RESEARCH ARTICLE OPEN ACCESS

Internet of Things (IoT) Driven Design and Implementation of Smart Campus

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ABSTRACT
Internet of things is an innovation in which devices are coordinated with the virtual universe of the internet and collaborate with it by tracking, sensing and monitoring objects to communicate with each other. On this thesis, an integrated framework for smart campus towards internet of things based on ZigBee wireless sensor network is presented. The system is proposed to be retrofitting to the existing system of campus. The smart campus uses smart devices to gather valuable information with the assistance of different existing advances and after that self-ruling stream of the information between different devices to create smart campus which includes smart environment, smart parking, smart security, smart building, smart office and classroom. A design is proposed which supports of all the components of the campus and a simulation is done to show the feasibility of the proposed system.

Keywords: **-**Internet of things, ZigBee, Wireless sensor network

I. INTRODUCTION

The Internet of Things (**IoT**) is the chain of environmental commodity appliance, automobile, buildings and actuators, software, sensors, and their connectivity. The IoT allows objects to be anticipate remotely across existing network base, creating a direct communication to the environmental world into computer-based systems, and resulting in improved security, well decision making and economic benefit in addition to improving human day to day activity [1][2]. According to ISOC, Internet of things refers to scheme where network connectivity and computing capability extends to devices, sensors, actuators, and everyday items not normally considered computers, allowing these devices to generate, exchange and consume data with minimal human intervention [3]. IoT systems allow users to attain immense computerization, analysis, and consumption within a system. They improve the reach of these areas and their accuracy. IoT utilizes existing and emerging technology for sensing, networking, and robotics [7].

Moreover, by enabling easy entry and communication with a wide array of devices such as, for instance, home tools, surveillance cameras, monitoring sensors, actuators, displays, vehicles, and so on, the IoT will advance the development of several applications that make use of the potentially excessive amount and array of data generated by such objects to provide new services [4]. IoT describes a system where items in the physical world, and sensors within or attached to these items, are connected to the Internet via wireless and wired Internet connections and these sensors can use various types of local area connections such as RFID, NFC, Wi-Fi, Bluetooth, and ZigBee [5]. Also, The IoT can be considered as a colossal base consisting of networks of appliance and computers connected through a series of average technologies where numerous technologies like RFIDs, wireless connections may act as enablers of this connectivity.

When we say “Things” it refers to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, electric clams in coastal waters, automobiles with built-in sensors etc. These devices gather valuable information with the assistance of different existing advances and after that self-ruling stream the information between different devices [6].

IoT is not entangled in origination, but rather it is intricate in its execution. Each individual part is direct, yet there are many required fragments for IoT. There are different components of IoT devices such as sensors, power source,

control unit, and communication model. The communication module is the piece of the device which oversees the correspondence of the device with the IoT stage to trade information between them [3]. The features of a device that can act as a member of an IoT network are summarized as follows:

- **Sensors** is a device that detects and responds to some type of input from the physical environment. The information could be light, warm, movement, dampness, weight, or any of an incredible number of other natural marvels [7][8].
- **An Actuator** is a mechanism that turns energy into a controlled motion. An actuator requires a control signal and a source of energy. It is usually used to apply a force on something [6].
- **IoT Gateway** is a device which fills in as the association point between IoT devices and the cloud. This gateway can be a hardware tool or virtual.

The main objective is to design and implement an internet of things based system for the components of campus. These components are security, environment, parking, building, offices and class room. The implementation is done using a simulation software for the campus components. To achieve the main objective, there are some specific objectives to be done, these are:

- Investigate the existing system and propose a suitable solution based on IoT.
- Design the proposed system structure based on internet of things.
- Implement the components of campus.
- Compare with the existing system and propose future work.

The rest of the paper is organized as follows. Section II overviews the concept of smart campus and the services that are commonly associated to the Smart Campus. Section III provides a general overview of the system architecture for an urban IoT. Section IV is all about the conclusion and future works to be done.

II. SMART CAMPUS CONCEPT AND SERVICE

A campus network system is a building or group of buildings all connected into one enterprise network that consists of many local-area networks (LANs). The distinct characteristic of a campus environment is that the company that owns the campus network usually owns the physical wires deployed in the campus. The campus network topology is essentially LAN innovation interfacing all the end frameworks inside the building. A Campus organizes by utilizing LAN innovations, for example, Ethernet, Token Ring, Fibre Distributed Data Interface (FDDI), Fast Ethernet, Gigabit Ethernet, and Asynchronous Transfer Mode (ATM). The innovation is going ahead and utilizing them to our everyday life change is the thing that we need to do now. Students and staff members want to improve their work through the help of new technology.

With fast development of new network technology and communication technology, there is a trend to make it much easier and efficient to get the needed service and desired requirements. But, the LAN technology provides poor efficiency to get the information by means of simple direct communication between computers. Therefore, the Internet-of-Things is proposed. Because the Internet-of-Things empowers omnipresent information sharing between connected things on a global scale, which almost existing systems do not provide. Further, IoT can provide more personalized, automatized and intelligent behaviour.

Smart Campus is a fashionable application in the standard of the internet of things. The idea of building a “smart campus” implies that the institution will adopt advanced ICT’S to automatically monitor and control every facility on campus. The students and staff members will benefit from location-aware services for using campus equipment and collaboration services. This will add a value for students and increases the attractiveness of the campus. New emerging technologies have changed human lifestyles dramatically. The smart campus implement an IoT-based system to a selected part of campus like the Campus Environment, Campus Security, Campus Parking, Campus Building, Campus offices, and classroom to create smart environment, smart security, smart building, smart parking, smart offices, and smart classroom. In the rest of these section we would like to discuss the detail service of the smart campus contains.

Smart Environment: According to Cook and Das, smart environment as "a small world where different kinds of smart device are continuously working to make inhabitants' lives more comfortable. Smart environments aim to satisfy the experience of individuals from every environment, by

replacing the hazardous work, physical labour, and repetitive tasks with automated agents" [18]. The primary utilization of smart environment is air pollution estimation, emanations from homesteads and incubation centres, control of substance and modern procedures, temperature, stickiness, climatic weight and so on.

Smart Security: These service is based on collecting real time data by using a different device and sensors. These devices can collect data and store to the cloud. The main applications for smart security is perimeter access control, IR human presence, Hall effect (doors and windows openings), Water presence, Liquid level, Liquid flow, Temperature, Humidity, Atmospheric pressure, Luminosity (Luxes Accuracy) for Smart Lighting, Ultrasound (distance measurement). These service gives the security guards remote accesses monitoring means the ability to monitor surveillance cameras and sensors remotely through a web portal or mobile app.

Smart parking: these service uses a parking sensor that allow the users to detect available parking spots by placing the node on the pavement. It works with an attractive sensor which recognizes when a vehicle is available or not. The advantage of these service is faster time to locate a parking slot means fewer CO emission from the car, lesser traffic congestion, and we won't have a supervisor on the parking spot.

Smart Buildings: Smart devices will be more self-administering and clever by the way they share information with building mechanization frameworks and the cloud. The cloud will give the managerial UI and the information investigation work. Systems that control such building capacities as warming, ventilation and aerating and cooling (HVAC); security; refrigeration; and lighting have generally worked as independent elements. Utilizing investigation to comprehend what's going on in a building and after that making fitting revisions is likely the most imperative propel utilizing IoT and brilliant building innovation. The application of smart building and IoT technology should accomplish three important things: reduce costs, reduce risk, and Improve the occupant experience.

Smart office and classroom: IoT systems have applications across offices and class rooms through their unique flexibility and ability to be suitable in any environment. They upgrade information accumulation, mechanization, operations, and significantly more through keen gadgets and capable empowering innovation. The part of office and classroom which needs control and solution using IoT revolution is lighting, digital class rooms boards, creating robot cleaning, online test and quiz, controlling smart devices like electronic Textbooks, Notebooks, Tablets and smartphones detections.

III. SMART CAMPUS IoT ARCHITECTURE

IoT needs to interface every potential question connect each other on the web to give secure and comfortable life for human. Generally, the web of things has three unique parts: the central computing resource (cloud), the access points and hubs (gateway) and the distributed sensor nodes (swarm). In case of smart campus, another component is added which is campus server which store the data [3].

Design of the smart campus shows that the flow of the data sensed by the smart devices and goes to the cloud through the IoT gateway. Also, it shows how the stored data are accessed through the standard devices like smartphones, tablets, and laptops.

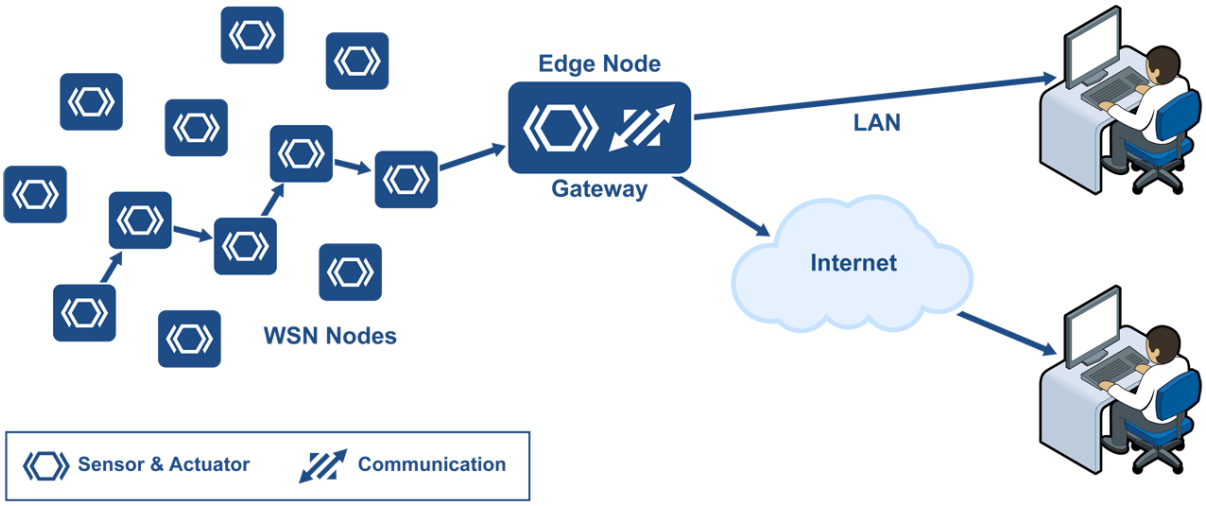

Fig 1. Conceptual representation of smart campus based on IoT

The smart campus system has three parts: -

- Things
- IoT Gateway
- Network and Cloud

All of them combined to form an IoT-based system. The basic concept of IoT is connectivity where things are internally linked to the web and a constant stream of data flows across them. It performs the logical operation, uses the internet to collect data, stores it on the cloud and allows the users to access the stored data remotely.

A. Hardware and Software

The hardware utilized in IoT systems includes devices for a remote dashboard, devices for control, servers, actuators, a routing device, and sensors. The main function of the IoT hardware is like system activation, action specification, security, communication and detection to support specific objective [9]. The different hardware that are used in the system are sensors, standard devices, router, and switch. The Software addresses its key areas of networking and action through platforms. The software is responsible for data collection and device integration with in the IoT network [9].

B. IoT Gateway

IoT is not just about sensing data but it also controls the system. The major function of the IoT gateway is device connectivity, protocol translation, data filtering and processing, security, management and more. It is a combination of sensor data, decipher between sensors protocol, process sensors, and data before sending it onward [12].

C. ZigBee communication protocol

In the IoT world, sensors must be communicated with each other to exchange information. It is an open, global, packet based protocol designed to provide an easy to use architecture for secure, reliable, low power wireless network. It supports three types of network topology like star, mesh and cluster tree network topology.

The ZigBee stack has three different parts IEEE 802.15.4 standard, ZigBee and Consumer application. Each contain different parts and functions. ZigBee provides routing and multi-hop functions to the packet-based radio protocol [10] [11].

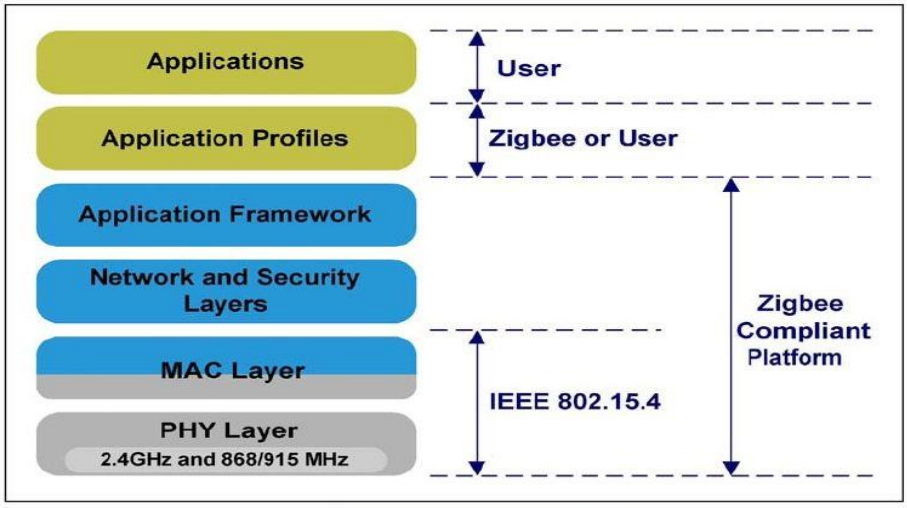

Fig 2. ZigBee protocol stack

ZigBee fundamentally utilizes digital radios to enable devices to speak with each other. A typical ZigBee network consists of several types of devices. A network coordinator is a device that sets up the network, is aware of all the nodes within its network, and manages both the information about each node as well as the information that is being transmitted/received within the network [11].

Table 1. function of ZigBee logical device types

Functions	Coordinator	Router	End Device
Establish a ZigBee network	✓		
Permit other devices to join or leave the network	✓	✓	
Assign 16-bit network addresses	✓	✓	
Discover and record paths for efficient message delivery	✓	✓	
Discover and record list of one-hop neighbours	✓	✓	
Route network packets	✓	✓	
Receive or send network packets	✓	✓	✓
Join or leave the network	✓	✓	✓
Enter sleep mode			✓

D. IoT Server

To collect and store data from the wireless sensor network through their IoT gateway their must a server which is connected to an internet. On this server, there is a website that used to access and control the sensors through the IoT gateway. The minimum hardware requirement for the IoT server can be: -

- Supports up to 7500 users
- 1 TB of disk space for cache
- 16 CPU cores
- 64 GB RAM
- Supports Ethernet or Wireless connection for internet

IV. CONCLUSION

This paper is set to investigate the concept of Internet of Things and its applicability in campus context. The fundamental idea of Internet of things innovation is devices are coordinated with the virtual universe of the web and collaborate with it by tracking, sensing and monitoring objects. In this paper, we have shown how to successfully build a smart campus that will embrace progressed ICT'S to consequently screen and control each activity and events inside a campus using IoT. In order to show the feasibility of the system a simulation is prepared and implemented. The empowering advances, moreover, have achieved a level of development that considers the down to earth acknowledgment of IoT arrangements and administrations, beginning from field trials that will ideally help clear the vulnerability that keeps an enormous selection of the IoT worldview.

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