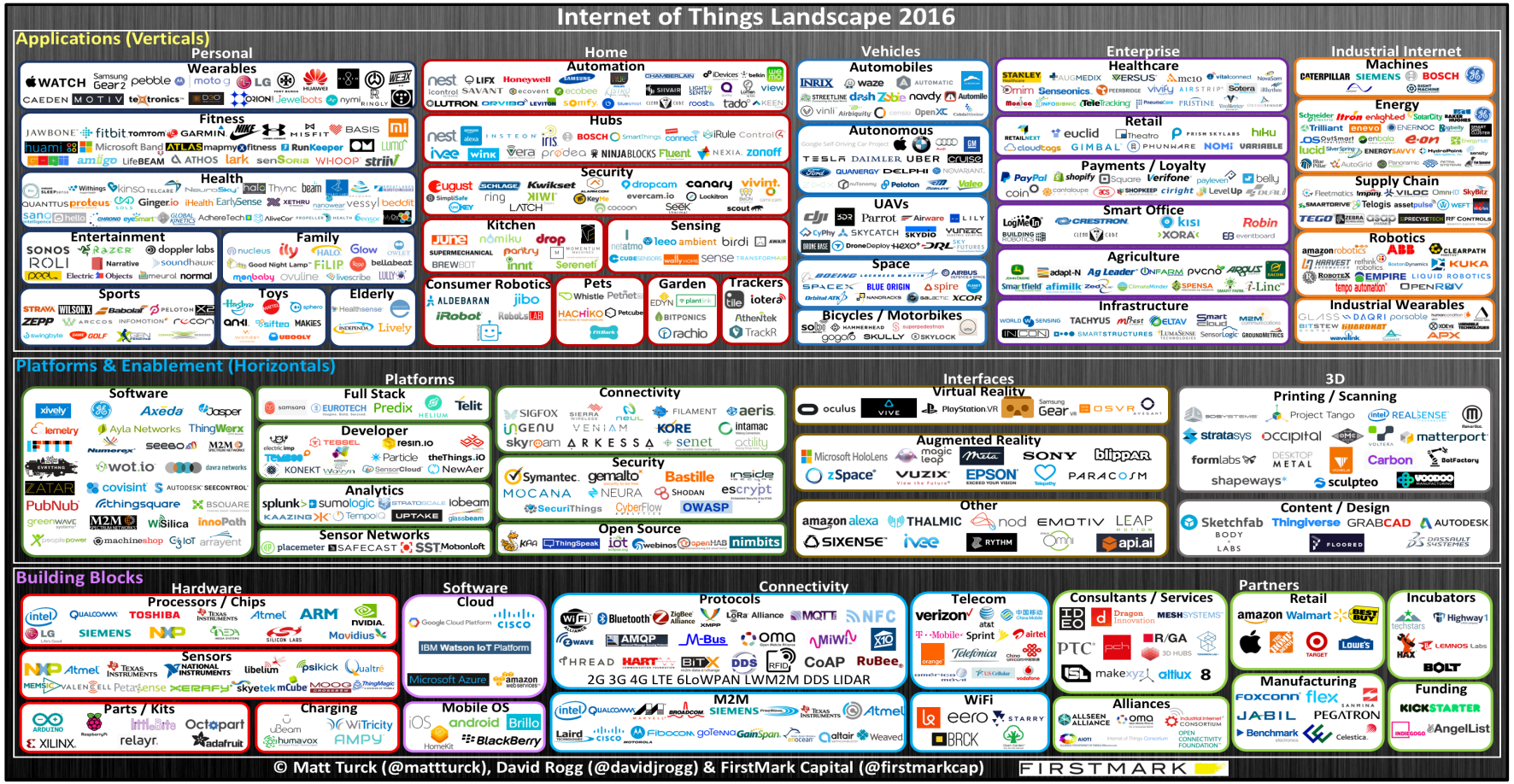
Table 4
Cellular IoT technologies operating in licensed bands. Some of the data were cross-checked with [87].

Name	Spectrum	Bandwidth	Peak DR UL	Peak DR DL	Range	Modulation	Access
EC-GSM	700–900 MHz	200 kHz	~10 kbps	~10 kbps	~15 km	GMSK	TDMA
LTE-M	700–900 MHz	1.4 MHz	~1 Mbps	~1 Mbps	~11 km	QPSK, 16-QAM, 64-QAM	OFDMA
NB-LTE-M	700–900 MHz	200 kHz	~144 kbps	~200 kbps	~15 km	QPSK, 16-QAM, 64-QAM	OFDMA
NB-CIoT	800–900 MHz	180 kHz	~36 kbps	~45 kbps	~15 km	BPSK, QPSK, 16-QAM	OFDMA

Main **wireless communication technologies** on the market, used to enable Machine-to-Machine communication on IoT scenarios

F. Montori, L. Bedogni, M. Di Felice, L. Bononi, Machine-to-Machine Wireless Communication Technologies for the Internet of Things: Taxonomy, Comparison and Open Issues, Pervasive and Mobile Computing (Elsevier), 2018.

IoT is … chaotic



POPULAR IOT PLATFORMS
https://iotify.io/top-10-selection-criteria-for-your-iot-cloud-platform/

IoT is … ???

"A global network infrastructure, linking physical and virtual objects through the exploitation of data capture and communication capabilities. This infrastructure includes existing and evolving Internet and network developments. It will offer specific object-identification, sensor and connection capability as the basis for the development of independent cooperative services and applications. These will be characterised by a high degree of autonomous data capture, event transfer, network connectivity and interoperability."

By CASAGRAS

RFID and the Inclusive Model for the Internet of Things

Internet of Things: An Integral Part of the Future Internet

By Stephen Haller, SAP Research

"A world where physical objects are seamlessly integrated into the information network, and where the physical objects can become active participants in business processes. Services are available to interact with these 'smart objects' over the Internet, query and change their state and any information associated with them, taking into account security and privacy issues."

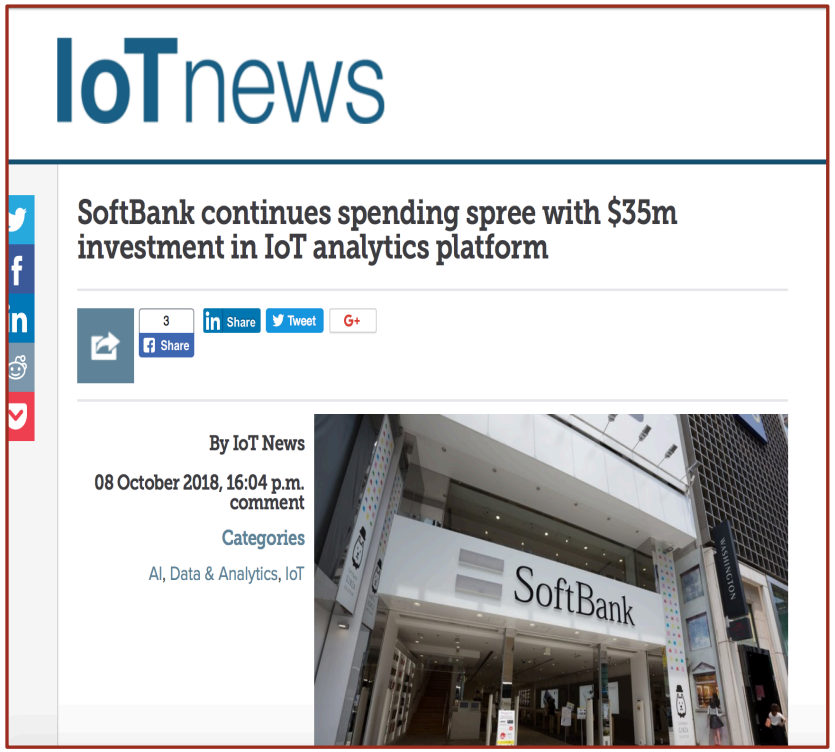
Vision and Challenges for Realising the Internet of Things

CERP-IoT Edited by Harald Sundmaeker Patrick Guillemin Peter Friess and Sylvie Woelfflé

The Internet of Things links the objects of the real world with the virtual world, thus enabling anytime, any place connectivity for anything and not only for anyone. It refers to a world where physical objects and beings, as well as virtual data and environments, all interact with each other in the same space and time.

More than 20 IoT definitions at:
https://www.postscapes.com/internet-of-things-definition/

IoT is … ???


IoTnews

SoftBank continues spending spree with $35m investment in IoT analytics platform

By IoT News

08 October 2018, 16:04 p.m. comment

Categories

AI, Data & Analytics, IoT

https://www.iottechnews.com/news/2018/oct/08/softbank-continues-spending-spree-35m-investment-iot-analytics-platform/


IoTnews

For oil and gas, patience is key to begin implementing IoT – but the pace needs to increase after

By James Bourne

23 October 2018, 16:04 p.m. comment

Categories

AI, Data & Analytics, Enterprise, IIoT, Oil & Gas

https://www.iottechnews.com/news/2018/oct/23/oil-and-gas-patience-key-begin-implementing-iot-pace-needs-increase-after/


IoTnews

Blue Vision Labs becomes Lyft's UK hub for driverless cars

By Ryan Daws

25 October 2018, 15:03 p.m. comment

Categories

Connected Cars, IoT, Smart Cities

Lyft has acquired London-based Blue Vision Labs to become the

https://www.iottechnews.com/news/2018/oct/25/blue-vision-labs-lyft-uk-driverless-cars/

Internet of Things: argomenti del corso

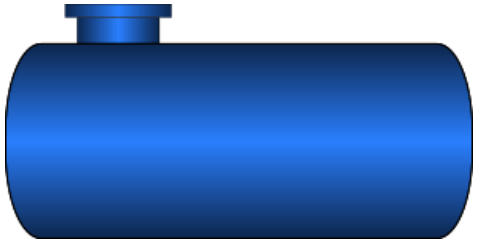
- OBIETTIVO: Apprendere **fondamenti architetturali** e **metodologici** alla base del nuovo paradigma dell'Internet of Things.
  - Nuove **applicazioni** e casi d'uso
  - Nuove **tecnologie** di:
    - Comunicazione wireless (dagli oggetti alla rete)

      [IEEE 802.15.4, LoRA, Dash7, Spirit, Z-Wave, …]
    - Protocolli di networking

      [6LoWPAN, MQTT, CoAP, AMQP…]
    - Data storage, management & analytics
  - Nuovi **dispositivi**, **linguaggi di programmazione** & **frameworks**

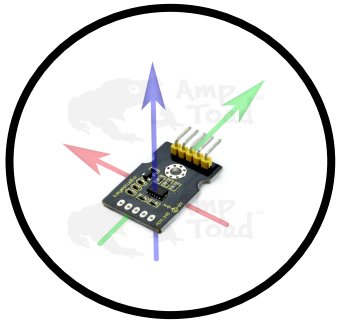
    [Boards (Arduino, Nucleo STM32, ESP8266), Cloud technologies (AWS IoT, ThingSpeak), etc]
  - Nuove **sfide di ricerca** (sicurezza, privacy, efficienza energetica, etc)

Internet of Things: programma del corso

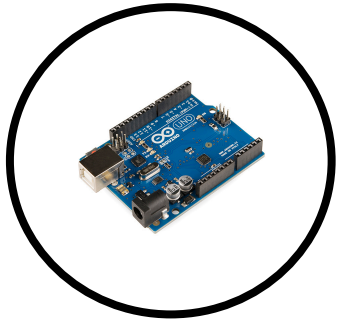


Esempio: **Monitoraggio Impianti**

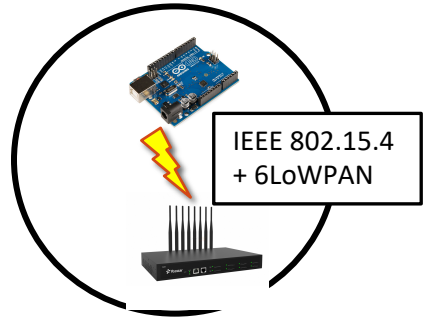
IL CAMMINO DEI DATI



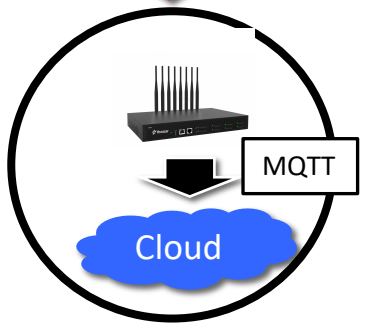
1. **DATA** generation



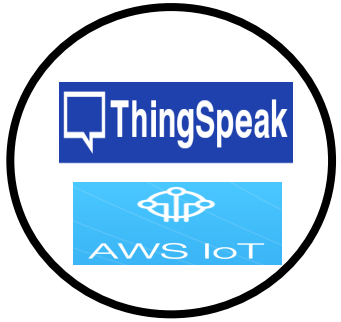
2. **DATA** processing



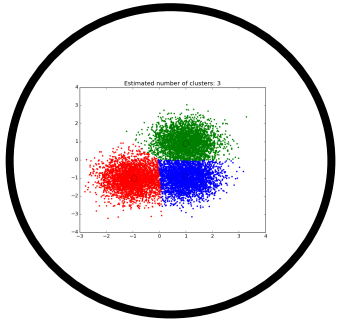
3. **DATA** communication
(sensor → gateway)



4. **DATA communication**
(gateway → cloud)



5. **DATA** storage

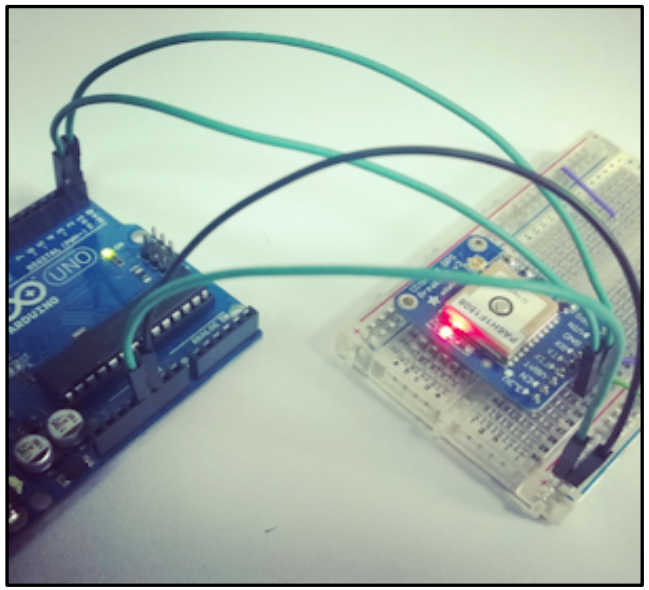


6. **DATA** analytics

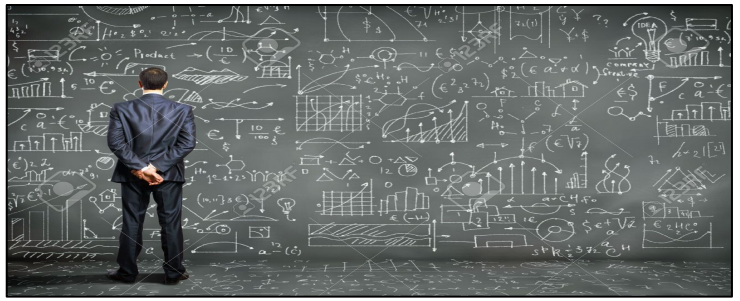
7. **SOFTWARE** deployment

Internet of Things: metodi del corso

LEZIONI FRONTALI



DEMO ED ESERCITAZIONI LIVE



ESAME: IL SEMINARIO (argomento a scelta)

ESAME: IL PROGETTO (spazio alla creatività)

Internet of Things: metodi del corso

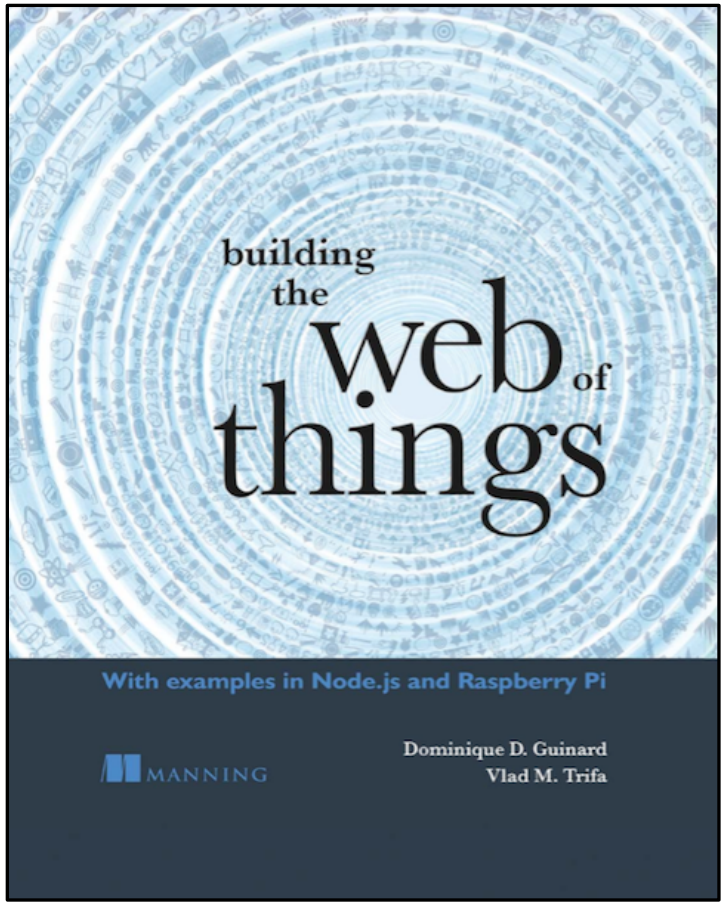
Via Ranzani, 14

DIGITAL COSANDO LAB

- Board (Arduino, Fishino, NodeMCU, Nucleo STM, Galileo, Raspberry PI …)
- Kit di Sensori
- Kit di prototipazione
- Rover mobili
- Stampante 3D + Fresa
- ….

Accesso libero a tutti gli studenti del corso previa registrazione

Internet of Things: metodi del corso



D. Guinard, V. Trifa
Building the Web of Things
MANNING Editions, 2016

Internet of Things: what's next

- ✧ Tesi di ricerca in contesti di progetti di rilevanza nazionale/internazionale (H2020 SWAMP, BRIC 2018 MAC4PRO, ALMAIdea BeeDrones)
- ✧ Tirocini presso aziende che operano nel settore dell'Industry 4.0
- ✧ Collaborazioni con gruppi di ricerca internazionali (USA, Francia, Svezia)

International PhD Program in Structural and Environmental Health Monitoring and Management (SEHM2)
https://phd.unibo.it/sehm2/en