Interconnection Networks for High-Performance Systems
ECE 8823 A / CS 8803 – ICN
Spring 2022
Lab 4: Impact of NoC on Real Application Traffic

Answer the following Questions in place [19 points]

This is an individual assignment. You need to <u>show the exact calculations</u> to get points. Please do not post the solutions on Piazza. You are also <u>not allowed</u> to discuss the solutions with each other.

1. **[2 points]** For BFS, VC-per-vnet =8, Router latency = 1, what is the ratio of total packets injected with L2=1kB to total packets injected with L2=16kB. Is it more than 1 or less than 1? Explain why, briefly.

   Solution:
   Total packets injected for L2 = 1kB = 69735
   Total packets injected for L2 = 16kB = 45098
   Ratio = 69735/45098 = 1.55.
   Ans: 1.55:1 for ratio of total packets injected for L2(1kB) to L2(16kB)
   Reason:
   The ratio is greater than 1 because with a larger L2 (16kB), the number of hits in L2 will be higher (with reduction in capacity misses and conflict misses). This means that the requirement of accessing memory is lower so, it needs to send out lower number of packets to the network, leading to lower total packets injected.

2. **[3 points]** For BFS, VC-per-vnet =8, Router latency = 1, L2=1kB, what is the ratio of total 1-flit packet injected to total 5-flit packets injected?
   [Hint: see the total flits and total packets injected].

   Solution:
   Flits injected total = 163807
   Packets injected total = 69735
   Considers mix of 5-flit and 1-flit packets as per Lab4.pdf. Thus,
   Say, no. of 1 flit packet = x, no. of 5 flit packet = y
   $x*1 + y*5 = 163807$
   $x + y = 69735$
   Subtracting the two equations,
   $y*4 = 94{,}072 => y = 23{,}518$
   So, $x = 46{,}217$

   Ratio = (# 1 flit packets)/ (# of 5 flit packets) = x/y = 46217/23518 = 1.965
   Answer: 1.965:1 for ratio of number of 1 flit packets injected to number of 5 flit packets injected.

3. **[2 points]** For L2 = 1kB and vc-per-vnet =8, how much % reduction in **total runtime** do you see when going from a 5-cycle router to a 1-cycle router, averaged across all the 4 benchmarks?

Formula used for % reduction (runtime(tr=5) – runtime(tr=1))*100/(runtime(tr=5))

Benchmark	Runtime 5 cycle router	Runtime 1 cycle router	% Reduction in runtime
BFS	785464000.0	533110000.0	32.12802 %
PageRank	800756000.0	544917000.0	31.94968 %
BellmanFord	785571000.0	527994000.0	32.78851 %
Radii	764750500.0	527294000.0	31.05019 %
Average % reduction in runtime =			**31.9791 %**

4. **[2 points]** For L2 = 1kB and VC-per-vnet =1, how much % reduction in **total runtime** do you see when going from 5-cycle router to a 1-cycle router, averaged across all the 4 benchmarks?

Formula used for % reduction (runtime(tr=5) – runtime(tr=1))*100/(runtime(tr=5))

Benchmark	Runtime 5 cycle router	Runtime 1 cycle router	% Reduction in runtime
BFS	852202500	573009500	32.76134 %
PageRank	869926000	585506500	32.69468 %
BellmanFord	856771000	565144000	34.03792 %
Radii	831775000	564402000	32.14487 %
Average % reduction in runtime =			**32.9097 %**

5. **[10 points]** For L2 = 1kB and Router latency = 1 cycle, sweep the number of VCs and find the minimum number of VCs required before the relative reduction in runtime becomes less than 1% for each benchmark separately.
[Hint: Suppose runtime for VC=K is 12345 cycles, and for VC=K+1 is 12300 cycles.
Reduction in runtime = (old runtime - new runtime) / (old runtime)
          = (12345 - 12300) / 12300 = 0.0036 => 0.36 %
You need to report the value of K for each benchmark.

Table 1: Assuming negative % change can be considered (-inf % to 1%)

Benchmark	No. of VCs (K)	Old runtime (VC = K)	New runtime (VC = K+1)	Relative % reduction
BFS	2	532255000	533370500	-0.20958 %
PageRank	2	543836000	546965000	-0.57536 %
BellmanFord	2	528137000	530252500	-0.40056 %
Radii	2	525128000	526119500	-0.18881 %

Table 2: Assuming only % reduction considered (0% to 1%)

Benchmark	No. of VCs (K)	Old runtime (VC = K)	New runtime (VC = K+1)	Relative % reduction
BFS	3	533370500	532714500	0.12299 %
PageRank	3	546965000	543128000	0.70151 %
BellmanFord	4	530266000	528437000	0.34492 %
Radii	5	527912000	526135000	0.33661 %

Detailed table for Q5:

BFS:

No. of VCs (k)	Runtime	% Reduction wrt previous k
1	573009500	
2	532255000	7.11236 %
3	533370500	**-0.20958 %**
4	532714500	**0.122991 %**
5	532804500	-0.01689 %
6	531991000	0.152683 %
7	533454500	-0.2751 %
8	533110000	0.064579 %

PageRank:

No. of VCs (k)	Runtime	% Reduction wrt previous k
1	585506500	
2	543836000	7.117 %
3	546965000	**-0.57536 %**
4	543128000	**0.701507 %**
5	544112500	-0.18126 %
6	545658000	-0.28404 %
7	544957000	0.128469 %
8	544917000	0.00734 %

BellmanFord:

No. of VCs (k)	Runtime	% Reduction wrt previous k
1	565144000	
2	528137000	6.548243 %
3	530252500	**-0.40056 %**
4	530266000	-0.00255 %
5	528437000	**0.344921 %**
6	528147500	0.054784 %
7	528034000	0.02149 %
8	527994000	0.007575 %

Radii

No. of VCs (k)	Runtime	% Reduction wrt previous k
1	564402000	
2	525128000	6.958515 %
3	526119500	**-0.18881 %**
4	526122000	-0.00048 %
5	527912000	-0.34023 %
6	526135000	**0.336609 %**
7	526238500	-0.01967 %
8	527294000	-0.20057 %