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Performance Evaluation of Optical switch based on Wavelength conversion

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Abstract - Optical Networks are data networks built on Fiber-Optics technology, which sends data digitally, as light through connected fiber strands. A reconfigurable optical add-drop multiplexer (ROADM) is a form of optical add-drop multiplexer that adds the ability to remotely switch traffic from a wavelength division multiplexing (WDM) system at the wavelength layer. In an optical packet network with optical packet switches interconnected with optical fibers running wavelength division multiplexing (WDM), packets are transmitted from source to destination without any optical-electrical-optical (O/E/O) conversion. The optical fiber entering an optical packet switch carries several wavelengths for packet transmission. Our work addresses a wavelength-division-multiplexed (WDM) optical packet switch with wavelength converters which can shift optical packets to any wavelength of their destined outbound links and analyze the performance of optical packet switch to achive lowest packet rate.

Index terms: WDM, ROADM, Wavelength converters, Optical packet switch.

I. INTRODUCTION

Optical networks appear to be the solution of choice for providing a faster networking infrastructure that can meet the explosive growth of the Internet. Optical packet switched networks are emerging as a serious future candidate for the evolution of optical telecommunication networks to support high-throughput services such as voice over IP (VoIP) and high quality video streaming on demand. In an optical packet network with optical packet switches interconnected with optical fibers running wavelength division multiplexing (WDM), packets are transmitted from source to destination without any optical-electrical-optical (O/E/O) conversion. The optical fiber entering an optical packet switch carries several wavelengths for packet transmission. All input fibers are demultiplexed into individual wavelengths, each of which is connected to an assigned input port of the switch fabric. Each input port connects to the output port that is assigned to one wavelength. Therefore, packets on two input fibers may be destined to one or many output fibers. Output contention occurs whenever two or more packets using the same wavelength try to enter the same output fiber at the same time slot. Among all contending packets, only one is forwarded to the output fiber directly and the others are dropped unless a contention resolver is used. The switch refers to its scheduling algorithm to decide the interconnection between input and output ports of the fabric. Hence wavelength conversion Fig.1 is widely used to avoid contention.

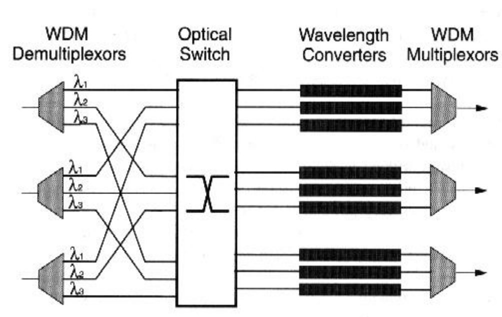

Fig.1- Optical switch node with wavelength conversion

In optical packet switch(OPS) as shown in figure (2) input fiber carry multiple wavelength, each of which carries a packet to one output fiber as several wavelengths from different inputs could be destined to same output fiber, one wavelength can be connected and other remain disconnect, losing the carried packets because of the multiple wavelengths available at an output fiber wavelength conversion(WC) in the optical packet switch(OPS) of the unconnected wavelengths into those available can increase the number of connections. A Parametric wavelength converter (PWC) provides multichannel wavelength where wavelength can be converted to another. A PWC uses a pump wavelength that can be flexibly chosen to define which wavelength can be converted, defining the so called wavelength conversion pair.

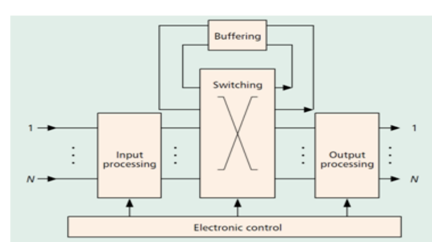

Fig-2-Optical packet switch

Our work addresses a wavelength-division-multiplexed (WDM) optical packet switch with wavelength converters

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which can shift optical packets to any wavelength of their destined outbound links with the architecture proposed as in Fig.2.

II Principle of Operation

A.WDM

Wavelength division multiplexing is a technology Which multiplies a number of optical carrier signals on to a single optical fiber by using different wavelengths. This technique enables bidirectional communications over one strands of fiber, as well as multiplication of capacity. In wavelength division multiplexing optical switching contention are mostly due to limited number of channels and wavelength collisions. If there are more packets to be switched to the same outbound link than the number of wavelength channels, then we have bandwidth contention. In an optical packet network with optical packet switches (OPSs) interconnected with optical fibers running wavelength division multiplexing (WDM), packets can be transmitted from source to destination without any optical-electrical-optical conversion [2-6].

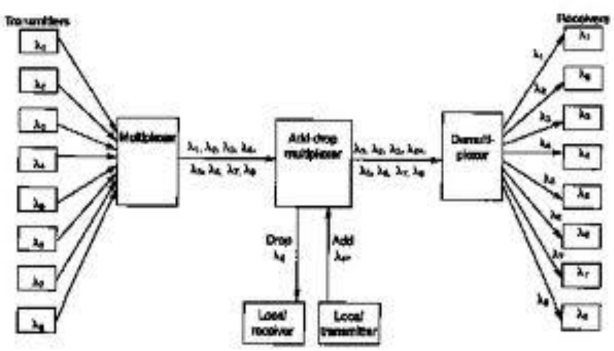

Fig.3: Wavelength Division Multiplexing

B.ROADM

A reconfigurable optical add drop multiplexer (ROADM) is a form of optical adds drop multiplexer that adds the ability to remotely switch traffic from a wave length division multiplexing (WDM) System at the wavelength layer addressed in fig.3.This is achieved through the use of selective switch module. This allows individual or multiple wavelengths carrying data channels to be added and/or dropped from a transport fiber without the need to convert the signals on all of the WDM channels to electronics signals back again to optical signals.

The main advantages of the ROADM are:

a) The planning of entire bandwidth assignment need not be carried out during initial deployment of a system. The configuration can be done as and when required without affecting traffic already passing the ROADM.

b) ROADM allows for remote configuration and reconfiguration.

c) ROADMs allow for automatic power balancing.

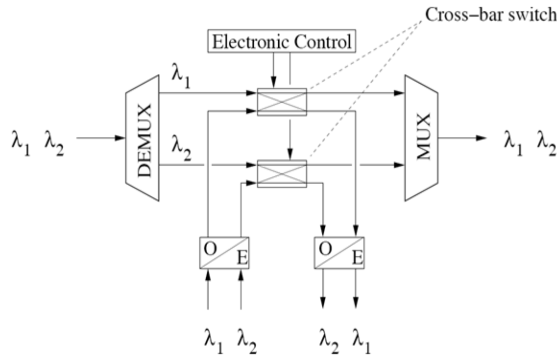

Fig4:ROADM

III Analysis of an Optical Switch

The objective of optical packet switching is to switch optical packets from incoming links to their desired outgoing links. The challenge is how to effectively resolve possible contentions. In wavelength-division-multiplexing (WDM) optical switching, contentions are mostly due to the limited number of channels and wavelength collisions. If there are more packets to be switched to the same outbound link than the number of wavelength channels, then we have bandwidth contention. The unsuccessful packets will be dropped. In addition, optical packets of the same wavelength and preferred outbound link contend for a wavelength channel to keep their wavelength continuous [1and8]. This is called wavelength contention.

IV Resolving Wavelength contention

Optical buffering through fiber delay lines (FDLs) [7] is used here to resolve wavelength contention. A packet is delayed for a specified amount of time while waiting for a future transmission. However, because the delay times that FDLs can provide depend on the fiber length, the delay times that FDLs can feasibly provide are small when they are compared with the delay times that a packet would have to wait before being forwarded. Another option is the use of deflection routing [9], which can reduce the need for buffering packets. In this approach, one packet is sent to the destined output while the others are sent to any available output as alternative routes. However, the network control for such an approach might be complex. Wavelength conversion [12, 13] is widely used to avoid contention. A signal with one wavelength is converted to another wavelength. The wavelength of the packet that loses the contention at the output is converted into another available wavelength and destined to the same output fiber.

The use of Full wavelength conversion (FWC)[13] can greatly improve the performance of an optical packet switch and reduce the switch dimension largely, but the approach is too costly for practical applications. Tunable wavelength converters (TWCs) are often adopted in the design of an optical packet switch [10, 11, and 14]. The function of TWC is to convert an input wavelength into several output wavelengths. When an optical packet contention occurs, the wavelength of a blocked packet can be converted to another available wavelength in the output port. Thus, the packet contention is resolved. TWCs can achieve good performance, however, with presently technology, they are very expensive and conversion capability is not efficient since only one wavelength is converted at a time. In this work we use parametric wavelength converters which is an alternative approach for wavelength conversion because multiple wavelengths, multiple channels, can be converted simultaneously. The architecture performance are evaluated by means of an analytical model and are compared with those of an optical packet switch architecture in which the wavelength converters are shared per output line[15]. Also, we try to demonstrate a significant reduction in the required no of converters used and give an improvement on the performance of an optical packet switch using parametric wavelength converters (PWCs).

V Expected Results

a) Not all the packets need conversion, and hence conversion should be optimized to reduce the number of converters, and improve the quality of signals by reducing unnecessary conversion.

b) In the convention schemes there is reduction in number of converters by 38 to 63%. We try to demonstrate the actual number of wavelength converters needed is even smaller than the maximum derived even if the network is fully loaded.

c)Packet loss is caused by packets dropped in contention we try achieve lowest packet loss rate than the convention scheme. This optimization is evaluated through computer simulation.

V Conclusion & Drawbacks

The proposed design can greatly improve the performance of an optical packet switch and reduce the switch dimension largely. We derive the maximum number of conversions in a packet switch with inbound/outbound links and wavelengths per link and develop a switch controller in order to minimize the number of wavelength conversions while maintaining the same minimum number of dropped packets. Analysis show that the packet dropping probability decreases significantly with wave- length conversion and that, fewer converters than the maximum number of conversions are needed.

Limitations of this model are:

(i)Only one packet can be transmitted on this channel, and others must be dropped.

(ii)Optical switches that support high bandwidth for high-speed networks are required as the demand for link speed and bandwidth keeps increasing.

VII Tools Used

1) NS-Tool

2) R-Soft

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