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Research paper

Internet of Things for Smart Environment and Integrated Ecosystem

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Abstract

Internet of things (IoT) is in increasing demand in our daily life. This is the technology that transforms the real-time system into the virtual system and makes the communication in between machines. The rapid growth of IoT can be easily noticed in industries like home automation, transport, robotics, environment, energy, water domain etc. The IoT is a technological revolution that represents the future of computing and communications, and its development depends on dynamic technical innovation in a number of important fields, from wireless sensors to nanotechnology. They are going to tag each object for identifying, automating, monitoring and controlling. The aim of this paper is to give an overview of introduction, history, architecture, real-time application, challenges and future aspects of IoT along with statistics and its application in monitoring for future.

Keywords: *Internet of Things, Environment, Sustainable, Smart Devices.*

1. Introduction

Internet of Things defines as a seamless combination of embedded, intelligence, ubiquitous, connectivity, and deep analytical insights that creates unique and disruptive value for companies, individuals and societies [1, 2]. It refers to the networking of physical object like wearable devices, smart devices, home appliances etc. using sensors, hardware, and software that can be controlled by use of the Internet protocol. IoT is to automate whole hardware or a physical thing that includes everything which we use in day to day life in home, office, industry for the purpose and to monitor the data and instruction, and to operate the device using the internet connectivity [3, 4]. Vast reach of this enables various controls from a simple control of LED or light or fan to a fully automated home; to hardware for data mining, to control and monitor the treatment process for the water and environment domain as well on other fields. Real-time monitoring of the trends, weather forecast using sensors, and monitoring data to improve performance are the few applications of IoT. Emerging technologies such as Cloud Computing Data Analytics, Machine Learning, Big Data are giving an enhanced experience to the IoT customers [5, 6].

With the ever-increasing number of connected devices globally and potential of smart objects, there is potential to transform and revolutionize multiple vertical sectors to operate in a connected ecosystem; IoT coupled with the proliferation of electronic devices that already exist in businesses, homes consumers, all of which can be transformed via the use of IoT technologies, and the stage is set for IoT to become ubiquitous.

2. Literature Survey

In the early 90's when the Internet was growing rapidly bandwidth penetration was too low. In just 20 years it has grown 100 times [7]. From a tool to connect with the world it has now grown as a total independent technology itself and become the mode to control the things, things that include each and everything making human life more and more comfortable. Cloud computing and Internet of things going to be the basis of everything in the next era. Giant organization like Amazon, Google, Microsoft already has impacted the whole 7 Billion population regardless of their services; as well as they are creating technologies, innovations for the next generation like Amazon Go, self-driving cars. These companies are going to create unimaginable things accessible to everyone, not just for the industry. IoT is already growing at a fast pace, it is estimated that by the end of 2020 the number of the active wireless connected device will exceed 40 Billion [8, 9].

Today it has become a tool to connect each and everything. Human as an intelligent species always looked and invented a new thing. These all things will make it possible to have a world which seems to be unimaginable and this technology will be first of its kind in terms of providing consumer where service, as well as product industry, will grow. As predicted by the authors in [4, 10], IoT hardware, software, and services industry itself will generate $332B revenue by 2020.

3. Market Dynamics: Evolution as a Product Based Service Industry

With more and more advancement and dependency on technology, development of new easy to handle and operate tools

and devices like Arduino, Rasberry pie, ESPKits, ARM Cortes M with human desire toward automation is going to be reason for the rapid growth in smart devices leading to a whole new market for it [11, 12]. Amazon has already proposed a whole modern technology for its retail hassle-free store where every purchase will be automated, with a tagline grab whatever you want and just go, Amazongo is using most advanced machine learning, deep learning algorithm, sensor fusion and calling it as just walk out technology same as used in self-driving cars [13]. These kinds of technology which are an example of Internet of things going to lead the next century, from home which is fully automated and controlled over just a click of the mouse to devices that can be operated and controlled using email and internet, going to be next things which consumer wants. Already demand for the first-generation products like Smart TVs, Wearable Devices, Home Automation, Automated Home Appliances is increasing and will further increase as the cost decrease, as per Ayla report it was estimated that on one in five consumers who have broadband at their homes going to have at least one smart house in the USA before 2016. Internet of Things going is going to be future for both products and service-based industry.

4. Opportunities and Forecast: Analysis

With growing trends of smart and small devices, and as the manufacturing cost of the hardware is decline there is rapid growth for the IoT industry. Also, availability of small sensors, DIY Kits that can be useful to control each and everything even without having core knowledge of the hardware and software leading to the growth of IoT markets.

As per Forbes, HIS forecast that IoT market will see a growth of 30.7 billion devices by the end of 2020 and 75.4 billion devices till 2025 compared to 15.4 billion devices in 2015. IoT going to impact every big sector and will see a rapid growth in the sector like transportation where major automotive industry already is in the business, security, and surveillance in government, inventory and warehouse management application (Amazon already has proposed next store that going to be based on IoT and Cloud). As per the McKinsey estimate, total IoT market going to have a growth of $3.7B by 2020 comparing to $900M during 2015. To the Product and services by enterprises, an estimated expenditure on IoT was expected to reach $120B, with a growth up to $253B in 2021. Profit alone for the IoT vendors involved in selling hardware and software going to be $60B by 2020 as per the analysis was done by Bain. As per a report published by Gartner in 2015, it predicted 6.4B connected devices worldwide in use for the year 2016 and that will reach up to 20.8B by 2020. IoT is a technology that going to be loved by not just service providers but also by the manufacturer. Basically, a hardware-based technology where hardware is connected by using software so ultimately a whole new market is going to develop for the hardware development. IOT going to change the way of connectivity for all and will be creating a life connected to the Internet. Gartner has reported that by 2020 world would have 20.6 billion connected technologies.

A. Opportunities in India

India has seen a lot of changes in a short span, since the inception of the new government, many programs have initiated because of which India is moving towards becoming a digital economy. The digital space in India is in the phase of transformation where IoT could play a vital role and hence the Department of Electronics & Information Technology (DeitY) drafted India's first "Internet of Thing Policy". This policy will help India to grow its IoT market to $15B by having a growth in the broadband connected devices from 200M in 2016 to 2.7B by 2020 [14].

Policy for the Internet of things will support the initiatives taken in the direction of Digital India and Smart Cities. Also, these two programs will ensure the growth of the IoT industry in India. Digital India program is aimed to make every household and every individual digitally empowered. India with a population of 1.3B has 2nd largest communication base in the world. The internet is driving technology adoption across India, and creating new business opportunities across various sectors

Digital Indian program which is based on 9 different small subprograms can be categorized as:

a) Broadband Highways: 2.5 Lakh gram panchayat will be connected by Broadband Internet.
b) Universal Access to Mobile Connectivity: By 2018 all villages covered through mobile connectivity.
c) Public Internet Access: Expand of common service centre (CSC) from 1.35 Lakh to 1.5 Lakh
d) E-Governance: Electronic databases, workflow automation.
e) E-Kranti: Electronic delivery for all services.
f) Global Information: online hosting of the platform.
g) Electronic Manufacturing: Focus on development of smart devices.
h) IT Training: Training in software tools.
i) Early Harvest Programme: Biometric system in every Govt. office.

As reported by NASCOM [15] in the report entitled Internet in India by 2020, India will have 730M Internet user, 75% of the new user growth will come from rural areas, mobile content video to grow at an 83% CAGR in next coming 5year that will lead to the use of smartphones and portable device. 70% e-commerce transaction will be done by mobile phones, and 75% new internet users consume content in local language. These factors will cause a growth of IoT market in the country to $15B by 2020 from $5.6B. Also, it is predicted that 60% of the total IoT market in India which is industrial IoT will be the major booster in the country. Whereas, Consumer IoT, which includes smart home devices as well as wearable's, will account for the remaining market. Smart cities and Digital India program will provide a vast market in the IoT field. Under the Smart Cities project, Govt. plant to turn 100 selected cities into smart cities. Smart cities will have all smart facilities like smart transportation, smart devices to control energy, water management plant and so forth. This all has lead to a quick expansion of the IoT sector in India, and to furnish the smart cities objective as well as in monitoring for sustainable development for smart environments and integerated ecosystem.

Digital India program with a vision of Transforming India into Digital Empowered Society & Knowledge Economy launched with the aim to take India towards an era of digitalization and to ensure that all Government services are available to citizen electronically; which will be possible by the IoT. The rapid growth of E-Commerce, the rise of tech-savvy consumers, and increasing penetration of internet and smartphones are set to expand both the consumer and industrial IoT business in India. IoT industry going to hit every sector and will be providing solutions for Security, Forecast and Predictions, Agriculture, Software, hardware, Energy, Health, Smart House and Building, Transportation, Industry, Wearables.

In the world of exponential technology, things are moving faster than the imagination and expectation. If the number of connected devices grew even at the pace which is predicted by Wresearch, then IoT market will grow at 28% in next 3 years, and as per Gartner, the number of devices connected to the Internet will be 13.5B in 2020 as compared to current 4B devices. Hence there is a big opportunity for IoT industry to grow and prosper in India [16].

B. Internet of Things Technology in Energy and Water Domain

Internet of Things technology is showing smart solutions in the field of water quality monitoring and water management with advanced communication technology [17]. The applications of smart water quality monitoring includes Smart monitoring with

the help of IoT for environment and water domain is simplifying the challenge and hence will be used as a next-gen tool to implement with the smart cities and many more areas for communities, housing societies etc. that includes for domestic running water [18]; domestic stored water [18]; lake, river, sea water, environmental monitoring [18]; aquaculture centers [18]; drinking water distribution systems [19, 20]; water and air quality [21] and many more application. This will not only improve the ecosystem but also will be helpful more the early warning system to avoid many problems.

Analysis of the 640+ IoT Projects in the list (Segmented by IoT Segment and Location) is explained and represented in Fig. 1. This list includes 280+ projects in the Americas, 140+ in connected industry (22%), and 120+ in Smart City environments (20%).

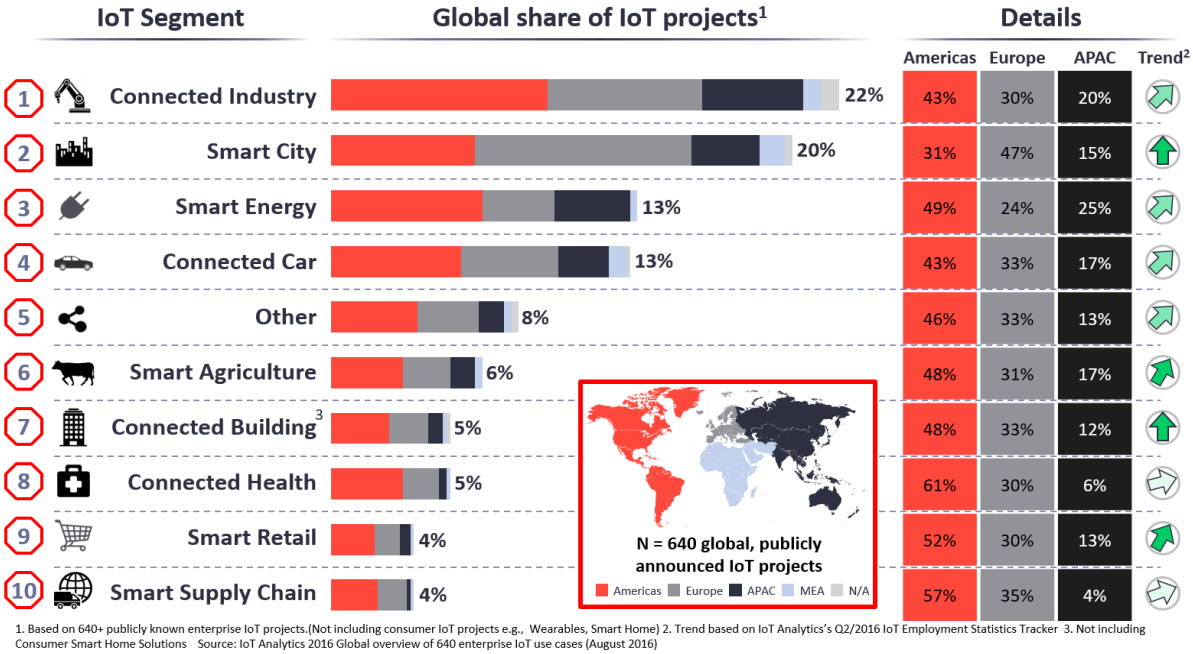

Fig. 1: Analysis of 640+ Projects for IoT Technology [22]

5. Restrains, Threats and Challenges

A. Concern Regarding Security: Internet of Things to Internet of Insecure Things

Today the digital world is like a Galaxy in which all stars, planets, and everything which can be found in the universe exists and that too expanding at a rapid rate. With the Internet, everyone relates to the world, From Bank account to our personal detail are now digitally available which both Government as well as private organize uses, sometimes for government benefiting schemes and some time to advertise and marketing. IoT is growing at a dangerously fast pace in each sector and impacted every part of our lives including homes, offices, cars and even now on our bodies. Although this technology has made it possible to do the things which we have only imagines or seen in Sci-fi movie, still IoT has its own flaws and negative aspect too. This technology has not attracted only consumer-oriented industry and research groups but also to the cybercriminals who are always ahead and looking for the loop to break into everywhere More digitalization means more connected people, and with IoT means more connected devices which mean more attack and more possibilities for a cyber hacker to attack us [23]. This has to be taken care of very seriously otherwise we'll soon be facing an inevitable disaster.

B. DATA and Concern

As predicted by Cisco, IoT will generate data of 507.5ZB per year by 2019 globally (42.3ZB per month) as compared to 134.5ZB) in

2014. This will be 269 times higher than the amount of data being transmitted to data centres from end-user devices and 49 times higher than the total data centres traffic by 2019. Today IoT devices share a 2% of the world's total data which will be raised up to 10% by 2020 as predicted by EMC/IDC. This huge repository where IoT data is being stored could be a target for the corporate hackers and industry people who directly or indirectly rely on the data of the client, consumer to gain more profit. Recent massive data breaches and data theft cases have already shown urgency of more effort to secure IoT-related data to ensure the privacy of consumers and the functionality of businesses and corporations. Although a significant impact already exists, Gartner notes [24] that both IoT and the business models associated with it are immature at this point, hence the huge transformation that the economy – and maybe even society as a whole – will face from the Internet of Things is still to come [16]. Based on the small survey by HP, there is a huge rise in the connected devices over the year, as explained in Table 1.

Table 1: Comparison of Connected Devices (Source: Hewlett-Packard)

Year	Number of Connected Devices
1990	0.3 M
1999	90.0 M
2010	5.0 B
2013	9.0 B
2025	1.0 T

C. What More Need to be done?

At the pace IoT devices have come in human life; the securities needed to be taken care more seriously as have not taken previously. Major steps need to be taken into these areas and Government direct involvement and strict laws are required to secure things. Also, strict laws for the cybercrime need to be implemented. While the effort to tackle security, issues regarding IoT devices is laudable, it isn't enough to ensure that can leverage the full power of this modern technology in a secure environment. The gateways that connect IoT devices to company and

manufacturer networks need to be secured as well as the devices themselves, most of the devices can be accessed remotely and are connected with the internet [25].

This kind of devices could be a very easy tool for the hackers to control. One time authentication process for the devices controlled by the human could be one of the best sources of infiltration into company networks. Thus, increase the concern to secure the overall security of the system. As with the evolution of the smart devices, not just password but biometric information can also be hacked very easily if the necessary step is not taken by the manufacturer or the service provider. Those days are gone when only social securities and password like details were accessible through cybercrime. With the latest portable technology, smart devices with inbuilt retina scanner and fingerprint scanner, wearable devices to monitor your health record everything is connected on the Internet which means somehow everything is accessible to the people who want to miss use it.

Few things which need to be considered very seriously or could be a threat to this rapidly growing technology is to understand its threat at the very beginning before the problem become unmanageable. Things need to be considered includes Privacy Concerns, Insufficient Authorization, Encryption, Interface, Insecure Software [26]. IoT has a tendency to create a future which seems to be impossible as of now and could bring a whole new market to every sector and benefits to each and individual if taken carefully, However, if not managed properly than could create the problem which is unimaginable.

6. Conclusion

If the number of connected things grew at twice Cisco's predicted annualized rate, we will have 223 billion connected things, or 12% of the total, by 2020. At a little less than quadruple Cisco's forecast, we would be talking 1.5 trillion connected things, or 82% of the total, by the end of the decade. IoT which already has taken its rapid growth and is the demand in the market. IoT which share currently 2% of the data used by the devices will grow up to 32B devices by 2020 representing 10% of the world's data (EMC/IDC). The sensing, monitoring and connectivity elements of IoT are being widely used together to prevent and mitigate the effects of natural disasters and in verge to become an eco-friendly technology which benefits not only the environment [27] but mankind as the whole.

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