

B053040017 方郁文

Step 1

The image displays three terminal windows side-by-side, each showing a network simulation log. The windows are titled 'jeff@jeff-M5-7A38: ~/桌面/network/network/step_1', 'jeff@jeff-M5-7A38-3: ~/桌面/network', and 'jeff@jeff-M5-7A38-3: ~/桌面/network/network/step_1'. The logs show a sequence of network events, including sending and receiving packets (DATA, ACK, FIN) and listening states. The simulation appears to be a file transfer process, with the first window showing the initial setup and the first few packets, the second window showing the continuation of the transfer, and the third window showing the final stages, including file creation and completion.

Step 2

The image displays two terminal windows side-by-side, showing a network simulation. The left window is titled "jeff-M5-7A38 - 桌面/network/network/step_2" and the right window is titled "jeff-M5-7A38 - 桌面/network/network/step_2". Both windows show a sequence of network events, including sending packets, receiving acknowledgments, and handling timeouts and losses.

Left Window (Sender Perspective):

- Receive a packet(ACK) from 127.0.0.1:1264
- receive a packet (seq num = 3262, ack num = 4)
- Send a packet(DATA) to 127.0.0.1:1264
- Timeout
- Send a packet(DATA) to 127.0.0.1:1264
- Receive a packet(ACK) from 127.0.0.1:1264
- receive a packet (seq num = 3263, ack num = 5)
- Send a packet(DATA) to 127.0.0.1:1264
- Receive a packet(ACK) from 127.0.0.1:1264
- receive a packet (seq num = 3264, ack num = 6)
- Send a packet(DATA) to 127.0.0.1:1264
- Receive a packet(ACK) from 127.0.0.1:1264
- receive a packet (seq num = 3265, ack num = 7)
- Send a packet(DATA) to 127.0.0.1:1264
- Receive a packet(ACK) from 127.0.0.1:1264
- receive a packet (seq num = 3266, ack num = 8)
- Send a packet(DATA) to 127.0.0.1:1264
- Receive a packet(ACK) from 127.0.0.1:1264
- receive a packet (seq num = 3267, ack num = 9)
- Send a packet(DATA) to 127.0.0.1:1264
- Receive a packet(ACK) from 127.0.0.1:1264
- receive a packet (seq num = 3268, ack num = 10)
- Send a packet(DATA) to 127.0.0.1:1264
- Unfortunately packet(DATA) was lost during transmit.
(seq num = 10, ack num = 3269)
- Timeout
- Send a packet(DATA) to 127.0.0.1:1264
- Receive a packet(ACK) from 127.0.0.1:1264
- receive a packet (seq num = 3269, ack num = 11)
- Send a packet(DATA) to 127.0.0.1:1264
- unfortunately packet(DATA) was lost during transmit.
(seq num = 11, ack num = 3270)
- Timeout
- Send a packet(DATA) to 127.0.0.1:1264
- Receive a packet(ACK) from 127.0.0.1:1264
- receive a packet (seq num = 3270, ack num = 12)
- Send a packet(DATA) to 127.0.0.1:1264
- Receive a packet(ACK) from 127.0.0.1:1264
- receive a packet (seq num = 3271, ack num = 13)
- Send a packet(DATA) to 127.0.0.1:1264
- Receive a packet(ACK) from 127.0.0.1:1264
- receive a packet (seq num = 3272, ack num = 14)
- Send a packet(DATA) to 127.0.0.1:1264

Right Window (Receiver Perspective):

- receive a packet (seq num = 4, ack num = 3263)
- Send a packet(ACK) to 127.0.0.1:16018
- Listening
- Receive a packet(DATA) from 127.0.0.1:16018
- receive a packet (seq num = 5, ack num = 3264)
- Send a packet(ACK) to 127.0.0.1:16018
- Listening
- Receive a packet(DATA) from 127.0.0.1:16018
- receive a packet (seq num = 6, ack num = 3265)
- Send a packet(ACK) to 127.0.0.1:16018
- Listening
- Receive a packet(DATA) from 127.0.0.1:16018
- receive a packet (seq num = 7, ack num = 3266)
- Send a packet(ACK) to 127.0.0.1:16018
- Listening
- Receive a packet(DATA) from 127.0.0.1:16018
- receive a packet (seq num = 8, ack num = 3267)
- Send a packet(ACK) to 127.0.0.1:16018
- Listening
- Receive a packet(DATA) from 127.0.0.1:16018
- receive a packet (seq num = 9, ack num = 3268)
- Send a packet(ACK) to 127.0.0.1:16018
- Listening
- Receive a packet(DATA) from 127.0.0.1:16018
- receive a packet (seq num = 10, ack num = 3269)
- Send a packet(ACK) to 127.0.0.1:16018
- Listening
- Receive a packet(DATA) from 127.0.0.1:16018
- receive a packet (seq num = 11, ack num = 3270)
- Send a packet(ACK) to 127.0.0.1:16018
- Listening
- Receive a packet(DATA) from 127.0.0.1:16018
- receive a packet (seq num = 12, ack num = 3271)
- Send a packet(ACK) to 127.0.0.1:16018
- Listening
- Receive a packet(DATA) from 127.0.0.1:16018
- receive a packet (seq num = 13, ack num = 3272)
- Send a packet(ACK) to 127.0.0.1:16018
- Listening
- Receive a packet(DATA) from 127.0.0.1:16018
- receive a packet (seq num = 14, ack num = 3273)
- Send a packet(ACK) to 127.0.0.1:16018
- Listening

Step 3

The image displays two side-by-side terminal windows, each showing a network simulation log. The left window's title bar is 'jeff@jeff-M5-7A38: ~/桌面/network/network/step_3' and the right window's title bar is 'jeff@jeff-M5-7A38: ~/桌面/network/network/step_3'. Both windows show a sequence of network events, including sending and receiving packets, acknowledgments, and listening for connections. The simulation progresses from sequence number 1020 to 1040.

Left Window Log:

```
receive a packet ( seq num = 1020, ack num = 193)
Send a packet(DATA) to 127.0.0.1:1264
Send a packet(DATA) to 127.0.0.1:1264
Receive a packet(ACK) from 127.0.0.1:1264
    receive a packet ( seq num = 1022, ack num = 195)
Send a packet(DATA) to 127.0.0.1:1264
Send a packet(DATA) to 127.0.0.1:1264
Receive a packet(ACK) from 127.0.0.1:1264
    receive a packet ( seq num = 1024, ack num = 197)
Send a packet(DATA) to 127.0.0.1:1264
Send a packet(DATA) to 127.0.0.1:1264
Receive a packet(ACK) from 127.0.0.1:1264
    receive a packet ( seq num = 1026, ack num = 199)
Send a packet(DATA) to 127.0.0.1:1264
Send a packet(DATA) to 127.0.0.1:1264
Receive a packet(ACK) from 127.0.0.1:1264
    receive a packet ( seq num = 1028, ack num = 201)
Send a packet(DATA) to 127.0.0.1:1264
Send a packet(DATA) to 127.0.0.1:1264
Receive a packet(ACK) from 127.0.0.1:1264
    receive a packet ( seq num = 1030, ack num = 203)
Send a packet(DATA) to 127.0.0.1:1264
Send a packet(DATA) to 127.0.0.1:1264
Receive a packet(ACK) from 127.0.0.1:1264
    receive a packet ( seq num = 1032, ack num = 205)
Send a packet(DATA) to 127.0.0.1:1264
Send a packet(DATA) to 127.0.0.1:1264
Receive a packet(ACK) from 127.0.0.1:1264
    receive a packet ( seq num = 1034, ack num = 207)
Send a packet(DATA) to 127.0.0.1:1264
Send a packet(DATA) to 127.0.0.1:1264
Receive a packet(ACK) from 127.0.0.1:1264
    receive a packet ( seq num = 1036, ack num = 209)
Send a packet(DATA) to 127.0.0.1:1264
Send a packet(DATA) to 127.0.0.1:1264
Receive a packet(ACK) from 127.0.0.1:1264
    receive a packet ( seq num = 1038, ack num = 211)
Send a packet(DATA) to 127.0.0.1:1264
Send a packet(DATA) to 127.0.0.1:1264
Receive a packet(ACK) from 127.0.0.1:1264
    receive a packet ( seq num = 1040, ack num = 213)
Send a packet(DATA) to 127.0.0.1:1264
Send a packet(DATA) to 127.0.0.1:1264
```

Right Window Log:

```
Receive a packet(DATA) from 127.0.0.1:53163
    receive a packet ( seq num = 201, ack num = 1029)
Listening
Receive a packet(DATA) from 127.0.0.1:53163
    receive a packet ( seq num = 202, ack num = 1030)
Send a packet(ACK) to 127.0.0.1:53163
Listening
Receive a packet(DATA) from 127.0.0.1:53163
    receive a packet ( seq num = 203, ack num = 1031)
Listening
Receive a packet(DATA) from 127.0.0.1:53163
    receive a packet ( seq num = 204, ack num = 1032)
Send a packet(ACK) to 127.0.0.1:53163
Listening
Receive a packet(DATA) from 127.0.0.1:53163
    receive a packet ( seq num = 205, ack num = 1033)
Listening
Receive a packet(DATA) from 127.0.0.1:53163
    receive a packet ( seq num = 206, ack num = 1034)
Send a packet(ACK) to 127.0.0.1:53163
Listening
Receive a packet(DATA) from 127.0.0.1:53163
    receive a packet ( seq num = 207, ack num = 1035)
Listening
Receive a packet(DATA) from 127.0.0.1:53163
    receive a packet ( seq num = 208, ack num = 1036)
Send a packet(ACK) to 127.0.0.1:53163
Listening
Receive a packet(DATA) from 127.0.0.1:53163
    receive a packet ( seq num = 209, ack num = 1037)
Listening
Receive a packet(DATA) from 127.0.0.1:53163
    receive a packet ( seq num = 210, ack num = 1038)
Send a packet(ACK) to 127.0.0.1:53163
Listening
Receive a packet(DATA) from 127.0.0.1:53163
    receive a packet ( seq num = 211, ack num = 1039)
Listening
Receive a packet(DATA) from 127.0.0.1:53163
    receive a packet ( seq num = 212, ack num = 1040)
Send a packet(ACK) to 127.0.0.1:53163
Listening
Receive a packet(DATA) from 127.0.0.1:53163
```

Step 4

The image displays two terminal windows side-by-side, showing a network simulation. The left window represents the host's perspective, and the right window represents the server's perspective. Both windows show the progression of a TCP connection from establishment to data transfer and congestion avoidance.

Left Window (Host Perspective):

- Initial state: `recv_wnd = 32768, threshold = 4096`
- Connection establishment: `*****Slow start*****`
- First data transfer: `Receive a packet(ACK) from 127.0.0.1:1264`, `receive a packet (seq num = 4837, ack num = 2)`, `Send: 2 MSS`
- Second data transfer: `Receive a packet(ACK) from 127.0.0.1:1264`, `receive a packet (seq num = 4839, ack num = 4)`, `Send: 4 MSS`
- Third data transfer: `Receive a packet(ACK) from 127.0.0.1:1264`, `receive a packet (seq num = 4841, ack num = 6)`, `Send: 6 MSS`
- Fourth data transfer: `Receive a packet(ACK) from 127.0.0.1:1264`, `receive a packet (seq num = 4843, ack num = 8)`, `Send: 8 MSS`
- Congestion avoidance: `*****Congestion avoidance*****`
- Continued data transfer: `Receive a packet(ACK) from 127.0.0.1:1264`, `receive a packet (seq num = 4845, ack num = 10)`, `Send: 10 MSS`
- Continued data transfer: `Receive a packet(ACK) from 127.0.0.1:1264`, `receive a packet (seq num = 4847, ack num = 12)`, `Send: 12 MSS`
- Continued data transfer: `Receive a packet(ACK) from 127.0.0.1:1264`, `receive a packet (seq num = 4849, ack num = 14)`, `Send: 14 MSS`
- Continued data transfer: `Receive a packet(ACK) from 127.0.0.1:1264`, `receive a packet (seq num = 4851, ack num = 16)`, `Send: 16 MSS`
- Continued data transfer: `Receive a packet(ACK) from 127.0.0.1:1264`, `receive a packet (seq num = 4853, ack num = 18)`, `Send: 18 MSS`
- Continued data transfer: `Receive a packet(ACK) from 127.0.0.1:1264`, `receive a packet (seq num = 4855, ack num = 20)`, `Send: 20 MSS`
- Continued data transfer: `Receive a packet(ACK) from 127.0.0.1:1264`, `receive a packet (seq num = 4857, ack num = 22)`, `Send: 22 MSS`
- Continued data transfer: `Receive a packet(ACK) from 127.0.0.1:1264`, `receive a packet (seq num = 4859, ack num = 24)`, `Send: 24 MSS`

Right Window (Server Perspective):

- Initial state: `Send a packet(ACK) to 127.0.0.1:5001`, `====Complete the three-way handshake====`
- Listening: `Receive a packet(DATA) from 127.0.0.1:5002`, `receive a packet (seq num = 1, ack num = 4837)`, `Send a packet(ACK) to 127.0.0.1:5002`
- Listening: `Receive a packet(DATA) from 127.0.0.1:5002`, `receive a packet (seq num = 2, ack num = 4838)`, `Send a packet(ACK) to 127.0.0.1:5002`
- Listening: `Receive a packet(DATA) from 127.0.0.1:5002`, `receive a packet (seq num = 3, ack num = 4839)`, `Send a packet(ACK) to 127.0.0.1:5002`
- Listening: `Receive a packet(DATA) from 127.0.0.1:5002`, `receive a packet (seq num = 4, ack num = 4840)`, `Send a packet(ACK) to 127.0.0.1:5002`
- Listening: `Receive a packet(DATA) from 127.0.0.1:5002`, `receive a packet (seq num = 5, ack num = 4841)`, `Send a packet(ACK) to 127.0.0.1:5002`
- Listening: `Receive a packet(DATA) from 127.0.0.1:5002`, `receive a packet (seq num = 6, ack num = 4842)`, `Send a packet(ACK) to 127.0.0.1:5002`
- Listening: `Receive a packet(DATA) from 127.0.0.1:5002`, `receive a packet (seq num = 7, ack num = 4843)`, `Send a packet(ACK) to 127.0.0.1:5002`
- Listening: `Receive a packet(DATA) from 127.0.0.1:5002`, `receive a packet (seq num = 8, ack num = 4844)`, `Send a packet(ACK) to 127.0.0.1:5002`
- Listening: `Receive a packet(DATA) from 127.0.0.1:5002`, `receive a packet (seq num = 9, ack num = 4845)`, `Send a packet(ACK) to 127.0.0.1:5002`
- Listening: `Receive a packet(DATA) from 127.0.0.1:5002`, `receive a packet (seq num = 10, ack num = 4846)`, `Send a packet(ACK) to 127.0.0.1:5002`
- Listening: `Receive a packet(DATA) from 127.0.0.1:5002`, `receive a packet (seq num = 11, ack num = 4847)`, `Send a packet(ACK) to 127.0.0.1:5002`
- Listening: `Receive a packet(DATA) from 127.0.0.1:5002`

Step 5

```
Jeff@Jeff-MS-7A38: ~/桌面/network/network/step_5
cwnd = 1 MSS, rwnd = 32768, threshold = 8192
send: 1 MSS
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 5041, ack num = 2)
cwnd = 2 MSS, rwnd = 32768, threshold = 8192
send: 2 MSS
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 5042, ack num = 3)
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 5043, ack num = 4)
cwnd = 4 MSS, rwnd = 32768, threshold = 8192
unfortunately packet(DATA) was lost during transmit.
( seq num = 4, ack num = 5044)
send: 4 MSS
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 5043, ack num = 4)
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 5043, ack num = 4)
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 5043, ack num = 4)
*****Fast retransmit*****
*****Slow start*****
cwnd = 1 MSS, rwnd = 32768, threshold = 2048
send: 1 MSS
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 5044, ack num = 5)
cwnd = 2 MSS, rwnd = 32768, threshold = 2048
send: 2 MSS
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 5045, ack num = 6)
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 5046, ack num = 7)
*****Congestion avoidance*****
cwnd = 2 MSS, rwnd = 32768, threshold = 2048
send: 2 MSS
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 5047, ack num = 8)
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 5048, ack num = 9)
cwnd = 3 MSS, rwnd = 32768, threshold = 2048
send: 3 MSS
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 5049, ack num = 10)

Jeff@Jeff-MS-7A38: ~/桌面/network/network/step_5
DestIP: 127.0.0.1
DestPort: 5002
Listening
Receive a packet(DATA) from 127.0.0.1:5002
receive a packet ( seq num = 1, ack num = 5041)
Send a packet(ACK) to 127.0.0.1:5002
Listening
Receive a packet(DATA) from 127.0.0.1:5002
receive a packet ( seq num = 2, ack num = 5042)
Send a packet(ACK) to 127.0.0.1:5002
Listening
Receive a packet(DATA) from 127.0.0.1:5002
receive a packet ( seq num = 3, ack num = 5043)
Send a packet(ACK) to 127.0.0.1:5002
Listening
Receive a packet(DATA) from 127.0.0.1:5002
receive a packet ( seq num = 5, ack num = 5045)
Send a packet(ACK) to 127.0.0.1:5002
Listening
Receive a packet(DATA) from 127.0.0.1:5002
receive a packet ( seq num = 6, ack num = 5046)
Send a packet(ACK) to 127.0.0.1:5002
Listening
Receive a packet(DATA) from 127.0.0.1:5002
receive a packet ( seq num = 7, ack num = 5047)
Send a packet(ACK) to 127.0.0.1:5002
Listening
Receive a packet(DATA) from 127.0.0.1:5002
receive a packet ( seq num = 4, ack num = 5044)
Send a packet(ACK) to 127.0.0.1:5002
Listening
Receive a packet(DATA) from 127.0.0.1:5002
receive a packet ( seq num = 5, ack num = 5045)
Send a packet(ACK) to 127.0.0.1:5002
Listening
Receive a packet(DATA) from 127.0.0.1:5002
receive a packet ( seq num = 6, ack num = 5046)
Send a packet(ACK) to 127.0.0.1:5002
Listening
Receive a packet(DATA) from 127.0.0.1:5002
receive a packet ( seq num = 7, ack num = 5047)
Send a packet(ACK) to 127.0.0.1:5002
Listening
```

Step 6

```
Jeff@Jeff-MS-7A38: ~/桌面/network/network/step_6
*****Slow start*****
cwnd = 1 MSS, rwnd = 32768, threshold = 4096
send: 1 MSS
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 6543, ack num = 2)
cwnd = 2 MSS, rwnd = 32768, threshold = 4096
send: 2 MSS
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 6544, ack num = 3)
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 6545, ack num = 4)
cwnd = 4 MSS, rwnd = 32768, threshold = 4096
unfortunately packet(DATA) was lost during transmit.
( seq num = 4, ack num = 6546)
send: 4 MSS
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 6545, ack num = 4)
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 6545, ack num = 4)
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 6545, ack num = 4)
*****Fast recover*****
cwnd = 5 MSS, rwnd = 32768, threshold = 2048
send: 5 MSS
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 6546, ack num = 5)
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 6547, ack num = 6)
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 6548, ack num = 7)
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 6549, ack num = 8)
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 6550, ack num = 9)
*****Congestion avoidance*****
cwnd = 3 MSS, rwnd = 32768, threshold = 2048
send: 3 MSS
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 6551, ack num = 10)
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 6552, ack num = 11)
Receive a packet(ACK) from 127.0.0.1:1264
receive a packet ( seq num = 6553, ack num = 12)

Jeff@Jeff-MS-7A38: ~/桌面/network/network/step_6
Send a packet(ACK) to 127.0.0.1:5002
=====Complete the three-way handshake=====
Set destination socket
DestIP: 127.0.0.1
DestPort: 5002
Listening
Receive a packet(DATA) from 127.0.0.1:5002
receive a packet ( seq num = 1, ack num = 6543)
Send a packet(ACK) to 127.0.0.1:5002
Listening
Receive a packet(DATA) from 127.0.0.1:5002
receive a packet ( seq num = 2, ack num = 6544)
Send a packet(ACK) to 127.0.0.1:5002
Listening
Receive a packet(DATA) from 127.0.0.1:5002
receive a packet ( seq num = 3, ack num = 6545)
Send a packet(ACK) to 127.0.0.1:5002
Listening
Receive a packet(DATA) from 127.0.0.1:5002
receive a packet ( seq num = 5, ack num = 6547)
Send a packet(ACK) to 127.0.0.1:5002
Listening
Receive a packet(DATA) from 127.0.0.1:5002
receive a packet ( seq num = 6, ack num = 6548)
Send a packet(ACK) to 127.0.0.1:5002
Listening
Receive a packet(DATA) from 127.0.0.1:5002
receive a packet ( seq num = 7, ack num = 6549)
Send a packet(ACK) to 127.0.0.1:5002
Listening
Receive a packet(DATA) from 127.0.0.1:5002
receive a packet ( seq num = 4, ack num = 6546)
Send a packet(ACK) to 127.0.0.1:5002
Listening
Receive a packet(DATA) from 127.0.0.1:5002
receive a packet ( seq num = 5, ack num = 6547)
Send a packet(ACK) to 127.0.0.1:5002
Listening
Receive a packet(DATA) from 127.0.0.1:5002
receive a packet ( seq num = 6, ack num = 6548)
Send a packet(ACK) to 127.0.0.1:5002
Listening
Receive a packet(DATA) from 127.0.0.1:5002
receive a packet ( seq num = 7, ack num = 6549)
```


step 8

