HIGH-RESOLUTION OPTICAL REFLECTOMETRY

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Reflectometers - these are instruments used to measure parameters of various types of optical systems, such as: return loss, insertion loss, location of reflective events in the fiber path. While standard optical reflectometers, time domain (English. Optical Time Domain Reflectometer – OTDR), are widely used in the characterization of medium and long-haul fiber networks, OBR backscatter OTDR, offers a unique combination of high spatial resolution and sensitivity. This makes OBR a very important tool for analyzing the parameters of shorter local, FOCL, components and modern photonic integrated circuits

Whether analyzing the performance of a miniature PIC or determining the best troubleshooting method for a long haul fiber optic cable, understanding and quantifying loss along the optical path is a key step.

Return Loss (RL) is defined as the ratio of the power of the radiation reflected back from the device / section of the FOCL (PR) to the power of the radiation introduced into this section (Pin). The value is logarithmic and is expressed in decibels (dB).

$$RL = 10\log\left(\frac{P_R}{P_{in}}\right).$$

High levels of optical return loss can reduce the signal-to-noise ratio, increase the bit error rate, interfere with the operation of the optical source, and generally degrade the performance of an optical component or the entire system.

The two main phenomena causing this type of loss are Fresnel backscatter and Rayleigh backscatter (Fig. 1). Backward Fresnel reflection occurs when radiation hits the interface between two media with different refractive indices (ni). In optical fiber, for example, Fresnel reflections are caused by air gaps, microcracks, macrobends, core misalignment during splicing, etc. On the other hand, Rayleigh backscattering is an intrinsic property of optical media and is caused by the presence of natural impurities and various inhomogeneities in the fiber. Rayleigh backscattering occurs along the entire length of the optical fiber.

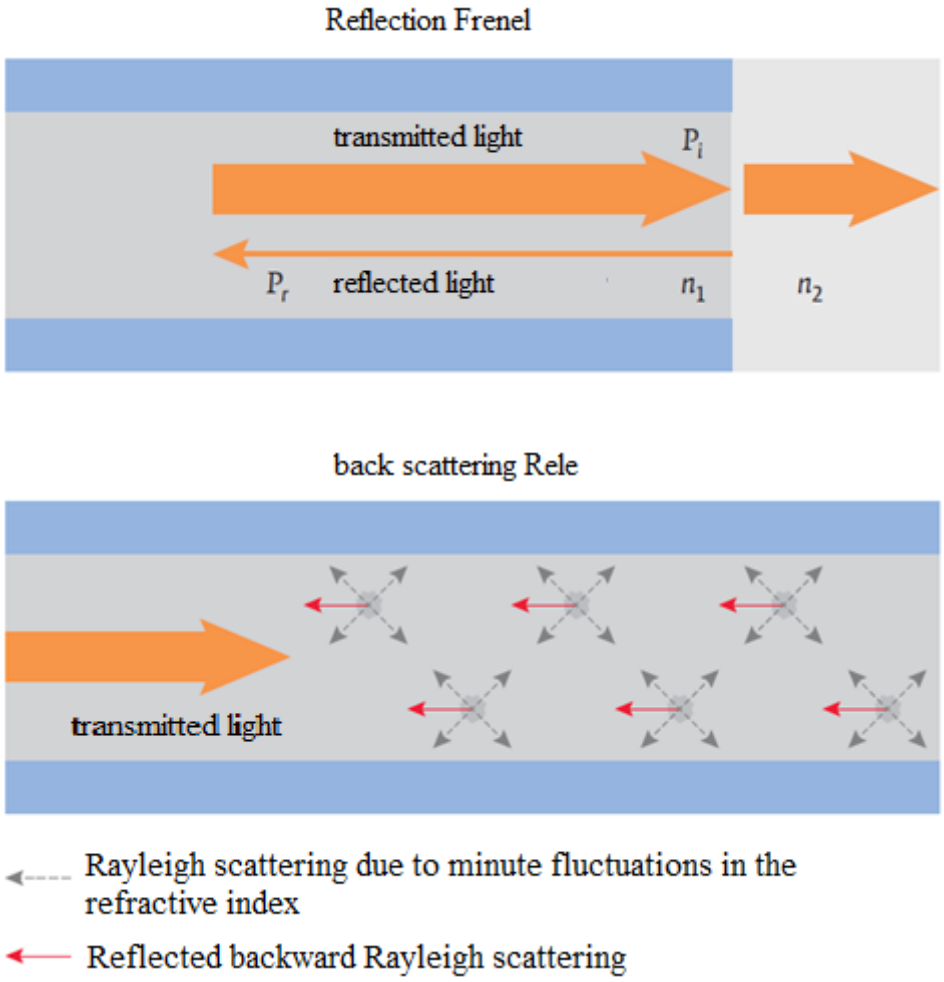

Fig. 1.. Main sources of reflections

Return Loss Measurement

OTDR is a collection of methods for measuring return loss (return loss). The principle of operation of the reflectometer consists in introducing a probing signal of known power into the investigated section of the fiber or FOCL, then measuring the power of the reflected light signal and calculating their ratio (Fig. 2). The measurement either quantifies the reflected light or calculates the loss along the optical path. Measuring the aggregate or total value of optical return loss (RL) in a fiber-optic link or in a separate section of it is a relatively simple operation and consists in supplying a light signal of a known power level to the component or section under investigation, followed by measuring the reflected radiation power. The simplest instrument used for this type of measurement is the Optical Continuous-Wave Reflectometer (OCWR). Although it is often necessary during operation to measure the total value of optical reflection loss, it does not provide an understanding of which part of the FOCL is the problem causing attenuation.

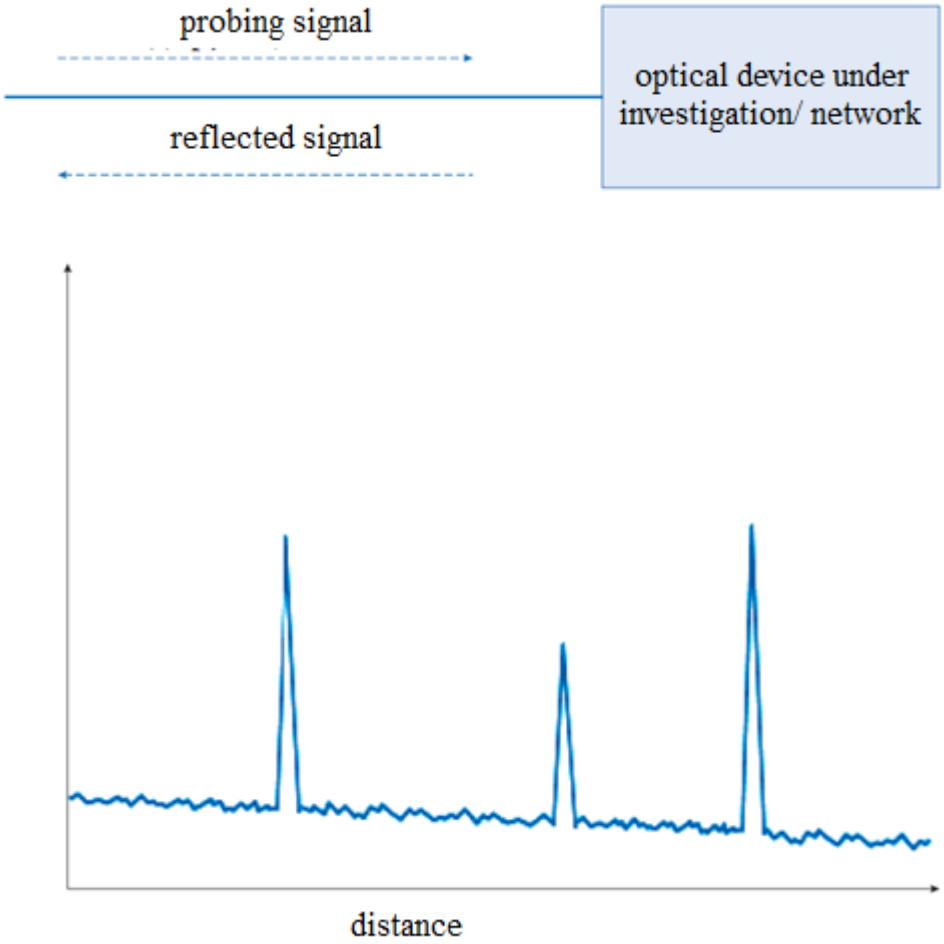

Fig. 2. Measuring Return Loss Using OTDR

However, using an Optical Time Domain Reflectometer (OTDR) or an Optical Frequency Domain Reflectometer (OFDR), it is possible to measure reflection loss along the entire length of the area under study. In total, there are three main methods of spatially resolved reflectometry: optical time domain reflectometry (OTDR), optical low coherence reflectometry (OLCR) and optical frequency domain reflectometry (OFDR).