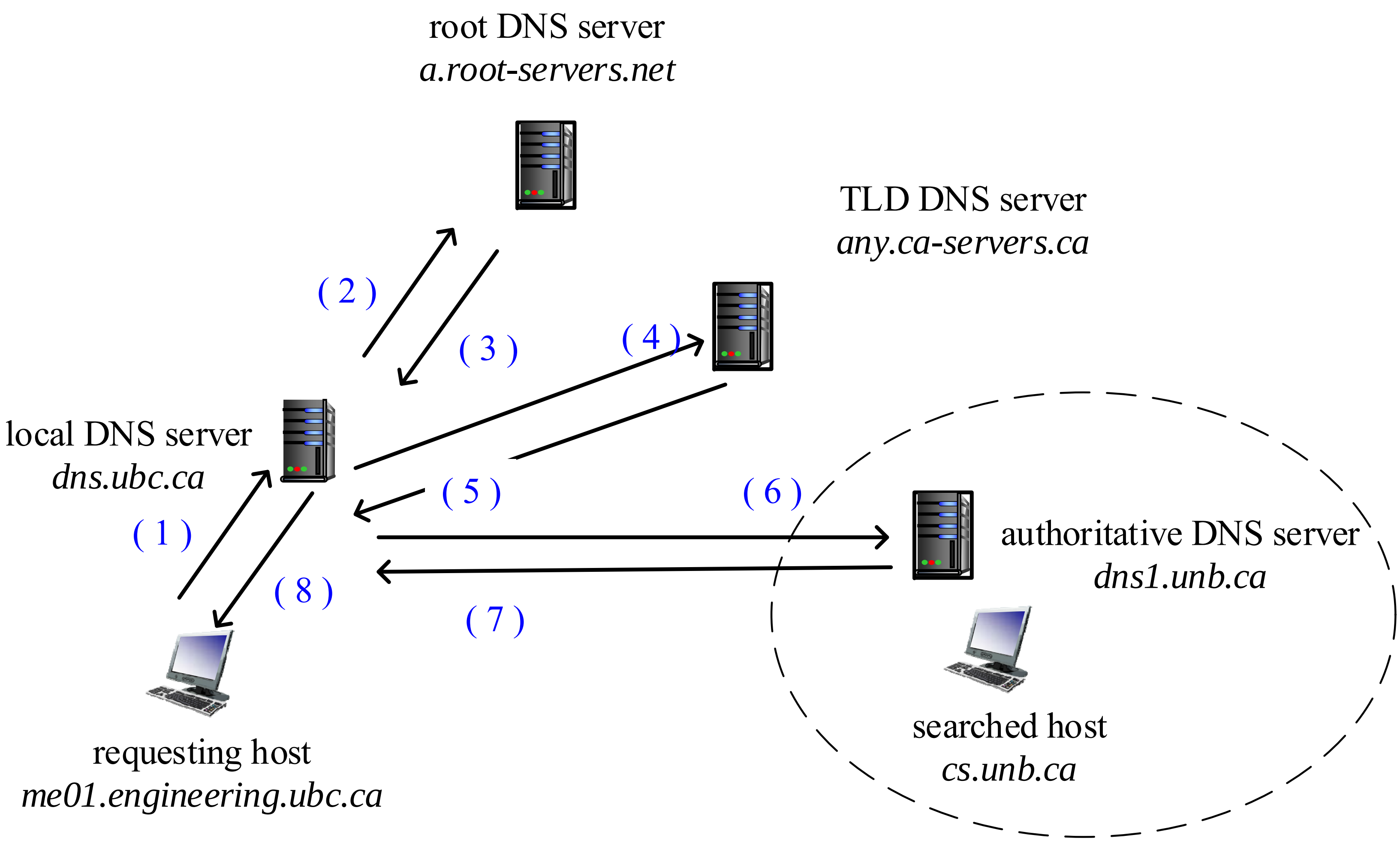
# CS3873: Midterm Answers

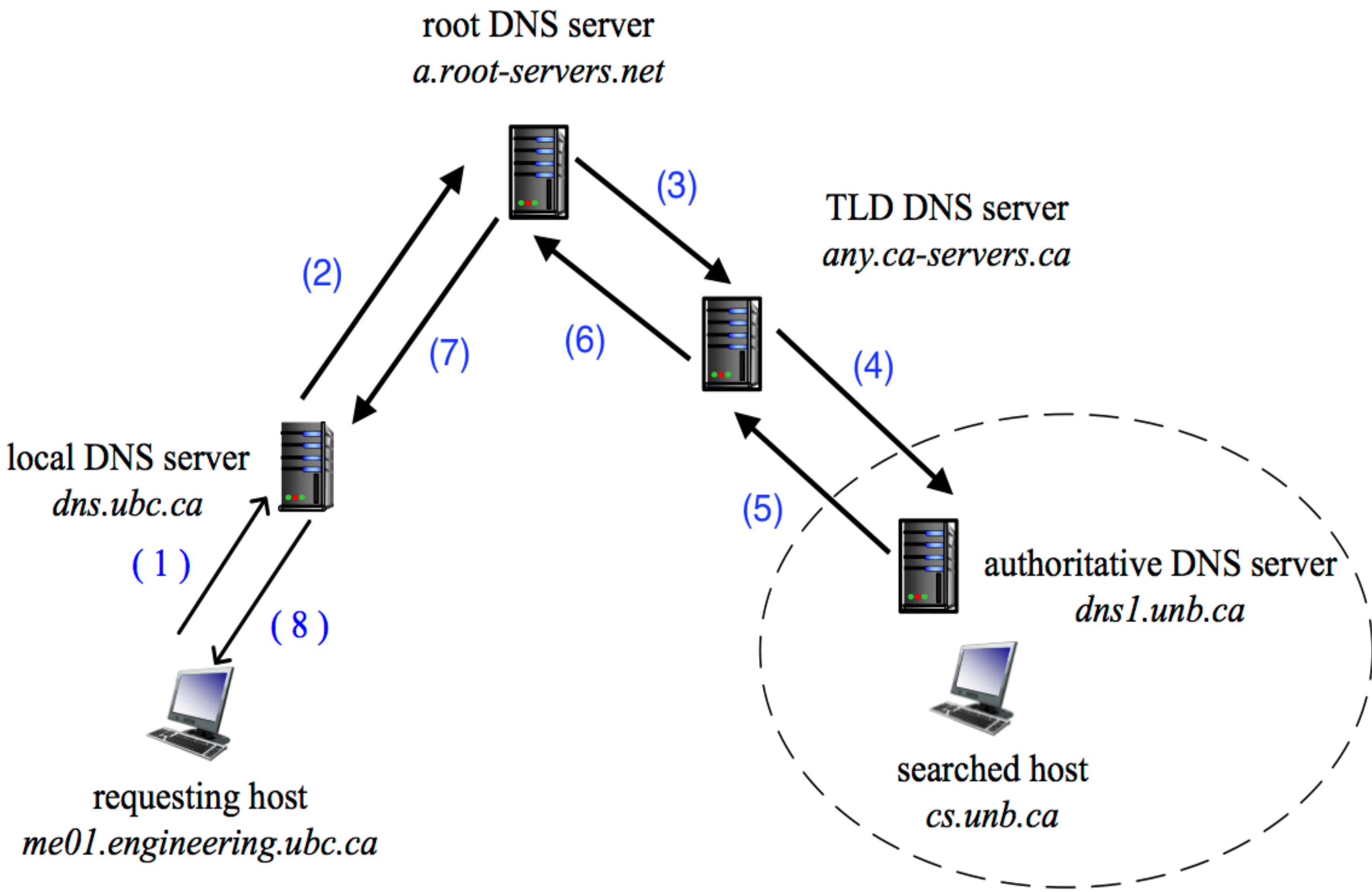
# A.Q3: DNS Name Resolution

## Iterative approach



# B.Q2: DNS Name Resolution

Recursive approach



# A.Q4

**Q4 (3 points).** It is known that UDP and TCP use the one's complement of the one's complement sum to calculate the checksum in the header of the UDP and TCP segments.

(a) Suppose a segment contains two 16-bit integers. What is checksum calculated by the one's complement of the one's complement sum of these two integers?

1 1 0 0 0 1 1 0   1 0 0 0 0 0 0 0

1 1 0 1 1 0 0 1   0 0 1 0 1 0 1 1

1's complement sum: 1 0 0 1 1 1 1 1   1 0 1 0 1 1 0 0

1's complement of the sum = Checksum

= 0 1 1 0 0 0 0 0   0 1 0 1 0 0 1 1

# A.Q4

(b) Suppose a host receives a segment that contains two 16-bit integers and a 16-bit checksum. Will the receiving host accept this segment as error-free? Justify your answer.

| | |
|---|---|
| | 1 1 0 0 0 0 1 0  1 0 0 0 0 0 0 1 |
| | 1 0 1 0 1 1 0 0  0 1 1 1 1 1 1 0 |
| Checksum: | 0 0 0 1 0 0 0 0  1 1 1 1 1 1 1 1 |

1's complement sum of all 3: **0** 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1

Answer: The receiving host does not accept this segment as error free.

# B.Q6

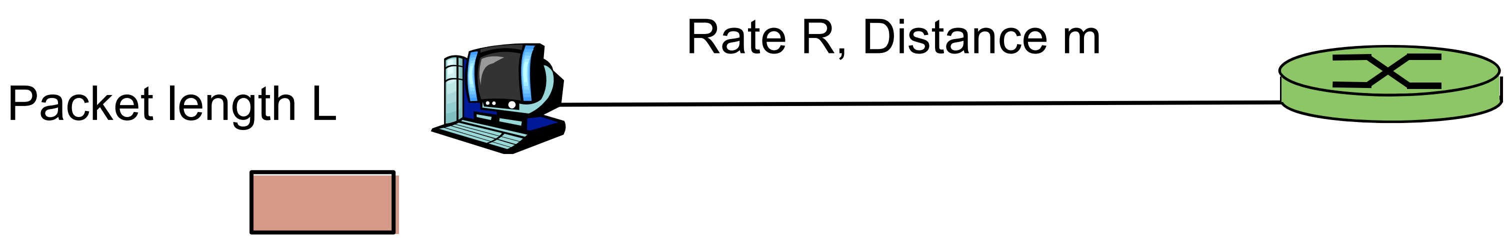
a) Checksum = 0 1 0 0 0 0 0 0   0 1 0 1 0 0 1 1

b) Accepted as error-free

# Nodal Delay

- Four sources of packet delay

$$d_{nodal} = d_{proc} + d_{queue} + d_{trans} + d_{prop}$$




$$d_{trans} = L/R$$

$$d_{prop} = m/s$$

# Units of Data Size and Data Rate

| Metric | Abbreviation | Value |
|---|---|---|
| kilobyte | KB | $10^3$ bytes |
| megabyte | MB | $10^6$ bytes |
| gigabyte | GB | $10^9$ bytes |
| terabyte | TB | $10^{12}$ bytes |

| Metric | Abbreviation | Value |
|---|---|---|
| kilobits/s | kbps, kbit/s | $10^3$ bits/s |
| megabits/s | Mbps, Mbit/s | $10^6$ bits/s |
| gigabits/s | Gbps, Gbit/s | $10^9$ bits/s |

b = bit, B = Byte
1B = 1 Byte = 8 bits

# A.Q5

a) L = 8000 bits    R = 10 Gbps = $10^{10}$ bits/sec

$$d_{trans} = \frac{L}{R} = \frac{8000}{10^{10}} = 8 \times 10^{-7} seconds = 0.8\ \mu s$$

b) d = 100 km = $10^5$ m    s = $2*10^8$ m/s

$$d_{prop} = \frac{d}{s} = \frac{10^5}{2 \times 10^8} = 5 \times 10^{-4}\ seconds = 0.5\ ms$$

# B.Q4

a) L = 6000 bits R = 20 Gbps = $2*10^{10}$ bits/sec

$$d_{trans} = \frac{L}{R} = \frac{6000}{2 \times 10^{10}} = 3 \times 10^{-7} seconds = 0.3\ \mu s$$

b) d = 50 km = $5*10^4$ m s = $2*10^8$ m/s

$$d_{prop} = \frac{d}{s} = \frac{5 \times 10^4}{2 \times 10^8} = 2.5 \times 10^{-4}\ seconds = 0.25\ ms$$

# End-to-End Delay for Multiple Packets

- For an end-to-end connection with same link rate R:

$$d_{e2e} = (P-1) * (L/R) + N * (L/R)$$
$$\approx (P * L)/R \qquad (\text{if } P >> N)$$

  - L: packet length, R: link rate
  - P: number of packets, N: number of links
- For an end-to-end connection with different link rates:

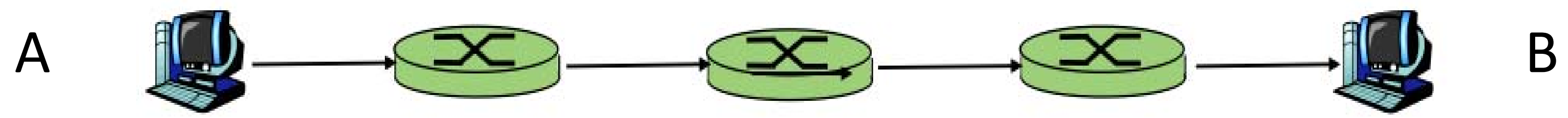
$$d_{e2e} \approx (P * L)/R_{min}$$

  - $R_{min}$: rate of the bottleneck link

# A.Q6

**Q6 (4 points).** Consider an end-to-end connection from Host A to Host B, which consists of four links. Suppose Host A is sending a large file to Host B over this connection. The file is divided into 600 packets of 512 KB each. Suppose only the transmission delay is considered and all other delay sources are neglected.

(a) Suppose the data rate of each link is R = 20 Mbps. Calculate the total end-to-end delay for sending all the packets of the file from Host A to Host B.



# A.Q6

P = 600, N = 4

L = 512*8*1000 bits, R = 20 Mbps = $20*10^6$ bps

$d_{trans}$ = L/R = 512*8*1000 / ($20*10^6$) = 0.2048 s

$d_{e2e}$ = (P-1)*$d_{trans}$ + N*$d_{trans}$

= (600-1)* 0.2048 + 4*0.2048 = 123.49 seconds

# A.Q6

(b) Suppose the first link of the end-to-end connection has a date rate of $R_1$ = 5 Mbps, while the other links have the same data rate of R = 20 Mbps. *Estimate* the total end-to-end delay for sending the whole file from Host A to Host B.

- P = 600, N = 4
- L = 512*8*1000 bits, $R_1 = 5$ Mbps $= 5*10^6$ bps
- $d_{trans} = L/R_1 = 512*8*1000 / (5*10^6) = 0.8192$ seconds
- $d_{e2e} = P*d_{trans} = 600 * 0.8192 = 491.52$ seconds

# B.Q5

- $P = 500$, $N = 4$, $L = 256*8*1000$ bits, $R = 10$ Mbps
  $d_{trans} = L/R = 256*8*1000 / (10*10^6) = 0.2048$ s
  $d_{e2e} = (P-1)*d_{trans} + N*d_{trans}$
  $= (500-1)*\ 0.2048+ 4*0.2048 = 103.01$ seconds

- $P = 500$, $N = 4$, $L = 256*8*1000$ bits, $R_1 = 5$ Mbps,
  $d_{trans} = L/R_1 = 256*8*1000 / (5*10^6) = 0.4096$ seconds
  $d_{e2e} = P*d_{trans} = 500 * 0.4096 = 204.8$ seconds