The Use of Internet of Things for Smart Cities

Jaime Lloret Mauri
Instituto de Investigación para la Gestión Integrada de Zonas Costeras, Universitat Politecnica de Valencia, Spain
jlloret@dcom.upv.es

Keywords: Internet of Things, Sensors, Smart Cities, Communication Protocols, Artificial Intelligence.

Abstract: This paper includes the information for the keynote speech of Jaime Lloret.

1 INTRODUCTION

Recent advances in new technologies jointly with the appearance of low cost sensors with computing and communication capacities have made possible to implement new systems to improve citizens daylife. Although the main constraints of Wireless Sensor Networks are the power consumption and the computing capacity (Sendra, 2011)(Azizi, 2016), their flexibility and adaptability make them very useful for any type of environment (Lloret, 2009)(Khaleeq, 2016). Data networks are evolving towards the transport of large amounts of information from sensor networks and the Internet of Things (IoT). Through IoT, we can monitor and control many sensors and devices, with the aim of collecting information and acting on them. IoT allows monitoring from everywhere at any time. Technological advances, the implementation of future fifth generation (5G) mobile networks and the reduction of manufacturing costs of IoT devices have boosted their use growth in a wide variety of applications.

In order to build smart city, it is required three basic components (see Figure 1):

- Sensors and (Wireless) Sensor Networks
- Communication Protocols and Algorithms
- Artificial Intelligence applied to Big Data

Figure 2 shows that sensors and internet of things gather data from urban environments, so network protocols, algorithms and architectures are required to provide the most updated data in a big database. The knowledge acquired by these sensors can be tackled in order to improve the electric consumption, the water wastage and even any type of lakes in gas, electricity or water. Big data and artificial intelligence techniques can be used to optimize the resources of the cities and improve their performance.

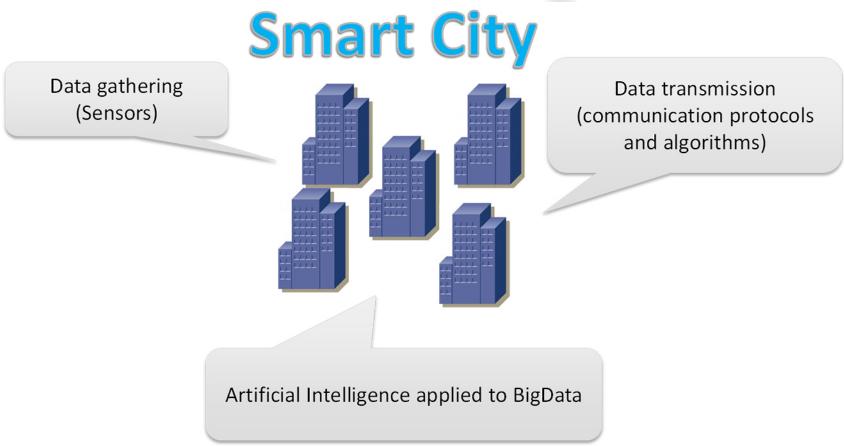

Figure 1: Basic IoT components to build a Smart City.

Lloret Mauri J.
The Use of Internet of Things for Smart Cities.
DOI: 10.5220/0007239600000000
In *Proceedings of the 8th International Joint Conference on Pervasive and Embedded Computing and Communication Systems (PECCS 2018)*, pages 15-18
ISBN: 978-989-758-322-3

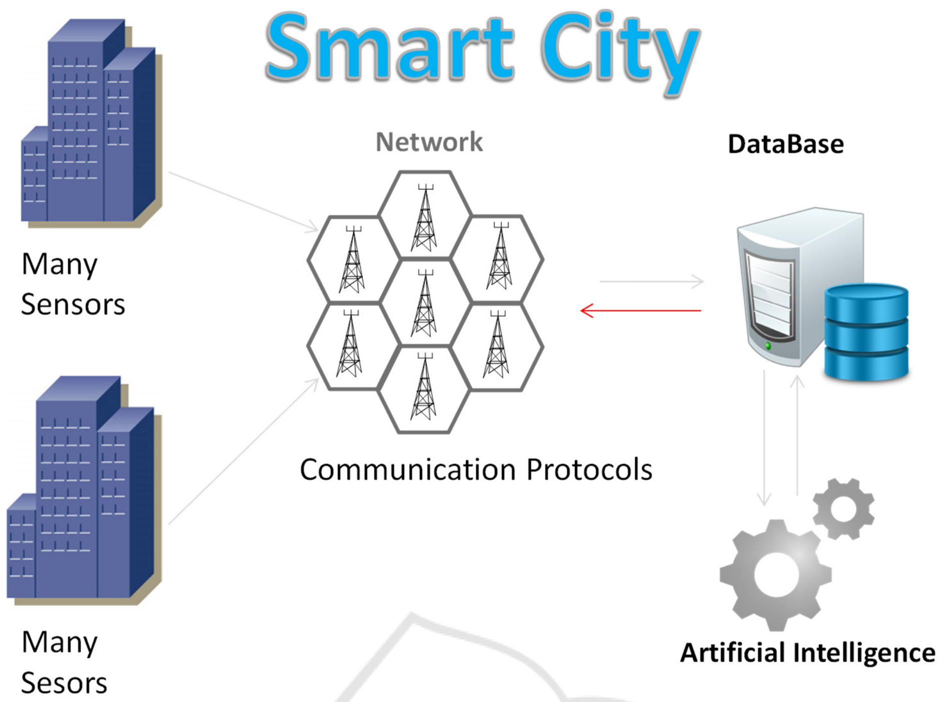

Figure 2: Information exchange between basic elements when using IoT for smart Cities.

2 SENSORS AND (WIRELESS) SENSOR NETWORKS

Along the years, the hardware technology to develop sensors and wireless sensor networks have evolved hugely. In about 10 years, sensor node deployments with few KBytes of Flash Memory and just 11 Mbps of data transfer rate (e.g. XPort and Matchport (Martchport, 2018), from Lantronicx, Figure 3), to some hundreds of Kbytes 5 years ago (e.g. Flyport (Flyport, 2018) and Waspmote (Waspmote, 2018), Figure 4).

Currently, Arduino (Arduino, 2018) and raspberry Pi (Raspberry, 2018) platforms are allowing a wide range of applications because of their low cost, computing capacity, modularity, and flexibility. Figure 5 shows Arduino Mega 2560 and Raspberry Pi 3.

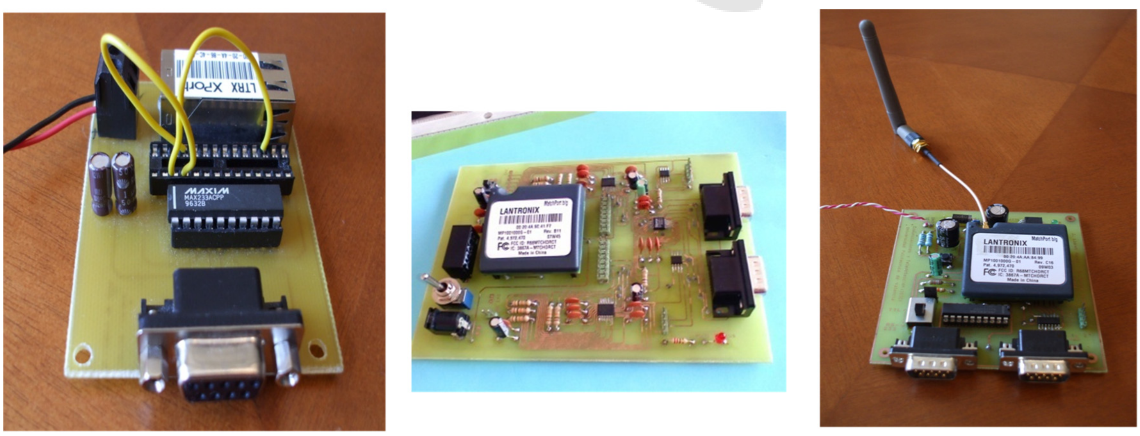

Figure 3: XPort and Matchport, from Lantronix.

Figure 4: Flyport and Waspmote (Libelium).

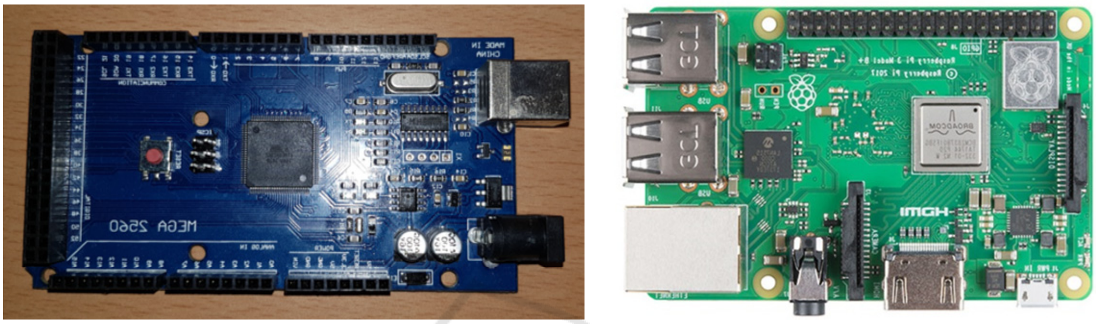

Figure 5: Arduino Mega 2560 and Raspberry Pi 3.

3 COMMUNICATION PROTOCOLS AND ALGORITHMS

In order to deliver the collected data from the sensors to a database one or several communication technologies are required. The connectivity from IoT can be from anywhere at any time (Lopez, 2017). Moreover, some specific protocols are needed for data, message frequency and alarms. The choice of the technology depends on multiple factors such as the type of data, the field of deployment, economical aspect, etc. The amount of protocols that can be used is high. Moreover, it is increasing constantly. Some of them are well known communication standards, and others are proprietary and developed exclusively for water or electricity metering. They provide two-way communications with the IoT, allowing sending commands from the database to the smart meter for multiple purposes, including monitor real time values and change the frequency of readings among others (Lloret, 2016). Communication protocols for IoT should allow the network management, improving their ability to operate autonomously, flexibly and robustly.

Given the information obtained through IoT, it is necessary to classify and differentiate the flows with the objective of offering an appropriate treatment to the priority and the relevance of the information managed. Moreover, IoT must face aspects related to privacy and information security. Furthermore, network infrastructures require mechanisms and protocols to discriminate the different needs of IoT data.

4 ARTIFICIAL INTELLIGENCE APPLIED TO BIG DATA

The amount of data collected from a single environment could be huge (Bakhshad et al, 2018). There must be one or several databases deployed in the smart city to facilitate the process of saving and treating high volume of data. Once the data has been saved in a database, it is very important to use the most powerful techniques to extract the useful data from it. Given a series of inputs the system has to be able to detect certain circumstances that require any type of intervention. Here is where artificial intelligence (AI) is required. Techniques such as artificial neural networks or inductive inference methods, that are able to anticipate the future based on past observed data, are used (Hernández et al., 2014). Machine learning employs statistical techniques with the goal of enabling machines to understand the set of data. AI can be applied to a wide variety of sensor data and environments.

Moreover, the traffic generated by the IoT devices must be determined and integrated into different types of flows. Based on this information, there should be a prioritization criteria and traffic safety levels corresponding to each flow in order to be able to be properly treated by the network devices. Machine learning / deep learning techniques can be used to apply the traffic classification criteria. AI algorithms can be responsible for determining the required Quality of Service (QoS) parameters and priorities in order to make modifications to the network device configurations required at each instant and for each type of specific traffic flow. An example of an algorithm that takes into account the aforementioned issues is shown in Figure 6.

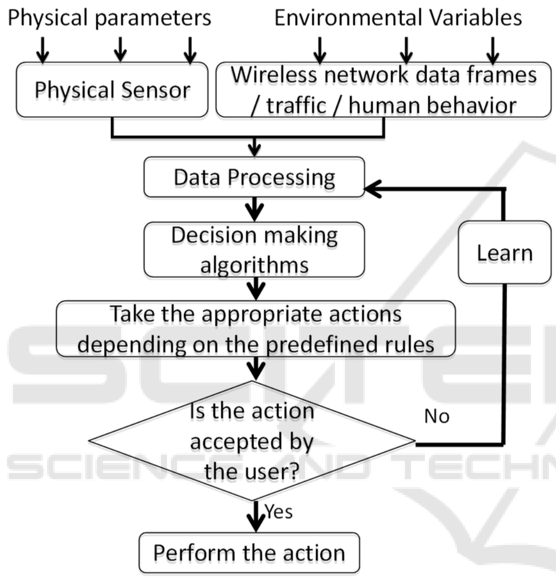

Figure 6: Algorithm that takes into account sensor data and traffic behavior to perform actions in the network.

5 CONCLUSIONS

The amount of technology introduced in the cities is growing hugely. The sensor devices are cheaper, smaller and with higher computing capacity, which allow them to be used to gather data from a wide variety of environments. Wireless technologies allow higher data transfer rates at higher distances and the communication protocols are quite more robust than years ago. All these issues are facilitating the deployment of many IoT devices to collect the data used by AI techniques to achieve a smarter city.

ACKNOWLEDGEMENTS

This work has been partially supported by the "Ministerio de Economía y Competitividad" in the "Programa Estatal de Fomento de la Investigación Científica y Técnica de Excelencia, Subprograma Estatal de Generación de Conocimiento" within the project under Grant TIN2017-84802-C2-1-P.

REFERENCES

Arduino website, available at: https://store.arduino.cc/arduino-mega-2560-rev3 [Last access June 2018]

Azizi, R. (2016) Consumption of Energy and Routing Protocols in Wireless Sensor Network, *Network Protocols and Algorithms*, Vol 8, No 3. Pp. 76-87

Bakhshad, S. et al., (2018) A Dynamic Replication Aware Load Balanced Scheduling for Data Grids in Distributed Environments of Internet of Things, *Ad Hoc and Sensor Wireless Networks*, Vol. 40, Number 3-4. Pp. 275-296.

Flyport website, available at: http://wiki.openpicus.com/index.php/Flyport_WiFi [Last access June 2018]

Hernández, L. et al., (2014) Artificial neural network for short-term load forecasting in distribution systems, *Energies* 7 (3), 1576-1598.

Khaleeq, H., Abou-ElNour, A., Tarique, M., (2016), A Reliable Wireless System for Water Quality Monitoring and Level Control, *Network Protocols and Algorithms,* Vol 8, No 3 Pp. 1-14

Martchport, Lantronix website, Available at: https://www.lantronix.com/products/matchport-bg/ [Last access June 2018]

Lloret, J.; Garcia, M.; Bri, D.; Diaz, J.R.; (2009) A cluster-based architecture to structure the topology of parallel wireless sensor networks, *Sensors* 9 (12), 10513-10544.

Lloret, J., Tomas, J., Canovas, A., Parra, L., (2016) An integrated IoT architecture for smart metering, *IEEE Communications Magazine* 54 (12), 50-57.

López Martín, M., Sánchez-Esguevillas, A., and Carro, B. (2017), Review of Methods to Predict Connectivity of IoT Wireless Devices, *Ad Hoc and Sensor Wireless Networks*, Vol. 38, Number 1-4. Pp. 1-20

Raspberry Pi website, available at: https://www.raspberrypi.org/products/raspberry-pi-3-model-b-plus/ [Last access June 2018]

Sendra, S.; Lloret, J.; García, M.; Toledo, J.F.; (2011) Power saving and energy optimization techniques for wireless sensor neworks, *Journal of communications* 6 (6), 439-459.

Waspmote website, available at: http://www.libelium.com/products/waspmote/ [Last access June 2018]