Wireless LAN and Power Line Communication platform for e-Learning multimedia system in underdeveloped area in Lombok Island

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Abstract
This paper presented a report about a multimedia project carried out in underdeveloped area in Indonesia. We first explained assumptions of the project, then followed by discussion on network design issues using wireless LAN and Power Line Communication (PLC) based the assumptions. The network design then would be a platform for the e-Learning applications we created based on feedback from local people, to address digital divide in the area of Lombok Island. Problem and challenge encountered from network design issues and applications would be addressed including lesson learnt.

Keyword
wireless LAN system, power line communication, rural area, digital divide, e-learning, tele-education

1. Introduction

This paper was a report about an experiment and implementation project sponsored by Asia-Pacific Telecommunity with main goal is: 1) To connect through broadband link between University of Mataram, and two rural High Schools to enhance educational system in Lombok islands and to obtain better access for educational institution expertise; 2) To examine the usefulness of Power Line Communication (PLC) and Broadband Wireless LAN in the difficult terrain, bad geographical conditions and lack of human resource; 3) To enhance the knowledge and skill in e-learning, and service using IP Technologies; 4) To motivate human resource exchange and development. Through these exchange programs, both Indonesians and Japanese institutions can get required knowledge to narrow the "Digital Divide" in developing countries by using ICT.

This project was following up projects with the similar theme in another country, Malaysia [1] and Vietnam [2], carried out in 2002 and 2003 respectively. We also reflect our experiment with others [3].

40% of the world population lives in rural and remote areas of developing countries, some in an area that far from the epicenter of advancement in information and telecommunication especially represented in the form of communication through the Internet. With growing common sense that the Internet seen as a driving force to advance civilization of humanity, leaders of the world already pointed the needs to link everyone in the world especially those in rural area.

Through this experiment, we tried to address digital divide in rural or underdeveloped region. The experiments have 2 advantages: communication systems implemented will expand knowledge sharing; the e-Learning system then would at the same time expand learning experience and empower the people.

In addressing digital divide, we have thought that there should be a place or some places with source of knowledge for the benefit of the rural place. The absence of that kind of knowledge sources, will lead to failure of addressing digital divide. Thus, we come forward with an assumption that in addressing digital divide, rural area should have one or more center of knowledge which will support or lead them.

In this experiment that take place in Lombok Island of Indonesia which is located next to Bali Island, we assume the role of knowledge center to Mataram University. The university located in the capital of the island, which is Mataram city. The university will be the source of knowledge for their community. As we expand the experiment, through using advancement in network technology, the role can be carried out also outside the boundary of land.

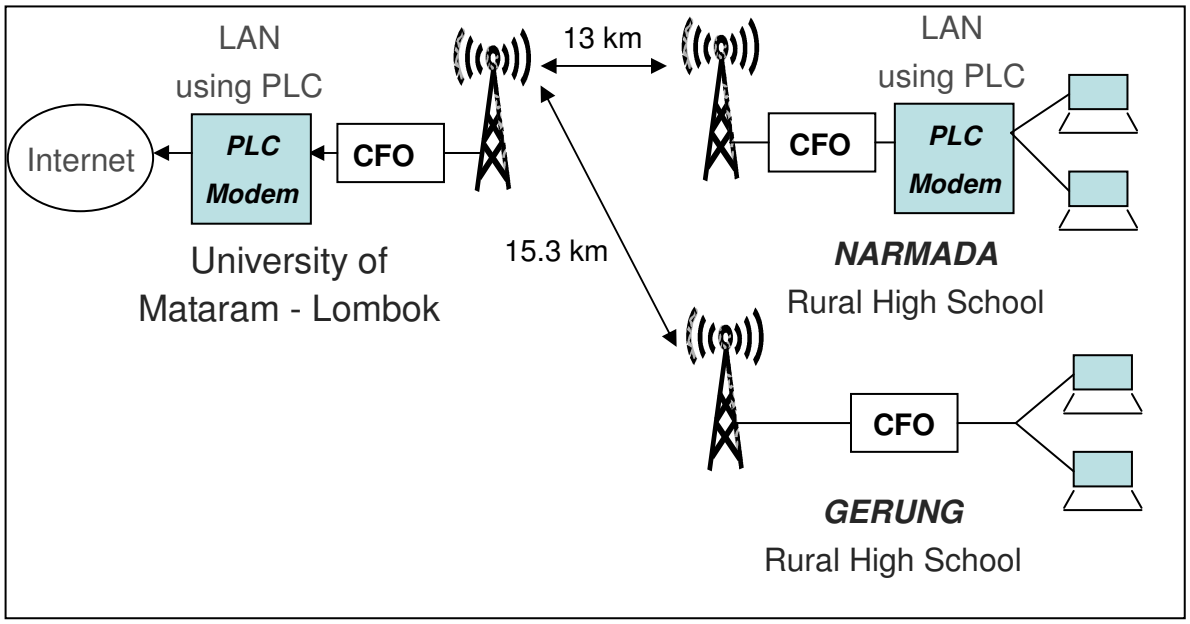

Figure 1: Experiment concept – network platform

We would discuss it later in conclusion and future work section.

We chose 2 high schools as our partner in this experiment, in Narmada (Narmada rural high school) and in Gerung (Gerung rural high school). Both rural high schools were located in a remote rural place.

In our survey, we found out that the schools suffer from: lack of teachers that made a teacher must handle a lot of subjects though he or she was not capable teaching it; and lack of equipment including material to study such as books.

2. Network Platform

From the assumptions and facts we found out through surveys in the rural area, we drew an experiment concept like in figure 1.

We used two systems for our experiment network, PLC network for short range network needs and wireless LAN network for long range network needs. We used PLC which is Home Plug 1.0 standard compatible modem for our experiment with 11Mbps. For wireless LAN system, we used KDDI developed unlicensed 2.4GHz long-range 10Mbps CFO-SS10A with range over 15 km limited only by line of sight and earth curve barrier.

PLC

Before using PLC in the project, we found out that the existence of power breaker for power network segmentation, as we could find in modern building, will have a lot of impact to PLC network performance as it will downgrade data throughput. Thus we made a survey of electricity cabling condition of the building.

Almost in all the building, the condition was not very good quality, as the breaker for power line segmentation was very limited or almost nowhere in the building, possibly this was due to save cost and maintenance. On the other hand, this created a good chance to use PLC. We notice that even for a long range, the downgrade was still acceptable, between 20%-50% lost.

CFO-SS10A

Specification for CFO-SS10A: modulation Carrier Frequency Offset-Spread Spectrum; access control CSMA/CA; Bandwidth 26 MHz; Data speed 10 Mbps; antenna gain maximum 24 dBi.

Network connectivity

We had arrangement with Mataram University to connect the experiment network with their network. Nevertheless, the experiment network is separated by network segmentation with to goal for manageability and expandability.

For testing purpose, we put also 3 set of SIP based IP telephony, as we can see in figure 2.

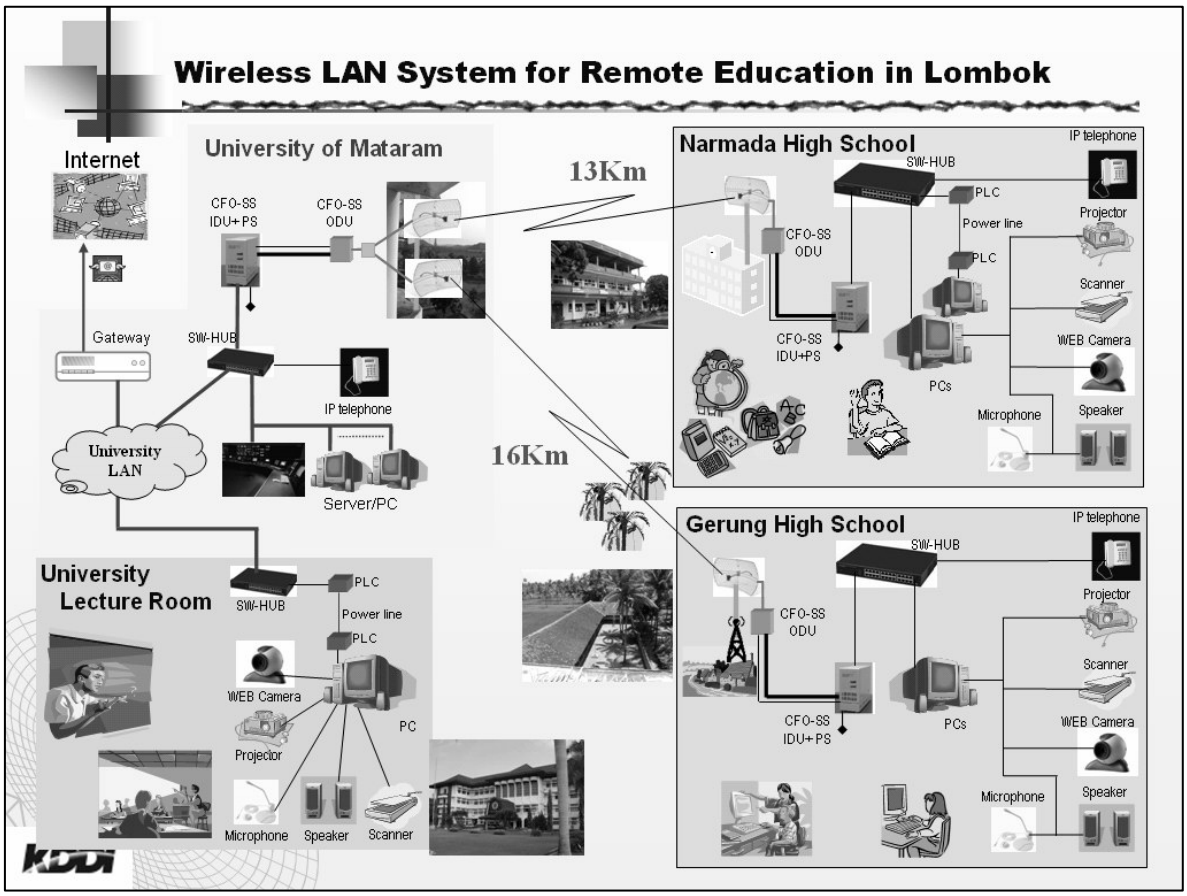

Figure 2: Network Topology

3. e-Learning Application

We had a survey on what kind of applications the teachers and students will need, and found out that 2 kind of applications is in need most: an application for bi-directional communication in learning process and an application for managing the learning process.

Remote Interactive e-Learning Application

As our primary premise is university as a center of knowledge in a rural area, thus connecting between rural people and the knowledge center is a must have application. Human tend to interact in multimedia, not just with voice or even just with word/letter. In this condition, video based application is one of a must have application.

The other good aspect is interactivity of video application, therefore between a student and the teacher can have an interactive communication using voice and also gesture. Nevertheless, as we have bandwidth preservation issue, in this application, only the teacher is limitless in his/her interaction and students can only have chat to communicate with the teacher.

The specification for the application is:

- Shoutcast based Linux server
- Apache server with PHP module
- Multimedia computer (soundcard, webcam)
- Open source tool for transmitting audio-video to server (vp3 codec, mp3 codec, nsv tool)
- Web browser (preferably Internet Explorer)

Through figure 2, we could see that cameras were put in Lecture room in university, and in class rooms of 2 participating high schools.

The students interacted with the teachers through a web page that host a video session in a frame and a text based 'chat' session in another frame. Both frames were in the same web page.

Teachers would have their teaching instructions through video, and students could respond to those instructions through the text message.

In every end point of class room, there should be a monitoring teacher who would guide and monitor

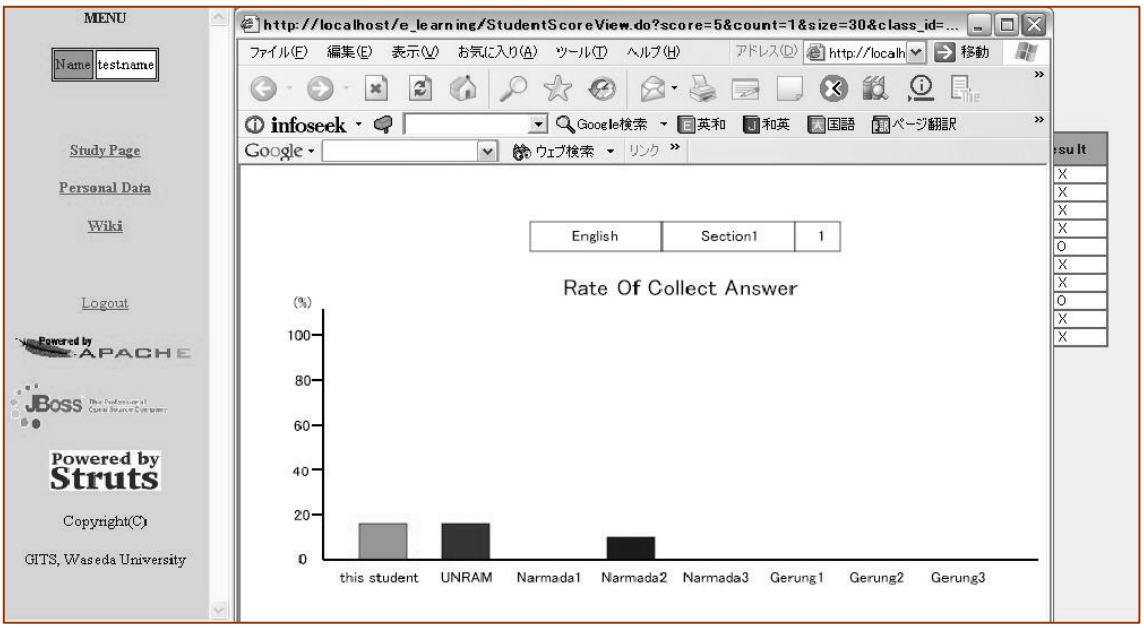

Figure 3: Screenshot of Course and Student Management Application

the students through class session. For classes that did not have a lot of computer for students, the teacher there could be inputting interaction message on behalves of students.

Course & Student Management Application

Main purpose of this system was supporting teacher's work and student's study in rural areas. Compared with the number of students, the number of the school teachers was insufficient. We had also problem with teacher's capability. So we had to develop the system which satisfies teachers and students to be able to take more efficient learning. A lecture was distributed to each school from University of Mataram using network built by Wireless LAN system and PLC. Yet, maybe a remote lecture is not enough. In the educational point of view, the opportunity for managing and reviewing is indispensable for teachers and students.

The specification for the application is:

- Tomcat 5.0.28 for application server
- JBoss 4.0 for EJB (Enterprise Java Beans) server
- Pukiwiki 1.44 for information sharing application
- MySQL for Data base server

The system can manage students, and at the same time can also be used as a tool for examination. The teacher can upload his/her question-answer through inputting the question, or for complex question answer like math formula, they can put the image of question-answer problem which already be scanned. This capability would make teachers could focus more on teaching than on input process of the system.

We also provided Wiki system in this application so teachers and students could have shared projects.

4. Result and Evaluation

Network Platform

We tested the PLC, and surely PLC is recommended for use in rural area, as almost electric infrastructure of building in rural area was streamlined compare to infrastructure in big city. We could get an acceptable throughput of about 5Mbps in some point-to-point.

Connecting 3 point with each has around 13km and 16km, made the throughput downgraded from its ideal throughput. We could get 3Mbps, and it was still acceptable by complement it with a high compression video codec like open source video codec vp3 with audio codec mp3 that in total just need around 500kbps.

E-Learning Application

For Remote Interactive e-Learning Applications, almost all the teachers said that they impressed with the applications (95%), with 80% of the students have similar opinion. Students had more objections especially they wanted a bigger picture of video in

the page.

For Course & Student Management Applications, almost all the teacher and students impressed with the applications (92% and 95%). Main objections here was the limited availability of computer made it difficult for them to use the applications.

Lesson Learnt

In the course of the project, we face a few problem like connectivity and adjustment with distant between each point of university and rural school. The other problem is interference with other wireless LAN system on same frequency band. This problem aroused because Lombok Island is underdeveloped in term of telecommunication infrastructure. Telephone fix line is limited mainly in town. Therefore, some telecommunication service providers rely on wireless technology. Unfortunately, there is no clear law about wireless technology, or the law is not effectively put in place. As a result, we had to face a wireless environment without clear channel frequency allocation. In other term, some wireless frequencies interfere with ours. We understand that every place even in rural area have their own custom and rule that the outsider cannot interfere. Nevertheless, we believe a strict rule of the game is needed to make all the user of wireless network can coexist between each other. The need of a government's active and proactive participation is important here. On the important role of the government is making the rule of the game, and also important is overseeing the rule is put into effect no matter what.

Connectivity with Internet is also an interesting point to reflect. Mataram University only has internet VSAT link to satellite, so the bandwidth is very limited. Therefore, we cannot use video-to-video between Japan and Lombok, as it will be saturated the already limited bandwidth.

Last but not least, the problem we encounter was about an unbalanced impedance of power line cable. These power problems made some equipment broken, and have to be repaired back in Japan.

5. Conclusion

Through this project, we have proved that an existence of one or more center of knowledge will help in addressing digital divide.

We already made a successful preliminary experiment of e-Learning collaboration, where we interact with each other using web base application.

In rural area as well as urban, Remote lecture and e-Learning with recent IP network and Personnel Computer Technologies are extremely effective in education system while teachers are lacking, and this would encourage students also teachers in rural area to learn ICT technology realistically and practically.

Future Work

As collaboration using Internet was very attractive to implement, we plan to have some trial experiment in the form of tele-lecture and discussion between Mataram University and Waseda University. After that, we will expand to include the rural schools. We hope this experiment will go further in the future.

By drawing more rural school to this scheme, and attracting more universities to join, we hope that this will be a model for future collaboration in addressing digital divide.

6. Reference

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