B. tree

1. topology creation

```
mungook@ubuntu:~/mininet$ sudo mn --topo tree,depth=3 --switch ovs --controller remote
*** Creating network
*** Adding controller
Unable to contact the remote controller at 127.0.0.1:6653
Unable to contact the remote controller at 127.0.0.1:6633
Setting remote controller to 127.0.0.1:6653
*** Adding hosts:
h1 h2 h3 h4 h5 h6 h7 h8
*** Adding switches:
s1 s2 s3 s4 s5 s6 s7
*** Adding links:
(s1, s2) (s1, s5) (s2, s3) (s2, s4) (s3, h1) (s3, h2) (s4, h3) (s4, h4) (s5, s6) (s5, s7) (s6, h5) (s6, h6) (s7, h7) (s7, h8)
*** Configuring hosts
h1 h2 h3 h4 h5 h6 h7 h8
*** Starting controller
c0
*** Starting 7 switches
s1 s2 s3 s4 s5 s6 s7 ...
*** Starting CLI:
```

i. links

```
mininet> links
s1-eth1<->s2-eth3 (OK OK)
s1-eth2<->s5-eth3 (OK OK)
s2-eth1<->s3-eth3 (OK OK)
s2-eth2<->s4-eth3 (OK OK)
s3-eth1<->h1-eth0 (OK OK)
s3-eth2<->h2-eth0 (OK OK)
s4-eth1<->h3-eth0 (OK OK)
s4-eth2<->h4-eth0 (OK OK)
s5-eth1<->s6-eth3 (OK OK)
s5-eth2<->s7-eth3 (OK OK)
s6-eth1<->h5-eth0 (OK OK)
s6-eth2<->h6-eth0 (OK OK)
s7-eth1<->h7-eth0 (OK OK)
s7-eth2<->h8-eth0 (OK OK)
```

ii. ports

```
mininet> ports
s1 lo:0 s1-eth1:1 s1-eth2:2
s2 lo:0 s2-eth1:1 s2-eth2:2 s2-eth3:3
s3 lo:0 s3-eth1:1 s3-eth2:2 s3-eth3:3
s4 lo:0 s4-eth1:1 s4-eth2:2 s4-eth3:3
s5 lo:0 s5-eth1:1 s5-eth2:2 s5-eth3:3
s6 lo:0 s6-eth1:1 s6-eth2:2 s6-eth3:3
s7 lo:0 s7-eth1:1 s7-eth2:2 s7-eth3:3
```

iii. net

```
mininet> net
h1 h1-eth0:s3-eth1
h2 h2-eth0:s3-eth2
h3 h3-eth0:s4-eth1
h4 h4-eth0:s4-eth2
h5 h5-eth0:s6-eth1
h6 h6-eth0:s6-eth2
h7 h7-eth0:s7-eth1
h8 h8-eth0:s7-eth2
s1 lo:   s1-eth1:s2-eth3 s1-eth2:s5-eth3
s2 lo:   s2-eth1:s3-eth3 s2-eth2:s4-eth3 s2-eth3:s1-eth1
s3 lo:   s3-eth1:h1-eth0 s3-eth2:h2-eth0 s3-eth3:s2-eth1
s4 lo:   s4-eth1:h3-eth0 s4-eth2:h4-eth0 s4-eth3:s2-eth2
s5 lo:   s5-eth1:s6-eth3 s5-eth2:s7-eth3 s5-eth3:s1-eth2
s6 lo:   s6-eth1:h5-eth0 s6-eth2:h6-eth0 s6-eth3:s5-eth1
s7 lo:   s7-eth1:h7-eth0 s7-eth2:h8-eth0 s7-eth3:s5-eth2
c0
```

2. setting switch forwarding table

i. switch configuration

```
mininet> sh ovs-ofctl add-flow s1 priority=20,in_port=1,actions=output:2
mininet> sh ovs-ofctl add-flow s2 priority=20,in_port=1,actions=output:3
mininet> sh ovs-ofctl add-flow s3 priority=20,in_port=1,actions=output:3
mininet> sh ovs-ofctl add-flow s3 priority=20,in_port=3,actions=output:1
mininet> sh ovs-ofctl add-flow s2 priority=20,in_port=3,actions=output:1
mininet> sh ovs-ofctl add-flow s1 priority=20,in_port=2,actions=output:1
mininet> sh ovs-ofctl add-flow s5 priority=20,in_port=2,actions=output:3
mininet> sh ovs-ofctl add-flow s5 priority=20,in_port=3,actions=output:2
mininet> sh ovs-ofctl add-flow s7 priority=20,in_port=3,actions=output:2
mininet> sh ovs-ofctl add-flow s7 priority=20,in_port=2,actions=output:3
```

    ii.    ping

        1.    before

```
mininet> h1 ping -c3 h8
PING 10.0.0.8 (10.0.0.8) 56(84) bytes of data.
From 10.0.0.1 icmp_seq=1 Destination Host Unreachable
From 10.0.0.1 icmp_seq=2 Destination Host Unreachable
From 10.0.0.1 icmp_seq=3 Destination Host Unreachable

--- 10.0.0.8 ping statistics ---
3 packets transmitted, 0 received, +3 errors, 100% packet loss, time 2047ms
pipe 3
```

        2.    after

```
mininet> h1 ping -c5 h8
PING 10.0.0.8 (10.0.0.8) 56(84) bytes of data.
64 bytes from 10.0.0.8: icmp_seq=1 ttl=64 time=1.97 ms
64 bytes from 10.0.0.8: icmp_seq=2 ttl=64 time=0.103 ms
64 bytes from 10.0.0.8: icmp_seq=3 ttl=64 time=0.103 ms
64 bytes from 10.0.0.8: icmp_seq=4 ttl=64 time=0.093 ms
64 bytes from 10.0.0.8: icmp_seq=5 ttl=64 time=0.059 ms

--- 10.0.0.8 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4068ms
rtt min/avg/max/mdev = 0.059/0.466/1.972/0.753 ms
mininet> pingall
*** Ping: testing ping reachability
h1 -> X X X X X X h8
h2 -> X X X X X X X
h3 -> X X X X X X X
h4 -> X X X X X X X
h5 -> X X X X X X X
h6 -> X X X X X X X
h7 -> X X X X X X X
h8 -> h1 X X X X X X
*** Results: 96% dropped (2/56 received)
```

    iii.    switch information

```
mininet> sh ovs-ofctl show s1
OFPT_FEATURES_REPLY (xid=0x2): dpid:0000000000000001
n_tables:254, n_buffers:256
capabilities: FLOW_STATS TABLE_STATS PORT_STATS QUEUE_STATS ARP_MATCH_IP
actions: output enqueue set_vlan_vid set_vlan_pcp strip_vlan mod_dl_src mod_dl_dst mod_nw_src mod_nw_dst mod_nw_tos mod_tp_src mod_tp_dst
 1(s1-eth1): addr:b6:3c:b6:b2:1e:31
     config:     0
     state:      0
     current:    10GB-FD COPPER
     speed: 10000 Mbps now, 0 Mbps max
 2(s1-eth2): addr:2a:65:1f:80:06:38
     config:     0
     state:      0
     current:    10GB-FD COPPER
     speed: 10000 Mbps now, 0 Mbps max
 LOCAL(s1): addr:92:fe:86:ef:a8:40
     config:     PORT_DOWN
     state:      LINK_DOWN
     speed: 0 Mbps now, 0 Mbps max
OFPT_GET_CONFIG_REPLY (xid=0x4): frags=normal miss_send_len=0
mininet> sh ovs-ofctl show s2
OFPT_FEATURES_REPLY (xid=0x2): dpid:0000000000000002
n_tables:254, n_buffers:256
capabilities: FLOW_STATS TABLE_STATS PORT_STATS QUEUE_STATS ARP_MATCH_IP
actions: output enqueue set_vlan_vid set_vlan_pcp strip_vlan mod_dl_src mod_dl_dst mod_nw_src mod_nw_dst mod_nw_tos mod_tp_src mod_tp_dst
 1(s2-eth1): addr:d6:27:67:ce:6f:b2
     config:     0
     state:      0
     current:    10GB-FD COPPER
     speed: 10000 Mbps now, 0 Mbps max
 2(s2-eth2): addr:0a:84:09:3d:0d:ec
     config:     0
     state:      0
     current:    10GB-FD COPPER
     speed: 10000 Mbps now, 0 Mbps max
 3(s2-eth3): addr:be:c3:ae:36:89:df
     config:     0
     state:      0
     current:    10GB-FD COPPER
     speed: 10000 Mbps now, 0 Mbps max
 LOCAL(s2): addr:5e:ca:09:2e:88:4f
     config:     PORT_DOWN
     state:      LINK_DOWN
     speed: 0 Mbps now, 0 Mbps max
OFPT_GET_CONFIG_REPLY (xid=0x4): frags=normal miss_send_len=0
mininet> sh ovs-ofctl show s3
OFPT_FEATURES_REPLY (xid=0x2): dpid:0000000000000003
n_tables:254, n_buffers:256
capabilities: FLOW_STATS TABLE_STATS PORT_STATS QUEUE_STATS ARP_MATCH_IP
actions: output enqueue set_vlan_vid set_vlan_pcp strip_vlan mod_dl_src mod_dl_dst mod_nw_src mod_nw_dst mod_nw_tos mod_tp_src mod_tp_dst
 1(s3-eth1): addr:ae:aa:2e:5e:44:43
     config:     0
     state:      0
     current:    10GB-FD COPPER
     speed: 10000 Mbps now, 0 Mbps max
 2(s3-eth2): addr:f2:10:b9:03:b2:d4
     config:     0
     state:      0
     current:    10GB-FD COPPER
     speed: 10000 Mbps now, 0 Mbps max
 3(s3-eth3): addr:3e:77:ab:b9:37:57
     config:     0
     state:      0
     current:    10GB-FD COPPER
     speed: 10000 Mbps now, 0 Mbps max
 LOCAL(s3): addr:b2:c0:c3:b9:03:48
     config:     PORT_DOWN
     state:      LINK_DOWN
     speed: 0 Mbps now, 0 Mbps max
OFPT_GET_CONFIG_REPLY (xid=0x4): frags=normal miss_send_len=0
```

```
mininet> sh ovs-ofctl show s4
OFPT_FEATURES_REPLY (xid=0x2): dpid:0000000000000004
n_tables:254, n_buffers:256
capabilities: FLOW_STATS TABLE_STATS PORT_STATS QUEUE_STATS ARP_MATCH_IP
actions: output enqueue set_vlan_vid set_vlan_pcp strip_vlan mod_dl_src mod_dl_dst mod_nw_src mod_nw_dst mod_nw_tos mod_tp_src mod_tp_dst
 1(s4-eth1): addr:ca:79:8c:27:f9:46
     config:     0
     state:      0
     current:    10GB-FD COPPER
     speed: 10000 Mbps now, 0 Mbps max
 2(s4-eth2): addr:4a:76:b1:24:54:c3
     config:     0
     state:      0
     current:    10GB-FD COPPER
     speed: 10000 Mbps now, 0 Mbps max
 3(s4-eth3): addr:f2:5d:38:76:5c:0e
     config:     0
     state:      0
     current:    10GB-FD COPPER
     speed: 10000 Mbps now, 0 Mbps max
 LOCAL(s4): addr:6e:39:d4:19:51:47
     config:     PORT_DOWN
     state:      LINK_DOWN
     speed: 0 Mbps now, 0 Mbps max
OFPT_GET_CONFIG_REPLY (xid=0x4): frags=normal miss_send_len=0
mininet> sh ovs-ofctl show s5
OFPT_FEATURES_REPLY (xid=0x2): dpid:0000000000000005
n_tables:254, n_buffers:256
capabilities: FLOW_STATS TABLE_STATS PORT_STATS QUEUE_STATS ARP_MATCH_IP
actions: output enqueue set_vlan_vid set_vlan_pcp strip_vlan mod_dl_src mod_dl_dst mod_nw_src mod_nw_dst mod_nw_tos mod_tp_src mod_tp_dst
 1(s5-eth1): addr:82:da:a7:c0:4e:5b
     config:     0
     state:      0
     current:    10GB-FD COPPER
     speed: 10000 Mbps now, 0 Mbps max
 2(s5-eth2): addr:2e:60:e1:6c:48:71
     config:     0
     state:      0
     current:    10GB-FD COPPER
     speed: 10000 Mbps now, 0 Mbps max
 3(s5-eth3): addr:66:40:35:06:ec:22
     config:     0
     state:      0
     current:    10GB-FD COPPER
     speed: 10000 Mbps now, 0 Mbps max
 LOCAL(s5): addr:96:be:fe:15:39:41
     config:     PORT_DOWN
     state:      LINK_DOWN
     speed: 0 Mbps now, 0 Mbps max
OFPT_GET_CONFIG_REPLY (xid=0x4): frags=normal miss_send_len=0
mininet> sh ovs-ofctl show s6
OFPT_FEATURES_REPLY (xid=0x2): dpid:0000000000000006
n_tables:254, n_buffers:256
capabilities: FLOW_STATS TABLE_STATS PORT_STATS QUEUE_STATS ARP_MATCH_IP
actions: output enqueue set_vlan_vid set_vlan_pcp strip_vlan mod_dl_src mod_dl_dst mod_nw_src mod_nw_dst mod_nw_tos mod_tp_src mod_tp_dst
 1(s6-eth1): addr:9a:54:9b:35:76:9c
     config:     0
     state:      0
     current:    10GB-FD COPPER
     speed: 10000 Mbps now, 0 Mbps max
 2(s6-eth2): addr:3a:65:cf:8d:c7:cf
     config:     0
     state:      0
     current:    10GB-FD COPPER
     speed: 10000 Mbps now, 0 Mbps max
 3(s6-eth3): addr:5e:6f:5f:55:bf:66
     config:     0
     state:      0
     current:    10GB-FD COPPER
     speed: 10000 Mbps now, 0 Mbps max
 LOCAL(s6): addr:06:d3:32:d6:7f:44
     config:     PORT_DOWN
     state:      LINK_DOWN
     speed: 0 Mbps now, 0 Mbps max
OFPT_GET_CONFIG_REPLY (xid=0x4): frags=normal miss_send_len=0
```