ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

*(An ISO 3297: 2007 Certified Organization)*

*Website: www.ijircce.com*

**Vol. 4, Issue 12, December 2016**

# A Survey of Growth and Opportunity of Internet of Things (IoT) in Global Scenario

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**ABSTRACT:** IoT is the interconnection via the internet of computing devices incorporated in the daily life objects, with capacity to exchange data. This paper discusses the vision, the challenges, possible usage scenarios and technological building blocks and applications of the "Internet of Things". It is the futuristic term used for Addressability, identification, communication, localization, ergonomics and sensing etc. IoT will surely be a potent tool in everyone's life, office, smart city, health, education, training, transportation, manufacturing, production etc. This paper presents the report/survey on how the IoT is going to emphazie on approximately all fields and what is its current trend on the basis of pervious literature, identifying current trends, describing challenges that will threaten IoT and future research directions.

**KEYWORDS**: Actuation, Heterogeneity, cloud computing, Addressing

## I. INTRODUCTION

The late Mark Weiser established an influential idea of future hi-tech omnipresence few decade ago. According to this idea the increasing "availability" of processing power would be convoyed by its decreasing "visibility". Initial forms of omnipresence communication networks and information are pointed in the persistent & consistent use of smart phones: the number of smart phones worldwide exceeded 2 billion in Jul 2005. These little gadgets have become an essential and close part of everyday life for most of people, even more so than the internet. Now, advancements are vastly made in this phenomenon to next level. To achieve these advancements, short range mobile transceivers are placed in wide array of additional electronic gadgets and our everyday life's items are now enabled to establishment communication among such things. It enables a new type of communication among things and people, and even among things as well. A new line has been drawn in this world of information & communication technology. This technology is may be used anytime, anyplace connectivity for anyone. We will now have connectivity for *anything* [**1]**

As internet is spread all over so it is the key to the advancement if any country. Internet has become pervasive in everyone's life. Most of the people have now come to rely on internet for their activities very much.

Due to its vast application and easy availability, internet is one of the very important part of our growing generation for getting connected with their friends, checking their e-mails, online shopping, online reservation, online banking, tracking any product, comparing insurance policies and may more. The new lifestyle even in urban area have focus many people to rely on the internet for their daily life. It has become one of the most essential technology crafted by human being and its outcome already had on many fields like: training, shopping, education, agriculture, real estate development, product tracking, science, business, research, education, communication, humanity and government.

In the year 1999, one of the group of MIT (Massachusetts Institute of Technology), was working in the field of networked RFID (Radio Frequency IDentification) and incorporating sensing technologies at the Auto-ID Center. For this across 4 continents, 7 research universities were located on the basis of the Auto-ID Center to design the architecture for IoT.

According to the Cisco IBSG (Internet Business Solutions Group), IoT is simply the point in time when more things were connected through the use of Internet as compared to people.

The IoT (Internet of Things) is also mentioned as the Internet of Objects, and it will change the entire lot including ourselves. From the view point of technological area, the Internet of Things may be defined as smart device interacting and communicating with other devices, objects, and infrastructure. It result in huge volume of data generated and

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International Journal of Innovative Research in Computer and Communication Engineering

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Website: www.ijircce.com

Vol. 4, Issue 12, December 2016

processing of that generated data into useful actions. Those actions can "control and command" things and make our life much easier [2].

## II. IOT TOPOLOGY

IoT architecture may be represented by 4 systems

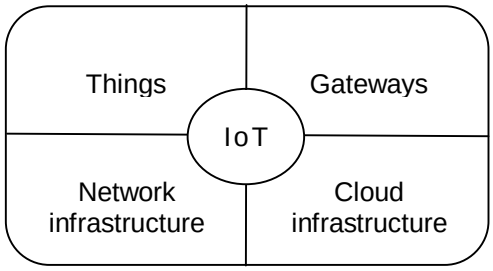


**Figure 1: Internet of Things**

*i) Things:* Things in IoT can be any object. It may be your smart phone, your fitpit, your car, your home appliances, your assistant, your bank etc. Things are active participants in office, business, social and information processes where those things are enabled to communicate & interact among themselves. Those things, with the environment by exchanging data and information sensed about the environment, while reacting without any name to the physical or real events in world. Those things may influence by running processes that executes actions and create services with or without direct human interaction.
These are defined as identifiable nodes which are unique. They also include primarily sensors that communicate without human interaction using IP connectivity. There are millions of IP locatable things in our everyday life. Those things may range from RFID tags to fitness bands – and their users are supposed to increase exponentially as sensing device become cheaper in cost, smaller in size and more power-efficient to save energy. As per the estimates of Morgan Stanley this number of users could be touched to fifty billion by 2020, which translates to 6.4 devices (approximately) for every one of the eight billion humans who are expected to be on this Earth at that point of time.
*ii) Gateways:* Gateways are the bridges among things. Besides this they provide the cloud so that proper security, connectivity and manageability may be obtained through Internet.
*iii) Network infrastructure*: In case of IoT network infrastructure majorly includes gateways, routers, repeaters aggregators, repeaters and several other devices to control data flow. They are also capable to connect to the telecom and cable networks (3G, 4G/LTE) which may be operated by service providers.
*iv) Cloud infrastructure:* To incorporate Cloud infrastructure, it includes large pools of virtualized servers and storage that are networked together. In support to IoT, this infrastructure executes applications to analyse data from various sensors and devices so that actionable information may be generated which may be used for services and decision-making. [3]

## III. RELATED WORK

In general IoT seems to be relatively new term. But it is not true. It has been used in various areas. The Internet of Things is definitely a technological revolution in computer science & engineering to represent the future of communication & computing, and its advancements depend on dynamic technical innovation in a number of important fields, which may vary from wireless sensors to nanotechnology.
It is very obvious that Internet is the first & foremost area in IoT in order to connect everyday objects and devices to large networks and databases. Secondly, if there is any change in the state of things, it may be easily detected through sensor technology and data may be collected. Finally, improvements in diminishment and nanotechnology mean that smaller things may be provided with the facility to connect & interact.
According to one pervious paper [4], the gap between virtual and physical world, may be filled via Internet of Things.

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The capabilities of IoT include:

| | |
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| *Address-ability* | If we are using IoT, then objects can be addressed and accessed via discovery, look-up or name services. After accessing they may be remotely interrogated or configured. |
| *Communic-ation and cooperation* | In case of curriculum that is other than syllabus, real world objects have the capacity to network with Internet resources or even with each other, so that use of data and services and update their state is updated. Wireless technologies such as GSM and UMTS, Wi-Fi, Bluetooth, ZigBee and various other wireless networking standards currently under development. |
| *Sensing* | Objects collect information about their surroundings with sensors, record it, forward it or react directly to it. |
| *Actuation* | Objects contain actuators to manipulate their environment Such actuators can be used to remotely control real-world processes via the Internet. |
| *Identification* | All the Objects are now uniquely identifiable. RFID, Near Field Communication (NFC) and optically readable bar codes are examples of technologies with which even passive objects which do not have built-in energy resources can be identified. Identification enables objects to be linked to information associated with the particular object and that can be retrieved from a server, provided the mediator is connected to the network. |
| *Embedded information processing* | Smart objects feature a processor or microcontroller, plus storage capacity. These resources can be used, for example, to process and interpret sensor information, or to give products a “memory” of how they have been used. |
| *User interfaces* | Smart objects can communicate with people in an appropriate manner (either directly or indirectly, for example via a smartphone). Innovative interaction paradigms are relevant here, such as tangible user interfaces, flexible polymer-based displays and voice, image or gesture recognition methods. |
| *Localization* | Smart things are aware of their physical location, or can be located. GPS or the mobile phone network are suitable technologies to achieve this, as well as ultrasound time measurements, UWB (Ultra-Wide Band), radio beacons and optical technologies. |

**Enabling Technologies**

There are several technologies which are enabled through IoT [5][6].

***A. RADIO FREQUENCY IDENTIFICATION (RFID):*** RFID system is composed of one or more reader(s) and several RFID tags. Tags are characterized by a specific address and are applied to objects. Tags uses radio-frequency electromagnetic fields to transfer data attached to an object. The tags contained electronically stored information which can be read by the RFID reader when the object came in the proximity of the reader. RFID allows to monitor objects in real-time, without the need of being in line-of-sight. From the physical point of view RFID tag or label is a tiny microchip combined with an antenna in a compact package. The tag’s antenna picks up signals from an RFID reader and then returns the signal, usually with some additional information.

The RFID tags comes in three configurations, the first one is Passive Reader Active Tag (PRAT) in which the reader is passive and receives the signal from the battery operated active tags. The second one is Active Reader Passive Tag (ARPT), which is most commonly used. This tag does not have on board power supplies, so it harvests the energy required to send data from the query signal sent by the RFID reader. The last one is an Active Reader Active Tag

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(ARAT). In this both the reader and the tags are active, but tags are only awoken by the reader when it comes in the proximity of the reader.
An Electronic Product Code (EPC) is one common set of data stored in a tag. EPC's are coded on RFID tags because of which objects can be tracked and identified uniquely. The tag contains a 96-bit string of data. The first eight bits are a header which identifies the version of the protocol. The next 28 bits identify the organization that manages the data for this tag, the organization number is assigned by the EPC Global consortium. The next 24 bits are an object class, identifying the kind of product; the last 36 bits are a unique serial number for a particular tag. These last two fields are set by the organization that distributed the tag .Rather like a URL, the entire electronic product code number can be used as a key into a global database to exclusively identify a particular product.

***B. NEAR FIELD COMMUNICATION* (NFC):** NFC is quite similar to RFID, or it can be looked as an integration of RFID reader into a mobile phone, which makes NFC customer-oriented as mobile phone is the most popular personal device worldwide NFC can also be seen as a type of radio communication between NFC enabled mobile devices by touching them together or bring close in the proximity of the other phone. The operating range is directly depended on the size of the antenna in the device.
NFC is a short range, low power wireless link evolved from RFID that can transfer small amounts of data between two devices held in proximity. Unlike Bluetooth, no paring is required before the actual transfer of data. NFC enabled communication between the smart objects is safe as this cannot be done from a remote location, so one with his/her NFC enabled device should be present there for the application like payment.
The NFC technology will significantly contribute to the future development of IoT. It will provide the necessary tool to be wirelessly connected to any smart objects. Mobile NFC also has the potential to transform the mobile headsets into different types of smart objects

***C. MACHINE-TO-MACHINE COMMUNICATION (M2M):*** Machine-to-Machine (M2M) refers to the communications between computers, embedded processors, smart sensors, actuators and mobile devices .The use of M2M communication is increasing in the scenario at a fast pace. For instance, researcher's redicted that, by 2014, there will be 1.5 billion wirelessly connected devices excluding mobile phones. There are four components of M2M which are sensing, heterogeneous access, information processing, application and services.

| | |
|---|---|
| M2M Device | A device capable of replying to request for data contained within that device. |
| M2M Area Network (Device Domain) | Provide connectivity between M2M Devices and M2M Gateways. |
| M2M Gateway | Use M2M capabilities to ensure M2M Devices inter-working and interconnection to the communication network. |
| M2M Communication Networks (Network Domain) | Communications between the M2M Gateway(s) and M2M application. |
| M2M Applications | Contains the middleware layer where data goes through various application services and is used by the specific business-processing engines. |

***D. VEHICLE-TO-VEHICLE (V2V) COMMUNICATION*:** V2V Communication is a new concept in which lots of research has to be done. In this, vehicles act as a node in a network and communicate with each other with the use of sensors connected in an ad-hoc network. The infrastructure of V2V network is a bit complicated as there is no fixed topology to be followed as vehicles are moving from one place to another all the time. Applications for vehicular networks can be divided into four broad categories, namely safety and collision avoidance, traffic infrastructure management, vehicle telematics, and entertainment services and Internet connectivity Vehicles communicate with each other within a range of 1000 m. Two types of communication are possible; first one is vehicle-to-vehicle and the other one is the vehicle with the road-side infrastructure. Vehicular communication system is developed as a part of Intelligent Transport System (ITS). From a network architecture point of view, focus is initially placed on routing protocols; Physical layer (PHY), Medium Access Control (MAC) layer, and broadcasting

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***E. WIRELESS SENSOR NETWORKS (WSN):*** Recent technological advances in low power integrated circuits and wireless communications have made available efficient, low cost, low power miniature devices for use in remote sensing applications.
Sensors are devices that monitor characteristics of the environment or other objects such as temperature, humidity, movement, and quantity. When multiple sensors are used together and interact, they are referred to as a wireless sensor network (WSN). Wireless sensor networks contain the sensors themselves and may also contain gateways that collect data from the sensors and pass it on to a server. While sensors "sense" the state of an environment or object, actuators perform actions to affect the environment or object in some way. Actuators can affect the environment by emitting sound, light, radio waves or even smells. These capabilities are one way that IoT objects can communicate with people. Actuators are frequently used in combination with sensors to produce sensor-actuator networks.
Sensor data are shared among sensor nodes and sent to a distributed or centralized system for analytics.

***F. ADDRESSING SCHEMES*:** The ability to uniquely identify things is critical for the success of IoT. This will not only allow us to uniquely identify billions of devices but also to control remote devices through the Internet. The few most critical features of creating a unique address are: uniqueness, reliability, persistence and scalability.
Every element that is already connected and those that are going to be connected must be identified by their unique identification, location and functionalities. The current IPv4 may support to an extent where a group of cohabiting sensor devices can be identified geographically, but not individually. The Internet Mobility attributes in the IPV6 may alleviate some of the device identification problems; however, the heterogeneous nature of wireless nodes, variable data types, concurrent operations and confluence of data from devices exacerbates the problem further.
Persistent network functioning to channel the data traffic ubiquitously and relentlessly is another aspect of IoT. Although, the TCP/IP takes care of this mechanism by routing in a more reliable and efficient way, from source to destination, the IoT faces a bottleneck at the interface between the gateway and wireless sensor devices. Furthermore, the scalability of the device address of the existing network must be sustainable. The addition of networks and devices must not hamper the performance of the network, the functioning of the devices, the reliability of the data over the network or the effective use of the devices from the user interface.
To address these issues, the Uniform Resource Name (URN) system is considered fundamental for the development of IoT. URN creates replicas of the resources that can be accessed through the URL. With large amounts of spatial data being gathered, it is often quite important to take advantage of the benefits of metadata for transferring the information from a database to the user via the Internet. IPv6 also gives a very good option to access the resources uniquely and remotely. Another critical development in addressing is the development of a light-weight IPv6 that will enable addressing home appliances uniquely

## IV. ARCHITECTURE

Architectures are needed to represent, organize and structure the IoT in a way that enables it to function effectively. The distributed, heterogeneous nature of the IoT, requires the application of hardware/network, software, and process architectures capable of supporting these devices, their services, and the work flows they will affect. We further classify architecture into hardware/network, software, process and general.
**Hardware/network architecture:** A number of hardware/ network architectures have been proposed to support the distributed computing environments required by the IoT.
**Software architecture:** Software architectures are necessary to provide access to and enable the sharing of services offered by IoT devices.
**Process architecture:** The IoT will certainly affect business processes. Process architectures are necessary to effectively structure the business processes that will incorporate the IoT.
**General/requirements:** There is no agreement on a single architecture that best fits the IoT. A number of articles proposed various conceptual architecture designs, while others proposed criteria for the assessment of proposed architectures as well as a conceptual architecture to meet the requirements of smart objects

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Vol. 4, Issue 12, December 2016

## V. FUNDAMENTAL CHARACTERISTICS OF IOT

Some characteristics [7] of IoT are**:**

| *(i) Interconnectivity* | *(ii) Things related service* |
|---|---|
| Anything can be interconnected with the global information and communication infrastructure. | IoT is capable of providing things related services within the constraints of thing such as privacy of protection and semantic consistency between physical things and associated virtual things. |
| *iii) Heterogeneity* | *iv) Dynamic Changes* |
| Devices are heterogeneous because based on different network and hardware platform | Context of the devices like location/speed as well as the state of device like sleep or wake-up and connected or disconnect can change dynamically enormous Scale. |

## VI. BENEFITS TO USE IoT

There are lots of benefits of IoT like: [8]

- Everything is connected so information flow with very high speed and at very low cost.
- Accurate computational performance is achieved at very low cost and at low power consumption.
- Due to powerful backend analytic and control capabilities use of cloud computing is increase.
- As the data increase so the advance paradigm are used for extracting information and knowledge and to analyse the data also.
- IoT minimize the time span in manufacturing the product and logistic.
- IP based networking spread globally
- Environmental knowledge increase.

## VII. APPLICATION OF IOT

According to Gartner hype chart of enabling technologies IoT is placed at the top. Now a days as human wants quick response or quick access so the dependency on Internet and technology is increase. Application area of IoT is very vast and very powerful and it will rises up to the higher level in coming years. [9]

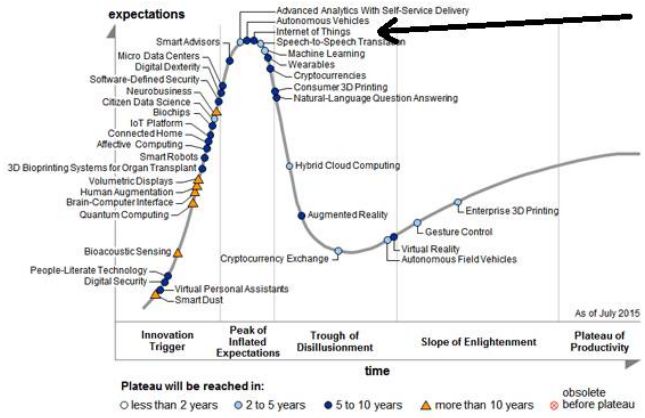


**Figure 2: Gartner's Hype Cycle: 2016**

Some application are as follows:

**1) Transportation, Travelling and logistic:**

In today's life as the population increased the number of vehicles are also increased so that pollution, parking and traffic jams are simultaneously increased. By using smart parking lot solved these problem up to certain extent. In

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Website: www.ijircce.com

Vol. 4, Issue 12, December 2016

smart parking ,parking sensors of vehicle can easily detect the free space for parking purpose also detect the arrival and departure of the vehicle, so the searching time, pollution as well as traffic jam is also reduce.
By using IoT technology like RIFD and NFC logistic is easy. They provide fast purchase or fast order of product, regular monitoring, regular tracking, regular communication, monitoring the delivery time, delivery delay or fault if exist, fast delivery as well as regular tracking of inventory for refilling in retail chain and supply chain management so it reduce the cost, waiting time and increase the sale as well as customer satisfaction.
Assisted driving is another application in which sensors may guide regarding the Safety, traffic jam, accidents and navigator also. It can also be used for fast control on highways instead manual tollbooth. It also give the information about the current location, hospitals, shopping mall, theatres, restaurants, hotels and provide the booking in the hotels if required, and send the digital key and digital tickets without wasting the time in checking. Smart cars are also used for travelling. A pilot operate remote control car, so it minimise the car accidents and reduce fuel consumption, stress of driving, and save valuable time.

**2) Healthcare:**
Healthcare is another segment of IoT. In this segment by using sensors and the technology we can monitor the health and can track the blood sugar level, body temperature, heartbeat, and blood pressure. In the absence of attendant it may notified the current status of the patient to the previous mentioned relatives and personnel doctor in case of emergency. It is also give the full attention regarding the patient condition and mention or indicate the time to take the drug or when fluid should be gives or stop. It is also useful for asthmatic as well as Alzheimer's patient. It is also track the patient's drug stock and supplies the drug whether required and also check the expiry date of drugs. It is also useful for forward or transfer the test samples and test reports to the patient and his concerned doctors by which doctor can start their procedure without any delay.[10][11][12].

**3) Smart home and Smart Environment:**
In smart homes every electronic device is connected to the network and remotely from across the world. It has the ability to confirm the OFF status of different devices after leaving the home. So it has able to coordinate energy usage. These devices allow users to connect directly to set the temperature while at home or not. And also have the ability for HVAC to coordinate power usage with water heater, furnace, refrigerator, freezer and other items that required different power at different time of the day with low energy cost.
In smart homes Sensors may also be used for mention the feeding time for old members, kids, patient as well as pets before leaving the house. And also track fire or unauthorised entries for security purpose.
One of the major IoT application area that is already drawing attention is smart environment.
Smart city includes smart infrastructure, smart parking, smart banking, smart hospitals and smart retailing.
IoT is also used in the field of garbage management , disaster management (like flood, earth quake, storms etc.), water management (water leakage, water quality, usage and distribution), efficient energy usage, control air pollution, noise monitoring , fuel monitoring by which wean save our resources for further use and control on their wastage.
We can prevent the food from climatic damage and plant diseases and store them in a well required place and temperature. Sensors can monitor and maintain the harvesting, production, rain, temperature, humidity, light and heat. And also detect the condition of soil according to Corps by which farming and its production growth can be rise.

**4) Industrial maintenance:**
Sensors fit in the machinery are used to monitor the temperature and vibration in industrial motors and also indicate when irregular operation is detected. It also used to maintain scheduled cleaning, parts replacement, replace and lubricants. It does not involve the repair of already existing malfunctions. According to the previous record, companies waste billions due to inefficient maintenance management. So by using IoT companies save lots of money, manpower and time also.

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ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

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Website: www.ijircce.com

Vol. 4, Issue 12, December 2016

## VIII. CHALLENGES

There are several challenges regarding the IoT and some are:

1) To connect such different type of devices that have. Their own standards, their own protocol, their own working style and also their own data format.[13]
2) To change or adjust either the whole existing working environment or new device in a new connection.
3) To handle the wireless network problem like network congestion or network delays.
4) To optimise the energy consumed during data communication among different devices.
5) There are several loopholes related to security and privacy. Once data is on Internet then customer lose their private data so any one can manipulate this data according to their need and chances of cybercrime is increase.
6) As the time pass the data grows. So data Analyst face the challenges related to manage the data and also there should be a unique standard format to exchange the information.
7) Another challenge is unreliability i.e. The type of approaches used in exchange of information should be transparent and visible to the user. [14]
8) Addressing / naming and locality of any object or device must be identified and tracked easily.
9) Each object or device must be self-organised, self-control and auto react to the real environment without any external control.

## IX. CONCLUSION & FUTURE WORK

IoT has been gradually bringing a sea of technological changes in our daily lives, which in turn helps to make our life simpler and more comfortable, though various technologies and applications. There is innumerable usefulness of IoT applications into all the domains including medical, manufacturing, industrial, transportation, education, governance, mining, habitat etc. Though IoT has abundant benefits, there are some flaws in the IoT governance and implementation level. The IoT presents numerous benefits to consumers, and has the potential to change the ways that consumers interact with technology in fundamental ways. The key observations in the literature are that (1) There is no standard definition in worldwide (2) Universal standardizations are required in architectural level (3) Technologies are varying from vendor-vendor, so needs to be interoperable (4) For better global governance, we need to build standard protocols. In the future, the Internet of Things is likely to meld the virtual and physical worlds together in ways that are currently difficult to comprehend. From a security and privacy perspective, the predicted pervasive introduction of sensors and devices into currently intimate spaces – such as the home, the car, and with wearables and ingestibles, even the body – poses particular challenges. As physical objects in our everyday lives increasingly detect and share observations about us, consumers will likely continue to want privacy.

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