AI+X: Report 2

Hanxi Lin

September 7, 2025

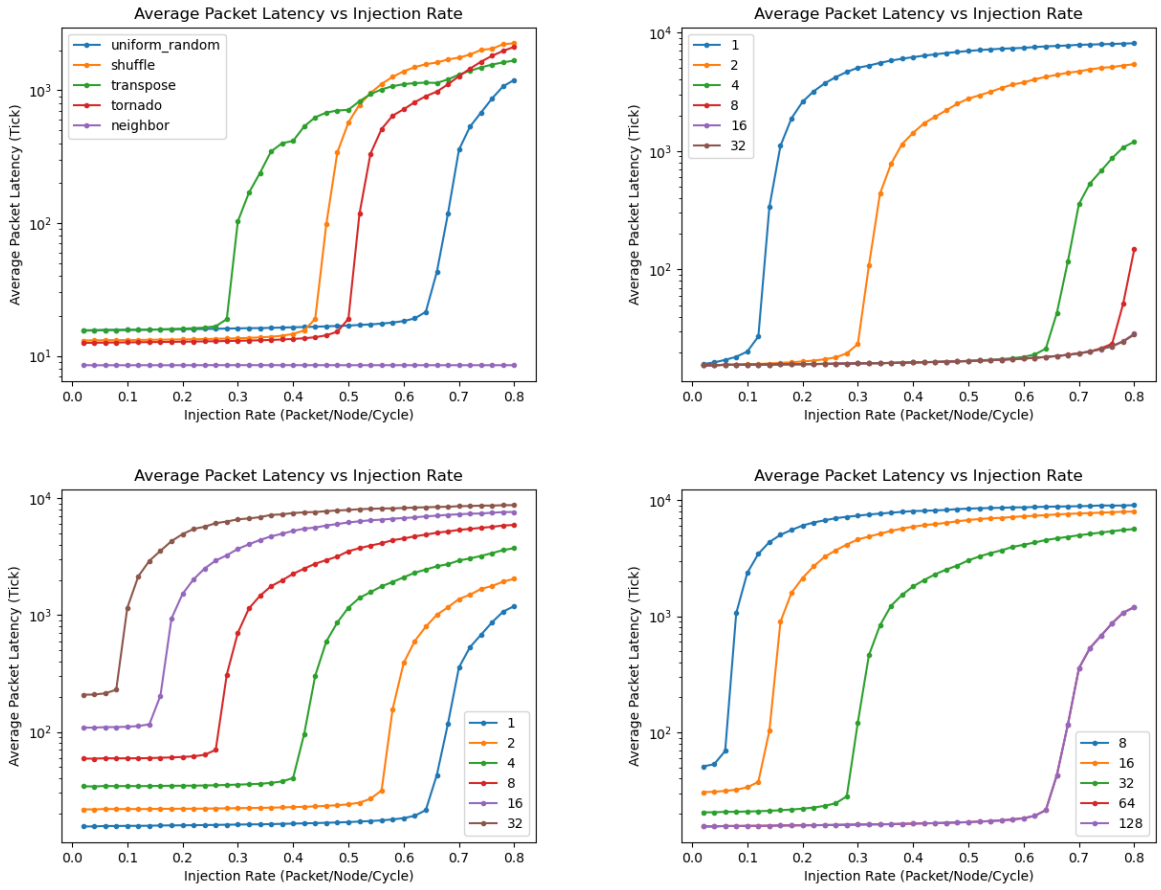

Figure 1: Average Packet Latency vs. Injection Rate under different configurations

Task 1&2

By running the shell script in appendix, we generated the four figures above.

- **SYNTHETIC TRAFFIC**: As figure 1 shows, when the injection rate is low, the average packet latency is dominated by the network latency, which is highly correlated to the average hops.

Appendix

```
#! /bin/bash

NUM_CPUS=64
SIM_CYCLES=10000

echo > network_stats.txt

for SYNTH in uniform_random shuffle transpose tornado neighbor
do
        echo "SYNTHETIC TRAFFIC: $SYNTH" >> network_stats.txt
        for INJ_RATE in 0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.18 0.20 0.22 0.24 0.26
            0.28 0.30 0.32 0.34 0.36 0.38 0.40 0.42 0.44 0.46 0.48 0.50 0.52 0.54 0.56 0.58
            0.60 0.62 0.64 0.66 0.68 0.70 0.72 0.74 0.76 0.78 0.80
        do
                ./build/NULL/gem5.opt \
                configs/example/garnet_synth_traffic.py \
                --network=garnet --num-cpus=$NUM_CPUS --num-dirs=64 \
                --topology=Mesh_XY --mesh-rows=8 \
                --inj-vnet=0 --synthetic=$SYNTH \
                --sim-cycles=$SIM_CYCLES --injectionrate=$INJ_RATE
                INJ_TOT=$(grep -Eo "packets_injected::total\s*[0-9.]*" m5out/stats.txt |
                    grep -Eo "[0-9.]*")
                RECV_TOT=$(grep -Eo "packets_received::total\s*[0-9.]*" m5out/stats.txt |
                    grep -Eo "[0-9.]*")
                RECV_RATE=$(echo "scale=6;$RECV_TOT/$NUM_CPUS/$SIM_CYCLES" | bc)
                AVG_PKT_QUEUE_LATENCY=$(grep -Eo "average_packet_queueing_latency\s*[0-9.]*"
                     m5out/stats.txt | grep -Eo "[0-9.]*")
                AVG_PKT_NETWK_LATENCY=$(grep -Eo "average_packet_network_latency\s*[0-9.]*"
                    m5out/stats.txt | grep -Eo "[0-9.]*")
                AVG_PKT_LATENCY=$(grep -Eo "average_packet_latency\s*[0-9.]*" m5out/stats.
                    txt | grep -Eo "[0-9.]*")
                AVG_HOPS=$(grep -Eo "average_hops\s*[0-9.]*" m5out/stats.txt | grep -Eo "
                    [0-9.]*")
                echo "[$INJ_RATE, $INJ_TOT, $RECV_TOT, $RECV_RATE, $AVG_PKT_QUEUE_LATENCY,
                    $AVG_PKT_NETWK_LATENCY, $AVG_PKT_LATENCY, $AVG_HOPS]" >> network_stats.
                    txt
        done
        echo >> network_stats.txt
done

python3 plot.py

echo > network_stats.txt

for VCS_PER_VNET in 1 2 4 8 16 32
```

```
do
        echo "VCS PER VNET: $VCS_PER_VNET" >> network_stats.txt
        for INJ_RATE in 0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.18 0.20 0.22 0.24 0.26
            0.28 0.30 0.32 0.34 0.36 0.38 0.40 0.42 0.44 0.46 0.48 0.50 0.52 0.54 0.56 0.58
            0.60 0.62 0.64 0.66 0.68 0.70 0.72 0.74 0.76 0.78 0.80
        do
                ./build/NULL/gem5.opt \
                configs/example/garnet_synth_traffic.py \
                --network=garnet --num-cpus=$NUM_CPUS --num-dirs=64 \
                --topology=Mesh_XY --mesh-rows=8 --vcs-per-vnet=$VCS_PER_VNET\
                --inj-vnet=0 --synthetic=uniform_random \
                --sim-cycles=$SIM_CYCLES --injectionrate=$INJ_RATE
                INJ_TOT=$(grep -Eo "packets_injected::total\s*[0-9.]*" m5out/stats.txt |
                    grep -Eo "[0-9.]*")
                RECV_TOT=$(grep -Eo "packets_received::total\s*[0-9.]*" m5out/stats.txt |
                    grep -Eo "[0-9.]*")
                RECV_RATE=$(echo "scale=6;$RECV_TOT/$NUM_CPUS/$SIM_CYCLES" | bc)
                AVG_PKT_QUEUE_LATENCY=$(grep -Eo "average_packet_queueing_latency\s*[0-9.]*"
                     m5out/stats.txt | grep -Eo "[0-9.]*")
                AVG_PKT_NETWK_LATENCY=$(grep -Eo "average_packet_network_latency\s*[0-9.]*"
                    m5out/stats.txt | grep -Eo "[0-9.]*")
                AVG_PKT_LATENCY=$(grep -Eo "average_packet_latency\s*[0-9.]*" m5out/stats.
                    txt | grep -Eo "[0-9.]*")
                AVG_HOPS=$(grep -Eo "average_hops\s*[0-9.]*" m5out/stats.txt | grep -Eo "
                    [0-9.]*")
                echo "[$INJ_RATE, $INJ_TOT, $RECV_TOT, $RECV_RATE, $AVG_PKT_QUEUE_LATENCY,
                    $AVG_PKT_NETWK_LATENCY, $AVG_PKT_LATENCY, $AVG_HOPS]" >> network_stats.
                    txt
        done
        echo >> network_stats.txt
done

python3 plot.py

echo > network_stats.txt

for ROUTER_LATENCY in 1 2 4 8 16 32
do
        echo "ROUTER LATENCY: $ROUTER_LATENCY" >> network_stats.txt
        for INJ_RATE in 0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.18 0.20 0.22 0.24 0.26
            0.28 0.30 0.32 0.34 0.36 0.38 0.40 0.42 0.44 0.46 0.48 0.50 0.52 0.54 0.56 0.58
            0.60 0.62 0.64 0.66 0.68 0.70 0.72 0.74 0.76 0.78 0.80
        do
                ./build/NULL/gem5.opt \
                configs/example/garnet_synth_traffic.py \
                --network=garnet --num-cpus=$NUM_CPUS --num-dirs=64 \
                --topology=Mesh_XY --mesh-rows=8 --router-latency=$ROUTER_LATENCY\
                --inj-vnet=0 --synthetic=uniform_random \
                --sim-cycles=$SIM_CYCLES --injectionrate=$INJ_RATE
                INJ_TOT=$(grep -Eo "packets_injected::total\s*[0-9.]*" m5out/stats.txt |
                    grep -Eo "[0-9.]*")
                RECV_TOT=$(grep -Eo "packets_received::total\s*[0-9.]*" m5out/stats.txt |
```

```
                    grep -Eo "[0-9.]*")
                RECV_RATE=$(echo "scale=6;$RECV_TOT/$NUM_CPUS/$SIM_CYCLES" | bc)
                AVG_PKT_QUEUE_LATENCY=$(grep -Eo "average_packet_queueing_latency\s*[0-9.]*"
                     m5out/stats.txt | grep -Eo "[0-9.]*")
                AVG_PKT_NETWK_LATENCY=$(grep -Eo "average_packet_network_latency\s*[0-9.]*"
                    m5out/stats.txt | grep -Eo "[0-9.]*")
                AVG_PKT_LATENCY=$(grep -Eo "average_packet_latency\s*[0-9.]*" m5out/stats.
                    txt | grep -Eo "[0-9.]*")
                AVG_HOPS=$(grep -Eo "average_hops\s*[0-9.]*" m5out/stats.txt | grep -Eo "
                    [0-9.]*")
                echo "[$INJ_RATE, $INJ_TOT, $RECV_TOT, $RECV_RATE, $AVG_PKT_QUEUE_LATENCY,
                    $AVG_PKT_NETWK_LATENCY, $AVG_PKT_LATENCY, $AVG_HOPS]" >> network_stats.
                    txt
        done
        echo >> network_stats.txt
done

python3 plot.py

echo > network_stats.txt

for LINK_WIDTH_BITS in 8 16 32 64 128
do
        echo "LINK WIDTH BITS: $LINK_WIDTH_BITS" >> network_stats.txt
        for INJ_RATE in 0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.18 0.20 0.22 0.24 0.26
            0.28 0.30 0.32 0.34 0.36 0.38 0.40 0.42 0.44 0.46 0.48 0.50 0.52 0.54 0.56 0.58
            0.60 0.62 0.64 0.66 0.68 0.70 0.72 0.74 0.76 0.78 0.80
        do
                ./build/NULL/gem5.opt \
                configs/example/garnet_synth_traffic.py \
                --network=garnet --num-cpus=$NUM_CPUS --num-dirs=64 \
                --topology=Mesh_XY --mesh-rows=8 --link-width-bits=$LINK_WIDTH_BITS\
                --inj-vnet=0 --synthetic=uniform_random \
                --sim-cycles=$SIM_CYCLES --injectionrate=$INJ_RATE
                INJ_TOT=$(grep -Eo "packets_injected::total\s*[0-9.]*" m5out/stats.txt |
                    grep -Eo "[0-9.]*")
                RECV_TOT=$(grep -Eo "packets_received::total\s*[0-9.]*" m5out/stats.txt |
                    grep -Eo "[0-9.]*")
                RECV_RATE=$(echo "scale=6;$RECV_TOT/$NUM_CPUS/$SIM_CYCLES" | bc)
                AVG_PKT_QUEUE_LATENCY=$(grep -Eo "average_packet_queueing_latency\s*[0-9.]*"
                     m5out/stats.txt | grep -Eo "[0-9.]*")
                AVG_PKT_NETWK_LATENCY=$(grep -Eo "average_packet_network_latency\s*[0-9.]*"
                    m5out/stats.txt | grep -Eo "[0-9.]*")
                AVG_PKT_LATENCY=$(grep -Eo "average_packet_latency\s*[0-9.]*" m5out/stats.
                    txt | grep -Eo "[0-9.]*")
                AVG_HOPS=$(grep -Eo "average_hops\s*[0-9.]*" m5out/stats.txt | grep -Eo "
                    [0-9.]*")
                echo "[$INJ_RATE, $INJ_TOT, $RECV_TOT, $RECV_RATE, $AVG_PKT_QUEUE_LATENCY,
                    $AVG_PKT_NETWK_LATENCY, $AVG_PKT_LATENCY, $AVG_HOPS]" >> network_stats.
                    txt
        done
        echo >> network_stats.txt
```

```
done

python3 plot.py
```