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Round Trip Time of Network Cables: A Comparative Analysis

Sheila Mae S. Pagayonan[1], Sheryl M. Salamaña[2], Bella Gertrude B. Alpasan[3], Sharra Mae B. Fernandez[4], April Rose A. Zaragosa[5], Audrey Karyl P. Maligang[6], Mary Jane V. Esimos[7]

[1,2,3,4,5,6,7] Northern Iloilo Polytechnic State College, Estancia, Iloilo

ABSTRACT: This experimental research study was conducted to compare the round-trip time of commonly used network cables among Internet Cafés in Estancia, Iloilo. Specifically, it focused on the brand names of network cable and the distance of cable from the access point to remote terminal. This study attempted to determine whether there was no significant difference among cables which differs from their brand names and distances. The research instrument used in gathering the data was the researchers-made survey form which was submitted to the three panels of experts for face validation before the instrument was given to Internet Cafe Owner's and computer stores in the Municipality of Estancia. The statistical tools used were the frequency counts, percentages, rank, arithmetic mean, and chi-square. The results revealed that there were significant differences in the round-trip time between brands of network cables when tested at long and short distances from access point to remote terminal. It was found out that there was no significant difference in the overall round-trip time between brands of network cables when tested at long, medium, and short distances from access point to remote terminal. This simply showed that Internet Cafés can make use of any brand available in the market because they perform the same. However, among the three brands being tested it was also revealed that the best brand of network cables in terms of round-trip time was the Belden.

KEYWORDS: Round Trip Time, Network Cables, Comparison, Internet Cafe, Belden

I. INTRODUCTION

The Information Age's two most potent wellsprings are computers and communications. A wave of technological change has erupted as a result of them. As technology advances, one's mind becomes more cognizant of the need to try new things that are beyond his imagination. The fusion of computers and communications has had a significant impact on the organization of computer systems.

A computer network is set up to allow data, sometimes critical data, to be transmitted from one computer to another. The original idea was to use two different computers to communicate with each other. Within the crumble, this concept was commercially embraced by the majority of computer users, institutions, schools, and IT (Information Technology) departments, and computer networking became a widespread compulsion. As today's communication networks get more complicated, as more users share peripherals, as more mission-critical operations are completed across networks, and as the demand for faster access to information grows, a solid foundation for these networks becomes more crucial.

It is used to be that two-way individual communications were accomplished mainly in two ways. They were carried by the medium of a telephone wire or a wireless method such as shortwave radio. Today, there are many kinds of communications media, although they are still wired or wireless. Guided media, such as copper wire and fiber optics, are classified as guided, whereas unguided media, such as radio and lasers in the air, are classified as unguided. Communications media carry signals over a communications path, the route between two or more communications media devices. The speed at which data is transmitted and the amount of data that may be conveyed by a signal are determined by the medium and the type of signal.

Network cables are available in the market with different brands and classifications. It is also a fact that each brand of network cables has its own advantage over the other brands of cables and it can lead confusion to people who are newly indulged in the networking concepts as they look forward in the advancement of networking technology.

Estancia is located in the northern part of Iloilo province approximately 135 kilometers from Iloilo City, the capital of the province. It is said that the economic status of Estancia has improved a lot compared to the previous years. There are already plenty of infrastructures investments and business establishments. By the birth of modern technology, Internet Café is one of the growing business opportunities in Estancia.

Realizing the importance of network cables in the networking activities, the researchers have come up with this study which focuses on the comparison of round-trip time of commonly used UTP cables among Internet Cafés in Estancia, Iloilo which differs in their brand names and length of 100 meters, 70 meters and 50 meters, respectively.

II. REVIEW OF RELATED LITERATURE

Network cable is the medium through which information usually moves from one network device to another. It is one of the components of Local Area Networks (LANs). In Tanenbaum (2003), stressed that a LAN must be within the interprocessor distance from 10 meters which can be a room, 100 meters which can be a building and 1 kilometer which can be a campus.

Network cabling comes in two varieties: unshielded and shielded. Unshielded Twisted Pair (UTP) cable is the most populous amongst all Network Transmission Media. UTP is made of eight copper wires intertwined into four pairs each covered in a plastic coating. The coating of each wire is in different color to aid engineers to follow wiring diagrams.

UTP cable is used in a variety of networks. When used as a networking medium, UTP cable has four pairs of either 22 or 24 gauge copper wire. UTP cable when used as a networking medium has an impedance of 100 ohms, differentiating it from other types of twisted pair wiring such as that used for telephone wiring. It is stated that UTP cable has an external diameter of approximately 0.43 cm equivalent to 0.17 inches. Its small size can be advantageous during installation.

This twisted pair configuration compared to straight wire somewhat reduces interference called crosstalk from electrical field (Williams and Sawyer, 2005). According to Tanenbaum (2003), it is stated that crosstalk is caused by inductive coupling between two wires that are close to each other. A signal is transmitted differentially between the two conductor wires.

Twisted pair cables use differential mode of transmission to reduce radiation losses and also to be immuned to noise from the external environment since the impedance of each conductor with reference to ground remains the same. This lack of balance can cause the differential mode signals to convert into common mode and if not cancelled by common mode chokes or differential receivers, these common mode signals will remain in the system as a potential form of crosstalk (Dorai, Yin, Kelly and Peyton 2007).This is based on the fact that both insulated conductors in a pair are similar enough to cancel emission and radiation noises into and from the environment. In a real twisted pair, there always exists differences between the conductors hence noise cancellation is not absolute.

The maximum length the cable can be extended should not longer than 300 feet or equivalent to 100 meters. It cannot guarantee to go further than 300 feet due to signal strength attenuation becomes more significant.

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

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 gauge (size), and twist rate per meter. According to www.comprehensivecable.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”. This research work is a testing for the quality of UTP cable based on three parameters. Cabling performance parameters are not mysterious. They are symptoms that enable the 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, New Riders (2001). New Riders 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, and quality of twisting and wall thicknesses”. The three tests conducted in this research are as follows:

UTP cable is supposed to be made of mainly pure copper but if electroplated with tin, it improves the bandwidth and capacitance (Cavette, 2008).

Factors Affecting Cable Performance

Twisted pairs are made from two identical insulated conductors, which are twisted together along their length at a specified number of twists per meter, typically forty twists per meter equivalent to twelve twists per foot. The tighter the twisting, the higher it supports transmission rate. The twisting of associated pairs and method of transmission reduces the interference from the other pairs of wire throughout the cable.The transmitted signals are in the form of changes of electrical state. An encodingprocess turns ones and zeros into these signals. Since these wires are of the same length and have the same construction, the signal travels at the same rate. Since the pairs are twisted together, anyoutside electrical interference will affect both wires in the same way.

Copper cables are good for signal transfer, but they are not perfect. Ideally, the signal at the end of a length of cable should be the same as at the beginning. Unfortunately, this will not be true in practice. All signals degrade when transmitted over a distance through any medium. This is because its amplitude decreases as the medium resists the flow of energy, and signals become distorted because the higher frequencies are attenuated more than the lower ones. Any transmission also consists of signal and noise components. Signal quality degrades for several reasons, including attenuation, crosstalk, and impedance mismatches.

III. METHODOLOGY

3.1 Research Design

The experimental method of research was used in this study. Experimental research designs is a highly controlled procedure in which manipulated treatments or actions from a factor or condition, called the experimental or independent variable, are applied upon another factor or condition, called the dependent variable, to determine the effect of the former upon the latter, all other factors or variables being kept constant or equal so that any change in the dependent variable is attributable only to the experimental or independent variable (Calderon and Gonzales, 2006).

In this study, the researchers had manipulated treatments which were the brand names and distances which were identified as long distance, medium distance, and short distance and was applied to the another factor which was the round-trip time of commonly used UTP cables. As the researchers go along with the study, they gathered data using the ping network command and compare the round-trip time of commonly used UTP cables as classified according to brand names and distances which were identified as long distance, medium distance and short distance.

3.2 Sources of Data

In this study, the researchers focused on two factors namely: brand names and distances which were identified as long distance, medium distance and short distance. The respondents of the study were the 30 establishments of Internet Cafés and computer stores in the Municipality of Estancia.

A researchers-made survey form was used to determine the common brand names of UTP cables among Internet Cafés and computer stores in the Municipality of Estancia, Iloilo. The materials that were used in this study were as follows: the three common brand names of UTP cable, one notebook computer which was used as the remote terminal, one router which was used as the access point.

3.3 Instrumentation and Data Collection

The first task was to secure the necessary permits to conduct the study. Once the permits became available, the researchers then constructed a survey instrument. The purpose of this was to solicit information from the existing Internet Cafés and computer stores in the Municipality of Estancia of their commonly used brands of UTP cables. The researchers-made survey instruments were subjected to face validation by three panels of experts. The suggestions made by the jurors were integrated into the survey form.

After validation, the researchers conducted the actual survey. As soon as the result of the survey became available, the researchers purchased the top three brands of UTP cables and labeled them as Cable A, Cable B, and Cable C. The actual testing of round-trip time of these UTP cables was materialized.

The researchers arranged the UTP wires based on the UTP Cable Termination Standards EIA/TIA 568A and EIA/TIA 568B. The RJ-45 were attached at the end of the wires. Then, the cables were placed on the crimping tool and gave firms squeeze to hold tight. A cable tester was used to test the connectivity of UTP cables to ensure that it will function in the field. Twelve pieces of RJ-45 were also used as a connectors on both ends of UTP cable, one roll tape measure (100 m) was used to measure the distances between the access point and the remote terminal, and also a crimping tool was used to crimp the UTP cable, a scissor was also used to align the ends of the wires to be inserted on the RJ-45. Three pieces of bond paper and a marker were also used to label the distance from access point to remote terminal, one digital camera was also used for the documentation and references, and one roll of paper tape was used to label the UTP cables as Cable A, Cable B, and Cable C.

After the router was configured, the researchers first tested each UTP cable brands at a long distance which was 100 meters. This was done by measuring the distance and marking appropriately. The three UTP cables namely: Cable A, Cable B, and Cable C were prepared. Each UTP cable was attached to the access point on one end which was the Wireless-N AP Router and the default IP Address was 192.168.0.254, and to the remote terminal which was the notebook computer in the other end. The ping network command was used to determine the round-trip time of each cable. The researchers executed the command on the remote terminal as follows: ping 192.168.0.254 -c 20. The IP address which was stated was the IP address of the access point. The –c character stands for count. The numerical value 20 means to display 20 counts of replies from the router. There were

first, second and third trials of ping test which were intended for this study. The results were copied to the Notepad application program of remote terminal for proper recording of the experimental data.

The same processes were done at a medium distance which was 70 meters and at a short distance of 50 meters. It can be noted that the first distance that was tested was 100 meters, followed by the actual testing at 70 meters and finally the testing at 50 meters. This was purposely planned so as to minimize expenses in the purchase of the UTP cables. When the experiments were done, the researchers encoded the data and subjected the same to statistical treatment and interpretation. To define the descriptive equivalent of the numerical value, an arbitrary scale had been used for the purposes of the study. A description of "very fast" with a weight below 0.6588 ms, "fast" with a weight of 0.6589 to 0.8007 ms, "moderate" with a weight of 0.8008 to 0.9425 ms, "slow" with a weight of 0.9426 to 1.0843 ms, and "very slow" with a weight above 1.0844 ms.

Table 1.The Arbitrary Scale and Descriptionn

Scale (in ms)	Description
Below 0.6588	Very Fast
0.6589 – 0.8007	Fast
0.8008 – 0.9425	Moderate
0.9426 – 1.0843	Slow
Above 1.0844	Very Slow

3.4 Tools for Data Analysis

The statistical tools that were used in the interpretation of data gathered were the frequency counts, percentages, ranks, arithmetic mean, and chi-square.

Frequency Counts. These were used to determine the respondents' responses on the commonly used UTP Cable in Estancia, Iloilo.

Percentages. These were used to determine the ratio of the respondents who chose a particular UTP cables.

Ranks. These were used to determine the commonly used UTP cables under Cat5e classification. It has a description of Rank 1 "First Acquired", Rank 2 "Second Acquired", Rank 3 "Third Acquired", Rank 4 "Fourth Acquired" and Rank 5 "Fifth Acquired".

Arithmetic Mean. These were used to determine the average round trip response in Cable A, Cable B, and Cable C when tested at different distances from access point to remote terminal.

Chi-square. These were used to determine the differences in response time in Cable A, Cable B, and Cable C when tested at different distances from access point to remote terminal.

IV. PRESENTATION, ANALYSES, AND INTERPRETATION OF DATA

4.1 Descriptive Data Analysis

In the conduct of this study, the results were statistically computed. The arithmetic mean was used as the descriptive statistical tool.

Common UTP Cable Brands among Internet Cafés and Computer Suppliers in the Municipality of Estancia

A researchers-made survey from was constructed for the purpose of this study. These were distributed personally by the researchers to the respondents wherein the respondents could directly fill in the brand names of UTP cables which their establishments were using in their daily networking activities and by ranking the brand names of UTP cable in the appropriate column having an option that were classified as Rank 1 "First Acquired", Rank 2 "Second Acquired", Rank 3 "Third Acquired", Rank 4 "Fourth Acquired" and Rank 5 "Fifth Acquired". After two days, the survey had already finished. In order to determine the commonly used UTP cables among Internet Cafés and Computer Suppliers from the researchers-survey form, the results were ranked according to highest frequency counts and percentages. After the result of survey has shown, the top 3 common brand names of UTP cable among Internet Cafés and computer stores were identified. They were: Intex, Digital, and Belden.

Table 2. Common UTP Cable Brands among Internet Cafés and Computer Stores in the Municipality of Estancia

Brand	Frequency	Percentage	Rank
Digital	13	43	1
Intex	12	40	2
Belden	8	26	3
Netconnect	2	6	4
iQuest	2	6	4
AMP Netconnect	2	6	4
24 AWG	2	6	4
ADC Truenet	2	6	4
Anpufy	2	6	4
Delkin Systems	2	6	4
Octagon	1	3	5
ASTRIX	1	3	5
LG	1	3	5
UTP	1	3	5
Panduit	1	3	5

The Average Round-Trip Time when Cable A is Tested at Different Distances from Access Point to Remote Terminal

Table 3 shows the average mean of three trials of testing using ping network command at different distances. Using the weighted mean, the result showed that the obtained mean score of Cable A when tested at long distance obtained was 0.6108 ms which was described as "very fast". The obtained mean score when tested at medium distance was 0.6152 ms which was also described as "very fast" while the obtained mean score when tested at short distance was 0.5954 which was also described as "very fast".

Table 3.The Average Round-Trip Time when Cable A is Tested at Different Distances from Access Point to Remote Terminal

Distance	Mean (in milliseconds)	Description
100	.6108	Very Fast
70	.6152	Very Fast
50	.5954	Very Fast

***Legend:** Scale (in ms) Below 0.6588 = Very Fast; 0.6589 –0.8007 = Fast; 0.8008 -0.9425=Moderate; 0.9426 –1.0843 = Slow; Above 1.0844 = Very Slow.*

The Average Round-Trip Time when Cable B is tested at Different Distances from Access Point to Remote Terminal

Table 4 shows the average mean of three trials of testing using ping network command at different distances. Using the weighted mean, the result showed that the obtained mean score of Cable B when tested at long distance obtained was 0.6105 ms which was described as "very fast". The obtained mean score when tested at medium distance was 0.6073 ms which was also described as "very fast" while the obtained mean score when tested at short distance was 0.5984 which was also described as "very fast".

Table 4.The Average Round-Trip Time when Cable B is tested at Different Distances from Access Point to Remote Terminal

Distance (in meter)	Mean (in milliseconds)	Description
100	.6105	Very Fast
70	.6073	Very Fast
50	.5984	Very Fast

***Legend:** Scale (in ms) Below 0.6588 = Very Fast; 0.6589 –0.8007 = Fast; 0.8008 -0.9425=Moderate; 0.9426 –1.0843 = Slow; Above 1.0844 = Very Slow.*

The Average Round-Trip Time when Cable C is tested at Different Distances from Access Point to Remote Terminal

Table 5 shows the average mean of three trials of testing using ping network command at different distances. Using the weighted mean, the result showed that the obtained mean score of Cable C when tested at long distance obtained was 0.6145 ms which

was described as "very fast". The obtained mean score when tested at medium distance was 0.5978 ms which was also described as "very fast" while the obtained mean score when tested at short distance was 0.5792 which was also described as "very fast".

Table 5.The Average Round-Trip Time when Cable C is tested at Different Distances from Access Point to Remote Terminal

Distance(in meter)	Mean (in milliseconds)	Description
100	.6145	Very Fast
70	.5978	Very Fast
50	.5792	Very Fast

***Legend:** Scale (in ms) Below 0.6588 = Very Fast; 0.6589 –0.8007 = Fast; 0.8008 -0.9425=Moderate; 0.9426 –1.0843 = Slow; Above 1.0844 = Very Slow.*

Overall Average of Round-Trip Time of UTP Cables at Different Distances from Access Point to Remote Terminal

Table 6 shows the overall average of round-trip time of UTP Cables at different distances**.** Using the weighted mean, the result showed that the obtained mean score of Cable A (Intex) when tested at different distances obtained was 0.6072 ms which was described as "very fast". The obtained mean score of Cable B (Digital) when tested at different distances was 0.6054 ms which was also described as "very fast" while the obtained mean score of Cable C (Belden) when tested at different distances was 0.5972 which was also described as "very fast".

Based on the results of the study, among the three brands being tested it was revealed that the best brand of UTP cables in terms of round-trip time was the Belden brand.

Table 6.Overall Average of Round-Trip Time of UTP Cables at Different Distances from Access Point to Remote Terminal

Brand	Mean (in milliseconds)	Description
Intex	.6072	Very Fast
Digital	.6054	Very Fast
Belden	.5972	Very Fast

***Legend:** Scale (in ms) Below 0.6588 = Very Fast; 0.6589 –0.8007 = Fast; 0.8008 -0.9425=Moderate; 0.9426 –1.0843 = Slow; Above 1.0844 = Very Slow.*

4.2 Inferential Data Analysis

In the conduct of this study, the results were statistically computed. The Chi-square test and Monte Carlo were used as the inferential statistical tool.

Differences in the Round-Trip Time between Brands of UTP Cables when Tested at Long Distance from Access Point to Remote Terminal

Table 7 shows that the UTP Cables when tested at long distance, the obtained Sig. (2-tailed) value was 0.020. This was lower than the 0.05 level of significance. Thus, the null hypothesis that states that there is no significant difference in the round-trip time between brands of UTP cables when tested at a long distance was rejected.

Table 7.Differences in the Round-Trip Time BetweenBrands of UTP Cables when Tested at Long Distance from Access Point to Remote Terminal

Distance(in meters)	Chi-square	df	Monte Carlo Sig. (2-tailed)
100	7.357*	2	0.020

*Significant at 0.05 alpha level.

Differences in the Round-Trip Time Between Brands of UTP Cables when Tested at Medium Distance from Access Point to Remote Terminal

Table 8 shows that the UTP Cables when tested at medium distance, the obtained Sig. (2-tailed) value was 0.121. This was greater than the 0.05 level of significance. Thus, the null hypothesis that states that there is no significant difference in the round-trip time between brands of UTP cables when tested at a medium distance was accepted.

Table 8.Differences in the Round-Trip Time between Brands of UTP Cables when Tested at Medium Distance from Access Point to Remote Terminal

Distance (in meters)	Chi-square	df	Monte Carlo Sig. (2-tailed)
70	4.217	2	0.121

*Significant at 0.05 alpha level.

Differences in the Round-Trip Time between Brands of UTP Cables when Tested at Short Distance from Access Point to Remote Terminal

Table 9 shows that the UTP Cables when tested at short distance, the obtained Sig. (2-tailed) value was 0.011. This was lower than the 0.05 level of significance. Thus, the null hypothesis that states that there is no significant difference in the round-trip time between brands of UTP cables when tested at a short distance was rejected.

Table 9. Differences in the Round-Trip Time between Brands of UTP Cables when Tested at Short Distance from Access Point to Remote Terminal

Distance (in meters)	Chi-square	df	Monte Carlo Sig. (2-tailed)
50	8.238*	2	0.011

*Significant at 0.05 alpha level.

Overall Differences in the Round-Trip Time between Brands of UTP Cables when Tested at Long, Medium, and Short Distances from Access Point to Remote Terminal

Table 10 shows that the UTP Cables when tested at long, medium, and short distances, the obtained Sig. (2-tailed) value was 0.471. This was greater than the 0.05 level of significance. Thus, the null hypothesis that states that there is no significant difference in the round-trip time between brands of UTP cables when tested at a short distance was accepted.

Table 10. Overall Differences in the Round-Trip Time between Brands of UTP Cables When Tested at Long, Medium, and Short Distances from Access Point to Remote Terminal

Distance(in meters)	Chi-square	df	Monte Carlo Sig. (2-tailed)
100,70,50	1.607	2	0.471

*Significant at 0.05 alpha level.

V. SUMMARY, CONCLUSIONS and RECOMMENDATIONS

5.1 Summary of the Study

This study was conducted for the purpose of determining the comparison of round-trip time of commonly used Unshielded Twisted Pair Cables among Internet Cafe's in Estancia, Iloilo which differs in brand names and distances.

Specifically, it sought to answer the following questions:

1. What is the average round-trip time when Cable A is tested at different distances from access point to remote terminal?
2. What is the average round-trip time when Cable B is tested at different distances from access point to remote terminal?
3. What is the average round-trip time when Cable C is tested at different distances from access point to remote terminal?
4. Is there a significant difference in round-trip time between cables when tested at different distances from access point to remote terminal?

The experimental method of research was utilized. The researchers secured the necessary permits to conduct the study. After the permits became available, the researchers constructed a survey instrument. Researchers-made survey instrument was used to solicit information from the existing Internet Cafés and computer stores in the Municipality of Estancia of their commonly used brands of UTP cables. The researchers-made survey instruments were subjected to face validation by three panels of experts. The respondents of the study were the 30 establishments of Internet Cafés and Computer Stores in the Municipality of Estancia. After validation, the researchers conducted the actual survey to the identified respondents. As soon as the result of the survey became available, the researchers purchased the top three brands of UTP cables and labeled them as Cable A, Cable B, and Cable C. The actual testing of round-trip time of these UTP cables was done at NIPSC Main Campus Estancia, Iloilo.

There were first, second and third trials of ping test which were intended for this study.

The Chi-square and Monte Carlo were used to determine the differences in round-trip time between Cable A (Intex), Cable B (Digital), and Cable C (Belden) when tested at different distances from access point to remote terminal.

The average round-trip time of Cable A (Intex) when tested at different distances from access point to remote terminal regarded the result as very fast. Similarly, the average round-trip time of Cable B (Digital) and Cable C (Belden) when tested at different distances from access point to remote terminal was also described as very fast.

5.2 Conclusions

Based on the analysis of the findings of the study, it was still revealed that the performance of UTP cables, regardless of the brand names, do not differ from each other because according to Ahaneku, Okonor and Offor, (2012) that when the transmission lines are properly laid straightly the electrical characteristics are the same, and therefore, performs the same.

From the findings of the study, the UTP cables have a significant difference at long distance and short distance from the access point to remote terminal. However, at a medium distance, there was no significant difference from the access point to remote terminal.

The researchers had previously assumed that at long and medium distance, there will be a significant difference in the average round-trip time because of the distance. Technically speaking, the 100 m length and 70 m length of UTP cables had already a gap in terms of distance from the router to the notebook computer as being pointed out, compared to 50 m length of UTP cables which has the nearest distance to the router and can possibly have the least round-trip time among the other distances that were mentioned above. Through this study, the researchers have discovered that not all UTP cables with distances assigned can have a significant difference within an interprocessor distance of LAN.

Therefore in this study, there were no significant differences in the overall round-trip time between brands of UTP cables when tested at long, medium, and

short distances from access point to remote terminal. This simply showed that Internet Cafés can make use of any brand available in the market because they perform the same. The researchers concluded that Cable C which was Belden has a better performance compared to Cable A (Intex) and Cable B (Digital). For a reason that, Cable C which was the Belden brand has a shortest obtained mean average of round-trip time.

5.3 Recommendations

Based on the aforementioned findings and conclusions drawn, the following recommendations are advanced:

1. A similar study should be made using different network cable brands and with different length.
2. A similar study should be made using the same 3 UTP cable brand names but instead of one (1) notebook computer which was used in this study, they should used 3 notebook computers.
3. The future researchers should find other variables that can be a factor in comparing cables.
4. It is recommended that the future researchers use this data gathered as their reference with similar problem.

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