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。

- 集线器hub和交换机switch是属于同种类型设备，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。

- 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

直通网线和交叉网线区别 (I) [4]

- 双绞线的RJ45接头（又称水晶头）有两面：一面是平的，另一面有塑料簧片，塑料簧片的弹性使得RJ45接头的8根金属插针能紧紧贴住RJ45插座上的8根插针，保证良好的接触性。
- RJ45接头的8根金属插针分别连接双绞线的8根铜导线，一条5类双绞线中的8根铜导线有8种颜色：橙色、白橙相间色、绿色、白绿相间色、蓝色、白蓝相间色、棕色、白棕相间色，8芯铜导线分成4对：
  - 橙色、白橙相间色的一对；
  - 绿色、白绿相间色的一对；
  - 蓝色、白蓝相间色的一对；
  - 棕色、白棕相间色的一对；
  - 每一对中的两根导线相互绞合在一起，以便提供较好的传输特性。

直通网线和交叉网线区别 (II) [4]

- **直通线**(straight-through)：双绞线两个RJ45头都按T568B接线顺序连接，对于两个RJ45头A和B而言，A的1＃针直连B的1＃针，A的2＃针直连B的2＃针，……，A的8＃针直连B的8＃针，即A的每个引脚直连B的相应序号的引脚。
  - 简单说就是网线两端的水晶头中线颜色排序是一致的。
- **交叉线(crossover)**：双绞线两个RJ45头中，一头按T568A线序连接，一头按T568B线序连接，对于两个RJ45头A和B而言，A的1＃、2＃针分别连接B的3＃、6＃针，A的3＃、6＃分别连接B的1＃、2＃针。即：一头的TD+、TD-引脚连另一头的RD+、RD-引脚，一头的RD+、RD-引脚连另一头的TD+、TD-引脚。
  - 简单说就是一头接受(RD)，另一头对应的是发送(TD)；一头是发送(TD)，则另一头对应的是接受(RD)。网线两端的水晶头不一样。一端是用A标 另一端是用B标。

直通网线和交叉网线区别 (III) [4]

（1）T568A 接线顺序：

插针号	1	2	3	4	5	6	7	8
铜线	绿白	绿	橙白	蓝	蓝白	橙	棕白	棕
功能	RD+	RD-	TD+	NC	NC	TD-	NC	NC
功能描述	接收+	接收-	发送+	不用	不用	发送-	不用	不用

注：关于 RJ45 头引脚的发送和接收是基于这样的假定：RJ45 头插在主机的网卡中，而不是插在交换机/集线器中。

（2）T568B 接线顺序：

插针号	1	2	3	4	5	6	7	8
铜线	橙白	橙	绿白	蓝	蓝白	绿	棕白	棕
功能	TD+	TD-	RD+	NC	NC	RD-	NC	NC
功能描述	发送+	发送-	接收+	不用	不用	接收-	不用	不用

直通网线和交叉网线区别 (IV) [4]

- **交叉网线**常用来连接**同类设备的以太网口**，属于同类设备之间互连的有：主机与主机、路由器与路由器、交换机/集线器与交换机/集线器、主机与路由器，因此，主机与主机连接要用交叉线，主机与路由器连接要用交叉线，集线器与交换机连接要用交叉线，交换机（或集线器）的uplink端口与交换机（或集线器）的uplink端口互连用交叉线，交换机（或集线器）的普通端口与交换机（或集线器）的普通端口互连用交叉线。
- **直通网线**常用来连接**非同类设备的以太网口**，属于非同类设备之间互连的有：主机与交换机/集线器、路由器与交换机/集线器，因此，主机与集线器连接要用直通线，路由器与交换机连接要用直通线。值得注意的是：交换机（或集线器）的uplink端口与交换机（或集线器）的普通端口互连也要用直通线。
- 但现在很多交换机都能够自动识别网线了，不管交叉还是直通，都能正常使用。

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.

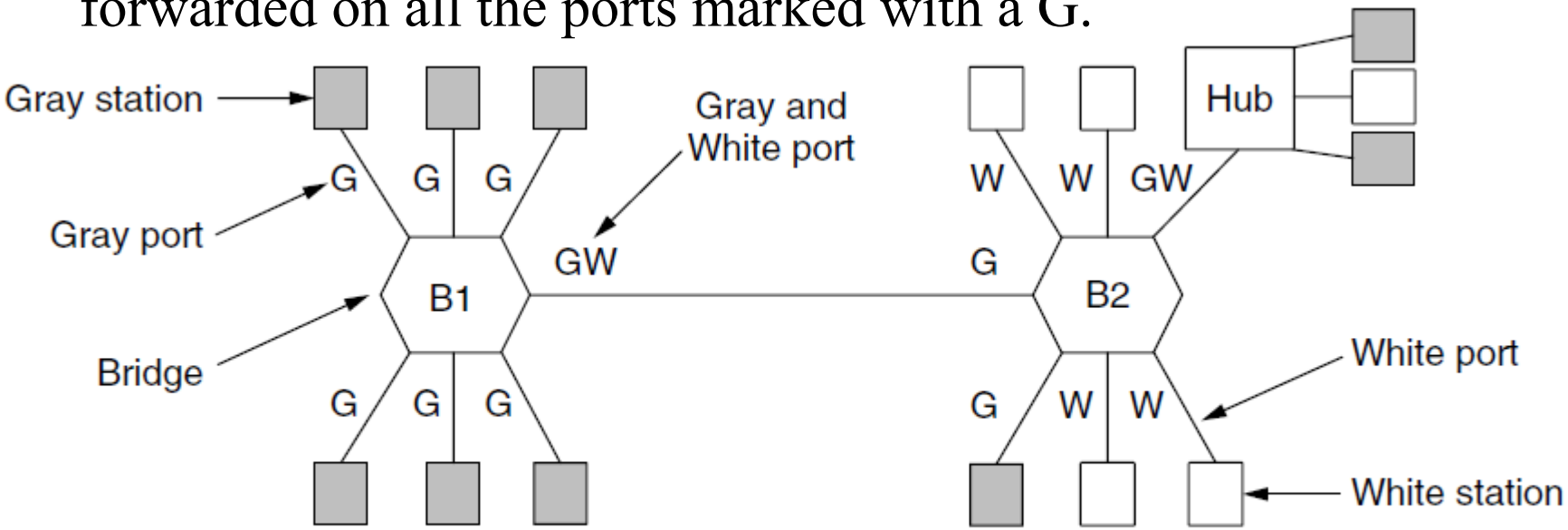


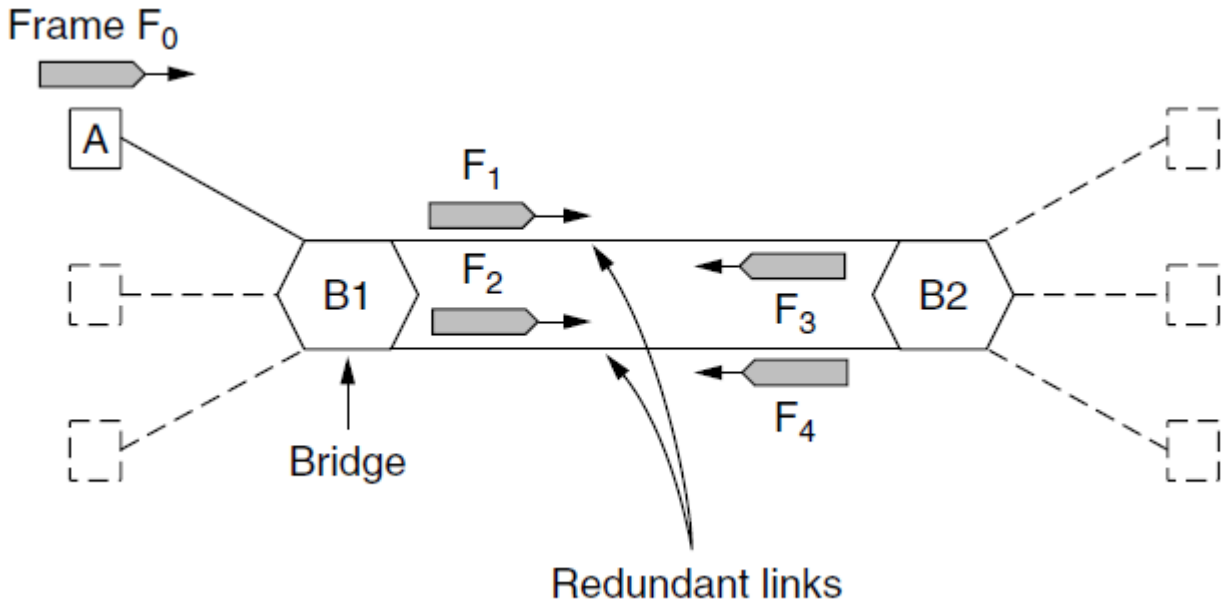
Figure 4-47. Two VLANs, gray and white, on a bridged LAN.

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

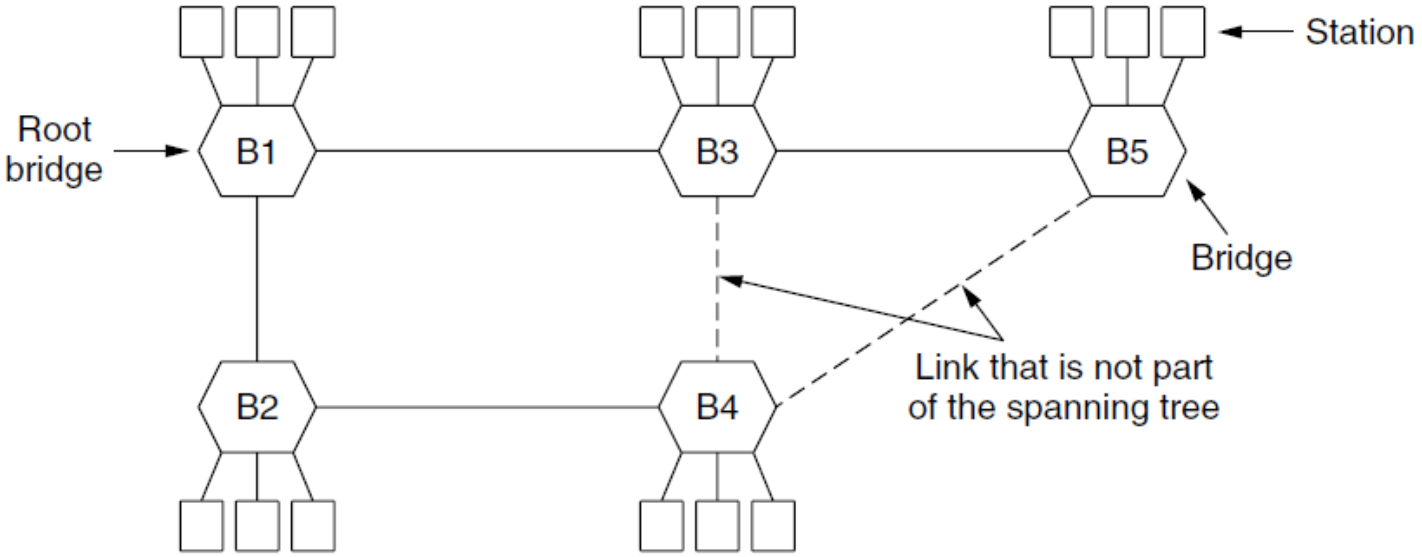


Figure 4-44. A spanning tree connecting five bridges. The dashed lines are links that are not part of the spanning tree.

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.

使用软件

- Cisco Packet Tracer (模拟软件)
  - 下载网址： https://www.packettracernetwork.com/
- PuTTY
  - 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。

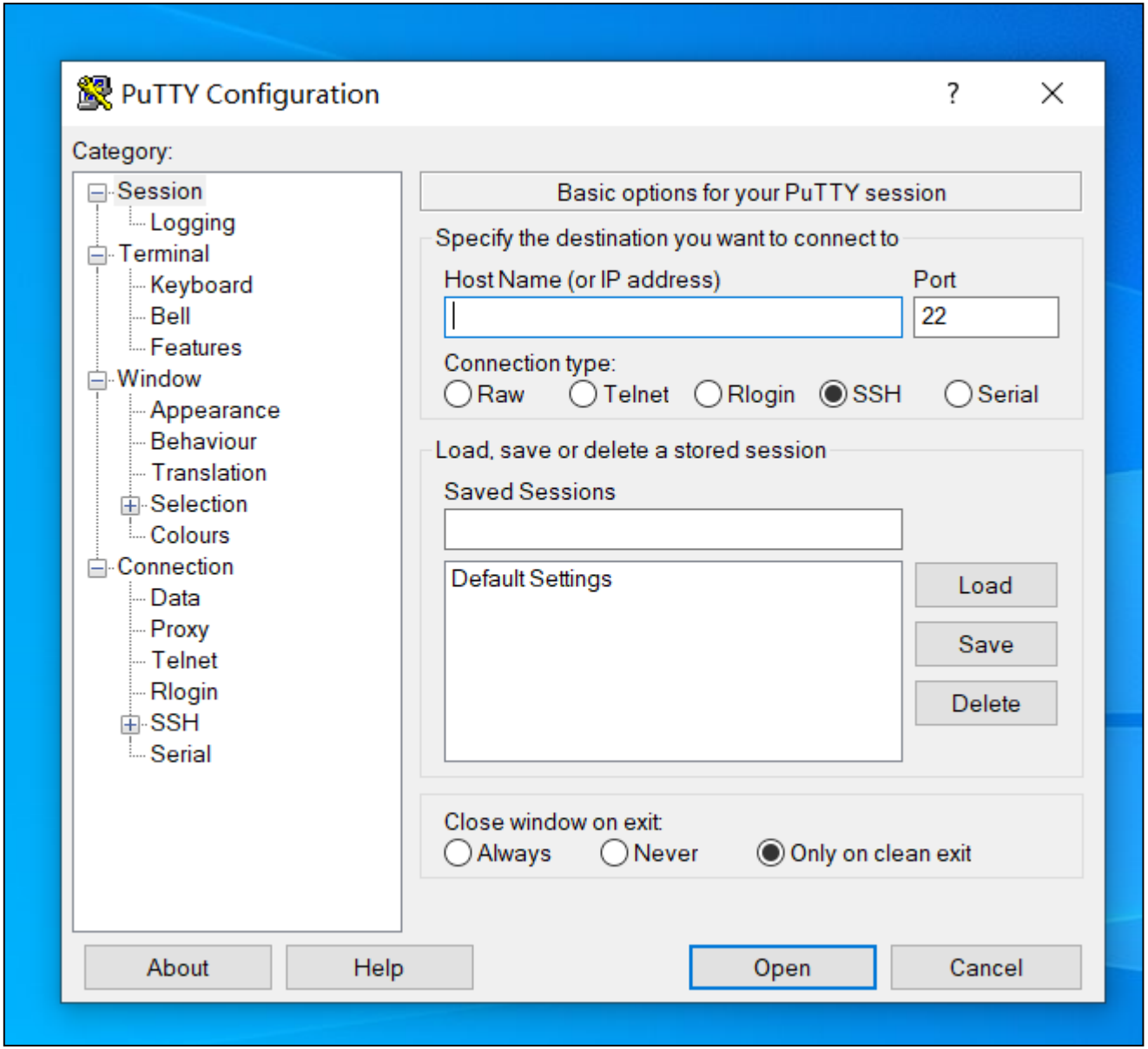
PuTTY [1, 2]

- 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.

PuTTY Interface



In the ‘Host Name’ box, enter the Internet host name of the server you want to connect to. You should have been told this by the provider of your login account.

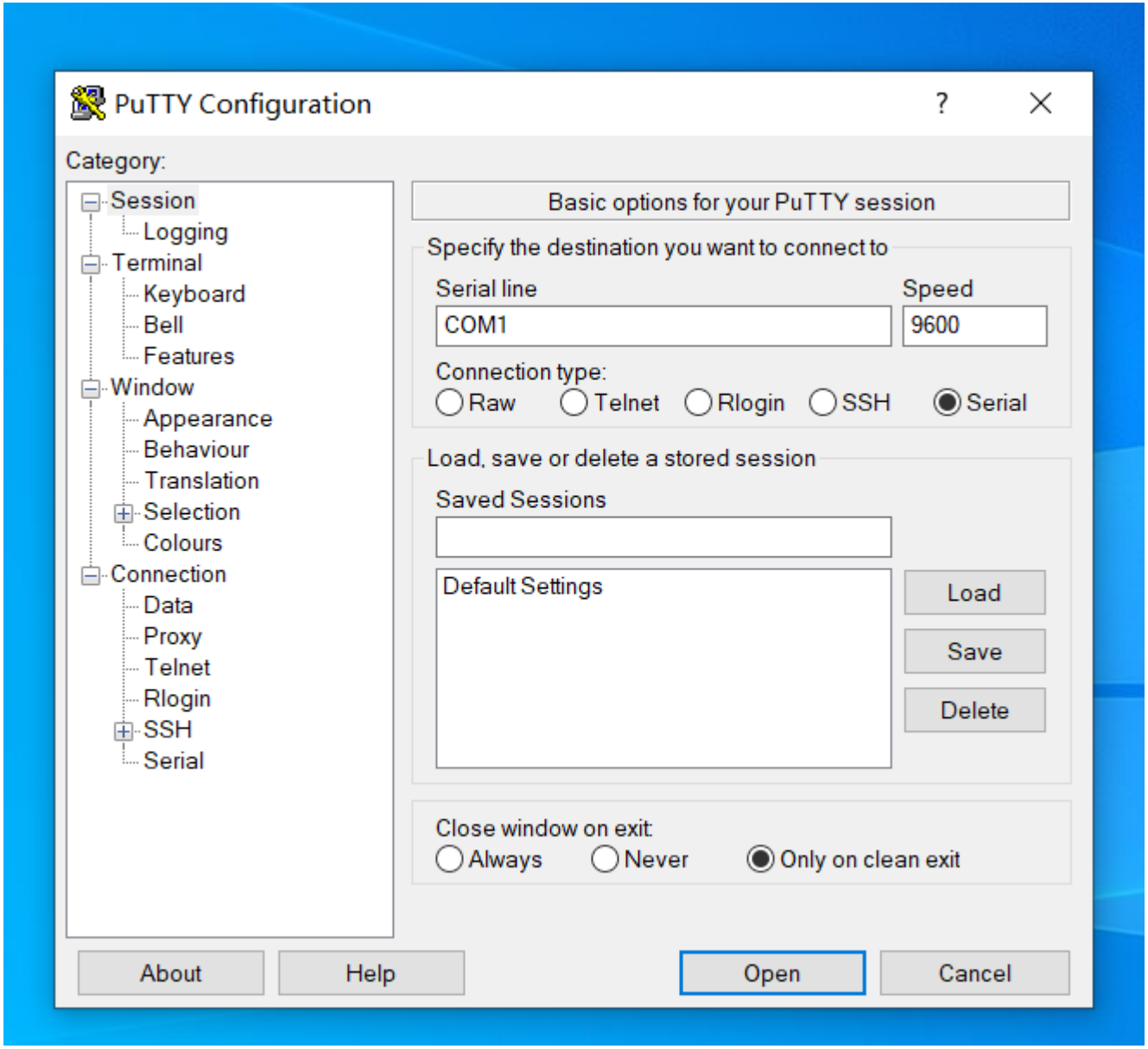
Now select a login protocol to use, from the `Connection type' buttons. For a login session, you should select Telnet, Rlogin or SSH. When you change the selected protocol, the number in the ‘Port’ box will change.

PuTTY Interface

- After you have connected, and perhaps verified the server's host key (for SSH), you will be asked to log in, probably using a username and a password.
- PuTTY will display a text window (the `terminal window' - it will have a black background unless you've changed the defaults), and prompt you to type your username and password into that window. (These prompts will include the PuTTY icon, to distinguish them from any text sent by the server in the same window.)
- Login: username + passwd
- Logout: “logout” or “exit”

Connecting to a Local Serial Line

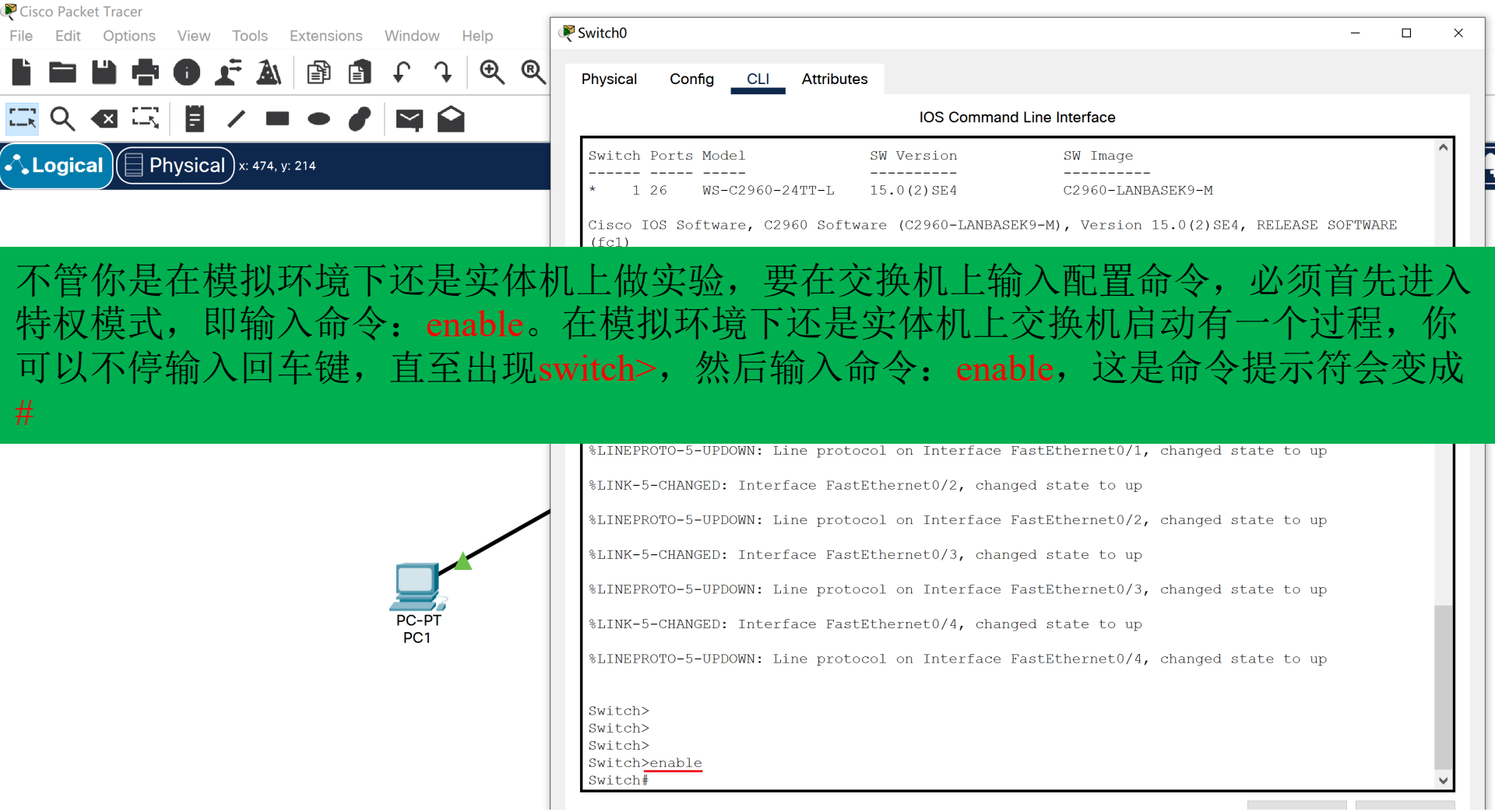
直接通过串口来收发信号。
If you start up a PuTTY serial session and nothing appears in the window, try pressing Return a few times and see if that helps.



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。

交换机 Switch

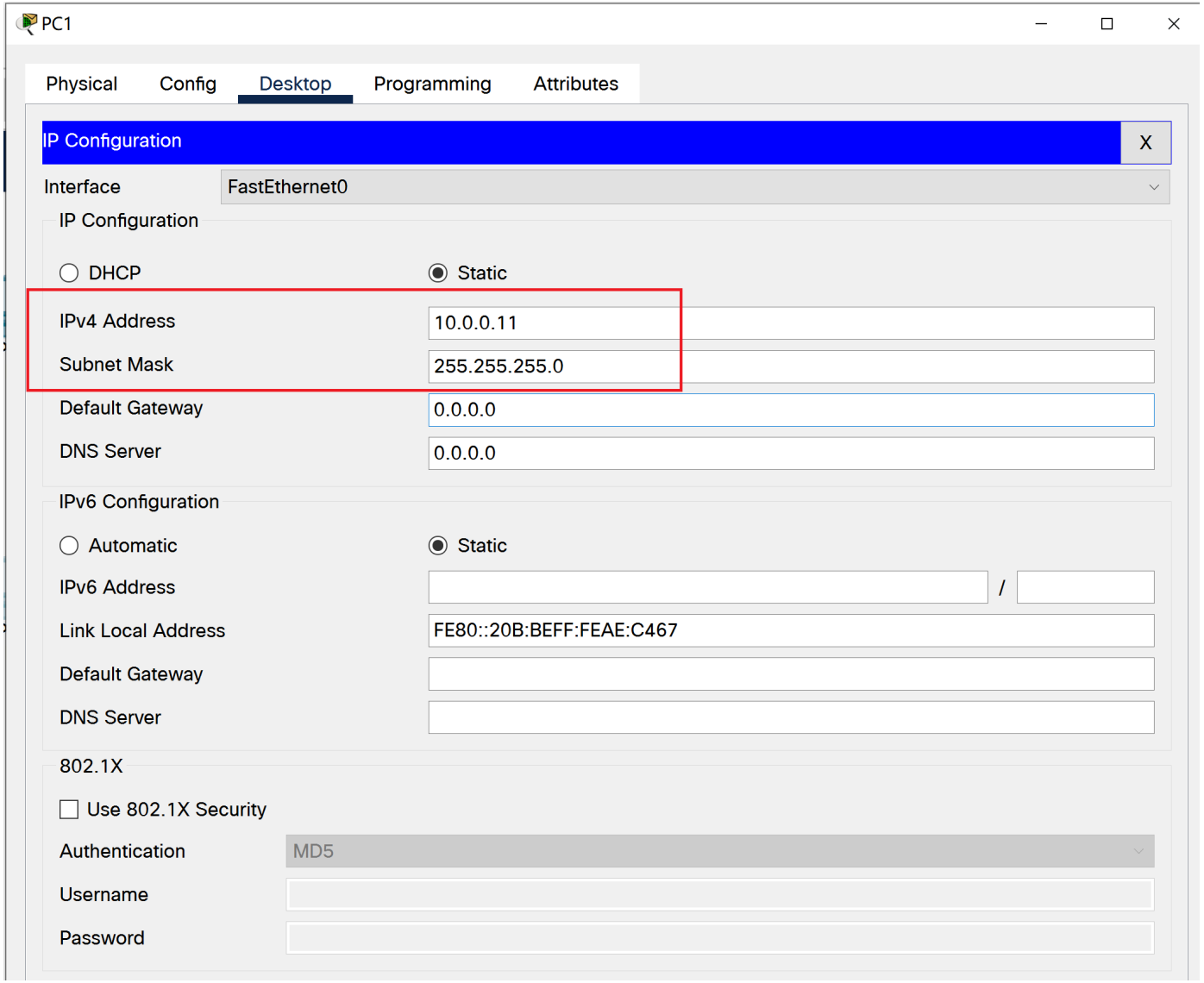


不管你是在模拟环境下还是实体机上做实验，要在交换机上输入配置命令，必须首先进入特权模式，即输入命令：enable。在模拟环境下还是实体机上交换机启动有一个过程，你可以不停输入回车键，直至出现switch>，然后输入命令：enable，这是命令提示符会变成#

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

实体机上注意事项 (I)

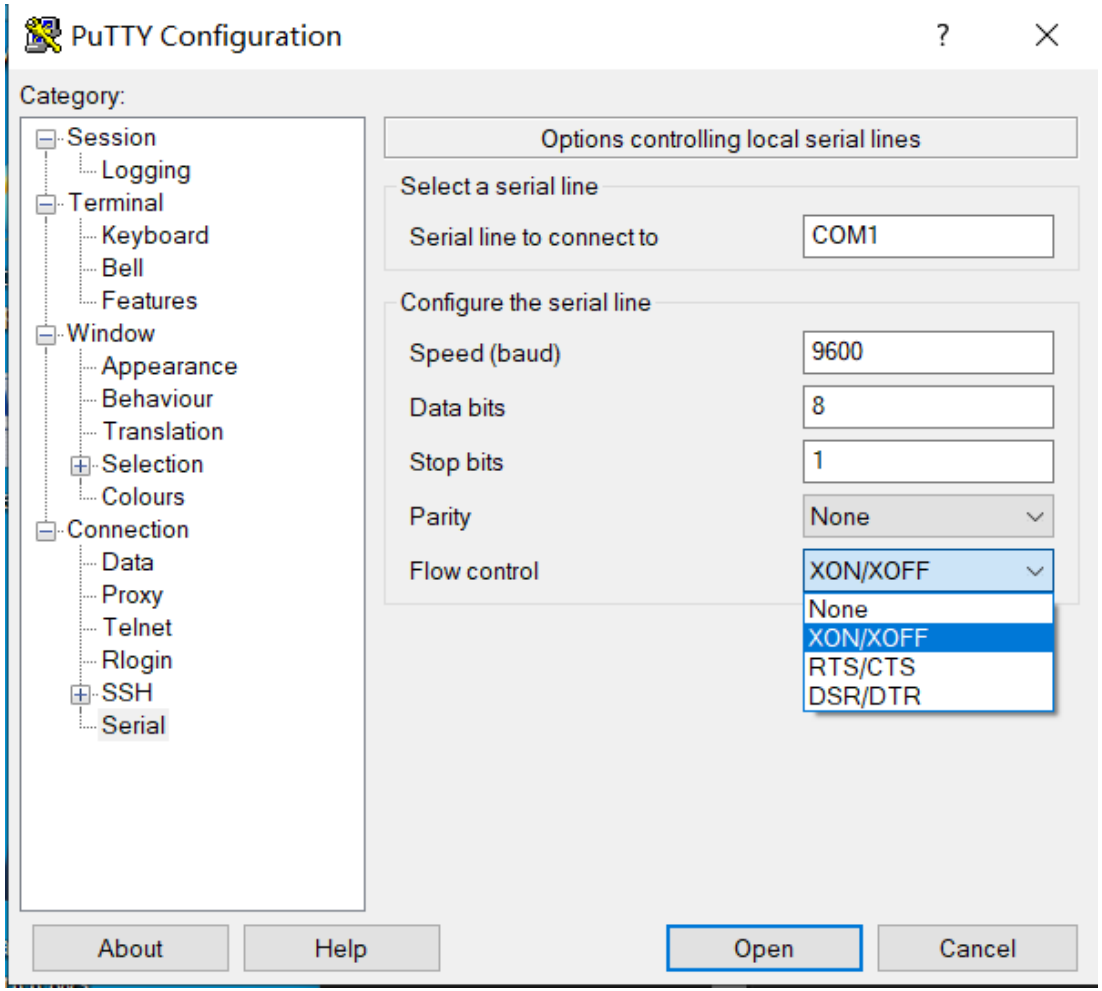
- 由于机架上PC机可能由于非正常状态下关机，所以很多时候开机会有摁F1进入BIOS设置状态，进入BIOS设置状态后可以直接退出，就能进入Windows操作系统了。
- 一般机架上有三台PC机，通过双击Scroll Lock可以在控制台上选择三台PC机中一台，但是有些机架上PC机是坏掉了，启动不了。
- 实验室桌子上PC机的密码为“123”。

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“enalbe”命令进入特权模式，提示符改成了“#”。

实体机上注意事项 (III)

- 通过Putty设置串口参数时，“Options controlling local serial lines”



实体机上注意事项 (IV)

- 一般交换机上端口数比较多，差不多应该在十几个以上；而一般路由器上端口数目相对比较少，大概4-5个左右。交换机如果要关机需要拔电源，而路由器有一个电源开关的。如果发现某些交换机或路由器电源指示灯不亮可以检查一下机架后面电源线是否接上。三层交换机型号一般“3”打头，二层交换机型号一般“2”打头。一般路由器启动过程比交换机启动过程要慢。

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