CS3120 Introduction of Integrated Circuit Design

Homework 3: NoC Simulator

Due Date: 2024/12/22 (Sun) 23:59:59

- Version: 20241128

I. Background

Modern systems-on-chip (SoCs) often integrate a large number of processing cores, memory modules, and specialized accelerators. As the number of components grows, efficient communication between them becomes a critical challenge. Traditional interconnection methods, such as point-to-point connections and shared-bus architectures, struggle to scale effectively. Point-to-point connections require dedicated wires for each pair of components, leading to significant design complexity, high area overhead, and excessive power consumption as the number of connections grows quadratically. Shared-bus architectures, while simpler, suffer from high latency and limited bandwidth due to contention when multiple components attempt to access the bus simultaneously. To address these scalability and efficiency issues, Network-on-Chip (NoC) has emerged as a scalable and modular interconnect solution for multicore processors and heterogeneous SoCs.

II. Description

In this homework, you are asked to use noxim, which is designed to simulate and analyze the communication behavior of Network-on-Chip (NoC) architecture. The goal of this assignment is to familiarize you with the noxim simulator and help you understand the fundamental concepts of NoC.

Please follow the instructions below to complete this homework.

Step 1. Unzip the `VLSI_HW3.zip` by using the following command:

```
$ unzip VLSI_HW3.zip
```

Step 2. A directory named `noxim` will be generated. Then, use the following command to go into the directory.

```
$ cd noxim
```

Its structure will look like this:

```
noxim/
├─ bin/              # The executable and simulation-related files
├─ config_examples/  # Example configuration files (YAML format)
├─ other/            # Deprecated or experimental files
├─ src/              # source code
```

The directories `bin/` and `config_examples/` are the most important for this assignment. The `bin/` directory contains the executable file, and simulation results and logs are typically generated here. Meanwhile, `config_examples/` contains example configuration files in YAML format, which defines the parameters for the simulation. You can try different configuration files or customize them to explore different scenarios and analyze their impact on network performance.

Step 3. An executable `noxim` is under `bin/`. Go under the folder and change the access permission of the compiled executable by using:

```
$ cd bin
$ chmod 777 ./noxim
```

Step 4. Now, we can start conducting some experiments. First, let's try a quick simulation using the following command:

```
$ ./noxim -config ../config_examples/default_config.yaml
```

Step 5. Check the output result. What do the following terms mean?

[Exercise 1]

Report your output result by screenshots and explain the following terms (including how they are calculated) in the output result.

- Total Received Flit
- Total Received Packet
- Global Average Delay
- Network throughput
- Average IP throughput

Step 6. See the comment for parameter description in `default_config.yaml`.

[Exercise 2]

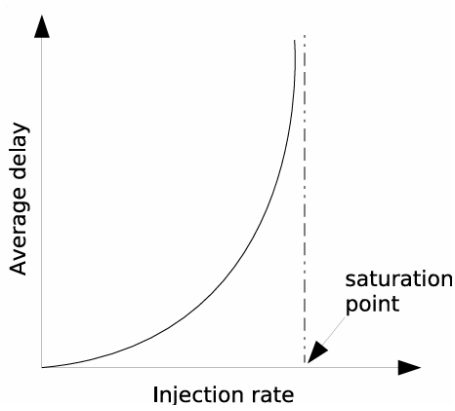
Create a `my_config.yaml` (from `default_config.yaml`), change modify some parameters and re-run the simulation by using:

```
$ ./noxim -config ../config_examples/my_config.yaml
```

Now, monitor the effect, and see how the following parameters will affect the output result mentioned in Exercise 1. Please also explain the reason.

- packet_size (min & max)
- packet_injection_rate
- simulation_time

Step 7. Theoretically, higher packet injection rate (PIR) will cause higher average delay as shown in the following figure. As the packet injection rate gets higher, it may reach its **saturation point**, which implies the congestion happens.



[Exercise 3]

The quality of a NoC can be measured by its saturation point. Plot the curve showing the relationship between PIR and average delay and indicate the saturation point.

Step 8.

[Exercise 4]

Try to find the optimal power configuration. You can plot figures showing the relationship between your selected parameters and energy to demonstrate the effect. And please also explain the reason of the phenomenon.

IV. Submission Requirement

You have to submit a report named StudID_Name_HW3_report.pdf (e.g., 9862534_陳聿廣_HW3_report.pdf), which contains all the exercises with **exercises' titles and your answers**. Note that the only acceptable report file format is .pdf, no .doc/.docx or other files are acceptable.

- Be sure that your answers are **clear** and **easy to follow**. The clearer and more readable your report is, the higher the score you will receive.
- Be sure to follow the **naming rule** mentioned above. Otherwise, your program will not be graded.

V. Grading

The grading is as follows:

(1) Correctness: 40% (10% for each exercise)

(2) Completeness: 40% (10% for each exercise)

(3) Readability: 20%

Please submit your assignment on time. Otherwise, the penalty rule will apply:

- Within 72hrs delay: 20% off
- More than 3 days: 0 point

If you have questions, please E-mail to both me (andyygchen@ee.ncu.edu.tw) and TA Y.T. Li (yitingli.y.t@gmail.com).