Computer Network	Student ID	Name	Page 1

< Please obey the rules of examination and do not use any Internet-connected devices. >

1. Please compare the feature of TCP with UDP services. At least 3 points of view. **(6%)**

2. What are the major two network components form socket? **(4%)**

3. Please introduce and explain what the difference between frequency division multiplexing (FDM) and time division multiplexing (TDM) technology in circuit switching. **(5%)**

4. See **Fig. 1**, Domain Name System (DNS). The DNS servers' levels are given. Host A wants the IP address of the Host at "gaia.cs.umass.edu", draw the resolution process and number the query and response messages by using following methods.
   a. Iterated query DNS. **(5%)**
   b. Recursive query DNS. **(5%)**
   c. Explain what the difference between iterated query DNS and recursive DNS? **(5%)**

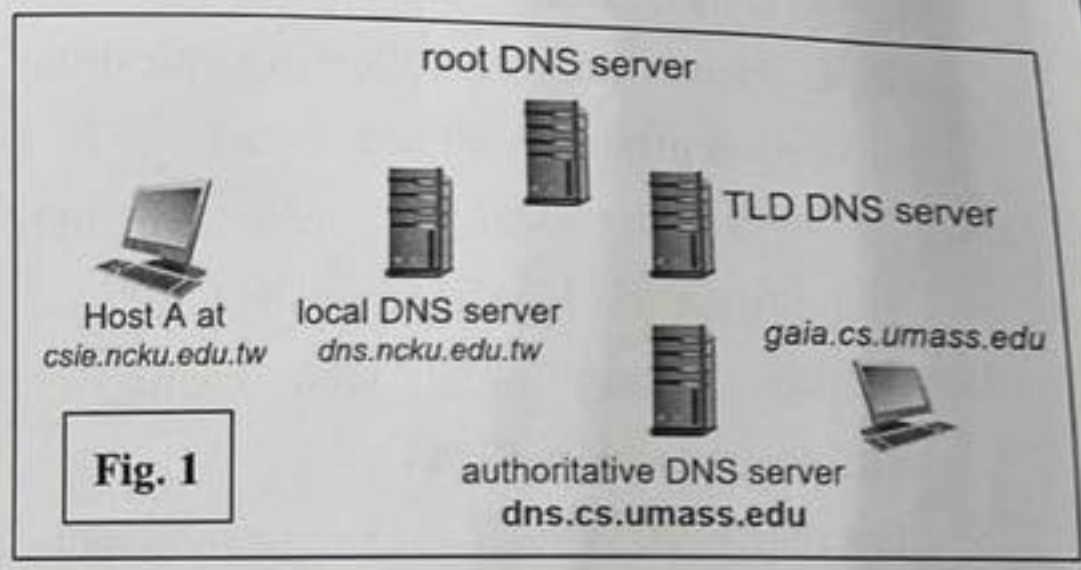

Fig. 1

5. See **Fig. 2**, calculate the end-to-end throughput of **per** connection between servers (server 1, 2, 3) and clients (client 1, 2, 3) respectively, if there are 10 connections **fairly** share the backbone link R = 200 bps. **(10%)** Note: no calculation process will not score.

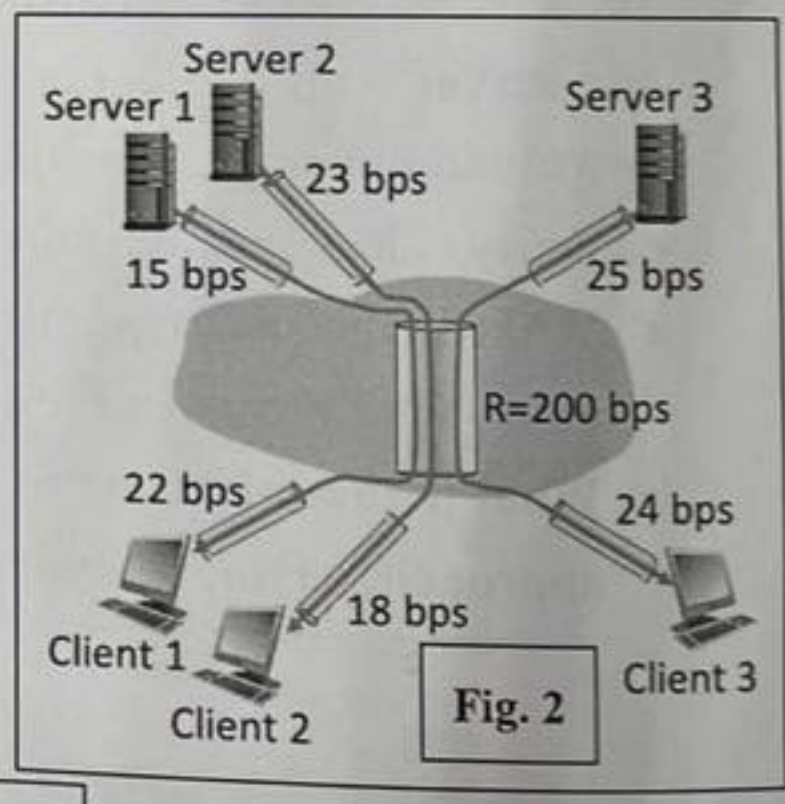

Fig. 2

6. See **Fig. 3**, the sources of packet delay.
   a. What are the four sources of packet delay? **(8%)**
   b. Please explain that how do loss and delay occur. **(7%)**

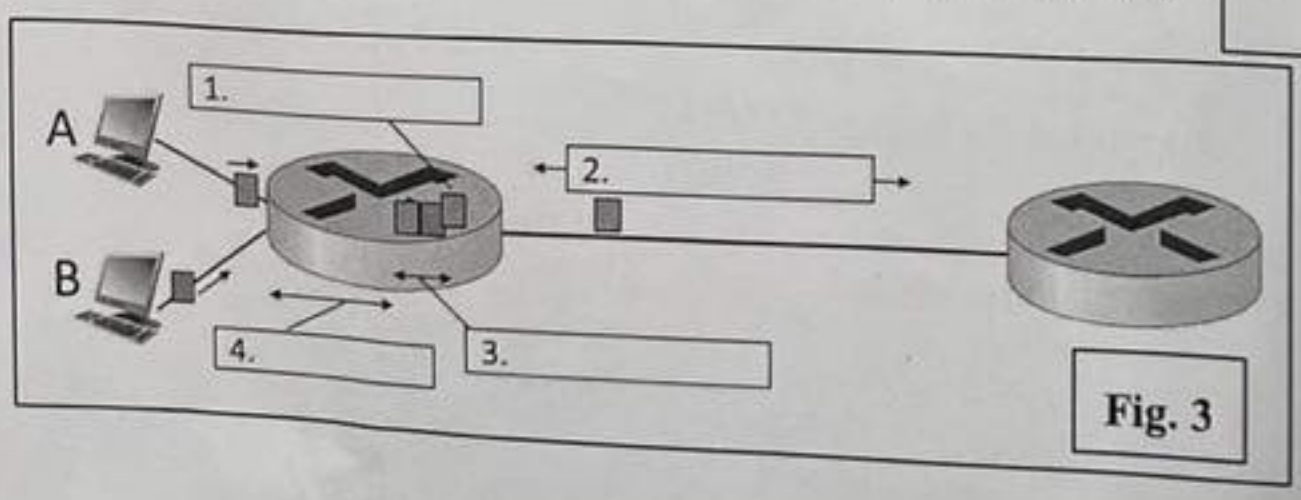

Fig. 3

< Please obey the rules of examination and do not use any Internet-connected devices. >

7. Two segment contents including header fields, as sequence of 16-bit integers are shown below. Please find the checksum. **(10%)** Note: no calculation process will not score.

1	**1**	**0**	**1**	**1**	**0**	**1**	**1**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**1**
0	**0**	**1**	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**1**

8. See **Fig. 4**, average object size from the origin server is 900K bits, average request rate from institution's browser to original server is 10 requests per second, internet delay (RTT from institution router to server) is 5 seconds, access link is 10 Mbps and local link 1 Gbps. Please answer following questions. Note: no calculation process will not score.

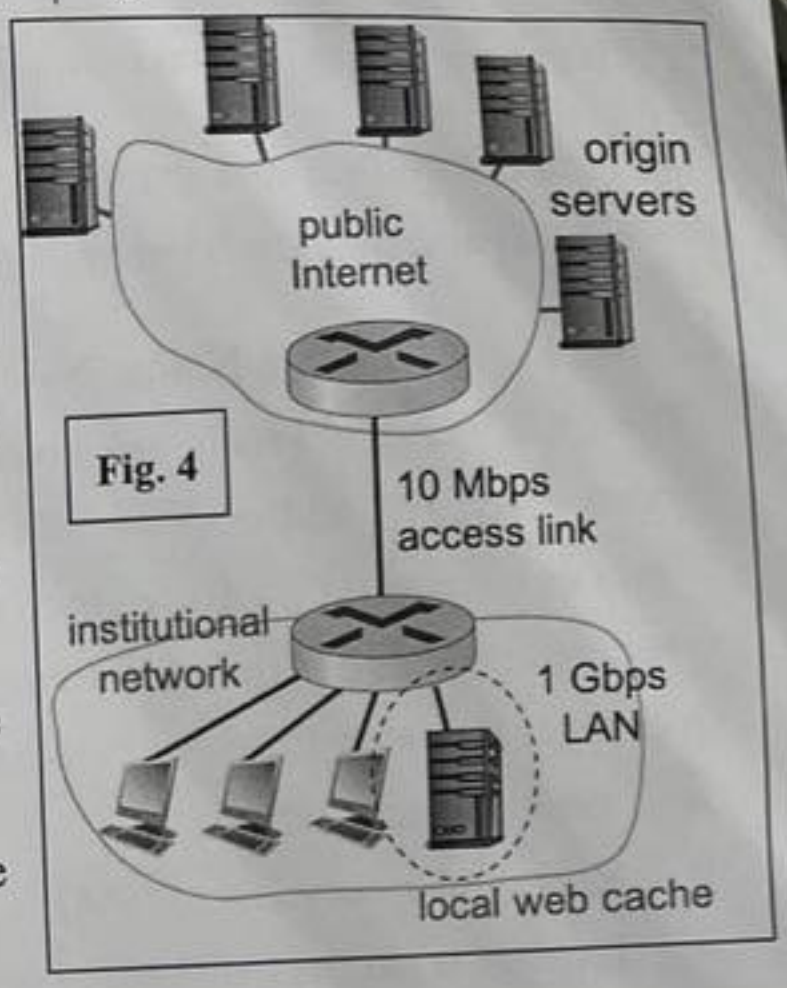

Fig. 4

a. Without using local web cache, calculate the access link utilization (traffic intensity). **(6%)**

b. Without using local web cache, calculate the end-to-end delay. **(7%)**

c. By using local web cache, let the cache hit rate be 0.7, calculate the average end-to-end delay. **(7%)**

9. See **Fig. 5**, a server distributes file F to 5 clients, the file size of F is 6M bits, and server's upload capacity u_s is 3 Mbps. A client i has u_i upload and d_i download capacity, e.g. the client 1 has 4 Mbps upload and 5 Mbps download capacity. Please answer following questions. Note: no calculation process will not score.

a. What is the **min** time to distribute F to **all** 5 clients by using client-server approach? (Hint: server must sequentially send 5 file copies to 5 clients) **(5%)**

b. What is the **min** time to distribute F to **all** 5 peers by using peer-to-peer (P2P) approach? (Hint: server must upload at least 1 file copy) **(10%)**

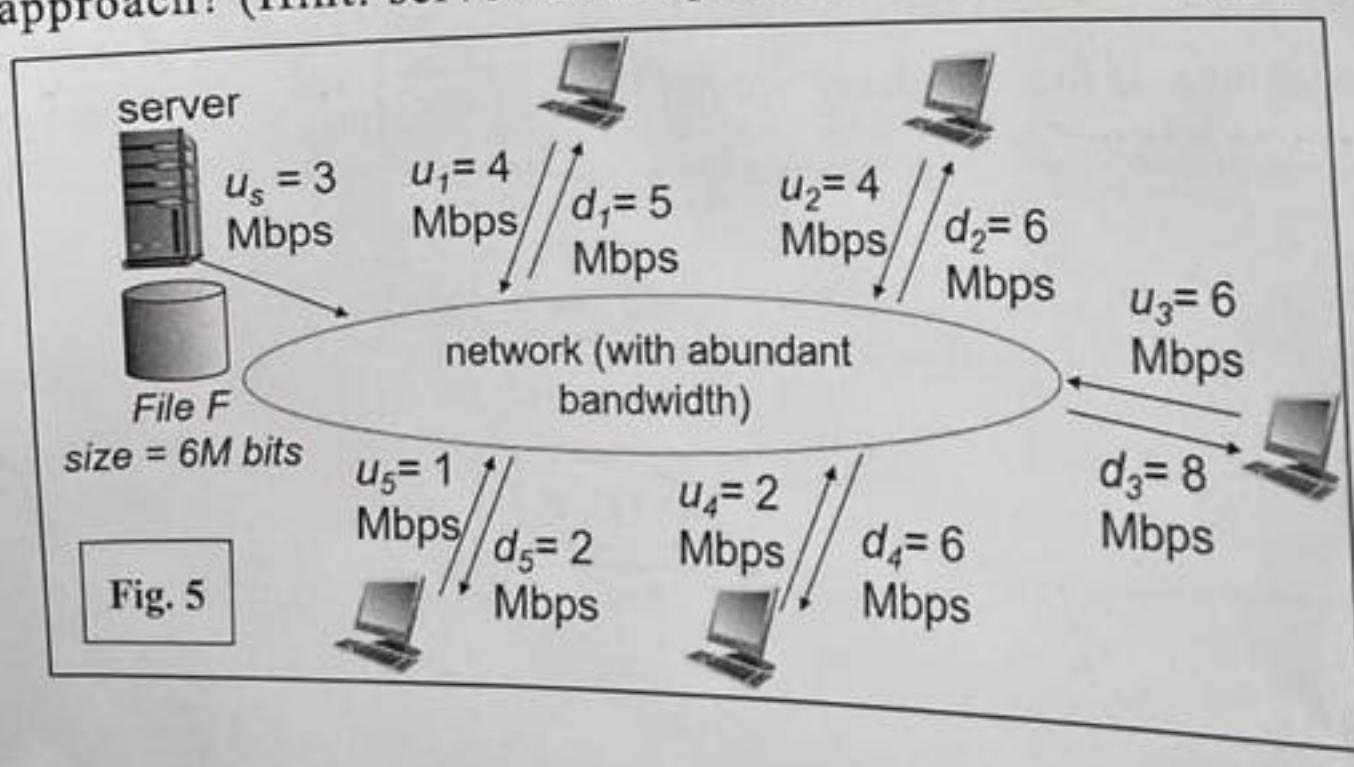

Fig. 5

Problem 1

Ans:

TCP:

- reliable, in-order delivery
- congestion control
- flow control
- connection-oriented
- demultiplexing using 4-tuple: source and destination IP addresses, and port numbers

UDP:

- unreliable, unordered delivery
- no congestion control
- no flow control
- connectionless
- demultiplexing using destination port number (only)
- "best effort" service

Problem 2

What are the major two network components form socket? (4%)

Problem 2

Ans:

IP addresses & port numbers

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Problem 3

- Please introduce and explain what the difference between frequency division multiplexing (FDM) and time division multiplexing (TDM) technology in circuit switching. **(5%)**

- **Ans:** FDM separates signals by using different carrier frequencies, whereas TDM separates signals by using different time slot so that each signal appears on the line only a fraction of time in an alternating pattern.

Problem 4

See **Fig. 1**, Domain Name System (DNS).

The DNS servers' levels are given. Host A wants the IP address of the Host at "gaia.cs.umass.edu", draw the resolution process and number the query and response messages by using following methods.

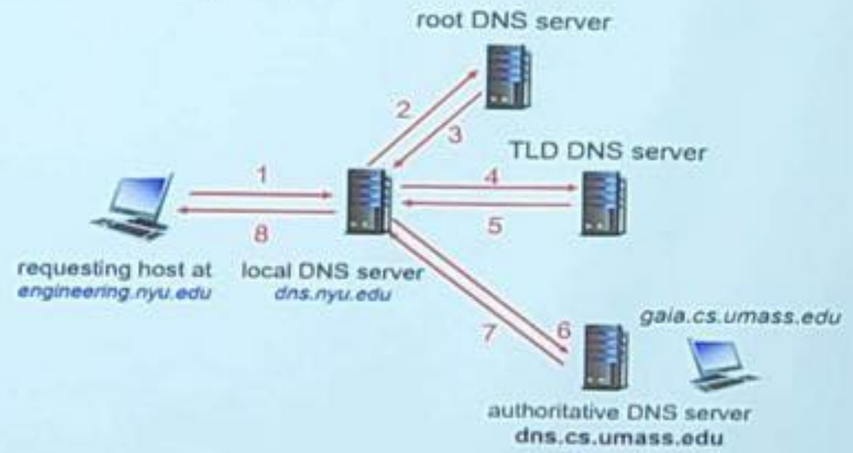
a. Iterated query DNS. **(5%)**

b. Recursive query DNS. **(5%)**

c. Explain what the difference between iterated query DNS and recursive DNS? **(5%)**

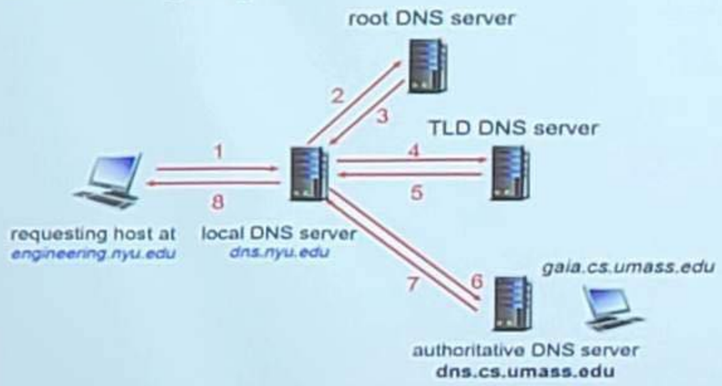
Problem 4

Iterated query:

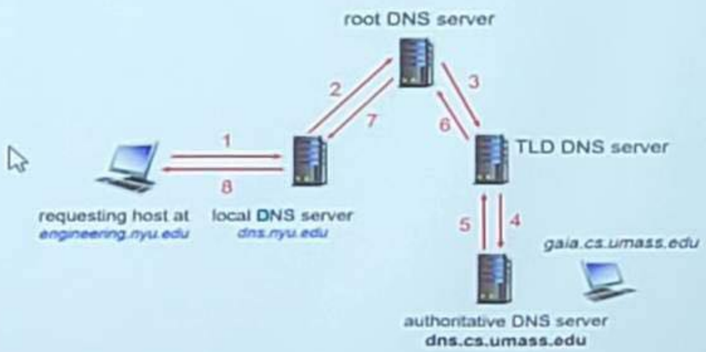


Problem 4

Iterated query:



Recursive query:



Problem 5

See **Fig. 2**, calculate the end-to-end throughput of per connection between servers (server 1, 2, 3) and clients (client 1, 2, 3) respectively, if there are 10 connections **fairly** share the backbone link R = 200 bps. **(10%)** Note: no calculation process will not score.

Problem 5

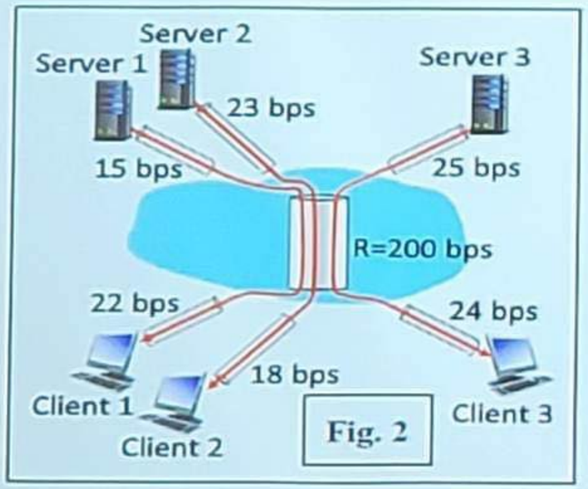


Fig. 2

Ans:

Connection between server1 and client1:
min{15, 20, 22}=15bps

Connection between server2 and client2:
min{23, 20, 18}=18bps

Connection between server3 and client3:
min{25, 20, 24}=20bps

Problem 6

See **Fig. 3**, the sources of packet delay.

a. What are the four sources of packet delay? **(8%)**

b. Please explain that how do loss and delay occur. **(7%)**

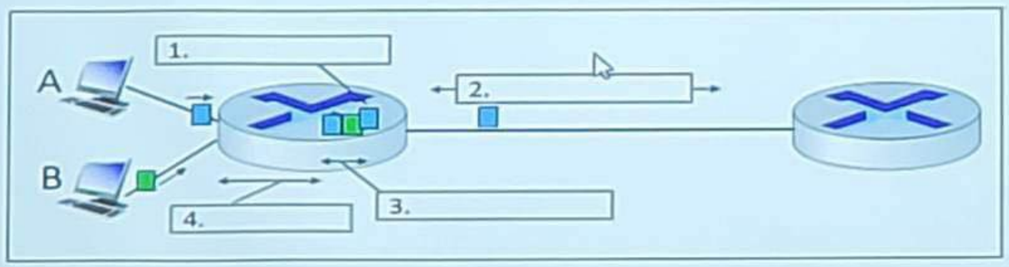
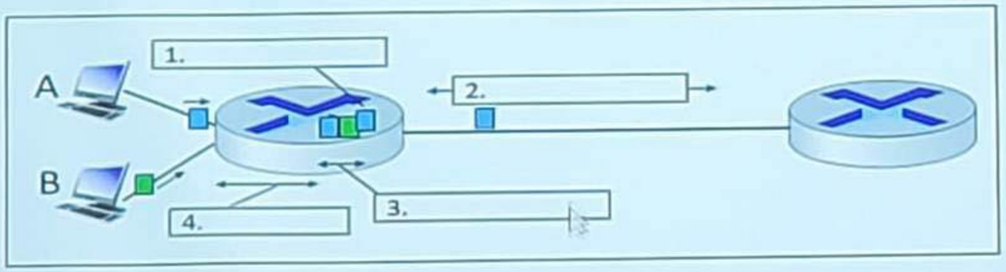


Fig. 3

Problem 6

- **Ans:**



- **(a)**

1. Transmission delay
2. Propagation delay
3. Queueing delay
4. (Nodal) processing delay

Problem 6

- **Ans:**
- Delay: packets queue in router buffers, waiting for turn for transmission. Queue length grows when arrival rate to link (temporarily) exceeds output link capacity.
- Loss: packet loss occurs when memory to hold queued packets fills up.

Problem 7

- Two segment contents including header fields, as sequence of 16-bit integers are shown below. Please find the checksum. **(10%)** Note: no calculation process will not score.

1	**1**	**0**	**1**	**1**	**0**	**1**	**1**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**1**
0	**0**	**1**	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**1**

Problem 7

Ans:

	1	1	0	1	1	0	1	1	0	1	0	1	0	0	0	1
	0	0	1	1	1	1	1	0	1	1	0	0	1	0	0	1
1	0	0	0	1	1	0	1	0	0	0	0	1	1	0	1	0
Sum =	0	0	0	1	1	0	1	0	0	0	0	1	1	0	1	1
Checksum=	1	1	1	0	0	1	0	1	1	1	1	0	0	1	0	0

Problem 8

See **Fig. 4**, average object size from the origin server is 900K bits, average request rate from institution's browser to original server is 10 requests per second, internet delay (RTT from institution router to server) is 5 seconds, access link is 10 Mbps and local link 1 Gbps. Please answer following questions. Note: no calculation process will not score.

a. Without using local web cache, calculate the access link utilization (traffic intensity). **(5%)**

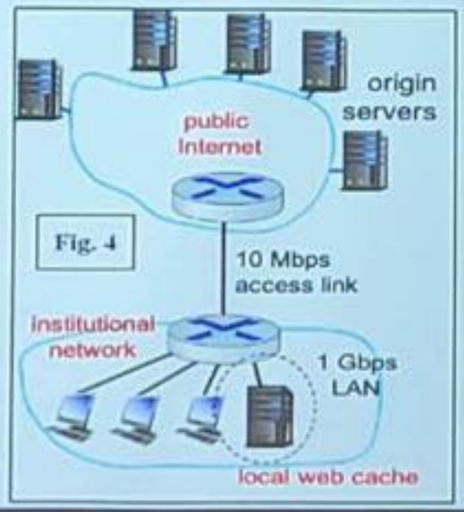
b. Without using local web cache, calculate the end-to-end delay. **(5%)**

c. By using local web cache, let the cache hit rate be 0.7, calculate the average end-to-end delay. **(10%)**

Problem 8

a. Without using local web cache, calculate the access link utilization (traffic intensity). **(5%)**

- **Ans:**
- (a) $\frac{10\times900K}{10M} = 90\%$



Problem 8

b. Without using local web cache, calculate the end-to-end delay. **(5%)**

- **Ans:**
- access link utilization = 90%,
- LAN utilization = $\frac{10M}{1G} = 0.01$
- end-end delay = Internet delay + access link delay + LAN delay
- end-end delay = 5sec + **minutes** + usecs

Problem 8

c. By using local web cache, let the cache hit rate be 0.7, calculate the average end-to-end delay. **(10%)**

- Ans: access link utilization $= \frac{10 \times 900K * 0.3}{10M} = 0.27$
- average end-end delay
- = 0.3 * (delay from origin servers) + 0.7 * (delay when satisfied at cache)
- = 0.3*(5+msecs+usecs) + 0.7*(~msecs)
- =~1.5secs

Problem 9

a. What is the **min** time to distribute F to **all** 5 clients by using client-server approach? (Hint: server must sequentially send 5 file copies to 5 clients) **(5%)**

Ans:

$\max\{ 6*5 / 3, 6/2 \} = 10(s)$

Problem 9

b. What is the **min** time to distribute F to **all** 5 peers by using peer-to-peer (P2P) approach? (Hint: server must upload at least 1 file copy) **(10%)**

Ans:

$\max \{ 6/3, 6/2, 30/(3+4+4+6+2+1) \} = \max \{ 2, 3, 1.5 \} = 3(s)$

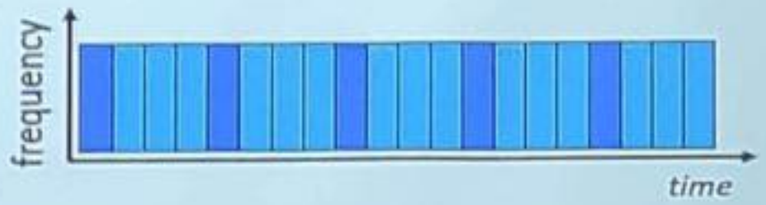
Circuit switching: FDM and TDM

Frequency Division Multiplexing (FDM)

- optical, electromagnetic frequencies divided into (narrow) frequency bands
  - each call allocated its own band, can transmit at max rate of that narrow band

Time Division Multiplexing (TDM)

- time divided into slots
- each call allocated periodic slot(s), can transmit at maximum rate of (wider) frequency band (only) during its time slot(s)



Problem 9

- Reliable data transfer (RDT) protocol. Fill the blanks with correct packets and messages.
  Fig. 6 is the sender of rdt2.0 **(2%)**, and **Fig. 7** is the sender of rdt2.1. **(8%)**

Problem 9

- **Ans:**
- **(1)** isNAK(rcvpkt)

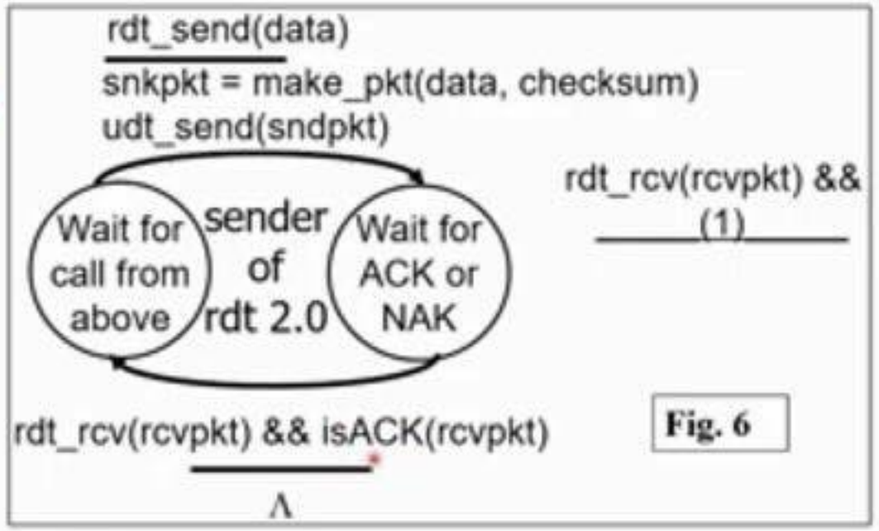


Fig. 6

Problem 9

- **Ans:**
- **(2)** 0, data, checksum
- **(3)** 1, data, checksum
- **(4)** corrupt(rcvpkt0)|| isNAK(rcvpkt)
- **(5)** &&notcorrupt(rcvpkt) && isACK(rcvpkt)