CS 305 Lab Tutorial
Lab9 DHCP & Packet-Tracer

Dept. Computer Science and Engineering
Southern University of Science and Technology

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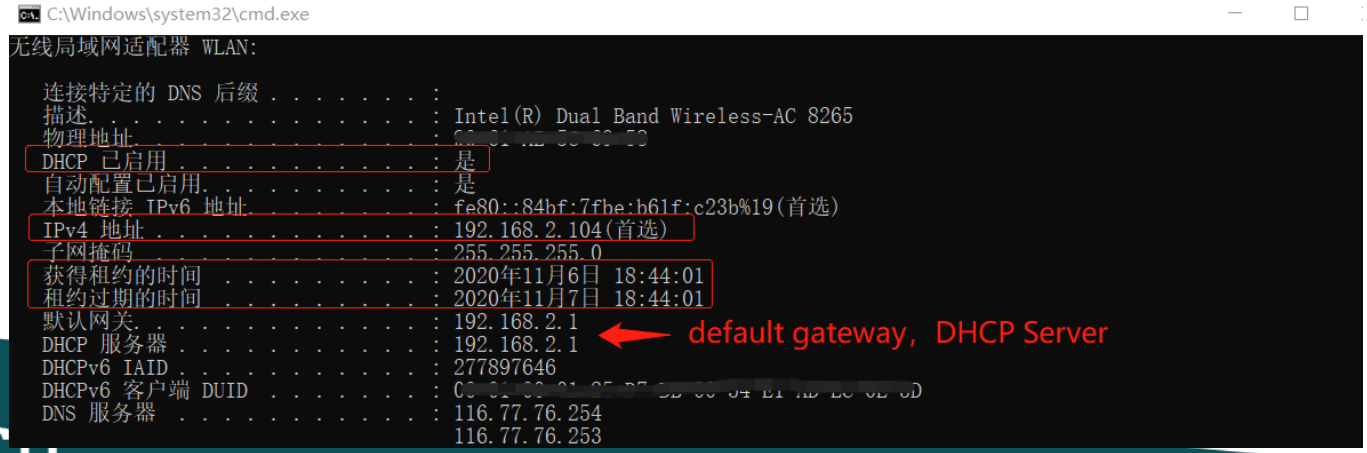
Thanks to Wei WANG

Part A. DHCP

- DHCP is built on a Client-Server model
  - server: a host providing initialization parameters through DHCP
  - client: a host requesting initialization parameters from a DHCP server
  - designated DHCP server hosts allocate network addresses and deliver configuration parameters to dynamically configured hosts
- BOOTP is a transport mechanism for a collection of configuration information. BOOTP using port 67 AND 68 of UDP.



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https://www.rfc-editor.org/rfc/rfc2131.txt

DHCP

RFC 2131 Dynamic Host Configuration Protocol March 1997

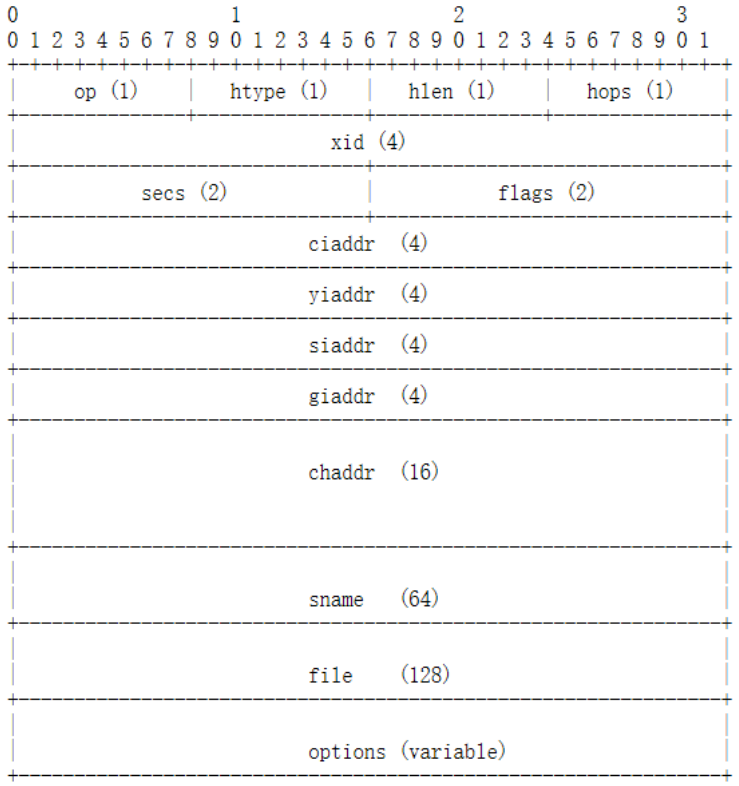

Figure 1: Format of a DHCP message

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 DHCPOFFER, DHCPACK 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

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https://www.rfc-editor.org/rfc/rfc2131.txt

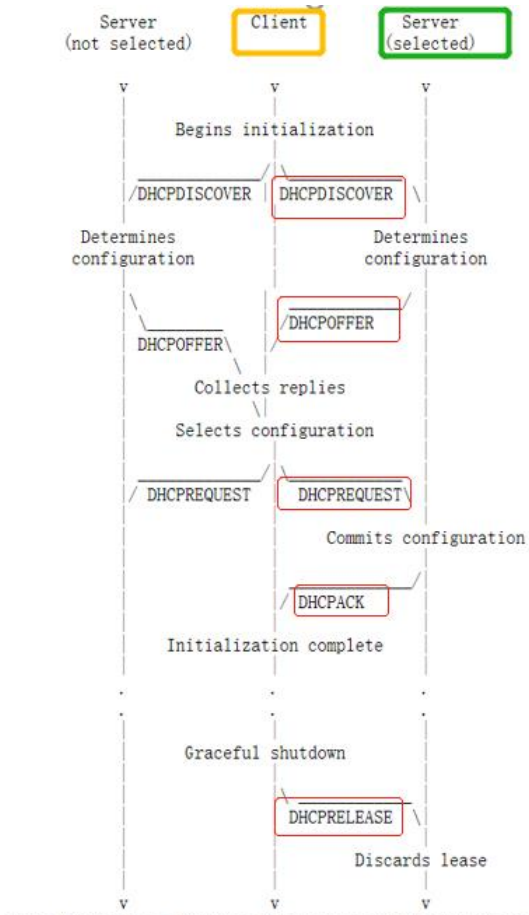
DHCP Session(1)

- Client-Server interaction when allocating a new 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

Tips in command line:
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 display filter : DHCP or
udp.port == 67 || udp.port == 68



igure 3: Timeline diagram of messages exchanged between DHCP client and servers when allocating a new network address

https://tools.ietf.org/html/rfc2131

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)
v 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: 000000000000000000
```

```
v Option: (53) DHCP Message Type (Discover)
      Length: 1
      DHCP: Discover (1)
v Option: (116) DHCP Auto-Configuration
      Length: 1
      DHCP Auto-Configuration: AutoConfigure (1)
v Option: (61) Client identifier
      Length: 7
      Hardware type: Ethernet (0x01)
      Client MAC address: Dell_4f:36:23 (00:08:74:4f:36:23)
v Option: (50) Requested IP Address
      Length: 4
      Requested IP Address: 192.168.1.101 (192.168.1.101)
v Option: (12) Host Name
      Length: 4
      Host Name: Noho
v Option: (60) Vendor class identifier
      Length: 8
      Vendor class identifier: MSFT 5.0
v 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)
```

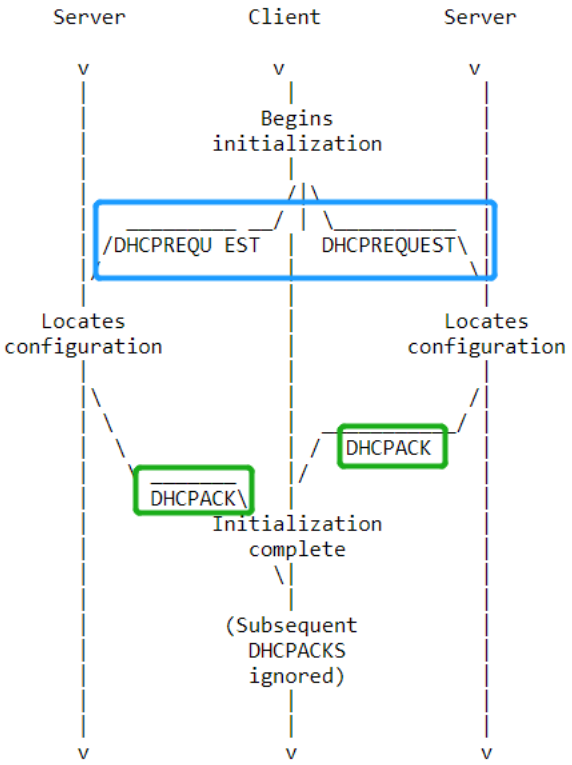
DHCP Offer

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

```
v Option: (53) DHCP Message Type (Offer)
      Length: 1
      DHCP: Offer (2)
v Option: (1) Subnet Mask
      Length: 4
      Subnet Mask: 255.255.255.0
v Option: (3) Router
      Length: 4
      Router: 192.168.1.1 (192.168.1.1)
v 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)
v Option: (15) Domain Name
      Length: 22
      Domain Name: ne2.client2.attbi.com
v Option: (51) IP Address Lease Time
      Length: 4
      IP Address Lease Time: (86400s) 1 day
v Option: (54) DHCP Server Identifier
      Length: 4
      DHCP Server Identifier: 192.168.1.1 (192.168.1.1)
v Option: (255) End
      Option End: 255
  Padding: 0000000000000000000000000000000000000000000000000...
```

DHCP Session(2)

- Client-Server interaction when reusing a previously allocated network address



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

https://tools.ietf.org/html/rfc2131

DHCP Request & Ack

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

Part B. 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.

https://en.wikipedia.org/wiki/Packet_Tracer

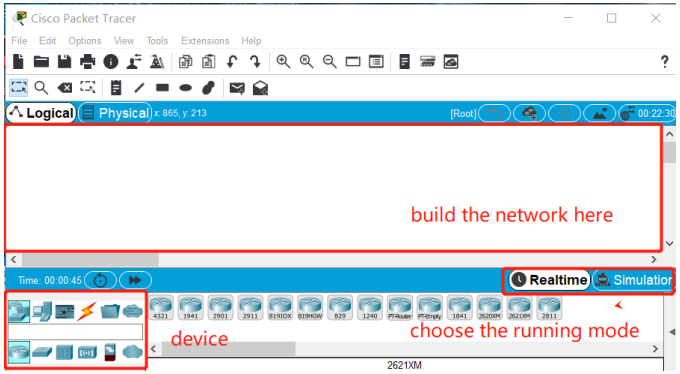
Cisco CLI

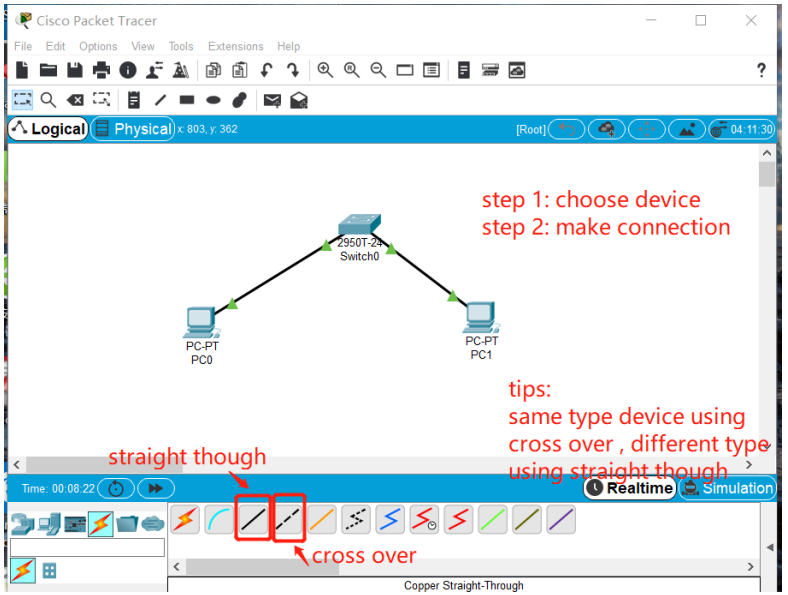
- Different views
  - Three kinds of view, each supports different operations, and each view has different command prompt.

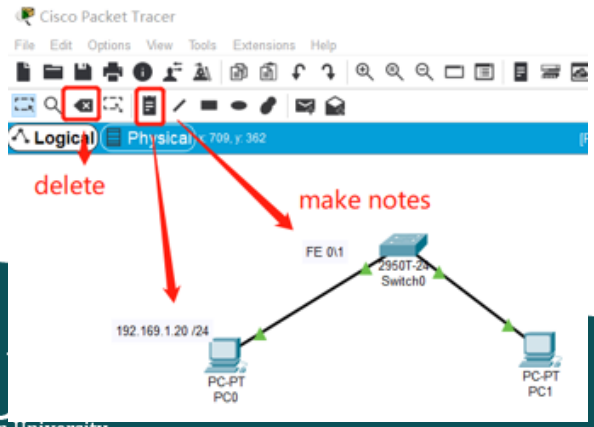
```
Router>    Router#      Router(config)#:     Router(config-if)#:
```

  - 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 *** //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



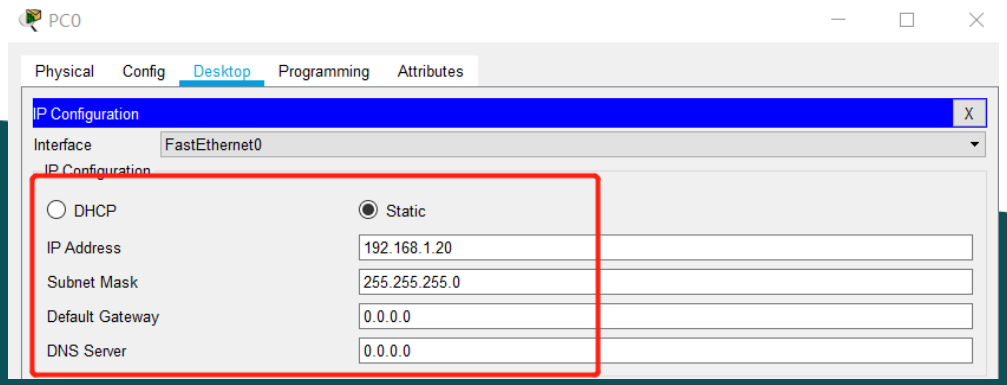


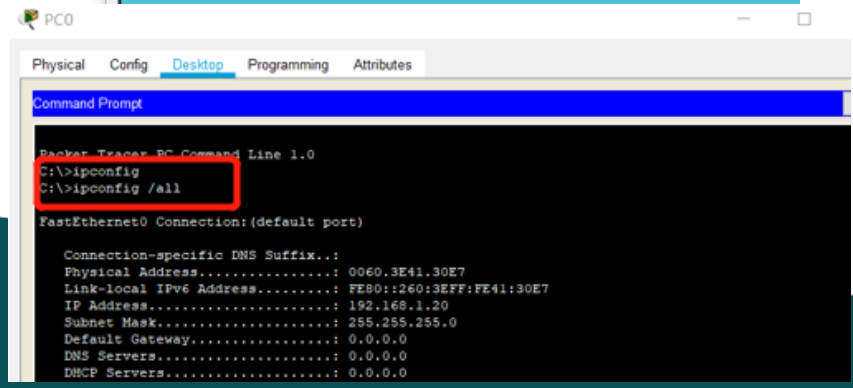


Download from
https://www.packettracernetwork.com/download/download-packet-tracer.html

Packet Tracer(2) PC Configuration

- Open configure window by clicking the PC icon.
- We can make all the configurations of PC in different interfaces.
- In IP Configuration interface, we can make IP configurations.
- In Command Prompt interface, we can use cmd commands just as what we can do on our own PC.
- Commands such as ping, ipconfig, etc. are available.





Packet Tracer(3) Router Configuration

- Open configure window by clicking the Router icon.
- We can make all the configurations of Router by using CLI commands.
- We can also make some simple configurations by using graphic interface, and the corresponding CLI commands will be generated on bellowing.

Router0

Physical Config CLI Attributes

IOS Command Line Interface

```
        --- 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

Router0

Physical Config CLI Attributes

GLOBAL
Settings
Algorithm Settings
ROUTING
Static
RIP
SWITCHING
VLAN Database
INTERFACE
GigabitEthernet0/0/0
GigabitEthernet0/0/1
GigabitEthernet0/0/2

GigabitEthernet0/0/0

Port Status: On
Bandwidth: 1000 Mbps 100 Mbps 10 Mbps Auto
Duplex: Half Duplex Full Duplex Auto
MAC Address: 0030.F255.E801

IP Configuration
IPv4 Address: 192.169.1.1
Subnet Mask: 255.255.255.0

Tx Ring Limit: 10

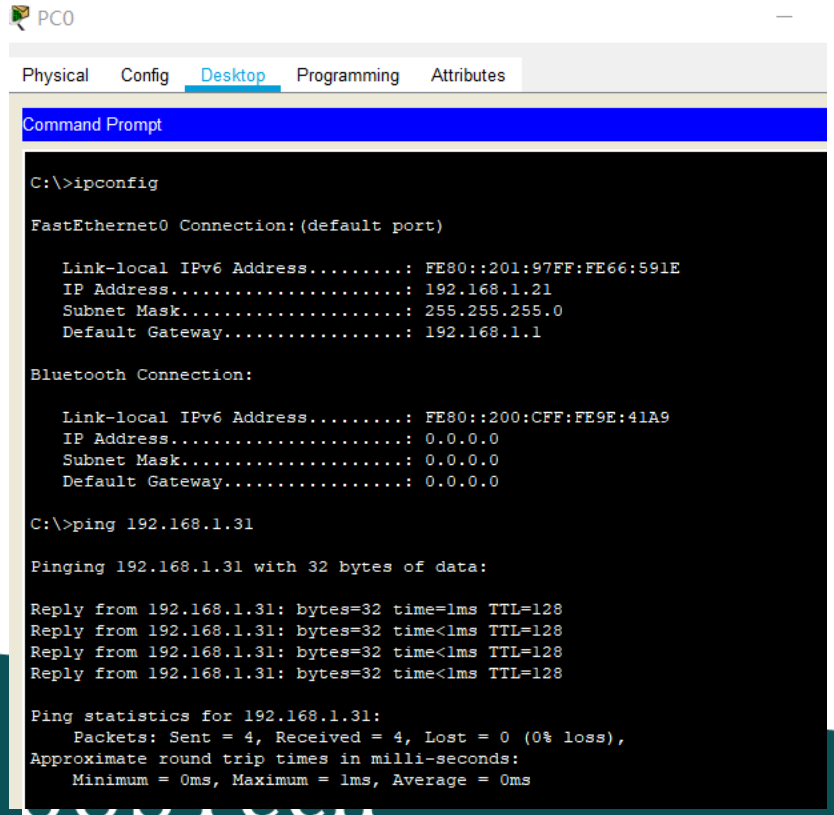
Equivalent IOS Commands

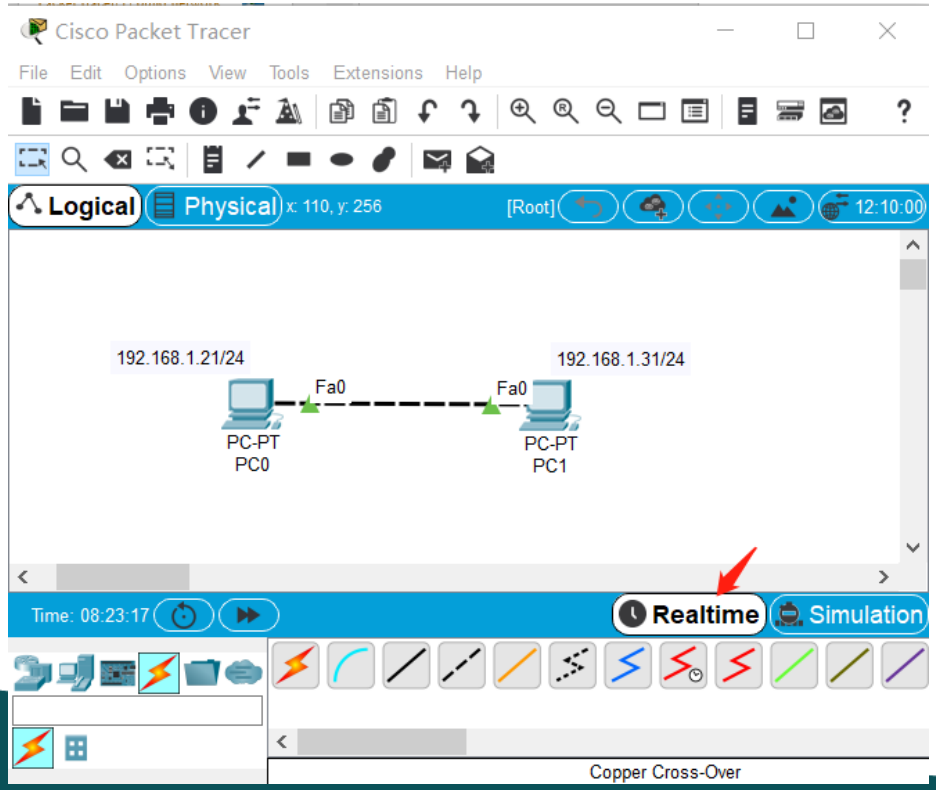
```
Router>
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#interface GigabitEthernet0/0/0
Router(config-if)#ip address 192.169.1.1 255.255.255.0
Router(config-if)#ip address 192.169.1.1 255.255.255.0
Router(config-if)#no shutdown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

Top

Packet Tracer(4) Realtime Mode

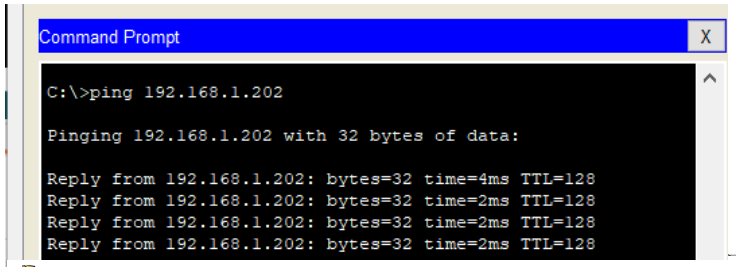
- Complete all the operations once start in realtime mode.
- You can get the result “Fail” or “Successful”.

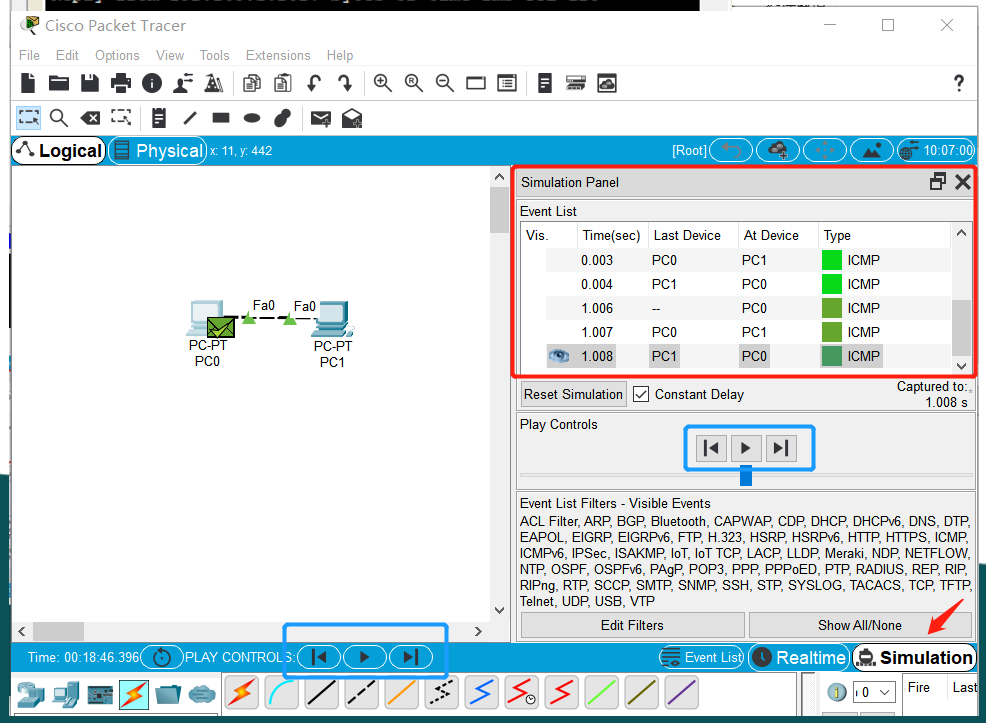


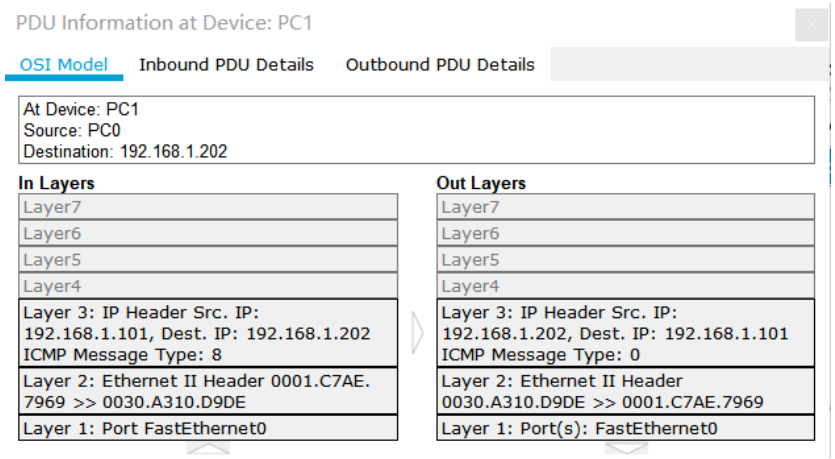


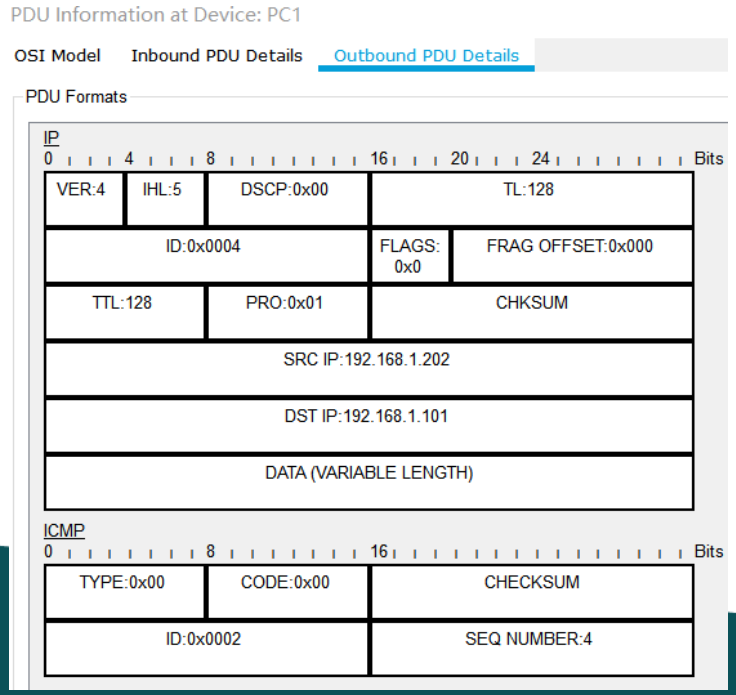
Packet Tracer(5) Simulation Mode

- All specified packets can be opbserved and analysed in simulation mode.





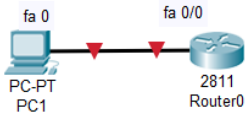




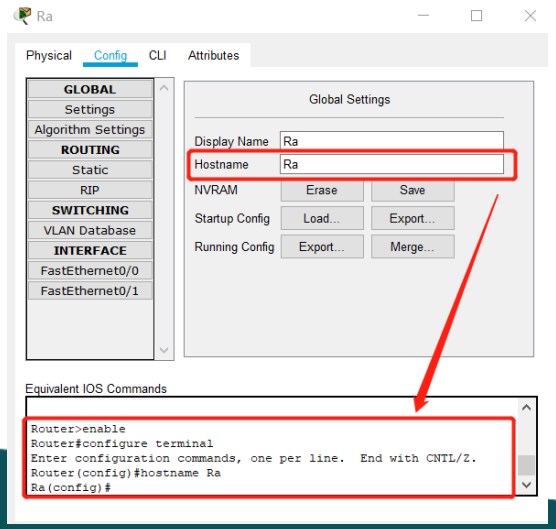
Packet Tracer DHCP(1)

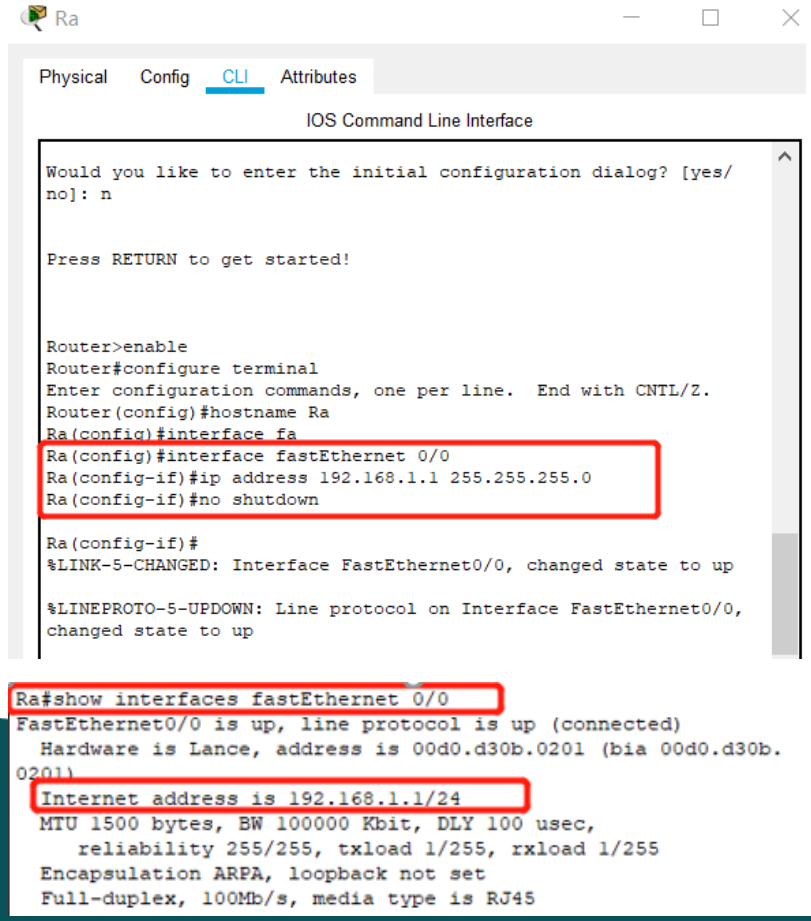
Tips: (1) The state of interface of router is down by default, we can use “no shutdown” command to enable the interface.

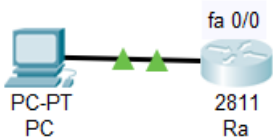
(2) As soon as the interface is enabled, DHCP server is enabled by default.



Red icons indicate unreachable







Green icons indicate reachable

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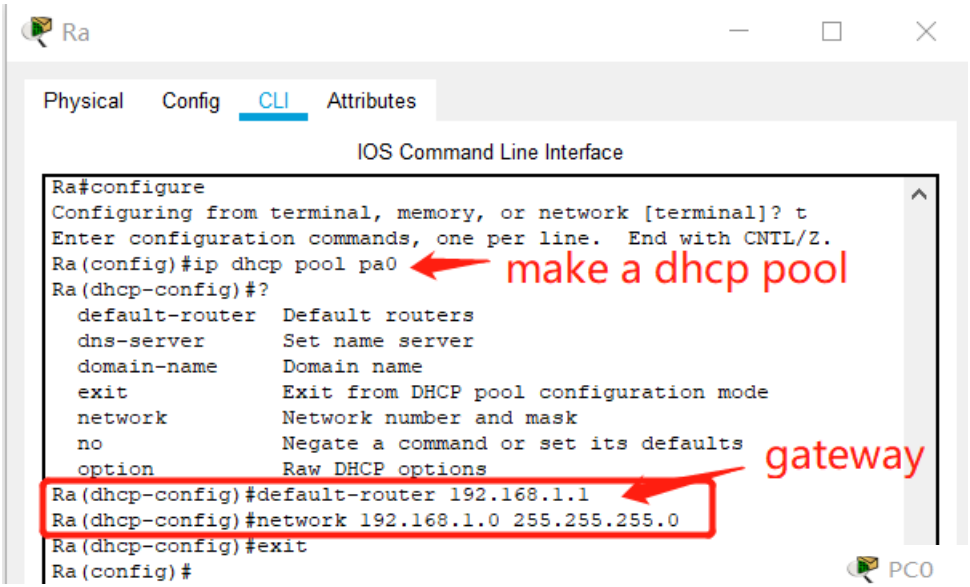
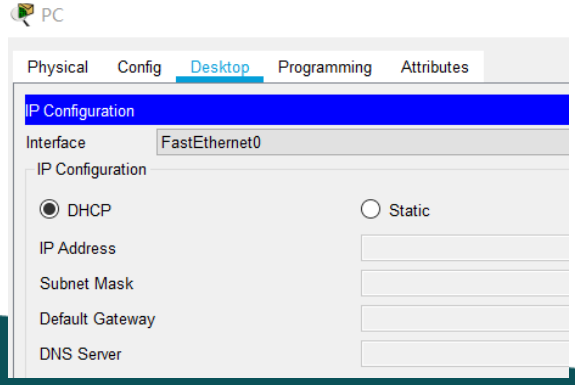
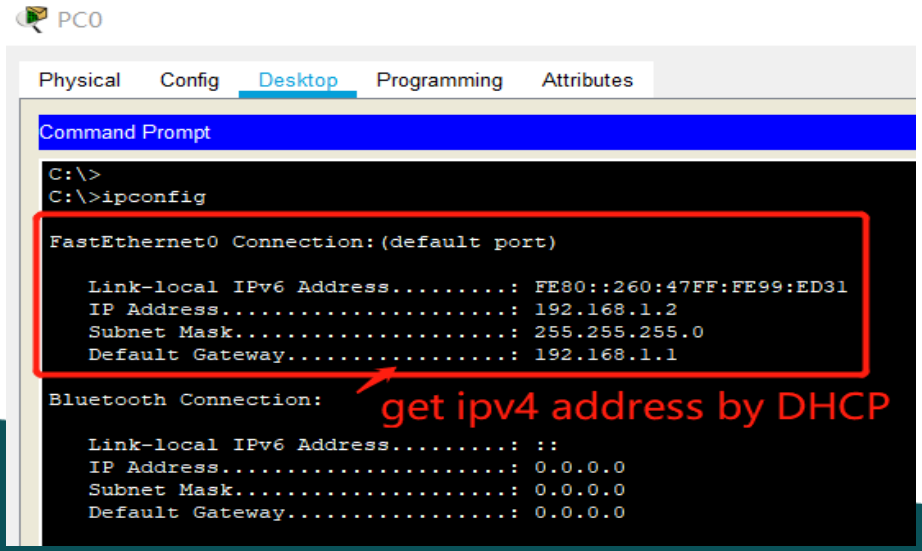
Packet Tracer DHCP(2)



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





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Packet Tracer DHCP(3)

- Some CLI commands about DHCP configuration.
- The DHCP commands should be used in DHCP conf view.

```
Router(config)#ip dhcp pool dhcpppp12
Router(dhcp-config)#network 192.168.2.0 255.255.255.0
```

Command	Function
show ip dhcp pool	Display information about DHCP address pool
show ip interface	Display information about interface
service dhcp	Launch DHCP server
ip dhcp pool	Configure DHCP address pool
network DHCP	Configure IP and network of server
default-router	Default gateway

Practise 9.1

1. Initiates a DHCP session on your Notebook, capture the session:
   - 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?

   Tips:
   - using 'ipconfig /renew' to request a dynamically assigned IP addresses.
   - using 'ipconfig /release' to release the dynamically assigned IP addresses

Practise 9.2

2. Practice on Packet Tracer

- Create a network with two PCs, connect the two PCs, configure them with static IP address, make them belong to same sub-network, test to see whether these two PCs could reach eachother or not.
- Create another network with a Router and two PCs, make the configuration 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 PCs as DHCP client
  - connect the Router with two PCs
  - test if two PCs could communicate with the Router
  - test if the two PCs could communicate with each other