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CHOICE OF COMPUTER NETWORKING CABLES AND THEIR EFFECT ON DATA TRANSMISSION

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ABSTRACT

Computer networking is the order of the day in this Information and Communication Technology (ICT) age. Although a network can be through a wireless device most local connections are done using cables. There are three main computer-networking cables namely coaxial cable, unshielded twisted pair cable and the optic fibre cable. In this research work the cables that most effectively transmit data given some distance in a computer network, were determined. To achieve this, a signal strength meter Multiple Dwelling Unit (MDU) from Applied Instruments Inc is used to measure the signal strength at particular distances in the network. Results show that coaxial cable has a correlation coefficient of -0.66857to t he distance, unshielded twisted pair cable has -0.47362 while optic fibre cable has —0.91674. From the analyses it was discovered that the signal strength is partially inversely related to the distance for coaxial cables and about half inversely related to the distance in unshielded twisted pair cables. While in optic fibre cables the signal strength is almost perfectly inversely related to the distance. Similarly the use of these cables was considered in download time. Download time for both plain text and graphics were recorded and from this it was discovered that the mean difference is significant at 0.05 level which shows that the unshielded twisted pair cable is better for plain text download while the optic fibre cable is better for graphic download.

KEYWORDS: Networking, cables, transmission, measurements and correlation.

INTRODUCTION

Computer Networking has become the order of the day. It is defined as a connection of two or more computers in order to share resources (such as printers, CD-ROMs etc), exchange files, or allow electronic communications. The computers on a network may be linked through cables, telephone lines, radio waves, satellites, or infrared light beams. We continuously make use of computer networks in either searching for information, sending E-mails, in e-commerce, e-banking e-Learning , e-conferencing or entertainments.

(Casad et al 1996) in their book " Windows 95 and Essentials of Networking" defined network as the interconnection of equipments for a particular purpose. They went further to localize it to computer networking by stating that computer networking is the interconnection of computers and computer peripheral with the view to sharing resources.

In his view Black (1993) defined computer network as a number of computers and usually terminals interconnected by one or more transmission paths. The paths are usually cables, which have their own characteristics. The networks usually meet one goal and that is the transfer and exchange of data between the computers and the terminals.

Computer networking is divided into three major types depending on their geographical coverage. These include (i) Local Area Network (LAN) which is geographically limited to the size of a building or campus. Although wireless LAN exists but most local area network uses cable as a transmission medium. Because of the size of the network it is relatively inexpensive and error free. (ii) Metropolitan Area Network (MAN) the metropolitan area network is a network that is wider in geographical terms than the local area network, for example the network of a city like Calabar. The MAN interconnects multiple LANs, it is more sophisticated and complex than LANs and the technology is moderately expensive. (iii) Wide Area Network (WAN): The wide area network is a network that uses such devices as telephone lines, satellite dishes or radio waves to interconnect other networks in a larger geographical area than the LAN or MAN can. Wide area network is characterized by the following, its ability to transfer data at high speeds, it is however more more sophisticated and complex than LANs and MANs and the technology is expensive, more susceptibility to errors due to the distance, interconnect multiple LANs and MANs.

Every network is arranged in such a way that the resources will be effectively shared. This arrangement is called computer networking topology (Pat,1999) These topologies could be logical or physical (Macrel 1991) The choice of networking topology depends on (i) Maximum possible reliable assurance for the proper receiving of the data sent.

(ii) Design of the topology within the least cost.

(iii) Giving the end user the best possible response time and throughput (Sheed 1990). The topologies include Bus, Star, Ring and Mesh/Tree.

Significance of study

Many people are involved in computer networking using cables. The choice of cable for a particular network affects the network itself. Therefore it is important that one knows the type of cable to choose and for what purpose. It is in line with this that the issues about the networking cable choice is important

Cables

The word cable has been used in many quarters to mean different things. For instance it has been used as a term in the foreign exchange market for the US Dollar/British Pound rate. It has also been defined as a flexible steel rope made up of numerous wire strands that are twisted helically together around a core of wire, wire rope. fibre, plastic or other material, (www.fao.org/docrep /v6530e/12.htm(2000))

The cables in use include coaxial. unshielded twisted pair and the optic fibre.

In order to reduce cost, every hardwired local area network is basically done using any of the three cables and their laying takes a particular structure (Mark 2002)

Coaxial Cable

Coaxial cable consists of two conductors separated by a dielectric material, the centre conductor and the outer conductor or metal shield which helps to block interference

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from fluorescent lights, motors, and other computers. Both the inner and outer conductors are configured in such a way that they form concentric cylinders with a common axis hence the name coaxial. This is shown in figure 1.

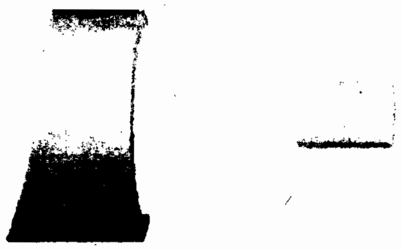

Fig. 1: Coaxial Cable

Unshielded twisted pair cable

Unshielded twisted pair (UTP) is the most popular. The quality of unshielded twisted pair Cable 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 turns per millimetre to help eliminate interference from adjacent pairs and other electrical devices This is shown in figure 2:

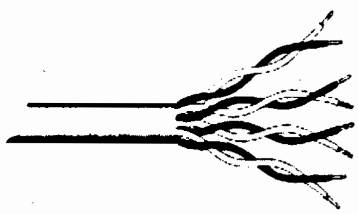

Fig. 2: Unshielded twisted pair cable.

Optic fibre cable

The optic fibre cable is made up of core and cladding which works on the principle of light propagation. It is coated with rubber shield to prevent inferences. Figure 3 shows a typical optic fibre cable.

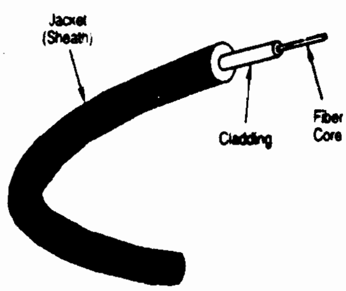

Fig. 3: Optic Fibre cable

METHODOLOGY

In carrying out this research, measurements of the signal strength on the cables at different distances were made with a view to finding out which of the cables can be used effectively in computer networking without losing much of the transmitted signal. To do this a Multiple Dwelling Unit (MDU) model number 9525 Signal level meter from Applied Instruments, Inc (Fig 4 below) was used to measure the signal strengths on the cables

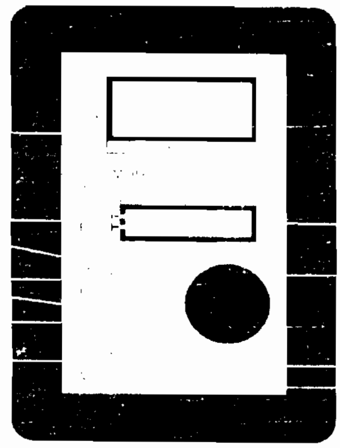

Fig. 4: Multiple Dwelling Unit (MDU) model number 9525.

It is a microprocessor controlled signal level meter. It has a frequency range between 5MHz and 2.15GHz with frequency tuning resolution of 125 KHz in Tune-By-frequency mode and single channels in Tune-BY-Channel mode. It has an amplitude measurement range of -30 to +30dBV, 5MHz to 860MHz.

The meter is connected at the output of the transmission at different points on the transmission line and the signal levels recorded. Figure 4 shows this meter. These measurements were done taking temperature and other environmental conditions as being constant. The second measurement involves the use of computers connected to the Internet to download text and graphics at a particular time. The timing was down and recorded. The analysis of the results are shown on tables 1(a), 1(b) and 1(c) for descriptive, one-way ANOVA and mean comparison respectively.

DATA

Appendix I shows the data for download of text and graphics by cables. The readings of signal strength against the distance as well as correlation between them are shown in Appendix II for the three types of cables used.

DISCUSSION OF RESULTS AND FINDINGS

Table 1(a) below shows the descriptive parameters of the download time for both plain text and graphics.

Table 1(a): Descriptive analysis of Down load time of graphics and plain text for the three cables

	Type of cable	N	Mean	Std. Deviation	Std. Error	95% confidence interval for mean		Minimum	Maximum
						Lower Bound	Upper bound		
Time of Download of Graphics	Coaxial	30	55.7520	0.7029	0.1283	55.4895	56.0145	54.12	56.89
	UTP	30	42.6740	0.7321	0.1337	42.4006	42.9474	41.20	44.20
	Optical	30	15.2583	0.5762	0.1052	15.0432	15.4735	13.89	16.20
	Total	90	37.8948	16.9810	1.7899	34.3382	41.4514	13.89	56.89
Time of Download of Text	Coaxial	30	33.6433	0.8109	0.1480	33.3405	33.9461	31.98	35.80
	UTP	30	11.1433	0.7832	0.1430	10.8509	11.4358	10.00	13.00
	Optical	30	25.0557	0.5109	9.328E-02	24.8649	25.2464	24.12	25.98
	Total	90	23.2808	9.3496	0.9855	21.3225	25.2390	10.00	35.80

For coaxial cable the mean time of download for text is 33seconds and for graphics it is 55seconds. The unshielded twisted pair cable has mean time of 42seconds and 11seconds for graphics and plain text respectively. In the case of optic fibre cable the table shows that the download mean time is 15seconds and 25seconds for graphics and plain text respectively. From the descriptive analysis of the data it was also discovered that the coaxial cable has a standard deviation of 0.7029 for graphics and 0.8109 for plain text with a 95% lower bound confidence interval of 55.4895 and an upper bound interval of 56.0145 for graphics. The 95% confidence interval for plain text is between 33. 3405 and 33.9461 . This is significant in data transmission Similarly the unshielded pair cable has a standard deviation of 0.7321 and 0.7832 for graphics and plain text respectively. The 95% confidence interval for the unshielded twisted pair cable is between 42.4006 lower bound and 42.9474 of upper bound. The table also shows that the optic fibre cable has a standard deviation of 0.5762 and 0.5109 for graphics and plaint text downloads respectively and 15.0432 lower confidence limit and 15.4735 upper limit.

In comparison and with respect to text download; Unshielded Twisted Pair, UTP cable has the least download time. With respect to download of graphics; Optical cable has the least download time. This observation needs further authentication by a statistical significance test. The ANOVA test was invoked for this purpose and the result is shown in Table 1(b) below.

Table 1(b): One way Analysis of Variance of download time of Graphics and Text for the three cables

		Sum of Squares	df	Mean Square	F	sig
Time of Download of Text.	Between Groups	7735.510	2	3867.755	7573.853	0.000
	Within Groups	44.428	87	0.511		
	Total	7779.939	89			
Time of Download of Graphics.	Between Groups	25632.899	2	12811.950	28219.141	0.000
	Within Groups	39.499	87	0.454		
	Total	25663.398	89			

The null hypotheses being tested are:

1. H_0: Mean download of plain text is the same irrespective of type cable used.
2. H_0: Mean download of graphics is the same irrespective of type cable used.

Based on the F ratio of 7573.853for plain text download and significant probability of 0.00 the first hypothesis is rejected and we accept that mean download time differ from cable to cable. Hypothesis 2 above is also rejected based on a high F ratio of 28219.141 and a significant probability of 0.00. Thus, for download time of graphics vary by cable type.

Table 1(c) below shows the result of the mean differences sensitivity test that isolates and confirms that the unshielded pair cable has the least download time and is therefore better in terms of plain text download while the optic fibre is better for graphic down load.

Table 1(c): Test of the mean difference of the download time of the three cables in use for graphics and text.

Dependent Variable	(I) Type of Cable	(J) Type of Cable	Mean Difference (I-J)	Std. Error	sig	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Time of Download Of Text	Coaxial	UTP	13.0780*	0.174	0.000	12.7322	13.4238
		Optical	40.4973*	0.174	0.000	40.1479	40.8395
	UTP	Coaxial	-13.0780*	0.174	0.000	-13.4238	-12.7322
		Optical	27.4157*	0.174	0.000	27.0699	27.7615
	Optical	Coaxial	-40.4937*	0.174	0.000	-40.8395	-40.1479
		UTP	-27.4157*	0.174	0.000	-27.7615	-27.0699
Time of Download Of Graphics	Coaxial	UTP	22.5000*	0.185.	0.000	22.1333	22.8667
		Optical	8.5877*	0.185	0.000	8.2208	8.9544
	UTP	Coaxial	-22.5000*	0.185	0.000	-22.8667	-22.1333
		Optical	-13.9123	0.185	0.000	-14.2791	-13.5456
	Optical	Coaxial	-8.5877*	0.185	0.000	-8.9544	-8.2209
		UTP	13.9123*	0.185	0.000	13.5456	14.2791

*The mean difference is significant at the 0.05 level

In terms of the signal strength and its association with distances; it was discovered from the measurements that the three cables have correlation coefficients of -0.66857, -0.47362 and -0.91674 for Coaxial, Unshielded twisted pair and Optic fibre cables respectively shown in Appendix II. The above result shows that signal strength is partially inversely related to the distance for coaxial, about half inversely related for unshielded twisted pair and almost perfectly inversely related for optic fibre cables.

CONCLUSION

From the analysis above it is clear that the optic fibre cable is reliable in graphic download as unshielded twisted pair cable is good for plain text download. These are authenticated by the statistical significance tests conducted at 0'05 level vide Tables 1 a, b and c these results are significant in data transmission. Correlation coefficient analysis was carried out to show how the distance of transmission is related to the signal strength. The results as shown in Appendix II indicate that for coaxial, unshielded twisted pair and optic fibre cables there exists an inverse relationship between signal strength and distance. With a correlation coefficient of -0.66857 for coaxial cable , it can be said that its fidelity is not fully guaranteed compared with that of optic fibre cable with correlation coefficient of -0.91674. The unshielded twisted pair cable has a correlation coefficient of - 0.47362 which indicates that the signal strength is about half inversely related to the distance of the cable in use

In conclusion, the choice of computer networking cable must be such that the use is mostly considered before the choice is made. This is because many people choose cables for computer networking without properly knowing the right type of cable for such a network. In this research it is clear that as optic fibre cable is good for graphics with better fidelity butless useful in terms of text download.

Appendix I:

TIME of TEXT and GRAPHICS DOWNLOAD By CABLE TYPE

S/N	COAXIAL		UTP		OPTICAL	
	480KB TEXT	525KB GRAPHICS	480KB TEXT	525KB GRAPHICS	480KB TEXT	525KB GRAPHICS
1	33.00	56.00	10.00	42.00	25.00	15.00
2	33.25	56.50	10.81	42.80	25.40	15.40
3	32.98	56.25	10.85	41.90	25.25	15.80
4	33.76	54.89	10.90	43.10	25.98	15.98
5	31.98	55.50	11.00	42.98	24.90	16.20
6	33.15	55.90	10.56	43.89	25.12	15.52
7	33.65	56.23	10.52	43.60	25.66	14.80
8	33.55	56.42	11.01	42.70	24.50	14.78
9	34.01	56.34	10.98	43.80	25.80	14.88
10	33.10	54.80	10.24	41.88	24.98	15.58
11	33.00	55.45	11.40	42.10	25.00	16.00
12	35.00	56.00	11.00	42.58	24.50	15.80
13	33.10	54.12	12.40	42.00	25.54	15.42
14	34.00	55.12	12.50	42.60	24.58	15.48
15	33.25	56.10	12.00	42.00	25.43	15.24
16	32.80	56.23	11.00	43.22	25.12	15.38
17	33.00	56.87	13.00	42.88	25.32	15.40
18	35.00	55.00	10.10	42.66	24.12	15.81
19	33.50	54.25	11.20	42.00	25.14	15.45
20	33.10	55.60	12.00	42.89	25.66	15.45
21	33.00	56.70	10.89	42.75	24.50	14.00

22	34.20	56.89	10.45	42.65	25.79	13.89
23	33.89	55.87	11.20	42.35	25.75	14.56
24	33.12	55.94	12.50	42.80	24.89	15.80
25	34.50	55.65	11.98	43.00	24.75	15.44
26	33.70	55.60	11.51	44.00	24.35	15.45
27	33.91	55.80	10.40	41.20	24.88	15.11
28	34.00	54.89	11.20	41.80	24.22	15.20
29	35.00	55.75	10.20	44.20	24.44	14.18
30	35.80	55.90	10.50	41.89	25.10	14.75

Appendix II

DISTANCES SIGNAL STRENGTH and CORRELATION BY CABLE TYPE

S/N	COAXIAL		UTP		OPTICAL	
	DISTANCE	SIGNAL STRENGTH	DISTANCE	SIGNAL STRENGTH	DISTANCE	SIGNAL STRENGTH
1	0.026	1.411	0.013	0.321	0.122	4.273
2	0.050	1.251	0.015	0.311	0.168	4.112
3	0.051	1.249	0.020	0.281	0.210	3.965
4	0.056	1.185	0.021	0.222	0.350	3.473
5	0.060	1.011	0.021	0.222	0.368	3.412
6	0.065	0.622	0.065	0.105	0.657	3.312
7	0.070	0.520	0.070	0.101	0.725	3.155
8	0.075	0.510	0.075	0.098	0.841	2.822
9	0.085	0.470	0.085	0.081	0.910	2.625
10	0.900	0.412	0.900	0.074	1.250	2.422
11	0.950	0.311	0.950	0.070	1.550	2.144
12	1.000	0.300	1.000	0.061	1.810	1.981
13	1.050	0.211	1.050	0.51	1.870	1.751
14	1.100	0.182	1.100	0.040	2.140	1.552
15	1.150	0.100	1.150	0.031	2.750	1.256
16	1.200	0.090	1.250	0.030	3.200	0.895
17	1.700	0.084	1.500	0.028	3.650	0.575
18	2.200	0.081	1.800	0.024	3.950	0.455
19	2.700	0.075	2.400	0.020	4.300	0.322
20	3.200	0.070	2.900	0.018	4.500	0.198
21	3.700	0.064	3.500	0.014	4.750	0.185
22	4.200	0.050	4.200	0.012	5.200	0.172
23	4.700	0.042	4.800	0.010	5.650	0.155
24	5.200	0.031	5.500	0.009	5.950	0.033
25	5.500	0.027	6.200	0.006	6.100	0.126
26	6.000	0.018	7.100	0.003	6.750	0.111
27	6.500	0.014	8.000	0.002	7.100	0.106
28	7.000	0.012	8.500	0.002	7.250	0.098
29	7.500	0.011	9.000	0.001	7.750	0.018
30	8.000	0.010	9.500	0.000	8.200	0.015
Corr. Coefficient	-0.66857		-0.47362		-0.91674	

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