
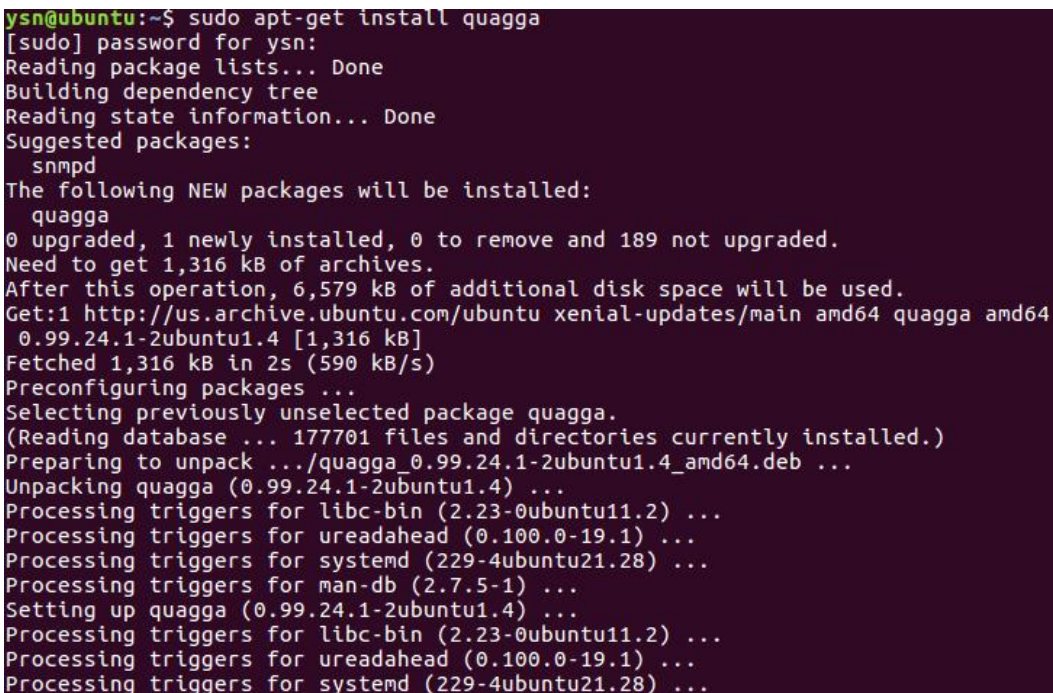


实验名称		BGP 实验	
姓名		学号	
所有实验均在 VMware 17.6.1 虚拟机环境下的 Ubuntu 16.04.7 系统中完成。			
实验步骤	一、Host1 设置		
	1、网卡编辑		
			
	2、安装 quagga		
			
	3、设置 IP 地址		

```

ysn@ubuntu:~$ sudo ifconfig ens33 192.168.0.1
ysn@ubuntu:~$ sudo ifconfig ens37 192.168.1.1
ysn@ubuntu:~$ ifconfig
ens33      Link encap:Ethernet  HWaddr 00:0c:29:06:32:6c
           inet addr:192.168.0.1  Bcast:192.168.0.255  Mask:255.255.255.0
           inet6 addr: fe80::9ecd:bae3:25b9:c834/64 Scope:Link
           UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
           RX packets:41663 errors:0 dropped:0 overruns:0 frame:0
           TX packets:3698 errors:0 dropped:0 overruns:0 carrier:0
           collisions:0 txqueuelen:1000
           RX bytes:61591874 (61.5 MB)  TX bytes:254267 (254.2 KB)

ens37      Link encap:Ethernet  HWaddr 00:0c:29:06:32:76
           inet addr:192.168.1.1  Bcast:192.168.1.255  Mask:255.255.255.0
           inet6 addr: fe80::20c:29ff:fe06:3276/64 Scope:Link
           UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
           RX packets:301 errors:0 dropped:0 overruns:0 frame:0
           TX packets:145 errors:0 dropped:0 overruns:0 carrier:0
           collisions:0 txqueuelen:1000
           RX bytes:39998 (39.9 KB)  TX bytes:23581 (23.5 KB)

lo         Link encap:Local Loopback
           inet addr:127.0.0.1  Mask:255.0.0.0
           inet6 addr: ::1/128 Scope:Host
           UP LOOPBACK RUNNING  MTU:65536  Metric:1
           RX packets:579 errors:0 dropped:0 overruns:0 frame:0
           TX packets:579 errors:0 dropped:0 overruns:0 carrier:0
           collisions:0 txqueuelen:1000
           RX bytes:59001 (59.0 KB)  TX bytes:59001 (59.0 KB)

```

4、修改 daemons 文件

```

ysn@ubuntu:/$ sudo gedit /etc/quagga/daemons

(gedit:9412): IBUS-WARNING **: The owner of /home/ysn/.config/ibus/bus is not root!

(gedit:9412): IBUS-WARNING **: Unable to connect to ibus: Unexpected lack of content trying to read a line

#
zebra=yes
bgpd=yes
ospfd=no
ospf6d=no
ripd=no
ripngd=no
isisd=no
babeld=no

```

5、生成 zebra 和 ospfd 配置文件并初始化

```

ysn@ubuntu:/$ cd /etc/quagga/
ysn@ubuntu:/etc/quagga$ sudo touch zebra.conf bgpd.conf
ysn@ubuntu:/etc/quagga$ sudo chown quagga:quagga zebra.conf bgpd.conf

```

```
ysn@ubuntu:/etc/quagga$ sudo gedit zebra.conf
```


```
(gedit:9435): IBUS-WARNING **: The owner of /home/ysn/.config/ibus/bus is not root!
```

```
(gedit:9435): IBUS-WARNING **: Unable to connect to ibus: Unexpected lack of content trying to read a line
```

```
(gedit:9435): Gtk-WARNING **: Calling Inhibit failed: GDBus.Error:org.freedesktop.DBus.Error.ServiceUnknown: The name org.gnome.SessionManager was not provided by any .service files
```

```
** (gedit:9435): WARNING **: Set document metadata failed: Setting attribute metadata::gedit-spell-enabled not supported
```

```
** (gedit:9435): WARNING **: Set document metadata failed: Setting attribute metadata::gedit-encoding not supported
```

Open ▾  zebra.conf
/etc/quagga

password zebra

```
ysn@ubuntu:/etc/quagga$ sudo gedit bgpd.conf
```


```
(gedit:9452): IBUS-WARNING **: The owner of /home/ysn/.config/ibus/bus is not root!
```

```
(gedit:9452): IBUS-WARNING **: Unable to connect to ibus: Unexpected lack of content trying to read a line
```

```
(gedit:9452): Gtk-WARNING **: Calling Inhibit failed: GDBus.Error:org.freedesktop.DBus.Error.ServiceUnknown: The name org.gnome.SessionManager was not provided by any .service files
```

```
** (gedit:9452): WARNING **: Set document metadata failed: Setting attribute metadata::gedit-spell-enabled not supported
```

```
** (gedit:9452): WARNING **: Set document metadata failed: Setting attribute metadata::gedit-encoding not supported
```

Open ▾  bgpd.conf
/etc/quagga

password bgp

6、启动 quagga

```
ysn@ubuntu:/etc/quagga$ sudo /etc/init.d/quagga start  
[ ok ] Starting quagga (via systemctl): quagga.service.
```

```
ysn@ubuntu:/etc/quagga$ sudo telnet localhost 2601
```

```
Trying 127.0.0.1...
```

```
telnet: Unable to connect to remote host: Connection refused
```

```
ysn@ubuntu:/etc/quagga$ sudo /etc/init.d/quagga restart  
[ ok ] Restarting quagga (via systemctl): quagga.service.
```

7、配置 zebra


```
ysn@ubuntu:/etc/quagga$ sudo telnet localhost 2601
Trying 127.0.0.1...
Connected to localhost.
Escape character is '^]'.
```

```
Hello, this is Quagga (version 0.99.24.1).
Copyright 1996-2005 Kunihiro Ishiguro, et al.
```

```
User Access Verification
```

```
Password:
Password:
Password:
ubuntu> enable
ubuntu# configure terminal
ubuntu(config)# interface ens33
% [ZEBRA] Unknown command: interface ens33
ubuntu(config)# interface ens33
ubuntu(config-if)# ip address 192.168.0.1/24
ubuntu(config-if)# no shutdown
ubuntu(config-if)# interface ens37
ubuntu(config-if)# ip address 192.168.1.1/24
ubuntu(config-if)# no shutdown
ubuntu(config-if)# write
Configuration saved to /etc/quagga/zebra.conf
ubuntu(config-if)# exit
ubuntu(config)# exit
ubuntu# exit
Connection closed by foreign host.
```

8、配置 bgp

```
ysn@ubuntu:/etc/quagga$ sudo telnet localhost 2605
Trying 127.0.0.1...
Connected to localhost.
Escape character is '^]'.
```

```
Hello, this is Quagga (version 0.99.24.1).
Copyright 1996-2005 Kunihiro Ishiguro, et al.
```

```
User Access Verification
```

```
Password:
ubuntu> enable
ubuntu# configure terminal
ubuntu(config)# router bgp 100
ubuntu(config-router)# network 192.168.1.0/24
ubuntu(config-router)# neighbor 192.168.0.2 remote-as 200
ubuntu(config-router)# neighbor 192.168.0.2 description "two"
ubuntu(config-router)# write
Configuration saved to /etc/quagga/bgpd.conf
ubuntu(config-router)# exit
ubuntu(config)# exit
ubuntu# exit
Connection closed by foreign host.
```

二、Host2 设置

与 Host1 基本一致，命令上的区别如下图所示：

```
ysn@ubuntu:~$ sudo ifconfig ens33 192.168.0.2
ysn@ubuntu:~$ sudo ifconfig ens37 192.168.2.1

ysn@ubuntu:/etc/quagga$ sudo telnet localhost 2601
Trying 127.0.0.1...
Connected to localhost.
Escape character is '^]'.

Hello, this is Quagga (version 0.99.24.1).
Copyright 1996-2005 Kunihiro Ishiguro, et al.

User Access Verification

Password:
ubuntu> enable
ubuntu# interface ens33
% [ZEBRA] Unknown command: interface ens33
ubuntu# configure terminal
ubuntu(config)# ip address 192.168.0.2/24
% [ZEBRA] Unknown command: ip address 192.168.0.2/24
ubuntu(config)# interface ens33
ubuntu(config-if)# ip address 192.168.0.2/24
ubuntu(config-if)# interface ens37
ubuntu(config-if)# ip address 192.168.2.1/24
ubuntu(config-if)# no shutdown
ubuntu(config-if)# write
Configuration saved to /etc/quagga/zebra.conf
ubuntu(config-if)# quit
ubuntu(config)# quit
ubuntu# quit
Connection closed by foreign host.
```

```

ysn@ubuntu:/etc/quagga$ sudo telnet localhost 2605
Trying 127.0.0.1...
Connected to localhost.
Escape character is '^]'.

Hello, this is Quagga (version 0.99.24.1).
Copyright 1996-2005 Kunihiro Ishiguro, et al.

User Access Verification

Password:
ubuntu> enable
ubuntu# configure terminal
ubuntu(config)# router bgp 200
ubuntu(config-router)# network 192.168.2.0/24
ubuntu(config-router)# neighbor 192.168.0.1 remote-as 100
ubuntu(config-router)# neighbor 192.168.0.1 description "one"
ubuntu(config-router)# write
Configuration saved to /etc/quagga/bgpd.conf
ubuntu(config-router)# quit
ubuntu(config)# quit
ubuntu# quit
Connection closed by foreign host.

```

三、检查路由表

1、重启 quagga 服务

```

ysn@ubuntu:/etc/quagga$ sudo /etc/init.d/quagga restart
[ ok ] Restarting quagga (via systemctl): quagga.service.

```

2、Host1 路由表

```

ysn@ubuntu:/etc/quagga$ sudo route
Kernel IP routing table

```

Destination	Gateway	Genmask	Flags	Metric	Ref	Use	Iface
link-local	*	255.255.0.0	U	1000	0	0	ens37
192.168.0.0	*	255.255.255.0	U	0	0	0	ens33
192.168.1.0	*	255.255.255.0	U	0	0	0	ens37
192.168.2.0	192.168.0.2	255.255.255.0	UG	0	0	0	ens33

3、Host2 路由表

```

ysn@ubuntu:/etc/quagga$ sudo route
Kernel IP routing table

```

Destination	Gateway	Genmask	Flags	Metric	Ref	Use	Iface
link-local	*	255.255.0.0	U	1000	0	0	ens37
192.168.0.0	*	255.255.255.0	U	0	0	0	ens33
192.168.1.0	192.168.0.1	255.255.255.0	UG	0	0	0	ens33
192.168.2.0	*	255.255.255.0	U	0	0	0	ens37

一、观察 OPEN 报文:

No.	Time	Source	Destination	Protocol	Length	Info
12	9.037681645	192.168.0.1	192.168.0.2	BGP	125	OPEN Message
18	10.552547660	192.168.0.2	192.168.0.1	BGP	125	OPEN Message
20	10.552789717	192.168.0.1	192.168.0.2	BGP	144	OPEN Message, KEEPALIVE Message
22	10.553136184	192.168.0.2	192.168.0.1	BGP	104	KEEPALIVE Message, KEEPALIVE Message

Transmission Control Protocol, Src Port: 45494, Dst Port: 179, Seq: 1, Ack: 1, Len: 59

Source Port: 45494

Destination Port: 179

[Stream index: 1]

[TCP Segment Len: 59]

Sequence number: 1 (relative sequence number)

[Next sequence number: 60 (relative sequence number)]

Acknowledgment number: 1 (relative ack number)

1000 = Header Length: 32 bytes (8)

Flags: 0x018 (PSH, ACK)

Window size value: 502

[Calculated window size: 64256]

[Window size scaling factor: 128]

Checksum: 0x81b5 [unverified]

[Checksum Status: Unverified]

Urgent pointer: 0

Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps

[SEQ/ACK analysis]

[Timestamps]

TCP payload (59 bytes)

Border Gateway Protocol - OPEN Message

Marker: ffffffffffffffffffffffffffffffff

Length: 59

Type: OPEN Message (1)

Version: 4

My AS: 100

Hold Time: 180

BGP Identifier: 192.168.1.1

Optional Parameters Length: 30

Optional Parameters

Optional Parameter: Capability

Parameter Type: Capability (2)

Parameter Length: 6

Capability: Multiprotocol extensions capability

Optional Parameter: Capability

Parameter Type: Capability (2)

Parameter Length: 2

Capability: Route refresh capability (Cisco)

Optional Parameter: Capability

Parameter Type: Capability (2)

Parameter Length: 2

Capability: Route refresh capability

Optional Parameter: Capability

Parameter Type: Capability (2)

Parameter Length: 6

Capability: Support for 4-octet AS number capability

Optional Parameter: Capability

(1) 传输协议层 TCP 中的端口号是否为 179?

是的, BGP 协议使用 TCP 179 端口进行通信。这是 BGP 的默认传输端口。

(2) Marker 字段的值是否全为 1?所观察到的值代表什么含义?

Marker 字段的值确实全为 1。这是一个固定的字段, 在 BGP 报文中用于标识 BGP 消息的起始, 并用于在 BGP 会话中验证数据完整性。它的值全为 1 是为了确保 BGP 消息的一致性和标识性, 帮助识别错误或篡改的消息。

(3) Length 字段的值?OPEN 报文各个字段的总长度?二者是否相等。

Length 字段的值为 59, OPEN 报文各个字段的总长度为 59, 二者相等。

(4) Type 字段的值是否与 OPEN 报文的类型值对应。

Type 字段的值为 1, 与 OPEN 报文的类型值对应, 因为 OPEN 报文在 BGP 中是第 1 类型的报文。

(5) Version 字段是否为 4?

是的。BGP 使用版本号 4 作为标准。

(6) 观察 My As 字段, Hold Time 字段, IP 地址字段, 确认这个 OPEN 报文发送者所在的 AS 号, 建议的保持时间, 以及 IP 地址。

OPEN 报文发送者所在的 AS 号为 100, 建议的保持时间为 180 秒, IP 地址为 192.168.1.1。

二、观察 KEEPALIVE 报文。

No.	Time	Source	Destination	Protocol	Length	Info
22	10.553136184	192.168.0.2	192.168.0.1	BGP	104	KEEPALIVE Message, KEEPALIVE Message
23	10.553183597	192.168.0.1	192.168.0.2	BGP	85	KEEPALIVE Message
25	11.553365099	192.168.0.1	192.168.0.2	BGP	144	UPDATE Message, UPDATE Message
27	11.553852562	192.168.0.2	192.168.0.1	BGP	144	UPDATE Message, UPDATE Message
▶ Frame 23: 85 bytes on wire (680 bits), 85 bytes captured (680 bits) on interface 0 ▶ Ethernet II, Src: Vmware_06:32:6c (00:0c:29:06:32:6c), Dst: Vmware_61:59:97 (00:0c:29:61:59:97) ▶ Internet Protocol Version 4, Src: 192.168.0.1, Dst: 192.168.0.2 ▼ Transmission Control Protocol, Src Port: 179, Dst Port: 47394, Seq: 79, Ack: 98, Len: 19 Source Port: 179 Destination Port: 47394 [Stream index: 2] [TCP Segment Len: 19] Sequence number: 79 (relative sequence number) [Next sequence number: 98 (relative sequence number)] Acknowledgment number: 98 (relative ack number) 1000 = Header Length: 32 bytes (8) Flags: 0x018 (PSH, ACK) Window size value: 509 [Calculated window size: 65152] [Window size scaling factor: 128] Checksum: 0x818d [unverified] [Checksum Status: Unverified] Urgent pointer: 0 Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps ▶ [SEQ/ACK analysis] ▶ [Timestamps] TCP payload (19 bytes) ▼ Border Gateway Protocol - KEEPALIVE Message Marker: ffffffffffffffffffffffffffffffff Length: 19 Type: KEEPALIVE Message (4)						

端口号为 179 端口; Marker 字段全为 1; Length 字段为 19 字节; Type 字段为 4, 表示 KEEPALIVE 类型。

三、观察 UPDATE 报文, 重启 quagga。

No.	Time	Source	Destination	Protocol	Length	Info
22	10.553136184	192.168.0.2	192.168.0.1	BGP	104	KEEPALIVE Message, KEEPALIVE Message
23	10.553183597	192.168.0.1	192.168.0.2	BGP	85	KEEPALIVE Message
25	11.553365099	192.168.0.1	192.168.0.2	BGP	144	UPDATE Message, UPDATE Message
27	11.553852562	192.168.0.2	192.168.0.1	BGP	144	UPDATE Message, UPDATE Message
▶ Frame 25: 144 bytes on wire (1152 bits), 144 bytes captured (1152 bits) on interface 0 ▶ Ethernet II, Src: Vmware_06:32:6c (00:0c:29:06:32:6c), Dst: Vmware_61:59:97 (00:0c:29:61:59:97) ▶ Internet Protocol Version 4, Src: 192.168.0.1, Dst: 192.168.0.2 ▼ Transmission Control Protocol, Src Port: 179, Dst Port: 47394, Seq: 98, Ack: 98, Len: 78 Source Port: 179 Destination Port: 47394 [Stream index: 2] [TCP Segment Len: 78] Sequence number: 98 (relative sequence number) [Next sequence number: 176 (relative sequence number)] Acknowledgment number: 98 (relative ack number) 1000 = Header Length: 32 bytes (8) Flags: 0x018 (PSH, ACK) Window size value: 509 [Calculated window size: 65152] [Window size scaling factor: 128] Checksum: 0x81c8 [unverified] [Checksum Status: Unverified] Urgent pointer: 0 Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps ▶ [SEQ/ACK analysis] ▶ [Timestamps] TCP payload (78 bytes) ▼ Border Gateway Protocol - UPDATE Message Marker: ffffffffffffffffffffffffffffffff Length: 55 Type: UPDATE Message (2) Withdrawn Routes Length: 0 Total Path Attribute Length: 28 ▶ Path attributes ▶ Network Layer Reachability Information (NLRI) ▼ Border Gateway Protocol - UPDATE Message Marker: ffffffffffffffffffffffffffffffff Length: 23 Type: UPDATE Message (2) Withdrawn Routes Length: 0 Total Path Attribute Length: 0						

端口号为 179 端口; Marker 字段全为 1; Length 字段为 55+23 字节; Type 字段为 2, 表示 UPDATE 类型。

四、观察 NOTIFICATION 报文。

No.	Time	Source	Destination	Protocol	Length	Info
8	5.177424134	Vmware_06:32:6c	Vmware_06:32:6c	ARP	60	192.168.0.2 is at 00:0c:29:61:59:97
1	0.000000000	192.168.0.1	192.168.0.2	BGP	87	NOTIFICATION Message
2	0.000195872	192.168.0.1	192.168.0.2	BGP	87	NOTIFICATION Message
12	9.037681645	192.168.0.1	192.168.0.2	BGP	125	OPEN Message
▶ Frame 1: 87 bytes on wire (696 bits), 87 bytes captured (696 bits) on interface 0 Ethernet II, Src: Vmware_06:32:6c (00:0c:29:06:32:6c), Dst: Vmware_61:59:97 (00:0c:29:61:59:97) ▶ Internet Protocol Version 4, Src: 192.168.0.1, Dst: 192.168.0.2 ▼ Transmission Control Protocol, Src Port: 179, Dst Port: 47392, Seq: 1, Ack: 1, Len: 21 Source Port: 179 Destination Port: 47392 [Stream index: 0] [TCP Segment Len: 21] Sequence number: 1 (relative sequence number) [Next sequence number: 22 (relative sequence number)] Acknowledgment number: 1 (relative ack number) 1000 = Header Length: 32 bytes (8) Flags: 0x018 (PSH, ACK) Window size value: 509 [Calculated window size: 509] [Window size scaling factor: -1 (unknown)] Checksum: 0x818f [unverified] [Checksum Status: Unverified] Urgent pointer: 0 Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps [SEQ/ACK analysis] [Timestamps] TCP payload (21 bytes) ▼ Border Gateway Protocol - NOTIFICATION Message Marker: ffffffffffffffffffffffffffffffffff Length: 21 Type: NOTIFICATION Message (3) Major error Code: Cease (6) Minor error Code (Cease): Peer De-configured (3)						

端口号为 179 端口; Marker 字段全为 1; Length 字段为 21 字节; Type 字段为 3, 表示 NOTIFICATION 类型。

五、部分示例数据

No.	Time	Source	Destination	Protocol	Length	Info
5	5.172773798	Vmware_06:32:6c	Vmware_06:32:6c	ARP	60	Who has 192.168.0.1? Tell 192.168.0.2
6	5.172788931	Vmware_06:32:6c	Vmware_06:32:6c	ARP	42	192.168.0.1 is at 00:0c:29:06:32:6c
7	5.176723995	Vmware_06:32:6c	Vmware_06:32:6c	ARP	42	Who has 192.168.0.2? Tell 192.168.0.1
8	5.177424134	Vmware_06:32:6c	Vmware_06:32:6c	ARP	60	192.168.0.2 is at 00:0c:29:61:59:97
1	0.000000000	192.168.0.1	192.168.0.2	BGP	87	NOTIFICATION Message
2	0.000195872	192.168.0.1	192.168.0.2	BGP	87	NOTIFICATION Message
12	9.037681645	192.168.0.1	192.168.0.2	BGP	125	OPEN Message
10	10.552547600	192.168.0.2	192.168.0.1	BGP	125	OPEN Message
20	10.552789717	192.168.0.1	192.168.0.2	BGP	144	OPEN Message, KEEPALIVE Message
22	10.553136184	192.168.0.2	192.168.0.1	BGP	104	KEEPALIVE Message, KEEPALIVE Message
23	10.553183591	192.168.0.1	192.168.0.2	BGP	85	KEEPALIVE Message
25	11.553365099	192.168.0.1	192.168.0.2	BGP	144	UPDATE Message, UPDATE Message
27	11.553852502	192.168.0.2	192.168.0.1	BGP	144	UPDATE Message, UPDATE Message
3	0.000254209	192.168.0.1	192.168.0.2	TCP	66	179 → 47392 [FIN, ACK] Seq=1 Ack=1 Win=509 Len=0 TSval=1399829112 TSecr=834415023
4	0.000825420	192.168.0.2	192.168.0.1	TCP	66	47392 → 179 [RST, ACK] Seq=1 Ack=44 Win=502 Len=0 TSval=834475008 TSecr=1399829112
9	0.037047485	192.168.0.1	192.168.0.2	TCP	74	45494 → 179 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 SACK_PERM=1 TSval=1399838149 TSecr=0 WS=128
13	0.037693892	192.168.0.2	192.168.0.1	TCP	74	179 → 45494 [SYN, ACK] Seq=0 Win=64240 Len=0 MSS=1460 SACK_PERM=1 TSval=1399838149 TSecr=1399838149 WS=128
11	0.037583850	192.168.0.1	192.168.0.2	TCP	66	45494 → 179 [ACK] Seq=1 Ack=1 Win=64256 Len=0 TSval=1399838150 TSecr=834480445
13	0.038049220	192.168.0.2	192.168.0.1	TCP	66	179 → 45494 [ACK] Seq=1 Ack=60 Win=65152 Len=0 TSval=834484045 TSecr=1399838150
14	0.038092001	192.168.0.2	192.168.0.1	TCP	66	179 → 45494 [RST, ACK] Seq=1 Ack=60 Win=65152 Len=0 TSval=834484045 TSecr=1399838150
15	10.552243719	192.168.0.2	192.168.0.1	TCP	74	47394 → 179 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 SACK_PERM=1 TSval=834485559 TSecr=0 WS=128
16	10.552207239	192.168.0.1	192.168.0.2	TCP	74	179 → 47394 [SYN, ACK] Seq=0 Ack=1 Win=65160 Len=0 MSS=1460 SACK_PERM=1 TSval=1399839664 TSecr=834485559 WS=128
17	10.552302483	192.168.0.2	192.168.0.1	TCP	66	47394 → 179 [ACK] Seq=1 Ack=1 Win=64256 Len=0 TSval=834485560 TSecr=1399839664
19	10.552550688	192.168.0.1	192.168.0.2	TCP	66	179 → 47394 [ACK] Seq=1 Ack=60 Win=65152 Len=0 TSval=1399839665 TSecr=834485560
21	10.553131527	192.168.0.2	192.168.0.1	TCP	66	47394 → 179 [ACK] Seq=60 Ack=79 Win=64256 Len=0 TSval=834485560 TSecr=1399839665
24	10.590533654	192.168.0.2	192.168.0.1	TCP	66	47394 → 179 [ACK] Seq=98 Ack=98 Win=64256 Len=0 TSval=834485604 TSecr=1399839665
26	11.553843414	192.168.0.2	192.168.0.1	TCP	66	47394 → 179 [ACK] Seq=98 Ack=176 Win=64256 Len=0 TSval=834486561 TSecr=1399840665
28	11.590638495	192.168.0.1	192.168.0.2	TCP	66	179 → 47394 [ACK] Seq=176 Ack=176 Win=65152 Len=0 TSval=1399840709 TSecr=834486561
29	19.074919121	10.81.0.62	239.255.255.250	SSDP	219	M-SEARCH * HTTP/1.1
30	19.044790077	10.81.0.62	224.0.0.251	MDNS	234	Standard query response 0x0000 PTR LAPTOP-05QND3DR._dosvc._tcp.local SRV 0 0 7680 LAPTOP-05QND3DR.local TXT
31	19.045223207	fe80::537f:b538:e433::ff02::fb	ff02::fb	MDNS	254	Standard query response 0x0000 PTR LAPTOP-05QND3DR._dosvc._tcp.local SRV 0 0 7680 LAPTOP-05QND3DR.local TXT
32	19.045223207	fe80::537f:b538:e433::ff02::fb	ff02::fb	MDNS	19	Standard query response 0x0000 PTR LAPTOP-05QND3DR._dosvc._tcp.local
33	19.045944158	fe80::537f:b538:e433::ff02::fb	ff02::fb	MDNS	113	Standard query 0x0000 ANY LAPTOP-05QND3DR._dosvc._tcp.local, "QM" question
34	19.092158481	10.81.0.62	239.255.255.250	SSDP	219	M-SEARCH * HTTP/1.1
35	19.090631383	10.81.0.62	224.0.0.251	MDNS	93	Standard query 0x0000 ANY LAPTOP-05QND3DR._dosvc._tcp.local, "QM" question
36	19.090643334	fe80::537f:b538:e433::ff02::fb	ff02::fb	MDNS	113	Standard query 0x0000 ANY LAPTOP-05QND3DR._dosvc._tcp.local, "QM" question
37	20.153817057	10.81.0.62	224.0.0.251	MDNS	93	Standard query 0x0000 ANY LAPTOP-05QND3DR._dosvc._tcp.local, "QM" question
38	20.154222183	fe80::537f:b538:e433::ff02::fb	ff02::fb	MDNS	113	Standard query 0x0000 ANY LAPTOP-05QND3DR._dosvc._tcp.local, "QM" question
39	20.415373998	10.81.0.62	224.0.0.251	MDNS	327	Standard query response 0x0000 PTR, cache flush LAPTOP-05QND3DR._dosvc._tcp.local SRV, cache flush 0 0 7680 LAPTOP-05QND3DR.local TXT, cache flush A, cache flush 1
40	20.415873392	fe80::537f:b538:e433::ff02::fb	ff02::fb	MDNS	347	Standard query response 0x0000 PTR, cache flush LAPTOP-05QND3DR._dosvc._tcp.local SRV, cache flush 0 0 7680 LAPTOP-05QND3DR.local TXT, cache flush A, cache flush 1
41	20.415903996	10.81.0.62	224.0.0.251	MDNS	263	Standard query response 0x0000 SRV, cache flush 0 0 7680 LAPTOP-05QND3DR.local TXT, cache flush A, cache flush 1
42	20.416183517	fe80::537f:b538:e433::ff02::fb	ff02::fb	MDNS	283	Standard query response 0x0000 SRV, cache flush 0 0 7680 LAPTOP-05QND3DR.local TXT, cache flush A, cache flush 1
43	20.693556815	10.81.0.62	239.255.255.250	SSDP	219	M-SEARCH * HTTP/1.1

观察整个 BGP 建立连接的过程, 依次使用了 NOTIFICATION、OPEN、KEEPLIVE、UPDATE 等类型的报文。

1、重启 quagga 程序后，出现的 UPDATE 消息是成对的，即两个 BGP 对等体都向对方那个发送了一个 UPDATE 消息。请结合这个具体例子思考产生这个现象的原因。

在 BGP（边界网关协议）中，UPDATE 消息用于通告路由信息。重启 Quagga 程序后，UPDATE 消息是成对的，这个现象的原因通常涉及以下几点：

（1）BGP 会话恢复时的路由同步

当 BGP 会话重启时，BGP 对等体之间的连接会重新建立，并重新交换路由信息。特别是在一些 BGP 实现中，重启后通常会触发完整的路由同步过程，这会导致两个对等体互相发送 UPDATE 消息。例如：在 A 和 B 之间，A 是一个 BGP 对等体，B 是另一个。重启 Quagga 后，BGP 会话恢复时，A 会向 B 发送自己的路由更新，同时 B 会根据 A 的更新内容和当前自己的路由状态，准备发送一个更新给 A。

这种现象的出现是正常的，因为在 BGP 会话恢复后，两端都会将自己的路由信息重新交换一次，以确保双方的路由表一致。

（2）BGP 邻居的路由表不一致

在 BGP 对等体间，UPDATE 消息通常是用来传递路由的变化。重启时，可能会导致两边的路由表发生不一致。当 A 重启时，可能会丢失一些路由状态，重新从 B 获取路由；同样，B 在重启后也可能会丢失路由状态，因此两端都需要发出 UPDATE 消息，分别通知对方。

这种行为可能导致两个对等体发送成对的 UPDATE 消息，以确保同步路由信息。

（3）BGP 路由撤销和重通告

BGP 是基于路径向量的协议，在某些情况下，重启可能导致 BGP 路由撤销并重新通告。例如，A 对 B 发出的 UPDATE 消息可能包含撤销某些先前通告的路由，而 B 收到 A 的 UPDATE 后可能会基于自己的路由信息重新生成并发送一个更新消息给 A，通知 A 它所知道的路由变化。这种情况也可能导致“成对”的 UPDATE 消息交换。

（4）BGP 保活和对等体状态变化

BGP 对等体之间通过定期交换保活消息维持会话状态。如果对等体之间的 BGP 连接因某种原因丢失，重启后它们会重新建立连接。在重新建立连接时，为了同步路由信息，可能会发出 UPDATE 消息。在 BGP 协议中，任何路由信息的变化或恢复，都会导致 UPDATE 消息的发送。

2、如何验证 BGP 声明的正确性？

验证 BGP（边界网关协议）声明的正确性，通常涉及确保 BGP 路由的有效性、完整性和政策符合预期。常见的验证方法包括以下几种：

（1）BGP 路由验证

- 查看 BGP 路由表：使用命令 `show ip bgp` 或 `show bgp` 查看路由表中的条目。需要确认 BGP 学习到的路由条目是否符合网络设计和预期。
- 验证路由前缀：确保所有 BGP 前缀正确地匹配目标网络。
- 验证路由路径：检查路由的 AS 路径（AS path）、下一跳（next-hop）、MED（多出口判定）等信息，确保它们符合设计政策。
- 查看路由状态：确保 BGP 路由的状态为“可达”（reachable），并检查是否有任何“不可达”（unreachable）或“撤销”（withdrawn）状态的前缀。

（2）BGP 邻居状态

- 检查邻居状态：使用命令 `show ip bgp neighbors` 或 `show bgp summary` 检查 BGP 邻居的状态。确保所有邻居状态是“Established”，如果是“Idle”或“Active”，需要检查 BGP 邻居配置和网络连接。

	<ul style="list-style-type: none"> ● 查看邻居的 BGP 会话：如果邻居状态不正常，查看日志文件或命令输出，确认 BGP 会话是否存在问题，例如 BGP 认证问题、TCP 连接问题等。 <p>(3) BGP 路由策略检查</p> <ul style="list-style-type: none"> ● 配置验证：检查路由策略（如过滤规则、路由映射、AS 路径预设等）是否正确配置，确保路由过滤器没有误阻止合法路由，或错误地允许了不应接受的路由。 ● 确认路由广告：使用 <code>show ip bgp neighbors</code> 和 <code>show ip bgp <prefix></code> 命令查看是否正确地从邻居那里收到了需要的路由，并确认正确的路由被广告到其他邻居。 ● 检查路由重分发：如果使用了路由重分发（例如将 IGP 路由重分发到 BGP），确保重分发的路由符合预期，没有误导网络。 <p>(4) 路径选择验证</p> <ul style="list-style-type: none"> ● 查看选择路径的决定因素：在 BGP 选择路径时，多个因素会影响最终的路径选择（如 AS 路径长度、下一跳 IP、MED 值等）。可以通过 <code>show ip bgp <prefix></code> 查看选择的最佳路径，确认选择符合预期。 ● 确认没有环路：确保 BGP 路由中没有出现环路，尤其是在多重 BGP 邻居和复杂拓扑中，环路可能由于错误的配置或者 AS 路径污染而产生。 <p>(5) BGP 过滤器和策略审查</p> <ul style="list-style-type: none"> ● 检查路由过滤器：确认所有的路由过滤器（如 <code>prefix-list</code>、<code>route-map</code> 等）都正确配置，防止误过滤路由。 ● 分析社区属性：确认 BGP 社区（BGP community）标记是否正确设置和传递，社区可以用来影响路由选择和传播。 <p>(6) BGP 安全验证</p> <ul style="list-style-type: none"> ● 验证 BGP 源验证：确保 BGP 路由广告来源的 IP 地址和 AS 号符合预期，并且通过 RPKI（资源公钥基础设施）进行验证。 ● BGP 前缀过滤：使用 <code>prefix filtering</code> 策略，以防止接收到意外的或不合法的 BGP 前缀。
经验总结	<p><i>（实验过程中遇到的困难，试验中需要额外注意的事项，实验中激发的灵感等）</i></p> <ol style="list-style-type: none"> 1、当按指导书跑不通命令时，需要 restart 一下 quagga。 2、虚拟机设置 ip 后需要用 ifconfig 检查一下 ip 设置是否生效。 3、在检查路由器时，restart quagga 后需要等一分钟才能得到正确的 route 命令运行结果，需要有耐心。 4、这次实验和上次 ospf 实验在流程上十分相似，故做起来很快很顺利。