

Report 4 — September 26

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第一部分 Hub

4.1 实验内容

1. 实现节点广播的 broadcast_packet 函数
2. 验证广播网络能够正常运行(从一个端节点 ping 另一个端节点)
3. 验证广播网络的效率(分两种场景在 three_nodes_bw.py 进行 iperf 测量, h1 同时向 h2 和 h3 测量与 h2 和 h3 同时向 h1 测量)
4. 自己动手构建环形拓扑, 验证该拓扑下节点广播会产生数据包环路

4.2 实验过程

4.2.1 实现节点广播的 broadcast_packet 函数

```
// the memory of ``packet`` will be free'd in handle_packet().
void broadcast_packet(iface_info_t *iface, const char *packet, int len)
{
    // TODO: broadcast packet
    // fprintf(stdout, "TODO: broadcast packet.\n");
    iface_info_t *iface_entry;
    list_for_each_entry(iface_entry, &instance->iface_list, list) {
        if (iface_entry->fd != iface->fd)
            iface_send_packet(iface_entry, packet, len);
    }
}
```

在这个函数里,我们遍历所有的接口,如果遍历到的接口不是发送所收到网络包的接口,就调用 `iface_send_packet` 函数广播发送数据包。

4.2.2 验证广播网络能够正常运行

拓扑图如下:

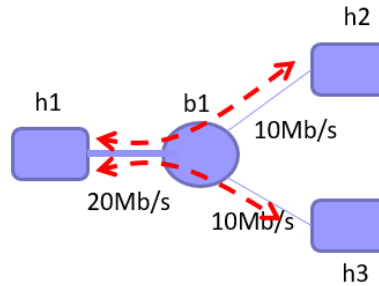


图 4.1. 广播网络拓扑图

h1, h2, h3 分别是三个节点, 它们如果能够相互 ping 通, 说明广播网络能够正常运行。这里 h1 的 IP 地址是 10.0.0.1, h2 的 IP 地址是 10.0.0.2, h3 的 IP 地址是 10.0.0.3。

```
"Node: h1"
root@zhangjiawei-VirtualBox: /home/zhangjiawei/2024_zjw_ComputerNetwork/Lab
04/04-hub+switch/hub# ping 10.0.0.2 -c 4
PING 10.0.0.2 (10.0.0.2) 56(84) bytes of data.
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=0.091 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.108 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.085 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=0.058 ms
--- 10.0.0.2 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3085ms
rtt min/avg/max/mdev = 0.058/0.085/0.108/0.018 ms
root@zhangjiawei-VirtualBox: /home/zhangjiawei/2024_zjw_ComputerNetwork/Lab
04/04-hub+switch/hub# ping 10.0.0.3 -c 4
PING 10.0.0.3 (10.0.0.3) 56(84) bytes of data.
64 bytes from 10.0.0.3: icmp_seq=1 ttl=64 time=0.338 ms
64 bytes from 10.0.0.3: icmp_seq=2 ttl=64 time=0.059 ms
64 bytes from 10.0.0.3: icmp_seq=3 ttl=64 time=0.073 ms
64 bytes from 10.0.0.3: icmp_seq=4 ttl=64 time=0.079 ms
--- 10.0.0.3 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3071ms
rtt min/avg/max/mdev = 0.059/0.137/0.338/0.116 ms
```

图 4.2. h1 ping h2, h3

```
"Node: h2"
root@zhangjiawei-VirtualBox: /home/zhangjiawei/2024_zjw_ComputerNetwork/Lab
04/04-hub+switch/hub# ping 10.0.0.1 -c 4
PING 10.0.0.1 (10.0.0.1) 56(84) bytes of data.
64 bytes from 10.0.0.1: icmp_seq=1 ttl=64 time=0.120 ms
64 bytes from 10.0.0.1: icmp_seq=2 ttl=64 time=0.109 ms
64 bytes from 10.0.0.1: icmp_seq=3 ttl=64 time=0.086 ms
64 bytes from 10.0.0.1: icmp_seq=4 ttl=64 time=0.084 ms
--- 10.0.0.1 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3052ms
rtt min/avg/max/mdev = 0.084/0.099/0.120/0.015 ms
root@zhangjiawei-VirtualBox: /home/zhangjiawei/2024_zjw_ComputerNetwork/Lab
04/04-hub+switch/hub# ping 10.0.0.3 -c 4
PING 10.0.0.3 (10.0.0.3) 56(84) bytes of data.
64 bytes from 10.0.0.3: icmp_seq=1 ttl=64 time=0.077 ms
64 bytes from 10.0.0.3: icmp_seq=2 ttl=64 time=0.074 ms
64 bytes from 10.0.0.3: icmp_seq=3 ttl=64 time=0.071 ms
64 bytes from 10.0.0.3: icmp_seq=4 ttl=64 time=0.069 ms
--- 10.0.0.3 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3109ms
rtt min/avg/max/mdev = 0.069/0.072/0.077/0.003 ms
```

图 4.3. h2 ping h1, h3

```
"Node: h3"
root@zhangjiawei-VirtualBox: /home/zhangjiawei/2024_zjw_ComputerNetwork/Lab
04/04-hub+switch/hub# ping 10.0.0.1 -c 4
PING 10.0.0.1 (10.0.0.1) 56(84) bytes of data.
64 bytes from 10.0.0.1: icmp_seq=1 ttl=64 time=0.072 ms
64 bytes from 10.0.0.1: icmp_seq=2 ttl=64 time=0.063 ms
64 bytes from 10.0.0.1: icmp_seq=3 ttl=64 time=0.073 ms
64 bytes from 10.0.0.1: icmp_seq=4 ttl=64 time=0.105 ms

--- 10.0.0.1 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3109ms
rtt min/avg/max/mdev = 0.063/0.078/0.105/0.015 ms
root@zhangjiawei-VirtualBox: /home/zhangjiawei/2024_zjw_ComputerNetwork/Lab
04/04-hub+switch/hub# ping 10.0.0.2 -c 4
PING 10.0.0.2 (10.0.0.2) 56(84) bytes of data.
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=0.200 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=0.067 ms
64 bytes from 10.0.0.2: icmp_seq=3 ttl=64 time=0.060 ms
64 bytes from 10.0.0.2: icmp_seq=4 ttl=64 time=0.071 ms

--- 10.0.0.2 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3068ms
rtt min/avg/max/mdev = 0.060/0.099/0.200/0.058 ms
```

图 4.4. h3 ping h1, h2

可以看出, h1, h2, h3 三个节点确实能够相互 ping 通, 这表明广播网络能够正常运行。

4.2.3 验证广播网络的效率

```
root@zhangjiawei-VirtualBox: /home/zhangjiawei/2024_zjw_ComputerNetwork/Lab
04/04-hub+switch/hub# iperf client
iperf: ignoring extra argument -- client
Usage: iperf [-s|-c host] [options]
Try 'iperf --help' for more information.
root@zhangjiawei-VirtualBox: /home/zhangjiawei/2024_zjw_ComputerNetwork/Lab
04/04-hub+switch/hub# iperf -c 10.0.0.2 -t 30

-----
Client connecting to 10.0.0.2, TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 1] local 10.0.0.1 port 52960 connected with 10.0.0.2 port 5001 (icwnd/mss/irt
t=14/1448/114)
[ ID] Interval      Transfer      Bandwidth
[ 1] 0.0000-31.2543 sec 7.38 MBytes  1.98 Mbits/sec
root@zhangjiawei-VirtualBox: /home/zhangjiawei/2024_zjw_ComputerNetwork/Lab
04/04-hub+switch/hub# iperf -c 10.0.0.2 -t 30

-----
Client connecting to 10.0.0.2, TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 1] local 10.0.0.1 port 41452 connected with 10.0.0.2 port 5001 (icwnd/mss/irt
t=14/1448/76)
[ ID] Interval      Transfer      Bandwidth
[ 1] 0.0000-31.2563 sec 15.5 MBytes  4.16 Mbits/sec
root@zhangjiawei-VirtualBox: /home/zhangjiawei/2024_zjw_ComputerNetwork/Lab
04/04-hub+switch/hub# iperf -c 10.0.0.2 -t 30

-----
Client connecting to 10.0.0.2, TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 1] local 10.0.0.1 port 45332 connected with 10.0.0.2 port 5001 (icwnd/mss/irt
t=14/1448/163)
[ ID] Interval      Transfer      Bandwidth
[ 1] 0.0000-31.3972 sec 10.5 MBytes  2.81 Mbits/sec
```

图 4.5. h1 向 h2 测量

```

root@zhangjiawei-VirtualBox:/home/zhangjiawei/EEE/2024_zjw_ComputerNetwork/Lab
04/04-hub+switch/hub# iperf -c 10.0.0.3 -t 30
-----
Client connecting to 10.0.0.3, TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 1] local 10.0.0.1 port 35204 connected with 10.0.0.3 port 5001 (icwnd/mss/irt
t=14/1448/48611)
[ ID] Interval      Transfer      Bandwidth
[ 1] 0.0000-30.6967 sec 27.3 MBytes  7.45 Mbits/sec
root@zhangjiawei-VirtualBox:/home/zhangjiawei/EEE/2024_zjw_ComputerNetwork/Lab
04/04-hub+switch/hub# iperf -c 10.0.0.3 -t 30
-----
Client connecting to 10.0.0.3, TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 1] local 10.0.0.1 port 46096 connected with 10.0.0.3 port 5001 (icwnd/mss/irt
t=14/1448/79442)
[ ID] Interval      Transfer      Bandwidth
[ 1] 0.0000-30.7181 sec 19.5 MBytes  5.33 Mbits/sec
root@zhangjiawei-VirtualBox:/home/zhangjiawei/EEE/2024_zjw_ComputerNetwork/Lab
04/04-hub+switch/hub# iperf -c 10.0.0.3 -t 30
-----
Client connecting to 10.0.0.3, TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 1] local 10.0.0.1 port 43652 connected with 10.0.0.3 port 5001 (icwnd/mss/irt
t=14/1448/85787)
[ ID] Interval      Transfer      Bandwidth
[ 1] 0.0000-30.6256 sec 24.6 MBytes  6.75 Mbits/sec

```

图 4.6. h1 向 h3 测量

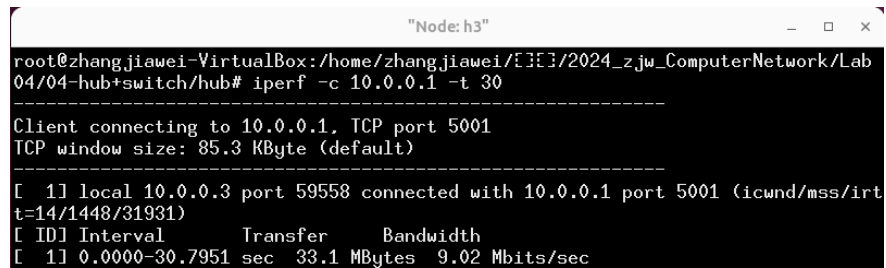
可以看出, h1 向 h2 测量和 h1 向 h3 测量的实际速率差异较大, 而且都远未达到理论带宽值。这是因为 h1 发出的数据都会广播至 h2 和 h3, 实际来看, h1 发送给 h2 的数据会占据 b1 到 h3 的带宽, 而 h1 发送给 h3 的数据也会占据 b1 到 h2 的带宽, 所以实际速率必定达不到理论带宽值。而对于实际速率的差异, 我的解释是, 因为我们在 xterm 终端中并不能保证两个 iperf 进程同时启动, 所以会造成 TCP 窗口大小的差异, 从而导致实际速率的差异。

```

"Node: h2"
root@zhangjiawei-VirtualBox:/home/zhangjiawei/EEE/2024_zjw_ComputerNetwork/Lab
04/04-hub+switch/hub# iperf -c 10.0.0.1 -t 30
-----
Client connecting to 10.0.0.1, TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 1] local 10.0.0.2 port 39354 connected with 10.0.0.1 port 5001 (icwnd/mss/irt
t=14/1448/246)
[ ID] Interval      Transfer      Bandwidth
[ 1] 0.0000-31.0295 sec 33.5 MBytes  9.06 Mbits/sec

```

图 4.7. h2 向 h1 测量



```
"Node: h3"
root@zhangjiawei-VirtualBox: /home/zhangjiawei/1313/2024_zjw_ComputerNetwork/Lab
04/04-hub+switch/hub# iperf -c 10.0.0.1 -t 30
-----
Client connecting to 10.0.0.1, TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 1] local 10.0.0.3 port 59558 connected with 10.0.0.1 port 5001 (icwnd/mss/irt
t=14/1448/31931)
[ ID] Interval      Transfer    Bandwidth
[ 1] 0.0000-30.7951 sec  33.1 MBytes  9.02 Mbits/sec
```

图 4.8. h3 向 h1 测量