INTERNETWORK eXpert

IEWB-RS Technology Labs

IP Services

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Common Configuration

Objective: Create common configuration for IP Services scenarios
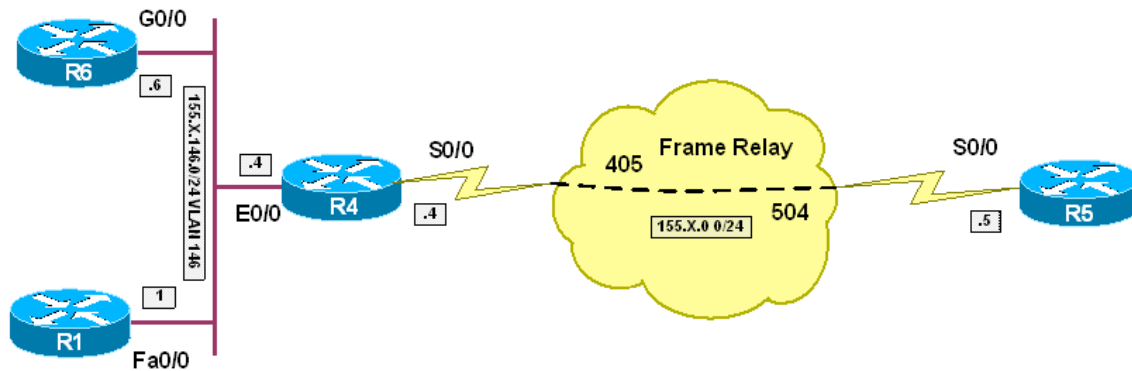
Directions

- Create VLAN 146 on SW1 and SW2
- Configure the respective switchports in this VLAN (SW1: Fa 0/1, SW2: Fa 0/4 and Fa 0/6)
- Configure interface Fa 0/13 on SW1 and SW2 as 802.1q trunk
- Configure IP addressing on VLAN146 interfaces as per diagram
- Configure Frame-Relay interfaces on R4 and R5. Use physical interface type, and static mappings. Map broadcasts to each endpoint
- Configure IP addressing on FR interfaces as per diagram

Final Configuration

```
SW1:
vlan 146
interface Fa 0/1
 switchport host
 switchport access vlan 146
!
interface fastEthernet 0/13
 switchport trunk encaps dot1q
 switchport mode trunk

SW2:
vlan 146
interface range Fa 0/4 , Fa 0/6
switchport host
 switchport access vlan 146
!
interface fastEthernet 0/13
 switchport trunk encaps dot1q
 switchport mode trunk

R1:
inter fa 0/0
 ip address 155.1.146.1 255.255.255.0
 no shut
```

```
R4:
inter ethernet 0/0
 ip address 155.1.146.4 255.255.255.0
 no shut
!
interface Serial 0/0
 encaps frame-relay
 no frame-relay inverse
 ip address 155.1.0.4 255.255.255.0
 frame map ip 155.1.0.5 405 broad
 no shutdown

R5:
interface Serial 0/0
 encaps frame-relay
 no frame-relay inverse
 ip address 155.1.0.5 255.255.255.0
 frame map ip 155.1.0.4 504 broad
 no shut

R6:
inter gig 0/0
 ip address 155.1.146.6 255.255.255.0
 no shut
```

Verification

```
R4#ping 155.1.146.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 155.1.146.1, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 1/2/4 ms

R4#ping 155.1.146.6

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 155.1.146.6, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 1/2/4 ms

R4#ping 155.1.0.5

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 155.1.0.5, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 60/65/76 ms
```

Proxy ARP

Objective: Configure router to answer ARP requests on behalf of remote routers
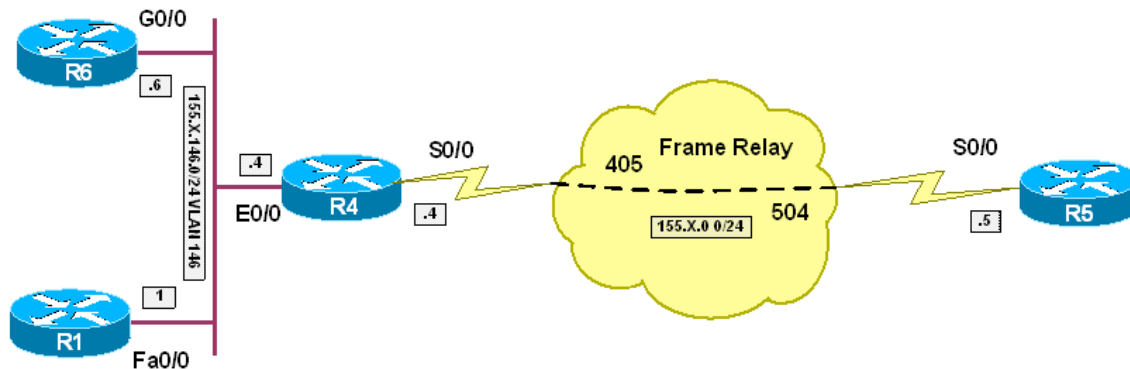
Directions

- Pre-configure routers per the IP Services "Common Configuration" scenario
- Disable IP routing on R1 and R6
- Enable Proxy ARP on R4 Ethernet interface

Final Configuration

```
R1 & R6:
no ip routing

R4:
interface Ethernet 0/0
 ip proxy-arp
```

Verification

```
R4#show ip interface ethernet 0/0
Ethernet0/0 is up, line protocol is up
  Internet address is 155.1.146.4/24
  Broadcast address is 255.255.255.255
  Address determined by setup command
  MTU is 1500 bytes
  Helper address is not set
  Directed broadcast forwarding is disabled
  Outgoing access list is not set
  Inbound  access list is not set
  Proxy ARP is enabled
  Local Proxy ARP is disabled
  Security level is default
  Split horizon is enabled
  ICMP redirects are always sent
  ICMP unreachables are always sent
```

```
  ICMP mask replies are never sent
  IP fast switching is enabled
  IP fast switching on the same interface is disabled
  IP Flow switching is disabled
  IP CEF switching is enabled
  IP CEF Fast switching turbo vector
  IP multicast fast switching is enabled
  IP multicast distributed fast switching is disabled
  IP route-cache flags are Fast, CEF
  Router Discovery is disabled
  IP output packet accounting is disabled
  IP access violation accounting is disabled
  TCP/IP header compression is disabled
  RTP/IP header compression is disabled
  Policy routing is disabled
  Network address translation is disabled
  BGP Policy Mapping is disabled

R1#debug arp
ARP packet debugging is on

R4#debug arp
ARP packet debugging is on

R1#ping 155.1.0.4

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 155.1.0.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/202/1000 ms

R1#
*Mar  1 00:56:54.203: IP ARP: creating incomplete entry for IP address:
155.1.0.4 interface FastEthernet0/0
*Mar  1 00:56:54.203: IP ARP: sent req src 155.1.146.1 0004.27b5.2fa0,
                 dst 155.1.0.4 0000.0000.0000 FastEthernet0/0
*Mar  1 00:56:54.207: IP ARP: rcvd rep src 155.1.0.4 00b0.6416.2dc1, dst
155.1.146.1 FastEthernet0/0

R4#
IP ARP: rcvd req src 155.1.146.1 0004.27b5.2fa0, dst 155.1.0.4 Ethernet0/0
IP ARP: sent rep src 155.1.0.4 00b0.6416.2dc1,
                 dst 155.1.146.1 0004.27b5.2fa0 Ethernet0/0

R4#show int ethernet 0/0
Ethernet0/0 is up, line protocol is up
  Hardware is AmdP2, address is 00b0.6416.2dc1 (bia 00b0.6416.2dc1)
  Internet address is 155.1.146.4/24
  MTU 1500 bytes, BW 10000 Kbit, DLY 1000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:56, output 00:00:04, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     1751 packets input, 842436 bytes, 0 no buffer
     Received 1734 broadcasts, 0 runts, 0 giants, 0 throttles
```

```
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     0 input packets with dribble condition detected
    216 packets output, 63872 bytes, 0 underruns
     0 output errors, 0 collisions, 1 interface resets
     0 babbles, 0 late collision, 0 deferred
     0 lost carrier, 0 no carrier
     0 output buffer failures, 0 output buffers swapped out
```

Local Proxy ARP

Objective: Configure router to answer ARP requests on behalf of hosts in the same local segment
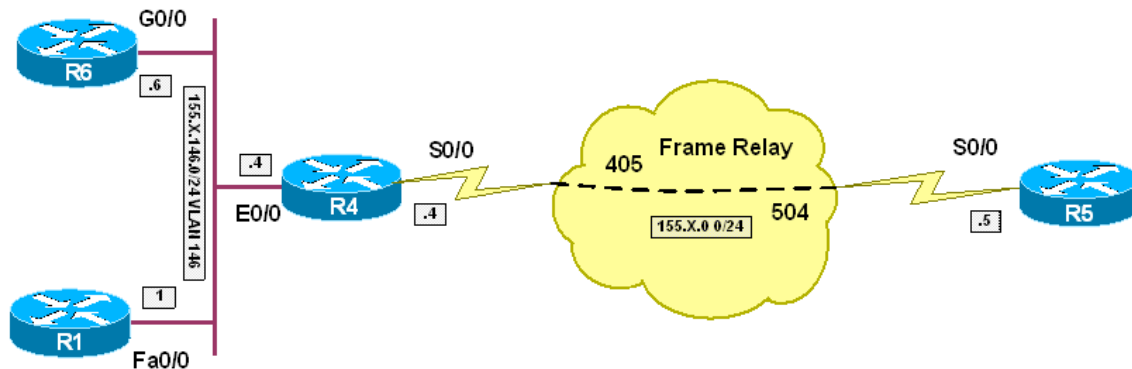
Directions

- Pre-configure routers per the IP Services "Common Configuration" scenario
- Enable IP routing on R1
- Enalbe Proxy ARP and Local Proxy ARP on R1's Ethernet interface
- Configure SW2 Fa 0/4 and SW2 Fa 0/6 as protected ports. This way, those routers won't hear each other's ARP requests

Final Configuration

```
SW2:
interface range Fa 0/4 , Fa 0/6
 switchport protected

R1:
ip routing
!
interface Fa 0/0
 ip proxy-arp
 ip local-proxy-arp
```

Verification

```
R4#clear arp-cache
R4#ping 155.1.146.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 155.1.146.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms

R4#ping 155.1.146.6
```

```
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 155.1.146.6, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 1/1/4 ms


R4#show ip arp
Protocol  Address          Age (min)  Hardware Addr   Type   Interface
Internet  155.1.146.1           1     0004.27b5.2fa0  ARPA   Ethernet0/0
Internet  155.1.146.4           -     00b0.6416.2dc1  ARPA   Ethernet0/0
Internet  155.1.146.6           0     0004.27b5.2fa0  ARPA   Ethernet0/0
```

Securing Virtual Terminal Line Access

Objective: Configure router to use secure transport for terminal line access
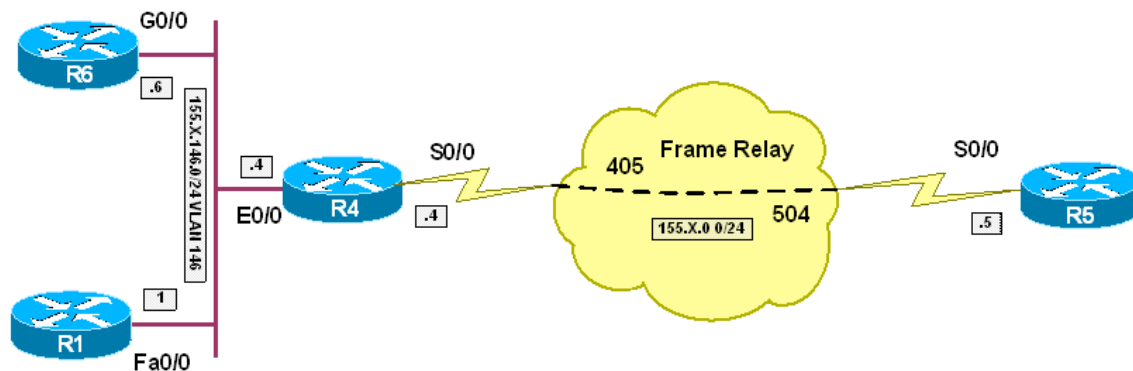
Directions

- Pre-configure routers per the IP Services "Common Configuration" scenario
- Configure domain-name "internetworkexpert.com" on R4.
- Generate RSA key-pair on R4
- Configure SSH as the only allowed input transport on R4's VTY lines
- Enable local authentication on VTY lines on R4
- Create local username CISCO with password CISCO on R4

Final Configuration

```
R4:
ip domain-name internetworkexpert.com
crypto key generate rsa general modulus 512
!
line vty 0 4
 login local
 transport input ssh
!
username CISCO pass CISCO
```

Verification

```
R4#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R4(config)#ip domain-name internetworkexpert.com
R4(config)#crypto key generate rsa general modulus 512
The name for the keys will be: R4.internetworkexpert.com

% The key modulus size is 512 bits
% Generating 512 bit RSA keys ...[OK]

%SSH-5-ENABLED: SSH 1.99 has been enabled
```

```
R1#ssh -l CISCO 155.1.146.4

Password: CISCO

R4>show ssh
Connection      Version Encryption      State                Username
0                1.5      3DES            Session started      CISCO
%No SSHv2 server connections running.
```

Controlling Virtual Terminal Line Access

Objective: Configure router to limit virtual terminal line access
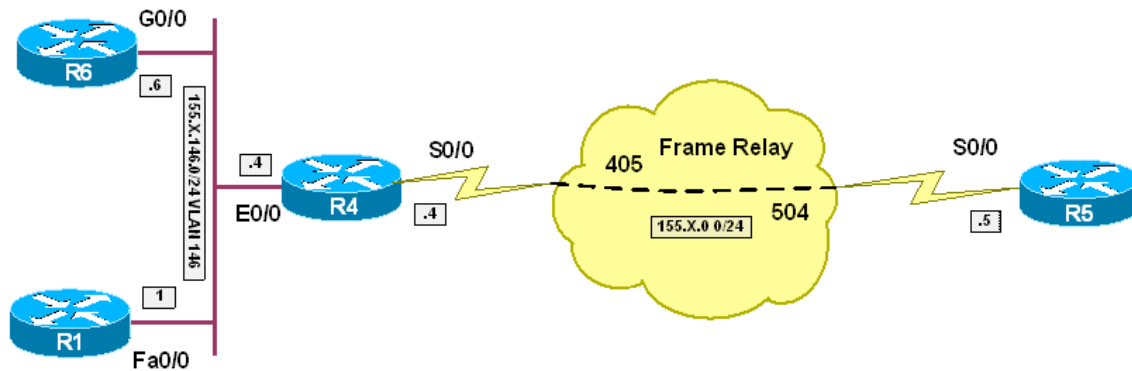
Directions

- Pre-configure routers per the IP Services "Common Configuration" scenario
- Configure R4 to access telnet connections on ports 23 and 3001. Use "**rotary**" command for this task
- Create access-list 100 on R4; permit TCP connections from network 155.X.146.0/24 to anywhere port 23; permit TCP connections from network 155.X.0.0/24 to anywhere port 3001. Deny any Log everything els
- Apply this access-list to R4's VTY lines and enable local authentication on these lines
- Create local username CISCO with password CISCO on R4

Final Configuration

```
R4:
line vty 4
 rotary 1
!
access-list 100 permit tcp 155.1.146.0 0.0.0.255 any eq 23
access-list 100 permit tcp 155.1.0.0 0.0.0.255 any eq 3001
access-list 100 deny ip any any log
!
line vty 0 4
 login local
 access-class 100 in
!
username CISCO pass CISCO
```

Verification

```
R1#telnet 155.1.146.4 3001
Trying 155.1.146.4, 3001 ...
% Connection refused by remote host
```

```
R1#telnet 155.1.146.4
Trying 155.1.146.4 ... Open


User Access Verification

Username: CISCO
Password: CISCO
R4>

R5#telnet 155.1.0.4
Trying 155.1.0.4 ...
% Connection refused by remote host

R5#telnet 155.1.0.4 3001
Trying 155.1.0.4, 3001 ... Open


User Access Verification

Username: CISCO
Password: CISCO
R4>

R4#
%SEC-6-IPACCESSLOGP: list 100 denied tcp 155.1.146.1(11000) -> 0.0.0.0(3001), 1
packet
%SEC-6-IPACCESSLOGP: list 100 denied tcp 155.1.0.5(30802) -> 0.0.0.0(23), 1
packet
```

Using DHCP for Autoconfiguration

Objective: Configure R4 to support configuration information to hosts on VLAN 146
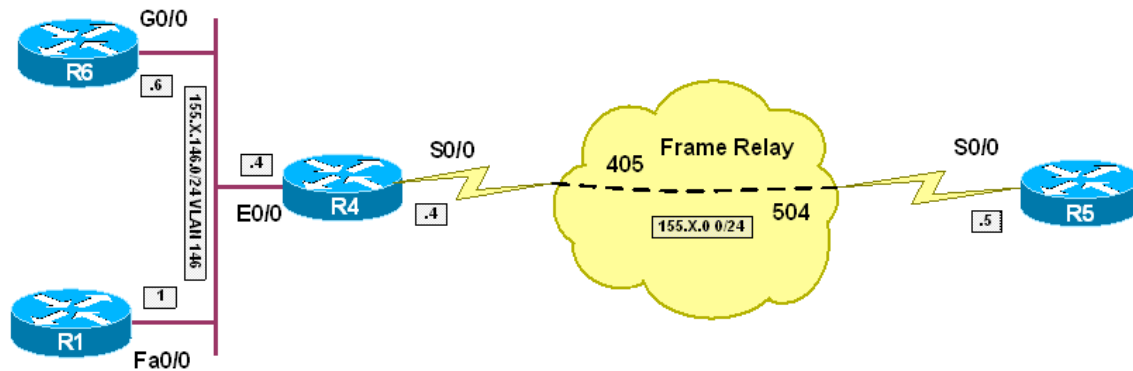
Directions

- Pre-configure routers per the IP Services "Common Configuration" scenario
- Create DHCP address pool VLAN146 on R4
- Clients should get their addresses from range 155.X.146.0/25. Exclude R4 address from this allocation
- Configure DHCP to allocate R4 as default gateway
- Domain-name should be "internetworkexpert.com"
- Configure R1 and R4 to obtain IP addresses via DHCP

Final Configuration

```
R4:
ip dhcp pool VLAN146
 network 155.1.146.0 /24
 default-router 155.1.146.4
 domain-name internetworkexpert.com
 exit
!
ip dhcp excluded-address 155.1.146.4

R1:
interface Gig 0/0
 ip address dhcp

R6:
interface Fa 0/0
 ip address dhcp
```

Verification

```
R1#debug dhcp
DHCP client activity debugging is on
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#int fa 0/0
R1(config-if)#ip add dhcp
DHCP: DHCP client process started: 10
RAC: Starting DHCP discover on FastEthernet0/0
DHCP: Try 1 to acquire address for FastEthernet0/0
DHCP: allocate request
DHCP: zapping entry in DHC_PURGING state for Fa0/0
DHCP: new entry. add to queue
DHCP: SDiscover attempt # 1 for entry:
DHCP: SDiscover: sending 294 byte length DHCP packet
DHCP: SDiscover 294 bytes
            B'cast on FastEthernet0/0 interface from 0.0.0.0


DHCP: Received a BOOTREP pkt
DHCP: offer received from 155.1.146.4
DHCP: SRequest attempt # 1 for entry:
DHCP: SRequest- Server ID option: 155.1.146.4
DHCP: SRequest- Requested IP addr option: 155.1.146.2
DHCP: SRequest placed lease len option: 86400
DHCP: SRequest: 312 bytes
DHCP: SRequest: 312 bytes
            B'cast on FastEthernet0/0 interface from 0.0.0.0
DHCP: Received a BOOTREP pkt
Interface FastEthernet0/0 assigned DHCP address 155.1.146.2, mask 255.255.255.0

DHCP Client Pooling: ***Allocated IP address: 155.1.146.2
Allocated IP address = 155.1.146.2  255.255.255.0

R1#show dhcp lease
Temp IP addr: 155.1.146.2  for peer on Interface: FastEthernet0/0
Temp  sub net mask: 255.255.255.0
   DHCP Lease server: 155.1.146.4, state: 3 Bound
   DHCP transaction id: 2B2278
   Lease: 86400 secs,  Renewal: 43200 secs,  Rebind: 75600 secs
Temp default-gateway addr: 155.1.146.4
   Next timer fires after: 11:58:51
   Retry count: 0   Client-ID: cisco-0004.27b5.2fa0-Fa0/0
   Hostname: R1

R4#show ip dhcp binding
Bindings from all pools not associated with VRF:
IP address          Client-ID/              Lease expiration        Type
                    Hardware address/
                    User name
155.1.146.2         0063.6973.636f.2d30.    Mar 22 1993 02:05 PM    Automatic
                    3030.342e.3237.6235.
                    2e32.6661.302d.4661.
                    302f.30
```
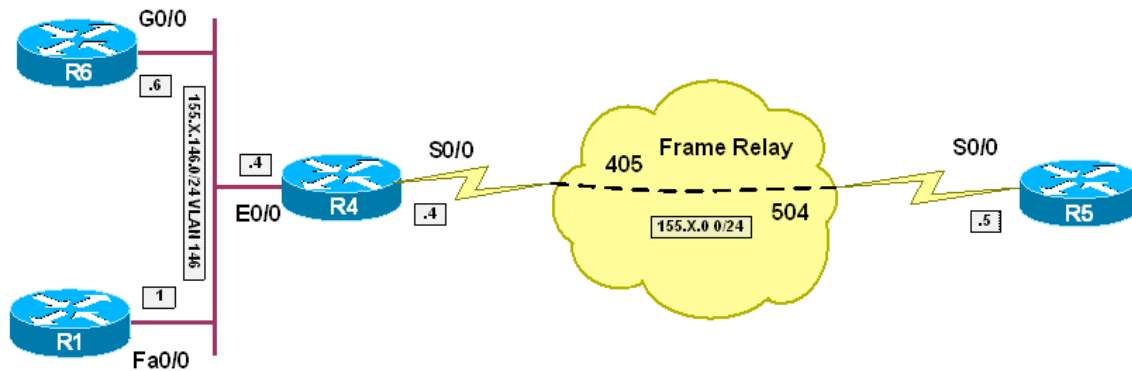
DHCP Relay

Objective: Configure router relay DHCP requests to DHCP server

Directions

- Pre-configure routers per the IP Services "Common Configuration" scenario
- Create DHCP address pool VLAN146 on R5
- Clients should get their addresses from range 155.X.146.0/25. Exclude R4 address from this allocation
- Configure DHCP to allocate R4 as default gateway
- Domain-name should be "internetworkexpert.com"
- Configure R4's Ethernet interface with helper address 155.X.0.5
- Configure R1 and R4 to obtain IP addresses via DHCP
- Add a static router to network 155.X.146.0/24 on R5, so that DHCP replies may reach R4's IP (giaddr field)

Final Configuration

```
R5:
ip dhcp pool VLAN146
 network 155.1.146.0 /24
 default-router 155.1.146.4
 domain-name internetworkexpert.com
 exit
!
ip dhcp excluded-address 155.1.146.4
!
ip route 155.1.146.0 255.255.255.0 155.1.0.4

R4:
interface Ethernet 0/0
 ip helper-address 155.1.0.5

R1:
interface Gig 0/0
 ip address dhcp

R6:
```

```
interface Fa 0/0
 ip address dhcp
```

Verification

```
R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R1(config)#int fa 0/0
R1(config-if)#ip add dhcp
DHCP: DHCP client process started: 10
RAC: Starting DHCP discover on FastEthernet0/0
DHCP: Try 1 to acquire address for FastEthernet0/0
DHCP: allocate request
DHCP: zapping entry in DHC_PURGING state for Fa0/0
DHCP: new entry. add to queue
DHCP: SDiscover attempt # 1 for entry:
DHCP: SDiscover: sending 294 byte length DHCP packet
DHCP: SDiscover 294 bytes
          B'cast on FastEthernet0/0 interface from 0.0.0.0


DHCP: Received a BOOTREP pkt
DHCP: offer received from 155.1.0.5
DHCP: SRequest attempt # 1 for entry:
DHCP: SRequest- Server ID option: 155.1.0.5
DHCP: SRequest- Requested IP addr option: 155.1.146.2
DHCP: SRequest placed lease len option: 86400
DHCP: SRequest: 312 bytes
DHCP: SRequest: 312 bytes
          B'cast on FastEthernet0/0 interface from 0.0.0.0
DHCP: Received a BOOTREP pkt
Interface FastEthernet0/0 assigned DHCP address 155.1.146.2, mask 255.255.255.0

DHCP Client Pooling: ***Allocated IP address: 155.1.146.2
Allocated IP address = 155.1.146.2  255.255.255.0


R5#show ip dhcp binding
Bindings from all pools not associated with VRF:
IP address          Client-ID/              Lease expiration        Type
                    Hardware address/
                    User name
155.1.146.2         0063.6973.636f.2d30.    Mar 22 1993 04:11 PM    Automatic
                    3030.342e.3237.6235.
                    2e32.6661.302d.4661.
                    302f.30
```

Configuring DHCP Host Pools

Objective: Configure router to support static DHCP bindings
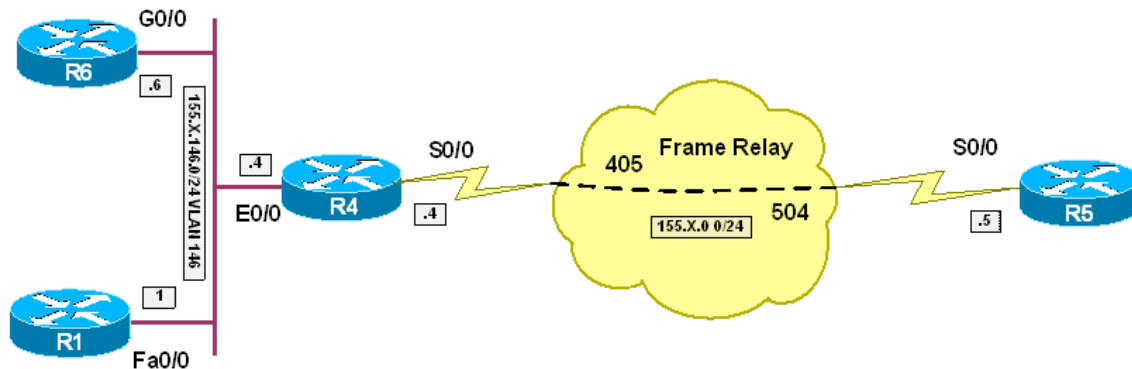
Directions

- Pre-configure routers per the IP Services "DHCP Relay" scenario
- Configure R5 to allocate static IP address 155.X.146.6 to R6 and static IP address 155.X.146.1 to R1
- Create DHCP pool R6 and assign host IP address 155.X.146.6/24 to it. This pool should be bound to R6's Client-ID
- Create DHCP pool R1 and host IP address 155.X.146.1/24 to it. This pool should be bound to R1's Client-ID
- You may discover particular Router's Client-ID by observing "debug ip dhcp server packet" output on DHCP server

Final Configuration

```
R5:
ip dhcp pool R6
   host 155.1.146.6
   client-id
0063.6973.636f.2d30.3031.352e.3632.3265.2e65.3533.302d.4769.302f.30
!
ip dhcp pool R1
   host 155.1.146.1
   client-id
0063.6973.636f.2d30.3030.342e.3237.6235.2e32.6661.302d.4661.302f.30
```

Verification

```
R5#debug ip dhcp server packet
R5#

R6#show dhcp lease
Temp IP addr: 155.1.146.6  for peer on Interface: GigabitEthernet0/0
Temp  sub net mask: 255.255.255.0
   DHCP Lease server: 155.1.0.5, state: 3 Bound
   DHCP transaction id: 4C2
```

```
   Lease: 86400 secs,  Renewal: 43200 secs,  Rebind: 75600 secs
Temp default-gateway addr: 155.1.146.4
   Next timer fires after: 11:59:48
   Retry count: 0    Client-ID: cisco-0015.622e.e530-Gi0/0
   Client-ID hex dump: 636973636F2D303031352E363232652E
                       653533302D4769302F30
   Hostname: R6

R1#show dhcp lease
Temp IP addr: 155.1.146.1  for peer on Interface: FastEthernet0/0
Temp  sub net mask: 255.255.255.0
   DHCP Lease server: 155.1.0.5, state: 3 Bound
   DHCP transaction id: 808017
   Lease: 86400 secs,  Renewal: 43200 secs,  Rebind: 75600 secs
Temp default-gateway addr: 155.1.146.4
   Next timer fires after: 11:59:35
   Retry count: 0    Client-ID: cisco-0004.27b5.2fa0-Fa0/0
   Hostname: R1


R5#
DHCPD: Sending notification of DISCOVER:
  DHCPD: htype 1 chaddr 0015.622e.e530
  DHCPD: circuit id 01f80000
DHCPD: DHCPDISCOVER received from client
0063.6973.636f.2d30.3031.352e.3632.3265.2e65.3533.302d.4769.302f.30 through
relay 155.1.146.4.
DHCPD: Seeing if there is an internally specified pool class:
  DHCPD: htype 1 chaddr 0015.622e.e530
  DHCPD: circuit id 01f80000
DHCPD: Sending DHCPOFFER to client
0063.6973.636f.2d30.3031.352e.3632.3265.2e65.3533.302d.4769.302f.30
(155.1.146.6).
DHCPD: unicasting BOOTREPLY for client 0015.622e.e530 to relay 155.1.146.4.
DHCPD: DHCPREQUEST received from client
0063.6973.636f.2d30.3031.352e.3632.3265.2e65.3533.302d.4769.302f.30.
DHCPD: Sending notification of ASSIGNMENT:
 DHCPD: address 155.1.146.6 mask 255.255.255.0
  DHCPD: lease time remaining (secs) = -1
DHCPD: No default domain to append - abort update
DHCPD: Sending DHCPACK to client
0063.6973.636f.2d30.3031.352e.3632.3265.2e65.3533.302d.4769.302f.30
(155.1.146.6).
DHCPD: unicasting BOOTREPLY for client 0015.622e.e530 to relay 155.1.146.4.
DHCPD: Sending notification of DISCOVER:
  DHCPD: htype 1 chaddr 0004.27b5.2fa0
  DHCPD: circuit id 01f80000
DHCPD: DHCPDISCOVER received from client
0063.6973.636f.2d30.3030.342e.3237.6235.2e32.6661.302d.4661.302f.30 through
relay 155.1.146.4.
DHCPD: Seeing if there is an internally specified pool class:
  DHCPD: htype 1 chaddr 0004.27b5.2fa0
  DHCPD: circuit id 01f80000
DHCPD: Sending DHCPOFFER to client
0063.6973.636f.2d30.3030.342e.3237.6235.2e32.6661.302d.4661.302f.30
(155.1.146.1).
DHCPD: unicasting BOOTREPLY for client 0004.27b5.2fa0 to relay 155.1.146.4.
DHCPD: DHCPREQUEST received from client
0063.6973.636f.2d30.3030.342e.3237.6235.2e32.6661.302d.4661.302f.30.
DHCPD: Sending notification of ASSIGNMENT:
 DHCPD: address 155.1.146.1 mask 255.255.255.0
  DHCPD: lease time remaining (secs) = -1
DHCPD: No default domain to append - abort update
```
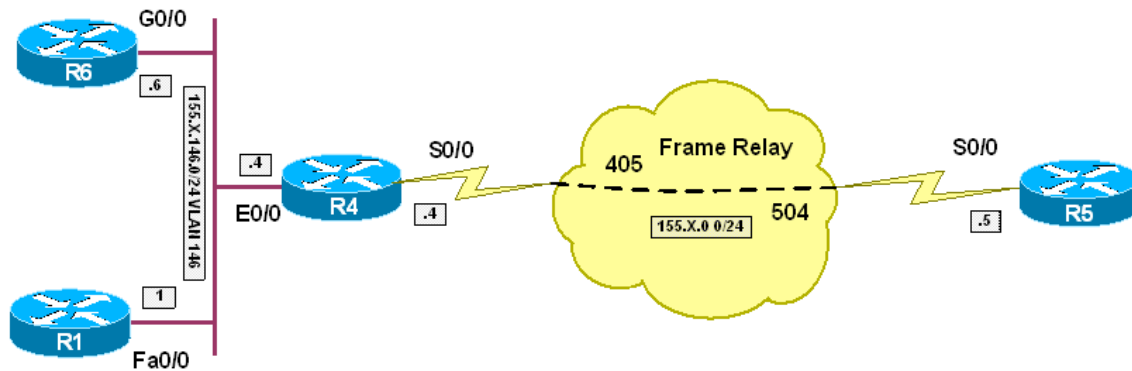
```
DHCPD: Sending DHCPACK to client
0063.6973.636f.2d30.3030.342e.3237.6235.2e32.6661.302d.4661.302f.30
(155.1.146.1).
DHCPD: unicasting BOOTREPLY for client 0004.27b5.2fa0 to relay 155.1.146.4.
DHCPD: checking for expired leases.
```

AutoInstall over Frame-Relay

Objective: Configure router for autoinstall over Frame-Relay Link

Directions

- Pre-configure routers per the IP Services "Common Configuration" scenario
- In this task, R5 is router that executes AutoInstall, R4 acts as staging router, R1 is TFTP and DNS server
- In the process of autoconfiguration, R5 will obtain it's IP address via BOOTP from static mapping on R4
- Next R5 will try to obtain network-wide configuration file from R1 and get it hostname from this file
- We are not going to provide this file to R5, so next it will try to obtain it's name via DNS request, which will be answered by R1
- Having obtained it's name, R5 will send TFTP request for it's host configuration, which will be provided by R1
- Configure R4 to relay broadcast requests to IP address of R1
- Configure R1 to store R5's configuration in the flash, on give it the name "r5-confg" (or use alias to this name later on)
- Enable TFTP server on R1 to respond to requests on this file
- Configure R6 as DNS server and map name R5 to ip address of 155.1.0.5
- Configure static route to 155.1.0.0/24 to R4 on R1

Final Configuration

```
First, obtain a copy of R5's configuration on R1:

R5#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R5(config)#tftp-server system:running-config alias R5.cfg
R5(config)#ip route 155.1.146.0 255.255.255.0 155.1.0.4

R1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
```

```
R1(config)#ip route 155.1.0.0 255.255.255.0 155.1.146.4
R1#copy tftp flash:
Address or name of remote host []? 155.1.0.5
Source filename []? R5.cfg
Destination filename [R5.cfg]?
Accessing tftp://155.1.0.5/R5.cfg...
Erase flash: before copying? [confirm]n
Loading R5.cfg from 155.1.0.5 (via FastEthernet0/0): !
[OK - 1263 bytes]

Verifying checksum...  OK (0x9A03)
1263 bytes copied in 4.948 secs (255 bytes/sec)

R4:
interface Serial 0/0
 ip helper-address 155.1.146.1

R1:
tftp-server flash:R5.cfg alias r5-confg
ip route 155.1.0.0 255.255.255.0 155.1.146.4
!
ip dns server
ip host R5 155.1.0.5
```

Verification

```
R5#wr era
Erasing the nvram filesystem will remove all configuration files! Continue?
[confirm]
[OK]
Erase of nvram: complete
R5#reload

System configuration has been modified. Save? [yes/no]: no
Proceed with reload? [confirm]
……

Would you like to enter the initial configuration dialog? [yes/no]:

Press RETURN to get started!


*Mar  1 00:00:10.695: %LINEPROTO-5-UPDOWN: Line protocol on Interface VoIP-
Null0, changed state to upsslinit fn

*Mar  1 00:00:24.691: %LINK-3-UPDOWN: Interface Serial0/0, changed state to up
*Mar  1 00:00:27.691: %LINK-3-UPDOWN: Interface Serial0/1, changed state to
down
*Mar  1 00:00:27.691: %LINK-3-UPDOWN: Interface Ethernet0/0, changed state to
up
*Mar  1 00:00:30.691: %LINK-3-UPDOWN: Interface Ethernet0/1, changed state to
up
*Mar  1 00:00:33.691: %LINEPROTO-5-UPDOWN: Line protocol on Interface , changed
state to up
*Mar  1 00:00:36.691: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0, changed state to up
*Mar  1 00:00:36.691: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/1, changed state to down
*Mar  1 00:00:36.691: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Ethernet0/0, changed state to up
```

```
*Mar  1 00:00:36.691: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Ethernet0/1, changed state to up
*Mar  1 00:00:57.691: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0, changed state to down
*Mar  1 00:01:15.643: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Serial0/0, changed state to up
*Mar  1 00:02:16.875: %LINK-5-CHANGED: Interface Ethernet0/0, changed state to
administratively down
*Mar  1 00:02:16.879: %LINK-5-CHANGED: Interface Ethernet0/1, changed state to
administratively down
*Mar  1 00:02:16.879: %LINK-5-CHANGED: Interface Serial0/1, changed state to
administratively down
*Mar  1 00:02:17.875: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Ethernet0/0, changed state to down
*Mar  1 00:02:17.879: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Ethernet0/1, changed state to down
*Mar  1 00:02:19.691: %IP-5-WEBINST_KILL: Terminating DNS process
*Nov 17 13:45:24.679: %SYS-5-RESTART: System restarted --
Cisco IOS Software, 3600 Software (C3640-JK9O3S-M), Version 12.3(14)T7, RELEASE
SOFTWARE (fc2)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2006 by Cisco Systems, Inc.
Compiled Wed 22-Mar-06 21:46 by pwade
*Nov 17 13:45:24.691: %SNMP-5-COLDSTART: SNMP agent on host Router is
undergoing a cold start
*Nov 17 13:45:33.975: %SYS-5-CONFIG_I: Configured from tftp://155.1.146.1/r5-
confg by console
R5#
```

Using NTP for Time Synchronization

Objective: Configure routers to synchronize time via NTP

Directions

- Pre-configure routers per the IP Services scenario "Common Configuration"
- Configure R5 as NTP master in stratum 1
- Configure R5 to broadcast NTP updates on Frame-Relay interface
- Configure R4 to listen to NTP updates on Frame-Relay interface
- Configure R1 and R6 to use R4 as NTP server
- Configure R1 and R6 to peer over NTP

Final Configuration

```
R5:
ntp master 1
!
interface Serial 0/0
 ntp broadcast

R4:
interface Serial 0/0
 ntp broadcast client

R1:
ntp server 155.1.146.4

R6:
ntp server 155.1.146.4
ntp peer 155.1.146.1
```

Verification

```
R4#show ntp associations detail
155.1.0.5 dynamic, our_master, sane, valid, stratum 1
ref ID .LOCL., time C906F6E3.C1916C87 (14:40:35.756 UTC Thu Nov 16 2006)
our mode bdcast client, peer mode bdcast, our poll intvl 64, peer poll intvl 64
root delay 0.00 msec, root disp 0.03, reach 16, sync dist 7917.526
delay 48.20 msec, offset 29.6415 msec, dispersion 7893.40
precision 2**24, version 3
org time C906F710.C19325BE (14:41:20.756 UTC Thu Nov 16 2006)
rcv time C906F710.CF7E9071 (14:41:20.810 UTC Thu Nov 16 2006)
xmt time 00000000.00000000 (00:00:00.000 UTC Mon Jan 1 1900)
filtdelay =    48.20    48.20     0.00     0.00     0.00     0.00     0.00     0.00
filtoffset =   29.64    -5.20     0.00     0.00     0.00     0.00     0.00     0.00
filterror =     0.99     1.97  16000.0  16000.0  16000.0  16000.0  16000.0  16000.0

R1#show ntp associations detail
155.1.146.6 dynamic, selected, sane, valid, stratum 3
ref ID 155.1.146.4, time C906FB7E.6A99B411 (15:00:14.416 UTC Thu Nov 16 2006)
our mode passive, peer mode active, our poll intvl 64, peer poll intvl 128
root delay 50.61 msec, root disp 74.83, reach 7, sync dist 7976.959
delay 2.30 msec, offset -2.6652 msec, dispersion 7875.67
precision 2**18, version 3
org time C906FB9C.69DAE6AB (15:00:44.413 UTC Thu Nov 16 2006)
rcv time C906FB9C.6AD54724 (15:00:44.417 UTC Thu Nov 16 2006)
xmt time C906FB75.AE31B8C7 (15:00:05.680 UTC Thu Nov 16 2006)
filtdelay =     2.30     2.20     0.00     0.00     0.00     0.00     0.00     0.00
filtoffset =   -2.67    -2.53     0.00     0.00     0.00     0.00     0.00     0.00
filterror =     0.61     1.59  16000.0  16000.0  16000.0  16000.0  16000.0  16000.0

155.1.146.4 configured, our_master, sane, valid, stratum 2
ref ID 155.1.0.5, time C906FB50.D2C513AD (14:59:28.823 UTC Thu Nov 16 2006)
our mode client, peer mode server, our poll intvl 64, peer poll intvl 64
root delay 48.20 msec, root disp 55.92, reach 377, sync dist 83.557
delay 3.11 msec, offset -12.9198 msec, dispersion 1.25
precision 2**24, version 3
org time C906FB6C.AB643E8D (14:59:56.669 UTC Thu Nov 16 2006)
rcv time C906FB6C.AF1942D7 (14:59:56.683 UTC Thu Nov 16 2006)
xmt time C906FB6C.AE4935DF (14:59:56.680 UTC Thu Nov 16 2006)
filtdelay =     3.11     3.20     3.22     3.13     3.23     3.40     3.17     3.13
filtoffset =  -12.92   -13.32   -13.50    -8.73    -8.44   -11.43   -13.80    -8.01
filterror =     0.02     0.99     1.97     3.63     5.58     6.56     7.10     8.07

R6#show ntp associations  detail
155.1.146.1 configured, selected, sane, valid, stratum 3
ref ID 155.1.146.4, time C906FBAC.AE9327F7 (15:01:00.681 UTC Thu Nov 16 2006)
our mode active, peer mode passive, our poll intvl 128, peer poll intvl 64
root delay 51.38 msec, root disp 88.82, reach 377, sync dist 116.364
delay 1.83 msec, offset 2.9012 msec, dispersion 0.95
precision 2**18, version 3
org time C906FBB5.ADA71EB2 (15:01:09.678 UTC Thu Nov 16 2006)
rcv time C906FBB5.AD253AAC (15:01:09.676 UTC Thu Nov 16 2006)
xmt time C906FB9C.69DAE6AB (15:00:44.413 UTC Thu Nov 16 2006)
filtdelay =     1.83     2.11     2.14     2.01     2.03     1.98     2.04     2.03
filtoffset =    2.90     2.57     2.50     2.17     1.87     1.62     0.01    -3.02
filterror =     0.40     1.24     2.08     3.05     4.03     5.00     5.98     6.96

155.1.146.4 configured, our_master, sane, valid, stratum 2
ref ID 155.1.0.5, time C906FB50.D2C513AD (14:59:28.823 UTC Thu Nov 16 2006)
our mode client, peer mode server, our poll intvl 128, peer poll intvl 128
```

```
root delay 48.20 msec, root disp 55.92, reach 377, sync dist 82.779
delay 2.41 msec, offset -9.2902 msec, dispersion 0.72
precision 2**24, version 3
org time C906FB7E.67E96411 (15:00:14.405 UTC Thu Nov 16 2006)
rcv time C906FB7E.6A99B411 (15:00:14.416 UTC Thu Nov 16 2006)
xmt time C906FB7E.69F75251 (15:00:14.413 UTC Thu Nov 16 2006)
filtdelay =     2.41    2.15    2.43    2.18    2.14    2.20    2.17    2.41
filtoffset =   -9.29   -9.90  -10.00  -10.04  -10.12  -10.18  -10.25  -10.38
filterror =     0.02    1.97    1.98    2.00    2.01    2.03    2.04    2.06
```

Authenticating NTP Updates

Objective: Authenticate NTP updates between routers
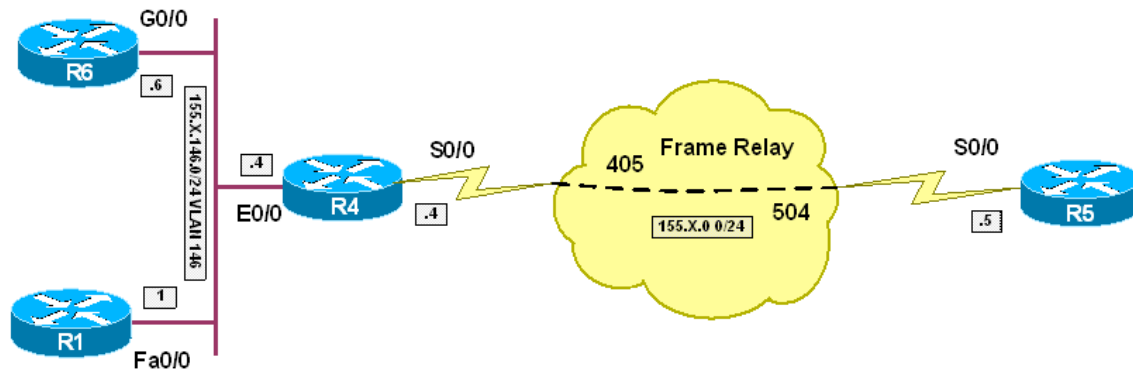
Directions

- Pre-configure routers per the IP Services scenario "Using NTP for Time Synchronization"
- Configure R5 to authenticate NTP messages sent over FR interface with key CISCO45. This key should have number 45
- Configure R4 to accept NTP messages only if they are authenticated with key number 45 having key-string CISCO45
- Configure R4 to respond on authenticated messages with key number 41 and 46. These are keys for R1 and R6 respectively. The corresponding key-strings should be CISCO41 and CISCO46
- Configure R1 to poll R4 with messages bearing key-number 41 and key-string CISCO41. This should be the locally trusted key, so that R1 may update it's clock
- Configure R6 to poll R4 with messages bearing key-number 46 and key-string CISCO46. This should be the locally trusted key, so that R6 may update it's clock
- Finally, authenticate R1 and R6 NTP peering. R6 should send key-number 16 with key-string CISCO16. The same key should be configured on R1, in order to respond on queries. Both routers should trust this key

Final Configuration

```
R5:
ntp authentication-key 45 md5 CISCO45
!
interface Serial 0/0
 ntp broadcast key 45

R4:
ntp authenticate
ntp authentication-key 45 md5 CISCO45
ntp trusted-key 45
!
```

```
ntp authentication-key 46 md5 CISCO46
ntp authentication-key 41 md5 CISCO41
!
interface Serial 0/0
 ntp broadcast client

R1:
ntp authenticate
ntp authentication-key 41 md5 CISCO41
ntp trusted-key 41
!
ntp server 155.1.146.4 key 41
!
ntp authentication-key 16 md5 CISCO16
ntp trusted-key 16

R6:
ntp authenticate
ntp authentication-key 46 md5 CISCO46
ntp trusted-key 46
!
ntp server 155.1.146.4 key 46
!
ntp authentication-key 16 md5 CISCO16
ntp trusted-key 16
ntp peer 155.1.146.1 key 16
```

Verification

```
R4#show ntp associations detail
155.1.0.5 dynamic, authenticated, our_master, sane, valid, stratum 1
ref ID .LOCL., time C906FFA3.C186E2D2 (15:17:55.755 UTC Thu Nov 16 2006)
our mode bdcast client, peer mode bdcast, our poll intvl 64, peer poll intvl 64
root delay 0.00 msec, root disp 0.03, reach 376, sync dist 46.753
delay 48.20 msec, offset -16.7511 msec, dispersion 22.63
precision 2**24, version 3
org time C906FFD0.C191A8CD (15:18:40.756 UTC Thu Nov 16 2006)
rcv time C906FFD0.DB5D757D (15:18:40.856 UTC Thu Nov 16 2006)
xmt time 00000000.00000000 (00:00:00.000 UTC Mon Jan 1 1900)
filtdelay =    48.20   48.20   48.20   48.20   48.20   48.20   48.20   48.20
filtoffset = -16.75  -20.00   19.50   32.92   39.37  -43.31   -3.69   11.06
filterror =     0.99    1.97    2.94    3.92    4.90    5.87    6.85    7.83

R1#show ntp associations detail
155.1.146.6 dynamic, authenticated, selected, sane, valid, stratum 3
ref ID 155.1.146.4, time C906FFAD.69F2C5BD (15:18:05.413 UTC Thu Nov 16 2006)
our mode passive, peer mode active, our poll intvl 64, peer poll intvl 128
root delay 50.55 msec, root disp 83.71, reach 36, sync dist 3987.579
delay 2.94 msec, offset -12.2832 msec, dispersion 3877.03
precision 2**18, version 3
org time C906FFF6.696885D7 (15:19:18.411 UTC Thu Nov 16 2006)
rcv time C906FFF6.6CEE1D2C (15:19:18.425 UTC Thu Nov 16 2006)
xmt time C907000C.A782E05E (15:19:40.654 UTC Thu Nov 16 2006)
filtdelay =     2.94    3.08    3.10    0.00    0.00    0.00    0.00    0.00
filtoffset = -12.28  -10.91   -9.48    0.00    0.00    0.00    0.00    0.00
filterror =     0.66    1.63    2.61 16000.0 16000.0 16000.0 16000.0 16000.0

155.1.146.4 configured, authenticated, our_master, sane, valid, stratum 2
ref ID 155.1.0.5, time C906FFD0.DB5D757D (15:18:40.856 UTC Thu Nov 16 2006)
our mode client, peer mode server, our poll intvl 64, peer poll intvl 64
```

```
root delay 48.20 msec, root disp 39.43, reach 177, sync dist 69.550
delay 3.07 msec, offset -2.9357 msec, dispersion 4.49
precision 2**24, version 3
org time C906FFFC.A747A33C (15:19:24.653 UTC Thu Nov 16 2006)
rcv time C906FFFC.A86CE0E0 (15:19:24.657 UTC Thu Nov 16 2006)
xmt time C906FFFC.A79005F1 (15:19:24.654 UTC Thu Nov 16 2006)
filtdelay =     3.07     3.10     3.30     3.05     3.05     3.13     3.13     3.14
filtoffset =   -2.94     0.85     4.27     1.64    -3.59    -7.38    -2.25    -0.60
filterror =     0.02     0.99     1.97     2.94     3.92     4.90     5.51     7.10

R6#show ntp associations detail
155.1.146.1 configured, authenticated, selected, sane, valid, stratum 3
ref ID 155.1.146.4, time C906FFFC.A86CE0E0 (15:19:24.657 UTC Thu Nov 16 2006)
our mode active, peer mode passive, our poll intvl 128, peer poll intvl 64
root delay 51.27 msec, root disp 53.88, reach 376, sync dist 83.603
delay 1.59 msec, offset 12.9571 msec, dispersion 2.79
precision 2**18, version 3
org time C907000C.A782E05E (15:19:40.654 UTC Thu Nov 16 2006)
rcv time C907000C.A466279E (15:19:40.642 UTC Thu Nov 16 2006)
xmt time C9070036.697A7A2B (15:20:22.412 UTC Thu Nov 16 2006)
filtdelay =     1.59     1.63     1.65     1.85     2.04     1.77     2.14     1.21
filtoffset =   12.96    11.63    10.20     8.86     8.12     8.40     7.54     6.38
filterror =     0.35     1.25     2.23     3.01     3.98     4.76     5.74     6.71

155.1.146.4 configured, authenticated, our_master, sane, valid, stratum 2
ref ID 155.1.0.5, time C9070010.DCC46CD2 (15:19:44.862 UTC Thu Nov 16 2006)
our mode client, peer mode server, our poll intvl 128, peer poll intvl 128
root delay 48.20 msec, root disp 37.61, reach 377, sync dist 68.085
delay 2.29 msec, offset 7.9938 msec, dispersion 5.23
precision 2**24, version 3
org time C907002D.6BDCC170 (15:20:13.421 UTC Thu Nov 16 2006)
rcv time C907002D.6A1C1014 (15:20:13.414 UTC Thu Nov 16 2006)
xmt time C907002D.69726ECC (15:20:13.411 UTC Thu Nov 16 2006)
filtdelay =     2.29     2.35     2.32     2.30     2.40     2.41     2.38     2.46
filtoffset =    7.99    13.02    13.69    10.39     5.20    -3.15   -10.74   -14.04
filterror =     0.02     1.97     2.94     3.63     7.54     9.49    10.50    12.45
```
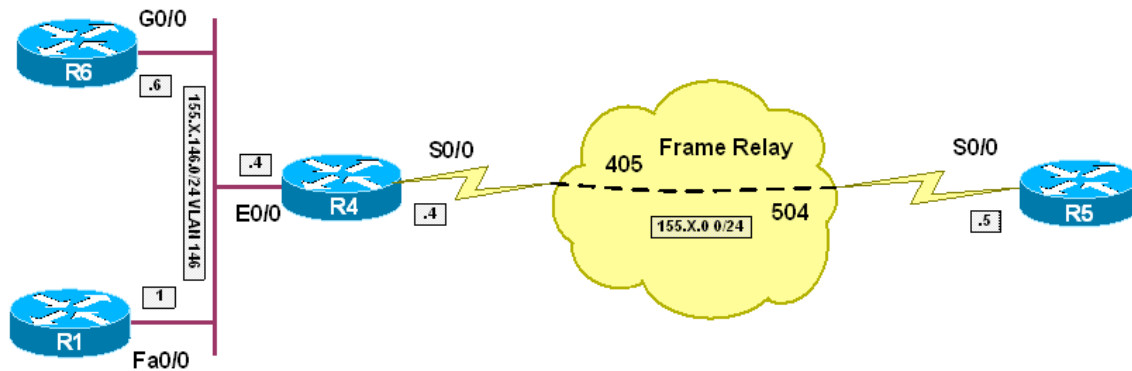
Router Menus

Objective: Create a menu on router

Directions

- Pre-configure routers per the IP Services scenario "Common Configuration"
- Create user on R4 with name CISCO and password CISCO
- Create menu USERMENU on R4 entitled: "Sample menu"
- The first menu line, named "Current Configuration" should execute "show run" command
- The second menu line, named "Ping R1" should execute "ping 155.X.146.1"
- The third menu line, named "Telnet to R6" shold execute "telnet 155.X.146.6"
- The forth menu line named "Exit to shell" should execute "menu-exit" command
- The last menu line named "Exit" should execute "exit" command
- Apply autocommand "menu USERMENU" to user CISCO
- Assign privilege level 15 to user CISCO
- Enabel local authentication on VTY lines

Final Configuration

```
R4:
menu USERMENU title $
Sample Menu
$
menu USERMENU text 1 "Current Configuration"
menu USERMENU command 1 show run
menu USERMENU text 2 "Ping R1"
menu USERMENU command 2 ping 155.1.146.1
menu USERMENU text 3 "Telnet to R6"
menu USERMENU command 3 telnet 155.1.146.6
menu USERMENU text 4 "Exit to Shell"
menu USERMENU command 4 menu-exit
menu USERMENU text 5 "Exit"
menu USERMENU command 5 exit
```

```
!
username CISCO password CISCO
username CISCO autocommand menu USERMENU
username CISCO privilege 15
!
line vty 0 4
 login local
```

Verification

```
R1#telnet 155.1.146.4
Trying 155.1.146.4 ... Open


User Access Verification

Username: CISCO
Password: CISCO

Sample Menu

    1            "Current Configuration"

    2            "Ping R1"

    3            "Telnet to R6"

    4            "Exit to Shell"

    5            "Exit"

Building configuration...

Current configuration : 1822 bytes
!
version 12.3
service timestamps debug datetime msec
service timestamps log datetime msec
no service password-encryption
!
hostname R4
!
boot-start-marker
boot-end-marker
!
logging buffered 4096 debugging
enable secret 5 $1$YIus$GKTLXAZbwGuTF9hk1U88Q1
!
no aaa new-model
!
resource policy
!
memory-size iomem 15
ip subnet-zero
ip tcp synwait-time 5

Sample Menu

    1            "Current Configuration"
```

```
    2           "Ping R1"

    3           "Telnet to R6"

    4           "Exit to Shell"

    5           "Exit"

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 155.1.146.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/4 ms

Sample Menu

    1           "Current Configuration"

    2           "Ping R1"

    3           "Telnet to R6"

    4           "Exit to Shell"

    5           "Exit"

R4#
```
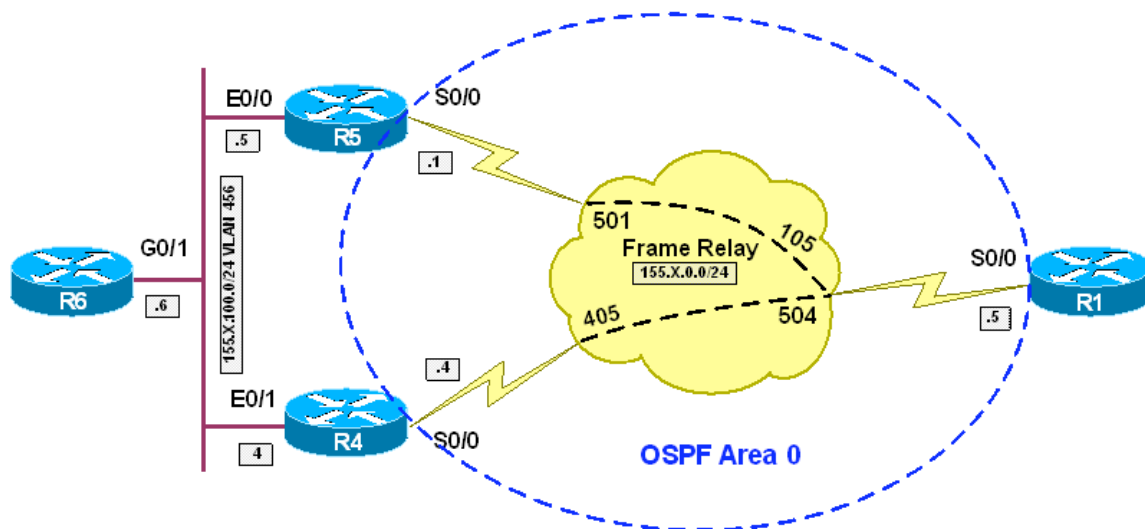
Gateway Redundancy with VRRP

Objective: Configure redundant gateways with VRRP

Directions

- Create VLAN 456 on all switches involved in the scenario
- Configure the respective switchports for R4, R5 and R6 in VLAN 456
- Configure IP addressing on VLAN 456 interfaces as per diagram
- Configure IP addressing on Frame-Relay interfaces. Use only physical FR interfaces, and use static mappings
- Map broadcast to the hub router (R1) and from hub to spokes. Use DLCI numbers specified on diagram
- Configure FR mappings on R5 and R4 so that they can reach each other via R1
- Configure FR interfaces in OSPF Area 0. Use OSPF network type broadcast for this link
- Configure FR interface on R5 and R4 to have OSPF priority of zero, so that they never could become DR
- Redistribute the connected subnets on R4 and R5 into OSPF. R5 should use metric 500 and R4 should use metric 400. This way, R1 will prefer R4 to reach VLAN456
- Configure VRRP on R4 and R5 Ethernet interfaces. Use VRRP group 1, and virtual IP 155.X.100.254
- R4 should have priority 110 and R5 should have the default priority 100.
- Authenticate VRRP packets using md5 hash with key CISCO
- Create track object 1 on R4 to track Serial 0/0 line-protocol state
- Configure VRRP on R4 to track object 1 and decrement priority down by 20 if the object is down

Final Configuration

```
SW1-SW4:
vlan 456

SW1:
interface Fa 0/5
 switchport host
 switchport access vlan 456

SW2:
interface Fa 0/6
 switchport host
 switchport access vlan 456

SW4:
interface Fa 0/4
 switchport host
 switchport access vlan 456

R1:
interface Serial 0/0
 encapsulation frame-relay
 no frame-relay inverse-arp
 ip address 155.1.0.1 255.255.255.0
 frame-relay map ip 155.1.0.5 105 broadcast
 frame-relay map ip 155.1.0.4 104 broadcast
 ip ospf network broadcast
 no shutdown
!
router ospf 1
 router-id 150.1.1.1
 network 155.1.0.1 0.0.0.0 area 0

R4:
track 1 interface Serial0/0 line-protocol
!
interface Ethernet0/1
 ip address 155.1.100.4 255.255.255.0
 half-duplex
 vrrp 1 ip 155.1.100.254
 vrrp 1 priority 110
 vrrp 1 authentication md5 key-string CISCO
 vrrp 1 track 1 decrement 20
!
interface Serial 0/0
 encapsulation frame-relay
 no frame-relay inverse-arp
 ip address 155.1.0.4 255.255.255.0
 frame-relay map ip 155.1.0.5 401 broadcast
 frame-relay map ip 155.1.0.1 401
 ip ospf priority 0
 ip ospf network broadcast
 no shutdown
!
interface Loopback0
 ip address 150.1.45.4 255.255.255.0
!
router ospf 1
 router-id 150.1.4.4
```

```
 redistribute connected subnets metric 400
 network 155.1.0.4 0.0.0.0 area 0

R5:
interface Ethernet0/0
 ip address 155.1.100.5 255.255.255.0
 half-duplex
 vrrp 1 ip 155.1.100.254
 vrrp 1 authentication md5 key-string CISCO
 no shutdown
!
interface Serial 0/0
 encapsulation frame-relay
 no frame-relay inverse-arp
 ip address 155.1.0.5 255.255.255.0
 frame-relay map ip 155.1.0.1 501 broadcast
 frame-relay map ip 155.1.0.4 501
 ip ospf network broadcast
 ip ospf priority 0
 no shutdown
!
interface Loopback0
 ip address 150.1.45.5 255.255.255.0
!
router ospf 1
 router-id 150.1.5.5
 network 155.1.0.5 0.0.0.0 area 0
 redistribute connected subnets metric 500

R6:
interface Gig 0/0
 ip address 155.1.100.6 255.255.255.0
 no shutdown
!
ip route 0.0.0.0 0.0.0.0 155.1.100.254
```

Verification

```
R4#show vrrp
Ethernet0/1 - Group 1
  State is Master
  Virtual IP address is 155.1.100.254
  Virtual MAC address is 0000.5e00.0101
  Advertisement interval is 1.000 sec
  Preemption enabled
  Priority is 110
    Track object 1 state Up decrement 20
  Authentication MD5, key-string "CISCO"
  Master Router is 155.1.100.4 (local), priority is 110
  Master Advertisement interval is 1.000 sec
  Master Down interval is 3.570 sec

R6#ping 155.1.0.1 repeat 1000 size 1000

Type escape sequence to abort.
Sending 1000, 1000-byte ICMP Echos to 155.1.0.1, timeout is 2 seconds:
.!!!!!!!!!
Rack1AS>4
[Resuming connection 4 to r4 ... ]
```
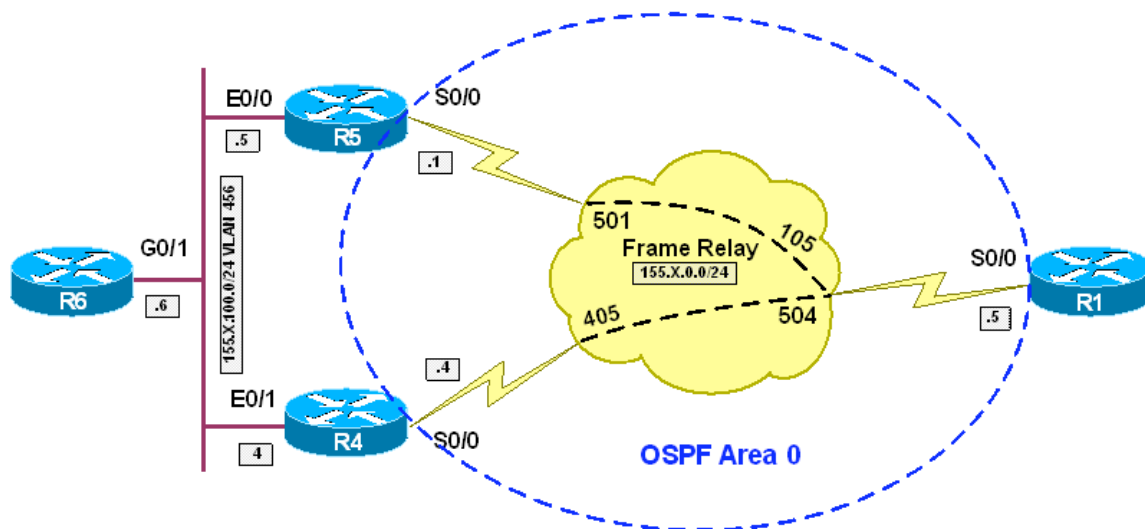
```
R4#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R4(config)#interface serial 0/0
R4(config-if)#shut
R4(config-if)#
Rack1AS>6
[Resuming connection 6 to r6 ... ]
!!.U...................!!!!!!!!!!!!!!!!!!!!!!!.
Success rate is 63 percent (41/65), round-trip min/avg/max = 508/512/544 ms

R4#show vrrp
Ethernet0/1 - Group 1
  State is Backup
  Virtual IP address is 155.1.100.254
  Virtual MAC address is 0000.5e00.0101
  Advertisement interval is 1.000 sec
  Preemption enabled
  Priority is 90  (cfgd 110)
    Track object 1 state Down decrement 20
  Authentication MD5, key-string "CISCO"
  Master Router is 155.1.100.5, priority is 100
  Master Advertisement interval is 1.000 sec
  Master Down interval is 3.570 sec (expires in 3.422 sec)

R4#show track 1
Track 1
  Interface Serial0/0 line-protocol
  Line protocol is Down (hw admin-down)
    3 changes, last change 00:02:03
  Tracked by:
    VRRP Ethernet0/1 1
```

Gateway Redundancy with HSRP

Objective: Configure redundant gateways with HSRP

Directions

- Create VLAN 456 on all switches involved in the scenario.
- Configure the respective switchports for R4, R5 and R6 in VLAN 456
- Configure IP addressing on VLAN 456 interfaces as per diagram
- Configure IP addressing on Frame-Relay interfaces. Use only physical FR interfaces, and use static mappings
- Map broadcast to the hub router (R1) and from hub to spokes. Use DLCI numbers specified on diagram
- Configure FR mappings on R5 and R4 so that they can reach each other via R1
- Configure FR interfaces in OSPF Area 0. Use OSPF network type broadcast for this link
- Configure FR interface on R5 and R4 to have OSPF priority of zero, so that they never could become DR
- Redistribute the connected subnets on R4 and R5 into OSPF. R5 should use metric 500 and R4 should use metric 400. This way, R1 will prefer R4 to reach VLAN456
- Configure HSRP on R4 and R5 Ethernet interfaces. Use HSRP group 1, name GROUP1 and virtual IP 155.X.100.254.
- R4 should have priority 110 and R5 should have the default priority 100.
- Configure HSRP for preemption
- Configure HSRP on R4 to track FR interface state with decrement value of 20

Final Configuration

```
SW1-SW4:
vlan 456

SW1:
interface Fa 0/5
 switchport host
 switchport access vlan 456

SW2:
interface Fa 0/6
 switchport host
 switchport access vlan 456

SW4:
interface Fa 0/4
 switchport host
 switchport access vlan 456

R1:
interface Serial 0/0
 encapsulation frame-relay
 no frame-relay inverse-arp
 ip address 155.1.0.1 255.255.255.0
 frame-relay map ip 155.1.0.5 105 broadcast
 frame-relay map ip 155.1.0.4 104 broadcast
 ip ospf network broadcast
 no shutdown
!
router ospf 1
 router-id 150.1.1.1
 network 155.1.0.1 0.0.0.0 area 0


R4:
interface Eth 0/1
 ip address 155.1.100.4 255.255.255.0
 standby 1 name GROUP1
 standby 1 ip 155.1.100.254
 standby 1 preempt
 standby 1 priority 110
 standby 1 track Serial 0/0 20
 no shutdown
!
interface Serial 0/0
 encapsulation frame-relay
 no frame-relay inverse-arp
 ip address 155.1.0.4 255.255.255.0
 frame-relay map ip 155.1.0.5 401 broadcast
 frame-relay map ip 155.1.0.1 401
 ip ospf priority 0
 ip ospf network broadcast
 no shutdown
!
interface Loopback0
 ip address 150.1.45.4 255.255.255.0
!
router ospf 1
 router-id 150.1.4.4
```

```
 redistribute connected subnets metric 400
 network 155.1.0.4 0.0.0.0 area 0
```

R5:
```
interface Ethernet 0/0
 ip address 155.1.100.1 255.255.255.0
 standby 1 name GROUP1
 standby 1 ip 155.1.100.254
 standby 1 preempt
 standby 1 priority 100
 no shut
!
interface Serial 0/0
 encapsulation frame-relay
 no frame-relay inverse-arp
 ip address 155.1.0.5 255.255.255.0
 frame-relay map ip 155.1.0.1 501 broadcast
 frame-relay map ip 155.1.0.4 501
 ip ospf network broadcast
 ip ospf priority 0
 no shutdown
!
interface Loopback0
 ip address 150.1.45.5 255.255.255.0
!
router ospf 1
 router-id 150.1.5.5
 network 155.1.0.5 0.0.0.0 area 0
 redistribute connected subnets metric 500
```

R6:
```
interface Gig 0/0
 ip address 155.1.100.6 255.255.255.0
 no shutdown
!
ip route 0.0.0.0 0.0.0.0 155.1.100.254
```

Verification

```
R4#show standby
Ethernet0/1 - Group 1
  State is Active
    5 state changes, last state change 00:00:26
  Virtual IP address is 155.1.100.254
  Active virtual MAC address is 0000.0c07.ac01
    Local virtual MAC address is 0000.0c07.ac01 (v1 default)
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 0.960 secs
  Preemption enabled
  Active router is local
  Standby router is 155.1.100.1, priority 100 (expires in 8.960 sec)
  Priority 110 (configured 110)
    Track interface Serial0/0 state Up decrement 20
  IP redundancy name is "GROUP1" (cfgd)

R6#ping 155.1.0.1 repeat 1000 size 1000

Type escape sequence to abort.
Sending 1000, 1000-byte ICMP Echos to 155.1.0.1, timeout is 2 seconds:
!!!!!!
```

```
Rack1AS>4
[Resuming connection 4 to r4 ... ]

R4#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
R4(config)#int se 0/0
R4(config-if)#shut
R4(config-if)#
Rack1AS>6
[Resuming connection 6 to r6 ... ]
!!.U..................!!!!!!!!!!!!!!!!!!!!!!!!!!!.
Success rate is 66 percent (44/66), round-trip min/avg/max = 508/510/516 ms

R5#show standby
Ethernet0/0 - Group 1
  State is Active
    5 state changes, last state change 00:01:31
  Virtual IP address is 155.1.100.254
  Active virtual MAC address is 0000.0c07.ac01
    Local virtual MAC address is 0000.0c07.ac01 (v1 default)
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 1.880 secs
  Preemption enabled
  Active router is local
  Standby router is 155.1.100.4, priority 90 (expires in 9.880 sec)
  Priority 100 (default 100)
  IP redundancy name is "GROUP1" (cfgd)

R4#show standby
Ethernet0/1 - Group 1
  State is Standby
    7 state changes, last state change 00:01:42
  Virtual IP address is 155.1.100.254
  Active virtual MAC address is 0000.0c07.ac01
    Local virtual MAC address is 0000.0c07.ac01 (v1 default)
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 2.788 secs
  Preemption enabled
  Active router is 155.1.100.1, priority 100 (expires in 8.764 sec)
  Standby router is local
  Priority 90 (configured 110)
    Track interface Serial0/0 state Down decrement 20
  IP redundancy name is "GROUP1" (cfgd)
```