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Single Link Failure in Mesh Network

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Abstract—*Wireless mesh networks (WMNs) have emerged as a key technology for next-generation wireless networking. Because of their rapid progress over other wireless networks, these are undergoing rapid progress and inspiring numerous applications. However, many technical issues still exist in this field. In order to provide a better understanding of the research challenges of WMNs, this paper represents different capacity allocation strategies for restoration and protection of single link failure scenario in mesh-based survivable networks. This paper evaluates the ability of wireless mesh architecture to provide high performance Internet access while demanding little deployment planning or operational management. The performance of working capacity allocation model, spare capacity allocation model and joint capacity allocation model has been compared.*

1. INTRODUCTION

Telecommunication networks have evolved during a century-long history of technological advances and social changes. The rapid increase of the Internet demands large volumes of bandwidth. Wavelength division multiplexing (WDM) technology has the potential to meet this need by allowing simultaneous transmission of traffic on multiple Wave lengths in a fiber. Network traffic analysis has been effectively utilized in Performing capacity estimates, load distribution, admission control and quality of service provisioning. In the case of protection, different mechanisms consider a pre-estimated static traffic demand over which different offline optimization algorithms are run to perform routing and wave length assignment. Today, optical fiber is widely deployed in backbone networks. However, only a small fraction of the full capacity of the installed optical fiber has been realized so far. The primary reason for this inefficiency is the large mismatch between peak electronic processing and source rates, and fiber capacity. Therefore, multiplexing techniques such as wavelength-division multiplexing (WDM) have been used in order to utilize fiber capacity more efficiently.

Network survivability is the ability of a telecommunication network to continue to provide service in the event of failures, and comprises both planning and operations aspects. The planning aspects involve different *protection schemes* for allocating spare capacity to the network, which is to be used upon the occurrence of a failure event. From a network operations standpoint, protection schemes are implemented via *restoration mechanisms* which are activated to restore service to affected customers when failure events happen. Survivable network architectures are based either on dedicated resources or on dynamic restoration. In

Dedicated-resource protection (which includes automatic protection switching (APS) and self-healing rings), the network resources may be dedicated for each failure scenario, or the network resources may be *shared* among different failure scenarios. In dynamic restoration, the spare capacity available within the network is utilized for restoring services affected by a failure.

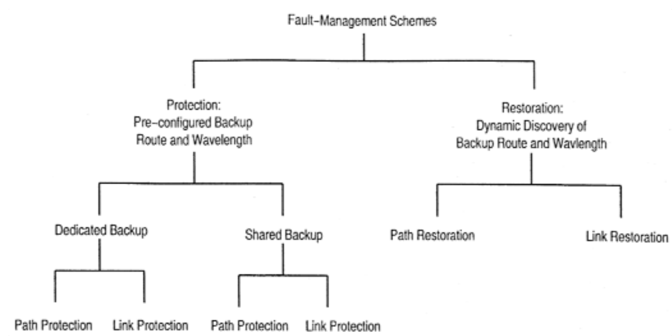

Fig. 1: Classification of survivability

The p-cycle concept is a recent strategy to recover from network failures. It provides a protection mechanism for spans and for transiting traffic through failed nodes. p-Cycles can be described as pre-configured closed protection paths in a mesh network . Cycle-oriented pre configuration remains fundamentally a mesh restorable network technology in terms of its capacity efficiency and in its functional differences from self-healing rings .They are physical structures formed in the spare capacity of a channelized network or virtual structures that use the slack i.e. unused working capacity of links in an ATM or MPLS network. Like rings, the protection capacity is pre-connected in advance of any failure and the protection switching is very fast and simple.

2. RELATED WORKS

The simplest telecommunication network design problem is to determine the least capacity needed to satisfy a set of given point-to-point demands. This is called the *working capacity allocation problem* and can be modeled as an integer linear program (ILP) using either a node–arc or an arc-path formulation light paths and a connection in a SONET over WDM optical network. Note that a light path uses a transmitter at the source node and uses a receiver at the destination node. Also, a connection must originate and end in the electronic domain, which is digital cross-connect (DXC)

A. The node arc model

Let $[N, L]$ be a graph where $N = \{1, 2, ..., n\}$ denotes the set of nodes and L denotes unordered pairs of nodes correspond into links. Let $E = \{(i, j), \{j, i\} : \{i, j\} \in L\}$

be a set of ordered pairs called arcs corresponding to the link Let the *n*-component requirement vector e^k for commodity $k \in N$ be given by

$$e_i^k = \begin{cases} \sum_{j \in N} d_{kj}, & if\ i = k, \\ -d_{ki}, & \text{otherwise.} \end{cases}$$

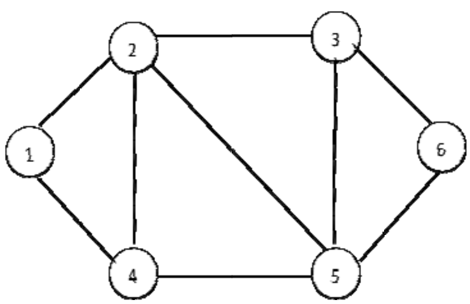

Fig. 2: Node arc model

Table 1: Look up table for node arc model

Link	Demand
(1,4)	10
(2,3)	10
(2,4)	10

B. The Arc-Path Model

A directed path from node s to node t in the network $G = [N, E]$ is a sequence of nodes and arcs $p = \{i_1, (i_1, i_2), i_2, (i_2, i_3), i_3, ..., i_l, (i_l, i_{l+1}), i_{l+1}\}$, where $i_1 = s,\ i_{l+1} = t,$ and each arc and node are distinct. Let D denote the set of demand pairs. That is, $(i, j) \in D$ implies that $d_{ij} > 0.$ total working capacity:

$$\sum_{\{i,j\} \in L} c_{ij}$$

3. EXPERIMENTAL ANALYSIS

This presents optimization models for the spare capacity allocation problem in a mesh telecommunications network. Since the users of this network require high reliability, these networks are designed to continue to operate even when a single link failure occurs. It is generally assumed that the probability of multiple link failures during the time required to repair a failure is so small that network designers plan restoration strategies based on single link failures. Designers have identified two basic strategies to protect a network against single link failures: dedicated protection and shared protection

Let c_{ij} for all $\{i, j\} \in L$ denote the known volume of working traffic on link (i, j). suppose link $\{s, t\}$ fails. Then c_{st} units of flow must be rerouted from node s to node t and vice versa. In the node-arc model for link restoration, the requirement at node i is given by

$$r_i^{st} = \begin{cases} c_{st}, & if\ i = s, \\ -c_{st}, & if\ i = t, \\ 0, & \text{otherwise.} \end{cases}$$

This model assumes symmetrical working and spare capacity. That is, the capacity is the same in both directions on all links. This model also assumes that the working traffic was routed separately prior to determining the routing for restoration.

A joint model is one in which both working and spare capacity can be determined in a single model.

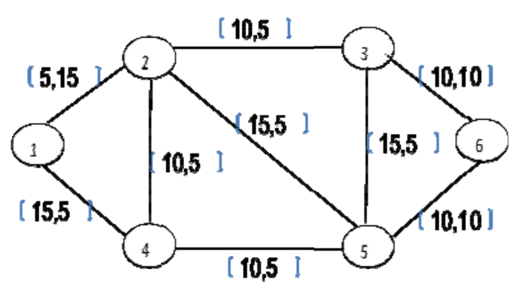

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Fig. 3: Arc path model

The joint model is a combination of the arc-path formulation of the working capacity allocation model and the arc-path formulation of the path restoration version of the spare capacity allocation model.

4. RESULTS

When this model is applied to the example problem, the total spare capacity for $|T| = 120$ needed was only 75 compared to 100 and 80 for p-cycle and link restoration, respectively. The solution is illustrated in Fig. 23 &24. Of course, a more sophisticated restoration procedure is needed to achieve these savings.

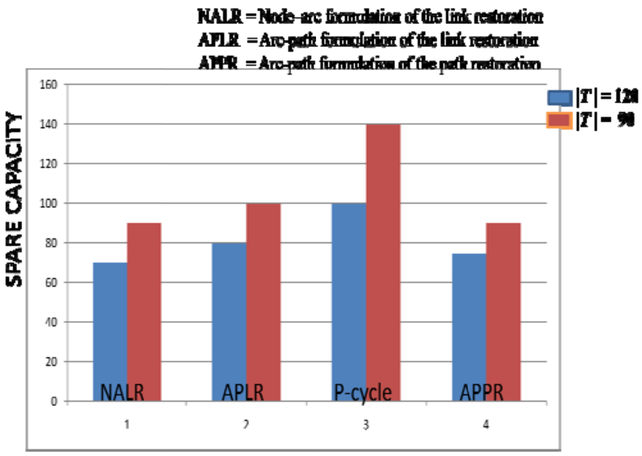

Fig. 4: Solution capacity allocation models for spare

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