CCE/8.4.0 Beta
Feedback from NERSC Users

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Oct 20, 2015, Cray Quarterly Meeting
CCE/8.4.0 Beta Program

- NERSC participated the beta program to help improving the quality of the Cray’s official CCE release.
- Beta program duration: July 20 – Aug 14 (later extended to Sept 24, when CCE/8.4.0 was officially released)
- CCE/8.4.0.215 installed on Edison on July 22. However, license was not available until July 30.
- Notified 90 users who have used CCE this year. Collected feedback.
- CCE/8.4.0.219 installed on Aug 11.
- NERSC provided user feedback to Cray on Aug 13.
CCE 8.4 Major Features

- Support for the C++11 language standard.
- Support for the OpenMP 4.0 specification.
- Support for the inline assembly ASM construct for x86 processor targets.
- Support for GNU extensions by default (-h gnu option).
- Performance improvements for Cray XE, Cray XK, Cray XC, and Cray CS series systems.
- Bug fixes.
NERSC User #1 (Valery Weber)

- **INC0070995**, provided 7 codes with either Internal Compiler Error, or wrong runtime results.
  - Submitted cases in CrayPort on Aug 13. Turned into 7 bugs. 3 resolved so far
  - Bug 830848, Internal compiler error (allocatable). Confirmed
  - Bug 830850, Internal compiler error (simd). Resolved on Sept 11
  - Bug 830851, Internal compiler error (udr). Confirmed
  - Bug 830844, run time error (allocatable). Confirmed
  - Bug 830849, compile error (atomic). Resolved on Sept 16
  - Bug 830847, compile error (alloc-comp). In progress.
  - Bug 830842, compile error (associate). Resolved on Sept 11.

- **Question:** Is it possible to use 8.4 to do offloading on GPU or MIC somewhere at NERSC?
  - We do not have GNU system at NERSC
  - CCE is not supported on MIC (will support KNL on Cori)

- **NERSC ticket INC0067318 reported May 19 with CCE/8.3.9.**
  - Bug 826470: CCE OpenMP firstprivate error with default initialized components and -g
  - User reported on July 31 that bug still not fixed under CCE/8.4.0.215.
  - Bug resolved on Aug 5
• **INC0070627**: Reported problem on Aug 1
  – Internal compiler error, using a 50-line sample test code
  – Works with CCE/8.3.11, but not with CCE/8.4.0
• **Bug 829300**: “Bug in ftn beta CCE 8.4 release” created on Aug 3
• **Bug resolved on Aug 6**, fix is in the official release
• Requested pre-release CCE documentation  
  – Received.

• Reported cmake could not detect C++ features

• Case #114730 created on Aug 3: “CCE/8.4.0.215: missing include file for c++11 standard “

  % CC -h std=c++11 -openmp xthi.c
  CC-5 craycc: ERROR File = /opt/cray/mpt/7.2.1/gni/mpich2-cray/83/include/mpi.h, Line = 42
  The source file "cstdint" is unavailable.
  # include <cstdint>
  ^

• Fix for bug 830846 is in official CCE/8.4.0 release.
Cray Staff (Marcus Wagner)

- Marcus has been working with NCAR CESM team on using CCE/8.4.0 internal releases to compile and run CESM
- Opened many private bugs on CCE/8.4.0.xxx
  - General compiler bugs
  - Bugs related to OpenMP
  - Bugs on performance issues (degradation, or slower than Intel compiler)
- Status as of Aug 13: CESM runs with pure MPI. And it runs faster than Intel compiler.
  - A sample case run time:
    - CCE/8.4.0.215: TOT Run Time: 145 seconds
    - Intel/15.0.3.187: TOT Run Time: 160 seconds
- Status as of Aug 13: CESM has run time error with hybrid MPI/OpenMP
  - Two bugs filed related to deep_copy and deep_privatize run time errors
- Status as of Aug 19
  - The above 2 bugs were fixed. CESM with hybrid MPI/OpenMP runs successfully with CCE/8.4.0 internal version, and slightly faster than Intel compiler.
  - CCE/8.4.0: # simulated years / cmp-day = 27.522
  - Intel/15.0.3: # simulated years / cmp-day = 26.987
  - However, CCE compile time is much slower than Intel compile time. Bug filed.
Cray Staff (Marcus Wagner)

• The OpenMP-4.0 Specification states
  – The type of list items appearing in the aligned clause must be C_PTR or Cray Fortran pointer, or the list item must have the POINTER or ALLOCATABLE attribute.

• CCE/8.4.0.211 does not compile *.F90 sources containing "$OMP SIMD ALIGNED (...)" clauses that does not comply with this restriction
  – Should OpenMP standard relax this requirement?
  – Should CCE relax this requirement?

• The Intel compiler compiles “"OMP SIMD ALIGNED (...)” anyway and achieves speedup

• Helen raised it with OpenMP Committee in Sept.
  – The requirement is going to be relaxed in OpenMP 4.1 standard.
NERSC User #4 (Jim Edwards), NCAR CESM

- Working on testing CESM with the CCE compiler.
- Reported a compiler bug.
- Thinks that the compiler is working well enough that it can be added to the CESM test suite to assure new problems going forward being introduced.
- This is a big step for the CESM team to be able to use Cray compilers.
• Optimizing CESM kernels using Intel and CCE compilers.
• CCE outperforms Intel compiler consistently.
• CCE/8.4.0.219 can vectorize loops having dependency as below:
  
  ```
  do k=1,nlayers
    urad(k) = urad(k-1) ... <- recursion in k
  enddo
  ```

  – Intel/15.0.1: major computational loop did not vectorize
    • Not able to restructure code to vectorize loops
  – cce/8.4.0.219: major computational loop did vectorize
    • What trick did CCE use 😊? Reverse loop ordering?

• In one case: Doubly nested conditionals in loops prevent vectorization; So precomputed conditionals outside loop
  – Intel compiler vectorized major computational loops
  – CCE does not vectorize major computational loops
  – Marcus filed a performance bug on CCE
Summary

- Sent slides presented today to Cray on Aug 13
- Cray acknowledged our feedback was very helpful
- With cases and bugs opened, the turnaround time for resolution was very quick (thank you!)
- Fixes are included in official 8.4.0 release
- The beta program directly benefits users at NERSC and other sites
Thank you.