LLVM AMDGPU for High Performance Computing: are we competitive yet?

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Layers of GPU computing

- **CUDA**
- **OpenCL**
- **Our work**

**Clang**
- NVIDIA proprietary compiler
- AMD proprietary compiler
- Clang

**NVIDIA proprietary driver**
- AMD proprietary driver
- Libclc, LLVM, Mesa, and amdgpu/nouveau
State of the art: CUDA and OpenCL

- **CUDA**
  - 338 applications listed at NVIDIA’s website
  - Over 50% market share in Top 500 (Nov 2016)

- **OpenCL**
  - ~70 applications listed on Wikipedia
  - ~30 in Scientific computing category
  - Couple of benchmarks and toys
OpenCL applications


- Focus on GROMACS, LAMMPS, OpenMM, ASL
Running open source OpenCL stack on Radeon/FirePro/FireStream

- AMD’s proprietary OpenCL driver and compiler
  - GPUs released 2012 or later
  - Will be open sourced soon™

- **Mesa/LLVM**
  - AMD GPUs released 2009 or later
  - Open source from the beginning™
Our work

- **No changes or minor changes in apps/libs**
- Improvements to LLVM, Clang, libclc, Mesa
  - Missing math functions, OpenCL 1.2 API calls
  - Bug fixes
GROMACS OpenCL kernel execution time

System size

Time

GROMACS OpenCL kernel execution time

AMDGPU-PRO

AMDGPU

System size

Time

GROMACS OpenCL kernel execution time

AMDGPU-PRO

AMDGPU
Other OpenCL software

- Blender
  - Different users report performance issues and crashes
- BEAGLE, phylogenetics library
  - Made some progress
- clBLAS and clFFT
  - Implemented clEnqueueFillBuffer, requires more work
  - Required for Octopus (quantum chem), probably others
Other OpenCL software

- BOINC, CP2K, Theano
  - Had users tell me “I would try it if worked”
- clpeak, opencl-stream, SNU NPB
  - Benchmarks
- App or lib you care about?
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