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March - April 2020
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Survivability Techniques Implementation by using Simulation Methods

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Abstract

optical network Survivability is important concept when it comes to fault detection and fault recovery. It also plays a very important role in detecting the shortest path and to route the data in that data path and data traffic management. Due to increase in industries and consumers, demand for the high data rate increases, to fulfill the demands the concept called Traffic Demand Distribution (TDD). Here the data is sensitive, if the system fails to maintain the data because of path fault it may incur huge lose in communication field. It leads to users will experience poor service and also optical survivability fails to maintain QoS. By considering this drawback, survivability techniques to serve the data to pass through desired data path is implemented. This paper further describes the TDD and survivability techniques to overcome failure.

Keywords: *DCS (Digital Cross Connectivity), DP (Diverse Protection), MSONS (Multiperiod Synchronous Optical Network Survivability), APS (Automatic Protection Switching).*

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1. Introduction

Network survivability determines the network capability to visualize whether or not the network is in a position to produce higher quality of service, even once the failure occur in network. If the desired resources aren't allotted before then it's tough to recover the occurring failure, in survivability sure set of techniques are followed to arrange consequently to assign resources so as to beat failure. Network failure arises not solely as a result of natural bad luck, failure arises as a result of fault in network parts like switches, routers and different deployed parts and recovery of failure in these cases is a few extent tough however failure is recovered. Survivability have 2 techniques like restoration and protection. The necessary feature is

that the ability to supply sensible service at the time of failure. On survivability side its definition is maintained equal on the standard attributes line reliableness, affordability and security. Survivability is accomplished by two techniques protection technique and restoration technique, where in protection techniques required resources are assigned when failure in working path occurs protection path take over the function of working path. In restoration techniques the data is routed in the working path of the network itself no extra resources are assigned.

2. Survivability Classification

Optical survivability techniques are classified based on the allocation of path resources in optical network

[1] Protection

[2] Restoration

Protection: In protection technique the resources are pre reserved. If any fault occur these reserved resources take over the functions need to be

March - April 2020
ISSN: 0193-4120 Page No. 65 - 70

performed by the working paths. Protection is further subdivided into two types, those arelink protection and path protection.

Link protection involves the reserving a protection paths between all nodes these protection paths perform the function when fault occur.

In path protection scheme the protection path for working path is pre-planned. Restoration: In restoration technique resources are not pre reserved upon failure it will check the shortest path and route the data in a desired working path. Restoration technique is classified into link restoration.

In case of link failure the adjacent nodes takes part in distributed algorithm to find a new path to resume the network functionality. Then both the adjacent nodes switch to newly discovered path to restore functionality of network

Comparison between Protection and Restoration Technique is depicted in Table 1.

Table 1. Comparison between Protection and Restoration Technique.

Sr. No.	Parameters	Protection Technique	Restoration Technique
1	Resources	Pre-Reserved	Not Pre-Reserved
2	Resource Utilization	Low Resource Utilization	Better Resource Utilization
3	Hardware Requirement	More Hardware is Required	Less Hardware Requirement
4	Efficiency	Ensures100% Recovery From Single Link Failures	Depends On Available Network Resources
5	Recovery time	Minimum	Depends upon availability of resources

If restoration technique is implemented in optical network that network is going to face two challenges

1. Data traffic in network.
2. Need to find the shortest path without disturbing data flow.

3. Overview of the Survivability Techniques

The data is highly sensitive and loss of such data may lead to huge loss in the field of communication. Survivability is a vast concept that is adopted to optical network failure recovery and management[1]. In [2] Restoration methods proposed for optical network are analysed.

Here authors presented idea about different protection techniques and feeds the idea regarding protection techniques based on ring configuration network should work in case of failure occur also if the optical network transmitting data at high data rate if any failure occur it may lead to huge revenue, data loss[3]. Hence the concept called Survivability arises. Here authors explained the idea about many technique which can be implemented in optical network to overcome failure[4].

Here authors discussed about the fault management schemes, fault management schemes plays a crucial step in managing survivability of high data rate networks. In WDM network failure of any network element which may lead to failure of many optical channels intern which leads to loss and also explain about the techniques namely protection and restoration to overcome from failure[5].

Here author explained the survivability in optical networks is defined as the network's resilience to failures. Survivability methods are broadly classified into protection and restoration techniques. The term protection refers to reserving the network resources for survivability, whereas in restoration, no such reservation is made, and the backup path is calculated after the occurrence of failures[6]. In optical networks, a single fiber can carry Tbps of data, and a failure of fiber can cause huge loss of data and revenue with the quality of service severely affected. Therefore, survivability in optical networks is very important for network functioning. Therefore, the process of protection and restoration in the optical layer is vital to the network's survivability[7]. The provision of survivability in the optical layer also has its own merits of speed, and efficiency to cope with failures. In survivable optical networks, the Shared Risk Link Group (SRLG) refers to the group in which the links in a network share a common physical element[8].

March - April 2020
ISSN: 0193-4120 Page No. 65 - 70

A single SRLG failure will result in the failure in all the elements that belong to the specific SRLG explained [9].Survivability against SRLG failures in optical networks was studied by [10] in which, only the static traffic is considered and the authors had described the formulation of shared path protection. As number of shared risk link groups increases, it is very difficult to provide a 100% SRLG failure protection in practical networks. In [11] author proposed an approach in which the protection paths are selected in such a way that they share a least number of shared risk link groups with the working paths. The literature on protection in optical networks focused mainly on survivabilityissues and the cost factors were not effectively considered. Therefore, in this work, the role of the topological parameters is investigated for dimensioning optical networks with protection, aiming at improved resilience and reduced cost. In [12] author discuss about the restoration scheme which is subdivided as link or path based. In link-based schemes, when a link failure arises, the connections which are affected are rerouted using another link. Link based restoration performs the recovery over a failed link, by restoring all the associated light paths.

4. Problem Defination

To overcome the challenges posed by the implementation of restoration techniques in optical network three methods are used those are Digital Cross Connect system(DCS), 1:2 diverse protection and Optical Network Assortment. In FDD of any given network topology, calculation of traffic in each link is done i.e DCC gives connectivity between two path that is source to destination.

Second technique is used to estimate the GSR or Network Survivability Ratio by using 1:2 diverse protection wrt protection restoration mechanism.

5. Methodology

Survivability components are classified as analysis and design. Before deploying the survivability techniques into the network, network failure analysisshould be carried out and based on the type of failure,network procedure and the architecture is adopted to minimize the impact of failure.

Three steps towards a survivable network

1) Prevention: Robust equipment and architecture.
2) Design of Topology and Allocation of capacity: Designing the network with required resources, additional capacity allocation to recover from failure.
3) Network Management and Traffic Restoration Procedure: Detecting the network failure and to reroute the data around failure.

Steps to recover the failure as shown in Figure 1.

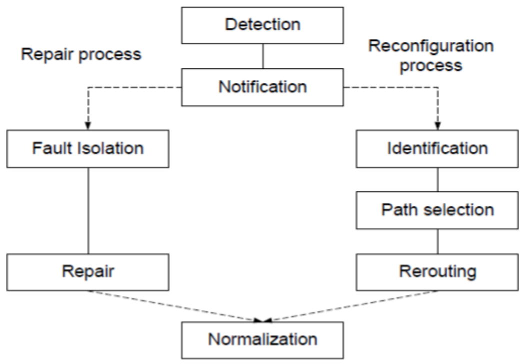

Figure 1.Steps to recover the failure

Algorithm is designed in such a way to find shortest path without disturbing the data flow in the network and to find Digital Cross Connect (DCS). Algorithm incudes the protection schemes like Automatic Protection Switching (APS) and Diverse Protection.

APS is further classified into 1:1, 1+1 and 1+N

In 1:1 Protection scheme data flows in both working path and protection path.

In 1+1 data flows in working path during failure data flow takes place in protection path.

In 1+N Single protection path assigned for N working paths here single protection path managed to handle failure.

In designed network topology as shown in Figure 4 Cost between each node is assumed and Traffic calculation is carried out based flowchart as shown in

March - April 2020
ISSN: 0193-4120 Page No. 65 - 70

Figure 2.

Traffic Distribution represents sequence of numbers each number in that sequence is multiplied by digital signal level to get bandwidth.

$$\textbf{Bandwidth} = \textbf{Traffic Distributio} \times \textbf{Digital Signal Level}$$

Ex:

$$\mathbf{1.29Gbps = 29 \times 44.736Mbps}$$

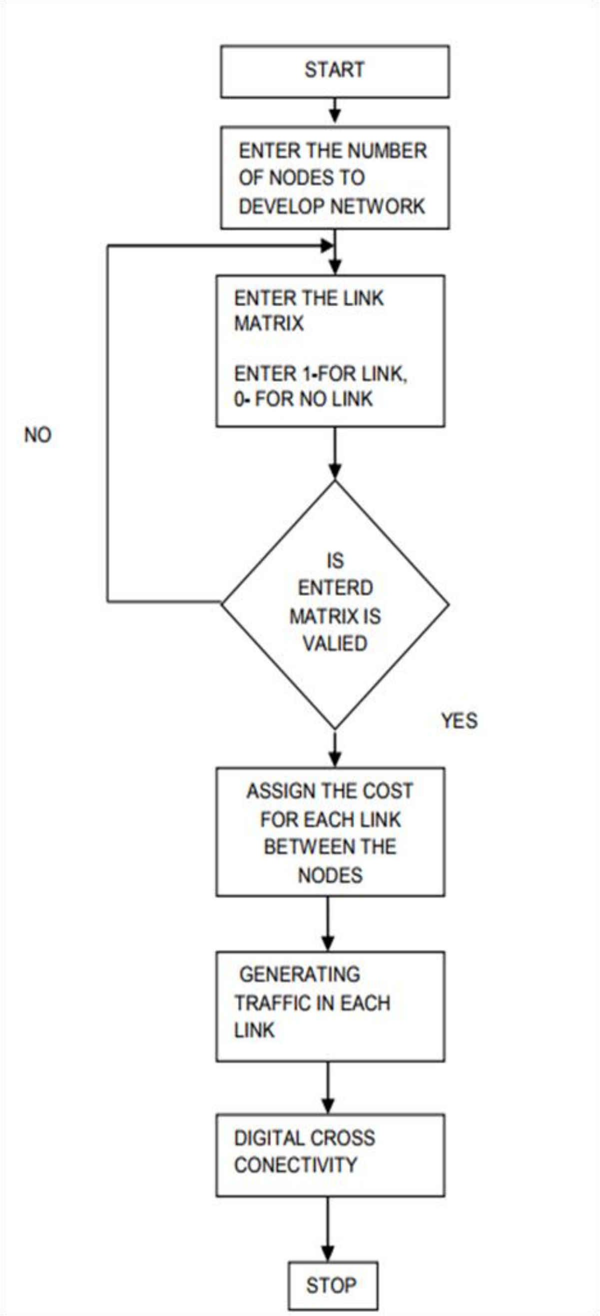

Figure 2. Flowchart of Digital Cross Connectivity

Bandwidth is obtained by multiplying Traffic Demand with digital signal level. Based on the obtained bandwidth shortest path is obtained. Digital signal levels are listed as shown in Table 2.

Table 2. Digital Signal Level

Digital Signal Designation	Line rate	Channels (DS0s)	Line
DS0	64Kbps	1	
DS1	1.544Mbps	24	T1
DS1C	3.152Mbps	48	T1C
DS2	6.312Mbps	96	T2
DS3	44.736Mbps	672	T3
DS4	274.176Mbps	4032	T4
DS5	400.352Mbps	5760	T5

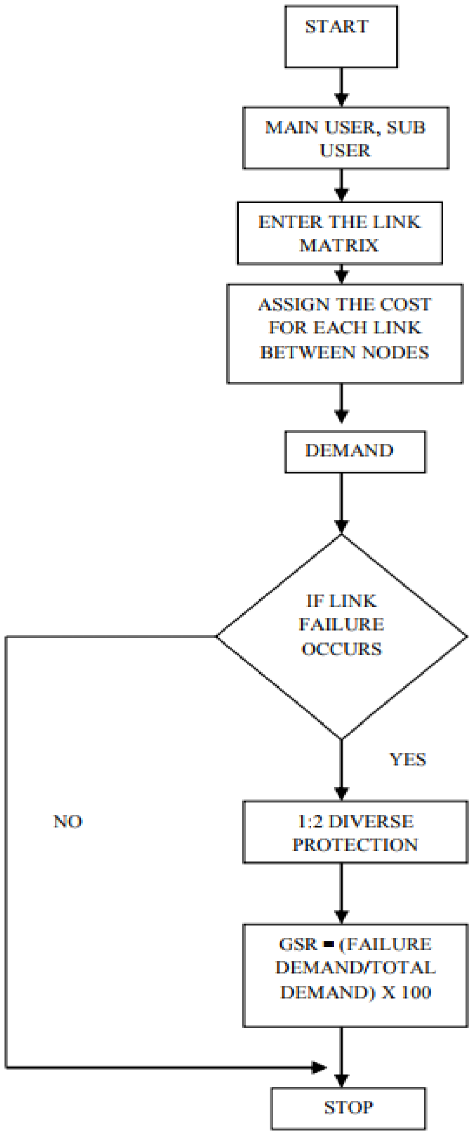

Figure 3. Flowchart of Protection Restoration Mechanism

TEST Engineering & Management
March - April 2020
ISSN: 0193-4120 Page No. 65 - 70

In designed network as shown in Figure 4 assumption of main user and sub user is made and link is developed to form a network, link is represented as 1 and no link is represented as 0 and cost is assigned between each link of two nodes. If the matrix representation of cost matrix as shown in Figure 6 does not match to the matrix representation of connectivity pattern as shown Figure 5 the process will directly enter into the termination. If cost matrix matches to the connectivity pattern then process continues it uses 1:2 Diverse protection technique to calculate GSR.

6. Results and Discussion

Consider the 16x16 topology as shown in Figure 4, network nodes algorithm demands the input as a connectivity matrix in the form of 1 and 0 to represent link between the two nodes and traffic demand need to enter where the link is established and it returns the output in the form of traffic in each link as shown in Figure 7. Shortest path between main user and sub user is shown in Figure 8.

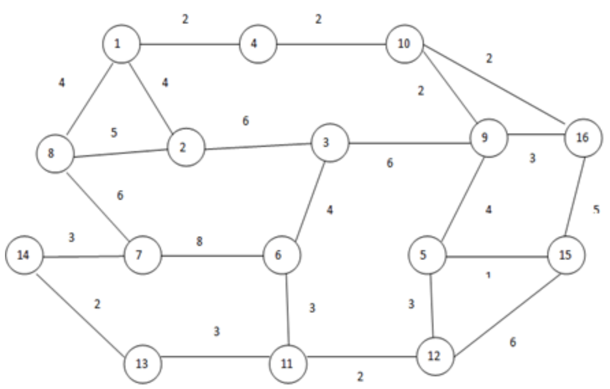

Figure 4. Network topology

[[0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0
1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0
0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0
0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0
0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0
1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	1
0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1
0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0
0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0
0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1
0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0]]

Figure 5.Connectivity pattern matrix of order 16×16

[[0	4	0	2	0	0	0	4	0	0	0	0	0	0	0	0
4	0	6	0	0	0	0	5	0	0	0	0	0	0	0	0
0	6	0	0	0	4	0	0	6	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
0	0	0	0	0	0	0	0	4	0	0	3	0	0	1	0
0	0	4	0	0	0	8	0	0	0	3	0	0	0	0	0
0	0	0	0	0	8	0	6	0	0	0	0	0	3	0	0
4	5	0	0	0	0	6	0	0	0	0	0	0	0	0	0
0	0	6	0	4	0	0	0	0	2	0	0	0	0	0	3
0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	2
0	0	0	0	0	3	0	0	0	0	0	2	3	0	0	0
0	0	0	0	3	0	0	0	0	0	2	0	0	0	6	0
0	0	0	0	0	0	0	0	0	0	3	0	0	2	0	0
0	0	0	0	0	0	3	0	0	0	0	0	2	0	0	0
0	0	0	0	1	0	0	0	0	0	0	6	0	0	0	5
0	0	0	0	0	0	0	0	3	2	0	0	0	0	5	0]]

Figure 6. Traffic requirement matrix of order 16×16

[[0	47	0	63	0	0	0	43	0	0	0	0	0	0	0	0
47	0	82	0	0	0	0	25	0	0	0	0	0	0	0	0
0	82	0	0	0	97	0	0	111	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	44	0	0	0	0	0	0
0	0	0	0	0	0	0	0	77	0	0	31	0	0	16	0
0	0	97	0	0	0	70	0	0	0	73	0	0	0	0	0
0	0	0	0	0	70	0	58	0	0	0	0	0	48	0	0
40	25	0	0	0	0	58	0	0	0	0	0	0	0	0	0
0	0	111	0	77	0	0	0	0	43	0	0	0	0	0	27
0	0	0	44	0	0	0	0	43	0	0	0	0	0	0	27
0	0	0	0	0	73	0	0	0	0	0	72	50	0	0	0
0	0	0	0	31	0	0	0	0	0	72	0	0	0	39	0
0	0	0	0	0	0	0	0	0	0	50	0	0	30	0	0
0	0	0	0	0	0	48	0	0	0	0	0	30	0	0	0
0	0	0	0	16	0	0	0	0	0	0	39	0	0	0	29
0	0	0	0	0	0	0	0	27	27	0	0	0	0	29	0]]

Figure 7. Digital Cross Connectivity matrix

The Shortest Path passes through
M→3→9→10→S1
M→3→9→16→S2
M→3→9→5→S3
M→3→2→S4
M→3→6→S5
M→3→2→S6
M→3→6→S7
M→3→9→S8
M→3→2→1→4→S9
M→3→9→S10
M→3→9→16→S11
M→3→9→10→S12
M→3→9→S13
M→3→9→5→15→S14

SURVIVABILITY for the given network = 93.086205

7. Conclusion

In 16x16 Network Configuration Digital Cross Connectivity and Fiber Survivability Ratio are calculated for end to end connectivity w.r.t DS3 level. By adopting survivability techniques in the network,data loss caused due to failure can be recovered and also fast access can be obtained by routing the data in shortest path according to the traffic table. Working efficiency of optical network can be increased by adopting these survivability techniques in logical layer.

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