The Implementation of the University-Wide Interconnectivity Project towards its Progress

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Abstract
Universities today are in critical need of an integrated university information system. This study aimed to see how far the University-wide Interconnectivity Project has progressed. Cebu Technological University's eight satellite campuses and main campus were surveyed using a descriptive survey method. According to the findings, the Internet Service Provider (ISP) installed a guaranteed 50Mbps upstream and downstream fiber optic leased line connection, with 10 Mbps and 40 Mbps allotted to eight campuses. The EDP Office on the main campus received a one 24-port managed switch, while each external campus received an eight-port gigabit switch. A wireless canopy has been installed for all satellite campuses. The connectivity of the institution was found to be sufficient to cater to the system's needs. However, the university information system encountered issues such as campus internal network stability, power fluctuation issues, lack of qualified personnel, and workstation security system updates and maintenance issues. Information technologies continue to drive the progress of communications and connectivity on the Internet of Things (IoT). In this connection, CTU's internet connectivity system must constantly be enhanced to cater to the institution's increasing needs.

Keywords: All-weather-unified broadband connectivity, internet bandwidth, inter-campus link, upstream and downstream fiber optic, wireless canopy

1. Introduction

The increasing number of individuals working in different domains and in many integrated institutes, institutions are growing and developing, causing system efficiency to deteriorate, making interoperability and automated integration impossible (Chandio et. al., 2012). Despite the fact that many institutions have multiple systems running on different platforms, their existing communication system does not yet have a set of connections. Nowadays, universities are highly in need of an integrated university information system (IUIS), to increase the efficiency and effectiveness of the business processes, which are eventually getting complicated due to the increasing number of enrollment (Özturan et. al., 2015). For the institution's function to be harmonized, all departments must be integrated in terms of communication. The effect of integrating the system is the ability for different departments in the educational system to share and exchange data (Cabukovski, 2010).

We are living in an era where information technology has become a major determinant of a project's efficacy and efficiency. The information of any firm has become a valuable resource. It is a big job to figure out how, where, when, and by whom it may be harnessed and exploited. As a result, an information systems strategy could be a useful tool for ensuring that the organization's objectives are realized. According to research by Banerji and Chowdhury (2013), a regular access point (AP) has a coverage area of about 20 meters indoors and 100 meters outdoors. It is more appropriate for usage at work and at home. WiFi was the first extensively used and deployed high-speed wireless technology, and it is now found at a growing number of institutions, cafes, hotels, and airports.

According to a report published by the World Economic Forum in 2015, the exchange of information from various areas is becoming more powerful, accessible, and widespread, and it is playing an increasingly important role in enhancing competitiveness, enabling development, and bringing progress to all levels of society. The dissemination of information and ideas will go beyond national borders as the world becomes increasingly linked.

This project is created as one of the primary undertakings indicated in the Information System Strategic Plan of Cebu Technological University (CTU) System Main Campus to better strengthen the discharge of its responsibilities. In accordance with the Philippines' E-government Master Plan (EGMP), upgrading the information technology infrastructure will be critical to achieving its objective and improving services to clients. The EGMP's ultimate goal is to establish transformational e-Government. By enabling the attainment of good governance goals such as operational efficiency, transparency and accountability, greater citizen involvement, and effective delivery of public services, transformative e-Government is critical to attaining the nation's development objectives.

This study will offer sufficient connectivity to all CTU campuses for high-speed Internet access, intranet Phone-over-IP PBX, school and student data collaboration, voice and video conferencing, and other important service applications that may be custom developed within the WDN system. It is true that campuses outside of Metro Cebu have had very limited access to actual broadband connections up until now. Although some locations have access to DSL, PLDT, Globe, and other internet connections, they are insufficient and unreliable to meet the expanding demands of schools and students (e.g., high-speed internet, voice, video, and data, and so on).

Interconnection of communication networks is now a requirement, and each company/institution is required to develop its own data communications network in order to achieve proper information exchange. This is also a requirement for colleges located in non-continuous geographic locations. For these reasons, the researchers want to start a study on the status of the University's Interconnectivity Project execution.

2. Materials and Methods

The study was conducted in all the Satellite Campuses of CTU and the Main Campus since every campus have to operate the University’s Management Information System (MIS) using the Interconnectivity (Figure 1).

Actual monitoring of the institution's interconnectivity status using relevant software tools, as well as physical inspection of the hardware and infrastructure, were utilized to determine the interconnectivity's stability. An interview to all the respondents (100% sampling) (i.e., MIS Heads, MIS Personnel, EDPO Personnel) of the Eight (8) CTU Satellite Campuses and the CTU-Main Campus as the central hub was used in the study.

The study gathered and interpreted data and responses using the Descriptive Survey Method, and a statistical analysis was conducted to determine the current status of the Interconnectivity Project Implementation of the CTU Management Information System (MIS). Actual monitoring was conducted on a monthly basis in each campus utilizing the MIS Chairpersons' Report presented at the MIS Chairpersons' Quarterly Meeting on the Main Campus.

The data gathered from the actual inspection and the responses from the interview and survey questionnaires will determine the status of the University-wide Interconnectivity Project Implementation.

3. Results and Discussions

3.1. Average internet connection bandwidth stability requirement

According to the findings of the investigation, a 50Mbps upstream and downstream fiber optic leased line connection from the Internet Service Provider (ISP) to the EDP office on the Main Campus

has been established. The Main Campus has a 10Mbps internet bandwidth allocation, while each of the eight campuses has a 5Mbps allocation, totaling 40Mbps (5Mbps X 8 External Campuses=40Mbps).

A wireless repeater rebroadcasts an existing signal from a wireless router or wireless access point to form a second network. CTU's main campus had twenty-four (24) wireless repeaters to connect its satellite campuses. Busay, Cantipla, Danao Hills, Moalboal Hills, Daan Bantayan Hills, and Gaas were among the places where these were put (Figure 1).

The term spread spectrum was also used in wireless communication. Spread spectrum is a type of wireless communication in which the transmitted signal's frequency is intentionally altered. This gives the signal a far wider bandwidth than it would have if the frequency was not altered. Frequency hopping is a digital method used by most spread-spectrum transmissions. In spread spectrum signal transmission, frequency hopping is a basic modulation technique. This approach ensures privacy while reducing any interference to other receivers.

The National Telecommunications Commission gave Cebu Technological University permission to use a Spread Spectrum to reduce interference while managing online classes. Setting up a wireless network, an access point (AP), and wireless network adapters, according to Song and Issac (2014), was a basic requirement for effective online communication, particularly in education. This way, it can share network resources while using the wireless medium and coordinating with the topology of the current wired network. According to Pareit et al. (2012), a developing wireless communication technology delivers high-speed Internet connectivity.

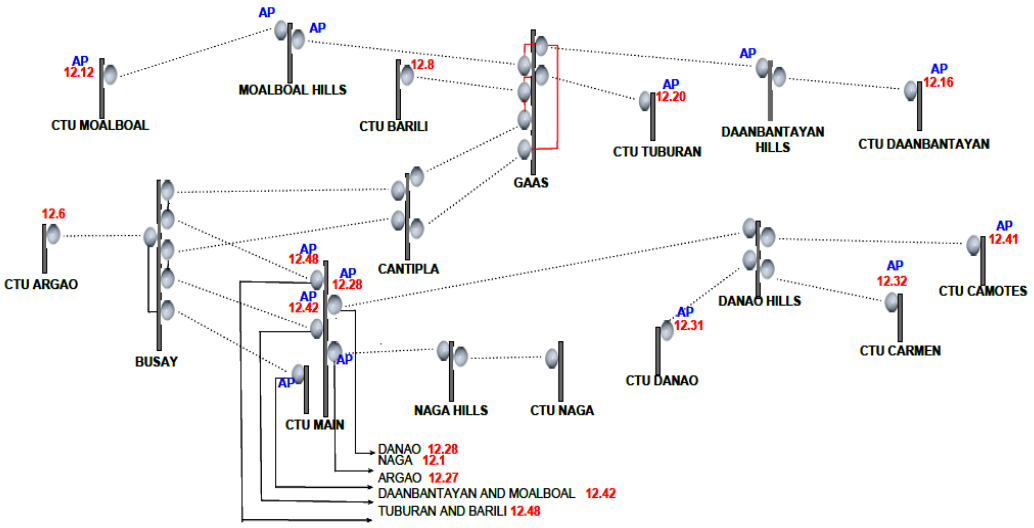

Figure 1. CTU Campuses-Wide Interconnectivity wireless Diagram

3.2. Average Inter-Campus Wireless Link stability requirements:

The average inter-campus wireless link stability, namely for the uplink and downlink, was 30 Mbps in this investigation, demonstrating the reliability of the wireless connections of the antenna in each external campus to the main campus. With the construction of these new towers, all satellite campuses will be able to receive a crisper signal as well as high-speed Internet connectivity.

For CTU connectivity, fourteen (14) APs were installed (Table 1, 2, 3, 4, 5, 6, 7, 8). A wireless repeater is used to bridge the gap between campuses because the distance between them is too great for a direct link to be formed. A 30dbi Disk Antenna and 40 - 80 ft. Monopole Tower fully equipped with standard grounding facility was installed.

Radio frequency (RF) technology, a frequency in the electromagnetic spectrum related with radio wave propagation, was used by CTU wireless networks. When an antenna receives an RF current, it generates an electromagnetic field that can travel over space. A device known as an access point (AP) is the foundation of a wireless network (in blue). An access point's principal function is to provide a wireless signal that computers can identify and "tune" into. Because wireless networks are frequently linked to wired networks, an access point can also act as a link to resources on a wired network, such as an Internet connection.

According to Song and Issac (2014), the properties of WiFi dictate that APs in a given area should have their own channels to avoid interference. Multiple operators, invoicing, and roaming have all become stumbling blocks to the creation of a more reliable internet connection.

Table 1. Detailed connection from CTU Main Campus to CTU Argao Campus

Points of Communication		Particulars of Equipment	Frequency
From	To		
CTU Main Campus	Busay Hills	Ubiquiti Network M5 <04:18:D6:8A:54:FE>	5665 MHz
Argao Campus	Busay Hills	Ubiquiti Network M5 <04:18:D6:36:FD:06>	5805 MHz

Table 2. Detailed connection from CTU Main Campus to CTU Camotes Campus

Points of Communication		Particulars of Equipment	Frequency
From	To		
CTU Main Campus	Danao Hills	Ubiquiti Network M5 <04:18:D6:36:FD:18>	5510 MHz
Camotes Campus	Danao Hills	Ubiquiti Network M5 <44:D9:E7:54:62:7D>	5785 MHz

Table 3. Detailed connection from CTU Main Campus to CTU Carmen Campus

Points of Communication		Particulars of Equipment	Frequency
From	To		
CTU Main Campus	Danao Hills	Ubiquiti Network M5 <04:18:D6:36:FD:18>	5510 MHz
Carmen Campus	Danao Hills	Ubiquiti Network M5 <44:D9:E7:68:DC:76>	5290 Mhz

Table 4. Detailed connection from CTU Main Campus to CTU Danao Campus

Points of Communication		Particulars of Equipment	Frequency
From	To		
CTU Main Campus	Danao Hills	Ubiquiti Network M5 <04:18:D6:36:FD:18>	5510 MHz
Danao Campus	Danao Hills	Ubiquiti Network M5 <44:D9:E7:68:DD:9D>	5240 Mhz

Table 5. Detailed connection from CTU Main Campus to CTU Moalboal Campus

Points of Communication		Particulars of Equipment	Frequency
From	To		
CTU Main Campus	Busay Hills	Ubiquiti Network M5 <04:18:D6:4E:D5:A5>	5650 MHz
Busay Hills	Cantipla	Ubiquiti Network M5 <44:D9:E7:72:D8:AB>	5300 MHz

Cantipla	Gaas	Ubiquiti Network M5 <04:18:D6:98:CB:21>	5765 MHz
Gaas	Cantipla	Ubiquiti Network M5 <44:D9:E7:72:D9:30>	5765 MHz
Moalboal Hills	Gaas	Ubiquiti Network M5 <04:18:D6:EC:04:53>	5835 MHz
Moalboal Campus	Moalboal Hills	Ubiquiti Network M5 <44:D9:E7:68:D0:2C>	5795 MHz

Table 6. Detailed connection from CTU Main Campus to CTU Barili Campus

Points of Communication		Particulars of Equipment	Frequency
From	To		
CTU Main Campus	Busay Hills	Ubiquiti Network M5 <04:18:D6:4E:D5:A5>	5650 MHz
Busay Hills	Cantipla	Ubiquiti Network M5 <44:D9:E7:72:D8:AB>	5300 MHz
Cantipla	Gaas	Ubiquiti Network M5 <04:18:D6:98:CB:21>	5765 MHz
Gaas	Cantipla	Ubiquiti Network M5 <44:D9:E7:72:D9:30>	5765 MHz
Barili Campus	Gaas	Ubiquiti Network M5 <44:D9:E7:54:62:3D>	5520 MHz

Table 7. Detailed connection from CTU Main Campus to CTU Daan Bantayan Campus

Points of Communication		Particulars of Equipment	Frequency
From	To		
CTU Main Campus	Busay Hills	Ubiquiti Network M5 <44:D9:E7:78:E7:A3>	5285 MHz
Busay Hills	Cantipla	Ubiquiti Network M5 <44:D9:E7:0A:E7:A1>	5330 MHz
Cantipla	Gaas	Ubiquiti Network M5 <04:18:D6:98:CB:21>	5765 MHz
Daan Bantayan Hills	Gaas	Ubiquiti Network M5 <04:18:D6:E3:0B:BA>	5685 MHz
Daan Bantayan Campus	Daan Bantayan Hills	Ubiquiti Network M5 <44:D9:E7:68:D0:85>	5320 Mhz

Table 8. Detailed connection from CTU Main Campus to CTU Tuburan Campus

Points of Communication		Particulars of Equipment	Frequency
From	To		
CTU Main Campus	Busay Hills	Ubiquiti Network M5 <44:D9:E7:78:E7:A3>	5285 MHz
Busay Hills	Cantipla	Ubiquiti Network M5 <44:D9:E7:0A:E7:A1>	5330 MHz
Cantipla	Gaas	Ubiquiti Network M5 <04:18:D6:98:CB:21>	5765 MHz
Tuburan Campus	Gaas	Ubiquiti Network M5 <04:18:D6:8A:55:01>	5660 Mhz

3.3. Application services that the interconnectivity can handle

CTU's interconnectivity, according to the findings of the study, can handle Internet Bandwidth Sharing: Internet (Learning Management Systems, www.ctu.edu.ph, social media, email, youtube, and other online applications), Client Server Database Sharing: SIS (Student Information System), e-NGAS, e-Budget, DMCS, HRIS, Procurement, Inventory Management, and Payroll System, and VOIP related applications: PABX. According to Song and Issac (2014), since the transmission of information is sent

through partitioned slots, not only is a single data flow reduced, but the transmission distance can increase with increased antenna range. As a result, MIMO technology can increase the existing wireless network spectrum data transmission speed.

Gumaidah et al, (2012) reiterated that the higher the base frequency the higher the Signal to Noise Ratio that leads to high throughput, low packet end to end delay. The result implies that the interconnectivity system of CTU is expected to deliver broadband access services to faculty and students' customers effectively, efficiently and in an economical manner (Ahmed, 2014).

3.4. Problems met in the implementation of the University-wide interconnectivity project

Based on the result of the study, among the few issues encountered during the project's implementation were campus Internal Network stability ((i.e., local area network design and configurations, compatibility and upgrades of network devices), power fluctuation issues inside the server room, a lack of qualified personnel and manpower issues, and workstation security system updates and maintenance issues.

The result of the study compliment with the study of Song and Issac (2014) that by the small transmission distance limitation, each WiFi access point becomes a network island. Therefore, it is expected that not all campus will experience an internal network stability. In addition, Song and Issac (2014) reiterated also that CTU internet connectivity has a difficulty to a high-speed moving vehicle such as the metro, railway and bus transit system.

In this connection there is a need for CTU internet connectivity system to be enhance so that it can cater the need of the institution. According to Elkhodr et al, (2016) Mobile and wireless technologies in their assortment of low, ultra-power, short- and long-range technologies continue to drive the progress of communications and connectivity in the Internet of Things (IoT).

4. Findings

The findings of this study reveal significant progress in implementing the University-Wide Interconnectivity Project at Cebu Technological University (CTU). The investigation indicates that a 50Mbps upstream and downstream fiber optic leased line connection has been established by the Internet Service Provider (ISP), catering to both the main campus and its eight satellite campuses. The main campus is allocated a 10Mbps internet bandwidth, while each satellite campus is allotted 5Mbps, up to 40Mbps for external campuses. A wireless canopy comprising multiple wireless repeaters has been strategically deployed across campuses, enabling efficient connectivity and internet access.

Additionally, the study underscores the successful deployment of wireless links between the main and satellite campuses. An average inter-campus wireless link stability of 30 Mbps has been achieved, ensuring reliable data transmission. Installing access points, antennas, and monopole towers has facilitated this wireless connection, enhancing communication efficiency across campuses. This interconnectivity system supports a range of essential application services, including internet bandwidth sharing for learning management systems, client-server database sharing for various administrative functions, and voice-over-IP (VOIP) applications, which enable effective communication within the university ecosystem.

However, despite these achievements, the study identifies specific challenges in the project's implementation. Notably, campus internal network stability issues, power fluctuations within server rooms, a lack of adequately qualified personnel, and concerns regarding workstation security system updates and maintenance have been encountered. These challenges emphasize the need for continuous enhancement and investment in the university's information technology infrastructure. The study concludes that while the interconnectivity project has significantly improved communication and access to resources across CTU's campuses, addressing these challenges is crucial to ensure a seamless and robust system that meets the institution's evolving demands.

5. Conclusion

Based on the result of the study, CTU has an average inter-campus wireless link stability for the uplink and downlink of 30 Mbps, which shows the stability of the wireless connections of the antenna in every external campus to the main campus. A wireless repeater uses a router's existing signal to create a second network for satellite campuses by rebroadcasting it. The National Telecommunications Commission gave Cebu Technological University permission to use a Spread Spectrum to reduce interference while managing online classes. Mobile and wireless technologies, in their assortment of low, ultra-power, short- and long-range technologies, continue to drive the progress of communications and connectivity in the Internet of Things (IoT). In this connection, CTU's internet connectivity system must always be enhanced to cater to the institution's increasing needs.

6. Recommendation

Based on the findings of this study, several recommendations emerge to enhance further the University-Wide Interconnectivity Project at Cebu Technological University (CTU). Firstly, addressing the identified challenges, such as campus internal network stability issues and power fluctuations, requires a proactive approach. The institution should invest in regular network assessments, maintenance, and upgrades to ensure consistent and reliable connectivity. Furthermore, establishing a dedicated technical team with specialized skills in network management and security will contribute to the resolution of these challenges.

In addition, given the increasing reliance on digital technologies and the expansion of online learning and administrative processes, CTU should prioritize the training and development of qualified personnel. This includes equipping staff with up-to-date network management, cybersecurity, and system maintenance knowledge. Such activity will address existing skill gaps and build a foundation for the university to adapt to future technological advancements.

Moreover, considering the growing demand for high-speed internet and seamless communication, CTU should explore the possibility of gradually increasing internet bandwidth allocation to both the main and satellite campuses. This will ensure that the interconnectivity infrastructure can comfortably accommodate the evolving needs of faculty, students, and administrative functions. Additionally, continuous monitoring and assessment of the wireless canopy's effectiveness, optimizing signal strength and stability, will contribute to a consistently reliable network.

To sum up, these recommendations underscore the importance of an adaptable and resilient interconnectivity system. CTU can create a solid digital environment supporting its academic and administrative aims by addressing difficulties, improving technological abilities, and increasing internet capacity.

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