ATM Network Restoration Using a Multiple Backup VPs Based Self-Healing Protocol

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Abstract: Physical route assignment and capacity allocation functions of a Virtual Path (VP) are decoupled in Asynchronous Transfer Mode (ATM) networks. This means a zero-bandwidth VP can be preconfigured as backup of a working VP. This feature makes self-healing ATM networks particularly interesting as faster and efficient restoration can be realized by capturing the necessary bandwidth on the backup VP after a failure. With an aim to further increase the restoration speed, we developed a new Multiple Backup VPs (MBV) based protocol that permits one or more backup VPs to protect a single working VP. This approach helps holding the spread of restoration information in reduced span leading to faster recovery. The multiple backup VPs can be setup either in overlapped or non-overlapped way. This paper describes the operation of the protocol and studies how it recovers from unidirectional and bidirectional single link failures using both non-overlapped and overlapped scenarios. Performances are evaluated in terms of restoration ratio for a meshed-topology.

1 Introduction

Asynchronous Transfer Mode (ATM) is the switching and multiplexing method adopted for implementing Broadband Integrated Services Digital Networks (B-ISDN). An infrastructure based upon fiber optics and high speed digital electronics allows ATM to reach high transfer rates. However, use of fiber optics implies more traffic being concentrated on fewer routes, any transmission link/system failure tends to cause extremely serious problems due to huge loss of bandwidth, loss of service to user and loss of revenue to the operating companies. Therefore, in B-ISDN networks, demands for network reliability have highly increased. In this context, restoration techniques that minimize damage by automatically rerouting the traffic away from the failure point play a key role in network reliability enhancement.
Originally proposed by Grover in 1987 [1], self-healing is a distributed control restoration scheme for networks with no topological restriction. Since 1992, Virtual Path (VP) layer based self-healing networks have been studied, and many schemes using ATM’s characteristics have been proposed [2, 3]. VP restoration has several fundamental advantages made possible by the VP path layer concept of ATM network as standardized in [4]. VP restoration realizes simple and resource-efficient restoration architecture. One of the most striking characteristics is the ability to pre-establish backup paths using zero bandwidth VPs. Another advantage useful for self-healing is the OAM (Operation, Administration and Maintenance) cell mechanism possible with VPs.

End-to-end (ETE) backup VP based self-healing protocol is the most widely studied VP layer based protocol till recently [5]. In this restoration scheme, the main VP and corresponding backup VP are established between source-destination on link/node-disjoint routes to avoid simultaneous failures in both VPs. However, such use of backup VPs is not efficient from restoration speed’s viewpoint in huge networks, as the restoration messages have to pass through all nodes on the failed and backup VP between the source and destination. In this context, we developed a protocol called Multiple Backup VPs (MBV) based self-healing protocol that allows a working VP to be split into one or more sections depending upon the length. A smaller VP that can be restored faster protects each part as presented in the following sections.

This article studies operation of the MBV protocol for unidirectional and bidirectional single link failure scenarios and evaluates its performances from restoration speed viewpoint.

Article is organized as follows. In section II, basic principle MBV self-healing protocol is presented. Restoration operation of the protocol for single link failure scenario is described in sections III and IV. Results are presented in section V, followed by the conclusion in section VI.

2 MBV Protocol

Services carried by an ATM transport network can be restored by using an ETE backup VP [5]. Initially, the network searches for several paths between source-destination pair. The best such path is designated as main VP, and the second best path is reserved as ETE backup path as depicted in Fig.1. VPI numbers and the required amount of bandwidth are assigned to the main VP. For efficient use of network resources, no bandwidth but only VPI numbers are assigned to the ETE backup VP.