1 Congestion control

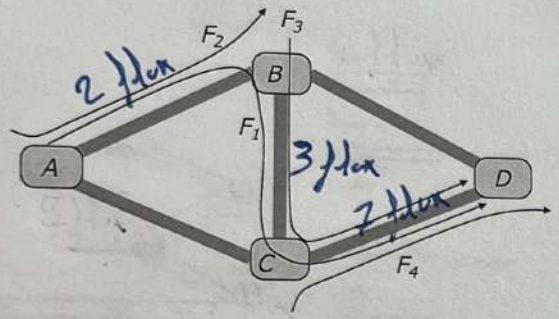

Figure 1: Example network

Consider an example network consisting of four routers A, B, C, and D presented in Figure 1. All links are of capacity 1 Mb/s. Several types of flows (F_1, F_2, F_3, F_4) take different routes shown in the figure and each source can transmit at a speed of 1 Mb/s. There is 1 flow of type F_1 and F_2, 2 flows of type F_3 and 4 flows of type F_4. Assume that all the flows are UDP with packets of the same size (unless specified otherwise).

1. What is the flow rate on each link if the routers schedule packets according to FIFO?

AB : $F_1 = \frac{1}{1+1} \times 1 = 0{,}5$ Mb/s
$F_2 = \frac{1}{2} \times 1 = 0{,}5$ Mb/s

BC : $F_1 = \frac{0{,}5}{0{,}5+2} \times 1 = 0{,}2$ Mb/s
$F_3 = 2/(0{,}5+2) \times 1 = 0{,}8$ Mb/s

CD : $F_1 = \frac{0{,}2}{0{,}2+0{,}8+4} \times 1 = 0{,}04$ Mb/s
$F_3 = \frac{0{,}8}{0{,}2+0{,}8+4} \times 1 = 0{,}16$ Mb/s
$F_4 = \frac{4}{0{,}2+0{,}8+4} \times 1 = 0{,}8$ Mb/s

$0 = 0{,}5 + 0{,}8 + (0{,}04 + 0{,}16 + 0{,}8) = 1{,}5$ Mb/s

2. What is the flow rate on each link if the routers schedule packets according to Fair Queueing?

AB : $F_1 = \frac{1}{1+1} = 0{,}5$ Mb/s
$F_2 = \frac{1}{2} = 0{,}5$ Mb/s

BC : $F_1 = \frac{1}{3} = 0{,}33$ Mb/s
$2 \times F_3 = \frac{1}{3} = 0{,}33$ Mb/s

CD : $F_1 = \frac{1}{7} = 0{,}14$ Mb/s
$2 \times F_3 = 1/7 = 0{,}14$ Mb/s
$4 \times F_4 = 1/7 = 0{,}14$ Mb/s

3. What is the flow rate on each link if the sources adapt their rates according to max-min fairness.

F_1	F_2	F_3	F_4
0_2	0_2	0_2	0_2
1/7	1/7 ↓ 6/7	1/7	1/7

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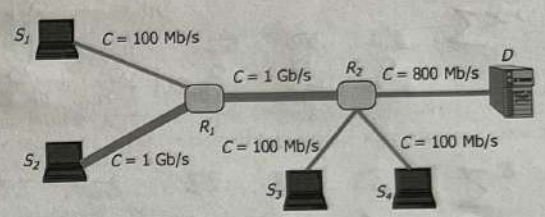

Figure 1: Example network

Consider an example network presented in Figure 1. Link capacity is indicated in the figure. Sources $S_i, i = 1, ..., 4$ generate flows to destination D. Assume that all the flows are UDP with packets of the same size (unless specified otherwise).

1. What is the flow rate on links $R_1 - R_2$ and $R_2 - D$ if the routers schedule packets according to FIFO?

R_1R_2: $S_1 = \frac{100}{1100} \times 1000 = 91$ Mb/s
$S_2 = \frac{1000}{1100} \times 1000 = 909$ Mb/s

R_2D: $S_1 = 91 / 1200 \times 800 = 61$ Mb/s
$S_2 = 909 / 1200 \times 800 = 606$ Mb/s
$S_3 + S_4 = 100 / 1200 \times 800 = 66$ Mb/s

2. What is the flow rate on the links if the routers schedule packets according to Fair Queueing?

R_1R_2:

S_1	S_2
0	0
100	100
	800

$\Sigma x_i = 200$
$4 = 1000$

R_1D:

S_1	S_2	S_3	S_4
0	0	0	0
100	100	100	100
		500	

$\Sigma x_i = 400$
$4 = 800$

3. What is the flow rate on each link if the sources adapt their rates according to max-min fairness.