Internet of Things

Master 's Degree in Informatics Engineering

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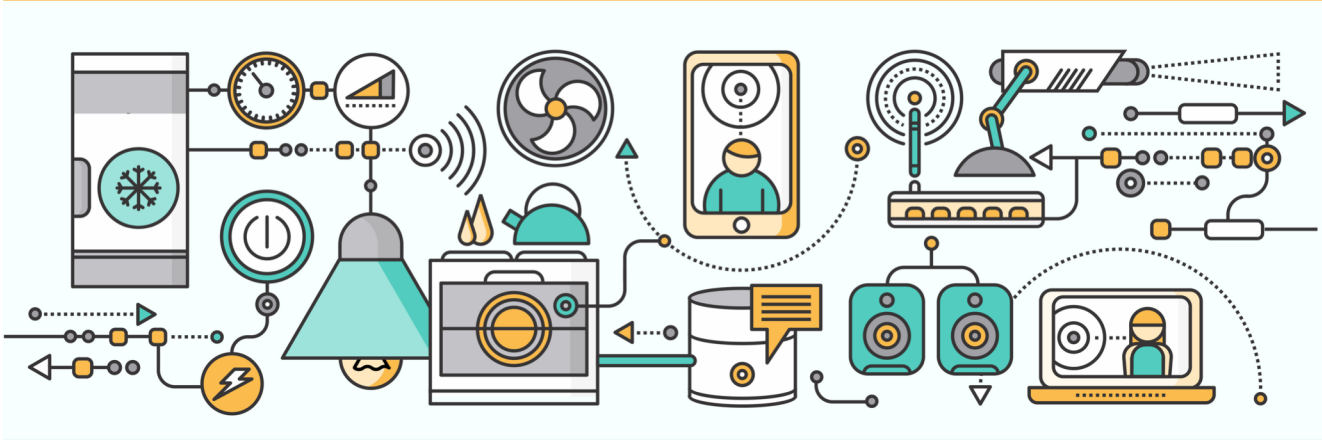
2. Why IoT?
3. IoT Components
4. IoT Convergence
5. Security Considerations



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What is Internet of Things?

Technopedia definition:

The Internet of Things (IoT) is a computing concept that describes physical objects connected to the Internet and able to identify themselves to other devices. No longer does the object relate just to you, but is now connected to surrounding objects and database data. When many objects act in unison, they are known as having "*ambient intelligence*."

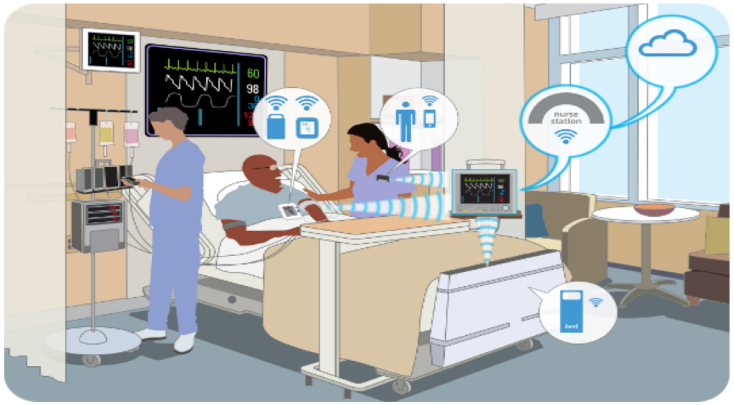
Wikipedia definition:

Is the *internetworking of physical devices*, vehicles (also referred to as "connected devices" and "smart devices"), buildings and other items—embedded with electronics, software, sensors, actuators, and *network connectivity* that enable these objects to *collect and exchange data*

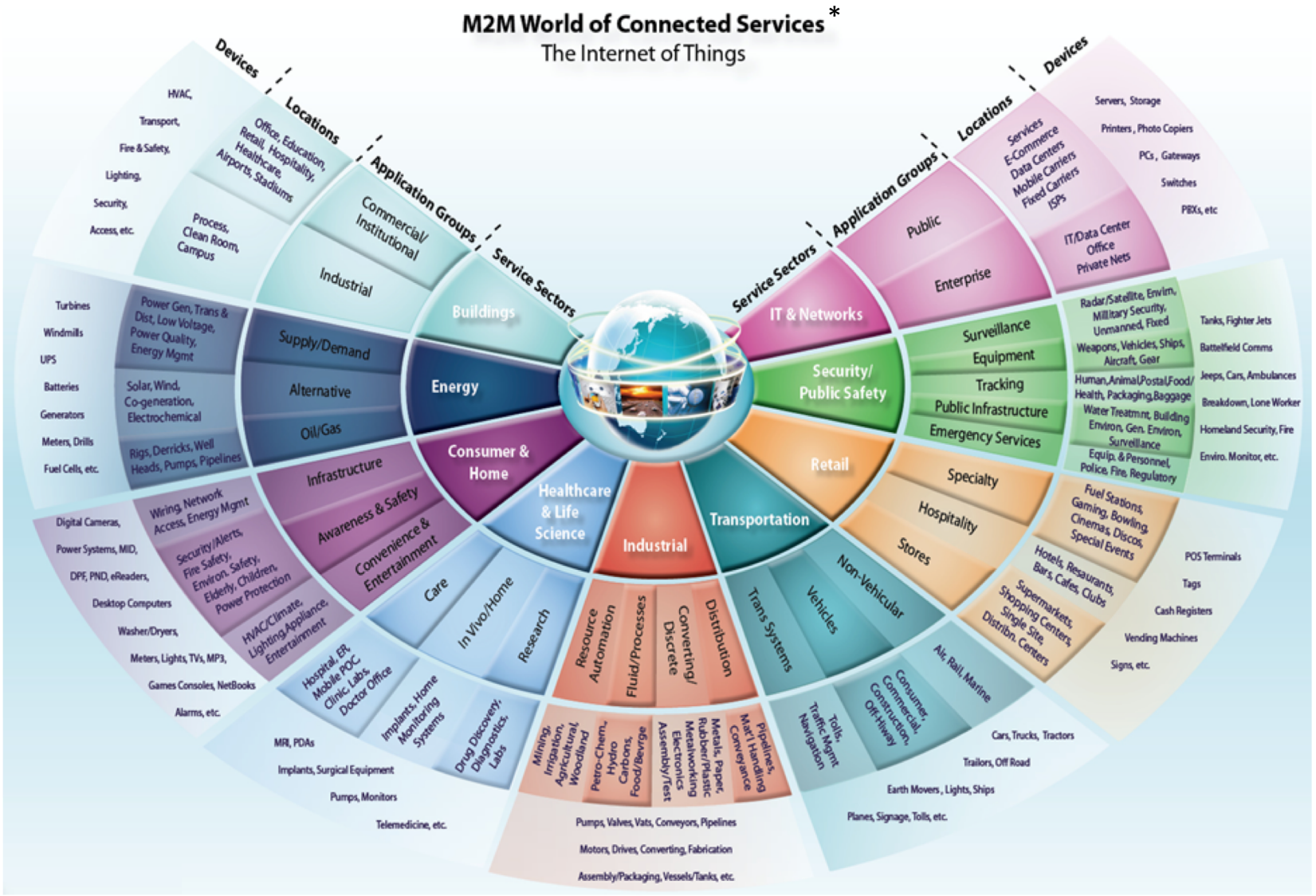
IoT can be applied anywhere!!!!

Smart Appliances

Wearable Tech



Healthcare



*M2M – Machine to Machine

Where is IoT?

Personalized learning with adaptive eTextbooks

Digital classroom white boards and display

iBeacons

Complete coverage with high performance Wi-Fi

Video recorders for lecture capture

Wearables for athletics and attendance tracking

International Collaboration and social exchange

Online testing

Sensors on trash receptacles

Supplies and inventory tracking by sensor with auto-reorder

Robot cleaning

Augmented and virtual reality

Makerspaces with 3D printers and laser trimmers

Student devices & eTextbooks

- Notebooks
- Tablets
- Smartphones

Internet of Things-based HVAC

Monitor and display of air quality throughout school

Robotics for STEM and remote presence

File and program storage, local or cloud-based

- Demographics, academics, behavior, interests
- LMS, CMS, SIS
- Educational programs and applications
- Video files: lectures and recorded lab experiments

Surveillance security cameras

Wi-Fi sensors and locks

- Entrances and exits
- Classroom doors

Sensors track buses and verify student passengers

Network application analytics to monitor devices and network behavior

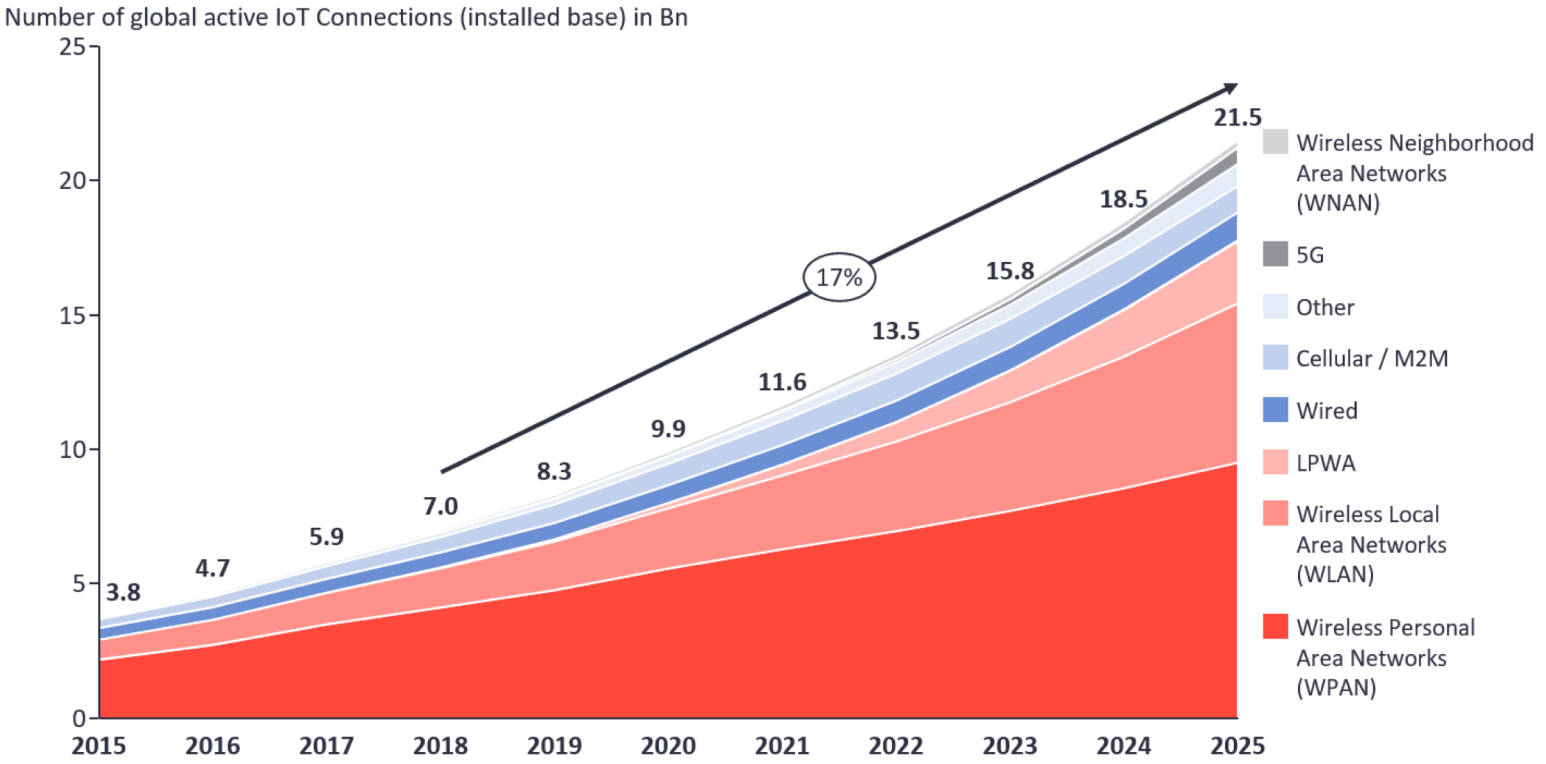
Sensors in parking lot and driveways

The IoT Market - Devices

IOT ANALYTICS

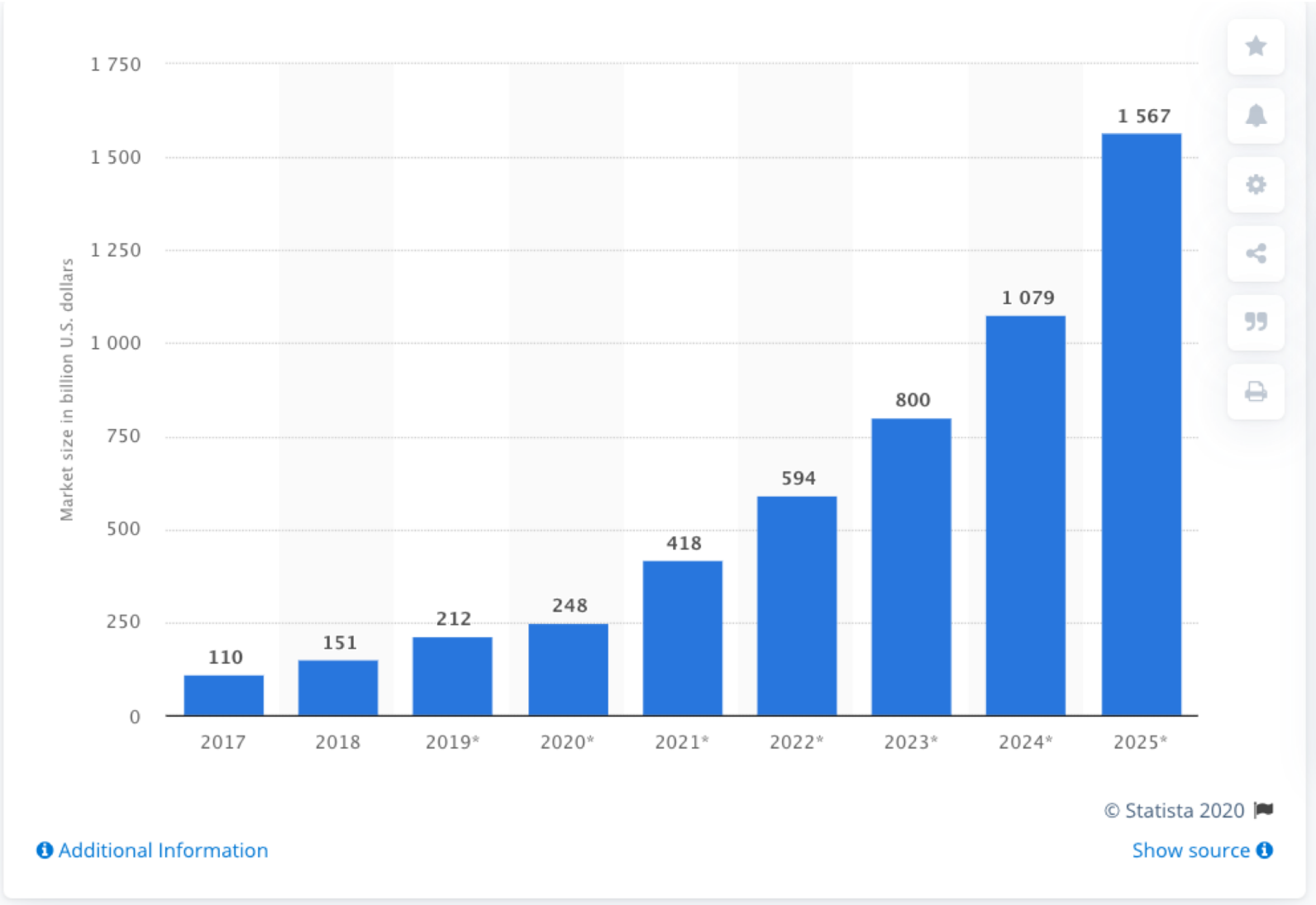
Insights that empower you to understand IoT markets

Global Number of Connected IoT Devices



Note: IoT Connections do not include any computers, laptops, fixed phones, cellphones or tablets. Counted are active nodes/devices or gateways that concentrate the end-sensors, not every sensor/actuator. Simple one-directional communications technology not considered (e.g., RFID, NFC). Wired includes Ethernet and Fieldbuses (e.g., connected industrial PLCs or I/O modules); Cellular includes 2G, 3G, 4G; LPWAN includes unlicensed and licensed low-power networks; WPAN includes Bluetooth, Zigbee, Z-Wave or similar; WLAN includes Wi-fi and related protocols; WNAN includes non-short range mesh; Other includes satellite and unclassified proprietary networks with any range.
Source: IoT Analytics Research 2018

The IoT Market – Market Size



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Why Internet of Things?

An article by Ashton published in the RFID Journal in 1999 said,

"If we had computers that *knew everything* there was to know about things - using data they gathered without any *help from us* - we would be able to track and count everything, and *greatly reduce waste, loss and cost*. We would know when things needed replacing, repairing or recalling, and whether they were fresh or past their best. *We need to empower computers with their own means of gathering information*, so they can see, hear and smell the world for themselves, in all its random glory."

This is precisely what IoT platforms does for us. It enables devices/objects to observe, identify and understand a situation or the surroundings without being dependent on human help.

Why Internet of Things?

Raj Talluri, Qualcomm senior vice president of product management

"When everyday devices are intuitive to use and can share data intelligently, it improves peoples' lives, from better personal safety, to being able to more closely monitor our health and that of our loved ones, to helping us save time and make better use of our natural resources."

Frank Gillett, vice president and principal analyst at Forrester

"Using IoT technologies creates a relationship between the product company and the customer. This becomes an ongoing service experience and relationship that dramatically improves customer engagement and brand awareness. The relationship goes from being a one-time, arm's-length transaction to an ongoing service relationship."

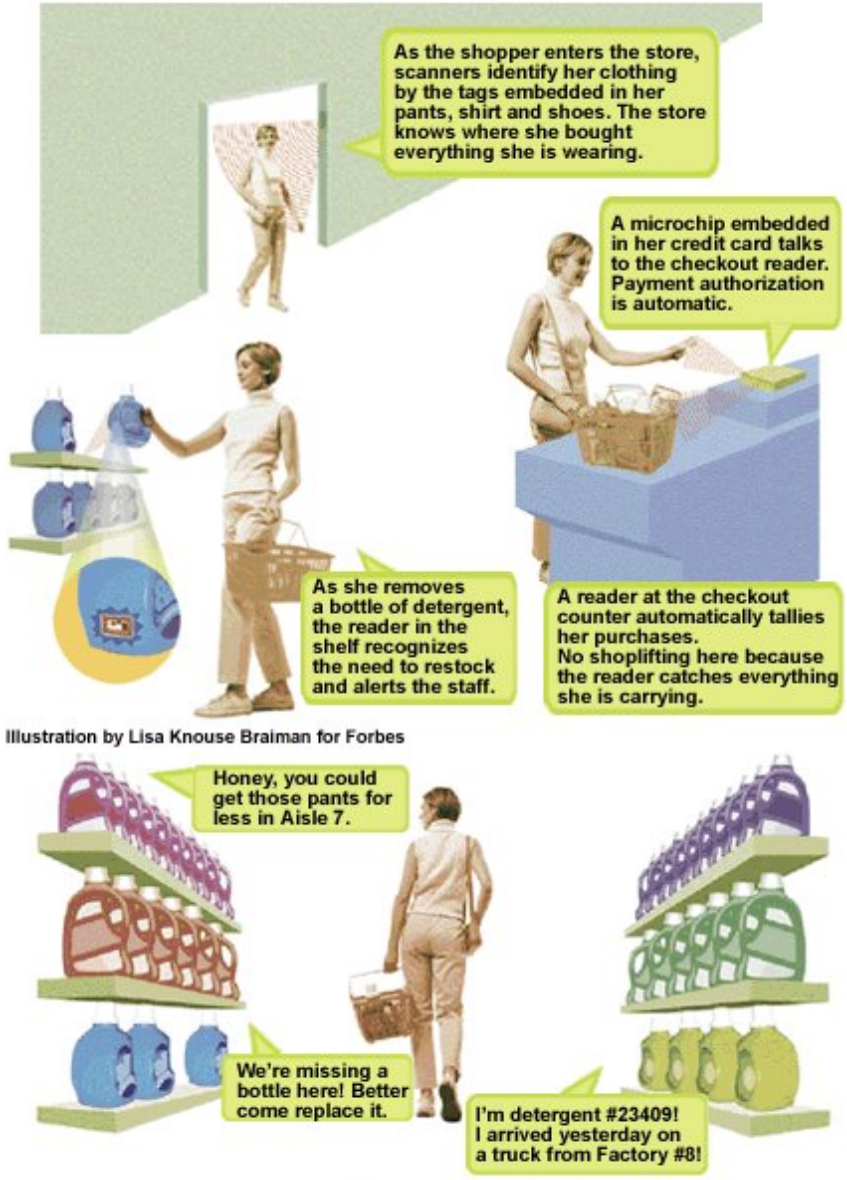
Why Internet of Things?

The main reasons can be summarize as:

- Generate, collect, process and use acquired information to make better decisions
- Provide intelligence - Smart objects: Make things that weren't meant to talk to each other interact smartly
- Improve the efficiency and reduce costs

Example: Home Power usage – If you cannot measure and take control you cannot optimize the power consumption. Furthermore, the energy companies can adapt the energy production in function of its real consumption.

Why Internet of Things?



Scenario: shopping

(1) When entering the doors, scanners will identify the tags on her.

(2) When shopping in the market, the goods will introduce themselves.

(3) When moving the goods, the reader will tell the staff to put a new one.

(4) When paying for the goods, the microchip of the credit card will communicate with checkout reader.

Amazon Go! (2017)

https://www.youtube.com/watch?v=NrmMk1Myrxc

Amazon Go! (2017)

https://www.youtube.com/watch?v=uoKsY9HDk6o

Why Internet of Things?

Scenario: Health

- National Health Information Network, Electronic Patient Record
- Home care: monitoring and control

  Pulse oximeters, blood glucose monitors, infusion pumps, accelerometers, …
- Operating Room of the Future

  Closed loop monitoring and control; multiple treatment stations, plug and play devices; robotic microsurgery

  System coordination challenge
- Progress in bioinformatics: gene, protein expression, systems biology, disease dynamics, control mechanisms

Why Internet of Things?

Scenario: Smart Home

- Remote monitor for smart house
- Remote control for smart appliance

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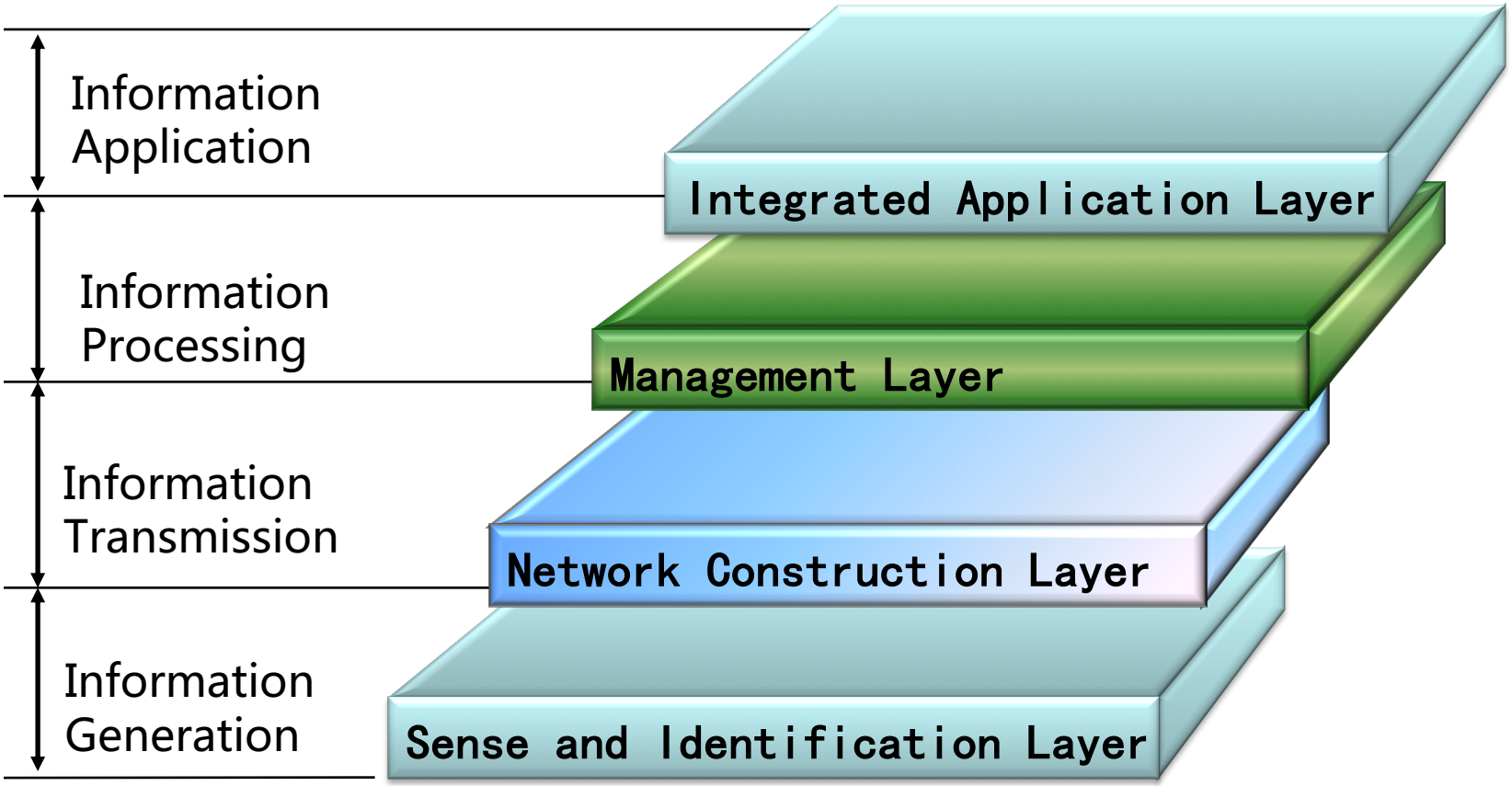
Components of Internet of Things? – Layers Model



Integrated Application


Smart Logistic


Smart Grid


Green Building


Smart Transport


Env. Monitor

Information Processing


Data Center

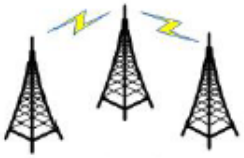
Search Engine

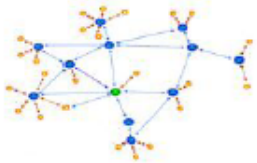

Smart Decision

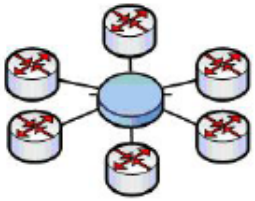

Info. Security


Data Mining

Network Construction


WWAN


WPAN


Internet


WMAN


WLAN

Sensing and Identification


GPS

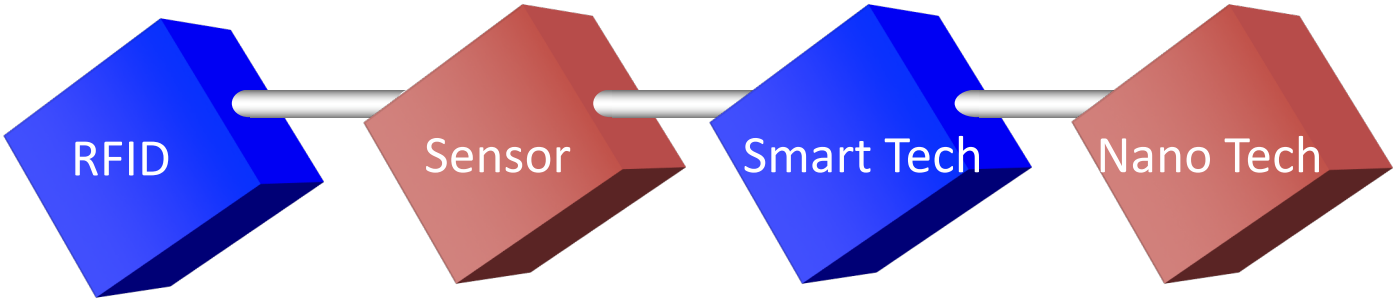

Smart Device


RFID


Sensor


Sensor

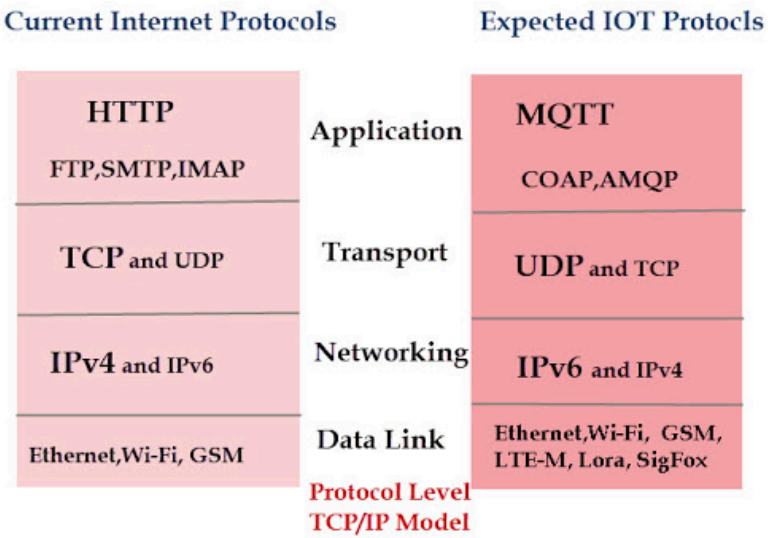
Enabling Technologies



To identify and track the data of things	To collect and process the data to detect the changes in the physical status of things	To enhance the power of the network by devolving processing capabilities to different part of the network.	To make the smaller and smaller things have the ability to connect and interact.

Important Characteristics for IOT Protocols

- Speed – Amount of data that can be transferred/second
- Latency – amount of time a message takes to be transferred
- Power consumption
- Security
- Availability of software stacks.



IOT and Internet Protocols

Main IoT protocols

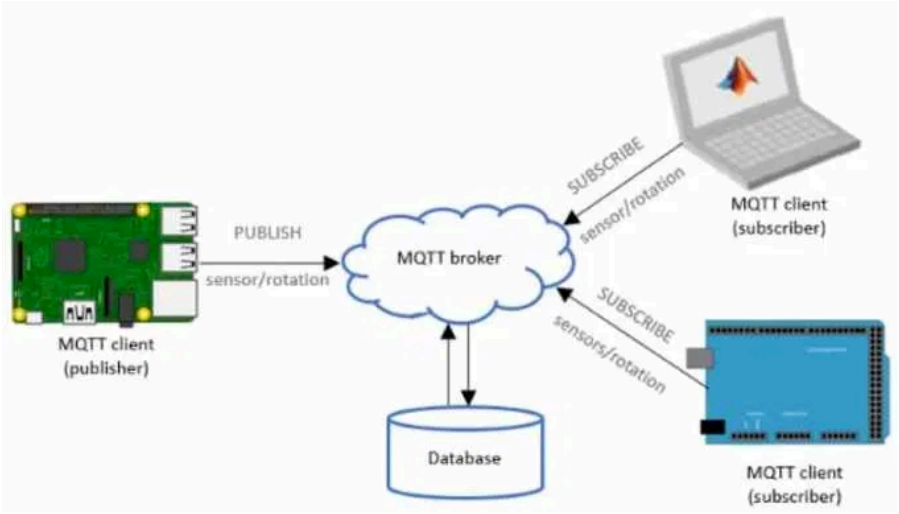
> HTTP → main mechanism for Web Applications and services to communicate. High protocol overhead HTTP is not likely to be a major IOT protocol.

> MQTT (Message Queuing Telemetry Transport) has emerged as the main IOT messaging protocol because it is lightweight and easy to use.

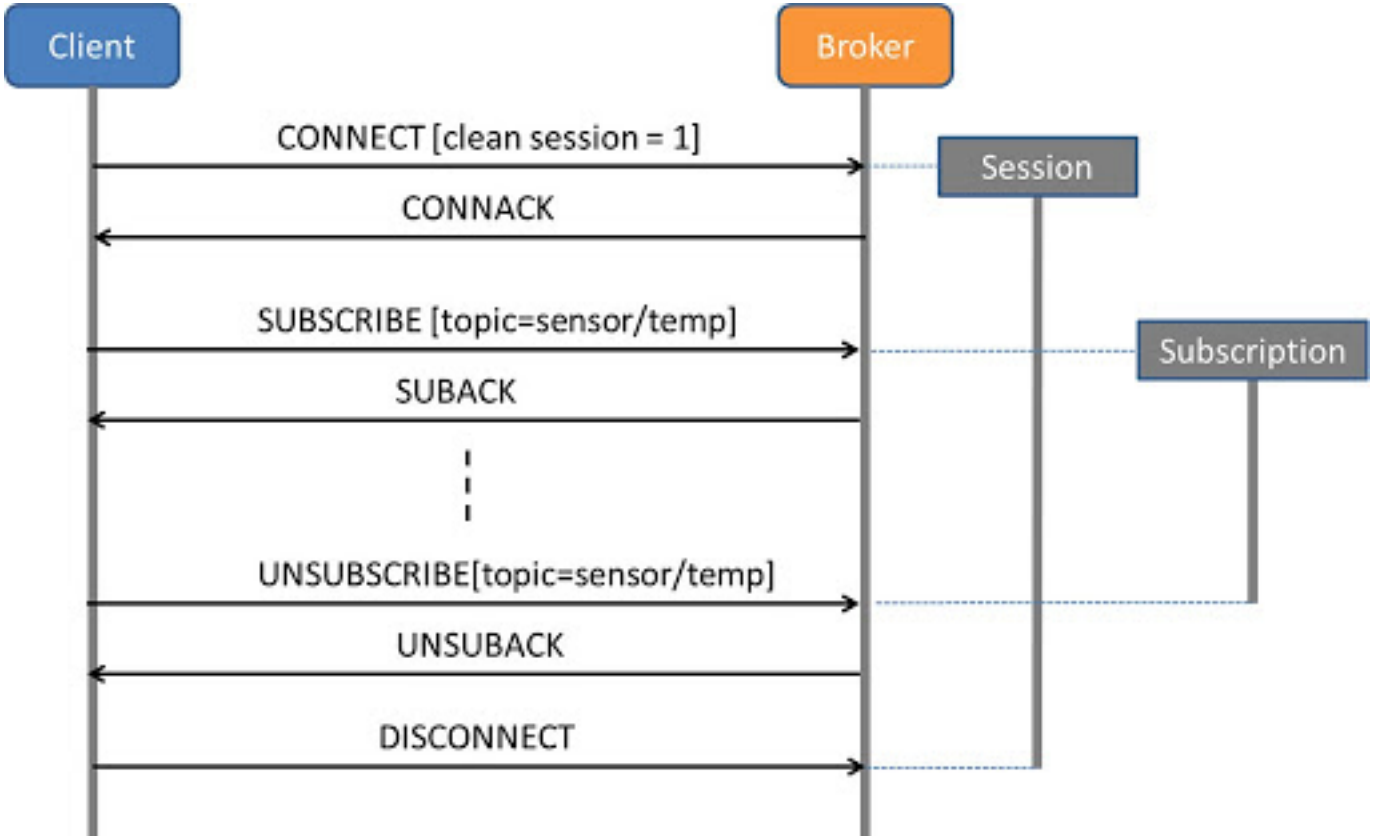
MQTT for IOT

- Its main purpose is telemetry, or remote monitoring. To collect data from many devices and transport that data to the IT infrastructure. It targets large networks of small devices that need to be monitored or controlled from the cloud.
- The protocol works on top of TCP to avoid losing data.
- Clients connect to a central server called a broker.
- It is a push messaging service with a publisher/subscriber (pub-sub) pattern.

  Messages are hierarchically organized in topics. → A customer can post a message on a certain topic. Other clients can subscribe to this topic, and the broker will send them the subscribed messages.
- It includes SSL/TLS transport and user/password or certificate authentication.



MQTT – Connection and topic subscription



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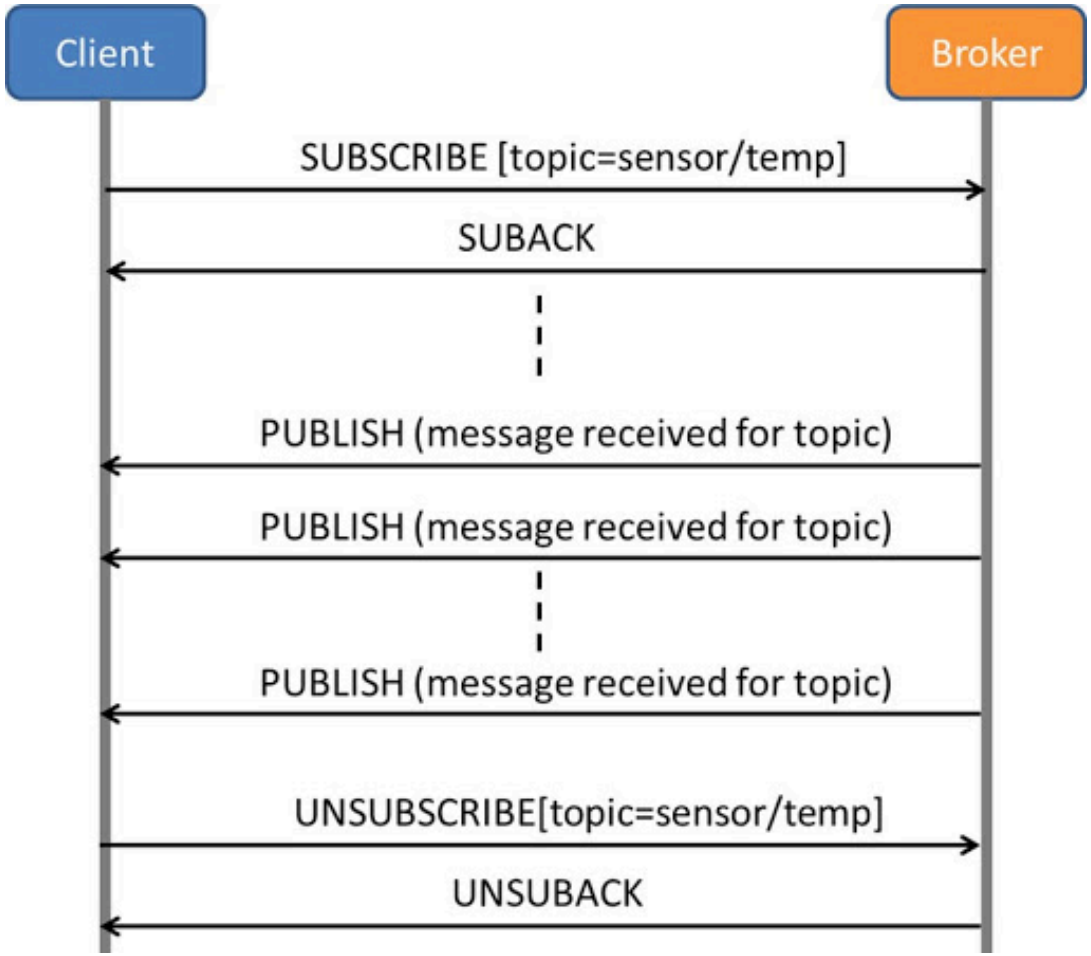
MQTT – Client flow



http://www.embedded101.com/Develop-M2M-IoT-Devices-Ebook/DevelopM2MIoTDevicesContent/ArticleId/224/3-7-Message-Flow

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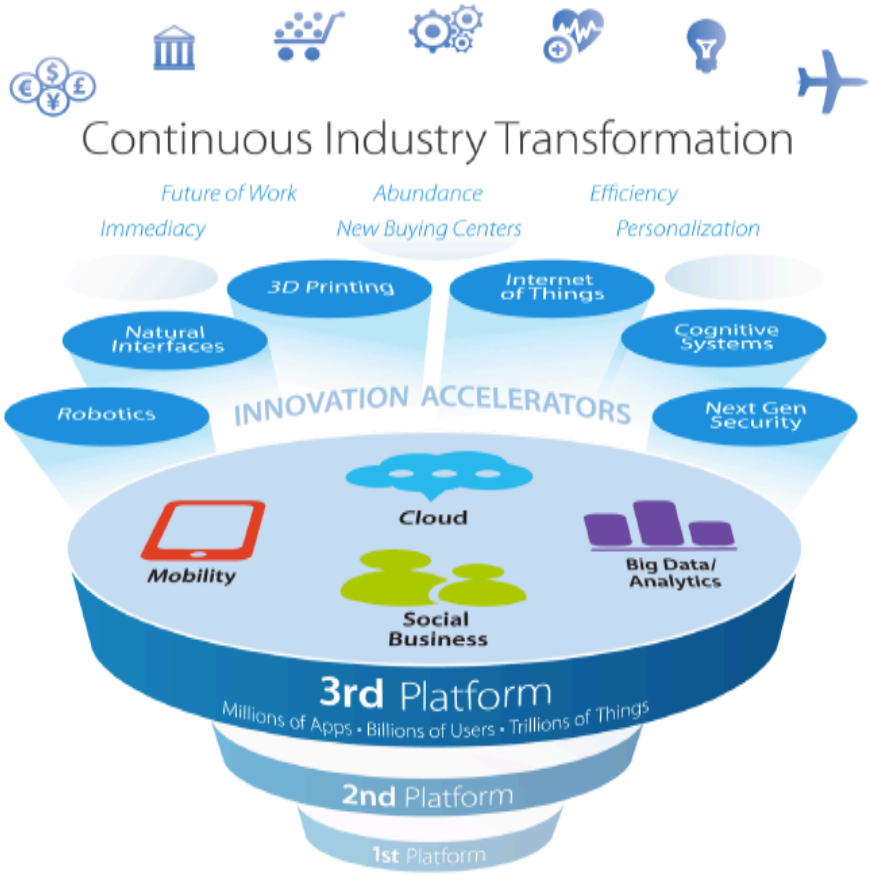
Convergence? Where?

- Convergence of technology
- Convergence of business and ecosystem
- Convergence of people, application, things, data, devices, etc.



Convergence of IoT, Big-Data and cloud

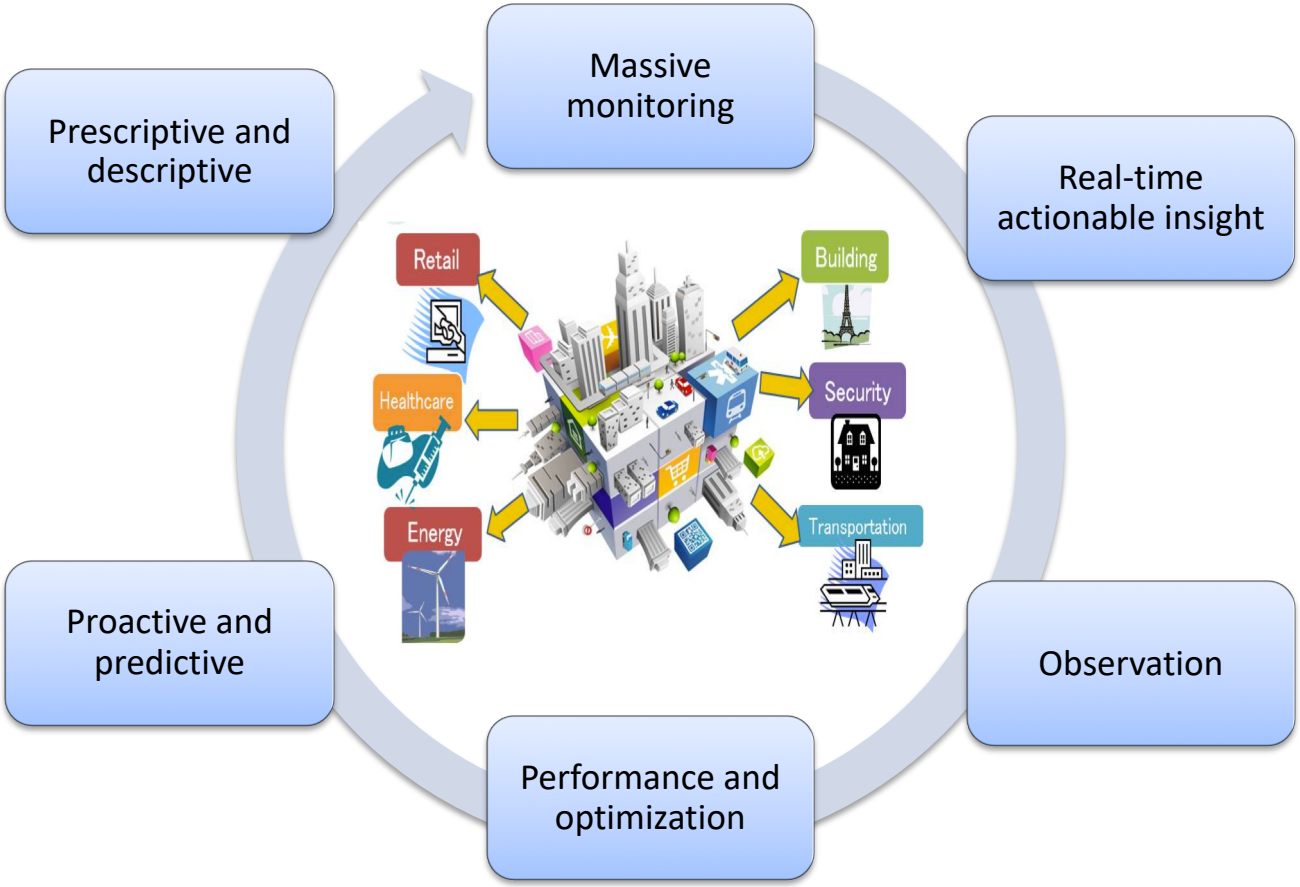
- For IoT, number of billions of connected devices is an indicator of IoT. The connectivity is just an enabler but *the real value of IoT is on data* (business insight/data-driven economy)
- For Big Data, *data collection* is one of the main concern, and IoT can play an important roles for data collection and data sharing
- For Big Data, data is nothing without *real business value insight*
- Cloud offers *Everything as a Service* business model for IOT and big data.

➔ IoT provides the data

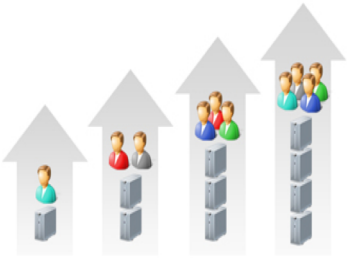
➔ Big Data provides the business value

➔ Cloud the service and computational process

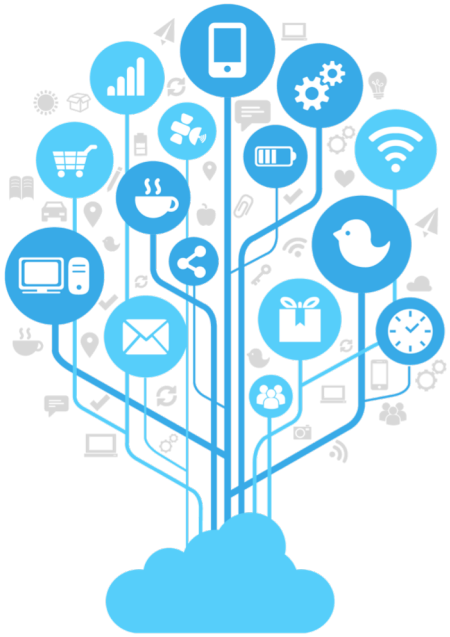
Cloud-based IoT Big Data applications



Key requirements of IoT-Big data platform



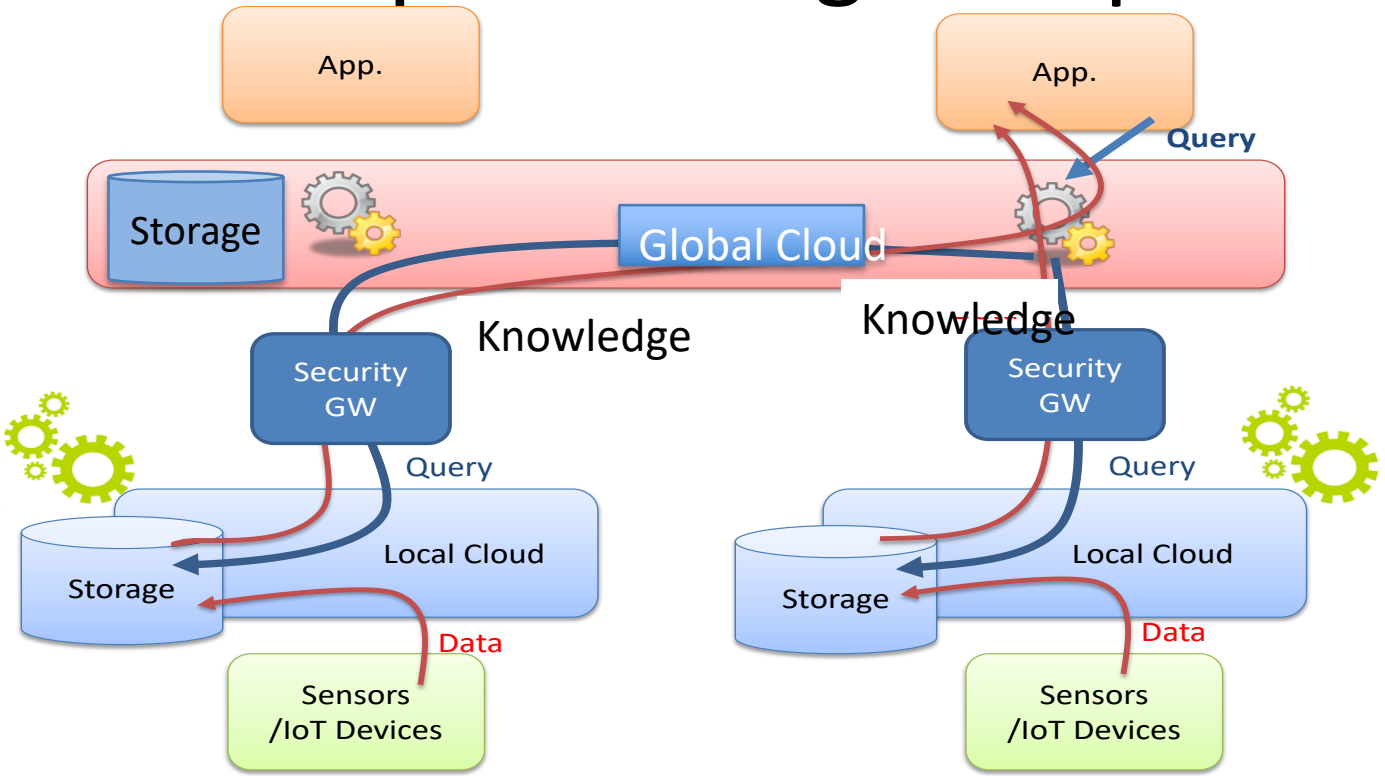
Security and privacy



Real-time

Distributed and decentralized

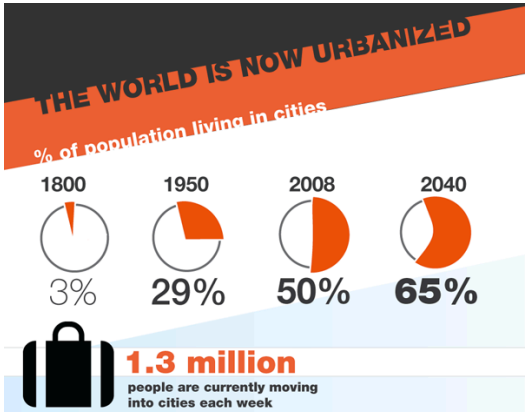
iKaaS-EU-Japan IoT big data platform

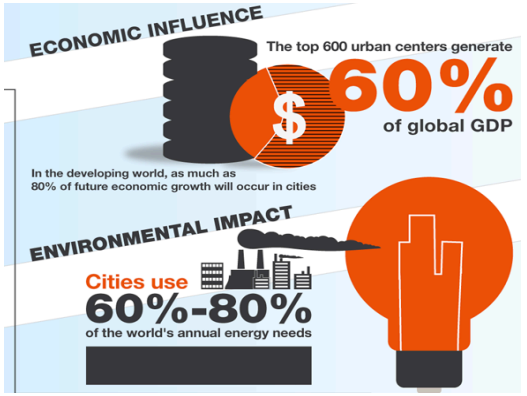


The goal of this project is to combine *ubiquitous and heterogeneous sensing*, smart objects, semantic, *big data and cloud computing technologies* in a platform enabling the Internet of Things process consisting of continuous iterations on data ingestion, data storage, *analytics, knowledge generation and knowledge sharing phases*, as foundation for cross-border information service provision.

Smart city opportunities and challenges

- Smart City is a concentration of people and devices
- Currently 72% of the EU population lives in urban areas, using 70% of the energy.
- Most of the data *is generated by people/citizen and process/machine*
- IoT/ big data *can offer value* to energy systems, mobility, climate change, and water and air quality, crime, autonomic car.





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5. **Security Considerations**

Why be concerned about IoT?

- It's just another computer, right?
  - All of the same issues we have with acce control, vulnerability management, patching, monitoring, etc.
  - Imagine your network with 1,000,000 more devices
  - Any compromised device is a foothold o the network

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?

Attacking IoT

- Default, weak, and hardcoded credentials
- Difficult to update firmware and OS
- Lack of vendor support for repairing vulnerabilities
- Vulnerable web interfaces (SQL injection, XSS)
- Coding errors (buffer overflow)
- Clear text protocols and unnecessary open ports
- DoS / DDoS
- Physical theft and tampering

Case of Study: Trane

- Connected thermostat vulnerabilities detected by Cisco's Talos group *allowed foothold* into network
- 12 months to publish fixes for 2 vulnerabilities
- 21 months to publish fix for 1 vulnerability
- Device owners may not be aware of fixes, or have the skill to install updates