# CS 305 Lab Tutorial
# Lab 13  Layer3 Switch

Dept. Computer Science and Engineering

Southern University of Science and Technology

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Thanks to Wei WANG

# Ethernet switch

- link-layer device: takes an *active* role
  - store, forward Ethernet frames
  - examine incoming frame's MAC address, selectively forward frame to one-or-more outgoing links when frame is to be forwarded on segment, uses CSMA/CD to access segment
- *transparent*
  - hosts are unaware of presence of switches
- *plug-and-play, self-learning*
  - switches do not need to be configured
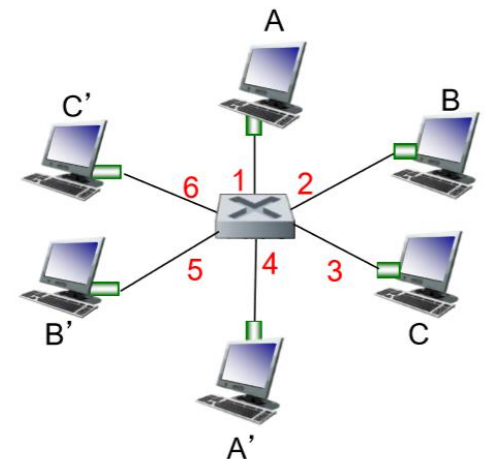
switch with six interfaces
(1,2,3,4,5,6)

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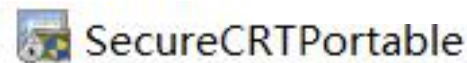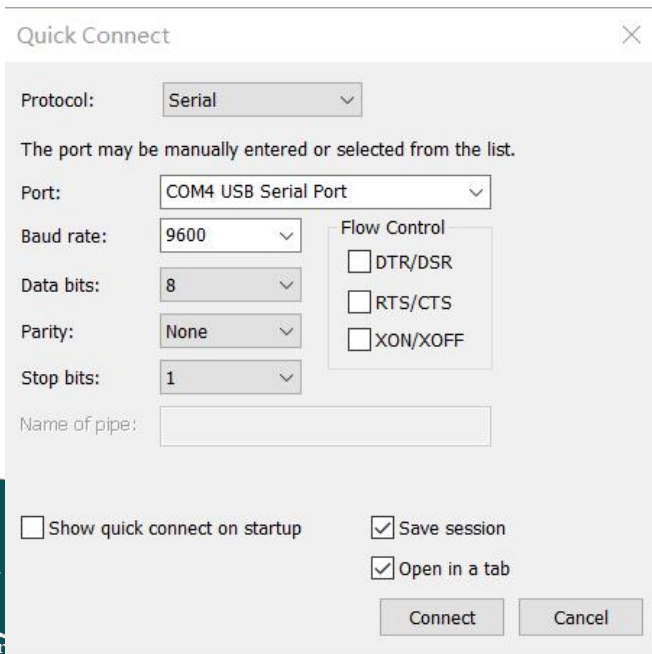# S5110 (Gigabit Ethernet switch)
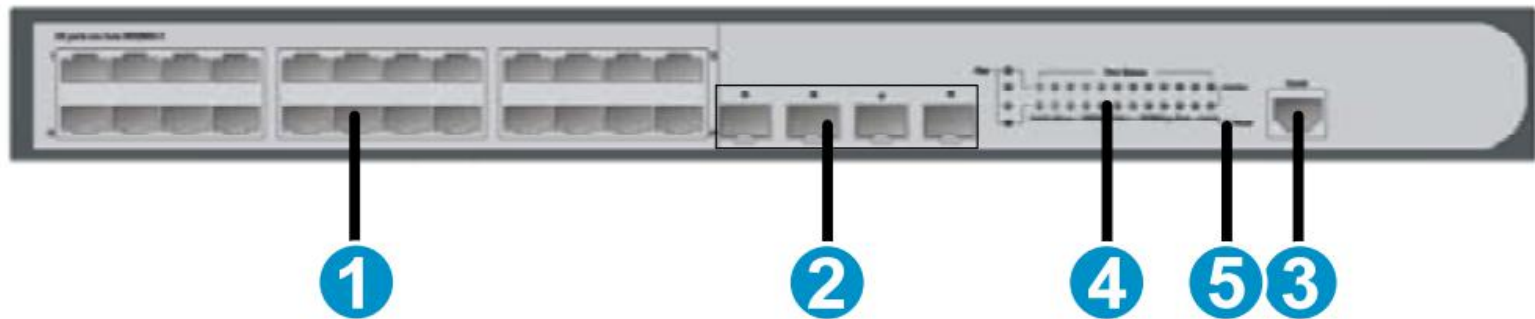


1. 10/100/1000M Base-T electric interface
2. 100/1000 Base-X SFP optical interface
3. Console interface
4. Port status indicator
5. Power status indicator

# Connect with switch by console

To configure the switch by PC

1. Connect the **console** port of switch with **com** port of PC
2. Invoke the SecureCRT Portable on PC to communicate with CLI of switch

**Quick Connect** ✕

Protocol: Serial

The port may be manually entered or selected from the list.

Port: COM4 USB Serial Port

Baud rate: 9600

Data bits: 8

Parity: None

Stop bits: 1

Name of pipe:

Flow Control
- ☐ DTR/DSR
- ☐ RTS/CTS
- ☐ XON/XOFF

☐ Show quick connect on startup
☑ Save session
☑ Open in a tab

Connect    Cancel

SecureCRTPortable

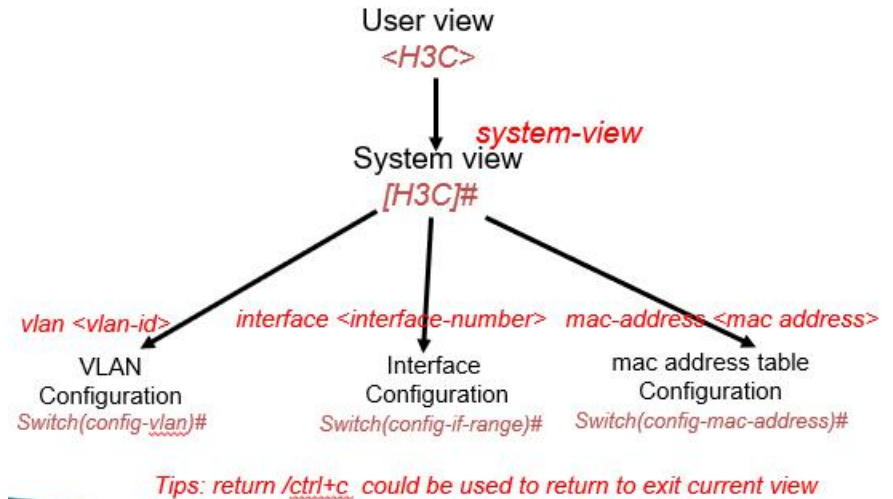Type : Serial
Port : COM*x*
Baud rate : 9600
Data-width: 8
Parity check: None
Stop bit: 1
Flow control : NO flow control

# Views in CLI

tips:
using "undo" to cancel the finished setting command.

User view
<H3C>

*system-view*

System view
[H3C]#

vlan <vlan-id>

interface <interface-number>

mac-address <mac address>

VLAN Configuration
Switch(config-vlan)#

Interface Configuration
Switch(config-if-range)#

mac address table Configuration
Switch(config-mac-address)#

Tips: return /ctrl+c could be used to return to exit current view

- **USER** : After the user logs on to the device, he enters **the user view** directly. The prompt displayed on the screen is <Device Name>.
  - The executable operations under user view mainly include **viewing** operation, **debugging** operation, file **management** operation, setting system time, restart device, FTP and Telnet operation, etc.
- **SYSTEM** : The **system view** can be shift from the user view, where the prompt displayed on the screen is: [device name].
  - The system view can **configure** the operation parameters and some functions of the equipment, such as configuration welcome information, shortcut keys, etc.
- **FUNCTION**: Input specific commands in the system view, you can enter the **corresponding function view**
  - complete the configuration of the corresponding functions, such as: enter the interface view to configure interface parameters, enter the VLAN view to add ports to the VLAN, and so on

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# Interface (work mode)

```
[H3C]display interface brief
[H3C]display interface brief
The brief information of interface(s) under route mode:
Link: ADM - administratively down; Stby - standby
Protocol: (s) - spoofing
Interface            Link Protocol Main IP        Description
NULL0                UP   UP(s)    --

The brief information of interface(s) under bridge mode:
Link: ADM - administratively down; Stby - standby
Speed or Duplex: (a)/A - auto; H - half; F - full
Type: A - access; T - trunk; H - hybrid
Interface            Link Speed  Duplex Type PVID Description
GE1/0/1              DOWN auto    A      A    1
GE1/0/2              DOWN auto    A      A    1
GE1/0/3              DOWN auto    A      A    1
GE1/0/4              DOWN auto    A      A    1
GE1/0/5              DOWN auto    A      A    1
GE1/0/6              DOWN auto    A      A    1
GE1/0/7              DOWN auto    A      A    1
GE1/0/8              DOWN auto    A      A    1
GE1/0/9              DOWN auto    A      A    1
GE1/0/10             DOWN auto    A      A    1
GE1/0/11             DOWN auto    A      A    1
GE1/0/12             DOWN auto    A      A    1
GE1/0/13             DOWN auto    A      A    1
GE1/0/14             DOWN auto    A      A    1
GE1/0/15             DOWN auto    A      A    1
GE1/0/16             DOWN auto    A      A    1
GE1/0/17             DOWN auto    A      A    1
GE1/0/18             DOWN auto    A      A    1
GE1/0/19             DOWN auto    A      A    1
GE1/0/20             DOWN auto    A      A    1
GE1/0/21             DOWN auto    A      A    1
GE1/0/22             DOWN auto    A      A    1
GE1/0/23             DOWN auto    A      A    1
GE1/0/24             DOWN auto    A      A    1
GE1/0/25             DOWN auto    A      A    1
GE1/0/26             DOWN auto    A      A    1
GE1/0/27             DOWN auto    A      A    1
GE1/0/28             DOWN auto    A      A    1

[H3C]
```

- Use "**display interface brief**" to show the brief info of all the interfaces.

- For S5110, all the gigabit-ethernet interface works on the **bridge** mode

- All the gigabit gigabit-ethernet interface **access** into the **VLAN 1** by default.

- '**port link-type**' is configurable :
  – access
  – trunk

tips：all the interfaces of **switch** work on **bridge** mode, while the interface of **router** could work on **bridge** or **route** mode.

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# MAC-address-table(1)

For S5110, the mac-address could be learned as dynamic, or configured as static or dynamic.

- A **static mac-address item** gets higher priority than a dynamic item
- A **dynamic mac-address item** has a default aging time which is configurable, while a static item is no-aged.

```
[H3C]display mac-address
MAC ADDR          VLAN ID  STATE        PORT INDEX              AGING TIME(s)
309c-236e-8f3b    102      Learned      GigabitEthernet1/0/2    AGING
309c-236e-8f81    102      Learned      GigabitEthernet1/0/23   AGING

 --- 2 mac address(es) found ---
```

```
[H3C]display mac-address aging-time
Mac address aging time: 300s
[H3C]
```

```
[H3C]display mac-address
MAC ADDR          VLAN ID  STATE          PORT INDEX              AGING TIME(s)
309c-236e-8f3b    102      Learned        GigabitEthernet1/0/2    AGING
309c-236e-8f81    102      Learned        GigabitEthernet1/0/23   AGING

 --- 2 mac address(es) found ---

[H3C]mac-address static 309c-236e-8f3b interface gigabitethernet1/0/2 vlan 102
[H3C]display mac-address
MAC ADDR          VLAN ID  STATE          PORT INDEX              AGING TIME(s)
309c-236e-8f3b    102      Config static  GigabitEthernet1/0/2    NOAGED
309c-236e-8f81    102      Learned        GigabitEthernet1/0/23   AGING

 --- 2 mac address(es) found ---
```

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# MAC-address-table(2)

The '**blackhole**' mac address means while the packets related to the blackhole, they will be dropped, switch will not forward the packets.

The 'blackhole' mac address is marked on the mac-address table.

```
[H3C]display mac-address
MAC ADDR          VLAN ID   STATE         PORT INDEX                    AGING TIME(s)
309c-236e-8f3b   102       Learned       GigabitEthernet1/0/2          AGING
309c-236e-8f81   102       Learned       GigabitEthernet1/0/23         AGING

 --- 2 mac address(es) found ---

[H3C]mac-address blackhole 309c-236e-8f3b vlan 102
[H3C]display mac-address
MAC ADDR          VLAN ID   STATE         PORT INDEX                    AGING TIME(s)
309c-236e-8f3b   102       Blackhole     N/A                           NOAGED
309c-236e-8f81   102       Learned       GigabitEthernet1/0/23         AGING

 --- 2 mac address(es) found ---

[H3C]
```

虚拟局域网    不同虚拟局域网相互隔离

'ping' a PC whose MAC address is marked as 'blackhole' on a connected switch to test if it is reachable or not.

**tips:** using command "**mac-address blackhole** *mac-address-x* **vlan** *vlan_id*" to configure the *mac-address-x* as a blackhole mac address.

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# Isolate Port Group

The interfaces which belong to an **isolate group** can't reach each other, but can communicate with the interfaces which does not belong to the isolate group.

```
[H3C]display port-isolate group
Port-isolate group information:
Uplink port support: NO
Group ID: 1
Group members:
    No ports.

[H3C]inter
[H3C]interface giga
[H3C]interface GigabitEthernet 1/0/2
[H3C-GigabitEthernet1/0/2]port-isolate enable
[H3C-GigabitEthernet1/0/2]quit
[H3C]interface giga
[H3C]interface GigabitEthernet 1/0/23
[H3C-GigabitEthernet1/0/23]port-isolate enable
[H3C-GigabitEthernet1/0/23]quit
[H3C]display port-isolate group
Port-isolate group information:
Uplink port support: NO
Group ID: 1
Group members:
    GigabitEthernet1/0/2        GigabitEthernet1/0/23

[H3C]
```

Two steps to add an interface into isolate port group:

step1:
using "interface xxx" to enter interface function configuration mode

step2:
using command "port-isolate enable" to add this interface into isolate port group

# Practice(1)

1. Build a network: connect PCa and PCb with a Layer 3 Switch / Router, set PCa to be in the same network with PCb

2. On PCa , use "ping" to test whether PCb is reachable.

3. Use at least two ways to make PCa un-reachable from PCb without changing the connections on them.

4. After finishing step1~3, using "display mac-address" to find the mac-address table of Layer 3 Switch/Router.

    1) How many items are there on the switch mac-address table? Is it static or dynamic?

    2) For every item, does the mac-address belong to the connected PC or the connected interface of Layer 3 Switch / Router?

# VLAN

A **Virtual LAN** (**VLAN**) is any broadcast domain that is partitioned and isolated in a computer network at the data link layer (OSI layer 2)

```
[H3C]display vlan
 Total 1 VLAN exist(s).
 The following VLANs exist:
  1(default),
[H3C]display vlan 1
 VLAN ID: 1
 VLAN Type: static
 Route Interface: not configured
 Description: VLAN 0001
 Name: VLAN 0001
 Tagged    Ports: none
 Untagged Ports:
    GigabitEthernet1/0/1      GigabitEthernet1/0/2      GigabitEthernet1/0/3
    GigabitEthernet1/0/4      GigabitEthernet1/0/5      GigabitEthernet1/0/6
    GigabitEthernet1/0/7      GigabitEthernet1/0/8      GigabitEthernet1/0/9
    GigabitEthernet1/0/10     GigabitEthernet1/0/11     GigabitEthernet1/0/12
    GigabitEthernet1/0/13     GigabitEthernet1/0/14     GigabitEthernet1/0/15
    GigabitEthernet1/0/16     GigabitEthernet1/0/17     GigabitEthernet1/0/18
    GigabitEthernet1/0/19     GigabitEthernet1/0/20     GigabitEthernet1/0/21
    GigabitEthernet1/0/22     GigabitEthernet1/0/23     GigabitEthernet1/0/24
    GigabitEthernet1/0/25     GigabitEthernet1/0/26     GigabitEthernet1/0/27
    GigabitEthernet1/0/28
```

Create/Enter a VLAN

use "**vlan** *vlan_id*"

Tips：using command "**vlan vlan_id**" to create and configure a VLAN

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# Link-type (access to VLAN)

```
[H3C-GigabitEthernet1/0/1]display this
#
interface GigabitEthernet1/0/1
#
return
[H3C-GigabitEthernet1/0/1]port link-type access
[H3C-GigabitEthernet1/0/1]port access vlan 101
[H3C-GigabitEthernet1/0/1]display this
#
interface GigabitEthernet1/0/1
 port access vlan 101
#
return
[H3C-GigabitEthernet1/0/1]
```

If the 'port link-type' is access,
It means the interface can only
belongs to one VLAN

NOTES:
VLAN 101 is not the default VLAN
on Layer Switch / Router.

VLAN should be created before be
accessed by interfaces

```
[H3C]display vlan
 Total 2 VLAN exist(s).
 The following VLANs exist:
  1(default), 101,
[H3C]display vlan 1
 VLAN ID: 1
 VLAN Type: static
 Route Interface: not configured
 Description: VLAN 0001
 Name: VLAN 0001
 Tagged    Ports: none
 Untagged Ports:
   GigabitEthernet1/0/2     GigabitEthernet1/0/3     GigabitEthernet1/0/4
   GigabitEthernet1/0/5     GigabitEthernet1/0/6     GigabitEthernet1/0/7
   GigabitEthernet1/0/8     GigabitEthernet1/0/9     GigabitEthernet1/0/10
   GigabitEthernet1/0/11    GigabitEthernet1/0/12    GigabitEthernet1/0/13
   GigabitEthernet1/0/14    GigabitEthernet1/0/15    GigabitEthernet1/0/16
   GigabitEthernet1/0/17    GigabitEthernet1/0/18    GigabitEthernet1/0/19
   GigabitEthernet1/0/20    GigabitEthernet1/0/21    GigabitEthernet1/0/22
   GigabitEthernet1/0/23    GigabitEthernet1/0/24    GigabitEthernet1/0/25
   GigabitEthernet1/0/26    GigabitEthernet1/0/27    GigabitEthernet1/0/28

[H3C]display
[H3C]display vlan 101
 VLAN ID: 101
 VLAN Type: static
 Route Interface: not configured
 Description: VLAN 0101
 Name: VLAN 0101
 Tagged    Ports: none
 Untagged Ports:
   GigabitEthernet1/0/1

[H3C]
```

# Link-type (trunk to VLAN)

```
[H3C-GigabitEthernet1/0/1]undo port link-type
[H3C-GigabitEthernet1/0/1]undo port access vlan
[H3C-GigabitEthernet1/0/1]port link-type trunk
[H3C-GigabitEthernet1/0/1]port trunk permit vlan 101
 Please wait... Done.
[H3C-GigabitEthernet1/0/1]display this
#
interface GigabitEthernet1/0/1
 port link-type trunk
 port trunk permit vlan 1 101
#
return
[H3C-GigabitEthernet1/0/1]
```

If the 'port link-type' is trunk,
It means the interface could belongs
to more than one VLAN.

```
[H3C]display vlan
 Total 2 VLAN exist(s).
 The following VLANs exist:
  1(default), 101,
[H3C]display vlan 1
VLAN ID: 1
VLAN Type: static
Route Interface: not configured
Description: VLAN 0001
Name: VLAN 0001
Tagged    Ports: none
Untagged Ports:
    GigabitEthernet1/0/1       GigabitEthernet1/0/2       GigabitEthernet1/0/3
    GigabitEthernet1/0/4       GigabitEthernet1/0/5       GigabitEthernet1/0/6
    GigabitEthernet1/0/7       GigabitEthernet1/0/8       GigabitEthernet1/0/9
    GigabitEthernet1/0/10      GigabitEthernet1/0/11      GigabitEthernet1/0/12
    GigabitEthernet1/0/13      GigabitEthernet1/0/14      GigabitEthernet1/0/15
    GigabitEthernet1/0/16      GigabitEthernet1/0/17      GigabitEthernet1/0/18
    GigabitEthernet1/0/19      GigabitEthernet1/0/20      GigabitEthernet1/0/21
    GigabitEthernet1/0/22      GigabitEthernet1/0/23      GigabitEthernet1/0/24
    GigabitEthernet1/0/25      GigabitEthernet1/0/26      GigabitEthernet1/0/27
    GigabitEthernet1/0/28

[H3C]display vlan 101
VLAN ID: 101
VLAN Type: static
Route Interface: not configured
Description: VLAN 0101
Name: VLAN 0101
Tagged    Ports:
    GigabitEthernet1/0/1
Untagged Ports: none

[H3C]
```

NOTES:
VLAN 101 is not the default VLAN
on Layer Switch / Router.

uing "vlan 101" could be used to
create VLAN 101

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# Practice(2)

1. Use "display vlan brief" to find the information about VLAN and interface.

2. Is there any default VLAN on Layer 3 Switch / Router? Which interfaces belong to this default VLAN?

3. Create two VLANs: VLAN 'x' and VLAN 'y' on L3 Switch / Router

4. Configure the VLANs and interfaces:

   1) Giga-ethernet interface 'a1' accesses to VLAN 'x'

   2) Giga-ethernet interface 'b1' accesses to VLAN 'y'

5. Setup the connections:

   1) Connect the Giga-ethernet interface 'a1' with PCa

   2) Connect the Giga-ethernet interface 'b1' with PCb

6. Configure PCa and PCb with static IP addresses which belong to the same network.
   Use "ping" on PCa to test if PCb is reachable.

7. Is there anyway to make the PCa reachable from PCb without changing the connection? Try and test.


NOTES: 'x', 'y' should be two different number, while 'a1' and 'b1' should be the index of interface on L3 Switch / Router

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# IPv6 configuration on Layer 3

- Different types of IPv6 address
  - State address : got from DHCP server , global address
  - Stateless address: got by Route Advise, same as private address in IPv4
  - Local link address: with prefix(FE80::/64) as its prefix, this address could be used to communicate with other PC on the local network

Tips:

S5110 Ethernet interface works on bridge mode, can't get an IPv6 address while the vlan-interface working on route mode.

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# Got a stateless IPv6 address(1)

Enable the an neighbor discover on an IPv6 interface

```
[H3C]vlan 101
[H3C-vlan101]quit
[H3C]interface vlan-interface 101
[H3C-Vlan-interface101]ipv6 address 1001::1/64
[H3C-Vlan-interface101]undo ipv6 nd ra halt
[H3C-Vlan-interface101]quit
[H3C]
```

```
[H3C]interface Vlan-interface 101
[H3C-Vlan-interface101]displ
[H3C-Vlan-interface101]display this
#
interface Vlan-interface101
 undo ipv6 nd ra halt
 ipv6 address 1001::1/64
#
return
```

```
IPv6 地址 . . . . . . . . . . . . . : 1001::9cc7:4dc7:b538:91f(首选)
临时 IPv6 地址. . . . . . . . . . . : 1001::3901:a40d:760:d81e(首选)
本地链接 IPv6 地址. . . . . . . . . : fe80::9cc7:4dc7:b538:91f%67(首选)
```

```
[H3C]display ipv6 neighbors all
                Type: S-Static      D-Dynamic
IPv6 Address                 Link-layer        VID  Interface        State T Age
FE80::3C56:9767:E588:42FC    309c-236e-8f3b    101  GE1/0/1          REACH D 12
FE80::9CC7:4DC7:B538:91F     00e0-4c68-0577    101  GE1/0/5          STALE D 34
```

```
C:\Users\vivi>ping -6 1001::3c56:9767:e588:42fc

正在 Ping 1001::3c56:9767:e588:42fc 具有 32 字节的数据:
来自 1001::3c56:9767:e588:42fc 的回复: 时间=3ms
来自 1001::3c56:9767:e588:42fc 的回复: 时间=1ms
来自 1001::3c56:9767:e588:42fc 的回复: 时间=1ms
来自 1001::3c56:9767:e588:42fc 的回复: 时间=1ms

1001::3c56:9767:e588:42fc 的 Ping 统计信息:
    数据包: 已发送 = 4, 已接收 = 4, 丢失 = 0 (0% 丢失),
往返行程的估计时间(以毫秒为单位):
    最短 = 1ms, 最长 = 3ms, 平均 = 1ms
```

# Got a stateless IPv6 address (2)

```
[H3C]display ipv6 interface Vlan-interface 101
Vlan-interface101 current state :UP
Line protocol current state :UP
IPv6 is enabled, link-local address is FE80::723D:15FF:FEA6:D540
  Global unicast address(es):
    1001::1, subnet is 1001::/64
  Joined group address(es):
    FF02::1:FF00:0
    FF02::1:FF00:1
    FF02::1:FFA6:D540
    FF02::2
    FF02::1
  MTU is 1500 bytes
  ND DAD is enabled, number of DAD attempts: 1
  ND reachable time is 30000 milliseconds
  ND retransmit interval is 1000 milliseconds
  ND advertised reachable time is 0 milliseconds
  ND advertised retransmit interval is 0 milliseconds
  ND router advertisements are sent every 600 seconds
  ND router advertisements live for 1800 seconds
  Hosts use stateless autoconfig for addresses
IPv6 Packet statistics:
  InReceives:              243
  InTooShorts:             0
  InTruncatedPkts:         0
  InHopLimitExceeds:       0
  InBadHeaders:            0
  InBadOptions:            0
  ReasmReqds:              0
  ReasmOKs:                0
  InFragDrops:             0
  InFragTimeouts:          0
  OutFragFails:            0
  InUnknownProtos:         0
  InDelivers:              237
  OutRequests:             252
  OutForwDatagrams:        0
  InNoRoutes:              0
  InTooBigErrors:          0
  OutFragOKs:              0
  OutFragCreates:          0
  InMcastPkts:             36
  InMcastNotMembers:       6
  OutMcastPkts:            23
  InAddrErrors:            0
  InDiscards:              0
  OutDiscards:             0

[H3C]
```

```
[H3C]display ipv6 fib
 FIB Table:
 Total number of Routes : 4

Flag:
 U:Useable    G:Gateway   H:Host   B:Blackhole   D:Dynamic   S:Static

Destination:    1001::                              PrefixLength : 64
NextHop    :    ::                                  Flag         : U
Label      :    Null                                Token        : Invalid
Interface  :    Vlan-interface101

Destination:    1001::1                             PrefixLength : 128
NextHop    :    ::1                                 Flag         : UH
Label      :    Null                                Token        : Invalid
Interface  :    InLoopBack0
```

Find the subnet ID of this IPv6 LAN.

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# Practice(optional)

- Build a LAN with PCa, PCb and a Layer3 switch/route
- Create a vlan-interface, configure its IPv6 address
- Enable the neighbor discovery on the vlan-interface to make the PCs which belong to the VLAN to get a stateless address
  - Can the PC get an IPv6 state-less address? What is the length of the prefix in the address?
  - What 's the difference between this address and IPv6 link address?
  - Invoke 'ping -6 ' test on PCa to check if PCb is reachable or not, explain the reason.

 (Optional) create and enable a DHCPv6 server on the Layer3 switch / Router and test.

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