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INTERNET DE LAS COSAS: ¿HAY UNA NUEVA POSICIÓN TECNOLÓGICA?

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Abstract: In the last decade, the internet has become an everyday tool of people and organizations and, at the same time, indispensable to the proper functioning of business. With the growing increase in network infrastructures and mass popularization of the high-speed network, a breakthrough has emerged related to the use of the Internet, making it a global platform to allow intelligent machines and objects to communicate autonomously. This possibility allows content and services to be around people, always available, facilitating communication and opening the way for new applications; enabling new forms of work, interaction and entertainment; developing a new standard of living and work. This new standard is made possible by advances in Information and Communication Technologies (ICT) to a new concept defined as Internet of Things - IoT. This introductory article presents and discusses the main features that characterize the Internet of Things, its origin, theoretical visions and fields of application, exploring the possibilities of fomenting a discussion about the application of IoT.

Keywords: Internet of Things, Technologic innovation, IoT, Information and Communication Technologies.

Resumen: En la última década, Internet se ha convertido en una herramienta cotidiana de personas y organizaciones y, al mismo tiempo, indispensable para el correcto funcionamiento de las empresas. Con el creciente aumento de las infraestructuras de red y la popularización masiva de la red de alta velocidad, ha surgido un avance relacionado con el uso de Internet, que lo convierte en una plataforma global para permitir que las máquinas inteligentes y los objetos se comuniquen de forma autónoma. Esta posibilidad permite que el contenido y los servicios estén alrededor de las personas, siempre disponibles, facilitando la comunicación y abriendo el camino para nuevas aplicaciones; habilitar nuevas formas de trabajo, interacción y entretenimiento; desarrollando un nuevo estándar de vida y trabajo. Este nuevo estándar es posible gracias a los avances en las Tecnologías de la Información y la Comunicación (TIC) para un nuevo concepto definido como Internet of Things - IoT. Este artículo introductorio presenta y discute las principales características que caracterizan el Internet de las Cosas, su origen, visiones teóricas y campos de aplicación, explorando las posibilidades de fomentar una discusión sobre la aplicación de IoT.

Palabras clave: Internet de las cosas, Innovación tecnológica, IoT.

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INTRODUCTION

About two billion people around the world use the Internet to communicate, browse the Web, access content and multimedia services, play games, interact on social networks and many other applications.

With the growing increase of the network infrastructure and the mass popularisation of the high-speed internet, a breakthrough related to the use of the internet becoming a global platform to make smart machines and objects able to communicate autonomously emerges (Miorandi, Sicari, De Pellegrini & Chlamtac, 2012).

Gao and Bai (2014) highlight that during the next decade, the network will inter-exist as a seamless fabric of classic networks and networked objects. Content and services will be around people, always available, facilitating communication and making way to new applications, enabling new ways of work, of interaction, of entertainment, causing a new standard of living to be developed. This new standard of living if made possible by the advances of the ICTs (Information and Communication Technologies), to a new concept defined as *Internet of Things* - IoT.

The term *Internet of Things* was coined for the first time in 1999 by Ashton, one of the pioneers of British technology who helped developing the concept (Gubbi, Marusic & Palaniswami, 2013).

The Internet of Things - IoT aims to extend the benefits of the internet providing a constant connectivity, developing an ability of remote control and data sharing to goods in the physical world (Peoples, Parr, McClean, Scotney, & Morrow, 2013).

The Internet of Things comes from the concept of the generalised presence around people and of a variety of things or objects, through *Radio Frequency IDentification* - RFID, sensors, actuators, gadgets as smartphones, tablets, televisions, bracelets and smartwatches, etc., by means of unique addressing schemes that are able to interact with each other and cooperate with their neighbours to reach common goals (Atzori, Iera & Morabito, 2010).

Within this perspective, the term *Internet of Things* - IoT is widely used to refer to: the global network resulting from the interconnection of smart objects; the set of support technologies needed to implement this vision; and the set of applications and services that boost such technologies in order to provide new business and market opportunities. (Miorandi et al., 2012).

The effectiveness of the IoT lies in the high impact that it has to provide on various aspects of everyday life and behaviour of potential users (Peoples et al., 2013). From the point of view of a private user, the most obvious effects of the introduction of the IoT are in their assisted functions.

Health care, learning orientation, and home control are just a few examples of the application fields of IoT. In the same way, from the perspective of business users, the most apparent consequences will be equally visible in areas such as automation and industrial

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manufacturing, logistics, management and decision-making processes, smart transportation of people and goods (Atzori et al., 2010).

Note that the IoT, as a technological innovation, gains ground in heated discussions both in the academic and professional fields.

Thus, with a view to contributing to amplification of the discussions, the present paper aims to discuss in a conceptual manner, the most relevant elements that make up the phenomenon of the IoT, constructing a line of theoretical argument that seeks in the literature to understate if there is in fact a new technological positioning, in order to subsidize future theoretical-empirical perspectives that has IoT as the focus of study. For this, the present paper is divided into five sections: this introduction as a first step; three theory sections focusing on the origin of the internet of things; a new technological position and the future of the IoT.

And, finally, the final considerations are made in the attempt of encouraging new study proposals.

THE ORIGIN OF THE INTERNET OF THINGS

From their creation to the present day, web-based applications have undergone a series of changes until arriving to the phenomenon called the Internet of Things. It is essential to understand the differences between applications that make use of the traditional resources of the internet and the collection of tools that make up the IoT in order to comprehend the phenomenon to be studied, its main potential applications and those that are already in use.

Over the course of its first 40 years, the Internet has been used primarily to connect people through email exchanges, discussion forums and, increasingly, through social networking sites that collect and distribute data and information. Also note that today the Internet is used to connect devices, machines, and other objects through wired and wireless networks, creating a new technological position named *Internet of Things* (Dutton, 2005).

The Internet of Things, (Internet das Coisas, in Portuguese) gained use for the first time in 1999 by Ashton (2009), one of the pioneering authors in this type of technology, whose research helped to develop the current concept for this positioning technology.

However, it is pertinent to note that the application and sophistication of this emerging set of technologies are sufficient to see it as a genuine innovation in the application of ICTs and in the Internet use (Gubbi et al., 2013).

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IoT				
Expansion	Action	Means	Purposes	Possibilities
of the constant connectivity capabilities	Detection	*Radio Frequency IDentification* - RFID	Detection or actuation of other devices that are online	Storage of information
of data sharing	Marking	Sensors and actuators	Monitoring	Submission of data and information
of remote control	Identification	Quick Response codes - QR	Identification	Receiving data and information

Figure 1
Internet of Things: general aspects
Based on Peoples (2013) and Dutton (2014).

The IoT, as presented in table 1, aims to extend, to the physical world, the constant connectivity capability to share data, the remote control, among other capabilities (Peoples, 2013). To achieve such pretensions, the IoT captures the many permutations of detection, marking or identification of things, such as through *Radio Frequency IDentification* - RFID, bar codes, quick response codes - QR, sensors and actuators, through the Internet for purposes such as identification, monitoring, detection or actuation of other devices that are *online*. This set of technologies allows products or other physical objects to store, send and receive information in a way that can transform the way people do things and justify the Internet of Things as a new technological concept (Dutton, 2014).

Due to the emerging growth of technology towards the IoT, multiple definitions on the Internet of Things are exposed in the current literature, presenting some difficulty in defining what this set of tools really means, it is necessary to understand its central ideas, the social, economic, and technical implications that may arise through its implementation and use (Zorzi, Gluhak, Lange & Bassi, 2010; Vasseur, Agarwal, Hui, Shelby, Bertrand & Chauvenet, 2011; Dutton, 2014; Saxby, 2015).

The reason for the existence of these difficulties is present in the interpretation of the syntactic of the term Internet of Things, as it deals with two concepts able to conduct to different interpretations wherein the first term, internet, leads to a vision directed to the network the Internet of Things is able to generate, whereas the second term, things, leads to a vision directed to something generic being able to be integrated to a more common landscape (Atzori et al., 2010).

These differences in the visions of those interested in the Internet of Things come from the various initiatives and interests related to this phenomenon, whether they are business alliances, research agencies or regulatory agencies - each approaching this phenomenon based on their own line of action, interest and purpose, be it internet-oriented or things-oriented (Brody & Pureswaran, 2015).

Taking into account the context developed so far, it is assumed that, by uniting the terms and presenting them as *Internet of Things,* a meaning is built that leads to the level of breakdown of innovation

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in modern communication. Thus, the Internet of Things translates into a worldwide network of interconnected objects uniquely addressable, based on standard communication protocols standard (Li, Da Xu & Zhao, 2014).

Such a reality is built around an indefinite number of objects involved in the process, resulting in the collection, exchange, storage and interpretation of information from multiple sources that originate from the activities of people and machines, leading directly to a new way of looking at such technologies, in a perspective oriented to the Internet of Things (Ashraf & Habaebi, 2015).

Atzori et al. (2010) point out such visions of the IoT arguing that one must consider a paradigm that is structured by means of the convergence of these three visions, as shown in figure 2.

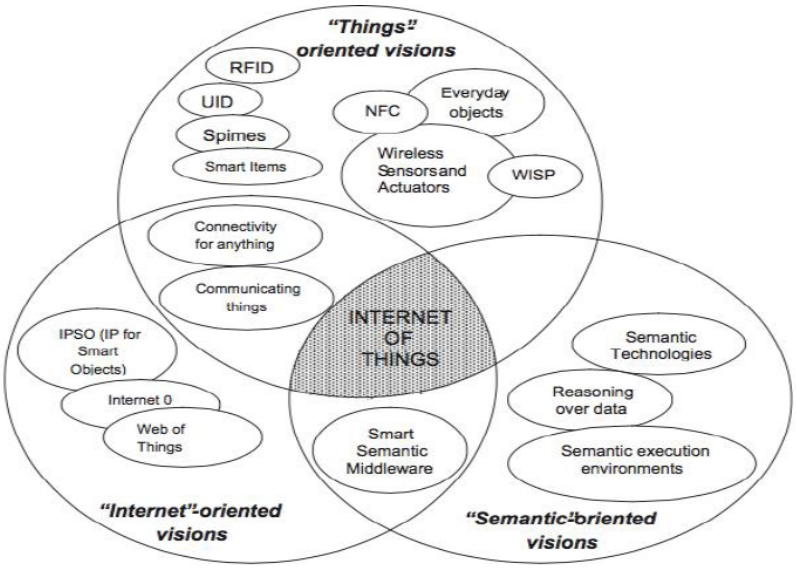

Figure 2
Visions of the Internet of Things
Atzori, et al., (2010).

The first vision presents a perspective oriented to things. It is a vision considered by the authors as a more simplistic one, since it is concerned initially with items that can be considered basic such as the technology *Radio Frequency IDentification* - RFID, *Wireless* sensors and technology equipment *Near Field Communication* - NFC, making these, key components to the full implementation of the vision of IoT. However, the IoT has a more vast and complex condition than the idea of a mere identification of things.

According to Presser, Barnaghi, Eurich and Villalonga, (2009) RFID technology is perceived as one of IoT structuring technologies. This perception is attributed to the low cost of the technology and the technological stability that it has factors that make the technology acceptable to the industry and the business community. However, there is a broad portfolio of devices, networks and services, technologies that will eventually build the IoT up.

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In this sense, a perspective oriented to things that go beyond the RFID presented by the United Nations - UN predicts the advent of the IoT as a ambiguity-based reality, in that humans can become the minority in relation to the machines with respect to generators and receivers of network traffic. Such changes, thus, being made possible by the advent of the Internet of Things and networking of smart objects of everyday life that the IoT will be able to support (Botterman, 2009).

In the same way, other relevant institutions have stressed the concept that the Internet of Things tends to be focused mainly on the things and that the path to its full deployment has to start from the increase of the things with intelligence. Accordingly to this concept, in the field of studies of the IoT the *spime,* emerges, defined as an object that can be tracked through space and time throughout its useful life, with a model of self-support and being able to be uniquely identified on the network (Atzori et al., 2010).

Although its definition is presented in a generic and essentially theoretical manner, the *spime* shall be implemented in the real world with its functionalities expanded, wherein its devices are popularly called smart objects that are not limited to the location, wireless communication and traceability as in the initial conception, but gaining memory and preparation capacity, potential for stand-alone behaviour, proactivity, awareness of context, collaborative communication, among other skills that suffer variations according to the applicability of the smart object (Atzoriet al., 2010; Vasseur, Agarwal, Hui., Shelby, Bertrand & Chauvenet, 2011).

The constant innovations from these technologies have paved the way for a new IoT vision, according to which connectivity that is available to anyone will also be available to anything (Strategy & Unit, 2005).

Such a vision of the Internet of Things, resembles the vision presented by the European Commission that the things that have virtual identities and personalities operate in smart spaces using smart interfaces to connect and communicate within the social, environmental, and user's context sphere (Li et al., 2014).

In a second vision, which is oriented to the internet, the efforts of the IoT are directed to the creation of smart environments, where things can communicate automatically with each other and with other people, improving already existent products and services and providing new ones in order to generate new benefits for the society.

Vasseur and Dunkels (2010) propose a concept of a smart environment based on a vision of the Internet of Things as a global infrastructure that connects physical and virtual objects, able to include existing networks, new developments through which the internet will still pass.

In this sense, the IoT becomes a generator of a virtual environment called smart environment, with the natural capacity for implementation of services and applications characterised by a high degree of data and information management in an autonomous and uninterrupted manner. Such characteristics arise as the link of union that connects the first vision,

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things-oriented, to the second vision that centralizes the internet in the panorama of the IoT.

With respect to the third vision, the one oriented to the semantics, it is concerned with the issues related to the ways to collect, store, connect, search, and organise the information generated by the Internet of Things, arguing that the challenges listed in these actions should be included in the primary discussions in relation to the IoT, due to the challenges that are aggregated and to its complexity.

In this context, semantic technologies could play a key role, becoming crucial for the construction of solutions capable of properly exploring and modelling data and information generated by the IoT, building and enabling the interpretation and the communication structure of the Internet of Things (Atzori et al., 2010).

Faced with different visions of a whole that constitutes the Internet of Things, this article adopts the definition of Li et al. (2014) that defines the IoT as a set of applications enabled for the Internet based on physical objects and the environment integrated to the information network ones.

The IoT consists of the protocols and related technologies that allow different elements to communicate through electronic communications channels, both wired or wireless, across a network of data and information exchange composed of things and people (Valéry, 2012).

Therefore, as pointed out by Dutton (2014) the IoT stands out for it allows electronic information to be transmitted by physical objects, such as when they move through space, in a similar manner to wireless networks that transmit electronic signals, creating a truly new dimension to the design and use of the Internet. Faced with the existence of different visions concerning the Internet of Things, one may wonder if the advent of the IoT can be seen as a new technological position or only as a reorganised way to use the resources already existing on the internet. Seeking to broaden this discussion and to assist in the understanding of this phenomenon, following, the elements that can be considered in order to understand the Internet of Things as an essentially innovative phenomenon are discussed.

INTERNET OF THINGS AS A NEW TECHNOLOGICAL POSITION

The next great innovation for the modern society will be the full implementation of the Internet of Things, connecting not only people, but also machines, things and smart objects, thanks to the wireless connectivity (Dutton, 2014).

The communication between things and people is possible regardless of the circumstances of location and form, featuring a new technological position in modern communication, (Roman, Najera & Lopez, 2011). Made possible by a variety of devices connected and identified, it becomes possible to perceive events and changes within the so- called smart environment (Chabridon, Laborde, Desprats, Oglaza, Marie & Marquez, 2014).

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Despite these new aspects assigned to the IoT, there is an ongoing debate about whether this is truly a new technological development or only an industry initiative to promote and sell products and services that are "refurbished" as innovation; whereas other people consider it a deviation of technological systems already existing in the past (Krucken, 2003).

Various factors that make up the technological position of the Internet of Things, such as wireless connectivity, sensors, capture devices and RFID technologies in relatively advanced stages and stable in use that are being combined in new ways (Dutton, 2014).

However, these technologies that were used focusing on the development of applications that sought to connect people by means of electronic messages and conferences started focusing their development in interconnecting *online* devices to other devices.

In this way, the IoT redirects the attention to the technological applications, to the relations established between person-thing, thing-person and between thing-thing, the environment of smart communication consisting of people and things being configured (Li et al., 2014).

The power of this vision is evidenced by the rise of new business models and solutions that are created by the IoT, such as smart cities, smart transportation, smart houses, and in the areas of manufacturing industry, logistics, security, health and environmental control.

For this reason, experts argue that the Internet of Things is the greatest innovation in communication since the Web (Valéry, 2012; Li et al., 2014; Dutton, 2014).

The social and organizational impact that the IoT potentially causes in the use of ICTs can reconfigure the way people deal with information, live together, receive and provide services, and use existing technologies (Pang, Zheng, Tian, Kao-Walter, Dubrova & Chen, 2015).

The expectation for such innovations based on the Internet of Things to actually happen is justified by a series of characteristics, as summarised in figure 3 and explained as follows.

First, the flexibility that the IoT presents, supported by various combinations of technologies and solutions that can be applied in a variety of ways and fitting to the various contexts, in addition to the constant improvements for which key components of the IoT suffer to expand their capacity, life cycle and scale of production so as to permit new areas of potential application (Dutton, 2014).

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Characteristic	Description	Capability/Applicability
Flexibility	The IoT can be combined in various ways and applied in different contexts	A wide range of applications: manufacturing, tracking, real-time monitoring, management of cities, transportation networks, optimisation of resources, etc.
Improvement	The IoT does not always make something entirely new, but makes things closer in real-time and in a greater level of precision than has ever been done before	Allocation of public workforce, real-time monitoring of public services, decision-making based on shared data from different sectors, etc.
Data sharing	Data sharing is a key aspect to the IoT, thus making the information more complete and accurate	Data sharing between different sectors of industry, government and organised civil society.

Figure 3
Characteristics of the Internet of Things
Based on Dutton (2014), Ashraf & Habaebi (2015).

Second, it is important to emphasise that the IoT does not always make something entirely new, but makes things closer in real- time and in a greater level of precision than has ever been done before. Third, the IoT makes data sharing the epicentre of its applicability, making it essential to the integration of data in different sectors and services that already exist and that will be created in the future (Dutton, 2014; Ashraf & Habaebi, 2015).

However, the idea of sharing data collected for one purpose to support another distinct purpose is filled with new questions of an ethical, political and practical order. But the idea of sharing is fundamental to allow the IoT to be able to support applications that involve the knowledge of the behaviour. Combining data of different individuals becomes the key to the full functioning of the IoT (Dutton, 2014).

THE FUTURE OF IOT

Recent studies highlight the main scenarios for the future of the Internet of Things. As shown by Figure 4 below, four perspectives stand out as the most popular, showing their view of new technology as well as its current barriers. These perspectives are named overly hyped, economic, opportunity and useful (Valéry, 2012; Dutton, 2014; Ashraf et al., 2015).

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Perspective	Description	Barriers
Overly hyped	The IoT has not yet reached the level of maturity required to meet realistic expectations.	It lacks a viable business model.
Economic	The IoT is a new milestone in the digital economy, and may be out of control if it is not standardised in the coming years.	It lacks rules and policies that standardise actions based on the IoT related to privacy, protection of data and social control.
Opportunity	The IoT is seen as the most promising opportunity of technological advance of the next decade for industries from various sectors.	It requires greater political commitment to the creation of laws and jurisdictions that may be applied in different countries.
Useful	The IoT is not a path that is inevitable, but represents a trend of consolidated improvements and technological innovations.	It is not yet possible to define which areas have achieved stability in the use of IoT technologies.

Figure 4
Prospects for the future of the Internet of Things
Based on Valéry (2012), Dutton (2014), and Ashraf et al., (2015).

The overly hyped perspective argues that there were useful applications of the IoT in identification, tracking and detection technologies, but that this area is not new, and most important, it lacks a convincing and strong business model in many cases, arguing that such applications are not yet financially viable (Valéry, 2012).

The economic perspective argues that the IoT is a new milestone in the digital economy, and, may eventually become out of control if it is not standardised in the coming years. It may increase problems regarding the issues related to user privacy, data protection and other social issues linked to sensors, actuators, devices, guided devices, personal identification and many more, being embedded in everyday life and at work.

The perspective focused on the opportunities that the technological advances caused by the IoT can provide is seen as highly promising for industrial of various industries, being fully technically and financially viable.

However, this perspective emphasises that the social and behavioural changes required for its implementation are equally complex and belong to spheres such as organisational, institutional, political, and so forth.

The last of the four perspectives, the useful perspective, presents IoT as a path that is not inevitable but represents a consolidated trend of technological improvements and innovations.

Noting that computer and Internet industries are investing heavily in this area, providing strong possibilities of application in several areas, even though it is still speculative the definition as to which areas have achieved stability in the use of IoT technologies.

FINAL CONSIDERATIONS

The discussion was directed towards the understanding that The Internet of Things represents a new technological vision that emerges from the Internet and related technologies such as RFID, sensors and other electronic devices. This vision moves from an emphasis on connecting

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people to each other and to documents and data, to connecting things. Even though much of the tools that make up the Internet of Things is not entirely new, the emerging vision entails connecting things on a new scale of sophistication, amplitude, exchange, and data analysis, connecting transport systems, distribution systems, and entire cities, in a single reality.

In this sense, the Internet of Things provides a new unprecedented scale of development given the potential of a trillion Internet-enabled devices in the foreseeable future.

However, based on the future perspectives found in the literature on the subject, it is suggested that research on the financial viability of adopting technologies based on the Internet of Things and the creation of business models are carried out in order to provide sustainability of the possible businesses based on this type of technology.

In order for the future of the Internet of Things to be promising, there is also a need for research that helps building public policies, laws and regulations that provide subsidies to governments and international organisations that can regulate the use of applications guaranteeing security of information, the right to privacy and free access of the user. In this sense, for such research to take place and the perspectives on IoT to be achieved as Dutton (2014) emphasises, the potential of IoT in all sectors of society needs to be valued. In this sense, corroborating other authors discussing this issue (Valéry, 2012; Li et al, 2014; Dutton, 2014; Pang et al., 2015), the present paper concludes that the Internet of Things should be understood as a new technological position that opens new and significantly improved possibilities. Those possibilities can be applied in different contexts, both in domestic or business environments.

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