Interconnected Smart Objects: Era of Internet of Things

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Abstract- **In this paper we have discussed about the very basics of Internet of things. The main objective of writing this paper is to put light on the impact of Internet of Things around the world. This paper discusses different application areas of IOT along with its characteristics. This paper also discusses about the challenges to implement internet of things.**

Index Terms- **Internet of things, Sensor networks, Characteristics of Internet of things, Smart objects.**

I. INTRODUCTION

'United we stand, divided we fall.' This early day's quote can be viewed in this era of technology as:-

"Connected we live, detached we expire."

Think of your one day without your smart phone or computing machine without internet. It would be really difficult to utilize your time. Internet has made all of us so dependent on it that most of our daily tasks are based on the net connection we have. These days we talk less and message more may be on whatsapp to stay connected with our friends, colleagues and all. The moment net connection goes off; we feel isolated and helpless to communicate, life seems ending then. This is a very ground level example to visualize the power of internet connectivity in context with Internet of Things. When it comes to Internet of things, see yourself controlling your computer at your home remotely using your smart phone through internet; or getting message alerts about who entered your house in your absence. This is the power of Internet of Things.

Internet has influenced almost all spheres of daily lives and then internet mated with technologies like, embedded information technology, to give boom to Internet of things. "Things" here are the objects which are smart. Smart in the sense that the acquire knowledge as an outcome of embedded information technology.

The term Internet of Things, was first coined by Kevin Ashton [3] in a presentation in 1998. He has mentioned "The Internet of Things has the potential to change the world, just as the Internet did. Maybe even more so". The hub of the Internet of things is machine to machine communication. To date, the world has deployed about 5 billion "smart" connected things. Predictions say there will be 50 billion connected devices by 2020 and in our lifetime we will experience life with a trillion-node network [1].

II. EVOLUTION

Before exploring 'Internet of Things' in depth, it is meaningful to glance at the evolution of the Internet. It started in 1960s, when two computers were made to communicate through a computer network. Then in 1980s the TCP/IP stack was introduced. Then, in the late 1980s, commercial use of the Internet started. Later, in 1991, the World Wide Web (WWW) became accessible making Internet popular and stimulate the rapid growth. Shortly, mobile devices united with the Internet and produced the mobile-Internet. With the emergence of social networking, users started to become connected together over the Internet. And then, objects around were able to connect to each other and correspond via the Internet. It is about M2M communication.

These phases can be seen through other perspective also, the way of utilization of network (Figure 1). If we look inside the phases, we can easily make out that in the first phase; only documented information was being communicated over the internet, so we can term it as Internet of Documents (documented webpages, e-libraries). In the next phase utilization expanded towards e-commerce, stock trading, e-banking etc and the web became web of commerce. Next came Web 2.0, internet got flooded with applications and then internet was in the era of applications and their utilization. Shortly after people too got into the web through social networking and all; and internet transformed into people's internet. It was through these two phases, that internet of things started taking shape actually. And finally with smart objects machines and devices too got connected with each other and communication started in between them, through this the 'Internet of Things' entering into its adult age. Still much more to be added into it lies in the near future.

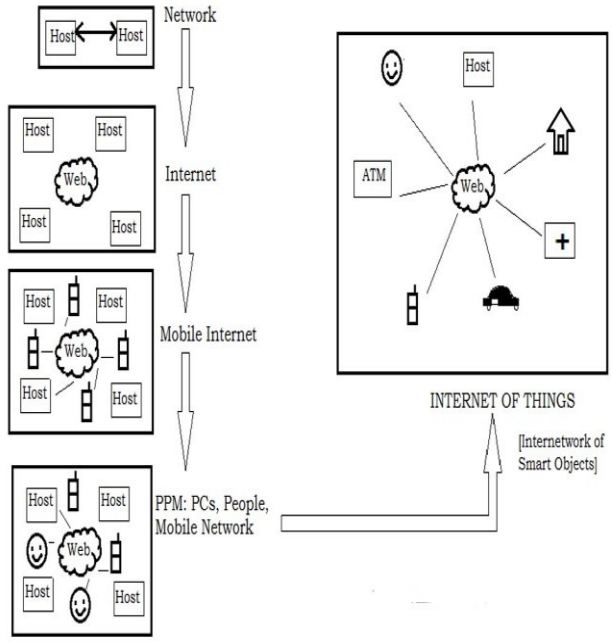

Fig. 1 Phases leading to the birth of Internet of Things.

III. DEFINING INTERNET OF THINGS

The Internet of Things was formally introduced by the International Telecommunication Union (ITU) by the ITU Internet report in 2005[7]. The expression 'Internet of Things' was coined first by Kevin Ashton [3] in a presentation in 1998. He has mentioned "The Internet of Things has the potential to change the world, just as the Internet did. Maybe even more so". Then, the MIT Auto-ID centre presented their IOT vision in 2001[6]

All through the last decade, the Internet of things has gained sufficient consideration in academia and industry. The core reasons for this attention are the offers and capabilities, IOT provides and will be providing in the future too. With IOT, world be a network of different smart objects connected over internet and these smart things will be communicating with each other with least inputs from human beings. Smart objects would be around us, knowing about our likes, wants needs. There isn't any typical definition for Internet of Things. Following are few definition given by different researchers.

Definition by T. Lu and W. Neng [4]: "Things have identities and virtual personalities operating in smart spaces using intelligent interfaces to connect and communicate within social, environment, and user contexts."

Definition by European Commission, [2]:"The semantic origin of the expression is composed by two words and concepts: Internet and Thing, where Internet can be defined as the world-wide network of interconnected computer networks, based on a standard communication protocol, the Internet suite (TCP/IP), while Thing is an object not precisely identifiable Therefore, semantically, Internet of Things means a world-wide network of interconnected objects uniquely addressable, based on standard communication protocols."

Definition by P. Guillemin and P. Friess[5]:"The Internet of Things allows people and things to be connected Anytime, Anyplace, with Anything and Anyone, ideally using Any path/network and Any service."

IV. SPHERE OF APPLICATIONS

The Internet of Things will facilitate connectivity not only among people and computing machines, but between actual, daily things. By enabling connectivity for virtually any physical object that can potentially offer a message, the Internet of Things will affect every aspect of life and business in ways that used to be the sphere of dreams- in fact more than that. The IOT, interconnection and communication between everyday objects, enables many applications in many domains.

The application areas can be mainly divided in to three categories based on their focus [23], [9]:

1. Industry: Few Industry focused application areas of IOT are Supply chain management[10], transportation and logistics[11], aerospace, aviation, and automotive
2. Environment: Recycling, ecological monitoring, disaster management and alerting are some of the environment focused application areas.
3. Society: Telecommunication, medical technology [12], healthcare, smart building, home [13] and office, media, entertainment, and ticketing are some of the society focused applications of IOT.

Total of 50 application domains have been listed by Asin and Gascon[8] under twelve categories. These categories are: - smart cities, smart environment, smart water, smart metering, security and emergencies, retail, logistics, industrial control, smart agriculture, smart animal farming, domestic and home automation, and e-Health.

V. INSIDE APPLICATION DOMAIN

In this section, we have taken three examples one from each category, to explain.

Industry: transportation
Vehicles with embedded sensors, gathering real time information from government organizations and agencies and about road conditions. These smart sensors will also be gathering the history of the vehicles and roadsides between the user and the destination, along with the speed of the vehicles on the road. With this information the sensor will advise the user which route to take, and how many minutes it will take. These smart vehicles will be aware of dangers and practical in making semi independent decisions. Such smart vehicles will reduce the accident rates. The co-operation of travelers and manufacturers of vehicles is required so as to equip the vehicles with the latest traffic and pollution monitoring and road safety technology. Vehicular Ad Hoc Networks, Car-to-Car Communication Intelligent Transportation Systems (ITS) are a few to name, as a part of IOT in the domain of transport.

Environment: Environmental monitoring
Applications within this realm are of crucial importance to the scientific community and society. Thousands of square kilometers of geographical areas may be supervised and the duration for this can be years. Application scenarios envisage that cooperating objects will monitor vegetation growth and air/water quality, oil spills and will coordinate (e.g statistical sampling and data filtering) to create a big picture of natural spaces. Because of the large-scale aspect, natural disasters such as prominent flooding and earthquakes could be anticipated through improved models of the global environment. Authorities would be alerted and actions taken quickly to respond to natural disasters. Also, the management of the population's waste could be efficient and sustainable leading to higher life quality and less costs for the city authorities. Financial incentives may be employed to encourage the correct disposal. Carbon emissions and absorption would be measured or estimated in order to charge/ration citizens according to their consumption. Individual scan receive carbon debits for their use of energy and carbon credits for clean energy that they generate, for example, by investing in wind farms and for carbon-absorption activities including trees and other vegetation planted or invested in. Carbon debits are then converted to a tax on the individual. The direct benefits are increased environmental and public health gains. There are the risks, however, of privacy loss and fraudulent interference with sensor systems.

Society: home and office
Consider a scenario you have a garden in your house or in the office a balcony garden, u need not to worry about when to water your plants and all. The smart object in the garden will check for the PH levels, humidity and water levels of the garden and might be the sprinkler connected along with, waters them up automatically when required.
Your electricity consumption and water utilization can also be captured and monitored and also analyzed based on smart objects implanted on electricity meters and water tanks. This data then give back reports on excess use and also about repairs required in plumbing system.
Your dog wearing smart object collar at home, u can view on a mobile app, sitting away from your home, about the eating habits of it and you can know what your pet is doing exactly. Think of a smart parking in your office or at shopping complex. There will be sensors either mounted on the pavement or on the ceiling of the parking spaces. These sensors are collecting data about the available space for parking. This data is provided to the parking space operator, where it can be shown or displayed about the place available for parking and also about the details of filled spaced, number of vehicles parked etc. this information can also be send to the user through internet on their mobile applications.

VI. CHARACTERISTICS OF IOT

IOT consists of all that a device network is formed of and a layer or 2 of arthropod genus or computer code element so the abstract devices like pc or mobile or cloud. IOT cannot work while not sensors and actuators. As main purpose of victimization sensors, is to gather knowledge. Sensors area unit being embedded on the thus referred to as sensible objects to form them sensible. Sensors method the {information} collected and additionally create selections supported the knowledge supplemental into the sensible object (embedded information technology) and therefore the call taken is then performed by the actuators. Same sensors will be wont to support completely different applications in IOT with the utilization of various arthropod genuses. For instance pressure sensors used for structural health observance, could also be of a bridge, will be wont to establish the traffic rates additionally.

The major characteristics within the IOT will be named [9]: intelligence, design, complicated system, size concerns, time concerns, area concerns, and everything-as-a-service. These characteristics ought to be thought of once developing IOT solutions throughout all the phases from style, development, implement and analysis.

Intelligence: This suggests the appliance of data. First the information must be generated by aggregation knowledge and reasoning it. Reworking the collected information into information (high-level information) will be done by aggregation, modeling, and reasoning the context. Context will be modeled to fuse device knowledge along to infer new information. Once we have got the information, it will be applied towards additional intelligent interaction and communication.

Architecture: IOT works on three-layer design, within which multiple device networks area units are connected along over the web. IOT ought to be expedited by a hybrid design that includes various alternative architecture. Primarily there would be 2 architectures: event driven [51] and time driven. Some sensors turn out knowledge once an occurrence happens (e.g. door sensor); the other sensors turn out knowledge continually, supported specified time frames (e.g. temperature sensor).

Complex system: The IOT includes an oversized range of objects (sensors and actuators) that act autonomously. New objects can begin communication and existing ones can disappear. Currently, there are unit uncountable sensors deployed round the world [53]. Interactions might take issue significantly counting on the objects capabilities. Some objects might have only a few capabilities, and in and of itself store terribly restricted data and do no process in any respect. In distinction, some objects might have larger memory, processing, and reasoning capabilities, that create them additional intelligent.

Size considerations: It has been foretold that there will be 50-100 billion devices connected to the web by 2020 [9]. The IOT must facilitate the interaction among these objects. The numbers can grow incessantly and can never decrease the same as the quantity of objects and range of interactions can also increase significantly.

Time considerations: The IOT may handle billions of parallel and coinciding events, because of the huge range of interactions. Period processing is crucial.

Area considerations: The precise geographic location of objects is going to be critical [15] as location plays a significant role in context-aware computing. Once the quantity of objects gets larger, trailing becomes a key demand. Interactions are extremely addicted to their locations, their surroundings, and presence of alternative entities (e.g. objects and people).

Everything-as-a-service: Because of the evolution of cloud computing [16], overwhelming resources as a service [17] like Platform-as-a-Service (PaaS), Infrastructure-as-a- Service (IaaS), Software-as-a-Service (SaaS), has become main stream. Everything-as-a-service [18] model is extremely economical, scalable, and simple to use. IOT demands significant amounts of infrastructure to be place, so as to form its vision a reality, wherever it might follow a community or crowd primarily based approach. Therefore, sharing would be essential, wherever associate degree everything-as-a-service model would suit largely sensing-as-a-service [14]

VII. CHALLENGES

In making the web of internet of things, the most fundamental challenges, including:[1]

Connectivity

There will not be one property commonplace that "wins" over the others. There will be a large sort of wired and wireless standards further as proprietary implementations accustomed connect the items within the IOT. The challenge is obtaining the property standards to speak to one another with one common worldwide knowledge currency.

Power Management

More things at intervals the IOT are going to be battery battery-powered or use energy harvest to be a lot of transportable and self-sufficing. Line-powered instrumentation can got to be a lot of energy economical. The challenge is creating it simple to feature power management to those devices and instrumentation. Wireless charging can incorporate property with charge management.

Security

With the number of information being sent at intervals the IOT, security could be a should. inherent hardware security and use of existing property security protocols is crucial to secure the IOT. Another challenge is just educating shoppers to use the protection that's integrated into their devices.

Complexity

Manufacturers want to feature property to devices and instrumentation that has ne'er been connected before to become a part of the IOT. Easy style and development is crucial to induce a lot of things connected particularly once typical RF programming is complicated. to boot, the

typical shopper has to be ready to set-up and use their devices while not a technical background.

Rapid evolution

The IOT is consistently ever-changing and evolving. A lot of devices are being accessorial every day. The challenge facing the trade is that of the unknown. Unknown devices, Unknown applications, Unknown use cases. Given this, there has to be flexibility at all aspects of development. Processors and microcontrollers that vary from 16–1500 megacycle to deal with the complete spectrum of applications from a microcontroller (MCU) during a little, energy-harvested wireless detector node to superior, multi-core processors for IOT infrastructure. Large sort of wired and wireless property technologies are required to satisfy the assorted desires of the market. Last, a large choice of sensors, mixed-signal and power-management technologies are needed to supply the program to the IOT and energy-friendly styles.

In general, we will expect the web of Things give rise to increasing numbers of hybrid merchandise that provide each, a standard physical perform and knowledge services.

VIII. CONCLUSION

In this paper, we have researched about the evolution of Internet of things. We have also searched about the characteristics of it. We have concluded that, establishing IOT do have its own challenges starting from the sensor level till the level of internet connectivity of different smart objects. A lot of devices have been developed till now, like the Google glasses, a lot more are jet to come into this web of internet of things. At sensor level tremendous research work can be done either to upgrade the available sensors or to develop and implement new sensors. We have also concluded that there will be compatibility issues regarding the use of available sensors with the cloud or internet. Need not to mention that research work can also be done at the protocol level.

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