

HW3 Report

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Exercise 1

```
Loading configuration from file "../config_examples/default_config.yaml"... Done
Loading power configurations from file "power.yaml"... Done
Reset for 1000 cycles... done!
Now running for 10000 cycles...
Noxim simulation completed. (11000 cycles executed)

% Total received packets: 1463
% Total received flits: 11698
% Received/Ideal flits Ratio: 1.01545
% Average wireless utilization: 0
% Global average delay (cycles): 11.7765
% Max delay (cycles): 77
% Network throughput (flits/cycle): 1.29978
% Average IP throughput (flits/cycle/IP): 0.0812361
% Total energy (J): 2.12491e-06
%   Dynamic energy (J): 1.49656e-07
%   Static energy (J): 1.97525e-06
[ts111062107@linuxcad30 bin]$
```

1 Total Received Flit

- 1.1 Flit (Flow Control Unit) 是在網絡傳輸過程中最小的數據單位。Total Received Flit 表示整個模擬過程中，目標節點接收到的 Flit 數量。
- 1.2 The total number of flits received by target nodes is accumulated.

2 Total Received Packet

- 2.1 Packet (數據包) 是由若干個 Flit 組成的完整數據單位。Total Received Packet 表示在模擬過程中，目標節點接收到的完整數據包的總數。
- 2.2 Each packet consists of a head flit (starting flit) and a tail flit (ending flit). When all flits of a packet are received, the Total Received Packet is

incremented by 1.

3 Global Average Delay

3.1 Global Average Delay 是指數據包從 source 發送到 destination 所花費的平均時間，通常以 cycle 來衡量。

3.2 Global Average Delay =

$$\text{Total Delay Time for All Packets} / \text{Total Number of Received Packets}$$

4 Network throughput

4.1 Network Throughput 是整個網絡的吞吐量，表示網絡在單位時間內（每個時鐘周期）成功傳輸的 Flit 數量。

4.2 Network Throughput (flits/cycle) = total received flit / total clock

$$11698 / 9000 = 1.29978$$

5 Average IP throughput

5.1 Average IP Throughput 表示每個 IP 節點（網絡上的處理單元）平均在單位時間內（每個時鐘周期）傳輸的 Flit 數量。

5.2 Average IP Throughput (flits/cycle/IP) =

$$\text{total received flit} / (\text{total clock} * \text{total number of IP node})$$

$$= \text{Network Through} / \text{total number of IP node}$$

$$= 1.29978 / 16 = 0.08123$$

Exercise 2

1 packet_size (min & max)

```
149 min_packet_size: 8
150 max_packet_size: 8
151 packet_injection_rate: 0.01
152 probability_of_retransmission: 0.01
153
```

```
Loading configuration from file "../config_examples/my_config.yaml"... Done
Loading power configurations from file "power.yaml"... Done
Reset for 1000 cycles... done!
Now running for 10000 cycles...
Noxim simulation completed. (11000 cycles executed)
```

```
% Total received packets: 1435
% Total received flits: 11483
% Received/Ideal flits Ratio: 0.996788
% Average wireless utilization: 0
% Global average delay (cycles): 11.6446
% Max delay (cycles): 58
% Network throughput (flits/cycle): 1.27589
% Average IP throughput (flits/cycle/IP): 0.0797431
% Total energy (J): 2.11887e-06
%   Dynamic energy (J): 1.43623e-07
%   Static energy (J): 1.97525e-06
```

```
148
149 min_packet_size: 4
150 max_packet_size: 4
151 packet_injection_rate: 0.01
152 probability_of_retransmission: 0.01
153
```

```
% Total received packets: 1485
% Total received flits: 5943
% Received/Ideal flits Ratio: 1.03177
% Average wireless utilization: 0
% Global average delay (cycles): 8.18182
% Max delay (cycles): 24
% Network throughput (flits/cycle): 0.660333
% Average IP throughput (flits/cycle/IP): 0.0412708
% Total energy (J): 2.04891e-06
%   Dynamic energy (J): 7.36611e-08
%   Static energy (J): 1.97525e-06
```

```
149 min_packet_size: 12
150 max_packet_size: 12
151 packet_injection_rate: 0.01
152 probability_of_retransmission: 0.01
```

```
% Total received packets: 1446
% Total received flits: 17363
% Received/Ideal flits Ratio: 1.0048
% Average wireless utilization: 0
% Global average delay (cycles): 22.1369
% Max delay (cycles): 167
% Network throughput (flits/cycle): 1.92922
% Average IP throughput (flits/cycle/IP): 0.120576
% Total energy (J): 2.19679e-06
%     Dynamic energy (J): 2.21537e-07
%     Static energy (J): 1.97525e-06
```

```
149 min_packet_size: 16
150 max_packet_size: 16
151 packet_injection_rate: 0.01
152 probability_of_retransmission: 0.01
```

```
% Total received packets: 1435
% Total received flits: 22967
% Received/Ideal flits Ratio: 0.996832
% Average wireless utilization: 0
% Global average delay (cycles): 39.2794
% Max delay (cycles): 270
% Network throughput (flits/cycle): 2.55189
% Average IP throughput (flits/cycle/IP): 0.159493
% Total energy (J): 2.26161e-06
%     Dynamic energy (J): 2.86361e-07
%     Static energy (J): 1.97525e-06
```

我們可以觀察出以下結果

1.1 Total Received Flit : packet size 變大 , Total Received Flit 增加

1.2 Total Received Packet : 數量不變

(因為 $\text{Total Received Flit} = \text{Total Received Packet} * \text{Average Packet Size}$, 所以隨著 packet size 增加, 傳送的 packet 數量不變, Total Received Flit 就會增加。)

1.3 Global Average Delay : packet size 增加, Global Average Delay 增加

(當 packet size 增加, 傳輸資料的時間本來就會增加, 再加上當 packet size 增加, 每個 node 需要更多時間處理單個節點, 這會導致排隊時間增長。)

1.4 Network throughput : 數量隨 packet size 變大而增加

1.5 Average IP throughput : 數量隨 packet size 變大而增加

(Network throughput, Average IP throughput 的計算公式裡面，與 Total Received Flit 成正比，所以當 Total Received Flit，他們也會增加。)

2 packet_injection_rate

0.005

```
% Total received packets: 716
% Total received flits: 5727
% Received/Ideal flits Ratio: 0.994271
% Average wireless utilization: 0
% Global average delay (cycles): 9.40363
% Max delay (cycles): 51
% Network throughput (flits/cycle): 0.636333
% Average IP throughput (flits/cycle/IP): 0.0397708
% Total energy (J): 2.04881e-06
%     Dynamic energy (J): 7.35538e-08
%     Static energy (J): 1.97525e-06
```

0.01

```
% Total received packets: 1415
% Total received flits: 11325
% Received/Ideal flits Ratio: 0.983073
% Average wireless utilization: 0
% Global average delay (cycles): 11.1576
% Max delay (cycles): 54
% Network throughput (flits/cycle): 1.25833
% Average IP throughput (flits/cycle/IP): 0.0786458
% Total energy (J): 2.1184e-06
%     Dynamic energy (J): 1.43145e-07
%     Static energy (J): 1.97525e-06
```

0.05

```
% Total received packets: 4784
% Total received flits: 38266
% Received/Ideal flits Ratio: 0.66434
% Average wireless utilization: 0
% Global average delay (cycles): 1656.85
% Max delay (cycles): 4833
% Network throughput (flits/cycle): 4.25178
% Average IP throughput (flits/cycle/IP): 0.265736
% Total energy (J): 2.46747e-06
%     Dynamic energy (J): 4.92221e-07
%     Static energy (J): 1.97525e-06
```

0.1

```
% Total received packets: 4667
% Total received flits: 37354
% Received/Ideal flits Ratio: 0.324253
% Average wireless utilization: 0
% Global average delay (cycles): 3583.04
% Max delay (cycles): 6986
% Network throughput (flits/cycle): 4.15044
% Average IP throughput (flits/cycle/IP): 0.259403
% Total energy (J): 2.4622e-06
%     Dynamic energy (J): 4.86951e-07
%     Static energy (J): 1.97525e-06
```

我們可以觀察出以下結果

2.1 Total Received Flit：隨 packet_injection_rate 變大而增加

2.2 Total Received Packet：隨 packet_injection_rate 變大而增加

(因為 Packet Injection Rate 是指每個時間單位內注入網絡的 packet 數量，所以當其增加，packet 的總數量就會增加，所以 Total Received Packet 會增加，當 packet 數量增加，Total Received Flit 也就會跟著增加。)

2.3 Global Average Delay：隨 packet_injection_rate 變大而增加

(當越來越多 packet 在網路裡面，這就會導致競爭變得更激烈，增加每個 node 的平均排隊等待時間，所以 Average Delay 就會跟著增加。)

2.4 Network throughput：隨 packet_injection_rate 變大而增加

2.5 Average IP throughput：隨 packet_injection_rate 變大而增加

(由公式可以得知，Network throughput 與 Average IP throughput 與 Total Received Flit 成正比，所以當 Total Received Flit 增加，他們也會跟著增長。)

3 simulation_time

5000

```
% Total received packets: 621
% Total received flits: 4977
% Received/Ideal flits Ratio: 0.97207
% Average wireless utilization: 0
% Global average delay (cycles): 12.1739
% Max delay (cycles): 52
% Network throughput (flits/cycle): 1.24425
% Average IP throughput (flits/cycle/IP): 0.0777656
% Total energy (J): 1.06004e-06
%     Dynamic energy (J): 7.24192e-08
%     Static energy (J): 9.87626e-07
```

10000

```
% Total received packets: 1400
% Total received flits: 11197
% Received/Ideal flits Ratio: 0.971962
% Average wireless utilization: 0
% Global average delay (cycles): 11.765
% Max delay (cycles): 66
% Network throughput (flits/cycle): 1.24411
% Average IP throughput (flits/cycle/IP): 0.0777569
% Total energy (J): 2.11658e-06
%     Dynamic energy (J): 1.41334e-07
%     Static energy (J): 1.97525e-06
```

15000

```
% Total received packets: 2228
% Total received flits: 17826
% Received/Ideal flits Ratio: 0.994754
% Average wireless utilization: 0
% Global average delay (cycles): 11.7522
% Max delay (cycles): 72
% Network throughput (flits/cycle): 1.27329
% Average IP throughput (flits/cycle/IP): 0.0795804
% Total energy (J): 3.18346e-06
%     Dynamic energy (J): 2.2058e-07
%     Static energy (J): 2.96288e-06
```

20000

```
% Total received packets: 3138
% Total received flits: 25114
% Received/Ideal flits Ratio: 1.03265
% Average wireless utilization: 0
% Global average delay (cycles): 11.702
% Max delay (cycles): 85
% Network throughput (flits/cycle): 1.32179
% Average IP throughput (flits/cycle/IP): 0.0826118
% Total energy (J): 4.25023e-06
%     Dynamic energy (J): 2.99725e-07
%     Static energy (J): 3.9505e-06
```

我們可以觀察出以下結果

3.1 Total Received Flit：隨 simulation_time 變長而增加

3.2 Total Received Packet：隨 simulation_time 變長而增加

(我們可以得知，當模擬時間增加，總共需要傳送的封包還有 flit 的數量本來就會增長。)

3.3 Global Average Delay：不變

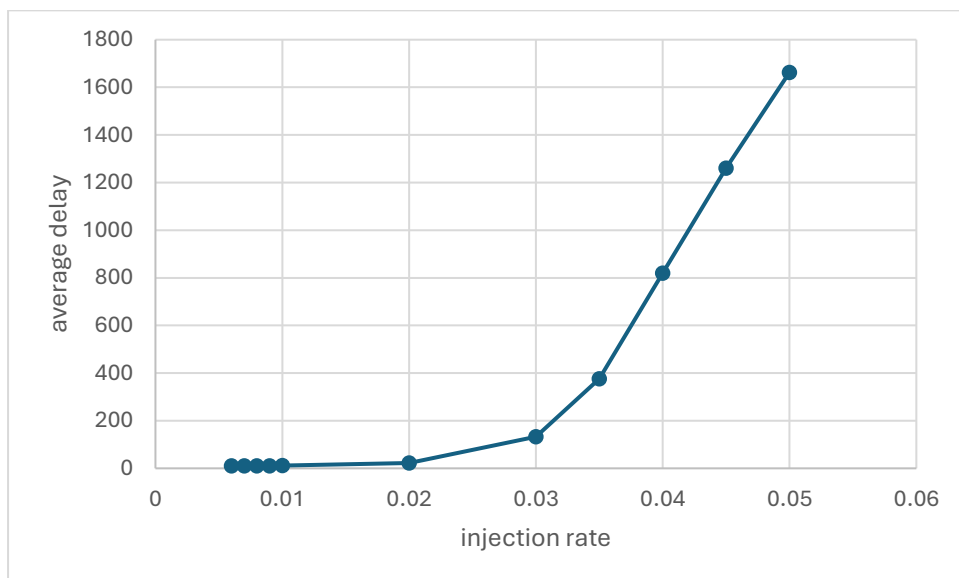
3.4 Network throughput：不變

3.5 Average IP throughput：不變

(因為這三個數據都是在系統穩定後所得出的結果，所以當模擬時間增長，這些平均的數據不會有太大變化。)

Exercise 3

| injection rate | average delay |
|----------------|---------------|
| 0.006 | 9.74421 |
| 0.007 | 9.75202 |
| 0.008 | 10.8879 |
| 0.009 | 10.907 |
| 0.01 | 11.8422 |
| 0.02 | 22.5466 |
| 0.03 | 132.446 |
| 0.035 | 376.099 |
| 0.04 | 818.985 |
| 0.045 | 1260.84 |
| 0.05 | 1662.78 |



saturation point 大約在 injection rate 為 0.03 的時候。

Exercise 4

buffer_depth: 2

Total energy (J): 1.37358e-06

% Dynamic energy (J): 1.34331e-07

% Static energy (J): 1.23925e-06

buffer_depth: 4

Total energy (J): 2.11667e-06

% Dynamic energy (J): 1.41415e-07

% Static energy (J): 1.97525e-06

buffer_depth: 8

Total energy (J): 2.17037e-06

% Dynamic energy (J): 1.71122e-07

% Static energy (J): 1.99925e-06

buffer_depth: 16

Total energy (J): 3.87253e-06

% Dynamic energy (J): 2.2528e-07

% Static energy (J): 3.64725e-06

buffer_depth: 32

Total energy (J): 9.23416e-06

% Dynamic energy (J): 3.54904e-07

% Static energy (J): 8.87925e-06

當 buffer_depth 增加，我們可以發現消耗的 energy 也會跟著增加，這是因為當 buffer_depth 增加，硬體需要更多的記憶單元來存儲數據，當有更多的記憶單元，就需要更多的 power 以維持其狀態，這就會導致 Static Energy 增加。