Using IU Jetstream for OpenMP offloading and OpenACC testsuites

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1 INTRODUCTION

The need for efficient scientific code has become increasingly prevalent. While computer hardware platforms are rapidly improving, the programs that run on these platforms also require improvement as to assist researchers in their tasks. One way developers have resolved this is by directive-based programming, which uses a construct, labeled directive or pragma, to specify how the compiler should process the input. This project focuses on the use of two directive-base programming models designed to simplify parallel computing, OpenMP and OpenACC, on the XSEDE's cloud based computer, Jetstream [5] [6].

OpenMP, first developed in 1997, is an API which allows programmers to use directives to increase efficiency in C, C++ and Fortran code. OpenMP allows for manipulation of processing threads to create parallelization so processes complete more quickly, with later versions including GPU threads. Similarly, OpenACC, developed in 2011, increases performance in C, C++ and Fortran code with the use of directives, manipulation of memory management and parallelization.

In order to utilize the functionality of OpenACC and OpenMP, compilers such as GCC, Clang, Nvidia HPC SDK, etc must support the specifications [1] [2]. As the OpenACC and OpenMP specifications evolve, it becomes common for developers to interpret features differently, leading to the development of the Verification and Validation suites, which ensures compiler conformity to the specification.

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2 TESTSUITE METHODOLOGIES

When the OpenACC and OpenMP parallel programming models update their specifications, it is likely that new directives and new clauses will be included. In order to create a test for a new clauses or new directive, the corresponding section of the specification is analyzed to formulate a simple function that would return an error if the directive is not working properly. In the scenario where certain compilers cause errors while other's don't, it is reasoned that compilers do not have the proper implementation, and a bug report is filed with the vendor. If the test does not pass on any compilers, a cause could be that the directive's specification is unclear or misleading, and is discussed with OpenMP or OpenACC. Finally, the test is reviewed publicly with the corresponding communities to ensure it aligns with the specification.

3 EXPERIMENTAL SETUP

The XSEDE cloud based HPC system, Jetstream, allows users to create instant Virtual Machines (VM) and is ideal for scientific, engineering and educational purposes. Due to it's accessibility, the Jetstream system is a likely candidate for OpenMP and OpenACC use and was selected for testing with the validation suites. While GPUs are available on this system, we were only able to test OpenACC within the heterogeneous platform. Due to the issues encountered when utilizing OpenMP, we only tested it on multi-core CPUs. The test suites do run on other HPC systems as well, including Oak Ridge National Lab's Spock, Tulip, Summit and Cori systems. The results are listed on the respective OpenMP or OpenACC Validation and Verification website [4] [3].

4 RESULTS

The Jetstream system, utilizing OpenMP and the Nvidia HPC compiler, was tested 398 times, with 234 passing and 164 failures - a passing rate of 58.8 percent [4]. This is likely due to the lack of implementation by the Nvidia compiler and not the system architecture. With the implementation of the Nvidia HPC OpenACC 2.6 compiler, the OpenACC test suite was run on Jetstream for 817 tests, passing 683 tests, and failing 134 tests - a passing rate of 83.6 percent [3]. This improvement demonstrated Nvidia's OpenACC compiler to be an excellent choice when paired with the Jetstream system. In the future, more compilers will be tested on the Jetstream system to display in-depth results.

5 CONCLUSION

Researchers often run code which can take days to complete, from weather models to arithmetic calculations. Using OpenMP or OpenACC, the time for completion can be cut down drastically. The validation and verification suites assist compiler vendors in their accordance to the specification, and researchers in their decisions on compilers, computer systems and hardware. Each testsuite will be updated and evolve as OpenMP and OpenACC evolve in the future.

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