Ethernet transmission method based on modified format for distribution domain protection system

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Abstract: This paper proposes an Ethernet transmission method based on modified format, which is applied to the distribution domain protection system. By tagging Ethernet data new identifications, the data has unique identity information in transmission. The switch replicates data and transmits in two directions. When the ring network is destroyed, there is no data loss caused by switching the transmission direction. The distribution domain protection system realizes ring network with seamless redundancy.

1. Introduction
At present, distribution network protection is in an important period of reform. In the past, the local protection that detects short-circuit current cannot accurately locate faults according to the overall information of the region in the scenario of multi-power supply access. However, the station-domain protection system can solve this problem well. The station-domain protection system requires peer to peer data interaction between devices, and Ethernet is the mainstream communication mode at present. In the distribution network, network equipment generally uses RSTP, STP, ring network protection protocol and so on to form ring network extension[1]. When the ring network fails, the topology self-healing time ranges from 10 ms to 500 ms. During this period, the local system cannot transmit instructions properly. In this paper, an Ethernet transmission method based on format modification is proposed to locate, copy and eliminate Ethernet data. The two copies of data are transmitted in the two directions of the ring network at the same time, so that there is no self-healing process and data is not lost when the ring network fails [2].

2. Principle and Design
The paper reports the operation principle of Ethernet ring network, and forming a ring network on the physical connection of the switch. The data transmission logic is single-direction transmission. Therefore, when a link fails, data must be switched to another direction for transmission, which results in data loss.

In this paper, two copies of the same data were formed through the data replication of the switch, and the two copies of data were transmitted in two directions of the ring network at the same time. In
the case of a link failure in one direction, data in the other direction can still reach the destination, thus eliminating the process of data transmission direction reversal in the case of a switch ring network failure to achieve seamless redundancy [3].

2.1. Ethernet data format modification

In the method discussed in this paper, the two-way transmission of the switch ring network depends on the replication of data by the starting switch and the elimination of duplicate data by the ending switch. Whether to copy data or eliminate redundant data, accurate identification of Ethernet data must be done first. The Ethernet format identifies only the source device (source MAC) and destination device (destination MAC) of the data (Figure 1). On the switch, the characteristics of the data sent from the same source MAC device to the same destination MAC are the same. Switches cannot data format distinguish between each data through Ethernet, the switch cannot to accurate identification of data, the starting switch to the format of data replication, end switches cannot distinguish between the same source MAC and destination MAC data replication data and original data of one-to-one correspondence relationship, also can't do the correct copy data to eliminate. Therefore, this paper first defines a modified Ethernet data format, so that the switch can accurately identify Ethernet data [4].

![Figure 1. Ethernet data format.](image1)

2.1.1 Modified Ethernet data format

The modified Ethernet format adds three additional identifiers: source switching device ID, target switching device ID, and data frame ID. The switching equipment of the fast protection system of distribution network website can identify the unique identity of data by the source switching equipment ID, target switching equipment ID, data frame ID, source MAC and destination MAC. The added Ethernet data format is shown in Figure 2.

![Figure 2. Added Ethernet data format.](image2)

In the new data format, the source switch ID refers to the ID of the switch connected to the source network device. Destination switch ID indicates the ID of the switch to which the destination network device connects. The data frame ID refers to the sequence ID of data frames sent by the switching device. The sequence starts from 1 to a certain value and then repeats from 1.

2.2 Process the modified data on the switch

The modified data format workflow is shown in Figure 3. Power distribution Site Domain protection devices send data in the original Ethernet format and the connected switches add new data in the format. Source switch ID indicates the ID of the switch. Destination switch ID indicates the ID of the last switch during data transmission (the ID of the destination switch can be all F if the data is broadcast). Frame ids are incremented from 1 to 1 based on the sequence of data entering the switch. The data format is added by the source switch and the data is copied into two copies for transmission.
The switch records data identification during the intermediate process. The destination switch records the identifier of the incoming data, reformatting the first incoming data, and sends the source-to-source-to-source-to-start Ethernet data to the domain-type protection device on the power distribution website to complete data transmission. The destination switch discards the data with the same id that reaches the destination switch for the second time.

![Diagram](Image)

**Figure 3.** Process after the format is changed.

| Project                  | Equipment  | Source Switches ID | Destination switch ID | Frame ID | Destination MAC | Source MAC |
|--------------------------|------------|--------------------|-----------------------|----------|-----------------|------------|
| Protection device A>B    | Protection A | a                  | n                     | 1        | B               | A          |
| first data               | Switches a | a                  | n                     | 1        | B               | A          |
|                          | Switches b | a                  | n                     | 1        | B               | A          |
|                          | Switches n | a                  | n                     | 1        | B               | A          |
|                          | Protection B |                  |                       |          |                 |            |
| Protection device A>B    | Protection A | a                  | n                     | 2        | B               | A          |
| second data              | Switches a | a                  | n                     | 2        | B               | A          |
|                          | Switches b | a                  | n                     | 2        | B               | A          |
|                          | Switches n | a                  | n                     | 2        | B               | A          |
|                          | Protection B |                  |                       |          |                 |            |
| Protection device C>B    | Protection A | b                  | n                     | 1        | B               | C          |
| first data               | Switches a | b                  | n                     | 1        | B               | C          |
|                          | Switches b | b                  | n                     | 1        | B               | C          |
|                          | Switches n | b                  | n                     | 1        | B               | C          |

**Table 1.** Data information received by each device
Table 1 shows the format of data received on each device (station domain protection device, switch) in the system.

2.3 *Redundant data transfer based on format modification of switch ring network*

In a switch ring network, after receiving data A sent by the device, the original switch modifies and replicates the data format to form data A1 and A2 with the same content. A1 and A2 transmit in different directions of the ring network respectively, and finally, A1 and A2 collide at the destination switch (Figure 4). The seamless redundancy of ring network can be realized by copying and transferring data and eliminating redundant data [5]. Eliminate loop network switchover time caused by link failure in the loop network structure of switches, increase the reliability of Ethernet data transmission in the domain protection system of power distribution sites, reduce communication time increase and control command failure caused by data loss and retransmission of data by protection devices.

![Figure 4. Ring network transmission method.](image)

3. **Conclusion**

In this paper, the Ethernet transmission method based on data format modification can be used to identify the unique identity of the data transmitted in the domain fast protection system of distribution website, so that the switch can identify the characteristics of each data. The data can be copied and transmitted, and redundant data can be eliminated to achieve seamless redundancy of ring network. Eliminate loop network switchover time caused by link failure in the loop network structure of switches, increase the reliability of Ethernet data transmission in the domain protection system of power distribution sites, reduce communication time increase and control command failure caused by data loss and retransmission of data by protection devices.
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