Multi-Perspective and Low-Cost Coverage Network Design for Implementing in Campus Network: A Case Study

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Abstract. This research proposed multi-perspective and coverage network design for implementing in two campuses of a university include physical and the logical design. This research shows the TOP model to concern three elements aspects of network design. The results of the research feature the technical perspective (T), the network designer considering the VLAN design and network management software. For the organizational perspective (O), the coverage network is necessary; designing a network depending on a practical value appropriately under the investment budget and quality of services (QoS). For the personal perspective (P), the network designer needs to recognize the applications that meet the requirement of the users, whether it is WIFI, VoIP, or CCTV—the authentication software to protect the network and still maintain system security.

1 Introduction
The Thai government has the policy to develop Thailand 4.0, focusing on innovative new ways of adding value, reducing labor, and bringing technology to all levels of education from elementary to higher education. In higher education or university, the government has pushed students to use classroom technology and management. Basic installation in design is essential to save as much money as possible. Universities have limited budgets to invest in; they must be designed to be cost effective and efficient.

Songkhla Rajabhat University is located in Amphoe Mueang, Songkhla Province. There are seven facades, and the building is scattered. Besides, agricultural buildings, gymnasiums, swimming pools, fitness, and sports facilities are also located in separate buildings. Network design requires to support three...
applications, including: VoIPs, access points, and a CCTV camera. If we use the same link, the data will be broadcasted.

There are much research talking about how to implement VLAN in the existing network. [1] The efficient VLAN design will reduce the risk of the network by using Simple Network Management Protocol (SNMP), decrease number of the routers, and also confine broadcast domains for reducing the traffics. However, there is a limit deployed in the real world situation especially in the campus network. [2] A research described a simulation-based study on network architecture using inter-VLAN routing and security. [3] The research showed the ability of the control and handled the reliable operation, however, it was a simulation-based study. [4]

This document is a presentation of network design and application by under considering of multi-perspective and low-cost coverage network design for Songkhla Rajabhat University Campus network. The quality of QoS services will be considered in this application.

2 Research Method

The research used mix methods to conduct this research. Both quantitative and qualitative data collected to support the framework and developed the new knowledge. The quantitative data included: a number of VLANs and software that implement in two campuses. The qualitative data included a model of multi-perspective represented in the TOP view point. A used a multi-perspective model to study the problem of deploying IT in an organization. [5] The results of the research indicate that the Organization (O) and Personal Systems (P) factors overlap with the Technical System (T). Also, the factors related to the organization system (O) and the people involved in the personal system (P) can help solve complex IT problems. Research used multidimensional models to study the problems of IT system installation in educational institutes. [6] As a result, the researcher has shown the factors that come from outside the school. The researchers analyzed the factors at various levels and used multidimensional models to study IT installation problems in both government and private sectors. [7] The problem is that the level of IT planning at various levels is not enough to consider multi-perspective views. The use of multi-perspective models is used to plan the installation of the network because the model is a clear pattern in determining the cause of the problem. Models can also explain the fundamental technical and organizational relevance of the problem. Multi-perspective models can also explain the depth of the problem and the culture of the organization. This paper demonstrated the design of VLAN in the Songkhla Rajabhat University in two campuses, main campus and Satun campus by considering the multi-perspective model.
3 Results and Discussions

The multiple perspective approach proposed by Mitroff and Linstone presenting the three parts. [8] The result can be expand those three parts of the multi-perspective TOP model: Technical perspective (T), Organizational perspective (O), and Personal perspective (P). Fig. 1. Shows adapted TOP model and details.

3.1 Technical perspective (T)

The technical perspective (T) included the coverage network design by using VLAN architecture and configuration. The main campus of Songkhla Rajabhat University consists of 77 buildings. All three switch models are S5750C, S2910PoE, and S2928. There is a set Virtual Switch Unit (VSU) switch to increase performance and to prevent failover. VLANs are designed to be 52 VLANs. Some buildings have more than one VLAN, depending on the number of devices. The VLAN design has a different IP address, such as / 22, / 24; the IP class B is designed for end users based on building numbers. For example, IP is 10.59.8.8., the IP address of the building VLAN number 59. This design has the advantage of being able to determine which user is accessing the building. If there is a problem, it is convenient to track the cause of the problem immediately, and easier to track down the IP address if sorted by building, it will be more comfortable to find and simple to control devices and policies.

3.2 Organizational perspective (O)

The construct of the organization perspective (O) views emerged from the uses of a digital system to manage the whole system known as E-University. However, the university had network design problems such as the obsolete of network.
infrastructure. The network infrastructure activated for over twenty years. Since then, the network was designed as a centralized system. In the long run, the design of the network is not up to date. Today, it cannot be compatible with new devices because of modern equipment and new technology. Today's technology is more efficient to manage data; The traditional system did not have a network monitoring system when problems such as broadcasting, loop, phishing of the device, occurred. Sometimes the problems emerged from the wrong settings. The problems made the campus network disrupted; Later, the university invested 18 million baht for installing new networks, infrastructures and implementing new systems to change the university. The implementation of this is to encourage the University to use both hardware and software cost-effectively. The new system has been selected for both open source and commercial software such as Linux, Elastix IP Phone.

The University planned is to provide internet service, full access across the university including the service to another campus, Satun Province. Satun Campus will have Internet access to Songkhla Rajabhat University main campus and will be able to use the same functions as the main campus had, such as MIS, e-document, e-meeting, and other ERP. Songkhla Campus has 77 buildings. It needs to be designed for the Internet expertly by covering all the buildings. Design the internet on a limited budget is very difficult. It needs to consider the environment and installation techniques and carefully selects the device, wiring cable selection, Length of the cable, choice of core switch, choice of distributed switch, selection of software authentication and configuration, user management, VLAN design, license, and MA use. Moreover, the access point devices need to be installed to the point where they are the most cost-effective without any additional cost.

3.3 Personal Perspective (P)

Satun campus is a new campus from Songkhla Rajabhat University. Previously, the branch did not have internet access and Internet infrastructure. The computer center at the main campus needs to design to link between the main campus and Satun campus. For personal perspective (P) view, it is necessary to design the Internet in Satun campus to fit the requirement of the users in that campus network. The demands of the users are as same as the main campus, such as the user of the Access point, VoIP, CCTV, MIS, and ERP.

Satun campus network consists of a firewall connected to another firewall at Songkhla Rajabhat University. Two firewalls will connect through VPNs site-to-site between the Songkhla and Satun campus. The two campuses used different networks and located on a different campus. The network was connected with a 300 Mbps lease line; The users at Satun can use VoIP calling from Stun to Songkhla campus by using four-digit numbers and use other applications such as MIS, database, journals under the requirement of teachers and students.

Regular internet packets used for standard applications will have authentication by ID to Songkhla, but if another application, it will have to run over another leased line, TOT leased line, with a speed of 1000 Mbps; The Telephone Organization of Thailand (TOT) line was used for particular applications such as multimedia, i.e., youtube or streaming at high speeds. The packet allocation will make the operation more efficient by using the routing function of the firewall on
both sides of the server. It is a VM or Virtual Machine to host the following: VoIP uses opensource Elastix V4.4 and runs on Ubuntu 16, authentication software, SKYRADIUS, run on Ubuntu 16, DHCP server runs on Ubuntu 16, respectively.

The VLAN class division classified by location and application for example in each building by physical and if that building contains a specific application, they also divide by application.

Inside the Satun campus building; During the building use fiber optic single mode connected to the hotel. Student dormitory has a switch between the building. VLANs are divided into 16 VLANs, namely VoIP, AP, Library, CCTV. This division of VLANs makes the performance more efficient and cost-effective and supports network expansion in the future.

For authentication software, Songkhla Rajabhat University, the main campus used RG-SAM+ and Satun campus used SKYRADIAS. We used RG-SAM+ is a proven comprehensive authentication and accounting system based on RADIUS systems. The RG-SAM+ has integrated with most of the available authentication modes including 802.1X and web. With the single unified authentication platform, the RG-SAM+ fully supports access control, accounting/billing, log management, and unified external interfaces for all the authentication methods. The user is only required to login once then able to enjoy automatic login in the future without all the tedious repeated login procedure again.

4 Conclusion
This paper discusses the design and implementation of the campus network, taking into consideration the multi-perspective model of coverage network that based on the design principles of both hardware and software. It takes into account several factors, including security, accessibility, ease of use, the network expansion, the increase in the number of users in the future, and more importantly, must support the technology in the future to speed up the network, reduce broadcast. For the technical perspective (T) the network designer needs to consider the VLAN design using VSU technology reduced the risk including using Simple Network Management Protocol (SNMP). Network management software can view the traffic of each network device, such as a switch and access point. For the organizational perspective (O), the coverage network is necessary to design a network depending on a practical value appropriately under the investment budget and quality of services (QoS). It needs appropriately designed and implemented to be the standard network design. However, the management and updating of the firmware in all network devices always need to be done. For the personal perspective (P), the network designer needs to consider on applications that meet the requirement of the users, whether WIFI, VoIP, or CCTV, the authentication software to protect the network and still maintain system security. Form the research results, the multi-perspective model can be applied with low-cost coverage for campus network and works effectively. Suggestions for future research and development should be included performance testing in each applications and the review of the users.
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