Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 09, September-2016

Internet of Things: Concepts, Applications, Challenges and Future Trends

Mário Márcio Figueiredo Rosa
Engineering and Architecture College
FUMEC University
Minas Gerais, Brazil

Thalita Bento da Silva
Engineering and Architecture College
FUMEC University
Minas Gerais, Brazil

George Leal Jamil
Production Management Research Area
Masters program in Engineering and Management for Processes and Systems
Minas Gerais, Brazil

Claudio Roberto Magalhães Pessoa, M.Sc.
Electrical and Electronics Center Coordinator
FUMEC University
Minas Gerais, Brazil

***Abstract*— There is a great trend that not only specific devices must be connected to the Internet, but anything or equipment. The home appliances, that we use day by day, for example, may have new forms of use when they are connected to the World Wide Web. The Internet of Things (IoT) arrived, driven by an expansion of the Internet in physical objects and providing smarter services. IPv6 protocol could provide a wider range of services and is a promising support resource for this connection. Its applications could be seen in commerce, industry, public services, healthcare, in the field, in short in all the "stuff". In this context, this work has the objective to analyze the initial concepts, and that has been in practice regarding this technology. Therefore, this article will present an overview of the IoT referencing its technical aspects, the applications already available and the challenges to be faced by this technology nowadays.**

***Keywords*— Internet of things; RFID; IPv6; Internet.**

I. INTRODUCTION

Some years ago, Hollywood futuristic movies, or even animated sitcom as the family of the future "The Jetsons", displayed from 1962 to 1963 on American TV, show innovations that seemed to be impossible and / or unimaginable. In the cartoon "The Jetsons", for example, the characters live in a fully automated home where they performed functions from a simple touch buttons or voice command. Today this reality is no longer so far. All this will be possible with the use of the Internet of Things (IoT). "Things" must be considered in the broadest sense of the word as real or virtual entities that exist and evolve in a context and time and have univocal identifiers. On the other hand, the term Internet applied to them conveys the idea that all these things are fully connected and interrelated among them [1].

The Internet of Things ecosystems are composed, on the one hand, of so called smart objects, i.e., tiny and highly constrained physical devices in terms of memory capacity, computation capability, energy autonomy, and communication capabilities [2]. They say the objective of the Internet of Things is the integration and unification of all communications systems that surround us. Hence, the systems can get a total control and access to the other systems in order to provide ubiquitous communication and computing with the purpose of defining a new generation of services.

This research aims to analyze the IoT concepts and applications, ranging from health care to transportation, logistics to meters and the perspective of a "smart city". As a specific purpose, it will be analyzed also, in an overview, the technical aspects of technology as architecture, protocols, and especially the challenges faced by it in the day-to-day. To this end, the theoretical analysis methodology will be used, mostly scholarly articles and books, which will enable to know the technology and the work carried out so far.

II. THEORETICAL FRAMEWORK

A. *IPv4*

The IP and TCP protocols are the key from a set of protocols that direct the operation of the Internet and is known as the TCP / IP suite of protocols. The IP protocol is important because it is responsible for addressing and routing packets that travel over the World Wide Web [3].

The most widely used version of the protocol, so far, is the version 4, which has 32-bit addressing, which allows about four billion addresses available for devices directly connected to the Internet [3]. However, these IPs ran out due to the large number of devices connected to the network as computers, servers, and smartphones. Demi Getschko, NIC.br[1] CEO, points out:

"It is always worth noting that nothing wrong happened to IPv4. The depletion of addresses in this version of the protocol is part of the growth of the Internet, and in Brazil its growth is remarkably large. At that time, the main concern is to encourage the adoption of IPv6." [4]

However, companies are still at an early stage of migration. Most of the companies surveyed and nothing has been done yet [5].

[1] Núcleo de Informação e Coordenação do Ponto BR - NIC.br was created to implement the decisions and projects of the Internet Management Committee in Brazil - CGI.br, which is responsible for coordinating and integrating initiatives and Internet services in the country.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 09, September-2016

B. IPv6

The solution to the continuous growth of the network is the IP protocol in use version 6 (IPv6). IPv6 has a number of addressing that will serve for a long time the Internet needs. IPv6 has 128 bits in its address field, which brings 3.4x〖10〗^38 IP enables to allocate 340,282,366,920,938,463,463,374,607,431,768,211,456 unique addresses [6].

Telecommunications providers are prepared to provide addresses in IPv6 to their new users from July 1st, 2015. For interconnections and corporative users, the new protocol is already available by all providers in its main points of traffic exchange [7].

But migration process is not simple. Techniques for adaptation (such as dual stack and data packaging) because while there is still access to the IPv4 content, it must coexist for some years, since the two protocols (IPv4 and IPv6) are not compatible [5].

It is known that billions of people rely on the Internet on a daily basis for work and business, and a long-term vision of the Internet is to integrate various human processes things. So make them accessible via the Internet is a key issue.

This new design to extend the Internet to any relevant thing is feasible thanks to the new version of the Internet Protocol (IPv6). IPv6 extends the address space to support all emerging devices enabled for Internet use [2].

The future of Internet protocols and uses IPv6 technologies, such as IPv6 at low power on personal local area networks (6LoWPAN). For these authors "in this regard, the 6LoWPAN allows the extension of the Internet for small and smart devices, making it possible to identify and create connections between people, devices and the things around us" [8]. Detailed that 6LoWPAN allows sensors exchange native and integrated information with the Internet without need for any extra processing [9].

IPv6 is considered the next appropriate technology for the Internet of Things as it offers scalability, flexibility, ubiquitous network connectivity and end-to-end [2].

"For this reason, some efforts are being made to provide mechanisms to allow an IPv6 address to each one of the things; ranging from RFID`s and legacy technologies to emerging technologies responsible for building intelligent objects. Thus, the integration of multiple technology networks in a totally shared IP network is reached". [2]

III. METHODOLOGY

The methodology choice is very important to direct a research. This study, used up of theoretical analyses that are developed from material already prepared mainly books and scientific articles [10].

The theoretical framework also allows to check the problem condition being studied, under the theoretical aspect and other studies and researches already carried out [11].

"Theoretical framework must contain an amount of what is most current, in the chosen theme approach, even if current theories are not part of their choices." [12]

In this way, for the research, were analyzed scholarly articles distributed as follows:

a) 10 Qualis CAPES articles classification A1:

- Acta biomaterialia;
- IEEE Communications Surveys and Tutorials; Future Generation Computer Systems;
- Journal of Telecommunications System & Management;
- Industrial Engineering & Management;
- Sensors;
- International Journal of Innovative Research in Computer and Communication Engineering;
- Ad Hoc Networks.

b) 2 Qualis CAPES articles classification A2:

- Computer Networks;
- International Journal of Distributed Sensor Networks.

c) 1 Qualis CAPES article classification B1:

- Journal of Network and Computer Applications.

d) 2 Qualis CAPES articles classification B2:

- International Journal of Distributed Sensor Networks (Online).

e) 1 Qualis CAPES article classification B4:

- Mobile Information Systems.

f) 1 Qualis CAPES article classification B5:

- International Journal of Innovative Research in Science, Engineering and Technology.

g) Books:

- Book: "Introdução à rede de computadores" [3];
- Ebook: Enabling Things to talk: Designing IoT solutions with the IoT Architectural Reference Model. Springer Heidelberg, New York, Dordrecht London [13].
- Book : "Managing and Mining Sensor Data", p. 383–391 [14].
- Book: "Interconnecting Smart Objects with IP - The Next Internet". Elsevier Inc [15].

h) Technical Articles

- 8 articles published on websites and reference magazines in technology and innovation.

The objective of the analysis is to present an IoT overview, considering its technical aspects, applications and the challenges to be faced by this technology, according to studies already carried out on the subject. Aiming to provide more reliable information, chose to analyze Qualis journal

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 09, September-2016

articles, homologated by CAPES[2] in ratings A1, A2, B1, B2, B4 e B5 and complete this analysis with technical articles and published books about the subject.

After analysis, it was crossed information about the articles presented and then the most important considerations analyzed.

IV. ANALYSES

B. IoT Technical Concepts

The term Internet of Things - IoT, was coined by Kevin Ashton in a presentation in 1999. As he said, "the Internet of Things has the potential to change the world, just as the Internet did, maybe even more." The Internet of things since becomes the focus of several efforts of standards organizations, including the International Telecommunication Union (ITU). The technology will allow forms that were previously unknown and collaboration unimaginable, communication and interaction between people and things and among the things [16].

Currently the IoT has gained great prominence in the telecommunications scene and is being considered the technological revolution that is the future of computing and communication [17].

For the Internet of Things is necessary to use smart objects, which by definition, is an object fitted with one form of sensor, a small microprocessor, a communication device and a power source [15]. This issue will be addressed in other items in the research line for IoT, at FUMEC University and it is not part of the objective of this work.

In order to present an overview of the technical concepts of IoT the following topics were discussed: IoT architecture, protocols, hardware, Mobility and Wireless Communications.

C. IoT Architecture

The architecture of IoT is a convergence of various technologies such as: Ubiquitous / pervasive computing, sensors / actuators, Information and Communication Technologies (ICT) and embedded systems [18] "Fig. 1".

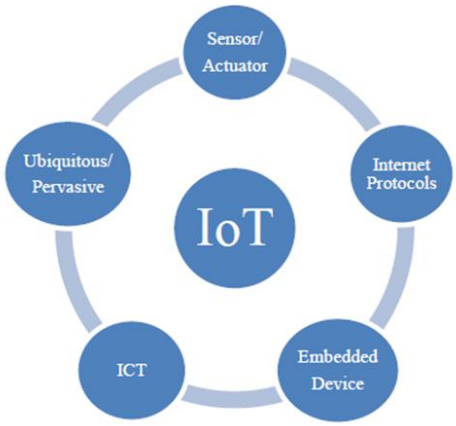


FIGURE 1. IOT ARCHITECTURE

[a.] [18].

In architecture, embedded systems and sensors / actuators are components which are physically in direct interaction with users who, in turn, manipulate the data through these components. ICT, ubiquitous / pervasive computing and Internet protocols are used to create a communication between the devices and manage user interactions.

Also the IoT architecture components are further classified into three functional units [18]:

1)Oriented Internet:

Represents the Internet and its technologies and acts between user and the smart things and so "is called intelligent middleware." Intelligent Middleware will enable the creation of a dynamic map of the real / physical world into the digital / virtual space using a temporal and spatial resolution and matching the network characteristics of ubiquitous sensors and others. The construction of IP protocols to enable smart objects are connected to the Internet [14].

2) Oriented things:

They are known as smart things that represent sensors and actuators that respond to stimuli consistently environment.

D. Oriented semantics:

[19] Define the semantics deals with data management issues that arise in the context of the vast amount of information that is exchanged by smart objects, and resources that are available through the web interface.

E. Protocols

The architecture of IoT is a convergence, protocols as part of the Internet. They represent one of the basic requirements to interact with the agents is the mechanism of interaction between agents, which should enable connectivity and understanding in order to provide interoperability [1][18]. To achieve this goal, different protocols are being proposed to provide an efficient connectivity, continuous, robust, namely:

1) CoAP (Constrained Application Protocol)

The CoAP is a web protocol that runs over UDP (User Datagram Protocol) and is designed primarily for the Internet of Things.

[2] Is a foundation under the Ministry of Education (MEC) of Brazil engaged in the expansion and consolidation of post-graduate studies (Masters and PhD) in all states.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 09, September-2016

CoAP is a variant of the most used synchronous protocol of Web, HTTP (Hypertext Transfer Protocol) and is adapted to restricted devices and machine to machine communication [20].

2) DTLS (Datagram Transport Layer Security)

DTLS is a very complete security protocol that can perform authentication, key exchange, and the application of data protection with switching of materials and coding algorithms. Using DTLS, it can be considered that the safety and protection for the Internet of Things can be achieved [20].

3) 6LoWPAN (Low-power Wireless Personal Area Networks)

The interconnection between the devices can be performed by means of Wireless Personal Area Networks, low power as defined in the IEEE 802.15.4 standard (2003) cited RFC 4919 (2007). A LoWPAN network is a simple communication network that enables wireless connectivity for applications with power limitations and transmission rates restrictions. The LoWPAN network typically includes devices that work together to connect the physical environment to real-world applications such as sensor network. LoWPAN is in compliance with the IEEE 802.15.4 standard [21].

These protocols may be implemented in the environment containing IoT intelligent sensors, devices, smartphones, etc., with real-time application [20].

F. Hardware

One of the reasons mobile computing is becoming increasingly available, no doubt, is because hardware prices are constantly decreasing. Projects like Raspberry Pi, Arduino, Fritzing, Writing provide cheap Waspmote modular hardware components that can be easily programmed and configured using Free and Open Source Software (FOSS) free and open-source software. To illustrate this reality will be presented in Table 1, an overview of these devices designed to be part of the IoT.

TABLE I. HARDWARE TYPES USED IN IOT

HARDWARE	DESCRIPTION
Raspberry Pi	Raspberry Pi is a low power consumption of the credit card-sized computer that costs as little as 25 euros. The device is provided with Linux distribution fully featured that contradicts the traditional notion that the operating systems for wireless networks are very different from those for desktop / laptop.
Arduino	Arduino is an open electronic prototyping platform with components that can extend its functionality to monitor the environment by parameters such as air quality, noise, lighting, temperature. The Arduino hardware is considerably more efficient in computing than Raspberry Pi. Arduino boards can be connected to a Raspberry Pi through a connecting bridge Shields . Through this connection, you can use any of the shields, boards and modules designed for Arduino on Raspberry Pi.
Waspmote	Waspmote is a platform explicitly designed for Internet of Things. Focused on creating node with low power consumption sensors, they are able to work independently for a long period of time (within a period of one to five years). The Waspmote reuses the same Arduino environment, so that the code developed for Arduino node can also be used in the device with the minimum adjustment or even none. There are currently over 60 different sensors can be connected to Waspmote.
Fritzing	As informed on the Web site of the manufacturer, Fritizing.org/home/, is an open-source hardware initiative that conducts electronic access as a creative material for anyone. It offers software tools that allows users to document their prototypes, share them, teach electronics in a classroom and manufacture layout and PCB (Printed circuit board or printed circuit board) Professional.
Wiring	Also informed the manufacturer's own site, Wiring.org.co refers to an open source programming framework for microcontrollers. It allows you to write cross-platform software to control devices connected to a wide range of microcontroller boards to create all kinds of coding, interactive objects, spaces or physical experiences.

[b.] Adapted [22]

The evolution of wireless networks has been driven by increasing the demand for pervasive connectivity, as demonstrated by the growth of mobile data traffic in ten thousand times and an increase of one hundred times the number of devices with the network capacity utilization. To meet this demand will be necessary to combine existing networks with emerging systems, such as cellular communication networks (eg, Long Term Evolution (LTE)) and Wi-Fi, and even new technologies developed to meet the service quality requirements [22].

Also according to [22], the Sensors Wireless Networks (WSN or WSNs) are the main components of the emerging paradigm Internet of Things (IoT). They are now ubiquitous, i.e. they are everywhere, and are used in a plurality of application domains. The WSNs are still specific areas and often deployed to support a specific application. However, the authors state that as "WSNs are becoming more and more powerful, they are becoming more relevant to research how many applications could share the same infrastructure WSN". Virtualization is a technology that could potentially allow this sharing.

Radio Frequency Identification (RFID) is a technology for the Internet of Things and can be used to identify and control their equipment [23]. According to them, the technology is interesting to identify the development objectives due to its typical parameters such as wireless reading, fast reading numerous identification tags at once and the possibility of having passive tags without internal energy source. Even if the objects are equipped with handles, they can be managed and inventoried automatically and can thus control the path of transport of these products.

G. Mobility

Mobility today is coming to a point where it is possible, through a smartphone, connect to wireless companies and the next moment, to leave the place, change the connection for the network 3G / 4G phone carrier, transparently to the user. However, this network migration brings with it the problem of changing IP address of the mobile device, thereby generating possible breaks (and even fall) connection. The use of the IPv6 protocol will happen differently because the machine will switch network while

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 09, September-2016

preserving the address you are using, preventing connections are lost.

To prevent these failures, we use a method that is basically across mobile host has a fixed address in their original local network, known as home address. When auto configure in any network, the mobile host sends a message to your local network "warning" your new address on the network that is as a visitor. Thus, all packets destined to its original address will be routed to your visitor address, thus allowing reception of packets transparently [24].

The protocol that enables this mobility is the MIPv6 (Mobile IPv6) established by RFC 2002, which, as [25], was developed as a subset of IPv6 to support mobile connections. The MIPv6 node facilitates the movement of an Ethernet-type network to another of the same type as the movement of an Ethernet network to a wireless LAN cell.

IV. APPLICATIONS DEVELOPED FOR IOT

The IoT refers to a technological revolution that will soon connect equipment such as appliances, transportation, clothing and handles on the Internet and in others devices such as computers and smart phones. Finally, the Internet has become a fundamental part of society. It is likely a future in which the network and the computers are invisible. They will be so integrated into the daily lives of people, disguised in everyday objects, which are not perceptible.

Therefore, because the importance of IoT, the National Intelligence Council of EUA (NIC) regards it as one of the six most promising civilian technologies and more impact the nation in the near future. The NIC (2008) provides that in 2025 all everyday objects (for example, food packaging, documents and furniture) will be connected to the Internet.

For the first time in a recent event, the CES 2015 (Consumer Eletronics Show), offered to the public some technology dedicated to smart homes, smart cars and wearables or wear devices. The idea is to reach the day when all equipment is controlled by intelligent devices.

Growth forecasts from the base of connected objects contain astronomical numbers. Some point to 50 billion mobile connections worldwide by 2020, adding smartphones, tablets and assorted objects such as cars, appliances, clothing accessories, etc. [27]

According the survey, the articles cited above, it was possible to detect the following applications for IoT.

A. *Smart Cities*

In the paper to IEEE Talks IoT, says that “cities are the centers of innovation and the people living in them want to be connected. Most cultures around the world are at a point where they cannot live without the Internet." Not only people, but a huge amount of other things are now connected to the Internet, and such a network of connected things underlies the grounds upon which smart cities emerge. The Internet of Things (IoT) thus naturally becomes the nerve center giving life to smart cities and opens up a vast road of promising potentials for innovation [28].

Another application in a smart city is in the waste collection. For instance, the use of intelligent waste containers, which detect the level of load and allow for an optimization of the collector trucks route, can reduce the cost of waste collection and improve the quality of recycling. To realize such a smart waste management service, the IoT shall connect the end devices, i.e., intelligent waste containers, to a control center where optimization software processes the data and determines the optimal management of the collector truck fleet.

Another important Internet of Things application is detecting pollution and natural calamities [26]. The IoT use will allow monitor the emissions from factories and vehicles to minimize air pollution, track the release of harmful chemicals and waste in rivers and the sea, thereby arresting water pollution. It is possible also send warnings of earthquakes and tsunamis by detecting tremors, furthermore, keep the water level of rivers and dams under surveillance to be alert in case of floods.

B. *Logistics*

Transport logistics, IoT improves not only material flow systems but also the global positioning and automatic identification of freight. It also increases energy efficiency and thus decreases energy consumption [13]. The author concluded that the IoT is expected to bring profound changes to the global supply chain by intelligent cargo movement. This will be achieved by means of continuous synchronization of supply chain information and seamless real time tracking and tracing of objects. It will make the supply chain transparent, visible and controllable, enabling intelligent communication between people and cargo/goods.

Mention that, in a global supply chain, companies will be able to track all of their products by means of Radio Frequency Identification (RFID) tags. As a consequence, companies will reduce their Operating Expenses (OPEX) and improve their productivity due to tighter integration with Enterprise Resource Planning (ERP) and other systems. Also, maintenance of machinery will be facilitated by connected sensors, allowing for real-time monitoring of the health and performance of the factory equipment [13].

C. *Agriculture Applications*

*1)*Internet of Things technologies have a great potential to improve the safety and quality of agricultural products. By providing near continuous monitoring from planting through harvesting and to our homes, IoT technologies are able to provide farm to fork visibility with all of the resulting benefits that accrue from that visibility [29].

D. *Health Area*

In the health area also we have applications. For example, some paralyzed patients must wear a diaper when they are in bed. A wetness sensor can immediately alert nurses and caregivers to replace the diaper as soon as it becomes wet. The detected signal is sent towards a reader using an RFID reader [30].

V. CHALLENGES FACED BY THIS TECHNOLOGY

The movement towards mass adoption of IoT already seems impossible to contain. If it's good or bad, only time

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 09, September-2016

will tell. It is known that many challenges will be faced in the course of this the IoT deployment process, such as data storage, information security, well-trained employees, among others, as seen below.

A. Information Storage

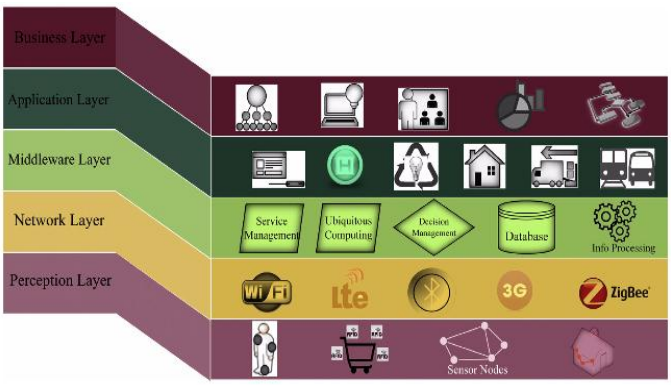
Systems, storage and network servers need to grow to support the transition and the massive growth of new devices. The IoT will impose new requirements on storage and this huge amount of data need to be stored somewhere to be useful [19].

B. Infrastructure

The basic IoT architecture consists of three layers: perception layer, network layer and application layer. For the authors, these layers may not be sufficient due to the rapid development of IoT. Therefore, a five layer architecture has been suggested, by adding two new layers: the processing layer and the business layer. “Fig. 2” shows the scheme with the five layer model [9].

[31] states that the future of the Internet of Things probably involves an architecture that "pushes" the application layer to the router and integrates the network with logical intelligence. Thus, the network does not have to bear all the burden; otherwise, there is simply no way to add enough bandwidth.

FIGURE 2. Iot Architecture



c. [9].

As reported by the magazine EXAME.com (2014) to John Donovan, vice president of technology and operations of AT&T, there is also a much more concrete and real problem that needs to be overcome, the question of the frequency spectrum for use in wireless networks. "We arrived at a point where we need to make huge investments and no use having the guarantee only that the next four or five years there will be sufficient spectrum. You have to think beyond that," he said, noting that not just think of optimizing spectrum and finding alternative forms of reuse of frequencies.

The IoT will enable a new generation of dynamic ecosystems in environments such as smart cities and hospitals. Dynamic ecosystems require ubiquitous access to the Internet, transfer seamless, flexible roaming policies and interoperable mobility protocol with existing Internet infrastructure. These features are challenges for the IoT devices, which are generally devices with low memory capacity, processing and communication and limited energy [2].

For Hans Vestberg, CEO of Ericsson Corporation, in an interview for Exame magazine, another challenge will be the interconnection between operators and businesses. According to him, in the Internet environment of things, different sectors need to be related with others. "There will be a conversation between telecommunications operators and their suppliers, but we have to listen to other sectors, other industries," he said.

C. Information Security

Compared to traditional networks, the security and privacy of Internet of Things become more prominent. Much information includes confidential and private information, so that privacy protection is an important issue to be considered [32].

According to the authors, the IoT needs low cost and technical solutions oriented communication M2M to ensure privacy and security. In many cases of use, the security of a system has been considered important. Low cost, low latency and energy efficiency of encryption and flexible hardware algorithms will be essential for the sensor or device.

Security is a major concern where networks are deployed on a large scale. There will be many ways to attack a system by disabling network availability, pushing erroneous data to the network, access to personal information, among others [19].

The IoT is vulnerable to attack for several reasons. First, relate that often components spend most time unattended making them easy targets to physically attack them. Secondly, most of the communications will be wireless, which makes simple eavesdropping [17].

The three physical components of IoT - RFID, WSN and cloud - are vulnerable to attack. Security is critical for any network and the first line of defense against data corruption is encryption [19]. Of the three technologies, RFID appears to be the most vulnerable because it allows track people and objects and no high level of intelligence can be enabled on these devices.

On the issue of protocols, the 6LoWPAN is the latest communication protocol and is expected to prevail in future networks. However, 6LoWPAN adaptation layer facing security threats, especially for packet fragmentation attacks. More studies are needed to 6LoWPAN to develop a proper mechanism of protection against attacks. Similarly, COAP has several security problems, which should be active area of research in the coming years [9].

D. Skilled Labor

The Internet of Things will provide automatic procedures that imply a reduction in the number of employees needed. Workers are replaced by bar code scanners, readers, sensors and actuators, and eventually, by complex robots as efficient as a human being. Undoubtedly, these technologies will bring opportunities for professionals because a large number of technicians

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 09, September-2016

will be needed to program and repair the equipment and sensors [13]. This is a new challenge for the provision of services for all workers with an opportunity to move toward these types of work.

On the other hand, the technology will generate new jobs with opportunities. It is also important to remember the Telecommunications Engineers, responsible for all network infrastructure and security, which must be attuned to the possibility of access to information through new technologies and devices.

E. Interoperability

The Interoperability as the ability of a system (computerized or not) to communicate transparently, or to be close to it with another system (similar or not). According to the author, for a system to be considered operable, Inter is very important because it works with open standards. Be a portal, educational system or an e-commerce system, he said, today you walk more and more to the creation of standards for systems. Therefore, this issue has also become a major challenge for the introduction of IoT [33].

Interoperability testing is a tool to accelerate the development and provides the performance evaluation by other manufacturers and / or developers who do not know how each solution was developed; tests whether the established standards are being used properly and that particular solution / product can work properly in conditions within the limits of the rules [34].

According to information of CPqD - Center for Research and Development (2015) - the concepts and interoperability challenges of the Internet of Things (IoT) were the subject of the lecture that the expert Vinicius Garcia de Oliveira, responsible for the Board of innovation processes Convergent networks CPqD did in Brazil IEEE RFID conference 2015 which took place on October 7, 2015, in São Paulo. Oliveira addressed one of the main challenges faced today in this scenario: interoperability. "The definition and use of a common framework is a critical requirement for the development of devices and Internet of Things applications able to communicate fully with each other," he says. "However, the main problem is not the absence of such a framework, but the large number of initiatives to become the industry standard."

F. Sustentability

Thinking in the near future, one can get a sense of challenges involving energy issues and developing efficient systems of energy and self-sustaining, being essential to support applications IoT. Environmental forms of energy should be developed [33]. And communication processing efficiency must also be enhanced through further circuits, new programming paradigms and development of energy efficient and smart antennas protocols. The development of new, effective and compact batteries, fuel cells, as well as the new generation of devices with power transmission methods or energy harvesting will be the key factors for the development of intelligent autonomous wireless systems.

CONCLUSION AND FUTURE TRENDS

This paper presents an overview based in several researches of authors that presents the technical aspect, existing applications and the challenges to be faced by IoT day-to-day.

Due to technical evolution, is possible to believe in the potential applications of this new technology. Among others, the IoT won't come back. As the Internet gained strength at the time that it did connects computers around the world, the IoT is emerging as a promise of applications that will help human beings in daily tasks [1][2].

The IoT will bring also the possibility of working to various sectors, especially application developers to the connected devices and telecommunication engineers, which should well plan the infrastructure that will support the network. But it is important to remember the need to study the safety of the data.

Security it is a subject which requires a more thorough research. Assuming that the datas will be stored on servers that are physically located in different places (in the cloud) and even in the user equipment. This makes security is crafted with all those who use the network and its equipment, with the possibility of having their data captured for possible people who use it in the wrong way.

It could be perceived that the IoT is still a great promise. Although the concept is no longer so new, dated in 1998 by Kevin Ashton, the devices are gradually adapted to be used within this concept. With the advent of IPv6, this reality changes, because the new protocol brings the possibility of exponential growth of network equipment.

Among the works of the newly launched line of research - Fumec of Things - created in Fumec University, this first article presented an overview of the IoT. No doubt that as previously, the subject still demand more studies, especially for the area of infrastructure and network security. Therefore, in future studies will be carried out thorough research into these issues in order to design the first application of Internet of Things of FoT.

REFERENCES

[1] Á. Asensio, Á. Marco, R. Blasco, R. Casas, "Protocol and architecture to bring things into Internet of Things," International Journal of Distributed Sensor Networks April 2014 vol. 10 no. 4J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68-73.

[2] A. Jara, L. Ladid, A. Skarmeta, "The Internet of Things through IPv6: An Analysis of challenges, solutions and spportunities." Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications, 2014.

[3] A. Miranda. "Introduction to computer networks" "Introdução às redes de computadores." Vol. 1, 2008.

[4] NIC.br. "NIC.br back to warn the exhaustion of IPv4 in the coming months", "NIC.br volta a alertar para o esgotamento do IPv4 nos próximos meses" unpublished

[5] C. Pessoa, G. Jamil, T. Geremias, P. Santos, M. Rosa. "Discourse analysis in multiple case studies on the implementation of the IPv6 protocol in Organizations." 12º CONTECSI - International Conference on Information Systems and Technology Management.

[6] R. Perini, "IPv6: New Protocol comes to supply the IP exhaustion in Latin America." "IPv6: Novo protocolo chega para suprir o esgotamento de IP na América latina." unpublished

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 09, September-2016

[7] Anatel. “IPv6 will be available to the public from July 2015.” “IPv6 estará disponível para o público a partir de julho de 2015.” unpublished.

[8] A. Jara, M. Zamora, A. Skarmeta. “Glowbal IP: An adaptive and transparent IPv6 integration in the Internet of Things.” Mobile Information Systems, Volume 8 (2012), Issue 3, Pages 177-197.

[9] I. Mashal, O. Alsaryraho, T. Chung, C. Yang, W. Kuo, D. Agrawal, “Choices for interaction with things on Internet and underlying, 5 issues.” Ad Hoc Networks 28 (2015) 68–90.

[10] C. Gil, “How to design research projects.” “Como elaborar projetos de pesquisa.” São Paulo: Atlas, 1991.

[11] M. Lakatos, A. Marconi, “Scientific Methodology Basics” “Fundamentos de Metodologia Científica,” São Paulo: 5ª ed. Atlas, 2003.

[12] J. Marion, R. Dias, M. Traldi, “Monograph for management courses, accounting and economics” “Monografia para cursos de administração, contabilidade e economia.” São Paulo: Atlas, 2002.

[13] A. Bassi, M. Bauer, M. Fiedler, T. Kramp, R. Van Kranenburg, S. Lange, S. Meissner, “Enabling Thngs to talk: Designing IoT solutions with the IoT Architectural Reference Model.” Ebook, Springer Heidelberg New York Dordrecht London.

[14] C. Aggarwal, “The Internet of Things: a Survey from the data-centric perspective, 2013.” Managing and Mining Sensor Data, p. 383–391.

[15] J. Vasseur, A. Dunkels, “Interconnecting Smart Objects with IP- The Next Internet.” Elsevier Inc, 2010.

[16] C. Perera. A. Zaslavsky. P. Christen. D. Georgakopoulos. Context Aware Computing for The Internet of Things: A Survey. IEEE COMMUNICATIONS SURVEYS & TUTORIALS.

[17] L. Atzori, A. Iera, G. Morabito. “The Internet of Things: A survey,” 2010. Computer Networks 54 (2010), p. 2787–2805.

[18] S.Pandikumar, R. Vetrivel. “Internet of Things Based Architecture of Web and Smart Home Interface Using GSM.” 2014 International Conference on Innovations in Engineering and Technology. Vol. 3, Special Issue 3, 2014.

[19] J. Gubbi, R. Buyya, S. Marusic, M.Palaniswami, “Internet of Things (IoT): A vision, architectural elements, and future directions.” Future Generation Computer Systems. Vol. 29, Issue 7, September 2013.

[20] A.Chavan, K. Nighot. “Secure CoAP Using Enhanced DTLS for Internet of Things.” International Journal of Innovative Research in Computer and Communication Engineering. Vol. 2, Issue 12, December 2014.

[21] G. Montenegro, N. Kushalnagar, J. Hui, D. Culler, “Request for Comments 4944: Transmission of IPv6 Packets over IEEE 802.15.4” Networks. 2007.

[22] A. Kotsev, F. Pantisano, S. Schade, S. Jirka. “Architecture of a Service-Enabled Sensing Platform for the Environment.” Sensors 2015, 15(2), 4470-4495.

[23] J. Kadlec, R. Kuchta, R. Novotný, O. Čožík. “RFID Modular System for the Internet of Things (IoT).” Industrial Engineering & Management. Vol. 3, Issue 4.

[24] IPv6 do PoP-BA. “IPv6 fundamentals”“Fundamnetos IPv6.” unpublished.

[25] C. Perkins. “IP Mobility Support.” Request for Comments: 2002

[26] B. Sannapureddy. “Pros & Cons of Internet Of Things (IOT).” unpublished.

[27] F. Paiva, “Internet of Things will produce "tsunami" signaling in mobile networks” “Internet das Coisas vai produzir "tsunami" de sinalização nas redes móveis.” unpublished.

[28] R. Rosseti. “Internet of Things (IoT) and Smart Cities.” IEEE Xplore Readings on Smart Cities. August 2015.

[29] Y. Liu, H. Wang, J. Wang, K. Qian, N. Kong, K. Wang, L. Zheng, Y. Shi, D. Engels, “Enterprise-Oriented IoT name service for agricultural product supply chain management.” International Journal of Distributed Sensor Networks August 2015 vol. 11 no. 8

[30] M. Domingo, “An overview of the Internet of Things for people with disabilities.” Journal of Network and Computer Applications. Vol. 35, March, 2012. 584–596.

[31] D. Falsarella. “The challenge of Internet of Things”, “O desafio da Internet das Coisas.” unpublished.

[32] S. Chen, H. Xhu, D. Liu, B. Hu, H. Wang, “A Vision of IoT: Applications, Challenges, and Opportunities With China Perspective.” IEEE Internet of Things Journal, VoL. 1, No. 4, August, 2014.

[33] R. Silva. “The importance of interoperability” “A importância da interoperabilidade.” Unpublished.

[34] G. Marão. “Internet of things: interoperability is the name of the game.” “Internet das coisas: interoperabilidade é o nome do jogo.” unpublished.