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Designing Smart Campus Using Internet of Things

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ABSTRACT

Internet of things is new technology. It generally refers to the communication between things like technological devices, sensors, actuators and peoples with unique identifiers. Internet of things improves day to day activities of the users by minimizing the time things to be done. However, IOT is made for the people and used by them for many reasons such as health, business technology innovations and mainly in our case, it is used to control the devices in the campus by using sensors and internet connections.

When the devices on the campus are automated, they can control the activities being done in the smart campus.

A university campus can be considered as the ideal place for the creation of a smart environment. The main objective of this research is to describe a new concept called Smart University by providing a comprehensive overview of the IoT scenario and reviews its enabling technologies and to come up with methods to design some of the components of the campus with smart devices to simplify the works being done in the campus.

Keywords:- Internet of things, wireless sensor network

I. INTRODUCTION

Internet of things is a network that can connect everything to the internet through wireless sensor networks. It is composed of two words: Internet and things. [7].

Background studies

IOT technology provides a means to transfer new innovations about industry, agriculture and energy distribution by adding important information with the help of sensors. According to Cisco there are a number of companies and research organizations which provides the impacts of IOT on the internet and the economy in the next five or ten years. In the research that had been done by Morgan Stanley states that more than 24 billion devices will be connected to the internet in the year of 2019. The Hawaii Company also predicts that100 billion IOT connections will be performed in the year of 2025.In economic concern McKinsey Global Institute indicates that the economic impacts of the IOT in the global will be as much as $3.9 to $11.1 trillion by 2025.

The internet of things was first introduced by pioneer Kevin Ashton in 1999 to define that the objects of the physical globe can be connected to the internet by sensors. He provided that the ability of connecting RFID (radio frequency Identification) used in

business to internet to track goods/materials ready selling without the need of the human intervention. Today's internet of things has an ability to describe different objects, devices and sensors to connect to the internet. As a result, internet of things is generally new concept, but the idea of integrating computers and networks to manage and control things had existed in this world for around several decades. In the late 1970's systems that are used to remotely control the electrical grids trough the smart phones were already in use in the market. In 1990's wireless technology that provides machine to machine company communication and industrials to control materials and operation was very popular at that time.

Things: things are physical objects that own ability to connect to the internet; it consists of several objects like: building, sensors, actuators and network connections that allow these objects to collect information and interchange data among them. Furthermore, things can have unique address that enables them to connect to the internet.

On the other hand, the Internet is the network of network, which is used for communication among billions of people in the world [5].

Definition of the internet of things: It is a network that consists of different objects which has the

capability to organize things automatically, it also has ability to share information and give reactions and actions towards the environment.

Internet of things (IOT) is a network which allows objects and users to communicate each other by giving a unique address to every object to identify which users are accessing to what resource of the network easily. It also describes a world of network in which every object is connected to the network so that data can be shared. Everybody already has a smart phone, but a phone is not smart rather it helps its user to make smarter decisions.

The internet of things is a recently emerged technology of technical, sensors and Industrial components and other objects for daily work are combined with internet connectivity and very strong data used for analytic capabilities that enables to transform the method we work, live and play. In predicting the number of people that can use or connect to the IOT devices will be as much as 100 billion. However, this will increase the global economy for more than$11 billion in the year of 2025. It is also brings a good challenge that can direct towards the realizing its potential benefits.

The following are the fundamental concepts that can act as a way of examining the circumstances and challenges of IOT.

Enabling technologies:
Several electronic devices like computers, sensors and smart devices are combined together to perform a new technology of the internet of things that are closer and closer towards the reality.
These include: Cloud computing, IP based networking, IOT servers and Routers used as an ISP device

Connectivity Models:
IOT uses different communication models for designing and implementing, any one of these models has its own traits. At the internet of the architecture board four communication models are described: Device-to-device, device- to –gateway, and device-to-cloud, any way this a method that provides the easiest way that IOT devices can connect and bring resources needed by the users.

Security:
In these years security concerns of information technology is not a new innovation.

But, It had been used in the last decades, the design and implementation of the IOT in the recent years present a unique security challenges. The nature of the IOT devices provides that any poorly secured device which is connected online generally affects the security and the internet globally. This security challenge may cause in the unsecure campus environment. However to overcome this problem a collaborative approach to ensure the IOT security challenges in the smart campus are needed. [15].
According to the Definition of IEEE standard internet of things is defined as:"a network that connects things to the internet by using communication protocols. However, things can have an identity, status and location by providing the information needed with or without the interference of the humans and gives every object to its unique identification "[14]. After the things are connected to the internet in order to know and avoid security credentials, then security checking mechanism can be taken into consideration.

Internet of things has a platform where things can be connected, sensed and remotely controlled across the network infrastructure.

A single administrator controls the devices connected to the cloud server and also facilitates to access and control all the devices that are connected to any user. But single user has his/her own authority to control the devices which are connected to that particular user. In other words, all Universities are connected to the internet and every University has similar objects that can be converted into smart object by using internet of things. In addition to this, classical campus can be transformed into a smart campus with the help of smart devices.

Internet of things is a mechanism in which objects or people are given with a unique identifier. It provides the way to transfer data over the network without the requirement of human and computer interaction. The Camera uses sensors as ears and eyes.
The Smart phone has sensors (Gps, campus, accelerometer, video, proximity, temperature or sound) and connectivity (NFC. Bluetooth, Wi-Fi or Ethernet power line). These features make the smart phone a best IOT device that automatically manages your locations, movements.

When Users understand the applications of the IOT, then user confidence is achieved. This refers to the ability of the users to read, learn, understand and monitor IOT through change. It increases the users of the IOT. User device interaction is among the generic requirement of the users for IOT. [16].

At the highest level, Smart Campus connects devices, applications, and people by delivering two key value propositions, enabling new experiences and improving operational efficiency.

A Smart Campus starts with clear, reliable wired and wireless connectivity, indoors and out. However, while that kind of connectivity may once was a goal in itself for many colleges, it is just the beginning of a Smart Campus. When all of the people, devices and applications on campus share a common technology infrastructure, they can interact with each other to enable experiences and efficiencies that were not possible before.

Campus network is a kind of metropolitan area network that consists of many interrelated local area networks which is larger than a local area (LAN) network in terms of geographical coverage, but smaller than a wide area network (WAN).It has network devices like: Switches, Routers, Firewalls and ISP those performing different functions. However, an IOT uses numerous technologies like RFIDs, Zigbee, and Bluetooth and so on.

II. LITERATURE SURVEY

Smart campus is an idea that includes the scope modernization of smart education to develop smart classrooms. Of the following are some of the literature surveys that were provided by different scholars at different times.

Aqeel-ur-Rahman et al.(2008). "Developed smart University research with the help of RFID technology." This concept gives unique identification number to every object to differentiate from the other. [2].

Kevin Ashton. (2009). "Presented the knowledge of radio frequency identification (RFID)". This idea belongs to IOT technology and gives objects to their unique identification number to a reader through wireless sensor networks.[6].

Alexandria Aloisi.(2014). "studied the interconnection among wireless sensor networks and the internet of things-ACOAP communication stacks." This principle states that the correspondance between remote sensor system and web of things.To do this ,First we focus on the idea of IOT and how wireless sensor networks are interconnected keeping in mind the end goal to make setting mindful to gather information.The communication constrained protocol(COAP) is used to enable wireless sensor networks to communicate the internet of things platform.In order to design and implement the smart objects in the smart campus by using COAP protocol as application.[1].

Marian cata et al.(2015). "Studied the idea of smart campus using internet of things." the idea that a university campus may represent the ideal place to provide technology environment for study. The concept of the smart University can be defined as a usual globalization in which objects are networked and sensors are enabled to work together in a collaborative manner to provide a qualified smart University infrastructure. [8].

Mrs.Chaira HK.(2016). "Presented the internet of things for smart college".This idea of
Smart college will clearly affect the thoughts of millions regarding the IoT technologies. Making the younger generation familiar with the application, it becomes easy to adopt the concept in a larger scale.[9].

Marti Widya sari et al. (2017). "Developed a mechanism to get smart campus by using internet of things in such a way that the technology helps to maintain the security of the campus, to improve the quality of education through interaction and cooperation to get qualified students and smart classroom that has attractive environment and well equipped with IOT devices to deliver the things easily".[12].

Sharpen Dey et al. (2017)."Studied on home automation with the help of smart phone and laptop." However, IOT monitors electrical and mechanical systems. Only one authorized person manages the devices to the cloud server and implements sensors. [13].

Mohamed Masud and said. (2013). "Developed Network layer advantages". It has features which are used for transferring and processing sensor data. It has an ability to allow the smart devices to interconnect with each other in a given campus. [11]

Miluzzo Choudhury and A. T. Campbell. (2010)." Provided a survey about a mobile phone sensor." The smart phone has a lot of embedded sensors that is why it is called the most important sensor available today It has movement sensor, location sensor (GPS) camera, light sensor and magnetometer. These things are mainly used in different fields of IOT applications. There are different sensors which used for measuring temperature, pressure, humidity, medical and so on a smart phone is mainly used for controlling access and controlling smart devices. [10].

Dlodlo et al.(2012)." Proposed identification and addressing of the idea of IOT". IOT is used to create objects of quickly identifiable and addressable objects that can communicate with each other using a variety of communications. Anyhow, this researcher provided a way to address billions of entities in the IOT; this enables them to identify with a unique identity. [3].

III. BASIC CONCEPTS OF THE INTERNET OF THINGS AND COMMUNICATION TECHNOLOGY

To know the basic concepts of the internet of things, devices are integrated together with the global internet virtually and interact with it by tracking, sensing and monitoring objects and their environment. [4].

A variety of can be considered 'things' like automobiles with built in sensors, firefighters with the help of field operation devices. However, these devices gather valuable information that helps the system.

 In an IoT solution, objects can be sensed and controlled through the Internet, whether these objects are remote devices, smart products, or sensors that represent the status of a physical location. And information can be made available to applications, data warehouses, and business systems. [4]

3.1. Smart campus concept and services/Smart campus infrastructure

A Smart Campus starts with clear, reliable wired and wireless connectivity, indoors and out. However, while that kind of connectivity may once was a goal in itself for many colleges, it is just the beginning of a Smart Campus. When all of the people, devices and applications on campus share a common technology infrastructure, they can interact with each other to enable experiences and efficiencies that were not possible before.

Network topology can be taken as a local area network (LAN) that interconnects the network frameworks inside the campus.

Of the following concerns about the different services provided by the smart campus.

> **Smart campus**: Is a characteristic application that keeps and work with the standards of the internet of things.

Smart Security: is a smart card with sensors and Technologies that can be used to alert the School authorities in case of any emergency will add great value to the information of the smart campus

Smart parking: This service uses a parking sensor that allows the users to detect available parking spaces by placing signs in the occupied areas
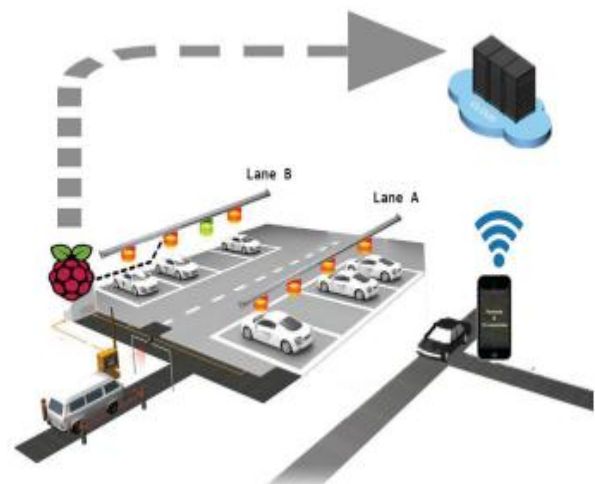
Figure 1. Smart parking system, Khanna, A.(2016).

➢ **Smart office**

Smart office is an intelligent environment in office using the information collected by the sensors, software and other intelligent agents. It has flexible to users, scalability, and reliability and have ability to support many devices**.**

Smart classroom: Smart IOT devices can be applied across Classrooms to get very attractable automated environment.

IV. DESIGNING AND IMPLEMENTING SMART CAMPUS USING INTERNET OF THINGS

To implement smart office Cisco packet tracer is used which is a new released technology that includes smart objects intended for office automation. These devices are like: smart light, smart fan, smart camera, smart door and smart window. However, home gateway provides controlling mechanisms by registering smart devices respectively via the cloud (WAN).

Smart office is an office that has some smart devices and they can be controlled by the staffs from smart phones. This makes the tasks easier, enjoyable and can be used as security means in the campus. However, IOT Gateway provides a connecting mechanism for the smart office devices to help of the internet through the cloud. It also provides, protocol translation, data filtering security and controlling means of the smart devices. It connects them to the cloud

And the servers (IOT server, DNS server) of the campus to store data, provide access and controlling mechanism of the devices with the help of laptop and smart phones. All the smart devices are indirect (remote) connected to the IOT server in such a way that the end user can access the data stored in the IOT server remotely through the web hosted on the server
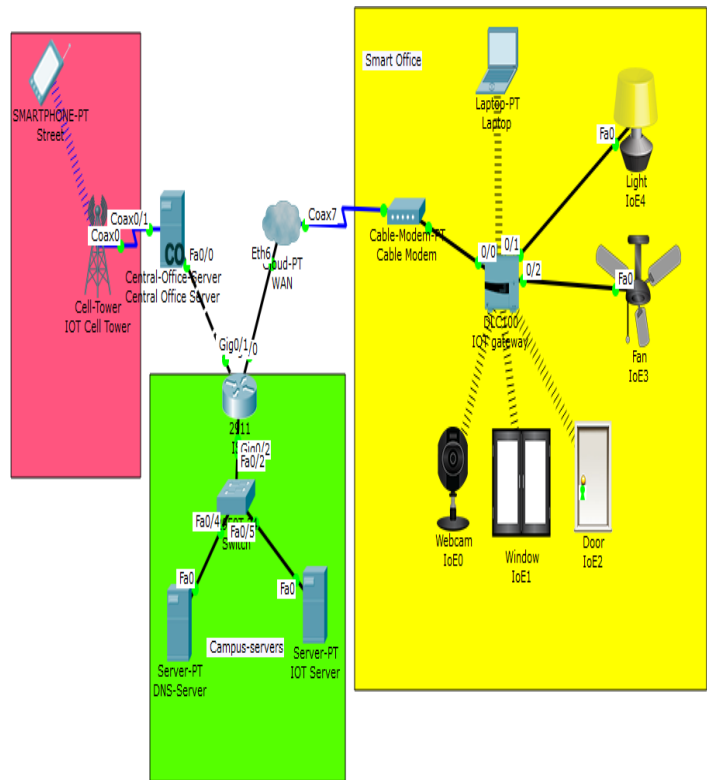

Figure 2: Smart office architecture

Structurally the diagram shown above consists of three parts. Smart office section, Street section and campus servers section. The street section has a smart phone device that can access and control the smart office devices outside the campus through the cellular network.

The campus server contains two things, IOT server and DNS server.

The DNS server provides an access to the hosted website on the IOT server not by IP address but a username.

The IOT server stores all the sensed data from the office and give users an authorized access to the resources by entering username and password.

As clear at the above figure the smart office is developed by using the network simulator which consists of different devices an IOT gateway with connected smart devices, IOT server, DNS server, IOT cloud (WAN), cellular tower, Central office server, ISP server, smart phone ,cable modem and

laptop. The discussion of this IOT devices and hardware devices is given as follows.

4.1. IOT Hardware and Software

The hardware used in IOT has devices for remote communication, control, servers and routing devices. The main function of the IOT hardware is like system activation, action specification, security, communication and detection to support specific objectives. The different hardware that is used in this smart campus system are sensors, router and switch. However the interconnection of these devices is enabled by software system which gives a platform for the devices to run. It also integrates the devices and collects information via the cloud (WAN).

IOT Gateway controls the activities of the smart devices connected to it; It gets an internet connection by using an IP address from the ISP server automatically after associating Ethernet cable and coaxial cable of the cloud (WAN) to allow services to pass through it. It registers smart devices and assigns an ip address to them. All the wireless connected smart devices to the IOT gateway like: webcam, window and door obtain an IP address automatically from the ISP router via the cloud (WAN).

The central office server gets all IP information from the ISP automatically after configuring DHCP server, DNS server and default router on the ISP router .It can also be used to connect a cell tower to the router and the router to the cell tower for transferring of information between them.

IOT server: IT brings services to the connected devices after the IOE server is enabled .Smart devices can access their services from the web server by using their respected ip addresses after the hypertext transfer protocol of the server is started. In other words, the smart devices can be accessed by using the ip address of the IOT server. It associates IOE smart devices to the IOT gateway with the ip address of the IOE server. In general, it controls the devices connected to it.

DNS server: It provides services to registered devices after the DNS server is enabled and made it to state, then all the connected devices directly or indirectly accesses the services by using the domain name of the DNS server (ioe.org) and starts their

communication. It is connected to the switch by suing straight through cable.

IOT cloud (WAN). First, the interfaces of the cloud (WAN) for the coaxial cable and Ethernet cable are enabled to associate the two interfaces and allow the information pass through it. It Transfers the information collected by the smart devices from the smart office environment and sends it to the IOT server for storage. Ip addresses assigned to the smart devices by the IOT gateway pass via the cloud.

Cellular tower: It is used to access and control the office services from remote.

It communicates to the central office server by using a coaxial cable interface. It gets data from the router (2911) via crossover cable.

ISP (internet service provider). It proves the internet services to smart campus, particularly to the smart office. The DHCP server is configured on this device and it assigns an IP address to every connected device, whether it is smart or not dynamically.

Smartphone: is used to access the smart devices through the web by using (www.ioe.org). Then all the devices which connect to the home gateway. It can also be controlled all the smart office IOE devices from remote with internet connection. It is very close and connected to the cell-tower

Table:1. Devices used for design

NO:	Device	Function
1	Router(1911)	It connects cellular network and smart office to each other
2	Cable modem	Is used to connect IOT gateway to the cloud and vice versa
3	IOT gateway	It registers smart devices and assigns an ip address to them
4	IOE server	Controls the smart IOE devices registered on it and brings a variety of server functions
5	Central office server	Is used to connect a cell tower to the router and the router to the cell tower for transferring of information.
6	Fan	Used to ventilate the smart

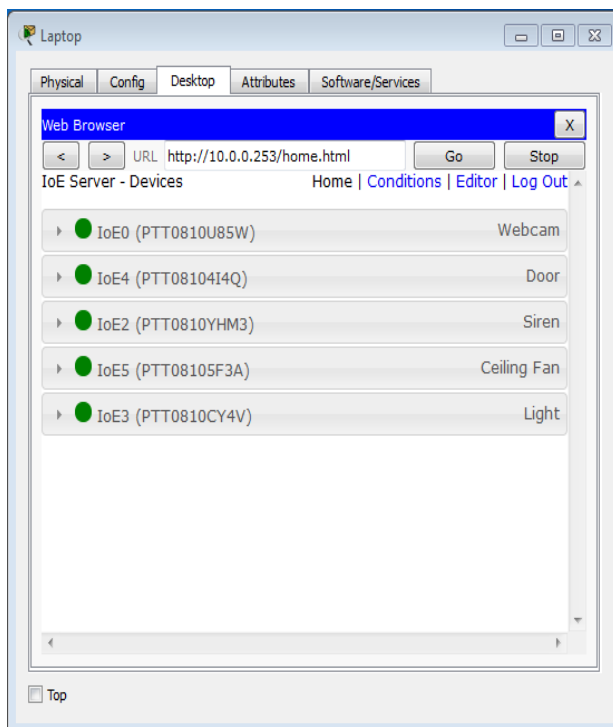|		office
777	Webcam	Is a smart device used to Control smart Office activities
888	Smart Light	Provides light for the smart office by using smart light devices
989	Smart door	Connects to the IOT gateway and brings some main important functions based events in the smart office.
1010	Cell-tower	It is a cellular mechanism that brigs controlling and accessing office services from remote.
1111	Smart window	It is used to control the window remotely with smart phone connected to a wireless internet This decreases the carbon monoxide, carbon dioxide, hydrogen and helium and it increases oxygen to get fresh air which is good for health.

V. RESULTS

Figure 3. Result/output of the IOE devices from the IOT gateway through the laptop The above figure shows that the smart devices can be accessed via the web after registering them to IOT gateway in legitimate person and can be checked whether the smart devices are working properly or not.

VI. CONCLUSION

This research work is to investigate the concept of the internet of things and its relevance in campus context. Internet of things is a new technology that is used for the interconnection of the devices with the help of the internet connection. It enables the devices to sense and monitor devices remotely. It has been shown how to successfully build a smart campus that will contain progressed ICT'S to consequently screen and control each activity and events inside a campus using IoT smart devices. In order to show the feasibility of the work a simulation tool is used for designing a smart campus portion named smart office.

REFERENCES

[1]. Alexandria, A. (2014). Enabling communication between wireless sensor networks and the internet of things-ACOAP communication stacks. *International journal of Science and Engineering , Vol.5*, PP.6-7.

[2]. Aqeel-ur-Rahman, e. a. (2008). Developed smart campus on the basis of RFID technology. *International conference on computer science and software Engineering, Vol.16*, PP.1-5.

[3]. Dlodlo, e. a. (2012). Proposed identification and addressing the idea of IOT. *Electronic journal of information systems evaluation , Vol.16* (Issue.3), PP.3-16.

[4]. Follet, J. B. (2016). foundational elements of an IOT solutions. *United states of America ,* PP.8-9.

[5]. Gundewar, k. (2017). A review on smart campus using Internet of things. *International journal of innovation in computer and computer Engineering, Vol.5* (Issue.3), PP.1-2.

[6]. Kevin, A. (2009). Developed the idea of internet of things using RFID. *international journal of internet of things , Vol.22*, PP.97-114.

[7]. Karen, R. (2015). The concept of internet of things in society. *Www.Internet society. Org*, PP.5-12.

[8]. Marian, c. e. (2015). Smart concept anew idea in the internet of things. *IEEE conference application , Vol.6*, PP.2-5

[9]. Mrs. Chaira, H. (2016). Presented the internet of things for smart college. *International journal for computer science and Engineering , Vol.4* (Issue.3), PP.3-4.

[10]. Miluzzo, C. a. (2010). a survey of mobile phone sensing. *IEEE communication magazine , Vol.48* (Issue.9), PP.140-150.

[11]. Mohamed, m. a. (2013). Asurvey towards internet of things and future vission. *International journal of computer networks , Vol.5* (Issue.1), PP.1-17

[12]. Marti, Widya.sari et al (2017). Studied the idea of smart campus development using internet of things. *IOP conference series material science Engineering , Vol.3*, PP.2-3.

[13]. Sharpen, D. e. (2017). Smart campus using IOT. *International journal of advanced research in science and Engineering , Vol.6* (Issue.8), PP.2-7.

[14]. Snehal, D. K. (2017). Smart campus using IOT. *International journal of advanced research in science and engineering, Vol.6* (Issue.8), PP.1-6.

[15]. Sumaya, M. e. (2015). Internet of things. *Journal of computer and communication Engineering*, *Vol.3*, PP. 164-173.

[16]. Victoria, N. (2015). User requirements for internet of things. *International research in institue of technology, Sweden, PP.4-25.*