Module VII.1

Early care and intelligent resources application: Internet of Things and Artificial Intelligence

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e-EarlyCare-T

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Early care and intelligent resources application: Internet of Things and Artificial Intelligence

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1. Introduction

IoT term refers to those scenarios or situations where the connectivity and the computation capabilities are extended to objects, sensors, and elements that are not usually considered computers.

IoT makes possible to those common use devices to generate, interchange, and consume data with a minimum human intervention.

1. Introduction

Examples of IoT are:

- Housing: home automation, smart household appliances, detection systems and alarms...
- Industry: sensors for preventive maintenance, clothes with sensors for avoiding accident rate...
- Cities: smart semaphores, autonomous irrigation systems...
- Healthcare: portable devices for electrocardiogram signal monitorization, oxygen saturation sensors, diabetes, among others.

2.1. Reasons for IoT popularity

The main reasons for IoT popularity are the following:

- Ubiquitous connectivity: the low cost of connections and their omnipresence make that almost everything can be connected to the network (via Internet).
- IP protocol adoption: IP has become to the standard of communications by network.
- Computers economy: processors and electronic devices have more power computation and lower costs, besides their low consumption.

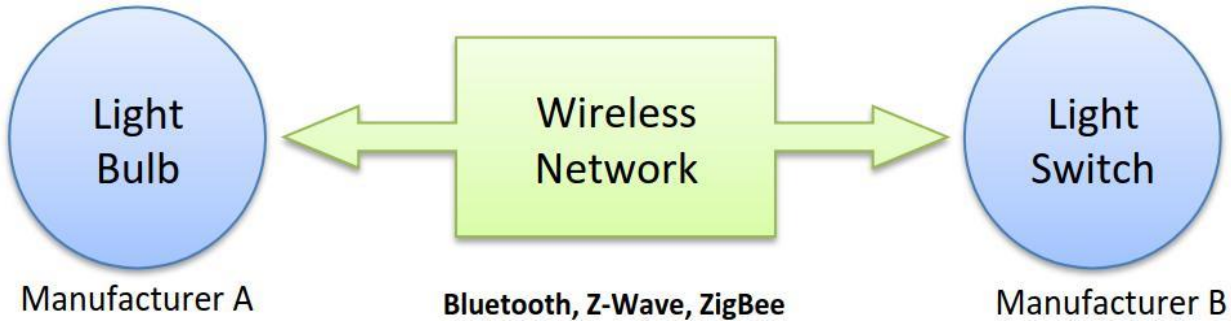
2.1. Reasons for IoT popularity

- Miniaturization: the electronic equipment miniaturization makes possible that almost any object can b attached a device.
- Advances of data analysis: the computer capacity, storage and development of new algorithms offer new opportunities for data analysis and exploitation.
- *Cloud computing:* the low cost of cloud computing and their ease of using have become cloud computing into an explosion. This makes possible for IoT devices to delegate the hard computation to other computers on the cloud, making IoT devices smaller and simpler.

2.2. Communication models of IoT

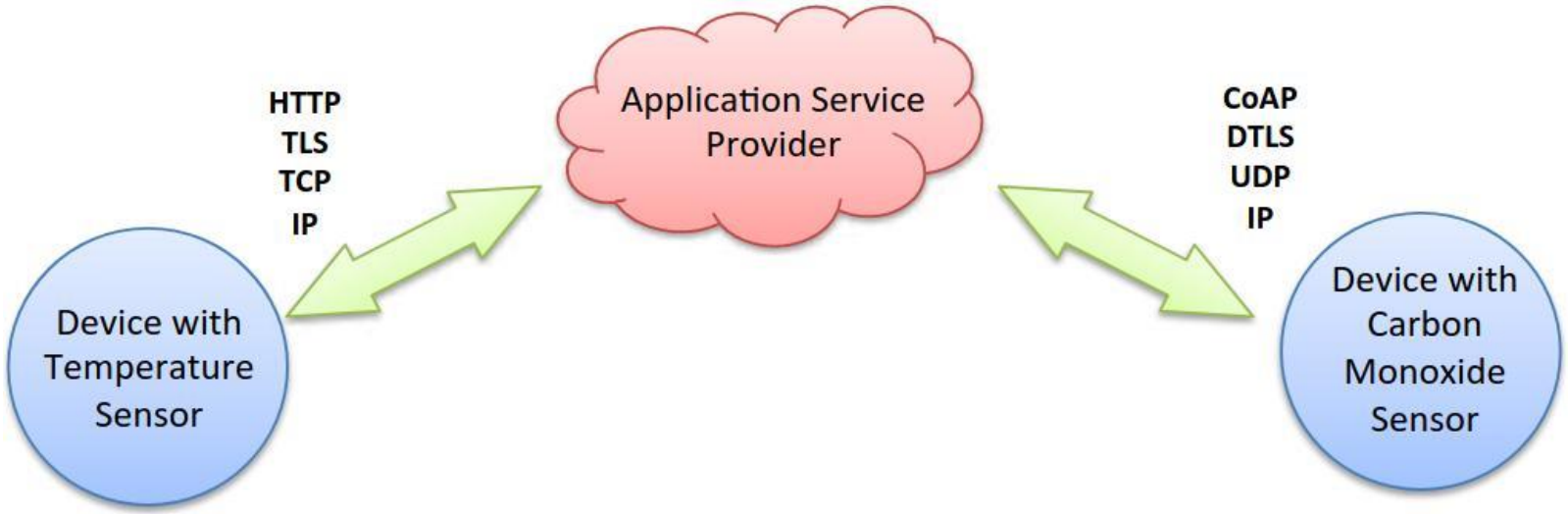
As it was previously noted, the basis and fundamentals of IoT devices is their interconexion. The RFC 7452 document gathers four models:

- Device to device: the IoT devices communicate together directly without the need of any intermediary. An example of this communication is Bluetooth.



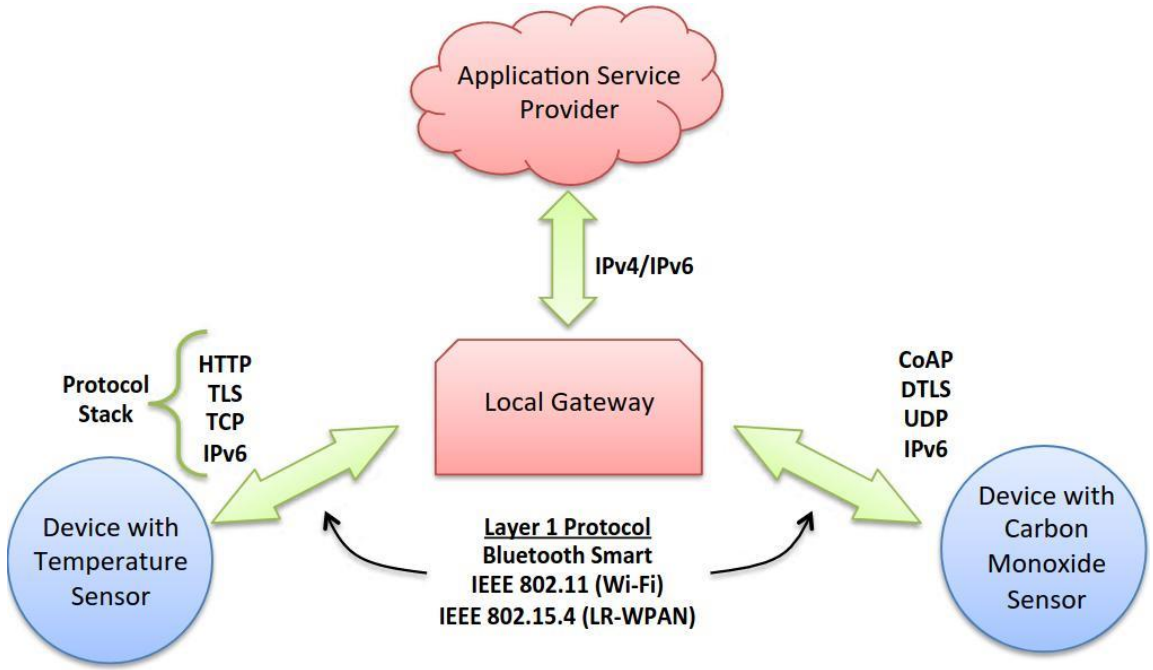
2.2. Communication models of IoT

- Device to cloud: the devices are connected to an application service provider hosted on the cloud. The application service aims at connecting the devices together.



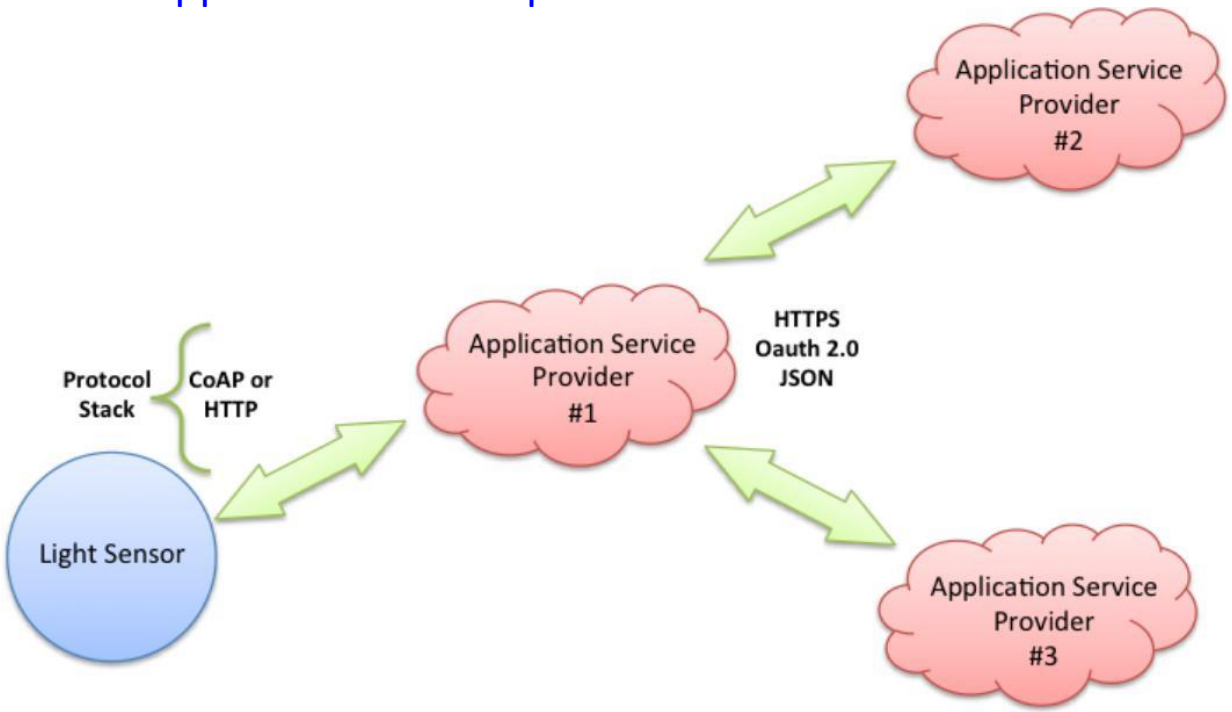
2.2. Communication models of IoT

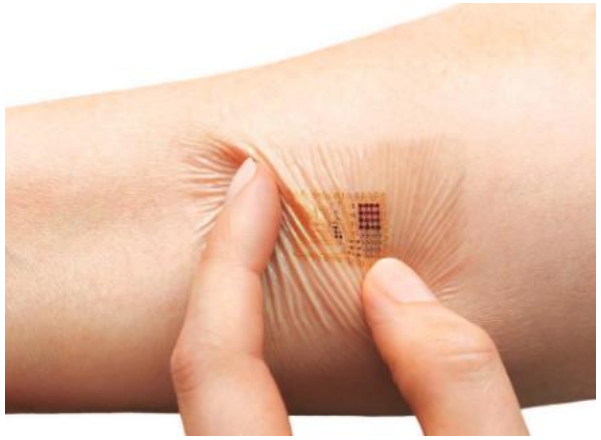
- Device to gateway: the devices are connected to a local gateway and the gateway is the one that connects directly to the application service provider on the cloud.



2.2. Communication models of IoT

- Back-end data sharing: the device connects to an application server on the cloud and this one interchange the information with other application service providers.





2.3. IoT applied to healthcare

The architecture of IoT devices applied to healthcare usually has three layers:

- Perception layer: the perception and identification technologies are the basis of IoT. Examples include infrared sensors, medical sensors, GPS...
- Network layer: the information gathered by sensors must be sent and shared between application/devices.

  Examples include WiFi, Bluetooth, Zigbee...
- Application layer: is the one in charge of interpreting data, being the responsible of giving the processed data to user. At this point is where IoT and AI are mutually benefited.

2.3. IoT applied to healthcare

There are multiple IoT applications to healthcare, some of the examples are listed below:

- Sensors and actuators:
  - Based on smartphones: taking advantage of the sensors that smartphones have such as accelerometers, camera, microphones, among others.
  - Medical sensors: monitor temperature, blood pressure sensors, pulse...
- Pre-processing: they are usually delegated on the cloud for providing more devices mobility and more autonomous.
- Communication: since RFID, Bluetooth, Zigbee, IP, among others.

2.3. IoT applied to healthcare: IoT for early care

While IoT devices have gained popularity in healthcare during the last decades, the IoT applications for early care are still in early stages.

Currently, only two publications relate IoT and early care:

- (de Vicente et al., 2016) proposed a new "Internet of toys" for making easier and improve health in children strengthening the prevention and attention disorder in childhood development.
- (Xing-Rong et al., 2021) identified a huge potential of IoT technologies for early care. On the paper they used clustering applications to identify groups of scientific publications. With that they identified the need of taking into account to the childhood development and to early care to put in practice smart education.

3. Artificial Intelligence

Artificial Intelligence (AI) is defined as the study of computation methods that can make possible to sensing, reasoning and acting. In a broader sense, it is usually assumed that AI studies the processes that make possible to computers to have behaviours that are observed in the human intelligence.

In the last decade, the AI advances have overcome the humans in several tasks that were commonly assumed as intractable. These advances have been possible thanks to the increase in available information combined with new algorithms and optimizations.

3. Artificial Intelligence

A common problem of AI methods is their interpretability and their lack of transparency. Frequently, they perform as black boxes which for an input offers an output/prediction, but it can be impossible to determine how the system has found the solution. Because of this, the explainable AI is gaining special interest in the community, especially when these methods are used in medical issues and related with healthcare:

- Integrated: based in transparency, that is one of the features that makes possible the interpretability. Some models, such as decision trees, can be interpreted by themselves, but unfortunately other more complex methods are hard to understand.
- Post-hoc: based in interpretability, extracting information from trained models. These methods do not depend on how the model performs internally.

3.1. Machine learning

It is a subdiscipline of AI that, by means of the use of huge datasets, is able to identify patterns among input variables.

Three big groups are usually identified inside machine learning:

- Supervised learning: datasets have several input variables and one (or more) output variables (target).
- Unsupervised learning: datasets have only input variables and relations between them are seek.
- Reinforcement learning: inspired in conductist theory, they try to identify the actions that an agent must choose for maximizing its benefit.

3.1. Machine learning

Different tasks can be distinguished among machine learning.

- Supervised learning:
  - Classification: tries to predict the output variable (the target one) looking for relations between input variables. The target/output variable is nominal (categorical). Thus, these methods can predict the output variable value of an unseen example (only using the input variables).
  - Regression: is the same use case than the previous, but in this case the output variable is continuous/numeric.
- Unsupervised learning:
  - *Clustering*: tries to find groups in the datasets by the relationships between the examples/instances.

3.2. Artificial Intelligence healthcare related

AI is changing healthcare systems in many aspects, thanks to the huge amount of available data and the application of new (and more precise) methods. Some AI applications related with healthcare are:

- Classification: cancer identification by X-rays, stroke damage identification of magnetic resonance, arrythmia detection in electrocardiogram...
- Regression: estimation of models for anticoagulation therapy, outbreak forecast of disease (such as dengue, malaria or Zika).
- *Clustering*: drug profiling of patients.

3.2. Applications of Artificial Intelligence to early care

AI can be applied in many aspects related with early care, since policy development to specific applications. Nevertheless, early care applications are still scarce.

Recently, (Sierra et al., 2022) presented a proof-of-concept in early care that includes several machine learning algorithms. Their study tries to help, by comparing several algorithms, to the diagnosis and assignation of therapy and treatment on below 6 years-old children. The study was conducted on San Juan de Dios hospital, Sevilla (Spain). One of the most difficult tasks was the natural language processing (NLP) for extracting features from clinical history with which train the AI models.

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Pictures

Pictures 1, 2, 3 y 4 Illustrations of Aliero, M. S., Ahmad, A. M., Kalgo, U. S., & Aliero, S. A. (2020). An Overview of Internet of Things: Understanding the Issues and Challenges of a More Connected World. *International Journal of Computing and Communication Networks*, *2*(1), 1-11.

Pictures 5 y 6 Illustrations of Sethi, P., & Sarangi, S. R. (2017). Internet of things: architectures, protocols, and applications. *Journal of Electrical and Computer Engineering*, *2017*.

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