

**CE3005: Computer Networks**  
**Semester 1 2016-2017**

**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.

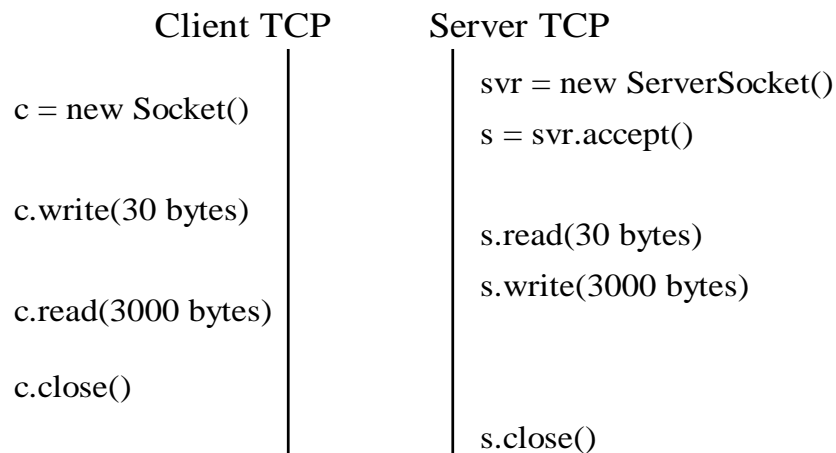
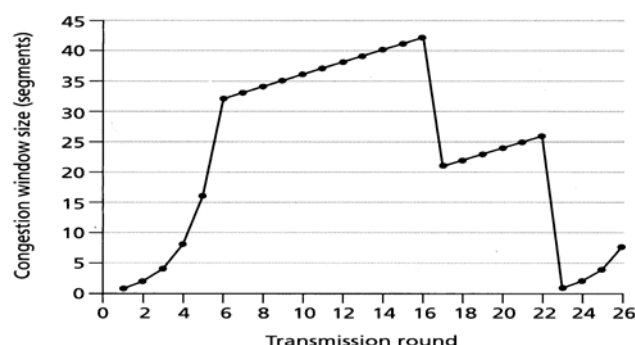


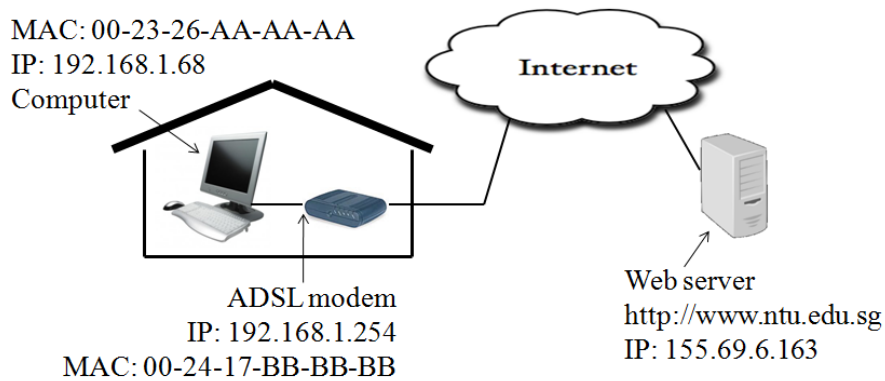
Figure Q1

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



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.

- Identify the intervals of time when TCP slow start is operating.
  - Identify the intervals of time when TCP congestion avoidance is operating.
  - After the 16<sup>th</sup> transmission round, is segment loss detected by a triple duplicate ACK or by a timeout?
  - After the 22<sup>nd</sup> transmission round, is segment loss detected by a triple duplicate ACK or by a timeout?
  - What is the initial value of *Threshold* at the first transmission round?
  - What is the value of *Threshold* at the 18<sup>th</sup> transmission round?
  - What is the value of *Threshold* at the 24<sup>th</sup> transmission round?
  - During what transmission round is the 70<sup>th</sup> segment sent?
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.
- Based on Figure Q3a and Q3b, deduce the roles performed by the ADSL modem, and briefly describe the purpose of each role.
  - 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.



**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 mseconds. 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.