CE3005: Computer Networks
CZ3005: Net Centric Computing

Tutorial 2-3:
Transport and Application Layers

1. Figure Q1 shows an extract of a Client program and a Server program (in pseudo code) interacting with their TCP layers. Fill in the ***minimum*** number of TCP segments that must be exchanged between the Client TCP and Server TCP, in an ideal communication situation without error retransmission. Indicate clearly the Sequence Number (SN) and the Acknowledgement Number (AN) in each segment. Include SYN or FIN flags if they are set.

Assume that the Initial Sequence Number (ISN) for the Client TCP is 100 and the ISN for the Server TCP is 600. Both window sizes are fixed at 2048 bytes. The Maximum Segment Size (MSS) is 536 bytes, and the initial congestion window size is 1 MSS.

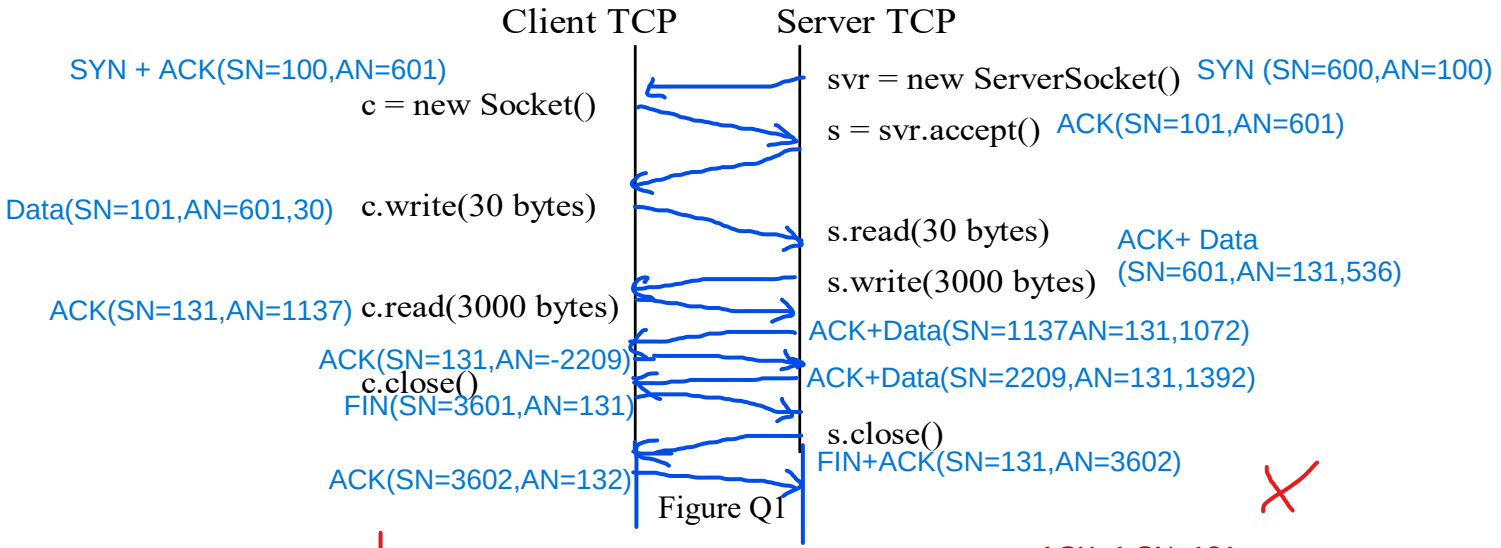


Figure Q1

TCP connection establishment

SYN=1,SN=100

SYN=1,ACK=1,SN=600,
AN=101,W=2048

ACK=1,SN=101,
AN=601,W=2048

TCP flow and congestion control

ACK=1,SN=101,AN=601,W=2048

Data+ACK(ACK=1,SN=601,
AN=131,W=2048

ACK=1,SN=131,
AN=1137,W=2048

Data(SN=1137)
Data(SN=1673)

ACK=1,SN=131
AN=2209,W=2048

Data(SN=2209)
Data(SN=2745)
Data(SN=3281)

ACK=1,SN=131,
AN=3281,W=2048

ACK=1,SN=131,
AN=3601,W=2048

TCP connection termination

FIN=1,SN=131

ACK=1,SN=3601,AN=132

FIN=1,SN=3601

ACK=1,SN=132,AN=3602

Qn 2
a) Transmission Round 1-6, 23-26
Congestion window increases exponentially each transmission round

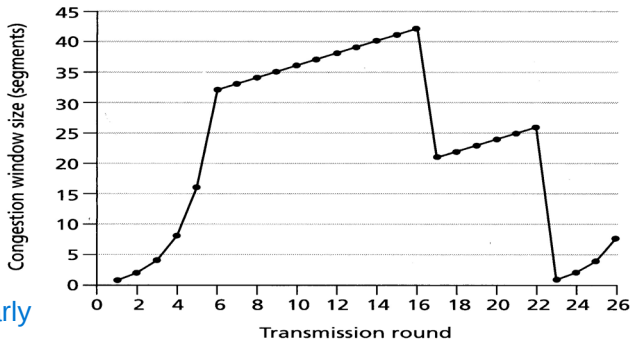
b) Transmission Round 6-16,17-22
Congestion window increases linearly each transmission round

2. Consider the following plot of TCP window size as a function of time.

c) Triple duplicate. The congestion window falls to the slow start threshold

d) Timeout. The congestion window falls to the ~~slow start~~ 1

e) 32. The congestion window increases exponentially from 1 for 5 transmission rounds until it hits the threshold and starts increasing linearly



f) 21. When triple duplicate is found, the congestion window is halved from 42

26/2=13

g) 12.5 When timeout detected, the congestion window is also halved from 25

26

Assuming TCP is the protocol experiencing the behavior shown above, answer the following questions. In all cases, you should provide a short discussion justifying your answer.

(a) Identify the intervals of time when TCP slow start is operating.
(b) Identify the intervals of time when TCP congestion avoidance is operating.
(c) After the 16th transmission round, is segment loss detected by a triple duplicate ACK or by a timeout?
(d) After the 22nd transmission round, is segment loss detected by a triple duplicate ACK or by a timeout?
(e) What is the initial value of *Threshold* at the first transmission round?
(f) What is the value of *Threshold* at the 18th transmission round?
(g) What is the value of *Threshold* at the 24th transmission round?
(h) During what transmission round is the 70th segment sent?

h) 1+2+4+8+16+32 = 63
63 + 33 = 96
70th segment send during 7th transmission round

3. A user subscribes to an ISP home broadband service and connects his computer directly to it via an ADSL modem as shown in Figure Q3a. An extract of the output by the *ipconfig* command issued on the computer is shown in Figure Q3b.

(a) Based on Figure Q3a and Q3b, deduce the roles performed by the ADSL modem, and briefly describe the purpose of each role.

(b) The user launches his web browser and requests for the default web page at *http://www.ntu.edu.sg* without the use of web proxy. Assume that all the caches of the computer are initially empty. Using a table similar to Table Q3, list the sequence of frames being sent and received by the computer until the first frame containing the requested web page is received.

3a) The ADSL modem is a router that acts as the relay agent and default gateway as DHCP is enabled and the network id of the DHCP server is the same as the computer. This enables the DHCP server to support multiple subnets using the relay agents. The IP address of the modem is also the same as the DHCP and DNS servers so it does the DNS protocol as well which resolves domain names to IP address.

Roles performed by ADSL modem:
1. DHCP server: configure host with IP address,subnet mask
2. DNS server: resolve domain name to corresponding IP address
3. Default gateway: forward packets to outside networks not directly reachable by the host
4. NAT: enable host to use private IP address by translating it to public IP address and vice versa.

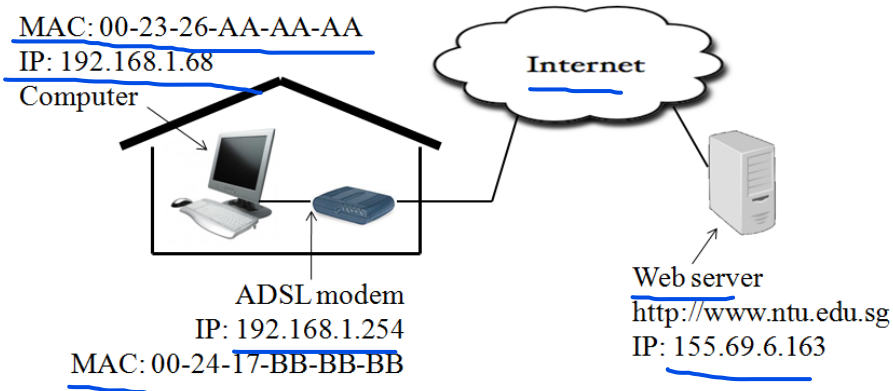


Figure Q3a

```
c:\>ipconfig /all
Ethernet adapter Local Area Connection:
   Physical Address . . . . . . . . . . . : 00-23-26-AA-AA-AA
   DHCP Enabled . . . . . . . . . . . . . : Yes
   IPv4 Address . . . . . . . . . . . . . : 192.168.1.68
   Subnet Mask . . . . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . . . . : 192.168.1.254
   DHCP Server . . . . . . . . . . . . . . : 192.168.1.254
   DNS Server . . . . . . . . . . . . . . . : 192.168.1.254
```

Figure Q3b

Table Q3

	MAC address		IP address (if applicable)		Purpose of Frame
Frame	Source	Destination	Source	Destination	
1.					
2.					
...					
Last.					HTTP reply

4. The research scientist at NTU, wants to upload a 1GByte file to Japan via a 10 Gbps link with a RTT of 100 milliseconds. The scientist notebook has the following TCP congestion control configuration:

   (i) Maximum segment size is 1K Bytes

   (ii) Maximum number of segment is 16

   Determine the expected time required for the scientist to upload the file. Assume no packet loss.

TCP throughput = cwnd * MSS /RTT = 16 * 1KB /100ms = 160KB/s
Time required = 1000000 KB / 160 * KB = 6250s