

Flex-Link&Monitor Configuration

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Chapter 1 Flex Links Configuration

1.1 Flex Links Overview

Flex links is layer 2 links backup protocol which provides for STP option scheme. Choose Flex links to realize link backup when the STP is not wanted in customer network. If STP enables, flex links is disabled. Flex links consists of a pair of interfaces (can be ports or convergent interface). One interface is transmitting data, the other is standby. The backup interface starts transmitting data when there is default in master link. The failure interface will be standby when it turns well and it will be transmitting data in 60 seconds when preempt mechanism is set. Flex links interface should disable STP and Flex links interface can configure bandwidth and delay being preempt mechanism and the superior one will be the master interface. There must be trap alarm when master or backup link default.

Flex Link is dedicated to dual-uplink networks. It delivers the following benefits:

- Keeping one uplink connected and the other blocked when both uplinks in a dual uplink network are healthy, thus preventing broadcast storms caused by network loops.
- Switching the traffic to the backup link within a few sub-seconds when the primary link fails, thus ensuring the normal forwarding of traffic in the network.
- Easy to configure.

1.1.1 Basic Concept of Flex Links

1. Flex Links group

A Flex link group consists of only two member ports: the master and the slave. At a time, only one port is active for forwarding, and the other port is blocked, that is, in the standby state. When link failure occurs on the active port due to port shutdown or presence of unidirectional link for example, the standby port becomes active to take over while the original active port transits to the blocked state.

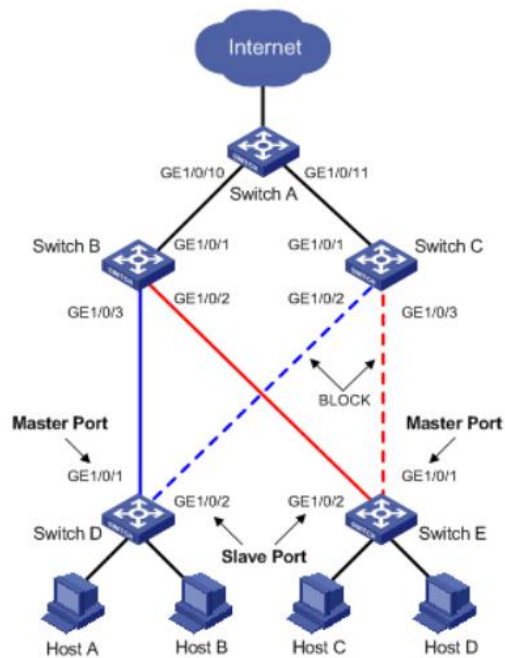


Figure 1-1 Flex Link application scenario

As shown in Figure 1-1, GigabitEthernet 1/0/1 and GigabitEthernet 1/0/2 of Switch D form a Flex link group (marked in blue). GigabitEthernet 1/0/1 is in the forwarding state (marked by a continuous line), and GigabitEthernet 1/0/2 is in the blocked state (marked by a broken line). GigabitEthernet 1/0/1 and GigabitEthernet 1/0/2 of Switch E form another Flex link group (marked in red). GigabitEthernet 1/0/1 is in the blocked state (marked by a broken line), and GigabitEthernet 1/0/2 is in the forwarding state (marked by a continuous line).

2. Master port

The master port of a Flex link group is a port role specified using commands. It can be an Ethernet port (electrical or optical), or an aggregate interface.

As shown in Figure 1-1, the active port in the Flex link group configured on Switch D is the master port GigabitEthernet 1/0/1, while that in the Flex link group on Switch E is the slave port GigabitEthernet 1/0/2. Although GigabitEthernet 1/0/1 of Switch E is blocked, it is still the master port.

3. Slave port

The slave port of a Flex link group is another port role specified using commands. It can be an Ethernet port (electrical or optical), or an aggregate interface. The link on which the slave port resides is called the backup link.

As shown in Figure 1-1, the blocked port in the Flex link group on Switch D is the slave port GigabitEthernet 1/0/2, while that in the Flex link group on Switch E is the master port GigabitEthernet 1/0/2. Although GigabitEthernet 1/0/1 of Switch E is in the forwarding state, it is still the slave port.

4. MMU (MAC address-table Move Update) message

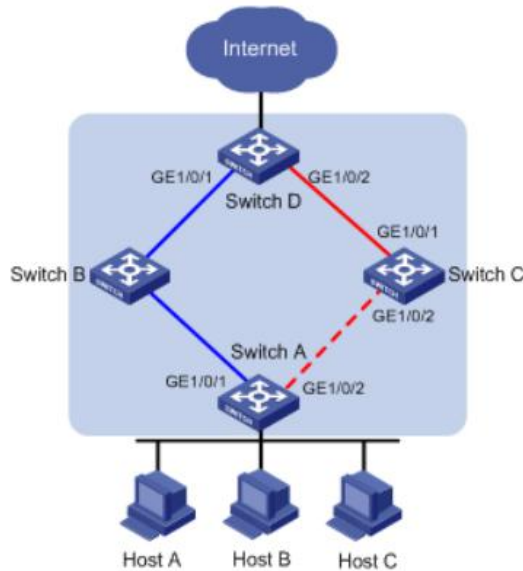
When link switchover occurs in a Flex link group, the old forwarding entries are no longer useful for the new topology. Therefore, all devices in the network need to

refresh their MAC address forwarding entries. Flex Link notifies devices to refresh their MAC address forwarding entries by sending MMU messages to them.

1.1.2 Operating Mechanism of Flex Link

This section uses the network shown in Figure 1-2 to describe the Flex link mechanism as the link status transiting from normal, to faulty, and then to recovery.

Figure 1-2 Flex Link application scenario



1.1.2.1 Link-Normal Operating

GigabitEthernet 1/0/1 and GigabitEthernet 1/0/2 of Switch A form a Flex link group, with the former as the master port and the latter as the slave port. When both uplinks are healthy, the master port is in the forwarding state, while the slave port is in the standby state, and the links on which the two ports are seated respectively are called the primary link and the backup link. In this case, data is transmitted along the link indicated by the blue line. There is no loop in the network, hence no broadcast storms either.

1.1.2.2 Link-Faulty Handling

When the primary link on Switch A fails, the master port GigabitEthernet 1/0/1 transits to the standby state, while the slave port GigabitEthernet 1/0/2 transits to the forwarding state. A link switchover occurs. After the link switchover, the MAC address forwarding entries kept on the devices in the network may become incorrect, and need to be refreshed, so that traffic can be rapidly switched to another link, thus avoiding traffic loss. Currently, one mechanism is available for refreshing MAC address forwarding entries: MMU message-notified refreshing.

This mechanism is applicable when the upstream devices (such as Switch B, Switch C, and Switch D in Figure 1-2) support Flex Link and are able to recognize MMU messages.

To enable rapid link switchover, you need to enable Switch A to send MMU messages, and all upstream devices' ports that are on the dual uplink network to receive and process MMU messages.

After link switchover occurs on Switch A, MMU messages are sent along the new primary link, that is, through GigabitEthernet 1/0/2. When an upstream device receives and handles a MMU message, transmit MAC address carried in the MMU message to the receiving port.

After that, when Switch D receives a data packet destined for Host A, Host B, Host C, switch D will broadcasts the packet at Layer 2; Switch C will search MAC address table after receiving it, and forward it to Switch A from GE1/0/2; Switch A forward it to Host A, Host B, Host C. In this way, data traffic can be forwarded correctly.

This mechanism will update MAC address without waiting for entry aged. Generally, the whole link will be shifted in milliseconds without traffic lost.

1.1.2.3 Link-Recovery Working Modes

Flex Link supports three working modes: role preemption, non-role preemption and bandwidth preemption. Under different modes, the port state changes are different:

- If role preemption is configured, when the primary link recovers, the master port enters the forwarding state and takes over the traffic, while the slave port enters the standby state. The slave port transits from standby to forwarding only when the primary link fails.
- If non-role preemption is configured, when the primary link recovers, the slave port remains in the forwarding state, while the master port remains in the standby state, so as to keep the traffic stable.
- If bandwidth preemption is configured, when the primary link recovers, the slave port remains in the forwarding state if it occupies more bandwidth, while the master port remains in the standby state; the slave port transits from forwarding to standby only when master port occupies more bandwidth.

As shown in Figure 1-2, if role preemption is configured on the Flex link group on Switch A, when the link of GigabitEthernet 1/0/1 on Switch A recovers, GigabitEthernet 1/0/2 is immediately blocked and transits to the standby state, while GigabitEthernet 1/0/1 transits to the forwarding state. If non-role preemption is configured, when the link of GigabitEthernet 1/0/1 on Switch A recovers, GigabitEthernet 1/0/1 remains in the standby state, and no link switchover occurs, thus keeping the traffic stable.

1.2 Flex Links Configuration

1.2.1 Flex Links Configuration Tasks

Table 1-1 Flex Links Configuration Tasks

Operation		Description	Related section
Flex Links basic configuration	Configure Flex Links group	Required	1.2.2
Advanced Flex Links configuration	Configure Flex Links preemption mode	Optional	1.2.3

	Configure Flex links preemption delay	Optiona 	1.2.4
	Configure Flex links MMU	Optiona 	1.2.5
Flex Links monitor and maintenance		Optiona 	1.2.6

1.2.2 Configure Flex Links group

Configuring Flex Links group needs specify master and slave port. If master port is Ethernet port, the configuration should be in interface configuration mode; if master port is channel-group port member, the configuration should be in global configuration mode.

Table 1-2 Configure Flex Links group

Operation	Command	Remarks
Enter global configuration mode	configure terminal	-
Configure Flex Links group	channel-group <i>channel-group-number_1</i> backup { interface <i>device/slot/port_2</i> channel-group <i>channel-group-number_2</i> }	<i>channel-group-number_1</i> is master port, <i>port_2/channel-group-number_2</i> is slave port
Delete Flex Links group	no channel-group <i>channel-group-number_1</i> backup	Optional
Enter interface configuration mode	interface ethernet <i>device/slot/port_1</i>	-
Configure Flex Links group	switchport backup { interface <i>device/slot/port_2</i> channel-group <i>channel-group-number_2</i> }	<i>port_1</i> is master port, <i>port_2/channel-group-number_2</i> is slave port
Delete Flex Links group	no switchport backup	Optional

Note:

The STP of master port and slave port should be disabled, and cannot be ERRP port.

1.2.3 Configure Flex Links Preemption Mode

At a time, only one port is active for forwarding, and the other port is blocked, that is, in the standby state. When link failure occurs on the active port due to port shutdown or presence of unidirectional link for example, the standby port becomes active to take over while the original active port transits to the blocked state.

Table 1-3 Configure Flex Links preemption mode

Operation	Command	Remarks
-----------	---------	---------

Enter global configuration mode	configure terminal	-
Configure Flex Links preemption mode	channel-group <i>channel-group-number_1</i> backup { interface <i>device/slot/port_2</i> channel-group <i>channel-group-number_2</i> } preemption mode { Forced Bandwidth Off }	<i>channel-group-number_1</i> is master port, <i>port_2/channel-group-number_2</i> is slave port
Enter interface configuration mode	interface ethernet <i>device/slot/port_1</i>	-
Configure Flex Links preemption mode	switchport backup { interface <i>device/slot/port_2</i> channel-group <i>channel-group-number_2</i> } preemption mode { Forced Bandwidth Off }	<i>port_1</i> is master port, <i>port_2/channel-group-number_2</i> is slave port

1.2.4 Configure Flex Links Preemption Delay

After configuring Flex Links preemption mode, the port will not be active status immediately. There has to be a time delay. The default delay is 45s.

Table 1-4 Configure Flex links preemption delay

Operation	Command	Remarks
Enter global configuration mode	configure terminal	-
Configure Flex links preemption delay	channel-group <i>channel-group-number_1</i> backup { interface <i>device/slot/port_2</i> channel-group <i>channel-group-number_2</i> } preemption delay <1-60>	<i>channel-group-number_1</i> is master port, <i>port_2/channel-group-number_2</i> is slave port
Enter interface configuration mode	interface ethernet <i>device/slot/port_1</i>	-
Configure Flex links preemption delay	switchport backup { interface <i>device/slot/port_2</i> channel-group <i>channel-group-number_2</i> } preemption mode <1-60>	<i>port_1</i> is master port, <i>port_2/channel-group-number_2</i> is slave port

1.2.5 Configure Flex Links MMU

MMU messages are used by a Flex link group to notify other switches to refresh their MAC address forwarding entries and ARP/ND entries when link switchover occurs in the Flex link group. MMU messages are common unicast data packets, and will be dropped by a blocked receiving port. This function is disabled by default.

Table 1-5 Configure Flex links MMU

Operation	Command	Remarks
-----------	---------	---------

Enter global configuration mode	configure terminal	-
Configure Flex links MMU	mac-address-table move update { transmit receive }	<i>port_1</i> is master port, <i>port_2/channel-group-number_2</i> is slave port

1.2.6 FLex Links Monitor and Maintenance

After finishing above configuration, user can check the configurations by command below.

Table 1-6 FLex Links monitor and maintenance

Operation	Command	Remarks
Display configured Flex Links group	show interface switch backup	On any configuration mode
Display Flex Links MMU status	sh mac-address-table move update	On any configuration mode

Chapter 2 Monitor Link Configuration

2.1 Monitor Link Overview

2.1.1 Background

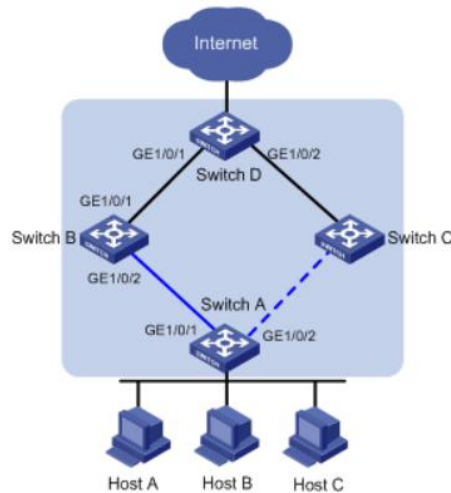


Figure 1-3 Monitor Link background

As shown in Figure 1-3, a Flex link group is configured on Switch A for link redundancy purpose, with GigabitEthernet 1/0/1 as the master port, and GigabitEthernet 1/0/2 as the slave port.

When the primary link on which GigabitEthernet 1/0/1 resides fails, traffic on it switches to the backup link on which GigabitEthernet 1/0/2 resides within a few sub-seconds. Flex Link delivers reliable link redundancy and rapid convergence.

However, when the link on which the uplink port GigabitEthernet 1/0/1 of Switch B resides fails, link switchover will not happen in the Flex link group configured on Switch A because the link on which the master port GigabitEthernet 1/0/1 resides is healthy. But in fact, traffic of Switch A can no longer reach Switch D through GigabitEthernet 1/0/1, and the traffic is thus interrupted. To address this problem, the Monitor Link technology is introduced.

2.1.2 Benefits

Monitor Link is developed to complement the Flex Link feature. By monitoring the uplink, and synchronizing the downlink with the uplink, Monitor Link triggers the switchover between the primary and backup links in a Flex link group, thus perfecting the link redundancy mechanism of Flex Link.

2.2 Monitor Link Implementation

2.2.1 Basic Concepts in Monitor Link

2.2.1.1 Monitor Link Group

A monitor link group is a set of uplink and downlink ports. Downlink ports adapt to the state changes of uplink ports.

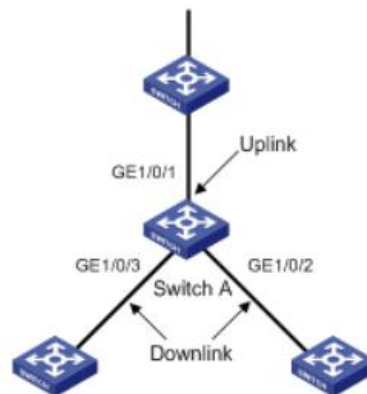


Figure 1-4 Monitor Link basic concepts

As shown in Figure 1-4, ports GigabitEthernet 1/0/1, GigabitEthernet 1/0/2, and GigabitEthernet 1/0/3 of Switch A form a monitor link group.

1. Uplink Port

An uplink port is a monitored port in a monitor link group. It is a port role specified using commands. It can be an Ethernet port (electrical or optical), or an aggregate interface.

As shown in Figure 1-4, GigabitEthernet 1/0/1 of Switch A is the only uplink port of the monitor link group configured on the device.

For a monitor link group that has multiple uplink ports, as long as at least one of its uplink ports is in the forwarding state, the monitor link group is up. However, when all uplink ports of the monitor link group fail, the monitor link group goes down, shutting down all the downlink ports. If no uplink port is specified in a monitor link group, the system considers the monitor link group's uplink ports to be faulty, and thus shuts down all the downlink ports in the monitor link group.

2. Downlink Port

A downlink port is a monitoring port in a monitor link group. It is another port role specified using commands. It can be an Ethernet port (electrical or optical), or an aggregate interface.

As shown in Figure 1-4, GigabitEthernet 1/0/2 and GigabitEthernet 1/0/3 of Switch A are two downlink ports of the monitor link group configured on the device.

Note:

When a monitor link group's uplink ports recover, only downlink ports that were blocked due to uplink port failure will be brought up. Downlink ports manually shut

down will not be brought up automatically. The failure of a downlink port does not affect the uplink ports or other downlink ports.

2.2.1.2 Monitor Link Mechanism

As shown in Figure 1-5, to provide reliable access to the Internet for the hosts, a Flex link group is configured on Switch A. GigabitEthernet 1/0/1 is the master port of the Flex link group, and is in the forwarding state. GigabitEthernet 1/0/2 is the slave port.

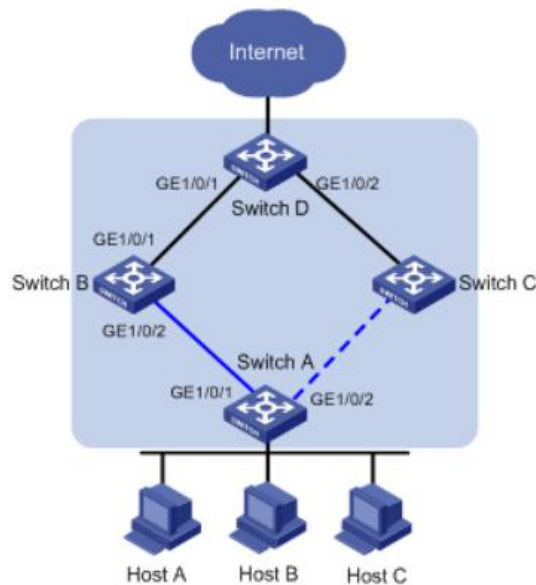


Figure 1-5 Monitor Link mechanism

To avoid traffic interruption due to the failure of the link on which GigabitEthernet 1/0/1 of Switch B resides, configure a monitor link group on Switch B, and specify GigabitEthernet 1/0/1 as the uplink port, and GigabitEthernet 1/0/2 as the downlink port.

When the link on which GigabitEthernet 1/0/1 of Switch B resides fails, the monitor link group shuts down its downlink port GigabitEthernet 1/0/2, triggering a link switchover in the Flex link group configured on Switch A.

When the link on which GigabitEthernet 1/0/1 of Switch B resides recovers, the downlink port GigabitEthernet 1/0/2 is also brought up, triggering another link switchover in the Flex link group if role preemption is configured in the Flex link group on Switch A.

Collaboratively, Monitor Link and Flex Link deliver reliable link redundancy and fast convergence for dual-uplink networks.

2.3 Configuring Monitor Link

2.3.1 Monitor Link Configuration Tasks

Table 2-1 Flex Links Configuration Tasks

Operation		Remarks	Related sections
Monitor configuration	Link For channel-group	Required	
	For port	Required	
Monitor Link monitor and maintenance		Optional	

2.3.2 Configure Monitor Links Group

If the port is Ethernet port, configuration should be in interface configuration mode; if port is channel-group member, configuration should be in global configuration mode.

Table2-1 Configure Monitor Links group

Operation	Command	Remarks
Enter global configuration mode	configure terminal	-
Monitor Link for channel-group	channel-group <i>channel-group-number</i> monitor-link-group <i>group-ID</i> { uplink downlink }	-
Delete channel-group from Monitor Link group	No channel-group <i>channel-group-number</i> monitor-link-group <i>group-ID</i> { uplink downlink }	Optional
Enter interface configuration mode	interface ethernet <i>device/slot/port</i>	-
Monitor Link for port	switchport monitor-link-group <i>group-ID</i> { uplink downlink }	-
Delete port from Monitor Link group	No switchport monitor-link-group <i>group-ID</i> { uplink downlink }	Optional

2.3.3 Monitor Link Monitor and Maintenance

After finishing above configuration, user can check the configurations by command below.

Table 2-3 Monitor Link monitor and maintenance

Operation	Command	Remarks
Show Monitor Link group	show monitor-link-group	On any configuration mode

2.4 Monitor Link Configuration Example

I. Network requirements

In Figure 2-1, Device C is Flex Links Device, Device A, Device B and Device D is the neighbor devices. The traffic of Device C double uplinks to Device A through Flex Links group.

Through configuration, Device C can make double uplink backup. When the link between Device A and Device B, Device C can detect the failure and shift the uplink .

II. Network diagram

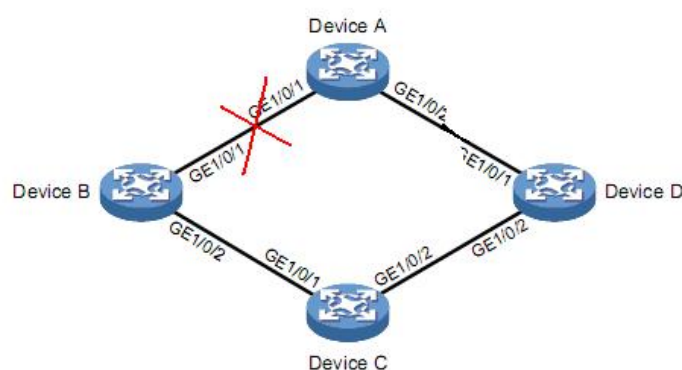


Figure 2-1 Monitor link example

III. Configuration procedure

Device C

```
# Disable STP on GE1/0/1 and GE1/0/2, configure them as Trunk
```

```
Device-C(config)#interface range ethernet 1/0/1 ethernet 1/0/2
```

```
Device-C(config-if-range)#no spanning-tree
```

```
Device-C(config-if-range)#switchport mode trunk
```

```
Device-C(config-if-range)#exit
```

```
# Configure Flex Links group, GE1/0/1 is the master port and GE1/0/2 is the slave port. The preemption is role preemption and the delay is 5s
```

```
Device-C(config-if-ethernet-1/0/1)#switchport backup interface ethernet 1/0/2
```

```
Device-C(config-if-ethernet-1/0/1)#switchport backup interface ethernet 1/0/2 preemption mode forced
```

```
Device-C(config-if-ethernet-1/0/1)#switchport backup interface ethernet
1/0/2 preemption delay 5
```

```
Device-C(config-if-ethernet-1/0/1)#exit
```

```
# Enable MMU packet sending
```

```
Device-C(config)#mac-address-table move update transmit
```

```
#Show Flex Links
```

```
Device-C(config)#show interface switchport backup
```

```
ActiveInterface BackupInterface State
```

```
-----  
e1/0/1      e1/0/2      active up /backup Standby
```

```
Preemption mode: Forced
```

```
Preemption Delay: 5 seconds
```

```
Total record 1.
```

```
Device-C(config)#show mac-address-table move update
```

```
Dst mac-address:      : 01:80:c2:00:00:10
```

```
Default/Current settings: : Rcv Off/Off,Xmt Off/On
```

```
Rcv Count:           : 0
```

```
Xmt Count:           : 0
```

Device A

```
# Configure GE1/0/1 and GE1/0/2 to be Trunk and enable MMU packet
receiving
```

```
Device-A(config)#interface range ethernet 1/0/1 ethernet 1/0/2
```

```
Device-A(config-if-range)#switchport mode trunk
```

```
Device-A(config-if-range)#exit
```

```
Device-A(config)#mac-address-table move update receive
```

Device B

Configure GE1/0/1 and GE1/0/2 to be Trunk and enable MMU packet receiving

```
Device-B(config)#interface range ethernet 1/0/1 ethernet 1/0/2
```

```
Device-B(config-if-range)#switchport mode trunk
```

```
Device-B(config-if-range)#exit
```

```
Device-B(config)#mac-address-table move update receive
```

Configure GE1/0/1 to be uplink port of Monitor Link group 1,GE1/0/2 to be downlink port of Monitor Link group 1

```
Device-B(config)#interface ethernet 1/0/1
```

```
Device-B(config-if-ethernet-1/0/1)#switchport monitor-link-group 1  
uplink
```

```
Device-B(config-if-ethernet-1/0/1)#exit
```

```
Device-B(config)#interface ethernet 1/0/2
```

```
Device-B(config-if-ethernet-1/0/2)#switchport monitor-link-group 1  
downlink
```

```
Device-B(config-if-ethernet-1/0/2)#exit
```

#Show Monitor Link

```
Device-C(config)#show monitor-link-group
```

Monitor-link Group

Group 1:

UplinkID	UplinkStatus
----------	--------------

e1/0/1	UP
--------	----

DownlinkID	DownlinkStatus
------------	----------------

e1/0/2	UP
--------	----

Device D

#Configure GE1/0/1 and GE1/0/2 to be Trunk and enable MMU packet receiving


```
Device-D(config)#interface range ethernet 1/0/1 ethernet 1/0/2
```

```
Device-D(config-if-range)#switchport mode trunk
```

```
Device-D(config-if-range)#exit
```

```
Device-D(config)#mac-address-table move update receive
```

```
# Configure GE1/0/1 to be uplink port of Monitor Link group 1,GE1/0/2  
to be downlink port of Monitor Link group 1
```

```
Device-DB(config)#interface ethernet 1/0/1
```

```
Device-D(config-if-ethernet-1/0/1)#switchport monitor-link-group 1  
uplink
```

```
Device-D(config-if-ethernet-1/0/1)#exit
```

```
Device-D(config)#interface ethernet 1/0/2
```

```
Device-D(config-if-ethernet-1/0/2)#switchport monitor-link-group 1  
downlink
```

```
Device-D(config-if-ethernet-1/0/2)#exit
```

```
#Show Monitor Link
```

```
Device-D(config)#show monitor-link-group
```

```
Monitor-link Group
```

```
-----
```

```
Group 1:
```

```
UplinkID   UplinkStatus
```

```
e1/0/1     UP
```

```
DownlinkID DownlinkStatus
```

```
e1/0/2     UP
```

```
When there is failure between Device A and Device B,show Flex Links and  
Monitor Link in Device B:
```

```
Device-B(config)#show monitor-link-group
```

```
Monitor-link Group
```

```
-----
```

```
Group 1:
```

```
UplinkID    UplinkStatus
e1/0/1      DOWN
DownlinkID  DownlinkStatus
e1/0/2      DOWN
```

Device-B(config)#show mac-address-table move update

```
Dst mac-address:      : 01:80:c2:00:00:10
Default/Current settings: : Rcv Off/On,Xmt Off/Off
Rcv Count:            : 0
Xmt Count:            : 0
```

show Flex Links and Monitor Link in Device C:

Device-C(config)#show interface switchport backup

```
ActiveInterface BackupInterface State
-----
e1/0/1          e1/0/2          active Standby /backup up
Preemption mode: Forced
Preemption Delay: 5 seconds
```

Total record 1.

Device-C(config)#show mac-address-table move update

```
Dst mac-address:      : 01:80:c2:00:00:10
Default/Current settings: : Rcv Off/Off,Xmt Off/On
Rcv Count:            : 0
Xmt Count:            : 1
```

show Flex Links and Monitor Link in Device D:

Device-D(config)#show monitor-link-group

```
Monitor-link Group
-----
```

```
Group 1:
UplinkID   UplinkStatus
e1/0/1     UP
DownlinkID DownlinkStatus
e1/0/2     UP
```

```
Device-D(config)#show mac-address-table move update
```

```
Dst mac-address:      : 01:80:c2:00:00:10
Default/Current settings: : Rcv Off/On,Xmt Off/Off
Rcv Count:            : 1
Xmt Count:            : 0
```

When the link between Device A and Device B recovers, GE1/0/1 of Device C will turn into forwarding after 5s. Show Flex Links and Monitor Link in Device B:

```
Device-B(config)#show monitor-link-group
```

```
Monitor-link Group
```

```
-----
Group 1:
UplinkID   UplinkStatus
e1/0/1     UP
DownlinkID DownlinkStatus
e1/0/2     UP
```

```
Device-B(config)#show mac-address-table move update
```

```
Dst mac-address:      : 01:80:c2:00:00:10
Default/Current settings: : Rcv Off/On,Xmt Off/Off
Rcv Count:            : 1
Xmt Count:            : 0
```

show Flex Links and Monitor Link in Device C:

Device-C(config)#show interface switchport backup

ActiveInterface BackupInterface State

e1/0/1 e1/0/2 active up /backup Standby

Preemption mode: Forced

Preemption Delay: 5 seconds

Total record 1.

Device-C(config)#show mac-address-table move update

Dst mac-address: : 01:80:c2:00:00:10

Default/Current settings: : Rcv Off/Off,Xmt Off/On

Rcv Count: : 0

Xmt Count: : 2

show Flex Links and Monitor Link in Device D:

Device-D(config)#show monitor-link-group

Monitor-link Group

Group 1:

UplinkID UplinkStatus

e1/0/1 UP

DownlinkID DownlinkStatus

e1/0/2 UP

Device-D(config)#show mac-address-table move update

Dst mac-address: : 01:80:c2:00:00:10

Default/Current settings: : Rcv Off/On,Xmt Off/Off

Rcv Count: : 1

Xmt Count: : 0

