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MECHANISM FOR OPTIMAL AND GUARANTEED ALTERNATIVE PATH (OGAP)

7.1 INTRODUCTION

As we described in earlier chapters, our proposal uses the preplanned (pre-established) alternative LSP to provide a fast and reliable restoration mechanism for single and multiple failures in MPLS-based networks. However, the preplanned protection scheme can have a risk that the preplanned alternative LSP will become out of date due to changes in the network. By out of date we mean that as network conditions evolve in time the preplanned alternative LSP may cease to be the optimal one. Moreover, after the restoration process, the restored LSP becomes unprotected.

The motivation of this study is to overcome these problems and propose a new mechanism:

i) To establish the updated optimal alternative LSP and

ii) To maintain always at least one alternative LSP for the protected LSP at any time.

7.2 PROPOSED MECHANISM

To overcome this problem we propose to search for a new alternative LSP with updated network information concurrently while rerouting the traffic to the preplanned alternative LSP. Note that a long restoration time is a main problem of a dynamic restoration scheme but this does not apply to our proposal because the protected traffic is rerouted to the alternative LSP using the preplanned alternative LSP. It is worthwhile to consider that inconsistencies in the routing database may exist, which would have a negative effect on the new alternative LSP calculation during the recovery period. To minimize this effect we use the algorithms proposed in [MSSD][MSSD02].

The idea behind this *hybrid approach* is to take advantage of the fast rerouting and the rerouting (dynamic) scheme [SH02]. At the same time our proposal provides a guarantee of an alternative LSP at any time for the protected LSP. It is important to note that, as far as we know, no one before has considered the protection of the alternative LSP once the traffic is rerouted on it. In other words, almost all proposals address a single failure situation. In our case we consider multiple failures on an LSP and also the failure of the new protected LSP (i.e., the old alternative LSP or the newly established optimal path). We also consider the reversion operation. The reversion consists of rerouting the traffic from the alternative LSP to the original protected LSP once the failure has been repaired. To do this, we first wait a certain amount of time before releasing the primary LSP, and then compute a new alternative LSP after a failure, which we can use if and only if the result of the LSP using the repaired link is better than that of the LSP which carries the rerouted traffic (i.e., the new protected LSP). Note that the repaired link announces its link status information as zero bandwidth usage (i.e., advertised cost is zero) [RM01]. Therefore, it is possible that this link may become overloaded if the rerouting point is far from the point of failure. If this is the case, it is impossible to return to the old LSP simply because there isn't sufficient bandwidth to accommodate the traffic.

Moreover, our proposal avoids the update of the alternative LSP each time the information database of the network changes. The update is done only when a failure occurs.

7.3 ALGORITHM DESCRIPTION

Figure 7.1 presents the flow diagram of the proposed mechanism. While no failure is detected in the protected LSP, each LSR continues carrying traffic through the protected LSP. Upon a failure the LSR which detects the failure (alert LSR) or one that receives protected traffic on the backward LSP looks for the preplanned alternative LSP in its label information base forwarding table (LIB). If the LSR is an ingress node for the SPD it should have an alternative LSP available. Otherwise, if the LSR is an intermediate node it must follow the RFR procedure described in Chapter 4. If an alternative LSP is found, then it redirects the traffic from the affected protected LSP to the preplanned alternative LSP and it computes a new alternative path using the network conditions at that time.

If the path discovery and selection algorithm gives us a new alternative LSP we compare it with the one that was established previously as the preplanned alternative LSP. If the new alternative LSP is better than the preplanned one, the traffic will be redirected to the new alternative LSP without disruption of services (using the principle of *make-before-break*). The criteria for considering a path "better" may be based on the length of the path and other QoS parameters. The LSR maintains in its LIB the same preplanned alternative LSP as before, and proceeds to setup the backward LSP for the new protected LSP.

If the result is "not better" (i.e., the previously established preplanned alternative LSP is better than the new alternative LSP computed by the LSR after the failure) we assign the new alternative LSP as the preplanned alternative LSP and proceed to set up the backward LSP for new protected LSP.

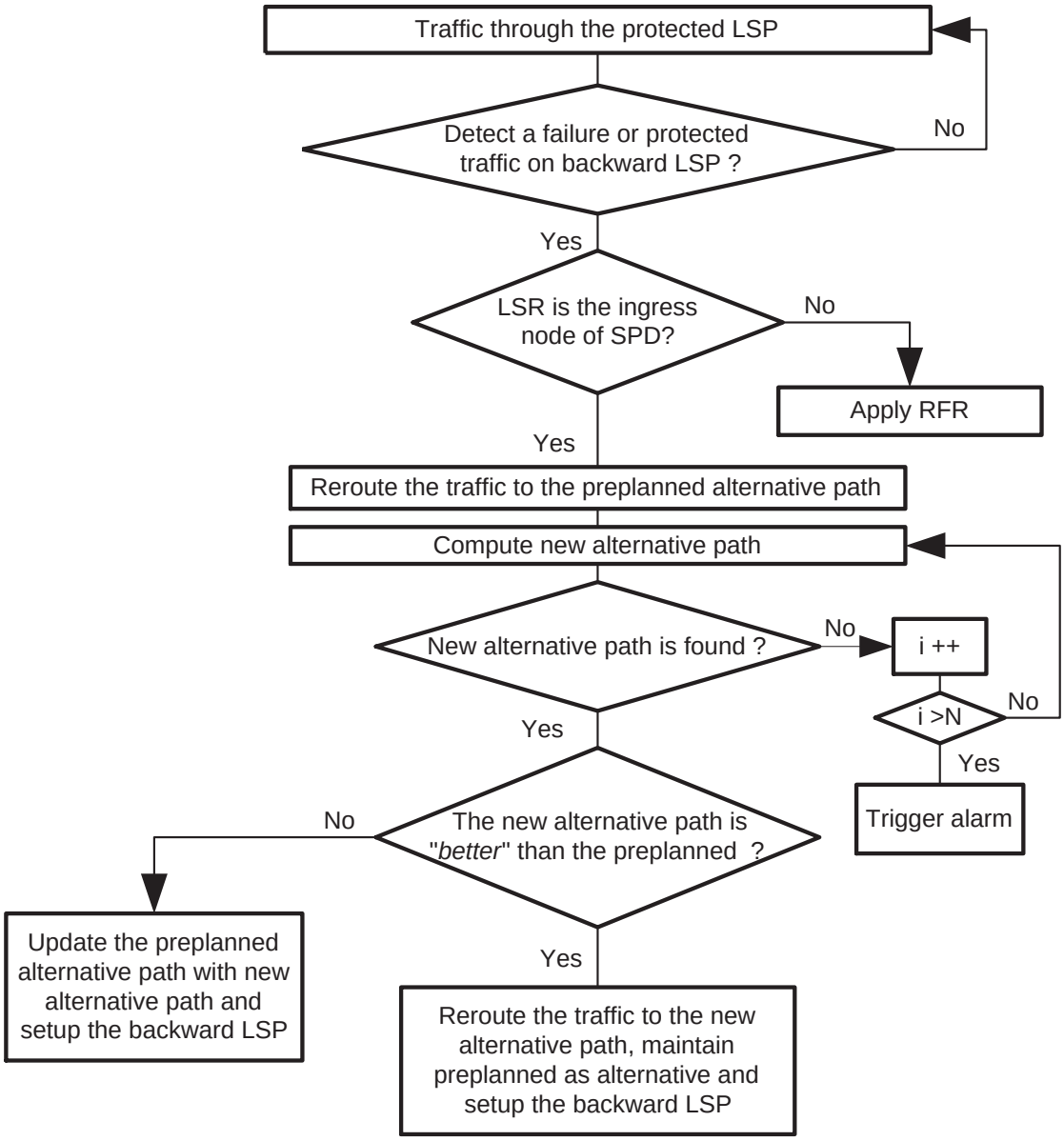

Figure 7.1 Flow diagram

If the routing algorithm is not able to find a new alternative path in the first attempt, we increment the iteration until its value (i) is greater than the control value established previously (N). This value (N) is determined by the network manager and it is a local implementation. If this iteration terminates without finding a new alternative path an alarm is sent to the network control manager to take appropriate measures.

7.4 RESULTS

Table 8.3 summarizes the pros and cons of the different protection schemes for LSPs. Some parameters correspond to QoS provision and others to network resource utilization and feasibility.

The last column refers to the proposal presented in this chapter combined with the previously proposed Reliable and Fast Rerouting mechanism (RFR) presented in Chapter 4.

Performance measurement	Haskin	Makam	OGAP	OGAP + RFR
Complexity	Low	High	Low	Low
Path placement	Restricted	Restricted	Flexible	Flexible
Restoration time	Fast	Slow	Fast	Fast
Packet Loss	Minimum	High	Minimum	None
Packet Re-ordering	High	Minimum	High	None
Resource Requirements	High	Low	Medium	Medium
Optimal path option	No	No	Yes	Yes
Protection for protected LSP	One Alternative	One Alternative	New Alternative Set-up	New Alternative Set-up

Table 7.1 Comparison of MPLS protection schemes

Although most of the concepts shown have been explained already, we would like to clarify some of them.

In the path placement row, unlike others, our proposal is flexible in the sense that the previously established alternative LSP can be changed to a new optimal alternative LSP computed using the rerouting (dynamic) scheme. Other proposals maintain the

same alternative LSP set up during the establishment of the protected LSP to reroute the traffic.

The packet loss and packet reordering values in our case are "none" because we incorporate in this proposal our Reliable and Fast Rerouting mechanism presented in Chapter 4.

Finally, in the last row we try to give the protection range not in terms of the amount of failure points on the protected LSP, but in the ability to handle further failures in the rerouted path. In our case as we establish a new alternative LSP to the rerouted path, our mechanism is able to handle further failures. For Haskin's and Makam's schemes, as they do not establish new alternative LSPs to the rerouted LSP, they only protect the first protected LSP (i.e., they handle only single failures).

7.5 SUMMARY

One of the disadvantages of using a preplanned alternative LSP is that it may not be the optimal one when needed (i.e., at the time of failure). To overcome this disadvantage we propose a hybrid approach OGAP (i.e., preplanned and dynamic rerouting) capable of identifying and using the optimal alternative path based on recent network change information (i.e., after the fault was detected). This avoids the possible use of a non-optimal alternative LSP to reroute the protected traffic and provides the flexibility of alternative route selection and setup as well as better resource utilization. Moreover, our proposal guarantees at least one alternative LSP at any time for the traffic on the protected LSP.