Examination of fiber link failure in optical WDM network

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Abstract

Wavelength Division Multiplexing (WDM) networks are extremely reliable and secure. Here chance of trapping the data and crosstalk is very low. It also can recover from net failure in a very efficient manner. There is provision for rerouting a path between a source-destination node pair. So in case of link failure we will not lose any data.
In this work, different conditions of link failure in 8-node duel ring WDM Optical network have been compared as far as performance is concerned on same traffic metric. We find no data loss in any condition and we have got approximately similar performances, when compared on different parameters, in any condition of link failure, which we taken in consideration. Duel ring WDM Optical Network is best in particular practical condition, to perform operation on the network, even in case of link failure in the Network. An eight node topology, have been designed, to make examination on survival of the WDM Optical Network.

Keywords

WDM, Fiber link failure, Dual ring topology, Optical fiber.

1.Introduction

The distribution of multicast traffic in the metropolitan environment requires highly resilient network infrastructures [1, 2]. Currently deployed fiber ducts in the metropolitan area are typically based on ring topologies interconnected by the dual homing approach. In this area, an easy evolution can be proposed, based on Double Rings with Dual Attachments. This work examines in detail the resilience capabilities of Duel Ring with Duel Attachments. It is shown that, just by ensuring service repair rates, large service availability values can be achieved. Additionally, the amount of backup capacity required to recover from link failures is further calculated. Furthermore, in these networks a mathematical framework or reference to all those network operators who are willing to deploy highly resilient metropolitan area networks at a moderate cost can be given. [6].

2.Payback of WDM network

WDM is an important technology used in these days in telecommunication systems. There are several advantages of WDM networks which make it different from other communication networks [3]

2.1Capacity improvement

a) Conveyance using optical fiber provides very large bandwidth. Here the carrier for the data stream is light. Generally a single light beam is used as the carries. But in WDM, lights having various wavelengths are tangled into a single optical fiber. So in the same fiber now more data is transmitted. We can upgrade the capacity without adding fibers. This increases the capability of the net considerably.

b) **Transparency:** WDM network supports data to be transmitted at various bit rates. It also supports a number of protocols. So there is not much constraint in how we want to send the data. So it can be used for various very high speed data broadcast applications.

c) **Wavelength Recycles:** WDM network allows for wavelength routing. So in various fiber links the same wavelength can be used again and again. This allows for wavelength reuse which in turn helps in increasing capability [4**].**

d) **Concept o Scalability:** WDM networks are also very flexible in nature. As per requirement we can make changes to the network. Extra processing units can be added to both transmitter and receiver ends. By this infrastructure can redevelop to serve more number of people.

e) **Reliability:** WDM networks are extremely reliable and secure. Here chance of trapping the data and crosstalk is very low. It also can recover from net failure in a very efficient manner. There is provision for rerouting a path between a source-destination node pair. So in case of link failure we will not lose any data [5].

3.Dual ring topology concept

This work introduces Double-Ring topologies with Dual Attachment and studies their resilience capabilities against link failures. This topology comprises two bidirectional rings of the same size, namely the inner and the outer ring, whereby each node in the inner ring is connected with its associated node in the outer ring via dual attachment, thus leading to a highly-redundant topology configuration. Such a solution is particularly useful when each pair of nodes (inner node and its dual attached outer node) are physically close, and the cost of connecting both nodes via dual-attachment is small. This is the case for most metropolitan area network of big cities. In a WDM-based network[8], a single physical link failure may correspond to multiple logical link failures. As a result, 2-connected logical topologies such as rings routed on a WDM physical topology, may become disconnected after a single physical link failure. Survivability to faulty components and simplified management drive the practical deployment of ring-based WDM networks. This paper [7] represents in many applications, location constraints and user scalability require that multiple rings are interconnected to form a single large network.

4.Simulation result

Through simulation, three cases have been compared. First is original dual ring topology. In second case two links have failed in the dual ring topology and in third two another links have failed in the dual ring topology. In all the three cases link reports have been mention below:

Table 1 Routed traffic first case

Per Link Report: Routed Traffic
Column 1: Link ID
Column 2: Origin node
Column 3: Destination node
Column 4: Distance
Column 5: Routed traffic (Gbps)

1	1	2	0.25	76.168
2	2	1	0.25	80.785
3	3	2	0.29	60.000
4	2	3	0.29	35.185
5	1	4	0.27	48.059
6	4	1	0.27	38.868
7	6	2	0.17	364.733
8	2	6	0.17	288.309
9	1	5	0.19	219.176
10	5	1	0.19	139.964
11	3	4	0.30	21.709
12	4	3	0.30	34.912
13	3	7	0.24	74.907
14	7	3	0.24	82.359
15	4	8	0.20	123.094
16	8	4	0.20	63.262
17	8	5	0.53	0.000
18	5	8	0.53	0.000
19	5	6	0.50	0.000
20	6	5	0.50	0.000
21	6	7	0.59	0.000
22	7	6	0.59	0.000
23	7	8	0.61	0.000
24	8	7	0.61	0.000

Summary information:
Average routed traffic per link: 72.9787

Table 2 (a) Wavelength utilization second case

Per Link Report: Wavelength Utilization
Column 1: Link ID
Column 2: Origin node
Column 3: Destination node
Column 4: Distance
Column 5: Existing wavelengths
Column 6: Used wavelengths

1	1	2	0.25	40	3
2	2	1	0.25	40	3
3	3	2	0.29	40	1
4	2	3	0.29	40	1
5	1	4	0.27	40	3
6	4	1	0.27	40	2
7	6	2	0.17	40	7
8	2	6	0.17	40	5
9	1	5	0.19	40	5
10	5	1	0.19	40	4
11	3	4	0.30	40	2
12	4	3	0.30	40	1
13	3	7	0.24	40	2
14	7	3	0.24	40	2
15	4	8	0.20	40	3
16	8	4	0.20	40	2
17	8	5	0.53	40	0
18	5	8	0.53	40	0
19	6	7	0.59	40	0
20	7	6	0.59	40	0

Summary information:
Average used wavelength per link: 2.3

Table 2 (b) Routed traffic second case

Per Link Report: Routed Traffic
Column 1: Link ID
Column 2: Origin node
Column 3: Destination node
Column 4: Distance
Column 5: Routed traffic (Gbps)

1	1	2	0.25	76.168
2	2	1	0.25	80.785
3	3	2	0.29	60.000
4	2	3	0.29	35.185
5	1	4	0.27	48.059
6	4	1	0.27	38.868
7	6	2	0.17	364.733
8	2	6	0.17	288.309
9	1	5	0.19	219.176
10	5	1	0.19	139.964
11	3	4	0.30	21.709
12	4	3	0.30	34.912
13	3	7	0.24	74.907
14	7	3	0.24	82.359
15	4	8	0.20	123.094

16	8	4	0.20	63.262
17	8	5	0.53	0.000
18	5	8	0.53	0.000
19	6	7	0.59	0.000
20	7	6	0.59	0.000

Summary information:
Average routed traffic per link: 87.5745

Table 3(a) Wavelength utilization third case

Per Link Report: Wavelength Utilization

Column 1: Link ID
Column 2: Origin node
Column 3: Destination node
Column 4: Distance
Column 5: Existing wavelengths
Column 6: Used wavelengths

1	1	2	0.25	40	3
2	2	1	0.25	40	3
3	3	2	0.29	40	1
4	2	3	0.29	40	1
5	1	4	0.27	40	3
6	4	1	0.27	40	2
7	6	2	0.17	40	7
8	2	6	0.17	40	5
9	1	5	0.19	40	5
10	5	1	0.19	40	4
11	3	4	0.30	40	2
12	4	3	0.30	40	1
13	3	7	0.24	40	2
14	7	3	0.24	40	2
15	4	8	0.20	40	3
16	8	4	0.20	40	2
17	5	6	0.50	40	0
18	6	5	0.50	40	0
19	7	8	0.61	40	0
20	8	7	0.61	40	0

Summary information:
Average used wavelength per link: 2.3

Table 3(b) Routed traffic third case

Per Link Report: Routed Traffic

Column 1: Link ID
Column 2: Origin node
Column 3: Destination node
Column 4: Distance
Column 5: Routed traffic (Gbps)

1	1	2	0.25	76.168
2	2	1	0.25	80.785
3	3	2	0.29	60.000
4	2	3	0.29	35.185
5	1	4	0.27	48.059
6	4	1	0.27	38.868
7	6	2	0.17	364.733
8	2	6	0.17	288.309
9	1	5	0.19	219.176
10	5	1	0.19	139.964
11	3	4	0.30	21.709
12	4	3	0.30	34.912
13	3	7	0.24	74.907
14	7	3	0.24	82.359
15	4	8	0.20	123.094
16	8	4	0.20	63.262
17	5	6	0.50	0.000
18	6	5	0.50	0.000
19	7	8	0.61	0.000
20	8	7	0.61	0.000

Summary information:
Average routed traffic per link: 87.5745

5.Conclusion

We have considered the design of physical topologies that ensure logical rings can be embedded in a survivable manner. First, we have developed necessary conditions for the physical topology to be able to embed all logical rings in a survivable manner. We then use these conditions to provide tight bounds on the number of physical links that an eight node physical topology must have in order to support all the considered logical rings. Finally, we have made observation, through simulation experiments, that designing the physical topology for supporting all logical rings in a survivable manner does not use significantly more physical links than a design that only supports a small number of logical rings. Hence, our approach of designing physical topologies that can be used to embed all possible ring logical topologies does not lead to a significant over-design of the physical topology. We considered the problem of physical topology design for embedding logical rings in a survivable manner. We obtained some basic necessary conditions on the physical topology in order to be able to route logical rings in a survivable manner.

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