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WDM-Based Storage Area Network (SAN) for Disaster Recovery Operations

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***Abstract*—**This paper proposes a Wavelength Division Multiplexing (WDM) technology based Storage Area Network (SAN) for all type of Disaster recovery operation. It considers recovery when all paths failure in the network as well as the main SAN site failure also the all backup sites failure by the effect of natural disasters such as earthquakes, fires and floods, power outage, and terrorist attacks, as initially SAN were designed to work within distance limited environments[2]. Paper also presents a NEW PATH algorithm when path failure occurs. The simulation result and analysis is presented for the proposed architecture with performance consideration.

***Keywords*—**SAN, WDM, FC, Ring, IP, network load, iSCSI, miles, disaster.

I. Introduction

SAN initially designed to work within distance-limited environments such as a campus. As the effect of natural disasters such as earthquakes, fires and floods, power outage, and terrorist attacks could be severely destructive in a limited distance environment; the need of extending SANs over large distances has become essential to protect data against loss or damage and to share storage resources among a larger number of users over large geographic areas. For a number of years high performance disaster recovery network is unavailable high-performance, high speed with all type of disaster consideration network is required. For the main SAN protection, primary and secondary mirror backup sites at sufficient distance and for the path failure the path restoration algorithm is Introduced in this paper, Current SAN protocols include Internet small computer system interface (iSCSI), Fibre Channel (FC) over TCP/IP (FCIP), and Internet Fibre Channel Protocol (iFCP), They are relatively slow transport protocols, especially compared with block-storage type commands like the SCSI commands [2], and less robust transport mechanisms compared to WDM technology. The formula for calculating the network load is given in the [2] and the ring length is given 138 km. that is 44 km in diameter. The result of proposed network model is compared with [2].

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II. Architecture of WDM-Based SAN for Disaster Recovery Operation

The Proposed Network consists of two backup sites for recovery after disaster. Three separate WDM ring connects three sites as shown in the Fig. 1. The back up sites are located at 105 miles from each other connected by separate paths. If any one of the three paths fails it uses alternate path using algorithm given in the section III the network remains working if any of the paths fails.

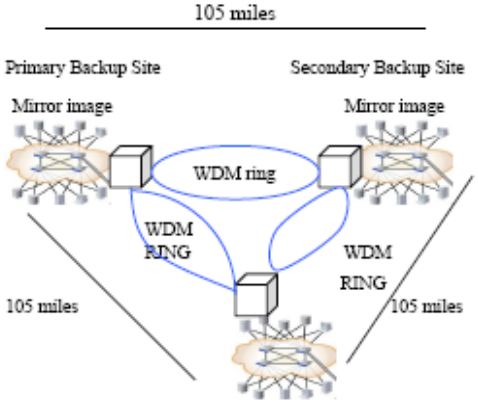


Fig. 1 Architecture of proposed WDM-based SAN for disaster recovery operation

Why 105 Miles?

Increasing the distance between a primary site and backup site would greatly enhance the assurance characteristics of the system the primary reason for this increase is due to the fact that further separation of primary and backup sites reduces the probability that both site will be adversely affected by same Disaster. It is clear from the survey that this distance recommendation was made in large part to protect against large natural disaster. This provides a baseline number so as to understand how high-assurance networks should be formed. As the distance is decreased, the chance of both sites becoming unavailable due to the same event increases, thus decreasing assurance. U.S. Chapter of the Association of Contingency Planners (ACP) participated in a survey-conducted by The Disaster Recovery Journal to determine the best distance separation between primary and backup sites [4]. Fig. 2 shows the distance affected by the natural disasters.

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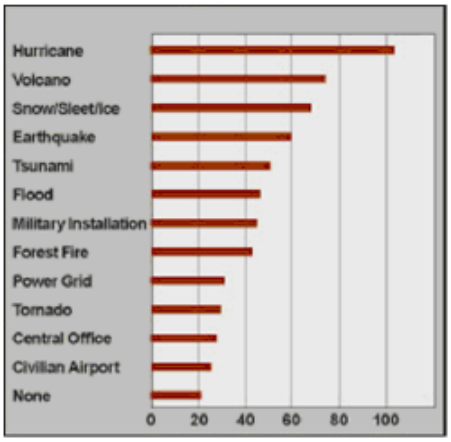


Fig. 2 Minimum distance recommended in miles [4]

Why WDM?

There are three IP based protocols FCIP, iFCP, iSCSI they all inherit the well-known drawbacks of IP as a slow transport protocol compared to FCP, particularly when delivering block-storage type commands like SCSI commands [2], a less robust transport mechanism compared to WDM [5], possessing large overheads and having in many cases, limited quality of service guarantees. IP-based SANs are prone to packet loss and their achievable high throughput ('1 0 Mbyteds) is limited. On the other hand, the legacy SAN has drawbacks such as, FC distance limitation and SONET inefficiency in transporting busty data traffic [2]. Therefore the efficient use of distributed SAN; WDM can be efficiently used to enhance the capacity and access speed.

Why Ring?

Most of the paper on WDM technology has been focus on following topologies,

- Star topology
- Broadcast and select
- Mesh topology

But from last few years attention is increased on WDM ring network. Because of following advantages of ring [7],

- Simple routing policy
- Simple control and management
- Simple hardware system
- Simple protection from network failure

The major difference distinguishing modern WDM rings from traditional low-speed networks such that several slots can be carried simultaneously through the optical medium If slots are freed after reaching their destination, they can be used several times as they propagate around the ring. Therefore, much better throughputs can be achieved in ring networks than in star networks where space reuse is not possible [7] in multiple ring architectures where a number of channels run in parallel [2] in the use of multitoken protocols. In a multitoken *ring*, multiple tokens circulate within a ring, and therefore simultaneous transmissions are possible. Multiple token rings achieve better performance than single token standard protocols [2]. As WDM technology now offers a very large number of wavelengths, WDM ring have become potential candidate for the network. Dense WDM (DWDM) technology now offers an unprecedented bandwidth. Currently available systems provide up to about 600 wavelengths per fiber, allowing a single fiber to carry up to 6 Tb/s[2]. WDM system are already diploid in large scale in long haul WAN in North America, Japan and Europe.

III. Algorithm New Path

1. Start
2. Graph (V,E).
3. Source is s and destination is D.
4. The broken edge e (u, v).
5. The failure is detected at the source, as the response has not come of send data.
6. Remove the broken edge from graph G (V, E)
7. Let the new graph is G'
8. Set the new path between source and destination using shortest path algorithm.
9. Mirroring at B1 and B2 via new route.
10. END

The Graph of the network is shown in the following figures, node S is the main SAN site and B1 and B2 are the two backup mirrored sites, path B1-B2 is the bi-directional and the other two paths are unidirectional. Consider if any one path fails then alternate path is available as shown in the Figs. b and c. Hence the working of the mirroring process is continued in any of the path failure occurs.

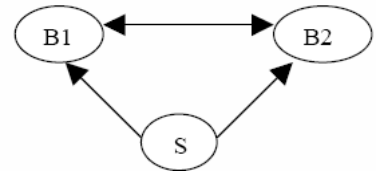


Fig. a

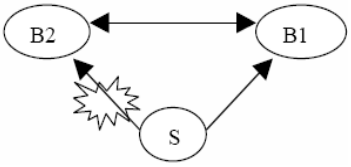


Fig. b

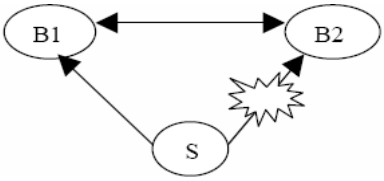


Fig. c

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Consider above figures if path s-b1 fails then path s-b2-b1 is used and path s-b2 fails then s-b1-b2 is used in the mirroring process of b1 and b2.

IV. Implementation and Simulation Result

A special simulator is developed in the MATLAB 7 software for obtaining the following results which are compared with result of [2] where multiple rings is used. Ring length consider is 138 km that is 44 km in diameter that is distance between two nodes but according to our proposed model the distance between two sites are 105 miles. That is 169km. hence the ring length will be 530 km. in proposed model single ring is used one fixed trancemeter and fixed receiver is used i.e. FT-FR. The performance of the ring at this much distance is calculated as follows:

$$L = \sum_{i=1}^{R} \sum_{j=1}^{N} (R_{nij} * U_{ij})\, R_w * N_w$$

The network load can calculated by following formula [2], where,
R – No. of the ring.
N- No. of the nodes.
R_{nij} –transmission rate of node j on ring i
Uij –Utilization of node j for ring i
R_w -Wavelength rate.
N_w -Number of wavelength.

In the proposed network model the total rings are three single rings, but each connects two nodes only (N=2) and if we calculate the performance of only one single ring(R=1) then performance of whole network is calculated by multiplying by three. Number of wavelength per fibre is four (N_w =4).

The performance is calculated by plotting graphs of following parameters:

- Average node throughput
- Throughput of the total network
- Queuing delay

under symmetrical and asymmetrical traffic. Following is the graphical output obtained after simulation, which are similar with results of [2] before and after disaster happened.

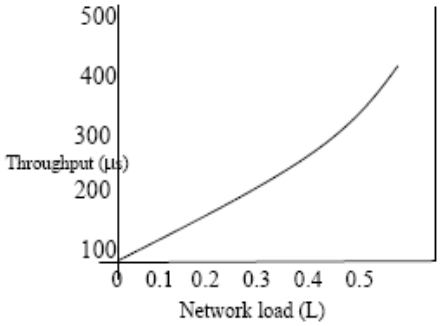


Fig. 3 Average throughput per Node

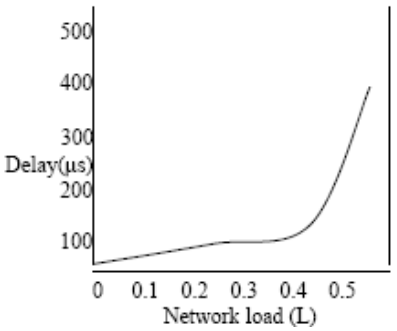


Fig. 4 Average Queuing-Delays

V. Conclusion

From last few years natural as well as Man-made disasters are increases and SANs of like dada centers as well as defense sites are highly insecure. The perfect secure SAN network with high performance was unavailable. The results of [2] are exactly matched with obtain result. Hence this will be the perfect solution for the disaster recovery operation. Simulation result show that increasing the ring length does not affect on the throughput of the network, with low Queuing delay and packet dropping probability, the performance of the overall network is increases. The multiple ring architecture is used in [2], but in proposed model single ring is used with one fixed trance-meter and fixed receiver i.e. FT-FR hence high performance with low cost as compare with other models. When wavelength was increased the overall performance of the network is not affected by the brushy traffic use of WDM in the SAN increases the overall speed of the dada backup. Recovery point objective and recovery time objective [1] gives the best values after disaster. The performance of the network after adding all the concern values for calculating the performance of total network with all three rings in consideration is best and is shown in following graph.

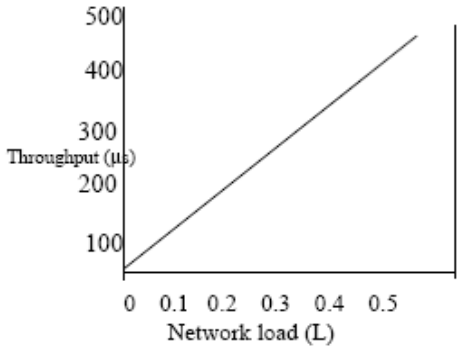


Fig. 5 Average throughput of total SAN

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