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Dual-Link Failure Resiliency through Backup Link Mutual Exclusion

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Abstract: ***In every network we see the link failures are common. For this purpose, we propose networks having the scheme to protect their links against the link failures. Networks use link protection to achieve fast recovery from link failures. While the first link failure can be protected using link protection (or defining back up node), there are several alternatives for protecting against the second failure. We formally classify the approaches to dual-link failure resiliency. One of the strategies to recover from dual-link failures is to employ link protection (or back) for the two failed links independently, which requires that two links may not use each other in their backup paths if they may fail simultaneously. Such a requirement is referred to as backup link mutual exclusion (BLME) constraint and the problem of identifying a backup path for every link that satisfies the above requirement is referred to as the BLME problem due to finding new link the senders time is out and we have the problem of packet loss. In this we use Backup link mutual exclusion (BLME), when the links fail simultaneously. The solution methodologies for BLME problem is 1).for mulating the backup path selection as an integer linear program;2)developing a polynomial time heuristic based on minimum cost path routing.***

Keywords: Backup link mutual exclusion, dual-link failures, link protection, optical networks..

1. Introduction

The growing transmission speed in the communication networks calls for efficient fault-tolerant network design. Current day's backbone networks use optical communication technology involving wavelength division multiplexing (WDM). One of the most gifted concepts for high capacity communication systems is wavelength division multiplexing (WDM). Each communication channel is allocated to a different frequency and multiplexed onto a single fiber. At the destination wavelengths are spatially separated to different receiver locations. In this configuration the high carrier bandwidth is utilized to a greater level to transmit multiple optical signals through a single optical fiber. Due to the large volume of information transported, it is necessary to reduce the resource unavailability time due to failures. Hence, efficient and fast recovery techniques from node and link failures are mandated in the design of high-speed networks. As link failures are the most common case of the failures seen in the networks, we restrict its scope to link failures alone. There are two ways for protecting single-link failure- path protection and link protection.

- Path protection: Path protection attempts to restore a connection on an end-to-end basis by providing a backup path in case the primary (or working) path fails. The backup path assignment may be either independent or dependent on the link failure in the network.

 Failure-independent path protection (FIPP): A backup path that is link-disjoint with the primary path allows recovery from single-link failures without the precise knowledge of failure location.

 Failure-dependent path protection (FDPP): more than one backup path may be assigned for a primary path and the connection is reconfigured on the backup path corresponding to the failure scenario that resulted in the primary path failure.

- Link Protection: Link protection recovers from a single link failure by rerouting connections around the failed link. Such a recovery may be achieved transparent to the source and destination of the connections passing through the failed link. Link protection at the granularity of a fiber switches all of the connections on a fiber to a separate (spare) fiber on the backup path. Link protection reduces the communication requirement as compared to path protection, thus providing fast recovery.

2. Existing System

Algorithms for protection against link failures have traditionally considered Single-link failures. However, dual link failures are becoming increasingly important due to two reasons. First, links in the networks share resources such as conduits or ducts and the failure of such shared resources result in the failure of multiple links. Second, the average repair time for a failed link is in the order of a few hours to few days, and this repair time is sufficiently long for a second failure to occur. Algorithms developed for single-link failure resiliency is shown to cover a good percentage of dual-link failures, these cases often include links that are far away from each other. Considering the fact that these algorithms are not developed for dual-link failures, they may serve as an alternative to recover from independent dual-link failures. The focus of our project is to protect end-to-end connections from dual-link failures using link protection.

3. Proposed System

This paper formally classifies the approaches for providing dual-link failure resiliency. Recovery from a dual-link failure using an extension of link protection for single link failure results in a constraint, referred to as BLME constraint, whose satisfiability allows the network to recover from dual-link failures without the need for broadcasting the failure location to all nodes.

Our proposed system develops the necessary theory for deriving the sufficiency condition for a solution to exist, formulates the problem of finding backup paths for links satisfying the BLME constraint as an ILP, and further develops a polynomial time heuristic algorithm. The formulation and heuristic are applied to six different networks and the results are compared

3.1 Problem Definition

Networks use link protection to achieve fast recovery from link failures. While the first link failure can be protected using link protection (or defining back up node), there are several alternatives for protecting against the second failure. This paper formally classifies the approaches to dual-link failure resiliency. One of the strategies to recover from dual-link failures is to employ link protection (or back) for the two failed links independently, which requires that two links may not use each other in their backup paths if they may fail simultaneously. Such a requirement is referred to as backup link mutual exclusion (BLME) constraint and the problem of identifying a backup path for every link that satisfies the above requirement is referred to as the BLME problem due to finding new link the senders time is out and we have the problem of packet loss.

3.2 Objective

- To recover the problem of Dual link failure we can use this system.
- To avoid the packet loss and delay we can apply this system.
- To find the feasible and back path for any failed link is the main goal of my system.

4. Methodology

Dual-link failure resiliency with link protection

Assume that two links, l and l', failed one after the other (even if they happen together, assume that one failed first followed by the other) in a network. The backup path of the first failed link is analogous to a connection (at the granularity of a fiber) established between two nonadjacent nodes in the network with link removed. The connection is required to be protected against a single-link failure. Therefore, strategies developed for protecting connections against single link failures may be directly applied for dual-link failures that employ link protection to recover from the first failure. Dual-link failure resiliency strategies are classified based on the nature in which the connections are recovered from first and second failures. The recovery from the first link failure is assumed to employ link protection strategy. Fig. 4.1 shows an example network where link 1-2 is protected by the backup path 1-3-4-2. The second protection strategy will refer to the manner in which the backup path of the first failed link is recovered.

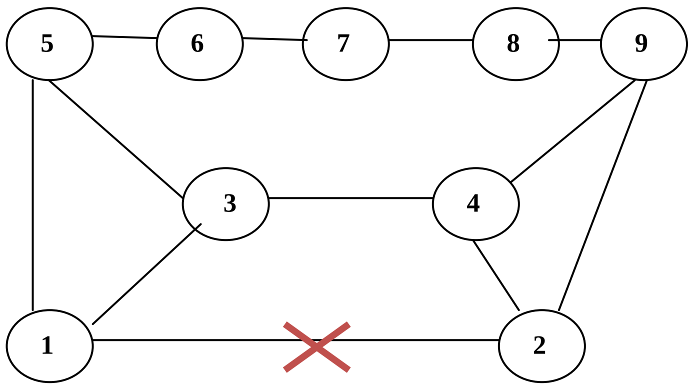

Figure 4.1 Link 1-2 Protected by Backup Path 1-3-4-2 when Failed

Link Protection—Failure Independent Protection (LPFIP):

One approach to dual-link failure resiliency using link protection is to compute two link-disjoint backup paths for every link. Given a three-edge-connected network, there exists three link-disjoint paths between any two nodes. Thus, for any two adjacent nodes, there exists two link-disjoint backup paths for the link connecting the two and B'l denotes the two link-disjoint backups for link Bl. If any link in the backup path Bl fails, the backup path of will be reconfigured to B'l. Hence, the nodes connected to link l must have the knowledge of the failure in its backup paths (not necessarily the location).

Link Protection—Failure Dependent Protection (LPFDP):

For every second failure that affects the backup path, a backup path under dual-link failure is provided. This backup path is computed by eliminating the two failed links from the network and computing shortest path between the specific node pairs. When a second link failure occurs, a failure notification must be sent to node specific node. It is fairly straight forward to see that the average backup path length under dual-link failures using LP-FDP will be lesser than that using LP-FIP. Every link is assigned one backup path for single link failure and multiple backup paths (depending on the number of links in the backup path for the single link failure) under dual-link failures.

Link Protection—Link Protection (LP-LP):

Notification of the second failed link to different nodes for them to reconfigure their backup paths may result in a high recovery time. In order to avoid notification to the other nodes and reconfiguring at the end of the paths, link protection may be adopted to recover from the second link failure as well. Under this strategy, every link will have only one backup path (for all failure scenarios). In order for this strategy to work, the backup path under the second failure must not pass through the first failed link. This condition is referred to as the backup link mutual exclusion (BLME) constraint.

Heuristic Approach

As ILP solution times for large networks may be prohibitively high, a heuristic approach is also developed. The heuristic solution is based on iterative computation of minimum cost routing. The network is treated as an undirected graph G. A set of auxiliary graphs corresponding to failure of a link l G is created. In each auxiliary graph Zl the objective is to obtain a path between the nodes that were originally connected by link l. Let Pl denote the path selected in auxiliary graph Zl. If a link l' is a part of the path selected on graph Zl, then the path in graph Zl must avoid the use of link l. This is accomplished by imposing a cost on the links in the auxiliary graphs and having the path selection approach select the minimum cost path. Let Wll' denote the cost of link l' on graph Zl such that it indicates that graph Zl' contains link l and the two links l and l' may be unavailable simultaneously. Hence, the cost values are binary in nature.

The cost of a path in an auxiliary graph is the sum of the cost of links in it. At any given instant during the computation, the total cost of all the paths (T) is the sum of the cost of the paths across all auxiliary graphs. It may be observed that the total cost must be an even number, as every link l' in a path Pl that has a cost of 1 implies that link l in path Pl' would also have a cost of 1. For a given network, the minimum value of the total cost would then be two times the number of dual-link failure scenarios that would have the network scenarios that would disconnect the graph, then the termination condition for the heuristic is given by T= 2 T. disconnected. If T denotes the number of dual-link failure

Steps involved in the IMCP heuristic solution.

Iterative Minimum Cost Path (IMCP) Heuristic:

Step1. Obtain auxiliary graphs Zl for every l € Z as Zl =Z - {l} Note that every link l Z is bidirectional in nature.

Step 2. Initialize the path to be found in every graph Zl as an empty set Pl ← 0 , l€ Z

Step 3. Initialize the cost of all the links in every auxiliary graph to 0, Wll'← 0, l€ Z, l' Zl

Step 4. For every auxiliary graph Zl 1. Erase the old path and and update the cost in auxiliary graphs; ie, for every link l' € Pl update Wl'l ← 0, Pl ← 0 2. Recompute the least cost path Pl 3. If the link l' is present in this graph, then modify the cost of link l in auxiliary graph Zl, ie for every link l' Pl update Wl'l ← Pll'

Step 5.Compute the total cost of all path over all the auxiliary graphs ie T = Σ l Z Σ l' Pl Wll'

Step 6.If the total cost all the paths equals the threshold of 2T , where T is the number of dual link failure scenarios that would disconnect the graph, then it indicated the best possible solution has been obtained, ie T= 2 T, go to step 7, otherwise go to step 4.

Step 7: stop

5. Conclusion

This paper formally classifies the approaches for providing dual-link failure resiliency. Our proposed approach provides recovery from a dual-link failure using an extension of link protection for single link failure. It results in a constraint, referred to as BLME constraint, whose satisfiability allows the network to recover from dual-link failures without the need for broadcasting the failure location to all nodes.

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