SC2008
CE3005:Computer Networks
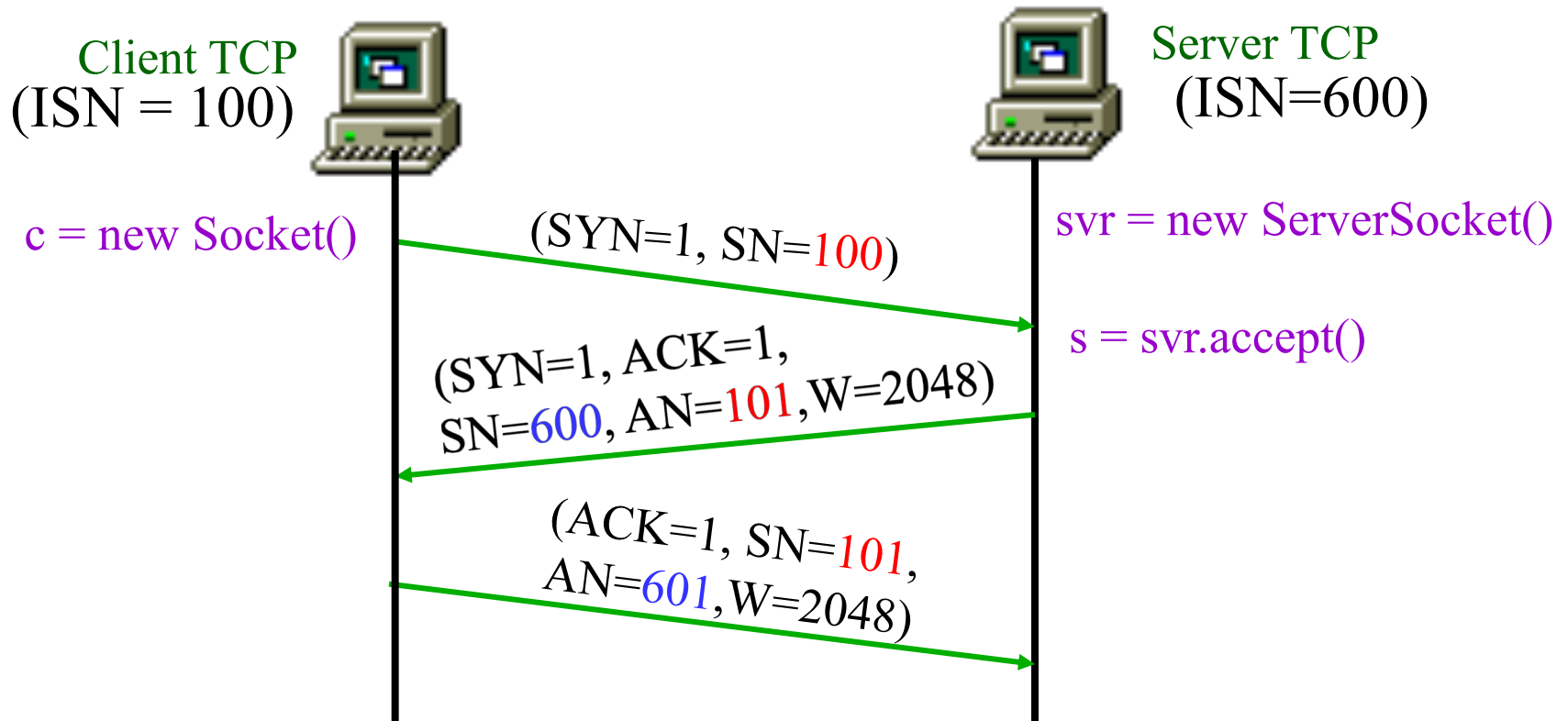# CZ3006:Netcentric Computing
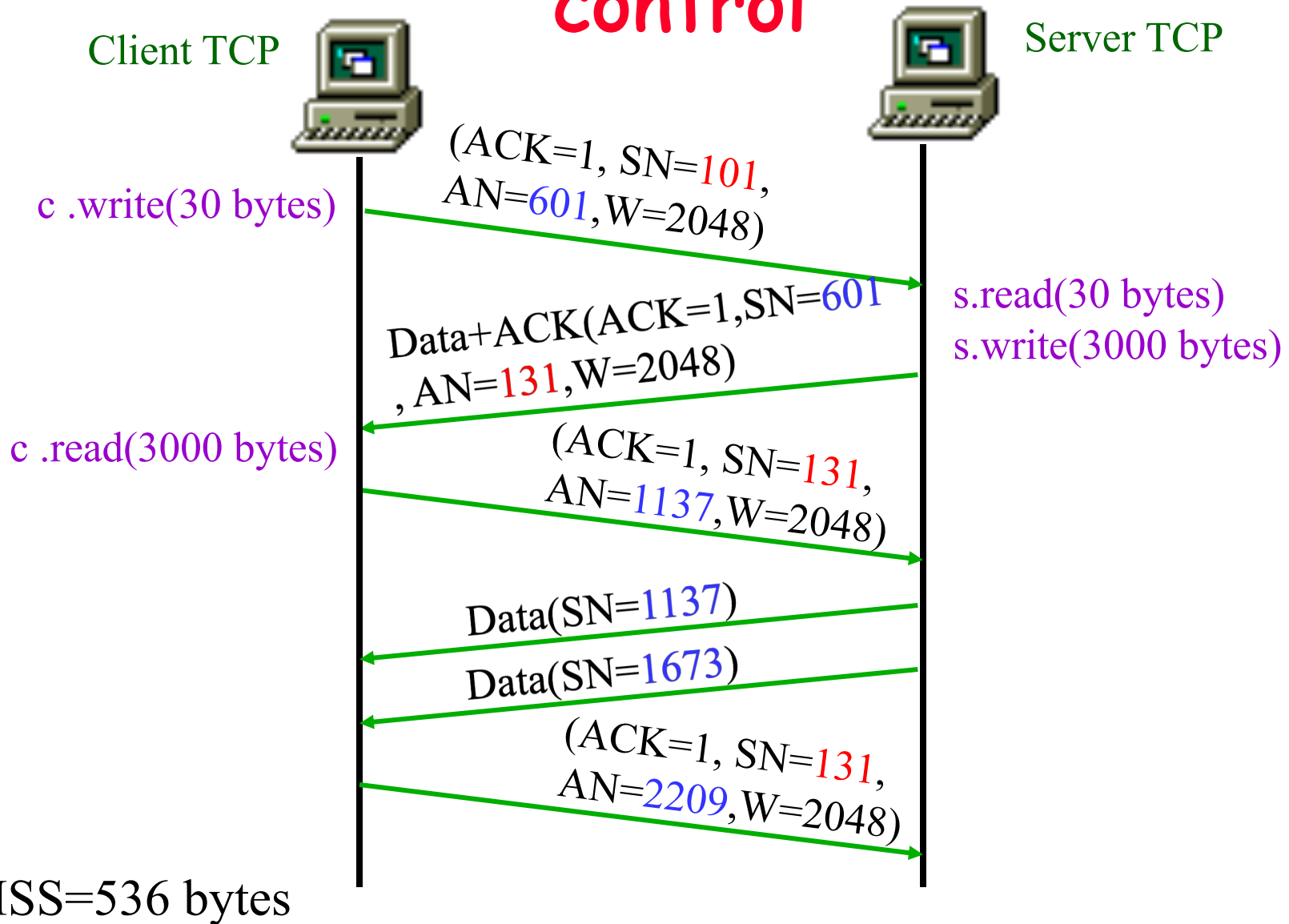
Transport layer

Q1. Information provided

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.

Client TCP	Server TCP
	svr = new ServerSocket()
c = new Socket()	s = svr.accept()
c.write(30 bytes)	s.read(30 bytes)
	s.write(3000 bytes)
c.read(3000 bytes)	
c.close()	
	s.close()

Q1: TCP – connection establishment

Client TCP
(ISN = 100)

Server TCP
(ISN=600)

c = new Socket()

svr = new ServerSocket()

(SYN=1, SN=100)

s = svr.accept()

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

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

Q1: TCP – flow and congestion control

Client TCP

Server TCP

c .write(30 bytes)

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

s.read(30 bytes)
s.write(3000 bytes)

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

c .read(3000 bytes)

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

Data(SN=1137)

Data(SN=1673)

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

MSS=536 bytes

Q1: TCP – flow and congestion control
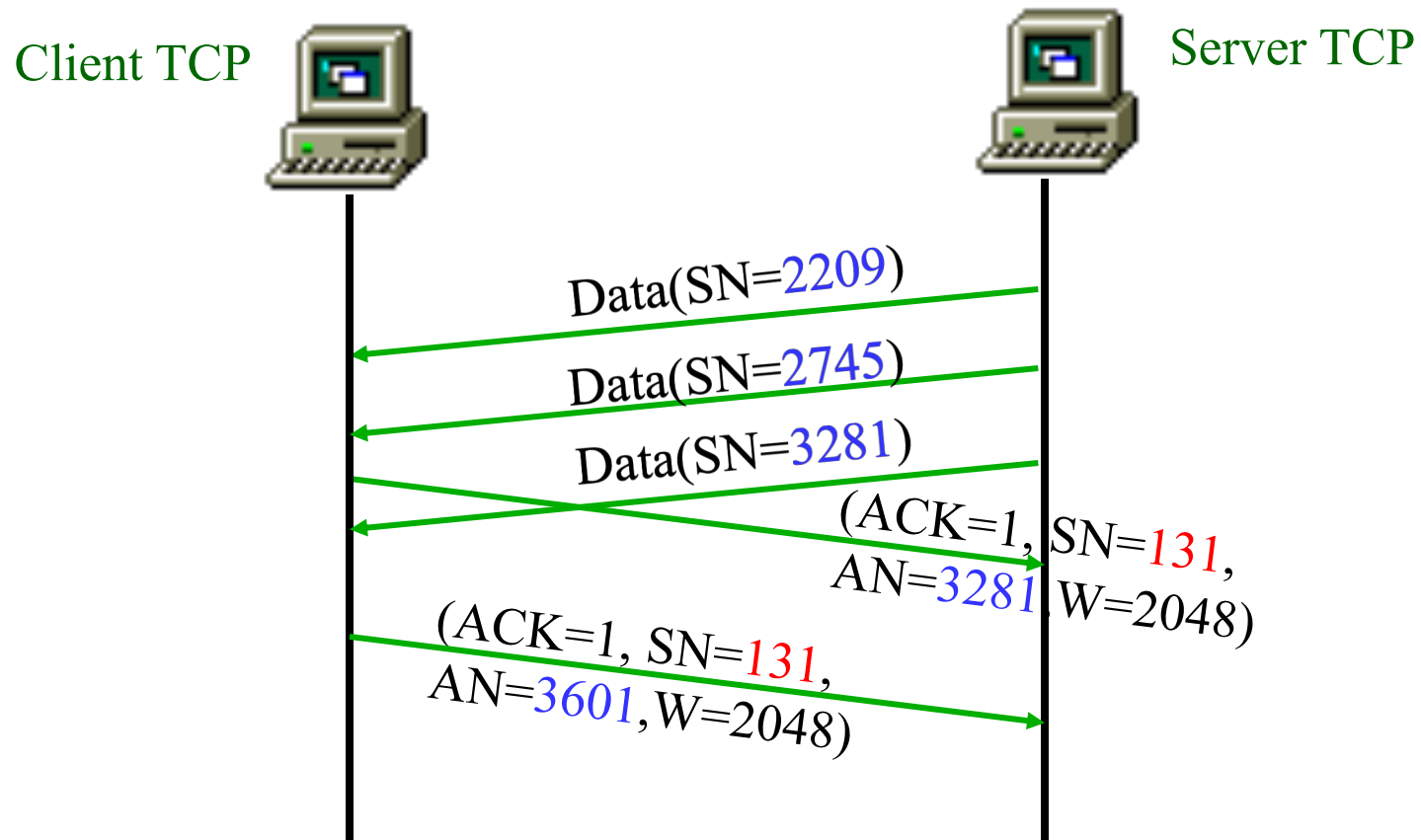
MSS=536 bytes

Q1: TCP – connection termination

Client TCP

Server TCP

c.close()

(FIN=1, SN=131)

(ACK=1, SN=3601, AN=132)

Alternatively, may combine into one single FIN/ACK message.

(FIN=1, SN=3601)

s.close()

(ACK=1, SN=132, AN=3602)
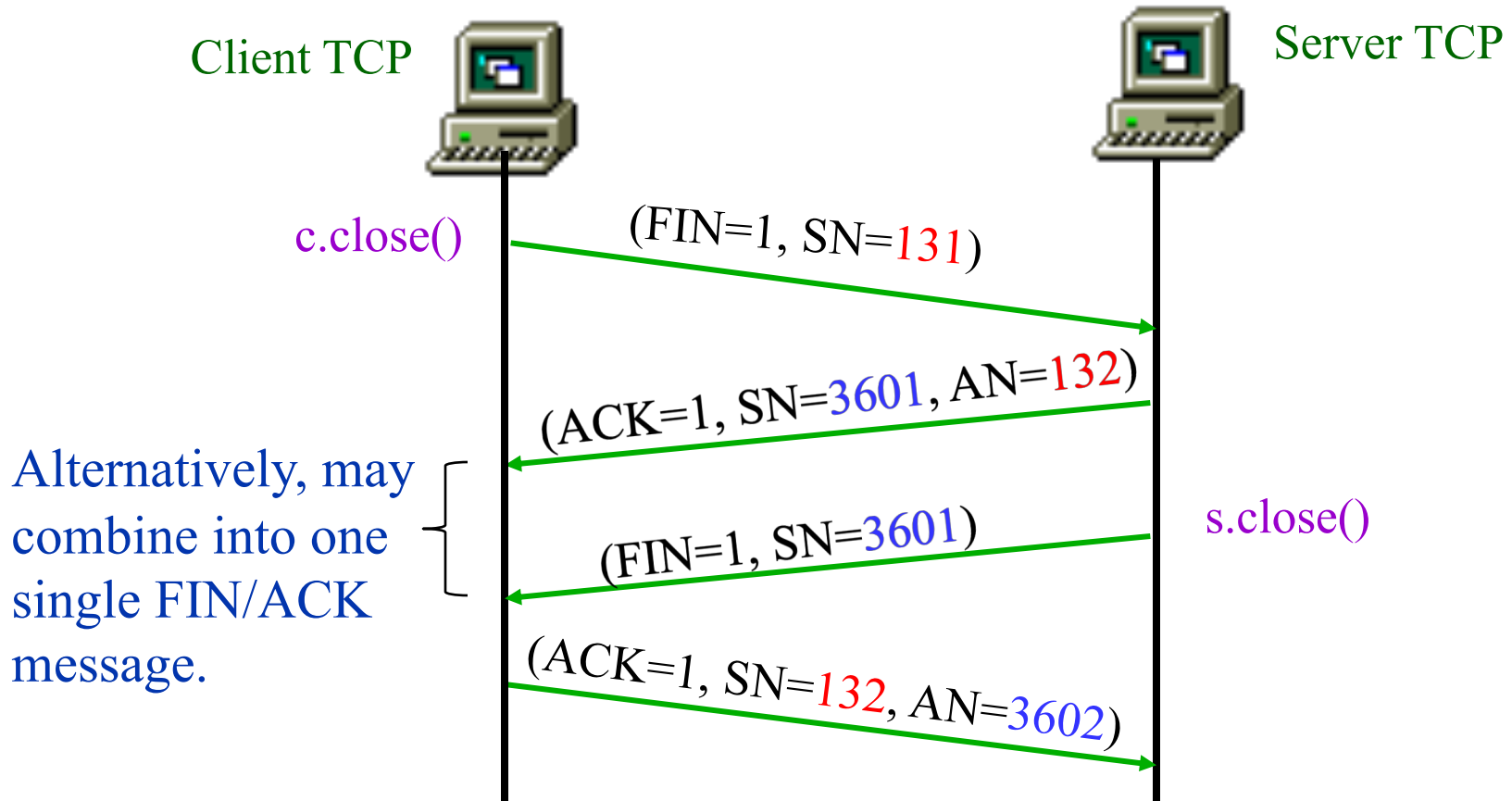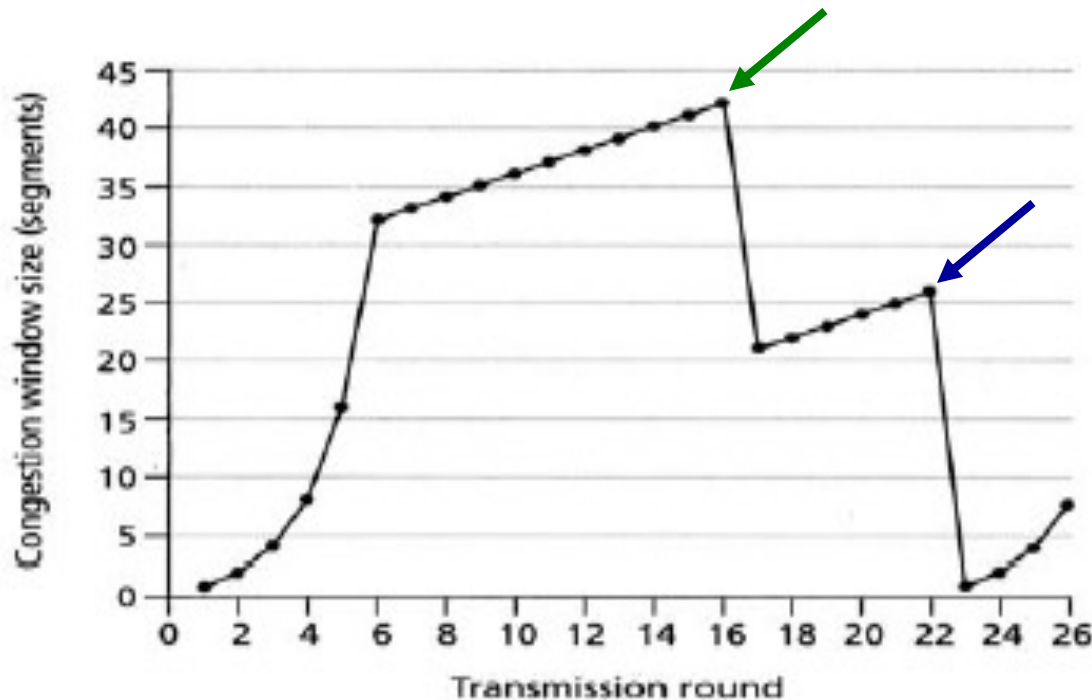
Q2: TCP Congestion Control
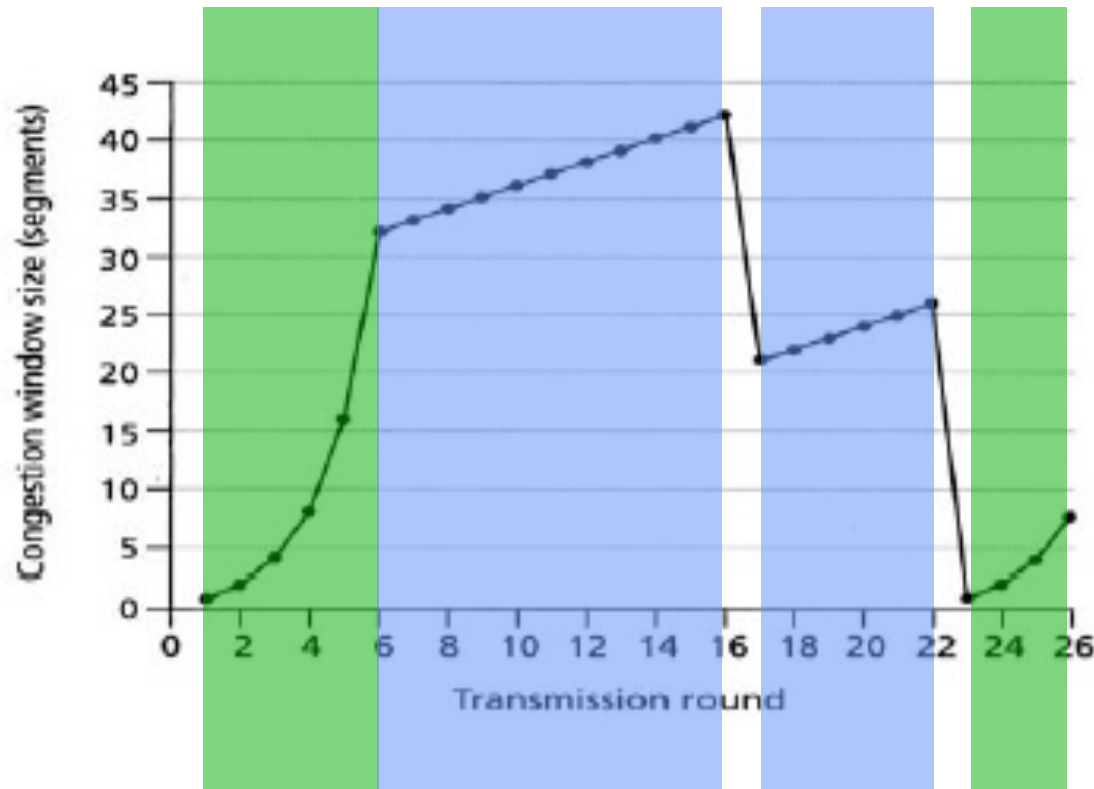
(a) Slow start [1,6] & [23,26]
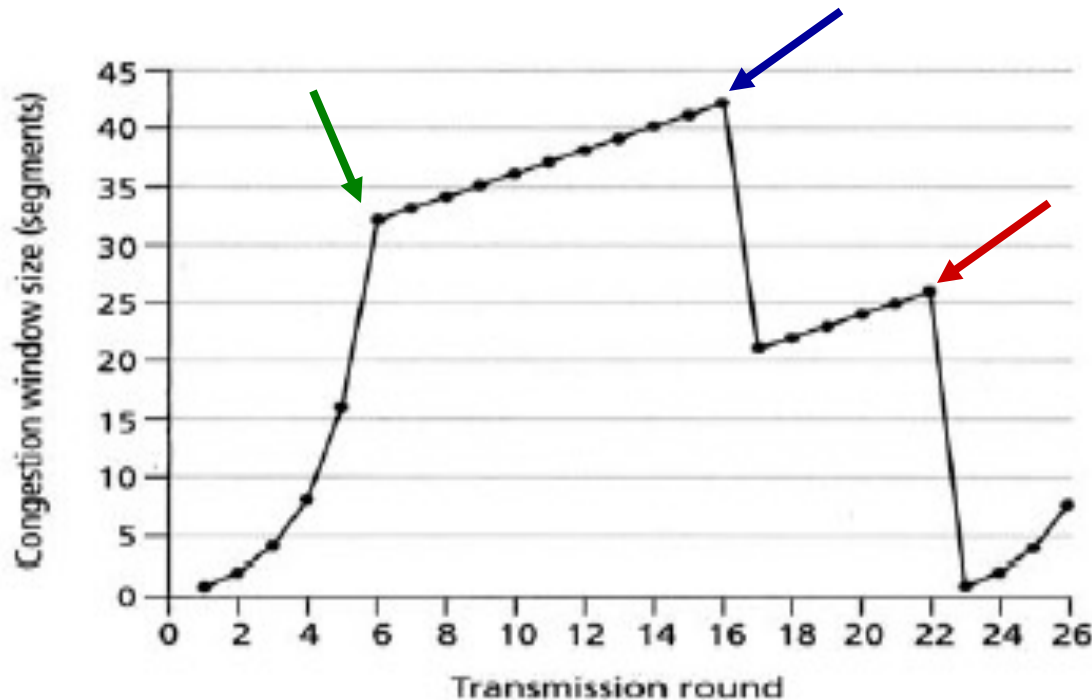(b) Congestion avoidance [6,16] & [17,22]

Q2: TCP

(c) At 16th transmission round, the host experienced a triple duplicate ACKs, because otherwise it will drop its cwnd to 1

(d) At 22nd transmission round, the host experienced a timeout of ACK, hence it drops its cwnd to 1
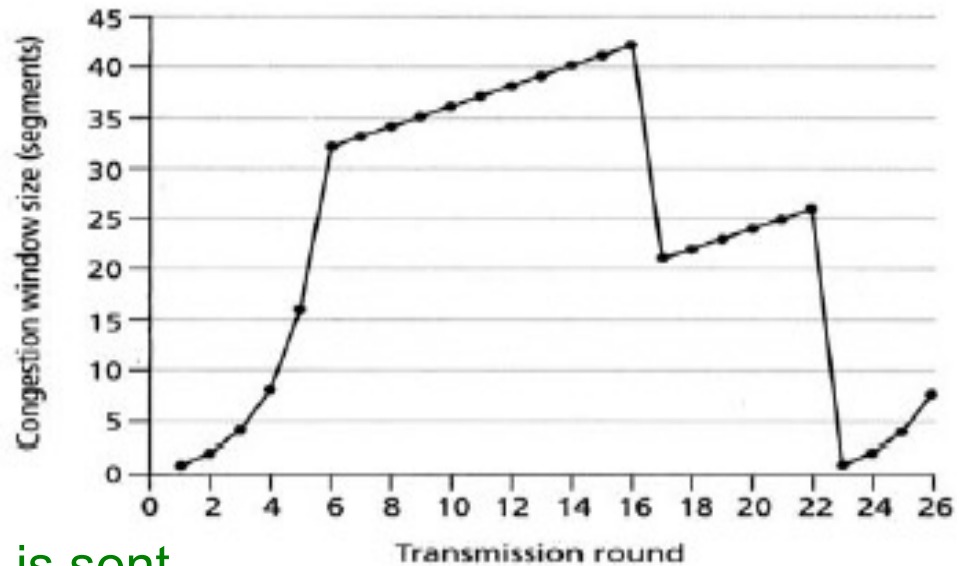
Q2: TCP

(e) Threshold at 1st = 32 (see 6th transmission round)
(f) Threshold at 18th = 42/2 = 21 (see 16th transmission round)
(g) Threshold at 24th = 26/2 = 13 (see 22nd transmission round)

Q2: TCP

(h)
During 1st, round, segment 1 is sent
During 2nd, round, segment 2-3 are sent
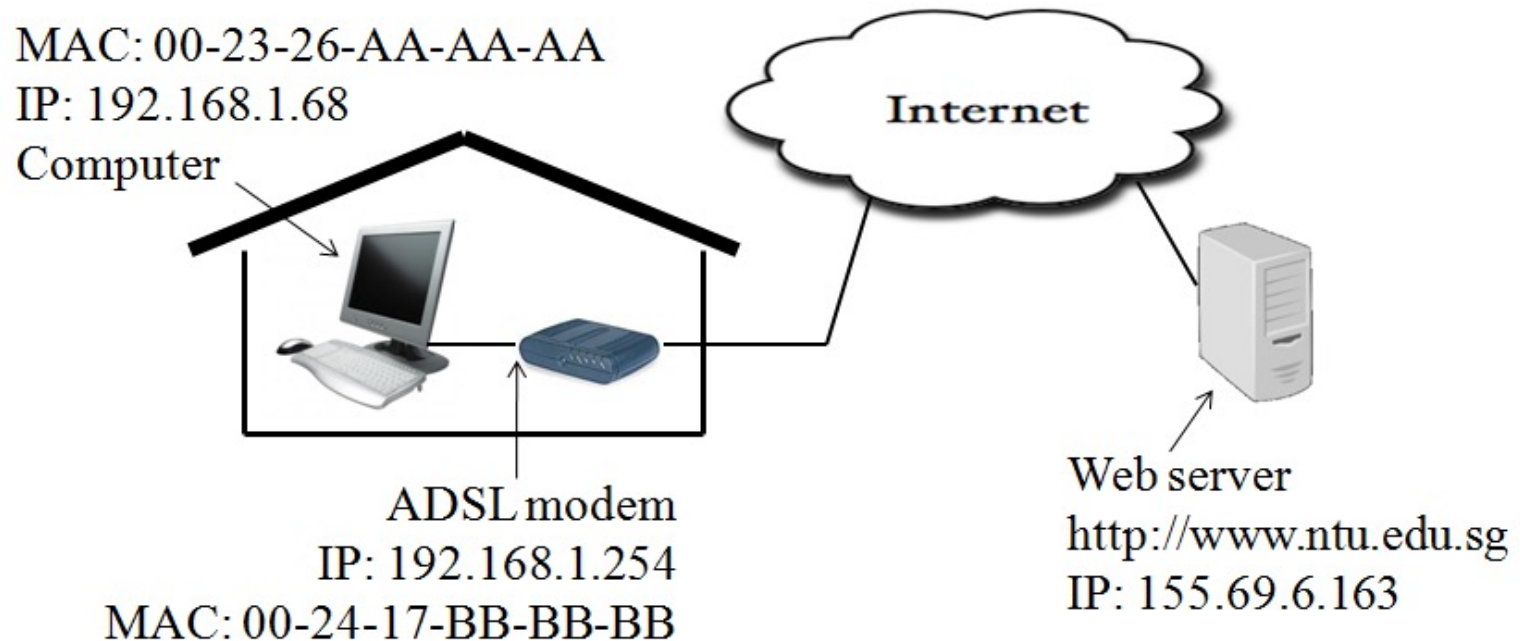During 3rd, round, segment 4-7 are sent
During 4th, round, segment 8-15 are sent
During 5th, round, segment 16-31 are sent
During 6th, round, segment 32-63 are sent
During 7th, round, segment 64-96 are sent <<< segment70 sent

Q3(a): Understanding Internet

MAC: 00-23-26-AA-AA-AA
IP: 192.168.1.68
Computer

Internet

ADSL modem
IP: 192.168.1.254
MAC: 00-24-17-BB-BB-BB

Web server
http://www.ntu.edu.sg
IP: 155.69.6.163

```
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
```

Q3(a): Understanding Internet

Roles performed by ADSL modem:

- DHCP server: configure host with IP address, subnet mask, etc.

- DNS server: resolve domain name to corresponding IP address

- Default gateway: forward packets to outside networks not directly reachable by the host

- NAT: enable host to use private IP address by translating it to public IP address and vice versa

Q3(b): Understanding Internet

Visit http://www.ntu.edu.sg

Frame	MAC Address		IP Address (if applicable)		Purpose of Frame
	Source	Destination	Source	Destination	
1.	00-23-26-AA-AA-AA	FF-FF-FF-FF-FF-FF broadcast	-	-	ARP request for 192.168.1.254 modem
2.	00-24-17-BB-BB-BB modem	00-23-26-AA-AA-AA	-	-	ARP reply
3.	00-23-26-AA-AA-AA	00-24-17-BB-BB-BB modem	192.168.1. 68	192.168.1.254 modem	DNS request for www.ntu.edu.sg web server
4.	00-24-17-BB-BB-BB modem	00-23-26-AA-AA-AA	192.168.1.254 modem	192.168.1.68	DNS reply 155.69.6.163 web server

Q3(b): Understanding Internet

Visit http://www.ntu.edu.sg

Frame	MAC Address		IP Address (if applicable)		Purpose of Frame
	Source	Destination	Source	Destination	
5.	00-23-26-AA-AA-AA	00-24-17-BB-BB-BB modem	192.168.1.68	155.69.6.163 web server	TCP 3-way handshake
6.	00-24-17-BB-BB-BB modem	00-23-26-AA-AA-AA	155.69.6.163 webserver	192.168.1.68	TCP 3-way handshake
7.	00-23-26-AA-AA-AA	00-24-17-BB-BB-BB modem	192.168.1.68	155.69.6.163 web server	TCP 3-way handshake

Q3(b): Understanding Internet

Visit http://www.ntu.edu.sg

Frame	MAC Address		IP Address (if applicable)		Purpose of Frame
	Source	Destination	Source	Destination	
8.	00-23-26-AA-AA-AA	00-24-17-BB-BB-BB modem	192.168.1.68	155.69.6.163 web server	HTTP request
9.	00-24-17-BB-BB-BB modem	00-23-26-AA-AA-AA	155.69.6.163 web server	192.168.1.68	HTTP reply

Q4: TCP throughput

Information Provided

- **Link information**:
  - Link speed = 1Gbps,
  - RTT = 100 milliseconds

- **File size:** 1 GByte

- **TCP congestion control configuration**:

  - Maximum segment size 1 Kbyte

  - Maximum number of segment 16

Q4 Solution

- In one RTT, the maximum amount of data that is transmitted is
  - 1KB x 16 = 16KB
- Since there are 10 RTT in one second, as RTT is 100 millisecond.
  - Throughput = 16KB x 10 = 160KB per second
- Duration of transfer
  - 1,000,000 KB/160KB = 6,250 seconds

**In addition to the office hours listed in the previous slide, please feel free to contact Assistant Professor Jun ZHAO
as follows to schedule appointments to ask questions. Thanks!**

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