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First Hop Redundancy Protocol Notes

Network Redundancy

- In this example, all the network infrastructure devices are a single point of failure
- If any switch or router goes down, the PCs will lose their internet access
- This is common for small branch offices where the cost of adding redundant devices cannot be justified
- The point of redundancy is to eliminate single points of failure
- Now we have added redundant switches, routers and internet connections
- We can still reach the internet if any core/distribution layer switch, router or link fails
- In a real world network the core/distributed layer switches would typically be L3 switches
- I'm using L2 switches in the example to aid learning

Access Layer

- we don't typically implement redundancy at the access layer because end hosts have only one network card
- Servers with redundant NICs are an exception

Layer 3 configuration

- Redundancy and failover are relatively easy to implement for layer 3 routing

Static route to sp1:

```
ip route 0.0.0.0 0.0.0.0 203.0.113.1
```

Backup default static route via R2 if link to SP1 goes down

```
ip route 0.0.0.0  0.0.0.0  10.10.20.2 5
```

Backup route to inside via r2 if link CD1 goes down:

```
ip route 10.10.10.0  255.255.255.0  10.10..20.2
```

FHRP

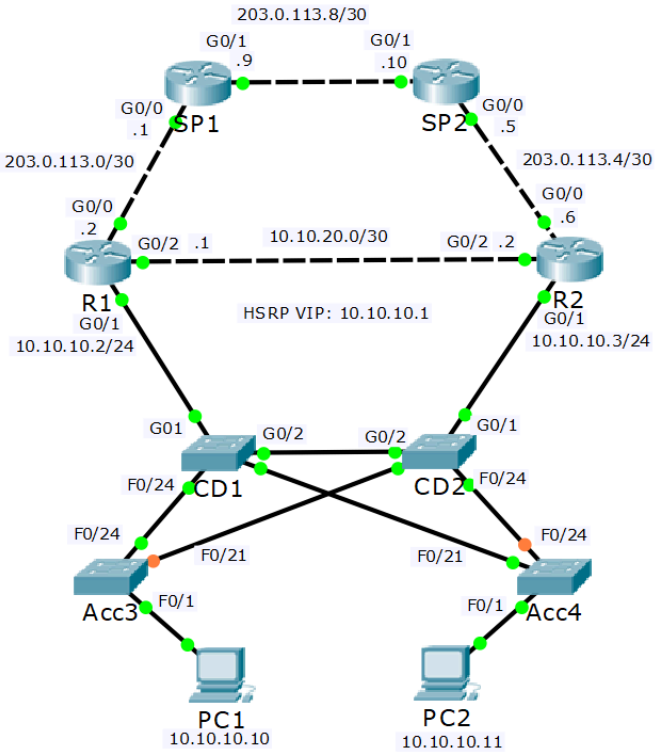
- Redundancy and failover are relatively easy to implement for L3 routing

- Routes on R1

Static route to SP1:
Ip route 0.0.0.0 0.0.0.0 203.0.113.1
Backup default static route via R2 if link to SP1 goes down:
Ip route 0.0.0.0 0.0.0.0 10.10.20.2 5
Backup route to instead via R2 if link to CD1 goes down:
Ip route 10.10.10.0 255.255.255.0 10.10.20.2

Host Gateways

How do we configure this? We could set up half of our PCs to use R1 at 10.10.10.2 as their default gateway, and the other half to use R2 at 10.10.10.3. However, this would be inconvenient. An even bigger problem arises if R1 goes down; all PCs using 10.10.10.2 as their default gateway would need manual reconfiguration to use 10.10.10.3 instead.
When we configured routing on R1 and R2, backup routes allowed automatic failover if a link goes down. We do not want to manually reconfigure PCs if a router or path goes down because it is inconvenient and time-consuming. Therefore, we need a better solution.



Types of First Hop Redundancy Protocols

There are several FHRPs available:

- **HSRP (Hot Standby Router Protocol):** Cisco proprietary, deployed in an active/standby pair. One router is active, and the other is standby. All traffic goes through the active router, and if it fails, traffic fails over to the standby router. HSRP is the most commonly used FHRP in Cisco environments.
- **VRRP (Virtual Router Redundancy Protocol):** An open standard similar to HSRP, also deployed in active/standby pairs. The configuration is nearly identical to HSRP, except VRRP uses the keyword `vrrp` instead of `standby`.
- **GLBP (Gateway Load Balancing Protocol):** Cisco proprietary, supports active/active load balancing across multiple routers for the same IP subnet. It is more complex to configure and troubleshoot than HSRP.

HSRP is the protocol covered in the CCNA exam and will be the focus of the next lecture.

HSRP

- HSRP uses a Virtual IP (VIP) and MAC address to allow for automated gateway failover
- The hosts use the VIP as their default gateway address
- If the active gateway fails. the standby gateway will take over

HSRP Configurations

```
R1(config)#interface g0/1
R1(config-if)#ip address 10.10.10.2 255.255.255.0
R1(config-if)# no shutdown
R1(config-if)#standby 1 ip 10.10.10.1

R2(config)#interface g0/1
R2(config-if)# ip address 10.10.10.3 255.255.255.0
R2(config-if)# no shutdown
R2(config-if)# standby 1 ip 10.10.10.1
```

Key Commands and Concepts:

- standby ip: Configures the virtual IP address for the HSRP group on an interface
- standby priority: Configures the priority of a router within an HSRP group.The router with the highest priority becomes the active router
- standby preempt: Allows a router to become active if its priority is higher than

the current active router, even if it was previously in standby mode
- standby track: Allows an interface's state to affect the HSRP priority. If a tracked interface goes down, the HSRP priority can be decremented, potentially causing a failover
- standby timers: Configures the hello and hold-time intervals for HSRP
- standby version: Specifies the HSRP version (1 or 2)
- standby follow: Configures an HSRP group to be a client of another HSRP group

HSRP uses the standby [group] [ip] command: Configures the virtual IP address for the HSRP group on an interface

Verification - show standby

HSRP Operations

- Both routers have a normal physical IP address and MAC address on their HSRP interface. UNique addresses are used on both routers
- They both also have the HSRP virtual IP and MAC address configured on the interface. The same addresses are used on both routers
- When they come online, one is elected the HSRP active router, the other is the standby
- The active router owns the virtual IP and MAC address and responds to ARP requests
- ALL traffic for the VIP goes through the active router
- The routers send hello messages to each over their HSRP interface
- If the standby router stops receiving hellos from the active it will transition to be the active router
- IT will take ownership of the virtual IP and MAC address and respond to ARP requests

Priority and Pre-emption
- You can choose which router will be the active by setting priority on the routers
- The router with the higher priority will be preferred (default is 100)
- In the event of a tie the **highest IP address wins**
- If pre-emption is also enabled, when a higher priority router comes back online after a failure it will transition back to active
- If **pre-emption is disabled** (default), the lower priority router will remain active when the failed router comes back online
- This can be more stable if a higher priority router is flapping

HSRP Configuration - Priority and Pre-emption

```
R1(config)#interface g0/1
R1(config)# ip address 10.10.10.2 255.255.255.0
T1(config-if) # no shutdown
R1(config-if)# standby 1 ip 10.10.10.1
R1(config-if)# standby 1 priority 110
R1(config-if)# standby 1 preempt

R2(config)# interface g0/1
R2(config-if)#ip address 10.10.10.3 255.255.255.0
R2(config-if)#no shutdown
R2(config-if)# standby 1 ip 10.10.10.1
R2(config-if)# standby 1 priority 90
```

HSRP VERSION

- HSRP version 2 introduced a few minor improvements
- The default is version 1
- Both routers must be running the same version

Verification - Show Standby

```
R2#show standby
FastEthernet0/0 - Group 1
  State is Standby
    1 state change, last state change 00:04:14
  Virtual IP address is 10.0.0.254
  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 0.996 secs
  Preemption disabled
  Active router is 10.0.0.252, priority 110 (expires in 8.660 sec)
  Standby router is local
  Priority 100 (default 100)
  Group name is "hsrp-Fa0/0-1" (default)
R2#
```

HSRP Configuration - Version

```
R1(config)# interface g0/1
R1(config-if)# ip address 10.10.10.2 255.255.255.0
R1(config-if)# no shutdown
R1(config-if)#standby 1 ip 10.10.10.1
```

```
R1(config-if)#standby version 2
```

```
R2(config)# interface g0/1
R2(config-if)# ip address 10.10.10.3 255.255.255.0
R2(config-if)# no shutdown
R2(config-if) standby 1 ip 10.10.10.1
R2(config-if)# standby version 2
```

Load Balancing with HSRP

By default, within an HSRP group, only one router is active and all traffic passes through it. However, there are ways to achieve load balancing with HSRP.

Method 1: Multiple HSRP Groups for the Same Subnet

One way to load balance is to configure two different HSRP groups for the same IP subnet, each with a different virtual IP address. For example:

- Group 1 uses virtual IP `10.10.10.1` with R1 as the active router.
- Group 2 uses virtual IP `10.10.10.254` with R2 as the active router.

Then, half of the PCs are configured to use `10.10.10.1` as their default gateway, and the other half use `10.10.10.254`. This splits the traffic between R1 and R2.
Although this requires configuring different default gateways on the PCs, it effectively balances the load between the two routers.

Configuration Example for Load Balancing with Two HSRP Groups

On interface GigabitEthernet0/1 in the `10.10.10.0` subnet:

- R1 has IP `10.10.10.2`.
- R2 has IP `10.10.10.3`.

HSRP Group 1:

- Virtual IP: `10.10.10.1`
- R1 priority: 110 (preferred)
- R2 priority: 90
- Pre-emption enabled on R1

HSRP Group 2:

- Virtual IP: `10.10.10.254`
- R2 priority: 110 (preferred)
- R1 priority: 90

This configuration causes outbound traffic from the `10.10.10.0` network to be load balanced between R1 and R2.

```
R1(config)# interface g0/1
R1(config-if)# ip address 10.10.10.2 255.255.255.0
R1(config-if) no shutdown

R1(config-if)# standby 1 ip 10.10.10.1
R1(config-if)# standby 1 priority 110
R1(config-if)#standby 1 pre-empt

R1(config-if)#standby 2 ip 10.10.10.254
R1(config-if)# standby 2 priority 90
```

```
R2(config)#interface g0/1
R2(config-if)# ip address 10.10.10.3 255.255.255.0

R2(config-if)
R2(config-if)# standby 1 priority 90

R2(config-if)# standby 2 ip 10.10.10.254
R2(config-if)#standby 2 priority 110
R2(config-if)#standby 2 preempt
```

Method 2: Load Balancing Across Multiple Subnets

If multiple subnets pass through the same pair of routers, you can assign one subnet to use one router as active and another subnet to use the other router as active. For example, with two subnets:

- `10.10.10.0/24` subnet active on R1
- `10.10.20.0/24` subnet active on R2

If there were ten subnets, five could be active on one router and five on the other, balancing the load.

Configuration Example for Multiple Subnets

For the `10.10.10.0` subnet on interface GigabitEthernet0/1:

- Virtual IP: `10.10.10.1`
- R1 priority: 110 (preferred)
- R2 priority: 90

For the `10.10.20.0` subnet on interface GigabitEthernet0/2:

- Virtual IP: `10.10.20.1`
- R2 priority: 110 (preferred)
- R1 priority: 90

Note that the HSRP group number is configured under each interface. Both interfaces use group 1, but since they are on different interfaces, these are distinct HSRP groups.

```
R1(config)#interface g0/1
R1(config-if)#ip address 10.10.10.2 255.255.255.0
R1(config-if)# no shutdown
R1(config-if)#standby 1 ip 10.10.10.1
R1(config-if)#standby 1 priority 110
R1(config-if)#standby 1 preempt

R1(config)# interface g0/2
R1(config-if)# ip address 10.10.20.2 255.255.255.0
R1(config-if)# no shutdown
R1(config-if)# standby 1 ip 10.10.20.1
R1(config-if)# standby 1 priority 90
```

```
R2(config)# interface g0/1
R2(config-if)# ip address 10.10.10.3 255.255.255.0
R2(config-if)# no shutdown
R2(config-if)# standby 1 ip 10.10.10.1
R2(config-if)#standby 1 priority 90

R2(config)# interface g0/2
R2(config)# ip address 10.10.20.3
R2(config)# no shutdown
R2(config-if)# standby 1 ip 10.10.20.1
```

```
R2(config-if)#standby 1 priority 110
R2(config-if)#standby 1 preempt
```