RESEARCHERID
THOMSON REUTERS

[Singh, 5(2): February 2018] ISSN 2348 – 8034
DOI- 10.5281/zenodo.1174135 Impact Factor- 5.070

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

SUBSET OF DOMAINS IMPACTED BY INTERNET OF THINGS

Hardeep Singh*
*Post Graduate Department of Computer Science, BBK DAV College for Women, Amritsar, Punjab

ABSTRACT

Internet of Things; abbreviated as IoT; is a new trend in connectivity which is outside the realm of laptops and smartphones. IoT is a recent communication paradigm in which the items of everyday life are embedded with micro-controllers, transceivers for digital communication, and with suitable protocol stacks that allow them to communicate with one another and also with the humans. These network connected items or devices use unique addressing schemes and are smart enough to share information with human, with the cloud based applications and with each other as device to device communication; hence automating our tasks and lessening efforts to almost zero. The IoT, with the prospect of seamlessly integrating the real and the virtual worlds through the massive deployment of embedded devices, has opened up many new domains of its applications. This paper will introduce a subset of domains of applications of IoT including smart homes, smart wearables, smart cars, smart cities and smart industries.

Keywords*: Internet of Things, X10, Z-Wave, ZigBee, UPB, Instabus, EnOcean, Tizen, Industrie 4.0, Smart Homes, Smart Wearables, Smart Cars, Smart Cities, Smart Industries.*

I. INTRODUCTION

Internet of Things is advancing exponentially. IoT has been identified as one of the emerging trends that are shaping the development of technologies in ICT sector. IoT is a vision of shifting from an Internet used for interconnecting end user devices; the interconnected computers; to an Internet used for interconnecting the physical objects around us; the interconnected things. This interconnection of things will assist humans by not only providing safety, comfort and efficiency, but also by allowing better decision making and reducing expenses. The term; Internet of Things; was first coined by Kevin Ashton, a British technology pioneer, in the year 1999 in the Auto-ID center of MIT while he was making a research on RFID [1]. Since then rapid research is going on to make IoT as our daily life style and hence transforming the way we live, work and play. According to a survey, many projections on IoT have been made over the years. In 2010, IBM assumed a world of 1 trillion connected devices by 2015. In 2011, Ericsson's CEO, Hans Vestberg, anticipated 50 billion connected devices by 2020. In 2013, according to Cisco, 50 billion things will be connected to the Internet by 2020 and according to Morgan Stanley report; there will be 75 billion devices connected devices by 2020. In 2014, an Intel infographic predicted 31 billion devices connected to the Internet by 2020. In 2015, according to Gartner Research, 4.9 billion connected things are already in use and will reach 20.8 billion by 2020.

II. RELATED WORK

Subset of Iot applications

The Internet of Things (IoT) is an extension of Internet which aims to integrate the virtual world of information technology with the real world of things. Internet of Things is characterized by diverse technologies, which coincide to provide several innovative services in various application domains. These domains can considerably improve our lives in various environments that are presently equipped with 'things' having only primitive intelligence. By permitting these things or objects to interact and share information, numerous applications can be deployed in several service fields including cultural, educational, medical, transportation, personal and working areas. Based on the type of network availability, heterogeneity, involvement of user, impact, repeatability, scale and coverage, the application domains can be classified into various categories [2]. The major three classifications of application domain are Personal and Home; Utilities; and Enterprise.

ISSN 2348 – 8034
Impact Factor- 5.070

III. PERSONAL AND HOME

Smart homes

Smart home is becoming an innovative step of achievement in the residential places and promises to make living space more comfortable, convenient and more secure. 'Smart home' is the term generally used to describe a home that has appliances, lighting, heating, air conditioning, television, computers, entertainment audio and video systems, security, and camera systems that are proficient of interacting with one another and can be managed remotely by an application from any site in the world by phone or internet. Smart home is one of the applications of Internet of Things (IoT). The IoT connected smart products assists in saving time, energy and money. These smart product are installed with one of the available protocols; namely; X10, Z-Wave, ZigBee, UPB, Instabus and EnOcean. Products that use the identical protocol have the capability to add new products and hardware at the proprietors own pace and budget. The key concept behind smart home is that any device in the home that consumes electricity can be put on in the home network. The owner can then give commands to devices by using voice or a remote control or a tablet or using a smartphone. The smart home products were invented in 1975 by a company in Scotland. The company developed a protocol named X10. X10 is a protocol that allows compatible products to converse with each other using the previously existing electrical wires of a home. All the appliances and devices behave like receivers and the means of controlling the system; remote controls, keypads, smartphones etc.; behave like transmitters. The most famous smart home to date is the home of Microsoft Chairman Bill Gate, Seattle, Washington. Each and every appliance of this home is pinned with an electronic tracking chip. These chips keep track of all the activities done and make adjustments according to the preferences. It is expected that in future the smart homes will be as common as our smartphones. Companies including Amazon, Apple and Google released their IoT enabled smart home products such as Amazon Echo, Apple HomeKit, and Google Home. Other companies such as Nest, August, Ring, Ecobee and many more are focusing on manufacturing IoT enabled household products. According to a survey conducted by wireless industry group GSMA, by 2017, sale of automation systems could grow to $44 billion [3]. Table 1 illustrates examples of some of the smart products and their functions. Figure 1 shows some of the IoT enabled smart home devices.

Table 1: Smart products and their functions (sorted alphabetically)

Smart Product	Function
Camera	Track home exterior even in dark.
Dish Washer	Sends text message alerts when their cycle has ended.
Door Locks	Opens automatically as the authenticate person enters the home.
Irrigation System	Waters the lawns automatically as and when needed by exact amount of water.
LED Light	Lights are switched on as one enters the room and switched off as one leaves.
Motion Sensors	Sends alert message if there is a motion in the home.
Refrigerators	Creates dinner recipes based in the ingredients stored inside them.
Thermostat	The temperature of home could be set from anywhere in the world.

ISSN 2348 – 8034
Impact Factor- 5.070

Figure 1: Some of the IoT enabled smart home devices

An example of IoT enabled smart home: As the owner is about to enter the house, the main gate opens automatically. As the main gate opens, it passes the message to the air conditioner to set the appropriate temperature inside home and to the lights of house so that they are switched on. The lights pass message to the oven to start pre-heating. As the owner enters the house, the main gets locked and the shades are opened automatically. The TV is switched on. All these interactions could be done automatically, directly between devices, once the overall strategy has been set via a smart phone interface.

Smart home provides assistances and peace of mind to the homeowners by letting them observe their homes remotely. Moreover, home automation is becoming more popular which in effect is reducing its implementation cost. One if the benefits it provide is the energy efficiency saving. This is because the protocols like Z-Wave and ZigBee reduces the level of functionality of some devices; they can turn off and turn on when commands are given. This reduces the electricity bill as the lights; for example; are automatically turned off in vacant rooms. In addition to this, the smart home technology provides great benefits to the elderly citizens who live alone. They could be notified regarding the time to take their medicine, hospitals could be notified automatically if the resident falls or gets injured. A survey discovered that installing smart home technologies would be less expensive as compared to placing a senior citizen into a residential care or providing them 24/7 nursing [4]. This technology is also a great help for handicapped people or people with disabilities.

Smart Wearables

'Smart wearables' are the electronic body-borne computational and sensory devices which can sense the person who wears them or may be their surroundings. Wearables can interact in two ways; either directly through embedded wireless connectivity or through another device such as a smartphone. The information gathered by the wearable device related to the user or its surroundings is processed in a processing unit located either locally or in an external server. The results are then finally delivered to the wearer [5]. IoT connected wearables are in great demand all over the world. IoT enabled wearable technology is a hallmark of the Internet of Things and the most ubiquitous of its applications to date. According to the European Parliament Scientific and Technology Options (STOA) assessment panel, wearables are identified as one of the ten technologies which will change human lives. IoT enabled wearables can be either worn as an accessory as glasses or watches; or as fabric as smart jackets or gloves; or as patches on fingers, arms or foot; or can be implanted inside the body. Mostly, wearable devices cover requirements related to fitness and wellness, healthcare and medical, industrial, infotainment and military [6]. Figure 2 shows various product categories available for different requirements discussed above. For fitness and wellness, smart wearables such as activity monitors, heart rate monitors and others are available. For healthcare and medical,

blood pressure monitors, ECG monitors and many more are available. Smart devices for industrial, infotainment and military purpose are also available, as presented in figure 2.

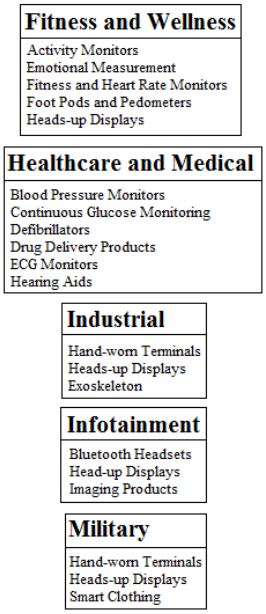

Figure 2: Wearable requirements with product categories

According to the latest report by ABI Research, the market of wearable devices can be grouped into seven sections, namely, smart clothing, smart healthcare devices, smart glasses, smart wearable cameras, smart activity trackers, smart 3D motion trackers, and smartphone compatible watches. In addition to the wearables for wrist and eyes, smart clothing initiatives are also on the rise. Companies such as NanoSonic, Textronics, WearTech and Sensoria are leading in the development of IoT enabled textiles. These wearables have ability to sense, store and track biometric measurements over time and then examine the results [7]. In addition to wearing sensors on body, the technology is advancing to manufacturing of sensors that could be embedded inside the body. These sensors could measure heart rate, temperature, hydration and other body metrics in a more granular way. In reality, the wearable technology was invented around early 60s, by a MIT math professor who designed a "Beat the Dealer" device. Smart wearable devices are going to be peripherals for a smart phone. Companies including Fitbit, Pebble, Google and Apple have designed IoT enables smart wearables namely, Fitbit health monitor, Pebble smartwatch, Google glass and Apple watch. In 2013, Samsung announced a Linux based operating system for smaller devices called Tizen. Other companies such as Jawbone, Adidas, Motorola, Johnson and Johnson are also concentrating in building such devices which are highly energy efficient and very small in size. Table 2 shows some of the currently well-known VC-funded private wearable companies with their location and turnovers. The list is according to Silicon Valley Business Journal [8].

Table 2: List of VC-funded private wearable companies (sorted decreasing turnover wise)

Company Name	Location	Turnover
Jawbone	San Francisco	$470.8 million
Fitbit	San Francisco	$66 million
Mc10	Cambridge	$63 million
MCube	San Jose	$37 million
Withings	France	$34 million
Ineda	Santa Clara	$26 million

ISSN 2348 – 8034
Impact Factor- 5.070

Systems	and India	
Misfit Wearables	Redwood City	$23 million
Zepp Labs	Los Gatos	$20 million
Quanttus	Cambridge	$19 million
Recon Instruments	Vancouver	$17 million

For the success of smart wearables, the devices need to have longer lifetimes. Moreover, the battery technology needs more advancement to provide more power in smaller space and easy recharging. The survey shows that more than 485 million units of shipments of wearable devices are expected by 2018 [9]. CCS Insight expects the wearables market to reach $14 billion by the end of this year, according to Forbes. And BI Intelligence, Business Insider's premium research service, expects the wearables market to grow to 162.9 million units by the end of 2020 [10].

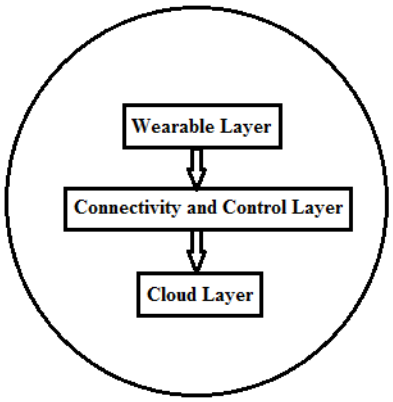

Figure 3: Three layer architecture of smart wearables

Figure 3 shows the three-level architecture of smart wearable devices. The first layer namely; wearable layer; consists of electronics that are placed closest to the body and that measure various body parameters such as temperature, heartbeat, pulse, movement etc. The second layer is the connectivity and control layer that consists of smartphones that act as an intermediate between the gadgets and the cloud and transfers information between them. The third layer is the cloud layer where the device supplies and reads data specific to the use case. Figure 4 shows some of the IoT enabled smart wearables.

ISSN 2348 – 8034
Impact Factor- 5.070

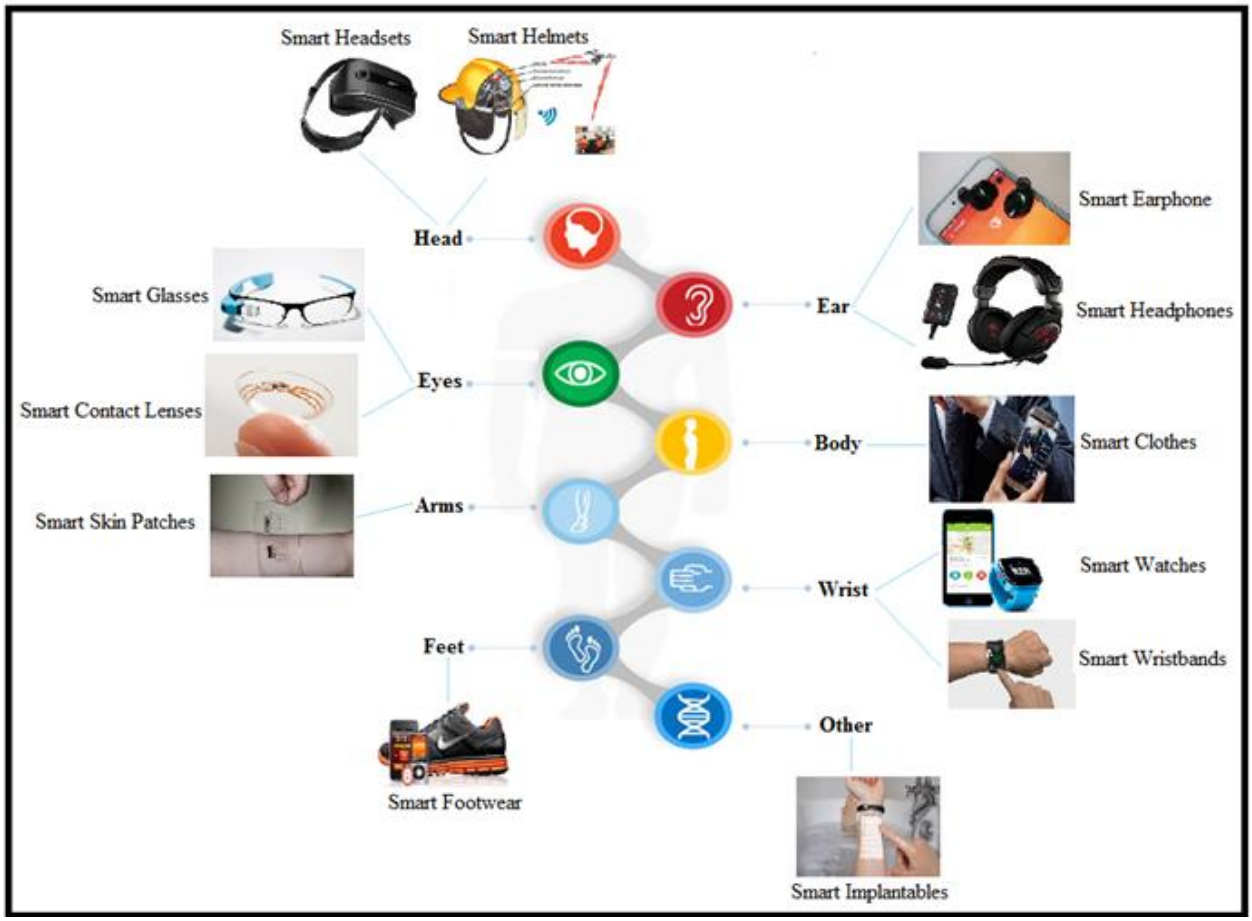

Figure 4: Some of the IoT enabled smart wearables

UTILITIES

SMART CARS AND VEHICLES

Companies are investing money into the Internet of Things, and one field of specific interest to financiers is IoT connected cars. Beyond the elementary perception of a connected vehicle equipped with Internet access, novel markets have emerged, such as Vehicle-to-Infrastructure (V2I), Vehicle-to-Vehicle (V2V), Vehicle-to-Cloud (V2C), Vehicle-to-Pedestrian (V2P), and Vehicle-to-Everything (V2X). The Internet of Things is enabling a transformational change in automotive companies that are in a process of manufacturing cars known as connected cars. Connected cars are modernizing the automotive industry, car dealerships and the transportation policies. A connected car or a smart car is a vehicle which is able to enhance and optimize its own operations and maintenance keeping in view the comfort of passengers. This is achieved by the use of the onboard sensors embedded within the vehicle and internet connectivity that directs useful information regarding the vehicle to the automotive companies. The automotive companies, with the collaboration of software developers, use the information received from the vehicle to examine its performance and acquire valuable data on how the drivers are using their vehicles. Figure 5 shows various internal sensors that would be embedded inside connected vehicles.

ISSN 2348 – 8034
Impact Factor- 5.070

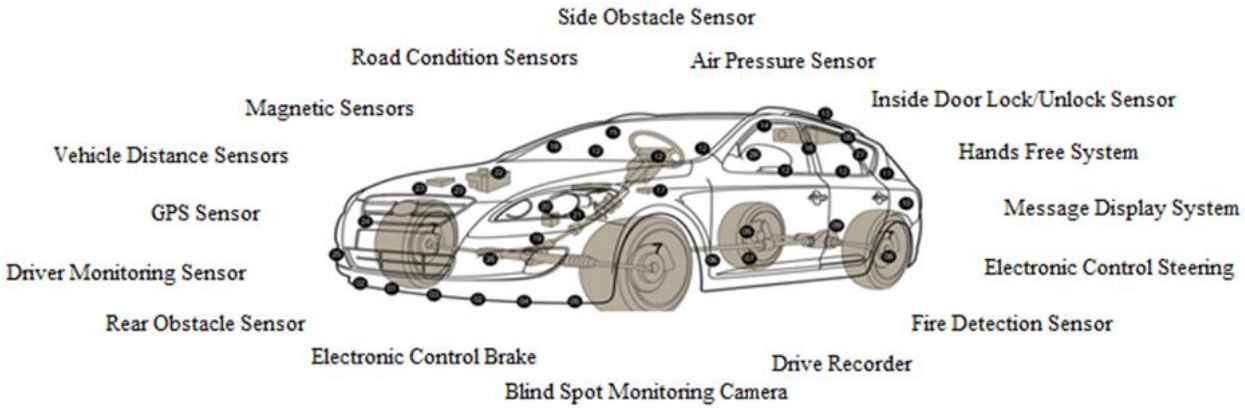

Figure 5: Sensors embedded inside IoT enabled cars

According to Sven Hammar, founder and chief strategy officer at Aprica, with the IoT the vehicles could be accessed remotely by the owners with the use an app to perform various functions such as adjusting vehicle temperature, checking the mileage or even starting the car. Automakers have observed an increasing trend and a major business opportunity for connecting their cars. The major reason behind the advancement in smart cars is to provide a safer driving environment. It is expected that once cars start driving by them, traffic fatalities could be decreased 90% by 2050. Business Insider's Intelligence, a premium research service, anticipates that in 2021, 94 million smart cars would be shipped [11]. Not only the cars, but the public transportation including buses and trains will also be IoT connected in near future. Presently, automakers are connecting their vehicles using two approaches; embedded approach and tethered approach. Embedded cars use an incorporated antenna and chipset, whereas tethered connections use hardware that allows drivers to connect to their cars with their smartphones. In addition to this, app integration is becoming common in vehicles. Major brands like Tesla, BMW, Apple, Microsoft, Uber, Amazon, Mercedes, Bosch, Nissan, Audi and Google are working on bringing the next revolution of totally driverless vehicles. According to a survey conducted by Global Automotive Executive for 200 automotive executives in 2017, BMW is found to be the champion in manufacturing IoT enabled vehicles [12]. Another report designed by Gartner declares that by 2020, just three years from now, there will be quarter billion connected cars [13].

The development of the connected vehicle, from pure vehicle-to-infrastructure to the vehicle-to-vehicle and increasingly vehicle-to-everything, allows vehicle manufacturers with the opportunity to distinguish from their competitors on the basis of digital services that they could provide to their customers. Following is the list of various services that could be provided by automakers in the IoT enabled vehicles [14]:

- *Advanced diagnostics:* IoT enabled cars will produce thousands of data points per second that will assist in providing the information needed to predict potential vehicle issues before they happen to both customers and the auto suppliers.
- *Telematics drivers:* Connected cars will have security features; such as automatic crash warning, stolen vehicle tracing and roadside support; that keep vehicles safe in the event of an emergency.
- *Remote services:* Allows customers to use wireless device to control their connected vehicle in order to perform various services such as tracing their car in a parking lot, directing their vehicle and even starting it remotely.
- *Rear seat infotainment*: Services such as Internet radio, video streaming, web browsing and many more could be available with the technology of 4G LTE available through built-in mobile hotspot.
- *Family tracker*: Assists in tracking a young driver as he travels beyond predetermined boundaries or cross a preset speed limit by sending notifications.
- *Voice recognition*: Enables hands-free services and helps to produce a safer driving experience.
- *Vehicle updates*: Allows the vehicle to automatically get updated with state-of-the-art firmware and software without making an appointment at the dealership.

ISSN 2348 – 8034
Impact Factor- 5.070

Figure 6 shows step wise integration of IoT in cars and other vehicles.

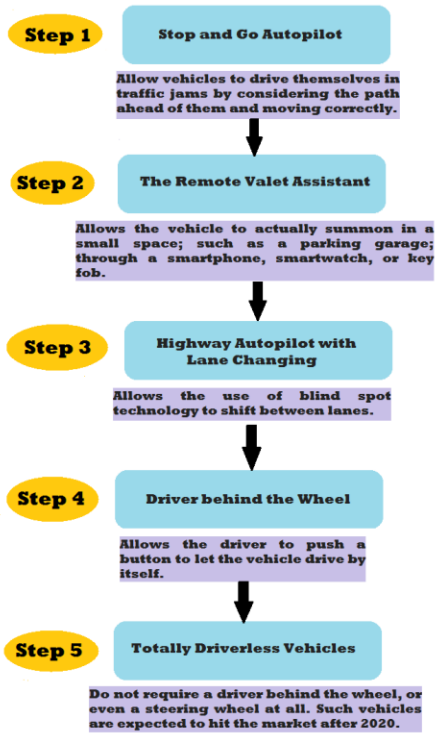

Figure 6: Step wise integration of IoT in vehicles

SMART CITIES

Another leading manifestation of the Internet of Things (IOT) is the smart cities. The world is entering a new era, where smart cities will play a significant role in solving the big challenges to meet objectives regarding socio-economic development and quality of life. With the use of sensors; either standalone or embedded into physical devices; data generated can be communicated, integrated and analysed to assist some aspect of city life to function better in some way. It is foreseen that in the near future the maximum world's population will live their lives in smart cities. The application of the IoT model to an urban perspective will thrust many national governments to implement ICT solutions to control public affairs and hence developing the so called Smart City concept [15]. The major goal here is efficient utilization of public resources, enhancing the quality of the facilities provided to the residents while decreasing the operational costs of the public administrations. IoT will assist in resolving key difficulties faced by the people living in cities like pollution, transportation overcrowding and scarcity of energy supplies etc. Internet of Things when applied to cities generates smart investigation, mechanized transportation, smarter energy management systems, smart water supply system, smart urban safety mechanisms and smarter environmental monitoring system. For example, by mounting sensors and using web applications, residents can find free available parking slots across the city. Also, the sensors can discover meter damaging issues, common malfunctions and any installation problems in the electricity system. Products like cellular communication enabled Smart Belly trash will send alerts to municipal services when a bin needs to be emptied. Figure 7 shows some of the application areas of smart cities.

ISSN 2348 – 8034
Impact Factor- 5.070

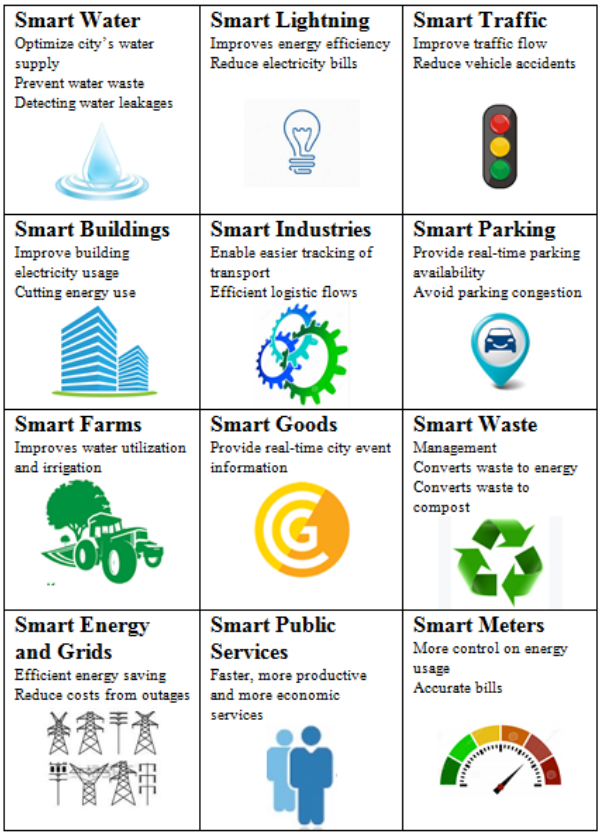

Figure 7: Areas of smart city applications

According to a survey, the Amsterdam is leading the world in smart city development. With the use of IoT in Amsterdam, the traffic on the roads has been decreased to great extent. Moreover, IoT has enabled energy savings and increased safety level of the people. Another city; Barcelona; implemented sensor technology and used the data analysis of traffic flows to design a novel bus traffic network. Santa Cruz used IoT technology to analyze the data of crimes in order to forecast the needs of police and to maximize the presence of police in required places. It is estimated that by 2025, the IoT initiatives will reach $1.7T of annual economic impression in cities. From power and energy savings to the lighting system, smart building construction, water supply, smart parking, more efficient and cost-effective municipal services, enhance public transportation, reduce traffic congestion and environmental monitoring, IoT is altering the way cities manage services, systems and infrastructure. Figure 8 reflects the step wise integration of Internet of Things in cities to convert them into smart cities.

ISSN 2348 – 8034
Impact Factor- 5.070

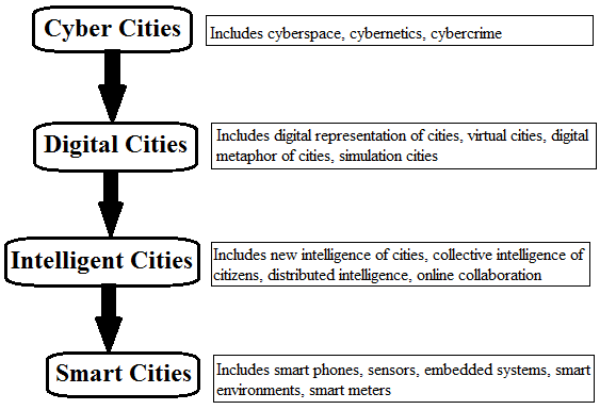

Figure 8: Step wise integration of IoT in cities

ENTERPRISE

SMART INDUSTRY (IIOT)

A new buzz in the industrial sector is the Industrial Internet; also termed as Industrial Internet of Things (IIoT) or Smart Industry or Smart Factory. Today, industries are progressing from cyber physical systems to the Industrial Internet of Things. The Industrial Internet of Things (IIoT) is the use of Internet of Things (IoT) technologies in manufacturing. IIoT is enabling industrial manufacturing with the use of sensors, strong connectivity, software, big data analytics and next generation of embedded devices; to generate brilliant smart machines. The IIoT is the root for an innovative level of organization and management of industrial value chains. IIOT facilitates extremely flexible and resource saving manufacturing as well as improved individualization of products at the cost of mass production. The key driving viewpoint behind IIoT is that the smart machines are extra accurate and reliable than humans in communicating through data that can assist companies to pick inefficiencies and problems faster. IIoT holds an extreme prospective for quality control and sustainability. Moreover, the apps for tracing goods, exchanging real time data regarding inventory among suppliers and retailers and the programmed delivery will increase the supply chain efficiency. In the IoT enabled industries, the products are fairly smart that they know their own individuality, history, description, documentation, and even regulate their own manufacturing process; through information in a barcode or RFID chip. These smart products do not only assemble records during their production but also when they are installed and used by the customers [16]. The German government defines this policy as the subsequent industrial revolution under the title 'Industrie 4.0' [17]. A comparable initiative named 'The Smart Manufacturing Leadership Coalition' is also made in US to make factories smarter [18] [19]. According to a report by McKinsey Global Institute, connecting the physical and digital worlds could produce up to $11.1 trillion a year in GDP by 2025 [20]. IIOT is not a new technology; rather it is a collaboration of existing technologies and disciplines as shown in figure 9.

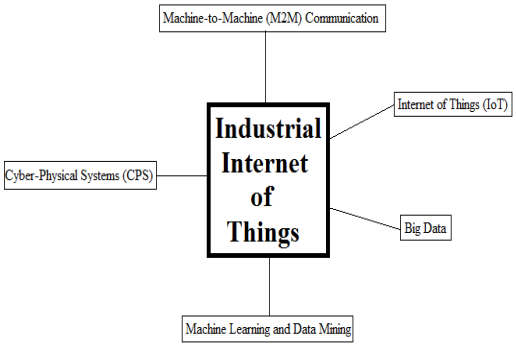

Figure 9: Existing technologies that collaborate to form IIOT [21]

ISSN 2348 – 8034
Impact Factor- 5.070

IV. CONCLUSION

The Internet of Things is considered as a new revolution of the World Wide Web. We have entered a life where electronic devices and machines are probably becoming our best friend. The IoT network not only benefits the one, but all, that is, individuals, society, stakeholders of business etc. by saving efforts, time and money. IoT can assist people with their everyday plans. The IoT, with the prospect of seamlessly integration the real and the virtual worlds through the massive deployment of embedded devices, has opened up many new domains of its applications. This paper included subset of domains of applications of IoT covering smart homes, smart wearables, smart cars, smart cities and smart industries. Even though IoT has not been applied according to the expectations of people, however, it is predicted that IoT with the integration of a number of innovative IT technologies, will change our societies significantly in coming 5 to 15 years

REFERENCES

1. *L. Atzori, A. Iera, and G. Morabito, "The internet of things: A survey," Computer Networks, vol. 54, no. 15, pp. 2787-2805, 2010.*
2. *A. Gluhak, S. Krco, M. Nati, D. Pfisterer, N. Mitton, T. Razafindralambo, A survey on facilities for experimental Internet of Things research, IEEE Communications Magazine 49(2011) 58-67.*
3. *CNN Tech, http://money.cnn.com/2014/01/02/ technology/innovation/ces-connected-home/*
4. *Fried, Ian. "Gateway turning off Net appliances?", ZDNet News, March 6, 2001. http://www.zdnet.com/zdnn/ stories/news/0,4586,2692918,00.html*
5. *Bhattacharyya, S. (2017). Handbook of Research on Recent Developments in Intelligent Communication Application. Retrieved from https://books.google.co.in*
6. *http://www.din.de/blob/160444/56136d9f7c1b2d5a6826c 844742903db/wearables-data.pdf*
7. *The Internet of Things, http://www.mouser.in/ applications/article-iot-wearable-devices/*
8. *Silicon Valley Business Journal, https://www. bizjournals.com/sanjose/news/2014/09/09/wearables-are-hot-heres-who-invested-andwho-got.html*
9. *Gartner; https://www.gartner.com/newsroom/id/3790965*
10. *Qlik; http://global.qlik.com/us/landing/go-sm/resources/ gartner-magic-quadrant-2017-bi*
11. *Automotive Industry Trends: IoT Connected Smart Cars & Vehicles, http://www.businessinsider.com*
12. *Global Automotive Executive Survey 2017, https://assets.kpmg.com/content/dam/kpmg/xx/ pdf/2017/01/ global-automotive-executive-survey-2017.pdf*
13. *Gartner, https://www.gartner.com/newsroom/id/29700 17*
14. *The Internet of Things and connected cars, http://assets1. dxc.technology/analytics/downloads/DXC-Analytics-the_ Internet_of_Things_and_connected_cars-4AA6-5105ENW. pdf*
15. *H. Schaffers, N. Komninos, M. Pallot, B. Trousse, M. Nilsson, and A. Oliveira, "Smart Cities and the Future Internet: Towards Cooperation Frameworks for Open Innovation", The Future Internet, Lecture Notes in Computer Science Volume 6656, pp. 431-446, 2011.*
16. *Security and Privacy Challenges in Industrial Internet of Things, https://www.informatik.tu-darmstadt.de/fileadmin/ user_upload/Group_TRUST/PubsPDF/SnPinIoT.pdf*
17. *H. Kagermann, W. Wahlster, and J. Helbig, "Recommendations for implementing the strategic initiative INDUSTRIE 4.0 Final report of the Industrie 4.0 Working Group," 2013.*
18. *J. Davis, T. Edgar, J. Porter, J. Bernaden, and M. Sarli, "Smart manufacturing, manufacturing intelligence and demand-dynamic performance," Computers & Chemical Engineering, vol. 47, pp. 145- 156, 2012.*
19. *P. C. Evans and M. Annunziata, "Industrial Internet: Pushing the Boundaries of Minds and Machines," General Electric 2013.*
20. *Unlocking the potential of the Internet of Things, https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/the-internet-of-things-the-value-of-digitizing-the-physical-world*
21. *P.C.Evans, M.Annunziata, Industrial Internet: Pushing the Boundaries of Minds and Machines, November 2012, Available online at http://www.ge.com/docs/chapters/ Industrial_Internet.pdf.*