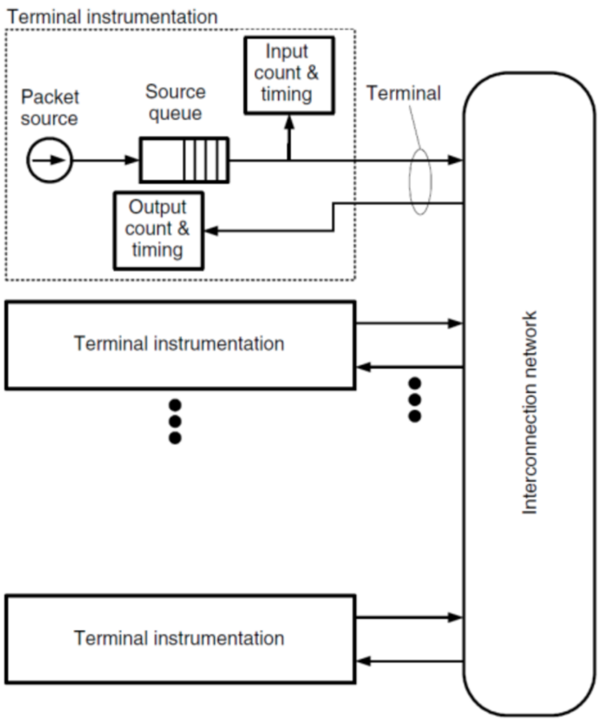
IL2236 Embedded Many-Core Architectures
Mini-Project: Network Simulation and Evaluation

The exercise covers the following topics:

- Network simulation
- Network performance evaluation

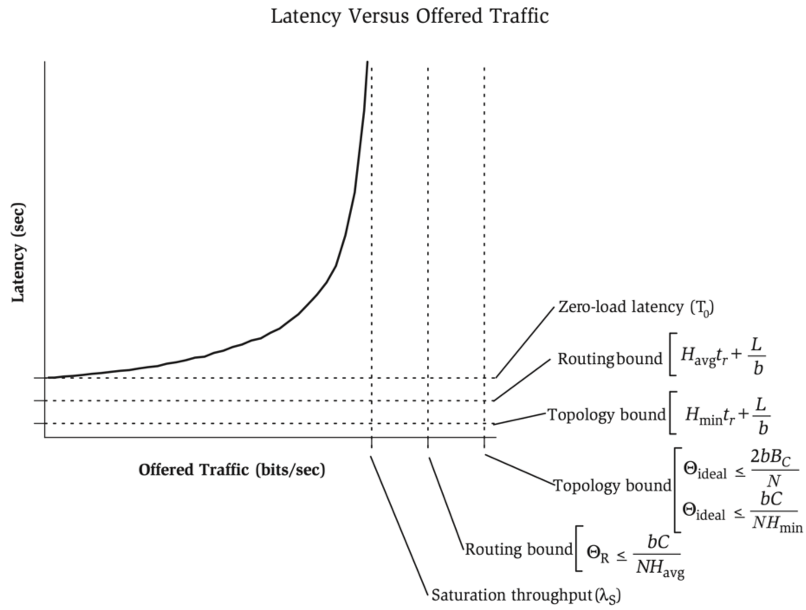
1. (Measurement setup) A student is setting up simulation environment to measure network performance. The traffic is generated synthetically. The measurement setup is illustrated below.



   The source queue has a constant size of 10k packets each. What problems you can detect from this setup? Why?

2. (Performance evaluation) Answer the following questions:

   a) Explain the differences of open-loop and closed-loop measurements.
   b) Explain why, in the open-loop measurement, during the drain phase, we need to run the network long enough for all of the measurement packets to reach their destination?
   c) Explain the throughput bounds in a general network as shown in the latency vs. offered traffic graph, specifically, why the Topology bound is larger than the routing bound, which is larger than the saturation throughput.



The following two tasks are mini-project type of exercises. You may need to study some additional materials in the course book by yourself in order to complete them.

3. (Simulator and Simulation) Download and install the simulator Booksim, http://cva.stanford.edu/books/ppin/ onto your computer. After the simulator is installed properly, we are going to **validate** the network performance graphs presented in Chapter 25 Simulation Examples of Dally and Towles' book. Some pre-study is needed along with setting up, running and understanding the experiments.

   A. The experimental setup

      1. Study Chapter 19 Allocation, in particular, 19.3 on iSLIP allocation algorithm. Explain how iSLIP algorithm works.

      2. Study the four rouging algorithms: DOR standing for dimension-order routing, ROMM for randomized minimal algorithm, VAL for Valiant's randomized algorithm, and MAD for minimal-adaptive routing algorithm. Explain the routing algorithms, namely, DOR, ROMM, VAL and MAD.

   B. Section 25.1, Routing experiments:

      1. Validate the latency performance of the four algorithms by re-producing **at least two** of the five figures, namely, Figure 25.1 and 25.2. 25.3, 25.4, and 25.5.

      2. Validate the throughput performance by re-producing Figure 23.2.

   C. Section 25.2, Flow control experiments:

      1. Understand the impact of virtual channel partitionings on network performance by re-producing Figure 25.7

      2. Understand the impact of network size on network performance by re-producing Figure 25.8

      3. Understand the impact of injection processes on network performance by re- producing Figure 25.9

(A: 2 point; B: 2 points; C: 2 points. In total, the task counts as 6 points)

4. (Simulation with BookSim) Within the Booksim simulator, make the following experimental Setup:

    - Input-queued router. Realistic pipelining is assumed and the per-hop latency of the routers is 3 cycles.
    - Virtual channel flow control. 4 virtual channels per input port, and each virtual channel contains 8 flits.
    - All packets are 12 flits in length.
    - Dimension order routing.
    - Uniform random traffic
    - Other un-mentioned router and traffic parameters are free to choose.

    Complete **at least three** of the following 5 subtasks.

    A. (Queuing latency vs. network latency) simulate a 6x6 mesh network, a 6x6 torus network. Draw average latency vs. offered traffic graphs, one with queuing latency, and the other without queuing latency.

    B. (Latency histogram) Draw latency histogram when offered traffic is at 30% of network capacity for the simulations in A). Please note that the maximum offered traffic is equivalent to ideal throughput which you can calculate.

    C. (Latency distribution) Draw per-node average latency as bar diagram (one bar for one node) for the 6x6 mesh and 6x6 torus networks in A).

    D. (Throughput distribution) Draw per-node throughput as bar diagram (one bar for one node) for the 6x6 mesh and 6x6 torus networks in A).

    E. (Scalability of mesh vs. torus) Simulate mesh and torus networks with the following sizes: 2x2, 4x4, 6x6, 8x8, 10x10. Design your own figures to illustrate the performance differences (average latency, maximum latency, saturation throughput) of the two types of networks. Which network is more scalable? Why?

    (Each subtask is worth 2 points. In total, the task counts 6 points.)

    Each group will need to submit **One** report for their mini-project. In your report, you shall answer the questions, report your results, and more importantly, **give explanations for the figures** you obtain from your simulations. Often, discussions on the results are expected.

    Note that, in your report, for each simulation task and figure, you need to indicate the reference figure number on the book. Then we know which figure/task you are reproducing.