Lab2使用二层交换机组网

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实验目的

- 掌握交换机的工作原理、管理配置方法；
- 掌握VLAN的工作原理、配置方法；
- 掌握跨交换机的VLAN Trunk配置方法；
- 掌握多个交换机的冗余组网、负载平衡的配置方法。

主要仪器设备

- PC机和路由器是在OSI网络参考模型的同一层，即第三层网络层Network Layer设备。

- 交换机switch是属于OSI网络参考模型中的第二层，即数据链路层设备。
  - 正常情况下，交换机是根据MAC地址直接转发数据帧frame的。
  - 交换机普通模式的端口只允许一个VLAN的数据通过，VLAN Trunk模式允许多个VLAN数据同时通过一个端口。
    - **VLAN**

- Console线(一个浅蓝色扁平线)：使用Console线连接到交换机的Console端口和控制台PC的串口，并在控制台PC上运行PuTTY终端软件。
  - 用于配置交换机

实验室思科交换机和路由器

- **Cisco catalyst 2950交换机** (二层交换机) 有24个FE (Fast Ethernet)端口，一个Console端口(交换机配置用)，Catalyst 2950具备8.8Gbps的交换背板。
- **Catalyst 3560-CX series 交换机**，有8个FE(Fast Ethernet)端口，一个Console端口，另外两个可能是FE端口，也可能是千兆级端口。有两个SFP端口 (Small Form-factor Pluggables，即小封装可插拔光模块，只能用于2.5Gbps及以下速率的超短距离、短距离和中距离应用)
- Cisco 2800 series 路由器 有两个FE (Fast Ethernet) 端口，一个Console端口。
- Cisco 1900 series 路由器有两个FE (Fast Ethernet) 端口，两个GE (Gigabit Ethernet), 一个Console端口。(此产品受思科支持，但不再销售。)
- Cisco 2600 series路由器有两个FE (Fast Ethernet) 端口，一个Console端口。(Cisco已经停止销售)

Virtual LANs (I)

- Network administrators like to group users on LANs
  - logically (according to department)
  - rather than physically (according to location).
- Reasons:
  - Security: promiscuous mode
  - Load: one department is not willing to donate their bandwidth to other department, they should not be on the same LAN.
  - Broadcast traffic: to keep LANs no larger than they need to be, the impact of broadcast traffic is reduced.
- Virtual LANs can **decouple** the logical topology from the physical topology. — to **rewire** buildings entirely in software.
  - Based on **VLAN-aware switches**.

Virtual LANs (II)

- To make the VLANs function correctly, configuration tables have to be set up in the bridges.
  - Note: a frame is not allowed to be forwarded to port with different VLAN ID.
  - When a frame comes in from, say, the gray VLAN, it must be forwarded on all the ports marked with a G.

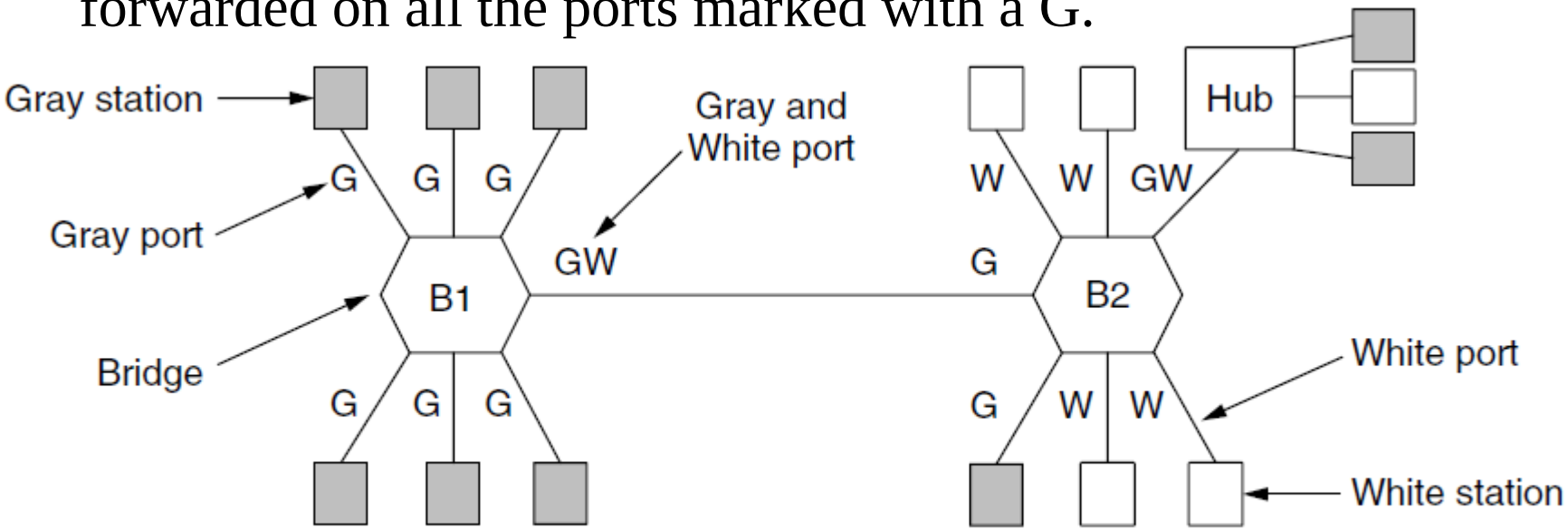


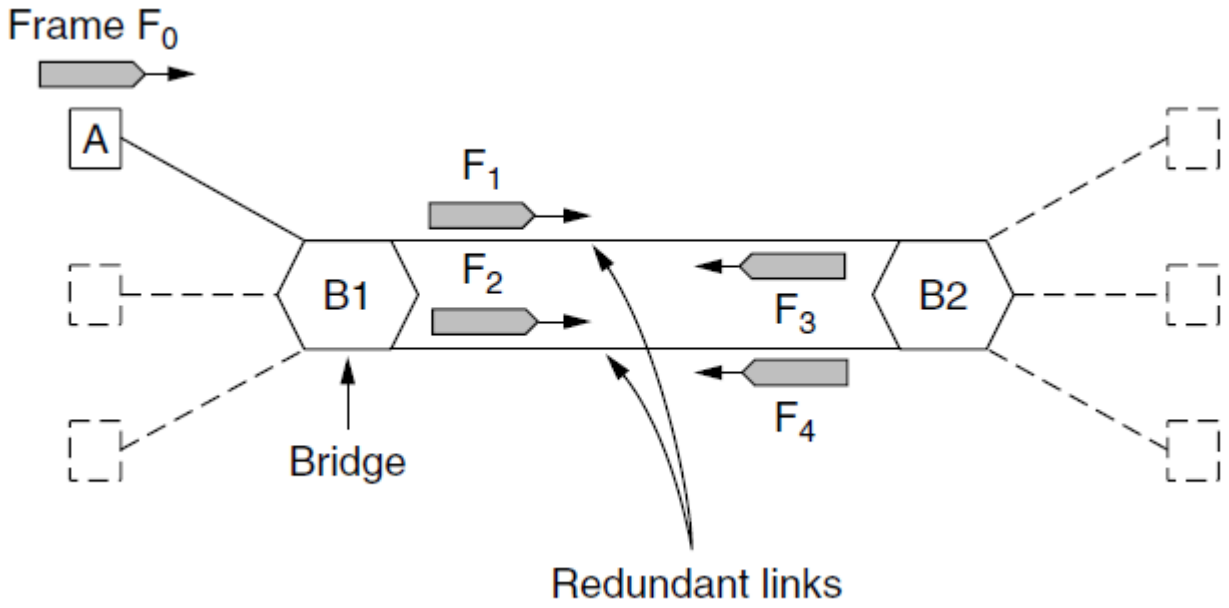
Figure 4-47. Two VLANs, gray and white, on a bridged LAN.

镜像端口

- 镜像端口就是把一个端口的流量完全复制到另外一个端口，这种技术就是端口镜像，主要用在网络监控上。
  - 如果在Packet-Tracer模拟环境中做，Lab2 Part1中第10至12步骤无法完成。
  - 解决方式就是这部分内容不用写了。

Spanning Tree Bridges

- May have a **loop** in the topology
  - Redundancy for increasing reliability
  - Or by simple mistakes (i.e. to plug a cable in a wrong port)
- **Loop** links will cause some serious problems.
  - For Example, if station A want to send a frame to a previously unobserved destination, so each bridge will flood the frame.



Spanning Tree

- The solution to this difficulty is switches collectively find **a spanning tree** for the topology.
  - A spanning tree is a subset of links that is a tree (no loops) and reaches all switches.
  - There is a **unique** path from each source to each destination

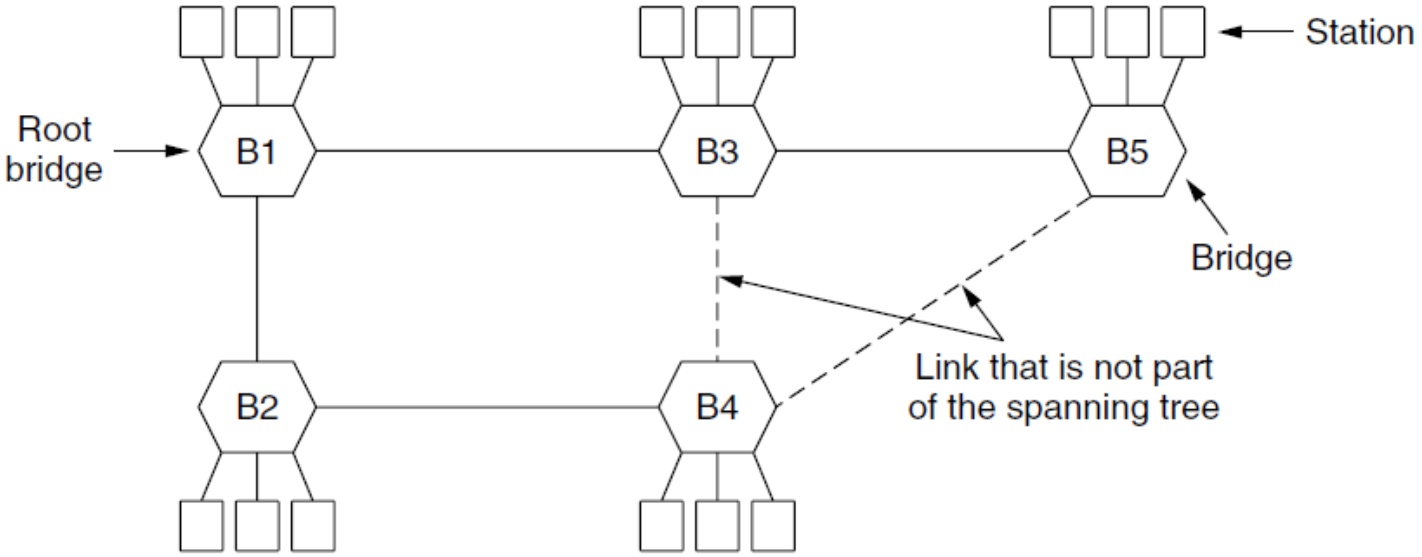


Figure 4-44. A spanning tree connecting five bridges. The dashed lines are links that are not part of the spanning tree.

Spanning Tree Algorithm (I)

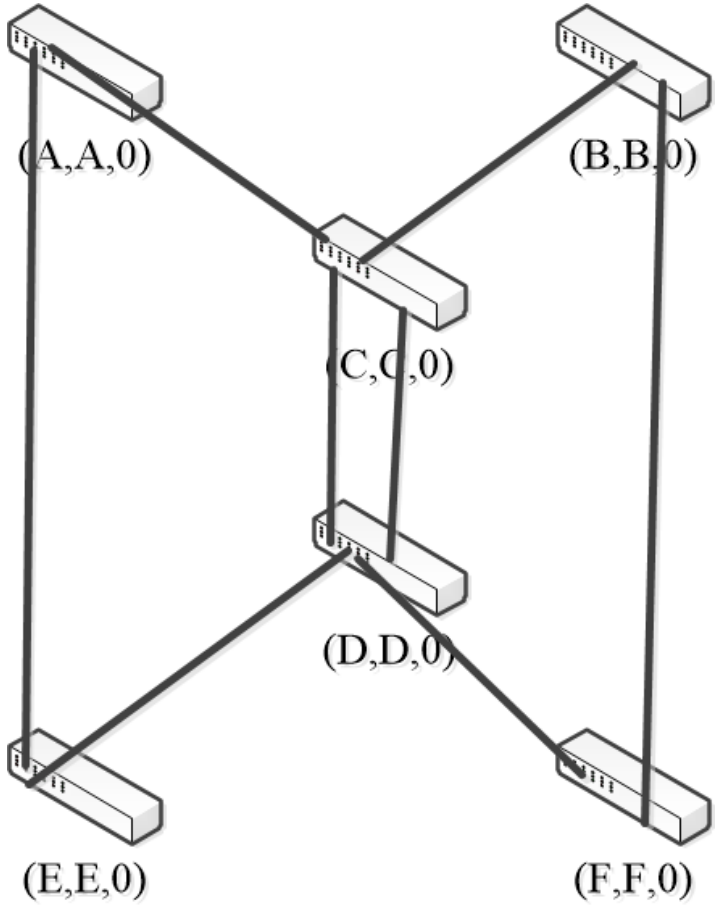
- To build the spanning tree, the switches run a *distributed* algorithm.
- Each switch *periodically* broadcasts **a configuration message** out all of its ports to neighbors and processes the messages it receives from other bridges. These messages are not forwarded, since their purposes is to build the tree, which can then be used for forwarding.
  - 1. Select a root node (switch with the **lowest** address (MAC address))
  - 2. Grow the tree as shortest distances from the root (using the lowest address to break distance ties).
  - 3. Turn off the port for forwarding if they are not on the spanning tree.

Spanning Tree Algorithm (II)

- Details:
  - Each switch initially believes it is the root of the tree.
  - Each switch sends periodic updates to neighbors with: its address, address of root, and distance (in hops) to root.
  - Switches favor ports with shorter distance to lowest root.
    - To use lowest address to break distance tie.

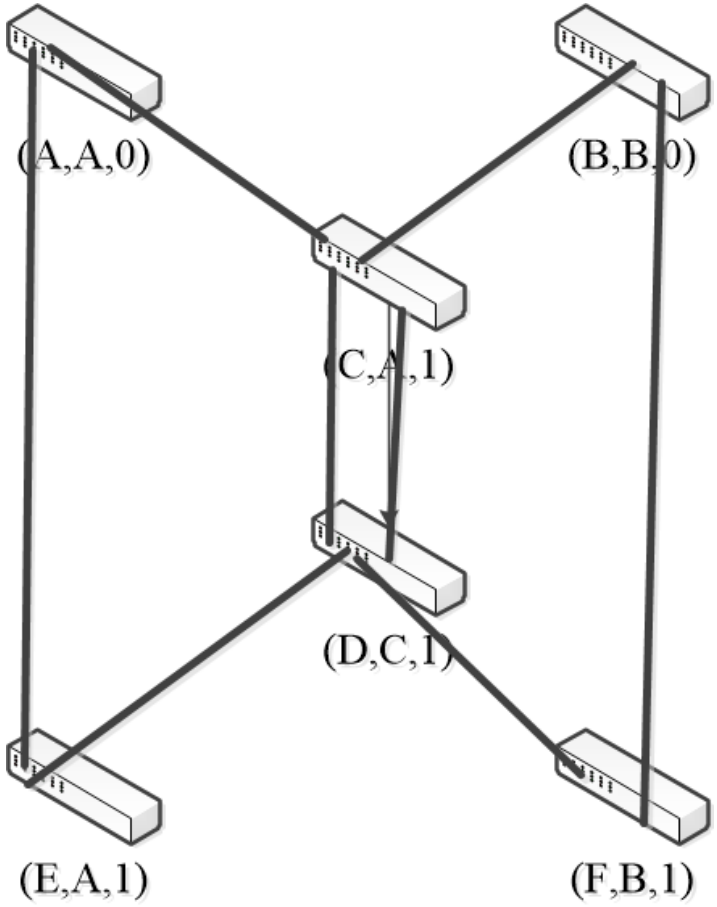
Illustrate Spanning Tree by an Example

- 1st round, sending:
  - A sends (A, A, 0) to say it is root.
  - B, C, D, E and F do likewise



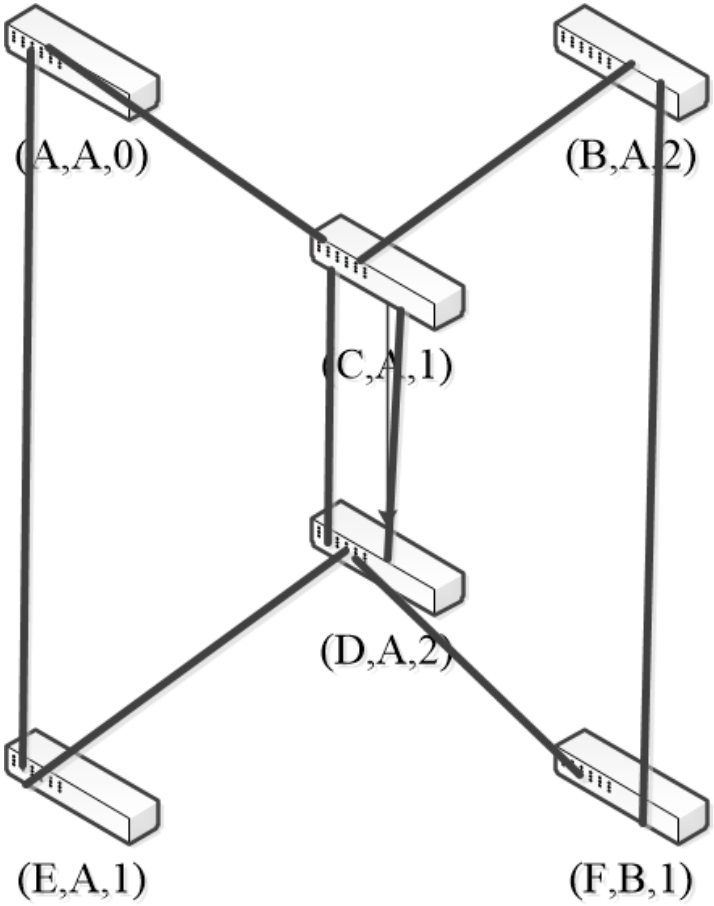
Spanning Tree Example (I)

- 1st round, receiving:
  - A still think it is root (A, A, 0)
  - B still think it is root (B, B, 0)
  - C updates to (C, A, 1)
  - D updates to (D, C, 1)
  - E updates to (E, A, 1)
  - F updates to (F, B, 1)



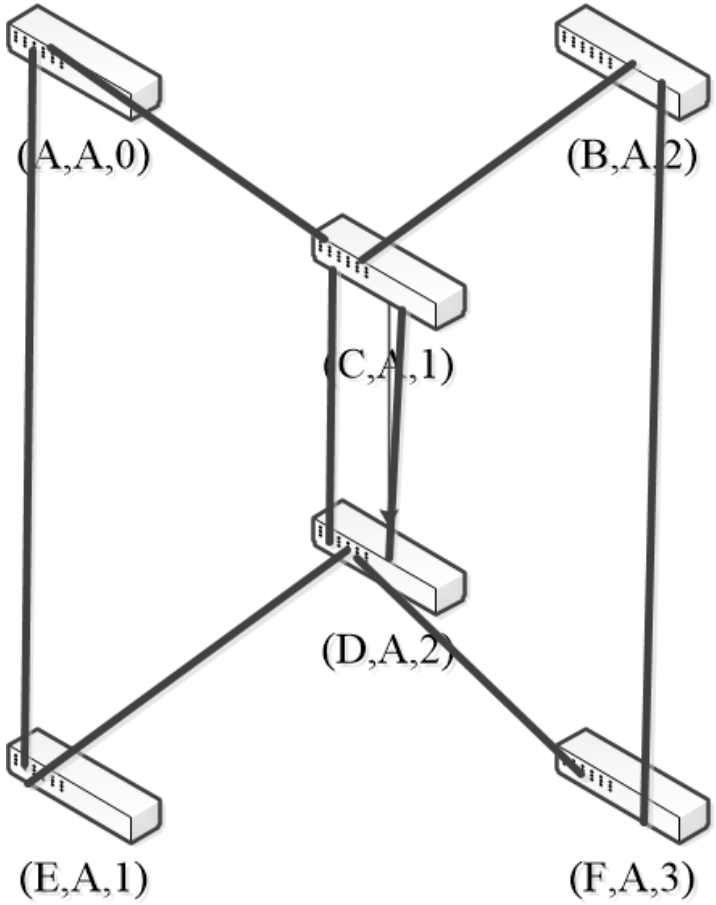
Spanning Tree Example (II)

- 2nd round, sending:
  - nodes send their update states
- 2st round, receiving:
  - A still think it is root (A, A, 0)
  - B updates to (B, A, 2) via C
  - C remains (C, A, 1)
  - D updates to (D, A, 2) via C
  - E remains (E, A, 1)
  - F remains (F, B, 1)



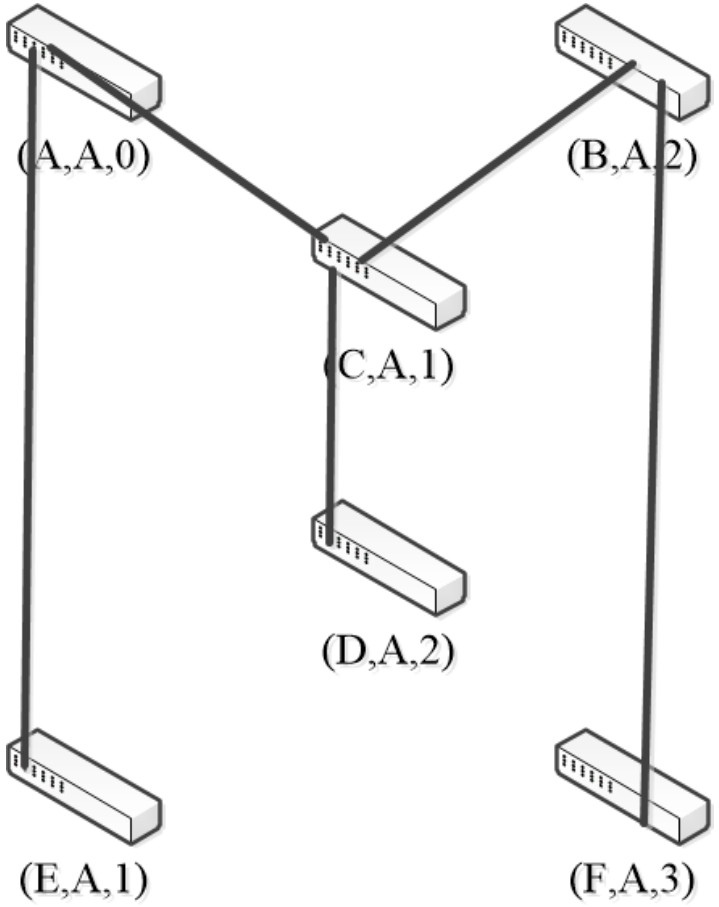
Spanning Tree Example (III)

- 3rd round, sending:
  - nodes send their update states
- 3rd round, receiving:
  - A remains (A, A, 0)
  - B remains (B, A, 2) via C
  - C remains (C, A, 1)
  - D remains (D, A, 2) via C-left
  - E remains (E, A, 1)
  - F updates (F, A, 3) via B (or via D)



Spanning Tree Example (IV)

- 4th round
  - Steady-state has been reached
  - Nodes turn off forwarding that is not on the spanning tree
- Algorithms continues to run
  - Adapts by timing out information
  - E.g., if A fails, other nodes forget it, and B will become the new root.



The algorithm for constructing the spanning tree was invented by **Radia Perlman.**

使用软件

- Cisco Packet Tracer (模拟软件)
  - 下载网址： https://www.packettracernetwork.com/
- PuTTY (如果不在实体机上做实验，PuTTY软件也可以不用装)
  - 下载网址：https://www.putty.org/
  - 也可以在作业系统中下载
  - 一般实验室电脑中装有PuTTY软件，不用担心。

PuTTY [1, 2]

- PuTTY is a free SSH, Telnet and Rlogin client for Windows systems.
- SSH, Telnet and Rlogin are three ways of doing the same thing: logging in to a multi-user computer from another computer, over a network.
  - Multi-user operating systems, such as Unix and VMS, usually present a command-line interface to the user, much like the ‘Command Prompt’ in Windows. The system prints a prompt, and you type commands which the system will obey.
  - Using this type of interface, there is no need for you to be sitting at the same machine you are typing commands to. The commands, and responses, can be sent over a network, so you can sit at one computer and give commands to another one, or even to more than one.

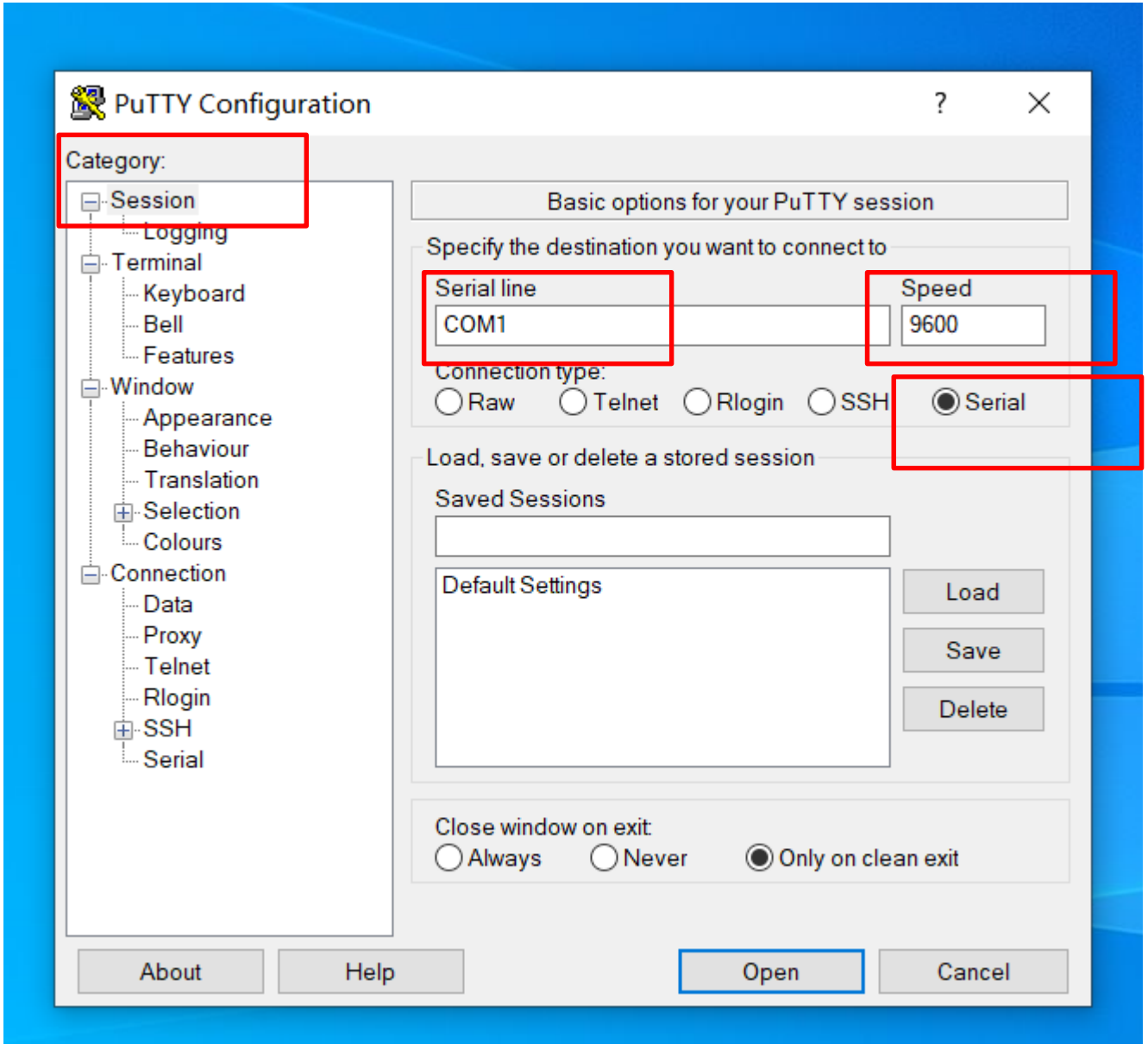
PuTTY [1, 2]

- Telnet is an **application-layer** protocol and allows a user to connect to an account on another remote machine, based on a reliable connection-oriented transport. Typically, this protocol is used to establish a connection to Transmission Control Protocol (TCP) **port number 23**, where a Telnet server application is listening.

- 因为telnet是Linux系统命令，而window操作系统是不支持Linux操作系统下命令，所以在window环境中需要用PuTTY软件来和交换机通信，这是为什么实体机中PC机必须装PuTTY软件。而Packet Tracer本身就是在Linux环境中的，所以PC机在命令行输入情况下能直接采用“telnet”命令来远程登录交换机。

Connecting to a Local Serial Line

直接通过串口来收发信号。
If you start up a PuTTY serial session and nothing appears in the window, try pressing Return a few times and see if that helps.

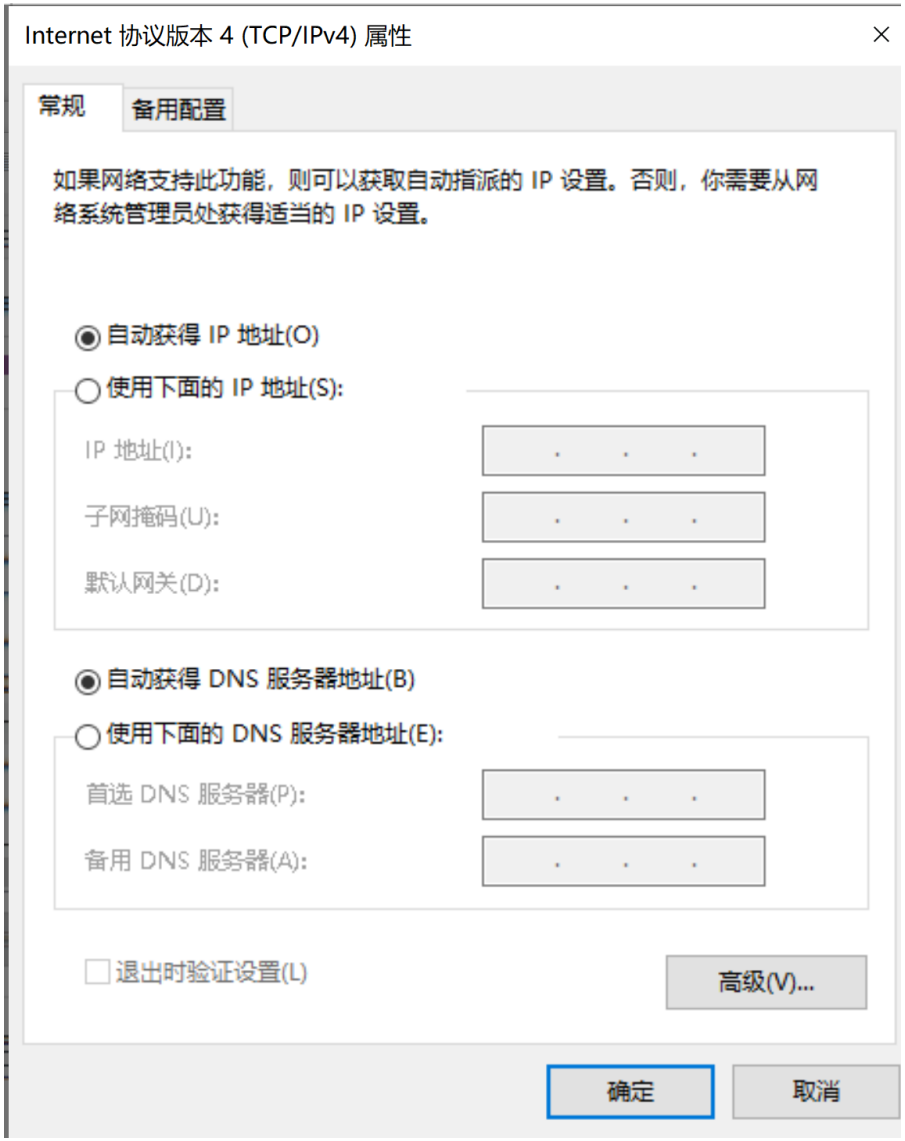


彻底清除以前的配置信息

- 请参见文献[4]中1.1.9小节，或知乎里列出命令[5]。
- 用“no switchport mode trunk”命令可以把已经配置成trunk模式端口改回来。

实体机上注意事项 (I)

- 每个机架上有四台PC机，但是只有一个控制台，可以通过“cap lock”键选择想要的PC机。所以在组网时最好用机架上的四台PC机，不要用桌面上电脑。
- 每台PC机刚启动可能需要摁F1键进入BIOS设置状态，进入BIOS设置状态后可以直接摁ESC键退出，就能进入Windows操作系统界面。（因为前一次实验很可能是直接关电源关机的）
- 查看每台PC机设置的IP地址：控制面板→网络和Internet→查看网络状态和任务→详细信息，就可查看机器的IP地址设置。也可以自己手工设置IP地址：属性→ 菜单鼠标移到“Internet (TCP/IPv4)”，这时下面的“属性”按钮就会激活，点击“属性”，就出现右边界面。点击“使用下面的地址”，就可以设置地址了，比如IP地址：10.0.0.11，子网掩码：255.255.255.0。
  - 注意连在同一交换机上四台PC机必须在同一子网内，也就是说如果子网掩码为255.255.255.0，PC机的前三个十进制数必须一样，最后一个不同。这时即便你没有配置交换机，这四台PC机是相互能”ping”通的。
  - 如果是“自动获得IP地址”，请问用什么协议能自动获取IP地址？
    - DHCP



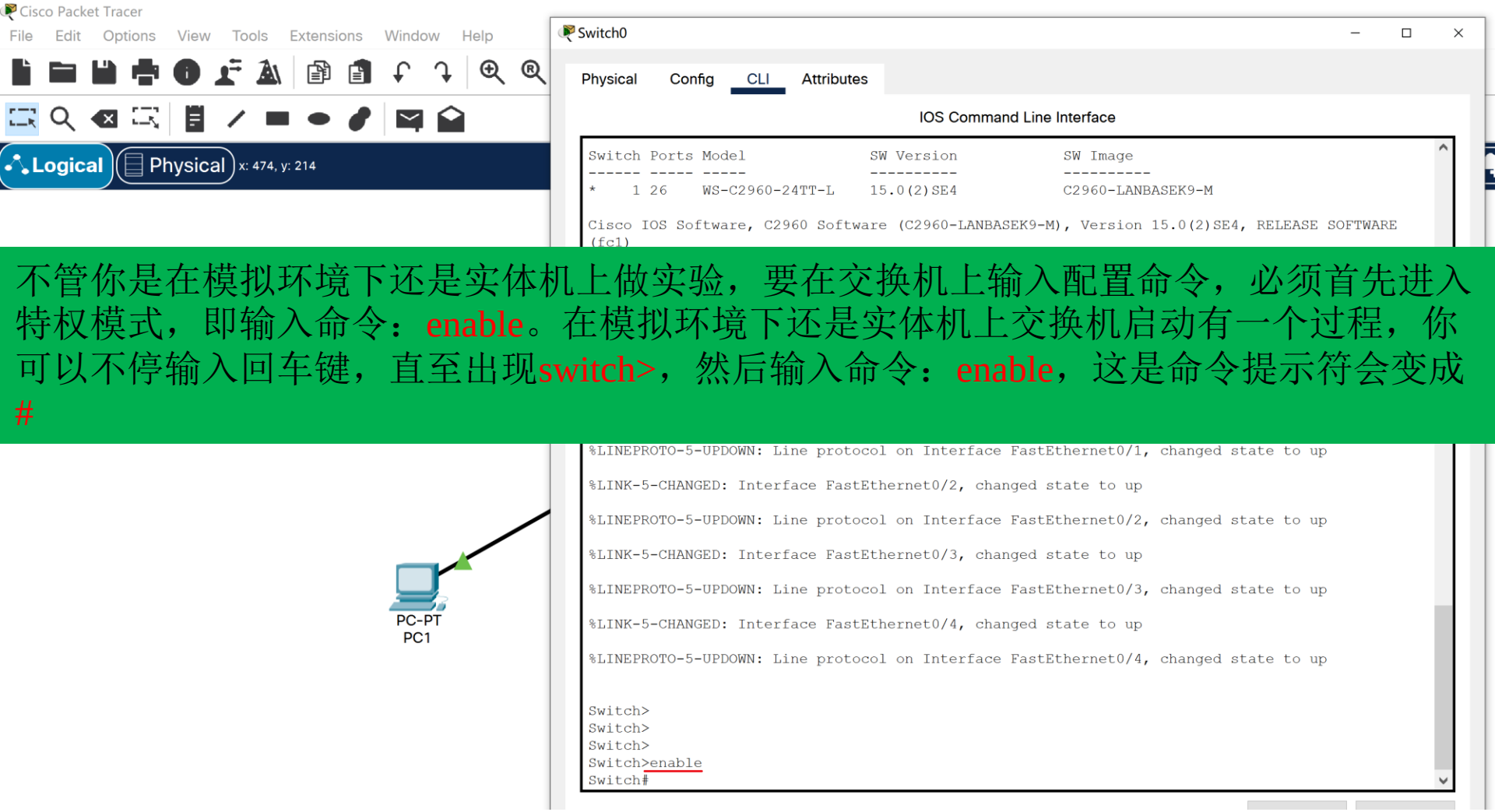
实体机上注意事项 (I)

- 由于机架上PC机可能由于非正常状态下关机，所以很多时候开机时需要摁F1进入BIOS设置状态，进入BIOS设置状态后可以直接退出，就能进入Windows操作系统了。
- 一般机架上有四台PC机，通过双击Scroll Lock可以在控制台上选择三台PC机中一台，但是有些机架上PC机是坏掉了，启动不了。
- 实验室桌子上PC机的密码为“123”。

实体机上注意事项 (II)

- 将Console线连在机架上一台PC机的串口和一台能正常运行的交换机Console口。如果正常连接，PC机上Putty软件能正常运行了。其实运行Putty软件能帮助我们判断是否交换机已经成功连接到PC机上串口。通过Putty进入交换机控制界面时，可能会出现“Would you like to enter the initial configuration dialogue?”输入no，则Switch提示符就能出现了。输入“enable”命令进入特权模式，提示符改成了“#”。

交换机 Switch

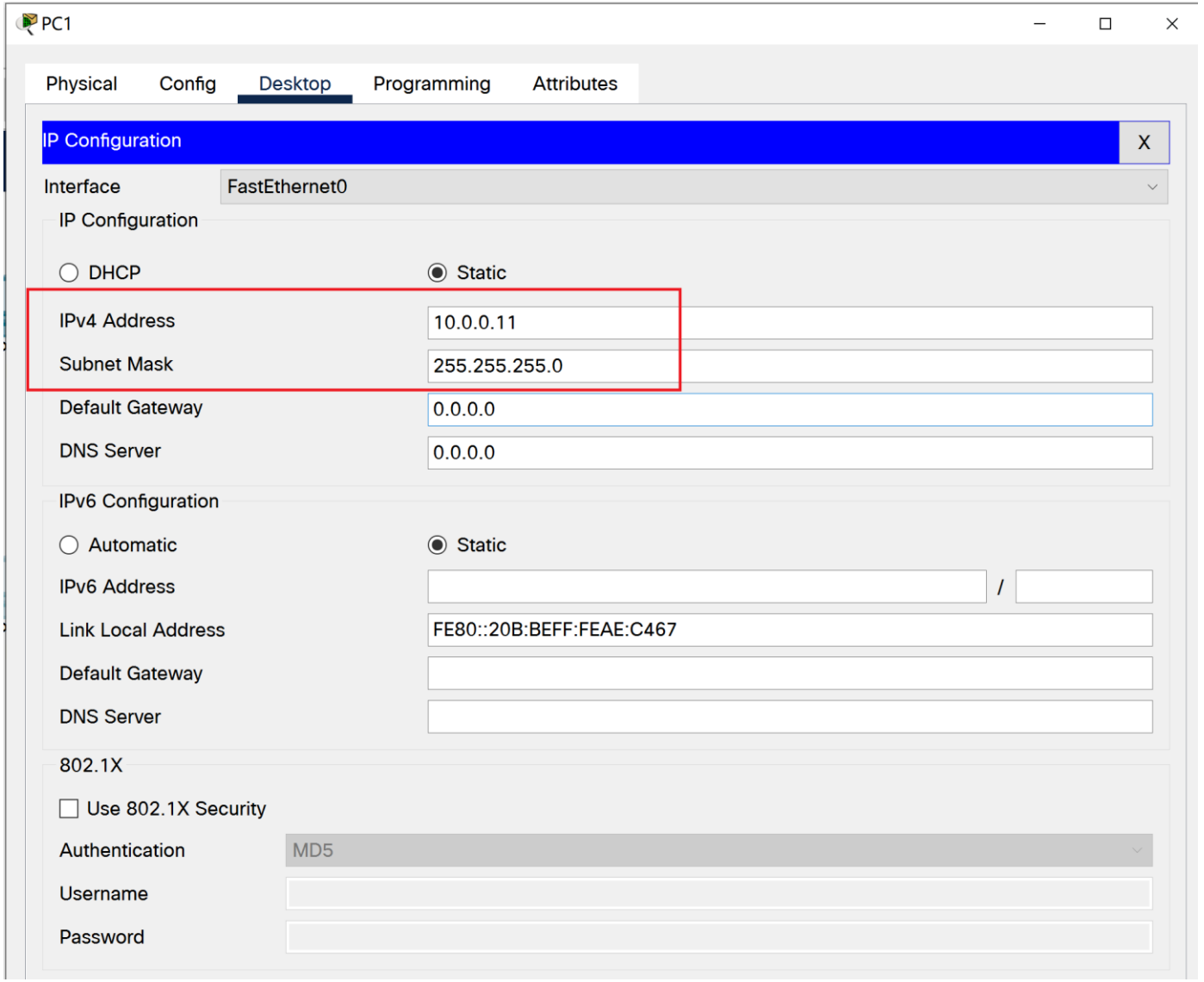


不管你是在模拟环境下还是实体机上做实验，要在交换机上输入配置命令，必须首先进入特权模式，即输入命令：enable。在模拟环境下还是实体机上交换机启动有一个过程，你可以不停输入回车键，直至出现switch>，然后输入命令：enable，这是命令提示符会变成#

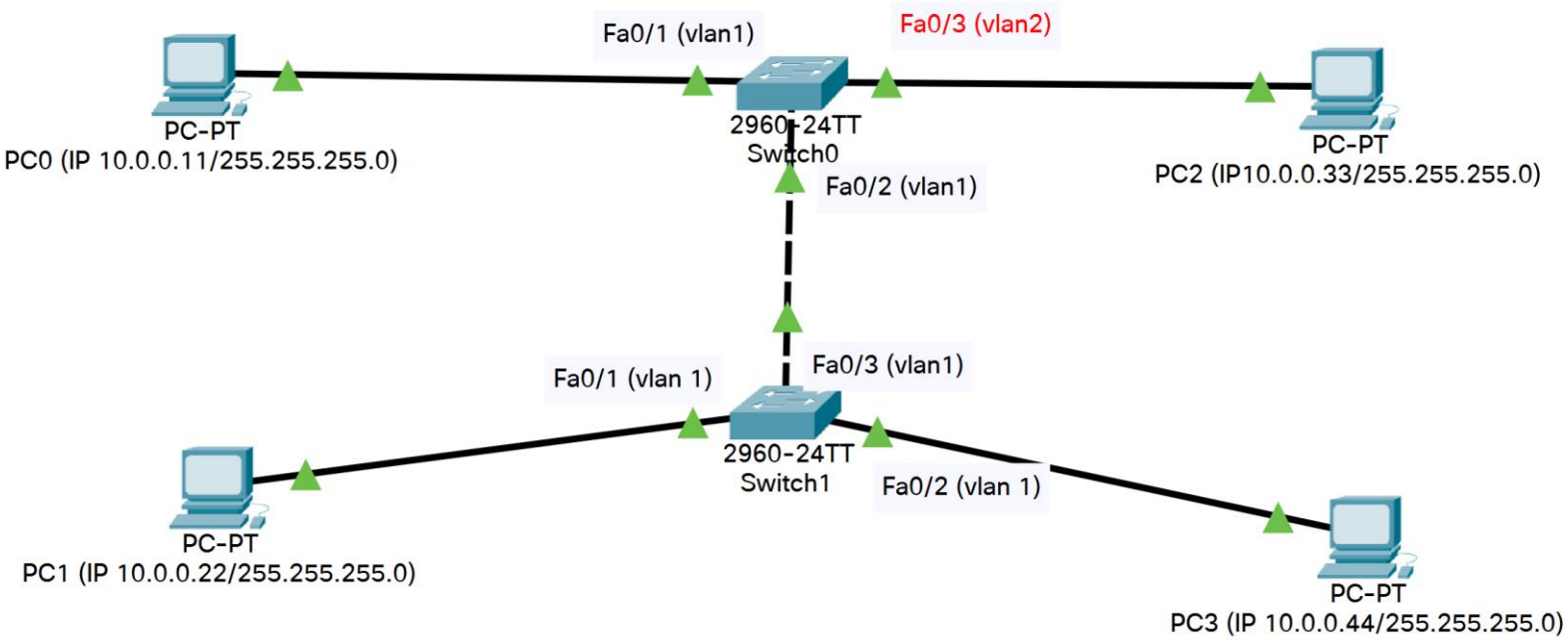
交换机 Switch

```
Switch>
Switch>enable
Switch#show version
Cisco IOS Software, C2960 Software (C2960-LANBASEK9-M), Version 15.0(2)SE4, RELEASE SOFTWARE
(fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2013 by Cisco Systems, Inc.
Compiled Wed 26-Jun-13 02:49 by mnguyen

ROM: Bootstrap program is C2960 boot loader
BOOTLDR: C2960 Boot Loader (C2960-HBOOT-M) Version 12.2(25r)FX, RELEASE SOFTWARE (fc4)

Switch uptime is 39 minutes
System returned to ROM by power-on
System image file is "flash:c2960-lanbasek9-mz.150-2.SE4.bin"


This product contains cryptographic features and is subject to United
States and local country laws governing import, export, transfer and
use. Delivery of Cisco cryptographic products does not imply
third-party authority to import, export, distribute or use encryption.
Importers, exporters, distributors and users are responsible for
compliance with U.S. and local country laws. By using this product you
agree to comply with applicable laws and regulations. If you are unable
to comply with U.S. and local laws, return this product immediately.

A summary of U.S. laws governing Cisco cryptographic products may be found at:
http://www.cisco.com/wwl/export/crypto/tool/stqrg.html

If you require further assistance please contact us by sending email to
export@cisco.com.

cisco WS-C2960-24TT-L (PowerPC405) processor (revision B0) with 65536K bytes of memory.
Processor board ID FOC1010X104
Last reset from power-on
1 Virtual Ethernet interface
24 FastEthernet interfaces
2 Gigabit Ethernet interfaces
The password-recovery mechanism is enabled.
```

给PC机配置IP地址


PC1
Physical
Config
Desktop
Programming
Attributes
IP Configuration
X
Interface
FastEthernet0
IP Configuration
DHCP
Static
IPv4 Address
10.0.0.11
Subnet Mask
255.255.255.0
Default Gateway
0.0.0.0
DNS Server
0.0.0.0
IPv6 Configuration
Automatic
Static
IPv6 Address
/
Link Local Address
FE80::20B:BEFF:FEAE:C467
Default Gateway
DNS Server
802.1X
Use 802.1X Security
Authentication
MD5
Username
Password

Lab2 - Step 15



1) Switch_0 上端口Fa0/3和Fa0/4设置为vlan 2，其它端口都属于vlan 1。Switch_1缺省状态下所有端口都属于vlan 1。请问PC0能不能“ping”通其它三台电脑？
2) “ping”是基于什么协议工作的？

References

- [1] https://www.putty.org/
- [2] https://the.earth.li/~sgtatham/putty/0.74/htmldoc/
- [3] https://www.netacad.com/zh-hans/courses/packet-tracer
- [4] 陆魁军，计算机网络实践基础教程，第二章，清华大学出版社，2005.
- [5] https://zhuanlan.zhihu.com/p/100765713 (Cisco交换机与路由器命令总结)
- [6] https://www.cisco.com/c/zh_cn/support/docs/smb/switches/cisco-small-business-300-series-managed-switches/smb5653-configure-port-to-vlan-interface-settings-on-a-switch-throug.html
- [7] https://www.packettracernetwork.com/download/download-packet-tracer.html
- [8] https://cloud.tencent.com/developer/article/1953025
- [9] https://blog.csdn.net/li_dongyun/article/details/129432656