

WebNMS-Based Topology Discovery in EPON Network

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Abstract

It is of great significance to manage and maintain EPON (Ethernet Passive Optical Network) effectively by discovering devices running in EPON network and relationships between devices automatically. After analyzing the characteristics of EPON network and basic principle of topology discovery, a topology discovery scheme is proposed, which is designed and implemented based on WebNMS framework to discover topology automatically in EPON network. The test results show that the scheme can discover topologic structure of EPON network quickly and precisely.

Keywords: EPON; WebNMS; topology discovery

1. Introduction

Ethernet Passive Optical Network (EPON) has become a mainstream technology used by the access network because of its high bandwidth and easy maintenance features. To guarantee a steady, efficient and accurate operation of EPON network, providing an effective Network Management System (NMS) is particularly important.

EPON NMS has four functions, including configuration management, performance management, fault management and security management. Topology management is one of the key aspects of the configuration management, and it is the basis of NMS. Its functions include topology discovery, topology rendering, fault display and inference. The topology information of Telecommunications Management Network (TMN) refers to distribution and connection between the managed devices and the common attributes of the devices themselves. Concise and accurate network topology information can not only reflect the layout of each network device in the network, but also is the basis of a series of functions including performance assessment, integrated analysis on the events, fault location, and resource management for NMS.

The AdventNet WebNMS Framework (hereinafter referred to WebNMS) is the industry-leading network management model developed by AdventNet Inc. based on Java, supporting for SNMP protocol, aiming to develop and release EMS and NMS applications rapidly in [1]. WebNMS is generally divided into five tiers, which are Database Tier, Management Server Tier, Back-end Server Tier, Front-end Server Tier and Client Tier, mainly provides automatic topology discovery, network event and fault collection, report processing, status query and set, NE (Network Element) display, group management, authentication and access control functions. The topology discovery module is the core module of WebNMS, and topology discovery is the first step for the topology management of the EPON network. Through deploying WebNMS, modeling the managed object (MO) and making a secondary development of WebNMS discovery engine, a topology automatic-discovering scheme of EPON network is proposed.

2. Design of Topology Automatic-Discovering

2.1. Requirement Analysis

For TMN, topology information has four implications: (1) which are managed devices; (2) the logical relationship between the devices (such as the connectivity relationship, control relationships, *etc.*); (3) location information of the managed devices; (4) common properties of the devices. Topology information is mainly from user configuration and MIB which contains all the information of MOs.

Topology management in NMS is to collect topology information from elements in the telecommunication network, to persistent collected data, and then to display the connections between NEs and the operating status of NEs through topology map on the user interface. At the same time to deal with and respond to data queries and requests for action from user, and to provide underlying data support for the topology client. In the early days of network development, network administrators take the work of the establishment and maintenance of network topology manually. But in nowadays, network structure is becoming more complex and volatile, and management requirements is even becoming more in-depth and comprehensive, it is very necessary for NMS to discover the network topology automatically and maintaining its change in a timely manner.

The NEs running in the EPON network include OLT (Optical Line Terminal), ONU (Optical Network Unit) and POS (passive splitter). POS is a kind of passive device, it only plays beam splitting role and hasn't the routing and gateway functions, so it is transparent in the network topology. For the management of OLT and ONU, as a proxy of NMS, OLT manages ONU remotely by operation, management and maintenance (OAM), so NMS can manage ONU through OLT and doesn't need to manage ONU directly, in reference [2].

In summary, topology discovery of EPON system is to obtain working information of each OLT and ONU and correlation between OLT and ONUs under its jurisdiction by real-time detection of network, and to display the current state of OLT and ONUs [3]. Specifically, the information needing to be perceived in EPON network through automatic topology discovery includes: (1) Equipment information: including OLT, OLT slot, OLT board card, OLT Ethernet port, OLT PON port, ONU, ONU slot, ONU board card, ONU Ethernet port and ONU PON port. (2) Connecting relationship: the connection between OLT and ONUs.

2.2. Basic Principles

The processing logic to achieve topology management functions is to select managed objects (MO) on behalf of EPON equipments from MIB library to construct topology node; to abstract configuration parameters selected from the physical port of MOs to the link between the topology nodes; in accordance with the management hierarchy, to construct parent-child relationship to form a treelike topology data model, namely topology tree model; and then to display topology in client interface according to topology tree model.

Main NEs in EPON network such as OLT and ONU haven't routing and forwarding functions, so common topology discovery algorithms for IP network are not suitable for topology discovery of EPON network. In EPON network, NEs usually support Internet Control Message Protocol (ICMP) and Simple Network Management Protocol (SNMP), and always have private MIB library. Through Ping method of ICMP can quickly access status information of NEs; using Get method of SNMP can put polling on NEs to obtain more information, using Trap method of SNMP can catch the change of NE's real-time status. So the data collection method of combing ICMP with SNMP can be used to discover topology of EPON network.

The steps of automatic topology discovery are: (1) Set the initial configuration, such as device type, interface address, interface type, write-community of SNMP, and transmitting times of ICMP and so on. This is equivalent to define a map explaining how to obtain the topology information; (2) Found networks and network nodes according to the initial configuration; (3) Establish object model for MOs; Put the found MOs into pre-defined discovery filter, and add MOs to the corresponding table in the database according to established object model.

3. Implement of Topology Automatic-Discovering

3.1. Configuration and Developing WebNMS

The discovery service is initiated when WebNMS is started. Discovery engine of WebNMS is primarily responsible for discovering the topology of the network, i.e. all the elements that are residing in the network. In addition it also gathers basic information such as sysOID, sysDescr etc. about the elements it has discovered. In actual application, according to the network environment and management needs, WebNMS should be customized configured and developed. Table 1 lists the secondary development needed to be done by using WebNMS to achieve topology management function.

Table 1. Topology Function and Development

Module name		Services provided on WebNMS	Functions needed to be customized developed
Discovery Service		Can use SNMP-Get, Ping operation to detect NEs	Need to specify network device list and protocol parameters
Topology service	Discovery Filter	Can create models for routers, switches, personal PC, and other equipment, achieve configuration parameters limited to the relevant parameters obtained from RFC1213 MIB library	Need to re-develop discovery filter for EPON network, establish component model of equipments, access configuration parameters in the private MIB library, complete modeling and discovering of the equipments
	Database management unit	Provide a complete database management capabilities	Do not require
	Status polling filter	Provide interfaces to update status	Need to develop status update code for their own devices

Topology discovery service in WebNMS involves two modules: discovery service module and topology service module. In view of the interaction between the two modules, discovery service module discovers the network connected to the network management server and equipments supporting protocols SNMP or ICMP through the discovery engine. The discovery process can be controlled through a variety of ways, for example through the configuration interface or configuration file. Topology service module makes MOs for founded network, NEs, and the components of NEs. MOs can be physical devices and logical

operations. Developers can add or delete some properties to or from MOs, and add MOs to the topology database. After device discover and modeling, topology service module will notice the graphics display module, fault management module and performance management module for further processing and then start state polling on the modeling of MOs.

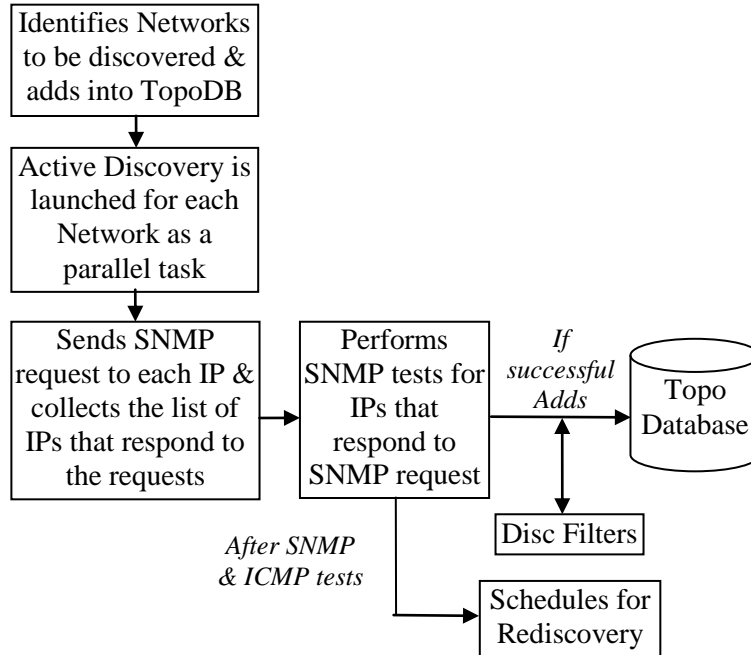


Figure 1. The General Process Performed by the Discovery Engine of WebNMS

The general process performed by the discovery engine of WebNMS is shown in Figure 1.

- Identifies the Networks to be discovered.
- Adds the Network objects into the topology database.
- Active discovery is launched for the identified networks, as a parallel task.
- Sends asynchronous SNMP requests to a batch of IPs and collects the list of IPs which responds to these requests.
- Sends ICMP requests to those IPs which does not respond to SNMP requests.
- To confirm the existence of the IP or nodes, performs test viz., user-defined test and SNMP /ICMP ping process.
- If the discovery engine succeeds in performing the tests, adds the nodes into the topology database.
- After performing the SNMP and ICMP tests, the discovery engine schedules the rediscovery process.

Before adding the objects into the database, the objects are passed through discovery filters to add/delete/update the managed object and its properties.

3.2. Discovery Process

The discovery process of WebNMS includes two stages in reference [3]. The first is a static process. In the stage, entries specified in the seed.file in <Web NMS Home>/conf directory are read to determine the parent networks for all the network/device entries given in the conf file. For EPON network, seed.file should be deployed. Configuration include EPON network addresses needed to be searched, protocol parameters of SNMP matched with EPON equipments, including port number, time-out time, retry number of times, read and write community, as well as ICMP parameters, including time-out time, retry number of times and so on.

And then the runtime process comes, it starts with obtaining the IP address of the host machine running the Web NMS server. When the SNMP ping succeeds, the discovery process actually tries to collect more information and learns about the network. To determine if the Node is an OLT or not, additional SNMP query will be sent to the Agent. If the device does not respond to this additional SNMP query, it will not be discovered as an OLT, but will be discovered as an SNMP device. In our EPON system, perform the query of OLTObjectID in the private MIB.

3.3. Modeling

For a NMS to manage an individual network element or a set of network elements, the managed network elements should first be represented or modeled as an object which can be stored in the database to perform management operations.

In customization of topology discovery, design and management of the information model is the core. Modeling actually represents the various attributes and the behavior of the corresponding physical device/network element and its components in a convenient way, so that their current state is reflected at time. The design philosophy of modeling is in accordance with the ideology of the OO (Object-Oriented), to abstract physical objects in telecommunications network, such as equipment, rack, slot, *etc.*, and logical objects, such as communication protocols, event reporting, network service to interrelated MOs, and defines attributes of these MOs and operations used in the MOs to give a complete description of the management model in telecommunications network.

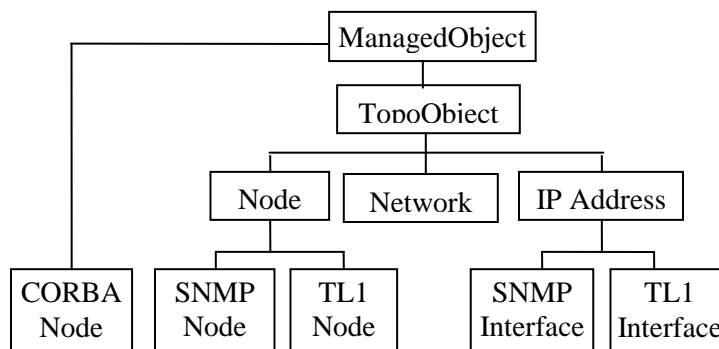


Figure 2. The Hierarchy of Classes Provided by WebNMS Topology Service

WebNMS predefined MO hierarchy to represent the different network elements in [4], shown in Figure 2. The ManagedObject is the base object, which defines the basic attributes and actions that are needed for managing a network element. All the network elements discovered by the Web NMS System are mapped or represented by a corresponding

derivative of this class and stored in the database for persistence. Node class represents nodes in IP network; SntpNode class represents SNMP agent nodes in IP network. Network elements which support SNMP protocol such as OLT can be easily derived from the SntpNode class.

Generally, EMS can construct their own management model by inheriting and extending the definition of these objects according to the characteristics of the actual managed network.

Through critical abstract to basic information of NEs in EPON network, the connection between NEs, status information of NEs, subclass diagram of the MOs in this application were summarized as Figure 3.

It can be seen from Figure 3 that the specific data object of EPON network include OLT, up connecting port and down connecting port of OLT, ONU, up connecting port and down connecting port of ONU, the connection between OLT and ONU. Via SNMP requests, the system collects index of up connecting port, enable status, link status, port types, ID and state of PON port of above equipment's. The status designed here are to ensure that the status of the network elements in the network is periodically monitored and communicated to the administrators and network operators. Status Polling is done by sending SNMP Ping commands to the discovered device periodically.

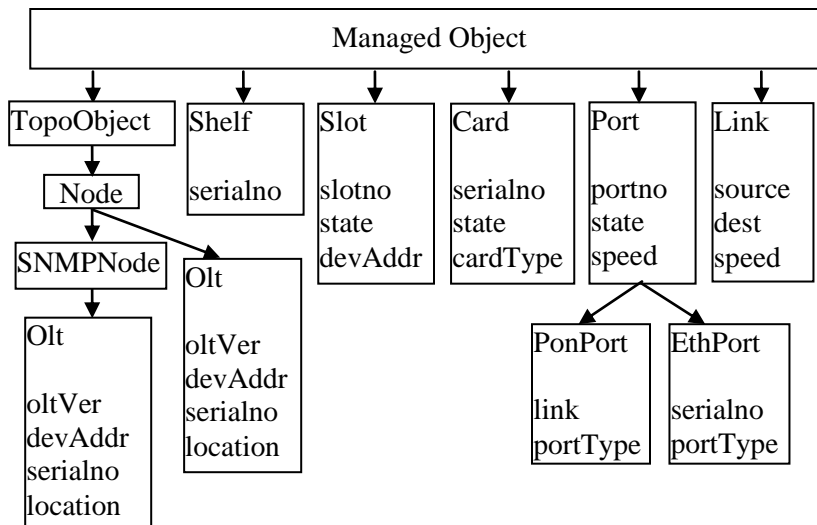


Figure 3. Subclass Diagram of the MOs in EPON Application

3.4. Discovery Filter

For a NMS to manage an individual network element or a set of network elements, the managed network elements should first be represented or modeled as an object which can be stored in the database to perform management operations.

All the discovered resources are passed through the discovery filter, before they are added into the database.

After creating MOs, the discovery filter should be re-defined, which should be found in DISCOVERYFILTER module of DISCOVERY unit under SERVICES in WebNMS Studio. According to the defined MOs (for example OLT) and the component hierarchy (such as shelf, slot, board, etc.), the filter instantiates subcomponents of equipments, gets relatively constant static properties from equipments, and then writes critical data to the topology database. The method to be implemented in DISCOVERYFILTER is filterObject().

The discovery process has the following four steps:

- Enter the discovered SNMP nodes;
- If the device is an OLT, via the SNMP protocol to obtain more information on the device, such as information of shelf, slot, card, port, and the status;
- Via the SNMP protocol to capture number, ID, status information of ONU managed by the OLT;
- The above information is written to the topology database, repeat until all SNMP nodes are scanned.

3.5. Customizing Topology Client

The Topology Module is represented on the Client side through the Network Database Panel. According to the type of device, graphic data management module generates a corresponding graphical symbol and writes to database. Based on the topology connection to generate topology map at all levels, also write to the database, and then send the topology map to display on the client.

4. Conclusions

With the continuous advance of triple play, the EPON network is widely applied, it is necessary to provide a unified NMS for it. The paper designed and implemented topology discovery function of EPON NMS on WebNMS. The scheme has been integrated and tested, and runs well. It can discover NEs in EPON network quickly and accurately, and can correctly judge the connection between the NEs. The scheme obtains the desired effect and provides support for other functional modules in EPON network.

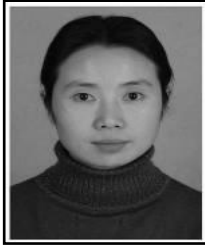
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