Implementing a reliable transport protocol

实验一：Alternating Bit Protocol

Alternating Bit Protocol 采用等停机制，每次只发送一个包，并等待收到 ACK 再发送下一个。采用定时器机制，超时后（这里设置20.0s）重传。

一、公共实现的函数：

1. 检验和相关：

```
- int Checksum(struct pkt *packet); // 计算检验和
- int IsCorrupt(struct pkt* packet); // 判断检验和是否正确
```

2. msg 与 **pkt** 相互转换

```
- void msg_to_pkt(struct msg *message, struct pkt *packet, int seq, int ack);
- void pkt_to_msg(struct msg *message, struct pkt *packet);
```

二、A端（发送端）实现

1. 状态变量与全局变量

- 上层发来的数据缓存（采用循环队列）

```
# define N 5 // Buffer 大小
struct msg BufferA[N];
int endA; // 上层共送来了endA个msg，endA有可能比N大（应该换个名字）
```

- 状态变量

```
int baseA; // 正在传送这个  也用此当作ack序号
int wait; // bool: wait is 1, ok is 0
// wait 用来识别是否在发送pkt状态，只在一开始启动有作用
```

- 临时变量（可以省掉）

```
struct msg sendmsg; // 当前正在操作的msg
struct pkt sendpkt; // 当前正在操作的pkt
```

2. 初始化

void A_init(void);

```
    baseA = 0; endA = 0;
    wait = 0; // 一开始未工作
```

3. 从上层传送消息给**A**

void A_output(struct msg message);

- step1: 存取msg，放入BufferA
- step2: 如果之前未工作，开始工作（根据wait状态变量）

4. 从下层收到**ACK**

void A_input(struct pkt packet);

- 检测是否被损坏，如果损坏则丢弃，否则开始传输下一个（如果有的话）

5. 重传

void A_timerinterrupt(void);

- 重传并重置定时器

三、B端（接收端）实现

1. 状态变量与全局变量

- 状态变量

```
    int SeqB;
    int AckB;
```

- 临时变量

```
    struct pkt ackpkt;
```

2. 初始化

void B_init(void);

```
    SeqB = -1;
    AckB = 0; // ACK 为期望值
```

```
    // 初始包装一个 ACK
    ackpkt.acknum = AckB;
    ackpkt.seqnum = SeqB;
    ackpkt.checksum = Checksum(&ackpkt);
```

3. 从下层收到pkt

void B_input(struct pkt packet) 伪代码描述：

```
    if 包坏掉了：
        舍弃，假装是噪声，没看见。
    elif 序列号错掉了：
        发送上一次的 ACK
    else
        发送正确的 ACK
```

四、Sample Output

自己打印版（需设置程序内宏变量为1）

```
$ gcc .\ABP_simple.c -o ABP
$ ./ABP.exe 10 0.1 0.1 2 0
-----  Stop and Wait Network Simulator Version 1.1 --------

the number of messages to simulate: 10
packet loss probability: 0.100000
packet corruption probability: 0.100000
average time between messages from sender's layer5: 2.000000
TRACE: 0
A get msg 0 by layer5
A snd pkt 0 by layer3
A get msg 1 by layer5
A get msg 2 by layer5
A get msg 3 by layer5
B rcv pkt 0 by layer3
B snd ack 1 to layer3
A get msg 4 by layer5
A get msg 5 by layer5
A get msg 6 by layer5
A get msg 7 by layer5
A get msg 8 by layer5
A get msg 9 by layer5
A snd pkt 0 to layer3
B rcv pkt 0 by layer3
B snd ack 1 to layer3
A rcv ack 1 by layer3
A snd pkt 1 to layer3
B rcv pkt 1 by layer3
```

```
B snd ack 2 to layer3
A rcv ack 2 by layer3
A snd pkt 2 to layer3
B rcv pkt 2 by layer3
B snd ack 3 to layer3
A rcv ack 3 by layer3
A snd pkt 3 to layer3
B rcv pkt 3 by layer3
B snd ack 4 to layer3
A snd pkt 3 to layer3
B rcv pkt 3 by layer3
B snd ack 4 to layer3
A snd pkt 3 to layer3
B rcv pkt 3 by layer3
B snd ack 4 to layer3
A snd pkt 3 to layer3
B rcv pkt 3 by layer3
B snd ack 4 to layer3
A rcv ack 4 by layer3
A snd pkt 4 to layer3
B rcv pkt 4 by layer3
B snd ack 5 to layer3
A snd pkt 4 to layer3
B rcv pkt 4 by layer3
B snd ack 5 to layer3
A rcv ack 5 by layer3
A snd pkt 5 to layer3
B rcv pkt 5 by layer3
B snd ack 6 to layer3
A rcv ack 6 by layer3
A snd pkt 6 to layer3
B rcv pkt 6 by layer3
B snd ack 7 to layer3
A rcv ack 7 by layer3
A snd pkt 7 to layer3
B rcv pkt 7 by layer3
B snd ack 8 to layer3
A snd pkt 7 to layer3
A snd pkt 7 to layer3
B rcv pkt 7 by layer3
B snd ack 8 to layer3
A rcv ack 8 by layer3
A snd pkt 8 to layer3
B rcv pkt 8 by layer3
B snd ack 9 to layer3
A snd pkt 8 to layer3
B rcv pkt 8 by layer3
B snd ack 9 to layer3
A rcv ack 9 by layer3
A snd pkt 9 to layer3
B rcv pkt 9 by layer3
B snd ack 10 to layer3
A rcv ack 10 by layer3
```

```
 Simulator terminated at time 272.130402
 after sending 10 msgs from layer5
```

直接调用打印版

```
$ gcc .\ABP_simple.c -o ABP
$ ./ABP.exe 10 0.1 0.1 2 2
-----  Stop and Wait Network Simulator Version 1.1 --------

the number of messages to simulate: 10
packet loss probability: 0.100000
packet corruption probability: 0.100000
average time between messages from sender's layer5: 2.000000
TRACE: 2

EVENT time: 0.187139,  type: 1, fromlayer5  entity: 0

EVENT time: 3.215430,  type: 1, fromlayer5  entity: 0

EVENT time: 4.589007,  type: 1, fromlayer5  entity: 0

EVENT time: 5.255288,  type: 1, fromlayer5  entity: 0

EVENT time: 5.679586,  type: 2, fromlayer3  entity: 1
          TOLAYER3: packet being corrupted

EVENT time: 7.110569,  type: 1, fromlayer5  entity: 0

EVENT time: 8.854641,  type: 1, fromlayer5  entity: 0

EVENT time: 10.826503,  type: 1, fromlayer5  entity: 0

EVENT time: 11.768608,  type: 2, fromlayer3  entity: 0

EVENT time: 14.476517,  type: 1, fromlayer5  entity: 0

EVENT time: 16.498062,  type: 1, fromlayer5  entity: 0

EVENT time: 19.715691,  type: 1, fromlayer5  entity: 0

EVENT time: 20.187140,  type: 0, timerinterrupt   entity: 0

EVENT time: 25.142887,  type: 2, fromlayer3  entity: 1

EVENT time: 33.719017,  type: 2, fromlayer3  entity: 0

EVENT time: 38.295452,  type: 2, fromlayer3  entity: 1

EVENT time: 46.324718,  type: 2, fromlayer3  entity: 0

EVENT time: 51.695213,  type: 2, fromlayer3  entity: 1
```

```
EVENT time: 52.752617,  type: 2, fromlayer3  entity: 0

EVENT time: 62.087650,  type: 2, fromlayer3  entity: 1
          TOLAYER3: packet being corrupted

EVENT time: 68.834503,  type: 2, fromlayer3  entity: 0

EVENT time: 72.752617,  type: 0, timerinterrupt   entity: 0

EVENT time: 76.130959,  type: 2, fromlayer3  entity: 1
          TOLAYER3: packet being corrupted

EVENT time: 85.109749,  type: 2, fromlayer3  entity: 0

EVENT time: 92.752617,  type: 0, timerinterrupt   entity: 0

EVENT time: 94.672478,  type: 2, fromlayer3  entity: 1
          TOLAYER3: packet being corrupted

EVENT time: 104.307449,  type: 2, fromlayer3  entity: 0

EVENT time: 112.752617,  type: 0, timerinterrupt   entity: 0

EVENT time: 118.833946,  type: 2, fromlayer3  entity: 1

EVENT time: 123.385658,  type: 2, fromlayer3  entity: 0

EVENT time: 129.716385,  type: 2, fromlayer3  entity: 1
          TOLAYER3: packet being lost

EVENT time: 143.385651,  type: 0, timerinterrupt   entity: 0

EVENT time: 152.806107,  type: 2, fromlayer3  entity: 1

EVENT time: 161.450073,  type: 2, fromlayer3  entity: 0

EVENT time: 166.420929,  type: 2, fromlayer3  entity: 1

EVENT time: 175.944656,  type: 2, fromlayer3  entity: 0

EVENT time: 178.019699,  type: 2, fromlayer3  entity: 1

EVENT time: 179.180374,  type: 2, fromlayer3  entity: 0

EVENT time: 183.376663,  type: 2, fromlayer3  entity: 1
          TOLAYER3: packet being lost

EVENT time: 199.180374,  type: 0, timerinterrupt   entity: 0
          TOLAYER3: packet being lost

EVENT time: 219.180374,  type: 0, timerinterrupt   entity: 0

EVENT time: 220.723938,  type: 2, fromlayer3  entity: 1
```

```
EVENT time: 224.513184,  type: 2, fromlayer3  entity: 0

EVENT time: 229.713379,  type: 2, fromlayer3  entity: 1
          TOLAYER3: packet being corrupted

EVENT time: 235.176163,  type: 2, fromlayer3  entity: 0

EVENT time: 244.513184,  type: 0, timerinterrupt   entity: 0

EVENT time: 252.720154,  type: 2, fromlayer3  entity: 1

EVENT time: 262.486145,  type: 2, fromlayer3  entity: 0

EVENT time: 270.468170,  type: 2, fromlayer3  entity: 1

EVENT time: 272.130402,  type: 2, fromlayer3  entity: 0
 Simulator terminated at time 272.130402
 after sending 10 msgs from layer5
```

实验二：Go Back N Steps(GBN)

Go Back N Steps 采用流水线机制，每次发送N个包，并等待收到 ACK（累计确认机制）再发送后面的。采用定时器机制，超时后（这里设置20.0s）全部重传。

一、公共实现的函数：

1. 检验和相关：

```
- int Checksum(struct pkt *packet); // 计算检验和
- int IsCorrupt(struct pkt* packet); // 判断检验和是否正确
```

2. msg 与 pkt 相互转换

```
- void msg_to_pkt(struct msg *message, struct pkt *packet, int seq, int ack);
- void pkt_to_msg(struct msg *message, struct pkt *packet);
```

二、A端（发送端）实现

1. 状态变量与全局变量

- 上层发来的数据缓存（采用循环队列）

```
# define N 500 // Buffer 大小
struct pkt BufferA[N]; //这里改为缓存封装好的pkt
```

```
int endA; // 上层共送来了endA个msg，endA有可能比N大（应该换个名字）
```

- 状态变量

```
# define n 3 // n steps
int baseA; // 正在传送这个  也用此当作ack序号
int nextseqnum; // 下一个序号
int wait; // bool: wait is 1, ok is 0
// wait 用来识别是否在发送pkt状态，只在一开始启动有作用
```

2. 初始化

void A_init(void);

```
    baseA = 0; endA = 0; nextseqnum = 0;
    wait = 0; // 一开始未工作
```

3. 从上层传送消息给**A**

void A_output(struct msg message); 伪代码描述：

- step1: 转换msg，存取pkt，放入BufferA
- step2: 如果还能接着发，满足 n steps，就继续发

4. 从下层收到**ACK**

void A_input(struct pkt packet) 伪代码描述：

- step1: 检测包是否损坏，累计确认机制
- step2: 开始传输后面n steps，如果有的话

5. 重传

void A_timerinterrupt(void);

- 重新发送序列号从base到nextseqnum（不包括nextseqnum）的包，并重置定时器

三、B端（接收端）实现

1. 状态变量与全局变量

- 状态变量

```
  int SeqB;
  int AckB;
```

- 临时变量

```
struct pkt ackpkt;
```

2. 初始化

void B_init(void);

```
    SeqB = -1;
    AckB = -1;
    // 先包装一个 ACK
    ackpkt.acknum = AckB;
    ackpkt.seqnum = SeqB;
    ackpkt.checksum = Checksum(&ackpkt);
```

3. 从下层收到pkt

void B_input(struct pkt packet) 伪代码描述：

```
    if 包坏掉了：
        舍弃，假装是噪声，没看见。
    elif 序列号错掉了：
        发送上一次的 ACK
    else
        发送正确的 ACK
```

四、Sample Output

自己打印版（需设置程序内宏变量为1）

```
$ gcc .\GBN_simple.c -o GBN
$ .\GBN.exe 20 0.1 0.1 10 0
-----  Stop and Wait Network Simulator Version 1.1 --------

the number of messages to simulate: 20
packet loss probability: 0.100000
packet corruption probability: 0.100000
average time between messages from sender's layer5: 10.000000
TRACE: 0
A get msg 0 by layer5
A snd pkt 0 by layer3
*****************************************
B rcv pkt 0 by layer3
B snd ack 0 to layer3
```

```
*************************************
A rcv ack 0 by layer3
A get msg 1 by layer5
A snd pkt 1 by layer3
*************************************
B rcv pkt 1 by layer3
B snd ack 1 to layer3
*************************************
A rcv ack 1 by layer3
A get msg 2 by layer5
A snd pkt 2 by layer3
*************************************
B rcv pkt 2 by layer3
B snd ack 2 to layer3
*************************************
A rcv ack 2 by layer3
A get msg 3 by layer5
A snd pkt 3 by layer3
*************************************
B rcv pkt 3 by layer3
B snd ack 3 to layer3
*************************************
A rcv ack 3 by layer3
A get msg 4 by layer5
A snd pkt 4 by layer3
*************************************
B rcv pkt 4 by layer3
B snd ack 4 to layer3
*************************************
A get msg 5 by layer5
A snd pkt 5 by layer3
*************************************
B rcv pkt 5 by layer3
B snd ack 5 to layer3
*************************************
A get msg 6 by layer5
A snd pkt 6 by layer3
A snd pkt 4 by layer3
A snd pkt 5 by layer3
A snd pkt 6 by layer3
*************************************
B rcv pkt 6 by layer3
B snd ack 6 to layer3
*************************************
*************************************
B rcv pkt 4 by layer3
B snd ack 6 to layer3
*************************************
*************************************
B rcv pkt 5 by layer3
B snd ack 6 to layer3
*************************************
A get msg 7 by layer5
A get msg 8 by layer5
```

```
A rcv ack 6 by layer3
A snd pkt 7 by layer3
A snd pkt 8 by layer3
**************************************
B get a corrupted pkt!
CheckSum 1962 and Correct is 1001955
**************************************
A get msg 9 by layer5
A snd pkt 9 by layer3
**************************************
B rcv pkt 7 by layer3
B snd ack 7 to layer3
**************************************
A rcv ack 7 by layer3
A get msg 10 by layer5
A snd pkt 10 by layer3
A get msg 11 by layer5
**************************************
B rcv pkt 8 by layer3
B snd ack 8 to layer3
**************************************
**************************************
B rcv pkt 9 by layer3
B snd ack 9 to layer3
**************************************
**************************************
B rcv pkt 10 by layer3
B snd ack 10 to layer3
**************************************
A rcv ack 9 by layer3
A snd pkt 11 by layer3
A rcv ack 10 by layer3
A get msg 12 by layer5
A snd pkt 12 by layer3
**************************************
B rcv pkt 11 by layer3
B snd ack 11 to layer3
**************************************
**************************************
B rcv pkt 12 by layer3
B snd ack 12 to layer3
**************************************
A get msg 13 by layer5
A snd pkt 13 by layer3
**************************************
B rcv pkt 13 by layer3
B snd ack 13 to layer3
**************************************
A rcv ack 11 by layer3
A get msg 14 by layer5
A snd pkt 14 by layer3
A rcv ack 12 by layer3
**************************************
B rcv pkt 14 by layer3
```

```
B snd ack 14 to layer3
****************************************
A rcv ack 14 by layer3
A get msg 15 by layer5
A snd pkt 15 by layer3
****************************************
B rcv pkt 15 by layer3
B snd ack 15 to layer3
****************************************
A get msg 16 by layer5
A snd pkt 16 by layer3
A get msg 17 by layer5
A snd pkt 17 by layer3
A snd pkt 15 by layer3
A snd pkt 16 by layer3
A snd pkt 17 by layer3
****************************************
B rcv pkt 16 by layer3
B snd ack 16 to layer3
****************************************
A get msg 18 by layer5
A rcv ack 16 by layer3
A snd pkt 18 by layer3
A get msg 19 by layer5
A snd pkt 19 by layer3
****************************************
B get a corrupted pkt!
CheckSum 2182 and Correct is 2158
****************************************
****************************************
B rcv pkt 15 by layer3
B snd ack 16 to layer3
****************************************
****************************************
B rcv pkt 17 by layer3
B snd ack 17 to layer3
****************************************
****************************************
B rcv pkt 18 by layer3
B snd ack 18 to layer3
****************************************
A snd pkt 17 by layer3
A snd pkt 18 by layer3
A snd pkt 19 by layer3
****************************************
B rcv pkt 19 by layer3
B snd ack 19 to layer3
****************************************
****************************************
B get a corrupted pkt!
CheckSum 2202 and Correct is 2177
****************************************
A rcv ack 18 by layer3
****************************************
```

```
B rcv pkt 19 by layer3
B snd ack 19 to layer3
*************************************
A rcv ack 19 by layer3
 Simulator terminated at time 199.451935
 after sending 20 msgs from layer5
```

直接调用打印版

```
$ gcc .\GBN_simple.c -o GBN
$ .\GBN.exe 20 0.1 0.1 10 2
-----   Stop and Wait Network Simulator Version 1.1 --------

the number of messages to simulate: 20
packet loss probability: 0.100000
packet corruption probability: 0.100000
average time between messages from sender's layer5: 10.000000
TRACE: 2

EVENT time: 0.935697,  type: 1, fromlayer5  entity: 0

EVENT time: 6.428144,  type: 2, fromlayer3  entity: 1

EVENT time: 8.927275,  type: 2, fromlayer3  entity: 0

EVENT time: 16.077150,  type: 1, fromlayer5  entity: 0

EVENT time: 17.478437,  type: 2, fromlayer3  entity: 1

EVENT time: 22.915127,  type: 2, fromlayer3  entity: 0

EVENT time: 23.220314,  type: 1, fromlayer5  entity: 0

EVENT time: 26.716484,  type: 2, fromlayer3  entity: 1

EVENT time: 29.601521,  type: 2, fromlayer3  entity: 0

EVENT time: 33.328045,  type: 1, fromlayer5  entity: 0

EVENT time: 37.904480,  type: 2, fromlayer3  entity: 1

EVENT time: 45.933746,  type: 2, fromlayer3  entity: 0

EVENT time: 50.578938,  type: 1, fromlayer5  entity: 0

EVENT time: 56.140324,  type: 2, fromlayer3  entity: 1
          TOLAYER3: packet being lost

EVENT time: 57.463303,  type: 1, fromlayer5  entity: 0

EVENT time: 66.798332,  type: 2, fromlayer3  entity: 1
```

```
         TOLAYER3: packet being corrupted

EVENT time: 68.762474,  type: 1, fromlayer5  entity: 0

EVENT time: 70.578934,  type: 0, timerinterrupt   entity: 0
         TOLAYER3: packet being corrupted

EVENT time: 71.940857,  type: 2, fromlayer3  entity: 1

EVENT time: 73.468216,  type: 2, fromlayer3  entity: 1

EVENT time: 73.545181,  type: 2, fromlayer3  entity: 0

EVENT time: 75.388077,  type: 2, fromlayer3  entity: 1

EVENT time: 76.715599,  type: 1, fromlayer5  entity: 0

EVENT time: 78.503983,  type: 1, fromlayer5  entity: 0

EVENT time: 79.626511,  type: 2, fromlayer3  entity: 0

EVENT time: 84.178223,  type: 2, fromlayer3  entity: 0

EVENT time: 85.023041,  type: 2, fromlayer3  entity: 1

EVENT time: 85.869316,  type: 1, fromlayer5  entity: 0

EVENT time: 90.508949,  type: 2, fromlayer3  entity: 0

EVENT time: 90.718742,  type: 2, fromlayer3  entity: 1

EVENT time: 92.719627,  type: 2, fromlayer3  entity: 0

EVENT time: 94.693436,  type: 1, fromlayer5  entity: 0

EVENT time: 96.947533,  type: 1, fromlayer5  entity: 0

EVENT time: 98.572495,  type: 2, fromlayer3  entity: 1
         TOLAYER3: packet being corrupted

EVENT time: 101.876122,  type: 2, fromlayer3  entity: 0

EVENT time: 106.433388,  type: 2, fromlayer3  entity: 1

EVENT time: 107.594070,  type: 2, fromlayer3  entity: 1

EVENT time: 107.976952,  type: 2, fromlayer3  entity: 0

EVENT time: 111.766190,  type: 2, fromlayer3  entity: 0

EVENT time: 112.375862,  type: 1, fromlayer5  entity: 0

EVENT time: 113.177155,  type: 2, fromlayer3  entity: 1
```

```
EVENT time: 115.042076,  type: 2, fromlayer3  entity: 1

EVENT time: 115.751205,  type: 1, fromlayer5  entity: 0

EVENT time: 119.291046,  type: 2, fromlayer3  entity: 1
          TOLAYER3: packet being lost

EVENT time: 121.384132,  type: 2, fromlayer3  entity: 0

EVENT time: 127.206024,  type: 1, fromlayer5  entity: 0

EVENT time: 131.150116,  type: 2, fromlayer3  entity: 0

EVENT time: 134.225342,  type: 2, fromlayer3  entity: 1

EVENT time: 136.011719,  type: 2, fromlayer3  entity: 0

EVENT time: 137.876511,  type: 1, fromlayer5  entity: 0

EVENT time: 144.112198,  type: 2, fromlayer3  entity: 1
          TOLAYER3: packet being lost

EVENT time: 152.692032,  type: 1, fromlayer5  entity: 0

EVENT time: 157.254547,  type: 1, fromlayer5  entity: 0
          TOLAYER3: packet being corrupted

EVENT time: 157.876511,  type: 0, timerinterrupt   entity: 0
          TOLAYER3: packet being lost

EVENT time: 159.133179,  type: 2, fromlayer3  entity: 1

EVENT time: 159.359711,  type: 1, fromlayer5  entity: 0

EVENT time: 160.144440,  type: 2, fromlayer3  entity: 0

EVENT time: 167.530731,  type: 1, fromlayer5  entity: 0

EVENT time: 167.791428,  type: 2, fromlayer3  entity: 1

EVENT time: 168.841141,  type: 2, fromlayer3  entity: 1

EVENT time: 172.926193,  type: 2, fromlayer3  entity: 1
          TOLAYER3: packet being lost

EVENT time: 177.297455,  type: 2, fromlayer3  entity: 1

EVENT time: 178.776596,  type: 2, fromlayer3  entity: 0

EVENT time: 180.144440,  type: 0, timerinterrupt   entity: 0
          TOLAYER3: packet being lost
          TOLAYER3: packet being corrupted

EVENT time: 180.840042,  type: 2, fromlayer3  entity: 1
```

```
EVENT time: 184.920151,  type: 2, fromlayer3  entity: 1

EVENT time: 187.806747,  type: 2, fromlayer3  entity: 0

EVENT time: 189.456757,  type: 2, fromlayer3  entity: 1

EVENT time: 196.964066,  type: 2, fromlayer3  entity: 0

EVENT time: 199.451935,  type: 2, fromlayer3  entity: 0
 Simulator terminated at time 199.451935
 after sending 20 msgs from layer5
```

实验三（扩展）：TCP

TCP 在 GBN 基础上增加了快速重传机制，增加了接收方的缓存，仍然采用累计确认机制。

一、公共实现的函数：

1. 检验和相关：

```
- int Checksum(struct pkt *packet); // 计算检验和
- int IsCorrupt(struct pkt* packet); // 判断检验和是否正确
```

2. msg 与 **pkt** 相互转换

```
- void msg_to_pkt(struct msg *message, struct pkt *packet, int seq, int ack);
- void pkt_to_msg(struct msg *message, struct pkt *packet);
```

二、A端（发送端）实现

1. 状态变量与全局变量

- 上层发来的数据缓存（采用循环队列）

```
# define N 500 // Buffer 大小
struct pkt BufferA[N]; //这里改为缓存封装好的pkt
int endA; // 上层共送来了endA个msg，endA有可能比N大（应该换个名字）
```

- 状态变量

```
# define n 5 // n steps
int baseA; // 正在传送这个  也用此当作ack序号
```

```
int nextseqnum; // 下一个序号
int count; // 快速重传计数器，收到三个执行快速重传
```

2. 初始化

void A_init(void);

```
baseA = 0; endA = 0; nextseqnum = 0;
count=0; // 快速重传计数器置零
```

3. 从上层传送消息给**A**

void A_output(struct msg message); 伪代码描述：

- step1: 转换msg，存取pkt，放入BufferA
- step2: 如果还能接着发，满足 n steps，就继续发

4. 从下层收到**ACK**

void A_input(struct pkt packet) 伪代码描述：

- step1: 检测包是否损坏，累计确认机制
- step2: 如果确认成功，开始传输后面n steps，如果有的话；如果是冗余ACK开始计数，计到3开始重传。

5. 重传

void A_timerinterrupt(void);

- 只重传序列号base的包，并重置定时器。

三、B端（接收端）实现

1. 状态变量与全局变量

- 下层发来的数据缓存（采用循环队列）

```
struct pkt BufferB[N]; //这里改为缓存封装好的pkt
int endB; // 上层共送来了endA个msg，endA有可能比N大（应该换个名字）
```

- 状态变量

```
int SeqB;
int AckB;
```

- 临时变量

```
struct pkt ackpkt;
```

2. 初始化

void B_init(void);

```
    SeqB = -1;
    AckB = -1;//ACK为确认ACK之前的（包括ACK）不是期望的，由于代码沿袭GBN，所以有修改
    // 先包装一个 ACK
    ackpkt.acknum = AckB;
    ackpkt.seqnum = SeqB;
    ackpkt.checksum = Checksum(&ackpkt);
```

3. 从下层收到pkt

void B_input(struct pkt packet) 伪代码描述：

```
    if 包坏掉了：
        舍弃，假装是噪声，没看见。
    elif 序列号错掉了：
        发送上一次的 ACK
    else
        发送正确的 ACK
```

四、Sample Output

自己打印版（需设置程序内宏变量为1）

```
$ gcc .\TCP.c -o TCP
$ ./TCP.exe 20 0.1 0.1 2 0
-----  Stop and Wait Network Simulator Version 1.1 --------

the number of messages to simulate: 20
packet loss probability: 0.100000
packet corruption probability: 0.100000
average time between messages from sender's layer5: 2.000000
TRACE: 0
A get msg 0 by layer5
A snd pkt 0 by layer3
A get msg 1 by layer5
A snd pkt 1 by layer3
A get msg 2 by layer5
A snd pkt 2 by layer3
```

```
****************************************
B rcv pkt 0 by layer3
B snd ack 0 to layer3
****************************************
A get msg 3 by layer5
A snd pkt 3 by layer3
A get msg 4 by layer5
A snd pkt 4 by layer3
A rcv ack 0 by layer3
****************************************
B rcv pkt 1 by layer3
B snd ack 1 to layer3
****************************************
A get msg 5 by layer5
A snd pkt 5 by layer3
A get msg 6 by layer5
A get msg 7 by layer5
A get msg 8 by layer5
A rcv ack 1 by layer3
A snd pkt 6 by layer3
A get msg 9 by layer5
****************************************
B rcv pkt 3 by layer3
B snd ack 1 to layer3
****************************************
A get msg 10 by layer5
****************************************
B rcv pkt 4 by layer3
B snd ack 1 to layer3
****************************************
A get msg 11 by layer5
A get msg 12 by layer5
A get msg 13 by layer5
A get msg 14 by layer5
****************************************
B rcv pkt 5 by layer3
B snd ack 1 to layer3
****************************************
A get msg 15 by layer5
****************************************
B rcv pkt 6 by layer3
B snd ack 1 to layer3
****************************************
A get msg 16 by layer5
A snd pkt 2 by layer3
A get msg 17 by layer5
A get msg 18 by layer5
A get msg 19 by layer5
A snd pkt 2 by layer3
****************************************
B rcv pkt 2 by layer3
B snd ack 6 to layer3
****************************************
A rcv ack 6 by layer3
```

```
A snd pkt 7 by layer3
A snd pkt 8 by layer3
A snd pkt 9 by layer3
A snd pkt 10 by layer3
A snd pkt 11 by layer3
****************************************
B get a corrupted pkt!
CheckSum 1982 and Correct is 1968
****************************************
****************************************
B rcv pkt 8 by layer3
B snd ack 6 to layer3
****************************************
A snd pkt 7 by layer3
****************************************
B rcv pkt 9 by layer3
B snd ack 6 to layer3
****************************************
****************************************
B rcv pkt 10 by layer3
B snd ack 6 to layer3
****************************************
****************************************
B rcv pkt 11 by layer3
B snd ack 6 to layer3
****************************************
A snd pkt 7 by layer3
****************************************
B rcv pkt 7 by layer3
B snd ack 11 to layer3
****************************************
A rcv ack 11 by layer3
A snd pkt 12 by layer3
A snd pkt 13 by layer3
A snd pkt 14 by layer3
A snd pkt 15 by layer3
A snd pkt 16 by layer3
****************************************
B rcv pkt 12 by layer3
B snd ack 12 to layer3
****************************************
****************************************
B rcv pkt 14 by layer3
B snd ack 12 to layer3
****************************************
****************************************
B rcv pkt 15 by layer3
B snd ack 12 to layer3
****************************************
****************************************
B rcv pkt 16 by layer3
B snd ack 12 to layer3
****************************************
A rcv ack 12 by layer3
```

```
A snd pkt 17 by layer3
***************************************
B rcv pkt 17 by layer3
B snd ack 12 to layer3
***************************************
A snd pkt 13 by layer3
***************************************
B rcv pkt 13 by layer3
B snd ack 17 to layer3
***************************************
A snd pkt 13 by layer3
***************************************
B get a corrupted pkt!
CheckSum 2102 and Correct is 1002088
***************************************
A snd pkt 13 by layer3
A snd pkt 13 by layer3
***************************************
B rcv pkt 13 by layer3
B snd ack 17 to layer3
***************************************
A rcv ack 17 by layer3
A snd pkt 18 by layer3
A snd pkt 19 by layer3
***************************************
B rcv pkt 18 by layer3
B snd ack 18 to layer3
***************************************
***************************************
B rcv pkt 19 by layer3
B snd ack 19 to layer3
***************************************
A rcv ack 18 by layer3
A rcv ack 19 by layer3
 Simulator terminated at time 220.631226
 after sending 20 msgs from layer5
```

直接调用打印版

```
$ gcc .\TCP.c -o TCP
$ ./TCP.exe 20 0.1 0.1 2 2
-----  Stop and Wait Network Simulator Version 1.1 --------

the number of messages to simulate: 20
packet loss probability: 0.100000
packet corruption probability: 0.100000
average time between messages from sender's layer5: 2.000000
TRACE: 2

EVENT time: 0.187139,  type: 1, fromlayer5  entity: 0
```

```
EVENT time: 3.215430,  type: 1, fromlayer5  entity: 0

EVENT time: 4.589007,  type: 1, fromlayer5  entity: 0
          TOLAYER3: packet being lost

EVENT time: 5.679586,  type: 2, fromlayer3  entity: 1

EVENT time: 6.850795,  type: 1, fromlayer5  entity: 0

EVENT time: 10.500809,  type: 1, fromlayer5  entity: 0

EVENT time: 10.603747,  type: 2, fromlayer3  entity: 0

EVENT time: 10.853969,  type: 2, fromlayer3  entity: 1

EVENT time: 12.258919,  type: 1, fromlayer5  entity: 0

EVENT time: 13.363933,  type: 1, fromlayer5  entity: 0

EVENT time: 14.740806,  type: 1, fromlayer5  entity: 0

EVENT time: 16.683249,  type: 1, fromlayer5  entity: 0

EVENT time: 17.740349,  type: 2, fromlayer3  entity: 0

EVENT time: 18.710531,  type: 1, fromlayer5  entity: 0

EVENT time: 19.093632,  type: 2, fromlayer3  entity: 1

EVENT time: 20.909451,  type: 1, fromlayer5  entity: 0

EVENT time: 21.978668,  type: 2, fromlayer3  entity: 1
          TOLAYER3: packet being lost

EVENT time: 23.413252,  type: 2, fromlayer3  entity: 0

EVENT time: 23.463606,  type: 1, fromlayer5  entity: 0

EVENT time: 27.306984,  type: 1, fromlayer5  entity: 0

EVENT time: 28.897608,  type: 1, fromlayer5  entity: 0

EVENT time: 29.954647,  type: 1, fromlayer5  entity: 0

EVENT time: 30.007935,  type: 2, fromlayer3  entity: 1
          TOLAYER3: packet being corrupted

EVENT time: 30.922817,  type: 1, fromlayer5  entity: 0

EVENT time: 31.065340,  type: 2, fromlayer3  entity: 1

EVENT time: 34.102600,  type: 1, fromlayer5  entity: 0

EVENT time: 37.740349,  type: 0, timerinterrupt   entity: 0
```

```
            TOLAYER3: packet being lost

   EVENT time: 37.940365,  type: 1, fromlayer5  entity: 0

   EVENT time: 38.986725,  type: 2, fromlayer3  entity: 0

   EVENT time: 41.113312,  type: 1, fromlayer5  entity: 0

   EVENT time: 42.894249,  type: 1, fromlayer5  entity: 0

   EVENT time: 48.587910,  type: 2, fromlayer3  entity: 0

   EVENT time: 57.740349,  type: 0, timerinterrupt   entity: 0

   EVENT time: 65.765495,  type: 2, fromlayer3  entity: 1

   EVENT time: 70.504257,  type: 2, fromlayer3  entity: 0
            TOLAYER3: packet being corrupted

   EVENT time: 78.216011,  type: 2, fromlayer3  entity: 1

   EVENT time: 83.911713,  type: 2, fromlayer3  entity: 1

   EVENT time: 85.926056,  type: 2, fromlayer3  entity: 0
            TOLAYER3: packet being lost

   EVENT time: 91.765465,  type: 2, fromlayer3  entity: 1

   EVENT time: 94.291786,  type: 2, fromlayer3  entity: 1
            TOLAYER3: packet being corrupted

   EVENT time: 96.328102,  type: 2, fromlayer3  entity: 1
            TOLAYER3: packet being lost

   EVENT time: 99.708214,  type: 2, fromlayer3  entity: 0

   EVENT time: 101.423721,  type: 2, fromlayer3  entity: 0

   EVENT time: 105.926056,  type: 0, timerinterrupt   entity: 0

   EVENT time: 108.478470,  type: 2, fromlayer3  entity: 1

   EVENT time: 117.190559,  type: 2, fromlayer3  entity: 0
            TOLAYER3: packet being lost

   EVENT time: 119.709465,  type: 2, fromlayer3  entity: 1
            TOLAYER3: packet being corrupted

   EVENT time: 124.392197,  type: 2, fromlayer3  entity: 1

   EVENT time: 127.360733,  type: 2, fromlayer3  entity: 1

   EVENT time: 128.371017,  type: 2, fromlayer3  entity: 0
```

```
EVENT time: 133.515396,  type: 2, fromlayer3  entity: 1

EVENT time: 135.390335,  type: 2, fromlayer3  entity: 0

EVENT time: 136.416977,  type: 2, fromlayer3  entity: 1

EVENT time: 137.176712,  type: 2, fromlayer3  entity: 0

EVENT time: 142.613678,  type: 2, fromlayer3  entity: 0

EVENT time: 148.200882,  type: 2, fromlayer3  entity: 1
          TOLAYER3: packet being lost

EVENT time: 149.054825,  type: 2, fromlayer3  entity: 0

EVENT time: 162.613678,  type: 0, timerinterrupt   entity: 0
          TOLAYER3: packet being corrupted

EVENT time: 170.930801,  type: 2, fromlayer3  entity: 1

EVENT time: 182.613678,  type: 0, timerinterrupt   entity: 0
          TOLAYER3: packet being lost

EVENT time: 202.613678,  type: 0, timerinterrupt   entity: 0

EVENT time: 206.698730,  type: 2, fromlayer3  entity: 1

EVENT time: 207.709991,  type: 2, fromlayer3  entity: 0

EVENT time: 210.741150,  type: 2, fromlayer3  entity: 1

EVENT time: 214.929199,  type: 2, fromlayer3  entity: 1

EVENT time: 219.023666,  type: 2, fromlayer3  entity: 0

EVENT time: 220.631226,  type: 2, fromlayer3  entity: 0
 Simulator terminated at time 220.631226
 after sending 20 msgs from layer5
```