Internet of Things as an Approach of Evolutionary Practice in Computer Applications

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Abstract:-- **The Internet of Things is a paradigm where everyday objects can be equipped with identifying, sensing, networking, and processing capabilities that will allow them to communicate with one another and with other devices and services over the Internet to accomplish some objective. Internet-of-Things envisions a future in which digital and physical entities can be linked, by means of appropriate information and communication technologies, to enable a whole new class of applications and services.**

The title of this paper may suggest different networking strategies, but we focus on latest research angles regarding the Internet of Things (IoT). These research angles includes all other disciplines and are in the process of being adopted by the IoT. Our paper serves a key purpose: from the perspective of closely connected technologies based on time, to review the evolutionary process of the IoT and depict the relations between the corresponding techniques which are largely missing in current literature in which the focus has been more on the introduction and comparison of existing technologies of the IoT. Through relations of particular focus in different stages of each technology, we get to know the current phase of the IoT and we can face future challenges. This paper aims to provide guidance in terms of the evolutionary process of the IoT and gives readers an overview of the IoT field without repeating what is already available in existing strategies.

***Index Terms*—IoT, evolution, M2M, architecture, WSN, WoT.**

I. INTRODUCTION

The Internet of Things may be a hot topic in the industry but it's not a new concept. In the early 2000's, Kevin Ashton was laying the groundwork for what would become the Internet of Things (IoT) at MIT's Auto ID lab. Ashton was one of the pioneers who conceived this notion as he searched for ways that Proctor & Gamble could improve its business by linking RFID information to the Internet. The concept was simple but powerful. If all objects in daily life were equipped with identifiers and wireless connectivity, these objects could be communicating with each other and be managed by computers. In a 1999 article for the RFID Journal Ashton wrote:

"If we had computers that knew everything there was to know about things—using data they gathered without any help from us -- we would be able to track and count everything, and greatly reduce waste, loss, and cost. We would know when things needed replacing, repairing or recalling, and

Whether they were fresh or past their best. We need to empower computers with their own means of gathering Information, so they can see, hear an smell the world for themselves, in all its random glory.RFID and sensor technology enable computers to observe, identify and understand the world—without the limitations of human-entered data."

At the time, this vision required major technology improvements. After all, how would we connect everything on the planet? What type of wireless communications could be built into devices? What changes would need to be made to the existing Internet infrastructure to support billions of new devices communicating? What would power these devices? What must be developed to make the solutions cost effective? There were more questions than answers to the IoT concepts up to now. The IoT has been launched as demonstration applications in different fields, including intelligent industry, intelligent agriculture, intelligent logistics [1], intelligent transportation [2], smart grid [3], environmental protection, security protection, intelligent medical care, smart home, and smart cities as in figure1.

Figure 1: Applications of IOT in different fields

The motivation of this paper is as follows... We aim to review the evolutionary process of the IoT. We conducted this from the perspective of correlative technologies and present the process in a chronological order. Through generalizations of particular focus in different stages of each technology, we can better understand the current phase of the IoT, and therefore predict future challenges. Information on evolving the IoT into the Web of Things is missing in the current literature. It focuses more on the introduction and comparison of existing technologies and less on the evolutionary process of the correlative technologies. We feel that the latter is crucial to understanding the evolution of the IoT.

The rest of the paper is organized as follows, we generalize the evolutionary process (in chronological order) of the IoT from the perspective of correlative technologies and depict the relations between the correlation techniques which are largely missing in current literature some research angles regarding technologies, applications, architecture, platforms, prototypes, existing problems, and future challenges of the IoT are summarized in existing researches.

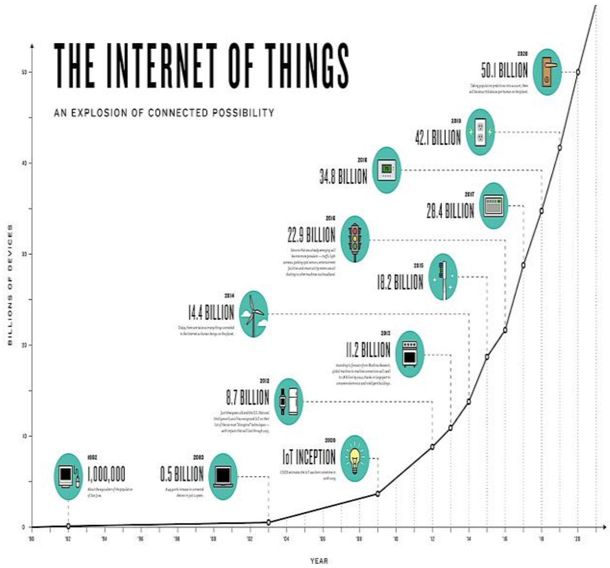
II. EVOLVING IOT INTO WEB OF THINGS:

The Internet of Things (IoT) is rapidly evolving. There is a need to understand challenges in obtaining horizontal and vertical application balance and the key fundamentals required to attain the expected50 billion connected devices in 2020. The IoT creates an intelligent, invisible network fabric that can be sensed, controlled, and programmed. IoT-enabled products employ embedded technology that allows them to communicate, directly or indirectly, with each other or the Internet.

Nowadays, the constant expansion of the Internet leads to more extensive network coverage. In addition to raising the level of the integrated circuit manufacturing process, modern wireless communication technology has steadily improved. Many electronic devices have a communication function, and research on wireless sensor networks (WSNs) began in the late 1990s in the United States and other countries. Today, the number of devices able to access network continues to increase. With the tendency of fast growth, we see the future of the IoT tentacles to be extended to all aspects of people’s lives.
In the subsections that follow, we review the chronological development of the IoT from the perspective of correlative technologies. Through generalizations of particular focus in different stages of each technology, we can better understand the current phase of the IoT and foresee the challenges to be faced in the future. Discussion of evolution of the IoT into the Web of Things is missing in the current literature, which instead has focused on the introduction and comparison of existing technologies and less on the development process of the correlative technologies, which are crucial to understanding the evolution of the IoT.

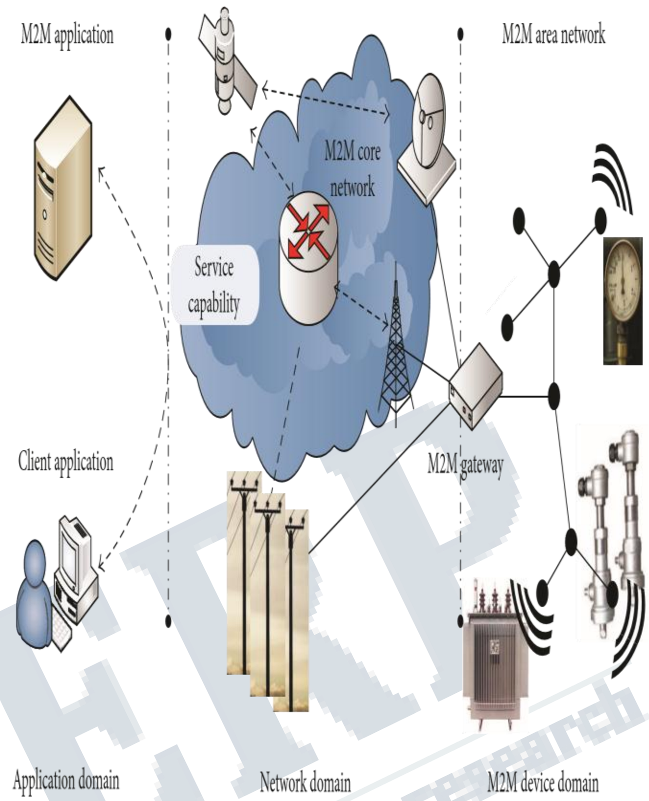
Figure 2: Expected evolution in IoT

The growth chart of IOT (current expected):



III. MACHINE-TO-MACHINE COMMUNICATION:

Machine to machine refers to direct communication between devices using any communications channel, including wired and wireless. Machine-to-Machine (M2M) Communication refers to the interconnection and interoperability between machines. More recent machine to machine communication has changed into a system of networks that transmits data to personal appliances. As shown in Figure 3, M2M communication is typically achieved by data exchange through wireless network transmission and backend content servers. The sensory data is collected by sensors fixed in device, transmitted by various types of network, and then processed in M2M applications as illustrated in Figure 3 in which the dataflow is from right to left side of the figure. From the perspective of M2M communication, the machine can automatically complete the communication process without human intervention. In this field, many organizations perform relevant work and develop standards, for example, the 3rd Generation Partnership Project (3 GPP); however, at this stage, standards have just been completed or remain partially completed, for example, the definition of M2M, service requirements, and functional structure. In 2010, 3GPP launched the radio access network for M2M communication. Heterogeneous networks consisting of M2M communication appear in many application areas. In the future, 3G and 4G wireless technologies will play an important role by virtue of their higher data transmission rates, satisfying the needs of more M2M application services.



3: machine-to-machine communication system architecture

M2M communications can be realized separately within various wireless networks, such as mobile cellular networks, wireless local area networks, and WSNs [4]. One of the most important components of M2M communication is WSN.

IV. WIRELESS SENSOR NETWORKS:

A WSN is composed of a large number of self-organizing sensor nodes that are deployed in free space by a given distribution. The sensors work together to complete the monitoring of specific surrounding environmental conditions, including temperature, humidity, chemical composition, pressure, sound, displacement, vibration, and contamination particles[5] . The primary goal of collecting data from the surrounding environment is for us to understand the given conditions and enable applications to better make automatable decisions with the assistance of specified rules.

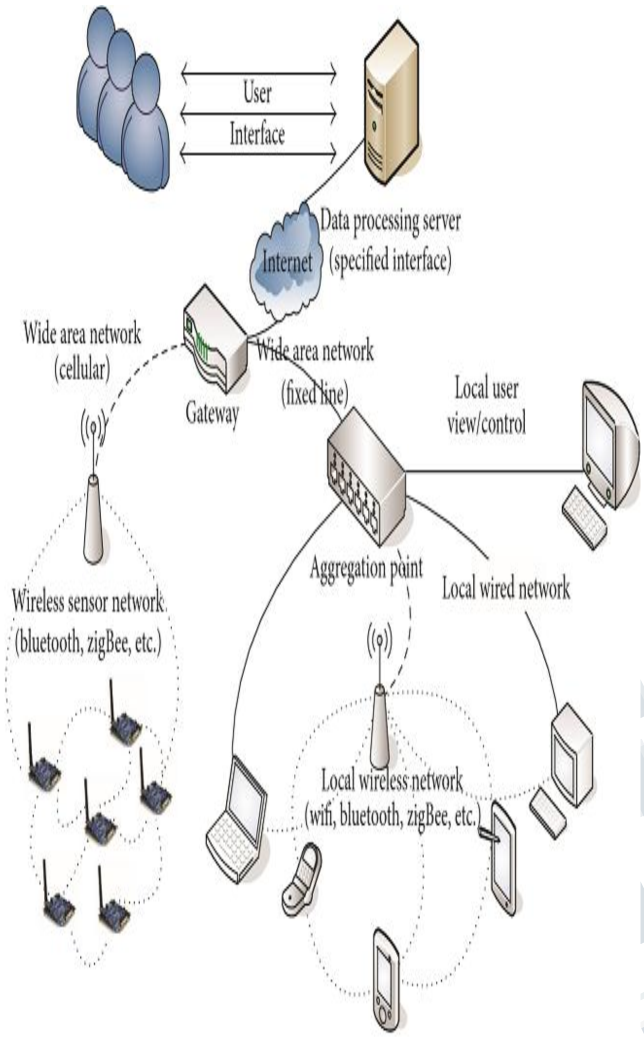


Figure 4: Wireless sensor networks outline

V. WEB OF THINGS:

The Web of Things (WoT) is a computing concept that describes a future where everyday objects are fully integrated with the Web. The prerequisite for WoT is for the "things" to have embedded computer systems that enable communication with the Web. Such smart devices would then be able to communicate with each other using existing Web standards. With the development of the Web, the traditional Web 2.0 will inevitably evolve to cope with the heterogeneity of data, networks, and devices. The concept of the Web of Things (WoT) has been proposed and developed. The WoT not only enables smart devices to share information and interoperate with the web but also introduces numerous electronic devices or sensors as services on the web.

The WoT shortened the distance between the virtual and physical worlds by complementing the conventional web with physical sensors. The WoT uses a standardized application protocol (HTTP) instead of a transport mechanism to provide a means for sensors to connect with the Internet. The WoT [6] started with smart gateways running a web server that provided access to different devices in a restful manner [7].

Above the level of transmission data, the WoT depicts data streams from the physical world as Web Service (WS) [8]. By interacting with conventional WS, we can discover, compose, and execute different WS in different application development. There are two optional methods for integrating with the web: direct and indirect integration [9]. The direct integration approach requires devices to have good hardware performance so that the devices can be addressed as IP enabled with a web server embedded directly in the device. Kovatsch et al. proposed an architecture called Actinium, providing a runtime container that supports the Restful programming model by using the constrained application protocol (CoAP) [10]. In Actinium, applications can be created by simply mashing up resources provided by CoAP servers on devices and classic WS.

Using the indirect approach to integrate with the web, devices are resource-constrained and are not powerful enough to run a web server. In such cases, an intermediate proxy is established between the devices and web. The proxy is used as a web server gateway to communicate with other web servers. Using the proxy, we can also integrate heterogeneous data as WS, such as from RFID or sensor data.

VI. SEMANTIC SENSOR NETWORKS:

With the scale of WSNs increasing, the compositions of such networks change more rapidly. Furthermore, an increasing number of types of sensors are being added to these networks. To solve the problems of variability and heterogeneity in WSNs, some researchers have proposed a new field of study called semantic sensor networks (SSNs).

The approach with SSNs is to abstract the data and explain its meaning. To better understand the meaning of sensor data, semantic technologies and ontologies have been introduced into this field, thus improving semantic interoperability and integration. This also facilitates automated reasoning and classification tasks not addressed in the OGC standards.

Sensors were abstracted and described in ontologies with results to be organized, managed, queried, understood, and controlled via high-level specifications. From 2009 to 2011,, the W3C Semantic Sensor Network Incubator Group produced ontologies that define the capabilities of sensors and sensor networks. The group also developed semantic annotations of a key language used by services-based sensor networks. In the final report of the W3C Semantic Sensor Network XG [11], published in June 28, 2011, a set of ontologies have been developed and studied to describe sensors and sensor networks for use in sensor network and sensor web applications.

VII. EVOLUTION AMONG TECHNOLOGIES:

IoT represents the next evolution of the Internet, taking a huge leap in its ability to gather, analyze, and distribute data that we can turn into information, knowledge, and, ultimately, wisdom. In this context, IoT becomes immensely important.

The evolution of sensors, starts from SNs, SWs, WoT, and SSNs. These technologies come from other disciplines and are in the process of being adopted by the IoT based on time, to review the evolutionary process and depict the relations between the correlation techniques which are describing evolutionary process of the IoT.

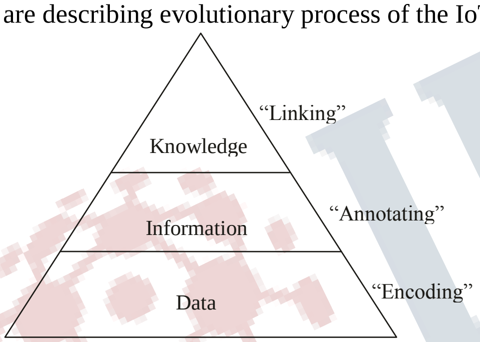


Figure 5: Development trend of core concerns of every Stage

Standards are promoted by different standardizing bodies which change from communication technology domain to information technology domain.

The fundamental difference in core concerns of every stage lies in finer granularity processing and more sufficient utilization of data. The change of core is elaborated further as extend gradually to incisive connotation of data. We can grasp the meaning of development trend in the perspective of data levering by Figure 5 in which preliminary stage is at the bottom and current stage is at the top. In preliminary, sensor devices, and sensor network, it addresses the major issue of encoding of raw sensory data; therefore we name the formatted raw sensory data as data in Figure 5. In the next stage, namely, sensor web and the Web of Things, it annotates the raw sensory data with various labels and tags. After that, the data possess the ability of self-explanation and interactivity with context; therefore we name the data as information in Figure 5. In the current stage, namely, Semantic Senor Network, it establishes broader and more comprehensive relationship with massive data which is generally from heterogeneous sources; therefore here we name the data as knowledge in Figure 5.

IoT is neither science fiction nor industry hype but is instead based on solid technological advances and visions of network ubiquity that are zealously being realized. A one fold technology cannot satisfy the IoT requirements we consider that the IoT is convergence of the six emerging technologies at least. The relations between M2M communication, SSNs, the WoT, the IoT, SNs, SSW, and SW which are the constitutive elements of the IoT are depicted in Figure 6. In, Atzori et al. summarized these relations as three visions of the IoT; they are things-oriented, semantic-oriented, and internet oriented visions

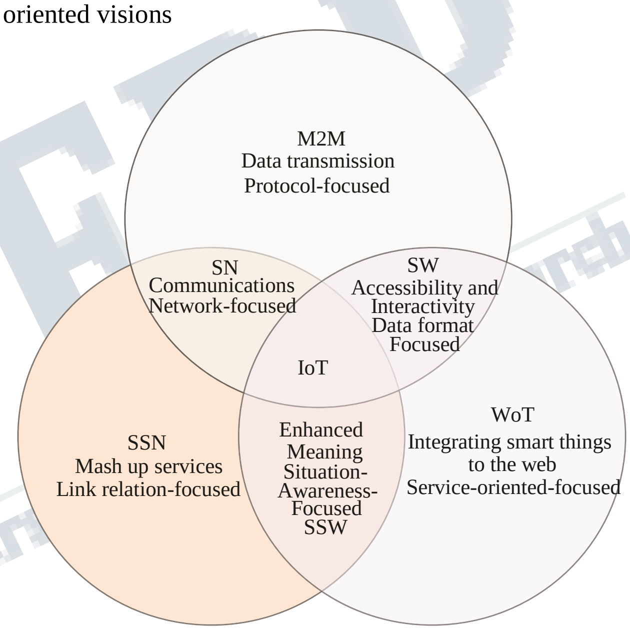


Figure 6: Relations between M2M Communication, SSNs, the WoT

VIII. OTHER IOT SURVEYS IN A NUTSHELL:

For completeness purpose, these aspects that have been covered by existing literature are briefly summarized with explicit references to the corresponding survey papers. This section gives readers a panoramic view of the IoT field without repeating what is already available in the literature. Miorandi et al. provided an overview of key technologies, applications, impact areas, related ongoing initiatives, and security for the IoT. Gubbi et al. [12] also summarized IoT technologies and applications, pointing out future challenges and directions; however, they focused on a cloud centric vision and presented Aneka, a user-centric cloud based model based on interactions within private and public clouds. Atzori et al. reported different visions of the IoT paradigm and reviewed related enabling technologies. Gluhak et al. identified requirements for the next generation of IoT experimental facilities, giving a taxonomy of applications.

This taxonomy had nine requirements, which were scale, heterogeneity, repeatability, federation, concurrency, experimental environment, mobility, user involvement, and impact. After comparing between different IoT applications, Gluhak et al. found that these applications did not fully satisfy the requirements, with the development of the Web, the traditional Web 2.0 will inevitably evolve to cope with the heterogeneity of data, networks, and devices.

The WoT survey papers [10,11], referring to the WoT, discussed the inevitability of the appearance of the WoT and proposed their views regarding the architecture and key enabling technologies. Inspired by the material cycle of the physical world, Zhong et al. [12] proposed the concept of the Wisdom Web of Things (W2T), which aims for a harmonious coexistence of humans, computers, and smart things in the emerging world. Zeng et al. [9] noted the trend of viewing the IoT as the WoT with open web standards supporting information sharing and device interoperation.

Context awareness has been a practical solution for helping us understand the raw data produced by large numbers of IoT devices. Perera et al. [11] surveyed context awareness from an IoT perspective, provided an in-depth analysis of context lifecycle, and evaluated a subset of 50 projects from 2001 to 2011 based on their own taxonomy.

Semantic technologies may help solve the problem of interoperability among heterogeneous embedded devices in the IoT. Hence, they reviewed recent developments in applying semantic technologies to the IoT, including information modeling, ontology design, and semantic data processing.

The IoT emphasize connecting every object around us by leveraging a variety of wireless communication technologies. These objects are typically referred to as "smart objects." Several middleware's were proposed for smart objects. In [11], the authors present a review of middleware's for smart objects and compare them according to the most important general and specific requirements that have been identified in the literature so far.

In 2014, an interesting study [11] analyzed the opportunity of integrating the concept of social networks into the IoT. In this paper, the researchers presented major ongoing research activities and classified three evolutionary stages of the objects comprising the IoT.

IX. CONCLUSION:

The reaches of the Internet have extended to all aspects of people's lives and drastically changed how we live. The IoT is considered as the next big leap ahead in the ICT sector, because it does not merely include the connectivity of smart things but it focuses more on the interactions and interoperations between things and people. Through the massive deployment of embedded devices, the IoT may see the vision of "anytime, anywhere, anything" communications realized. The IoT aims to seamlessly merge the real and virtual worlds such that tomorrow's world will be a fusion of human life and information.

The IoT is the combination of multiple techniques; a one fold technology cannot become the IoT. In this paper, we summarized the development of the IoT from the perspective of correlative technical development according to time. Through generalizations of particular focus for different stages in the study of each technology, we can better understand the current development stage of the IoT and predict key points of its future development. We consider core concern of the loT in future which is to facilitate utilization of data in finer granularity.

We hope that this survey has served to be useful to researchers and practitioners in the field, helping them to understand the history and motivation of the IoT. Predictably, the IoT will grow into information infrastructure in people's future lives. Therefore, more efforts to tackle these challenging issues must be made from both industry and academia to promote the progress and realization of the IoT.

REFERENCES

[1] X. Wang, W. Li, Y. Zhong, and W. Zhao, "Research on cloud logistics-based one-stop service platform for logistics center,"in *Proceedings of the IEEE 16th International Conference*, May 2012.

[2] Y. Yuxiang and X. Chenxue, "A development analysis of China's intelligent transportation system," in *Proceedings of the IEEE and Internet of Things and IEEE Cyber, Physical and SocialComputing (iThings/CPSCom) and IEEE Cyber, Physical and Social Computing*, pp. 1072–1076, 2013.

[3] D. Han, J. Zhang, Y. Zhang, and W. Gu, "Convergence of sensor networks/internet of things and power grid information network at aggregation layer," in *Proceedings of the International Conference on Power System Technology (POWERCON '10)*, pp. 1–6, October 2010.

[4] K. A. Delin, "The sensor web: a macro-instrument for coordinated sensing," *Sensors*, vol. 2, no. 7, pp. 270–285, 2002.

[5] Microsoft's "Sensor Web" Project, http://research.microsoft .com/en-us/projects/senseweb/.

[6] L. Lefort, C. Henson, K. Taylor et al., "Semantic sensor network XG final report," W3C Incubator Group Report 28, 2011.

[7] P. Barnaghi, W. Wang, C. Henson, and K. Taylor, "Semantics for the internet of things: early progress and back to the future," *International Journal on Semantic Web and Information Systems*, vol. 8, no. 1, pp. 1–21, 2012.

[8] C. C. Aggarwal, N. Ashish, and A. Sheth, "The internet of things: a survey from the data-centric M. Compton, P. Barnaghi, L. Bermudez et al.perspective," in *Managing and Mining Sensor Data*, C. C. Aggarwal, Ed., pp. 383–428, Springer, New York, NY, USA, 2013.

[9] M. Botts, G. Percivall, C. Reed, and J. Davidson, "OGC sensor web enablement: overview and high level architecture," in *GeoSensor Networks*, vol. 4540 of *Lecture Notes in Computer Science*, pp. 175–190, Springer, Berlin, Germany, 2008.

[10] J. Gubbi, R. Buyya, S. Marusic, and M. Palaniswami, "Internet of Things (IoT): a vision, architectural elements, and future directions," *Future Generation Computer Systems*, vol. 29, no. 7 , pp. 1645–1660, 2013.

[11] D. Guinard, V. Trifa, F. Mattern, and E. Wilde, "From the internet of things to the web of things: resource-oriented architecture and best practices," in *Architecting the Internet of Things*, pp. 97–129, Springer, New York, NY, USA, 2011.

[12] C. Perera, A. Zaslavsky, P. Christen, and D. Georgakopoulos, "Context aware computing for the internet of things: a survey," *IEEECommunications Surveys & Tutorials*, vol. 16, no. 1, pp. 414–454, 2014.