

## **Cloud Based Smart Cities Roadmap to Build Cities Using Cloud Technologies to Reduce Carbon Footprints.**

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**Abstract:** *The conceptualization of smart cities has gathered the requirements of quality, connection and communication between various services and use of technology. The growing need of resources, safety and public management services can be seen as a major factor for development of Smart City concept. The evolving technologies like cloud computing and IoT can be of huge help when developing smart cities. Cloud computing can provide hardware, software and applications pay-as-per use basis and Internet of Things (IoT) uses sensors and RFID to communicate between the devices and resources. In this paper, we have put light on the concept of smart city, the need for the same and also the areas which will be affected by this concept. This has proven by the case of Singapore city which has already established themselves as smart city.*

**Keywords:** *Cloud Computing, ICT, IOT, Sensor, Smart City.*

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### **I. Introduction**

There is a persuasive feeling that future has already arrived...Let's make that now [4] Cities however can only be smart if there are functions that are intelligent which are able to incorporate and fuse the data to achieve any purpose or rather to mend efficiency, quality, equity and sustainability to improve urban life. There aren't any major papers written on developing smart cities and as far as this paper is concerned, we have tried to portray the principal behind the smart city in section II.

In section III we have tried to explain the danger the world shall face if cities are not smartly build. Also how information and communication technologies helps in building smart cities. Section VI shall help you in understanding how different sectors have been affected in a positive way when they chose to become "smart" by embracing the cloud computing technologies. Last section that is section V shall put some light on the conclusion, the pros and cons about building the smart cities etc. This paper doesn't provide solution to build smart cities. This research represents an initial step in joining with force of researchers in building smart cities in future. [1]

#### **1. Smart City**

Smart city is no behind when compared to its sister technologies like big data, IOT etc. Although this concept is in recent books of all developers, even companies citizens around the globe have been swayed from this concept. Currently, smart city concept or idea is most popular among business and software developers, urban residents, policy makers, etc. and all are on the run collectively to create 'SMART CITIES' [2]. Now to define smart city IBM has come up with a smart definition which says that: "One that makes optimal use of all the interconnected information available today to better understand and control its operations and optimized the use of limited resources" [2]. In layman's term we can define smart city as making good use of ICT to make human urban life better. In developed world, cities have become an epicentre in terms of creative thinking, modernization of technologies and also in attaining sustainable alteration in socio-economic development. Thus these cities are examples for other cities to portray the growth of world economy. Converting rural area to urban area is not the only success to be achieved to get a tag of smart city. Urbanization also include all the necessary steps that has to be undertaken for increasing all the works that can be commingled with Cloud computing technologies and reducing the carbon foot prints. If a city has labelled as smart city, the adjectives attached with it would be "intellectual city", "digital city", "practical city" etc.[1]. To enjoy the remunerations of a smart city, all modern technologies backed with appropriate market environment has to be set in.

### **II. Need For Smart City**

In today's world each and every country whether developed or developing, wants to provide public services in an effective and efficient way. It is noted that a huge number of rural population is migrating to the

cities for employment due to urbanization to get the benefits of development. Over the years pace of migration is increasing rapidly day by day. With the increase in migration to the cities it leads to various pressures on infrastructure systems like water supply, drainage, waste management, etc and problems like housing to the huge scale of migrants in the city. With the increase in population more problems such as air pollution and traffic congestion appear. With such huge amount of migration from rural to urban area will lead to poor quality of urbanization leading to misery, poverty, unemployment, rapid growth of slum and degradation in the quality of urban life. [3] The main aim of constructing smart city is to not only provide good infrastructure but also 24\*7 water and electricity supply. Now the question is how that would help. Well we can certainly monitor the data with the help of smart detectors which shall compile them into small grids and shall be fed to the computer. With the help of smart cities development activities such as building of a school or a mall or an office building would be very much possible. [5]

### **III. Cloud Computing**

Cloud computing in layman's language can be explained as providing the shared pool of resources to customer whenever they are demanded over the internet. According to the official NIST definition, "cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management. The above definition explains that this model enables the access of shared resources where the customers can access it via internet and they have to pay only for what they have been using without much of management effort.

### **IV. Internet Of Things (Iot)**

Internet of things is a system developed from the concept that if all the everyday devices which we use whether electronic or mechanical or even animals, can be given unique identifiers then they can seamlessly communicate with each other over a network. With IPv6's huge increase in address space, each and every item in the world can be given unique identifiers. Once the system is in motion then hardly any human or computer intervention is required as the information is continuously being exchanged with the required parties. Consider for example a person fitted with a device which can wirelessly connect with the hospital's data centre and gives continuous information so as to blood pressure, temperature, heart rate or even blood constituents on a real time basis. Here the 'thing' would be the person and hospital being the said 'party'. The machine generated data can also be transmitted to the required service agents so that the machine's overall performance can be verified and better accuracy can be achieved regarding equipment breakdown.

### **V. Sectors Affected By Smart Cities**

The following are the sectors that are affected in a constructive way by embracing cloud computing technologies to make smart cities.

#### **5.1. Health care**

Our health is the most valuable asset we humans take care the most. Apart from citizens enjoying the profits of smart cities, wellness of a citizen will always be a prime focus. Hence concept of smart health-care has emerged and it happens to be the one of the most important aspect of smart cities.[6]Through digital technologies, not only innovative health products have arrived but also it has facilitated about the idea of how we humans manage our health. In the medical field, one of the main visions is to create a digital censor that would scan or check the whole body. The reports generated by the censors shall be transferred to the health care specialists who could access it remotely and can guide the patient accordingly. More the data of a particular patient, more data could be analyzed. [7]Smart health care can be very well contemplated with mobile health or m-health. Medical field has come up with a device which could monitor asthma patient's record by helping them to choose the itinerary which shall be displayed through mobile. The mobile shall gain access to the pollution level in atmosphere through censors and shall display the right itinerary in the patients mobile. The recent app named "PRACTO" helps the users to call doctors in their doorstep.

#### **5.2. Transport**

Technology happens to be the key feature in prophesying the demand and supply data to be fed in transportation planning. Technology can also improve the network in visibility of arrivals/departure for voyagers to feel hassle free journey. One of the innovative ways to be smart and reduce the pollution level is using bicycles for short distances. The bicycles can shared among passengers like for a passenger picking up a bicycle from appoint A can travel to point B and can drop the vehicle there for other users. To get the periodic traffic forecast Geospatial enabled services should be brought in action. Carpooling is one the most trending

idea where passengers travelling to same route can call for the taxi and the driver shall get the info about the passengers through mobile. This would certainly reduce the pollution level as less no of vehicles will be running also this is pocket friendly. Integrating the transport hub improves the connectivity among different nodes like bus, metro etc. [8] Transport in the shipping field can also take a turn for the better. Imagine in a container loading terminal, all the containers are communicating seamlessly regarding their weight, type of cargo carried, certification number and other necessary details to the terminal. The terminal in exchange upon verification of the same would allow the container through its gates. Upon receiving a container which doesn't match the description previously given should be stowed away separately and should be subjected to more intense inspection. This would not only curb contraband crossing the borders but also helps is faster, accurate and easier methods of container inspection as very little human intervention is required.

### 5.3. Education

Smart cities technology has already started creating future in education. Education in smart city should comprise of a mobile app of a university where the students can gain access to every nook and corner of the campus. For a new student, university app will be his best friend for the initial days. Now to be even smarter instead of manual attendance, as soon as the student checks in the classroom his attendance shall be marked. The app would also provide him the schedule for the day. Professors can access the student's data and can draw conclusion about the total attendance in his lecture, the performance of the class in various tests. Even issuing a book from a library could be done through the app. Well most of the above technologies are yet to be brought in good shape yet few of them are in action and the colleges using those functions have witnessed deep impact in their style. Smart education in India shall be changed in terms of migration from books to e-books which shall be delivered through computer or mobile. By adapting these technologies, students would be at par with real time information. In order to integrate the rural children into mainstream education, we can arrange video conferencing to connect with the village children.

### 5.4. Energy management

India has adopted the conceptual idea of IOT which has helped us in providing energy saving mechanism to march towards sustainable environment. If we talk about the energy sector few fragments like state electricity boards, transmission companies, etc have adopted smart grid technology. This adoption shall provide effective ways to manage power supply and demand. Apart from this it shall also gather the customer's usage. Researchers have been scorching on an idea of creating energy management system by embracing cloud computing technology that contains the paramount use of solar and wind energy backed with an intelligent power consumption mechanism for household appliances with a smart grid.

### 5.5. Housing

It goes without saying that people make up the cities. A smart housing would not only be a boon to mankind in terms of accident relief but also would inculcate that sense of digital awareness to each and everyone in the family. Just imagine that a house on fire could transmit wirelessly to the nearest fire station regarding its plight the moment the smoke or flame detector is triggered. Or even the buildings can be connected with seismic activity beneath it so that it can give the residents an early warning regarding an earth quake. Also if a person alone in his house is severely incapacitated due to any reason, maybe a voice over command or a push button should suffice to alert the family physician or the nearest hospital. On a lighter note, the houses could sense arrival of a member of a family and accordingly start the cooler or switch on the lights or even start the microwave so that a hot meal is ready by the time the person arrives his home. Even adjust the brightness of lighting inside according to the outside light thereby conserving energy.

### 5.6. Municipal Facilities

The Municipal Authorities can have probes in their lakes and rivers which constantly communicate with them regarding the water level, the pollutant level, whether it is fit for consumption, etc. If there is a continuous flow of information then the governing authorities stands at a much better place in planning the future water consumption. Similar probes can be installed at various places across the city to monitor the air pollution, radiation levels, and virus outbreaks and warn the authorities if any of it is being breached. Also probes measuring CO2 emissions can also be installed to check the overall efficiency of the city.

## VI. Case Study

### “Singapore determined to be worlds first smart city”

Singapore has witnessed same political party which has been governing them for decades. Neglecting the flaws in democratic rule, the government has been responsible to prepare Singapore city for

the future. The ongoing preparation for being the smart city was named as smart nation couple of years ago. Fibre cables were in extreme use then to connect different parts of the Singapore through internet. Focusing on different sectors such as housing, transport, health care is their next intention.[9] Dr Vivian Balakrishnan minister of external affairs Singapore strongly believes in that this project will transform Singapore city in to highly develop and environment friendly nation. According to him, Smart city is an action rather than generation ideas, the generated ideas have to be implemented and coming generations can enjoy the benefits. Singapore has believed in one objective “**Tackling tomorrows problems today**”. Like many other countries, Singapore has been facing problems such as aging population, and urban density.

### **6.1 Home**

#### **Problem faced:**

With growing population of Singapore, there is a huge consumption of water and energy. Also huge amount of waste in generated. To meet its water requirement Singapore imports gallons of water each year from Malaysia. More than 80 percent of residents (3.2 million people) live in affordable apartments maintained by the country's Housing and Development Board (HDB).

#### **Solution:**

To keep tabs on individual apartments, thousands of sensors have been installed in the Yuhua estate. With the help of sensors, authorities are able to measure energy usage, waste production and water usage in real time. With a new vacuum waste-management system, solar panels and water-reclamation efforts Yuhua estate has transformed itself into eco-friendly estate. With the help of smart applications, the sensors provide residents with feedback on their behaviour. This feedback helps them to lower the usage of water, electricity and so on, resulting in lower household costs. Using analytics and computer simulation, the government aggregates this data in order to improve the planning, design and maintenance of public housing estates.

### **6.2. Health Care**

#### **Problem faced:**

Many developed nations have been facing problems of aging population and corresponding increase in cost for caring it. Tradition have shown that Singaporeans follow **filial piety** (Chinese tradition of taking care of parents or siblings who are quiet aged) hence increase in elderly people shall show increase in time invested in taking care of them which shall eventually showcase less attention on work. Statistics says that by 2030 the number of people who are aged 65 and above is expected to triple to reach a whopping figure of 9 lakhs.

#### **Solution**

Though in a pilot phase, the idea behind this solution to the problem is that you don't have to leave your home. The sensors attached to the patient's body shall provide constant updates to the doctor with the help of IOT. This will help the patients in spending more time with the family members and thus there will be considerable reduction in hospital beds and eventually it would be available for those who actually need them.

### **6.3. On the Road**

#### **Problem Faced**

Transport is the heart of any nation. Problems faced during transportation must be solved immediately or else it would not only result in government loss but also increase in pollution level and traffic since more people would prefer buying private vehicle. With the population of 5.4 Million, there are roughly 1 million cars on the roads. In Singapore road takes up around 12% of land space which has put the government in dilemma whether to increase the no of cars in city or to add more roads.

#### **Solution**

Singapore nation has come up with unique idea of placing sensors in every nook and corner which would help in tracking the fleet of buses. These sensors would give us the live feed of the crowd that are present in any particular area and thus more fleet of buses can be released in that particular affected area. This has resulted in 90% reduction in crowd and waits time also reduced considerably from 5 to 3 minutes.

#### **Future Plans**

Singapore is planning to have an inbuilt government mandated satellite navigation system in all vehicles. Implementing this shall result in silently observing the position of the car at given point of time. Also data generated can be used for analysis. Government can have much better control on traffic and they can also monitor the speed at which vehicles are moving, congestion issues with road etc.

## VII. Conclusion

The further research for smart cities is still in progress to provide all facilities through IOT using cloud as middle ware. The current rate at which carbon footprints are produced would be considerably reduced which in turn shall aim for a better environment. According to Gartner “An urbanized area where multiple sectors cooperate to achieve sustainable outcomes through the analysis of contextual, real-time information shared among sector-specific information and operational technology systems.” If we talk about India, the greed for creating smart cities has full-fledged into reality with more innovative changes needs to be undertaken. India has already mentioned top 100 smart cities thus creating the urge for the Indian researchers to build all Indian cities as smart cities.

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