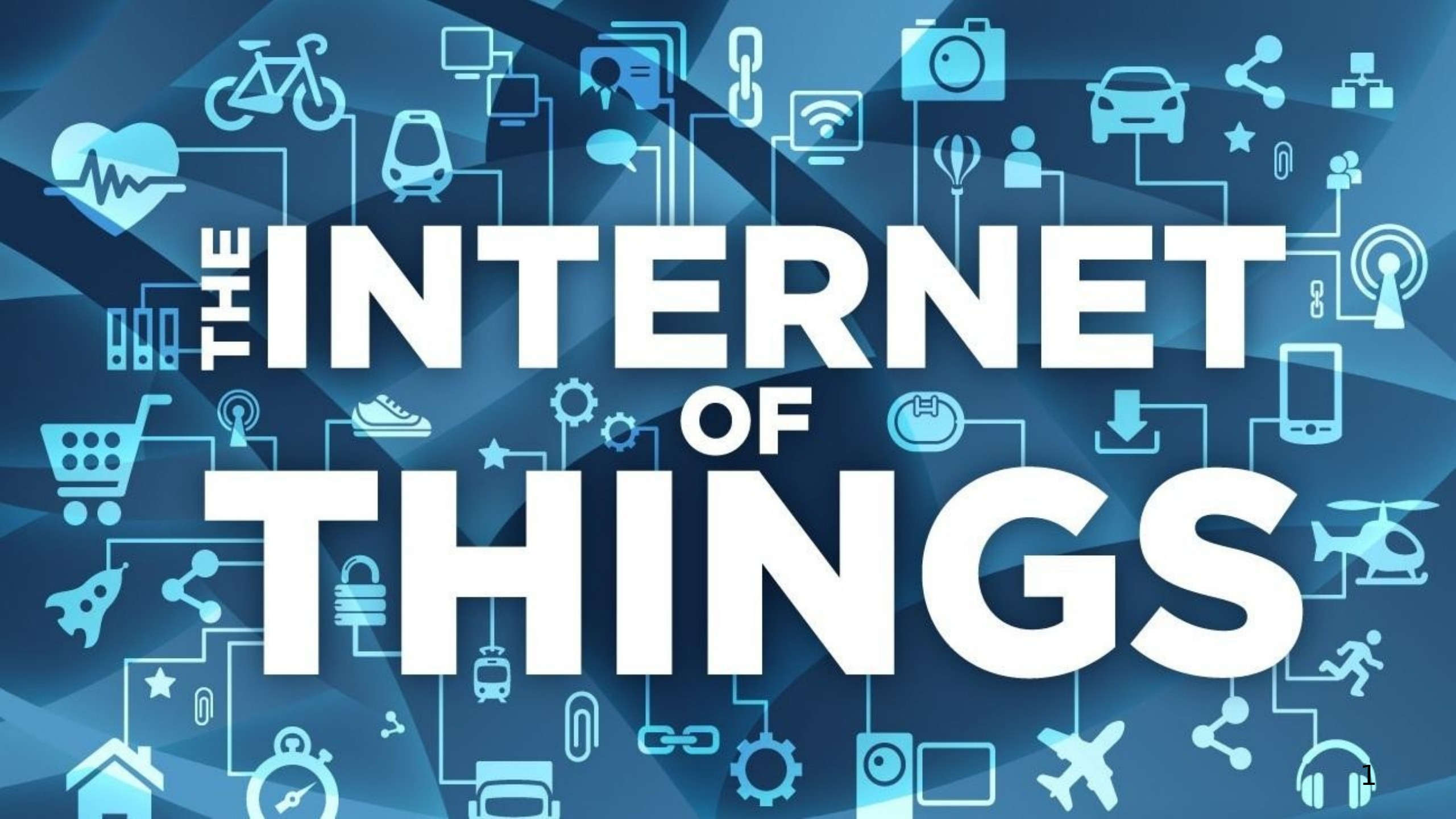

THE INTERNET OF THINGS



What is IoT?

The internet of things, or 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-

What is IoT

- The Internet of Things (IoT) is the network of physical objects or "things" embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data.
- IoT allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration between the physical world and computer-based systems, and resulting in improved efficiency, accuracy and economic benefit.
- Universal inter-networking.
- CISCO'S IoT REVISION
  - In 2008 the number of things connected to the Internet was greater than the people living on Earth.
  - Within 2020 the number of things connected to the Internet will be about 50 billion.

- Connecting everything embedded with electronic, software, and sensor to the internet enabling them to collect and exchange data
- The term Internet of Things (IoT) according to the 2020 conceptual framework is expressed through a simple formula such as:

IoT= Services+ Data+ Networks + Sensors

IoT

- **“Things**" in the IoT, can refer to devices that are embedded with internet connectivity, sensors and other hardware that allow communication and control via the web.
- These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices
- Why do we need IoT:
  - Expanding the interdependency of humans
    - To interact , contribute, and collaborate to things

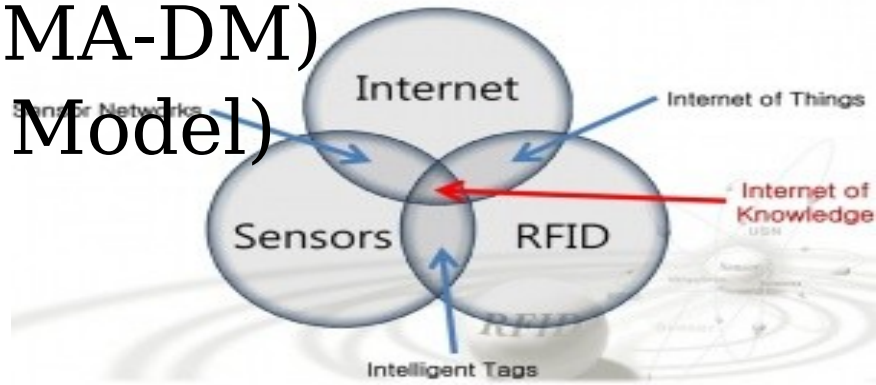
Features

- **Connectivity** : connect various things to the IoT platforms
- **Sensors** : IoT loses its distinction without sensors. They act as defining instruments that transform IoT from a standard passive network of devices into an active system capable of real-world integration.
- **Active Engagement** : IoT introduces a new paradigm for active content, product, or service engagement.
- **Small Devices** : Devices, as predicted, have become smaller, cheaper, and more powerful over time. IoT exploits purpose-built small devices to deliver its precision, scalability, and versatility.
- **Artificial Intelligence:** IoT makes things “smart”, meaning it enhances every aspect of life with the power of data collection, artificial intelligence algorithms, and networks. E.g. refrigerator detect when milk run low, and to then place an order from grocer.
- **Analyze**: Analyze the data collected and use it to build business

What are IoT protocols?



- protocols of **IoT** are
  - Infrastructure (ex: 6LowPAN, IPv4/IPv6, RPL)
  - Identification (ex: EPC, uCode, IPv6, URIs)
  - Comms / Transport (ex: Wifi, Bluetooth, LPWAN)
  - Discovery (ex: Physical Web, mDNS, DNS-SD)
  - Data Protocols (ex: MQTT, CoAP, AMQP, Websocket, Node)
  - Device Management (ex: TR-069, OMA-DM)
  - Semantic (ex: JSON-LD, Web Thing Model)



How does it work?

- An IoT ecosystem consists of
  - Web-enabled smart devices that collect, send and act on data they acquire from their surrounding environments using embedded sensors, processors and communication hardware.
  - Data is either sent to the cloud to be analyzed or analyzed locally.
  - These devices communicate with other related devices and act on the information they get from one another.
- Gather data from objects through sensors, and control them through actuators.
- The devices do most of the work without human intervention, although people can interact with the devices

The Structure of IoT

- The IoT can be viewed as a gigantic network consisting of networks of devices and computers connected through a series of intermediate technologies where numerous technologies like RFIDs, wireless connections may act as enablers of this connectivity.
  - **Tagging Things** : Real-time item traceability and addressability by RFIDs.
  - **Feeling Things** : Sensors act as primary devices to collect data from the environment
  - **Shrinking Things** : Miniaturization and Nanotechnology has provoked the ability of smaller things to interact and connect within the “things” or “smart devices.”
  - **Thinking Things** : Embedded intelligence in devices through sensors has formed the network connection to the Internet. It can make the “things” realizing the intelligent control.

Advantages of IoT

- **Improved Customer Engagement** (Communication): IoT system increases and encourages machine to machine communication (also known as M2M).
- **Enhanced Data Collection**: Sense and collect data from connected devices, and then share that data across the internet where it can be processed and utilized for various purposes and decisions.
- Real-time information.
- Development of AI through IoT
- Analyze Data Better. The IoT will generate massive amounts of data
- Increase Profitability: Reduced Waste, and Save time
- Minimize human effort,
- Technology Optimization: efficient resource utilization

IoT – Disadvantages

- Some of the disadvantages of IoT
  - hacker could steal confidential information
  - 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
  - Enterprises may eventually have to deal with massive numbers maybe even millions of IoT devices and collecting and managing the data from all those devices will be challenging

History of IoT

- Communication
  - Telegraph (the first landline) was developed in the 1830s and 1840s.
  - “wireless telegraphy,” the first radio voice transmission took place on June 3, 1900,
- The development of computers began in the 1950s
- Internet
  - Started out as part of DARPA (Defense Advanced Research Projects Agency) in 1962 and evolved into ARPANET in 1969
  - In the 1980s, commercial service providers began supporting public use of ARPANET
- Global Positioning Satellites (GPS) became a reality in early 1993, with the Department of Defense providing a stable, highly functional system of 24 satellites.

History of IoT

- The Internet of Things, as a concept, wasn’t officially named until 1999 Kevin Ashton the Executive Director of Auto-ID Labs at MIT,
- Kevin Ashton stated that Radio Frequency Identification (RFID) was a prerequisite for the Internet of Things
- He concluded if all devices were “tagged,” computers could manage, track, and inventory them.

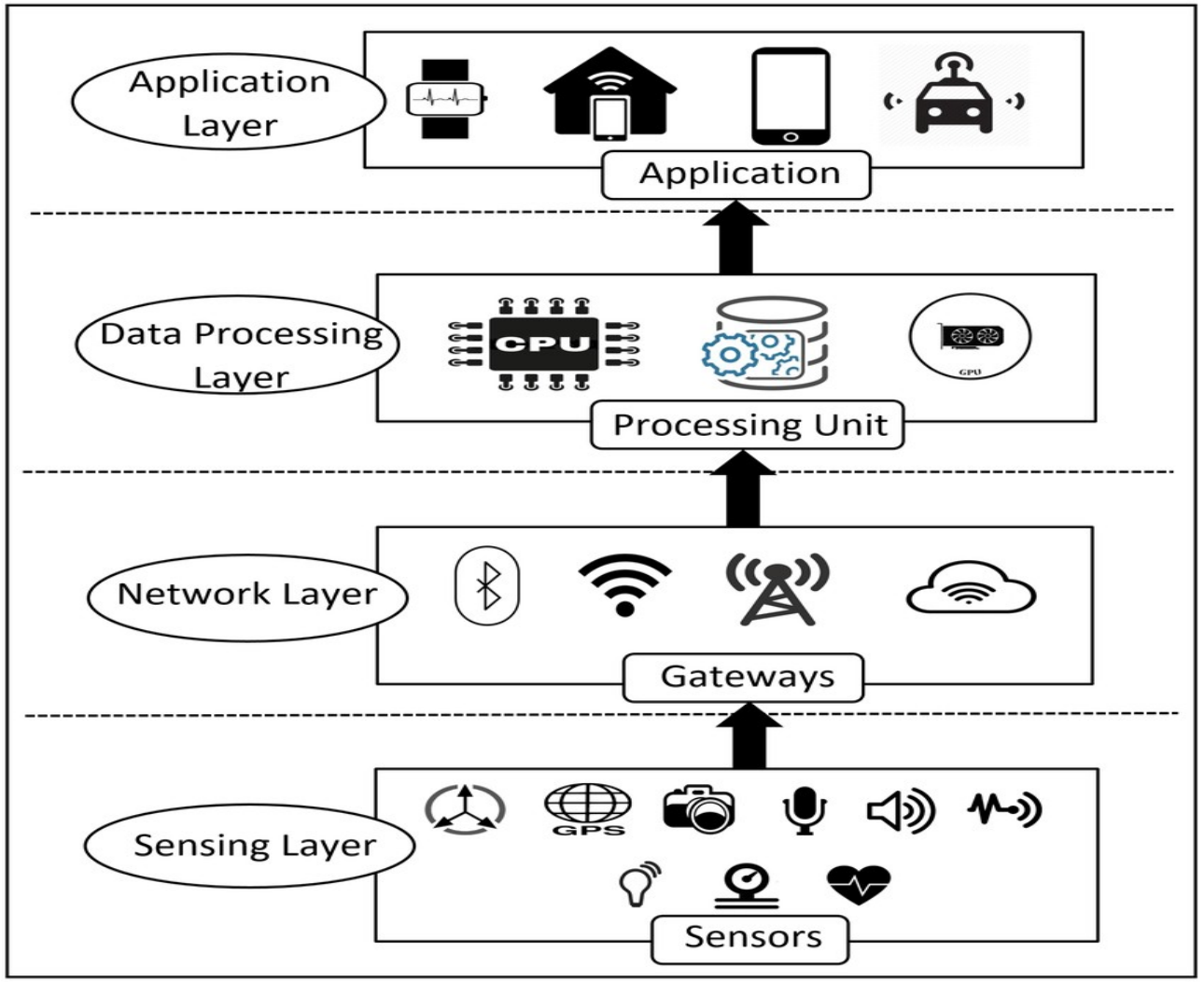
History of IoT

- To some extent, the tagging of things has been achieved through technologies such as digital watermarking, barcodes, and QR codes. Inventory control is one of the more obvious advantages of the Internet of Things.
- Coca Cola
  - Local programmers would connect by the Internet to the refrigerated appliance, and check to see if there was a drink available and if it was cold, before making the trip
- 2013
  - IoT evolved into a system using multiple technologies
    - Internet to wireless communication and from micro-electromechanical systems (MEMS) to embedded systems
    - wireless sensor networks, GPS, control systems, and others

Challenges/issues of IoT

- Major issues IoT face are in the following area:
  - Security , Privacy, Complexity ,Flexibility, Compliance, Autonomy and Control, Social control, Political manipulation, Design, Environmental impact, Influences human moral decision making

Architecture of IoT



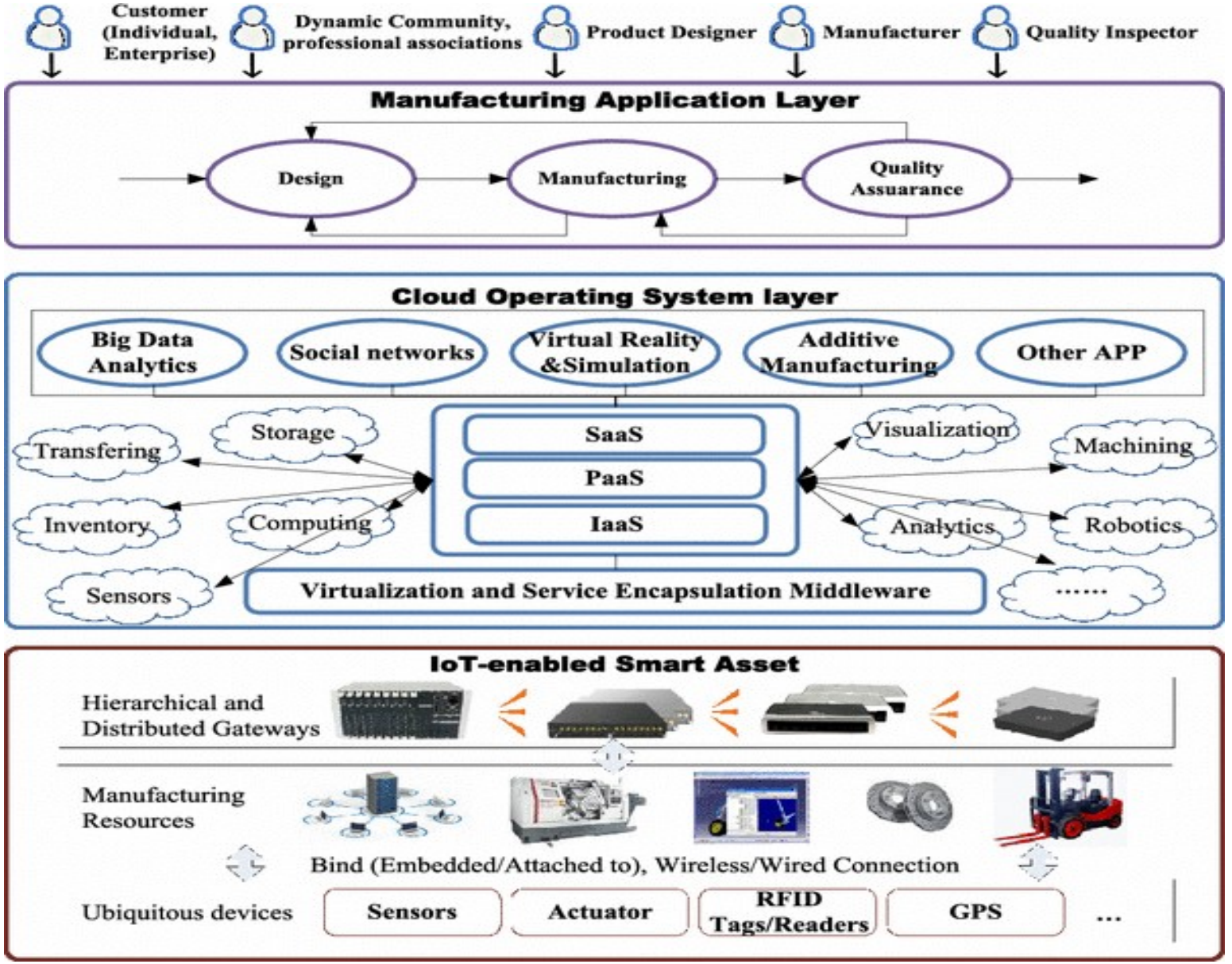
Sensing layer: sensor senses or gather data about the environment, and can be classified into three broad categories as described below:

- Motion Sensors
- Environmental Sensors
- Position sensors

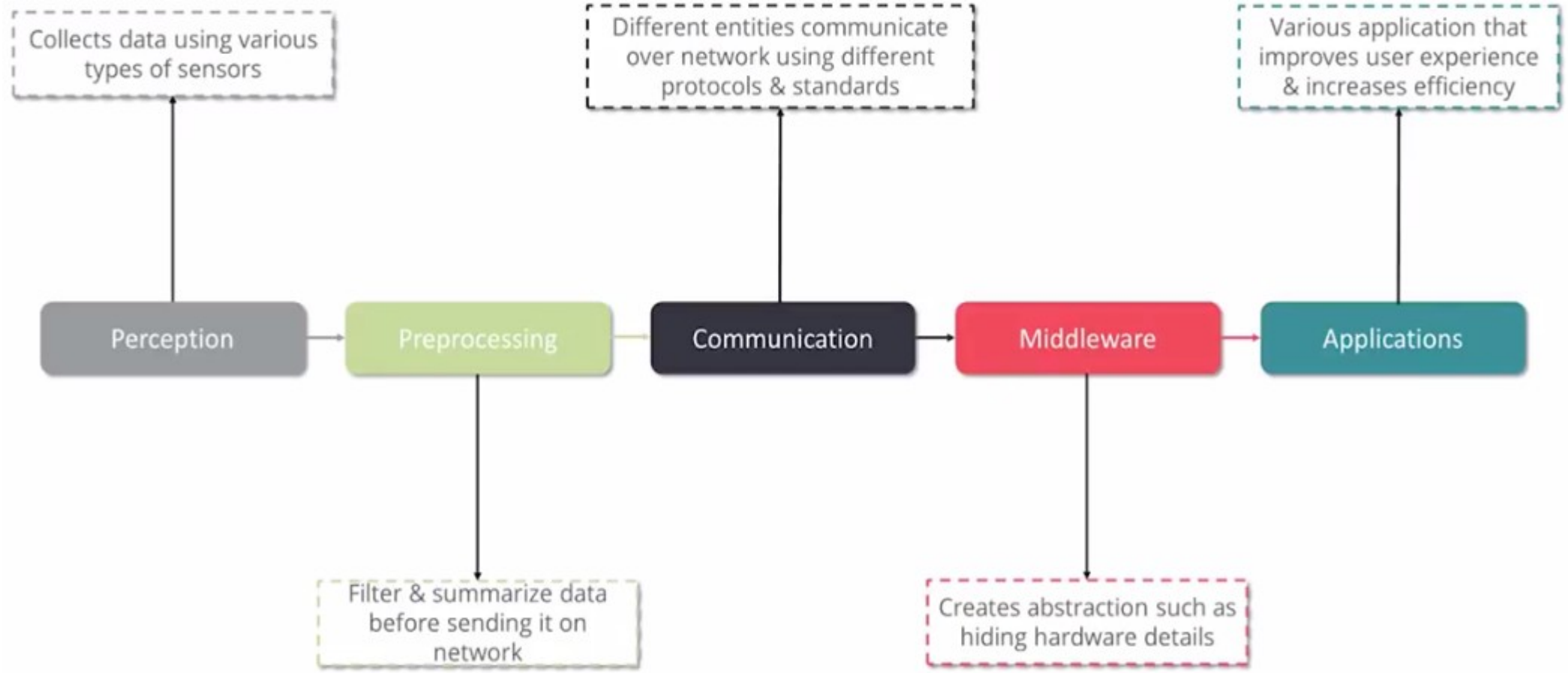
Network Layer: for data transmissions by layers : Wi-Fi, Bluetooth, Zigbee, Z-Wave, LoRa, cellular network, etc.) to allow data flow between other devices within the same network

Architecture of IoT

- Data Processing Layer: process information or decision unit
  - Stores, analyzes, and processes collected data form the sensing layer to make decisions based on the result
    - E.g. smartwatch, smart home hub, etc.), the data processing layer also saves the result of the previous analysis to improve the user experience.
- Application Layer -
  - The application layer is a user-centric layer that executes various tasks for the users.
  - Responsible for delivering application specific services to the user
    - E.g smart transportation, smart home, personal care, healthcare etc


Customer (Individual, Enterprise)
Dynamic Community, professional associations
Product Designer
Manufacturer
Quality Inspector
Manufacturing Application Layer
Design
Manufacturing
Quality Assuarance
Cloud Operating System layer
Big Data Analytics
Social networks
Virtual Reality &Simulation
Additive Manufacturing
Other APP
Storage
Transfering
Inventory
Computing
Sensors
SaaS
PaaS
IaaS
Visualization
Machining
Analytics
Robotics
.....
Virtualization and Service Encapsulation Middleware
IoT-enabled Smart Asset
Hierarchical and Distributed Gateways
Manufacturing Resources
Bind (Embedded/Attached to), Wireless/Wired Connection
Ubiquitous devices
Sensors
Actuator
RFID Tags/Readers
GPS
...

IoT Taxonomy



Devices and Networks

- IoT devices can be categorized into three main groups:
  - Consumer,
    - Smart TVs, smart speakers, toys, wearables, smart air conditioning, smart thermostats, smart lighting, and smart security,
  - Enterprise: enables physical 'things' with embedded computing devices (tiny computers) to participate in business processes for reducing manual work and increasing overall business efficiency.
    - connected security systems, thermostats, cars, electronic appliances, lights in household and commercial environments, alarm clocks, speaker systems, vending

Devices and Networks

- **Industrial** Internet of Things (IIoT) is a way to digital transformation in **manufacturing**. **Industrial IoT** employs a network of sensors to collect critical production data and uses cloud software to turn this data into valuable insights about the efficiency of the **manufacturing** operations
    - smart cities, smart industrial plants, Digitized Monitoring and Optimization of Trains, robotics, Intelligent logistics
- Indeed, it is necessary to take into account several elements such as scalability, interoperability, energy efficiency, topology control, Quality of Service (QoS), fault tolerance, and security

IoT Tools and Platforms

- There are many vendors in the industrial ***IoT platform*** marketplace, offering remarkably similar capabilities and methods of deployment.
- These IoT Platform Solutions are based on the Internet of Things and cloud technology.
- They can be used in areas of smart home, city, enterprise, home automation, healthcare or automotive, just to name a few.

IoT platform

- Given below are the top 10 IoT platforms for 2018 that you can use for building an app
  - Microsoft Azure IoT.
  - Amazon Web Services or AWS.
  - Google Cloud Platform.
  - ThingWorx.
  - Cisco IoT Cloud Connect.
  - HP's Universal of Things.
  - SAP Cloud Platform.
  - Oracle Internet of Things.

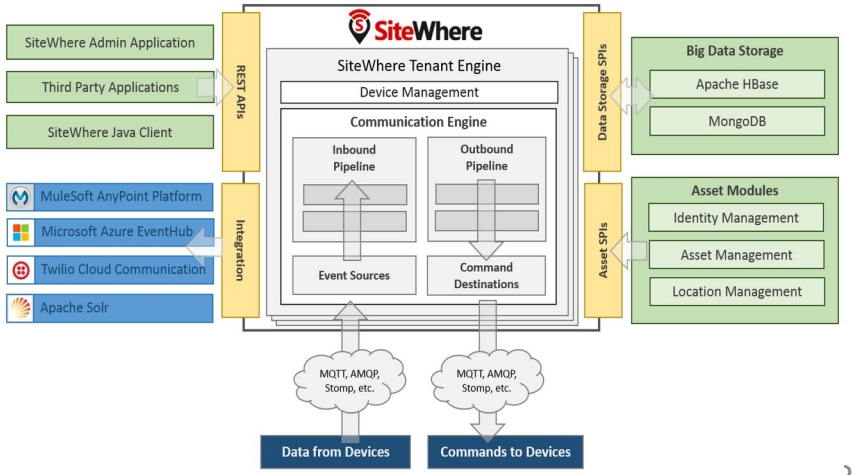
IoT Platform



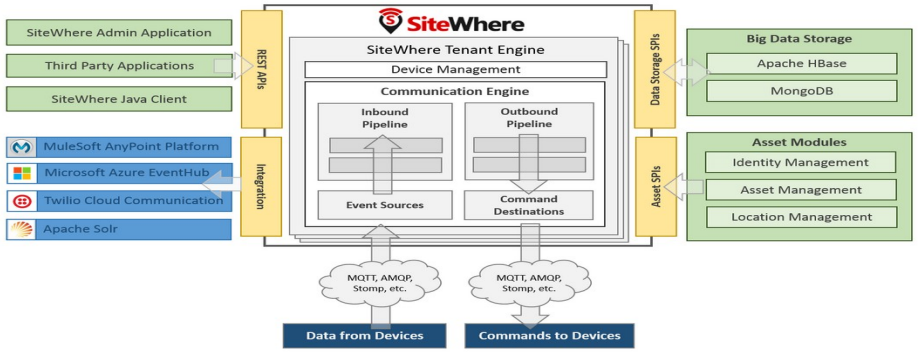
- KAA: **Kaa** is an enterprise-grade **IoT** platform that enables a broad range of cloud capabilities for your connected devices.
- Key features
  - Manage an unlimited number of connected devices
  - Set up cross-device interoperability
  - Perform real-time device monitoring
  - Perform remote device provisioning and configuration
  - Collect and analyze sensor data
  - Analyze user behavior and deliver targeted notifications
  - Create cloud services for smart products

IoT Platform

- SiteWhere
  - SiteWhere is an industrial strength open-source application enablement platform for the Internet of Things (IoT).
  - It provides a multi-tenant microservice-based infrastructure that includes device/asset management, data ingestio storage, and integration th scalable architecture.



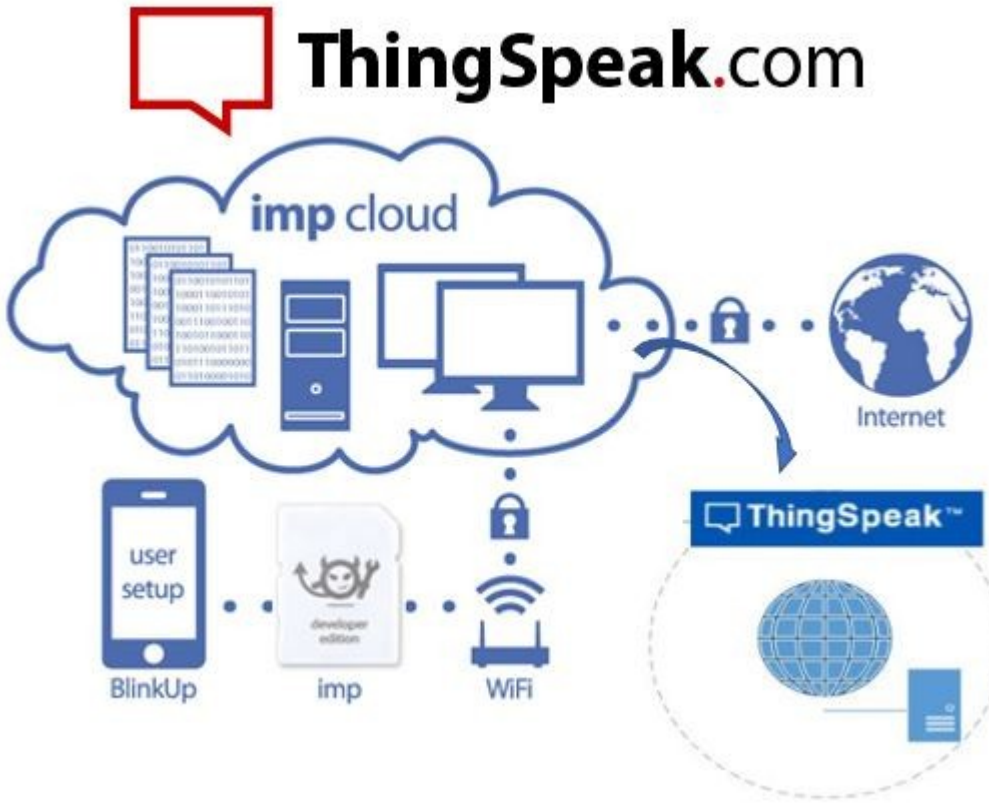
IoT Platform

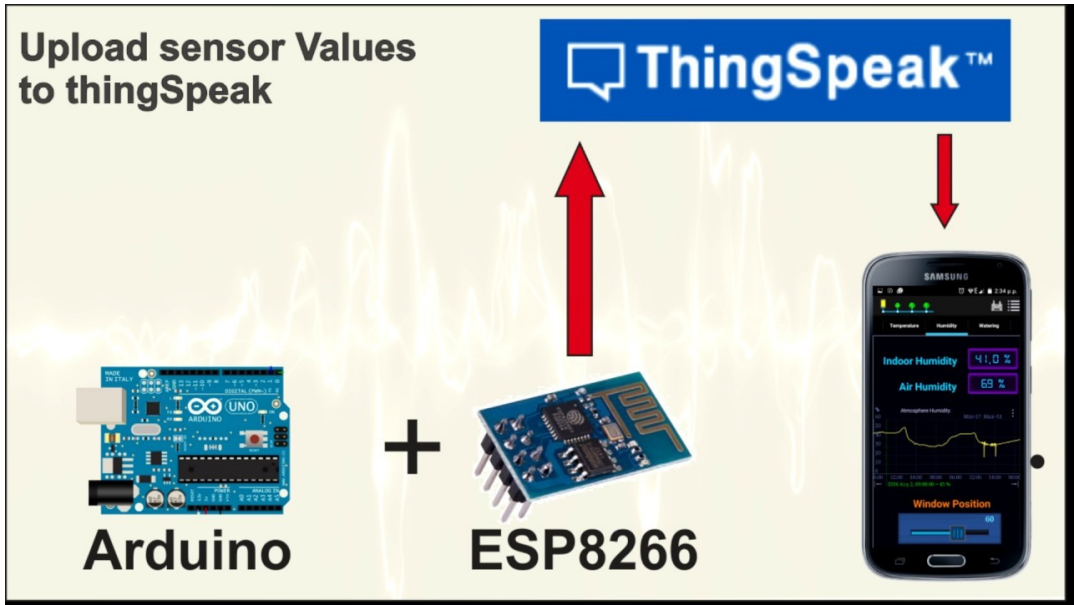


- Key features
  - Run any number of IoT applications on a single SiteWhere instance
  - Spring delivers the core configuration framework
  - Add devices through self-registration
  - Integrates with third-party integration frameworks such as Mule any point
  - Default database storage is MongoDB
  - Eclipse Californium for CoAP messaging
  - InfluxDB for event data storage
  - Grafana to visualize SiteWhere data

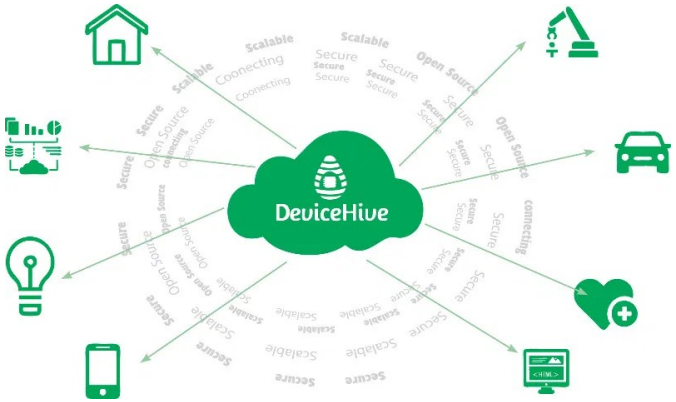
IoT Platform

- ThingSpeak
  - **ThingSpeak** is **an Internet of Things** (**IoT**) platform that lets you collect and store sensor data in the cloud and develop **IoT** applications. The **ThingSpeak™ IoT** platform provides apps that let you analyze and visualize your data in MATLAB®, and then act on the data.
- Key features
  - Collect data in private channels
  - Share data with public channels
  - MATLAB analytics and visualizations
  - Alerts
  - Event scheduling
  - App integrations
  - Worldwide community





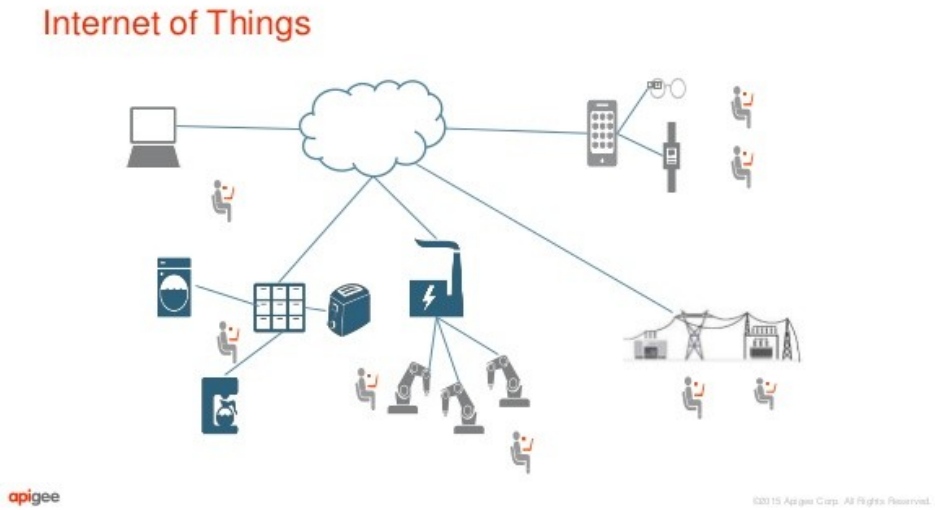
IoT Platform





- DeviceHive
  - DeviceHive is an open source platform which provides instruments for your smart devices communication and management.
- Key features
  - Directly integrate with Alexa
  - Visualization dashboard of your choice
  - It supports Big data solutions such as ElasticSearch, Apache Spark, Cassandra and Kafka for real-time and batch processing.
  - Connect any device
  - It comes with Apache Spark and Spark Streaming support.
  - Supports libraries written in various programming languages, including Android and iOS libraries
  - It allows running batch analytics and machine learning on top of your device data

IoT Platform



- Zetta
  - *Zetta* is an open source platform built on Node.js for creating Internet of Things servers that run across geo-distributed computers and the cloud
- Key features
  - Supports a wide range of hacker boards
  - Zetta allows you to assemble smartphone apps, device apps, and cloud apps

IoT Platform

- ThingsBoard
  - ThingsBoard is an open-source IoT platform for device management, data collection, processing and visualization for your IoT projects.
- Key features
  - Real-time data visualization and remote device control
  - Customizable rules, plugins, widgets and transport implementations
  - Allows monitoring client-side and provision server-side device attributes.
  - Support multi-tenant installations out-of-the-box.
  - Supports transport encryption for both MQTT and HTTP(s) protocols.

Web of Things

- To achieve IoT we need a universal protocol to combine several heterogeneous devices.
- This protocol should be: simple, lightweight, loosely-coupled, scalable, flexible and standard.
- Several technologies and protocols already available and widely accepted by the community:
  - HTTP, TCP, IPV6, XML, JSON, RSS, ATOM, REST, WS-*, URI, etc.
- URI to make the objects easily identifiable and addressable XML, WS-* and REST to allow the objects to expose their features and to communicate with external or centralized services

IoT Applications

- Consumer Use
- Agriculture
- Traffic monitoring
- Health care
- Insurance
- Security
- Transport and Logistics
- Utilities
- Retail
- Manufacturing

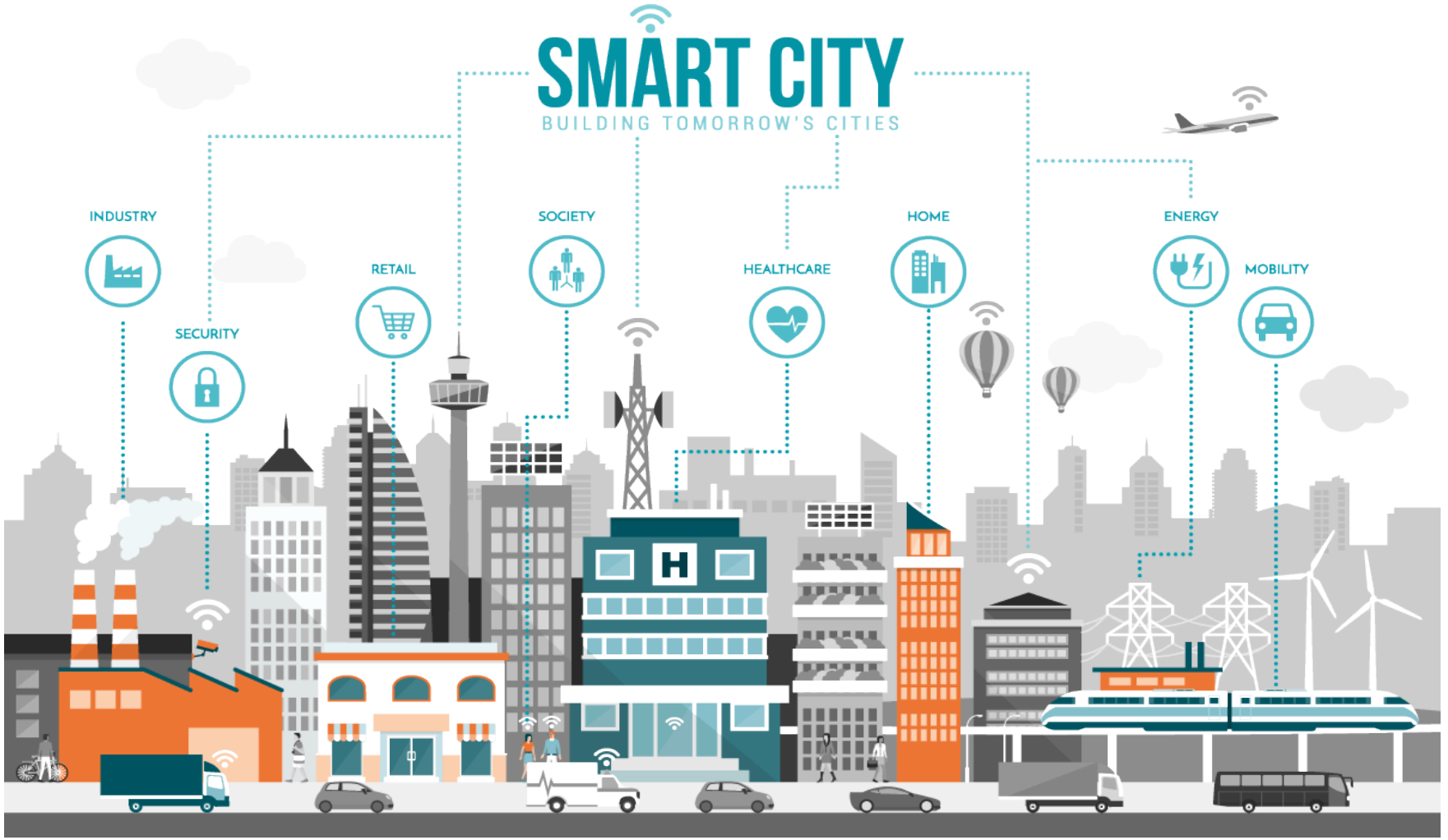
IoT Based Smart Home

- Smart Home initiative allows subscribers to remotely manage and monitor different home devices from anywhere via smartphones or over the web with no physical distance limitations
  - Safety Monitoring
  - Remote Control Appliances
  - Weather:
  - Smart Home Appliances
  - Intrusion Detection Systems
  - Energy and Water Use



IoT Based Smart City

- Smart cities use Internet of Things (IoT) devices such as connected sensors, lights, and meters to collect and analyze data. The cities then use this data to improve infrastructure, public utilities and services, and more.
  - Structural Health, Lightning
  - Safety, Transportation, Smart Parking
  - Waste Management, Compost:
  - Animal Farming/Tracking, Green Houses
  - Offspring Care, Field Monitoring


SMART CITY
BUILDING TOMORROW'S CITIES
INDUSTRY
SECURITY
RETAIL
SOCIETY
HEALTHCARE
HOME
ENERGY
MOBILITY
H

Other Example of Internet of Things



Medical Checkup



Medical Report

Health Sector



Operational Efficiency



Health Devices



Remote Home Contro

Smart Home



Automatic Parking



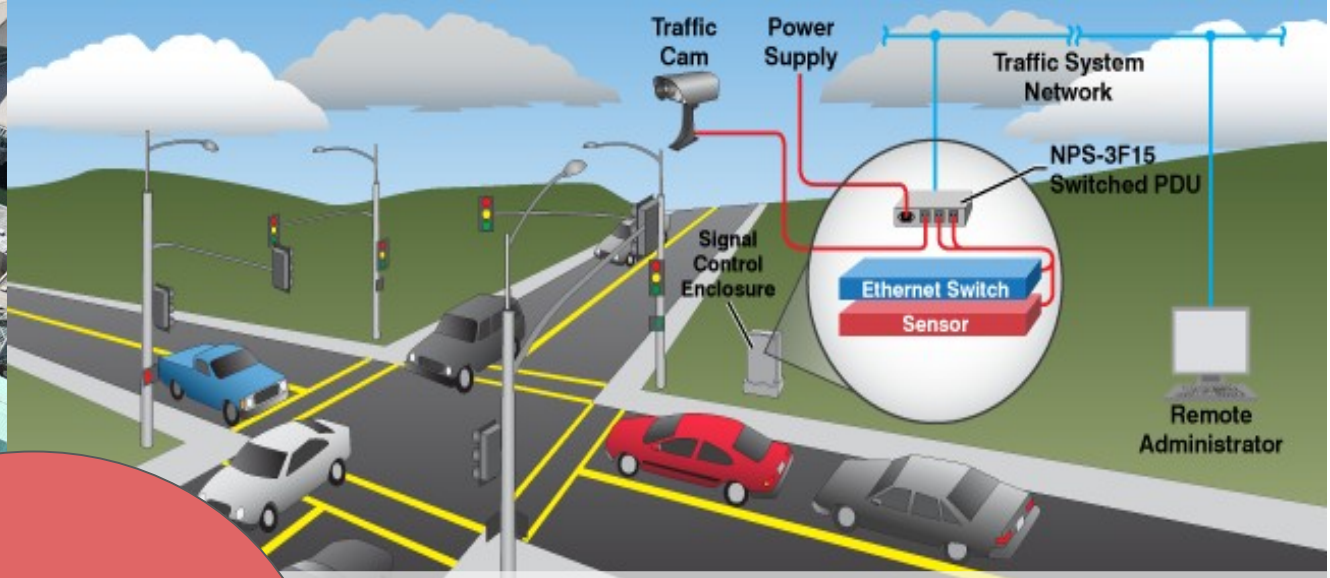
Security System



Advanced Kitchen



WiFi Connectivity



Traffic Control

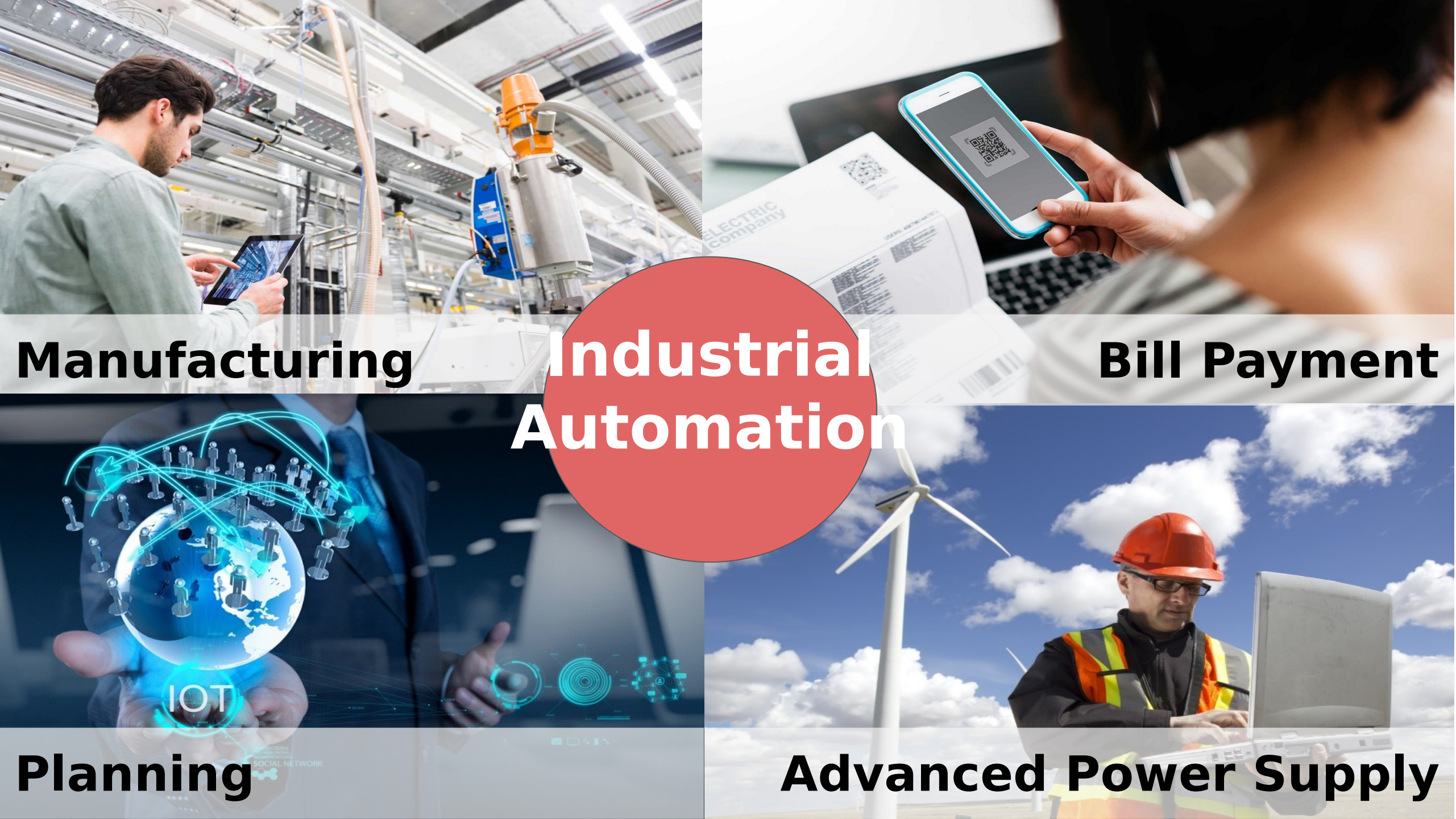
Smart City



Security System



Advanced Parking System


Industrial Automation
Manufacturing
Bill Payment
IOT
Planning
Advanced Power Supply

THANKS

End of chapter 4
Does anyone have any questions?