Topic 7
DHCP and NAT
Dynamic Host Configuration Protocol (DHCP)

- IP address assignment
- Default Gateway assignment
- Network services discovery

I just booted. What network is this? What is the gateway?

Where is the TFTP Server?

DHCP Server

Host A VLAN 30

Phone A VLAN 40
DHCP Process

• Host issues a DHCP discover message to any available server.
• Server(s) replies back with DHCP offer message.
• Client issues DHCP request using offered IP.
• Server replies with DHCP acknowledgement indicating lease time and other options requested by the client.
DHCP Packet Quick Look

- Ethernet II, Src: 68:a8:6d:4a:89:10 (68:a8:6d:4a:89:10), Dst: ff:ff:ff:ff:ff:ff (ff:ff:ff:ff:ff:ff)
  - Destination: ff:ff:ff:ff:ff:ff (ff:ff:ff:ff:ff:ff)
    - Type: IP (0x0800)
- Internet Protocol Version 4, Src: 0.0.0.0 (0.0.0.0), Dst: 255.255.255.255 (255.255.255.255)
  - Version: 4
  - Header length: 20 bytes
  - Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN: 0x00: Not configured (Not ECN-Capable Transport))
  - Total Length: 328
  - Identification: 0x3cd2 (15570)
  - Flags: 0x00
  - Fragment offset: 0
  - Time to live: 255
  - Protocol: UDP (17)
- Header checksum: 0x7dd3 [validation disabled]
  - Source: 0.0.0.0 (0.0.0.0)
  - Destination: 255.255.255.255 (255.255.255.255)
- User Datagram Protocol, Src Port: 68 (68), Dst Port: 67 (67)
- Bootstrap Protocol

• Note that destination MAC and IP is all broadcast
• Create a DHCP pool.
  ip dhcp pool (pool_name)

• Assign a network and default router to the pool.
  network 10.1.1.0 255.255.255.0
  default-router 10.1.1.1

• Assign additional options if required.
  dns-server 10.40.1.51
  option 150 ip 10.40.1.99
Infrastructure DHCP Configuration Example

- Remove any conflicting pool from the router
  
  ```
  no ip dhcp pool (pool_name)
  ```

- Enter interface configure mode for the required interface and configure broadcast relay.
  
  ```
  interface vlan 30
  ip helper-address 10.40.1.51
  ```
Helpful Commands

- show ip dhcp binding
- clear ip dhcp binding (address or *)
- debug ip dhcp server packet
Network Address Translation (NAT)

- Address Depletion
- Migration/Mergers
- Server load sharing
- Changing ISP

Cisco.com
Types of NAT

- **Static NAT** – one-to-one mapping between local and global addresses.
- **Dynamic NAT** – many-to-many mapping between local and global addresses by using a pool of real IP addresses.
- **Overloading (PAT)** – many-to-one local to global mapping using a real IP’s transport layer ports.
NAT Address Names

- Inside Local – inside source address before translation.
- Outside Local – destination host before translation.
- Inside Global – inside host after translation.
- Outside Global – outside destination host after translation.
Dynamic and Static NAT

NAT TABLE

<table>
<thead>
<tr>
<th>Inside Local</th>
<th>Inside Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.1.1</td>
<td>170.168.2.2</td>
</tr>
<tr>
<td>10.1.1.2</td>
<td>170.168.2.3</td>
</tr>
<tr>
<td>10.1.1.3</td>
<td>170.168.2.4</td>
</tr>
</tbody>
</table>
Overloading (PAT)

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Inside Local</th>
<th>Inside Global</th>
<th>Outside Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCP</td>
<td>10.1.1.1:1721</td>
<td>170.168.2.2:1493</td>
<td>61.40.7.3:23</td>
</tr>
<tr>
<td>TCP</td>
<td>10.1.1.2:1024</td>
<td>170.168.2.2:1723</td>
<td>61.40.7.3:23</td>
</tr>
<tr>
<td>TCP</td>
<td>10.1.1.3:1723</td>
<td>170.168.2.2:1024</td>
<td>61.40.7.3:23</td>
</tr>
</tbody>
</table>

Networking Basics
Static NAT config example

- `ip nat inside source static 10.1.1.1 170.46.2.2`
- `interface ethernet0/0`
  - `ip address 10.1.1.10 255.255.255.0`
  - `ip nat inside`
- `interface serial0/0`
  - `ip address 170.46.2.1 255.255.255.0`
  - `ip nat outside`
Dynamic NAT config example

- `ip nat pool globalnet 170.168.2.2 170.168.2.254 netmask 255.255.255.0`
- `ip nat inside source list 1 pool globalnet`
- `interface ethernet0/0`
  - `ip address 10.1.1.10 255.255.255.0`
  - `ip nat inside`
- `interface serial0/0`
  - `ip address 170.68.2.1 255.255.255.0`
  - `ip nat outside`
- `access-list 1 permit 10.1.1.0 0.0.0.255`
PAT (overloading) config example

- `ip nat pool globalnet 170.168.2.1 170.168.2.1 netmask 255.255.255.0`
- `ip nat inside source list 1 pool globalnet overload`
- `interface ethernet0/0`
  - `ip address 10.1.1.10 255.255.255.0`
  - `ip nat inside`
- `interface serial0/0`
  - `ip address 170.68.2.1 255.255.255.0`
  - `ip nat outside`
- `access-list 1 permit 10.1.1.0 0.0.0.255`
• Troubleshooting commands
  show ip nat translation
  clear ip nat translation *
  debug ip nat
Dynamic host configuration protocol (DHCP) allows network administrators to easily configure hosts for network access by centralizing configuration of IP addresses and network mask information, default gateway information, and other options that might be required when bootstrapping a host onto the network.

Network Address Translation (NAT) is used by network administrators to resolve issues of IP address overlap or incompatibility. NAT is also an IP address conservation technique where-in multiple hosts can leverage a single IP address when communicating with a global network like the internet. NAT is commonly configured in conjunction with RFC 1918 addresses to provide privately IP addressed hosts the capability of communicating with publically IP addressed hosts.

In this topic, you will configure both technologies on an IOS router. The lab environment has been partially configured for you for the sake of time. A simple network consisting of a router, connected switch, three internal VLANs (Marketing, Engineering, and Server), and an outside host have been preconfigured. Your tasks will include:

Task 1 - Configure DHCP Services on the Router
Task 2 - Move DHCP Services to the Infrastructure Server
Task 3 - Configure Dynamic NAT Translation for Inside Hosts Using Interface Gig 0/1 Address
Task 4 - Configure Static NAT to Provide Access to the Web Server from the Outside Host
Task 5 - Configure Dynamic NAT Translation for Inside Hosts Using a Pool

Task 2 – Configure DHCP Services on the Router
In small networks, your router can serve many different roles as a DNS, an NTP, and even a DHCP server. Configure your router to provide DHCP services.

1. Open a command prompt on the marketing and engineering PCs and check to make sure no IP is currently listed.
   a. ipconfig /all
2. In global configuration mode, add an IP DHCP pool for marketing
   a. ip dhcp pool Marketing
3. Set the default router for this pool to the interface IP address of VLAN 2
   a. default-router 10.1.2.1
4. Set the network for this pool
   a. network 10.1.2.0 255.255.255.0
5. Add an IP DHCP pool for engineering
   a. ip dhcp pool Engineering
6. Set the default router for this pool to the interface IP address of VLAN 3
   a. default-router 10.1.3.1
7. Set the network for this pool
   a. network 10.1.3.0 255.255.255.0
8. Open a command prompt on the marketing and engineering PCs and check the IP address
   a. ipconfig /all
9. Confirm that you can ping the server from both the marketing and engineering PCs
   a. ping 10.1.4.11
10. From the router CLI in enable mode, show the DHCP bindings and observe that the router is
    managing the data base for DHCP addresses.
    a. show ip dhcp binding

**Task 2 – Configure Your Router for an Infrastructure DHCP Server**
Enterprise networks more often provide DHCP services through an infrastructure server tied to AD or other. In this exercise, modify your router to support using the infrastructure DHCP server.

1. Open a command prompt on the marketing and engineering PCs and release the DHCP IP address.
   a. ipconfig /release
2. On the router in global config mode, remove the Marketing and Engineering DHCP pools.
   a. no ip dhcp pool Marketing
   b. no ip dhcp pool Engineering
3. Open a command prompt on the marketing and engineering PCs and attempt to renew the
   DHCP IP address. Does this work? Why?
   a. ipconfig /renew
4. In interface configuration mode, configure the router to relay the DHCP request to the
   infrastructure server.
   a. interface gigabit 0/0.2
   b. ip helper-address 10.1.4.11
   c. interface gigabit 0/0.3
   d. ip helper-address 10.1.4.11
5. Open a command prompt on the marketing and engineering PCs and attempt to renew the
   DHCP address. Does this work? Why?
6. Confirm that you can ping the Infrastructure server from both the marketing and engineering
   PCs.
   a. ping 10.1.4.11

**Task 3 – Dynamic Network Address Translation Using a Single IP Address (Many to One)**
In smaller networks or when working with overlap situation you may only have a single IP address to be used in the NAT configuration. In this situation, the router must be programmed to map sessions from
NAT’d hosts to unique source ports of the global IP address in use. This is also known as port address translation (PAT).

1. Open a command prompt on the marketing or engineering PC and ping the outside host. Does this work? Why?
   a. ping 1.1.1.254

2. Create and access list that identifies what traffic the NAT process should operate on.
   a. access-list 100 permit ip 10.1.2.0 0.0.0.255
   b. access-list 100 permit ip 10.1.3.0 0.0.0.255
   c. access-list 100 permit ip 10.1.4.0 0.0.0.255

3. Specify the interfaces that will act as the inside of the NAT process.
   a. interface gigabit 0/0.2
   b. ip nat inside
   c. interface gigabit 0/0.3
   d. ip nat inside
   e. interface gigbit 0/0.4
   f. ip nat inside

4. Specify the interface that will act as the outside of the NAT process.
   a. interface gig 0/1
   b. ip nat outside

5. Write a NAT statement to dynamically translate the inside hosts to the IP address of gigabit 0/1 when going to an IP address on the outside assuring that multiple hosts can operate behind the single IP address.
   a. ip nat inside source list 100 interface gigabit 0/1 overload

6. Open a command prompt on the marketing or engineering PC and ping the outside host. Does this work? Why?
   a. ping 1.1.1.254

7. From enable mode on the router, run the command show ip nat translation and observe the entries listed. What is common to all the translations shown? What is unique?

**Task 4 – Static Network Address Translation**

Dynamic network address translation works well for end host computers, but servers that are contacted in an unsolicited manner require a known accessible IP address to which a host can connect when the service is needed. In this exercise, use a static NAT to make the web server available to the outside host.

1. Using a web browser on the outside host, try and access the web server running inside the translated network. Did this work? What IP address did you use and why?
2. Write a NAT statement to statically translate the http server inside the network to 1.1.1.11 on the outside of the network.
   a. ip nat inside source static 10.1.4.11 1.1.1.11
3. Using a web browser on the outside host, try and access the web server running inside the translated network. Did this work? What IP address did you use and why?

4. From enable mode on the router, run the command show ip nat translation and observe the entries listed. What is unique about the static server translation? Clear the existing nat entries and re-run the show ip nat translation command. Are there any entries in the table now? Why? Why did the server not use the dynamic NAT statement we created above and NAT to the IP address of interface gigabit 0/1?
   a. show ip nat translation
   b. clear ip nat translation *
   c. show ip nat translation

Task 5 – Dynamic Network Address Translation Using a Pool of Addresses

Sometimes the interface IP address is not available as a NAT IP for outside connectivity and you have to NAT to a pool of IP addresses provided. When your inside host count exceeds the number of IP addresses in your outside pool, then similarly to using a single IP, you must make a provision to overload and perform a PAT. In this exercise, remove the dynamic NAT statement which used the IP address of interface gigabit 0/1 which we created above and create a new NAT statement using an address pool.

1. Remove the dynamic NAT statement created above.
   a. no ip nat inside source list 100 interface gigabit 0/1 overload

2. From global configure mode, clear the existing translations in preparation for the new NAT pool.
   a. clear ip nat translation *

3. Create a new dynamic NAT pool with addresses 1.1.1.12 and 1.1.1.13
   a. ip nat pool Dynamic_Pool 1.1.1.12 1.1.1.13 netmask 255.255.255.0

4. Write a new dynamic NAT statement to translate inside hosts to your new dynamic pool.
   a. ip nat inside source list 100 pool Dynamic_Pool

5. Open a command prompt on the marketing and engineering PCs and ping the outside host.
   a. ping 1.1.1.254

6. From enable mode on the router, run the command show ip nat translation and observe the new translations create. What is different about these translations from the previous dynamic NAT?
   a. show ip nat translation