Introduction à l'IoT

CPE LYON LIVE AND DISCOVER

Aujourd'hui

- Vue globale du module
- Histoire
- Définitions
- Domaines d'applications
- Caractéristiques et composants
- Protocoles d'acquisition des données
- TP No. 1 : Prise en main d'un micro-contrôleur

Compétences

- Maîtriser les concepts fondamentaux de l'IoT
- Analyser et comparer protocoles d'acquisition des données
- Analyser et comparer plusieurs types de liaison sans fils
- Obtenir données depuis un terminal mobile
- Comprendre les protocoles d'envoie de données vers le cloud
- Mise en place chaîne IoT

Programme

04/09	04/09	Cours: Intro IoT	TP1
05/09	06/09	TP2	
09/09	12/09	Cours: Protocoles réseaux	TP3
03/10	30/09	Cours: Capteurs mobiles (Android)	TD1
04/10	14/10	TP4	
18/10	17/10	Mini-Projet	
14/11	04/11		
28/11		Soutenance	

Evaluation

- Examen machine QCM - 15/11/2019 : 30%
- Mini-projet (4)
  - 8 heures
  - Soutenance 10min - 28/11/2019
  - 70%

Intervenants

- Oscar Carrillo
- Anthony Chomienne
- Nicolas Stouls

Un peu d’histoire…

Un regard à l'histoire

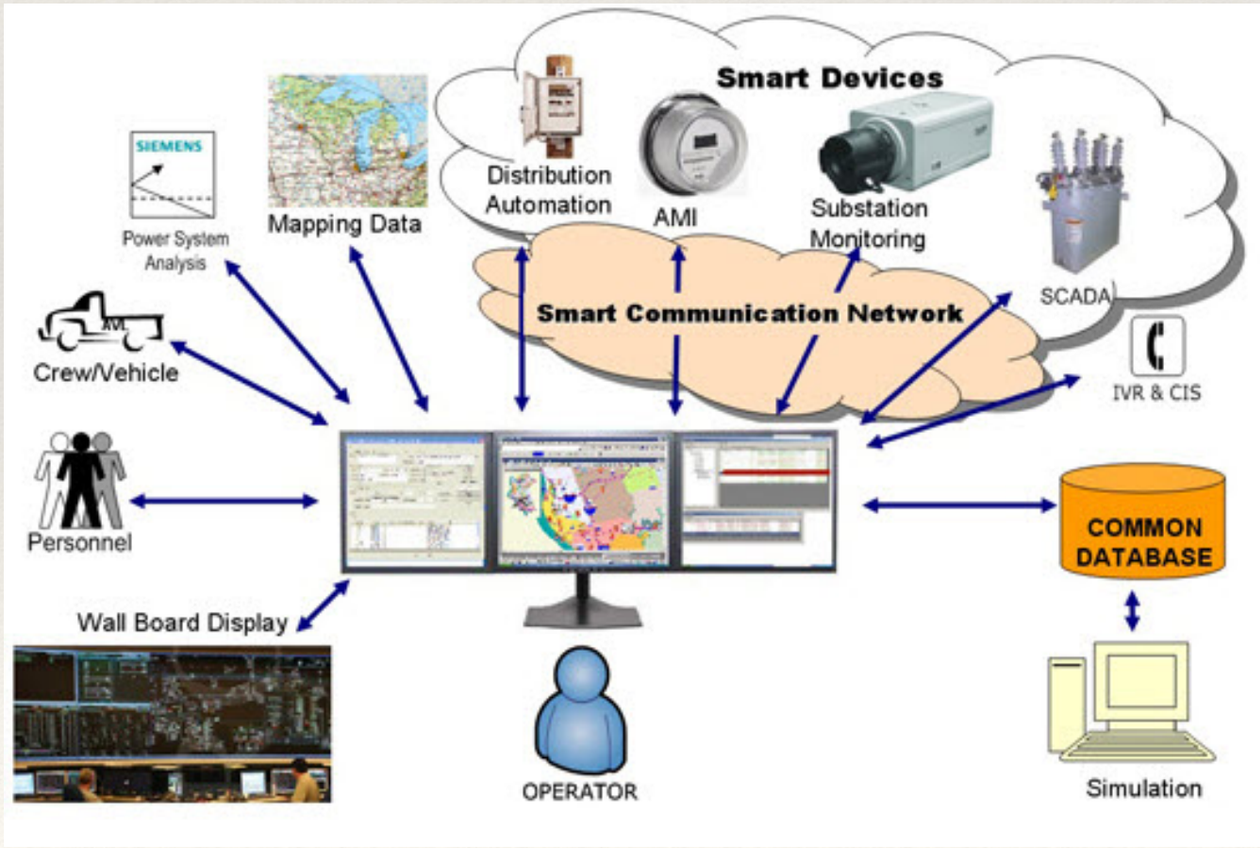
SCADA

60s

SCADA SYSTEMS – LE GRAND-PÈRE DE L'IOT

(Supervisory Control and Data Acquisition)

Un système SCADA est compose de plusieurs unités terminales remotes et une unité terminal principale



Un regard à l'histoire

SCADA

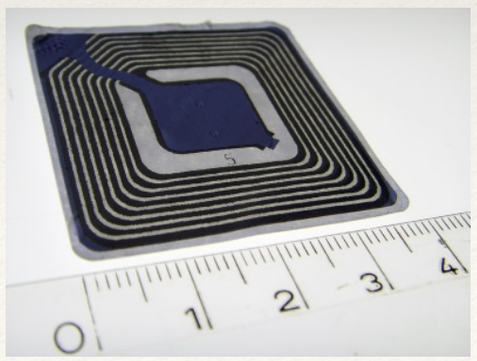
RFID – LE PÈRE DE L'IOT

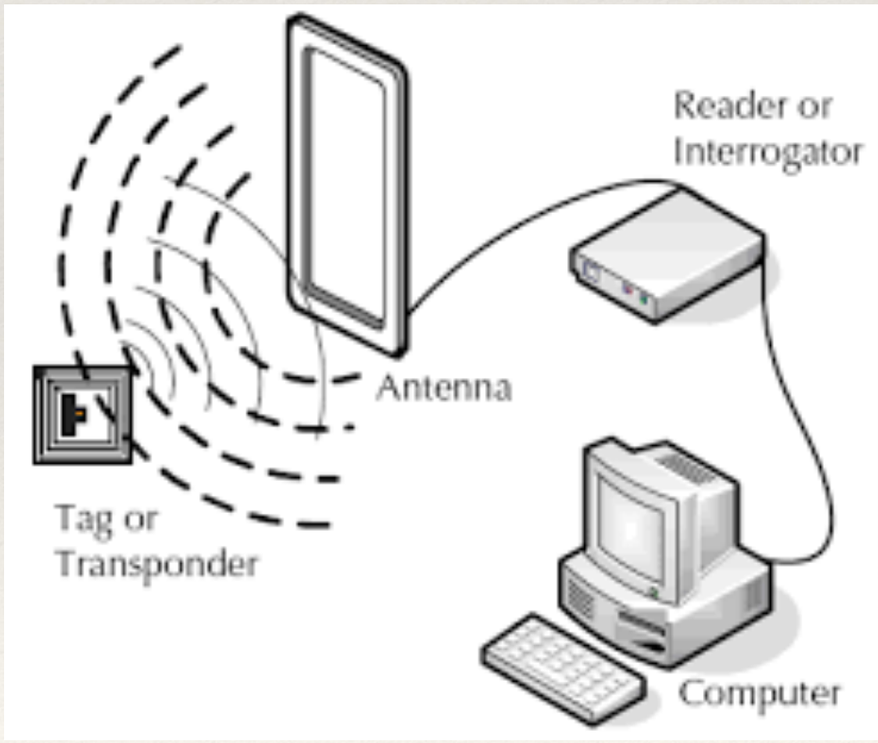
(Radio Frequency Identification)

60s 70s …

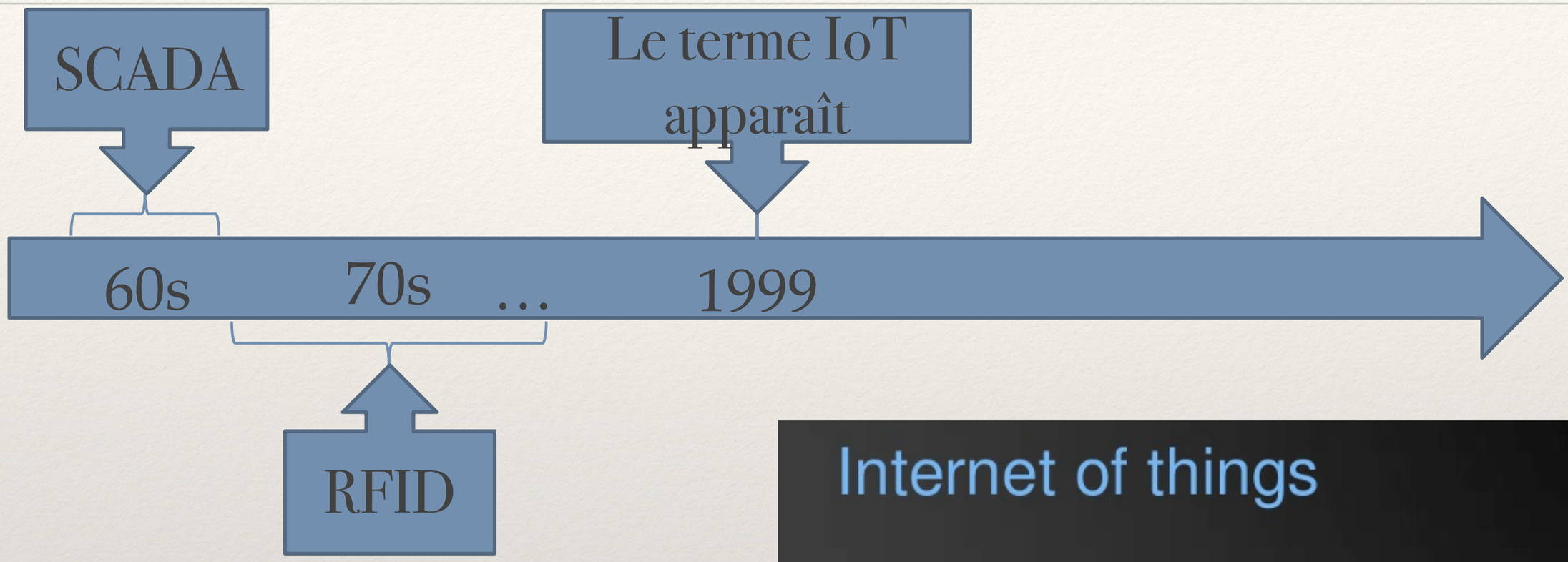
RFID

RFID provides a unique identifier for an object, it must be scanned to get the information





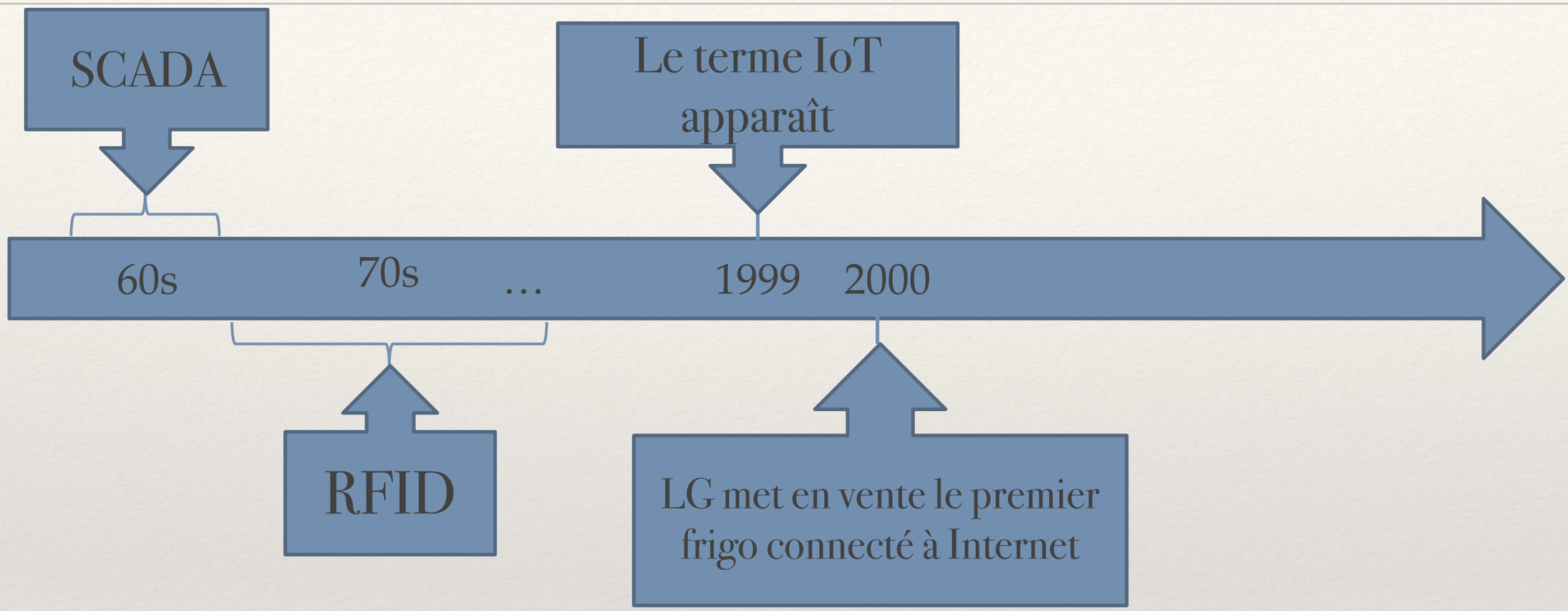
Un regard à l'histoire



1999: The **IoT** gets a name.

Kevin Ashton coines the term « **Internet of Things** ».

Un regard à l'histoire



Un regard à l'histoire

SCADA

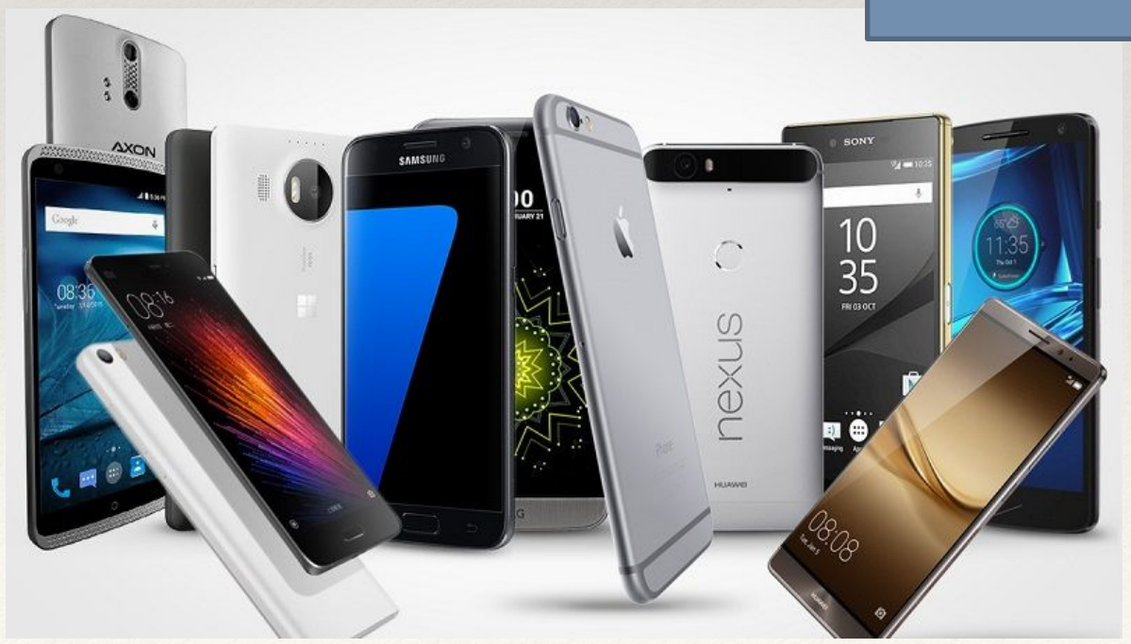
Le terme IoT apparaît

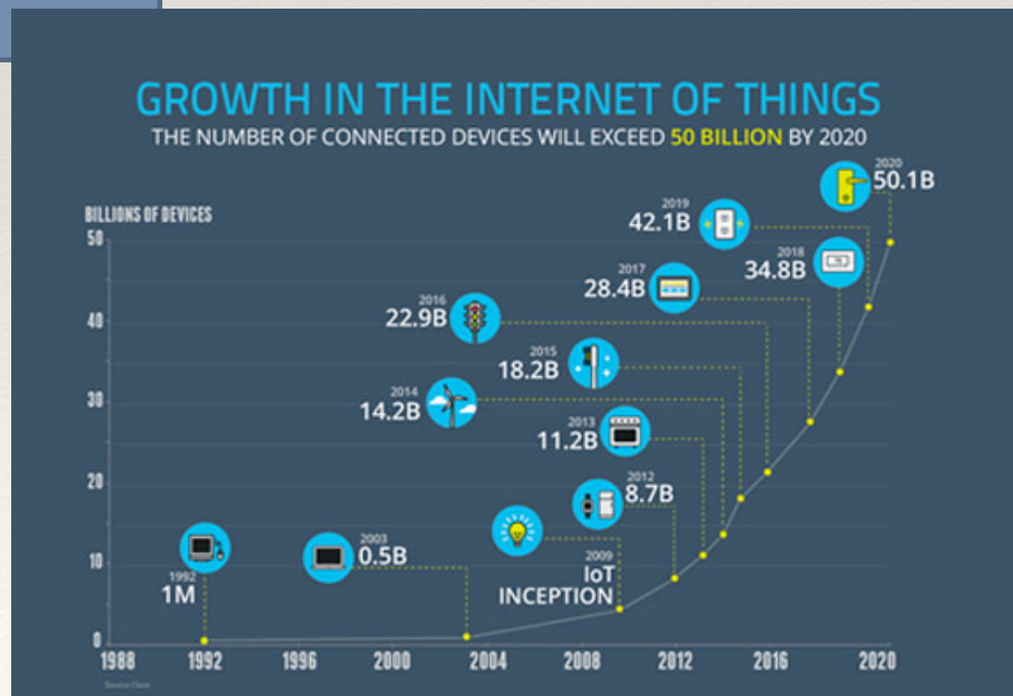
IoT devient populaire

60s 70s … 1999 2000 2010

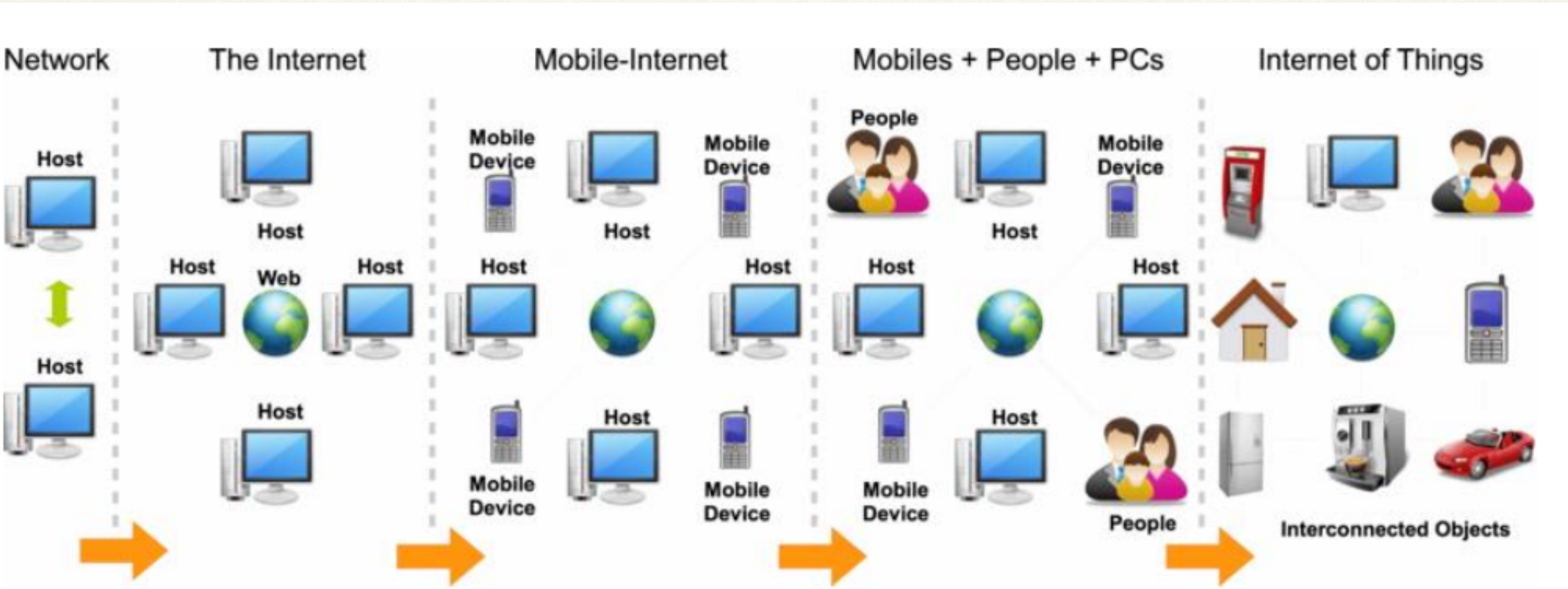
RFID

LG met en vente le premier frigo connecté à Internet





Phases d'évolution



C’est quoi l’IoT ?

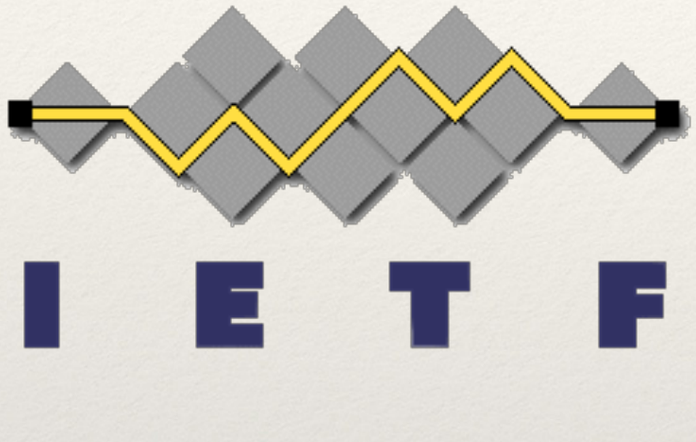
IoT was born when more “things” were connected to the Internet than people.

The explosive growth of smartphones and tablet PCs brought the number of devices connected to the Internet to 12.5 billion in 2010. Refining these numbers further, Cisco IBSG estimates IoT was born sometime between 2008 and 2009.

IoT refers to a transition state where things will have more and more information associated with them and may have the ability to sense, communicate, network and produce new information, becoming an integral part of the Internet .

In the viewpoint of US National Intelligence Council (NIC), IoT refers to everyday objects that are readable, recognizable, locatable, addressable, and/or controllable via the Internet.

It can focus on the virtual identity of the smart objects and their capabilities to interact intelligently with other objects, humans and environments.



IoT is an extension of internet technologies to constrained devices, moving away from proprietary architectures and protocols.

IoT is a world where physical objects are seamlessly integrated into the information network and where the physical objects can become active participants in business processes.

- Research :

IoT can be understood as an enabling framework for the interaction between a bundle of heterogeneous objects and also as a convergence of technologies.

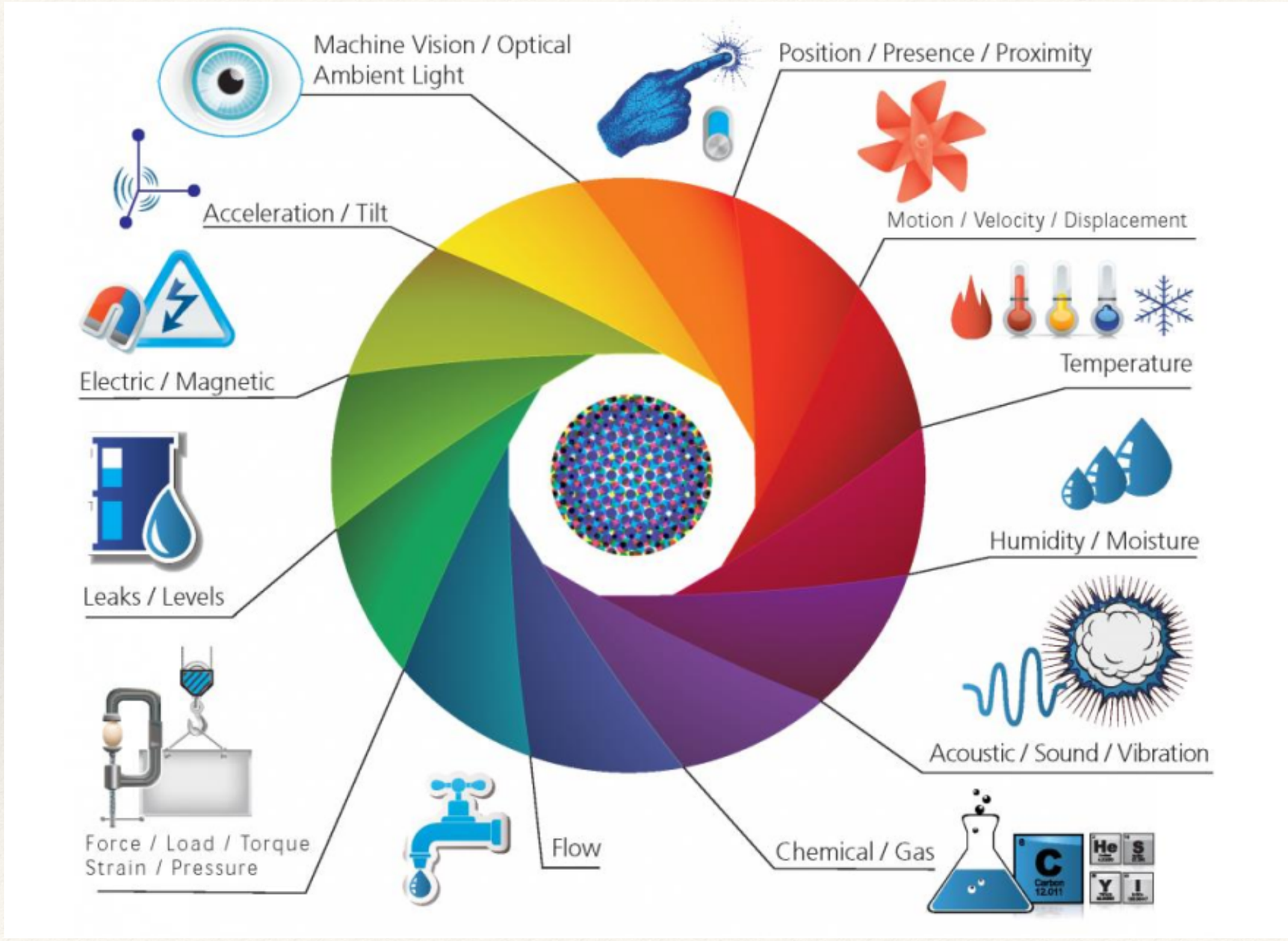
Une définition en commun pour IoT ?

- IoT Connects the physical world to the internet

1	2	3
Sensors & Devices	**Connectivity / Networks**	**People & Processes**
		
The Internet of Things connects billions of sensors and devices such as consumer objects and industrial equipment onto networks.	Increasing amounts of Data produced by those Sensors and connected Devices are hence Acquired, logged and Stored onto networks.	Networked inputs are then Combined into bi-directional Systems for better decision making, Increased efficiency, new services or Environmental benefits.

1. Capteurs et acteurs

- Nous donnons au monde un système nerveux numérique.



1.1 Sensor types

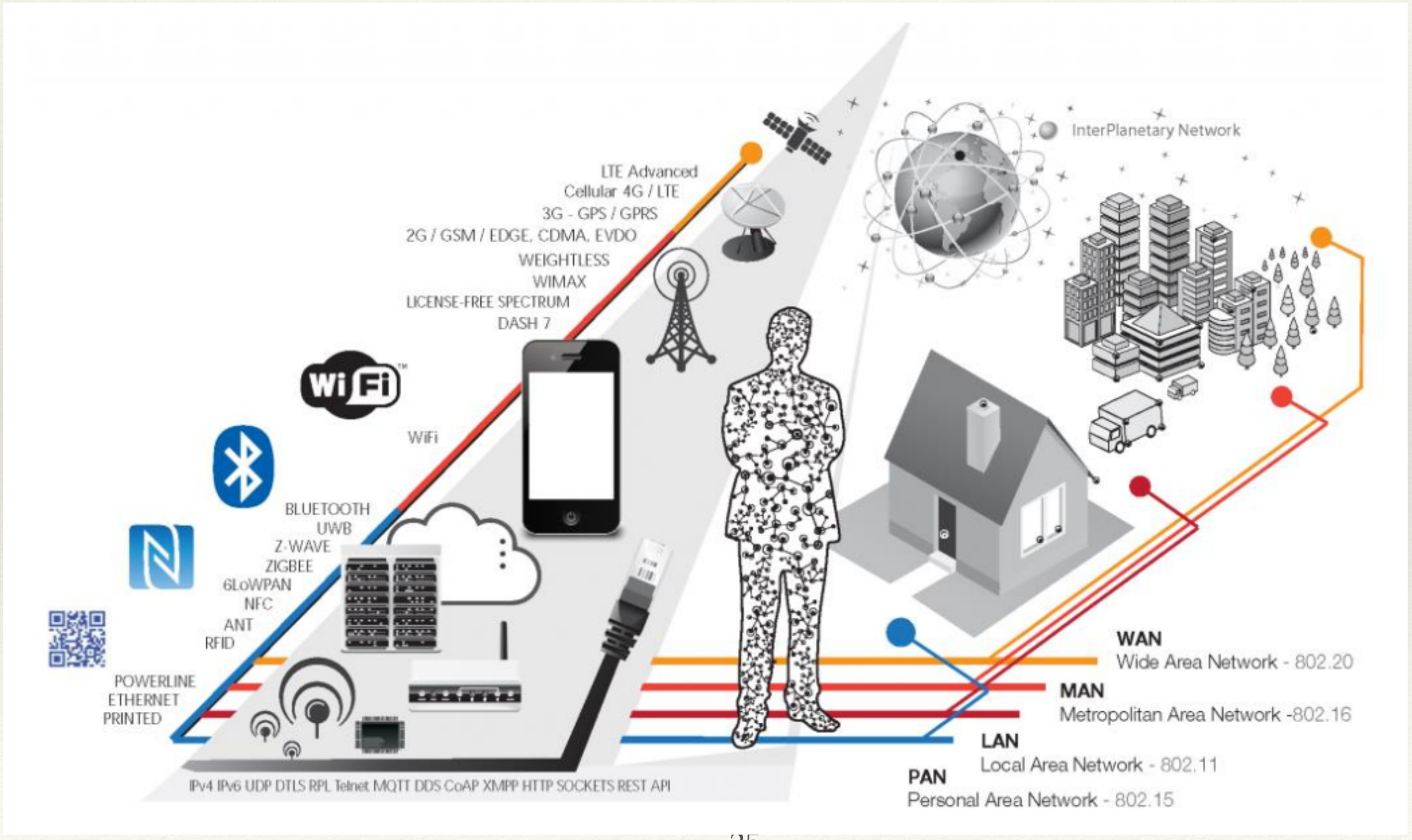
- Temperature
- Pressure
- Flow
- Level
- Imaging
- Noise
- Air pollution
- Proximity and displacement
- Infrared
- Moisture and humidity
- Speed

1.2 Sensor characteristics

- Data filtering
- Minimum power consumption
- Compact
- Smart detection (remote)
- High sensitivity
- Linearity
- Higher reliability
- Dynamic range
- Accuracy
- Hysterisis
- Limited noise
- Wide bandwidth
- High resolution
- Minimum interruption
- Ease of use

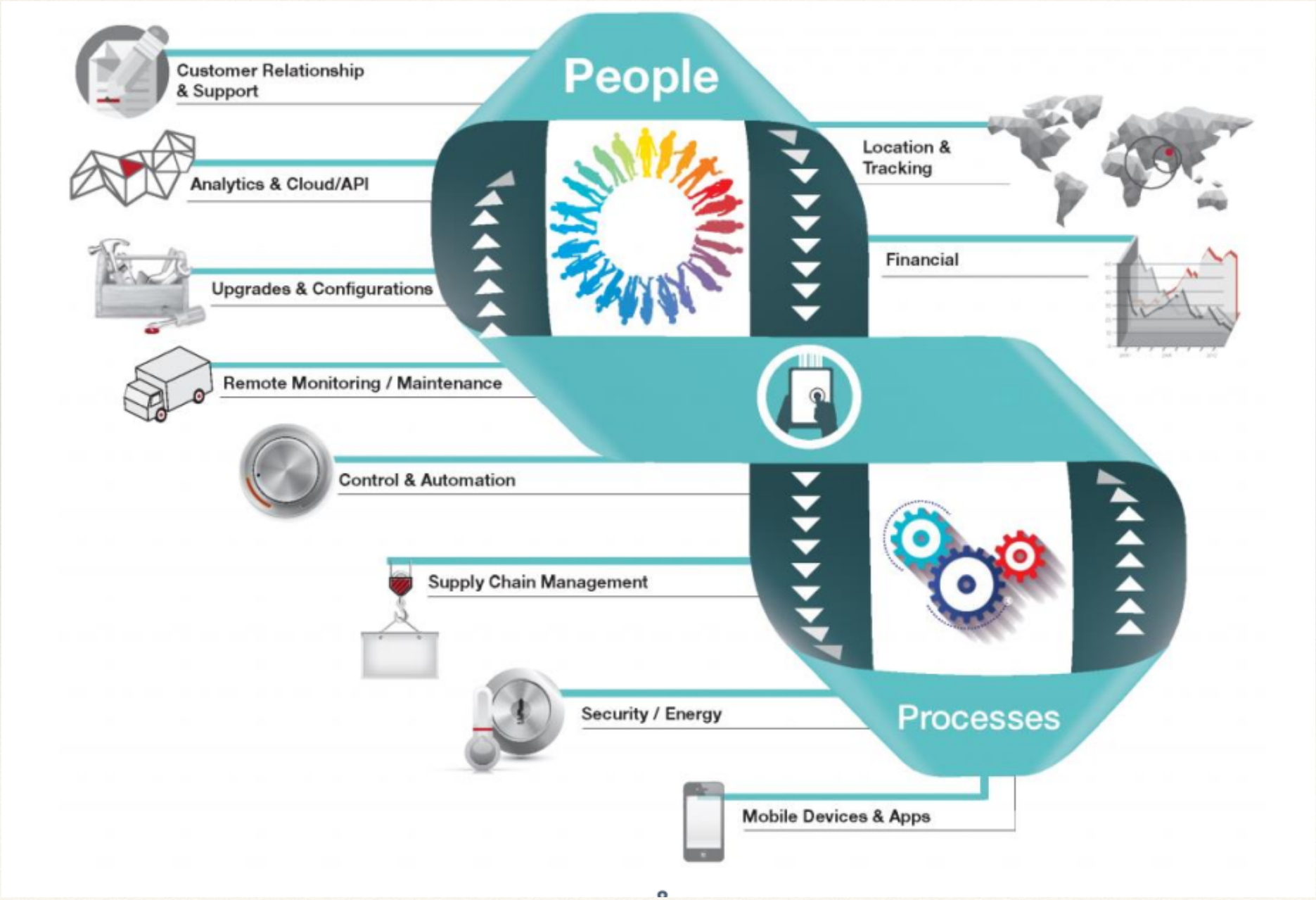
2. Connectivité

- Les entrées sont numérisées et mises dans les réseaux

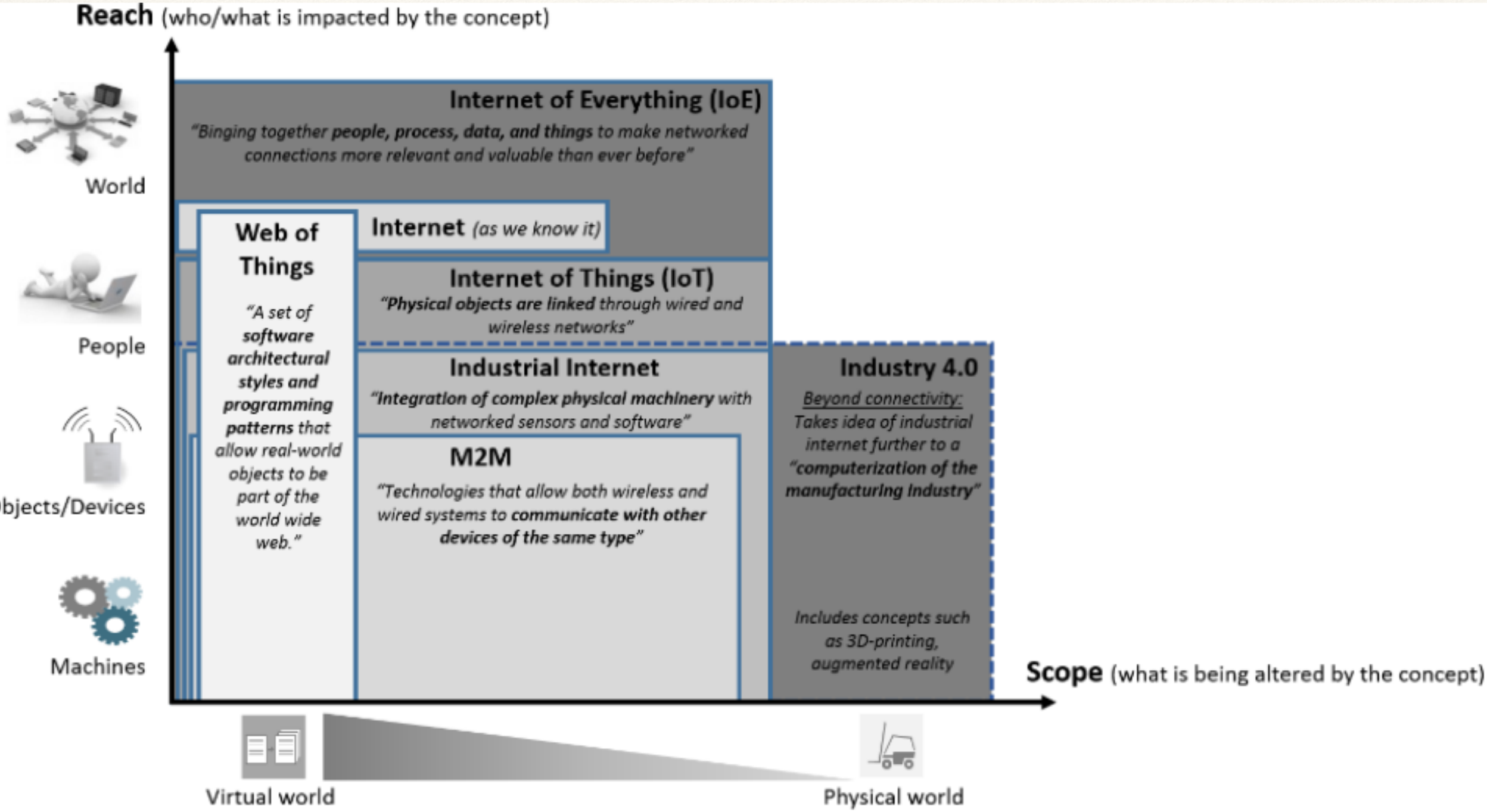


3. Personnes et processus

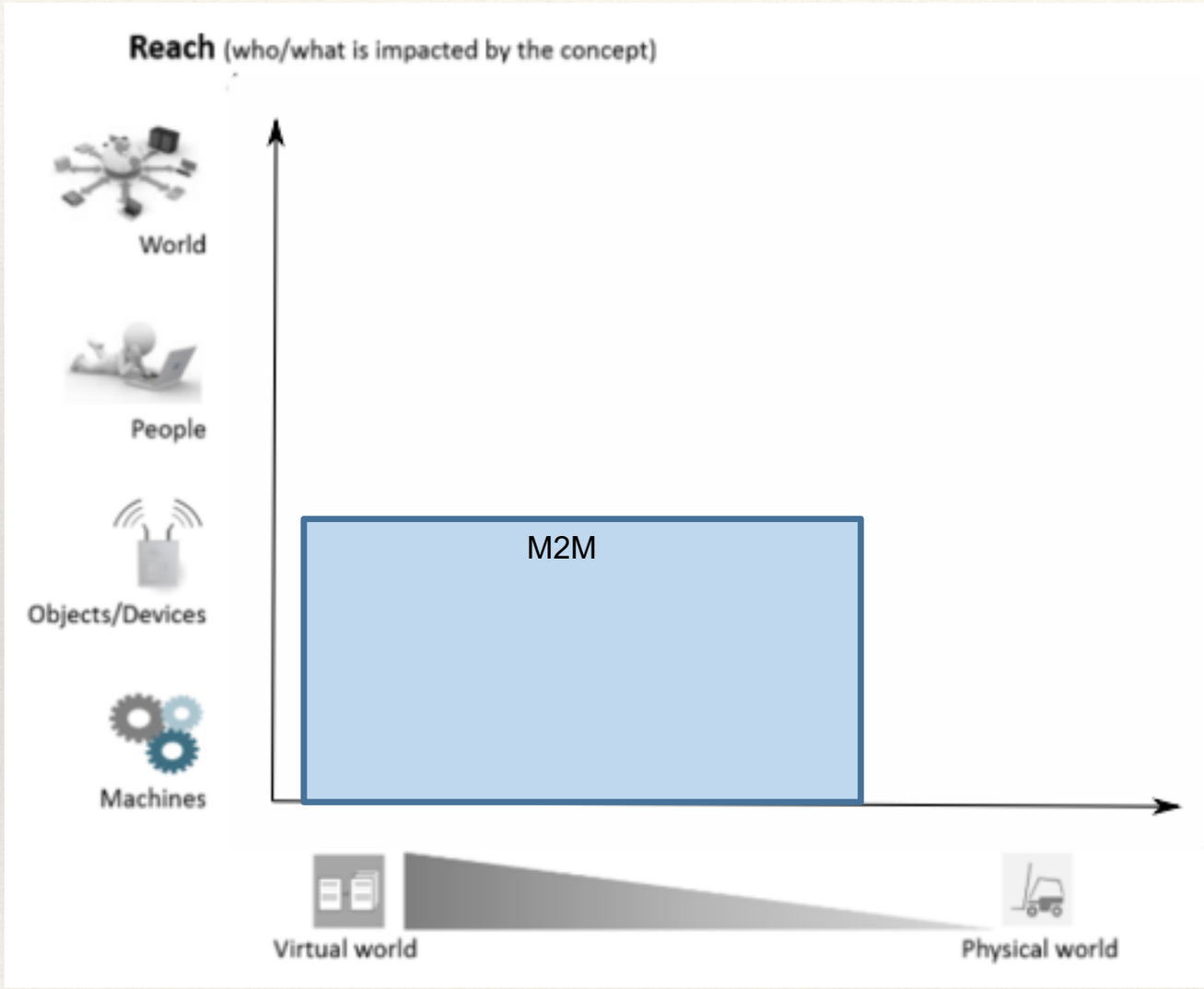
- Les entrées sont combinées dans des systèmes bidirectionnels



IoT et les autres réseaux ?



Machine-to-Machine



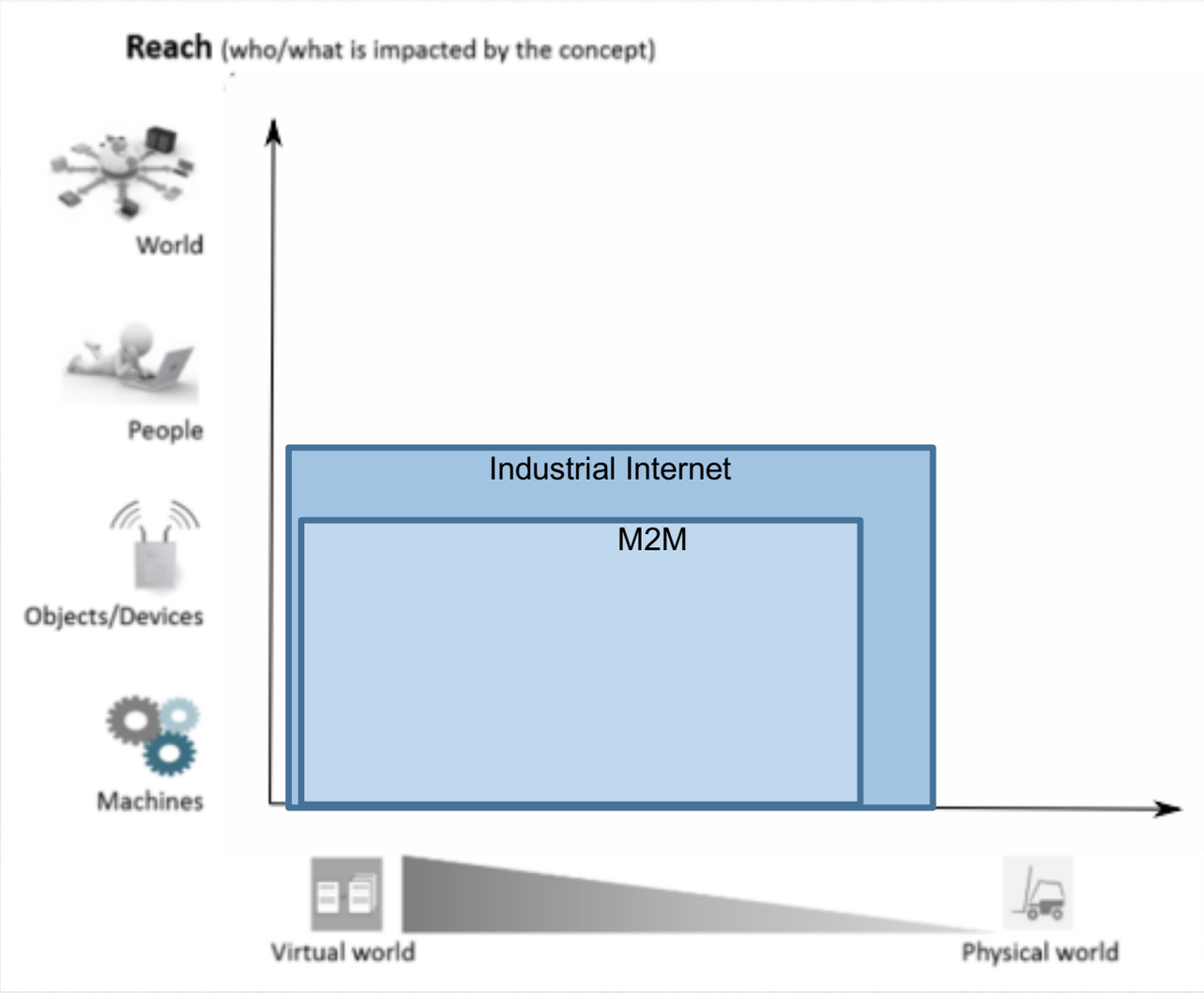
Technologies that allow both wireless and wired systems to communicate with other devices of the same type

M2M

The term Machine to Machine (M2M) has been in use for more than a decade, and is well-known in the Telecoms sector.

M2M communication had initially been a one-to-one connection, linking one machine to another. But today's explosion of mobile connectivity means that data can now be more easily transmitted, via a system of IP networks, to a much wider range of devices.

Industrial Internet

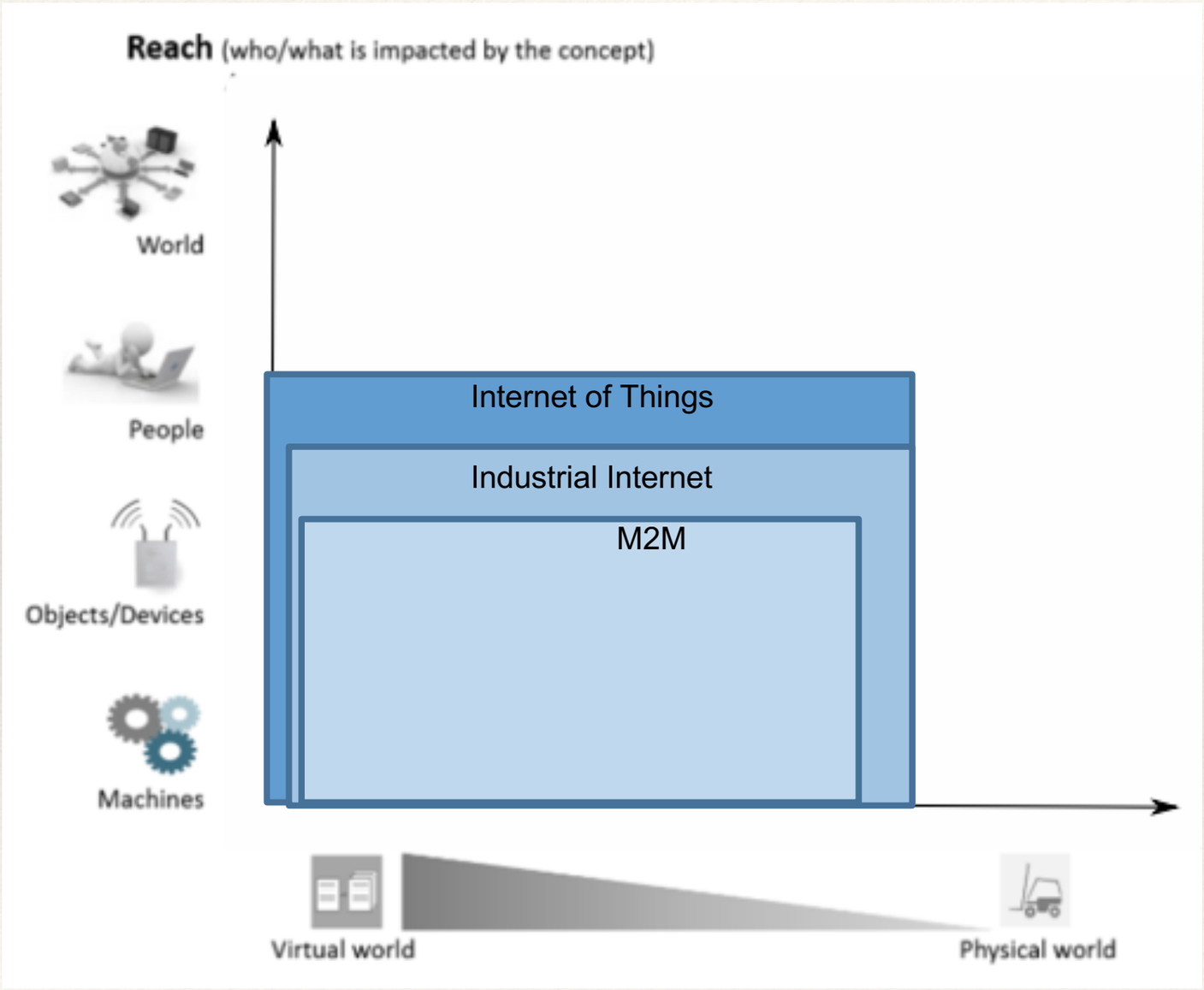


Integration of complex physical machinery with networked sensors and software

Industrial Internet (of Things)

The term industrial internet is strongly pushed by GE. It goes beyond M2M since it not only focuses on connections between machines but also includes human interfaces.

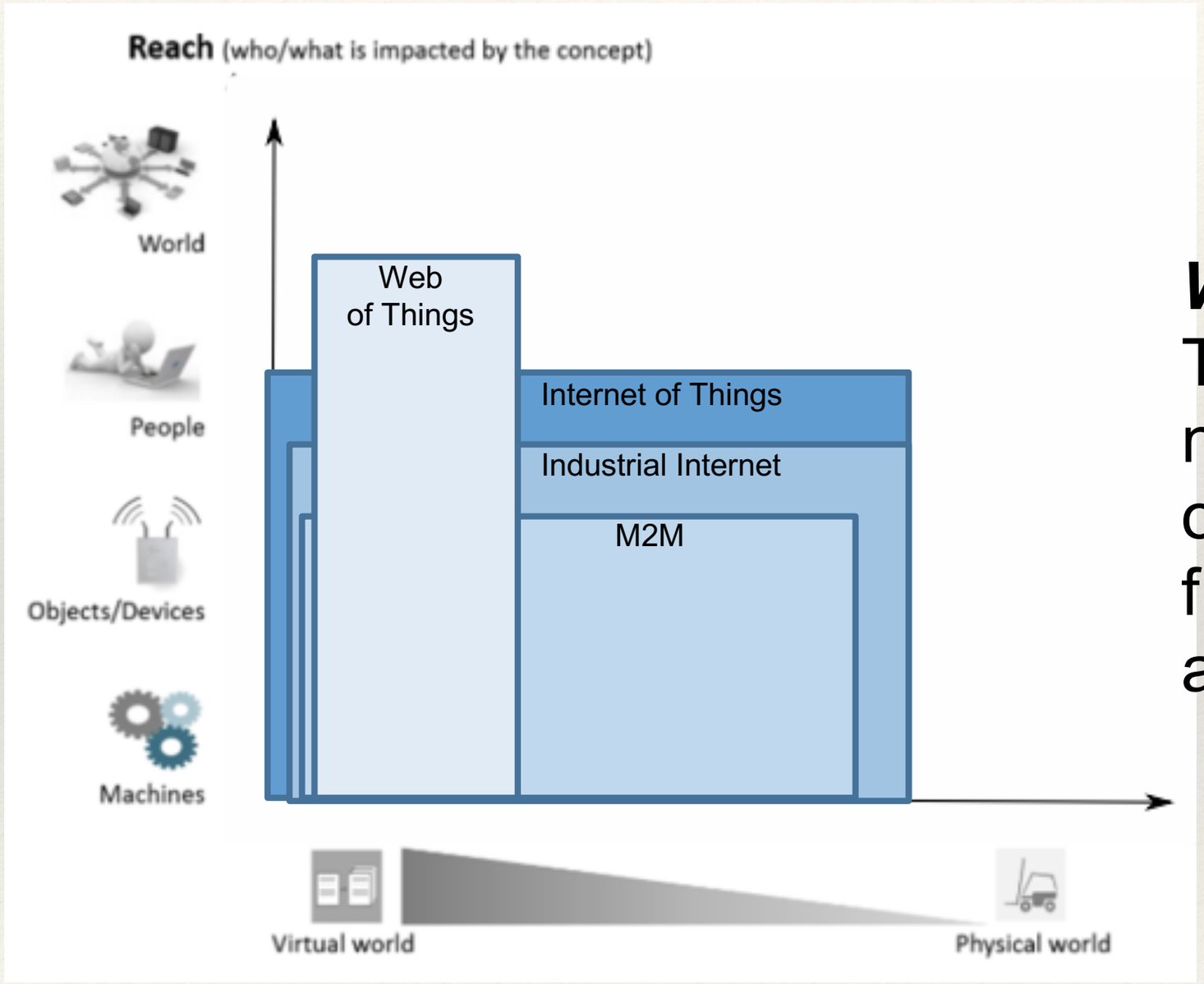
Internet of Things



Internet of Things

Physical objects are linked through wired and wireless networks.

Web of Things

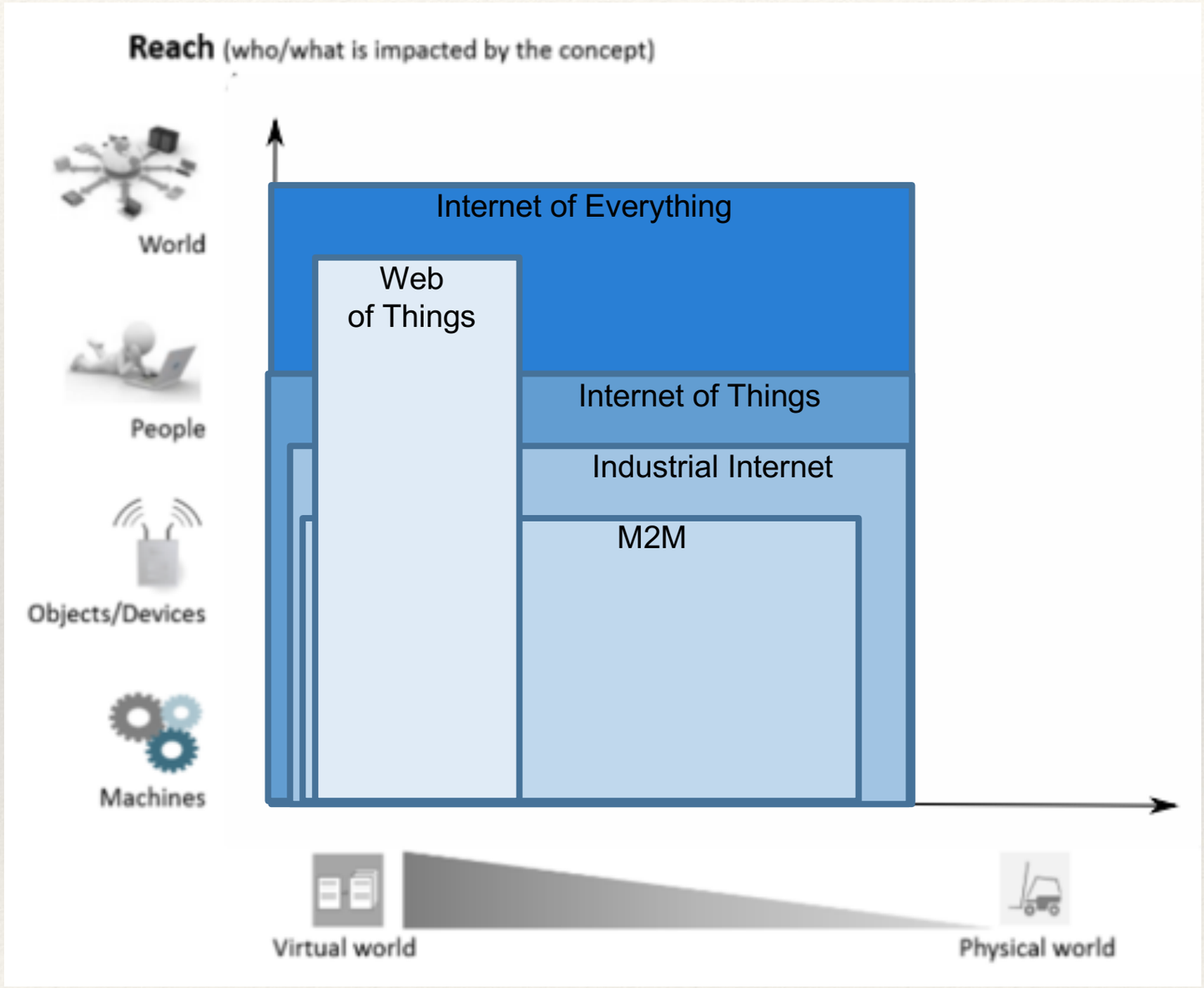


A set of software architectural styles and programming patterns that allow real world objects to be to be part of the World Wide Web

Web of Things

The Web of Things is much narrower in scope as the other concepts as it solely focuses on software architecture.

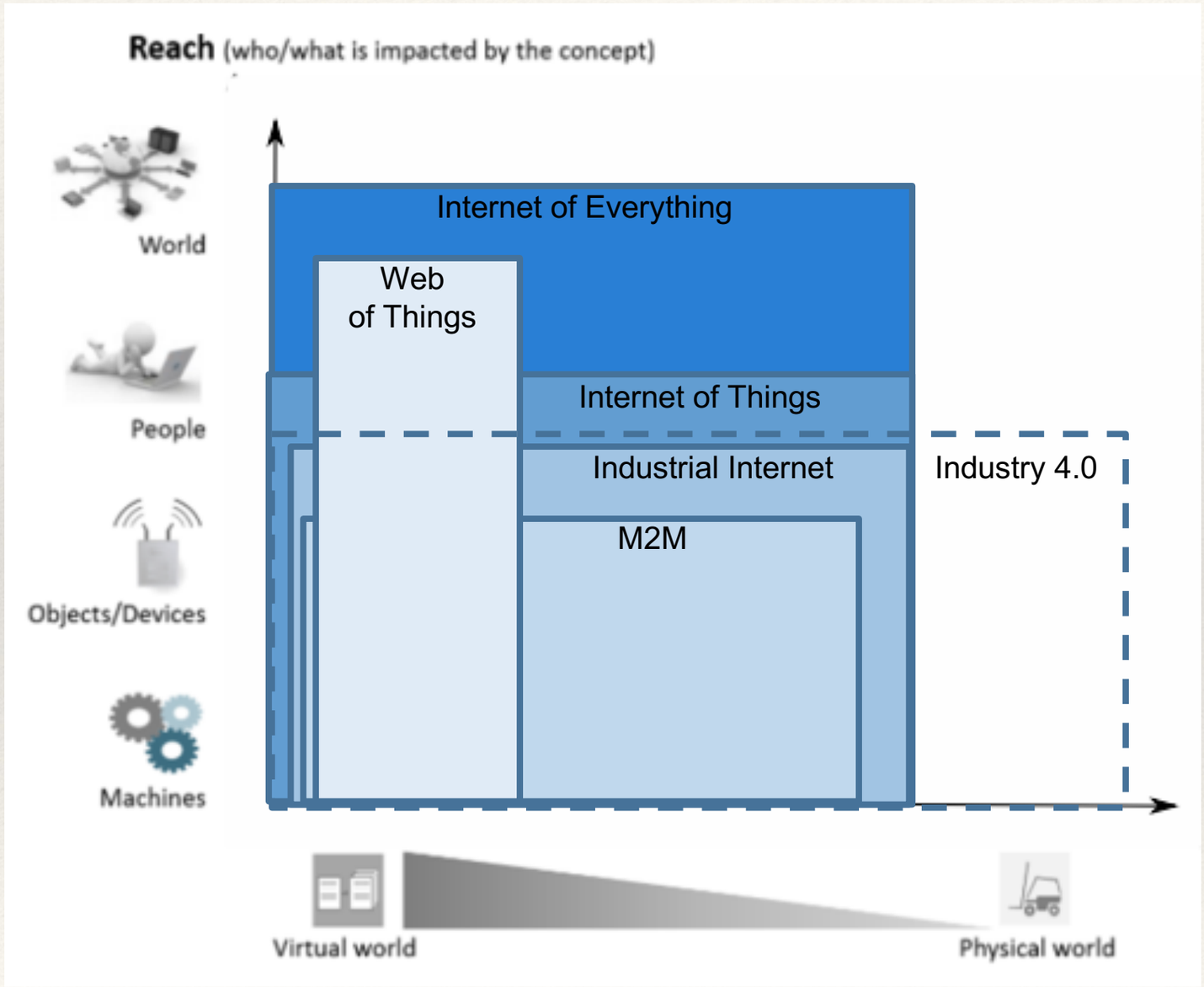
Internet of Everything



Internet of Everything
Still a rather vague concept, IoE aims to include all sorts of connections that one can envision. The concept has thus the highest reach.

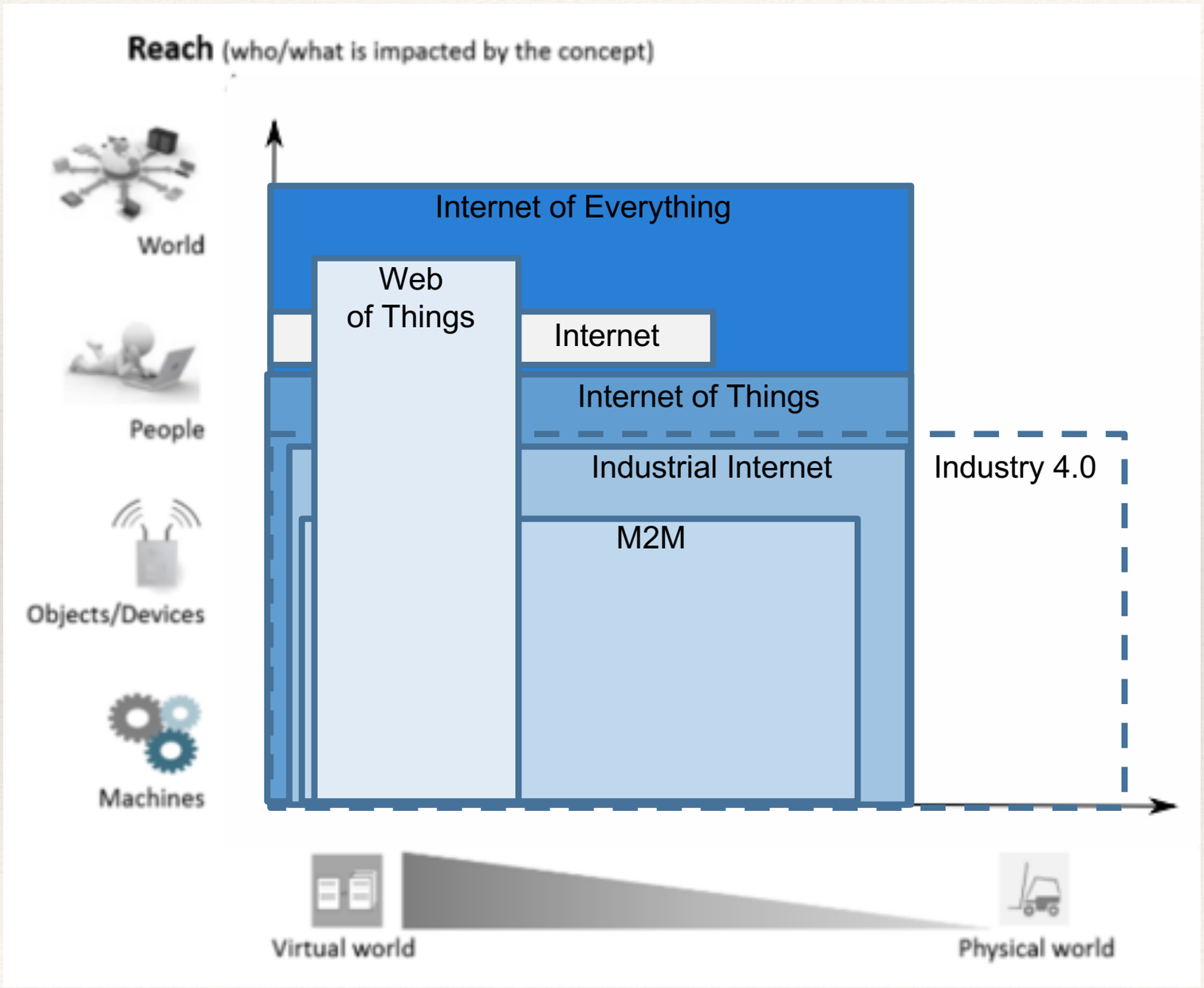
Bringing together **people, process, data, and things** to make networked connections more relevant and valuable than ever before.

Industry 4.0



- The term Industry 4.0 that is strongly pushed by the German government is as limited as the industrial internet in reach as it only focusses on industrial environments.
- However, it has the largest scope of all the concepts. Industry 4.0 describes a set of concepts to drive the next industrial revolution. It includes all kinds of connectivity concepts but also goes further to include real changes to the physical world around us such as ***3D-printing technologies, new augmented reality hardware, robotics, and advanced materials.***

Internet



In the above graph, the internet is a fairly small box.

In its core it connects only people.

Domaines d’application de l’IoT

Libelium Smart World

Air Pollution
Control of CO_2 emissions of factories, pollution emitted by cars and toxic gases generated in farms.

Forest Fire Detection
Monitoring of combustion gases and preemptive fire conditions to define alert zones.

Wine Quality Enhancing
Monitoring soil moisture and trunk diameter in vineyards to control the amount of sugar in grapes and grapevine health.

Offspring Care
Control of growing conditions of the offspring in animal farms to ensure its survival and health.

Sportsmen Care
Vital signs monitoring in high performance centers and fields.

Structural Health
Monitoring of vibrations and material conditions in buildings, bridges and historical monuments.

Quality of Shipment Conditions
Monitoring of vibrations, strokes, container openings or cold chain maintenance for insurance purposes.

Smartphones Detection
Detect iPhone and Android devices and in general any device which works with Wifi or Bluetooth interfaces.

Perimeter Access Control
Access control to restricted areas and detection of people in non-authorized areas.

Radiation Levels
Distributed measurement of radiation levels in nuclear power stations surroundings to generate leakage alerts.

Electromagnetic Levels
Measurement of the energy radiated by cell stations and WiFi routers.

Traffic Congestion
Monitoring of vehicles and pedestrian affluence to optimize driving and walking routes.

Smart Roads
Warning messages and diversions according to climate conditions and unexpected events like accidents or traffic jams.

Smart Lighting
Intelligent and weather adaptive lighting in street lights.

Intelligent Shopping
Getting advices in the point of sale according to customer habits, preferences, presence of allergic components for them or expiring dates.

Noise Urban Maps
Sound monitoring in bar areas and centric zones in real time.

Water Leakages
Detection of liquid presence outside tanks and pressure variations along pipes.

Vehicle Auto-diagnosis
Information collection from CanBus to send real time alarms to emergencies or provide advice to drivers.

Item Location
Search of individual items in big surfaces like warehouses or harbours.

Waste Management
Detection of rubbish levels in containers to optimize the trash collection routes.

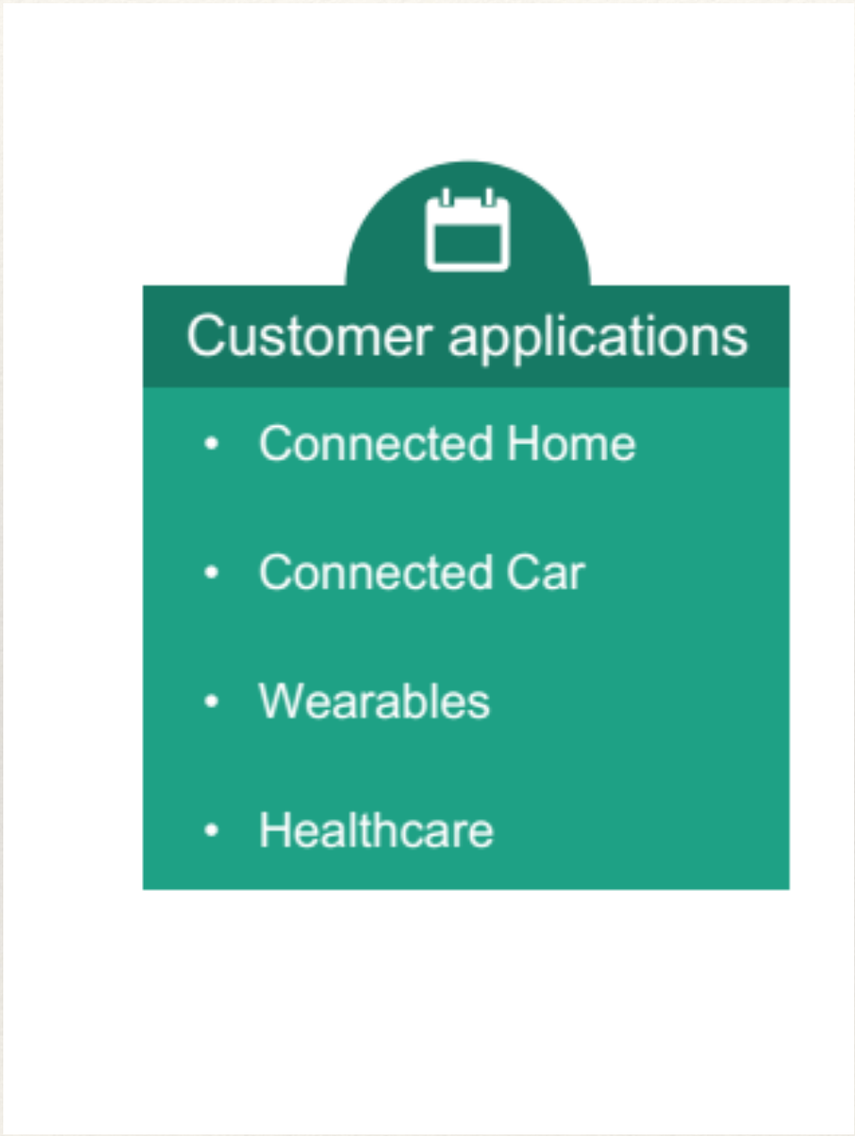
Smart Parking
Monitoring of parking spaces availability in the city.

Water Quality
Study of water suitability in rivers and the sea for fauna and eligibility for drinkable use.

Golf Courses
Selective irrigation in dry zones to reduce the water resources required in the green.

libelium
www.libelium.com

Domaines d'application de l'IoT



Connected home

How it works?

- Central hub in home connected to internet
- Number of sensors and controllers connected to central hub
- Radio connection using mesh network
- Central hub is accessible by web / mobile app

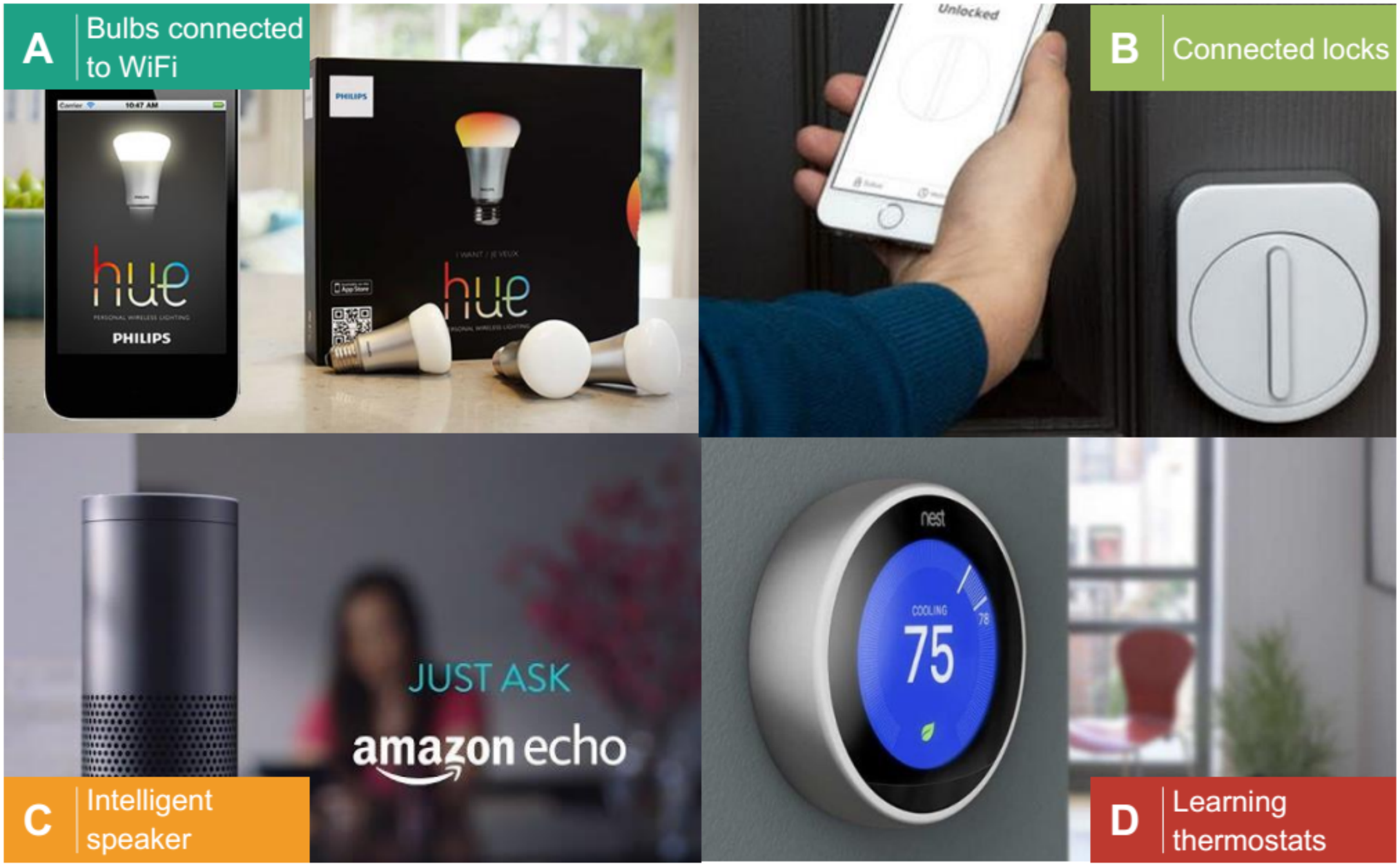
Key areas

Energy saving

Convenience

Security

Exemple d'applications



Healthcare + Smart Home

40 million adults age 65 and over will be living alone in the U.S, Canada and Europe.

- U.S. Department of Health and Human Services: Administration for Community Living (ACL)

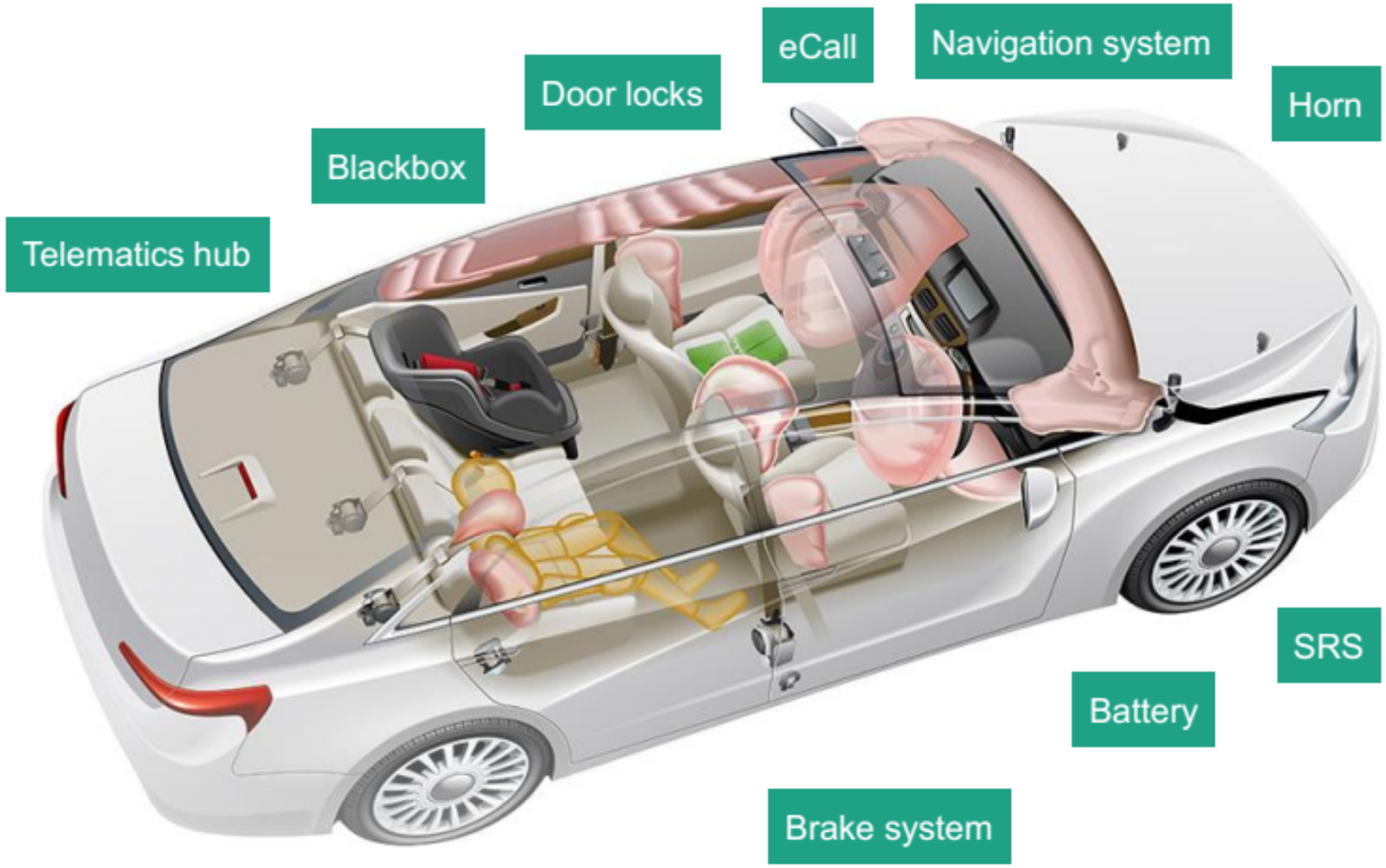
Connected Car

How it works?

- Dongle or smartphone used for telematics
- OEMs mount own systems
- SIM card pre-installed and mobile network operators
- EU require blackbox in car

Key areas

- Insurance
- Autonomous driving
- Predictive maintenance
- Emergency
- Sharing

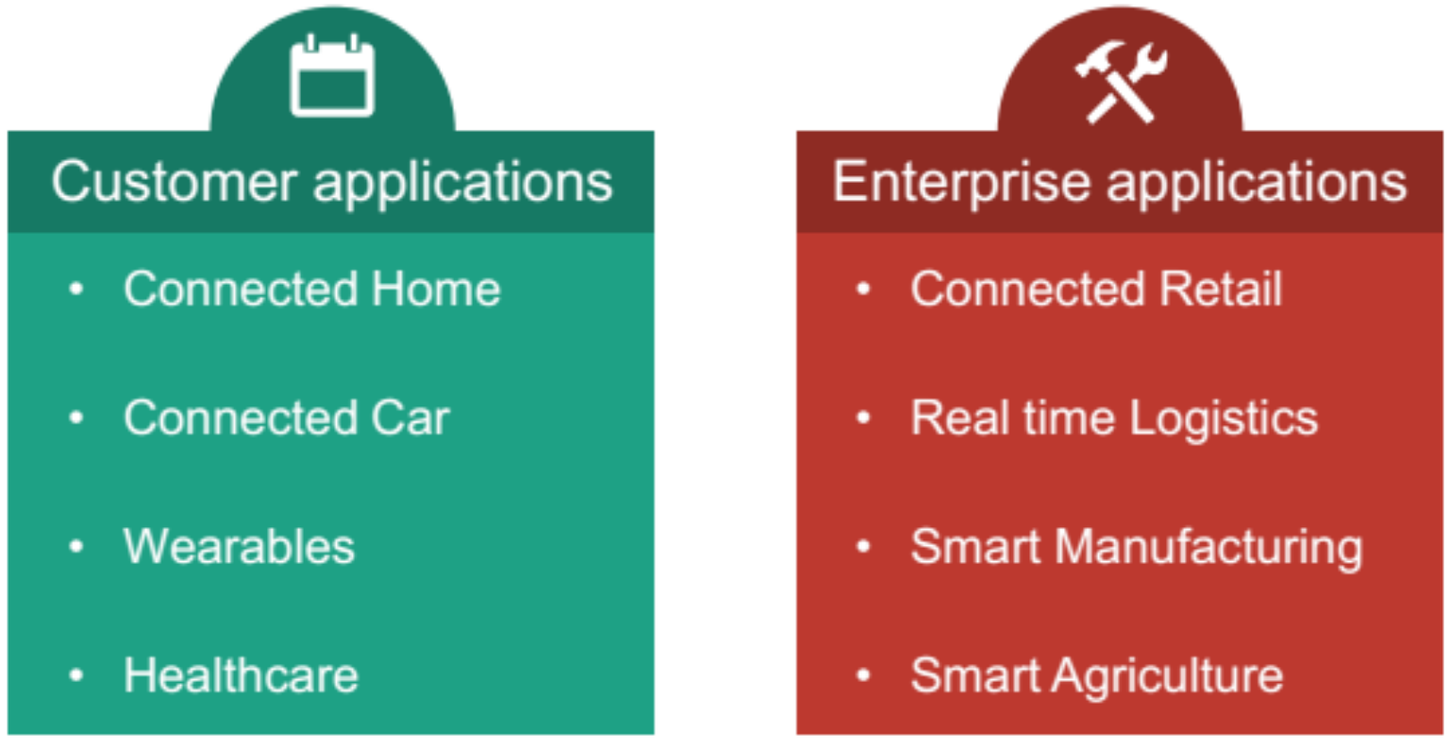


Exemple d'applications

Portables


• Head-worn
• Straps
• Shirts
• Wrist-worn
• Clips
• Shoe-worn / Foot pods
Apps

Domaines d'application de l'IoT

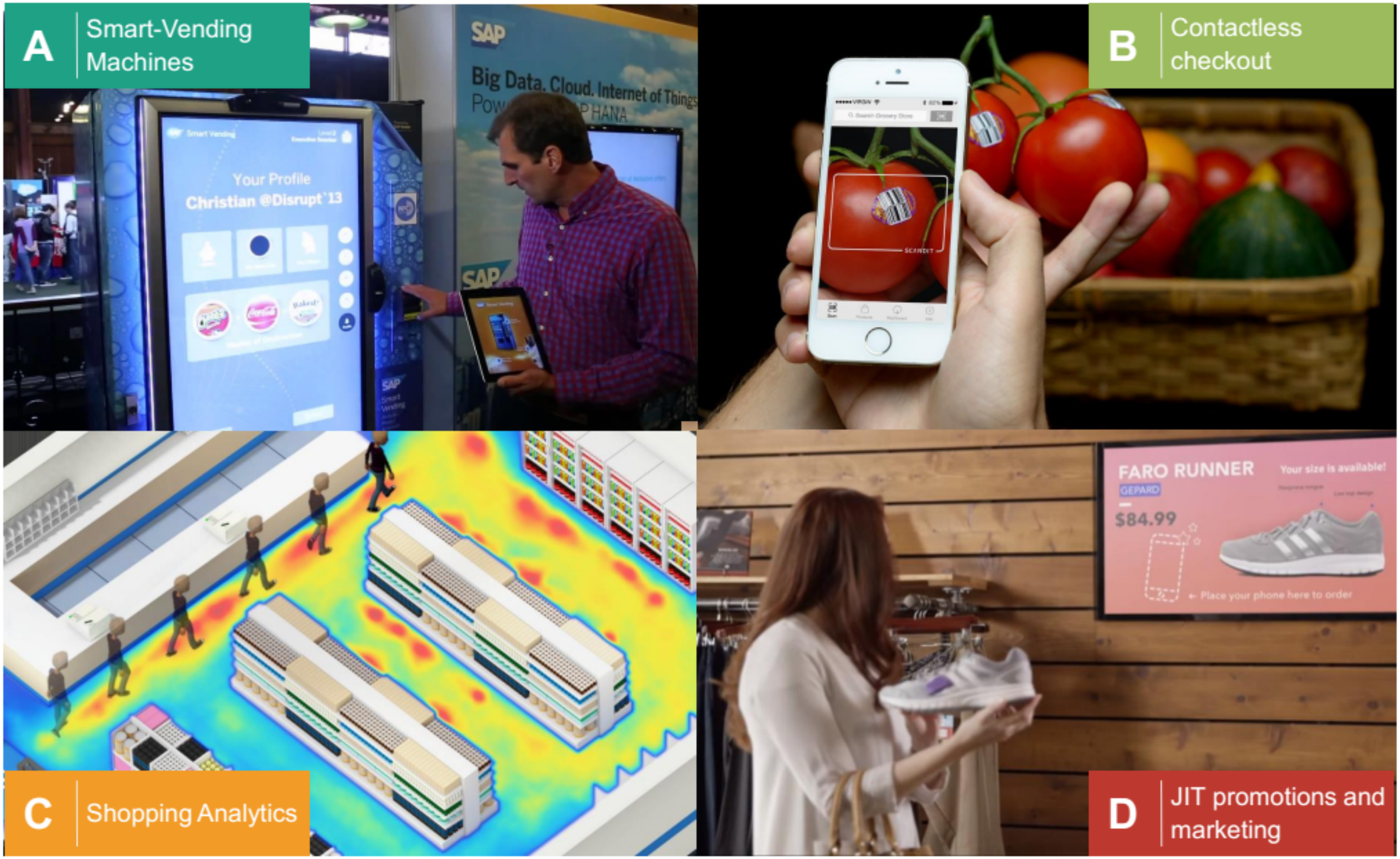


Vente au détail connectée

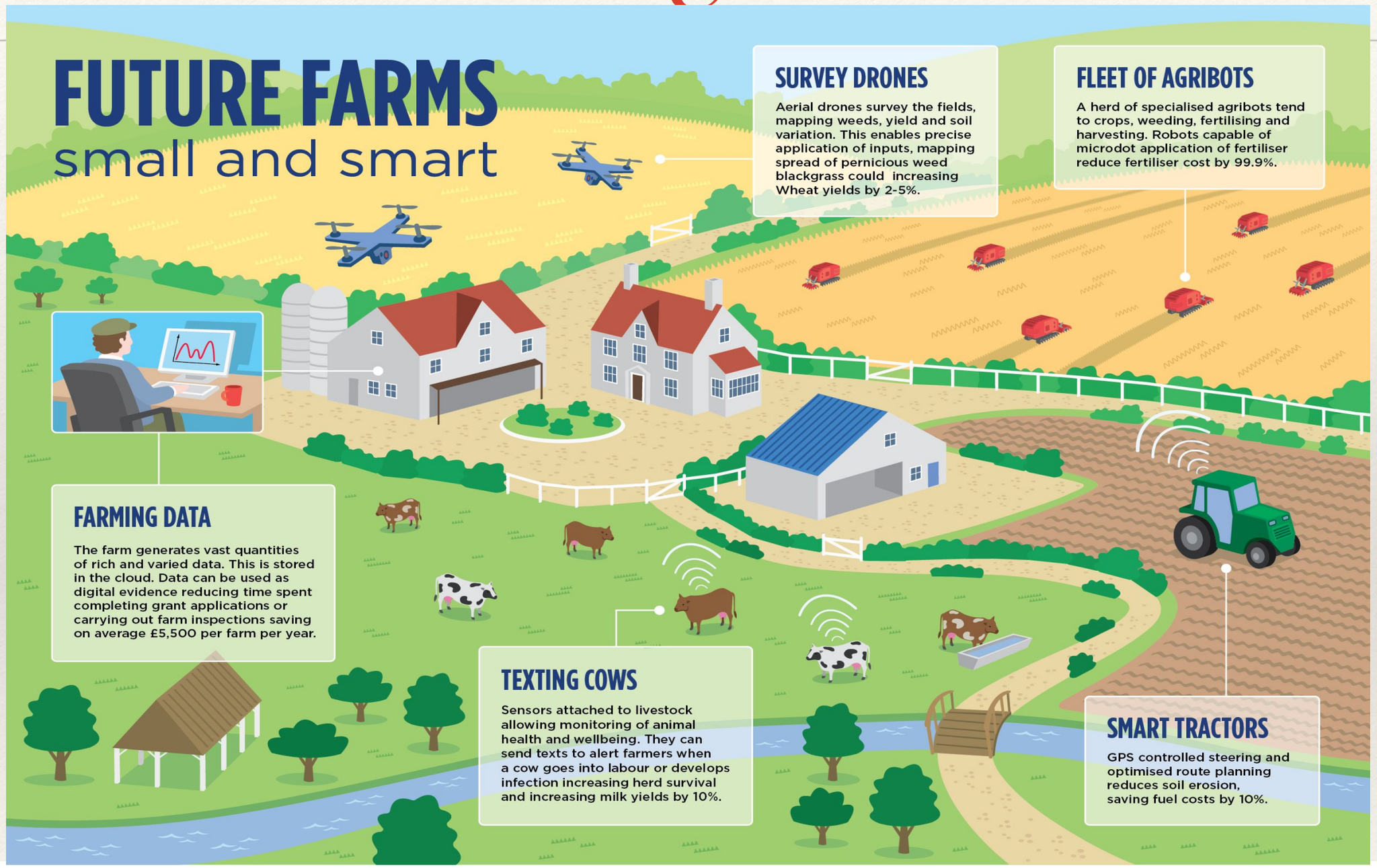
Key areas

Creating new channels and revenue streams	Optimizing supply chain operations	Improving the customer experience

Connected retail :
Exemple d'applications



Smart Agriculture

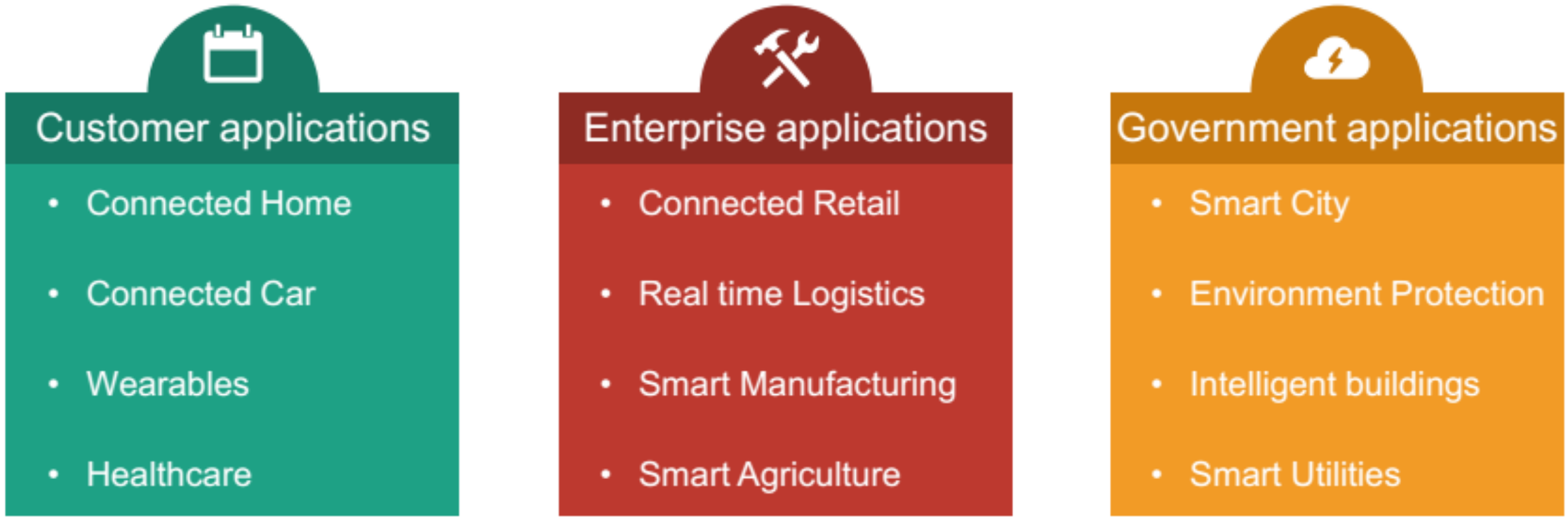


Key areas

- Increase the quality and quantity of the production
- Reduction of cultural inputs
- Resolve the climatic change issue

Smart Agriculture:
Exemple d'applications

Domaines d'application de l'IoT



Government applications

Sanitation

Jerusalem – Garbage collection and waste management

Mobility Efficiency

City of London Transit hub efficiency and Route Navigation for Commuters

Voting

Franchise & Opinions Singapore Govt. experiments and also uses for delivering location based service and info.

Utilities

Smart Grids and water management cloud based water management in Houston

Co-operate

Singapore Govt. has mapped all govt. agencies and are efficiently delivering target based services and infor

Safety

Public safety & Disaster management anticipate crime patterns and deploy resources effectively

Government applications:
Impact on government

Process re-engineer

Fine tune practices and innovate novel services based on data

Cost Reduction

Reduced cost with optimal utilization of resources

Decision

Enable real time decision making to prioritize govt efforts in right direction

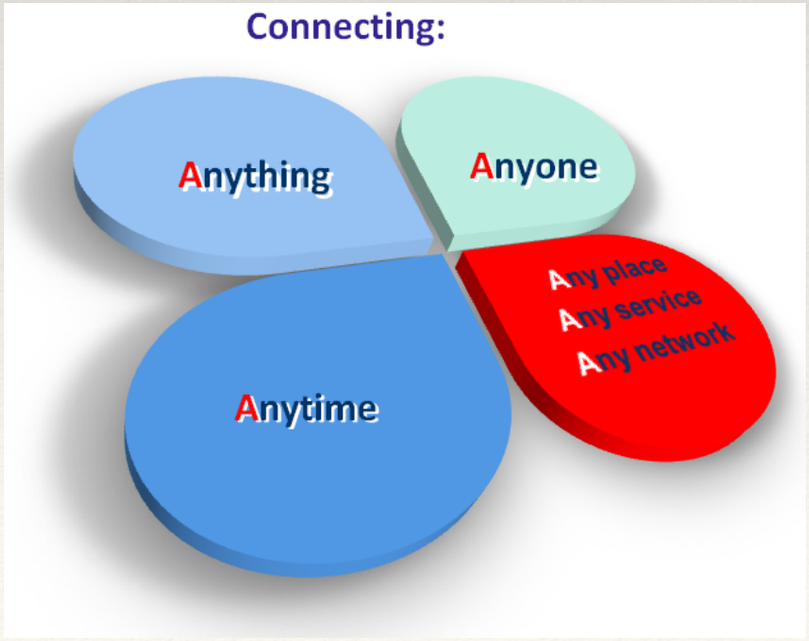
Productive Society

These efforts lead to satisfied and productive citizen

Caractéristiques de l'IoT

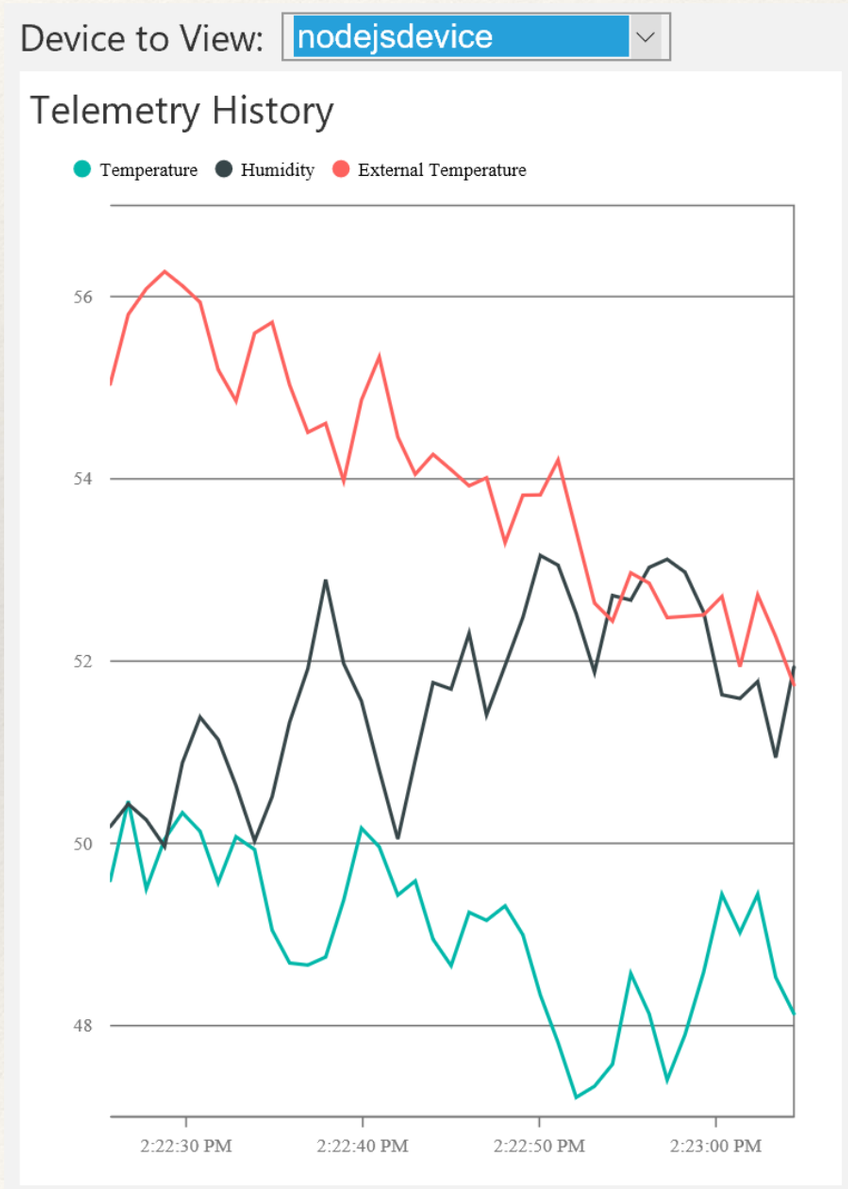
Interconnectivité

- With regard to the IoT, anything can be interconnected with the global information and communication infrastructure.
- Connectivity enables network accessibility and compatibility. Accessibility is getting on a network while compatibility provides the common ability to consume and produce data.



Dynamicité

- The state of devices change dynamically, e.g., sleeping and waking up, connected and/or disconnected as well as the context of devices. Moreover, the number of devices can change dynamically.

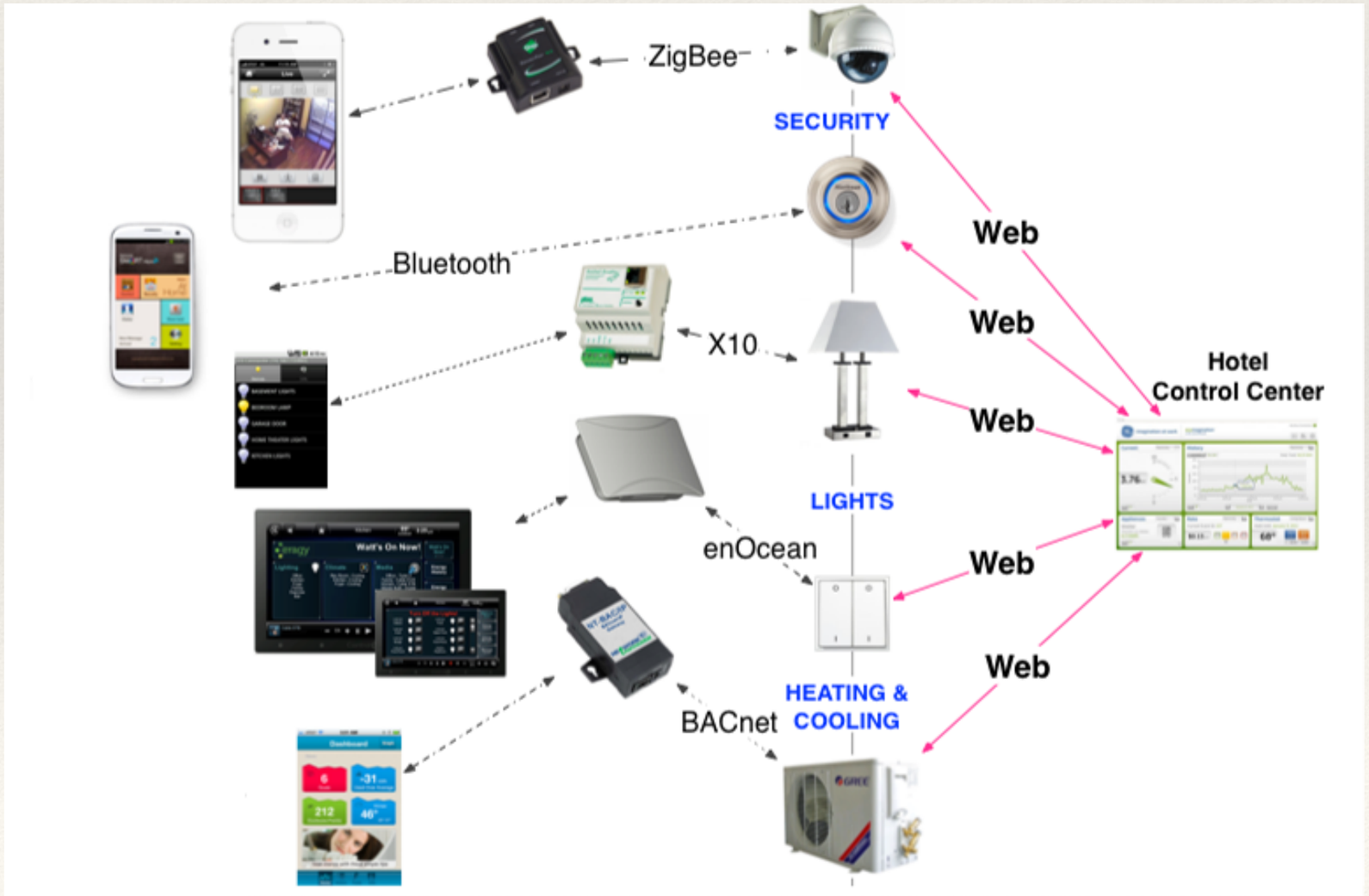


Mobilité

- Most of the smart devices are mobile. Their changing location makes it difficult to communicate with the cloud data center because of changing network conditions across different locations.

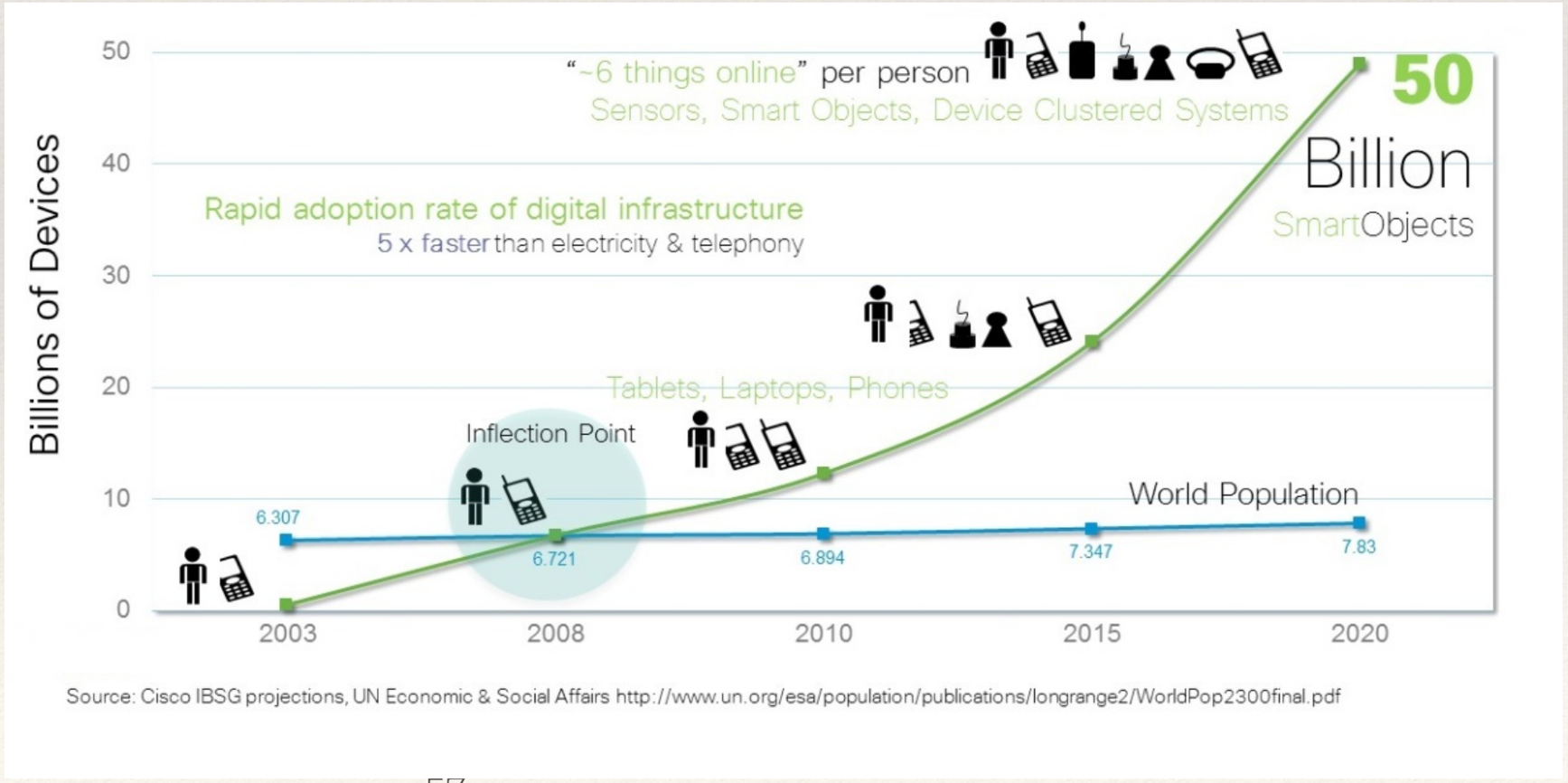
Heterogéneité

- The devices in the IoT are heterogeneous as based on different hardware platforms and networks. They can interact with other devices or service platforms through different networks.



Grande escale

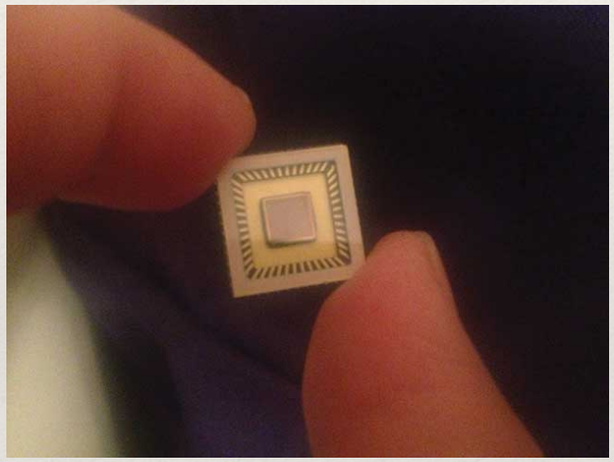
- The number of devices that need to be managed and that communicate with each other will be at least an order of magnitude larger than the devices connected to the current Internet.
- Scalability: more devices means more requests to the cloud, thereby increasing the latency.

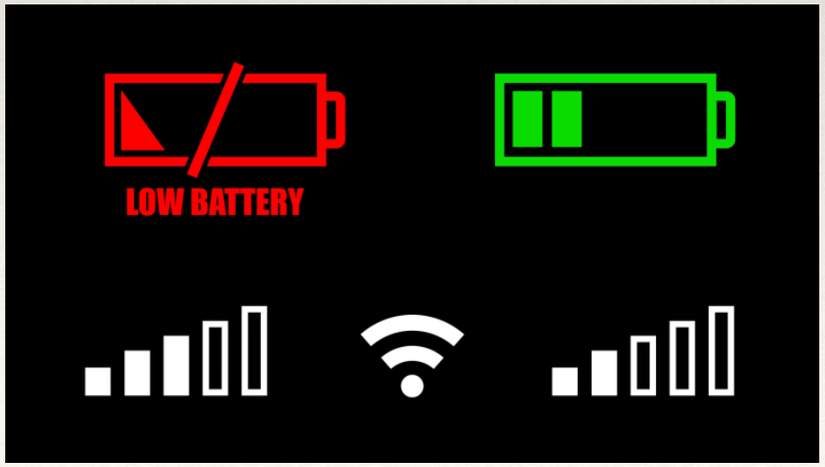


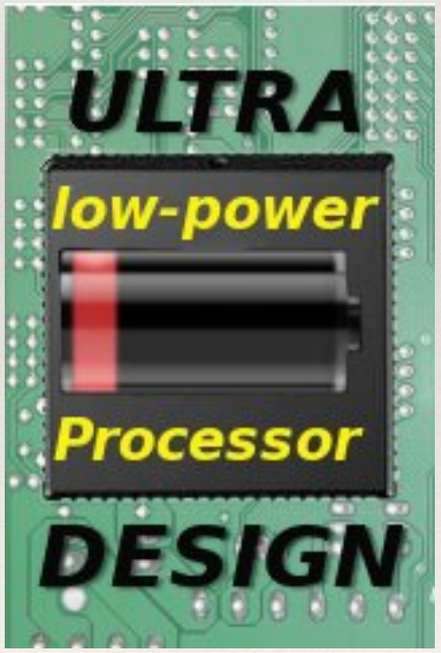
Source: Cisco IBSG projections, UN Economic & Social Affairs http://www.un.org/esa/population/publications/longrange2/WorldPop2300final.pdf

Contraintes de consommation

- Communication consumes a lot of power, and IoT devices are battery powered. They thus cannot afford to communicate all the time.







Security

- As we gain benefits from the IoT, we must not forget about safety. As both the creators and recipients of the IoT, we must design for safety. This includes the safety of our personal data and the safety of our physical well-being. Securing the endpoints, the networks, and the data moving across all of it means creating a security paradigm that will scale.

Des contraintes…

- Capacité de calcul
- Capacité de stockage
- Accessibilité
- Energie minimal
- Taille réduite
- Coût réduit

Les composants de l'IoT

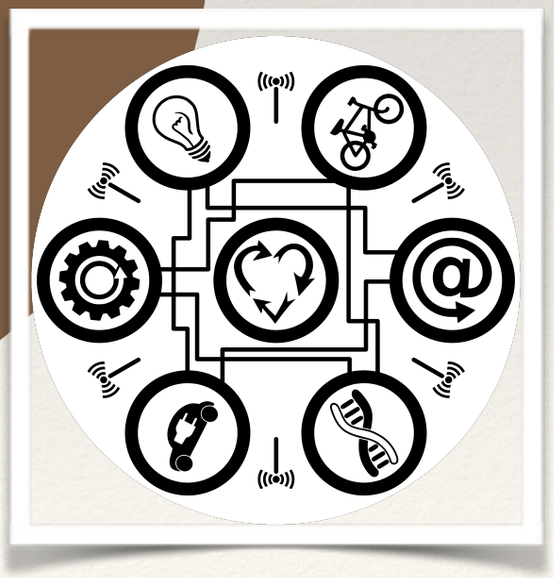
Composants

Personnes

Processus

IoT

Données



Objets

Les Objets

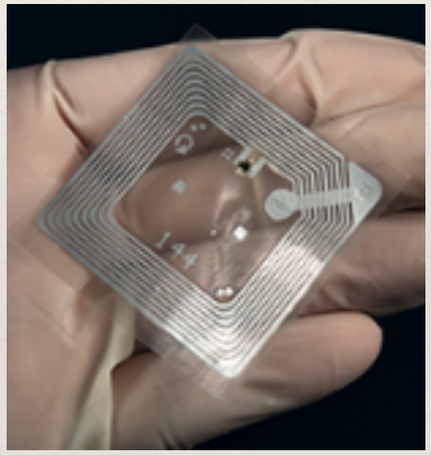
- Des dispositifs connus auxquels on se connecte sans-fils, comment ?
- Ordinateur portable, smartphone, tablette
- Comment ? WiFi, Bluetooth,…

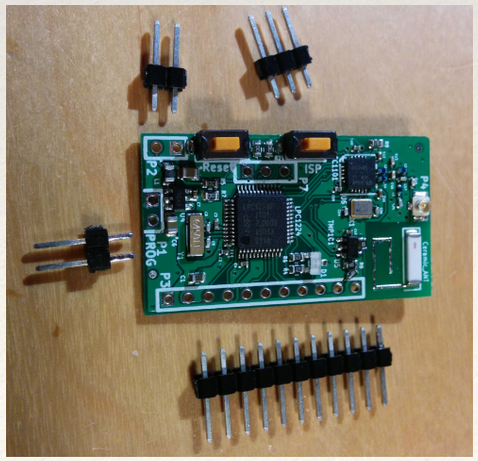




Les Objets …aussi

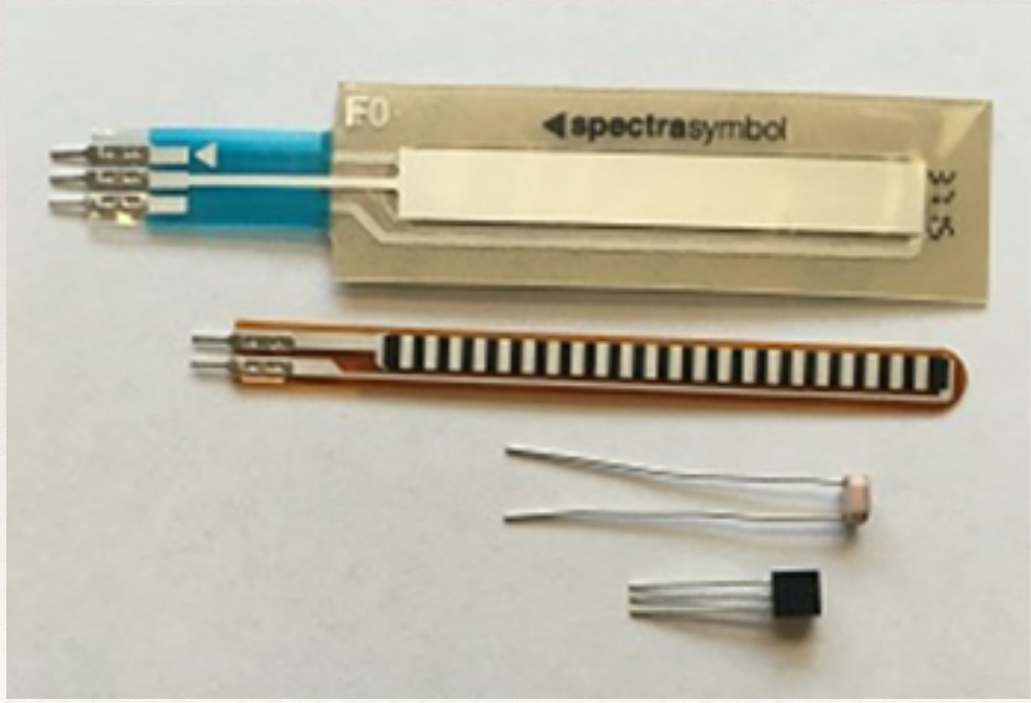
- Capteurs
  - Monde physique vers signaux électriques
- RFID
  - Identifier et suivre les objets marqués
- Contrôleurs
  - Collectent données des capteurs et envoient vers internet





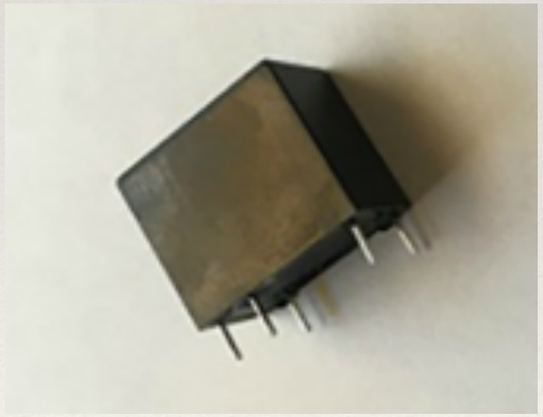
Les Objets : Capteurs

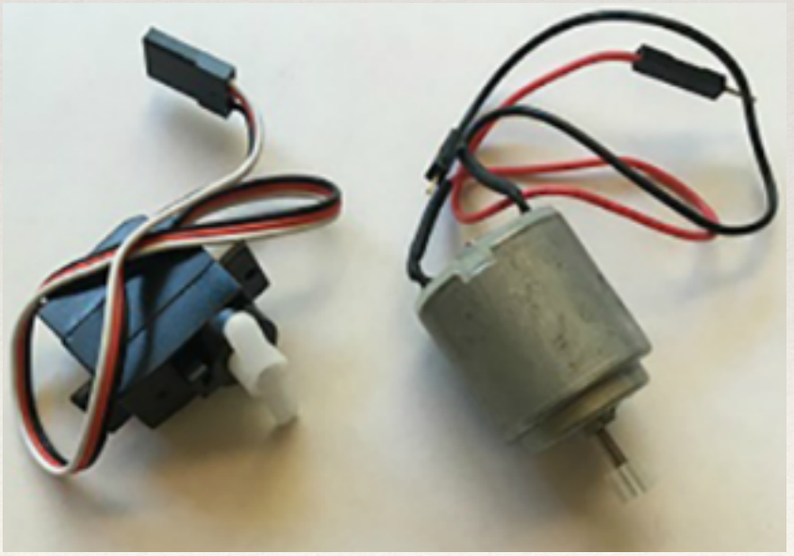
- Dispositif qui detecte un événement de l'entourage physique et répond avec des signaux physiques ou optiques.
- Exemples: lumière, température, pression,…



Les objets : Acteurs

- Dispositif responsable de donner une réponse vers l'environnement.
- Exemple: moteur, relais, LED,…





Contrôleurs

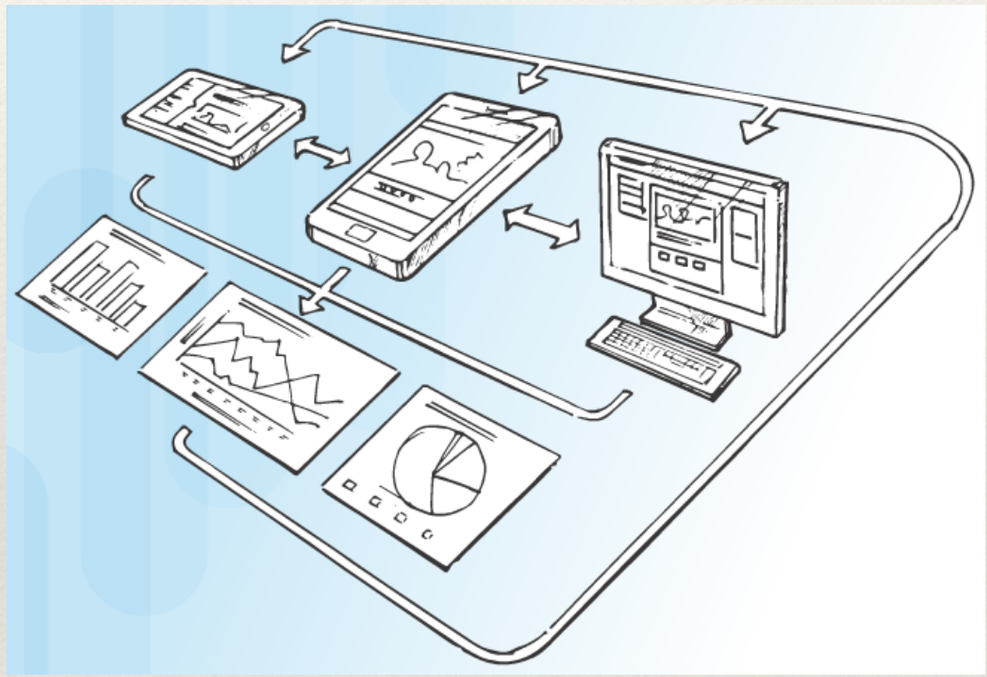
- Chargés de collecter les données depuis les capteurs.
- Peuvent prendre des décisions locales.
- Envoient des données vers des passerelles plus puissantes.

Les Données

- C'est quoi les données ?
  - ✓ Valeur donnée à tout ce qui est autour de nous.
  - ✓ En électronique: 0 ou 1 (bits)
  - ✓ Transmission plus fiable
- Comment elles sont gérées ?
  - ➡ Structurellement
  - ➡ Non structurellement
- Stockage ?
  - ➡ Local, centralisé, distribué.

Personnes

- Le comportement adapté à l'information
  - ✓ Décisions mieux informées
  - ✓ Actions appropriées

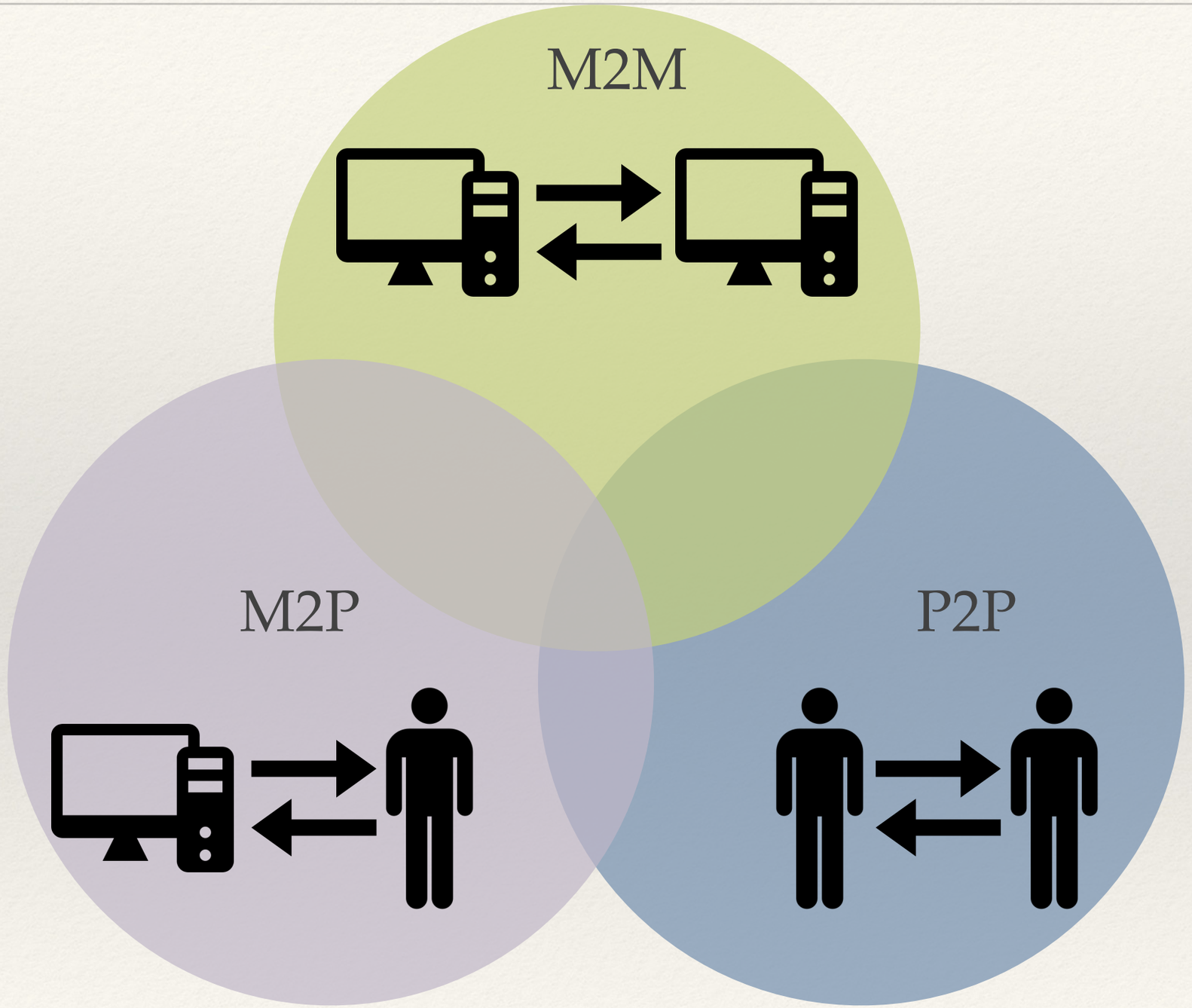


- Retour d'actions en boucle
  - ✓ Information en temps-réel suite à une action
  - ✓ Donner actions pour modifier un comportement

Les entreprises

- Comment utiliser les données ?
  - ✓ Nouvelles offres selon les besoins des clients
  - ✓ Marketing ciblé
  - ✓ Micro-marketing
- Collaboration avec les clients

Les Processus



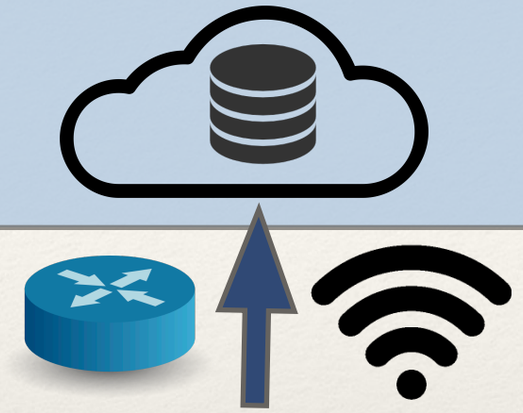
Information opportune et relevante

TP 1

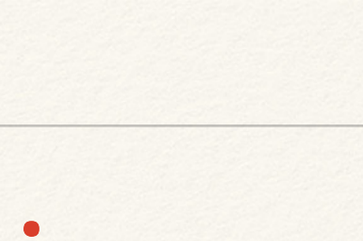
Coder un micro-contrôleur

Architecture

Internet

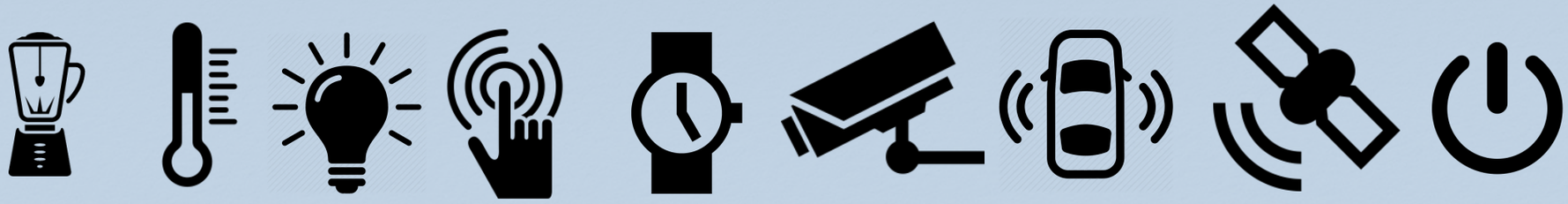


Passerelles

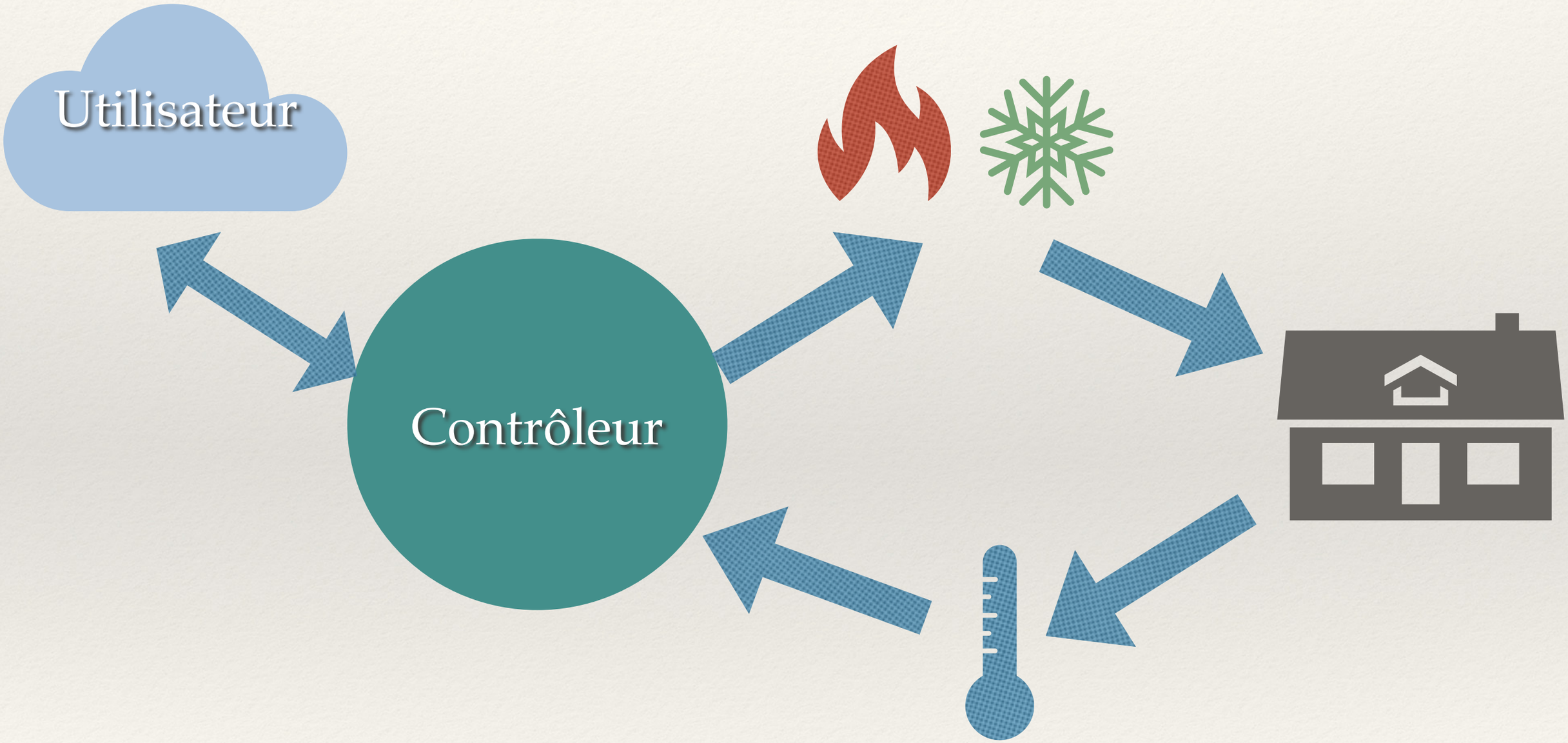


Contrôleurs

Objets



Température dans une pièce



Protocoles d'acquisition des données physiques

Protocoles lecture/écriture

- Numérique : HIGH - LOW
- Analogique : associe une valeur numérique aux nombres de bits ADC spécifique au contrôleur.
- Bus I2C
- Bus SPI

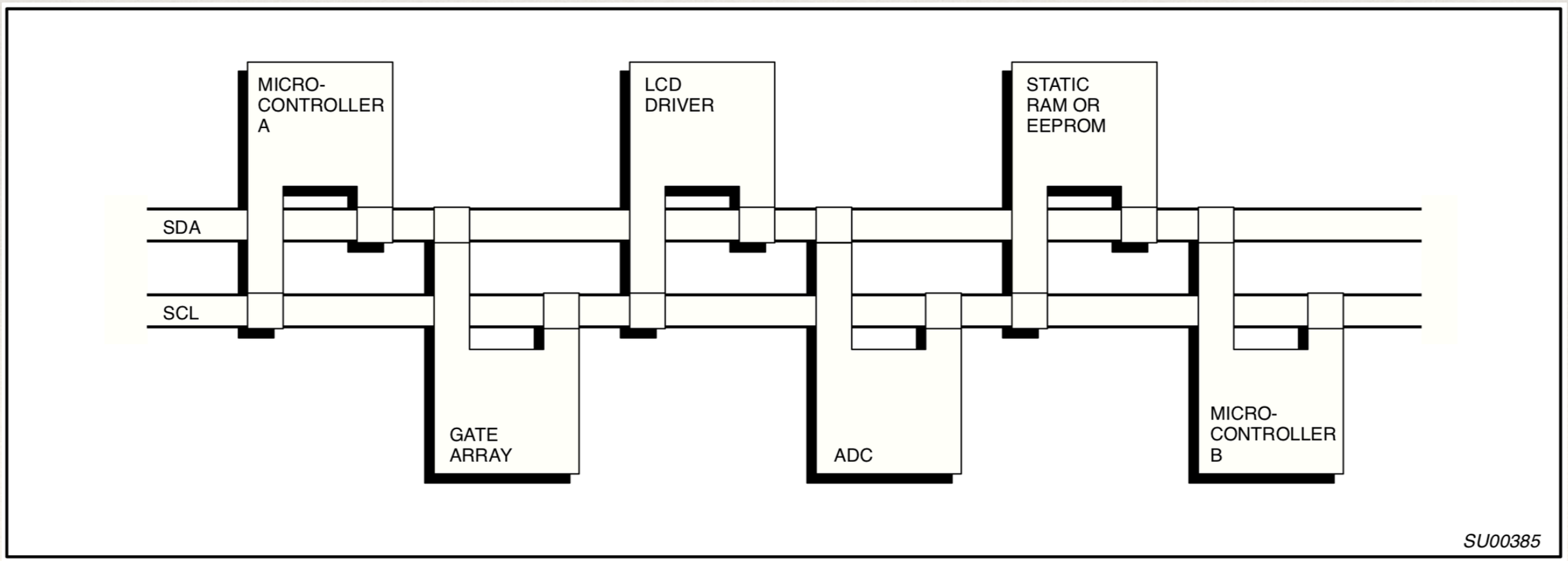
I²C

- I2C: Inter Integrated Circuit
- Développé par Philips en 1982 pour relier composants télé
- Maintenue par NXP
- Réduit le nombre de lignes à 2 (SDA, SCL)

`http://www.i2c-bus.org/fileadmin/ftp/i2c_bus_specification_1995.pdf`

I²C (suite)

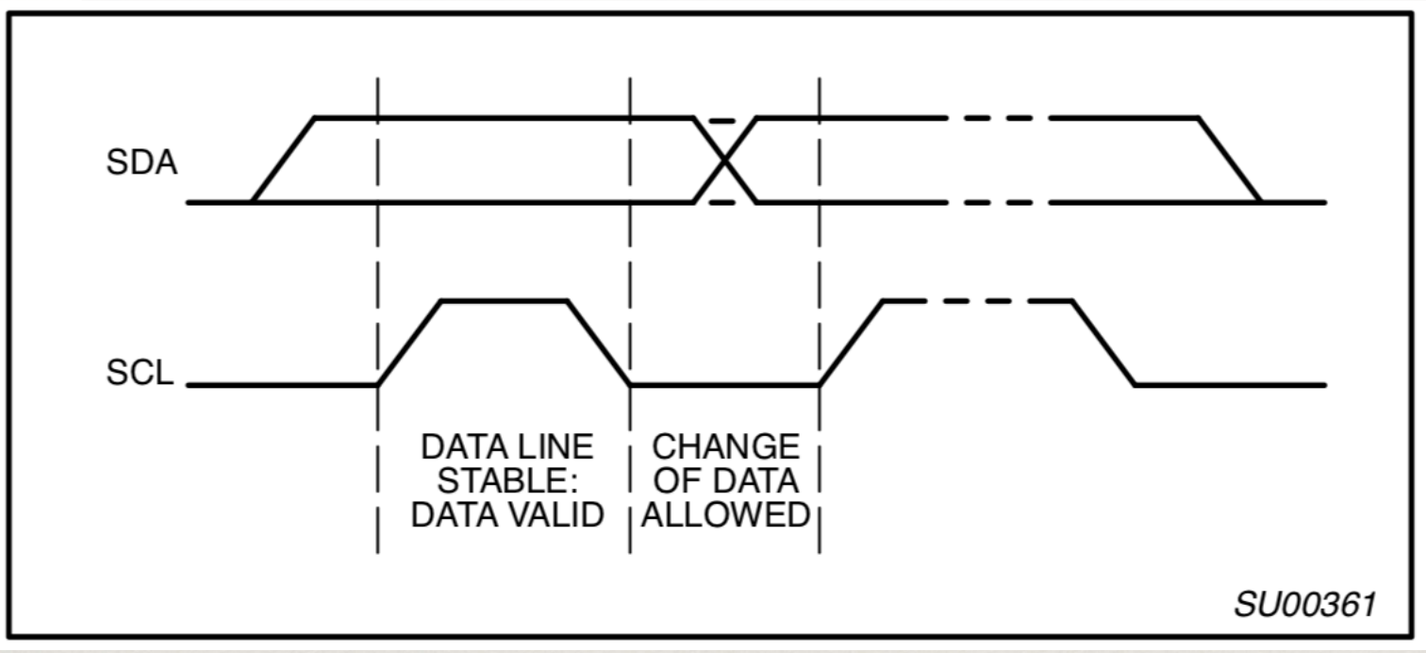
- SDA : Serial Data Line
- SCL : Serial Clock Line
- Chaque dispositif a son adresse



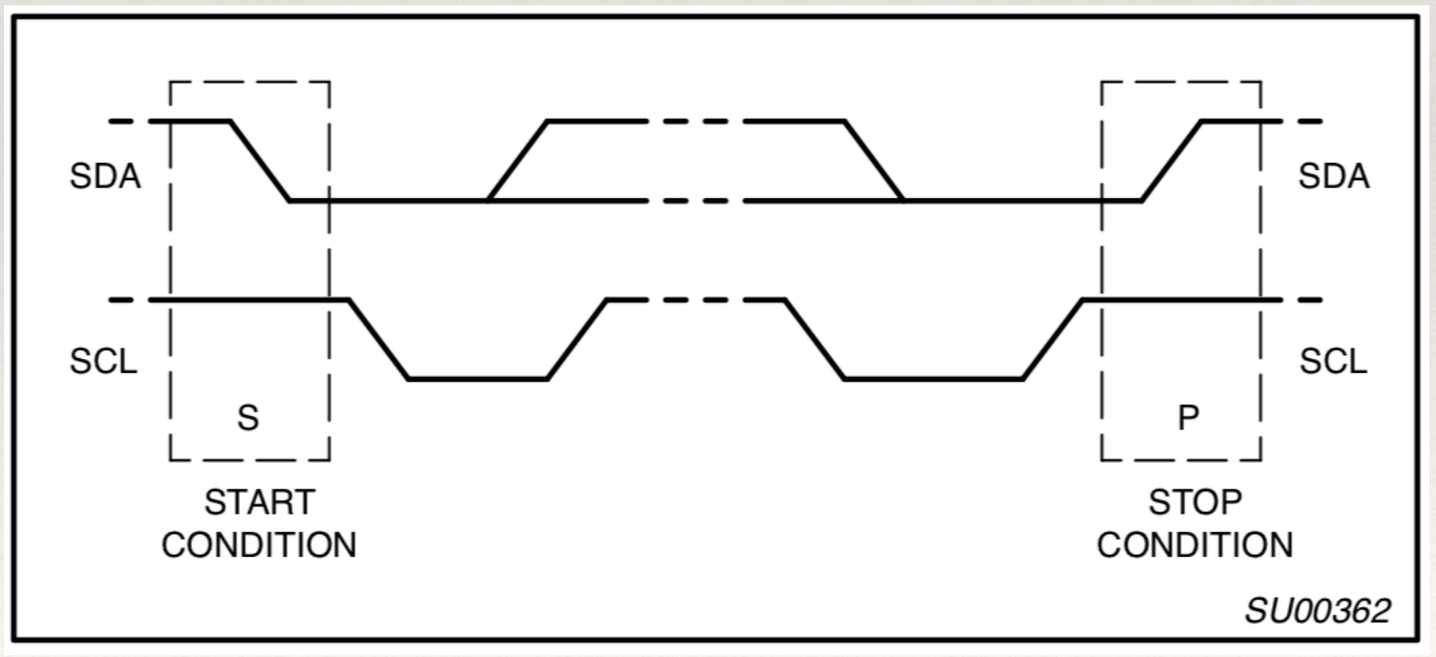
I²C (suite)

- Vitesse fixée par l'horloge du maître (jusqu'à 1Mbps en FM+)
- Taille de messages fixée à 8 bits
- Plusieurs maîtres sont possibles
- Seulement un maître à un instant donné
- Detection de collisions et arbitrage

I²C (suite)



Envoi de données

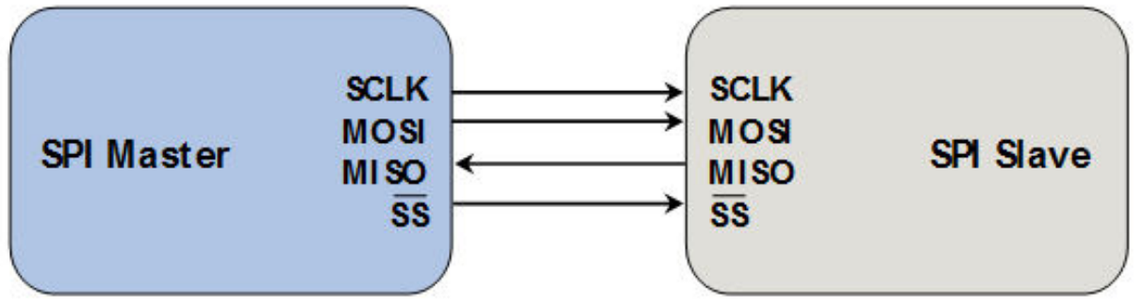


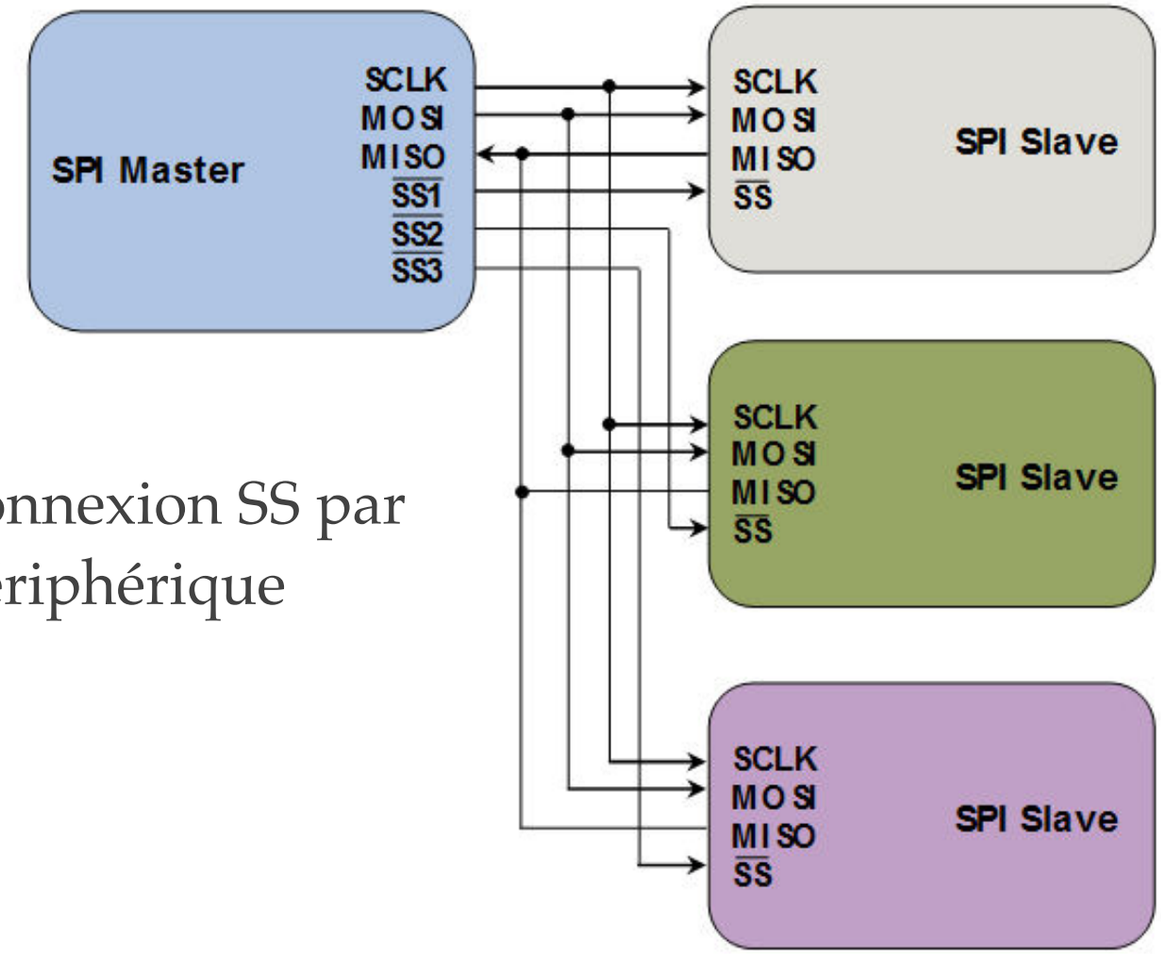
Démarrage et arrêt de transmission

SPI

- SPI : Serial Peripheral Interface
- Développé par Motorola dans les années 1980
- Bus série 4 fils
  - SDO : Serial Data Out (MOSI)
  - SDI : Serial Data Input (MISO)
  - SCK : Serial Clock
  - SS : Slave Select

SPI (suite)



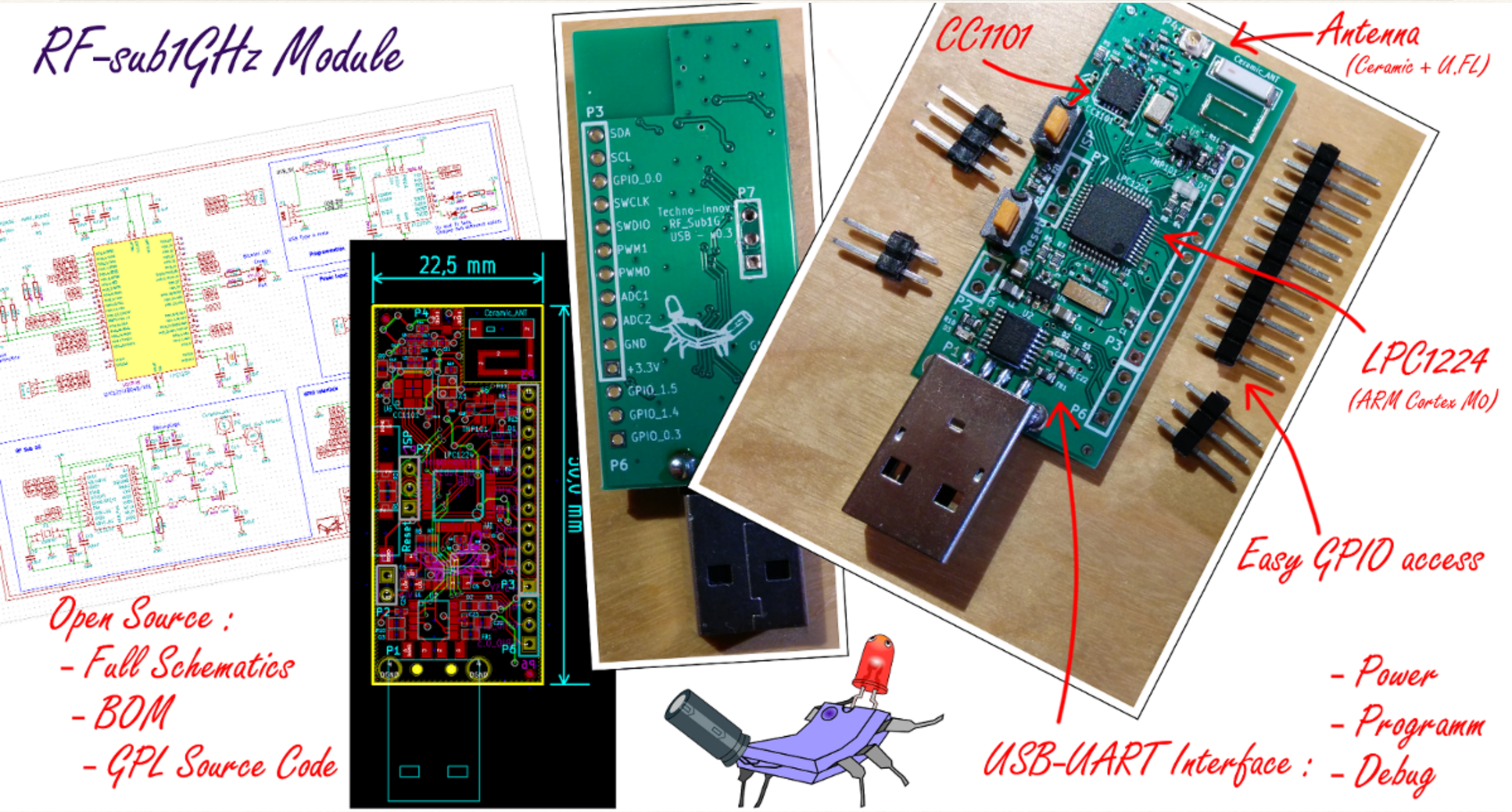


Une connexion SS par périphérique

SPI (suite)

- Full duplex communication
- Meilleure vitesse que I2C / cycles d'horloge non limités
- Taille arbitraire du message
- Pas besoin d'adresse du périphérique
- *De facto* standard

Module RF-sub1GHz



À ne pas oublier…

- Micro-contrôleur toujours connecté quand la VM est en exécution
- Dans la VM : /dev/ttyS3, dans l'hôte : /dev/ttyUSB0
- Sauvegarder votre code !

Questions ?