

Lab 12. LACP, FHRP

TA 許仲宇 (hsuchy)

Credit to clc

Purpose

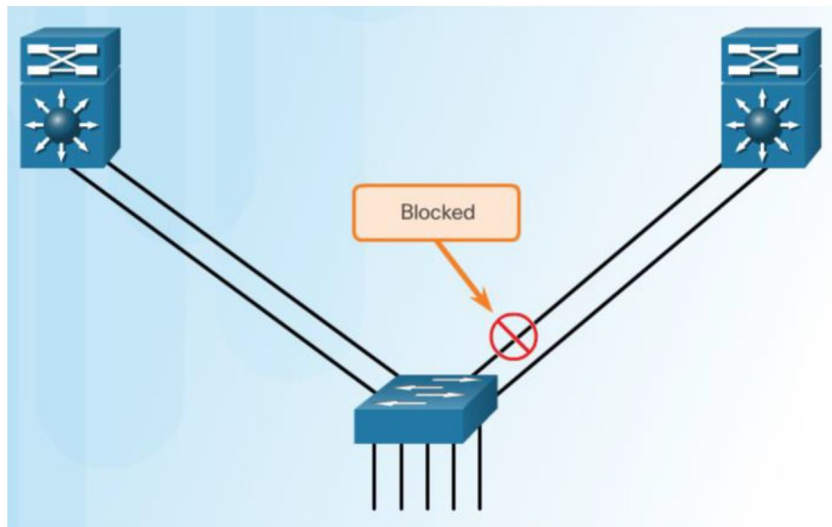
- Learn about EtherChannel for data link layer (L2).
- Understand various FHRP for network layer (L3) redundancy and high availability.
- Know how to config on Cisco IOS.

Outline

- Purpose / Background
- EtherChannel (for Layer 2)
 - Static EtherChannel
 - Port Aggregation Protocol (PAgP)
 - Link Aggregation Control Protocol (LACP)
 - Config
- First Hop Redundancy Protocol (FHRP for Layer 3)
 - Virtual Router Redundancy Protocol (VRRP)
 - Hot Standby Router Protocol (HSRP)
 - Gateway Load Balancing Protocol (GLBP)

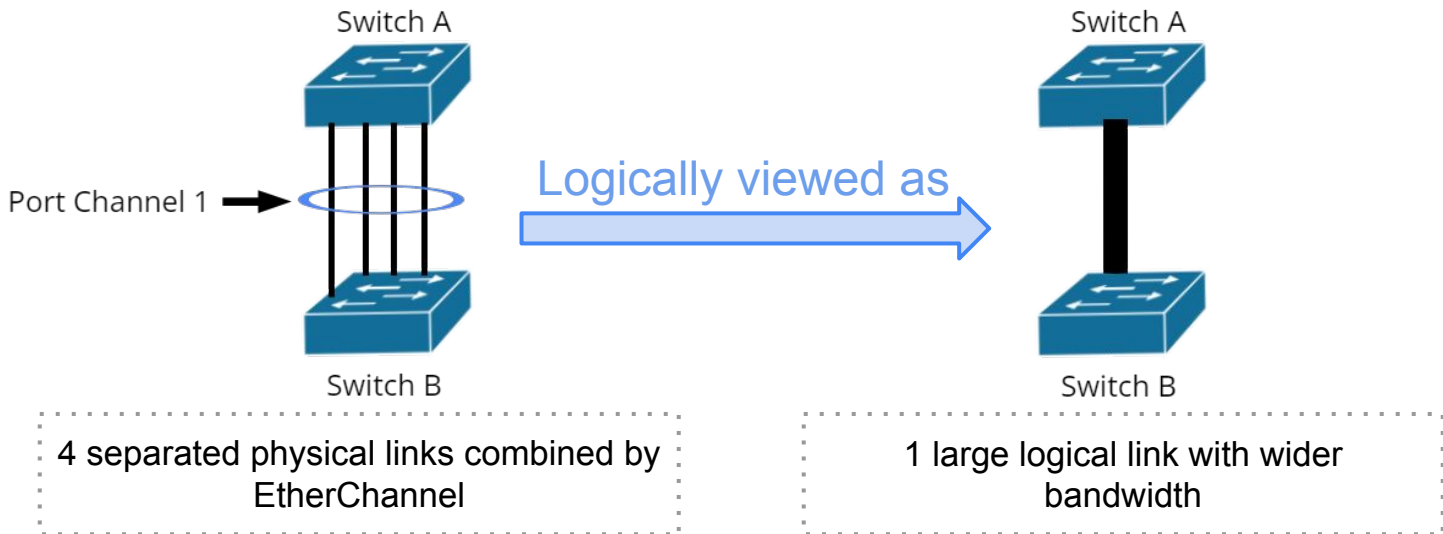
Background

- Replacing with faster links is expensive.
- STP will block redundant links to prevent routing loops.
 - The bandwidth of redundant links would be wasted.



Link Aggregation

- **Combine physical links** between the switches to increase the overall speed of switch-to-switch communication.
- Implemented as **EtherChannel** on Cisco IOS.
 - Also known as **port-channel**.



EtherChannel

EtherChannel (1/2)

- Purpose / Background
- **EtherChannel (for Layer 2)**
 - Static EtherChannel
 - Port Aggregation Protocol (PAgP)
 - Link Aggregation Control Protocol (LACP)
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- First Hop Redundancy Protocol (FHRP for Layer 3)

- Grouping multiple physical ports into one or more logical EtherChannel links.
 - Interface types can't be mixed.
- Each EtherChannel can consist of up to 16 physical ports.
 - But Only 8 interfaces can be active.
 - Those interfaces inactive will be used as **backup**.
- Enhance total throughput **via load balancing**
 - (Try to) Fairly **distribute traffic** across all active links.

EtherChannel (2/2)

- Purpose / Background
- **EtherChannel (for Layer 2)**
 - Static EtherChannel
 - Port Aggregation Protocol (PAgP)
 - Link Aggregation Control Protocol (LACP)
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- Group member port configuration must be consistent on both devices.
 - Same Media type (Fast, Gigabit, 10-Gigabit)
 - Same Speed and Duplex mode
 - Same VLAN configs (native VLAN and allowed VLAN)
 - Same VLAN modes (Access or Trunk Mode)
 - All ports must be **configured as L2 (Data link layer) ports.**
- Can be formed through negotiation using PAgP or LACP.

- Purpose / Background
- EtherChannel (for Layer 2)
 - **Static EtherChannel**
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Static EtherChannel

- Simply creates a channel without negotiating parameters with the peer device
- NO misconfiguration protection.
 - It will not even check if peer device have set up EtherChannel.
 - Any misconfiguration can ruin everything.
- Not recommended to use in almost every case
 - unless you have device too old to support dynamic negotiation protocol, like PAgP or LACP.

- Purpose / Background
- EtherChannel (for Layer 2)
 - Static EtherChannel
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Port Aggregation Protocol (PAgP)

- Cisco-proprietary protocol for negotiating and managing EtherChannel links.
- Sends PAgP packets every 30 seconds.
- Checks config consistency.
 - Stop establishing EtherChannel link when misconfiguration occurred.
- Manages link additions and failures.
- Combine a maximum of 8 physical links into a single virtual link.

- Purpose / Background
 - EtherChannel (for Layer 2)
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Link Aggregation Control Protocol (LACP) (1/2)

- Industrial standard, IEEE 802.1AX (previously 802.3ad).
- Performs similar to Cisco PAgP
 - Periodically send LACPDU to exchange information
 - Config consistency, addition of link, detect and remove failure link.
 - Cisco device support both LACP and PAgP
- Can be used to facilitate EtherChannels in multi-vendor environments.
- LACP allows for **8 active** links and **8 standby** links.
 - A standby link will become active when one of the current active links fails.

Link Aggregation Control Protocol (LACP) (2/2)

- How to decide which links to be active or standby?
- System priority
 - Decide which switch to become leader first.
 - 2 bytes of priority (0 - 65535) + 6 bytes of MAC address
 - Default priority = 32768
 - Switch with the **lower** value will become the leader.
- Port priority
 - The **leader chooses** which ports to be active or standby.
 - 2 bytes of priority (0 - 65535) + 2 bytes of port number
 - Default priority = 32768
 - Port (and correspond link) with the **lower** value will be chosen to be active.

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EtherChannel Modes Relation

Channel Mode	on	Active LACP	Passive LACP	Desirable PAgP	Auto PAgP
on	Static	?	?	?	?
Active LACP	?	LACP	LACP	×	×
Passive LACP	?	LACP	×	×	×
Desirable PAgP	?	×	×	PAgP	PAgP
Auto PAgP	?	×	×	PAgP	×

✗: EtherChannel would not be set up

? : Dangerous
(EtherChannel will be set up on ONLY ONE side)

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Load Balance

- Traffic in an EtherChannel is distributed across the physical links.
- Use a deterministic method to decide which link to use for sending out a packet
 - Use MAC addr, IP addr or Port of packet to calculate the physical link to use.
 - Ensure that same data flow (e.g. A TCP session) is always sent via the same physical link
 - But this may not necessarily be balanced equally across all the links.
- Choose the load-balancing method that provides the greatest distribution.
- How to configure: `Switch(config)# port-channel load-balance method`

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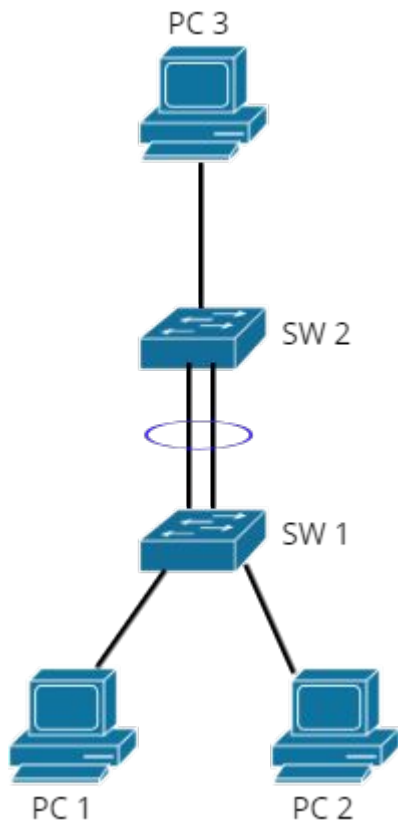
Load Balance Methods

Method Value	Hash Input
src-port	Source port number
dst-port	Destination port number
src-dst-port *	Source and destination port number
src-ip	Source IP address
dst-ip	Destination IP address
src-dst-ip *	Source and destination IP address
src-mac	Source MAC address
dst-mac	Destination MAC address
src-dst-mac *	Source and destination MAC address

* XOR of two values

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Choosing load balance method



For this example scenario:

- SW1 should choose method based on src
 - Distributing traffic from PC1 and PC2 to different physical link
- SW2 should choose method based on dst
 - Distributing traffic to PC1 and PC2 to different physical link

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EtherChannel must have the same...

- Media type
 - All interfaces should be the same media type.
 - E.g., FastEthernet, GigabitEthernet
- Speed and duplex
 - Operate at the same speed and in the same duplex mode.
- VLAN match
 - Should be configured in the same switchport mode, and match the range of VLANs.
- No need to be physically contiguous.

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Config Steps

1. Setting LACP system priority & port priority.
 - Optional, Not support in Packet Tracer.
2. Assign the interfaces to EtherChannel group (channel-group)
3. Config the correspond port-channel interface.
 - switchport mode, trunk allowed vlan

Terminology:

- **Channel group:** Collection of Ethernet interfaces
- **Port Channel interface:** Virtual interface associated with a channel group
 - Config make on Port Channel interface will apply to all interface in the channel-group.

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Command

- Setting lacp System priority

```
Switch(config)# lacp system-priority priority-value
```

- Setting lacp port priority

```
Switch(config)# int interface
```

```
Switch(config-if)# lacp port-priority priority-value
```

- Setting load balance method (configure globally)

```
Switch(config)# port-channel load-balance method
```

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Command

- Assign an interface to a channel group and specify control protocol

```
Switch(config)# int interface
Switch(config-if)# channel-group channel-num mode channel-mode
# channel-mode:
#   desirable   Enable PAgP unconditionally
#   auto        Enable PAgP only if a PAgP device is detected
#   active      Enable LACP unconditionally
#   passive     Enable LACP only if an LACP device is detected
#   on          Enable Etherchannel only
Switch(config-if)# channel-protocol {lacp|pagp}
```

If the group is not existed, this will create it.

Command

- Remove an interface from a channel group

```
Switch(config)# int interface  
Switch(config-if)# no channel-group
```

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- EtherChannel (for Layer 2)
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Config Example

- Purpose / Background
- EtherChannel (for Layer 2)
 - Static EtherChannel
 - Port Aggregation Protocol (PAgP)
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 - **Config**
- First Hop Redundancy Protocol (FHRP for Layer 3)

```
Switch(config)# lacp system-priority 100

Switch(config)# interface range Gi0/1-4

Switch(config-if)# channel-protocol lacp

Switch(config-if)# channel-group 5 mode active

Switch(config-if)# lacp port-priority 1024
```

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Config Guidelines

- Change EtherChannel setting after creation.

```
Switch(config)# interface port-channel 5
Switch(config-if)# switchport mode trunk
Switch(config-if)# switchport trunk allowed vlan 28,420
```

- Avoiding misconfiguration with EtherChannel.
 - `Switch(config)# spanning-tree etherchannel guard misconfig` (Enabled by default)
- If you want to change those configs, **set them in the port-channel interface.**
 - It will also **affect all individual interfaces in the group.**
 - Individual interface config does not affect the port-channel interface.

Verification (1/4)

- Purpose / Background
- EtherChannel (for Layer 2)
 - Static EtherChannel
 - Port Aggregation Protocol (PAgP)
 - Link Aggregation Control Protocol (LACP)
 - **Config**
- First Hop Redundancy Protocol (FHRP for Layer 3)

- **show interfaces port-channel *identifier***
 - Displays the general status of the port-channel interface.
- **show etherchannel summary**
 - Simply display one line of information per port-channel.
- **show etherchannel port-channel**
 - Display detailed information of port-channel.
- **show interfaces *interface* etherchannel**
 - Not support in Packet Tracer.
 - Display role of particular interface in an EtherChannel.

Verification (2/4)

- Purpose / Background
- EtherChannel (for Layer 2)
 - Static EtherChannel
 - Port Aggregation Protocol (PAgP)
 - Link Aggregation Control Protocol (LACP)
 - **Config**
- First Hop Redundancy Protocol (FHRP for Layer 3)

```
Sw1# show etherchannel summary
```

```
Flags:  D - down          P - in port-channel
        I - stand-alone  s - suspended
        H - Hot-standby (LACP only)
        R - Layer3       S - Layer2
        U - in use       f - failed to allocate aggregator
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port
```

```
Number of channel-groups in use: 1
```

```
Number of aggregators: 1
```

Group	Port-channel	Protocol	Ports
1	Po1 (SU)	LACP	Fa0/1 (P) Fa0/2 (P) Fa0/3 (P) Fa0/4 (P)

Verification (3/4)

- Purpose / Background
- EtherChannel (for Layer 2)
 - Static EtherChannel
 - Port Aggregation Protocol (PAgP)
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 - **Config**
- First Hop Redundancy Protocol (FHRP for Layer 3)

```
Sw1# show etherchannel port-channel
Port-channel: Po1      (Primary Aggregator)
-----
Age of the Port-channel = 00d:01h:30m:00s
Logical slot/port      = 2/1          Number of ports = 2
GC                     = 0x00000000   HotStandBy port = null
Port state             = Port-channel
Protocol               = LACP          Port Security    = Disabled

Ports in the Port-channel:
Index   Load   Port      EC state      No of bits
-----+-----+-----+-----+-----+
  0      00     Fa0/1     Active       0
  0      00     Fa0/2     Active       0
Time since last port bundled: 00d:01h:30m:00s   Fa0/2
```

Verification (4/4)

- Purpose / Background
- EtherChannel (for Layer 2)
 - Static EtherChannel
 - Port Aggregation Protocol (PAgP)
 - Link Aggregation Control Protocol (LACP)
 - **Config**
- First Hop Redundancy Protocol (FHRP for Layer 3)

```
Sw3750# show interface Gi1/0/24 etherchannel
```

```
Port state      = Up Mstr Assoc In-Bndl
Channel group   = 1                Mode = Active                Gcchange = -
Port-channel    = Po1              GC    = -                  Pseudo port-channel = Po1
Port index      = 0                Load = 0x00              Protocol = LACP
```

```
Flags:  S - Device is sending Slow LACPDUs.  F - Device is sending fast LACPDUs.
        A - Device is in active mode.         P - Device is in passive mode.
```

Local information:				LACP port	Admin	Oper	Port	Port
Port	Flags	Priority	State	Key	Key	Number	State	
Gi1/0/24	SA	32768	bndl	0x1	0x1	0x101	0x3D	

Partner's information:				LACP port	Admin	Oper	Port	Port
Port	Flags	Priority	Dev ID	Age	key	Key	Number	State
Gi1/0/24	SA	32768	885a.92df.73fc	5s	0x0	0x29	0x10D	0x3D

```
Age of the port in the current state: 42d:10h:30m:00s
```

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Practice

1. Download and open **Lab12-1_ LACP.pkt**.
2. Establish the EtherChannel.
 - Verify your EtherChannel settings.
3. Change the setting in Port-Channel.
 - Try to change allowed VLAN range (E.g., Remove VLAN 235).
 - **Packet Tracer can't detect config inconsistency between two switches.**
4. Change the setting in individual interface.
 - Try to change one of the interface into switchport access mode.
 - What would happen?

First Hop Redundancy Protocol

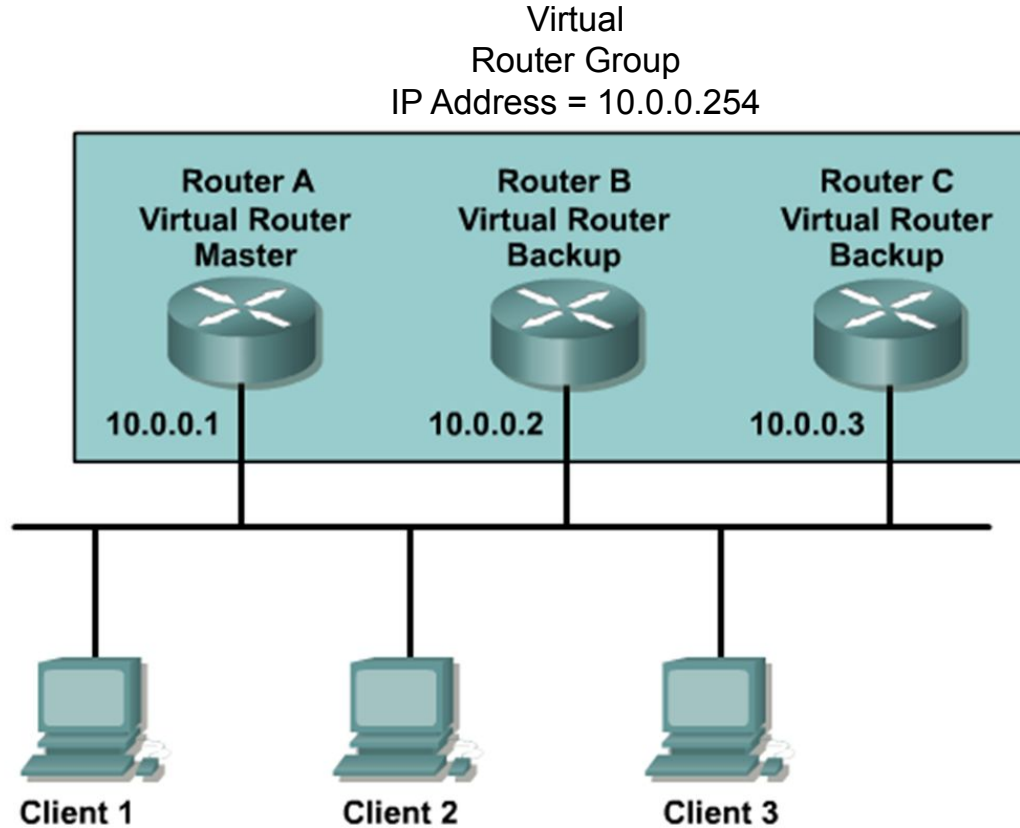
- Purpose / Background
- EtherChannel (for Layer 2)
- **First Hop Redundancy Protocol (FHRP for Layer 3)**
 - Virtual Router Redundancy Protocol (VRRP)
 - Hot Standby Router Protocol (HSRP)
 - Gateway Load Balancing Protocol (GLBP)

First Hop Redundancy Protocol (FHRP)

- The **default gateway** for end devices is called **first-hop**.
- FHRP allows 2+ routers to provide backup for gateway address.
- When master is dead, backup routers will take over within seconds.
- FHRP is a category, there are several FHRP protocols:
 - **VRRP**, Virtual Router Redundancy Protocol
 - **HSRP**, Hot Standby Router Protocol
 - **GLBP**, Gateway Load Balancing Protocol

How It Works

- Purpose / Background
- EtherChannel (for Layer 2)
- **First Hop Redundancy Protocol (FHRP for Layer 3)**
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Virtual Router Redundancy Protocol

First Hop Redundancy Protocol (1/3)

- Purpose / Background
- EtherChannel (for Layer 2)
- First Hop Redundancy Protocol (FHRP for Layer 3)
 - **Virtual Router Redundancy Protocol (VRRP)**
 - Hot Standby Router Protocol (HSRP)
 - Gateway Load Balancing Protocol (GLBP)

Virtual Router Redundancy Protocol (VRRP)

- Defined in RFC 2338.
- Designed to be transparently failover for an IP address.
- Provides virtual router IP address for a group of routers as a gateway.
 - A router with **the highest priority** becomes the master. Others will become backup routers.
 - If same VRRP priority, choose the router with numerically highest IPv4 address.
- Master sends VRRP advertisements at 1 second intervals.
 - When not hearing advertisements over 3*intervals from the master router.
 - A backup router would take over.
- By default, VRRP routers will preempt if priority is greater.

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Advertisements Packet Format (1/2)

5.1. VRRP Packet Format

```

0          1          2          3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-----+-----+-----+-----+
|  TTL = 255   | Protocol = 112 |      IP header checksum      |
+-----+-----+-----+-----+
|                                     source address                |
+-----+-----+-----+-----+
|                                     destination address = 224.0.0.18
+-----+-----+-----+-----+

+-----+-----+-----+-----+
|Version|Type=1 | Virtual Rtr ID|   Priority   |Count IPv4 Addr|
+-----+-----+-----+-----+
|(rsvd) | Max Advertis Interval |   VRRP header checksum   |
+-----+-----+-----+-----+
|
+                                     IPv4 Address(es)          +
|
+-----+-----+-----+-----+

```

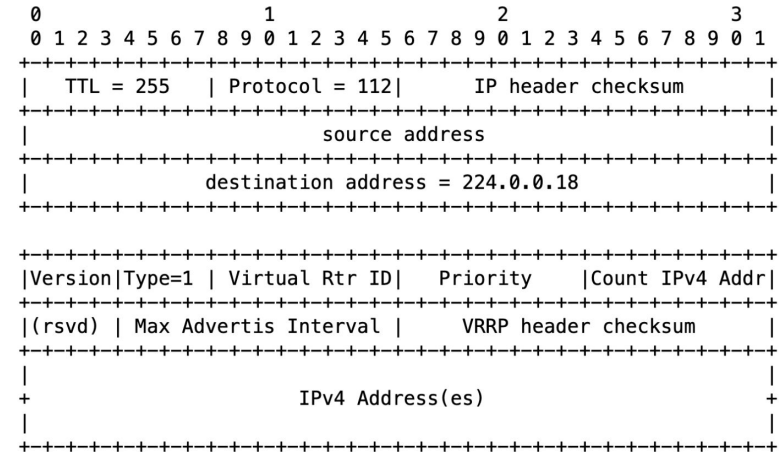
Source: [RFC 5798 § 5.1](#)

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Advertisements Packet Format (2/2)

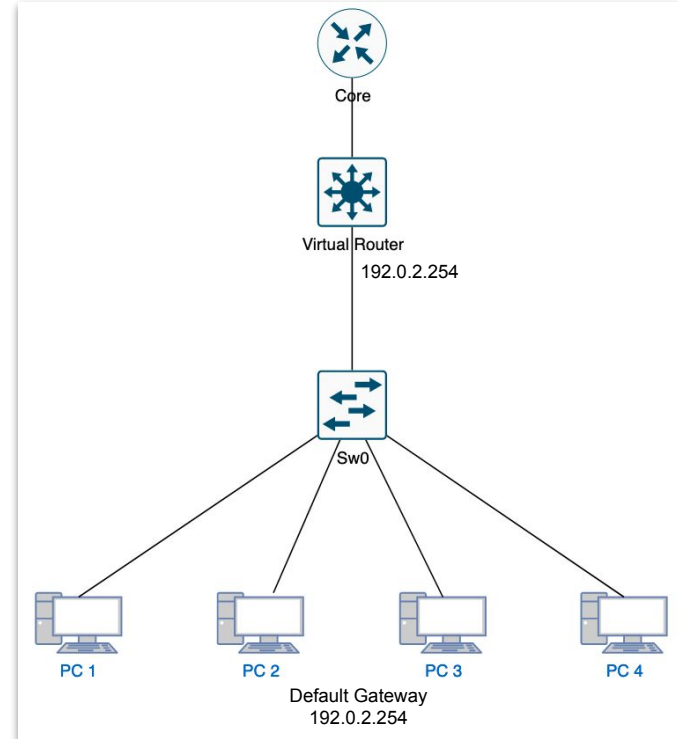
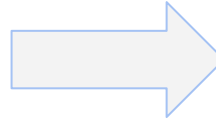
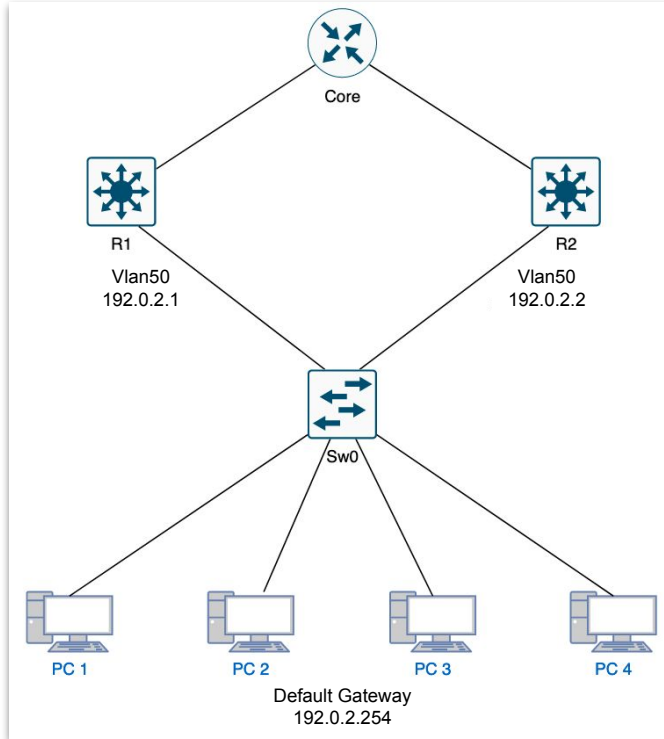
- Destination IPv4 address is fixed to 224.0.0.18.
 - Which is a Multicast address
 - The corresponding MAC address is 00:00:5E:00:01:XX.
- Priority should be 1 - 254.
 - 0 and 255 have special meaning.
- Count IPv4 Address
 - The number of IPv4 addresses contained in this VRRP group.
- Maximum Advertisement Interval
 - Indicates the time interval in centiseconds.
 - Default is 100 cs (1 sec). Max is 40.95 sec.

5.1. VRRP Packet Format



Config Scenario

- Purpose / Background
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- Purpose / Background
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Config Example

```
R1(config)# interface vlan 50
R1(config-if)# ip address 192.0.2.1 255.255.255.0
R1(config-if)# vrrp 1 priority 200
R1(config-if)# vrrp 1 ip 192.0.2.254
```

```
R2(config)# interface vlan 50
R2(config-if)# ip address 192.0.2.2 255.255.255.0
R2(config-if)# ! vrrp 1 priority 100
R2(config-if)# vrrp 1 ip 192.0.2.254
R2(config-if)# no vrrp 1 preempt
```

Verification

- Purpose / Background
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```
R1# show vrrp detail
Vlan50 - Group 1
  State is Master
  Virtual IP address is 192.0.2.254
  Virtual MAC address is 0000.5e00.0101
  Advertisement interval is 1.000 sec
  Preemption is enabled
    min delay is 0.000 sec
  Priority is 200
  Authentication is enabled
  Master Router is 192.0.2.1 (local),
    priority is 200
  Master Advertisement interval is 1.000 sec
  Master Down interval is 3.200 sec
```

```
R2# show vrrp detail
Vlan50 - Group 1
  State is Backup
  Virtual IP address is 192.0.2.254
  Virtual MAC address is 0000.5e00.0101
  Advertisement interval is 1.000 sec
  Preemption is disabled
  Priority is 100
  Authentication is enabled
  Master Router is 192.0.2.1,
    priority is 200
  Master Advertisement interval is 1.000 sec
  Master Down interval is 3.600 sec
  (expires in 2.800 sec)
```

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Config Reference

Command	Description
<code>(config-if)# vrrp group ip <i>ip-addr</i></code>	Makes the interface a member of the vrrp group and assign the virtual IP address. (The virtual IP address can be the same as the interface IP address of one member in the group)
<code>(config-if)# vrrp group priority <i>priority</i></code>	Set the VRRP router priority from 1 to 254 (Default is 100).
<code>(config-if)# vrrp group timers advertise <i>timer</i></code>	Change the advertisement timer (Default 1 second).
<code>(config-if)# vrrp group-num timers learn</code>	Learn the advertisement interval from the master router.
<code>(config-if)# vrrp group preempt [delay <i>seconds</i>]</code>	Change the preempt delay.
<code>(config-if)# no vrrp group preempt</code>	Disable preempting. (Default is to preempt)
<code>(config-if)# vrrp group track <i>object-number</i> [decrement <i>priority</i>]</code>	Track an object and decrease the priority when the object is down.

Hot Standby Router Protocol

First Hop Redundancy Protocol (2/3)

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Hot Standby Router Protocol (HSRP)

- A Cisco-proprietary FHRP protocol.
- Send periodic Hello messages to `all-routers` multicast address.
- HSRP group consist of **1 active** router + **1 standby** router.
 - Others remain in the speak state.
- Use MAC address `00:00:0C:07:AC:XX` or `00:00:0C:9F:FX:XX`.

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HSRP States

- **Initial** When HSRP is disabled or the interface first comes up.
- **Learn** The router has not determined the virtual IP address.
- **Listen** Waiting for Hello message from active or standby router.
- **Speak** Participating in the HSRP election.
- **Standby** The router is a candidate to become the next active router
- **Active** Forwarding packets that are sent to the group's virtual IP / MAC address.
- Sends Hello messages periodically: Speak, Standby, Active
- At most one router in: Standby, Active

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HSRP Timers

- There are 2 amount of time in the HSRP Hello message:
 - **Hello time** The frequency of routers to send hello packets. (Default 3 seconds)
 - **Hold time** The time that an active or standby router will be expired. (Default 10 seconds)
- Each router maintains 3 timers:
 - **Hello Timer** After entering Speak state, it will send Hello msg when Hello timer expired.
 - **Active Timer** Used to monitor the Active router. Expire in `Hold time` seen in Hello msg.
 - **Standby Timer** Used to monitor the Standby router. Similar to the Active Timer.

- Purpose / Background
- EtherChannel (for Layer 2)
- First Hop Redundancy Protocol (FHRP for Layer 3)
 - Virtual Router Redundancy Protocol (VRRP)
 - **Hot Standby Router Protocol (HSRP)**
 - Gateway Load Balancing Protocol (GLBP)

Election (1/2)

- Determine the role of each router in HSRP group based on the priority value.
- HSRP priority
 - Range from 0 to 255 (Default 100)
 - **Highest** priority in the group = Active router
 - If the priorities are equal, router with numerically **highest IPv4 address** is elected.
- `Switch(config-if) # standby group priority priority`

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Election (2/2)

- By default, the active router **won't be replaced** by a router with higher priority.
- To force a new HSRP election process, preemption must be enabled.
 - `Switch(config-if)# standby group preempt [delay [minimum seconds] [reload seconds]]`
 - **delay** Delay the preemption (0 to 3600 seconds)
 - **reload** Force the router to wait after it has been reloaded or restarted.
- Only preempt if the router has a **higher priority**.

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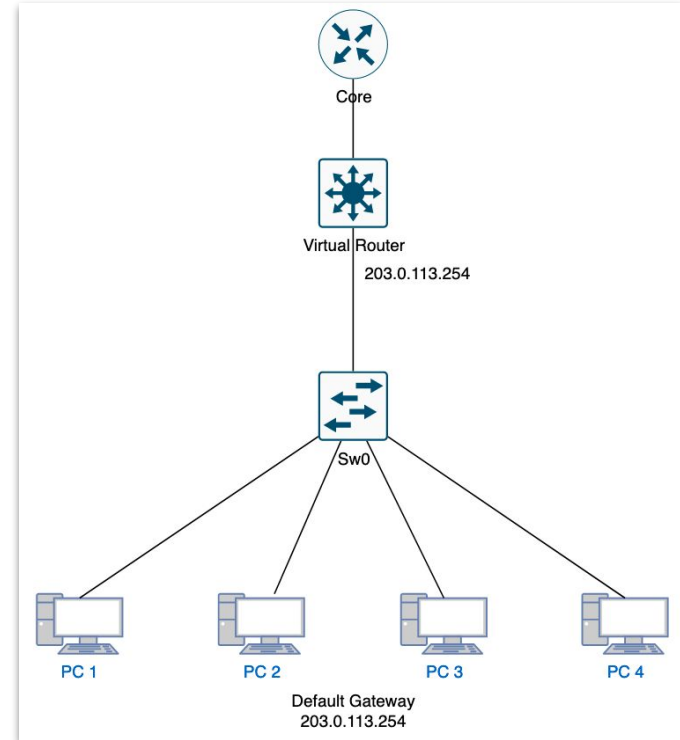
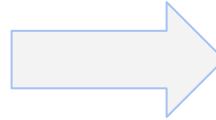
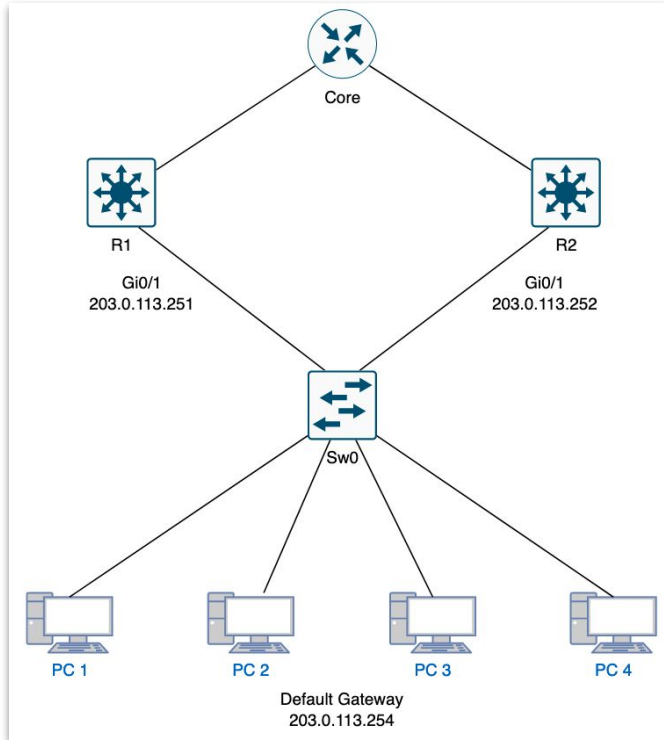
Config Steps

1. Configure the HSRP version 2.
2. Set the virtual IP address for the group.
 - The IP address of interface and the virtual address should be in the **same IP subnet**.
3. Configure the priority for the desired active router.
4. Make the active router to be preemptive.

```
Switch(config-if)# standby version 2
Switch(config-if)# standby [ group-number ] ip [ ip-address ]
Switch(config-if)# standby [ group-number ] priority priority-value
Switch(config-if)# standby group preempt [ delay [ minimum seconds ] [ reload
seconds ]]
```

Config Scenario

- Purpose / Background
- EtherChannel (for Layer 2)
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 - Gateway Load Balancing Protocol (GLBP)



- Purpose / Background
- EtherChannel (for Layer 2)
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Config Example

```
R1(config)# interface Gi0/1
R1(config-if)# ip address 203.0.113.251 255.255.255.0
R1(config-if)# standby version 2
R1(config-if)# standby 1 ip 203.0.113.254
R1(config-if)# standby 1 priority 160
R1(config-if)# standby 1 preempt
R1(config-if)# no shutdown

R2(config)# interface Gi0/1
R2(config-if)# ip address 203.0.113.252 255.255.255.0
R2(config-if)# standby version 2
R2(config-if)# standby 1 ip 203.0.113.254
R2(config-if)# no shutdown
```


Verification (1/2)

- Purpose / Background
- EtherChannel (for Layer 2)
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```
R1# show standby
GigabitEthernet0/1 - Group 1 (version 2)
  State is Active
    8 state changes, last state change 00:08:30
  Virtual IP address is 203.0.113.254
  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 0.500 secs
Preemption enabled
  Active router is local
  Standby router is 203.0.113.252
  Priority 160 (configured 160)
  Group name is hsrp-Gig0/1-1 (default)
```

```
R2# show standby
GigabitEthernet0/1 - Group 1 (version 2)
  State is Standby
    6 state changes, last state change 00:08:30
  Virtual IP address is 203.0.113.254
  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 0.500 secs
Preemption disabled
  Active router is 203.0.113.251
  Standby router is local
  Priority 100 (default 100)
  Group name is hsrp-Gig0/1-1 (default)
```

- Purpose / Background
- EtherChannel (for Layer 2)
- First Hop Redundancy Protocol (FHRP for Layer 3)
 - Virtual Router Redundancy Protocol (VRRP)
 - **Hot Standby Router Protocol (HSRP)**
 - Gateway Load Balancing Protocol (GLBP)

Verification (2/2)

```
R1# show standby brief
```

```
          P indicates configured to preempt.
```

```
|
```

Interface	Grp	Pri	P	State	Active	Standby	Virtual IP
Gig0/1	1	160	P	Active	local	172.16.0.252	172.16.0.254

```
R2# show standby brief
```

```
          P indicates configured to preempt.
```

```
|
```

Interface	Grp	Pri	P	State	Active	Standby	Virtual IP
Gig0/1	1	100	P	Standby	172.16.0.251	local	172.16.0.254

- Purpose / Background
- EtherChannel (for Layer 2)
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Practice

- Download and open **Lab12-2_FHRP.pkt**.
- Set HSRP on R1 and R2.
 - Gateway IP is 192.168.0.254
- Verify HSRP states by the commands on the previous page.

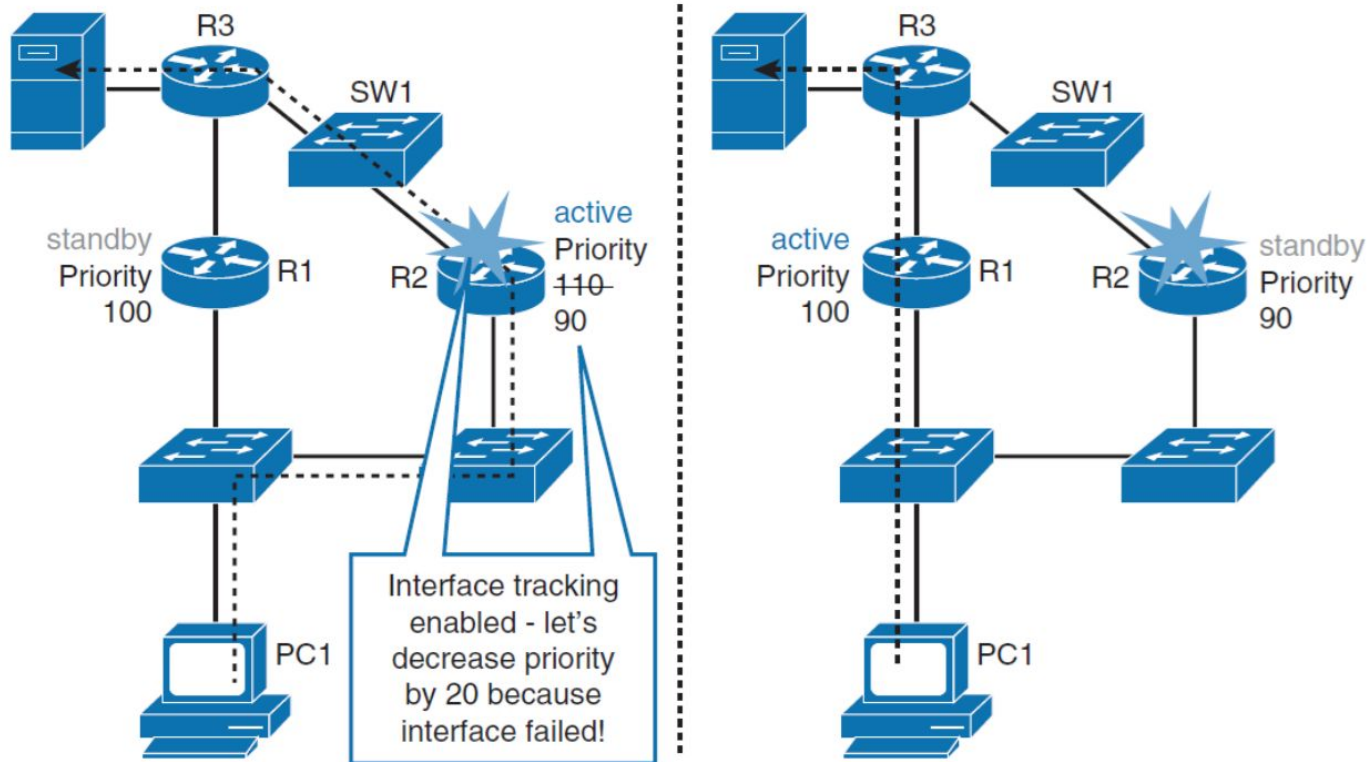
- Purpose / Background
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Interface Tracking (1/2)

- What if all the links of active router is down?
 - It still serves as the active role since the router itself is alive.
 - Need to detecting link failures so that the standby router can take over.
- HSRP would track the interface of router.
 - When the tracked interface goes down, HSRP reduces the router's priority.
- `Switch(config-if)# standby group track type mod/num [interface-priority]`
 - **interface-priority** The value is decremented when the interface goes down, and would be added back when the interface comes back.
 - Packet tracer cannot set interface-priority, will use default value 10

Interface Tracking (2/2)

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 - **Hot Standby Router Protocol (HSRP)**
 - Gateway Load Balancing Protocol (GLBP)



Gateway Load Balancing Protocol

First Hop Redundancy Protocol (3/3)

- Purpose / Background
- EtherChannel (for Layer 2)
- First Hop Redundancy Protocol (FHRP for Layer 3)
 - Virtual Router Redundancy Protocol (VRRP)
 - Hot Standby Router Protocol (HSRP)
 - Gateway Load Balancing Protocol (GLBP)

Gateway Load Balancing Protocol (GLBP)

- Another Cisco-proprietary FHRP protocol.
- **Active Virtual Gateway & Active Virtual Forwarder**
- Support load balancing and authentication.
- Load balancing modes: `round-robin`, `host-dependent`, `weighted`

Thanks

Any questions?

References

- Jan Ho's Network World: [EtherChannel](#), [FHRP](#)
- RFC: [VRRP](#), [HSRP](#)
- CCNP Textbook