DESCRIPTION FOR THE GENERAL PUBLIC

According to forecasts of Cisco – the leading manufacturer of equipment for communication networks – the traffic in the Internet will grow on average with annual compound growth rate (CAGR) of 23% in years 2014-2019. Assuming that the same annual traffic growth of 23% will be continued in next years, in the 10 years perspective, the Internet traffic will increase by 800%, while taking into account next 30 years the overall growth will be 500 fold. The increase in the network traffic is a result of two main trends. Firstly, the number of devices connected to the Internet is growing. Few years ago, usually one user was using one device, i.e., computer or laptop. Nowadays, many persons use many devices at the same time, including tablets and smartphones. Moreover, the concept of Internet of Things (IoT) has been focusing much attention in recent years. The main aim of IoT is to connect to the Internet many objects such as refrigerators, washing machine, bulbs, clothes, sensors, etc. In consequence, the number of devices connected to the Internet will grow from 5 billion now up to 50 billion in 2020. The second important trend influencing the traffic in the Internet is popularity of bandwidth demanding services such as video streaming and cloud computing. According to many statistics, the various services related to video streaming generates most of the Internet traffic. For instance, about 35% of the US traffic in the Internet is generated by the Netflix offering video on demand service. It is predicted that popularity of video streaming and cloud computing services will intensify in near future. Moreover, it is very probable that some new bandwidth demanding services will appear in few years.

The Internet consists of many single networks connected together. The backbone connecting these various networks are optical networks based on fiber connections. A good analogy to the backbone optical network are the highways connecting big cities, countries and continents. The lack of highways or a limited number of highways can significant limit the development capabilities of a particular country or continent. Similarly, limitations in the optical backbone networks can be a bottleneck in the progress and development of the Internet and new network services.

Currently, the most popular technology in optical networks is WDM (Wavelength Division Multiplexing). In last few years, a new concept for optical networks has been deployed, i.e., Elastic Optical Networks (EONs). However, in the perspective on next decades, some new approaches must be developed to overcome the predicted ‘capacity crunch’ of the Internet. One of the most promising approach is *spatial flexibility*. The key idea behind this approach is to use a space domain, in which the spatial resources can be flexibly assigned to different traffic demands, increasing the utilized degrees of flexibility, and the network planning and optimization capabilities of the network.

The main objective of the Project is to develop, implement, and examine novel models and algorithms for optimization of optical networks with spatial flexibility. The existing optimization methods developed in the context of WDM networks and EONs do not account for new constraints that arise from the spatial flexibility. The application of the new optimization methods will make it possible to verify the main pros and cons of optical networks with spatial flexibility compering to existing optical networks.

The research to be carried out in the project includes construction of optimization models that illustrate optical networks with spatial flexibility according to various scenarios of implementation of such networks. Next, using these optimization model, new optimization algorithms will be developed. Among others, innovative soft optimization techniques based on artificial intelligence will be applied to this purpose. The algorithms will be implemented in programming environments, what make it possible to run extensive computer experiments in order to verify performance of the algorithms as well as to examine the main features of optical networks with spatial flexibility.