

OpenMP[®]

SC'20 Booth Talk Series

SOLLVE OpenMP Validation and Verification Effort

ECP Project WBS 2.3.1.13 STPM15

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SOLVE OpenMP V&V: The Team

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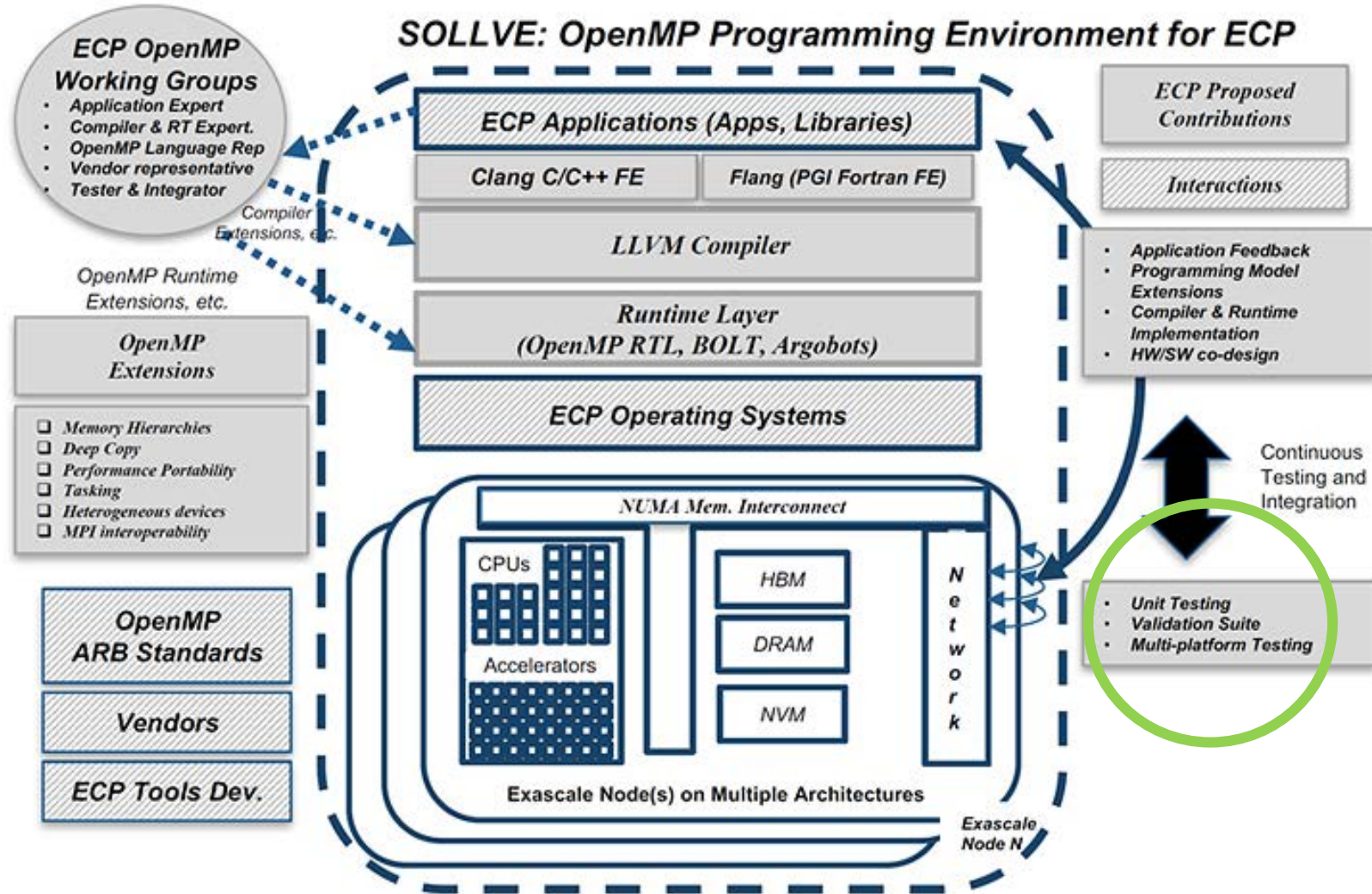
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Outline

- Introduction
 - What is SOLLVE ?
 - Scope and Intent of the Validation and Verification Suite
 - OpenMP Offload (4.x+) Machine Model
 - OpenMP 5.0 New Features
- Validation and Verification Suite
 - Test design process
 - Examples
 - Infrastructure design
- Sample Results
- Success Stories
- Ways to collaborate

Introduction: The SOLLVE ECP Project

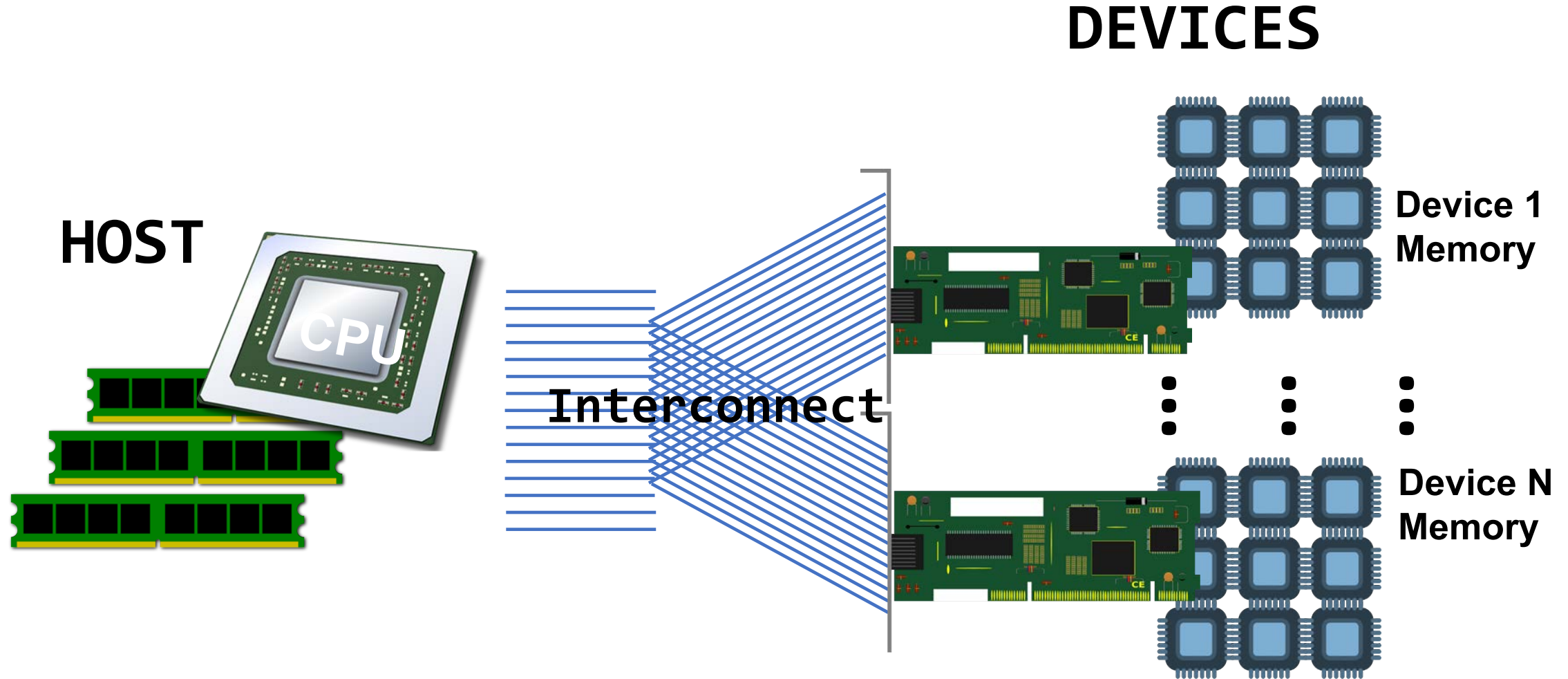


Introduction: Scope and Intent of V&V suite

- Verify the status of OpenMP implementations across ECP platforms
- Evaluation of OpenMP functionality and performance on target architectures
- Check implementations' conformance to the OpenMP standard
- Tests and kernels primarily motivated by ECP Applications
- Verify platforms are ready for OpenMP applications

Introduction: OpenMP Offload (4.x+)

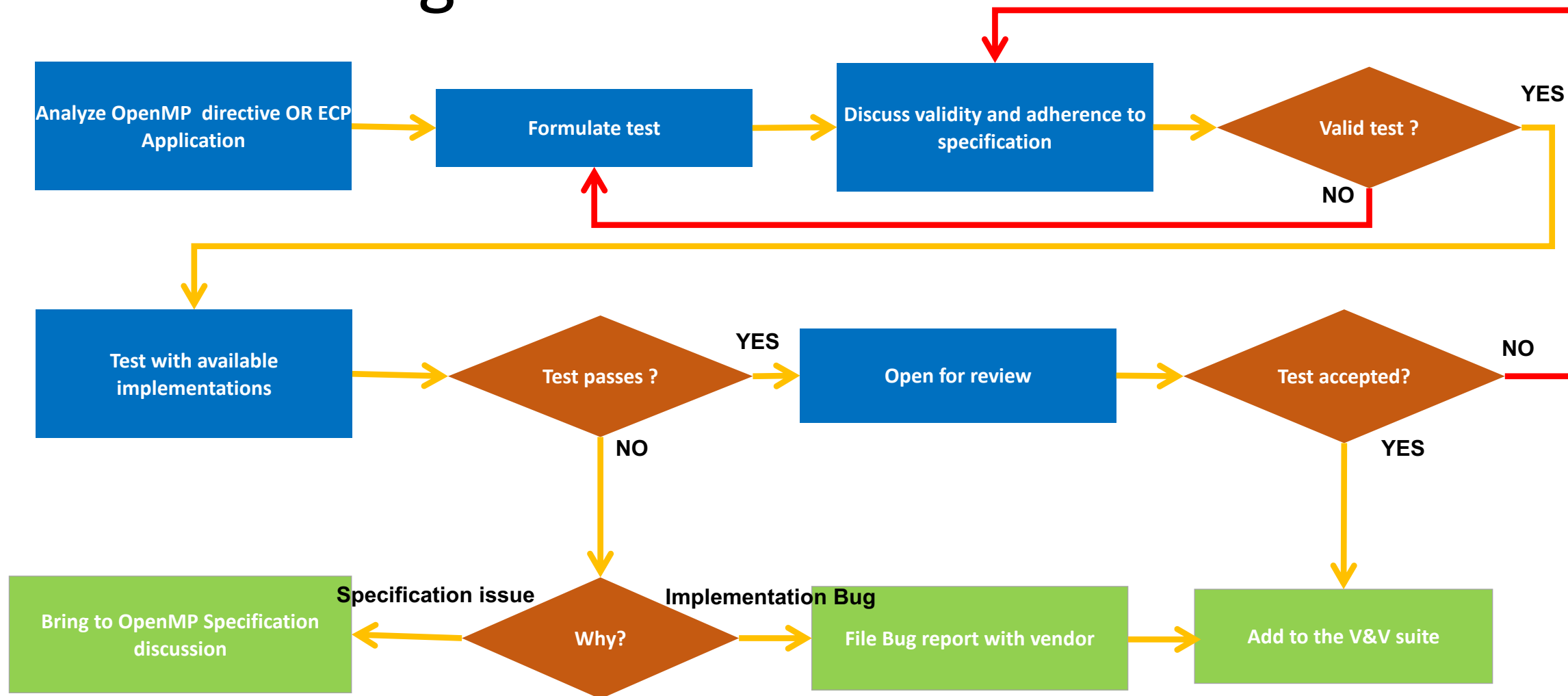
Machine Model



Introduction: OpenMP 5.0 New Features

- OpenMP contexts, metadirective, and declare variant
- Addition of requires directive, including support for unified shared memory
- Memory allocators and support for deep memory hierarchies
- Descriptive loop construct
- Release/acquire semantics added to memory model
- First (OMPT) and third (OMPD) party tool support
- Completed support for Fortran 2003
- Added support for Fortran 2008, C11, C++11, C++14 and C++17

V&V: Test Design Process



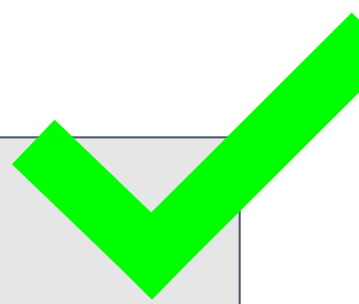
V&V Example 1: Understanding Spec.

```
#pragma omp target data map(tofrom: a[0:ARRAY_SIZE]) {  
#pragma omp target teams distribute  
    ...  
}
```

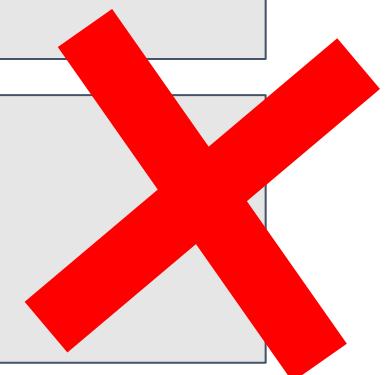
```
#pragma omp target data map(tofrom: a[0:ARRAY_SIZE/2]) {  
#pragma omp target teams distribute  
    ...  
}
```

V&V Example 1: Understanding Spec.

```
#pragma omp target data map(tofrom: a[0:ARRAY_SIZE]) {  
#pragma omp target teams distribute  
    ...  
}
```

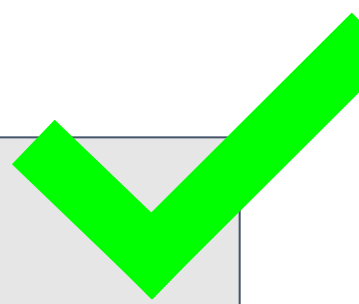


```
#pragma omp target data map(tofrom: a[0:ARRAY_SIZE/2]) {  
#pragma omp target teams distribute  
    ...  
}
```

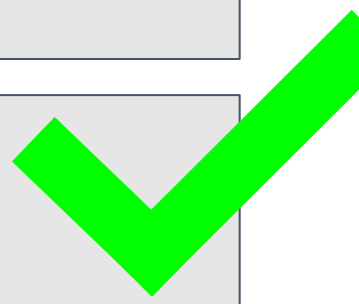


V&V Example 1: Understanding Spec.

```
#pragma omp target data map(tofrom: a[0:ARRAY_SIZE]) {  
#pragma omp target teams distribute map(alloc: a[0:ARRAY_SIZE])  
    ...  
}
```



```
#pragma omp target data map(tofrom: a[0:ARRAY_SIZE/2]) {  
#pragma omp target teams distribute map(alloc: a[0:ARRAY_SIZE/2])  
    ...  
}
```



- Specification doesn't explicitly mention this requirement, but it is an implication arising from multiple interacting sections of the specification
- Prone to misinterpretation by vendors — XLC compiles and runs with no complaint, Clang gives a compile error explaining the problem, and GCC gives a runtime error

V&V Example 2: Ambiguous Specification

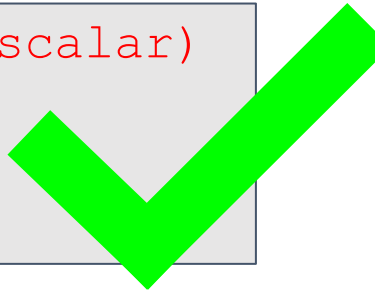
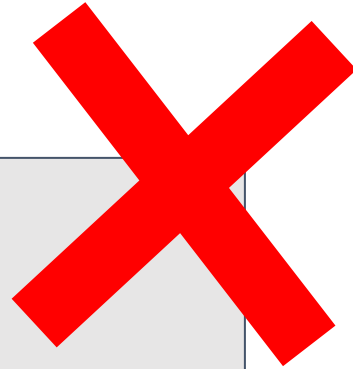
14 Restrictions

- 15 • A list item cannot appear in both a **map** clause and a data-sharing attribute clause on the same
16 construct.

(From map clause specification, pg. 218)

```
#pragma omp target teams distribute shared(share) map(tofrom:share)
for (int x = 0; x < SIZE; ++x) {
    ...
}
```

```
#pragma omp target teams distribute shared(share) defaultmap(tofrom:scalar)
for (int x = 0; x < SIZE; ++x) {
    ...
}
```



V&V Example 3: Test from Application

```
#pragma omp target map(tofrom: a, sum) depend(out: a) nowait
{
    for (i = 0; i < N; i++) {
        sum++;
    }
    a += 1;
}

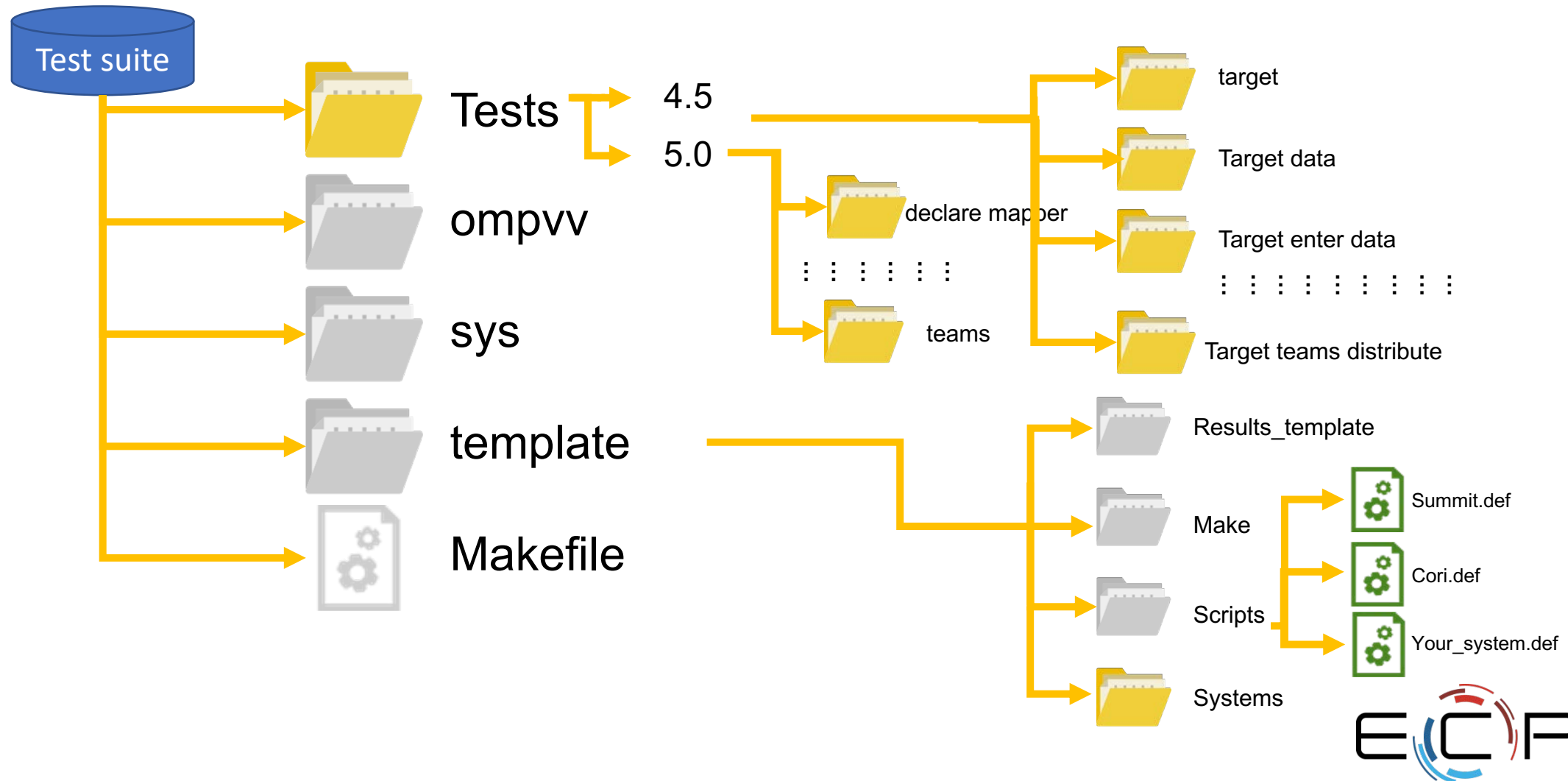
#pragma omp task depend(in: a) shared(a, errors)
{
    if(a != 1) {
        errors += 1;
    }
}

#pragma omp taskwait
if (sum != N) {
    errors++;
}
```

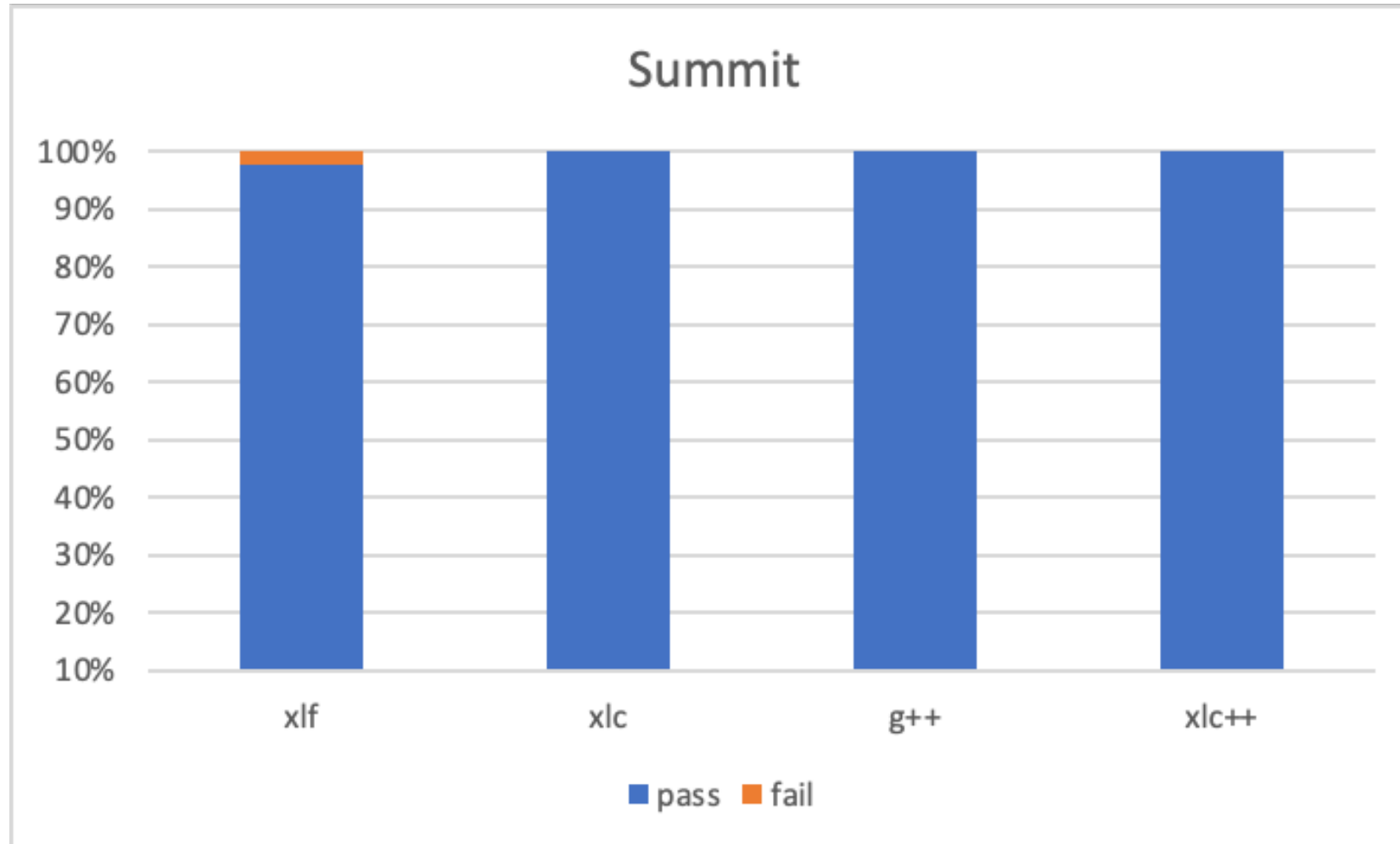
V&V: Infrastructure Design

- Our infrastructure is based on a **Makefile + scripts**
- Design parameters:
 - Portability across multiple **compilers** and **systems** and easy to use
 - Support for different compiler options
 - Support for Lua-like Modules and batch schedulers
 - Fast test addition and modification
 - Divided compilation and execution phases
 - Subset of tests selection for partial execution

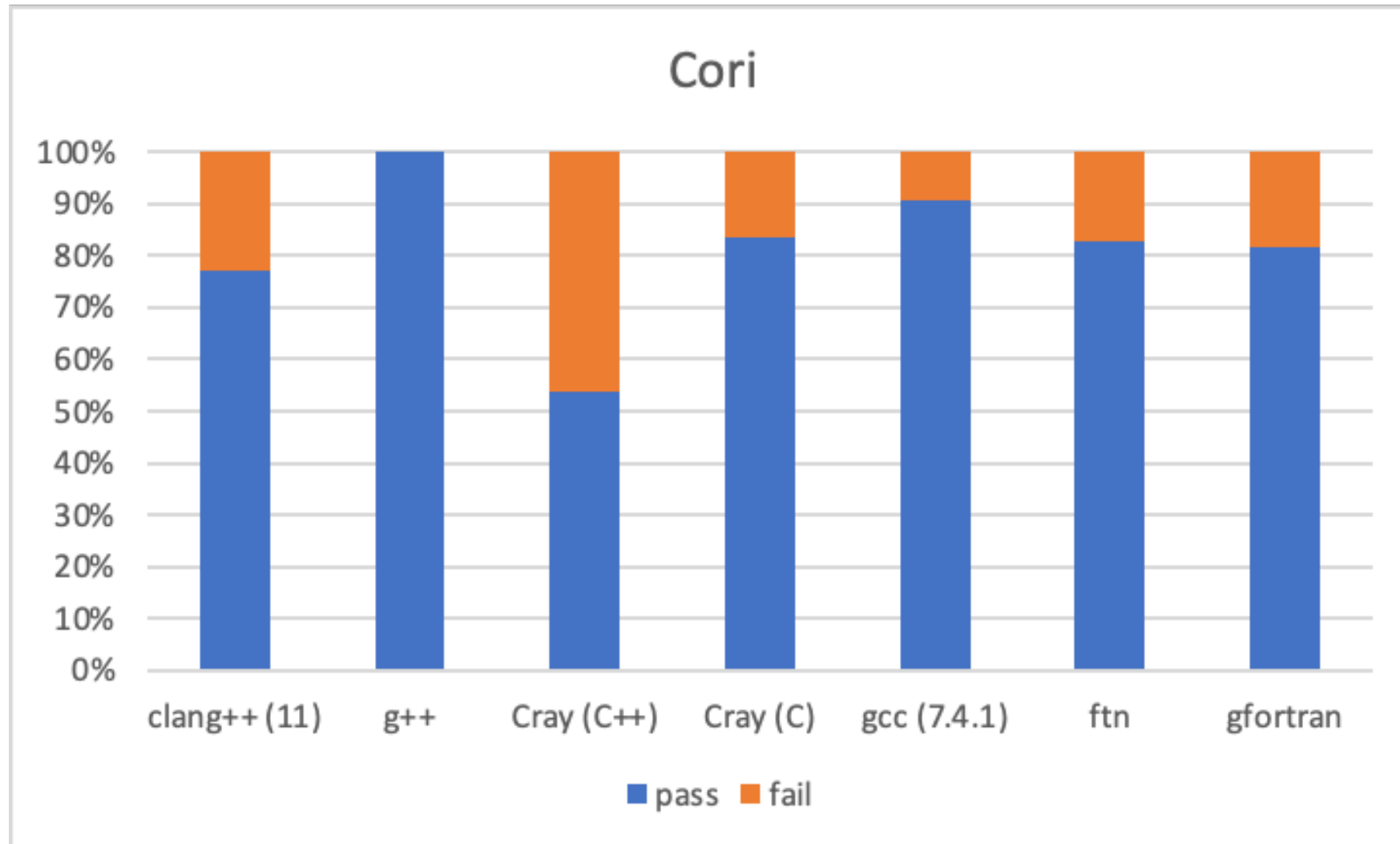
V&V: Infrastructure Design (cont.)



Sample Results: Summit

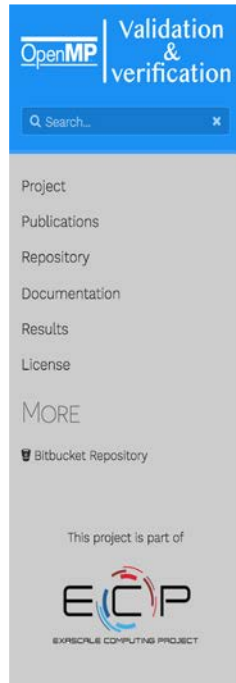


Sample Results: Cori



Sample Results: Current status of OMP Compilers

<https://crpl.cis.udel.edu/ompvvsolve/>



OPENMP VALIDATION AND VERIFICATION

This website contains all related to the OpenMP Validation and Verification suite developed as part of the [Exascale Computing Project \(ECP\)](#). In particular the Scaling OpenMP Via LLVM for Exascale Performance and Portability (SOLLVE) project.

This project is a collaboration of



| | | | | | | |
|----------------------|------------------------------|-----------|---------------------------|------|------|--|
| Front Page > Results | | | | | | |
| 391 | test_target_update_depend.c | summit | clang version 3.8.0 CORAL | PASS | PASS | |
| 392 | test_target_update_depend.c | summit | xlc 16.01.0001.0000 | PASS | PASS | |
| 393 | test_target_update_depend.c | summitdev | clang version 3.8.0 CORAL | PASS | PASS | |
| 394 | test_target_update_depend.c | summitdev | gcc 7.11 | PASS | PASS | |
| 395 | test_target_update_depend.c | summitdev | xlc 13.01.0006.0001 | PASS | PASS | |
| 396 | test_target_update_depend.c | titan | cc 8.7.5 | PASS | PASS | |
| 397 | test_target_update_devices.c | summit | clang version 3.8.0 CORAL | PASS | PASS | |
| 398 | test_target_update_devices.c | summit | xlc 16.01.0001.0000 | PASS | FAIL | |
| 399 | test_target_update_devices.c | summitdev | clang version 3.8.0 CORAL | PASS | PASS | |
| 400 | test_target_update_devices.c | summitdev | gcc 7.11 | PASS | PASS | |
| 401 | test_target_update_devices.c | summitdev | xlc 13.01.0006.0001 | PASS | FAIL | |
| 402 | test_target_update_devices.c | titan | cc 8.7.5 | PASS | PASS | |
| 403 | test_target_update_from.c | summit | clang version 3.8.0 CORAL | PASS | PASS | |
| 404 | test_target_update_from.c | summit | xlc 16.01.0001.0000 | PASS | PASS | |
| 405 | test_target_update_from.c | summitdev | clang version 3.8.0 CORAL | PASS | PASS | |
| 406 | test_target_update_from.c | summitdev | gcc 7.11 | PASS | PASS | |
| 407 | test_target_update_from.c | summitdev | xlc 13.01.0006.0001 | PASS | PASS | |
| 408 | test_target_update_from.c | titan | cc 8.7.5 | PASS | PASS | |
| 409 | test_target_update_ifc | summit | clang version 3.8.0 CORAL | PASS | PASS | |
| 410 | test_target_update_ifc | summit | xlc 16.01.0001.0000 | PASS | PASS | |
| 411 | test_target_update_ifc | summitdev | clang version 3.8.0 CORAL | PASS | PASS | |
| 412 | test_target_update_ifc | summitdev | gcc 7.11 | PASS | PASS | |
| 413 | test_target_update_ifc | summitdev | xlc 13.01.0006.0001 | PASS | PASS | |
| 414 | test_target_update_ifc | titan | cc 8.7.5 | PASS | PASS | |

Front Page > Results

These results were last reviewed on Sunday January 13th 2019

Filter results

Search Results

Compilers

clang version 3.8.0 CORAL

xlc 16.01.0001.0000

gcc 7.11

Systems

summit

summitdev

titan

Compiler results ☒ Both ☐ FAIL ☐ PASS

Test run results ☒ Both ☐ FAIL ☐ PASS

| # | Source code | Test name | Test system | Compiler name | Compiler result | Runtime res |
|---|--------------------------------|-----------|-------------|---------------------------|-----------------|-------------|
| 1 | ompvn_template.c | | summit | clang version 3.8.0 CORAL | PASS | PASS |
| 2 | linked_list.c | | summit | clang version 3.8.0 CORAL | PASS | PASS |
| 3 | mmm_target.c | | summit | clang version 3.8.0 CORAL | PASS | PASS |
| 4 | mmm_target_parallel_for_simd.c | | summit | clang version 3.8.0 CORAL | PASS | PASS |



Success Stories

- Cray and AMD are actively using SOLLVE V&V tests to verify correctness and coverage of new features introduced in OpenMP 4.5 and 5.0 (on-going effort).
- Vendors are actively engaging to improve coverage and bug fixes.
- Implementation bugs were identified in the GCC, IBM, and Cray implementations and have been brought to the vendor's attention.
- OLCF is using SOLLVE V&V as part of acceptance tests for exascale ECP platform Frontier.
- NERSC has integrated SOLLVE V&V for testing OpenMP 4.5/5.0 implementations.

Ways to Collaborate: GitHub

https://github.com/SOLLVE/solve_vv

SOLLVE / solve_vv Sponsor Unwatch 7 Star 3 Fork 2

Code Issues 15 Pull requests 4 Wiki Security Insights Settings

OpenMP Offloading Validation & Verification Suite; Official repository. We have migrated from bitbucket!! For documentation, results, publication and presentations, please check out our website -> <https://crpl.cis.udel.edu/ompvvsolve/> Edit

openmp testing testing-framework openmp-offloading openmp-target compilers verification validation Manage topics

202 commits 34 branches 0 releases 7 contributors View license

Branch: master New pull request Create new file Upload files Find file Clone or download

jhDavis8 Merge pull request #29 from SOLLVE/fix_test/test_target_teams_distrib... Latest commit d212f60 7 days ago

| File | Commit Message | Time Ago |
|------------|--|--------------|
| .github | Update issue templates | 19 days ago |
| ompvv | Fixing problem with string for when it is defined in constant memory ... | 20 days ago |
| sys | removing -std=c99 from clang | 2 months ago |
| template | Merging changes made to the infrastructure on the development branch.... | last year |
| tests/4.5 | Merge pull request #29 from SOLLVE/fix_test/test_target_teams_distrib... | 7 days ago |
| .gitignore | Merging changes made to the infrastructure on the development branch.... | last year |
| LICENSE | adding multiple files from the development branch. LICENSE, Makefile ... | 2 years ago |
| Makefile | Adding OMPVV_SYSTEM as an option for system. To be used as an env var... | 10 days ago |
| README.md | Updated README.md | 25 days ago |

README.md

NEWS!

We have recently moved from Bitbucket into Github. The old Bitbucket repository is now a mirror of Github, it has been set up to read only and it will not be maintained any further. Any communication please use our [Github Repo](#)

Ways to Collaborate: GitHub

- Need to check the behavior of YOUR OpenMP application ?
 - Create an application kernel
 - SUBMIT an Issue OR CREATE a PR on https://github.com/SOLLVE/solve_vv
- Found something we missed ?
 - SUBMIT an Issue OR CREATE a PR on https://github.com/SOLLVE/solve_vv

Ways to Collaborate: Contact information



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For the OpenMP specification, tutorials, forum, reference guides, and links to other resources, visit **www.openmp.org**