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A PROTOTYPE NETWORK ENTERPRISE DESIGN FOR ISABELA STATE UNIVERSITY SYSTEM

Sherwin S. Ravana[1]
Isabela State University, San Mariano Campus
Sta. Filomena, San Mariano, Isabela, Philippines
Email : ssr_1409@yahoo.com CP No. +63157574080

Abstract—Isabela State University System has four (4) clusters composing of nine (9) satellite campuses and two (2) campus extensions; it has peculiar Networking needs or interconnectivity for each campus to support effective dissemination of knowledge to the studentry of the university.

The objectives of the study are: assess the ICT and Network infrastructure of ISU Campuses; evaluate response time of the server using leased line Internet Provider and the performance with the client side using PLDT DSL, Globe Broadband (WiMax) and Cable TV System/IPStar Internet Provider and; design a prototype network enterprise that applicable for ISU system, that make all campuses to share information and resources and future adaptation of application such as data mining, cloud computing, E-learning, VOIP and other technologies that can be very useful in the university.

Keywords — Prototype Design, Network Enterprise Design, Network Infrastructure, Network performance

I. INTRODUCTION

Academic institutes and higher education are now using Information and Communication Technology (ICT), and Networking is only one technology that a campus should be equipped with. In a Campus Enterprise Networks, a large number of nodes are interconnected together through a computer networks, a **network** means a collection of computers and other hardware components interconnected by communication channels that allow sharing of resources and information; where at least one process in one device is able to send/receive data to/from at least one process residing in a remote device, then the two devices are said to be in a network(http://en.wikipedia.org) and these networks have distinctive topologies, protocols, policies and configuration.

Isabela State University (ISU) System has four (4) clusters composing of nine (9) satellite campuses and two (2) campus extensions, it has peculiar Networking needs or interconnectivity for each campus to support effective dissemination of knowledge to the studentry of the campus. The main goals of an Isabela State University network are resource sharing and access to information to all satellite campuses.

[1] Faculty & Instructor 1,Isabela State University, San Mariano Campus, Sta. Filomena, San Mariano, Isabela, Philippines

The main issue in designing and implementing such Local Area Network(LAN) or Wide Area Networks (WAN) in ISU system or within the four(4) ISU cluster is the distance of each campus, Internet connection and the performance under ever increasing network traffic and how this affected by various networks metrics such as latency and end to end delay.

With the appropriate Network design and software in the system, sharing of information and resources to ISU system will be maximized and application such as data mining, cloud computing, E-learnig, VOIP and other technologies that can be very useful in the university.

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II. RELATED ARTICLE

There are papers that are published concerning network enterprise, campus enterprise design and LAN/WAN performance. Abou, A. et al [1] visualized that as organizations face changing business imperatives and burgeoning bandwidth requirements, they are seeking ways to consolidate multiple voice, data, and video networks onto integrated, high-performance, multimedia infrastructures, called enterprise networks, these infrastructures will likely emerge gradually, paced to the specific requirements of each organization. Brocade [2] stated that the corporate data center network undergoes transformation with technologies such as server virtualization and network consolidation, the focal point of change is currently centered in the user-facing campus side of the network. Buckler [3] point's outs Canadian organization to move toward enterprise networks appears almost inevitable. Choi [4] explained that enterprise network infrastructure has served as a vehicle on which data and information can be transferred between functional units regardless of their location. DiNikolo [5] focuses on another important network model, the Cisco hierarchical network design model. Very different that the OSI model, this model is used as the basis for designing Cisco networks for security and performance. Fischer et al [6] points out that both enterprise networks and the public telecommunications infrastructure are moving toward the use of packet-switching Internet Protocol technology for efficient integrated voice and data services. Greene [7] explained the PERFORMANCE of applications across the WAN are beset by a range of problems - latency, congestion, chatty applications, contention with other apps, and low bandwidth. Juniper [8] explained that a new campus LAN design is needed as legacy solutions cannot meet the key requirements, nor reduce costs and streamline operations. The new LAN design must also have a scale and accommodate emerging computing trends and additional network services without an entire redesign. Kakadia et al [9] explained Availability has always been an important design goal for network architectures. Mohan, R KS [10] explained strategic network planning is a vital activity in the enterprise network (EN) design process. It explained the 5 stages in the strategic network planning process. Ramaswamy [11] points out steps to avoid problems when client-server applications are run over a WAN. SUNG et al [12] showed systematic design approach that can handle two key areas of enterprise design: virtual local area networks (VLANs) and reachability control. Triplett [13] explained a new model, called the Five Domains of Network Security in securing the enterprise network

III. NETWORK DESIGN MODEL

Network design model exists in the networking world and all can be used in enterprise networks. One design or network model that is used as the basis for designing Cisco networks for security and performance: the Cisco hierarchical network design model. The model is made up of three layers, including Core, Distribution, and Access. Figure 1 shows each of these layers relative to one another.

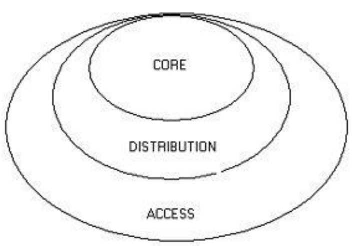

Figure 1. The Network Hierarchical Model

A. THE LAYERS

Each layer in the model has a general level of responsibility, in terms of what capabilities should be implemented there, and with a particular emphasis on how that layer should perform.

The Core Layer

The core layer is literally the Internet backbone. At the top of the hierarchy, the core layer is responsible for transporting large amounts of traffic both reliably and quickly. In general the core layer should In general the core layer should

- Be used to provide high-speed switching.
- Provide reliability and fault tolerance.
- Grow by using faster, and not more, equipment.
- Never implement performance-decreasing elements such as access lists.

The Distribution Layer

The distribution layer is sometimes referred to as the workgroup layer and is the major communication point between the access layer and the core. The primary function of the distribution layer is to provide routing, filtering, and WAN access and to determine how packets can access the core, if needed.

The distribution layer must determine the fastest way that network service requests are handled; for example, how a file request is forwarded to a server. After the distribution layer determines the best path, it forwards the request to the core layer. The core layer then quickly transports the request to the correct service.

The distribution layer is the place to implement policies for the network. Here you can exercise considerable flexibility in defining network operation. There are several items that generally should be done at the distribution layer such as:

- Implementation of tools such as access lists, of packet Filtering, and of queuing
- Implementation of security and network policies including firewalls
- Redistribution between routing protocols, including static routing
- Routing between VLANs and other workgroup support functions
- Definitions of broadcast and multicast domains

Things to avoid at this layer are limited to those functions that exclusively belong to one of the other layers.

The Access Layer

The access layer controls user and workgroup access to internetwork resources. The access layer is sometimes referred to as the desktop layer. The network resources most users need will be available locally. The distribution layer handles any traffic for remote services.

The following are some of the functions to be included at the access layer:

- Continued access control and policies
- Creation of separate collision domains
- Workgroup connectivity into the distribution layer through layer 2 switching

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IV. HARDWARE AND NETWORK INFRASTRUCTURE IN THE ISU SYSTEM

Hardware infrastructure are being assessed in the whole university, the purpose of the assessment is to evaluate ISU campuses in terms of readiness in interconnectivity. Table 1 display the summary of computers nodes in the ISU system that are being accessed by student in their everyday use in their respective campuses. The computers are categorized according to their type processor, Category A: (Corei7, i5,13,Core 2 Quad, AMD Phenom and Athlon X2), Category B: (Core 2 Duo, Pentium E5**0 > E2 **0), Athlon 64 x2,Athlon 64), Category C: (Celeron Dual Core(E1*00), Celeron 4*0) Sempron), Category D: (Pentium D, Pentium 4, Celeron D, Pentium 3, Athlon XP Athlon).

Campus	Category A	Category B	Category C	Category D
Angadanan	6	2	12	20
Cabagan	109	-	-	-
Cauayan	57	85	60	60
Echague	65	58	50	-
Jones	-	8	33	-
Ilagan	19	52	18	4
Roxas	32	60	37	26
San Mariano	6	7	7	43
San Mateo	–	16	9	25
Total	**294**	**288**	**226**	**178**
Grand Total: **986**				

TABLE I. ISU's Hardware infrastructure

Table 2 Display the Internet Provider and speed used by each campus in facilitating internet needs of students in the campus.

Campus	Internet Service Provider	Speed
Angadanan	Cable TV	Up to 512kbps
Cabagan	PLDT DSL	Up to 2mbps
Cauayan	PLDT DSL	Up to 2mbps
Echague	PLDT DSL	Up to 2mbps
Jones	SMART broadband	Up to 512kbps
Ilagan	PLDT DSL	Up to 1mbps
Roxas	IPSTAR/ Globe	Up to 1mbps
San Mariano	Globe Broadband\IPSTAR	Up to 1mbps
San Mateo	-	-

TABLE II. ISU's Internet Service Provider and Speed

V. COMMUNICATION BETWEEN PROTOTYPE CAMPUS AND THE SERVER

The layout of ISU's network system is showed in figure 2, where campuses uses different computer specification to act as node that are physically connected; in communicating with the server, Internet connection had the major role in connecting the server and the client. Three (3) campuses will act as the prototype campus (client side) and could be the basis for the future implementation of enterprise network in ISU system.

A. NETWORK PERFORMANCE EVALUATION

In measuring the performance of the network the researcher considered Wide Area Network (WAN) in the university and included four (4) campuses to participate in the testing and evaluation. The server resides in Echague campus (main campus), using PLDT leased line with 6mbps and CISCO router and switch. Angadanan Campus, uses National Cable TV (NCTV) with up to 512 kbps of speed and with TP-Link router D-Link switch, and uses 10 nodes for testing, Ilagan Campus , PLDT with up to 2mbps of speed , with TP-Link (CISCO) router and D-Link switch and uses 10 nodes for testing; and San Mariano Campus uses GLOBE broadband 4g with up to 1mbps of speed with TP-Link router and D-Link Switch and 10 nodes for testing .

The researcher considered two tools to measure the performance: Ping Test software which is a handy, powerful, visual ping test utility, scans IP for system administrator to check network connection. PingEasy is a graphical ping utility allows to watch easily the states of network and test the connection speeds of various locations. It can save IP addresses and hosts name, intuitive interface shows the route, hosts, packet loss percentage, min/max/average response times.

Core FTP is also considered to test the availability of the server and evaluate the response time in the client side using different bandwidth and Internet Provider in downloading and uploading files from the server.

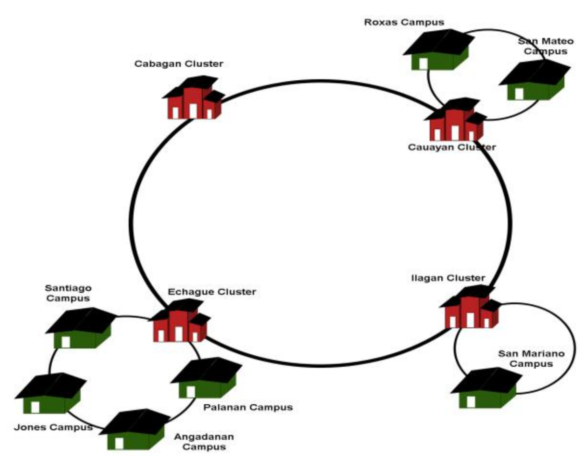

Figure 2. Layout of Wide Area Network in the ISU Cluster

The test result that was conducted in the prototyped campus; the test is performed to evaluate the performance by generating packets from the 10 nodes to the server. Table

3 , 4 and 5 display information about the Ping result from the prototyped campus, that is how many packets are sent from the server and it also display packets received from the server and the packet lost for the whole duration process of downloading and uploading the file to the server. With these readings we can find out the transmission rate of the network.

TABLE III. Network Traffic Angadanan Campus

No. of Node	Packet Sent	Packet Received	Packet Lost
1	756	638	118
2	643	530	113
3	603	511	92
4	1317	539	778
5	377	325	52
6	616	526	90
7	710	544	166
8	298	278	20
9	692	606	86
10	272	226	46
Average	**628.4**	**472.3**	**156.1**

TABLE IV. Network Traffic Ilagan Campus

No. of Node	Packet Sent	Packet Received	Packet Lost
1	108	73	35
2	1700	1096	604
3	1583	1032	551
4	1482	958	524
5	1351	857	494
6	1387	864	523
7	825	558	276
8	924	563	366
9	1438	937	501
10	1389	875	514
Average	**1218.7**	**781.3**	**438.8**

TABLE V. Network Traffic San Mariano Campus

No. of Node	Packet Sent	Packet Received	Packet Lost
1	1366	919	447
2	1317	539	778
3	835	273	565
4	1334	224	1013
5	1331	434	897
6	1392	971	421
7	1068	697	371
8	1287	466	821
9	1317	539	778
10	1275	865	410
Average	**1252.2**	**592.7**	**650.1**

Figure 3 displays the average packets sent from the prototyped campus from the server in the network that is graphically presented.

Figure 4 displays the average packets received from the prototyped campus from the server in the network that is graphically presented.

Figure 5 displays the average packets lost or delay caused by getting a network message to the server and getting the response back.

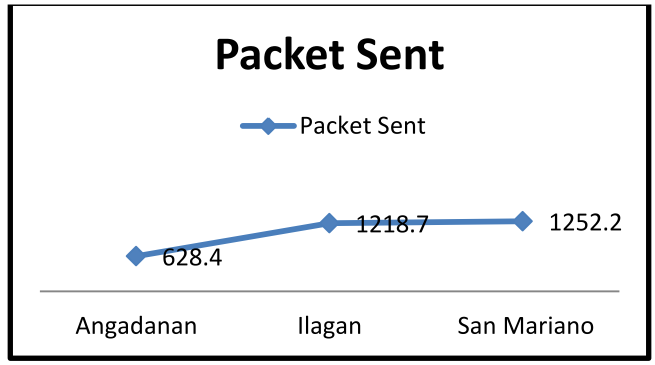

Figure 3 Average Packet Sent from the prototyped campus

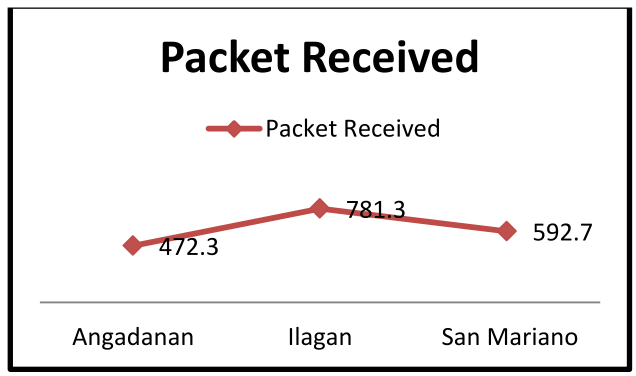

Figure 4 Average Packet Received from the prototyped campus

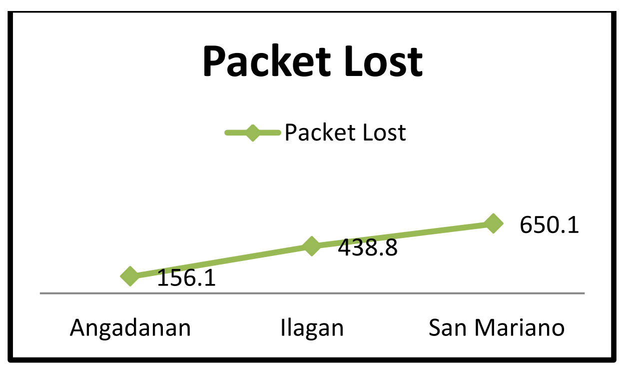

Figure 5 Average Packet Lost from the prototyped campus

Table 6 displays the total number of nodes and average time in seconds which are successfully downloaded and uploaded the file from the server.

TABLE VI. Number of Nodes; Download; Upload and the Average time in the prototyped campus

Campus	No. of Nodes that are able to download	Ave. time to download in second/s	No of Nodes that are able to Upload	Ave. time to Upload in second/s
Angadanan	9	3.8 \ 9 nodes	9	4.032 \ 9 nodes
Ilagan	10	1.065 \ 10 nodes	9	7.4\ 10 nodes
San Mariano	8	14\ 8 nodes	4	10.8 \ 4 nodes

VI. Conclusions

Based from the result in the testing and evaluation of the network, it shows that Ilagan campus had the most nodes that were able to connect to the server, followed by Angadanan and San Mariano; it had also the fastest average time in terms of downloading files. On the other hand, Angadanan campus has the fastest in uploading file, followed by Ilagan and San Mariano; San Mariano has the lowest number of nodes that were able to download and upload file to the server; it has also the highest percentage rate in packet lost with 0.48968 average lost rate; Ilagan with 0.31938 average lost rate and Angadanan with 2.20793 lost rate

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References

[1] Abou-Arrage, George; Merritt, Ian, "Making the journey to enterprise networking," Telesis 98 (May 1994): 34

[2] Brocade," Campus LAN: Designing a Robust and Cost-Effective Campus Network," Campus LAN Design Guide. Retrieved from www.brocade.com/downloads/documents/design-guides/robust-cost-effective-lan.pdf

[3] Buckler,Grant "Structuring the enterprise network," I.T. Magazine 25. 5 (May 1993): 30-33

[4] Choi, Beomjin; Tsai,Nancy; Jones, Tom. " Building enterprise network infrastructure for a supermarket store chain," Journal cases of information technology 11.1 (Jan – Mar) 2009)

[5] Dinikolo, Dan "Understanding Network Models-The CISCO Network Design Model" (February 2002) .Retrieved from www.ebookbrowse.com/understanding-network-models-the-cisco-network-design-model-pdf-d443437145

[6] Fischer, Martin J; Masi, Denise M Bevilacqua; McGregor, Patrick V. "Efficient Integrated Services in an Enterprise Network," IT Professional Magazine 9. 5 (Sep/Oct 2007): 28-35.

[7] Greene, Tim. "How to Improve WAN performance ". Network World 27.21. (Nov 8,2010) : 20

[8] Juniper. "CAMPUS LAN DESIGN GUIDE: Design Considerations for the High-Performance Campus LAN, " Juniper Networks, Design Guide. Retrieved from www.juniper.net/us/en/local/pdf/design-guides/8020001-en.pdf

[9] Kakadia,Deepa;, Halabi, Sam;Comier Bill; from SUN Microsystem Inc. and Extreme Networks Inc." Enterprise Network design patterns: High Availability," SUN Blue Prints online (Sep 2002)

[10] Mohan, K S Ram, " Major considerations in planning and designing the enterprise network," Telecommunications , North American Ed. 26. 12 (Dec 1992): 43

[11] Ramawamy, Ravi, " Optimizing client-server application performance on the WAN," Network Magazine 14.11 (Nov 1999): 70-74

[12] Sung, Yu-Wei Eric; Sun, Xin; Rao, Sanjay G.; Xie, Geoffrey G.; Maltz, David A., "Towards Systematic Design of Enterprise Networks," IEEE/ACM Transactions on Networking 19. 3 (Jun 2011): 695-708

[13] Triplet, James, " Securing the enterprise network," Telecommunications Americas edition. 30.4 (April 1996):38