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Need of Internet of Things for Smart Cities

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ABSTRACT

The world is moving forward at a fast hop, and the credit goes to ever growing technology. One such idea is IOT (Internet of things) with which automation is no longer a virtual reality. The Internet of Things will seamlessly incorporate a large number of different and heterogeneous end systems, while providing open access to selected subsets of data for the development of an overabundance of digital services. Building a wide-ranging architecture for IoT is required because of the extremely large variety of devices but it is a very complex task, link layer technologies, and services that may be involved in such a system. In this paper we emphasis specifically to an urban IoT systems that, while still being quite a broad category, are characterized by their specific application domain. Urban IoTs, in fact, are designed to support the Smart City vision, which aims at take advantage of the most advanced communication technologies to support added-value services for the administration of the city and for the citizens.

Keywords: *Smart Cities, Sensor System Integration, Network Architecture, IOT, Microcontroller*

I. INTRODUCTION

The Internet of Things (IoT) is a synonym for the fully interconnected world [1]. It connects all the things with technology and makes a whole new separate world for them to interact with each other with the help of internet. IOT is not just a concept but can prove to be a revolution in advancing technology to change the lifestyles of humans altogether [2].

IOT will not leave any physical or theoretical concept unpretentious. Communication between objects is the primary goal, anyone should be able to get any content from any device at any time from anyone located anywhere and who can be a part of any business or service, through any path or network. Constructively, 'availability' could be a crucial issue that affects the performance of IOT [3].

The IoT contains three layers, including the perception layer, the network layer, and the application layer, as shown in Figure 1. The perception layer comprises a group of Internet-enabled devices that are able to perceive, detect objects, gather information, and exchange information with other devices through the Internet communication networks. Cameras, sensors, Radio Frequency Identification Devices (RFID), Global Positioning Systems (GPS) are some examples of perception layer devices. Progressing data from the perception layer to the application layer under the constraints of devices' capabilities, network limitation and the applications' constraints is the task of the network layer. IoT systems use a mixture of short-range networks communication technologies such as Bluetooth and ZigBee which are used to carry the information from perception devices to a nearby gateway based on the capabilities of the communicating nodes [4]. Internet technologies such as 2G, 3G, 4G, WiFi and Power Line Communication (PLC) carry the information over long distances based on the application. Creating smart homes, smart cities, power system monitoring, demand-side energy management, coordination of distributed power storage, and integration of renewable energy generators is the main goal of the application, the last layer which is the application layer, is where the information is conventional and processed. Accordingly, we are able to project better power distribution and management strategies [5].

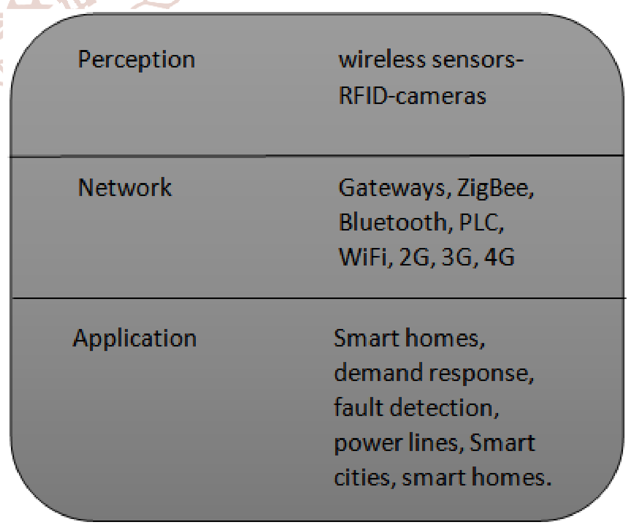

Figure1. IoT layers

II. MOTIVATION

The city is becoming smarter than in the past as a consequence of the current expansion of digital technologies. Smart cities encompass numerous styles of equipment applied by some applications, such as cameras in a monitoring system, sensors in a transportation system, and so on. Furthermore, use of individual mobile equipment can be spread. As stated, a sensible town employs info and communications technologies (ICT) in a very method that addresses quality of life by enterprise urban living challenges encompassed by a lot of economical utilization of limited resources (space, mobility, energy, etc.). World leading cities, in terms of services and quality of life, have provided efficient services to their citizens by the forward thinking and use of technology in monitoring various environmental parameters. Most of these systems contain of sensor, data storage device, and computer at a base station where experts analyse the data. From the technological viewpoint, the evolution of social networking in the past period clearly shows the usability of ICT at an individual's level. Large- scale applications at system level have made some progress in recent years. A fully integrated system of systems covering sensing, storage, analytics, and interpretation is required. The integrated system must have core abilities of plug-and-play sensing, secure data aggregation, Quality of Service, and re-configurability. With an urban sensing system of systems in place, the ability to evaluate the impact of the previous actions is readily available as the sensing cycle repeats.

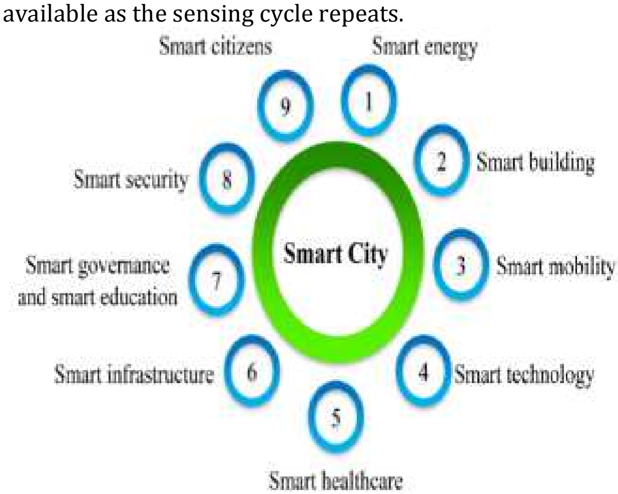

Figure2. Main Aspects of Smart City

A. Smart lighting

In order to support the 2020 directive, the optimization of the street lighting efficiency is an important feature. In particular, this service can optimize the street lamp intensity according to the time of the day, the weather conditions and the existence of people. In order to properly work, such a facility needs to include the street lights into the Smart City infrastructure. It is also possible to feat the increased number of connected spots to provide WiFi connection to citizens. In addition, a fault detection system will be easily understood on top of the street light controllers.

B. Noise monitoring

Noise can be seen as a form of aural pollution as much as carbon oxide (CO) is for air. In that sense, the city authorities have already issued specific laws to decrease the amount of noise in the city centre at specific hours. A city IoT can offer a noise monitoring service to measure the amount of noise produced at any given hour in the places that adopt the service. Besides building a space-time map of the noise pollution in the area, such a service can also be used to apply public security, by means of sound detection algorithms that can recognize.

C. Traffic Signal System

Nowadays congestion in traffic is a thoughtful issue. The traffic congestion is also be caused by large Red light delays, etc. The delay of respective light is hard implied in the traffic light and it is not dependent on traffic. Therefore for pretending and optimizing traffic control to better accommodate this increasing demand is arises. The optimization of traffic light controller in a City can be done using microcontroller. This system tries to reduce possibilities of traffic jams, caused by traffic lights, to an extent. The microcontroller used in the system is PIC. This system contains IR transmitter and IR receiver which should mounted on the either sides of roads. Whenever a vehicle passes on road between IR transmitter and IR receiver, the IR system gets activated. Microcontroller controls the IR system and counts number of vehicles passing on the road. Microcontroller also store vehicles count in its memory. Based on vehicles count, the microcontroller should take decision and update the traffic light delays as a result. The traffic light should be situated at a certain distance from the IR system. Microcontroller defines different ranges for traffic light delays and updates those accordingly based on vehicle count. The system records vehicle counts in its memory at user specified recording interval on real time basis. This recorded vehicle count data can also be used in future to analyse traffic condition at respective traffic lights connected to the system. For suitable analysis, the recorded data can be downloaded to computer through communication between microcontroller and the computer. Thus, manager on a central station computer can access traffic conditions on any approachable traffic lights and nearby roads to reduce traffic congestions to an extent. This system can be used to intimate people about different places traffic condition.

III. IoT TECHNOLOGIES FOR SMART CITIES

The IoT is a broad band network which employs standard communication protocols [9,10], whereas the Internet would be its convergence point. The major plan of the IoT is that the widespread existence of objects that square measure able to be measured and inferred, moreover because it is in a position to change things. Accordingly, IoT is authorized by the expansion of several things and communication equipment. Things within the IOT embrace good instrumentation like mobile phones and alternative facilities as well as foodstuff, appliances and landmarks [7,8] that can collaborate to achieve a joint objective. The main characteristic of the IoT is its effect on consumers´ life [6]. In the concept of IoT, since the cabling cost for lots of sensors is expensive, the communication between sensors should be wireless. Low-power standard communication is appropriate for interconnection among many devices. According to location and distance covered, some networks are introduced as follows.

A. Home Area Networks (HAN)

HAN use short-range standards like, ZigBee, Dash7, and Wi-Fi. All control components and monitoring in a home are connected by the HAN.

B. Wide Area Networks (WAN)

WAN provide interaction between customers and distribution utilities which require much broader coverage than HAN and for implementation needs fiber cable or broadband wireless like 3G and LTE.

C. Field Area Networks
Field area networks are used for connection between customers and substations [5].

In IoT, two tasks, sensing and processing the data, are performed, but they are not unified from a wireless sensor network (WSN) viewpoint. The unified solutions are Speakthing and iOBridge. Speakthing is considered as an analytics IoT platform for gathering, visualizing and analyzing the live data in the cloud and you are able to analyze the data by MATLAB coding. In difference, iOBridge has its own hardware modules that are connected to the cloud which can be accessed by web interfaces and collected data can be aggregated to other webservices. It is noteworthy that cloud is incredibly vital in good cities for information storage and process.

1. Radio-Frequency Identification (RFID)
RFID includes readers and tags and has a vital task in the framework of the IoT. Employing technologies on every connected factor, achieving their automatic identification and dedicating the single digital identity to any of the things will be possible, to include the network associated with the digital information and services [11]. RFID provides some applications in healthcare applications, smart grids, including tracking and localization of objects, parking lots and asset management. Each tag can be as a sensor because they have not only data which is inscribed manually but also capture data like environmental information.

2. Near Field Communication (NFC)
Near Field Communication (NFC) is used for bidirectional petite distance communication, especially in smart-phones. This range usually involves a centimeter range. The application of NFC in smartphones allows us to use it in smart cities. One of the applications includes using smartphones with NFC as a wallet which enables us to use smartphones as our personal cards such as bank card, identification card, public transportation card, access control cards. Moreover, since NFC is bi-directional, it is accustomed shared at a between devices, multimedia, and documents [5]. By placing NFC at a planned position at the house and providing an interface with the main controller, it is possible to change the position of objects by checking the location for instance switch on the Wi-Fi when the user comes home.

3. Low Rate Wireless Personal Area Network (LWPAN)
LWPAN is among short-range radio technology, that covers large distances up to 10–15 km. The energy consumption of this technology is very low and battery lifetime is about 10 years [2]. According to the IEEE 802.15.4 standard, it provides little cost and low-rate communication for sensor networks. It has the lowest two layers of protocols including physical and medium access level, besides upper layers protocols including 6LoWPAN and ZigBee [12].

4. ZigBee
In the sensor nodes, ZigBee is pragmatic as a low-power and low-cost wireless communication technology [5]. ZigBee is based on the IEEE 802.15.4 standard and is suitable for creating wireless personal area networks (WPAN) such as medical device collection, home automation and other low-power, low-bandwidth. Some of its applications include electrical meters, wireless light switches and traffic management systems. ZigBee is appropriate for limited ranges, for example coverage of city region and supporting billions of devices. A mechanism for transmission of IPv6 packets is specified with the ZigBee-based network. To apply ZigBee, extra equipment usually is required linking a coordinator, router and ZigBee end-devices.

5. 6LoWPAN
The 6LoWPAN standard is specified to become accustomed IPv6 communication. Over the time, IPv4 which was the foremost addressing technology supported by Internet hosts has been substituted by IPv6 due to the enervation of its address blocks and the incapability to separately address billions of nodes which is a characteristic of IoT networks. IPv6 providing 128-bit addresses solves the dearth of adequate nodes for IoT networks, but it creates another problem however, which is compatibility with forced nodes. This problem is addressed by 6LoWPAN which the compression format for IPv6 is [13].

6. Wireless Sensor Networks (WSNs)
WSNs make diverse proper data available and might be applied in lots of uses like healthcare, as well as government and environmental services [14]. Moreover, WSNs can be combined with RFIDs to obtain numerous targets such as gaining data related to the position of people and objects, movement, temperatures, etc. A WSN contains of wireless sensor nodes which include a radio interface, an analog-to-digital converter (ADC), multiple sensors, memory and a power supply [5]. According to the wireless sensor node framework, it includes various kinds of sensors which ration data in analog format which are converted to digital data through an ADC. Some events are processed on the data through a memory and microcontroller according to data requirements. Finally, data are transmitted by a radio interface. All of this equipment needs to be armed with a power supply.

A finished WSN is an extremely tiny low-power, low-cost sensor node which can be applied in any environment and works unceasingly for a few years. This utopic WSN has not been realized. WSN has severe source limits like reliance on battery life. With many sensor nodes in smart cities, replacing or recharging their batteries is infeasible. Designing a protocol for urbane power management schemes like solar panels is essential for WSN power sources.

I. Dash7
Dash 7 is a capable standard for WSNs used in long distance and low power sensing applications such as building automation and logistics. This protocol is used for kilometer-distance range and operates at 433 MHz which not only has better diffusion through walls than 2.4 GHz but is also alluring for HANs. It is worth discerning that Dash is very attractive in military application especially substation construction. Some of its applications are manufacturing, hazardous material monitoring and warehouse optimizations and smart meter development [16].

II. 3G and Long-Term Evolution (LTE)
3G and LTE are canons for wireless communication for mobile phones and data terminals. Regarding the development and enlargement of wireless communication infrastructures, LTE and 3G are available everywhere, even in third world countries. This technology is used for broadband connectivity and was not designed for short range uses. It is useful for WANs which require longer

distance ranges. Nevertheless, there are some barriers to their implementation that should be was not premeditated for short range uses. It is applied for WANs which need longer distance ranges. However, there are some barriers to their implementation that should be addressed. High data cost due to providing this service by the service providers, and inability to use them for communication among billion devices are some of the problems of these services.

III. Smart Cities Platforms and Standards

The bond between the physical and IT infrastructure constructs a innovative machine-to-machine (M2M) communication for smart cities which along with new features of network drives smart cities' communication platforms. These platforms help to cover the communication requirements between diverse access technologies and application suppliers. Moreover, these stages help form the IoT with real world sensors and communication networks. One of these platforms which is being used widely is open MTC pull out from the latest ETSI standards for the smart M2M specification. The aim of the open MTC platform is to provide a compliant middleware platform for M2M applications and implementation of the smart city [17]. The standard for smart cities is IEEE 802.15 which is for wireless personal area networks. This standard consists of different parts including: Bluetooth, coexistence, high rate WPAN, low rate WPAN, mesh networking, body area networks, visible light communication, peer aware communication, key management protocol, layer to routing, wireless next generation standing committee [18].

IV. INTERNET OF THINGS CHALLENGES

The fact that Internet of things applications and scenarios delineated above are very interesting which provides technologies for everything, but there are some challenges to the application of the Internet of Things concept in charge of implementation. The expectation that the technology must be obtainable at low cost with many objects. IoT are also faced with many other encounters such as:

A. Scalability:

Internet of Things has a big idea than the conventional Internet of computers, because of things are cooperated within an open environment. Basic practicality is communication and repair discovery so ought to operate equally with efficiently in each tiny scale and large-scale environments. The IoT requires new functions and methods to gain an efficient operation for scalability.

B. Self-Organizing:

Smart things should not be achieved as computers that require their users to configure and adapt them to situations. Mobile things, which are often only intermittently used, need to establish connections impulsively, and able to be organize and configure themselves to suit their environment.

C. Data volumes:

Some application situations of the internet of things will involve to infrequent communication, and gathering information's form sensor networks, or form logistics and large-scale networks, will collect a many number of datas on central network nodes or servers. The term represents this phenomenon is big data which is requires many operational mechanisms in addition to new technologies for storing, processing and management.

D. Data interpretation:

To support the users of smart things, there is a need to understand the local context determined by sensors as accurately as possible. For service providers to profit from the dissimilar data that will be generated, needs to be able to draw some generalizable deductions from the interpreted sensor data.

E. Interoperability:

Each type of smart things in Internet of Things have different information, processing and communication capabilities. Different smart things would also be exposed to different conditions such as the energy availability and the communications bandwidth requirements. To ease communication and cooperation of these objects, common standards are required.

F. Automatic Discovery:

In dynamic environments, right services for things must be automatically identified, which requires appropriate semantic means of describing their functionality.

G. Software complexity:

A more extensive software infrastructure will be needed on the network and on background servers to manage the smart objects and provide services to support them, because the software systems in smart objects will have to function with minimum resources, as in conventional embedded systems.

H. Security and privacy:

In addition to the security and protection aspects of the Internet such in communications confidentiality, the authenticity and trustworthiness of communication partners, and message integrity and other necessities would also be important in an Internet of Things. There is a need to contact some services or prevent from communicating with other things in IoT and business transactions involving smart things would need to be protected from competitors' snooping eyes.

I. Fault tolerance:

Things in internet of things is much more dynamic and mobile than the internet computers, and they are in changing rapidly in unexpected ways. Configuring an online of Things in a very sturdy and trustworthy manner would need laying-off on many levels and a capability to mechanically adapt to modified conditions.

J. Power supply:

Things typically move from one place to another and are not connected to a power supply, so their smartness needs to be powered from a self-sufficient energy source. Although reflexive RFID transponders do not need their own energy source, their functionality and communications range are very limited. Hopes are held on future low power processors and communications units for embedded systems that can function with meaningfully less energy. Energy saving is a issue not only in hardware and system architecture, but also in software, for example the application of protocol stacks, where every single transmission byte will have to justify its existence.

K. Wireless communications:

From an energy point of view, recognized wireless technologies such as GSM, UMTS, Wi-Fi and Bluetooth are far less suitable; more recent WPAN standards such as ZigBee and others still under growth may have a thinner bandwidth, but they do use significantly less power.

V. CONCLUSIONS

With fast development in the emerging Internet of Things technology, we give in this paper a comprehensive blueprint of developing a smart city using IoT, which is motivated and strongly required from city councils as they seek to ensure the provision of necessary services and quality of life for city populations. In this context, we understand the key IoT building blocks of smart cities, as well as provide the approaches and resolutions to meet the irrespective communications, computing and computation necessities. Furthermore, IoT enabled noise mapping work in association with the City of Melbourne is presented as a case study to highlight the practical usage and merit of our recommended framework. Finally, to thrust the development forward, the proper business model of smart city is believed to be equally important as technological advancement.

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