



Exceptional service in the national interest

KEEPING TRILINOS RUNNING PERFORMANTLY EVERYWHERE EVERY NIGHT

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HPSF Conference 2025

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MOTIVATION

- Motivation: Taking ownership of Trilinos performance
 - Avoid (negative) surprises by the app teams saving them time.
 - Reducing time for initial setup for apps / developers on new-to-them systems / updated libs.
 - Work with Sandia Application Performance Team (APT) to stay at the most recent "good" version of libraries.
 - Understand behavior across time and across different systems.
 - Provide a way for app teams to know if it is safe to update Trilinos.
- FY25 Team: Chris Siefert, Jonathan Hu, Luc Berger-Vergiat, Tim Fuller, Curt Ober.



WHAT DO WE MEAN BY “RUNS EVERYWHERE” ?

CPU

Eclipse (Broadwell)
Amber (Sapphire Rapids/DDR)
Tachi/Rocinante (Sapphire
Rapids/HBM)

NVIDIA GPU

Vortex (V100)
Perlmutter (A100)
Hops (H100)

AMD GPU

Frontier (MI250)
Tioga (MI250)
RZAdams/EI Dorado (MI300)

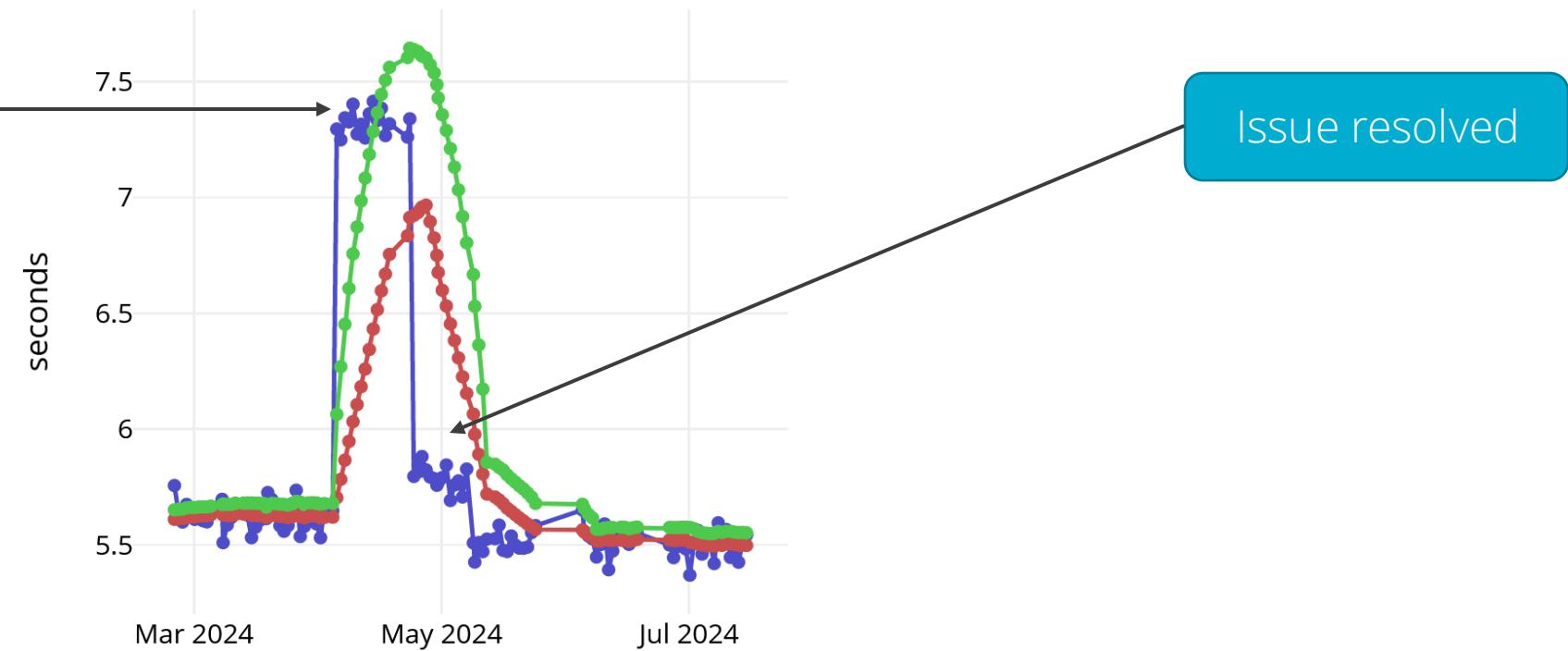
Intel GPU

Aurora (Intel Max)

WATCHR^[1] PERFORMANCE SYSTEM

- Consists of 36 tests^[2] run nightly on relevant systems covering Tpetra, Epetra, Intrepid2, MueLu, FROSCh and proxies for EMPIRE, SPARC, SIERRA-SD and SIERRA-TF.

/Amber Serial: Tpetra FE Assembly 9 ranks



[1] <https://github.com/sandialabs/watchr-core> (developed by E. Ridgway)

[2] Not every test is run on each system --- Some are CPU or GPU only, others require certain TPLs, etc.



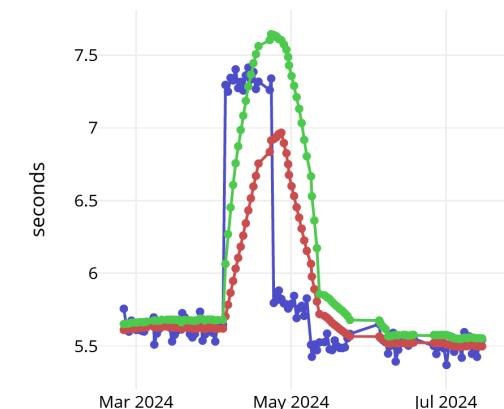
SUCCESS STORY #1: KOKKOS 4.3

- Kokkos 4.3 update switched the default behavior of operations in Kokkos::Serial.
 - They became atomic by default.
 - This makes Kokkos behavior correct if you use Kokkos::Serial within a threaded calculation.
 - Trilinos doesn't do that, so performance degraded.
- After consultation with the Kokkos Team, we...
 - Changed the performance builds to use the -DKokkos_ENABLE_BYPASS_ATOMICS=ON
 - Emailed stakeholders recommending they do likewise.
 - Personal correspondence with stakeholders who had more questions.

/Amber Serial: Tpetra FE Assembly 9 ranks

Issue detected and resolved before apps even noticed.

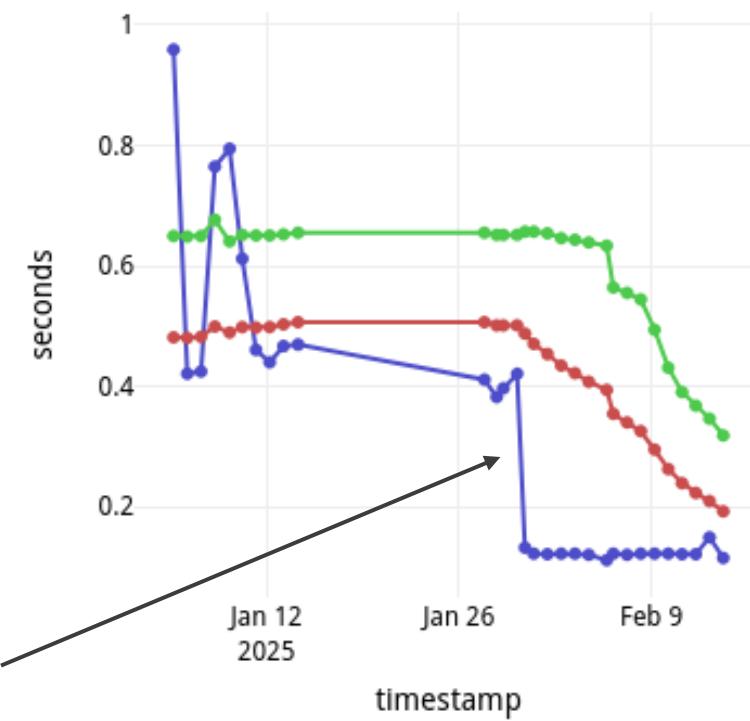
Credit to Christian Trott for helping us diagnose the issue!



SUCCESS STORY #2: FRONTIER MODULE UPDATE

- Early Trilinos testing used ROCM 5.7.1.
- OLCF made ROCM 6.1.3 available in Q1.
- What would the effect on Trilinos be?
- Result: Automatically captured 2x performance increase on certain tests!

/FRONTIER: Tpetra CGSolve 4 ranks



ROCM Update



HPC CONFIGURATIONS REPO

- Single one-stop location for SNL users to get the nightly build script.
- Goal: Push configurations for NERSC / OLCF / ALCF to github.com for non-SNL Trilinos users.

Screenshot of the GitHub repository page for "Trilinos-HPC-configurations".

Repository statistics:

- 77 Commits
- 1 Branch
- 0 Tags
- 44 KiB Project Storage

Recent commit:

Automatic update of stoplight chart. User edits will be clobbered.
Chris Siefert authored 7 hours ago

Code navigation:

- master
- trilinos-hpc-configurations
- + v

File navigation:

- README
- Add LICENSE
- Add CHANGELOG
- Add CONTRIBUTING
- + Set up CI/CD
- Configure Integrations

Table of system configurations:

Name	Last commit	Last update
amber	Automatic nightly update. User edits will be clobbered.	2 weeks ago
crusher	Automatic nightly update	2 months ago
eclipse	Automatic nightly update. User edits will be clobbered.	2 weeks ago
frontier	Automatic nightly update. User edits will be clobbered.	4 weeks ago
hops	Automatic nightly update. User edits will be clobbered.	3 weeks ago
lassen	lassen build	4 months ago
perlmutter	Automatic nightly update. User edits will be clobbered.	1 month ago
rocinante	Automatic nightly update. User edits will be clobbered.	1 month ago
rzvernal	Automatic nightly update. User edits will be clobbered.	1 week ago
stria	Automatic nightly update. User edits will be clobbered.	2 weeks ago
tachi	Automatic nightly update. User edits will be clobbered.	4 weeks ago
tioga	Automatic nightly update. User edits will be clobbered.	1 week ago
vortex	Automatic nightly update. User edits will be clobbered.	3 weeks ago

Credit to Christian Glusa for the idea!



DAILY STOPLIGHT CHART

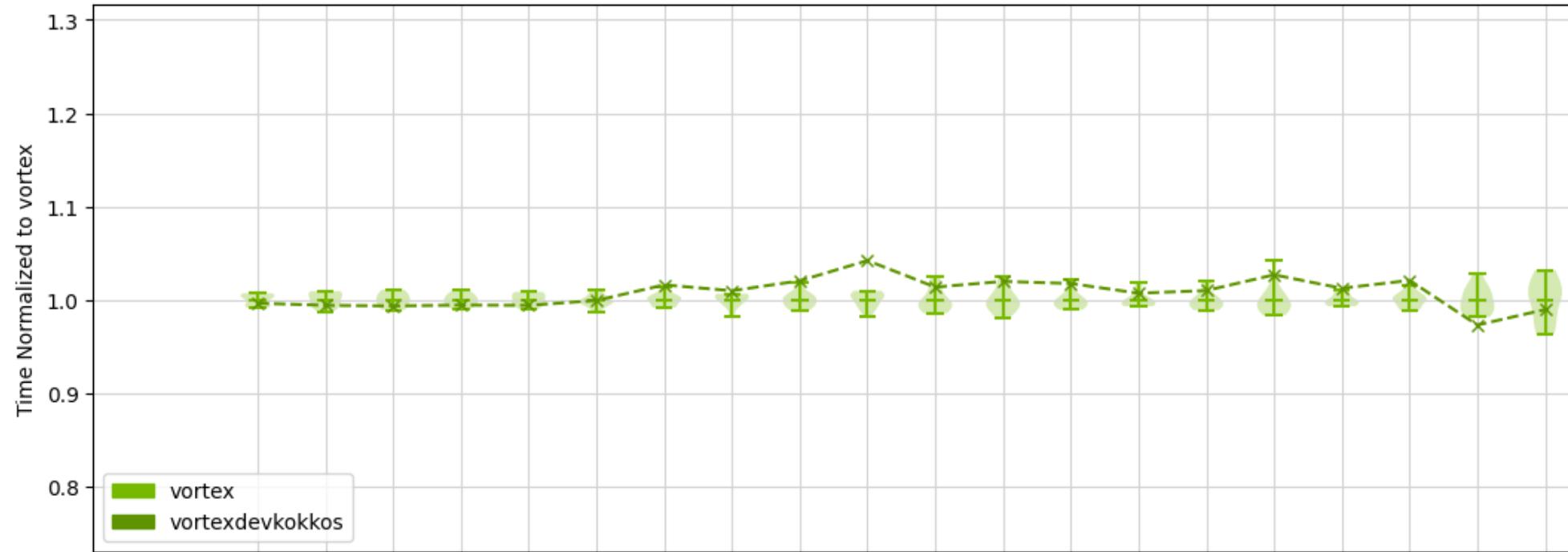
Current builds managed by the Tpetra/Performance team

System	Days Run	Epetra	FROSch	Intrepid2	MiniEM	MueLu	SIERRA/SD	SIERRA/TF	SPARC	Tpetra
Amber	7/7	2.0 / 2 1.0	4.0 / 4 1.0	1.0 / 1 1.0	3.0 / 3 1.0	4.0 / 4 1.0	1.0 / 1 ---	7.9 / 8 1.0	---	13.0 / 13 1.0
Eclipse	7/7	2.0 / 2 1.0	4.0 / 4 1.0	1.0 / 1 1.0	3.0 / 3 1.0	4.0 / 4 1.0	1.0 / 1 ---	8.0 / 8 1.0	---	11.0 / 11 1.0
Rocinante	7/7	---	---	---	3.0 / 3 1.0	4.0 / 4 1.0	1.0 / 1 ---	---	---	13.0 / 13 1.0
Stria	7/7	2.0 / 2 1.0	---	1.0 / 1 1.0	3.0 / 3 1.0	4.0 / 4 1.0	1.0 / 1 ---	8.0 / 8 1.0	---	11.0 / 11 0.9
Vortex	4/7	---	---	---	3.0 / 3 1.0	4.0 / 4 1.0	1.0 / 1 ---	8.0 / 8 1.0	4.0 / 4 1.0	13.0 / 13 0.8
Frontier	7/7	---	---	---	1.0 / 1 1.0	4.0 / 4 1.0	1.0 / 1 ---	---	4.0 / 4 1.0	5.0 / 5 1.0
Perlmutter	7/7	---	---	---	---	3.0 / 3 1.0	1.0 / 1 ---	---	---	2.0 / 2 1.0
Hops	7/7	---	---	---	---	4.0 / 4 1.0	1.0 / 1 ---	---	---	5.0 / 5 1.0
RZVernal	7/7	---	---	---	---	1.9 / 2 1.0	1.0 / 1 ---	---	4.0 / 4 1.0	3.0 / 3 1.0
Tioga	7/7	---	---	---	1.0 / 1 1.0	4.0 / 4 1.0	1.0 / 1 ---	---	4.0 / 4 1.0	3.0 / 3 1.0

Credit to Michael Wolf for the idea!

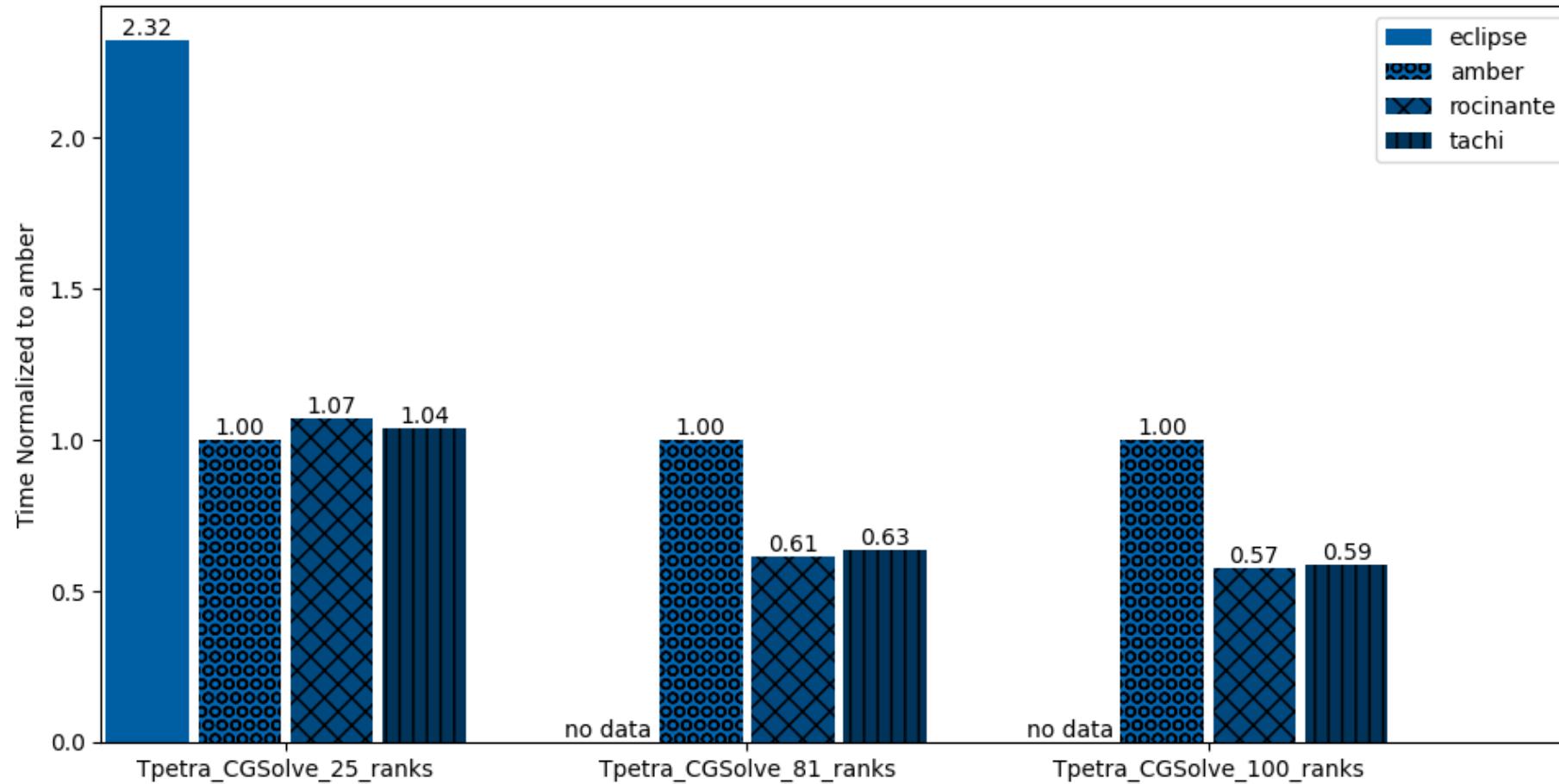
Last updated: 2024_07_09

KOKKOS / KOKKOS KERNELS DEVELOP INTEGRATION



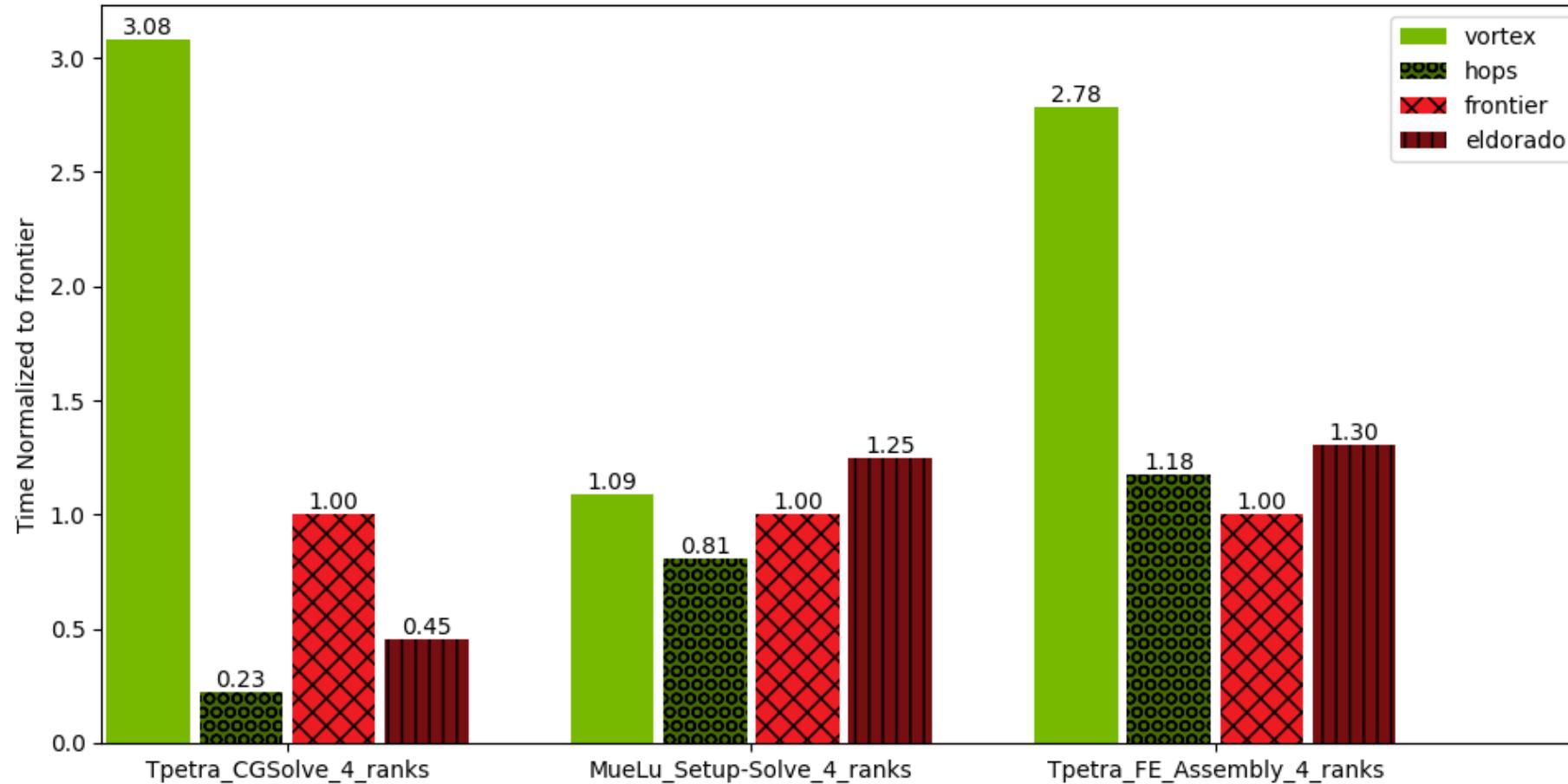
- Does using develop Kokkos have a performance impact on Trilinos performance?

CROSS-SYSTEM COMPARISONS: CPU



- Note how HBM (Roci/Tachi) only offer speedup over DDR (Amber) for higher core counts.

CROSS-SYSTEM COMPARISONS: GPU



- Early access to El Dorado has exposed performance issues.



FILESYSTEM ISSUES CAN MUDDLE PERFORMANCE RESULTS

- Up 4x slowdown on El Dorado vs. expected performance!
- Worked with James Elliott (SNL/APT) to identify issue.
 - Short running tests w/ big binaries show this... on the first run.
 - We believe this due to the OS getting the file off "disk" and into memory.
 - Have a non-Trilinos reproducer.
 - This issue is *not* unique to El Dorado.
- Portable mitigation: `ctest --repeat until-fail:2`
 - This will run the test twice and record the second run's timings.
 - Other options include using machine-specific RAM disks or local storage.
- With the mitigation, El Dorado results look a lot better.



REMARKS & FUTURE DIRECTIONS

- We've provided a *maintained* means for dissemination of "good" Trilinos configurations.
- Trilinos Tpetra/Performance team reviews the results once a week.
 - Weekly feedback provided to Kokkos / KokkosKernels teams as well
- Cross-system comparisons provide feedback to apps and admins.
- Looking forward
 - Getting the user facility configurations on the open internet.
 - Working with admins to identify & flag system issues (e.g. thermal throttling, file system issues) automatically.
 - Proxies for more Trilinos applications.
 - Adding DOE-relevant systems as they come online.



<https://github.com/trilinos/Trilinos>