# A state of the art review on the Internet of Things (IoT)

## History, Technology and fields of deployment

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**Abstract—Internet and its applications have become an integral part of today's human lifestyle. It has become an essential tool in every aspect. Due to the tremendous demand and necessity, researchers went beyond connecting just computers into the web. These researches led to the birth of a sensational gizmo, Internet of Things (IoT). Communication over the internet has grown from user - user interaction to device - device interactions these days. The IoT concepts were proposed years back but still it's in the initial stage of commercial deployment.Home automation industry and transportation industries are seeing rapid growth with IoT. Yet not many articles have been published in this field of study. This paper aims in structuring a state of the art review on IoT. The technology, history and applications have been discussed briefly along with various statistics.**

***Keywords: Internet of Things, IoT, network protocols, web, network security, internet engineering, smart solutions, automation etc…***

## I. INTRODUCTION

In the near future it's the computers that would dominate the world by outperforming human computing capabilities. From manufacturing of a ball pin to a space shuttle the computers and the internetare playing a vital role. Controlling electrical and electronic equipment's ("Things") remotely is a well-known concept since the early 1990's but is yet to be deployed across our societies with full throttle.The term things refer to everything around us from a small atom to a large ship. The IoT environment would allow users to manage and optimize electronic and electrical equipment's using the internet. It is speculated that in the near future majority of communication will be between the computers and other electronic equipment's that would be connected with each other and would exchange information among them thereby lessening the human interactions. This would also make the number of "things" increase drastically than the number of active users in the internet. We would also become the meagre generators and receivers of traffic in the internet as the most interactions would be between the "Things" as reported[1].One of the major challenges in the IoT is bridging the gap between the physical world and the information world. A sensor does this process to a greater extent [2]. They serve as an interface between the users and the equipment's. Sensors collect physical raw data from real time scenarios and convert them into machine understandable format so that it would be easily interchanged between various "Things".

Selecting the appropriate medium to perform this process is a challenging aspect in the IoT environment. Since most of the process is done through the internet we must have an active high speed internet connection. Many countries have gone beyond 4G in internet services and several countries have even achieved 7G (like South Korea). Carrying these much amount of data and processes would probably encounter numerous challenges like connectivity and security.

In this paper we are going to analyse IoT's history, various medium of deployment of IoT, performance analysis and applications of IoT. Since majority of IoT usage is through wireless medium we are going to analyse some of the top notched wireless platform i.e. RFID, Bluetooth and IEEE 802.11 for our study. A detailed analysis of the same is depicted. Observations have been done based on operational dependencies, routing, and security concerns. Environmental and health impacts are also discussed. The rest of the paper is structured as below;

Section II depicts a short history of IoT with a timeline. Section III narrates the various mediums in which IoT can be employed. Section IV discusses the observations of the authors. Section V consolidates the various applications of IoT. Section VI lists out the challenges concerning IoT. The paper concludes in Section VII envisioning the future tasks.

## II. . IoT: THE HISTORY AND TECHNOLOGY

Ever since the birth of the internet in 1989, connecting "Things" in the internet began widely. Trojan Room coffee pot

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is possibly the first application of this kind [3]. In 1990 John Romkey created the first Internet 'device'[5], a toaster that could be turned on and off over the Internet.[6] WearCam was invented in 1994 by Steve Mann. It had a near-real-time performance using a 64-processor system. Paul Saffo's [7] gave the first brief description about sensors and their future course of action in 1997. In 1999 The Internet of Things term was coined by Kevin Ashton, executive director of the Auto-IDCentre, MIT. They also invented a global RFID-based item identification system in the same year [8]. As a major leap in commercialisingIoT, in 2000 electronics giant LG announced its plans of revealing a smart refrigerator that would determine itself whether or not the food items stored in it are replenished. In 2003 RFID was deployed at a massive level in US army in their Savi program. The same year saw retail giant Walmart to deploy RFID in all its shops across the globe to a greater extent. In 2005 main stream publications like The Guardian, Scientific American and Boston Globe cited many articles about IoT and its future course. In 2008 a group of companies launched the IPSO Alliance to promote the use of Internet Protocol (IP) in networks of "smart objects" and to enable the Internet of Things. In 2008 the FCC approved the usage of the "white space spectrum". Finally the launch of IPv6 in 2011 triggered massive growth and interests in this field. Later IT giants like Cisco, IBM, Ericson took a lot of educational and commercial initiatives with IoT.

The IoT technology can be simply explained as a connection between humans – computers – things. All the equipment's we use in our day to day life can be controlled and monitored using the IoT. A majority of process is done with the help of sensors in IoT. Sensors are deployed everywhere and these sensors convert raw physical data into digital signals and transmits them to its control centre [18]. By this way we can monitor environmental changes remotely from any part of the world via internet. This systems architecture would be based on context of operations and processes in real-time scenarios. In home automation every electrical switch box would be connected with a smart phone (or sometimes a remote) so that it could be operated remotely. But such a scenario doesn't need a processor and a storage device installed in every switch box. It just needs a sensor to capture signals and process it(mostly switching ON/OFF). So this systems architecture varies depending on the context of its application.

## III. MEDIUM OF DEPLOYMENTS

The IoT is a wide spread strategy and its presence is required everywhere in the globe for full-fledged deployment. So such a technology requires a widely accepted and an effective medium of operation. Since the internet initially became widespread through wired communication, it could be argued that IoT can be implemented in wired communication as well. But if we consider the reality wired communication cannot be accomplished everywhere. Wired network has its own disadvantages considering the mobility issues and installation cost. An effective, low costand a simple alternative for deploying IoT would be the wireless medium.We would now analyse some of the globally recognised and widespread wireless mediums along with their merits & demeritswith regards to the IoT scenario.

### *A. RFID*

Radio Frequency Identification (RFID) is a technology that uses radio frequencies to transmit data. This process is executed using RFID tags that would be deployed at the respective spots. These tags are of two kinds; active tags are those with an internal power supply and passive tags are those without internal power supply.These tags communicate to the RFID readers. A detailed note about RFID and its specs could be found in previous literature [10].

What this RFID technology could offer to IoT environment is of great potency. The miniature size of RFID tags would enable its deployment in any area irrespective of the environmental condition. Fig 1 shows various RFID chips ranging in different sizes. A benchmark innovation with RFID is the anti-collision protocols (Aloha based protocols or tree based protocols) that are serving as a boon in avoiding vehicular accidents. Transport and logistics industries have seen tremendous growth and innovation with the introduction of RFID technology. RFID works between 135 KHz and 5.875 GHz frequency band as LF, HF, UHF and SHF.

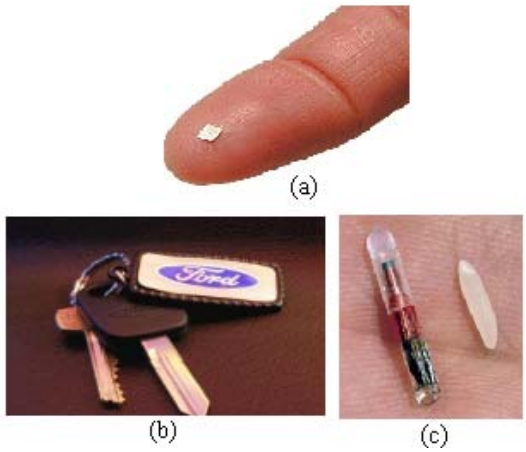


Fig. 1. RFID chips ranging in various sizes and forms. (a) Miniature sized RFID chip, (b) RFID chip in a car keychain and (c) A rice sized RFID chip

RFID would simplify many activities that we do in our day to day life. Mobile cardiac telemetry monitoring platform [12], an innovative application of RFID in healthcare industry provides 24*7 supports a patient by constantly monitoring his/her heart beat and keeps the concerned medical attender updated by sending regular updates.RFID transponders responds with remarkable speed of less than 100 milliseconds every time. Such tremendous applications and merits of RFID make it viable for usage in an IoT environment.

### *B. IEEE 802.11*

The IEEE 802.11 widely known as "Wi-Fi" is a globally accepted wireless medium that is used to send/receive data, signals, commands and much more. It works in the 2.4GHz – 60GHz frequency band. It supports data rates ranging from 1Mb/s to 54Mb/s, but however speeds up to 6.75Gb/s [20] have also been achieved. Wi-Fi is now a default amenity available in every modern smartphones, PDA's, Tablets, laptops etc… This WLAN standard just requires a transceiver (mostly a router or an antenna) that spans an

operational range around it. Depending upon the capacity of the transceiver the range and speed of Wi-Fivaries. Based on the networking application several IEEE 802.11 standards (collectively known as Wi-Fi standards) have been proposed.

Simple and low cost installation/maintenance of Wi-Fi devices have boosted their usage over the years. Nowadays it's common to see a Wi-Fi network in public places, schools, colleges, hospitals etc… Such a scope for Wi-Fi would be an added advantage for the IoTwhich require its network widespread everywhere. Such a scenario is tedious to implement using traditional wired infrastructure. Wi-Fi devices could be implemented in any remote area irrespective of the landscape and environmental constraints.IoT requires access to every "Thing" which means the number of "Things" increases day by day. This is a constraint with respect to wired mediums or RFID as new equipment's needs to be installed to add more devices. However in a Wi-Fi scenarioit's simple to add more devices without installing any new devices.This promising feature of Wi-Fi makes it viable for deployment in IoT scenarios.

### *C. Barcode e QR Code*

Barcode is a symbol attached to every object that could be read only by a barcode scanner. Barcodes are in use since the early 1970's and are now employed everywhere in recognizing objects in most of the firms [11]. It became globally famous after the automated checkout system implemented in various retail outlets. Barcodes can be implemented simply. There are no technological difficulties in implementing or using a Barcode. An updated 2D matrix representation of barcode is the QR Code. Various barcode types are shown in Fig 2. [17]Depicts more about barcodes and their technical specs.


Fig. 2. Clockwise: Linear barcode, stacked barcode, 2D barcode and composite codes

Any product that is tagged with a barcode could be identified using a barcode reader. A mobile phone camera can identify the details of a product using a QR Code. This would enable global identification of "Things" and would additionally hold the specs about that "Thing". It might be a similar technology as the RFID but differs in size. Barcode would be like a sticker that can be pasted in any product however RFID is a chip that holds information about that "Thing". Cost and installation of a barcode is cheap compared with RFID. A barcode scenario would enable deployment of IoT simpler. While we surf the internet we might click hyperlinked words to know more about them. The same principal was made possible in the physical world using QR Codes.

### *D. ZigBee IEEE 802.15.4*

ZigBeeis a specification for small, low power radios based on IEEE 802.15.4 – 2003 WPAN standard. It can also be regarded as a low power version of Wi-Fi. It operates in the unlicensed bands including 2.4GHz, 900MHz and 868MHz. This specification was accepted and endorsed for deployment in 2004. Its low power enables a ZigBee device to send a data over a long distance passing through the intermediate devices thereby forming a mesh network.It has a secure network connection with very long battery power backup. In 2002 many small companies together formed the ZigBee alliance, a non-profitable organization consisting of members from academic, government and industrial streams. [19]. More about ZigBee and its specs could be found in [14-16].

One of the major contrasting features about ZigBee is that it's cheaper than Bluetooth and Wi-Fi. This boosts the feasibility of its deployment for IoT applications. Industrial automation, health care, telecom, retail outlets etc… are seeing tremendous growth in ZigBee. It reduces operational expenses and improves QoS.It uses AES 128 bit encryption for security. This reliable and self-healing attributes of ZigBee is added merit to the IoT stream. Due to its immense qualities many commercial home automation products use ZigBee technology.

### *E. Bluetooth*

Bluetooth is a popular technology among mobile phone users. It is an open wireless technology for PAN operating at 2.4GHz ISM band [21]. Most recent assets in the Bluetooth technology are the development of "Bluetooth low energy (BLE)" and "Bluetooth smart" technology. It would be legitimate to say that IoT is a reality today because of Bluetooth. The amount of wearable electronic devices (smart watches, phones, earphones, glass and shoes that use Bluetooth) that we use now would concrete the previous statement. Ever since its inception in 1998, Bluetooth has seen tremendous advancements in terms of technology. Mobile phones used Bluetooth technology which was later followed by Bluetooth mouse, keyboard, printer etc… now the Bluetooth product shipments have crossed 2.5 billion this fiscal [21].

The seamless interconnectivity that Bluetooth offers is imminent in the IoT stream. Since the Bluetooth contributed the means for device to device communication and for PC's, cars, smartphones, tablets etc… Now the modern world is seeing a mammoth hike with an inconceivable array of devices connected with each other. Many researchers believe that Bluetooth would play a key role in the trillion dollar IoT market in the coming years [21].

Fig. 3. Bluetooth wearable devices: (clockwise) smart watch, headset, smart shoe and smart glass

## IV. OBSERVATIONS

Looking at the vast IoT's turf it is evident that this technology has a mammoth scope in the coming years. As far as the previous section is concerned, choosing the right medium for this technology is a major design consideration.Every technology depicted in the previous chapter is unique and have their own advantages in the IoT stream. At the same time a single technology cannot be engaged in every area of IoT.Based on the research analysis we did on various mediums of IoT deployment, we have observed several key aspects that could be a concern for IoT in the respective mediums. They are consolidated below;

RFID was our first consideration. One of the major flaws we witnessed with RFID was the lack of global standards. Many companies that provide RFID functions use their own standards and this could be inconvenient for users to migrate from one RFID facility to anotherwhich is an unlikely approach or strategy[10].RFID uses electromagnetic spectrum which is more vulnerable to jamming. It could be disastrous for defence and health care industry. But otherwise RFID is economically feasible for operation in retail outlets, campus environment etc…

Wi-Fi uses the 2.4GHz unlicensed band spectrum. This frequency range is the most crowded range with other devices (Bluetooth, cordless phones, microwave ovens etc…).The range of a Wi-Fi device is limited depending upon the environment (around 45m indoor and around 90m outdoor). Additional repeaters and access points should be installed to fetch more range for a Wi-Fi device. Besides these issues simple installation and maintenance makes wi-fi a front runner in IoT design. Majority of educational institutions, corporates, public libraries and many other are wi-fi enabled nowadays. Security, reliability and inter-operability issues are also a concern over wi-fi [9].

Barcodes and QR codes are so appealing in today's modern techno world. There is no doubt about barcodes/QRcode scanningis more reliable than manual data collection, yielding higher data rates at higher accuracy. Line of sight is another major concern inIoT.Barcode labels must be clear and visible for scanning. QR codes and barcodes could take information to any place irrespective of environmental conditions, provided there is a barcode scanner.But having a barcode reader everywhere is a concern. QR code scanners are now available with every smart phone. These technologies could be a huge boost in enhancing IoT everywhere.

Zigbee and Bluetooth posts similar issues as IEEE 802.11 and RFID. A major flaw with Bluetooth is that a piconet could only have upto 255 slave devices which means not more than 255 devices can be connected with a single Bluetooth device at a time [22]. This is a major setback considering the number of devices with IoT in the future. On the other hand Zigbee is very much scalable and it consumes only less energy. A regrettable aspect about Zigbee is that an unknown third party device could mimic a zigbee node and collect details of transmission in it. This poses a serious security issue in zigbee.

Considering all the above mentioned technologies with respect to IoT stream would be hectic. Using an appropriate technology at the apt places with enhancedperformance is the main challenge in front of IoT researchers and industrialists. But among these technologies Wi-Fi looks to be a better option for the deployment of IoT. Edgar Figueroa, CEO of Wi-Fi alliance [13] depicts the scope of Wi-Fi in the IoT design. Moreover Wi-Fi is present in majority of placesin the world. With the deployment of MANET's and VANET's, taking Wi-Fi everywhere is a feasible aspect of technology. There are numerous design considerations in Wi-Fi but still the authors prefer Wi-Fi as a base technology of deployment of IoT. However at the same time in remote places and abandoned land mass, RFID or Barcodes/QR codes could be an option as well. Interoperability between these technologies could help in bringing out an efficient IoT mechanism in the future.

## V. PERFORMANCE ANALYSIS

The previous section depicts the specification of various mediums of deployment for IoT. However the characteristics of these mediums needs to be analysed in order to fetch accurate results of these medium's performance in real-time operating scenarios. There are three techniques for performance evaluation, which are analytical modelling, simulation and measurement. Simulation had being chosen because it is the most suitable technique to get more details that can be incorporate and less assumption is required compared to analytical modelling. We perform simulated tests and analyse their performance in terms of sending/receiving packets, speed, accuracy and quality.

### *A. Barcode / QR code*

Barcodes are read using barcode scannersor barcode readers as shown in Fig .4.They are engineered to specific requirement which can resist error up to a certain level.Henceforth they differ in performance irrespective of the same make. Some scanners scan at long range like shelf tags in a warehouse while some are made to scan extremely high density. In olden days barcodes were prone to interference due to light sources. Nowadays we use Laser, LED scanners and camera based scanners.

Fig. 4. various barcode scanners clockwise: Handheld barcode scanner, Hands free barcode scanner and Stock barcode reader.

Performance of these barcode readers mainly depends on their scanning speed. Their performance deteriorates mainly due to any variations or damages in the barcode. Dirt or any other foreign particle present in the barcode would also cause Line of Sight (LoS) issue thereby diminishing its performance. The KarTrack ACI project was abandoned mainly due to this reason.The MS – 9 high speed barcode scanners from Microscan Systems, Inc is one of the fastest barcode scanners in the world. It could process over 2000 scans per second.More about performance analysis of barcode could be found in [23].

*B. Wireless mediums: Wi-Fi, Bluetooth andZigBee*

Wireless mediums are simple to simulate rather than going for analytical modelling. Initially we consider 50 nodes for our study and simulated real time operating scenarios of these nodes in Bluetooth, Wi-Fi and ZigBee mediums respectively. The parameters we consider for our study are Packet loss, number of nodes and distance between nodes.We simulateda wireless scenariowith 50 nodes for Wi-Fi (IEEE 802.11) environment, 50 nodes for Bluetooth and 12 nodes for ZigBee. We simulate them using "Network Simulator – 2".

The performances of these wireless mediums are calculated using various parameters.A 100% accurate performance analysis is not possible with these mediums. Due to different operational conditions and dependencies wireless networks are prone to packet loss issues, connectivity issues etc… which might dent the performance. So our study considers some of the basic parameters that would reveal performance of these wireless networks during highly congested scenarios. IoT would make thousands of nodes to club into a same area which would obviously scale down the performance.

Distance between the nodes would also be a cause of concern. Wireless technology works only upto a certain distance from its source node. This range depends on the type of hardware used.Therefore the distance between nodes would also be a concern that would arbitrate performance. Signal strength of a Wi-Fi network would also be affected due to interference by other mediums or in some case due to security breach. Our considerations are 50 nodes for Wi-Fi and Bluetooth and 12 nodes for ZigBee. However their performance is projected for 100 nodes to generalise the results.

Diminishing signal strength would obviously escalate the chances for packet loss. Our analysis is mainly based on packet loss, distance between nodes and the number of nodes. We designed a wireless network in Network Simulator – 2. Operating frequencies, bandwidth and other specs were set according to their respective standards. Once we simulate this scenario NS-2 would compile the network with interactions as in real time environments. The variations in packet loss rate and the number of nodes are plotted in Fig 5. Similarly Fig 6 and 7 depicts the variations in distance to the number of nodes and packet loss with the distance between nodes.

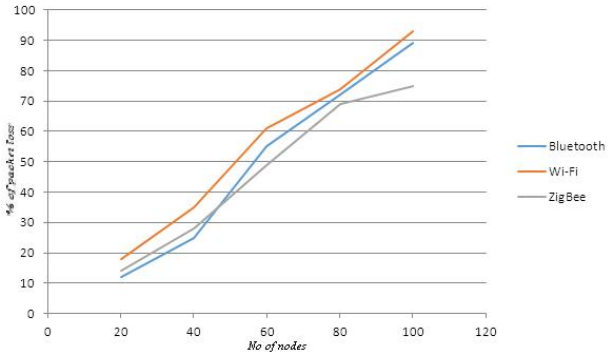


Fig. 5. Packet loss vs Number of nodes

Figure 5shown above depicts the graphical representation of the variations in the percentage of packet loss with respect to the number of nodes.

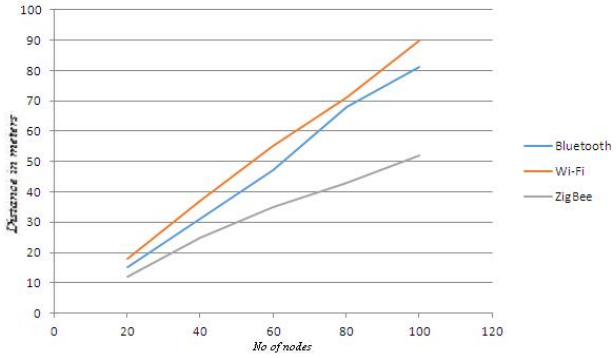


Fig. 6. Distance vs Number of nodes

Increase in the number of nodes would also result in expanding the coverage area of a network, ie in case of a MANET more the number of active devices, more will be its coverage area as each node would transmit and receive signals. Fig 6 shows that Wi-Fi seems to perform better in this scenario.

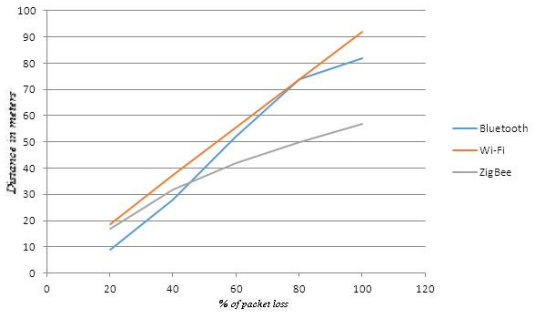


Fig. 7. Distance vs Packet loss

As the distance between each node increases obviously chances for packet loss would increase. Fig 7 shown above depicts the variations in packet loss with respect to distance between nodes. Looking at the above graph ZigBee seems to perform better than Wi-Fi and Bluetooth. The performance

analysis not only depends on the above mentioned statistics. There are many other operational conditions such as interference, power backup, etc… that needs to be considered.

## VI. THE IOT FIELDS OF DEPLOYMENT

With an estimate of over 50 billion devices to be connected with the internet by 2020 [4], this field is likely to have enormous amount of applications now and in the near future. From monitoring a baby in incubator to supporting an age old senior citizen, IoT has a mammoth growth not just the healthcare industry but in many other fields as well. With this kind of a rapid growth at forecast,this section will depict a brief note about various applications of IoT in numerous domestic and commercial streams.

### *A. Smart environment*

A smart environment is what everyone likes to be in these days. Since we live in an automated society, a smart environment would embody this trend by linking computers, smartphones and internet into our everyday activity. IoT paves way for a smart environment. In general Smart City refers to urbanisation and having world class infrastructure development. But in the context of IoT smart city refers to automating an entire city and managing everything via the internet.From controlling traffic signals to monitoring pollution levels various applications are on course. A smart city would see sensors playing a vital role in IoT deployment. A smart city would have some of the major automation systems that serve as a backbone in its economy. A few are; tracking vehicle parking arrangements, Monitoring seismic vibrations in buildings, tracking pollution levels and radiation levels of a city, managing traffic, disaster recovery, waste management, supply chain management and much more…

### *B. Domestic applications*

Home automation industry is a best example for IoT applications at domestic level. A user can control the usage of water from his homes water tank by having sensors linked to it. Toasting a bread on giving commands via a phone, turning ON the air conditioner before reaching home to keep the room cool, remotely operating all the electronic devices and electrical devices at home via a smart phone. Logging details of room temperature, dust level, noise level, even oxygen level could help users to optimize living conditions. Monitoring carbon footprint by consolidating the electricity consumption, water consumption, biological wastages, and food wastages is an astonishing aspect about home automation.

### *C. Industrial Applications*

Industrial automation on the other hand is remarkably developing with the induction of IoT. Smart Grid monitors energy consumption monitoring and management. Supply Chain Control monitors of storage conditions along the supply chain and product tracking for traceability purposes.Rotation of products in shelves and warehouses could be controlled by smart product management system. Monitoring of ozone levels during the drying meat process in food factories is effective with IoT. Selective irrigation in dry zones to reduce the water resources required would enhance performance in the agricultural sector. Monitoring of conditions of patients inside hospitals and in old people's home is an asset in health care industry.

### *D. Security & Emergencies*

24*7 surveillance via CCTV cameras is a contrasting feature in securing premises. These cameras could be monitored from anywhere in the world via internet. Perimeter Access Control to restricted areas and detection of people in non-authorized areas is a latest addition into its stream.Liquid detection in data centres, warehouses and sensitive building grounds to prevent break downs and corrosion, Distributed measurement of radiation levels in nuclear power stations surroundings to generate leakage alerts, Detection of gas levels and leakages in industrial environments, surroundings of chemical factories and inside mines and much more…

### *E. Logistics and Transport*

Monitoring of vibrations, strokes, container openings and cold chain maintenance for insurance purposes is an innovative application. Searching of individual items in big surfaces like warehouses or harbours, Storage Incompatibility Detection, Fleet Tracking etc… are some of the few applications in Logistics platform. The transport industry has seen tremendous applications with IoT. GPS, V2V and V2I communication have transformed the transportation industry to a new level. Machine to machine (M2M) technology is gaining momentum. If vehicles communicate with each other, chances for accidents and mishaps would be very low and it could be aboon in developing smart transport facilities in future. Tracking public transport system, knowing traffic and pedestrian densities, identifying damages in roads, avoiding collisions, optimizing travel route and many more abundant applications are feasible with IoT.

## VII. CONCERNS OVER IOT

Iot is a modern eras techno gimmick but the challenges and issues concerning to IoT are enormous. Numerous considerations are need to be done before implementing IoT. We have consolidated these issues as shown below;

### *A. Design Issues*

Designing a simple computer network involves many considerations from hardware components to the software versions incorporated for the same. So obviously designing an IoT system would post numerous design considerations. The first constraint is the medium of deployment. Sections III and IV depicts about various available mediums for deployment. Using a single medium is not a likely scenario. So obviously we must go for a hybrid technology (combination of technologies). But interoperability issues within a single medium and with different mediums are a huge challenge in front of IoT researchers. For example, if we consider an Apple I Phone, it is designed in such a way that it could transmit data's via Bluetooth only to another Apple I Phone or any other Apple device. These kinds of design issues would dent the progress of IoT.

*B. Security Issues*

Security is an alarming issue concerning the IoT industry. No computer system is 100% secure from security threats. With billions of devices likely to be connected to the internet in the coming years, security threats needs to be addressed. Data integrity and compatibility issues would topple economies across the global market if not defended. For example anything put on the internet will remain for a long time (sometimes forever). This could affect privacy norms of individuals and organisations. An intelligent RFID based retail outlet system could trigger burglary. Such a system would enable to detect the products in your cart and even the total money in a valet. Jamming of radio networks in a battle field or a hospital that uses smart wireless environment could be disastrous. Many other concerns over security have been raised in the past and many are yet to be rectified completely. These drawbacks could delay the progress of IoT.

*C. Impacts on our environment*

A major appeal kept forth the world before IoT's inception is that it would make our earth a greener place to live. Sensors could detect pollution levels in our atmosphere and thermostats could help in saving electricity from wastage. Irrigation systems could save water to a greater extent. But this vast network of devices could leave the world into an electronic dump yard in the near future. Rather than repairing minor issues in smart phones and electronic devices, now the trend has changed that people are going for new devices. 20 to 50 million tons of E-wastes are disposed annually. With this number set to increase in the near future, it's a major hit in our ecosystem. Unfortunately only 12.5% of E-wastes are recycled currently. An average business man emits 131 grams of carbon annually by using E-mails alone, says a study by McAfee. The study also states that millions of KWh could be saved if we properly manage E-waste. But these adverse effects of E-wastes posts a huge threat to global warming.

## VIII. CONCLUSION AND FUTURE WORK

"Now we are able to collect data everywhere from our environment, infrastructures, businesses and even ourselves, and this huge amount of information is generating a new ecosystem of business opportunities around its storage, analysis and accessibility" saidLibelium's CEO Alicia Asín.IoT is a fascinating industry and would make life easy to live. But at the same time many innovative technologies in the past have been proven disastrous in about 50-60 years later. Nuclear energy is a best example for the same. But however providing an adequate lifestyle enabled with modern technology is a must in the current scenario. Technological advancements would be contrasting but their long term impacts needs to be analysed before its deployment. The authors hope that this article would have given a clear picture about IoT and its technological specs in detail. We hope more researches would pour into the IoT stream in the future.

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