THE STUDY OF TELECOMMUNICATIONS IN NIGERIA AND THE INTERCONNECTIVITY PROBLEM

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DECLARATION

I **Ibitomihi Sunday Michael** hereby declare that this thesis "*The Study of Telecommunications in Nigeria and the Interconnectivity Problem*" presented for the award of Bachelor of Engineering has not been presented either wholly or partially for the award of any other degree elsewhere.

Information derived from published or unpublished works have been duly acknowledged.

.....Ibitomihi..... .....08/12/04.....

SIGNATURE DATE

CERTIFICATION

This is to certify that this thesis "The study of telecommunications in Nigeria and the problem of interconnectivity" is the original work of **Ibitomihi Sunday Michael (99/9047EE)** carried out under my supervision. I found the work adequate both in scope and quality for the partial fulfillment of the requirement for the award of Bachelor of Engineering (B.Eng) in Electrical/Computer engineering.

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DEDICATION

This project is dedicated to the entire family of **Chief and Mrs. Peter Ibitomihi** who never ceased believing in me and to **God almighty** who never made me to disappoint them.

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ABSRACT

Telecommunication is the most exciting discovery of modern day society. The world has finally turned into a global village as a result of effective communication system through telephone network that ranges from Public Switched Telephone Network (PSTN) to Global System for Mobile Communication (GSM) and computer communication such as intranet and Internet. Interconnection of all available communication networks is solely responsible for this glorious feat of a global village.

The importance of full interconnectivity among all the communication network operators in Nigeria is inevitable if truly the nation is to be integrated into the global village, hence the need for this project.

The use of a clearinghouse that may be known as National switch centre to resolve the interconnectivity problem formed the basis of the project. The clearinghouse is a multi-protocol tandem switch that can use any of the available transmission media.

This centre is to be established and maintained by Nigeria Communications Commission (NCC) or consortium of all network operators or any neutral operator licensed as an Application Service provider.

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CHAPTER ONE

GENERAL INTRODUCTION

1.0 INTRODUCTION

Telecommunications is an essential part of any economy. It is the vital engine upon which other sectors' development and growth are hinged on.

Effective and efficient telecommunications is only achievable if there is perfect interaction (interconnectivity) among all the different services providers in the industry.

This project is a research study conducted to look at the concept of telecommunications with emphasis on the most widely accepted mobile telephony technology: *Global System for Mobile communication* (GSM).

A brief historical background of Nigeria telecommunications and an extensive work on interconnectivity also formed elements of the project.

1.1 LITERATURE REVIEW

Telecommunications is as old as the existence of man. Examples of early telecommunications include the use of whistle, smoke fire, talking drum etc.

The advent of modern telecommunications started on February 14, 1876, with the invention of telephone set by Alexander Graham Bell. Modern telecommunications has witnessed series of changes and development. The invention of automatic exchange by Almon B. Strowger in 1889 marked the beginning of new lease of life into telecommunications.

In 1893 the first central office exchange with common battery and signalling became operational. This led to reduction in subscriber telephone size, which often come with bulky battery to provide power. The unveiling of transistor by the Bell System on July 1st, 1948, a joint invention by Bell laboratory scientists: William Shockley, John Bardeen and Walter Brathain revolutionised the telecommunications industry leading to the invention of automatic electronic exchange in 1960.

As the telecommunications traffic begins to increase beyond what the conventional twisted pair and coaxial cable could effectively cope with, efforts were concentrated on the use of optic fibre as early as in the 1960s. However the effort yielded result in 1970 when the trio of Drs. Robert Maurer, Donald Keck and Peter Schultz who were upcoming scientist manufactured an optic fibre measured attenuation of less than 20dB/km. By 1976, optic fibre was successfully deployed in telecommunications network marking the beginning of fibre optic system.

In order to combat the problem of subscriber being fixed to a location for telephoning and other telecommunications services, the mobile telephony whose hallmark is mobility became operational in 1981 and this has since proved to be the fastest growing aspect of telecommunications. For instance, GSM in Nigeria, which is barely three years old (2001 - 2004) host over 80% of the total telephone lines in the country.

However in all these years, the government or a single operator often owned virtually all the world telecommunications outfits.

The liberalization/deregulation wind blowing all over the world economy has brought about a new phase of challenge in the telecommunications sector.

In Nigeria for instance, before the establishment of Nigeria Communication Commission (NCC) by decree 75 of 1992, the only single network operator was Nigeria telecommunications Limited (NITEL) and the world interconnectivity was never an issue.

With the licensing of some Private Telecommunications Operators (PTO) in 1996 by NCC, and Multilink Limited commencing commercial services in 1997, the first interconnectivity problem was witnessed in the over a century old telecommunications industry in Nigeria.

However the problem was amicably resolved after several negotiations between the incumbent then (NITEL) and the new entrant (Multilink),

these series of negotiations wasted enormous time and money.

The same problem of interconnectivity re-emerged a couple of years later when the other licensed Fixed Wireless Access (FWA) operators commenced operation.

With the coming of GSM operators: MTN, Econet (Now Vmobile), and M-TEL in 2001, the problem of interconnectivity once more came with full force and the effect this time was really frustrating because several people were affected unlike in the pre-GSM era where owning a telephone line was a sign of affluent and opulent living, with only the rich being able to afford one.

In September 2003, when Globacom the fourth GSM operator and second national operator commenced their GSM services, the same problem of interconnectivity still repeated itself between the new entrant and some of the incumbents.

The NCC is working assiduously to resolve this problem so as to bring the telecommunications industry in Nigeria into a state where fair competition will be feasible thereby paving way for new entrants. Some of their efforts include the resolution of the interconnection charge rate, this charge rate was developed in conjunction with Messrs Detecon GMBH a world leading firm in integrated management and technological consultancy in telecommunications (TC) and information technology (IT) markets. This interconnection charge rate was

developed in December 2003 and it is to be operational by January 2004, although it is operational at the moment, but the charge rate has been challenged in the court of law by one of the network operators.

Also in the bid to get competent personnel for the industry, which can indirectly, affect the interconnectivity problem resolution, the Digital Bridge Institute (DBI), an institution to train personnel in telecommunications and IT was commissioned in May 2004.

1.2 PROJECT OBJECTIVEN AND MOTIVATION

This project is born out the need to have a telecommunications industry in Nigeria that can fully integrate the nation into the global village.

The sole aim of deregulation/liberalization of any industry is to make room for fair competition among all the players; it is a global fact that competition brings about quality services at cheaper price. But these lofty dreams will be unachievable without perfect and seamless interconnection among all the players.

This work itemized the various causes of interconnectivity problem and it proffers the best possible technical way of resolving and preventing interconnectivity problem.

The present boom of the telecommunications industry in Nigeria also serves as an impetus to conduct the research. With the deployment of GSM technology in 2001, it is expedient that the basic technology behind this world acclaimed best mobile technology to be briefly discussed within the context of an under graduate project.

1.3 PROJECT LAYOUT

The first chapter gives a general introduction of the work paying attention to the literature review, objectives and motivation of the work as well as the project layout.

Chapter two is all about the concept telecommunications, some of the present day telephone technologies discussed under this chapter are Public Switch Telephone Network (PSTN), Integrated Service Digital Network (ISDN), Voice over Internet Protocol (VoIP) and Public Land Mobile Network (PLMN) with emphasis on GSM which is a type of PLMN.

A brief history of telecommunications industry in Nigeria is detailed out in chapter three by dividing the history into two era/phases; pre-independence and post-independence, while the latter is subdivided into three phases.

Chapter four outlines interconnectivity problem looking at it from the

perspective of the causes and possible solutions to the problem.

Lastly, chapter five is the general comments, recommendation and conclusion.

CHAPTER TWO

THE CONCEPT OF TELECOMMUNICATIONS

2.0 INTRODUCTION

Telecommunications can be viewed as a word comprising of *tele* and *communication*. *Tele* stands for remote indicating bridging of geographical distance while *communication* is the exchange of comprehensible information. Therefore telecommunications can be simply defined as the remote exchange of comprehensible information. From technical point of view, telecommunications network is a coherent system of switching and transmission devices, which allow connections between any two subscribers terminal of the networks. Telecommunications has witnessed series of changes, which are fallouts of technological advancement that are usually applied in the technical make-up of telecommunications network.

2.1. IMPORTANCE OF TELECOMMUNICATIONS

Telecommunications is no doubt the most exciting occupational field offered by the modern society. There are numerous applications of telecommunications and this is evident in the day-to-day endeavours of man. The following points highlight the importance.

- It is the bedrock of modern days' convenience. For instance information can travel over a distance of several kilometres without

the users themselves moving an inch i.e. it replaces physical movement of people across distances.

- Telecommunications is referred to as infrastructure of infrastructures because it is the very vital engine of any economy, promoting the development of other sectors such as agriculture, education industry, health, banking etc.
- It is very cost effective. This is evident on everyday basis how telecommunications saves time and money.
- The security of any nation depends on effective communication. Some of the technological breakthroughs in telecommunications were military based.
- Telecommunications is indispensable in the times of emergency. For examples, the use of special emergency codes. In Nigeria, 119 is for emergency ambulance, 190 for fire services etc. USA uses 911 for emergency services.
- Above all, telecommunications has brought about rapid dissemination of knowledge and information because the world now is a global village.

2.2 COMPOSITION OF TELECOMMUNICATIONS NETWORK

Every telecommunications network can be broadly subdivided into:

1) Switching

2) Transmission

2.2.1 SWITCHING

Switching is the circuitry (hardware and software) that allows the interconnection of several subscribers.

Switch or exchange is any equipment meant to switch calls from the connected subscribers in the same exchange or to some specific equipment in the same exchange or in another exchange and also supply the necessary data to the billing system.

There are different name given to a switch depending on the type of telecommunications network it is being deployed. For instance, in Public Switched Telephone Network (PSTN) it is called public switch/exchange while in Public Land Mobile Network (PLMN) it is known as Mobile services Switching Centre (MSC).

TYPES OF SWITCHING TECHNOLOGY

The routing of traffic (data and voice) between network nodes/devices is done through one of these three basic forms of switching technology.

1) Circuit switching

2) Message switching

3) Packet switching

2.2.1.1 CIRCUIT SWITCHING

Circuit switching is a method of routing traffic between an originator and a destination through a switching centre from local users or from other switching centre.

In a circuit switched network, a physical path is obtained for and dedicated to a single connection between two end points in the network for the duration of the connection. During that time no one else can use the physical lines involved.

Circuit switching systems are ideal for communication that requires traffic to be transmitted in real-time. It is use in PSTN and ISDN.

2.2.1.2 MESSAGE SWITCHING

Message switching is a store-and-forward concept where a message with an appropriate destination address is sent into the network and is stored at each intermediate switching point where its integrity is checked before it is sent onto the next stage of its journey. The path or route for message transmission may be fixed or may be determined dynamically as the message progresses towards its destination node.

2.2.1.3 PACKET SWITCHING

In packet switching, a message is divided into packets and each packet sent individually unlike message switching where the whole message is sent at once. At the destination node, the packets are reassembled into the corresponding message.

Packet switching makes more efficient use of bandwidth compared with the circuit switching because there are no dedicated channels for users. It is mostly applied in data switching where some amount of delay is acceptable. It is exclusive to the Public Switched Data network the *X.25* network.

2.2.2 TRANSMISSION

This is the transport of information from one point to another. Transmission could be between a subscriber terminal and the switch or between two exchanges.

The information being transported is either a user's traffic or control signals needed for effective communications. The medium used for transmission is known as physical channel or link.

2.2.2.0. TYPES OF TRANSMISSION MEDIA

In telecommunicationss, the transmission media can be broadly divide into two categories thus;

a) Bounded media

b) Unbounded media

2.2.2.1 BOUNDED MEDIA

In bounded media, the signals are transmitted in a confined physical medium. Bounded media are also known as cabled or wired media. The following types of bounded media exist.

2.2.2.1.1 TWISTED PAIR

Twisted pair wire is made up of insulated copper wires that are twisted or bounded together.

Their size varies from *22AWG – 26AWG*. Initially twisted pair cables were called telephone wires due to its dominance as transmission media in PSTN between subscribers and the exchange.

2.2.2.1.2 COAXIAL CABLE

Coaxial cable consists of a central copper surrounded by an insulating material. They are concentric in cross sectional view. They are classified into different classes based on their transmission line impedance. For example there are 50Ω, 75Ω, 93Ω impedance coaxial cable.

One of the advantages of coax cable over Twisted Pair is its high bandwidth. Due to high bandwidth coaxial cable are used as submarine telecommunications media in linking two countries i.e. intercontinental

link. Coaxial cable for Submarine telecommunications system has special requirements than the landline coaxial cable. This special requirement is evident in its shielding. The two types of submarine coax cable are;

a) Shallow-water cable

b) Deep -water cable

2.2.2.1.3 OPTIC FIBRE

These are non-metallic cable that uses a beam of light to carry data through glass fibre. Optic fibre is the transparent material along which light is transmitted. Every fibre (optic fibre) comprises of core, cladding, cover and strength member.

The core is usually glass surrounded by either a glass or plastic cladding that is of lower optical density. The difference between the refractive indices of the core and the cladding keeps the beam of light inside the core of the fibre.

The cover and strength member are to give protection to the glass fibre as well as isolate the fibre from environmental contamination.

There are two general categories of optic fibre based on the mode of propagation of light through it;

i. Single-mode fibre

ii. Multi-mode fibre

2.2.2.2. UNBOUNDED MEDIA

Unlike bounded media, they are relatively unrestricted in terms of physical dimension yet signals are convey through them. Unbounded media is also known as wireless. Examples of unbounded media are ocean and free space.

The free space uses radio waves as a 'vehicle' for conveying a transmitted signal to the receiving antenna.

Communication through free space can be broadly divided into

a) Terrestrial: In terrestrial system, the radio wave propagation is confined within the earth atmosphere. The radio wave propagation mode can be

   i. Ground wave
   ii. Ground reflected wave
   iii. Line of sight
   iv. Refracted wave
   v. Ionospheric reflection
   vi. Tropospheric scattering
   vii. Trans-ionospheric space wave

b) Extra-terrestrial: this mode involves the propagation of radio waves beyond the atmosphere into the outer space. The satellite communication falls under this category.

2.3. TELECOMMUNICATIONS NETWORK

Telecommunications network is any network that offers either bearer *services* or *teleservices.*

A bearer service solely provides a 'transport system' for exchanging of information whole a teleservices is 'complete' in the sense that it includes defined protocol for communication.

From the network operator's perspective, the teleservices can be divided into *basic services*, *value-added services* and *supplementary services*. The type of traffic passing through any telecommunications network is either voice or non-voice traffic such as data, video, and multimedia. For every good telecommunications network, its services must be affordable, widely spread, user friendly, reliable and has a high degree of availability.

2.4.1. TYPES OF TELECOMMUNICATIONS NETWORK

Various types of telecommunications networks exist to fulfil the actual need of the users. The networks considered in this section, fulfil both voice and non-voice bearer services and teleservices: PSTN, ISDN, VoIP and PLMN.

2.4.1.1 PSTN - PUBLIC SWITCHED TELEPHONE NETWORK

PSTN is the oldest and hitherto largest communication network in existence. The primary characteristics of PSTN are;

- Analogue access 300 – 3400Hz
- Circuit-switched duplex connection
- Switched bandwidth of 64Kbps, or 300 – 3400Hz for analogue exchange
- Immobility at (best restricted mobility)

TRANSMISSION MEDIA

The medium mostly used in PSTN is twisted pair primarily between subscribers and the network. In fixed Wireless Access (FWA), radio communication is used. Coaxial cable and optic fibre when used are mainly for backbones.

SWITCHING

Switching in PSTN is based on circuit switching method. During the long era of analogue PSTN, the purpose of interconnecting any two subscribers was to establish a physical contact between their respective telephone lines, but in modern day digital switching and transmission, times slot containing subscribers voice samples are

linked together to form logical connection. PSTN digital exchange sets up 64Kbps connections.

PSTN NODES

PSTN nodes are grouped into *local exchanges, transit exchanges* and *gateway exchanges.*

- Local exchanges (LE): - they are used for connecting subscribers in the same local area. Its three fundamental functions are
  a) To switch calls from the connected subscribers to other subscribers in the same exchange or to some specific type of equipment in the exchange
  b) To switch calls between the connected subscribers and other parts of the network and
  c) To charge for local and trunk calls and the use of distributed subscriber services.
- Transit exchange: switches traffic within and between different geographical areas
- Gateway exchange: Switches traffic to the other telecommunications networks that belong to other networks operators.

BASIC PSTN TELESERVICES

1. Fixed telephony
2. Cordless telephony (fixed telephony with restricted terminal mobility)
3. Fax
4. Data communication (Via modem)

SIGNALING

Before a voice connection is established by A-party (calling side) with B-party (called side). A-party exchange has to send message to the host exchange of B-party, the message has to be sent indicating which route is required, whether the route is free or busy, whether B-party is on-hook or off-hook. The interchange of this information is called signalling.

In PSTN, the type of signalling method used is Channel Associated Signalling (CAS). In CAS, there is no dedicated channel for signalling, the signal is sent is sent along the speech channel.

2.1.1.2. ISDN – INTEGRATED SERVICES DIGITAL NETWORK

ISDN purpose is to support a wide range of both new and existing voice and data services using a limited, but well-defined set of connections types and interfaces the user and the network.

B- Channel: This is one of the two types of channel used in ISDN. A B-channel has a transmission rate of 64Kbps and it is used for the transmission of subscribers' information through the network.

D- Channel: With a transmission rate of 64Kbps or 16Kbps and is mainly used fore signalling but also for packet traffic.

BRA – Basic Rate Access: It is defined as "2B + D" i.e. (2* 64 + 16) bps. It employs pleisochronous Digital Hierarchy (PDH) mini-transmission system. The PDH has a bit rate of 160Kbps; with BRA requiring 2B+D i.e. 144Kbps, the remaining 16Kbps (160-144) is used as follows: 13Kbps for synchronization and 3Kbps for network management.

PRA – Primary Rate Access: This is defined as "23B+D" for (N/America and Japan) and "30B+D" for Europe. 23B+D uses a T1 standard 1,544Kbps PCM transmission system while 30B+D uses an E1 standard 2,048Kbps. For the synchronization and network management the E1 standard uses (2,048 – 30*30+64) = 64Kbps.

BASIC ISDN TELESERVICES

1. Telephony
2. Telefax
3. Videotext
4. Teletext
5. Video telephony and video conferencing

ISDN also offers supplementary services such as

- ✓ Calling Line Identification
- ✓ Calling Line Identification Restriction
- ✓ Direct Dialling- in
- ✓ Multiple Subscriber number
- ✓ Terminal portability

2.6. VOIP – VOICE OVER INTERNET PROTOCOL

VoIP popularly known as Internet telephony (IPT) is the transport of telephone calls over the Internet. The basic operations of VoIP is the digitising of the voice signal followed by compressing of the data stream into a lower data rate based on proprietary or standardised voice-compression technique.

There are two primary transport protocols used for an Internet telephony session. TCP- *Transport Control Protocol* is used to transport

addressing or directory information, while UDP- *User Datagram Protocol* is used for the actual transfer of voice-digitised packets. Signalling (calling side) and party B (called side) combinations are as follows.

Party A Terminal	**Party B Terminal**
PC	PC
PC	Telephone (PSTN/ISDN/GSM...)
Telephone (PSTN/ISDN/GSM...)	PC
Telephone (PSTN/ISDN/GSM...)	Telephone (PSTN/ISDN/GSM...)

Table 2.1: Possible Combinations of Party A & B in VoIP

The three major components of VoIP are as follows;

- Media gateways
- Media gateway/signalling controller
- IP network

ADVANTAGES OF VoIP

1) It can be used as a single infrastructure for providing both Internet access and Internet telephony bringing about lower cost.
2) It is cheaper to make long distance calls e.g. international calls through Internet than other networks such as PSTN, PLMN and ISDN.

DISADVANTAGES

1) The major setback of VoIP is its lower voice quality often caused by higher delay and jitters.
2) Another major constraint of VoIP is compatibility and interoperability, which result out of proprietary ways of solving different problems encountered.

2.4.1.3. PLMN – PUBLIC LAND MOBILE NETWORK

A PLMN is telecommunications network for mobile units. It is one of the fastest and most popular teleservices that has ever existed.
The hallmark of PLMN is mobility in which subscribers are not tied/fixed to a location for teleservices. Most subscribers are connected via radio access.

Any PLMN (mobile network) has four sections or compositions, which are Network Switching System (NSS), Base Station System (BSS), Operating and Maintenance Centre (OMC) and Mobile Station (MS).

The development of PLMN has been phenomenal progressing from analogue to digital as well as complementing the terrestrial system with satellite system.

2.4.1.3.1 TYPES OF PLMN

The mobile networks can be broadly divided into analogue mobile networks and Digital mobile networks.

ANALOGUE MOBILE NETWORK

Analogue mobile network are characterised by the fact that both control channels and traffic channels are analogue. In the same vein, both voice (300 – 3400KHz) and data are frequency modulated on a carrier. The following are the various standards under analogue mobile network.

1. NMT – Nordic Mobile Telephony

   This was the first commercially operated PLMN (1981). The standards were defined by Nordic telecommunications Administration for the Nordic countries.

Two variants based on frequency band were specified viz, NMT450 and NMT900. the latter was introduced in 1986.

2. AMPS – Advanced (American) Mobile Phone System

   A consortium of TIA/EIA/ANSI developed this Mobile network standard and it became operational in 1984. In 1988 an extended version E-AMPS was deployed to comprise of wider frequency band. AMPS networks are found in Americas, Australia and Asia.

3. TACS – Total Access Communication System

   TACS is a modified version of AMPS; its frequency band is somewhat higher. The modification was made with the British market in view. It became operational in 1985. As a result of almost exhausting the available channels on TACS frequency band , E-TACS (Extended or enhanced) – TACS) was introduced and became operational in 1988. TACS has spread to many countries of the world.

Table 2.2 summarises the Analogue Mobile Network

Standard	System start	Freq. band *Uplink* (MHz)	Freq. band *Downlink* (MHz)	Channel capacity
NMT450	1981	453- 457.3	463 – 467.5	180/359
NMT900	1986	890 - 915	935 - 960	999/1999

AMPS	1984	824 - 849	869 - 894	832
TACS	1985	890 - 915	935 - 960	1000

Table 2.2: Analogue Mobile Standards

DIGITAL MOBILE NETWORK

They are primarily characterised by their digital traffic channels, which implies the speech is coded. As regards the control channels, they can be either digital or analogue. The four standards of Digital Mobile network are as follows:

1. GSM – Global System for Mobile communication

   This is the world acclaimed best mobile network. It became commercially operational in 1992. The history of GSM is an interesting one; initially the acronym GSM stands for *Groupe, Spéciale Mobile*, an ETSI (Europe Telecommunications Standards Institute) group, which in 1982 was assigned the task of specifying a mobile network that most importantly will allow international roaming and certain ISDN functionality. The GSM standard is expatiated further in section 2.5 of this project work.

2. PDS – Personal (Pacific) Digital Cellular

   This was specified by RCR (Research & Development Centre for Radio Systems) in Japan in cooperation with eleven

manufacturers, three of which were non-Japanese enterprises. It was previously called JDC – Japanese Digital Cellular. PDS became commercially available in 1993 – 1994. The air interface is open and similar to that of D-AMPS while the network architecture and services are more like GSM. For the time being it is only available in Asia.

3. D-AMPS – Digital Advanced Mobile Phone System

   This is the digital version of AMPS. It was initially known as ADC (American Digital Cellular). It is an AMPS that uses TDMA (three time slots) as access method. Recent version of AMPS was designed to operate at frequency band 1900MHz and is called 1900- AMPS. Its coverage area is same with AMPS.

4. PCS – Personal Communication Service

   This is an open standard; it mainly specifies service interface. PCS systems can either be analogue or digital, using cellular and cordless techniques. However it is often implemented as digital system because of digital system advantages over analogue. The digital access method is either TDMA or CDMA.

Table 2.3 below summarise the Digital Mobile Network standards.

Standard	System start	Freq. band *Uplink* (MHz)	Freq. band *Downlink* (MHz)	Channel Separation (KHz
GSM	1992	890 - 915	935 – 960	200

PDC	1993	940 – 956 1429 - 1441 1453 - 1465	810 – 826 1477 –1489 1501 - 1513	25
D - AMPS	1991	824 – 849	869 - 894	30

Table 2.3: Digital Mobile standards

2.3. GSM

Due to the wide acceptability of GSM as a digital mobile cellular Communications standard worldwide, with its presence in over 190 countries including Nigeria. This section will give a concise analysis of the technology of GSM. Its wide acceptability is due to the advantages enumerated below.

ADVANTAGES OF GSM OVER ANAOLOGUE MOBILE NETWORK

1. *Compatibility*: GSM as a digital cellular standard is operational in over 190 countries of the world, and this has further strengthen international roaming facility available to the subscribers. In analogue system, this feature is not readily available due to the different star dards in neighbouring countries. For instance, the world map below shows different analogue mobile networks in use in different European countries.

2. *Noise Robust*: The analogue systems are more vulnerable to noise interference from various sources such as lightning, ignition system, co-channel interference, adjacent channel interference and spurious background noise. With digital system the network is less susceptible to noise interference.
3. *Standardised Open interface*: With GSM, a network operator is not tied to as single equipment vendor/manufacturer, because all GSM equipment manufacturers that brings about competition which eventually leads to cost reduction.
4. *Improved Security and confidentiality:* prior to the advent of digital communication system, over 20% of calls made on analogue network are stolen .e. intercepted by unintended party. Digital communication system has been able to curb this act to the barest minimum through the following means;
    a) Encryption of the air interface
    b) The use of ME and SIM card
    c) MS Authentication
5. *ISDN compatibility*: One of the major advantages of GSM is its ISDN compatibility. It offers available services on ISDN.
6. *Enhanced range of Services*: GSM offers various teleservices including several form of supplementary and value-added-services.

7. *Flexible handover*: Unlike the analogue mobile networks, the handover process in GSM is more effective because it depends on quality level of uplink and downlink as well as MS distance from the BTS.
8. *Flexibility and increase capacity*: GSM is software dependent and so new features can be easily added and the installation of new network components and reconfiguration of existing ones can easily be done. The development of half rate speech that is presently on, this will effectively double the number of traffic channel on a carrier.

2.5.1. GSM NETWORKS ELEMENTS

This can be divided into four categories thus:

1. Network Switching System (NSS)
2. Base Station System (BSS)
3. Operating and Maintenance Centre (OMC)
4. Mobile Stations (MS)

NETWORK SWITCHING SYSTEM (NSS) COMPONENTS

a. MSC - Mobile services Switching Centre

All telephony-switching functions for the mobile network are performed by the MSC. Such functions include controls of calls to

and from other telephony and data systems e.g. PSTN, ISDN, Public Data network through the G-MSC – Gateway Mobile services Switching Centre. The MSC also provide operation and maintenance supervision, billing and mobility management.

b. HLR- Home Location Register

The HLR serves as the centralized network database that stores and manages all mobile subscriptions belonging to a specific network operator. It is more of a permanent database for subscribers' information. The information stored in the HLR includes

- ✓ Subscriber identity
- ✓ Subscriber supplementary services
- ✓ Subscriber location information
- ✓ Subscriber authentication information

The HLR can be implemented as a stand-alone or integrated into the same network node as the MSC.

c. VLR – visitor Location Register

The VLR is a network database containing information about all mobile subscribers currently located in an MSC area. This implies each MSC has a VLR attached to it. As soon as a Subscriber

roams into a new MSC area, the HLR supplies the subscriber information to the concerned MSC's VLR while at the same the HLR updates its location information. Information in the VLR includes

- ✓ Temporary copy of HLR
- ✓ Mobile Status
- ✓ Location Area Identity (LAI)

d. AUC – AUthentication Centre

As the name delineates, its main function is to authenticate subscribers attempting to use a network. The AUC is connected to the HLR and it ensures network security.

e. EIR – Equipment Identity Register

This is a database containing mobile equipment identity information that helps to block calls from stolen, unauthorised or defective Mobile station(s). Any given Mobile equipment is classified as any of the following

Mobile Equipment Status	***Implication***
White List	Authorised to be used
Grey List	Defective Mobile Equipment
Black List	Stolen Mobile Equipment

Table 2.4: EIR Mobile Equipment Status

However the EIR is an optional component in GSM networks and is often not used by most Mobile networks operators.

BASE STATION SYSTEM (BSS) COMPONENTS

a. BSC – Base Station Controller

It is a high capacity switch that manages all radio related functions of GSM such as MS handover, radio channel assignment. It controls one or more BTS depending on the configuration use by a particular network.

b. BTS – Base transceiver Station

It comprises of transceivers and antennae that are needed to serve each cell in the network. BTS controls the radio interface to the MS> The BTs supports cell with limited control functionality.

NETWORK MONITORING CENTRE (NMC) COMPONENTS

a. OMC – Operation and Maintenance Centre

An OMC is a computerised monitoring centre that is use for monitoring network status as well as the control of various system parameters. The OMC is connected to other network components via X.25 data network links.

b. NMC – Network Monitoring Centre

The NMC is usually one in a given network. The centre is used for centralised network control. All OMCs in the network are controlled by the NMC. Both OMC and NMC may be implemented in the same physical network node or at different locations.

MOBILE STATION (MS)

The MS is the subscriber equipment used to communicate with a mobile network. It allows a subscriber to receive and make calls.

MS COMPONENTS

GSM MS consists of

a. A mobile terminal/equipment (ME)

b. A subscriber Identity Module (SIM)

ME - Mobile Equipment

ME is the actual telephone terminal. Every ME has a unique IMEI – International Mobile Equipment Identity. They can be classified into five various classes based on its power utilization.

CLASS	MAXIMUM POWER
1	20W
2	8W
3	5W
4	2W
5	0.8W

Table 2.5: Power Consumption Classification of Mobile Equipment

The ME can be classified based on size as hand-portable unit, portable unit or vehicle mounted.

SIM – Subscriber Identity Module

It is an electronic smart card containing subscriber information, which is grouped as follows.

1. Fixed data stored before subscription is sold e.g. IMSI, authentication key.
2. Temporary network data: e.g. Location area of the subscriber and forbidden PLMNs.
3. Service data e.g. language, advice of charge.

There are two types of SIM card.

1. ID-1 SIM
2. PLUG-IN SIM

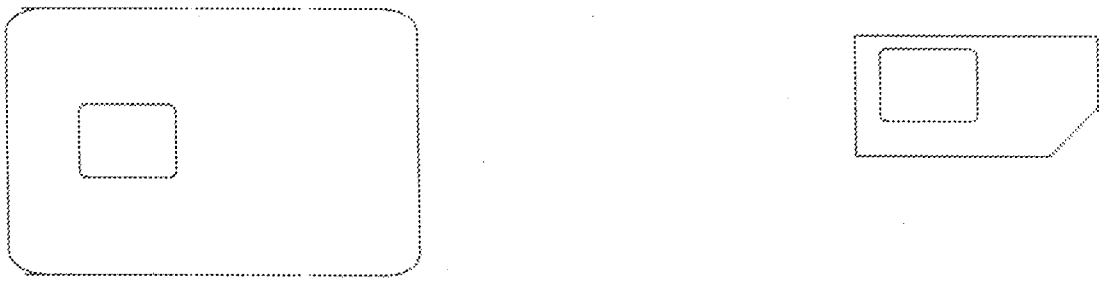

Fig 2.4: SIM Card

2.5.2. GSM FREQUENCY BAND

GSM operates at four frequency bands of 900, 1800, 1900 and 400 MHz.

GSM 900

Originally in the development of GSM standards, 900MHz frequency band was specified for its operation. Most GSM networks in the world use this band. There also exists the E-GSM (Extended - GSM) in some countries so as to provide extended capacity for GSM. In the countries where both original and E-GSM operate the former is called Primary-GSM (P-GSM).

GSM 1800

Due to the limited available Absolute Radio Frequency Channel Numbers (AFRCN) at the 900MHz frequency band, and so as to increase competition by increasing the numbers of operators: the United Kingdom (UK) in 1990 requested for GSM 1800MHz version. Prior to 1997, the GSM 1800 was called Digital Cellular System.

GSM 1900

This was developed to implement the PCS of United States. Due to prior allocation of the 900MHz frequency for D-AMPS in the North America, GSM 1900 was seen as an opportunity to bridge the gap of

PCS that operates at 1900MHz. GSM 1900 and GSM 900 standards are the same safe for the support of ANSI signalling by GSM 1900.

GSM 400

This is the latest GSM Frequency band released by European Telecommunications Standard Institute, to serve as a logical way of introducing quality digital services and seamless international roaming for NMT450. The two leading manufacturer of GSM telecommunications equipment: Nokia and Ericsson are fully involved in the release of GSM 400. The GSM400 technical details as proposed by ETSI are as shown below.

	GSM400	***E- GSM400***
Frequency Range	(450.4 – 467.7) MHz	(478.8 - 496) MHz
Uplink	(450.4 - 457.6) MHz	(478.8 – 486) MHz
Downlink	(460.4 - 467.6) MHz	(488.8 - 496) MHz
Wavelength	≈67cm	≈67cm
Bandwidth	200KHz	200KHz
Duplex Distance	10MHz	10MHz
Carrier Separation	7MHz	7MHz
ARFCN	34	34

Table 2.6: GSM 400 Technical Standards

The summary of the GSM Frequency bands commercially operational is as shown in Table 2.7

	P-GSM	*E-GSM*	*GSM 1800*	*GSM 1900*
Frequency Range	(390 – 960) MHz	(880 – 960) MHz	(1710 –1880) MHz	(1850 – 1990) MHz
Uplink	(390 – 915) MHz	(880 – 915) MHz	(1710 –1785) MHz	(1850 – 1910) MHz
Downlink	(935 – 960) MHz	(925 – 960) MHz	(1805-1880) MHz	(1930 – 1990) MHz
Wavelength	≈33cm	≈33cm	≈17cm	≈16cm
Bandwidth	200KHz	200KHz	200KHz	200KHz
Duplex Distance	45MHz	45MHz	75MHz	60MHz
Carrier Separation	25MHz	35MHz	95MHz	80MHz
ARFCN	124	174	374	299

Table 2.7: GSM 900, 1800, 1900 Technical Standards

2.3.3. GSM MODULATION METHOD

GSM uses Gaussian Modulation Shift keying (GMSK); this is a modified and more efficient form of Phase Shift Keying (PSK) that requires less bandwidth than ordinary PSK. GMSK is achieved by passing the digital

signal through a gaussian filter and the output of the filter is fed into a phase modulator.

2.3.4. ACCESS METHOD

The access method used in GSM is Time Division Multiple Access (TDMA). It has eight timeslots in a TDMA frame. Implying a single AFRCN can carry eight calls.

2.3.5. GSM TRANSMISSION PROCESS

The eight stages involved in GSM transmission are depicted diagrammatically in Fig 2.5

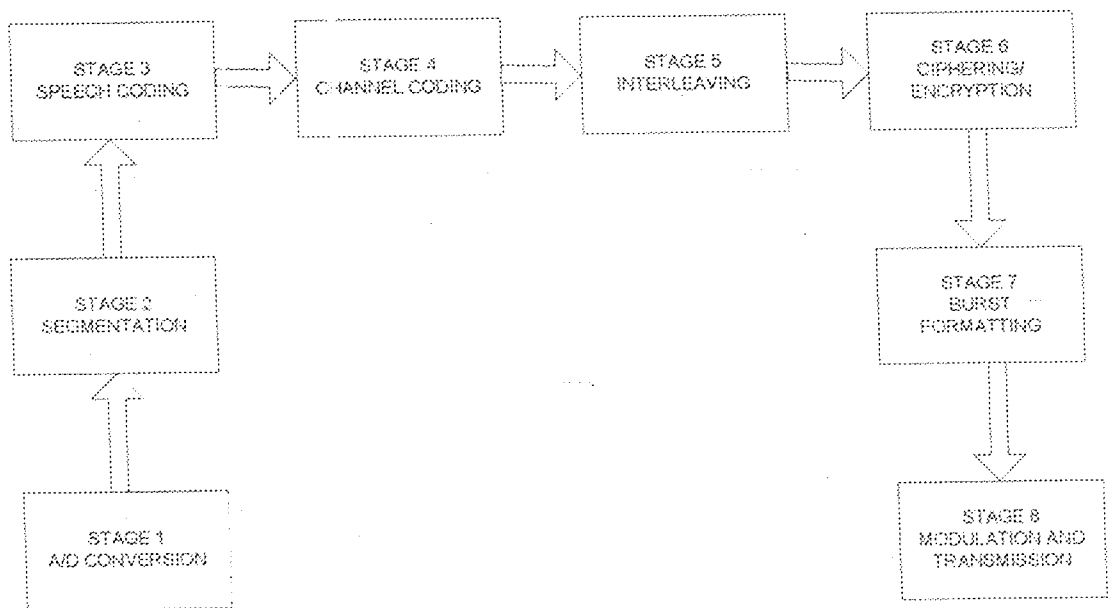

Fig 2.5: GSM Transmission Process

2.3.6. TRANSMISSION PROBLEM

In the course of GSM transmission process the following are the common problems encountered.

- Path Loss
- Shadowing
- Multipath Fading: This is either in the form of
  - *a) Rayleigh fading*
  - *b) Time dispersion.*
- Time Alignment
- Combined Signal Loss: It is not a form of transmission problem but it is the combination of two or more of the aforementioned problems occurring at the same time. Combined signal loss is predominantly responsible for transmission path loss.

2.3.7. TRANSMISSION PROBLEM SOLUTIONS

Some of the methods used in minimizing the effects of the above problems include

- Antenna Diversity: This is either in the form of
  - a) *Space Diversity*
  - b) *Polarization Diversity.*
- Frequency Hopping

- Timing Advance
- Adaptive Equalization

CHAPTER THREE

3.0 TELECOMMUNICATIONS EVOLUTION IN NIGERIA

The advent of modern telecommunications in Nigeria is over a century (1886 – 2004). Modern communications itself started in 1876 with the discovery of telephone set by Alexander Graham Bell, this revolutionary change in telecommunications started ten years later in Nigeria thanks to the colonial status of the nation to the British.

In trying to x-ray the telecommunications evolution in Nigeria, the history of Nigeria telecommunications is divided into the pre-independence and post –independence era. The post independence era is further subd vided into three phases.

3.1. PRE-INDEPENDENCE ERA

1886 marked the beginning of modern telecommunications in Nigeria with the establishment of a cable connection between Lagos and London office of the colonial master. Seven years later (1893), telephony services were made available to all Lagos government offices as well as extending it to Jebba and Ilorin.

3.1.1. ESTABLISHMENT OF POST AND TELEGRAPHY (P&T)

Prior to 1907, all telecommunications services were under the Public Works and Department (PWD). By 1907, the responsibility was transferred to the Post & telegraphy department that had been formed to operate all telecommunications services.

The amalgamation of southern and Northern protectorates in 1914 brought about a new challenge for the P&T; the challenge was the need of linking all the colonial administration offices so as to ease the colonial governance.

The P&T focus after linking all the colonial offices was the commencement of commercial telecommunications services, this noble effort yielded result in 1923, with the beginning of telecommunications services between Itu and Calabar. Prior to this time all the telecommunications services were geared towards the colonial administration. Significant growth of commercial telephone wads witnessed between 1945 and 1952, when a three-channel line carrier system was commissioned between Lagos and Ibadan, and it was later extended to Benin, Oshogbo, Enugu, Kaduna and Kano. This specific network formed what can be called the first national network.

The introduction of a contractor company: General Electric Corporation (GEC) in 1950 serves as a landmark effort in the development of Nigeria telecommunications. Some of the worth

noted jobs executed by GEC include the installation of a 600 lines Strowger automatic exchange (the first of its kind) in Port-Harcourt; this was followed by another 500 lines automatic exchange in 1953 located in Lagos.

In terms of transmission media, throughout this era, the main transmission medium was Unshielded Twisted Pair (UTP) cable. Subsequently other media such as radio in the form of Ultra High Frequency (UHF) and Very High Frequency (VHF) were introduced before the Nigeria independence.

3.2. POST INDEPENDENCE ERA

This era is subdivided into three phases viz;

1. 1960 – 1984
2. 1985 – 2000
3. 2001 – Till date (2004)

3.2.1. 1960 – 1984 (PRE-NITEL ERA)

Nigeria became an independent state on October 1, 1960, and this gave a new hope in all ramifications with the telecommunications sector not left out. The P&T, which was hitherto dominated and run by the colonial staffs, began to be run more of indigenous staffs. The management main focus was the expansion of the network to meet the needs of the fledging commercial and industry.

In the bid to systematically develop the telecommunications infrastructure, the government through P&T formulated periodic development plans that were meant to take the new Nigeria to its rightful place in the world particularly in Africa.

The first of these periodic development plans was marked to provide reliable and efficient telecommunications services for the country. In the first ten years (1960 - 1970), the plan was to increase the number of telephone lines by a marginal increase of 60000 and the establishment of Nigeria External Telecommunications (NET) Limited to handle external (international) teleservices. However the objectives were not absolutely accomplished principally as a result of the civil war of 1967 - 1970 and under funding of the scheme before the broke out of the civil war. Some of the notable achievements of this first periodic development plans were;

a) Increase of the number of telephone lines by 26,000, which is about 40% of its plan target

b) Provision of radio relay transmission system, linking the commercial centres of Enugu, Port-Harcourt Ibadan, Benin and Lagos

c) The establishment of the Nigeria External Telecommunications (NET)

The second periodic plan was earmarked for the period of 1970 - 1980. Suffice to say the civil war of 1967 - 1970 left so

many infrastructures destroyed and this was a serious setback in Nigeria telecommunications development. Half of the 10 years plan (1970 - 1975) was towards the rehabilitation and reconstruction of the aftermath of the civil war.

After the rehabilitation and reconstruction of 1970 - 1975, P&T was charged with the completion of the first periodic plan that were not wholly realised. Within 1976 - 1980, the telecommunications network was expanded to about 177 locations and the same time provision of 29 public mobile exchanges, this obvious development gave the number of telephone lines a quantum leap from 56000 to about 244,000 in 1980.

In this same phese, the 930km coaxial cable transmission link between Lagos and Kaduna commenced. At the end of the day, this 930km coaxial cable link transmission project turned out to be a colossal waste of resources due to lightning problem along some part of the route; this rendered it unusable as transmission link.

Other notable achievements include

- Completion of satellite communication link DOMSAT - Domestic Satellite which was initially meant for television and sound broadcasting but due to its under utilization telephony communication was later incorporated into it.
- A microwave link was installed between Lagos and Coutonou (Benin Republic).
- The national telex and gentex network were also completed.

The last development plan for this era was outlined for the period of 1981 – 1984 and its main focus was to complete the spill over projects from previous development plans and at the same time to provide 370,000 telephone lines. This goal was far from being realised. At the end of this era (1960 – 1984), a cumulative 350,000 lines short of the projected 612,000 telephone lines was recorded.

3.2.2. 1985 – 2000

This period seems to be the most important era in the development of telecommunications in Nigeria. It can be rightly termed as the foundation laying era of what is to become of the telecommunications industry. Some of the important events in this era include

i. 1985 – Establishment of NITEL
ii. 1992 – Creation of NCC
iii. 1993 – Commencement of analogue mobile cellular
iv. 1997 – Commercial operations by Private Telecommunications Operators (PTO)

i. 1985 - ESTABLISHMENT OF NIGERIA TELECOMMUNICATIONS LIMITED (NITEL)

NITEL was established in 1985, with the merger of the telecommunications arm of P&T and the Nigeria External

telecommunications (NET). The creation of NITEL was spurred by a number of reasons.

Firstly, to curb the various problems associated with two separate distinct organisations for the management of internal and external communications, which did not augur well for efficient national telecommunications network.

Secondly, there was need to modernize the network in line with the digitisation revolution that was sweeping across the global telecommunications networks.

Thirdly, towing the line of American telephone & Telegraphy (AT&T) of the US and British Telecomm (BT) of UK, their experiences showed that national telecommunications company can only performed optimally if they are privatised and free from government interferences.

Between 1986 and 1987 several seminars on telecommunications policy were convened with the primary objectives of fashioning out policies serving as guidelines toward the achievement of government objectives of growing and modernizing the telecommunications sector.

Among other main points of the seminars was a systematic development of the telecommunications of the rural communities and to achieve a landmark goal of one million telephone lines within the shortest possible time frame.

In 1988, Nigeria joined International Maritime Satellite Organization, which operates a system of satellites to provide mobile communications for the world's shipping and offshore industries. Through the INMARSAT system, NITEL offers Maritime Mobile Service (MMS) as well as satellite mobile communication.

By 1992, NITEL has increased its network telephone line capacity from 295,370 it inherited in 1985 to about 600,000 capacities. NITEL was also able to digitise the major cities and the university towns.

Due to the new status of a reputable company enjoyed by NITEL, it was able to go into joint venture with Digital Telecommunications of USA in June 1992 to provide Mobile Telecommunications Services (MTS). Other partners with NITEL were SATCOM to provide data communication and CELLTEL for value-added services.

From the period of 1995 – 1998, NITEL was more or less stagnant and some of its joint venture deals could not materialized due to the strain relationship between Nigeria and the rest of world particularly the western developed nations.

With the coming of civilian administration in 1999, NITEL was able to set up a packet switched X.25 services via TELKOM SA's VSAT based space stream services to South Africa to link major cities for data communication.

It is expedient to say despite the seemingly achievements of NITEL, the telephone line demands of the nation was far from being met.

Because of the few telephone lines available with too many people queuing up to be served, a situation which shot up subscription rate to the roof, this led to the statement *phones are not meant for the poor* credited to a former minister of communication.

ii. 1992 - CREATION OF NIGERIA COMMUNICATION COMMISSION (NCC)

By decree 75 of 1992, the Nigeria Communication Commission was created. The board was inaugurated on July 16, 1993. Initially, NCC was handicapped of fund to begin its statutory roles but the federal government mandated NITEL to give a kick-start fund of N50 million to NCC; with this arrangement NITEL felt they were not under the regulatory purview of NCC.

The statutory roles of NCC based on decree 75 of 1992 are as follows.

- Licensing of telecommunications operators
- Assignment and registration of frequency to duly licensed operators;
- Administration of national numbering plan
- Facilitating private sector participation and investment in the telecommunications sector of the Nigerian economy;
- Promoting and enforcing a fair competitive environment for all operators.

- Defining standards for economic regulation of dominant operators, including tariff regulation.
- Establishing mechanisms for promoting universal access to telecommunications services in Nigeria.
- Establishing and enforcing technical operational standards and practices for all operators including the imposition of penalties for violations.
- Ensuring that the public interest is protected.

In 1996, the NCC recovered from the initial setback of lack of operational fund by issuing licenses to the fort set of Private Telecommunications Operators, which were Multilinks Telecommunications Limited (MLTC) and Intercellular. With the commencement of commercial operation in December by 1997 by Multilinks, as there will always be inertia, NITEL (national carrier) refused interconnecting the private operators. This was the first acid test for NCC, but it was disheartening NCC was incapacitated because, NITEL was dictating the tune in the industry and they only shift ground after interventions by the Federal Government which always come with the threat of wielding the big stick.

If NCC is to effectively meet with the demand of the day, there was need for the amendment of the decree 75 of 1992 that established NCC. In 1998, the decree was amended and was known as *Decree 75 Amendments of 1998*. The decree can simply be

defined as a rewording of decree 75 0f 1992. The decree emphasized the following points.

- Licensing of telecommunications operators and facilitating private sector participation in the telecommunications sector of the Nigerian economy.
- Ensuring the improvement of the penetration of telecommunications services in Nigeria.
- Establishing and supervising the technical standards for network operators, oversee and set terms for the interconnection of different operators to the national network and
- Ensuring that the interests of consumers of telecommunications services are protected, by promoting competitive pricing of such services.

In year 2000, the preparation for auctioning of GSM licenses and Second National Operator license by NCC commenced.

iii. 1993 - COMMENCEMENT OF ANALOGUE MOBILE CELLULAR MOBILE NETWORK

Before 1993, all the telephone lines in Nigeria were fixed. The first analogue mobile network was the product of the joint venture between NITEL and Digital Telecommunications Company of USA.

It started with a 10,000 lines capacity in 1993, within one year the system was filled to capacity leading to congestion that almost mars the services of the network. The analogue mobile services (090) deployed was Total Access Communication System (TACS).

By 1996 the mobile telecommunications services (MTS) was separated from NITEL as an independent entity and christened as M- TEL. The cellular services of M-TEL were only available in the major cities such as Lagos, Port- Harcourt, Warri, Kano and Abuja.

In term of subscription fee, the subscription fee for an M-TEL analogue mobile line was astronomical with only the rich and possibly top government officers having one; the subscribers readily flaunt their handset to show an affluent living.

At the close of year 2000, the total telephone line capacity of the network was just 30,000, giving a marginal increase of 20,000 over the period of seven years.

iv. COMMERCIAL OPERATION BY THE PRIVATE TELECOMMUNICATIONS OPERATORS (PTO)

After the success of NCC in licensing PTOs, giving way to the participation of private operators in the provision of telecommunications services to Nigerians.

It was in 1997 precisely, that NITEL monopoly in the telecommunications industry was broken with the coming of the

PTOs with Multilink Telecommunications Ltd serving as the trailblazer while other licensed operators subsequently followed.

The coming of the PTOs was not hitch free; their first challenge was the refusal of the incumbent then (NITEL) that also doubles as the national carrier to interconnect the new entrants. This situation led to the first interconnectivity problem in the over century old telecommunications industry in Nigeria.

Due to the very small capacities of the PTOs at the beginning, the competition that ought to come with a liberalized and deregulated sector were missing, and as far as affordability and availability which are the basic parameters of measuring any telecommunications industry were concerned, Nigeria telecommunications services was still far from being affordable and available, given the high subscription fee of the few telephone lines from the staple of the PTOs as well as NITEL.

As at year 2000, the total number of telephone lines from all the private operators was still far less than 25% of the total connected telephone lines in the country.

The low impact of the PTOs in the industry cannot be isolated from the high operating cost due to the absence of enabling/favorable business environment and lack of fund for the thriving operators.

3.2.2 2001 - TILL DATE

The year 2001 signifies a telecommunications revolution in Nigeria. This is principally due to the advent of GSM technology in the country, this has ushered Nigeria into the twenty-first century. The GSM technology is the world acclaimed best mobile technology with its presence in over 190 countries worldwide.

The coming of GSM has completely changed the perception of Nigerians about telecoms. Prior to this time telephone lines were only available for the rich, this led to an erroneous belief of telephone being a luxury rather than a necessity.

In 2001, the trio of Econet (now Vmobile), MTN and M-TEL (then NITEL GSM) commenced the much awaited 2G GSM cellular telephone services.

However, at the beginning of GSM in Nigeria, the price of GSM line was a cut-throat one but unlike in the pre-GSM era, the SIM pack (mobile telephone line) were readily available for the people who could afford it. The announced tariff rate was also not friendly (N50:00 per minute), this can not be said to be unrelated to the high license fee of $285 million paid by the network operator and the unfriendly business environment of the country.

By September 2003, Globacom the fourth licensed GSM operator began GSM services with its 2.5G cellular network and at the same time doubles as the first network operator to introduce Per Second

Billing (PSB). This led other operators to migrate from Per Minute Billing (PMB) to PSB.

Mobile telephony has greatly improved the teledensity of the country. In year 2000, the teledensity of the country was 0.47% i.e. one telephone line to 213 people. Within two months (December 2001) of GSM commercial services the teledensity rose to 0.89%, given about 90% improvement of the teledensity. By October 2004 (3 years of GSM n Nigeria) the improvement in teledensity is about 1332% bringing the teledensity to 6.73%. Although this is still far from the ITU recommended teledensity of 25% (four people per one telephone line) but the improvement is encouraging.

In term of the fixed environment, there has been a steady growth and development. Several new regional Fixed Wireless Access (FWA) Operators have been licensed by the NCC. This has made telephone lines more affordable to most people at a not too expensive price. For example, getting a telephone line in 1998 may cost N100, 000:00 and could take several months of cumbersome paperwork, but today with N25, 000:00 or less, one can walk up into any of the PTO's office and acquire a fixed telephone line within three hours.

3.3 SUMMARY OF NIGERIA TELECOMMUNICATIONS INDUSTRY

As the name delineate this section is to show various necessary information about the Nigeria telecommunications industry. Some of the information includes: telecommunications growth in the country, teledensity, the major GSM operator etc.

There are various types of telecommunications licenses already issued BY NCC. The table below shows the categories of licenses.

S/N	License Category	Operators
1	National Carriers	Nitel, Globacom
2	Mobile Operators	Nitel, MTN, Vmobile, Globacom
3	Long Distance operator	NEPSKOM, MTS
4	National (PTO)	Intercellular, Multilinks, Starcomms, Mobitel,Reltel,21st Century, VGC,ITN, Discom, GTE, XPT,, Bourdeux, Prest
5	Regional FWA	Rainbownet, Odua Telecoms, Startech Connection, Stuff Network
6	VSAT (VPN)	GS telecoms, Schlumberger(Omnes), TELNET, Virgin, BT, DCC, PPC, Warsun, United Telesys, SITA

Table 3.1: Categories of Telecoms Licenses

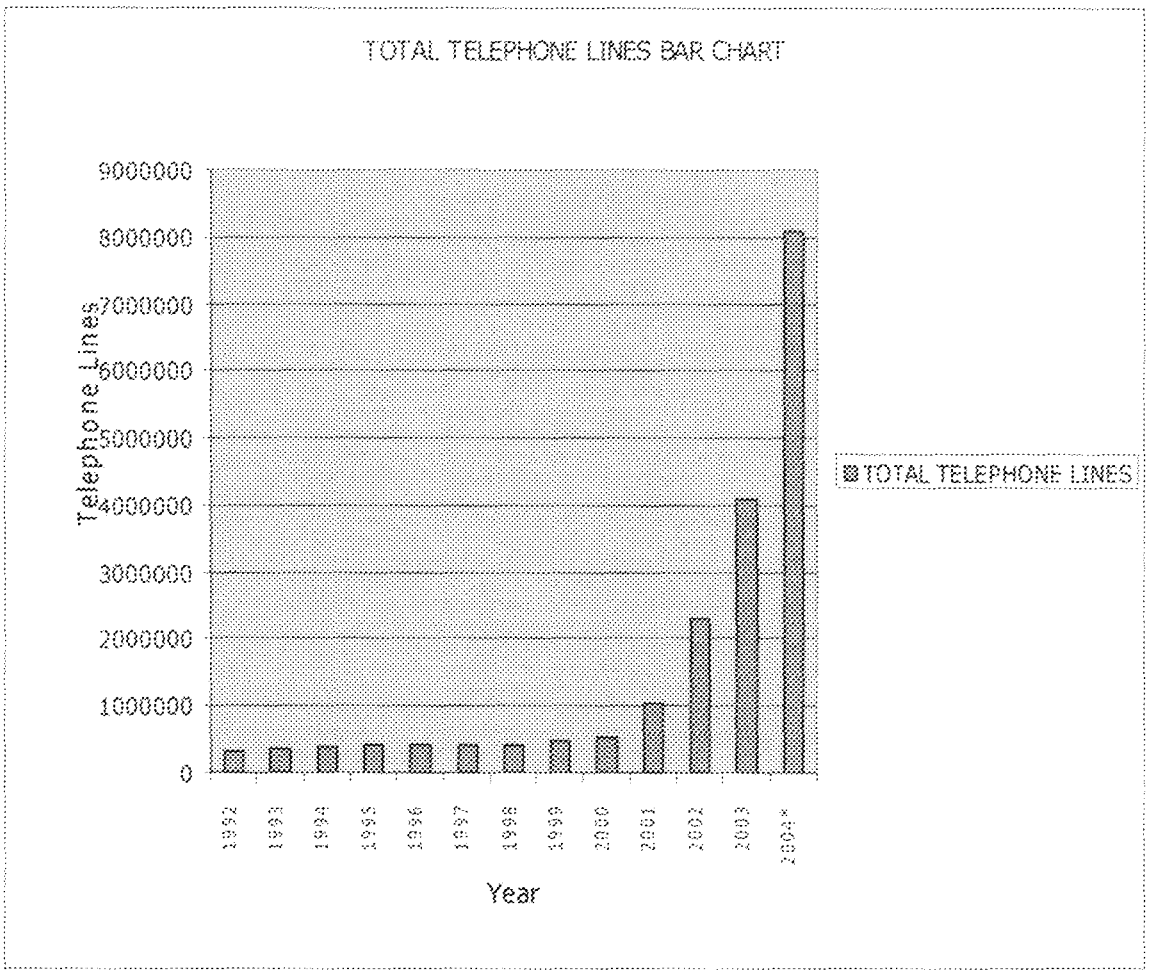

Figure 3.1: Histogram of Total Telephone Lines from 1992 – 2004*

The coming of GSM has greatly increased the number of telephone lines in the country; Nigeria is one of the few countries of the world with a considerable majority of her total telephone lines being hosted on Mobile network.

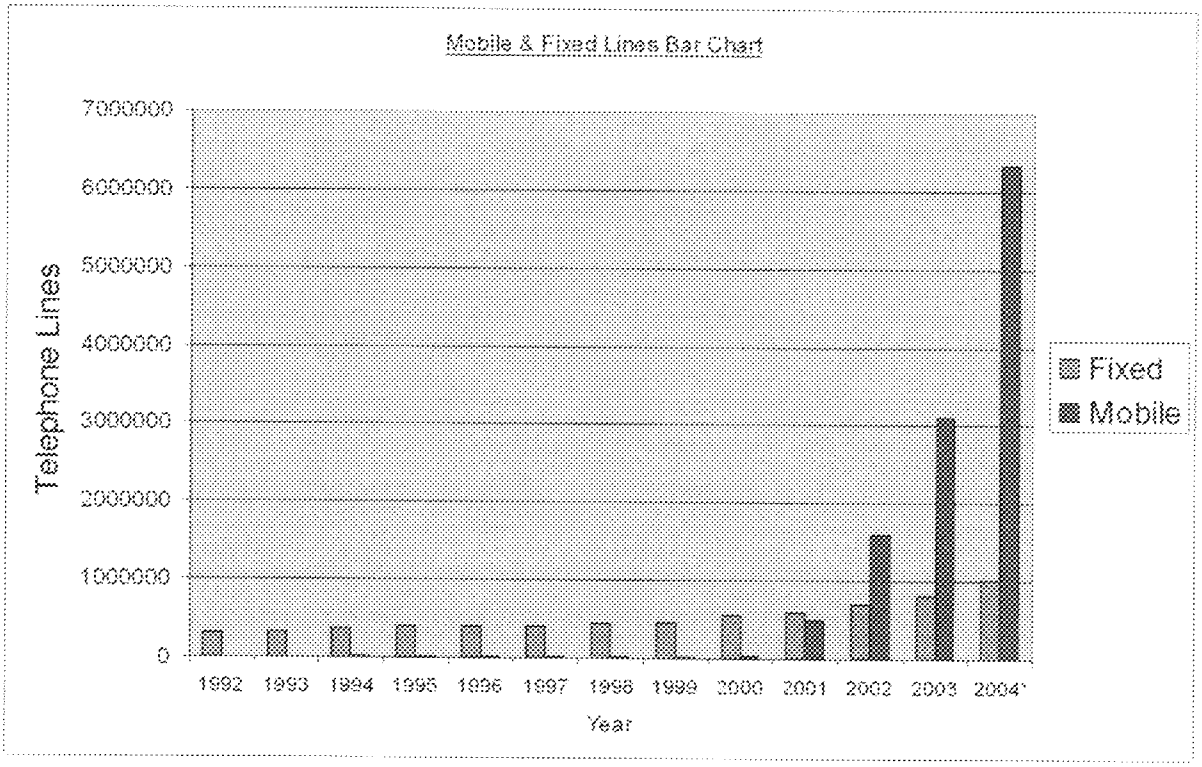

Fig 3.2: The Nigeria telephone distribution on Mobile and fixed Network (1)

A pie chart as illustrated below furthers shows that most Nigerians are hosted on the mobile network. However it s worth noting that there are many Nigerians with more than a single mobile line thereby making it a bit difficult to ascertain telephone penetration of the Nigeria population.

Note: 2004* is at October 2004

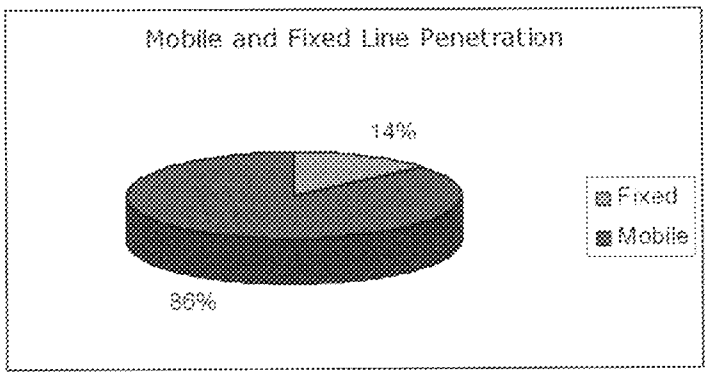

Fig 3.3: The Nigeria telephone distribution on Mobile and fixed Network (2)

Fig 3.4 illustrates the share of the mobile market among the four licensed GSM operators in Nigeria.

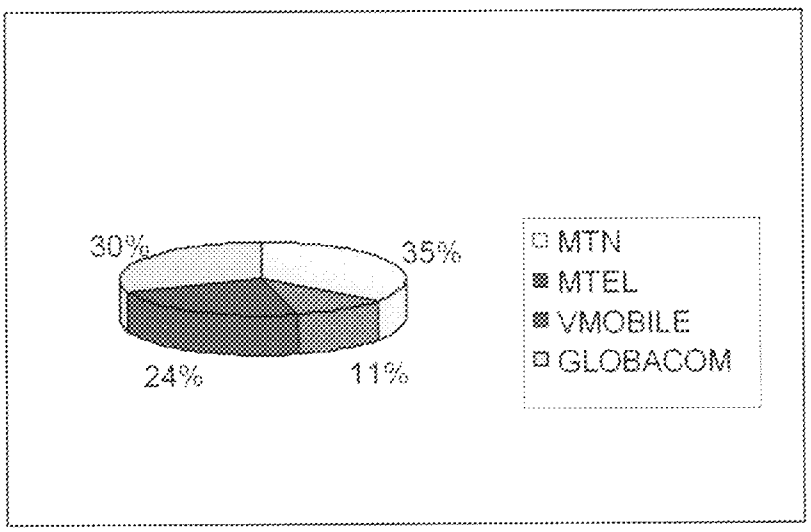

Fig 3.4: GSM market share (October 2004)

The fixed telephony environment has also witnessed a considerably increase in number. The number of operating PTOs has increased

CHAPTER FOUR

INTERCONNECTIVITY

4.1. INTRODUCTION

The word interconnectivity is unique and very important in the telecomm industry; it is best understood with lack of it. The issue of interconnection started in 1894 when the initial patents of the Bell System expired and they had to enter into interconnection contracts with independent telephone companies, and the Independents similarly signed contracts with each other.

In Nigeria, the problem of interconnectivity has been a recurrent one in the telecomm industry after the deregulation and liberalization process of the industry, which started, with the creation of NCC in 1992. Precisely the first interconnection problem was in 1997 with the refusal of the incumbent then (NITEL) that also doubles as the national carrier to interconnect the new entrants that were Private Telecommunication Operators (PTOs). With the coming of GSM operators: MTN, Econet (Now Vmobile), and M-TEL in 2001, the problem of interconnectivity once more came with full force.

Lack of perfect interconnectivity brings about unnecessary financial burden and inconveniences for the subscribers. For example in Nigeria, in 2001, it was a common thing to see a

subscriber carrying multiple handsets, a handset for each network. Imagine a situation whereby the four incumbent GSM operators are having a zero interconnectivity, it implies for a given subscriber to effectively communicate with any other subscriber irrespective of his host network, he needs minimum of four different handsets each with individual network SIM card, or best bet a single handset but should be ready to swap the four available SIM cards depending on whose network is Party B (called side) hosted.

Interconnectivity literally, is the key to competition, without linkages among operators; competition would simply not be possible. The issue of interconnectivity is highly emphasised by the International Telecommunication Union (ITU), she says " this is an age where any network operator should be able to establish connectivity with any network operator and for this reason regulators and market players from around the globe should consider interconnection regulation to be the single most important issue in the development of a competitive marketplace for telecommunications services"[4.1].

4.2. DEFINITION

Several definitions have been given to interconnectivity; the following definitions are all encompassing. Interconnectivity according to Nigeria Communication Commission (NCC) "Interconnectivity means the physical and logical linking of

telecommunications networks used by the same or a different operator in order to allow the users of one telecommunications network to communicate with the users of the same or another telecommunications network or to access services provided by a telecommunications network and the services may be provided by the parties involved or other parties who have access to the network".

Looking at interconnectivity from service providers' perspective, "Interconnection" refers to the establishment of electronic linkages between service providers so that they can conduct business transactions electronically. In short, interconnection is ecommerce or business-to-business trading between and among carriers.

From the view point of subscribers, the words of Prof. Mobolaji Aluko succinctly captured what interconnectivity is "how can A and B, separated possibly by thousands of kilometres within Nigeria (or any country), transmit voice and data to each other without each having to be subscribers to the same operator?".

4.3. GLOBAL DRIVERS FOR INTERCONNECTIVITY

In recent time, the need for interconnection among service providers in the telecomm industry has been increasing at an exponential rate. The reasons (drivers) for this high interconnectivity demand can be summarised under the following headings.

1. Market Dereculation and liberalization

   Globally, all countries are opening up the communication sector so as to allow private operators, hence making room for competition and at the same time changing the trend of communications being controlled by state-run monopolies.

2. New Regulatory mandates.

   For the full implementation of some services especially emergency ones in any nation full interconnectivity must exist among all services providers. For example, special emergency codes used in Nigeria such as 119 (emergency ambulance), 190(emergency fire service) and others all require carrier-to carrier interaction

3. Digital Subscriber Line (DSL) Explosion

   The demand for data, internet access and other supplementary services offered by various network operators by subscribers can only be meant with perfect and seamless interconnectivity among all services provider in the telecommunication industry.

4. Proliferation of Players/Operators

   Telecommunications services need of an individual subscriber may not be feasible to be met by one big homogenous single operator. Some of the basic value-added-services need to be provided by a third party company. This has brought about the need for numerous players; each player is to provide a

particular aspect of the consumers teleservices need. For instance packages like "Magic Plus" on Globacom network that gives information like News, Jokes, Flight schedule, M-banking, horoscope, needs third party companies.

4.4. WAYS OF ACHIEVING INTERCONNECTIVITY

There are two primary ways of achieving interconnectivity. The first one is through one-on-one interconnectivity (dual interconnectivity) between operators, this also covers the use of national carrier and if possible long-distance operator by a service provider to interconnect into another service provider network.

Secondly, interconnectivity can be achieved through the use of clearinghouse, this is the best and most effective and efficient approach to achieving interconnectivity. However, it has not been widely used in most telecommunications industry.

4.5. INTERCONNECTIVITY IN NIGERIA

The interconnection of service providers in Nigeria is via the method of one-on-one approach. This method is the pioneer method used for interconnection, it started in 1894 with the interconnection agreement of The Bell system and the Independent operators. This implies the method has been on ground for a while, and many other countries are still using it. There are a number of problems associated with this approach of interconnection. Its working

principle shall be discussed as well as the various problem associated with it that makes perfect and seamless interconnectivity impossible and the various ways of resolving and managing the associated problems.

4.5.1. WORKING PRINCIPLE OF ONE-ON-ONE INTERCONNECTIVITY

This requires a new entrant into the telecommunication industry to set up its gateway to each of the incumbent operators. It implies the new entrant will have to set up multiple connections, which may involve many gateways based on different protocols and business rule of individual operators.

Let N_{inc} = Number of incumbent operators,

F_{and} = Number of negotiation deals for full interconnectivity

N_{new} = Number of new entrants

N_{total} = Total number of operators

Assume $N_{new} = 1$

$N_{inc} = X$

The new operator would have to go into X separate negotiations deals for it to achieve full interconnectivity with all the incumbent operators.

i.e. $F_{and} = X$. If X= 10, then ten separate negotiation deals will be entered into by the new service provider.

From another point of view, assume a situation of $N_{new} = n$, for full interconnectivity among all the new entrants excluding the incumbents,

$$F_{cnd} = {}^{n}C_{2} = n! / [2! *(n-2)!]$$

If n = 15,

$$F_{cnd} = 10! / [2! *(10-2)!] = 10*9 / 2 = 45$$

Factoring in the incumbents,

For full interconnectivity between the new operators and the incumbent, each operator would have $F_{cnd} = (n + \chi - 1)$.

For full interconnectivity in the industry,

$$F_{cnd} = N_{total}! / [2! * (N_{total} - 2)!]$$

$$N_{total} = (N_{new} + N_{inc}) = (n + \chi)$$

$$\Rightarrow \quad F_{cnd} = (n + \chi)! / [2! * (n + \chi - 2)!]$$

Assume a country with 50 different licensed operators for all form of teleservices, $N_{total} = 50$

$$\Rightarrow \quad F_{cnd} = 50! / [2! * (50 - 2)!] = (50 * 49) / 2 = 12,745.$$

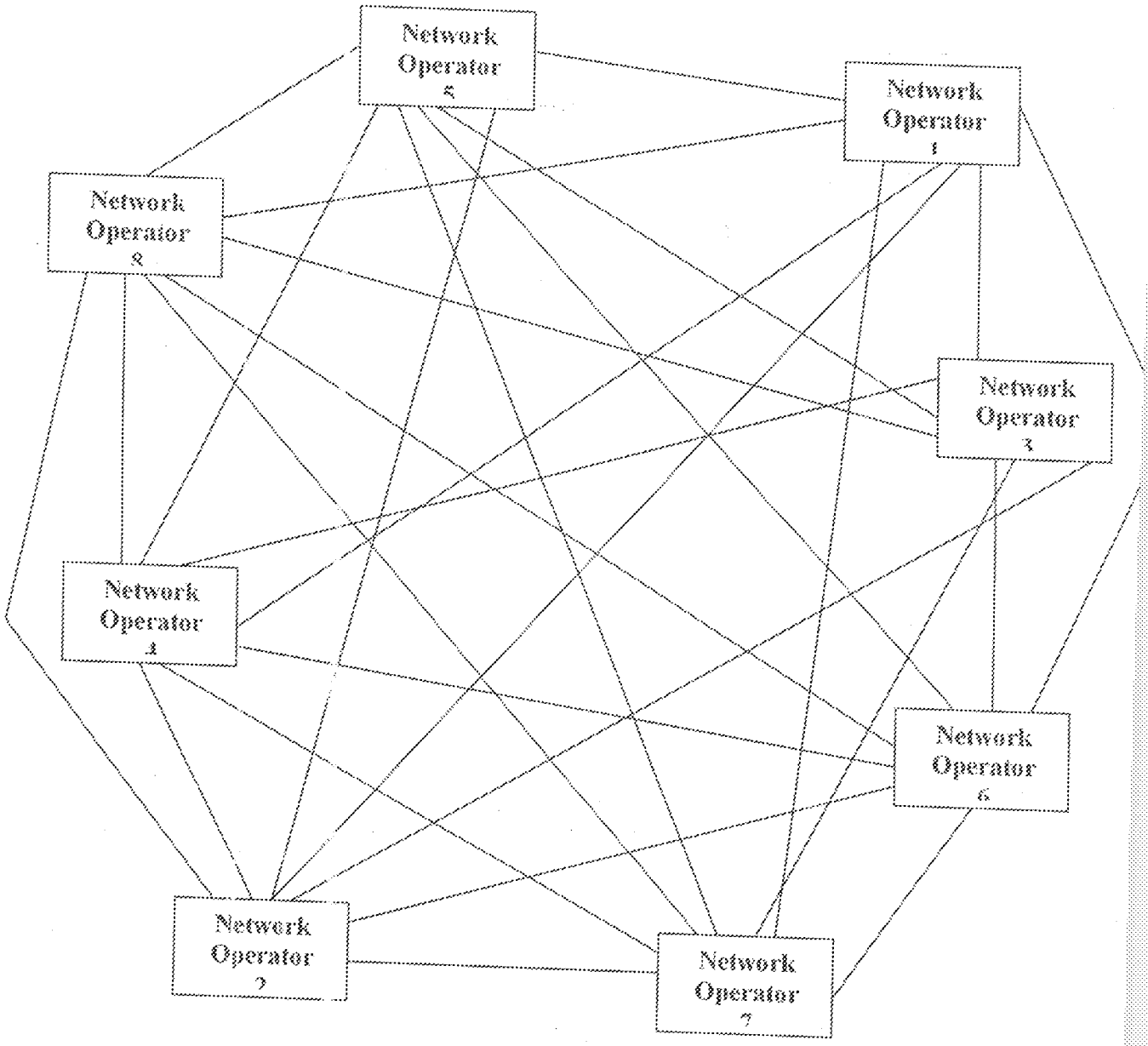

Fig 4.1: Perfect Interconnectivity through One-on-One Approach

4.3.2. PROCEDURES FOR ONE-ON-ONE (DIAL) INTERCONNECTIVITY

There are various steps involved in establishing interconnection with another service provider. These procedures vary from one operator to the other. One of the simplest interconnectivity procedures found is that of MTN Nigeria (MTNN), MTN Nigeria being the dominant Mobile services provider in the country developed a general procedure for establishing interconnectivity between its network and another operator. For the purpose of this work, the procedures will be illustrated using flow diagram only without going into the details of each step. The procedures flow chart is as shown below in fig 4.2.

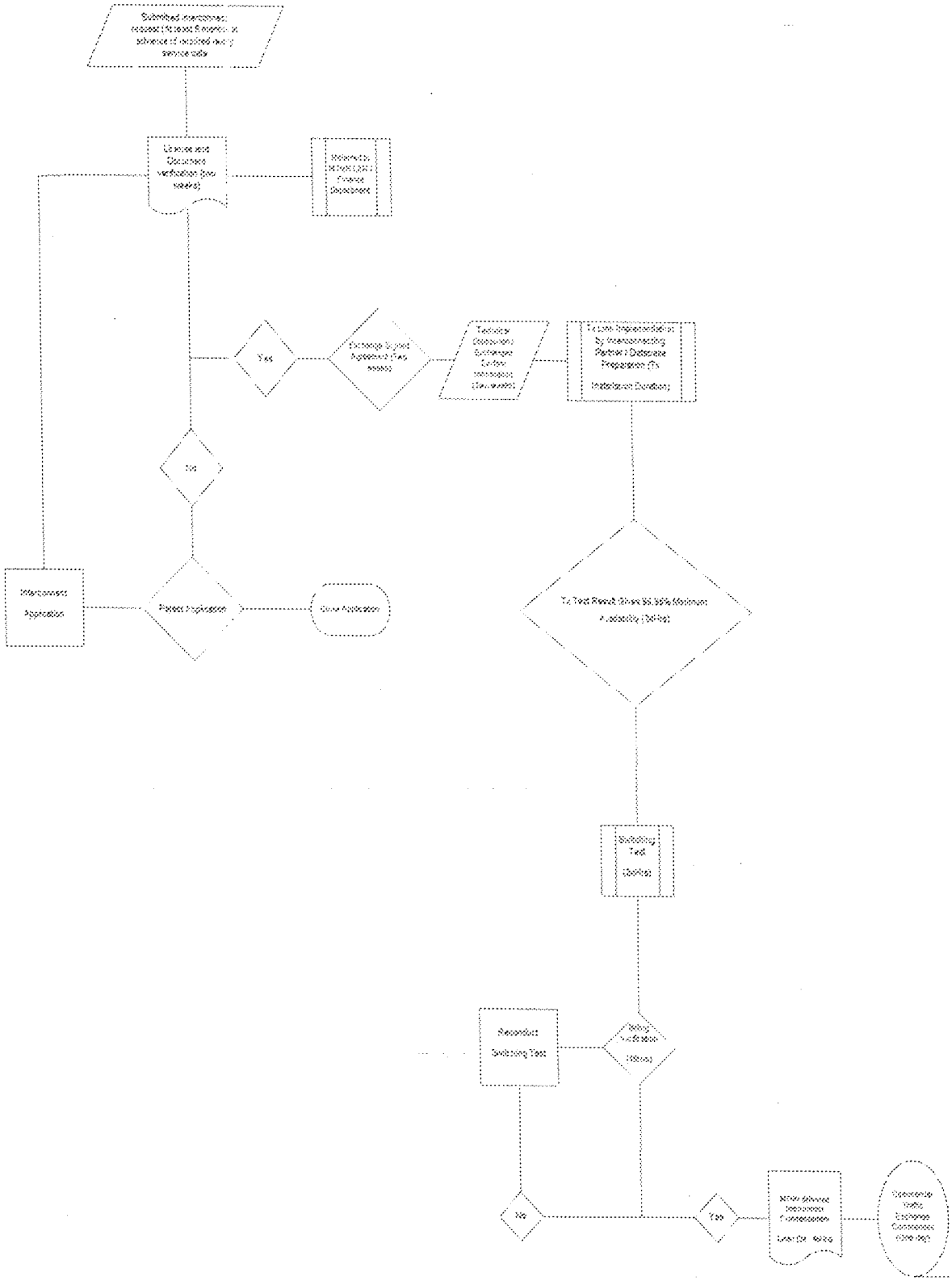

Fig 4.2. MTNN Interconnect Flowchart

4.3.3. FACTORS LIMITING PERFECT INTERCONNECTIVITY USING ONE-ON-ONE METHOD

Although it sounds simple enough theoretically to say a new entrant would just need to set up gateways to the incumbents' network but in practice it seems practically impossible. Interconnection is fraught with many problem of financial and technical nightmare as well great deal of time involved in carrying out negotiations, for instance a service provider may have as many as hundreds of business rules which often come with legal implication. It is a common thing worldwide that the use of this approach is often characterised with imperfect interconnectivity. The following factors are responsible for the interconnectivity problems.

1. Inadequate infrastructures

   Most of the time, the dominant operator is often not able to provide the required number of interconnection link such as E1's to an intending interconnecting network operator principally due to the high numbers of E1's required for multiple interconnection. At times the inadequate E1's links can also be from the intending interconnecting network operator.

   For instance, in Nigeria, when Globacom started its operation in 2003, the number of E1's links it requested of MTN could not be absolutely met by MTN. This led to congestion of the available links leading to drop calls and most of the time

failure to establish a call between Globacom and MTN subscribers.

2. Anti-competition tendencies

This is a major inhibiting factor in trying to achieve interconnection through this approach. To a very large extent the new entrants are at the mercy of the incumbents operators. The incumbent operators are found of reeling out figures that supports the fact that their network cannot accommodate more traffic from other operators.

A case study was the ensued battle between NITEL and the PTOs in 1997 where NITEL claimed, based on its network design; more traffic cannot be accommodated from PTOs. The same scenario also came up in 2001, when NITEL also declared inadequacy of its network to provide the required E1's for the new GSM operators. However Pentascope (the new consultant manager) later confirmed this claim to be untrue. It is worth noting that the claims of inadequate infrastructures at times by operators are false but an anti-competition stunt.

3. Point of Interconnectivity (PoI)

Point of Interconnectivity is the various points at which a given network operator can interconnect other service providers into its network. Since the number of PoIs for every network is limited and may not necessarily be located in the

desired place by an intending interconnecting operator. This may lead to inability of the two operators to be interconnected except through a third party such as national carrier or Long Distance Operator.

4. Interconnection charge rate

Establishing the price of the interconnection is a highly challenging undertaking that often leads to interconnection disagreement among stakeholders. Interconnection itself is the business transaction between operators. Due to the varied charge rate of individual service provider, coming to a common point as regards interconnection is always very tasking.

In October 2001, when MTEL commenced their GSM services with a subscriber charge rate of N22:00 per minute, it was impossible for MTEL to terminate its calls on MTN network because of the interconnection price demand of MTN which was based on MTN subscriber charge rate of N50:00 per minute. Also with the recent pricing regulation of NITEL where local calls charge rate was jerked up from N4:30 to N6:00, it implies the PTOs using NITEL as carrier for their local calls either increase their local charge rate or risk a situation of indirectly making money for NITEL at their own peril.

5. Inadequate/incompetent personnel

With the arrangement of one-on-one (dual) interconnectivity where individual gateways to each service provider is to be set up, there is need for added staff to manage comings, goings of pre-order, order, maintenance, provisioning and billing messages. But most establishments including network operators try to use the minimum possible number of staff for its operations. This often leads to delay in carrying out interconnection related operations. Also considering the enormity and complexity of the task, there is need for sophisticated training, which is not only money consuming but can also be time consuming in the short run.

6. Incompatibility of Networks

Although this problem is no more a prevalent one due to the adoption of Open system Interconnect (OSI) standard by many telecommunications equipment manufacturer. There could be situations of being able to interconnect with each other but no full transparency between the various signalling protocols adopted by different equipment. This incompatibility of networks comes into play with interconnection of networks with generational difference.

4.3.1. POSSIBLE SOLUTIONS

In trying to resolve the itemised problems associated with dual interconnectivity, the cooperation of all the players and the industry

regulator is paramount for the efforts to yield meaningful results. It is also essential to strongly empower the regulator with laws and legal backings to initiate some disciplinary actions and sanctions measures for effective discharge of her roles. The following points will minimise the interconnectivity problem associated with one-on-one method.

Improvement of Infrastructures

The provision of acequate infrastructure is prima facie in trying to secure perfect interconnectivity in the industry. The issue of national carriers and Long distance Operator should be closely looked into, because over the years it has become obvious that NITEL cannot effectively provide the entire necessary infrastructure. The licensing of Globacom as the second National carrier by NCC and the issuing of licenses for MTS and NEPSKOM as Long distance operator is a laudable approach to improving the infrastructures. There is also the need for the interconnection of the two national carriers with fibre-optic backbone preferably with SONET OC-192, OC-256 or OC-768 (40Gbps), or its SDH variant, and the incorporation of telecommunication satellite as been proposed by Ministry of communication would go along way in providing the necessary infrastructures for effective communication. Presently, The Europe-Africa-Asia SAT-3/WASC fibre-optic international link with a gateway landing in Lagos is currently controlled by NITEL and

is seriously under-utilised (NITEL was connected to it in 2002). It should be shared with other operators as a national mandate. The Federal Government should also enact polices that will make telecommunication equipment particularly gateways either tax free or with a very low tax rate.

Empowerment of NCC

The National Communication Commission (NCC) should be highly empowered with the necessary laws to perform its regulatory functions, which includes Promoting and enforcing a fair competitive environment for all operators, and establishing and enforcing technical operational standards and practices for all operators including the imposition of penalties for violations as outlined in the telecommunications policy of the country. With this empowerment the anti-competition tendencies of the service providers can be highly checked.

NCC should also try to implement to the letter its responsibilities concerning interconnection as stipulated in the *GUIDELINES ON INTERCONNECTION OF TELELECOMMUNICATIONS NETWORKS*; the responsibilities include ensuring a high degree of legal certainty over the Telecommunications Interconnection Regulations and its development, and to ensure transparency, accountability, fairness and timeliness in reaching regulatory decisions on interconnection. Also, in the bid of solving difficulties related with PoI, the NCC should enforce the Article 8, subsection 1(b) that says Points of

interconnection (PoI) shall be established and maintained at any technically feasible point in a dominant operator's network requested by another operator seeking interconnection. The technical possibility of POI should be determined by both the NCC and the network operator so as to avoid any form of anti-competition tendencies.

Interconnection Charge rate determination

Telecom networks are unique because they require a high degree of cooperation from all parties involved and because of the interdependency of network components. The need for an agreed price for termination of calls is very important for the free flow of information among subscribers of different network operators. The issue of interconnection charge rate is a global issue that demands high accuracy in its determination. The major reason for its difficulty is not unrelated with the inability to measure the value or benefits of a telephone call especially for the party receiving the call. In this approach the assumption is based on the caller only being charged. There are three basic methods of approaching interconnection charge rate. They are as follows

1. Top-down cost estimation
2. Bottom- up cost estimation
3. International Benchmarking

Top-down cost estimation

This approach uses the cost accounting records of the regulated firm. The Information from the cost accounting records of the regulated operator are adjusted so that they would correspond to the required cost standard of Forward – Looking Long Run Average Incremental Cost (FL-LRAIC). This approach is often characterized with inaccurate assignment of cost elements to the various products and services, and acceptance as cost of elements that are caused by inefficient production.

Bottom- up cost estimation

This approach is currently favoured by many regulators around the world. Examples of Regulators who have used this approach to determine interconnection rate include the Federal Communications Commission (FCC) in the USA, Office of telecommunications (Oftel) in the UK, the German Regulatory Authority for Telecommunications and Post (Reg. TP) and the Austrian Telekom Control. It is the preferred approach whenever the cost accounting data of the regulated operator are not deemed reliable enough. In this approach the physical network of the regulated operator is simulated on a computer. After the simulation of the necessary network elements the interconnection charge rate is then determined.

International Benchmarking

This approach uses interconnection charges from other countries that are based on the relevant cost standard, i.e. Forward – Looking Long Run Average Incremental Cost (FL-LRAIC). These are then adjusted to take account of differences in circumstances. It is the approach that has been extensively used in member nations of the European Union, in particular at the beginning of the market liberalization process when their cost models were not ready.

The Nigeria Communication Commission (NCC) has performed wonderfully well as regards interconnection charge rate determination. In December 2003, NCC in conjunction with Messrs Detecon GMBH a world-leading firm in integrated management and technological consultancy in telecommunication (TC) and information technology (IT) markets developed an interconnection charge rate using the combination of *Bottom-up cost estimation* and *International Benchmarking* for Nigeria telecomm industry. At the end of the whole process the following were the conclusions arrived at:

Interconnection rates for termination on;

a) Mobile networks should be *N11.52* (eleven Naira, fifty-two kobo)- Fixed networks should be *N5.52* (five Naira, fifty-two kobo) thus resulting in a ratio of *68:32* (mobile to fixed)

b) Adjusted parameters proposed should be applicable for a minimum of eighteen (18) months.

c) The Commission will commence the process of conducting another in-depth study of cost based interconnection rates to be employed at the expiration of the eighteen (18) months tenor.

d) The commencement of the new rates regime is 1st of January 2004.

However, the interconnection rate is operational at the moment but it has been challenged in the court of law by one of the service provider and the ruling was in favour of the service provider but NCC in the court of appeal has challenged the ruling.

Manpower Skills Improvement

As the telecommunications explosion continues in Nigeria in particular, and in Africa in general, more service providers will definitely come in, leading to great increase in the number gateways that are needed for perfect interconnectivity through the one-on-one approach. There is an urgent need for local training of competent staff to mount and operate these various gateways as well as the telecommunications sector in general.

In line with this, the NCC has risen up to the challenge by establishing the Digital Bridge Institute (DBI); an institution to train personnel in telecommunications and IT, it was commissioned in

May 2004[4.2]. This will in no small way indirectly help in easy and fast resolution of interconnection related dispute.

Digitisation of Analogue exchanges

The federal government through NITEL should digitise all the analogue exchanges in the country, this will not only modernise the whole telecomm sector it will as a matter of fact avoid the problem of interconnectivity which may result from incompatibility of networks as a result of wide generational gap which comes to bear in the signalling protocols.

2.6. DISADVANTAGES OF ONE-ON-ONE-INTERCONNECTIVITY

The method of dual interconnectivity is fraught with many problems and difficulties; these have all translated in to great disadvantages, rendering the approach unfit for this twenty- first century telecommunications network interconnectivity. The following are the very important disadvantages

1. It requires high financial and technical input to set up the numerous gateways by individual service provider to achieve full interconnectivity. Simply put, it is not cost effective to set up.
2. This method of interconnectivity demands high operating cost, due to the number of gateways required by a network

operator, extra staff are needed to manage and coordinate the gateways Enormous amount of time and money is expended on this.

3. It is enormously difficult for the two concerned parties to agree on interconnection price and other related elements of interconnectivity principally because of the different business rules that may be on their hundreds by a given service provider.
4. It generally brings about high cost of teleservices for the consumer because a service provider with a very low charge rate may not be able to interconnect other service providers with high charge rate. This situation was better depicted in year 2001, despite the low charge rate of MTEL many Nigerians still prefer other networks because with MTEL SIM you cannot call people on other GSM network where most Nigerians are hosted.
5. Above all, it limits services provider to doing business on a regional basis where relative fewer parties are involved compare with national, thereby limiting competition that ought to bring about better services at lower price.

2.7. INTERCONNECTIVITY THROUGH CLEARINGHOUSE

Achieving full interconnectivity is very important but the 'technique' of achieving is all-important because of diverse business rules from

individual operator, the markets, regulatory environment and technical idiosyncrasies of individual network. The best possible way of achieving interconnectivity is through the use of clearinghouse. This type of electronic clearinghouse is a market-tested concept that has proven invaluable to other industries. For example, in the banking industry, it has accelerated and simplified the processing of billions of checks, which must be received from and routed to thousands of different banks.

The clearinghouse is a multi-protocol tandem switch that can support transmission link such as *Synchronous Optical NETwork* (SONET) or *Synchronous Digital Hierarchy* (SDH) optical fibre standard with speed as high as 40Gbps. This clearinghouse may be called a *National Switch Centre* or *National Numbers Registry clearinghouse* or if more than one would be use it can be referred to as *Regional Switch Centre* (*Zonal Clearinghouses*) with each located in the six geopolitical zones or preferably on the existing six *ZONAL NATIONAL NUMBERING PLAN,* which is as follows; Lagos Zone, South East Zone, Central Zone, South West Zone, North West Zone, North East Zone.

This centre is to be established and maintained by NCC or consortium of all network operators or preferably any neutral operator licensed as an Application Service provider with the other services provider serving as her own subscribers/consumers.

2.7.1. WORKING PRINCIPLE OF THE CLEARINGHOUSE

This approach is in the form of interconnection Application Service Provider (ASP).

The interconnection ASP serves as a centralized, automated clearinghouse for carrier communications and transactions. The clearinghouse receives all messages and order and preorder information, these are automatically translated to the right protocol and transmitted to the destination network. Figs 4.3 & 4.4 depict the clearinghouse principle diagrammatically.

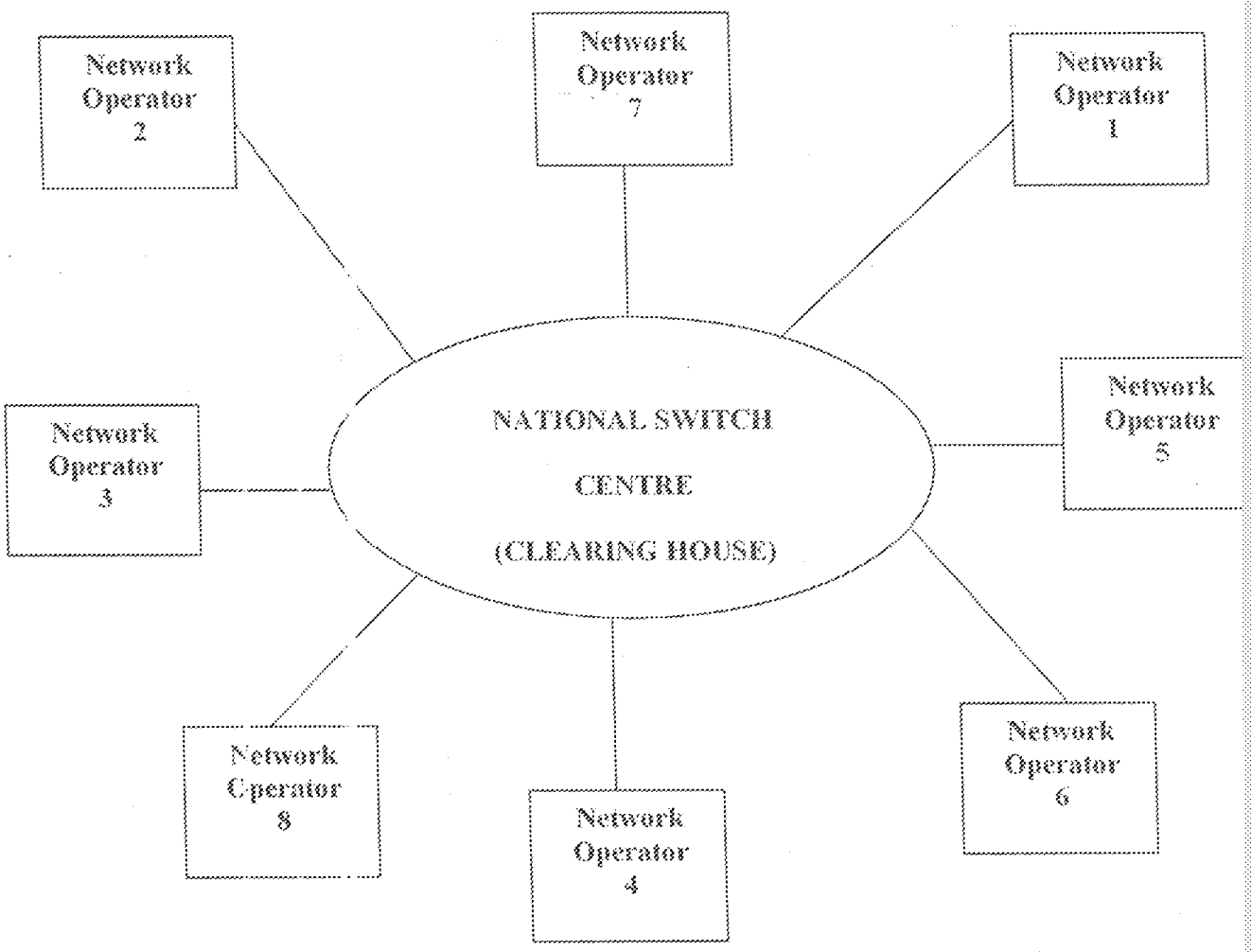

Fig: 4.3: Interconnection through an ASP Clearinghouse

However if zonal clearinghouses are to be used the configuration can take the following shape

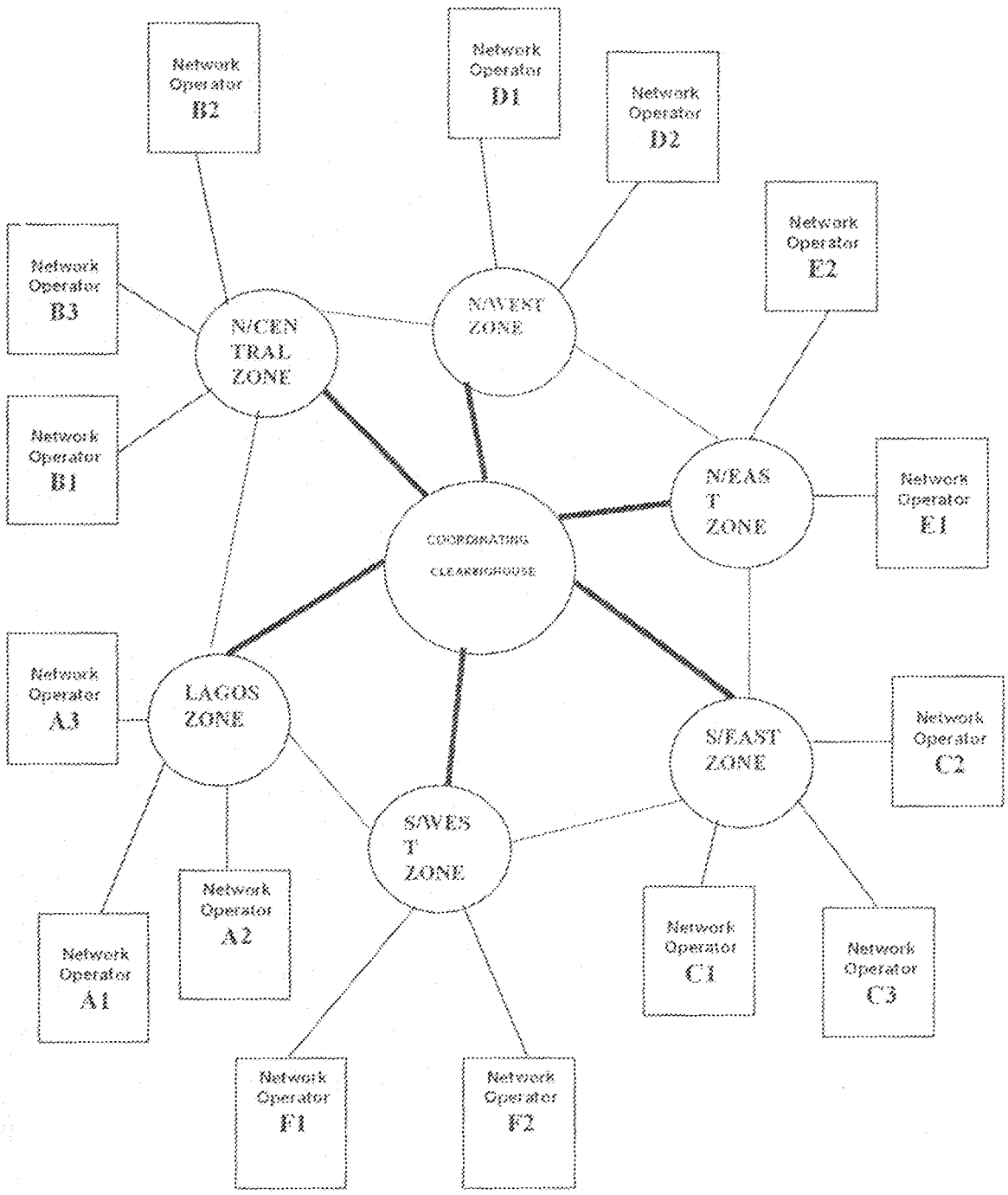

Fig: 4.4: Full National Interconnectivity through the Use of Zonal Clearinghouses

From Fig: 4.3, It is obvious the number of negotiation deals required for perfect interconnectivity $F_{cnd} = 8$.

Generally, for "N" number of operators, the total number of negotiation deals for full interconnectivity is given by

$$F_{cnd} = N$$

Aside from the advantage of relatively few number of negotiations deals required compared with dual interconnectivity, each operator only needs to enter into agreement with a single operator; the Application Service Provider (ASP).

For a large country like Nigeria, the use of zonal clearinghouses will be handier as depicted in Fig: 4.4

Each zone requires a total number of negotiation deals equivalent to the total number of network operators in that particular region.

Mathematically,

$F^{i}_{cnd} = N_i$ For i= 1, 2 ...n

Where F^{i}_{cnd} – total number of negotiation deals in a particular zone

N_i – Number of network operators in that particular zone

A national operator may interconnect at each zonal clearinghouse with The ASP, or possibly at the central coordinating clearinghouse depending on the network design by both the ASP and the national network operator.

A closer look at Fig 4.4 shows a transmission link between adjacent/ neighbouring zonal clearinghouses may also be necessary but it is optional, the advantages of having such links include,

i. It can serve as a redundant (backup or secondary) link to the main link between the zonal clearinghouse and the central coordinating clearinghouse.

ii. It will serve as the Least Cost route (LCR) for calls between adjacent zones i.e. As shown in Fig 4.4 a call from zone "A" to B" or "F" will be programmed to primarily go through the link between "A" and "B" or "A" and "F".

The total number of connections required for full national interconnectivity is given as

$$F_{cnd} = N_z + \sum F_{cnd}$$

Where N_z - Number of zonal clearinghouses,

Assuming, a country with a total number of 50 operators, with six zonal clearinghouses, the total number of connection is thus;

$F_{cnd} = 6 + 50 = 56$

Note, in reality, the number of negotiation deals is 50 and not 56 because the same company (ASP) operates both the zonal clearinghouses and the central coordinating clearinghouse.

Generally, if the same ASP operates both the central coordinating and zonal clearinghouses, the total number of different negotiation deals is N (the total number of network operators in the country).

The effectiveness of this interconnectivity is based on the fact that, the business rules of all participating services provider are programmed into the clearinghouse, where they are updated as soon as possible based on the changes in the industry. Service providers can access the clearinghouse via traditional gateways or the Internet. It is expedient to say, this approach has helped in achieving worldwide-unrivalled telecommunications network interconnectivity in USA shortly after the new 1996 Telecommunications Act of the USA was enacted.

Clearinghouse approach of interconnectivity offers several advantages; some of these advantages are simply stated in the following subheacing.

ADVANTAGES OF INTERCONNECTIVITY THROUGH CLEARINGHOUSES

1. A clearing house automate and simplify interconnection among several service providers.
2. It reduces the escalating cost involved in maintaining many-to-many connections.
3. It is efficient , and virtually error-free as proven in united state where it has made nationwide interconnection simple.

4. The use of clearinghouse insulated each particpating service provider from the trouble of having and maintaining rules , protocols and interfaces.
5. It allows service provider to interconnect infinite partners via one connection, a concept called "one way in, one way out".

CHAPTER FIVE

COMMENTS/RECOMMENDATION/CONCLUSION

5.0 COMMENTS

Telecommunications is the backbone of any economy. The growth and development of this great sector in any economy has a multiplier effect on the whole economy as evident in Nigeria.

Although Nigeria is yet to meet the ITU standard of 25% teledensity, but a considerable improvement has been recorded since the full liberalization of the telecoms sector especially with the commencement of GSM services in year 2001.

For a considerable growth in Nigeria telecommunications industry, the prima facie is "competition" and this is only possible if there is interconnectivity among all the service providers.

Globally, competition brings about quality service at a lower price. In Nigeria there has been a great improvement in the teleservices available in the country, prior to the GSM era in the country, a telephone line was not only very expensive it was also not available and this often led to several people on the waiting list of the only operator (NITEL).

All that a consumer (calling side) cares about is the ability to communicate with anyone he/she desires without minding the network the other party (called Side) is being hosted.

A network with a very cheap charge rate but with no interconnectivity with other networks may not be able to win the hearts of many consumers as proven in year 2001, when the charge rate of Mtel was N2:00 while MTN and Econet charged N50:00 per minute, despite this distant difference many Nigerians wouldn't subscribe to Mtel network, primarily due to lack of interconnectivity with other networks.

The recent drop in the cost of GSM SIM pack in Nigeria is as a result of competition (interconnectivity) among the four GSM operators in the country. As at the time of rounding up of this project work, the price of SIM Pack for some network is free while the most expensive one is less than one thousand worth of naira. The fall in the price of telephone lines is not only in the mobile environment. A considerable drop in the price of fixed lines has also been recorded. In terms of the charge rate, Nigeria GSM charge rate is still on the high side but as the competition continues and may be with the coming of new entrants into the sector this will definitely bring about a crash in the current charge rate available in the country.

Another important parameter of describing telecommunications services is reliability. In Nigeria, reliability of most of the network is very questionable. Lack of signal (non-availability of service) is a common thing in the country. Often time when there is signal (service), the problem of transparency is still

prevalent. Competition will also go a long way to reduce this problem.

The penetration of telecommunications into the nook and cranny of the country is mainly due to GSM services. There is need for other form of telecommunications to be available in the villages that should be easily affordable to the inhabitant of such remote locations. The proposed rural telephony project by the ministry of communication should be encouraged and implemented. This will further improve the penetration of telecommunications services.

5.1 RECOMMENDATIONS

The world is fast becoming a global village and a necessary tool for this process is communication of which telecommunications is a key player. The importance of full interconnectivity among all the communication network operators in Nigeria is inevitable if truly the nation is to be integrated into the global village.

Looking at the available methods of achieving interconnectivity, it is important that the Nigeria telecoms industry should start migrating to the use of clearinghouse technique for the implementation of interconnection in the country. The use of regional clearinghouses will be more appropriate for the country because of the size and other benefits such as secondary links and the Least Cost Route (LCR) available options.

According to "Nigeriabusinessinfo.com", No doubt, Nigeria has become an irresistible lure to telecom investors notwithstanding the purported high cost of doing business in the country. The sheer size of Nigeria and her teeming population is enough incentive for investors to confront the Nigerian business challenge frontally.

It is obvious many telecommunications investors are ready to invest in the country. If the incumbents, with the vast majority of customers, do not interconnect with the new entrants, the new entrants would have little chance of attracting customers of their own.

In order to reap the fruits of full liberalization, the operating environment must be made a level playing ground. The best way of doing this, is to make sure every form of anti-competition tendencies from the incumbents service providers are reduced to the barest minimum and this is absolutely possible if and only if, the new entrants are not at their (incumbents) mercy for interconnection. This further emphasizes the fact that, perfect liberalization of the telecom sector will be readily facilitated by interconnection through clearinghouse, other factors being put into consideration.

Since the migration from the present method of interconnectivity is not an instantaneous thing, the Nigeria Communication Commission (NCC) should be more empowered to perform its roles as a free and fair regulator who can bark and as well bite if need arises.

Another area that should be deeply looked into is the issue of human resources that are involved in the installation and management of the various telecommunications equipment. The use of foreign expatriates is a common scenario in our telecoms industry which ought not to be. I strongly believe Nigerians can act in the capacity of these foreign expatriates if they are well trained. This calls for urgent attention of the Federal Government to take different approach in solving the problems associated with our technological backwardness. In the same vein, it is expedient the Federal Government gives the necessary support to Digital Bridge Institute (DBI) created by NCC to train personnel in telecommunications and Information Technology (IT).

One critical issue in the Nigeria telecoms as at today is the alarming rate of GSM handset theft. This problem can be combated if all the GSM operators incorporate and activate *Equipment and Identity Register* (EIR) in their network. Although, the use of EIR in the GSM standard is optional. As a matter of national way of reducing crime, it should be made compulsory in Nigeria because of the high crime rate.

5.2 CONCLUSION

Recognizing that effective interconnection delivers benefits to end users through the choice of service providers, access to innovative services and fair and reasonable prices. Effective interconnection

arrangements assist economies to tap the benefits of rapid growth and innovation in the telecommunications sector. They consequently contribute to growth and efficiency in the economy at large.

In Nigeria, the problem of interconnectivity has been a recurrent one especially at the instance of new entrants coming into the sector. The re-auctioning of GSM licenses in 2016 and 2017, which may formally open doors for new GSM operators, and unless a workable approach of interconnectivity is put in place, the new entrants may be easily discouraged to bid for licenses. It is therefore an issue of national urgency that Perfect interconnectivity through clearinghouse technique is recommended for implementation before then.

GLOSSARY

A/D	Analogue To Digital Conversion
AMPS	Advanced (America)Mobile Phone System
AUC	AUthentication Centre
BRA	Basic Rate Access
BSC	Base Station Controller
BSS	Base Station System
BTS	Base Transceiver Station
CAS	Channel Associated Signalling
D-AMPS	Digital-Advanced Mobile Phone System
DBI	Digital Bridge Institute
E-GSM	Enhanced- Global System for Mobile Communication
EIR	Equipment Identity Register
ETACS	Extended-Total Access Communication System
GMSC	Gateway- Mobile services Switching Centre
GSM	Global System for Mobile Communication
HLR	Home Location Register
ISDN	Integrated Services Digital Network
LE	Local Exchange
ME	Mobile Equipment
MS	Mobile Station
MSC	Mobile services Switching Centre
MSC	Mobile services Switching Centre

NCC	National Communications Commission
NMC	Network Maintenance Centre
NMT	Nordic Mobile Telephone
NSS	network Switching System
OMC	Operating and Maintenance Centre
PCS	Personal Communication Services
PDC	Personal(Pacific) Digital Cellular
P-GSM	Primary- Global System for Mobile Communication
PLMN	Public Land Mobile Network
PMB	Per Minute Billing
PRA	Primary Rate Access
PSB	Per Second Billing
PSTN	Public Switch Telephone Network
SIM	System Identity Module
TACS	Total Access Communication System
TCP	Transport Control Protocol
VLR	Visitor Location Register
VoIP	Voice over Internet Protocol

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