POLYTECHNIQUE MONTRÉAL

TECHNOLOGICAL UNIVERSITY

AMD ROCm GPU profiling in Trace Compass

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Polytechnique Montreal

DORSAL Laboratory

Agenda

I. Introduction

   1. GPU Development

   2. Optimization Problems

II. Tracing and profiling of CPU-GPU systems

   1. ROC Platform

   2. Tracing GPUs

   3. Profiling GPUs

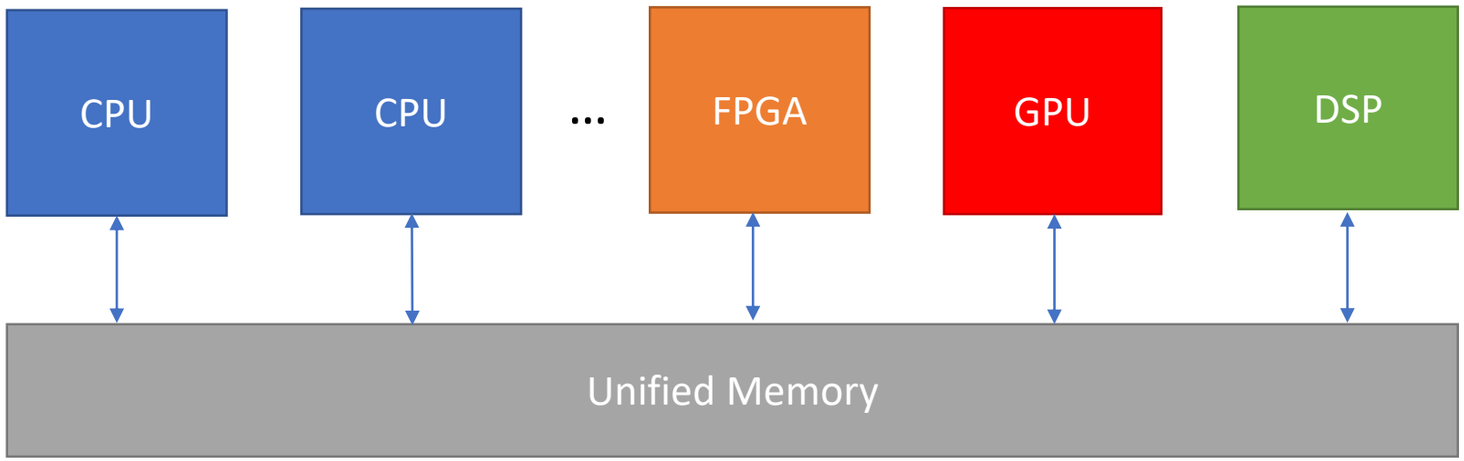
GPU Development - Introduction

- A few definitions :
  - Kernel : A small piece of code executed on the device.

```
__kernel void saxpy(__global float *src, __global float *dst, float factor)
{
  long i = get_global_id(0);
  dst[i] += src[i] * factor;
}
```

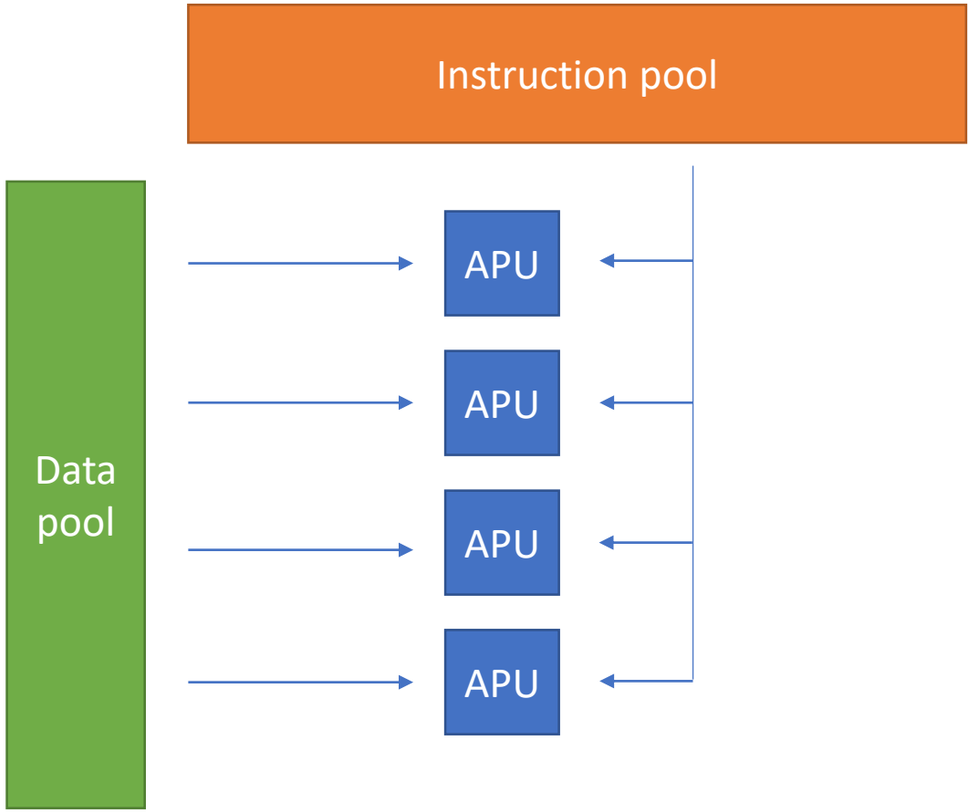
GPU Development - Introduction

- A few definitions :
  - Kernel : A small piece of code executed on the device.
  - Heterogeneous system : system mixing multiple types of processors

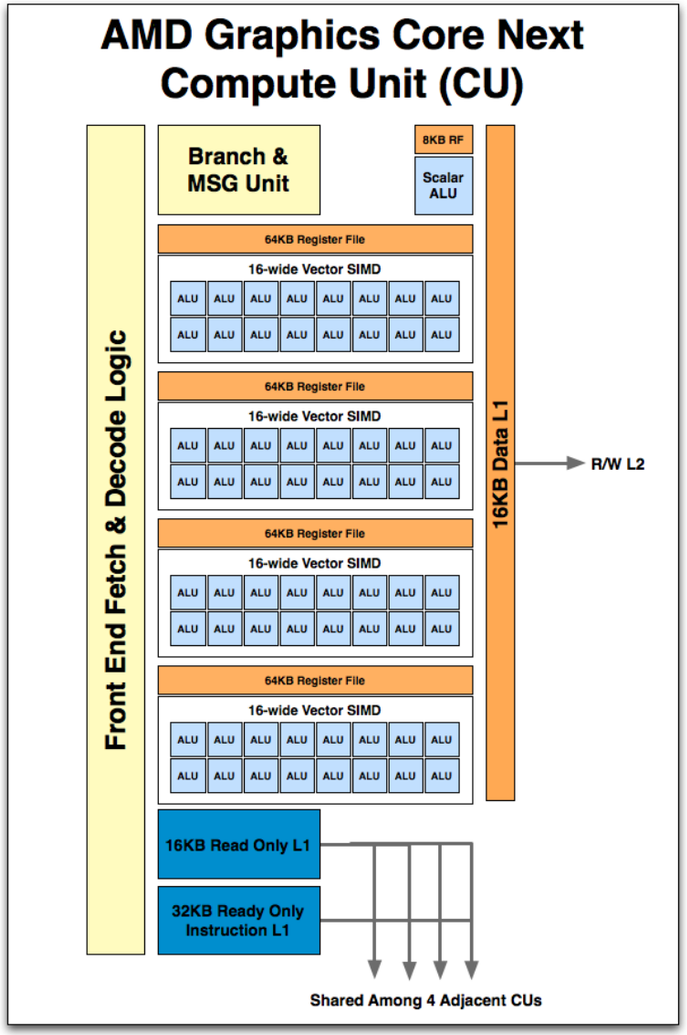


GPU Development - Introduction

- SIMD Architecture :



GPU Development - Introduction



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Optimization Problems - Introduction

- Communication Overhead :
  - Memory synchronisation
  - Interprocessor Communication

- Scheduling and load balancing :
  - Benchmarking
  - Load characteristics of kernels

- Shared Cache :
  - Cache misses, thrashing

Optimization Problems - Introduction

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  - Memory synchronisation
  - Interprocessor Communication

Tracing

- Scheduling and load balancing :
  - Benchmarking
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Profiling
(Performance Counters)

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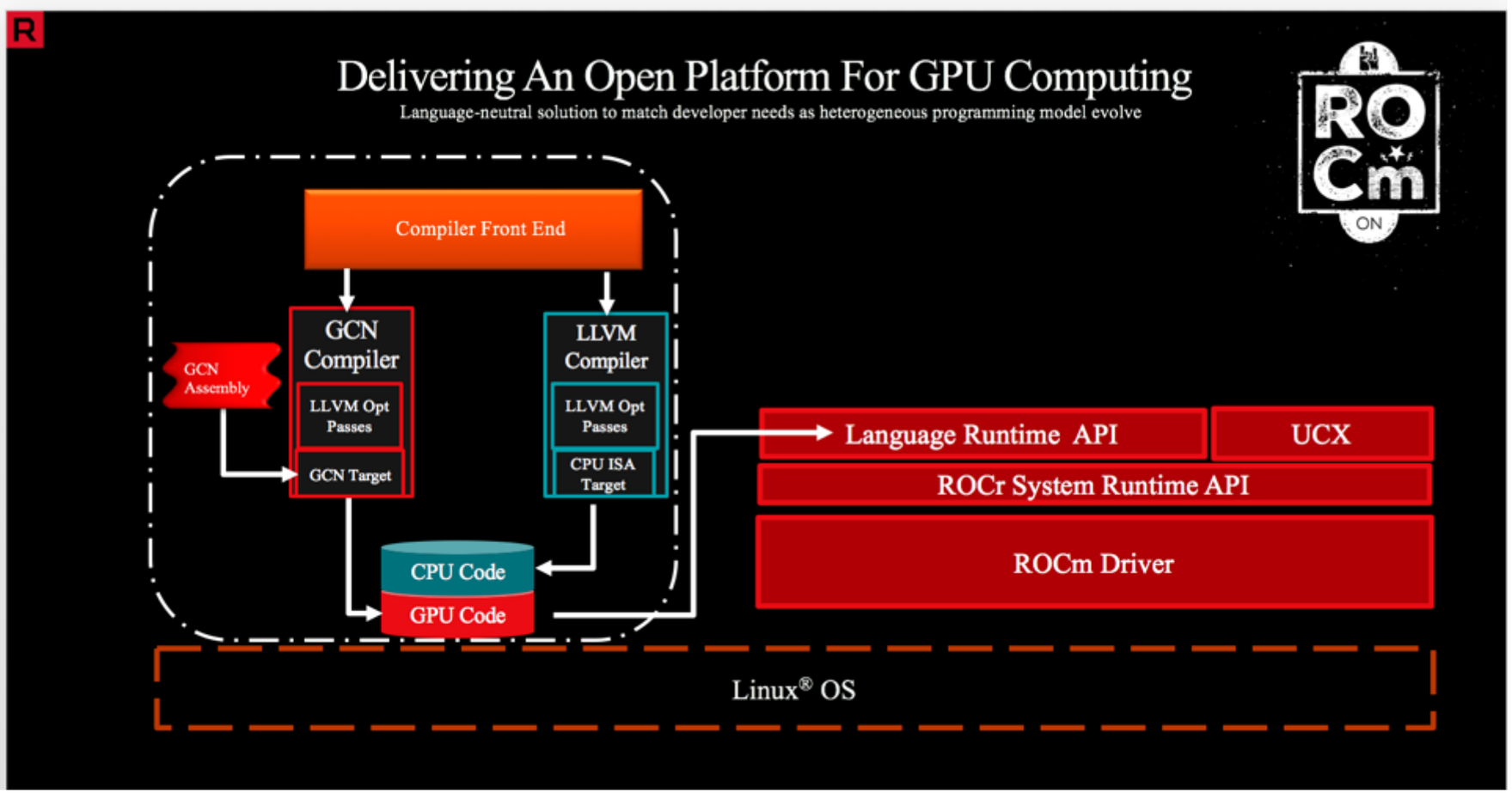
ROC Platform - Tracing and profiling of CPU-GPU systems



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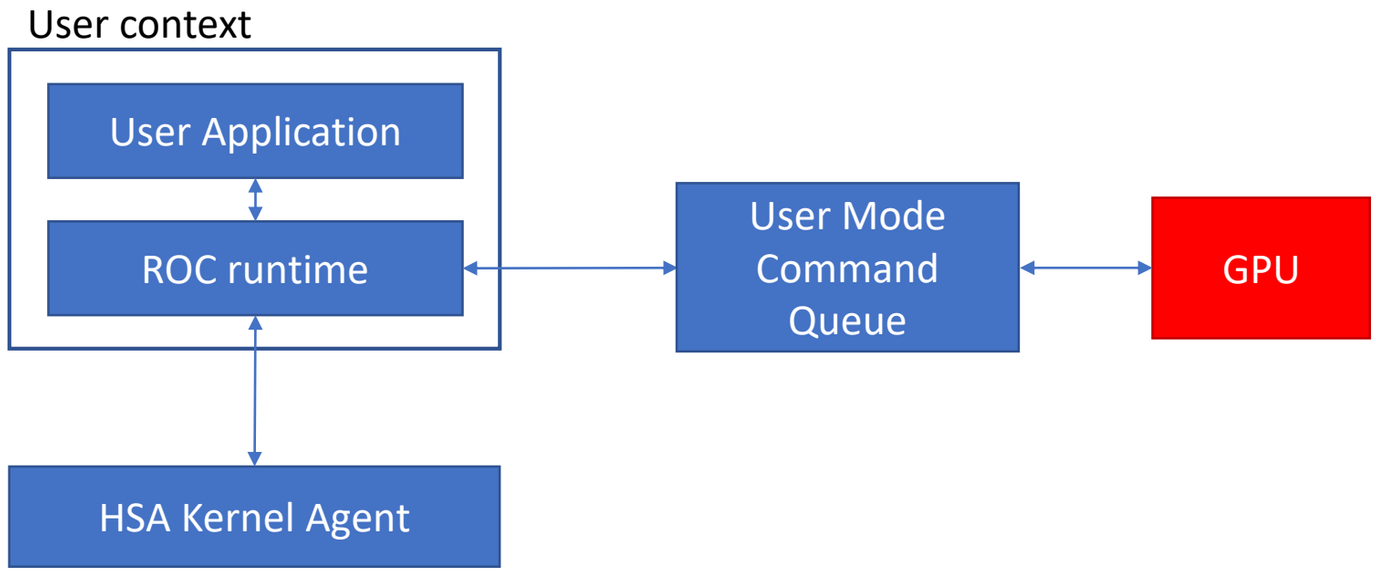
ROC Platform - Tracing and profiling of CPU-GPU systems

ROCm functioning summarized :



ROC Platform - Tracing and profiling of CPU-GPU systems

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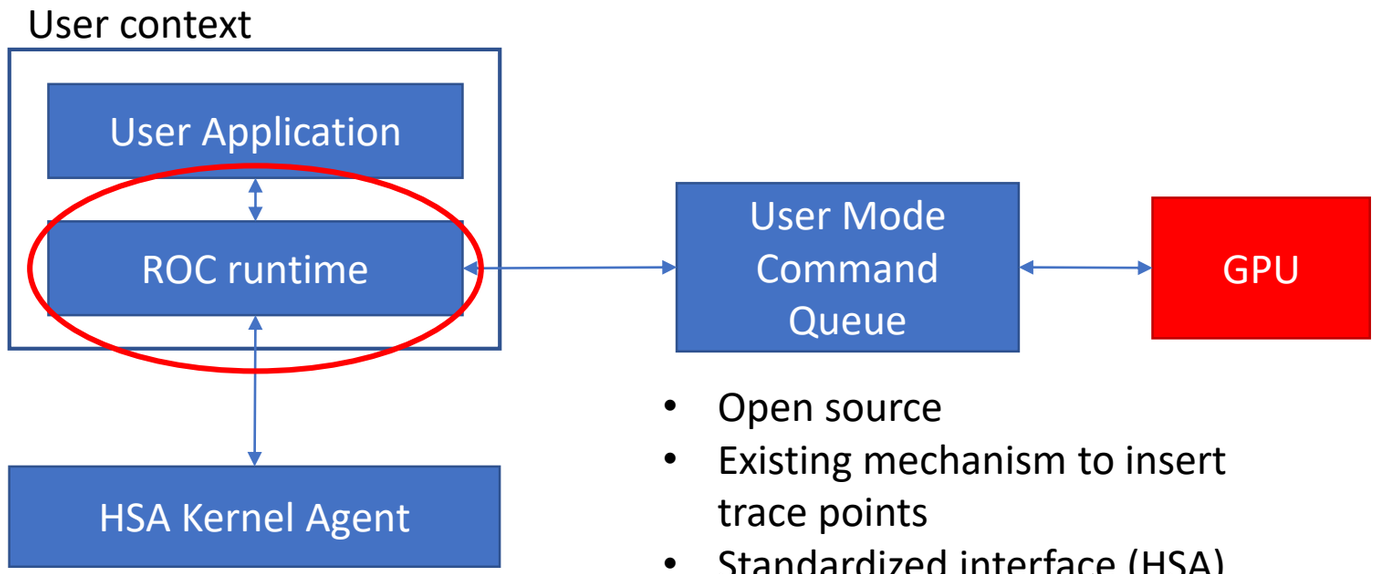


- Open source
- Existing mechanism to insert trace points
- Standardized interface (HSA)

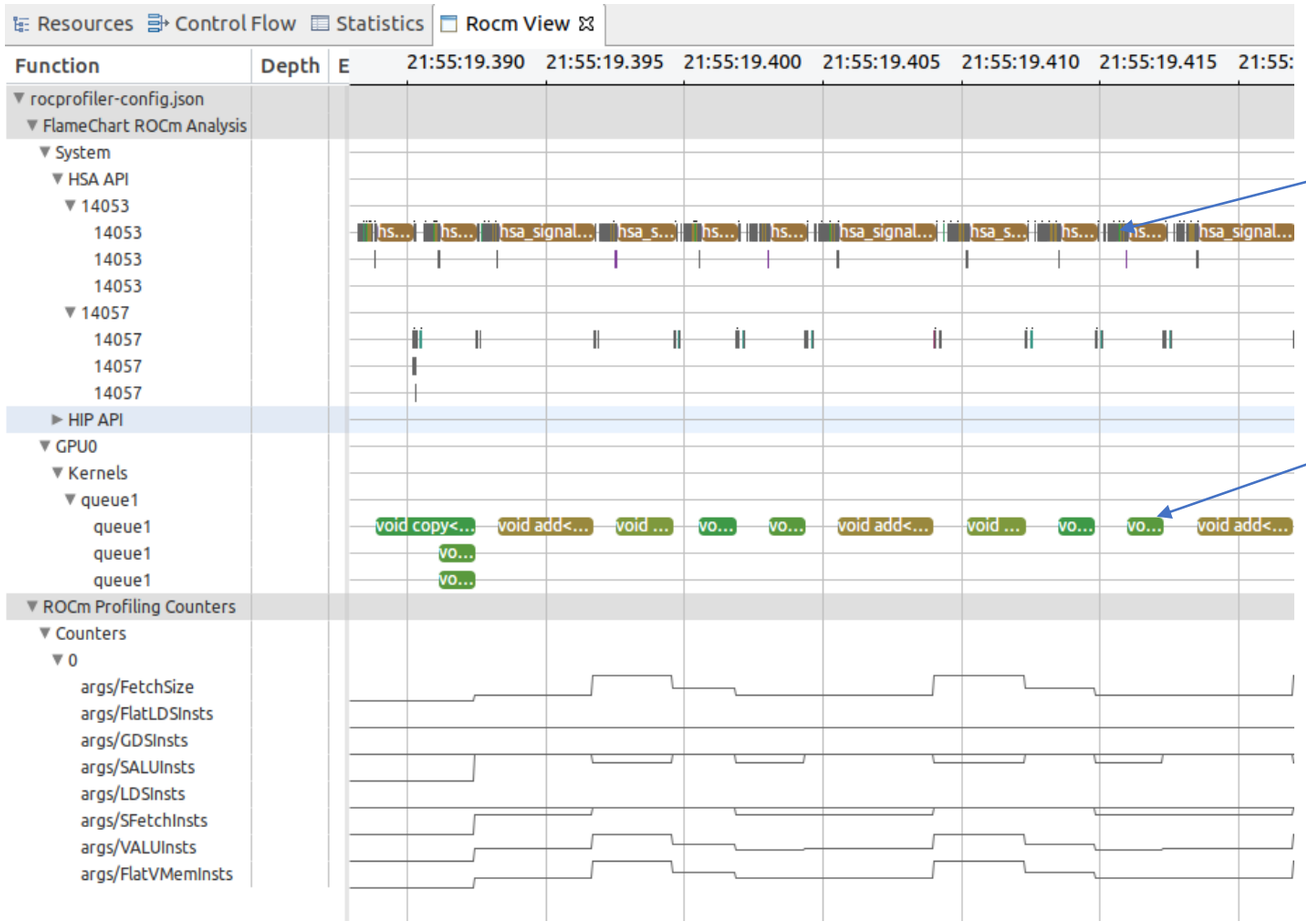
ROC Platform - Tracing and profiling of CPU-GPU systems

- This work has already been done by AMD and is open source :
  https://github.com/ROCm-Developer-Tools/rocprofiler
  https://github.com/ROCm-Developer-Tools/roctracer

- AMD has released a few other libraries and tools thanks to their Radeon Open Compute initiative.

Tracing GPUs - Tracing and profiling of CPU-GPU systems

TraceCompass ROCm plugin



HSA function calls separated by thread

Kernel executions

Tracing GPUs - Tracing and profiling of CPU-GPU systems

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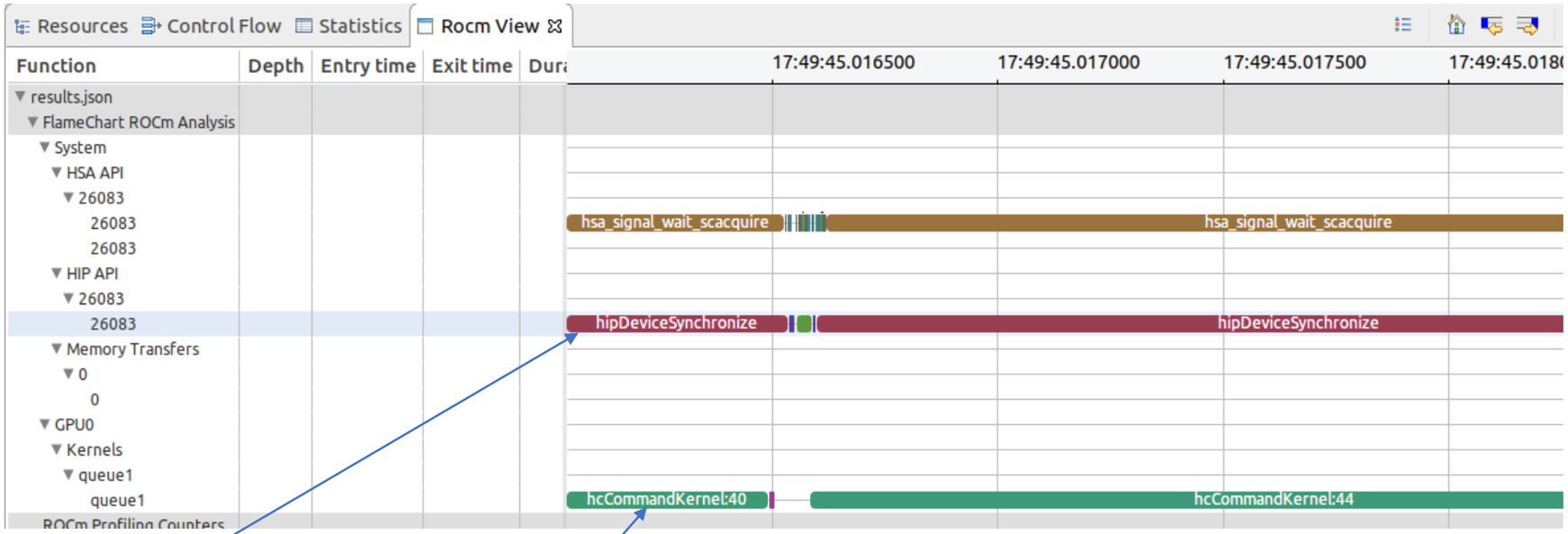
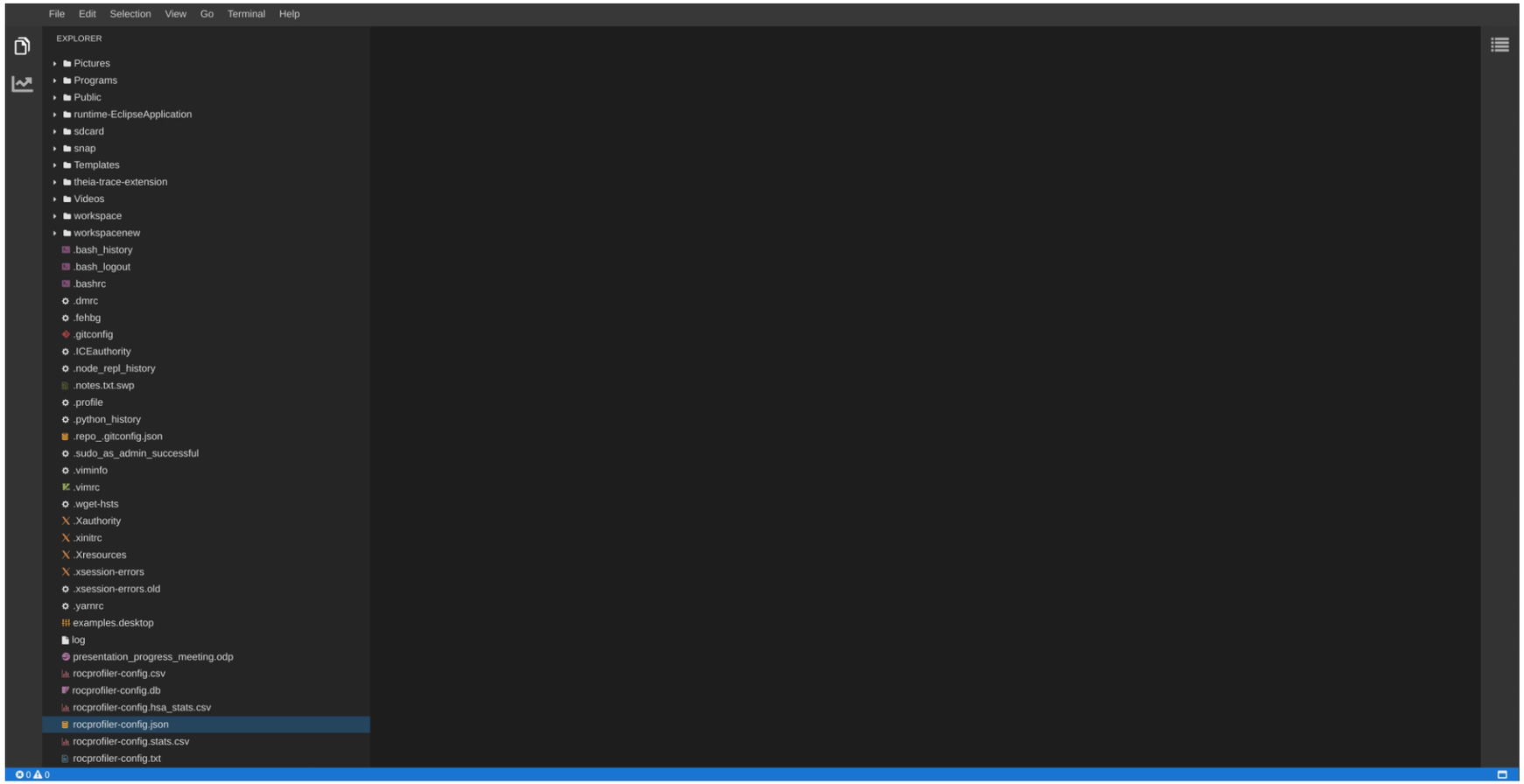


HIP function calls separated by thread

Kernel executions

Tracing GPUs - Tracing and profiling of CPU-GPU systems

TraceCompass ROCm plugin running on Theia front-end



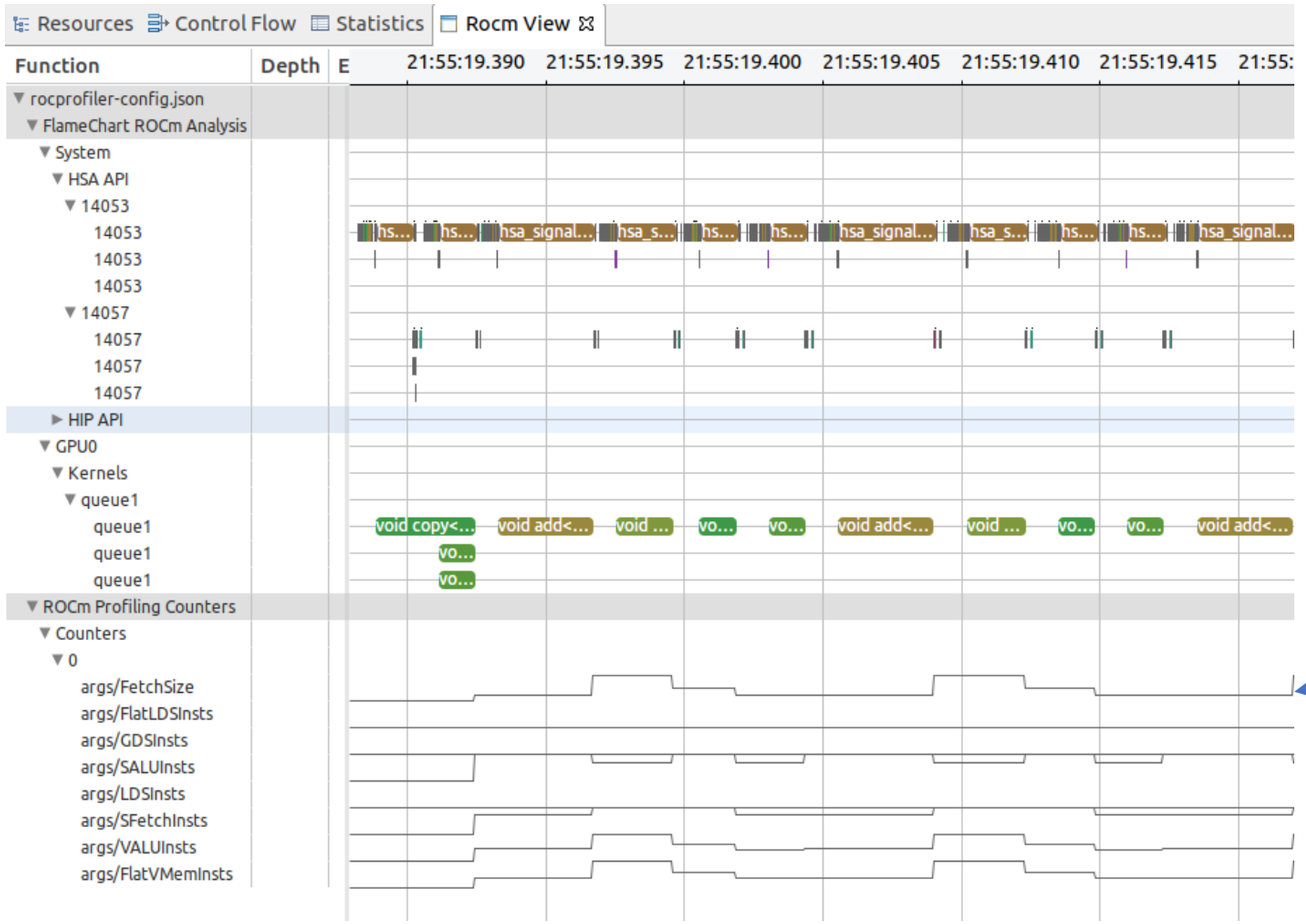
Tracing GPUs - Tracing and profiling of CPU-GPU systems

Analyzing this tracing data further, future work includes :

- Critical path analysis of CPU-GPU execution
- Determining whether the program performance is limited by the GPU or the CPU
- Extracting statistics to use in profiling analysis

Profiling GPUs - Tracing and profiling of CPU-GPU systems

TraceCompass ROCm plugin

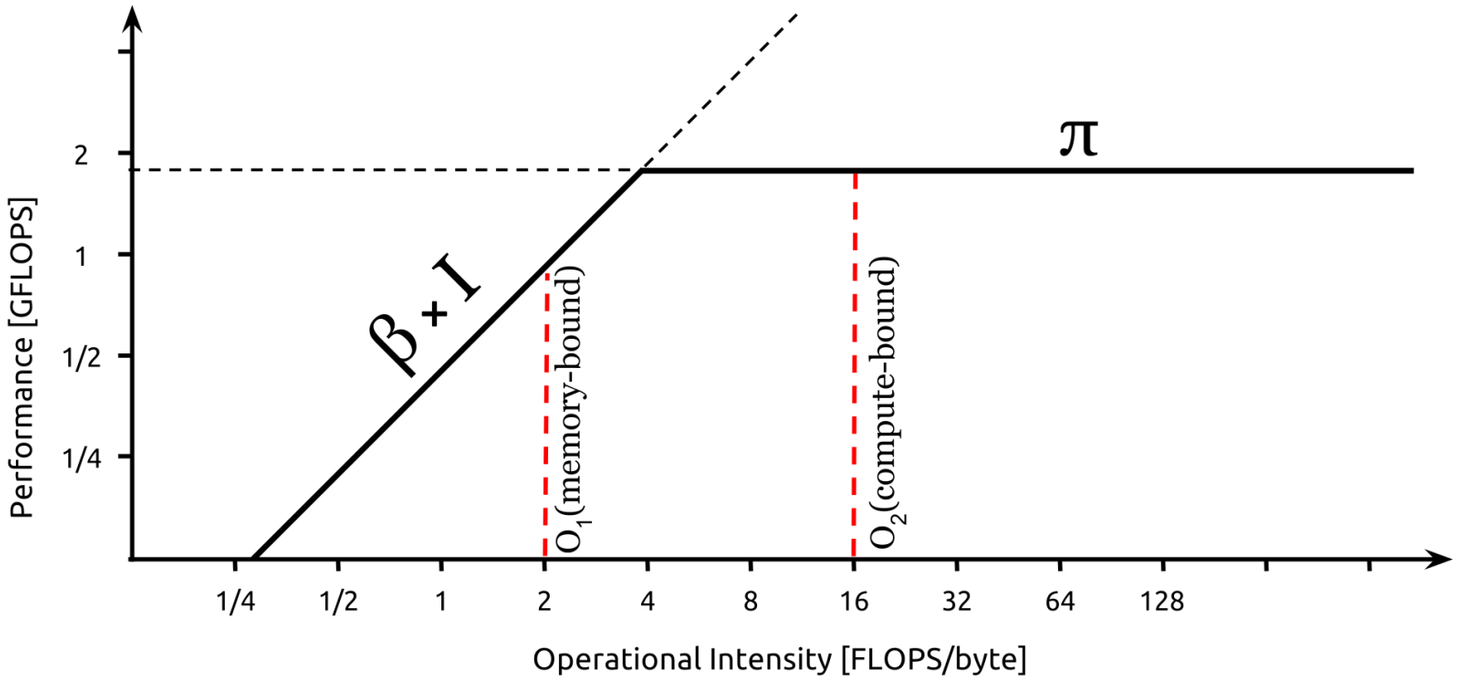


Performance counters

Profiling GPUs - Tracing and profiling of CPU-GPU systems

Using tracing and profiling data, future work includes :

- Roofline model



β : peak bandwidth
I : arithmetic intensity
π : peak performance

Profiling GPUs - Tracing and profiling of CPU-GPU systems

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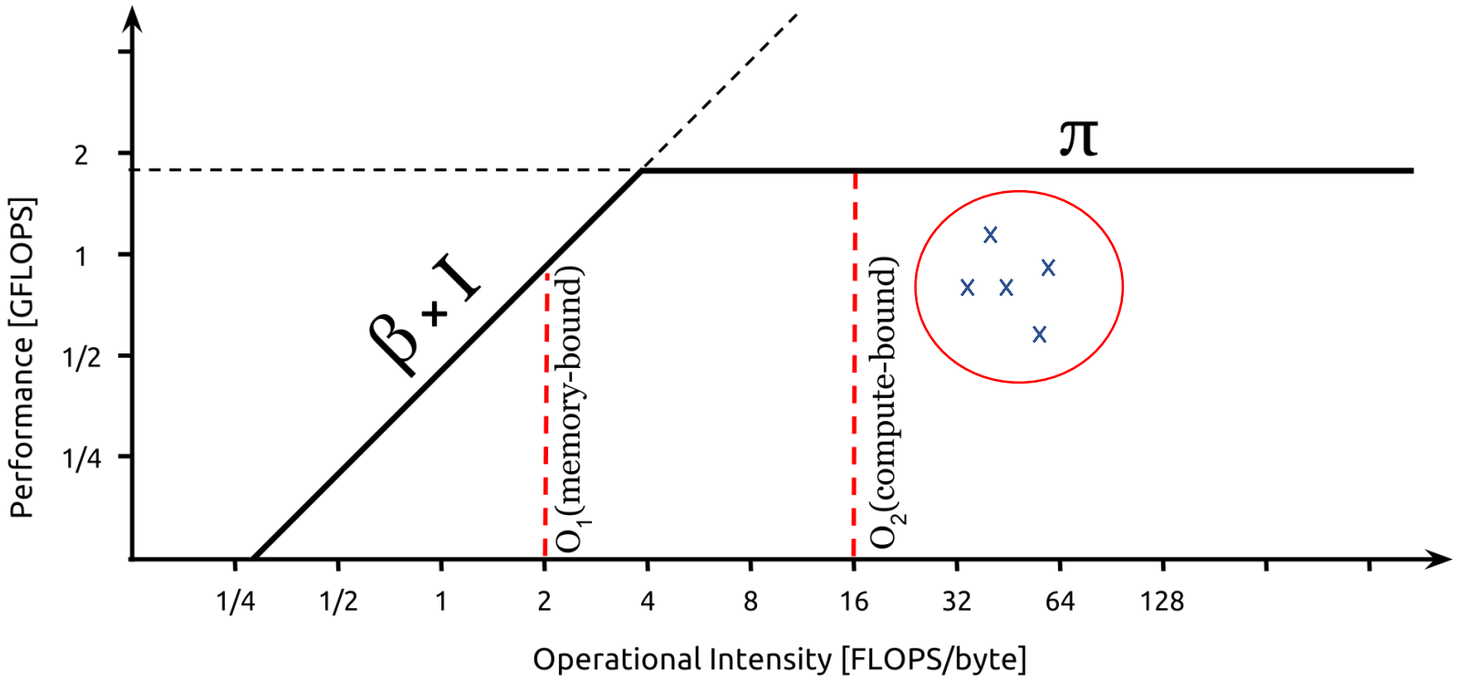

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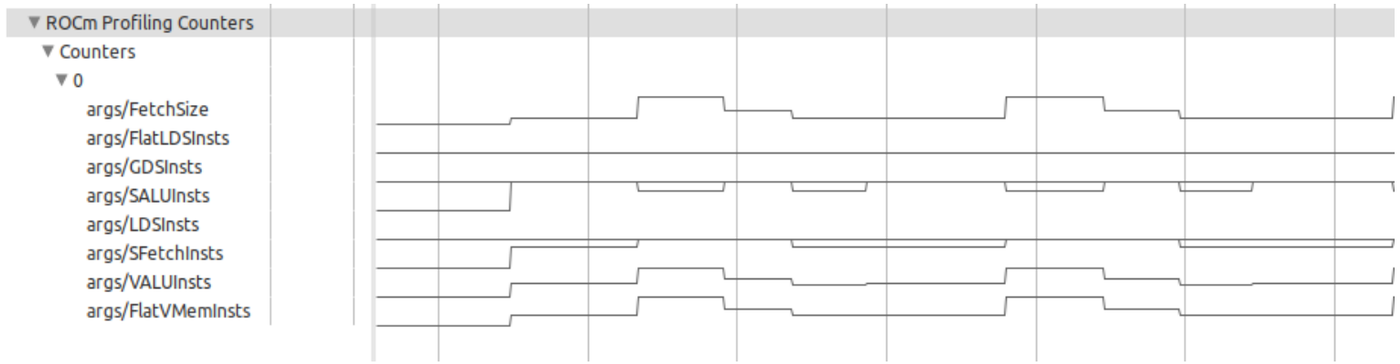
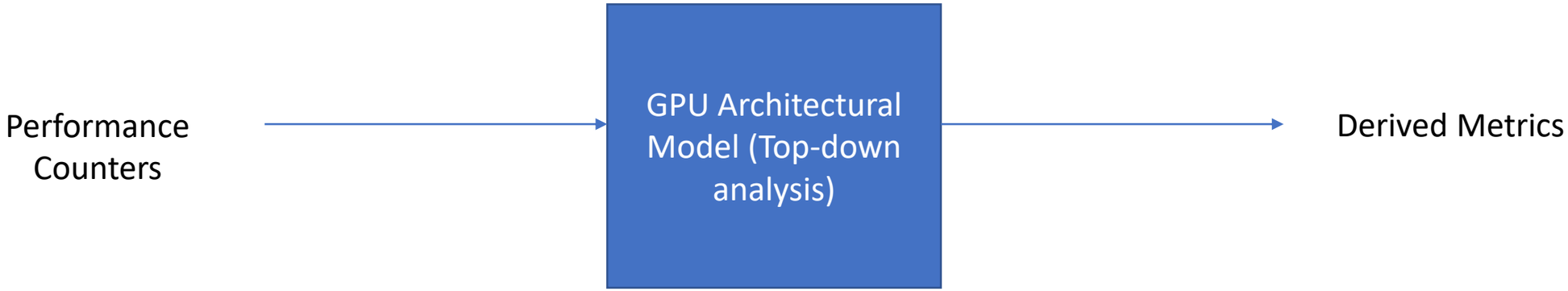
Profiling GPUs - Tracing and profiling of CPU-GPU systems

Using tracing and profiling data, future work includes :

- Top-down analysis





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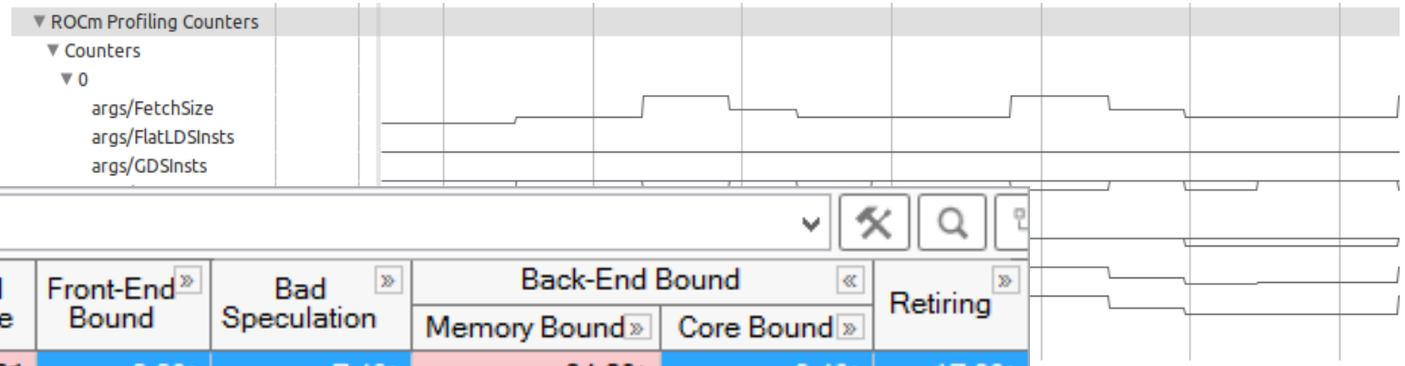

Grouping: Function / Call Stack

Function / Call Stack	Instructions Retired	CPI Rate	Front-End Bound	Bad Speculation	Back-End Bound		Retiring
					Memory Bound	Core Bound	
price_out_impl	62,556,093,834	1.261	2.2%	7.4%	64.2%	8.4%	17.8%
refresh_potential	17,836,026,754	3.589	3.0%	8.1%	73.2%	9.6%	6.1%
primal_bea_mpp	38,108,057,162	1.393	5.6%	24.3%	34.4%	21.0%	14.7%
update_tree	4,092,006,138	3.373	7.2%	11.5%	62.3%	11.8%	7.2%
sort_basket	12,246,018,369	1.037	20.7%	50.4%	3.8%	4.6%	20.6%
primal_iminus	5,324,007,986	2.148	7.1%	6.7%	55.0%	20.5%	10.8%
primal_net_simple:	266,000,399	2.466	17.4%	43.4%	13.1%	13.1%	13.0%

Performance Counters

rics

analysis)

Thank you for listening !

Questions ?

References

- https://github.com/RadeonOpenCompute/ROCm
- https://rocm-documentation.readthedocs.io/en/latest/
- http://www.hsafoundation.com/
- HSA Runtime Programmer’s Reference Manual, Version 1.2
- HSA Programmer's Reference Manual, Version 1.2
- HSA Platform System Architecture Specification, Version 1.2
- https://github.com/ucb-bar/opencl-kernels/blob/master/saxpy/kernel.cl
- https://medium.com/@smallfishbigsea/basic-concepts-in-gpu-computing-3388710e9239
- https://www.techpowerup.com/gpu-specs/docs/amd-gcn1-architecture.pdf
- https://software.intel.com/content/www/us/en/develop/documentation/vtune-cookbook/top/methodologies/top-down-microarchitecture-analysis-method.html