Chapter 1
Wavelength Allocation and Scheduling Methods for Various WDM-PON Network Designs With Traffic Protection Securing

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ABSTRACT

The wavelength division multiplexing passive optical network (WDM-PON) is a natural path forward to satisfy demands of optical network operators to develop valuable converged optical metropolitan and access networks. For effective utilization of possible transmission capacities, available wavelengths must be carefully designed for their utilization. Therefore, some principles of wavelength allocation and scheduling methods are characterized and specified. For ensuring the network reliability, efficient traffic protection mechanisms must be implemented. Simultaneously, different equipment in remote nodes can be installed. Therefore, different WDM-PON network designs with traffic protection securing are analyzed and compared. Protection possibilities for various network parts and elements are characterized and optical power budgets are evaluated and optimized. Finally, a research of the DWA algorithms can be realized using functionalities of selected wavelength scheduling methods. Moreover, the wavelength transmission capacity characterizing can be simultaneously determined.

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INTRODUCTION

In the design of optical telecommunication networks, it is necessary to take into account various parameters and characteristics, for example network type, utilized technology, distance for the signal transmission, network traffic protection, mutual interconnection between network components, network control and many others (Róka, 2014), (Róka, 2019). The idea for utilizing multiple wavelength channels in metropolitan and access optical networks is well known (Róka, 2003). This chapter is focusing on the realistic design of the Wavelength Division Multiplexing - Passive Optical Network (WDM-PON) from a viewpoint of its interconnecting scheme. First, an in-depth survey of existing methods and algorithms is presented. Subsequently, basics of the main protocol are introduced and main wavelength allocation categories - static and dynamic - are particularly presented. Next, various WDM-PON network designs are analyzed with regard to the traffic protection securing. For this aim, passive optical components are mainly considered and a protection of another control element and access part is characterized. Finally, optical power budget possibilities for various WDM-PON network designs are optimized. Simultaneously, a deployment environment for dynamic wavelength algorithms is introduced and main functionalities of wavelength scheduling techniques are summarized.

There are certain basic variants of WDM-PON architectures (Grobe, 2008), (Róka, 2015) varying in utilization of the wavelength routing - Broadcast-and-Select (B&S), Arrayed Waveguide Grating (AWG), Spectrum Slicing (SS). Except fundamental changes in the Optical Line Terminal (OLT) equipment (WDM transmitters, circulators), real WDM-PON network implementations could include several stages of splitting points, allowing the topology to be scalable with a number of users connected using the Optical Network Terminal (ONT) equipment. There are various approaches that have been proposed for implementing in WDM-PON networks (Abbas, 2016), also different architectural options (Mahloo, 2014) varying in the Remote Node (RN) equipment (power splitter, array wavelength grating) are defined. In presented WDM-PON network designs, an attention is paid to only passive components in the RN location based on extensive utilization.

For current Time Division Multiplexing - Passive Optical Network (TDM-PON) networks, one of main tasks is increasing the effective utilization of the determined transmission capacity on the available wavelength used in the upstream direction of data transmitting. This can be achieved using advanced