MID-SEM PROJECT

Aman Dangi (21CS01027)
Manan Khanna (21CS01028)
Shubham Kaushik (21CS01030)
Soumyabrata Chaudhuri (21CS01032)

Definitions of different warp states:

Waiting Warps: These are warps that are waiting for a specific instruction to be completed before they can proceed with their tasks. Often, they are waiting for data to be fetched from memory. To reduce waiting times, it's important to have a sufficient number of these warps active at once to effectively hide memory access delays.

Issued Warps: This category includes warps that have successfully sent an instruction to the execution pipeline. The more warps in this state, the better the overall performance because it indicates that the processor is effectively utilizing its resources.

Excess ALU (Xalu) Warps: These are warps that are ready to perform arithmetic operations but can't do so immediately because there are not enough resources available at that moment. This category shows the extra warps ready for arithmetic tasks, waiting for their turn.

Excess Memory (Xmem) Warps: These warps are ready to send instructions to the Load/Store pipeline, but they might be delayed due to memory-related issues or because the pipeline is already handling the maximum number of instructions it can manage. Xmem warps can put additional pressure on the memory subsystem of the processor.

Others: This category encompasses warps that are in a variety of states. Some are waiting for synchronization instructions, while others may not have instructions available in the instruction buffer. Their specific requirements or status may not be clear because they lack the necessary instructions or are waiting for specific synchronization events.

Modifications in Code (shadder.cu):

We have added these headers file in shadder.cu file, where we have implemented warp_counters.h by ourself

```
#include <stdio.h>
#include "../warp_counters.h"
```

Initialization of variables:

```
for (std::vector<shd_warp_t *>::const_iterator iter =
        m_next_cycle_prioritized_warps.begin();
     iter != m_next_cycle_prioritized_warps.end(); iter++) {

  //* Added ////////////////////
  totalWarps++;
static long long int count = 0;
static long long int total = 0;
static long long int totalWarps = 0;
static long long int waiting = 0;
static long long int issue = 0;
static long long int excessALU = 0;
static long long int excessMEM = 0;
static long long int others = 0;
unsigned long long warp_state_counters[NUM_COUNTERS] = {0};
```

Others: If warp_id's instruction buffer is empty or warp is waiting for synchronization then the warp comes in others category.

```
//* Added ////////////////////
if(warp(warp_id).ibuffer_empty() || warp(warp_id).waiting()){
  others++;
  // printf("Others\n");
}
}
SCHED_DPRINTF("Testing (warp_id %u, dynamic_warp_id %u)\n",
              (*iter)->get_warp_id(), (*iter)->get_dynamic_warp_id());

//* Added ////////////////////
// printf("warp_id %u\n",(*iter)->get_warp_id());
total++;
```

XMEM: Excess warps for load/store instructions fall under XMEM. Here if mem is not free then we will go in else block and excessMEM is incremented.

```
if ((pI->op == LOAD_OP) || (pI->op == STORE_OP) ||
    (pI->op == MEMORY_BARRIER_OP) ||
    (pI->op == TENSOR_CORE_LOAD_OP) ||
    (pI->op == TENSOR_CORE_STORE_OP)) {
  if (m_mem_out->has_free(m_shader->m_config->sub_core_model,
                          m_id) &&
      (!diff_exec_units ||
       previous_issued_inst_exec_type != exec_unit_type_t::MEM)) {
    m_shader->issue_warp(*m_mem_out, pI, active_mask, warp_id,
                         m_id);
    issued++;
    issued_inst = true;
    warp_inst_issued = true;
    previous_issued_inst_exec_type = exec_unit_type_t::MEM;
  } else {
    //* Added ///////////////////////
    excessMEM++;
    // printf("Excess Memory\n");
  }
```

XALU: Excess warps for arithmetic instructions fall under XALU. If resources are not available for arithmetic operation then excessALU is incremented.

```
//* Added ///////////////////////
// At the end of ALU instructions
if(!issued_inst){        // is instruction is not yet issued then XALU
  excessALU++;
  // printf("excessALU\n");
}
```

Waiting: If warp is waiting for an instruction to commit so that further depedent instructions can be issued to the pipeline are in this category.

```
//* Added ////////////////////
// Data Hazard and no control hazard
waiting++;
// printf("Waiting\n");
```

Issued: Warps that issue an instruction to the execution pipeline are accounted here.

```
if (warp_inst_issued) {
  //* Added /////////////////
  issue++;
  // printf("Issued\n");

  SCHED_DPRINTF(
      "Warp (warp_id %u, dynamic_warp_id %u) issued %u instructions\n",
      (*iter)->get_warp_id(), (*iter)->get_dynamic_warp_id(), issued);
  do_on_warp_issued(warp_id, issued, iter);
}
```

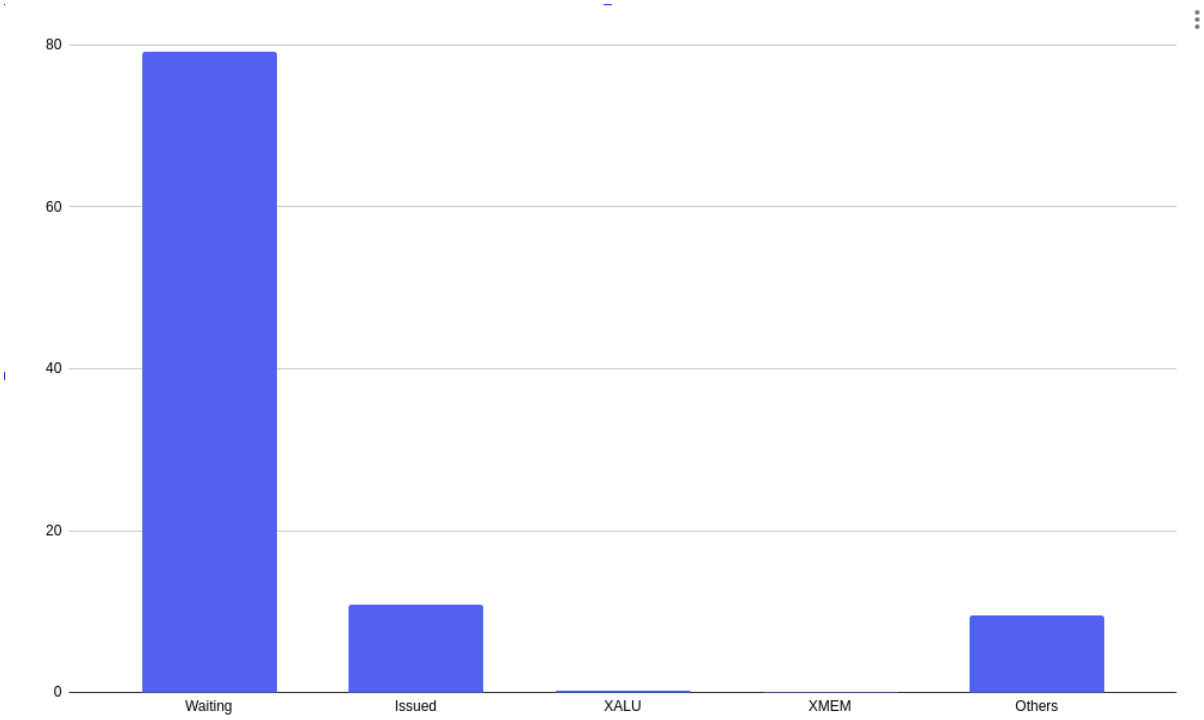
```
//* Added /////////////////
// warp_state_counters[CYCLE] = count;
warp_state_counters[TOTAL_WARPS] = totalWarps;
warp_state_counters[WARP] = total;
warp_state_counters[WAITING] = waiting;
warp_state_counters[ISSUE] = issue;
warp_state_counters[XALU] = excessALU;
warp_state_counters[XMEM] = excessMEM;
warp_state_counters[OTHERS] = others;
/* printf("total = %lld\t
          waiting = %lld\t
          issued = %lld\t
          excessALU = %lld\t
          excessMEM = %lld\t
          others = %lld\n",
          total, waiting, issue, excessALU, excessMEM, others);*/
// printf("Count of cycles = %lld\t totalWarps = %lld\n",count,totalWarps);
```

Outputs

Path Finder:

```
GPGPU-Sim: *** exit detected ***
Waiting :                    1630522
Issued:                      222776
ExcessALU:                   3574
ExcessMEM:                   3050
Others:                      195853
TotalWarpsIssued(Sum):       2055775
WARPS:                       2060344
```

Path Finder	Warp_State	Warp Count	Percentage
	Waiting	1630522	79.14
	Issued	222776	10.81
	XALU	3574	0.17
	XMEM	3050	0.15
	Others	195853	9.5

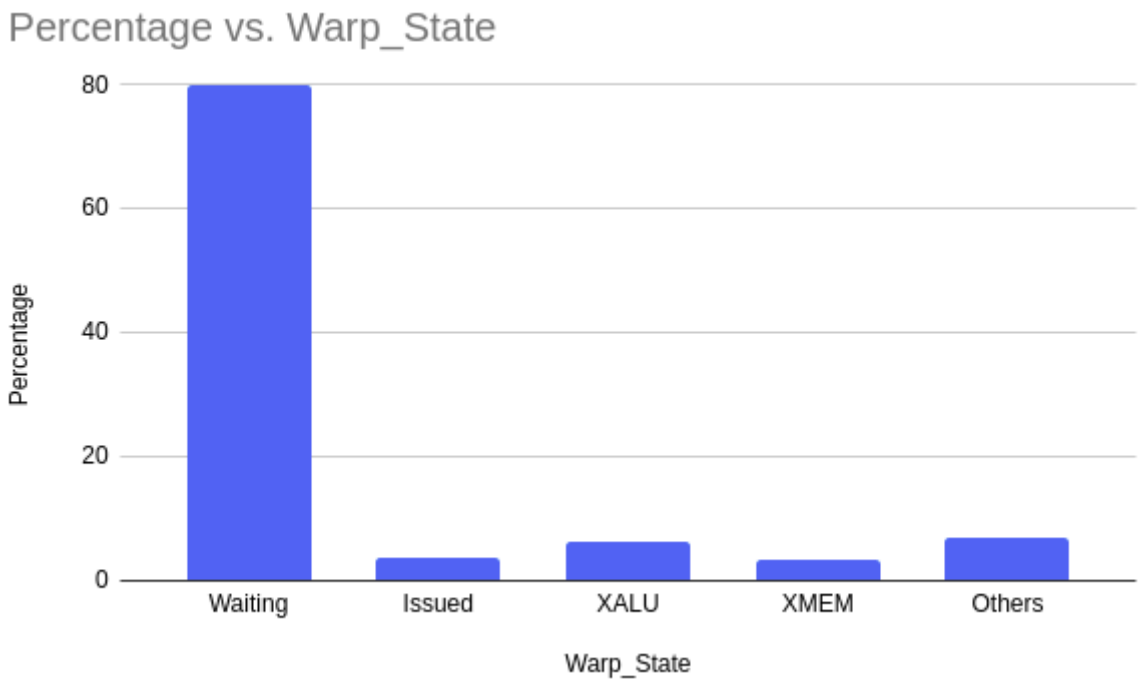


Total cycles: 79866 **Warps:** 32 **Product:** 2555712

BFS:

```
GPGPU-Sim: *** exit detected ***
Waiting :                    52058722
Issued:                      2324006
ExcessALU:                   4073334
ExcessMEM:                   2146132
Others:                      4457075
TotalWarpsIssued(Sum):       65059269
WARPS:                       65173245
```

BFS	Warp_State	Warp Count	Percentage
	Waiting	52058722	79.87
	Issued	2324006	3.56
	XALU	4073334	6.25
	XMEM	2146132	3.3
	Others	4457075	6.83

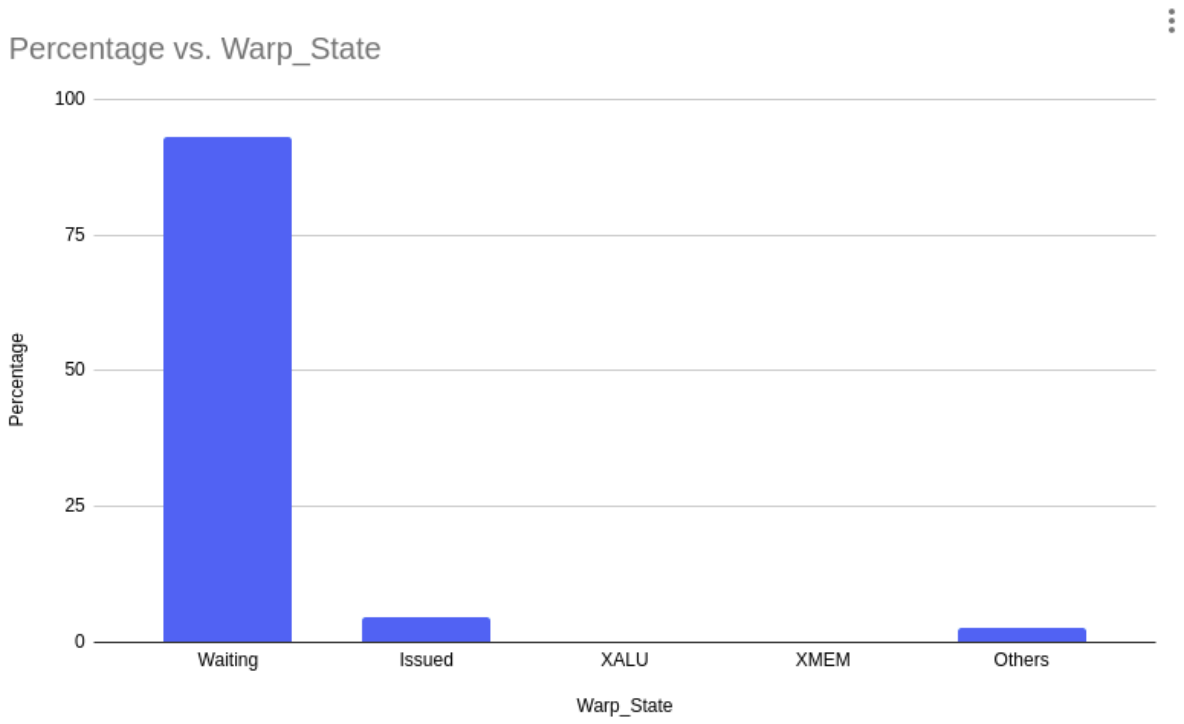


Total Cycles: 252475 **Warps:** 32 **Product:** 8079200

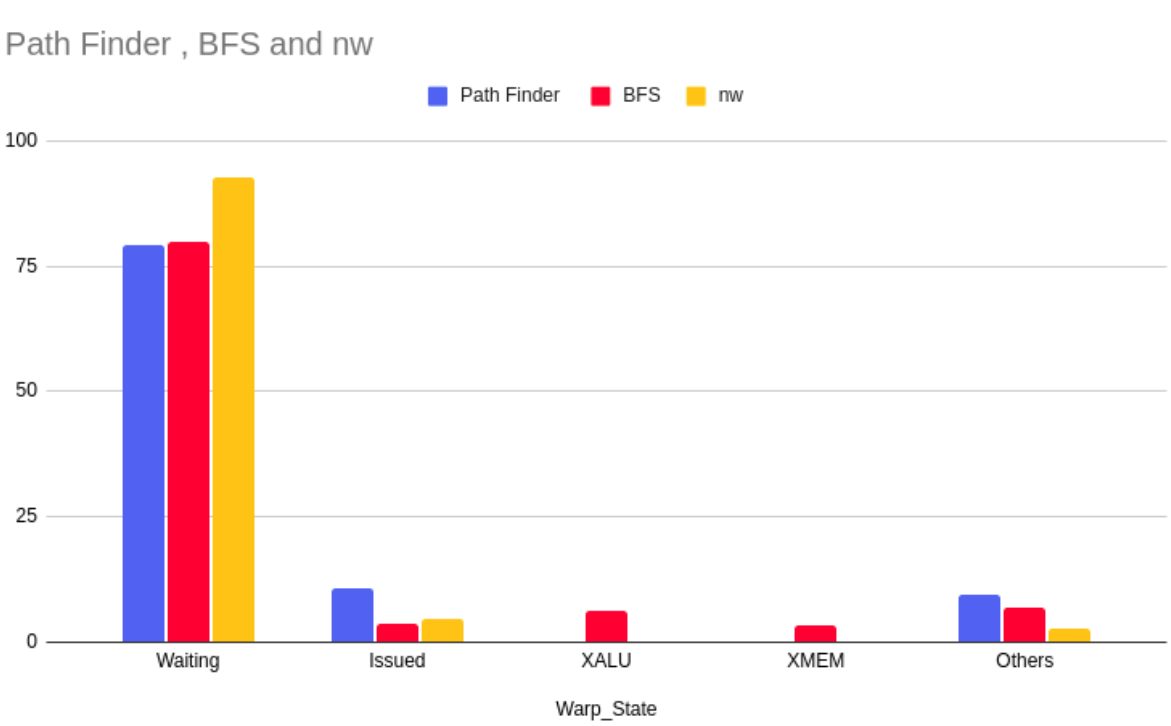
nw:

```
GPGPU-Sim: *** exit detected ***
Waiting :                    183881511
Issued:                      9019200
ExcessALU:                   131
ExcessMEM:                   4687
Others:                      4973728
TotalWarpsIssued(Sum):       197879257
WARPS:                       197879257
```

nw	Warp_State	Warp Count	Percentage
	Waiting	183881511	92.92
	Issued	9019200	4.55
	XALU	131	0.000066
	XMEM	4687	0.0023
	Others	4973728	2.51



Total Cycles: 4405863 **Warps:** 32 **Product:** 140987616


Path Finder , BFS and nw
Path Finder
BFS
nw
100
75
50
25
0
Waiting
Issued
XALU
XMEM
Others
Warp_State