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ABOUT MEASUREMENTS IN GPON NETWORKS

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Abstract*. The problems of measurement on the network GPON. Recommendations in these measuring instruments. Today there are two most common PON network technologies: Gigabit PON (GPON) and Ethernet PON (EPON). GPON technology is defined in the ITU -T G.984 series of recommendations*

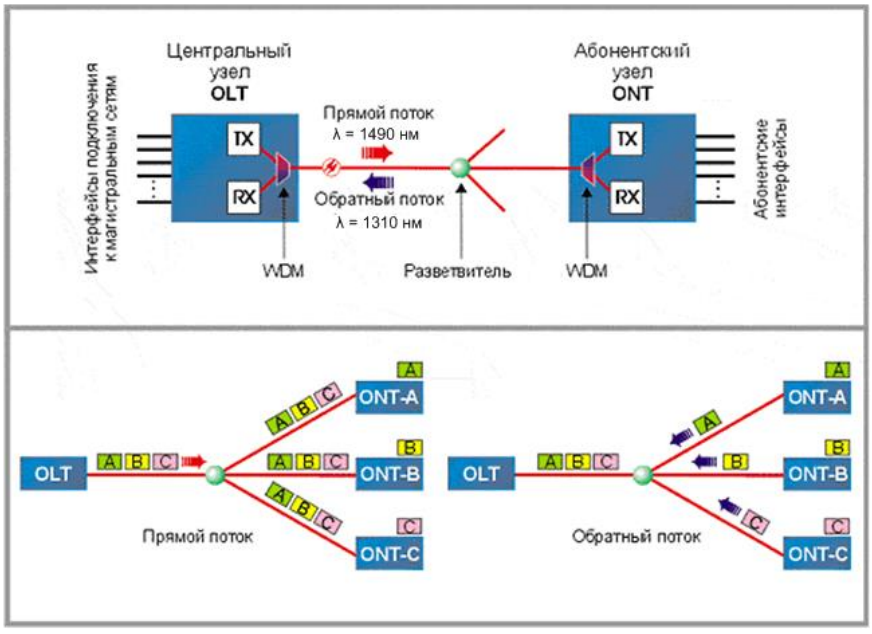
Keywords*: optical line terminal, optical network terminal, measurements, networks.*

Today there are two most common PON network technologies : Gigabit PON (GPON) and Ethernet PON (EPON). GPON technology is defined in the ITU -T G.984 series of recommendations. It provides transfer rates of 1,244 or 2,488 Gbit / s in the forward link()

EPON network technology is based on the IEEE 802.3 ah -2004 standard. It uses Ethernet frames to deliver data at a symmetrical rate of 1 Gbit / s.

GPON technology [1] is popular in Europe and North America, and EPO is the dominant type of PON In Asia. Operators in Uzbekistan using passive optical access networks have chosen European GPON technology.

GPON networks are actively developed by Uzbektecom, East Telecom LLC, and Shark Telecom LLC. and others. Figure 1 shows a fragment of a tree-like PON network.



Rice. 1. Fragment of the PON tree network.

OLT - optical line terminal,
ONT - optical network terminal.
ONU is an optical network device.

All this infrastructure connecting OLT C ONT / ONU are called optical distribution network (ODN). Internet and OLT telephony traffic transmits and receives (from ONT / ONU)

at wavelengths of 1490 and 1310 pt respectively, and video data is entered into the PON “tree” via BOM WDM wavelength division multiplexing devices and are broadcast to subscribers at a wavelength of 1550 pt.

GPON network measurements. One of the main problems in the construction and operation of GPON networks is measuring and testing the network as a whole. The entire set of testing operations for GPON networks can be divided into two categories: optical measurements (network testing at the physical level) and analysis of the GPON protocol (performed using a specialized analyzer).

Testing segments of any fiber-optic network during its construction allows it to be in operation, identify problematic connections, dirty and damaged connectors and other defective components that can have a very negative impact on user service.

Ideally, the PON network should be tested after each basic component is installed. For example, having installed a splitter, you should check the signal transmission parameters between each of its (splitter) outputs and the station equipment.

It is also recommended to test for optical loss and reflection (optical return loss of the connection using ORL) all connectors. This is done with an OTDR optical reflectometer. The normal level of loss in such a connection (a pair of mated connectors) is 0.2-0.5 dB, and the normal level of reflection is in the range of -45 to -65 dB. If any connection is not correct, technicians will need to repair it or replace the connectors.

It is recommended to carry out two-way loss measurements in each splice (spliced optical fiber connection), even if the losses during signal propagation throughout the ODN are within the standard. The fact is that over time, poor-quality splicing can become a source of network problems. These measurements are done with similar reflectometer.

To certify a newly built ODN in accordance with [1-3], three main tests should be carried out. These are two-way ORL measurements, two-way end-to-end signal attenuation measurements, and detailed characterization of the entire path. The first two tests use an ORL meter and an optical loss meter (OLTS), respectively, and the last one uses an OTDR OTDR . The given recommendations for optical measurements apply to all types of P ON networks. They must be carried out during construction, commissioning and subsequent maintenance of PON networks, as well as when connecting new ONT / ONU to them.

As is known from world practice, some OLTS are capable of determining ORL, which makes the use of a specialized ORL tester unnecessary. Such universal products include the CMA50 device from the Japanese company Anritsu, which has proven itself in practice (Fig. 2).

Rice. 2. Meter optical losses SMA50

Along with the capabilities, C basic has OH optional measurement functions ORL AND EZ Test. The latter provides loss measurement at several wavelengths with automatic switching

from one wavelength to another. The instrument can accommodate up to four highly stable laser light sources, and the built-in power meter is calibrated to operate at 26 wavelengths. For testing GPON, the CMA 50 model with radiation sources operating at wavelengths of 1310, 1490, 1550 and 1625 nm is suitable.

Together with the basic model, the VFL (flaw detector) option, which is also useful for diagnosing fiber-optic networks, is usually supplied, capable of identifying (highlighting) faulty, cracked, broken connections or optical cables, cords and tips.

Unlike OLTS, which measures the total loss of a fiber path under test, an OTDR provides a visual representation of the distribution of losses along the entire length of the path, allowing technicians to determine its length, the location of any discontinuities in it (defects, detachable and permanent connections), losses in connections, etc.

However, not every reflectometer is suitable for testing PON networks. A suitable model must have a small event dead zone (to control inhomogeneities located next to each other) and a significant dynamic range, since PON paths are characterized by large losses due to the division of signal power in splitters.

Network optical reflectometer. Manufactured by Anritsu miniature platform MT 9090 A Network Master with μOTDR module MU 909014 x /15x series is shown in Fig. 3.

Rice. 3 Appearance of the MT9090 A analyzer Network Master c OTDR module

This analyzer is very attractive because, with very small overall dimensions (190 x 96 x 48 mm) and weight (less than 700 g), it has high performance characteristics, and is also simple and convenient to use. Ero's capabilities are quite sufficient for complete and accurate testing of fiber-optic access networks, as well as city fiber optic trunk lines.

μOTDR module with a dynamic range of up to 37 dB allows you to perform OTDR measurements on a PON network through splitters with up to 64 outputs and analyze fiber optic paths up to 175 km long. The dead zone for event y of this module is less than 1 m, and the sampling resolution is 5 sm, which ensures a fairly accurate determination of the location of all inhomogeneities. The OTDR module has a built-in 10 m extension fiber, allowing you to test the initial path connectors without the need for additional fiber optic cables.

A number of models of these modules have built-in functionality for an optical power meter. This reflectometer model can be equipped with a flaw detector or video microscope, which is designed to check the condition of the tips of optical connectors. This operation is extremely important in PON networks, often on optical connectors, since contamination causes poor performance of the fiber optic path.

μ OTDR modules with different performance characteristics, other functional modules are also available for the basic platform of the MT9090A optical reflectometer - Optical Channel Analyzer (for analyzing CWDM networks), Gigabit Ethernet (for testing Ethernet networks) and Fault Locator (for localizing faults in short fiber optic lines). For example, using the Optical

module Channel Analyzer , you can control the signal level in the PON network, Fault module Locator , which is a reflectometer with a small dynamic range (about 7 db) and a number of additional functions, is recommended by Anritsu to be used for diagnosing subscriber cable outlets in existing PON networks. Operating at a wavelength of 780 nm , this module does not interfere with their functioning. Combined with a variety of plug-in modules, the MT9090A platform provides an ideal solution for field testing of fiber optic networks, reflectors have higher technical characteristics compared to the characteristics of OTDR modules for the MT9090A platform ectometers, MT9083 ACCESS series Master, manufactured by Anritsu.

It is shown in Figure 4.

Fig.4. Appearance of the MT9083A ACCESS reflectometer Master.

These reflectometers allow you to test fiber-optic lines of LANs, cable TV networks, and access networks made on fiber. The MT9083A optical reflectometer model (with a dynamic range of up to 45 db) allows you to carry out reflectometric measurements on a PON network through optical splitters with up to 128 outputs and analyze fiber-optic lines over 200 km in length.

Optical reflectometers of the MT9083A series provide an event dead zone length of less than 1 m and a sample resolution of 5 sm. To relieve technicians from the need to carry several different instruments, the developers of these reflectometers have provided them with additional functions OLTS, flaw detector, video microscope and IP - testing.

Troubleshooting technique. Typically, before putting a newly built PON network into operation, it is necessary to ensure that the central communication center transmits optical signals of sufficient power. This is done by disconnecting the linear fiber from the wavelength division multiplexing (WDM) fiber optic system and measuring the level of the optical signals directly at the output of the optical transmitter using a conventional optical power meter or O LTS . Each time a new ONT / ONU is connected to the PON network, the optical signal power in the subscriber cable outlet is measured.

PON networks, network operator technicians and engineers must diagnose and troubleshoot problems in their operation. As practice and information data from the Internet show [4], each operator prepares a technological map or algorithm for troubleshooting in the GPON network for its engineers. They are usually drawn up in the form of external or internal regulatory documents that are binding.

As an example, Figure 5 shows a typical troubleshooting technique in a PON network when all subscribers or only some of them are not served

Rice. 5. Methodology for troubleshooting in a PON network.

Analysis of the GPON protocol. As noted earlier, problems in the operation of the GPON network can arise not only at the physical level, but also at the GPON protocol level. To diagnose these problems and verify that GPON equipment meets technical requirements, a multi-level analyzer model " GPON" is used Xpert by TraceSpan With communications. This modular tool, available in lab and portable versions, can check the compatibility of GPON equipment from different manufacturers and test any combination of OLTs with ONTs / ONUs against GPON guidelines. GPON analyzer Xpert helps you find the root cause of problems in GPON networks and devices, and also allows you to check the operation of important services, including VoIP and IPTV, over the GPON network. To test ONT / ONU devices, this device can also be used as a GPON emulator Xpert.

GPON analyzer Xpert simultaneously displays downstream and upstream data flows and shows the relationship between data transmitted by OLT and ONT / ONU. It has a functional, rich graphical user interface that presents multi-level information in the form of easy-to-read graphs and tables.

In Fig. Figure 6 shows possible options for connecting this analyzer to a GPON network.

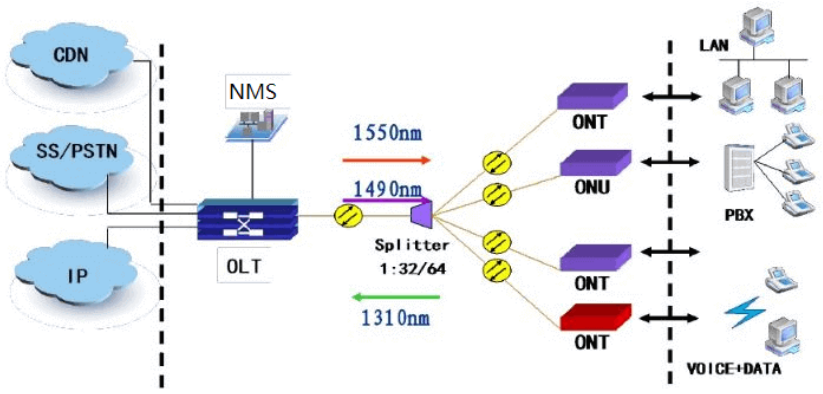


Figure 6. Example of OLT control.

To automate qualification tests in a GPON analyzer Xpert has over 40 built-in test scenarios defined according to ITU-T G.984.3 (GPON MAC). G .984.4/ G .988. (OMS I) and G.984.4 ImpIementer's Guide. By providing pass/fail metrics, these scripts allow you to quickly evaluate the correct functioning of various processes and services on a GPON network. In addition, the analyzer provides VLAN routing information, analyzes dynamic bandwidth allocation (DBA), and generates custom reports. Its important advantages include support for continuous network analysis in real time. This mode is especially useful for diagnosing problems that occur long after the connection between the OLT and ONT / ONU has been established.

In conclusion, we note the following:

To troubleshoot an existing PON network, you can use the μ OTDR module or the MT9083A series optical reflectometer, which operates at a wavelength of 1650 nm, which is not used in PON, and has a built-in filter that does not transmit PON signals with wavelengths of 1490 and 1550 nm so that they do not distorted the results of reflectometric measurements;

For PON diagnostics, it is recommended to use an optical reflectometer of the MT9083A series, operating at a length of 780 nm, and no filter is required;

Modern GPON analyzer Xpert will be useful for service providers.

When searching for damage, it is necessary to use a standard method for troubleshooting problems in the PON network.

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