Electrical and Computer Engineering
Memorial University of Newfoundland
ENGI 9876 - Advanced Data Networks
Fall 2018

Problem Set 3

(Due: Friday, November 9, 2018)

Question 1

A resource has a capacity of 30 units and use of the resource is desired by 5 users. The users A, B, C, D, and E have demands of 6, 8, 12, 24, and 2 units, respectively. Determine the allocation of the resource on the basis of max-min fair sharing. You may assume that users may utilize fractions of resource units if required. Repeat the question, assuming that the users are given weights 20, 40, 10, 20, and 10, respectively.

Question 2

Consider a GPS scheduler used to determine the servicing for 6 sources. Each source requires servicing according to the following:

Source	Start Time	Required Service Time
1	0	3
2	2	6
3	3	5
4	10	5
5	15	8
6	20	2

Determine the time at which each source is finished being served.

Question 3

Consider a weighted round robin scheme for scheduling packets on a 100 Mbps link where each packet has a size of 1000 bits. We can view time divided into timeslots equivalent to the time required to transmit one cell on the link. Cells arrive at the link queues synchronized to a timeslot. The link is servicing 4 connections each having its own queue and the following service weights:

Connection	Weight
1	20
2	10
3	40
4	30

At a particular time, the queues have the following number of cells in them.

Connection	Cells in Queues
1	10
2	10
3	20
4	20

A weighted round robin scheduling of the cells in queues begins at connection 1 and proceeds to connection 2, etc.. What is the time required for the first round of the round robin? Determine how the cells would be scheduled for transmission on the link, assuming no other cells come in. Comment of the fairness of the scheme by comparing to GPS.

Question 4

Consider the scheduling of packets in a queuing system. Packets arrive for 2 different connections (each having its own queue) and are to be transmitted on a link of 100 kbps. The 2 connections have equal weights. Eight packets arrive as follows:

Packet	Connection	Arrival Time (ms)	Packet Size (bits)
1	A	0	2000
2	B	10	1000
3	B	20	1000
4	A	30	2000
5	B	30	2000
6	B	40	1000
7	A	60	2000
8	B	80	1000

(a) Assume that the packets are served using a round robin approach starting with connection A at time 0 and with the round proceeding from A to B to A, etc.. Determine the finishing times of the packets.
(b) Determine the finishing times of the packets if GPS scheduling was employed.
(c) Comment on the fairness of the round robin scheme versus the GPS scheme in the context of this example. In general, how can the round robin scheme be made more fair?

Question 5

A scheduler used to determine the order of packet servicing for 3 connections on a link uses a weighted fair queuing scheme. The link rate is 100 kbps and packets are of varying sizes. The arrival patterns of packets is given below.

Connection	Arrival Times (ms)	Packet Sizes (bits)
A	0.0	100
	1.0	300
	5.0	200
B	0.5	200
	2.0	100
	8.0	100
C	2.0	300
	5.0	100

(a) Assuming that the links are not weighted, determine the order of transmitting the packets on the link. Determine the actual completion times of each packet and the completion times of packets in the simulated GPS scheme.
(b) Repeat the problem if connections A, B, and C are weighted with weights 2, 1, and 1,

respectively and all packet sizes are 100 bits.

Question 6

Consider the scheduling of packets arriving to 2 different connections. They are to be transmitted on a link of 100 Mbps. Each packet is 1000 bits in length. The 2 connections have weights of W_A = 1 and W_B = 4. Five packets arrive as follows:

Packet	Connection	Arrival Time (μs)
1	A	0
2	B	5
3	B	10
4	A	20
5	B	40

Using a weighted fair queuing approach, determine the finishing times of all five packets in (i) the simulated GPS scheme and (ii) the actual scheduling.

Question 7

Consider the arrivals of packets to a system as shown below. Packets are to be served by the system at a rate of 1 Mbps according to a scheduler and while they wait to be served they are queued.

Connection	Packet ID	Arrival Time (ms)	Packet Length (bits)
A	A1	0	1000
A	A2	1	2000
B	B1	2	4000
A	A3	4	2000
B	B2	6	1000
A	A4	8	2000
A	A5	10	1000

(a) Assume that the scheduler uses a Weighted Round Robin approach where the weight of all connections is 1 and the round robin always begins at connection A. Determine the finishing time of each packet.

(b) Assume that the scheduler uses a Weighted Fair Queuing approach where the weight of all connections is 1. Determine the finishing times for each packets in the simulated GPS scheme and the actual finishing times for the WFQ approach.

(c) Comment on the fairness and practicality of the WRR vs. the WFQ schemes for this example.

ANSWERS

Q1. A → 6, B → 7.33, C → 7.33, D → 7.33, E → 2
A → 6, B → 8, C → 4.67, D →9.33, E → 2

Q2. 1 → 4.5, 2 → 15.33, 3 → 16.83, 4 → 23.5, 5 → 29, 6 → 25.17

Q3. First round takes 10 timeslots = 100 μs
1 done at timeslot 42, 2 at 60, 3 at 47, 4 at 57
Fair for times >> 100 μs

Q4. (a) 1 → 20 ms, 2 → 30 ms, 3 → 60 ms, 4 → 50 ms
5 → 100 ms, 6 → 110 ms, 7 → 80 ms, 8 → 120 ms
(b) 1 → 30 ms, 2 → 30 ms, 3 → 50 ms, 4 → 70 ms
5 → 90 ms, 6 → 110 ms, 7 → 110 ms, 8 → 120 ms
(c) Answer not available.

Q5. (a) Actual finish times:
A1 → 1 ms, B1 → 3 ms, B2 → 4 ms, A2 → 7 ms,
C1 → 10 ms, B3 → 11 ms, C2 → 12 ms, A3 → 14 ms
GPS finish times:
A1 → 1.5 ms, B1 → 5.75 ms, B2 → 8.75 ms, A2 → 10.25 ms,
C1 → 11 ms, B3 → 11.75 ms, C2 → 13.25 ms, A3 → 14 ms
(b) Actual finish times:
A1 → 1 ms, A2 → 2 ms, B1 → 3 ms, C1 → 4 ms,
B2 → 5 ms, A3 → 6 ms, C2 → 7 ms, B3 → 9 ms
GPS finish times:
A1 → 1.25 ms, A2 → 3 ms, B1 → 3.5 ms, C1 → 4.5 ms,
B2 → 5 ms, A3 → 6.5 ms, C2 → 7 ms, B3 → 9 ms

Q6. (i) GPS finish times:
1 → 30 μs, 2 → 17.5 μs, 3 → 30 μs, 4 → 40 μs, 5 → 50 μs
(ii) Actual finish times:
1 → 10 μs, 2 → 20 μs, 3 → 30 μs, 4 → 40 μs, 5 → 50 μs

Q7. (a) WRR finish times:
A1 → 1 ms, A2 → 3 ms, A3 → 9 ms, A4 → 12 ms,
A5 → 13 ms, B1 → 7 ms, B2 → 10 ms
(b) GPS finish times:
A1 → 1 ms, A2 → 4 ms, A3 → 8 ms, A4 → 12 ms,
A5 → 13 ms, B1 → 10 ms, B2 → 12 ms
Actual WFQ finish times:
A1 → 1 ms, A2 → 3 ms, A3 → 9 ms, A4 → 11 ms (or 12 ms),
A5 → 13 ms, B1 → 7 ms, B2 → 12 ms (or 10 ms)