IOT: INTERNET OF THINGS

Carles Mateu

GREiA Research Group
Universitat de Lleida

Esquema

Introduction

The Real IoT

Why IoT?

How

Issues

Introduction

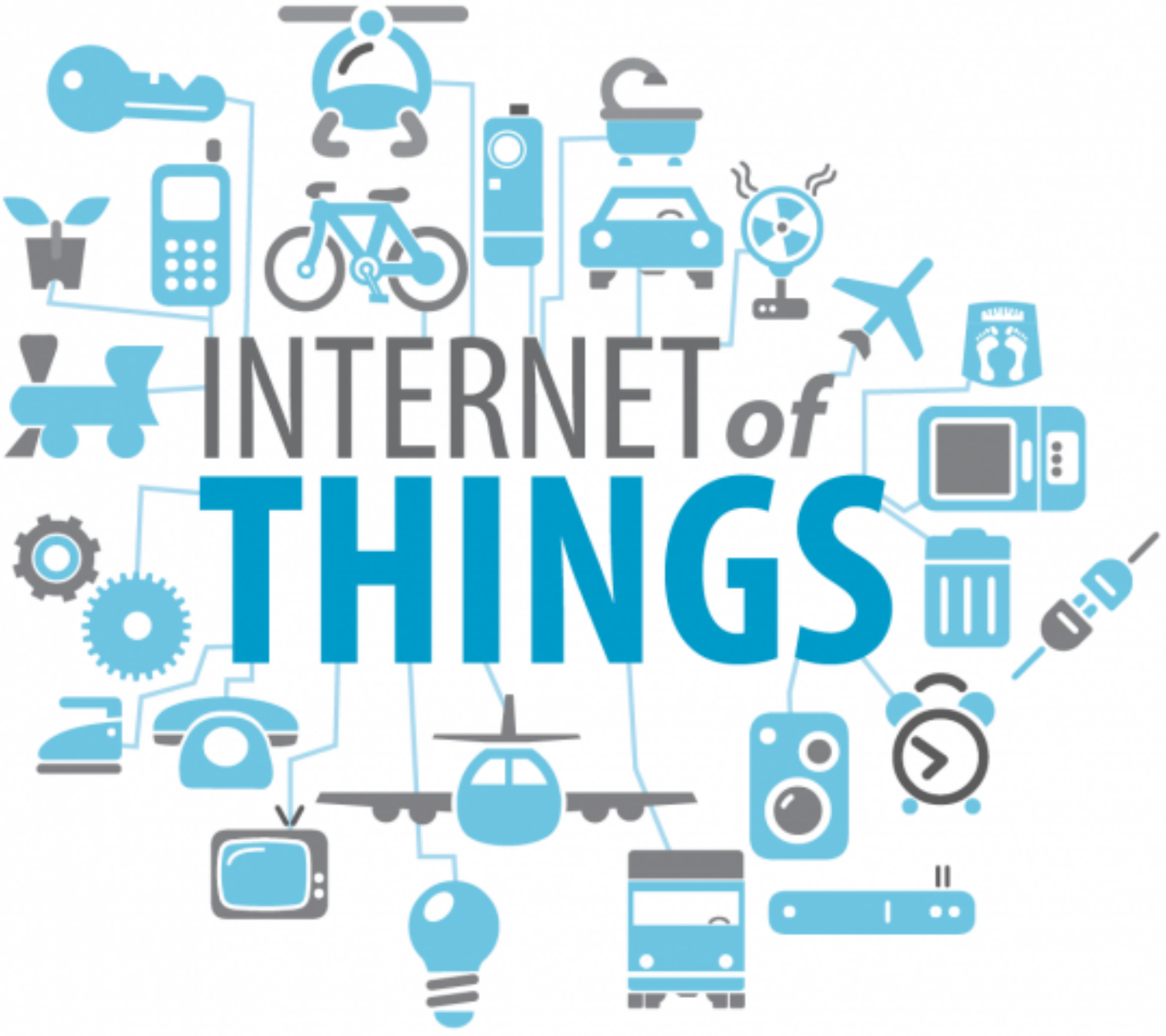
What is IoT?

The Internet of Things, IoT, is a network of physical objects that allows a great deal of machine-2-machine intercommunications and interchange of information.

That communications allow both:

- Device to network information flow: sensor networks.
- Network to device information flow: control networks.

What is IoT?



What is IoT?

Things?

The kind of things we can connect range from: small biosensors (pacemakers, implanted biochips, etc.) to big physical devices (cars, planes, etc.) and even embedded sensors in industrial compounds.

What will IoT be?

IoT will be the first layer of a cyber-physical connected smart world (or something like that)

The main idea is that ”Things” will have a processor and connectivity electronics that will allow that ”Thing” to send data to other things and to the ”Cloud” and will receive commands from other ”Things” or from the network.

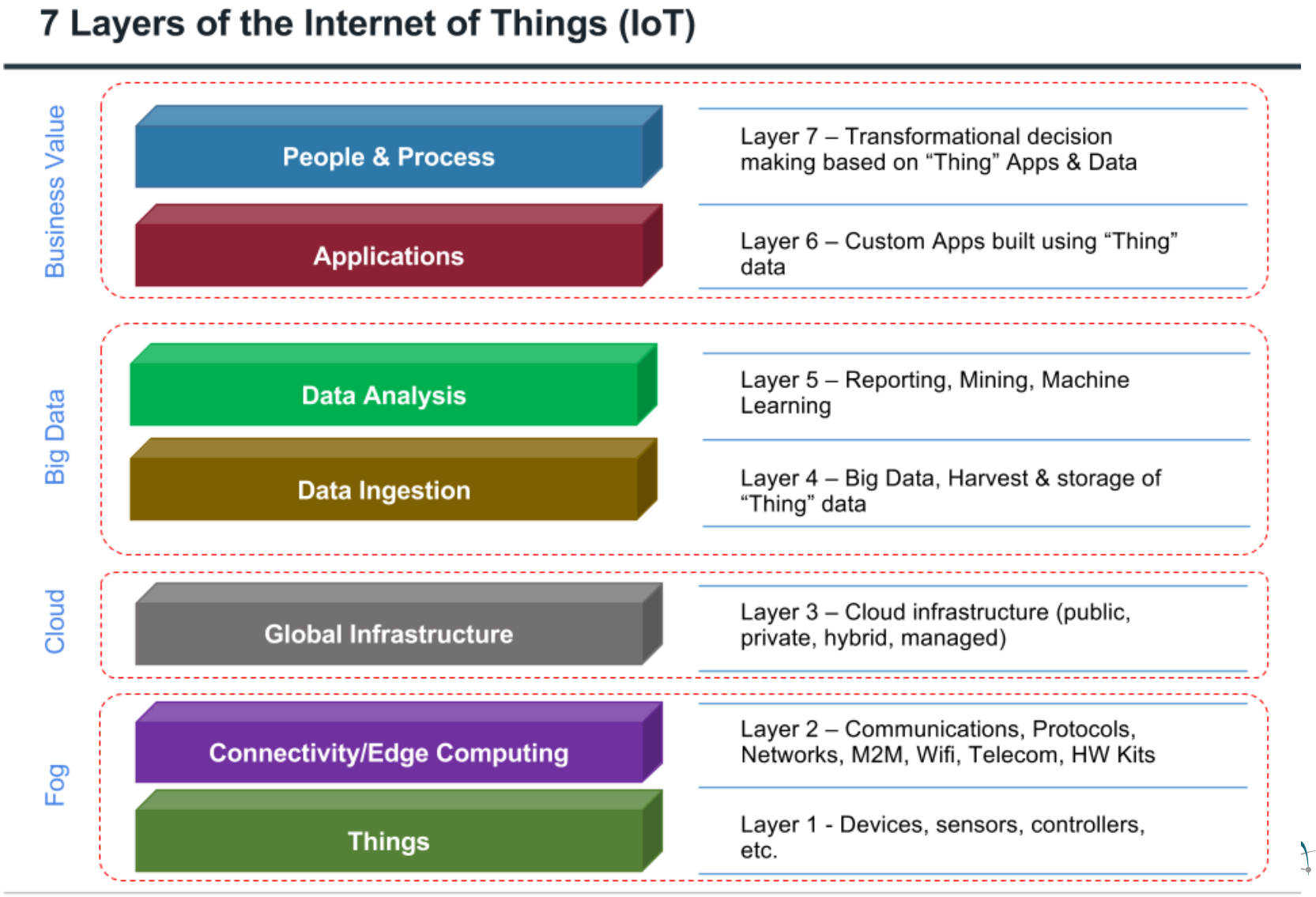
The Real IoT

The size of the IoT

Our main interest (BigData!) on the Internet of Things is on its estimated size: by 2020 it was estimated that more than 50.000.000.000 (50 billion) devices would be connected (Cisco estimate on 2011, probably more)[1].

That means: a lot of data!!!

The 7 Layers of IoT



What is a "Thing"

The 'Thing'

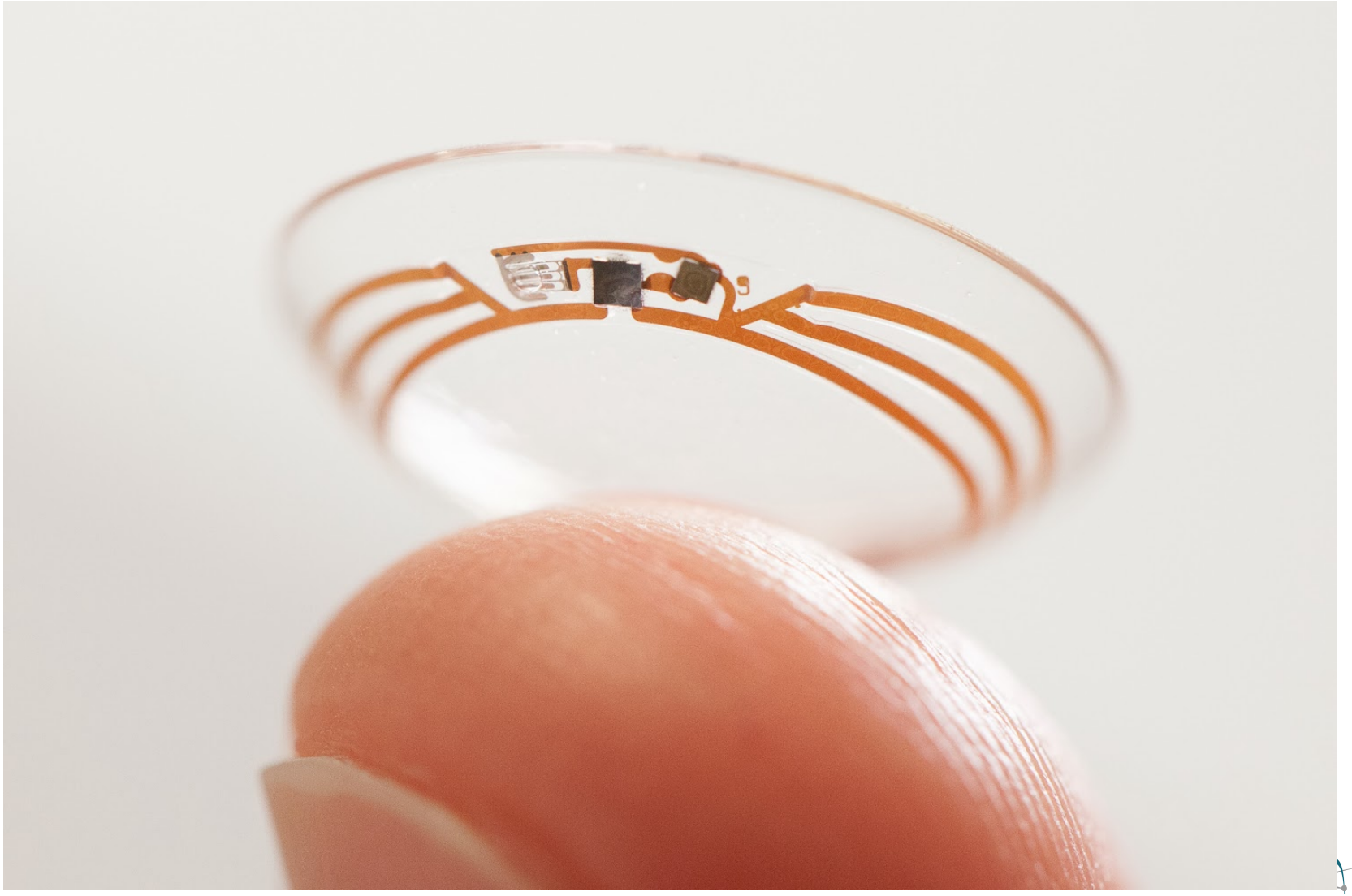
The 'Thing' in the IoT is any physical entity capable of connectivity that directly interfaces the physical world, such as embedded devices, sensors and actuators.
... an inextricable mixture of hardware, software, data and service... [2]

Small things

There is a staggering world of possibilities to add "internet" to small daily devices:

- Health implants: pacemakers, smart contact lenses, ... nano scale blood sensors.
- Biotransponders: farming, smart agriculture, greenhouses, ... auto-farming.
- Smart home: Thermostats, window blinds, humidity sensors, ... personal home butlers.
- Automobiles: speed, position, fuel usage, battery, ... auto drivers.

Google Contact Lenses



Google Contact Lenses

Google[x] (former name of Google's secret lab, now its X) developed some contact lenses that could read, from tears, the glucose levels on the blood.

And if those levels reach a too high level, the idea is to alert the user. Those devices can do a measure per second.

The device uses RFID [BAN] communications (and gets its power from RFID).

Precision Livestock Farming

By implanting on all animals an EID (RFID/NFC), and by deploying a connected network of readers throughout the explotation, movement, status, and behaviour can be modeled on real-time.

Smarthome

Nest

Nest Labs is a home automation producer of programmable, self-learning, sensor-driven, Wi-Fi-enabled thermostats, smoke detectors, and other security systems. It introduced the Nest Learning Thermostat in 2011 as its first product. The Nest Protect smoke and carbon monoxide detector was then introduced in October 2013. After the acquisition of Dropcam, the rebranded Nest Cam was introduced in June 2015.

Automobiles

By Michael Shick - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=44405988

Connected /autonomous car

Connected car: A transport system that enables:

- inter and intra vehicular communication
- smart traffic control
- smart parking
- electronic toll collection systems
- logistic and fleet management
- vehicle control
- and safety and road assistance.

Connected /autonomous car

Autonomous car: A connected car that:

- is capable of sensing its environment.
- is able to navigate without human input.

Lots of vehicles are, progressively, adding different levels of autonomous driving: from cruise control, to autonomous parking, to fully automated driving.

And BigData?

Obviously, with so many devices, collecting those huge amounts of data, we do really have

BIGDATA

Special care/technologies should be developed/deployed to collect that data, transfer it, process it, etc.

Why IoT?

Why IoT NOW?

Some enabling technologies have only appeared recently that have been key to the rise of the Internet of Things:

- RFID and NFC, especially it's inclusion on smartphones (even QR codes).
- BLE, standardized on most smartphones.
- Embedded SoC with low energy IP networks (low power WiFi, etc.)
- ZigBee and Z-Wave
- LTE-A, improved LTE with more throughput and lower latency on wider coverage.
- WiFi Direct, LoFi, Li-Fi, etc.
- Cheap ($<$2US\$) SoC μControllers (arduino-like)
- Cheap ($<$50US\$) SoC μProcessors (RaspberryPi-like)

Why IoT NOW?

Some enabling technologies have only appeared recently that have been key to the rise of the Internet of Things:

- Cloud computing: private and public low cost clouds, docker, etc.
- ”BigData”: stream processors, hadoop, mapreduce, etc
- Deep learning and machine learning.
- Rapid Web Application development.
- Mobile Apps.
- Permanent connection.

How

Connectivity

”Normal” network technologies are:

- Hardware level: Ethernet family, 802.11, 802.15.1/Bluetooth
- Network level: IPv4
- Transport level: TCP/UDP
- Application level: SMTP, HTTP

None of those technologies is designed with the IoT in mind, and many of them have serious issues when it comes to the IoT.

Connectivity

"Normal" network technologies are:

- Hardware level: Ethernet family, 802.11, 802.15.1/Bluetooth, BLE, LoFi, Li-Fi, Passive WiFi, ZigBee, RFID/NFC.
- Network level: IPv4, IPv6, 6LowPAN.
- Transport level: TCP/UDP, PGM, STP, RTP.
- Application level: SMTP, HTTP, XMPP, Constrained Application Protocol (CoAP), MQTT, ZeroMQ.

Most of those technologies will allow fogging and thus the IoT.

Networks

Range of coverage

- BAN (body area network): Ambient hearing aides, smart wear, Google Glasses
- PAN (personal area network): bluetooth lights, speakers
- LAN (local area network): smart meters, smart homes
- WAN (wide area network): Telematics, Connected Car
- VWAN (very wide area network): Smart city.

Networks

Range of coverage

- BAN (body area network): Ambient hearing aides, smart wear, Google Glasses
- PAN (personal area network): bluetooth lights, speakers
- LAN (local area network): smart meters, smart homes
- WAN (wide area network): Telematics, Connected Car
- VWAN (very wide area network): Smart city.

Networks

Range of coverage

- BAN (body area network): Ambient hearing aides, smart wear, Google Glasses
- PAN (personal area network): bluetooth lights, speakers
- LAN (local area network): smart meters, smart homes
- WAN (wide area network): Telematics, Connected Car
- VWAN (very wide area network): Smart city.

Cloud computing

Cloud computing is a key enabling technology on IoT

- 24x7 connected processing nodes allow for quick data gathering.
- Dynamically scalable clouds allow for easy load change responses.
- New toolsets allow for quick (instantaneous) cloud deployment: docker-compose.
- Cheap hardware (MIPS per US$) allows the creation of private clouds.

Data Ingestion/Analysis

Internet-wide companies, with milions of users, have led the development of scalable powerful data processing tools:

- Hadoop as a framework for distributed processing of large data sets.
- Map Reduce as a paradigm for parallel/distributed computations on large data sets.
- Spark as a computation engine on Hadoop for ETL, Machine Learning, graph computation, etc.
- Real time distributed processors: Storm.
- Stream processors (kafka+samza)

Issues

Issues with the IoT

There are two main (related) issues:

SECURITY and PRIVACY

There are two main (related) issues:

SECURITY and PRIVACY

References i

D. Evans.
The internet of things: How the next evolution of the internet is changing everything.
Cisco White Paper, 2011.

G. Noto La Diega and I. Walden.
Contracting for the 'internet of things': Looking into the nest.
Queen Mary School of Law Legal Studies Research Paper, 219, 2016.