

Analysis Report

kernelReduceGroupShfl(float*, float*, int, int)

| | |
|-------------------------|----------------|
| Duration | 34.977 μ s |
| Grid Size | [4,128,1] |
| Block Size | [32,32,1] |
| Registers/Thread | 9 |
| Shared Memory/Block | 0 B |
| Shared Memory Executed | 96 KiB |
| Shared Memory Bank Size | 4 B |

[0] GeForce GTX 1060 6GB

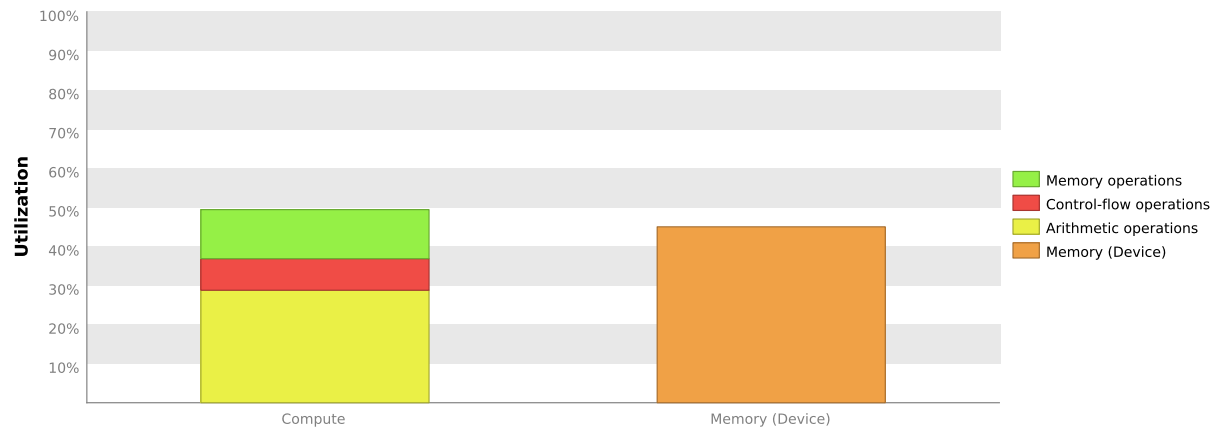
| | |
|---------------------------------------|--|
| GPU UUID | GPU-eb2e304c-810c-cf47-9ddc-b9f1ccdb795a |
| Compute Capability | 6.1 |
| Max. Threads per Block | 1024 |
| Max. Threads per Multiprocessor | 2048 |
| Max. Shared Memory per Block | 48 KiB |
| Max. Shared Memory per Multiprocessor | 96 KiB |
| Max. Registers per Block | 65536 |
| Max. Registers per Multiprocessor | 65536 |
| Max. Grid Dimensions | [2147483647, 65535, 65535] |
| Max. Block Dimensions | [1024, 1024, 64] |
| Max. Warps per Multiprocessor | 64 |
| Max. Blocks per Multiprocessor | 32 |
| Half Precision FLOP/s | 34.17 GigaFLOP/s |
| Single Precision FLOP/s | 4.374 TeraFLOP/s |
| Double Precision FLOP/s | 136.68 GigaFLOP/s |
| Number of Multiprocessors | 10 |
| Multiprocessor Clock Rate | 1.708 GHz |
| Concurrent Kernel | true |
| Max IPC | 6 |
| Threads per Warp | 32 |
| Global Memory Bandwidth | 192.192 GB/s |
| Global Memory Size | 5.935 GiB |
| Constant Memory Size | 64 KiB |
| L2 Cache Size | 1.5 MiB |
| Memcpy Engines | 2 |
| PCIe Generation | 2 |
| PCIe Link Rate | 5 Gbit/s |
| PCIe Link Width | 16 |

1. Compute, Bandwidth, or Latency Bound

The first step in analyzing an individual kernel is to determine if the performance of the kernel is bounded by computation, memory bandwidth, or instruction/memory latency. The results below indicate that the performance of kernel "kernelReduceGroupShfl" is most likely limited by instruction and memory latency. You should first examine the information in the "Instruction And Memory Latency" section to determine how it is limiting performance.

1.1. Kernel Performance Is Bound By Instruction And Memory Latency

This kernel exhibits low compute throughput and memory bandwidth utilization relative to the peak performance of "GeForce GTX 1060 6GB". These utilization levels indicate that the performance of the kernel is most likely limited by the latency of arithmetic or memory operations. Achieved compute throughput and/or memory bandwidth below 60% of peak typically indicates latency issues.

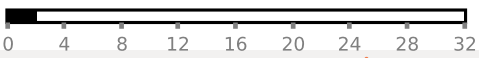
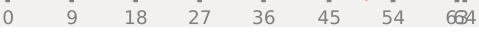
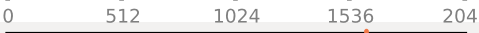
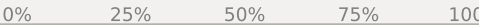


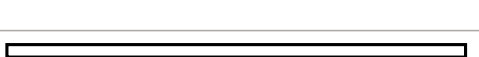
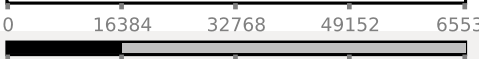

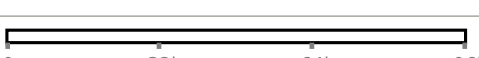




2. Instruction and Memory Latency

Instruction and memory latency limit the performance of a kernel when the GPU does not have enough work to keep busy. The performance of latency-limited kernels can often be improved by increasing occupancy. Occupancy is a measure of how many warps the kernel has active on the GPU, relative to the maximum number of warps supported by the GPU. Theoretical occupancy provides an upper bound while achieved occupancy indicates the kernel's actual occupancy.

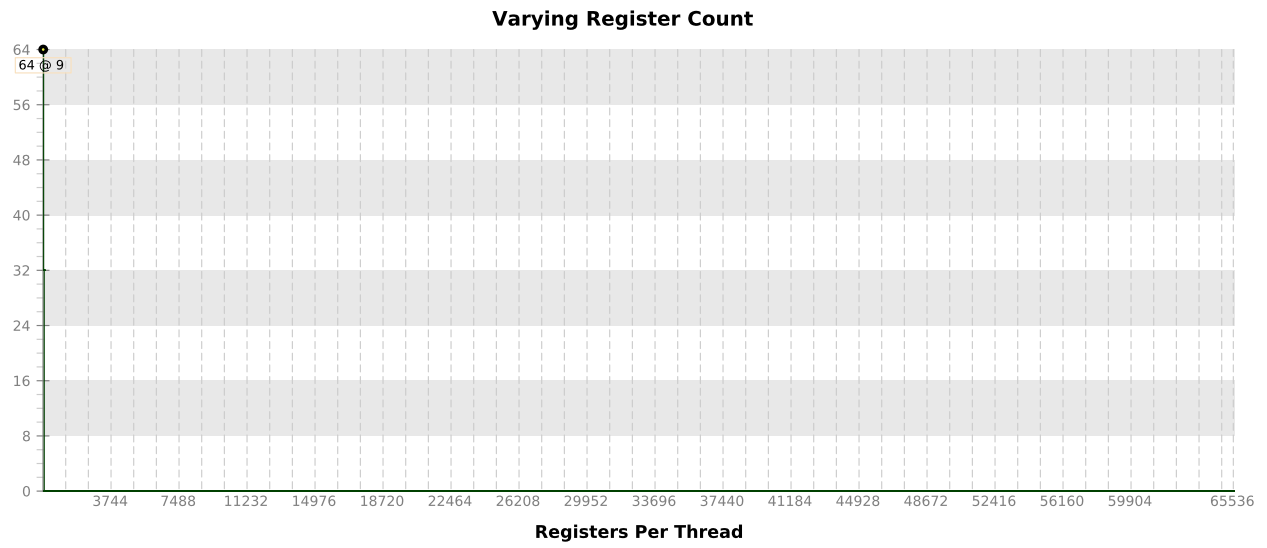
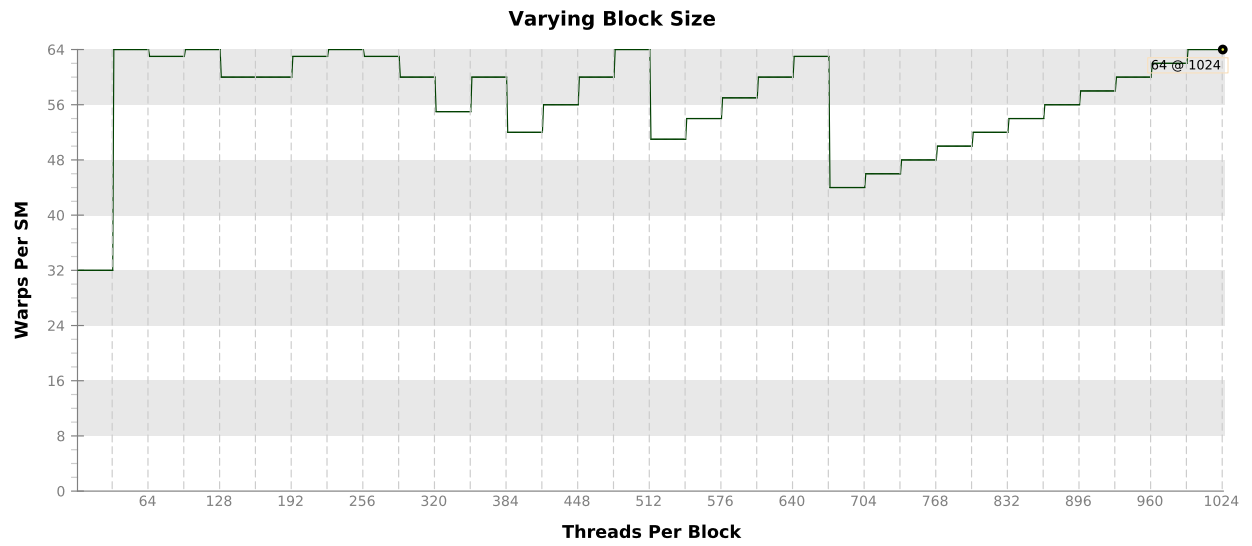
2.1. Occupancy Is Not Limiting Kernel Performance

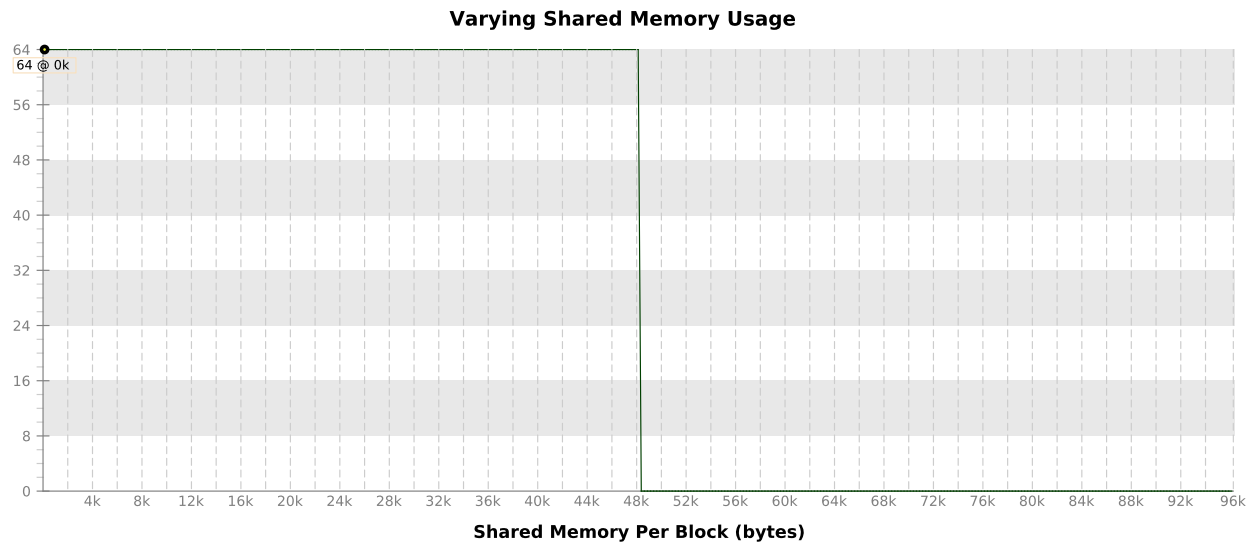
The kernel's block size, register usage, and shared memory usage allow it to fully utilize all warps on the GPU.

| Variable | Achieved | Theoretical | Device Limit | Grid Size: [4,128,1] (512 blocks) Block Size: [32,32,1] |
|---------------------|----------|-------------|--------------|--|
| Occupancy Per SM | | | | |
| Active Blocks | | 2 | 32 |  |
| Active Warps | 49.94 | 64 | 64 |  |
| Active Threads | | 2048 | 2048 |  |
| Occupancy | 78% | 100% | 100% |  |
| Warps | | | | |
| Threads/Block | | 1024 | 1024 |  |
| Warps/Block | | 32 | 32 |  |
| Block Limit | | 2 | 32 |  |
| Registers | | | | |
| Registers/Thread | | 9 | 65536 |  |
| Registers/Block | | 16384 | 65536 |  |
| Block Limit | | 4 | 32 |  |
| Shared Memory | | | | |
| Shared Memory/Block | | 0 | 98304 |  |
| Block Limit | | 0 | 32 |  |

2.2. Occupancy Charts

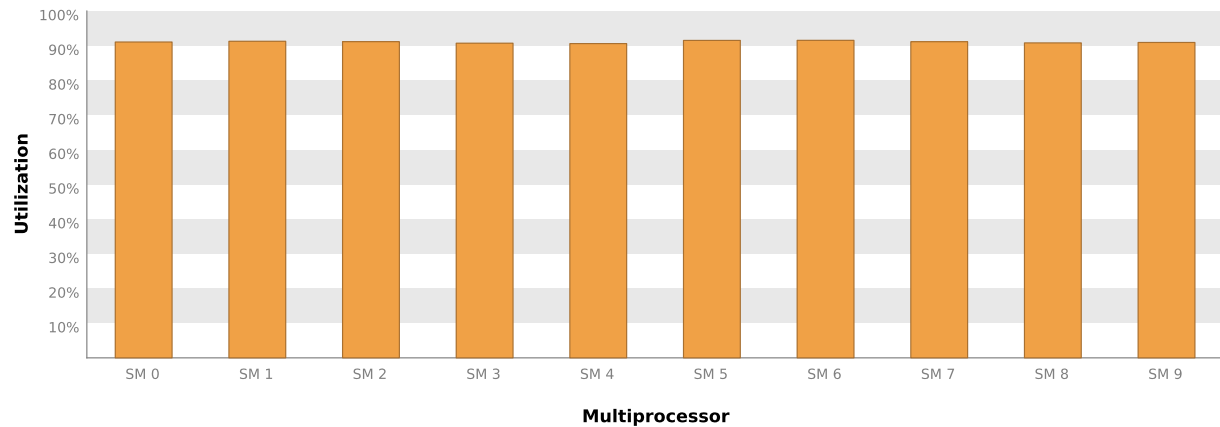
The following charts show how varying different components of the kernel will impact theoretical occupancy.





2.3. Multiprocessor Utilization

The kernel's blocks are distributed across the GPU's multiprocessors for execution. Depending on the number of blocks and the execution duration of each block some multiprocessors may be more highly utilized than others during execution of the kernel. The following chart shows the utilization of each multiprocessor during execution of the kernel.



3. Compute Resources

GPU compute resources limit the performance of a kernel when those resources are insufficient or poorly utilized. Compute resources are used most efficiently when all threads in a warp have the same branching and predication behavior. The results below indicate that a significant fraction of the available compute performance is being wasted because branch and predication behavior is differing for threads within a warp.

3.1. Divergent Branches

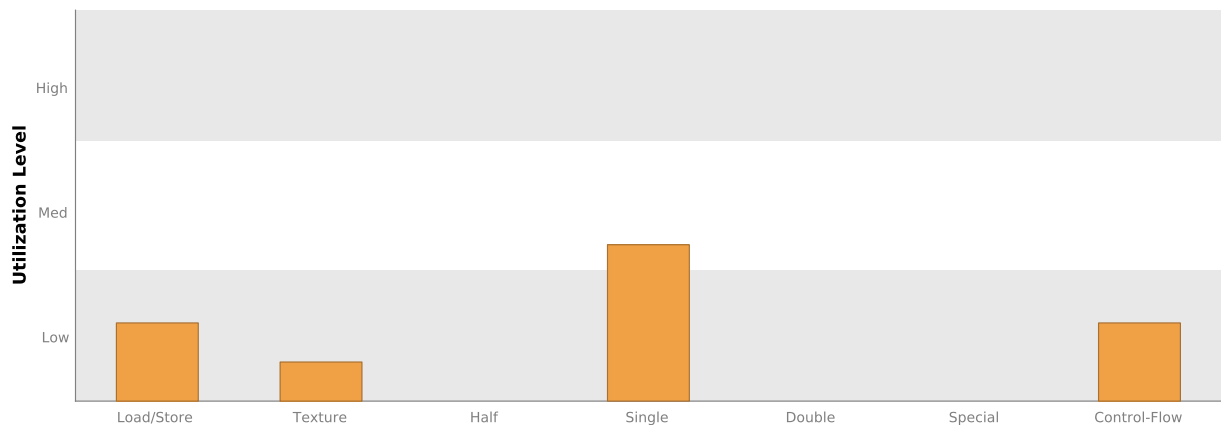
Compute resource are used most efficiently when all threads in a warp have the same branching behavior. When this does not occur the branch is said to be divergent. Divergent branches lower warp execution efficiency which leads to inefficient use of the GPU's compute resources.

Optimization: Each entry below points to a divergent branch within the kernel. For each branch reduce the amount of intra-warp divergence.

3.2. Function Unit Utilization

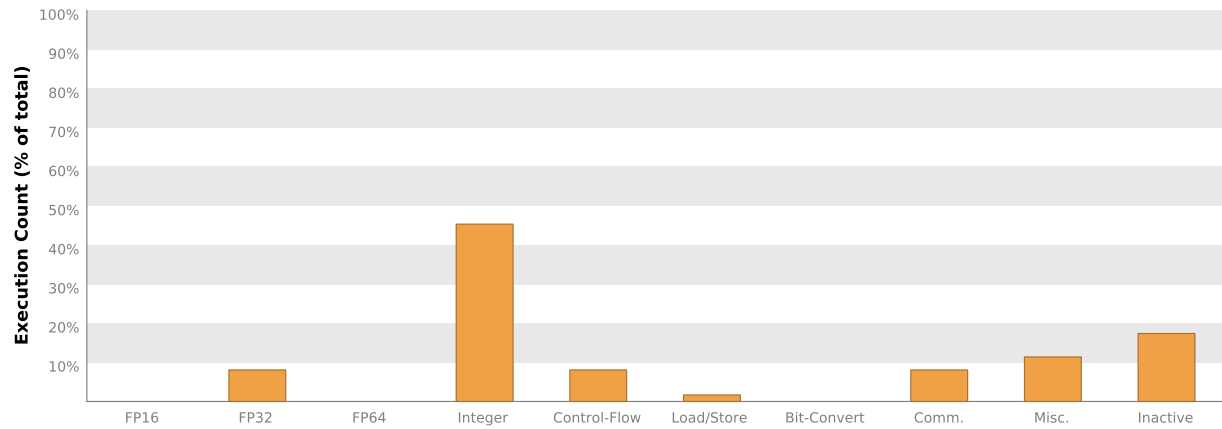
Different types of instructions are executed on different function units within each SM. Performance can be limited if a function unit is over-used by the instructions executed by the kernel. The following results show that the kernel's performance is not limited by overuse of any function unit.

- Load/Store - Load and store instructions for shared and constant memory.
- Texture - Load and store instructions for local, global, and texture memory.
- Half - Half-precision floating-point arithmetic instructions.
- Single - Single-precision integer and floating-point arithmetic instructions.
- Double - Double-precision floating-point arithmetic instructions.
- Special - Special arithmetic instructions such as sin, cos, popc, etc.
- Control-Flow - Direct and indirect branches, jumps, and calls.



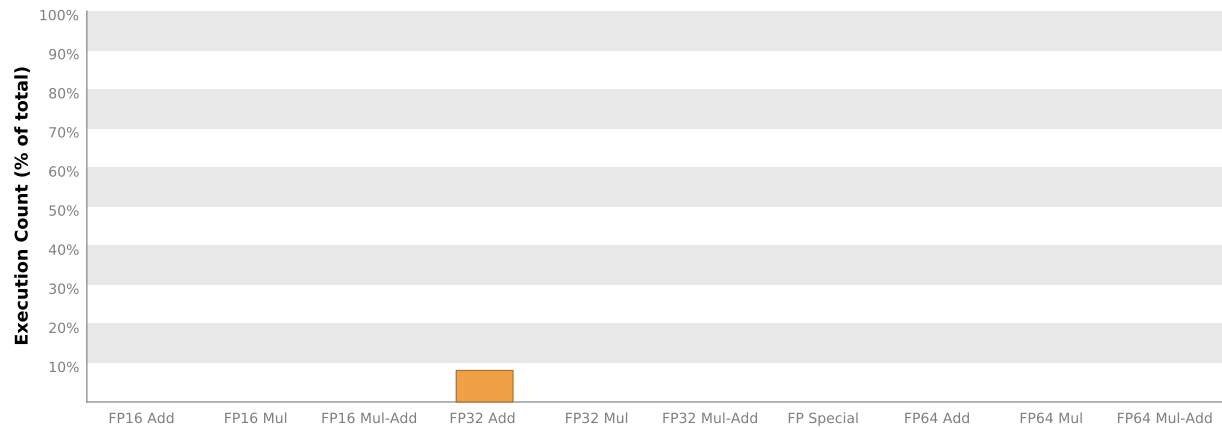
3.3. Instruction Execution Counts

The following chart shows the mix of instructions executed by the kernel. The instructions are grouped into classes and for each class the chart shows the percentage of thread execution cycles that were devoted to executing instructions in that class. The "Inactive" result shows the thread executions that did not execute any instruction because the thread was predicated or inactive due to divergence.



3.4. Floating-Point Operation Counts

The following chart shows the mix of floating-point operations executed by the kernel. The operations are grouped into classes and for each class the chart shows the percentage of thread execution cycles that were devoted to executing operations in that class. The results do not sum to 100% because non-floating-point operations executed by the kernel are not shown in this chart.



4. Memory Bandwidth

Memory bandwidth limits the performance of a kernel when one or more memories in the GPU cannot provide data at the rate requested by the kernel.

4.1. Memory Bandwidth And Utilization

The following table shows the memory bandwidth used by this kernel for the various types of memory on the device. The table also shows the utilization of each memory type relative to the maximum throughput supported by the memory.

| Transactions | Bandwidth | Utilization | |
|--|-----------|-------------|--|
| Shared Memory | | | |
| Shared Loads | 0 | 0 B/s | |
| Shared Stores | 0 | 0 B/s | |
| Shared Total | 0 | 0 B/s | |
| L2 Cache | | | |
| Reads | 66080 | 64.997 GB/s | |
| Writes | 16397 | 16.128 GB/s | |
| Total | 82477 | 81.126 GB/s | |
| Unified Cache | | | |
| Local Loads | 0 | 0 B/s | |
| Local Stores | 0 | 0 B/s | |
| Global Loads | 131072 | 64.462 GB/s | |
| Global Stores | 16384 | 16.116 GB/s | |
| Texture Reads | 65536 | 64.462 GB/s | |
| Unified Total | 212992 | 145.04 GB/s | |
| Device Memory | | | |
| Reads | 66740 | 65.647 GB/s | |
| Writes | 21279 | 20.93 GB/s | |
| Total | 88019 | 86.577 GB/s | |
| System Memory | | | |
| [PCIe configuration: Gen2 x16, 5 Gbit/s] | | | |
| Reads | 0 | 0 B/s | |
| Writes | 5 | 4.918 MB/s | |