Running OpenACC Programs on NVIDIA and AMD GPUs

Michael Wolfe, Compiler Engineer

The Portland Group

www.pgroup.com

What is OpenACC?

A set of directive-based extensions to C, C++ and Fortran that allow you to annotate regions of code and data for offloading from a CPU host to an attached Accelerator

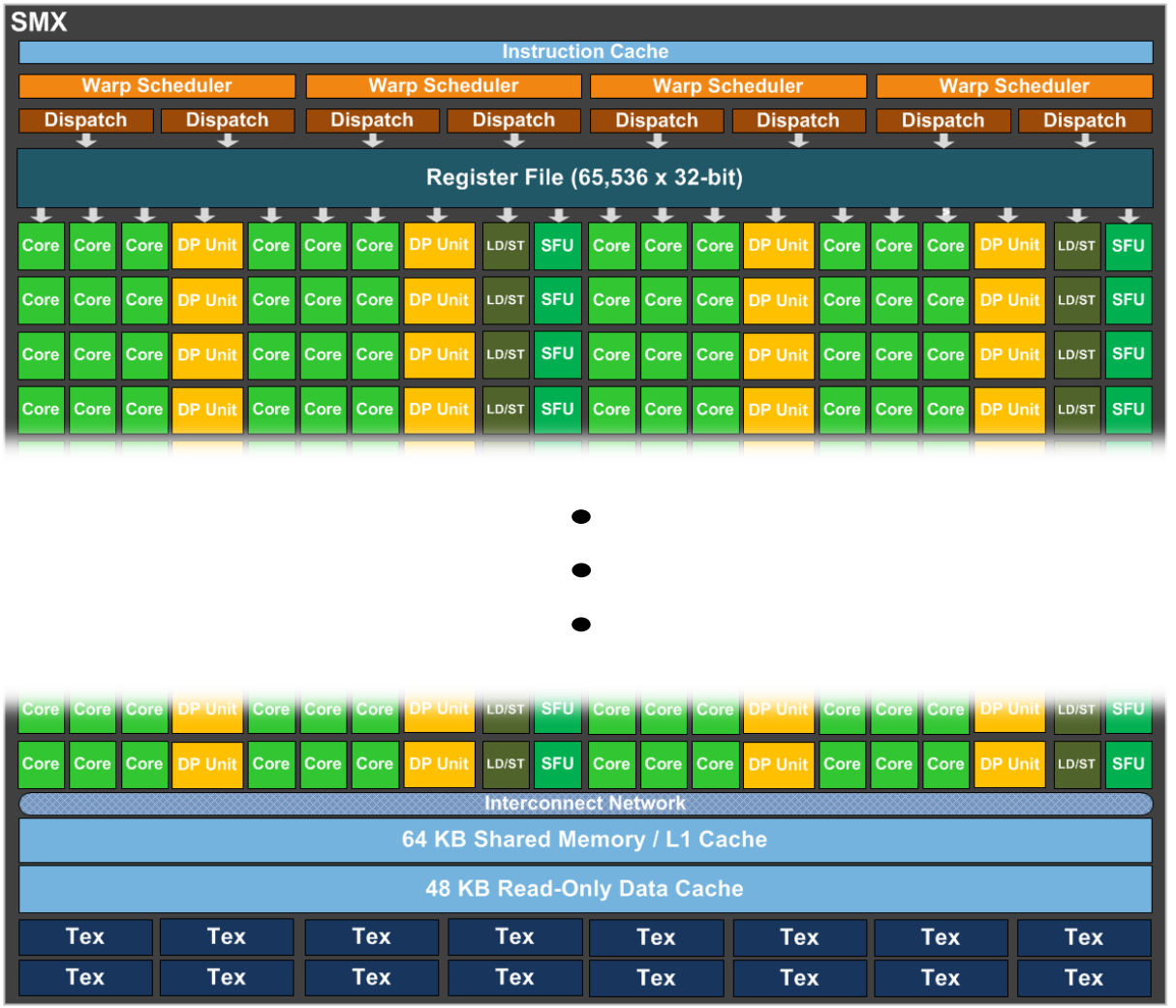
https://www.pgroup.com/lit/videos/ieee_openacc_webinar_june2013.html

NVIDIA Kepler Overall Block Diagram*

* From the whitepaper "NVIDIA's Next Generation CUDA™ Compute Architecture: Kepler TM GK110", © 2012 NVIDIA Corporation.

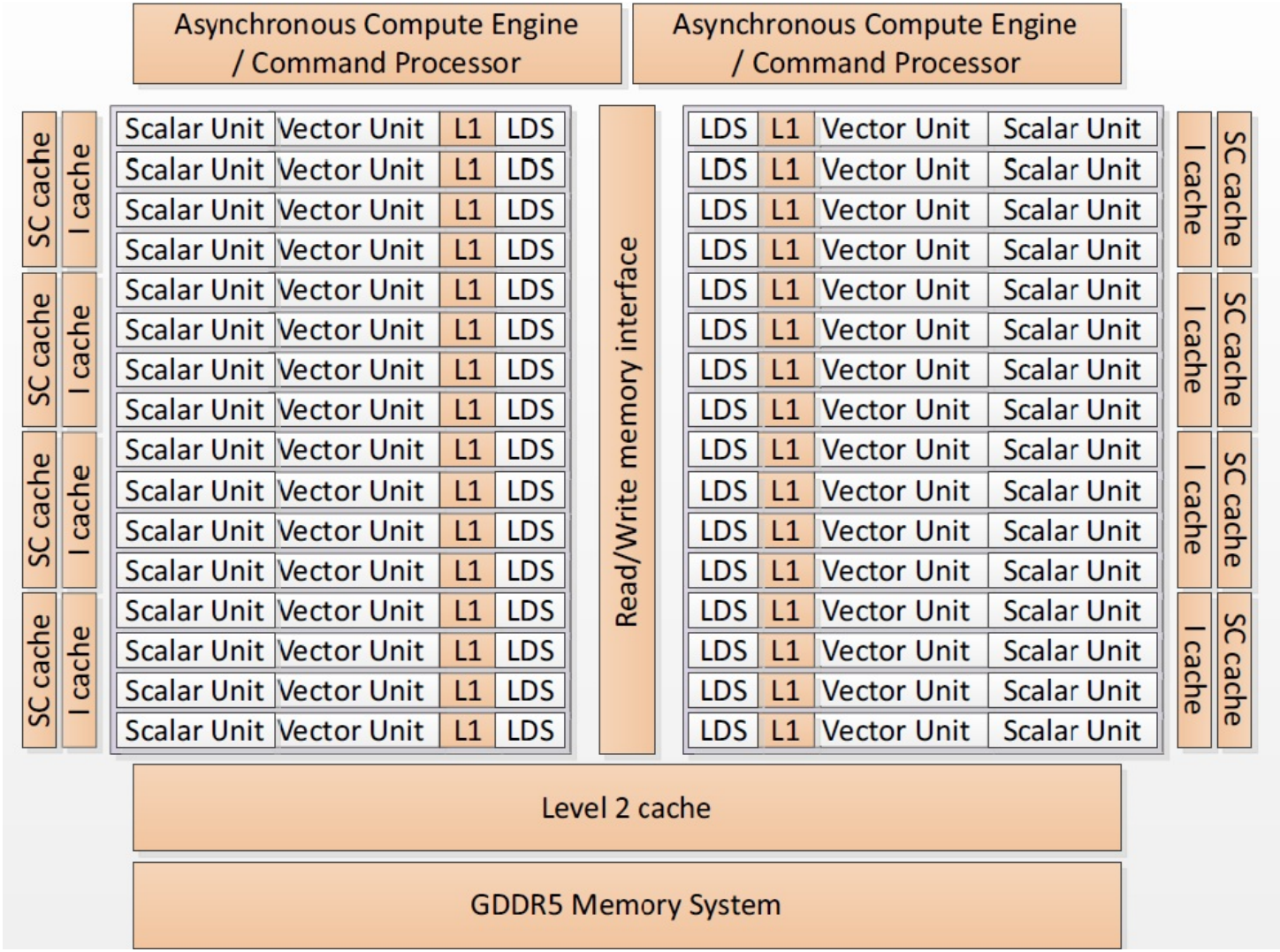
NVIDIA Kepler SMX Block Diagram*

- 192 SP CUDA cores
- 64 DP units
- 32 SFUs
- 32 ld/st units



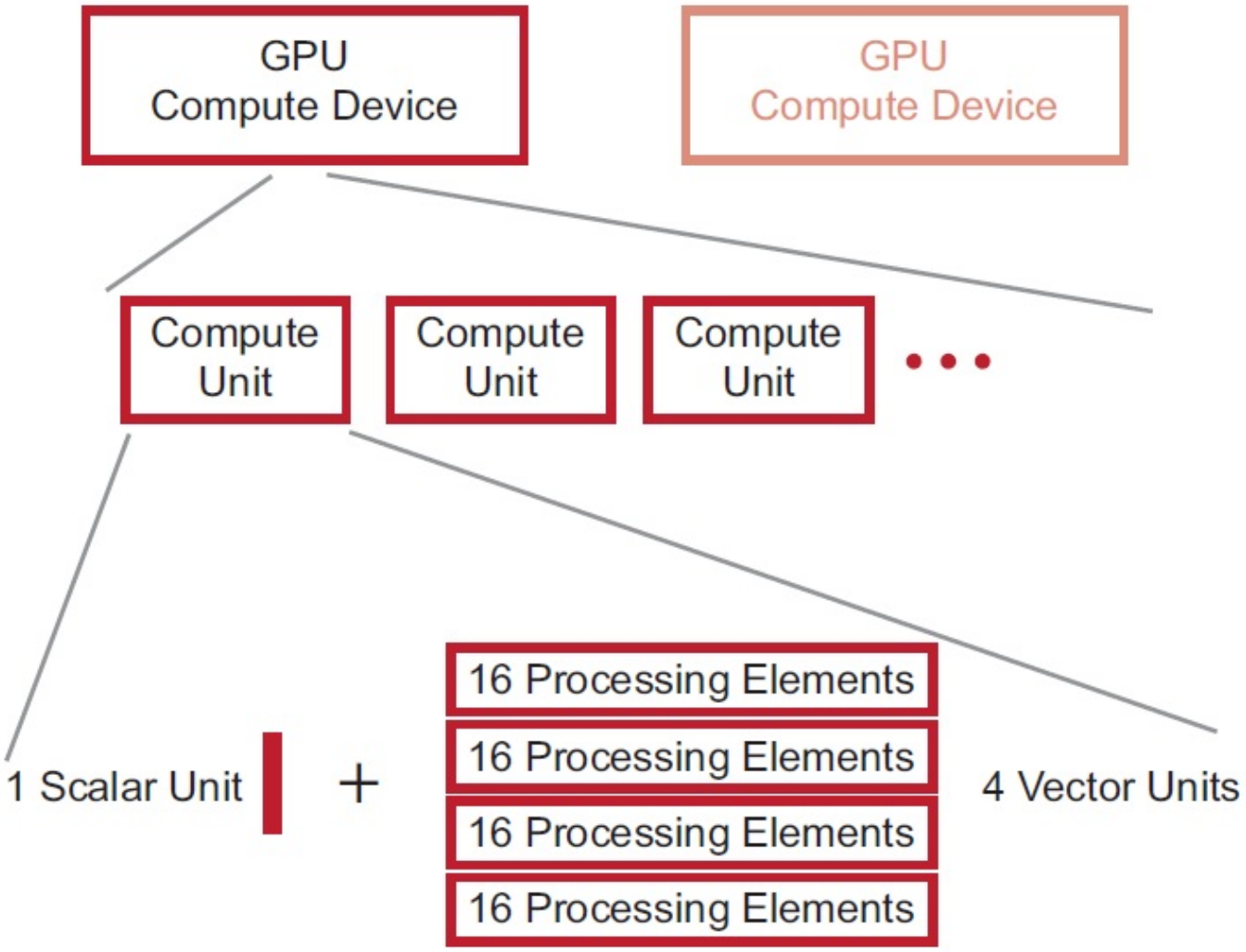
* From the whitepaper "NVIDIA's Next Generation CUDA™ Compute Architecture: Kepler TM GK110", © 2012 NVIDIA Corporation.

AMD Radeon 7970 Block Diagram*



*From "AMD Accelerated Parallel Processing – OpenCL Programming Guide", © 2012 Advanced Micro Devices, Inc.

AMD Radeon 7970 Compute Unit*



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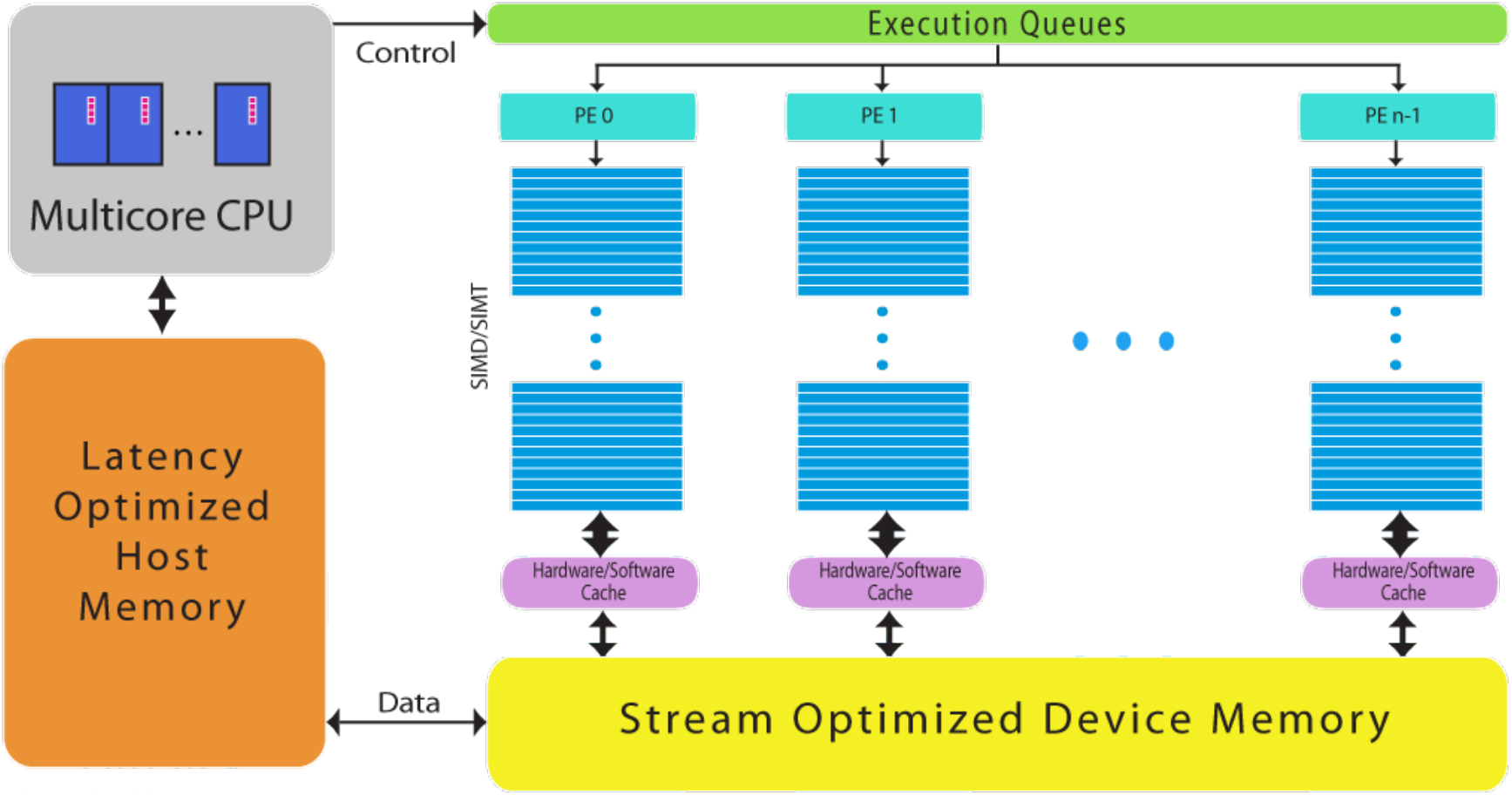
CPU+Accelerator Abstract Machine Architecture



OpenACC Directives

```
#pragma acc data copyin(in[0:n]) copyout(out[0:n]) \
                 copy(force[0:n], vel[0:n])
{
    #pragma acc parallel loop
        for (int i = 0; i < n; i++)
        {
          . . . // update forces
        }
    #pragma acc parallel loop
        for (int i = 0; i < n; i++)
        {
          . . . // update positions, velocities
        }
}
```

Building OpenACC Programs

```
% pgcc -acc -ta=nvidia -c foo.c
% pgcc -acc -ta=nvidia -o foo.exe foo.o
% foo.exe

% pgcc -acc -ta=radeon -c bar.c
% pgcc -acc -ta=radeon -o bar.exe bar.o
% bar.exe

% pgcc -help -ta
```

OpenACC Features

- Single source code for CPU and GPU
- Offload data and loops with directives
- Incrementally tune data movement
- Overlap data movement with computation
- Re-use Accelerator data across kernels, even across procedure calls
- Easy to experiment with alternative loop schedules, mapping of parallelism to HW

OpenACC 2.0
Upcoming Features

- Procedure calls on the Accelerator
- Unstructured Accelerator data lifetimes
- Nested parallelism
- Atomic operations
- Better interaction with OpenMP parallelism
- and more...

Running OpenACC Programs on NVIDIA and AMD GPUs

- `-acc  -ta=nvidia  -ta=radeon`
- Accelerators exploit parallelism, regularity
  - expose, express, exploit
    - algorithm
    - language
    - compiler + runtime + hardware

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www.openacc.org

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