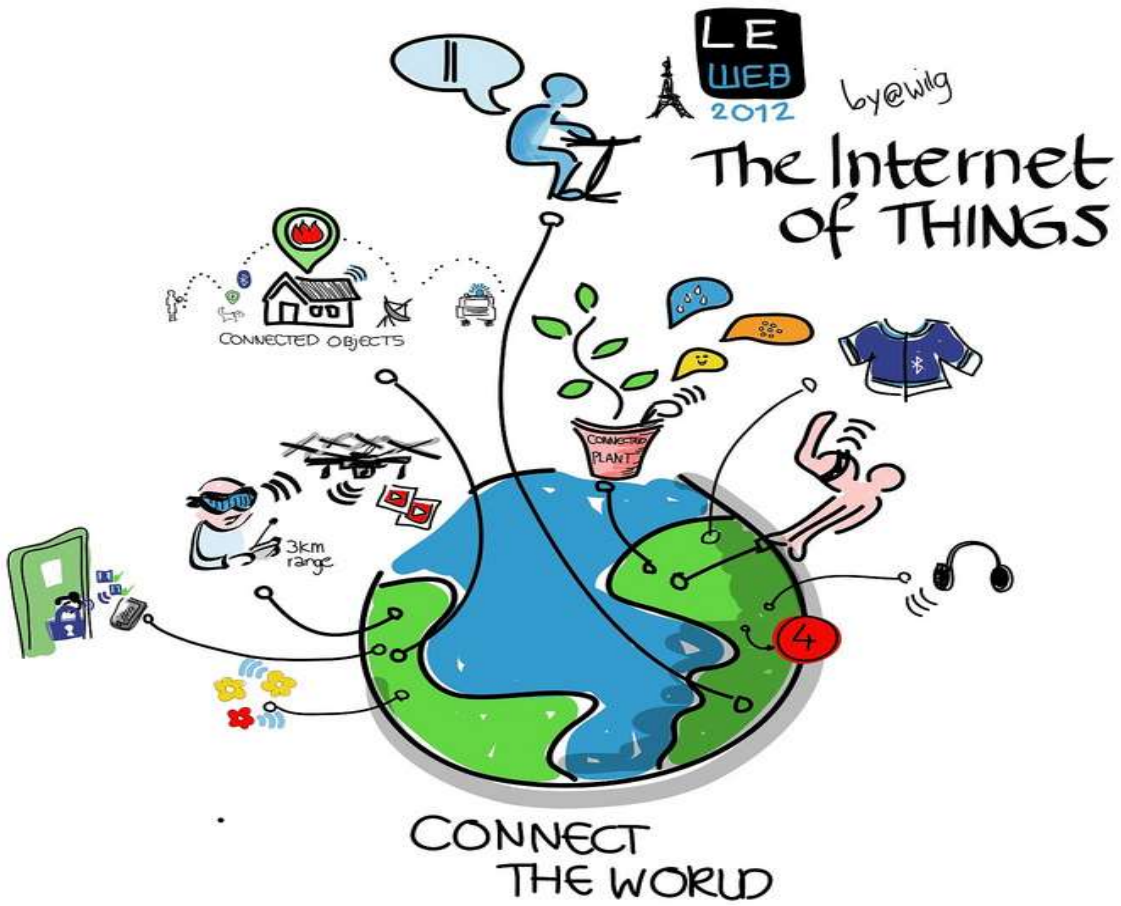
Computer Systems

Lecture : Internet of Things

What is the Internet of Things??



What is the Internet of Things??

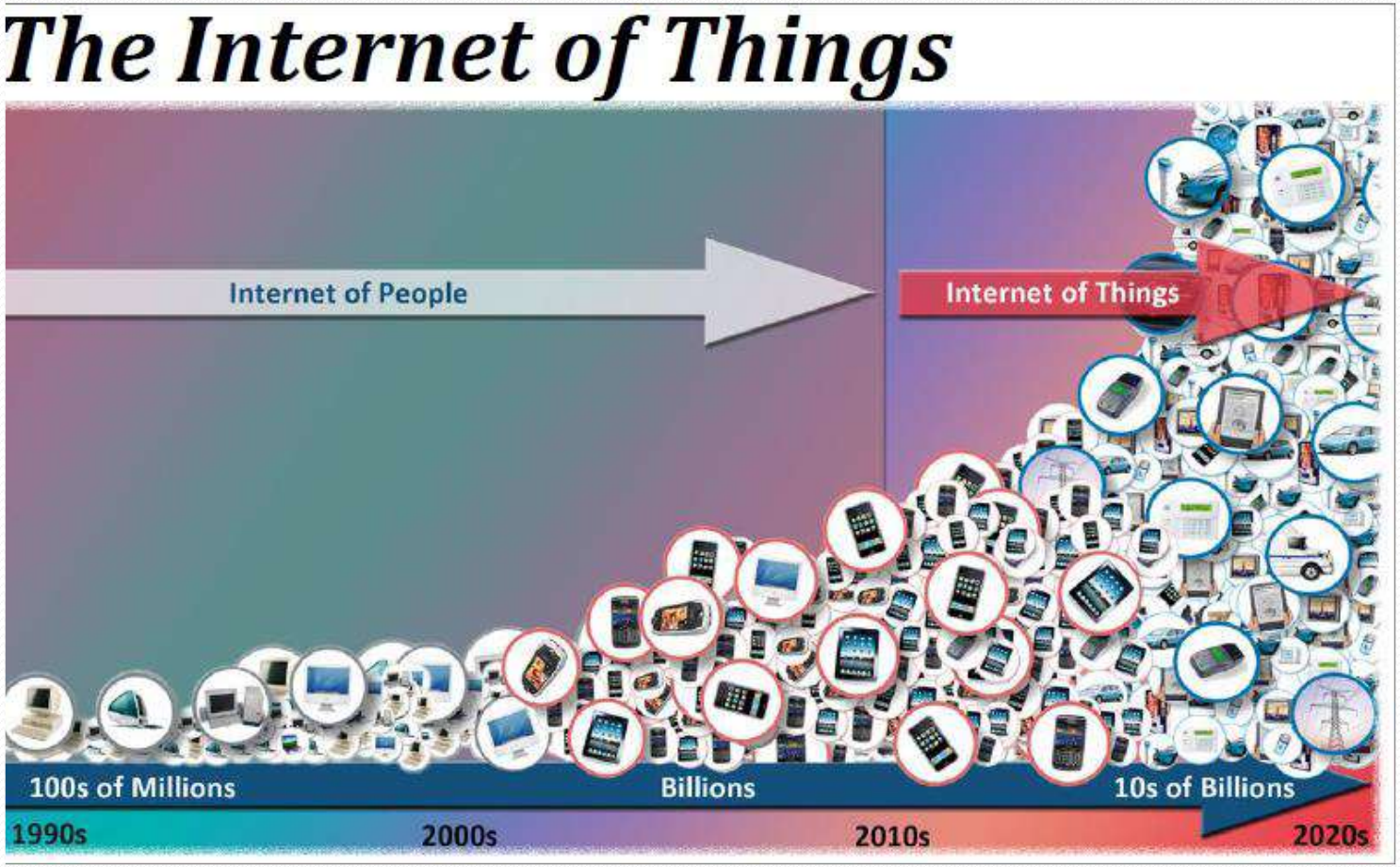
The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

IoT has evolved from the convergence of wireless technologies, micro-electromechanical systems (MEMS), microservices and the internet.

Internet connects all people so it is called the “Internet of People”

IoT connects all things so it is called “Internet of Things”

The Internet of Things



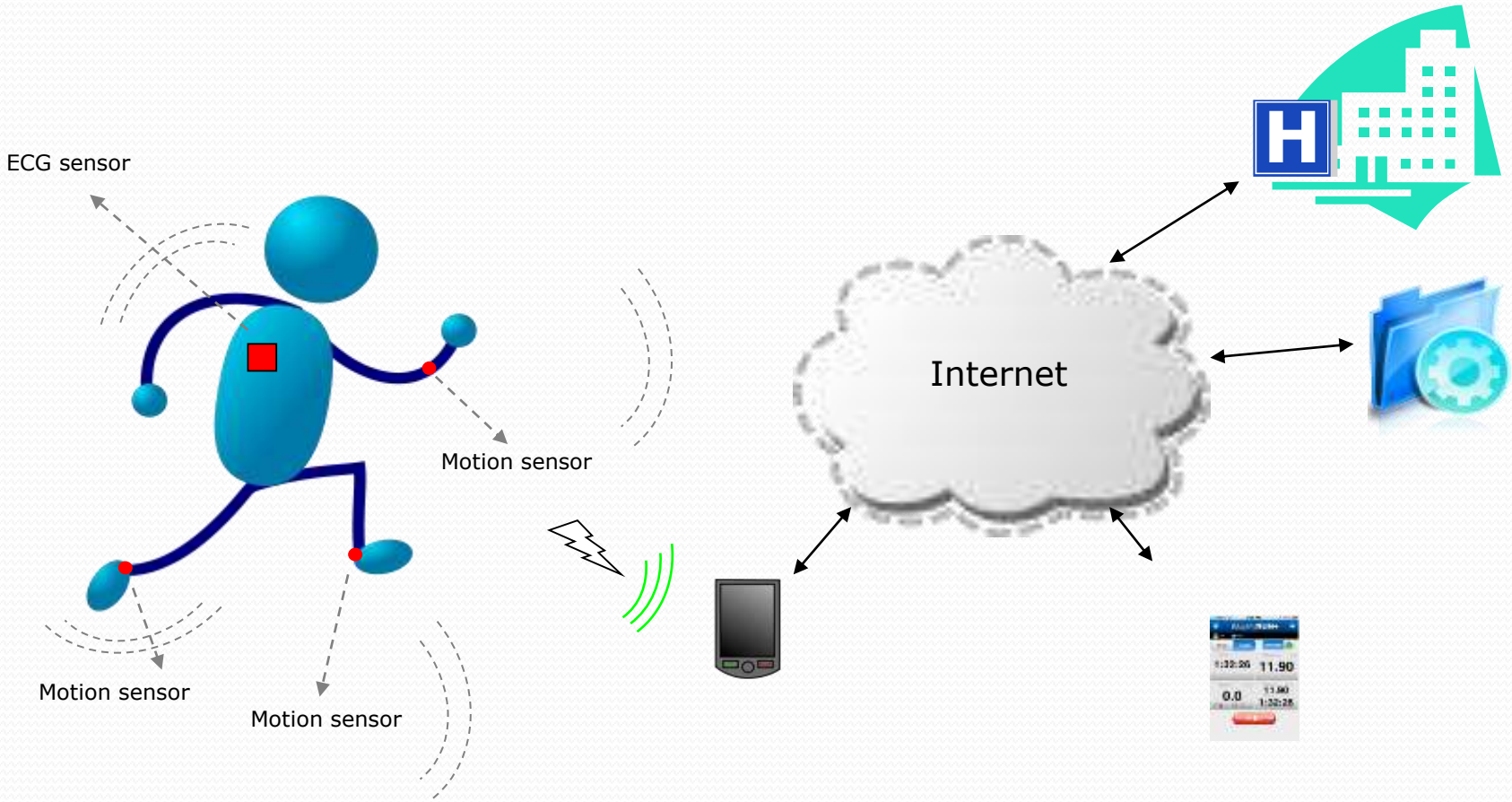
Sensor Devices Are Becoming Widely Available

- Programmable devices
- Off-the-shelf gadgets/tools

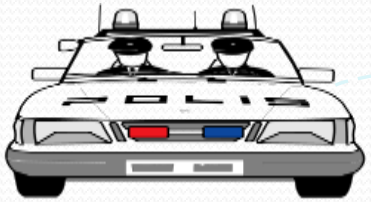
More “Things” Are Being Connected

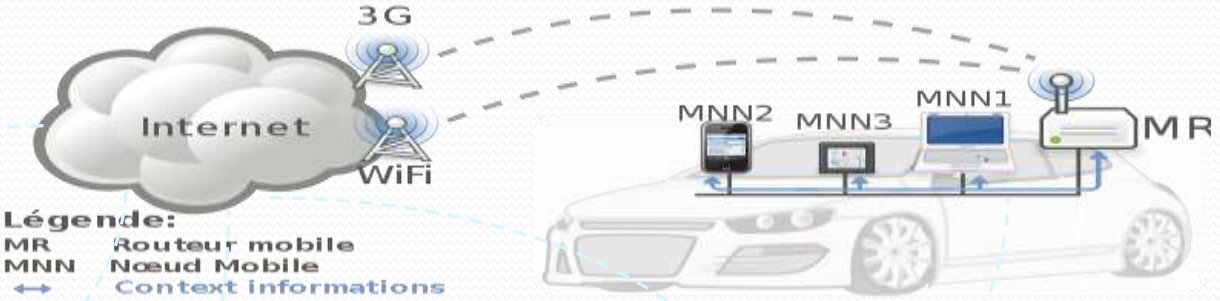
Home/daily-life devices
Business and
Public infrastructure
Health-care
…

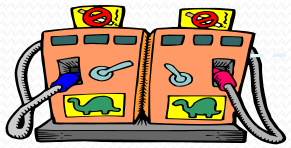
People Connecting To Things

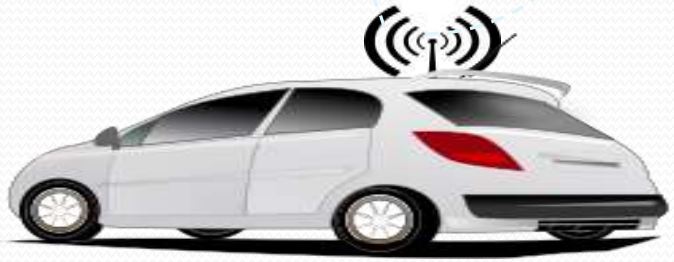


Things Connecting To Things



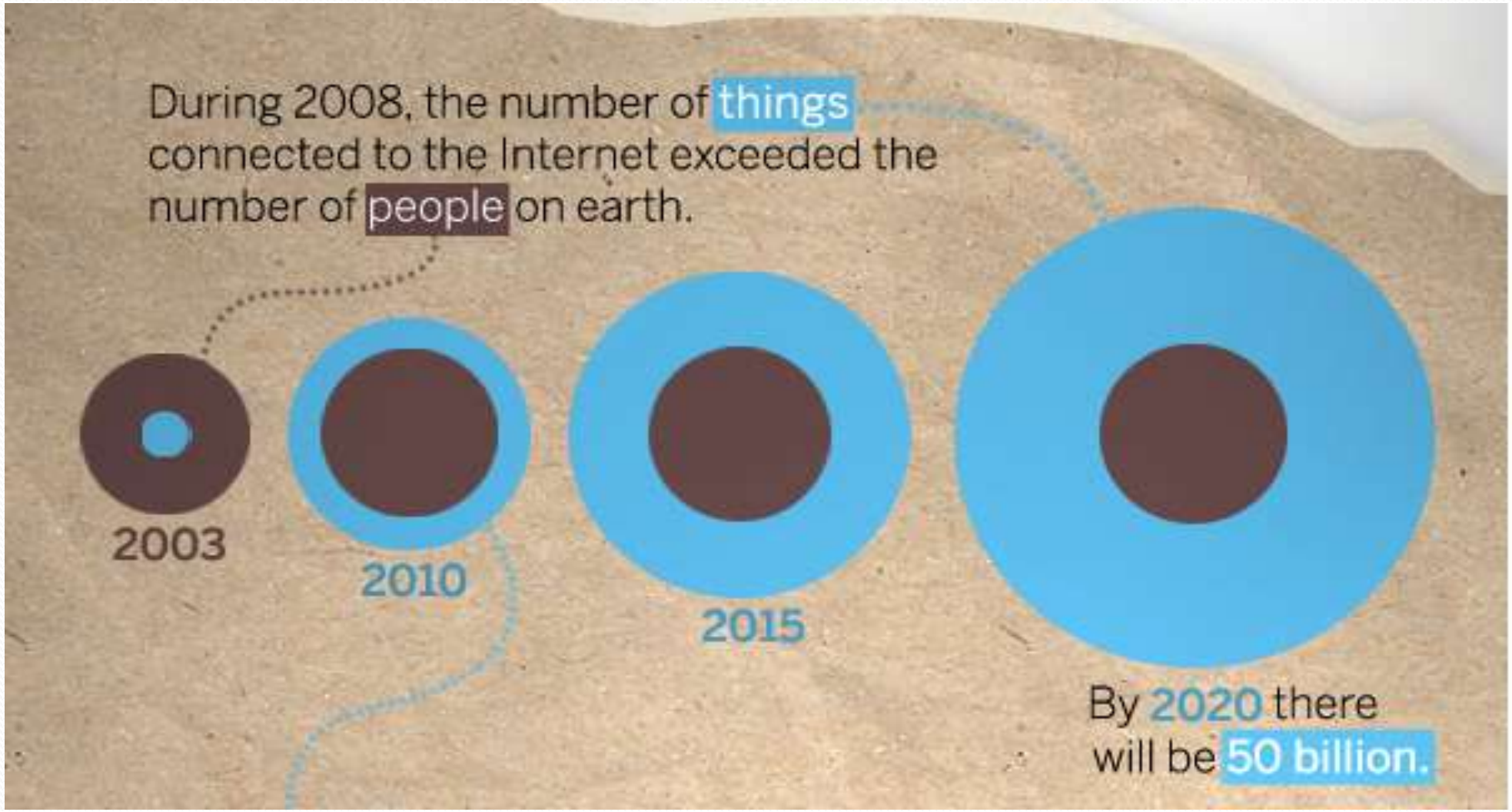






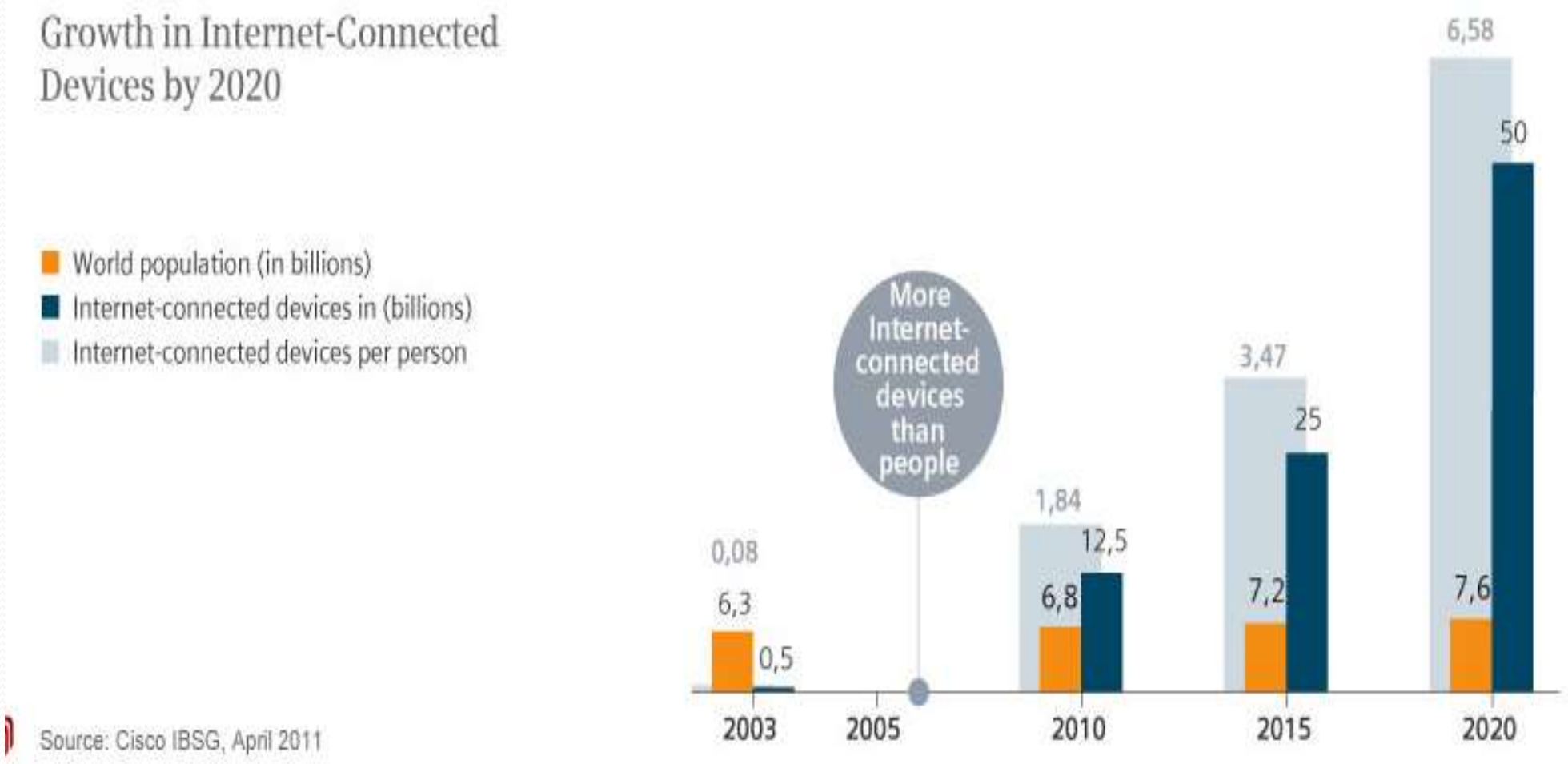
- Complex and heterogeneous resources and networks

“Thing” Connected To The Internet

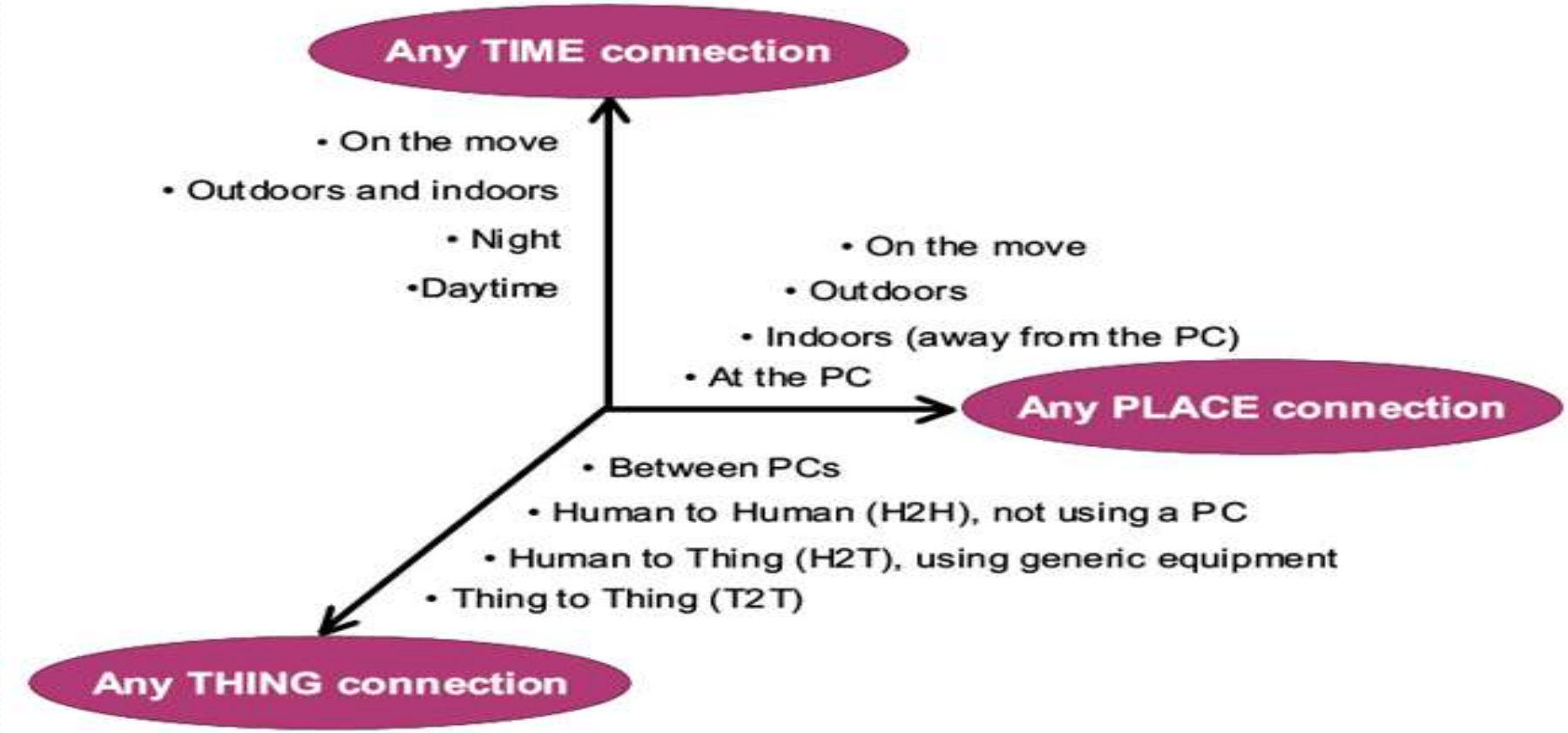


Smart Product Sales

Internet Connected Devices

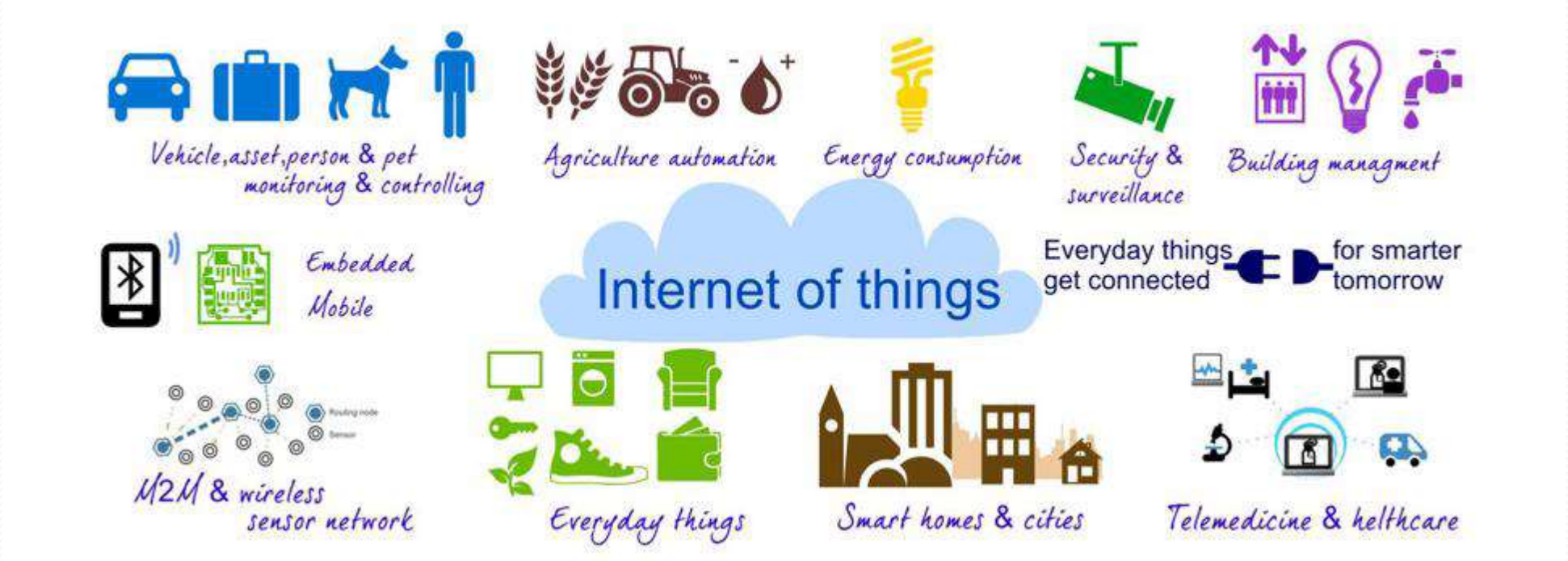


Future Networks



Source: ITU adapted from Nomura Research Institute

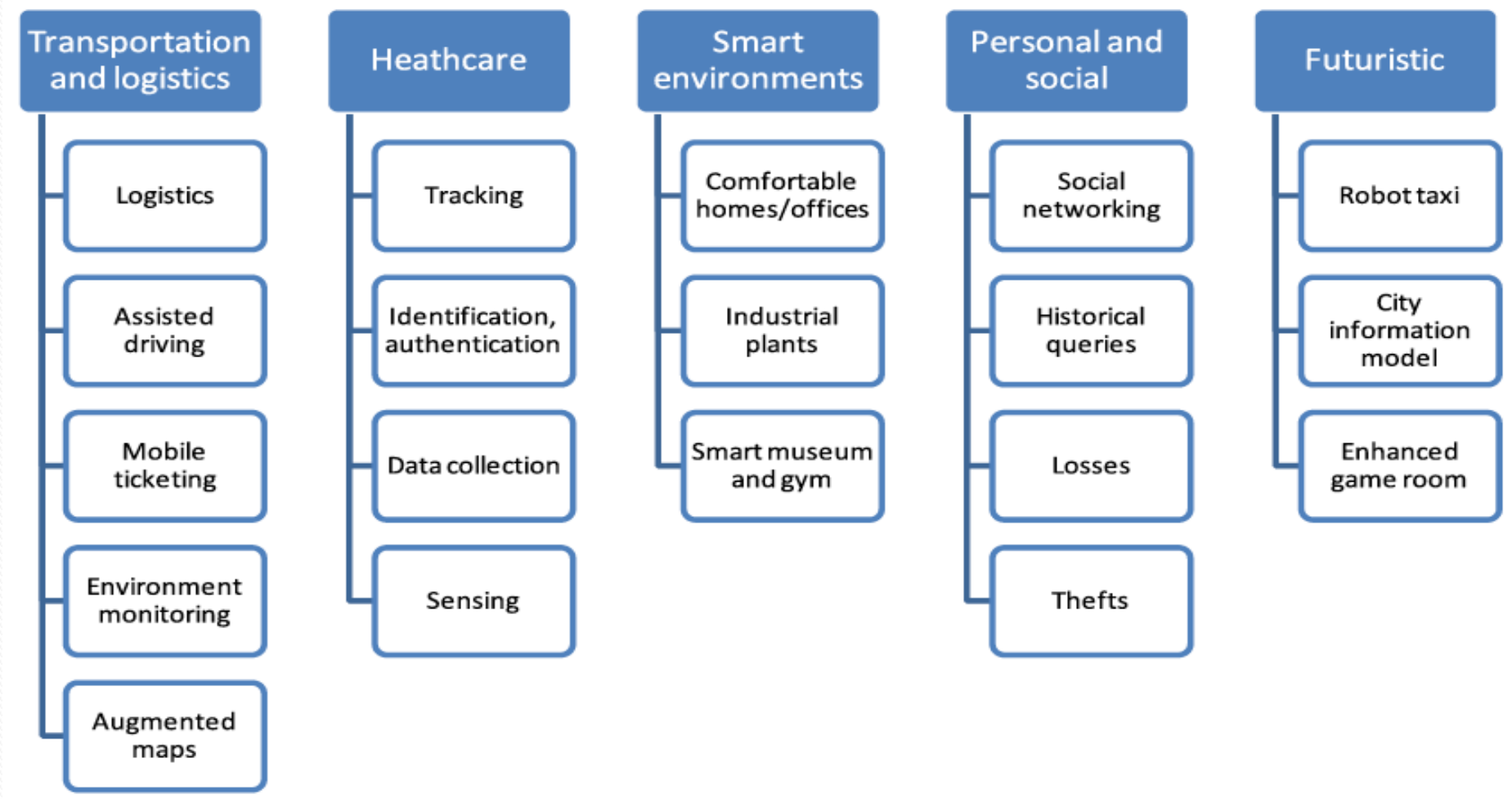
Applications



Several different domains

- – Transportation and logistics
- – Healthcare
- – Smart environment (home, office,etc.)
- – Personal and social domain

Applications



Healthcare Applications

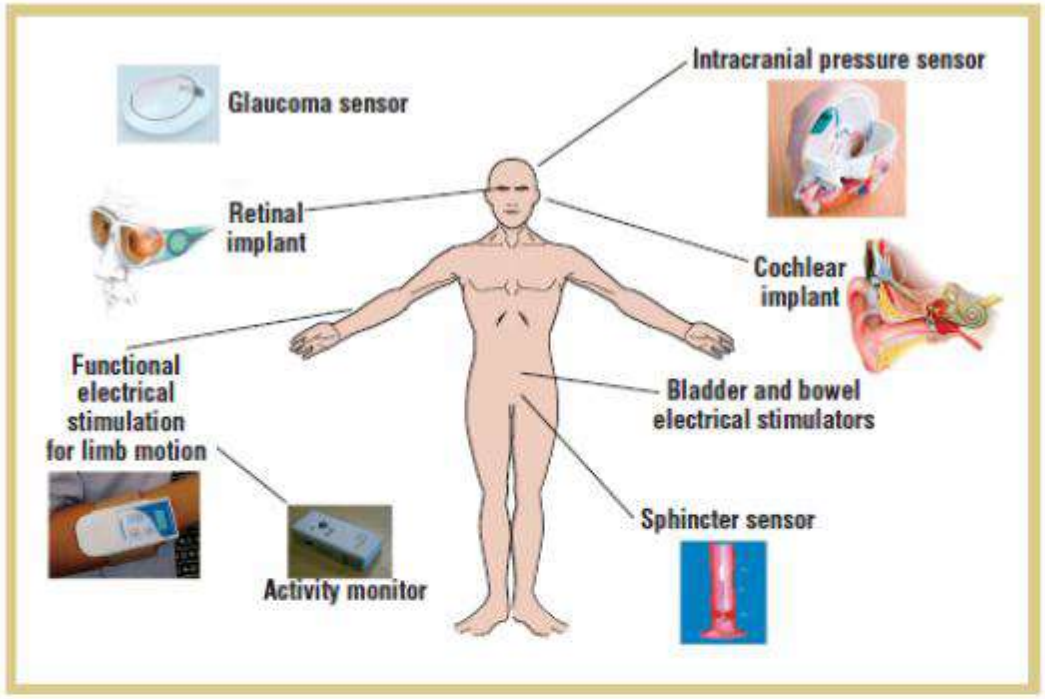
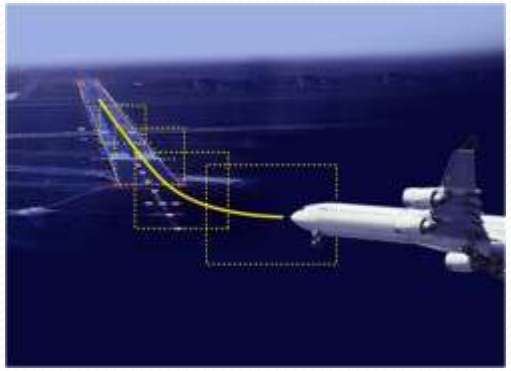


Figure 6. Fully implantable wireless sensor for the intracranial pressure monitoring system.

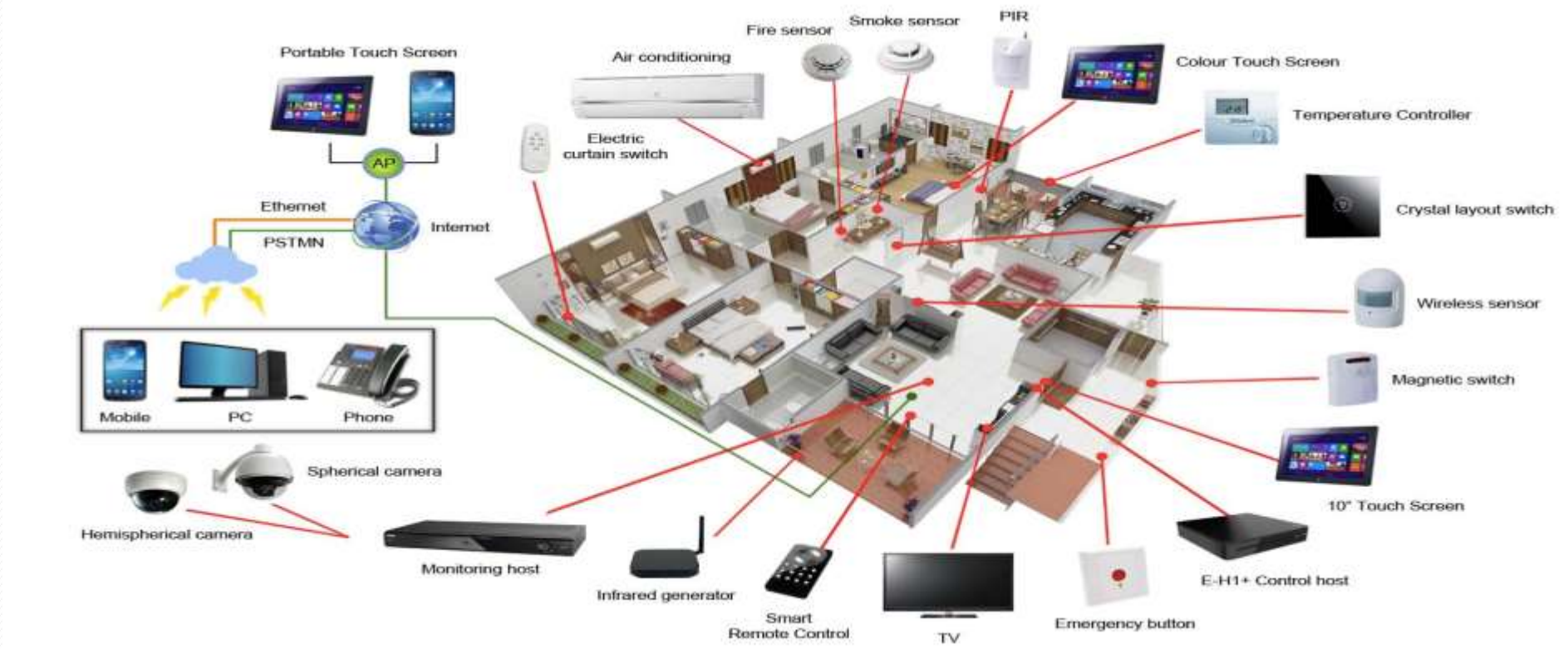
- Various sensors for various conditions.
- Sensors can be implanted anywhere in the body.
- Sensor and associated electronics encapsulated in safe and biodegradable material.
  - Even biodegradable pills with sensors.
- External RF reader powers the sensors and receives the signals.
- Home monitoring and control
  - Doctors can take blood pressure readings, record motions etc.
- Reduces patient visits to hospitals.

Transportation Applications

- Vehicle control:
  - Airplanes, automobiles, autonomous vehicles
  - All kinds of sensors to provide accurate, redundant view of the world
  - Several processors in cars (Engine control, break system, airbag deployment system, windshield wiper, door locks, entertainment system, etc.)
  - Actuation is maintaining control of the vehicle
  - Very tight timing constraints and requirements enforced by the platforms



Smart Home Applications



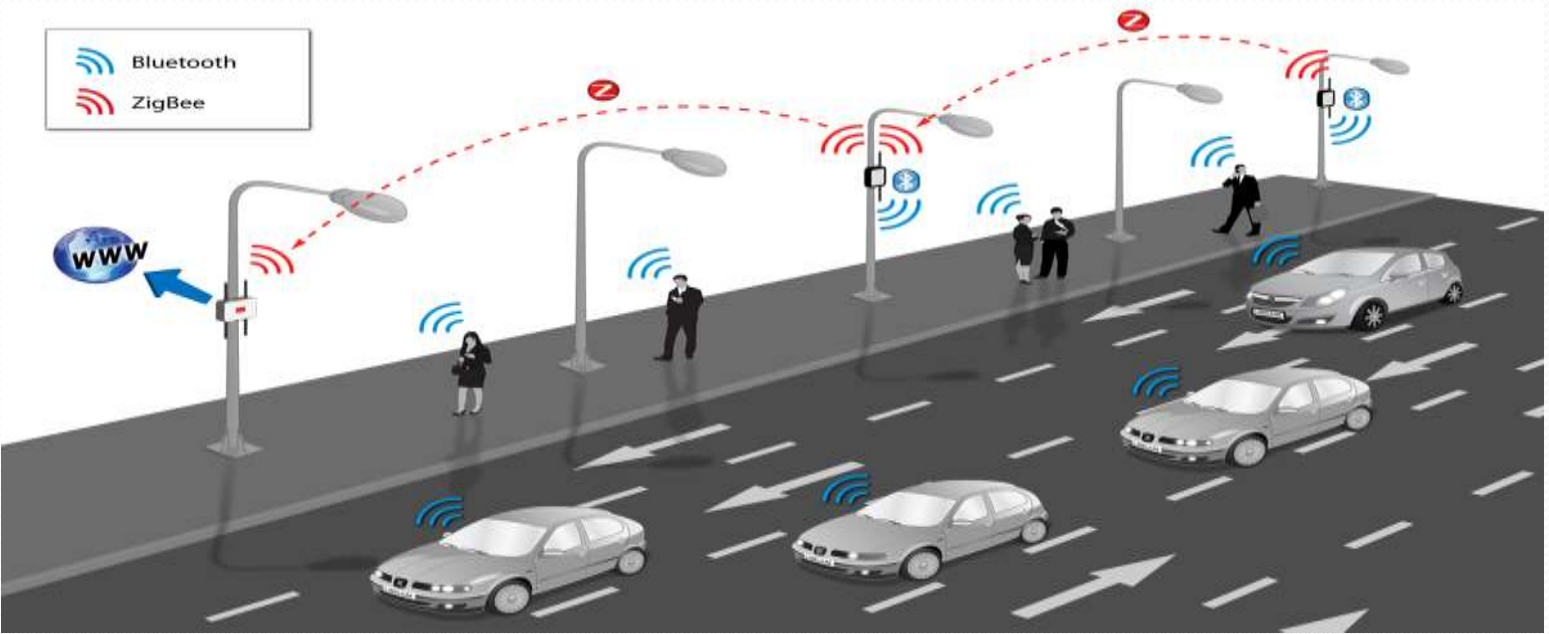
- Smart meters, heating/cooling, motion/temperature/ lighting sensors, smart appliances, security, etc.

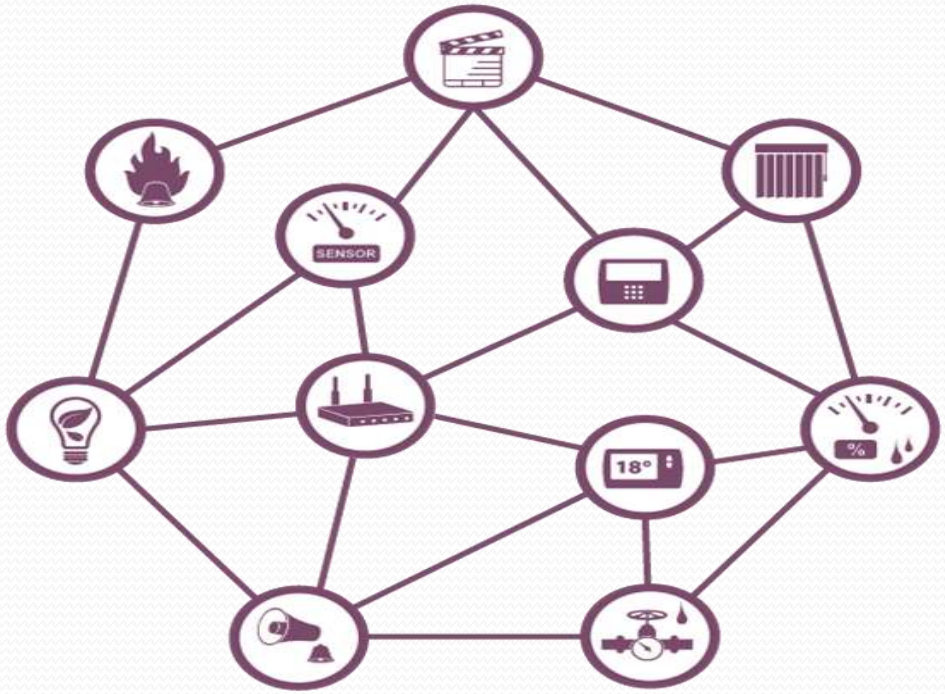
ZigBee / Z Wave

- Two different types of wireless technology available for smart device communication / home automation.
- Low strength, low power, low bandwidth.
- WiFi for large amount of data, Bluetooth for medium amount of data, ZigBee and Z-Wave for small data.
- ZigBee and Z-Wave are completely different and do not work with each other. So for devices to communicate with each other, they are all ZigBee devices or Z-Wave devices.
- ZigBee is an open standard where as Z Wave is not.

ZigBee / Z Wave

- ZigBee and Z-Wave signals use a mesh network to function.
- For data to get to it's destination, it can hope from one device to another until it arrives at it's destination or a router to forward it on.
- Devices must be close by each other.





Smart Hubs

- ZigBee / Z Wave devices cannot connect directly to WiFi.
- For ZigBee / Z Wave devices to connect to WiFi we require specialised smart hubs connected to the Wifi network.

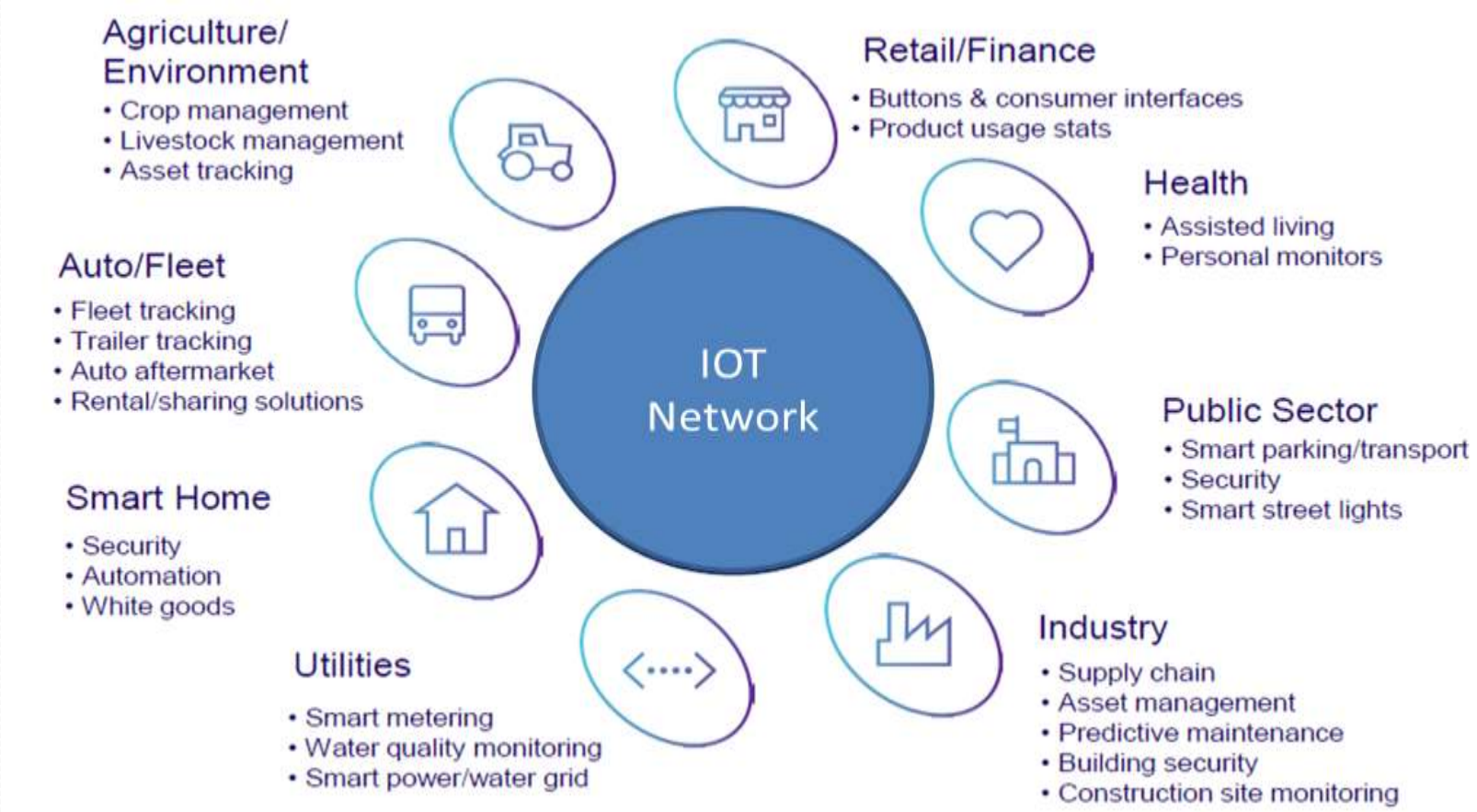
Smart House


Home Automation
All controlled by Smartphone or Tablet
Lights
Speakers
Window Shades
Laptop
TV
Tablet
Exterior Lighting
Pool & Spa
Thermostat
Smoke Alarm
Garage Door
Lights
Refrigerator
Speakers
TV
Irrigation System
Video Surveillance
Door Locks
Wi-Fi Router
Power Meter
Source: Raymond James research.

Smart Speakers

- Voice activated smart speakers that connect to cloud based Virtual Assistant.
- Also have integrated support for home automation.
- Amazon Echo Plus comes with a Zigbee hub built in.
- Apple and Microsoft to announce their own versions in the future.

Business Opportunities



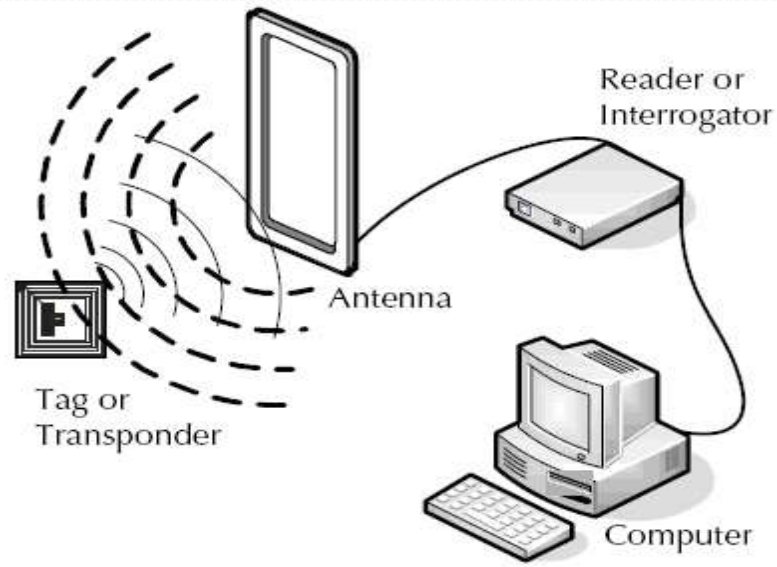
IoT Stadium – Croke Park

- Pitch monitoring: 7 million images and 970 Gb of light exposure and moisture have been generated through sensors and outdoor IP cameras to provide datasets for pitch automation, management, and maintenance.
- Flood management: rain gauges, weather stations, sewer sensing, sewer watt level sensing, and water tank sensing have all been installed in the Croke Park area to forecast and detect flooding risks.
- Crowd management: use of calculated crowd motion patterns to provide collectiveness, conflict and stability indexes for forecasting transportation flows, identifying congestion patterns during events as well as describing and detecting abnormal collective behaviour.
- Athlete performance monitoring: wearable sensing RFID tags in the athletes' sports clothes produce real time performance statistics during matches.

Networking And Communication

RFID

- The reduction in terms of size, weight, energy consumption, and cost of the radio takes us to a new era
- This allows us to integrate radios in almost all objects and thus, to add the world “anything” to the above vision which leads to the IoT concept
- Composed of one or more readers and tags
- RFID tag is a small microchip attached to an antenna
- Can be seen as one of the main, smallest components of IoT, that collects data



Networking And Communication

- Telecommunication systems
  - Initial/primary service: mobile voice telephony
  - Large coverage per access point (100s of meters – 10s of kilometers)
  - Low/moderate data rate (10s of kbit/s – 10s of Mbits/s)

- WLAN
  - Initial service: Wireless Ethernet extension
  - Moderate coverage per access point (10s – 100s meters)
  - Moderate/high data rate (Mbits/s – 100s)
  - Examples: IEEE 802.11(a--g), Wimax

Networking And Communication

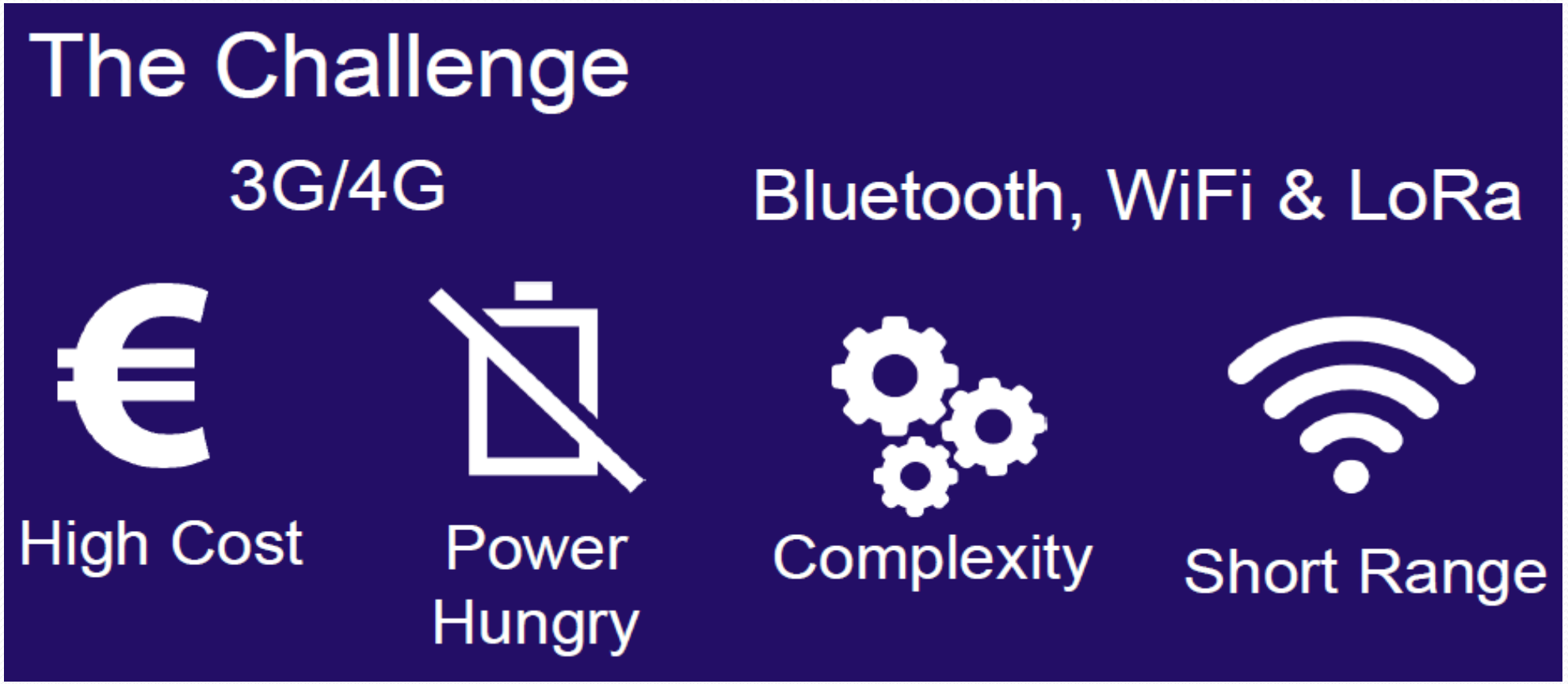
- Short range:
  - Direct connection between devices – sensor networks
  - Typical low power usage
  - Examples: Bluetooth, Zigbee, Z--wave (house products)

- Other examples:
  - Satellite systems
    - Global coverage
    - Applications: audio/TV broadcast, positioning, personal communications

- Broadcast systems
  - Satellite/terrestrial
  - Support for high speed mobiles

First Dedicated IoT Network In Ireland

- How do we connect devices to the network??

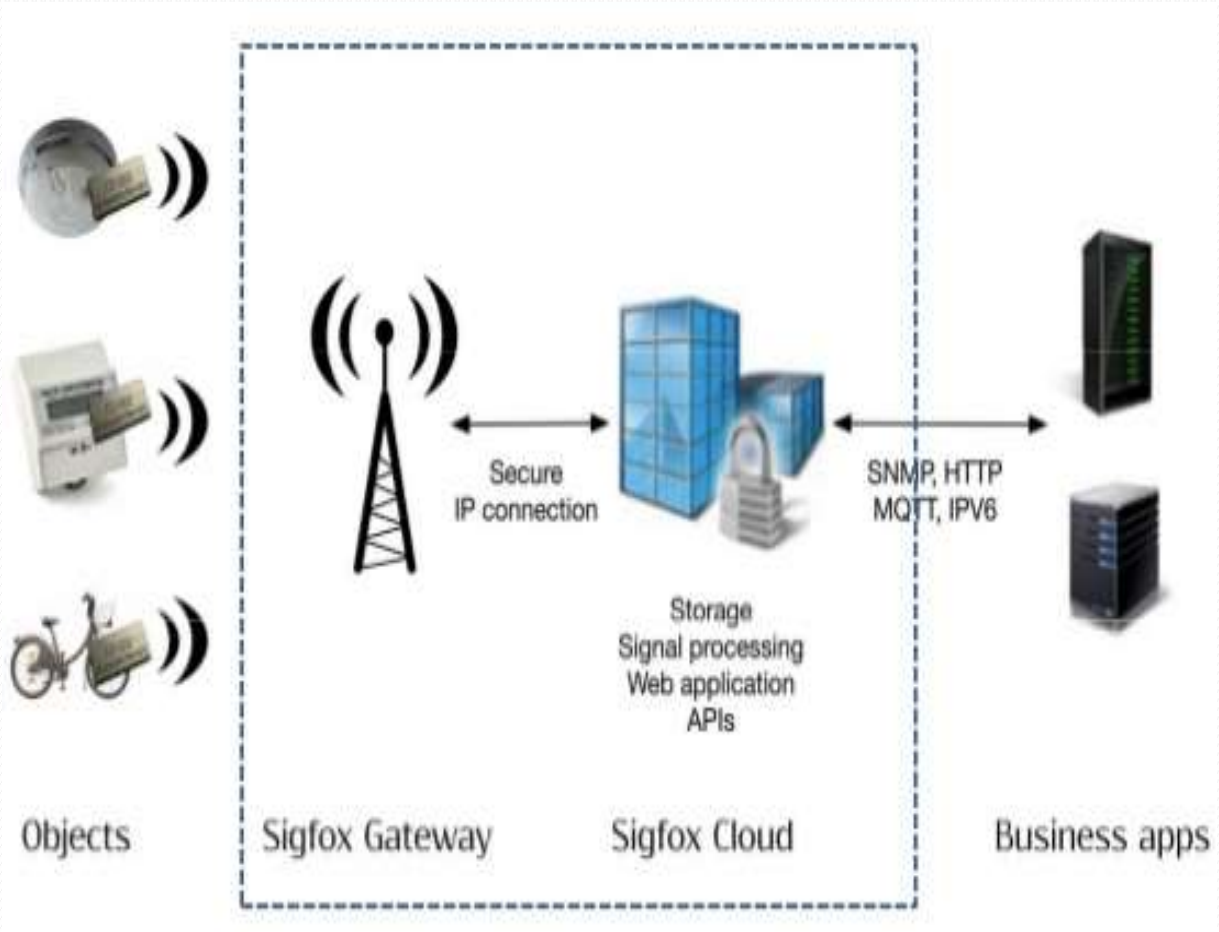


First Dedicated IoT Network In Ireland

By the end of 2017 more than 1 million devices connected in Ireland

First Dedicated IoT Network In Ireland

- Piggy backs into the RTE network.
- Using ISM (industrial, scientific and medical) radio band.
- Network covering 97% of Ireland.
- As soon as they are powered up, the devices are connected to the network.
- All the end-user has to do is start an account for their device so they can view the data it transmits to the cloud.



Driving Forces Of IoT

- Sensor Technology – Tiny, Cheap, Variety
- Cheap Miniature Computers
- Low Power Connectivity
- Capable Mobile Devices
- Power of the Cloud

1. Sensor Technology

Accelerometer
(4mm diameter)

Force Sensor
(0.1N – 10N)

Pulse Sensor
€15

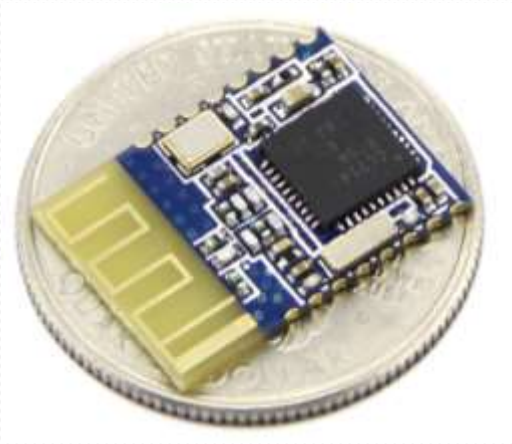
2. Cheap Mini Computers

Raspberry Pi

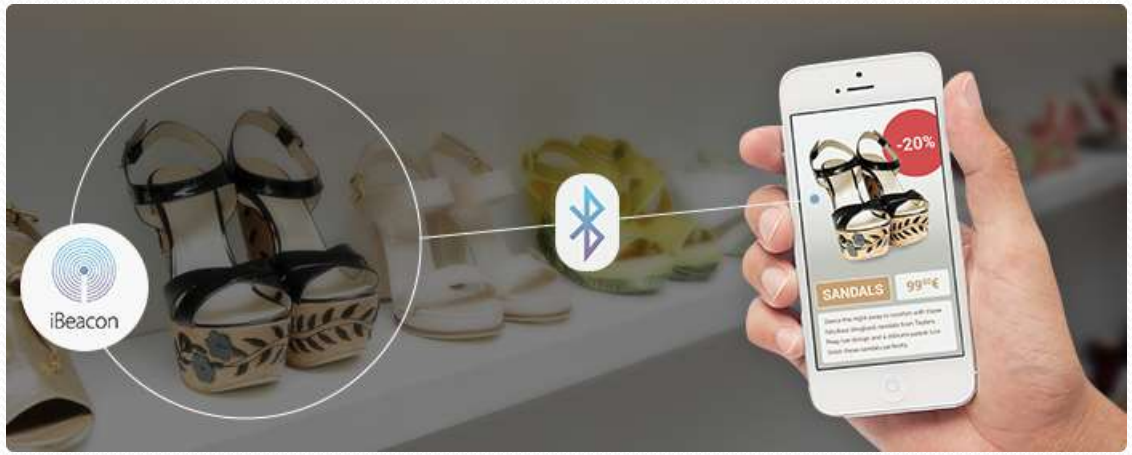
Intel® Compute Stick.

Guess the Price?

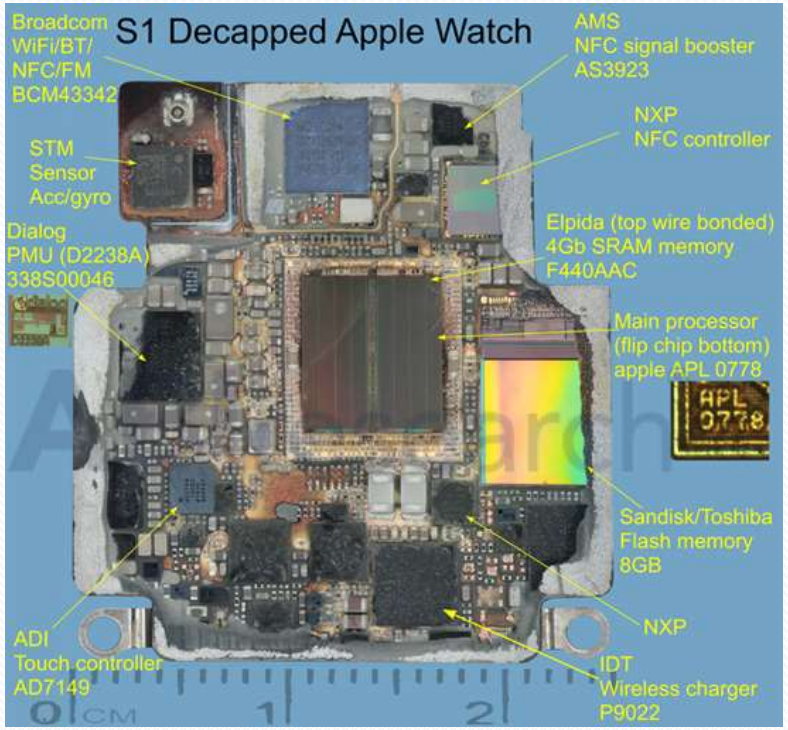
3. Low Power Connectivity



Bluetooth Smart (4.0)
(Up to 2 years with a single Coin-cell battery)



4. Capable Mobile Devices



Quad Core 1.5 GHz
128 GB Internal Memory
3 GB RAM
16 MP Camera
2160p@30fps video
WiFI, GPS, BLE

5. Power Of The Cloud

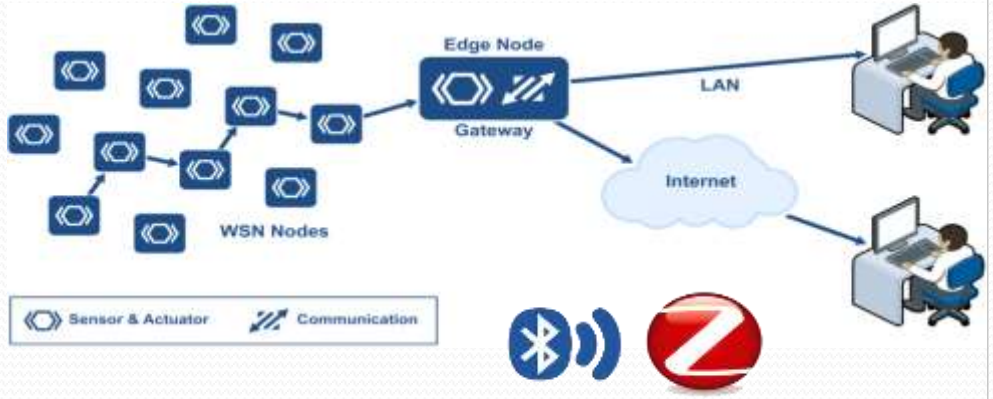
amazon web services™

ABCD's Of IoT

Applications

Big Data Analytics

Connectivity and Communication



Devices – that are smart!

Problems and Challenges

- Standardisation
- Scalability
- New Traffic to Handle
- Security issues
- Privacy issues

In The Media


siliconrepublic
Internet of things to light up Mayo town of Crossmolina
by John Kennedy
16 JUN 2016
208 SHARES

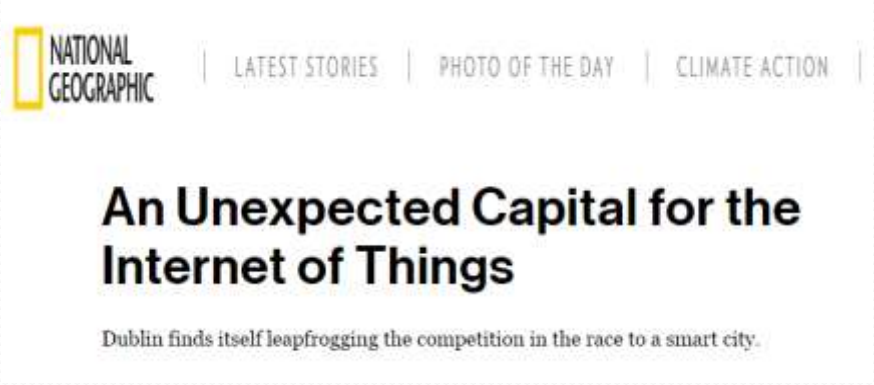

Designed in Ireland – Intel's technology for 'internet of things' a pure Irish creation


SMART DUBLIN
SMART BINS IN DUBLIN
25/02/2016
Smart Bins send emails when they are full!


BUSINESS & TECH
ALL CONSUMER FINANCE PRODUCT REVIEWS HOW TO TECH
How the GAA has come to be leaders in IOT technology


THE IRISH TIMES
NEWS SPORT BUSINESS OPINION LIFE & STYLE CULT
Technology How to ... Data Privacy Tech Tools
Internet of Things to become everyday reality with spending to jump to $2tn
New forecast suggests a 31% rise in the number of connected 'things' this year
Thu, Feb 9, 2017, 06:45


Intel to turn Dublin into world's first 'internet of things' city


NATIONAL GEOGRAPHIC
LATEST STORIES PHOTO OF THE DAY CLIMATE ACTION
An Unexpected Capital for the Internet of Things
Dublin finds itself leapfrogging the competition in the race to a smart city.


INDEPENDENT.IE NEWS OPINION BUSINESS SPORT LIFE STYLE ENTERTAINMENT
Brexit Irish World Technology Personal Finance Small Business Farmireland Jobs
Thursday 9 March 2017
Business Newsletter
Business Technology
Internet of Things the latest target for hackers