

Research of SNMP-based network topology discovery algorithm in IOT

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Abstract. Due to the rapid development of the *IOT*, more and more devices in the network need to be connected to the *IOT*. Device management and device auto-discovery has become increasingly important. Network topology is a way to describe the logical or physical connections between network devices, and it is extremely necessary for the configuration management, even for the entire network management. Because of the dynamic and the increasing scale of the networks, getting topology manually is almost impossible. As a result, the researchers begin to study the network topology auto-discovery technology. For the reasons of more and more network equipment providing *SNMP* protocol, a *SNMP*-based topology discovery algorithm is brought forward. This paper first research the *SNMP*-based topology discovery algorithm. Then on the base of the indicators refined for topology discovery algorithms, we compare several topology discover methods and sum up the most suitable application environment for the *SNMP*-based algorithm. Finally this paper provides the details of implementation of the *SNMP*-based topology discovery tool, including the implementation of the algorithm and the architecture and the mutual flow of the software.

1. Introduction

In recent years, due to the rapid development of computer networks, effective network management has been more and more attention, and accessing the latest network topology structure is important to network management [1]. A good network management system must be aware of the topology of the entire network. Besides, due to the rapid development of the *IOT*, more and more devices in the network need to be connected to the *IOT*. Device management and device auto-discovery has become increasingly important. Network topology is an important basic information of computer network, which is the basis of network management, data simulation and information gathering. Topology discovery can effectively help network management, also topology discovery results can be widely applied to the device management and device auto-discovery. Based on the above reasons, the research of network topology discovery technology is very important. The topology discovery in network management is to obtain and maintain the information of the existence of network elements and the connection between them, then achieve effective management of network.

2. Key technologies

2.1 SNMP.

Simple network management protocol (*SNMP*) is the most widely used network management protocol in *TCP/IP* network. In May 1990, RFC1157 defined the first version of *SNMP* (simple network management protocol) called *SNMPv1*. RFC1157 and another file RFC1155, provide a method for monitoring and managing computer networks. Because *SNMP* has the following characteristics, *SNMP* has been widely used, and has become the standard of network management: Easy to implement. Open standards, complete technical documentation. Based on the *UDP*, do not rely too much on the agreement, and will not increase the burden of management.

2.2 MIB.

The basic idea of *SNMP* is that all network devices maintain a management information base (*MIB*) to keep the relevant information of all the running processes and to respond to the query of the management workstation [2]. Each managed device which support *SNMP* keeps a number of *MIB* libraries.

The management information base (*MIB*) specify the variables maintained by the network elements, and provide the data structure of the collection of all the possible managed objects in the network. All the statistical contents of the gateway can be obtained by accessing these data items. *MIB-II* is the second edition of *MIB*, which is the extension of it. Network topology discovery is to find the connection between the router and the subnet, the information source is the *MIB-II* library defined by *SNMP*. The structure of *MIB* is shown in Fig.1.

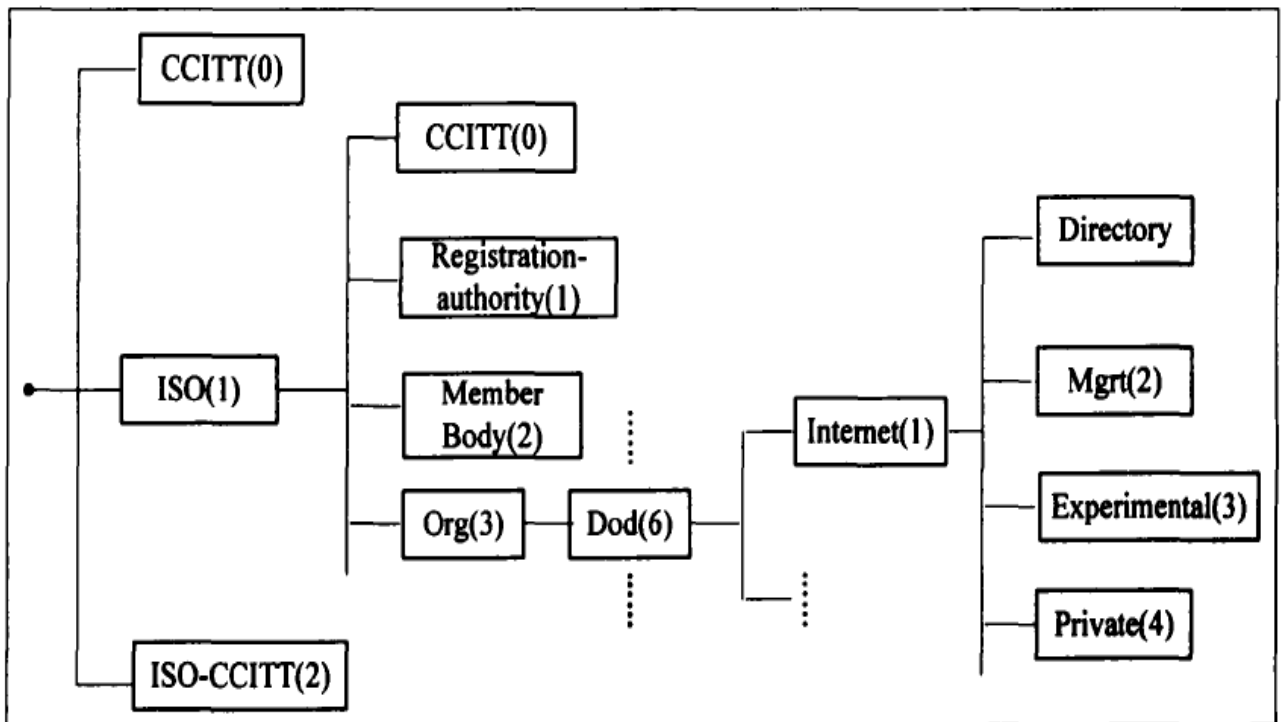


Fig.1 The structure of *MIB*

The *MIB-II* information about router level topology discovery is divided into 3 groups: system group, interface group and *IP* group.

System group. Including 7 simple variables, *sysService* can be used to determine the type of device, from the lowest to seventh in its binary form, if a bit is 1 then provide service of *OSI* corresponding level. The third bit is 1 shows that the node provides routing function and is a router device.

Interface group. Contains general information about the physical interface of the entity, including the configuration information and the statistical information that occurs at each interface [3]. It defines a simple variable *ifNumber*, which represents the number of the device interfaces, and an interface table *ifTable*, one line for each interface. Index represents the index terms of the table, whose values range from 1 to *ifNumber*, and assign a unique serial number for each interface. *ifDescr* is the interface name, *ifType* is the interface type, which is the type of the sub network of the interface, such as Ethernet, 802.5 token ring, *FDDI*. It can be seen that the *ifTable* of router interface table shows the simple topology of the connected sub network.

IP group. The *IP* group defines a number of simple variables. *ifForwarding* is 1 indicates that the node has a *IP* forwarding function, which represents this node is a router. This group also defines 3 very useful table variables: *IP* address table, *IP* routing table, and *ARP* address translation table [4]. They are important information sources for network topology discovery.

3. Algorithm Research

The key to Topology discovery technology is capturing the network topology information. The difficulty is to find the place where the effective topology information store, and to find the way to get these information legally. *SNMP* protocol is a good solution to these two difficulties.

The topology of the network is the connection relation of the sub network. The division of the sub networks is based on the *IP* address of the terminal equipment. The common features between the *IP* addresses in the sub networks are called sub networks [5]. The connection between the sub networks is achieved by the routing device, and a sub network is connected to a port on a router device. Also, routing devices can be interconnected. The scheme of network topology is shown in Fig.2.

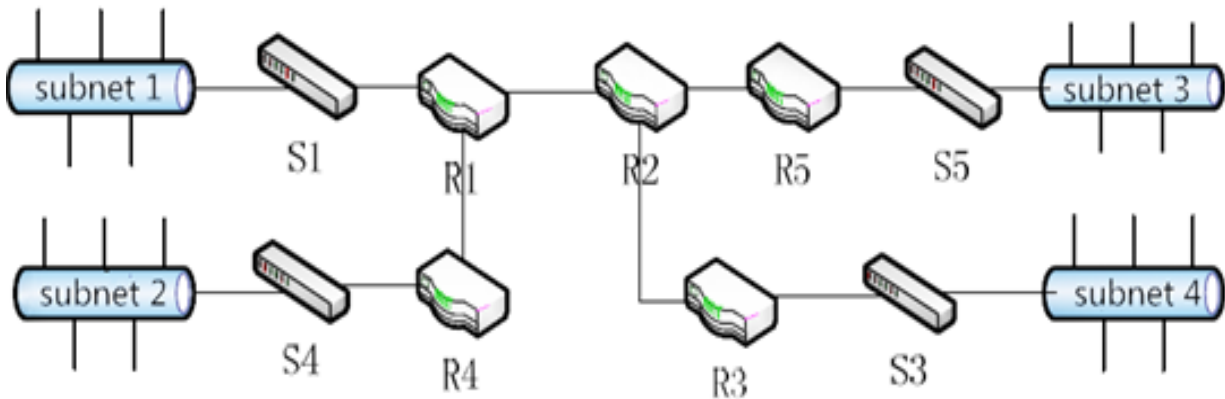


Fig.2 The scheme of network topology

According to the characteristics of the *SNMP* protocol, we access the list of routing devices or the list of hosts from *MIB-II* information in routers or *VLAN-MIB*, *Bridge-MIB* information in switches, bridges through the *SNMP* protocol, these information are basic information to construct network topology. Based on these information, we can use breadth first search algorithm to construct the three list: the Unchecked routing equipment, topology information chain, subnet information list. Unchecked routing equipment list stores the known but not scanned routing devices; Topology information list stores the scanned routing devices and the sub network connected to these devices. The scan process is to obtain the sub network of the device and the unchecked routing equipment; Sub network information linked list stores the information of the scanned sub network, including the device condition under the sub network.

Topology discovery algorithm based on *SNMP* can be described as such a process: use a seed router, access all the reachable segment from its routing table records, and the next hop router port *IP* address and the related routing information, then it will continue to expand its search, until reaching the user specified depth. Also it can obtain directly connected subnet and its subnet mask of all ports on each routing equipment, according to the information, and then get all the active hosts in the subnets. If these devices support *SNMP*, the system and *IP* address information can be collected.

In short, as long as the *IP* address of the seed router is given (usually using the *IP* address of the local gateway as the address of the seed router), the network topology information of all routing devices and active hosts in the specified depth can be obtained.

4. Summary

At present, most routers have shielded the broadcast ping, the *ICMP* netmask request packet, and *DNS Zone Transfer* detecting packet. And *SNMP* is the most commonly used environmental management agreement.

SNMP's biggest advantage is that the network status information is automatically updated, and almost all network equipment support *SNMP*. The topology information obtained by *SNMP* is always able to objectively and accurately reflect the latest status of the network. In addition, the *SNMP* is designed to be independent of the protocol, so it can be used in *IP*, *IPX*, *AppleTalk*, *OSI*, etc., which greatly improves the compatibility of the network environment and the general applicability of the

topology discovery tool. These advantages ensure the accuracy and real-time of the topology information, and will not bring too much network load, which is in line with the actual needs of small and medium network topology discovery.

Because of the complexity and heterogeneity of the network structure itself, any single network topology discovery method can not have a good generality. In order to improve the accuracy of the results, and to provide a reliable analytical basis for all kinds of research based on network topology discovery, we should combine several methods, and analyze and mine the information that we collected. However, for the general research and application, especially in small and medium size networks, the network topology based on *SNMP* protocol has the incomparable advantages.

Acknowledgments

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