Speed and reliability – the key parameters for a new generation of field-test OTDRs

By Optical Product Marketing, Yokogawa Europe

Broadband network service providers and network operators could be forgiven for thinking that they are between a rock and a hard place. On the one hand, consumers' consumption of high data-rate services such as HD video streaming continually grows. Without high levels of investment to extend their high-speed optical fibre networks to the antenna (FTTA) and to the home (FTTH), service providers will lose subscribers (see Figure 1).

At the same time, a brutally competitive market and the fast development of communications technology is constantly driving down revenue per delivered bit, squeezing the service providers' return on capital and operational expenditures. Operators of enterprise IT systems face the same steep rise in demand for bandwidth in commercial buildings and in campus settings. The speed and cost of new, high-bandwidth optical network infrastructure has a substantial impact both on user's satisfaction with the IT system's operation, and on the value which the enterprise gains from its investment in infrastructure.

Network owners and operators must therefore look for efficiencies wherever they can, and eliminate any preventable

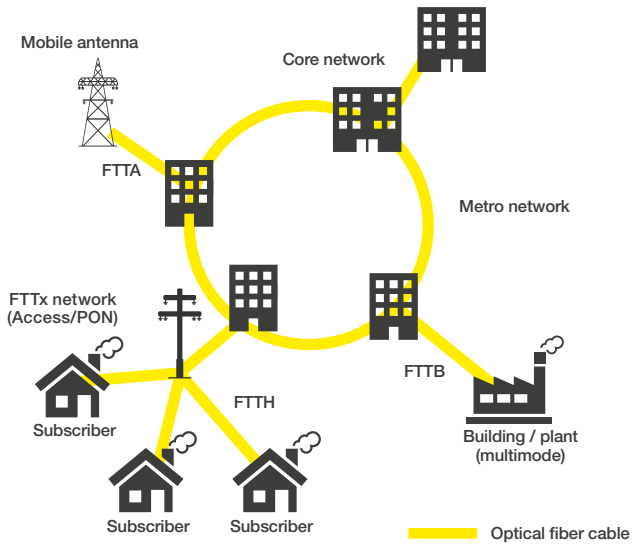

Fig. 1: In many regions, optical fibre is today being extended to the antenna and to the home. *(Image credit: Yokogawa)*

sources of revenue loss. And today, one promising area for efficiency gains is in the installation and maintenance of Passive Optical Network (PON) infrastructure. Here, installation and field technicians are responsible for testing and verifying new and legacy optical fibre. Their productivity depends on the capabilities of the test equipment they use to detect and diagnose faults.

Speed and reliability

Field testers for optical networks are important to service providers, as well to network managers and installers responsible for optical Local Area Network (LAN) cabling in enterprise IT systems, because:

- They affect the speed, quality and cost of new fibre installation projects
- They enable the fast repair of faults in live networks, to maximise revenue-earning uptime

The principle of operation of an Optical Time Domain Reflectometer (OTDR) is based on optical light pulses that are injected into the fibre under test with the effect of measuring the amount of backscattered light that is received as the pulses propagate down the length of the fibre. From these measurements the instrument is able to derive and determine at specific points along the fibre important factors like the length of the fibre, attenuation, location of connectors or splices or even faults like a fibre break or a dirty interface connector.

The OTDR measurement is displayed in the form of a reflectogram which is further enhanced by specifically designed software called Smart Mapper that interprets the generated trace and correlates the so called event to easy to read icons which are easily interpreted by the operator further enhancing the usability of the instrument.

Intended for use in the field, an OTDR enhances the operator's productivity while providing a simple user interface which is convenient and easy to use.

In addition, when used for field testing, the OTDR might be exposed to harsh conditions, including:

- Operation outdoors in extreme high and low ambient temperatures, and in all weather. Moisture in the form of humidity and rain is a common hazard for field network testers.
- Rough handling – a field tester needs to be able to cope with shock and vibration. It might be dropped by the user, or stored in a vehicle which has to travel off-road to reach remote network locations.

And because the purpose of the tool is to verify that fibre has been installed correctly, or to find a fault when a section of the network is malfunctioning, the OTDR must be capable of providing very accurate location of faults, and a diagnosis of the fault which is easy for the installer to understand.

- Accurate location of the fault minimises the time which the network technician must spend digging a hole in the ground to gain access to cable in an access network, or searching through the ceiling or floor voids in which optical LAN cable typically runs.
- Measurements which are easy to understand ensure that the technician on site can handle the repair autonomously and quickly, without the need to call out specialist engineers.

This means that network operators require a field-test OTDR which combines reliability – to withstand rough handling and operation outdoors – and speed, to make installation and repair as fast as possible.
It was to meet these requirements that Yokogawa developed its new AQ1210 series of OTDR field-test instruments.

Robust but lightweight

To be used as a field instrument, an OTDR must be small and light enough to be carried in one hand. The AQ1210 is a comfortable size - 210mm (W) x 148mm (H) x 69mm (D), roughly the area of an A5 sheet of paper. It weighs just 1kg including its battery, which has the capacity to run for 10 hours between charges – enough to last a whole working day. The tester may be fast-charged via its USB Type-C port.

Despite its small dimensions, Yokogawa has made it mechanically robust. Importantly, it is a fanless design, so there is no cooling mechanism to fail inside the chassis. The body is made of high-quality plastic and rubber, and the 5.7-inch capacitive multi-touchscreen display is industrial-grade to cope with shock and vibration. The intuitive touchscreen user interface is backed by a selection of hard-key buttons which support operation when the user is wearing gloves.
A wide operating-temperature range of -10°C to 50°C ensures that the instrument can be used reliably outdoors.

Fast detection and location of faults

In the AQ1210, then, field technicians have an OTDR which is small, lightweight and robust. But to achieve high productivity and minimise installation and maintenance costs, technicians also need their tester to help them work fast. The AQ1210 delivers on this as well.

The instrument itself operates at high speed: it boots up from power-off in less than 10s, and once it is running its measurement refresh rate is 5Hz. It also supports multi-tasking: the instrument may be configured to perform an OTDR test such as a return loss measurement on one fibre while performing an optical power measurement on a second fibre, a surface quality check on a third fibre and a visible light test to detect a crack or bend in a nearby fourth fibre simultaneously.

Fig. 2: The display screen of the AQ1210 in multi-tasking mode

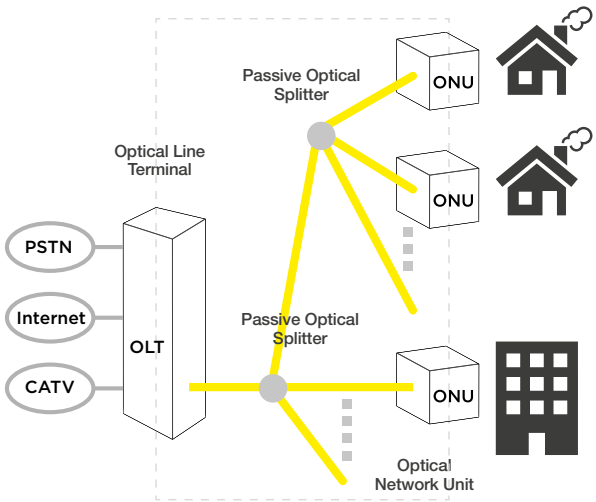

Fig. 3: The AQ1210 may be used to test PON configurations with a splitting ratio of up to 1:128. *(Image credit: Yokogawa)*

For advanced users, the AQ1210 series OTDRs also provide more sophisticated operating modes, including:

- Multi-trace analysis – up to four traces can be overlaid for comparison
- Two-way trace analysis to accurately measure the connection loss, averaging the values measured from each direction
- Differential trace analysis to check the impact of ageing on fibres or connection points

Despite offering this sophisticated functionality, the AQ1210 takes account of the need to be user-friendly to technicians. It is controlled via an intuitive touchscreen interface. It supports features such as multi-touch zoom and swipe gestures that users will recognise from their smartphone. The Smart Mapper software enables the operator to rapidly characterise fibres over a range long enough to support any field technician's normal requirements, and to generate easy-to-read pdf reports with icons which clearly highlight events such as breaks and losses.

Support for Wi-Fi® wireless connections to a smartphone or PC allows for simple data transfer from the instrument, and for remote control via a web browser. The AQ1210 is backed by Yokogawa's AQ7933 emulation software for the PC, which may be used to analyse and edit trace data.

Applications in metro, access and LAN networks

Models in the AQ1210 series are suitable for use in PON installations worldwide. The AQ1210A (standard model for use in access network installations)_ and the AQ1215A (high dynamic range model for access or metro networks) operate at wavelengths of 1310nm and 1550nm.
Other models in the series are suitable for both installation and maintenance operations:

- The AQ1210E is for use in access network cabling, supporting frequencies of 1310nm, 1550nm and 1625nm.
- The AQ1215E, AQ1215F and AQ1216F are for use in both access and metro networks, and support the 1310nm, 1550nm and 1625/1650nm frequencies.

These OTDRs can analyse PON networks with a splitting ratio of up to 1:128 (see Figure 3), with a dynamic range of 42dB. A short dead zone of 50cm and a resolution of 2cm ensure that breaks and other events can be detected precisely and quickly in a range from within reach of the technician's arm out to a distance of many kilometres.

A new addition to the series, the AQ1210D, extends the benefits of ease of use and precise identification and location of faults to LAN as well as access network fibre installations. The AQ1210D is the first OTDR in the series to support four frequencies (850/1300nm and 1310/1550nm), and both single-mode and multi-mode fibre.

The single-mode fibre port features a dynamic range of 37dB at 1310nm and 35dB at 1550nm, ideal for inter-building and short network spans. It is suitable for testing installations of FTTB (fiber to the building), point-to-point optical links, and datacentre interconnects (DCI).
The multi-mode fibre port has dynamic range of 25dB at 850nm and 27dB at 1300nm, for use in intra-building networks in LAN, private, enterprise, campus, and datacentre deployments.

Fig. 4: The Yokogawa AQ1210 series OTDR

A technician's productivity tool

Combining the high precision and accuracy of advanced bench-top instrumentation with the robustness and portability of a handheld tester, the AQ1210 series OTDRs enable installers and maintenance operators to test, verify and troubleshoot PON fibre installations quickly, reliably and confidently (see Figure 4). This means that network operators can reduce operating and installation expenses and benefit from quicker repairs and longer uptime, making the AQ1210 a vital tool in the competitive battle over broadband internet provision.

About Yokogawa Test & Measurement

Yokogawa Test & Measurement are the 'Precision Makers', and the company's instruments are renowned for maintaining high levels of precision and for continuing to deliver value for far longer than other instruments. Yokogawa believes that precise and effective measurement lies at the heart of successful innovation – and has focused its own R&D on providing the tools that researchers and engineers need to address challenges great and small.

Learn more on AQ1210 OTDR at
https://tmi.yokogawa.com/eu/