Smart Drop Protection Scheme (SDPS) in EPON network

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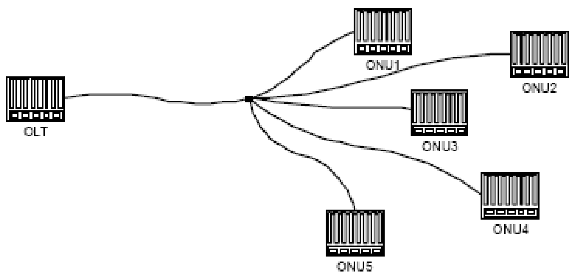
Summary

This paper proposed for smart drop protection scheme (SDPS) will be implemented in the drop region section to provide the survivable protection scheme. The SDPS will contribute for tree topology in EPON network. The SDPS will ensure the data flow continuously due to breakdown occur in the network and instantly repair operation. The protection mechanism for tree based optical switch will have capability to divert the signal onto protection line according to the types of failure condition and location of failures in access network. This paper will represent for three types of protection mechanism which will employ the shared protection scheme. Three faulty conditions are considered in this article and OptiSystem software is used to prove the solution feasibility.

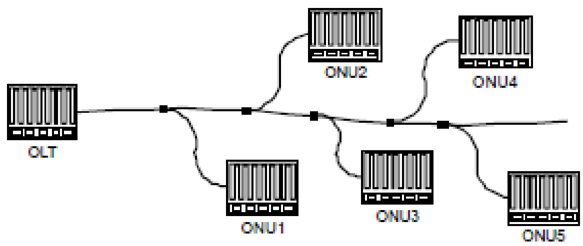
Key words: FTTH, PON, protection route, failure

1. Introduction

Fiber-to-the-home (FTTH) gives the value measurement in the ease of network testing, measuring and monitoring. FTTH technology also offers an attractive solution for providing high bandwidth from the central office to residences and to small- and medium-sized businesses. FTTH is cost-effective because it uses a passive optical network (PON).[1] FTTH is a network infrastructure that is capable of supporting not only the services the cable operators can offer today, but also the services that will be offered in the future. We can classify FTTH technologies into two groups. One is AON (Active Optical Network) which is a cheap solution, but it includes active devices in the field causing high maintenance and operation cost [2]. Figure shows the several topologies which are tree, ring, or bus in access network. A PON can also be deployed in redundant configuration as double ring or double tree; or redundancy may be added only to a part of the PON, say the trunk of the tree. For the rest of this paper, we will focus our attention on the tree topology; however, most of the conclusions made are equally relevant to other topologies. All transmissions in a PON are performed between Optical Line Terminal (OLT) and Optical Network Units (ONU). Therefore, in the downstream direction (from OLT to ONUs), a PON is a point-to-multipoint network, and in the upstream direction it is a multipoint-to-point network. The OLT resides in the local exchange (central office), connecting the optical access network to an IP, ATM, or SONET backbone. The ONU is located either at the curb (FTTC solution), or at the end-user location (FTTH, FTTB solutions), and provides broadband voice, data, and video services. The fiber is dedicated to each user in the access network which is called a point-to point (PTP) network. The other one fiber is shared (via a power splitter) among a set number of users, typically between sixteen and thirty-two. This is called a passive optical network (PON). There are advantages and disadvantages to the deployment of PTP and PON networks based on financial, bandwidth, and component considerations. [3]



(a) Tree topology



(b) Bus topology

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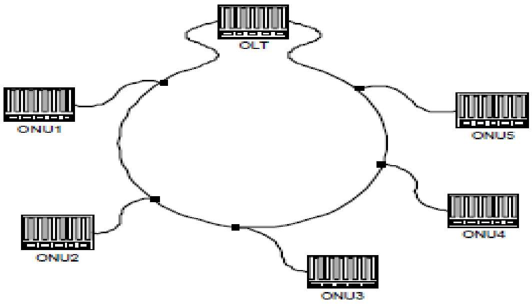

(c) Ring topology

Figure 1 PON topology scheme

Active and passive are two commonly used FTTH architectures for FTTH deployment. Active Architecture is also called as Pont 2 Point (P2P) and Passive Optical Network (PON) architecture is called Point to Multi Point (P2M). Choice of active or passive architectures for deployment depends on the type of services to be delivered, cost of the infrastructure, current infrastructure and future plans for migrating to the new technologies [4]. PON is also called a point to multipoint (P2M) network. The advantage of FTTH PON is the fact that they use purely optical passive components that can withstand severe and demanding outside plant environment conditions without the need to consumer energy between in the central office exchange and the customer premises.

2. Smart Drop Protection Schemes

Figure 2 shows the mechanisms of protection in FTTH-PON access network in breakdown condition. Purple arrow represents the mechanism of dedicated protection in FTTH access network when there is breakdown occurs at working line. When the failure is detected in working line, protection mechanism will be activated and convert the optic signal direction to the protection line. The purple arrow shows the protection mechanism as dedicated protection. In linear protection PON-FTTH scheme, each ONU is connected to splitter output terminal by two fibers; working line and protection line through two optical switches that is controlled by Access Control System (ACS). So, this research was proposed to implement the protection scheme by using the 2x1 and 2x2 optical switch which is used to switch the signal to the protection line when failure occurs in the working line. The route depends on the restoration mechanism that is activated according to the types of failure. The two optical switches are allocated in the transmission line in which both ONU and splitter are located. A first optical switch is used to switch the signal to protection line at local transmission or switch to protection line at transmission line nearby. The second optical switches will switch the signal in protection line back to the original path before sending it to the local ONU. For dedicated path protection, a working path and an end to- end backup path is established, and resources are assigned to it at connection set up time.

Condition 1

Figure 2 shows the failure is detected in working line, protection mechanism will be activated and convert the optic signal direction to the protection line. The purple arrow shows the protection mechanism as dedicated protection.

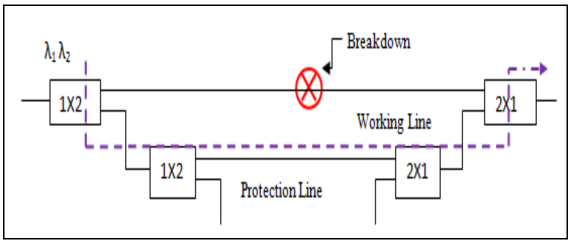

Figure 2 Breakdown at working line and signal diverted to the protection line.

Condition 2

Figure 3 shows the shared protection scheme when breakdown occurs in both line in working line and protection line. Shared protection scheme will be activated and optic signal will convert the route to neighbor line protection as depicted in blue arrow.

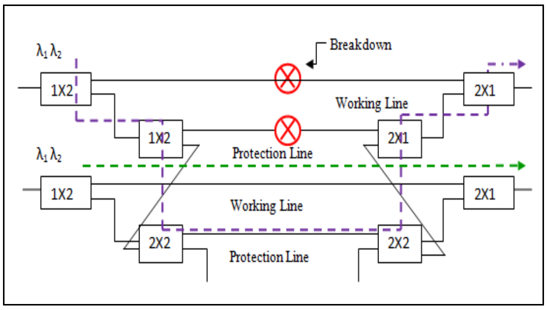

Figure 3 Breakdown at working line and protection line. Signal diverted to the neighbor protection line.

Table 1 Simulation parameters

Component	**Parameter type**	**Value**
PBRS Generator	upstream Bit rate (Gbps) downstream Bit rate (Gbps)	1.25 1.25 (symmetrical)
Electrical Generator	Rise time/ Fall time	0.05 bit
Light source	Downstream wavelength(nm) Upstream wavelength (nm)	1480, 1550 1310
Modulator	Modulation format	NRZ
Multiplexer/Demultiplexer	Insertion loss (dB)	0.5
Bidirectional Splitter (1:8)	Insertion loss (dB)	5
Circulator bidirectional	Insertion loss (dB)	1
Bidirectional optical fiber	Attenuation constant (dB/km)	0.25
Opticl switches	Insertion Loss (dB)	1.2
SMF (2km) 16 numbers	Attenuation constant (dB/km)	0.25

3. Simulation setup

The FTTH based network design was modelled and simulated using the Optisystem CAD program by Optiwave System, Inc. The two optical fibers were connected between the transmitter and 1:8 bidirectional splitter (18km) using a bidirectional optical fiber also the other one was linked between splitter and ONUs (2km) by using single mode fiber (SMF). In the downstream direction, at the OLT, two wavelength channels which are 1550nm and 1480nm are multiplexed and transmitted in optical fiber (18km) to the bidirectional splitter. In the upstream direction the 1310nm wavelength was transmitted. Simulation aims to verify the network system feasibility and investigate the system performance of the proposed protection route mechanism based EPON architecture. In this simulation we proposed FTTH-EPON design will have 8 ONUs. A transmission distance between OLT and ONU is 20 km. The 1480 nm and 1550nm downstream signals and 1310 nm upstream signal have 1.25 Gb/s direct modulation in the test access network. And the output powers of 1480 and 1310 nm lasers are 2 dBm. Moreover, the power budget of the architecture as follows. In normal condition, 1480 nm and 1550nm signals will traverse one circulator bidirectional (1dB), bidirectional optical splitter (3dB),and about 20 km single mode fiber (SMF) (5 dB), one multiplexer (0.5 dB), one demultiplexer (0.5 dB) and two numbers of optical switch (2.4 dB) thus, the total loss budget is about 12.4 dB. The sensitivity of optical receiver, which is used in our test system, is nearly to -34 dBm. The bit error rate (BER) performances are measured by a 1.25 Gb/s non-return-to-zero (NRZ) pseudo random binary sequence (PRBS) with a pattern length of 2^{31}-1 for the downstream traffic between the OLT and 8 ONUs. The specifications of components in this simulation model are tabulated in Table 1.

4.0 Simulation Results

Condition 1

Our results were obtained by observing bit error rates, eye diagrams, optical power levels and dispersion levels. Figure 4(a) and (b) show the eye diagram with Max Q factor and Min BER at ONU 1 for downstream 1550nm wavelength and 1480 nm wavelength respectively.

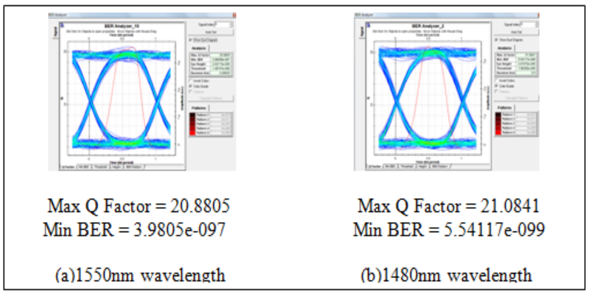

Figure 4 (a) Max Q factor and Min BER at ONU 2 for downstream 1550nm wavelength, (b) Max Q factor and Min BER at ONU 1 for downstream 1550nm wavelength.

Condition 2

Figure 5 shows the eye diagram for both downstream wavelength at ONU 2.

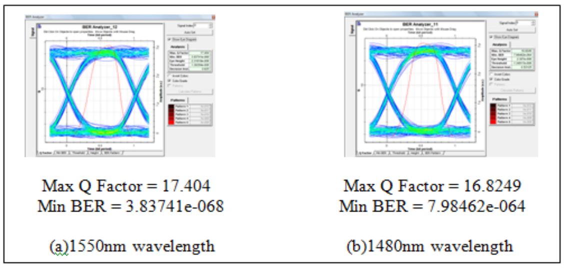

Figure 5 (a) Max Q factor and Min BER at ONU 2 for downstream 1550nm wavelength (b) Max Q factor and Min BER at ONU 3for downstream 1480nm wavelength.

5. Conclusion

We presented the smart drop protection scheme used in passive optical network for FTTH protection application and the simulation result that was achieved. Employing the optical switch for 1x2 and 2x2 type will ensure the network to restoration scheme since it cover for dedicated and shared protection. The BER characteristics were measured at 1.25 Gbps and no degradation was observed, as confirmed by a comparison of these simulation results with those obtained from systems without restoration element.

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