FSOS

OSPF Configuration

Contents

1. OSPF Configuration

1.1 OSPF Overview

Open Shortest Path First (OSPF) is an interior routing protocol, which is developed by IETF based on the link state detection and shortest path first technologies. In an IP network, OSPF dynamically discovers and advertise routes by collecting and transmitting the link states of autonomous systems (ASs). It supports interface-based packet authentication for purposes of route calculation security and employs IP multicast to send and receive packets.

Each OSPF router maintains a database that describes the topological structure of an AS. The database is a collection of link-state advertisements (LSAs) of all the routers. Every router always broadcasts the local state information across the entire AS. If two or more routers exist in a multi-access network, a designated router (DR) and a backup designated router (BDR) must be elected. The DR is responsible for broadcasting the LSAs of the network. With a DR, a multi-address access network may require less neighbor relationships to be established between routers. OSPF allows an AS to be divided into areas, between which routing information is further abstracted. As a result, smaller network bandwidth will be occupied.

OSPF uses four types of routes, which are listed in order of priority as follows:

Intra-area routes

Inter-area routes

Type 1 external routes

Type 2 external routes

Intra-area and inter-area routes describe the network structure of an AS, while external routes depict how routes are distributed to destinations outside an AS. Generally, type 1 external routes are based on the information imported by OSPF from other interior routing protocols and comparable to OSPF routes in routing cost; type 2 external routes are based on the information imported by OSPF from exterior routing protocols and the costs of such

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routes are far greater than those of OSPF routes. Therefore, route calculation only takes the external costs into consideration.

Based on the link state database (LSDB), each router builds a shortest path tree with itself as the root, which presents the routes to every node in an AS. An external route emerges as a leaf node and can also be marked by the router that broadcasts the external route so that additional information about an AS is recorded.

All the OSPF areas are connected to the backbone area, which is identified by 0.0.0.0. OSPF areas must be logically continuous. To achieve this end, virtual connection is introduced to the backbone area to ensure the logical connectivity of areas even if they are physically separated.

All the routers in an area must accept the parameter settings of the area. Therefore, the configuration of routers in the same area must be performed in consideration of the parameter settings of the area. A configuration error may lead to the failure of information transfer between adjacent routers and even routing failures or routing loops.

1.1 OSPF Detailed Configuration

1.1.1 Enable/Disable OSPF Configuration

OSPF basic configuration

Operation	Command	Remarks
Enter global configuration mode	configure terminal	
Enable ospf	**router ospf**	-
Disable ospf	**no router ospf**	-

1.1.2 Configure the ID of a Router

The router ID is a 32-bit unsigned integer and the only one label of a router in AS. Therefore, user should configure the router ID. When configure the router ID manually, you

should ensure that any two router's IDs in AS are different. Generally, the router ID is in line with the IP address of this router's certain interface.

Operation	Command	Remarks
Enter global configuration mode	**configure terminal**	
Configure router id	**router id** *router-id*	-

When performing the network planning, you should choose the router ID and manually configure it so as to ensure the stability of OSPF.

The smallest IP address in the interface IP will be selected to be the router ID by default.

1.1.3 Specify an Interface and Area ID

OSPF divides an AS into different areas, based on which routers are logically classified into different groups. Area border routers (ABRs) may belong to different areas. A network segment belongs to only one area, that is, the homing area of an OSPF interface must be specified. An area is identified by an area ID. Routes between areas are transmitted by ABRs.

In addition, all the routers in an area must unanimously accept the parameter settings of the area. Therefore, the configuration of routers in the same area must be performed in consideration of the parameter settings of the area. A configuration error may lead to the failure of information transfer between adjacent routers and even routing failures or routing loops.

OSPF related parameter configuration

Operation	Command	Remarks
Run the command in OSPF configuration mode.	**router ospf**	
Specify area for IP interface	**network address wildcard-mask area area-id**	
Cancel to specify area for IP interface	**no network address wildcard-mask area area-id**	
Configure the authentication type for	**area** *area-id* **authentication [message-digest]**	

an area.		
Restore the authentication type of an interface to no authentication.	**no area *area-id* authentication**	

1.1.4 Configure the Authentication Type for an Area

When in the same area, the authentication types of all routers should be the same. (MD5 authentication and plaintext authentication are supported.)

Operation	Command	Remarks
Run the command in OSPF configuration mode.	**router ospf**	
Configure the authentication type for an area.	**area *area-id* authentication [message-digest]**	
Restore the authentication type of an interface to no authentication.	**no area *area-id* authentication**	

1.1.5 Set a Password for Packet Authentication

OSPF supports MD5 authentication or plaintext authentication between two adjacent routers.

Operation	Command	Remarks
Enter interface configuration mode	interface {**vlan-interface** *vid* | **supervlan-interface** *id* }	
Set a password for plaintext authentication.	**ip ospf authentication-key *password***	
Disable plaintext authentication.	**no ip ospf authentication-key**	
Set a password for MD5 authentication.	**ip ospf message-digest-key *key-id* md5 *key***	
Disable MD5	**no ip ospf message-digest-key**	

authentication.		

1.1.6 Configure OSPF Interface Type

OSPF calculates routes based on the topological structure of the network adjacent to the local router. Each router describes the topology of its adjacent network and transmits it to the other routers. According to the link layer protocol, OSPF classifies networks into the following four types:

Broadcast networks: When Ethernet or FDDI is used as the link layer protocol, OSPF considers that the network type is broadcast by default.

Non Broadcast MultiAccess (NBMA) networks: When ATM is used as the link layer protocol, OSPF considers that the network type is NBMA by default.

Point-to-Multipoint networks: This network type will be considered as default in no case. It is always a substitute of other network types through forcible change. An NBMA network that is not fully meshed is often changed to a point-to-multipoint network.

Point-to-Point networks: When PPP, LAPB, or POS is used as the link layer protocol, OSPF considers that the network type is Point-to-Point by default.

The ATM network is a typical NBMA network. A polling interval can be configured to specify the interval of sending Hello packets before a router establishes a neighbor relationship with its neighboring router.

On a broadcast network incapable of multi-address access, you can configure the interface type to nonbroadcast.

If some routers are not directly reachable on an NBMA network, you can configure the interface type to point-to-multipoint.

If a router has only one peer router on an NBMA network, you can set the interface type to point-to-point.

The differences between an NBMA network and a point-to-multipoint network are as follows:

In OSPF, an NBMA network refers to a non-broadcast multi-access network that is fully

meshed. A point-to-multipoint network may not be fully meshed.

A DR and a BDR must be elected on an NBMA network but are not involved on a point-to-multipoint network.

NBMA is a default network type. For example, if the link layer protocol is ATM, OSPF considers that the network type is NBMA by default no matter whether the network is fully meshed. Point-to-multipoint is not a default network type. No link layer protocol is viewed as a point-to-multipoint protocol. You can use this network type through a forcible change. An NBMA network that is not fully meshed is often changed to a point-to-multipoint network.

On an NBMA network, packets are transmitted in unicast mode, which requires you to configure neighbor relationship manually. On a point-to-multipoint network, packets are transmitted in multicast mode.

An Ethernet Switch uses Ethernet as the link layer protocol, so OSPF regards that the network type is broadcast. Do not change the network type of an Ethernet Switch at discretion.

Related configuration of OSPF interface

Operation	Command	Remarks
Enter interface configuration mode	interface {**vlan-interface** *vid* | **supervlan-interface** *id* }	
Set the network type of an interface.	**ip ospf network { broadcast | non-broadcast | point-to-multipoint | point-to-point }**	-
Restore the network type of an interface to the default value.	**no ip ospf network**	-
Set the cost of sending packets through a VLAN interface.	**ip ospf cost** *cost*	
Restore the packet sending cost of a VLAN interface to the default value.	**no ip ospf cost**	
Set the priority of an interface in DR election.	**ip ospf priority** *value*	
Restore the default priority of an interface.	**no ip ospf priority**	
Set the interval of sending Hello packets for	**ip ospf hello-interval** *seconds*	

an interface.		
Restore the interval of sending Hello packets for an interface to the default value.	**no ip ospf hello-interval**	
Set the timeout time of the neighboring router.	**ip ospf dead-interval** *seconds*	
Restore the timeout time of the neighboring router to the default value.	**no ip ospf dead-interval**	
Set the interval of LSA retransmission between two adjacent routers.	**ip ospf retransmit-interval** *seconds*	
Restore the interval of LSA retransmission between two adjacent routers to the default value.	**no ip ospf retransmit-interval**	
Set the time for sending a link state update packet.	**ip ospf transmit-delay** *seconds*	
Restore the time for sending a link state update packet to the default value.	**no ip ospf transmit-delay**	
Set a password for plaintext authentication.	**ip ospf authentication-key** *password*	
Disable plaintext authentication.	**no ip ospf authentication-key**	
Set a password for MD5 authentication.	**ip ospf message-digest-key** *key-id* **md5** *key*	
Disable MD5 authentication.	**no ip ospf message-digest-key**	

1.1.7 OSPF Area Related Configuration

A stub area is a special LSA area in which ABRs do not distribute the external routes they have received. In stub areas, both the size of routing tables and the amount of the routing information are drastically reduced.

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Any area that meets certain conditions can be configured into a stub area. Generally, a stub area is located at the border of an AS. It may be a non-backbone area with only one ABR or a non-backbone area with multiple ABRs between which no virtual connection is configured.

To make a stub area reachable for other ASs, the ABR in the stub area generates a default route (0.0.0.0) and advertises it to non-ABR routers in this area.

When configuring a stub area, note the following points:

A backbone area cannot be a stub area and a virtual connection is not allowed in a stub area.

All the routers in a stub area must be configured to indicate that they are located in a stub area.

No ASBR is allowed in a stub area, that is, routes from outside the AS where the stub area resides cannot be advertised within the stub area.

OSPF area related configuration

Operation	Command	Remarks
Enter OSPF protocol configuration mode	**router ospf**	
Configure a stub area.	**area *area-id* stub [no-summary]**	-
Cancel the stub area configuration.	**no area *area-id* stub**	-
Configure the cost of the default route to a stub area.	**area *area-id* default-cost *cost***	
Cancel the cost configuration for the default route to a stub area.	**no area *area-id* default-cost**	
Configure an NSSA area.	**area *area-id* nssa [no-summary]**	
Cancel the NSSA area configuration.	**no area *area-id* nssa**	
Configure the cost of the default route to an NSSA area.	**area *area-id* default-cost *cost***	
Cancel the cost configuration for the default route to an NSSA	**no area *area-id* default-cost**	

area.		
Configure route aggregation in an OSPF area.	**area** *area-id* **range** *address mask* **[advertise | notadvertise]**	
Remove route aggregation in an OSPF area.	**no area area-id range address mask**	
Configure external router aggregation and broadcast this aggregation.	**summary-address** *address mask* **tag** *value*	
Configure external router aggregation but not broadcast this aggregation.	**summary-address** *address mask* **notadvertise tag** *value*	
Cancel external router aggregation	**no summary-address** *address mask*	
Create and configures a virtual connection.	**area** *area-id* **virtual-link** *router-id* **[{ hello-interval** *seconds* **| retransmit-interval** *seconds* **| transmit-delay** *seconds* **| dead-interval** *seconds* **| { authentication-key** *password* **| message-digest-key** *keyid* **md5** *key* **} } *]**	
Cancel a virtual connection.	**no area** *area-id* **virtual-link** *router-id*	
Import routes of other protocols into OSPF.	**redistribute** *protocol* **[metric** *metric* **] [type { 1 | 2 }] [tag** *tag-value* **][prefix-list** *prefix-list-name***]**	
Disable the import of routes of other protocols into OSPF.	**no redistribute** *protocol*	
Import the default route to OSPF.	**default-information originate [always] [metric** *metric-value* **] [type** *type-value* **]**	
Disable the import of the default route.	**no default-information originate**	
Configures a default metric value for reception of external routes.	**default redistribute metric** *metric*	
Cancel the default metric value configuration for reception of external routes.	**no default redistribute metric**	
	default redistribute type { 1 | 2 }	

Configure the default type of external routes to be received.		
Cancel the default type configuration for the external routes to be received.	**no default redistribute type**	By default, the metric value is 1 and type is 2 for the external routes to be received by an OSPF router.
Filter the learned routes.	**ip ospf distribute-list prefix-list** *prefix-list-name* **in** no ip ospf distribute-list prefix-list in	interface configuration mode
Filter the advertised routes.	**ip ospf distribute-list prefix-list** *prefix-list-name* **out** no ip ospf distribute-list prefix-list out	interface configuration mode
Receive the routes from a specified neighboring Ethernet router.	**ip ospf distribute-list gateway** *prefix-list-name* **in** no ip ospf distribute-list gateway in	interface configuration mode
Enable BFD for link state monitoring.	**ip ospf bfd**	interface configuration mode
Disable BFD.	**no ip ospf bfd**	interface configuration mode

1.2 Configuration Example

！ To configure MD5 authentication for OSPF area 1, run the following command:

Switch(config-router-ospf)#area 0.0.0.1 authentication message-digest

！ To configure the cost of the default route 192.168.0.100 to 10, run the following command:

Switch(config-router-ospf)#area 192.168.0.100 default-cost 10

！ To aggregate the routes 202.38.160.0/24 and 202.38.180.0/24 into a route 202.38.0.0/16, run the following command:

Switch(config-router-ospf)#network 202.38.160.3 0.0.0.255 area 1.1.1.1

Switch(config-router-ospf)#network 202.38.180.3 0.0.0.255 area 1.1.1.1

Switch(config-router-ospf)#area 1.1.1.1 range 202.38.0.0 0.0.255.255

！ To configure area 1.1.1.1 as a stub area, run the following command:

Switch(config-router-ospf)#area 1.1.1.1 stub

！ To configure area 1.1.1.1 as an NSSA area, run the following command:

Switch(config-router-ospf)#area 1.1.1.1 nssa

！ To configure a virtual connection, for which the transit area is 1.1.1.1 and router-id of the peer router is 10.11.5.2, run the following command:

Switch(config-router-ospf)#area 1.1.1.1 virtual-link 10.11.5.2

！ To configure that an ASE LSA is generated for a default route if any, run the following command:

Switch(config-router-ospf)#default-information originate

！ To configure that an ASE LSA is generated for the default route and advertised to OSPF routing domains even if no default route exists, run the following command:

Switch(config-router-ospf)#default-information originate always

！ To set the default routing metric value of an imported external route to 10, run the following command:

Switch(config-router-ospf)#default redistribute metric 10

！ To configure that OSPF imports type 1 external routes by default, run the following command:

Switch(config-router-ospf)#default redistribute type 1

！ To set the password for plaintext authentication on VLAN interface 3 to abc123, run the following command:

Switch(config-if-vlanInterface-3)#ip ospf authentication-key abc123

！ To set the cost of running OSPF on VLAN interface 3 to 10, run the following command:

Switch(config-if-vlanInterface-3)#ip ospf cost 10

！ To set the timeout time of the neighboring router on VLAN interface 3 to 60s, run the following command:

Switch(config-if-vlanInterface-3)#ip ospf dead-interval 60

！ To set the interval of transmitting OSPF Hello packets for VLAN interface 3 to 15s, run the following command:

Switch(config-if-vlanInterface-3)#ip ospf hello-interval 15

！ To set the password for MD5 authentication on VLAN interface 3 to abc123, run the following command:

Switch(config-if-vlanInterface-3)#ip ospf message-digest-key 12 md5 abc123

！ To configure VLAN interface 2 as a non-broadcast interface, run the following command:

Switch(config-if-vlanInterface-2)#ip ospf network non-broadcast

！ To set the priority of VLAN interface 3 to 100, run the following command:

Switch(config-if-vlanInterface-3)#ip ospf priority 100

！ To set the interval of retransmitting LSAs between VLAN interface 3 and its adjacent routers to 8s, run the following command:

Switch(config-if-vlanInterface-3)#ip ospf retransmit-interval 8

！ To set the LSA transmission delay of VLAN interface 3 to 3s, run the following command:

Switch(config-if-vlanInterface-3)#ip ospf transmit-delay 3

！ To run OSPF on the interfaces whose primary IP address is 192.168.0.100 and inverse mask is 0.0.0.255 and set the ID of the area where these interfaces reside to 1.1.1.1, run the following command:

Switch(config-router-ospf)#network 192.168.0.100 0.0.0.255 area 1.1.1.1

！ To import RIP routes into OSPF, run the following command:

Switch(config-router-ospf)#redistribute rip

！ To use address prefix lists to match the routes learned by VLAN interface 2, run the following command:

Switch(config-if-vlanInterface-2)#ip ospf distribute-list prefix-list check in

！ To enable OSPF BFD on VLAN interface 2, run the following command:

 Switch(config-if-vlanInterface-2)#ip ospf bfd

！ To set the router ID of a switch to 192.168.0.100, run the following command:

Switch(config)#router id 192.168.0.100

！ To enable OSPF on a switch, run the following command:

Switch(config)#router ospf

！ To disable OSPF on a switch, run the following command:

Switch(config)#no router ospf

！ To display OSPF information, run the following command:

Switch(config)#show ip ospf

！ To display the information of OSPF border routers, run the following command:

Switch(config)#show ip ospf border-routers

Switch(config-if-vlanInterface-2)#show ip ospf cumulative

！ To display the information of OSPF LSDBs, run the following command:

Switch(config)#show ip ospf database

！ To display the information of OSPF errors, run the following command:

Switch(config-if-vlanInterface-2)#show ip ospf error

！ To display the information of OSPF interfaces, run the following command:

Switch(config)#show ip ospf interface

！ To display the information of all the OSPF neighbors, run the following command:

Switch(config)#show ip ospf neighbor

！ To display the information of an OSPF request list, run the following command:

Switch(config)#show ip ospf request-list

！ To display the information of an OSPF retransmission list, run the following command:

Switch(config)#show ip ospf retrans-list

！ To display the information of an OSPF virtual connection, run the following command:

Switch(config)#show ip ospf virtual-link

！ To display the router ID, run the following command:

Switch(config)#show router id

！ To display the configured prefix lists, run the following command:

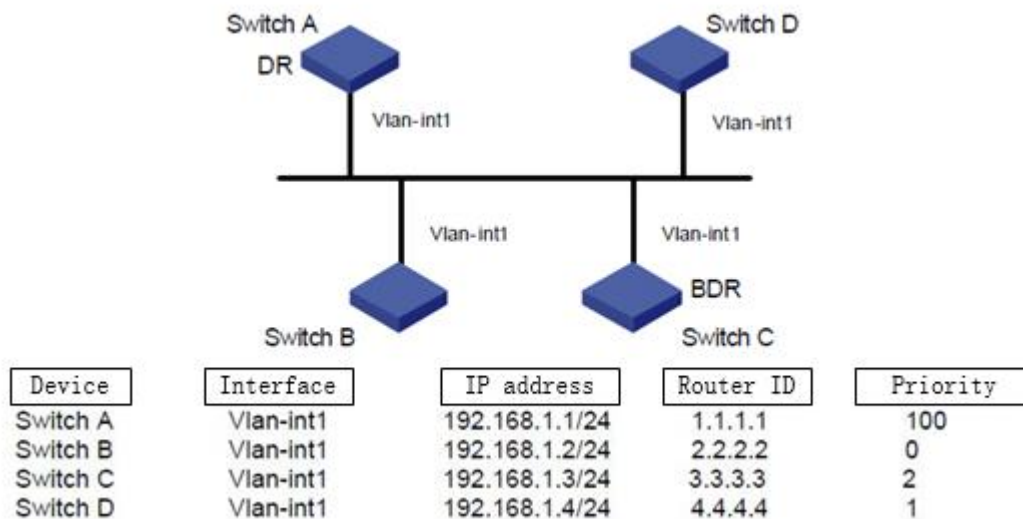Switch(config)#show ip ospf distribute-link

1.3 Application Example

A) Configure the DR selection of OSPF priority

1.Network requirements

SwitchA, SwitchB, SwitchC and SwitchD run OSPF protocol in the same network segment, as shown below. Make sure to perform the right configuration to ensure SwitchA to be DR, SwitchC to be BDR (SwitchA possesses the highest priority of 100, so it is selected as DR; SwitchC possesses the second highest priority of 2, so it is selected as BDR; the priority of SwitchB is 0, so it cannot be DR; SwitchD has no priority, so its value is 1 by default).

2. Network diagram

Network diagram for DR selection of OSPF priority

3. Configuration steps

(1). Configure SwitchA

Switch#configure terminal

Switch(config)#interface vlan-interface 1

Switch(config-if-vlanInterface-1)#ip address 192.168.1.1 255.255.255.0

Switch(config-if-vlanInterface-1)#exit

Switch(config)#router id 1.1.1.1

Switch(config)#router ospf

Switch(config-router-ospf)#network 192.168.1.1 0.0.0.255 area 0

Switch(config-router-ospf)#exit

Switch(config)#interface vlan-interface 1

Switch(config-if-vlanInterface-1)#ip ospf priority 100

Switch(config-if-vlanInterface-1)#

(2). Configure SwitchB

Switch#configure terminal

Switch(config)#interface vlan-interface 1

Switch(config-if-vlanInterface-1)#ip address 192.168.1.2 255.255.255.0

Switch(config-if-vlanInterface-1)#exit

Switch(config)#router id 2.2.2.2

Switch(config)#router ospf

Switch(config-router-ospf)#network 192.168.1.2 0.0.0.255 area 0

Switch(config-router-ospf)#exit

Switch(config)#interface vlan-interface 1

Switch(config-if-vlanInterface-1)#ip ospf priority 0

Switch(config-if-vlanInterface-1)#

(3). Configure SwitchC

Switch#configure terminal

Switch(config)#interface vlan-interface 1

Switch(config-if-vlanInterface-1)#ip address 192.168.1.3 255.255.255.0

Switch(config-if-vlanInterface-1)#exit

Switch(config)#router id 3.3.3.3

Switch(config)#router ospf

Switch(config-router-ospf)#network 192.168.1.3 0.0.0.255 area 0

Switch(config-router-ospf)#exit

Switch(config)#interface vlan-interface 1

Switch(config-if-vlanInterface-1)#ip ospf priority 2

Switch(config-if-vlanInterface-1)#

(4). Configure SwitchD

Switch#configure terminal

Switch(config)#interface vlan-interface 1

Switch(config-if-vlanInterface-1)#ip address 192.168.1.4 255.255.255.0

Switch(config-if-vlanInterface-1)#exit

Switch(config)#router id 4.4.4.4

Switch(config)#router ospf

Switch(config-router-ospf)#network 192.168.1.4 0.0.0.255 area 0

Switch(config-router-ospf)#exit

Switch(config)#

Run the command of show ip ospf neighbor in SwitchA to display OSPF neighbors. If the entire neighbor's state is "full", it means that SwitchA has adjoined with all its neighbors. SwitchA is DR, whereas SwitchC is BDR and all the other neighbors are DRother (DRother means that they are neither DR or BDR.)

Change the priority of SwitchB to be 200

Switch#configure terminal

Switch(config)#interface vlan-interface 1

Switch(config-if-vlanInterface-1)#ip ospf priority 0

Run the command of show ip ospf neighbor in SwitchA to display OSPF neighbors. The priority of SwitchB will become 200, but it is not the DR. Turn off SwitchA, and then run the command of show ip ospf neighbor in SwitchD to display OSPF neighbors. You will find SwitchC turns into DR while SwitchB becomes BDR.
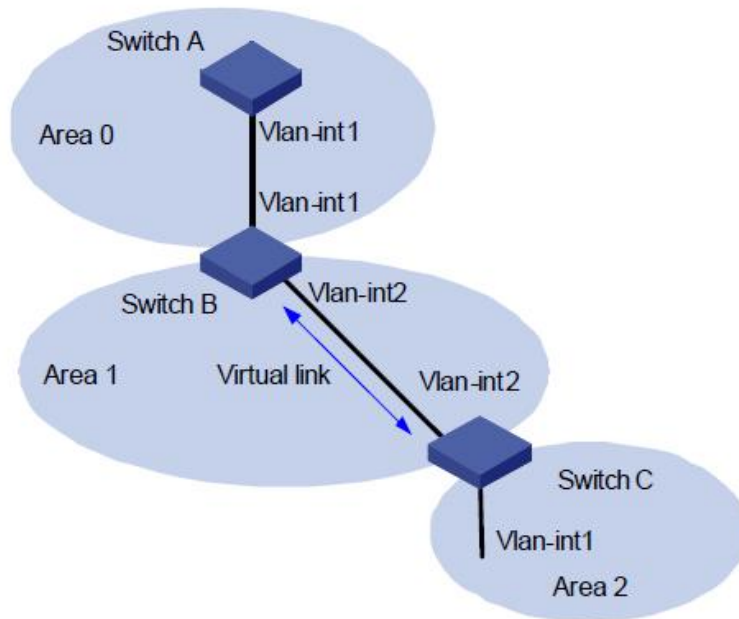
If all switches are moved away firstly and then added again, SwitchB will be selected to be DR with the priority of 200, and SwitchA will be selected to be BDR with the priority of 100. If you turn off all switches and then reboot the switches, it will have a new selection of DR/BDR.

B) Configure OSPF virtual connection

1. Network requirements

There is no direct connection between area 2 and area 0. Area 1 is asked to act as a transportation zone to connect area 2 with area 0. Therefore, there should be a virtual link between SwitchB and SwitchC in area 1.

2. Network diagram

设备	接口	IP 地址	Router ID
Switch A	Vlan-int1	192.168.1.1/24	1.1.1.1
Switch B	Vlan-int1	192.168.1.2/24	2.2.2.2
	Vlan-int2	193.168.1.2/24	
Switch C	Vlan-int1	155.100.1.1/24	3.3.3.3
	Vlan-int2	193.168.1.1/24	

Network diagram of OSPF virtual link

3. Configuration steps

(1). Configure SwitchA

Switch#configure terminal

Switch(config)#interface vlan-interface 1

Switch(config-if-vlanInterface-1)#ip address 192.168.1.1 255.255.255.0

Switch(config-if-vlanInterface-1)#exit

Switch(config)#router id 1.1.1.1

Switch(config)#router ospf

Switch(config-router-ospf)#network 192.168.1.1 0.0.0.255 area 0

Switch(config-router-ospf)#exit

Switch(config)#

(2) Configure SwitchB

Switch#configure terminal

Switch(config)#vlan 2

Switch(config-if-vlan)#exit

Switch(config)#interface vlan-interface 1

Switch(config-if-vlanInterface-1)#ip address 192.168.1.2 255.255.255.0

Switch(config-if-vlanInterface-1)#exit

Switch(config)#interface vlan-interface 2

Switch(config-if-vlanInterface-2)#ip address 193.168.1.2 255.255.255.0

Switch(config-if-vlanInterface-2)#exit

Switch(config)#router id 2.2.2.2

Switch(config)#router ospf

Switch(config-router-ospf)#network 192.168.1.2 0.0.0.255 area 0

Switch(config-router-ospf)#network 193.168.1.2 0.0.0.255 area 1

Switch(config-router-ospf)#area 1 virtual-link 3.3.3.3

Switch(config-router-ospf)#exit

Switch(config)#

(3) Configure SwitchC

Switch#configure terminal

Switch(config)#vlan 2

Switch(config-if-vlan)#exit

Switch(config)#interface vlan-interface 1

Switch(config-if-vlanInterface-1)#ip address 155.100.1.1 255.255.255.0

Switch(config-if-vlanInterface-1)#exit

Switch(config)#interface vlan-interface 2

Switch(config-if-vlanInterface-2)#ip address 193.168.1.1 255.255.255.0

Switch(config-if-vlanInterface-2)#exit

Switch(config)#router id 3.3.3.3

Switch(config)#router ospf

Switch(config-router-ospf)#network 155.100.1.1 0.0.0.255 area 2

Switch(config-router-ospf)#network 193.168.1.1 0.0.0.255 area 1

Switch(config-router-ospf)#area 1 virtual-link 2.2.2.2

Switch(config-router-ospf)#exit

Switch(config)#