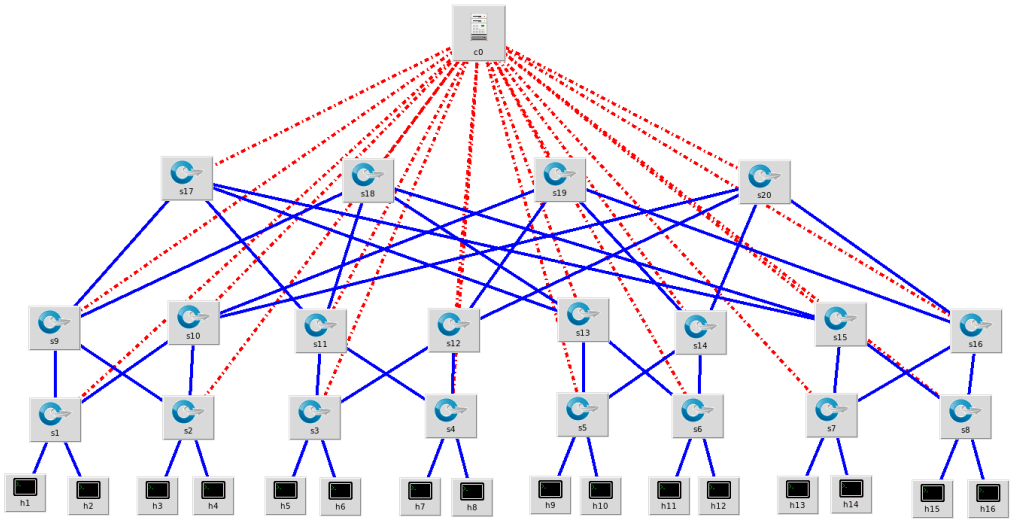
reporter

实验1（with controller)

使用miniedit搭建FatTree拓扑：



控制器采用remoteController

ip base:10.0.0.0/8

开启pox控制器

```
``sudo ~/pox/pox.py forwarding.l2_learning openflow.spanning_tree --no-flood --hold-down openflow.discovery host_tracker openflow.of_01 --port=6633
```

参数设置为**二层学习交换机模式**， 启用**生成树**。

查看生成树拓扑

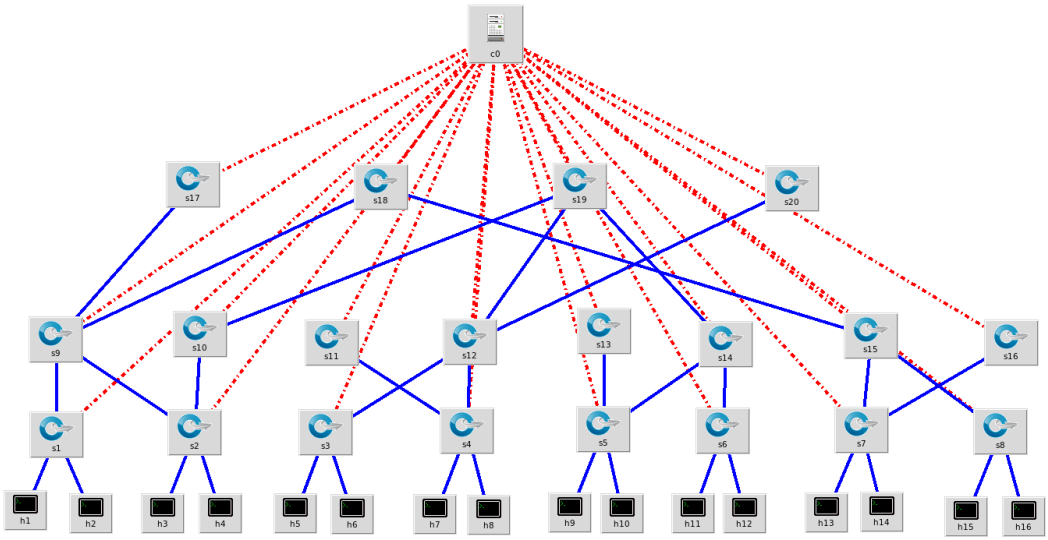
在mininet CLI下使用`net`查看网络连接状态

```
mininet> net
h8 h8-eth0:s4-eth2
h11 h11-eth0:s6-eth1
h10 h10-eth0:s5-eth2
h9 h9-eth0:s5-eth1
h4 h4-eth0:s2-eth2
h6 h6-eth0:s3-eth2
h5 h5-eth0:s3-eth1
h12 h12-eth0:s6-eth2
h16 h16-eth0:s8-eth2
h2 h2-eth0:s1-eth2
h14 h14-eth0:s7-eth2
h13 h13-eth0:s7-eth1
h3 h3-eth0:s2-eth1
h15 h15-eth0:s8-eth1
h7 h7-eth0:s4-eth1
h1 h1-eth0:s1-eth1
s18 lo:  s18-eth1:s9-eth4 s18-eth2:s11-eth4 s18-eth3:s13-eth4 s18-eth4:s15-eth4
s7 lo:  s7-eth1:h13-eth0 s7-eth2:h14-eth0 s7-eth3:s15-eth1 s7-eth4:s16-eth1
s10 lo:  s10-eth1:s1-eth4 s10-eth2:s2-eth4 s10-eth3:s19-eth1 s10-eth4:s20-eth1
s5 lo:  s5-eth1:h9-eth0 s5-eth2:h10-eth0 s5-eth3:s13-eth1 s5-eth4:s14-eth1
s6 lo:  s6-eth1:h11-eth0 s6-eth2:h12-eth0 s6-eth3:s13-eth2 s6-eth4:s14-eth2
s4 lo:  s4-eth1:h7-eth0 s4-eth2:h8-eth0 s4-eth3:s11-eth2 s4-eth4:s12-eth2
s20 lo:  s20-eth1:s10-eth4 s20-eth2:s12-eth4 s20-eth3:s14-eth4 s20-eth4:s16-eth4
s2 lo:  s2-eth1:h3-eth0 s2-eth2:h4-eth0 s2-eth3:s9-eth2 s2-eth4:s10-eth2
s13 lo:  s13-eth1:s5-eth3 s13-eth2:s6-eth3 s13-eth3:s17-eth3 s13-eth4:s18-eth3
s14 lo:  s14-eth1:s5-eth4 s14-eth2:s6-eth4 s14-eth3:s19-eth3 s14-eth4:s20-eth3
s3 lo:  s3-eth1:h5-eth0 s3-eth2:h6-eth0 s3-eth3:s11-eth1 s3-eth4:s12-eth1
s16 lo:  s16-eth1:s7-eth4 s16-eth2:s8-eth4 s16-eth3:s19-eth4 s16-eth4:s20-eth4
s17 lo:  s17-eth1:s9-eth3 s17-eth2:s11-eth3 s17-eth3:s13-eth3 s17-eth4:s15-eth3
s15 lo:  s15-eth1:s7-eth3 s15-eth2:s8-eth3 s15-eth3:s17-eth4 s15-eth4:s18-eth4
s11 lo:  s11-eth1:s3-eth3 s11-eth2:s4-eth3 s11-eth3:s17-eth2 s11-eth4:s18-eth2
s1 lo:  s1-eth1:h1-eth0 s1-eth2:h2-eth0 s1-eth3:s9-eth1 s1-eth4:s10-eth1
s8 lo:  s8-eth1:h15-eth0 s8-eth2:h16-eth0 s8-eth3:s15-eth2 s8-eth4:s16-eth2
s9 lo:  s9-eth1:s1-eth3 s9-eth2:s2-eth3 s9-eth3:s17-eth1 s9-eth4:s18-eth1
s12 lo:  s12-eth1:s3-eth4 s12-eth2:s4-eth4 s12-eth3:s19-eth2 s12-eth4:s20-eth2
s19 lo:  s19-eth1:s10-eth3 s19-eth2:s12-eth3 s19-eth3:s14-eth3 s19-eth4:s16-eth3
c0
```

使用`dpctl dump-ports-desc`查看交换机端口连接状态

```
*** s19 ------------------------------------
OFPST_PORT_DESC reply (xid=0x2):
 1(s19-eth1): addr:5e:bd:8a:01:df:e5
     config:     0
     state:      0
     current:    10GB-FD COPPER
     speed: 10000 Mbps now, 0 Mbps max
 2(s19-eth2): addr:2a:8f:69:51:ba:a0
     config:     0
     state:      0
     current:    10GB-FD COPPER
     speed: 10000 Mbps now, 0 Mbps max
 3(s19-eth3): addr:62:0f:1f:b2:20:ae
     config:     0
     state:      0
     current:    10GB-FD COPPER
     speed: 10000 Mbps now, 0 Mbps max
 4(s19-eth4): addr:ce:fe:ad:2b:e4:df
     config:     NO_FLOOD
     state:      0
     current:    10GB-FD COPPER
     speed: 10000 Mbps now, 0 Mbps max
 LOCAL(s19): addr:9a:10:2e:c4:43:4a
     config:     PORT_DOWN
     state:      LINK_DOWN
     speed: 0 Mbps now, 0 Mbps max
```

其中，带NO_FLOOD表示逻辑链路被禁用，也就是不在生成树上，画出生成树：



pingall结果

```
mininet> pingall
*** Ping: testing ping reachability
h8 -> h11 h10 h9 h4 h6 h5 h12 h16 h2 h14 h13 h3 h15 h7 h1
h11 -> h8 h10 h9 h4 h6 h5 h12 h16 h2 h14 h13 h3 h15 h7 h1
h10 -> h8 h11 h9 h4 h6 h5 h12 h16 h2 h14 h13 h3 h15 h7 h1
h9 -> h8 h11 h10 h4 h6 h5 h12 h16 h2 h14 h13 h3 h15 h7 h1
h4 -> h8 h11 h10 h9 h6 h5 h12 h16 h2 h14 h13 h3 h15 h7 h1
h6 -> h8 h11 h10 h9 h4 h5 h12 h16 h2 h14 h13 h3 h15 h7 h1
h5 -> h8 h11 h10 h9 h4 h6 h12 h16 h2 h14 h13 h3 h15 h7 h1
h12 -> h8 h11 h10 h9 h4 h6 h5 h16 h2 h14 h13 h3 h15 h7 h1
h16 -> h8 h11 h10 h9 h4 h6 h5 h12 h2 h14 h13 h3 h15 h7 h1
h2 -> h8 h11 h10 h9 h4 h6 h5 h12 h16 h14 h13 h3 h15 h7 h1
h14 -> h8 h11 h10 h9 h4 h6 h5 h12 h16 h2 h13 h3 h15 h7 h1
h13 -> h8 h11 h10 h9 h4 h6 h5 h12 h16 h2 h14 h3 h15 h7 h1
h3 -> h8 h11 h10 h9 h4 h6 h5 h12 h16 h2 h14 h13 h15 h7 h1
h15 -> h8 h11 h10 h9 h4 h6 h5 h12 h16 h2 h14 h13 h3 h7 h1
h7 -> h8 h11 h10 h9 h4 h6 h5 h12 h16 h2 h14 h13 h3 h15 h1
h1 -> h8 h11 h10 h9 h4 h6 h5 h12 h16 h2 h14 h13 h3 h15 h7
*** Results: 0% dropped (240/240 received)
```

查看流表

`dpctl dump-flows`

```
mininet> dpctl dump-flows
*** s18 ------------------------------------------------------------------------
 cookie=0x0, duration=2651.730s, table=0, n_packets=2032, n_bytes=83312, priority=65000,dl_dst=01:23:20:00:00:01,dl_type=0x88cc actions=CONTROLLER:65535
 cookie=0x0, duration=2651.729s, table=0, n_packets=0, n_bytes=0, priority=32769,arp,dl_dst=02:00:00:00:be:ef actions=CONTROLLER:65535
*** s7 -------------------------------------------------------------------------
 cookie=0x0, duration=2651.757s, table=0, n_packets=1016, n_bytes=42672, priority=65000,dl_dst=01:23:20:00:00:01,dl_type=0x88cc actions=CONTROLLER:65535
 cookie=0x0, duration=2651.757s, table=0, n_packets=42, n_bytes=1764, priority=32769,arp,dl_dst=02:00:00:00:be:ef actions=CONTROLLER:65535
*** s10 ------------------------------------------------------------------------
 cookie=0x0, duration=2651.777s, table=0, n_packets=2031, n_bytes=85301, priority=65000,dl_dst=01:23:20:00:00:01,dl_type=0x88cc actions=CONTROLLER:65535
 cookie=0x0, duration=2651.777s, table=0, n_packets=0, n_bytes=0, priority=32769,arp,dl_dst=02:00:00:00:be:ef actions=CONTROLLER:65535
*** s5 -------------------------------------------------------------------------
 cookie=0x0, duration=2651.760s, table=0, n_packets=1017, n_bytes=41697, priority=65000,dl_dst=01:23:20:00:00:01,dl_type=0x88cc actions=CONTROLLER:65535
 cookie=0x0, duration=2651.759s, table=0, n_packets=42, n_bytes=1764, priority=32769,arp,dl_dst=02:00:00:00:be:ef actions=CONTROLLER:65535
*** s6 -------------------------------------------------------------------------
 cookie=0x0, duration=2651.796s, table=0, n_packets=1014, n_bytes=41574, priority=65000,dl_dst=01:23:20:00:00:01,dl_type=0x88cc actions=CONTROLLER:65535
 cookie=0x0, duration=2651.796s, table=0, n_packets=42, n_bytes=1764, priority=32769,arp,dl_dst=02:00:00:00:be:ef actions=CONTROLLER:65535
*** s4 -------------------------------------------------------------------------
```

以S7上的流表为例，

第一条表示：目的以太网地址为01:23:20:00:00:01的数据包转发给controller

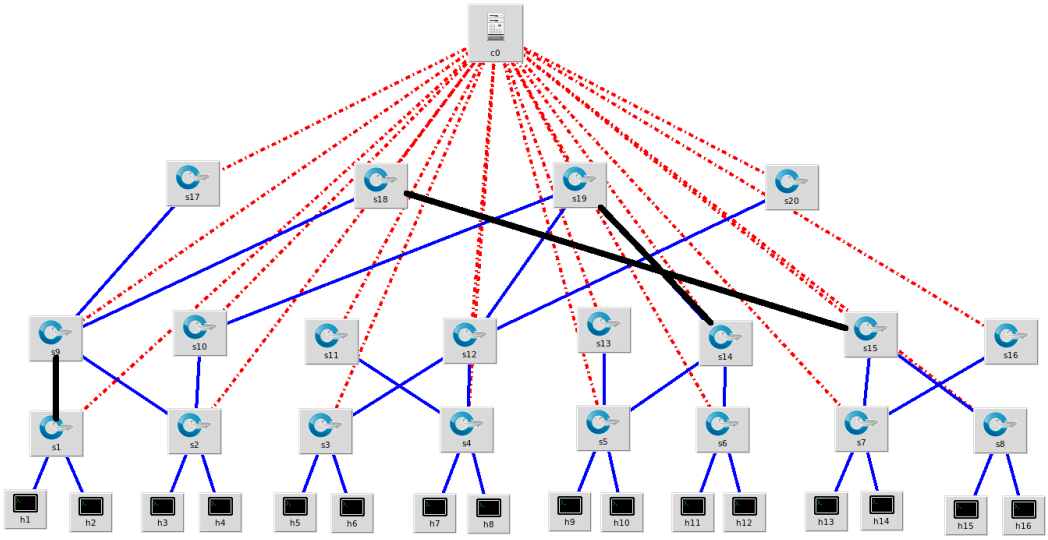
第二条表示：arp包转发给controller，优先级比第一条高

关闭三条链路

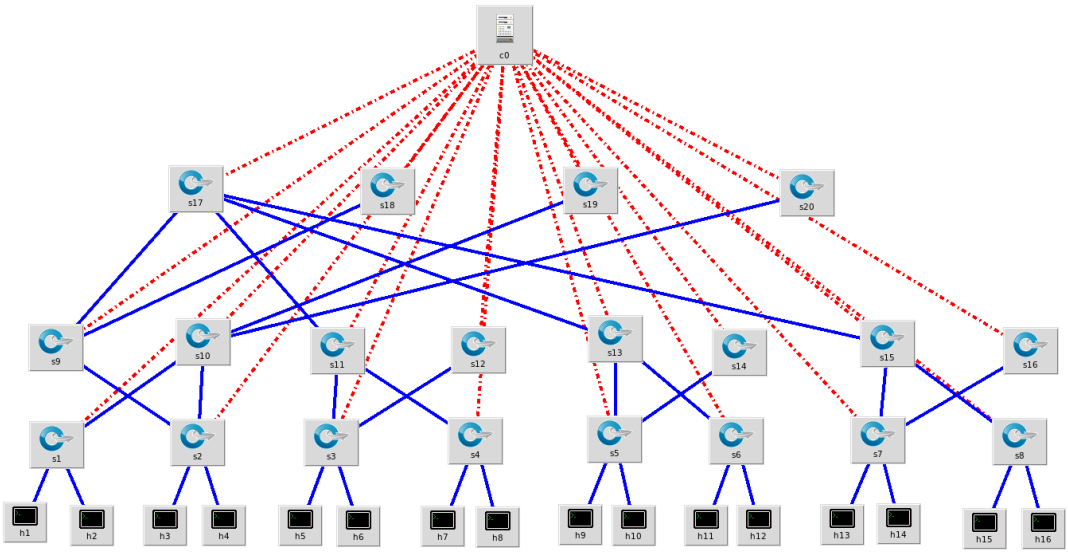
s1-s9: `link s1 s9 down`

s18-s15: `link s18 s15 down`

s19-s14: `link s19 s14 down`



重建生成树



pingall

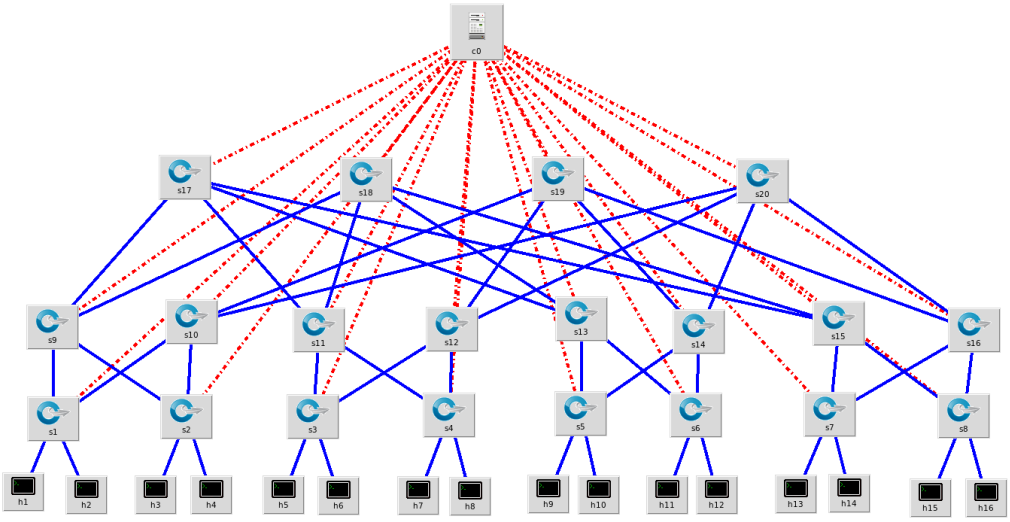
```
mininet> pingall
*** Ping: testing ping reachability
h8 -> h11 h10 h9 h4 h6 h5 h12 h16 h2 h14 h13 h3 h15 h7 h1
h11 -> h8 h10 h9 h4 h6 h5 h12 h16 h2 h14 h13 h3 h15 h7 h1
h10 -> h8 h11 h9 h4 h6 h5 h12 h16 h2 h14 h13 h3 h15 h7 h1
h9 -> h8 h11 h10 h4 h6 h5 h12 h16 h2 h14 h13 h3 h15 h7 h1
h4 -> h8 h11 h10 h9 h6 h5 h12 h16 h2 h14 h13 h3 h15 h7 h1
h6 -> h8 h11 h10 h9 h4 h5 h12 h16 h2 h14 h13 h3 h15 h7 h1
h5 -> h8 h11 h10 h9 h4 h6 h12 h16 h2 h14 h13 h3 h15 h7 h1
h12 -> h8 h11 h10 h9 h4 h6 h5 h16 h2 h14 h13 h3 h15 h7 h1
h16 -> h8 h11 h10 h9 h4 h6 h5 h12 h2 h14 h13 h3 h15 h7 h1
h2 -> h8 h11 h10 h9 h4 h6 h5 h12 h16 h14 h13 h3 h15 h7 h1
h14 -> h8 h11 h10 h9 h4 h6 h5 h12 h16 h2 h13 h3 h15 h7 h1
h13 -> h8 h11 h10 h9 h4 h6 h5 h12 h16 h2 h14 h3 h15 h7 h1
h3 -> h8 h11 h10 h9 h4 h6 h5 h12 h16 h2 h14 h13 h15 h7 h1
h15 -> h8 h11 h10 h9 h4 h6 h5 h12 h16 h2 h14 h13 h3 h7 h1
h7 -> h8 h11 h10 h9 h4 h6 h5 h12 h16 h2 h14 h13 h3 h15 h1
h1 -> h8 h11 h10 h9 h4 h6 h5 h12 h16 h2 h14 h13 h3 h15 h7
*** Results: 0% dropped (240/240 received)
```

flow-table:

```
mininet> dpctl dump-flows
*** s7 ------------------------------------------------------------------------
 cookie=0x0, duration=1244.155s, table=0, n_packets=480, n_bytes=20160, priority=65000,dl_dst=01:23:20:00:00:01,dl_type=0x88cc actions=CONTROLLER:65535
 cookie=0x0, duration=1244.155s, table=0, n_packets=18, n_bytes=756, priority=32769,arp,dl_dst=02:00:00:00:be:ef actions=CONTROLLER:65535
*** s10 -----------------------------------------------------------------------
 cookie=0x0, duration=1244.078s, table=0, n_packets=958, n_bytes=40236, priority=65000,dl_dst=01:23:20:00:00:01,dl_type=0x88cc actions=CONTROLLER:65535
 cookie=0x0, duration=1244.078s, table=0, n_packets=0, n_bytes=0, priority=32769,arp,dl_dst=02:00:00:00:be:ef actions=CONTROLLER:65535
*** s5 ------------------------------------------------------------------------
 cookie=0x0, duration=1244.008s, table=0, n_packets=480, n_bytes=19680, priority=65000,dl_dst=01:23:20:00:00:01,dl_type=0x88cc actions=CONTROLLER:65535
 cookie=0x0, duration=1244.008s, table=0, n_packets=18, n_bytes=756, priority=32769,arp,dl_dst=02:00:00:00:be:ef actions=CONTROLLER:65535
*** s6 ------------------------------------------------------------------------
 cookie=0x0, duration=1243.953s, table=0, n_packets=684, n_bytes=28044, priority=65000,dl_dst=01:23:20:00:00:01,dl_type=0x88cc actions=CONTROLLER:65535
 cookie=0x0, duration=1243.953s, table=0, n_packets=18, n_bytes=756, priority=32769,arp,dl_dst=02:00:00:00:be:ef actions=CONTROLLER:65535
*** s4 ------------------------------------------------------------------------
 cookie=0x0, duration=1243.900s, table=0, n_packets=479, n_bytes=19639, priority=65000,dl_dst=01:23:20:00:00:01,dl_type=0x88cc actions=CONTROLLER:65535
 cookie=0x0, duration=1243.900s, table=0, n_packets=18, n_bytes=756, priority=32769,arp,dl_dst=02:00:00:00:be:ef actions=CONTROLLER:65535
*** s20 -----------------------------------------------------------------------
 cookie=0x0, duration=1243.835s, table=0, n_packets=957, n_bytes=39717, priority=65000,dl_dst=01:23:20:00:00:01,dl_type=0x88cc actions=CONTROLLER:65535
 cookie=0x0, duration=1243.835s, table=0, n_packets=0, n_bytes=0, priority=32769,arp,dl_dst=02:00:00:00:be:ef actions=CONTROLLER:65535
*** s13 -----------------------------------------------------------------------
 cookie=0x0, duration=1243.746s, table=0, n_packets=1367, n_bytes=57421, priority=65000,dl_dst=01:23:20:00:00:01,dl_type=0x88cc actions=CONTROLLER:65535
 cookie=0x0, duration=1243.745s, table=0, n_packets=0, n_bytes=0, priority=32769,arp,dl_dst=02:00:00:00:be:ef actions=CONTROLLER:65535
*** s18 -----------------------------------------------------------------------
 cookie=0x0, duration=1243.687s, table=0, n_packets=924, n_bytes=37884, priority=65000,dl_dst=01:23:20:00:00:01,dl_type=0x88cc actions=CONTROLLER:65535
 cookie=0x0, duration=1243.686s, table=0, n_packets=0, n_bytes=0, priority=32769,arp,dl_dst=02:00:00:00:be:ef actions=CONTROLLER:65535
*** s14 -----------------------------------------------------------------------
 cookie=0x0, duration=1243.605s, table=0, n_packets=922, n_bytes=38694, priority=65000,dl_dst=01:23:20:00:00:01,dl_type=0x88cc actions=CONTROLLER:65535
 cookie=0x0, duration=1243.604s, table=0, n_packets=0, n_bytes=0, priority=32769,arp,dl_dst=02:00:00:00:be:ef actions=CONTROLLER:65535
*** s3 ------------------------------------------------------------------------
 cookie=0x0, duration=1243.531s, table=0, n_packets=479, n_bytes=19639, priority=65000,dl_dst=01:23:20:00:00:01,dl_type=0x88cc actions=CONTROLLER:65535
 cookie=0x0, duration=1243.531s, table=0, n_packets=18, n_bytes=756, priority=32769,arp,dl_dst=02:00:00:00:be:ef actions=CONTROLLER:65535
*** s16 -----------------------------------------------------------------------
 cookie=0x0, duration=1243.435s, table=0, n_packets=955, n_bytes=40111, priority=65000,dl_dst=01:23:20:00:00:01,dl_type=0x88cc actions=CONTROLLER:65535
 cookie=0x0, duration=1243.428s, table=0, n_packets=0, n_bytes=0, priority=32769,arp,dl_dst=02:00:00:00:be:ef actions=CONTROLLER:65535
*** s17 -----------------------------------------------------------------------
 cookie=0x0, duration=1243.342s, table=0, n_packets=958, n_bytes=39278, priority=65000,dl_dst=01:23:20:00:00:01,dl_type=0x88cc actions=CONTROLLER:65535
 cookie=0x0, duration=1243.341s, table=0, n_packets=0, n_bytes=0, priority=32769,arp,dl_dst=02:00:00:00:be:ef actions=CONTROLLER:65535
*** s15 -----------------------------------------------------------------------
```

实验2

创建的拓扑如实验1，手动添加流表



路由器编号记为i

switch 1-8:

- ip编号为2*i从port2转发，为2*i-1从port1转发
- port 1进入的包从port 3转发，port 2进入的包从port 4转发

switch 9-16: k=i-8

- k为奇数，则ip编号为$2k-1, 2k, 2(k+1)-1, 2k$分别从1，1，2，2号端口转发
- k为偶数，则ip编号为$2(k-1)-1, 2(k-1), 2k-1, 2k$分别从2，2，1，1号端口转发
- port 1进入的包从port 3转发，port 2进入的包从port 4转发

switch17-20:

- ip编号为j的包，从端口$(j-1)//4+1$转发

```
    # 1~8号交换机添加流表
    for i in range(1, 9):
        eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} ip,nw_dst=10.0.0.{i*2-
1},actions=output:1')")
        eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} ip,nw_dst=10.0.0.
{i*2},actions=output:2')")
        eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} arp,nw_dst=10.0.0.{i*2-
1},actions=output:1')")
        eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} arp,nw_dst=10.0.0.
{i*2},actions=output:2')")
        eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} in_port=1,actions=output:3')")
        eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} in_port=2,actions=output:4')")

    # 9~16号交换机添加流表
    for i in range(9, 17):
        k = i-8
        if k%2 == 1:
            eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} ip,nw_dst=10.0.0.{k*2-
1},actions=output:1')")
            eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} ip,nw_dst=10.0.0.
{k*2},actions=output:1')")
            eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} ip,nw_dst=10.0.0.{(k+1)*2-
1},actions=output:2')")
            eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} ip,nw_dst=10.0.0.
{(k+1)*2},actions=output:2')")
```

```
            eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} arp,nw_dst=10.0.0.{k*2-
1},actions=output:1')")
            eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} arp,nw_dst=10.0.0.
{k*2},actions=output:1')")
            eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} arp,nw_dst=10.0.0.
{(k+1)*2-1},actions=output:2')")
            eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} arp,nw_dst=10.0.0.
{(k+1)*2},actions=output:2')")
        else:
            eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} ip,nw_dst=10.0.0.{k*2-
1},actions=output:2')")
            eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} ip,nw_dst=10.0.0.
{k*2},actions=output:2')")
            eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} ip,nw_dst=10.0.0.{(k-1)*2-
1},actions=output:1')")
            eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} ip,nw_dst=10.0.0.{(k-
1)*2},actions=output:1')")
            eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} arp,nw_dst=10.0.0.{k*2-
1},actions=output:2')")
            eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} arp,nw_dst=10.0.0.
{k*2},actions=output:2')")
            eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} arp,nw_dst=10.0.0.{(k-
1)*2-1},actions=output:1')")
            eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} arp,nw_dst=10.0.0.{(k-
1)*2},actions=output:1')")
        eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} in_port=1,actions=output:3')")
        eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} in_port=2,actions=output:4')")


    # 17~20号交换机添加流表
    for i in range(17, 21):
        for j in range(1, 17):
            eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} ip,nw_dst=10.0.0.
{j},actions=output:{(j-1)//4+1}')")
            eval(f"s{i}.cmd(r'ovs-ofctl add-flow s{i} arp,nw_dst=10.0.0.
{j},actions=output:{(j-1)//4+1}')")
```

pingall观察流表

```
mininet> pingall
*** Ping: testing ping reachability
h16 -> h3 h8 h4 h12 h13 h1 h9 h5 h14 h7 h10 h6 h2 h15 h11
h3 -> h16 h8 h4 h12 h13 h1 h9 h5 h14 h7 h10 h6 h2 h15 h11
h8 -> h16 h3 h4 h12 h13 h1 h9 h5 h14 h7 h10 h6 h2 h15 h11
h4 -> h16 h3 h8 h12 h13 h1 h9 h5 h14 h7 h10 h6 h2 h15 h11
h12 -> h16 h3 h8 h4 h13 h1 h9 h5 h14 h7 h10 h6 h2 h15 h11
h13 -> h16 h3 h8 h4 h12 h1 h9 h5 h14 h7 h10 h6 h2 h15 h11
h1 -> h16 h3 h8 h4 h12 h13 h9 h5 h14 h7 h10 h6 h2 h15 h11
h9 -> h16 h3 h8 h4 h12 h13 h1 h5 h14 h7 h10 h6 h2 h15 h11
h5 -> h16 h3 h8 h4 h12 h13 h1 h9 h14 h7 h10 h6 h2 h15 h11
h14 -> h16 h3 h8 h4 h12 h13 h1 h9 h5 h7 h10 h6 h2 h15 h11
h7 -> h16 h3 h8 h4 h12 h13 h1 h9 h5 h14 h10 h6 h2 h15 h11
h10 -> h16 h3 h8 h4 h12 h13 h1 h9 h5 h14 h7 h6 h2 h15 h11
h6 -> h16 h3 h8 h4 h12 h13 h1 h9 h5 h14 h7 h10 h2 h15 h11
h2 -> h16 h3 h8 h4 h12 h13 h1 h9 h5 h14 h7 h10 h6 h15 h11
h15 -> h16 h3 h8 h4 h12 h13 h1 h9 h5 h14 h7 h10 h6 h2 h11
h11 -> h16 h3 h8 h4 h12 h13 h1 h9 h5 h14 h7 h10 h6 h2 h15
*** Results: 0% dropped (240/240 received)
```

可以看到，各流表项被正确添加。

```
*** s4 ----------------------------------------------------------------------
 cookie=0x0, duration=584.001s, table=0, n_packets=30, n_bytes=2940, ip,nw_dst=10.0.0.7 actions=output:"s4-eth1"
 cookie=0x0, duration=583.976s, table=0, n_packets=30, n_bytes=2940, ip,nw_dst=10.0.0.8 actions=output:"s4-eth2"
 cookie=0x0, duration=583.946s, table=0, n_packets=30, n_bytes=1260, arp,arp_tpa=10.0.0.7 actions=output:"s4-eth1"
 cookie=0x0, duration=583.923s, table=0, n_packets=30, n_bytes=1260, arp,arp_tpa=10.0.0.8 actions=output:"s4-eth2"
 cookie=0x0, duration=583.911s, table=0, n_packets=56, n_bytes=3920, in_port="s4-eth1" actions=output:"s4-eth3"
 cookie=0x0, duration=583.885s, table=0, n_packets=56, n_bytes=3920, in_port="s4-eth2" actions=output:"s4-eth4"
*** s10 ----------------------------------------------------------------------
 cookie=0x0, duration=583.357s, table=0, n_packets=14, n_bytes=1372, ip,nw_dst=10.0.0.3 actions=output:"s10-eth2"
 cookie=0x0, duration=583.345s, table=0, n_packets=14, n_bytes=1372, ip,nw_dst=10.0.0.4 actions=output:"s10-eth2"
 cookie=0x0, duration=583.327s, table=0, n_packets=14, n_bytes=1372, ip,nw_dst=10.0.0.1 actions=output:"s10-eth1"
 cookie=0x0, duration=583.310s, table=0, n_packets=14, n_bytes=1372, ip,nw_dst=10.0.0.2 actions=output:"s10-eth1"
 cookie=0x0, duration=583.294s, table=0, n_packets=14, n_bytes=588, arp,arp_tpa=10.0.0.3 actions=output:"s10-eth2"
 cookie=0x0, duration=583.279s, table=0, n_packets=14, n_bytes=588, arp,arp_tpa=10.0.0.4 actions=output:"s10-eth2"
 cookie=0x0, duration=583.260s, table=0, n_packets=14, n_bytes=588, arp,arp_tpa=10.0.0.1 actions=output:"s10-eth1"
 cookie=0x0, duration=583.240s, table=0, n_packets=14, n_bytes=588, arp,arp_tpa=10.0.0.2 actions=output:"s10-eth1"
 cookie=0x0, duration=583.228s, table=0, n_packets=48, n_bytes=3360, in_port="s10-eth1" actions=output:"s10-eth3"
 cookie=0x0, duration=583.218s, table=0, n_packets=48, n_bytes=3360, in_port="s10-eth2" actions=output:"s10-eth4"
*** s12 ----------------------------------------------------------------------
 cookie=0x0, duration=583.085s, table=0, n_packets=14, n_bytes=1372, ip,nw_dst=10.0.0.7 actions=output:"s12-eth2"
 cookie=0x0, duration=583.074s, table=0, n_packets=14, n_bytes=1372, ip,nw_dst=10.0.0.8 actions=output:"s12-eth2"
 cookie=0x0, duration=583.064s, table=0, n_packets=14, n_bytes=1372, ip,nw_dst=10.0.0.5 actions=output:"s12-eth1"
 cookie=0x0, duration=583.052s, table=0, n_packets=14, n_bytes=1372, ip,nw_dst=10.0.0.6 actions=output:"s12-eth1"
 cookie=0x0, duration=583.039s, table=0, n_packets=14, n_bytes=588, arp,arp_tpa=10.0.0.7 actions=output:"s12-eth2"
 cookie=0x0, duration=583.031s, table=0, n_packets=14, n_bytes=588, arp,arp_tpa=10.0.0.8 actions=output:"s12-eth2"
 cookie=0x0, duration=583.008s, table=0, n_packets=14, n_bytes=588, arp,arp_tpa=10.0.0.5 actions=output:"s12-eth1"
 cookie=0x0, duration=582.995s, table=0, n_packets=14, n_bytes=588, arp,arp_tpa=10.0.0.6 actions=output:"s12-eth1"
 cookie=0x0, duration=582.983s, table=0, n_packets=48, n_bytes=3360, in_port="s12-eth1" actions=output:"s12-eth3"
 cookie=0x0, duration=582.972s, table=0, n_packets=48, n_bytes=3360, in_port="s12-eth2" actions=output:"s12-eth4"
*** s17 ----------------------------------------------------------------------
 cookie=0x0, duration=582.382s, table=0, n_packets=6, n_bytes=588, ip,nw_dst=10.0.0.1 actions=output:"s17-eth1"
 cookie=0x0, duration=582.364s, table=0, n_packets=6, n_bytes=252, arp,arp_tpa=10.0.0.1 actions=output:"s17-eth1"
 cookie=0x0, duration=582.345s, table=0, n_packets=6, n_bytes=588, ip,nw_dst=10.0.0.2 actions=output:"s17-eth1"
 cookie=0x0, duration=582.329s, table=0, n_packets=6, n_bytes=252, arp,arp_tpa=10.0.0.2 actions=output:"s17-eth1"
 cookie=0x0, duration=582.307s, table=0, n_packets=6, n_bytes=588, ip,nw_dst=10.0.0.3 actions=output:"s17-eth1"
 cookie=0x0, duration=582.293s, table=0, n_packets=6, n_bytes=252, arp,arp_tpa=10.0.0.3 actions=output:"s17-eth1"
 cookie=0x0, duration=582.267s, table=0, n_packets=6, n_bytes=588, ip,nw_dst=10.0.0.4 actions=output:"s17-eth1"
 cookie=0x0, duration=582.257s, table=0, n_packets=6, n_bytes=252, arp,arp_tpa=10.0.0.4 actions=output:"s17-eth1"
 cookie=0x0, duration=582.245s, table=0, n_packets=6, n_bytes=588, ip,nw_dst=10.0.0.5 actions=output:"s17-eth2"
 cookie=0x0, duration=582.221s, table=0, n_packets=6, n_bytes=252, arp,arp_tpa=10.0.0.5 actions=output:"s17-eth2"
 cookie=0x0, duration=582.210s, table=0, n_packets=6, n_bytes=588, ip,nw_dst=10.0.0.6 actions=output:"s17-eth2"
```

流量分布

以上图为例，统计各交换机各端口传输的数据包

switch\port	1	2	3	4
s4	60	60	56	56
s10	56	56	48	48
s12	56	56	48	48
s17	48	48	48	48

可以看出，各端口负载相对均衡