The Frontier Programming Environment at OLCF

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Contributors to Frontier Programming Environment

Vendor-Provided

- Cray Programming Environment (CPE)
  - Includes Cray compiler for C, C++, and Fortran plus GCC compiler. All the Cray profiling, tuning, and debugging tools. OpenMP and Cray MPI optimized for AMD GPU direct.

- AMD ROCm programming environment
  - Includes LLVM compiler to generate optimized code for both the AMD Epyc CPU and Instinct GPU. It will support: C, C++, and Fortran and have GPU offload support. HIP for converting CUDA codes to run on AMD GPUs.

Other Sources

- ECP
  - LLVM enhancements: Flang (Fortran front-end), OpenMP, OpenACC
  - Kokkos and RAJA
  - HIP LZ (HIP support for Aurora)
  - MPI, HPCToolkit, PAPI enhancements
  - …

- ALCF + OLCF
  - Pilot implementation of DPC++/SYCL for Frontier

- OLCF
  - GCC enhancements to better support OpenACC, OpenMP, Fortran on Summit and Frontier

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Programming Environment

- Compilers Offered
  - Cray PE (C/C++ LLVM-based; Cray Fortran)
  - AMD ROCm (LLVM-based)
  - GCC

- Programming Languages & Models Supported (in which compilers)
  - C, C++, Fortran (all)
  - OpenACC (GCC)   2.6 substantially complete, 2.7 planned
  - OpenMP (all)
  - HIP (Cray, AMD) – New: Cray has added HIP support to CPE
  - Kokkos/RAJA (all)
  - UPC (Cray, GCC)

- Transition Paths
  - CUDA: semi-automatic translation to HIP
  - CUDA Fortran: HIP kernels called from Fortran (a more portable approach)
    - CUDA Fortran kernels need to be translated to C++/HIP (manual process)
    - Fortran bindings to HIP and ROCm libraries and HIP runtime available through AMD's hipfort project

Items in green are also available on Summit

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Programming Tools

Debuggers and Correctness Tools

Tool
System-Level Tools
Arm DDT
Cray CCDB
Cray ATP
STAT
Node-Level Tools
ROCgdb
Cray GDB4HPC

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Performance Tools

Tool
System-Level Tools
Arm MAP/Performance Reports
CrayPat/Apprentice2 (Cray)
Reveal (Cray)
TAU
HPCToolkit
Score-P / VAMPIR
Node-Level Tools
gprof
PAPI
ROCprof
ROC-profiler & ROC-tracer libraries

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Scientific Libraries and Tools

Functionality	CPU	GPU	Notes
BLAS	**Cray LibSci**, **AMD BLIS**, PLASMA	**Cray LibSci_ACC**, **AMD roc/hipBLAS**, AMD rocAMD ROCm Tensile, **MAGMA**	MAGMA and PLASMA are open source software led by the UTK Innovative Computing Laboratory
LAPACK	**Cray LibSci**, **AMD libFlame**, PLASMA	**Cray LibSci_ACC**, **AMD roc/hipSolver**, **MAGMA**	
ScaLAPACK	Cray LibSci	ECP SLATE, Cray LibSci_ACC	
Sparse		**AMD roc/hipSparse**, AMD rocALUTION	
Mixed-precision iterative refinement	Cray IRT, MAGMA	MAGMA	
FFTW or similar	**Cray**, **AMD**, ECP FFTX, FFT-ECP	**AMD rocFFT**, ECP FFTX, FFT-ECP	FFT-ECP focuses on 3D FFTs
PETSc, Trilinos, HYPRE, SUNDIALS, SuperLU			Spack recipes from ECP xSDK

Functionality in **green** is also available on Summit

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Timeline…

- Early Access System (spock) now available
  - "n-1" hardware (processors, network, etc.)
  - With the evolving Cray and AMD programming environments

- Frontier will be delivered in 2021, with acceptance expected in first half of 2022
  - ECP expected to gain access in June 2022
  - INCITE access will ramp up from Jan 2023 to full allocation starting Jan 2024
  - ALCC access will ramp up from Jul 2023 to full allocation starting Jul 2024

In the mean time

- Summit provides many of the same tools and a similar architecture
  - Especially useful if you're new to GPU programming

- Early Access systems will provide the (evolving) software stack on near-Frontier hardware