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Foreword

Alhamdulillah. First of all a big thank you and congratulations to the Editorial Board of *Esteem Academic Journal* of Universiti Teknologi MARA (UiTM), Pulau Pinang for their diligent work in producing this issue. I also would like to thank the academicians for their contributions and the reviewers for their meticulous vetting of the manuscripts. A special thanks to University Publication Centre (UPENA) of UiTM for giving us this precious opportunity to publish this first issue of volume 5. In this engineering issue we have upgraded the standard of the manuscript reviewing process by inviting more reviewers from our university as well as other universities in Malaysia. We have embarked from previous volume to establish a firm benchmark and create a journal of quality and this current issue remarks a new height of the journal quality. Instead of publishing once in every two years, now *Esteem* publishes two issues annually.

In this issue, we have compiled an array of 13 interesting engineering research and technical based articles for your reading. The first article is entitled "The Response of Tube Splitting on Circular Tubes by Using Various Types of Semi-angles Dies and Slits". The authors, Mohd Rozaiman Aziz and Roslan Ahmad investigated the axial splitting and curling behavior of aluminum circular metal tubes which was compressed axially under static loading using three types of dies with different semi-angles. The authors concluded that the introduction of slit to the specimen is necessary to initiate slitting rather than inversion.

Salina Budin, Aznifa Mahyam Zaharudin, and Sugeng Priyanto presents a model of energy conversion and impact energy generation during collision based on free falling experiment, which is closely resembles direct collision between ball and inner wall of the vial. Simulation results from the proposed impact energy model demonstrated that the impact energy generated during the collision is strongly influenced by the thickness of the work materials and reaches zero at certain value of the work materials thickness, which increases with an increase of falling height.

Salina Alias, Caroline Marajan and Mohamad Azrul Jemain wrote an article that looks at adsorption of zinc from waste water using bladderwort (*Utricularia vulgaris*). In batch adsorption studies, data show that dried bladderwort has considerable potential in the removal of metal ions from aqueous solution. The fourth article written by

Muhammad Khusairi Osman et al. looked at 3D object recognition using affine moment invariants and Multiple Adaptive Network Based Fuzzy Inference System (MANFIS). The experimental results show that Affine Moment Invariants combined with MANFIS network attain the best performance in both recognitions, polyhedral and free-form objects.

The article entitled "Construction Waste Management Methods Used by Contractors in the Northern Region" authored by Siti Hafizan Hassan, Nadira Ahzahar and Mohd Nasrul Nizam Nasri reports an ongoing study on the use of construction waste management methods by contractors and its impact on waste reduction in the Northern Region. In conclusion, the sizing and amount of materials to be ordered to reduce wastage is significant in reducing construction waste generation waste, alleviating the burden associated with its management and disposal. The sixth article by Muhammad Sofian Abdullah et al. examined on the performance of Performance of Palm Oil Fuel Ash (POFA) with lime as stabilizing agent for soil improvement. The authors concluded that POFA can be used to treat the silty soil as well as to reduce the environmental problem.

The seventh article penned by Soffian Noor Mat Saliah, Noorsuhada Md. Nor and Megat Azmi Megat Johari presents the results of an experimental study on the interfacial bond strength (IBS) of polypropylene fiber concrete (PFC). It was found that the interfacial bond strength between concrete and reinforcement bar was not affected by the inclusion of polypropylene fibers. However, concrete containing fibers exhibited no breaking of concrete and no debonding of reinforcement. The article by Juliana Zaabar and Rusnani measures, evaluates and analyzes the network link performance of fiber optic cable using OTDR. The authors suggested that the major loss for these measurements is connector loss. Preventive maintenance will increase the life time of fiber optic. From some of the findings, the PVC dust cap has been identified as a main source of contamination for the SC connector.

The article entitled "Symbolic Programming of Finite Element Equation Solving for Plane Truss Problem" by Syahrul Fithry Senin proposed a plane truss problem to be solved by finite element method using MAPLE 12 software. The numerical solution computed by the author was almost matched with the commercial finite element software solution, LUSAS. The tenth article by Nor Azlan Othman, Nor Salwa Damanhuri and Visakan Kadirkamanathan presents a detail review of fault diagnosis in rotating machinery using pattern recognition technique. The authors proposed a solution based on artificial neural network (ANNs) which is Multi-Layer Perceptron (MLP). The authors concluded that the proposed methods are suitable for rotating machinery on fault detection and diagnosis.

The eleventh article is entitled "RAS Index as a Tool to Predict Sinkhole Failures in Limestone Formation Areas in Malaysia". Damanhuri Jamalludin et al. found that, using the RAS classification method, the prediction of sinkhole occurrences can be easily be made by simply knowing the weekly rainfall especially in areas having limestone as the bedrock. The twelfth by Muhammad Hafeez Osman et al. explores cases regarding the histories of rock slope repair and stabilization of unstable boulder along the road from Bukit Cincin to Genting Highland and along the road from Gap to Fraser Hill. The last article is "Soil Nail and Guniting Works in Pahang". The authors, Damanhuri Jamalludin et al. concluded that if the stability of the embankment needs to be improved, soil nails can be installed and embankment surface can be covered with gunite to prevent erosion.

We do hope that you not only have an enjoyable time reading the articles but would also find them useful. Thank you.

Mohd Aminudin Murad
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Performance Test and Analysis for Fiber Optic Network UiTM Pulau Pinang Campus: A Case Study

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ABSTRACT

Fiber optic cables are being increasingly employed in industrial and universities in a host of communication applications. Fiber optic cable permits transmission over longer distances and at higher data rates than other forms of communication media. Fiber optic networks in Universiti Teknologi MARA (UiTM) Pulau Pinang campus is used for data and computer links. The performance maintenance was not being done in a proper manner since the network was installed in the year of 2002. Optical Time Domain Reflectometer (OTDR) is a sophisticated instrument which provides a graphical trace to measure the fiber optic cable performance (Coulombe, 1988). Before any measurement is done, fiber optic network links for vertical and horizontal links are identified. The main objective of this case study is to measure, evaluate and analyze the network link performance of fiber optic cable in Kompleks Perdana building and the links to adjacent buildings. The measurements were done using OTDR. From the measurement and evaluation done, it is found that even though the type of fiber cable used is the same for all paths, the loss involved are different, depending on the terminations, connectors, cleanliness of the terminals, cable looping and the condition of the room where the terminals are located.

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Keywords: *Fiber optic, fiber optic networking, fiber optic performance, Optical Time Domain Reflectometer (OTDR)*

Introduction

In recent years, fiber optic is replacing copper wire as an appropriate means of communication signal transmission. Fiber has many advantages compared to copper (Debra, 2001). They span the long distances between local phone systems as well as providing the backbone for many network systems. Other system users include cable television services, university campuses, office buildings, industrial plants, and electric utility companies. A fiber optic system is similar to the copper wire system that fiber optics is replacing. The difference is that fiber optics use light pulses to transmit information down fiber lines instead of using electronic pulses to transmit information down copper lines. As the fiber optic communication systems develop, they become newer and more complex parameters to monitor. An instrument that can be used to monitor the parameters for fiber optic cable plants is the Optical Time Domain Reflectometer (OTDR). OTDR is the best instrument to characterize an optical fiber (James, 2005). An OTDR injects a series of light pulses into the fiber optic under test. It then extracts, from the sending end of fiber, light that is scattered and reflected back to the source. The intensity of the return pulses is measured and integrated as a function of time, and is plotted as a function of fiber length. An OTDR may be used for estimating the fiber's length and overall attenuation, including splice and mated-connector losses. It may also be used to locate faults, such as breaks, and to measure optical return loss.

The slope of the fiber trace represents the attenuation coefficient of the fiber and is calibrated in dB/km by the OTDR. Connectors and splices are called "events" in OTDR jargon. Both should show a loss, but connectors and mechanical splices will also show a reflective peak. The height of that peak will indicate the amount of reflection at the event, unless it is so large that it saturates the OTDR receiver. Then the peak will have a flat top and tail on the far end, indicating the receiver was overloaded.

Sometimes, the loss of a good fusion splice will be too small to be seen by the OTDR. That is good for the system but can be confusing to the operator. It is very important to know the lengths of all fibers in the network, so that the operator knows where to look for events and will not get confused when unusual events show up.

Scope of Work

This case study was conducted by identifying the problems on the fiber optic cable network architecture performance in Kompleks Perdana building for all ten floors. OTDR is a measurement tool that used in the measurement. The networking links of the fiber optic cable for all ten floors in Kompleks Perdana building is studied and identified before any measurement is made.

In this case study, OTDR to be used is NetTek Analyzer OTDR module YSS1315. This equipment is used to do the performance test of fiber optic cable networking in UiTM Pulau Pinang, in Kompleks Perdana building and the links to adjacent buildings. The first termination of fiber optic cable is placed at the server room at the second floor of Kompleks Perdana building. The server room is the main part for multiplexing and switching of fiber optic transmission. From the server room, the fiber optic cable then separates into a few parts to Asynchronous Transfer Mode (ATM) rooms. There are fifteen ATM rooms in Kompleks Perdana building. From ATM rooms, the fiber optic cable then links to various racks. Most racks are placed in laboratories. From Kompleks Perdana, there are links to Hotel and Mechanical buildings from the server room to the Main Distribution Frame (MDF) room at the ground floor at Kompleks Perdana building.

Measurements were conducted in ATM rooms and MDF rooms. The measurement jobs were done in five stages. The first stage was the measurement from ATM rooms to the server room. For the links between ATM rooms and server room, there were fifteen links. But, only nine ATM rooms were analyzed in this case-study. The Second stage was the measurement from ATM rooms to racks. The third stage was the from MDF room to Hotel and Mechanical ATM. The fourth stage was the measurement for links which were on looped cable and unlooped cable condition. The last stage of measurement was to capture terminations of the temperature reading of fiber optic in ATM rooms. It was captured by using Infrared (IR) thermal imaging camera. After that, the data was collected and analyzed.

Research Methodology

Equipment and Sites Set-up

The measurements were conducted in the ATM rooms available on all the ten floors in the Kompleks Perdana building, and in the MDF room at the ground floor for the links to the Hotel and Mechanical buildings. Fiber optic patch cord was used for connection between connector adapter at OTDR and terminal panel at ATM rack. Figure 1 shows the equipment and site set-up for the measurements. Before any measurement was done, certain procedures were followed.

Figure 2 shows the test setting of an OTDR. For every measurement, the test setting and limitation must be set-up. Some general safety must be considered. The exposed end of the laser output ports was not allowed to be touched with anything. The proper cleaning material was suggested to be used. It was to maintain the performance of the fiber optic connector. The connector must be cleaned prior to every measurement (NetTek, 2000).

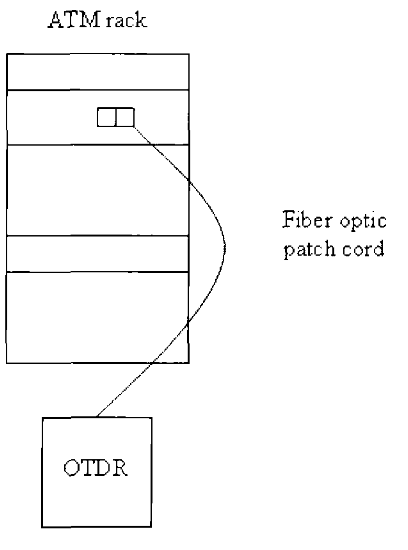

Figure 1: Equipment and Site Set-up

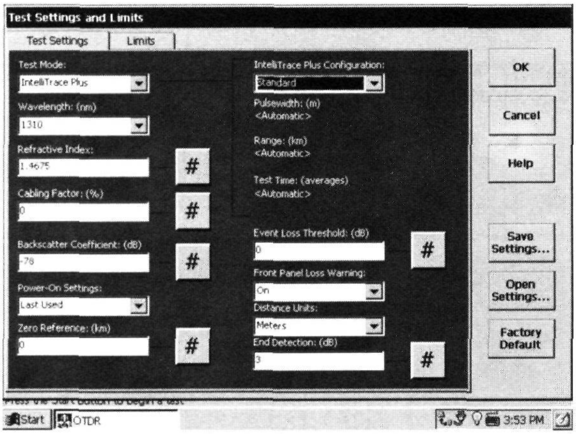

Figure 2: Test Setting and Limitation

Links of Measurement

Fiber optic cable networking in UiTM Pulau Pinang in Kompleks Perdana building and the links to adjacent buildings are illustrated in Tables 1, 2 and 3.

Table 1 shows the links of links between the server room and ATM rooms. Table 2 shows the lists of links between ATM rooms and racks. Table 3 shows the links between MDF at Kompleks Perdana to Hotel and Mechanical building.

Table 1: Links between Server Room and ATM Rooms

Server Room	Level	ATM rooms
2-4	Ground	0-11
		0-24
	First	1-1
		1-31
	Second	2-2
		2-51
	Third	3-4
		3-21
	Fourth	4-1
		4-2
	Fifth	5-1
	Sixth	6-1
	Seventh	7-1
	Eighth	8-1
	Ninth	9-1

Table 2: Links between ATM Rooms and Racks

Level	ATM rooms	Rack
Ground	0-24 (Wing A)	0-21 0-22 0-23 0-25 0-26 0-31 0-32
	0-11 (Wing B)	0-12 1-13 0-14 0-15
First	1-1 (Wing A)	1-11 1-12 1-13 1-14 1-15 1-16 1-17 1-18 1-19 1-42
	1-31 (Wing B)	1-21 1-22 1-23 1-32 1-33 1-34 1-41

Level	ATM rooms	Rack
Second	2-2 (Wing A)	2-11 2-12 2-13 2-21 2-22 2-23 2-24 2-25 2-26 2-31 2-32
	2-51 (Wing B)	2-33 2-34 2-35 2-36 2-37 2-38 2-39 2-52 2-310
Third	3-21 (Wing A)	3-11 3-22 3-23 3-31 3-32
	3-4 (Wing B)	3-41 3-42 3-43

Table 3: Links between MDF to Adjacent Buildings

MDF	Adjacent Building
Kompleks Perdana	Hotel MDF
	Mechanical ATM

Data Collection

Data for Links between Server Room and ATM Rooms

There were ten readings for links measurement between ATM room and server room. Figure 3 to Figure 12 represent the trace obtained.

Table 4 shows the readings from link ATM ground floor (0-11) to server room. Figure 3 shows the trace from ATM ground (0-11) to server room. Ground floor is denoted as '0'. Number '11' means the rack number of ATM room. Every ATM room is denoted by a different name.

Tables 5, 6, 7, 8, 9, 10, 11, 12 and 13 show the readings for links between ATM rooms located at each of the floors to the server room. Figures 4, 5, 6, 7, 8, 9, 10, 11 and 12 show the traces for links between ATM rooms at each of the floors to the server room.

Table 4: Data from ATM 0-11 to Server Room

Event no.	Distance (km)	Loss (dB)	Reflectance (dB)	Cuml. loss (dB)	Slope (dB/km)
1	0.000	1.942	-14	1.942	-
2	0.033	-	-	-	-
3	0.137	-	-18	-	-

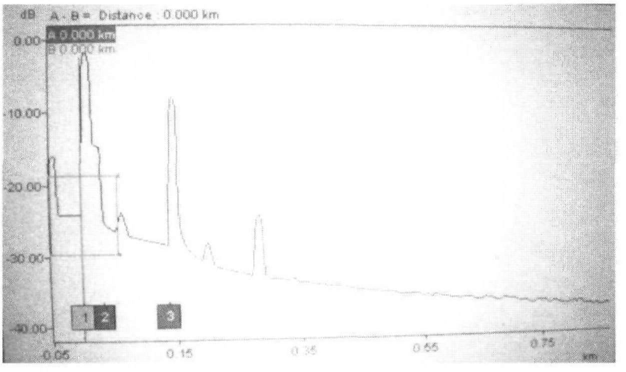

Figure 3: Trace Data from ATM 0-11 to Server Room

Table 5: Data from ATM 1-1 to Server Room

Event no.	Distance (km)	Loss (dB)	Reflectance (dB)	Cuml. loss (dB)	Slope (dB/km)
1	0.000	1.530	-13	1.530	-
2	0.027	-	-	-	-
3	0.153	-	-15	-	-

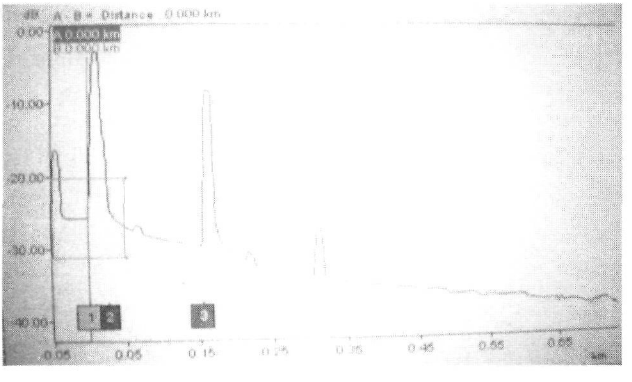

Figure 4: Trace Data from ATM 1-1 to Server Room

Table 6: Data from ATM 2-2 to Server Room

Event no.	Distance (km)	Loss (dB)	Reflectance (dB)	Cuml. loss (dB)	Slope (dB/km)
1	0.000	-0.750	>-9	--0.750	-
2	0.053	-	-	-	-
3	0.067	-	-	-	-
4	0.184	-	-25		

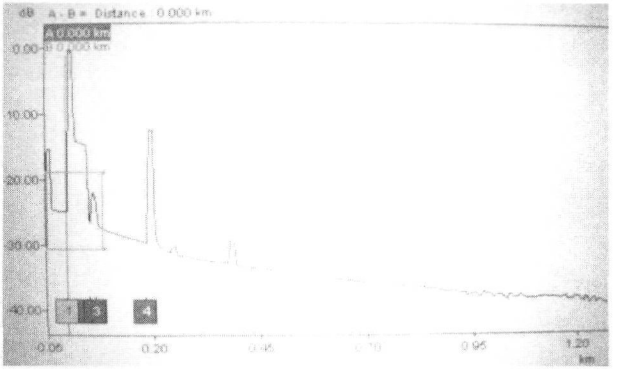

Figure 5: Trace Data from ATM 2-2 to Server Room

Table 7: Data from ATM 3-4 to Server Room

Event no.	Distance (km)	Loss (dB)	Reflectance (dB)	Cuml. loss (dB)	Slope (dB/km)
1	0.000	-0.923	>-9	-0.923	-
2	0.051	-	-	-	-
3	0.217	-	-21	-	-

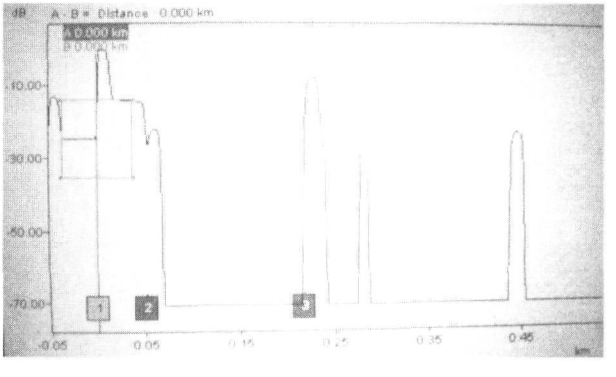

Figure 6: Trace Data from ATM 3-4 to Server Room

Table 8: Data from ATM 4-1 to Server Room

Event no.	Distance (km)	Loss (dB)	Reflectance (dB)	Cuml. loss (dB)	Slope (dB/km)
1	0.000	2.632	-15	2.632	-
2	0.031	-	-	-	-
3	0.204	-	-22	-	-

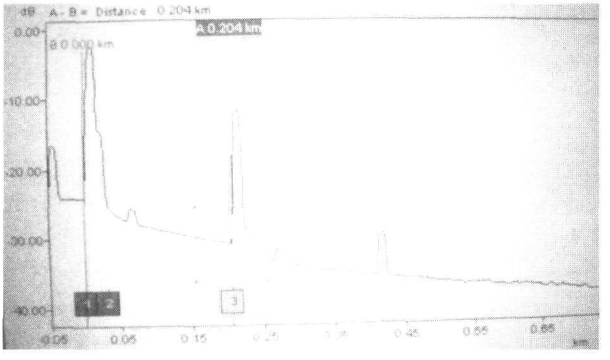

Figure 7: Trace Data from ATM 4-1 to Server Room

Table 9: Data from ATM 5-1 to Server Room

Event no.	Distance (km)	Loss (dB)	Reflectance (dB)	Cuml. loss (dB)	Slope (dB/km)
1	0.000	-2.144	>-9	-2.144	-
2	0.055	-	-	-	-
3	0.074	-	-	-	-
4	0.147	-	-21		

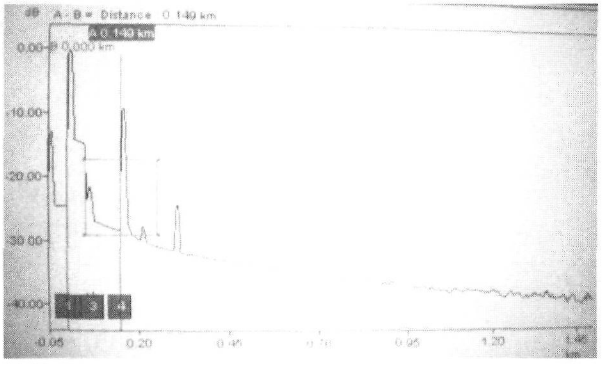

Figure 8: Trace Data from ATM 5-1 to Server Room

Table 10: Data from ATM 6-1 to Server Room

Event no.	Distance (km)	Loss (dB)	Reflectance (dB)	Cuml. loss (dB)	Slope (dB/km)
1	0.000	1.935	-15	1.935	-
2	0.031	-	-	-	-
3	0.149	-	-20	-	-

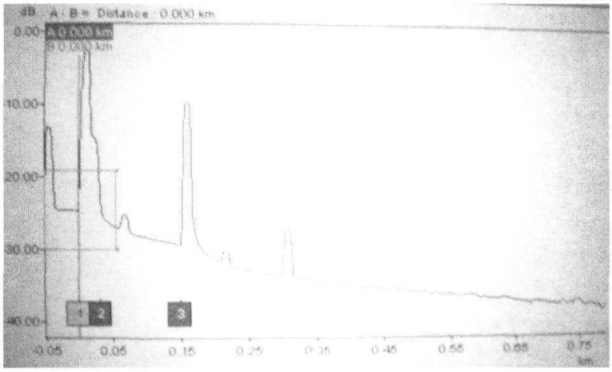

Figure 9: Trace Data from ATM 6-1 to Server Room

Table 11: Data from ATM 7-1to Server Room

Event no.	Distance (km)	Loss (dB)	Reflectance (dB)	Cuml. loss (dB)	Slope (dB/km)
1	0.000	-3.946	>-10	-3.946	-
2	0.031	-	-	-	-
3	0.149	-	-14	-	-
4	0.155	-	-32		

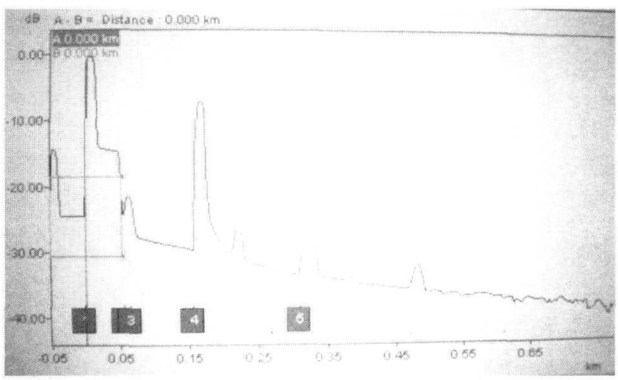

Figure 10: Trace Data from ATM 7-1 to Server Room

Table 12: Data from ATM 8-1 to Server Room

Event no.	Distance (km)	Loss (dB)	Reflectance (dB)	Cuml. loss (dB)	Slope (dB/km)
1	0.000	-1.430	-31	-1.430	-
2	0.020	-	-	-	-
3	0.161	-	-28	-	-

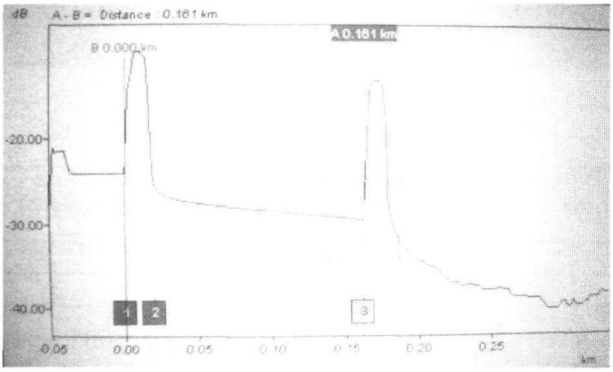

Figure 11: Trace Data from ATM 8-1 to Server Room

Table 13: Data from ATM 9-1 to Server Room

Event no.	Distance (km)	Loss (dB)	Reflectance (dB)	Cuml. loss (dB)	Slope (dB/km)
1	0.000	1.298	>-11	1.298	-
2	0.047	-	-	-	-
3	0.165	-	-20	-	-

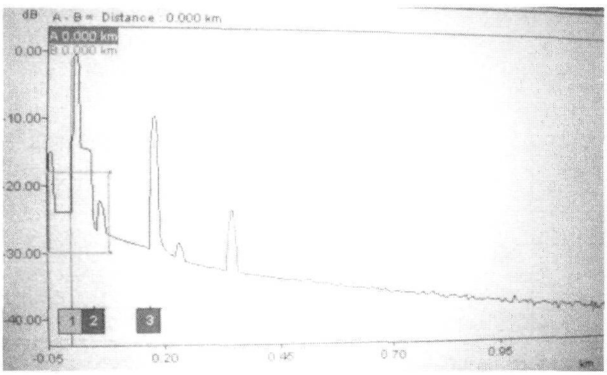

Figure 12: Trace Data from ATM 9-1 to Server Room

Data for Links between ATM Rooms and Racks

Two readings were collected for link measurements between ATM rooms to racks. Table 14 shows the readings obtained from ATM room 0-11 to rack 0-12. Figure 13 shows the trace from link between ATM room 0-11 and rack 0-12.

Table 15 shows the data readings from link ATM 2-2 to rack 2-31. Figure 14 shows the trace from link between ATM room 2-2 and rack 2-13.

Table 14: Data from ATM room 0-11 to Rack 0-12

Event no.	Distance (km)	Loss (dB)	Reflectance (dB)	Cuml. loss (dB)	Slope (dB/km)
1	0.000	2.969	-19	2.969	-
2	0.031	-	-	-	-
3	0.157	-	-18	-	-

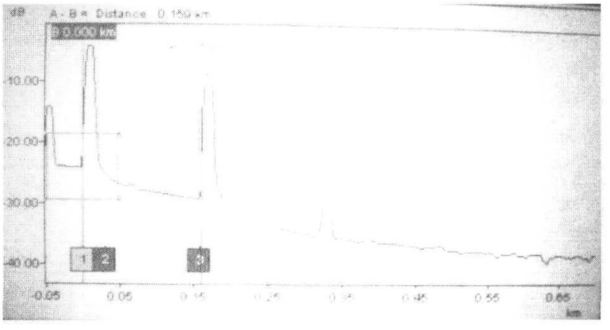

Figure 13: Trace Data from ATM 0-11 to Rack 0-12

Table 15: Data from ATM 2-2 to Rack 2-31

Event no.	Distance (km)	Loss (dB)	Reflectance (dB)	Cuml. loss (dB)	Slope (dB/km)
1	-0.001	0.451	-12	0.451	-
2	0.014	-	-	-	-
3	0.092	-	-14	-	-
4	0.188	-	-37	-	-

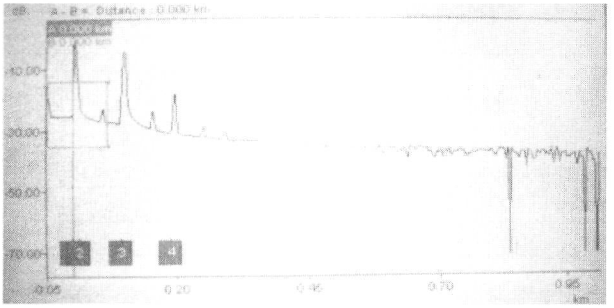

Figure 14: Trace Data from ATM 2-2 to Rack 2-31

Data for Links from MDF Kompleks Perdana to Hotel and Mechanical Building

Tables 16 and 17 show the data for links from MDF room to Hotel and to Mechanical building respectively. Figures 15 and 16 show the traces for links from MDF room to Hotel and to Mechanical building respectively.

Table 16: Data Links from MDF to Hotel Building

Event no.	Distance (km)	Loss (dB)	Reflectance (dB)	Cuml. loss (dB)	Slope (dB/km)
1	-0.004	1.574	>-7	1.574	-
2	0.082	-	-	-	-
3	0.113	-	-	-	-

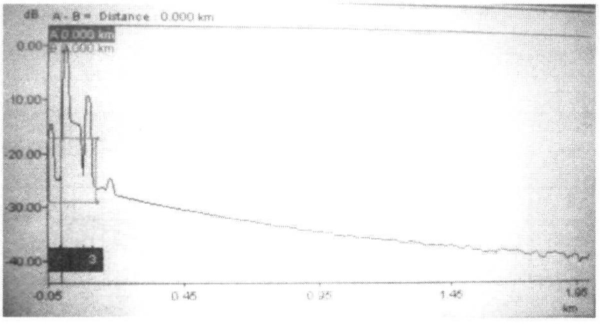

Figure 15: Trace Data Links from MDF to Hotel Building

Table 17: Data Links from MDF to Mechanical Building

Event no.	Distance (km)	Loss (dB)	Reflectance (dB)	Cuml. Loss (dB)	Slope (dB/km)
1	-0.004	-2.493	>-7	-2.493	-
2	0.020	-	-	-	-
3	0.374	-	-32	-	-

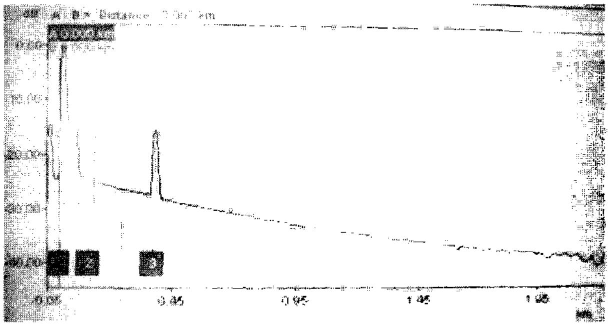

Figure16: Trace Data Links from MDF to Mechanical Building

Comparisons for Loop and Unlooped Fiber Optic Cable

Tables 18 and 19 show the readings for looped and unlooped fiber optic cable at links from ATM 1-11 to rack 1-19. Figures 17 and 18 show the trace for looped and unlooped fiber optic cable at links from ATM 1-1 to rack 1-19.

Table 18: Data for Looped Fiber Optic at Links between ATM 1-1 to Rack 1-19

Event no.	Distance (km)	Loss (dB)	Reflectance (dB)	Cuml. loss (dB)	Slope (dB/km)
1	0.000	3.652	-16	3.652	-
2	0.027	-	-	-	-
3	0.077	-	-	-	-

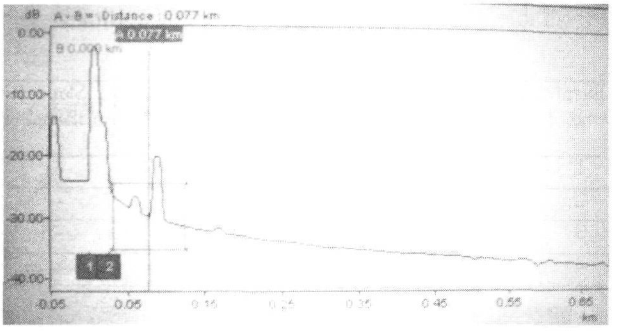

Figure 17: Trace Data for Looped Fiber Optic at Links between ATM 1-1 to Rack 1-19

Table 19: Data for Unlooped Fiber Optic at Links between ATM 1-1 to Rack 1-19

Event no.	Distance (km)	Loss (dB)	Reflectance (dB)	Cuml. loss (dB)	Slope (dB/km)
1	-0.004	2.360	-13	2.360	-
2	0.042	-	-	-	-
3	0.081	-	-	-	-

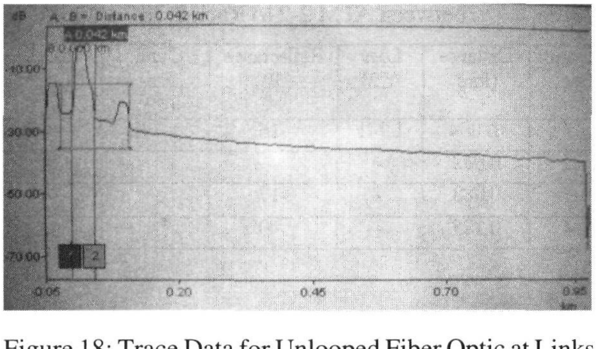

Figure 18: Trace Data for Unlooped Fiber Optic at Links between ATM 1-1 to Rack 1-19

Tables 20 and 21 show the readings for looped and unlooped fiber optic cable at links from ATM 1-11 to rack 1-19. Figures 19 and 20 show the traces for looped and unlooped fiber optic cable at links from ATM 2-2 to rack 2-23.

Table 20: Data for Looped Fiber Optic at Links between ATM 2-2 to Rack 2-23

Event no.	Distance (km)	Loss (dB)	Reflectance (dB)	Cuml. loss (dB)	Slope (dB/km)
1	-0.004	3.142	-9	3.142	-
2	0.088	-	-	-	-
3	0.123	-	-	-	-
4	0.185	-	-38	-	-

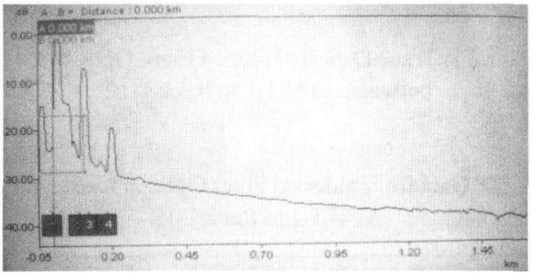

Figure 19: Trace Data for Looped Fiber Optic at Links between ATM 2-2 to Rack 2-23

Table 21: Data for Unlooped Fiber Optic at Links between ATM 2-2 to Rack 2-23

Event no.	Distance (km)	Loss (dB)	Reflectance (dB)	Cuml. loss (dB)	Slope (dB/km)
1	-0.004	1.741	-16	1.741	-
2	0.052	-	-	-	-
3	0.088	-	-17	-	-
4	0.185	-	-40	-	-

Figure 20: Trace Data for Unlooped Fiber Optic at Links between ATM 2-2 to Rack 2-23

Thermographic captures of Fiber Optic Cable Terminals at ATM Rooms

Figures 21and 22 show the thermographic images of fiber optic cable terminals captured using IR thermal imaging camera for ATM room 1-1 and ATM room 2-2.

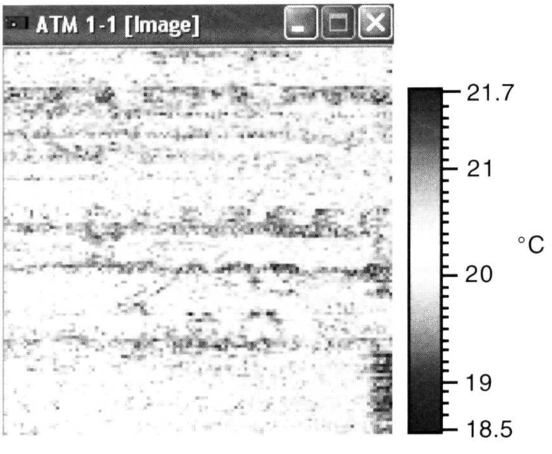

Figure 21: Temperature of Terminal at ATM Room 1-1

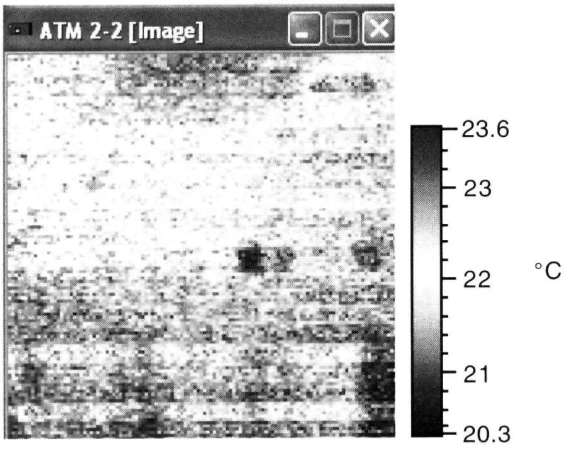

Figure 22: Temperature of Terminals at ATM Room 2-2

The average maximum temperature captured for the ATM rooms was 22.7°C. All the ATM rooms were air-conditioned.

Data Analysis and Findings

Data for Links between ATM Rooms and Server Room

Figure 3 shows the data link from ATM 0-11 to server room. At event 2, there is a break event at distance 0.033 km. It shows that there is a bend in the fiber optic. The bend in the fiber optic can be seen at the bottom of ATM room. Many cable loops of the fiber optic can be seen. The loops can affect the performance of the fiber optic. Minimum bending radius is important to which the cable may be safely bent during installation and for the long term. From the first floor to the ninth floor, except at the third and eighth floors, the characteristics of the link are almost the same. There are bends or connector loss. At the eighth floor, there is no connector loss.

Data for Links between ATM Rooms and Racks

Figure 13 shows the data that had been collected for the link from ATM room 0-11 to rack number 0-12. From Table 14, the fist event is the beginning of the fiber at the front panel. From event 2 to event 3, this is an attenuation of the fiber. At distance 0.070 km, there is a break event. The break event shows the connector loss (NetTek, 2000). The length of the fiber can be determined by looking at the last event. The total length of the fiber is 0.157 km. The trace after event 3 shows the reflection occurring before it slopes gently to the lower right. This is because the fiber optic link measured is too short for the OTDR used. Each link has its own distance and losses measured. The performance of the fiber optic can be obtained by looking at the traces.

Data for Links from MDF Kompleks Perdana to Hotel and Mechanical

From Figure 15 the distance from the MDF to the Hotel building is 0.133 km. From that trace, there is a bend of fiber optic at distance 0.082 km. The link loss is 1.574 dB. Figure 16 shows the trace for link between MDF to Mechanical building. The distance from MDF to Mechanical building is 0.374 km. The limitation of the slope for this OTDR is 5 dB/km. For short distances, the slope cannot be displayed.

Comparisons for Loop and Unlooped Fiber Optic Cable

Figure 17 shows the data for looped fiber optic at links between ATM 1-1 to rack 1-19. Figure 18 shows the data for unlooped fiber optic at links between ATM 1-1 to Rack 1-19. The comparison of data can be obtained by looking at Table 18 and Table 19. For looped fiber optic cable, the loss is 3.652 dB. For unlooped fiber optic cables, the loss is 2.360 dB. It shows that the loss can be reduced by unlooping the fiber optic cable. Sharper bend produces more loss at fiber optic cable (John Lester Miller, 2002). At ATM 2-2, for looped fiber cable the loss is 3.142 dB. For unlooped fiber cable, the loss is 1.741 dB. By unlooping the fiber optic cable, especially at the terminal ends, the loss can be reduced.

Thermographic Captures of Fiber Optic Cable Terminals at ATM Room

Figures 21 and 22 show the temperature of fiber optic cables at ATM room 1-1 and ATM room 2-2 respectively. At ATM room 1-1 the maximum temperature is 21.7°C. At ATM room 2-2, the maximum temperature is 23.6°C. The temperature at both ATMs is below room temperature. It means the fiber optic cable terminals are in good condition. Temperature cycling is a threat to fiber. Thermal cycling induces movement of the strength member that can cause physical changes in the internal structure of the cable, which may lead to high optical loss (John & Ed, 2002). For this reason, the ATM room must have an air conditioner. All the air conditioners at the ATM rooms in Kompleks Perdana are functioning, except for that at the MDF room at ground floor. It is shown in Figures 15 and 16 that there is a loss at the terminal, at event 1 (at distance less than 0.00 km). From this measurement, it shows that the temperature of the room where the cables are terminated should be kept below room temperature, and the best method is by installing air-conditioner.

Discussion

Cleanliness of optical connectors is considered as one of the basic requirements for successful performance measurement. It is a common practice to clean connectors before measurement and use (Berdinskikh et al., 2002). Dirty connectors are the main cause of increased back-reflection and insertion loss in connectors (John & Ed, 2002). The test setting and limit set-ups must be set correctly because it will affect the readings. The test settings may not change in the trace tabs (NetTek, 2000). Starting from the fourth floor to ninth floor, there are no loops at the bottom of the ATM rack. From the data, there are break events at certain distance. The bends or connectors cannot be seen because the fiber optic cable network is horizontally placed at the ceiling. The approximate position of the break can be determined from the trace.

Conclusion

Testing fiber optic cable networks are easy if the right instruments are chosen and industry testing standards are followed. When diagnosing problems, one must be creative in developing techniques that help reveal problems that show up on standard tests. It is of utmost importance to know the tools operation and limitations, and how to work around them. It is most helpful to have good cable network documentation, since knowing what and where the links to be tested will make it easier to find problems. From the trace in OTDR, the performance of fiber optic cable in UiTM Pulau Pinang can be determined. The performance of fiber optic cable is obtained by looking at the trace and the value of the link loss. The major loss for this case study is connector loss and the cable looping loss. This means that the bend of fiber optic cable also contribute for losses. In the long term, the losses will affect the performance of fiber optic cable. So, to maintain the good performance of fiber optic cables, the testing and maintenance procedure should be conducted every few months. It provides preventive maintenance in the future. Preventive maintenance will increase the life time of fiber optic. Some other findings are that, at the end of the connector, the use of Polyvinyl Chloride (PVC) dust cap has been identified as a main source of contamination for the Subscriber Connector (SC) connector. To solve this problem, it is recommended that it is replaced by a stiff, high density or polyethylene plastic cap. Connector loss is significant in this measurement. To reduce the connector loss, glue is used to tighten the connection. At the MDF room, the air conditioner is needed because high temperature will reduce the performance of the fiber optic cables, their connectors and terminations. It also reduces the life of fiber optic cables.

References

Berdinskikh, T., Bragg, J., Tse, E., Daniel, J., Arrowsmith, P., Fisenko, A., & Mahmoud. S. (2002). The contamination of fiber optics connectors and their effect on optical performance. *Journal of SMT*, *16*, 617-619.

Coulombe, R. F. (1988). *Fiber optic testing in the plant environment.* West Haven, CT: Fiber Optic Products.

Debra, C. (2001). *Optical networking.* John Wiley & Sons, Inc.

Gerd, K. (1999). *Optical fiber communications*, (3rd ed.). McGraw-Hill.

James, N. D. (2005). *Fiber optic communication.* Thomson Delmar Learning.

John, L. M., & Ed F. (2002). *Optical communication rules of thumb.* McGraw-Hill.

NetTekTM Analyzer OTDR Modules User Manual, Tektronix. (2000).