Chapter

Introductory Chapter: Internet of Things

Fausto Pedro García Márquez

1. Overview of Internet of Things

Internet of Things (IoT) can be understood as a closed loop system, where a set of sensors are connected by a network to servers. The data from sensors are stored in a database. The data is then analyzed by IoT analytics, where the results are usually employed to make decisions to the operation of the system [1]. The system must be seen as a general one that monitors by using any type of sensor, e.g., weather conditions, images, velocity, etc. [2]. The decision making can be done by human, but also by a machine, software, etc.

New data science techniques are appearing in the last few years to solve the complex and robust problems generated in IoT [3]. The volume, variety, velocity, complexity, etc. of the data obtained by IoT require of new approaches to solve the problems for decision making [4], where quality and computational cost are the main variables to evaluate them. Some examples to be addressed by IoT are maintenance management, optimization, planning, decision making, operations management/research, safety, security, etc., in fields as transport, energy, bank/finance, social science, media, marketing, etc., and, nowadays, the called Smart XX and e-XX, where XX can be any term, e.g., car, home, cities, industry, manufacturing, bank, agriculture, farm, environment, water, metering, health, etc.

Simulation methods are employed to determine the design of a future IoT system, therefore, an anticipated load generated by its sensors [2]. The results can be compared with the real ones, leading to get conclusions.

Statistics and Machine Learning are also extended methods applied to IoT analytics, e.g., multivariable linear regression, time series forecasting, dimensionality reduction, clustering, classification, artificial neural networks, support vector machines, and hidden Markov models [5]. These types of methods are being of great interest for the researchers, where they are working developing new ones, or hybrid based on the use of two or more different methods [6].

Performance evaluation and modeling can be considered as an operations research technique. They are employed mainly to study the computing facilities used in fog computing and high-layer server(s). On the other side, they are applied to the supporting IP network that provides connectivity between sensors, actuators, fog computing devices, and higher-layer servers. Finally, it can be utilized in sensors and actuators. The performance is usually employed to set the capacity of any IoT system, or in any of the layers. The performance is also considered for the computational time employed for the IoT, mainly jitter of the end-to-end response time and end-to-end response time. The performance is applied to working IoT, but it cannot be employed to design of IoT because of many parameters are unknown yet. In this case, it is employed a prototype or a model, being the first one the most expensive and the last one the most utilized.

The IoT system should be defined by a model, which is based on interconnected layers. Each layer is given by a functionality. Some examples of layers are: networking, IoT controllers and devices, data storage, fog computing, data abstraction, etc. The model is named reference model.

The advances are going very fast in all the layers, and now the governments and main responsibilities are working to develop laws and standards to guarantee the main rights for human, and also for the ethical issues. On the other side, the layers must have the required security from different point of views, e.g., communication, protocol, authentication, network, etc.

The reduction of power together to the transmission distance between the inter-devices are issued to cover and research in IoT. In this sense, ZIGBEE (has a defined rate of 250 kbit/s, best suited for intermittent data transmissions from a sensor or input device), Bluetooth (short-range wireless technology standard used for exchanging data between fixed and mobile devices over short distances using ultra high frequency radio waves in the industrial, scientific and medical (bands 2.402–2.48 GHz, and building personal area networks), Wireless Sensor Network (WSN), Radio Frequency Identification (RFID, reader and transmits digital data that contain identification and other information required), Wi-Fi (wireless network protocols, based on the IEEE 802.11 family of standards), Cellular networks, IPv6 over Low power Wireless Personal Area Networks (6LoWPAN), etc. are technologies that appear to solve it. On the other side, the demand of energy is rising. Efficient and low power consumption devices are being developed and employed, e.g., smart lighting systems are being utilized in cities to manage the public lighting, which is estimated to be about 10% of the overall energy consumed in a city, by using led, local control units that save the data in cloud and is then analyzed.

Other examples of IoT use are shown as follows: waste and garbage management; Smart homes domain; agriculture domain (e.g., sampling and mapping of soil, irrigation, fertilizer, crop disease and pest management, crop monitoring, forecasting and harvesting); Industrial Internet of Things (IIoT); Energy conservation (including smart grid, Energy Internet of Things (EIoT), Smart Metering (SM) and Advanced Metering Infrastructure); Healthcare (e.g., monitor patients distantly, Monitoring of Blood Glucose Level, Electrocardiogram Monitoring, Blood Pressure Monitoring, Body Temperature Monitoring, Monitoring of Blood Oxygen Saturation, Rehabilitation System, Wheelchair Management).

Author details

Fausto Pedro García Márquez
Ingenium Research Group, University of Castilla-La Mancha, Spain

*Address all correspondence to: faustopedro.garcia@uclm.es

References

[1] Kopetz, H. Internet of things. In *Real-time systems*, Springer: 2011; pp 307-323.

[2] Weber, R.H.; Weber, R. *Internet of things*. Springer: 2010; Vol. 12.

[3] Márquez, F.P.G.; Lev, B. *Data science and digital business*. Springer: 2019.

[4] Marugan, A.P.; Márquez, F.P.G. Decision-making management: A tutorial and applications. **2017**.

[5] Atzori, L.; Iera, A.; Morabito, G. The internet of things: A survey. Computer networks **2010**, *54*, 2787-2805.

[6] Márquez, F.P.G.; Lev, B. *Advanced business analytics*. Springer: 2015.