DIGISOL®

Routing Protocol Configuration

As our products undergo continuous development the specifications are subject to change without prior notice.

Table of Contents

Chapter 1 Routing Protocol Overview

1.1 IP Routing Protocol

The router of the Company implements multiple IP dynamic routing protocol. They will be introduced in the description of each potocol in this Chapter.

IP routing protocols are classified into two categories: interior gateway router protocol (IGP) and exterior gateway router protocol (EGP). The routers of our Company support RIP, OSPF, BGP and BEIGRP. RIP, OSPF, BGP and BEIGRP can be configured separately on real needs. The router of our company supports simultaneous configuration of multiple routing protocol, including unlimited OSPF (if memory is sufficient) processes, a BGP process, a RIP progress and unlimited BEIGRP processes. Command “redistribute” can be used to inject other router protocols into the database of current routing protocol so that the multiple routing protocols can be associated.

In order to configure IP dynamic routing protocol, the corresponding process shall be started and the corresponding network interfaces and the specific dynamic routing process should be associated, to indicate on which interfaces where the routing process run. To this end, the relevant steps for configuration shall be referred to in the corresponding document of configuration commands.

The routing device in this article refers to the switch.

1.2 Choosing Routing Protocol

The choice of routing protocol is a complicated process. When choosing a routing protocol, the following factors shall be taken into account:

- The size and complexity of the network
- Whether the support for VLSM is needed
- Network traffic
- Security requirement
- Reliability requirement
- Policy
- Others

The subject will not be detailed here. It is noted that the chosen routing protocol shall meet the real condition of network and comply with your requirements.

1.2.1 Interior Gateway Router Protocol

Interior Gateway Routing Protocol is used for the network in a single autonomous system. All the IP interior gateway routing protocol shall be associated with some specific networks (such as configuring: *network*) when it is launched. Each routing process listens to update messages from other routers on the network and broadcasts its own routing information on the network at the same time. The inside gateway router protocol supported by the router of the Company includes:

- RIP
- OSPF
- BEIGRP

1.2.2 Exterior Gateway Routing Protocol

Exterior gateway routing protocol is used for exchange routing information between different autonomous systems. It is usually required to configure the corresponding neighbors for exchanging routes, the reachable networks and local autonomous system number. The exterior gateway routing protocol supported by the router of our company is BGP.

Chapter 2 Configuring VRF

2.1 Overview

One of the key of VPN is to keep safe and isolate data; it must be able to prevent communication of stations which belongs not to a same VPN. In order to differentiate VPN user route sent by which local interface on PE device, create virtual routes on PE device. Every virtual route has its own routing table and forwarding table. These routing tables and forwarding tables are called VRF (VPN Routing and Forwarding instances). One VRF includes the same station related routing table, interface (sub-interface), routing instances and routing policies. On PE, the physical port or the logic port with the same VPN corresponds to one VRF.

2.2 VRF Configuration Task List

If you would like to configure the VRF, the following tasks are necessary.

- Creating VRF Table
- Relating the interface to VRF
- Configuring the Target VPN Expansion Attribute of VRF
- Configuring Description of VRF
- Configuring Static Route of VRF
- Monitoring VRF
- Maintaining VRF
- Example of the VRF Configuration

2.3 Configuration Task

2.3.1 Creating VRF Table

To create VPN routing and forwarding table, do as follows in the global configuration mode:

Command	Purpose
PE_config#**ip vrf** ce	Enters VRF configuration mode, define VRF table.
PE_config_vrf_ce#**rd** *ASN:nn or*	Designate the routing tag of VRF, create

IP-address:nn	VRF routing and forwarding table
PE_config_vrf_ce#**route-target** [**export** | **import** | **both**] *ASN:nn or IP-address:nn*	Create input of VRF and output target VPN expansion attribute

2.3.2 Relating the interface to VRF

Relate the interface to VRF, do as follows:

Command	Purpose
PE_config#**interface vlan** 1	Enters the interface configuration mode
PE_config_v1#**ip vrf forwarding** *vrf-name*	Relate the interface to VRF
PE_config_v1#**ip address** *ip-address subnet-mask*	Configures the IP address of the interface.

2.3.3 Configuring the Target VPN Expansion Attribute of VRF

To configure the target VPN expansion attribute of VRF, do as follows:

Command	Purpose
PE_config#**ip vrf** ce	Enters the configuration mode of VRF
PE_config_vrf_ce#**rd** *ASN:nn or IP-address:nn*	Configures VRF routing tag and creates VRF table.
PE_config_vrf_ce#**route-target** [**export** | **import** | **both**]*ASN:nn or IP-address:nn*	Configures input of VRF and output target expansion attribute.
PE_config_vrf_ce#**import map** *WORD*	Configures route-map filter of the route adding to VRF routing table.
PE_config_vrf_ce#**export map** *WORD*	Add target VPN expansion attribute complying with route-map condition to the output target VPN expansion attribute of VRF.

Before publish the local route to other PE routing device, the entrance PE will add a route target attribute to every route learned from the direct station. The target value affiliated to the route is based on the VRF value configured in the output target expansion attribute.

Before installing the remote route published by other PE on the local VRF, every VRF on the entrance PE route device will be configured with one input target expansion attribute. The PE routing device can only be installed on a certain VRF until the routing target attribute borne by VPN-IPv4 matching with the VRF input target.

2.3.4 Configuring Description of VRF

To configure the description of VRF, do as follows:

Command	Purpose
PE_config#**ip vrf** ce	Enters VRF configuration mode.
PE_config_vrf_ce#**rd** *ASN:nn* *or* *IP-address:nn*	Configures VRF routing tag, and creates VRF table.
PE_config_vrf_ce# **description** LINE	Configures description of VRF.

2.3.5 Configuring Static Route of VRF

To configure the static route of VRF, do as follows:

Command	Purpose
PE_config#**ip vrf** ce	Enters VRF configuration mode.
PE_config_vrf_ce#**rd** *ASN:nn* *or* *IP-address:nn*	Configures VRF routing tag and creates VRF table.
PE_config_vrf_ce#**exit**	Exits from VRF configuration mode.
PE_config#**ip route** [**vrf** vrf-name] dest mask { type num | nexthop } [distance]	Configures VRF static route.

2.3.6 Monitoring VRF

To monitor VRF, show the statistics of VRF. To monitor, do as follows:

Command	Purpose
PE#**show ip vrf**	Shows VRF and its associated port information.
PE#**show ip vrf** [{**brief** | **detail** | **interfaces**}] *vrf-name*	Shows VRF configuration and its associated port information.

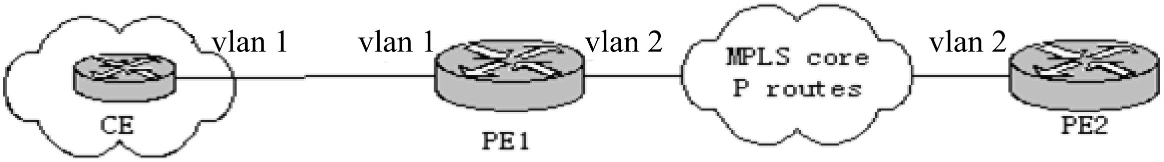
PE#**show ip route vrf** *vrf-name*[A.B.C.D | all | beigrp | bgp | ospf | rip | connect | static | summary]	Shows the routing information in VRF routing table.

2.3.7 Maintaining VRF

Maintain VRF, track the main routing table and change of VRF routing table and VRF configuration information in the management mode and do as follows:

Command	Purpose
PE#**debug ip routing**	Track the addition, deletion and change of the route in the main routing table
PE #**debug ip routing message**	Track information VRF received and sent
PE #**debug ip routing vrf** *vrf-name*	Track the change of designated VRF routing table including adding, deleting and changing.

2.4 Example of the VRF Configuration



The configuration of the routing device is as follows:

Routing device CE:

```
interface loopback 0

  ip address 22.1.1.1 255.255.255.0

!

interface vlan 1

  ip address 170.168.20.152 255.255.255.0
```

```
!
router ospf 1
   network 170.168.20.0 255.255.255.0 area 0
   network 22.1.1.0 255.255.255.0 area 0
!
```

Routing device PE1:

```
ip vrf pe1
       rd 1:1
       route-target 1:1
!
interface vlan 1
   ip vrf forwarding pe1
   ip address 170.168.20.153 255.255.255.0
!
interface vlan 2
   ip address 176.168.20.152 255.255.255.0
!
router ospf 1 vrf pe1
   network 170.168.20.0 255.255.255.0 area 0
```

```
!

router bgp 1

        neighbor 176.168.20.154 remote-as 2



        address-family vpnv4

        neighbor 176.168.20.154 activate

        exit-address-family



        address-family ipv4 vrf pe1

        no synchronization

        redistribute ospf 1

        exit-address-family
```

Routing device PE2:

```
ip vrf pe2

        rd 1:1

        route-target 1:1

!

interface loopback 0
```

```
  ip vrf forwarding pe2
  ip address 44.1.1.1 255.255.255.0
!
interface vlan 2
  ip address 176.168.20.154 255.255.255.0
!
router bgp 2
     neighbor 176.168.20.153 remote-as 1

     address-family vpnv4
     neighbor 176.168.20.153 activate
     exit-address-family

     address-family ipv4 vrf pe2
     no synchronization
     redistribute connected
     exit-address-family
```

Chapter 3 Static routing Configuration

3.1 Overview

Static routing is a special routing configuration, and is configured by an administrator. In the network that structure is relatively simple, you only need to configure static routes on network interoperability. Properly setting up and using static routes can improve network performance and be guaranteed bandwidth for important network applications.

The shortcomings of the static route is: It cannot automatically adapt to changes in network topology. When network failure or topology change, the route may be unreachable, resulting in network outages. Then administrator must manually modify the configuration of static routes.

Default route is used when the router cannot find a matching routing table entry:

- If the packet's destination address cannot match any entries in the routing table, the packet will select the default routing;
- If there is no default route and destination of the packet is not in the routing table, the packet will be discarded.

Default route can be configured with static routes and appear in the route table as the form of network 0.0.0.0/0.

3.2 Static Routing Configuration Task List

If you would like to configure the static routing, the following tasks are necessary.

- configure the relevant physical parameters of the interface
- configure the link layer attributes of the related interface
- configure the IP address of the relevant interface

3.3 Static Routing Configuration Task

3.3.1 Configure the Static Routing

To activate the static routing, the following steps shall be carried out under the global configuration mode:

Command	Purpose
ip route *A.B.C.D mask* {next-hop | interface} [distance] [tag tag] [global] [description]	Configure the Static Routing

3.4 Example of the Static Routing Configuration

To assign to the network segment 10.0.0.0/8 packets port is interface vlan 1, the configuration command is as follows:

```
ip route 10.0.0.0 255.0.0.0 vlan 1
```

Chapter 4 Configuring RIP

4.1 Overview

The Route Information Protocol (RIP) is a relatively old but still commonly used Interior Gateway Protocol (IGP), which is mainly used in the small-sized network of the same kind. And RIP is a traditional Distance Vector Routing Protocol, which occurs in the RFC 1058.

RIP exchanges Routing Information through broadcasting UDP Packets. In the Router, the update Route Information will be sent every 30 seconds. In case that no update information from the neighbor router has been received within 180 seconds, the Routes from that neighboring router in the Routing Table will then be labeled as “Unusable”. And if there is still no updated information received in the next 120 seconds, these Routes will be deleted from the Routing Table.

The Hop Count is taken by the RIP as a metric to measure different routes. And the Hop Count refers to the number of the passed routers of packets from the Source to the destination. The metric of the Route that is directly connected to the Network is “0”, the metric of the Route whose network is not able to reach is “16”. As the Route metric used by the RIP is in a relatively small range, it is not applicable to large-scale network.

If a router has a default route, RIP then will advertises the route to the false Network of 0.0.0.0. In fact, the 0.0.0.0 network does not exist, which is only used for realizing the function of default route in RIP. If the RIP has learned a default route, or the default gateway is configured in router and configured with default metric, the router will then announce the default network.

The RIP will send the updates to the interface of the appointed network. If the network of the very interface is not appointed, the network then will not be announced in any RIP updating.

The RIP-2 of our company's router supports Plaintext and MD5 Authentication, Route Summary, CIDR and VLSM.

4.2 RIP Configuration Task List

If you would like to configure the RIP, the following tasks are necessary. While you have to first activate the RIP, the other tasks are optional.

- Starting the RIP
- Enabling Unicasting of RIP route update messages.
- Applying the offset on the route metric

- Regulating the Timer
- Designating the RIP Version Number
- Activating the RIP Authentication
- Activating the ‘Passive’ and ‘Deaf’ of the Interface
- Prohibitting Route summary
- Prohibitting the Authentication on Source IP Address
- Activating or Prohibit the split-horizon
- Example of RIP Configuration

4.3 RIP Configuration Task

4.3.1 Starting the RIP

To activate the RIP, the following steps shall be carried out under the global configuration mode:

Command	Purpose
router rip *process-id* [**vrf** *vrf-name*]	Activate the RIP Routing Process and enter the router configuration mode.

4.3.2 Generating the RIP instance interface

After the RIP instance is enabled, only the interfaces associated with the instance can generate RIP network segments and use these interfaces to exchange routing information. Instances need to be associated with interfaces. In the interface configuration mode, configure as the following steps:

Command	Purpose
router rip *process-id* **enalbe**	Associates the interface to the process-id instance.

To make an interface an active RIP interface (generate a direct route to the interface, and the interface can send and receive RIP protocol packets), you need to meet the following: the interface is associated with a RIP instance, the interface has a legal IP address, and the interface status is up.

In addition, when a RIP instance is enabled on an interface, if the instance's vrf and the designated vrf on the interface are inconsistent, the interface cannot become the active RIP interface until the interface's vrf is revised.

When an interface is associated with an uncreated RIP instance, the RIP instance will be created with the vrf on the interface (if vrf is specified) and the enable process-id.

Each interface can only belong to one RIP instance.

4.3.3 Allowing the mono-broadcasting updtaed and grouped by RIP Router

The RIP is a broadcasting-Type Protocol. If you would like the updating of routes to to access to the non-broadcasting type network, the router shall be configured so as to enable information exchange. To this end, the following commands shall be used under router configuration mode:

Command	Purpose
neighbor *ip-address*	Define a neighbor router to exchange with it the Routing Information.

In addition, if you would like to control which interface(s) that can be used to exchange routing information, the command "ip rip passive" can be used to designate an interface or some interfaces prohibiting the sending of the update of routes. If necessary, please refer to the relevant discussion on the route filtration in the "Filtrating the Routing Information" in the Chapter of " Protocol-Independent Commands in Configuring IP Router".

4.3.4 Using the Offsets on the Route metric

Offset List is taken to increase an offset on the Input and Output Routes, which have been learned with the RIP. On the other hand, you can use the Access List or the interface to limit the Offset List. In order to increase the Route metric, the following commands should be executed in the router configuration mode:

Command	Purpose
offset-list {*interface-type number* | * } {**in**|**out**} *access-list-name offset*	Increase an offset on the route metric.

4.3.5 Regulating the Timer

Routing protocols use several timers to determine the frequency for sending the updating of routes, how long the router will become invalid and other parameters. You can regulate these timers so as to make the performance of the Routing Protocols more suitable to the requirements of the network.

It is also possible to regulate the Route Protocol to accelerate the Convergence Time of all kinds of the IP Routing computation, to quickly backup to the redundant router so as to minimize the time of quick recovery. To regulate the Timer, the following commands should be used under router configuration model.

Command	Purpose
timers holddown *value*	Regulating the time (Unit: Second) it take to delete certain route from the Routing Table
timers expire *value*	Regulating the time (Unit: Second) that the router is announced to be

	invalid.
timers update *value*	Regulating the frequency for sending the updating of the Router (the time interval between sedning of the updating of routing, (unit: Second)
timers trigger *value*	Trigger update interval (unit: s)
timers peer *value*	peer timeout interval (unit: s)

4.3.6 Appointing the RIP Version Number

The RIP-2 of our company's router supports Authentication, Password Management, Route summary, CIDR and VLSM.

Under the default circumstance, the router can receive the updates of RIPv1 and RIPv2, while it can only send the updates of RIP-1. By configuration, the router can be set to receive and send the updates of RIPv1 only, or receive and send the updates of RIPv2 only. For this purpose, the following commands should be taken in the router configuration mode:

Command	Purpose
version {**1** | **2**}	Configure the router to send and receive the updates of RIPv1 or RIPv2 only.

The above tasks are controlling the default behavior of the RIP. And you can also configure a certain interface to change this default behavior. In order to control the interface to send the RIP-1 updates or the RIP-2 updates, the following commands shall be used under interface configuration mode.

Command	Purpose
ip rip send version 1	Configure the interface to send the updates of RIP-1 only.
ip rip send version 2	Configure the interface to send the updates of RIP-2 only.
ip rip send version compatibility	Send by broadcasting the Updating of RIP-2.message.
ip rip v1demand	Send RIP-1 packets when request is sent.
ip rip v2demand	Send RIP-2 packets when request is sent.

At the same time, to control the interface to receive the updates of RIP-1 and RIP-2, the following commands shall be used under the interface configuration mode:

Command	Purpose
ip rip receive version 1	Configure the interface to receive the updates of RIP-1 only.
ip rip receive version 2	Configure the interface to receive the updates of RIP-2 only.
ip rip receive version 1 2	Configure the interface to receive the updates of RIP-1 and RIP-2.

4.3.7 Activating the 'Passive' and 'Deaf' of the Interface

By default the interface covered by RIP can forward and receive the routing update by flexibly applying the RIP protocol.

To configure the passive and deaf status of the interface in the interface configuration mode:

Command	Purpose
Ip rip passive	The interface will not forward the rip protocol grouping.
ip rip deaf	The interface does not receive rip protocol grouping.

4.3.8 Activating RIP Authentication

RIP-1 does not support authentication. If the grouping of RIP-2 is forwarding and receiving, the RIP authentication can be activated on the interface.

Multiple authentication modes are supported on RIP activated interface: plaintext authentication, MD5 authentication, dynamic authentication (md5 and sha1). Each RIP-2 grouping uses plaintext authentication by default.

Note:

If considering safety, do not use the plaintext authentication in RIP grouping, this is because the authentication key without encryption is forwarded to each RIP-2 grouping. If safety is not considered (for instance, the host with error configuration cannot participate in the route), the plaintext authentication is available.

To configure RIP plaintext authentication, do as follows in the interface configuration mode:

Command	Purpose
ip rip authentication simple	Configures the interface with the plaintext authentication.
ip rip password *string*	Configures the plaintext authentication key.

To configure MD5 authentication of RIP, do as follows in the interface configuration mode:

Command	Purpose
ip rip authentication md5	Configures the interface with MD5 authentication.
ip rip md5-key *key-ID* **md5** *key*	Configures MD5 authentication key and authentication ID.

To configure the dynamic authentication of RIP, do as follows in the interface configuration mode:

Command	Purpose

ip rip authentication dynamic	Configures the interface with dynamic authentication (md5 and sha1).
ip rip dynamic-key *key-ID* { **md5** | **sha1** } *key xxxx-xx-xx-xx:xx xx:xx*	Configures dynamic authentication key and authentication ID.

After configuring the RIP authentication configuration, do as follows in the interface configuration mode:

Command	Purpose
ip rip authentication commit	If the authentication cannot pass, age the opposite end peer and the route learned from the opposite end.

4.3.9 Prohibitting the Route summary

Under the default circumstance, the RIP-2 supports the automatic route summary, summarizing the RIP-2 Routes when crossing the boundary of the classified network. And the RIP-1 Automatic Route Gathering Function is always activated.

If there is a separated Sub-net, it is necessary to prohibit the Route summary to declare this Sub-net. If the Route Gathering is prohibited, when crossing the boundary of the classified network, the router will then send the route information of the sub-net and the host. Under the router configuration mode, the following command should be taken to prohibit the automatic gathering.

Command	Purpose
no auto-summary	Prohibit the Automatic summary

4.3.10 Prohibitting the Authentication of Source IP Address and Zero-domain

Under the default circumstance, the router will authenticate the Authenticable Source IP Address of the received route update. If this address is illegal, the router update will then be rejected.

If you have a router in hope to receive the updating from it, but you have not configured the corresponding "network" or "neighbor" on the receiver, the function should be therefore prohibited. However in the common practice, this command is not recommended to use. Under router configuration mode, the following commands will prohibit the default function of authenticating the source IP address in incoming route updates.

Under the default circumstance, the router will authenticate the zero-domain of the received route entry under version 1. If the corresponding field fails the authentication of the zero-domain, the routing entry will be discarded. If the configuration does not enable this authentication, it may cause the local to learn the wrong routing information from the peer.

Command	Purpose
no validate-update-source	Prohibit to authenticate the Source IP Address of the incoming RIP Router Updating.
no check-zero-domain	Prohibit to authenticate zero-domain of the incoming

	RIP Router Updating.

4.3.11 Maximum Number of Equivalent Routes

By default, the local RIP routing table can contain up to 4 equivalent routes. When learning routing information from multiple neighbors on one or some same network segments to generate equivalent routes, if the number of equivalent routes on a certain network segment is greater than the current maximum number of equivalent routes, it cannot be added to the RIP database.

Run the commands in the following table to configure the maximum number of the equivalent routes in the local RIP routing table in router configuration mode.

Command	Purpose
maximum-nexthop *number*	Configures the maximum number of equivalent routes for the RIP routing table.
No maximum-nexthop	Resumes the default maximum number of the routes in the RIP routing table.

4.3.12 Activating or Prohibit the Horizontal Split

Normally, the router, which is connected with IP Network and using the Distance Vector Routing Protocol, takes split-horizon to lower the possibility of route loops. The Split-Horizon prevents the announcements of route information to the receiving interface of this route information. In this way, communication within several routers (especially when the loop breaks) will be optimized. However, to Non-broadcasting Network (such as FR), things are not so easy. And maybe you have to prohibit the Horizontal Split.

If an interface has been configured with a supplementary IP Address and he Horizontal Split has been activated, the update-Source IP Address of the route update may not include every secondary IP address. The source IP address of one route update includes only one Network Number (unless the split-horizon is Prohibited).

In order to activate or prohibit the Horizontal Split, the following commands should be taken under interface configuration mode:

Command	Purpose
ip rip split-horizon {simple | poisoned}	Activate the Split- Horizon
no ip rip split-horizon {simple | poisoned}	Prohibit the Split- Horizon

Under the default circumstance, for the point to Point Interface, the Split-Horizon is activated; For Point-to multiple point Interface, the Split-Horizon is prohibited. The optional parameters **simple** and **poisoned** represent simple horizontal split and poisoned reversal horizontal split respectively.

Please refer to the specific example of using Split-Horizon in the "Examples of Split-Horizon" in Section of this Chapter.

Notes:

Commonly, it is suggested that the default state remain unchanged unless you are sure that your application can't declare the route correctly until you change its state. Always remember: if the Split-Horizon is prohibited on a serial interface (and the interface is connected with a Packet-switched Network), you have to prohibit Split-Horizon to all routers in any relevant Multicast Group on that Network.

4.3.13 Monitoring and Maintainance of RIP

With the RIP monitored and maintained, the Network Statistics can be displayed, such as: RIP protocol Parameter Configuration, Network utilization, Real-time Tracing of Network Communication and so on. Such information can help you judge the use of Network Resource and further solve the network problems and know the reachability of network nodes.

The following commands can be used to display the statistics information of all kinds of routes under management statistics:

Command	Purpose
show ip rip	Displays the present Status of all RIP.
Show ip rip *process-id*	Displays the present Status of designated RIP.
show ip rip *process-id* **database**	Displays all routes of RIP
show ip rip *process-id* **protocol**	Displays all the relevant information of RIP Protocol
Show ip rip *process-id* **interface**	Displays all interfaces and interface states of designated RIP.
show ip rip *process-id* **peer**	Displays all peers and states of designated RIP.

Under the management mode, the following commands shall be used to trace route protocol information.

Command	Purpose
debug ip rip database	Trace the procedure information of RIP Routing such as Insertion into the Routing Table, Deletion from the Routing Table, Changes of Routes and so on.
debug ip rip packet [send | receive]	Trace the RIP protocol messages.
debug ip rip message	Trace the RIP event, such as timer timeout.

4.4 Example of the RIP Configuration

Two switches A and B are configured as follows:

Router A

```
interface vlan1
ip address 192.168.20.81 255.255.255.0
ip rip 1 enable
!
interface loopback 0
```

```
ip address 10.1.1.1 255.0.0.0
ip rip 1 enable
!
router rip 1
!
```

Router B

```
interface vlan1
ip address 192.168.20.82 255.255.255.0
ip rip 1 enable
!
interface loopback 0
ip address 20.1.1.1 255.0.0.0
ip rip 1 enable
!
router rip 1
!
```

Chapter 5 BEIGRP Dynamic Routing Protocol Configuration

5.1 Overview

The technology used by BEIGRP is similar to distance vector routing protocol:

- The router only makes routing decisions with the information provided by directly connected neighbours;
- The router only provides the routing information it uses to the directly connected neighbors.

But, BEIGRP has some main differences with distance vector routing protocol, which entitles it to have more advantages:

- BEIGRP saves all routes from all neighbours in the topology table, not just the best routes so far;
- BEIGRP can make query to the neighbors when it is unable to access the destination and no alternative routes are available, so, the convergence speed of BEIGRP can compete with the best link-state protocol.

Diffused Update Algorithm (DUAL) is vital for BEIGRP's superiority to other traditional distance vector routing protocol. It always works actively and queries the neighbous when it is unable to access the destination and there is no alternative routes (feasible replacement). As the convergence process is active rather than negative (negatively waiting for the timeout of the routers), so the convergence speed of BEIGRP is very quick.

BEIGRP is a specific routing protocol designed to adapt to the requirements of EIGRP and is directly based on IP. It meets the following requirements of BEIGRP:

- Dynamically discover new neighbor and the disappearance of old neighbors through "Hello" message;
- So the transfer of data are all reliable;
- The transfer protocol permits unicast and multicast data transfer;
- The transfer protocol itself can adapt to the change of network condition and neighbor responding;
- BEIGRP can limit the percentage of its occupation of the bandwidth according to the requirements

5.2 BEIGRP Configuration Task List

To complete the configuration of BEIGRP the following tasks are required to be done, among them, the activation of BEIGRP is necessary while others can be decided according to the requirement.

- Activate BEIGRP protocol
- Configure the sharable percentage of bandwidth
- Adjust the arithmetic coefficient of BEIGRP composite distance
- Using “offset” to adjust the composite distance of the router
- Turn off auto-summary
- Redistributing other routes
- Customize route summary
- Configure other parameters of BEIGRP
- Disable horizontal separation
- The supervision and maintenance of BEIGRP

5.2.1 Activating BEIGRP Protocol

In order to create a BEIGRP process, it is required to execute the following commands:

Command	Purpose
router beigrp *as-number*	Add a BEIGRP process under global configuration mode
network *network-number network-mask*	Add addresses to this BEIGRP process under router configuration mode

After finishing the above configuration, BEIGRP will start to run on all interfaces belonging to this address, discoveres new neighbours through “Hello” and carryes out initial routing interaction through “update”.

5.2.2 Configuring the Sharable Percentage of Bandwidth

Under default circumstances, BEIGRP can occupy 50% of the bandwidth at most. You may wish to change this default value in order to guarantee the normal interaction of other data, or wishes to adjust the actually usable bandwidth of BEIGRP through the command when the interface is configured with a bandwidth not fit for actual situation. Under these conditions, you can use the following commands under interface configuration mode:

Command	Purpose
ip beigrp bandwidth-percent *percent*	Configure the maximum percentage of BEIGRP

	messages' occupation of the bandwidth

5.2.3 Adjusting the Arithmetic Coefficient of BEIGRP Composite Distance

Under certain situations, the arithmetic co-efficient of BEIGRP composite distance may need to be adjusted, and finally influences the routing policy of the router. Although the default arithmetic co-efficient of BEIGRP can satisfy most networks, but it may still need to be adjusted under some particular conditions. But this adjust may bring great change to the whole network, so it must be performed by the most experienced engineers.

Use the following command under router configuration mode:

Command	Purpose
metric weights *k1 k2 k3 k4 k5*	Adjust the arithmetic co-efficient of BEIGRP composite distance.

5.2.4 Using "Offset" to Adjust the Composite Distance of the Router

We use offset list to purposely add all incoming and outcoming routes according to the requirement, or the composite distance of certain routes meeting the requirements. The aim of this approach is to finally influence the routing result of the router, and meets our expected result. During the process of configuration, the user can designate access list or application interface in the offset list selectively and according to your requirements, in order to more clearly notify which routes to carry out operations to increase offset. Looking at the following command:

Command	Purpose
offset{*type number* | *} {**in** | **out**} *access-list-name offset*	Apply an offset list.

5.2.5 Turning off Auto-Summary

The automatic summary of BEIGRP is turned off by default, and it is not currently supported:

Command	Purpose
no auto-summary	Turn off auto-summary.

5.2.6 Redistributing Other Routes into the BEIGRP Process

The **redistribute** operation follows the below rules:

- It isn't have to configure the command "default-metric" when redistribute the static routes and the connected routes. The related parameter(such as: bandwidth, delay, reliability , load and MTU) is attained from the related interface.

- It isn't necessary to configure the command "default-metric" when redistribute the routes of other beigrp process. The related parameter is attained from the BEIGRP process redistributed.

- It is necessary to configure the command "default-metric" when redistribute the routes of others protocol (such as: rip, ospf). The related parameter is validated by the configuration of "default-metric". If we redistribute the routes of these types without the command "default-metric", the redistribution doesn't work.

In a router running the BEIGRP protocol and the RIP protocol, the following commands must be configured when we need obtain the routes from RIP protocol to BEIGRP protocol.

Command	Purpose
default-metric *bandwidth delay reliability loading mtu*	configure the default parameter of redistribute
redistribute *protocol [process]* [**route-map** *name*]	redistribute the routes to BEIGRP protocol.

5.2.7 Configuring Other Parameters of BEIGRP

In order to adapt to different network environments, and to make BEIGRP be more effectively and fully functions, we may need to adjust the following parameters:

- Adjust the time interval of BEIGRP to send “hello” messages and the timeout death time of the neighbours

- Turn off split-horizon

1. Adjusting the time interval of BEIGRP to send "hello" messages and the timeout death time of the neighbors

BEIGRP hello protocol archieves 3 objectives to enable correct BEIGRP operation:

- It discovers accessible new neighbors. The discovery is automatic and requires no manual configuration;

- It checks neighbors’ configuration and only permits communication with the neighbours configured with compatible mode.

- It continues to maintain the availability of the neighbors and detects the disappearance of the neighbors.

The router sends “hello” multicast packet on all interfaces running BEIGRP. All routers support BEIGRP receive these multicast groups, so that it can discover all neighbours.

“Hello” protocol uses two timers to detect the disappearance of the neighbours: hello interval defines the frequency of sending BEIGRP hello messages on the interface of the router, while hold timer defines the interval of time the router has to wait for the communication data from the designated neighbor before the declaration of the neighbour’s death. We ordered that every time it receives BEIGRP packet from the neighbour router, it resets the hold timer.

Different network type or network bandwidth will use different default value of hello timer:

Interface type encapsulation		Hello timer (second)	Hold timer (second)
LAN interface	Any	5	15
WAN interface	HDLC or PPP	5	15
	NBMA interface, bandwidth<=T1	60	180
	NBMA interface, bandwidth>T1	5	15
	The point-to-point sub-interface of NBMA interface	5	15

The difference of the default value of the timer in Hello protocol may induce the result that the BEIGRP neighbours connected to different IP sub-network use different hello and hold timer. To resolve the problem, the hello packet of every router designates its own hold timer, every BEIGRP router uses neighbour's the designated hold timer of the hello group to decide the timeout of this neighbour. Here, it can enable the appearance of different neighbour error detection timers in the different stands of the same WAN nephogram. But under some particular situation, the default value of the timer cannot be met, so if you want to adjust the time interval of sending hello messages, use the following command:

Command	Purpose
ip beigrp hello-interval *seconds*	Adjust the time interval of sending hello message from this interface

If you wish to adjust the timeout timer of the neighbour, use the following command:

Command	Purpose
ip beigrp hold-time *seconds*	Adjust the timeout death time of the neighbor

2. Shutting down the horizon split

Commonly, we wish to use split-horizon. It will prevent the routing information from one interface to be broadcasted back to the same interface, so as to avoid route loop. But under certain circumstances, this is not the optimized choice, and then we can use the following command to disable split-horizon:

Command	Purpose
no ip beigrp split-horizon	Turn off horizontal split

5.2.8 Monitoring and Maintaining BEIGRP

To clear the neighbourship with all neighbours, use the following command:

Command	Purpose
clear ip beigrp neighbors [*as-number* | *interface*]	To clear the neighborship with all neighbours

In order to show various statistics information of BEIGRP, execute the following commands:

Command	Purpose
show ip beigrp interface [*interface*] [*as-number*]	show interface information
show ip beigrp neighbors [*as-number* | *interface*]	show neighbor information
show ip beigrp topology [*as-number* | **all-link | summary | active**]	show topology information

5.3 Examples of BEIGRP configuration

None

Chapter 6 Configuring OSPF

6.1 Overview

OSPF is an IGP Route protocol developed by the OSPF Working Group of IETF. The OSPF, which is designed for the IP Network, supports the IP Sub-network and the External Route Information Label and at the same time allows the authentication of message and supports the IP Multicast.

The implementation of OSPF of our company complies with the OSPF V2 specification (Refers to RFC2328). Some key feathers in the implementation are listed in the following:

- Stub Area--Supporting the Stub Area
- Route redistribution--Any route, formed by and learned a routing protocol, can always be redistributed to the other route protocol Domain. Within the autonomous System, it means that OSPF can input the route learned by the RIP. And the routes learned by OSPF can also be redistributed to the RIP. Between autonomous Systems, OSPF can input the routes learned by BGP; and OSPF routes can also be injected to BGP.
- Authentication--The Plaintext and MD5 Authentications are supported between the neighboring routers within a area.
- Router Interface Parameters--The configurable Parameters include: Outgoing Cost, Retransmission Interval, Interface Transmission Delay, router Priority, Judgement on the router Switching-off Interval, the Interval of Hello Message and the Authentication Password.
- NSSA area--Refer to RFC 1587
- OSPF---RFC 1793 on the virtual circuit.

6.2 OSPF Configuration Tast List

OSPF requires to exchange routing data among all routers, ABR and ASBR in a area. In order to simplify the configuration, you may let them all work under default parameters without authentication, etc… but if you want to alter some parameters, you should guarantee the identity of the parameters on all routers.

In order to configure OSPF complete the following tasks. Besides the necessity of activating OSPF, other configurations are all optional.

- Start OSPF

- Configure the interface parameters of OSPF
- OSPF configuration on network type
- Configuring One-to-Multiple Broadcast Network
- Configuring Non-Broadcasting Network
- Configure OSPF domain
- Configuring the NSSA Area of OSPF
- Configure route summary within OSPF domain
- Configure the summary of a forward router
- Create default route
- Select router ID through LOOPBACK interface
- Configure the management distance of OSPF
- Configure the route calculating timer
- Enable the On-Demand link configuration
- The supervision and maintenance of OSPF

In addition to that, about configuring route redistribution, please refer to the related content about "Route Redistribution" of "Protocol-independent Feather Configurations of IP routing Protocol".

6.3 OSPF Configuration Task

6.3.1 Starting OSPF

Like other routing protocols, activating OSPF demands creating OSPF routing process, allocation of an IP address range related to the executing process, allocation of an area ID related to IP address range. Under the global configuration mode, use the following commands:

Command	Purpose
router ospf *process-id*	This command activates OSPF routing protocol, and enters router configuration mode.
network *address mask* **area** *area-id*	This command configures the interface(s) running OSPF and the area ID of the interface

6.3.2 Configuring the Interface Parameter of OSPF

During the implementation of OSPF, it is permitted to change the OSPF parameters related to interface according to the requirement. There is no need to change any parameter, but you should guarantee the identity of certain parameters on all routers on connected network.

Under interface configuration mode, use the following commands to configure interface parameters:

Command	Purpose
ip ospf authentication	Configures the authentication method for OSPF interface to send and receive packets.
ip ospf cost *cost*	Configures the metric of OSPF interface to forward packets.
ip ospf retransmit-interval *seconds*	The seconds taken to retransmit LSA between the neighbors belonging to the same OSPF interface.
ip ospf transmit-delay *seconds*	Configures the estimated time to transmit LSA on an OSPF interface (second as the unit).
ip ospf priority *number*	Configures the priority of router to become the DR router
ip ospf hello-interval *seconds*	Configures the time interval to send hello packet on OSPF interface.
ip ospf dead-interval *seconds*	If the router does not receive “hello” packet from the neighbor within the time interval defined, it considers the neighbor router to be turned off.
ip ospf password *key*	It is an authentication password of the adjacent router in an address, which uses simple password authentication of OSPF.
ip ospf message-digest-key *keyid* **md5** *key*	Demand OSPF to use MD5 authentication.
ip ospf passive	Not send “hello” message on the interface.
ip ospf mtu-ignore	Do not check the mtu value in the packet on the port.

OSPF divides the physical media of the network into the following three categories:

- Broadcast network (Ethernet, Token Ring, FDDI)
- Non-broadcast, multi-access network (SMDS, Frame Relay, X.25)
- Point-to-point network (HDLC, PPP)

Can configure your network or broadcast network or non-broadcast multi-access network.

X.25 and Frame Relay networks provide optional broadcast capability. OSPF can be configured to work on broadcast networks through the map command. For the Map command, please refer to the description of the x.25 and Frame Relay map commands in the WAN Command Reference.

6.3.3 Configuring OSPF Network Type

No matter what the physical media type of the network is, you can configure your network to be broadcasting network or non-broadcasting, multi-access network. Using this feature, you can flexibly configure the network, you can configure the physical broadcasting network to be a non-broadcasting, multi-access network; you can also configure non-broadcasting network (X.25, Frame Relay, and SMDS) to be broadcasting network. This feature also reduces the configuration of the neighbors, for detailed information, please refer to the related content of non-broadcasting network's configuration of OSPF.

Configure non-broadcasting, multi-access network to be broadcasting network or non-broadcasting network, that is, to suppose there exists virtual links from every router to other routers, or suppose they consist of a full-mesh network. Because of the restriction of expenses, it is usually not practical; or a partially full-mesh network. Under this situation, you can configure a point-to-multiple point network. Routers not adjacent to each other can exchange routing information through virtual links.

OSPF point-to-multiple point interface can be defined as several point-to-point network interfaces, which creates multiple host routes. OSPF point-to-multiple point network has the following advantages over non-broadcasting, multi-access network and point-to-point network:

Point-to-multiple point network is easy to configure, it does not demand neighbor configuration command, it only uses one IP and will not produce DR.

Because it does not need to full-mesh network topology, it costs less.

It is more reliable. Even when virtual links fail, it can still maintain the connection.

Under interface configuration mode, configure OSPF network type with the following command:

Command	Purpose
ip ospf network {**broadcast** | **non-broadcast** | {**point-to-multipoint** [**non-broadcast**] }}	This command configures the network type of OSPF.

At the end of this chapter, you can see an example of the configuration of OSPF point-to-multiple point network.

6.3.4 Configuring One-to-Multiple Broadcast Network

You do not need to describe the neighbor relations in point-to-multiple point network and broadcasting network. But you can use command “neighbor” to describe the priority of a certain neighbor.

Before using this command, some OSPF point-to-multiple point protocol traffic is multicast traffic. So for point-to-multiple point interface, command “neighbor” is not needed. Packet “hello”, update packet and confirmation packet are all transmitted through broadcasting form, especially, multicast “hello” packet can dynamically discover all neighbors.

In point-to-multiple point network, the router supposes that all neighbors have the same metric. This value can be configured through command “ip ospf cost”. In fact, the bandwidth of every neighbor is different, so the value should be different. This feature only applies to point-to-multiple point interface.

Using the following command to configure the interface to be point-to-multipoint interface and allocate a metric for each neighbor:

Command	Purpose
ip ospf network point-to-multipoint	On broadcasting media, configure the interface to be a point-to-multiple point network
exit	Return to global configuration mode
router ospf *process-id*	Configure an OSPF router process and enter into router configuration mode.
neighbor ip-address **cost** number	Designate a neighbor and allocate a metric for it. Repeat the above configuration command for each neighbor who wants to specify the weight. Otherwise, the weight of the neighbor uses the weight specified by the ip ospf cost command.

6.3.5 Configuring Non-Broadcasting Network

Because there are many routers in the OSPF network, so there must be one DR elected for the network. If the broadcasting ability is not configured, it is requested to perform parameter configuration for the selection process.

These parameters only carry out configuration on the routers that are eligible to become DR or BDR.

Under router configuration mode, use the following command to configure routers of non-broadcasting network which are mutually related:

Command	Purpose
neighbor *ip-address* [**priority** *number*] [**poll-interval** *seconds*]	Configure the router connected to the non-broadcasting network

You can designate the following parameters for a neighbor router:

- The precedence of neighbor router.
- Non-broadcasting poll interval.
- Interface accessible to the neighbor

In point to multiple point, non-broadcasting network, you can use command “neighbor” to designate neighbor relation. Allocate an optional priority.

In the previous software versions, some users configure point to multipoint connections on non-broadcasting media (IP over ATM), so the router cannot dynamically discover its neighbor router. This feature permits the usage of command “neighbor” on point to multipoint interface.

In a point to multipoint network, the router supposes all neighbors have the same metric. This value can be configured through the command "ip ospf cost". In fact, as the bandwidth of each neighbor is different, the value should also be different. This feature only applies to point to multiple point interfaces.

Under interface configuration mode, use the following command to configure point to multiple point interfaces on media that do not support broadcasting.

Command	Purpose
ip ospf network point-to-multipoint non-broadcast	Configure point to multiple point interface on non-broadcasting media
exit	Enter into global configuration mode.
router ospf *process-id*	Create a OSPF routing process and enter into router configuration mode
neighbor *ip-address* [**cost** *number*]	Designate an OSPF neighbor and allocate a metric for it. Repeat the above configuration command for each neighbor who wants to specify the weight.

6.3.6 Configure OSPF domain

Configurable area parameters include: authentication, designating Stub area, designating metric for default summary route. Authentication adopts protection based on passwords.

Stub areas are those that don't distribute external routes in them. Instead, ABR generates a default external route to enter the stub area, enable it to enter the external network of the autonomous system. in order to utilize the features OSPF Stub support, you should use default route in the Stub area. In order to additionally reduce LSA number sent into the Stub area, you can prohibit gathering ABR to reduce the sending of summary LSA (type3) entered into the Stub area.

Under router configuration mode, use the following command to define the area parameter:

Command	Purpose
area *area-id* **authentication simple**	Activates OSPF area authentication
area *area-id* **authentication message-digest**	Enables OSPF to use MD5 for authentication
area *area-id* **stub [no-summary]**	Defines a Stub area
area *area-id* **default-cost** *cost*	Sets metric for default route in Stub area.

6.3.7 Configuring the NSSA Area of OSPF

The NSSA area is similar to the STUB area. However, the NSSA area allows external routes to be entered. The route summary and packet filtration are also supported during transmission. If ISP requires to use the remote network with different routing protocols, the NSSA can simplify management.

The enterprise-core boundary router cannot run in the STUB area of OSPF if NSSA is not applied. That's because the routes of the remote network cannot be forwarded to the STUB area. The simple routing protocols such as RIP can be advertised, but two kinds of routing protocols need be maintained. NSSA can put the center router and the remote router in the same NSSA area and OSPF thus be applied to the remote network.

When the NSSA area is used, note that the route generated by the ABR router can enter the NSSA area once NSSA is configured. Each router in the same area must admit that they are in the NSSA area, or different routers cannot communicate with each other. The displayed release must be used on ABR to avoid packet transmission confusement of the router.

Run the following command in router configuration mode to set the NSSA area of OSPF:

Command	Purpose
Area *area-id* **nssa** [**no-redistribution**][**no-summary**][**default-information -originate**] [**translate-always**]	Configures the OSPF NSSA area.

6.3.8 Configuring Route Summary Within OSPF Domain

This feature enables ABR to broadcast a summary route to other areas. In OSPF, ABR will broadcast every network to other areas. If the network number can be allocated according to a certain method, and be continuous, you can configure ABR to broadcast a summary route to other areas. A summary route can cover all networks within a certain range.

Under router configuration mode, use the following commands to define the address ranges:

Command	Purpose
area area-id **range** address mask	Define the address range for route summary.

6.3.9 Configuring the Gathering of a Forwarding Router

When distributing routes from other router areas to OSPF router area, each performs independent broadcasting in the form of external LSA. But you can configure the router to broadcast a route, which covers a certain address range. This method can reduce the size of OSPF link status database.

Under the router configuration mode, use the following command to configure gathering the router:

Command	Purpose
summary-address *prefix mask* [not advertise]	Describe the address and mask that cover the distribution route, only one gathering route is broadcasted.

6.3.10 Creating Default Route

You can demand ASBR to create a default route to enter into the OSPF route area. Whenever you configure a router distribute route to enter into OSPF domain, this router automatically changes into ASBR. But, ASBR does not create default route entering into OSPF route area by default.

Under router configuration mode, use the following command to force ASBR to create a default route:

Command	Purpose
default-information originate [**always**] [**route-map** *map-name*]	Force ASBR to create a default route entering into OSPF route area.

6.3.11 Selecting Router ID Through Loopback Interface

OSPF uses the biggest IP address configured on the interface as its router ID. If the interface connected to this IP address changes into DOWN state, or this IP address is deleted, OSPF process will restart to calculate new router ID and resend routing information from all interfaces.

If one loopback interface is configured with IP address, then the router uses that IP address as its router ID, since loopback interface will never become Down, and all these make the routing table more stable.

The router preferably uses LOOPBACK interface as the router ID, meanwhile selects the biggest IP address among all loopback interfaces as the router ID. If there is no loopback interface, then uses the biggest IP address of the router. You cannot designate OSPF to use any special interface.

Under global mode, use the following command, to configure IP Loopback interface.

Command	Purpose
interface loopback 0	Create a loopback interface and enter into interface configuration mode.
ip address *ip-address mask*	Allocate an IP address for the interface.

6.3.12 Configuring the Management Distance of OSPF

Management distance is defined as the reliability level of routing information source, such as a router or a group of routers. Generally speaking, management distance is an integer between 0-255, the higher the value is, the lower the reliability level it is. If the management distance is 255, then the route information source will not be trusted and should be neglected.

OSPF uses 3 different types of management distances: inter-domain, inner-domain and exterior. The route within an area is inner-domain; the route to other areas is inter-domain; the route distributed from other route protocol domains is exterior. The default value of every kind of route is 110.

Under router configuration mode, use the following command to configure the distance value of OSPF:

Command	Purpose
distance ospf [**intra-area** *dist1*] [inter-area *dist2*] [**external** *dist3*]	Change the management distance value of OSPF inner-domain, inter-domain and exterior route.

6.3.13 Configuring the Route Calculation Timer

You can configure the time delay between the time when OSPF receives topologic change information and when it starts to calculate SPF. You can also configure the interval between two consecutive calculations of SPF. Under router configuration mode, use the following command to configure:

Command	Purpose
timers delay *delaytime*	Set the time delay in the route calculation in a area.
timers hold *holdtime*	Set the minimum time interval of route calculation in a area.

6.3.14 Configuring the On-Demand Link

OSPF over on-demand circuits is an upgrade of OSPF, which enables the protocol more efficient in case of on-demand dialing network surfing. The OSPF protocol is to regularly exchange the HELLO packets and the link-state broadcast-refresh packets among the connected routers after the connection is first established or the information contained in the packet is changed, which means that the minimum spanning tree will be recalculated and the packet will be transmitted only when the topology is really changed.

If the point-to-point connection is among the routers, the configuration should be conducted on one terminal. Of course, the router on the other terminal must support this trait. If the point-to-multipoint connection is among the routers, the configuration must be conducted on the multipoint terminal.

It is recommended to configure the on-demand dialing in the STUB area. If this attribute is configured on each router in the STUB area, the routers outside the STUB area are allowed not to support the on-demand dialing. If on-demand dialing is configured in a standard area, other standard areas must support this trait, because the second kind of external link-state broadcast packets will be broadcast in all areas.

When the trait is configured on the broadcast-based network, the link-state broadcast packets can be restraint, while the HELLO packets cannot be restraint. That’s because the HELLO packets are used to maintain the neighborhood relation and to select DR.

Run the following command in interface mode:

Command	Purpose
ip ospf demand-circuit	Configures OSPF on-demand dialing.

6.3.15 Monitoring and Maintaining OSPF

It can display the statistic information of the network, such as: the statistics about the content of IP routing Table, cache and database and etc… This information can help you to judge the utilization of the network resource, and solve the network problem. You can understand the availability of the network nodes, discover the route the network data packet goes through the network.

Use the following commands to display various routing statistics:

Command	Purpose
show ip ospf [*process-id*]	Display the general information about OSPF routing process.
show ip ospf [*process-id*] **database**[**router**| **network**| **summary**| **asbr-summary**| **external**| **database-summary**]{ *link-state-id*| **self-originate**| **adv-router** [*ip-address*]}	Display the related information about OSPF database.
show ip ospf border-routers	Display the internal routing table entry of ABR and ASBR.
show ip ospf interface	Display the information about OSPF interface.
show ip ospf neighbor	Display the OSPF neighbor information according to the interface.
debug ip ospf adj	Supervise the adjacency establishment of OSPF.
debug ip ospf events	Supervise the interface and neighbour events of OSPF.
debug ip ospf flood	Supervise the flooding process of OSPF database.
debug ip ospf lsa-generation	Supervise the LSA generation of OSPF.
debug ip ospf packet	Supervise the message of OSPF.
debug ip ospf retransmission	Supervise the message retransmission process of OSPF.
debug ip ospf spf [**intra**| **external**]	Supervise the SPF calculation route of OSPF.
debug ip ospf tree	Supervise the establishment of SPF tree of OSPF

6.4 Examples of OSPF Configuration

6.4.1 Examples of OSPF point to multipoints, non-broadcasting configuration

Switch A:

```
interface vlan 1
  ip address 10.0.1.1 255.255.255.0
  ip ospf network point-to-multipoint non-broadcast
!
router ospf 1
  network 10.0.1.0 255.0.0.0 area 0
  neighbor 10.0.1.3 cost 5
  neighbor 10.0.1.4 cost 10
```

Switch B:

```
interface vlan 1
  ip address 10.0.1.3 255.255.255.0
  ip ospf network point-to-multipoint non-broadcast
!
router ospf 1
  network 10.0.1.0 255.0.0.0 area 0
  neighbor 10.0.1.1
  neighbor 10.0.1.4 cost 14
```

Switch C:

```
interface vlan 1
  ip address 10.0.1.4 255.255.255.0
  ip ospf network point-to-multipoint non-broadcast
!
router ospf 1
  network 10.0.1.0 255.0.0.0 area 0
  neighbor 10.0.1.1
  neighbor 10.0.1.3
```

6.4.2 Configuring example of variable-length subnet mask

OSPF and static routing support variable-length subnet masks (VLSMs). With VLSMs, you can use different masks for the same network number on different interfaces, which saves IP addresses and makes more efficient use of network address space.

In the following example, a 30-bit subnet mask is used, and a two-bit address space is reserved as the host address of the serial port. This is enough for a point-to-point serial link of two host addresses.

```
interface vlan 1
  ip address 131.107.1.1 255.255.255.0
!
interface serial 1/1
  ip address 131.107.254.1 255.255.255.252
!
router ospf 107
  network 131.107.0.0 255.255.0.0 area 0.0.0.0
```

6.4.3 Examples of the configuration of OSPF route and route distribution

OSPF requires exchanging information among many internal routers, ABRs and ASBRs. Under minimum configuration, the routers based on OSPF can work under default parameters and have no requirement of authentication.

Here are three examples of configuration:

- The first example practices the basic OSPF command.
- The second example configures the configuration of internal router, ABR and ASBR in a single OSPF autonomous system.
- The third example illustrates a more complex example of configuration with various OSPF tools.

1. An example of basic OSPF configuration

The following example illustrates a simple OSPF configuration. Activate routing process 90, then connect the vlan 1 to area 0.0.0.0. Meanwhile, redistribute RIP to OSPF, OSPF to RIP.

```
interface vlan 1
 ip address 130.130.1.1 255.255.255.0
!
router ospf 90
 network 130.130.0.0 255.255.0.0 area 0
 redistribute rip 1
!
router rip 1
 redistribute ospf 90
```

2. An example of the basic configuration of inner router, ABR and ASBR

The following example allocates 4 areas ID for 4 IP address range. Firstly, routing process 109 is activated, the 4 areas are: 10.9.5.0, 2, 3, 0. The masks of area 10.9.50.0,2,3 designate the address range, but area 0 includes all the networks.

```
router ospf 109
 network 131.108.20.0 255.255.255.0 area 10.9.50.0
 network 131.108.0.0 255.255.0.0 area 2
 network 131.109.10.0 255.255.255.0 area 3
 network 0.0.0.0 0.0.0.0 area 0
 redistribute static
!
interface vlan 1
 ip address 131.108.20.5 255.255.255.0
!
interface vlan 2
```

```
 ip address 131.108.1.5 255.255.255.0
!
interface vlan 3
ip address 131.108.2.5 255.255.255.0
!
interface vlan 4
 ip address 131.109.10.5 255.255.255.0
!
interface vlan 5
 ip address 131.109.1.1 255.255.255.0
!
interface vlan 6
 ip address 10.1.0.1 255.255.0.0
!
ip route 44.0.0.0 255.0.0.0 VLAN1
!
```

The functions of network area configuration command are ordinal, so the order of the commands is important. The router matches the address/mask pair of each interface in order. For detailed information, please refer to the related content in the reference of related network protocol command in “OSPF command”.

Let’s return to the first network area in the above example. The area ID 10.9.50.0 is configured with an interface sub-network mask as 131.108.20.0. So vlan 1 matches. So vlan 1 only exists in area 10.0.50.0.

Then come to the second area. Except vlan 1, apply the same process on other interfaces, then vlan 2 matches. So vlan 2 connects to area2.

Continue the matching of other network areas. NOTICE that the last network area command is a special case, which means that the rest interfaces are all connected to network area 0.

3. An example of the virtual link.

Figure 5-2 is the network topology of the example:

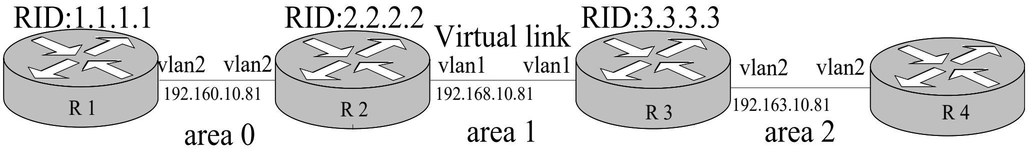


Figure 5-2 Network Topology of the Example

Configure the router according to the above Figure:

R1:

```
interface vlan 2
```

```
 ip address 192.160.10.81 255.255.255.0
!
router ospf 1
 router-id 1.1.1.1
 network 192.160.10.81 255.255.255.0 area 0
!
```

R2:

```
interface vlan 1
 ip address 192.168.10.81 255.255.255.0
!
interface vlan 2
 ip address 192.160.10.82 255.255.255.0
!
router ospf 192
 router-id 2.2.2.2
 network 192.168.10.81 255.255.255.0 area 1
 network 192.160.10.82 255.255.255.0 area 0
 area 1 virtual-link 3.3.3.3
!
```

R3:

```
interface vlan 1
 ip address 192.168.10.82 255.255.255.0
!
interface vlan 2
 ip address 192.163.10.81 255.255.255.0
!
router ospf 192
 router-id 3.3.3.3
 network 192.168.10.82 255.255.255.0 area 1
 network 192.163.10.81 255.255.255.0 area 2
 area 1 virtual-link 2.2.2.2
!
```

4. an example of complex OSPF on ABR router configuration

The following example illustrates several tasks involved in configuring ABR. It can be divided into the following two directories:

- Basic OSPF configuration
- Route distribution

The tasks in this configuration are briefly described below.

Figure 5-3 illustrates the range and allocation of network addresses.

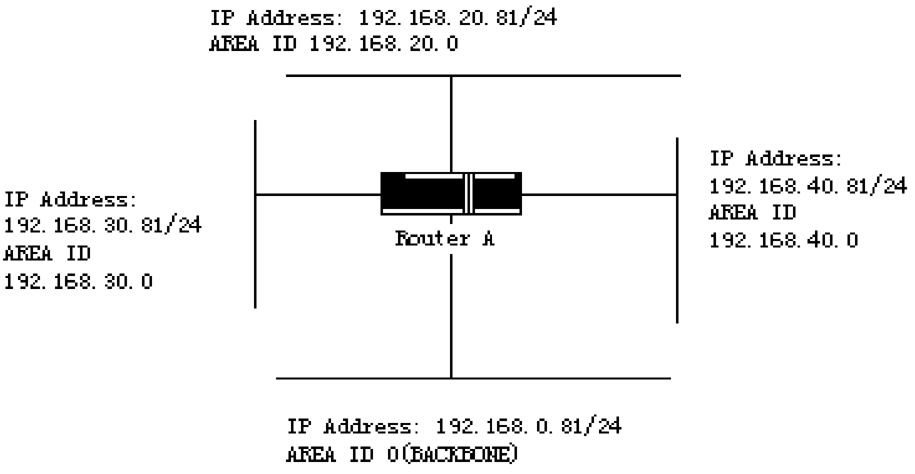


Figure 5-3 Range and allocation of network addresses

The basic configuration tasks for this example are as follows:

- Configure the address range for VLAN 1 to 4.
- Activate OSPF on each interface.
- Set the OSPF authentication password for each area and network.
- Set link state weights and other interface parameters.
- Create 36.0.0.0 in the Stub area. (Note: For the authentication and stub area parameter settings, use an area command respectively. You can also use one command to set these parameters.)
- Set the backbone area (Area 0).

The configuration tasks associated with the distribution are as follows:

- Distribute IGRP and RIP routes into OSPF parameter settings (including metric-type, metric, tag, and subnet).
- Distribute IGRP and OSPF routes into RIP.

Here is an example of OSPF configuration:

```
interface vlan 1
 ip address 192.168.20.81 255.255.255.0
 ip ospf password GHGHGHG
 ip ospf cost 10
!
interface vlan 2
 ip address 192.168.30.81 255.255.255.0
 ip ospf password ijklmnop
```

```
  ip ospf cost 20
  ip ospf retransmit-interval 10
  ip ospf transmit-delay 2
  ip ospf priority 4
!
interface vlan 3
  ip address 192.168.40.81 255.255.255.0
  ip ospf password abcdefgh
  ip ospf cost 10
!
interface vlan 4
  ip address 192.168.0.81 255.255.255.0
  ip ospf password ijklmnop
  ip ospf cost 20
  ip ospf dead-interval 80
!
router ospf 192
  network 192.168.0.0 255.255.255.0 area 0
  network 192.168.20.0 255.255.255.0 area 192.168.20.0
  network 192.168.30.0 255.255.255.0 area 192.168.30.0
  network 192.168.40.0 255.255.255.0 area 192.168.40.0
  area 0 authentication simple
  area 192.168.20.0 stub
  area 192.168.20.0 authentication simple
  area 192.168.20.0 default-cost 20
  area 192.168.20.0 authentication simple
  area 192.168.20.0 range 36.0.0.0 255.0.0.0
  area 192.168.30.0 range 192.42.110.0 255.255.255.0
  area 0 range 130.0.0.0 255.0.0.0
  area 0 range 141.0.0.0 255.0.0.0
  redistribute rip 1
RIP in network 192.168.30.0:
router rip 1
  redistribute ospf 192
!
```

Chapter 7 Configure BGP

7.1 Overview

This chapter describes how to configure border gateway protocol (BGP). For complete description about BGP commands in this chapter, please refer to other sections related to “BGP command”. BGP is an Exterior Gateway Protocol (EGP) defined in RFC1163, 1267 and 1771. It permits to establish a route selection mechanism among different autonomous systems, this mechanism can automatically guarantee the loop-free routing information exchange between the autonomous systems.

7.1.1 The BGP implementation of the router

In BGP, each route includes a network number, the autonomous system list this route has tranverse (called As-path) and other attribute lists. Our router software supports BGP v4 defined in RFC1771. The basic function of BGP is to exchange network reachability information with other BGP systems, including information about AS-path information. This information can be used to construct the AS connection graph which can eliminate route loop, and it can implement AS level routing policy with AS connection graph. BGP v4 supports classless inter-domain router (CIDR), CIDR can reduce the size of the routing table through creating summary routes and thus creates a super network. CIDR removes the concept of network level in BGP, and supports IP prefix broadcasting. CIDR route can be transferred through OSPF, Enhanced IGRP, ISIS-IP and RIP2.

An important difference between exterior gateway routing and interior gateway router is the former has better controllability. In order to control the route, the implementation of BGP provides several optional methods:

- In order to filter routes, it can be based on access-list based on neighbour, aspath-list, prefix-list and also use the access-list based on interface, prefix-list to filter routes or the Nexthop attribute of the routes.

- In order to change the attribute of the routes, you can use the route-map to mend the attributes of BGP routes including MED, Local preference, route value and etc.

- In order to interact with the interior gateway dynamic routing protocol (OSPF, RIP, etc.), you can redistribute route, so as to automatically generate BGP routing information. You can also generate BGP routes through manual configuration of network, aggregation. While generating BGP routes, you can use route-map to configure the attributes of the routes.

- In order to control the precedence of BGP routes in the system, you can use command “distance” to configure the management distance of BGP routes.

7.1.2 How does BGP select the path

The decision process of BGP is established on the basis of comparing route attribute value. When the same network has several routes, BGP selects the best route to the destination. The following process summarizes how BGP selects the best route:

- If it cannot arrive at the next hop, it will not be considered.
- If the path is internal and the synchronization is activated, and if the route is not in IGP, the route will not be considered.
- Select preferable path with the maximum precedence.
- If each route has the same value, preferably select the route with the maximum local precedence.
- If each route has the same local precedence, select preferably the route generated by local router. For example, route may be generated by local router through the using of command “network, aggregate” or by redistributing IGP route.
- If the local precedences are the same, or if there is no route generated by local router, then select preferably the route with the shortest AS path.
- If the AS path lengths are the same, then select preferably the route with the lowest attribute value of “origin” (IGP<EGP<IMCOMPLETE)
- If the attribute values of “Origin” are the same, then select preferable route with the lowest MED value. Unless “bgp always-compare-med” is activated, this comparable can only be carried out between the routes from the same neighbour AS.
- If each route has the same MED, select preferable external path (EBGP) rather than internal path (IBGP). All paths inside the autonomous system confederation are considered to be internal paths, but select preferably EBGP confederation not IBGP confederation.
- If each route has the same connection attribute, select preferable route with a smaller router-id.

7.2 BGP Configuration Task List

The configuration tasks of BGP can be divided into basic tasks and advanced tasks. The first two entries of basic tasks are necessary to configure BGP, other entries in basic tasks and all advanced tasks are optional.

7.2.1 Basic configuration task list of BGP

The basic configuration tasks of BGP include:

- Activate the route selection of BGP.

- Configure BGP neighbor.
- Configure BGP soft reconfiguration
- Reset BGP connection.
- Configure the synchronization between BGP and IGPs
- Configure BGP route value
- Configure BGP route filter based on the neighbour
- Configure BGP route filtration based on the interface
- Disable the nexthop treatment of BGP update

7.2.2 Advanced BGP configuration tasks list

Advanced, optional BGP configuration tasks are listed as the following:

- Use route-map to filter and modify route update
- Configure aggregate address
- Configure BGP community attribute
- Configure autonomous system confederation
- Configure route reflector
- Shut down peer entity
- Configure multihop external peer body
- Configure the management distance of BGP routes
- Adjust BGP timer.
- Compare MED of routes from different AS.
- Configure the MD5 authentication for BGP neighbor
- Configure BGP restart gracefully
- Configure output routing filtering (ORF)

For more related information about the configuration of the attributes of several IP route selection protocols, please refer to“The configuration of attributes of IP routing which are independent from the protocol”.

7.3 BGP Configuration Task

7.3.1 Configuring Basic BGP Features

1. Activate the route selection of BGP

In order to activate BGP route selection, use the following commands under global configuration mode to activate BGP route selection:

Command	Purpose
router bgp autonomous-system	Under router configuration mode, activate BGP route selection process.
Network network-number/masklen [route-map route-map-name]	Tag the network as local autonomous system and add it to the BGP list.

Notes:

For exterior gateway routing protocol, the using of configuration command "network " to configure an IP network canand to only control which networks will be informed. This is opposite to interior gateway protocol (IGP), such as RIP, it is using command "network" to decide where to send the update.

Command "network" is used to import IGP routes to BGP routing table. Router resource, such as configured RAM, decides the upper limit of the usable command "network". As a choice, you can use command "redistribute" to achieve the same effect.

2. Configure BGP neighbour

To configure BGP neighbour is to establish the peer to exchange routing information. BGP neighbour ought to be configured in order to exchange routing information with the outer world.

BGP supports two kinds of neighbours: internal neighbour (IBGP) and external neighbour (EBGP). Internal neighbours are in the same AS; external neighbours are in different ASs. Normally, external neighbours are adjacent to each other and share the same sub-network. But internal neighbours can be at any place in the same AS.

Use configuration command "Neighbor" to configure BGP neighbour:

Command	Purpose
neighbor {*ip-address* | *peer-group-name*} **remote-as** *number*	Designate a BGP neighbour.

For example about the configuration of the BGP neighbor, please refer to the section in the bottom of this chapter "an example of the configuration of the BGP neighbor".

3. Configure BGP soft reconfiguration

Generally speaking, BGP neighbors only exchange all routes when the connections are established, after that, they only exchange update routes. So if the configured routing policy gently changes, in order to apply it on the received routes, it is necessary to clear BGP session. The clearing of BGP session will cause the invalidation of cache and will exert great influence on the operation of the network. Soft reconfiguration function enables the configuration and activation of policy without clearing BGP session. So, we recommend you to use soft reconfiguration, currently, we enable the soft reconfiguration based on each neighbour. When the soft reconfiguration is used on the incoming update produced by the neighbor, it is called incoming soft reconfiguration; When the soft reconfiguration is used on the outcoming update to the neighbor, it is called outcoming soft reconfiguration. Applying incoming soft reconfiguration can make the new input policy effective, Applying outcoming soft reconfiguration makes new local output policy effective without the reset of BGP session.

In order to generate new incoming update without resetting of BGP session, local BGP speaker should save the received incoming update without any modification, regardless whether it would be accepted or denied under current incoming policy. This will be very memory consuming and should be avoided. On the other hand, outcoming reconfiguration does not have any extra memory consumption, so it is always effective. You can trigger outcoming soft reconfiguration on the other side of BGP session to make the new local incoming policy effective.

In order to permit incoming soft reconfiguration, you should configure the BGP to save all accepted routing update. Outcoming reconfiguration need not be pre-configured.

Use the following router configuration command to configure BGP soft reconfiguration:

Command	Purpose
Neighbor {*ip-address* | *peer-group-name*} **soft-reconfiguration [inbound]**	Configure BGP soft reconfiguration

If you use parameter **"peer-community-name"** to designate BGP peer community, all peer community members in it will inherit the feature of this command.

4. Reset BGP connection

Once two routers are defined as BGP neighbours, they create a BGP connection, and exchange routing information. If the BGP routing policy has been changed, or other configurations have been changed, then you should reset the BGP connection in order to make the change of configuration effective. Use one of the following two management mode commands to reset BGP connection:

Command	Purpose
clear ip bgp *	Recreate a special BGP connection.
clear ip bgp *address*	Reset all BGP connections.

5. Configure the synchronization between BGP and IGPs

If you permit another AS to transfer data to the third AS through your AS, then the synchronization between your AS internal routing state and the routing information it broadcasted to another ASs is very important. For example, if your BGP wants to broadcast routes before all routers in your AS get to know the routes through IGP, then your AS may receive some information that some routers cannot route. In order to prevent these situations, BGP should wait until all IGP routers inside AS get to know that routing information, this is the synchronization between BGP and IGP, and the synchronization is activated by default.

Under certain situations, it is not necessary to synchronize. If you do not permit other ASs to transfer data through your AS, or if all routers in your AS will run BGP, your can cancel the Synchronization function. Cancelling that feature will enable you to put fewer routes in your IGP, and enable quicker convergence of BGP. Use the following router configuration command to cancel synchronization:

Command	Purpose
no synchronization	Cancel the synchronization between BGP and IGP.

While canceling synchronization, you should use command “clear ip bgp” to clear BGP dialogue.

For an example about BGP synchronization, please refer to the section in the bottom of this chapter “an example of BGP path filtration by the neighbors”.

Normally, you do not expect to redistribute all routes to your IGP. A common design is to redistribute one or two routes, and make them the external routes in IGRP, or force the BGP session to generate an AS default route. When BGP redistribute routes to IGP, only the routes acquired through EBGP will be redistributed. Under most situations, you do not want to allocate your IGP to BGP, just use configuration command “network” to list the network in AS, then your network will be broadcasted. The networks listed in this form are called local network, and enables BGP to have attribute “Origin” of IGP. They must appear in the main IP routing table, and are effective; for example, they are direct-connected routes, static routes or routes known through IGP. BGP routing process periodically scans the main IP routing table to check the existence of a local network, and accordingly updates BGP routing table if you really want BGP to execute redistribution, you must be very careful, because these may be the routes in IGP that are injected by other routers through BGP, this may bring force a kind of situation that BGP potentially injects the information into IGP, and then send back the information to BGP. Vice versa.

6. Configure BGP route value

BGP route value is a number set to BGP route in order to control the route selection process, value is local for the router. The value ranges from 0 to 65535. BGP route generated locally has a default value of 32768, the route got from the neighbour values 0. The administrator can implement routing policy through the change of route value.

Use the following router configuration command to configure BGP route weight:

Command	Purpose
neighbor {*ip-address* | *X:X::X:X* } **weight** *weight*	Designate a value to each route from one neighbour.

Besides, you can change the route weight through route-map.

7. Configure BGP route filter based on the neighbour

There are 4 methods in BGP implementation of router software to filter BGP routes of the designated neighbours:

Use Aspath list filter together with global configuration command **“ip aspath-list”** and command “**neighbour filter-list**”.

Command	Purpose
ip as-path access-list *aspaths-list-name* {**permit | deny**} *as-regular-expression*	Define an accessing list relative to BGP.
router bgp *autonomous-system*	Enter into router configuration mode.
neighbor {*ip-address* | *X:X::X:X* } **filter-list** *aspath-list-name* {**in | out** }	Establish a BGP filter.

Use access list together with global configuration command "ip access-list" and command "neighbour distribute-list".

Command	Purpose
ip access-list standard *access-list-name*	Define an access list.
router bgp *autonomous-system*	Enter into router configuration mode.
neighbor {*ip-address* | *X:X::X:X* } **distribute-list** *access-list-name* {**in | out** }	Establish a BGP filter.

Use prefix list together with global configuration command "ip prefix-list" and command "neighbour prefix-list".

Command	Purpose
ip prefix-list *prefixs-list-name* **{permit |deny}** A.B.C.D/n **ge** x **le** y	Define a prefix list.
router bgp *autonomous-system*	Enter into router configuration mode.
neighbor {*ip-address* | *X:X::X:X* } **prefix-list** *prefix-list-name* {**in | out** }	Establish a BGP filter.

Use route-map together with global configuration command "route-map" and command "neighbour route-map".

Using route-map cannot only filter routes, but also changes routes attribute, the usage will be described in the following chapters.

For example based on neighbour filter route, please refer to "example of BGP route filtration based on the neighbor".

8. Configure BGP route filtration based on the interface

Configuring BGP route filtration based on the interface can be achieved through using access list and prefix list. Network number and the gateway address of the routes can be filtered. It can designate "access-list" option to use access list for filtration of network number of the routes, designate "prefix-list" option to use prefix list for filtration of network number of the routes, designate "gateway" option to use access list for filtration of "nexthop" attribute of the routes. It can even filter the network number and "nexthop" attribute of routes at the same time, but "access-list" option cannot be used together with "prefix-list" option. Designate "*" can filter the routes on all interfaces.

To order to configure the filtration of BGP routes based on the interface, you should carry out the following configurations under BGP configuration mode:

Command	Purpose

filter interface {**in** | **out**} (**access-list** access-list-name) (**prefix-list** prefix-list-name) (**gateway** access-list-name)	Filter BGP routes based on the interface.

For examples of route filtration based on the interface, please refer to "examples of BGP route filtration based on the interface".

9. Disable the nexthop treatment of BGP update

You can configure to disable the nexthop treatment of neighbour BGP update. This may be useful in non-broadcasting network (such as FR or X.25), in FR or X.25 network, BGP neighbour may not directly access all other neighbors in the same IP sub-network. There are two methods to cancel nexthop treatment:

1. Use the local IP address of this BGP connection to replace the nexthop address of the outcoming route;

2. Use route-map to designate the nexthop address of incoming or outcoming routes. (Please refer to other chapters)

Use the following router configuration command to disable nexthop treatment and use the local IP address of this BGP connection to replace the nexthop address of the outcoming routes.

Command	Purpose
neighbor {*ip-address* | *X:X::X:X* } **next-hop-self**	Disable the nexthop treatment while carrying out BGP neighbour update.

Using this command to configure will enable the current router to inform itself to be the nexthop of the route. So, other BGP neighbours will forward packets to this network to the current router. This is very useful in non-broadcasting network environment, because there exists a path from the current router to the designated neighbor. But it is not the case in broadcasting network environment, because this will induce unnecessary extra hops.

7.3.2 Configuring advanced BGP features

1. Use route-map to filter and modify route update

You can use route-map to filter route update and modify parameter attribute based on each neighbour. Route-map can be applied both on incoming update and outcoming update. Only the routes passing route-map can be processed while sending or accepting route update.

Route-map supports incoming and outcoming update to match with AS path, community and network number. AS matching demands the using of command "aspath-list"; the matching based on community demands the using of command "community-list", the matching based on the network demands the use of command "ip access-list".

Use the following BGP configuration command to configure route-map for filtration and modification of route update:

Command	Purpose
neighbor {*ip-address* | *X:X::X:X* } **route-map** *route-map-name* **{in | out}**	Apply route-map on incoming or outcoming routes.

For examples of using route-map to filter and modify the route update, please refer to “Examples of BGP route-map”.

2. Configure aggregate address

Classless inter-domain routing can create aggregate routing (and super network) to minimize the routing table. You can configure aggregate routing in BGP through redistributing aggregate routes to BGP or through using conditional aggregate attributes described in the following task list. If there is at least one more detailed record in BGP routing table, add the aggregate address to the BGP routing table.

Use one or more router configuration commands in the following to create an aggregate address in the routing table:

Command	Purpose
aggregate *network/len*	Create aggregate address in BGP routing table.
aggregate *network/len* **summary-only**	Broadcast summary address only.
aggregate *network/len* **attribute-map** *map-name*	Generate aggregate address according to conditions designated by route-map.

For examples regarding the using of BGP route aggregation, please refer to the section in the bottom of this chapter “examples of BGP route aggregation”.

3. Configure BGP community attribute

The routing policy that BGP supports is mainly based on one of the 3 values in BGP routing information:

- Network number of routes:
- as_path attribute value of routes:
- The “community” attribute value of routes

Dividing the routes into communities through “community” attribute, and applying the routing policy based on the community, thereby simplifies the configuration of control of routing information.

Community is a group of routes with the common attributes; each route may belong to several communities. AS administrators can define a certain route belongs to a certain community.

Community attribute is an optional and transferable global attribute ranging from 1 to 4,294,967,200. The famous communities pre-defined in the Internet communities include:

- **No-export**--- Do not advertise this route to EBGP peer (Including the EBGP peers inside the autonomous system confederation).

- **No-advertise**---Do not advertise this route to any peer .
- **local-as**---Do not advertise this route to the exterior of autonomous system (ca send this route to the other sub-AS peers in the autonomous system confederation.)

When generating, accepting or sending routes, BGP speakers can configure, add or modify the route community attribute. when aggregating routes, the generated aggregation includes the "community" attributes from complete communities of all original routes.

By default, "Community" attributes are not sent to the neighbor. Use the following BGP configuration command to designate sending "community" attribute to the neighbour:

Command	Purpose
neighbor {*ip-address* | *X:X::X:X* } **send-community**	Designate to send attribute "community" to the neighbor.

You need to do the following jobs to configure community attribute for the router:

Command	Purpose
route-map *map-name sequence-number* {**deny** | **permit**}	Configure route-map.
set community *community-value*	Configure rule of setting.
router bgp *autonomous-system*	Enter into router configuration mode.
neighbor{*ip-address* | *X:X::X:X* } **route-map** *access-list-name* {**in** | **out** }	Apply route-map.

To filter routing information based on community attributes, you need to do the following jobs:

Command	Purpose
ip community-list {**expanded** | **standard** } *community-list-name* {**permit** | **deny**} *communtiy-expression*	Define community list.
route-map *map-name sequence-number* **{deny | permit}**	Configure route-map.
match community *community-list-name*	Configure rules of matching.
router bgp *autonomous-system*	Enter into router configuration mode
neighbor {*ip-address* | *peer-group-name*} **route-map** *route-map-name* {**in** | **out** }	Apply route-map.

For examples of using community attributes, please refer to "Examples of route-map using BGP community attribute".

4. Configure autonomous system confederation

The way to reduce the number of IBGP connections is to divide an AS into several sub-AS, then form them into an autonomous system confederation. From the external perspective, the confederation looks like an AS. In the confederation, each sub-AS is full-mesh inside, and has connections with other sub-ASs in the same confederation.

Even if there are EBGP sessions between peers of different sub-ASs, they may still exchange routing selection information like IBGP peers. Concretely speaking, it is saving the nexthop, MED and local precedence information.

To configure a BGP autonomous system confederation, you should designate the confederation identifier. The confederation identifier is an AS number, from an external perspective, the confederation is just like a single AS with AS number being the confederation identifier.

Use the following BGP configuration command to configure confederation identifier of the autonomous system:

Command	Purpose
bgp confederation identifier *autonomous-system*	Configure the confederation identifier of the autonomous system.

In order to designate the autonomous system number belonging to autonomous system confederation, use the following BGP configuration command:

Command	Purpose
bgp confederation peers *autonomous-system* [*autonomous-system ...*]	Designate the AS belongs to the confederation of autonomous system.

For examples of autonomous system confederation, please refer to “examples of BGP autonomous system confederation”.

5. Configure route reflector

Another method to reduce the number of IBGP connections instead of configuring autonomous system confederation is to configure route reflector.

The internal peers of the route reflector are divided into two groups: client peers and all other routers (non-client peers). The route reflector reflects the routes between the two groups; the route reflector and its client peers form a cluster. Non-client peers must be full-mesh connected, but client peers need not. The clients in the cluster do not communicate with IBGP speakers outside the cluster.

When route reflector receives routing information, it completes the following tasks:

- Broadcast the routes from external BGP speaker to all clents and non-client peers.
- Broadcast the routes from non-client to all clents.
- Broadcast the routes from the clients to all clients and non-client peers. So, the client peers need not be full-mesh-conneted.

Use the following router configuration command to configure the local router as the reflector and designate neighbors as the router reflector client:

Command	Purpose
Neighbor {*ip-address* | *X:X::X:X* } **route-reflector-client**	Configure the local router as route reflector and designate neighbors as the client.

An AS may have several route reflectors, the way route reflector to process other route reflectors is the same as the processing of IBGP speakers.Normally, a cluster of clients have only one route reflector, and then the cluster is identified by the route reflector 's router ID. In order to increase the redundancy and avoid the failure of single node, a cluster may have more than one route reflectors. In this case, all the route reflectors in the cluster should be configured with 4-bit cluster ID, so that the route reflector can identify the update information of the route reflector in the same cluster. All the route reflectors belonging to the same cluster should be full-mesh-connected, and they should have the same client and non-client peer set.

If there is more than one route reflector in the cluster, you can use the following BGP configuration command to configure cluster ID:

Command	Purpose
bgp cluster-id *cluster-id*	Configure cluster-ID.

For examples of the configuration of route reflector, please refer to "examples of the configuration of BGP route reflector".

6. Shut down peer entity

Use the following BGP configuration command to shut down BGP neighbour:

Command	Purpose
Neighbor {*ip-address* | *X:X::X:X* } **shutdown**	Shut down BGP neighbour.

Use the following BGP configuration command to activate the neighbour shut down previously:

Command	Purpose
no neighbor {*ip-address* | *X:X::X:X* } **shutdown**	Activate BGP neighbour.

7. Configure multihop external peer body

By default, external peers should be on a directly connected network, in order to configure multihop external peer, you need to carry out the following task:

Command	Purpose
neighbor {*ip-address* | *X:X::X:X* } **ebgp-multihop** ttl	Configure BGP neighbor as multihop external peer.

8. Configure the management distance of BGP routes

Management distance is a kind of measurement of the preference of different routing protocol. BGP uses 3 different management distances: external distance, internal distance and local distance. The routes obtained from external BGP will be assigned with the external distiance; the routes obtained from internal BGP will have a distance as internel distance, local routes will be given the local distance. Use the following BGP configuration command to configure BGP route management distance:

Command	Purpose
distance bgp {*external-distance*| *internal-distance* |*local-distance*}	Configure BGP route management distances.

The change of management distances of BGP route is dangerous, and normally it is not recommended. The external distance should be shorter than the distance of any other dynamic routing protocol and the internal distance should be longer than the distance of any other dynamic routing protocol.

9. Adjust BGP timer

Use the following BGP configuration command to adjust the BGP "keepalive" and "holdtime" timers of detailed neighbour:

Command	Purpose
neighbor {*ip-address* | *X:X::X:X* } **timers** *keepalive holdtime*	Set "keepalive" and "holdtime" timer interval (count with unit 'second') for designated peer or peer community

Use command "no neighbour timers" to reset the timer interval of BGP neighbor or peer community to the default value.

10. Compare MED of routes from different AS

MED is a parameter to be considered when selecting the best route from several paths. The path with lower MED value will be preferably considered than the route with higher MED value.

Under default situation, during the process of selecting the best route, MED's comparison only takes place in the routes from the same AS. You can permit the MEDs' comparison to take place in routing selection, regardless of which AS the routes come from.

Use the following BGP configuration command to realize the above objective:

Command	Purpose
bgp always-compare-med	Permit to make MEDs comparison among routes from different AS.

11. Configure the MD5 authentication for BGP neighbor

To make sure of the secure routing information forwarding between ASs, perform the password authentication on the BGP connection through the MD5 option provided by TCP.

Run the following command to achieve the previous purpose:

Command	Purpose
neighbor *A.B.C.D* **password** *LINE*	Enables the MD5 authentication of the BGP neighbor and set the password.

You can run **no neighbor A.B.C.D password** to cancel the MD5 authentication for the BGP neighbor.

7.4 Monitoring and Maintaining BGP

The administrator can display or delete the BGP routing table or the content of other databases. Of course the detailed statistics information can also be displayed. The following are relative tasks:

- Deleting the BGP routing table and the database
- Displaying the routing table and the system statistics information
- Tracking the BGP information

7.4.1 Deleting the BGP Routing Table and the BGP Database.

The following table lists the tasks relative with high-speed cache deletion, table deletion or BGP database deletion. The commands listed in the following table are all run in EXEC mode.

Command	Purpose
clear ip bgp *	Resets all BGP connections.
clear ip bgp *as-number*	Resets the BGP connections of the designated autonomous system.
clear ip bgp *address*	Resets the BGP connections of the designated neighbor.
clear ip bgp *address* soft {**in|out**}	Deletes the incoming database or the outgoing database of the designated neighbor.
clear ip bgp *aggregates*	Deletes the routes generated in route aggregation.
clear ip bgp *networks*	Deletes the routes generated during forwarding process.
clear ip bgp *redistribute*	Deleting the routes generated by the **network** command.

7.4.2 Displaying the Routing Table and the System Statistics Information

The detailed statistics information about the BGP routing table or the database will be displayed. The provided information can decide resource utilization and help resolving network problems. The information about the node reachability can also be displayed.

You can run the following commands to display all kinds of routing statistics information:

Command	Purpose
show ip bgp	Displays the BGP routing table in the system.
show ip bgp prefix	Displays the routes which match the

	designated prefix list.
show ip bgp community	Displays the statistics information about the group attribute.
show ip bgp regexp *regular-expression*	Displays the routes which match the designated regular expression.
show ip bgp *network*	Displays the designated BGP route.
show ip bgp neighbors *address*	Displays the information about the TCP and the BGP connections of the designated neighbor.
show ip bgp neighbors *[address]* [**received-routes** | **routes** | **advertised-routes**]	Displays the routes learned from the special BGP neighbor.
show ip bgp paths	Displays the information about all BGP paths in the database.
show ip bgp summary	Displays the states of all BGP connections.

7.4.3 Tracking the BGP Information

You can observe BGP connection establishment and route transmission/reception by tracking the BGP information, which helps to locate the troubles and resolve the problems. The commands to track the BGP information are shown in the following table:

Command	Purpose
debug ip bgp	Tracks the general BGP information.
debug ip bgp all	Tracks all BGP information.
debug ip bgp fsm	Tracks the BGP state machine.
debug ip bgp keepalive	Tracks the KeepAlive packets of BGP.
debug ip bgp open	Tracks the OPEN packets of BGP.
debug ip bgp update	Tracks the UPDATE packets of BGP.

7.5 Examples of BGP configuration

The following sections provide the examples of BGP configuration:

7.5.1 Example of BGP route-map

The following example illustrates how to use route-map to change the incoming route attribute from the neighbor. Set the metric of all routes that come from neighbour 140.222.1.1 and meet the requirement of ASPATH accessing list “aaa” to 200, local precedence value to 250, and they are accepted, all other routes will be denied.

```
router bgp 100
 neighbor 140.222.1.1 route-map fix-weight in
```

```
  neighbor 140.222.1.1 remote-as 1
!
route-map fix-weight 10 permit
  match as-path aaa
  set local-preference 250
  set weight 200
!
ip as-path access-list aaa permit ^690$
ip as-path access-list aaa permit ^1800
```

In the following example, the first entry of route-map “freddy” will set the MED attributes of all routes origining from autonomous system 690 to 127. The second entry allows the routes that don’t meet the above conditions to be transferred to neighbor 1.1.1.1.

```
router bgp 100
  neighbor 1.1.1.1 route-map freddy out
!
ip as-path access-list abc permit ^690_
ip as-path access-list xyz permit .*
!
route-map freddy 10 permit
  match as-path abc
  set metric 127
!
route-map freddy 20 permit
match as-path xyz
```

The following example illustrates how to use route-map to change the routes from route redistribution:

```
router bgp 100
  redistribute rip 1 route-map rip2bgp
!
route-map rip2bgp
  match ip address rip
  set local-preference 25
  set metric 127
  set weight 30000
  set ip next-hop 192.92.68.24
  set origin igp
!
ip access-list standard rip
  permit 131.108.0.0 255.255.0.0
  permit 160.89.0.0 255.255.0.0
  permit 198.112.0.0 255.255.128.0
```

7.5.2 Example of neighbour configuration

In the following example, BGP router belongs to AS109, and creates two networks. This router has 3 neighbors: the first neighbor is an external one (in different AS); the second is internal one (with the same AS number). The third is also an external one.

```
router bgp 109
 network 131.108.0.0
 network 192.31.7.0
 neighbor 131.108.200.1 remote-as 167
 neighbor 131.108.234.2 remote-as 109
 neighbor 150.136.64.19 remote-as 99
```

7.5.3 Example of BGP route filtration based on the neighbor

Here is an example of BGP path filtration based on the neighbor. The routes passing through as-path access list “test1” will receive a metric value as 100. Only routes passing through as-path access list “test2” will be sent to 193.1.12.10, similarly, only those routes passing access list “test3” will be accepted by 193.1.12.10:

```
router bgp 200
neighbor 193.1.12.10 remote-as 100
neighbor 193.1.12.10 filter-list test1 weight 100
neighbor 193.1.12.10 filter-list test2 out
neighbor 193.1.12.10 filter-list test3 in
!
ip as-path access-list test1 permit _109_
ip as-path access-list test2 permit _200$
ip as-path access-list test2 permit ^100$
ip as-path access-list test3 deny _690$
ip as-path access-list test3 permit .*
```

7.5.4 Examples of BGP route filtration based on the interface

The following is the example of the configuration of route filtration based on the interface. It filters the routes from interface vlan1 through access list “ac1”:

```
router bgp 122
filter vlan1 in access-list acl
```

The following example uses access list “filter-network” to filter the network numbers of the routes, and meanwhile, uses access list “filter-gateway” to filter gateway address of the routes from interface vlan1.

```
router bgp 100
filter vlan1 in access-list filter-network gateway filter-gateway
```

The following example: uses prefix list “filter-prefix” to filter the network numbers of the routes, and meanwhile, use accessing list “filter-gateway” to filter gateway address of routes from all interfaces.

```
router bgp 100
 filter * in prefix-list filter-prefix gateway filter-gateway
```

7.5.5 Examples of using prefix list to configure route filtration

In the following example default route 0.0.0.0/0 is denied.

```
ip prefix-list abc deny 0.0.0.0/0
```

The following example: permits routes matching prefix 35.0.0.0/8:

```
ip prefix-list abc permit 35.0.0.0/8
```

In the following example, BGP process only accepts prefix with length ranges from /8 to /24:

```
router bgp 1
 network 101.20.20.0
 filter * in prefix max24
!
 ip prefix-list max24 seq 5 permit 0.0.0.0/0 ge 8 le 24
!
```

In the following configuration, the router filters routes from all interfaces, it only accepts routes with prefix from 8 to 24:

```
router bgp 12
filter * in prefix-list max24
!
ip prefix-list max24 seq 5 permit 0.0.0.0/0 ge 8 le 24
```

Here are some other examples of configuration of prefix lists

The following example: permits routes with prefix length no more than 24 in network 192/8:

```
ip prefix-list abc permit 192.0.0.0/8 le 24
```

The following example: denies routes with prefix length of more than 25 in network 192/8:

```
ip prefix-list abc deny 192.0.0.0/8 ge 25
```

The following example: permits routes with prefix length of more than 8 yet less than 24 in all address space:

```
ip prefix-list abc permit 0.0.0.0/0 ge 8 le 24
```

The following example: denies all routes with prefix length of more than 25 in all address space:

```
ip prefix-list abc deny 0.0.0.0/0 ge 25
```

This example: denies routes from network 10/8, because if the mask on class A network 10.0.0.0/8 is smaller or equal to 32 bit, all routes from that network will be denied:

```
ip prefix-list abc deny 10.0.0.0/8 le 32
```

The following example: denies routes with mask length of more than 25 in network 204.70.1.24:

```
ip prefix-list abc deny 204.70.1.0/24 ge 25
```

The following example: permits all routes:

```
ip prefix-list abc permit any
```

7.5.6 Example of BGP route aggregation

The following example illusrates how to create aggregation routes in BGP.It may be created by route redistribution or the using of conditional route aggregation function.

In the following example, command “redistribute static” is used to redistribute aggregation route 193.*.*.*:

```
ip route 193.0.0.0 255.0.0.0 null 0
!
router bgp 100
redistribute static
```

When there is at least one route in the routing table within the designated range, the following configuration will create an aggregation route in BGP routing table. The aggregation route will be considered to be from your AS, and has the “atomic” attribution, to indicate the possibilities of the loss of information.

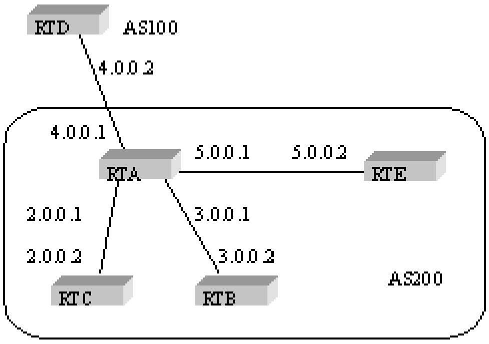
```
router bgp 100
aggregate 193.0.0.0/8
```

The following example not only creates an aggregation route 193.*.*.*, but also prohibit it to broadcast the more concrete routes to all the neighbours:

```
router bgp 100
aggregate 193.0.0.0/8 summary-only
```

7.5.7 Example of BGP route reflector

The following is an example of route reflector configuration. RTA, RTB, RTC, RTE all belong to the same autonomous system AS200, RTA serves as route reflector, RTB and RTC are route reflector clients, and RTE is normal IBGP neighbor. RTD belongs to AS100, and creates EBGP connection with RTA, the configuration is illustrated as the following:



RTA configuration:

```
interface vlan2
ip address 2.0.0.1 255.0.0.0
!
interface vlan3
ip address 3.0.0.1 255.0.0.0
!
interface vlan4
ip address 4.0.0.1 255.0.0.0
!
interface vlan5
ip address 5.0.0.1 255.0.0.0
!
router bgp 200
neighbor 2.0.0.1 remote-as 200      /*RTC IBGP*/
neighbor 2.0.0.1 route-reflector-client
neighbor 3.0.0.1 remote-as 200      /*RTB IBGP*/
neighbor 3.0.0.1 route-reflector-client
neighbor 5.0.0.1 remote-as 200      /*RTE IBGP*/
neighbor 4.0.0.2 remote-as 100      /*RTD EBGP*/
network 11.0.0.0/8
!
ip route 11.0.0.0 255.0.0.0 2.0.0.12
```

RTB configuration:

```
interface vlan3
ip address 3.0.0.2 255.0.0.0
!
router bgp 200
```

```
neighbor 3.0.0.1 remote-as 200     /*RTA IBGP*/
network 13.0.0.0/8
!
ip route 13.0.0.0 255.0.0.0 3.0.0.12
```

RTC configuration:

```
interface vlan2
ip address 2.0.0.2 255.0.0.0
!
router bgp 200
neighbor 2.0.0.1 remote-as 200     /*RTA IBGP*/
network 12.0.0.0/8
!
ip route 12.0.0.0 255.0.0.0 2.0.0.12
```

RTD configuration:

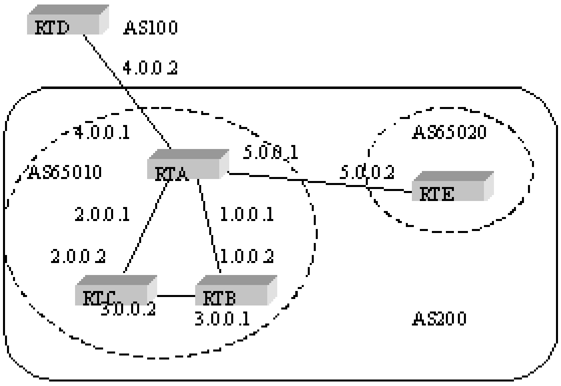
```
interface vlan4
ip address 4.0.0.2 255.0.0.0
!
router bgp 100
neighbor 4.0.0.1 remote-as 200     /*RTA EBGP*/
network 14.0.0.0/8
!
ip route 14.0.0.0 255.0.0.0 4.0.0.12
```

RTE configuration:

```
interface vlan5
ip address 5.0.0.2 255.0.0.0
!
router bgp 200
neighbor 5.0.0.1 remote-as 200     /*RTA IBGP*/
network 15.0.0.0/8
!
ip route 15.0.0.0 255.0.0.0 5.0.0.12
```

7.5.8 Example of BGP confederation

The following is the configuration of confederation. RTA, RTB, RTC create IBGP connections, and it belongs to a private autonomous system 65010; RTE belongs to another private autonomous system 65020; RTE and RTA establish internal EBGP connection of confederation; AS65010 AS65020 conprise the confederation, whose identifier is AS200; RTD belongs to autonomous system AS100, RTD establishes EBGP connection with autonomous system 200 through RTA.



RTA configuration:

```
interface vlan1
ip address 1.0.0.1 255.0.0.0
!
interface vlan2
ip address 2.0.0.1 255.0.0.0
!
interface vlan4
ip address 4.0.0.1 255.0.0.0
!
interface vlan5
ip address 5.0.0.1 255.0.0.0
!
router bgp 65010
bgp confederation identifier 200
bgp confederation peers 65020
neighbor 1.0.0.2 remote-as 65010   /*RTB IBGP*/
neighbor 2.0.0.2 remote-as 65010   /*RTC IBGP*/
neighbor 5.0.0.2 remote-as 65020   /*RTE EBGP*/
neighbor 4.0.0.2 remote-as 100     /*RTD EBGP*/
```

RTB configuration:

```
interface vlan1
ip address 1.0.0.2 255.0.0.0
!
interface vlan3
ip address 3.0.0.1 255.0.0.0
!
router bgp 65010
```

```
bgp confederation identifier 200
bgp confederation peers 65020
neighbor 1.0.0.1 remote-as 65010    /*RTA IBGP*/
neighbor 3.0.0.2 remote-as 65010    /*RTC IBGP*/
```

RTC configuration:

```
interface vlan2
ip address 2.0.0.2 255.0.0.0
!
interface vlan3
ip address 3.0.0.2 255.0.0.0
!
router bgp 65010
bgp confederation identifier 200
bgp confederation peers 65020
neighbor 2.0.0.1 remote-as 65010    /*RTA IBGP*/
neighbor 3.0.0.1 remote-as 65010    /*RTB IBGP*/
```

RTD configuration:

```
interface vlan4
ip address 4.0.0.2 255.0.0.0
!
router bgp 100
neighbor 4.0.0.1 remote-as 200    /*RTA EBGP*/
```

RTE configuration:

```
interface vlan5
ip address 5.0.0.2 255.0.0.0
!
router bgp 65020
bgp confederation identifier 200
bgp confederation peers 65010
neighbor 5.0.0.1 remote-as 65010    /*RTA EBGP*/
```

7.5.9 Example of route map with BGP group attribute

This section includes three examples of using route map with BGP community attribute.

In the first example, “route map set-community” is applied on the outcoming update of neighbor 171.69.232.50. Set the special community attribute with value “no-export” for the routes passing access list aaa, while other routes are broadcasted normally. This special community attribute will automatically prevent BGP speakers in AS200 from advertising the route outside of the autonomous system.

```
router bgp 100
  neighbor 171.69.232.50 remote-as 200
  neighbor 171.69.232.50 send-community
  neighbor 171.69.232.50 route-map set-community out
!
  route-map set-community 10 permit
  match ip address aaa
  set community no-export
!
  route-map set-community 20 permit
```

In the second example, “route map set-community” is used for the outcoming update of neighbour 171.69.232.90. All routes orgining from AS70 will insert value 200 into the community attribute 200, all other routes will just be advertised normally.

```
route-map bgp 200
  neighbor 171.69.232.90 remote-as 100
  neighbor 171.69.232.90 send-community
  neighbor 171.69.232.90 route-map set-community out
!
route-map set-community 10 permit
  match as-path test1
  set community-additive 200 200
!
route-map set-community 20 permit
  match as-path test2
!
ip as-path access-list test1 permit 70$
ip as-path access-list test2 permit .*
```

In the third example, selectively set the MED and local preference value of routes from neighbor 171.69.232.55 according to the commmunity attribute value of the routes. All routers matching with community list com1will be set with MED as 8000, this may include routes with community value “100 200 300” or “900 901”. These routes may have other attribute values.

All routes transmitting community list com2 will be set with the local preference value as 500.

All other routes will be set with the local priority value as 50. So, all the rest of the routes of neighbor 171.69.232.55 have the preference of 50.

```
router bgp 200
neighbor 171.69.232.55 remote-as 100
neighbor 171.69.232.55 route-map filter-on-community in
!
route-map filter-on-community 10 permit
match community com1
set metric 8000
!
```

```
route-map filter-on-community 20 permit
match community com2
set local-preference 500
!
route-map filter-on-community 30 permit
set local-preference 50
!
ip community-list standard com1 permit 100 200 300
ip community-list standard com1 permit 900 901
!
ip community-list standard com2 permit 88
ip community-list standard com2 permit 90
!
```

Chapter 8 Congiuring PBR

8.1 Overview

This section descripe how to configure PBR. PBR is the abbrecation of Policy Based Routing. PBR make the user have the ability to route ip packet according some policy other than dynamic routing protocol. We currently support the following policy: based on the length of ip packet, source ip address. You can set gateway or outgoing interface for packets matching the policy. PBR can support load balance.

The rule for PBR selecting nexthop is following :

- If set ip next-hop is configured,and the gateway is reachble,the gateway will be used. If multiple gateway is configured, use the first reachable gateway, if load-balance key word is used, the load balance is used between these gateways.
- If set interface is configured, and the outgoing interface is routabale(interface protocol up, and ip address is confured), use the outgoing interface. If multiple outgoing interfaces are configured, first routable interface will be used. If load-balance key word is used, the load balance is used between these interface. If both set ip next-hop and set interface configured, , use set ip next-hop first.
- **set ip default next-hop** or **set default interface** won't be used untill routing lookup failed.

For the following packets, policy routing will not be applied:

- The destination address is a local packet.
- Multicast message.
- Local direct broadcast packet.

8.2 PBR Configuration Task List

If you want to use PBR, the following configuration is needed:

- Create standard access-list (optional)
- Creat route-map
- Apply route-map on interface

8.3 PBR Configuration Task

8.3.1 Create standard access-list

To create access-list, following the step bellow:

Command	Function
ip access-list standard net1	Enter access-list configurtion mode.

8.3.2 Create route-map

To create route-map, following the step bellow:

Command	Function
route-map pbr	Enter route-map configuration.
match ip address *access-list* **match length** *min_length max_length*	Configure matching policy.
set ip [**default**] **next-hop** *A.B.C.D* **set** [**default**] **interface** *interface_name*	Configure the next hop address or port of the IP packet.

8.3.3 Apply route-map on interface

To enable PBR on interface, following the step bellow:

Command	Function
interface *interface_name*	Enter interface configurtion mode.
ip policy route-map *route-map_name*	Apply PBR on interface.

8.3.4 Maintaining PBR

To maintain PBR, follow the steps below in the EXEC mode:

Command	Function
debug ip policy	View the results of applying policy routing.

8.4 PBR configution example

Switch configuration:

```
!
interface Vlan1
ip address 10.1.1.3 255.255.255.0
no ip directed-broadcast
```

```
ip policy route-map pbr
!
interface Vlan2
ip address 13.1.1.3 255.255.255.0
no ip directed-broadcast
!
interface Vlan3
ip address 14.1.1.3 255.255.255.0
no ip directed-broadcast
!
ip access-list standard net1
permit 10.1.1.2 255.255.255.255
!
ip access-list standard net2
permit 10.1.1.4 255.255.255.255
!
ip access-list standard net3
permit 10.1.1.21 255.255.255.255
!
route-map pbr 10 permit
match ip address net1
set ip next-hop 13.1.1.99
!
route-map pbr 20 permit
match ip address net2
set ip next-hop 14.1.1.99
!
route-map pbr 30 permit
match ip address net3
set ip next-hop 13.1.1.99 14.1.1.99 load-balance
!
route-map pbr 40 permit
set ip default next-hop 13.1.1.99
```

Configuration explanation

Policy routing is enabled on interface vlan1. For packets origined from 10.1.1.2, the next hop is 13.1.1.99 if 13.1.1.99 is reachable. If 13.1.1.99 isn't reachable, destination base routing is used. For packets from 10.1.1.21, route-map pbr 30 is used. Since load-balance key word is used, both 13.1.1.99 and 14.1.1.99 will be used as the next hop (assuming there are routes to 13.1.1.99 and 14.1.1.99 in the routing table).

Chapter 9 Switch Routing Protocol Highpriority Configuration

9.1 Overview

When testing routing protocols, the priority of routing protocol packets to the CPU can be improved through FP. This can ensure that the routing protocol packets can be received when the system receives overloaded background traffic (such as IP packets that need to be forwarded).

9.2 Configuration task list

To enable priority improving of the routing packets forwarding to CPU, following configuration task is necessary:

- Enable priority improving of the routing packets forwarding to CPU

9.3 Configuration task

9.3.1 Enable priority improving of the routing packets forwarding to CPU

In global configuration mode, configure as follows:

Command	Purpose
switch routing-protocol-highpriority	Enable priority improving of the routing packets forwarding to CPU.