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Study on Physical Network Separation Method and Maintenance System Composed of Optical Cable in Buildings

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Abstract

The network should be separated to protect internal data from external hacking. In other words, it would be separated from the Public Domain Network connected to the external Internet and the Private Domain Network for the internal intranet to increase security. In this case, the configuration of another physical network is classified as logical network separation by classifying internal and external traffic with software technique. Basically, the network separation started with security emphasized. However, as recent IoT technology has been developed and applied to buildings, many items that need to be separated from the outside building occurred in a building itself. As one of typical examples, CCTV images inside a building should not be exposed to external hackers. Data and signals for building control are also the same. In this paper, physical network separation with relatively high safety using the optical cable network which was already installed in a building is explained. Also, the line configuration is introduced to improve the reliability of the network, the test method and the analysis algorithm of the state of the optical cable.

Keywords: Network Separate, IoT, WDM, OTDR, Network Management

INTRODUCTION

In order to block fundamentally the leakage of internal secrets and important material from major cyber-attack such as hacking, the Internet business computer network should be separated. Network separation with emphasis on security has been increasing with the development of IoT technology connected to the Internet. As the applications using the network in general offices and residential spaces are widely used, it is necessary to expand the physical network separation for the security and control [1]. Physical network separation means that there is another network for internal operations in addition to the internet network which is connected to the outside. Therefore, the external internet network used in a public domain and the internal intranet is used in a private domain individually.

In a specific case where data security is required, data and control signals can be applied to a separate network. CCTV can be one of examples. An external hacker never sees the picture inside the building without permission. As camera performance gradually increases, a high-performance server capable of processing high-resolution images and processing applications of applications is required. The DID (Digital Information Display) is another example. When sending messages to someone in a building, it is sometimes more efficient to use the display and the broadcast message in a fixed device than to use mobile phones. The display does not seem to be just message itself, it can be used for roles of notifying kiosks, advertisements, public relations, and announcements. The management function of indoor air quality is required to sense the contamination status of room air and to control ventilation equipment and air purification equipment. For disaster prevention, more efficient detection of temperature, smoke, flame, and etc. would be required in a building. In the near future, AI (Artificial Intelligence) along with CCTV, DID, indoor environment, etc. will be merged through multi-dimensional server application by applying server virtualization. Ultimately, all processing would be linked with the network separation.

THE IMPLEMENTATION OF PHYSICAL NETWORK SEPARATION

In optical communication, the communication is carried out by transmitting a light to the optical core in the optical cable. The light has a communication wavelength band defined by the ITU (International Telecommunication Union). If a WDM (Wavelength Division Multiplexing) element is used, optical signals of different wavelengths are combined and separated [2]. Previously, a single signal is transmitted to a single optical core. However, signals of different wavelengths can be transmitted to a single optical core using WDM and the

surplus optical core can be utilized as a spare line. The WDM device is shown in fig.1.

Figure 1: WDM device

When synthesizing optical signals of three wavelengths using WDM, one is assigned for a communication in the internet, another for the internal service (Private Domain), the other for control and monitor (Manage). This method allows Public, Private, Manage channels to share with a single optical core. In other words, it is possible to increase the capacity of light core. As a result, the light core) used for communication and the light core unused are generated. An unused optical core is called a spare core and is configured to form a bypass route (path switching) when an abnormality occurs in the operational core. Also, when using a changeover switch for a 2x2 scene, automatic path switching by the system becomes possible. The following fig.2 is a conceptual diagram.

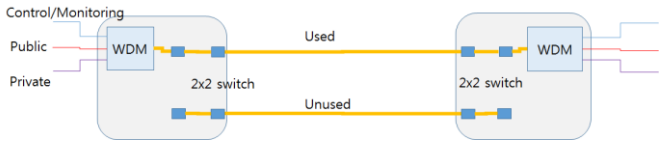

Figure 2: A diagram of Network Separate and Fiber Management

Although the spare core is not currently used, it is necessary to check whether it is always in the normal state or not and then it can provide a detour route at the time of abnormality [3]. However, in order to check always if it is in good condition, a scheme that allows continuous checking at the lowest cost should be presented. In the conventional optical cable monitoring system, the optical core selector is used for each optical core, and the cost is increased accordingly. However, it is advantageous for the optical core inside the building to be continuously connected with a short laying distance. In addition, when branched, it is possible to keep the connection continuous by using splitter. The status of the optical core can be tested with OTDR (Optical Time Domain Reflectometer). The idle optical cores are measured with the point connected to the OTDR as the starting point.

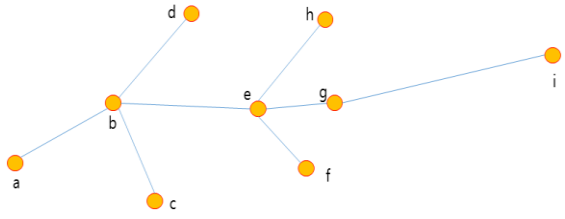

Figure 3: Test configuration of Optical core with only spare core

Firstly, OTDR is connected to point a as in fig.3 and then a splitter is used at point b to branch out three. A branch is generated once again at point e and is connected up to i point which is the farthest point. Though a point is the starting point, each endpoint is assumed to be different. Since the end-point has a Fresnel reflection, the measurement results of OTDR are different as in fig.4.

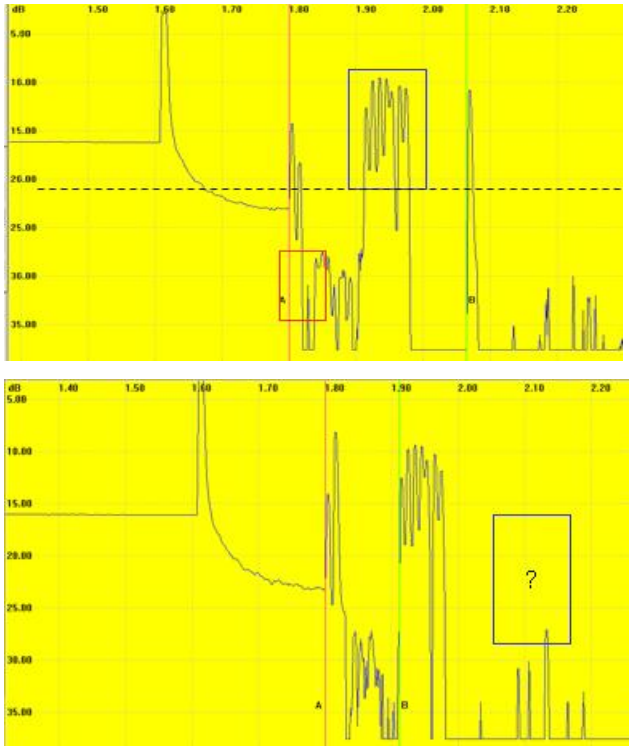

Figure 4: Comparison diagram of normal (left) and abnormal (right) waveforms seen on the OTDR screen

The peak in the box of center is appeared at the Frenel reflection point of b, c, e, d, f, g, h respectively and the last peak is the peak at the end of i point. If an abnormality occurs in the g-i section, it will be diagnosed using the phenomenon that the peak at the point i of the terminal disappears as shown in the right side of fig.4.

FAULT POINT ANALYSIS WITH OTDR MEASURED WAVEFORM

The start and end-point of the section are set for the analysis of the OTDR measured waveform. Since the data coming from the OTDR is a continuous sequence of dBm values at constant distance intervals, the primary differential value (dx/dy) is obtained from the start point of the interval. The differential value increases before peak point and decrease after peak point, and the vertex of the inflection point is detected. The distance of each inflection point from the starting point becomes an each end-point as in Fig. 3. In the management system, the inflection point is stored in the database and it is compared with the changes of inflection

point whenever remeasurement occurs. Fig. 5 is an example in which a fault point is forcibly generated with respect to a reference and a difference is detected through a differential judgment method.

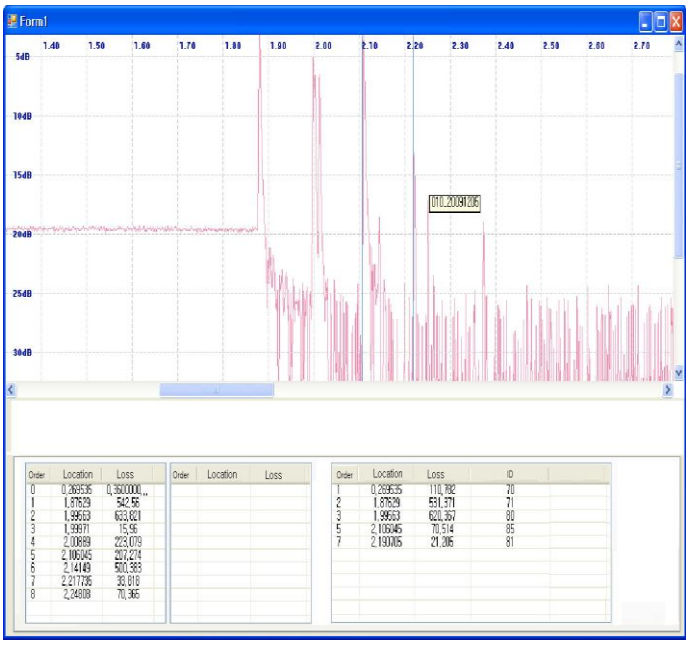

Figure 5: Automatic analysis program of fiber fault location

This program applies the comparison algorithm to the position of the inflection point using the differential value in a way to compare the reference waveform with the current measurement waveform at regular intervals, and the system regularly updates the waveform of OTDR. Therefore, the problematic section can be recognized.

CONCLUSIONS

It is explained why network separation is necessary to fundamentally block the leakage of internal secrets and important material from cyber-attacks. Network separation can be divided into physical network separation and logical network separation, and the high security is physical network separation that constructs another network. However, it is cost to lay a new optical cable in the building. Therefore, the concept of installing WDM elements were taken into consideration as much as possible by using the existing optical cables to construct a physical network separation and make a detour route in the surplus optical core. In addition, the surplus optical core was continuously connected with a splitter, and the inflection point comparison method was described by comparing normal trace with abnormal trace. In order to realize these physical network separation and efficient network management, the virtualization solution was introduced as one of the most efficient ways.

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