Developing Fortran Applications: HIPFort, OpenMP®, and OpenACC

Bob Robey and Brian Cornille
CASTIEL

May 2nd, 2023

Authors and Contributors

Brian Cornille

Bob Robey

Mahdieh Ghazimirsaeed

Justin Chang

Thanks to all the AMD contributors for their work on creating these materials.

HIPFort

HIPFort

- A native GPU language solution is desired for cases with
  - CUDA Fortran conversion
  - Pure Fortran code
- HIP functions are callable from C, using `extern C`, so they can be called directly from Fortran
- The strategy here is:
  - **Manually port** CUDA Fortran code to HIP kernels in C-like syntax
  - Wrap the kernel launch in a C function
  - Call the C function from Fortran through Fortran’s ISO_C_binding.
  - Fortran 2003 is required. An improved interface is available with Fortran 2008.
  - With HIP, resulting code can run on both AMD and Nvidia GPUs
  - ROCm™ interfaces will only run on AMD GPUs

[Public]

HIPFort -- installation

- HIPFort is part of the ROCm™ software package
  - HIPFort is installed as part of the meta-packages starting with ROCM-5.4.0
  - Check to see if it is installed with your ROCm packages – check for /opt/rocm<-version>/bin/hipfc
  - May need to be specifically installed with a package install command before 5.4.0
  - PATH should include /opt/rocm<-version>/bin/hipfc
  - INCLUDE_PATH should include /opt/rocm<-version>/include/hipfort
  - LD_LIBRARY_PATH should include /opt/rocm<-version>/libexe/hipfort
  - Sample Makefile.hipfort at /opt/rocm<-version>/share/hipfort/Makefile.hipfort
- If need to do a user install
  - git clone https://github.com/ROCmSoftwarePlatform/hipfort
  - Add the hipfort/bin location to your path

CUDA Fortran -> Fortran + HIP C/C++ (I)

- There is no HIP equivalent to CUDA Fortran
- But HIP functions are callable from C, using `extern C`, so they can be called directly from Fortran
- The strategy here is:
  - **Manually port** CUDA Fortran code to HIP kernels in C-like syntax
  - Wrap the kernel launch in a C function
  - Call the C function from Fortran through Fortran’s ISO_C_binding. It requires either Fortran 2003 or a simpler version with Fortran 2008.
- This strategy should be usable by Fortran users since it is standard conforming Fortran
- ROCm™ has an interface layer for libraires, hipFort, which provides the wrapped bindings for use in Fortran
  - https://github.com/ROCmSoftwarePlatform/hipfort

More explanation -- example of hipLaunchKernelGGL wrapper

```
extern "C" {
  void launch(double **dout, double **da, double **db, int N) {
    hipLaunchKernelGGL((vector_add), dim3(320), dim3(256), 0, 0, *dout, *da,
  *db, N);
  }
}
  interface
     subroutine launch(out,a,b,N) bind(c)
       use iso_c_binding
       implicit none
       type(c_ptr) :: a, b, out
       integer, value :: N
     end subroutine
  end interface
```

Example

Install HIPFort

```
export HIPFORT_INSTALL_DIR=`pwd`/hipfort
git clone https://github.com/ROCmSoftwarePlatform/hipfort hipfort-source
mkdir hipfort-build; cd hipfort-build
cmake -DHIPFORT_INSTALL_DIR=${HIPFORT_INSTALL_DIR} ../hipfort-source
make install
export PATH=${HIPFORT_INSTALL_DIR}/bin:$PATH
```

Try a test problem

```
ROCM_GPU=`rocminfo |grep -m 1 -E gfx[^0]{1} | sed -e 's/ *Name: *//'`
cd ../hipfort-source/test/f2003/vecadd
hipfc -v --offload-arch=${ROCM_GPU} hip_implementation.cpp main.f03
./a.out
cd ../../f2008/vecadd
hipfc -v --offload-arch=${ROCM_GPU} hip_implementation.cpp main.f03
./a.out
```

Other Resources

- Github repository -- https://github.com/ROCmSoftwarePlatform/hipfort
- Lunch & Learn: Joe Schoonover: Porting multi-GPU SELF Fluids code to HIPFort
  - Part of the AMD “Lunch & Learn” series
  - https://www.youtube.com/watch?v=RGDmu29T4ik
- FortranCon2021: HIPFort: Present and Future Directions for Portable GPU Programming in Fortran
  - Alessandro Fanfarillo, AMD staff
  - https://www.youtube.com/watch?v=tunH_GUeiPg

Thank you!

Disclaimer

The information presented in this document is for informational purposes only and may contain technical inaccuracies, omissions, and typographical errors. The information contained herein is subject to change and may be rendered inaccurate for many reasons, including but not limited to product and roadmap changes, component and motherboard version changes, new model and/or product releases, product differences between differing manufacturers, software changes, BIOS flashes, firmware upgrades, or the like. Any computer system has risks of security vulnerabilities that cannot be completely prevented or mitigated. AMD assumes no obligation to update or otherwise correct or revise this information. However, AMD reserves the right to revise this information and to make changes from time to time to the content hereof without obligation of AMD to notify any person of such revisions or changes.

THIS INFORMATION IS PROVIDED ‘AS IS.” AMD MAKES NO REPRESENTATIONS OR WARRANTIES WITH RESPECT TO THE CONTENTS HEREOF AND ASSUMES NO RESPONSIBILITY FOR ANY INACCURACIES, ERRORS, OR OMISSIONS THAT MAY APPEAR IN THIS INFORMATION. AMD SPECIFICALLY DISCLAIMS ANY IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR ANY PARTICULAR PURPOSE. IN NO EVENT WILL AMD BE LIABLE TO ANY PERSON FOR ANY RELIANCE, DIRECT, INDIRECT, SPECIAL, OR OTHER CONSEQUENTIAL DAMAGES ARISING FROM THE USE OF ANY INFORMATION CONTAINED HEREIN, EVEN IF AMD IS EXPRESSLY ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

AMD, the AMD Arrow logo, ROCm and combinations thereof are trademarks of Advanced Micro Devices, Inc. Other product names used in this publication are for identification purposes only and may be trademarks of their respective companies.

The OpenMP name and the OpenMP logo are registered trademarks of the OpenMP Architecture Review Board.

Git and the Git logo are either registered trademarks or trademarks of Software Freedom Conservancy, Inc., corporate home of the Git Project, in the United States and/or other countries

HPE is a registered trademark of Hewlett Packard Enterprise Company and/or its affiliates.

LLVM is a trademark of LLVM Foundation

Siemens is a registered trademark of Siemens Product Lifecycle Management Software Inc., or its subsidiaries or affiliates, in the United States and in other countries

© 2022 Advanced Micro Devices, Inc. All rights reserved.

AMD