Flang: Developing an open source Fortran front-end for LLVM

ARM HPC User Group 2016

Doug Miles, PGI Compilers & Tools, NVIDIA Corporation, 14 November, 2016

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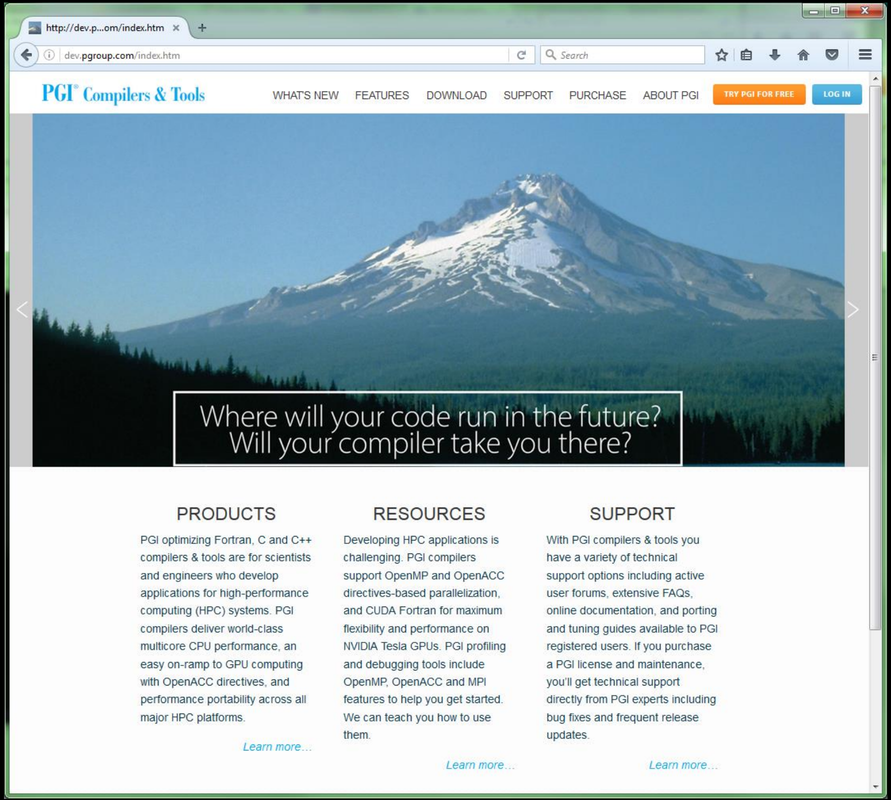

PRODUCTS

PGI optimizing Fortran, C and C++ compilers & tools are for scientists and engineers who develop applications for high-performance computing (HPC) systems. PGI compilers deliver world-class multicore CPU performance, an easy on-ramp to GPU computing with OpenACC directives, and performance portability across all major HPC platforms.

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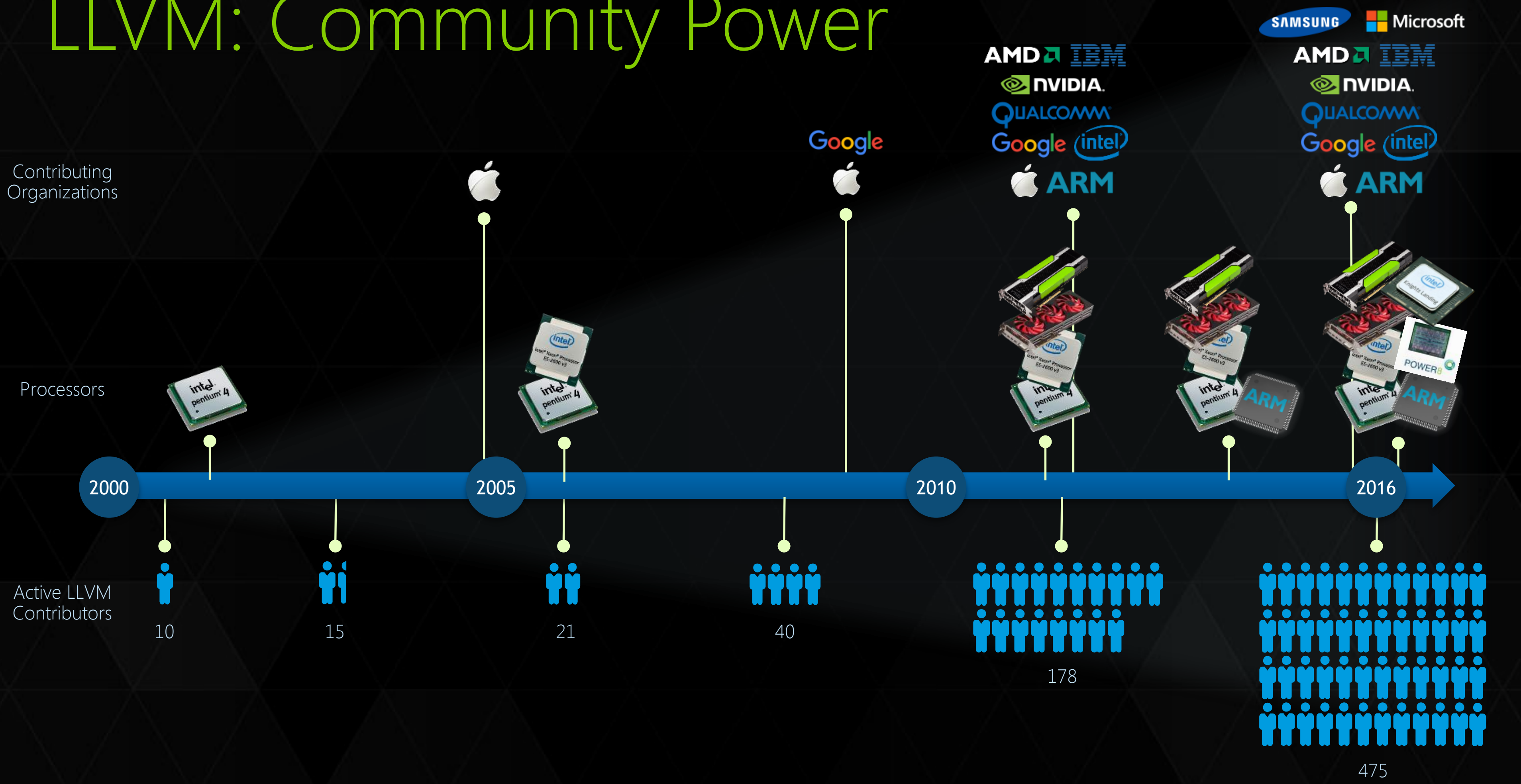
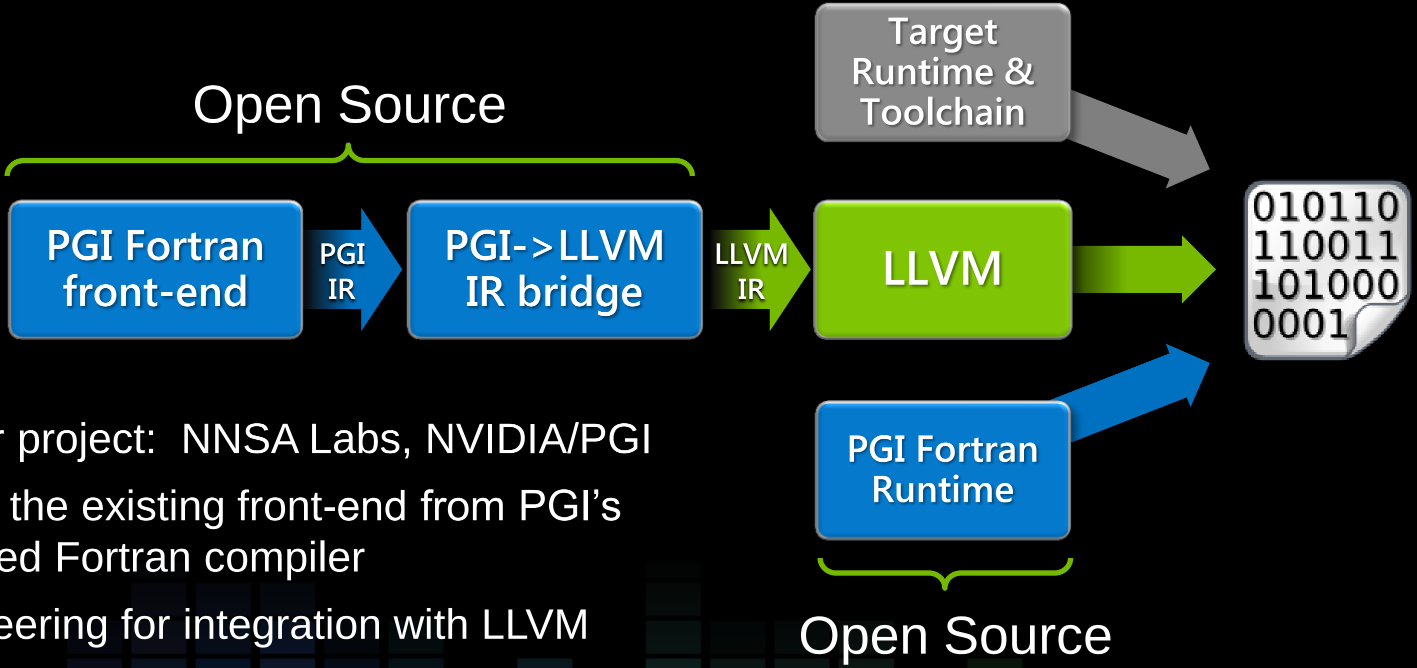


An open source Fortran front-end for LLVM
a.k.a. the Flang project

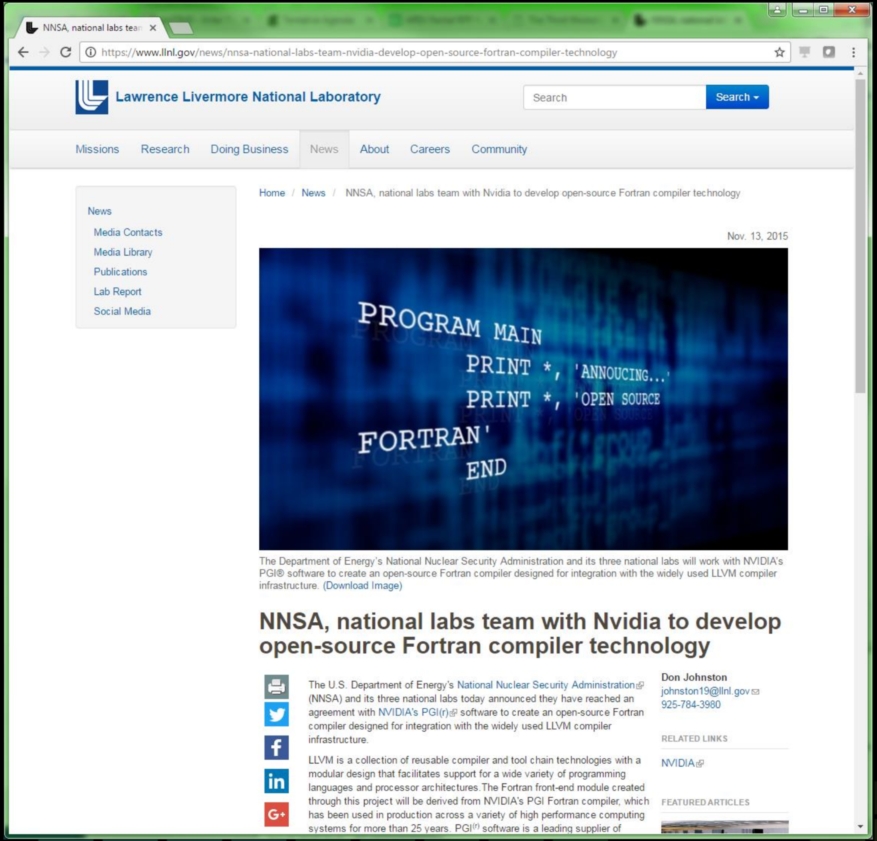


- Multi-year project: NNSA Labs, NVIDIA/PGI
- Based on the existing front-end from PGI's widely-used Fortran compiler
- Re-engineering for integration with LLVM
- Develop CLANG-quality Fortran msg facility

Many Stakeholders, Many Goals

LANL	New developer productive in source base in 4 – 8 weeks
Sandia	Single-thread/SIMD and OpenMP 3.1 performance
LLNL	OpenMP 4.x features, GPU and OpenPOWER support
NVIDIA	Accelerate Fortran features support, PGI interoperability
Everyone	Adoption by both the HPC and LLVM communities

ANL, IBM, ARM Ltd, ORNL, Codethink, …



Home / News / NNSA, national labs team with Nvidia to develop open-source Fortran compiler technology

Nov. 13, 2015

```
PROGRAM MAIN
      PRINT *, 'ANNOUCING...'
      PRINT *, 'OPEN SOURCE
FORTRAN'
      END
```

The Department of Energy's National Nuclear Security Administration and its three national labs will work with NVIDIA's PGI® software to create an open-source Fortran compiler designed for integration with the widely used LLVM compiler infrastructure. (Download Image)

NNSA, national labs team with Nvidia to develop open-source Fortran compiler technology

The U.S. Department of Energy's National Nuclear Security Administration (NNSA) and its three national labs today announced they have reached an agreement with NVIDIA's PGI(r) software to create an open-source Fortran compiler designed for integration with the widely used LLVM compiler infrastructure.

LLVM is a collection of reusable compiler and tool chain technologies with a modular design that facilitates support for a wide variety of programming languages and processor architectures. The Fortran front-end module created through this project will be derived from NVIDIA's PGI Fortran compiler, which has been used in production across a variety of high performance computing systems for more than 25 years. PGI(r) software is a leading supplier of

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Creating the initial Flang source base

- Front-end 85%
- Runtime Libraries 15%

- Front-end 85%
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- Front-end 80%
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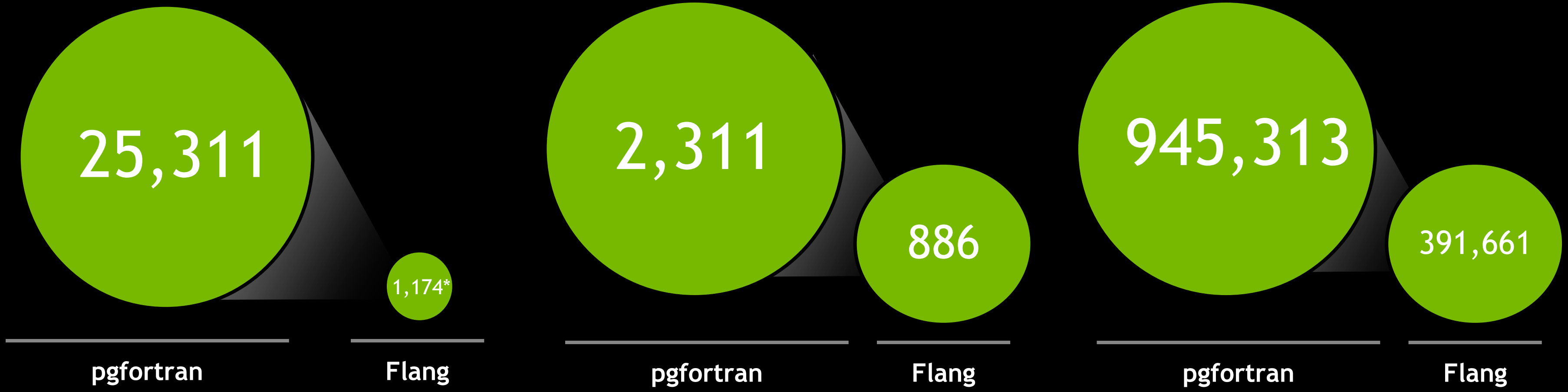


95% fewer #ifdefs

62% fewer files

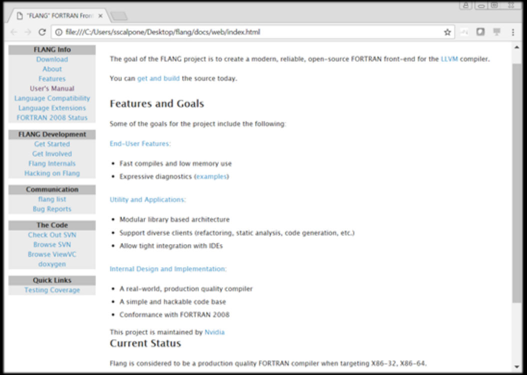
59% fewer LOC

*Clang has 212 #ifdefs in lib, include, tools

Flang Development Status

- Source code clean-up, refactoring & documentation ongoing
- Vendor neutrality nearly complete
- Frequent source and Flang binary updates to partners
- Passes most PGI Fortran Linux/x86 QA tests
- SIMD vectorization via the LLVM vectorizer, tuning ongoing
- Most of OpenMP 4.5 is implemented (CPU-side only)

Flang Source Code



"FLANG" FORTRAN Fron

file:///C:/Users/sscalpone/Desktop/flang/docs/web/index.html

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The goal of the FLANG project is to create a modern, reliable, open-source FORTRAN front-end for the LLVM compiler.

You can get and build the source today.

Features and Goals

Some of the goals for the project include the following:

End-User Features:

- Fast compiles and low memory use
- Expressive diagnostics (examples)

Utility and Applications:

- Modular library based architecture
- Support diverse clients (refactoring, static analysis, code generation, etc.)
- Allow tight integration with IDEs

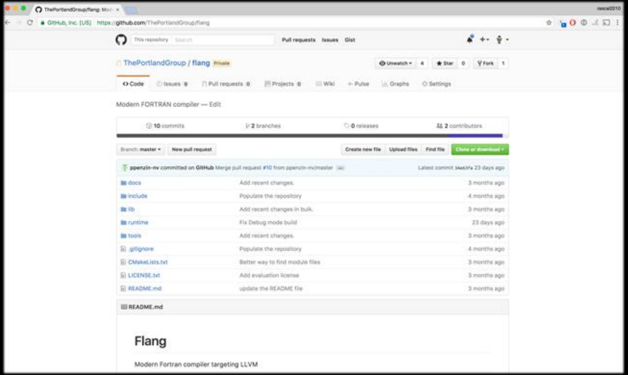
Internal Design and Implementation:

- A real-world, production quality compiler
- A simple and hackable code base
- Conformance with FORTRAN 2008

This project is maintained by Nvidia

Current Status

Flang is considered to be a production quality FORTRAN compiler when targeting X86-32, X86-64.



ThePortlandGroup/flang: Mo

GitHub, Inc. [US] https://github.com/ThePortlandGroup/flang

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Modern FORTRAN compiler — Edit

10 commits 2 branches 0 releases 2 contributors

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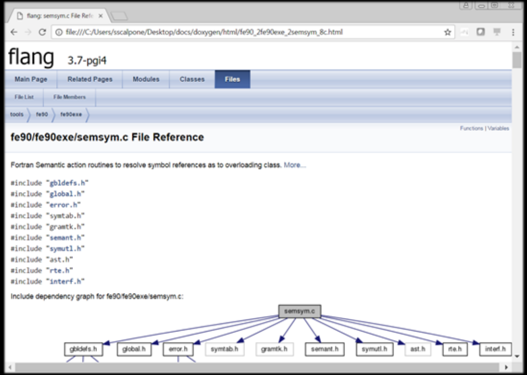
ppenzin-nv committed on GitHub Merge pull request #10 from ppenzin-nv/master Latest commit 23 days ago

docs	Add recent changes.	3 months ago
include	Populate the repository	4 months ago
lib	Add recent changes in bulk.	3 months ago
runtime	Fix Debug mode build	23 days ago
tools	Add recent changes.	3 months ago
.gitignore	Populate the repository	4 months ago
CMakeLists.txt	Better way to find module files	3 months ago
LICENSE.txt	Add evaluation license	3 months ago
README.md	update the README file	3 months ago

README.md

Flang

Modern Fortran compiler targeting LLVM



flang: semsym.c File Refe

file:///C:/Users/sscalpone/Desktop/docs/doxygen/html/fe90_2fe90exe_2semsym_8c.html

flang 3.7-pgi4

Main Page Related Pages Modules Classes Files

File List File Members

tools fe90 fe90exe

Functions | Variables

fe90/fe90exe/semsym.c File Reference

Fortran Semantic action routines to resolve symbol references as to overloading class. More...

```
#include "gbldefs.h"
#include "global.h"
#include "error.h"
#include "symtab.h"
#include "gramtk.h"
#include "semant.h"
#include "symutl.h"
#include "ast.h"
#include "rte.h"
#include "interf.h"
```

Include dependency graph for fe90/fe90exe/semsym.c:

Home page

Github

Doxygen

Flang Single-core Performance

SPEC CPU 2006 Fortran codes, all times in seconds, 1 Haswell core

	PGI FORTRAN 16.10	GFORTRAN 6.1	FLANG DEV LLVM 3.9
410.bwaves	182s	220s	251s
416.gamess	507s	Fails	475s
434.zeusmp	183s	221s	240s
436.cactusADM	165s	194s	208s
437.leslie3d	179s	209s	435s
454.calculix	171s	297s	608s
459.GemsFDTD	261s	286s	391s
465.tonto	295s	373s	Fails
481.wrf	157s	271s	247s

PGI Fortran: -fast -Mfprelaxed -Mstack_arrays gfortran: -O3 -funroll-loops -fpeel-loops -ffast-math Flang: -O3 -march=core-avx2 -ffp-contract=fast -Knoieee
Performance measured November, 2016 and are considered estimates per SPEC run and reporting rules. SPEC® and SPEC CPU® are registered trademarks of the Standard Performance Evaluation Corporation (www.spec.org).

Flang OpenMP Performance

SPEC OMP 2012 Fortran codes, all times in seconds, 32 Haswell cores (64 threads)

	PGI FORTRAN 16.10	GFORTRAN 6.1	FLANG DEV LLVM 3.9
350.md	517s	3460s	459s
351.bwaves	469s	519s	805s
357.bt331	449s	492s	474s
360.ilbdc	541s	6846s	539s
362.fma3d	575s	504s	656s
363.swim	633s	634s	632s
370.mgrid	693s	697s	690s
371.applu	451s	414s	514s

PGI Fortran: -fast -mp -Mfprelaxed -Mstack_arrays gfortran: -O3 -funroll-loops -fpeel-loops -ffast-math –fopenmp
Flang: -O3 -mp -march=core-avx2 -ffp-contract=fast -Knoieee All: OMP_NUM_THREADS=64 OMP_PROC_BIND=true
Performance measured November, 2016 and are considered estimates per SPEC run and reporting rules. SPEC® and SPEC OMP®
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Flang Year 2 Development Plans

- Source code
  - Continue source clean-up, refactoring, documentation
  - Create repository and release as open source
  - Deploy an open source testing infrastructure
- Features
  - Enhance compile-time Fortran error/warning messages
  - Incremental F08 and OpenMP 4.5 features
  - LLVM enhancements to enable Fortran DWARF generation
- Performance
  - Incremental, likely to be reactive after initial pass is done