

CS 305 Lab Tutorial

Lab 9 DHCP & Packet-Tracer

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DHCP

DHCP is built on a **Client-Server** model:

where designated **DHCP server** hosts allocate network addresses and deliver configuration parameters to **dynamically configured hosts**.

"**server**" refers to a host providing initialization parameters through DHCP,

"**client**" refers to a host requesting initialization parameters from a DHCP server.

BOOTP is a transport mechanism for a collection of configuration information.
BOOTP using port **67** AND **68** of **UDP**.

```
C:\Windows\system32\cmd.exe
无线局域网适配器 WLAN:

    连接特定的 DNS 后缀 . . . . . : 
    描述 . . . . . : Intel(R) Dual Band Wireless-AC 8265
    物理地址. . . . . : 88-31-42-58-38-50
    DHCP 已启用 . . . . . : 是
    自动配置已启用. . . . . : 是
    本地链接 IPv6 地址. . . . . : fe80::84bf:7fhe:b61f:c23b%19(首选)
    IPv4 地址 . . . . . : 192.168.2.104(首选)
    子网掩码 . . . . . : 255.255.255.0
    获得租约的时间 . . . . . : 2020年11月6日 18:44:01
    租约过期的时间 . . . . . : 2020年11月7日 18:44:01
    默认网关. . . . . : 192.168.2.1
    DHCP 服务器 . . . . . : 192.168.2.1
    DHCPv6 IAID . . . . . : 277897646
    DHCPv6 客户端 DUID . . . . . : 00-01-00-01-00-00-00-00-00-00-00-00-00-00-00-00
    DNS 服务器 . . . . . : 116.77.76.254
    . . . . . : 116.77.76.253
```

default gateway, DHCP Server

DHCP

RFC 2131

Dynamic Host Configuration Protocol

March 1997

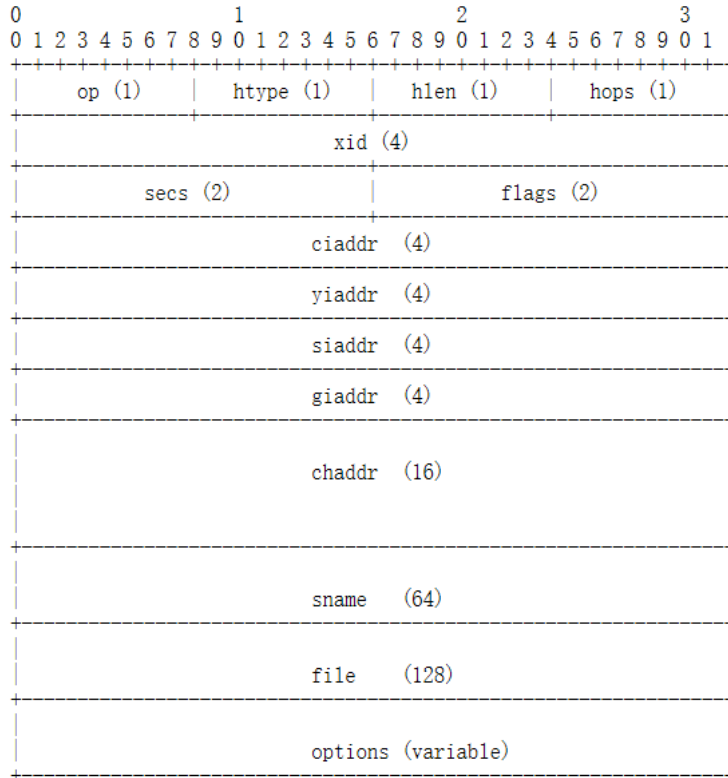


Figure 1: Format of a DHCP message

FIELD	OCTETS	DESCRIPTION
op	1	Message op code / message type. 1 = BOOTREQUEST, 2 = BOOTREPLY
htype	1	Hardware address type, see ARP section in "Assigned Numbers" RFC; e.g., '1' = 10mb ethernet.
hlen	1	Hardware address length (e.g. '6' for 10mb ethernet).
hops	1	Client sets to zero, optionally used by relay agents when booting via a relay agent.
xid	4	Transaction ID, a random number chosen by the client, used by the client and server to associate messages and responses between a client and a server.
secs	2	Filled in by client, seconds elapsed since client began address acquisition or renewal process.
flags	2	Flags (see figure 2).
ciaddr	4	Client IP address; only filled in if client is in BOUND, RENEW or REBINDING state and can respond to ARP requests.
yiaddr	4	'your' (client) IP address.
siaddr	4	IP address of next server to use in bootstrap; returned in DHCPDISCOVER, DHCPOFFER by server.
giaddr	4	Relay agent IP address, used in booting via a relay agent.
chaddr	16	Client hardware address.
sname	64	Optional server host name, null terminated string.
file	128	Boot file name, null terminated string; "generic" name or null in DHCPDISCOVER, fully qualified directory-path name in DHCPOFFER.
options	var	Optional parameters field. See the options documents for a list of defined options.

Table 1: Description of fields in a DHCP message

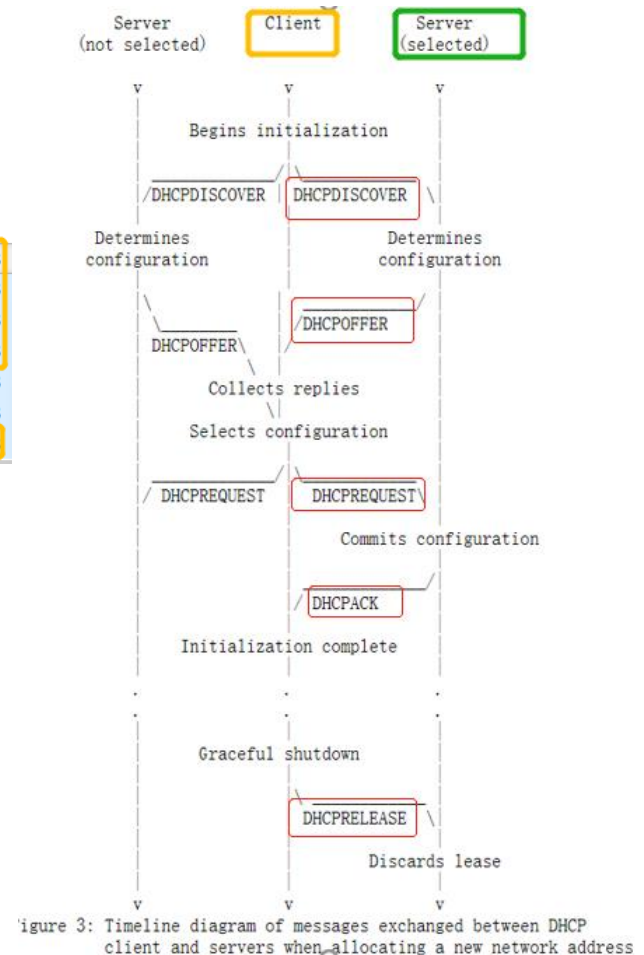
DHCP Session(1)

Client-Server interaction - allocating a network address

Source	Destination	Protocol	Info
0.0.0.0	255.255.255.255	DHCP	DHCP Discover - Transaction ID 0x3e5e0ce3
192.168.1.1	255.255.255.255	DHCP	DHCP Offer - Transaction ID 0x3e5e0ce3
0.0.0.0	255.255.255.255	DHCP	DHCP Request - Transaction ID 0x3e5e0ce3
192.168.1.1	255.255.255.255	DHCP	DHCP ACK - Transaction ID 0x3e5e0ce3
192.168.1.101	192.168.1.1	DHCP	DHCP Request - Transaction ID 0x257e55a3
192.168.1.1	255.255.255.255	DHCP	DHCP ACK - Transaction ID 0x257e55a3
192.168.1.101	192.168.1.1	DHCP	DHCP Release - Transaction ID 0xb7a32733

While network interface card is set as DHCP client,
using 'ipconfig /renew' to request a dynamically assigned IP addresses.
using 'ipconfig /release' to release the dynamically assigned IP addresses.

Tips in Wireshark : DHCP or
udp.port == 67 || udp.port == 68



DHCP Discover

```
> Frame 2: 342 bytes on wire (2736 bits), 342 bytes captured (2736 bits)
> Ethernet II, Src: Dell_4f:36:23 (00:08:74:4f:36:23), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
> Internet Protocol Version 4, Src: 0.0.0.0 (0.0.0.0), Dst: 255.255.255.255 (255.255.255.255)
> User Datagram Protocol, Src Port: bootpc (68), Dst Port: bootps (67)
```

✓ Bootstrap Protocol (Discover)

Message type: Boot Request (1)

Hardware type: Ethernet (0x01)

Hardware address length: 6

Hops: 0

Transaction ID: 0x3e5e0ce3

Seconds elapsed: 0

> Bootp flags: 0x0000 (Unicast)

Client IP address: 0.0.0.0 (0.0.0.0)

Your (client) IP address: 0.0.0.0 (0.0.0.0)

Next server IP address: 0.0.0.0 (0.0.0.0)

Relay agent IP address: 0.0.0.0 (0.0.0.0)

Client MAC address: Dell_4f:36:23 (00:08:74:4f:36:23)

Client hardware address padding: 00000000000000000000

Server host name not given

Boot file name not given

Magic cookie: DHCP

> Option: (53) DHCP Message Type (Discover)

> Option: (116) DHCP Auto-Configuration

> Option: (61) Client identifier

> Option: (50) Requested IP Address

> Option: (12) Host Name

> Option: (60) Vendor class identifier

> Option: (55) Parameter Request List

> Option: (255) End

Padding: 00000000000000000000

✓ Option: (53) DHCP Message Type (Discover)

Length: 1

DHCP: Discover (1)

✓ Option: (116) DHCP Auto-Configuration

Length: 1

DHCP Auto-Configuration: AutoConfigure (1)

✓ Option: (61) Client identifier

Length: 7

Hardware type: Ethernet (0x01)

Client MAC address: Dell_4f:36:23 (00:08:74:4f:36:23)

✓ Option: (50) Requested IP Address

Length: 4

Requested IP Address: 192.168.1.101 (192.168.1.101)

✓ Option: (12) Host Name

Length: 4

Host Name: Noho

✓ Option: (60) Vendor class identifier

Length: 8

Vendor class identifier: MSFT 5.0

✓ Option: (55) Parameter Request List

Length: 11

Parameter Request List Item: (1) Subnet Mask

Parameter Request List Item: (15) Domain Name

Parameter Request List Item: (3) Router

Parameter Request List Item: (6) Domain Name Server

Parameter Request List Item: (44) NetBIOS over TCP/IP Name Server

Parameter Request List Item: (46) NetBIOS over TCP/IP Node Type

Parameter Request List Item: (47) NetBIOS over TCP/IP Scope

Parameter Request List Item: (31) Perform Router Discover

Parameter Request List Item: (33) Static Route

Parameter Request List Item: (249) Private/Classless Static Route (Microsoft)

DHCP Offer

```
> User Datagram Protocol, Src Port: bootps (67), Dst Port: bootpc (68)
```


- ▼ Bootstrap Protocol (Offer)

Message type: Boot Reply (2)

Hardware type: Ethernet (0x01)

Hardware address length: 6

Hops: 0

Transaction ID: 0x3e5e0ce3 

Seconds elapsed: 0

```
> Bootp flags: 0x0000 (Unicast)
```

Client IP address: 0.0.0.0 (0.0.0.0)

```
Your (client) IP address: 192.168.1.101 (192.168.1.101)
```

```
Next server IP address: 0.0.0.0 (0.0.0.0)
```

Relay agent IP address: 0.0.0.0 (0.0.0.0)

Client MAC address: Dell 4f:36:23 (00:08:74:4f:36:23)

```
Client hardware address padding: 00000000000000000000
```

Server host name not given

Boot file name not given

Magic cookie: DHCP

- Option: (53) DHCP Message Type (Offer)

Length: 1

DHCP: Offer (2)

- Option: (1) Subnet Mask

Length: 4

Subnet Mask: 255.255.255.0

- Option: (3) Router

Length: 4

Router: 192.168.1.1 (192.168.1.1)

- Option: (6) Domain Name Server

Length: 8

Domain Name Server: ns10.attbi.com (63.240.76.19)

Domain Name Server: 204.127.198.19 (204.127.198.19)

✓ Option: (15) Domain Name

Length: 22

Domain Name: ne2.client2.attbi.com

- Option: (51) IP Address Lease Time

Length: 4

IP Address Lease Time: (86400s) 1 day

- Option: (54) DHCP Server Identifier

Length: 4

DHCP Server Identifier: 192.168.1.1 (192.168.1.1)

Option: (255) End

Option End: 255

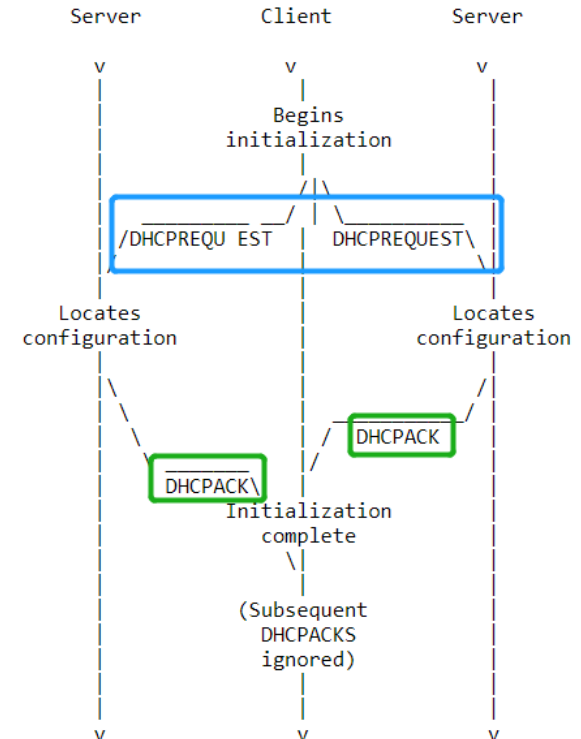
[illegible]

DHCP Session(2)

Client-Server interaction :

reusing a previously allocated network address

*Tips in Wireshark : DHCP or
udp.port == 67 || udp.port == 68*



dhcp			
Source	Destination	Protocol	Info
activate.adobe.com	255.255.255.255	DHCP	DHCP Request - Transaction ID 0x98bd1be8
192.168.2.1	LAPTOP-RITC8FUU.local	DHCP	DHCP ACK - Transaction ID 0x98bd1be8

DHCP Request & Ack

```
> User Datagram Protocol, Src Port: bootpc (68), Dst Port: bootps (67)
< Dynamic Host Configuration Protocol (Request)
  Message type: Boot Request (1)
  Hardware type: Ethernet (0x01)
  Hardware address length: 6
  Hops: 0
  Transaction ID: 0x98bd1be8
  Seconds elapsed: 0
  > Bootp flags: 0x0000 (Unicast)
  Client IP address: activate.adobe.com (0.0.0.0)
  Your (client) IP address: activate.adobe.com (0.0.0.0)
  Next server IP address: activate.adobe.com (0.0.0.0)
  Relay agent IP address: activate.adobe.com (0.0.0.0)
  Client MAC address: LAPTOP-RITC8FUU.local (90:61:ae:5c:69:58)
  Client hardware address padding: 00000000000000000000
  Server host name not given
  Boot file name not given
  Magic cookie: DHCP
  > Option: (53) DHCP Message Type (Request)
  > Option: (61) Client identifier
  > Option: (50) Requested IP Address (192.168.2.104)
  > Option: (12) Host Name
  > Option: (81) Client Fully Qualified Domain Name
  > Option: (60) Vendor class identifier
  > Option: (55) Parameter Request List
  > Option: (255) End
```

```
User Datagram Protocol, Src Port: bootps (67), Dst Port: bootpc (68)
Dynamic Host Configuration Protocol (ACK)
  Message type: Boot Reply (2)
  Hardware type: Ethernet (0x01)
  Hardware address length: 6
  Hops: 0
  Transaction ID: 0x98bd1be8
  Seconds elapsed: 0
  > Bootp flags: 0x0000 (Unicast)
  Client IP address: activate.adobe.com (0.0.0.0)
  Your (client) IP address: LAPTOP-RITC8FUU.local (192.168.2.104)
  Next server IP address: 192.168.2.1 (192.168.2.1)
  Relay agent IP address: activate.adobe.com (0.0.0.0)
  Client MAC address: LAPTOP-RITC8FUU.local (90:61:ae:5c:69:58)
  Client hardware address padding: 00000000000000000000
  Server host name not given
  Boot file name not given
  Magic cookie: DHCP
  > Option: (53) DHCP Message Type (ACK)
  > Option: (1) Subnet Mask (255.255.255.0)
  > Option: (2) Time Offset
  > Option: (3) Router
  > Option: (23) Default IP Time-to-Live
  > Option: (51) IP Address Lease Time
  > Option: (54) DHCP Server Identifier (192.168.2.1)
  > Option: (6) Domain Name Server
  > Option: (58) Renewal Time Value
  > Option: (59) Rebinding Time Value
  > Option: (255) End
  Padding: 00
```

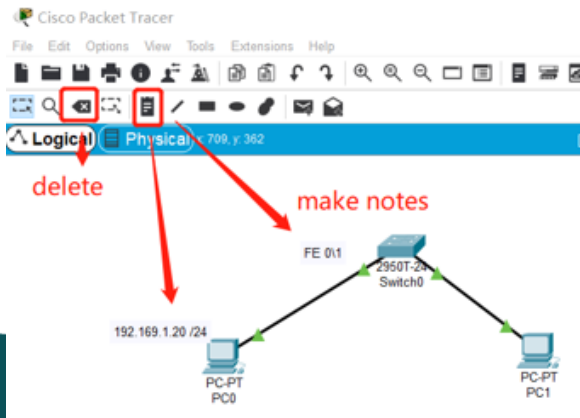
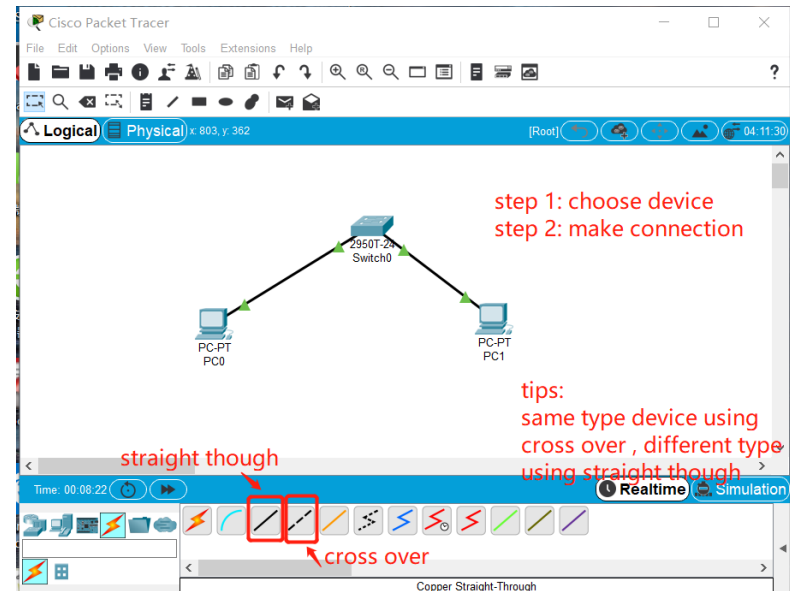
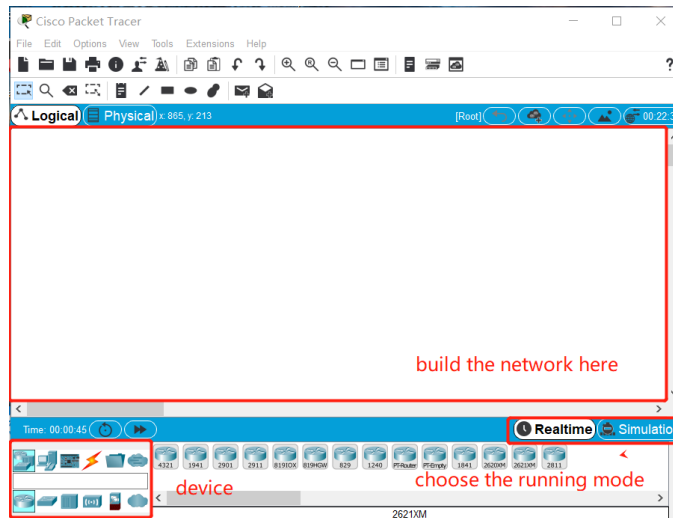

Simulator: Packet Tracer

- **Packet Tracer** allows users to create simulated network topologies by dragging and dropping routers, switches and various other types of network devices.
- Packet Tracer supports an array of simulated Application Layer protocols, as well as basic routing with RIP, OSPF, EIGRP, BGP to the extents required by the current CCNA curriculum.
- Packet Tracer can be run on Linux and Microsoft Windows. Similar Android and iOS apps are also available.

Cisco CLI

- Different views
 - From **user view** to **system view**, using command “**enable**” ,
 - From **system view** to **function view**, using **function name** or object name as command, such as “interface giga 0/0”
- Frequently used commands
 - **show** //display the info (ip routing table, interface, mac-address table)
 - **exit, end** //back to upper layer, back to root layer
 - **?, Tab** // help to find the rest part of command
 - **no** //the 1st word of command to cancel the following command, such as: using “route rip” to config rip while using “no route rip” to cancel the setting

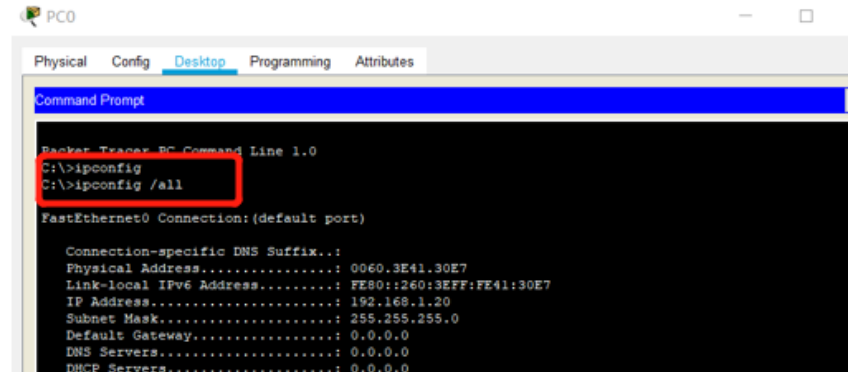
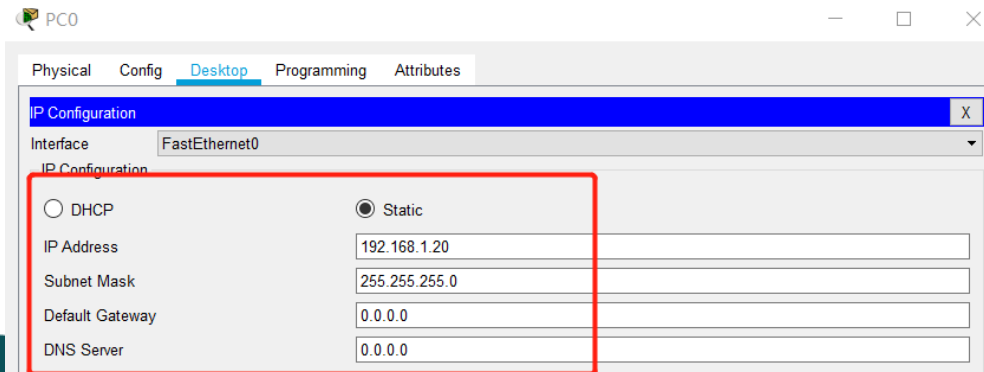
Packet Tracer(1) Create Network



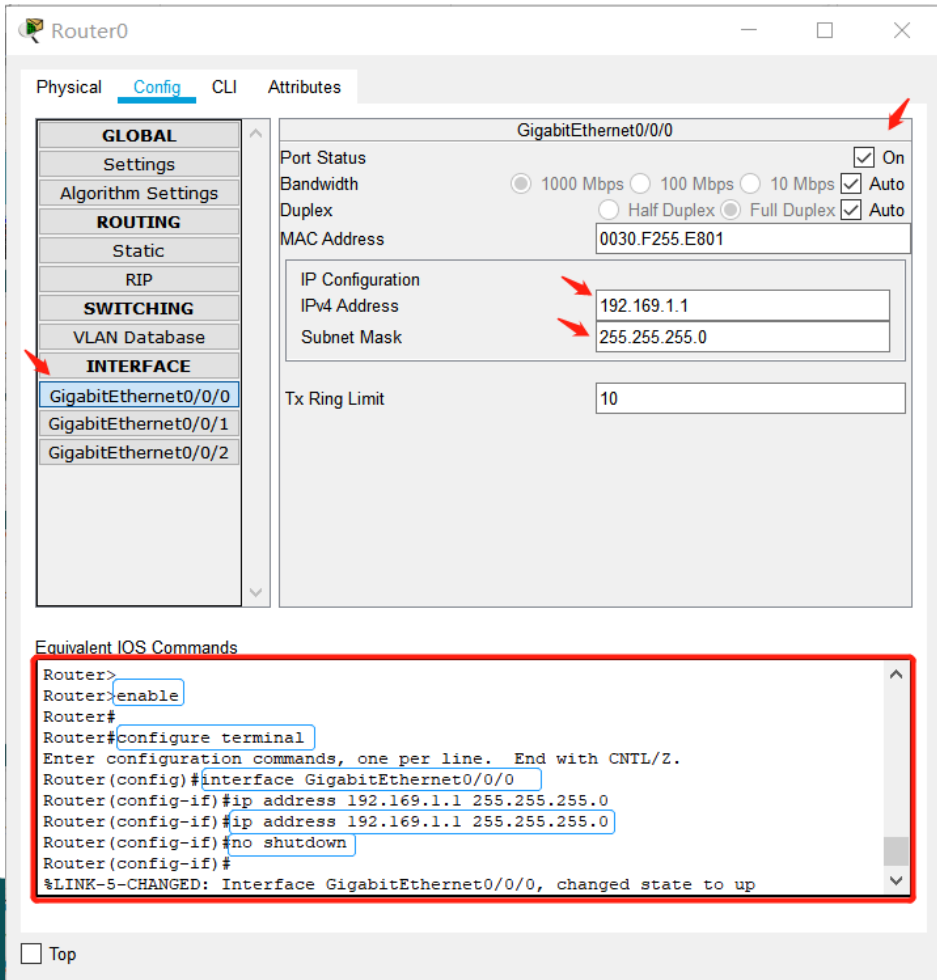
Download from
<https://www.packettracernetwork.com/download/download-packet-tracer.html>

Packet Tracer(2) PC Configuration

Config and test on PC

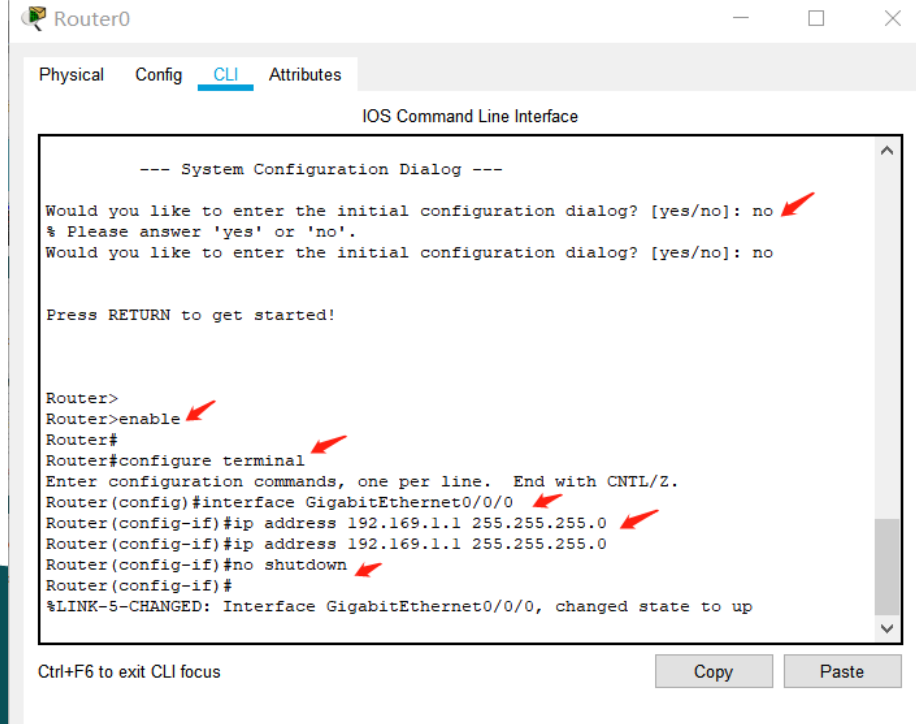


Packet Tracer(3) Router Configuration



The screenshot shows the configuration window for Router0. The 'Config' tab is selected. On the left, the 'INTERFACE' section is expanded, and 'GigabitEthernet0/0/0' is selected. The main area shows the configuration for this interface. The 'Port Status' is 'On'. The 'Bandwidth' is set to '1000 Mbps'. The 'Duplex' is set to 'Full Duplex'. The 'MAC Address' is '0030.F255.E801'. The 'IP Configuration' section shows the 'IPv4 Address' as '192.169.1.1' and the 'Subnet Mask' as '255.255.255.0'. The 'Tx Ring Limit' is '10'. At the bottom, the 'Equivalent IOS Commands' section shows the following commands:

```
Router>
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface GigabitEthernet0/0/0
Router(config-if)#ip address 192.169.1.1 255.255.255.0
Router(config-if)#ip address 192.169.1.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0/0, changed state to up
```



The screenshot shows the CLI window for Router0. The 'CLI' tab is selected. The window displays the 'IOS Command Line Interface'. The text in the window is as follows:

```
--- System Configuration Dialog ---

Would you like to enter the initial configuration dialog? [yes/no]: no
% Please answer 'yes' or 'no'.
Would you like to enter the initial configuration dialog? [yes/no]: no

Press RETURN to get started!

Router>
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface GigabitEthernet0/0/0
Router(config-if)#ip address 192.169.1.1 255.255.255.0
Router(config-if)#ip address 192.169.1.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0/0, changed state to up
```

Ctrl+F6 to exit CLI focus

Copy Paste

Packet Tracer(3) Realtime Mode

```
PC0
Physical Config Desktop Programming Attributes
Command Prompt

C:\>ipconfig

FastEthernet0 Connection: (default port)

Link-local IPv6 Address . . . . . : FE80::201:97FF:FE66:591E
IP Address . . . . . : 192.168.1.21
Subnet Mask . . . . . : 255.255.255.0
Default Gateway . . . . . : 192.168.1.1

Bluetooth Connection:

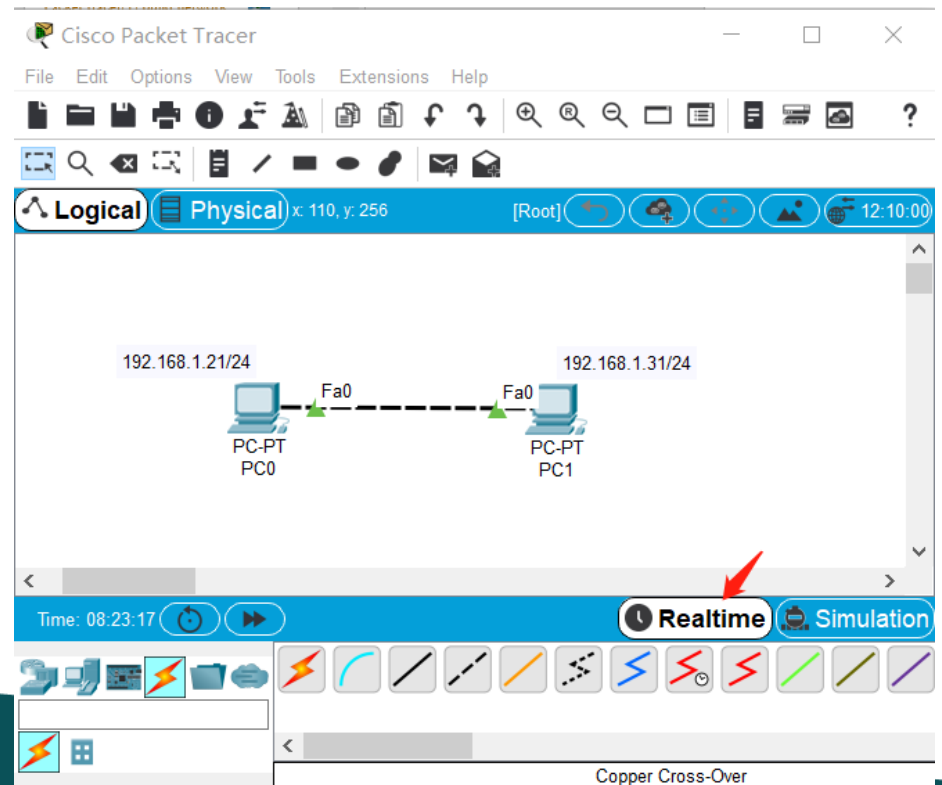
Link-local IPv6 Address . . . . . : FE80::200:CFF:FE9E:41A9
IP Address . . . . . : 0.0.0.0
Subnet Mask . . . . . : 0.0.0.0
Default Gateway . . . . . : 0.0.0.0

C:\>ping 192.168.1.31

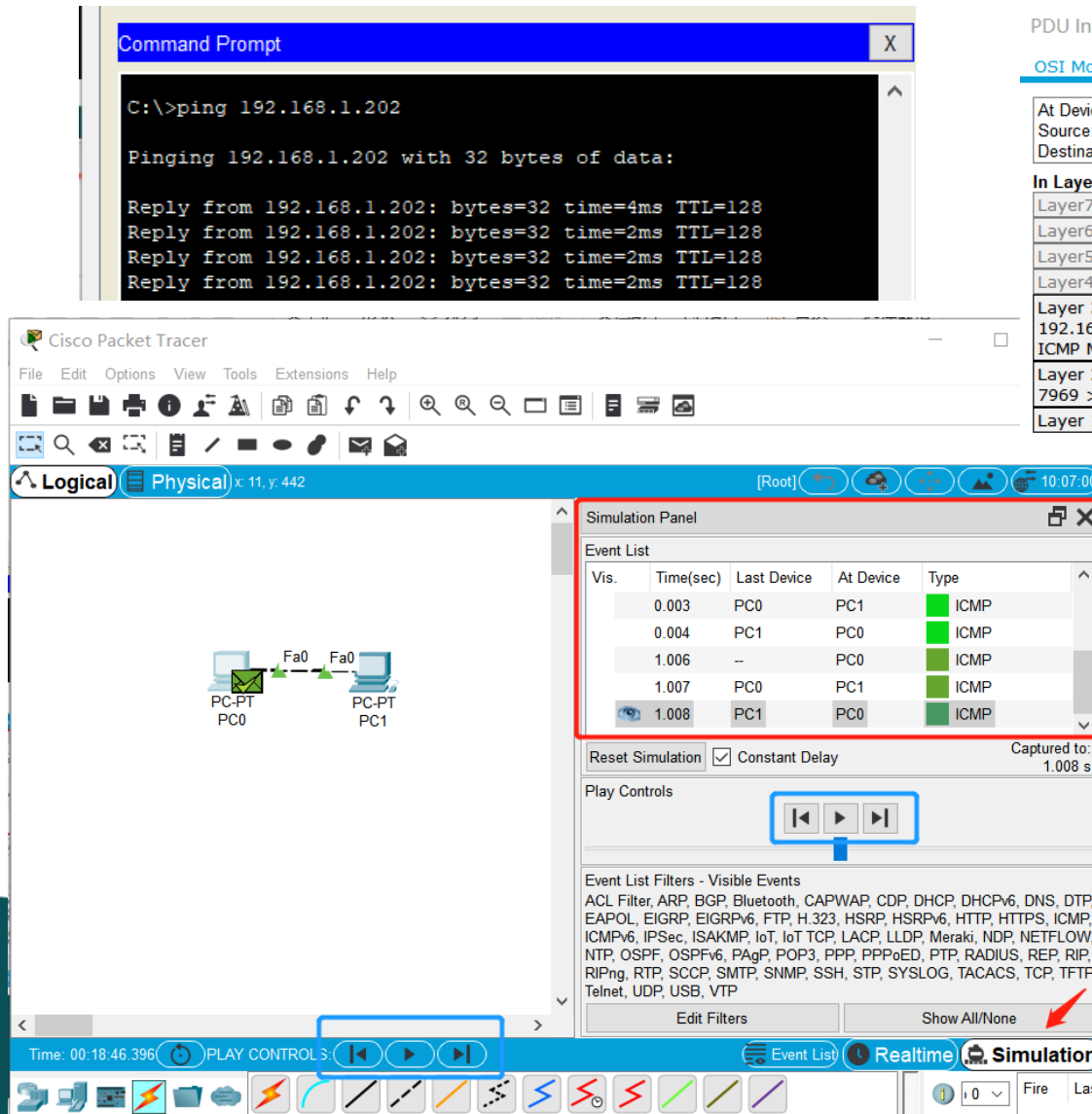
Pinging 192.168.1.31 with 32 bytes of data:

Reply from 192.168.1.31: bytes=32 time=1ms TTL=128
Reply from 192.168.1.31: bytes=32 time<1ms TTL=128
Reply from 192.168.1.31: bytes=32 time<1ms TTL=128
Reply from 192.168.1.31: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.1.31:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms
```



Packet Tracer(4) Simulation Mode



PDU Information at Device: PC1

OSI Model

Inbound PDU Details

Outbound PDU Details

At Device: PC1
Source: PC0
Destination: 192.168.1.202

In Layers

Layer7
Layer6
Layer5
Layer4
Layer 3: IP Header Src. IP: 192.168.1.101, Dest. IP: 192.168.1.202 ICMP Message Type: 8
Layer 2: Ethernet II Header 0001.C7AE. 7969 >> 0030.A310.D9DE
Layer 1: Port FastEthernet0

Out Layers

Layer7
Layer6
Layer5
Layer4
Layer 3: IP Header Src. IP: 192.168.1.202, Dest. IP: 192.168.1.101 ICMP Message Type: 0
Layer 2: Ethernet II Header 0030.A310.D9DE >> 0001.C7AE.7969
Layer 1: Port(s): FastEthernet0

PDU Information at Device: PC1

OSI Model

Inbound PDU Details

Outbound PDU Details

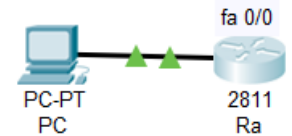
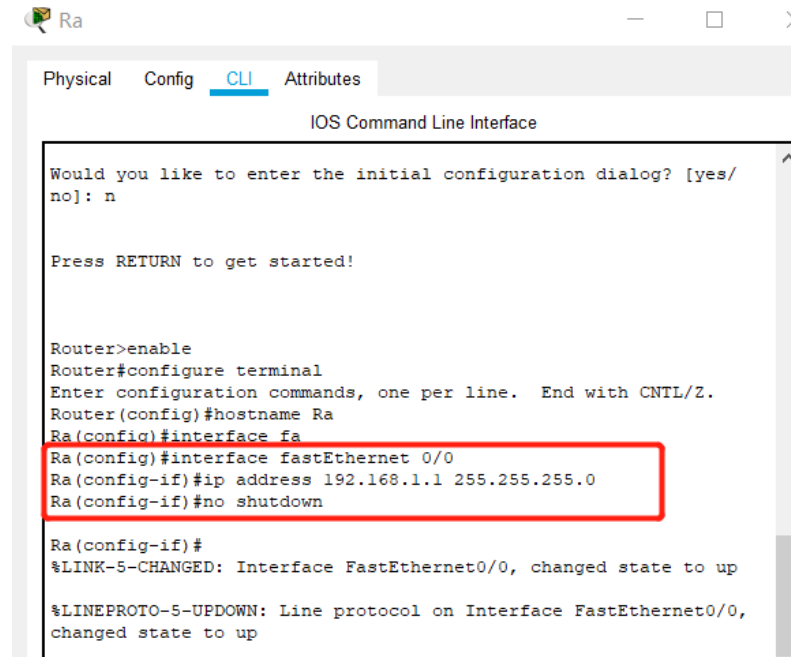
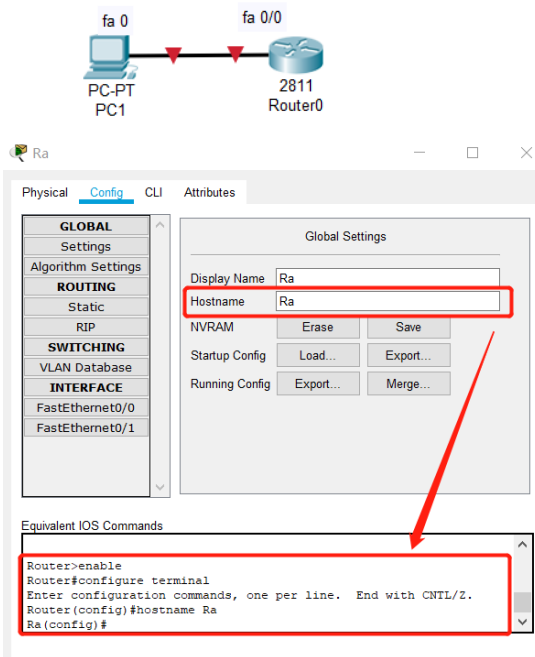
PDU Formats

IP		0		4		8		16		20		24		Bits	
VER:4				IHL:5				DSCP:0x00				TL:128			
ID:0x0004								FLAGS:0x0				FRAG OFFSET:0x000			
TTL:128				PRO:0x01				CHKSUM							
SRC IP:192.168.1.202															
DST IP:192.168.1.101															
DATA (VARIABLE LENGTH)															

ICMP		0		8		16		Bits			
TYPE:0x00				CODE:0x00				CHECKSUM			
ID:0x0002								SEQ NUMBER:4			

Packet Tracer DHCP(1)

Tips : the state of interface of router is down by default



```
Ra#show interfaces fastEthernet 0/0
FastEthernet0/0 is up, line protocol is up (connected)
  Hardware is Lance, address is 00d0.d30b.0201 (bia 00d0.d30b.0201)
  Internet address is 192.168.1.1/24
  MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Full-duplex, 100Mb/s, media type is RJ45
```

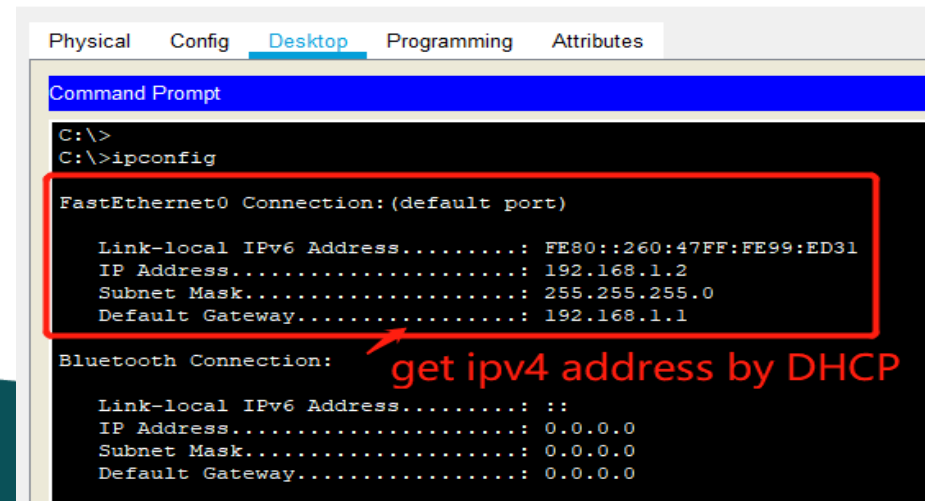
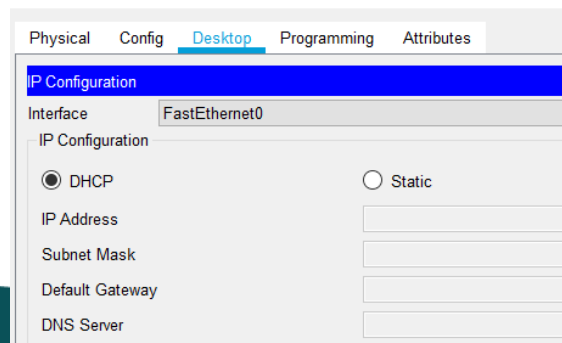

Packet Tracer DHCP(2)



1. Up the interface connect with PC, configure its IP address
2. Make a DHCP pool
 - 1) Configure the default-router with the IP address of the interface
 - 2) Configure the network with the same sub-net ID as default-router

```
Ra#configure
Configuring from terminal, memory, or network [terminal]? t
Enter configuration commands, one per line. End with CNTL/Z.
Ra(config)#ip dhcp pool pa0
Ra(dhcp-config)#?
  default-router  Default routers
  dns-server      Set name server
  domain-name     Domain name
  exit            Exit from DHCP pool configuration mode
  network         Network number and mask
  no              Negate a command or set its defaults
  option          Raw DHCP options
Ra(dhcp-config)#default-router 192.168.1.1
Ra(dhcp-config)#network 192.168.1.0 255.255.255.0
Ra(dhcp-config)#exit
Ra(config)#
```

Annotations: "make a dhcp pool" points to `ip dhcp pool pa0`; "gateway" points to `default-router 192.168.1.1`.



Lab9.1 Assignment

1. Initiates a DHCP session on your Notebook

- How to initiate a DHCP session? How to find the DHCP session packets?
- Is DHCP an application protocol or an network protocol? explain how do you make such a judgement.
- What's the source IP address and destination IP address of a DHCP request? What is the type of these two IP address?
- What info items are required for a host if it need to contact with others by its name on the Internet?
- Find the Lease Time of a dynamic IP address, What's its value? In which type of DHCP packet could this field be set?

Please add the necessary screenshots when answering questions.

Lab9.2 Assignment

2. Practice on Packet Tracer

- Connect two PCs, configure them with static IP address, make them belong to same sub-network, test to see if these two PCs could reach each other or not.
- Create a network with a Router and 2 PCs, make the info of interface visible
 - configure the interface of Router with IP address and netmask, 'up' the interface
 - configure the IP DHCP pool with name, default-gateway and subnet
 - configure the PC as DHCP client
 - connect the Router with 2 PCs
 - test if PC could reach the Router, test if 2 PCs could reach each other or not.
 - how many subnet in this network? what are their net IDs?

Please add the necessary screenshots when answering questions.