



# 실시간 통신과 IoT

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(CC533)

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(Department of Computer Science)



# Introduction to Internet of Things (IoT)

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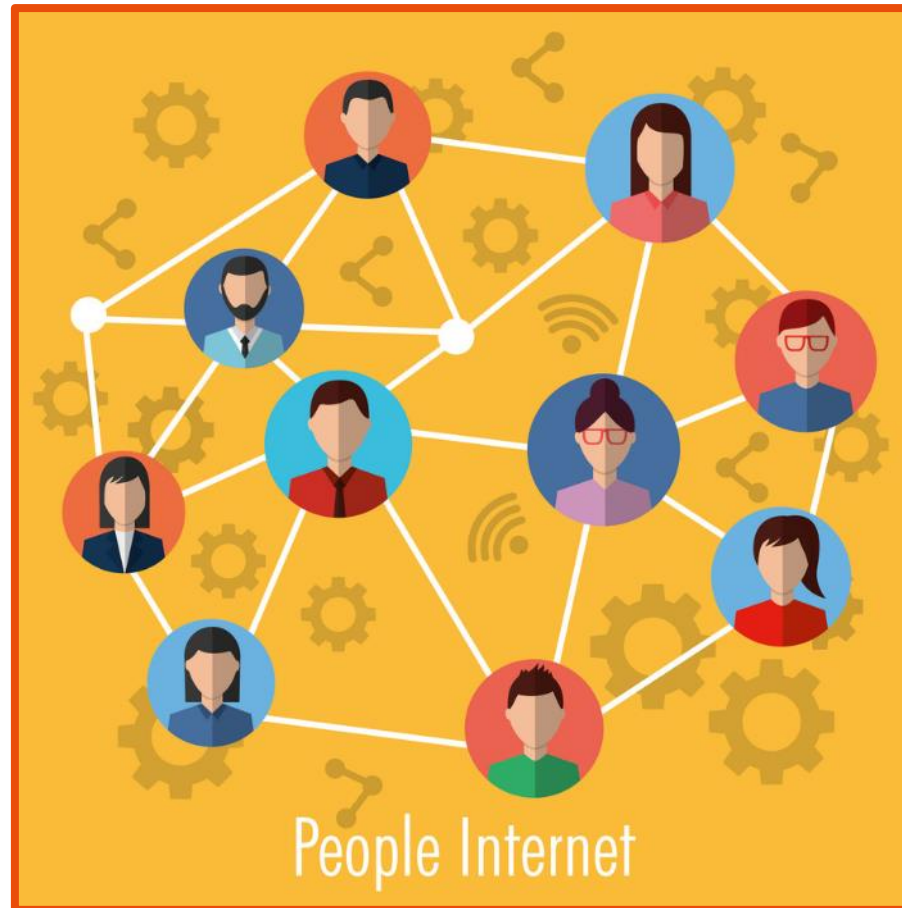
# CONTENTS

- **What Is Internet of Things?**
- **How IoT Works?**
- **IoT Applications**
- **Driving Forces of IoT**
- **Challenges of IoT**
- **Advantages And Disadvantages of IoT**
- **Conclusions**

# WHAT IS INTERNET OF THINGS?

## ■ Traditional Internet

- Connection between people and people



# WHAT IS INTERNET OF THINGS?

*"The **Internet of things (IoT)** is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction*

*- **IoTAgenda***

# WHAT IS INTERNET OF THINGS?

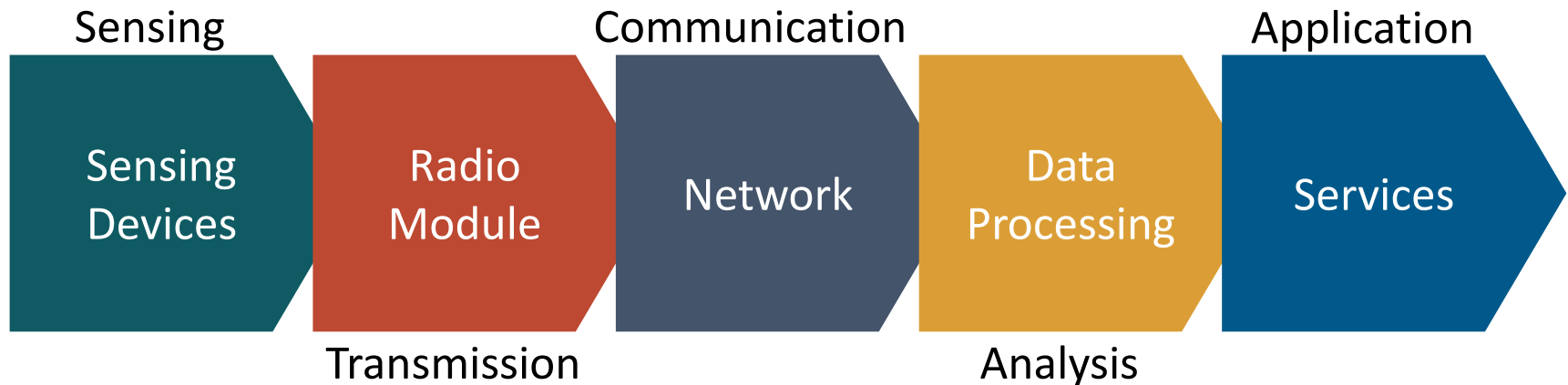
## ■ Internet of Things (IoT)

- Network of "things"
  - Small devices, vehicles, buildings, ...
  - Things collect and exchange data

### Thing in IoT

*"An embedded computing device  
that transmits and receives information over a network"*

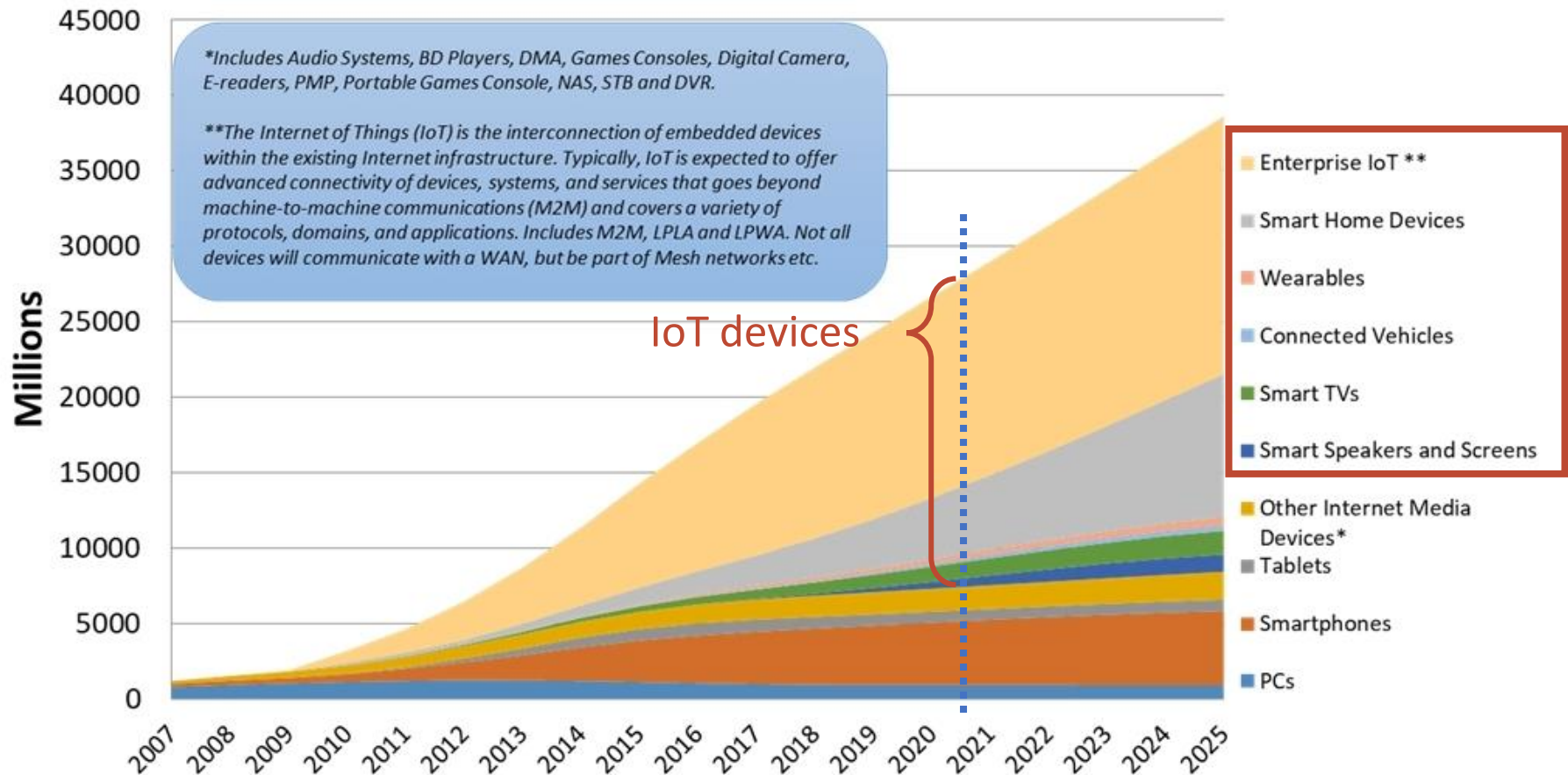
## ■ IoT Technology



# WHAT IS INTERNET OF THINGS?

## ■ IoT Market

### Global Connected and IoT Device Installed Base Forecast



Source – Strategy Analytics research services, May 2019: IoT Strategies, Connected Home Devices, Connected Computing Devices, Wireless Smartphone Strategies, Wearable Device Ecosystem, Smart Home Strategies

# WHAT IS INTERNET OF THINGS?

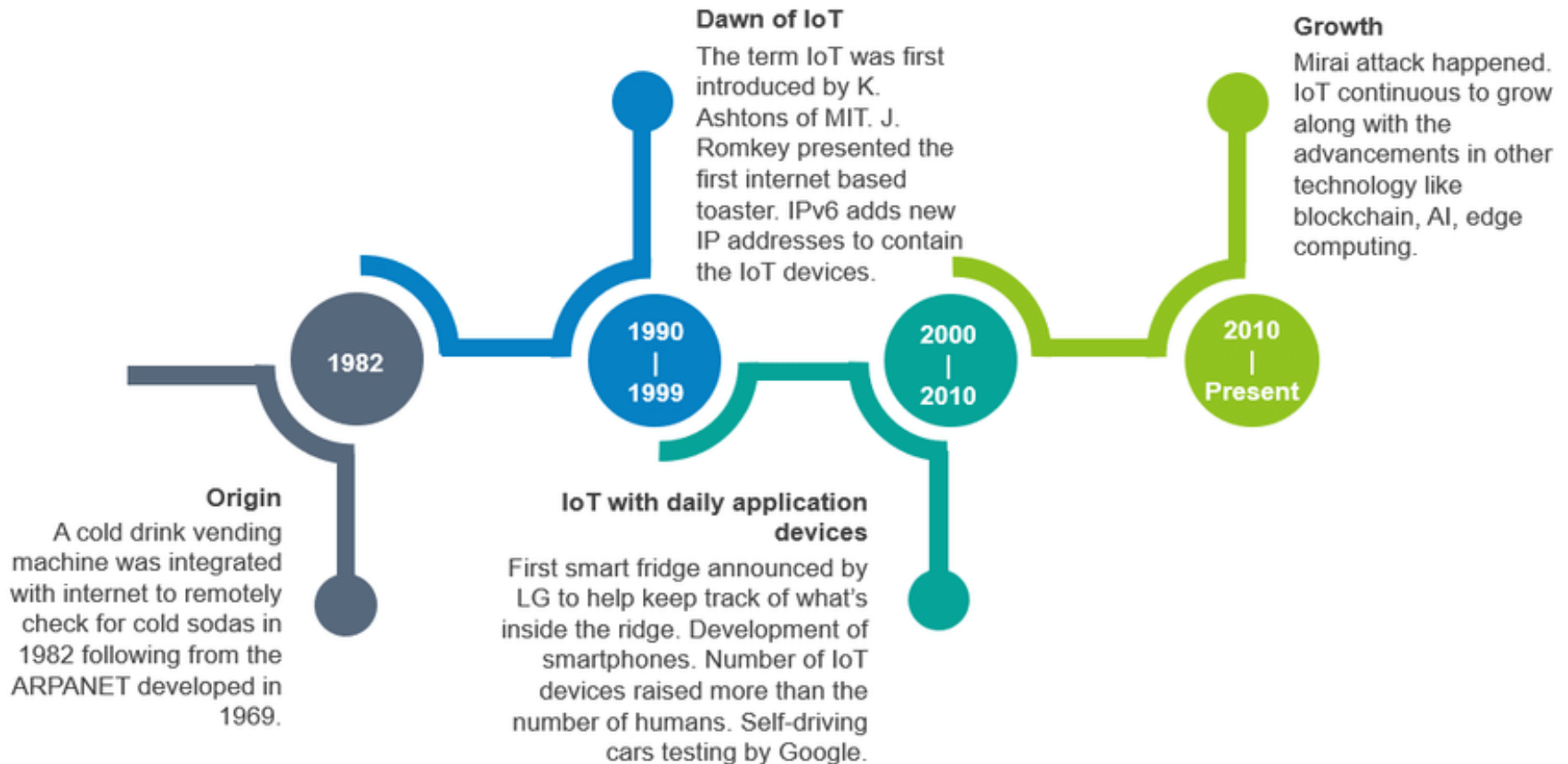
## ■ History of IoT

- 1999- The term "Internet of Things" was used by Kevin Ashton during his work which became widely accepted
- 2004 - The term was mentioned in famous publications like the Guardian, Boston Globe, and Scientific American
- 2005-UN's International Telecommunications Union (ITU) published its first report on this topic.
- 2008- The Internet of Things was born
- 2011- Gartner, the market research company, include "The Internet of Things" technology in their research



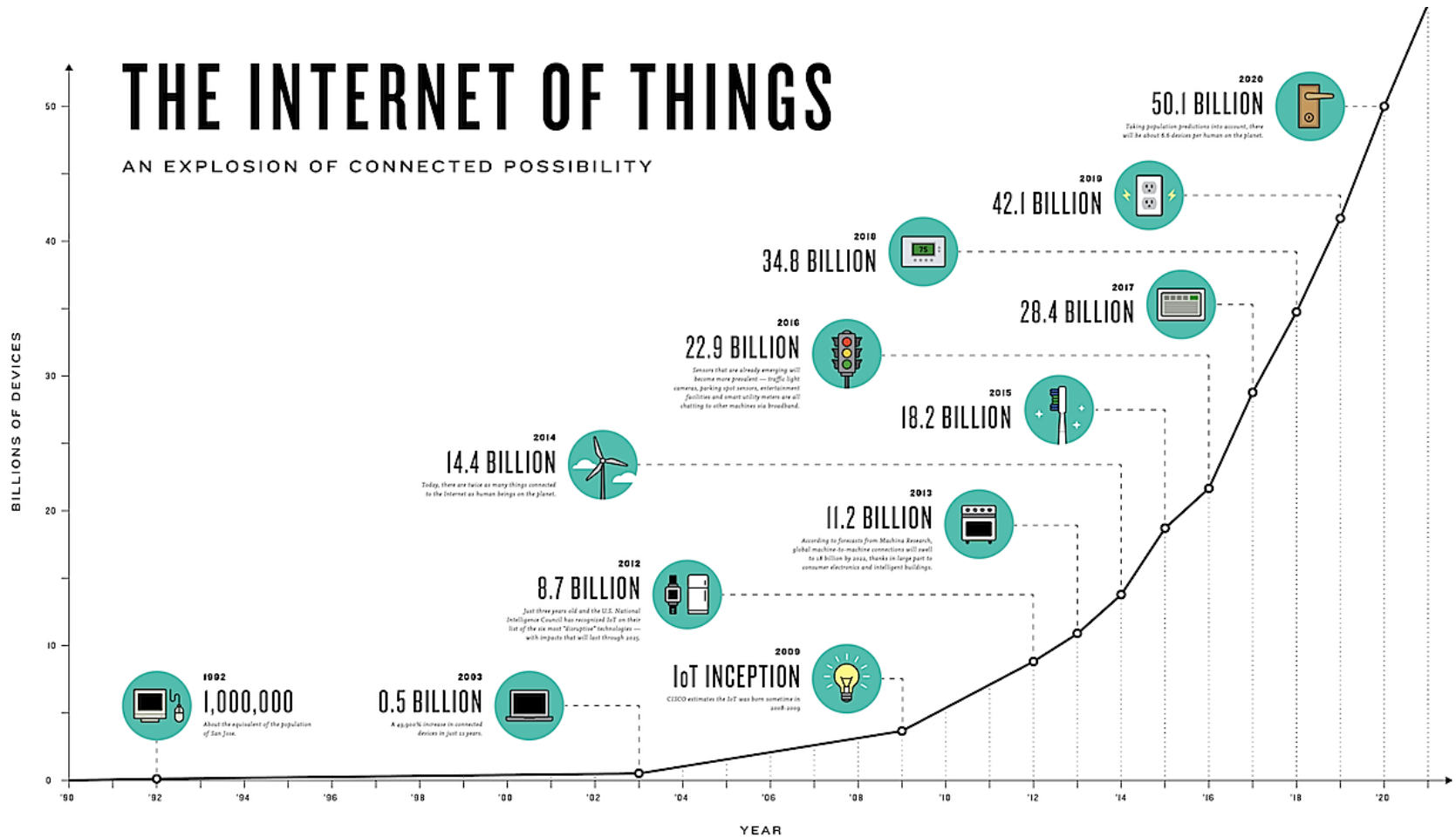
# WHAT IS INTERNET OF THINGS?

## ■ IoT timeline of advancement



Sonali Agarwal et al., "Unleashing the power of disruptive and emerging technologies amid COVID 2019: A detailed review", 2020

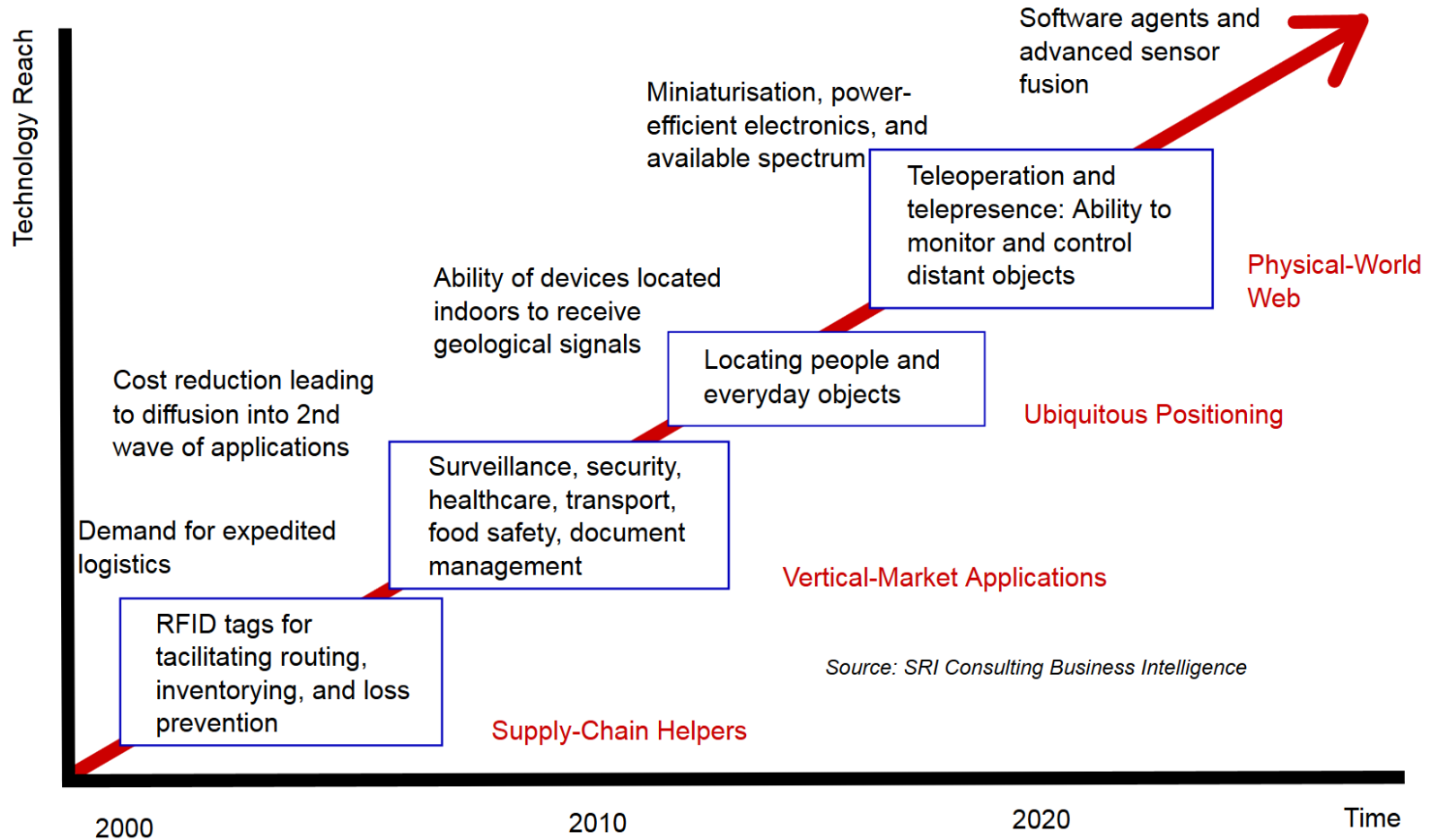
# WHAT IS INTERNET OF THINGS?



<https://www.quora.com/How-is-IOT-going-to-be-used-in-the-future>

# WHAT IS INTERNET OF THINGS?

## ■ Technology Roadmap of IoT



Source: SRI Consulting Business Intelligence

# WHAT IS INTERNET OF THINGS?

## ■ Why Is IoT So Important?

*Now, we can connect everything to the internet via embedded devices. Seamless communication is possible between people, processes, and things.*

*→ Everything can share and collect data with minimal human intervention (low cost)*

# WHAT IS INTERNET OF THINGS?

## ■ Benefits of IoT

1. Monitor their overall business processes
2. Improve the customer experience
3. Save time and money
4. Enhance employee productivity
5. Integrate and adapt business models
6. Make better business decisions
7. Generate more revenue

# HOW IoT WORKS?

## ■ 4 Main Components of IoT



### Sensors

Collecting data



### Connectivity

Sending data to cloud



### Data Processing

Making data useful



### User Interface

Delivering information to user

Edsson, "Overview of the best IOT platforms. Tips for selecting the right cloud solution in 2019. Anna Davydova"

# HOW IoT WORKS?



1

## Sensors

Collecting data



2

## Connectivity

Sending data to cloud



3

## Data Processing

Making data useful



4

## User Interface

Delivering information to user

Edsson, "Overview of the best IOT platforms. Tips for selecting the right cloud solution in 2019. Anna Davydova"

- Sensors
  - Key component that collect live data from the surrounding environment
    - Velocity, GPS coordinates, temperature, ...

# HOW IoT WORKS?



## Sensors

Collecting data



## Connectivity

Sending data to cloud



## Data Processing

Making data useful



## User Interface

Delivering information to user

Edsson, "Overview of the best IOT platforms. Tips for selecting the right cloud solution in 2019. Anna Davydova"

- **Connectivity**

- All the collected data is sent to a cloud infrastructure
- The sensors should be connected
  - Mobile or satellite networks, Bluetooth, WI-FI, WAN, ...



# HOW IoT WORKS?



## Sensors

Collecting data



## Connectivity

Sending data to cloud



## Data Processing

Making data useful



## User Interface

Delivering information to user

Edsson, "Overview of the best IOT platforms. Tips for selecting the right cloud solution in 2019. Anna Davydova"

- Data Processing
  - Software performs processing on the gathered data
    - Number, text, audio, video, ...

# HOW IoT WORKS?



## Sensors

Collecting data



## Connectivity

Sending data to cloud



## Data Processing

Making data useful



## User Interface

Delivering information to user

Edsson, "Overview of the best IOT platforms. Tips for selecting the right cloud solution in 2019. Anna Davydova"

- User Interface

- The processed results are given to users
  - Computer, mobile, alarm, display, speaker, ...

# IoT APPLICATIONS

## ■ Smart Home

- Sensors gather information of a house
  - Temperature, humidity, illuminance, movement, ...
- Actuators control home functions
  - Lighting, TV, air conditioner, ...

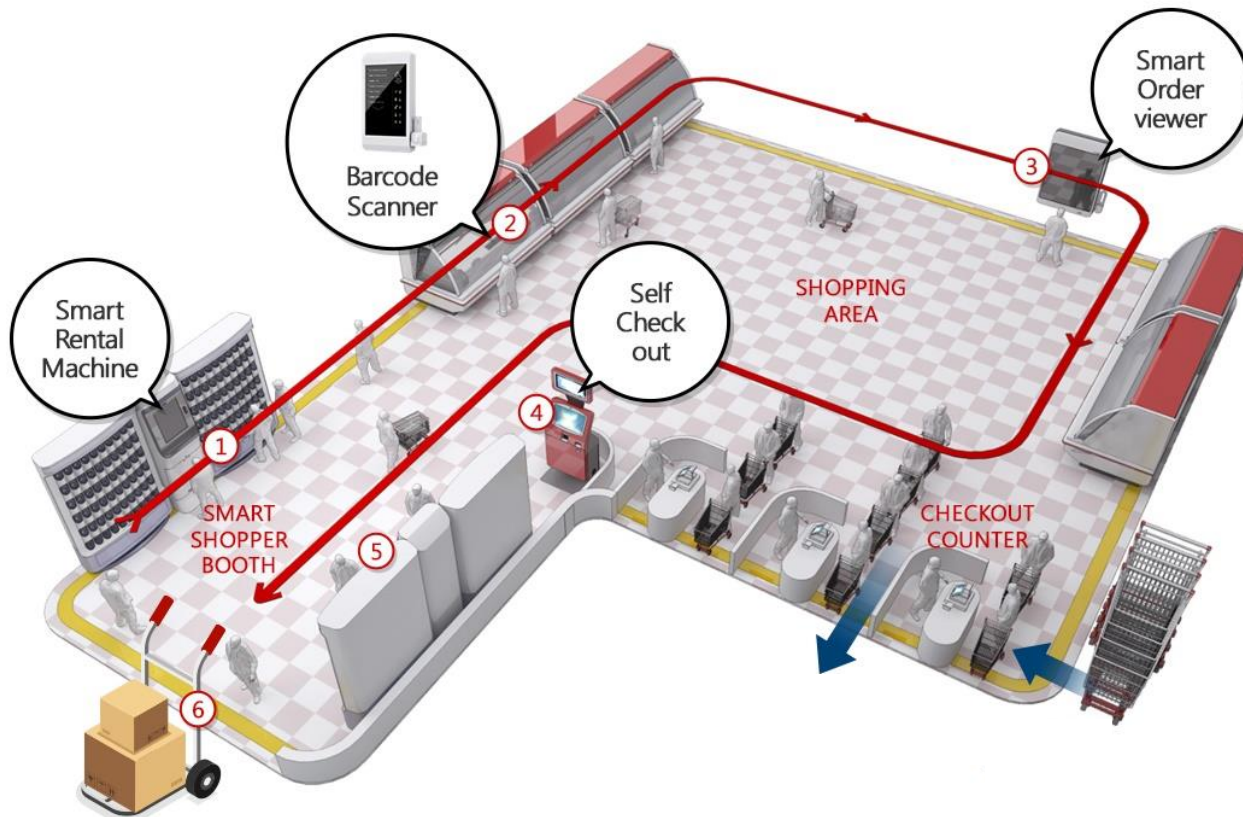


monitor and control

# IoT APPLICATIONS

## ■ Smart Shopping

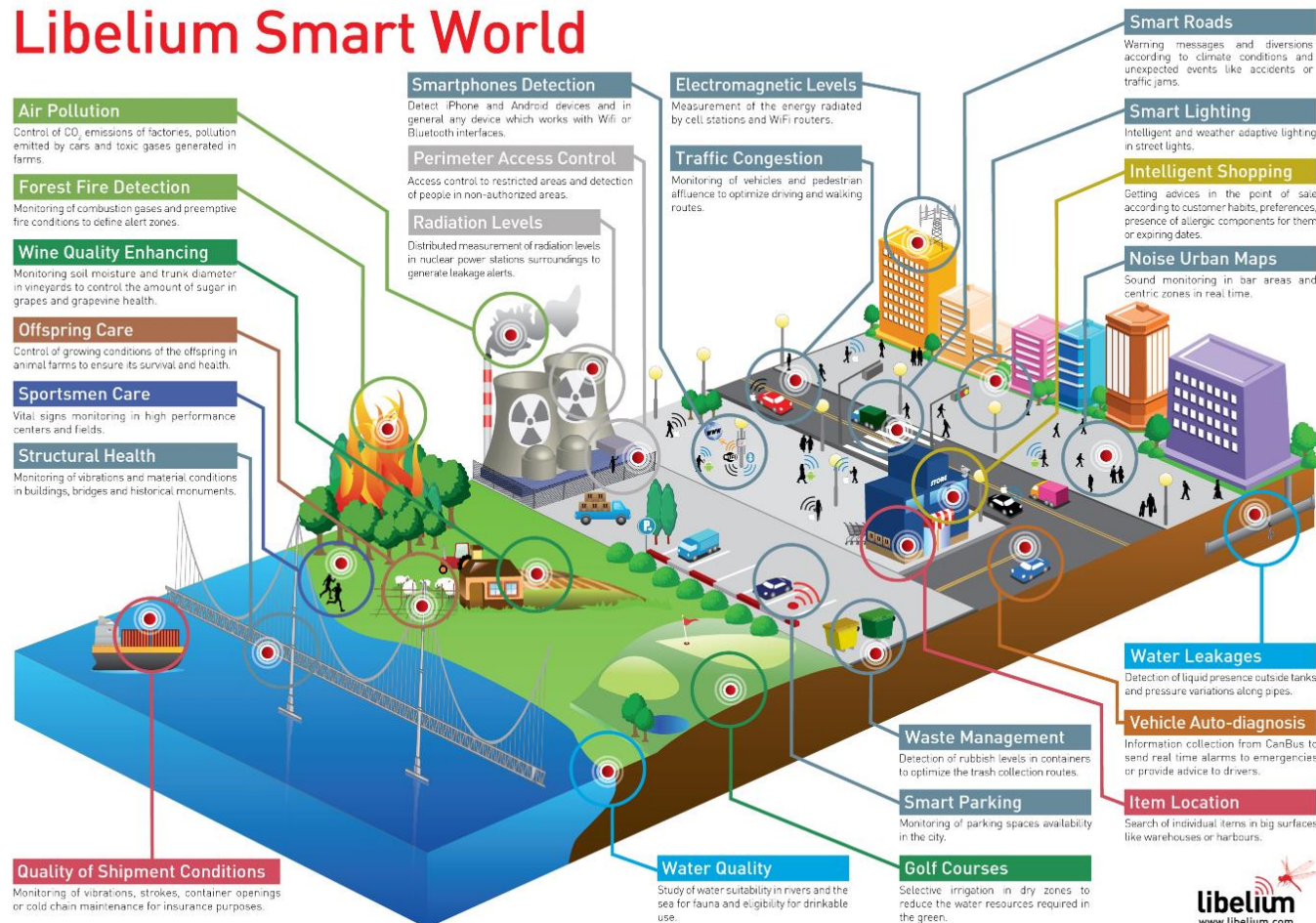
- Scanners identify the tags on goods
- Payment is made automatically using a registered card



# IoT APPLICATIONS

## Smart World

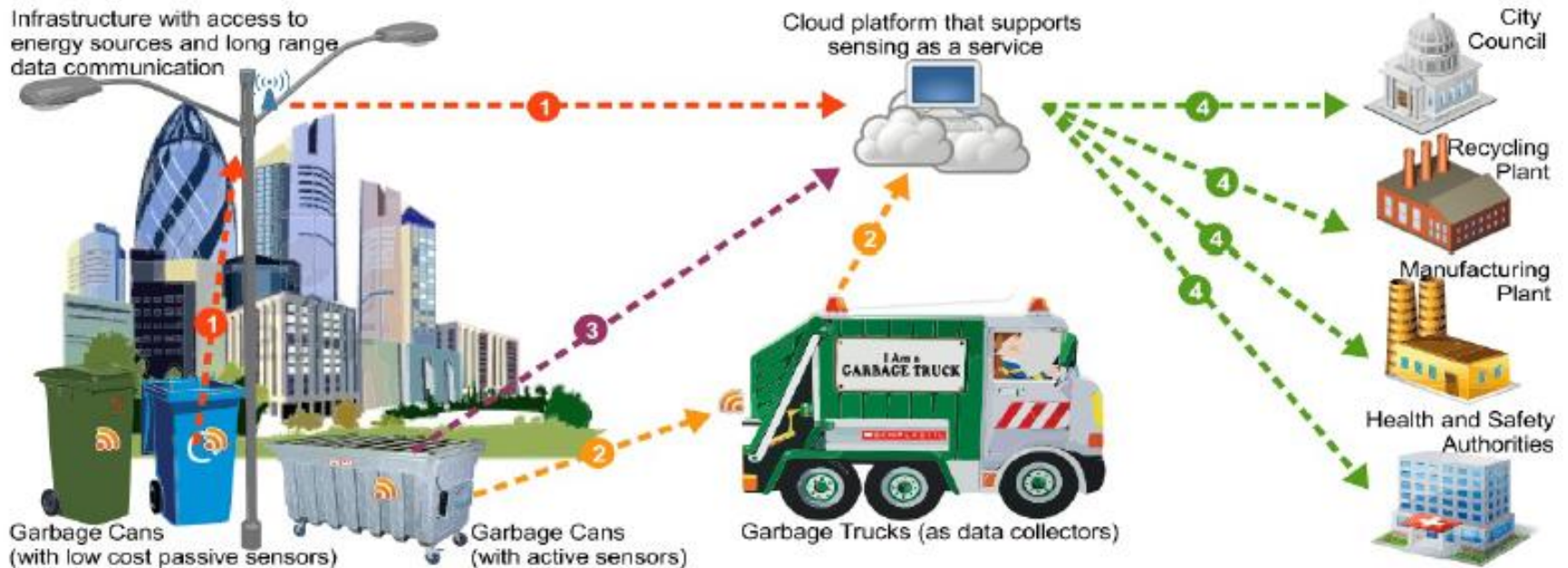
### Libelium Smart World





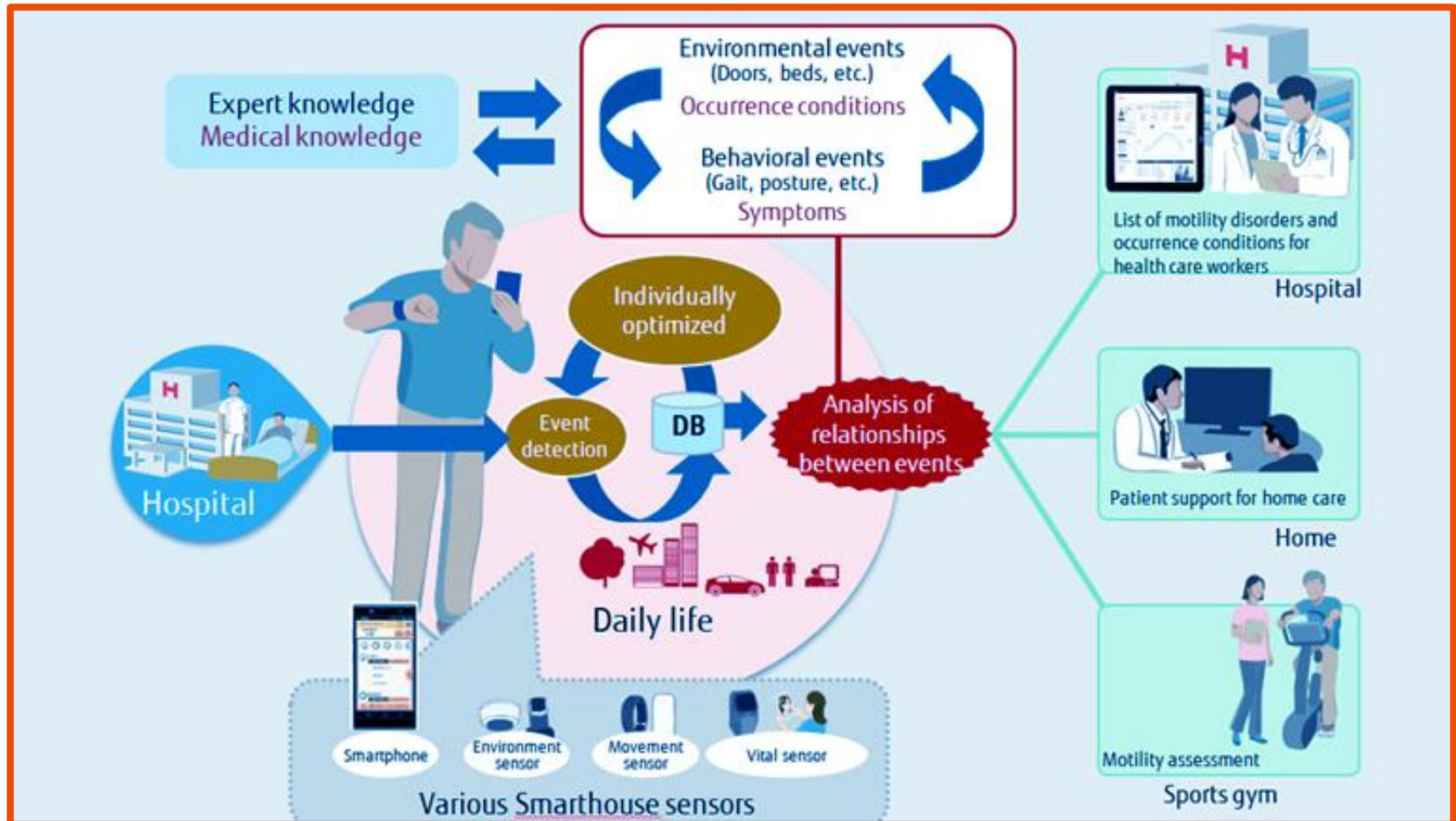
# IoT APPLICATIONS

## Efficient Waste Management in Smart Cities Supported by the Sensing-as-a-Service



# IoT APPLICATIONS

## ■ Healthcare: Care



<https://data-flair.training/blogs/iot-applications-in-healthcare/>

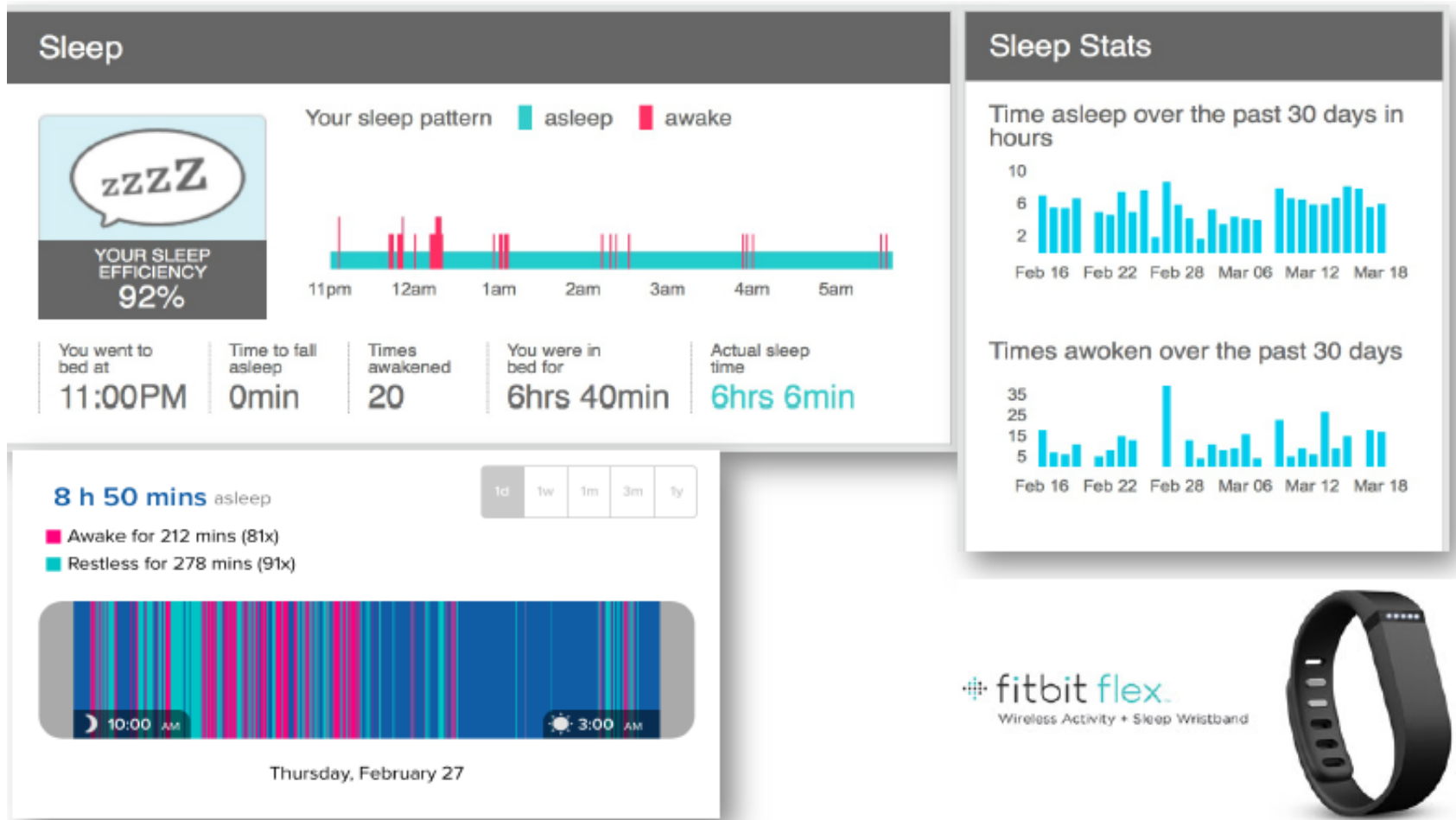
## ■ Healthcare: Medical Information Distribution





# IoT APPLICATIONS

## ■ How Well Do I Sleep?



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

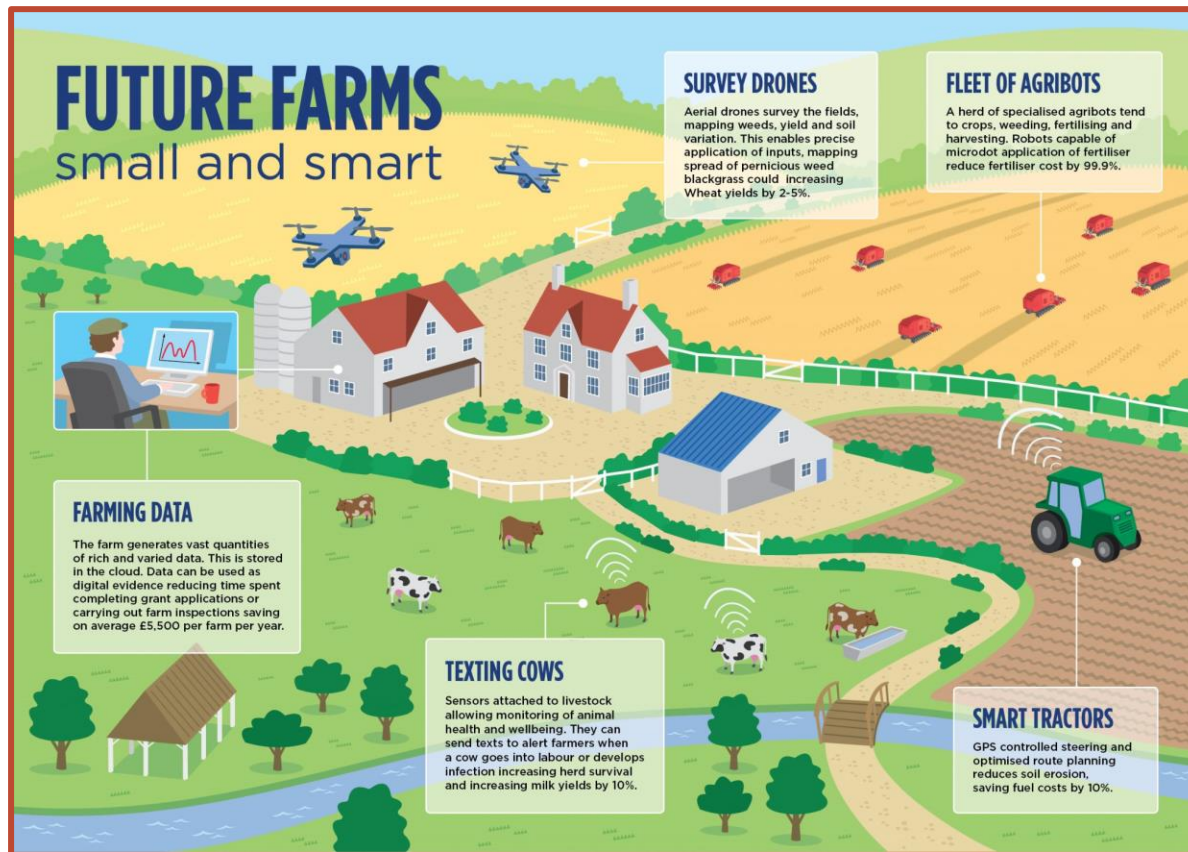
fitbit flex.  
Wireless Activity + Sleep Wristband



# IoT APPLICATIONS

## ■ Smart Farming

- Monitoring data collection using many sensors
- Using autonomous drones and smart tractors

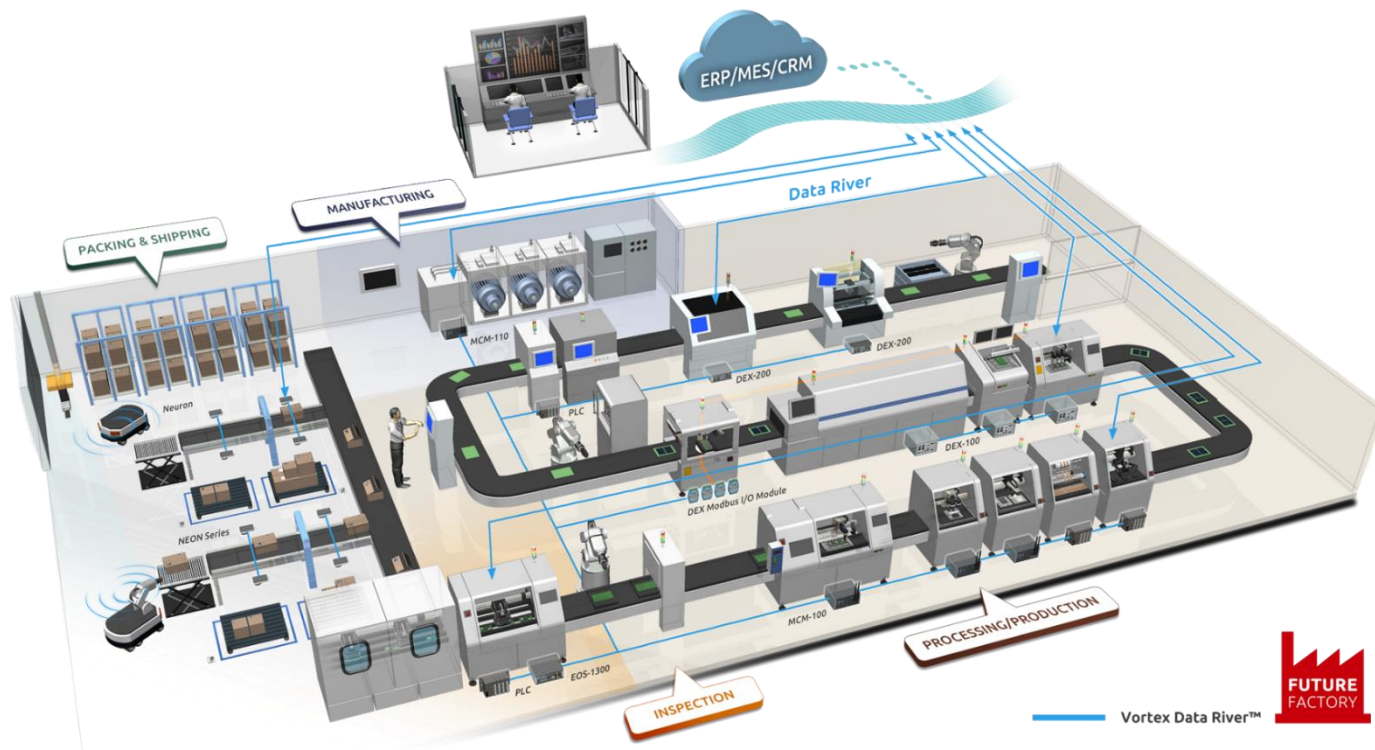


<https://www.nesta.org.uk/blog/precision-agriculture-almost-20-increase-in-income-possible-from-smart-farming/>

# IoT APPLICATIONS

## ■ Smart Factory

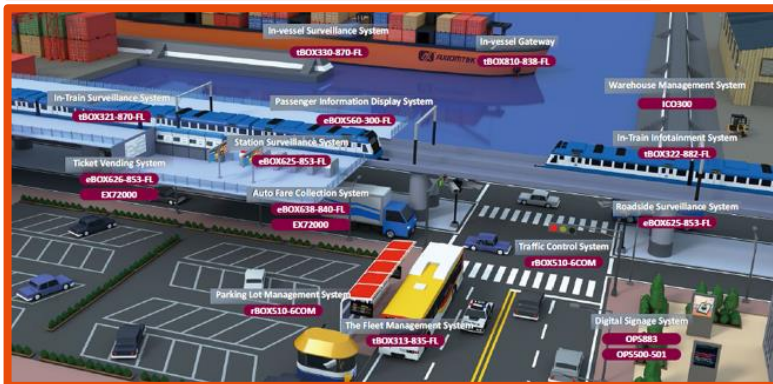
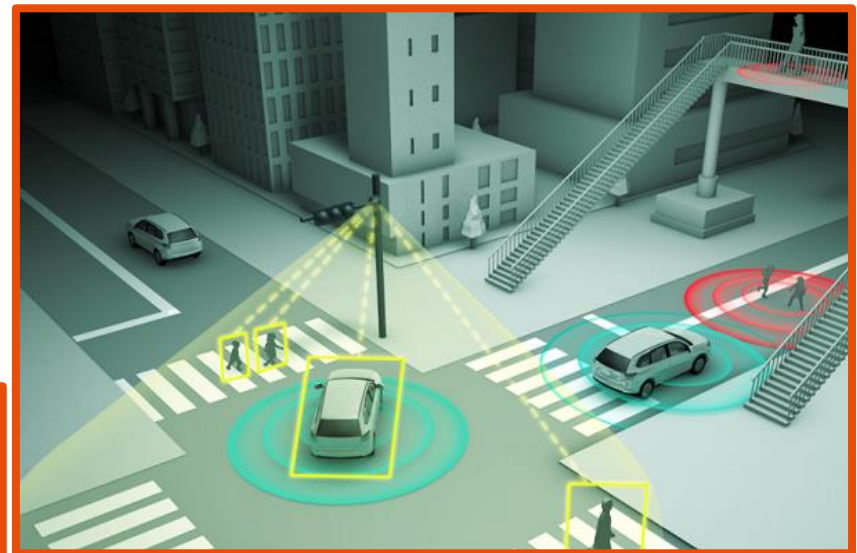
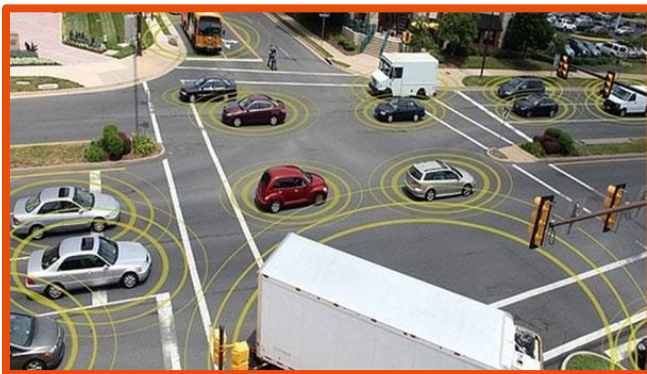
- Real-time inspection
- Manufacturing Robots
- Production process optimization



# IoT APPLICATIONS

## ■ Intelligent Transportation Systems (ITSs)

- Safety: Each vehicle sends its information to other vehicles
- Traffic Information: avoid congested route





# IoT APPLICATIONS

## ■ Smart Parking

### Smart Parking

Create **USD 41 Billion** by providing visibility into the availability of parking spaces across the city.



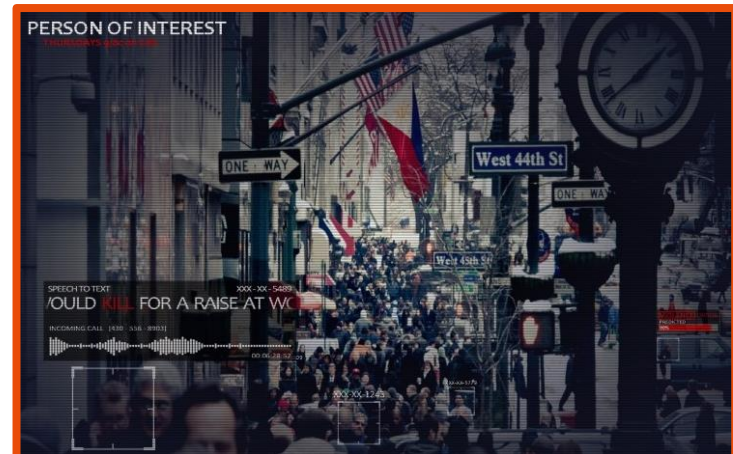
Residents can identify and reserve the closest available space, traffic wardens can identify non-compliant usage, and municipalities can introduce demand-based pricing.

[Source: <http://www.telecomreseller.com/2014/01/11/cisco-study-says-ice-can-create-savings/>]

# IoT APPLICATIONS

## ■ Security System

- Monitor people by using CCTV or various sensors



*Drama: Person of interest*

# DRIVING FORCES OF IoT

1. **Sensor Technology**
2. **Cheap Mini Computers**
3. **Low Power Connectivity**
4. **Capable Mobile Devices**
5. **Power of the Cloud**

# DRIVING FORCES OF IoT

## ■ Specific issues pertaining IoT nodes

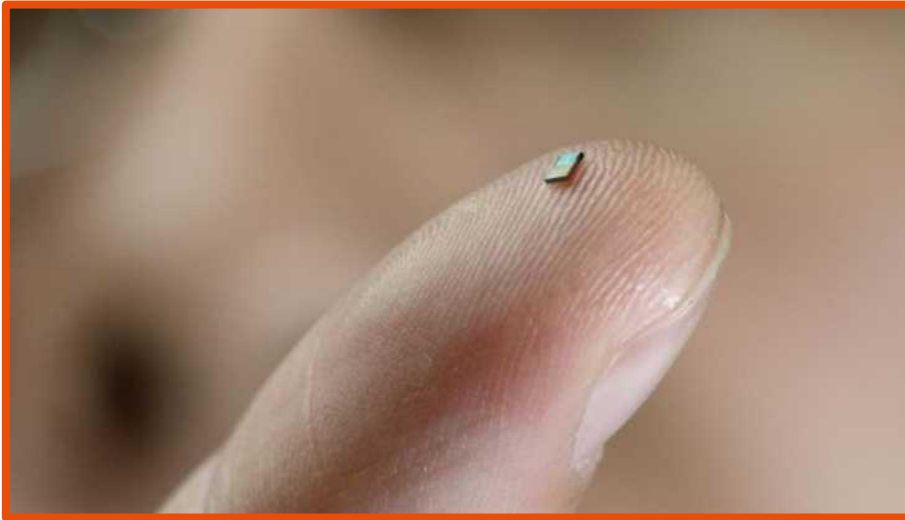
- Limited processing power
- Battery operated
  - Low power, sleeping capabilities highly desirable
- Robust, deployable in harsh environment
- Weatherproof
- Easy to configure
- Inexpensive, deployable in great numbers



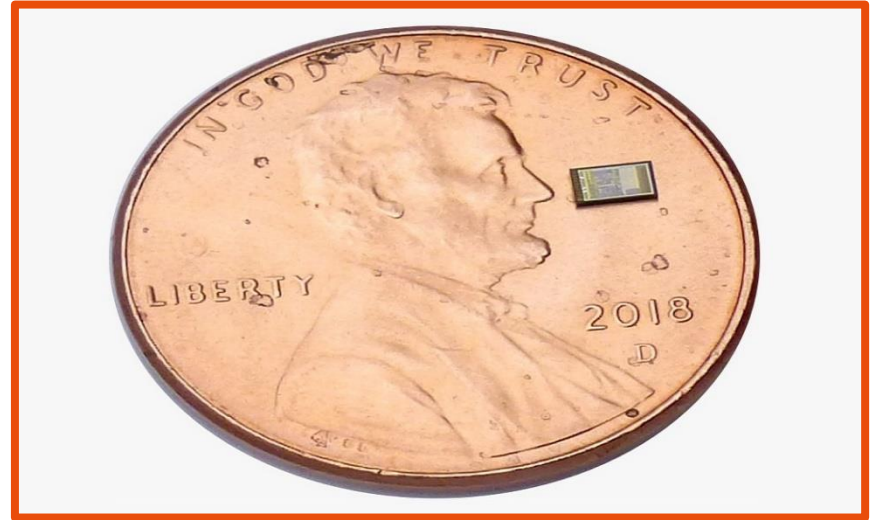
# DRIVING FORCES OF IoT

## ■ Sensor Technology

- Cheap, tiny, and powerful sensors
- Mount more sensors cheaply on an IoT device.



Temperature sensor  
(AdHawk Microsystems)

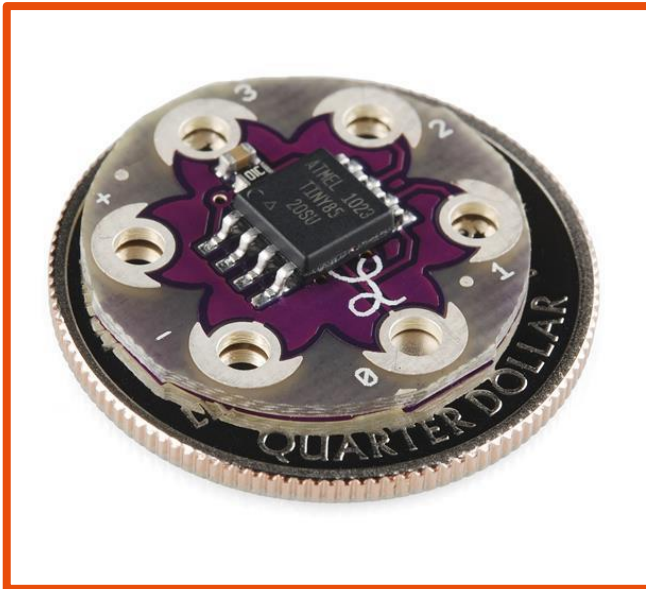


Touch sensor  
(UltraSense Systems)

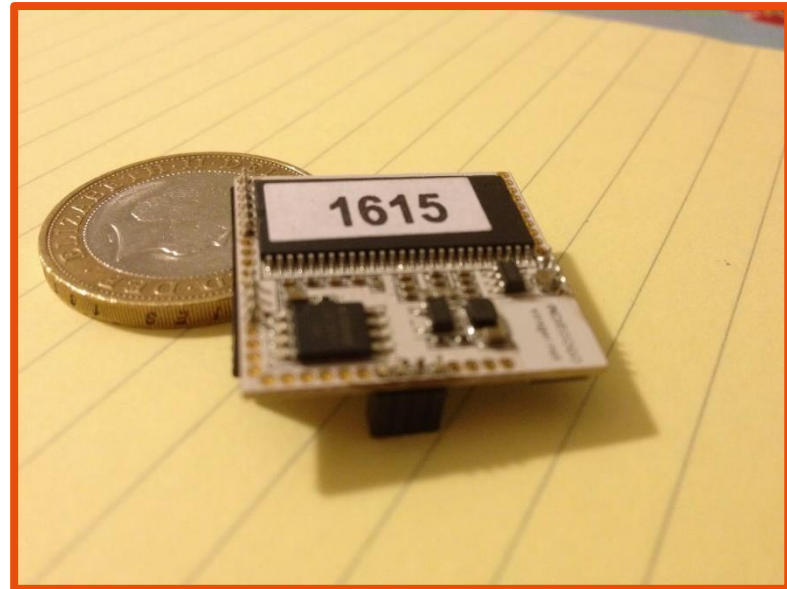
# DRIVING FORCES OF IoT

## ■ Cheap and Small Computers

- Can be used to operate tiny sensors
- IoT devices can be made cheaper and smaller



LilyTiny

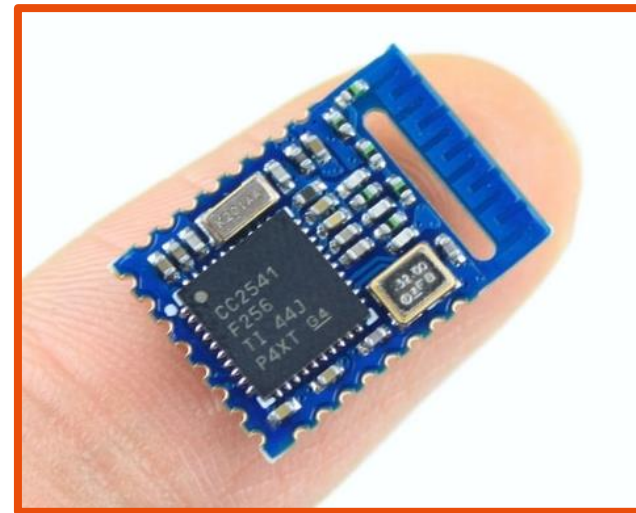


VoCore

# DRIVING FORCES OF IoT

## ■ Low Power Wireless Communication

- Up to 2 years with a single coin-cell battery



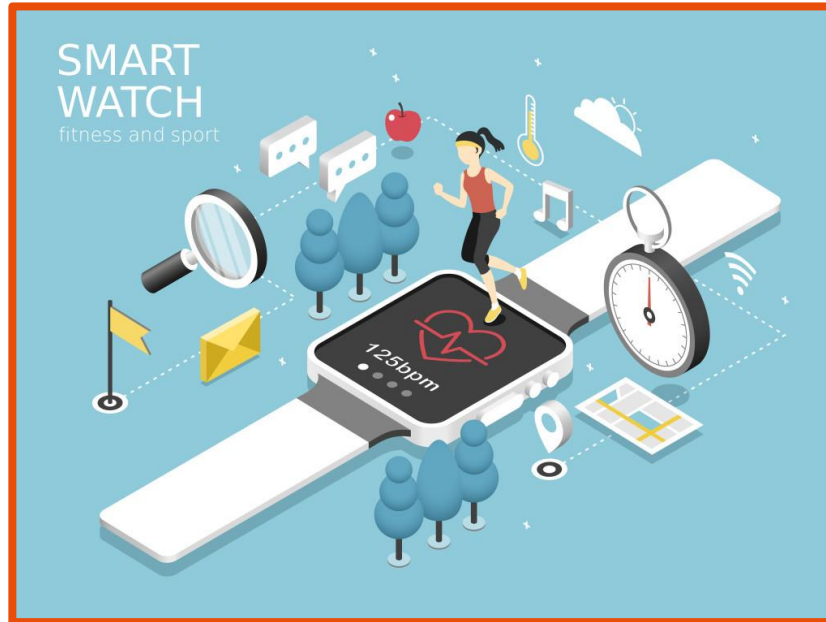
BLE 4.0 TI CC2541 BLE M1



# DRIVING FORCES OF IoT

## ■ Capable Mobile Device

- Everyone has mobile devices
- Connect to the Internet from anywhere



# DRIVING FORCES OF IoT

## ■ Power of the Cloud

- Can always use computer resources (storage, computing power, etc)
- Easy to create an IoT service



# DRIVING FORCES OF IoT

- IoT Cloud Platforms
  - Google Cloud Internet of Things
  - Azure Internet of Things
  - Amazon Web Services (AWS)



# CHALLENGES OF IoT

## ■ Challenges

- Privacy and security
- Scalability
- Technological standardization
- Inter operability
- Software complexity
- Data volumes and interpretation
- Power supply
- Interaction and short-range communication
- Fault tolerance

# ADVANTAGES AND DISADVANTAGES OF IoT

## ■ Advantages

- Ability to access information from anywhere at any time
- Improved communication between devices
- Transferring data over a network saving time and money
- Automating tasks helping to improve the quality of a business's services and reducing the need for human intervention



# ADVANTAGES AND DISADVANTAGES OF IoT

## ■ Disadvantages

- More connected devices, more information is shared
  - A hacker could steal confidential information also increases
- Enterprises may eventually have to deal with massive numbers of IoT devices (maybe even millions)
  - Collecting and managing the data from all those devices will be challenging
- If there's a bug in the system, it's likely that every connected device will become corrupted
- Since there's no international standard of compatibility for IoT, it's difficult for devices from different manufacturers to communicate with each other.

# CONCLUSIONS

## ■ Future of IoT

*"IoT is growing rapidly"*

*"Billions of cheap and small devices  
will provide real-time insights"*

*"IoT will become Invisible and ubiquitous"*

***"Preparing for the New Wave: The IoT Era"***