AI+X: Report 3

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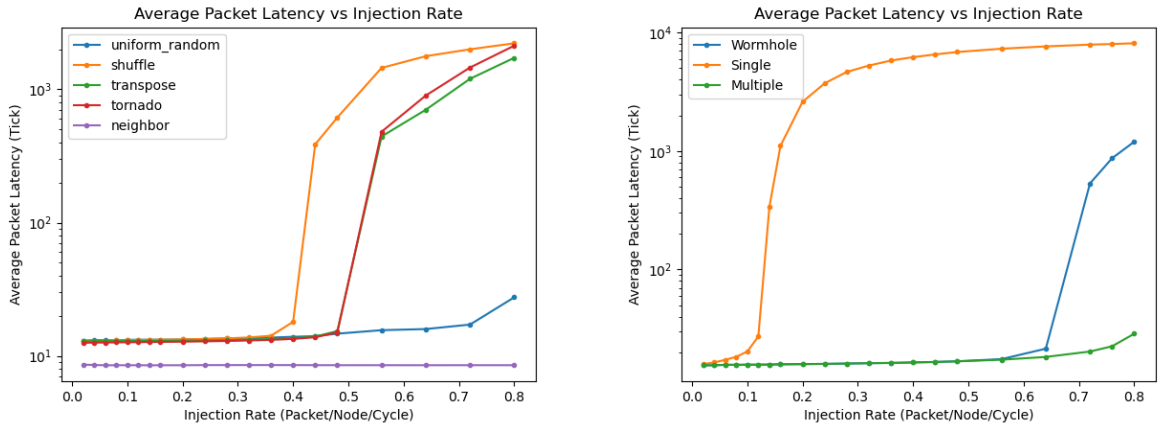

Figure 1: Average packet latency vs. injection rate

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

```
#! /bin/bash

NUM_CPUS=16
SIM_CYCLES=10000

echo > network_stats.txt

for SYNTH in uniform_random
do
        echo "SYNTHETIC TRAFFIC: $SYNTH" >> network_stats.txt
        for INJ_RATE in 0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.20 0.24 0.28 0.32 0.40
            0.48 0.56 0.64 0.72 0.80
        do
                ./build/NULL/gem5.opt \
                configs/example/garnet_synth_traffic.py \
                --network=garnet --num-cpus=$NUM_CPUS --num-dirs=64 \
                --topology=Ring --routing-algorithm=3\
                --inj-vnet=0 --vcs-per-vnet=2 --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

NUM_CPUS=64

echo > network_stats.txt
echo "VC TYPE: Wormhole" >> network_stats.txt
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
    0.64 0.72 0.80
        do
                ./build/NULL/gem5.opt \
                configs/example/garnet_synth_traffic.py \
```

```
                --network=garnet --num-cpus=$NUM_CPUS --num-dirs=64 \
                --topology=Mesh_XY --mesh-rows=8 \
                --inj-vnet=0 --synthetic=uniform_random \
                --sim-cycles=$SIM_CYCLES --injectionrate=$INJ_RATE --wormhole
                INJ_TOT=$(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


echo "VC TYPE: Single" >> network_stats.txt
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
    0.64 0.72 0.80
        do
                ./build/NULL/gem5.opt \
                configs/example/garnet_synth_traffic.py \
                --network=garnet --num-cpus=$NUM_CPUS --num-dirs=64 \
                --topology=Mesh_XY --mesh-rows=8 \
                --inj-vnet=0 --synthetic=uniform_random \
                --sim-cycles=$SIM_CYCLES --injectionrate=$INJ_RATE --vcs-per-vnet=1
                INJ_TOT=$(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
```

```
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
        0.64 0.72 0.80
80          do
81                  ./build/NULL/gem5.opt \
82                  configs/example/garnet_synth_traffic.py \
83                  --network=garnet --num-cpus=$NUM_CPUS --num-dirs=64 \
84                  --topology=Mesh_XY --mesh-rows=8 \
85                  --inj-vnet=0 --synthetic=uniform_random \
86                  --sim-cycles=$SIM_CYCLES --injectionrate=$INJ_RATE --vcs-per-vnet=16
87                  INJ_TOT=$(grep -Eo "packets_injected::total\s*[0-9.]*" m5out/stats.txt |
                        grep -Eo "[0-9.]*")
88                  RECV_TOT=$(grep -Eo "packets_received::total\s*[0-9.]*" m5out/stats.txt |
                        grep -Eo "[0-9.]*")
89                  RECV_RATE=$(echo "scale=6;$RECV_TOT/$NUM_CPUS/$SIM_CYCLES" | bc)
90                  AVG_PKT_QUEUE_LATENCY=$(grep -Eo "average_packet_queueing_latency\s*[0-9.]*"
                         m5out/stats.txt | grep -Eo "[0-9.]*")
91                  AVG_PKT_NETWK_LATENCY=$(grep -Eo "average_packet_network_latency\s*[0-9.]*"
                        m5out/stats.txt | grep -Eo "[0-9.]*")
92                  AVG_PKT_LATENCY=$(grep -Eo "average_packet_latency\s*[0-9.]*" m5out/stats.
                        txt | grep -Eo "[0-9.]*")
93                  AVG_HOPS=$(grep -Eo "average_hops\s*[0-9.]*" m5out/stats.txt | grep -Eo "
                        [0-9.]*")
94                  echo "[$INJ_RATE, $INJ_TOT, $RECV_TOT, $RECV_RATE, $AVG_PKT_QUEUE_LATENCY,
                        $AVG_PKT_NETWK_LATENCY, $AVG_PKT_LATENCY, $AVG_HOPS]" >> network_stats.
                        txt
95          done
96          echo >> network_stats.txt
97
98  python3 plot.py
```