Computing, Information Systems
& Development Informatics Journal

Volume 3. No. 3. July, 2012

The Quality of Transmission Media, a Determinant of Network Throughput: Nigeria Unshielded Twisted Pair (UTP) Cable-Market Study

Oguntunde Toyin
Computer Science Department
University of Ibadan,
Ibadan, Nigeria
t.oguntunde@ui.edu.ng
tantos557@yahoo.com

Reference Format: Oguntunde, T. (2012). The Quality of Transmission Media, a Determinant of Network Throughput: Nigeria Unshielded Twisted Pair (UTP) Cable-Market Study. Computing, Information Systems & Development Informatics Journal. Vol 3, No.3. pp 77-82. Online at www.cisdijournal.net

cisdiJournal Computing, Information Systems & Development Informatics Journal Vol 3. No. 3, July, 2012

The Quality of Transmission Media, a Determinant of Network Throughput: Nigeria Unshielded Twisted Pair (UTP) Cable-Market Study

Oguntunde, T.

ABSTRACT

Generally, the sight of numerous kinds of cable in the Nigerian IT (Information Technology) market requires immediate alerted attention. The focus of this research paper is to look into the quality of collected samples of Unshielded Twisted Pair (UTP) cable available in Nigeria IT market by measuring some parameters or properties vis-à-vis quality of copper wire used, the wire guage (size), twist rate per meter. According to www.comprehensive.com (2009), While cables may look very similar from outside, they can be completely different on the on the inside. It continued to say that, "Construction practices, materials used, quality control and other factors all contribute to the performance of a cable". The Paper first renders a brief introduction on Unshielded Twisted Pair (UTP) cable. It then justifies the reasons why UTP, especially category 6 becomes the focus of attention out of various other UTP categories and other variety of other Network Transmission Media (cables through which electronic signals travel between a point A and another point B). The research paper also looks into the ideal qualities of a good copper-made cable for video, audio and computers. It finally presents a discussion on the analyzed parameters of collected cable samples. The conclusion is a critical summary of the research findings. This research work is necessary such that buyers of these IT products in Nigeria can be aware of some main considerations when shopping for everyday cables for video, audio and computers. It is also with the intent that the IT products regulatory bodies such as Standard Organization of Nigeria (SON) can be on the alert for sub-standard cable products.

Keywords: Quality, Transmission media, Determinant, Network throughput, Nigeria, UTP Cable Market Study.

1. INTRODUCTION

Unshielded Twisted Pair (UTP) cable is the most populous amongst all Network Transmission Media. UTP is made of eight (8) copper wires intertwined into four (4) pairs. www.comprehensivecable.com (2009) established this that, "Copper is the material of choice because of its conductive properties and flexibility which is important for cable durability. Copper is one of the basic chemical elements. In its nearly pure state, copper is a reddish-orange metal known for its high thermal and electrical conductivity, Chris Cavette (2008).

Chris continued to say that, copper is combined with zinc to produce brass and with tin to produce bronze which improves the bandwidth (the highest frequency to which a cable will perform) and capacitance. Copper was first used as early as 10,000 years ago. In the United States, the first copper mine was opened in Branby, Connecticut, in 1705 followed by one in Lancaster, Pennsylvania, in 1732. Pure copper is rarely found in nature but is usually combined with other chemicals in the form of copper ores. Chris Cavette (2008) exposited that, there are about 15 copper ores mined commercially in 40 countries around the world. The most common are known as sulfide ores in which the copper is chemically bonded with sulfur. Others are known as oxide ores, carbonate ores or mixed ores depending on the chemicals present. Many copper ores also contain significant quantities of gold, silver, nickel and other valuable metals, as well as large quantities of commercially useless material, he added.

2. WHY UTP CABLE IS THE FOCUS OF STUDY ESPECIALLY CATEGORY-6 UTP CABLE

Although UTP was once considered to be slower at transmitting data than other types of cable, this is no longer true. In fact, UTP is considered the fastest copper-based medium today, declared Cisco Systems. Moreover, Gallen Udell (2006) quoted Paul Kish (2002) as saying that, "From a performance perspective, Category 6 cabling provides twice the Bandwidth (200 MHz) and 16 times (12 dB) better than signal-to-noise margins compared with Category 5e cabling". Also, While cables may look very similar from the outside, they can be completely different on the inside. Construction practices, materials used, quality control and other factors all contribute to the performance of a cable, explained www.comprehensivecable.com (2009).

First, cable quality cannot be underestimated in successful networking because it is the medium through which data packets flow from point A to another point B on the network. Jay Potter (2002, pp.12) confirmed this by saying that, the networking environment is determined by the quality of the cable, its length, patch panels, installation practices and local electrical noise. He explained further that, one thing hampering the migration to 1000Base-T is performance problems associated with the physical layer. The Physical layer defines the electrical, mechanical and functional

specifications for establishing the physical links between systems.

Moreover the Physical Layer is made up of the cable, connectors, the physical links on the devices and the encoding/ decoding circuitry of the network devices. So, cable(s) is an issue of serious concern that is worth study especially in an open IT market like Nigeria's. Also J. Griffith et al (2000, pp.1) stated that, "However, in our experience, designers under-appreciate how strongly cable properties affect devices behavior in both experiment and simulation". Furthermore, many a times, manufacturers of cables introduce errors (intentionally or unintentionally) in the manufacture of cables. Common cable modeling errors include incorrectly determined electrical-parameter values, using lumped element representations where distributed-element representation are needed and even neglecting the cable entirely, J. Griffith et al (2000, pp.1).

This is also confirmed by www.comprehensivecable.com (2009) saying, "One thing to watch out for is some China factories and Internet importers have begun substituting a material known as copper coated steel for copper (pure). This is inferior conductive material and is not suited for audio/ video use. Copper clad steel has much poorer and does not perform nearly as well". It is used by some companies because it is much cheaper and significantly lowers the cost of the cable as a whole, www.comprehensivecable.com (2009) added.

Some manufacturers even reduce the wire guage (size) but trade-off performance to cut cost. The larger the size of the center conductor, the higher conductivity it will have because the larger the guage, the lower the resistance. The lower the resistance, the less signal loss a cable will have, the more signal that makes it to the display from the source, declared by www.comprehensivecable.com (2009, pp.1). Moreover, aside of the low cost of UTP compared with the coaxial cable and optical fiber cable, its flexibility and 10 Gigabyte throughput, UTP is also finding increasing use in video applications, primarily in security cameras. Many middle to high-end cameras include a UTP output with setscrew terminals. This is made possible by the fact that UTP cable bandwidth has improved to match the baseband of television signals, Chris Shore

Table-1: The pre-analysis information of each UTP cable sample.

S/N	Cable name	Category	Guage	Make	Standard
1.	DATATWLST	6E	Not specified	Belden	ISO/IEC/11801
2.	Super-Link	6	23 AWG	Datacom Express	EIA/TIA 568B.2/ISO/IEC 11801
3.	SYSTIMAX-G	6	Not specified	SYSTIMAX-G	Not specified
4.	NETCONNET	6E	24 AWG	SKYDUDE	Not specified
5.	NETCONNECT	6	23 AWG	AMP	Not specified
6.	E190815	6	23 AWG	DINTEK	EIA/TIA 568B.2-ISO/IEC 11801
7.	PLFS4B	6	23 AWG	AICO	EIA/TIA 568B.2
8.	NETCONNECT	6E	23 AWG	AMP	Not specified
9.	PREMISENET	6	23 AWG	KRONE	ISO/IEC 11801

3. DISCUSSION

This research work is testing for quality of UTP cable based on three parameters. Cabling performance parameters are not mysterious. They are symptoms that enable you to track down flaws that can distort and ruin the signal on twisted-pair cable. Flaws in the cable structure might be causing part of the signal to be reflected back to the source, resulting in problems there, NewRiders (2001, chap. 10, pp.4-5). NewRiders further stated that, "Expressing performance characteristics as measurable quantities makes it possible to set cable quality standards and use cable-testing equipment to detect faults". Moreover, according to Quabbin Wire and Cable (2009), "Manufacturers know that a cable pair's impedance varies very slightly along its length. This is due to small variations in manufacturing such as concentricity, diameter, quality of twisting and wall thicknesses". The three tests conducted in this research are as follows:

3.1 Elemental analysis of the sample cables

According to Hitachi Cable Manchester (2009), In the past, shortages of some materials, including those used in making plenum rated cables forced manufacturers to find alternative compounds and alternative construction methods that would allow them to continue manufacturing and to pass the appropriate UL burn tests required for plenum rated cables. These compounds have a direct impact on the speed at which a signal will travel down the conductor (Nominal Velocity of Propagation), Hitachi Cable Manchester (2009) reiterated. This was also expatiated on by ECOSSE REFERENCE CABLE that, "Impurities within the copper, including oxygen, silver, iron, sulphur, antimony, aluminum and arsenic, coalesce at the grain surface, or boundary. This creates much higher impedance to the electron flow by essentially forcing the electrons to have to 'jump' those poorly conducting boundaries where grains touch". Reducing the impurity content and the number of grains per foot can make a wire a much more efficient conductor, ECOSSE REFERENCE CABLE, concluded.

3.1.1 Methodology

1. An equal length (2 inches) of each sample cable was cut
2. The jacket of the cut cable were stripped exposing the insulated 4-pairs of UTP
3. The 4-pairs were unwound giving eight insulated wires
4. The individual wires were stripped of their rubber insulation leaving bare supposedly copper wires
5. The eight copper wire pieces were all crunched together in a cup each. The cups were arranged in circular form on a tray of Minipal 4 Spectrometer (Energy Dispensing X-ray Flourescent)
6. Steps 1 to 5 was observed for each cable sample
7. Elemental Analysis was performed on the stripped copper wires in the different cups on the tray. The findings are as displayed in table-2 below

Table-2: Elemental Analysis of 9-UTP cable samples

Cable Name	Constituent makeup (%)												
	Si	Ca	Mn	Fe	Cu	Os	Al	K	Ni	Br	Yb	S	Mo
AMP NETCONNECT	16	1.6	0.49	58.9	**21.3**	2.0	-	-	-	-	-	-	-
AICO PLFS48	13	1.4		0.58	**85.0**	-	-	-	-	-	-	-	-
BELDEN	12	0.64	-	14.2	**19.8**	-	53	0	0.38	0.05	0.6	-	-
SKYDUDE NETCONNECT	9.6	0.76	-	18.9	**33.5**	-	37	-	-	0.05	-	-	-
AMP NETCONNECT ENHANCED	12	1.2		19.8	**66.3**	-	-	0.3	-	-	-	-	-
SYSTIMAX-G	20	1.8	-	7.39	**51.9**	-	18	-	-	0.2	-	-	-
KRONE PREMISENET	13	1.1	-	0.42	**73.1**	-	13	-	-	0.1	-	-	-
DINTEK	-	-	-	-	**6.7**	-	88	-	3	0.4	2	-	-
SUPER-LINK	14	0.97	-	0.51	**70.1**	-	13	-	-	0.1	-	1	0.2

UTP cable is supposed to be made of mainly pure copper but if electroplated with tin, it improves the bandwidth and capacitance, Chris Cavette (2008). In none of these cable samples is tin or silver used to improve cable performance. Looking into table-2, most of these cable analyzed are alloyed with some other elements such as Si (Silica), Al (Aluminium), Bromide (Br) and others. It is only in cables AICO PLFS48, AMP NETCONNECT ENHANCED, SYSTIMAX-G, KRONE PREMISENET & SUPER-LINK that copper (Cu) dominated. In cable AMP NETCONNECT, Fe (Iron) dominated (58.9%) while in cables BELDEN DATATWLST, SKYDUDE NETCONNECT & DINTEK, Aluminium dominated with 53%, 37% and 88% respectively. From this analysis, it has shown that most of the cables shipped into Nigeria might not perform optimally on the network when even the dominant compounds of manufacture are not copper.

This was corroborated by eHow Tech(2009-2012) that, "If a difference in speed or performance is noticed in Ethernet cables less than 100 meters, the problem is probably with the quality of the cable itself, not the length". In a white paper by Cisco Systems (2004, pp.1) it is stated that, "Government regulations require that cable networks meet certain minimum standards for analog television signal CNR (Carrier-to-Noise Ratio) which is the difference between the amplitude of an RF signal and the amplitude of noise present in the transmission path of the RF signal". Nigeria should also enact such a regulation especially, now that she is launching a network-driven economy such as cashless Lagos (as a kick-off point) and various other e-payment schemes, network cable quality should not be compromised.

3.2 Number of Twists per Meter (Twists rate)

According to Wikipedia (2012), "the twist rate (also called pitch of the twist, usually defined in twists per meter) makes up part of the specification for a given type of cable". Wikipedia continued to say that, where nearby pairs have equal twist rates, the same conductors of the different pairs may repeatedly lie next to each other, partially undoing the benefits of differential mode. For this reason, it is commonly specified that at least for cables containing small numbers of pairs, the twist rates must differ.

Pairs having the same twist rate can still experience some degree of crosstalk, the site concluded. Diaverty (2009, pp.2) noted that, "When a signal travels down a conductor, an electric field is created, which interferes with any wire close by. Diaverty continued to say that, "This is Crosstalk and gets larger at higher frequencies and the more parallel the wires. The twists in the pairs should (in theory) cancel this effect. For good signal cancellation it is important that the twists are symmetrical and that adjacent pairs have different twists".

Table-4: Twists rate count per pair of the sample cables

Cable Name	Pair-1 (wbr/br)	Pair-2 (wbl/bl)	Pair-3 (wo/o)	Pair-4 (wgr/gr)
AMP NETCONNECT	42	49	58	51
AICO PLFS48	93	51	69	59
BELDEN DATATWLST	35	35	36	36
SKYDUDE NETCONNECT	35	38	51	46
AMP NETCONNECT ENHANCED	40	52	55	46
SYSTIMAX-G	35	36	35	35
KRONE PREMISENET	54	80	59	70
DINTEK	83	64	94	72
SUPER-LINK	78	58	68	53

Where W/Br= White Brown, Br=Brown, W/Bl=White Blue, Bl=Blue, W/O=White Orange, O=Orange, W/Gr=White Green, G=Green and stand for the color-code of the UTP sample cable. Looking at table-4, cable sample SYSTIMAX-G even though has fairly high copper content, high wire guage, has low and non-varying number of twists per meter at all. BELDEN DATATWLST was poor in copper content, wire guage and number of twists per meter. Sample cables AMP NETCONNECT, AMP NETCONNECT ENHANCED and SKYDUDE NETCONNECT even though have varying number of twists rate but the twists rate are low. KRONE PREMISENET, DINTEK, SUPER-LINK and AICO PLFS48 have high and varying number of twists rate.

3.3 Wire Guage (size)

The larger the size of the center conductor, the higher conductivity it will have. Why? Because the larger the gauge, the lower the resistance. The lower the resistance, the less signal loss a cable will have. The less signal loss a cable will have, the more signal that makes it to the display from the source, www.comprehensivecable.com (2009).

This was corroborated by Paul Kish (2002) that, "The reason for the larger conductor size (approx. 23 AWG) is to provide a lower insertion loss (also called Attenuation) over the specified frequency range. A lower Insertion Loss means a stronger signal at the receiver compared with Category 5/5e". This improves the noise immunity to external and internal noise sources, Paul reiterated.

Table-3: Micrometer Screw Guage readings of the sample cable wires

Cable Name	Wire-1	Wire-2	Wire-3	Wire-4	Wire-5	Wire-6	Wire-7	Wire-8	Average Wire Guage
AMP NETCONNECT	0.5	0.5	0.52	0.52	0.51	0.5	0.53	0.52	0.51
AICO PLFS48	0.53	0.53	0.54	0.55	0.53	0.53	0.54	0.54	0.54
BELDEN DATATWLST	0.51	0.52	0.52	0.5	0.52	0.5	0.51	0.51	0.51
SKYDUDE NETCONNECT	0.54	0.53	0.51	0.51	0.51	0.5	0.51	0.51	0.52
AMP NETCONNECT ENHANCED	0.53	0.53	0.53	0.53	0.53	0.53	0.52	0.53	0.53
SYSTIMAX-G	0.56	0.56	0.56	0.56	0.54	0.54	0.54	0.54	0.55
KRONE PREMISENET	0.53	0.53	0.53	0.52	0.54	0.54	0.54	0.54	0.53
DINTEK	0.53	0.54	0.54	0.54	0.53	0.53	0.54	0.54	0.54
SUPER-LINK	0.52	0.53	0.54	0.54	0.53	0.54	0.54	0.53	0.53

The Micrometer Screw Guage readings (diameter) of the sample cable wires were taken and recorded above. The sample cables with low copper content still have low average wire guage (AMP NETCONNECT, BELDEN DATATWLST, SKYDUDE NETCONNECT) of 0.51, 0.51 and 0.52 respectively with the exception of DINTEK that has a high average wire guage of 0.54. But then, the others with high copper content still have high average wire guage (AICO DATATWLST, AMP NETCONNECT ENHANCED, SYSTIMAX-G, KRONE PREMISENET and SUPER-LINK). This, to some large extent, corroborates the fact that those cables with poor copper content are still poor in size (diameter) while those that have high copper content continued to maintain their high quality in wire guage (size).

4. CONCLUSION

It is important that we realize that Unshielded Twisted Pair Cable (UTP) has unalloyed values in the networking world. It is affordable, slim (does not fill up trunks and pipes quickly) and now can push and scale evenly with 10 Gigabyte data which made it convenient for its use in data, audio and video applications. We had taken nine (9) samples of UTP cable in the Nigerian UTP-cable market and have conducted elemental analysis with the use of Minipal 4 spectrometer, wire guage (diameter) measurement using micrometer screw guage and twists per meter count (per pair of cable). The main and basic constituent element of a UTP cable is copper, the bigger the wire guage the lower the resistance and the lower the resistance the less the signal loss. The less the signal loss the better the performance of category six cable. Also, the UTP four (4) wire pairs are not supposed to be same length and so the number of twists per meter should be different and high such that crosstalk among wire pairs can be reduced to the barest minimum.

Three of the samples (AMP NETCONNECT, BELDEN DATATWLST, and SKYDUDE NETCONNECT) fall short of the three tests out-rightly (low copper content, least wire size and low & non varying wire pairs twists rate). Another sample (DINTEK) has very low copper content (88% Aluminium) but has very good wire size, high and varying twists rate per meter (copper should be basic element of UTP cable). Even though samples AMP NETCONNECT and SYSTIMAX-G have fairly average copper content (66% and 51% respectively) and good wire size, their wire pair number of twists per meter are low and non-varying (somehow will be susceptible to crosstalk among wire pairs). Only three of the UTP cable samples (AICO PLFS48, KRONE PREMISENET and SUPER-LINK) passed the three tests having high copper content (85.0%, 73.1% and 70.1% respectively), high wire guage and high & varying twists per meter. This pass percentage of the tested samples is approximately 33.3%, which is low. This then implies that most UTP cables shipped into Nigeria are not adequate in quality.

4.1 From a Practicing Field-Engineer's Perspectives

Aside of these tests, we want to relate some field experiences on some of the cables we had used for projects before this time. Some UTP cables even though rated Cat 6 behave more or less like Category 5, 5e cables in performance.

4.1.1 Ease of Crimp

Once the outer rubber jacket is stripped, wires' edges being trimmed and arranged for crimping, the organized and straightened wires begin to sag and cannot stand straight on their own (which could be due to quality of copper cable). At insertion of the eight wires into the RJ45 connector, they do not easily fall into the eight appropriate slots meant for them in the connector so some wires pass through and some do not. They are hard to crimp.

4.1.2 Conveyance of Power

Sometimes one needs to install outdoor router(s) high up on the roof or somewhere out of the reach of the available mains. One might need to carry power for router(s) with the same cable carrying data which should not be more than a distance of ten (10) meters for optimal result.

Many of the current UTP rated category 6 cables cannot be used even though category 5 & 5e were used in the earlier times. A case of a project we installed for a faculty in my Institution convinced us. We initially thought the new router used was defective from the supplier but we later discovered that the UTP cable, rated category 6 being used, was defective and refused to carry power for the router.

4.1.3 Defective Manufacture processes

Even before being inserted into the connectors, some UTP cable wires' coded insulation begin to peel from the wires, leaving the wires naked. This, should not have being. This could be due to defective manufacture processes.

5. RECOMMENDATION

We recommend that the Government of the Federal Republic of Nigeria through the Standard Organization of Nigeria (SON) arise to this situation to salvage Nigeria IT market from being turned into a dumping ground for substandard IT products. The SON should collaborate with the Computer Professional of Nigeria (CPN) (and other related professional bodies), Nigerian immigration, Association of Importers and Exporters of IT goods to rid off this menace. This collaboration will ensure that SON together with the Computer Professional bodies set adequate IT standards according to the Nigeria IT policy, the immigration enforces the policy by refusal of substandard IT products from entering into Nigeria and the importers and importers will refuse offer of substandard IT products from manufacturers.

Nigeria needs to bridge the digital divide gap with leading world countries and meet her IT Millennium Development Goals (IT MDGs). This can only be done when quality and standard IT products are deployed in her Institutions of Learning, Ministries and Parastatals and industries to obtain the best results especially now that Nigeria is launching into cashless community, best IT products will forestall downtime, digital disappointments and unwarranted network failures to give best dividends of Return-on-Investments (RoI) on various e-Commerce schemes.

REFERENCES

[1]. http://www.comprehensivecable.com (2009) Cable Construction Basics: Under the Jacket and Beyond www.comprehensivecable.com/LearningCenter/About_cables.html

[2]. Chris Cavette(2007) How Copper is made-material used, processing steps, products, Raw Materials, The Manufacturing Process of Copper, Quality Control, Byproducts/Wastes, The Future www.madehow.com/Volume-4/Copper.html#ixzzisofY6FdV

[3]. Chris Shore www.ehow.com/about_5207438_utp-cable_.html#ixzz1klDNFlye

[4]. Cisco Systems, Inc (2003) CCNA: Network Media Types

[5]. Cisco Systems, Inc. (2004) Carrier-to-Noise Ratio in Cable Networks White Paper

[5]. Diaverty (2009) Network Cable Testing- What Causes Data Loss? OPENXTRA Limited, Building Society Chambers, Wesley Street, Otley, LS21 1AZ http://www.openxtra.co.uk/articles/network-cable-testing-causes-data-loss#ixzz1ySEqLJNV

[6]. ECOSSE REFERENCE CABLE Cable Info http://www.ecossecables.co.uk/Tables/faqmainframe.html

[7]. eHow Tech (2009-2012) Ethernet Cable Length & Computer Performance www.ehow/facts_7548706_ethernet-cable-length-computer-performance.html#ixzz1mY4xwuJ6

[8]. Extron Electronics (2006) Sending A/V Signals Over Twisted Pair Cables: Optimizing Performance Extron Elec. HQ in Anaheim, CA.

[9]. Galen Udell (2006) Discussion Paper: Category 6 versus Category 5e Cabling Systems and Implications for Voice Over IP Networks Belden CDT Networking

[10]. Hitachi Cable Manchester (2009) The Facts About Category 6 and 6A Cabling Hitachi Cable Manchester, 900 Holt Avenue, Manchester, NH 03109 White Paper, January 2009. http://www.accu-tech.com/Portals/54495/docs/hcm%20copper%20cable%20selection%20guide%202010.pdf

[11]. Jay Potter (2002) Ethernet Over Standard Category 5 Cable: Functional Testing &eE Certification International Academy of Science

[12]. J. Griffith et al (2000) Cable Parameters and Acoustic Probe Performance E & H Resources, Inc., Phoenix, AZ 85048; Weidlinger Associates, inc., Los Altos, CA 94022 and NUWC, Newport RI, 02841. Preprint of an article in the 2000 IEEE Ultrasonics Symposium Proceedings

[13]. Paul Kish(2002) Category 6 Cabling Questions and Answers NORDX/CDT Cable Designs Tech.

[14]. Quabbin Wire & Cable Co. Inc., "Tech Brief-Effect of Return Loss& Impedance Stability on Premise Wiring Systems at Extended Frequencies" Headquarters (Office, Manufacturing, Warehouse) 10 Maple Street Ware, MA 01082.

[15]. www.Wikipedia.com (2012).

Author's Brief

OGUNTUNDE Toyin obtained both the B.Sc and the M.Sc degree in Computer Science from the University of Ibadan in 1997 and 2007 respectively. He was a network (wired & wireless) field engineer for over seven years before joining the academics in 2008. His area of research currently is network-driven environment for collaborative scientific research. He can be reached at tantos557@yahoo.com. Phone: +2348023658019