IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.-7, Special Issue, 6, March 2019 E-ISSN: 2347-2693

Technologies That Shape Smart Cities

Murali Mohan Kotha

Dept. of Mathematical Sciences, Sree Vidyanikethan Degree College, Sri Venkateswara University, Tirupati, India

*Corresponding Author: kotha_mm@yahoo.com, Tel.: +91-9490 264 274

DOI: https://doi.org/10.26438/ijcse/v7si6.2023 | Available online at: www.ijcseonline.org

***Abstract*—** In recent decades, the world has been witnessing unprecedented growth of urban population. This trend is likely to continue in next decades, which may result in unusual sizes and densities of cities. This leads to social, economical and environmental challenges. Thus, smarter solutions are needed to face these challenges, and to provide better services to the dwellers - by ensuring efficient and optimal utilization of available resources. The emerging technologies like Internet of Things, Cloud Computing, Big Data, advances wireless technologies and smart devices can deliver innovative solutions to the citizens, and lead to the emergence of what is called the "smart cities". Such fusion of technologies aims to improve overall quality of life in many ways. This paper presents state-of-the-art technologies that are shaping smart cities. Further the paper discusses the challenges that must be addressed to, so that the smart cities become safer, and sustainable.

***Keywords*—**Smart Cities, Urban Development, Internet of Things, Cloud Computing, Sustainability, Blockchain

I. INTRODUCTION

The global population is increasing at a rapid pace. Currently, the world is home to 7.1 billion people. It is expected that, by 2025, this figure will grow to 8 billion. Many cities around the world have been witnessing rapid inflow of people from rural areas – due to various reasons. The urbanization has been increasing over past decades. For the first time in the history, the year 2008 witnessed more people living in cities than in villages. The towns and cities are accommodating half of the world's population. By year 2050, it is predicted that – two out of every three people will be in metropolitan cities.

Such concentration of population in small areas, bring about many issues – like scarcity of natural resources, more pollution, congested roads, higher emissions, shortage of drinking water, poor waste management, insufficient power supply, inadequate public health systems etc.

At the same time, it is estimated that the urban population may contribute 70-75% of GDP by 2020. According to UN DESA's Population Division Report, (United Nations Department of Economic and Social Affairs) a successful urban planning agenda is required for urban settlements of all sizes.

Thus, it is required to understand these situations, and a plan is to be prepared to resolve urban population problems and to improve quality of their life. Thus, sustainable development is need of the hour. It can be realized through innovations like IoT – the seamless integration of Information and Communication Technologies (ICT). Smart Devices, Cloud Computing, Internet of Things form the foundation of what is called the "Smart City". Thus, smart cities use ICT in all aspects of city life. A smart city processes the networked information effectively and improves outcomes in every aspect of city operations. The concept of "Smart Cities", was introduced by IBM, in the year 2008, as part of its Smarter Planet Initiative.

The citizens should easily access the data and information regarding colleges/ schools, banks, hotels, petrol/ charging stations, emergency services like – hospitals, fire or police etc. Such applications ease the life of dwellers as well as the city administrators.

The rest of the paper is organized as follows. Section II deals with technologies used in smart cities; Section III contains the smart city objectives while the Section IV presents challenges that must be addressed to.

II. TECHNOLOGIES THAT SHAPE SMART CITIES

The first decade of the 21st century witnessed the rapid development and stability of the Internet and other relevant technologies. Some of them are discussed here, which play key role in smart cities:

A. Internet of Things (IoT)

A thing could be any device/ structure. The things are embedded with sensors. Then, these devices collect and

exchange the data using electronics, software, and network connectivity. Thus, the IoT is considered as the intelligent connectivity of physical devices. It is expected that they drive massive gains in efficiency, business growth and quality of life. The researchers have analyzed, designed and developed various hardware and software platforms to support IoT applications. The figure-1 depicts the IoT architecture, meant for smart cities.

Kevin Ashton, the visionary technologist, an innovator and consumer sensor expert, who is predominately known for coining the word "the Internet of Things" to describe the network connecting objects in the physical world to the Internet. The International Telecommunication Union (ITU) mentioned about the IoT as a "new dimension that has been added to the world of information and communication technologies (ICTs): from anytime, anyplace connectivity for anyone, we will now have connectivity for anything."

The Internet of Things (IoT) has become a feasible option for modern cities. In fact, it is perceived that IoT is a major enabler for the smart cities. The IoT - as a technology, is believed to have a great potential to solve life-threatening problems in various angles of our daily life.

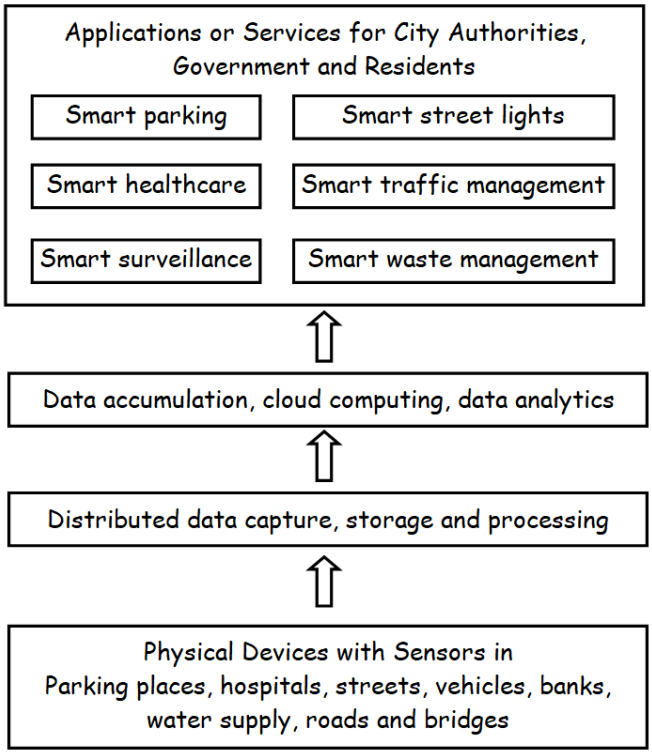

Figure-1: The IoT architecture, meant for smart cities

B. BIG DATA

The IoT-driven services, involved in millions of devices, generate large amounts of real-time data at high velocities. Such data is the driving force behind smart city initiatives. Further, the data may be of different varieties. Such big data is generally characterized by three Vs - volume, velocity and variety.

The businesses, which operate in the smart cities can gain access to this data and use it to improve their services, understand their target users and even identify the places where their services are required.

The smart cities should ensure best use of such big data, and should preserve the citizens' privacy and data security. Further, such data should be stored and mined for useful information using data analytics. To achieve this, the services of cloud computing can be considered

C. CLOUD COMPUTING

The IoT sensors have small computational power. Thus, the complex data processing can be done using cloud by following computational offloading. The information, which is generated after processing the data, can be used in several smart city applications. Further, machine learning can also be applied to obtain more meaningful information. From which, the further course of action can be planned. The three fundamental services provided by cloud technologies are:

1. *SaaS – Software as a Service* – It provides required applications to the intended parties.
2. *PaaS – Platform as a Service* – It provides required tools for virtualization, database management, and Operating Systems.
3. *IaaS - Infrastructure as a Service* – This provides physical infrastructure like processors (servers), storage and several others.

III. THE SMART CITY OBJECTIVES

Some of the main objectives of any smart city are:

- Better citizen services like water, gas, energy, communication etc.
- Safe and securing living environment
- Provide seamless IT connectivity
- Efficient mobility
- Spur technological innovation

The following are prominent domains that exist in smart cities:

A. Smart Environment

The residents can have seamless interaction with devices, to improve their usability.

B. Smart Traffic

For optimal utilization of mass transit system, the last-mile connectivity is also essential, along with the public transport system.

A smart city can adopt different forms of transportation system, so that it can provide reliable and efficient transportation of its citizens. The whole idea is to avoid congestion, optimize transportation routes, finding a vacant parking place, improve traffic movement, reduce commuting hours, and provide safety to pedestrians. A smart city should provide a green channel – i.e. green traffic lights should glow (switch on), automatically, along the path, though which an ambulance, carrying a patient in critical condition passes.

C. Smart Energy

The energy production, distribution and consumption can be managed and automated using ICT. The varying charges, during different times (peak and off-peak hours) can be implemented. Smart meters can provide feedback on power consumption, with which a concrete plan can be prepared for improving the efficiency.

D. Smart Buildings

They should reduce energy wastage, and consumption, by using smart appliances like Air Conditioners, lighting, water heaters, refrigerators and other home appliances.

E. Smart Waste Management

One should focus on solid waste management through smart solutions, for clean roads and a healthy environment. Such cleanliness and hygiene call for a baseline cultural change.

F. Smart Healthcare

Several medical applications can be developed like remote health monitoring, fitness programs, chronic diseases and elderly care. The whole idea is to reduce costs, increase quality of life and enrich the user's experience.

G. Smart Libraries

The routine library transactions like book issuance, returns and stock verification can be done easily with RFID technology.

H. Smart Government

The government can offer online services using applications for revenue (taxes, charges); expenditures (salaries, inventory); administration (employees, files management); and citizens' services (like birth/ death certificates, approval of building plans).

I. Smart People

The people in smart cities should posses' primary skill to make use of these technologies. Then only people can benefit from these services.

J. Smart Water

Water scarcity is due to lack of sufficient available water resources to meet the demands of water usage. According to the "United Nations Development Programme," the water scarcity is mainly caused by poor management of water resources, and affects around 1.2 billion people around the world. The water cycle (water resource, distribution, consumption, collection, and treatment of waste water) is a vital element and in every part of the water cycle, IoT can be utilized to manage water resources better.

K. Smart Agriculture

Smart farming enable farmers reduce waste and enhance productivity ranging from the quantity of fertilizer utilized to the number of journeys the farm vehicles have made. It means the adoption of modern Information and Communication Technologies into agriculture.

Thus, a smart city, which provides applications for citizens, businesses and governments, is summarized in figure-2.

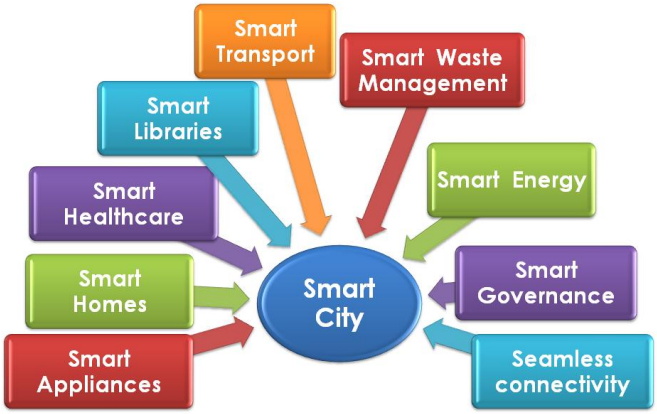

Figure-2: Different Services Provided by Smart Cities

IV. CHALLENGES

There are several challenges in the formation of smart cities, with the use of ICT. Some of them are:

A. Technology

Smart Cities depend very much on technology and its proper functioning. There are many technical challenges inherent to IoT. The things, their interconnected networks, capabilities, power consumption, sensing, data management are all to be addressed by manufacturers and enterprises.

B. Heterogeneity and Interoperability Challenges

Many standards are proposed to allow interconnectivity and interoperability of devices. However, further study is required to promote more sophisticated platform, architecture and middleware.

C. Data Challenge

Different sensors collect data in different formats. Their data analysis, representation, integration, and validation is done by multiple sources. Different applications understand different data formats. The large volumes of data that is collected in smart cities require efficient big data prediction algorithms.

D. Security Challlenges

A potential risk can arise from any sensor or device in the IoT networks. The smart cities contain near to a billion or trillion sensors, which mean, that many number of vulnerabilities. In a smart home, the daily life of a person is closely related to the devices of IoT. In smart city applications, the security is paramount. Many devices are vulnerable to cyber attacks and require security.

Since the new vulnerabilities are mushrooming every day, the IoT requires adaptive security systems to fend off not only known cyber threats, but also new, unseen attacks. The future security solutions may involve AI enabled, uses Machine Learner, which can detect suspicious patterns in IoT traffic and can detect so far unknown attack patterns. The blockchain technology, though in its initial phase, can be used in many sectors, to eliminate vulnerabilities so that it creates a smart city with more trust and more efficient.

E. Regulatory Challenges

If a self driving vehicle involves in an accident, or if a robot causes a damage or injury, the liability needs to be regulated. This results in legal uncertainty to manufacturers.

V. CONCLUSION

Planning a smart city involves an understanding of the soul of the city and managing it for the future of citizens. The smart city creation is not so easy task. It is not even just adoption of technologies in such process. It needs involvement of well informed citizens, private organizations and government bodies.

The Internet of Things platforms can even be enabled with Artificial Intelligence. Further, Machine Learning techniques will learn from historic data, to improve the efficiency of a smart city. Even the recent successes of Deep Learners can also influence the future development of IoT. The smart cities will not be able to achieve their intended purpose, without handling the security and privacy issues. The two emerging technologies - Blockchain and Internet of Things have the potential for future development. The Blockchain in IoT can solve many problems in IoT. It even develops Blockchain in the environment of IoT. All these developments help in creation of sustainable smart cities.

Thus, a smart city is expected to be a greener, harmonious efficient, more economical, and spur innovation, which integrates various Information and Communication Technologies, that lead to sustainable development.

REFERENCES

[1] Yogita Pundir, Nancy Sharma and Yaduvir Singh, "*Internet of Things(IoT): Challenges and Future Directions*." International Journal of Advanced Research in Computer and Communication Engineering Vol. 5, Issue 3, March 2016.

[2] Smart Cities India 2015 Brochure,"*Smarter Solutions for a Better Tomorrow*" Pragati Maidan, New Delhi 20th -22th May, 2015.

[3] Ali Dorri, Salil S. Kanhere, and Raja Jurdak, "*Blockchain in Internet of Things : Challenges and Solutions*"

[4] Kamanashis Biswas Vallipuram Muthukkumarasamy, "*Securing Smart Cities Using Blockchain Technology*", 2016 IEEE 18th International Conference on High Performance Computing and Communications; IEEE 14th International Conference on Smart City; IEEE 2nd International Conference on Data Science and Systems

Author's Profile

Mr. Murali Mohan Kotha is currently working as Lecturer in Computer Science, in the Department of Mathematical Sciences, Sree Vidyanikethan Degree College, affiliated to Sri Venkateswara University of India. He has presented many research papers in several national and international conferences. His interests include – IoT, and Programming Languages. He has 25 years of teaching experience.

