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Deployment Plan of Wireless Distribution System of ASIST Intranet Network Infrastructure

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ABSTRACT

Corporate giants have long recognized the importance of intranet in doing business. It is often implemented using conventional structured cabling. It increases productivity and produces higher Return on Investment (ROI). The study was conducted to develop Abra State Institute of Sciences and Technology (ASIST) Intranet Network Plan. It employed the descriptive and applied methods of research. A pre-validated research survey questionnaire adopted from the E-Government Fund Management Office Survey Questionnaire for Existing ICT Infrastructure Inventory (2014) was used. This paper defines how Wireless Distribution System (WDS) was configured to deploy an intranet in ASIST Lagangilang Campus, Lagangilang, Abra, Philippines. Several simulation processes on network test were performed to validate the connectivity. Testing provided an understanding and confidence before deployment. Wireless Distribution System is effective in sharing Internet connectivity where physical connectivity is impossible. The use of the Digitized School map has helped a lot in providing a clear view on the vegetation in the vicinity in between buildings. Moreover, it provided assistance in decision making to which type of 802.11 wireless is appropriate in distributing the internet signal over long distances. Finally, Squid proxy server is effective in restricting accessible websites.

Keywords— Wireless distribution system, intranet, network plan, local area network, descriptive-applied design, Philippines

INTRODUCTION

An intranet enables both internal and remote employees connected to a computer network to share documents, files, calendars, and other information. It is often implemented using conventional structured cabling. Intranet helps organizations capture business intelligence (Soon, 2010). Nursing Intranet for Communication and Knowledge Management (Teow, 2006) was developed to enhance e-learning. The School Intranet of Penn State University (http://weblion.psu.edu) for instance, serves as a central information resource for faculty, staff, and students, including dual navigation and online forms and workflow applications to replace paper-based processes. Moreover, users of the Department of Health (DOH Intranet (http://intranet.doh.gov.ph), can have access to various files like official forms, documents, specifications, templates, etc. Internal services like the web-mail, directory search and listings, and search and download of issuances like administrative orders, department orders, memoranda, and circulars. The intranet also provides the latest announcements, news, events, activities, and contents internal to the DOH employees and stakeholders.

Primarily, the problems seen on the current Local Area Network (LAN) infrastructure of the Abra State Institute of Sciences and Technology (ASIST), the only state college in the province of Abra, Philippines were: a) does not help the administration capture business intelligence, b) confined area of internet access and thus limiting the number of students, faculty, administration and staff to access the internet, and c) the Administration does not have restriction and control over the internet activities of the students, faculty, staff and itself.

The main objective of this study, defines how Wireless Distribution System (WDS) is configured in intranet environment. This study differs with that of Leonnel, D., Fleras, A. M., Pagdato, K. P., & Yu, M. R. B.(2014) on "Design and Development of an Intranet-Based IT Asset Management System with Mobile Application" as it focused on the intranet-based web application with a mobile application on android-enabled devices.

OBJECTIVE OF THE STUDY

The study defines how Wireless Distribution System of ASIST Intranet is configured. Specifically, it aimed to identify the: 1) Offices included in the ASIST Intranet; 2) Existing information and communications technology infrastructure in terms of hardware or other ICT equipment, number of computing devices and peripherals by type and by year acquired, software, application systems, information systems and databases, operating system for stand-alone personal computers (desktops and laptops), operating system for servers and office automation software, network (Local Area Network (LAN), Internet connection and Agency web site), Security, Disaster recovery and backup, data archiving, special solutions and other services, data center, on-going ICT projects and issues encountered; 3) Geographic location of the offices using ASIST Digital School Map; resource requirement; and 4) Develop deployment plan of Wireless Distribution System of ASIST Intranet Network Infrastructure.

METHODOLOGY

The researcher used both descriptive and applied methods of research in the study. Descriptive research was used to narrate the existing Information and Communication Technology infrastructure and campus network setup. The study applied Network Development Methodology and came up with ASIST intranet network plan.

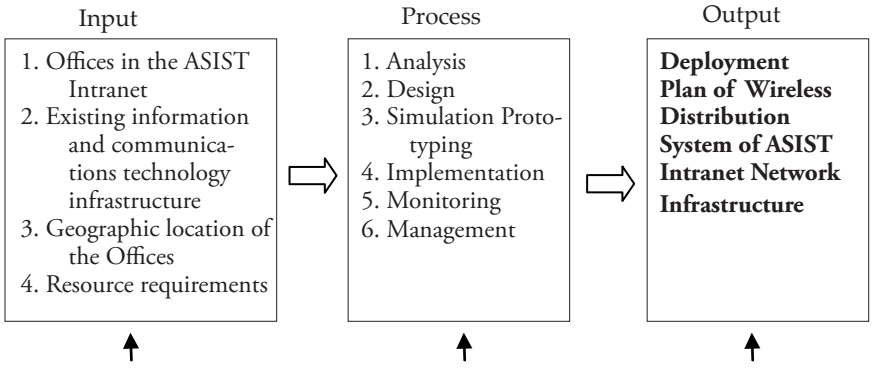


Figure 1. The Research Paradigm

Figure 1 shows the input box contains the offices to be connected to the

intranet, existing ICT equipment of ASIST, Geographic Location of offices, and the ICT equipment needed for the Intranet while the process box shows the activities of the researcher in defining how Wireless Distribution System of ASIST Intranet is configured. Lastly, the output box shows the derived output that is a Deployment Plan of Wireless Distribution System of ASIST Intranet Network Infrastructure. The feedback loop indicates that the researcher may refer to the Input, Process, and Output boxes for an update whenever necessary during the deployment planning.

Sources of data

The study was conducted at Abra State Institute of Science and Technology, Lagangilang Campus, Philippines on February to May 2015. The respondents were the Vice President for Administration and Finance, ICT experts, and Program Project and Building maintenance Officer. Likewise documents pertaining to the ICT equipments purchased was retrieved from the Supply Office.

Instrumentation

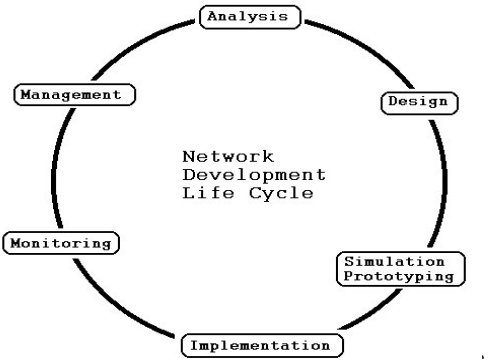
For objective 1, the study used a survey questionnaire. It was done to determine the Offices included in the ASIST Intranet.

For objective 2, the study adopted the E-Government Fund Management Office Survey Questionnaire for Existing ICT Infrastructure Inventory. It was done to determine the existing ICT infrastructure.

For objective 3, the study used ASIST Digital School Map and survey questionnaire. It was done to determine the geographic location of the Offices

For objective 4, the study used survey questionnaire. It was done to determine the resource requirements.

For objective 5, the Network Plan was developed using the Network Development Life Cycle. It has six phases namely Analysis, Design, Simulation Prototyping, Implementation, Monitoring, and Management.



Data Analysis

Existing ICT infrastructure of the school was tabulated to determine whether there is a need to buy or not. Moreover, the school terrain, geographic location offices, and vegetation in between buildings were carefully studied.

Design

The design of the network is based on the concept of a star topology. One antenna will be acting as internet source and others will be acting as tranceivers.

Simulation Prototyping

Network internet connectivity was simulated by configuring one antenna which acted as the access point. Likewise, three antennae were configured as stations. A laptop was connected to each station. Each laptop was tested to connect to the internet.

Later on, another access point that was connected to a hub along with a station was configured to connect to the other three stations. A laptop was also connected to each station. Each laptop was tested to connect to the internet.

Implementation

The network plan will be implemented using a Star topology.

Monitoring

The network will be monitored physically and electronically. A network technician will be scheduled to roam the campus to visit offices and check for physical network failure and network path obstacles like trees. Likewise, network logs will be constantly monitored for vulnerabilities.

Management

The network will be managed using basic Ubuntu Linux server tools for information gathering, vulnerability, stress testing and maintaining access. Likewise, the management of the radio antenna will be managed using the builtin airOS7.

RESULTS AND DISCUSSION

The following are the offices that are included in the ASIST Intranet: President, Vice President for Administration and Finance, Vice President for Academic Affairs, Planning, Director for External Affairs, Supply, Records, Human Resource, Administrator, Budget, Accounting, Cashier, Registrar, CSIT Dean, CAFC Dean, CTETH Dean, IT Chairman, Sciences Chairman, Agriculture Chairman, Forestry Chairman, Lab School Chairman, IT Faculty Room, Science and Math Faculty Room, Education Faculty Room, Research Director, Extension Director, Agribusiness, and Guidance.

This implies that the inclusion of greater number of offices in the ASIST Intranet compared to the existing Local Area Networks, increases the number of students, faculty members, and staff to be connected eventually on the internet.

Table 1. Number of computing devices and peripherals by type and by year acquired

TYPES	TOTAL NUMBER OF FUNCTIONING UNITS BY YEAR ACQUIRED										
	2014		2013		2012		2011		2010		Before 2010
	New	Used	New	Used	New	Used	New	Used	New	Used	
Desktop PC	13		65		37		33		37		210 31(donations)
Laptop / Notebook / Netbook PC	8				9		1		2		20
Mobile Phone1 (incl. smart phones)									1		11
Multimedia player									1		4
Multi-function printer (print, scan, copy or fax)	2				6				2		11
Printer only	1				9		1		2		28
Digital Camera	1				1						
Wide-format Printer or Plotter	1										
Small Scanner (ex. flatbed scanner)	1		1		2		2		1		4
External Hard Drive	3		1								2
Generator Set											1
Projector	6				3				2		4
Hub											3
Router			3								

Table 1 shows the number of computing devices and peripherals by type and by year acquired. The School has a total of 185 desktops and 20 laptops. Moreover, it has three existing routers.

This implies that the school started to establish Wireless Local Area Network (WLAN) not just to eliminate the use of cables, but also to share data, knowledge, information, and hardware resources, among employees inside the offices with the freedom to roam around by acquiring routers in the calendar year 2013. This finding is a practical application as cited by Pahlavan (2011) in his book entitled, "Principles of wireless networks: A unified approach".

Table 2. Operating System for Stand-alone PCs (desktops and laptops)

OPERATING SYSTEM	Lifetime License?	If not, write the year of expiration
Older than Windows XP	☐	
Windows XP	☐	
Windows Vista	☐	
Windows 7	☐	
Windows 8 and up	☐	
Linux	☒	
Mac OS	☐	
Mac OS X	☐	
Others, please specify	☐	

Table 3. Office Automation Software

SOFTWARE / APPLICATION PACKAGE	Lifetime License?	If not, write the year of expiration
Older than MS Office 2003	☐	
MS Office 2003	☐	
MS Office XP	☐	
MS Office 2007	☐	
MS Office 2010	☐	
MS Visio	☐	
MS Project	☐	
Open Project	☐	
Open Office	☒	

Tables 2 and 3 display the Operating System and Office Automation Software being utilize in the school are Linux and Open Office. This implies that the school prefers open source over the enterprise products. This finding supports the study that there is a growing acceptance of the Linux operating system and the open source software in general (Hahn, 2010).

Network

Local Area Network (LAN)

Based on the physical inspection, the school has separate Local Area Network that can be located in the Administration Building, Electronic Library, and Laboratory School.

There are two independent Local Area Networks (LAN) in the Administration Building. Based on observation, the two LANs were created due to internet speed. The greater number of users simultaneously connected to the internet, the slower the internet speed. The Offices that are connected to LAN A are the Offices of Accounting, Cashier, President, Vice President for Administration and Finance, Director for External Affairs and Director for Planning while the Offices that are connected to LAN B are Offices of Budget, Administrator, Records, Supply and Human Resource Office.

Based on the records and physical inspection, the school does not have existing operational oversight or administrative systems, operating systems for workstations, operational server, database, data center, strategic information systems, Intranet, Virtual Private Network, Wide Area Network and Private Automatic Branch Exchange (PABX or PBX). Moreover, the school does not have on-going ICT Project.

This implies that the Local Area Network (LAN) is not in anyway used to capture business intelligence during transactions. Furthermore, only the employees in these areas have the capability to share data, information, knowledge and hardware resources, and have access to the internet. Therefore, students, employees and staff assigned outside these areas need to visit the area to use services offered in the network.

Internet connection

Based on Budget Office records, the School has six (6) individual MyBro Internet subscriptions. The mode of access to the internet is fixed wireless broadband. The Internet Service Provider (ISP) is MyBro. The combined internet bandwidth of voice and data is up to 2Mbps.

The school was able to subscribe internet access using the names of six (6) permanent employees. One internet subscription is installed at the Laboratory School Building providing internet access to the Faculty, Staff and students. In addition to this, one internet subscription is installed in the Information and Communication and Technology Building which provides internet access to IT faculty members, librarian, radio disc jockeys, staff, and library users.

There are two internet subscriptions in the Administration Building providing internet access to administrators and staff. Likewise, there is a separate internet access installed in the Research Building and Science Building.

Each of these accounts has individual billing statements. According to the administrative aide to the Budget Officer, Philippine Postal Corporation delivers billing statements. More often than not, the billing statements do not reach the Office, which is a very important attachment of voucher for the issuance of check, earlier than due date. Much more, the billing statements are not delivered all at once since each of the accounts has different due dates. This makes the preparation of voucher for the monthly internet bills done multiple times. In return, this causes the failure of the school to pay its obligation on time resulting to internet disconnection.

This implies that the Administration does not have control over the internet activities of the students, faculty, staff and itself. Thus, they may visit any site they want and the same time download and install applications they want. This makes the school very vulnerable to outside attack. This finding supports the idea that the freedom offered by the Internet is susceptible to abuse by hostile groups(Weimann, 2006).

Agency website

The school has a website. The school website is www.asist.edu.ph. This implies that the school has the capability to publicly publish accompishments. Furthermore, the school has the capability to implement online intranet software infrasture.

Security, Disaster Recovery & Back-up

Based on the records, the school has a protection scheme for ICT resources like software firewall, subscription to a security service, secure servers, regular ICT security training of employees and usage of secondary storage devices like thumb-drive, optical disk, and hard disk drive. This implies that the school has the capability to secure classified, sensitive and private files. Likewise, it has the capability to easily recover files in case of hardware or software failure.

Data Archiving

The school has a data archiving system. The school uses both the manual and electronic archiving systems. The mode of electronic data archiving is conventional. The medium of storage of the archived data are hard disk drive, external hard drive, and filing cabinet. The school archived publications like annual report and statistical report and others, maps, letters, memorandum orders, communications, photographs, public documents like civil registration forms, passports, land titles and student database electronically.

Table 4. Special Solutions and other Services

PACKAGE	USE	MAINTENANCE COST
Geographic Information System	1	
Automated Fingerprint Identification System	4	
CCTV System	2	

The Table 4 shows that there are four (4) Automated Fingerprint Identification Systems and a Geographic Information System. This implies that the school adheres to the government policy being implemented by Civil Service Commission (CSC) to strictly monitor the punctuality, attendance, and accountability of the employees at all times.

Table 5. Finished /On-going ICT Projects

PROJECT NAME	DESCRIPTION	PERIOD (in mm/dd/yyyy) Start Date	End Date	COST (in pesos)	DEVELOPMENT STRATEGY (Please write codes only; refer below)	STATUS (Please write codes only; refer below)	USE (Pls. write codes only; refer below)
ASIST Management Information System (AMIS)	Development of the following Information Systems: Enrolment System Income Generating Project System College Entrance Examination System	2015	2017				
Board of Trustees Archive System	Archiving system intended for easy storage and retrieval of records concerning Meetings of the Board of Trustees	1/ 1 /2014	4/ 1/ 2014	50,000.00	I	D	2

It can be seen on Table 5 that the school is currently developing its information systems like Enrollment system and Income Generating Project System, among others. This implies that the school has manpower to develop software that may run over the Intranet.

Issues Encountered in the Implementation of ICT Projects

The problems encountered by the school in the implementation of ICT Projects are no budget or insufficient budget and unavailability of required bandwidth to support system/s.

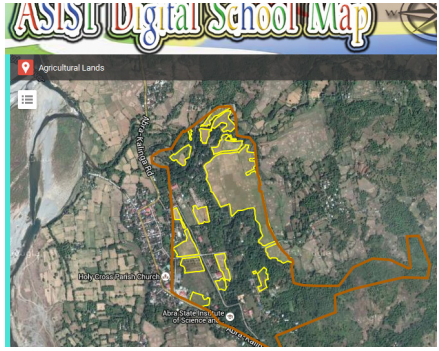


Figure 2. ASIST Digital School Map

Figure 2 shows the ASIST Digital School Map. According to Rodriguez (2013), the digitized map contains geo-tagged and geo-referenced pictures of the school buildings and facilities. Moreover, it has the functionalities of panning and zooming.

According to the PPBMO, the school has the current set up. The Agri-business Building houses the office of the Poultry Manager. Moreover, the Laboratory Building accommodates the Office of the High School Chairman, faculty room, and classrooms. In addition to this, the Research Building holds the offices of Research Director and Intellectual Property. Furthermore, the Information and Communication Building is the houses the office ICT Department Chair, faculty room, computer laboratory rooms, classrooms, library and radio station.

The Administration Building contains the Office of the President, Vice President for Administration and Finance, Planning, Director for External Affairs, Supply, Records, Human Resource Office, administrator, budget, accounting, cashier, and registrar.

The Sciences Building accommodates the Offices of the College of Sciences and Information Technology Dean, Science Department Chair, Faculty room, Science Laboratory rooms and classrooms.

The Old Agriculture Building accommodates the offices of the Vice President for Academic Affairs, Executive Dean, and the Electronic Library.

The Alava Building contains Offices of College of Agriculture and Forestry Dean, Forestry Chair, faculty room, Home Technology Laboratory room, and classrooms.

The Teacher Education Building houses the offices of College of Teacher Education and Home Technology Dean, Teacher Education Chair, Guidance

Counselor, faculty room, and classrooms.

The FADC Building holds the Offices of the Extension Director, Extension Staff, and Conference Hall.

Finally, the Integrated Laboratory and Agriculture Building houses the faculty room, classrooms, and laboratories.

The researcher thoroughly followed the tutorials on how to use the map and was able to locate the buildings that house the different Offices.

The map provided a clear top-view of the entire ASIST map. It has helped a lot in providing a clear view of the vegetation in the vicinity in between buildings. Moreover, it provided assistance in decision making to which type of radio is appropriate. This implies that the offices that need to be interconnected and be included in the Intranet are housed in different buildings.

Table 6. Resource requirements

Building	Item	Proposed Number of Units
ICT	Pico Station	1 pc
	UTP cable	30 meters
	Wireless Router	1pc
Research	Nano Station Loco M2	1 pc
	UTP cable	30 meters
	Wireless Router	1 pc
	Desktop Switch (4 Ports)	1 pc
Lab School	Nano Station Loco M2	1pc
	Nano Station M2	1pc
	UTP cable	60 meters
	Wireless Router	1 pc
	Desktop Switch (4 Ports)	1pc
Agribusiness	Nano Station Loco M2	1 pc
	UTP cable	30 meters
	Wireless Router	1 pc
	Desktop Switch (4 Ports)	1 pc
Administration	Nano Station Loco M2	1 pc
	Nano Station M2	1 pc
	UTP cable	60 meters
	Desktop Switch (4 Ports)	1 pc
Sciences	Nano Station Loco M2	1 pc
	Pico Station M2	1 pc
	UTP cable	60 meters

	Wireless Router	1pc
	Desktop Switch (4 Ports)	1 pc
Alava	Nano Station Loco M2	1 pc
	UTP cable	30 meters
	Wireless Router	1pc
	Desktop Switch (4 Ports)	1 pc
Teacher Education	Nano Station Loco M2	1 pc
	UTP cable	30 meters
	Wireless Router	1 pc
	Desktop Switch (4 Ports)	1 pc
FADC	Nano Station Loco M2	1 pc
	UTP cable	30 meters
	Desktop Switch (4 Ports)	1 pc
Integrated Laboratory	Nano Station Loco M2	1 pc
	UTP cable	30 meters
	Desktop Switch (4 Ports)	1 pc

Table 6 shows the resource requirements for the installation of ASIST Wireless Distribution System. According to Ubiquiti Networks, Inc. (2016), the frequency of Nano Station M2 (NSM2), Pico Station M2 and Nano Station Loco M2 (LocoM2) is 2.4 GHz. Moreover, the throughput of the stated antennae is 150 + Mbps. In addition to this, the range of NSM2 is 13+ Km, while Pico Station is 800 m to 1 Km and LocoM2 is 5+ Km. Furthermore, the antennae use Time Division Multiple Access (TDMA) airMAX protocol that enables unprecedented scalability, high throughput and low latency in unlicensed and multipoint networks.

The resource requirements were based on the geographic locations of the buildings, the distance of the antenna from the nearest electricity outlet in which there is a Line of Sight (LOS) of Access Point (AP) and Customer Premises Equipment (CPE). In addition to this, resource requirements were also based on the official canvass of outdoor antennae, most especially, the cheapest among its class.

This implies that internet connectivity of buildings inside the campus is possible with the use of radio. Thus, the number of offices that can be provided with internet connectivity increases. The study is similar to the study of Page, Bainbridge, Gardner, and Hahn (2014) which deploys 802.11 networks over long distances.

Table 7. Items and unit costs

Item	Price (Peso)	Quantity	Total
Pico Station M2	6,580.00	2 pcs	13,160.00 (280 USD)
Nano Station M2	6,580.00	2 pcs	13,160.00 (280 USD)
Nano Station Loco M2	3,580.00	9 pcs	31,500.00 (670 USD)
Desktop Switch	1,500.00	8 pcs	12,000.00 (255 USD)
Wireless router	2,500.00	7 pcs	17,500.00 (372 USD)
Laptop	25,000.00	1 pc	25,000.00 (531 USD)
Server	25,000.00	1 pc	25,000.00 (531 USD)
Cat 5e UTP Cable	3,500.00	2 boxes	7,000.00 (148 USD)
	Total	**144,320.00 (3070 USD)**	

Table 7 shows the items and total cost of the devices that shall be used in the intranet. The stated prices were the actual prices from the ICT reseller on the present Peso to US Dollar Exchange Rate which is peg at P47.00 is to 1 Dollar. It is the cheapest among three resellers canvassed. This implies that the implementation cost may vary in the actual cost by the time the intranet is implemented as the exchange rates change from time to time.

ASIST Intranet Network Plan: Wireless Distribution System

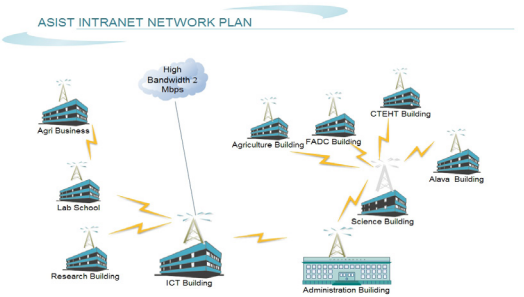


Figure 3. ASIST Intranet Network Plan

The radio towers, a 10 ft. mast, are placed on top of the strategic buildings. The internet source within the intranet shall come from the ICT Building using Pico Station M2 HP. The Pico Station is Omni–directional antenna. The Pico Station shall be configured as Access Point WDS (AP). This will prohibit wireless devices from accessing directly, through wireless network interface card (WNIC)

to the antenna. The name of the AP is ICT building. This signifies that the radio is located on top of the ICT building. The AP channel is 6.

On the left side, the Research Building and the Lab school shall be connected to the AP using Nano Station Loco M2, a Customer Premises Equipment (CPE). The Nano Station Loco M2 is directional antenna. The CPEs shall be configured as Station WDS. Since there is a thick-forested area in between the ICT Building and the Agri-Business Building, a repeater shall be installed on top the CPE of the Lab School facing the direction of the Agri-business building. The AP shall be Nano Station M2. It is a directional antenna. The name of the AP shall be Lab School. AP will also be configured as AP WDS. The AP channel is 7. This shall eliminate interference between ICT_Building and Lab_School. The CPE in the Agri-Business shall be Nano Station Loco M2.

On the right side, the Administration Building shall be connected to the ICT Building using Nano Station Loco M2. Since there is also a forested area in between the Science building and the ICT building, a repeater is also be installed on top of the CPE. Likewise, the AP shall be Nano Station M2. The name of the AP shall be Admin_Buildreling. AP will be configured as AP WDS. The AP channel is 8.

A CPE shall be configured on top of the Science Building connecting to the Administration Building. Likewise, an AP shall be installed on top of the CPE. The AP shall be Pico Station. The AP channel shall be 9. This shall be used by the CPEs on top of the Alava, CTEHT, FADC and Agriculture Buildings.

This implies that intranet plan will deploy multiple access points and tranceivers around the campus. This network plan is an application of method and apparatus for WIFI long range radio coordination (Frei, 2012). In addition to this, network topology discovery systems and methods (Bearden, 2013) were also applied where in the devices are mapped and the links that join them.

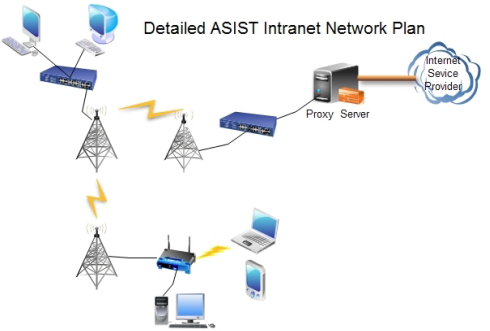


Figure 4. Detailed ASIST Intranet Network Plan

The source of Internet connectivity of the entire college shall be a Squid proxy server running on Ubuntu Server. The gateway address of the proxy server will be 192.168.1.1 and the assigned port will be 3128. The IP address of the routers and devices that are not behind the routers shall be assigned with static IP while the devices that are behind the routers shall be assigned with IP address of the automatically. Websites containing or promotes pornography and torrent sites will be blocked. Moreover, social media sites like Facebook.com, and Youtube.com wil be blocked from 8 am to 12 pm and from 1 pm to 5 pm as required by the management. However, these sites will be accessible in between 12 pm and 1 pm.

This implies that the internet access of the students, employees, staff and the administration itself can be restricted and controlled. This finding corroborates the findings of Zittrain and Palfrey (2008) indicating the mechanics and control of internet filterning.

CONCLUSIONS

Wireless Distribution System is effective in sharing Internet connectivity where physical connectivity is impossible. The use of the Digitized School map has helped a lot in providing a clear view of the vegetation in the vicinity in between buildings. Moreover, it provided assistance in decision making to which type of radio is appropriate in distributing the internet signal. Finally, Squid proxy server is effective in restricting accessible websites.

TRANSLATIONAL RESEARCH

The outcome of the study had been translated into Wireless Network Administration Guide and was used by the Bachelor of Science in Information Technology (BSIT) students. The Guide improved the knowledge of BSIT students on Wireless Network configuration and Installation. The translation of the study results were made possible by the Abra State Institute of Sciences and Technology-College of Arts and Sciences Department.

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