

南京大学本科生实验报告

课程名称：计算机网络 任课教师：田臣/李文中 助教：方毓楚、郑浩、陈伟等（排名不分先后）

学院	地理与海洋科学学院	专业	地理信息科学
学号	191830173	姓名	徐嵩
Email	song.xv@outlook.com	开始/完成日期	2022/3/24

1. 实验名称

Lab 6: Reliable Communication

2. 实验目的

构建一个在 IP 协议基础上的可靠传输网络，包含服务端、客户端和中间盒。

3. 实验内容

实现中间盒转发和随机丢弃

实现客户端回复 ACK

实现服务端构造可靠传输报文

4. 实验结果

Show how you implement the features of middlebox.

对于来自服务器端的报文选择性丢弃，通过生成的随机数与设定的 `dropRate` 比较，具体如下：

```
if random.random() < self.dropRate:
    log_info(f"Drop packet: {packet}")
    return
```

然后将收到的报文 ip 包头的 `ttl` 减 1，修改以太网包头的源地址和目的地址，从对应的端口转发。

Show how you implement the features of blastee.

从收到的报文中大端方式读取 RawPacketContents 的前 4 个字节作为 ACK 的序列号，第 5~6 字节作为有效载荷的长度，然后从有效载荷中截取前 8 个字节，作为 ACK 的有效载荷，不足补 0，发送 ACK。

```
# TODO: 获取 seqnum (4 字节) 将其添加到 ACK 中
seqnum = int.from_bytes(packet[3].data[:4], 'big')
# TODO: 获取 length (2 字节)
length = int.from_bytes(packet[3].data[4:6], 'big')
```

Show how you implement the features of blaster.

为收到 ACK 时，检查 LHS 对应的 ACK 是否超时，若超时则将窗口中未收到 ACK 的序号加入 resend list 中。若 resend list 不为空，则发送队列中的第一个序号对应的报文，并删除该序号后返回。若已发送的包小于窗口大小，则将 RHS 右移一位，并发送对应的报文。

```

# 判断是否符合发包条件
if self.checktime():
    log_info("Timeout, generate resend list...")
    self.acktimer = time.time()
    self.resend()

if self.resendlist:
    self.sendseq(self.resendlist[0])
    self.resendlist.pop(0)
    return

if self.RHS - self.LHS + 1 >= self.SW:
    log_info("Sender Window full")
    return

# 调用发包
if self.RHS < self.num:
    self.RHS += 1
    self.sendseq(self.RHS)
    log_info(f"Send a packet {self.RHS}")

```

收到报文时，截取 RawPacketContents 前 4 字节作为 ACK 序列号，并在 ACK list 中记录。然后遍历 ACK list，从 LHS 开始一直到 RHS+1 的位置，遇到 0 则停下，将对应的序号赋给 LHS，如果 LHS 与之前不同，则更新计时器。

```

# TODO: 获取 ACK 的序号
seqnum = int.from_bytes(packet[3].data[:4], 'big')
self.acklist[seqnum - 1] = 1

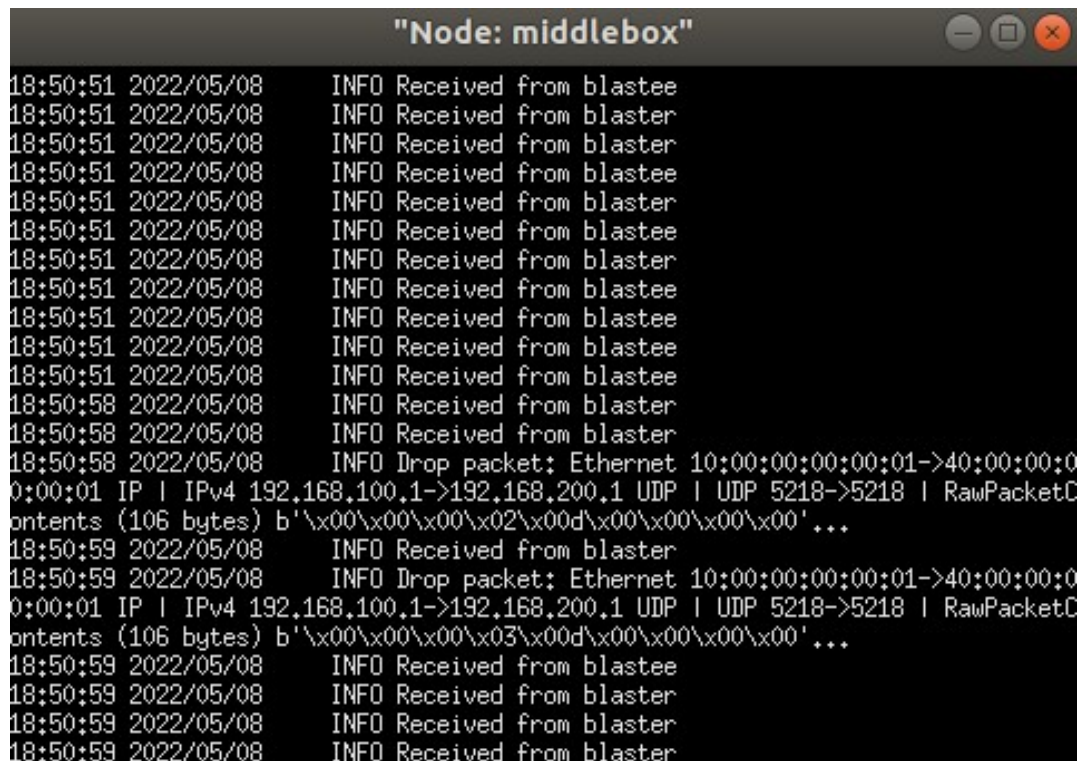
nextLHS = self.LHS
for i in range(self.LHS, self.RHS + 2):
    nextLHS = i
    if self.acklist[i - 1] == 0:
        break

if nextLHS != self.LHS:
    self.LHS = nextLHS
    self.acktimer = time.time()

```

Write the procedure and analysis with screenshots.

先观察 middlebox 的输出日志，在截图中，非常巧合地，middlebox 将序列号为 2 和为 3 的包都丢弃了。



```
"Node: middlebox"
18:50:51 2022/05/08 INFO Received from blastee
18:50:51 2022/05/08 INFO Received from blaster
18:50:51 2022/05/08 INFO Received from blaster
18:50:51 2022/05/08 INFO Received from blastee
18:50:51 2022/05/08 INFO Received from blaster
18:50:51 2022/05/08 INFO Received from blastee
18:50:51 2022/05/08 INFO Received from blaster
18:50:51 2022/05/08 INFO Received from blastee
18:50:51 2022/05/08 INFO Received from blastee
18:50:51 2022/05/08 INFO Received from blastee
18:50:51 2022/05/08 INFO Received from blastee
18:50:58 2022/05/08 INFO Received from blaster
18:50:58 2022/05/08 INFO Received from blaster
18:50:58 2022/05/08 INFO Drop packet: Ethernet 10:00:00:00:00:01->40:00:00:00:00:01
0:00:01 IP | IPv4 192.168.100.1->192.168.200.1 UDP | UDP 5218->5218 | RawPacketC
ontents (106 bytes) b'\x00\x00\x00\x02\x00d\x00\x00\x00\x00'...
18:50:59 2022/05/08 INFO Received from blaster
18:50:59 2022/05/08 INFO Drop packet: Ethernet 10:00:00:00:00:01->40:00:00:00:00:01
0:00:01 IP | IPv4 192.168.100.1->192.168.200.1 UDP | UDP 5218->5218 | RawPacketC
ontents (106 bytes) b'\x00\x00\x00\x03\x00d\x00\x00\x00\x00'...
18:50:59 2022/05/08 INFO Received from blastee
18:50:59 2022/05/08 INFO Received from blaster
18:50:59 2022/05/08 INFO Received from blaster
18:50:59 2022/05/08 INFO Received from blaster
```

观察 blaster 的输出日志，发现由于序列号为 1 的包正常发送和收到 ACK，因此当 blaster 发送序列号为 6 的包后便不再发送。一直到超时事件发生，blaster 生成重发表，分别在两次 recvTimeout 事件中重发 2 和 3，在收到 2 和 3 的 ACK 后，blaster 的 LHS 直接变为 7，继续正常发包。在序列号 100 的包正常收到 ACK 后不再发送新的数据包。


```
"Node: blaster"
21:22:04 2022/05/18 INFO Didn't receive anything
21:22:04 2022/05/18 INFO sented packets = 4; sender window = 5
21:22:04 2022/05/18 INFO Get ACK Sequence Num: 97; ACK list at 97: 1
21:22:04 2022/05/18 INFO Current LHS = 97; Next LHS = 98
21:22:04 2022/05/18 INFO sented packets = 3; sender window = 5
21:22:04 2022/05/18 INFO Get ACK Sequence Num: 98; ACK list at 98: 1
21:22:04 2022/05/18 INFO Current LHS = 98; Next LHS = 99
21:22:04 2022/05/18 INFO sented packets = 2; sender window = 5
21:22:04 2022/05/18 INFO Didn't receive anything
21:22:04 2022/05/18 INFO sented packets = 2; sender window = 5
21:22:04 2022/05/18 INFO Get ACK Sequence Num: 99; ACK list at 99: 1
21:22:04 2022/05/18 INFO Current LHS = 99; Next LHS = 100
21:22:04 2022/05/18 INFO sented packets = 1; sender window = 5
21:22:04 2022/05/18 INFO Get ACK Sequence Num: 100; ACK list at 100: 1
21:22:04 2022/05/18 INFO Current LHS = 100; Next LHS = 101
21:22:04 2022/05/18 INFO sented packets = 0; sender window = 5
21:22:04 2022/05/18 INFO Total Transmission Time: 9.769261837005615
21:22:04 2022/05/18 INFO Number of Retransmission: 18
21:22:04 2022/05/18 INFO Number of Coarse Timeouts: 10
21:22:04 2022/05/18 INFO Throughput: 1207.863394609323
21:22:04 2022/05/18 INFO Goodput: 1023.6111976803342
21:22:04 2022/05/18 INFO Restoring saved iptables state
(syenv) root@njucs-VirtualBox:~/Desktop/lab-06-SonicoGO#
```

修改重传时间为 150ms 后，总吞吐量、超时次数和重传次数接近原来的 2 倍，有效吞吐量变化不大，截图如下：

```
"Node: blaster"
21:23:30 2022/05/18 INFO Get ACK Sequence Num: 100; ACK list at 100: 1
21:23:30 2022/05/18 INFO Current LHS = 97; Next LHS = 97
21:23:30 2022/05/18 INFO Didn't receive anything
21:23:30 2022/05/18 INFO sented packets = 4; sender window = 5
21:23:30 2022/05/18 INFO Didn't receive anything
21:23:30 2022/05/18 INFO Timeout, generate resend list...
21:23:30 2022/05/18 INFO Get ACK Sequence Num: 100; ACK list at 100: 1
21:23:30 2022/05/18 INFO Current LHS = 97; Next LHS = 97
21:23:30 2022/05/18 INFO sented packets = 4; sender window = 5
21:23:31 2022/05/18 INFO Didn't receive anything
21:23:31 2022/05/18 INFO sented packets = 4; sender window = 5
21:23:31 2022/05/18 INFO Didn't receive anything
21:23:31 2022/05/18 INFO Timeout, generate resend list...
21:23:31 2022/05/18 INFO Get ACK Sequence Num: 97; ACK list at 97: 1
21:23:31 2022/05/18 INFO Current LHS = 97; Next LHS = 101
21:23:31 2022/05/18 INFO sented packets = 0; sender window = 5
21:23:31 2022/05/18 INFO Total Transmission Time: 8.626621723175049
21:23:31 2022/05/18 INFO Number of Retransmission: 90
21:23:31 2022/05/18 INFO Number of Coarse Timeouts: 29
21:23:31 2022/05/18 INFO Throughput: 2202.46975678991
21:23:31 2022/05/18 INFO Goodput: 1159.1921419875946
21:23:31 2022/05/18 INFO Restoring saved iptables state
(syenv) root@njucs-VirtualBox:~/Desktop/lab-06-SonicoGO#
```