CSEE 4119 Computer Networks
Project 2: Stage C

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In my configuration of stage 3, I first configure **prefer-customer** policy and then **no-valley** policy in sequence.
Below are ASs that I directly I connect to:

Stub	Prov1	6	2	NEWY	179.24.49.0/24
Stub	Prov2	6	8	SEAT	179.24.37.0/24
Stub	Peer1	6	20	WASH	179.24.54.0/24
Stub	Peer2	6	19	SALT	179.24.50.0/24
Stub	AS22	6	22	MILW	200.0.6.0/24

Let's consider prefer-customer policy first and take router **NEWY** from **AS2,** whose ip is 179.24.49.2, performing as my customer, as an example to explain my operation.
I set 3 kinds of tags, which named **provider**, **peer** and **customer** respectively:
G6_NEWY(config)# ip community-list standard provider permit 6:100
G6_NEWY(config)# ip community-list standard peer permit 6:200
G6_NEWY(config)# ip community-list standard customer permit 6:300
Next, I create a route-map named **newyin**, permitting everything in, and set its two attributes: **community** and **local preference**. Since that AS2, who I connect to, is my customer, I set **local-preference** as 2000 and **community** as 6:200:
G6_NEWY(config)#route-map newyin permit 10
G6_NEWY(config-route-map)#set community 6:200
G6_NEWY(config-route-map)#set local-preference 2000
Lastly, I configure my **bgp** and execute the route-map I configured above just now:
G6_NEWY(config)#router bgp 6
G6_NEWY(config-router)#neighbor 179.24.49.2 route-map newyin in

Until now **prefer-customer** policy has been configured successfully. From my policy, each router permits everything in and that from its customer has the highest local-preference value. Now, let's consider **no-valley** policy.

According to **no-valley** policy definition, if packet comes from our peer or provider, we should deny its route to peer/provider and permits its route to customer. Comparatively, if packet comes from our customer, we permit all its way to peer, customer and provider.
Let's take router **NEWY** again, who performs as my provider as an example to show how I configure **no-valley** policy:
First, we define three types of out route-map, named **newyout,** and match them with provider, peer and customer community defined in prefer-customer part.
G6_NEWY(config)#route-map newyout permit 20
G6_NEWY(config-route-map)#match community customer
G6_NEWY(config)#route-map newyout deny 30
G6_NEWY(config-route-map)#match community peer
G6_NEWY(config)#route-map newyout deny 40
G6_NEWY(config-route-map)#match community provider

Next, I set three route-maps above out to my neighbor.

G6_NEWY(config-route-map)#neighbor 179.24.49.2 route-map newyout out

Now, I've successfully completed no-valley policy configuration, below is the screenshot of **show run** command in **NEWY** router.

```
 neighbor 179.24.49.2 remote-as 2
 neighbor 179.24.49.2 route-map newyin in
 neighbor 179.24.49.2 route-map newout out
!
 address-family ipv6
 exit-address-family
 exit
!
router ospf
 network 6.0.0.0/8 area 0.0.0.0
!
ip community-list standard customer permit 6:300
ip community-list standard peer permit 6:200
ip community-list standard provider permit 6:100
!
route-map newyin permit 10
 set community 6:100
 set local-preference 1000
!
route-map newout permit 20
 match community customer
!
route-map newout deny 30
 match community peer
!
route-map newout deny 40
 match community provider
!
ip forwarding
!
line vty
!
end
```

Two parts above have shown how I apply two policies to router **NEWY** in my AS. It is the same with other 4 routers in my AS: **WASH, MILW, SEAT** and **SALT.**

Let's prove that I've implemented these two policies correctly.

Taking router NEWY again as an example, below are screenshots of running

1. **show ip bgp community 6:100**

```
G6_NEWY# show ip bgp community 6:100
BGP table version is 0, local router ID is 179.24.49.1
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
              i internal, r RIB-failure, S Stale, R Removed
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*  0.0.0.0          179.24.49.2                 1000       0 2 20 17 13 18 i
*  1.0.0.0          179.24.49.2                 1000       0 2 20 17 16 1 i
*  3.0.0.0          179.24.49.2                 1000       0 2 20 17 13 18 3 i
*  4.0.0.0          179.24.49.2                 1000       0 2 20 17 13 18 3 4
i
*  5.0.0.0          179.24.49.2                 1000       0 2 5 i
*  7.0.0.0          179.24.49.2                 1000       0 2 20 17 13 18 7 i
*  10.0.0.0         179.24.49.2                 1000       0 2 20 17 13 18 7 10
 i
*  11.0.0.0         179.24.49.2                 1000       0 2 20 17 13 11 i
*  12.0.0.0         179.24.49.2                 1000       0 2 20 17 13 18 12 i
*  13.0.0.0         179.24.49.2                 1000       0 2 20 17 13 i
*  14.0.0.0         179.24.49.2                 1000       0 2 14 i
*  15.0.0.0         179.24.49.2                 1000       0 2 20 17 13 18 7 9
15 i
*  16.0.0.0         179.24.49.2                 1000       0 2 20 17 16 i
*  18.0.0.0         179.24.49.2                 1000       0 2 20 17 13 18 i
*  18.0.0.0/18      179.24.49.2                 1000       0 2 20 17 13 18 i
*> 22.0.0.0         179.24.49.2                 1000       0 2 22 i
*> 22.102.0.22/32   179.24.49.2                 1000       0 2 22 i

Displayed  17 out of 44 total prefixes
```

2. **show ip bgp community 6:200**

```
G6_NEWY# show ip bgp community 6:200
BGP table version is 0, local router ID is 179.24.49.1
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
              i internal, r RIB-failure, S Stale, R Removed
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*>i0.0.0.0          6.103.0.2                2000       0 20 17 13 18 i
*>i1.0.0.0          6.103.0.2                2000       0 20 17 16 1 i
*>i2.0.0.0          6.103.0.2                2000       0 20 2 i
*>i3.0.0.0          6.103.0.2                2000       0 20 17 13 18 3 i
*>i4.0.0.0          6.103.0.2                2000       0 20 17 13 18 3 4 i
*>i5.0.0.0          6.103.0.2                2000       0 20 2 5 i
*>i7.0.0.0          6.103.0.2                2000       0 20 17 13 18 7 i
*>i10.0.0.0         6.103.0.2                2000       0 20 17 13 18 7 10 i
*>i11.0.0.0         6.103.0.2                2000       0 20 17 13 11 i
*>i12.0.0.0         6.103.0.2                2000       0 20 17 13 18 12 i
*>i13.0.0.0         6.103.0.2                2000       0 20 17 13 i
*>i14.0.0.0         6.103.0.2                2000       0 20 2 14 i
*>i15.0.0.0         6.103.0.2                2000       0 20 17 13 18 7 9 15
 i
*>i16.0.0.0         6.103.0.2                2000       0 20 17 16 i
*>i18.0.0.0         6.103.0.2                2000       0 20 17 13 18 i
*>i18.0.0.0/18      6.103.0.2                2000       0 20 17 13 18 i
```

3. show ip bgp community 6:300

```
G6_NEWY# show ip bgp community 6:300
G6_NEWY#
```

All paths that connecting my AS to other Ass in screenshots above correspond to **no-valley policy** and **prefer-customer policy**.

I also take a screenshot of running command **show ip bgp neighbor 179.24.49.2**

```
G6_NEWY# show ip bgp neighbor 179.24.49.2 advertise
BGP table version is 0, local router ID is 179.24.49.1
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
              i internal, r RIB-failure, S Stale, R Removed
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop            Metric LocPrf Weight Path
*> 6.0.0.0          179.24.49.1              0         32768 i
*> 8.0.0.0          179.24.49.1                    100       0 8 i
*> 9.0.0.0          179.24.49.1                    100       0 8 10 9 i
*> 17.0.0.0         179.24.49.1                    100       0 20 17 i
*> 19.0.0.0         179.24.49.1                    100       0 8 19 i
*> 20.0.0.0         179.24.49.1                    100       0 20 i

Total number of prefixes 6
```

Now let's go into VM to check the implementation of two policies.

First fetch MAC address of my AS6's HOUS router d2:f2:83:c8:b7:6d.

```
byoi-lg@byoi-as99:~$ sudo arping 6.0.199.1
ARPING 6.0.199.1
42 bytes from d2:f2:83:c8:b7:6d (6.0.199.1): index=0 time=3.050 msec
42 bytes from d2:f2:83:c8:b7:6d (6.0.199.1): index=1 time=13.839 msec
42 bytes from d2:f2:83:c8:b7:6d (6.0.199.1): index=2 time=8.556 msec
```

Then trying to traceroute to AS4, which locates at tier1, below is the screenshot of running command:

```
byoi-lg@byoi-as99:~$ sudo nping --dest-mac d2:f2:83:c8:b7:6d --interface as6 --source-ip 6.0.199.2 --dest-ip 4.107.0.1 -

Starting Nping 0.7.40 ( https://nmap.org/nping ) at 2019-12-12 19:59 UTC
SENT (1.8562s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=1] IP [ttl=1 id=62400 iplen=28 ]
RCVD (2.0465s) ICMP [6.0.199.1 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=64 id=30658 iplen=56 ]
SENT (2.8565s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=2] IP [ttl=2 id=62400 iplen=28 ]
RCVD (2.8665s) ICMP [6.0.7.1 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=63 id=54037 iplen=56 ]
SENT (3.8585s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=3] IP [ttl=3 id=62400 iplen=28 ]
RCVD (3.8945s) ICMP [6.0.5.1 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=62 id=8155 iplen=56 ]
SENT (4.8605s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=4] IP [ttl=4 id=62400 iplen=28 ]
RCVD (4.9145s) ICMP [179.24.54.2 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=61 id=16237 iplen=56 ]
SENT (5.8626s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=5] IP [ttl=5 id=62400 iplen=28 ]
RCVD (5.9385s) ICMP [20.0.9.1 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=60 id=112 iplen=56 ]
SENT (6.8646s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=6] IP [ttl=6 id=62400 iplen=28 ]
RCVD (6.9585s) ICMP [20.0.6.1 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=59 id=17413 iplen=56 ]
SENT (7.8665s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=7] IP [ttl=7 id=62400 iplen=28 ]
RCVD (7.9865s) ICMP [20.0.2.1 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=58 id=56999 iplen=56 ]
SENT (8.8685s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=8] IP [ttl=8 id=62400 iplen=28 ]
RCVD (9.0145s) ICMP [179.24.53.2 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=57 id=59856 iplen=56 ]
SENT (9.8705s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=9] IP [ttl=9 id=62400 iplen=28 ]
RCVD (10.0345s) ICMP [17.0.9.1 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=56 id=57004 iplen=56 ]
SENT (10.8725s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=10] IP [ttl=10 id=62400 iplen=28 ]
RCVD (11.0545s) ICMP [17.0.6.1 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=55 id=28042 iplen=56 ]
SENT (11.8745s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=11] IP [ttl=11 id=62400 iplen=28 ]
RCVD (12.0785s) ICMP [17.0.1.1 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=54 id=59103 iplen=56 ]
SENT (12.8764s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=12] IP [ttl=12 id=62400 iplen=28 ]
RCVD (12.8945s) ICMP [179.24.44.1 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=53 id=27888 iplen=56 ]
SENT (13.8784s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=13] IP [ttl=13 id=62400 iplen=28 ]
RCVD (13.9145s) ICMP [13.0.10.1 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=52 id=55576 iplen=56 ]
SENT (14.8805s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=14] IP [ttl=14 id=62400 iplen=28 ]
RCVD (14.9345s) ICMP [13.0.7.1 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=51 id=22325 iplen=56 ]
SENT (15.8825s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=15] IP [ttl=15 id=62400 iplen=28 ]
RCVD (15.9585s) ICMP [13.0.5.1 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=50 id=535 iplen=56 ]
SENT (16.8845s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=16] IP [ttl=16 id=62400 iplen=28 ]
RCVD (16.9785s) ICMP [13.0.4.1 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=49 id=46603 iplen=56 ]
SENT (17.8865s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=17] IP [ttl=17 id=62400 iplen=28 ]
RCVD (18.0025s) ICMP [18.0.10.2 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=53 id=52584 iplen=56 ]
SENT (18.8885s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=18] IP [ttl=18 id=62400 iplen=28 ]
RCVD (19.0265s) ICMP [18.0.7.2 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=54 id=14287 iplen=56 ]
SENT (19.8902s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=19] IP [ttl=19 id=62400 iplen=28 ]
RCVD (20.0465s) ICMP [18.0.5.2 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=55 id=49062 iplen=56 ]
SENT (20.8925s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=20] IP [ttl=20 id=62400 iplen=28 ]
RCVD (21.0705s) ICMP [179.24.21.2 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=56 id=17330 iplen=56 ]
SENT (21.8944s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=21] IP [ttl=21 id=62400 iplen=28 ]
RCVD (22.0985s) ICMP [18.0.4.1 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=55 id=15627 iplen=56 ]
SENT (22.8964s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=22] IP [ttl=22 id=62400 iplen=28 ]
RCVD (22.9145s) ICMP [3.0.10.2 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=53 id=11187 iplen=56 ]
SENT (23.8985s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=23] IP [ttl=23 id=62400 iplen=28 ]
RCVD (23.9385s) ICMP [3.0.9.2 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=54 id=64655 iplen=56 ]
SENT (24.9006s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=24] IP [ttl=24 id=62400 iplen=28 ]
RCVD (24.9585s) ICMP [179.24.7.2 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=53 id=6275 iplen=56 ]
SENT (25.9025s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=25] IP [ttl=25 id=62400 iplen=28 ]
RCVD (25.9785s) ICMP [179.24.2.2 > 6.0.199.2 TTL=0 during transit (type=11/code=0) ] IP [ttl=53 id=55431 iplen=56 ]
SENT (26.9046s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=26] IP [ttl=26 id=62400 iplen=28 ]
RCVD (26.9985s) ICMP [4.107.0.1 > 6.0.199.2 Echo reply (type=0/code=0) id=36320 seq=26] IP [ttl=52 id=17879 iplen=28 ]
SENT (27.9075s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=27] IP [ttl=27 id=62400 iplen=28 ]
RCVD (28.0185s) ICMP [4.107.0.1 > 6.0.199.2 Echo reply (type=0/code=0) id=36320 seq=27] IP [ttl=52 id=17950 iplen=28 ]
SENT (28.9095s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=28] IP [ttl=28 id=62400 iplen=28 ]
RCVD (29.0425s) ICMP [4.107.0.1 > 6.0.199.2 Echo reply (type=0/code=0) id=36320 seq=28] IP [ttl=52 id=18018 iplen=28 ]
SENT (29.9115s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=29] IP [ttl=29 id=62400 iplen=28 ]
RCVD (30.0625s) ICMP [4.107.0.1 > 6.0.199.2 Echo reply (type=0/code=0) id=36320 seq=29] IP [ttl=52 id=18256 iplen=28 ]
SENT (30.9135s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=30] IP [ttl=30 id=62400 iplen=28 ]
RCVD (31.0825s) ICMP [4.107.0.1 > 6.0.199.2 Echo reply (type=0/code=0) id=36320 seq=30] IP [ttl=52 id=18452 iplen=28 ]
SENT (31.9155s) ICMP [6.0.199.2 > 4.107.0.1 Echo request (type=8/code=0) id=36320 seq=31] IP [ttl=31 id=62400 iplen=28 ]
RCVD (32.1105s) ICMP [4.107.0.1 > 6.0.199.2 Echo reply (type=0/code=0) id=36320 seq=31] IP [ttl=52 id=18539 iplen=28 ]
```