Fast Fault Recovery Method
With Pre-established Recovery Table
For Wide Area Ethernet

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Abstract—We propose a fault recovery method, in which nodes can send frames without waiting for path switching to be completed. In this method frame loss can be decreased to 20 % or less.

keywords: Wide Area Ethernet, protection, restoration

I. INTRODUCTION

Recently, Wide Area Ethernet (WAE) that provides virtual connections between company branches by using Ethernet technology is widespread. WAE is often constructed by optical network, because in the near future required transmission rate becomes up to 100Gbps or 1Tbps in Ethernet. To expand existing Ethernet for LAN (Local Area Network) to for WAN (Wide Area Network), there are many problems that should be solved in terms of reliability or scalability. One of these problems is a fault recovery.

There are two major conventional fault recovery methods. One is protection, the other is restoration [1]. Both methods cause many frame loss when a fault occurs.

To improve reliability of WAE, a fault recovery method with little frame loss is required. Then, we propose a new fault recovery method with pre-established recovery table, in which nodes can send frames without waiting for path switching of the conventional fault recovery method to be completed. Our proposed method can be added to the conventional fault recovery methods seamlessly.

Computer simulation shows that by applying the proposed method to the conventional methods, frame loss can be decreased to 20 % or less.

II. CONVENTIONAL FAULT RECOVERY METHODS

There are two major conventional fault recovery methods. One is protection, the other is restoration.

In protection, backup paths that is used when the fault occurs is statically reserved for each connection during call setup. When a fault occurs, the node that detects a fault informs the fault to a source node, and then the source node switches path from a primary path to the backup path. So, in protection much time is required until the source node is aware that the fault occurred, meanwhile many frames are lost. Therefore, frame loss in protection is depends on a distance between the source node and the node that detect a fault.

In restoration, after a fault occurs, a backup route is dynamically discovered by the node that detects the fault. So, in restoration much time is required until route calculation is completed, meanwhile many frames are lost. Because route calculation increases according to the number of nodes, frame loss in restoration is depends on the network size.

III. PROPOSED METHOD

In our proposal, to fast recovery we innovate a new forwarding table used when a fault occurs, which is called “recovery table”, and a modified frame. Therefore, nodes can forward frames without waiting for path switching of the conventional protection or restoration to be completed.

That is, in our proposal, each node has two forwarding tables. One is a forwarding table used usually, which is called “forwarding table”. The other is a recovery table. Additionally, in our proposal we suppose that control PCs in a control plane control nodes in a data plane and that a routing protocol always runs in the control plane.

A. Creating a recovery table

1) One-hop search: In Fig. 1, we suppose that node 2 will decide an adjacent node to which it should forward frames when a fault occurs in the link 2-1.

Node 3 and node 6 check their own shortest path table, and inform to node 2 whether the shortest path from themselves to node 1 traverses the link 2-1. In this case,
the shortest path from node 3 to node 1 traverses the link 2-1, and the shortest path from node 6 to node 1 doesn’t traverse the link 2-1. Node 2 gets these information and knows that when a fault occurs in the link 2-1, node 2 should forward frames to node 6. Then, node 2 writes in its recovery table. Thus, when a fault occurs in link 2-1, node 2 can forward frames to node 6 according to own recovery table. If node 2 can’t decide an adjacent node to which it should forward frames, it wait for path switching of protection or restoration to be completed.

2) Two-hop search: In two-hop search, if in one-hop search nodes can’t decide an adjacent node to which it should forward frames when a fault occurs, nodes also gets more information from nodes its two hops ahead similarly.

In two-hop search, a node can decide an adjacent node to which it should forward frames against more link failure than in one-hop search. However, in two-hop search, complexity, traffic, and amount of information will increase.

B. Forwarding method when a fault occurs

All nodes check frame’s high one bit of VLAN ID, because this bit is used as a frag which shows that a fault occurred. Usually, all frame’s frag is set to 0.

When the node that detects a fault receives the frames which should be forwarded to the failed link, it sets these frame’s frag to 1, which is modified frame, and forwards frames to the node which shown in its recovery table, as shown in Fig.1.

When the node receives the frames whose frag is 1, in principle, it forwards these frames to the node which shown in its forwarding table. If the node receives the frames whose frag is 1 from the node which shown in its forwarding table, it forwards to the node which shown in its recovery table, because it knows that the fault occurs in the link its two hops ahead.

When path switching of protection or restoration is completed, frames are forwarded by using new route. In our method, therefore, when a fault occurs, nodes can forward frames without frame loss until path switching of protection or restoration is completed.

IV. PERFORMANCE EVALUATION

We measure the probabilities that nodes can decide an adjacent node to which it should forward frames when a fault occurs, that is the probabilities that nodes can forward frames without waiting for path switching of protection or restoration to be completed, in one-hop search and two-hop search. We evaluate frame loss when our proposal is applied to the conventional protection or restoration.

In Fig.2, we show frame loss of the protection and the protection with our proposed method. We suppose the number of nodes is 1000, the average link degree is 8, and the transmission rate is 100Gbps. Additionally, “distance” in this graph means that the distance between the source node and the node that detect a fault. Therefore, by applying the proposed method to the conventional protection, frame loss can be decreased to 20 % if using one-hop search and almost 0 % if using two-hop search.

In Fig.3, we show frame loss of the restoration and the restoration with our proposed method. We suppose the average link degree is 8, and the transmission rate is 100Gbps. Therefore, by applying the proposed method to the conventional restoration, frame loss can be decreased to 20 % if using one-hop search and almost 0 % if using two-hop search.

V. CONCLUSION

We proposed a new fault recovery method with pre-established recovery table for WAE. In this method frame loss is less than in the conventional fault recovery methods, because in our proposal frames are not lost until path switching of protection or restoration is completed. Furthermore, by the computer simulations, we showed that by applying the proposed method to protection or restoration, frame loss can be decreased to 20 % or less.

ACKNOWLEDGMENT

This work is partly supported by the Japan Society for the Promotion of Science’s (JSPS) Grant-in-aid for Scientific Research and by a Grant-in-Aid for the Global Center of Excellence for high-Level Global Cooperation for Leading-Edge Platform on Access Spaces from the Ministry of Education, Culture, Sport, Science, and Technology in Japan.

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