IoT based Smart Cities and Cloud Data Storage

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Abstract
This article gives detail regarding the use of technology and how it is affecting the daily chores that are associated with usual physical efforts. This paper furthermore provides an outline for authors and people who are interested and curious regarding technology effects in our daily life as well as its replacement with older technology. Introduction to cloud storage is an important component for individual use as well as implementing smart city idea in a certain region.

Keywords *- IoT based smart cities, cloud storage data, IoT and cloud storage data, smart cities*

Internet of Thing and Smart Cities

In the early times, we all watched some cartoons, in which the future was showed extremely fascinating. With hovering cars going all around. Star wars made us fantasize about the growth of swords into plasma glowing weapons. There were many ideologies when we were kids, which depicted how the world would turn out to be. However, in the present era, much effort is being made in order to modernize the orthodox trends and patterns that were followed. Technology is one of the greatest thing ever that happened to a man. Ever since the advent of technology, there has been more effort in reducing human effort. It is true robots would take over the world, not literally, but majority of the humans would be replaced by robots, due to their efficiency and work capabilities. Some companies target on acquiring Harvard graduates, Stanford graduates, but sadly all these people would be threatened by the replacement of robots. The main context here is not to talk about robots, or make you petrified of the technology. The main goal is to discuss and highlight how technology is changing city trends and how much changes have been made from the conventional technologies, and how it changed human ideology.

From literature, [1] defines internet of things as everything in the form of soft data. Stuff from a person's credentials to their address, all is available in the form of soft data. In another literature reference, [2] defines smart city as "the use of Smart Computing technologies to make the criticalinfrastructure components and services of a city more intelligent, interconnected, and efficient". This data hence can be utilized for various useful purposes, rather than falling into the wrong hands. Internet of things first appeared in literature by Ashton himself. Internet is a powerful thing, when utilized, it could do some potential benefit for everyone who is seeking benefit. Every sort of information is available on the internet these days. Most of the cities in the world are capturing internet and technologies to not only make processing faster, but also more accurate. One of the major advantage of latest technology described by [3] is that it makes difficult tasks seem easy. It could be described as where the square root of the integer pi (π) seemed impossible, now, it can easily be calculated by a press of a few buttons.

When we are to relate internet of things and smart cities, major context to understand is to make an entire city work on technology. This includes the components that can be digitized in order for their maintenance. One of the main components that should be considered when talking about smart cities, is the use of sensors. [4]describes many uses for the implementation of technology for a smarter city. The whole idea of digitizing components of a city is to have a better view and more precise data regarding the citizens for a fair and just environment and a much feasible situation for the authorities. [5]describes that there are six characteristics that can be used to identify the smart city components, which can be utilized in order to facilitate a city with major changes that may influence the functioning of a city, but with maximum effect and minimum effort. The components are described in the figure below. Moreover, each of this component targets a particular city driving factor, which can be further utilized.

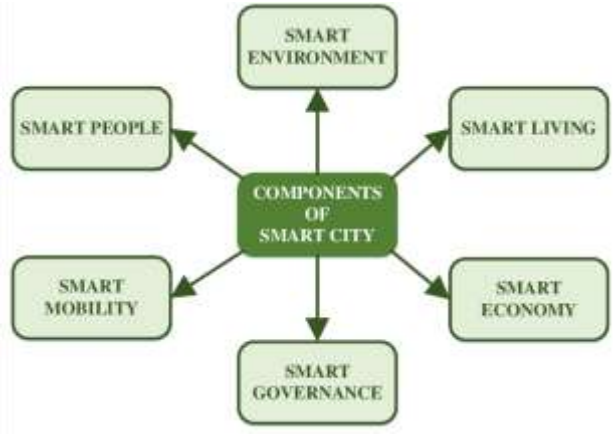

Figure 1 describes the components that would be included in thesmart city project

The components are shown below:

Table 1 Smart city components and their related aspects

Components	Related aspects
Economy	Industry
People	Education
Governance	E-democracy
Mobility	Logistics and infrastructure
Environment	Efficiency and sustainability
Living	Security and quality

Smart economy includes the expenditure within a city. This includes money spent on education, joblessness rate and growth domestic product of a city for its effective growth per citizen. Similarly, when we talk about people, main focus is towards their education and exposure to foreign events and formulas taking place. These include personal computer skills, patent applications per inhabitant and participation in lifelong learning. Governance, is one of the main factors that need to be focused. When we talk about E-democracy, we are discussing changing conventional governance methods, introducing more genuine and interactive methods for the government individuals to correlate with the citizens and make the entire city better for a living standard, in regard to security and growth. With the advent of technology and innovation of internet, there are subtle chances that online enhanced interaction would increase the transparency between government individuals and the citizens, which would promote better opportunities for the formulation of public opinion outside channels that were before made among a reserved group of people. This would allow people to be more engaged in the political situation and decision making that is going on in the city. Therefore, implementing internet of things and technology into the government sector has its own perks. [6][7]

Smart environment is all about reducing global warming and emission of environmentally hazard gases. These include CO2 gases along with NO2 and SO2 gases. This is all chemistry, however we are to focus on how these gases can be reduced. Therefore, implementation of smart environment would include introduction to electric cars, as well as the public transports that are used by a person everyday could be made environmentally friendly.

Things technology in smart cities

While implementing smart cities, there are certain components technology wise that could be digitized. These components are utilized by everyday citizen of a wide age range, and hence, there digitization provides a clearer passage for more effective smartness of the city.The major concern here is that

the main target of digitization is towards things that can be measured, inferred, understanding and changing the broadness of environmentally affected objects. Based upon these ideas, components of technology that can be utilized for the development of smart cities is cellphones, which are mainstream in this era. Moreover, food can also be targeted along with household appliances and art work. The major factors of everyday life that are related to internet in one way or another are the key components of smart cities.[8]

Radio Frequency Identification

One of the most discussed component in literature is radio frequency identification. The major role of this component concludes in the reader and tag things in the environment. Utilizing these objects, they can be automatically identified and assigned a unique number identifying each object to be mixed with the network, along with the digital information and the server.

Wireless sensor

In the present era, eradication of wired connections are being implemented, such as wireless headphones, wireless chargers, wireless tv and everything. This was only possible through the advent of wifi, which is the availability of the internet wherever we go. WIFI uses Wireless sensor networks that can provide a different and a moderate set of data. Also, in many cases, such as healthcare, government and environmental services, and seismic sensors, wifi can be utilized for a more unique purpose.Moreover, with integration of radio frequency identification with wifi, numerous advantages can be practiced, such as obtain information position, motion, and temperature at a specific altitude.[9].

IoT Applications for Smart Cities

When we consider the applications of technology and IoT in urban areas, there are many possibilities that may allow changing in the conventional methods adopted since the eary ages. [10]concludes that many governments of various countries are at the verge of change and are studying how to implement ICT solutions for managing the city and the people living in it, for their effective lifestyle opportunities as well as a much better method of management that may be included. Considering these factors, many implementations can be made which will be further discussed in this chapter.

Building's Health

In many country, there are numerous historical buildings which define their culture and history. But, their maintenance is also very important. It needs to be pondered upon that there should be much effective efforts that need to be made in order to sustain and maintain these buildings. For this purpose, proper methodology needs to be implemented. This includes continuous monitoring of the historical buildings of the city, as well as determine the areas that are being affected due to rains and other various environmental factors. [9] To implement this strategy, [11] is of the hypothesis that passive WSNs can be installed within a concrete structure, that sends and receives radio frequency, which can be then studied and identified if there are any problematic situations present or there is a scope of any potential problems that may occur, which would significantly harm the structure.

Monitoring the Environment

With the passage of time, many vehicular advancements have been made, that have had a crucial drawback for the environment, making it less sustainable with the passing hour. Environment needs to be monitored and looked after, for it is essential for a healthy lifestyle. However, smart city concept includes the essentiality of environment, and the factors related to it. Therefore, for this purpose, [12] suggests the utilization of WSNs. Wireless sensors can be installed at various places which are highly populated and are a busy part of a city. The busy part includes where there is more emission of environmentally harmful gases. By using sensors, we would have the following benefit:

- Determination for the decreased water level in river, lakes, streams etc.
- Concentration of gases present in the air, that could significantly harm the environment.
- Wetness of the soil that may influence construction. Stability of soil is very important when considering construction of a building.
- Positional changes, which may predetermine landslides.
- For detection of animals, infrared radiations can be emitted that identify a body exhibiting heat.
- Determine the lighting conditions at various places that need sufficient luminosity.

Waste Management

Management of waste that is produced by homes and factories is a very big problem, as to where to dispose it. Several factories dispose off harmful materials that may damage the lithosphere. Therefore, management of this waste in order to avoid impairment to the Earth, implementation of IoT devices could help us in many ways. One of the ways is that by collecting data from various industries and factories, amendments can be made and also, gives us enough time to come up with a proper strategy to deal with waste materials.

For the local household needs, garbage trucks that run around the entire city collecting waste, even collect the waste materials that are already empty. This costs for petrol that is consumed by the garbage truck, along with other various factors. It is of

suggestion that the use of sensors within the waste bins, which can be identified and realized before even going to that specific station. Allowing this would make effective measurements regarding time wastage and petrol consumption. Sensors and other technological aspects can be utilized in order to avoid wasting time. This whole scenario revolves around the fact that waste management can be done more efficiently. Moreover, by using sensors that detect radioactive material within a waste, or some other material that may harm the environment, necessary adjustments could be made in order to dispose this waste material more effectively.[13]

Smart Health

There are many health concerns that may arise due to inadequate measures and facilities that may be available for the hospitals and the people who need medical facilitations. To utilize the technology that is available for the people, use of Wireless Body Area Network, or WBAN is of common practice. Major advantage posed by this technology is that it enables more effective patient monitoring system in a hospital as well as in the working environments.[14] Methodology of implementing this technology is that it uses sensors, inside or on the surface of the body that can be detected by technology affiliated with WBAN. Moreover, it can also be used to detect uneven blood pressure, blood flow, and body temperature. However, the mechanics and structure of this micro device should be considered carefully. The sensors should not be heavy, they should be light enough to allow passage and maintainability. They should also be small enough so that they would not hinder the movement of the patient, or cause him any discomfort than he already is in. Furthermore, since the sensors are to be small in size, therefore the battery to be used within this sensor should be of high efficiency, so that the need of replacement may be eradicated as much as possible.[15]

Limitation for smart cities

Smart city seems like a great idea for its implementation, providing a much better lifestyle for the people along with better facilities for them. However, there are many problems that are posed while we execute this idea.

Security Issues

One of the major obstacles in the employment processing of smart city is security. If a smart city was to be instigated, security of various companies and administrations should be considered. According to a report by US Federal Trade Commission, implementation of IoT in cities would pose the city to many security related issues, therefore, proper strategies should be adopted in order to avoid breach of security and privacy.[16]. This includes using corrupt data for processing of applications related to citizens, which would lead to a catastrophic loss for data. In this regard, conventional methods of security tasks such as authentication of data, confidentiality of data etc. are crucial for maintain a secure smart city. However, there are much resource constraints for the smart city technologies that are to be installed.[17]

Heterogeneity of Data

Smart city idea is based upon gathering a large amount of data from a lot of sources, such as transportation, companies, traffic data, city plans etc. All these different data are classified into different formats, therefore, there is a huge hurdle that risks the analyzation, processing and storage strategies. Not only does this pose a threat to mix up different collection of data, also this lack of standard and effective protocol poses a huge perplexing step for the integration of data.

Key Management

This step is another major factor that needs to be considered. Key management plays a crucial role in implementing the security measures within a smart city idea. Key management on the whole includes multiple components, such as key generations, distribution, update and destruction. Among these, the major portion that is posed to risk is that of key distribution, which requires safe data transmission from one source to another. This sensitive data includes secret keys in the case of symmetric cryptography. [18]

Cloud Data Storage

Since the advent of computer technology, there were a lot of useful data that was exploited. Even though efforts were made. USBs were most widely used and they were faster and for the availability of storing data, there was still an issue regarding transferring of data. For this purpose, there were floppy drives, which were plastic and were capable of storing little amount of data. Therefore, came around compatible disks, which were capable of storing more data compared to floppy disks. However, there was still need of a faster and more efficient way to consume this. Hence, came around universal serial bus. These brought upon a revolution in the computer industry capable of storing a lot of data compared to the previous storage devices. One of the drawbacks USBs posed for the users was their small size, and their capability of getting lost. Since they required a lot of care and attention, scientists then revealed a much efficient and currently employed and consumed means of data transfer, recognized as cloud data storage.

Cloud computing is the on-demand delivery of compute power, database storage, applications, and other IT resources through a cloud services platform via the internet with pay-as-you-go pricing[1].Cloud computing provides various services in which data storage is the main cloud service.

Cloud computing works behind the scene in our day to day activities such as to watch movies, play games, sending mails and listen to music etc, With Cloud computing, we can store, recover and backup data, create new applications, deliver software on demand, host websites and so on. Whenever there is a demand, user can access the services of cloud dynamically via internet[2].
Cloud storage can be defined as computing on demand delivery, with ease of access for database storage, applications and other IT resources through a cloud storage system, which can be accessed via internet on a pay-as-you-go pricing. Cloud computing provides many facilities, mainly data storage. With cloud storage, anything and everything can be stored on a virtually accessible cloud, including new applications, delivering software, sharing important data mostly for business and professional applications. [19]

[20]concludes that there are three classifications of cloud storage, based upon the service they provide for their users. They are as follows:

- Software as a Service (SaaS)
- Platform as a Service (PaaS)
- Infrastructure as a Service (IaaS)

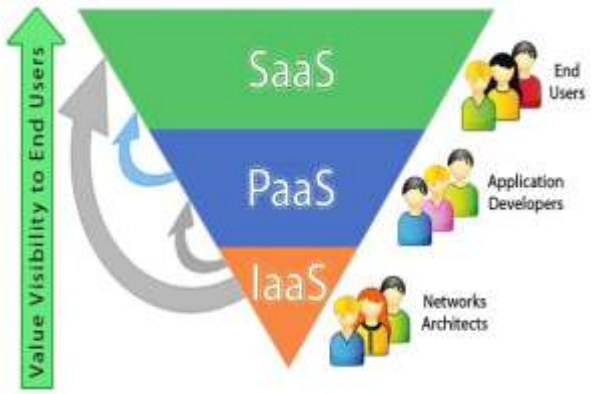

Figure 2 Classifies the types of Cloud Data Storage

Cloud storage when classified as Software as a Service (SaaS) provides users with a vendor's cloud-based software. PaaS is more generally for users, who are into development. Cloud storage provides a platform for such users that they could develop, manage and deliver applications. Lastly, Iaas is a software thatprovides software for users to access resources related to computing, such as servers, storages and networks. This is mostly utilized in business industry and companies, where large amount of data is available on cloud, for executive and employees to access.[20].

Implementation of Cloud Storage

There are many companies, who already have started providing facilities for the users to utilize cloud storage. Cloud storage is the next generation data storage facility for every user all around the world. One of the major advantages that cloud storage poses is its ease of sharing among others.

This advantage was recognized by variety of companies and most of them implemented this facility. Following are some of the companies that have implemented cloud storage facility[21]:

1. Amazon
   One of the leading world companies, Amazon was one of the first who managed to release its very own cloud storage service. Best thing about Amazon is it provides a generous 5GB free storage for every user, however, more storage facility can be utilized for its paid customers. Amazon drive managed to secure every smartphone platform, and penetrated the field of computer science with its high end security measures taken in regard. Amazon provides annual storage plans for users who are seeking for more storage capacity.
2. Dropbox
   Dropbox was the first ever company that issued the acquisition of data on cloud storage that allowed ease of sharing among friends via a self-generated link. Dropbox offered 2GB of free data for every user.
3. GoogleDrive
   One of the major companies in the world,, derived cloud data storage for the users. At first, it was only accessible for android users all around the world, later on, google drive was available on all platforms. This company of cloud storage not only provides security and privacy, but also, a large amount of storage capacity for the users to enjoy.
4. Mega
   Mega is a company that proclaims that all the data stored on its platform is user encrypted, providing a safe storage capacity for the users to enjoy. Mega is mostly used to store applications, along with other necessary data.
5. OneDrive
   OneDrive, or previously known as SkyDrive was a windows generated cloud storage facility, introduced in windows 10. This was an innovative step by Microsoft to provide its users with end-to-end-encrypted data for the users of windows. Moreover, it provides enough storage capacity without any charge, considered as a generous storage capacity. However, users can enjoy more data storage capacity by subscription. One of the major proclamation of windows is that paid subscription is one of the better ways for windows to provide even more security for its users.

6. iCloud
   Apple company introduced iCloud in iPhone 5, which was a competitive step in reply to Google's Google Drive. iCloud usually provides comparatively less storage as compared to other companies; however, it is one of the least hackable and the most contingency proof cloud storage available in the world. iPhone has worked extremely hard in making their products more secure and less penetrable by outside scam sources.

Smart City and Cloud Data Storage

Smart city project requires immense data to be collected and consumed. However, certain storage capabilities restrict their capacity. There is only finite amount of space available, technologically stating. However, cloud storage can be used as an essential tool for storing data. What this would do is enable different sectors and industries of a smart city to access the required data relative to city components they want to digitize. Therefore, inclusion of cloud data storage is considered immensely important for a smart city implementation, along with adequate data organization and management techniques that may be initiated, once this whole operation is begun. [22]

One of the most important components of smart city is the availability of proper communication between individuals of the city. This can be done by implementing a cloud storage system. Since majority of the data is posed to perplexed management situations as described in the literature, however, cloud storage allows multiple benefits for its purpose. Cloud storage, along with management and organizational facilities, provides basic physical resources required for data transmission, such as server, network and storage devices. Moreover, along with technological advancements that can be made in smart city development, security of data is essential and provisional with cloud storage facility. Therefore, by implementing cloud data storage, there are more benefits for the smart city idealization.[23]

Limitations

Although cloud storage was an innovative step for the computer field, and yes it made a whole lot of revenue while implementing innovation, there are some hurdles that many cloud data users had gone through, and were considered as the ignorance of cloud storage providers. In the modern world, with every successful step, there is always someone who is trying to bring you down.

Immaturity of the algorithm and file support system was one of the major disadvantage that was faced by many companies. Storage providers usually had to rewrite algorithms and data structures in order to provide support for the files stored on the cloud. When the file was uploaded, after a while it was inaccessible by the uploader, and even the receiver. This posed a major hurdle for the users, especially companies who had uploaded sensitive company related data on cloud.[22]

Security was one of the major concerns of the users of cloud storage. There were chances that the data stored on cloud could be viewed by other people, and could be hacked as well. This posed the companies utilizing cloud data storage to a threat that their sensitive data may get compromised. Therefore, one of the major problems that were faced by cloud companies as well as the clients was security. However, there were certain strategies that were applied in order to maintain a more secure connection between the user and the company, by using encryption.[22]

Bandwidth allocation was one of the major problems that were faced by the companies who were using cloud storage, along with the provider of cloud storage. Bandwidth can be defined as transfer of data from one source to another in a specific amount of time. Cloud storage, as it is online, requires internet connection for its access. Even though, considering that there is an internet connection available for the user, there are certain problems, such as fast data transmission between certain users, along with the internet connection that you are using, which basically portrays the fast transmission along with upload and download.

Conclusion

Technological advancements have made an effective progress from the start to the current time. The concept of smart city seems like an ideal job, however, there are certain hurdles that may cause glitches in the process. First and foremost, one of the major problems is that convincing the people of the city that their data, is in secure hands. This further accounts for the security of the data being obtained from various sources. There are certain limitations and risk that have been identified in this article, therefore, considering all the pessimistic approaches for this project, appropriate and necessary strategies and methodologies should be adopted in order to sustain an advanced, but more importantly, a secure city. Most of the cities in the world, such as Singapore, Dubai, and Southampton etc. have utilized the resources necessary for the implementation of smart cities.

As far as the cloud storage is concerned, it was an innovation for the computing world. Implementation of cloud storage was one of the biggest steps ever taken in the advancement of computer technology field. Cloud storage is immensely being used by various companies that require large amount of data transmissions, along with schools, banks and various business firms. However, there are certain security threats for the users who are consuming cloud data storage. These risks have been identified, and acted

upon. Such as, security threat and risk was overcome by the advent of end-to-end encrypted data security. This claims that the data is secure between the company, and the user. Moreover, all time availability of an internet connection for accessing files on cloud storage was overcome by offline data availability. Therefore, the scope of cloud data storage has been considered great in the upcoming years, with more effective advancement in the technology utilized in making cloud data storage. Moreover, combination of both of these components could be essential and crucially beneficial for implementing and initiating a smart city project in a particular region. However, city related data is highly sensitive in its kind, therefore, there should be proper security measures for this purpose, along with limitations to the drawbacks described in cloud data storage, mainly being security and lagging of transfer of data.

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