First Hop Redundancy Protocol (Basic)

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Introduction

The **First Hop Redundancy Protocol** (FHRP) was developed by **Cisco** in the early **1990s**. Hot Standby Router Protocol (HSRP) was designed **to provide redundancy** for Cisco Routers, but it became popular with other vendors as well. In **1997**, the Internet Engineering Task Force (IETF) published a draft standard for a new FHRP protocol called **Virtual Router Redundancy Protocol** (VRRP). VRRP was designed to be an **open standard** FHRP protocol that could be used by routers from different vendors. VRRP was eventually finalized and published as an IETF standard in **2002**. The VRRP protocol was defined in **RFC 2338** in **1998** and later **updated** in **RFC 5798**.In early **2000s**, another FHRP protocol named **Gateway Load Balancing Protocol** (GLBP) was developed by **Cisco** and introduced some limitations of HSRP and VRRP. It was designed to offer not only redundancy but also **load balancing** of traffic across multiple routers.

The history of the different versions of FHRP protocols is as follows:

HSRP - • Version 1: Released in 1992.

  • Version 2: Released in 1995 with support for multiple standby routers and load balancing.

VRRP - • Version 1: Released in 1998 as a draft standard.

  • Version 2: Released in 2002 as an IETF standard.

  • Version 3: Released in 2012 with support for IPv^6 and other new features.

GLBP - • Version 1: Released in 2001 as a draft standard.

  • Version 2: Released in 2004 as an Cisco Proprietary Protocol.

First Hop Redundancy Protocol (FHRP)

FHRP is a computer networking protocol that is designed to **protect the default gateway** used on a subnetwork by allowing two or mote routers to **provide backup** for that address; in the event of **failure** of an active router, the **backup router** will **take over** the address, usually within a few seconds.
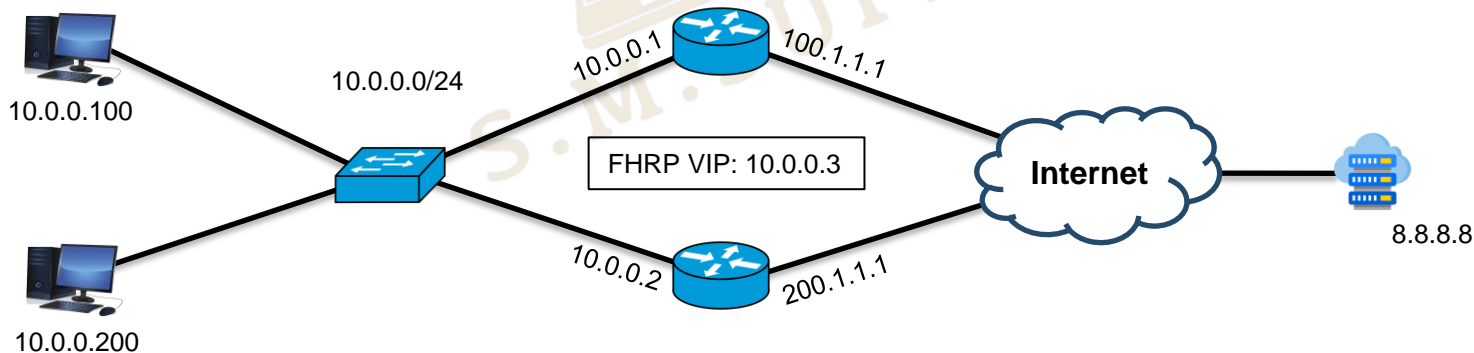
- **Virtual IP Address** (VIP) – configured on all of the routers in the FHRP group.
- **Virtual MAC Address** (VMA) – configured on the active router.
- **Priority** - each router in the FHRP group is assigned a priority. The router with the **highest priority** becomes the **active router**, and the others become **standby routers**. In case of tie breaker, the router with **highest IP address** will become the active router. If the active router fails, the standby router with the next highest priority takes over.
- **Periodical Hello Message** is sent to the active router by the standby routers. If the active router fails to respond for a certain period of time, one of the standby routers will become the new active router and it updates its **ARP cache** so that the VMA is mapped to its own MAC Address.
- **Transparent Protocol** – end hosts do not need to be aware of the FHRP group or the VIP. They simply configure the VIP as their default gateway. This makes FHRP idea for use in enterprise networks, where it can provide a high level of redundancy and available without requiring any changes to end hosts.
- **Preemption** – is the ability of a standby router with a higher priority to become the active router if it becomes available again. Preemption is generally disabled by default in FHRP protocols.

First Hop Redundancy Protocol (FHRP)

FHRP is a valuable tool for improving the reliability and high availability of networks. By providing redundancy for the default gateway, FHRP can help to ensure that networks remain operational even if one of the routers in the network fails.

There are **three main types** of FHRP Protocols –

1. Hot Standby Router Protocol (**HSRP**) – is a Cisco Proprietary Protocol that was the first FHRP protocol to be developed.
2. Virtual Router Redundancy Protocol (**VRRP**) – is an Open Standard FHRP Protocol that is supported by a wide range of vendors.
3. Gateway Load Balancing Protocol (**GLBP**) – is an Cisco Proprietary Protocol that can be used to Load Balancing traffic across multiple routers.

10.0.0.100

10.0.0.0/24

10.0.0.1

100.1.1.1

FHRP VIP: 10.0.0.3

Internet

8.8.8.8

10.0.0.2

200.1.1.1

10.0.0.200

Hot Standby Router Protocol (HSRP)

- **Cisco Proprietary** (RFC2281).

- **Multicast group IP** address in HSRPv1 is **224.0.0.2** and in HSRPv2 is **224.0.0.102**.

- **Group Virtual Mac Address** in HSRPv1 is **0000.0C07.ACXX** and in HSRPv2 is **0000.0C9F.FXXX** for IPv6 (Group id in XX/XXX positions).

- **Group number** range in HSRPv1 is **0 to 255** and in HSRPv2 is **0 to 4095**.

- **IPv6** is supported in HSRPv2.

- **Millisecond timer** values are advertised and learned in HSRPv2.

- Send and receive **multicast UDP *Hello Packets*** in every **3 seconds** and Hold Time is **10 seconds** by default.

- Uses **UDP port 1985**.

- **One active router** election based on highest priority and highest IP address in tiebreaker, **one standby router** and rest are **listening routers**.

- **Priority is 100** of every router in HSRP by default (range **0 to 255**).

- **Not-preemptive** by default.

- Supports **plain text** and **MD5 authentication**.

- The following conditions have to be same in every router in HSRP-

  1. Group Number
  2. Virtual IP Address
  3. Subnet Mask
  4. Virtual MAC Address
  5. Hello & Hold Timer
  6. Preemption Settings
  7. Version
  8. Authentication (if used)

Hot Standby Router Protocol (HSRP)
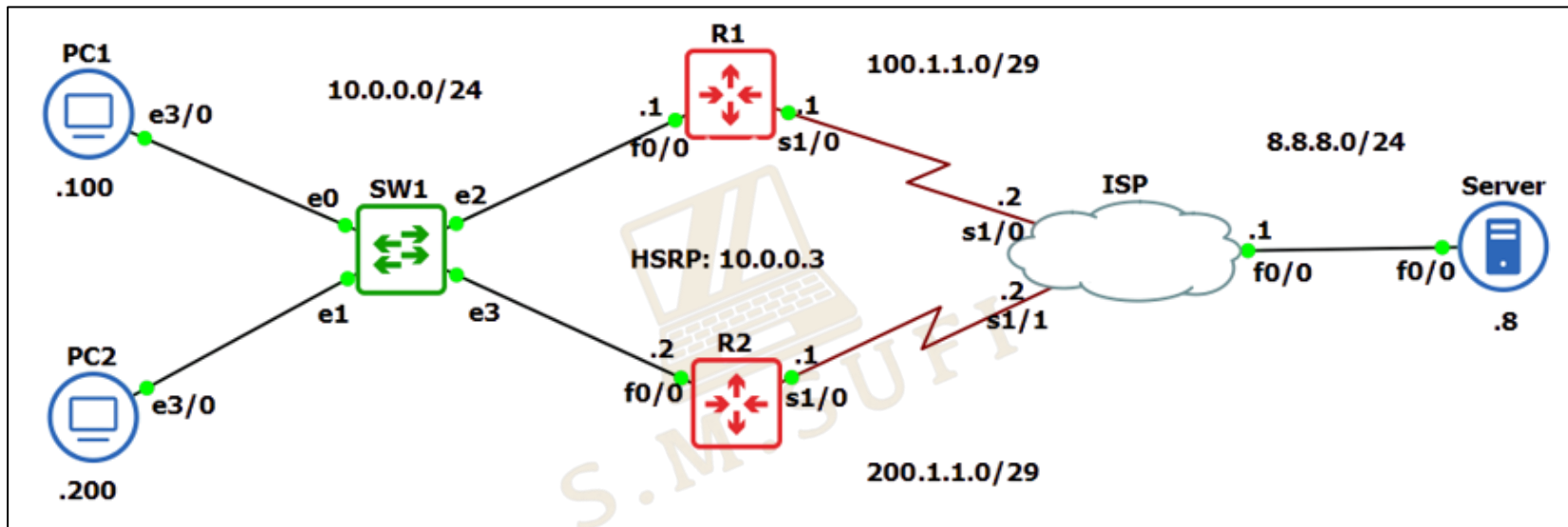
***This lab/topology was created in GNS3 2.2.43

***Routers/ISP Cloud: Cisco Catalyst 7200 Series Router

***Switch: GNS3 Default Ethernet Switch

***PCs/Server: Cisco Catalyst 3600 Series Router

Hot Standby Router Protocol (HSRP)

- Commands for HSRP in Cisco Routers-

  '**RTR(config)# interface <interface name>**'

  '**RTR(config-if)# standby <group id> ip <virtual IP address>**'

```
R2(config)#interface fa0/0
R2(config-if)#standby ?
  <0-255>          group number
  authentication  Authentication
  bfd             Enable HSRP BFD
  delay           HSRP initialisation delay
  follow          Name of HSRP group to follow
  ip              Enable HSRP IPv4 and set the virtual IP address
  ipv6            Enable HSRP IPv6
  mac-address     Virtual MAC address
  mac-refresh     Refresh MAC cache on switch by periodically sending packet
                  from virtual mac address
  name            Redundancy name string
  preempt         Overthrow lower priority Active routers
  priority        Priority level
  redirect        Configure sending of ICMP Redirect messages with an HSRP
                  virtual IP address as the gateway IP address
  timers          Hello and hold timers
  track           Priority tracking
  use-bia         HSRP uses interface's burned in address
  version         HSRP version

R2(config-if)#standby 1 ip ?
  A.B.C.D  Virtual IP address
  <cr>

R2(config-if)#standby 1 ip 10.0.0.3
R2(config-if)#
*Oct 18 00:51:42.111: %HSRP-5-STATECHANGE: FastEthernet0/0 Grp 1 state Standby -> Active
```

```
R1(config)#interface fa0/0
R1(config-if)#standby 1 ip 10.0.0.3
R1(config-if)#
*Oct 18 00:48:59.779: %HSRP-5-STATECHANGE: FastEthernet0/0 Grp 1 state Speak -> Standby
```

- Commands for changing HSRP version-

  '**RTR(config-if)# standby version <1/2>**'

  Default version is 1.

```
R2(config-if)#standby version ?
  <1-2>   Version number

R2(config-if)#standby version 2
R2(config-if)#
*Oct 18 01:06:01.767: %HSRP-5-STATECHANGE: FastEthernet0/0 Grp 1 state Active -> Init
R2(config-if)#
*Oct 18 01:06:23.399: %HSRP-5-STATECHANGE: FastEthernet0/0 Grp 1 state Standby -> Active
R2(config-if)#
*Oct 18 01:06:23.455: %IP-4-DUPADDR: Duplicate address 10.0.0.3 on FastEthernet0/0, source
d by 0000.0c07.ac01
```

```
R1(config-if)#
*Oct 18 01:01:58.515: %HSRP-5-STATECHANGE: FastEthernet0/0 Grp 1 state Standby -> Init
R1(config-if)#
R1(config-if)#
*Oct 18 01:03:02.975: %HSRP-5-STATECHANGE: FastEthernet0/0 Grp 1 state Standby -> Active
R1(config-if)#
*Oct 18 01:03:13.447: %IP-4-DUPADDR: Duplicate address 10.0.0.3 on FastEthernet0/0, source
d by 0000.0c9f.f001
R1(config-if)#
R1(config-if)#standby version 2
R1(config-if)#
*Oct 18 01:03:26.883: %HSRP-5-STATECHANGE: FastEthernet0/0 Grp 1 state Active -> Init
R1(config-if)#
*Oct 18 01:03:47.527: %HSRP-5-STATECHANGE: FastEthernet0/0 Grp 1 state Speak -> Standby
```

Hot Standby Router Protocol (HSRP)

- Commands to enable preemption-

  'RTR(config-if)# standby <group id> preempt'

- Commands to change priority of the router-

  'RTR(config-if)# standby <group id> priority <0-255>'

```
R2(config-if)#standby 1 ?
  authentication  Authentication
  follow          Name of HSRP group to follow
  ip              Enable HSRP IPv4 and set the virtual IP address
  ipv6            Enable HSRP IPv6
  mac-address     Virtual MAC address
  name            Redundancy name string
  preempt         Overthrow lower priority Active routers
  priority        Priority level
  timers          Hello and hold timers
  track           Priority tracking

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

```
R1(config-if)#standby 1 ?
  authentication  Authentication
  follow          Name of HSRP group to follow
  ip              Enable HSRP IPv4 and set the virtual IP address
  ipv6            Enable HSRP IPv6
  mac-address     Virtual MAC address
  name            Redundancy name string
  preempt         Overthrow lower priority Active routers
  priority        Priority level
  timers          Hello and hold timers
  track           Priority tracking

R1(config-if)#standby 1 preempt
R1(config-if)#standby 1 priority ?
  <0-255>  Priority value

R1(config-if)#standby 1 priority 150
R1(config-if)#
*Oct 18 01:07:08.119: %HSRP-5-STATECHANGE: FastEthernet0/0 Grp 1 state Standby -> Active
R1(config-if)#
```

```
R2(config-if)#
*Oct 18 01:10:18.091: %HSRP-5-STATECHANGE: FastEthernet0/0 Grp 1 state Active -> Speak
R2(config-if)#
*Oct 18 01:10:29.195: %HSRP-5-STATECHANGE: FastEthernet0/0 Grp 1 state Speak -> Standby
```

Hot Standby Router Protocol (HSRP)

```
R1(config-if)#standby 1 ?
  authentication  Authentication
  follow          Name of HSRP group to follow
  ip              Enable HSRP IPv4 and set the virtual IP address
  ipv6            Enable HSRP IPv6
  mac-address     Virtual MAC address
  name            Redundancy name string
  preempt         Overthrow lower priority Active routers
  priority        Priority level
  timers          Hello and hold timers
  track           Priority tracking
R1(config-if)#standby 1 track ?
  <1-500>            Tracked object number
  Async             Async interface
  Auto-Template     Auto-Template interface
  BVI               Bridge-Group Virtual Interface
  CDMA-Ix           CDMA Ix interface
  CTunnel           CTunnel interface
  Dialer            Dialer interface
  Ethernet          IEEE 802.3
  FastEthernet      FastEthernet IEEE 802.3
  Lex               Lex interface
  Loopback          Loopback interface
  MFR               Multilink Frame Relay bundle interface
  Multilink         Multilink-group interface
  Port-channel      Ethernet Channel of interfaces
  SSLVPN-VIF        SSLVPN Virtual Interface
  Serial            Serial
  Tunnel            Tunnel interface
  Vif               PGM Multicast Host interface
  Virtual-PPP       Virtual PPP interface
  Virtual-TokenRing Virtual TokenRing
  vmi               Virtual Multipoint Interface

R1(config-if)#standby 1 track s1/0 ?
  <1-255>  Decrement value
  <cr>

R1(config-if)#standby 1 track s1/0 60
```

- Commands to track interfaces in HSRP-

  'RTR(config-if)# standby <group id> track

  <interface name> <priority decrement value>'

- **Why will we use track?**

For example, if our ISP-end interface goes down in the active router, the standby router cannot identify the problem and it will still be in standby mood because the hello packets will ensure all the connectivity in the LAN network is okay and running. Therefore, packets will be lost.

If we use this feature, the active router will automatically track the ISP-end interface. By any chance if the ISP-end interface goes down, the router will immediately decrease its priority value and go to standby mood because of the preemption feature and no data will be lost.

Hot Standby Router Protocol (HSRP)

When the ISP-end interface goes down-

```
R1(config)#interface se1/0
R1(config-if)#
R1(config-if)#shutdown
R1(config-if)#
*Oct 18 03:56:31.467: %TRACKING-5-STATE: 1 interface Se1/0 line-protocol Up->Down
R1(config-if)#
*Oct 18 03:56:33.443: %LINK-5-CHANGED: Interface Serial1/0, changed state to administrativ
ely down
*Oct 18 03:56:33.803: %HSRP-5-STATECHANGE: FastEthernet0/0 Grp 1 state Active -> Speak
*Oct 18 03:56:34.443: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed s
tate to down
R1(config-if)#
*Oct 18 03:56:45.355: %HSRP-5-STATECHANGE: FastEthernet0/0 Grp 1 state Speak -> Standby
```

```
R2(config-if)#
*Oct 18 03:55:13.607: %HSRP-5-STATECHANGE: FastEthernet0/0 Grp 1 state Standby -> Active
```

When the ISP-end interface comes up-

```
R1(config-if)#no shutdown
R1(config-if)#
*Oct 18 03:58:07.443: %LINK-3-UPDOWN: Interface Serial1/0, changed state to up
R1(config-if)#
*Oct 18 03:58:07.447: %TRACKING-5-STATE: 1 interface Se1/0 line-protocol Down->Up
*Oct 18 03:58:07.751: %HSRP-5-STATECHANGE: FastEthernet0/0 Grp 1 state Standby -> Active
*Oct 18 03:58:08.447: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/0, changed s
tate to up
```

```
R2(config-if)#
*Oct 18 03:56:47.543: %HSRP-5-STATECHANGE: FastEthernet0/0 Grp 1 state Active -> Speak
R2(config-if)#
*Oct 18 03:56:58.631: %HSRP-5-STATECHANGE: FastEthernet0/0 Grp 1 state Speak -> Standby
```

Ping test from PC1-

```
PC1#ping 8.8.8.8

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 8.8.8.8, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 84/102/140 ms
PC1#traceroute 8.8.8.8

Type escape sequence to abort.
Tracing the route to 8.8.8.8

  1 10.0.0.1 32 msec 36 msec 24 msec
  2 100.1.1.2 64 msec 60 msec 72 msec
  3 8.8.8.8 84 msec 60 msec 76 msec
```

- Commands to show HSRP interface status-

  'RTR# show running-config interface <interface name>'

- Commands to show HSRP status-

  'RTR# show standby'

- Commands to show HSRP status in brief-

  'RTR# show standby brief'

Hot Standby Router Protocol (HSRP)

```
R2#show run interface fa0/0
Building configuration...

Current configuration : 142 bytes
!
interface FastEthernet0/0
 ip address 10.0.0.2 255.255.255.0
 duplex half
 standby version 2
 standby 1 ip 10.0.0.3
 standby 1 preempt
end

R2#
R2#show standby
FastEthernet0/0 - Group 1 (version 2)
  State is Standby
    7 state changes, last state change 00:03:37
  Virtual IP address is 10.0.0.3
  Active virtual MAC address is 0000.0c9f.f001
    Local virtual MAC address is 0000.0c9f.f001 (v2 default)
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 0.480 secs
  Preemption enabled
  Active router is 10.0.0.1, priority 150 (expires in 8.464 sec)
    MAC address is ca01.13bc.0000
  Standby router is local
  Priority 100 (default 100)
  Group name is "hsrp-Fa0/0-1" (default)
R2#
R2#show standby brief
                     P indicates configured to preempt.
                     |
Interface   Grp  Pri P State    Active     Standby        Virtual IP
Fa0/0       1    100 P Standby 10.0.0.1    local          10.0.0.3
```

```
R1#show run interface fa0/0
Building configuration...

Current configuration : 196 bytes
!
interface FastEthernet0/0
 ip address 10.0.0.1 255.255.255.0
 duplex half
 standby version 2
 standby 1 ip 10.0.0.3
 standby 1 priority 150
 standby 1 preempt
 standby 1 track Serial1/0 60
end

R1#
R1#show standby
FastEthernet0/0 - Group 1 (version 2)
  State is Active
    5 state changes, last state change 00:01:53
  Virtual IP address is 10.0.0.3
  Active virtual MAC address is 0000.0c9f.f001
    Local virtual MAC address is 0000.0c9f.f001 (v2 default)
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 1.296 secs
  Preemption enabled
  Active router is local
  Standby router is 10.0.0.2, priority 100 (expires in 9.296 sec)
  Priority 150 (configured 150)
    Track interface Serial1/0 state Up decrement 60
  Group name is "hsrp-Fa0/0-1" (default)
R1#
R1#show standby brief
                     P indicates configured to preempt.
                     |
Interface   Grp  Pri P State    Active     Standby        Virtual IP
Fa0/0       1    150 P Active  local       10.0.0.2       10.0.0.3
```

Hot Standby Router Protocol (HSRP)

HSRP **does not support load-balancing**. But we can make the router to **support load sharing** by adding **multiple groups**. The secret technique is, create another HSRP group. In the second group make the active router as standby and the standby router as active router.

Try it on yourself before watching the following commands!

```
R2(config)#interface fa0/0
R2(config-if)#standby 2 ip 10.0.0.4
R2(config-if)#standby 2 preempt
R2(config-if)#standby 2 priority 150
R2(config-if)#standby 2 track s1/0 60
R2(config-if)#
*Oct 18 04:41:19.135: %HSRP-5-STATECHANGE: FastEthernet0/0 Grp 2 state Listen -> Active
R2(config-if)#
R2(config-if)#do show standby brief
                     P indicates configured to preempt.
                     |
Interface   Grp  Pri P State    Active      Standby       Virtual IP
Fa0/0       1    100 P Standby 10.0.0.1     local         10.0.0.3
Fa0/0       2    150 P Active  local        10.0.0.1      10.0.0.4
```

```
R1(config)#interface fa0/0
R1(config-if)#standby 2 ip 10.0.0.4
R1(config-if)#standby 2 preempt
R1(config-if)#
*Oct 18 04:45:36.291: %HSRP-5-STATECHANGE: FastEthernet0/0 Grp 2 state Speak -> Standby
R1(config-if)#
R1(config-if)#do show standby brief
                     P indicates configured to preempt.
                     |
Interface   Grp  Pri P State    Active      Standby       Virtual IP
Fa0/0       1    150 P Active  local        10.0.0.2      10.0.0.3
Fa0/0       2    100 P Standby 10.0.0.2     local         10.0.0.4
```

```
R1#show standby
FastEthernet0/0 - Group 1 (version 2)
  State is Active
    2 state changes, last state change 00:14:41
  Virtual IP address is 10.0.0.3
  Active virtual MAC address is 0000.0c9f.f001
    Local virtual MAC address is 0000.0c9f.f001 (v2 default)
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 2.320 secs
  Preemption enabled
  Active router is local
  Standby router is 10.0.0.2, priority 100 (expires in 9.952 sec)
  Priority 150 (configured 150)
  Group name is "hsrp-Fa0/0-1" (default)
FastEthernet0/0 - Group 2 (version 2)
  State is Standby
    1 state change, last state change 00:05:11
  Virtual IP address is 10.0.0.4
  Active virtual MAC address is 0000.0c9f.f002
    Local virtual MAC address is 0000.0c9f.f002 (v2 default)
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 1.568 secs
  Preemption enabled
  Active router is 10.0.0.2, priority 150 (expires in 11.376 sec)
    MAC address is ca02.10e8.0000
  Standby router is local
  Priority 100 (default 100)
  Group name is "hsrp-Fa0/0-2" (default)
```

Virtual Router Redundancy Protocol (VRRP)

- **IEEE Standard Protocol** (RFC3768).

- **Multicast group IPv4** address in VRRP is **224.0.0.18** and **IPv6** is **FF02:0:0:0:0:0:0:12** (or FF02::12).

- **Group Virtual Mac Address** in VRRP is **0000.5E00.01XX** for **IPv4** and in VRRPv3 is **0000.5E00.02XX** for **IPv6** (Group id in XX positions).

- **Group number** range in VRRPv1 and VRRPv2 is **0 to 255** and in VRRPv3 is **0 to 4095**.

- **IPv6** is supported in VRRPv3.

- **Millisecond timer** values are advertised and learned in VRRPv3.

- Send and receive **multicast UDP *Hello Packets*** in every **1 second** and Hold Time is **3 seconds** by default.

- Uses **UDP port 112**.

- **One Master Router** election based on Highest Priority and Highest IP address in tiebreaker, the rest are **Backup Routers**.

- Priority can be set from **1 to 254**, priority **255** is reserved for the **master router** (range 1 to 255).

- **Preemptive** by default in VRRPv2 and VRRPv3.

- **Simple** and **MD5 authentication** is supported in VRRPv2 only.

- **Interface IP** can be used as **Virtual IP** in VRRP.

- The following conditions have to be same in every router in VRRP-

  1. Group Number
  2. Virtual IP Address
  3. Subnet Mask
  4. Virtual MAC Address
  5. Hello & Hold Timer
  6. Preemption Settings
  7. Version
  8. Authentication (if used)

Virtual Router Redundancy Protocol (VRRP)
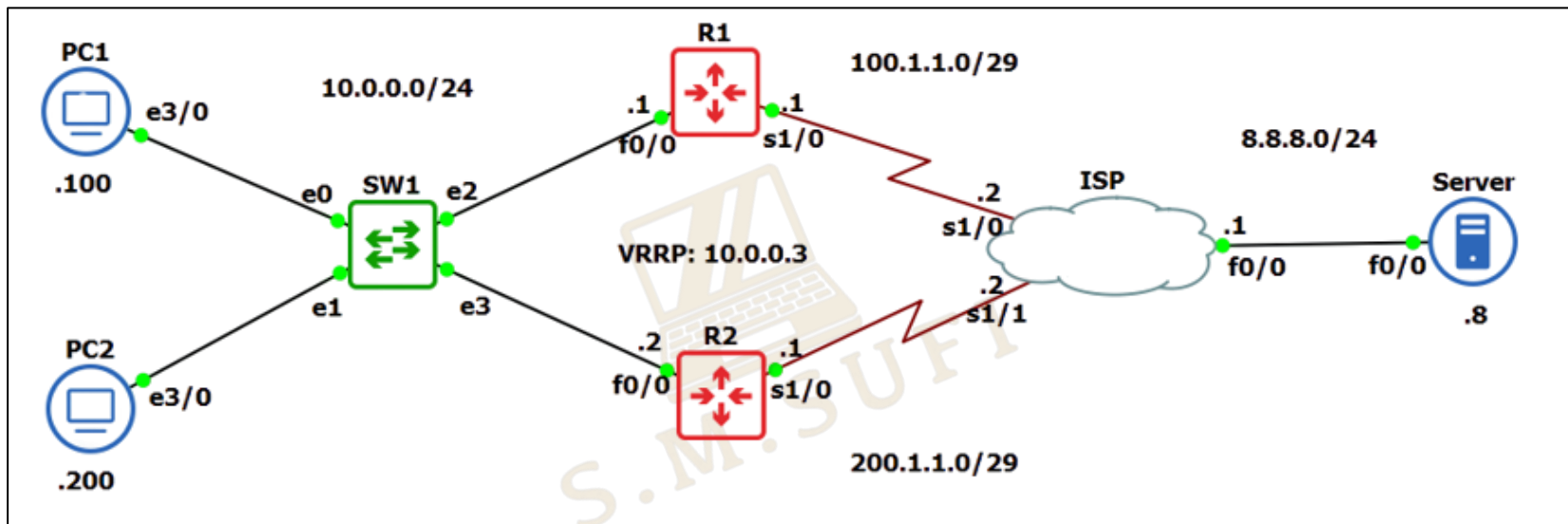
***This lab/topology was created in GNS3 2.2.43**

***Routers/ISP Cloud: Cisco Catalyst 7200 Series Router

***Switch: GNS3 Default Ethernet Switch

***PCs/Server: Cisco Catalyst 3600 Series Router

Virtual Router Redundancy Protocol (VRRP)

- Commands for VRRP in Cisco Routers-

  '*RTR(config)# interface <interface name>*'

  '*RTR(config-if)# vrrp <group id> ip <virtual IP address>*'

```
R2(config)#interface fa0/0
R2(config-if)#vrrp ?
  <1-255>  Group number

R2(config-if)#vrrp 11 ?
  authentication  Authentication
  description     Group specific description
  ip              Enable Virtual Router Redundancy Protocol (VRRP) for IP
  preempt         Enable preemption of lower priority Master
  priority        Priority of this VRRP group
  shutdown        Disable VRRP Configuration
  timers          Set the VRRP timers
  track           Event Tracking

R2(config-if)#vrrp 11 ip 10.0.0.3
R2(config-if)#
*Oct 18 12:52:14.143: %VRRP-6-STATECHANGE: Fa0/0 Grp 11 state Init -> Backup
R2(config-if)#
*Oct 18 12:52:17.755: %VRRP-6-STATECHANGE: Fa0/0 Grp 11 state Backup -> Master
```

```
R1(config)#interface fa0/0
R1(config-if)#vrrp 11 ip 10.0.0.3
R1(config-if)#
*Oct 18 12:52:44.883: %VRRP-6-STATECHANGE: Fa0/0 Grp 11 state Init -> Backup
```

- Commands to change priority of the router-

  '*RTR(config-if)# vrrp <group id> priority <1-254>*'

```
R1(config-if)#vrrp 11 ?
  authentication  Authentication
  description     Group specific description
  ip              Enable Virtual Router Redundancy Protocol (VRRP) for IP
  preempt         Enable preemption of lower priority Master
  priority        Priority of this VRRP group
  shutdown        Disable VRRP Configuration
  timers          Set the VRRP timers
  track           Event Tracking

R1(config-if)#vrrp 11 priority ?
  <1-254>  Priority level

R1(config-if)#vrrp 11 priority 120
R1(config-if)#
*Oct 18 13:02:12.487: %VRRP-6-STATECHANGE: Fa0/0 Grp 11 state Backup -> Master
R1(config-if)#
R1(config-if)#shutdown
R1(config-if)#
*Oct 18 13:02:44.735: %VRRP-6-STATECHANGE: Fa0/0 Grp 11 state Master -> Init
R1(config-if)#
*Oct 18 13:02:46.739: %LINK-5-CHANGED: Interface FastEthernet0/0, changed state to adminis
tratively down
*Oct 18 13:02:47.739: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, cha
nged state to down
R1(config-if)#no shutdown
R1(config-if)#
*Oct 18 13:02:54.411: %VRRP-6-STATECHANGE: Fa0/0 Grp 11 state Init -> Backup
R1(config-if)#
*Oct 18 13:02:56.399: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to up
*Oct 18 13:02:57.399: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, cha
nged state to up
R1(config-if)#
*Oct 18 13:02:57.943: %VRRP-6-STATECHANGE: Fa0/0 Grp 11 state Backup -> Master
```

```
R2(config-if)#
*Oct 18 13:02:02.483: %VRRP-6-STATECHANGE: Fa0/0 Grp 11 state Master -> Backup
R2(config-if)#
*Oct 18 13:02:35.371: %VRRP-6-STATECHANGE: Fa0/0 Grp 11 state Backup -> Master
R2(config-if)#
*Oct 18 13:02:47.939: %VRRP-6-STATECHANGE: Fa0/0 Grp 11 state Master -> Backup
```

Virtual Router Redundancy Protocol (VRRP)

- Commands to track interfaces in VRRP-

  'RTR(config-if)# vrrp <group id> track <tracked object no> decrement <priority decrement value>'

```
R1(config-if)#vrrp 11 ?
  authentication  Authentication
  description     Group specific description
  ip              Enable Virtual Router Redundancy Protocol (VRRP) for IP
  preempt         Enable preemption of lower priority Master
  priority        Priority of this VRRP group
  shutdown        Disable VRRP Configuration
  timers          Set the VRRP timers
  track           Event Tracking

R1(config-if)#vrrp 11 track ?
  <1-500>  Tracked object

R1(config-if)#vrrp 11 track 1 ?
  decrement  Priority decrement
  <cr>

R1(config-if)#vrrp 11 track 1 decrement ?
  <1-255>  Decrement value

R1(config-if)#vrrp 11 track 1 decrement 30
```

VRRP **does not support load-balancing**. But we can make the router to support **load sharing** by adding **multiple groups**. The secret technique is, create another VRRP group. In the second group make the master router as backup and the backup router as master router.

Try it on yourself before watching the following commands!

```
R2(config)#interface fa0/0
R2(config-if)#vrrp 22 ip 10.0.0.4
R2(config-if)#vrrp 22 priority 120
R2(config-if)#vrrp 22 track 1 decrement 30
R2(config-if)#
*Oct 18 13:13:16.419: %VRRP-6-STATECHANGE: Fa0/0 Grp 22 state Init -> Backup
R2(config-if)#
*Oct 18 13:13:20.031: %VRRP-6-STATECHANGE: Fa0/0 Grp 22 state Backup -> Master
```

```
R1(config)#interface fa0/0
R1(config-if)#vrrp 22 ip 10.0.0.4
R1(config-if)#
*Oct 18 13:13:50.379: %VRRP-6-STATECHANGE: Fa0/0 Grp 22 state Init -> Backup
```

- Commands to show VRRP interface status-

  'RTR# show running-config interface <interface name>'

- Commands to show VRRP status-

  'RTR# show vrrp'

- Commands to show VRRP status in brief-

  'RTR# show vrrp brief'

Virtual Router Redundancy Protocol (VRRP)

```
R1#show running-config interface fa0/0
Building configuration...

Current configuration : 175 bytes
!
interface FastEthernet0/0
 ip address 10.0.0.1 255.255.255.0
 duplex half
 vrrp 11 ip 10.0.0.3
 vrrp 11 priority 120
 vrrp 11 track 1 decrement 30
 vrrp 22 ip 10.0.0.4
end
```

```
R2#show running-config interface fa0/0
Building configuration...

Current configuration : 175 bytes
!
interface FastEthernet0/0
 ip address 10.0.0.2 255.255.255.0
 duplex half
 vrrp 11 ip 10.0.0.3
 vrrp 22 ip 10.0.0.4
 vrrp 22 priority 120
 vrrp 22 track 1 decrement 30
end
```

```
R1#show vrrp
FastEthernet0/0 - Group 11
  State is Master
  Virtual IP address is 10.0.0.3
  Virtual MAC address is 0000.5e00.010b
  Advertisement interval is 1.000 sec
  Preemption enabled
  Priority is 120
  Master Router is 10.0.0.1 (local), priority is 120
  Master Advertisement interval is 1.000 sec
  Master Down interval is 3.531 sec

FastEthernet0/0 - Group 22
  State is Backup
  Virtual IP address is 10.0.0.4
  Virtual MAC address is 0000.5e00.0116
  Advertisement interval is 1.000 sec
  Preemption enabled
  Priority is 100
  Master Router is 10.0.0.2, priority is 120
  Master Advertisement interval is 1.000 sec
  Master Down interval is 3.609 sec (expires in 3.177 sec)

R1#show vrrp brief
Interface   Grp Pri Time  Own Pre State  Master addr   Group addr
Fa0/0        11  120 3531      Y   Master 10.0.0.1     10.0.0.3
Fa0/0        22  100 3609      Y   Backup 10.0.0.2     10.0.0.4
```

```
R2#show vrrp
FastEthernet0/0 - Group 11
  State is Backup
  Virtual IP address is 10.0.0.3
  Virtual MAC address is 0000.5e00.010b
  Advertisement interval is 1.000 sec
  Preemption enabled
  Priority is 100
  Master Router is 10.0.0.1, priority is 120
  Master Advertisement interval is 1.000 sec
  Master Down interval is 3.609 sec (expires in 2.861 sec)

FastEthernet0/0 - Group 22
  State is Master
  Virtual IP address is 10.0.0.4
  Virtual MAC address is 0000.5e00.0116
  Advertisement interval is 1.000 sec
  Preemption enabled
  Priority is 120
  Master Router is 10.0.0.2 (local), priority is 120
  Master Advertisement interval is 1.000 sec
  Master Down interval is 3.531 sec

R2#show vrrp brief
Interface   Grp Pri Time  Own Pre State  Master addr   Group addr
Fa0/0        11  100 3609      Y   Backup 10.0.0.1     10.0.0.3
Fa0/0        22  120 3531      Y   Master 10.0.0.2     10.0.0.4
```
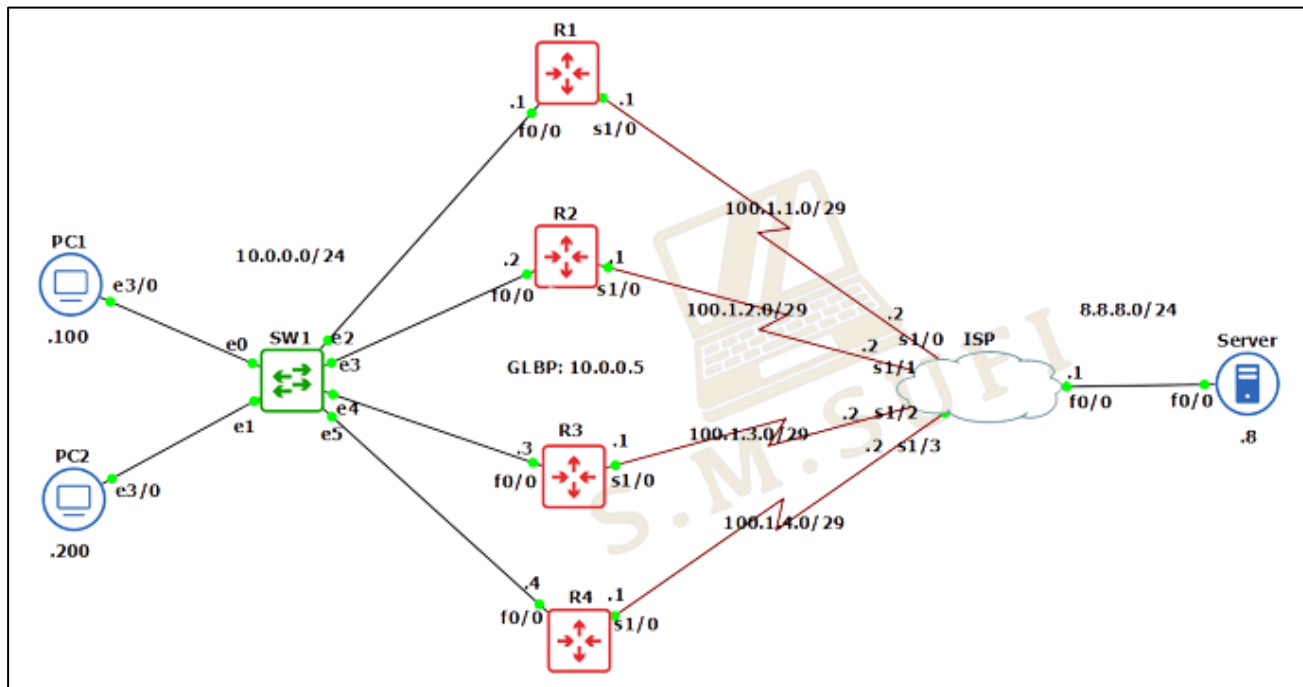
Gateway Load Balancing Protocol (GLBP)

- **Cisco Proprietary**.
- **Multicast group IPv4** address in GLBP is **224.0.0.102** and **IPv6** address is **FF02::6:1**.
- **Group Virtual Mac Address** in GLBP is **0007.B400.XXYY** (Group id in XX position and AVF router id in YY position).
- **Group number** range in GLBPv1 **is 0 to 255** and in GLBPv2 is **0 to 1023**.
- **IPv6** is supported in GLBPv2.
- Send and receive **multicast UDP *Hello Packets*** in every **3 second** and Hold Time is **10 seconds** by default.
- Uses **UDP port 3222**.
- One router is elected as the **AVG (Active Virtual Gateway),** based on Highest Priority] and Highest IP address in tiebreaker, which **performs load balancing** duties, up to Four routers are **AVFs (Active Virtual Forwarders)**, which **assist in load balancing** in GLBP, and up to **1024 Virtual Routers** can exist in GLBP.
- A router becoming AVF or not depends on **Weighted Values** of the routers. Having weighted **value 0**, that router **will not become AVR**.
- Provides **automatic failover** in case the AVG becomes unavailable.
- **AVG assign** the **virtual MAC** address to AVF routers.
- Customizable load-balancing algorithms, including **round-robin** and **weighted load balancing**.
- **Non-preemptive** by default in GLBP.
- **Simple** and **MD5 authentication** is supported in GLBPv2.

Gateway Load Balancing Protocol (GLBP)

***This lab/topology was created in GNS3 2.2.43**

***Routers/ISP Cloud: Cisco Catalyst 7200 Series Router

***Switch: GNS3 Default Ethernet Switch

***PCs/Server: Cisco Catalyst 3600 Series Router

Gateway Load Balancing Protocol (GLBP)

- Commands for GLBP in Cisco Routers-

    'RTR(config)# interface <interface name>'

    'RTR(config-if)# glbp <group id> ip <virtual IP address>'

- Commands to change priority of the router-

    'RTR(config-if)# glbp <group id> priority <1-255>'

```
R1(config-if)#glbp 111 ?
  authentication  Authentication method
  client-cache    Client cache
  forwarder       Forwarder configuration
  ip              Enable group and set virtual IP address
  ipv6            Enable group for IPv6 and set the virtual IPv6 address
  load-balancing  Load balancing method
  name            Redundancy name
  preempt         Overthrow lower priority designated routers
  priority        Priority level
  timers          Adjust GLBP timers
  weighting       Gateway weighting and tracking

R1(config-if)#glbp 111 preempt
R1(config-if)#glbp 111 priority ?
  <1-255>  Priority value

R1(config-if)#glbp 111 priority 120
R1(config-if)#
*Oct 18 22:18:37.559: %GLBP-6-STATECHANGE: FastEthernet0/0 Grp 111 state Speak -> Active
```

```
R2(config-if)#glbp 111 preempt
R2(config-if)#
```

```
R3(config-if)#glbp 111 preempt
R3(config-if)#
```

```
R4(config-if)#glbp 111 preempt
R4(config-if)#
*Oct 18 20:38:42.659: %GLBP-6-STATECHANGE: FastEthernet0/0 Grp 111 state Active -> Speak
```

```
R4(config)#interface fa0/0
R4(config-if)#glbp ?
  <0-1023>  Group number

R4(config-if)#glbp 111 ?
  authentication  Authentication method
  client-cache    Client cache
  forwarder       Forwarder configuration
  ip              Enable group and set virtual IP address
  ipv6            Enable group for IPv6 and set the virtual IPv6 address
  load-balancing  Load balancing method
  name            Redundancy name
  preempt         Overthrow lower priority designated routers
  priority        Priority level
  timers          Adjust GLBP timers
  weighting       Gateway weighting and tracking

R4(config-if)#glbp 111 ip 10.0.0.5
R4(config-if)#
*Oct 18 20:27:44.211: %GLBP-6-STATECHANGE: FastEthernet0/0 Grp 111 state Speak -> Active
R4(config-if)#
*Oct 18 20:27:54.755: %GLBP-6-FWDSTATECHANGE: FastEthernet0/0 Grp 111 Fwd 1 state Listen -> Active
```

```
R3(config)#interface fa0/0
R3(config-if)#glbp 111 ip 10.0.0.5
R3(config-if)#
*Oct 18 20:28:15.527: %GLBP-6-FWDSTATECHANGE: FastEthernet0/0 Grp 111 Fwd 2 state Listen -> Active
```

```
R2(config)#interface fa0/0
R2(config-if)#glbp 111 ip 10.0.0.5
R2(config-if)#
*Oct 18 20:29:11.315: %GLBP-6-FWDSTATECHANGE: FastEthernet0/0 Grp 111 Fwd 3 state Listen -> Active
```

```
R1(config)#interface fa0/0
R1(config-if)#glbp 111 ip 10.0.0.5
R1(config-if)#
*Oct 18 20:29:03.955: %GLBP-6-FWDSTATECHANGE: FastEthernet0/0 Grp 111 Fwd 4 state Listen -> Active
```

Gateway Load Balancing Protocol (GLBP)

- Commands for creating Track object in routers-

    'RTR(config)# track <track object no> interface <interface no> line-protocol'

```
R1(config)#track 1 ?
  application  Application
  interface    Select an interface to track
  ip           IP protocol
  list         Group objects in a list
  stub-object  Stub tracking object

R1(config)#track 1 interface ?
  Async           Async interface
  Auto-Template   Auto-Template interface
  BVI             Bridge-Group Virtual Interface
  CDMA-Ix         CDMA Ix interface
  CTunnel         CTunnel interface
  Dialer          Dialer interface
  Ethernet        IEEE 802.3
  FastEthernet    FastEthernet IEEE 802.3
  Lex             Lex interface
  Loopback        Loopback interface
  MFR             Multilink Frame Relay bundle interface
  Multilink       Multilink-group interface
  Port-channel    Ethernet Channel of interfaces
  SSLVPN-VIF      SSLVPN Virtual Interface
  Serial          Serial
  Tunnel          Tunnel interface
  Vif             PGM Multicast Host interface
  Virtual-PPP     Virtual PPP interface
  Virtual-TokenRing  Virtual TokenRing
  vmi             Virtual Multipoint Interface

R1(config)#track 1 interface se1/0 ?
  ip           IP parameters
  line-protocol  Track interface line-protocol

R1(config)#track 1 interface se1/0 line-protocol
```

Track is a feature of GLBP that allows you to **monitor the status of an interface** or other object and **dynamically adjust** the GLBP group's **weighting** based on the results of the tracking. This can be used to improve the performance and reliability of the GLBP group.

The **priority** value is used to determine which device in a GLBP group will become the **active router**. The device with the highest priority will become the active router.

The **weight value** is used to determine **how traffic will be distributed** across the devices in a GLBP group. The default weight value is **100**. The router having weight **value 0 will not forward traffic**, but if that router is AVG. it will **control the AVF** routers.

Gateway Load Balancing Protocol (GLBP)

Commands for creating configuring track and weight value on the routers-

'RTR(config)# interface <interface name>'

'RTR(config-if)# glbp <group no> weighting track <track object no>

  decrement <decrement weighting value>'

'RTR(config-if)# glbp <group no> weighting <max value> lower

  <lower threshold> upper <upper threshold>'

There are two ways to track. The shortcut way is if the tracked interface goes down, immediately weighted value of that router will become zero. Therefore, it will not forward traffic as long as the interface comes up. **Default decrement value is 10**.

Another way is creating a weighting threshold value. If the weighted value is less than the threshold, the router will not forward traffic. When the interface will come up, the weighted value will be greater than the threshold value and the router will resume forwarding traffic.

```
R1(config-if)#
R1(config-if)#glbp 111 weighting track 1 decrement 100

R1(config-if)#glbp 111 weighting ?
  <1-254>  Weighting maximum value
  track    Interface tracking

R1(config-if)#glbp 111 weighting track ?
  <1-500>  Tracked object

R1(config-if)#glbp 111 weighting track 1 ?
  decrement  Weighting decrement
  <cr>

R1(config-if)#glbp 111 weighting track 1 decrement ?
  <1-255>  Decrement value

R1(config-if)#glbp 111 weighting track 1 decrement 10
R1(config-if)#glbp 111 weighting ?
  <1-254>  Weighting maximum value
  track    Interface tracking

R1(config-if)#glbp 111 weighting 100 ?
  lower  Weighting lower threshold
  upper  Weighting upper threshold
  <cr>

R1(config-if)#glbp 111 weighting 100 lower ?
  <1-99>  Weighting lower threshold value

R1(config-if)#glbp 111 weighting 100 lower 95 ?
  upper  Weighting upper threshold
  <cr>

R1(config-if)#glbp 111 weighting 100 lower 95 upper ?
  <95-100>  Weighting upper threshold value

R1(config-if)#glbp 111 weighting 100 lower 95 upper 100
```

Gateway Load Balancing Protocol (GLBP)

- Commands to show GLBP interface status-

  'RTR# show running-config interface <interface name>'

- Commands to show GLBP status-

  'RTR# show glbp'

- Commands to show VRRP status in brief-

  'RTR# show glbp brief"

Details of the Active AVG router-

```
R1#show running-config interface fa0/0
Building configuration...

Current configuration : 218 bytes
!
interface FastEthernet0/0
 ip address 10.0.0.1 255.255.255.0
 duplex half
 glbp 111 ip 10.0.0.5
 glbp 111 priority 120
 glbp 111 preempt
 glbp 111 weighting 100 lower 95
 glbp 111 weighting track 1 decrement 10
end

R1#show glbp brief
Interface  Grp  Fwd Pri State   Address         Active router  Standby router
Fa0/0      111  -   120 Active  10.0.0.5        local          10.0.0.4
Fa0/0      111  1   -   Listen  0007.b400.6f01  10.0.0.4       -
Fa0/0      111  2   -   Listen  0007.b400.6f02  10.0.0.3       -
Fa0/0      111  3   -   Listen  0007.b400.6f03  10.0.0.2       -
Fa0/0      111  4   -   Active  0007.b400.6f04  local          -
```

```
R1#show glbp
FastEthernet0/0 - Group 111
  State is Active
    5 state changes, last state change 01:07:42
  Virtual IP address is 10.0.0.5
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 0.576 secs
  Redirect time 600 sec, forwarder timeout 14400 sec
  Preemption enabled, min delay 0 sec
  Active is local
  Standby is 10.0.0.4, priority 100 (expires in 9.408 sec)
  Priority 120 (configured)
  Weighting 100 (configured 100), thresholds: lower 95, upper 100
    Track object 1 state Up decrement 10
  Load balancing: round-robin
  Group members:
    ca01.13bc.0000 (10.0.0.1) local
    ca02.10e8.0000 (10.0.0.2)
    ca07.336c.0000 (10.0.0.3)
    ca08.067c.0000 (10.0.0.4)
  There are 4 forwarders (1 active)
  Forwarder 1
    State is Listen
    MAC address is 0007.b400.6f01 (learnt)
    Owner ID is ca08.067c.0000
    Redirection enabled, 598.368 sec remaining (maximum 600 sec)
    Time to live: 14398.368 sec (maximum 14400 sec)
    Preemption enabled, min delay 30 sec
    Active is 10.0.0.4 (primary), weighting 100 (expires in 8.800 sec)
  Forwarder 2
    State is Listen
    MAC address is 0007.b400.6f02 (learnt)
    Owner ID is ca07.336c.0000
    Redirection enabled, 598.208 sec remaining (maximum 600 sec)
    Time to live: 14398.208 sec (maximum 14400 sec)
    Preemption enabled, min delay 30 sec
    Active is 10.0.0.3 (primary), weighting 100 (expires in 9.632 sec)
    Client selection count: 1
  Forwarder 3
    State is Listen
    MAC address is 0007.b400.6f03 (learnt)
    Owner ID is ca02.10e8.0000
    Redirection enabled, 597.984 sec remaining (maximum 600 sec)
    Time to live: 14397.984 sec (maximum 14400 sec)
    Preemption enabled, min delay 30 sec
    Active is 10.0.0.2 (primary), weighting 100 (expires in 9.120 sec)
  Forwarder 4
    State is Active
      1 state change, last state change 02:57:17
    MAC address is 0007.b400.6f04 (default)
    Owner ID is ca01.13bc.0000
    Redirection enabled
    Preemption enabled, min delay 30 sec
    Active is local, weighting 100
```

Gateway Load Balancing Protocol (GLBP)

Details of the Standby AVF router-

```
R4#show running-config interface fa0/0
Building configuration...

Current configuration : 121 bytes
!
interface FastEthernet0/0
 ip address 10.0.0.4 255.255.255.0
 duplex half
 glbp 111 ip 10.0.0.5
 glbp 111 preempt
end

R4#show glbp brief
Interface   Grp  Fwd  Pri  State    Address         Active router   Standby router
Fa0/0       111  -    100  Standby  10.0.0.5        10.0.0.1        local
Fa0/0       111  1    -    Active   0007.b400.6f01  local           -
Fa0/0       111  2    -    Listen   0007.b400.6f02  10.0.0.3        -
Fa0/0       111  3    -    Listen   0007.b400.6f03  10.0.0.2        -
Fa0/0       111  4    -    Listen   0007.b400.6f04  10.0.0.1        -
```

```
R4#show glbp
FastEthernet0/0 - Group 111
  State is Standby
    9 state changes, last state change 01:30:23
  Virtual IP address is 10.0.0.5
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 1.152 secs
  Redirect time 600 sec, forwarder timeout 14400 sec
  Preemption enabled, min delay 0 sec
  Active is 10.0.0.1, priority 120 (expires in 11.552 sec)
  Standby is local
  Priority 100 (default)
  Weighting 100 (default 100), thresholds: lower 1, upper 100
  Load balancing: round-robin
  Group members:
    ca01.13bc.0000 (10.0.0.1)
    ca02.10e8.0000 (10.0.0.2)
    ca07.336c.0000 (10.0.0.3)
    ca08.067c.0000 (10.0.0.4) local
  There are 4 forwarders (1 active)
  Forwarder 1
    State is Active
      1 state change, last state change 03:21:26
    MAC address is 0007.b400.6f01 (default)
    Owner ID is ca08.067c.0000
    Preemption enabled, min delay 30 sec
    Active is local, weighting 100
  Forwarder 2
    State is Listen
      2 state changes, last state change 00:00:27
    MAC address is 0007.b400.6f02 (learnt)
    Owner ID is ca01.13bc.0000
    Time to live: 14396.000 sec (maximum 14400 sec)
    Preemption enabled, min delay 30 sec
    Active is 10.0.0.1 (primary), weighting 100 (expires in 7.680 sec)
  Forwarder 3
    State is Listen
      2 state changes, last state change 00:00:19
    MAC address is 0007.b400.6f03 (learnt)
    Owner ID is ca07.336c.0000
    Time to live: 14397.120 sec (maximum 14400 sec)
    Preemption enabled, min delay 30 sec
    Active is 10.0.0.3 (primary), weighting 100 (expires in 7.680 sec)
  Forwarder 4
    State is Listen
      2 state changes, last state change 00:00:16
    MAC address is 0007.b400.6f04 (learnt)
    Owner ID is ca02.10e8.0000
    Time to live: 14395.424 sec (maximum 14400 sec)
    Preemption enabled, min delay 30 sec
    Active is 10.0.0.2 (primary), weighting 100 (expires in 6.880 sec)
```

Gateway Load Balancing Protocol (GLBP)

Details of an Listening AVF router-

```
R2#show running-config interface fa0/0
Building configuration...

Current configuration : 121 bytes
!
interface FastEthernet0/0
 ip address 10.0.0.2 255.255.255.0
 duplex half
 glbp 111 ip 10.0.0.5
 glbp 111 preempt
end

R2#show glbp brief
Interface  Grp  Fwd Pri State   Address        Active router  Standby router
Fa0/0      111  -   100 Listen  10.0.0.5       10.0.0.1       10.0.0.4
Fa0/0      111  1   -   Listen  0007.b400.6f01 10.0.0.4       -
Fa0/0      111  2   -   Listen  0007.b400.6f02 10.0.0.3       -
Fa0/0      111  3   -   Active  0007.b400.6f03 local          -
Fa0/0      111  4   -   Listen  0007.b400.6f04 10.0.0.1       -
```

```
R2#show glbp
FastEthernet0/0 - Group 111
  State is Listen
  Virtual IP address is 10.0.0.5
  Hello time 3 sec, hold time 10 sec
    Next hello sent in 1.088 secs
  Redirect time 600 sec, forwarder timeout 14400 sec
  Preemption enabled, min delay 0 sec
  Active is 10.0.0.1, priority 120 (expires in 11.200 sec)
  Standby is 10.0.0.4, priority 100 (expires in 9.888 sec)
  Priority 100 (default)
  Weighting 100 (default 100), thresholds: lower 1, upper 100
  Load balancing: round-robin
  Group members:
    ca01.13bc.0000 (10.0.0.1)
    ca02.10e8.0000 (10.0.0.2) local
    ca07.336c.0000 (10.0.0.3)
    ca08.067c.0000 (10.0.0.4)
  There are 4 forwarders (1 active)
  Forwarder 1
    State is Listen
    MAC address is 0007.b400.6f01 (learnt)
    Owner ID is ca08.067c.0000
    Time to live: 14399.904 sec (maximum 14400 sec)
    Preemption enabled, min delay 30 sec
    Active is 10.0.0.4 (primary), weighting 100 (expires in 10.528 sec)
  Forwarder 2
    State is Listen
    MAC address is 0007.b400.6f02 (learnt)
    Owner ID is ca07.336c.0000
    Time to live: 14399.072 sec (maximum 14400 sec)
    Preemption enabled, min delay 30 sec
    Active is 10.0.0.3 (primary), weighting 100 (expires in 10.432 sec)
  Forwarder 3
    State is Active
      1 state change, last state change 03:11:58
    MAC address is 0007.b400.6f03 (default)
    Owner ID is ca02.10e8.0000
    Preemption enabled, min delay 30 sec
    Active is local, weighting 100
  Forwarder 4
    State is Listen
    MAC address is 0007.b400.6f04 (learnt)
    Owner ID is ca01.13bc.0000
    Time to live: 14398.272 sec (maximum 14400 sec)
    Preemption enabled, min delay 30 sec
    Active is 10.0.0.1 (primary), weighting 100 (expires in 9.504 sec)
```

Thank You ────────────────

Feel free to reach out to me for any **suggestions** or **feedback** via **LinkedIn** or **Mail**

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