https://doi.org/10.48009/1_iis_2013_113-121

Issues in Information Systems
Volume 14, Issue 1, pp.113-121, 2013

INSTALLING INTERNET SERVICE ON A CAMPUS – COUNTRY COMPARISON BETWEEN FAIRFIELD, UNIVERSITY, USA AND UNIVERSITE ALIOUNE DIOP BAMBEY, SENEGAL

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ABSTRACT

Fairfield University and the Université Alioune Diop de Bambey (UADB) were selected by the United States Agency for International Development (USAID)/ Higher Education for Development (HED), for a project in Senegal (Appendix B), to disseminate health information to rural populations using technology through Service Learning. The project would run from October 2010 through September 2013. The main campus for UADB is in Bambey, a village 125 kilometers from the capital Dakar, and two rural campuses in Diourbel, and Ngoundiane, about 35 kilometers north and south of Bambey respectively. The remote campuses are off the only paved road in the area, and lack modern amenities. Instructors teach at multiple campuses, and they are driven in university vehicles over unpaved trails for over 40 minutes. They are then engaged in instruction for at least two hours, after which they return to Bambey. Presently, only the Bambey campus has access to the Internet via an unstable ADSL line, whereas the other campuses have poor CDMA technology (the base station is about 30km from the campus) Internet connection. The students at the Ngoundiane campus learn Math, Physics, Chemistry, Decisional Informatics, Web design, and other computer topics despite the lack of access to the Internet. As part of HED's strategy to spread education to the rural population, UADB technical staff and Fairfield University counterparts engaged in the design of a campus-wide WiFi project, and using available WiMax technology to distribute the Internet signal to the other campuses.

Keywords: networking, developing country, wireless, multi-campus

INTRODUCTION

The network project was possible only because of the funds available through USAID/HED. The effect would be transformational for the campuses and indeed the entire area. UADB has a major commitment to Service Learning (also through this grant), and as the university community serves the population, knowledge will continue to spread. Grade schools would experience the advantages of higher education through interaction with the university students serving them, and local organizations would benefit from the service projects in the courses. For the first time, campuses would be interconnected electronically, offering them the potential of application efficiencies. A region that is generally deprived of resources and lacking in educational opportunities would emerge from this project with enhanced capabilities for all segments of the population. The power of the Internet and technology could empower the rural community, with particular emphasis on the young school-age students.

METHODOLOGY

Project to acquire Internet Signal in Rural Senegal

Initial Investigation

Massamba Seck, Director of Technology and lecturer in Computer and Information Technology (TIC), started the network design in January 2012, with the campus network engineer. The first step was to investigate whether the fiber optic line in the Rector's building was of sufficient capacity to support wider campus use. However, the line was installed by the Informatics Agency of Government of Senegal, designated for the interconnection of the State's services in Bambey department (region) – see Appendix B, and not yet activated, and thus unavailable for general campus use. Seck was therefore forced to seek Internet Service Providers (ISP) who would be willing to serve the rural population. The area surrounding the university is sparsely populated by mostly poor, rural people. Many of them do not have electricity in their homes, and they must walk some distance to access potable water. Thus, the ISP

vendors were reluctant to invest in this area, since the return on their infrastructure investment would be minimal. Seck would need to seek another method of transmitting the Internet signal to the two remote campuses.

UADB currently shares a server with the University Cheikh Anta Diop (UCAD) in Dakar, about 125 kilometers away. If UADB were to run an inter-campus network, they would need a reliable, locally managed server.

Power is available on all campuses, but it frequently fails. This requires an Uninterruptible Power Supply (UPS) to be installed to protect the servers. As the university relies increasingly on its computer resources, it is imperative that access to the network is unimpeded. Each campus also has a large power generator that runs on diesel fuel.

As other institutions do, UADB must consider developing policies to control the available network bandwidth, so that critical university functions are not compromised by recreational use that is often associated with university residential areas.

A Firewall and a programmable switch are needed to do this and UADB selected the open source software "pfSense" to distribute the Firewall. pfSense is a free, open source customized distribution of FreeBSD tailored for use as a firewall and router. In addition to being a powerful, flexible firewalling and routing platform, it includes other features and a package system allowing further expandability without adding bloat and potential security vulnerabilities to the base distribution [1].

Design Process

Seck's design (appendix A) would locate the main Internet signal in the Secretary General's Administrative building, using routers and access points to distribute the signal wirelessly throughout the Bambey campus, and thereafter to distribute the signal to the two remote campuses. The next step would be to seek competing bids from reliable vendors, if possible.

Identify devices to be used
As described above, a complete system would include the Internet signal, servers, sufficient wireless access points, devices to distribute the signal to the remote campuses, switches, routers, and UPS devices as required.

Seck engaged in extensive research to determine an acceptable and affordable method of transmitting the Internet signal from Bambey to the two remote campuses. His analysis showed that the concept of Wide Area Wireless access was a viable option. In addition, he located a vendor in Dakar who might provide the devices needed for this function.

Identify vendors
In January 2012, Seck began the task of seeking vendors for each item on the list of network devices needed for the UADB network. Since Bambey is a rural area, there were no local vendors; they were all located in Dakar. In addition, Seck had to ascertain that the vendor's product was compatible with the UADB network, and that the item was available in Senegal. According to established university policy, he was required to provide three price quotations. This could be an obstacle, because for some devices, only a single vendor existed in Senegal. The ISP and the Signal distribution vendor were examples where only a single vendor existed and both were critically important devices.

The only ISP that could provide the needed bandwidth in Bambey was Sonatel [2]. They were responsive, and agreed to send a technical team to the campus from Dakar, to determine if they already had a fiber optic cable in the area. However, it was not until March 2012 - many weeks later - that this took place, and they agreed they could provide sufficient bandwidth to support the main campus and the satellite campuses as well. However, they were unwilling to install the fiber cable at the remote campuses, since the cost would be prohibitive, and no other potential customers could be located in the villages.

Hewlett Packard servers are widely used in Senegal, and several vendors were readily identified. Seck then requested quotations from three major vendors, and investigated their reputation and reliability. The model Seck

selected was DL 380- G7, on which he would install Linux Operating System, with which he is intimately familiar, having taught server management courses regularly. He consulted with the campus network engineer, and she approved of the choice of server model and Operating System, as she was familiar with both.

Research on signal distribution to the remote campuses indicated that in the absence of an ISP, the best available option was to use wide-area antennae to send the Internet signal from Bambey to Ngoundiane and Diourbel. The only vendor for such a device was Airmax [3], whose only agent was in Dakar. This device uses point-to-point transmission using TDMA technology, but the antennae must be installed so that there is no hindrance to the signal between points. The uninterrupted signal would easily travel the distances between Bambey and the other two campuses, each requiring a separate antenna.

There were several options regarding UPS vendors. Seck followed university policy by seeking multiple quotations. The order was placed January 2013, and the vendor indicated that when the payment was received, the order would be shipped within a week, since there was adequate inventory in Dakar.

Request quotation, delivery date
Once the vendors were identified, Seck was prepared to place the orders. At the time of his initial inquiry, the vendors all indicated that the material was in storage in Dakar, and available quickly. In all cases, the vendors would only consider an inquiry seriously, when accompanied by a 50 per cent deposit. In fact, that was not sufficient for a delivery date; full payment was required prior to the vendor providing a firm delivery date. The reputation of universities in Senegal for not paying the amount due has caused the vendors to require full payment when the order is placed.

At that time, some of the vendors gave delivery dates that were in excess of two months, much different from their earlier assurance that the material was in stock and ready for delivery.
This was clearly the case with the Airmax vendor, whose delivery time increased from "available now" to "minimum three months" about which, Seck could do nothing. In fact, as he asked for expedited delivery, he was quoted a price that was higher than the purchase price of the units, because delivery would require air cargo shipment from the United States. As this was perhaps the most important element of the signal distribution, the project could not be completed prior to the start of the January semester, as Seck had planned. In fact, the implementation of various Service Learning projects was negatively affected by this delay.

It was June 2012 before Sonatel's proposal was delivered to Seck after the vendor's feasibility testing. Other vendors also delivered their price quotations in June 2012. Most vendors needed onerous proof of tax exception status for the university. Even if the main campus had the status, satellite campuses would not derive that benefit and vice versa. This caused further delay, since the amount of the tax on large purchases could be significant. Finally, the funds were transferred from Fairfield University's bank in Fairfield, CT, to UADB's bank in Bambey, Senegal. However, that created an additional obstacle, in that each bank charged a transfer and currency conversion fee, thus effectively reducing the amount received in Bambey, making it insufficient to pay the amount due to the vendor. Other creative solutions would have to be developed to pay the vendors in full despite the shortage of funds.

October 2012
The orders were placed in October 2012, although Sonatel received the order in August, and installed the Internet line in December 2012. The USAID/HED funds were transmitted electronically from Fairfield University in October; however, the Accountant at UADB was unable to confirm receipt of the funds for one month, which delayed placing the orders. Inevitably, delivery dates changed once the money was received.

December 2012
Sonatel installed and tested the Internet line. The country's President Macky Sall, the University President Matar Seck, and others participated in a videoconference session using the newly installed Internet line. All participants were duly impressed; the only interruption was one of the frequent power failures that halted transmission for five minutes.

The Server was installed within a rack that houses two additional servers donated by a US organization. The installation will be completed after the UPS is installed. The frequent power failures could irreparably damage the

servers without adequate UPS protection, so the system engineer would not proceed with installation until the UPS was in place.

Once the network line was operational, intra-campus wireless access (WiFi) was available, in part, due to the access points donated by Fairfield University. These will eventually be located in student residences, administrative, and classroom buildings, so that the Internet will be widely available on the Bambey campus. The other two campuses must await the installation of the Airmax antennae so that the signal may be transmitted to those sites.

January 2013
Airmax delivered the entire shipment January 17, 2013. The components of the network for the entire project were in place. The installation would begin shortly. However, the Pylon problem will remain unsolved until the funds are provided by the Rector. At that stage, all the components would be in place and what began in February 2012 would be complete when the users are able to access the Internet freely across all campuses.

At that point, UADB would go from 0 interconnection to complete internet service, and videoconference capability. The last item will be implemented incrementally as funds become available. As videoconferencing could have a significant startup cost, in the interim, Seck is considering using services such as Skype and Google Talk to conduct classes on multiple campuses in real time. The physical and financial cost of teaching at multiple campuses could be reduced or eliminated if classes were available electronically.

The outcome of the network project with the Internet availability could present new opportunities to the instructors, students, and the communities in Bambey, Diourbel, and Ngoundiane. The students are eager to learn, and the quality of the students is excellent. In a report to the USAID/HED, we have presented the results of pretesting the population involved in the USAID/HED project. In May 2013, we will conduct post-use testing. The comparison would indicate the effect of training and technology on the rural population, most of whom had never used a computer previously.

Project to acquire Internet Signal in the United States

Unlike schools in Senegal as described above, schools in the USA had already seen gains from technology as far back at 2000 [4]. Technology helped students in after-school programs at low-income inner city Los Angeles schools achieve gains as much as wealthy schools, something not seen prior to the technology implementation. For this reason, the CEO of Classroom Connect sees technology as the "great equalizer" [4].

Finding a suitable Internet Service Provider (ISP)
While the UADB had only one ISP - Sonatel - that was willing to provide a signal to Bambey, Senegal, Fairfield University had a choice among numerous vendors who were already providing service to Fairfield, CT. While most towns in the United States have several ISPs, there are a few exceptions. For example, Nome, a town with about 4000 residents in far western Alaska, had no local ISP in their area, no road, or rail connections to the rest of the US, and only a satellite link to provide telephone service [5]. However, even this remote Alaskan town had an ISP in their area by 1996.

Laying fiber cables across campus
When Fairfield University was planning to implement a network in 1980, they asked their telephone vendor, the Southern New England Telephone Company to send a crew to lay fiber cable across campus. Fairfield University already had underground conduits connecting all the buildings on campus. The telephone company accessed these through manholes spread throughout campus, to lay their cables between all the buildings on campus.

UADB, on the other hand, could not use a similar approach. They did not have any fiber cable lines installed in the area. The closest installed fiber cable lines were in Thies, located 30 miles away. The vendor refused to lay fiber cable lines from Thies to Bambey, as the process was too cost exorbitant for a reasonable return on their investment. The World Bank has offered to help Bambey and all the other public universities in Senegal in this regard. Fiber cable lines are expected in Bambey within two or three years.

While most places in the USA did not have such issues, there are a few exceptions. The school in the remote Alaskan town of Nome, for example, had similar problems. When an ISP moved to their area, the school considered leasing a line, but this proved too expensive. There was state-sponsored network in their area, but the state refused them access for administrative reasons [5]. This can be compared to the state-sponsored line at UADB, as the only pre-existing installed Internet line in the area, which was also unavailable for use for the rest of the Bambey campus and other campuses. It may only be used by the University President for official State business.

Networking between campuses:
Universities in the US that have multiple campuses, as does Fairfield University, may easily enable an intranet with different sub-networks for each campus. Several campuses already had existing data cables installed in their area when they installed their intranet. Their ISP could enable additional IP addresses for new campuses as well.

On the other hand, UADB had no similar option. There were no existing data cables on any campus, or between any two of their four campuses. Eventually, UADB decided that the only way to implement internet access to the other three campuses was to transmit the signal over 30 miles to each of the other campuses from Bambey, using TDMA antennae.

In addition to this, Fairfield University has multiple schools on each campus, and each school has a unique IP address. The main entry point of the Internet signal on campus has a switch that directs the incoming packet to the particular building on campus based on its IP address. Each building has a switch that does the same for each floor in the building. In this manner, the Internet traffic is controlled at the source. Routers are imperative for implementing such traffic control policies.

At UADB, there is only one switch – it analyzes incoming Internet packets as well as transmits the Internet packets destined for the remote campuses using Airmax antennae. As resources permit, UADB will add switches to direct traffic and improve overall network performance.

Each building on Fairfield University's campus has its own fiber-optic cable providing it with network access at maximum speed. Each building also has wireless access. Similarly, K-12 schools in the USA that already have existing wired networks are adding wireless networks for reasons of flexibility, savings, and adaptability [6], [7].

At UADB, one building will receive an Internet signal from the ISP. From there, it has to be transmitted via dish antenna to each building separately, since there are no cables connecting the buildings. In each building, a router and access points will manage the traffic and distribute the signal for wireless access.

One US campus that had issues similar to UADB was the school at Nome, Alaska [5]. They also had to use antennas to acquire higher-speed Internet. The performance of these antennas can suffer if there are any obstructions, such as trees or buildings. Therefore, the antennas at the Nome School had to be on top of their 40-foot buildings, and on top of a 20-foot building at the ISP. The latter antenna had to be raised to 30 feet [5]. In Nome's case, however, the distance was only one mile. The signal is transmitted using line-of-sight, which allows no interruption of signal.

One advantage Bambey may have is possibly "leapfrogging" directly into wireless technology. Schools in the USA have found wireless to be more flexible, cost effective, and expandable as compared to wired networks [5], [6]. Thus, UADB is using current technology immediately, whereas institutions in developed countries were slower to adopt these technologies as they became available. Costs are lower now, than they were when Fairfield was considering wireless implementation.

Internet speed and use:
Fairfield University has a high-speed fiber-optic cable with transmission capabilities of up to one-gigabit per second, connecting classrooms, residence hall rooms, and faculty and administrative offices, providing access to the world wide web, Fairfield University's library collection, student, faculty and staff email, various databases, Fairfield University's intranet and other on-campus resources. The school in the remote Alaskan town of Nome, by contrast, initially connected using 28.8 kbps modems through the University of Alaska. This only allowed a few computers to stay online at a time. By 1998, they had moved up to 2 Mbps through an ISP [5].

UADB has one four-gigabit line for all their campuses. They currently do not have an intranet or their own email; instead, they use personal email accounts for official work. Bambey hopes to start with email, and then add administrative applications to connect all campuses for the first time. They also hope to engage in videoconferencing to conduct classes over the Internet.

Electric Power:
Most Universities in the United States do not have trouble with electricity. Even in cases of unusual weather, for example Hurricane Sandy in 2012, when the town of Fairfield, several parts of Connecticut and New York City lost power for weeks, Fairfield University had a backup generator providing electricity to the residence halls and offices with minimal disruption. The most changes that the University needed to make were to add outlets in a room to accommodate a lab. Fairfield University is currently planning laptop classrooms and is installing power outlets on desks so that students can plug in their own laptops, which they carry to all classes.

Senegal has very unreliable electricity supply all over the country, including the capital, Dakar. The government supplies power through its Energy Ministry, and there are frequent power cuts. UADB, therefore, acquired a large generator for each campus, to supply electricity during power cuts.

Funding:
At Fairfield University, the original investment in the infrastructure was covered by the University Computer Center's budget. Funding for additional facilities is now each department's or school's responsibility. Schools pay for servers as required, and the overhead covers the access points across each building.

At UADB, on the other hand, most of the funding was through USAID / HED, whose mission is to improve the education in rural areas of Senegal. The funds were transmitted via bank-to-bank transaction from Fairfield to Bambey. However, the amount received in Bambey was lower than the invoiced amount because the bank at each end deducted a fee for the conversion.

The school in Nome, Alaska, was one of the schools in the US that could not fund their own Internet infrastructure due to the problems outlined above. They have received state grants to help with the installation of wireless LANs [5].

CONCLUSIONS

UADB in Bambey Senegal is completing installation of their campus Internet service in 2013. Technology is over a decade more advanced than when Fairfield University and most other academic institutions in the US installed their campus Internet networks, and UADB has an opportunity to 'leapfrog' directly into more advanced technology. However, UADB still faces numerous problems, including funding, organizational, and infrastructure issues. Funding problems include the issue that USAID/HED provides funds for some activities, but not for others. The Senegalese government provides all the funding for UADB operation, but the funds are inadequate and often delayed in delivery. Organizational issues include the delays caused by Sonatel, Airmax, and UADB's internal administration. Vendors require full payment before work would begin, leaving the customer with little leverage if the vendor does not meet expectations. Infrastructure issues include the lack of installed fiber cables in the country and the frequent power cuts in the government's power supply. In these respects, UADB's challenges are more akin to those the school in the remote Alaskan town of Nome faced over a decade ago, than other campuses in the USA.

What UADB is currently facing as they implement an inter-campus network with Internet access, is what most US schools and institutions faced over twenty years ago. Further, the US has far greater resources than does Senegal, and the school systems in the US are better funded than their counterparts in Senegal are. Despite all the challenges, UADB has made major strides with the timely help of funds from USAID/HED, and talented and dedicated employees at the UADB. The expectation is that by October 2013, all UADB campuses will be using the Internet for various purposes and in addition, they will use videoconferencing between campuses to present courses to students for whom travel between campuses would be difficult since there is no transportation other than animal drawn carts. The power of education to raise the dignity and enhance the knowledge of the rural population would be a lasting legacy of this project.

Disclaimer

HED is supported through a cooperative agreement between the United States Agency for International Development and the American Council on Education. The information provided in this article is not official U.S. Government information and does not represent the views or positions of the U.S. Agency for International Development or the U.S. Government.

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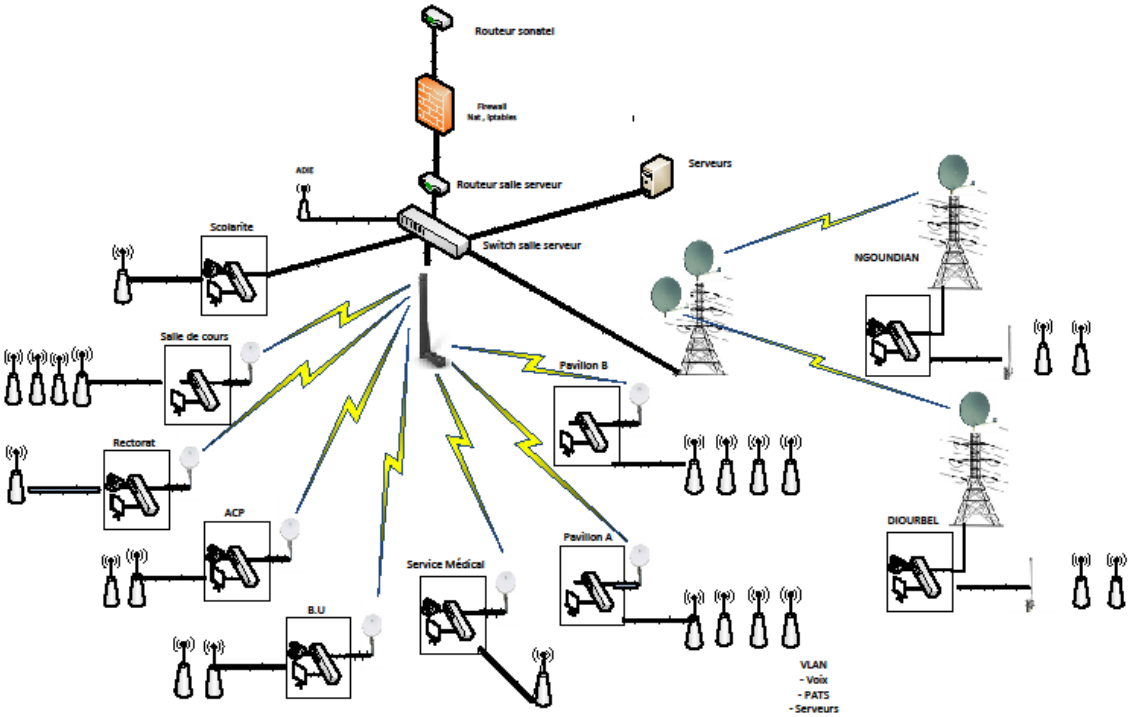
APPENDIX A
Network Diagram



LEGENDE

NOM	NOMBRE	SYMBOLE
AMO-5G13 + Rocket M5	1	
AP	23	
AMO-2G13 + Rocket M2	2	
NanoBridge M5	7	
RocketDish 5G-34	4	
Pylône	3	
switch	11	

APPENDIX B
Departments of Senegal

http://www.bing.com/images/search?q=senegal+department+map&qpvt=senegal+department+map&FORM=IGRE