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Assessment of Events in Fiber Optics Communication Links

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ABSTRACT

As signal (light pulse) travels down fiber optics communication links, the signal strength decreases because of possible presence of some events. Events are instances of disturbance to fiber optics signals which have direct impact on the cumulative loss in any communication link. An Optical Time Domain Reflectometer (OTDR) was used to locate and characterized these events in fiber optics cables as reflective, non-reflective, and positive events at Abubakar Tafawa Balewa University Teaching Hospital (ATBUTH) to Abubakar Tafawa Balewa University (ATBU). The OTDR used backscatter changes to detect the events in the fiber optics under test and are displayed in OTDR traces. Non-reflective events (caused by splices, macrobends or microbends) were seen to have more impact on the cumulative loss than the reflective events (caused by presence of connectors, mechanical splices, or poor quality splices) and positive events (dreaded gainers) because of their high losses. Therefore, minimizing the number of non-reflective events in fiber optics communication links promises a better and quality fiber optics communication network.

Keywords: Event, OTDR, Backscatter, Reflective and Non-reflective Events

INTRODUCTION

The signal strength at the end of every communication link is very critical to the quality of the communication network. However, for a practical fiber optics communication link, signal strength decreases as signal travels down the line as a result of different events present (Douglas, 2010). The events are instances of disturbance to fiber optics signals (Dharamvir, 2012). These events could be expected or unplanned in every communication links. Examples of expected events include connector loss, splice loss, gainers, ghost etc. Sharp bends, dirty connectors, and mismatched fiber core sizes are examples of unplanned events. These events could further be categorized into three: positive events, reflective events, and non-reflective events (Etten & Plaats, 1991). Positive events occur when three sections of fiber optics are spliced together, with the central section having a slightly larger core than the other two. Loss value is specified for positive events. However, this loss does not indicate the true loss of the event. The true loss is obtained by bidirectional test analysis. Reflective events are obtainable from connectors, ghost, gainer, mechanical splices etc. and are specified with loss and reflectance values. Non-reflective events are often caused by macrobends, microbend, and splices and are specified with loss values. No reflectance is specified for non-reflective events.

Optical Time Domain Reflectometer (OTDR) is an optical equipment used to detect, locate, and characterize events (Ilyas and Moftah, 2003). It transmits pulses of very short high-power light from laser diodes and detects the light reflected/ back-scattered as each pulse travels down the fiber (Agrawal, 2002). A fraction of the pulse is scattered in several directions due to normal glass structure of optical fiber core (Rayleigh scattering) and at the points where fiber comes in contact with air or any other media like splices, joints connectors, fiber end/break (Fresnel reflections). The OTDR uses changes in 'Back-scatter' light pulses to detect events which are illustrated in OTDR Traces as seen in Figures 1 and 2.

2.0 MATERIALS & METHODS

Materials:

1. Single-Mode Patch cords
2. Power meter
3. Optical Time Domain Reflectometer (OTDR)
4. Media Converter/Transmission Equipment
5. Flash drive

OTDR test procedures

Location: Abubakar Tafawa Balewa University Teaching Hospital (ATBUTH), Bauchi State, Nigeria to Abubakar Tafawa Balewa University (ATBU), Bauchi State, Nigeria

Fiber Type: SM 36CORE

Device: MTS 6026VSR

Module: 7508 Num.8126 VSRE

The OTDR parameters were set as:

Wavelength: 1550 nm

Range (Km): 88.6673

Acq. Time: 10s

Resolution: 1.25m

Index: 1.466480

A power meter was used in testing for continuity along the cable before the measurements were taken. A single-mode patch cord was attached to the OTDR and to cable plant (Core 01) under test via the patch panel. The OTDR was preset as stated above and it emitted light power pulses along the cable in a forward direction by the injection laser. The light pulses then bounced back and were measured by the factoring out of time and distances. The backscattered light was detected by the Avalanche photodiode receiver. The output of the photodiode receiver was driven by an integrator which improved the Signal to Noise Ratio (SNR) by giving an arithmetic average over a number of measurements at one point. This signal was fed into a logarithmic amplifier and the average measurements for successive points within the fiber were plotted and recorded with the chart recorder. The media converter was then used in converting the trace to another format which was retrieved with an external drive. The same procedure was repeated for fiber core 19 and results tabulated as seen in Tables 1 and 2.

3.0 RESULTS

Table 1: ATBUTH to ATBU (CORE 01)

NO.	LOC. (km)	Event Type	Loss (dB)	Cumul. (dB)
1	0.0000	Launch level	----	0.000
2	3.0830	Non-Reflective	0.219	0.219
3	6.1328	Positive	-0.133	0.087
4	9.2490	Non-Reflective	0.195	0.280
5	21.3999	Positive	-0.059	0.221
6	24.5518	Non-Reflective	0.155	0.376
7	27.6272	Non-Reflective	0.088	0.464
8	30.6489	Positive	-0.065	0.399
9	33.8060	Non-Reflective	0.062	0.461
10	36.8507	Non-Reflective	0.132	0.594
11	39.9847	Non-Reflective	0.042	0.636
12	49.1649	Non-Reflective	0.087	0.723
13	52.2377	Non-Reflective	0.104	0.826
14	55.3411	Non-Reflective	0.119	0.946
15	61.4816	Non-Reflective	0.116	1.062
16	63.9955	Non-Reflective	0.063	1.125
17	67.0683	Non-Reflective	0.179	1.304
18	73.1909	Non-Reflective	0.200	1.504
19	76.3276	Non-Reflective	0.077	1.581
20	78.7342	Non-Reflective	0.162	1.743
21	79.4004	Positive	-0.223	1.520
22	85.5894	Non-Reflective	0.156	1.676
23	88.5805	Reflective	---	1.676

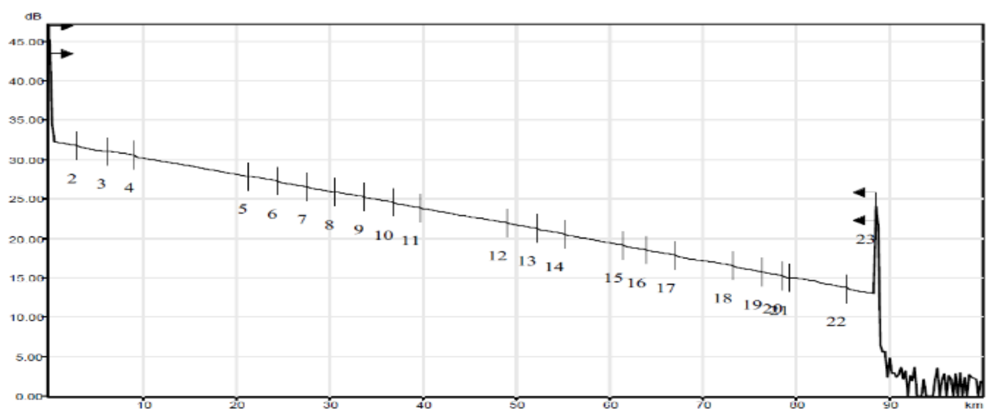

Figure 1: Core 01 OTDR Trace

Table 2: ATBUTH to ATBU (CORE 19)

NO.	LOC. (km)	Event Type	Loss(dB)	Cumul. (dB)
1	0.0000	Launch level	---	0.000
2	18.4649	Non-Reflective	0.091	0.091
3	21.5658	Non-Reflective	0.068	0.159
4	30.7204	Non-Reflective	0.202	0.361
5	40.0077	Non-Reflective	0.078	0.439
6	43.0295	Non-Reflective	0.090	0.529
7	52.2862	Non-Reflective	0.076	0.606
8	64.0823	Non-Reflective	0.081	0.687
9	76.3786	Non-Reflective	0.108	0.794
10	88.6673	Reflective	---	0.794

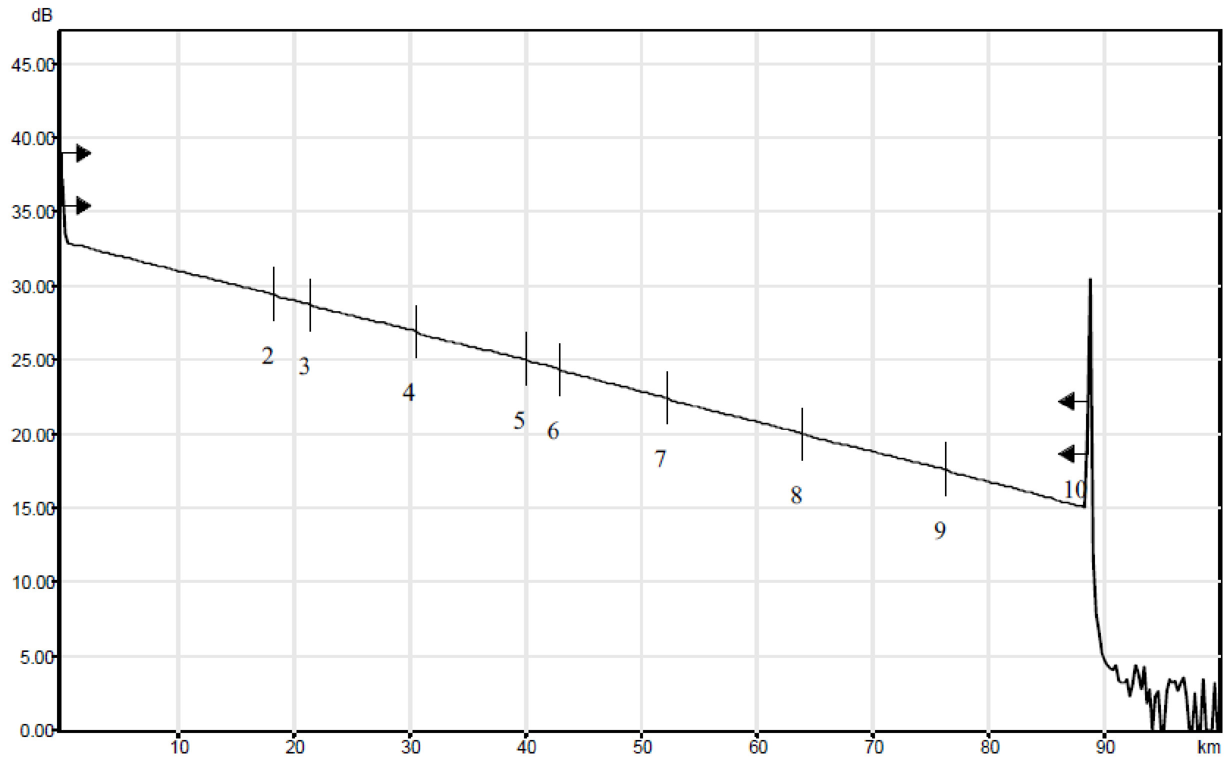

Figure 2: Core 19 OTDR Trace

4.0 DISCUSSION

Table 1 presents 23 events with cumulative loss of 1.676 dB. By careful observation the non-reflective effects occurred more frequent than others. This is because of the possible presence of fusion splices, microbends, and macrobends in the fiber. Event 23 is reflective in nature indicating an end of the fiber cable clearly illustrated in Figure 1. Similarly, for Core 19, 10 events can be seen with cumulative loss of 0.794 dB as shown in Table 2 and Figure 2. Core 01 offered high cumulative loss than core 19 because it has more events. By implication, the more the events, the higher the cumulative loss and vice versa.

5.0 CONCLUSION

Optical Time Domain Reflectometer (OTDR), a commonly used optical equipment was used to locate and characterize events in fiber optics communication links. The results showed that links with more events suffer high loss compared with links with less number of events. Also, links with more non-reflective events were seen to offer high cumulative loss. For the maintenance of quality fiber communication network, it is advisable to minimize the number of non-reflective events where possible.

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