PID No. PP-FIO-15

A Novel Architecture for Fiber Based Optical Memory

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ABSTRACT

In this paper we have proposed a novel architecture for optical memory. This architecture consist of fiber delay lines for the buffering of the data and a regenerator which regenerates the signal after some fixed number of circulations.

Keywords: Loop Buffer, Tunable wavelength converters, Memory, Regenerator

1. INTRODUCTION

The demand for higher bandwidth is increasing day by day; and it becomes two fold in every ten years. The speed of the electrical component is major constraint in high speed communications. To overcome this constraint electrical components are now replacing by optical components. But in present data is stored in electrical form by doing optical to electrical conversion. This O/E conversion also reduces the speed of the systems. In this paper we have proposed an architecture for optical memory in which data can be stored in optical form for very large duration without doing any O/E conversion.

2. DESCRIPTION OF THE MEMORY

This architecture consist of N tunable wavelength converters, one at each input, a recirculating loop buffer and N fixed filters, one at each output. Packet from all the inputs uses WDM technology to share the loop buffer [1]. The number of buffer wavelength depends on the switch design, desired traffic throughput, packet loss probability and size of the memory [2, 3]. The packets to be buffered are converted to the wavelengths available in the buffer; if memory is full then either packet is dropped or will send to other memory module.

3. WORKING OF THE MEMORY

When a packet has to be stored in the memory .At the input end of the memory ,packet wavelength is converted into memory wavelength, at this wavelength packet is keep on circulating in the fiber memory. To compensate losses in the loop optical amplifier is placed. This placement of the amplifier in the fiber memory increases the number of the circulations of the data, but this number cannot be arbitrary large because the optical amplifier not only amplifies the optical signal but unfortunately also add ASE noise, which degrades the system performance [4]. This amplifier noise put an upper limit on the number of circulations of data in the fiber loop memory, when this upper limit is achieved at specified wavelength, then respective TWC tuned the wavelength of the data to regenerator wavelength, at this wavelength data will be regenerated, then again by tuning the wavelength of the TWC which is placed after regeneration process) data can be put again in the buffer at the same wavelength or at any other wavelength in case of dynamic wavelength reallocation.

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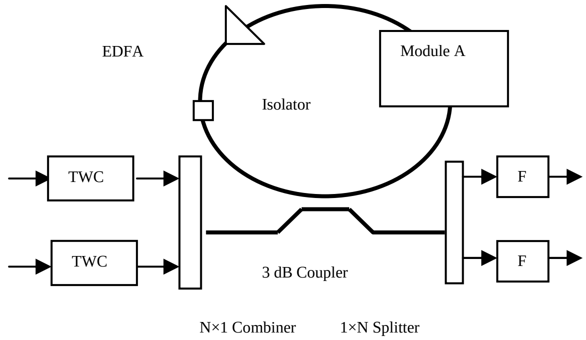


Figure1 Architecture of the optical memory

4. BUFFERING AND READ/WRITE OPERATION

The buffer memory has a word size equal to one cell period. Its capacity corresponds to pre-determined memory positions or number of buffer wavelengths. A packet is assigned a wavelength not being used by the packets within the buffer by the input TWC The buffer TWCs can be tuned to any of the input or output wavelengths. As shown in fig.2 a packet at λ_b is written into buffer, by tuning the input TWC to buffer wavelength λ_b. It takes one cell period for writing a packet (data); this is the minimum time a packet can be buffered, the buffer TWC is tuned to λ_{out} for outputting the packet. Packet is read out from the buffer after getting converted to λ_{out}. After conversion, as complete packet crosses the TWC, in process of being buffered out, the TWC is tuned back to same buffer wavelength λ_b as before. Hence the writing of a new packet on this wavelength can take place simultaneously as a packet from buffer is being read out. There will be no interference in two wavelengths as the inputting/ outputting device is a WDM 3dB coupler. Thus, the possibility of tuning a TWC soon after a packet is written-in and before its read-out will result in simultaneous reading and writing on the same wavelength.

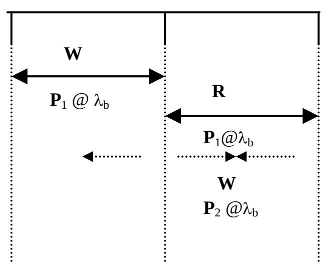


Figure2 Schematic of read/write operation

5. DYNAMIC WAVELENGTH REALLOCATION

A minimum channel spacing of six times the maximum data rate has been proposed and examined in literature [5]. For minimizing cross talk in DWDM networks with a TWC as a buffer gate, it will be possible to dynamically modify the channel spacing while a packet is circulating. This will give a flexibility of operation by tuning a packet wavelength to any other available wavelength in the buffer. There is a limit to the maximum number of circulations, [6], and thus on the maximum time for which a packet can remain in the buffer to resolve an output contention. One of the factor responsible for this limit is the inter and intra channel cross talk. The dynamic wavelength re-allocation will reduce the noise due to cross talk and may in turn result in an increase in buffer time. Consider, for example, two packets in buffer at adjacent wavelengths, λ_1 and λ_2, with rest of the buffer wavelengths being free. The packet interchannel spacing,$\Delta\lambda$, can be increased to the extremes of the buffer capacity by tuning one of the TWCs to that wavelength.

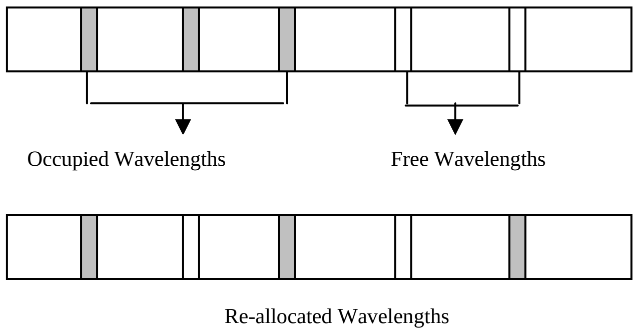


Figure3 Dynamic wavelength re-allocation

6. MODULE-A

The module A consist of Demux ,Combiner,TWC and Regeneration unit. WDM packets which enters in the module A, are first demultiplexed ,then allow to pass either through regeneration unit or through TWC depending on whether signal to be regenerated or not to be regenerated. Signals are again multiplexed by a combiner to put them in the main memory.Before combining the regenerated signal is allowed to pass through TWC to switch the wavelength of the regenerated signal to available loop wavelength.

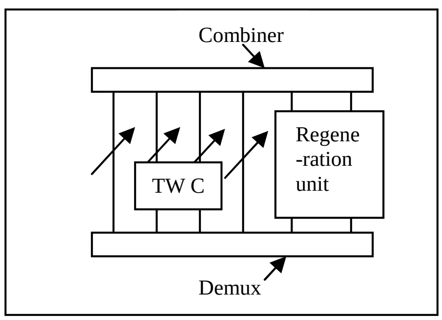
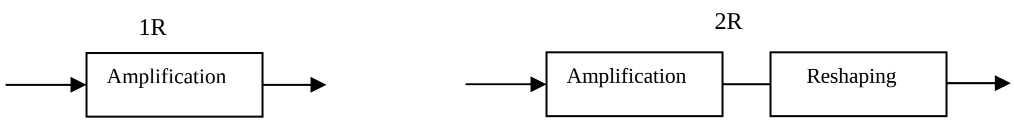


Figure 4 Schematic of module A

7. REGENERATION UNIT

This regeneration unit can be 1R, 2R, 3R and 4R.In 1R regeneration process signal is amplified by the amplifier to compensate losses of the loop. In 2R regeneration process signal is both amplified and reshaped, in 3R regeneration signal is amplified, reshaped and retimed, and in 4R regeneration signal is amplified ,reshaped ,retimed and wavelength is reallocated.



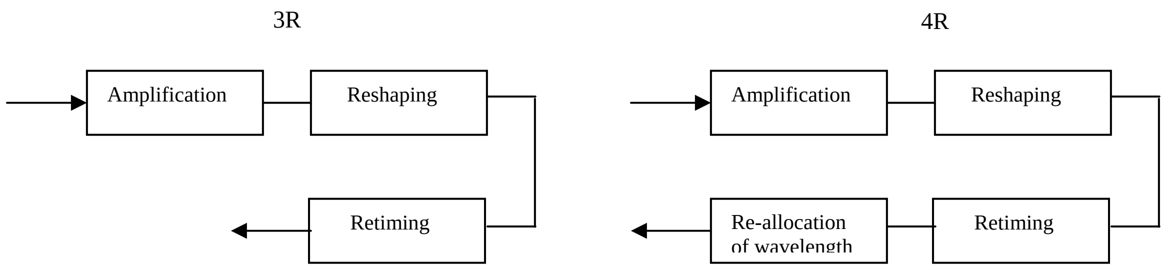


Figure 5 Schematic of regeneration schemes

These different types of regeneration schemes can be used as per buffer requirement of the signal.

8. CONCLUSIONS

This architecture can be used as optical memory for data storage. Theoretically it is possible, simulations and mathematical model is still to be developed. All the aspects like maximum number of wavelength that architecture can accommodate, in these how many will be regenerator wavelength, the variation in the number of circulations as number of wavelength changes and analysis of the architecture under different load conditions need to be further investigated.

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