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Fiber Fault Localization in FTTH Using Online Monitoring

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ABSTRACT: At present optical fiber cable is used as media to design network and it support high Band width in Gbps speed. Earlier OFC is used to connect the long distance places called OTN (Optical Transport Network) and presently used even in local/access network called OAN (Optical Access Network). Inorder to provides the broadband accessing the PON (Passive Optical Network) used which splits the voice and data at the customer end and this technique has been improved to GPON (Gigabit Passive Optical Network) which provides the higher data rate then the PON . It is also accessible in the Ethernet connectivity called GEPON (Gigabit Ethernet Passive Optical Network). GEPON/GPON/PON terminals used in between the ONT (Optical Network Terminal) and OLT (Optical Line Terminal) terminals.OLT is located at the service providers end and ONT is located at the customer end. Customers are required high QoS and BW and they interested to make SLA (Service Level Agreement) for their service which are expecting from the service providers. The biggest challenge is the maintenance of the network includes localization and identification cable fault in network that ensures maximum QoS.

KEYWORDS*:* Optical Terminal Network, Optical Access Network, Passive Optical Network, Gigabit Passive Optical Network, Fiber To The Home, Optical Time Domain Reflector.

I. INTRODUCTION

The requirement of the customers is mainly based on the entertainment applications like IPTV (Internet Protocol TV), INTERNET, VOIP (Voice Oriented Internet Protocol). The maximum data rates that is required for the IPTV is from 22-30mbps BW and for INTERNET it is upto10mbps and for VOIP is to 0.1mbps,to satisfies the above requirement of the customers the BW should be increased and also the QoS (Quality Of Service) should be increased. In the previous case to provide the services copper cables are used the major limitations of using the copper cables are Bw is limited in the copper cables and the maintenance is very difficult but in the optical fiber the limitations of copper be overcome the advantages of the optical fiber are unlimited Bw and low loss (0.5db/km) and weight is less. The propagation time taken by the copper cable is more whereas in OF the transmission speed will be more. When compare with the copper cables the security will be high so the chances for the losses in the information is less. In the continuous monitoring the fault can be determined as well as the exact location at which the fault present can also be detected so that the time taken to rectifying the fault can be minimised. The service providers begin the new techniques called FTTH (Fiber To The Home)[4], FTTB (Fiber To The Buildings)[4], FTTC (Fiber To The Curb)[4]. In the FTTB single fiber is provided to the several blocks of buildings so that the fiber complexity can be minimised and in FTTC it is nothing but the street cabinet from the cabinet the service are given to the corresponding customer home. FTTH is connect a several number of customers end to the access node. The responsible for this access node is to deliver the application and services to the corresponding customers via the optical fiber. There are two kinds of topologies used in FTTH are, first point to point topology in this each customers are connected to their dedicated fiber so that the number of fibers used get increased and point to multipoint topology by using PON (1:2, 1:4, 1:8...) one single fiber is dedicated for more than 32 customers so that the fiber complexity get reduced and also it provide higher BW for many customers. The main device that play the vital role in the fault monitoring be ODTR (Optical Time Domain Reflector) [5] by using this the losses in the fiber can be determined and also it provides the details about the distances as well as the cumulative loss that present in the fiber. In the other countries the GPON [2] used upto 128 number of splits and in India 32 number of splits used. Splits can be done by using the TDM (Time Division Multiplexing) [2]. Depending upon the customers location the each fiber length may get differ, depending upon the splitting ratio the contribution of each distribution

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fiber get varied, the splitting ratio and the contribution of the individual distribution fiber are inversely proportional to each other. By using the OTDR [4] the reflective and non-reflective losses can be measured and by using the CFDS (Centralised Failure Detection Fault)[4] the failure in the line terminal can be determined. If the service is failed to reach the customer end then the service providers check the fiber that is corresponding to the customers home and then if no fault is occurred in the fiber then they will looking for the line terminals of the failure customer end.

II. OTDR TRACE

OTDR [4] is the meter to determine the localisation of fault, the maximum range is upto 250 to 400km. Depending upon the splitting ratio the number of customers can be determined .If the splitting ratio in the technique is increased then the number of customers can be decreased as well as the BW required for each customer can also be decreased. The losses in the optical network are due to the splitting devices, depending upon the splitting ratio the distance can be changed. Depending upon the distance of the customer end the fiber length be differ so each parameter are depend on each other. The reflective and non-reflective losses in the fiber defer the break loss, splice loss, connector loss, and cable loss. The break and connector loss in the fiber is known as reflective loss and the reflective losses can be determined by the Fresnel equation. The splice loss and cable loss are called as non-reflective losses this can be determined by using Rayleigh event. The default losses that can be present at good condition fiber is the default splice loss in every fiber is 0.1db/splice, the default cable loss be 0.25db/km and the default connector loss be 0.5db/connect. For the 1:32 splitter the total/cumulative loss can be determined by using the ratio of distance to the attenuation in the fiber. The cable that is used between the access point/access nodes to the splitting device is feeder cable is used because feeder cable is strong in nature and also it cannot affect by any environmental hazards. For the 2.5km fiber the reflective and non reflective event can be exactly determined by the OTDR [4]. In this device the list of event that can be appear are,

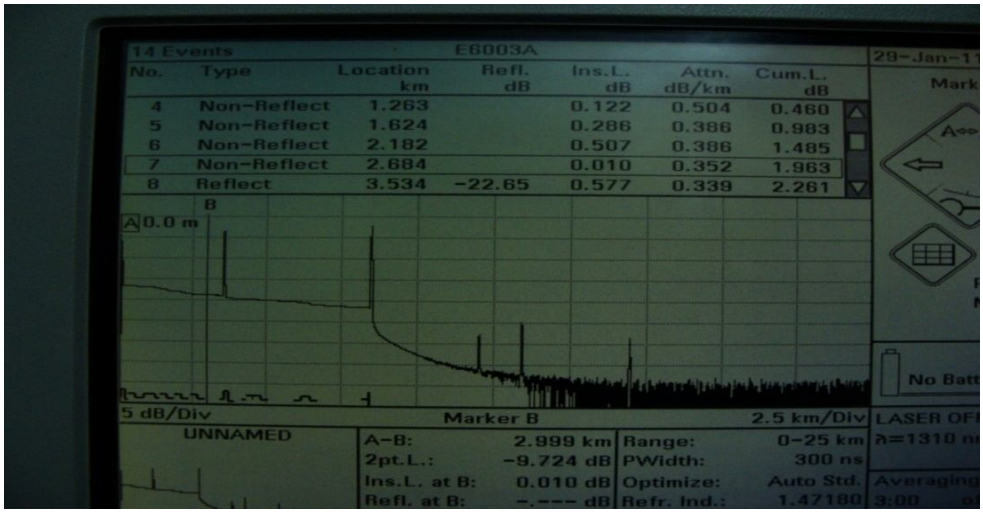

Fig: OTDR trace

The event includes the event type, location/km, reflection loss/db, insertion loss/db, attenuation db/km. Attenuation in the fiber is occurred due to the distance as well as due to the insertion loss in the splitting device. The settings that can be fixed in the device be range, pulse width, reference indication, optimization, distance and also for every 2km repeaters are used the major role of the repeaters is to produce the original signal or boost up the weakest signal into strongest signal. In this process for the upstream and downstream transmission the two kinds of wavelength that has been used are 1390/1410 nm wavelength. The BW for the upstream transmission is always lesser then the downstream transmission. The upstream wavelength be 1310nm and the downstream wavelength be 1490nm. The modulation technique used for the upstream and downstream is differ for the upstream transmission TDMA (Time Division Multiple Access)[1]-[2] is used for the downstream transmission TDM (Time Division Multiplexing)[1]-[2] is used. In

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the pon all the customers are multiplexed and the services for the corresponding details are stored at the pon core shell. The data rate for the GEPON[1] technology is 1.25Gbps for both up/down transmission and for the GPON 1.25/2.5 Gbps for up/down transmission and the GPON will provides the high BW.

III. FAULT LOCALIZATION

The frequent faults in PON are OLT and ONT. Since the infrastructure altered or damaged the reason must be identify in a short period. The first solution is to monitor optical access network with alarm of active elements in the PON. The second step is to make the service personal to measure the PON from OLT to find network failure location , the parameter of OLT is ITU-T G.984.X and G.987.X which are the components of EMS (element management system. This information is given by the OLT, from network management centre. This information gives which customers are affected by failure and it caused by active or passive element network. In order to had more customer the alarms can be correlated with the topology of the PON. The cuts of distribution cable between splitter and customers should be listed. This stuff has the capability to measure the cable either from the CO sight or from the customer sight to identify the correct location of the failure in the situation of failure break.

Since such architecture can accommodate a large number of subscribers, when a fiber break occurs at one point in an optical fiber (especially the feeder fiber), this access network will be without any function behind break point. The upstream signal from multiple optical network units (ONU`s) or optical network terminals (ONT`s) to OLT [2] or the downstream signal from OLT to multiple ONU`s after the breakpoint will become unreachable. Any service outage due to a fiber break can be translated into tremendous financial loss in business for the service providers.

Any failure of feeder fiber or drop fiber in FTTH access network is affected the service transmission. Conventionally, the breakpoint of faulty fiber in FTTH [4] access network is affected the service transmission. Conventionally, the break point of faulty fiber in FTTH access network can be located by using OTDR upwardly, technician is sent to the ONUs side at different residential customer locations to inject an OTDR pulse into the faulty fiber. This approach would require much time and effort. Moreover, OTDR [4] can only display a measurement result of a line in a time. Therefore it becomes a hindrance to detect failure of optical line with a large number of subscriber and large coverage area in the fiber plant by using an ODTR. Besides it is difficult to detect a failure fiber and failure location in point to multipoint connectivity or passive optical network architecture equipped with optical splitter by using a pc to display the troubleshooting result.

IV. OPTICAL LINE TERMINAL ARCHITECTURE

After the installation the default fault can be checked in the fiber. In the service providers end OLT (Optical Line Terminal) is located the purpose of OLT is to multiplex all the customers and their services at the core shell.

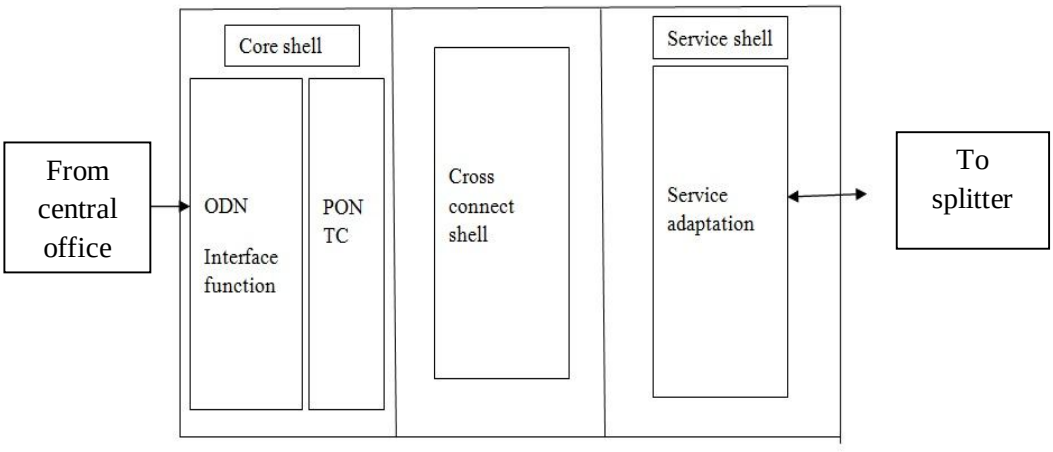

Fig: OLT Architecture

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Service shells the corresponding services for each and every customers details to that dedicated fiber. The distance between the OLT and ONT is about 10-20km . The OTDR is connected with pc if any fault that is if any reflection is occurred in the fiber then the ODTR detect the reflected signal and the faulty location is mentioned in the corresponding pc.
In the ONT all the multiplexed users are demultiplexed this can be done by using TDM technique [4].

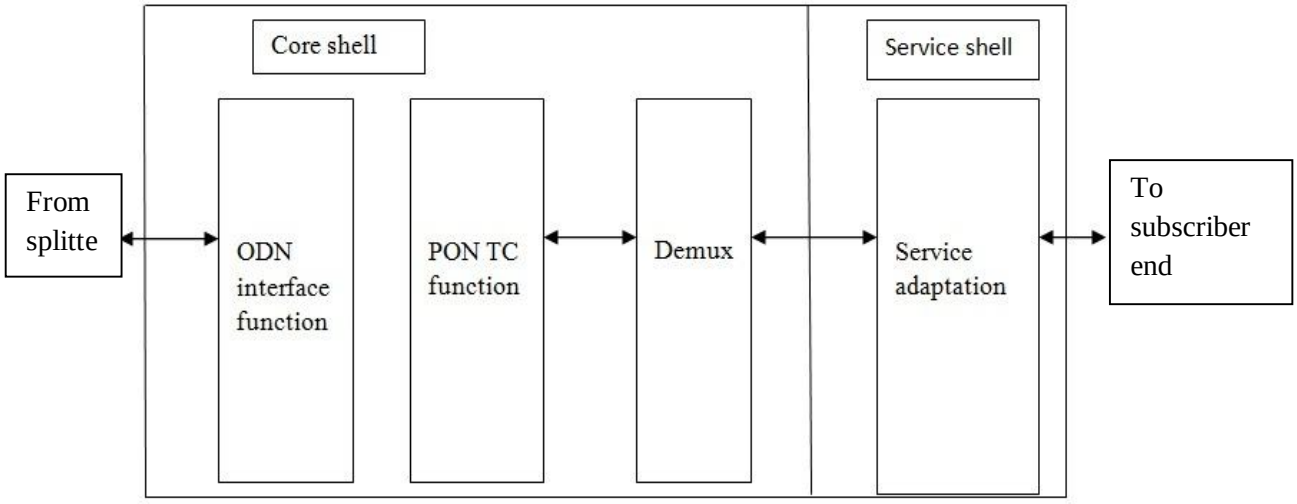

Fig: ONT Architecture

V. DEMARCATION DEVICES

By viewing the ODTR demarcation trace we can easily detect all kinds of attenuation that occurs in the fiber .Here one end the fiber is connected to the light source. The traces can be recorded for further testing of the cable. A FTTH PON tree structure has many drop filters (branches) in the drop region .thus it may be necessary to send a technician to the ONUs side at different residential locations to inject an OTDR pulse into the drop fiber from customer premises to the CO
This Conventional technique delays the restrictions (repair or maintenance) time of the FTTH-PON [4] network system because this approach would require much time and effort. Moreover OTDR can only display a single measurement result in a time. To reduce the time delay one of the solutions is to install an ODTR or a fault locator to the system permanently. However it is not cost effective since an OTDR is very expensive adding them to the system will increase the cost of system extremely on top of that adding these test gears into the system is impractical especially when considering that the event of fiber break does not occur frequently.
Here the demarcation device yokogawa simulation is used.AQ7932 is application software that performs analysis of trace data from the ODTR on a pc and conveniently creates professional reports. The built in report create localized function because of this task simple quick and easy. Display up to the eight traces on screen and differential trace analysis for comparing recent waveforms with old ones and use the two way trace analysis function for analysing average values of data measured from both directional in the optical fiber.

This yakogowa simulation having some features the trace analysis of simulation it is possible to edit event search conditions approximate curve line settings and respect the analysis operation is also easy, simply click the function icon uses of this yakogowa simulation, it is used to display the ODTR trace which is stored previously and compares with the present trace result. As it displays the losses in event table it is easy and more comfortable to view the loss. A new discrete demarcation device for monitoring the wavelength range installed the front end of the ONT on the customer end is used for OTDR measurement ,the identification of the different end points and connected customer very easily but a network operator must concentrate in such a reflection device and an additional investments for the

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PON required and such a device must be implemented in the fiber network for all the connected customers design the installation process and just before the PON is released for operation. The total return loss for all fibers must be lower than 32db so that all fibers all spliced together and some are used for connectors with an angled physical contact. Design the fiber termination point it should be visible in ODTR measurements where a reflection required.

This tested demarcation device was designed for implementation in PON [1]. The operation wavelength range are 1490/1310 nm and foe downstream and upstream in G-PON [1] and XG-PON [2] system. The wavelength range of 1625-1650nm is deserved for in service measurement in PON without affecting the traffic and active elements in PON. The insertion loss for the wavelength is from 1270-1600nm is less than 1db. The return loss characteristics value for less than 32db in the operational wavelength range of the PON is upto 6.5db in the wavelength range.

In concern for FTTH the fiber network between CO and termination point usually consist of the PON belonging to the network .In some of the branches demarcation device was inserted behind the PON and behind the in house network as well. The available OTDR is 1310/1490/1550/1625/1650 nm is used for measurement. The region behind 1:8 splitters between 3290and 3370m of the ODTR trace was concerned. At fiber length of 3330m four fiber terminations with exactly the same fiber length at 336,337,339m single fiber ends are terminated. We have four different peaks in the ODTR trace recorded at a wavelength of 1550nm. At a wavelength of 1625nm many ghost peaks in the curve on locations, where no termination point of the PON is located. The following single fiber termination point with length of 336m, 337m, 339m cannot be detected. The measurement with other wavelength low reflectively exhibit like the ODTR with the wavelength of 1550nm.

VI. RESULT

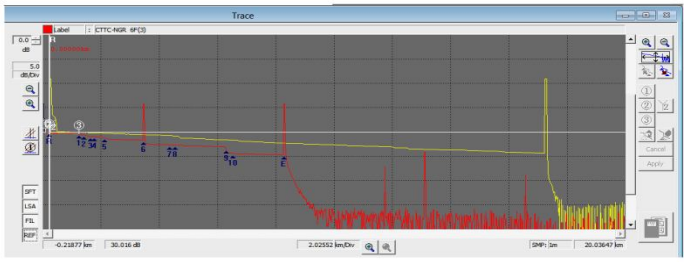

Fig: yakogawa trace

In the simulation by using this yakogawa software the location at which the fault can occurred as well as the losses like splice loss, cable loss, connector loss can be specified directly in the personal computer. And also by using this we can also found the event type (i,e) whether the event type is reflective or non reflective event.

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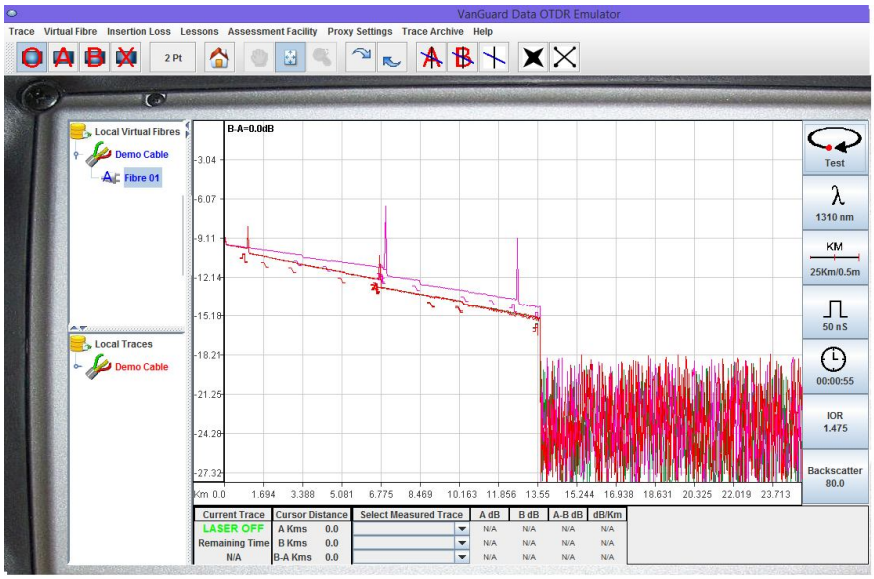

Fig : vanguard trace

By using this software two way tracing can be done, two way tracing is nothing but the fault can be checked whether from the exchange side to the subscriber end or from the subscriber end to the exchange side in the other words the fault can be determined from (A –B) or (B-A).

VI. CONCLUSION

During the installation of a PON the fiber parameters should be classified in order to guarantee errorless operation of the transmission of data from CO to the customer end. Due to point to multi point structure the simple OTDR [4], the measurements of insertion loss for fiber link are important at the wavelength of PON system. During PON [1] operation the independent measurement are necessary for connection of customer side to the PON localisation for the fault. The configuration of monitoring point in the central office is an edge with two input ports dividing the working wavelength range of the PON. Therefore the characterisation of a PON at a wavelength outside the working wavelength range is connectable for in service without interaction and without traffic. The operation of a PON is to locate fault. A PON demarcation point at the customer end next to the ONT will give identification of different end points .It should not exit the low return loss. Thus the demarcation point must not be upto 3db in the wavelength range of 1600-1650 nm hence a low reflectivity of the demarcation point at the wavelength used for the measurement is enough to identify the termination of PON and also in the online monitoring system the fault in the line terminal can be determined by using CFDS[4] and the location at which can also be measured by using the ODTR and software.

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