Implementation method of Single Point Fault of Computer Equipment in Electric Power Monitoring System

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***Abstract*—With the increasing of power network projects in China, as well as the updating and developing UHVDC and AC transmission systems, the construction of a strong power grid needs a safe and stable computer monitoring system to complete. However, the security of the windows system itself is difficult to guarantee at present. In addition to equipment aging, hardware damage, etc., virus intrusion and other methods make the power system monitoring computer network difficult to be secure and stable. According to the method provided in this paper, virtual technology can be effectively used to solve the single point fault of equipment and ensure the normal, stable and reliable operation of the redundant system. Effective solution and avoidance of single point fault of power system monitoring equipment.**

Keywords—Electric Power Monitoring System; Virtual Technology; Single Point of Failure

I. INTRODUCTION

Power system monitoring has been developed for many years, and has begun to develop toward unattended defense line, which leads to higher requirements for the reliability of monitoring system equipment. But for the computer equipment, redundancy design (such as some auxiliary system managers, fault recorder hosts, etc.) has not been taken into account in the initial stage of design, and uploaded. Statistics show that there are mechanical rotating parts (such as hard disk, fan, etc.) in computer equipment, and their failure rate is relatively high. In the current power system monitoring, due to the improvement of automation, the dependence on computer equipment has gradually increased, making computer equipment has become a key equipment. Once a failure occurs, the whole system will be unavailable[1].In addition, in some early power system monitoring designs, some non-redundant network designs lead to equipment failures in the network, which will also lead to the unavailability of the whole system. Because of the design reasons, it is difficult to update these devices and products independently[2]. Even if the redundant equipment is updated, it is also necessary to update the existing application software to adapt to the redundancy. Updating the application software will bring a series of stability problems when running on the rest of the equipment; if the whole system is replaced, it will bear higher time and equipment costs[3]. This article provides a way to solve a single point of failure without replacing the equipment.

II. INTRODUCTION OF PRP AND HSR TECHNOLOGY

PRP (Parallel Redundancy Protocol) provides redundancy for the system through the network nodes supporting PRP. Each network node connects to two independent parallel working LAN at the same time, and copies the message into two copies, sends it through two full-duplex communication ports, and then forwards it to the destination network nodes through two parallel working LAN[4]. The redundant network schematic diagram implemented by PRP technology is shown in Figure 1.

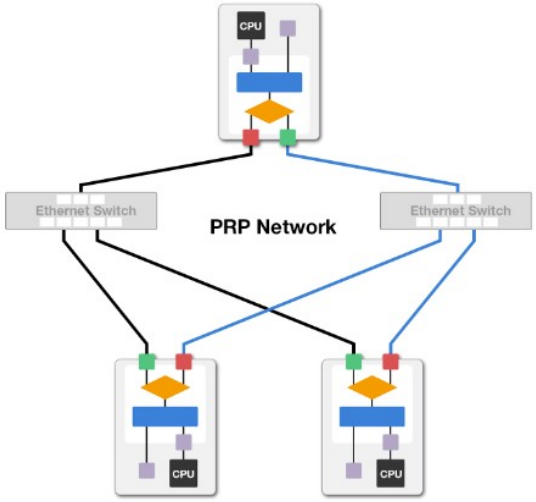

Figure 1 Schematic diagram of the PRP network

HSR (High-availability Seamless Redundancy)is a seamless redundancy protocol with high availability[5]. It is a typical ring topology. The source node replicates all information and transmits it through two different paths. Once one network fails, it can ensure data transmission without delay. The redundant network schematic diagram implemented by HSR technology is shown in Figure 2.

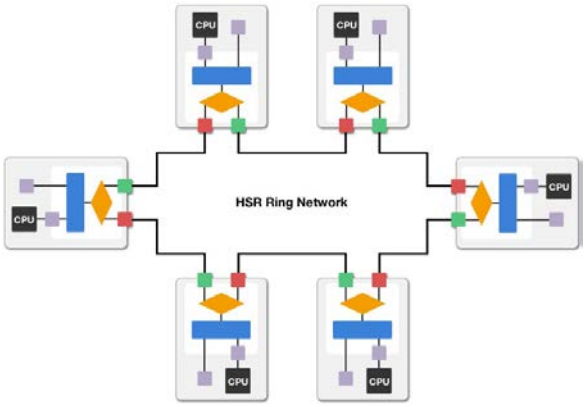

Figure 2 Schematic diagram of the HSR network

In recent years,, only the High-Availability Seamless Redundancy (HSR) protocol and the Parallel Redundancy Protocol (PRP) are the only redundant network protocols that can achieve self-healing in 0ms, that is, the "zero packet loss" and "zero switching" are realized[6].

1) Single-network PRP/HSR conversion equipment:

It enables devices with only one network interface that does not support PRP/HSR protocol to access the conversion equipment of PRP/HSR network. One end of it provides a network interface to connect to the device to be connected, and the other end provides two interfaces to connect to the redundant network of PRP/HSR. The schematic diagram of the conversion device is shown in Figure 3.

Figure 3 Schematic diagram of a sigle-network PRP/HSR conversion device

2) Virtual Machine:

Virtual machine (VM) refers to a complete computer system with complete hardware system functions simulated by software and running in a completely isolated environment[7]. The virtual machine software can create a virtual machine on multiple physical machines through clustering technology[8]. When a physical machine fails, the application running on the physical machine can be automatically switched to another physical machine to continue running, and the application is not interrupted[9]-[11]. The current implementation software includes Open Stack, KVM, VM ware, and so on. The comparison between the system model sketch and the entity computer model sketch is shown in Figure 4.

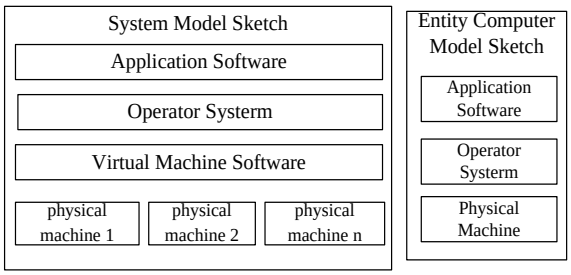

Figure 4 The comparison of virtual machine and physical computer models

2 Design Ideas

In view of a series of problems that may arise in updating redundant equipment and application software in order to avoid single point failures of power monitoring system, this paper provides a solution, which can run on redundant equipment without changing the existing application software and configuration, thus solving single point failures. The main steps include:

1) Using virtual machine technology, create a virtual machine on a redundant physical machine and deploy the operating system and applications that were originally running on a single computer node to the virtual machine.

2) Rebuilding redundant networks with switch devices based on PRP/HSR technology.

3) Connecting Redundant Physical Machines to PRP/HSR Redundant Network.

4) Accessing devices that do not support redundant network in the original system to redundant network through PRP/HSR conversion equipment.

The beneficial effect of this paper is: through virtual machine technology, the hardware redundancy of computer equipment is realized, the original application is deployed to the virtual machine, so that the original application can be updated and modified configuration without modification, and realize the redundancy function; Through the PRP/HSR conversion device, the device that does not support the redundant network can be connected to the redundant network.

III. IMPLEMENTATION

The technical scheme of this paper is further elaborated with attached drawings below.

Suppose there is a device network structure diagram as shown in Figure 5. This is a typical structure design of managing several devices through one host. In this network, there are several devices and one host connected together through a star Ethernet. In this design, there are several single point failures which can affect the availability of the whole system. The main weaknesses include:

1) Host hardware failure in the diagram;

2) The connection line Lc from the host to the network LAN in the figure;

3) In the figure, because of the number of devices, there may be more than one switch in the Ethernet switchboard. Any faults or damaged connection between switches will cause some devices to be unavailable.

For this typical design, the following methods are used to solve these single points of failure according to this method. PRP network is used, and the schematic diagram of equipment network structure is shown in figure 5. HSR network is used, and the schematic diagram of equipment network structure is shown in figure 6.The main steps include:

Use virtual mechanism to build the host in figure 5 to solve the single point of failure of the host, as shown in figure 6 and figure 7, if any physical machine hardware fails after the deployment is complete, the virtual machine will perform fault migration without affecting the operation of the application software.

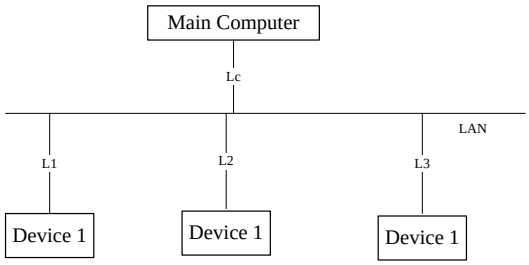

Figure 5 Schematic diagram of the device network structure

There are dual NICs in the redeployed physical machine, which are connected to the redundant network separately to solve the system unavailability caused by the network connection line fault.

Redundant networks are deployed by switches supporting PRP technology, as shown in Figure 6, or by switches supporting HSR technology, as shown in Figure 7, any switch failure or cable damage will not cause the system to be unavailable.

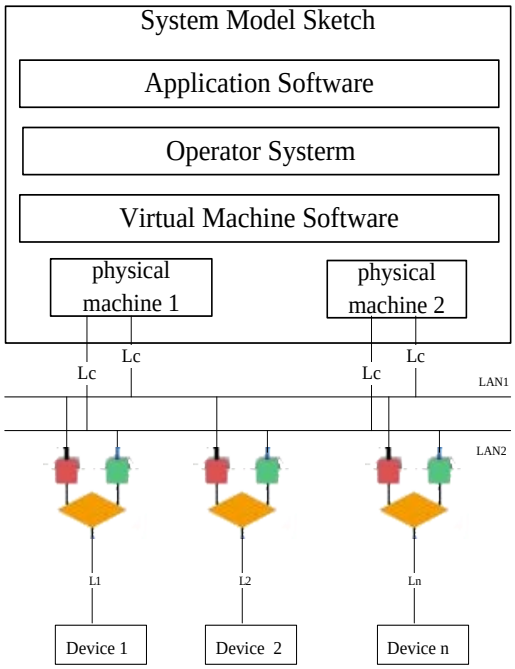

Figure 6 Schematic diagram of the network structure of the PRP networking device

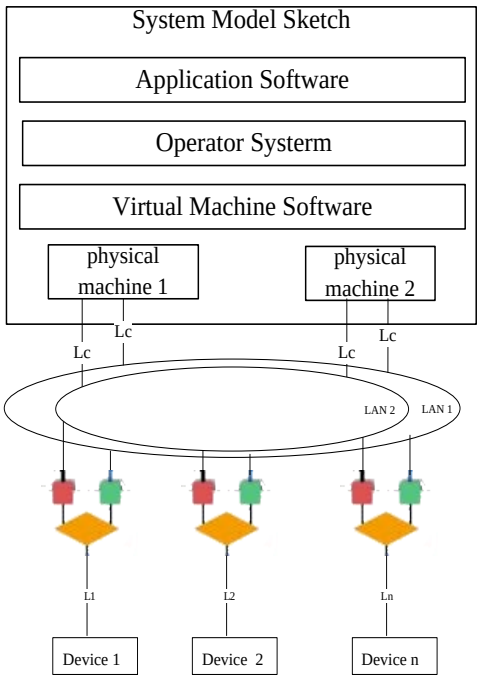

Figure 7 Schematic diagram of the network structure of the PRP networking device

The PRP/HSR conversion device is used to access the device in the original system.Since the hardware may not have a redundant network port when the device is designed, the conversion setting can be used to connect to the redundant network without replacing the hardware device.

IV. Using the Template

With the continuous development of the power system, the power system monitoring system is also a very complete technology. However, due to the rapid development of computer technology, it is difficult to ensure the normal operation of the equipment after the equipment of the monitoring system such as the converter station and the substation is aging.Single point of failure is a common problem that often plagues converter operators and maintenance personnel.Through virtual technology and PRP technology, the single point of failure can be solved without changing the hardware of the original equipment.It is convenient, effective and feasible, and is suitable for use in redundant power monitoring systems such as converter stations and substations.

In this paper, the application of PRP/HSR technology and virtual technology in power system monitoring system network is discussed, and the model is built, designed and implemented. However, due to the author's limited research time, the research is not deep enough, and the discussion is not perfect enough, there are still a lot of work to be done in the next step:

It is necessary to combine theory with practice in order to apply this design to the project site as soon as possible and promote the application and development of PRP/HSR and virtual technology in HVDC transmission system.

At present, the application of ubiquitous Internet technology in power grid is is increasingly popular. In the future, these technologies can be combined with ubiquitous Internet to study networks and systems more in line with the requirements of the State Grid.

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