Development of a VSAT Based Virtual E- Learning System: (ARCSSTE-E as a Case study)

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Abstract— *In this modern age, Information and communications technological innovations have turned the world into a small global village. E-Learning is one of the by-products of ICT and has been widely recognized as a valuable tool for learning and training other than the traditional method of learning (which involves physical contact between the student and the instructor). This paper presents the design of virtual classroom interface for teacher and student interaction using VSAT technology, which offers a tremendous potential to provide high-quality education to remote areas in Nigeria and Anglophone countries in Africa. Virtual classroom is a form of e-learning that acts as a supplement to the traditional learning methods, whereby, the physical contact is elusive and yet the classroom management is effective. The case-study for the proposed system is ARCSSTE-E. A conceptual framework for ARCSSTE-E is proposed and is developed to enhance and reach out to people within developing (Africa) countries that cannot make it to ARCSSTE-E due to constraint in time, distance, lack of sponsorship, Financial or other challenges. The study confirms the relevance of the growing interest in the use of virtual e-learning system for distance education.*

Keywords—*Virtual classroom, VSAT technology, E-learning, Anglophone countries, ARCSSTEE*

I. INTRODUCTION

The advancement in technology has increased dramatically in every sphere including mainstream education. Presently, in Nigeria, very few conventional universities make use of ICT to carry out academic activities, while for some, the urge to embark on e-learning is still a dream yet to be realized because the infrastructure for ICT's is very weak or unavailable [1]. The rapid expansion of ICT in Nigeria offers an opportunity to consider its use in the promotion of e-learning [2].

E-learning is an acronym for electronic learning. It is an aspect of virtual classroom that is concerned with sharing of knowledge electronically by use of text,audio, video, web or any other IT tools.

The African Regional Centre for Space Science and Technology Education in English (ARCSSTEE-E) was inaugurated in Nigeria on 24th November, 1998 and affiliated to United Nation (UN) Office for Outer Space Affairs (OOSA), the centres aim is to build a high quality critical mass of indigenous space scientists/educators in English speaking African countries for the development of various application of space science and technology for sustainable national and regional development.Thus, the centre plans to achieve this by developing skills and knowledge in four prime area of space science technology which are; Remote Sensing/GIS, Satellite Meteorology and Global Climate, Satellite Communication and Basic Space and Atmospheric Sciences.

So far, Arcsste-e has graduated Four Hundred and Twenty One (421) students in both Master and Post Graduate Diploma (PGD) in the aforementioned areas of disciplines since its establishment. Today, as a result of technological advancement and the need to cater for distance and mainstream education there is a need for e-learning solutions for ARCSSTE-E as supplement to the traditional method of teaching and learning as a means of reaching out to people within Anglophone countries.

The paper presents the design and implementation of virtual classroom application for teacher and student interaction using VSAT technology. The remaining of this paper is divided into four sections. The second section provides an overview of related work in the area of e-learning systems and VSAT technology. The third section provides the determination of technical requirement for a VSAT based eLearning system and presents the design and implementation of virtual classroom application using VISUAL BASIC 6.0 Programming Language (Enterprise Edition). The fourth sectionpresents and discusses the experimental results obtained and finally, summary and conclusion are found in Section 5.

II. LITERATURE REVIEW

This section gives an overview of the research work which has been carried out in the area of E-learning.

A. E-learning Systems

E-learning has become an important part of modern educational system. It is a means of education that contains self-motivation, communication, efficiency, and technology [3]. E-learning is efficient as it eliminates distances. Distance is eliminated because the e-learning content is designed with media that can be accessed from properly equipped computer terminals, and other means of Internet accessible technology [4]. Technology used to implement instruction is not limited to only web-based materials. E-learning can be achieved by utilizing any form of technology that sustains information yielding media [5].

A virtual classroom as described by [6] is aLearning system that provides the same opportunities for the teaching and learning process, beyond the physical limits of the physical classroom walls.

Consequently, physical classroom features have been transformed into a virtual classroom with enhanced features. Virtual classrooms give the learners the flexibility of attendance at their convenience [7].

The design and implementation of a virtual classroom system for Covenant University in Nigeria was proposed by [8]. The system was developed using PHP (Personal Home Page-Hypertext Pre-processor HTML-embedded scripting language) and MySQL (My Structured Query Language) as server side programming and database respectively. The web-based virtual classroom provides a web enabled interactive model for e-learning in which the course material is presented using multimedia and hypermedia.

An Architectural Design of an Integrated Virtual Classroom System was developed by [9]. In theirpaper, e-Learning tools or features are used to enhance interaction. These are namely; Entry login screen, User registration module, Course registration module, Course category screen, Virtual classroom screen, Assignment module, Chats, Forums, Quizzes, Blog & Glossary module.

A unique feature presented by [10] was selected to aid interaction in a virtual classroom system. The feature (hand raising tool) was used in this research to act as a form of notification in real time mode to indicate that the student have something to say or wants to ask a question or answer a question about the lectured delivered.

III.METHODOLOGY

This section presents the methods and procedures which were used to achieve the design and implementation of the VSAT Based Virtual E-Learning System.

A. Determination of Technical Requirement for a VSAT Based E-Learning System

The primary data was sourced from Interactive interview conducted for some lecturers and students of ARCSSTE-E.

The questions asked were on the learning tools and the features, students and lecturers would like to have on the virtual classroom interface that will aid learning and interaction in the virtual classroom.

While the secondary data was sourced from online materials on VSAT based e-learning systems and NIGCOMSAT 1R (Nigeria communication satellite).

B. Design Phase for Virtual Classroom System

The design phase for the virtual classroom application was developed in Visual Studio 6.0 environment using VISUAL BASIC 6.0 Programming Language (Enterprise Edition).

The design was based on the required features by Students, Lecturers and some features used in some of the reviewed papers as mentioned in [9 and 10]. The application consists of the login interface, instructor/student interface and the live e-classroom transmission for both instructor and student interface. The VSAT architecture is presented in Figure 1. The connection between the various are linked together with arrows showing the different technical tools which will be used to implement the proposed e-learning virtual classroom system. The proposed system is implemented using Microsoft Office VISIO professional 2003 software. Time Division Multiple Access scheme (TDMA) was used for allocating a fixed time plan to each VSAT station for the purpose of efficient information broadcast.

i. *Virtual classroom E-Learning system for ARCSSTE-E*

The VSAT architecture in Figure 1 shows the link via which the ARCSSTE e-Learning application can be launched via satellite. The instructor is connected to the satellite via an uplink using the network facilities in the studio. The satellites relay the information via the downlink to the various receiving VSAT stations. The information to be transmitted from the instructor, be it text, video, or audio is converted using the modem. The modem modulates the analogue signal into digital signal to the uplink antenna which transmit the IF (Intermediate Frequency) signal to the satellite. The satellite receives the signal, amplifies it and retransmits to various receiving earth station via down link antenna. The modem demodulates the RF (Radio Frequency) signal and transmits the signal to the server which is connected to the wireless antenna via which the various users access the information.

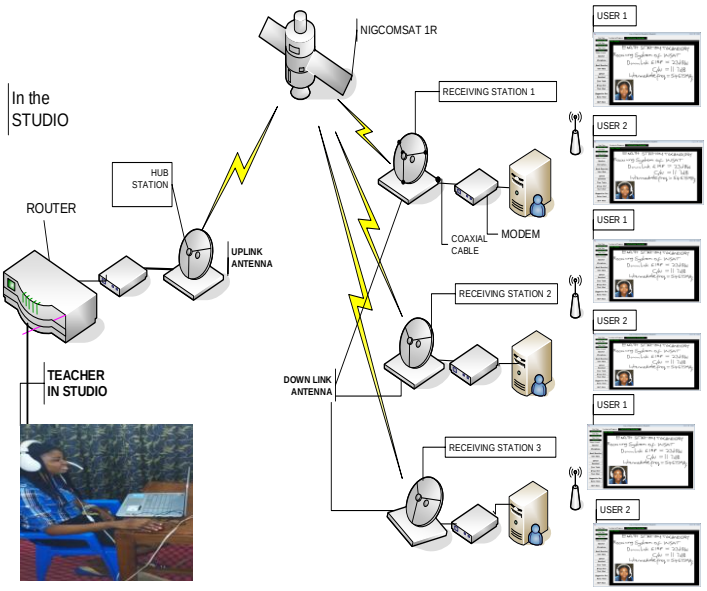

Figure 1: VSAT Architecture for ARCSSTE-E E-learning platform.

IV. RESULT AND DISCUSSION

This section presents the results obtained from the experiment.

A. Virtual Classroom Application

i. *Log-in Interface*

The log-in interface demands you input your username and password to enable the user access to the instructor and the student page. Here, the instructor and the student can sign-in to the platform and also exit the platform. The interface is shown in Figure2.

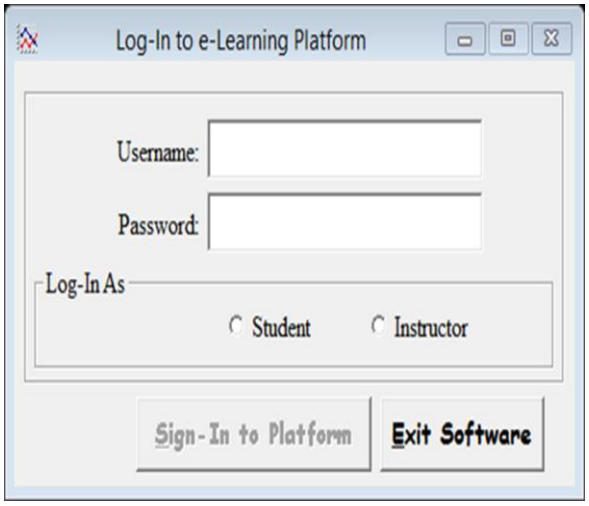

Figure 2: Screenshot of log-in interface to the developed E-learning platform.

ii. *Instructor Interface*

When the instructor logs into the interface, the instructor interfaces with his/her graphic user interface (GUI) as shown in Figure 3. On the interface, there is a list of ARCSSTE-E programmes and courses registered for lecture in the classroom. The instructor will select the programme and choose the course he/she wants to lecture the students and then click on create e-learning classroom to enable access to the class.

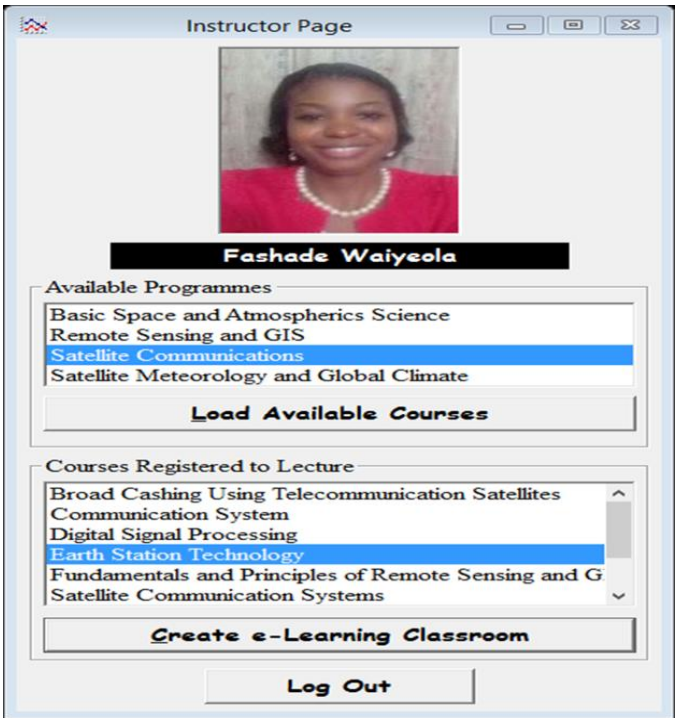

Figure 3: Screenshot of instructor interface for virtual e-learning.

iii. E-Learning Classroom Transmission for Instructor

On the live e-learning classroom interface for the instructor, here the lecturer or instructor navigates freely within the virtual classroom environment. The screen consists of the following features as shown in Figure 4. Using the audio (speaker, microphone and volume control), video display, or the whiteboard, the instructor is able to present, tutor or broad cast to the students in attendance in the e-learning classroom. Furthermore, the instructor is able to view the suggestion of the students, view answers, send quiz, upload (media materials, reading materials, result and assignment), download and view notifications or hand raisers (Students that have questions to ask the lecturer).

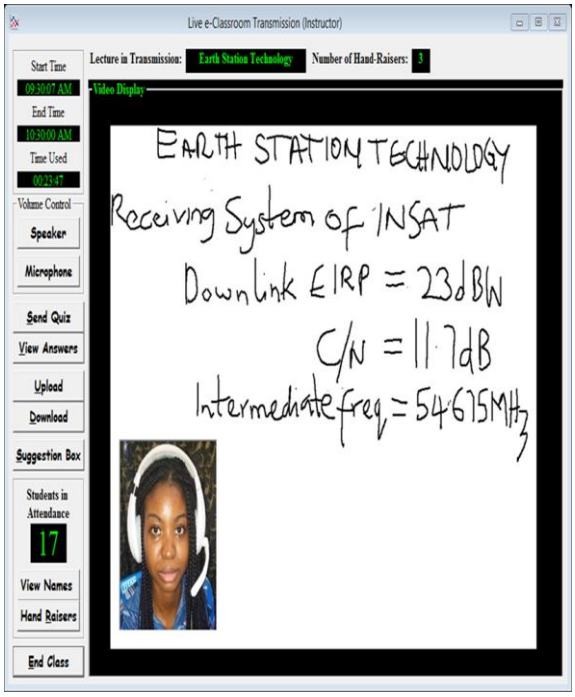

Figure 4: Screenshot of the live virtual classroom for instructor.

iv. Student Interface

When the student logs in, the student interface comes up to enable user interaction as shown in Figure 5. In the interface, there is a list of ARCSSTE programmes and courses registered for lecture in the virtual classroom. The student is required to select the program and then choose a course he/she wants and then click on the "attend e-learning classroom" to access the classroom.

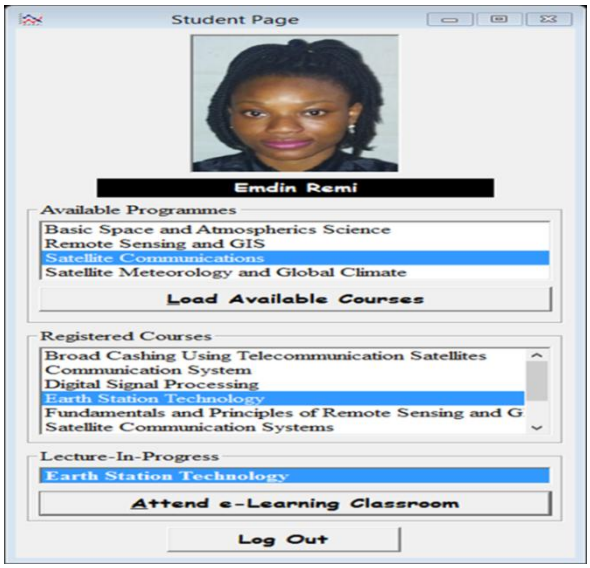

Figure 5: Screenshot shows the student interface

C. Calculation of the TDMA for Each VSAT Station

The following values were obtained from the experiment carried out.

For the Time Division Multiplexing Access scheme (TDMA) the initial paramters are;

NigComsat 1R Transponder C-bandwidth $= 36MHz$

Video bitrate $= 268kbps$

Audio bitrate $= 32kbps$

one TDMA fame $=$ one sec $= 1000$ms

Time guard $= 20$ms

The hub equipment computer as shown in Figure 1 tells each VSAT station what particular time slot to use in the TDMA frame and this time plan information is broadcast to all stations periodically.

The total capacity of the TDMA frame for the HUB station (Master station) is 1000ms. The HUB station allocates the time slots to the various VSAT stations and the TDMA has an interval of 20ms as the time guard between each VSAT station. For this work, the burst period of each VSAT station is 60ms, 180ms, 200ms, 220ms and 240ms respectively as shown in Figure 6.

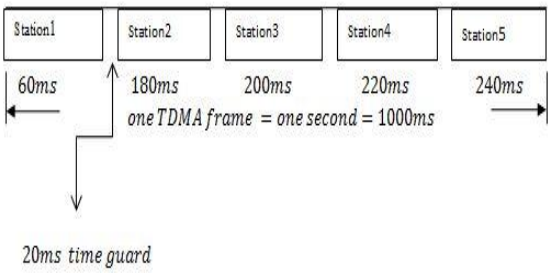

Figure 6: shows the TDMA frame and time slot allocated for video and audio bitrate for VSAT stations.

The Video bandwidth/ bitrate $N_{BR} = 268kbps$ and the Audio bandwidth/ bitrate $N_{BR} = 32kbp$Transmission rate $(T_r) = t_b \times N_{BR}$, where$t_b$ is the Burst period given as$60ms$. Table I gives the obtained values for each VSAT receiving center/station for video communication.

VSAT Station 1 transmits a video burst, starting at the beginning of each TDMA frame. The burst lasts 60*ms*, so at a bitrate of 268*kbps*, Station1 sends 16,080 bits per burst, or 16,080 bits per second.

Table I: VSAT Stations Transmission and Burst Period for Video Transmission

VSAT STATION	TRANSMISION RATE (T_r) in bps for Video	BURST PERIOD in (ms)
1	16080	60
2	48240	180
3	53600	200
4	58960	220
5	64320	240

For efficient Audio communication the Bandwidth and burst period obtained is given in Table II. VSAT Station 1 transmits anaudio burst starting at the beginning of each TDMA frame. The burst lasts 60ms, so at a bitrate of 32kbps, Station1 sends 1920 bits per burst, or 1920 bps. The same process is repeated for the other VSAT stations namely 2, 3, 4 and 5.

Table II: VSAT Stations Transmission and Burst Period for Audio Transmission

VSAT STATION	TRANSMISION RATE (T_r) in bps for Audio	BURST PERIOD in (ms)
1	1920	60
2	5760	180
3	6400	200
4	7040	220
5	7680	240

The results obtained as shown in Table I and II respectively, show the transmission rates for video transmission is 8.375 times greater than that of the audio transmission which is comparatively lower than the video transmission rate as shown in Figure 7.

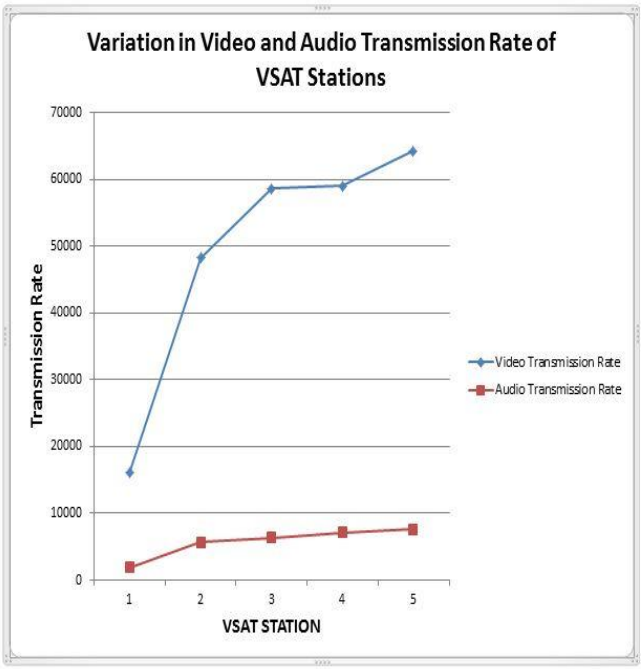

Figure 7: Variation in Video and Audio Transmission Rate of VSAT stations.

The ratio of the video transmission rate to audio transmission rate of VSAT stations is 8.375. This means for every 1bps of the video transmission, 8.375 of the audio is transmitted at the same time. Therefore, the video transmission will require more bandwidth than the audio transmission.

V. CONCLUSION

In this paper, we have presented a framework for the design and implementation of an integrated virtual classroom system for delivering lectures, issuing and controlling assignments, with chatting capability for ARCSSTE-E. The VSAT, WAN and Internet communication channels if implemented on a large scale will provide facilities for ARCSSTE Tele-Education and enables the live classroom session to be broadcasted in Nigeria and other Anglophone countries. The future is bright for Nigeria in term of information sharing as regards the launching of the NigComsat-1R – a communication satellite that will enhance the information sharing and dissemination ability of the country.

RECOMMENDATION

The following recommendations are made based on the study:

1. Adequate info-tech facilities should be provided for ARCSSTE-E and the centre should intensify ICT training for resource persons.
2. Recognition given to certificates acquired through distance learning is still very low. Government may have to create new legislations and

guidelines for the implementation of e-learning and virtual classrooms so that the certificates obtained through e-learning can be universally acceptable.

3. Using NigComsat 1R (a communication satellite), the mother agency of ARCSSTE-E, National Space Research and Development Agency (NASRDA) in collaboration with Nigeria Communication Commission (NCC) should provide adequate VSAT station for ARCSSTE-E to implement the virtual e-learning platform application to interconnect all students' and lecturers' for virtual learning.

4. ARCSSTE-E should ensure constant power supply for the platform.

ACKNOWLEDGMENT

Authors wish to acknowledge the support provided by African Regional Centre for Space Science and Technology Education in English and the Information Technology and Communications Unit, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria.

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