

Research of Physical Topology Discovery in Heterogeneous IP Networks with VLAN

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Abstract—The network topology discovery is the basis of network management. A hierarchical design model which includes access layer, distribution layer and core layer is widely used in a construction of a switched LAN. “Layer 3 switching” and VLAN is used in equipments from different vendors. This paper proposes an algorithm of physical topology discovery of heterogeneous IP networks with VLAN which is designed and implemented according to hierarchical design model. This algorithm can find the accurate physical topology of heterogeneous IP networks with VLAN.

Keywords: *heterogeneous IP networks; VLAN; physical topology discovery*

I. INTRODUCTION

The network topology is the joining method and form of elements in network. It is crucial to a number of critical network management tasks, including reactive and proactive resource management, orientation of server, and root-cause analysis [1]. It is required to discovering the network topology accurately and effectively.

- Network simulation: in order to simulate the real network, we should know the topology structure of the network first.
- Network management: network topology information can help administrator that adding new router or not, hardware configuration right or wrong, and finding bottleneck of network and disabled link.
- Orientation of server: helping the user to find the location of oneself in network, network topology information can confirm the location of server and

choice ISP that can minimizing the delay and maximizing the bandwidth.

- Topology sensitive algorithm: some novel protocols and algorithms can improve network quality according to network topology information. For example, selecting route algorithm which is based on topology sensitive policy and QoS, and communicating group algorithm which is based on topology sensitive group option.
- Locating radial server: according to the information of network topology, we can configure the radial server effectively and reducing the delay and solving the bottleneck problems.

II. PHYSICAL TOPOLOGY DISCOVERY ALGORITHM IN HETEROGENEOUS IP NETWORK WITH VLAN

A. The thought of algorithm

Our algorithm is based on the SNMP Bridge MIB- II (which is supported by most manufacturers). We analyses the feature of AFT of switch, and give a reasonable and fast algorithm to find out physical relationship of layer 2 elements in network and separation of VLAN. The algorithm has universal feature, and it can capture topology information from different vendors and make sure to access and explain related information from different vendors.

Definition down Trunk port: the down port that is configured as Trunk mode.

- If the network is separated by VLAN, then we can judge relationship of layer 3 switch and layer 2

switch and layer 2 switch and layer 2 switch by down Trunk port.

- To judge layer 3 switch have routing functions to VLAN or not. If there is, then to find out all VLANs configured. And layer 3 switch is the same as a router, deal it as a router.
- To judge layer 2 switch configure VLAN or not. If there is, then we can know that one physical switch has been separated to several logical switches by VLAN. If we can find out each port belongs to which VLAN, then the separation of VLAN can be found.

B. Description of algorithm

Algorithm

Procedure FindConnectionsWithVLAN (S1,S2,...,Sn)

/*S1,S2, ...,Sn are the switches of a subnet S */

begin

```

CurrentQue:={ S1,S2,...,Sn }
for each switch Si do {
  If (Si separates VLAN) then{
    find out Aij of down port that has least records
    If (Aij={Sk})then {
      Aij connects to up port of Sk
      Delete Sk from other AFT
    }
    Continue }
  else{
    let Aij={ Sj,...,Sk }
    Sij connects to up port of Sj,...,Sk by a HUB
    Delete Sj,...,Sk from other AFT}
    Delete Si from CurrentQue}
  else {
    find out Aij of down port that has least records
    If(Aij={Sk}) then {
      Sij connects to up port of Sk
      Delete Sk from other AFT
      Continue}
    else{
      let Aij={ Sj,...,Sk }
      Sij connects to up port of Sj,...,Sk by a HUB
      Delete Sj,...,Sk from other AFT}
      Delete Si from CurrentQue}
    }
  }
for each switch Si do {
  If(Si is layer 3 switch) then {

```

If(Si configures routing function to VLAN) then

Find out separation of VLAN and VLAN ID

/*each logical port of layer 3 switch is a VLAN*/}

If (Si is layer 2 switch) then {

 If (Si separates VLAN) then

 Find all physical interfaces cardinality of each VLAN}

 }

end

By the program of algorithm, the physical topology and separation of VLAN of a certain campus heterogeneous IP network with VLAN is consistent to real network basically. The result indicates the program can show the link layer topology information, separation of VLAN and information of configuration of the campus network.

III. EXPERIMENTAL RESULTS

A. Related protocol and criterion

SNMP MIB defines each object of itself by ASN.1 criterion, and defines whole MIB structure at the same time.

- 1) It is defined about related information of bridge equipment in RFC1493:

dot1dTpFdbTable:

dot1dTpFdbAddress: “Unicast address of port, i.e. the MAC address that is learned from the port.”

dot1dTpFdbPort : “This data is learned from which port.”

dot1dTpFdbStatus : “The type of data: 1 denotes other type, 2 denotes unlawful (i.e. overtime), 3 denotes learned, 4 denotes the MAC address of equipment oneself, 5 denotes static address (i.e. the MAC address of port binding).”

dot1dBasePortTable:

dot1dBasePort: “Number of port.”

dot1dBasePortIfIndex : “Corresponding interface index of each port.”

- 2) Interfaces group of RFC1213 defines about the information of interfaces:

IfTable:

ifIndex : “The range of the only corresponding interface index of each interface is 1 to ifNumber.”

ifDescr : “It is a text strand about each interface, describes information of manufacturer, production and edition of hardware interface.”

▪ 3) It is implemented Q-Bridge-MIB in RFC 2674. It is defined related information of VLAN in dot1qVlan group:

The picking up of VLAN information dispart to two condition, Huawei uses oid=1.3.6.1.2.1.17.7.1.4.5.1.1, Cisco uses oid=1.3.6.1.4.1.9.9.68.1.2.2.1.2.0

Dot1qPortVlanTable:

Dot1qPvid: “PVID, the VLAN ID of untagged frame or priority tagged frame that is received on this port.”

B. Analysis of results

The algorithm is based on Ethernet, the element should support SNMPv2 or higher version, and layer 2 element should support spanning tree protocol and implement Bridge MIB. The lab experiment network is comprised of equipments from Cisco and Huawei: layer 3 switch is Cisco c3560, layer 2 switch is Huawei Quidway 2126.

▪ 1) To search up port :

We have known the MAC address of program running host is 000c-76c7-0006, so according to AFT table (figure 1 and figure 4), the up port of Cisco c3560 is 4, the up port of Huawei 2126 is 11.

SwitchID	SwitchAftPort	SwitchAftMac
0	24	0-6-28-84-53-c0
0	24	0-6-28-84-53-d2
0	4	0-c-76-c7-0-6
0	15	0-f-e2-1b-5-ff
0	26	0-f-f7-2d-c1-19
0	13	0-11-92-df-fa-80
0	13	0-11-92-df-fa-93

Figure.1 Cisco c3560 AFT table Cisco c3560 BridgePort table

SwitchID	SwitchBasePort	SwitchBaseIfIndex
0	10007	9
0	10008	10
0	10009	11
0	10010	12
0	10011	13
0	10012	14
0	10013	15

Figure .2 Cisco c3560 BridgePort table

NodeID	IfDescr	IfIndex
0	FastEthernet0/1	10001
0	FastEthernet0/10	10010
0	FastEthernet0/11	10011
0	FastEthernet0/12	10012
0	FastEthernet0/13	10013
0	FastEthernet0/14	10014
0	FastEthernet0/15	10015

Figure.3 Cisco c3560 Interfaces table

SwitchID	SwitchAftPort	SwitchAftMac
0	4	0-c-76-c5-f5-d3
0	11	0-14-8a-8d-97-8f
0	11	0-14-8a-8d-97-8f
0	11	0-c-76-c7-0-6
0	11	0-c-76-a7-2b-e6
0	11	0-c-76-c4-b4-62
0	11	0-14-8a-8d-97-8f

Figure 4. Huawei Quidway 2126 AFT table

▪ 2) To search Trunk down port:

The judging of Trunk port departs to two points. The element of Huawei: according to records of AFT table, if the time of catching certain MAC addresses of certain port is equal to the number of VLAN, then we see the port as down Trunk port. Element of Cisco: if one port does not belong to any VLAN and is not a up port, then it is the down Trunk port.

The result of program shows the port 15 of Cisco c3560 is a down Trunk port, and it is connected to the up port of Huawei Quidway 2126. According to relationship of tables, we know that the port 15 is FastEthernet0/13 of Cisco c3560, and port 11 is Ethernet0/11 of Huawei Quidway 2126.

▪ 3) To judge separation of VLAN

The implementation result of our program about separation of VLAN is the same as the one that showed on the terminal.

```

<Quidway>dis vlan all
---output omitted---
VLAN ID: 2
VLAN type: static
Route Interface: not configured
Description: VLAN 0002
Name: VLAN 0002
Tagged Ports:
Ethernet0/11
Untagged Ports:
Ethernet0/1 Ethernet0/2 Ethernet0/3
Ethernet0/4 Ethernet0/5

VLAN ID: 3
VLAN type: static
Route Interface: not configured
Description: VLAN 0003
Name: VLAN 0003
Tagged Ports:
Ethernet0/11
Untagged Ports:
Ethernet0/6 Ethernet0/7 Ethernet0/8

```

Figure5 Huawei Quidway 2126 VLAN configuration

NodeID	VlanID	BaseIfIndex
0	2	514
0	2	842
0	2	770
0	2	898
0	2	1026
0	3	1154
0	3	1282
0	3	1410
NodeID	IfDescr	IfIndex
0	Ethernet0/1	514
0	Ethernet0/2	842
0	Ethernet0/3	770
0	Ethernet0/4	898
0	Ethernet0/5	1026
0	Ethernet0/6	1154
0	Ethernet0/7	1282
0	Ethernet0/8	1410

Figure6 Huawei Quidway 2126 VlanPortConfig table

IV. CONCLUSION

We research the automatic physical topology discovery algorithm in heterogeneous network with VLAN in this paper. And we give a physical topology discovery algorithm in heterogeneous network with VLAN fitting for popular network frame. The algorithm is based on Bridge MIB, and according to some private MIBs, it can capture Trunk port and VLAN information. It can get physical relationship of network nodes and separation VLAN swiftly.

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