EMC (ENERGY MANAGEMENT AND CONTROLLER) USING IOT FOR PUBLIC SCHOOLS

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Abstract

Internet of things is the new uprising technology in the industry. It is the interconnection via the internet of the computing devices embedded in everyday objects, enabling them to send and receive packets.

The proponents chose "EMC (Energy Management and Controller) using IOT for Public schools because of its need with the rehabilitation and development in terms of technology. Through the use of the Project the public schools can control the Lights and fans that will help them in lessening the Man power and the Energy consumption within the public school the proponents conducted an evaluation to San Miguel National Highschool and Bulacan Polytechnic College as for the basis in the project and to prove the effectives of EMC.

Based on the results gathered, the proposed project successfully passed the requirements in terms of reliability, security, Management and Scalability. The proponents also met the project's objectives.

Keywords: Internet of Things (IoT), Public School, Man Power, Reliability, Management, Security, Scalability.

Introduction

School is one of the most important unit of the society. We consider this place as the children's second home. It provides education to the young generation who are considered as the hope of the nation.

There are two types of school in the Philippines, the Private institutions which are owned and managed by Private individuals and the Public schools which are managed and supervised by the Government. Education from Private schools are believed to be of higher quality than education from Public schools. Maybe because of the number of students and facilities. And since Education from Public school is free, most of its students came from poor or average earner families.

It is a fact that facilities from Private Institutions are better than that of the Public schools. It is for this reason that the Proponents chose Public Schools to be their main concerns; that in their own little way, they can help improve their facilities and make them a comfortable place to stay.

Project Context

Now a days, technology changes the people's lifestyle, How we think, interact and move goes with the fast changing technology. As the technology grows, new discoveries are found. Internet of Things (IoT) is the gift the new uprising technology, in which everything that can be connected through the internet. The industry is now adapting and acquiring the change that the internet of things brought in the society. As the industry adapts the change, schools are trying their best to provide and let the magic of the internet of things of things as their guide for their future.

The proponents proposed a project called "EMC (Energy Management and Controller) using Internet of Things for Public schools" is a project that will enable the

fans and lights to be manipulated by a web controller. In this project, the proponents will be using an Arduino Uno, Ethernet shield, Light Bulb and a Fan for the demonstration. Using the web controller, turning on and off of the lights and fans can easily be facilitated. The administrator or the principal of the school can manipulate the web controller. The project will also provide a network design of the computers in each department in the public school.

The proposed network design will use Cisco devices and IoT devices for better management and security. The project will have a LAN Based network topology. It will also use a web-based controller that will be used in the manipulation of the Lights and Fans. The assigned network administrator and sub-admin of the Public School can only facilitate the web controller.

Statement of Project Objectives

The main objective of the project is to create and implement an Internet of things (IoT) fans and lights for public schools, providing a web controller that will manipulate the fans and lights in each room and to implement a Cisco Network design that would ensure the security and communication in each department inside the Public school.

Specific Objectives

1. To manage and control the lights and fans inside the room that will:
   a. Lessen the energy consumption
   b. Lessen the man power
   c. Manipulate the Lights by turning it off and on.
   d. Manipulate the fans by turning it Off and On.
2. To have a network administrator that will:
   a. control the lights and fans in the rooms using the web controller.
3. To provide a Cisco network design that will ensure the

security and fast communication among the departments inside the public school.

Scope and Limitations of the Project

The project's focal point is to provide a Cisco network design and an IoT devices for Public Schools. The project will provide a network design with physical and logical topology that will cover the departments of the school. The project also includes IoT devices such as fans and lights. This project limits its extent to the focal point and the proposed network design which is exclusive for the Philippine Public schools. The proposed network design focuses on two (2) rooms of the public school and a web controller to be controlled and monitored by a network administrator and sub-admin/user. The scope of the project in terms of IoT fans and lights is in the student's room only and is limited to other rooms or departments.

Significance of the Study

The proposed network design for the Bustos Municipality would benefit the following:

Students. This project will let the Students experience what the internet of things has to offer.

Future Researcher. This project will help the future researchers to be familiar with network design and protocols. This can also be the reference and guide for future capstone projects.

Government. This project can help the government to have new generation technologies in their public schools.

Public Schools. The project would lessen the burden of slow, unreliable, and unsecured data communication. The project will also let the school experience what the future technology has to offer.

Janitors or the one who monitors the fans and lights inside the rooms. This project will help the janitors or the one who monitors the classrooms to manipulate or control the fans and lights effortlessly or without taking much of their time.

Network Administrators. This project can be one of their reference for the future projects especially in terms of IoT devices. This study will provide them with concepts on how to design and manage a networks with IoT devices.

Definition of Terms

Arduino. is an open source computer hardware and software company, project, and user community that designs and manufactures single-board microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world.

Bandwidth. It consists of a range of frequencies that indicate the transfer rate of data in a network.

Connectivity. It serves as the metric that tells the accuracy of a network to connect to one another.

EIGRP (Enhanced Interior Gateway Routing Protocol). It is an advanced distance vector routing protocol that is used on a computer network for automating routing decisions and configuration. This protocol is only available on Cisco routers.

Ethernet Shield Module. is a microcontroller board based on the ATmega328. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz crystal oscillator, a RJ45 connection, a power jack, an ICSP header, and a reset button.

IP Address. It is a numerical label assigned to each device connected to a computer network.

ISP (Internet Service Provider). It is an organization that provides internet connection.

LAN (Local Area Network). It is a network of interconnected computers within a limited area.

Management. In networking, it is the capability of a network to be managed based on the needed requirement.

Network Design. It is a network topology that represents the physical and logical design of a network.

Port Security. It is a configuration command for security that secures access through mac addresses.

Reliability. It is a characteristic of a network to consistently function according to its specification.

Scalability. It is the capability of a network to handle the growing amount of tasks, and its potential to accommodate enlargement in hosts.

Security. It is the process of taking physical and software preventive measures to protect the network from threats and attacks.

VLAN (Virtual Local Area Network). It is a group of devices on one or more LANs that are configured to communicate as if they were attached to the same wire, when in fact they are located on a number of different LAN segments.

Review of Related Literature and Studies

Foreign Related Literature

Madakam (2015) the future is Internet of Things, which will transform the real world objects into intelligent virtual objects. The IoT aims to unify everything in our world

under a common infrastructure, giving us not only control of things around us, but also keeping us informed of the state of the things.

According to Madakam (2015) Internet of Things will transform the real-world object into intelligent virtual objects. His article about IoT gives an imperative view which is connected to the studies. The IoT information reflected in this article help a lot considering the researcher's desire to monitor and control the Lights and Fans which is of great help in energy conservation.

Metz (2013), "The Internet is experiencing and will continue to experience tremendous growth. It is equally popular with both residential and corporate end users. To the latter it could mean millions of new revenues. Powerful and creative industry forces are at work seeking to exploit the internet to their and their customers' advantage."

The work of Metz (2013) somehow related to the Project of the researchers considering the tremendous growth of internet, the researchers intended to use the internet and its network to monitor the use of fans and lights to be able to help them save more energy.

Manali (July 10, 2018) Emerging technologies like Internet of Things (IoT) are redefining the way businesses are generating and consuming data. As these technologies take shape and bring more data sources on line, one of the biggest challenges will be to understand and act on the data generated by anything that can be connected. This data holds paramount importance for the organizations. In fact, successful businesses thrive on the ability to convert data into insights.

According to Manali (2018) Emerging technologies like internet of things (IoT) are redefining the way businesses are generating and consuming data. The article of Manali (2018) is related to the project of the researchers because the project of the researchers includes the Internet of things

(IoT) which will help the public school to monitor their lights and fan.

Stamper (2014), “Over the past decades, local area networks (LANs) have had an increasingly significant impact on the way companies conduct business. With the assistance of LAN technology, both large and small companies can take advantage of the ability to share valuable hardware and software resources among multiple users. These decades saw the rise of network-oriented software (groupware), which allows people working together on a project to share ideas and information more quickly and systematically."

The book written by Stamper (2014) is related to the project of the researchers because it demonstrates the important role of a LAN which is one of the basic type of computer network. The project of the researchers shall use LAN network to monitor the lights and fans inside the room with the help of some devices like Arduino.

Pankaj V (2014) Versa Drives has come up with super -efficient electric ceiling fans, which consume less than half of the energy of similar-sized ordinary fans. Moreover, they are equipped with infrared remote controls and are available for consumers in multiple variants. Super fan is the first of its kind in the market today. Speaking about future plans, Sundar says, "Versa Drives is keen on developing more efficient ceiling and other types of fans and other appliances with energy efficiency and intelligence."

According to Pankaj V (2014) this journal is related to the study of the researcher’s because Pankaj (2014) articles is all about electric fan with energy efficiency. So that the researcher’s would apply a network of electric fan and lights in the public school that would help the school to save more energy by monitoring the use of fans and lights in the classroom.

Changwon, et al. (2018) "The Internet of Things (IoT) is drawing great attention from communication providers and terminal manufacturers as a new service of advanced mobile communication.” "As various IoT communication techniques are developed, a communication environment can cover different IoT networks. Hence, a method for using a suitable IoT network for characteristics of an IoT device is desirable."

According to Changwon et al. (2018) this article of Changwon is related to the project of the researcher’s because the researcher’s would apply Internet of things (IoT) to their project. By the use of the Internet of things (IoT) to the researcher’s project, the fans and lights could be monitored inside or outside the public school to help them save more energy.

Aldebert et al. (2018)"Aspects of the present disclosure are related to handling of data traffic in relation to a network controller-sideband interface (NC-SI). In a computer or other network connected device (e.g. switches, routers, and network controllers) a baseboard management controller ('BMC') is a service processor or a microcontroller usually embedded on the motherboard of a server. The microcontroller uses sensors to report on matters such as temperature and fan speeds. "In such a network environment, the interface between the BMC and the NC can be referred to as the Network Controller-Sideband Interface (NC-SI). The NC-SI is a standardized interface that enables an NC to provide network access for a BMC, while allowing the NC to simultaneously and transparently provide network access for a host system.

According to Aldebert et al. (2018) this journal is related to the researcher’s project because the project of the researcher is network with Internet of things (IoT) and with network controller like in the article of Aldebert et al. (2018). The researcher’s would use an Arduino and Ethernet shield devices as a network controller to minimize the use of energy

in the public school by monitoring their fans and lights inside the room.

Shruti Mishra (2018) Being a power regulation device, an LED driver has the same impact on the end product's performance as the LED light engine. The driver is chiefly responsible for basic light requirements such as flicker-free operation, as well as for evolving features such as wireless connectivity or current-level programming that are implemented in the driver. “This will make the LED drivers of the future significantly different from those that we see today. Higher levels of efficiency will become the norm, and drivers will also integrate extremely high levels of complexity in terms of performance and power monitoring.”

According to Shruti Mishra (2018) this journal is related to the researcher’s studies because the researcher’s would use a programming language such as Arduino sketch that would attach some codes in the LED lights to help the public school monitor the use of lights inside the room. By the Use of programmable LED lights and Arduino sketch the researcher’s would easily turn on or off the lights by the help also of the network.

Dong-hyun et al. (2018) "An apparatus and a method consistent with exemplary embodiments broadly relates to a server for controlling an external device, and an operating method thereof, and more particularly, to a server for controlling an external device based on a user's utterance and an operating method thereof. “With the development of internet of things (IoT) technologies, users are able to control, via electronic devices, IoT devices providing various services. In particular, as users have been able to control the IoT devices by speaking commands, the IoT devices around the users may be easily controlled by the users.

According to Dong-hyun et al. (2018) this journal is related to the researcher’s project because the researcher’s would also apply Internet of things to the project, it also

enable the users to control the electronic devices that will improve the technologies and lifestyle in the industry and somehow the article is connected with the voice commands that he used in able to control the devices, on the other hand the proponents uses web controller in order to control the electronic devices.

Technical Background

Hardware

The researchers proposed the following devices as it best fits the proposed network design. This hardware offers several network features and necessary configuration for network and devices. The proposed hardware for the network design are the following:

Proposed Hardware

Particulars	Description
Router	Cisco 2911 Integrated Service Router
Switch	Cisco SG200-08-Port Gigabit Smart Switch
Light bulb	IOT Lights that can configure for network
Fan	IOT Fans that can configure for network

Software

The researchers created the project with the appropriate software. The researchers assured that the software is dependable and can be used in designing, configuration and documenting the project. The researchers used the following software:

Software Used by Researchers

Particulars	Requirements
Operating System	Windows 10: 64-bit Operating System (3M Cache, up to 3.10 GHz)
Word-processing Program	Microsoft word 2016
Simulation Program	Cisco Packet Tracer Version 7.0
Program Software	Arduino IDE
Web program	Notepad ++

Peopleware

At present, the network of the host public school has members to manipulate the fan and lights. The peopleware for the proposed and present network design is the same as suggested by the researchers. These are the following:

People ware for the Present Network

Requirements	Description
Teachers	The teachers from the public schools who will facilitate the turning on and of lights
Students	The students from the public schools who will facilitate the turning on and off of lights
Janitors	The person in charge in manipulating the fans and lights.

Researcher's Peopleware

Requirements	Description
Project Leader	Direct and leads the team members in order to finish the project requirements.
Project members	Do their assigned tasks in order to finish the project requirements. The members and the leader is divided according to their tasks such as network designer, documentation writer, requirements analyst, and evaluator.

Continuation

Requirements	Description
Network designer	Designs and configures the network to meet the needs of the project
Documentation Writer	Documents the process and requirements of the project. Collects the documents and information used for the projects
Requirements Analyst	Analyzes the requirements and gathers specific information needed for the project
Evaluator	Conducts the evaluation of the projects and interprets its result.

Peopleware for the Proposed Network

Requirements	Description
IT Technical Support	Responsible for the maintenance of the computer devices used within the organization
Network Administrator	Responsible for utilizing and maintenance of a computer network.

Methodology

User need Analysis

Most schools especially Public schools are having problems about energy conservation. The main problem comes during the breaktime of the students what they tend to forget to switch off the Fans and Lights. The absence of self-discipline causes the school to have higher energy consumption. This situation requires the school to be in need of more man power which incur additional man power costs.

Based on the information gathered, and the assessments done by the proponents, Public schools need to

have a Controller who will monitor the Lights and Fans of each rooms which will help in minimizing the energy consumption and man power cost.

Sources of Data

Internet. The Internet provides an unlimited information and data that are easily obtained. The proponents gathered information and data through the internet which related to the project that makes the project progress easily.

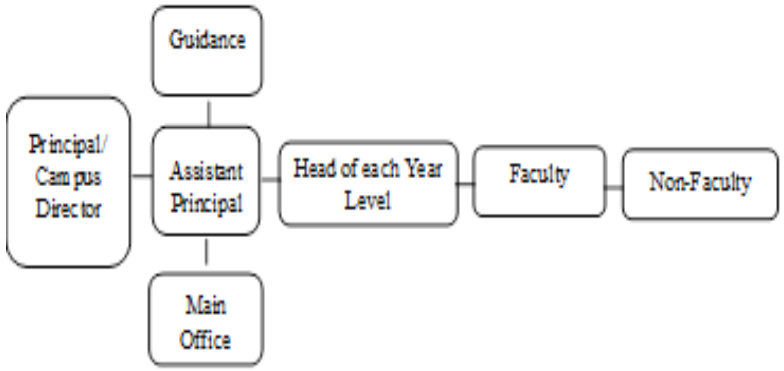
Interviews and Visitations. The proponents conducted series of interviews and visitations throughout the process of creating the project. The proponents asked some questions to a specific number of faculty, non-teaching personnel and students in order to obtain information regarding the problems that they experience. A series of visitations are conducted by the proponents in order to acquire data and information about the facilities and structure of the different departments of San Miguel National High School and Bulacan Polytechnic College in Salacot San Miguel Bulacan.

Libraries. The proponents visited some libraries that provides a wide collection of books about previous studies and literatures that helped them gained knowledge and facts about the project.

Locale

The proponents visited San Miguel National High School located at San Juan San Miguel, Bulacan and Bulacan Polytechnic College at Salacot, San Miguel, Bulacan. The proponents visited the school for their basis about the common structure and design of the fans and Lights in each room and also for the different departments that are commonly seen inside a public school.

Organizational Structure

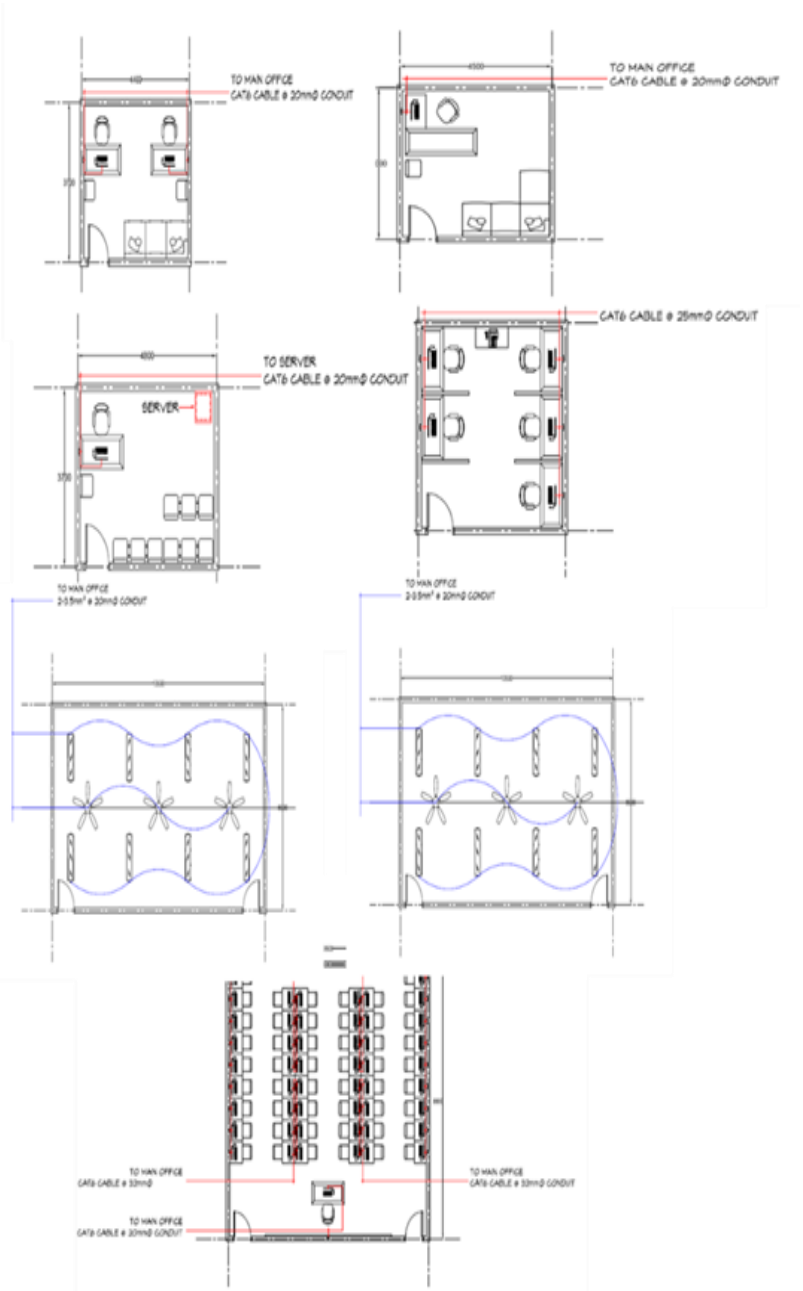


Operational Feasibility

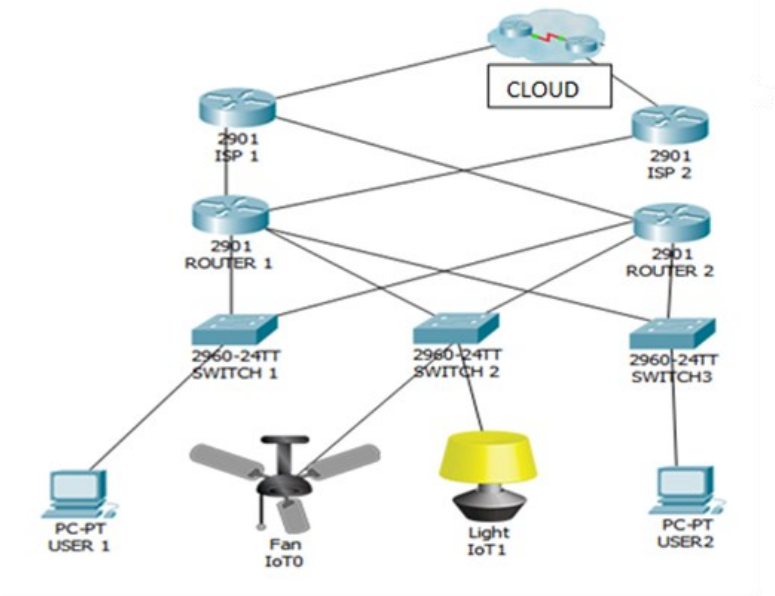
This section includes the discussions about the connection of the devices in the proposed network and the functional decomposition diagram or the network design. The diagram includes the IP addresses and hosts in the proposed computer network design.

The proposed network design is connected by using Cisco switches and routers. The Principal's Office has 2 hosts: The Faculty Room has 5 hosts: Guidance Office has 2. Main Office has 2. The room 1 has 5 hosts as well as the room 2. The computer laboratory has 51 hosts. There are a total of 72 hosts.

Functional Decomposition Diagram



Network Model

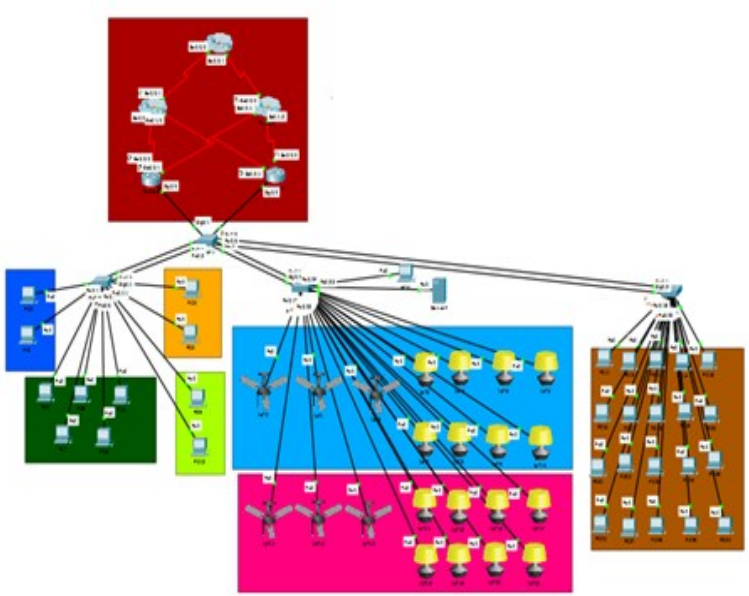


Network Security

The proponents used VLAN configuration, switch port configuration, channel-group configuration, spanning tree protocol, OSPF (Open Shortest Path First), NAT (Network Address Translation) and ACLs (Access Control List) for the network's security. VLAN configurations are used in order to distribute the different departments into their own respective groups. Switch port configurations are used to provide and ensure both trunk and access mode. Access mode is used to allow access for a single VLAN while trunk mode allows multiple VLANs to enter through a single port. Access Control List (ACL) are used to give permission and deny a specific host or network from entering. The configurations mentioned helped secure the network by prohibiting unauthorized access and management of the network. Channel-group are used to create a single logical link that provides the aggregate bandwidth of up to eight physical

links. Spanning tree are used to prevent loops from being formed when switches or bridges are interconnected via multiple paths. NAT (Network address Translation) is used to enable private IP address that uses unregistered IP address to connect in the Internet.

Proposed Network Topology



Workplan

The proponents started the project by brainstorming about the possible IoT projects that can easily be implemented and will be beneficial in the society. The Capstone project proposal was written and thoroughly discussed by the proponent. The defense and approval of the chosen project proposal was conducted within a day. After the defense, the proponents searched for the possible hardware that is compatible with the objectives of the project. The tasks and activities mentioned with the number of days consumed are presented through a Gantt chart.

Testing

The proposed network design for Public schools aims to provide a good computer network that ensures security, reliability, speed, redundancy, proper bandwidth distribution, and good data communication in every department. The proponents also provide a web server that controls the Fans and Lights of the public School in which the administrator can manipulate and control. The proponents tested the proposed network design and the IoT Device before the actual implementation of the project.

Implementation Plan

This section includes the needed requirements for the implementation of the proposed project. For the hardware requirements, the proponents used Cisco 2901 Integrated Services Router, and Cisco Catalyst 2960 Series Switches.

The proponents also used an Arduino device and Ethernet shield module to control the device for the demonstration. Bulb and mini fan used as a device for demonstration and they use a relay to on and off them. The proponents did not implement any software in order to maximize the use of the hardware. For the network's security, the proponents implemented Access Control List (ACLs) to permit and deny the networks that are segmented through multiple VLANs. For the people requirements, a network administrator was suggested by the proponents in order to maintain, manage, and control the network according to the needs of the company.

Results and Discussion

The proponents used an evaluation form to assess the operational function of the proposed network and The IoT devices. Seventy-Two (72) respondents were chosen to evaluate the proposed network.

The information gathered by the proponents from evaluation determined the overall performance of the proposed network. The information were tabulated, analyzed, and computed in order to get the totality of its results.. It used fixed choices response format and designed to measure the network's effectiveness. The measurement levels ranges from strongly agree (SA) which is equivalent to 4 points, agree (A) which is equivalent to 3 points, disagree (DA) which is equivalent to 2 points, and strongly disagree (SDA) which is equivalent to 1 point. That tabulation of data also includes the total number of votes, frequency, percentage, and the statistical means.

CONDITIONS	SA		A		DA		MEAN
	F	%	F	%	F	%	
I. Reliability							
1. The proposed network can successfully allow network traffic	20	28	39	63	7	10	3.2
2. It lessens the man power within the Public School	40	56	30	42	2	3	3.5
II. Management							
1. The fans and lights can easily be controlled using the Web Controller	37	51	33	46	2	3	3.5
2. The web controller is accessible and easy to use	35	49	35	49	2	3	3.5
III. Security							
1. An unauthorized device cannot access or control the web controller	26	36	39	54			3.3
2. Cisco Switches are configured with switchport restrictions.	25	35	47	65			3.3
IV. Scalability							
1. The network's accessibility can be adjusted and updated by ACL.	29	40	39	54	4	6	3.3
2. The network is tolerant to fault and error	14	19	39	54	9	13	2.7
Grand Mean							**3.29**

In terms of reliability of the network, the first condition showed that out of the total number of respondents, 28% strongly agreed, 63 % agreed and 10% disagreed that the proposed network can successfully allow network traffic. On the other hand, the second condition showed that 35% strongly agreed, 65% agreed and 3% disagreed that It lessens the man power within the Public School.

In terms of network manageability, the first condition showed that out of the total number of respondents, 51% strongly agreed, and 46% agreed and 3% disagreed that The fans and lights can easily be controlled using the Web Controller. On the other hand, the second condition showed that 49% strongly agreed, 49% agreed, and 3% disagreed that the web controller is accessible and easy to use.

In terms of security, the first condition showed that out of the total number of respondents, 36% strongly agreed, and 54% agreed that an unauthorized device cannot access or control the web controller. On the other hand, the second condition showed that 35% strongly agreed, and 65% agreed that the Cisco switches used in the proposed network are configured with switchport security and restrictions.

In terms of scalability of the network, the first condition showed that out of the total number of respondents, 40% strongly agreed, 54% agreed, 6% disagreed that the proposed network's scalability can be adjusted and updated using ACL. On the other hand, the second condition showed that 19% strongly agreed, 34% agreed and 13% disagreed that the proposed network is tolerant to fault and errors.

Based on the results of the evaluation, the proponents concluded that the EMC (Energy Management and Controller) using IoT for Public Schools met the passing criteria provided to determine the overall performance of the network and the IoT devices.

Recommendations

For Public Schools. The proponents would like to recommend to adapt the proposed network design in the organization. The proponents believe that the network design will be a great help in terms of ensuring and providing a good communication, efficiency and security in the organization. The proponents also recommend to adapt the IoT devices for the Public school.

For the Government. The proponents would like to recommend to the Government to provide and reserve funds for the rehabilitation and development of the Public schools in terms of future trends in the industry.

For the Future Researchers. The proponents would like to recommend to the future researchers to use wireless network instead of using wired networks for lesser cables and more efficient productivity. The proponents would also like to recommend to the future researchers to directly use IoT devices instead of using Arduino Uno.

For Baliuag University. The proponents would like to recommend the school to continuously provide a good quality of education to the students and to focus on teaching the new and future trends in the industry, Like the Internet of Things.

The conducted testing and evaluations proved that the proposed network design can significantly improve the host public school's productivity while ensuring security and efficiency.

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VerticalNews (2018 APR 25*) By a News Reporter-Staff News Editor at Electronics Business Journal -- A patent by the inventors Zheng, Dehua (Zhuhai, CN); Zhao, Xianyun (Zhuhai, CN), filed on August 17, 2017, was published online on April 10, 2018, according to news reporting originating from Alexandria, Virginia, by VerticalNews correspondents*.

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