Instrumentation

Internet of Things (IoT)

Course Instructor: Mohammad Reza Nayeri

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What is IoT?

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.

Parts of IoT

THINGS WITH NETWORKED SENSORS
At rest
Active
DATA STORES
Data
Models/analyses
Text
Videos
Images
ANALYTIC ENGINES
Human/machine learning
Servers/cloud
Feedback and Control
Commands and requests
Iterate
Models/analyses

Application Layer
Application
Data Processing Layer
CPU
Processing Unit
Network Layer
Gateways
Sensing Layer
GPS
Sensors

IoT Market

Data as of March 2022
Global Spending on Enterprise IoT Technologies, in $B
600
500
400
300
200
100
0
115
129
158
194
240
295
361
437
525
+12%
+22%
+23%
+22%
4%
35%
36%
26%
2019a
2020a
2021a
2022f
2023f
2024f
2025f
2026f
2027f
IoT Security
IoT Hardware
IoT Services
IoT Software
Total
CAGR

Global IoT Market Share by Sub-Sector
26%
24%
20%
14%
7%
3%
4%
2%
Smart Cities
Industrial IoT
Connected Health
Smart Homes
Connected Cars
Wearables
Smart Utilities
Others
[Source: GrowthEnabler Analysis]

IoT Analytics – *Quantifying the connected world*

Applications	Overall popularity (and selected examples)	Scores [1]	[2]	[3]
1 Smart Home	Smart thermostat, Connected lights, Smart fridge, Smart doorlock — 100%	61k	3.3k	430
2 Wearables	Smart watch, Activity tracker, Smart glass — 63%	33k	2.0k	320
3 Smart City	Smart parking, Smart waste mgmt — 34%	41k	0.5k	80
4 Smart grid	Smart metering — 28%	41k	0.1k	60
5 Industrial internet	Remote asset control — 25%	10k	1.7k	30
6 Connected car	Remote car control — 19%	5k	1.2k	50
7 Connected Health	6%	2k	0.5k	5
8 Smart retail	2%	1k	0.2k	1
9 Smart supply chain	2%	0k	0.2k	0
10 Smart farming	1%	1k	0.0k	1

1. Monthly worldwide Google searches for the application 2. Monthly Tweets containing the application name and #IOT 3. Monthly LinkedIn Posts that include the application name. All metrics valid for Q4/2014.
Sources: Google, Twitter, LinkedIn, IoT Analytics

Billions of IoT Devices
80
70
60
50
40
30
20
10
0
8.98
11.25
14.38
15.41
17.68
20.35
23.14
26.66
30.73
35.82
42.62
51.11
62.12
75.44
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025

Communication Networks

Communication Networks

Zigbee

NRF

WIFI

Bluetooth

Low Power Wide Area Network

Long Range

Low Power

Low Data Rate

LPWAN is becoming popular day-by-day

Different LPWANs

SIGFOX
One network A billion dreams

LoRa™

RAK8211-NB Front

RAK8211-NB Back

Long Range (LoRa)

9 miles

50 kbps

10 years

LoRa

MULTITECH
MultiConnect Conduit
Access Point
Internet
LORIOT
Ethernet
LoRa
LoRa Gateway
LoRa Node

IoT NetWorks

Smart Cities

- **Smart Parking**

Monitoring of parking spaces availability in the city.

Smart Cities

- **Structural health**
  Monitoring of vibrations and material conditions in buildings, bridges and historical monuments.

Smart Cities

- **Noise Urban Maps**

  Sound monitoring in bar areas and centric zones in real time.

Smart Cities

- **Smartphone Detection**
  Detect iPhone and Android devices and in general any device which works with WiFi or Bluetooth interfaces.

Smart Cities

- **Traffic Congestion**
  Monitoring of vehicles and pedestrian levels to optimize driving and walking routes..

Smart Cities

- **Smart Lighting**
  Intelligent and weather adaptive lighting in street lights.

Smart Cities

- **Waste Management**
  Detection of rubbish levels in containers to optimize the trash collection routes.

Smart Cities

- **Smart Roads**
  Intelligent Highways with warning messages and diversions according to climate conditions and unexpected events like accidents or traffic jams.

Smart Environment

- **Forest Fire Detection**

  Monitoring of combustion gases and preemptive fire conditions to define alert zones.

Smart Environment

- **Air Pollution**

  Control of CO2 emissions of factories, pollution emitted by cars and toxic gases generated in farms.

Smart Environment

- **Snow Level Monitoring**
  Snow level measurement to know in real time the quality of ski tracks and allow security corps avalanche prevention.

Smart Metering

- **Smart Grid**
  Energy consumption monitoring and management.

Smart Metering

- **Tank level**
  Monitoring of water, oil and gas levels in storage tanks and cisterns.

Smart Metering

- **Silos Stock Calculation**
  Measurement of emptiness level and weight of the goods.

Retail

- **Supply Chain Control**
  Monitoring of storage conditions along the supply chain and product tracking for traceability purposes.

Retail

- **NFC Payment**
  Payment processing based in location or activity duration for public transport, gyms, theme parks, etc.

Retail

- **Intelligent Shopping Applications**
  Getting advices in the point of sale according to customer habits, preferences, presence of allergic components for them or expiring dates.

Smart Animal Farming and Animal Tracking

- **Animal Tracking**
  Location and identification of animals grazing in open pastures or location in big stables.

This allows farmers to monitor cows' health and track their movements, ensuring a healthier, more plentiful supply of milk and meat for people to consume. On average, each cow generates about 200 MB of information per year.

Smart Animal Farming and Animal Tracking

- **Animal Tracking**
  Location and identification of animals

Smart Agriculture

- **Green Houses**

  Control micro-climate conditions to maximize the production of fruits and vegetables and its quality.

Smart Agriculture

- **Meteorological Station Network**
  Study of weather conditions in fields to forecast ice formation, rain, drought, snow or wind changes.

Home Automation

- **Energy and Water Use**
  Energy and water supply consumption monitoring to obtain advice on how to save cost and resources.

Home Automation

- **Remote Control Appliances**
  Switching on and off remotely appliances to avoid accidents and save energy.

Home Automation

- **Intrusion Detection Systems**
  Detection of windows and doors openings and violations to prevent intruders.

eHealth

- **Wearable Health care**

eHealth

- **Fall Detection**
  Assistance for elderly or disabled people living independent.

eHealth

- **Sportsmen Care**
  Vital signs monitoring in high performance centers and fields.

eHealth

- **Patients Surveillance**
  Monitoring of conditions of patients inside hospitals and in old people's home.

eHealth

- **Ultraviolet Radiation**

  Measurement of UV sun rays to warn people not to be exposed in certain hours.

Industrial Control

Alibaba Cloud partners with Siemens to foster industrial IoT in China

Industrial Control

- **M2M Applications**
  Machine auto-diagnosis and assets control.

Industrial Control

- **Indoor Air Quality**
  Monitoring of toxic gas and oxygen levels inside chemical plants to ensure workers and goods safety.

Temperature, Humidity, CO2 - SigFox, WIFI, 3G sensor. On Sector

Temperature, Humidity, CO2 - LoRaWAN sensor, on battery

Industrial Control

- **Indoor Location**
  Asset indoor location by using active (ZigBee/Beacon) and passive tags (RFID/NFC).

Industrial Control

- **Vehicle Auto-diagnosis**
  Information collection from CanBus to send real time alarms to emergencies or provide advice to drivers.

Thought Controlled Computing

The flagship product, MindWave, is a headset that can log into your computer using just your thoughts. Researchers recently used the EEG headset to develop a toy car that can be driven forward with thought.

NeuroSky's smart sensors can also track your heart rate and other bodily metrics and can be embedded in the next generation of wearable devices.

"We make it possible for millions of consumers to capture and quantify critical health and wellness data," Yang (CEO of Softbank) said. Softbank is the funder.

[Source: http://venturebeat.com/2013/11/04/next-step-for-wearables-neurosky-brings-its-smart-sensors-to-health-fitness/]

ambuseri@utsa.edu