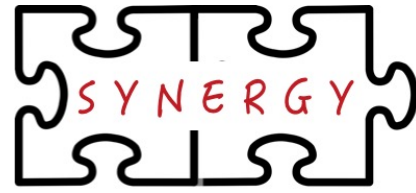




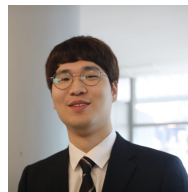
Georgia Tech School of Electrical and
Computer Engineering
College of Engineering



<http://synergy.ece.gatech.edu>



Exercise 1: Getting Started with ASTRA-sim



William Won

Ph.D. Student, School of Computer Science
Georgia Institute of Technology
william.won@gatech.edu

Acknowledgments: Srinivas Sridharan (Facebook), Sudarshan Srinivasan (Intel)

Agenda

| Time (PDT) | Topic | Presenter |
|-------------|--|-------------------------------------|
| 1:00 – 2:00 | Introduction to Distributed DL Training | Tushar Krishna |
| 2:00 – 2:20 | Challenges on Distributed Training Systems | Srinivas Sridharan |
| 2:20 – 3:30 | Introduction to ASTRA-sim simulator | Saeed Rashidi |
| 3:30 – 4:00 | Coffee Break | |
| 4:00 – 4:50 | Hands-on Exercises on Using ASTRA-sim | William Won and Taekyung Heo |
| 4:50 – 5:00 | Closing Remarks and Future Developments | Taekyung Heo |

Tutorial Website

includes agenda, slides, ASTRA-sim installation instructions (via source + docker image)

<https://astra-sim.github.io/tutorials/mlsys-2022>

Attention: Tutorial is being recorded

Objective

- Installing ASTRA-sim
 - Download
 - Compilation
- Writing Input Files
 - Network
 - System
 - Workload
- Running ASTRA-sim
 - Running ASTRA-sim
 - Understanding Results

Downloading ASTRA-sim

Prerequisite: Check installation dependencies

<https://astra-sim.github.io/tutorials/mlsys-2022/installation>

(1) Clone ASTRA-sim tutorials GitHub repository

```
$ git clone https://github.com/astra-sim/tutorials.git
```

```
$ cd tutorials/mlsys2022/
```

(2) Run setup script

```
$ ./clone_astra_sim.sh
```

Compiling ASTRA-sim

(1) Go to **Exercise 1** directory

```
$ cd exercise_1/
```

(2) Compile ASTRA-sim

```
$ ./build.sh
```

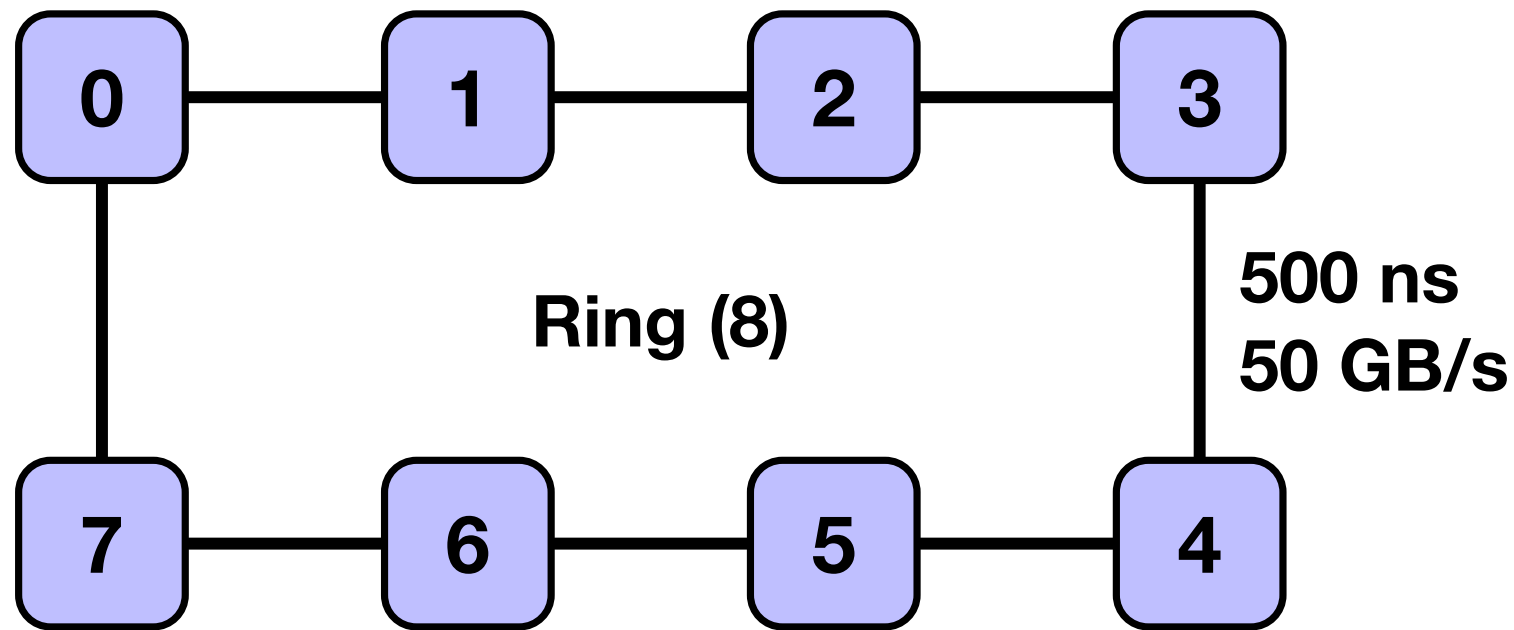
Exercise: Ring All-Reduce

Objective:

- (1) We will configure an 8-NPU Ring
- (2) And run **1 MB All-Reduce** on it

Configurations: Network

- **Ring** topology with **8 NPUs**
- **500 ns** (latency), **50 GB/s** (bandwidth)
- **2 links** per NPU



Configurations: Network

inputs/ring.json

```
{  
  "dimensions-count": 1, ← 1D network  
  "topologies-per-dim": [ "Ring" ], ← Ring topology  
  "units-count": [ 8 ], ← 8 NPUs  
  "links-count": [ 2 ], ← 2 links per NPU  
  "link-latency": [ 500 ], ← 500ns link latency  
  "link-bandwidth": [ 50 ] ← 50GB/s link bandwidth  
}
```


Configurations: System

`inputs/ring.txt`

| | | |
|--|---|--------------------------------------|
| <code>scheduling-policy: LIFO</code> | ← | LIFO chunk scheduling policy |
| <code>endpoint-delay: 10</code> | ← | 10ns delay per NPU |
| <code>active-chunks-per-dimension: 1</code> | ← | 1 active chunks |
| <code>preferred-dataset-splits: 4</code> | ← | 4 chunks per collective |
| <code>boost-mode: 1</code> | ← | fast simulation when symmetric |
| <code>all-reduce-implementation: ring</code> | ← | ring All-Reduce Algorithm |
| <code>all-gather-implementation: ring</code> | ← | ring All-Gather Algorithm |
| <code>reduce-scatter-implementation: ring</code> | ← | ring Reduce-Scatter Algorithm |
| <code>all-to-all-implementation: direct</code> | ← | direct All-to-All Algorithm |
| <code>collective-optimization: localBWAware</code> | ← | collective optimization |

Configurations: System

inputs/ring.txt

scheduling-policy: LIFO

endpoint-delay: 10

active-chunks-per-dimension: 1

preferred-dataset-splits: 4 ← 4 chunks per collective

boost-mode: 1

all-reduce-implementation: ring ← ring All-Reduce Algorithm

all-gather-implementation: ring

reduce-scatter-implementation: ring

all-to-all-implementation: direct

collective-optimization: localBWAware

Configurations: Workload

inputs/all_reduce.txt

MICRO ← training loop

1 ← #layers

allreduce -1 1 NONE 0 1 NONE 0 1 ALLREDUCE 1048576 1 ← layer data

| Metadata | | Forward | | | Input grad | | | Weight grad | | | Layer |
|------------|---------|--------------|------------|------------|--------------|------------|------------|--------------|------------|------------|-------|
| Layer Name | (rsvd.) | Compute Time | Comm. Type | Comm. size | Compute Time | Comm. Type | Comm. Size | Compute Time | Comm. Type | Comm. Size | Delay |
| allreduce | -1 | 1 | NONE | 0 | 1 | NONE | 0 | 1 | ALLREDUCE | 1048576 | 1 |

1 MB

Running ASTRA-sim

Run ASTRA-sim

```
$ ./exercise_1.sh
```

exercise_1.sh

```
"${BINARY}" \
```

| | | |
|--|---|------------------|
| <code>--run-name="Exercise 1" \</code> | ← | Run name |
| <code>--network-configuration="\${NETWORK}" \</code> | ← | Network |
| <code>--system-configuration="\${SYSTEM}" \</code> | ← | System |
| <code>--workload-configuration="\${WORKLOAD}" \</code> | ← | Workload |
| <code>--path="\${RESULT_DIR}/"</code> | ← | Result file path |

Running ASTRA-sim

45,681 ns (45.681 μ s)

```
all passes finished at time: 45681, id of first layer: allreduce
path to create csvs is: /usr/scratch/will/tutorials/asplos2022/exercise_1/result/
success in opening file
*****
Time to exit: Sun Feb 27 06:46:51 2022
all-reduce Collective implementation: ring
reduce-scatter Collective implementation: ring
all-gather Collective implementation: ring
all-to-all Collective implementation: direct
Collective optimization: localBWAware
Total sim duration: 0:0 hours
Total streams injected: 4
Total streams finished: 4
Percentage of finished streams: 100 %
*****
Exiting
```

Understanding Results

result/tutorial_result.csv

| Name | Total Time (us) | Compute Time (us) | Exposed Communication Time (us) | Total Message Size (MB) |
|------------|--------------------|----------------------|------------------------------------|----------------------------|
| Exercise 1 | 45.681 | 0 | 45.681 | 1.75 |

45.681 μ s

No compute

All communication exposed

1.75 MB/NPU

Agenda

| Time (PDT) | Topic | Presenter |
|-------------|--|------------------------------|
| 1:00 – 2:00 | Introduction to Distributed DL Training | Tushar Krishna |
| 2:00 – 2:20 | Challenges on Distributed Training Systems | Srinivas Sridharan |
| 2:20 – 3:30 | Introduction to ASTRA-sim simulator | Saeed Rashidi |
| 3:30 – 4:00 | Coffee Break | |
| 4:00 – 4:50 | Hands-on Exercises on Using ASTRA-sim | William Won and Taekyung Heo |
| 4:50 – 5:00 | Closing Remarks and Future Developments | Taekyung Heo |

Tutorial Website

includes agenda, slides, ASTRA-sim installation instructions (via source + docker image)

<https://astra-sim.github.io/tutorials/mlsys-2022>

Attention: Tutorial is being recorded