Fiber tests in PON networks: commissioning and maintenance

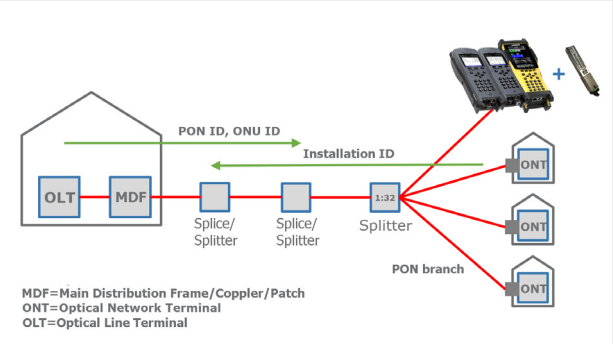
It is now 2021; in the telecommunications industry, one thing is undisputed: the future is fiber.

Although the transition technologies VDSL2 with super vectoring (profile 35b) and G.fast (up to profile 212a) can easily cover current broadband needs over a wide area, all those who want to be ready for the future must concurrently continue to invest in modern fiber optic technologies. All major and many smaller network operators all across Europe are pursuing this technology. The most commonly used wide-area technology is the Gigabit Passive Optical Network (GPON), specified according to ITU-T G.984.

The advantage is that GPON supports high data rates (up to 2.5 Gbit/s) over long distances (theoretically up to 20 km) while ensuring a relatively simple and low-cost rollout, as this technology does not require any active components (e.g. switches) that need their own power supplies. The signal is distributed passively within a point to multipoint topology. GPON is unique in that it functions as a shared medium, which means that all subscribers on a GPON branch must share the data rate. And this characteristic presents metrological challenges.

Metrological challenges

Particularly the point to multipoint topology makes commissioning and troubleshooting such a PON branch somewhat more complex than most technicians are accustomed to from DSL, in which each subscriber was connected via a modem "exclusively" to their own DSLAM port. In GPON, the analogous devices are optical line terminations (OLT) on the central office side and optical network terminals or units (ONT/ONU) on the subscriber side. Thus, in GPON multiple ONTs connect to a single OLT, the datastream to the individual ONTs is transmitted at a wavelength of 1490 nm (downstream) and distributed to the subscribers with the help of passive splitters. Up to 32 subscribers are possible in practice, in theory up to 128. Each subscriber can have a different line length; overall however, the OLT only only transmits with a fixed transmission (Tx) level, e.g. +3.6 dBm.



ARGUS 163 / 166 / 260 and ARGUS GPON ONT.

Attenuation

During rollout, a technician must test each end point to verify whether the optical performance budget is sufficient. However, this type of consumption measurement requires a precisely calibrated power meter with an accuracy of +/-0.5 dB. Anything less would be little better than an estimate that would have to be calculated solely on the basis of the optical fiber itself with an attenuation of approx. 0.44 dB per kilometre. Because there will always be accesses at the limit that cause problems, and often require the use of measurement technology.

Thus, the insertion loss must be determined individually by means of a verification measurement at each end point. This is only possible when the measuring instrument "knows" the original transmission level (see above); ideally, this value can be read from the OLT and referenced directly at the end point. When previously configured with the target values, the instrument can then immediately calculate and assess the insertion attenuation. A graphical OK/fail assessment is readily and rapidly understandable.

The wizard

A software wizard that is aware of the customer's basic topology and registers the individual structure on site in advance – e.g. number of end points, splitters, number of fibers, fiber optic line length, ONT type, etc. – through directed questions can define a precise measuring sequence and guide the technician through the installation of the entire PON branch. At the end of the process, the instrument provides the technician with a detailed installation report that precisely matches the commissioned PON branch.

In addition to determining the insertion attenuation, the wizard should read out the PON ID individually assigned to this PON branch from the OLT and verify that it matches; otherwise, the process could end up registering multiple different PON branches at once.

Some instruments can even interpret the often highly customer-specific PON IDs and extract important information from them, for instance the assigned static IP address or the port or slot to which the end point is connected.

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An automated query of job data by the wizard is must-have feature. These data complete the handover report and permit the measurement sequence to be resumed at any time.

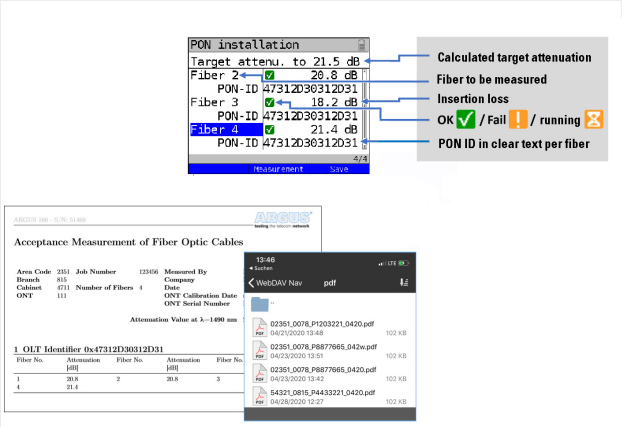

Figure 2: Example of a measuring wizard in an instrument (top) and an acceptance measurement log in PDF format on a PC (left) and a smart phone (bottom right).

Quick check

However, for a quick check, it must also be possible to determine the attenuation and PON ID of a single end point independently of the wizard. A PON level check or quick check functionality is essential: it simplifies troubleshooting and shortens measuring times considerably. The days in which the job could be done using just a power meter are now over.

GPON terminal mode

Assuming that our PON branch has been properly tested and handed over to the network operator: Does that mean the job is done?

No, because the devil is usually in the details. For instance, if customers experience problems after setup of the ONT because the installation ID was not correctly transmitted, the PPP login password is incorrect or the Ipv4 or Ipv6 connection behind it is causing problems, meters that can only read out the attenuation and PON ID quickly reach their limits.

It may be necessary to completely replace the customer ONT, and a proper GPON connection is needed. Just as for VDSL2, a protocol must be initiated and then a services test performed. The foundation for customer satisfaction does not exist until downloads are possible and VoIP service is operational.

Time can be saved here too, for instance when the instrument is able to start a VoIP call. Such a call can be established and satisfactory voice quality verified rapidly. In this way, problems in the ONT configuration can be ruled out or confirmed quickly. The GPON upstream direction is concurrently tested in the same way as well. By itself, the insertion attenuation does not take this into account at all. An essential check.

By connecting with the OLT, the instrument can acquire and display many other interesting parameters and save them to the measurement report. Here as well, it can register the OLT transmission level, the resulting attenuation and the PON ID – even without the quick check – along with the vendor ID, the own ONT ID and the power class. A GPON status trace can highlight which step of the authentication process the GPON is currently executing and whether there are any problems.

Performance tests

In some cases, customers may complain of deficiencies in download or upload performance. This requires a performance check to be performed against a designated remote station, e.g. a suitable HTTP, FTP, Ookla or iperf server.

The performance can be measured at the Ethernet interface of the ONT, i.e. on copper (Ethernet), but also directly on the optical fiber. The instrument should be capable of providing the bandwidth actually promised to the customer, where necessary concurrently with the other tests. It must be able to answer the question of how much downstream bandwidth remains while one IPTV stream and multiple VoIP calls are in process at the same time. Triple play tests must be possible at the end of a GPON branch just as they are in ADSL or VDSL. A multipurpose instrument can simulate all devices needed, whether ONT, PC, set-top box or telephone, without having to handle multiple devices on site.

Conclusion

In addition to the metrological capabilities, which deliver high accuracy thanks to rigorous calibration and ergonomic instrument operation facilitated by wizards and quick tests, “soft skills” play an important role for work process orientation. For instance, measurement reports should be generated in PDF format and distributable to cloud services (e.g. As FTP upload via WLAN) directly via the GPON interface, without the need for a smart phone.

Ideally, the measurement solution should take the form of an all-in-one instrument, so that all tests are always at hand. Time-consuming, error-prone connection attempts and reconfiguration of phone-based WLAN or Bluetooth links are then no longer necessary. The instrument can simply be passed around within the team.

Even years after purchase, ARGUS brand VDSL and G.fast test instruments made by intec GmbH from Lüdenscheid, Germany, can be cost-effectively retrofitted with a PON installation test functionality and a GPON-ONT (end-user device) mode for testing GPON/fiber systems, an ideal multipurpose solution for the transition period “from copper to fiber” for day-to-day working in the field.

The advantage of this solution: The commissioning test process and fault-finding on the GPON interface are identical with those familiar to technicians from ADSL or VDSL. First a check of layer 1 and then the connection with function and performance test – that saves time and training overhead when introducing new measuring and test procedures.

Retrofit your current ARGUS 163 or ARGUS 166 instruments quickly and inexpensively today instead of buying new devices, or – if you are already looking into investing in new meters – check out intec's new ARGUS 260, the next-generation fiber-multipurpose instrument. It unites in a single instrument the functions of xDSL combination testers with those for which other vendors offer an entire package of meters.

The generous touch display permits in-depth tests such as the optical fault finder and fiber inspection tool. The ARGUS 260 is additionally equipped with an optical light source that transmits a defined ID on a selected wavelength, and can be expanded using the optical power meter (OPM) to form an extremely precise (± 0,25 dBm) optical loss test kit without having to cart around a full bag of gear.

Figure 3: ARGUS 260 fiber multitester/multimeter for GPON-TE and PON installation tests, here with video microsope for optical inspection of glass fibers.

This article was written by Dennis Zoppke in cooperation with the editorial office of the professional journal „net".

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