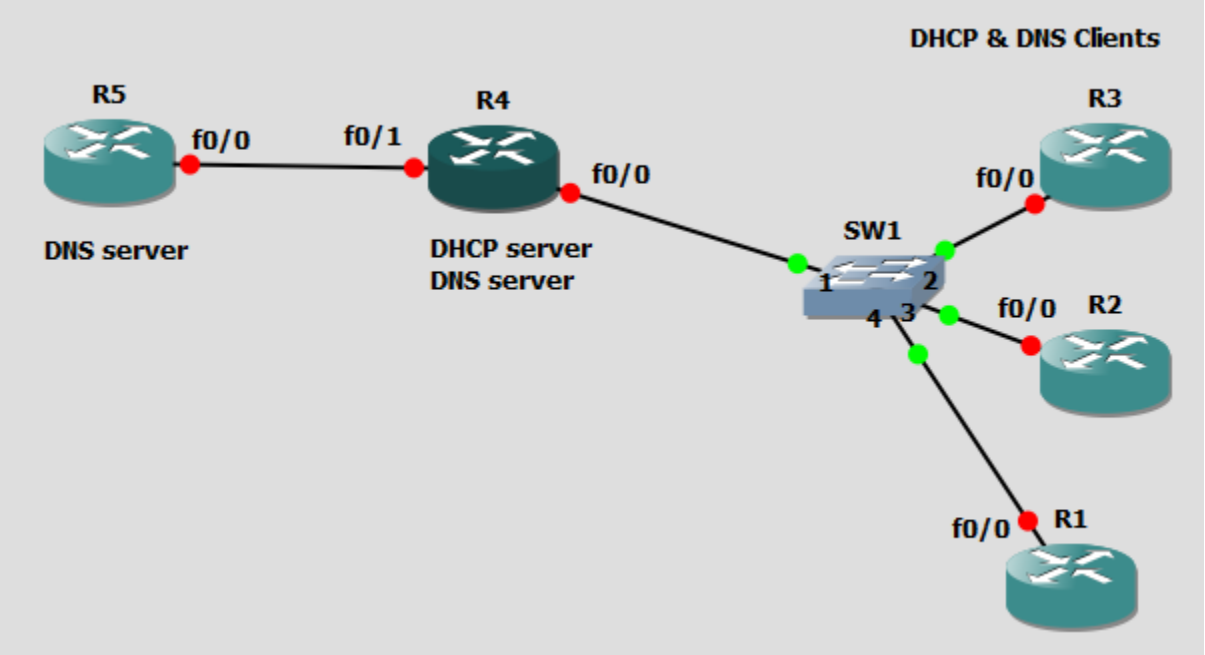
Topology we will use:



DHCP Lab

Just before we start let's remember the DHCP messages exchanged between DHCP server & clients

Basic Layer three configuration and IP address will be as the following:

R4

int f0/0
ip add 10.123.123.4 255.255.255.0

int f0/1
ip add 10.45.45.4 255.255.255.0

R5

int f0/0
ip add 10.45.45.5 255.255.255.0
no sh

on all routers R1/R2/R3/R4/R5 where x in router-id is your router number:

router ospf 1
router-id 0.0.0.3
network 0.0.0.0 255.255.255.255 area 0

Task 1:

- Configure R4 as DHCP server for network 10.123.123.0/24.
- Make sure R1 act as DHCP client and get his IP address / Subnet Mask / Default Gateway from R4.
- Make sure your DHCP server will never rent ip address from range 10.123.123.1 to 10.123.123.99.

R4

```
service dhcp
```

Above command enables the Cisco IOS DHCP server and relay features on your router. Its enabled by default and now need to type

```
R4(config)#ip dhcp pool net123
R4(dhcp-config)#network 10.123.123.0 255.255.255.0
R4(dhcp-config)#default-router 10.123.123.4
R4(dhcp-config)#exit
R4(config)#ip dhcp excluded-address 10.123.123.1 10.123.123.99
```

R1

```
R1(config)#int f0/0
R1(config-if)#ip add dhcp
R1(config-if)#no sh
```

R1#sh ip int br | i 123

```
FastEthernet0/0        10.123.123.100  YES DHCP   up                  up
```

R4 will store all information about his DHCP clients bindings in table we call it DHCP binding table

R4#sh ip dhcp binding

```
Bindings from all pools not associated with VRF:
IP address        Client-ID/              Lease expiration        Type
                  Hardware address/
                  User name
10.123.123.100    0063.6973.636f.2d63.    Feb 23 2015 03:39 PM    Automatic
                  6130.342e.3131.3134.
                  2e30.3030.302d.4661.
                  302f.30
```

When we do not specify which dhcp client should take which ip address , we call this process Automatic Binding , like what we did in Task 1.
When we do specify which dhcp client should take which ip address , we call this process Manual Binding , Like what we are going to do in Task 2 & Task 3.

Task 2

- R4 should work as DHCP server for R2.
- R4 should rent (lease) specific ip address to R2 which is 10.123.123.202/24 using default client identifier broadcast by R2 interface .
- R4 should also send DNS server ip address to R2 , Since R4 will act as DNS server Later , we will send same ip address 10.123.123.1 of R1.

```
R4(cofig)#ip dhcp pool R2
R4(dhcp-config)#host 10.123.123.202 255.255.255.0
R4(dhcp-config)#default-router 10.123.123.4
R4(dhcp-config)#dns-server 10.123.123.4
```

Now we need to discover what is the client identifier R2 is broadcasting to us , so we will need to turn debugging on

```
R4(dhcp-config)#do debug ip dhcp server packet
```

Now let's go to R2 and make its interface as DHCP client so it start broadcasting its client identifier

```
R2(config)#int f0/0
R2(config-if)#ip add dhcp
R2(config-if)#no sh
```

Let's go back to R4

```
R4(dhcp-config)#
*Feb 22 15:43:41.259: DHCPD: DHCPDISCOVER received from client
0063.6973.636f.2d63.6130.322e.3165.6530.2e30.3030.302d.4661.302f.30 on interface
FastEthernet0/0.
*Feb 22 15:43:41.259: DHCPD: Allocate an address without class information (10.123.123.0)
```

The number above is the client identifier for R2 int f0/0 , we will use it in R4 dhcp pool created it for R2 , But first let's clear our binding table and turn off debugging

```
R4(dhcp-config)#do u all
R4(dhcp-config)#do clear ip dhcp bin *

R4(config)#ip dhcp pool R2
R4(dhcp-config)#client-identifier
0063.6973.636f.2d63.6130.322e.3165.6530.2e30.3030.302d.4661.302f.30

R2(config)#int f0/0
R2(config-if)#sh
R2(config-if)#no sh
R2(config-if)#
```

R2#sh ip int br | i 123

```
FastEthernet0/0         10.123.123.202  YES DHCP   up                    up
```

Task 3

- R4 should work as DHCP server for R3.
- R4 should rent (lease) specific ip address to R3 which is 10.123.123.203/24 using R3 int f0/0 mac-address as client identifier .
- R4 should also send DNS server ip address to R3 , Since R4 will act as DNS server Later , we will send same ip address 10.123.123.1 of R1

R3#sh int f0/0 | i bia
Hardware is DEC21140, address is ca03.0520.0000 (bia ca03.0520.0000)

So **ca03.0520.0000** will be used but we need to add 01 in the beginning of it , where **01** represents the Ethernet media type.

So client identifier for mac address **ca03.0520.0000** is **01ca.0305.2000.00**

```
R4(config)#ip dhcp pool R3
R4(dhcp-config)#host 10.123.123.203 255.255.255.0
R4(dhcp-config)#client-identifier 01ca.0305.2000.00
R4(dhcp-config)#default-router 10.123.123.4
R4(dhcp-config)#dns-server 10.123.123.4

R3(config)#int f0/0
R3(config-if)#ip add dhcp client-id f0/0 hostname R3
R3(config-if)#no sh
```

R3#sh ip int br | i 123
FastEthernet0/0 10.123.123.203 YES DHCP up up

Configuring Manual Bindings
An address binding is a mapping between the IP address and MAC address of a client. The IP address of a client can be assigned manually by an administrator or assigned automatically from a pool by a DHCP server.

Manual bindings are IP addresses that have been manually mapped to the MAC addresses of hosts that are found in the DHCP database. Manual bindings are stored in NVRAM on the DHCP server. Manual bindings are just special address pools. There is no limit on the number of manual bindings, but you can only configure one manual binding per host pool.

Automatic bindings are IP addresses that have been automatically mapped to the MAC addresses of hosts that are found in the DHCP database. Automatic bindings are stored on a remote host called a database agent. The bindings are saved as text records for easy maintenance.

All DHCP clients send a client identifier (DHCP option 61) in the DHCP packet. To configure manual bindings, you must enter the client-identifier DHCP pool configuration command with the appropriate hexadecimal values identifying the DHCP client.
To configure a manual binding, first create a host pool, then specify the IP address of the client and client identifier or hardware address.

Table 12 Configuration Method and Resulting Contents of the DISCOVER Message

Configuration Method	Contents of DISCOVER Messages
ip address dhcp	The DISCOVER message contains "cisco-*mac-address* -Eth1" in the client ID field. The *mac-address* is the media access control (MAC) address of the Ethernet 1 interface and contains the default host name of the router in the option 12 field.
ip address dhcp hostname *host-name*	The DISCOVER message contains "cisco-*mac-address* -Eth1" in the client ID field. The *mac-address* is the MAC address of the Ethernet 1 interface, and contains *host-name* in the option 12 field.
ip address dhcp client-id ethernet 1	The DISCOVER message contains the MAC address of the Ethernet 1 interface in the client ID field and contains the default host name of the router in the option 12 field.
ip address dhcp client-id ethernet 1 hostname *host-name*	The DISCOVER message contains the MAC address of the Ethernet 1 interface in the client ID field and contains *host-name* in the option 12 field.

Task 4

- Make sure R4 pool net123 will rent ip address for limited duration which is 8 days 7 hours
- Ensure R4 pool net134 will send cbtme.com as a domain name for DHCP clients

```
R4(config)#ip dhcp pool net123
R4(dhcp-config)#lease ?
  <0-365>   Days
  infinite  Infinite lease

R4(dhcp-config)#lease 8 ?
  <0-23>  Hours
  <cr>

R4(dhcp-config)#lease 30  7
R4(dhcp-config)#domain-name cbtme.com
```

Task 5

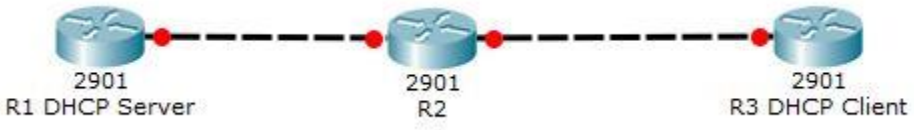
As you might know before DHCP assign ip address to client , it should ping that ip address 5 times to ensure its not assigned to another host , DHCP wait 300ms before timing out a ping packet .
Now let's change these timers to 6 packets and 320ms wait time .

R4

ip dhcp ping packets 6
ip dhcp ping timeout 3200

Task 6

Let's assume we have the following topology



When R3 send his DHCP DISCOVER message to find DHCP server , he will send it as Broadcast
And if we have router such as R2 in above diagram in between the DHCP server & their clients , R2 will drop Broadcast.

This normal Behavior on any router , he create border for Broadcast Domain and will never let Broadcast traffic go through him .

To solve this issue , we need to tell R2 to work as DHCP Relay Agent , which mean he take this broadcast packets send from R3 DHCP Client and converted to unicast and send it to DHCP Server R1

To do so , we type under R2 interface facing the DHCP client R3
Int f0/0
Ip helper-address 3.3.3.3 < 3.3.3.3 is DHCP Server ip address

Remember the following about ip helper address command

- It Forwards UDP broadcasts, including BOOTP and DHCP.
- The address argument can be a specific DHCP server address, or it can be the network address if other DHCP servers are on the destination network segment. The network address enables other servers to respond to DHCP requests.
- If you have multiple servers, you can configure one helper address for each server.

DNS Lab

Task 1

- Configure R4 as DNS server (enable the name server on a router)
- Create DNS (A) record resolve r3.cbtme.com to 10.123.123.203

```
R4(config)#ip host r3.cbtme.com 10.123.123.203
R4(config)#ip dns server
```

- Configure R1 as DNS client for R4 name server
- Make sure R1 is Enables DNS-based host name-to-address translation

```
R1(config)#ip domain lookup
R1(config)#ip name
R1(config)#ip name-server 10.123.123.4
```

R1#ping r3.cbtme.com

```
Translating "r3.cbtme.com"...domain server (10.123.123.4) [OK]

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.123.123.203, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 120/153/172 ms
```

Task 2

- Configure R5 as DNS server (enable the name server on a router)
- Create DNS (A) record resolve r2.cbtme.com to 10.123.123.202

```
R5(config)#ip host r2.cbtme.com 10.123.123.202
R5(config)#ip dns server
```

Task 3

Configure R4 to query r2.cbtme.com ip address from R5

```
R4(config)#ip name-server 10.45.45.5
R4(config)#ip domain-lookup
```

Notice here that R4 is DNS server but to be able to query another DNS server for a (A) record he do not have , we will need to type ip name-server command which we normally use with DNS clients , also R4 will need to have ip domain lookup enabled so he can query R5 to resolve that record.

Simply , ip name-server command can be used in two scenarios :

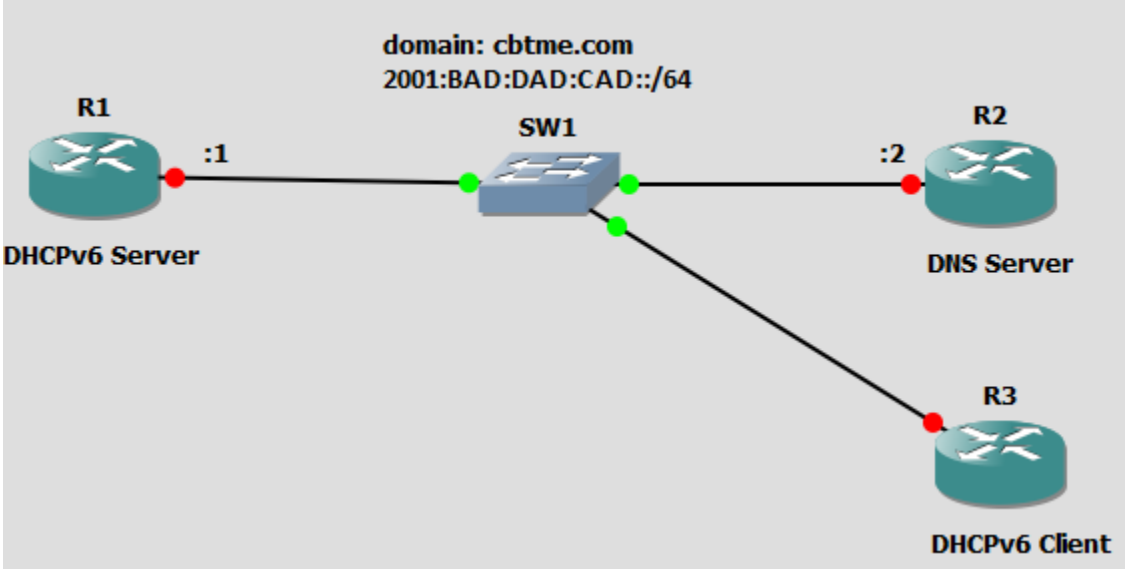
- **in DNS client to tell them about DNS server ip address**
- **in DNS server to ask (query) another DNS server about a specific record he could not resolve by himself.**

R1#ping r2.cbtme.com

Translating "r2.cbtme.com"...domain server (10.123.123.4) [OK]

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.123.123.202, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 20/88/232 ms
R1#

DHCPv6 Lab



R1(config-if)#ipv6 uni
R1(config)#int f0/0
R1(config-if)#ipv6 add 2001:BAD:DAD:CAD::1/64

R2(config)#ipv6 uni
R2(config)#int f0/0
R2(config-if)#ipv6 add 2001:BAD:DAD:CAD::2/64

R1(config)#ipv6 dhcp pool net45
R1(config-dhcpv6)#address prefix 2001:BAD:DAD:CAD::/64
R1(config-dhcpv6)#dns-server 2001:BAD:DAD:CAD::2
R1(config-dhcpv6)#domain-name cbtme.com

R1(config)#int f0/0
R1(config-if)#ipv6 dhcp server net45
R1(config-if)#ipv6 nd managed-config-flag

(ipv6 nd managed-config-flag called M bit = thats mean address provided by DHCPv6 server)

R3(config)#int f0/0
R3(config-if)#ipv6 enable
R3(config-if)#ipv6 add dhcp
R3(config-if)#no sh

```
R3#sh ipv6 int br
FastEthernet0/0       [up/up]
   FE80::C803:1EFF:FEAC:0
   2001:BAD:DAD:CAD:EC0B:A916:FC5F:51E1


R3#sh ipv dhcp interface | i DNS|Domain
     DNS server: 2001:BAD:DAD:CAD::2
     Domain name: cbtme.com


R1#sh ipv6 dhcp bind
Client: FE80::C803:1EFF:FEAC:0
  DUID: 00030001CA031EAC0000
  Username : unassigned
  VRF : default
  IA NA: IA ID 0x00030001, T1 43200, T2 69120
    Address: 2001:BAD:DAD:CAD:EC0B:A916:FC5F:51E1
          preferred lifetime 86400, valid lifetime 172800
          expires at Mar 11 2015 05:06 PM (172724 seconds)
```

DHCPv6 will not give extra info such as DNS , domain-name , we can get it from autoconfig SLAAC router , Let's say R2

```
int f0/1
ipv6 dhcp relay destination 2001:BAD:DAD:CAD::2
ipv6 nd other-config-flag
```

(ipv6 nd other-config-flag called O bit = that's mean address OR extra information provided by autoconfig SLAAC)

Final Note:

Normally dhcpv6 client can acquire address and optional parameters from server with 2 messages or 4 messages as illustrated below :

2 messages called Rapid-Commit
client >>>>Solicit >>>>>server
server >>>>>Reply >>>>>Client

4 messages (default)
client >>>>Solicit >>>>>server
server >>>>>Advertise >>>>>Client
client >>>>Request >>>>>server
server >>>>>Reply >>>>>Client

to use rapid we need to do the following on both server & client :

server:
int f0/0
ipv6 dhcp server net45 rapid-commit

client :
int f0/0
ipv6 add dhcp rapid-commit

DHCP & PPP

PPP can Automatically assign ip address and default gateway but it is a little bit different and worth to talk about it .
Let say we have R1 connected to R2 using S1/0 , R1 will provide R2 with ip address & default gateway

```
R1
int s1/0
ip add 10.12.12.1 255.255.255.0
enap ppp
no sh

ip dhcp pool R2
network 10.12.12.0 255.255.255.0
default-router 10.12.12.1
```

now the main different here is telling the router in which ppp interface the above pool will be activate it:

```
int s1/0
peer  default ip address dhcp-pool R2
```

from R2 the client side ,we should notice two main differences , first we will not use "ip add dhcp" command instead we will use "ip add negotiation" command , second even we configured server with default-router , ppp client still will not be able to get the default gateway information unless we type "ppp ipcp route default " command

```
R2
int s1/0
ip add nego
encap ppp
ppp ipcp route  default

R2#sh ip int br | i Serial1/0
Serial1/0              10.12.12.2     YES IPCP   up                 up

R2#sh ip route | i 0.0.0.0/0
S*   0.0.0.0/0 [1/0] via 10.12.12.1
```

Remember ,
R1 can use different method to give ip address to R2 , instead of using dhcp pool we can use local pool

```
R1
int s1/0
encap ppp
peer  default ip address pool R2     <instead of using "peer  default ip address dhcp-pool R2"

ip local pool R2 10.12.12.2          < instead of using ip dhcp pool
```

Good Luck
Yasser Auda
CCIE R&S # 45694
CCSI # 34215
https://learningnetwork.cisco.com/people/yasser.r.a?view=documents
https://www.facebook.com/YasserRamzyAuda
https://www.youtube.com/user/yasserramzyauda