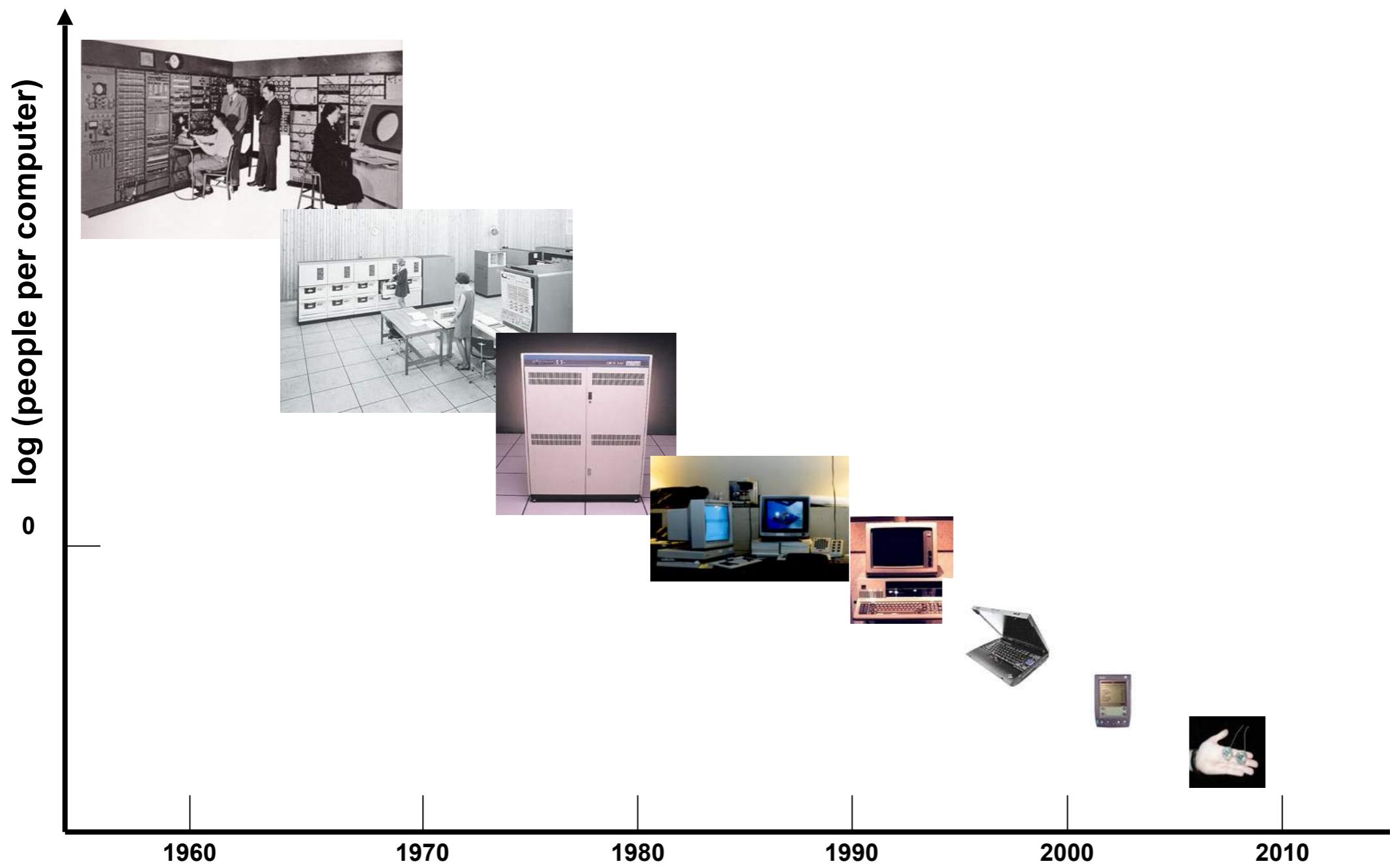


Marco Zennaro, PhD
T/ICT4D Laboratory
The Abdus Salam International Centre for
Theoretical Physics

Vision for IoT



History

“Machine to Machine” (M2M)
(~1970s +)



Internet of Things Beginnings



Carnegie Mellon Internet
Coke Machine (1982, 1990)



Trojan Room Coffee
Pot
(first webcam)
(1991)



Internet Toaster
(1990)

What is IoT

- Kevin Ashton (British entrepreneur) coined the term IoT in **1999**. He was referring to a global network of radio-frequency identification (RFID) connected objects.

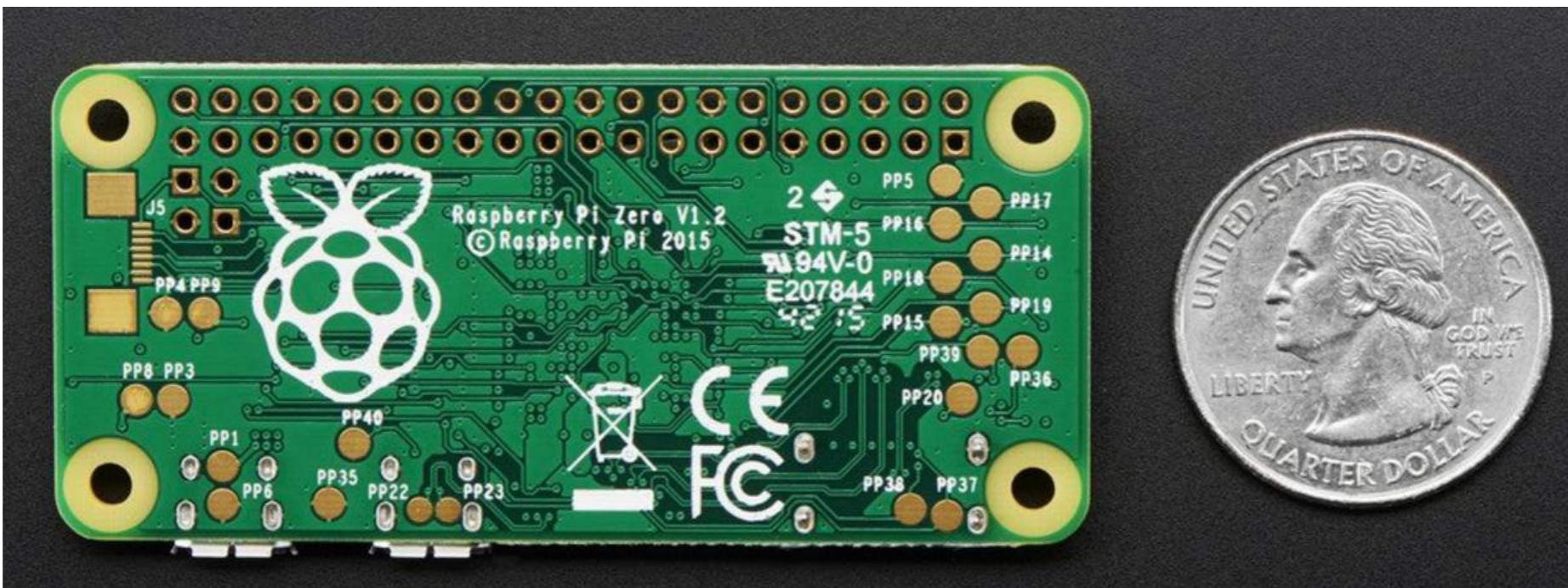


Kevin Ashton (MIT) definió “sin querer”
Internet de las Cosas en 1999 en una PPT sobre
el uso de RFID en cadenas de producción

En 2000 Neil Gershenfeld (MIT) publicó *When Things Start to Think* agregando elementos a la definición

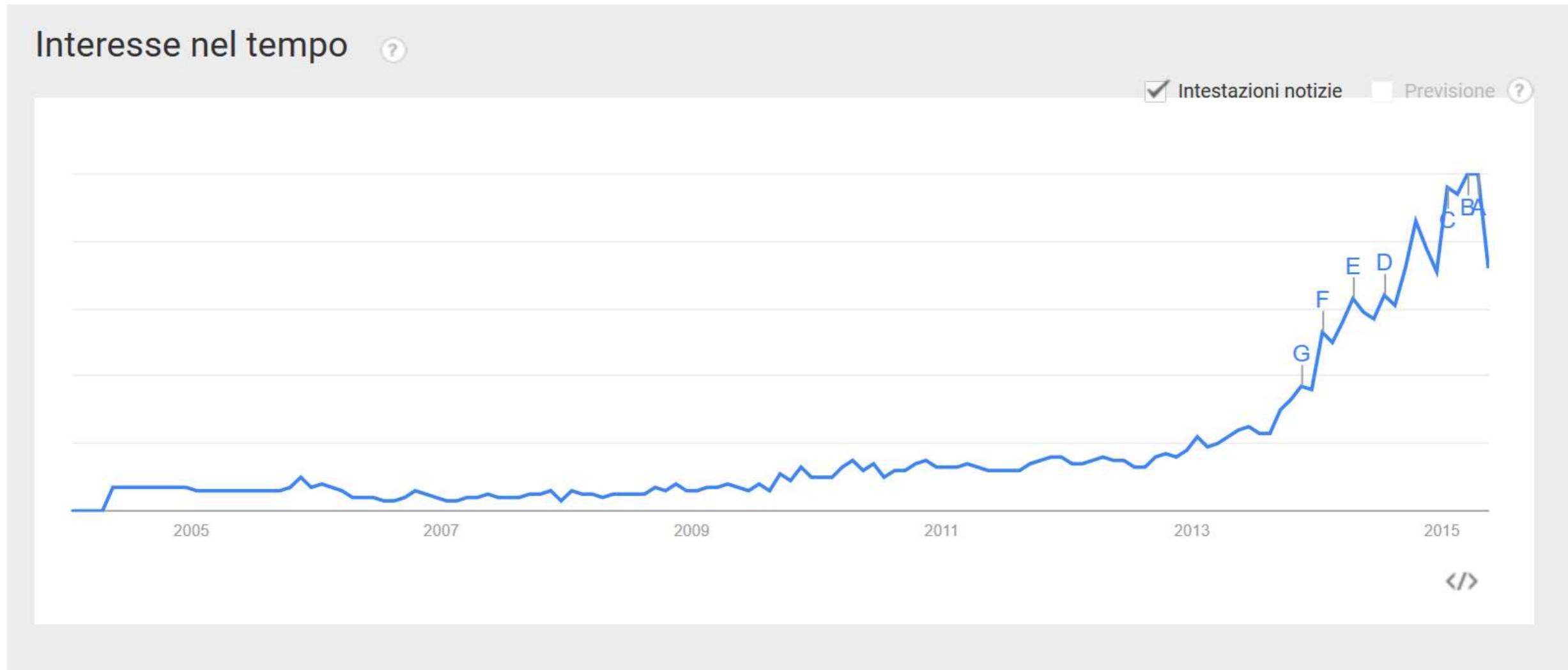


Raspberry Pi Zero

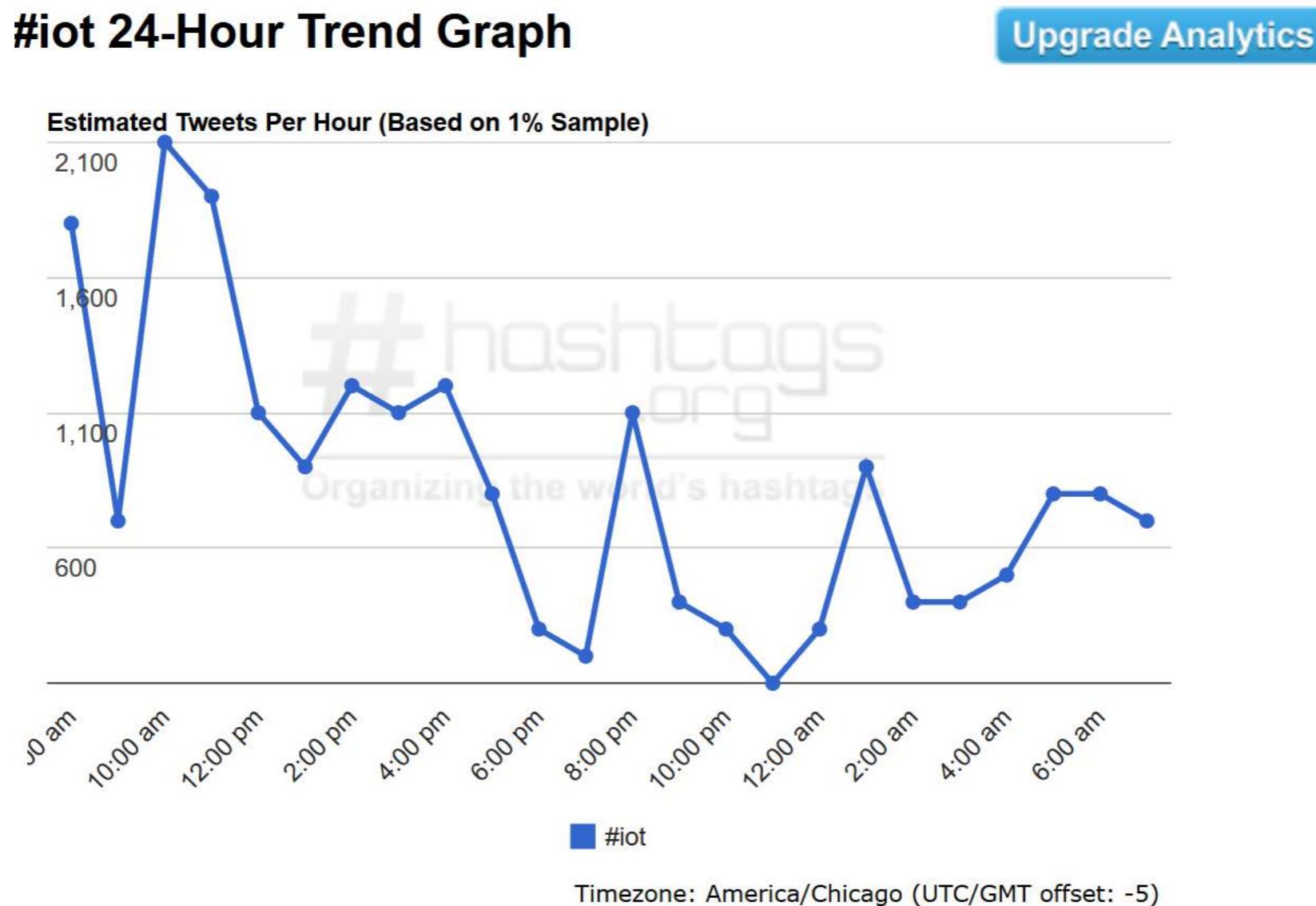


- A Broadcom BCM2835 application processor
 - 1GHz ARM11 core (40% faster than Raspberry Pi 1)
- 512MB of LPDDR2 SDRAM
- A micro-SD card slot
- A mini-HDMI socket for 1080p60 video output
- Micro-USB sockets for data and power
- An unpopulated 40-pin GPIO header
 - Identical pinout to Model A+/B+/2B
- An unpopulated composite video header
- Our smallest ever form factor, at 65mm x 30mm x 5mm

Google Trends for IoT

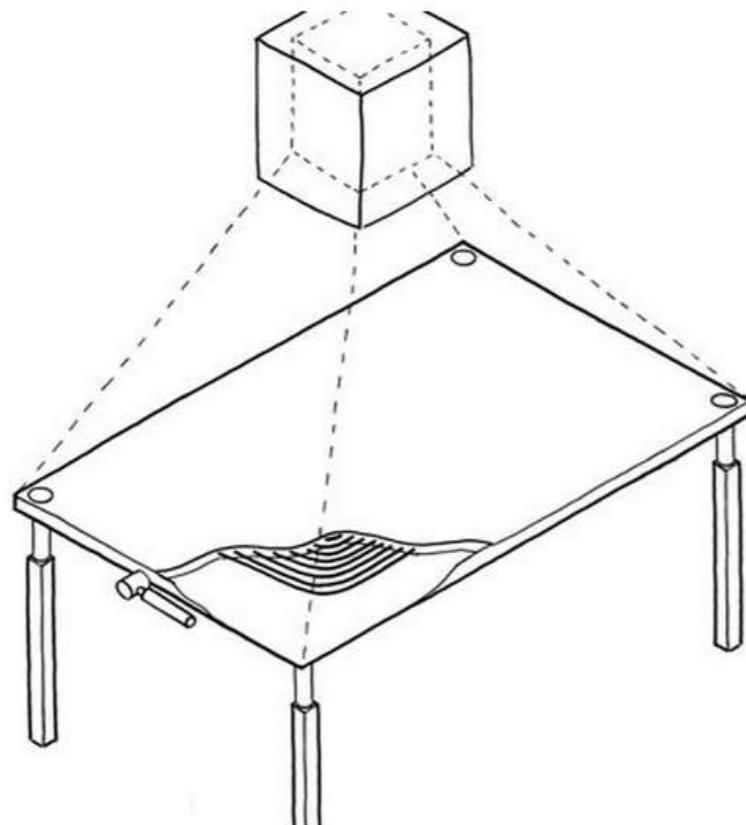


Twitter #IoT



Google News for IoT

IKEA's Internet of Things plans imagine the networked kitchen



A camera and projector is positioned above the table and induction coils underneath the table surface. Networked together, they allow the system to recognize objects and their movement and to project a display. Credit: IKEA

IKEA is hoping new 'intuitive and unobtrusive' technology will augment the kitchens of the future.

RELATED



How wireless power and wireless charging works



Why is Apple avoiding wireless charging?



Review: Galaxy S6 and S6 Edge lead the Android pack

on IDG Answers ➔

How to remove TouchWiz from my smartphone
Samsung Note 3?

An advertisement for a free eBook. It features the front cover of the book 'Next-Generation Firewalls For Dummies' by Lawrence C. Miller, CISSP. The cover is blue with white text and includes a cartoon character of a person with glasses. To the right of the book cover, there is promotional text and a download button.

Next-Generation Firewalls
For DUMMIES

Download Your FREE eBook Today!

Google News for IoT



Almost one year ago, **Amazon.com** released the “**Dash Button**”, for ordering items with just a click. The Dash buttons or the **push buttons** are made for the **single purpose, i.e., ordering only one item**. The Dash Button was **launched in the US exactly one year ago**, which was the day of April 1st. The idea behind this push button is to let users order only one thing.

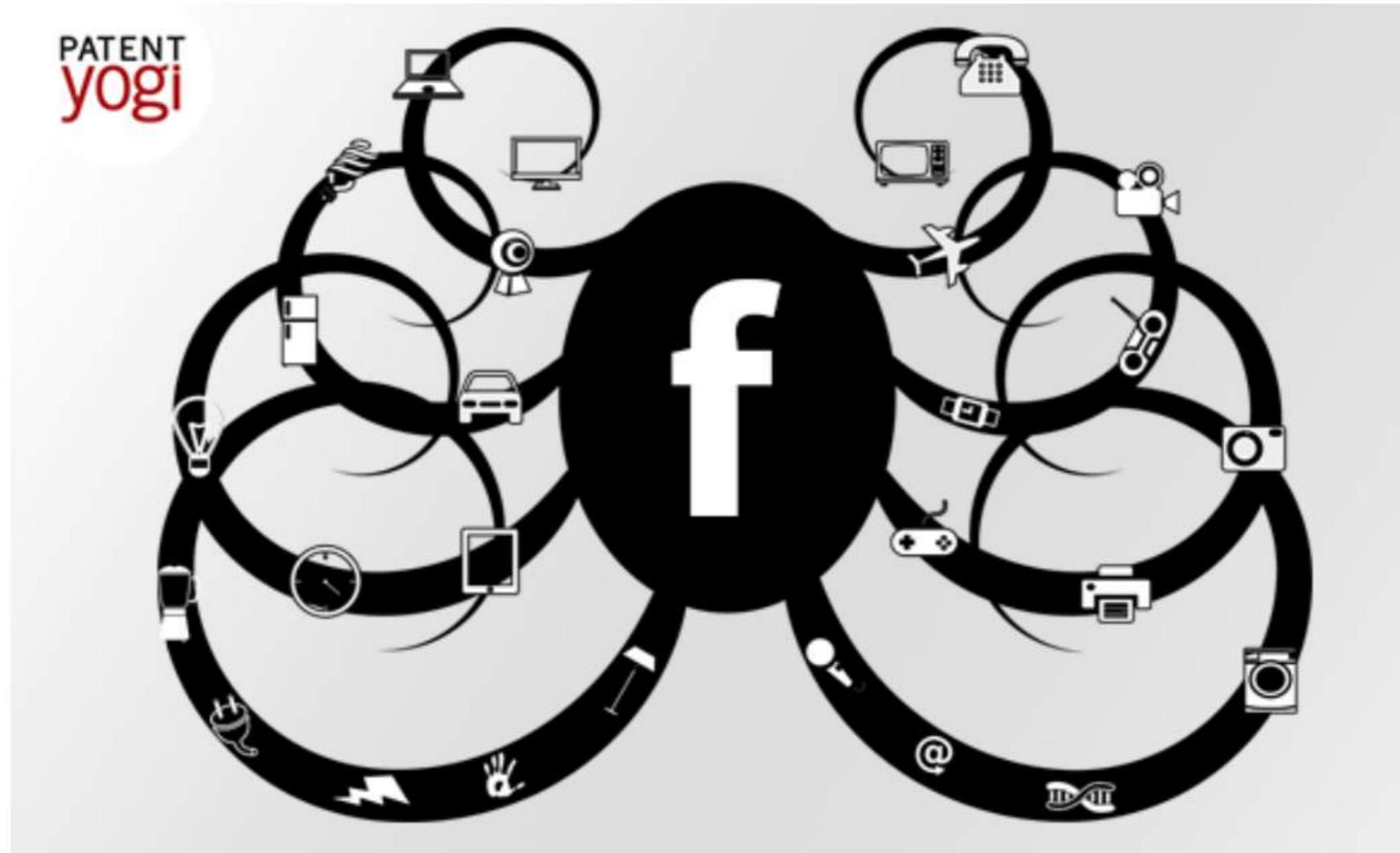
Today, **Amazon announced** that they are expanding this **Dash Button program in the USA**. Currently, With Dash Button, users can request only one thing per button. There are very few brands associated with Dash Button project. But Amazon announced that there are more

brands willing to join, which will improve the experience of shopping through the Dash Button. The brands like Zico Premium Coconut water, Stayfree sanitary pads, Energizer batteries, etc. will have their own Dash button. As per **Amazon**, The orders coming from **Dash buttons increased by 75%** in last three months.

Google News for IoT

Facebook wants to be IoT command center

Patent Number – US 20160080389



IoT definition

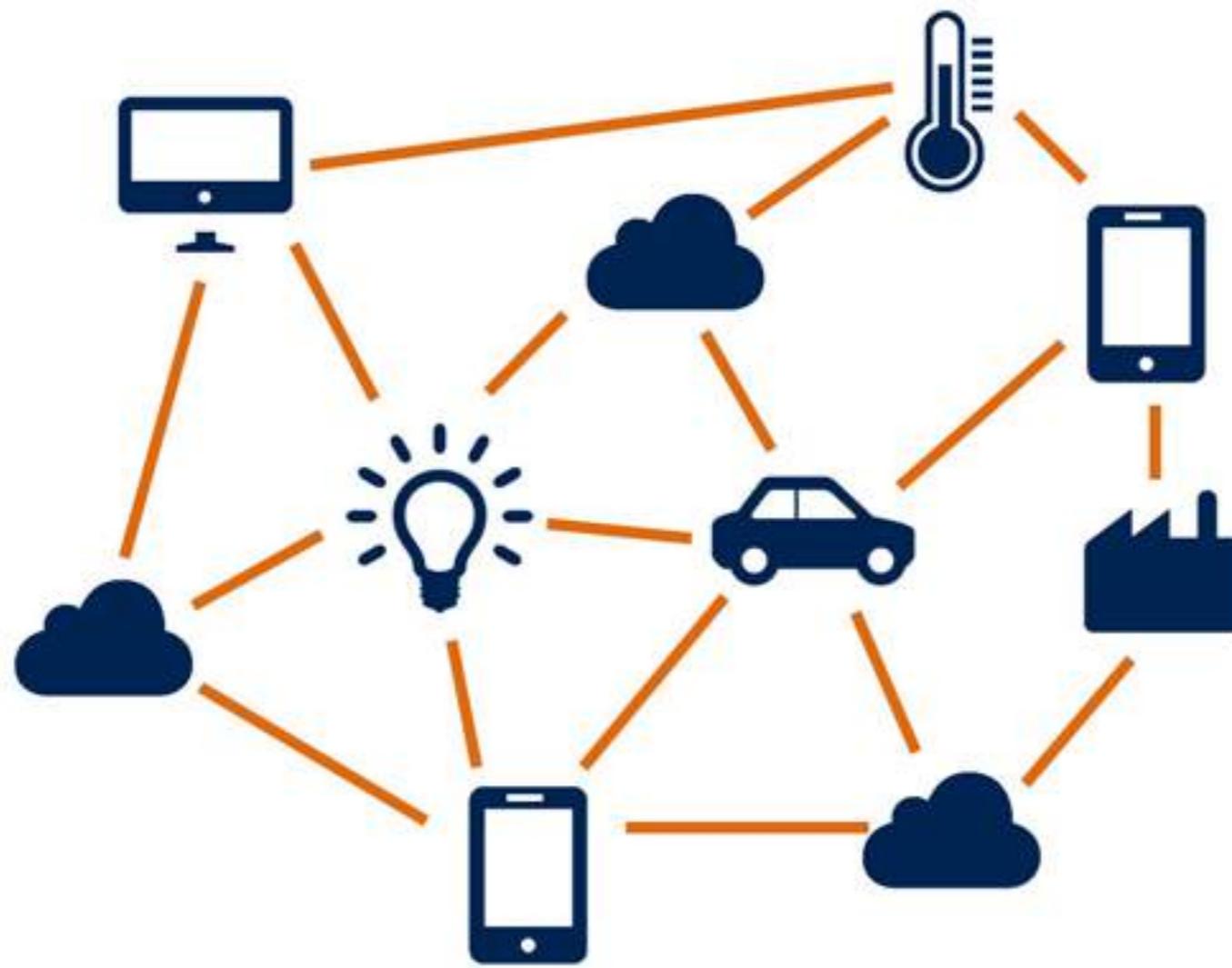
- **Wikipedia**: The Internet of Things (IoT) refers to uniquely identifiable objects and their virtual representations in an Internet-like structure.

[http://en.wikipedia.org/wiki/Internet_of_things - 21-Jun-2014]

- **Cisco**: The Internet of Things (IoT) is the network of physical objects accessed through the Internet, as defined by technology analysts and visionaries. These objects contain embedded technology to interact with internal states or the external environment. In other words, when objects can sense and communicate, it changes how and where decisions are made, and who makes them.

[<http://www.cisco.com/web/solutions/trends/iot/overview.html> - 21-Jun-2014]

IoT definition



The Internet of Things (IoT) is a scenario in which objects, animals or people transfer data over a network **without requiring human-to-human or human-to-computer interaction**.

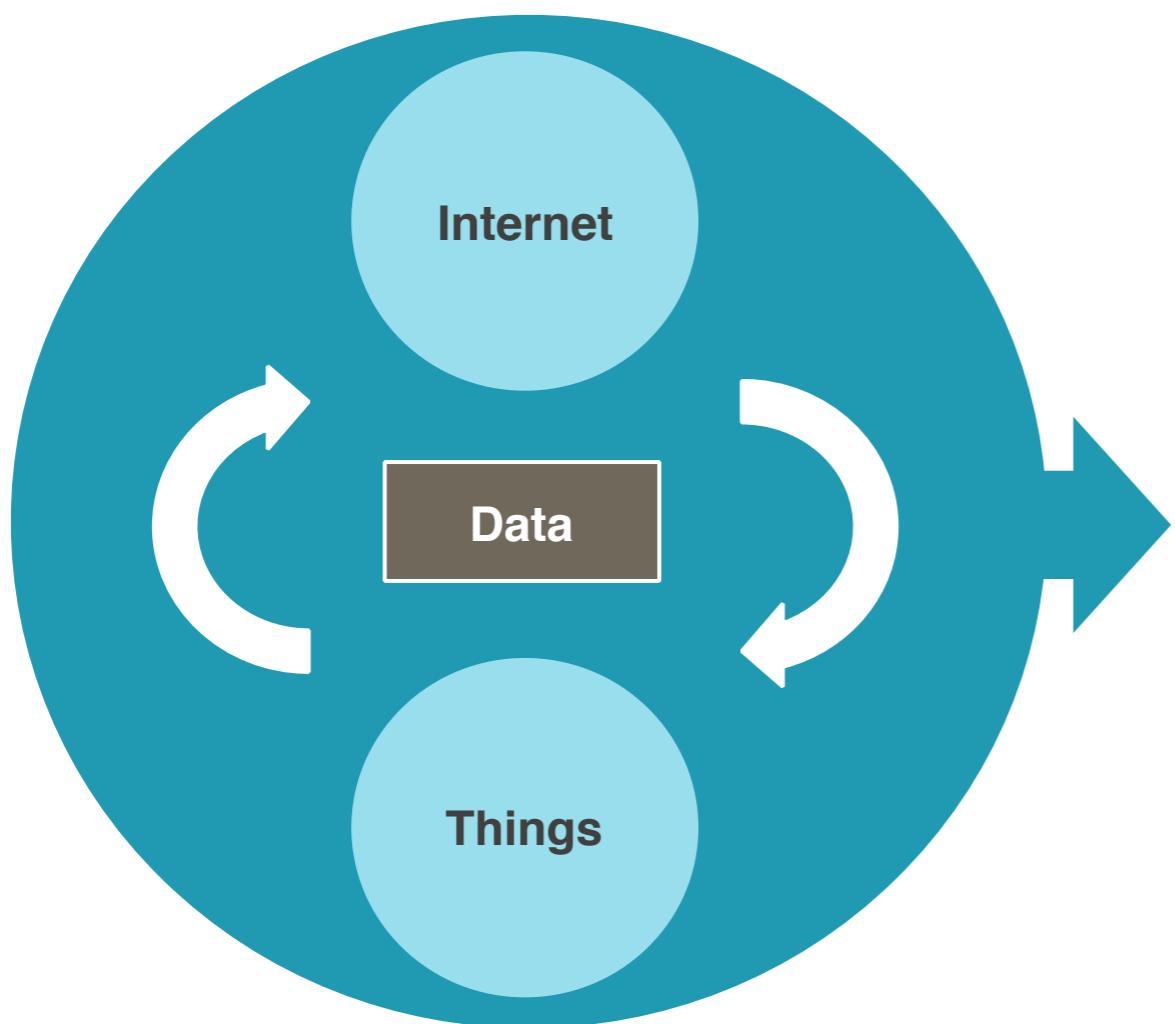
IoT definition

The term "Internet of Things" has come to describe a number of **technologies** and **research disciplines** that enable the Internet to reach out into the real world of physical objects.

IoT 2008

What is IoT

- The IoT is more than connecting things to the internet, it's about bridging the physical and digital worlds **to create value for people**



New value for people:

Capabilities
Services
Experiences
Business models
...

What is IoT

Internet + Things + Data

Things

These **nodes** are highly constrained in terms of

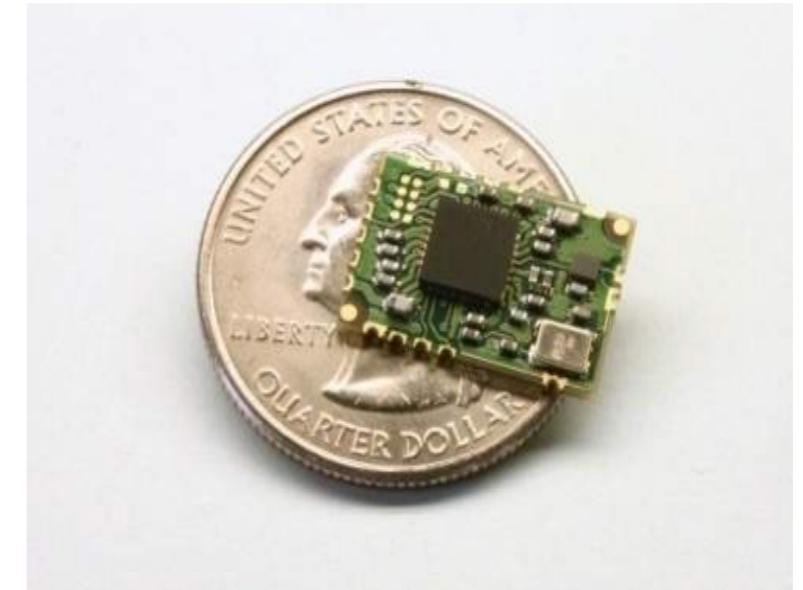
Physical size

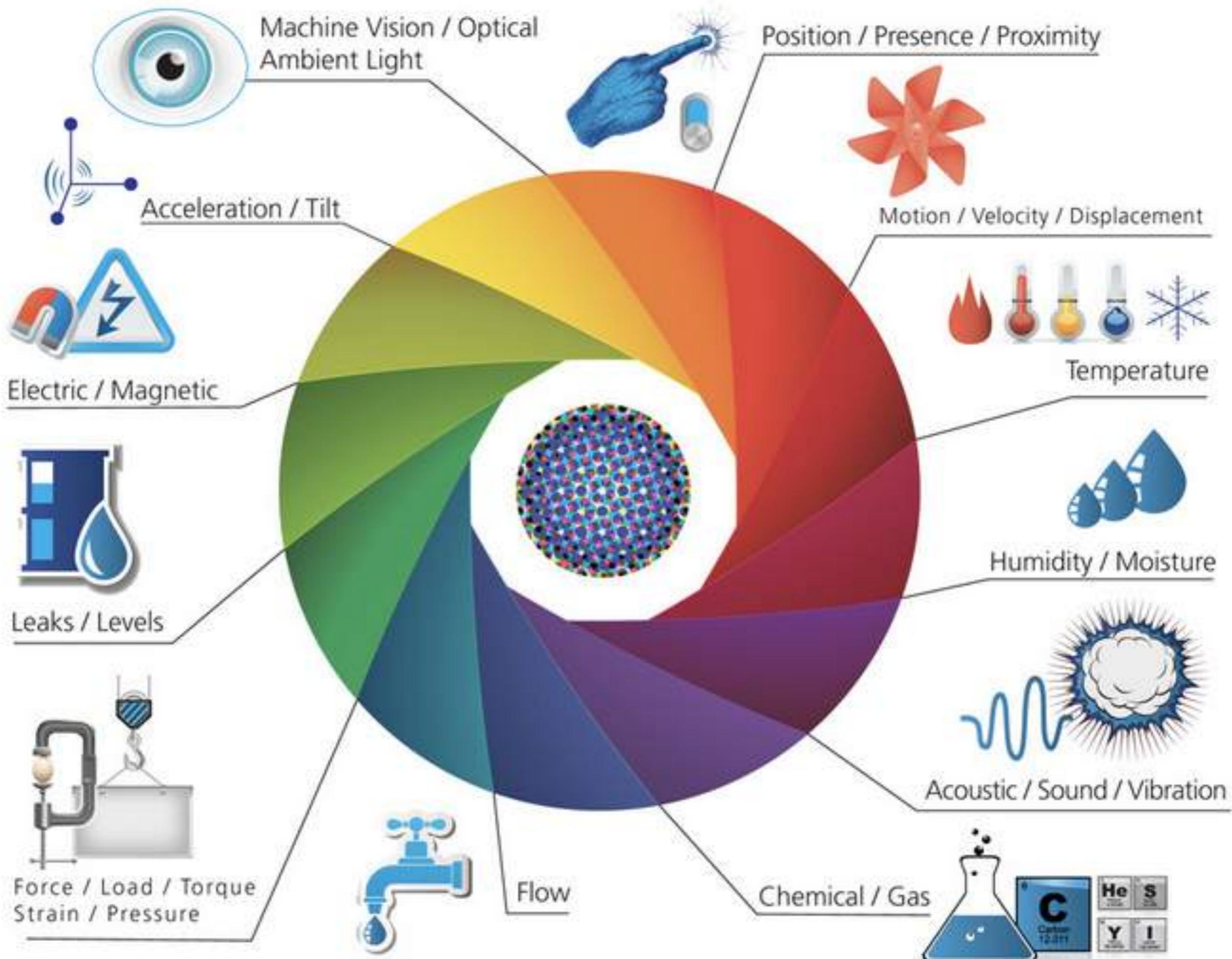
CPU power

Memory (few tens of kilobytes)

Bandwidth (Maximum of 250 KB/s, lower rates the norm)

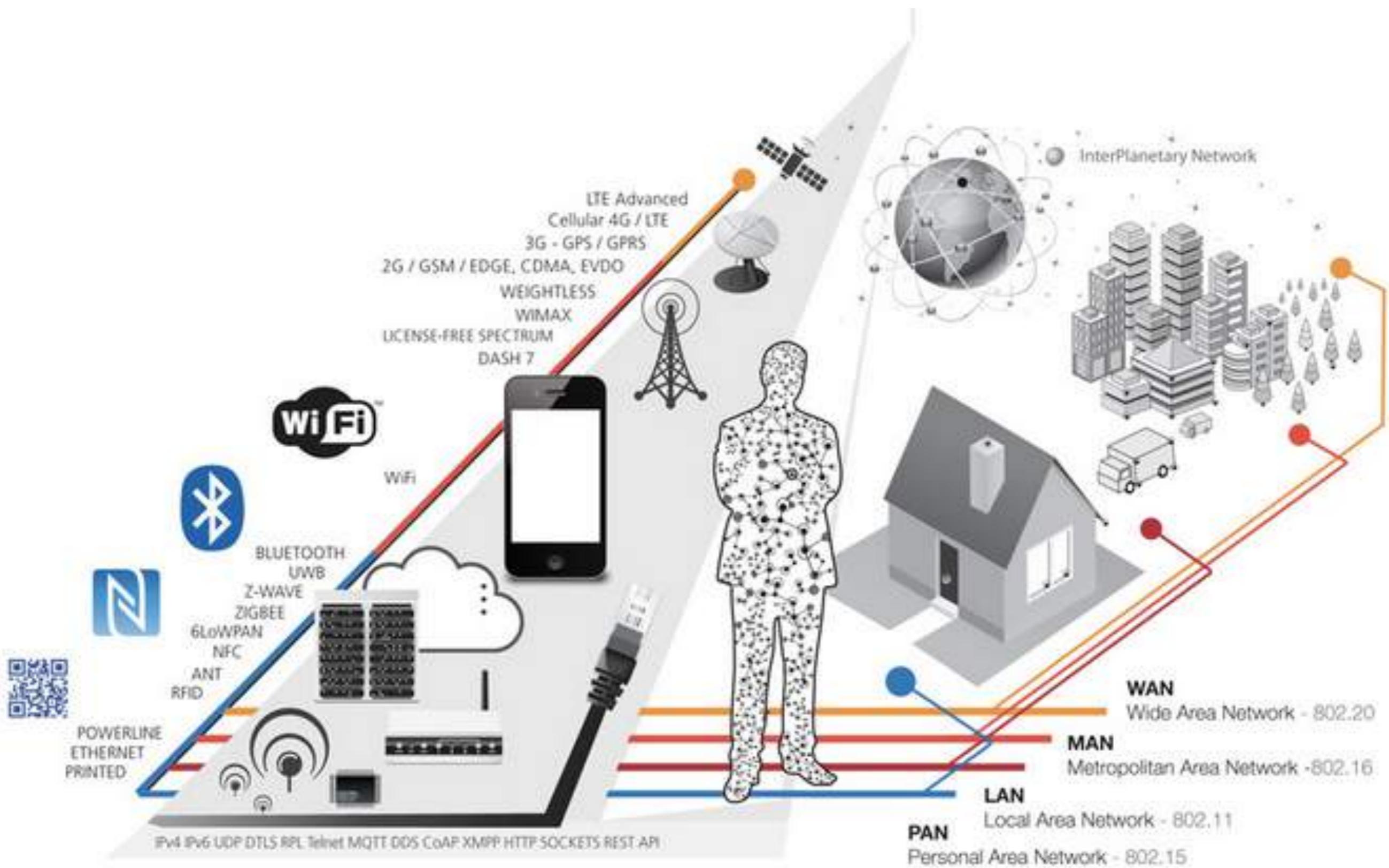
Power consumption is critical, if battery powered then energy efficiency is paramount.



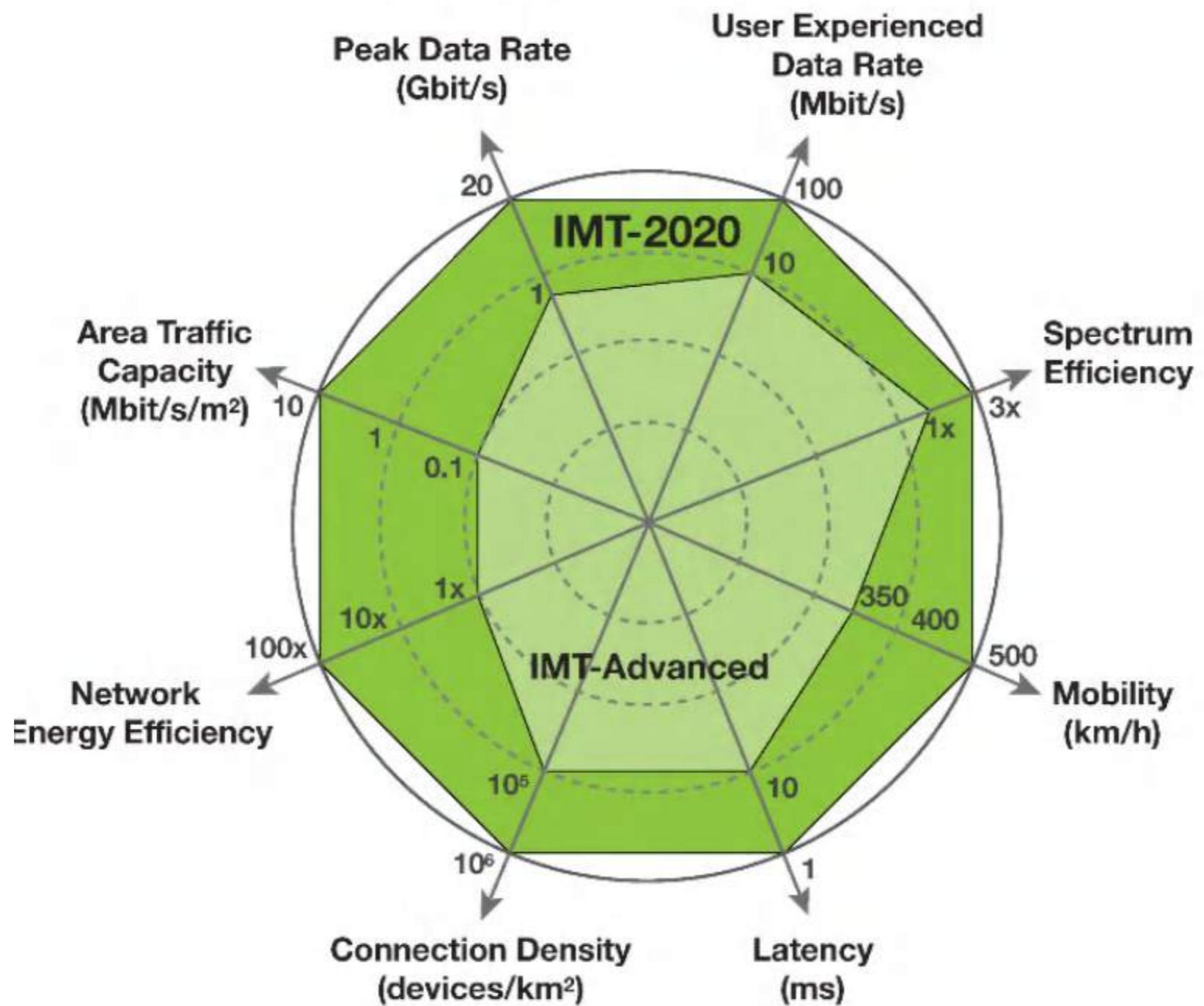


What is IoT ?

Internet + Things + Data



Technologies: 5G



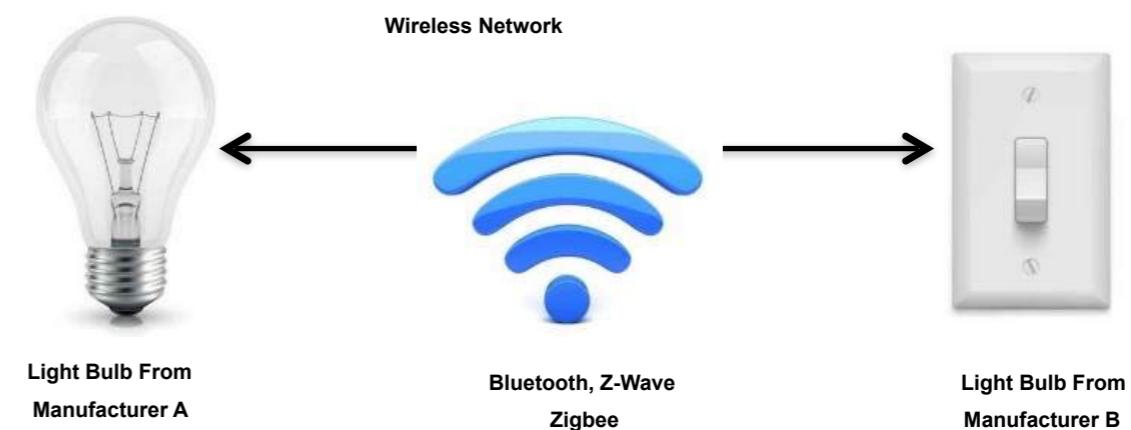
Device-to-Device

Two or more devices which **directly connect and communicate.**

They are not dependent on intermediary application servers and can communicate via numerous different networks.

Exemplified in applications such as home automation systems (light bulbs/light switches/thermostats/door locks, etc.)

Interoperability issues appear due to built-in security/trust mechanisms and device-specific data models.



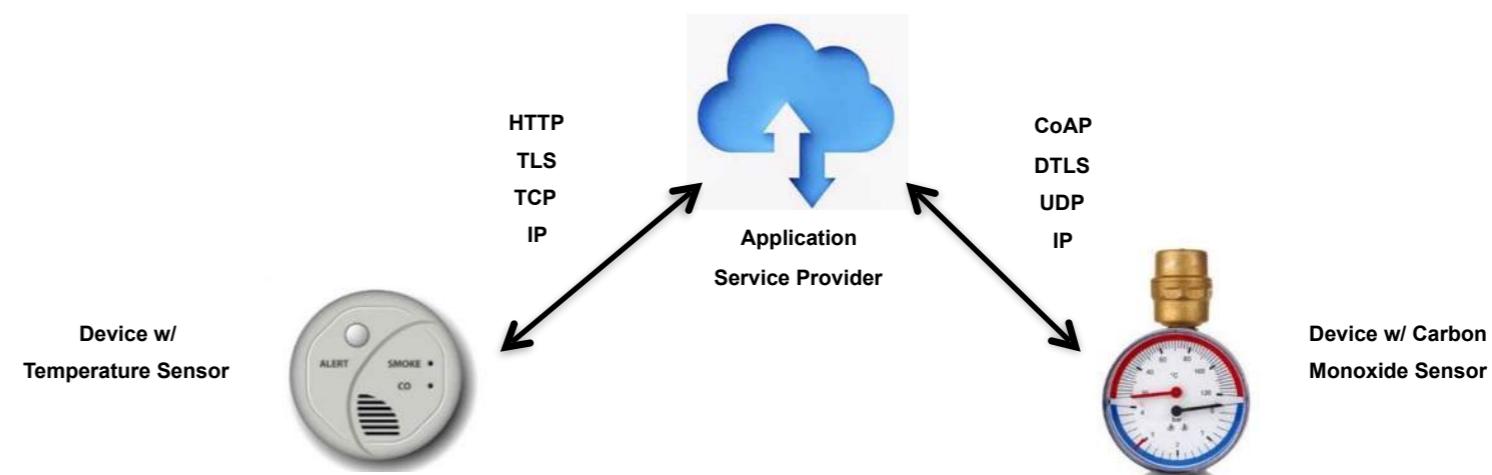
Device-to-Cloud

Device connects directly to Internet cloud service, such as an application service provider, to exchange data and control message traffic.

Utilizes existing communication mechanisms such as Ethernet or WiFi to establish connection with IP network and devices.

Employed by devices such as Nest Labs Thermostat & Samsung Smart TV.
Interoperability issues appear when integrating devices by different manufacturers.

Proprietary data protocols may tie devices to specific cloud services (vendor lock-in).



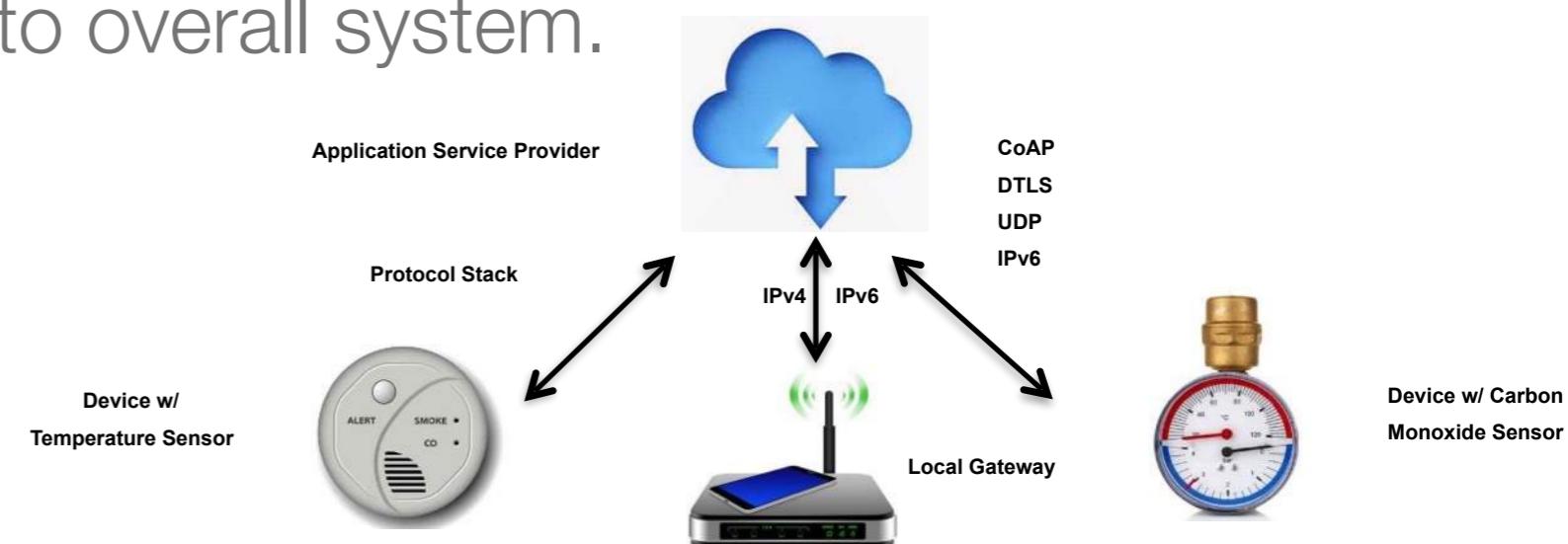
Device-to-Gateway

Device connects through a gateway as a conduit to access a cloud service.

Intermediary between cloud service and device; provides security and protocol translation.

Device-to-Gateway model's primary feature is the ability to overcome proprietary device restrictions in connecting devices.

Adds complexity and costs to overall system.



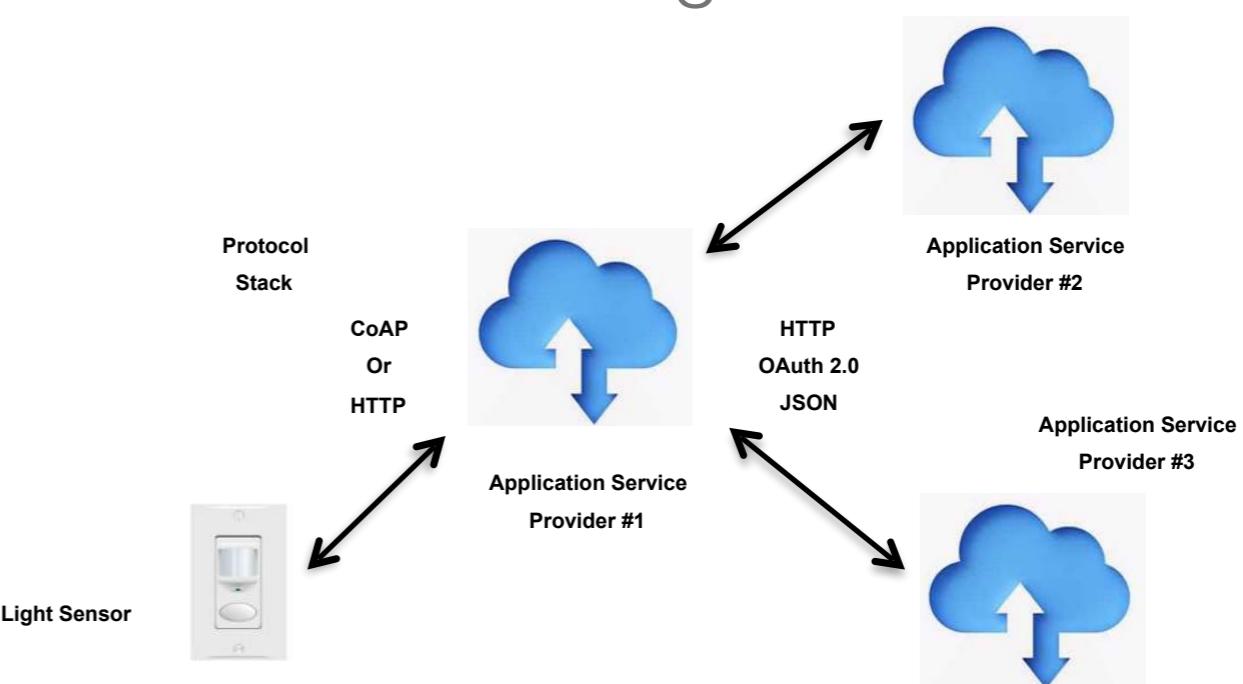
Back-end Data Sharing

Communication architecture that allows users to analyze and export smart object data from a cloud service in combination with data from other sources.

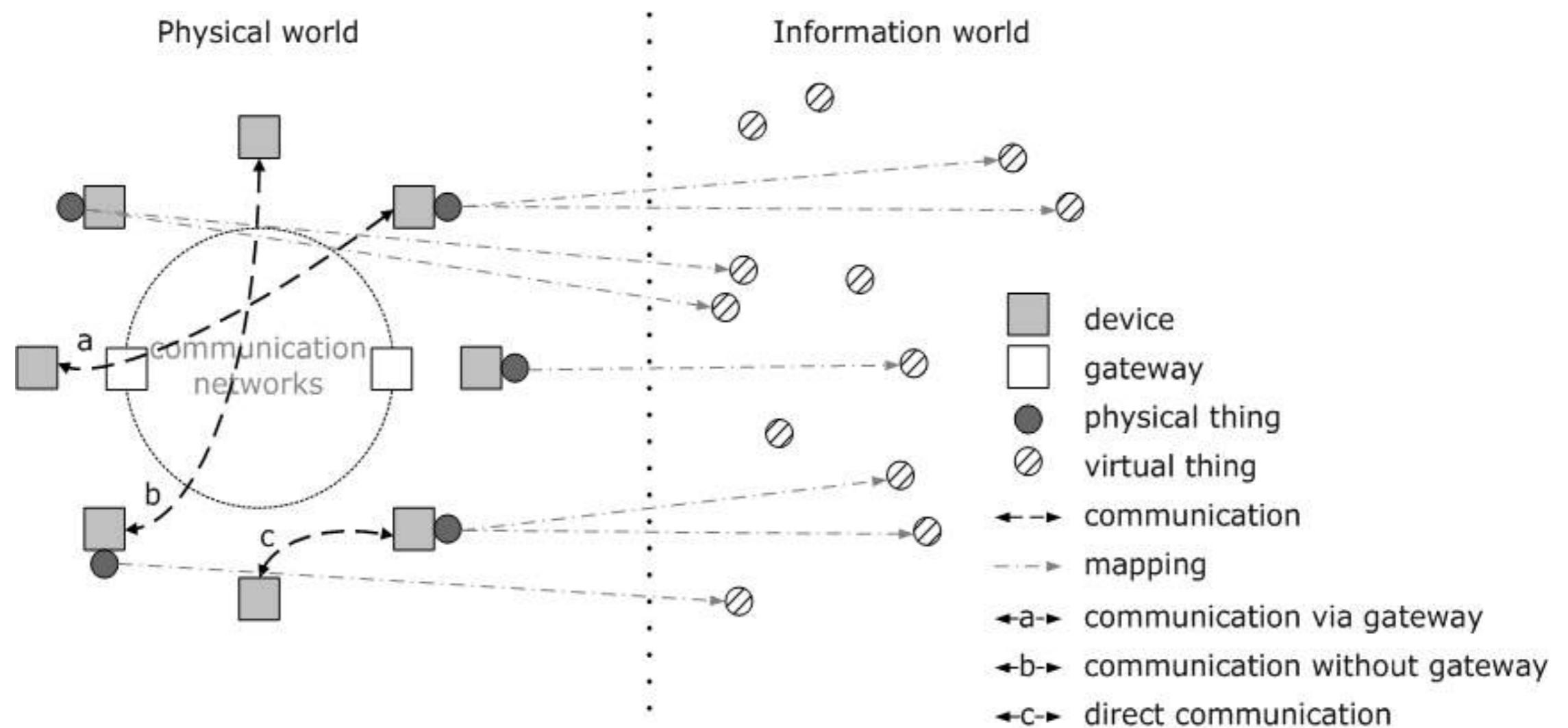
Grants access to uploaded 3rd party sensor data.

Extension of single device-to-cloud communication model.

Allows users to relocate/share data when switching between IoT services.



IoT landscape



Credit: IoT in ITU-T: Technical Overview

What is IoT

Internet + Things + Data

What does that mean in size?

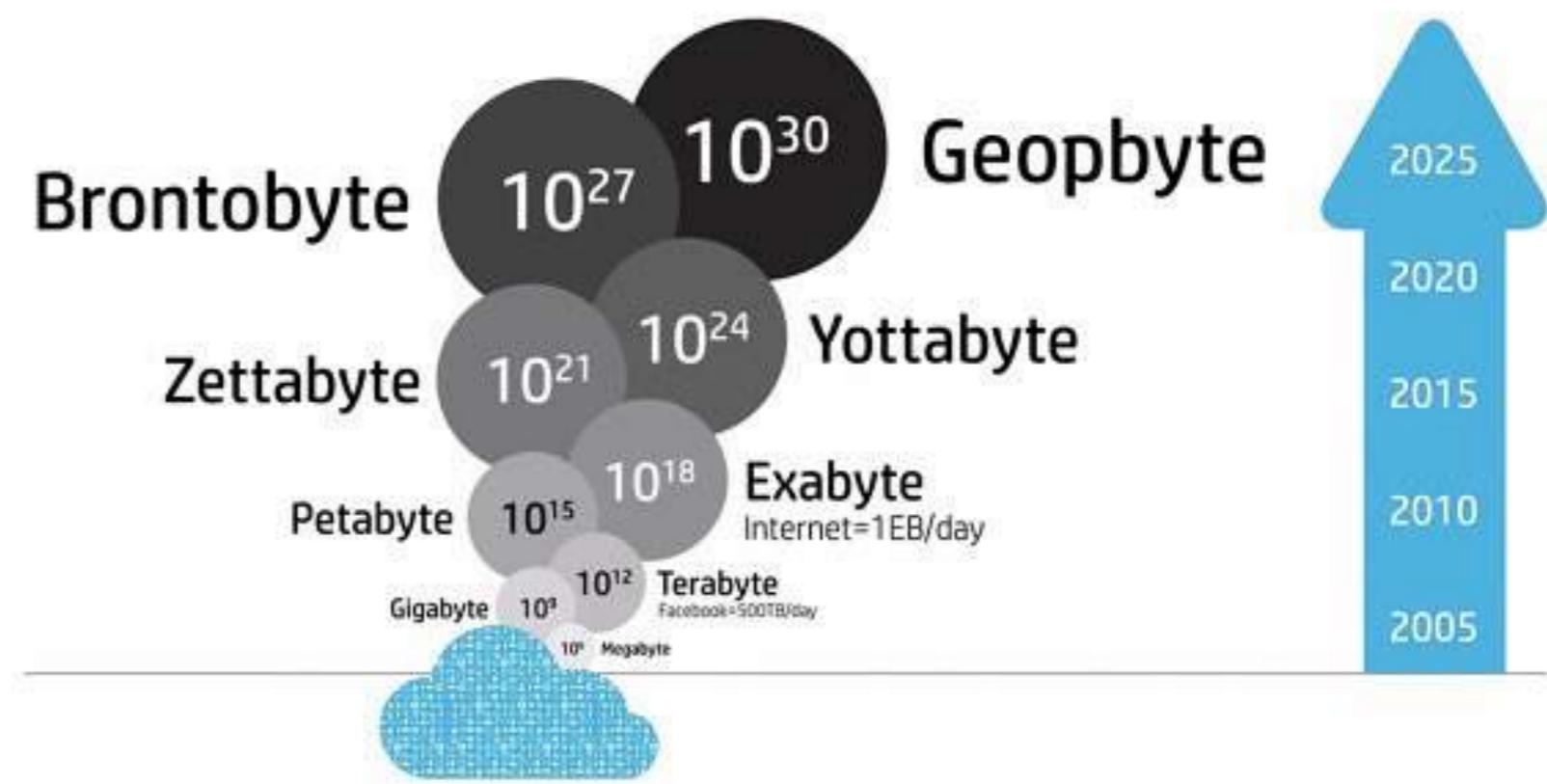
Not gigabytes

Most likely not a few terabytes

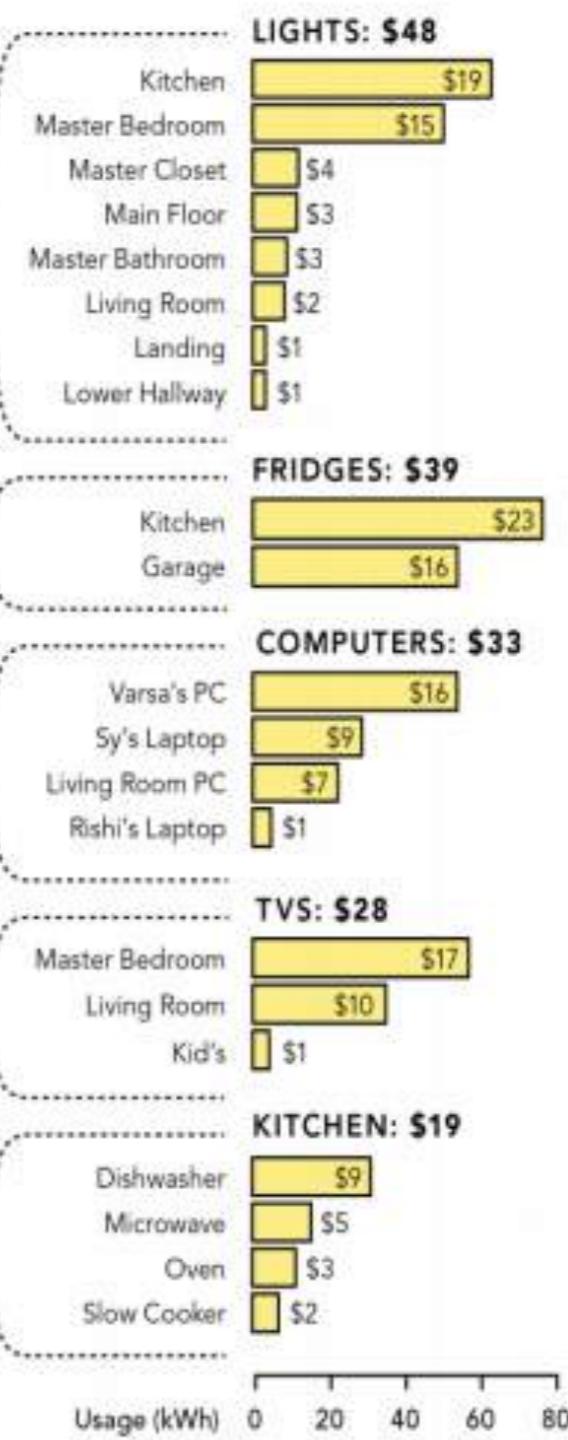
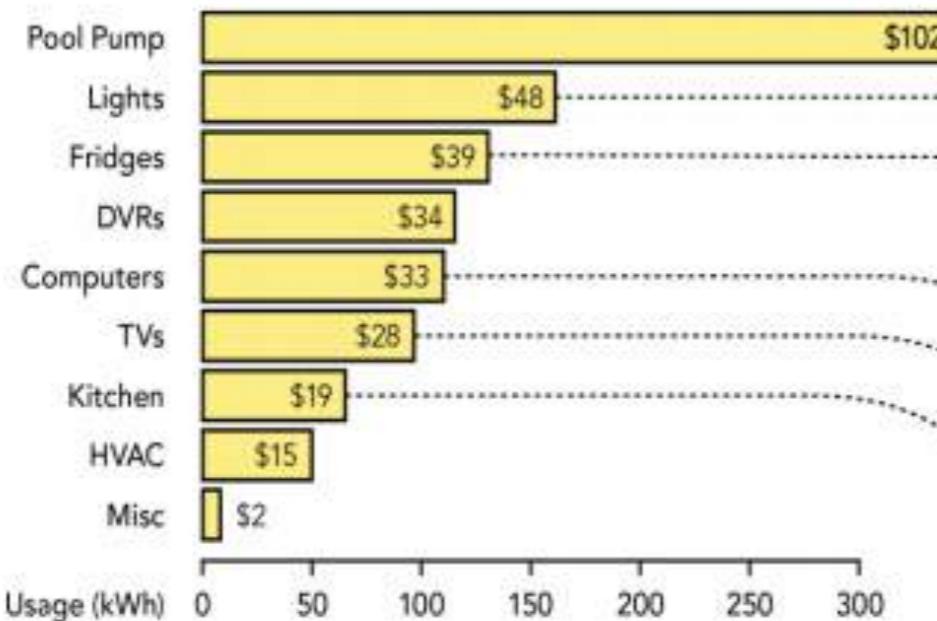
Possibly not 10's of terabytes

Probably 100's of terabytes

Definitely petabytes

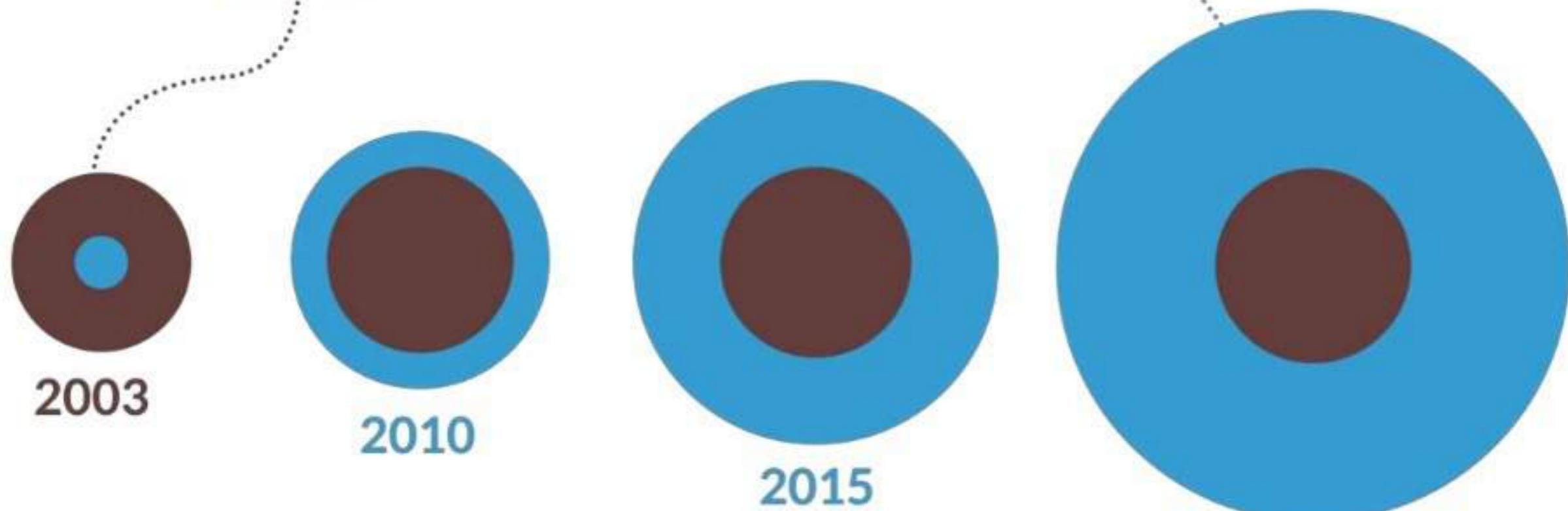


ELECTRICITY: \$319



IoT Revolution

During 2008, the number of **things** connected to the Internet exceeded the number of **people** on earth



By **2020** there will be **50 billion**.

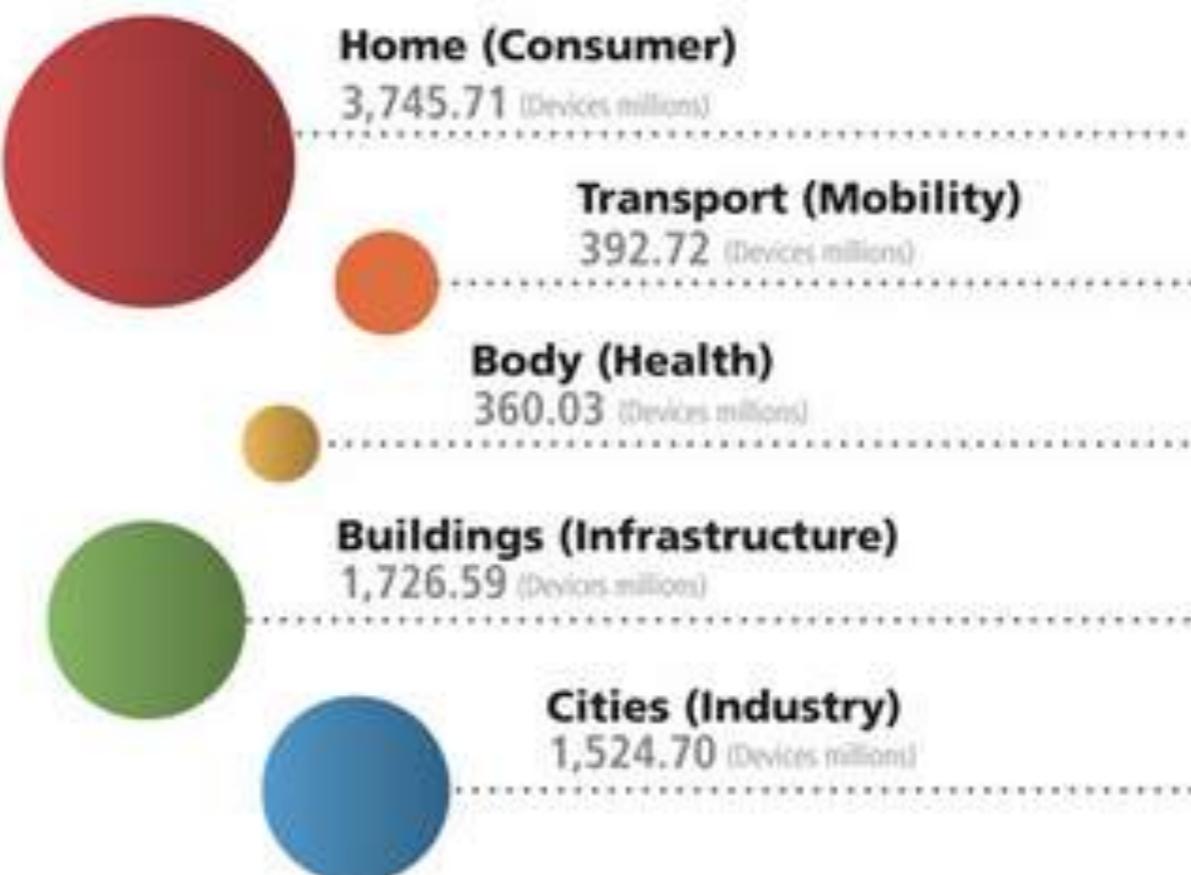
Connected Devices



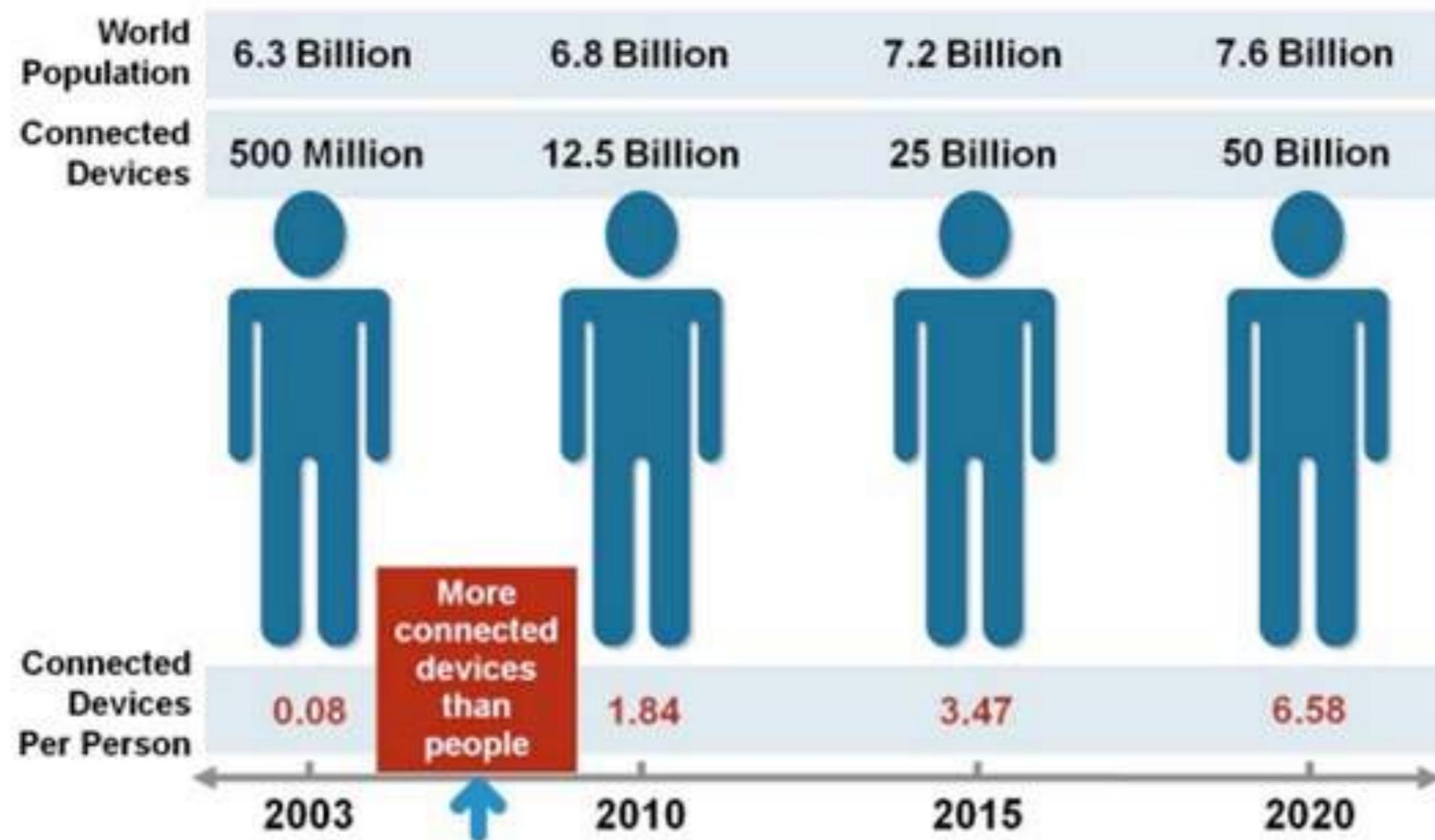
In 2014 nearly **2 billion** connected devices will be shipped

This number will grow to nearly **8 billion** devices for the year 2020

*Not including mobile phones



IoT Revolution



Source: Cisco IBSG, April 2011

IoT Revolution

The interactions between these
entities are creating new types
of smart applications and services.

Starting with popular connected devices already on the market



SMART THERMOSTATS



Save resources and money on your heating bills by adapting to your usage patterns and turning the temperature down when you're away from home.

CONNECTED CARS



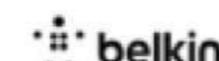
Tracked and rented using a smartphone. Car2Go also handles billing, parking and insurance automatically.

ACTIVITY TRACKERS



Continuously capture heart rate patterns, activity levels, calorie expenditure and skin temperature on your wrist 24/7.

SMART OUTLETS



Remotely turn any device or appliance on or off. Track a device's energy usage and receive personalized notifications from your smartphone.

PARKING SENSORS



Using embedded street sensors, users can identify real-time availability of parking spaces on their phone. City officials can manage and price their resources based on actual use.

HAPIfork

The HAPIfork is an electronic fork that helps you monitor and track your eating habits. It also alerts you with the help of indicator lights and gentle vibrations when you are eating too fast.



<http://www.hapi.com/products-hapifork.asp>

Smart Egg Tray

Egg Minder syncs with your smartphone to tell you how many eggs you've got at home (up to 14 eggs) and when they're going bad.

<http://www.quirky.com/shop/619>



MyVessyl Cup

It can hold 13 ounces of liquid.
The battery takes 60 minutes to
fully charge and will last for 5-7
days. Also has wire-free charging.

<https://www.myvessyl.com/>



Smart Garbage Cans

BigBelly alerts when it needs to be emptied so smarter collection decisions can be made.

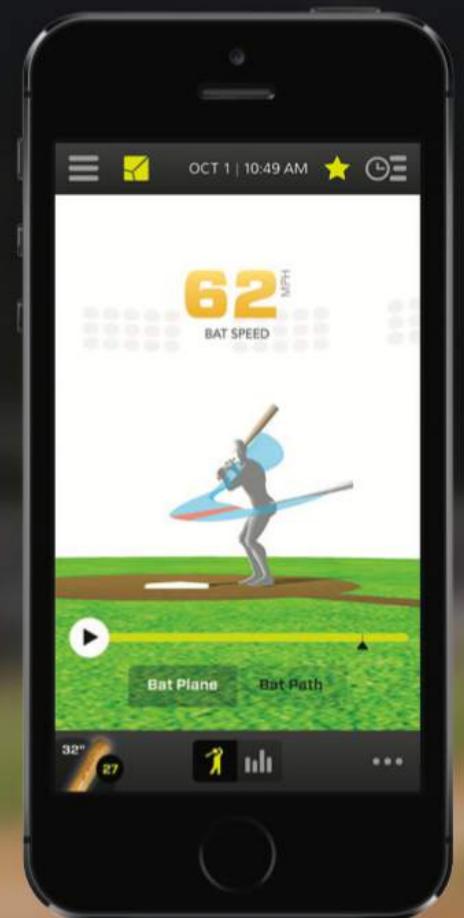
BigBelly
SOLAR™



<http://www.bigbelly.com/solutions/stations/smартbelly/>

Swing Analyzer

Make your Zepp Sensor multi-sport, all you need to do is purchase additional sport specific mounts and download the app.



<http://www.zepp.com/>

Bluetooth-Enabled Insoles

Shares navigation, directions and orientation.



<http://lechal.com/products.html>

Smart Socks

Socks infused with proprietary 100% textile sensors. They are paired with a Bluetooth Smart cool and detachable anklet that delivers accuracy in step counting, speed, calories, altitude and distance tracking.



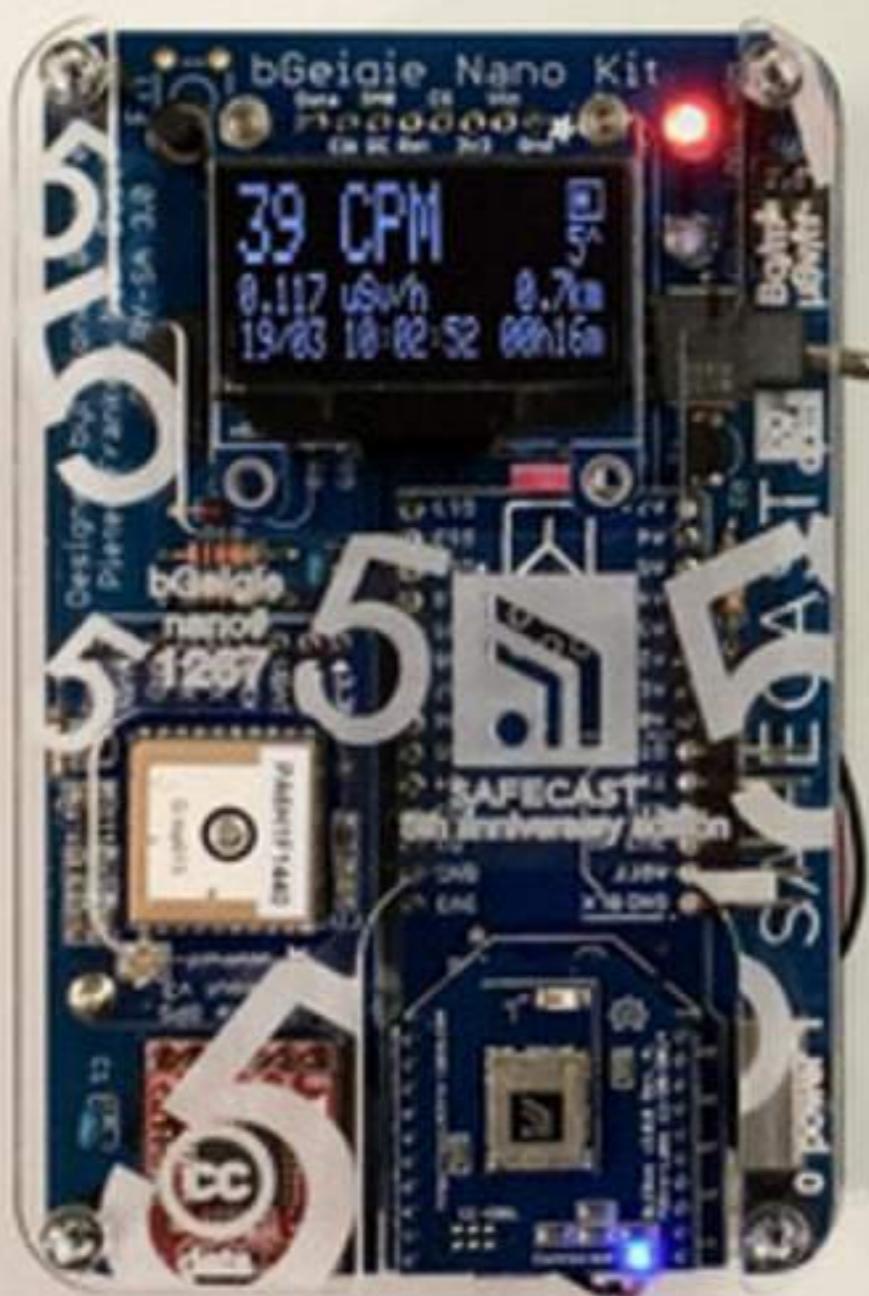
<http://store.sensoriafitness.com/>

Smart Citizen Kit



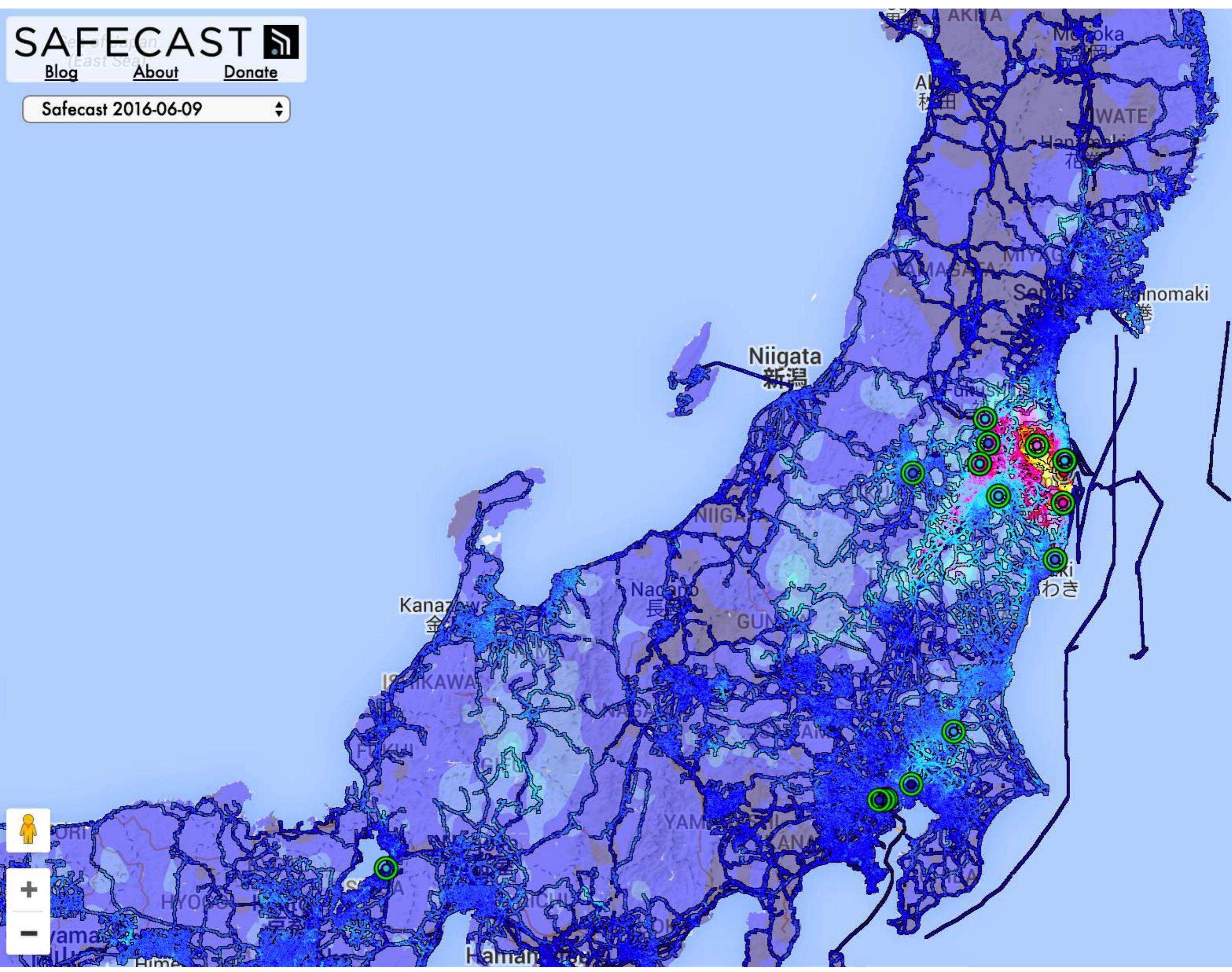
Air Quality



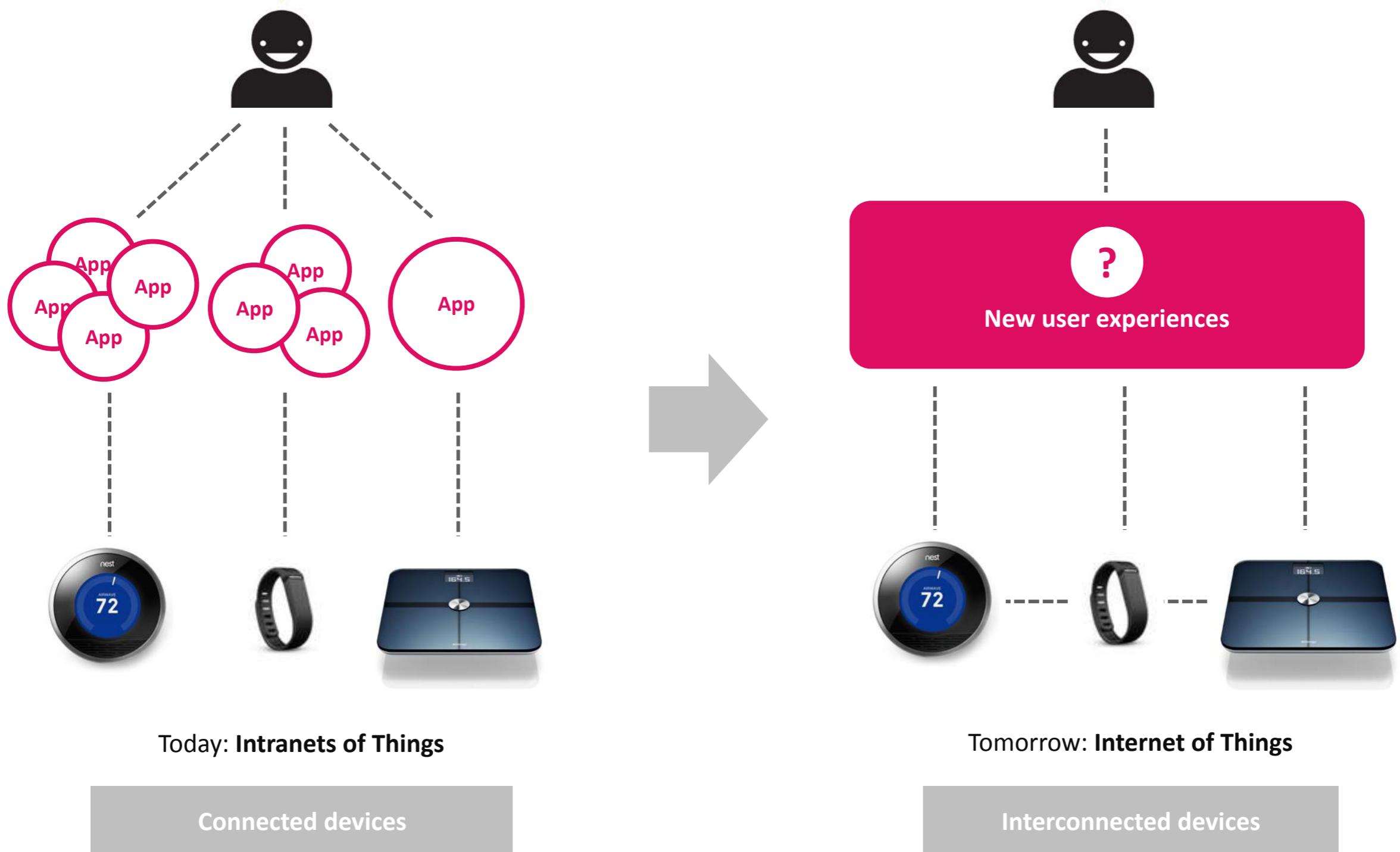




Safecast 2016-06-09



Intranet vs Internet



These **things** are starting to talk to each other and develop their own intelligence.
Imagine a scenario where.....

This is communicated to your **alarm clock**, which allows you 5 extra minutes of sleep.



And signals your **car** to start in 5 minutes to melt the ice accumulated in overnight snow storms.



...your **meeting** was pushed back 45 minutes.



...your **car** knows it will need gas to make it to the train station. Fill-ups usually take 5 minutes.



...there was an accident on your **driving route** causing a 15 minute detour.



...your **train** is running 20 minutes behind schedule.



And signals your **coffee maker** to turn on 5 minutes late as well.

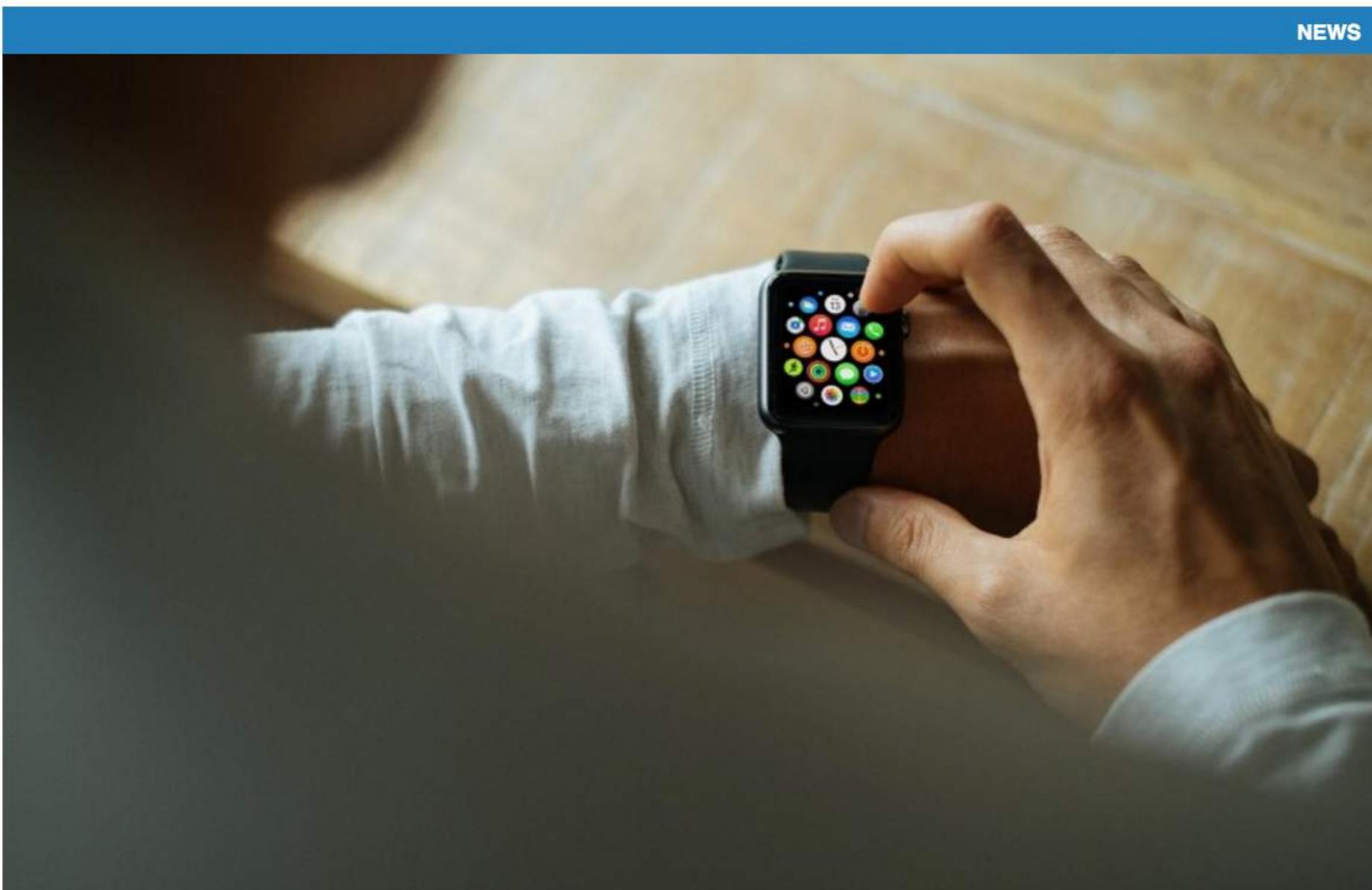
IoT and privacy

Apple Watch knows a heart attack when it sees one

BY [EVAN KILLHAM](#) • 4:45 PM, MARCH 14, 2016



NEWS



IoT and privacy

Privacy rights and expectations are critical to ensuring Internet trust.

Everyone has different personal privacy expectations and ability to trust the Internet.

Unknown 3rd party information/data sharing and analyzing exhibited (e.g. social media).

Traditional “notice & consent” online privacy model; **devices frequently have no user interface to configure privacy preferences.**

IoT and privacy

ALGORITHM
AUDIT: PENDULUM



DURATION: 15 S

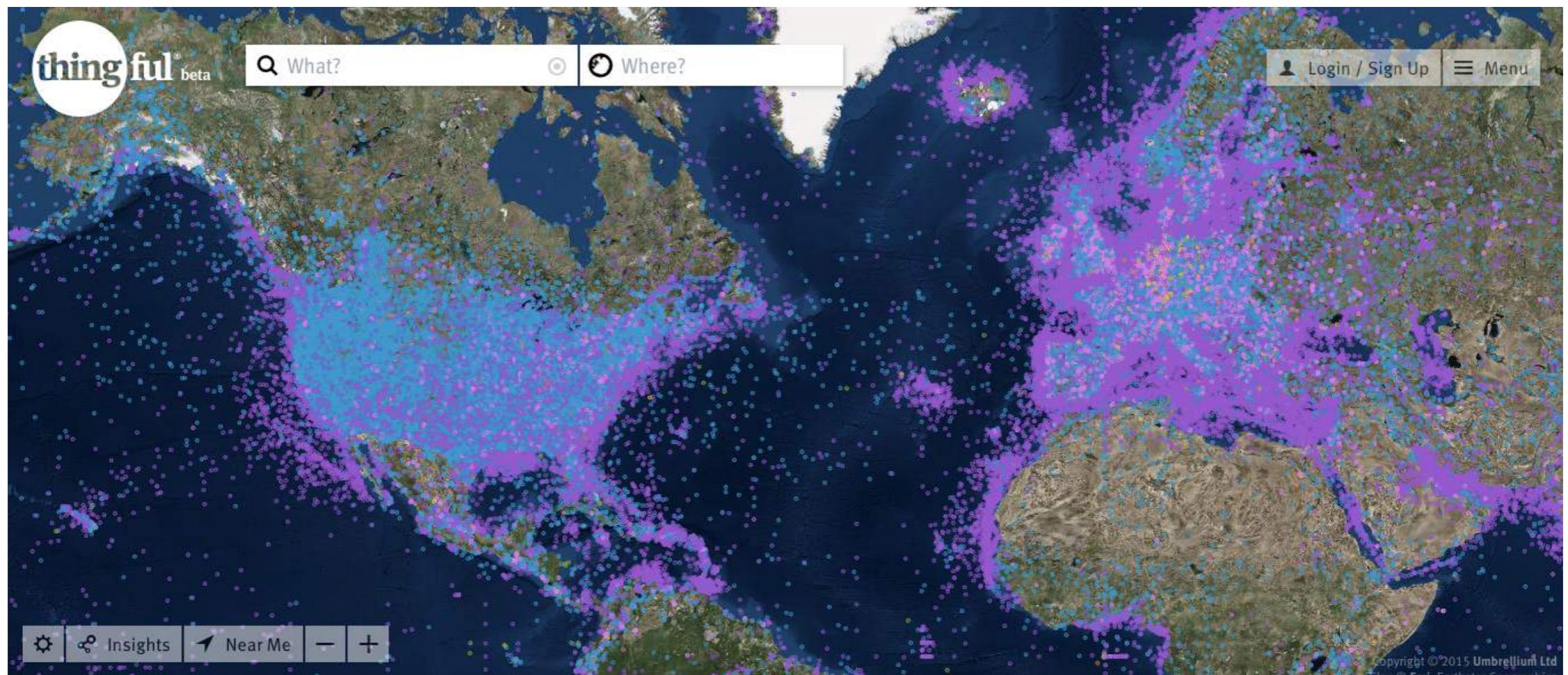
FITBIT

- STEPCOUNT: 71
- DISTANCE: 0.05KM
- CALORIES: 2

JAWBONE

- STEPCOUNT: 51
- DISTANCE: 0.04KM
- CALORIES: 4

IoT4D



IoT4D - weather

In **Africa**, one WMO weather station covers an area of 27,347 km².

Altogether, there are **1,108 WMO weather stations** on the continent.

In **Germany**, the covered area per WMO weather station is 1,244 km².

There are **287 WMO weather stations** operated in Germany.

IoT4D – Weather stations in Kenya



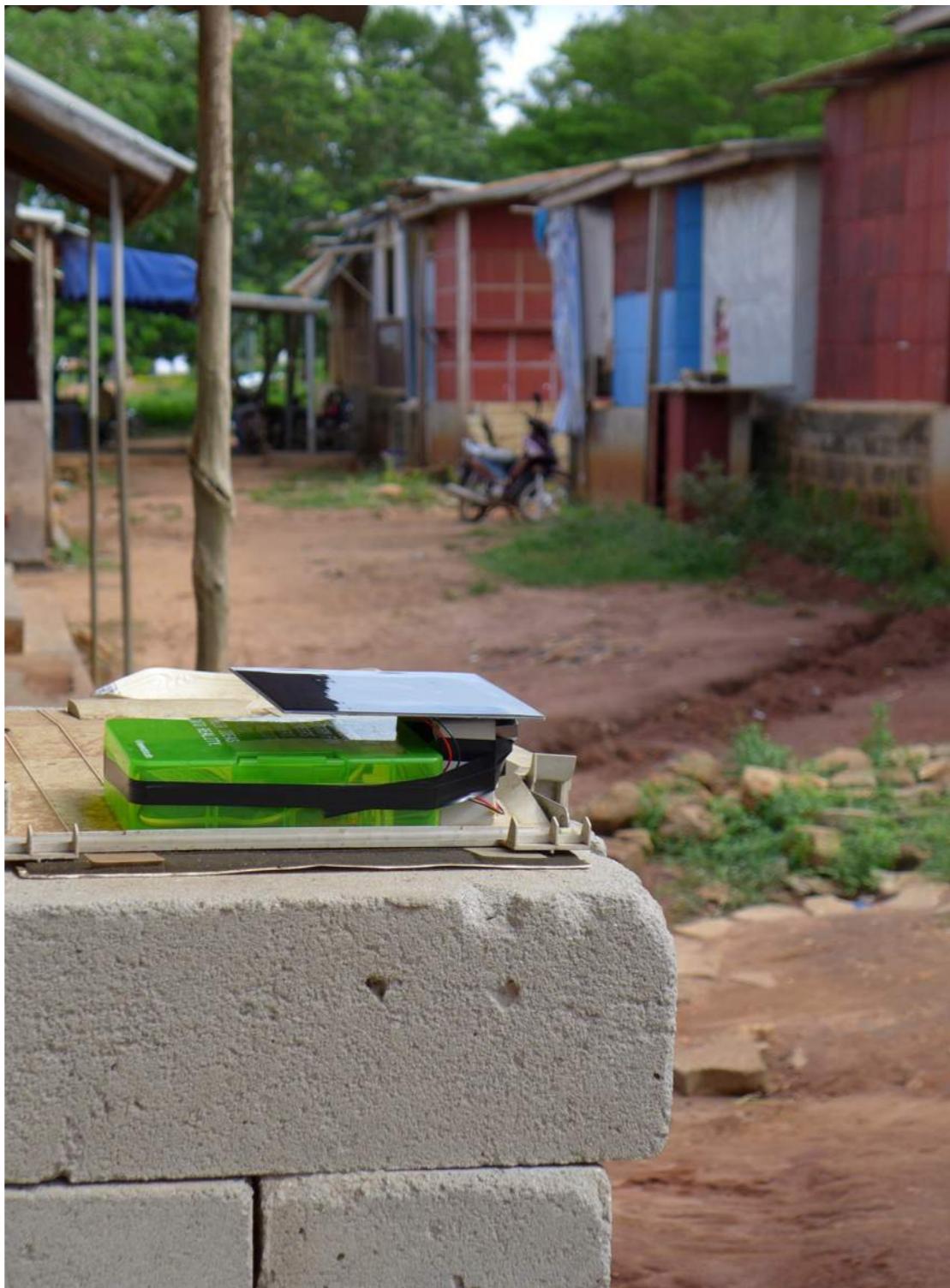
IoT4D – Radiation sensors in Indonesia



IoT4D – Air quality sensors in Benin



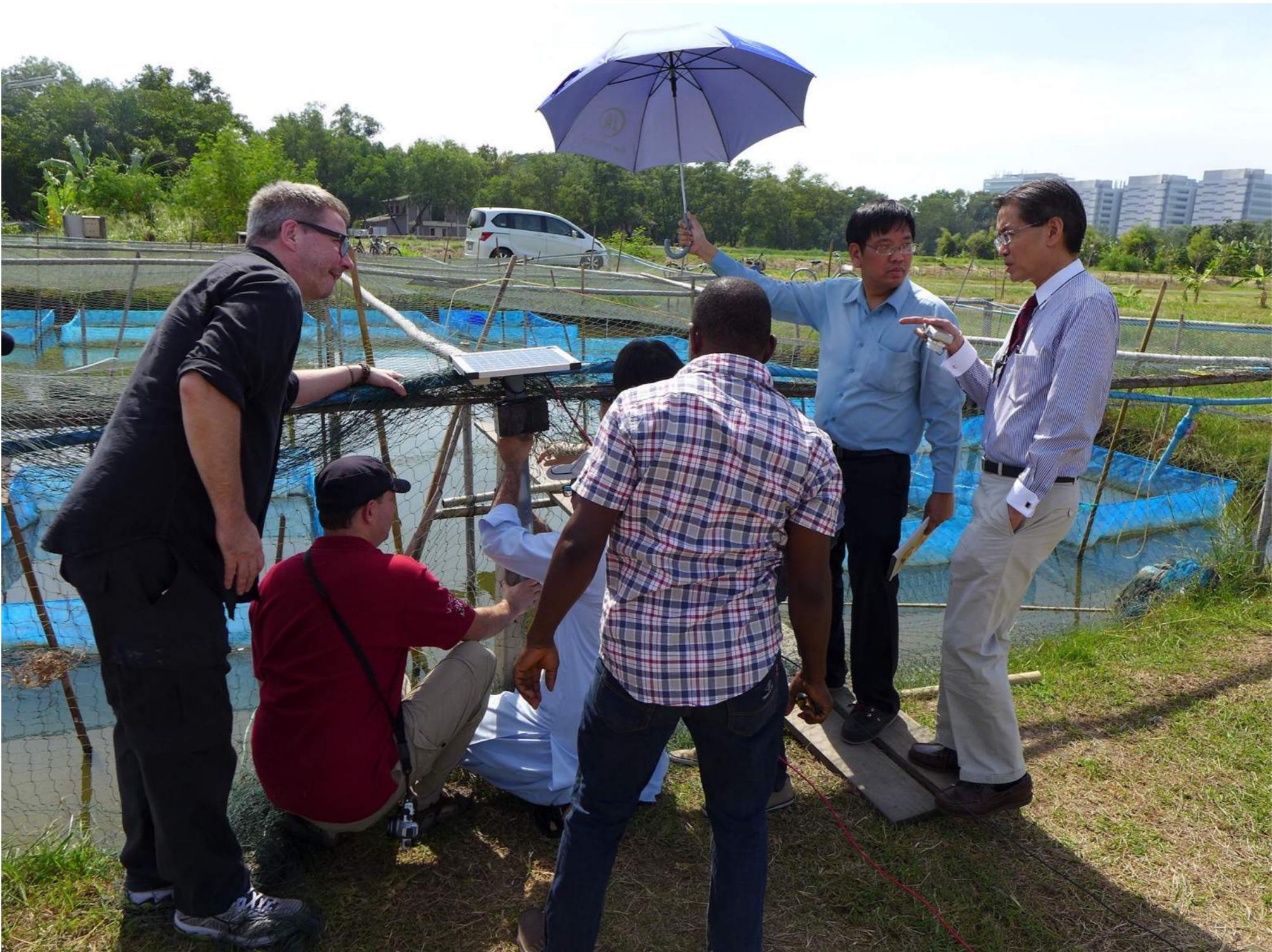
IoT4D– Air quality sensors in Benin



IoT4D – IoT Living Lab in Thailand



IoT4D – IoT Living Lab in Thailand



Thanks!

Marco Zennaro
T/ICT4D Laboratory
The Abdus Salam International Centre
for Theoretical Physics
Trieste-Italy

mzennaro@ictp.it
<http://wireless.ictp.it>