Optimized network node architecture evaluation for packet switching networks based on Optical Time Division Multiplexing in WDM

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ABSTRACT: Optical time-division multiplexing (OTDM) is promising to be considering a practical high-speed optical transmission scheme. It enables optical packet switching (OPS) in wavelength-division multiplexing (WDM) networks with excessive flexibility and efficiency for bandwidth assignment [4]. In this paper [1], both optical circulator and Tunable Fiber Bragg Grating (TFBG) are proposed to be introduced into an innovative OPS node architecture to add/drop time slots or frames. The node architecture provides finer granularity to perform both time-slot and packet switching depending on the scheduling strategies. Based on it, local packet assemble algorithm for network Quality of Services (QoS) will be proposed and extensive evaluation will show the throughput variation comparing to that of the pure OTDM node architecture. This research will focus on evaluation of this model by proposing structural design of the packet header which could be helpful for implementing in different time slots with optical time division multiplexing. After evaluation we can proceed with the comparison studies for this model with other solutions available.

Keywords: *Orthogonal Time Division Multiplexing, network management protocol, Quality of Service, End to End Delay, Wavelength Division Multiplexing*

1. INTRODUCTION

Optical wavelength division multiplexing (WDM) networks are very promising due to their large bandwidth, their large flexibility and the possibility to upgrade the existing optical fiber networks to WDM networks

From the last decade, Optical packet switching has been considering as a disruptive data transmission technology to fully utilize the huge bandwidth provided by a single wavelength in the Wavelength Division Multiplexing networks [2]. However, the bandwidth Limitations applied by WDM systems is too coarse to perform packet switching. On the other hand, Optical Time Division Multiplexing techniques offer fine granularity by subdividing an individual wavelength into time slots and it is promising to combine both OTDM and WDM in the Optical Packet Switching networks [3]. Moreover while Wavelength-division multiplexing (WDM) technology offers tremendous transmission capacity in optical fiber communications but, switching and routing capacity lags behind the transmission capacity, since most of today's packet switching is implemented using slower electronic components [4]. Ultrafast slotted optical time-division multiplexed networks as a viable means of implementing a highly capable next-generation all-optical packet-switched network [7]. Such a network is capable of providing simple network management, the ability to support variable quality-of-service, self-routing of packets, scalability in the number of users, and the use of digital regeneration, buffering, and encryption [6].

A few research works have been conducted on OPS in OTDM-WDM networks. In [3], the author presented a self-synchronization scheme for 100G/s OTDM packet switching networks.

In [1] author suggested an architecture for combining the optical time division multiplexing and optical packet switching with Tunable Fiber Bragg Grating (TFBG) and

Circulator are firstly introduced into an OPS node architecture enabling optical packet add/drop from/to local node and assemble local packets into time slots. This architecture offers trade-off between the throughput and the real-time traffic transmission. It also offers more flexibility to bandwidth assignment for OPS. Our focus will be on evaluation of this model by proposing structural design of the packet header which could be helpful for implementing in different time slots with optical time division multiplexing [9].

In ITU-T Recommendation E.800, QoS is defined as: The collective effect of service performance, which determines the degree of satisfaction of a user of the service. This definition of QoS includes aspects such as customer support, service dependability, service performance and service security [9]. But QoS guarantee is an important and challenging issue for the next generation Internet. The service on the next generation Internet includes voice video, data, and so on. There is the issue ‘QoS that is close concern to throughput of a service, loss rate, and delay distribution for information sent through a network [10].
Node architecture for quality of service is shown below:

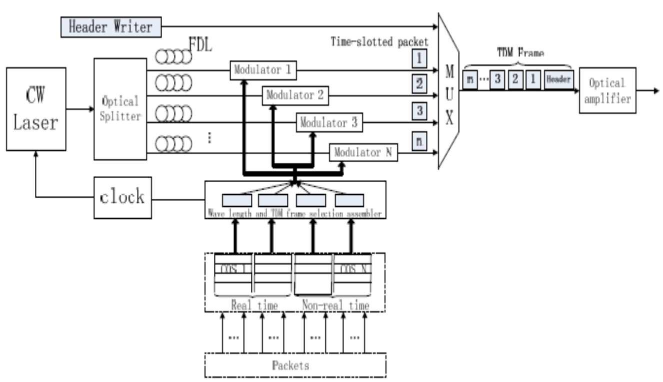

Figure 1: Node Architecture of Packet Assembler for QoS Guarantee [1].

Optical packet Add/Drop module can provide QoS guarantees on OTDM-WDM OPS networks. Architecture called packet assembler to aggregation traffic in one wavelength of Figure 1 is considered. Each Time-slotted packet is a dependent sub-channel for packets. A TDM frame can be make up by different QoS lever classes of service (CoS) packets or same QoS lever CoS. Only transport time meet the high lever COS packet Requirements, it can be assemble in a TDM frame. But the low lever COS can be transport when it has a path to routing. In Figure 1, Each wavelength channel is fed with multiple traffic streams, and each TSI has its own separate queue: one is real-time traffic; the other is non real-time datagram type of traffic. Real-time traffic has QoS requirements such as delay bound, in-sequence delivery, and packet loss rate, it had high QoS lever in our research, and non real-time traffic either has no QoS requirement such as the “best effort”, it had low QoS lever. Each CoS can be transmitting to any wavelength channel and TDM sub-channel if it can be routing.

2. PROBLEM DEFINITION

Optical time-division multiplexing (OTDM) is promising to be considering a practical high-speed optical transmission scheme. It enables optical packet switching (OPS) in wavelength-division multiplexing (WDM) networks with excessive flexibility and efficiency for bandwidth assignment. But bandwidth Limitations applied by WDM systems is too coarse to perform packet switching. Both optical circulator and Tunable Fiber Bragg Grating (TFBG) are proposed to be introduced into an innovative OPS node architecture to add/drop time slots or frames. The node architecture provides finer granularity to perform both time-slot and packet switching depending on the scheduling strategies. But the evaluation of the proposed model is not been done with various structure of packet header design. This proposed model is still under early experimentation so there is a lot of space for changes and testing. Our focus will be on evaluation of this model by proposing structural design of the packet header which could be helpful for implementing in different time slots with optical time division multiplexing. After evaluation we can proceed with the comparison studies for this model with other solutions available.

3. SIGNIFICANCE AND OBJECTIVES

We have started our experimentation for the improvement in quality of all over process of orthogonal communication based on time division multiplexing. It is very important issue for improvement of orthogonal communication as more and more technologies are using orthogonal channels as base for communication. Millions of packet processes takes place in single second of time. Congestion is also on the edge for every communication. So we have developed a scheme which successfully provides solution for quality of service in TDMA structure.

The main focus of the research is to improve the speed and accuracy of the channel selection and selection of packets based on priority.

4. RESULT AND DISCUSSION

Our research started with the study of already existing techniques containing the packet switching connecting with time division multiplexing so that we could find some packet design headers. Our research started with simulation of discussed structure in network simulator 2. Experiment area chosen for experiment is uniformly distributed over 800 × 800 meters. We have developed the discussed structure by implementing it on wired optical network which provides priority to the traffic.

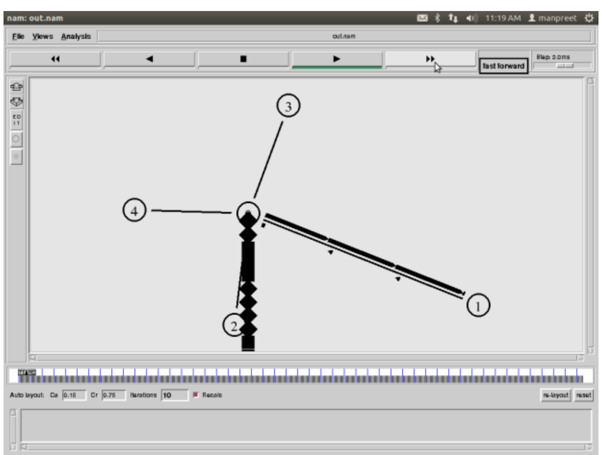

Figure 2: Simulation for the proposed scheme

For improvement over the traditional TDMA structure, we have done header improvement by reducing time for updates which have huge impact on the performance of the communication through orthogonal channel.

Throughput of the proposed work and traditional TDMA is given below:

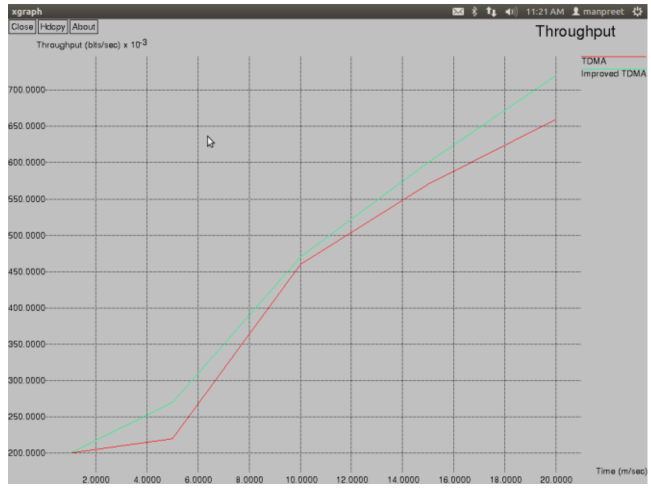

Figure 3: Throughput comparison of Traditional and proposed TDMA

Proposed TDMA is based on the quality of service improvement over traditional TDMA structure.

The packet delivery is also improved by changing header information based on updates of the channel and links with accordance of packet priority. The packet delivery ration comparison is shown below:

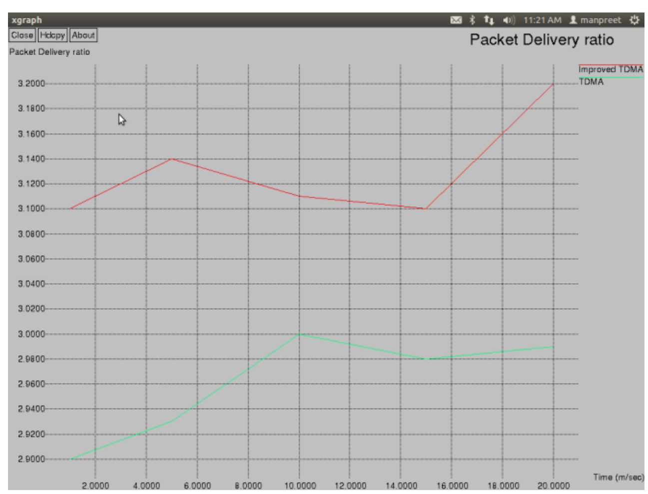

Figure 4: Packet Delivery Ratio comparison of Traditional and proposed TDMA

Proposed work shows improvement in packet delivery as compared to the normal process.

Overhead of the packets is also a big concern while process number of packets through orthogonal channels. Overhead comparison of the proposed scheme is given below:

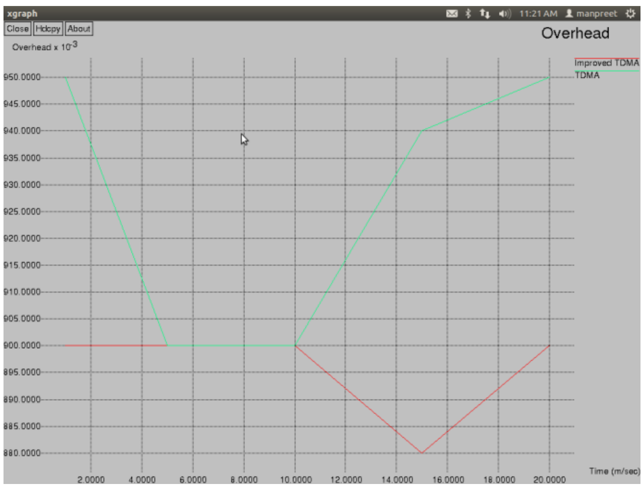

Figure 5: Overhead comparison of Traditional and proposed TDMA

Finally the delay always counts to be the factor which decides the outcome of the communication.

The delay comparison of the proposed and traditional schemes is given below:

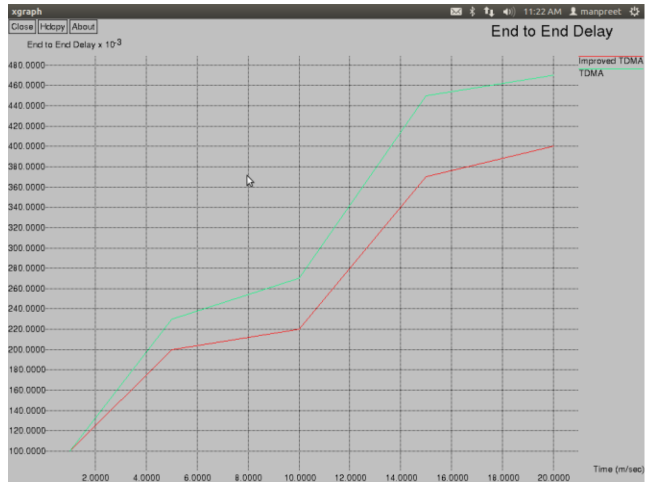

Figure 6: End to End Delay comparison of Traditional and proposed TDMA

5. CONCLUSION

This paper explains the concept and outcome of the optimized TDM network. Proposed scheme has shown good improvements over the traditional network in every parameter. OTDM-WDM is introduced and the QoS performance of node architecture is evaluated. It also offers more flexibility to bandwidth assignment for OPS. In future it is very interesting see the performance of the proposed scheme over the distributed channels with limitation of bandwidth and energy systems.

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