ANALYSIS & MEASUREMENT OF SERVICE CONTINUITY ENHANCEMENT BY USING AUTOMATIC PROTECTION SYSTEM (APS) IN FIBER OPTIC COMMUNICATION LINK

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Supervisor's Name : MR. CHAIRULSYAH BIN ABDUL WASLI

Date : 05 MAY 2011

DEDICATION

This project is dedicated
to my dearest parent,
Mohd Nordin bin Mohd Yusof and Rosmawati binti Samsuddin,
all my siblings, and not forget to my friends,
who have always sincerely pray for my
success and glory.
To my Supervisor,
Mr. Chairulsyah bin Abdul Wasli
Thank you for your loving and taught so
that this task can be accomplished
successfully

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ABSTRACT

This project is about Analysis & Measurement of Service Continuity Enhancement by Using Automatic Protection System (APS) in Fiber Optic Communication Link. The APS system is important to provide protection for fiber optic communication link that have been used widely nowadays. This system will provide protection for the link and provide fast fault recovery system. The main element of the system is protection fiber and optical switches. This project will analyze the system based on some parameters of the optical switch such as insertion loss, switching time, driving voltage and other parameters of the switch. By analyzing all parameters, the best switch that used in the system can be choose and apply it to the fiber optic communication link.

ABSTRAK

Projek ini adalah tentang Analisis & Pengukuran Peningkatan Perkhidmatan Menggunakan Sistem Perlindungan Automatik (APS) di talian komunikasi gentian optik. Sistem APS adalah penting untuk memberi perlindungan untuk talian komunikasi gentian optik yang telah digunakan secara meluas ketika ini. Sistem ini akan memberikan perlindungan untuk talian dan menyediakan sistem pemulihan yang cepat. Elemen utama dari sistem ini adalah gentian optik dan suis optik. Projek ini akan menganalisa sistem berdasarkan beberapa parameter dari suis optik seperti kadar kehilangan kuasa, masa penukaranan, voltan dan lain-lain. Dengan menganalisis semua parameter, suis terbaik dapat dipilh untuk digunakan di dalam Sistem Perlindungan Automatik.

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CHAPTER I

INTRODUCTION

1.1 Background

A fiber-optic link is one of an optical fiber communications system which provides a data connection between two points. The link will be connected by an equipment such as multiplexer and demultiplexer. In general optical link it will contain an optical transmitter, connector, optical fiber as the media and an optical receiver.

There are many types of optical transmitter such as Light Emitting Diode (LED) and laser. It will be used based on the application in the optical link. For a connector, it will choose depend on the equipment. There are many types of connecter such as SC, FC, SMA and many more. The medium for transmitting the data is fiber optic. There are two types of fiber optic which are single mode fiber and multimode fiber. Single mode is used to transmit one light at a time and multimode fiber is used to transmit multiple lights in different wavelengths. For receiver part, there are various types of optical receiver like Avalanche Photo Diode, PIN diode and etc.

Each component in the optical communication link contain insertion loss that will reduce the power transmit or power input. For example, the connector that been

used have it own loss that will reduce the power. Each different connector has its specific loss and the general value for the insertion loss is 0.2dB. Fiber optic that been used as media for the link also contain it own insertion loss. The insertion loss for each fiber is different based on the mode and the wavelength for the fiber.

Like a normal system, a failure can occur for the fiber optic link that can cause error to the data that was transmitted. The most prevalent form of communication failures is the accidental disruption of buried fiber optic cables. Fiber cuts may result among other reasons, from construction work, rodent damage, fires or human error. Clearly, the need for fast and reliable protection of services is essential in high capacity optical system. Enhance continuity is very important in operation aspect especially in telecommunication [1]. The service down time must be decrease to shortest time. One method to decrease the down time is by using alternate link. If the main link have problem, the traffic will be transfer to the alternate link very quickly. Automatic protection switch is the device that will do the restoration action.

In networks using APS as their protection mechanism, failures are corrected by rerouting signals from working channels to protection channels, using protection switches at the ends of each network link, which are activated immediately when a fault is detected [2]. The basic types of APS are linear protection and ring protection. This protection used 1+1 system. One line is used for the main working connection and the other one is for the protection in case there are breakdown with the communication of the fiber optic. The loss of signal to the equipment will trigger the switchover to protection line.

There are two main components in APS system. The components are protection fibers and protection switch. The objective of this process is to protect the connections passing through the failed fiber link once failure occurs. It means routing the signals from the switching node at one side of the failed fiber link to the other side of the failed fiber link using protection optical fibers. The APS process will restore the connections

that use the failed link in both directions. More specific process will be explained in chapter two of this report.

1.2 Problem Statement

Fiber optic is used in much telecommunication equipment nowadays. A failure can occur for the fiber optic link that can cause error to the data that has been transmitted. All the failure that can occur is caused by anything such as cable damage, equipment failure or natural disaster. The error will cause downtime to the system due to repairing the damage fiber, changing the new equipment and many more. The downtime from the failure will affect many people because fiber optic link is being used by many people nowadays. Because of the problem, a fault recovery system that is fast and reliable that can reduce the down time and prepared alternate link for the transmission data process. One of the solutions for this problem is use an Automatic Protection Switching system in all fiber optic links to reduce the downtime so it will not affected important thing like data transfer.

1.3 Objectives

The objectives of this project are:

- To understand the standard operation of the Automatic Protection Switching system.
- To analyze the Automatic Protection Switching (APS) system in designed fiber optic network to reduce down time.
- To compare few Automatic Protection Switching system in the market.
- To compare between theoretical, simulation and measurement result about the APS system.
- To measure the improvement fiber optic link protection system using APS.
- Design an animation for Automatic Protection Switching system.

1.4 Scope of work

Scope of work for this project is regarding to all of the objectives that have been stated. The most important thing for this project is understand clearly about the Automatic Protection Switching system like the basic and standard operation of the system, the component that been used for the system and the advantages and disadvantages of the system. It also important to know the parameter and characteristic that will affect the APS system.

Based on the parameter, analysis part for the project can be done. Designing for calculation, simulation and measurement part will be included to analyze the project. Comparison all those result is the next scope that must be taken care off. After analyzing the result, the effect of the parameter to the system will be known. The improvement for fiber optic link after using APS system also can be measured. Comparison the Automatic Protection Switching system in the market can be done based on the information that obtained earlier. Lastly, an animation regarding this project must be prepared for the final presentation.

1.5 Organization of the Report

The structure of this project report was planned to provide a clear explanation about the project entirely. This thesis is divided into five chapters.

Chapter One introduces background, problem statement, objectives and scope of work. In this chapter, some general knowledge about fiber optic and the system will be presented.

Chapter Two provides the literature review on the Automatic Protection Switching system. It is about the process, the mechanism and the parameters that affect the systems.

Chapter Three describes in detail the methodology used during the project. There are 3 method that been used in the project which are calculation, simulation and measurement. In calculation part, the formula that been used to calculated in the system will be presented. The circuit for simulation part will be shown in this chapter. For the measurement part, the measurement process will be introduced. The equipment that been used also will be shown in this chapter

Chapter Four discuss about the result and the analysis. The result will also have three part which are calculation, simulation and measurement data. The analysis and the comparison for the three data will be included in this chapter.

Chapter Five is about the conclusion for the project. The conclusion will be summarizing about the entire project. Recommendation for the project will also be included in this chapter.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

This chapter provides the literature review on the Automatic Protection Switching system. It is about the process, the mechanism and the parameters that affect the systems. This chapter also shows some of the manufacturer that provides the Automatic Protection Switching equipment.

2.2 Introduction to Fiber Optic

Fiber Optic is a technique of transmitting light through transparent, flexible fibers of glass or plastic. The fiber which is optical fibers can channel light over a curved path. Bundles of fibers can be used to illuminate and observe hard-to-reach and long distance places. Optical fibers that made from pure glass are able to carry light over long distances ranging from a few inches to more than 100km with only little dimming. Cables that used such fibers are commonly being chosen in certain types of communications link. There are some single fibers that are thinner than human hair and measure less than 0.00015 inch (0.004 mm) in diameter.

As part of a communications system, an optical transmitter will transmit information in the form of light signals. The signals are generated by a light source such as semiconductor laser or light-emitting diode (LED) at one end of the fiber and detected by a light-sensitive device at the other end which called the receiver part. A fiber optic cable can transmit much more information than an electrical type of cable such as the copper cable at the same size. A major application of optical-fiber cable is in linking two or more points. Many communication parties have installed large networks of fiber-optic cables across the country and under the oceans to provide information worldwide.

Fiber-optic communication systems have many advantages that make them more efficient than the old system which used copper cable as the medium for transmitting and receiving the data. One of the main advantages is they have a much larger information-carrying capacity than copper cable. Fiber optic cable can carry information signal larger than 10Giga bits per second. Other than that, fiber optic cables are not bothered by electrical interference, and require fewer amplifiers than copper-cable systems. This will save the budget in designing the optical communication link. Other advantages in fiber optic communications link is fiber optic have larger bandwidth over a long distance. Like that has been stated earlier, fiber optic can carry high capacity information signal. The increasing of the capacity will increase the frequency and it shows that fiber optic have larger bandwidth. Generally, fiber optic has bandwidth larger than 400MHz per km but coaxial cable only has fewer MHz per km.

2.3 Fiber Optic Element in Communication System

In every communication link, it has its own element in the system. Generally in communication link it contains transmitter, cable as the medium, and receiver. In fiber optic communication system, the entire elements are using light as their main source. For the transmitter it will use optical type of transmitter. The medium will be the fiber optic cable and the receiver will be used is optical type of receiver which also have various type that can be choose based on the application of the link.

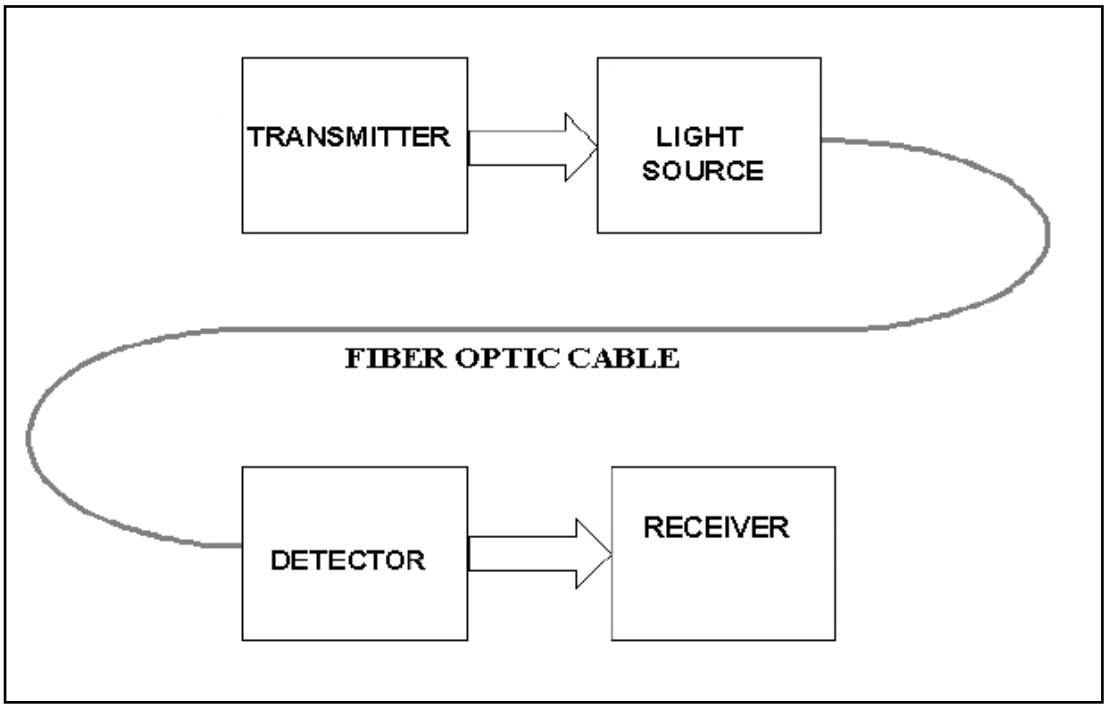

Figure 2.1 Fiber Optic Communication Systems

Based on the figure above, the first part in the fiber optic communication system is transmitter. An optical transmitter is a device that will receive an electrical signal as their input and will converted it to optical signal to transmit it in optical fiber. There are various type of optical transmitter which is Light Emitting Diode (LED) and laser. Both of the components have its own advantages based on the application that requires in the system. For example LED will be choosing as the light source when multimode fiber is used as the medium for the communication link. Laser light source will be used for long

distance communication link because it has low attenuation when transmitting information signal.

For the medium of the communication link, the fiber optic will be used. Fiber optics also has two different types which are single mode fiber and multimode fiber. Single mode fiber is a fiber optic cable that can channel only one single light at a time. It has higher bandwidth and also higher transmission rate. This type of fiber is usually used in telephones and cable television applications. Figure 2.2 shows the ray propagation in the single mode fiber. The second type of fiber is multimode fiber. It is used to transmit many signals or lights per fiber. Multimode fibers also have different types which are graded index and step index. This kind of fiber is used in computer networks and LAN applications. Figure 2.3 shows the ray propagation in multimode fiber.

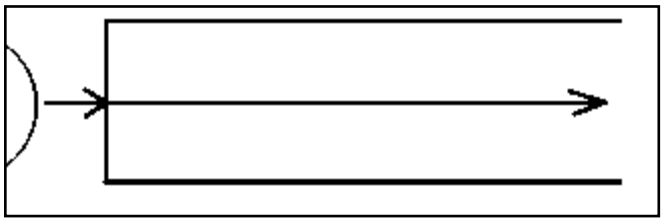

Figure 2.2 Single mode fiber

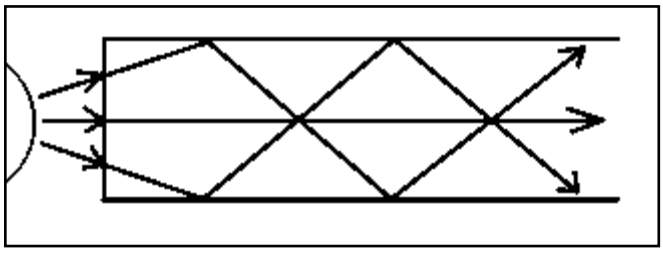

Figure 2.3 Multimode fiber