

# AI+X: Report 3

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September 7, 2025

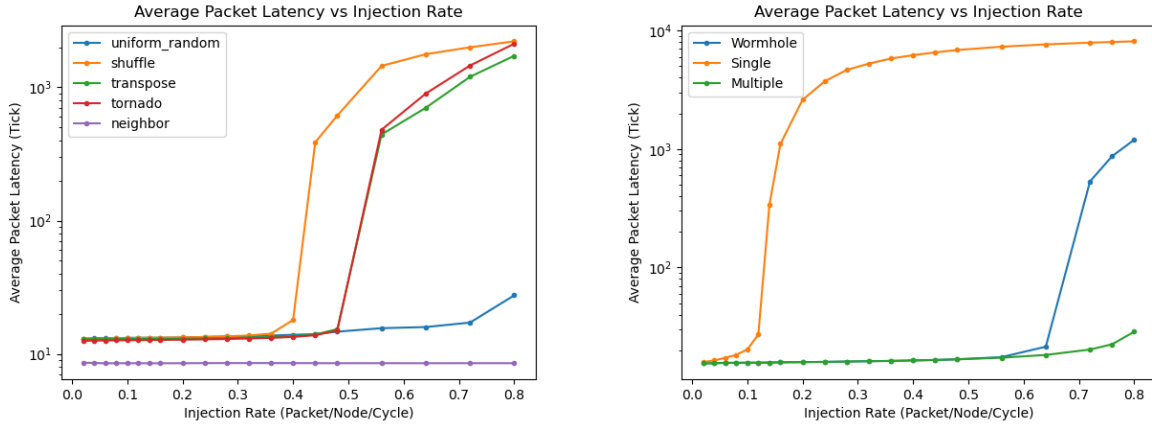


Figure 1: Average packet latency vs. injection rate

## Task 1

We've implemented a simple minimal routing algorithm for a ring topology (which is not deadlock-free). As shown in figure, structured synthetic traffics such as tornado are more likely to cause deadlocks, hence lower congestion points.

## Task 2

As shown in figure, using wormhole far improves the performance of a single virtual channel. However, wormhole doesn't perform as well as the same capacity of virtual channels. This is because wormhole requires all flits in a packet to be sent in order, which may cause blocking if the head flit is blocked. On the other hand, virtual channels can send flits from different packets in an interleaved manner, which improves the overall throughput.

An interesting observation: wormhole performs as well as 4 virtual channels.

## Appendix

```
1  #!/bin/bash
2
3  NUM_CPUS=16
4  SIM_CYCLES=10000
5
6  echo > network_stats.txt
7
8  for SYNTH in uniform_random
9  do
10     echo "SYNTHETIC TRAFFIC: $SYNTH" >> network_stats.txt
11     for INJ_RATE in 0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.20 0.24 0.28 0.32 0.40
12         0.48 0.56 0.64 0.72 0.80
13     do
14         ./build/NULL/gem5.opt \
15         configs/example/garnet_synth_traffic.py \
16         --network=garnet --num-cpus=$NUM_CPUS --num-dirs=64 \
17         --topology=Ring --routing-algorithm=3\
18         --inj-vnet=0 --vcs-per-vnet=2 --synthetic=$SYNTH \
19         --sim-cycles=$SIM_CYCLES --injectionrate=$INJ_RATE
20         INJ_TOT=$(grep -Eo "packets_injected::total\s*[0-9.]*" m5out/stats.txt |
21             grep -Eo "[0-9.]*")
22         RECV_TOT=$(grep -Eo "packets_received::total\s*[0-9.]*" m5out/stats.txt |
23             grep -Eo "[0-9.]*")
24         RECV_RATE=$(echo "scale=6;$RECV_TOT/$NUM_CPUS/$SIM_CYCLES" | bc)
25         AVG_PKT_QUEUE_LATENCY=$(grep -Eo "average_packet_queueing_latency\s*[0-9.]*"
26             m5out/stats.txt | grep -Eo "[0-9.]*")
27         AVG_PKT_NETWK_LATENCY=$(grep -Eo "average_packet_network_latency\s*[0-9.]*"
28             m5out/stats.txt | grep -Eo "[0-9.]*")
29         AVG_PKT_LATENCY=$(grep -Eo "average_packet_latency\s*[0-9.]*" m5out/stats.
30             txt | grep -Eo "[0-9.]*")
31         AVG_HOPS=$(grep -Eo "average_hops\s*[0-9.]*" m5out/stats.txt | grep -Eo "
32             [0-9.]*")
33         echo "[$INJ_RATE, $INJ_TOT, $RECV_TOT, $RECV_RATE, $AVG_PKT_QUEUE_LATENCY,
34             $AVG_PKT_NETWK_LATENCY, $AVG_PKT_LATENCY, $AVG_HOPS]" >> network_stats.
35             txt
36     done
37     echo >> network_stats.txt
38 done
39
40 python3 plot.py
41
42 NUM_CPUS=64
43
44 echo > network_stats.txt
45 echo "VC TYPE: Wormhole" >> network_stats.txt
46 for INJ_RATE in 0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.20 0.24 0.28 0.32 0.40 0.48 0.56
47     0.64 0.72 0.80
48 do
49     ./build/NULL/gem5.opt \
50     configs/example/garnet_synth_traffic.py \
```

```

41     --network=garnet --num-cpus=$NUM_CPUS --num-dirs=64 \
42     --topology=Mesh_XY --mesh-rows=8 \
43     --inj-vnet=0 --synthetic=uniform_random \
44     --sim-cycles=$SIM_CYCLES --injectionrate=$INJ_RATE --wormhole
45     INJ_TOT=$(grep -Eo "packets_injected::total\s*[0-9.]*" m5out/stats.txt |
46         grep -Eo "[0-9.]*")
47     RECV_TOT=$(grep -Eo "packets_received::total\s*[0-9.]*" m5out/stats.txt |
48         grep -Eo "[0-9.]*")
49     RECV_RATE=$(echo "scale=6;$RECV_TOT/$NUM_CPUS/$SIM_CYCLES" | bc)
50     AVG_PKT_QUEUE_LATENCY=$(grep -Eo "average_packet_queueing_latency\s*[0-9.]*"
51         m5out/stats.txt | grep -Eo "[0-9.]*")
52     AVG_PKT_NETWK_LATENCY=$(grep -Eo "average_packet_network_latency\s*[0-9.]*"
53         m5out/stats.txt | grep -Eo "[0-9.]*")
54     AVG_PKT_LATENCY=$(grep -Eo "average_packet_latency\s*[0-9.]*" m5out/stats.
55         txt | grep -Eo "[0-9.]*")
56     AVG_HOPS=$(grep -Eo "average_hops\s*[0-9.]*" m5out/stats.txt | grep -Eo "
57         [0-9.]*")
58     echo "[$INJ_RATE, $INJ_TOT, $RECV_TOT, $RECV_RATE, $AVG_PKT_QUEUE_LATENCY,
59         $AVG_PKT_NETWK_LATENCY, $AVG_PKT_LATENCY, $AVG_HOPS]" >> network_stats.
60         txt
61 done
62 echo >> network_stats.txt
63
64 echo "VC TYPE: Single" >> network_stats.txt
65 for INJ_RATE in 0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.20 0.24 0.28 0.32 0.40 0.48 0.56
66     0.64 0.72 0.80
67 do
68     ./build/NULL/gem5.opt \
69     configs/example/garnet_synth_traffic.py \
70     --network=garnet --num-cpus=$NUM_CPUS --num-dirs=64 \
71     --topology=Mesh_XY --mesh-rows=8 \
72     --inj-vnet=0 --synthetic=uniform_random \
73     --sim-cycles=$SIM_CYCLES --injectionrate=$INJ_RATE --vcs-per-vnet=1
74     INJ_TOT=$(grep -Eo "packets_injected::total\s*[0-9.]*" m5out/stats.txt |
75         grep -Eo "[0-9.]*")
76     RECV_TOT=$(grep -Eo "packets_received::total\s*[0-9.]*" m5out/stats.txt |
77         grep -Eo "[0-9.]*")
78     RECV_RATE=$(echo "scale=6;$RECV_TOT/$NUM_CPUS/$SIM_CYCLES" | bc)
79     AVG_PKT_QUEUE_LATENCY=$(grep -Eo "average_packet_queueing_latency\s*[0-9.]*"
80         m5out/stats.txt | grep -Eo "[0-9.]*")
81     AVG_PKT_NETWK_LATENCY=$(grep -Eo "average_packet_network_latency\s*[0-9.]*"
82         m5out/stats.txt | grep -Eo "[0-9.]*")
83     AVG_PKT_LATENCY=$(grep -Eo "average_packet_latency\s*[0-9.]*" m5out/stats.
84         txt | grep -Eo "[0-9.]*")
85     AVG_HOPS=$(grep -Eo "average_hops\s*[0-9.]*" m5out/stats.txt | grep -Eo "
86         [0-9.]*")
87     echo "[$INJ_RATE, $INJ_TOT, $RECV_TOT, $RECV_RATE, $AVG_PKT_QUEUE_LATENCY,
88         $AVG_PKT_NETWK_LATENCY, $AVG_PKT_LATENCY, $AVG_HOPS]" >> network_stats.
89         txt
90 done
91 echo >> network_stats.txt

```

```

76
77
78 echo "VC TYPE: Multiple" >> network_stats.txt
79 for INJ_RATE in 0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.20 0.24 0.28 0.32 0.40 0.48 0.56
80     0.64 0.72 0.80
81     do
82         ./build/NULL/gem5.opt \
83         configs/example/garnet_synth_traffic.py \
84         --network=garnet --num-cpus=$NUM_CPUS --num-dirs=64 \
85         --topology=Mesh_XY --mesh-rows=8 \
86         --inj-vnet=0 --synthetic=uniform_random \
87         --sim-cycles=$SIM_CYCLES --injectionrate=$INJ_RATE --vcs-per-vnet=16
88         INJ_TOT=$(grep -Eo "packets_injected::total\s*[0-9.]*" m5out/stats.txt |
89             grep -Eo "[0-9.]*")
90         RECV_TOT=$(grep -Eo "packets_received::total\s*[0-9.]*" m5out/stats.txt |
91             grep -Eo "[0-9.]*")
92         RECV_RATE=$(echo "scale=6;$RECV_TOT/$NUM_CPUS/$SIM_CYCLES" | bc)
93         AVG_PKT_QUEUE_LATENCY=$(grep -Eo "average_packet_queueing_latency\s*[0-9.]*"
94             m5out/stats.txt | grep -Eo "[0-9.]*")
95         AVG_PKT_NETWK_LATENCY=$(grep -Eo "average_packet_network_latency\s*[0-9.]*"
96             m5out/stats.txt | grep -Eo "[0-9.]*")
97         AVG_PKT_LATENCY=$(grep -Eo "average_packet_latency\s*[0-9.]*" m5out/stats.
98             txt | grep -Eo "[0-9.]*")
99         AVG_HOPS=$(grep -Eo "average_hops\s*[0-9.]*" m5out/stats.txt | grep -Eo "
100             [0-9.]*")
101         echo "[$INJ_RATE, $INJ_TOT, $RECV_TOT, $RECV_RATE, $AVG_PKT_QUEUE_LATENCY,
102             $AVG_PKT_NETWK_LATENCY, $AVG_PKT_LATENCY, $AVG_HOPS]" >> network_stats.
103             txt
104     done
105 echo >> network_stats.txt
106
107 python3 plot.py

```