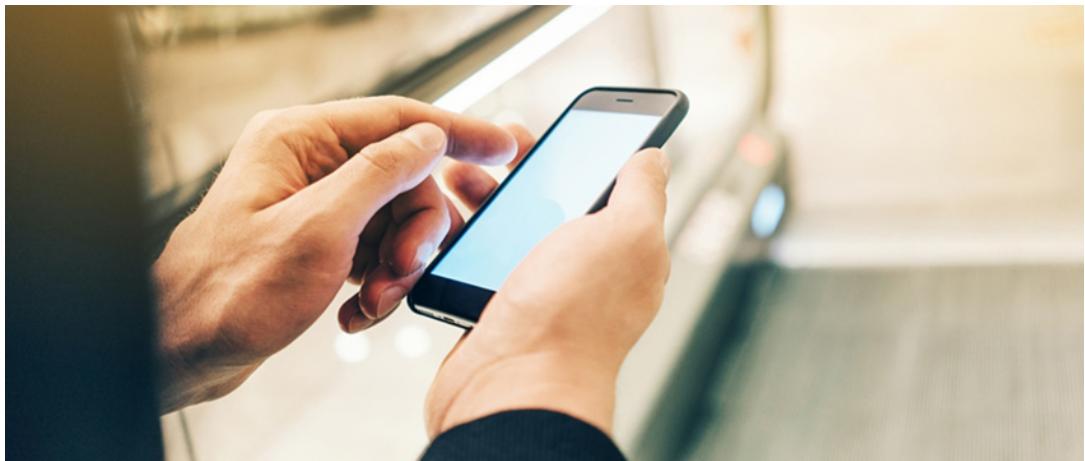


The Internet of Things (IoT)

Introduction

Marco Teran

Introduction to IoT



The idea of the Internet of Things is that instead of having a small number of powerful computing devices in your life, you have a large number of low energy, ubiquitous computing devices.

Various Names, One Concept

M2M (Machine to Machine)

“Internet of Everything” (Cisco Systems)

“World Size Web” (Bruce Schneier)



IoT Definition



IoT Definition



IoT Definition

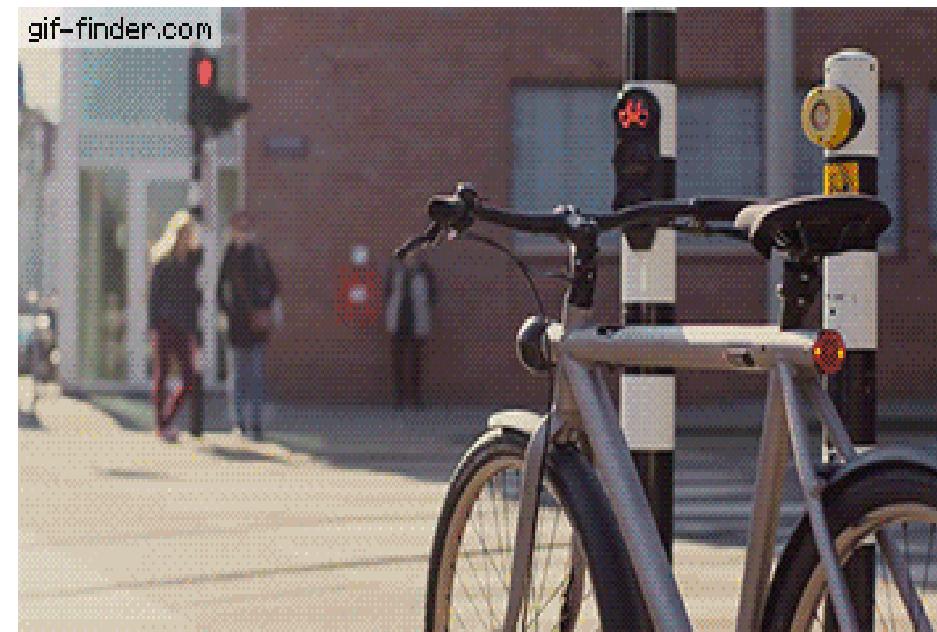
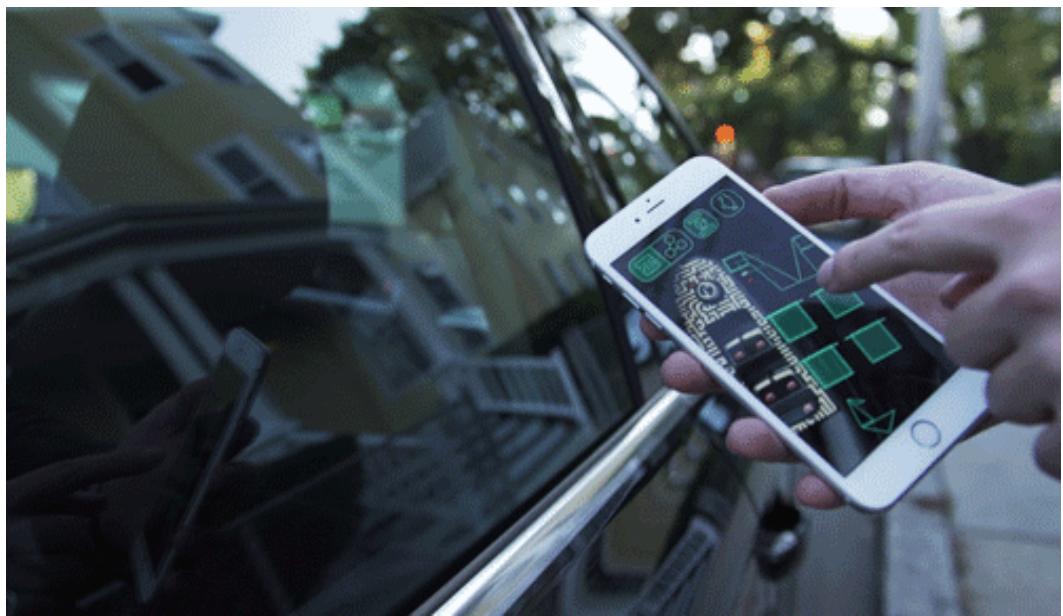
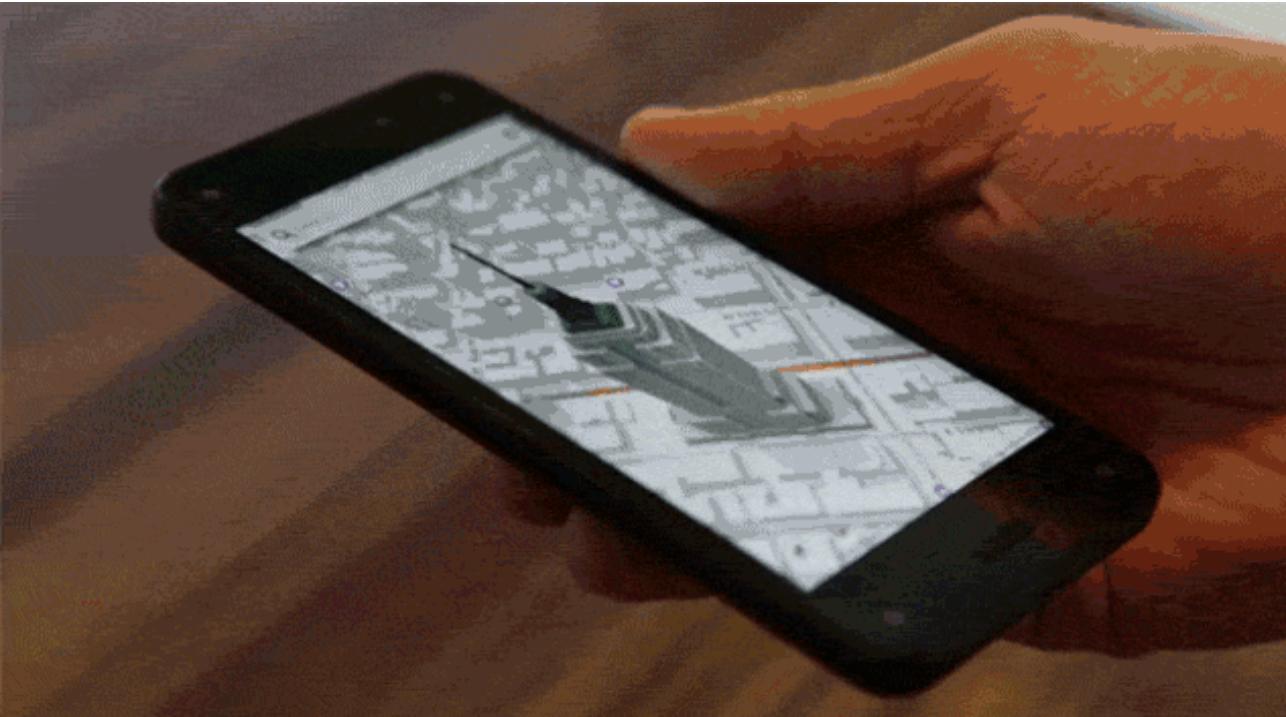
The Internet of Things (IoT) is the interconnection of uniquely identifiable embedded computing devices within the existing Internet infrastructure.

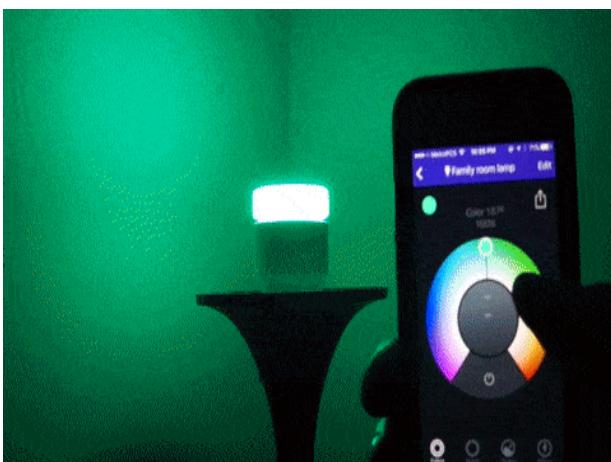
- ‘Interconnection’ refers to networking (mostly wireless)
- ‘Uniquely identifiable’ reminds addressing (IPv6)
- ‘Embedded Computing’ reminds of processing capabilities, reduced size and full integration of components
- ‘Existing Internet’ reminds IoT as the next evolution of the current Internet



Not a Network of Humans

From the Internet of People to the Internet of Things

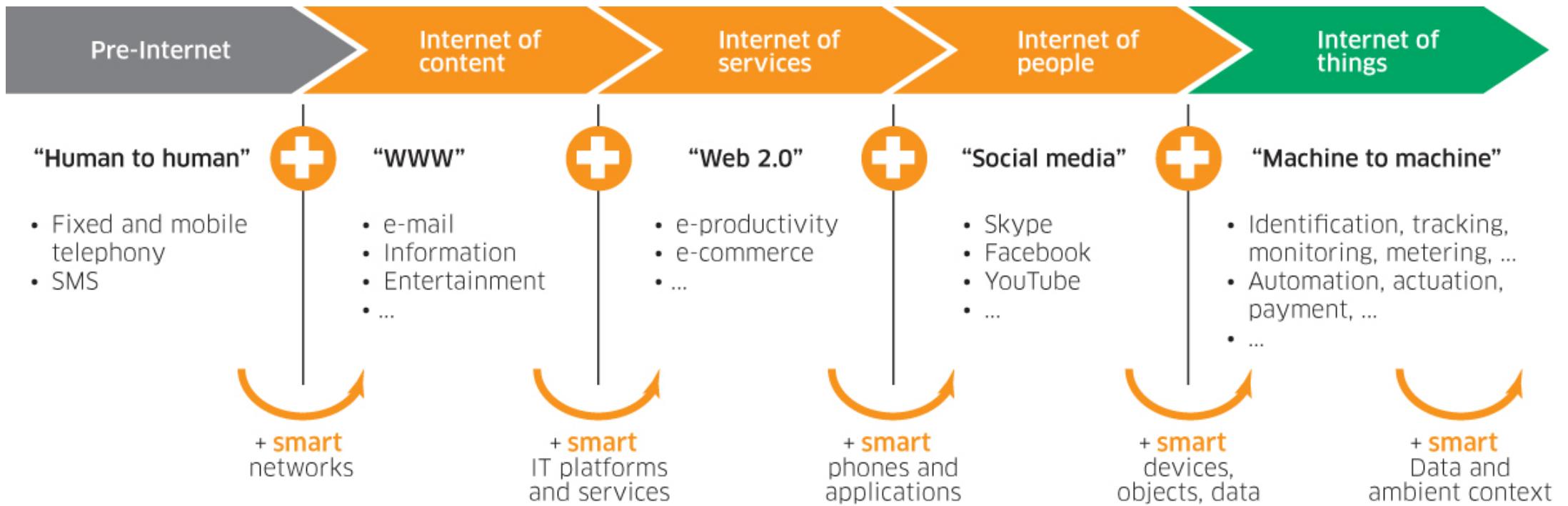


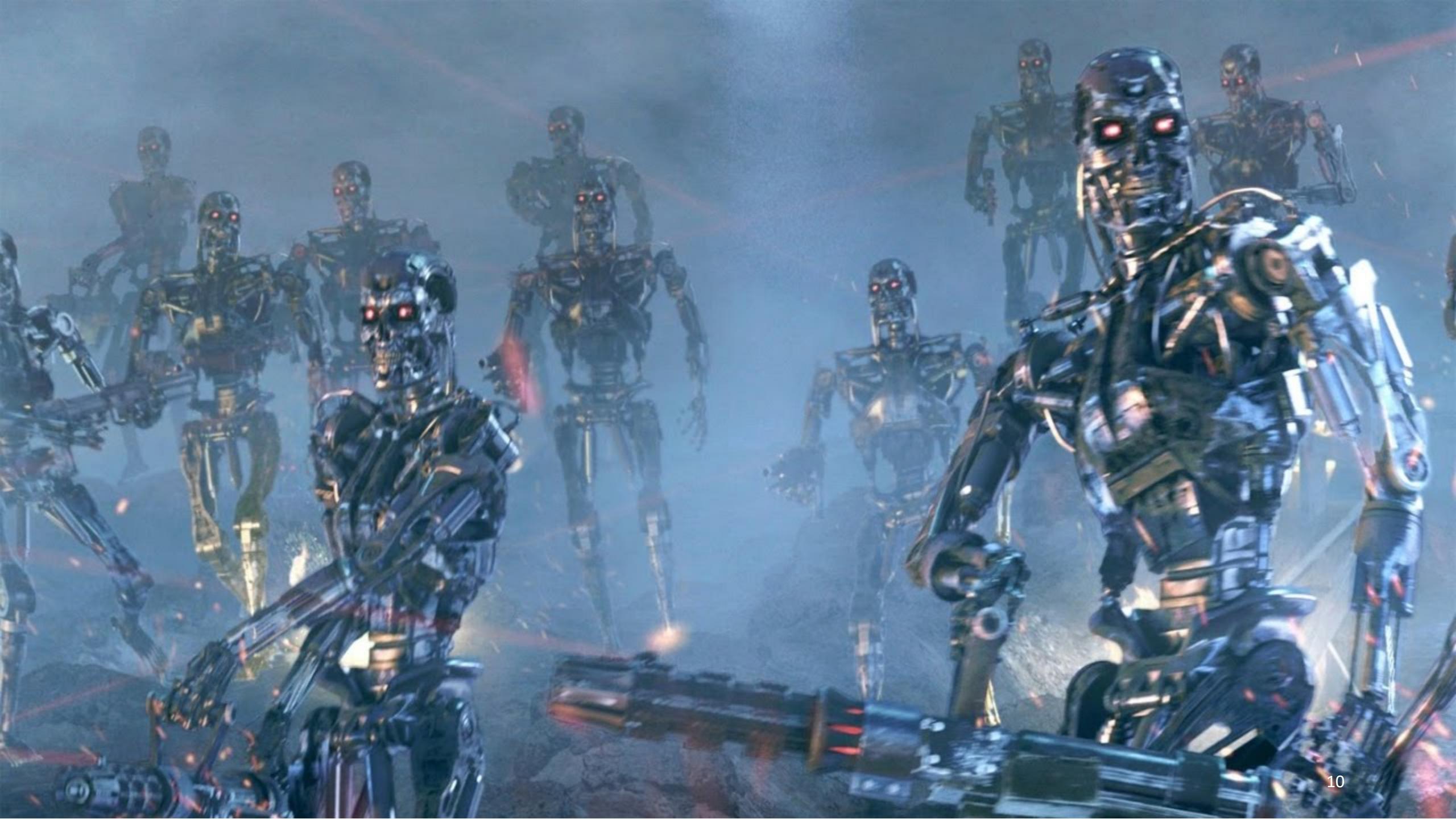


Smart devices

Characteristic of Internet of Things

- Highly connected
- Smart
- Thing = Not necessarily a computer/phone/tablet
- Network/physical world interface





Characteristic of Internet of Things

Population of the world: 7.2 Billion

Population of Internet users: 3 Billion

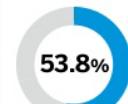
By 2020, expected connected devices:

- 26 Billion by Gartner
- 30 Billion by ABI
- 50 Billion by Cisco

Beware of Skynet!



50 billion
Connected devices in the Internet of Things by 2030¹



53.8%
Drop in average cost of sensors over last 10 years²



60x
Reduction in cost of processing over last 10 years³



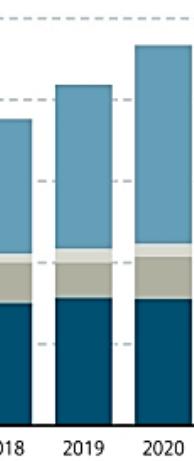
40x
Reduction in cost of bandwidth over last 10 years⁴



Big Data is doubling every 18 months⁵
Global shipments of smartphones predicted by 2018⁶



1.87 billion



The Rise of Sensors

Sensors enable IoT. Every object, even the human body.



Today's devices have between 6-9 sensors:



AMBIENT LIGHT



ACCELEROMETER



MAGNETOMETER



M7 MOTION COPROCESSOR



AMBIENT SOUND



GYROSCOPIC



PROXIMITY



TEMPERATURE & HUMIDITY

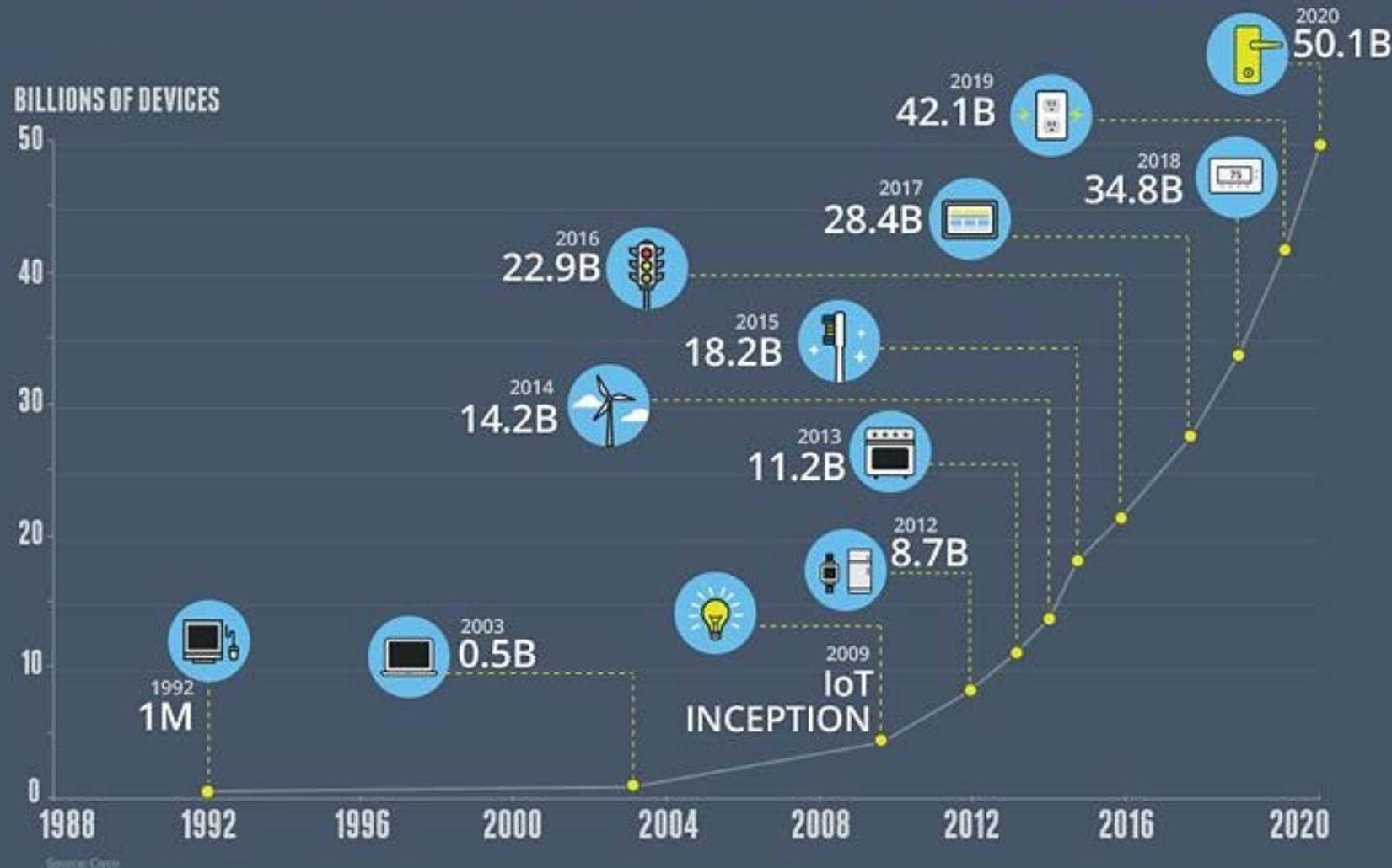


BAROMETER



GROWTH IN THE INTERNET OF THINGS

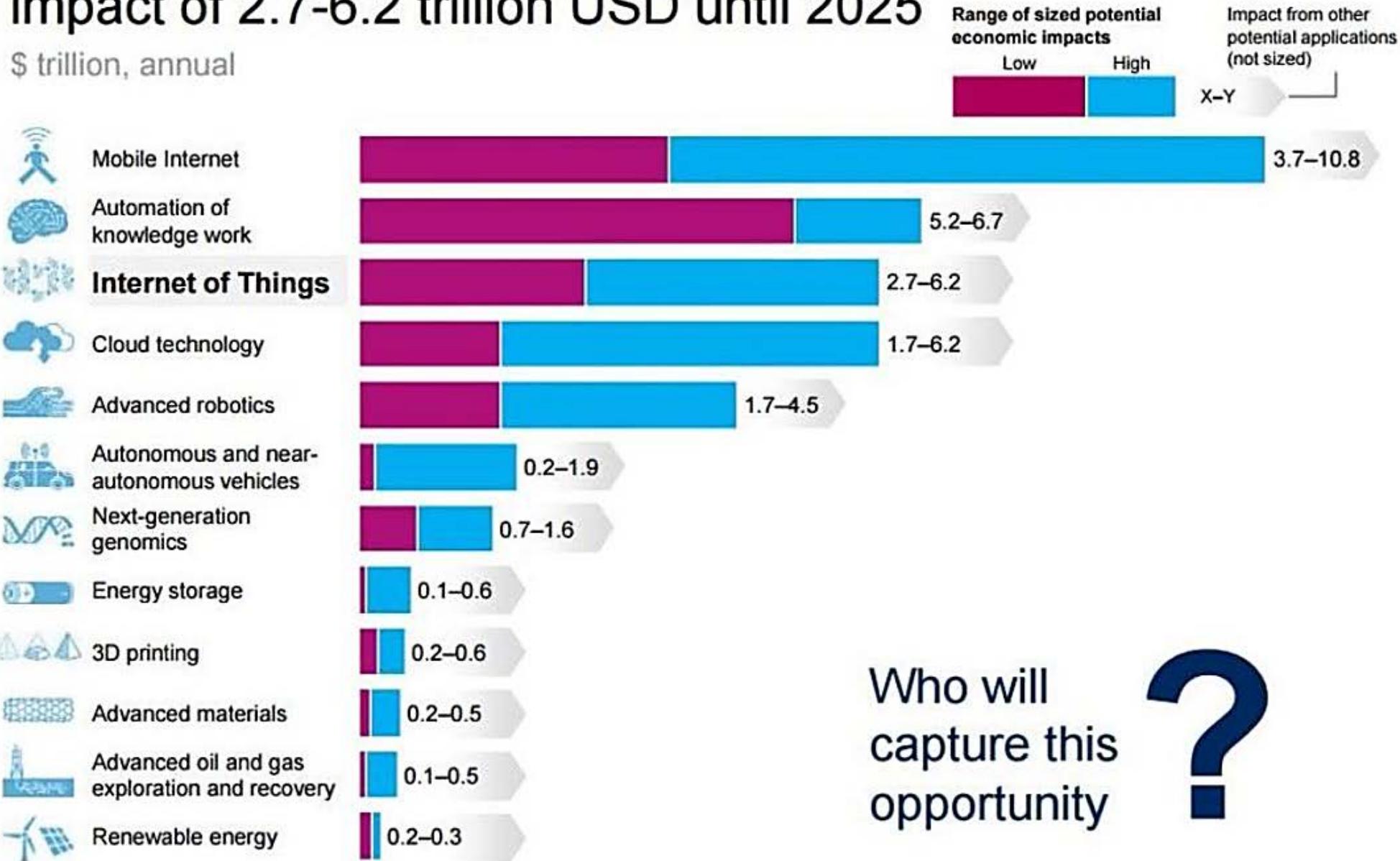
THE NUMBER OF CONNECTED DEVICES WILL EXCEED 50 BILLION BY 2020



Source: Cisco

The Internet of Things (IoT) has a potential economic impact of 2.7-6.2 trillion USD until 2025

\$ trillion, annual



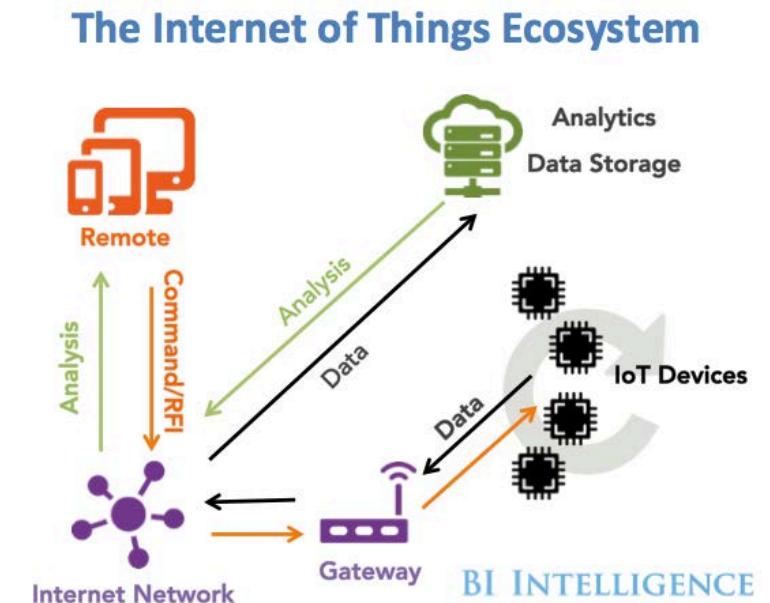
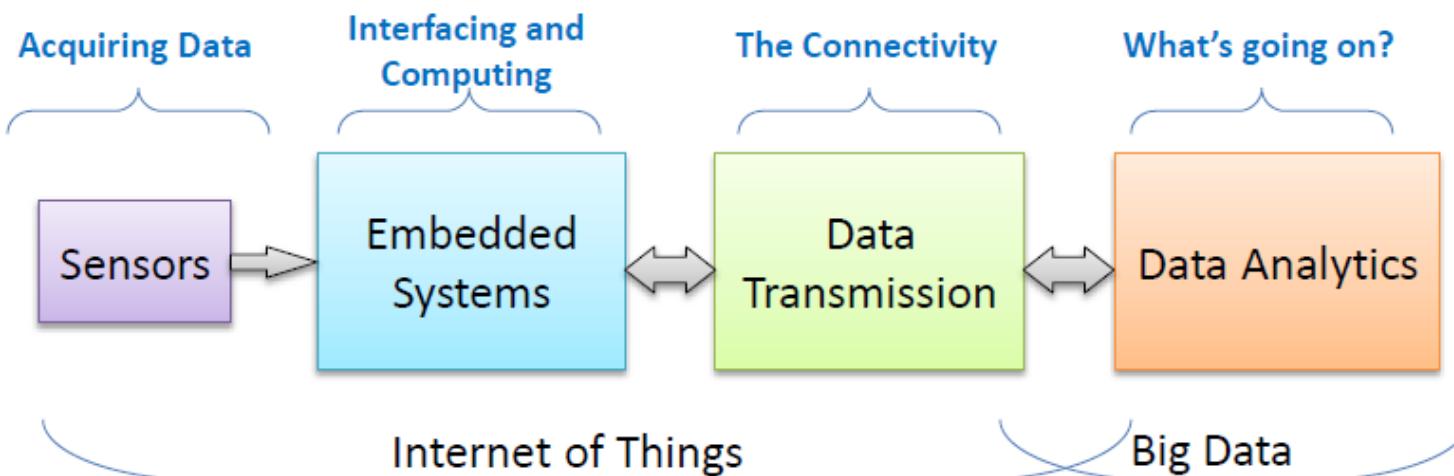
Who will capture this opportunity



IoT basic model

A Basic IoT Model

A very simplistic model for the IoT would consider the following modules:



Why deploy IoT solutions?

To optimize:

an automated air conditioning system could improve your daily life.

–But it can also allow the electricity company to limit your power consumption during summer peak days.

20% cheaper electricity

all year to allow the electricity company to limit by 10% your consumption during 3 peak days a year ?

Think hardware + software data service rather than just hardware

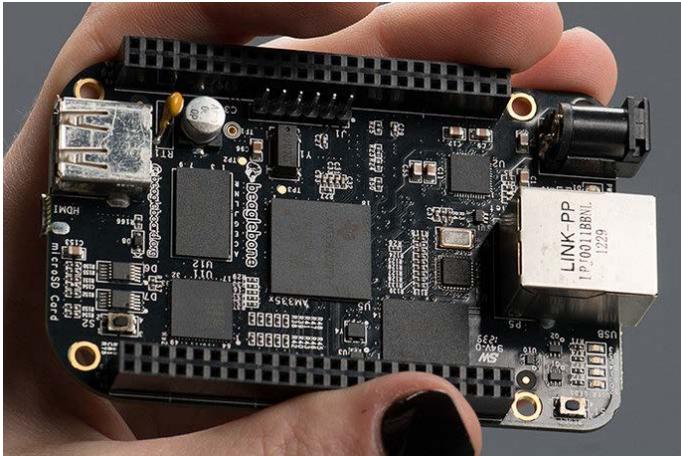
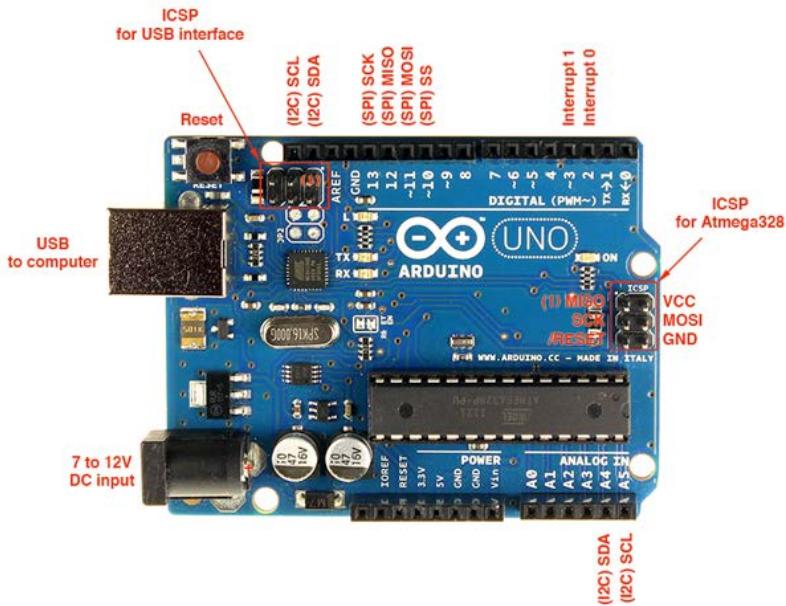
To collect data:

Internet access and communications are already highly monitored to characterize your behavior,

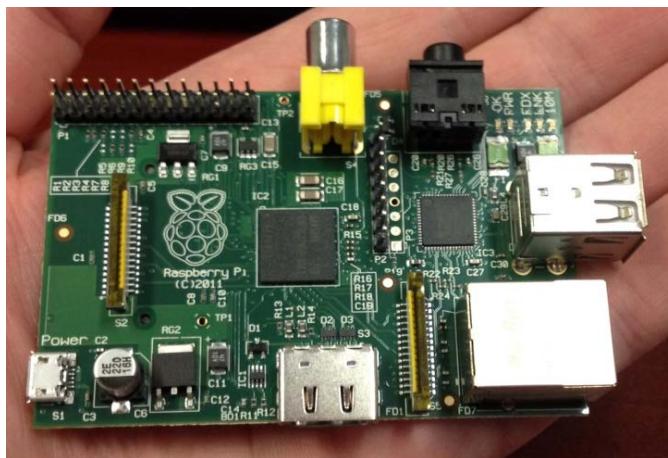
- but the physical world is not, except for GPS.
- Knowing everything about your electrical devices, consumptions, movements at home has a lot of value.
- Happy?



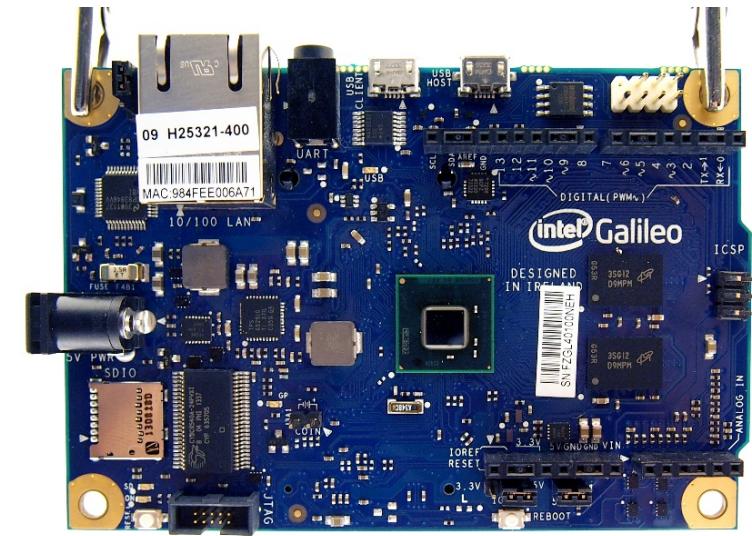
Implementing Smart Objects



Beaglebone black

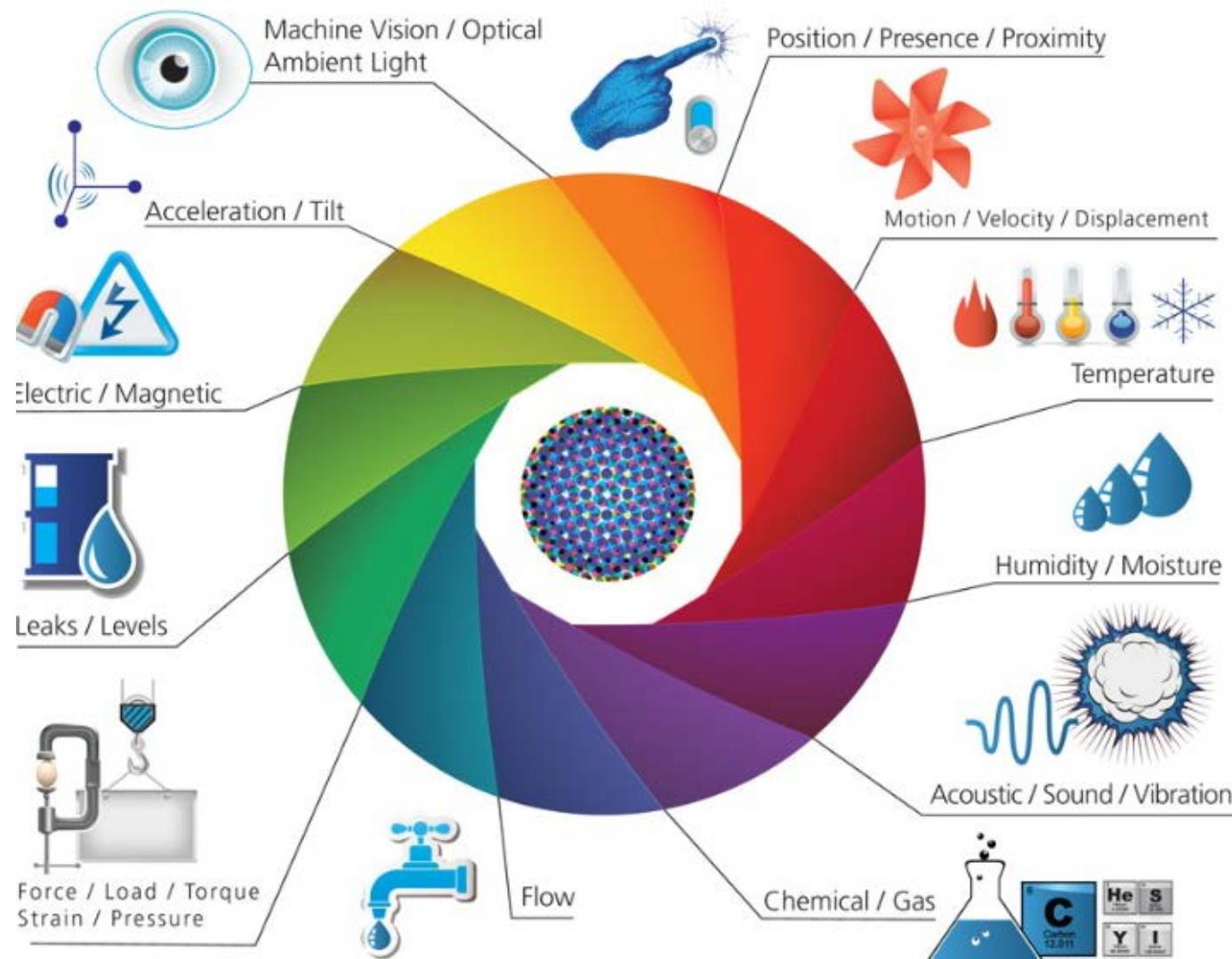


Raspberry Pi



Intel Galileo

Sensors and Actuators



Sensors and Actuators



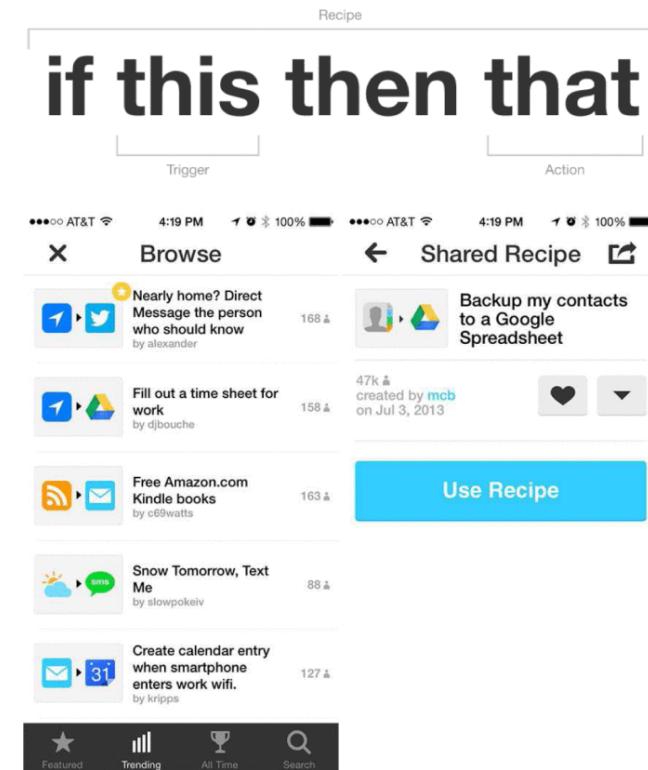
Sensors and Actuators



Power of the Cloud



Power of the Cloud

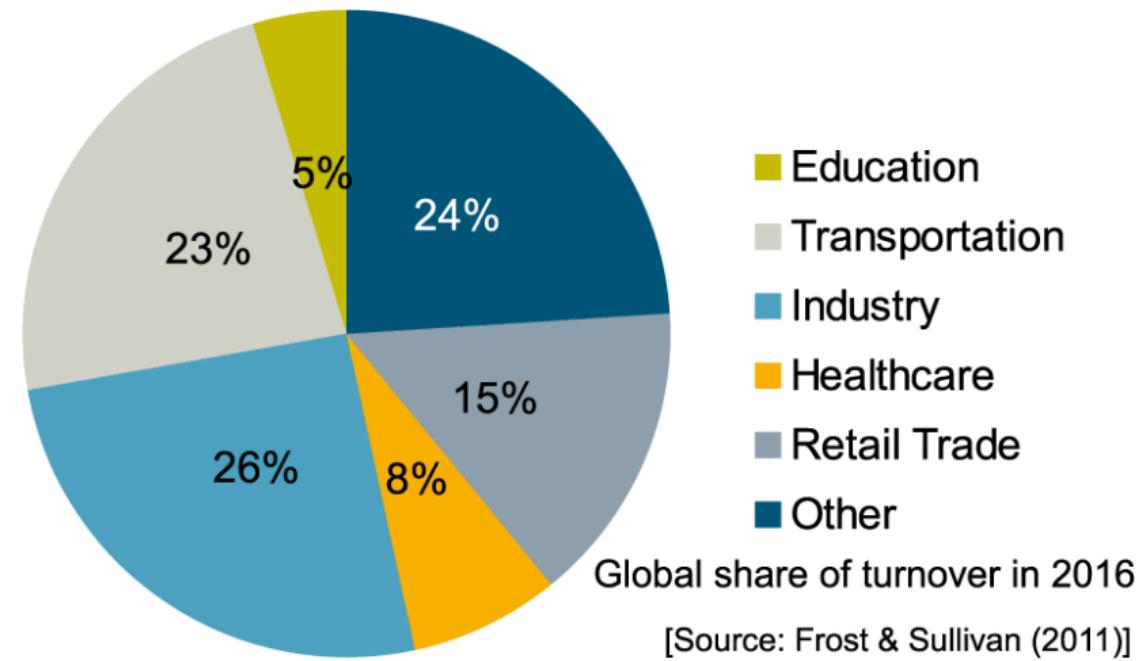


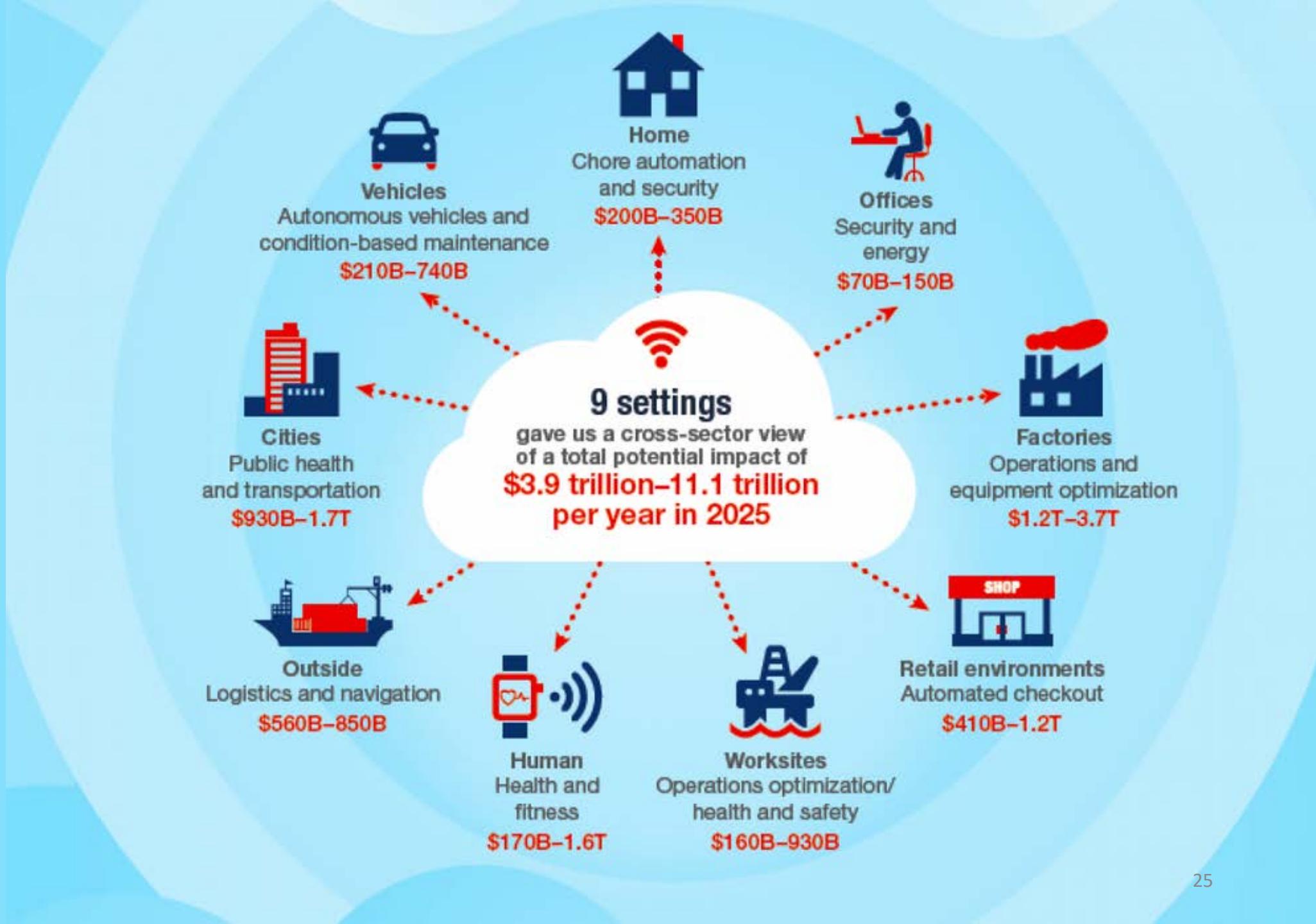
Applications of IoT

Applications of IoT



The IoT is EVERYWHERE





Wearables

Much more diverse market than investors realize



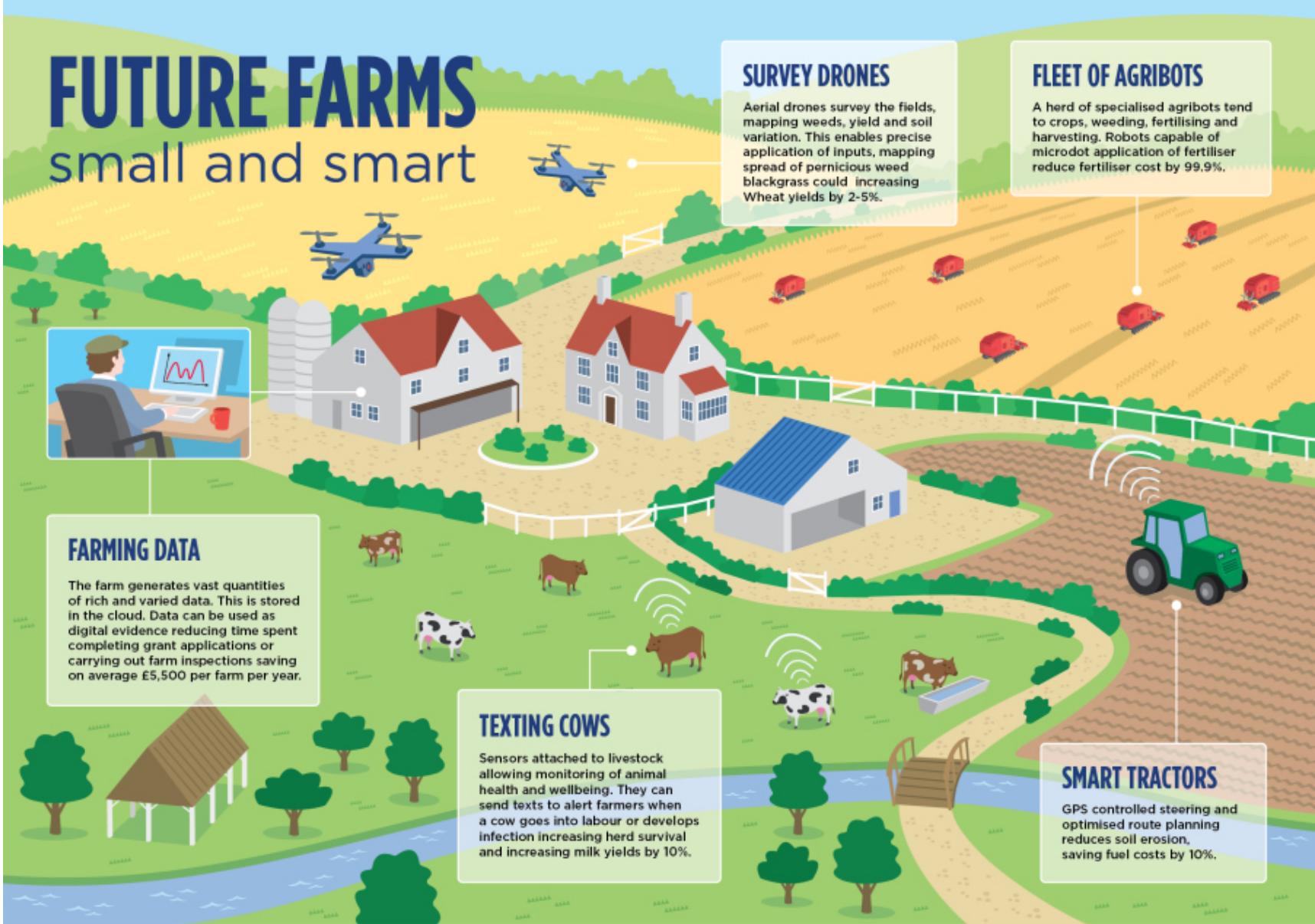
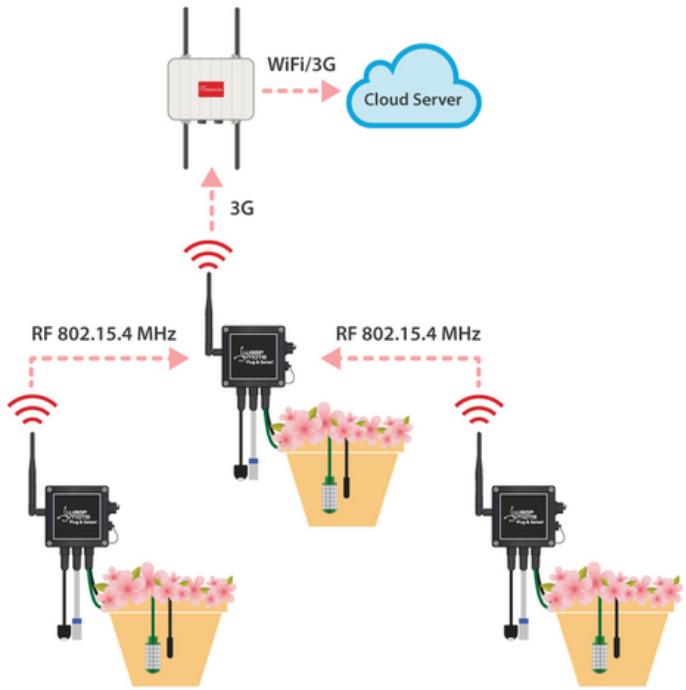
Wearables

iRing

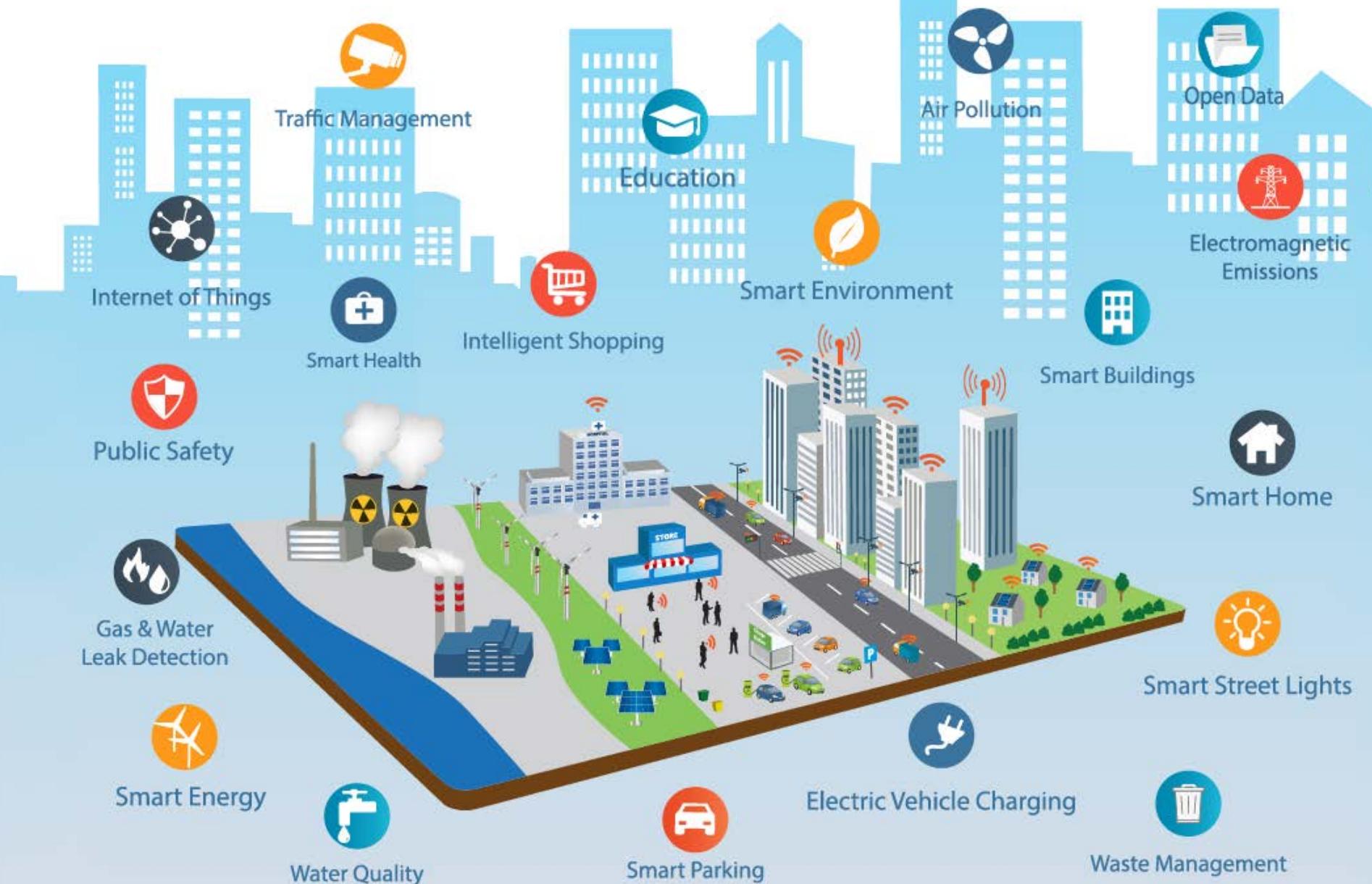


Smart agriculture

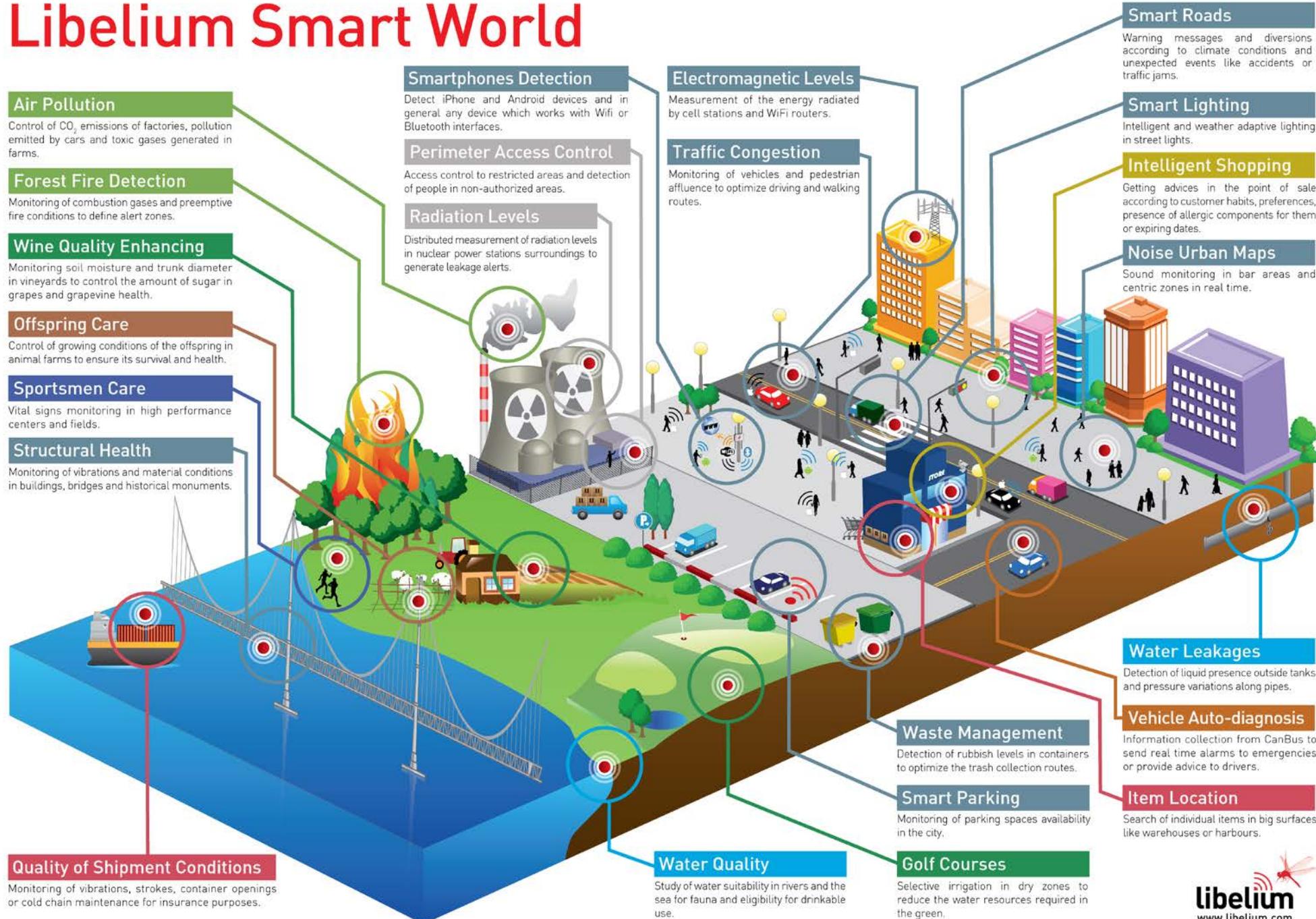




SMART CITY



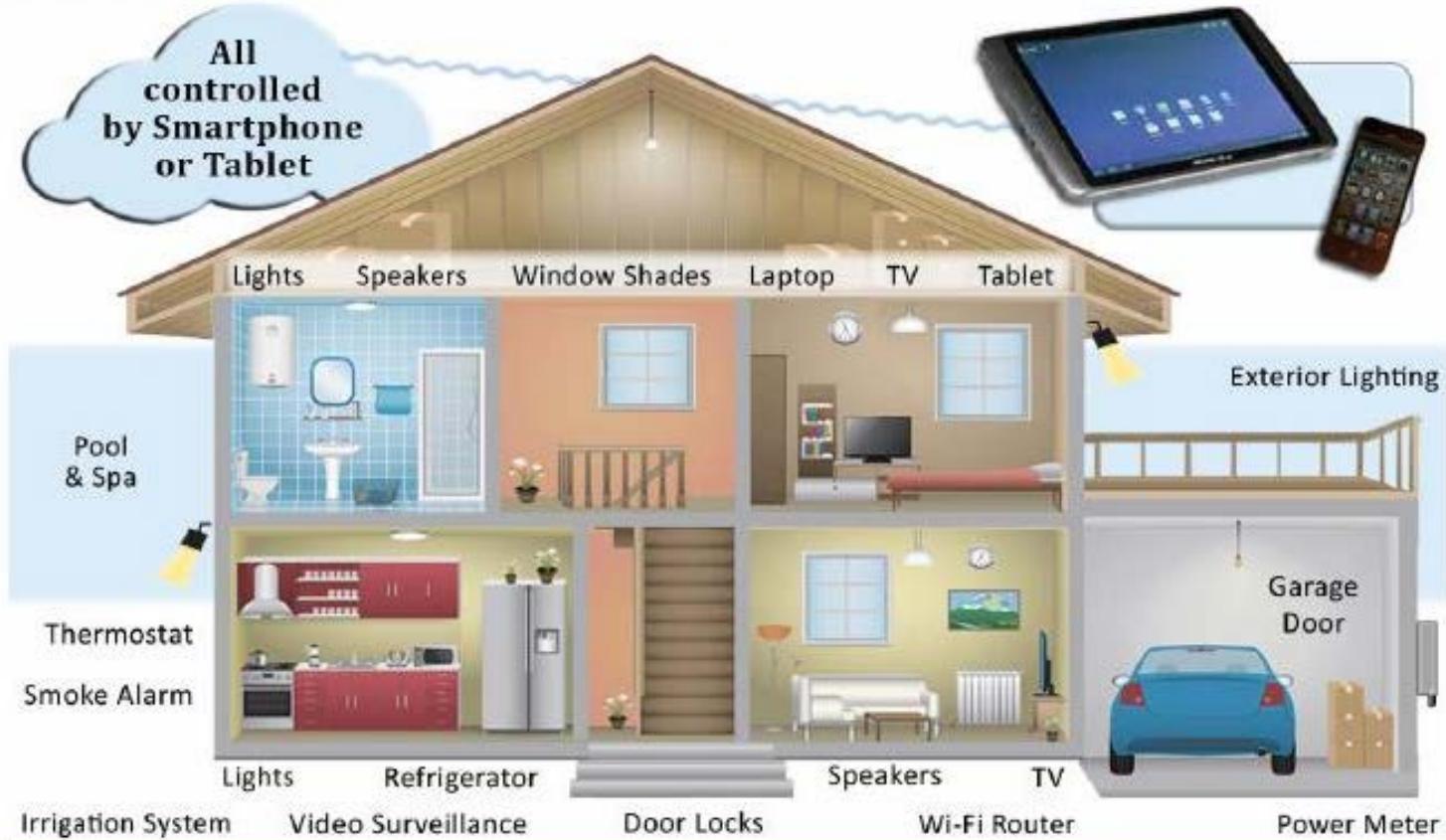
Libelium Smart World





Intelligent Home

Home Automation



Source: Raymond James research.



M



AMAZON ALEXA

Transportation



Source: Raymond James research.

ON THE GO Tap The App To Access Info On Buses, Routes, Timings, And Plan Journey

BMTC gets smart, kicks off bus tracker

Bengaluru: Starting Wednesday noon, you can catch your bus on time. BMTC is launching the country's first Intelligent Transport System (ITS) which will give you the estimated time of arrival (ETA) down to the minute, on an app.

The ITS will integrate the vehicle tracking system, infra-red passive electronic ticketing machines (ETMs) and real-time passenger information and make it available on the app. Walking into the app can help you plan your travel route and get to the bus stop from where you want to access the bus and destination on the latest version of the BMTC app, which provides details of buses in the city and its suburbs.

The ETAs of buses at major bus stations, including 10 TTMCs, Kempegowda and Shrinagar bus stations and KIA, can now be seen at a tap. KIA already has display boards showing the estimated time of departure (ETD) of the shuttles in the airport.

Although Mysuru was the first city to roll out the ITS, Bengaluru is the first in the country to collect data and integrate information from 6,404 buses and 10,000 drivers. All the buses are fitted with a GPS tracking network along with real-time data of the location of the bus every 10 seconds.

MTTC MD Ekroop said, "We can now operate efficiently by reducing the time on a route, analyze routes, have few take-off points and deploy more where demand is."

"We can also find buses skip stops or go from routes or wait at undesigned places unnecessarily, plug pilferage and revenue on a daily basis," said director Bishwajit Mishra.

"Control room monitors all data from daily trips and we have developed a card that categorizes the different types of operations to know what is going on the ground. Initially, we are facing technical glitches because the IT handle is huge and the biggest task is to give the ETA, which cannot be accurate." It will cost BMTC Rs 1.10 month, but EV Ramantha Reddy, secretary of the transport department says it is just 1% of the corpora-

BMTC FACTSHEET

- 6,404 Buses | 700 AC buses | 2,424 Routes
- 140 Depots | 7,753 Bus stops | 2,212 Bus stops within BBMP limits | 6,216 Schedules | 75,993 Trips | 53 lakh Daily passengers | 12.9 lakh Km covered per day

COMPLAINT SURVEY

- 81.6% No real-time info on buses
- 80% Unpredictable waiting time
- 76% Ticketing process
- 76% Route deviations
- 71% Skipping bus stops/platforms
- 55% Driving habits of crew

LOCATE BUSES ON ROUTE

ENTER SOURCE BUS STOP AND DESTINATION, CLICK EITHER FIND ON MAP OR LIST BUSES ICON TO CHECK BUSES BOUND TO THAT STOP OR AVAILABLE ON THE ROUTE WITHIN EACH BUS

ROUTE NO. 369C Bus arriving in 2 mins

ROUTE NO. V 356 Bus arriving in 12 mins

LOCATE BUSES NEAR STOPS

Type name of bus stop or junction where you want to access bus and either click Find on Map or List Buses to see buses around that stop with ETA of each bus

HERE'S HOW YOU CAN TRACK YOUR SARIGE

Download BMTC app

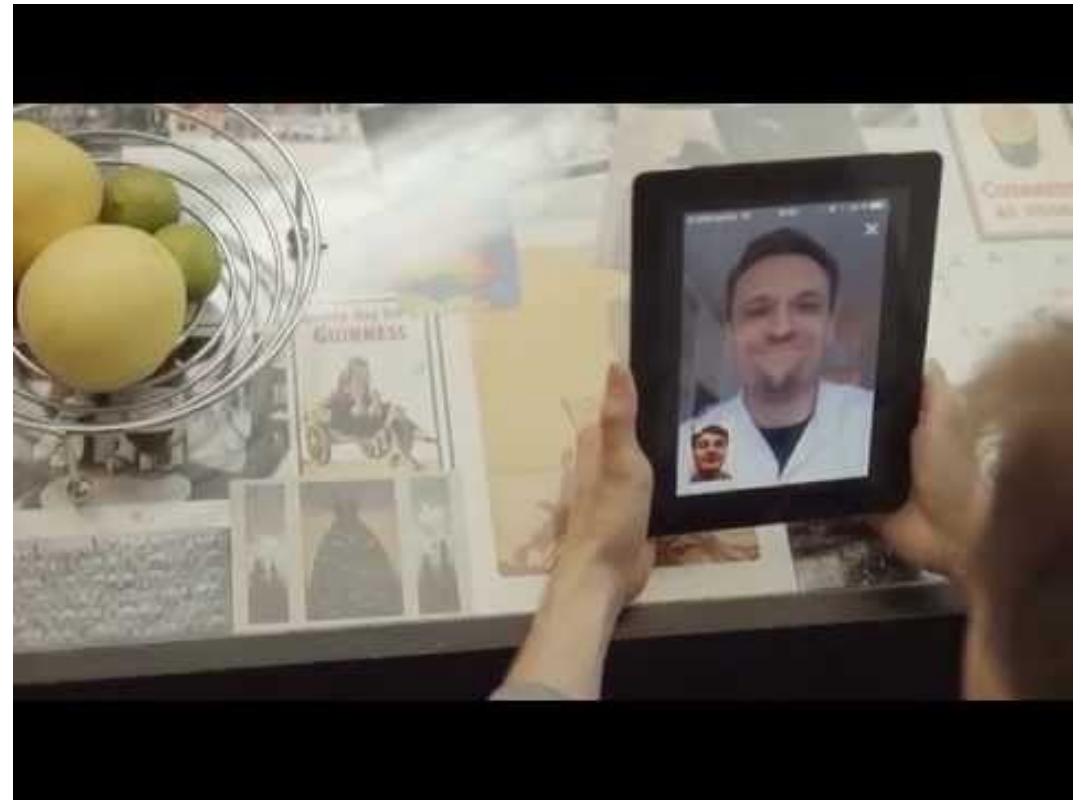
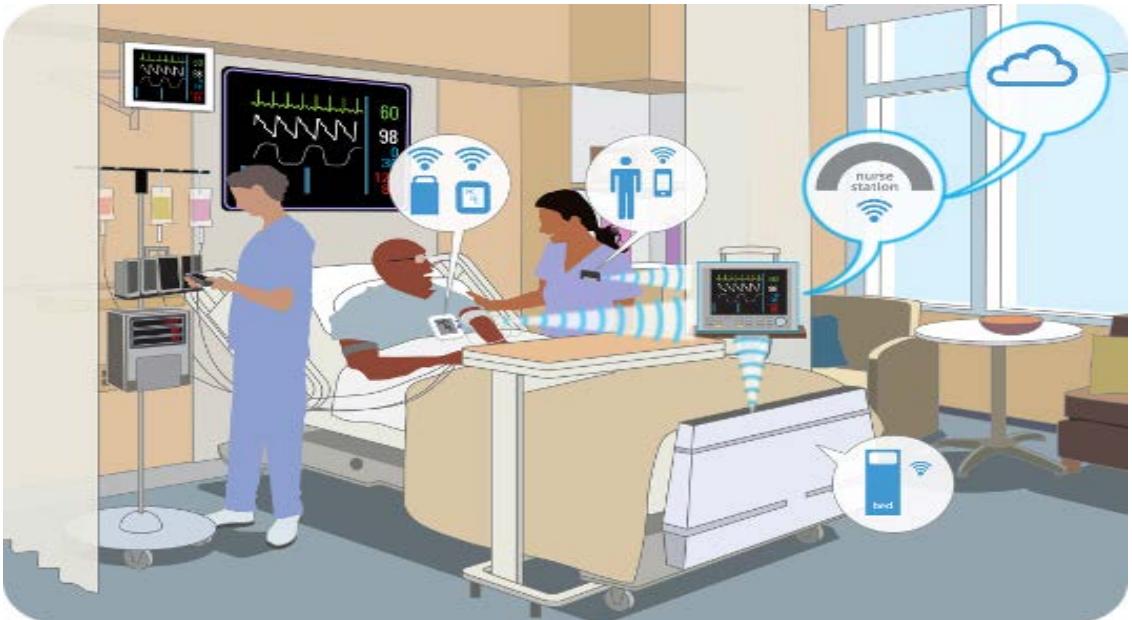
No smartphones? Call toll-free helpline 1800 425 1663 for ETA details

FIND FOUR OPTIONS

Locate Buses On Route, Locate Buses Near Stops, Buses Arriving At TTMC, Trip Planner

Image: A hand holding a smartphone displaying the BMTC app interface, showing bus routes and arrival times. The background shows a bus stop with people waiting and a bus.

Healthcare

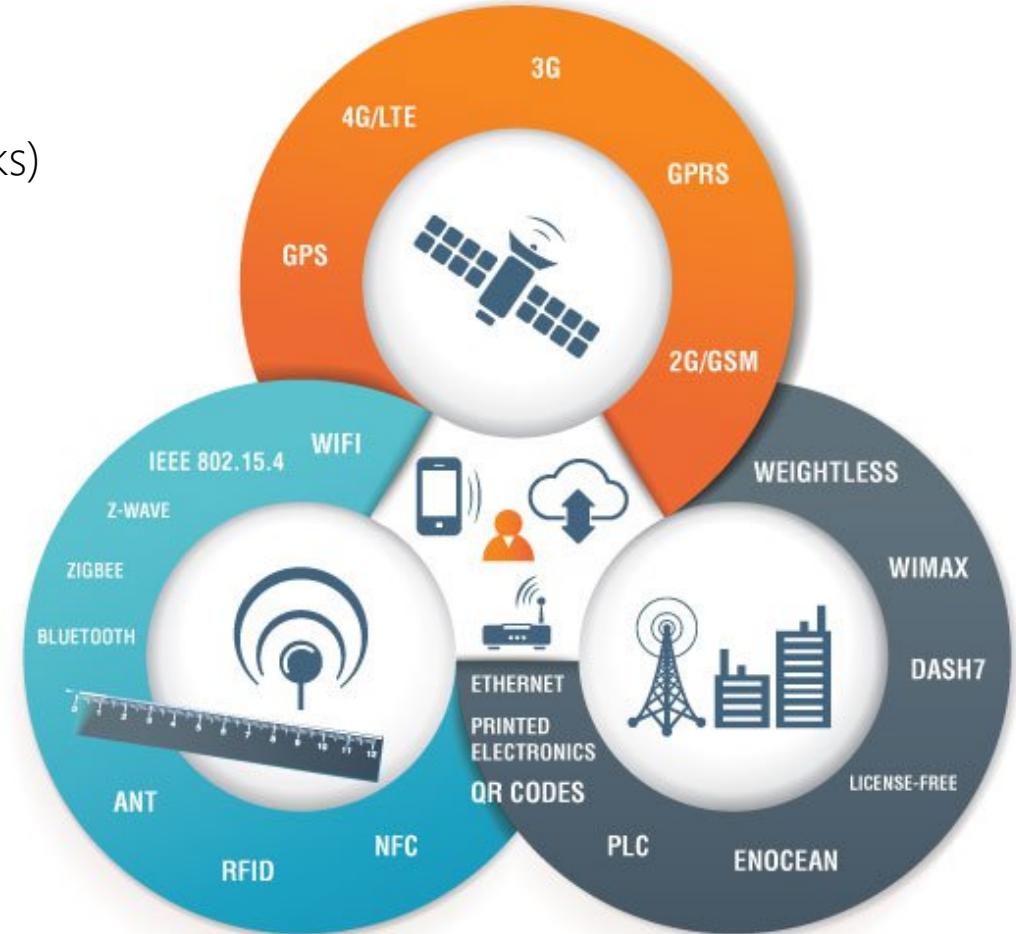


Communication Technology

- M2M
- Wireless Sensor Networks
- IPv6 and 6LoWPAN (Low power Wireless Personal Area Networks)
- Bluetooth LE and ZigBee
- WiFi and LTE

Protocols

CoAP (Constrained Application Protocol)
MQTT (Message Queue Telemetry Transport)
AMQP
HTTP
XMPP (Extensible Messaging and Presence Protocol)



Emerging Challenges for IoT

Scale

devices >> # users, and growing fast

Volume of data (and network traffic)

Pace

Innovation pressure: analysis, command and control, cost

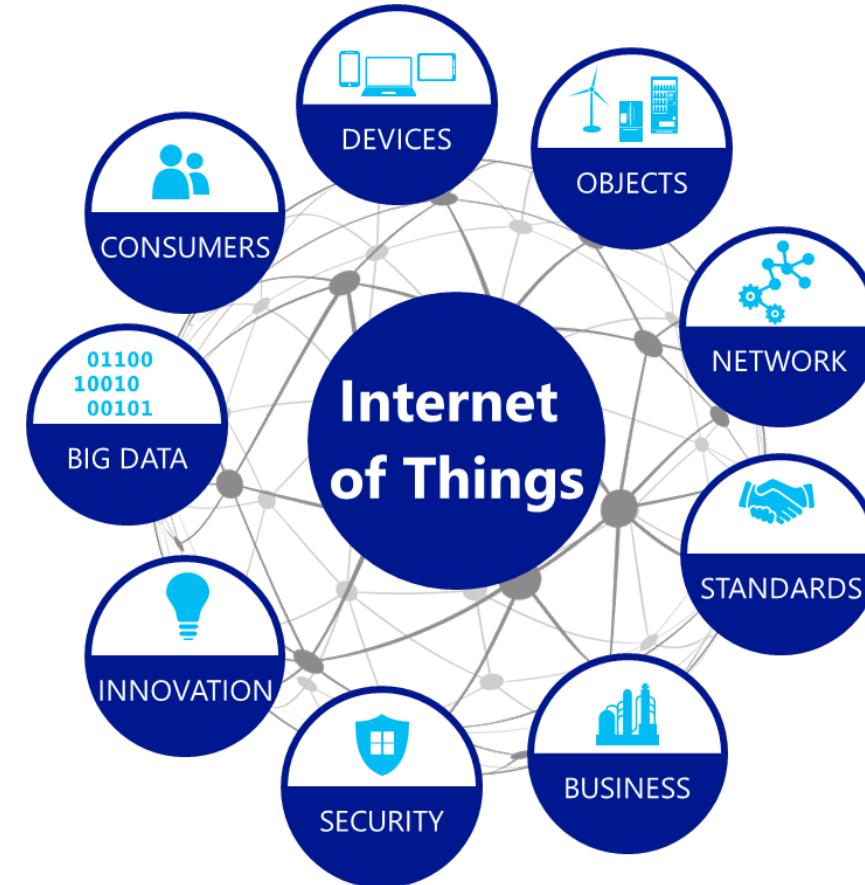
Skill pressure: data science, new platforms

Environment

IT/OT collaboration

Security and privacy threats

Emerging standards



Does IoT add additional risk?

- Are highly portable devices captured during vulnerability scans?
- Where is your network perimeter?
- Are consumer devices being used in areas – like health care – where reliability is critical?
- Do users install device management software on other computers? Is that another attack vector?



Threat vs. Opportunity

- If misunderstood and misconfigured, IoT poses risk to our data, privacy, and safety
- If understood and secured, IoT will enhance communications, lifestyle, and delivery of services

