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A new shared-risk link groups (SRLG)-disjoint path provisioning with shared protection in WDM optical networks

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Abstract

This paper addresses the protection problem in WDM optical networks and presents a New Shared-risk link groups (SRLG)-Disjoint Path Provisioning (NSDPP) approach with shared protection to tolerate the single-risk failure. Comparing to previous Shared-risk link groups (SRLG)-Disjoint Path Provisioning (SDPP) approach, NSDPP is able to obtain better performance, because in NSDPP some primary path and backup paths of other primary paths can share the common resources if the corresponding rules can be satisfied. Simulation results are shown to be promising.

Keywords: WDM optical networks; Shared-risk link groups (SRLG); Path provisioning; Shared protection

1. Introduction

In WDM optical networks, the protection design is a very key issue due to the risk of losing a lot of traffic under the failures (Maier et al., 2002). To tolerate the failures, previous works have proposed many protection approaches, which include path-based protection and link-based protection (He et al., 2005; Ramamurthy et al., 2003; Zang et al., 2003; Wen et al., 2003; He et al., 2004; Mohan et al., 2001). In these approaches,

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path-based protection generally is able to yield better resource utilization and be easy to implement in the current phase. In path-based protection, each connection will be assigned a primary path and a backup path to avoid any single failure. To survive single-link failure, the primary path and backup path should be link-disjoint; to survive single-risk failure, the primary path and backup path should be risk-disjoint. This paper will address the single-risk failure protection problem in WDM optical networks.

1.1. Previous work

Previous work has proposed the concept called Shared-risk link groups (SRLG) to address the risk failure problem (Shen et al., 2005). An SRLG is a group of links that are subject to a common risk, such as a conduit cut. Each fiber link may be related to several SRLGs. Although the concept of SRLG was originally proposed to deal with conduit cuts, it can be extended to include general risks. For example, all the fiber links located in a geographic area may be assigned the same SRLG considering the risk of earthquakes. An SRLG risk in this paper represents a general risk. The SRLG can be determined from routing information on physical links and also can be distributed by the network managers. For each connection, a primary path and an SRLG-disjoint backup path are necessary for surviving any single-SRLG failure.

Previous work's have proposed the SRLG-Disjoint Path Provisioning (SDPP) approach with shared protection (Shen et al., 2005; Guo et al., 2005; Xu et al., 2004). In SDPP, each connection will be assigned a primary path and an SRLG-disjoint backup path from the source node to the destination node, and any two backup paths can share the spare resources if their corresponding primary paths are SRLG-disjoint. Therefore, with the shared protection method, SDPP has better resource utilization and lower blocking probability than other approaches with the dedicated protection method.

1.2. Motivation

In SDPP, although the resources utilization ratio has high, there also may be some redundant spare resources since the resources can only be shared among the backup paths and cannot be shared between the primary and backup paths. In fact, in some situations, we have found some primary paths and backup paths of other primary paths sharing common resources, which have been investigated in our recent works (Guo et al., 2006a, b). In the following, we give an illustration shown in Fig. 1 to explain our novel concept, in which we assume the network has the full wavelength conversion capacity and the SRLGs of fiber links can be given.

In Fig. 1, p_n and b_n denote the primary path and backup path for connection n, respectively. In SDPP, a spare wavelength-link w_3 needs to be reserved for b_1 on link j in Fig. 1(a). However, w_3 is redundant because in fact b_1 can share the primary wavelength-link w_1 used by p_0 on link j. Because the SRLGs included by p_1 are all included by p_0, then if p_1 fails, p_0 must fail simultaneously. When p_0 and p_1 both fail, the primary wavelength-link w_1 used by p_0 needs to be released, so that w_1 is free now and can be re-used by b_1. Then, in Fig. 1(b), the primary wavelength-link w_1 on link j can be shared by b_1, and the spare wavelength-link w_3 can be saved. The resources shared by primary and backup paths are called mixed resources.