Laboratory exercise 1 of Fiber Optical Communication course

OPTICAL TIME-DOMAIN REFLECTOMETER

Tallinn 2016
Aim of the laboratory exercise:
The aim of this laboratory exercise is to introduce the Optical Time Domain Reflectometer (OTDR) measurement tool and parameters influencing the measurement accuracy. After the exercise, students should have a clear overview about the possibilities provided by the OTDR equipment for fault localization.

The list of equipment is provided in the last section of this document.

Preparation for the laboratory exercise
Please note that sufficient preparation for this laboratory exercise is needed!

The student is asked to study and prepare answers for preparation questions (see below) before coming to the lab exercise. The lab exercises are meant for practical introductory matter with real fiber optic devices and either lab report or defence of lab report is not necessary. Participation in the laboratory exercise is compulsory.

In the beginning of each lab, these preparation questions are discussed through. If student fails completely without knowing any matter of correct answers, then student is asked to file a lab report with conclusions. Sufficient understanding of covered topics by these preparation questions is the basis of the successful completion of the lab exercise. Questions are following:

1. What kind of loss mechanisms can be present in the fiber optic communication link?
2. What device is OTDR (Optical Time-Domain Reflectometer) and why is it used by fiber optic network engineers?
3. What is the working principle of OTDR?
4. What happens with the propagating light in the fiber medium if we bend fiber too much?

You can write your answers here:
IMPORTANT DISCLAIMER: Please note that before starting work with the laboratory equipment you are asked to confirm that you have read carefully the safety instructions for working in the lab and working with fiber optic communication equipment!

A. The Optical Time-Domain Reflectometer (OTDR)

![OTDR diagram](https://via.placeholder.com/150)

**Figure 1 Example of the OTDR trace interpretation**

1. **Loss events of the fiber optical communication link**

The test link consisting of multiple fiber spools and fiber patches is already set up in the laboratory exercise room. The link with connected OTDR should have the following configuration depicted in the figure 2.

![Test schema](https://via.placeholder.com/150)

**Figure 2 Test schema for the OTDR measurement**

a. Locate the link and connect the OTDR to it.

b. Launch the OTDR test. Analyse the test results by changing the pulse length parameters from 5ns, 300ns and 20ms. What about the measurement accuracy? Can you identify all events at all pulse lengths?

c. Pick the optimum value for the pulse and span length and run the trace. Inspect the results very carefully. Note that there is some extra complexity in the fiber link that is not shown in the figure 2. What can you see on the screen and what can you do with that information? Sketch up a rough drawing in figure 3 of OTDR trace result and mark also the events on your drawing. Can you identify any negative attenuation events with OTDR? What are these?
d. After identifying the broken fiber patchcord, remove it from the setup and make new OTDR measurement. Have you removed the correct cable from the setup?

e. Now remove the launch cables and connect OTDR directly to the fibre. Do you see any differences compared to the previous measurements? Sketch up a rough drawing in figure 4 of OTDR trace result.

2. Reflectance

a. Recover the schema used at exercise 1 and pick the optimum pulse and span length for the measurements. Inspect the reflectance on the event table and the trace view. Where does the reflectance occur? Where are they mostly reflected from?

b. Remove all the spools and leave only one launch cable connected to the OTDR module as it is seen in the figure 5. Find the optimum parameters and run the trace. Inspect carefully the end of the trace. Could you explain the ghost reflectance?
3. Fibre bends
a. Recover the setup used at exercise 1 and add a short patchcord between Launch cable and the first fibre spool as it is shown in the figure 6. Pick the optimum pulse and span length for the measurements.

b. Bend the small added patchcord in a multiple rings with diameters of 10cm, 5cm, and 1.5cm. Run the trace after every ring. What can you conclude? What would a micro-bend mean?

4. Inspection of the live fibres – Televõrgu infrastructure
a. Connect OTDR and Launchbox to Televõrgu Metro fiber as it is shown in the figure 7, run test and inspect the readings.

b. Write down the readings and explain, what these events might mean in the real life. How long are the fibres? Do you see any imperfections on the infrastructure?
List of equipment:

**Optical fibres and handling tools:**
One to three fibre spools in Lab environment (ITU-T G652 standard based fibre, ITU-T G.655 compliant Corning LEAF (Non-Zero Dispersion Shifted Fiber) and Corning Metrocore optical fibers)

One to four optical routes with variable lengths on Televõrgu Metro fibre in Tallinn area (all ITU-T G.652 compliant optical fibres)

Fiberscope and necessary adapters

Fibre cleaning equipment (cleaning cassette and cleaning sticks)

Attenuators and patch cords/optical jumpers

**Optical identification and measurement equipment:**
Optical Time-Domain Reflectometer (OTDR)

Dead Zone Eliminator or OTDR Launchbox