Internet of Things: challenges and opportunities

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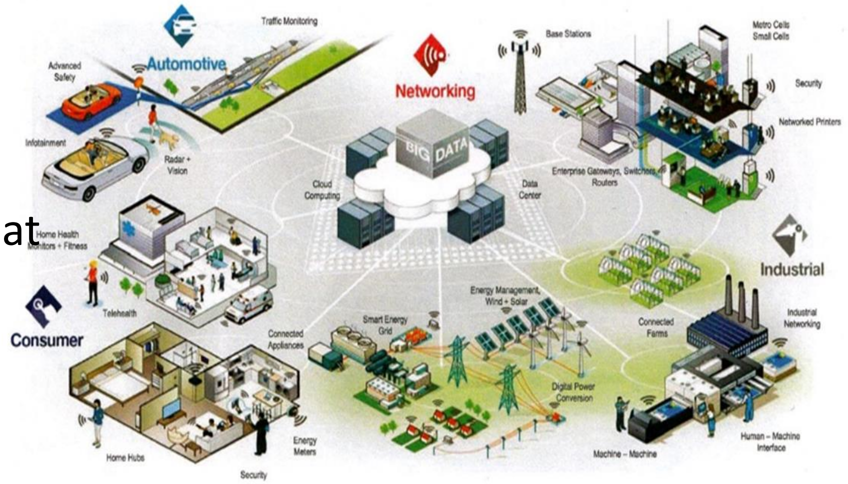
What is the Internet of Things?

- The Internet of Things (IoT) : the ever-growing network of physical objects that feature an IP address for internet connectivity, and the communication that occurs between these objects and other Internet-enabled devices and systems.
- An ecosystem of connected physical objects that are accessible through the internet.
- It is also referred to
  - Internet of Everything
  - Internet of Things and Humans



Components of IoT : Things

Things are objects (physical or virtual) which are capable of being identified and integrated into communication networks.
Things have associated information, which can be static and dynamic.

- Physical things exist in the physical world and are capable of being sensed, actuated and connected. Examples of physical things include the surrounding environment, industrial robots, goods and electrical equipment.

- Virtual things exist in the information world and are capable of being stored, processed and accessed. Examples of virtual things include multimedia content and application software.

ITU – Recommendation ITU-T Y.4000

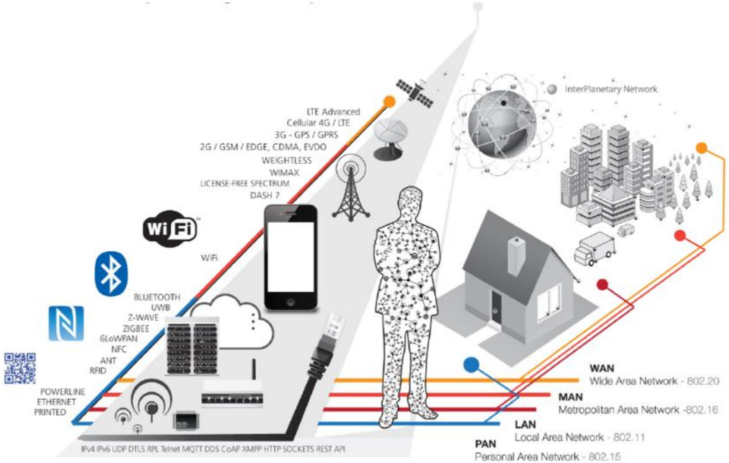
THE CONNECTED CAR
100% Of cars will be connected by 2025
75% Of cars on the road will be autonomous by 2035

Components of IoT : Interconnectivity

Today’s Internet provides a ubiquitous networked environment with high interconnectivity where a person can interact at any time or place with the digital world and physical world, through wireless and wired connections and unique addressing schemes.

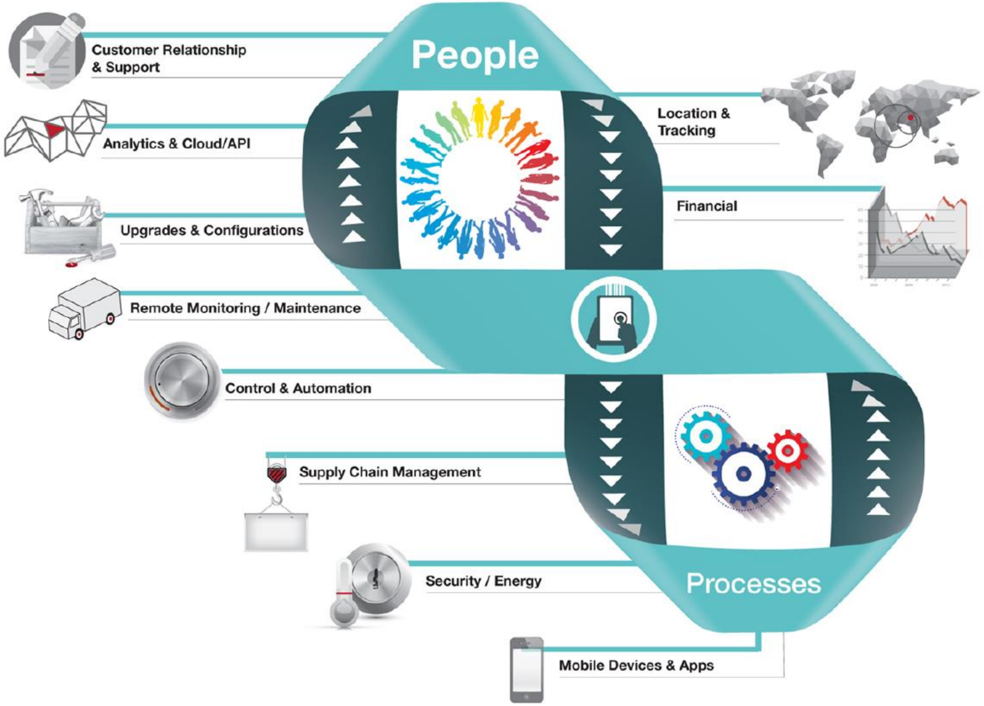
IoT adds the dimension "Any THING communication" to the ubiquitous network.

ITU – Recommendation ITU-T Y.4000 : Overview of the Internet of things

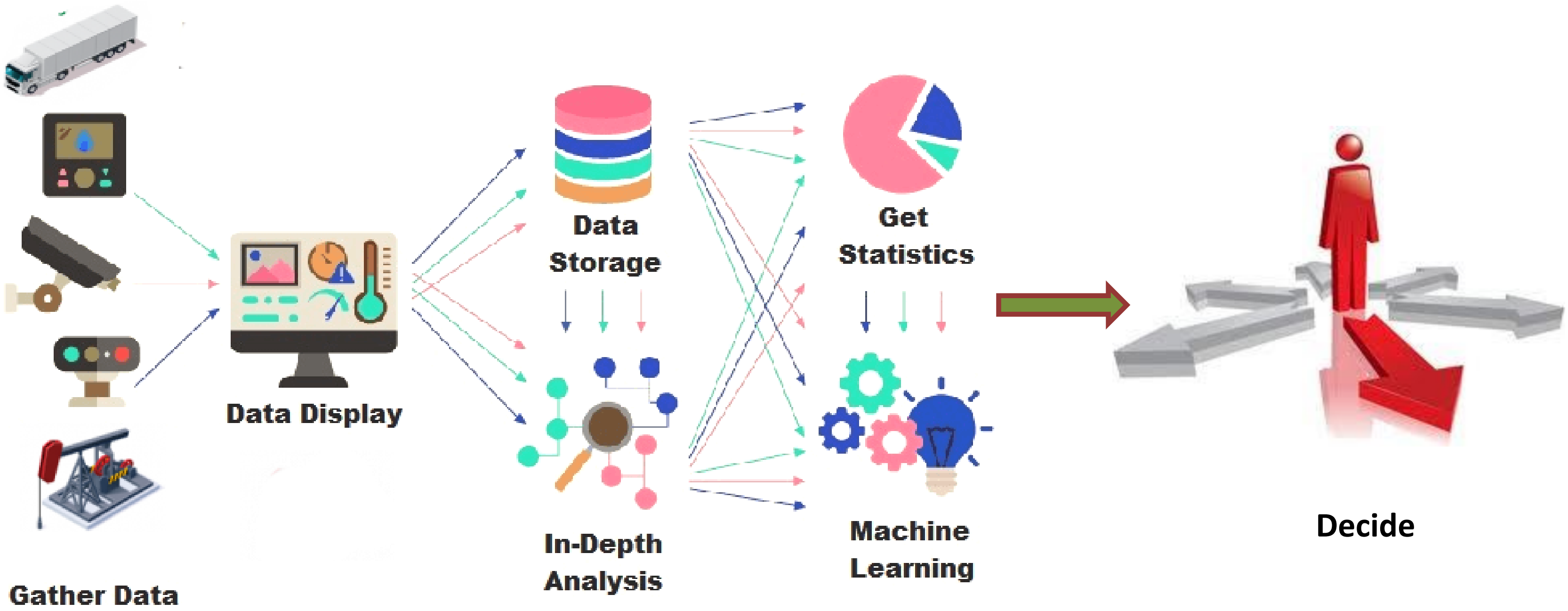

InterPlanetary Network
LTE Advanced
Cellular 4G / LTE
3G - GPS / GPRS
2G / GSM / EDGE, CDMA, EVDO
WEIGHTLESS
WIMAX
LICENSE-FREE SPECTRUM
DASH 7
Wi Fi
WiFi
BLUETOOTH
UWB
Z-WAVE
ZIGBEE
6LoWPAN
NFC
ANT
RFID
POWERLINE
ETHERNET
PRINTED
IPv4 IPv6 UDP DTLS RPL Telnet MQTT DDS CoAP XMPP HTTP SOCKETS REST API
WAN
Wide Area Network - 802.20
MAN
Metropolitan Area Network -802.16
LAN
Local Area Network - 802.11
PAN
Personal Area Network - 802.15

Components of IoT : People & Processes

Combining the networked inputs into systems that integrate data, people, processes and systems that will allow better decision making



IoT operation

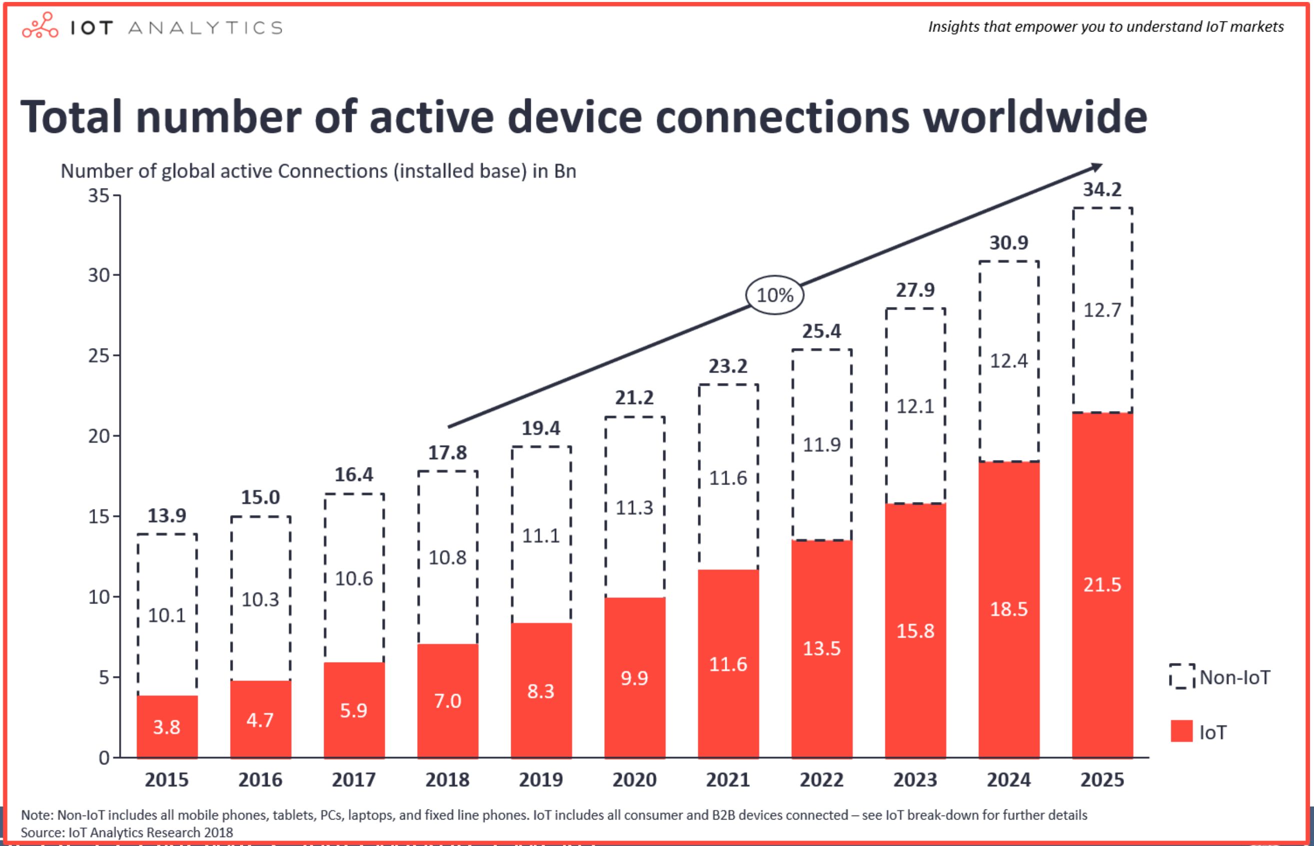


Pros and Cons of the IoT

- Automation and Control
  - Efficient M2M communication results in time savings
- Information and Big Data
  - Knowledge is power
- Communication
  - Complete transparency, fewer inefficiencies, and greater quality
- Monitor
  - Real-time measurement of just about anything
- Overall quality of Life

- Compatibility
  - No high-level international standard
- Complexity
  - Many points of failure, technical and operational
- Privacy and Security
  - Sensitive data in the wild
- Safety
  - Manipulation of data
- Loss of human skills
  - Social interaction

IoT & connected devices evolution



IOT ANALYTICS

Insights that empower you to understand IoT markets

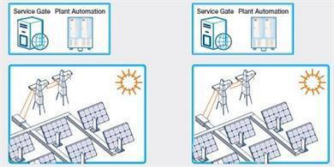
Total number of active device connections worldwide

Note: Non-IoT includes all mobile phones, tablets, PCs, laptops, and fixed line phones. IoT includes all consumer and B2B devices connected – see IoT break-down for further details
Source: IoT Analytics Research 2018

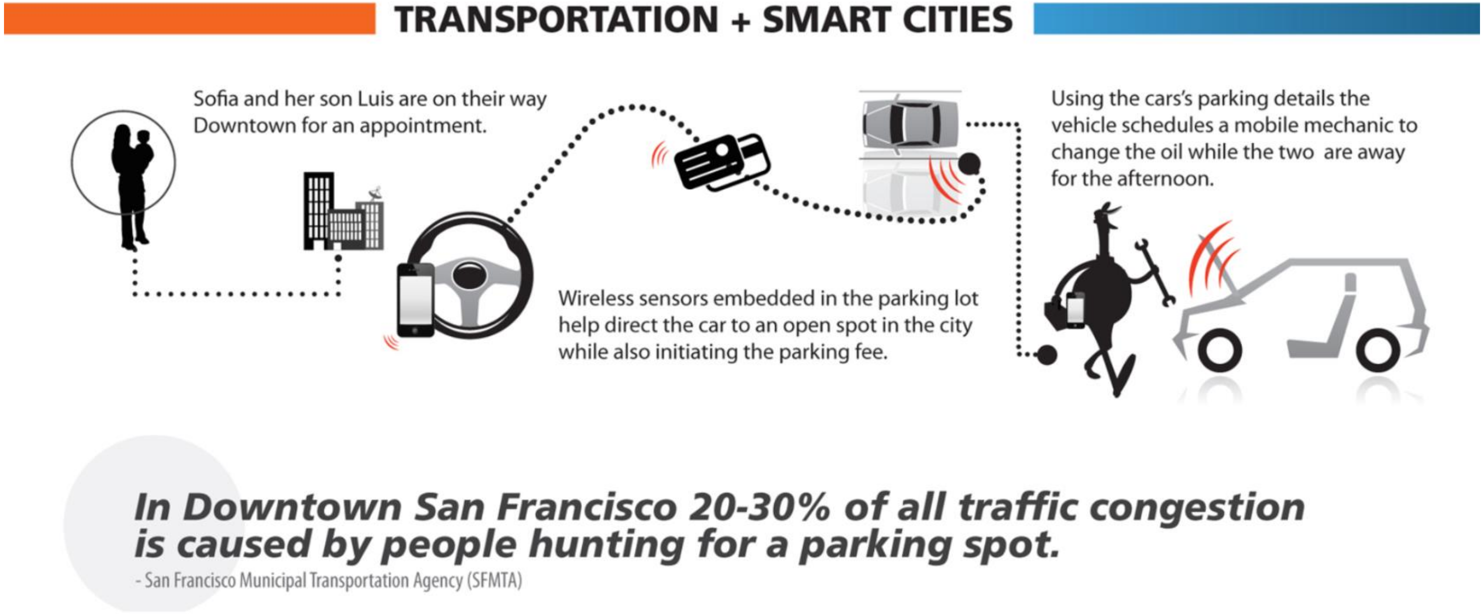
Where “IoT” is used today?

Energy

- Connected oil and gas production
- Connected vessels
- Connected renewables



Where IoT is used today?



TRANSPORTATION + SMART CITIES

Sofia and her son Luis are on their way Downtown for an appointment.

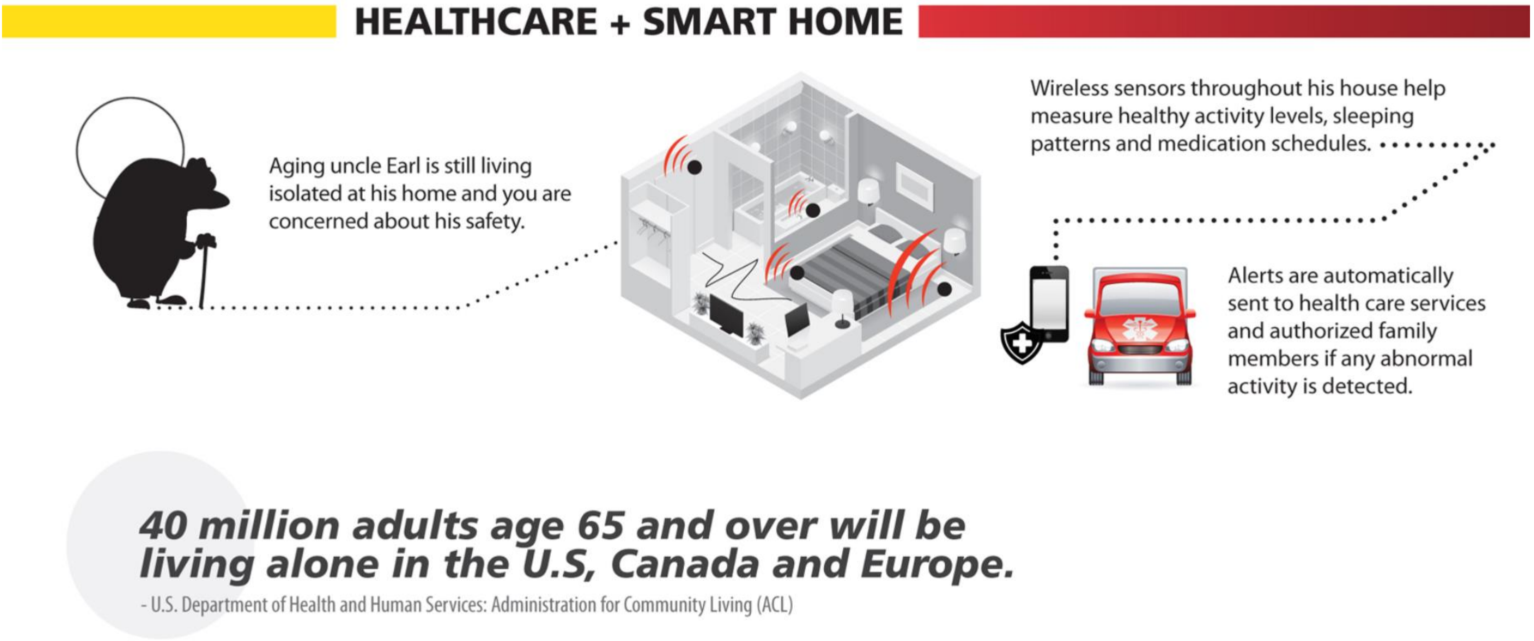
Wireless sensors embedded in the parking lot help direct the car to an open spot in the city while also initiating the parking fee.

Using the cars's parking details the vehicle schedules a mobile mechanic to change the oil while the two are away for the afternoon.

In Downtown San Francisco 20-30% of all traffic congestion is caused by people hunting for a parking spot.

- San Francisco Municipal Transportation Agency (SFMTA)

Where IoT is used today?



HEALTHCARE + SMART HOME

Aging uncle Earl is still living isolated at his home and you are concerned about his safety.

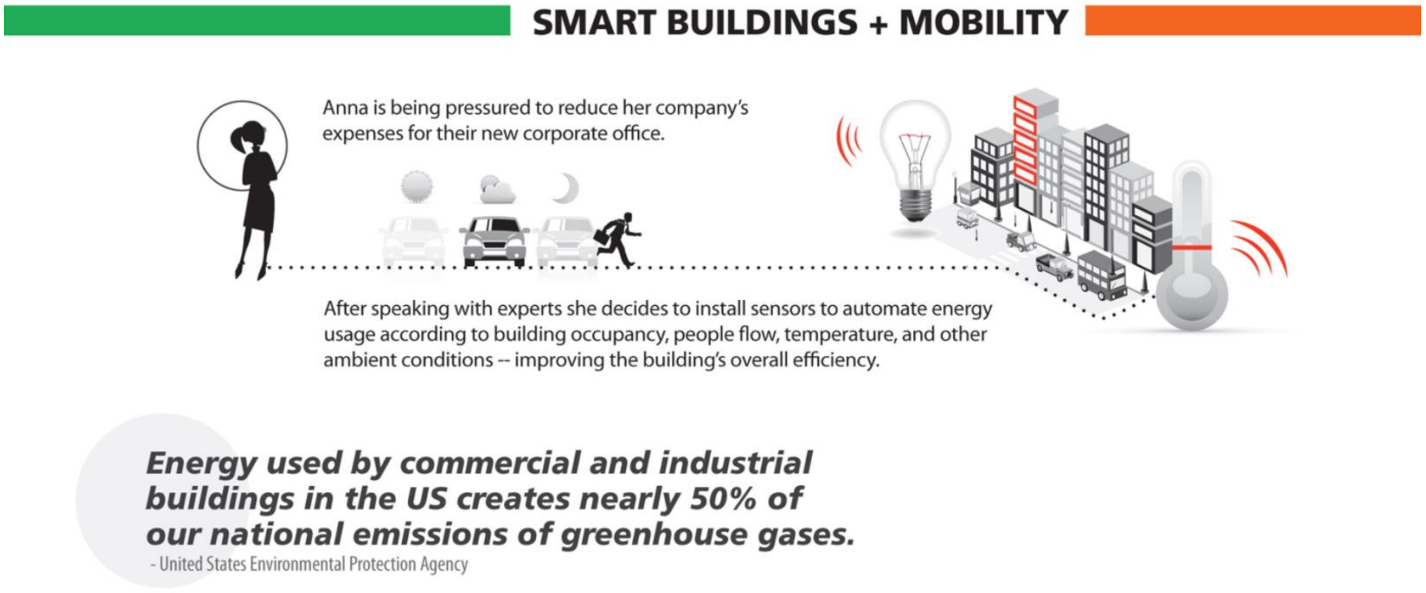
Wireless sensors throughout his house help measure healthy activity levels, sleeping patterns and medication schedules.

Alerts are automatically sent to health care services and authorized family members if any abnormal activity is detected.

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)

Where IoT is used today?



SMART BUILDINGS + MOBILITY

Anna is being pressured to reduce her company's expenses for their new corporate office.

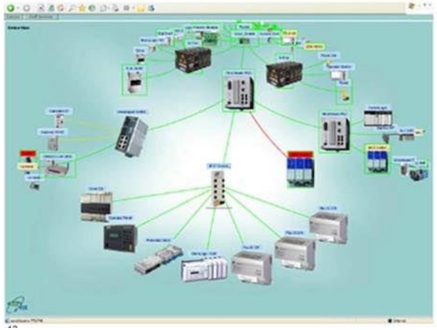
After speaking with experts she decides to install sensors to automate energy usage according to building occupancy, people flow, temperature, and other ambient conditions -- improving the building's overall efficiency.

Energy used by commercial and industrial buildings in the US creates nearly 50% of our national emissions of greenhouse gases.

- United States Environmental Protection Agency

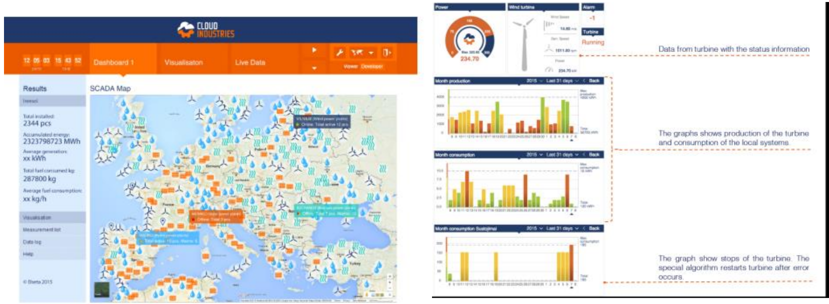
But .. Lets have a closer look

Monitoring was there since longtime ago



IntraVue network monitoring software by Panduit Corp

- Monitoring industrial plants
- Monitoring power plants
- Monitoring vehicle fleet



Results

Total installed: 2344 pcs

Accumulated energy: 2323798723 MWh

Average generation: xx kWh

Total fuel consumed kg: 287800 kg

Average fuel consumption: xx kg/h

Data from turbine with the status information

The graphs shows production of the turbine and consumption of the local systems

The graph show stops of the turbine. The special algorithm restarts turbine after error occurs.

See all your portfolio in the map. Easy to differentiate between different kind of power plants as they are shown with icons.

Power plant monitoring Cloudindustries.eu

Is it really IoT ?

Last decades industrial monitoring systems were

- Equipped with numerous sensors
- Were transmitting data via some network
- Operation data were stored in databases
- Some analytics tools were used to analyse

But were not called IoT systems!!

IoT … is it a buzzword or reality?

I THINK WE SHOULD BUILD AN IOT
UH-OH
E-mail: SCOTTADAMS@AOL.COM
S. Adams
DOES HE UNDERSTAND WHAT HE SAID OR IS IT SOMETHING HE SAW IN A TRADE MAGAZINE AD?
© 1995 United Feature Syndicate, Inc.(NYC)
11/17
WHAT COLOR DO YOU WANT THAT IOT?
I THINK MAUVE HAS THE MOST RAM.

What really makes IoT

The ability to collect unrelated data and make sense out of them

- Ex: collect water/electricity distribution monitoring data (as done since 20 years now) from 100.000 sensors (*not yet and 2020 IoT*)
- Collect city traffic data (traffic jams, accidents)
- Collect weather data
- Collect demographic data of city regions/buildings

Mix all together and

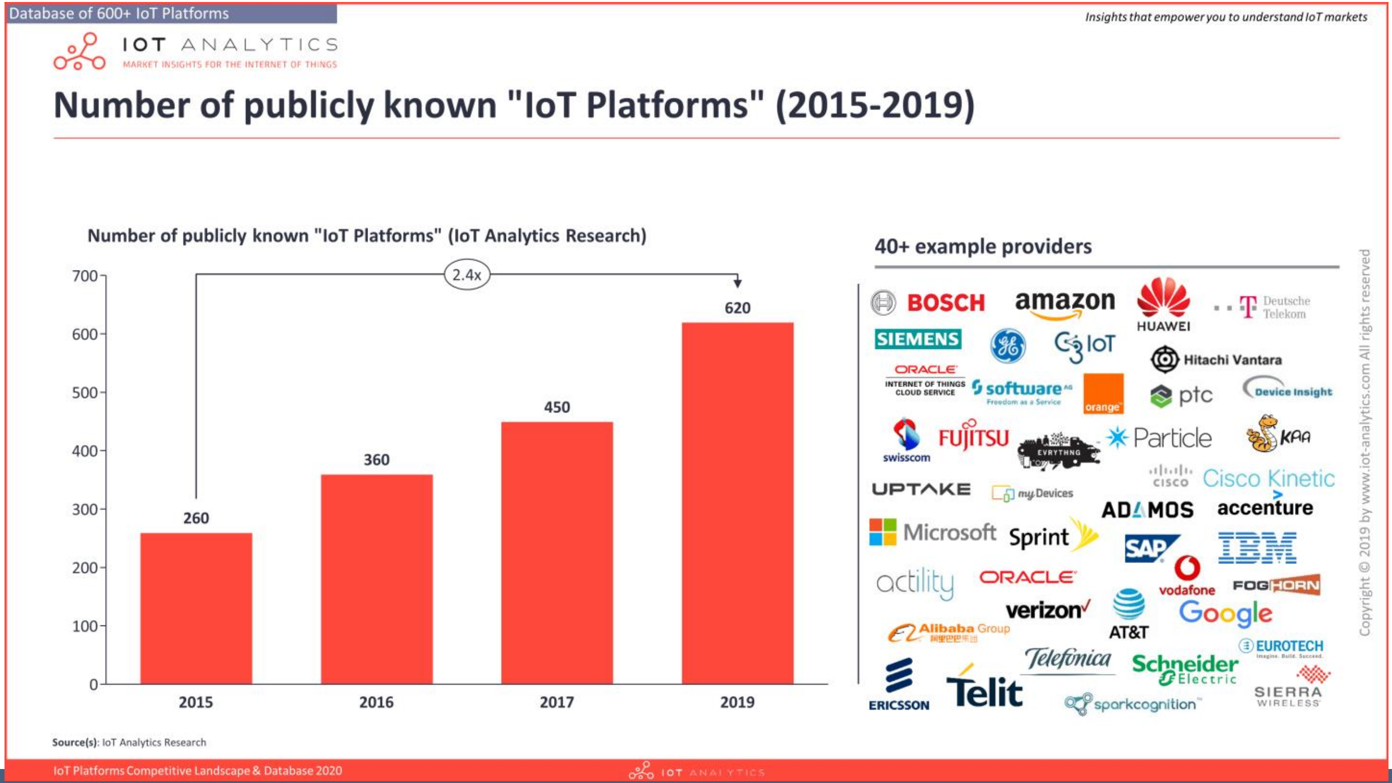
- Anticipate consumption picks in minute scales
- Identify leakages with meter precision

The IoT value is not in the devices, nor the data, but the analysis and understanding of the information the data represent

The dark side of IoT

- IoT jungle
- IoT security
- IoT privacy

The IoT platform Jungle



Database of 600+ IoT Platforms

IOT ANALYTICS

MARKET INSIGHTS FOR THE INTERNET OF THINGS

Insights that empower you to understand IoT markets

Number of publicly known "IoT Platforms" (2015-2019)

Number of publicly known "IoT Platforms" (IoT Analytics Research)

40+ example providers

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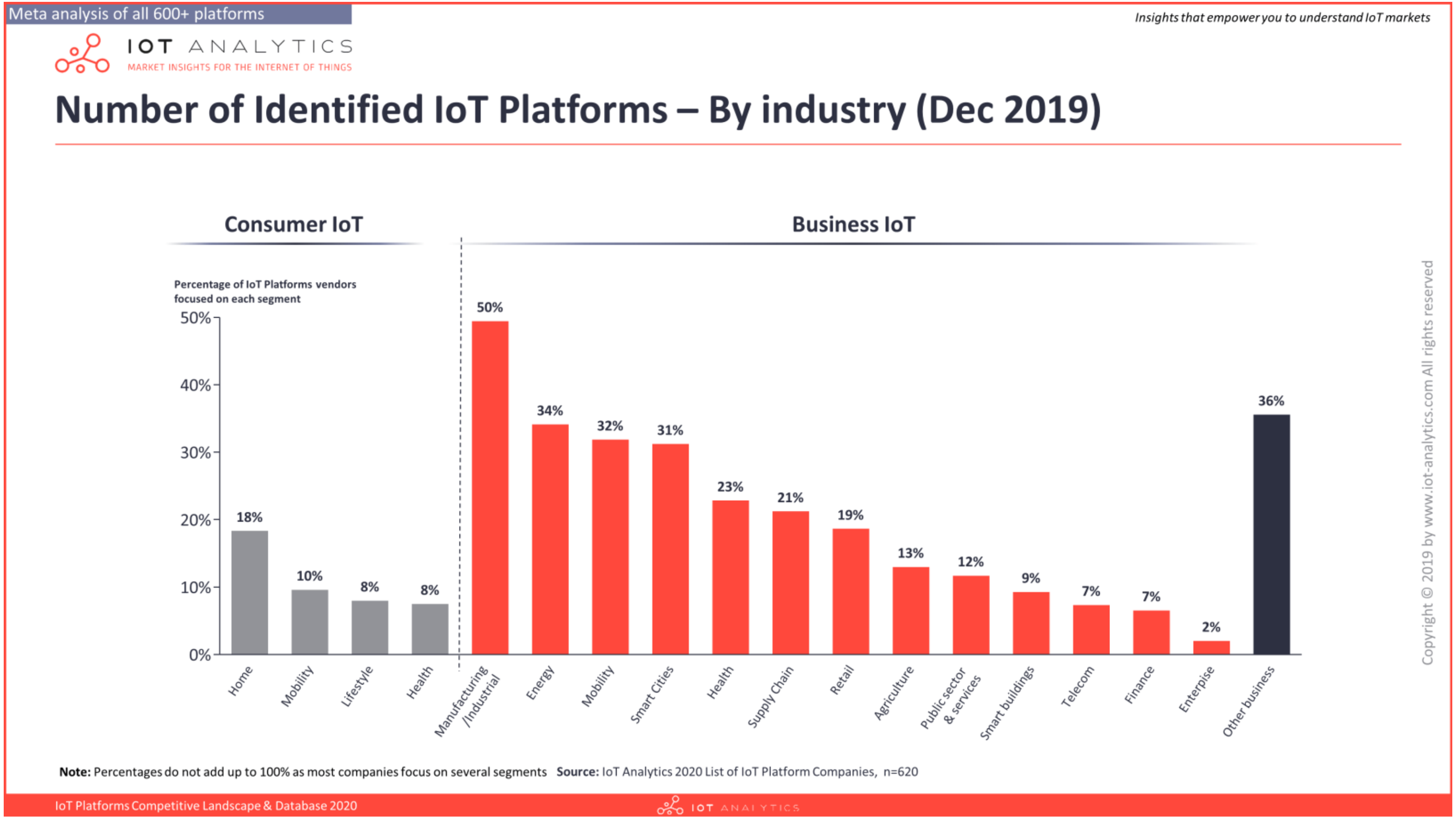
Source(s): IoT Analytics Research

IoT Platforms Competitive Landscape & Database 2020

Meta analysis of all 600+ platforms



Insights that empower you to understand IoT markets

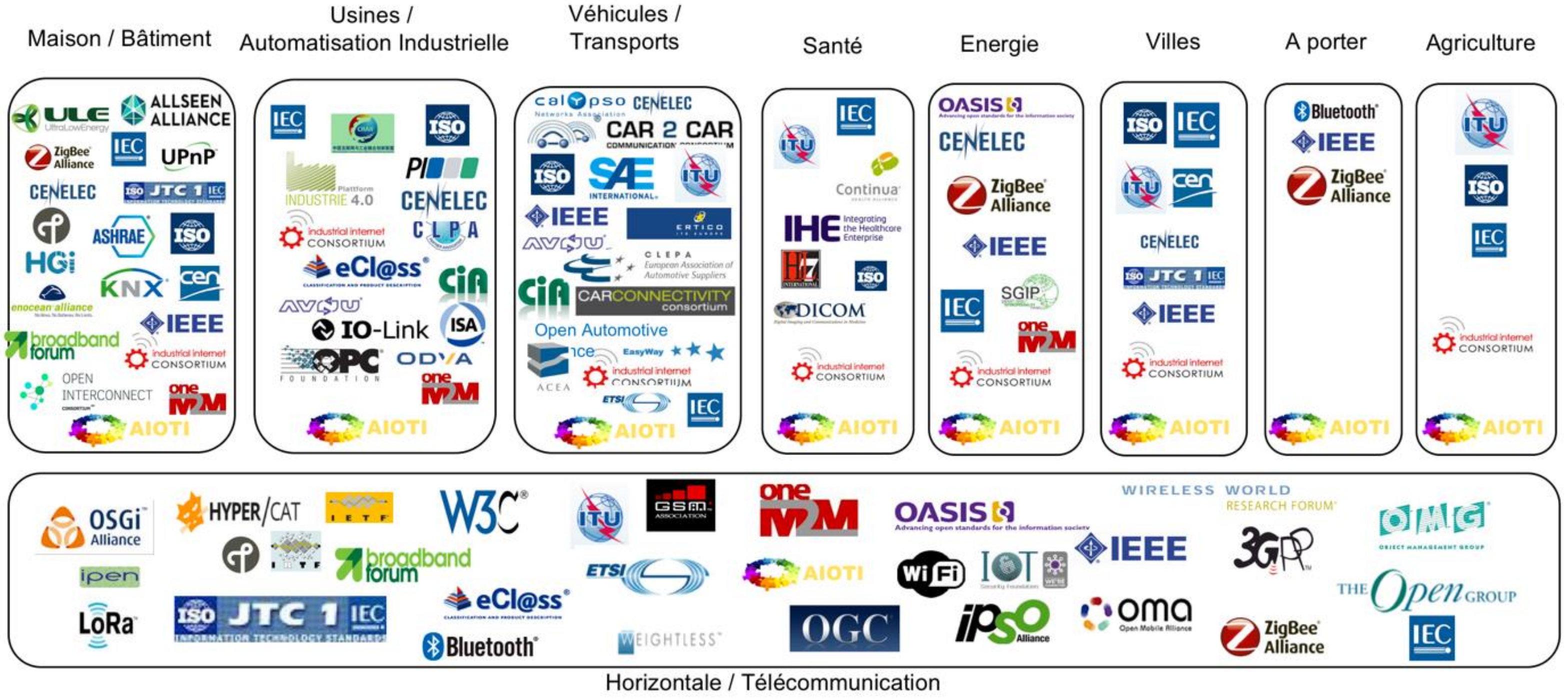
IOT ANALYTICS
MARKET INSIGHTS FOR THE INTERNET OF THINGS

Number of Identified IoT Platforms – By industry (Dec 2019)

Note: Percentages do not add up to 100% as most companies focus on several segments **Source:** IoT Analytics 2020 List of IoT Platform Companies, n=620

IoT Platforms Competitive Landscape & Database 2020 IOT ANALYTICS

IoT protocols’ jungle



Source: AIOTI WG3 (IoT Standardisation) – Release 1.2

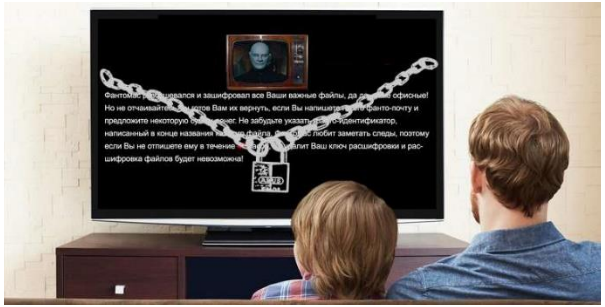
Consequences of the IoT Jungle

- Improbable interoperability
- Vendor locking
- No standards = obsolense is just around the corner
- Scalability questions

IoT Security

The golden era for hackers!!!

- Things not designed with security as basis
  - Evolved from standalone objects (TV, car sensors …)
- Denial of service attacks are trivial



IoT Security

- **Why IoT Devices are subject to attack**
  - Difficult to update OS and firmware
  - Default, weak, or hardcoded credentials
  - Vulnerable web interfaces (XSS, SQL injection)
  - Poor vendor support
  - Coding errors (buffer overflow)
  - DoS / DDOS
  - Physical theft and tampering
  - Clear text protocols, unnecessary services, and unneeded open ports

- **What has been learned from recent IoT related incidents**
  - Vendors delay or ignore response to issues
  - All software and firmware can and probably does contain vulnerabilities
  - Product lifecycles & end-of support ignored
  - Patching IoT devices often does not scale well in large environments
  - Significant delay in informing the public of vulnerabilities and related issues

What was planned and what is the reality

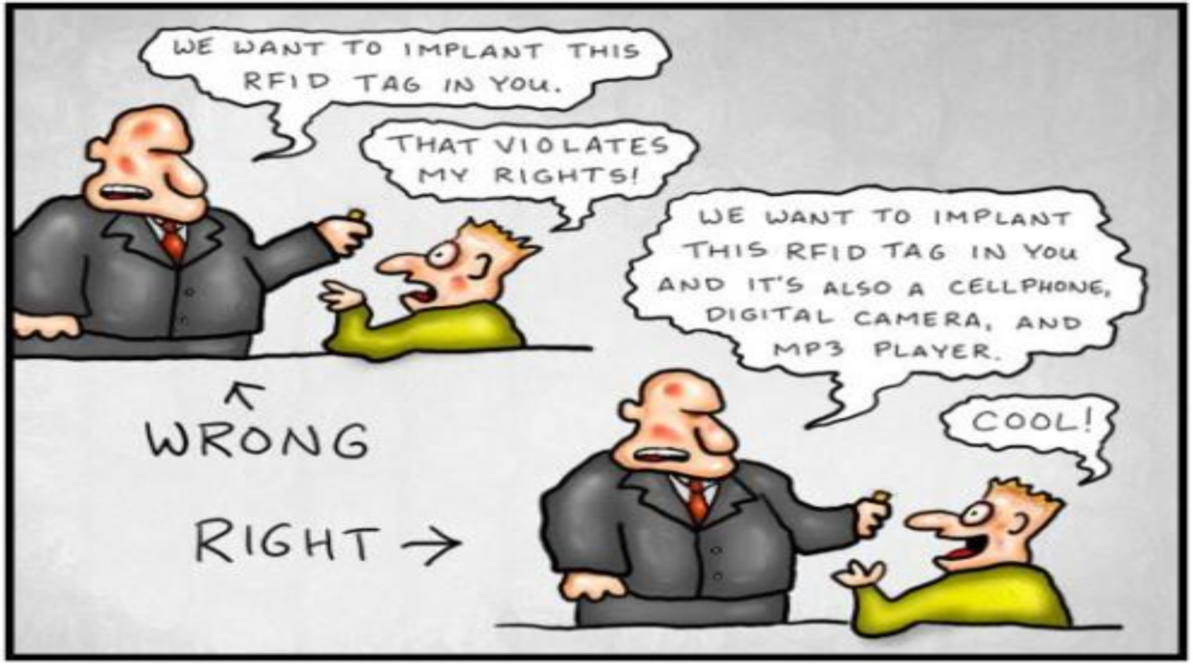
Promises from the past	Reality
Hundreds of devices part of tightly coupled architecture	Thousands of loosely connected devices
Devices cost 5-500$, customised for specific IoT application	Devices cost 0.01-3$ combined with existing in-person generic devices
Use well structured communication networks (i.e. IPv6) with always on connectivity	A mix of ad-hoc P2P, 2G/3G/4G and WiFi based on existing networks and with intermittent connectivity
Perform cloud-centric data collection and analysis with centralised control	Data collection and personalised analytics seamlessly span edge devices and the cloud, with control over data sharing and ownership while encouraging Open Data
Have a single vendor who owns the platform, cloud services and eco-system for an application	Open eco-system without vendor lock-in using standard Internet and Web protocols, allowing devices and data to be shared across IoT applications

IoT Privacy

IoT promises highly personalized services

Think for a second what it needs to know to offer high personalization!!!

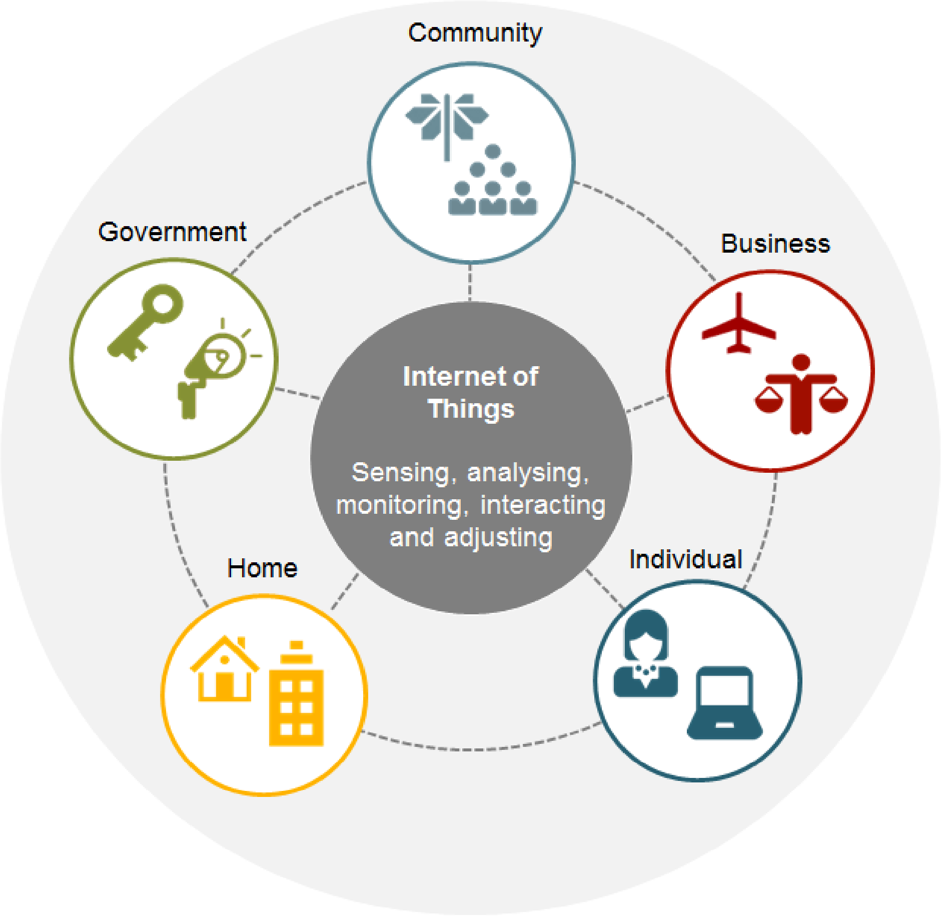
Do we really understand?


WE WANT TO IMPLANT THIS RFID TAG IN YOU.
THAT VIOLATES MY RIGHTS!
WE WANT TO IMPLANT THIS RFID TAG IN YOU AND IT'S ALSO A CELLPHONE, DIGITAL CAMERA, AND MP3 PLAYER.
COOL!
WRONG
RIGHT →

IoT has created a need for data collection

GET ALL THE INFORMATION YOU CAN, WE'LL THINK OF A USE FOR IT LATER.
CHRIS

IoT : all is based on Data correlation



… and for what reason ??

INSURANCE CLAIM
DENIED
FOR EMPLOYMENT
REJECTE
ARRIVALS
BIG DATA
TG'11
"Your recent Amazon purchases, Tweet score and location history makes you 23.5% welcome here."
Big Data
Predictive Analytics
ANDERSON
eQuest
A STEVEN SPIELBERG FILM
MINORITY REPORT
Pre-Crime Prevention

Q&A