Internet of Things (IoT): A vision, architectural elements, and future directions

By

IOT Group

Salah Amean Ahmmed Saeed

Authors:
Gubbi, Jayavardhana Buyya, RajkumarMarusic,
Slaven Palaniswami, Marimuthu

Summary

- Ubiquitous sensing enabled by Wireless Sensor Network (WSN) technologies cuts across many areas of modern day living.
- This offers the ability to measure, infer and understand environmental indicators, from delicate ecologies and natural resources to urban environments.
- The proliferation of these devices in a wherein sensors and actuators blend communicating–actuating network creates the Internet of Things (IoT),seamlessly with the environment around us, and the information is shared across platforms in order to develop a common operating picture (COP).
- Fueled by the recent adaptation of a variety of enabling wireless technologies such as RFID tags and embedded sensor and actuator nodes,
  - the IoT has stepped out of its infancy and is the next revolutionary technology in transforming the Internet into a fully integrated Future Internet.

Summary

- This paper presents a Cloud centric vision for worldwide implementation of Internet of Things. The key enabling technologies and application domains that are likely to drive IoT research in the near future are discussed.

- A Cloud implementation using Aneka, which is based on interaction of private and public Clouds is presented.

- We conclude our IoT vision by expanding on the need for convergence of WSN

Introduction

Introduction

- New computing paradigm where every object is alive on the internet.
- RFID and communication system will rise to meet this new challenges,
  - Where info and communication system are invisible in the environment around us
- The easiness of wirelessly connecting mobile items to the Internet via WiFi, Bluetooth, or proprietary wireless communications protocols.

Introduction

- The introduction of IoT results in enormous amount of data
- Cloud computing is meant for such burst in data
- Demands of IoT
  - Shared understanding of appliances and its users
  - Software architectures and pervasive communication networks to process and convey the contextual information to where relevant
  - Analytics tools in the IoT aiming for smart and autonomous behavior

Definitions, Trends, Elements

Defining the Internet of Things

- IoT is simply a concept wherein machines and everyday objects are connected via the Internet.

- Within the IoT, devices are controlled and monitored remotely and usually wirelessly.

- IDC predicts that the IoT will include 212 billion things globally by the end of 2020.

- [Wifi-connected bees](#) are now in development to help with pollination.
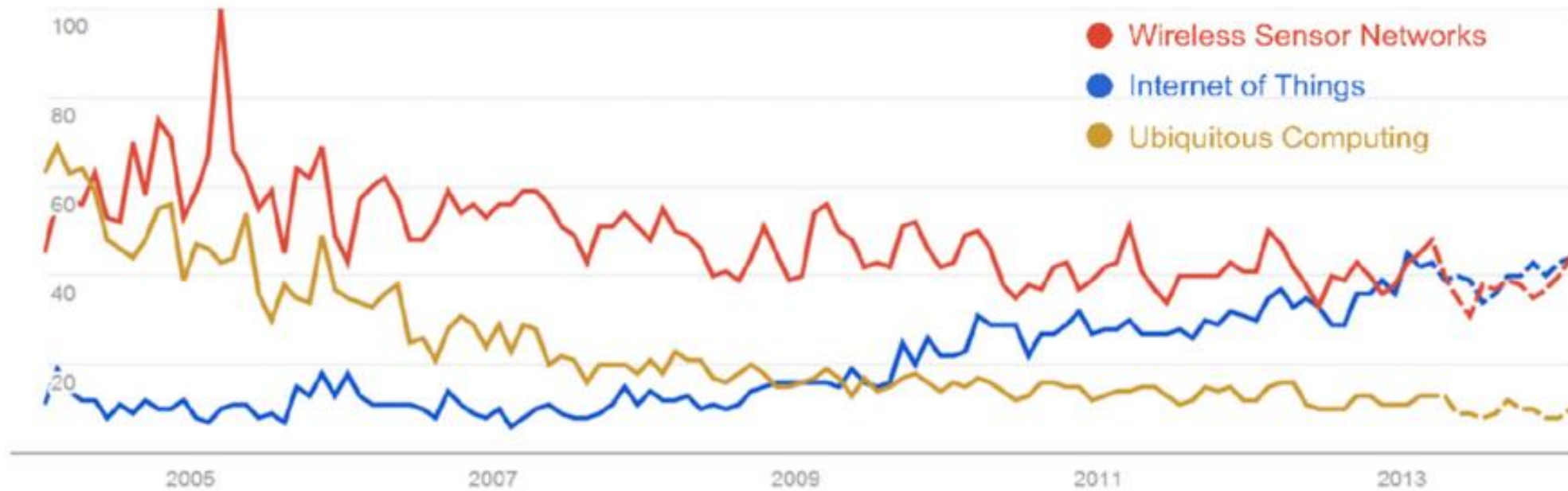
IoT Motivation

Fig. 3. Google search trends since 2004 for terms Internet of Things, Wireless Sensor Networks, Ubiquitous Computing.
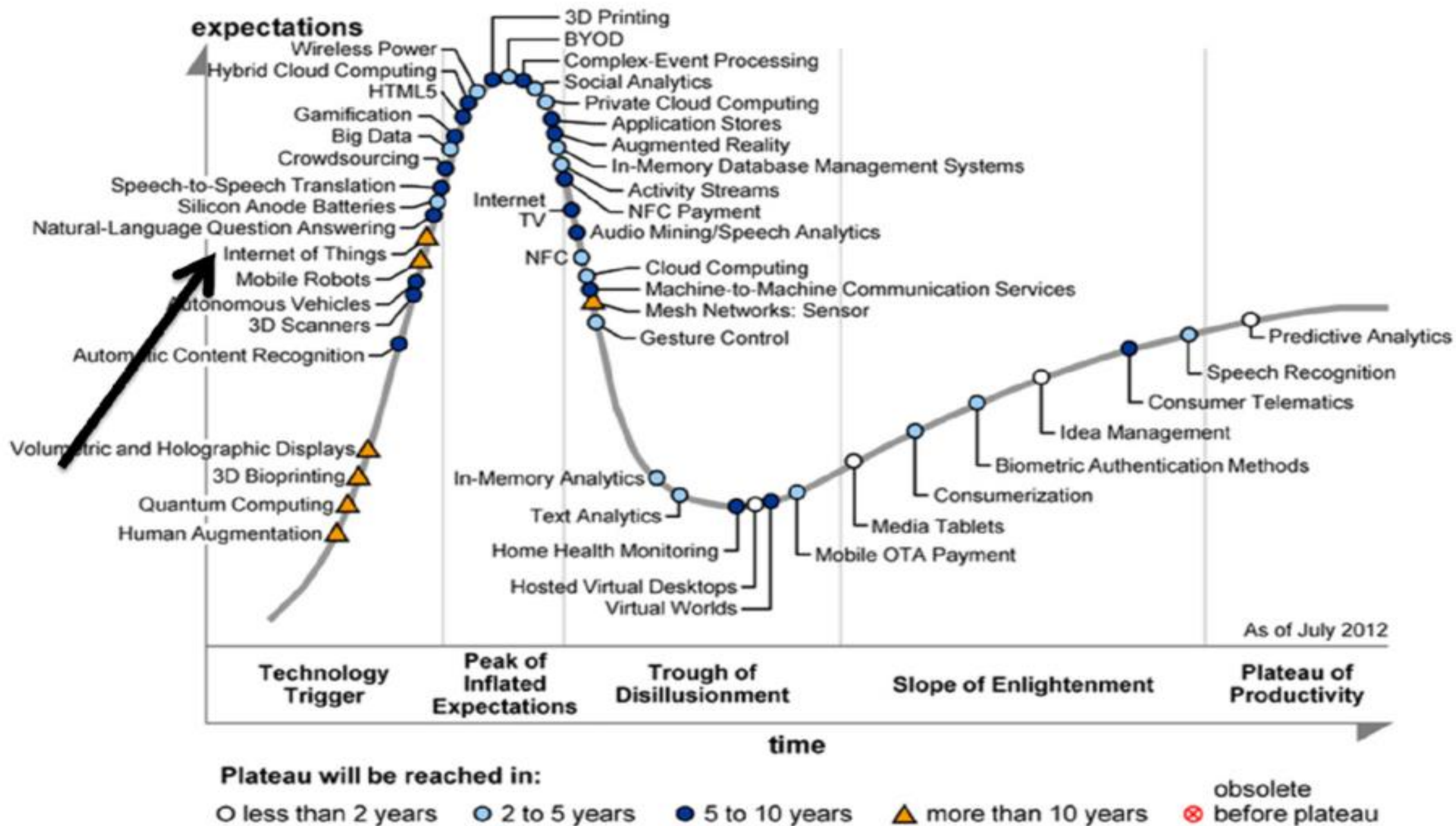
Fig. 2. Gartner 2012 Hype Cycle of emerging technologies.
Source: Gartner Inc.

Elements

- **Hardware**—made up of sensors, actuators and embedded communication hardware
- **Middleware**—on demand storage and computing tools for data analytics and
- **Presentation**—novel easy to understand visualization and interpretation tools which can be widely accessed on different platforms and which can be designed for different applications.

Technologies build IoT

- Radio Frequency Identification (RFID) or similar technologies
- Wireless sensor networks (WSN)
  - WSN hardware
  - WSN communication stack
  - WSN middle-ware
  - Secure data aggregation
- Addressing Schemes
- Data storage and visualization
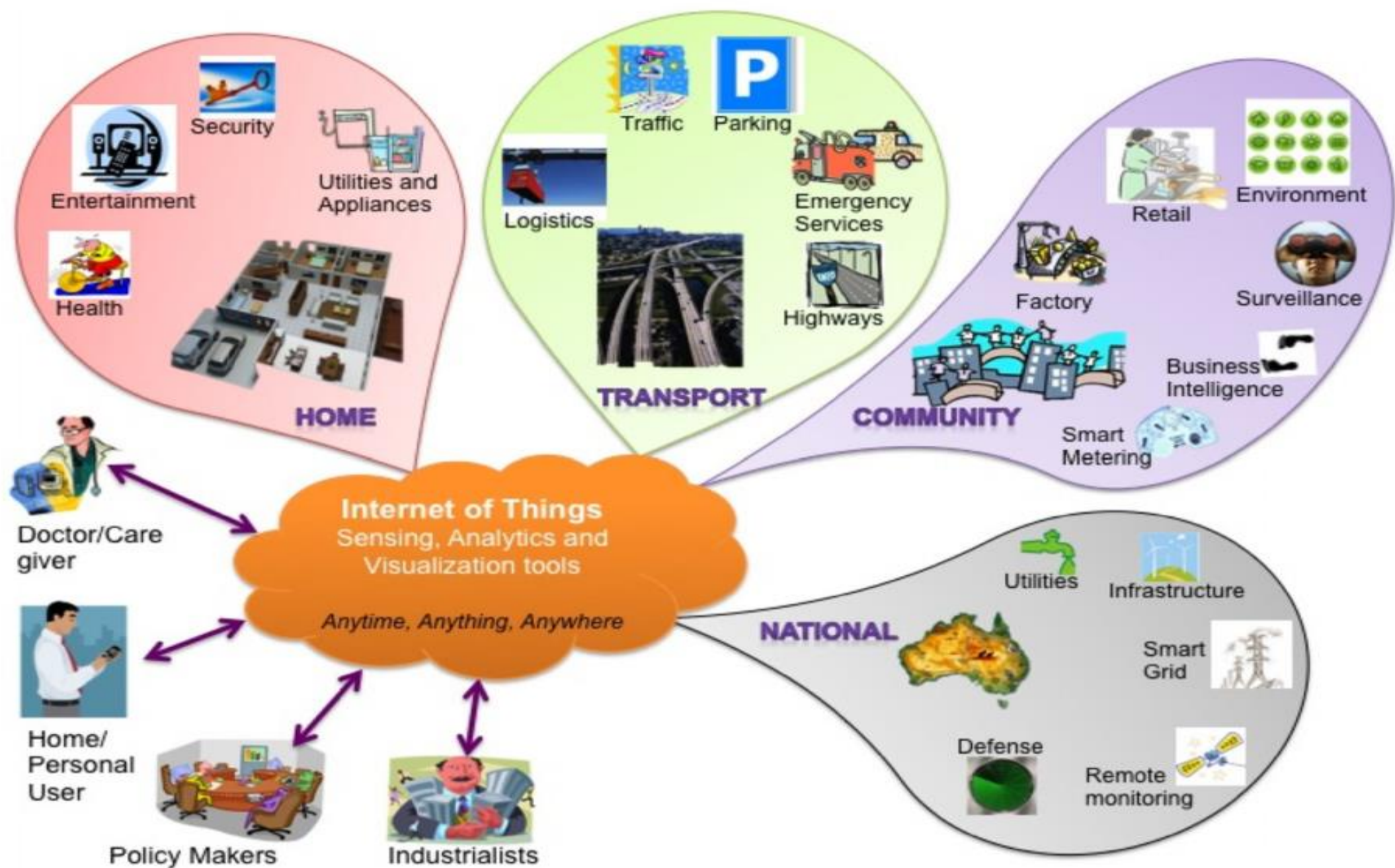
Applications

The incense of superiority

Fig. 1. Internet of Things schematic showing the end users and application areas based on data.

Libelium Smart World

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

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

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

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

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

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

Smart Lighting
Intelligent and weather adaptive lighting in street lights.

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

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

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

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

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

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.

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.

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

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

Smart Parking
Monitoring of parking spaces availability in the city.

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

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

Table 1

Smart environment application domains.

	Smart home/office	Smart retail	Smart city	Smart agriculture/forest	Smart water	Smart transportation
Network size	Small	Small	Medium	Medium/large	Large	Large
Users	Very few, family members	Few, community level	Many, policy makers, general public	Few, landowners, policy makers	Few, government	Large, general public
Energy	Rechargeable battery	Rechargeable battery	Rechargeable battery, energy harvesting	Energy harvesting	Energy harvesting	Rechargeable battery, Energy harvesting
Internet connectivity	Wifi, 3G, 4G LTE backbone	Wifi, 3G, 4G LTE backbone	Wifi, 3G, 4G LTE backbone	Wifi, satellite communication	Satellite communication, microwave links	Wifi, satellite communication
Data management	Local server	Local server	Shared server	Local server, shared server	Shared server	Shared server
IoT devices	RFID, WSN	RFID, WSN	RFID, WSN	WSN	Single sensors	RFID, WSN, single sensors
Bandwidth requirement	Small	Small	Large	Medium	Medium	Medium/large
Example testbeds	Aware home [29]	SAP future retail center [30]	Smart Santander [31], citySense [32]	SiSViA [33]	GBROOS [34], SEMAT [35]	A few trial implementations [36,37]

21

Coolest

Internet of Things

Gadgets

Adopted from:
Bernard Marr

No: 1 Google Glass

The amazing internet connected glasses that contain a camera, microphone, display and will generally revolutionize the wearable device market.

Find out more at: http://www.google.com/glass/start/

No: 2 Withings Scale

These are wifi-enabled scales that recognize you, send your weight and body fat % to your phone and even measures air quality in your room.
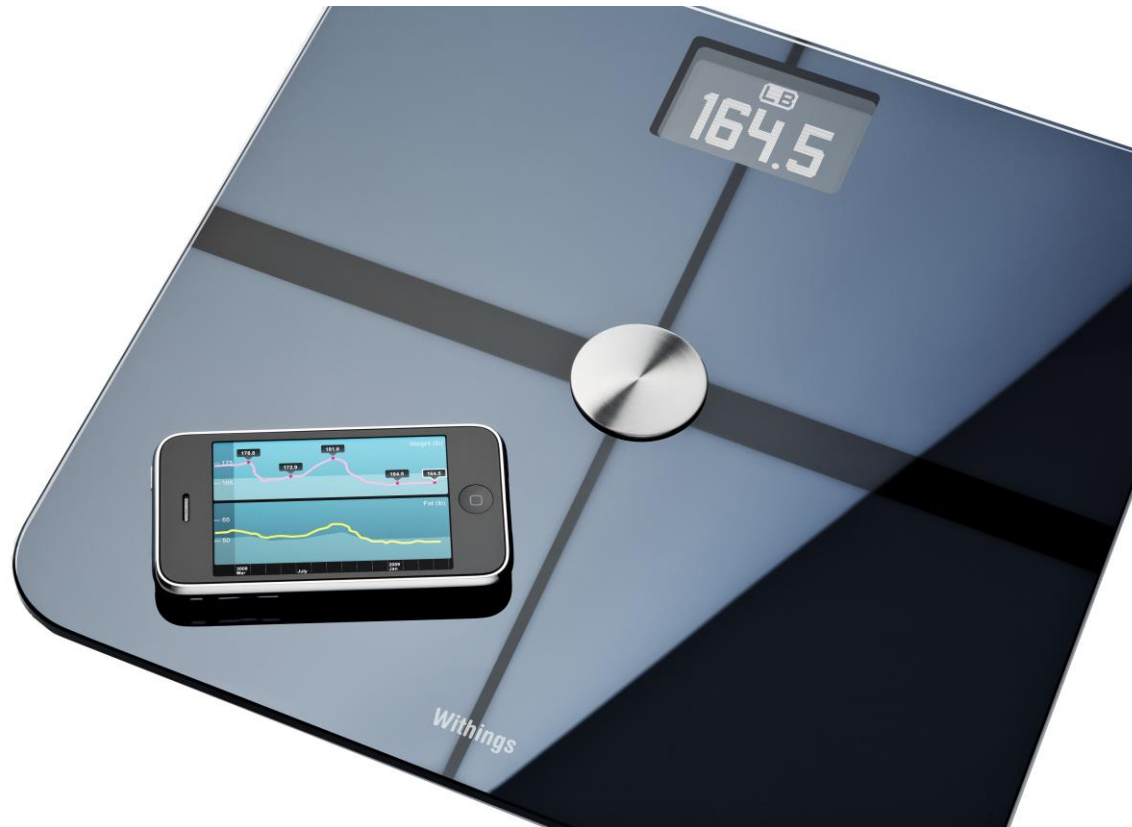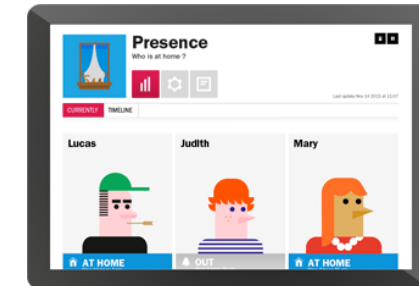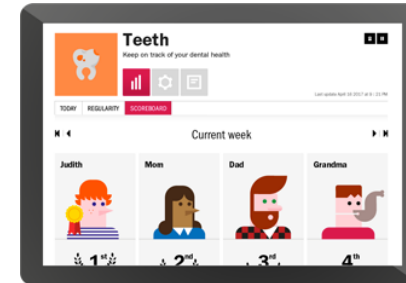
No: 3 Delphi Connect

A wonderful way of connecting your car to your phone, allowing remote controls and diagnostics.

No: 4 Sen.se Mother

Like a mother, you now have a device that looks after you. It connects lots of sensors that will take care of your health, safety and well being.

Find out more...

No: 5 Trackdot

It will monitor your luggage on air travel and text you when it arrives at the destination as well as how far it is from the luggage belt.

Find out more...

No: 6 Jawbone Up

This smart wearable device will sync with your phone and help you monitor your activities, calories as well as sleep. I love the smart alarm!

No: **7** Fitbit ZIP

Great entry level device to start monitoring your activities calories. With that price tag anyone can enter the revolution. There is more from Fitbit…

Find out more…

No: 8 SkyBell

A wifi connected door bell that allows you to remotely answer your door and receive alerts in form of pictures to see who's calling…

No: 9 Moto 360

Google powered smart watch equipped with Android-based operating system. The possibilities are endless.

Find out more...

No: 10 Smart Tennis Sensor

A device by Sony that will make your tennis game a lot smarter. Currently only available in Japan…

Find out more...

No: 11 Septimu Earbuds

Microsoft Research work in progress – will allow sensors in ear buds to work out what mood you are in.

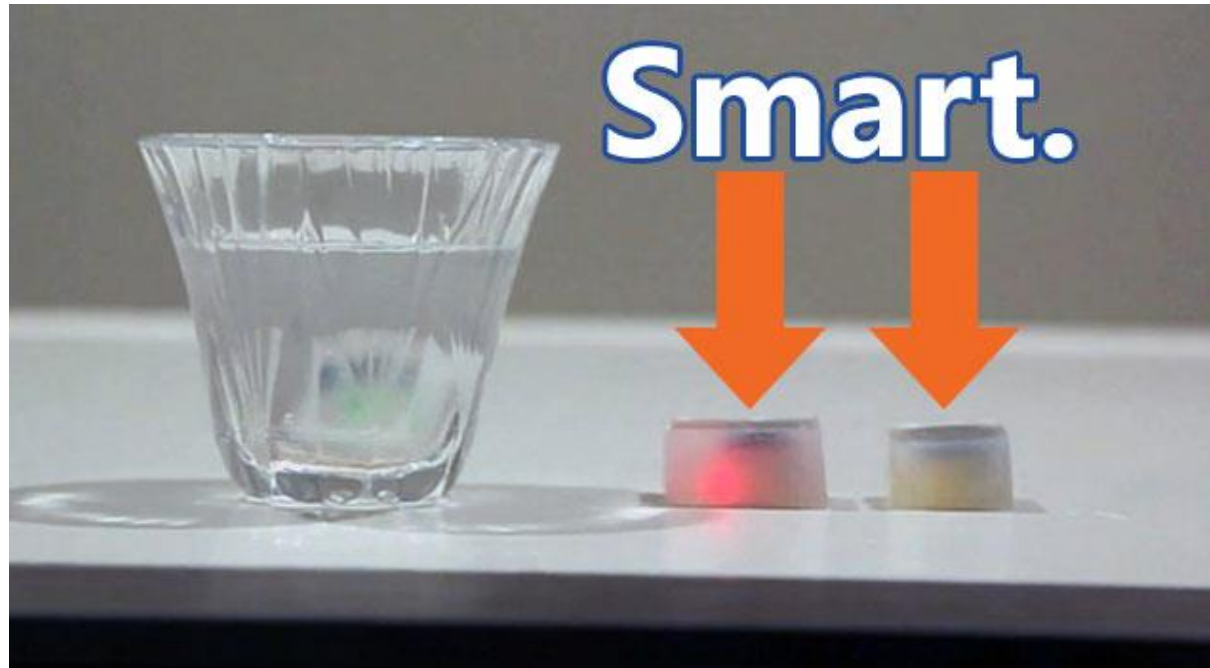**Find out more...**

No: 12 LIFX light bulb

A energy efficient and wifi enabled light bulb that you can control from your smartphone – you can even change colours and mood.

No: 13 Smart Ice Cubes

Smart ice cubes that pulse to the beat of the music but most importantly monitor how much and how fast you are drinking.
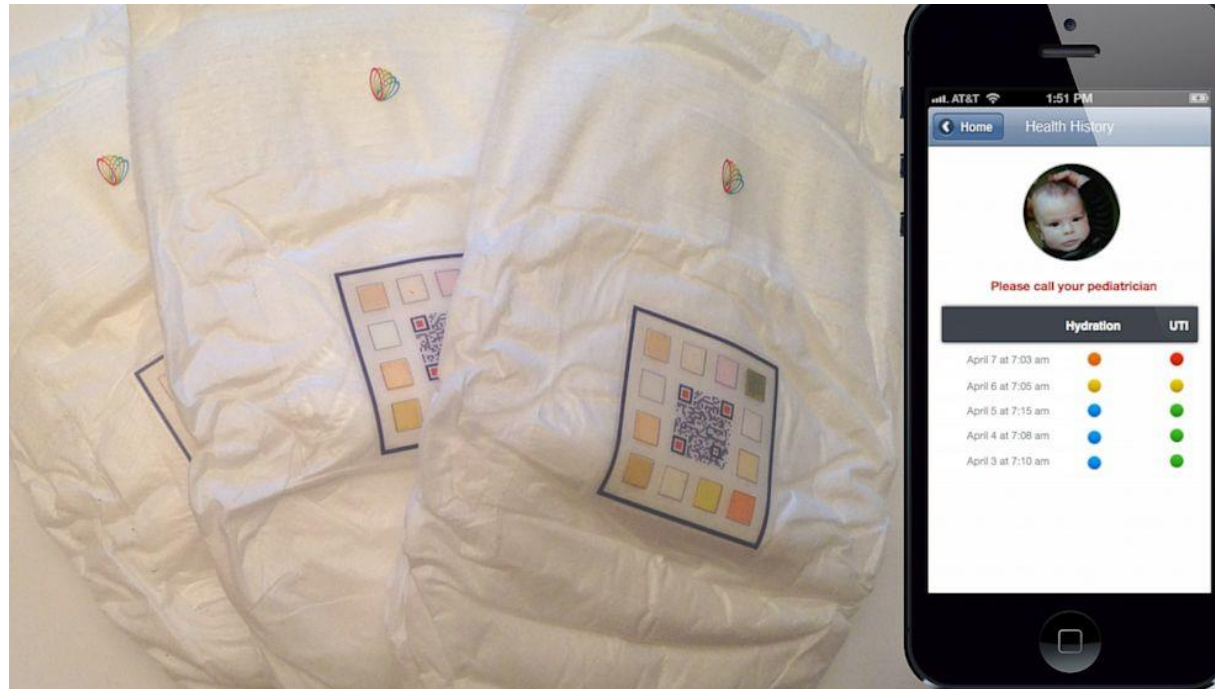
No: 14 Bikn

Thumb-sized electronic tags which you can attach to any of your possessions, and then locate them through your phone's GPS.

No: 15 Smart Diapers

Disposable diapers with in-built sensors that parents and paediatricians can use to track a child's health.

No: 16 Smart Notifications

Software from Base that determines when it is the best time to send you notifications, based on an understanding of how you use your devices.

No: 17 Kensington Proximo

Stops you losing your phone by sending you an alert to your key fob when you are moving a certain distance away from your phone.

No: 18 Nest Thermostat

A thermostat that will get to know you and learn from the way it is used to automatically adjust the temperature in your home.

No: 19 Belkin Wemo

A line of wifi enabled home automation devices that allow you to control most electrical devices from one smart phone app.

No: 20 Firefox iKettle

A wifi enabled kettle that you can operate remotely using your smart phone. You can even set it to start boiling when your alarm goes off.

Find out more...

No: 21 SmartThings

Software that will allow you to control all your Internet of Things gadgets from one place – great if you are getting all the things on this list!

Find out more...

No: 22 HAPIfork

Electronic fork that helps you monitor and track your eating habits

Thank you