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FUTURE OF INTERNET OF EVERYTHING (IOE)

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Abstract: In the world, the man matters, not the machine, people need to be care, not data. There is transition from information technology to human technology. The answer is internet of everything (IoE). The internet of everything (IoE) is a concept that extends the internet of things (IOT) by encompassing the machine-to-machine (M2M) communication, machine-to-people (M2P) and technology-assisted people-to-people (P2P) with expended digital features. It includes different types of devices, appliances and items that are connected to the global internet. The internet of everything (IoE) comprises four components, namely, people, process, data and things to make the networked connections more relevant and valuable. These components enable us to create new capabilities, wide experiences and economic opportunity for individuals and businesses. IoE connects people in more relevant and valuable ways, deliver the right information to the right people and/or machine at the right time, leverages data into more useful information for decision making and connect physical devices and objects with each other via the internet of things (IoT). The IoE includes user-generated communications and interactions associated with the global internet. The IoE is 5G technology that include evolution, elasticity, capacity, speed and agility. In this research work, we discuss the potentiality of IoE technology that includes the seamless interconnections and autonomous coordination among people, data and process through the global internet infrastructure. We will highlight the various applications of IoE in the area of privacy and security. Security and privacy are the major challenge in today world. There are various challenges like software and hardware compatibility, wired and wireless infrastructure, data analysis, data mining, big data and many other things that need to be solves globally. We will discuss the security aspects of IoE that ensure the securing the environment, the infrastructure and the process. Data collection is also the major challenge at the network edge. It includes multitude of endpoint devices and sensors that automatically collect, analyze and transmit the data on the massive scale and at very fast rate. Internet of everything (IoE) will have a huge impact on individuals and business in the next few years. It will be a radial shift to think that how we live, solve the problem, create value, secure environment to keep people, data, process and things under one umbrella. It will include devices and objects at the massive scale. The network capabilities will create the new experiences, capabilities and economic opportunities for individuals, businesses and governments. In short, the internet of everything (IoE) changes only one thing, which is everything.

Keywords: Internet of everything (IoE), future internet, security technologies, digital security, internet of things (IoT)

I. INTRODUCTION

According to Ray Kurzweil, Futurist, Inventor, Author, and Entrepreneur, "The 21st century will be equivalent to 20,000 years of progress at today's rate — about 1,000 times greater than the 20th century". Internet of Everything (IoE) will play the vital role to achieve this milestone. In broader term,

IoE refers to the devices and consumer products that are connected via Internet with expanded digital features. IoE envisions a world that is fully interconnected through the internet. IoE creates a cyber-physical universe around us [1]. IoE will change the way we live, work and play. IoE will transform the characteristics and operation of homes, cars, hospitals, factories, businesses etc. This is shown in the figure 1.



Fig. 1. Internet of Everything (IoE)

The IoE technology is built on the top of the Internet of Things (IoT) by adding more features that allows the systems to converge and visible across multiple locations through the intelligent, reliable and secure global network. Therefore, IoE re-invent the organization how they deliver the values in terms of technology, business strategies, people-to-machine and machine-to-machine engagement [1]. This is shown in the figure 2:

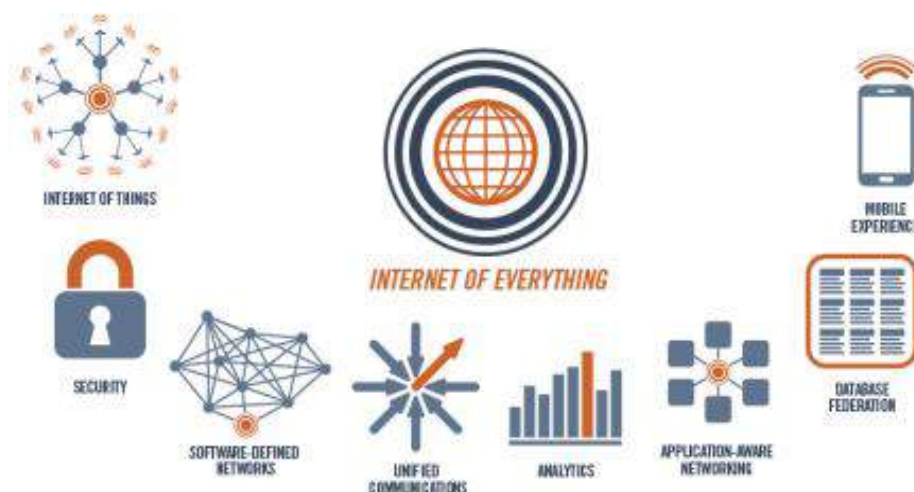


Fig. 2. IoE technology is built on the top of the IoT

IoE comprises technology solutions that drive productivity, innovation, community improvement, cost optimization, development, security and global resource management for public and private sectors. IoE solutions includes transportation, smart phones, automotive, utility, energy, surveillance, security, financial services, public safety, healthcare, retail, warehouse, industrial, distribution and many more [3]. This is shown in figure 3:

Motivation

Internet of Everything (IoE) provides the seamless interconnection and autonomous coordination of huge number of computing nodes, sensors, entities, data, people, process and machine through the Internet connection in a secure environment, is an emerging research area that will enable the whole world connected from tiny sensors to people, vehicles and machines. IoE has the vast potentiality that will transform the whole world in a way we connect with each other, our thinking process to do the work, utilization of the machine, extend the human consciousness, work collaboratively with people and/ or machines and unprecedented environment which we never imagine before. It leads to novel innovative solutions to overcome the unique connectivity, interoperability, miniaturization and energy-efficiency challenges. The IoE platform is highly scalable, flexible, secure that manage billions of nodes of all types and use highly sophisticated protocols so that these nodes authenticate themselves online, prove their integrity and securely communicate through the global network and collaborate and communicate with each other. IoE support these nodes from the initial phase of their life to final phase and provide maintenance, transfer of ownership, message transportation and these processes occur in a reliable and valuable way. These facilities of IoE is across all the sectors including agriculture, manufacturing, IoT gateways, payment, healthcare, smart grid and industrial ecosystems.

As the Internet of Everything (IOE) is built on the top of the Internet of Things (IoT), it is important to have a close look on IoT which can have three paradigms – internet-oriented (middleware), things-oriented (sensors) and semantic-oriented (knowledge). According to RFID group, the IoT can be defined as “worldwide network of interconnected objects that are uniquely addressable based on the standard protocols of communication”. According to Cluster of European research projects on the Internet of Things – “Things are active participants in business, information and social processes where they are enabled to interact and communicate among themselves and with the environment by exchanging data and information sensed about the environment, while reacting autonomously to the real/ physical world events and influencing it by running processes that trigger actions and create services with or without direct human intervention”. According to Forrester, “a smart environment Uses information and communications technologies to make the critical infrastructure components and services of a city’s administration, education, healthcare, public safety, real estate, transportation and utilities more aware, interactive and efficient”.

The actuating and sensing devices are interconnected with each other and share the information across heterogeneous platforms through the unified framework that leads to develop the innovative applications in various sectors. This is achieved by the data analytic, cloud computing, ubiquitous sensing that acts as a unifying framework. Smart connectivity with context-aware computation using existing network is an integral part of IoT. In recent trends, there is fast growth of WiFi and 4G-LTE wireless Internet access which shows the evolution towards the communication networks and ubiquitous information. However, IoT goes beyond the traditional mobile computing environment and evolve into connecting everyday existing things and embed intelligence into the today environment. IoT focus on these aspects: share the understanding of the situation of its users and their appliances, pervasive communication networks and software architectures to convey and process the contextual information to where it is relevant and the analytic tools to IoT that aim for smart behaviour and autonomous [4]. The key technological developments in the context of IoT application domains is shown in the figure 5:

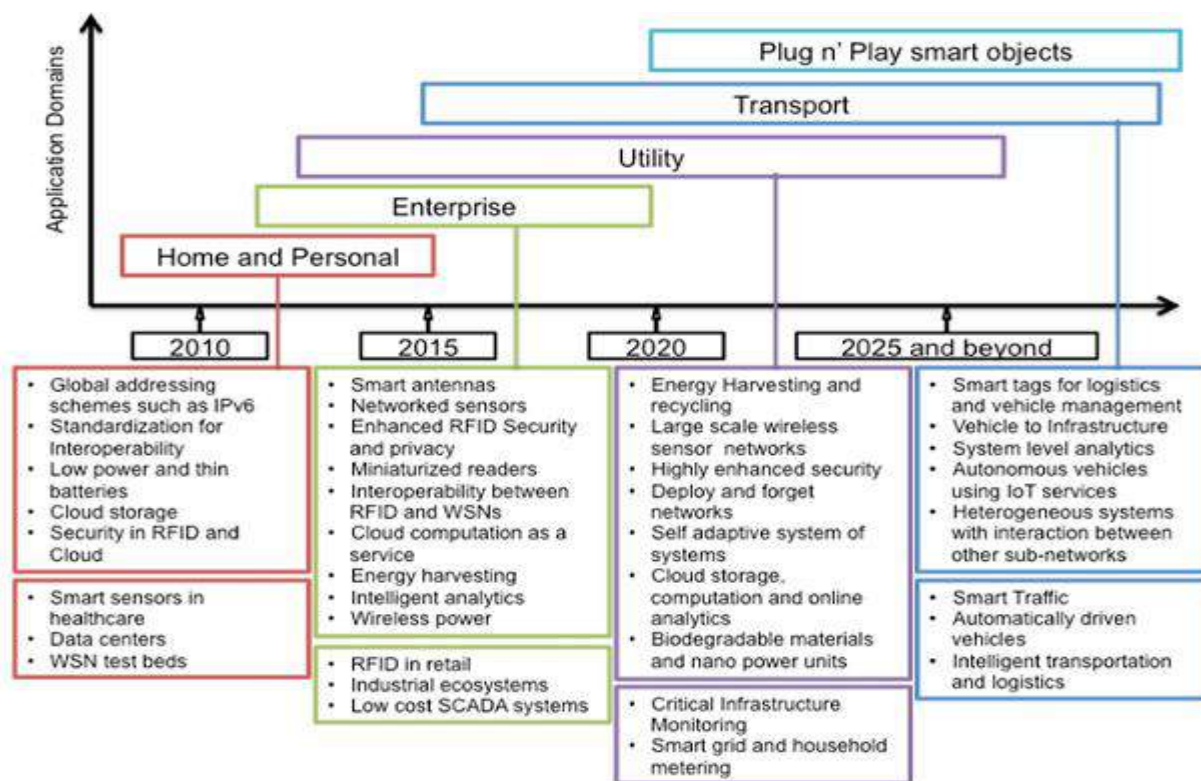


Fig. 5. Key technological developments in the context of IoT application domains

II. LITERATURE REVIEW

In recent years, the internet connectivity is not restricted only to desktop computers, smart phone, tablet and laptop, but the machines also become more intelligent and smarter to access the data and work collaboratively with high speed networks in the secure environment. Internet of Everything (IoE) play an important role to achieve this goal [5]. The applications of IoE are from small tiny sensors to enterprise integration system that are operated automatically and intelligently in more reliable and valuable way. The features of IoE are fall into two main categories: Input which allow data to be inserted into the hardware device while output allow this hardware device to put back into the Internet.

The IoE is now driving the future of information technology, e.g. Cisco use the IoE to develop the future and modern technology. Internet of Everything (IoE) is built on the foundation of Internet of Things (IoT) by adding more features so that the networks become more intelligent that allow orchestration, convergence and visibility across the heterogeneous systems in more reliable and valuable ways. IoE connects these devices into one single cohesive component. It is not just allowed devices to communicate with each other, but rather allow communicating everything with each other [6]. Therefore, IoE is just not same as IoT, but something more. It is broad term that refers to devices and consumer products connected to the Internet and outfitted with expanded digital features. It is a philosophy in which technology's future is comprised of many different types of appliances, devices and items connected to the global Internet."

IoE is the essential pre-requisite for the creation of ecosystem and virtual community of public and private organizations. It is built on the Internet connections among data, people, things and processes. IoE are explicitly linked with higher educational system globally and involve into the betterment of economic development, innovation and new research that result in the increase of learning activities in a new dimension [7]. It will allow people to more access to learning process regardless of their background. It includes: (1) access to right content and information and availability of materials on any device, at any time, (2) customization of curriculum to enable high/ active engagement, interaction and attendance, and (3) to reduce the skills mismatch between what the labor force can do and what employers need as indicators of success for IoE adoption in higher education. IoE filter, select and distinguish relevant information to specific need of users. It is necessary to share and use of knowledge so that the information is transformed into processes and product. In [8], the authors develop a vision of how the IoE may alter business models and the ways in which individuals and organizations create value. The research aims to adopt a holistic approach to devising a secure IoE architecture for cross-culture communication organizations, with attention paid to the various technological wearable devices, their security policies, communication protocols, data format and data encryption features to avoid the data exploitation [9]. The authors [3] identifies the 21 most significant current and future challenges as well as scenarios for the possible future expansion of their applications.

III. INTERNET OF EVERYTHING (IOE)

IoE brings together people, process, data and things to make the network connections more valuable and relevant and valuable that create richer experiences, new capabilities and unprecedented economic opportunity for individuals, businesses and countries [10, 11]. IoE's consists the four individual components which are shown in figure 6:

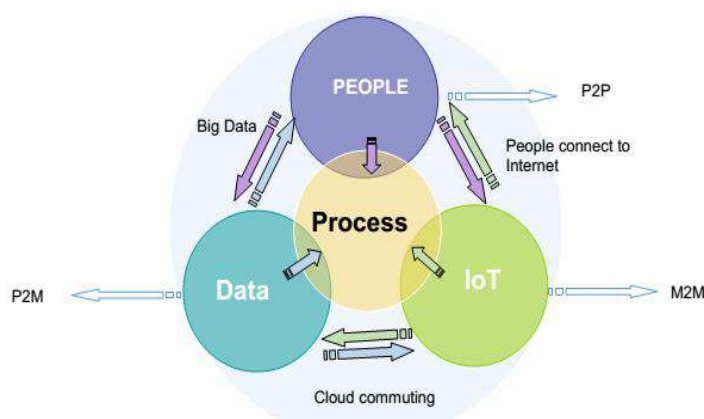


Fig. 6. The What, Where, and How of the IoE

1. People: In today world, people are connected via internet through various ways. For example, PCs, laptop, smart phones, social networks etc. But, with the evolution of IoE, people will connect in more relevant and valuable ways. For example, a device inserts into the body of the patient which sense the medical condition of patient and report to the doctor over a secure network connection. In this case, patients themselves act as internet nodes that constantly monitoring the information and transferring to the data storage system which analyze by the doctors to take corrective and timely action.
2. Data: With the IoT, the various devices collect the data and transport it over the internet to the central storage where it is mined, analyzed and processed in more intelligent way.
3. Therefore, the data is not just a raw data, but this high-level information is sent back to computer, machine and people for further evaluation and decision making in more effective and efficient way in the secure environment.

4. Things: It consists the physical things, for example, devices, sensors and enterprise that are connect with each other via secure networked connections. In IoE, these things are context-aware, sense more data, more valuable information that allow people and machines to make more relevant, valuable and timely decisions.
5. Process: Process plays a vital role among these three entities- people, data and things those are connected and collaboratively work with other with IoE and deliver the information to right people and/ or machines at the right time in the appropriate ways over the secure internet connection.

IoE will impact individuals, businesses, and countries in number of ways [10].

1. Individuals: People experience the world through their five senses (touch, sight, taste, hearing and smell). In this context, Internet of Everything (IoE) acts an exponential proxy to sense, understand and manage the world in which we live. The physical things will now become the living one which includes these senses in more meaningful and relevant way in the global environment.
2. Businesses: IoE transform the approach to visualize the businesses world by creating the new global opportunities and achieve the maximum efficiencies and optimization.
3. Countries: IoE will allow the governments to increase the transparency level to their citizens while ensuring the safety, privacy and security and deliver the best services to them.
4. The IoE impacts business strategies, human interaction with technology and technology adoption:
 - a. Business strategies: Various private and public organizations adopt the IoT solutions to process their business in more efficient manner. By utilization of these solutions, the businesses are cost-effective, collaborative, connected with global network and providing more services in innovative ways.
 - b. Human interaction with technology: With the emergence of IoE technology, there is increase level of interaction between humans and technology. Now, people-to-people (P2P), machine-to-machine (M2M), people-to-machine (P2M) and machine-to-people (M2P) communication provides more opportunities and collaboration between people and things. This is shown in the figure 7:

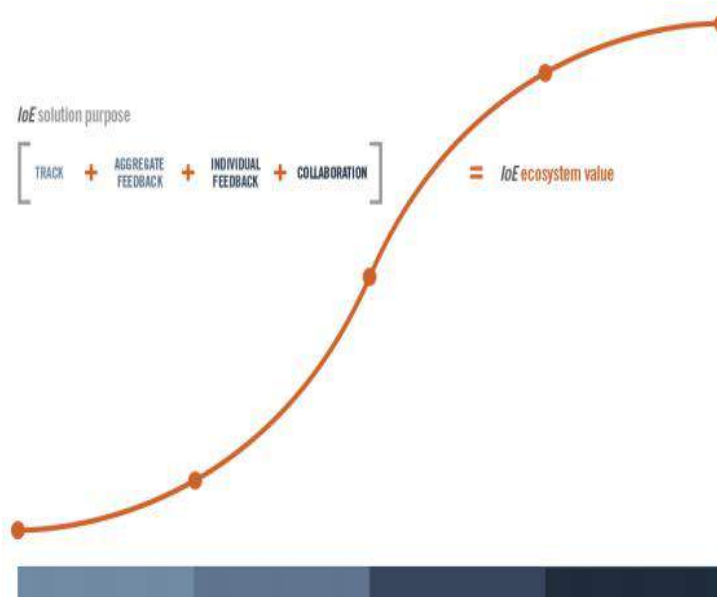


Fig. 7. IoE ecosystem value and solution

- c. Technology adoption: IoE rely on the network connectivity to deploy the solutions that offers programmability, improved flexibility and enhanced policy management by the various private and public sectors. There is exponential growth in the field of IoE that is shown in the figure 8:
- d. Hardware devices: The devices now act as an intelligent node while the core networks will remain vibrant. The voluminous data, complex algorithms, real-time modifications will require more intelligent resources at the edge of the network. The objective of IoE is not just providing the data, but the automation, rapid, analysis, fast accurate decisions and enhanced abilities from these intelligent nodes.
- e. Platforms: IoE ecosystem requires multiple heterogeneous platforms and management tools to manage the networks, connectivity and end-point nodes that support the potential solutions in the given application environment. These platforms should be workable in virtualized environment, cloud-enabled, fully automated and easily integrable with other applications through global network in a secure environment.

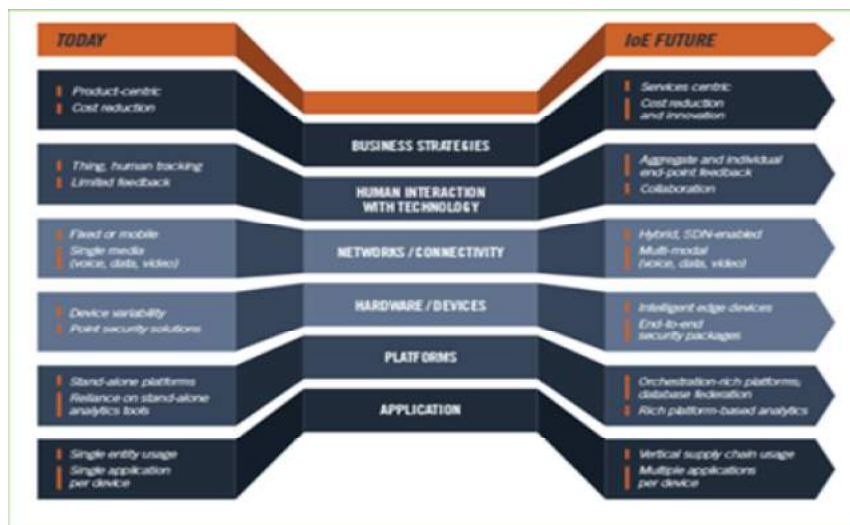


Fig. 8. Development of the Internet of Everything

From the technical point of view, IoE comprises four major areas which are smartness, interconnectivity, big data and semantic interoperability [1].

1. First, the emergence of IoT in the global interconnected environment opened up the new opportunities for the increased level of smartness of things.
2. Second, big data is the driving force for the growth of smart things in the technological enabled development. It enhanced the quality of information along with voluminous data and improvement in the complex algorithms to interpret and analyze the massive amount of sensing data.
3. Third, the smart things lead to the theoretical artificial intelligence which can sense, reason and perform actions based on the given data to accomplish the predefined goal in the stipulated time.
4. Finally, the semantic interoperability allows the heterogeneous devices to collaborate with each other and performs the designated services bases on the policy, protocols and standards.

The architecture of IoE that include applications, service platform, Internet, gateways, communications and nodes, is shown in the figure 9:

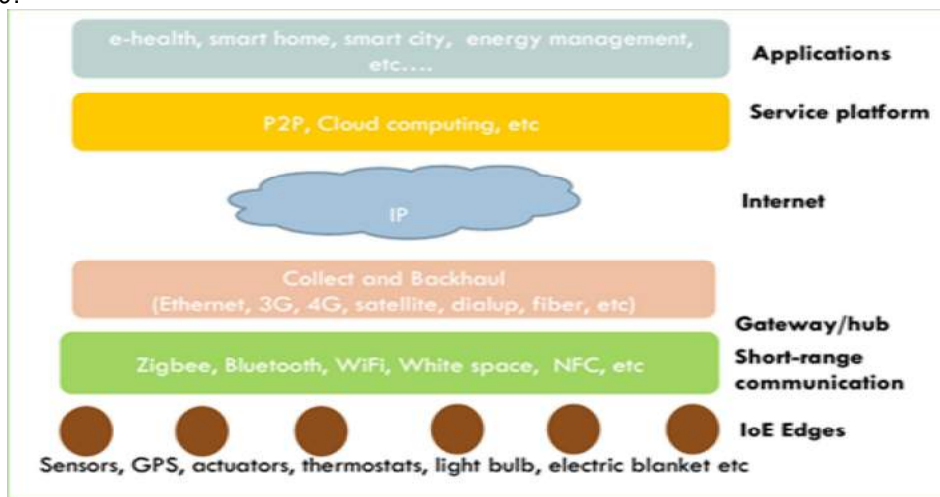


Fig. 9. Architecture of IoE

The following features of IoE are as:

1. Unique addressable object
2. Unique location within a network
3. Processing of information by people-to-people (P2P), machine-to-machine (M2M), people-to-machine (P2M) and machine-to-people (M2P) to work collaborate and efficiently in the secure global network environment.
4. Complex interoperability of networks will require intelligent analytics, security and management.
5. Time and location take on new meaning as real-time ambient intelligence becomes the norm.

IV. APPLICATION OF IOE

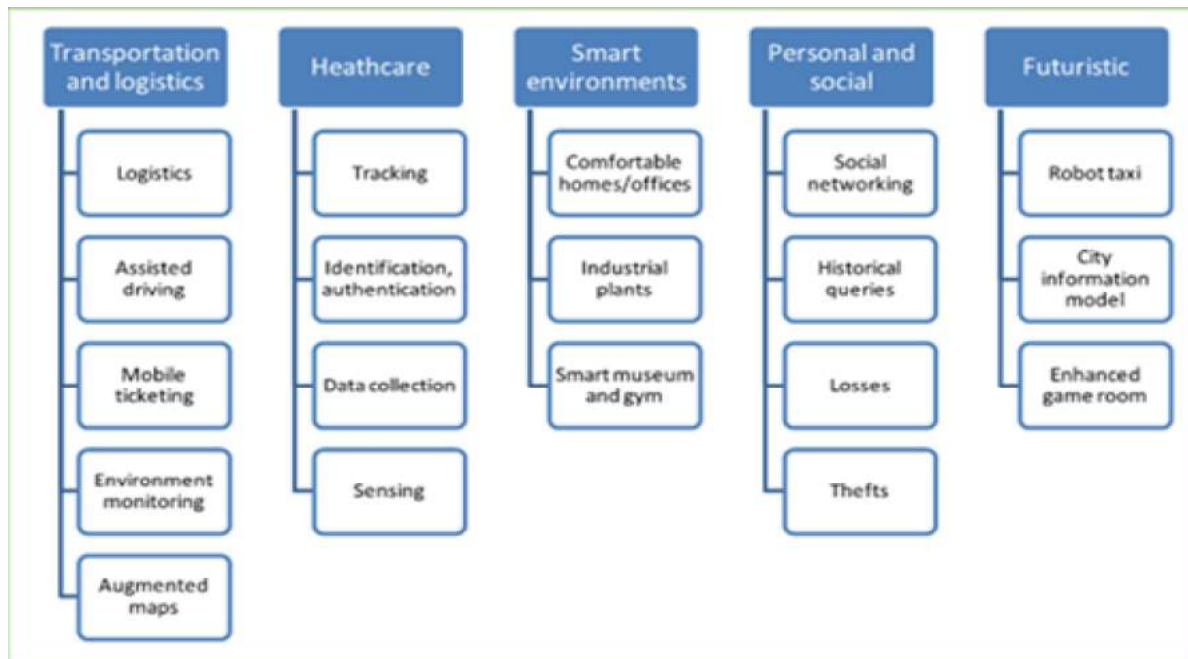


Figure 10: Applications of IoE in various sectors

V. FUTURE OF IOE

IoE add comfort and productivity in our day-to-day lives, for example, while driving back to home, I can adjust the temperature of my room, adjust the electric blanket with room temperature to provide heat to the body and locate my keys using my phone [1]. The comfort versus productivity along with example is shown in the figure 11:



Figure 11: a) TI's NFCpowered temperature sensor, b) comfort vs productivity

In term of growth in the future, it is estimated that the industrial Internet will add \$10 to \$15 trillion to global over the next 20 years. The economic value created by smart devices will increased to \$20 trillion in next five years. Gartner estimates IoE products, services and suppliers will generate incremental revenue exceeding \$300 billion in 2020. IDC forecast world market for IoE solutions grow from \$1.9 trillion in 2013 to \$7.1 trillion in 2020. We need to change ourselves with the changing world. The two things are always be demand and supply. Demand is undergoing a paradigm shift from information technology to human technology, while supply is shifting from the highly skilled craft to hard science and engineering.

VI. CHALLENGES IN IOE

IoE presents unique communication challenges such as integration with various wireless network, low data-rate, large volume of links -- the "one-bit" challenge, power, spectrum resources, security, automatic deployment and maintenance. In IoE, the collection of data starts at the edge of the network, including the multitude of endpoint nodes and sensors that automatically collect, analyze and transmit data on a massive scale. Therefore, the volume and velocity of this data make it cumbersome to bring together into one place and extract information in seamless timely manner. One key challenge is what data is to be store and what data is to be ignored. For example, high-definition video surveillance cameras combined with data analysis offer customers insight into everything from facial recognition to age, gender and socioeconomic aspects. However, not all the data from these devices needs to be stored or even analyzed, but rather used in the moment to create interactive engagements with the customers.

To address these challenges, automate and intelligence data processing must be embedded in the network. When data is in motion, the application need to move where the data is, not the other way around [12]. Another important challenge is security which need to be attentive from the very starting points to end points. It leads to design the various network-centric security approaches. We are still in the early stages of evolution for Data in Motion and the impact it will have on all of us. But it is clear that the more knowledge we have, based on meaningful information pulled from a variety of data sources, the more wisdom we can gain and apply. It will profoundly change the world. Because of the tremendous amount of transformation and disruption IoE is expected to create, it is not too early to start planning for a world where more people, information, and things will be connected than ever before [12].

VII. CONCLUSIONS

IoE technology have the capability to transform the world. IoE leads to increased level to smart things that we buy and use. These are driven by technical progress in the area of interconnectivity, big data, artificial intelligence and semantic operability. The private and public organizations play the vital roles to influence the way of IoE that will change our societies. The IoE is expected to bring about unprecedented societal change, opening up new opportunities and posing new challenges. Research from different disciplines such as psychology, law, economics, computer science, and ethics is needed to better understand and influence future developments in the IoE. In short, Internet of Everything (IoE) changes only one thing, which is “everything”. According to Dave Evans, Cisco’s Chief Futurist; Chief Technology Officer, Cisco IBSG, “When the history of IoE is written, its success or failure will be determined by answering one question: How did IoE benefit humanity? In the end, nothing else matters.”

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