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# AUTOTESTER2

Modernized Trilinos CI Testing

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**ENVIRONMENT  
MANAGEMENT**



# MANAGING TRILINOS BUILD ENVIRONMENTS

- Currently use a home-grown system called 'GenConfig'
- Paired with third-party library modules that are maintained on our internal systems
- How do individual developers replicate pull request builds/tests?

The screenshot shows a Trilinos Wiki page with a dark theme. At the top, there are navigation links for Projects (10), Wiki, Security, Insights, and Settings. The main heading is 'Reproducing PR Testing Errors', with 'Edit' and 'New page' buttons to the right. Below the heading, it says 'Samuel Browne edited this page 2 weeks ago · 59 revisions'. A note in a dashed orange box states: 'Note: these steps assume that the system you will be running on has been setup with the proper modules, meets the hardware requirements, and has access to the various git repositories needed for configuration.' Below this is a section titled 'Steps to reproduce a Trilinos\_PR\_\* Pull Request Build'. Underneath, there is a sub-section 'Gather the necessary information' with a numbered list: '1. Navigate to the most recent CDash link posted by the AutoTester:'. Below the list is a screenshot of a comment from 'trilinos-autotester' from 7 days ago. The comment contains a status flag 'Pull Request AutoTester' - Jenkins Testing: 1 or more Jobs FAILED, a note about testing frequency, and a link to expand 'Pull Request Auto Testing has FAILED'. On the right side of the page, there is a 'Pages' section with 63 items, including links like 'Trilinos Developer Home', 'Trilinos Package Owners', 'Policies', 'New Developers', 'Trilinos PR/CR', 'Productivity++', 'Support Policy', 'Test Dashboard Policy', 'Testing Policy', 'Managing Issues', 'New Issue Quick Ref', 'Handling Stale Issues and Pull Requests', 'Software Quality Plan', 'Proposing a New Package', and 'Tools' with sub-links for 'CMake' and 'Doxygen'.



## EXTERNALLY-UNAVAILABLE REQUIREMENTS

- 5/7 GenConfig-related repositories
- TPLs on hardware
- Hardware itself (thought we have no control over this aspect)

How can we provide the configuration tool and a software environment (TPLs) that work together to external partners?



# MAKING GENCONFIG AVAILABLE TO THE COMMUNITY

- Continuing to use GenConfig (and related tooling) will require open-sourcing to make available to the broader community
- Open-source process is progressing, but is slow

GenConfig	LoadEnv	KeywordParser	SetEnvironment	DetermineSystem	ConfigParserEnhanced	SetProgramOptions
Yellow	Yellow	Yellow	Light Green	Yellow	Green	Green



## MAKING TPLS AVAILABLE TO THE COMMUNITY

- Currently a team (SEMS) within Sandia deploys third-party libraries, compilers, and MPIs to select systems that are used for automated testing
- Un-releasable to external partners for technical reasons
  - However, SEMS moving towards delivery of TPLs with containers
- Also unavailable to internal systems outside the scope of the support agreement

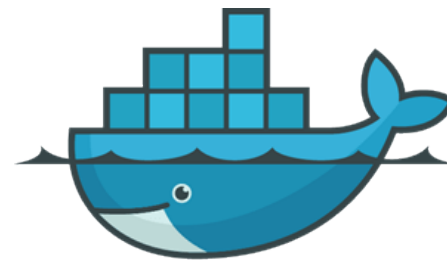
**BLOCKED**

# CONTAINERS AS A MECHANISM FOR DISTRIBUTING TPLS

- Containers handily solve the third-party software problem
- There are limitations of reproducing novel software environments (e.g. DOE ATS systems), but these environments are not currently in pull request testing, and are outside the scope of this effort
- Containers *greatly* simplify the act of setting up build environments
  - Complexity is still there, but is largely handled within the Dockerfile that describes how to build the container image
  - **Complexity is largely removed from user workflow**



podman



docker



# HOW TO RUN A CONTAINER

# Pull the image that you want to use from the registry

```
docker pull your-registry.yourdomain.com/yourimage
```

# Run the image

# Remove container once it exits

# Run interactively and attach tty

# Run bash as the container entrypoint

```
docker run --rm -it --entrypoint bash yourimage
```





## EXAMPLE

```
sebrow@triloamd01:~ $ podman run --rm -it registry-ex.sandia.gov/trilinos-project/trilinos-containers/experimental/ubi8-gcc-10.3.0
-openmpi-4.1.6:20240819
Loading gcc/10.3.0-gcc-8.5.0-ikdggsg
  Loading requirement: zlib-ng/2.1.4-gcc-8.5.0-4mix3jq zstd/1.5.5-gcc-8.5.0-4okppqr binutils/2.41-gcc-8.5.0-xt4vsa7
    gmp/6.2.1-gcc-8.5.0-w7wsbbi mpfr/4.2.0-gcc-8.5.0-3d45ev6 mpc/1.3.1-gcc-8.5.0-jdpkpm
[root@ec8674252690 /]# module list
Currently Loaded Modulefiles:
 1) ccache/4.8.2                11) openmpi/4.1.6             21) superlu/5.3.0            31) emacs/29.1
 2) valgrind/3.20.0            12) cmake/3.27.7             22) superlu-dist/8.1.2      32) gh/2.32.1
 3) gdb/13.1                   13) ninja/1.11.1             23) zlib/1.3
 4) zlib-ng/2.1.4-gcc-8.5.0-4mix3jq 14) boost/1.83.0             24) matio/1.5.17
 5) zstd/1.5.5-gcc-8.5.0-4okppqr 15) cgns/4.4.0                25) libx11/1.8.4
 6) binutils/2.41-gcc-8.5.0-xt4vsa7 16) hdf5/1.14.3              26) binder/1.3.0
 7) gmp/6.2.1-gcc-8.5.0-w7wsbbi    17) metis/5.1.0              27) py-mpi4py/3.1.4
 8) mpfr/4.2.0-gcc-8.5.0-3d45ev6   18) netcdf-c/4.9.2           28) py-numpy/1.26.1
 9) mpc/1.3.1-gcc-8.5.0-jdpkpm     19) parallel-netcdf/1.12.3   29) py-pybind11/2.11.1
10) gcc/10.3.0-gcc-8.5.0-ikdggsg   20) parmetis/4.0.3           30) openblas/0.3.24
[root@ec8674252690 /]# type cmake
cmake is /home/runner/spack/opt/spack/linux-rhel8-x86_64/gcc-10.3.0/cmake-3.27.7-zxyov77bwd7e6r5ynkwypcwqljlymw6/bin/cmake
[root@ec8674252690 /]# type ncdump
ncdump is /home/runner/spack/opt/spack/linux-rhel8-x86_64/gcc-10.3.0/netcdf-c-4.9.2-jj4cau2kiec6kcmqsd4xycyoqkk4laaq/bin/ncdump
[root@ec8674252690 /]#
```

Note that all TPLs are “Just There”, with no module load, source, etc. All (ish) of the complexity is baked into the container recipe itself.

Can now clone Trilinos, or any other code you wish to develop.



# HOW TO MOUNT YOUR LOCAL CODE INTO A CONTAINER

```
docker run --rm -it --entrypoint bash \  
--mount type=bind,src=/path/on/your/machine,dst=/path/in/container \  
yourimage
```

Allows you to get data in/out of container through the mounted directory

Depends on host filesystem (e.g. can have some issues when mounting a Windows directory into a Linux container)

Extension: It is possible to point VSCode at a container image and have it boot said image, mount your code project for you, and then place your terminal in the running container.



# CONTAINERS HELP ENSURE CONSISTENCY

## Cons

- There is overhead in learning to use containerized development environments
- Containers suffer a large performance hit for crossing CPU architectures (e.g. running an x86\_64 container on an Apple Silicon MacBook)

## Pros

- Near-perfect reproducibility between container runs
- Ability to easily share development environments between developers
- Anybody can create a new container on any machine with compatible architecture
- Can take container used for “validation” runs (PR testing) and run locally on developer machines



# GITHUB ACTIONS



# CHECKS INTERFACE

## OLD (AT1)

trilinos-autotester commented on Sep 3 Member

Status Flag 'Pull Request AutoTester' - Jenkins Testing: 1 or more Jobs FAILED

Note: Testing will normally be attempted again in approx. 2 Hrs 30 Mins. If a change to the PR source branch occurs, the testing will be attempted again on next available autotester run.

▼ Pull Request Auto Testing has FAILED (click to expand)

### Build Information

Test Name: PR\_gcc-openmpi-openmp

- Build Num: 454
- Status: FAILED

### Jenkins Parameters

Parameter Name	Value
FORCE_CLEAN	true
GENCONFIG_BUILD_NAME	rhel8_sems-gnu-8.5.0-openmpi-4.1.6-openmp_release-debug_static_no-kokkos-arch_no-asan_no-complex_no-fpic_mpi_no-pt_no-rtc_no-uvmm_deprecated-on_no-package-enables
PR_LABELS	AT: RETEST;AT: AUTOMERGE
PULLREQUESTNUM	13407
PULLREQUEST_CDASH_TRACK	Pull Request
TEST_REPO_ALIAS	TRILINOS
TRILINOS_NODE_LABEL	rhel8
TRILINOS_SOURCE_REPO	https://github.com/sebrowne/Trilinos
TRILINOS_SOURCE_SHA	f931bd3
TRILINOS_SRN_CONFIG	true
TRILINOS_TARGET_BRANCH	develop
TRILINOS_TARGET_REPO	https://github.com/trilinos/Trilinos
TRILINOS_TARGET_SHA	49d2b72

## NEW (AT2)

**Changes approved** Show all reviewers

1 approving review by reviewers with write access. [Learn more about pull request reviews.](#)

✓ 1 approval

👤 19 pending reviewers

**Some checks were not successful** Hide all checks

15 successful, 3 cancelled, 2 failing, and 2 pending checks

- ✓ AT2-EXPERIMENTAL / gcc10-openmpi416-EXPERIMENTAL (pull\_request\_review) Successful... Details
- ⓘ AT2-EXPERIMENTAL / gcc830-serial-EXPERIMENTAL (pull\_request) Cancelled after 48m Details
- ✓ AT2-EXPERIMENTAL / gcc830-serial-EXPERIMENTAL (pull\_request\_review) Successful in 72m Details
- ✗ AT2-EXPERIMENTAL / cuda11-uvmm-EXPERIMENTAL (pull\_request\_review) Failing after 52m Details
- ⓘ AT2-EXPERIMENTAL / cuda11-uvmm-EXPERIMENTAL (pull\_request) Cancelled after 49m Details
- ✗ AT2-EXPERIMENTAL / framework-tests-EXPERIMENTAL (pull\_request\_review) Failing after 7m Details

**Required statuses must pass before merging**

All required [statuses](#) and check runs on this pull request must run successfully to enable automatic merging.

Merge pull request ▼ You can also [open this in GitHub Desktop](#) or view [command line instructions](#).



# CDASH SNEAK PEEK

Pull Request 23 builds

[\[view timeline\]](#)

Site	Build Name	Update	Configure		Build		Test			Start Time
		Revision	Error	Warn	Error	Warn	Not Run	Fail	Pass	
gnu-serial-container-triloamd02	PR-13528-test-rhel8_gcc-serial_release-debug_shared_no-kokkos-arch_no-asan_no-complex_no-fpic_no-mpi_no-pt_no-rdc_no-uvdm_deprecated-on_no-package-enables	92e09d	0	4	0	50				12 minutes ago
cuda-container-trilogpu02	PR-13407-test-rhel8_cuda-gcc-openmpi_release_static_Ampere80_no-asan_complex_no-fpic_mpi_pt_no-rdc_uvdm_deprecated-on_no-package-enables	49defd	0	3	0	50	0	1	45	5 hours ago
gnu-openmi-container-triloamd02	PR-13407-test-rhel8_gcc-openmpi_debug_shared_no-kokkos-arch_no-asan_complex_no-fpic_mpi_no-pt_no-rdc_no-uvdm_deprecated-on_no-package-enables	49defd	0	4	0	50	0	0	2999	5 hours ago
gnu-serial-container-triloamd01	PR-13407-test-rhel8_gcc-serial_release-debug_shared_no-kokkos-arch_no-asan_no-complex_no-fpic_no-mpi_no-pt_no-rdc_no-uvdm_deprecated-on_no-package-enables	49defd	0	4	0	50	0	0	2211	5 hours ago
gnu-openmi-container-triloamd01	PR-13527-test-rhel8_gcc-openmpi_debug_shared_no-kokkos-arch_no-asan_complex_no-fpic_mpi_no-pt_no-rdc_no-uvdm_deprecated-on_no-package-enables	fb5c6	0	3	0	50	0	0	876	3 hours ago
gnu-serial-container-triloamd01	PR-13527-test-rhel8_gcc-serial_release-debug_shared_no-kokkos-arch_no-asan_no-complex_no-fpic_no-mpi_no-pt_no-rdc_no-uvdm_deprecated-on_no-package-enables	fb5c6	0	3	0	50	0	0	377	3 hours ago
gnu-openmi-container-triloamd02	PR-13527-test-rhel8_gcc-openmpi_debug_shared_no-kokkos-arch_no-asan_complex_no-fpic_mpi_no-pt_no-rdc_no-uvdm_deprecated-on_no-package-enables	fb5c6	0	3	0	50	0	0	876	6 hours ago
gnu-serial-container-triloamd02	PR-13527-test-rhel8_gcc-serial_release-debug_shared_no-kokkos-arch_no-asan_no-complex_no-fpic_no-mpi_no-pt_no-rdc_no-uvdm_deprecated-on_no-package-enables	fb5c6	0	3	0	50	0	0	377	6 hours ago
gnu-serial-container-triloamd01	PR-13527-test-rhel8_gcc-serial_release-debug_shared_no-kokkos-arch_no-asan_no-complex_no-fpic_no-mpi_no-pt_no-rdc_no-uvdm_deprecated-on_no-package-enables	fb5c6	0	3	0	50	0	0	377	6 hours ago
gnu-openmi-container-triloamd01	PR-13527-test-rhel8_gcc-openmpi_debug_shared_no-kokkos-arch_no-asan_complex_no-fpic_mpi_no-pt_no-rdc_no-uvdm_deprecated-on_no-package-enables	fb5c6	0	3	0	50	0	0	876	6 hours ago



## UNAPPROVED USERS

- [ ] Failure Status for user dependabot[bot]: 404 Not Found
- [ ] Initiating User dependabot[bot] is not approved to run jobs on this machine.
- [ ] AT2: Please have **someone from Developers** trigger this workflow
- [ ] Job is not approved



## “SPECIAL” DIRECTORIES

```
[ ] .github directory was modified, requiring special approval...  
[ ] AT2: latest special approval: No special approval found  
[ ] AT2: Please have someone from framework review this PR and apply the  
AT2-SpecialApprove label
```

**\*\* The workflow(s) will then need to be manually re-run**





# ACTIONS VS JENKINS-BASED CI

## Cons

- Load balancing is more difficult without an “orchestration” tool (currently manually assign containers to hardware)
  - OpenShift/Kubernetes has potential to help address this

## Pros

- Transparency about run stages and state
- Much more configuration-as-code under test (e.g. changing a CI configuration in the .github files is “self-testing”)
- Ability to re-run only specific checks (e.g. “only the GCC check failed, it looks like a load issue, let’s try re-running it”)
- Jobs are queued immediately, and queued state is visible



# INTERACTIVE DEMO

<https://github.com/trilinos/Trilinos/actions/runs/11223351354?pr=13507>



# FILTERED CDASH OUTPUT EXAMPLE

**Filters** Help

- Build Name starts with PR-13507

Begin 2024-01-01 End now

Apply Clear Create Hyperlink

**Pull Request** 8 builds [view timeline]

Site	Build Name	Update	Configure		Build		Test			Start Time
			Error	Warn	Error	Warn	Not Run	Fail	Pass	
python-container-triloamd02	PR-13507-test-rhel8_python_debug_shared_no-kokkos-arch_no-asan_no-complex_no-fpic_no-mpi_no-pt_no-rdc_no-uvvm_deprecated-on_pr-framework	efc894	1	1	1	0	0	0	0	Oct 07, 2024 - 20:41 UTC
python-container-triloamd02	PR-13507-test-rhel8_python_debug_shared_no-kokkos-arch_no-asan_no-complex_no-fpic_no-mpi_no-pt_no-rdc_no-uvvm_deprecated-on_pr-framework	fcdfde	1	1	1	0	0	0	0	Oct 07, 2024 - 20:28 UTC
gnu-openmi-container-triloamd02	PR-13507-test-rhel8_gcc-openmpi_debug_shared_no-kokkos-arch_no-asan_complex_no-fpic_mpi_no-pt_no-rdc_no-uvvm_deprecated-on_no-package-enables	efc894	0	3	2	50	873	1	1648	Oct 07, 2024 - 21:32 UTC
gnu-openmi-container-triloamd02	PR-13507-test-rhel8_gcc-openmpi_debug_shared_no-kokkos-arch_no-asan_complex_no-fpic_mpi_no-pt_no-rdc_no-uvvm_deprecated-on_no-package-enables	fcdfde	0	3	2	50	873	1	1648	Oct 07, 2024 - 21:12 UTC
gnu-serial-container-triloamd02	PR-13507-test-rhel8_gcc-serial_release-debug_shared_no-kokkos-arch_no-asan_no-complex_no-fpic_no-mpi_no-pt_no-rdc_no-uvvm_deprecated-on_no-package-enables	efc894	0	3	1	50	80	1	1534	Oct 07, 2024 - 20:32 UTC
gnu-serial-container-triloamd02	PR-13507-test-rhel8_gcc-serial_release-debug_shared_no-kokkos-arch_no-asan_no-complex_no-fpic_no-mpi_no-pt_no-rdc_no-uvvm_deprecated-on_no-package-enables	fcdfde	0	3	1	50	80	1	1534	Oct 07, 2024 - 20:29 UTC
cuda-container-trilogpu01	PR-13507-test-rhel8_cuda-gcc-openmpi_release_static_Ampere80_no-asan_complex_no-fpic_mpi_pt_no-rdc_uvvm_deprecated-on_no-package-enables	efc894	0	2	1	50	0	0	46	Oct 07, 2024 - 20:29 UTC
cuda-container-trilogpu02	PR-13507-test-rhel8_cuda-gcc-openmpi_release_static_Ampere80_no-asan_complex_no-fpic_mpi_pt_no-rdc_uvvm_deprecated-on_no-package-enables	fcdfde	0	2	1	50	0	0	46	Oct 07, 2024 - 20:22 UTC

# CONCLUSIONS

- Containers + GitHub Actions will be the CI testing driver technologies moving forwards
- Containers allow distribution of exact CI testing environments to any collaborator, internal or external
- Containers allow for testing of any containerized software stack in a similar manner (e.g. SEMS, AUE)
- GitHub Actions will allow for higher levels of transparency, hopefully fostering better developer confidence in CI
- AT2 system will allow for individual re-runs in case of system instability

**Containers will be an important tool for all developers moving forwards**

Thank you to the AutoTester2 team from SEMS, as well as the CSRI system admins for all of their work on enabling this system!



# DISCUSSION