Hierarchical VP Restoration Framework for Reliable IP Network Configuration

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1. Introduction

Since routers in IP network are connected with ATM Virtual Path (VP) Permanent Virtual Connection (PVC) and each VP contains bundles of VCs, a VP layer network can serve as a server layer and each IP layer network can be a client layer. Therefore the effective Internet service provisioning completely depends on reliability of VP server layer network from the perspective of the optimality and the network survivability. This paper proposes the distributed ATM VP PVC restoration framework with the dynamic rerouting scheme in hierarchical transport network. The rerouting algorithm aims to provide rapid ATM VP PVC restoration in the case of fault or performance degradation in terms of maximization of the network resource utilization and satisfaction of end user's QoS requirement. We evaluate the rerouting performance under the real network of High Speed Information Network (HSIN) in Korea Telecom.

2. Layered hierarchical network model

To maximize the network scalability, it is the most necessary thing to define the common network model that is uniformly applicable to all kinds of networks and that is not specific to a specific single layer network or a specific vendor's technology. We define the generic transport network model with the ITU-T G.805 layering and partitioning concepts [1]. The transport network can be decomposed into a number of independent layer networks with a client/server relationship between adjacent layer networks. There can be client/server layer network relationship between the IP layer network and the ATM Virtual Path layer network because each router in IP network is connected with ATM VP Virtual Path Connection (VPC).

In order to uniformly describe the transport network not specific to a vendor's technology and a specific single layer network, this paper defines two fragments: *network topology* and *connectivity fragments*. The network topology fragment represents the topological structure of a transport network, which is composed of layer network (LNW), subnetwork (SNW), link, and link termination point (LTP). A layer network (LNW) describes the generation, transport and termination of the particular characteristic information.

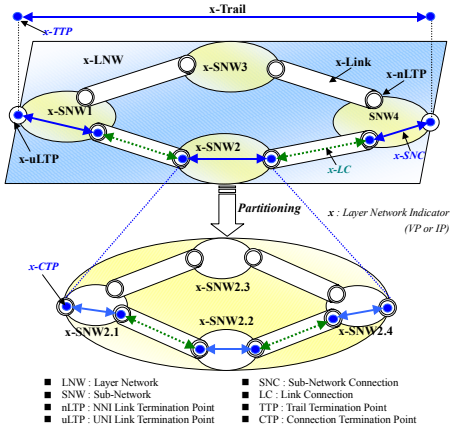

Figure 1. Layered hierarchical network model

The connectivity fragment is to describe the logical or physical connection stream traversing the objects of network fragment, which is composed of trail, trail termination point (Ttp), subnetwork connection (SNC), link connection (Lc) and connection termination point (Ctp).

3. Hierarchical rerouting model

In this paper, we propose a hierarchical VP rerouting model that can provide the reliable IP service provisioning in hierarchical transport network from the perspectives of alarm correlation, fault isolation and localization and fault restoration. Alarm correlation is generally made on the rule by which several alarms are narrowed down for a mass of problems to a root cause. We define our own *Alarm Correlation Model (ACM)* taking into account the effective rerouting in the hierarchical transport network. To do this, we define two new concepts of the *Avoidance List (AL)* and the *Restoration Flag (RF)* from the perspectives of network topology and connectivity fragments, respectively.

3.1 Determination of avoidance list

The avoidance list represents the set of topological components that should be excluded in the process of finding alternative route for VP PVC restoration. The possible avoidance list can be *Link*. It is determined by the fault locations such nLtp and SNC as depicted in Figure 2. In the case of nLtp1 fault, the avoidance list can be Link1. The avoidance list concept is to support the alarm correlation, fault localization and fault isolation.

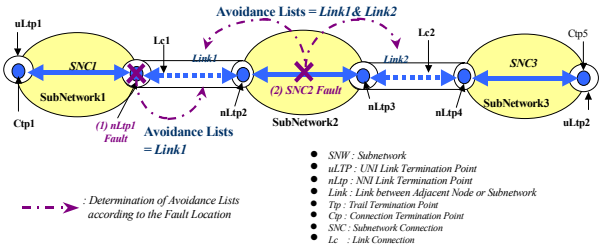

Figure 2. Determination of avoidance list

3.2 Determination of rerouting flag

On the other hand, the restoration flag represents manipulation mode of the connectivity objects traversing the existing and alternative routes in the process of restoration. The restoration flag is applied to the connectivity objects of *Subnetwork Connection (SNC)* and *Link Connection (Lc)*. There are four kinds of restoration flags such as *creation, deletion, rerouting* and *none*. The restoration flag is determined by the following rules with the results of the comparison between the existing and the alternative routes.

- If a topological component is included in the existing and alternative routes simultaneously, the connectivity object traversing the topological component is not changed. Its restoration flag can be "*none*".
- If a topological component is include in the existing route and is not included in the alternative route, the connectivity object traversing the topological component included in the existing route is deleted. Thus its restoration flag for the connectivity object traversing the topological component included in the existing route can be "*deletion*".
- If a topological component is included in the alternative route and is not included in the existing route, the connectivity object traversing the topological component included in the existing route is newly created. Thus its restoration flag for the connectivity object traversing the topological component included in the alternative route can be "*creation*".
- The connectivity object such as SNC or LC is terminated at the two Ltps such as transmitted and received Ltps. If the transmitted Ltp is the same part of the existing and the alternative routes and the received Ltp of the existing route is different from that of the alternative route, the connectivity object terminated at the receive Ltp of the existing route is changed to the receive Ltp contained in the alternative route. We define the migration process of connectivity objects of Ctps pertained in Ltp from the existing route to the alternative route as the "*rerouting*".

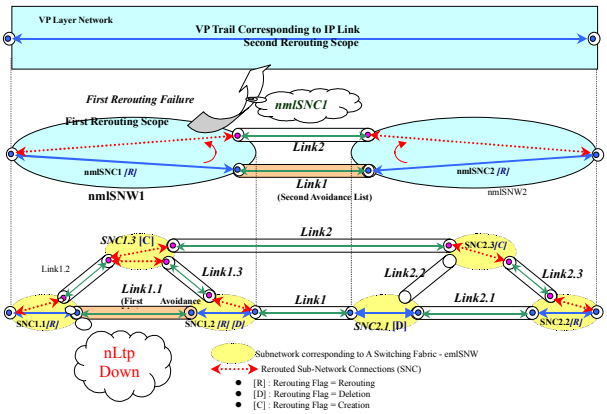

Figure 3. Hierarchical rerouting model

The partitioned subnetwork itself can be the rerouting scope. The identification of avoidance list and rerouting flags is the role of NML function. Referring to Figure 3, if nmlSNW1 failed to find alternative route with the network topology information of nmsSNW1, its rerouting scope is expanded to layer network with the logical nmslSNC fault.

4. Conclusion

This paper proposed the rule for the determination of the avoidance list that is one should be excluded in the process of finding alternative route and the rule for identification of restoration flags comparing the existing routing with the alternative route for restoration. In addition, this paper describes the restoration expansion model suitable for hierarchical transport network. We implemented the ATM Virtual Path Network Management System (ATM VP-NMS) adopting the proposed hierarchical rerouting scheme in hierarchical VP network.

References

[1] ITU-T Recommendation G.805, "Generic Function Architecture Of Transport Networks," November 1995.