

## Design Architecture for the Development of an mLearning Infrastructure for the National Open University of Nigeria.

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### ABSTRACT

The shift towards technology enabled-learning has continued in geometric progression as more institutions globally sets up learning platforms that are powered and supported by ubiquitous technologies and the internet. This paper builds on our efforts at identifying the research gaps in development architecture for mobile learning (mLearning) systems. We Using the National Open university of Nigeria (NOUN) as testbed, this paper presents the design Architecture for the development of an mLearning infrastructure for (NOUN). elucidate cogent parameters and infrastructure as well as architecture and methodology that must be in place in order to develop a viable mLearning System. We conclude with a symbolic representation of the main system components

**Keywords:** Design Architecture, Development, mLearning Infrastructure, NOUN, Nigeria.

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### 1. INTRODUCTION

MLearning is a new educational paradigm which is more flexible than learning using the desktop computers. It is moveable from one environment to another such as classroom to outdoors and vice versa. Hence, a seamless learning potential is realized, where the technology mediates between the learners and the learning content; the learning is flexible and adaptable so that teachers and students are not bound to a particular learning space. Learning while being mobile and through the use of mobile devices (such as Mobile phones, PDAs, Smart Phones, Tablets, Palmtop, Laptop or even digital cameras) are considered to be independent of time and location, as it could occur at any time and in any place. It also provides access on demand of learning content to learners. (Akinyede, 2010). MLearning technology is portable as the name suggests and it is wireless. Learners are able to move around with these learning tools. MLearning can be viewed as the focal point, where mobile technologies and web-based learning intersect to offer anywhere anytime instant on-demand educational information.

It can be generally defined as the acquisition of any knowledge and skills through the use of mobile devices anywhere anytime that results in an alteration in behavior. According to (Brown, 2005) “mobile technologies have the power to make learning even more widely available and accessible than we are used to in existing web-based learning environments”. According to the report NCC of 2011, more than 90% of Nigerians own at least one mobile phone and mobile phone usage peaks in the range from 16 to 45 years, where 70% of this age group regularly uses a mobile phone.

The majority of Nigerian University Students fall in this age group thus making mobile phones the most commonly used device among University Students. Therefore, National Open University of Nigeria should take up the challenge to use these mobile devices, specifically mobile phones to provide and offer learning services. New technologies are constantly being developed and produced; examples of different mobile devices that could be used for learning today include; Mobile phones, Ipads, Mp3, Mp4, PDAs, GPS, and Organizers to mention a few. With the rapid advancement of new technologies, you generally will only need one mobile device which will be capable of integrating many features to support learning.

Therefore, learners need not have multiple devices but rather one mobile device which will be able to meet their needs, as a standard phone in today's market is equipped with much functionality which if used effectively, can make learning an easy process. Most hi-tech mobile phones, currently available like the 3G iPhone, the Android, the Google G-1 phone or any smart phone, contain the functionalities to help the users perform many tasks and allow them have access to information as required anytime and from anywhere. This access to information is normally achieved in an interactive way, where the mobile phone user feels in control of handling the accessibility, management and sharing of resources. Today mobile devices have some unique features which make them an efficient device capable of providing, sharing and exchanging of learning content.

At the National Open University of Nigeria (NOUN), most students are meant to read and understand their course materials independently. Students are only facilitated when they are up to fifty (50) or more in a class thus making it difficult for those students, who are not taught, to comprehend most of their course materials. Hence, the need for NOUN to develop an interactive online video conferencing platform from which students can interact anytime with their course facilitators and each other on their mobile devices, irrespective of how many they are or where they are located. In Nigeria, the problem of accessing education poses a major challenge to development.

## **2. RESEARCH METHODOLOGY**

Research methodology has to do with the means necessary to systematically proffer step-by-step description of how solutions to actualize stated objectives of a research work will be carried out. It is sometimes perceived as trying to understand how research is scientifically carried out. It outlines the various steps that are painstakingly adopted by the researcher in achieving the objectives of the research along with the logic behind the adopted methods.

### **2.1 Research Design**

Nest we chronicle the steps for our research design as follows:

1. Concept mapping techniques were used to integrate elements into functionally dependent aggregate that facilitated the design of the proposed mLearning model with Microsoft Visio.
2. Identification of all components that will make up the proposed mlearning model by extensive and exhaustive analyses of various mLearning models. Consequently a schematic outlay of the proposed model was done.
3. Extensive Interviews with experts in the field of M-learning were conducted and vital information and directives were gathered that facilitated the design of the mlearning model.
4. Appropriate correlation of the various components of the new mlearning model to each other so as to design the proposed mlearning model was executed.
5. Document Engineering was used for specifying, designing, and implementing the models of documents that use Internet information exchange mechanisms to request or return the results of transactions.
6. Comparative analysis was employed to describe, analyze and tabulate the strengths and weaknesses of the mLearning models.

7. Papers and e-books on mlearning and Satellite technology and education were extensively reviewed.
8. Video files were transmitted from a Laptop, using skype, across an Ad-hoc network to a mobile phone and from the mobile phone back to the Laptop to test multimedia data transmission across the mlearning model.
9. The video streaming across the Ad-hoc network was experimented with three routing protocols to ascertain which routing protocol will be most effective for transmitting multimedia data from the proposed mlearning model/infrastructure to mobile devices.
10. Video data was used to test transmission across the Ad-hoc network because it is the most problematic data type that records the highest error and packet loss in data transmission.
11. The video transmission was done across an ad-hoc network in order to ascertain the functionality/relevance of the proposed mlearning model in areas lacking infrastructure.

### 3. PROPOSED NATIONAL MLEARNING MODEL FOR NOUN

In achieving the objective of this research, the next sections discuss things that must be taken into consideration:

#### 3.1 Infrastructure for Local broadcast Coverage

The proposed infrastructure can be accomplished with the existing Nigeria Communication Satellite-1R (NigComSat-1R). The communication satellite uses beams that cover the entire West African Region. To provide local broadcast coverage, channels intended for only one local area (INSTITUTION) are scrambled so users elsewhere cannot view them. NigComSat-1R is designed to project spot beams at selected areas, allowing the same radio frequencies to be reused in different areas, thus increasing the channel capacity.

#### mLearning Broadcasting Station

The generic framework of the National mLearning infrastructure as illustrated in figure 10 could be used by any Institution. This framework is a generic method for building a satellite based mLearning system. The framework consists of three major components; these are:

#### Centralized Broadcasting Center (CBC)

In order to reduce the cost of satellite communication, and media production and editing, the proposed framework suggests the centralization of such facilities which can be used later on the basis of time sharing.

The central facility consists of several sub-components such as live and recorded broadcasting facility, earth station, a satellite channel connected to NigComSat-1R, video servers and storage devices, web servers, SMS servers and so forth.

#### Client Side

This enables the Institution to be connected to the centralized broadcasting center (CBC) and can share the resources for reception and broadcasting of educational materials. The setting required by the Institution is minimal and consists of a satellite dish connected to a transceiver (Rx/Tx) module with Digital Video Recorders (DVR).

It requires dedicated internet connection. A mobile broadcasting van can be readily made available for live broadcasting and live event coverage.

### Communication and Broadcasting Channels

Three types of communication channels are required to provide broadcasting, reception and interaction namely; interactive channel (upload and download channel), satellite reception on client (Institution) side and satellite broadcasting.

**Interactive Channel:** This is a regular Internet connection between the user and the central broadcasting channel. It consists of two channels:

1. Upload Channel: will be used for uploading interactivity signals initiated by the user (online queries, requests and responses); therefore, small bandwidth is fair enough to satisfy user needs.
2. Download channel: requires a high speed connection for passively downloading requested videos.

**Satellite Reception:** This is a satellite receiver and a satellite dish through which a client can view live broadcasting.

**Satellite Broadcasting:** Broadcasting can take place from the centralized broadcasting center using the dedicated earth station or by using the mobile broadcasting stations (broadcasting van) located temporarily on the client side. In order to implement this mLearning model for any Institution, first it is required to establish a satellite broadcasting capability by constructing an earth station connected to a spot beam satellite (NigComSat-1R), a broadcasting center and a production and auditing center are to be established and may well be integrated with the Institution's centralized hub.

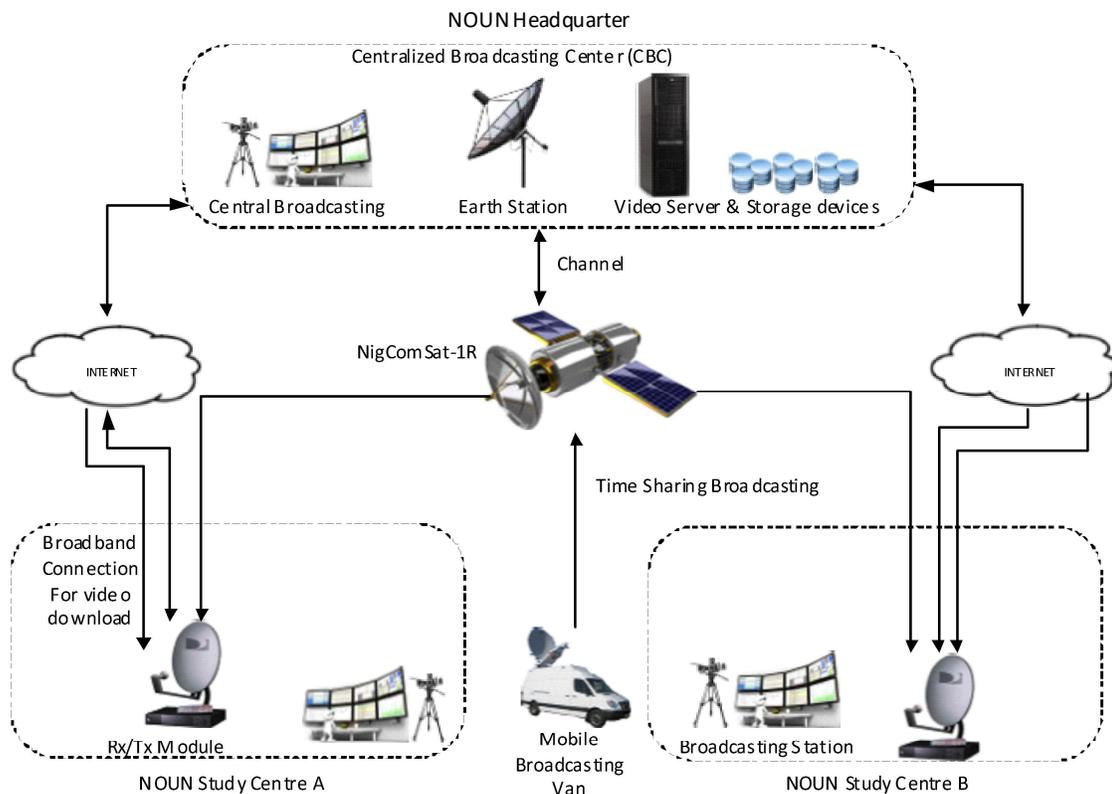


Figure 1: A CBC providing NOUN with time shared broadcast and VoD services.

### 3.2 Components of the Proposed Model

The proposed interactive satellite consists of the following main components:

- Communication satellite (NigComSat-1R) with spot beam technology.
- Substations with VSAT terminals.
- Institution's headquarters with archiving capabilities.
- Mobile Broadcasting Van

#### 3.2.1 Communication Satellite (NigComSat-1R) with Spot Beam Technology

NigComSat-1R is a communication satellite with spot beam technology because it's enabled to deliver more local channels to specific, precisely defined areas; which improves its ability to compete with cable broadcasters. The communication satellite uses beams that cover the entire West African Region.

To provide local broadcast coverage, channels intended for only one local area (Institution) are scrambled so users elsewhere cannot view them. NigComSat-1R is designed to project spot beams at selected areas, allowing the same radio frequencies to be reused in different areas, thus increasing the channel capacity.

#### 3.2.2 Substation/Study centers with VSAT Terminals

A typical study center described here constitutes of an interactive receiving end base consisting of a variety of components such as a satellite dish, special satellite receiver, transceiver, computers, routers, multimedia equipment, E-Learning software. The two distinguishing components that can be used as remote stations are: the Very Small Aperture Terminal (VSAT) and Satellite Interactive Terminal (SIT).

#### VSAT

This is a low cost business terminal with small antenna. It is a two way data terminal or one-way data link depending on the situation. The most common VSAT configuration is the Time Division Multiplexing (TDM)/TDMA star network. VSAT has a high bit rate outbound TDM carrier from the hub to the remote earth stations and one or more low or medium bit rate TDMA carriers.

Remote users' sites have several low bit rate Data Terminal Equipment's (DTEs) operating at 1.2 to 9.6 Kbits/s. These are connected through the VSAT network to a centralized host processor.

SIT: Is a satellite receiver with broadband internet connection. The multiplexer of SIT exchange video content with the multiplexer of the MENOS hub for:

- Live TV contribution/distribution (reserved channel)
- High speed streaming on reserved channel or best effort file transfer hub.
- Short time storage in the SIT or long term archiving in the network hub. These exchange sessions are synchronized and activated automatically by the hub's Multimedia Reservation Server (MRS). The TV SIT is connected to the MENOS hub via two satellite subsystems: A Multiple Frequency TDMA (MF-TDMA) broadband subsystems for data and voice communication and a Reservation Access Multiple Access (RAMA) subsystem for video and fast file transfers.

### 3.2.3 Institution's Headquarters with Archiving Capabilities

Part of the VSAT network is the hub, which is the centralized high performance earth station (with an antenna of up to 9m in diameter). The proposed communication network is constructed using a STAR topology with the hub at the center of the star.

The hub plays an important role in enhancing the performance and efficiency of the proposed MLearning system as:

- Institution's headquarters is considered as the heart of communication between NigComSat-1R and the study centers.
- All study centers are connected to Institution's headquarters at all times.
- Institution's headquarter provides the study centers with broad band internet services, and voice services.
- Institution's headquarters works as a centralized operational center that provides collaboration and media exchange between connected study centers.
- Institution's headquarter can be used to broadcast programs to all the connected study centers
- It can be used to direct specific programs to specific study centers utilizing the spot beam technology in NigComSat-1R.

### Mobile Broadcasting Van

This mobile broadcasting van could be located anywhere within the coverage area of NigComSat-1R. This will enable intending learners who are not opportune to be at any of the study centers access to Institution's MLearning contents.

### 3.4 Benefits of incorporating a dedicated Satellite-NIGCOMM-1R in NEduSat

In the Tele-education pilot project for NOUN, the satellite incorporated in the model is an unbranded commercial satellite. There are grave consequences for using an ISP that is connected to a satellite that is not dedicated to education.

Here we outline the immense benefits of incorporating NIGCOMM-1R in NEduSat, a satellite dedicated to education among other functions.

- i. To Avoid excessive charges from ISP in purchase of Bandwidth for Internet access.
- ii. To avoid customization of Bandwidth with ISP.
- iii. To avoid bandwidth eruption i.e. to have enough bandwidth.
- iv. To avoid cheating on bandwidth allocation.
- v. To evade usage of bandwidth stripper to deceive and short change on bandwidth allocation
- vi. Satellite transmission can overcome many of the previously insurmountable problems presented by delivering quality experiences to remote students.
- vii. Satellite Technology is extremely versatile and features a variety of delivery sub-modes.
- viii. In addition to video, Satellite transmission includes three audio or data Channels.
- ix. Reception is simple. No cabling required.
- x. The programme is up-to-date because it is live

#### 4. SYMBOLIC REPRESENTATION OF THE MAIN SYSTEM COMPONENTS

In this section, we present the symbolic representation of our proposed system

##### Main-Systems Definition

Root System ML = ML-Learning:

ML = {NOUN, CLIENT, Inter-COMM} where Inter-COMM refers to the communication between the client/user and NOUN architecture.

1. Main System NOUN = {NCS, CBC, ST} where

NCS, CBC, ST refer to:

System NCS = NigComSat-1R with spot beam technology;

System CBC = Centralized Broadcasting Center (CBC);

System ST = A list of Study Centers defined as followed:

System ST = {[ST<sub>1</sub>], [ST<sub>2</sub>], [ST<sub>3</sub>]... [ST<sub>n</sub>]}.

2. Main System CLIENT = {Mobile user} possesses a wireless device able to connect to NCS system.

3. Main system Inter-COMM = {Interactive Channel, Satellite Reception, Satellite Broadcasting}

##### 4.1 Sub-System Definition

System CBC = {CB, ES, SS}

Where CB, ES and SS are subsystems and defined as follow:

**Subsystem CB** = Central Broadcasting containing live and recorded broadcasting and educational materials

**Subsystem ES** = Earth Station,

**Subsystem SS** = contains a stack of storage and servers for {Video, web, SMS, data}

System ST = {[ST<sub>1</sub>], [ST<sub>2</sub>], [ST<sub>3</sub>] ... [ST<sub>n</sub>]}

Where each **ST<sub>i</sub> subsystem** contains:

**Subsystem ST<sub>i</sub>** = {R<sub>x</sub>/T<sub>x</sub>, BS} such as R<sub>x</sub>/T<sub>x</sub> is the Receiver/Transceiver Module for Internet connection and BS is the Broadcast Station.

If System CLIENT connects to System NCS using interactive channel = FALSE Step 1  
 Print alert (connection to the Satellite failed)

OUTPUT = FAILED

Else

START Transaction

Step 2

Connection between System NCS and CLIENT maintained

IF System NCS connects to Subsystem ES = FALSE

Print alert (connection to the Earth Station failed)

OUTPUT = FAILED

Else

Step 3

START Transaction

Inform subsystem CB 'process in progress' – Send GET QUERY

System CLIENT sends its request to System CBC using upload channel

System CBC broadcasts the query to subsystem CB

Subsystem retrieve the requested data from subsystem SS – retrieve GET RESPONSE

IF GET RESPONSE = FALSE

Print alert (Data unavailable or moved)

Send the alert to the System ST<sub>i</sub> to correct the problem and make the resources available

Send a "Data unavailable to the CLIENT system" response

Break all connections

OUTPUT = FAILED

Else

START Transaction

Step 4

Send the retrieved data to the System NCS to broadcast it to the mobile user

System CLIENT receives the data using download channel

OUTPUT = SUCCESS

Do you need to make another request? = CONTINUED

IF CONTINUED = FALSE

Break all connection

Return OUTPUT

Else

Go to step 3.

Ability to change the query using GET QUERY

END Transaction

Return OUTPUT

END Transaction

Return OUTPUT

END Transaction

## 5. CONCLUDING REMARKS

Lack of adequate Information and Communications Technology (ICT) infrastructure hampers the efforts of governments to give citizens some essential services, such as education. The proposed National mLearning Model through Interactive Education Satellite (NEduSat) is a project which focuses on tackling this problem. The limitation of learning locations reduces access to knowledge and formal education. In Nigeria some states have terrains that make it difficult for Governments and Non-Governmental Organizations (NGOs) to make delivery of conventional education easy. Some places are not easy to reach in the highlands therefore resulting in lack of essential basic services as electricity which could be used to power some teaching aids e.g. computers. Adapting the architecture discussed and presented in this paper will assist in ameliorating these challenges.

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