Optical delay buffer optimization in packet switched optical network

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Nowadays the delay sizing and optimization within all-optical networks is one of the most crucial points in the field of optical network communication. The information in al-optical networks is transformed to light and transmitted with the help of optical waves. We are currently investigating optical buffers that could meet the requirements of high speed/low latency communication within these networks. The information in such systems is traveling with the speed of light, but in the active nodes it is very likely experiencing delay, due traffic congestion, path switching or just because of hardware processing time. During delay in the network node, the information can not be stored and restored easily as we can do in „normal" electrical networks. During operation, light signal can not be stopped, and the electrical-optical (OEO) conversion takes huge amount of time comparing with the communication speed in such networks. As a result, the information should remain in form of optical waves all the time. To artificially introduce delay for the information in the network node we could use optical delay buffers. We can define the optical buffer as a device with both its input and output data streams in optical format without optical-electrical-optical conversion.

In the first section of the paper we give a short overview how to introduce time delays in the network nodes, what kind of optical delay elements are available and what are their basic characteristics. After that we focus on one widely used solution, namely the usage of the simple and cost effective optical delay line. The simplest implementation of an optical delay line is introducing a physical distance, such as a length of optical fiber, or free space. Although simple this implementation suffers from two drawbacks; significant tenability is difficult to achieve, and long time-delays require large physical distances. In the paper we will describe fully the basic symptoms of the usage of optical delay lines.

In the next section we compare the „normal" electrical delay buffers to optical delay buffers. Show the differences in latency and throughput and usable buffer sizes. With the help our investigation we introduce and build up an optical delay buffer model which can help hardware manufacturer to make accurate sizing and optimization of the optical buffer according to the system needs. According to our theoretical approach and simulations we optimize multistage optical delay line structures, to handle delay problems with multiple in/output channels. In the next section we give formal description and functional model of the proposed optical delay buffer.

We have carried out various simulations with network simulation software, to analyze the proposed delay buffer model and to make the functional analysis of such system. To search for the highest throughput, and minimize latency during network communication, we have worked with single and multistage optical delay buffer simulations as well. The major topics investigated include: latency evolution during single and multistage buffer usage, optimal buffer sizes for different data communication speed and variable packet sizes. In the last section of the paper we discuss the performance results of simulations and draw conclusions on our optical delay buffer model.

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