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IoT: The Age of Machine

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Abstract— IoT is not just a technology but it is an ideology or a concept which leads to a new age that is age of machine. IoT is the key to fully digitalize the world. Move towards IoT will revolutionise human life where machine-to-machine communication is emphasized and human interaction is minimized. IoT demands everything on internet and be controlled and managed by machine itself. The goal of this paper is to give an imagination and a Skelton of IoT. This paper also highlights the challenges in IoT implementation and other critical issues.

Keywords— IoT, age of machine, smart objects, IoT challenges, automation, architecture, open loop, RFID.

INTRODUCTION

The term IoT was first coined by Kevin Ashton in 1992 [7]. IoT don't have any exact or wildly accepted definition. We can explain IoT by saying that "IoT is a network of things, where thing refers to a smart object. Objects are embedded with electronics, software, sensors, and network connectivity, which enable these objects to collect and exchange data [7]. The idea is to connect every object via Internet and make them communicate. IoT is expected to offer advanced connectivity of devices, systems, and services that goes beyond machine-to-machine communications (M2M) and covers a variety of protocols, domains, and applications [12]. To do so, creating a new framework, infrastructure or technology is not feasible. So, IoT implementation needs to use existing infrastructure as well as existing technologies. IoT architecture has not been standardized yet as it will depend on involved technologies and scope of application.

Evolution Towards IoT

Internet started its journey by connecting computers where WWW was the top level service. Introducing social networking made revolution and connect people via internet [6]. Future internet will connect smart things which will be "internet of things". Moving towards "internet of computer" to "internet of things" involves many other technologies. IoT will require two main functions: Identification and networking. For identification purpose, RFID, NFC, barcodes and QRCode plays an important role [9]. RFID is considered as a batter candidate for object identification [1]. Evolution in network technologies like GPRS, GSM, UMTS, Wifi, WiMax, 3G and 4G change the human life style. IoT may use these technologies to connect things [5].
In a 2005 report the International Telecommunications Union (ITU) suggested that the "Internet of Things will connect the world's objects in both a sensory and intelligent manner" [8]. By combining various technological developments, the ITU has described four dimensions in IoT: item identification ("tagging things"), sensors and wireless sensor networks ("feeling things"), embedded systems ("thinking things") and nano-technology ("shrinking things").

IoT and Artificial Intelligence

It should be noted that, IoT does not possess any kind of decision making algorithm unlike AI. Ambient intelligence and autonomous control are not part of the original concept of the Internet of Things [7]. But IoT can be considered as the first step to AI. Protocols in IoT should have rigid boundary for decision making based on predefined algorithms and so it do not possess any intelligence.

Architecture of IoT

IoT architecture has not been standardized yet. But it should be event-driven and follow bottom-up approach (based on the context of processes and operations, in real-time)[7]. Basic and architecture of IoT is considered of three layers: (1)Perception layer (2)Network layer (3)Application layer [4]

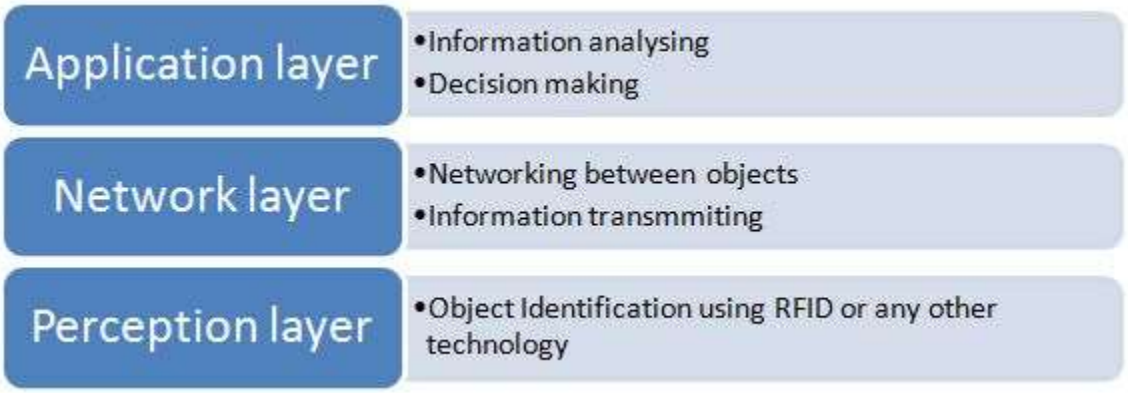

Figure 1: IoT Architecture

(1) **Perception layer:** Do object identification and information gathering using edge technology like RFID, Barcodes, NFC and sensor networks
(2) **Network layer:** The main function is to transmitting and processing information
(3) **Application layer:** This layer is combination of IoT's social division and industry demand to realize the extensive intellectualization. Processed information is analyzed and decisions are made

IoT architecture should possess the characteristics of SOA. However, some Basic requirements of Architecture of IoT are as follows:

(1) **Open loop:** closed loop architecture is design for particular application or particular technology and has boundary in its acceptance. For example traditional RFID architecture is closed loop where set of tags can only be read by set of readers [1]. One should relax this boundary by making the elements of architecture generally acceptable and by widen the scope of application.
(2) **Scalable:** in very near future there are millions of object will be deployed over internet and the growth rate is exponential. So the architecture must be enough scalable to accommodate all the objects without affecting the performance and efficiency of network.
(3) **Adaptable:** IoT need to accommodate and adapt existing technology as well upcoming technologies to achieve the goal. All applications do not of same types and so, based on demands and requirements IoT should adapt change in its architecture also.
(4) **Flexible:** To deal with different objects and process their information is very essential. Architecture should be flexible enough to deal with heterogeneous objects.
(5) **Reliable:** In IoT everything is on internet and communication is also through internet. Architecture should be reliable enough for object identification and message delivery

Challenges:

IoT demands open loop architecture which leads to expose everything to public. As well attacker may get more area to exploit.

(1) **Authentication:** object identification is the main function in IoT where authentication is critically important. Traditional cryptographic schemes are not appropriate for IoT [1][2]. Technology like RFID need very secure and lightweight authentication. In case of machine-to-machine communication, failure of authentication raises many problems and makes the architecture vulnerable to many kinds of attacks. Authentication is must for reliable communication.
(2) **Identity and privacy preservation:** open loop architecture exposes the identity to public which need to be preserved from misuse. Also, privacy must not be compromised. The question "who can access what" has a significant role in IoT[6]. Here who relates with identity and what relates with privacy.
(3) **Standardization:** IoT will deal with heterogeneous systems and networks. So, the role of each and every entity as well as the rules related to them should be defined and standardized [6]. Malfunction, anonymous and inefficient activity must be regulated by standardizing them.
(4) **Data flow:** IoT will consist billions of object. Information exchange between them produces tremendous traffic over internet. Regulate and analyse this traffic is very difficult but essential also.
(5) **Power consumption:** IoT will work on 6LoWPAN [7]. So, existing cryptographic scheme will solve many security issues but they are power consumptive which are not accepted in IoT. So, we cannot use them directly as they are. It is expected that IoT devices will be integrated into all forms of energy consuming devices [7]. Among cryptographic schemes, asymmetric key cryptography is more power consumptive than symmetric key cryptography [3]. Hash

functions are faster and will be the good choice for message authentication purpose rather than other cryptographic techniques [10].

The age of machine: criticism

In spite of the challenges discussed above, world move towards IoT rapidly. South Korea, Denmark and Switzerland have 37.9, 32.7 and 29 IoT devices online per 100 inhabitants respectively where as India have 0.6 devices online per 100 inhabitants [7]. IoT have billions of objects connected via internet. As well those are controlled and managed by the machine itself. Today also, people are machine dependent. They need machine in each and every step of life from day start to day end. One step ahead, IoT will make all these machines communicate with each other. In Today's life, machine is necessary but tomorrow, it will be the habit and the day after it, machine will be the synonym of life. In a different meaning, it will be the raise of machine age where machine will control the world. In a January 2014 article in Forbes, cybersecurity columnist Joseph Steinberg said that internet connected application can spy you in your own home [11] and IoT will play significant role in this if IoT will be implemented in its true meaning. Working principles of machine are different from human being as machine's decisions are rigid and lacking in intelligence. If our routine decisions will be made by machines then it will make human life more complex and complicated. Machine's decision is irrespective of human desire and may lead to unwanted and unnecessary events. This can be solved if we bring IoT and Artificial Intelligence together but this solution will raise many questions.

CONCLUSION

IoT is coming with lots of challenges, controversies and criticisms. It will save time and human effort but also makes human life machine dependent. RFID is a pivotal technology for object identification. To enable IoT, architecture should be made open loop and adaptive.

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