Fiber optic time and frequency transfer is considered nowadays as a possible alternative for the commonly used satellite techniques. The bi-directional transfer in a single fiber and possibility of signals amplification in the optical domain that does not disturb the link symmetry, provide the unsurpassed accuracy and stability of the reference signals transmitted at the distance of hundreds of kilometers. However, the link bi-directionality and the long range require judiciously chosen settings of the optical amplifiers, to cover the required transmission distance, but also to minimize undesirable effects that may occur in the link, disturbing its performance.

The gain optimization procedure bases on the simulations of the link performed at the design stage. The mathematical model requires to approximate or take for constant some of the parameters (i.e. attenuations of the spans, Rayleigh backscattering coefficients, connectors/splices losses, chromatic dispersion of the fiber, laser linewidth etc.) that may have the influence on the link performance, and thus the optimization may be inaccurate. For this reason, the idea of on-line optimization has been investigated and resulted with the development of the devices control algorithms that operate based on real-time measurements of the phase fluctuations (jitter) of the frequency reference signal transmitted in the link. However, the experiments revealed the risk of triggering the stimulated Brillouin scattering (particularly if the gains are high) that may disturb the optimization process and the link performance. Moreover, developed optimization method requires remote access to all the nodes along the link (local and end modules and amplifiers), which is cumbersome due to either temporal loss of communication or inability to provide the communication channel.

In this project we propose a novel approach where the optimization process will run over the distributed system in an autonomous way exploiting the intelligence embedded within all components of the link. To make it possible it is necessary to solve a few problems related to increasing the measurements capability of the link devices (particularly the optical amplifiers) and development of the new algorithms that would allow to carry out the optimization process based on the locally measured parameters. In our research we will focus on the possibilities of effective and early detection of the stimulated Brillouin scattering as well as investigation of parameters possible to be measured locally in the amplifiers, which reflect the whole time me and frequency transfer system performance. In the next stage, we will develop the strategy of proper optimization of the autonomously controlled amplifiers. It requires considering the aspects of collisions avoidance, that could occur if two or more devices would counteract to the changes introduced by the other.

The results of the research will allow to increase the knowledge about parameters that allow to estimate the time and frequency system performance and the possible methods of their measurements. Moreover, the investigation over the stimulated Brillouin scattering will result with the development of an effective method for its early detection. The developed measurement solutions will allow to implement the novel approach for the link optimization, that will be based on locally performed link performance evaluation, without the need of providing inter-devices communication. The proposed solution will increase the time and frequency transfer systems reliability by providing the optimization capability in case of the devices management network failure or inaccessibility.