PACKET RADIO TECHNOLOGY AND ITS

APPLICATION IN NIGERIAN LIBRARIES

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(PGD / MCS / 2001 / 1112)

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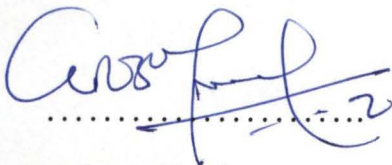## BY

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A PROJECT SUBMITTED TO THE DEPARTMENT OF MATHEMATICS / COMPUTER SCIENCE, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA IN PARTIAL FULFILMENT OF THE AWARD OF THE POST GRADUATE DIPLOMA IN COMPUTER SCIENCE.

NOVEMBER 2003

CERTIFICATION

This project work has been read and certified by the undersigned as meeting the requirement of the department of mathematics / computer science, federal university of technology, minna.

....28/11/2003

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....

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DEDICATION

This project is dedicated to ALMIGHTY GOD, the author and finisher of our faith. I appreciate him for seeing me through financially and otherwise throughout my course of study.

ACKNOWLEDGEMENT

To Almighty GOD be the glory, honour and praise for he has done great thing again, he has given me strength, courage, good health and wisdom to write this project and of course see me through my study.

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To my sister-in-law"ENO", MY nephew and nieces, Daniel, tomi and rolake, I love you all.

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TABLE OF CONTENTS

CONTENTS	PAGE

TITLE

CHAPTER ONE	1

CHAPTER TWO

CHAPTER THREE

CHAPTER FOUR

CHAPTER FIVE

ABSTRACT

The project was conceived, designed and developed to overcome the problem of sharing information, data, inventions and materials between two or more libraries, due to poor and sometimes, lack of telecommunication facilities. This poor telecommunication has prevented the full growth of the internet in our libraries, hence the need to provide an alternative solution to accessing of information, inventions, data and materials arises.

To achieve this end, a packet radio technology is introduced, this involves using radio signals to pass data from one end to another. For the full achievement of this a visual basic (VB) programming language will be used, which gives room for a user interface control, and a query language.

CHAPTER ONE

1.0 **INTRODUCTION**

In the aspect of high technology development, Industrialized nation has experienced an explosion in the use of information technology that has provided scientists, researchers and private citizen with unlimited access to information.

Anyone with a computer and a link to a network can access an astonishing array of information resources. Located throughout the world. In particular, library has also benefited from these developments.

Initial barriers between libraries and their users has dissolved creating a library without wall. Through these, advanced users enjoy increase library services and benefit from enhanced resources sharing.

Such widespread access to information is made possible by the existence of well developed telecommunication infrastructures, the telephone system, packet switched data networks and high-speed backbone networks that support computer connectivity/connecting. This framework bas been enhanced further by the development of large computer networks, such as the internet that links local, regional, national and international

networks into large world-wide systems. Irrespective of rapid development of network in other countries, Nigeria situation is opposite due to lack of telecommunication infrastructure to support the connection of computer system. The absence of reliable telephone denied most libraries in Nigeria the opportunity for even simple dial-up access to remote database. As a result, the potential for increased information access and enhanced resources sharing that network offers library and their users are severely limited in Nigeria.

A technology called packet radio has the potential of providing some connectivity solutions in developing nations where land-based communication are available or absent. Packet radio applies packet communication to a radio channel rather than wire-based media, enabling wireless data communication. This technology can be used to create local area network (LAN) that link terminals, micro-computers and large mainframes as well as to provide access to other network system and databases. This project shows that packet radio provides an opportunity to extend the benefit of networking and computer connectivity to Nigeria, thereby increasing access to library services and enhancing resources sharing.

1.1 OBJECTIVES

The purpose of this project is to provide a technology overview of packet radio technology and its uses for data communication

in the colleges and universities libraries in Nigeria. This project shows that packet radio provides an opportunity to extend the benefit of networking and computer connectivity to Nigeria libraries thereby increasing access to library services and enhancing resources sharing.

1.2 PROJECT MOTIVATION

The need for this project is an attempt to apply a single solution, such as packet radio to the problems affecting Nigeria colleges and universities libraries and information infrastructures within, which make it extremely difficult, due to the problem of isolation and lack of a well developed telecommunication infrastructure. Due to the fact that Nigeria suffers poor telecommunication infrastructure, there is need to study the application of packet radio technology as a means of overcoming this problem that hinders information dissemination in colleges and universities libraries in Nigeria.

1.3 PROJECT METHODOLOGY

Literature review on packet radio technology was carried out, its application in libraries and some projects demonstrating the application were also considered, conclusion and recommendation were made.

1.4 SCOPE OF THE PROJECT

There are many types of packet radio that can be used to transmit data and create computer networks. Such as:-

3

i. Line-of-site (LOS) Terrestial packet radio where stations must see each other.

ii. High frequency terrestrial packet radio where stations can be over the horizon.

iii. Packet radio using geostationary satellite.

iv. Packet radio using low Earth Orbit (LEO), store and forward satellite.

v. Packet radio using LEO Constellation.

In this project, the major areas concerned are the Line-of-site and high frequency terrestrial packet radio.

CHAPTER TWO

LITERATURE REVIEW OF PACKET RADIO TECHNOLOGY

2.0   UNDERLYING CONCEPT OF PACKET RADIO

Packet radio technology is the application of packet switching techniques to radio (Lynch Browning 1986). Packet radio switching provide an efficient mechanism to support wireless computer communication over a wide geographical area. Recent technological advancement has made packet radio communication more effective and affordable and to be used in Nigeria.

Packet radio is particularly a digital node of Amateur radio (HAM RADIO) Communication which, correspond to computer telecommunication. A magic box called a terminal node controller (TNC) replaces the telephone modem, the telephone is replaced by an Amateur radio transceiver and the phone system is replaced by the free Amateur radio waves. Packet radio takes any data stream sent from a computer and sends via radio to another Amateur radio station similarly equipped. Packet radio is so named because it sends data in small burst or packets. Packet radio will necessarily have a device called a terminal node controller (TNC). This device translates the normal American Standard code for information interchange (ASCII) Computer characters to tones similar to a telephone modem and then grouped into short-burst (packets) for

transmission, it then controlled the radio, switching it from receive to transmit, so the packet could be sent. When receiving, the TNC decodes the tones and ungroup the characters so that the computer could understand them.

2.1 COMPONENT OF A PACKET RADIO NETWORK

There are wide varieties of hardware and protocol options for building a packet radio network. The choice of specific components depends upon the applications, performance requirements and operating environment of the proposed network. The component needed in packet radio network includes packet radio hardware.

2.2 PACKET RADIO HARDWARE

The basic hardware components of a packet radio network include a radio transceiver, terminal node controller (or a radio modem), an antenna and a personal computer. An independent power supply may be required depending on the state of local power supplies. The basic components of a packet radio station are as follows:-

2.3 RADIO TRANSCEIVER

The radio transceiver is a device that provides connectivity to other radio in a network. It transmits the signal produced by the terminal node controller (TNC) via RF radiation. One of the

advantages of using transceivers is that existing two-way radio stations can be used in packet radio network.

2.4 THE TERMINAL NODE CONTROLLER

This is a device used for encoding digital data into radio signals. It can also be referred to as the interface between the radio and the computer. It is also known as a packet controller, a packet assembler/dissembler or a frame assembler/dissembler. (Mayo, 1989). It breaks the digital information from the computer into packets and transmits them through the radio via audio tones. At the receiving end, the TNC converts the audio tones back into packets and sends this reconstructed digital information into the computer. Thus, it acts like a standard modem that enables computers to communicate through standard analogue telephone lines by converting digital information to analogue information and back again. The TNC also performs error-checking as part of its functions (Garriott 1990).

2.5 COMMERCIAL PACKET RADIO MODEM

Commercial radio modem combines the radio and terminal controllers in one device. Commercial radio modems incorporate sophisticated digital signal processing techniques such as forward error correction; to achieve higher data rates than that of TNC-based packet radios. Such techniques however are typically suitable or fit.

2.6 MICRO COMPUTERS

The TNC or radio modem connects directly to a computer although any micro computer can be used, but laptop computers are considered to be the best choice for application in developing countries because they are highly portable and have low power requirement (cannata 1991).

DIAGRAM
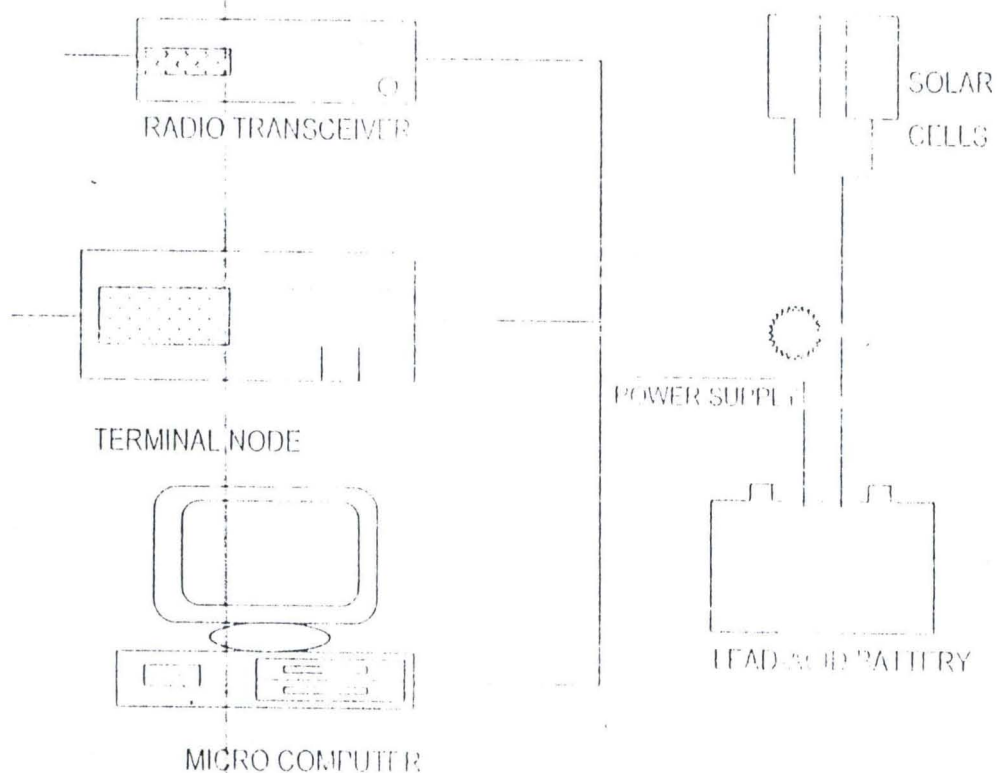
Figure 2.1 Schematic Diagram of a packet radio station with solar power supply and battery back-up (derived from VITA Diagram).

2.7   PACKET RADIO PROTOCOL

A protocol is a set of rules or a procedure, which is followed when sending data between two devices. It is a standard for two computers system to communicate with each other.

2.8   AX-25 (AMATEUR X-25)

This is the communication protocol used for packet radio. AX-25 was developed in the 1970's and based on the wired network protocol X-25.

Due to the difference in the transport media (i.e Radio Versus Wires) and because of difference in addressing schemes, X-25 was modified to suit amateur radio's needs. One advantage of AX-25 is that every packet sent contains the senders and recipient amateur radio call sign, thus providing stations identification with every transmission. It also specifies identification with every transmission and channel access (ability to transfer on the channel) to be handled by carrier sense multiple access (CSMA). If you want to transmit, your TNC monitors the channel to see if someone else is transmitting if no one else is transmitting, then the TNC keys up the radio and send its packet. All other stations could accidentally transmit at the same time, this is called a collision. If a collision occurs, neither TNC will receive, reply back from the last packet if sent. Each TNC will await a random amount of

time and then retransmit the packet. Thought, a more complex scheme is used to determine when the TNC transmits.

2.9 TCP/IP (TRANSMISSION CONTROL PROTOCOL/ INTERNET PROTOCOL).

This is a set of protocol developed to allow communications across a network. Transmission control protocol, but often called transport control protocol is that part of a system which is responsible for getting our data from one place to the next. It will re-send anything that did not get through and it will breakdown large amount of data into smaller, more manageable packets or datagrams and make sure they all arrive safely. Internet protocol establishes various rules for formatting, routing and processing of data. The various protocols in the TCP/IP family include:-

i. FILE TRANSFER PROTOCOL (FTP):-

This is used to exchange files with another FTP user else where on the network. Any kind of data may be transferred using FTP.

ii. TELNET:_

This facility allows you to conduct a person to person chat with another user on the network. It allows remote log in, which means you can log on any other computer system on the network, while connected to the station, anything you type will

be sent to the other screen and anything the other guy type will appear on your screen.

iii.   SIMPLE MAIL TRANSFER PROTOCOL (SMTP):-

This allows sending of messages to other TCP/IP User on the network. The idea is to leave a message in your own system and the SMTP will automatically feed it into the network for forwarding in the destination.

iv.   POST OFFICE PROTOCOL (POP) :-

This is variant of SMTP mail handling facility where you may nominate some other systems as your "post office", so that any mail addressed to you will be stored there for you. Then when you run POP, your mail will be automatically forwarded to you from the post office station. There are lots of other protocols used in the TCP/IP family but this is to give an idea of the complexity and sophistication of this advanced system.

2.10   OPEN SYSTEM INTERCONNECTION (OSI) REFERENCE MODEL

The OSI reference model defines a standard model for understanding and describing data communication. This model sub-divide the general problem of computer communication into a set of layers of communication.

DIAGRAM

LAYER	FUNCTIONS
7	Application
6	Presentation
5	Session
4	Transport
3	Network
2	Data link
1	Physical

Fig.2.2

Because of the hostile radio broadcast environment within which packet radio must operate, the protocol issue that must be considered are almost entirely at the lower 3 layers, the physical, data-link and network layers. Problems of higher layers are the same as in other network except for the fact that packet radio protocols impose some limitations on data transfer rate, which for example may make it unpractical to transfer large files in real time.

Brief discussion of protocol layers are stated below :-

i.   PHYSICAL LAYERS:-

The physical layer enables and defines the procedure for transfer of data over a wireless broadcast channel. Other things to consider in implementation of a packet radio network in physical layer include choice of frequency, modulation technique, transmitter power and antenna configuration.

ii.   DATA LINK :-

It ensures errors free transfer of data between two points. Things to be considered in designing a packet radio network in this layer are :- Channel access, frame (packet) size, acknowledgement, error defection and correction.

III.   NETWORK LAYER: It ensures that data reached its intended destination across a network via one or more intermediate links. Issues to be considered in designing packet radio networks are in this layer; addressing routing and inter networking.

(IV)   TRANSPORT LAYER ;- This is the first layer in which data is exchanged between the systems.

(V)   SESSION LAYER :- This layer adds structure to the connection provided by the transport layer

(VI)   PRESENTATION LAYER :- This layer ensures that information is transferred in a form mutually intelligible to different, possibly incompatible computer system.

(VII)   APPLICATION LAYER:- is the highest and must complex layer of OSI model. It specifies to a computer systems for a number of specific purposes

2.11 PROBLEMS WITH THE NIGERIAN LIBRARIES

1. No proper links to facilitate collaboration and information sharing.

2. Lack of joint rural information telecommunication exchange program to promote research.

3. Lack of developed technology to facilitate broad access to libraries (wireless access "INTERNET").

2.12 FACTORS OF PACKET RADIO NETWORK

There are great number of factors, often interrelated that affect the design of a packet radio network. These include, but are not limited to:-

A LOCAL GEOGRAPHY:-the type of terrain in which the network will operate.

B PERFORMANCE REQUIREMENT:- the required through put and geographical slope of the system.

C NETWORK TOPOGRAPHY:-
Whether repeater are needed and the number, density and location.

D THE FREQUENCY AND RF BAND WIDTH:-
A suitable radio frequency must be chosen that provides necessary bandwidth and area coverage. (depend on constraints imposed by RF Communication Regulatory Commission). The choice of frequency and the design of network topology are dependent on several interrelated issues.

e. **HARDWARE:-**Such as transmitter type and power data rate and capabilities of radio modem and antenna design (including height and direction).

f. **CHOICE OF PROTOCOLS:-**

Such as CSMA (carrier sense multiple access) protocol. CSMA Protocol is largely used in 1-hop networks where data is transmitted between directly connected station. Data is transmitted from its source to its destination without the use of an intermediate station.

In CSMA, each sender first senses the channel and then transmit a packet only if the channel is idle. Each packet radio network must be designed to satisfy the unique set of requirements needed to carry out a given purpose in a given environment.

DIAGRAM

| COMPUTER OR DUMB - TERMINAL | Transmit Receive Ground | TNC | Push to Talk MD Audio Ground Speaker audio | RADIO | Antenna |
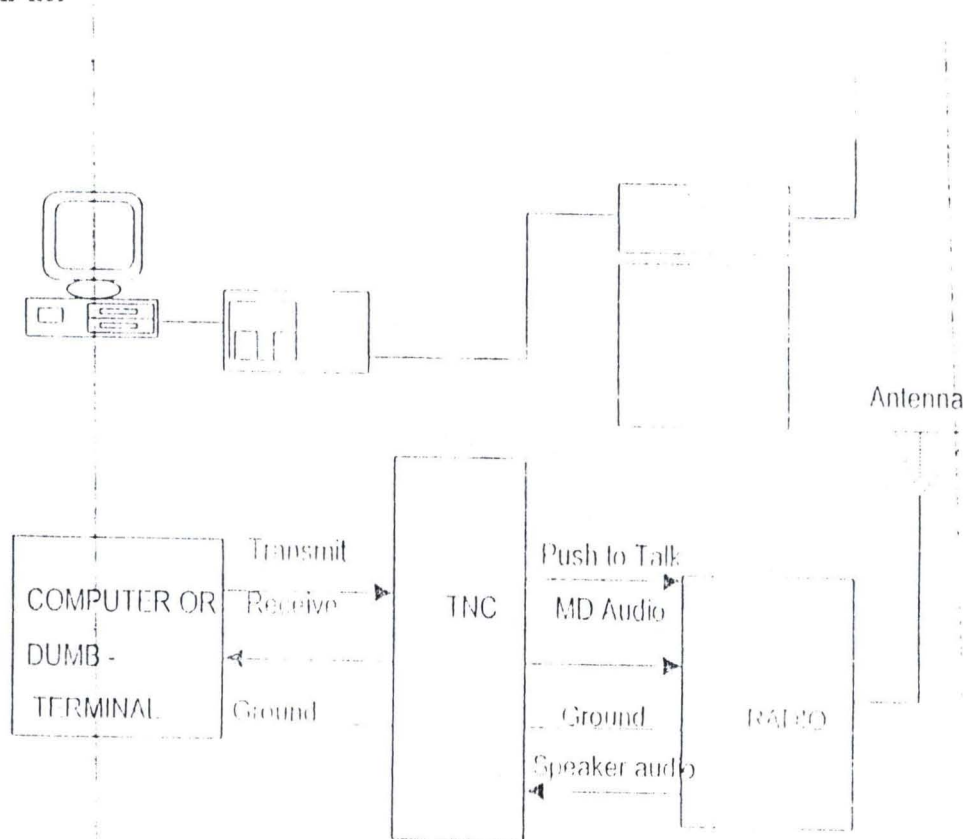
Serial connection   radio connection

Basic connection   basic connection

Only requires   only requires speakers

Pin 2,3,7 (DB-25)   and mic plugs

TNC (Terminal controller)

Fig. 2.4: shows an illustration of a typical station set-up with a schematic diagram of a station wiring.

2.13 LIBRARY APPLICATION OF PACKET RADIO

In the industrialized world, libraries have become reliant upon computer and telecommunications technology to support their activities. These technologies have revolutionalized all aspects of library work from the provision of services of library work to end users (i.e. information retrievals, inter-library loan and document delivery) to technical services (i.e. cataloguing and acquisition, library use of variety of system to support these tasks, such as public access catalogue, public data network, bibliographic utilities and library networks. More recently, the internet has brought data communications and information exchange among libraries in industrialized nation to a new level, providing libraries with the means to access a wide variety of database and information repositories throughout the world.

Thus, packet radio solutions are to:-

-     Provide access to information or library data located at a center site.

-   Supplement existing networks by providing remote extensions to network such as the Internet.
-   Support pre-established decentralized activities.
-   The packet radio solution for information retrieval, document supply, cataloguing and professional development as discussed briefly as below.

2.14 INFORMATION RETRIEVAL

Information retrieval has become an indispensable tool for libraries in providing fast and efficient access to information. Since the development of early on-line information system in the 1970's, supporting information retrieval has been proliferated. Such system includes; on-line public access catalogues, remote on line database, locally mounted database and CD-ROM System. In Industrial nations, the connection of these systems into computer network has allowed provision of simultaneous access to multiple, remotely located users.

Examples include the development of campus-wide networks, networked CD-ROM and the internet which now provides access to hundreds of systems, including those that have been traditionally available only through private networks. Access to information retrieval systems and the development of networked information is hampered by expensive or inadequate telecommunications. Packet radio technology has the potential to bridge these telecommunication gaps and provide more widespread and economical access to information retrieval

system. Example of the method in which packet radio can provide increase access to online database, CD-ROM work stream, locally developed database are explained below.

ACCESS TO REMOTE ONLINE DATABASE

The data information originating from the database of the industrialized world is criticized as inappropriate for use in Nigeria. A study by an individual at the International Development Research Centre (IDRC) shows that librarian and information workers in developing nation regard access to online database as useful. For very recent material and database that were infrequently used at their institution. (Beanmout and Balson 1988), such information include, time sensitive scientific, technical, medical information as examples.

USE OF PACKET FOR ONLINE

Where there is presence of international telecommunication node, packet radio can be used to establish link between a rural library and the nearest node. From this node, connections to database in industrialized countries can then be made. Data Communication line will be used from Nigeria to an Industrialized country and packet radio link will extend to the remote users.

2.15 REMOTE ACCESS TO CD-ROM

This is a better alternative access to information retrieval system, because it does not involve direct telecommunication

channel. It links through international computer network. It has some advantages, which include, massive storage capability, a single CD-ROM can store about 600mb of data.

Onsite location, thus avoiding problem and cost of creating telecommunication link with remote database, durability and portability, unrestricted access to information, suitable for semi-trained user, microcomputer based and multimedia capable (CD-ROMS) can store many type of data including bibliography information, sounds, images, full-text and ability to deliver primary information such as article.

2.16 ACCESSING LOCALLY DEVELOPED DATABASES

While CD-ROM is often an alternative to remote online database, they still remain a source of information from industrialized countries.

Another type of database that can be made more widely available through packet radio link is locally developed database created for and by developing countries. Tools that have been used to create such database include :-

DATABASE MANAGEMENT SYSTEM (DBMS) :-

This is a software package that manages the storage manipulation and retrieval of information in a database (e.g. dbase), such database has received widespread use because they simplify the creation and use of information retrieval system. Because of their simplicity, DBMS have been used in a

number of projects in Nigeria to create local database. Some examples include population data achieve project in the Philippines which used a DBMS (dbase 111+) to provide access to census data (Browne and Gavin, 1990).

2.17 ACCESS TO INTERNATIONAL COMPUTER NETWORKS

This is another method of accessing database as well as hundreds of other information from computer networks. In the industrialized world, such networks are quickly becoming important tools for information access. There are several benefits in providing libraries and information centers in developing countries with access to international computer network.

a. There is a wealth of scientific, technical, health and agricultural information available on the network.

b. The information is virtually free of charge.

c. Extension to international computers network can help overcome the increasing information gap.

GENERAL OBSTACLES TO ACCESSING INTERNATIONAL COMPUTER NETWORKS.

The lack of access to international computer network in Nigeria has made the information gap between Nigeria and the

industrialized world widen. A solution to this problem would be to provide wireless extension to international computer network with packet radio technology. Packet radio can be interconnected with loss expensive landlines (telephone) networks, such as FIDONET and BITNET or the INTERNET (Garriot, 1990).

Thus, packet radio through links to local ground modes or orbital satellite can provide access to international computer network in rural areas where it might not exist.

2.18 THE INTERNET

In the mid 1980's the United States National Science Foundation (NSF) founded a network based on TCP/IP called NSFNet a large coast-to-coast network that interconnected many smaller networks and provide researcher with access to resources. With the involvement and findings of NSF, the network slowly began to connect more and more networks and computers located at research institutions, universities and colleges, government departments and research-oriented private industry. The Internet is currently a vast network that connotes thousands of computer networks worldwide. The internet physically interconnects separately administered TCP/IP based networks. It also provide E-mail gateways to other non-TCP/IP Networks such as BITNET, FIDONET, and many other networks e.g. AT & T Mail.

2.19 INTERNET RESOURCES AND SERVICES

The international community has seized the opportunities provided by the Internet and has connected hundreds of information services and resources to the networks. Internet offers access to a wealth of information that includes library journals, catalogues, databases, electronic journal and newsletters, satellite images and so on. Examples of these information resources and the network services that support them includes :-

Electronic Mail- which involves sending, messages from one computer to another in a store ad forward manner. Once the messages are at its destination, it awaits the addresses until he or she has time to read it. Electronic mail is the most commonly supported services across the diverse set of network that are connected or gate wayed to the Internet. Where electronic mail crosses a boundary between networks using different protocols a gateway translates the messages into appropriate format.

2.20 USE OF PACKET RADIO TO LINK TO THE INTERNET

Packet radio has the potential to provide access to the wealth of information available on the Internet in areas that lack adequate land based telecommunications. There are several types of links that can be created through packet radio:-

      i.   A terrestrial packet radio link to a ground based TCP/IP mode.

ii.   A terrestial packet radio link to a ground based e-mail network (i.e. BITNET, FIDONET etc)

iii. Via a packet satellite link.

The particular services a developing country would have access to, depends upon the type of link established.

DOCUMENT SUPPLY

Document supply is defined as the provision and supply of publications from their organizations through intermediaries to their users. It is a broad term to describe a wide range of activities involving publishers, document supply centers, information brokers and libraries that have the end goal of document deliveries for users. It also includes acquiring materials from local collections as well as providing access to materials not held locally through inter library loan (ILL) and document delivery.

2.21 USE OF PACKET RADIO FOR INTER LIBRARY LOAN (ILL)

With packet radio links, inter library loan department can gain access to many information resources and network services. The extensive electronic mail network supporter by the Internet and networks gatewayed to the Internet can be used for sending and receiving ILL messages. The use of electronic mail for ILL messaging is well established in industrialized countries.

Problems of co-operation must be solved in Nigeria before inter library loan can flourish.

2.22 DOCUMENT DELIVERY

This is the final stage in the process of document supply involving the transfer of document from supplier to a requesting library or user.

OBSTACLES TO DOCUMENT DELIVERY

Document delivery in developing countries is hindered by many obstacles, which are stated below:-

a. Long delay in delivery caused by unreliable postal system.

b. High cost of delivery by air.

c. Inability to use fax machines due to invaluable telecommunication system.

d. Risk of lost or damaged materials.

e. Reluctance of some libraries to lend their materials outside their own organization.

2.23 USE OF PACKET RADIO FOR ELECTRONIC DOCUMENT DELIVERY.

The packet radio application provides access to bibliographic information and other information's, which support the rapid delivery of documents. The method of sending documents through electronic networks shows that packet radio can

support electronic mail, document imaging, transmission system and facsimile.

2.24 COOPERATE CATALOGUING

Co-operative cataloguing refers to the mutual exchange of bibliographic record among libraries. Bibliographic utilities, such as research library group (RLG), the online computer library center (OCLL) and western library network (WLN) developed computer networks to provide access to the database, allowing member libraries to contribute new records and to draw from this central store.

USE OF PACKET RADIO FOR CATALOGUING

The existence of a packet radio network done will not foster shared cataloguing projects. A tradition of cooperation is a pre-requisite to a successful computerized, shared cataloguing scheme where non-automated, organizational network already exist to support such schemes along with sufficient monetary and technical resources, packet radio can provide the real network to facilitate the sharing of library data. Cataloguing CD-ROMS are designed typically for use in industrialized nations and not all materials collected in developing country library will be included in them. To support co-operative original cataloguing, packet radio link could be used to provide access to a local database containing cataloguing data.

2.25 PROFESSIONAL COMMUNICATION

The final application of a packet radio discussed in this project is the support of professional communication among librarian

both within and outside Nigeria libraries. A fast growing tool for information exchange, professional communication and development are electric conference. Electronic conference allows individual to engage in simultaneous discussion with a large number of widely spread colleagues. Participant can make comments ask questions, request for provide information, announce new procedures or techniques and generally keep up to date with a particular topic or field since electronic mail is the common application across all electronic networks, packet radio link to network such as the internet, BITNET, FIDONET and other development networks can allow library professionals in developing countries to tap into this electronic colleges and the wealth of information it provides.

CHAPTER THREE

3.0 THE PROPOSED SYSTEM

The primary objective of a packet radio network is to provide communication among computing resources connected to a network (e.g a host computer, terminals, Pcs work stations and servers). The system involves the creation of packet radio local area network connecting some library in order to :

i. Have access from one library to another library.

ii. Demonstrate the idea of libraries connecting to the internet.

iii. Provides a "resemblance" of internet access to a number of sites.

iv. Share information and resources available at different locations.

v. Document delivery problem (lang delay caused by unreliable postal system and high cost of delivery by air etc)

vi. Inability to use fax machines due to poor telecommunication system.

vii. Risk of loss or damaged materials

3.1 WHY PACKET RADIO OVER OTHER MODE

The operation of packet station is transparent to the end user. It entails connection to the other station, type in your message and it is automatically sent. The terminal mode controller (TNC) automatically divides the message into packets, keys the transmitter and then send the packets. While receiving the

packet, the TNC automatically decode check for error and display the received messages.

Packet radio provides error free communication because of built-in error detection schemes. If a packet is received, it is checked for errors and will be displayed only if it is correct.

In addition, any packet TNC can be used as a packet relay station sometimes called a REPAEATER. This allows for greater range by string several packet stations together. User can connect to their friends NTC at any time they wish to see if they are at home, some TNCs even have personal mailboxes where others can have messages for them when they are not at home. Another advantage of packet radio over other modes is the ability for many users to be able to use the same frequency channel simultaneously.

3.2 CAPABILITIES OF PACKET RADIO

The primary objective of a packet radio network is to provide communication among computing resources connected to a network (e. g host computers, terminals, PCs, workstation and severs).

In order to satisfy these overall objectives, the packets radio network must provide some basic capabilities and services. The capabilities and services are stated as requirements rather than inherent features of a packet radio network. Because it is a developing technology, not all packet radio networks provide the same features. However all packet radio networks are based upon the same underlying concept and principles,

therefore most of the basic requirements will in general be satisfied.

3.3 TRANSPARENCY

The basic internal operation of the network should be transparent to their user. All user data presented to the network should be delivered to its destination without any modification. Only the data to be delivered and the necessary control and addressing information should be required of the user as input. All other aspect of routine reliable delivery protocols and network operations should be handled by the network itself.

3.4 CONNECTIVITY

All valid traffic originators within the network should be provided with connectivity with all other valid receiver subject only to the over all liability and performance of the network. The network need not have prior knowledge of which users may wish to connect to other users or resources in the network.

3.5 INTERNETTING

The packet radio network should be capable of internetting in such a way that a user providing a packet with an address in another network can expect the packet to be rioted to a gateway to the other network as an intermediate network for forwarding.

Similarly, arrived INTERNET packets should be routed to the appropriate packet radio network user. This capability is

particularly useful once all the resources in a particular library, packet radio network are exhausted at which point a wider resources base can be accessed through internet connection.

3.6 THROUGHPUT AND DELAY

The throughput and delay of the packet radio network should be sufficient to provide real time interactive services and to accommodate efficient data transfer. This specific requirement will largely depend on the requirement of the particular application running on the network. The important aspect is that the greater the number of packet hops through the network, the greater the end-to-end delay. In addition, the specific multiple access protocol implemented in the network greatly affect throughput.

3.7 COEXISTENCE

Radio frequency characteristics of the packet radio system should allow coexistence with existing users of a chosen frequency band. This would provide a greater degree of frequency spectrum sharing, particularly among similar system and may facilitate the introduction of the technology in new geographic areas. As a example of co-existence, the RF characteristics of signal of the familiar AM radio band allow several radio stations to co-exist without interfering with one another.

3.8 ERROR CONTROL

For wire based communication system, bit error rates from 1 in 100,00 to 1 in 1,000,000,000 can be achieved with such but error rate, the well known ARR (automatic repeat request) mechanism (i.e. transmission followed by acknowledgement a negative acknowledgement, possibly followed by re-transmission) are sufficient to ensure high efficiency data transmission.

In forward error correction additional bits are calculated and transmitted to enable the receiver not only to detect but also correct certain kinds of transmission error.

3.9 OTHER CAPABILITIES

There are number of the other capabilities that are typically required for military packet radio network application and are not required for library application. These include area coverage, mobility, rapid and convenient deployment, addressing options and resistance to jamming, detection and direction finding.

3.10 PACKET RADIO PROJECT

While very few projects have been implemented that specifically uses packet radio technology for library applications in developing countries, a wide array of packet radio networks have been developed for other purposes. In the industrialized worlds packet radio networks have been created for experiment with protocols and hardware by amateur packet radio

enthusiastic and for investigating its utility for library application. Hence packet radio networks have been set up to support much different type of development activities, such as to disseminate health information. Projects demonstrating the application of packet radio technology in libraries are relatively, little, a wide set of packet radio networks have been developed for other purposes. In these sections some projects shall be briefly described.

3.11 GENERAL PACKET RADIO NETWORK PROJECTS.

(a) THE ALOHA PROJECT

The first packet radio Aloha net, project was developed by the University of Hawaii and became functional in 1970. its primary objective was to allow user terminals in widely scattered locations to access the University computer system. ALOHA demonstrated the feasibility of using packet broadcasting. In a sing hop system, (Abrahamson, et al 1970). And this eventually led to the development of a multi hop multiple access packet radio networks.

(b) PACKET RADIO INTERNET EXTENSION DEMONSTRATING

This project was carried out interstitial packet radio to connect to the Internet, it was carried out in Budapest, Hungary in 1992 (Browries and Hendrick 1992).

It was a joint venture between U.S national agricultural library and the North Caroline State University. The primary objective

of the project was to carry out the feasibility of creating packet radio links to the Internet.

The overall objectives of the project were (Browsing and Hendricks, 1992).

(a)   To show the potential for sharing documents through the Internet.

(b)   To establish a packet radio link between a conference site and the Hungarian Academy of Science and Internet node.

(c)   To connect the packet radio link to the Internet.

3.12 PACKET RADIO AND LIBRARY PROJECTS

(a)   UNIVERSITY OF CALIFORNIA (DIVISION OF LIBRARY AUTOMATION (DLA) WIDE ARE PACKET RADIO AND SANDIEGO PACKET RADIO INTERNET.

University of California division of library automation (DLA) was one of the earliest packet radio projects supporting library applications. The network was to operate at a data rate (Data rate signal is the rate in bits per second, that data is transmitted] of 200Bps and will run the TCP/IP suit of protocols.

The project was deserted however due to:-

1. Problem in obtaining frequency allocations.

2. Diminished cost effectiveness of packet radio link compared with rapidly dropping of common carrier cost.

33

3. Problem at the time of scalping up to sufficiently high width.

3.13 SAN DIEGO PACKET RADIO INTERNET EXTENSION (PRIE)

The project involves the creation of packet radio local are network connecting the San Diego public library, the San Diego State University library and the San Diego Zoo Library. Federal regulations and advances in packet radio technology have finally solved the problem that plagued the project for its 10-years history. The memex research institutes, with funding and equipment from the council of library resources, Apple Computers and Tetherless Access Ltd is developing the San Diego PRIE.

Began in August 1991 and yet to be completed, the goals of project are to (Hendrics and Browing, 1992):-

a). Provide access from the San Diego public library to San Diego State University of California.

b). Demonstrate the feasibility of public libraries connecting to the internet.

c). Test different radios, network protocols and application software to support a wireless metropolitan area network.

d). Provide Internet access to a number of sites.

e). Study how access to resources available on the Internet can provide additional capabilities and services to the participants in experiment.

3.14 PACKET RADIO PROJECT IN DEVELOPING COUNTRIES

The following section describes a number of packet radio projects in developing countries. They do not necessarily portion to library use, through the exchange of information may be central goal. The sources of there case studies are taken from international workshop on digital radio technology and applications held in August 24-26, 1992 in Nairobi Kenya.

3.15 VOLUNTEERS IN TECHNICAL ASSISTANCE (VITA)

Vita is a 30 years old non-profit organization devoted to providing technical assistance to peoples in developing countries in the area of disaster relief, renewable energy, sustainable agriculture, food processing, housing, water supply, sanitation, small business development and information management (Rosenberg and Garriot, 1992; VITA, 1992).

With central staff in Virginia. VITA has field staff spread throughout eight countries and access to over 500 volunteer technicians and engineers. Central to VITA's activities is the use of satellite and packet (PACSAT) radio technology to support communication and information exchange in developing countries.

3.16 VITA PACSAT PROJECTS

This is the use of satellite and packet radio technology, this communication experiment the projects in Republic of Djibouti, Sierra Leone and Tanzania.

(a)   TANZANIA

The university of Southampton in the UK and the University of Dares Salam in Tanzania have established a link through PACSAT to facilitate collaboration, experimentation and information exchange in their joint rural telecommunication program.

A satellite station was already available at Southampton for the link and VITA was constructed to create a ground station in Tanzania, the main goal of the link was to support remote research on rural telecommunication.

3.17 OTHER WIRELESS TECHNOLOGY AND LIBRARY PROJECTS.

The introduction of wireless data communication is revolutionizing many jobs and services much as the introduction of desktop computer did some years ago. The developing technology offer great potential for broadening access to library will be the next logical step in the evolution of Library system.

The explosive growth of the internet and continued proliferation of electronic information resources place libraries in the middle of revolutionary changes in the way information is stored and accessed.

These dramatical changes in wire-base information delivery are paralleled by development in the wireless realm. If libraries are to take advantages of the great potential offered by wireless data communication technology. It is imperative that they

understand the rudiments of its technology. There are many wireless communication technology suitable for virtual library. The basic type of wireless data transfer technologies currently available are: Cellular, Wireless, Local area networks (WLAN) and Packet radio.

3.18 CELLULAR COMMUNICATION

Cellular technology is based on geographical areas called cells. Each cell include a base station that subscribers within the cell communication with, using two RF Links. All transmissions are full duplex and one RF Link is used for receiving. Cellular phone base stations connect to the local mobile telephone switching office (MTSO). MTSO's are connected to the wire line telephone network and to one another. Cells are typically represented as octagons and placed close to each other as to resemble a honeycomb. To make sure that interference within a cell is minimized, frequencies are carefully allocated and chosen so that adjacent cells use different frequencies to make sure they do not interfere with one another.

At the same time the number of frequencies available is limited, which means they must be re-used. One common re-use pattern is one-in-seven which dictates that any cell only use seventh of the available frequencies. (Konssari; 1995).

DIAGRAM
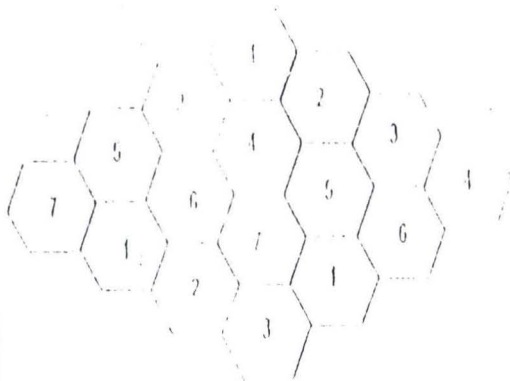
Fig 3.1.   Typical Cellular Wireless Network

The size of a cell is dictated by the transmitter power and the alternation of the RF signal. These two factors are usually taken into account by the designer of the cell networks. The advantages of using wireless cellular technology for data transmission is that it is widely implemented through the country and that it has been standardized. The most fairly form of two-way (2-way) wireless cellular communication technology is analogue, digital cellular communication. In this system, i.e. analog cellular communication, cellular data transmission is much like cellular voice transmission in that it uses the same analog radio signal routed through circuit-switched networks. In the simplest configuration, a user can plug a desktop, laptop or notebook computer equipped with a modem into a cellular data

38

interference. Bell and Hulperin used this method with some success in testing wireless online searching capabilities (Bell, 1991). Several public libraries have used existing analog cellular voice services to connect bookmobile to online catalogs, (Alloway, 1992, Pralt, 1992 and Logsdon, 1990). While certain one of the least expensive wireless option in terms of equipment expenditure, analogy cellular has three major drawbacks. These are transmission costs, speed and reliability (Foster, 1996). Since analogy cellular systems are designed primarily for voice. They tend to be very slow at carrying data. Speeds of up to 9.6kbps are possible with any degree of reliability.

Reliability of data transmission is often a factor since static in analog voice channels can lead to garbled data on the computer screen. Microcosm Inc. has gone a long way to enhance the speed and reliability of analogy cellular capacity by developing the proprietary MNP10 Cellular network networking protocol (foster, 1996). Still, for application requiring high-speed data rates, analog cellular is not suitable. Digital cellular technologies were developed to overcome some of the shortcomings of analog signals data delivering. Two major types of digital cellular transmission technology are available for use in standard circuit switched networks. These are Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA). Both translate analogy signal format, greater transmission speeds and greater accuracy of data are possible. The packetised data transmission occur either during the

normal gaps in the usage of the cellular. Channels for voice communication or on separate cellular channels that have been step-aside for such purposes. In either, the normal analog cellular operations can continue without interference or interaction with the data traffic. The cellular digit packet data (CDPD) system allows the carrier to exploit economics of scope or integrating while providing customers with a wide coverage packet data communications capability or a combination of normal cellular voice services and packet data services with a single devices. A large number of cellular carrier support CDPD (Hatfield, 1996).

The availability of any of the digital cellular transmission technologies is totally dependent upon the type of system installed by cellular carriers. CPDC networks are still quite new and have not received widespread installation (Foster 1996).

3.19 WIRELESS LOCAL AREA NETWORK

This is another type of wireless technology offering a major potential for library. Wireless local area networks (WLAN) do the same thing as the conventional computer LAN's, only without the need to lay costly phone or coaxial cables throughout a building or campus.

A Wireless Local Area Network (WLAN) is a flexible data communication system implemented as an alternative to a wired local area network within a building or campus. Using radio frequency (RF) technology, WLANs transmits and receives data over the air, minimizing the need for wired

40

connections. Thus, WLAN's combine data connectivity with user mobility and through simplified configuration enables moveable LANs.

Over the last seven years, WLANs have gained strong popularity in a number of vertical markets, including the health care, retail, manufacturing, warehousing and academic arenas. These industries have profited from the productivity gains of using hand held terminals and notebook computers to transmit real-time information to centralized loss for processing. Today WLANs are becoming more widely recognised as a general purpose connectivity alternative for a broad range of business concern.

3.20 BENEFITS OF WLANs

The widespread strategic reliance on networking among competitive business, the meteoric growth of the internet and the online services made possible are strong testimonies to the benefits of shared data and shared informations. Without looking for a place to plug in, a network manager can set up or augment networks without installing or moving wires. WLANs offer the following productivity convenience and cost advantages over traditional wired network.

i.   MOBILITY: WLAN system can provide LAN users with access to Real time information anywhere in their organizations. This mobility supports productivity and services opportunities not possible with wired networks.

ii.   INSTALLATION SPEED AND SIMPLICITY: Installing a WLAN system can be fast and easy and can eliminate the need to pull cable through walls and ceiling.

iii.   INSTALLATION FLEXIBILITY: Wireless technology allows the network to go.

iv.   REDUCED COST OF OWNERSHIP: While the initial investigation required for WLAN hardware can be higher than the cost of wired LAN hardware, overall installation expenses and lifecycle cost can be significantly lower. Long term cost benefits are greatest in dynamic environment requiring frequent moves, adds and changes.

v.   SCALABILITY: WLAN systems can be configured in a variety of topologies to meet the needs of specific application and installations. Configurations are change and range from peer-to-peer networks suitable for small number of users; full infrastructure networks of thousands of users that allow roaming over a broad area.

CHAPTER FOUR

4.0 SYSTEM IMPLEMENTATION / DOCUMENTATION

Implementation is the process of applying the developed system for the purpose it is meant for. System implementation involves the development of quality assurance procedures, including data security, back-up, recovery and system control. system implementation objective is to complete the orderly and unobstructive installation of the new system.

4.1 INTRODUCTION

Nigerian libraries has been facing the problem of geographical isolation and lack of telecommunication facilities to enhance data sharing from one end to another. Here packet radio is introduced to enhance resources sharing between libraries instead of the epileptic and expensive telephone lines to bring about information sharing and prompt access to materials in different locations.

4.2 CHOICE OF PROGRAMMING LANGUAGE

The basic aim of the project is that users of libraries may have access to information /resources in remote locations. Therefore there is need for a design that brings user's interface and query language to place. The query language and her interface connect the interface to the database. The proposed program is written using VISUAL BASIC (VB) Programming Language. VB provides packages of programs

and documentation needed to create, maintain, organize and retrieve information from a database. It is software that helps an organization to manage its data resources.

4.3 FEATURES OF LANGUAGE CHOSEN

Visual Basic is the most widely used object oriented programming language. The Microsoft windows operating system provides the user with a simple graphical users interface (G.U.I) in GUI, a user controls the computer operations by moving a pointer and selecting icons. VB provides the programmer with tool box of user interface controls that can be used to design interfaces with point-and-click, drag-and-drop. In order to create a user interface, the programmer needs only to select the desired control from the toolbox and place them in the program, so VB is designed as a language for rapid application development (RAD), under the window operating system, it allows a programmer to easily design a user interface that satisfies the customer's requirements.

4.4 WRITING THE CODE

After the form is designed and the default property setting is changed, the source code should be written double click the command button on the form. A code window opens and VB automatically places the code heading in the window and you will now type in the code. After typing the code 'in' the program is running by clicking the start button on the tool bar, selecting Run/start from the menu bar, or pressing it

4.5   TESTING AND DEBUGGING OF PROGRAM

After the choice of software development package is made, the coding was done in Visual Basic and on completion, a test running is done using already existed data with known result and all error encountered in the program were removed through a process called debugging. This was expected until the program was found working to expectation.

4.6   OPERATIONAL MANUAL

After the installation of the software and system is switched on, a box appear for you to log in with a password, if a wrong password is typed in the program will not open, it will request for the password again, until the proper password is typed in,a menu box appear, at this point you will have to navigate with the aid of the mouse to click the place you are interested in. if you want to register as a user of the facility a box appear for you to put in all necessary information and you click save, the open type of the box re-appear again , in case you have more than one interested users. If not click on exit, this takes you back to the menu box where you will click the path to take again. At this point you can access the dialog area to check for the list of books in the library, here you can also confirm the available ones on the shelves that has not been borrowed out. If library A, does not have the particular book you can check in library B or C that is networked together using packet radio technology.

The project programming is limited to 3 libraries that is networked together. After the confirmation is done and user is satisfied. You

click on closed to take you back to the main menu again. At this end you can exit the entire program when you are satisfied.

4.7 HARDWARE AND SOFTWARE REQUIREMENT

COMPUTER :- Multimedia 64KB RAM

PRINTER : (1) Laser printer 5L/6L. (2) desk jet 640.

UPS :Uninterruptible Power Supply

STABILIZER: 250 Voltage

SOFTWARE PACKAGE: Visual basic (VB).

OPERATING SYSTEM : DOS, MS-DOS, Windows 98, window 2000, window XP etc.

4.8 DOCUMENTATION

This is necessary to keep user abreast of the importance and implementation of the system. The final report covering the entire designed system must be documented showing every aspect of the actions. An operating system like PC-DOS, MS-DOS,window98 e.t.c. are essential to startup the computer, the application is then installed on the hard disk or load from a floppy diskette 3.5inch each time its needed. The disk is however protected from virus attack, for security of the software to be maintained from unauthorized users. The package has a built in security system called "PASSWORD" which only the operator has a knowledge of, and until such is entered the package cannot be used.

BOOK DELIVERY FORM

File Edit View Insert Format Help

BOOKS DELIVERY   _ □ x

BOOKS DELIVERY

ISBN	0-07-219527-4
TITLE	ORACLE 9i DBA
AUTHOR	CHARLES A. PACK
PUBLISHER	MCGRAWHILL
YEAR PUBLISHED	2002
DATE	20/11/2003

[|◀] [◀] [▶] [▶|]   SAVE   CANCEL

For Help, press F1   CAP NUM

Start | Project1 - ... | Microsoft ... | Form2 | Document -... | 11:53 AM

FORM BOOKLEND

File Edit View Insert Format Help   Minimize

BOOK LENDING   _ □ x

BOOK LENDING

ISBN	
TITLE	
AUTHOR	
PUBLISHER	
YEAR PUBLISHED	
USER NUMBER	
DATE COLLECTED	
RETURN DATE	

SAVE   CANCEL

For Help, press F1   CAP NUM

Start | Project... | Microso... | Docum... | Form2 | BOOK L... | 11:58 AM

47

LIBRARY LIST OF BOOKS

Zoom 100%

LIBRARY LIST OF BOOKS

BOOK ISBN	TITLE	AUTHOR	PUBLISHER	YEAR PUBLISHED
07 094189 X	REAL AND COMPLEX ANALYSIS	WALTER RUDIN	MCGRAW-HILL	1970
0-07-219537-1	OCP INTRODUCTION TO ORACLE9I SQL EXAM GUIDE	J. COUCHMAN	MCGRAWHILL	2001
0-07-219543-6	OCP ORACLE 9I DATABASE	RAMA VELPURI	MCGRAWHILL	2002

Pages: 1

Start | Project... | Microso... | Docum... | Form2 | LIST O... | 11:59 AM

LIST OF LIBRARY USERS

Zoom 100%

LIST OF LIBRARY USERS

USER REG. NO SEX	SURNAME	FIRST NAME	OTHER NAMES	POSTAL ADD.	RES. ADD.
97/5771BM MALE	AWOTOYE	FIYINFOLU	CYRIL	P.O BOX 1680, GARKI, ABUJA	#170 T. Y. DANJUMA CRESCENT, ASOKORO, ABUJA
99/8890BM FEMALE	AWOTOYE	ADEYINKA	DEBORAH	P.O.BOX 1680, GARKI, ABUJA	#170 T. Y. DANJUMA CRESCENT, ASOKORO, ABUJA

Pages: 1

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48

CHAPTER FIVE

5.0 CONCLUSION

The problem of geographical isolation and lack of a telecommunication infrastructure implications in Nigerian Library has been dealt with in this project by the application of packet radio as a means given to overcome such problem and to render Nigerian library abilities to use electronic networking to support resources sharing and to give to users, timidly access to information resources.

5.1 ISSUES AND OBSTACLES IN THE USE OF PACKET RADIO

Packet radio has the potential /providing many benefits to Nigeria (especially the libraries). Examining the problems of geographical situation and poor telecommunication alone will not solve problems facing Nigeria Library. Thus the problems afflicting Nigeria must be looked into. It is good to have an understanding of these problems which can hinder the successful implementation of packet radio network in Nigeria. The must noticeable ones includes:-

LACK OF STANDARD FOR PACKET RADIO PROTOCOL:-

These are many different protocols for the implementation of specific packet radio networks, there are, however few if any, standard in place for packet radio interconnection. For example, at the physical layer, it is impossible to specify a single frequency, which all transceiver will support; it is not even

possible to specify a set of such frequencies. The choice of frequency depends on a complex consideration of both physical and political techniques, this depends to a considerable extent on the frequency available, data transfer rates are a function of frequency and encoding technicality, the primary implication of this lack of standard is the probability of poor interoperability between different product manufacturers.

FREQUENCY ALLOCATION:- This is a very serious problem encountered when setting up a packet radio network anywhere in the world, that is obtaining permission to use a portion of the frequency spectrum. In Nigeria where the airwaves were less congested, obtaining permission to use a frequency from the government can be tedious and frustrating. It is evident that acquiring approval for operating any sort of communication equipment in Nigeria may not be an easy task due to political problem.

LACK OF GRADING OR STANDARD FOR MATERIALS:-
One of the barriers to the easy installation of a packet radio network is the lack of the shelf hardware and software grading. The responsibility for testing and integration lies with the implanter and not with the vendor(s) of the various component. Implementation of a packet radio network for library application is therefore likely to be a complex and lengthy process, requiring stuff with various areas of expertise.

NEED FOR TRAINING:-

There is generally little-or-no training at all to support the efficient use of information technology in Nigeria. Among libraries, specifically there is a high rate of computer illiteracy (ware 1990) compounding problems include lack of agencies to train in the use of equipment and software language of documentation. A shortage of funds to train staffers overseas, and the brain drain syndrome of few well trained staffs to developed countries (wayers, 1990); this lack of adequate training can actually affect the efficacious use of any information technology including packet radio.

COST AND FINANCIAL CONSTRAINTS:-

A complete packet radio installation can be costly. The most chronic problem facing libraries is the shortage of funds. If there is no money to buy enough books, then a sophisticated packet radio network workstation may be difficult to justify. One solution is to obtain assistance in the form of equipment of fund from donor agencies in order to startup with cost of computer and packet radio equipment as well as on going costs such as paper ribbons for printer, database licences, network changes.

5.2   BENEFITS OF PACKET RADIO

Packet radio has been a promising technology because of its utility in creating digitizing network in the reliable telecommunication. Packet radio can support many libraries application. These application includes:-

a. Professional communication among libraries in a region. These are by building operation link.

b. Electronic document delivery thus avoiding inefficiency of ground/land transportation.

c. Providing remote extension to internal computer network such as the Internet.

d. Supporting pre-established decentralized activities such as co-operative catalogue initiative.

e. Gateways to network and database centered in industrialized nation (e.g. the internet).

f. Creating or accessing union catalogues and union list serials.

g. Inter-library loan (ILL) messaging among libraries within a region.

h. Information retrieved of locally created database and networked CD-ROMS for remote location.

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PROGRAM CODES

CODE FOR FRMBLEND

```
Dim punum, bknum As String
Dim flag1, flag2, flag3, flag4 As Integer

Private Sub cmdcancel_Click()
    punum = ""
    bknum = ""
    Me.Hide
End Sub


Private Sub cmdsave_Click()
    With Data2.Recordset
        If flag1 = 1 And flag2 = 1 Then
            .AddNew
            ![tisbn] = UCase(Trim(txtisbn.Text))
            ![tlregno] = UCase(Trim(txtunum.Text))
            ![tdcollect] = Trim(txtdcollect.Text)
            ![tdreturn] = Trim(txtdreturn.Text)
            .Update
        Else
            MsgBox "THERE IS AN UNCOMPLETED BOX, CHECK FORM
PROPERLY", vbInformation
            txtisbn.SetFocus
        End If
    End With

    With Data3.Recordset
        .MoveFirst
2       If bknum = ![tisbn] Then
            .Edit
            ![tstatus] = 0
            .Update
        Else
            .MoveNext
            GoTo 2
        End If
    End With

    MsgBox "BOOK LEND HAS BEEN REGISTERED", vbInformation
    punum = ""
    bknum = ""
    txtisbn.Text = ""
```

```vb
        txttitle.Text = ""
        txtauthor.Text = ""
        txtpublisher.Text = ""
        txtypublish.Text = ""
        txtunum.Text = ""
        txtdcollect.Text = ""
        txtdreturn.Text = ""
        cmdsave.Enabled = True
        cmdnew.SetFocus
End Sub

Private Sub bklend1()

    flag3 = 0
    With Data4.Recordset
        .MoveFirst
5       If .EOF Then
            MsgBox "THIS BOOK ISBN DOES NOT EXIST IN LIBRARY 2!", _
vbInformation
            Call bklend2
            Exit Sub
        End If

        If bknum = ![tisbn] Then
            flag3 = 1
            txttitle.Text = ![ttitle]
            txtauthor.Text = ![tauthor]
            txtpublisher.Text = ![tpublisher]
            txtypublish.Text = ![typublish]
            MsgBox "THIS BOOK ISBN EXISTS IN LIBRARY 2!", vbInformation
            txtunum.Enabled = False
            txtdcollect.Enabled = False
            txtdreturn.Enabled = False
            cmdsave.Enabled = False
            cmdnew.SetFocus
        Else
            .MoveNext
            GoTo 5
        End If
    End With
End Sub

Private Sub bklend2()

    flag4 = 0
    With Data5.Recordset
```

```vb
        .MoveFirst
5       If .EOF Then
            MsgBox "THIS BOOK ISBN DOES NOT EXIST IN LIBRARY 3!",
vbInformation
            cmdnew.SetFocus
            Exit Sub
        End If

        If bknum = ![tisbn] Then
            flag4 = 1
            txttitle.Text = ![ttitle]
            txtauthor.Text = ![tauthor]
            txtpublisher.Text = ![tpublisher]
            txtypublish.Text = ![typublish]
            MsgBox "THIS BOOK ISBN EXISTS IN LIBRARY 3!", vbInformation
            txtunum.Enabled = False
            txtdcollect.Enabled = False
            txtdreturn.Enabled = False
            cmdsave.Enabled = False
            cmdnew.SetFocus
        Else
            .MoveNext
            GoTo 5
        End If
    End With
End Sub

Private Sub Form_Activate()
    txtisbn.Text = ""
    txttitle.Text = ""
    txtauthor.Text = ""
    txtpublisher.Text = ""
    txtypublish.Text = ""
    txtunum.Text = ""
    txtdcollect.Text = ""
    txtdreturn.Text = ""
    cmdsave.Enabled = True
    txtisbn.SetFocus
End Sub

Private Sub Form_Load()
    Data1.DatabaseName = App.Path & "\lib1.mdb"
    Data1.RecordSource = "users"
    Data2.DatabaseName = App.Path & "\lib1.mdb"
    Data2.RecordSource = "lend"
    Data3.DatabaseName = App.Path & "\lib1.mdb"
```

```vb
    Data3.RecordSource = "books"
    Data4.DatabaseName = App.Path & "\lib2.mdb"
    Data4.RecordSource = "books"
    Data5.DatabaseName = App.Path & "\lib3.mdb"
    Data5.RecordSource = "books"
End Sub

Private Sub txtisbn_Lostfocus()
    flag1 = 0
    bknum = UCase(Trim(txtisbn.Text))

    If txtisbn.Text = "" Then
        MsgBox "BOOK ISBN CANNOT BE BLANK", vbInformation
        cmdcancel.SetFocus
    End If

    With Data3.Recordset
        .MoveFirst
5       If .EOF Then
            MsgBox "THIS BOOK ISBN DOES NOT EXIST IN THIS LIBRARY!", _
vbInformation
            punum = ""
            bknum = ""
            cmdsave.Enabled = False
            Call bklend1
            Exit Sub
        End If

        If bknum = ![tisbn] And ![tstatus] = 1 Then
            flag1 = 1
            txttitle.Text = ![ttitle]
            txtauthor.Text = ![tauthor]
            txtpublisher.Text = ![tpublisher]
            txtypublish.Text = ![typublish]
            txtunum.SetFocus
        ElseIf ![tstatus] = 0 Then
            txttitle.Text = ![ttitle]
            txtauthor.Text = ![tauthor]
            txtpublisher.Text = ![tpublisher]
            txtypublish.Text = ![typublish]
            MsgBox "BOOK EXISTS BUT IT HAS BEEN LENT OUT", vbInformation
            punum = ""
            bknum = ""
            cmdsave.Enabled = False
            cmdnew.SetFocus
        Else
```

```vb
        .MoveNext
        GoTo 5
      End If
    End With
End Sub


Private Sub txtunum_Lostfocus()
    flag2 = 0
    punum = UCase(Trim(txtunum.Text))

    If txtunum.Text = "" Then
      MsgBox "USER NUMBER CANNOT BE BLANK", vbInformation
      cmdnew.SetFocus
    End If

    With Data1.Recordset
      .MoveFirst
5     If .EOF Then
        MsgBox "THIS USER NUMBER DOES NOT EXIST", vbInformation
        cmdnew.SetFocus
        Exit Sub
      End If

      If punum = ![tregno] Then
        flag2 = 1
        txtdcollect.Text = Date
        txtdreturn.SetFocus
      Else
        .MoveNext
        GoTo 5
      End If
    End With
End Sub
```

CODE FOR FRM BRETURN
```vb
Dim bknum As String

Private Sub cmdcancel_Click()
    Me.Hide
End Sub

Private Sub cmdsave_Click()
    If txtisbn.Text = "" Then
      MsgBox "BOOK ISBN CANNOT BE BLANK", vbInformation
      cmdcancel.SetFocus
```

```vb
      End If
      bknum = UCase(Trim(txtisbn.Text))
      With Data2.Recordset
        .MoveFirst
5     If .EOF Then
          MsgBox "BOOK DOES NOT EXIST IN THE LIST OF LENT BOOKS",
vbInformation
          Exit Sub
        End If

        If bknum = ![tisbn] Then
          .Delete
        Else
          .MoveNext
          GoTo 5
        End If
      End With

      With Data1.Recordset
        .MoveFirst
10      If .EOF Then
          MsgBox "BOOK DOES NOT EXIST IN THIS LIBRARY", vbInformation
          Exit Sub
        End If

        If bknum = ![tisbn] Then
          .Edit
          ![tstatus] = 1
          .Update
        Else
          .MoveNext
          GoTo 10
        End If
      End With
      MsgBox "BOOK RETURN HAS BEEN REGISTERED", vbInformation
      txtisbn.Text = ""
      txtlnum.Text = ""
      txtdcollect.Text = ""
      txtdreturn.Text = ""
      txtremarks.Text = ""
      txtisbn.SetFocus
      cmdsave.Enabled = True
    End Sub

Private Sub Form_Load()
    Data1.DatabaseName = App.Path & "\lib1.mdb"
```

```vb
    Data1.RecordSource = "books"
    Data2.DatabaseName = App.Path & "\lib1.mdb"
    Data2.RecordSource = "lend"
    txtdreturn.Text = Date
End Sub

Private Sub txtisbn_Lostfocus()
    'flag1 = 0
    bknum = UCase(Trim(txtisbn.Text))

    With Data2.Recordset
        .MoveFirst
15      If .EOF Then
        MsgBox "THIS BOOK ISBN DOES NOT EXIST IN THE LIST OF LENT
BOOKS!", vbInformation
        punum = ""
        bknum = ""
        cmdsave.Enabled = False
        'Call bklend1
        , Exit Sub
        End If

        If bknum = ![tisbn] Then
            'flag1 = 1
            'txttitle.Text = ![ttitle]
            'txtauthor.Text = ![tauthor]
            'txtpublisher.Text = ![tpublisher]
            'txtypublish.Text = ![typublish]
            txtlnum.Text = ![tlregno]
            txtdcollect.Text = ![tdcollect]
            txtremarks.SetFocus
            'txtdreturn.SetFocus
        Else
            .MoveNext
            GoTo 15
        End If
    End With
End Sub
```

CODE FOR FRMBDELIVERY

```vb
Private Sub cmdcancel_Click()
    Me.Hide
End Sub

Private Sub cmdnew_Click()
```

```vb
    txtisbn.Text = ""
    txttitle.Text = ""
    txtauthor.Text = ""
    txtpublisher.Text = ""
    txtypublish.Text = ""
    txttdate.Text = ""
    Me.Hide
    cmdsave.Visible = True
End Sub


Private Sub cmdsave_Click()
    If txtisbn.Text = "" Then
        MsgBox "ISBN CANNOT BE BLANK", vbInformation
        txtisbn.SetFocus
        Exit Sub
    ElseIf txttitle.Text = "" Then
        MsgBox "BOOK TITLE CANNOT BE BLANK", vbInformation
        txttitle.SetFocus
        Exit Sub
    End If

    With Data1.Recordset
        .AddNew
        ![tisbn] = UCase(Trim(txtisbn.Text))
        ![ttitle] = UCase(Trim(txttitle.Text))
        ![tauthor] = Trim(txtauthor.Text)
        ![tpublisher] = Trim(txtpublisher.Text)
        ![typublish] = Trim(txtypublish.Text)
        ![tstatus] = 1
        .Update
    End With
    MsgBox "BOOK HAS BEEN REGISTERED", vbInformation
    txtisbn.Text = ""
    txttitle.Text = ""
    txtauthor.Text = ""
    txtpublisher.Text = ""
    txtypublish.Text = ""
    txttdate.Text = ""
    txtisbn.SetFocus
End Sub


Private Sub Form_Load()
    Data1.DatabaseName = App.Path & "\lib1.mdb"
    Data1.RecordSource = "books"
End Sub
```