SMART CITY: A REALISATION WITH IoT AND BIGDATA

Ms. Sunita A Yadwad, Ms. DeepikaPuvvula

Assoc. Prof., CSE Dept, Pragati Engg College, Surampalem ,Kakinada,East Godavari ,A.P,9059529510

Asst. Prof., CSE Dept, ANITS, Visakhapatnam,A.P,9160862151

ABSTRACT :

Smart City, IoT(Internet of Things) and big data are modern and important Concepts; and hence many of them started integrating to develop Smart City applications that will help reach sustainability, better flexibility, powerful governance, enhanced quality of life, and Intelligent management of smart city resources. In this paper a model is proposed for developing a Smart City based on IoT and Big data and we explore both concepts and their different definitions. Despite the differing definitions each concept has a number of characteristics that uniquely describes it. Depending on these common characteristics, it is possible to specify the benefits of using Big data and IoT to design Smart Cities.

Keywords: Big data ,Smart City , IoT , Hadoop, Mapreduce

INTRODUCTION :

As the world continues to urbanize with 1,80,000 people a day moving into cities, the competition between cities will continue to emerge as economically, environmentally and even socially. The cities that embrace technology will surface as the winners. The Internet of Things has arrived and is ready to change the world.

According to a survey by Gartner, the number of connected objects stands at 7 billion in 2014 and projected to be at 26 billion in 2020. According to survey by Forbes, the number of connected cars and connected lights are at 23 and 2 million, respectively, and are projected to reach at 253 and 100 billion respectively. Industries belonging to sectors of IT, Retail, manufacturing and many others are increasingly adopting IoT practices, and the number of connected businesses stands at 1.7 billion in 2014 alone. The number of people using it or plan to use it is hugely increasing in the numbers. The youth market currently stands at 2.3 trillion dollars and is expected to reach at 14.6 trillion dollars. [4][5]

With the Internet of Things, we are able to achieve smart cities, which engage citizens and reinvent themselves connecting everything which makes safer places for people to live and work. City administrators are busy creating relatively better and safer places for people to live and work. A lamppost equipped with various sensors and having proper connectivity, can remotely monitor everything from the air quality to the public safety. In transportation, by the use of smart and intelligent programs one can alert drivers in real time about the traffic delays, synchronized light for emergency vehicles and suggest various alternate routes to keep traffic running smoothly.

In communities with aging infrastructure, maintaining the water pipes is a critical issue. So now, with acoustic sensors cities can easily detect the exact locations of water leaks making repairs more cost effective.

IoT for Smart Cities is also called as "Urban IoT". IoT is an environment in which everything ranging from objects, people, and animals are provided with unique identifiers and the ability to transfer data over a network without human to human or human to machine interaction. Now the data accumulated in the cloud in numerous amount can provide services to different domains such as:

1. Consumer and home where smart homes with various functionalities can be built.
2. To provide security services based on video analytics.
3. Smart infrastructure, providing services such as smart parking, waste management.
4. Health Care domain to provide better health care services.
5. Transportation domain in traffic and transportation monitoring
6. And many other domains

MOTIVATION :

The main motive of smarter cities is that the residents of the city should get the right information at the right time on their smart device to perform their tasks in a relatively efficient way.

The various services provided are: [6]

- Smart Lighting: optimization of street lighting efficiency is an important feature in smart city. In particular, this service can optimize street lamp intensity according to time of the day, weather condition and the presence of people
- Smart Parking: Finding a parking spot in the city is very difficult. So sensors detect whether a parking spot is available or not and transmit this data to the server, which is then communicated to end user by the antenna.
- Smart transportation: Even though monitoring system by basis of camera are already available and deployed in many cities, low power wide spread communication can prove a dense source of info. Traffic monitoring can be realized by using sensing capabilities and GPS installed
- Smart Waste Management: Is the primary issue in many cities. Intelligent waste containers detect the level of load and allow for optimization of collected
- Other services in smart city are: Structured Health Services, Video Surveillance, City Services for Emergency response, Energy management of public buildings, Noise Monitoring, Air pollution monitoring.

Fig. 1 shows the overview of the smart applications and the kind of sensors to be deployed to build a smart city.

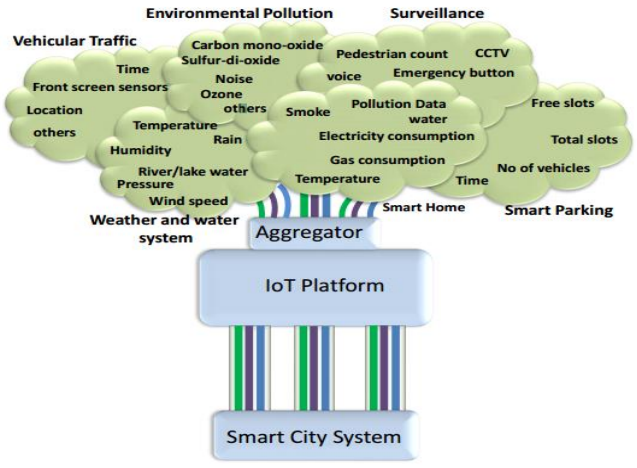

Fig. 1: Smart services and sensor deployment [1]

All these services should be cost effective. The main challenge lies in managing uncertainty in real time data collected from the ground and designing appropriate methods to process it.

EXISTING SMART CITIES

Barcelona City is one among few smart cities that has developed new services and is providing richer experiences of using IoT. [2]

Barcelona is initializing highly efficient street lights which aid in saving energy, optimize maintenance and provide a safe environment for the citizens. This city has installed a wide network of sensors, which provide city officials with concrete information so that they make decisions on real time data. Getting information from the citizens on noise and pollution, weather and traffic allows the officials to streamline the city operations which reduce cost, and improve overall sustainability, economic sustainability, social sustainability and environmental sustainability.

It is estimated that in this city, 40% of traffic congestion in city centers is caused by cars trying to find out a parking space. If ground parking sensors are provided which communicate with devices in the car to help vehicles find an available spot, this problem can be solved. By putting ground sensors in parking spots aids to get less cars, less traffic by making people happy so that the city becomes a more livable place. People need to understand that the internet might change daily life to improve the lifestyle.

Barcelona officials believe that "Technology is for people. Technology is for using it and technology is for improving citizen's life,even much better than it is now". Smart cities are a place for connecting unconnected, these are the cities that see the power of IoE.

FRAMEWORK

A Four-tier architecture is proposed to establish smart cities. The architecture is shown in the Fig 2.

On the ground level, (Bottom Tier) devices like sensors, surveillance cameras, emergency call buttons,etc should be installed wherever required to collect data like temperature, humidity, pollution, traffic, parking, etc. Huge amounts of data is generated by these devices in different formats at varying time intervals. Preprocessing should be done at this level to remove all the unnecessary and repeated data. Finally a Control center is provided, Cloud Server where all data accumulates. An example for Cloud Server is Google Cloud. As there are many existing heterogeneous devices which gives different data types and communication technologies, IoT is still struggling for a reference architecture which could be used as a standard for any its structure.

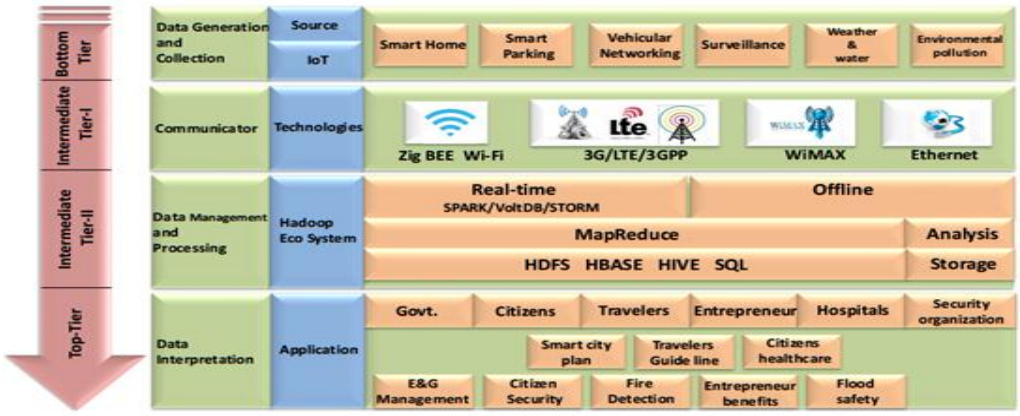

Fig 2. Framework for Smart city based on IoT and Bigdata. [1]

To connect all the devices and for all the devices to communicate with each other, a communication network is required. Zigbee technology, Wimax, Ethernet can be used for this purpose (Intermediate Tier-I).

As the standards provided by IETF (Internet Engineering Task Force), are open and are based on the best internet practices, it suggests a web service based architecture which is flexible, interoperable, extendable to IoT nodes. Considering the standards of the IETF, ReST (Representational State Transfer) web service based on architectural approach can be used in IoT for Smart City.

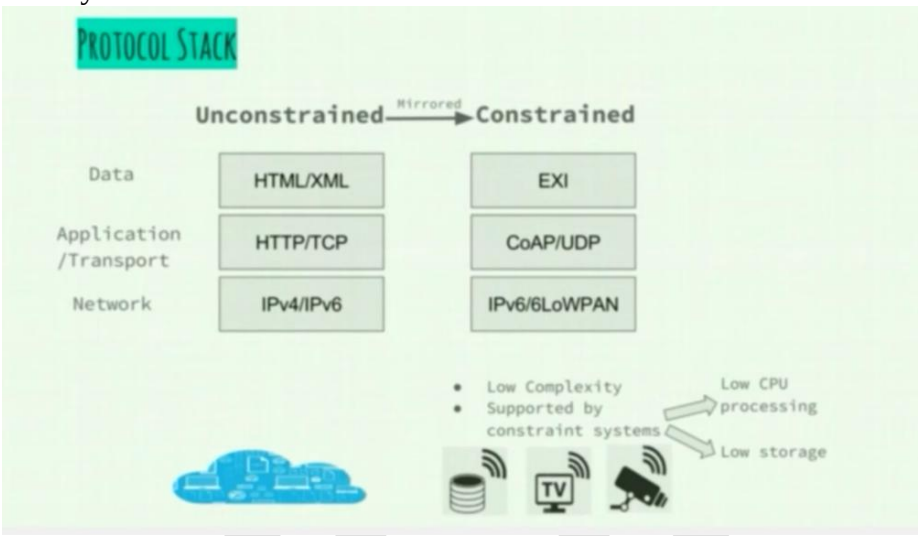

Fig 3. IoT Network [3]

Devices in IoT network are grouped under two categories: Unconstrained Devices and Constrained Devices. The major differences between the two are storage and processing capability. The important layers are Application layer, transport layer and network layer.
Data on Unconstrained device are HTML/XML, HTTP/TCP used in Application/Transport and IPv4/IPv6 in Network layer. A stack of unconstrained devices are mirrored into a stack of constrained devices with some specification changes. Unconstrained devices in Protocol Stack have high complexity and is supported by any devices. Constrained Devices have low complexity and supported by low CPU processing and low storage. Data in Unconstrained devices HTML/XML are large size messages and often too large for IoT devices. They are inefficient if used by low capacity devices. And hence the solution is EXI. EXI is used for data transmission and strongly compatible with XML. EXI is efficient to be used by low capacity devices.
Most traffic at the application layer are HTTP, and at the transport layer by TCP. Complexity of HTTP makes it unsuitable for Constrained Devices. TCP does not scale well for Constrained Devices. The Solution is: CoAP over UDP. CoAP proposes a binary format , UDP is a light weight transport layer protocol. CoAP and UDP have easy interoperability.
These devices generate abundant data, which we consider as *Big Data*. This data is used to analyze the characteristics of the city and this knowledge can be used to develop it into a smart city. We need one central system to further process and analyze the data.(Intermediate Tier-II).
The applications have great capabilities like monitoring remotely, controlling or managing devices converting huge streams of real time data into information
The big data systems will be storing ,processing and mining the information generated by the applications of smart city and facilitate the services that can be provided ,The presence of big

data as a facility takes care of the scalability of services and resources. The characteristic features of big data are listed as 3Vs to which now additional Vs are added.
Volume: Refers to the massive size of data that the smart city applications generate from all sources .
Velocity: Refers to the speed with which the data is created by various applications is created, analyzed as most of the applications run on a real time basis.
Variety: Refers to the varied types of data that is generated. Big data and analytics are enabling Smart City initiatives all over the world due to their capability to handle unstructured and structured data.
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Big Data Management: The Smart city Conceptualization and realization generate huge volumes of data in varied forms as they receive from sectors like traffic, energy, healthcare, education. The data generated is from real time, hence it is massive and regular. To assert that the data generated is properly utilized we need to have proper big data management tools. Big data management tools have features that recognize the various formats of data from their sources, to manage and control their structuring. Both offline and online streaming of data needs scalable handling and decision making for smart city application.[7].

Big Data Processing Platforms: Big data applications built for smart cities need to perform data analytics requiring huge processing capability. This leads to the need for software and hardware platforms that are scalable and reliable. The software platforms should provide high performance computing capabilities, should be optimized to suit the hardware which is used, is stable and reliable for the different applications being executed, supports streaming processing, provides a fault resilient of high-levels, and is supported by a well-trained and capable team and vendor.
To visualize, summarize, analyze and discover knowledge from this data apache introduced a new framework called Hadoop. Hadoop is a software library that supports the processing of large data sets in a scalable and distributed manner across a cluster of computers using a simple programming model. The Hadoop framework consists of two major components one is HDFS(Hadoop distributed file system) and another one is MapReduce. MapReduce is programming technique to process the data in parallel manner using key/value pairs and HDFS are used to store data persistently. The input to the MapReduce program is taken from HDFS in the form of key/value pairs and return store the output to the HDFS again. HPCC , Stratosphere , and IBM Infosphere Streams are other frameworks which provide the stream processing needed by real-time big data applications such as intelligent transportations in a smart city . These platforms function well on cluster systems.

For the survey of the Big Data, the available traditional SQL databases are not adequate because of the scalability issue. To process or examine this big volume of data . NoSql database is needed. Big data is not a single technology but a combination of older and newer technologies that helps companies to gain actionable insight. Therefore, big data has the capability to manage a huge volume of variable data, at the right velocity, and within the right time frame to allow real-time analysis and to react. Hadoop consists of HDFS (Hadoop Distributed File System), Hbase, and Hadoop MapReduce .It is capable of analyzing big data [8-9]. It is an open source framework. With the help of which we can write and implement an application program for processing big data With the advent of Hadoop distributed computing platform and the MapReduce programming model it has become easier for all the machine learning algorithms to process the data parallel[10]. This makes it easy to transform the machine learning algorithms to be transformed to Map reduce paradigm to use Hadoop Distributed File System HDFS .

SMART CITY- IoT CHALLENGES

One of the bigger challenges of Big data ,IOT and smart city amalgamation is Implementation of privacy by proper design with transparency in whereabouts of data, its processing and the distribution of data among third parties with proper consent of the provider .Collection and storage of data only if necessary for any legal purpose , allowing individuals to correct and have a control on their data. For example collection of data for Aadhar cards the individual has overall control on the data and can change it through proper access control authorization. Proper control of the data and limited careful usage. Maintenance of data by periodic verification of the data. Data obtained from connected devices is highly sensitive, tremendous in quantity and quality and personal ,hence must be regarded with care and proper technology not to divulge it publicly. The connecting devices should be clear about the purpose of collection of data and ensure the period of retention of the data. To uniformly balance the positive and negative impact of big data big data and IoT in our lives we must reduce the risk involved in collection and usage of Big data. IoT devices when coupled with big data can make life better .The other challenges are:

Sensing: from the physical world to cloud

Connectivity: varied connectivity standards and wireless connectivity standards are needed to enable the various application needs
Power: Many IoT applications available needs to run for years and thus reducing battery consumption is the overall challenge
Security and Privacy: Security is vital. Detecting and blocking malicious activity always remains a challenge.
High Complexity: IoT complex and IoT application development needs to be easy for all developers and not just limited to experts.

SECURITY &PRIVACY

As IoT is now the key element in developing smart cities, it is also important to provide the security. All IoT applications use various devices to collect large amounts of data from the environment. In an industrial plant, a cooler failing to maintain appropriate temperature could place the unit at risk and might lead to big accidents. Therefore an efficient data model is required to accommodate and analyze the data sent by the sensors in uniform intervals of time. These large scale applications based on IoT are more susceptible to attacks, disruption and data theft. Trust based models can be used to handle these IoT vulnerabilities like to compromise nodes, DDOS attacks, and malicious code hacking attacks.
Considering the large volumes of personal information, it is highly required to support privacy and restricted handling of that information. Multilevel authentication, cryptographic techniques can be used to address the privacy issues. Not all its nodes can be made secure because of resource constraints of nodes.
Secured networks must be designed for authentication, data privacy and integrity. Efficient routing protocols to be used for efficient routing. A registry to maintain the database of all the devices connected with a city and their attributes. Smart cities need proper key management system for IoT networks to generate, store, distribute and change and use keys. These four are the building blocks of any secured smart city based on IoT and can be deployed across the smart city.

CONCLUSION

As Smart city, it and big data, though modern, recent and crucial concepts they are at their best integrated as smart city applications. These benefit will help reach sustainability, better flexibility, powerful governance, enhanced quality of life, and intelligent management of smart city resources. In our study, we ha for developing highlighted the benefits and definitions of each concepts and discussed how when combined they could result in ve a smart city based on IoT and Big data and explored both concepts and their different definitions. We identified some similar attributes for each. Despite the differing definitions each concept has a number of characteristics that uniquely describes it. Depending on these common characteristics, we were able to specify the benefits of using Big data and IoT to design smart cities.

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About the Authors

Ms. Sunita A Yadwad [CSI - N1271451] is currently working as Associate Professor in Dept. of CSE at Pragati Engineering College Surampalem Kakinada. She is pursuing Ph.D. at A U College of Engg, Andhra University Campus, Vishakapatnam. Her research interests mainly focus on data mining and Machine learning. She can be reached at

Ms. DeepikaPuvvula [CSI-I1500964] is currently working as Assistant Professor in Dept. of CSE at Anil Neerukonda Institute of Technology and Sciences, Visakhapatnam. Her research interests mainly focus on Computer Networks and Software Engineering. She can be reached at