SAKARYA ÜNİVERSİTESİ
Bilgisayar ve Bilişim Bilimleri Fakültesi
Bilgisayar Mühendisliği Bölümü

BSM 451

Internet of Things (IoT) and Applications

INTRODUCTION TO INTERNET OF THINGS

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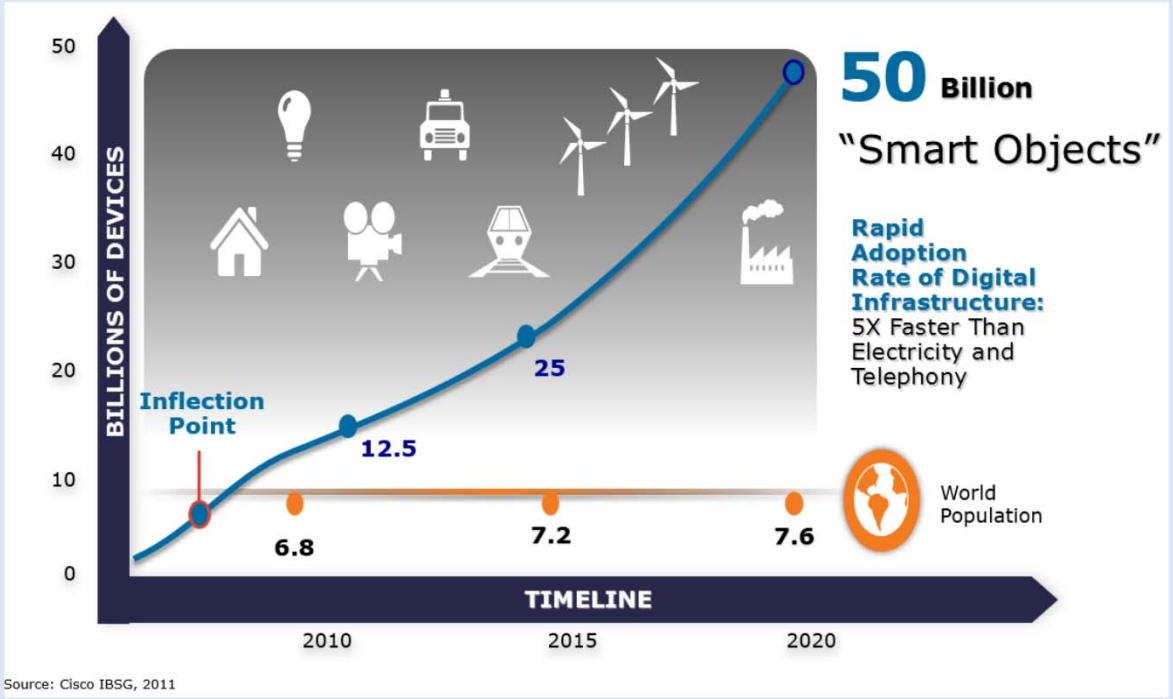
What is IoT?

Introduction

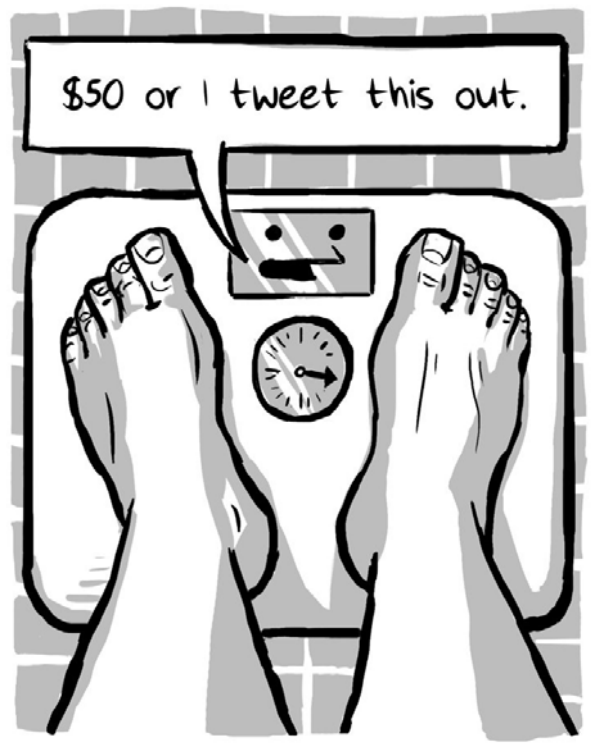
- Thanks to advancements in communication technologies and micro-electronic circuits, the number of devices connected to the internet has been rapidly increasing.
- Although data users (who generates and receives data) were mostly humans until 2010s, nowadays majority of internet traffic is generated by smart things and machines.
- By 2020, more than 50 billion things is predicted to be connected to the internet.

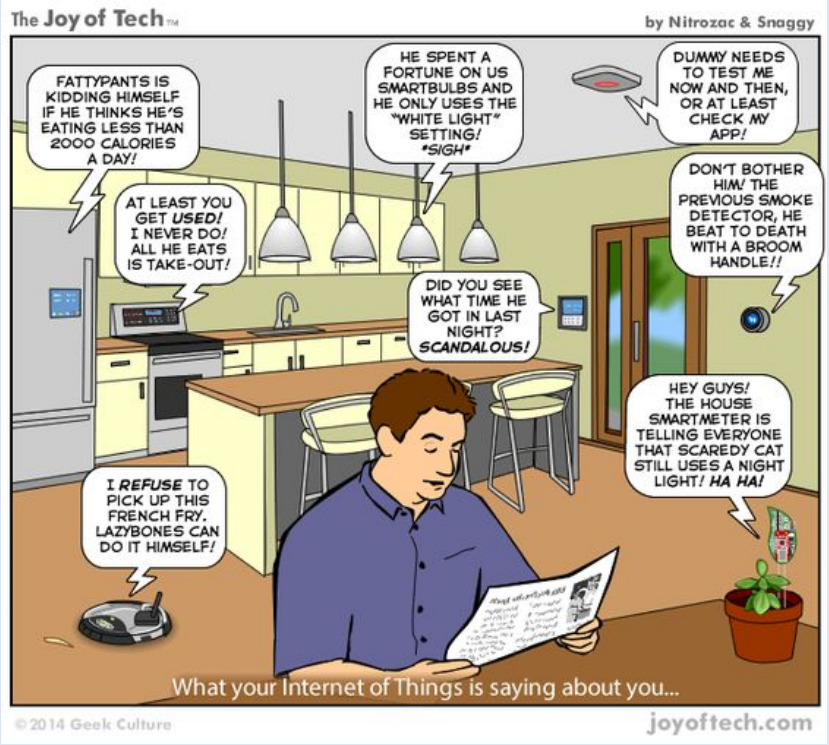


Internet of Things

- IoT is a global network that includes things that have sensing, communication, addressing, networking, and data processing capabilities.

- IoT is a network system that consists of smart devices that communicate with different protocols and has sensing capabilities.





IoT; aims to connection with everyone anytime, anywhere.

History of IoT

- The first application of IoT: the images of a coffee machine (which was used by 15 researchers in Cambridge University in 1991) sent to computer screen 3 times per minute to monitor it.
- Why is it accepted as IoT? Online and real time connection without internet

- The term of IoT was first coined by Kevin Ashton in 1999 in a presentation prepared for Procter & Gamble (P&G) company.
  - Radio Frequency Identification (RFID) technology was planned to be used in P&G's supply.

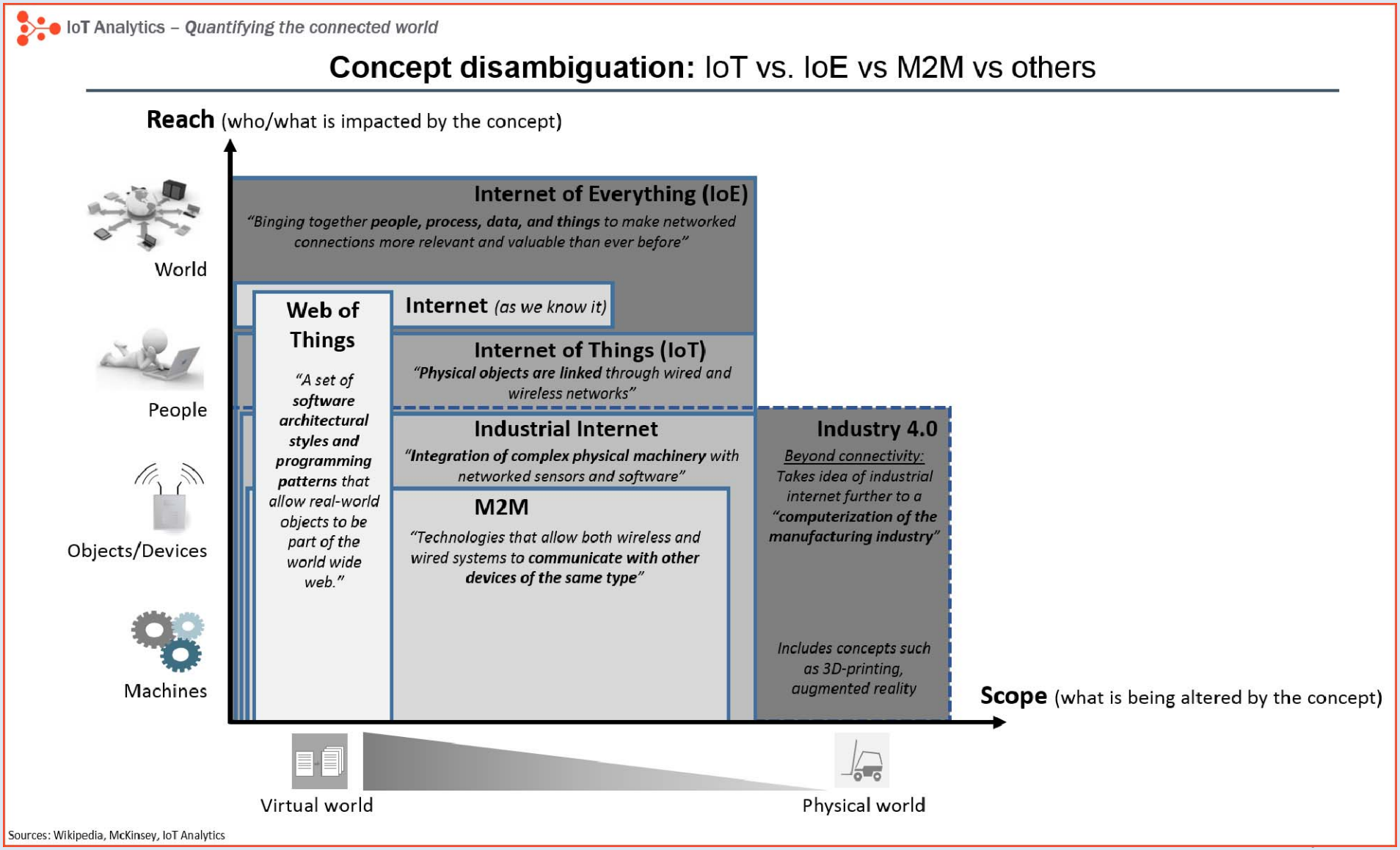
- In 2005, International Telecommunication Union (ITU) published a report about IoT.

- In 2009, CEO of IBM, S. J. Palmisano, coined the term Smart Planet, which increased the popularity of IoT.

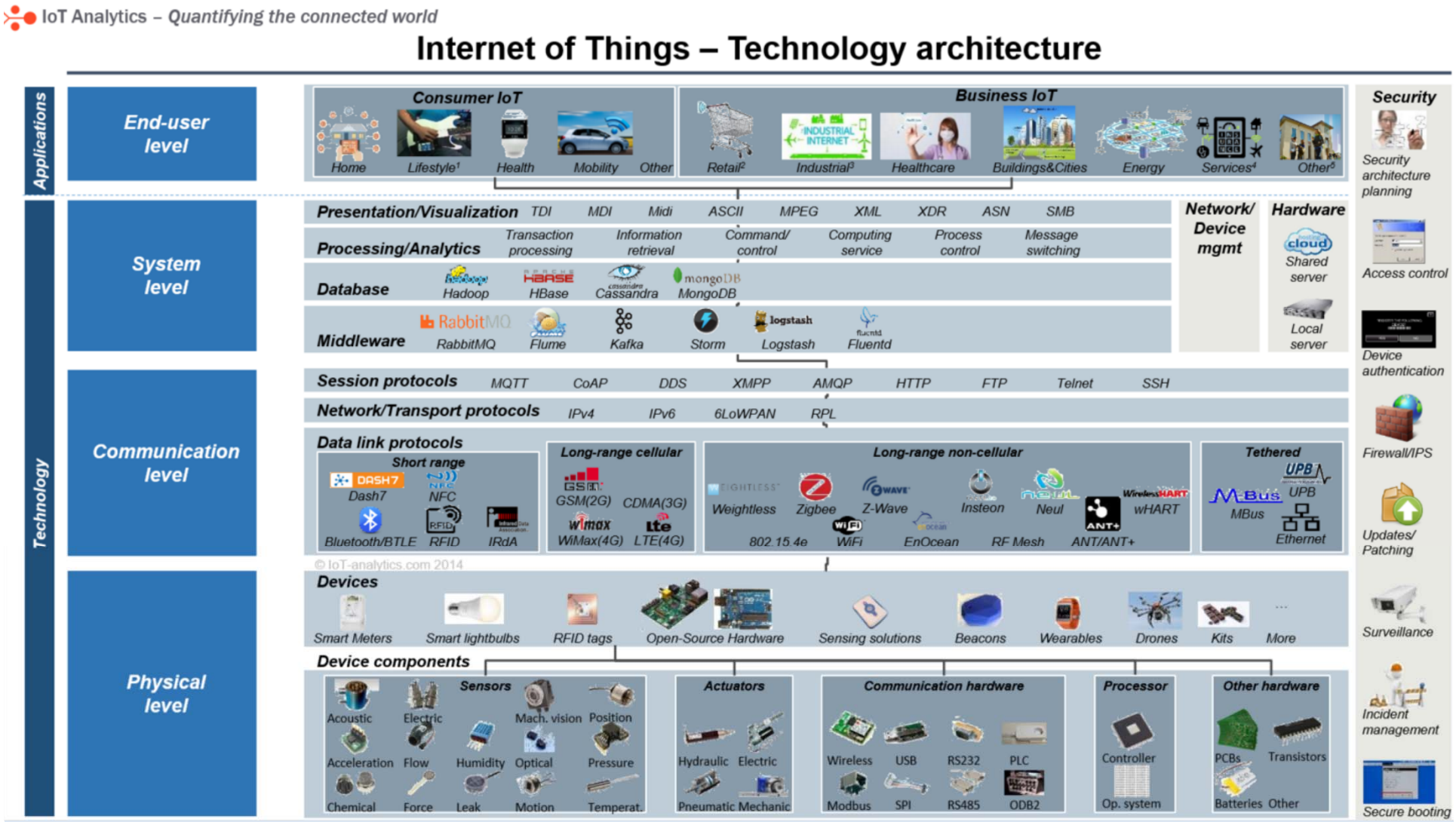
Pros and Cons

- **Pros**
  - **Industry, health, Social life applications will improve human life.**
- **Cons**
  - **over-reliance on technology,**
  - **Privacy,**
  - **job loss**

The Relationship Between IoT and Related Technologies



IoT Technology / Protocol Architecture



IoT Network and Components

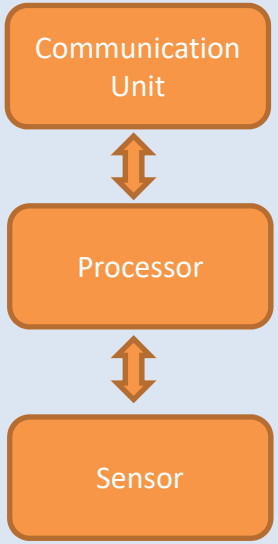
- Network components of IoT

Information Technology, IT + Operational Technology, OT + Smart Objects

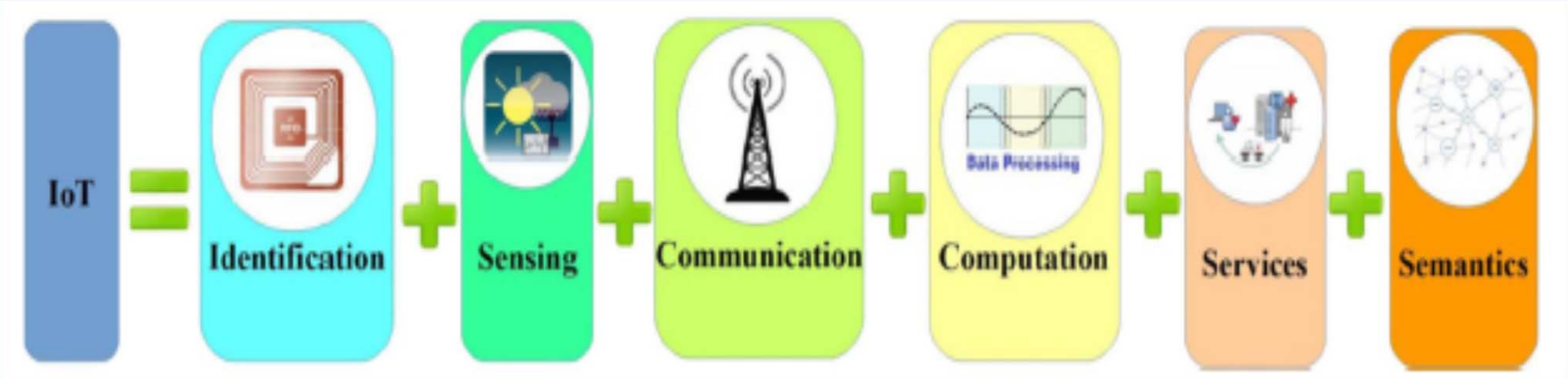
- OT: Transferring right info to the right person in the right time.

- IoT Smart Things

- Physical devices that can process data, make smart decisions, communicate with each other and internet



IoT Components



Naming	EPC, uCode
Addressing	IPv4, IPv6

Smart Sensors, Wearable sensing devices, Embedded sensors, Actuators, RFID tag

RFID, NFC, UWB, Bluetooth, BLE, IEEE 802.15.4, Z-Wave, WiFi, WiFiDirect, , LTE-A

Hardware

SmartThings, Arduino, Phidgets, Intel Galileo, Raspberry Pi, Gadgeteer, BeagleBone, Cubieboard, Smart Phones

Identity-related (shipping), Information Aggregation (smart grid), Collaborative-Aware (smart home), Ubiquitous (smart city)

RDF, OWL, EXI

Software

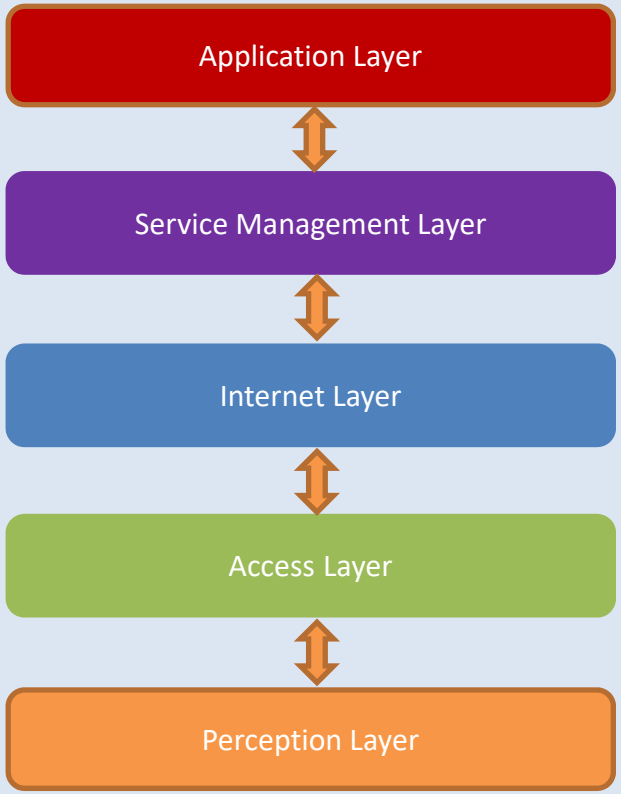
OS (Contiki, TinyOS, LiteOS, Riot OS, Android); Cloud (Nimbits, Hadoop, etc.)

- IoT Components

Kaynak: Fuquha etc.

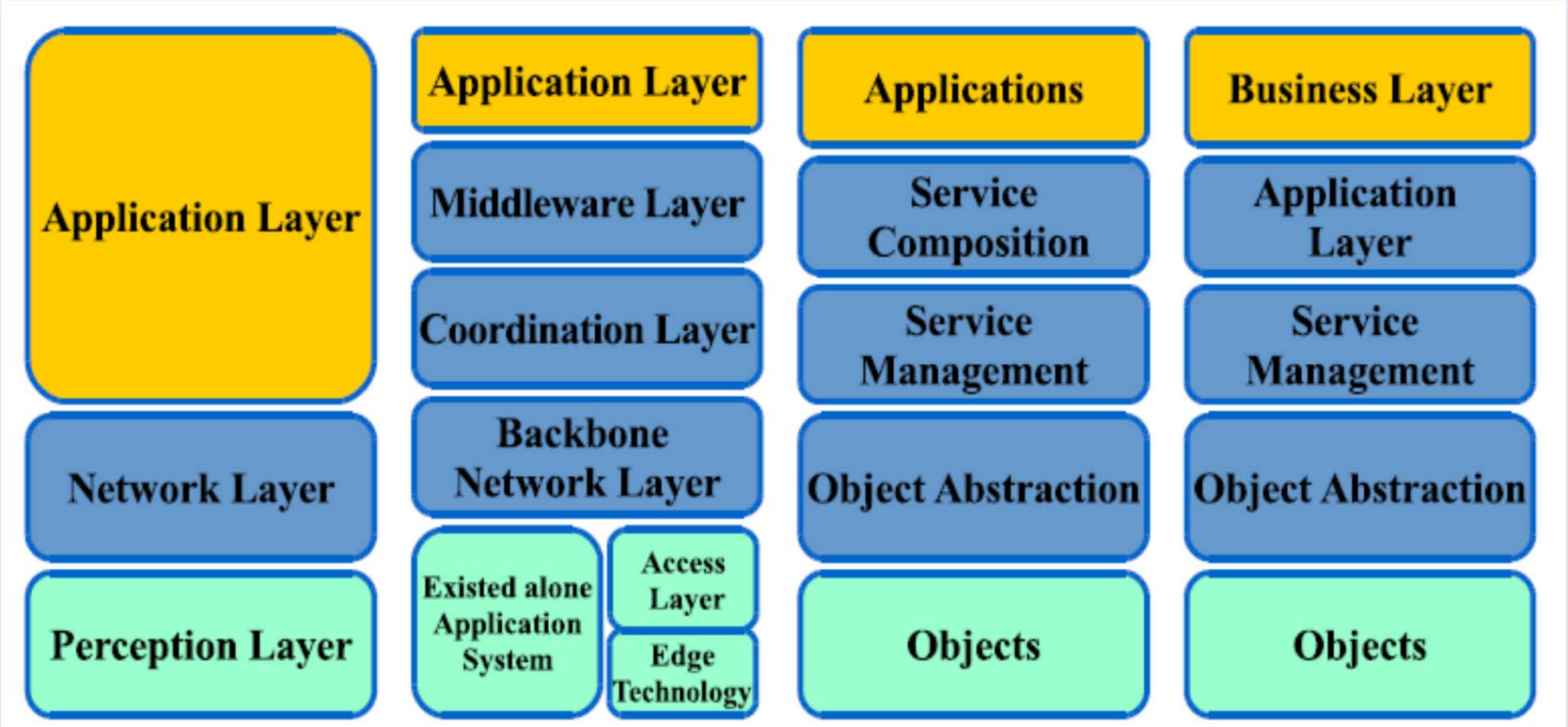
Layered Architecture of IoT

- There are various layered architectures for IoT structures.
- IoT technology fundamentally consists of perception, network, and application layers.
- ITU proposes a 5-layer model for IoT.



- Responsible for all applications.
- Service management layer. Receiving and resulting service requests.
- Network management layer. Responsible for functional addressing of things.
- Provides efficient and reliable structure for thing to be connected to internet.
- Responsible for transfering data obtained from perception layer to the internet with various communication Technologies.
- Element management layer. Aims to manage vendor independent devices
- Network element layer
- Data gathering through sensors
- Each component has a Universal Unique Idenfifier

Other layered architectures proposed for IoT



3-layer architecture

Middle-ware based

Simple Access (SOA) -based

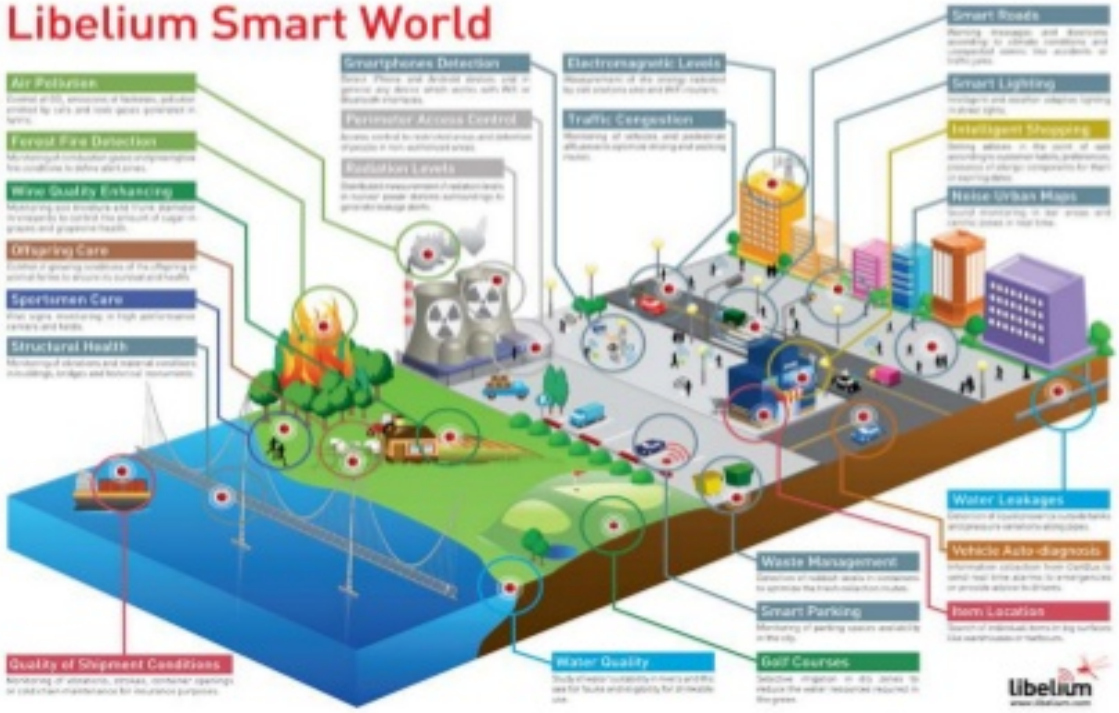
Object Protocol

5-layer achitecture

Kaynak: Fuquha etc.

Applications of IoT

The Future is Now
- Perspectives of a Smart City



Sensors for

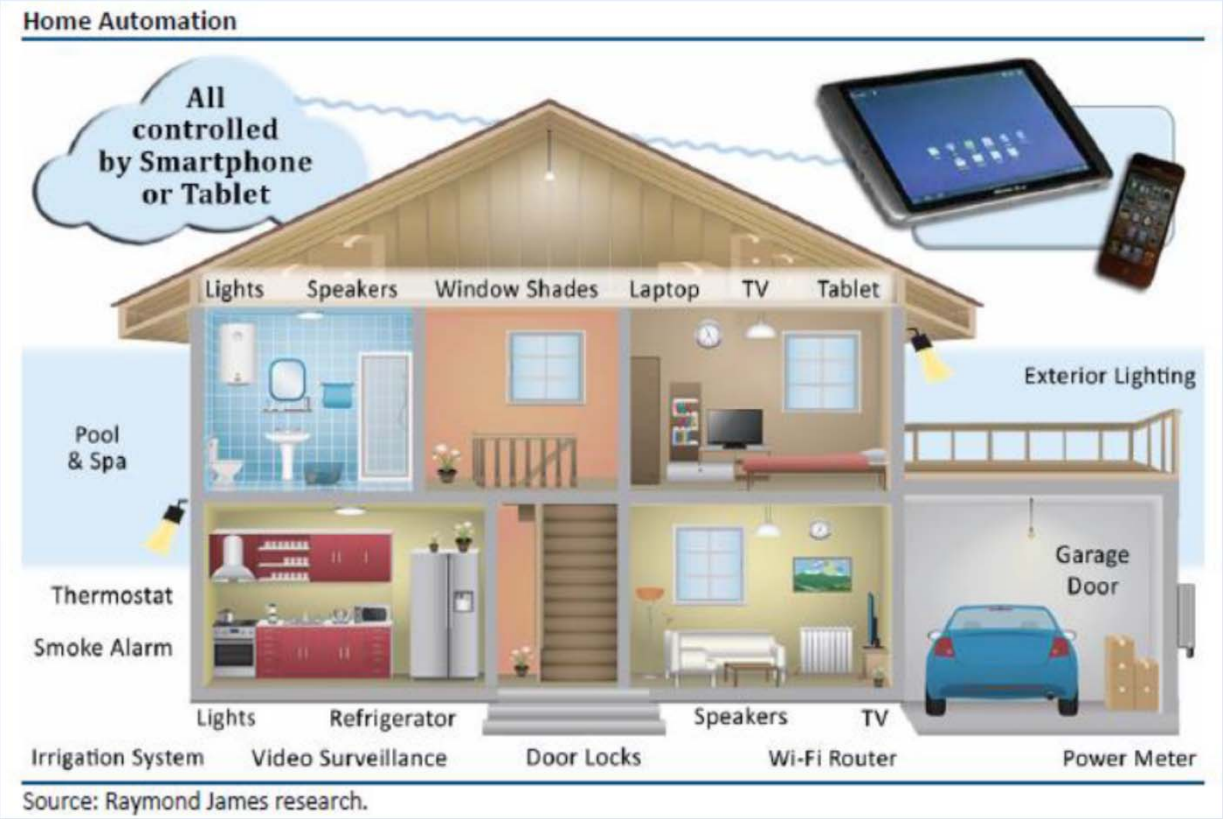
- Air pollution
- Fire detection
- Water quality
- Smart parking
- Traffic congestion
- Waste management
- Golf course conditions

... sensor city

Jury Konga
eGov*Futures* Group

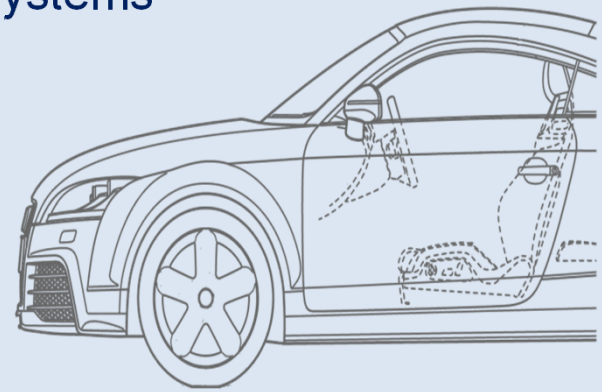
Applications of IoT

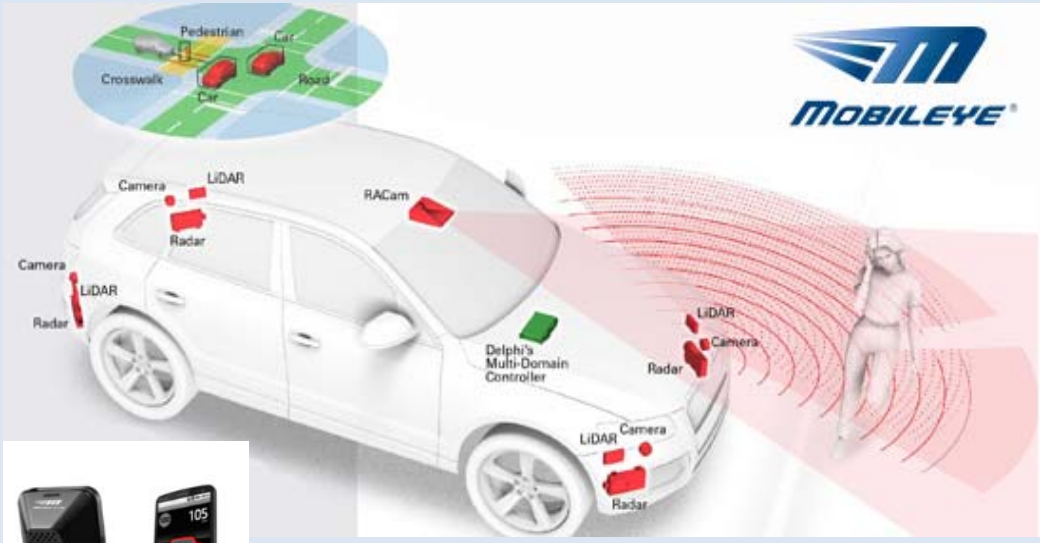
- Smart house and buildings
  - Security,
  - Energy efficiency,
  - Door, light, temperature, etc. control.



Applications of IoT

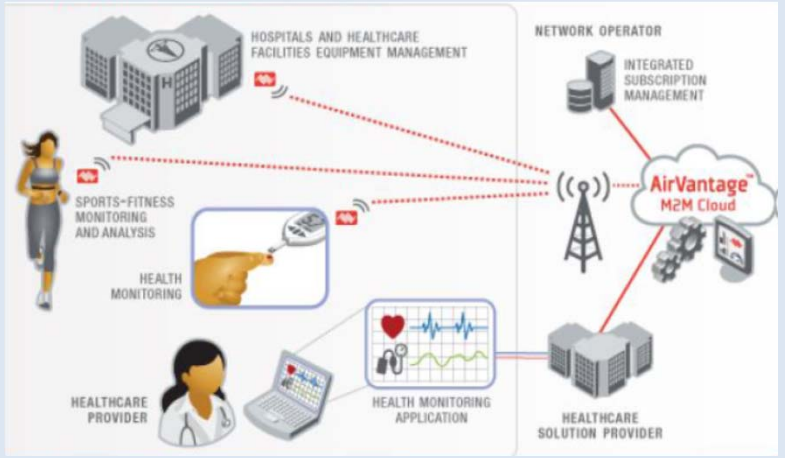
- Automobile and Transportation Systems
  - Safety,
  - Fuel control,
  - Route optimization,
  - Collision avoidance.

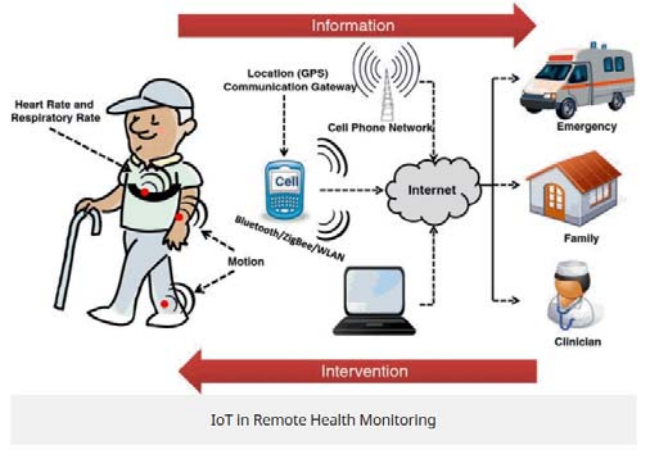




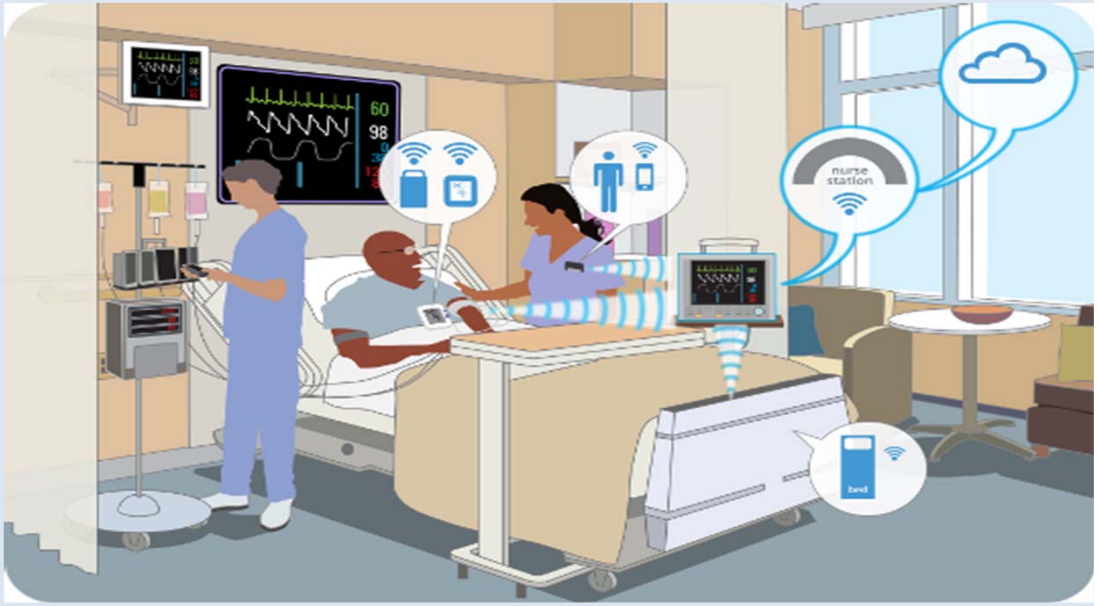
Applications of IoT

- Healthcare
  - Remote patient monitoring,
  - Medicine tracking,
  - Hospital asset tracking/monitoring,
  - Wearable technologies.



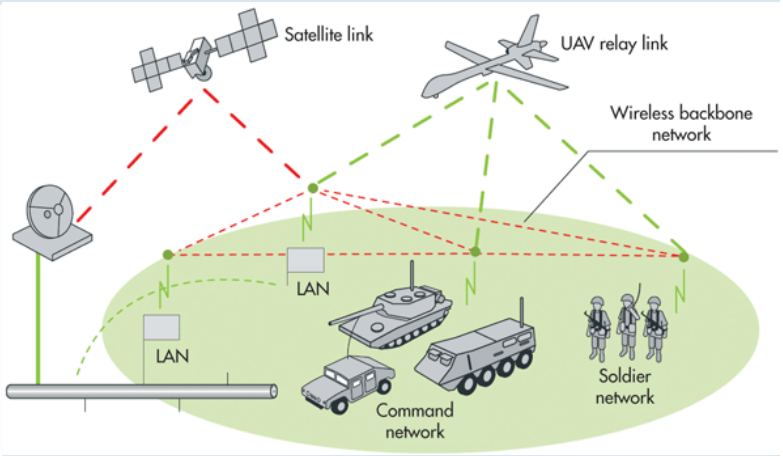


IoT In Remote Health Monitoring

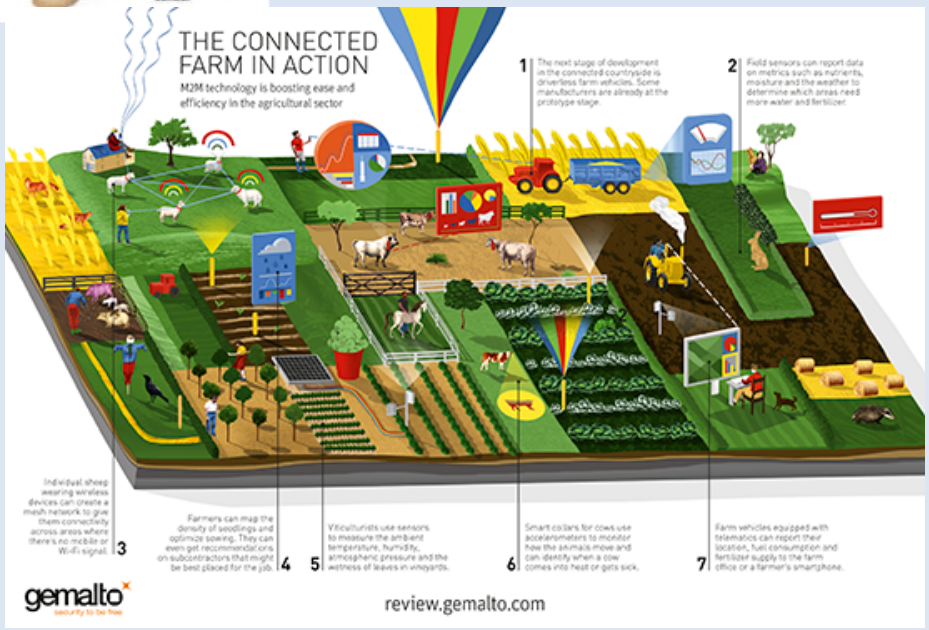


Applications of IoT

- Military applications
  - Border surveillance,
  - Target detection,
  - Attack detection,
  - Logistics.

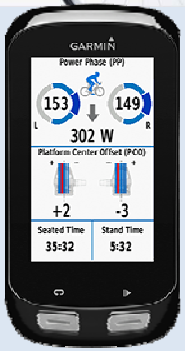


- Agriculture applications
  - Livestock monitoring/tracking,
  - Farm/harvest tracking,



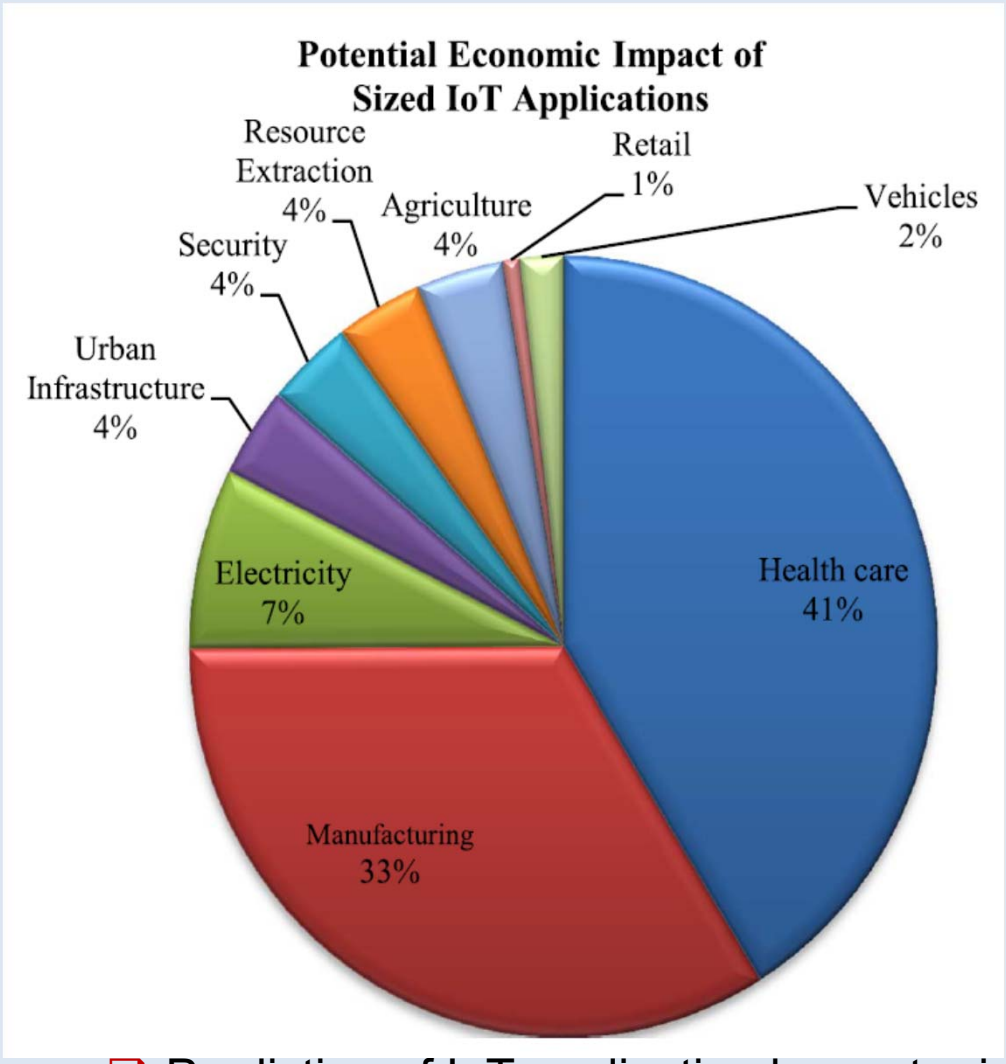
Applications of IoT

- Smart things/devices



Smart Cargo robots

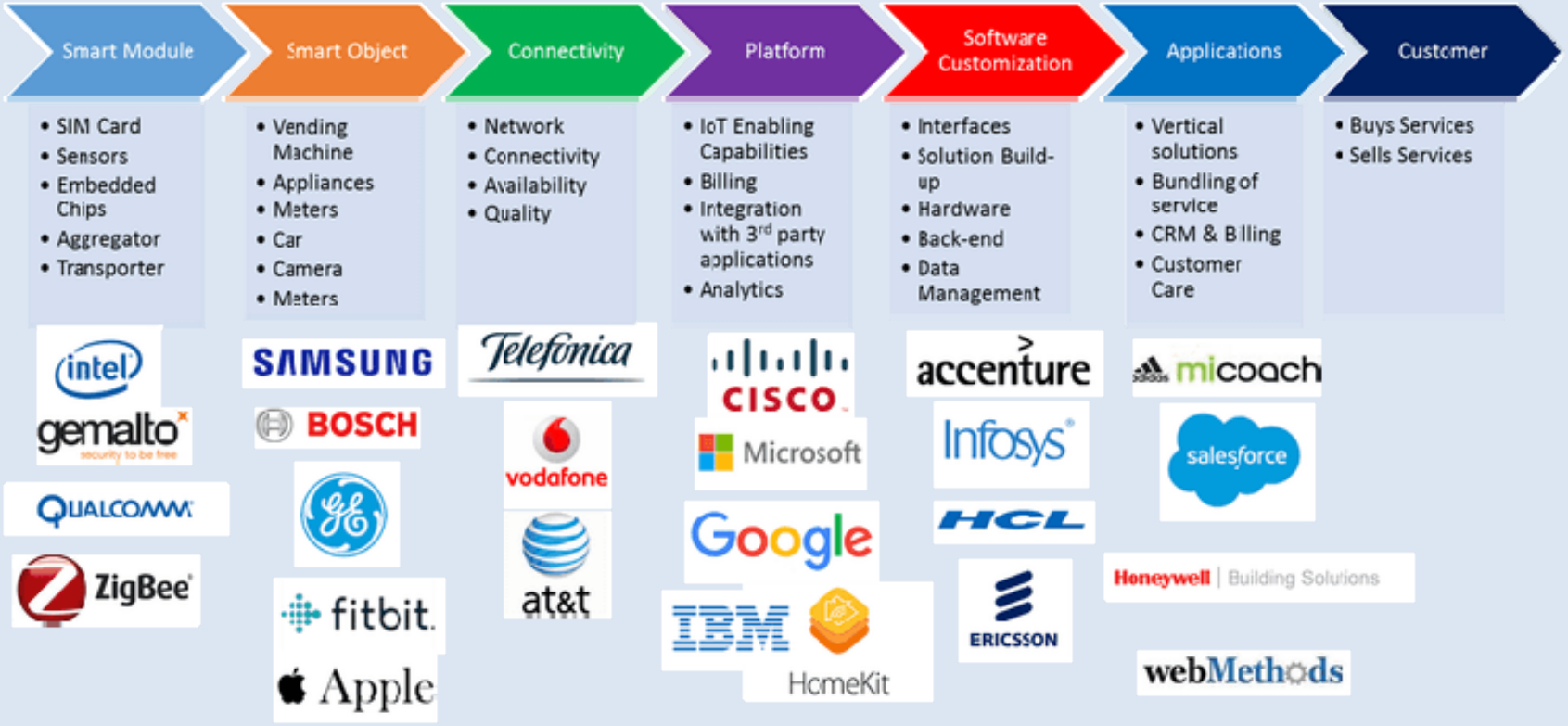
Potential of Iot



- Prediction of IoT application by sector in 2025

Kaynak: Fuquha etc.

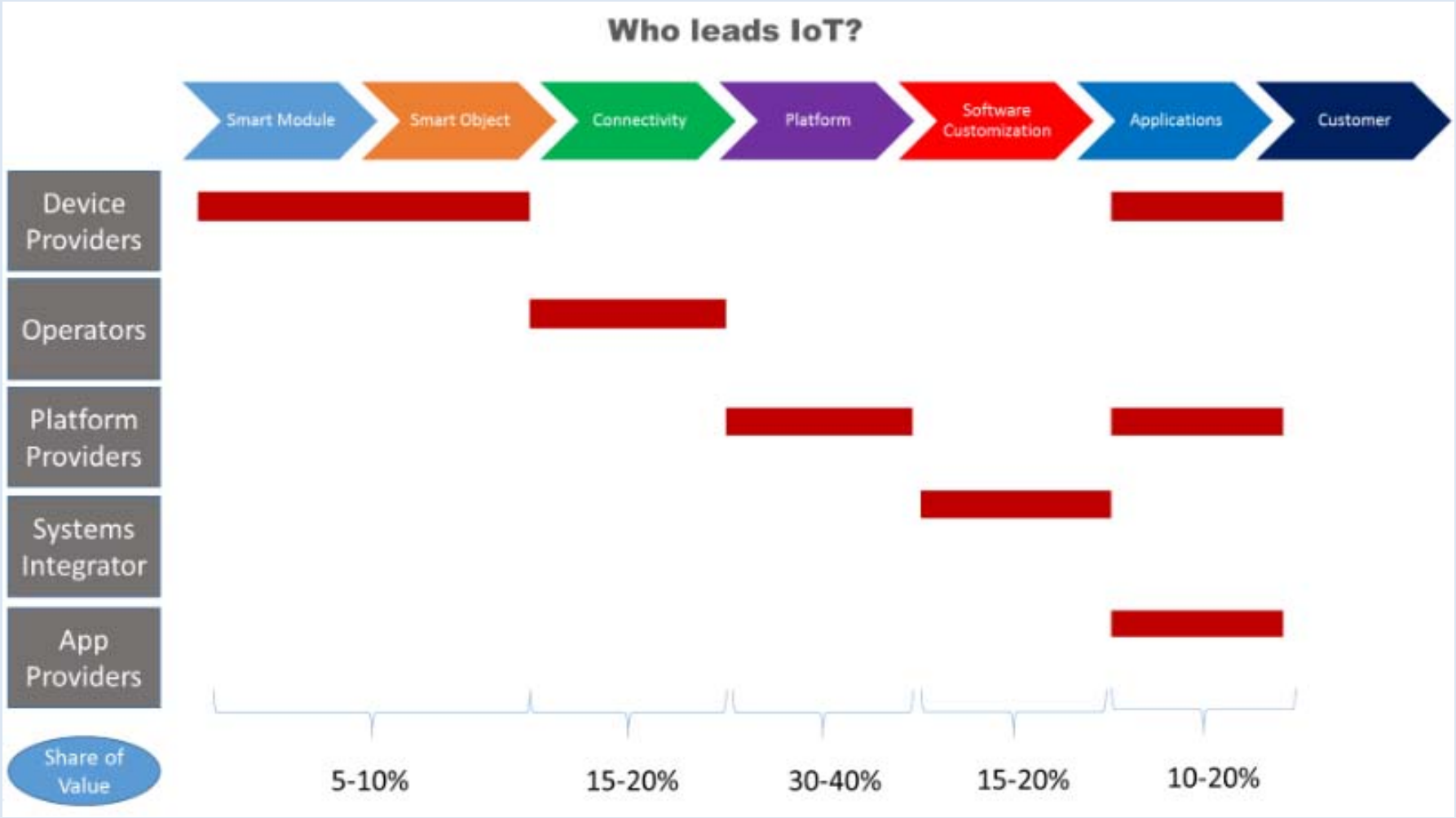
IoT Value Chain



Note, the above is not an exhaustive list of companies and any company may have play in more than one component of value chain

- **Where would you be in this chain as a computer engineer?**

IoT Value Chain



Challenges in IoT

- Technology,
- Lack of standardization,
- Security,
  - Unreliable web interfaces (SQL injection, XSS)
  - Denial of Service (DoS)
  - Physical theft and alter
- Privacy,
- Big data management,
- Interoperability,
- Firmware and OS update,

Practice

- When is the first IoT concept used?
- What is IoT?
- Give examples of communication Technologies used in IoT.
- What are the layers of layered IoT architecture?
- What are fields of IoT applications?
- List IoT value chain elements?

REFERENCES

- Course notes/Slides

❖ Others

- L. Atzori, A. Iera, G. Morabito, "The Internet of Things: A Survey", Computer Networks, vol. 54, 2787-2805, 2010.
- A. Fuqaha, M. Guizani, M. Mohammadi, M. Aledhari, M. Ayyash, "*Internet of Things: A Survey on Enabling Technologies, Protocols, and Applications*", IEEE Communication Survey&Tutorials, vol. 17 (4), 2347-2376 ,2015.