03-nat

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This lab took me about 10 hours to do.

Implementation Explanation: NAT的工作原理 NAT实现了私网IP和公网IP之间的相互转换和通信

- 对于DIR_OUT，NAT根据私网IP：PORT和目的IP：PORT查找对应的entry（查找失败则创建一个entry），改写源IP和源PORT后转发至公网
- 对于DIR_IN，NAT根据源IP：PORT和目的IP：PORT查找对应的entry（查找失败则根据rules创建一个entry，或发送不可达ICMP报文），改写目的IP和目的PORT后转发至私网

函数实现实在是又臭又长，在此不占用篇幅贴源码介绍，本着程序员的最高礼仪，代码注释非常详细，详见源代码

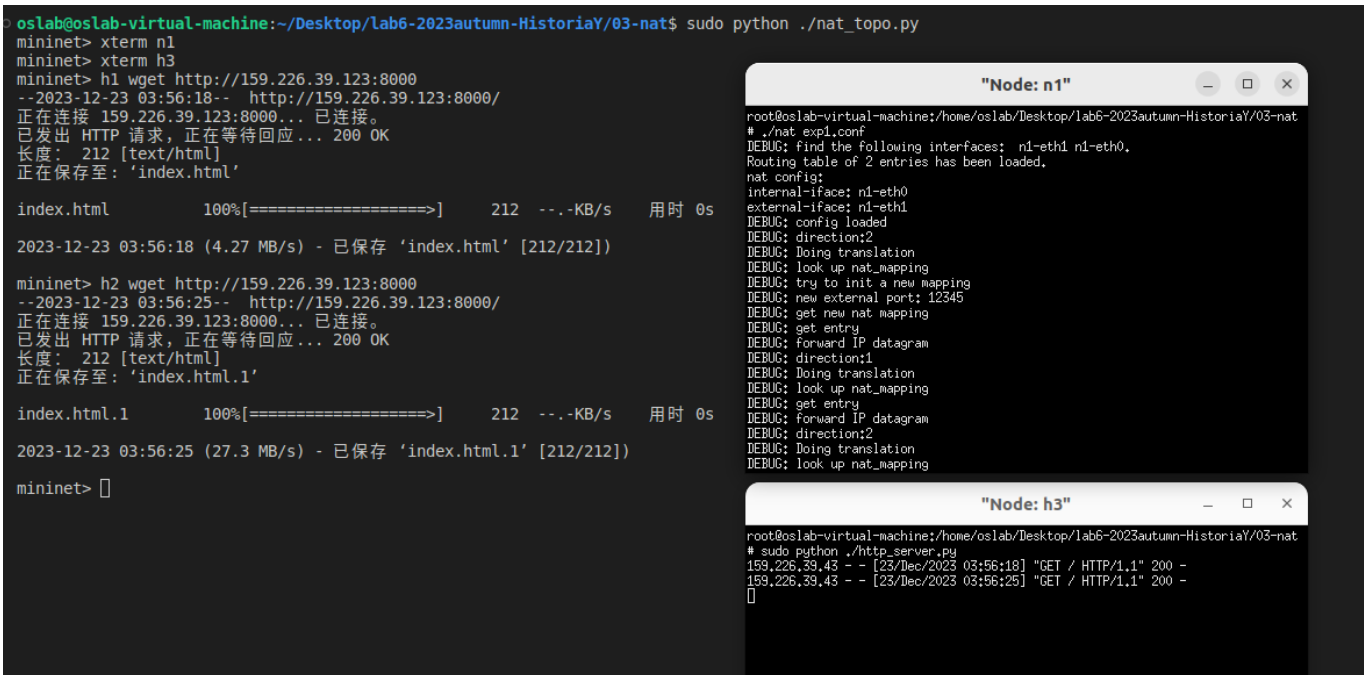
在这里提一下遇到过的一个容易疏忽的bug（可能是我菜） 哈希的时候，本来想着用全部的源IP：PORT和目的IP：PORT进行四元哈希，以尽量减少冲突 但忽略了IN和OUT的时候只有remote部分会保持一致，另外一部分会在私网和external之间横跳，会出现进出哈希值不一致，导致entry无法匹配

```
// there was once a bug, hash value can only depend on remote!!!
static u8 nat_hash_val(u32 remote_ip, u16 remote_port)
{
    u8 res = 0;
    res ^= hash8((void *)&remote_ip, 4);
    res ^= hash8((void *)&remote_port, 2);
    return res;
}
```

还需要注意的点是临界区访问加锁解锁（两个操作需配对）

Screenshots: index.html文件已包含在库中

截图中的DEBUG LOG是我调试的时候加的，可忽略（但也清晰地表现了NAT执行过程） **SNAT**

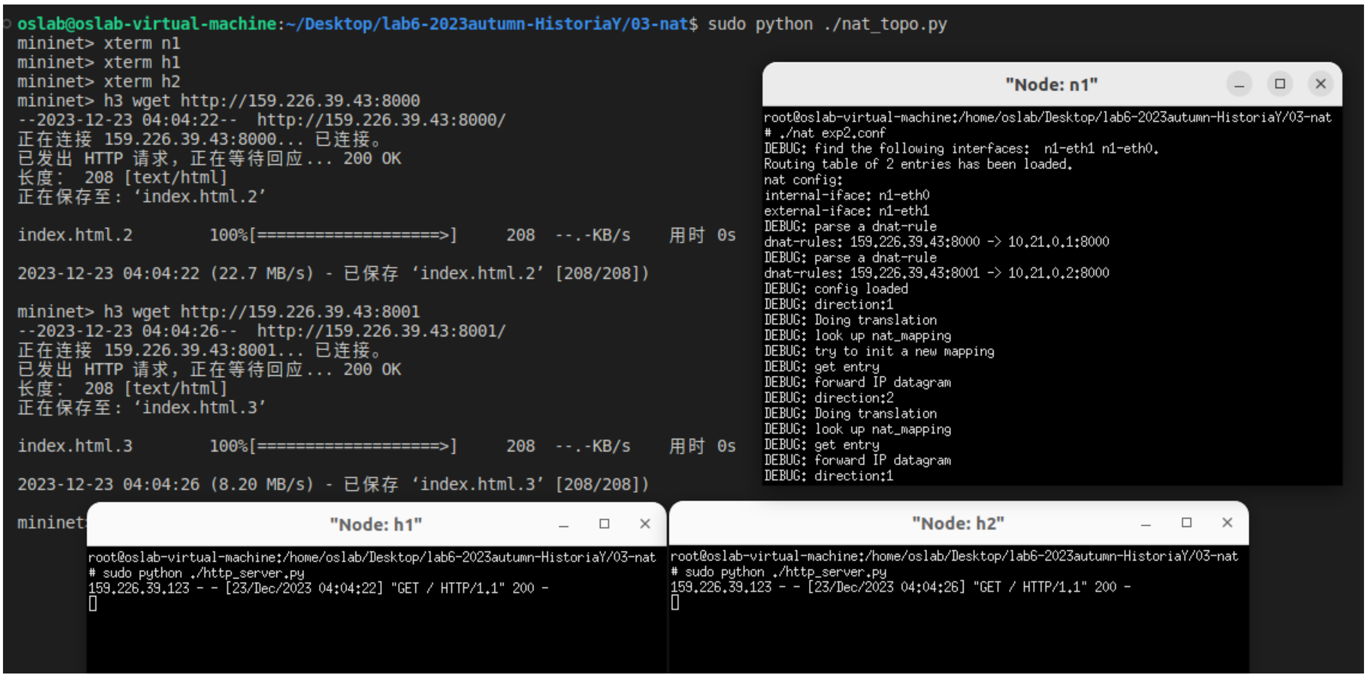


```
oslab@oslab-virtual-machine:~/Desktop/lab6-2023autumn-HistoriaY/03-nat$ sudo python ./nat_topo.py
mininet> xterm n1
mininet> xterm h3
mininet> h1 wget http://159.226.39.123:8000
--2023-12-23 03:56:18--  http://159.226.39.123:8000/
正在连接 159.226.39.123:8000... 已连接。
已发出 HTTP 请求，正在等待回应... 200 OK
长度： 212 [text/html]
正在保存至: ‘index.html’

index.html          100%[===================>]     212  --.-KB/s    用时 0s

2023-12-23 03:56:18 (4.27 MB/s) - 已保存 ‘index.html’ [212/212])

mininet> h2 wget http://159.226.39.123:8000
--2023-12-23 03:56:25--  http://159.226.39.123:8000/
正在连接 159.226.39.123:8000... 已连接。
已发出 HTTP 请求，正在等待回应... 200 OK
长度： 212 [text/html]
正在保存至: ‘index.html.1’

index.html.1        100%[===================>]     212  --.-KB/s    用时 0s

2023-12-23 03:56:25 (27.3 MB/s) - 已保存 ‘index.html.1’ [212/212])

mininet> 
```

```
root@oslab-virtual-machine:/home/oslab/Desktop/lab6-2023autumn-HistoriaY/03-nat
# ./nat exp1.conf
DEBUG: find the following interfaces:  n1-eth1 n1-eth0.
Routing table of 2 entries has been loaded.
nat config:
internal-iface: n1-eth0
external-iface: n1-eth1
DEBUG: config loaded
DEBUG: direction:2
DEBUG: Doing translation
DEBUG: look up nat_mapping
DEBUG: try to init a new mapping
DEBUG: new external port: 12345
DEBUG: get new nat mapping
DEBUG: get entry
DEBUG: forward IP datagram
DEBUG: direction:1
DEBUG: Doing translation
DEBUG: look up nat_mapping
DEBUG: get entry
DEBUG: forward IP datagram
DEBUG: direction:2
DEBUG: Doing translation
DEBUG: look up nat_mapping
```

```
root@oslab-virtual-machine:/home/oslab/Desktop/lab6-2023autumn-HistoriaY/03-nat
# sudo python ./http_server.py
159.226.39.43 - - [23/Dec/2023 03:56:18] "GET / HTTP/1.1" 200 -
159.226.39.43 - - [23/Dec/2023 03:56:25] "GET / HTTP/1.1" 200 -
```

DNAT



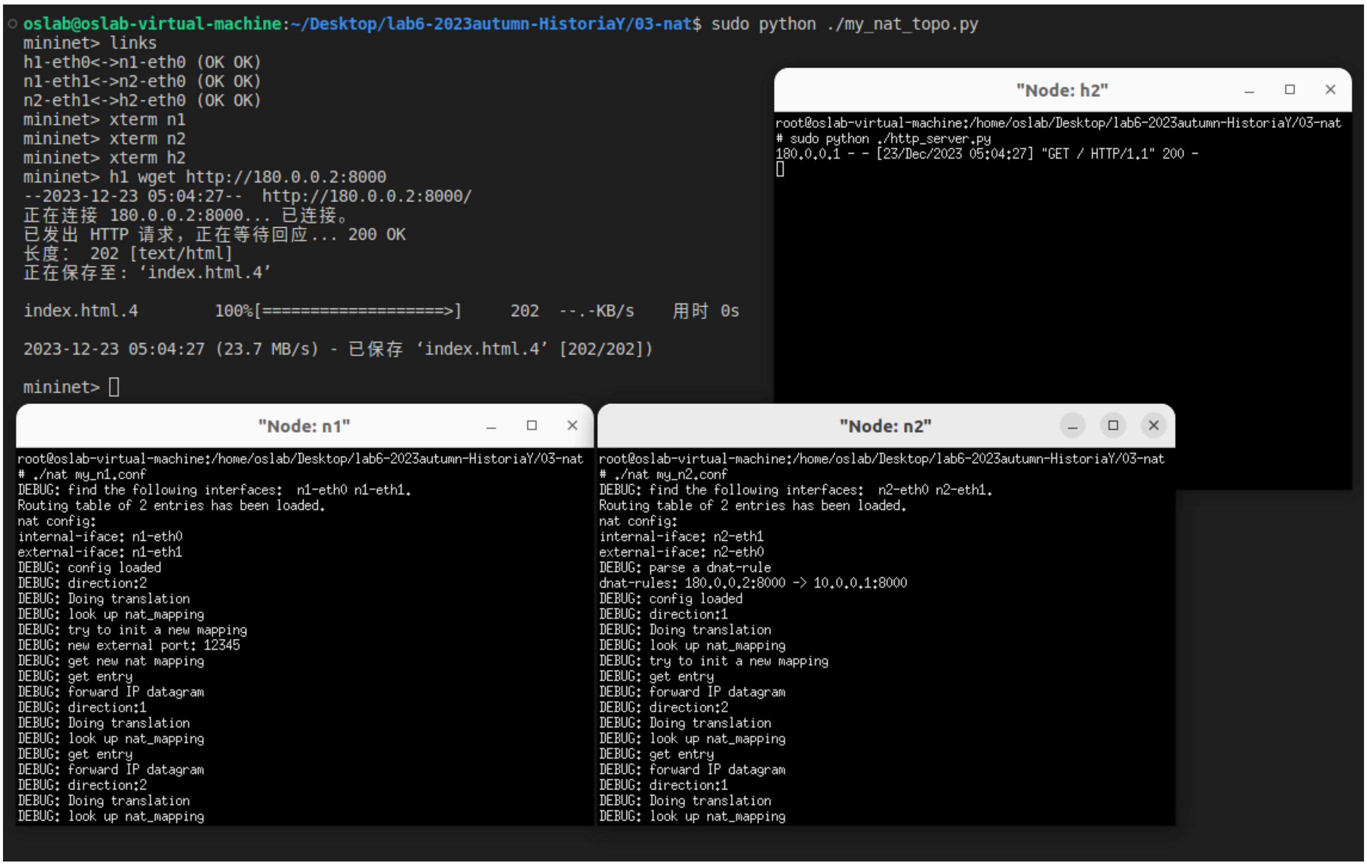
```
oslab@oslab-virtual-machine:~/Desktop/lab6-2023autumn-HistoriaY/03-nat$ sudo python ./nat_topo.py
mininet> xterm n1
mininet> xterm h1
mininet> xterm h2
mininet> h3 wget http://159.226.39.43:8000
--2023-12-23 04:04:22--  http://159.226.39.43:8000/
正在连接 159.226.39.43:8000... 已连接。
已发出 HTTP 请求，正在等待回应... 200 OK
长度： 208 [text/html]
正在保存至: ‘index.html.2’

index.html.2        100%[===================>]     208  --.-KB/s    用时 0s

2023-12-23 04:04:22 (22.7 MB/s) - 已保存 ‘index.html.2’ [208/208])

mininet> h3 wget http://159.226.39.43:8001
--2023-12-23 04:04:26--  http://159.226.39.43:8001/
正在连接 159.226.39.43:8001... 已连接。
已发出 HTTP 请求，正在等待回应... 200 OK
长度： 208 [text/html]
正在保存至: ‘index.html.3’

index.html.3        100%[===================>]     208  --.-KB/s    用时 0s

2023-12-23 04:04:26 (8.20 MB/s) - 已保存 ‘index.html.3’ [208/208])

minine
```

```
root@oslab-virtual-machine:/home/oslab/Desktop/lab6-2023autumn-HistoriaY/03-nat
# ./nat exp2.conf
DEBUG: find the following interfaces:  n1-eth1 n1-eth0.
Routing table of 2 entries has been loaded.
nat config:
internal-iface: n1-eth0
external-iface: n1-eth1
DEBUG: parse a dnat-rule
dnat-rules: 159.226.39.43:8000 -> 10.21.0.1:8000
DEBUG: parse a dnat-rule
dnat-rules: 159.226.39.43:8001 -> 10.21.0.2:8000
DEBUG: config loaded
DEBUG: direction:1
DEBUG: Doing translation
DEBUG: look up nat_mapping
DEBUG: try to init a new mapping
DEBUG: get entry
DEBUG: forward IP datagram
DEBUG: direction:2
DEBUG: Doing translation
DEBUG: look up nat_mapping
DEBUG: get entry
DEBUG: forward IP datagram
DEBUG: direction:1
```

```
root@oslab-virtual-machine:/home/oslab/Desktop/lab6-2023autumn-HistoriaY/03-nat
# sudo python ./http_server.py
159.226.39.123 - - [23/Dec/2023 04:04:22] "GET / HTTP/1.1" 200 -
```

```
root@oslab-virtual-machine:/home/oslab/Desktop/lab6-2023autumn-HistoriaY/03-nat
# sudo python ./http_server.py
159.226.39.123 - - [23/Dec/2023 04:04:26] "GET / HTTP/1.1" 200 -
```

定制NAT



```
oslab@oslab-virtual-machine:~/Desktop/lab6-2023autumn-HistoriaY/03-nat$ sudo python ./my_nat_topo.py
mininet> links
h1-eth0<->n1-eth0 (OK OK)
n1-eth1<->n2-eth0 (OK OK)
n2-eth1<->h2-eth0 (OK OK)
mininet> xterm n1
mininet> xterm n2
mininet> xterm h2
mininet> h1 wget http://180.0.0.2:8000
--2023-12-23 05:04:27--  http://180.0.0.2:8000/
正在连接 180.0.0.2:8000... 已连接。
已发出 HTTP 请求，正在等待回应... 200 OK
长度： 202 [text/html]
正在保存至: ‘index.html.4’

index.html.4        100%[===================>]     202  --.-KB/s    用时 0s

2023-12-23 05:04:27 (23.7 MB/s) - 已保存 ‘index.html.4’ [202/202])

mininet> 
```

```
root@oslab-virtual-machine:/home/oslab/Desktop/lab6-2023autumn-HistoriaY/03-nat
# sudo python ./http_server.py
180.0.0.1 - - [23/Dec/2023 05:04:27] "GET / HTTP/1.1" 200 -
```

```
root@oslab-virtual-machine:/home/oslab/Desktop/lab6-2023autumn-HistoriaY/03-nat
# ./nat my_n1.conf
DEBUG: find the following interfaces:  n1-eth0 n1-eth1.
Routing table of 2 entries has been loaded.
nat config:
internal-iface: n1-eth0
external-iface: n1-eth1
DEBUG: config loaded
DEBUG: direction:2
DEBUG: Doing translation
DEBUG: look up nat_mapping
DEBUG: try to init a new mapping
DEBUG: new external port: 12345
DEBUG: get new nat mapping
DEBUG: get entry
DEBUG: forward IP datagram
DEBUG: direction:1
DEBUG: Doing translation
DEBUG: look up nat_mapping
DEBUG: get entry
DEBUG: forward IP datagram
DEBUG: direction:2
DEBUG: Doing translation
DEBUG: look up nat_mapping
```

```
root@oslab-virtual-machine:/home/oslab/Desktop/lab6-2023autumn-HistoriaY/03-nat
# ./nat my_n2.conf
DEBUG: find the following interfaces:  n2-eth0 n2-eth1.
Routing table of 2 entries has been loaded.
nat config:
internal-iface: n2-eth1
external-iface: n2-eth0
DEBUG: parse a dnat-rule
dnat-rules: 180.0.0.2:8000 -> 10.0.0.1:8000
DEBUG: config loaded
DEBUG: direction:1
DEBUG: Doing translation
DEBUG: look up nat_mapping
DEBUG: try to init a new mapping
DEBUG: get entry
DEBUG: forward IP datagram
DEBUG: direction:2
DEBUG: Doing translation
DEBUG: look up nat_mapping
DEBUG: get entry
DEBUG: forward IP datagram
DEBUG: direction:1
DEBUG: Doing translation
DEBUG: look up nat_mapping
```

拓扑结构：h1-n1-n2-h2

my_nat_topo.py

```python
class NATTopo(Topo):
    def build(self):
        h1 = self.addHost('h1')
        h2 = self.addHost('h2')
        n1 = self.addHost('n1')
        n2 = self.addHost('n2')

        self.addLink(h1, n1)
        self.addLink(n1, n2)
        self.addLink(n2, h2)


if __name__ == '__main__':
    check_scripts()

    topo = NATTopo()
    net = Mininet(topo=topo, switch=OVSBridge, controller=None)

    h1, h2, n1, n2 = net.get('h1', 'h2', 'n1', 'n2')

    h1.cmd('ifconfig h1-eth0 10.0.0.1/24')
    h1.cmd('route add default gw 10.0.0.2')

    h2.cmd('ifconfig h2-eth0 10.0.0.1/24')
    h2.cmd('route add default gw 10.0.0.2')
    n1.cmd('ifconfig n1-eth0 10.0.0.2/24')
    n1.cmd('ifconfig n1-eth1 180.0.0.1/24')

    n2.cmd('ifconfig n2-eth0 180.0.0.2/24')
    n2.cmd('ifconfig n2-eth1 10.0.0.2/24')
```

my_n1.conf internal-iface: n1-eth0 external-iface: n1-eth1

my_n2.conf internal-iface: n2-eth1 external-iface: n2-eth0

dnat-rules: 180.0.0.2:8000 -> 10.0.0.1:8000

Remaining Bugs: 本次实验测试全部通过，无遗留bug