Analysis Of Attentuation In The System Of Communication Of Optical Fiber

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Abstract– *The research is on the use of optical fiber as a medium of transmission in form of optical wave (light), namely, G. 652 SMF and G.655 SMF NZDS, in Link Main Route and Link Diversity Route. Optical fiber also experiences losses. One of them is attentuation or the decrease of the light due to the distance and characteristic of the fiber. The value of the attentuation is measured by using Optical Power Meter and OTDR YOKOGAWA AQ7275. The result of the measurement is compared with the standard stipulated by International Telecommunication Union (ITU). Through the comparison, it is known that most of the values of the attentuation of the optical fiber is under the standards of ITU. It means optical fiber used is in good condition, except in Link Diversity Route in Core 22 and Core 23 due to bending in the distance 13 kms and 17 kms from the Link Main Route. And, to know the performance of system of the optical fiber communication, the method of Link Power Budget is employed.*

Keywords– *Optical Fiber, Attentuation of Optical Fiber, Link Power Budget*

1. Introduction

The use of optical fiber as medium of transmission has been increasingly using, replacing cable transmission. It is because of optical fiber has more advantages than cable or radio transmission, though, optical fiber is more expensive.

In optical fiber cable, data is transferred via laser beam in a bulk of data (200.000 Mbps/200 Gbps) with high speed. And, optical fiber is able to send data not more than 100 kms (or 60 miles) without repeater or transmission amplifier. In addition, the use of optical fiber preventing data from stealing as well as tapping while it is transmitting.

Backbone or transmission of communication using optical fiber is also experiencing disturbances. The disturbances are in form of losses which occur along the cable of the optical fiber. One of the losses is power loss due to the attentuation which occurs along the cable of the optical fiber. It causes the changes of the power from the transmitter to the receiver. In addition, it also brings about the decrease of bandwidth of the system, the quality of information transmission, efficiency, and system capacity as a whole. Losses are also able to derive from the installation of the supporting components needed in a network, such as, connector, splice, or other components installed in a transmission channel.

Therefore, the needs for an analysis of the use of optical fiber are important in order to know the feasibility of the use of it. In this research, the analysis focuses on the attentuation occuring in the optical fiber used, namely, optical fibers type G. 652 SMF and G.655 SMF NZDS, in Link Main Route and Link Diversity Route, so that the researcher can conclude that the use of the optical fiber is feasible.

2. Basic Theory

Optical fiber is one of transmission media which is able to transmit highly capacity data and highly reliable. Its reliability is due to its optical wave (laser beam) as a wave carrier. There are two kinds of optical fiber. One is single mode; and, the other one is multiple mode.

Single mode is a type of optical fiber having diameter 8-11 micrometer and its cladding has been standardized in 125 μm.

The structure of the optical fiber consists of three component: core, cladding, and coating, as shown below.

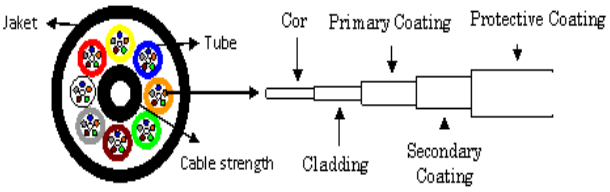

Figure 1. Cable Structure of Optical Fiber in Indosat Company, Pontianak Indonesia

Types of losses are as follows: absorb, scattering, radioactive losses. Attentuation is a kind of losses in optical fiber in form of the decrease of the light power, or the power of the light transmitting from the transmitter (P_{in}) until certain distance will be weakening or receiver (P_{out}).

The weakening of the signal (losses) is stated by dB and its symbol used is α. Sistematically, its formula uses par 2.1 and 2.2 as follows:

$$\mathbf{L = L_H \times (\sum_S + 1)} \qquad (2.1)$$

$$\mathbf{a = [(P_{in}\,(dBm) - P_{out}\,(dBm)) - \alpha_{CT}] / L} \qquad (2.2)$$

Where:

l attentuation is by using par 2.3. as follows:

$$\mathbf{\sum Loss = (\alpha_F + \alpha_{CT} + \alpha_{ST})} \qquad (2.3)$$

Where :

$\alpha_F = L \times \alpha$

$\alpha_{ST} = \sum_S \times \alpha_S$

Remarks:

$\sum$ **Loss** = Total Attentuation (dB)

α = Attentuation of the Cable per km (dB/Km)

L = Length of Cable (Km)

α_F = Total of Attentuation in Cable (dB)

α_{ST} = Total of Attentuation in the Coupling (dB)

α_S = Attentuation of the Coupling (dB)

$\sum_S$ = Number of Coupling

α_{CT} = Total of the Attentuation of the Splicer (dB)

While according to International Telecommu- nication Union, standard for attentuation for op- tical fiber ITU-T G.652 and ITU-T G.655 can be seen in par 2.4. as follows:

$$A = \alpha \ . L + \alpha_s \ . x + \alpha_c \ . y \qquad (2.4)$$

Remarks :

A = Total of Attentuation (dB)

α = Attentuation of Cable per km (dB/Km)

L = Length of Cable (Km)

α_s = Attentuation of Coupling (dB)

x = Number of Coupling

α_c = Attentuation of Splicer (dB)

y = Number of Splicer

In this research, method of measuring optical fiber is Through Power Technique and Backscattering Technique. Through power technique is done by comparing the result of the measurement of the optical fiber in the end (receiver) with the result of the measurement of the optical fiber in the short fiber (transmitter) by using short fiber as a reference. Measuring tool used in this type of measurement is Optical Power Meter (OPM).

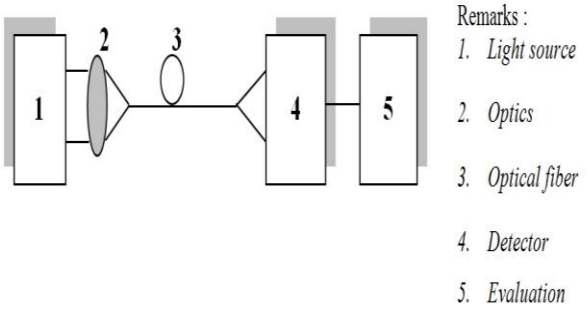

Figure 2. Block Diagram of *Trough Power Technique*

Backscattering technique is used by giving light to one of the fiber, whether transmitter or receiver, that will be measured.

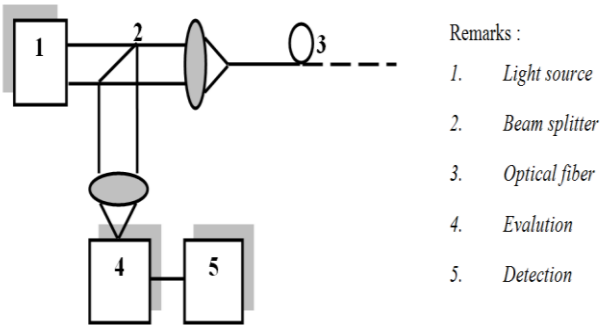

Figure 3. *Backscattering technique*

Measuring tools used are *Optical Time Domain Reflectometer* (OTDR) and *Optical Power Meter* (OPM). *Power meter used based on throught power technique*

3. Experimental Results

Table 1. Data on the Result of the Measurement, Theory Calculation, and Standard Calculation of ITU-T on Attentuation per Kilometer of Link Main Route

No	Splice	ODF/OTB	Distance (Km)	Calculation of Attentuation /Km Based on Theory (dB/Km)	Attentuation per Km of Measurement by using engukuran OTDR (dB/Km)	Attentuation per Kilometer According to ITU-T Standard (dB/Km)
March						
1	AYNI-SKK	1	27,74	0,22	0,21	0,35
2	AYNI-SKK	2	27,74	0,24	0,19	0,35
3	AYNI-SKK	9	27,74	0,21	0,19	0,30
4	AYNI-SKK	10	27,74	0,21	0,19	0,30
5	AYNI-SKK	13	27,74	0,22	0,20	0,30
6	AYNI-SKK	14	27,74	0,22	0,20	0,30
7	AYNI-SKK	19	27,74	0,21	0,20	0,30
8	AYNI-SKK	20	27,74	0,20	0,19	0,30
9	AYNI-SKK	25	27,74	0,22	0,20	0,30
10	AYNI-SKK	26	27,74	0,20	0,20	0,30
11	AYNI-SKK	31	27,74	0,19	0,19	0,30
12	AYNI-SKK	32	27,74	0,21	0,15	0,30
13	AYNI-SKK	43	27,74	0,23	0,18	0,30
14	AYNI-SKK	44	27,74	0,23	0,19	0,30
April						
1	AYNI-SKK	1	27,74	0,23	0,20	0,35
2	AYNI-SKK	2	27,74	0,25	0,20	0,35
3	AYNI-SKK	9	27,74	0,21	0,19	0,30
4	AYNI-SKK	10	27,74	0,20	0,19	0,30
5	AYNI-SKK	13	27,74	0,20	0,19	0,30
6	AYNI-SKK	14	27,74	0,20	0,20	0,30
7	AYNI-SKK	19	27,74	0,21	0,19	0,30
8	AYNI-SKK	20	27,74	0,20	0,21	0,30
9	AYNI-SKK	25	27,74	0,22	0,21	0,30
10	AYNI-SKK	26	27,74	0,20	0,18	0,30
11	AYNI-SKK	31	27,74	0,21	0,20	0,30
12	AYNI-SKK	32	27,74	0,21	0,18	0,30
13	AYNI-SKK	43	27,74	0,20	0,18	0,30
14	AYNI-SKK	44	27,74	0,23	0,19	0,30

Table 2. Data on the Result of the Measurement, Theory Calculation, and Standard Calculation of ITU-T on Attentuation per Kilometer of *Link Diversity Route*

No	Koneksi	ODF/OTB	Jarak (Km)	Perhitungan Redaman/Km Berdasarkan Teori (dB/Km)	Redaman Perkilometer Pengukuran OTDR (dB/Km)	Redaman Perkilometer Menurut Standar ITU-T (dB/Km)
Bulan Maret						
1	AYNI-SKK	1	42,68	0,22	0,21	0,35
2	AYNI-SKK	2	42,68	0,23	0,21	0,35
3	AYNI-SKK	9	42,68	0,22	0,24	0,30
4	AYNI-SKK	10	42,68	0,21	0,22	0,30
5	AYNI-SKK	15	42,68	0,21	0,20	0,30
6	AYNI-SKK	16	42,68	0,21	0,20	0,30
7	AYNI-SKK	22	42,68	0,33	0,14	0,30
8	AYNI-SKK	23	42,68	0,43	0,18	0,30
9	AYNI-SKK	25	42,68	0,22	0,20	0,30
10	AYNI-SKK	26	42,68	0,22	0,21	0,30
11	AYNI-SKK	31	42,68	0,22	0,19	0,30
12	AYNI-SKK	32	42,68	0,22	0,20	0,30
13	AYNI-SKK	43	42,68	0,20	0,19	0,30
14	AYNI-SKK	44	42,68	0,20	0,20	0,30
Bulan April						
1	AYNI-SKK	1	42,68	0,22	0,21	0,35
2	AYNI-SKK	2	42,68	0,23	0,21	0,35
3	AYNI-SKK	9	42,68	0,21	0,21	0,30
4	AYNI-SKK	10	42,68	0,22	0,16	0,30
5	AYNI-SKK	15	42,68	0,21	0,20	0,30
6	AYNI-SKK	16	42,68	0,21	0,20	0,30
7	AYNI-SKK	22	42,68	0,32	0,19	0,30
8	AYNI-SKK	23	42,68	0,41	0,17	0,30
9	AYNI-SKK	25	42,68	0,22	0,20	0,30
10	AYNI-SKK	26	42,68	0,21	0,87	0,30
11	AYNI-SKK	31	42,68	0,21	0,17	0,30
12	AYNI-SKK	32	42,68	0,21	0,20	0,30
13	AYNI-SKK	43	42,68	0,20	0,19	0,30
14	AYNI-SKK	44	42,68	0,20	0,20	0,30

Table 3. Data on the Result of Measurement, Calculation of *Link Power Budget* and Standard Calculation of ITU-T on Total of Attentuation in *Link Main Route*

No	Splicer	ODF/OTB	Distance (Km)	Total Calculation of Attentuation based on Power Budget (dB)	Total of Attentuation by using OTDR (dB)	Total of Attentuation According to Standard of ITU-T (dB)
March						
1	AYNI-SKK	1	27,74	8,13	6,10	11,90
2	AYNI-SKK	2	27,74	8,54	5,98	11,90
3	AYNI-SKK	9	27,74	7,73	5,77	10,52
4	AYNI-SKK	10	27,74	7,56	5,88	10,52
5	AYNI-SKK	13	27,74	7,95	5,81	10,52
6	AYNI-SKK	14	27,74	7,95	5,74	10,52
7	AYNI-SKK	19	27,74	7,68	6,10	10,52
8	AYNI-SKK	20	27,74	7,47	5,79	10,52
9	AYNI-SKK	25	27,74	7,97	5,73	10,52
10	AYNI-SKK	26	27,74	7,31	5,63	10,52
11	AYNI-SKK	31	27,74	7,09	5,77	10,52
12	AYNI-SKK	32	27,74	7,77	6,24	10,52
13	AYNI-SKK	43	27,74	8,32	5,81	10,52
14	AYNI-SKK	44	27,74	8,22	5,91	10,52
April						
1	AYNI-SKK	1	27,74	8,27	7,10	11,90
2	AYNI-SKK	2	27,74	8,76	6,54	11,90
3	AYNI-SKK	9	27,74	7,63	5,71	10,52
4	AYNI-SKK	10	27,74	7,45	6,75	10,52
5	AYNI-SKK	13	27,74	7,40	6,09	10,52
6	AYNI-SKK	14	27,74	7,46	5,95	10,52
7	AYNI-SKK	19	27,74	7,68	6,47	10,52
8	AYNI-SKK	20	27,74	7,50	6,36	10,52
9	AYNI-SKK	25	27,74	8,00	6,02	10,52
10	AYNI-SKK	26	27,74	7,42	5,85	10,52
11	AYNI-SKK	31	27,74	7,81	5,82	10,52
12	AYNI-SKK	32	27,74	7,77	5,94	10,52
13	AYNI-SKK	43	27,74	7,33	6,00	10,52
14	AYNI-SKK	44	27,74	8,22	6,20	10,52

Tabel 4. Data on the Result of Measurement, Calculation of *Link Power Budget* and Standard Calculation of ITU-T on Total of Attentuation in *Link Diversity Route*

No	Splicer	ODF/OTB	Distance (Km)	Total Calculation of Attentuation based on Power Budget (dB)	Total of Attentuation by using OTDR (dB)	Total of Attentuation According to Standard of ITU-T (dB)
March						
1	AYNI-SKK	1	42,68	12,20	10,81	17,83
2	AYNI-SKK	2	42,68	12,64	9,88	17,83
3	AYNI-SKK	9	42,68	12,40	9,26	15,70
4	AYNI-SKK	10	42,68	11,88	9,78	15,70
5	AYNI-SKK	15	42,68	11,96	9,63	15,70
6	AYNI-SKK	16	42,68	12,03	9,53	15,70
7	AYNI-SKK	22	42,68	17,34	2,83	15,70
8	AYNI-SKK	23	42,68	22,08	3,72	15,70
9	AYNI-SKK	25	42,68	12,43	10,18	15,70
10	AYNI-SKK	26	42,68	12,54	9,87	15,70
11	AYNI-SKK	31	42,68	12,38	9,32	15,70
12	AYNI-SKK	32	42,68	12,43	9,28	15,70
13	AYNI-SKK	43	42,68	11,43	9,34	15,70
14	AYNI-SKK	44	42,68	11,50	9,69	15,70
April						
1	AYNI-SKK	1	42,68	12,20	10,64	17,83
2	AYNI-SKK	2	42,68	12,63	10,10	17,83
3	AYNI-SKK	9	42,68	11,74	9,60	15,70
4	AYNI-SKK	10	42,68	12,16	9,95	15,70
5	AYNI-SKK	15	42,68	11,85	10,01	15,70
6	AYNI-SKK	16	42,68	12,02	9,77	15,70
7	AYNI-SKK	22	42,68	16,98	3,24	15,70
8	AYNI-SKK	23	42,68	21,16	3,59	15,70
9	AYNI-SKK	25	42,68	12,68	9,99	15,70
10	AYNI-SKK	26	42,68	12,65	9,90	15,70
11	AYNI-SKK	31	42,68	12,31	9,35	15,70
12	AYNI-SKK	32	42,68	11,79	9,24	15,70
13	AYNI-SKK	43	42,68	11,43	9,37	15,70
14	AYNI-SKK	44	42,68	11,32	9,62	15,70

4. Conclusions

Link Main Route is still in good condition or feasible to operate. Because, the values of the attentuation of the optical fiber do not excess the value standards of ITU-T for this link, namely, total of attentuation of this link: 11,90 dB (G655) and 10,52 dB (G652) and attentuation per kilometer 0,35 dB/Km (G655) and 0,3 dB/Km (G652). The difference of the result of the measurement is less than + 40% from the result of attentuation standard according to ITU-T.

The value of attentuation for *Link Diversity Route* based on OTDR ranges from 9,26 to 10,81 dB and by using OPM, ranges from 11,43 to 12,64 dB. If we take average result of the difference of both measuring tools, the difference is 2 dB. The difference is not to much.

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Biography

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