# CHAPTER ONE

## INTRODUCTION

Internet is the greatest gift of technology which has made life easier. It is not the only fastest mode of providing information but today it is serving us in various ways. One of the biggest benefits that internet users enjoy is communication; people living in different parts of the world can communicate with each other through the internet. Equipped with most modern interactive tools like emails, chats, SMS, voice SMS, internet provides fastest and most hassle-free communication. Unlike post offices and telephone connections, internet is accessible from all corners of the world and being a 24x7 service, it keeps on providing its service to people all the time. Without the internet prosperity of most businesses in today's world would have been a great challenge.

Broadband internet access refers to a signalling method that includes a relatively wide range of frequencies, which may be divided into channels or frequency bins. Broadband internet access is a high rate internet access. Broadband internet access, through both fixed and wireless infrastructures, is clearly one of the key focus areas for ICT development in this country.

Currently in Cape Coast only Unshielded Twisted Pair (UTP) cables are used in Broadband right from the exchange to the cabinet and from the cabinet to the customer's place. Internet users will like to have if not the best, the kind of internet service that is acceptable. In order to provide this kind of ADSL service in Vodafone there are different ways of doing that and using Fibre Optic cables instead of UTP cables is one of them.

It is very obvious that changing all the cabling at a goal entails a lot of work and funds. Therefore, in order to enhance the Asymmetric Digital Subscriber Line service in Cape Coast by using Fibre Optics, it has to be done gradually.

The use of Fibre Optic cables in telecommunication has large advantages over the existing copper wire in long-distance and high-demand applications. There are other good reasons why Fibre Optic is the best when it comes to telecommunication. Some of the reasons are:

- The optical carrier frequency in the range 1013 to 1014 Hz offers the potential for a fibre information carrying capacity that is many orders of magnitude in excess of that

obtained using copper cable or wideband radio systems. This makes it possible for fibres to simultaneously carry voice, data, image and video signals.

- Fibre Optic is often no wider than the diameter of a human hair; thus even after applying protective layers, they are far smaller and much lighter than corresponding copper cables.
- They form a dielectric and are therefore free from electromagnetic interference.
- As light from a fibre does not radiate significantly, a transmitted optical signal cannot be obtained non-invasively, thus ensuring a high degree of signal security.
- With losses as low as 0.2 dB/km, this feature alone has become a major advantage of optical fibre as extremely wide repeater spacing (70 to 100km) may be used in long distance communication links. This in turn reduces both system cost and complexity.
- Due to the low loss property, system reliability is generally enhanced in comparison to conventional electrical conductor systems. Furthermore, reliability of optical components have predicted lifetimes of 20 to 30 years. Combined, these factors tend to reduce maintenance time and costs (S. A. Bashar, 2002).

Meanwhile, Fibre Optic cables have some disadvantages and some of them are; infrastructure development within cities is relatively difficult and time-consuming, and fibre optic systems are complex and expensive to install and even to operate.

## 1.1 Problem Statement

For now, Vodafone ADSL service in Cape Coast is not encouraging in the sense that customers staying very far away from the Exchange have difficulty in using the broadband. The attenuation becomes very high and the signal-to-noise ratio also reduces because the Unshielded Twisted Pair cables from the Main Distribution Frame (Exchange) to the customer's end become very long and the electronic signal passing through the cable becomes very weak. Before a customer can use the broadband, the person should not be nine (9) kilometres from the Main Distribution Frame since the strength of the signal begins to decrease as it travels a long distance. And if the customer is even within the nine kilometres, the drop wire from the Distribution point to the customers end should not be more than the 300 meters. Some of the customers who are staying within the nine kilometres but are a little far away find it very difficult to get full access to the internet. This is because the attenuation

keeps on increasing as the cables become longer.

Users like companies and schools need the ADSL service for so many reasons. Since we are in the computer age a lot of schools will need the internet for studying and also for doing their research. Some schools also use it for distance learning, companies like manufacturing companies will need the internet to deal directly with their customers and so on.

## 1.2 Research Objective and Research Questions

### 1.2.1 Research Objective



Due to the problem stated above the objectives of this thesis are as follows:

- To help enhance the quality of the ADSL service by reducing the attenuation in order to make it possible for the Vodafone customers living within the 9 km radius to get full access to the ADSL service. By improving the ADSL service companies for example will be able to increase their workforce productivity with more effective and efficient communication system example mail and voice over IP (VoIP) and remote application.
- To make it possible for customers staying beyond the 9 km radius to also get access to the ADSL service.
- The last but not the least, the use of fibre optic cables will make it possible for more customers to have access to the ADSL service as compared to the UTP cables. There are different options available for improving the ADSL service; examples are changing some of the ADSL equipment, having repeaters in cabinets in order to decrease the attenuation thereby increasing the signal. Also exchanges can be erected every 9km from each other in order to increase the signals. However, the objective of this thesis is to find ways of improving upon the broadband service.

### 1.2.2 Main Research Question

What can be done to improve the quality of ADSL service in Vodafone?

Customers using the ADSL service find it difficult to get full access to the Internet. This is

because the number of customers who are using the broadband keep on increasing and the UTP cable cannot sustain it.

**Research Sub-question 1**

What are the options available for improving the quality of the ADSL service?

**Research Sub-question 2**

Which of these options is the best?



**Research Sub-question 3**

How does this option affect Vodafone?

## 1.3 Research Design

### Type of Research

Quantitative research method and also qualitative research method are the type of research that will be used for this study.

## 1.4 Research Methodology

A sample of the Vodafone Broadband Internet service users, and a sample of the Vodafone staff in Cape Coast especially the management would be given questionnaires to fill so that we can find out whether they are satisfied with the current ADSL services or not.

Other literatures on the use of cables and wireless in telecommunication will be reviewed to know the best way to improve the quality of ADSL services.

## 1.5 Analysis Plan

Information would be gathered from the literature review. Information such as the advantages and disadvantages of the options available for improving the quality of the service will be

gathered; example is the advantages and disadvantages between the existing medium of transmission, that is, the UTP cables and the other medium of transmission. Information on the speed of each medium of transmission, the distance each of them can cover and also the cost of each of them.

After gathering this information, we will know whether to keep the existing system in Vodafone or to change it in order to improve upon the quality of the ADSL service in Vodafone.

- At least one hundred (100) customers will be given questionnaire for them to answer in order to know whether they are satisfied with the ADSL service that they are receiving right now. Also we would want to know if the users are ready to continue using the ADSL service in case there is an increase in price. Some workers at Vodafone (about 10) will be given questionnaires to fill. The analysis technique that will be used is Weighted Average (Mean).

### 1.6 Stakeholders and Actors

#### Stakeholders

The main stakeholders of this research are:

- Vodafone
- Customers
- Ghana Government

#### Actors

The main actors in this research are:

- Supervisors
- Examiner
- Customers
- Vodafone (management)

### 1.7 Milestones and Expected Timelines

The milestones and expected timelines are shown in table 1.1.

| Activity | Date |
|---|---|
| Research Proposal | November, 2009 |
| Factors defining the quality of service for internet users;<br>-literature review,<br>-Vodafone Infrastructure<br>-Applying the analysis of the factors to Vodafone Cape Coast. | December-February, 2009 |
| Questionnaires | March, 2009 |
| Report on Investigation | March, 2009 |
| Analysis of the factors;<br>-how the quality of the ADSL service can be improved,<br>- cost implication | April, 2010 |
| Data analysis | April, 2010 |
| Conclusion and Future Research | May, 2010 |

**Table 1.1 Milestones and Expected Timelines**

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

The most important need of people since the ancient times has always been communication. As the days went by many forms of communication have been developed. The motivation behind each new form of communication was basically either to make it possible for more data or information to be sent by increasing the data rate, to enhance the transmission accuracy, or to increase the transmission distance between different relay stations. Before the nineteenth century, all communication systems operated at a very low information rate and they involved only acoustical or optical means, examples are drums, signal lamps, horns and fire. People were using especially fire signal for making announcements, to call for help or send alarms (Keiser, 2000).

Now there are new ways of communicating with people far and near. One of them is the use of internet. Although the basic applications and guidelines that make the internet possible had existed for almost two decades, the network did not gain a public face until the 1990s. On 6 August 1991, CERN, a pan European organization for particle research, publicized the new World Wide Web project. Miniwatts Marketing Group, 2009).

There are different means of gaining access to the internet. Some of them are wireless, dial-up and broadband (ADSL). Each of them has its own pros and cons.

## 2.2 Telecommunication

Telecommunication is transmission over a distance for the purpose of communication. In the past, this may have involved the use of smoke signals, drums, semaphore, flags or heliograph but in recent times, telecommunication typically involves the use of electronic devices such as the telephone, television, radio and computer. (G. Keiser, 2000).

### 2.2.1 Modern Operation

**Telephone:** telephone is a telecommunication device that transmits and receives sound, most commonly the human voice. The device operates principally by converting sound waves into electrical signals, and electrical signals into sound waves. Such signals when conveyed

through telephone networks — and often converted to electronic and/or optical signals — enable nearly every telephone user to communicate with nearly every other worldwide.

As shown in figure 2.1, a telephone mouthpiece contains a thin metallic coating separated from an electrode by a thin barrier (today we use plastic) which connects to a wire carrying an electric current. When a person speaks into the mouthpiece, the acoustic vibrations from her speech push the metallic coating slightly closer to the electrode, resulting in variations in voltage and therefore a speedy conversion from acoustic to electric energy. The electric pulses are conveyed through a wire to the speaker on the other end, where electric pulses are converted into acoustic energy again (M. Anissimov, 2009).

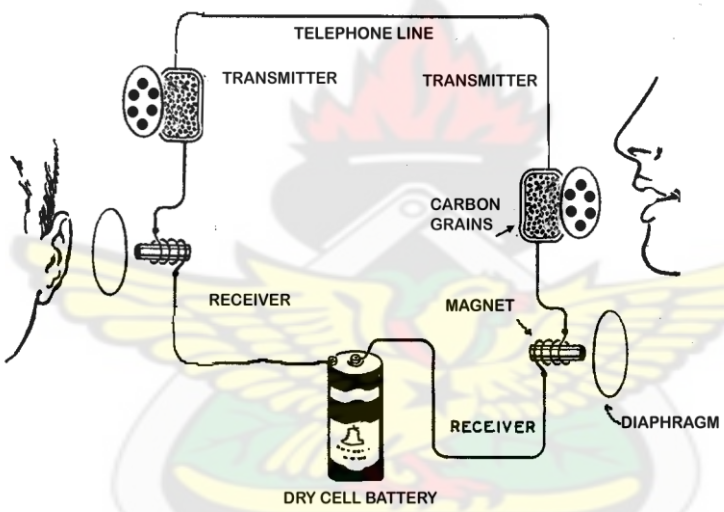


**Figure 2.1 How the telephone works**

- **Radio and Television:** Radio is the transmission of signals by modulation of electromagnetic waves with frequencies below those of visible light (R. F. Graf, 1974). Electromagnetic radiation travels by means of oscillating electromagnetic fields that pass through the air and the vacuum of space. Information is carried by systematically modulating or changing some property of the radiated waves, such as amplitude, frequency or phase.

  Television (TV) is a widely used telecommunication medium for transmitting and receiving moving images, either monochromatic ("black and white") or color, which is usually accompanied by sound. Television may also refer specifically to a television set,

television programming or television transmission. Broadcast TV is typically disseminated via radio transmissions on designated channels in the 54–890 megahertz frequency band (CSGNetwork.com, 2009)

- **Intranet:** The definition of an intranet continues to vary from source to source. Here are some of the varying definitions:

  According to Prescient Digital Media (2010), an intranet is private network, similar to the Internet and using the same protocols and technology, contained within an enterprise or not-for-profit organization. Widely referred to as the home page of the internal website, the intranet also includes many inter-linked local area networks (LANs), desktop computers, websites and portals, and email system(s).

  According to Wikipedia (2009), an intranet is a private computer network that uses Internet protocols, network connectivity, and possibly the public telecommunication system to securely share part of an organization's information or operations with its employees. Sometimes the term refers only to the most visible service, the internal website.

- **Internet:** The Internet is a global system of interconnected computer networks that use the standard Internet Protocol Suite (TCP/IP) to serve billions of users worldwide and the internet operates without a central governing body (Wikipedia, 2009).

  Common methods of Internet access in homes and also in offices include dial-up, broadband, Wi-Fi, satellite and 3G technology cell phones. Public places which use the Internet include libraries and Internet cafes, where computers with Internet connections are available. There are also Internet access points in many public places such as airport halls and coffee shops, in some cases just for brief use while standing. Wi-Fi provides wireless access to computer networks, and therefore can do so to the Internet itself. Hotspots provide access which includes Wi-Fi cafes, where would-be users need to bring their own wireless-enabled devices such as a laptop or PDA. These services may be free to all, free to customers only, or fee-based. A hotspot need not be limited to a confined location. A whole campus or park, or even an entire city can be enabled. The Internet can then be accessed from such places as a park bench (Pasternak, 2006).

### 2.2.2 Economic and Social Impact of Telecommunication

On the microeconomic scale, companies have used telecommunication to help build global empires. This is evident in the case of online retailers like Amazon.com, according to Edward Lenert (1998), even the conventional retailer Wal-Mart has benefited from better telecommunication infrastructure compared to its competitors. In cities throughout the world, home owners use their telephones to organize many home services ranging from pizza deliveries to electricians. Even relatively poor communities have been noted to use telecommunication to their advantage. In Cote d'Ivoire, coffee growers share mobile phones to follow hourly variations in coffee prices and sell at the best price (Samaan, 2003).

The Internet has enabled entirely new forms of social interaction, activities, and organizing, thanks to its basic features such as widespread usability and access. Social networking websites such as Facebook, Hi5 and MySpace have created a new form of socialization and interaction. Users of these sites are able to add a wide variety of information to their personal pages, to pursue common interests, and to connect with others. It is also possible to find a large circle of existing acquaintances, especially if a site allows users to represent themselves by their given names, and to allow communication among existing groups of people. Sites like meetup.com exist to allow wider announcement of groups which may exist mainly for face-to-face meetings, but which may have a variety of minor interactions over their group's site.

## 2.3 Internet Access and Services

There are different methods of internet access; the common methods of Internet access include wireless, dial-up, and broadband (over Cable Internet access, Optical fibre or twisted pairs).

### 2.3.1. Wireless

Wireless communication is the transfer of information over a distance without the use of electrical conductors or "wires" (Sintef, 2009).The distances involved may be short (a few meters as in television remote control) or long (thousands or millions of kilometres for radio communications). When the context is clear, the term is often shortened to "wireless".

### 2.3.2 Dial-up

Dial-up Internet access is a form of Internet access that uses telephone lines (Cisco Documentation, 2009). The user's computer or router uses an attached modem connected to a telephone line to dial into an Internet service provider's (ISP) node to establish a modem-to-modem link, which is then used to route Internet Protocol packets between the user's equipment and hosts on the Internet. Dial-up connections have different speed. For example, Modem 110 baud has a speed of 0.1 kbit/s, Modem 300 (300 baud) (Bell 103 or V.21) has a speed of 0.3 kbit/s and Modem 9600 (2400 baud) (V.32) has a speed of 9.6 kbit/s (ITU, 2008).



As telephone access is widely available, dial-up remains useful to travellers. Dial-up is usually the only choice available for rural or remote areas where broadband installations are not prevalent due to low population and demand.

Dial-up requires time to establish a usable telephone connection (several seconds, depending on the location) and perform handshaking for protocol synchronization before data transfers can take place.

Dial-up access is a transient connection, because either the user or the Internet Service Provider terminates the connection. Technically-inclined users often find a way to disable the auto-disconnect program such that they can remain connected for days. This is particularly useful for downloading large files such as videos.

### 2.3.3 Broadband

According to the 802.16-2004 standards, broadband means 'having instantaneous bandwidth greater than around 1 MHz and supporting data rates greater than about 1.5 Mbit/s, meaning a customer should have a very fast Internet service. This means that Wireless Broadband features speed is roughly equivalent to wired broadband access, such as that of ADSL or that of a cable modem (Wikipedia, 2009).

Broadband allows you to take advantage of new services not available or not convenient to use with a dial-up Internet connection. One such service is Voice over Internet Protocol (VoIP), which is an alternative to traditional voice telephone service that may be less costly

for you depending on your calling patterns.

Some VoIP services only allow you to call other people using the same service, but others allow you to call anyone who has a telephone number – including local, long distance, mobile, and international numbers.

Broadband makes "telemedicine" possible: patients in rural areas can confer online with medical specialists in more urban areas and share information and test results very quickly.

Broadband helps you efficiently access and use many reference and cultural resources, such as library and museum data bases and collections. You also need broadband to best take advantage of many distance learning opportunities, like online college or university courses, and continuing or senior education programs. Broadband is an important tool for expanding educational and economic opportunities for consumers in remote locations.

In addition to these new services, broadband allows you to shop on-line and Web surf more quickly and efficiently. Downloading and viewing videos and photos on your computer are much faster and easier. With broadband you can access the Internet by turning on your computer without needing to dial up your Internet Service Provider (ISP) over a telephone line, which permits you to use the Internet without tying up your telephone line. (Federal Communication Commission, 2008)

The standard broadband technologies in most areas are DSL and cable modems. Newer technologies in use include VDSL (not yet in Ghana) and pushing optical fibre connections closer to the subscriber in both telephone and cable plants. Fibre-optic communication, while only recently being used in fibre to the home (FTTH) and fibre to the Cabinet (FTTC), has played a crucial role in enabling Broadband Internet access by making transmission of information over larger distances much more cost-effective than copper wire technology. In a few areas not served by cable or ADSL, community organizations have begun to install Wi-Fi networks, and in some cities and towns local governments are installing municipal Wi-Fi networks.

The standard broadband technologies in most areas are Digital Subscriber Line (DSL) and cable modems. There are different DSL technologies. These DSL technologies are sited from

Wikipedia (2009). Each of them has its own advantages and disadvantages. Some of the DSL technologies are:

**Rural broadband**

One of the great challenges of broadband is to provide service to potential customers in areas of low population density, such as to ranchers, and small towns. In cities where the population density is high, it is easy for a service provider to recover equipment costs, but each rural customer may require expensive equipment to get connected.

Several rural broadband solutions exist, though each has its own pitfalls and limitations. Some choices are better than others, but are dependent on how proactive the local phone company is about upgrading their rural technology.

**Satellite Internet**

Satellites in geostationary orbits are able to relay broadband data from the satellite company to each customer. Satellite Internet is usually among the most expensive ways of gaining broadband Internet access. However, costs have been coming down in recent years to the point that it is becoming more competitive with other broadband options.

Most satellite Internet providers also have a FAP (Fair Access Policy). Perhaps one of the largest disadvantages of satellite Internet, these FAPs usually throttle a user's throughput to dial-up data rates after a certain "invisible wall" is hit (usually around 200 MB a day). This FAP usually lasts for 24 hours after the wall is hit, and a user's throughput is restored to whatever tier they paid for. This makes bandwidth-intensive activities nearly impossible to complete in a reasonable amount of time (examples include P2P and newsgroup binary downloading).

**Advantages**

1. True global broadband Internet access availability
2. Mobile connection to the Internet (with some providers)

**Disadvantages**

1. High latency compared to other broadband services, especially 2-way satellite service
2. Unreliable: drop-outs are common during travel, inclement weather, and during sunspot activity
3. The narrow-beam highly directional antenna must be accurately pointed to the satellite orbiting overhead
4. One-way satellite service requires the use of a modem or other data uplink connection
5. Satellite dishes are very large. Although most of them employ plastic to reduce weight, they are typically between 80 and 120 cm (30 to 48 inches) in diameter.



**Cellular broadband**

Cellular phone towers are very widespread, and as cellular networks move to third generation (3G) networks they can support fast data; using technologies such as EVDO.

These can give broadband access to the Internet, with a cell phone with Cardbus, ExpressCard, or USB cellular modems, or with cellular broadband routers, which allow more than one computer to be connected to the Internet using one cellular connection.

**iBlast**

iBlast was the brand name for a theoretical bandwidth (7 Mbit/s), one-way digital data transmission technology from a Digital TV station to users that was developed between June 2000 to October 2005.

**Advantages:**

1. Low cost, broadband data transmission from TV station to users. This technology can be used for transmitting website / files from Internet.

**Disadvantages:**

1. One way data transmission.

2. No Privacy/security.

3. Lack of 8VSB tuner built into many consumer electronic devices needed to receive the iBlast signal.

In the end, the disadvantages outweighed the advantages and the glut of fibre optic capacity that ensued following the collapse of the Internet bubble drove the cost of transmission so low that an ancillary service such as this was unnecessary, and the company folded at the end of 2005. The partner television stations as well as over 500 additional television stations not part of the iBlast Network continue to transmit separate digital signals as mandated by the Telecommunications Act of 1996.



**2.4 Options available for improving the quality of the ADSL service**

- **Changing the ADSL equipment:**

ADSL is the short for asymmetric digital subscriber line; ADSL is a type of DSL broadband communications technology used for connecting to the Internet. ADSL allows more data to be sent over existing copper telephone lines (POTS), when compared to traditional modem lines. A special filter, called a micro-filter, is installed on a subscriber's telephone line to allow both ADSL and regular voice (telephone) services to be used at the same time. ADSL requires a special ADSL modem and subscribers must be in close geographical locations to the provider's central office to receive ADSL service. Typically this distance is within a radius of 2 to 2.5 miles. ADSL supports data rates of from 1.5 to 9 Mbps when receiving data (known as the downstream rate) and from 16 to 640 Kbps when sending data (known as the upstream rate). (Wikipedia, 2010)

There are different kinds of ADSL equipment in the market(see figure 2.2 and figure 2.3). Some are better than others in terms of reliability, cost and compatibility. These ADSL equipment can contribute to the performance of the ADSL service but its contribution is minimal.

There are three main types of ADSL hardware on the market and these are examples of some of the ADSL equipment at the customers end and each of them has its own advantages and disadvantages.

**USB Modems**

**Figure 2.2 An example of a USB Modem**



**Advantages:**

1. Normally this type of modem is the easiest to install, just plug it into your computer and then install the included drivers.
2. Can be moved easily between PCs as required.

**Disadvantages:**

1. USB modems suffer from a common problem with power management, especially with SiS and VIA chipset motherboards.
2. This can cause unreliable connections and dropouts.
3. Driver Support can be limited, meaning that getting these to work on some systems can cause problems. Mac, Linux and Windows compatibility should be researched before choosing your model (Ianwild, 2006).
4. The USB modem relies on system resources (e.g. processor speed, RAM). The less you have, the less speed you get (to a small extent).

**Ethernet Modems/Routers**

**Figure 2.3 An example of a port modem.**

**Advantages:**

1. Most reliable - Keeps your connection online even with all PCs switched off.
2. Works on any equipment which has network support.
3. Allows you to share your connection with more than one PC.
4. Very flexible and future proof.

**Disadvantages:**



1. More expensive than USB modem.
2. Every PC needs to have a Network Card fitted and cabling needs to be done back to the router.
3. With a single port router you will also need a type of bridge, hub or switch to connect more than one PC.

A number of hybrid devices are available which combine the features of an Ethernet modem and a USB modem. They offer the ease of connection and setup of both USB modems and Ethernet modem. (Ianwild, 2006)

**Reducing the number of customers:**

Reducing the number of ADSL users is one of the options that can help in improving the ADSL service. Even though it will help, it is not a good idea. Home user is contended at 50:1 and upwards, meaning that one home user might be sharing his or her 512Kbps with 49 or more other people, giving him or her less than 10Kbps. For this reason the speed of the internet reduces as the number of users increase. Reducing the number of home users especially will help improve the speed of the internet but this is not the best solution.

- **Putting up mini-exchanges every 9km from the other:**

Mini-exchanges like the M-SUN can be erected every 9km from each other. This is one option that can help people living further to get access to the internet. One

disadvantage of using this method is most of the countries in the world are now using Fibre optics for telecommunication so if exchanges are to be fixed every 9km from each other, a time will come when all the UTP cables will have to be changed to Fibre Optics. This will be waste of resources. So to improve the performance of the ADSL service this option is not so important.

- **Using other alternatives to ADSL**

There are lots of variations in DSL technology; many of them address DSL's distance limitations in one way or another. Other types of DSL include:

- **Very high bit-rate DSL (VDSL)** - This is a fast connection, but works only over a short distance. It is capable of handling Internet access, HDTV and on-demand services at rates of 52 Mbps downstream and 12 Mbps upstream.
- **Rate-adaptive DSL (RADSL)** - This is a variation of ADSL, but the modem can adjust the speed of the connection depending on the length and quality of the line.
- **ISDN DSL (IDSL)** - This is a combination of the Integrated Services Digital Network (ISDN) and DSL technology. ISDN was the solution to dial-up Internet -- it allowed voice, text graphics, video and other data to share one telephone line. This made it possible to talk on the phone and use the Internet at the same time. IDSL is faster than ISDN connections but slower than DSL. It can travel a longer distance of 8 - 9.6 km, so it is usually a good option for people who can't get DSL in their area. (Wikipedia, 2010)

- **Changing the mode of transmission:**

  Changing the mode of transmission has a very great impact on the ADSL services performance. This is discussed into details in section 2.5

## 2.5 Mode of Transmission

### 2.5.1 Coaxial cables

Coaxial cable, or coax, is an electrical cable with an inner conductor surrounded by a tubular insulating layer typically of a flexible material with a high dielectric constant, all of which are surrounded by a conductive layer (typically of fine woven wire for flexibility, or of a thin metallic foil), and finally covered with a thin insulating layer on the outside (see figure 2.4)(Nahin, 2002).

Coaxial cable is used as a transmission line for radio frequency signals, in applications such as connecting radio transmitters and receivers with their antennas, computer network (Internet) connections, and distributing cable television signals. One advantage of coax over other types of transmission line is that in an ideal coaxial cable the electromagnetic field carrying the signal exists only in the space between the inner and outer conductors. This allows coaxial cable runs to be installed next to metal objects such as gutters without the power losses that occur in other transmission lines, and provides protection of the signal from external electromagnetic interference.

Coaxial cable should not be confused with other shielded cable used for carrying lower frequency signals such as audio signals. Shielded cable is similar in that it consists of a central wire or wires surrounded by a tubular shield conductor, but it is not constructed with the precise conductor spacing needed to function efficiently as a radio frequency transmission line.

**Types of Coaxial cable**

There are two main types coaxial cable, they are thicknet and thinnet.

**Thicknet**.

This type of coaxial cabling is used with Ethernet 10Base5 networks and is able to span distances of up to 500 meters. Originally used to directly connect computers, it eventually became popular in backbone implementations between LANs. Systems connected to the cable using an external transceiver unit than actually tapped directly into the wire.

**Advantages of thicknet**

- Thicknet provides greater bandwidth than the thinnet

**Disadvantages of thicknet**

- Thicknet cable can be too rigid to install easily in some situations because of its thickness. Thicknet cable is almost never used except for special-purpose installations.

**Thinnet**.

A much thinner and more flexible type of coaxial cable, Thinnet is used on Ethernet 10Base2 networks and can span distances of up to 185 meters. This was usually the media of choice for connecting computers on a LAN.



**Advantages of thinnet**

- Thinnet is easier to install and also
- Cheaper to install compared to thicknet.

**Disadvantages of thinnet**

- Thinnet covers a shorter distance compared to the thicknet.

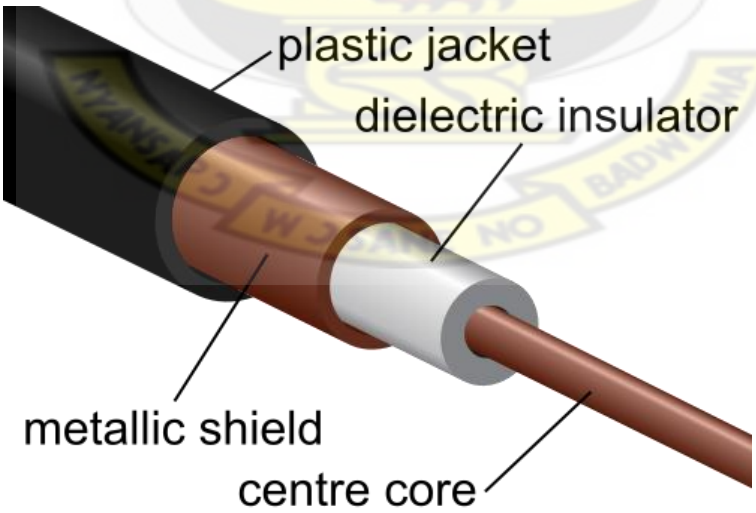


**Figure 2.4 Coaxial cable cutaway**

**Advantages of coaxial cable**

The advantages of coax include the following:

- **Broadband system**-Coax has a sufficient frequency range to support multiple channels, which allows for much greater throughput.
- **Greater channel capacity**-Each of the multiple channels offers substantial capacity. The capacity depends on where you are in the world Within one of these channels, you can provision high-speed Internet access-that's how cable modems operate. But that one channel is now being shared by everyone using that coax from that neighbourhood node, which can range from 200 to 2,000 homes.
- **Greater bandwidth**-Compared to twisted-pair, coax provides greater bandwidth system-wide, and it also offers greater bandwidth for each channel. Because it has greater bandwidth per channel, it supports a mixed range of services. Voice, data, and even video and multimedia can benefit from the enhanced capacity.
- **Lower error rates**-Because the inner conductor is in a Faraday shield, noise immunity is improved, and coax has lower error rates and therefore slightly better performance than twisted-pair. The error rate is generally 10-9 (i.e., 1 in 1 billion) bps.
- **Greater spacing between amplifiers**- Coaxial cable shielding reduces noise and crosstalk, which means amplifiers can be spaced farther apart than with twisted-pair.

**Disadvantages of coaxial cable**

The main disadvantages of coaxial cables are as follows:

- **Bidirectional upgrade required**-In countries that have a history of cable TV, the cable systems were designed for broadcasting, not for interactive communications. Before they can offer to the subscriber any form of two-way services, those networks have to be upgraded to bidirectional systems.
- **Great noise**-The return path has some noise problems, and the end equipment requires added intelligence to take care of error control.
- **High installation costs**-Installation costs in the local environment are high.
- **Susceptible to damage from lightning strikes**-Coax may be damaged by lightning strikes. People who live in an area with a lot of lightning strikes must be wary because if that lightning is conducted by a coax, it could very well fry the equipment at the end of it.

- More expensive than twisted pairs and is not supported for some network standards (e.g. token ring)
- It is also very bulky and also has high attenuation so would have the need to implement repeaters etc (Wikianswer, 2009)

### 2.5.2 Radio (Wireless)

Wireless communication uses radio frequencies (RF) or infrared (IR) waves to transmit data between devices on a LAN. For wireless LANs, a key component is the wireless hub, or access point, used for signal distribution. To receive the signals from the access point, a PC or laptop must install a wireless adapter card (wireless Network Interface Card). Wireless signals are electromagnetic waves that can travel through the vacuum of outer space and through a medium such as air. Therefore, no physical medium is necessary for wireless signals, making them a very versatile way to build a network. (See figure 2.5)Wireless signals use portions of the RF spectrum to transmit voice, video, and data. Wireless frequencies range from 3 kilohertz (kHz) to 300 gigahertz (GHz). The data-transmission rates range from 9 kilobits per second (kbps) to as high as 54 Mbps. (Wikianswer, 2009)

The primary difference between electromagnetic waves is their frequency. Low-frequency electromagnetic waves have a long wavelength (the distance from one peak to the next on the sine wave), while high-frequency electromagnetic waves have a short wavelength.

Some common applications of wireless data communication include the following:

- Accessing the Internet using a cellular phone
- Establishing a home or business Internet connection over satellite
- Beaming data between two hand-held computing devices
- Using a wireless keyboard and mouse for the PC

**Figure 2.5 Wireless Network**

### Advantages

The advantages of wireless network are:

- easier transmission of data
- a communication device can easily be added to a system or a system can be removed from a system without any disruption to the remainder of the system
- a communicating device can easily be relocated, without any additional cost of rewiring and no excessive downtime is associated with such a move
- the cost of running and maintaining a radio based communications solution is minimal

### Disadvantages

The disadvantages of wireless network include:

- Limited spectrum available for communications
- Data less secure
- The waves could be damaging to our health. The effects of radio communication on human health are being examined (M. A. Stuchly, 1992)

### 2.5.3 Twisted Pair cables

Twisted-pair cable is a type of cabling that is used for telephone communications and most modern Ethernet networks. A pair of wires forms a circuit that can transmit data. The pairs

are twisted to provide protection against crosstalk, the noise generated by adjacent pairs. When electrical current flows through a wire, it creates a small, circular magnetic field around the wire. When two wires in an electrical circuit are placed close together, their magnetic fields are the exact opposite of each other. Thus, the two magnetic fields cancel each other out. They also cancel out any outside magnetic fields. Twisting the wires can enhance this cancellation effect. Using cancellation together with twisting the wires, cable designers can effectively provide self-shielding for wire pairs within the network media.

Two basic types of twisted-pair cable exist: unshielded twisted pair (UTP) and shielded twisted pair (STP). The following sections discuss UTP and STP cable in more detail. (Cisco Systems, 2003)



**Figure 2.6 Unshielded Twisted Pair.**

Unshielded twisted pair (UTP) is the most popular cable used in telecommunication (figure 2.6). The quality of UTP may vary from telephone-grade wire to extremely high-speed cable. The cable has four pairs of wires inside the jacket. Each pair is twisted with a different number of twists per inch to help eliminate interference from adjacent pairs and other electrical devices. The tighter the twisting, the higher the supported transmission rate and the greater the cost per foot. (Winkelman, 2009)

The EIA/TIA (Electronic Industry Association/Telecommunication Industry Association) has established standards of UTP and rated six categories of wire. Table 2.1 shows the different standards of UTP cables and their uses.

| Category | Data rate | Use |
|---|---|---|
| 1 | Up to 1Mbps | Telephone communications, ISDN-Modem, doorbell wiring. |
| 2 | Up to 4Mbps | Token ring networks |
| 3 | Up to 10Mbps | Token ring networks and Ethernet networks (10BASE-T). |
| 4 | Up to 16Mbps | Token ring networks |
| 5 | Up to 100Mbps | Ethernet (10Mbps), Fast Ethernet (100Mbps) and Token ring (16Mbps) |
| 5e | Up to 1000Mbps | Gigabit Ethernet |
| 6 | Up to 1000Mbps | Gigabit Ethernet |

**Table 2.1 Different categories of UTP cables, their data rate and uses**

**Shielded Twisted Pair**

Although UTP cable is the least expensive cable, it may be susceptible to radio and electrical frequency interference (it should not be too close to electric motors, fluorescent lights, etc.). If you must place cable in environments with lots of potential interference, or if you must place cable in extremely sensitive environments that may be susceptible to the electrical current in the UTP, shielded twisted pair may be the solution (see figure 2.7). Shielded cables can also help to extend the maximum distance of the cables.

Shielded twisted pair cable is available in three different configurations:

- Each pair of wires is individually shielded with foil.
- There is a foil or braid shield inside the jacket covering all wires (as a group).
- There is a shield around each individual pair, as well as around the entire group of wires (referred to as double shield twisted pair). (Winkelman, 2009)

**Figure 2.7 Shielded Twisted Pair**

**Advantages**

- These are the least-expensive media for data communication. UTP is less expensive than STP
- It is a thin, flexible cable that is easy to string between walls.
- Because STP is small, it does not quickly fill up wiring ducts.

**Disadvantages**

- Twisted pair cables are susceptible to the electromagnetic interference and it greatly depends on the pair twisting schemes (usually patented by the manufacturers) staying intact during the installation. As a result, twisted pair cables usually have stringent requirements for maximum pulling tension as well as minimum bend radius. This relative fragility of twisted pair cables makes the installation practices an important part of ensuring the cable's performance.

- In video applications that send information across multiple parallel signal wires, twisted pair cabling can introduce signaling delays known as skew which results in subtle color defects and ghosting due to the image components not aligning correctly when recombined in the display device. The skew occurs because twisted pairs within the same cable often use a different number of twists per meter so as to prevent common-mode crosstalk between pairs with identical numbers of twists. The skew can be compensated by varying the length of pairs in the termination box, so as to introduce delay lines that take up the slack between shorter and longer pairs, though the precise lengths required are difficult to calculate and vary depending on the overall cable length. (Wikipedia, 2009)

### 2.5.4 Fibre Optic cables

Fibre optic cabling consists of a centre glass core surrounded by several layers of protective materials. It transmits light rather than electronic signals eliminating the problem of electrical interference. This makes it ideal for certain environments that contain a large amount of electrical interference.

Fibre optic cable has the ability to transmit signals over much longer distances than coaxial and twisted pair. It also has the capability to carry information at vastly greater speeds. This capacity broadens communication possibilities to include services such as video conferencing and interactive services. The cost of fibre optic cabling is comparable to copper cabling.

The centre core of fibre cables is made from glass or plastic fibres (as illustrated in figure 2.8). A plastic coating then cushions the fibre centre, and Kevlar fibres help to strengthen the cables and prevent breakage. The outer insulating jacket made of Teflon or PVC.

There are two common types of fibre cables -- single mode and multimode. Multimode cable has a larger diameter; however, both cables provide high bandwidth at high speeds. Single mode can provide more distance, but it is more expensive.

**Figure 2.8 Fibre Optic Cable**

### Composition of Fibre Optic

Silica based glass or plastic filaments are spun and packed into bundles of several hundreds or thousands. Bundles may be put together as rods or ribbons and sheets. These bundles are flexible and can be twisted and contorted to conduct light and images around corners. The thin glass centre of the fibre where the light travels is called the “core”. The outer optical material surrounding the core that reflects the light back into the core is called the “cladding”. In order to protect the optical surface from moisture and damage, it is coated with a layer of

buffer coating.

### 2.5.4.1 Elements of Fibre Optic Transmission Link

A fibre optic transmission link consists of the elements which are shown in figure 2.9. The most important parts are a transmitter, which consists of a light source and its associated drive circuitry, a cable offering mechanical and environmental protection to the fibre optics contained inside and a receiver consisting of a photo detector and amplification and signal-restoring circuitry. Extra components of the fibre optic transmission link are optical amplifiers, connectors, splices, couplers, and regenerators which are used for restoring the signal-shape characteristics. (G. Keiser, 2000)



**Attenuation in Fibre Optic**

Attenuation is a reduction in the transmitted power (Hecht, 2000). Attenuation is an important consideration when dealing with the design of an optical communication system, since it plays a major role in determining the maximum transmission distance between the transmitter and the receiver. The basic attenuation mechanisms in fibre are absorption, scattering and radiative losses of the optical energy (Sayder and Love, 1983).

**Absorption in Fibre Optics**

Absorption occurs when the light beam is partially absorbed by lingering materials, which are water and metal ions, within the core of the fibre as well as in the cladding (see figure 2.10). Though absorption in standard glass fibres tends to increase between the critical lengths of 700 and 1550 nanometres (nm) (Hecht, 2000), almost any type of fibre at any length will have light absorbed by some of the traces of impurities that inevitably appear in all fibres. As the light signal travels through the fibre, each impurity absorbs some of the light, weakening the signal; therefore, longer fibres are more prone to attenuation due to absorption than shorter ones.

Absorption is caused by three different mechanisms. These mechanisms are:

- Absorption by atomic defects in the glass composition.
- Extrinsic absorption by impurity atoms in the glass material
- Intrinsic absorption by the basic constituent atoms of the fibre material.

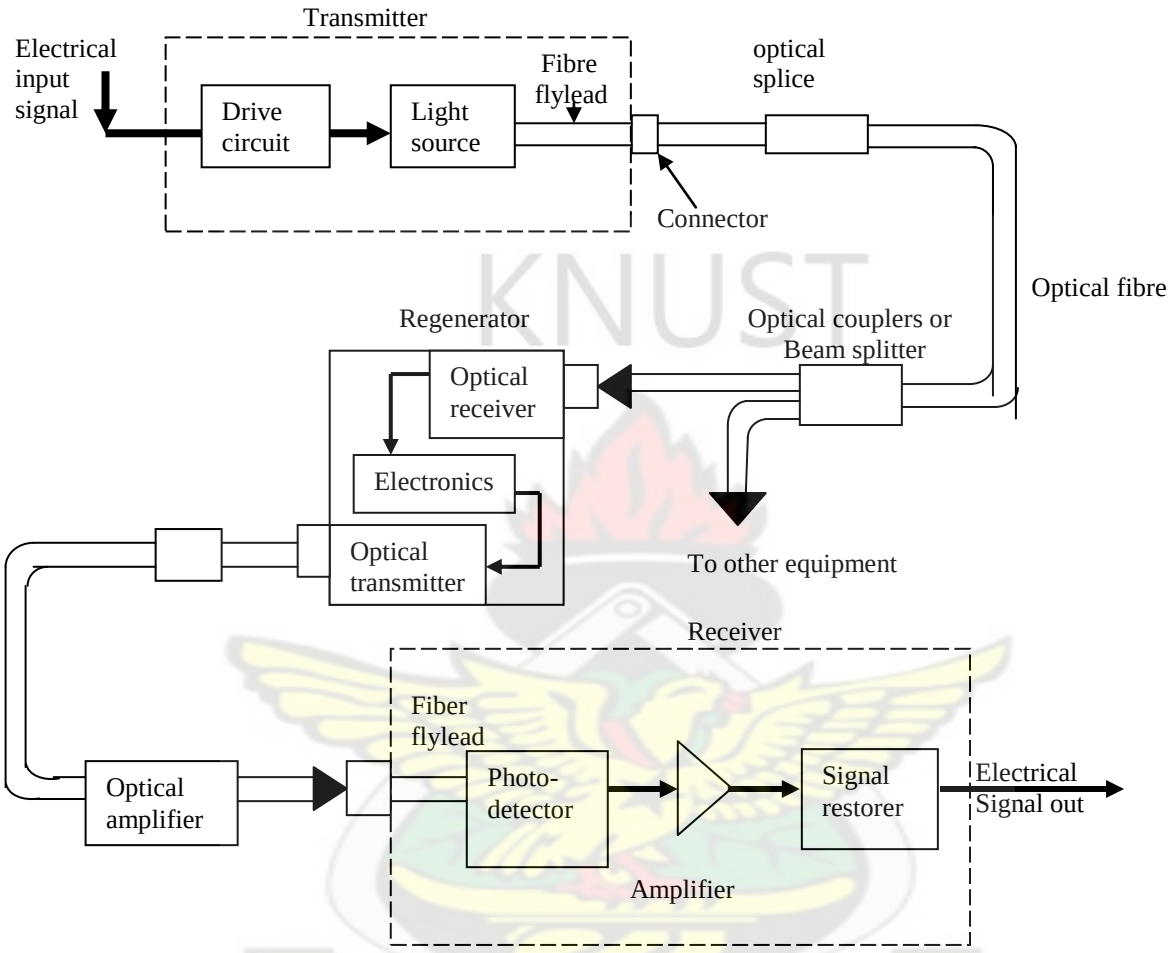


**Figure 2.9 Major elements of a fibre optic transmission link. (A. B. Carlson, 1986)**

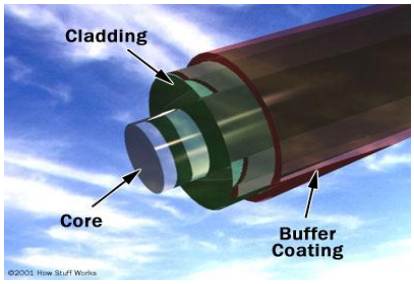


**Figure 2.10 Lingering materials within the core and the cladding help to cause absorption. Image retrieved from http://www.howstuffworks.com/fiber_optic1.htm**



## Scattering in Fibre Optics

Scattering, another significant aspect of attenuation, occurs when atoms or other particles within the fibre spread the light. This process differs with absorption in that, for the most part, foreign particles on the fibre are not absorbing the light, but the light signal bounces off the particle rather than the fibre's wall and spreads the signal in another direction (Single-Mode, 2000).

For glass fibres, the foremost type of scattering is Rayleigh scattering, which somewhat contrasts with the accepted definition of scattering. With this process, atoms or other particles within the fibre fleetingly absorb the light signal and instantly re-emit the light in another direction. In this way, Rayleigh scattering appears very much like absorption, but it absorbs and re-directs the light so quickly that it is considered scattering (Hecht, 2000).

Both scattering and absorption are cumulative, in that they keep building up. Light is absorbed and scattered continuously, so the signal at the end of the fibre is almost never exactly the same signal as it was at the beginning. However, for the most part, the signal loss is minimal and does not greatly hinder the communication.

## Bending losses

Radiative losses occur whenever an optical fibre undergoes a bend of finite radius of curvature (Love, 1989; Faustini and Martini, 1997). Fibres are subject to two different types

of bends, which are:

- Macroscopic bends having radii that are large if compared to the fibre diameter, an example is; such as those that occur when fibre cables have to turn a corner
- Random microscopic bends of the fibre axis that can arise when the fibres are integrated into cables. (G. Keiser, 2000)

Most of the telecommunication companies in the world are using optical fibre to transmit telephone signals, Internet communication, and cable television signals. Examples of such countries are the United State of America (USA), England, and The Netherlands. Due to much lower attenuation and interference, optical fibre has large advantages over existing copper wire in long-distance and high-demand applications. However, infrastructure development within cities is relatively difficult and time-consuming, and fibre optic systems were complex and expensive to install and operate. Due to these difficulties, fibre optic communication systems have primarily been installed in long-distance applications, where they can be used to their full transmission capacity, offsetting the increased cost. Since 2000, the prices for fibre-optic communications have dropped considerably. The price for rolling out fibre to the home has currently become more cost-effective than that of rolling out a copper based network (K. Wieland, 2006).

**Advantages**

When it comes to telecommunication Fibre Optic cables have more advantages than the other medium of transmission therefore making it far better than the other mediums even though it has some disadvantages. Some of the advantages of Fibre Optic cable are as follows:

- Fibre optic cables have a much greater bandwidth than metal cables (UTP). For example, a single copper pair conductor can carry six phone calls. A single fibre pair can carry more than 2.5 million phone calls simultaneously (Federals Communications Commission, 2009).
- Fibre optic cable is less susceptible to signal degradation than copper wire.
- Fibre optic cables weigh less than a copper wire cable.
- Data can be transmitted digitally.

- Lower-power transmitters can be used instead of the high-voltage electrical transmitters used for copper wires.
- Unlike electrical signals in copper wires, light signals from one fibre do not interfere with those of other fibres in the same cable.
- Because no electricity is passed through optical cable it is non-flammable, and immune to lightning.
- Impossible to tap into a fibre optics cable, making it more secure

**Disadvantages**



Some of the disadvantages of the fibre optics cable are:

- Fibre optic cables are expensive to install.
- The termination of a fibre optics cable is complex and requires special tools.
- They are more fragile than coaxial cable.

In conclusion, the fibre optic is the best since it can cover a longer distance and also has a higher speed and does have little or no electromagnetic interference, even though it has its own limitations compared to the UTP cables, coaxial cables and wireless.

The speeds of fibre optic and copper cables are both limited by length, but copper is much more sharply limited in this respect. For example, gigabit Ethernet runs over relatively economical category 5e, category 6, or augmented category 6 unshielded twisted pair copper cabling but only to 100 meters. However, over the right kind of fibre, gigabit Ethernet can easily reach distances of tens of kilometres.

Fibre is often said to be 'future proof' because the speed of the broadband connection is usually limited by the terminal equipment rather than the fibre itself, permitting at least some speed improvements by equipment upgrades before the fibre itself must be upgraded.

## 2.6 Vodafone Infrastructure

### 2.6.1 In Ghana

The Vodafone infrastructures in Ghana include the following:

- Switches (Exchange): These switches channel incoming data from any of multiple input ports to the specific output port that will take the data toward its intended destination.
- DSLAM (Digital Subscriber Line Access Multiplexer): The DSLAM is a network device; it receives signals from multiple customer Digital Subscriber Line (DSL) connections and puts the signals on a high-speed backbone line using multiplexing techniques.
- Main Distribution Frame (MDF): Cables from the outside network plant (OSP) are terminated on one side of the MDF which is often referred to as the vertical side. At the other side of the MDF known as Intermediate distribution frame (IDF) also referred to as the horizontal side, PCM cables from the switch are terminated on the tag block. An MDF connects external lines and trunks from the public network on one side (vertical) and internal cables on the other (horizontal). Jumper wires with a cable gauge of about 0.5mm are often used to loop the line from the OSP and the switch for effective communication connection to be established.
- Cabinets: Often referred to as the cross connection point (CCP) is a 3m by 3m square structure where the underground cables from the Exchange through the various duct routes are terminated.
- Distribution Point (DP): A point where the UTP cables terminate, this provides a point of entry for field technicians or serves as an interface between the cabinet and the customer premises where a drop wire is used to connect a line from the DP to the customer premises.
- Unshielded Twisted Pair (UTP): It is composed of two unshielded wires twisted around one another.
- ADSL Modem: A device that comprises both a modulator that changes a signal in some way in the forward direction and a demodulator that changes the signal back to its original form in the backward direction, essentially reversing the modulation process
- Drop wires: A pair of wire which is suitable for extending the UTP cable from the Distribution Point to a customer's house or building for connection, either to a telephone or a modem.

### 2.6.2 In Cape Coast

Almost all the infrastructure in all the Vodafone branches are the same. The only difference is the Main branch has more infrastructure than the rest of exchanges.

## 2.7 ADSL Equipment

ADSL uses two pieces of equipment, one on the customer end and one at the Internet service provider (ISP), Telephone Company or other provider of DSL services. At the customer's location there is a DSL transceiver, which may also provide other services. The DSL service provider has a DSL Access Multiplexer (DSLAM) to receive customer connections. The diagram below shows a basic connection of a broadband from the central office to the customer premises.

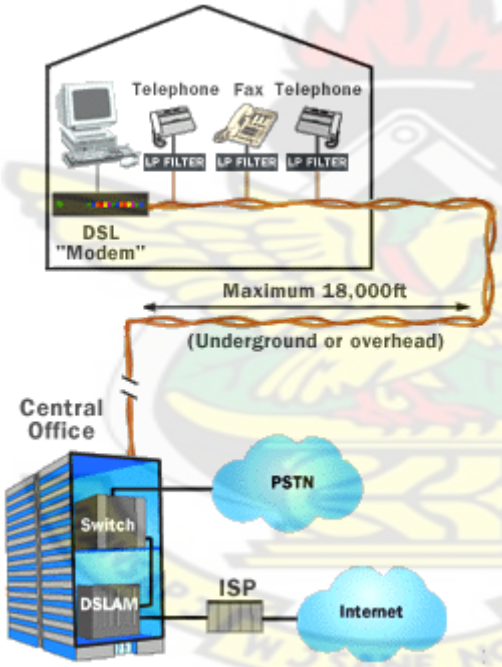


**Figure 2.11 How DSL works (HowStuffWorks, 2001)**

### Transceiver

Mostly, the DSL transceiver is called a "DSL modem." (see figure 2.12) It is the point where data from the user's computer or network is connected to the DSL line.


**Figure 2.12 DSL modem**

The transceiver can connect to a customer's equipment in several ways, though most residential installation uses USB or 10 base-T Ethernet connections. While most of the ADSL transceivers sold by ISPs and telephone companies are simply transceivers, the devices used by businesses may combine network routers, network switches or other networking equipment in the same platform.

**The DSLAM**

The DSLAM at Vodafone is the equipment that really makes the DSL to function; A DSLAM takes connections from many customers and aggregates them onto a single, high-capacity connection to the Internet. DSLAMs are generally flexible and able to support multiple types of DSL in a single central office. In addition, the DSLAM may provide additional functions including routing or dynamic IP address assignment for the customers.

The DSLAM provides one of the main differences between user service through ADSL and through cable modems. Because cable-modem users generally share a network loop that runs through a neighbourhood, adding users means lowering performance in many instances. ADSL provides a dedicated connection from each user back to the DSLAM, meaning that users won't see a performance decrease as new users are added -- until the total number of

users begins to saturate the single, high-speed connection to the Internet. At that point, an upgrade by the service provider can provide additional performance for all the users connected to the DSLAM.

**Vodafone Cable Network Diagram**

The cable network diagram of the Cape Coast Exchange is shown in figure 2.17.

**LEGEND**


Cabinet, N meaning number



Manhole

Each of the numbers in the diagram has its own meaning in terms of cabling, an example is **01-2400/0.4.** The **01** is a cable number which is used to identify the type of cable among other cables of the same size. The 2400 represent the number of pairs in the cable; this means that UTP cables of this size can be used to provide telephone service to 2400 customers. The 0.4 is the thickness or the gauge of the cable. Each manhole is identified with a number, examples is, F2 -1001or S4 -4001.

As mentioned earlier, the type of cable mostly used in telecommunication and for that matter Vodafone is UTP Cable. The cable is terminated from the Exchange, through the various duct route to the cabinets and finally to the Distribution Point (DP). Cable ends are joined in the manholes. The UTP Cables are good to use when it comes to telecommunication, because they are cheap as compared to other types of cable and also easy to install. However, with the increasing number of broadband customers and technology advancement the UTP cable will not be reliable as a means of providing a high speed internet service to customers. People who lived outside the 9 km radius from the telecom exchange hardly get access to the broadband especially in the Central Region. This inefficiency and unavailability of good service could be overcome if other type of cable such as fibre optic is used as a medium to provide the service.

### 2.8 Fibre to the Cabinet

To help in improving the ADSL (broadband) service, we believe using Fibre Optics will be a better solution. Running Fibre Optic cables from the Exchange to the cabinet will help solve most of the problems, example the coverage, speed and the number of customers the ADSL service can take at this moment. Fibre to the cabinet (FTTC) is a telecommunications system based on fibre optic cables run to a platform that serves several customers. Here in Ghana each customer has a connection to this platform through unshielded twisted pair.

Fibre to the cabinet allows delivery of broadband services such as high speed internet. High speed communications protocols such as broadband cable access or some form of DSL are used between the cabinet and the customers. The data rates vary according to the exact protocol used and according to how close the customer is to the cabinet.

FTTC is lightly distinct from Fibre to the node (FTTN) or Fibre to the home (FTTH). The main difference is the placement of the cabinet. FTTC is placed near the cabinet which differs from FTTN which is placed far from the customer and FTTH which is placed right at the serving location, that is, the customer's home, office, etc.

Unlike the fibre to the home (FTTH) technology, fibre to the cabinet can use the existing unshielded twisted pair infrastructure from the cabinet to the customer's place to provide last mile service. For this reason, fibre to the cabinet costs less to deploy. However, it also has lower bandwidth potential than fibre to the home.

### 2.8.1 Applying the Analysis in Vodafone

Before the fibre optic cables can be installed, all the UTP cables from the exchange to the cabinet have to be removed, except the once from the cabinet to the Distribution Point (DP).

### 2.8.2 Cost Implication

Fibre optic cable is one of the best types of cable for telecommunication providers but it has its own disadvantages and one of them is the initial cost. Fibre optic cables are very expensive to install and because of that it makes it difficult for telecommunication companies to use hence the adoption of the UTP cables.

For Vodafone Company to install new fibre cables, requires a lot of work. All the UTP cables will have to be changed to Fibre Optic cables and this demand a lot of capital investment. For the Broadband users, changing the UTP Cables to Fibre Optic cables might bring about an increase in cost.

The literature review comprises of general information about the research (pages 7-11) and pages 11 to 39 are more relevant to the research.

# Chapter 3

# METHODOLOGY

## 3.1 Overview

The problem observed with the use of copper for Vodafone broadband service in the Cape Coast area is that as the length of the UTP cable increases the attenuation increases leading to loss of signal. Therefore, it becomes difficult for customers to get full access to the ADSL service. Because the bandwidth of the UTP cat 5e cable is at most 100MHz, the speed of the ADSL decreases at a very high rate as more customers are hooked onto it.

One objective of this research is to find means of reducing the attenuation hence losses in the broadband signal. And also questionnaires were given out to know if Vodafone customers are enjoying the Broadband service and if not what steps will be adopted to improve the Broadband (ADSL) service in Vodafone, Ghana. Each method that could be used to improve the Broadband service has its own advantages and disadvantages. The method which was dwelt on is the use of Fibre Optics. The advantages, disadvantages, and reliability of Fibre Optics are part of the objective. In order to answer the research questions we decided to obtain the views of Vodafone Broadband service users and some Vodafone workers, which are in line with this topic. A total of 110 respondents were randomly selected. 100 were Vodafone Broadband internet service users and 10 were Vodafone workers in Cape Coast. The selected participants answered a questionnaire in a structured form. The data collected were computed for interpretation. Along with primary data (questionnaire), we also made use of secondary resources in the form of published articles and literatures to support the survey results.

## 3.2 Research Design and Method

The survey research design was used for this study. According to P. Ghauri and K. Grønhaug (2005), a survey is an effective tool to get opinions, attitudes and descriptions as well as for getting cause-and-effect relationships. There are different circumstances that may influence the respondents and their reactions as well as their answers. Some of the factors that might influence respondents are:

- Sponsor: respondents may decide not to answer questions correctly when a study is sponsored or financed by a certain organization.
- Appeal: when the researcher makes an appeal to the respondents on how important it is to get answers to his or her questions and also how useful it can be to the society and the respondent if the study is carried out.
- Stimulus: when some type of reward is given to the respondent it can influence the respondent in a certain way.
- Questionnaire format: the length of the questions, the layout and also the appearance of the paper can have an influence on whether the questions will be responded to properly or not.
- Covering letter: the tone and stance of the questionnaire can have a great impact on the respondent.
- Stamped and self-addressed envelope: this will make it easier and convenient for the respondent to send the answers back to the researcher.

The basic idea behind survey methodology is to measure variables by asking people questions and then to look at the relationships among the variables. The types of survey which are commonly used are the cross-sectional design and longitudinal design. The cross-sectional design is the type where the researcher asks the respondents questions at one point in time. This kind of survey is highly weak because the researcher may or may not be able to analyze the direction of causal relationships. Adding past behaviour and future propensities items to a cross-sectional survey may help, but generally it's more useful to have a longitudinal design, which asks the same questions at two or more points in time. The three subtypes of longitudinal design are:

- the trend study, which is basically a repeated cross-sectional design, asking the same questions to different samples of the target population at different points in time
- the cohort study, which is a trend study that tracks changes in cohorts (people belonging to an organization or location who experience the same life events) over time and
- The panel study, which asks the same questions to the same people time after time. This type of longitudinal design is used for this research.

With the questionnaire type of research, it is very important that the researcher already has a

clear picture of the phenomena being investigated before the data collection procedure is carried out. We used this kind of research method to obtain first hand data from the respondents (Vodafone broadband users) in order to get logical and sound conclusions and recommendations for this research. The questionnaire approach is quick and practical in terms of the financial aspect.

In this research, the survey research design was employed so as to identify the role and significance of using questionnaire in getting information on how Vodafone broadband users see the existing broadband service and if there is a problem with the existing one, how this service can be improved. Also Vodafone staffs (mostly management) were also given questionnaires to answer, in order to find out whether the management of Vodafone have any intention of improving the broadband internet service. The questionnaire was used considering the objective to obtain first hand data from the respondents. The advantages and disadvantages of the different ways of improving the ADSL (broadband) service are also considered. The questionnaire research method is appropriate for this research since this method is used for gathering existing conditions and what can be done to improve it.

The research used one hundred Vodafone broadband service users in Cape Coast and ten Vodafone staffs in Cape Coast as respondents in order to gather relevant data; questionnaire is then appropriate as this can allow the identification of the similarities and differences of the respondents' answers. For this research, two types of data were gathered. These included the primary and secondary data types. The primary data were derived from the answers the respondents gave during the survey process. The secondary data on the other hand, were obtained from published documents and literatures reviewed that were relevant to this research. With the use of the published literatures (pages 6-47) and survey questionnaire, this research took on the combination of quantitative and qualitative approach of research. By means of using this combined approach, the advantages of both quantitative and qualitative approaches were obtained and their limitations were overcome.

### 3.3 Approaches to a Research Problem

Quantitative data collection methods are centred on the quantification of relationships between variables. Quantitative data-gathering instruments establish relationship between measured variables. The aim is to classify features, count them, and construct statistical models in an attempt to explain what is observed. Quantitative research designs are either

descriptive (subjects usually measured once) or experimental (subjects measured before and after a treatment) (Hopkins, 2002). Quantitative method relies less on interviews, observations, small number of questionnaires, focus groups, subjective reports and case studies but is much more focused on the collection and analysis of numerical data and statistics. Measurement, numerical data and statistics are the main substance of quantitative instruments. The quantitative approach is more on the detailed description of a phenomenon. The quantitative approach is primarily deductive reasoning; it basically gives a generalization of the gathered data with uncertain synthesized interpretations.

Quantitative approach is useful as it helps the researcher to prevent bias in gathering and presenting research data. For the quantitative method, the researcher knows clearly in advance what he/she is looking for and this method is recommended during latter phases of research projects. The quantitative data collection methods are useful especially when a study needs to measure the cause and effect relationships evident between pre-selected and discrete variables. The purpose of the quantitative approach is to avoid subjectivity by means of collecting and exploring information which describes the experience being studied or researched. Before data is collected all aspects of the study are carefully designed.

Quantitative methods establish very specific research problem and terms. Subjectivity of judgment, which is not needed in a thesis discussion, can be avoided through quantitative methods. Thus, conclusions, discussion and experimentation involved in the process are more objective. Variables which are both dependent and independent, that are needed in the study are clearly and precisely specified in a quantitative study. In addition, quantitative method enables longitudinal measures of subsequent performance of the respondents. According to Reichardt and Cook (1979), data collected can be generalized by population membership. The focus of the researchers utilizing the framework of the interpretative paradigm is on the investigation of authenticity, complexity, and contextualization, mutual subjectivity of the researcher and the respondent as well as the reduction of illusion.

Quantitative research method has some few disadvantages and some of them are; the quantitative method has a limited ability to look into answers. People who are willing to respond may share characteristics that don't apply to the audience as a whole, creating a potential bias in the study. Also they can be very costly.

Contrary to the quantitative method, qualitative approach involves analysis of data such as

words (e.g., from interviews), pictures (e.g., video), or objects (e.g., an artifact) (Neill, 2007). Instead of using statistical analysis, the qualitative approach utilizes content or holistic analysis; to explain and comprehend the research findings, inductive and not deductive reasoning is used. The main point of the quantitative research method is that measurement is valid, reliable and can be generalized with its clear anticipation of cause and effect (Cassell & Symon, 1994). Being particularistic and deductive in nature, quantitative method is dependent on the formulation of a research hypothesis and confirming them empirically using a specific data set (Frankfort-Nachmias & Nachmias, 1992). Qualitative research is used to help us understand how people feel and why they feel as they do. It is concerned with collecting in-depth information asking questions such as why do you say that? Samples tend to be smaller compared with quantitative projects that include much larger samples. Depth interviews or group discussions are two common methods used for collecting qualitative information. (DJS Research Ltd., 2005)

Qualitative research seeks out the 'why', not the 'how' of its topic through the analysis of unstructured information – things like interview transcripts, emails, notes, feedback forms, photos and videos. It doesn't just rely on statistics or numbers, which are the domain of quantitative researchers. Qualitative research is used to gain insight into people's attitudes, behaviours, value systems, concerns, motivations, aspirations, culture or lifestyles. Focus groups, in-depth interviews, content analysis, evaluation and semiotics are among the many formal approaches that are used, but qualitative research also involves the analysis of any unstructured material, including customer feedback forms, reports or media clips. Qualitative research is often used for policy and program evaluation research since it can answer certain important questions more efficiently and effectively than quantitative approaches. This is particularly the case for understanding how and why certain outcomes were achieved (not just what was achieved) but also answering important questions about relevance, unintended effects and impact of programs such as: "Did processes operate as expected", "Were key players able to carry out their duties" (Wikipedia, 2010). Qualitative approaches have the advantage of allowing for more diversity in responses as well as the capacity to adapt to new developments or issues during the research process itself.

Qualitative research method has some cons too. They are; qualitative method can arrive at different conclusions based on the same information depending on the personal characteristics of the researcher. It cannot investigate causality between different research

phenomena. Qualitative method has difficulty in explaining the difference in the quality and quantity of information obtained from different respondents and arriving at different, non-consistent conclusions. It requires a high level of experience from the researcher to obtain the targeted information from the respondent. The lastly, the qualitative method lacks consistency and reliability because the researcher can employ different probing techniques and the respondent can choose to tell some particular stories and ignore others.

### 3.4 Participants

In order to determine whether the Vodafone broadband service needs to be improved or not, a total of 100 Vodafone broadband service users and 10 Vodafone staffs were given questionnaires to answer. In order to achieve relevant information, certain important measures were to be taken. The respondents who were qualified for the sample selection were customers who were using Vodafone ADSL (broadband) service and also are above eighteen years of age. Ten Vodafone staffs were also selected in Cape Coast. This qualification ensured that the respondents understand the questionnaire very well and the reason behind it was easier for them to answer the questionnaires. These Vodafone broadband internet service users were given questionnaires in their home and offices. The study also aimed to determine whether there are other internet services in Ghana and if so, are some of these internet services better than the Vodafone broadband service?

### 3.5 Instruments

The survey questionnaire was used as the main data-gathering instrument for this study. Some of the questions were structured and a few were unstructured, the respondents were to fill the unstructured ones themselves. The questionnaire for the Vodafone broadband service customers contained twenty questions (see Appendix A). The questionnaire was divided into two sections: a profile and the survey. The profile contains only the age of the customer. The survey explored the reason why the customers purchased the Vodafone broadband internet service and whether they are enjoying the service or not particularly in terms of speed, reliability and availability. The survey section also contains questions that identify the type of Vodafone broadband service the respondents are using and what they are using it for. The respondents were also asked whether they know of any other internet service and if they have used some of them before, and if yes whether any of them was better (in terms of speed, reliability and availability) than the Vodafone broadband internet service. In this

questionnaire, the choices for each question are different. Some of the choices were good, very good, bad and very bad, some of the choices were yes, no, etc.

The questionnaire for the Vodafone staffs contained ten questions (see Appendix B). This questionnaire is also divided into two sections: a profile and the survey. The profile section contains the number of years the worker has worked in Vodafone, and the section of Vodafone the person is working. The survey section contains questions that identify the types of options which are available in improving the Vodafone broadband internet service and what other internet services are available in Vodafone. The respondents were also asked if the Vodafone Company has considered the use of fibre optic cables in telecommunication and the advantages to be derived.

# Chapter 4

# DATA ANALYSIS

## 4.1 Introduction

This research was conducted in order to know if the Vodafone broadband users are enjoying the service and also to determine the best way of making it possible to increase the coverage of the Vodafone broadband service, increase the speed of the service and also to make the service more reliable. The descriptive method of research was applied. Through quantitative and qualitative approaches, a questionnaire that would gather important data was developed. Literatures to support the findings were also reviewed and included. After gathering all the completed questionnaires from the respondents (sample of Vodafone broadband users and Vodafone staffs), the entire responses for each item were obtained. The answers given by the one hundred and ten (110) selected respondents were then presented in tables to facilitate the analysis. The results for each question were then computed to find the weighted average (mean). Weighted mean is the average wherein every quantity to be averaged has a corresponding weight. To compute the weighted mean, each value must be multiplied by its weight. Products should then be added to obtain the total value. The total weight should also be computed by adding all the weights. The total value is then divided by the total weight. For example, from table 4.1 the weights are 1, 2, 3 and 4 and the values are 10, 49, 28 and 13. Hence, the weighted mean will be [(1*10) + (2*49) + (3*28) + (4*13)] / (10+49+28+13) = 2.44. This means most of the customers are within the ages of 18 to 35.

## 4.2 Survey Results

Below are the tables summarizing the gathered values for each question category (questionnaire for the sampled Vodafone broadband users); questions asked are indicated against each table.

1. What is your age?

**Table 4.1 Ages of the broadband users**

| AGES OF RESPONDENTS | NUMBER OF RESPONDENTS | PERCENTAGE |
|---|---|---|
| Below 18 | 10 | 10% |
| 18 – 35 | 49 | 49% |
| 36 – 45 | 28 | 28% |
| 46 and above | 13 | 13% |
| **Total** | **100** | 100% |
| **Weighted Mean** | **2.44** | |



2. Are you enjoying the Broadband internet service?

**Table 4.2 Response to whether the customers are enjoying the broadband service**

| RESPONSE | NUMBER OF RESPONDENTS | PERCENTAGE |
|---|---|---|
| Yes | 34 | 34% |
| No | 66 | 66% |
| **Total** | **100** | 100% |
| **Weighted Mean** | **1.66** | |

3. If answer to question 1 is **No**, what do you suggest should be done?

**Table 4.3 What the broadband users want to be done on the Broadband service**

| SUGGESTION | NUMBER OF RESPONDENTS | PERCENTAGE |
|---|---|---|
| Improve upon the speed | 59 | 89.40% |
| Reduce the price | 7 | 10.60% |
| **Total** | **66** | 100% |
| **Weighted Mean** | **1.11** | |



4. Which type of Broadband service are you using?

**Table 4.4 Types of broadband services in Vodafone**

| TYPES OF BROADBAND SERVICE | NUMBER OF RESPONDENTS | PERCENTAGE |
|---|---|---|
| Lite | 27 | 27% |
| Residential | 45 | 45% |
| Business | 12 | 12% |
| Business Plus | 6 | 6% |
| Business SOHO | 2 | 2% |
| Business Plus Pro | 0 | 0% |
| School | 8 | 8% |
| **Total** | **100** | 100% |
| **Weighted Mean** | **2.43** | |

5. What exactly are you using the broadband service for?

**Table 4.5 What the broadband users use the service for**

| USE OF THE BROADBAND SERVICE | NUMBER OF RESPONDENTS | PERCENTAGE |
|---|---|---|
| School | 8 | 8% |
| Personal use | 72 | 72% |
| Internet Cafe | 20 | 20% |
| Other | 0 | 0% |
| **Total** | **100** | 100% |
| **Weighted Mean** | **2.12** | |

6. Who installed your broadband for you?

**Table 4.6 Installation of broadband by various group of people**

| BROADBAND INSTALLATION | NUMBER OF RESPONDENTS | PERCENTAGE |
|---|---|---|
| Vodafone staff | 100 | 100% |
| Yourself | 0 | 0% |
| Other | 0 | 0% |
| **Total** | **100** | 100% |
| **Weighted Mean** | **1** | |

7. What is the speed for the broadband service that you are using?

**Table 4.7 The speed for the broadband service the customers are using**

| SPEED OF THE BROADBAND SERVICE | NUMBER OF RESPONDENTS | PERCENTAGE |
|---|---|---|
| 128/64 Mbps | 27 | 27% |
| 256/64 Mbps | 45 | 45% |
| 512/128 Mbps | 14 | 14% |
| 1024/256 Mbps | 14 | 14% |
| **Total** | **100** | 100% |
| **Weighted Mean** | **2.15** | |



8. Why did you choose Vodafone broadband internet connection? Because it is

**Table 4.8 Reasons why the customers chose Vodafone broadband internet connection**

| REASON FOR CHOOSING THE BROADBAND SERVICE | NUMBER OF RESPONDENTS | PERCENTAGE |
|---|---|---|
| Fast | 43 | 43% |
| Cheap | 57 | 57% |
| **Total** | **100** | 100% |
| **Weighted Mean** | **1.57** | |

9. How will you rate the reliability of the broadband service?

**Table 4.9 Rating the reliability of the broadband service**

| RELIABILITY | NUMBER OF RESPONDENTS | PERCENTAGE |
|---|---|---|
| Very Bad | 0 | 0% |
| Bad | 10 | 10% |
| Good | 66 | 66% |
| Very Good | 24 | 24% |
| **Total** | **100** | 100% |
| **Weighted mean** | **3.14** | |

10. How will you rate the availability of the broadband service?

**Table 4.10 Rating the availability of the broadband service**

| AVAILABILITY | NUMBER OF RESPONDENTS | PERCENTAGE |
|---|---|---|
| Very Bad | 0 | 0% |
| Bad | 24 | 24% |
| Good | 60 | 60% |
| Very Good | 16 | 16% |
| **Total** | **100** | 100% |
| **Weighted mean** | **2.92** | |

11. Apart from the broadband service do you know of any other internet service?

**Table 4.11 Response to whether the broadband customers know of other internet services**

| RESPONSE | NUMBER OF RESPONDENTS | PERCENTAGE |
|---|---|---|
| Yes | 57 | 57% |
| No | 43 | 43% |
| **Total** | **100** | 100% |
| **Weighted Mean** | **1.43** | |

12. Have you used any of these internet services before?

**Table 4.12 Response to whether the broadband users have used other internet services before**

| RESPONSE | NUMBER OF RESPONDENTS | PERCENTAGE |
|---|---|---|
| Yes | 36 | 63% |
| No | 21 | 37% |
| **Total** | **57** | 100% |
| **Weighted Mean** | **1.37** | |

13. Which internet service is that?

**Table 4.13 Other internet services the broadband customers have used before**

| OTHER INTERNET SERVICES | NUMBER OF RESPONDENTS | PERCENTAGE |
|---|---|---|
| Kasapa | 7 | 19% |
| MTN | 11 | 31% |
| Vodafone (stick) | 12 | 33% |
| Zain | 5 | 14% |
| Tigo | 1 | 3% |
| **Total** | **36** | 100% |
| **Weighted Mean** | **2.5** | |

14. Was that internet service better than the broadband service?

**Table 4.14 Comparing the Vodafone broadband service to the other internet services**

| RESPONSE | NUMBER OF RESPONDENTS | PERCENTAGE |
|---|---|---|
| Yes | 7 | 19.44% |
| No | 29 | 81.67% |
| **Total** | **36** | 100% |
| **Weighted Mean** | **1.81** | |

15. How long have you used the broadband service?

**Table 4.15 Duration of use of broadband service**

| RESPONSE | NUMBER OF RESPONDENTS | PERCENTAGE |
|---|---|---|
| For a long time ( 2 years and above) | 42 | 42% |
| Not for long ( less than 2 years) | 58 | 58% |
| **Total** | **100** | 100% |
| **Weighted Mean** | **1.58** | |

16. Who introduced you to the broadband service?

**Table 4.16 How the broadband customers got to know about the service**

| HOW CUSTOMERS GOT TO KNOW ABOUT THE BROADBAND | NUMBER OF RESPONDENTS | PERCENTAGE |
|---|---|---|
| A friend | 35 | 35% |
| A colleague | 37 | 37% |
| No one | 28 | 28% |
| **Total** | **100** | 100% |
| **Weighted Mean** | **1.93** | |

17. Where do you live?

**Table 4.17 Where the Vodafone broadband users stay**

| WHERE CUSTOMERS STAY | NUMBER OF RESPONDENTS | PERCENTAGE |
|---|---|---|
| Far from Vodafone (6km and below) | 24 | 24% |
| Closer to Vodafone (above 6km) | 76 | 76% |
| **Total** | **100** | 100% |
| **Weighted Mean** | **1.76** | |

18. At what time of the day do you experience constant browsing?

**Table 4.18 Time of the day the customers experience constant browsing**

| RESPONSE | NUMBER OF RESPONDENTS | PERCENTAGE |
|---|---|---|
| In the morning | 13 | 13% |
| In the Afternoon | 9 | 9% |
| In the evening | 42 | 42% |
| At Night | 36 | 36% |
| **Total** | **100** | 100% |
| **Weighted Mean** | **3.01** | |

19. What type of computer are you using?

**Table 4.19 Type of computers the broadband users use**

| TYPES OF COMPUTERS | NUMBER OF RESPONDENTS | PERCENTAGE |
|---|---|---|
| Desktop (Pentium 2) | 4 | 4% |
| Desktop (Pentium 3) | 5 | 5% |
| Desktop (Pentium 4) | 31 | 31% |
| Laptop | 60 | 60% |
| **Total** | **100** | 100% |
| **Weighted Mean** | **3.47** | |

20. How often do you use the internet?

**Table 4.20 How often the internet is used**

| RESPONSE | NUMBER OF RESPONDENTS | PERCENTAGE |
|---|---|---|
| Everyday | 68 | 68% |
| Once a while | 32 | 32% |
| **Total** | **100** | 100% |
| **Weighted Mean** | **1.32** | |

For the ten questionnaires given to the sampled Vodafone staffs in Cape Coast, different answers were given. Each respondent was asked to give his/her own opinion. These are the questions asked and answers given by the respondents.

1. How many years have you worked in Vodafone?

From the answers given, nine of the staffs in Vodafone, Cape Coast have worked for more than six years in Vodafone and one has worked for less than six years. This can be concluded that most of the workers in Vodafone, Cape Coast have worked there for a long time and for that reason they know much about the broadband service and have an idea of what can be done to improve the service and also the problems the company is facing in improving the broadband service.

2. In which section of Vodafone do you work?

Eight of the respondents are working with the Technology section (Fixed Access Network / BB4U&Data Services) and two of the respondents are working with the Customer (Care4U) section. Most of the questionnaires were given to the staffs in the Technology section because they know much about Telecommunication.

3. Do you use Vodafone broadband internet service?

Eight of the respondents are not having broadband internet service in their homes but they are using other internet connections like the Vodafone mobile internet. Only two are using the broadband service. This can be concluded that majority of the Vodafone workers in Cape Coast are not using the broadband service.

4. Which options are available for improving the broadband service?

These are the options given by the respondents:

- The old cables need to be changed
- Using fibre optics
- Changing the modems
- Using wireless broadband

5. Apart from broadband service are there any other internet services in Vodafone? What are they?

Apart from the broadband service, there are other internet services in Vodafone, and they are:

- Mobile internet
- Dial-up
- Lease circuit for data
- Dedicated internet

6. Is your company considering the use of fibre optics in Telecommunication?

All the ten respondents said the Vodafone Company is considering the use of fibre optic cables for improving the broadband service.

7. What do you think will be the benefits of using fibre optics in Telecommunication?

These are the benefits given by the respondents:

- The noise will reduce (attenuation will reduce)
- Will help make the broadband service faster
- Unlimited and Guaranteed bandwidth
- The bandwidth will increase
- Telecommunication will be more reliable

8. What problems is Vodafone facing in improving the reliability of the Broadband internet service?

- Limited resources
- Cables are sometimes stolen
- Their drop wires too are sometimes stolen
- Mostly due to the quality of existing copper lines

9. What problems is Vodafone facing in terms of coverage?

The company is facing some problems in terms of coverage. Some of them are:

- Litigation on lands acquired for building of cell sites.
- Limited availability of fixed access network
- Wireless network is addressing this issue gradually, though expensive for the end

user.

- Unavailability of electricity.
- legal problems

10. In terms of population, what percentage of Central Region has the broadband coverage?

Each respondent gave a different answer to this question. The answers are as follows:

30%, 5%, 25%, 25%, 30%, 15%, 10%, 15%, 25%, 20%

The mean is 20%.



**4.3 Discussion**

The results of the survey are discussed in relation to the objectives of this research. Specifically, if broadband users are really enjoying the service, the level of reliability and availability of the broadband service, the options available in improving the ADSL service as well as the benefits of using fibre optics in telecommunication.

**The Sampled ADSL (Broadband) Users**

Table 4.1 shows that most of the Vodafone broadband users are between the ages of eighteen to thirty-five. Only a few are below eighteen.

Table 4.2 shows that most of the broadband users are not enjoying the service.

Table 4.3 shows that most of the broadband users who are not enjoying the service will like the speed of the broadband service to be increased. Some will also like the prices to be reduced.

Table 4.4 shows that a greater number of the broadband users are interested in the residential type of broadband.

Table 4.5 shows that most of the broadband users use the service for personal use.

Table 4.6 shows that all the broadband installation done in the customers place were done by Vodafone staffs

Table 4.7 shows that most of the broadband users are using the services with the speed of 256/64 Mbps.

Table 4.8 shows that compared to other internet connections, some of the broadband users went in for the broadband because it is faster but most of the users went in for the broadband because it is cheap.

Table 4.9 shows that majority of the broadband users believe the reliability of the service is good but not very good.

Table 4.10 shows that majority of the broadband users believe the availability of the service is good but not very good. Meaning it is not always ready for use.

Table 4.11 shows that apart from the broadband service most of the broadband users know about other internet services.

Table 4.12 shows that not all the broadband users who know about other internet services have used them before. Although majority of them have used or are still using other internet connections.

Table 4.13 shows that Vodafone mobile internet and MTN internet service users are more than those using the other internet connections.

Table 4.14 shows that most of the broadband internet users believe that even though, the broadband is slow it is faster than the other internet connections

Table 4.15 shows that most of the users in Cape Coast have not used the broadband service for long.

Table 4.16 shows that most of the broadband users got to know about the broadband service through colleagues. Some also got to know about it through friends, adverts, etc.

Table 4.17 shows that only a few broadband users live farther from 6 km radius from the Exchange (Vodafone). These are the people who experience the attenuation the most.

Table 4.18 shows that most of the broadband users experience constant browsing in the evenings and in the night. Some of them also experience constant browsing in the morning

and in the afternoons.

Table 4.19 shows that most of the broadband users use laptops. This means that their computers have nothing to do with the reason why the broadband internet service is slow.

Table 4.20 shows that most of the broadband users use the broadband every single day.

Based on the results of the survey, the selected respondents were able to identify some of the problems they are having with the broadband service and also the respondents were able to identify specific factors that contribute to how the broadband service can be. The findings indicated that most of the Vodafone broadband users are around the ages of eighteen to forty-five, only a few are above forty-five years. Most of the respondents are not really enjoying the broadband service and their major problem is the speed of the broadband is very slow. Even though, there are different types of broadband service most of the users are interested in the Residential one which is for personal use. Here in Ghana, most people need the internet during the day to do their work but most of the time the internet service is very slow, in order to get constant browsing one has to wait till evening which is a very big disadvantage. Though, most of the customers leave close to the Exchange, some of these customers also stay a little farther from the Exchange and these people are the ones who normally experience very slow internet service. Among the given factors, the respondents believe that even though, the Vodafone broadband service is cheaper compare to other internet services, its speed is not so good therefore making it less reliable and available.

**The Sampled Vodafone staffs (Cape Coast)**

Based on the data gathered from the questionnaires given to the Vodafone staffs, most of the staffs believe that there are different ways of making the broadband service better since most of the staffs have worked with Vodafone for more than six years. Most of the sampled workers suggested that using fibre optics instead of UTP cables is the best option and the Vodafone Company is even considering that. The company is also having problems with the improvement of the reliability of the broadband service, example, UTP cables and drop wires are sometimes stolen. The last but not the least, expanding their coverage, at this moment is also a problem. Some of the problems the company is facing are, some of the places in the Central Region have problems with electricity. In this case, making the ADSL (broadband) service better is not going to be an easy task.

# Chapter 5

## Conclusion

This study is focused on investigating the ADSL service in Vodafone and therefore come up with remedies , in the Cape Coast area so that people staying farther from the 9km radius from the Exchange could get access to the broadband Internet service. Again, the study is aimed at making it possible for more customers to be connected to the broadband without the speed of the internet service being affected and also to help in increasing the speed of the Vodafone broadband service. Primary and secondary resources were used in the study. Secondary resources derived from various publications including books and journals were included to support the findings. There are different ways of improving the ADSL service (as discussed in Chapter 2), and each of them has its own pros and cons. Table 5.1 shows the different types of cables available for telecommunication and their advantages and disadvantages.

| **Media Type** | **Maximum Segment Length** | **Speed** | **Cost** | **Advantages** | **Disadvantages** |
|---|---|---|---|---|---|
| UTP | 100 m | 10 Mbps to 1000 Mbps | Compared to the STP, Coaxial and Fibre Optic cables, UTP is the least expensive | Easy to install; widely available and widely used | Susceptible to interference; can cover only a limited distance |
| STP | 100 m | 10 Mbps to 100 Mbps | More expensive than UTP but cheaper than the Coaxial cable and Fibre Optic cable | Reduced crosstalk; more resistant to EMI than Thinnet or UTP | Difficult to work with; can cover only a limited distance |
| Coaxial | 500 m (Thicknet) | 10 Mbps to 100 Mbps | Relatively inexpensive, but more | Less susceptible to EMI | Difficult to work with limited |

| | | | | | |
|---|---|---|---|---|---|
| | 185 m (Thinnet) | | costly than UTP and STP | interference than other types of copper media | bandwidth; limited application damage to cable can bring down entire network |
| Fibre Optic | 10 km and farther (single-mode)<br><br>2 km and farther (multimode) | 100 Mbps to 100 Gbps (single mode)<br><br>100 Mbps to 9.92 Gbps (multimode) | Compared to the UTP, STP and Coaxial cables, Fibre Optics is the most expensive | Cannot be tapped, so security is better; can be used over longer distances; has a higher data rate than coaxial and twisted-pair cable | Difficult to terminate |

**Table 5.1 Different types of cables**

This research also aimed to identify how the Vodafone broadband users feel about the present broadband internet service and also what the Vodafone staff think can be done to improve the service and also the problem their facing in improving the broadband service. This was done by sampling the Vodafone broadband users and the Vodafone staff in Cape Coast and giving them questionnaires to fill. This questionnaire was used for data gathering. The answers given by the respondents were processed by computing their corresponding weighted averages. The results of the computation were then used as basis for the data analysis.

Based on the results of the survey, it will be better to use Fibre Optics in enhancing the Vodafone ADSL service. Even though, UTP cables are cheap and easy to install when it comes to ADSL services it has a lot of disadvantages therefore discouraging lot of people from using this Vodafone service. In order to enhance the ADSL service using Fibre Optic cables instead of UTP cables will be the right solution.

The age of optical communications is a new era. In almost every way, fibre optic cable is the ideal cable for data transmission. Not only does this type of cable accommodate extremely

high bandwidths, but it also supports durable cables and cable runs as long as several kilometres. Data travels at the speed of light, obviously wireless transmission is not compatible with its speed because microwave has less bandwidth and speed than fibre (M. Ahsan, 2000). The centre conductor of fibre optic cable is a fibre that consists of highly refined glass or plastic designed to transmit light signals with little loss. A glass core supports a longer cabling distance, but a plastic core is typically easier to work with. The fibre is coated with a cladding that reflects signals back into the fibre to reduce signal loss. Fibre optic cable also has a plastic sheath which protects the fibre from corrosion and also to prevent the entrance of water, humidity and hydrogen gas into the fibre.

Fibre optic cables have a bandwidth and information capacity which is thousand times greater than that of copper circuits, making the bandwidth of the fibre virtually unlimited coupled with a long reach. This makes it "future safe," or a standard medium that will be in place for a long time to come; fibre optics may soon provide us with all the communication technology we could want in a lifetime, at a cost efficient price.

Despite these benefits, fibre optic cables have certain drawbacks. Fibre optic cables are expensive compared to the other cables but in many years to come almost every telecommunication company in every country will be using the fibre optics because of that it will be a very good investment in the long run. Changing cables in Vodafone will mean their workers have to be trained on how fibre optic cables work and how these cables have to be installed. Training the staffs will involve lots of money. Using an expensive cabling like Fibre optics in telecommunication might mean increase in the payment of the broadband service. Vodafone broadband user would have to pay a little more for their broadband service since fibre optics are very expensive and the company will not like to run at a loss.

In general, using Fibre optic cables is the best way of improving the Vodafone ADSL (broadband) service. Any new communication system that does not use fibre optics, or consider its use, is obsolete even before it has been built. It is apparent that the average technician may also become superseded if he or she fails to master fibre optics. After all, the technician will be responsible for repairing and maintaining fibre optic systems wherever they are used, not the engineer.

## 5.1 Research Question

The main research question which needs to be answered is:

What can be done to enhance the quality of ADSL service in Vodafone?

**Research Sub-question 1**

What are the options available for improving the quality of the ADSL service?

In chapter 2, we discussed the various ways of improving the Vodafone ADSL service. Different literature were reviewed. Each of them tells us the different ways of improving the service and their advantages and disadvantages. In chapter 3 and 4, we discussed how data was collected from the Vodafone staffs in Cape Coast who were sampled by using a questionnaire. These respondents were asked if there are other options available for improving the ADSL service and what these options are. Each of them gave a different answer to that question.

**Research Sub-question 2**

Which of these options is the best?

After reviewing the literature and also collecting data from the sampled respondents (both the Vodafone broadband users and Vodafone staffs in Cape Coast) it was concluded that changing the UTP cables to fibre optic cables from the Exchange to the cabinet is a very good option of improving the ADSL (broadband) service. People staying farther from the 9km radius from the Exchange will get the chance to use the ADSL service, the speed of the broadband service will enhance and also more customers can be connected to the broadband service without affecting the speed greatly.

**Research Sub-question 3**

How does this option affect Vodafone?

As stated earlier in this chapter, Fibre optic cables are very expensive compared to the other

cables meaning Vodafone will have to invest more in cabling. Changing from UTP cables to fibre optic cables will need lot of work. Changing cables in Vodafone will also mean their workers have to be trained on how fibre optic cables work and how these cables have to be installed and this will involve lots of money. But in many years to come almost every telecommunication company in every country will be using the fibre optics because of that it will be a very good investment in the long run.

### 5.2 Discussion

There were some limitations in this study. Data used for this research was limited to only Vodafone broadband users in the Cape Coast area of the Central Region although hopefully this should give a good representation of the whole country. Giving out the questionnaires to the Vodafone broadband customers was not that easy. It wasn't every customer who was willing to fill the questionnaire. Some of the respondents too were not all that sincere.

If this research can work in Cape Coast then it should be possible for Vodafone to do it for the whole country just that it will take a very long time and also cost assessment will be different.

### 5.3 Future research

The next logical step for research is using fibre-to-the-home (FTTH) in making the ADSL service in Vodafone, Ghana better. The world is advancing and new technologies are developed almost everyday. In order to make broadband users happier Vodafone Ghana has to try its best by giving their customers better connectivity. New technologies such as fibre-to-the-home (FTTH) broadband connections allow for easier use of features such as videoconferencing and also offer faster connection speed. The pressure for better connectivity is one of the main reasons providers and users are looking at fibre-to-the-home broadband connections as a potential solution. Many people believe that making FTTH technology the standard in connectivity will solve the forecasted "Web traffic jam".

Fibre-to-the-home broadband connections refer to fibre optic cable connections for individual residences. Such optic-based systems can deliver a multitude of digital information such as telephone, video, data, et cetera, more efficiently than traditional copper coaxial cable for about the same price (T. Crosby, 2008).

According to Broadband Properties Magazine (2008) FTTH broadband connections already are a reality for more than 1 million consumers in the United States, while more than 6 million in Japan and 10 million worldwide enjoy its benefits.

A key benefit to FTTH is that it provides far faster connection speeds and carrying capacity than twisted pair conductors or coaxial cable. For example, a single copper pair conductor can carry six phone calls. A single fibre pair can carry more than 2.5 million phone calls simultaneously (Federal Communications Commission)

According to some experts at the FTTH Council (2009) fibre-to-the-home connections are the only technology with enough bandwidth to handle projected consumer demands during the next decade reliably and cost effectively. The technology is already affordable, as businesses around the world are demonstrating by getting into the business as they speculate on consumer demand.

FTTH broadband connections also will allow consumers to "bundle" their communications services. For instance, a consumer could receive telephone, video, audio, television and just about any other kind of digital data stream using a simple FTTH broadband connection. Such an arrangement would be more cost effective and simpler than receiving those services using different lines, as is often the situation today.

## References


Ahsan, M. (2000) Fibre-Optic, [Online], Available: http://www.suite101.com/article.cfm/laning_retired/44738 [3 November, 2000]

Anissimov M. (2009). How does a Telephone work: Conjecture Corporation.

Bashar S. A. (2002) Fiber-Optic Telecommunication and the Economic Benefits of a Better ICT Infrastructure in the Context of Bangladesh: Bengal Telecommunication and Electric Corp.

Calson, A. B. (1986) Communication Systems, 3rd edition, New York: McGraw-Hill.

Cape Wind Association LLC (2004) Interstitial Optical Unit for Submarine Composite Cables: Perelli.

Cassel, C. and Symon, G. (1994) Qualitative Methods in Organizations Research: A Practical Guide, London: Sage Publications.

Cisco Systems, Inc. (2003) CCNA: Network Media Types, [Online], Available: http://www.ciscopress.com/articles/article.asp?p=31276 [14 Mar, 2003].

Cisco Systems, Inc. (2008) Dial-up Technologies, [Online], Available: http://www.cisco.com/en/US/docs/internetworking/technology/handbook/Dial_up.html [18 February, 2008]

Crosby T. (2008) How Fibre-to-the-Home Broadband Works, [Online], Available: http://computer.howstuffworks.com/dsl.htm. [2008]

CSGNetwork (2010) Television Frequency Table, [Online], Available: http://www.csgnetwork.com/tvfreqtable.html [5 January, 2010]

DJS Research Ltd (2005) Qualitative Research: Research Portal Ltd.

Duchesne, M. (2008) Building the Fiber-Connected Community: Broadband Properties.

Faustini, L. and Martini, G. (1997) 'Bend loss in single-mode fibers', J. Lightwave Tech., vol. 15, no. 4, pp 671-679.

Federal Communication Commission (2009) Getting Broadband: Consumer and Government Affair Bureau.

Frankfort-Nachmias and Nachmias (1992) Research Methods in the Social Sciences, 4th Edition, New York: St. Martin's Press.

Franklin, C. (2000) How DSL Works, [Online], Available: http://computer.howstuffworks.com/dsl.htm [7 August, 2000].

FTTH Council (2009) Building Fibre-to-the-Home Communities Together: Tahoe, Inc.

Graf. R. F. (1974) Dictionary of Electronics, pp 467.

Hecht, J. (2000) Absorption and scattering determine fiber attenuation: Laser Focus World.

Keiser, G. (2000) Optical Fiber Communications, 3rd edition, Singapore: McGraw-Hill.

Lenert E. M. (1998) 'A Communication Theory Perspective on Telecommunications Policy', Journal of Communication, vol. 48, no. 4, pp 3-23.

Love J. D. (1989) 'Application of low-loss criterion to optical waveguides and devices', IEE Proceedings, vol.136, no. 4, August, pp. 225-228.

Miniwatts Marketing Group (2009). World Internet Users and Population Stats, [Online], Available http://www.internetworldstats.com/stats.htm [30 September, 2009]

Nahin, P. J. (2002) Oliver Heaviside: The Life, Work, and Times of an Electrical Genius of the Victorian Age, Baltimore: Johns Hopkins University Press.

Neill, J. (2007) Qualitative versus Quantitative Research: Key Points in a Classic Debate, [Online], Available: http://wilderdom.com/research/QualitativeVersusQuantitativeResearch.html [28 February, 2007].

Paternak S. B. (2006) Toronto Hydro to Install Wireless Network in Downtown Toronto, [Online], Available: http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aQ0ZfhMa4XGQ&refer=canada-redirectoldpage [19 March, 2006].

Prescient Digital Media (2010) Finding ROI: Measuring Intranet Investment: Prescient Digital Media Ltd.

Reichardt, C.S. and Cook, T.D. (1979) Qualitative and quantitative methods in evaluation research, Beverly Hills, CA: Sage.

Samaan M. (2003) The Effect of Income Inequality on Mobile Phone Penetration: Boston University.

Sayder, A. R. and Love, J. D. (1983) Optical Wavelength Theory, New York: Chapman and Hall

SINTEF (2008) Wireless Communication, [Online], Available: http://www.sintef.no/content/page1____11881.aspx. Wireless Communication [16 March, 2008].

Stuchly, M. A. (1992) 'Health Considerations for Portable Transceivers', In *Proceedings IEEE International Conference on Selected Topics in Wireless Communications*, June, pp 409-412.

Telecommunication Union (2008) Data Communication over the telephone network, [Online], Available: http://www.itu.int/rec/T-REC-V/en. [18 February, 2008]

The International Engineering Consortium (2001) Single-Mode Fiber Performance Characteristics, [Online], Available: http://www.iec.org/tutorials/fiber_optic/topic06.html [9 July, 2001]

Wieland, K. (2006) DigiWorld: FTTH Costs Coming Down, [Online], Available: http://www.iet.ntnu.no/projects/beats/Documents/Thesis_Hekland.pdf: [November, 2006]

Wikipedia (2009) Coaxial cable, [Online], Available: http://en.wikipedia.org/wiki/Coaxial_cable [June, 2009].

Wikipedia (2009) Qualitative Research, [Online], Availability: http://en.wikipedia.org/wiki/Qualitative_research [April, 2010]

Wikipedia (2007) Twisted Pair, [Online], Availability: http://en.wikipedia.org/wiki/Twisted_pair [September, 2007]

Wikianswer (2009) What are the advantages of Coaxial cable, [Online], Available: http://wiki.answers.com/Q/What_are_the_advantages_of_coaxial_cable [2009]

Winkelman, R. (2009) An Educator's Guide to School Networks: University of South Florida.

YourDictionary (2010) Modem, [Online], Available: http://www.yourdictionary.com/telecom/modem [18 January, 2010]

## APPENDIX

### A. Questionnaire for Vodafone Broadband Customers

Your input will be greatly appreciated and it will be very helpful in developing better internet service for you.

You can be rest assured that all of the information and views that you provide will be treated in the strictest confidence and at no time will any of the information you provide be attributed directly to you.



1. What is your age?

☐ Below 18 ☐ 18 – 35 ☐ 36-45 ☐ 46 – above

2. Are you enjoying the Broadband internet service?

☐ Yes ☐ No

3. If answer to question 1 is **No**, what do you suggest should be done?

   a. Improve upon the speed
   b. Reduce the price

4. Which type of Broadband service are you using?

   a. Lite
   b. Residential
   c. Business
   d. Business Plus
   e. Business SOHO
   f. Business Plus Pro
   g. School

5. What exactly are you using the broadband service for?

   a. School
   b. Personal use

c. Cafe d. Other. _____

6. Who installed your broadband for you?

a. Vodafone staff b. Yourself

c. Other._____

7. What is the speed for the broadband service that you are using?

a. 128/64 Mbps b. 256/64 Mbps c. 512/128 Mbps

d. 1024/256 Mbps

8. Why did you choose Vodafone broadband internet connection? Because it is

a. Fast b. Cheap

c. Other_____

9. How will you rate the reliability of the broadband service?

a. Very Bad b. Bad c. Good d. Very Good

10. How will you rate the availability of the broadband service?

a. Very Bad b. Bad c. Good d. Very Good

11. Apart from the broadband service do you know of any other internet service?

☐ Yes ☐ No

12. Have you used any of these internet services before?

☐ Yes ☐ No

13. Which internet service is that?

_____

14. Was that internet service better than the broadband service?

☐ Yes ☐ No

15. How long have you used the broadband service?

_____

16. Who introduced you to the broadband service?

a. A friend b. A colleague

c. No one

17. Where do you live?

_____

18. At what time of the day do you experience constant browsing?

a. In the morning b. In the Afternoon

c. In the evening d. At Night

19. What type of computer are you using?

a. Laptop b. Desktop (Pentium 2)

c. Desktop (Pentium 3) d. Desktop (Pentium 4)

e. Other_____

20. How often do you use the internet?

a. Everyday b. Once a while

**B. Questionnaire for Vodafone Staffs**

1. How many years have you worked in Vodafone?

2. In which section of Vodafone do you work?

3. Do you use Vodafone broadband internet service?

4. Which options do you think are available for improving the broadband service?

5. Apart from broadband service are there any other internet services in Vodafone? What are they?

6. Is your company considering the use of fibre optics in Telecommunication?

7. What do you think will be the benefits of using fibre optics in Telecommunication?

8. What problems is Vodafone facing in improving the reliability of the Broadband internet service?

9. What problems is Vodafone facing in terms of coverage?

10. In terms of population, what percentage of Central Region has the broadband covered?