



# Network Services

First Hop Redundancy Protocols



## In This Section

- + First Hop Redundancy Overview
- + HSRP, VRRP, & GLBP
- + FHRPs and Enhanced Object Tracking
- + FHRP Support for IPv6

# What is First Hop Redundancy?

- + Used to provide end host default gateway failover
  - + 2 or more default gateways work together for redundancy
- + Implemented by using virtual IP/MAC
  - + Multiple gateways have the same virtual IP
  - + End hosts use virtual IP as default gateway
  - + Only one router responds to ARP requests for virtual IP
  - + ARP response contains virtual MAC address
- + If active gateway fails, backup becomes active
  - + Failure detected via a keepalive protocol
  - + The backup assumes virtual MAC and IP upon primary failure

# HSRP

- + Cisco proprietary, but RFC defined
  - + [RFC 2281 - Cisco Hot Standby Router Protocol \(HSRP\)](#)
- + Elects active gateway based on priority
  - + 100 is the default, 255 is maximum
  - + Highest IP as the tie-breaker
  - + Non-preemptive by default
- + Uses UDP multicast 224.0.0.2 at port 1985 for transport
  - + Messages can be authenticated using clear text or MD5
- + Supports multiple groups per interface
  - + Group ID encoded in virtual MAC 0000.0c07.acXX

# VRRPv2

- + Virtual Router Redundancy Protocol
  - + Standards based alternative to HSRP
  - + [RFC 3768 - Virtual Router Redundancy Protocol \(VRRP\)](#)
  - + Uses terms master/backup as opposed to active/standby
- + Other concepts are similar
  - + Uses own transport protocol 112 to IP 224.0.0.18
  - + Virtual MAC is 0000.5E00.01XX
  - + Preemptive by default

# GLBP

- + Gateway Load Balancing Protocol
  - + Cisco Proprietary Protocol
  - + Extends HSRP functionality to support load balancing
  - + Transport via UDP port 3222 to IP 224.0.0.102
- + Every physical gateway may now be active
  - + Called Active Virtual Forwarders (AVF)
  - + Each AVF assigned a virtual MAC address
- + One gateway responds to ARP requests for GLBP IP
  - + Called Active Virtual Gateway (AVG)
  - + ARP response uses virtual MACs of AVFs to implementing load-balancing

## GLBP (cont.)

- + AVG elected based on priority
  - + By default AVG is the only AVF, all other are standby
  - + No AVG preemption by default
    - + Enable using **glbp preempt**
- + To enable load-balancing...
  - + Command **glbp xxx load-balancing weighted**
  - + Assign weights with **glbp xxx weighting Y**
- + Weight can be adjusted based on object tracking

# FHRPs and Enhanced Object Tracking

- + Gateway recovery relies on correct failure detection
  - + E.g. FHRP keepalives or BFD
- + What if southbound link is up but northbound is down?
  - + Result is Active/Master router maintains state but cannot forward
  - + Solution is to integrate FHRPs with Enhanced Object Tracking
    - + E.g. IP SLA
- + Object tracking is bound to priority
  - + Decrement priority if object is down
  - + Assumes preemption is configured



# FHRP Support for IPv6

## + HSRPv2

- + Increases group range
- + Adds new dedicated transport address 224.0.0.102
  - + Doesn't overlap with ALL ROUTERS
- + Adds IPv6 support
- + Enabled with interface level **standby version 2**

## + VRRPv3

- + [RFC 5798 - Virtual Router Redundancy Protocol \(VRRP\) Version 3 for IPv4 and IPv6](#)
- + Enabled with global **fhrp version vrrp v3**





# Network Services

HSRP Configuration

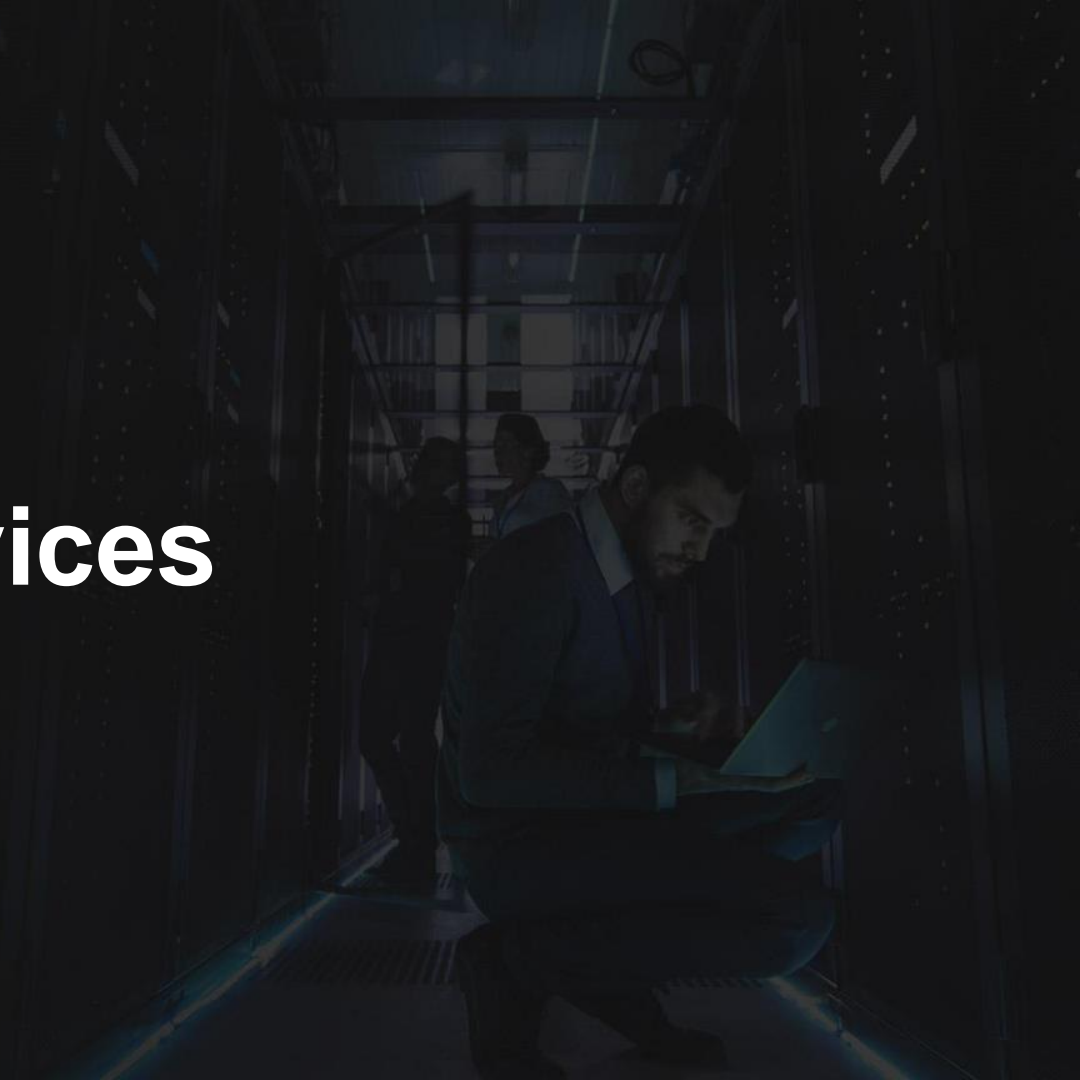






# Network Services

VRRP Configuration







# Network Services

GLBP Configuration







# Network Services

Network Time Protocol (NTP)



## In This Section

- + NTP Configuration Examples





# Network Services

DHCP on Cisco IOS



## In This Section

- + IOS DHCP Server, Client, & Relay

# DHCP in IOS

- + DHCP in IOS supports...
  - + DHCP server
  - + DHCP client
  - + DHCP proxy
    - + E.g. translate IPCP request into DHCP
  - + DHCP relaying

# IOS DHCP Server

- + Server configured using DHCP pools
  - + Each pool has an IP subnet for allocation
  - + Host pools are supported
- + Pool is selected based on...
  - + DHCP Client ID (could be any string)
    - + Supplied by Windows clients but not Linux
  - + DHCP Hardware Address if ID is missing
  - + Relaying gateway IP address
  - + Receiving interface IP subnet if no matching pool found and no relay IP address present

# IOS DHCP Relaying

- + Broadcast can be relayed to unicast
  - + **ip helper-address <IP>** interface command
- + In case of DHCP, relaying router inserts interface IP address
  - + Known as “giaddr” or gateway address
  - + Other options could be inserted, e.g. Information Option
- + DHCP server matches pool based on giaddr







# Network Services

Network Address Translation (NAT)



## In This Section

- + NAT Overview
- + NAT Configuration Examples

# Network Address Translation

- + Rewrites source IP addresses in packet
  - + Normally to hide private IP addresses
  - + Can also resolve overlapping subnet issues
- + Destination IP rewrite may be used for redirection
  - + Normally configured as static mapping
- + Port Address Translation
  - + Many to one translation based on TCP/UDP port
  - + Common for overloading scenarios

# NAT Terminology

- + Inside zone - networks that translator wants to hide
  - + Inside local - Inside IPs before translation
  - + Inside global - Inside IPs after translation
- + Outside zone - networks that are external to translator
  - + Outside global - Original outside IP address
  - + Outside local - Outside IP after translation as it seen inside

# NAT Order of Operations

- + On the inside
  - + Packets are first routed and then have sources translated
  - + Destination addresses are global so this is OK
- + On the outside
  - + Packets have destinations un-translated first
  - + Routing occurs after translation
  - + Allows proper routing for returning packets with translated sources

# VRF Aware NAT

- + Used to leak traffic from VRF table to global table
- + Requires static routing with next hop and **global** keyword
  - + **ip route VRF1 0.0.0.0 0.0.0.0 gig0/1 1.2.3.4 global**
- + NAT statement is VRF aware
  - + **ip nat inside source list 1 interface gig0/1 vrf VRF1 overload**

# VRF Aware NAT on IOS XE

- + Classical inter-vrf nat configuration not supported in IOS XE
- + Inter-vrf NAT on IOS-XE is achieved via VASI implementation
  - + VRF-Aware Software Infrastructure
- + Configured as VASI pairs
  - + Each VASI interface is associated with a different VRF instance
  - + Uses **interface vasileft** and **interface vasiright** interfaces
- + VASI is the next-hop interface for packets that needs to be switched between these two VRF instances
  - + Result is traffic leaking between VRFs using NAT



