



# Internet of Things (IoT) for Smart Cities- The Future Technology Revolution

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**Abstract-** Today the world is becoming connected. The number of devices that are connected are increasing day by day. Many studies reveal that about 50 billion devices would be connected by 2020 indicating that Internet of things have a very big role to play in the future to come. The applications of IoT are immense which include Energy, Healthcare, and Agriculture to name a few. IoT is an emerging technology that works with the integration of many other present day technologies. There are many threats to the environment today among them urbanization is one. The growing needs of the urban population across the world are posing a serious threat to the environment. We need to act fast and meet these needs by developing technologies that cater the world problems. One such solution is to develop a smart world. The most important application of IoT is smart cities. Smart city represents one of the most promising, important and difficult Internet of Things (IoT) applications. In the last few years, the smart city concept has played an important role in both scholastic and industry fields, with the advancement and operation of various middleware platforms and IoT-based infrastructures. This paper talks about the role of IoT in developing smart cities for a smarter world.

**Keywords:** *internet, cloud, big data, smart cities, smart healthcare.*

**GJCST-H Classification:** C.2.5 C.2.6



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# Internet of Things (IoT) for Smart Cities- The Future Technology Revolution

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**Abstract-** Today the world is becoming -connected. The number of devices that are connected are increasing day by day. Many studies reveal that about 50 billion devices would be connected by 2020 indicating that Internet of things have a very big role to play in the future to come. The applications of IoT are immense which include Energy, Healthcare, and Agriculture to name a few. IoT is an emerging technology that works with the integration of many other present day technologies. There are many threats to the environment today among them urbanization is one. The growing needs of the urban population across the world are posing a serious threat to the environment. We need to act fast and meet these needs by developing technologies that cater the world problems. One such solution is to develop a smart world. The most important application of IoT is smart cities. Smart city represents one of the most promising, important and difficult Internet of Things (IoT) applications. In the last few years, the smart city concept has played an important role in both scholastic and industry fields, with the advancement and operation of various middleware platforms and IoT-based infrastructures. This paper talks about the role of IoT in developing smart cities for a smarter world.

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## 1. INTRODUCTION

Smart city is a terminology that we are going to hear a lot more in the future years. It's predicted that by the year 2020 about 50 billion devices would be connected around the world. Internet of Things (IoT) is a recent communication idea that visualizes a near future, where the objects or devices used in everyday life will be equipped with sensors, microcontrollers, trans-receivers for digital communication, and suitable protocol stacks and network models will make these devices to communicate with each other and with the users, becoming an essential part of the Internet.

The initiative of the IoT (Internet of Things) was developed in parallel to Wireless Sensor Networks, and refers to distinctively identifiable objects in the environment and the object's virtual representations in

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an "internet-like" model. Though IoT does not follow a particular communication technology, but wireless communication technologies will play a major role in the advancement of the IoT. The development of a technology like IoT will make every part of the world connected. The rural and remote areas will be the one's that will enjoy the benefits of IoT the most.

## Internet of Things Reference Model

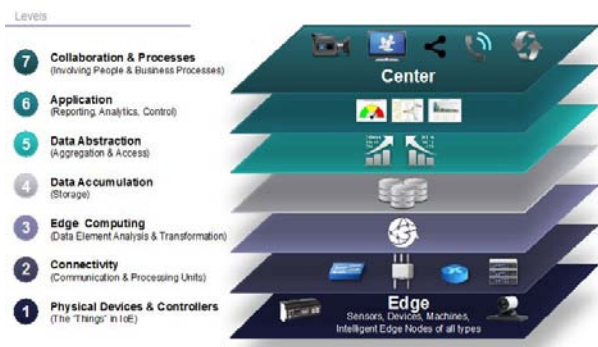


Fig.1.

The above figure is a reference model for the Internet of Things which contains 7 layers.

- The first layer i.e the Physical Device layer is the first layer which consists of user devices which are equipped with sensors, nodes micro chips etc.
- The second layer, Connectivity layer consists of several communication protocols and communication models used for inter communication of the devices
- The third layer is the edge computing layer which performs data element analysis and data manipulations.
- The fourth layer is the data accumulation layer. As the name goes all the data that is collected by the mobile devices is stored here.
- The fifth layer is the Data Abstraction layer that performs aggregation on the data.
- The sixth layer, Application layer performs operations like displaying analytics and reposting them so that the user can understand the trends and data patterns.
- The last layer is the Collaboration and process layer which people and business models and processes.

## II. SMART CITIES

**Smart City:** A smart city is one that has mobile technology rooted across all functions of the city. A Smart City usually consists of basic infrastructure in an order to provide a good quality of life and a clean and lively environment for a smart living.

Smart Cities uses the mobile technology and information and communication technologies (ICT) to improve the quality and performance in order to connect with its people in an more active and efficient manner.

The components of a smart City includes smart government services, efficient transport system, smart traffic monitoring, sustainable energy, smart health care, improved water and waste management.



**Fig. 2 :** The major changes in technology, environment and economy have generated curiosity in building smart cities. The major goals of smarter city applications are improving the governance and transforming the lives in urban areas

As per the report released by Juniper Research in 2015 Barcelona is named the world's smartest city. The research inspected several aspects like technologies used, transportation systems, buildings, utilities etc. The study also predicted that there would be more number of smart cities coming up in the near future.

## III. ROLE OF IOT IN BUILDING SMART CITIES

Until now, the Internet has been used primarily as a medium for the transmitting and collecting the data and information. Experts of the industry now believe that the next chapter in the "Internet devised for the People" is opened by the rise of the Internet of Things (IoT).

IoT is leading to a change in the culture as a huge number of devices, sensors, actuators, and other objects are being interconnected to each other and to next level systems. The connectivity of a huge number of devices that are programmed to collect the data gave

rise to an entirely new services and features which form the basis of some important concepts like the "Smart Cities".

IoT and big data are both technology-driven developments. The applications of IoT for Smart City will bring huge market opportunities and will make lives of the people smarter. Today the devices around us are day by day becoming more intelligent. Further more, these developments are bound to change our behaviour and the way we use them.

We are in the middle of an era where we are trying to discover new opportunities brought to life by new software and hardware designed to take advantage of the flow of new personal and global data. Cities are likely to invest about \$41 trillion on IoT technologies in the next 20 years. In order to make cities smarter, the governments have started promoting several startups and other industries in order to work on the IoT technologies so that they can be implemented in several spheres of urban living. Here are some of the areas that the governments must work to achieve their goal of building smart cities.

1. **Smart Grids:** Creating smart energy sources to meet the need of the increasing urban population is an important step in building a smart city. Thus to achieve this we implement the concept of smart grid. A smart grid is one of the most successful IoT technologies that are being used. A smart grid simply means computerizing the existing power grid. Additionally it has two way digital communication technologies embedded for communicating directly with the grid. Each device on the network consists of a sensor to collect data, two way communication between the device in the field and the grid's main network operations center. A key feature of the smart grid is computerization technology that lets the grid to adjust and control each individual device or millions of devices connected to it from a single location.
2. **Smart Environment:** The governments these days are planning to deploy sensors that collect the climatic data at several parts of the cities. This data collected by these devices will be continuously monitored by research institutes, so that they can predict the patterns in the changes of the climate and make predictions about the local issues like congestion. Further this data is made available to the public, so that they can know more about the surrounding environmental issues.
3. **Smart Water System:** Smart water system is a vital part of the smart city, and the IoT, linked to smart energy, smart grid and the "smart city" implementation. It is also a move towards e-governance, enabling households to have the actual knowledge of their utilization and interaction with the water resources, which helps improve energy efficiency, through Smart Water and Energy

applications. Apart from this the implementation of smart irrigation for agriculture is again another innovation in the smart water system. This smart irrigation system will help farmers incur the losses occurred due to wastage of water resources by following traditional irrigation methods. Hence this smart irrigation helps developing better agricultural facilities for the farmers and improves the crop yield.

4. **Waste Management System:** Both private waste management companies and government municipalities can benefit from smart waste technology. Usually one of the methods for implementing smart waste management is by embedding sensors in the trash bin which can communicate directly with the central server which in turn indicates the local municipality about the amount of trash being dumped into the bin. By doing so, will make the trash being cleared as soon as the trash bin is full leading to a clean surroundings. Further people should be educated to segregate the waste appropriately and proper recycle techniques must be implemented for the waste disposal.
5. **Smart Transport System:** With the increasing world population day by day, the problems people face due to traffic congestion is very high. Hence the governments these days are working on building a smart transport system in the cities. With many devices being connected by various communication technologies like GPS, Cloud, Machine to Machine communication, huge amounts of data regarding the location can be collected. The collected data can be used to predict the traffic movements, traffic congestions, estimated travel time, best route possible etc. This data when made available to the public eases the traffic management in the city and hence leads to a smooth flow of traffic leading to less congestion. Further a new technology called vehicle to vehicle communication is being experimented. As a part of this the vehicles, communicate with each other and intimate the driver about the possible risks that may occur by choosing the route.
6. **Smart Parking:** This is a part of smart traffic management. With increase in number of vehicles and buildings, finding an appropriate parking space for the vehicle has become difficult. Hence leading to parking of vehicles on busy roads and increase in traffic congestion. Thus the governments have come up with a solution of installing sensors which direct the vehicle owner to the available parking space in the nearby area, thereby reducing the problems caused by unavailability of parking grounds.
7. **Smart HealthCare:** Smart Healthcare system is the most promising segment in the Internet of things domain. It is estimated that its market size will grow

up to \$117Billion by 2020. Smart Beds are one concept that is being implemented; these beds indicate about the patient movements to the hospital staff so that they can take the necessary actions. The various medical reports of the patient generated by various machines can be directly accessed by the doctor if they are connected. Further a lot of research is being done on the devices that can indicate any significant alterations (like change in heart beat, increased blood sugar levels, clots etc) in the patient's body directly to the doctor.

8. **Smart Buildings:** Smart Buildings have several advantages. A smart building is equipped with a smart energy system that would help people know their energy usage and manage accordingly. Any internal changes like changes in water pressure in the pipes are continuously monitored using sensors and hence will not result in hindrance to living. Further smart buildings implement high security levels by always monitoring the people who enter and leave the building.

Hence all the above are the integral part of a smart cities that the governments must incorporate and develop.

#### IV. KEY TECHNOLOGIES FOR SMART CITIES

The key enabling technologies that must be used along with IoT to achieve the goals of the smart cities are as follows:

1. **Big Data Analytics:** In smart cities, large amount of sensors will be installed so as to collect huge amounts of data. Hence this will create large amounts of data that should be stored and managed in order to achieve the goals of smart cities. Hence big data analytics forms a key technology for building smart cities. The data collected is analyzed and suitable predictions are made to attain p
2. **roper governance.** Some of the advantages of embedding big data analytics with IoT for smart cities are as follows:
  - Big data can help in traffic and vehicle management. It helps in reducing the emissions from the vehicles. Sensors fitted on roads at various parts of the cities can help us by collecting data about the traffic at different times of the data and the volume of vehicles and their emission levels. This data collected at central server can be used by traffic cops to control the traffic and divert them accordingly to prevent congestion.
  - Smart parking system can be easily implemented using data collected from different parts in the nearby locality.
  - Keeping a track of the daily energy consumption and giving a detailed analysis of the areas using

high energy utilities and areas using lower energy utilities can be balanced if proper data is collected.

- Huge amounts of citizen data should be organized properly. This make governance easy as the entire citizen database is made available to the government in an organized manner.

Apart from the above points there are several applications of big data analytics in IoT for building smart cities, as huge amounts of data collected must also be efficiently organized and used.

3. *Cloud Computing*: Cloud computing solutions provide a good solutions for the cities to have a strong physical architectural platform. Cloud computing represents a new paradigm for delivering both software and hardware resources to its users. Today Internet of Things is one of the most important concepts of ICT. By using cloud computing technology, the delivery of the software and hardware resources are made available on demand as a service over the internet. Further the IoT concept envisions modern devices like the sensors, actuators and other mobile devices will be connected to each other through Internet and provide different services and data to its users. The data collected from various IoT devices can be easily managed and handled by implementing the decentralized cloud model.

Usually in a cloud based approach, the government provides technological platform for gathering, mining the data and provides this data over the public internet platform to a third party cloud vendors. Doing so will reduce the burden for the government and also helps cutting the unnecessary cost of having excess storage for the data. The data collected from the sensors can be transmitted to each other via Internet and hence cloud architecture will be the most apt model by providing both the hardware and software services over the internet.



Fig. 3 : Proposed IBM Infrastructure

4. *Mobility*: The mobile devices are the major devices that collect and transfer the data over the internet. These devices enable the user to access the information from any point of the globe on a simple

device and take necessary actions. These mobile devices include our smart phones, wearable etc.

5. *Social*: The social platform is yet another technology that educates people about the usage of their mobile devices and the current changes occurred as a part of developing a smart city. By using a social platform communication between the government and common public would become even easier.

## V. CHALLENGES FACED FOR DEVELOPING SMART CITIES

Though IoT provides immense opportunities to improve efficiency of governance, public safety and support development, it also offers some challenges for the cities to overcome in order to build the dream smart cities. Some of the challenges are:

1. *Security and Privacy*: Maintaining privacy and security for the data being collected is one of the biggest concerns. Since the entire data is being collected over the internet, cyber security is a very important aspect. Ensuring the privacy of the citizen's data is the most difficult deed for the governments. Hacking a single smart device can cause a huge loss to the city. Hence following a strict cyber security policies and implementing high level security protocols is very important.
2. *Using the right technology*: This is another challenge. Cities already have lots of data in their existing data base systems but lack the skills of implementing the right technology necessary for handling it. Hence cities must ensure that they deploy proper data gathering systems along with analytics, so that data can be analysed and used properly. Further people with proper technical skills must be employed for handling the citizen data.

## VI. CONCLUSION

In the future, all cities will be smart cities .With smart and forward-looking governance and management, IoT has the possibility to create a revolution in urban organization and development. By implementing the true potential of IoT, governments can improve services to its citizens, increase sustainability, and make the existing cities a better and more livable place for all its citizens. Our future life in smart cities is full of promise. All the discussed technologies will develop and there will also be many new innovations coming up as well. In other words, we would be witnessing some exciting times soon. With more than one-half of the world's population living in cities pioneering new IoT solutions, such as smart healthcare, smart parking, smart energy, connected waste, and traffic management, holds great promise for fighting the major challenges of high end urbanization. We are likely to see many smart cities of the future coming to life

overnight. However, like in the past with the adoption of revolutionary technologies such as electricity, traffic lights, green buildings and the Internet, governments will gradually execute IoT solutions to save money, shape the future and make the cities a smarter and a better place to live.

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