2019/5/8 Security Level:

SUBNETTING & ROUTING PROTOCOLS

Huawei Turkey Enterprise & Openlab

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IP Address, Subnet Mask & Default Gateway

IP Address: The IP address is the identity of the devices connected to the network.

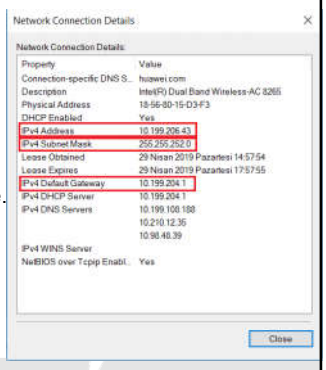
IP ADRESS: 10.199.206.43

Subnet Mask: Subnet Mask is used to separate and divide identity and identity groups.

1 is used to specify the network ID

0 is used to specify the Host ID.

SUBNET MASK: 255.255.255.0



Default Gateway: Gateway allows two different networks to communicate.

DEFAULT GATEWAY: 10.199.204.1

IPv4 & Subnetting

IP Addresses (IPv4) are 32-bit numbers.

1.Octet	2.Octet	3.Octet	4.Octet
00000000	00000000	00000000	00000000
11111111	11111111	11111111	11111111

1	1	1	1	1	1	1	1	
128	64	32	16	8	4	2	1	**= 255**

Example:

Q1-) 11000000.10101000.00000001 .00000101

Q2-) 00001010.00010100.00011110 .00101000

IPv4 & Subnetting-2

IP Ranges: 0.0.0.0 – 255.255.255.255

	Octet 1	Octet 2	Octet 3	Octet 4
Class A	Network	Host	Host	Host
Class B	Network	Network	Host	Host
Class C	Network	Network	Network	Host

CLASS	1.Octet Binary	Başlangıç IP	Bitiş IP	Varsayılan Alt Ağ Maskesi
A	00000000-01111110	0.0.0.0	126.255.255.255	255.0.0.0
B	10000000-10111111	128.0.0.0	191.255.255.255	255.255.0.0
C	11000000-11011111	192.0.0.0	223.255.255.255	255.255.255.0
D	11100000-11101111	224.0.0.0	239.255.255.255	
E	11110000-111111111	240.0.0.0	255.255.255.255	

Subnetting Table

Decimal	Bits	Common Use
255.255.255.252	30	2 host
255.255.255.248	29	6 host
255.255.255.240	28	14 host
255.255.255.224	27	30 host
255.255.255.192	26	32 host
255.255.255.128	25	126 host
255.255.255.0	24	254 host
255.255.254.0	23	510 host
255.255.252.0	22	1022 host
255.255.248.0	21	2046 host
255.255.240.0	20	4094 host
255.255.224.0	19	8190 host
255.255.192.0	18	16382 host
255.255.128.0	17	32766 host
255.255.0.0	16	65534 host

Subnetting Table-2

255.254.0.0	15	131.070 host
255.252.0.0	14	262.142 host
255.248.0.0	13	524.286 host
255.240.0.0	12	1.048.574 host
255.224.0.0	11	2.097.150 host
255.192.0.0	10	4.194.302 host
255.128.0.0	9	8.388.606 host
255.0.0.0	8	16.777.214 host

Classful Routing

A class subnet mask: 255.0.0.0
B class subnet mask: 255.255.0.0
C class subnet mask: 255.255.255.0

Classless Routing

172.20.0.0/16, 172.21.0.0/16, 172.22.0.0/16, 172.23.0.0/16

172.20.0.0 => 10101100 . 000101|00 . 00000000 . 00000000
172.21.0.0 => 10101100 . 000101|01 . 00000000 . 00000000
172.22.0.0 => 10101100 . 000101|10 . 00000000 . 00000000
172.23.0.0 => 10101100 . 000101|11 . 00000000 . 00000000
172 . 20 . 0 . 0 \14

Private IP Blocks

CLASS	Start IP	End IP
A	10.0.0.0	10.255.255.255
B	172.16.0.0	172.16.31.255
C	192.168.0.0	192.168.255.255

2^n -2 >= number of hosts on a subnet (First IP Subnet ID or Network ID last IP broadcast IP)

2^m >= subnet number

Example : 192.168.0.0 255.255.255.0 Let's split the network into 2 subnets.

11111111 11111111 11111111 00000000 = 255.255.255.0
11111111 11111111 11111111 10000000 = 255.255.255.128

Subnet ID	First IP Adres	Last IP Adres	Broadcast IP
192.168.0.0	192.168.0.1	192.168.0.126	192.168.0.127
192.168.0.128	192.168.0.129	192.168.0.254	192.168.0.255

Example 2: 192.168.0.0/24 Let's split the network into 6 subnets.

11111111 11111111 11111111 00000000 = 255.255.255.0

11111111 11111111 11111111 11100000 = 255.255.255.224

Subnet ID	First IP Adres	Last IP Adres	Broadcast IP
192.168.0.0	192.168.0.1	192.168.0.30	192.168.0.31
192.168.0.32	192.168.0.31	192.168.0.62	192.168.0.63
192.168.0.64	192.168.0.65	192.168.0.94	192.168.0.95
192.168.0.96	192.168.0.97	192.168.0.126	192.168.0.127
192.168.0.128	192.168.0.129	192.168.0.158	192.168.0.159
192.168.0.160	192.168.0.161	192.168.0.190	192.168.0.191
192.168.0.192	192.168.0.293	192.168.0.222	192.168.0.223
192.168.0.224	192.168.0.225	192.168.0.254	192.168.0.255

Proof:

11000000.10101000.00000000 .00011110 = 192.168.0.30

11111111.11111111.11111111.11100000 = 255.255.255.224

11000000.10101000.00000000.00000000 = 192.168.0.0

Layer-2 and Layer-3 Communication

LAYER-2

-Operate on layer 2 (Data link) of OSI model.

-Send packet to destination on the basis of MAC address.

-Can communicate within a network only.

-Quite fast as they do not look at the Layer 3 portion of the data packets.

LAYER-3

-Operate on layer 3 (Network Layer) of OSI model.

-Route Packet with help of IP address

-Can communicate within or outside network

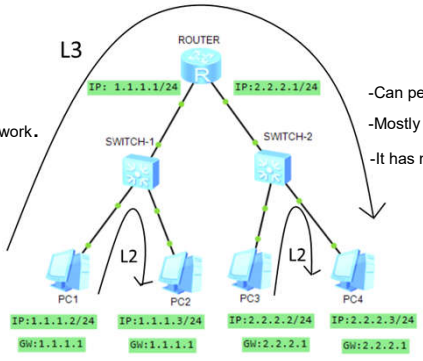
-Takes time to examine data packets before sending them to their destination

LAYER-2 SWITCH

-Work with MAC address only

-Used to reduce traffic on local network.

-It has single broadcast domain



LAYER-3 SWITCH

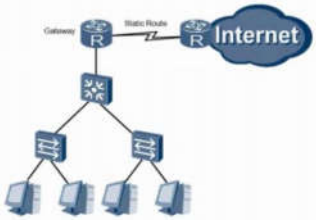
-Can perform functioning of both 2 layer and 3 layer switch

-Mostly Used to implement VLAN (Virtual Local area network)

-It has multiple broadcast domain.

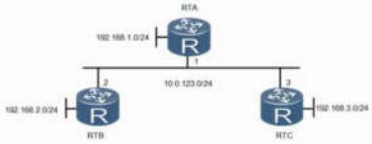
Static Route & Default Route

Application for Static Route



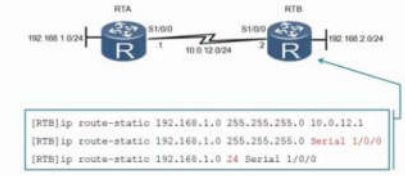
- Static routes define a means of path selection to other networks.

Static Route Behavior



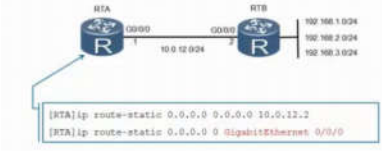
- The forwarding of packets over broadcast networks such as Ethernet, requires that the next hop be defined.

Configuring a Static Route



- A static route can be configured based on one of three variations.

Default Static Routes

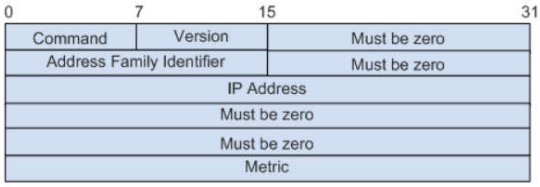


- Default routes provide a form of last resort route in the event that no other longest match is found within the routing table.

RIP (Routing Information Protocol)

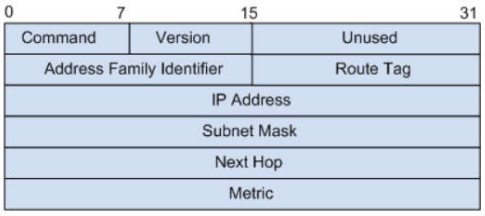
- Interior Gateway Protocol (IGP)
- Distance Vector Algorithm
- Use for small scale network

RIP-1



Classful routing protocol
Broadcast route updates
UDP 520 port send and receive packets
Metric (Hop count)

RIP-2

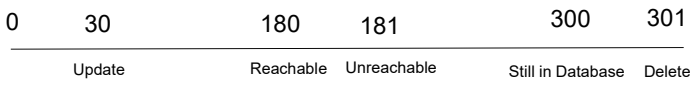


Classless routing protocol
Multicast route updates 224.0.0.9
UDP 520 port send and receive packets
Metric (Hop count)
Support external route tag, route summarization
Specified next hop and authentication (MD5)
Classless inter- domain routing (CIDR)

RIP (Routing Information Protocol)-2

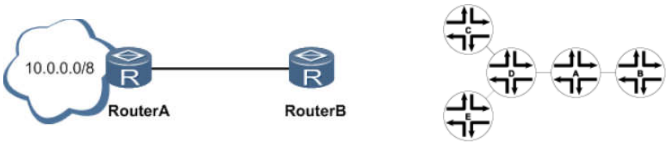
TIMERS

-Update timer (30 sec update interval)
-Aging timer (180 sec)
-Garbage collect timer (120 sec)



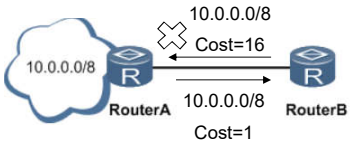
SPLIT HORIZON

-Prevent routing loops
-Disable by default
-Split horizon has to be enable



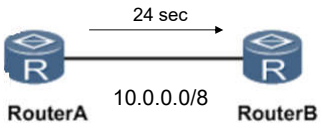
POISON REVERSE

-Prevent routing loops
-Disable by default
-Split horizon has to be enable

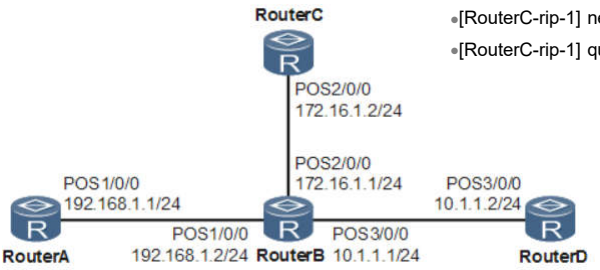


TRIGGER UPDATE

- When Routing information changes RIP device send an update packet to neighbors immediately
- Trigger update must be enable



RIP-Example



- [RouterC] rip
- [RouterC] version 2
- [RouterC-rip-1] network 172.16.0.0
- [RouterC-rip-1] quit

- [RouterA] rip
- [RouterA] version 2
- [RouterA-rip-1] network 192.168.1.0
- [RouterA-rip-1] quit

- [RouterB] rip
- [RouterB] version 2
- [RouterB-rip-1] network 192.168.1.0
- [RouterB-rip-1] network 172.16.0.0
- [RouterB-rip-1] network 10.0.0.0
- [RouterB-rip-1] quit

- [RouterD] rip
- [RouterD] version 2
- [RouterD-rip-1] network 10.0.0.0
- [RouterD-rip-1] quit

display rip 1 route

OSPF

- Link state Interior Gateway Protocol (IGP)
- SPF Algorithm
- Use for Enterprise network

Fundamentals of OSPF

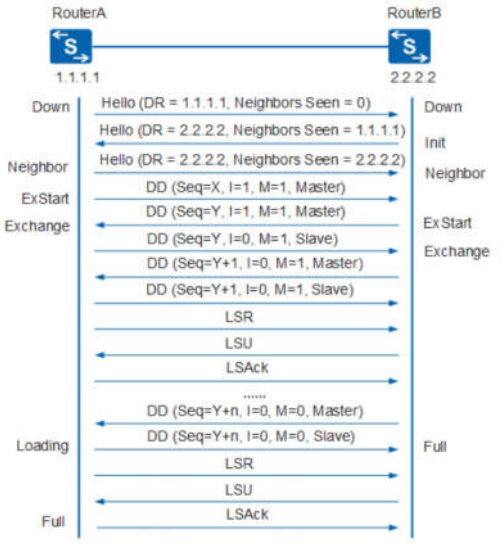
- Dividing an Autonomous System (AS) into one or multiple logical areas
- Advertising routes by sending Link State Advertisements (LSAs)
- Exchanging OSPF packets between devices in an OSPF area to synchronize routing information
- Encapsulating OSPF packets into IP packets and then sending the packets in unicast or multicast mode

Packet Types

Packet Type	Function
Hello packet	Sent periodically to discover and maintain OSPF neighbor relationships.
Database Description (DD) packet	Contains brief information about the local link-state database (LSDB) and synchronizes the LSDBs between two devices.
Link State Request (LSR) packet	Requests LSAs from neighbors. LSR packets are sent only after DD packets are successfully exchanged.
Link State Update (LSU) packet	Sends requested LSAs to neighbors.
Link State Acknowledgement (LSAck) packet	Acknowledges receipt of an LSA.

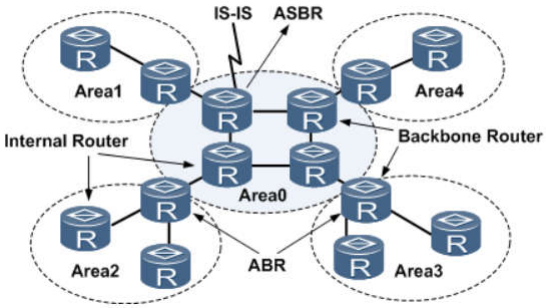
OSPF-2

Process of establishing an OSPF adjacency on a broadcast network



OSPF-3

Router Types



Router Type	Description
Internal router	All interfaces on an internal router belong to the same OSPF area.
Area Border Router (ABR)	An ABR belongs to two or more areas, one of which must be a backbone area. An ABR is used to connect the backbone area and non-backbone areas. It can be physically or logically connected to a backbone area.
Backbone router	One or more interfaces on a backbone router belong to a backbone area. Internal routers in Area 0 and all ABRs are backbone routers.
ASBR (AS Boundary Router)	An ASBR exchanges routing information with other ASs. An ASBR is not required to reside on the border of an AS. It may be an internal router or an ABR. An OSPF device that has imported external routing information becomes an ASBR.

OSPF-4

LSA Types

LSA Type	Function
Router-LSA (Type 1)	Describes the link status and link cost of a router. Every router generates and advertises Router-LSAs in its area.
Network-LSA (Type 2)	Describes the link status of all routers on the local network segment. A designated router (DR) generates and advertises Network-LSAs in its area.
Network-summary-LSA (Type 3)	Describes routes on a network segment. An Area Border Router (ABR) generates and advertises Network-summary-LSAs within the non-totally stub area and Not-So-Stubby Area (NSSA).
ASBR-summary-LSA (Type 4)	Describes routes to an Autonomous System Boundary Router (ASBR). An ABR generates and advertises ASBR-summary-LSAs to areas other than the area to which the ASBR belongs.
AS-external-LSA (Type 5)	Describes routes to a destination outside the AS. An ASBR generates and advertises AS-external-LSAs to all areas except stub areas and NSSAs.
NSSA-LSA (Type7)	Describes routes to a destination outside the AS. An ASBR generates and advertises NSSA-LSAs only in NSSAs.
Opaque-LSA (Type 9/Type 10/Type 11)	Provides a universal mechanism for OSPF extensions. • Type 9 LSAs are advertised only on the network segment where the originating interface resides. Grace LSAs used to support graceful restart (GR) are Type 9 LSAs. • Type 10 LSAs are advertised inside an OSPF area. LSAs used to support traffic engineering (TE) are Type 10 LSAs. • Type 11 LSAs are advertised within an AS. At present, there are no applications for Type 11 LSAs.

OSPF-5

Area Type	Function
Common area	By default, OSPF areas are common areas. Common areas include standard areas and backbone areas. • A standard area is the most prevalent area and transmits intra-area routes, inter-area routes, and external routes. • A backbone area connects all other OSPF areas; it is typically named Area 0.
Stub area	A stub area allows only intra-area and inter-area routes to be advertised within this area. In a stub area, a router maintains fewer routing entries in the routing table and transmits less routing information. To ensure reachability of AS external routes, ABRs in a stub area advertise Type 3 default routes to the entire stub area. All AS external routes must be advertised by ABRs.
Totally stub area	A totally stub area allows only intra-area routes to be advertised within this area. In a totally stub area, a router maintains fewer routing entries in the routing table and transmits less routing information. To ensure reachability of AS external and inter-area routes, ABRs in a totally stub area advertise Type 3 default routes to the entire totally stub area. All AS external and inter-area routes must be advertised by ABRs.
NSSA	An NSSA allows AS external routes to be imported to this area. ASBRs use Type 7 LSAs to advertise imported AS external routes to the entire NSSA. These Type 7 LSAs are then translated into Type 5 LSAs on ABRs and flooded within the entire AS. An NSSA area has the characteristics of a stub area within an AS. ABRs in an NSSA advertise Type 7 default routes to the entire NSSA. All inter-area routes must be advertised by ABRs.
Totally NSSA	A totally NSSA allows AS external routes to be imported to this area. ASBRs use Type 7 LSAs to advertise imported AS external routes to the entire NSSA. These Type 7 LSAs are then translated into Type 5 LSAs on ABRs and flooded within the entire AS. A totally NSSA area has the characteristics of a totally stub area within an AS. ABRs in a totally NSSA advertise Type 3 and Type 7 default routes to the entire totally NSSA. All inter-area routes must be advertised by ABRs.

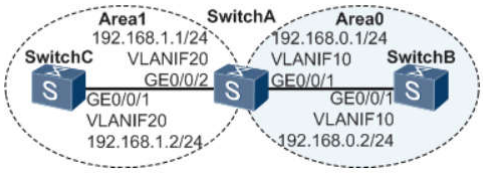
OSPF Authentication

-Based on interface

-Based on Areas

Null , Simple , MD5, HNAC-MD5

OSPF-Example



sysname SwitchA
vlan batch 10 20
interface Vlanif10
ip address 192.168.0.1 255.255.255.0
interface Vlanif20
ip address 192.168.1.1 255.255.255.0
interface GigabitEthernet0/0/1
port link-type trunk
port trunk allow-pass vlan 10
interface GigabitEthernet0/0/2
port link-type trunk
port trunk allow-pass vlan 20
ospf 1 router-id 10.1.1.1
area 0.0.0.0
authentication-mode md5 1 cipher huawei
network 192.168.0.0 0.0.0.255
area 0.0.0.1
authentication-mode md5 1 cipher huawei
network 192.168.1.0 0.0.0.255

sysname SwitchB
vlan batch 10
interface Vlanif10
ip address 192.168.0.2 255.255.255.0
interface GigabitEthernet0/0/1
port link-type trunk
port trunk allow-pass vlan 10
ospf 1 router-id 10.2.2.2
area 0.0.0.0
authentication-mode md5 1 cipher huawei
network 192.168.0.0 0.0.0.255

sysname SwitchC
vlan batch 20
interface Vlanif20
ip address 192.168.1.2 255.255.255.0
interface GigabitEthernet0/0/1
port link-type trunk
port trunk allow-pass vlan 20
ospf 1 router-id 10.3.3.3
area 0.0.0.1
authentication-mode md5 1 cipher huawei
network 192.168.1.0 0.0.0.255

Set the DR priority on each switch interface.

[SwitchA] interface vlanif 10
[SwitchA-Vlanif10] ospf dr-priority 100
<SwitchA> reset ospf 1 process

display ospf peer

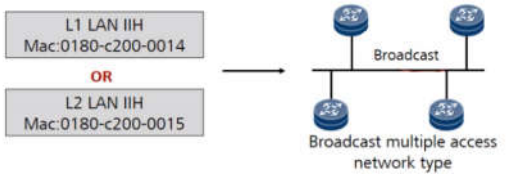
IS-IS

- Link state Interior Gateway Protocol (IGP)
- SPF Algorithm
- Use for large scale network

Router Types

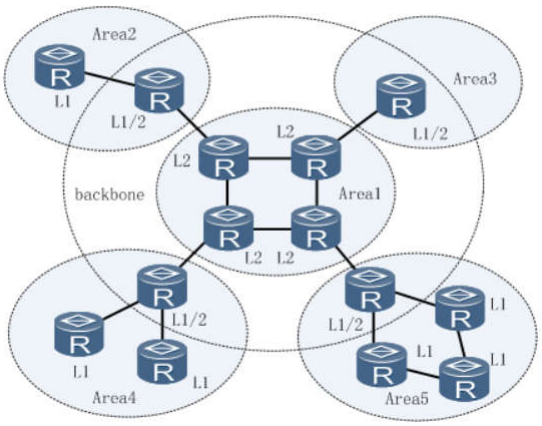
- IS-IS routers are classified into three types:
  - Level-1 router: supports only Level-1 LSDB.
  - Level-2 router: supports only Level-2 LSDB.
  - Level-1-2 router: is the default router type and supports both Level-1 and Level-2 LSDBs.

- Integrated IS-IS characteristics:
  - Works at the data link layer.
- OSPF characteristics:
  - Works at the IP layer.

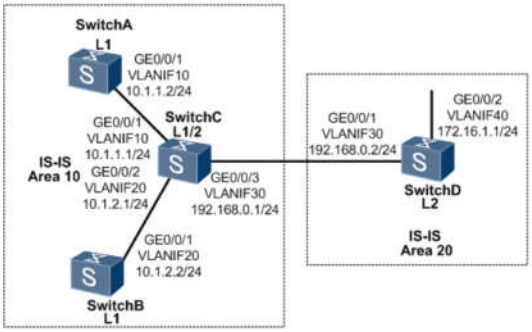


IS-IS-2

- IS-IS uses a two-level hierarchy (backbone area and non-backbone area) to support large-scale routing networks. Generally, Level-1 routers are deployed in non-backbone areas, whereas Level-2 and Level-1-2 routers are deployed in backbone areas. Each non-backbone area connects to the backbone area through a Level-1-2 router.



IS-IS Example




```
sysname SwitchA
vlan batch 10
isis 1
is-level level-1
network-entity 10.0000.0000.0001.00
interface Vlanif10
ip address 10.1.1.2 255.255.255.0
isis enable 1
interface GigabitEthernet0/0/1
port link-type trunk
port trunk allow-pass vlan 10
```

```
sysname SwitchB
vlan batch 20
sis 1
is-level level-1
network-entity 10.0000.0000.0002.00
interface Vlanif20
ip address 10.1.2.2 255.255.255.0
isis enable 1
interface GigabitEthernet0/0/1
port link-type trunk
port trunk allow-pass vlan 20
```

```
sysname SwitchC
vlan batch 10 20 30
isis 1
network-entity 10.0000.0000.0003.00
nterface Vlanif10
ip address 10.1.1.1 255.255.255.0
isis enable 1
interface Vlanif20
ip address 10.1.2.1 255.255.255.0
isis enable 1
interface Vlanif30
ip address 192.168.0.1
255.255.255.0
isis enable 1
interface GigabitEthernet0/0/1
port link-type trunk
port trunk allow-pass vlan 10
interface GigabitEthernet0/0/2
port link-type trunk
port trunk allow-pass vlan 20
interface GigabitEthernet0/0/3
port link-type trunk
port trunk allow-pass vlan 30
```

```
sysname SwitchD
vlan batch 30 40
isis 1
is-level level-2
network-entity
20.0000.0000.0004.00
interface Vlanif30
ip address 192.168.0.2
255.255.255.0
isis enable 1
interface Vlanif40
ip address 172.16.1.1
255.255.255.0
isis enable 1
interface GigabitEthernet0/0/1
port link-type trunk
port trunk allow-pass vlan 30
interface GigabitEthernet0/0/2
port link-type trunk
port trunk allow-pass vlan 40
```

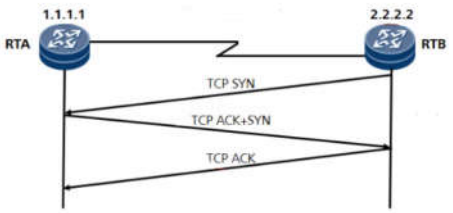
display isis route

BGP

-Exterior Gateway Protocol (EGP) - Optimal route between ASs - Use for large scale network

1- 64511 Public IS 64512-65535 Private IS

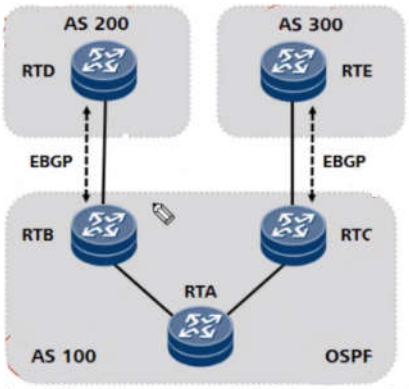
BGP Neighbor Discovery



- The device that starts BGP first initiates a TCP connection. In the figure, RTB first starts BGP and uses a random port number to initiate a TCP connection with port 179 of RTA.

BGP-2

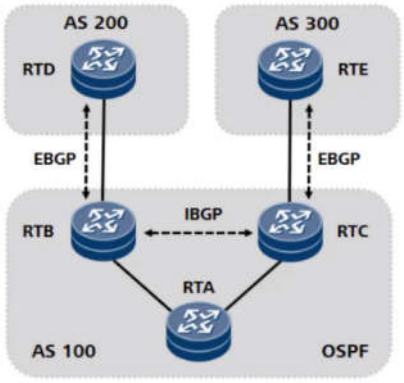
BGP Neighbor Type - EBGP



- BGP routers in different ASs establish EBGP neighbor relationships.

BGP-3

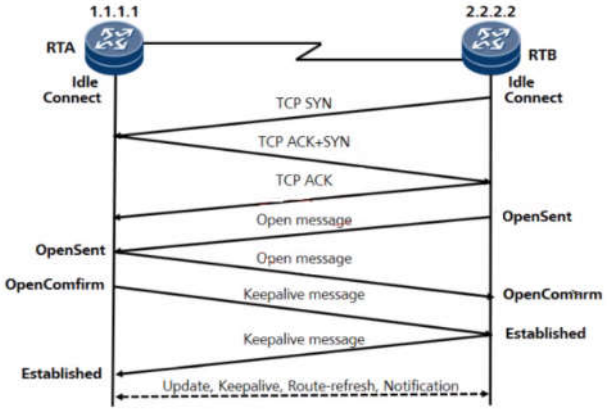
BGP Neighbor Type - IBGP



- BGP routers in the same AS establish IBGP neighbor relationships.

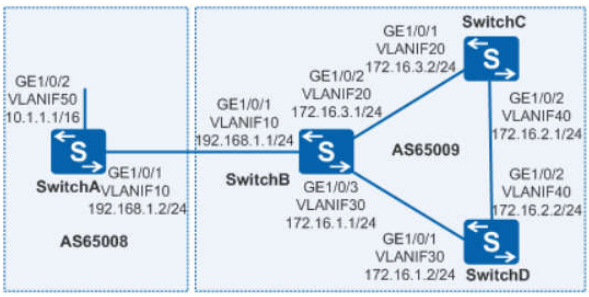
BGP-4

BGP Neighbor Relationship Establishment



BGP-Example

- BGP runs between Switches; an EBGP connection is established between SwitchA and SwitchB; IBGP full-mesh connections are established between SwitchB, SwitchC, and SwitchD.




```
sysname SwitchA
vlan batch 10 50
interface Vlanif10
 ip address 192.168.1.2 255.255.255.0
interface Vlanif50
 ip address 10.1.1.1 255.255.0.0
interface GigabitEthernet1/0/1
 port link-type trunk
 port trunk allow-pass vlan 10
interface GigabitEthernet1/0/2
 port link-type trunk
 port trunk allow-pass vlan 50
bgp 65008
 router-id 172.17.1.1
 peer 192.168.1.1 as-number 65009
 ipv4-family unicast
  undo synchronization
  network 10.1.0.0 255.255.0.0
  peer 192.168.1.1 enable
```

BGP-Example-2

```
sysname SwitchB
vlan batch 10 20 30
interface Vlanif10
 ip address 192.168.1.1
255.255.255.0
interface Vlanif20
 ip address 172.16.3.1
255.255.255.0
interface Vlanif30
 ip address 172.16.1.1
255.255.255.0
interface GigabitEthernet1/0/1
 port link-type trunk
 port trunk allow-pass vlan 10
interface GigabitEthernet1/0/2
 port link-type trunk
 port trunk allow-pass vlan 20
interface GigabitEthernet1/0/3
 port link-type trunk
 port trunk allow-pass vlan 30
```

```
bgp 65009
 router-id 172.17.2.2
 peer 172.16.1.2 as-number 65009
 peer 172.16.3.2 as-number 65009
 peer 192.168.1.2 as-number 65008
ipv4-family unicast
  undo synchronization
  import-route direct
  peer 172.16.1.2 enable
  peer 172.16.3.2 enable
  peer 192.168.1.2 enable
```

```
sysname SwitchC
vlan batch 20 40
interface Vlanif20
 ip address 172.16.3.2 255.255.255.0
interface Vlanif40
 ip address 172.16.2.1 255.255.255.0
interface GigabitEthernet1/0/1
 port link-type trunk
 port trunk allow-pass vlan 20
interface GigabitEthernet1/0/2
 port link-type trunk
 port trunk allow-pass vlan 40
bgp 65009
 router-id 172.17.3.3
 peer 172.16.2.2 as-number 65009
 peer 172.16.3.1 as-number 65009
 ipv4-family unicast
  undo synchronization
  peer 172.16.2.2 enable
  peer 172.16.3.1 enable
```

```
sysname SwitchD
vlan batch 30 40
interface Vlanif30
 ip address 172.16.1.2 255.255.255.0
interface Vlanif40
 ip address 172.16.2.2 255.255.255.0
interface GigabitEthernet1/0/1
 port link-type trunk
 port trunk allow-pass vlan 30
interface GigabitEthernet1/0/2
 port link-type trunk
 port trunk allow-pass vlan 40
bgp 65009
 router-id 172.17.4.4
 peer 172.16.1.1 as-number 65009
 peer 172.16.2.1 as-number 65009
 ipv4-family unicast
  undo synchronization
  peer 172.16.1.1 enable
  peer 172.16.2.1 enable
```

display bgp routing-table

Administrative Distance

Routing Protocol or Route Type	Default External Preference
Direct	0
OSPF	10
IS-IS	15
Static	60
RIP	100
OSPF ASE	150
OSPF NSSA	150
IBGP	255
EBGP	255

THANK YOU

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